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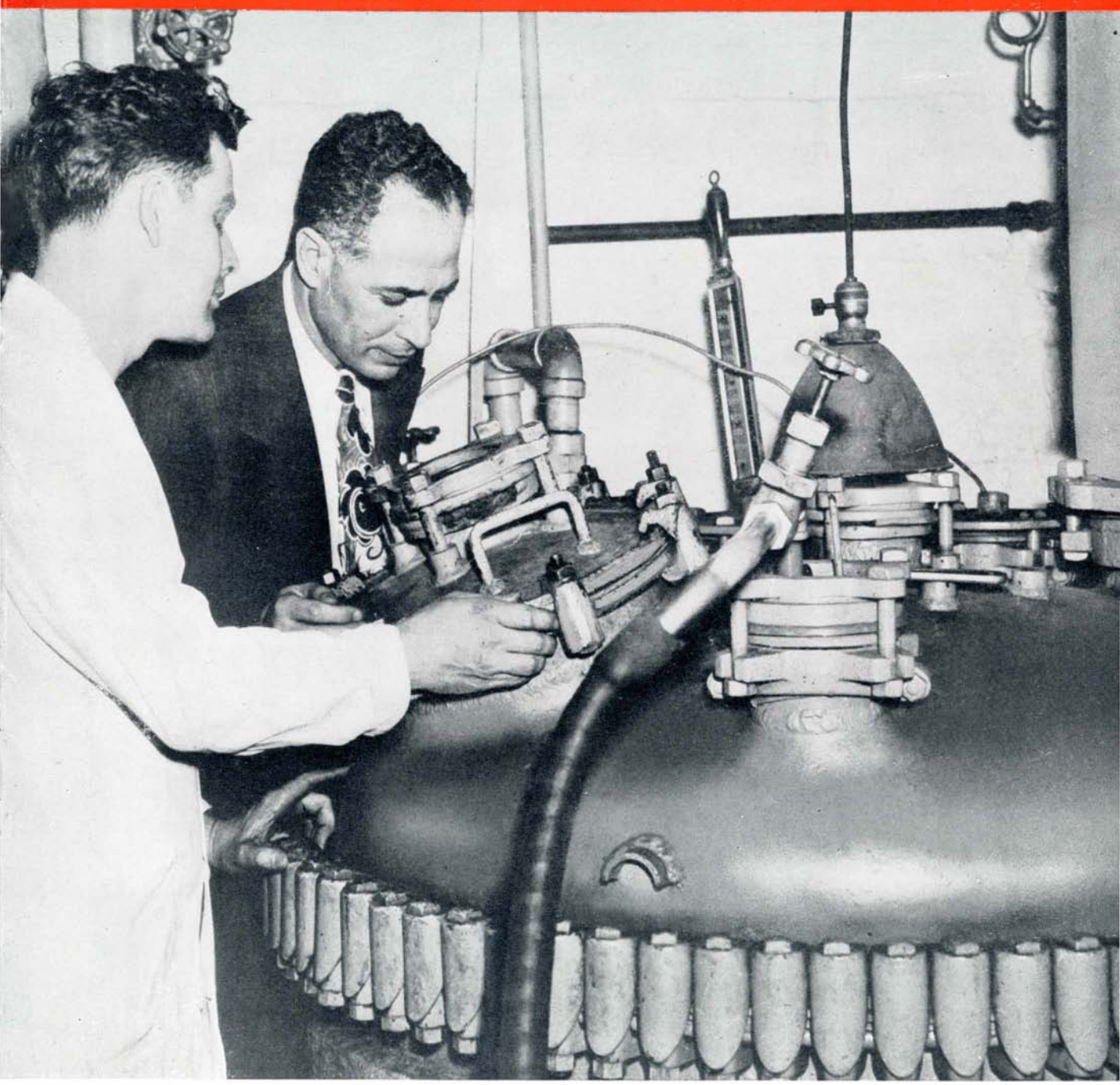
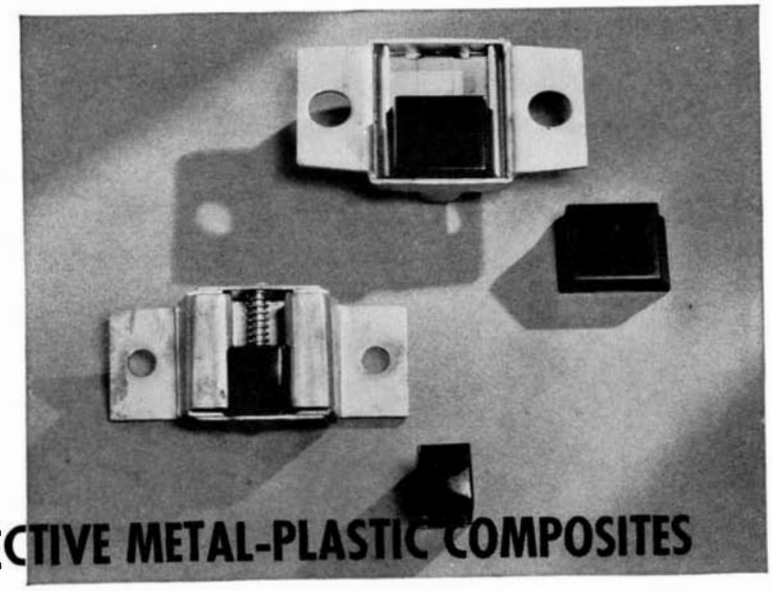


Amino Acid on the Way . . . See page 62



DEMONSTRATING EFFECTIVE METAL-PLASTIC COMPOSITES

The slamming of a door, particularly a truck door, puts a terrific strain on the materials which must stand the impact of this sharp contact. The contact wedges and take-up units illustrated are especially designed for this purpose and serve as an excellent example of the effectiveness of a metal-plastic composite.

Why Plastics?

Both the sliding wedges and the contact members were originally made from either die-cast metal or graphite-impregnated bronze. There are, however, a number of very definite advantages gained by molding the pieces of plastic. For one thing, the danger of corrosion is completely eliminated. Furthermore, wear is reduced considerably, for neither the metal nor the plastic tends to wear the other. Then there is the added feature that no finishing operations are necessary with the plastic pieces other than the removal of a slight flash or fin.

Why Phenolic Plastics?

Because of the wide range of desirable properties which are inherent characteristics of all phenolic plastics, one from this group was selected to do the job required of these take-up units. Impact strength, for example, was a prime requisite because both the sliding wedges and the contact members are subjected to terrific strain when the door is slammed. Then there is the lubrication problem. This is automatically taken care of by the inclusion of graphite as a filler material in the phenolic used. This provides self-lubrication. Noise is also reduced, for one of the unusual properties of phenolic plastics is non-reverberation.

Why Durez Phenolic Plastics?

As specialists in the development and production of phenolic plastics for the past quarter century, Durez laboratory technicians have gained the rich background necessary for maintaining the leadership of the more than 300 multi-propertied Durez phenolic molding compounds available today. Manufacturers in every field of industry are making it their practice to look to Durez phenolics for the plastics that fit their jobs.

Valuable Assistance Available

Our technicians can give you a number of examples of effective metal-plastic composites . . . examples which decisively prove that these two basic materials can be combined to make a better product . . . combined to do a job more efficiently than could either of the materials used alone.

The competent advice of experienced Durez service engineers and a wealth of proved product development data are available at all times to you and your custom molder. Durez Plastics & Chemicals, Inc., 12 Walck Road, North Tonawanda, N. Y. *Export Agents: Omni Products Corporation, 40 East 34th Street, New York 16, N. Y.*

PLASTICS THAT FIT THE JOB

Scientific American

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Our Cover: A 600 gallon batch of casein starts off on its way to become amino acid. The story of this newest branch of chemical industry is told in the article starting on page 62.

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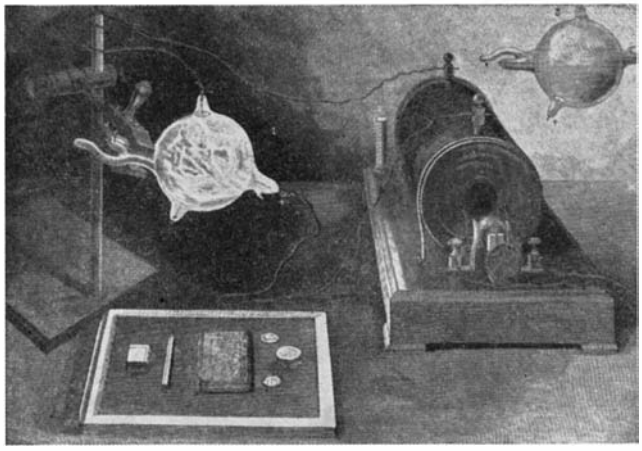
50 Years Ago in . . .

(Condensed from Issues of February, 1896)

X-RAYS — "The discovery of X ray photography by Roentgen will immortalize the physicist who so fully developed it before giving it to the public. . . It is with no small gratification that we are able to put before our readers the



exact details of the experiment, as carried out by Prof. A. W. Wright, of Yale University. He was among the first of the American experimenters. . . The arrangement of the apparatus is clearly shown in the engraving. . . On a clamp support is carried the Crookes tube. . . The excitation was furnished by an induction coil. . . On the table, a few inches below the tube, the sensitized plate contained in an ordinary plate holder was placed, and on its slide of ebonite were placed the objects to be photographed."

LAMP — "A unique bicycle lamp recently illustrated in the Electrical World has a small magneto-electric machine, operated by a friction wheel, to furnish current for a miniature incandescent lamp. . . The slightest rotation of the bicycle wheel causes the lamp to glow. Indeed, it would be difficult to ride the wheel slowly enough to maintain equilibrium and not have light."

RUST-PROOFING — "By forming on the surface of iron and steel a double carbide of hydrogen and iron, which is extremely hard and adhesive, protection of the metal from rusting is said to be insured."

SAND BLAST — "Ornamental and fancy castings can be thoroughly and cheaply treated by means of sand blown by compressed air, producing an article which would otherwise require considerable labor to finish. . . Steel is very hard to clean in the usual manner, but yields readily to the sand blast. The outside appearance of the sand box is like that of a vertical boiler. It is fitted with feed valves and sand chambers, so arranged that an air pressure of about 10 pounds per square inch forces the sand through a rubber hose."

GLASS — "What is claimed to be the largest single pane of glass in the country was received at Hartford, Conn., from Belgium recently. It is 12½ feet high, 15½ feet wide, ½ inch thick, and weighs 1,800 pounds."

TROLLEYS — "The Metropolitan Traction Company, of this city, having organized and put in operation their highly developed cable traction system, has now gone a step farther and installed an underground trolley system on part of its line, with the double view of working the portion of the road now equipped therewith by electricity and of extending it in the near future to other portions of their line."

LIGHTING — "Light may yet be produced in a way less extravagant than that of the incandescent lamp, where the results of an entire horse power of energy are represented by four or five feet of incandescent carbon filament. These hopes are based on induction, for it is in the utilization of alternating or broken currents that the future seems to lie."

MEASUREMENTS — "Refinements of measurements have gone to almost incredible limits. On lenses, curvatures of 1-150,000 inch can be measured. In spectroscopic analysis of mere traces of different elements, fractional wave lengths are read to 1-2,500 millionth of an inch. Professor Dewar in his researches on liquid air attained a vacuum of 1-2,500 millionth of an atmosphere."

INVENTORS — "The Connecticut Yankee still preserves his pre-eminence as an inventor. For the last few years more patents in proportion to population have been issued to Connecticut than to any other State."

PALACE CARS — "The recent growth and development of Brooklyn is largely due to the extension of the surface railway companies' system, whose lines now extend for miles into the country. Last summer the Brooklyn Heights Railroad Company placed several excursion cars in service. These cars were profusely decorated and were furnished with incandescent lamps of all colors. They could be chartered for trips of all kinds, and it was not an unusual sight to see a procession of five of these cars, the first having a band, passing through some of the principal streets."

FROM THE ADS — The Pocket Kodak; The Ingersoll Dollar Cyclometer; Rand Rock Drills; Stereopticons; The American Bell Telephone Company; Jessop's Steel; Carborundum; "Wolverine" Gas and Gasoline Engines; Mogey Telescopes.

100 Years Ago in . . .

(Condensed from Issues of February, 1846)

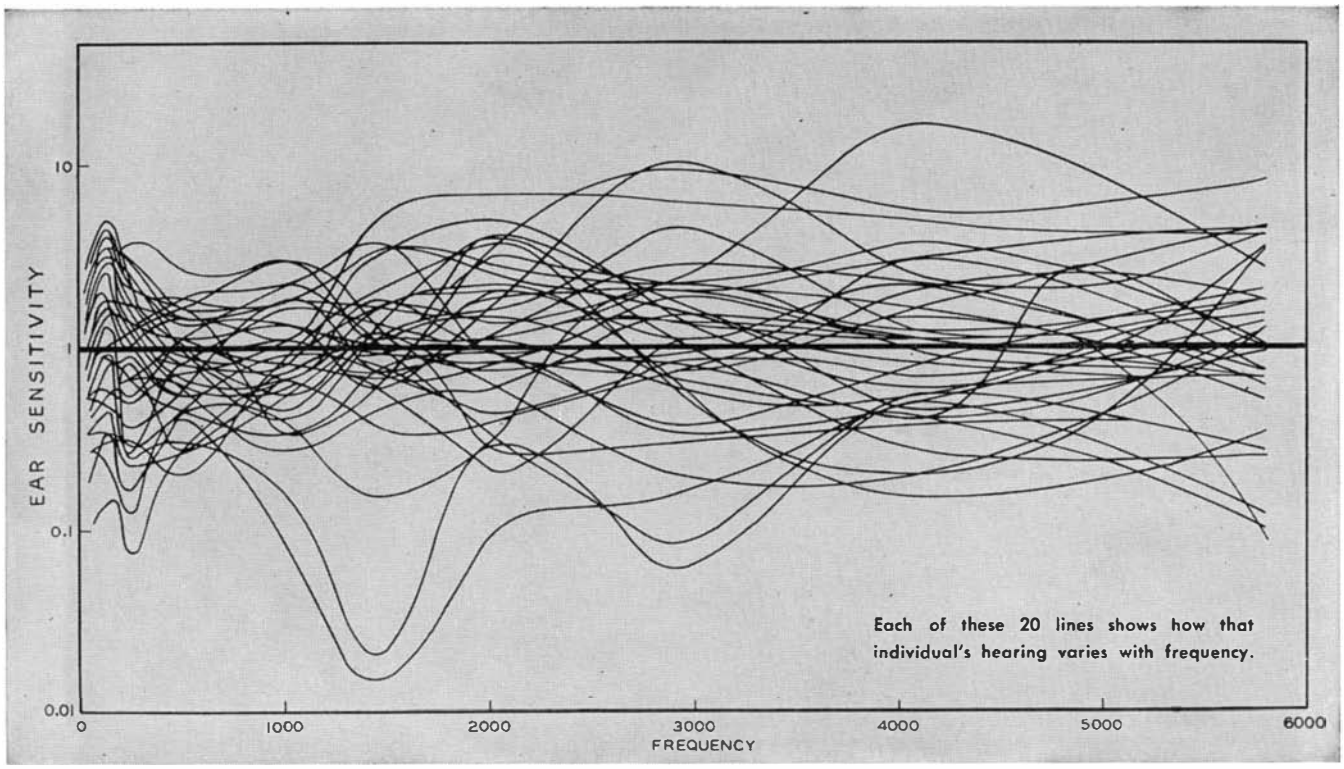
PANAMA CANAL — "The report of engineers sent by the French government to examine the Isthmus of Panama, with the view of ascertaining the possibility of cutting a canal through it has been published. It declares most decidedly for the practicability of the scheme."

FIRE EXTINGUISHING — "An apparatus for the instantaneous extinguishment of fires projects upon the fire a peculiar gaseous vapor, which has a greater affinity for the oxygen of the atmosphere than the burning combustibles, and consequently extinguishes the fire by depriving it of oxygen."

WATER RESISTANCE — "When a body is made to move in, or pass through still water, the resistance of the water against this motion, depends on the position, as well as the extent of the surface which encounters the fluid."

MECHANICS — "Show us the man who would consider it a disgrace to associate with honest, well informed mechanics, and we will show you a worthless ignorant creature, useless to himself and the world, and a disgrace to society."

FROM THE ADS — Portraits in Daguerreotype; The Business Man's Guide and Legal Companion; Locke's Portable Shower Bath; Lap-Welded Boiler Flues; Ever-Pointed Gold Pens; Scythe Stones; Wire Window Shades.



To measure is to know

Twenty-five years ago, one standard of sound power was the ticking of a watch, another was the clicking of two coins; and the measure was how far away the tick or the click could be heard. That test was made in measuring people's hearing, a field of interest to the Bell System scientists because the ear is the end-point of every talking circuit.

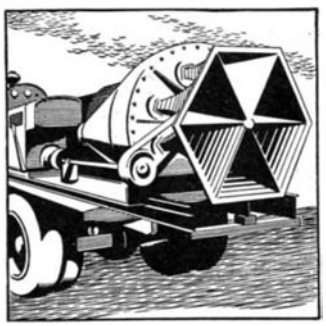
Accustomed to exact measurements, Bell scientists proceeded to develop a method of measuring hearing-sensitivity in terms which could be precisely defined and reproduced. After plotting hundreds of runs like those above, they decided on a particular sound intensity, representing an average "threshold of hearing," as a starting point.

The sounds delivered by a telephone line had previously been evaluated by listeners who compared their loudness with that of a standard source. There were wide variations in ears, as the chart shows, so the engineers replaced them by electrical instruments. When later their associates developed the Western Electric radio and public address systems, the necessary measuring circuits were promptly forthcoming. Addition of a standard microphone made a noise meter, widely used in quieting airplanes and automobiles.

"Through measurement to knowledge," said a famous Netherlands scientist. The principle finds wide application in Bell Laboratories, whether the quest be for a way to measure sound, a new kind of insulation, or more economical telephone service.

Hearing was first measured reliably by engineers in the Bell Telephone Laboratories

For good reception, program loudness must stay within certain limits. Volume-meters help to hold it there



From the throat of this mighty air-raid siren comes the loudest sustained sound ever produced

Visible Speech, result of telephone research, turns sound into "pictures" that the deaf can read

BELL TELEPHONE LABORATORIES

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

Previews of the Industrial Horizon

By A. P. Peck

A DAY'S PAY FOR . . .

A SCREWY individual, speaking from the juvenile standpoint, is one who does not conform, in one way or another, with the rest of the crowd. So, from the same standpoint, James F. Lincoln, of Cleveland, Ohio, is probably one of the screwiest of individuals in industry today. And all Mr. Lincoln is doing is operating a business on the basis of paying his employees what they are worth.

Such an industrial plan of operation must be too simple. It goes against all the ideas of the efficiency experts, the union demagogues, the big-domed statisticians, and the brain-trust (but not trusting) Government analysts who would regulate everything for the greatest good to the clamorous few.

But Mr. Lincoln's industrial philosophy works. For some 20 years his employees in the electrical welding equipment business have had these advantages over other workers: No worker has been laid off because of lack of work; no reduction has been made in individual wage rates; every employee has received a steady income; there has been no labor trouble that has resulted in the loss of a single hour of time; wages have increased steadily; more jobs have been created. And while all this has been going on, the price of Lincoln's products has decreased more than 50 percent.

It must be all wrong. Lincoln is operating on the basis of free enterprise. He is doing things the way our forefathers wanted them to be done. He is doing things the American way and getting them done. But he is doing them the simple way—the way in which labor unions say they shouldn't be done. He is paying each worker what he is worth. And the result is that his workers produce more for less money. Simple, isn't it? Of course it is—it's too simple. What will work for a single company could work for the entire country. What could work for the entire country would work for the whole world. But Lincoln's plan is too elementary. It leaves out of the picture the run-everything boys, the big brains, the economic experts. Seemingly, all too few people want to work for what they are worth. That's too little pay! And in those last three sentences lies the crux of labor troubles and the problems that face industry today. The sooner we return to the fundamentals, the basics of the American way, the sooner labor unions and the run-everything boys will have to take a back seat and the sooner industry will be able to solve its own problems.

SHARE-THE-PATENTS

THE SHARE-EVERYTHING groups are at it again. Now it is agitation to share-the-patents. Self-appointed saviors of the small business man would force licensing of patents in order, they say, to avoid monopolies. Here is another of those dangers to American business which seems credible on the surface but carries a real threat when studied carefully. The 17-year exclusive rights to an invention, granted by our patent laws, is one of the greatest incentives to competitive industry; destroy that exclusive right and you destroy competition. Industry—big and small—is built on patents, not on monopoly. To force a licensing system on patent holders is to force a sharing of property by those whose diligence produced it, with those who were too lazy or lacking in initiative to produce for themselves.

PATENT SUPPRESSION

ONE OF the boogies that is raised by the share-the-patents group is that of patent suppression. Monopoly is fostered, they say, by the suppression of patents that would create competition or would vitiate existing production plans. Therefore, they cry, compel patent licensing and eliminate patent suppression. This is a point that has often been brought up; the belief in patent suppression is far too wide spread. Thus far, to our knowledge, no positive proof of willful patent suppression has ever been brought forth. Loose talk, based on loose thinking, can do a lot of harm when applied to the subject of patent suppression. It is the kind of talk that should be answered by "Put up or shut up!"

TELEVISION PROGRESS

LEAD ITEM on this page in our January number concerned new advances in television equipment. Since then, RCA has demonstrated still more brilliant receiving images that can be viewed in a fully-lighted room. Basic to the new images is an aluminum-backed cathode-ray tube screen which decreases internal reflection and increases picture contrast. RCA also demonstrated full-color television, at the same time stating that the mechanical methods used lacked perfection and that color television by a satisfactory electronic means was still five years in the future. Television reception for the general public is an immediate possibility (RCA will be in production with receivers within the next six months), but their engineers admit that obsolescence of receiving equipment is a big problem.

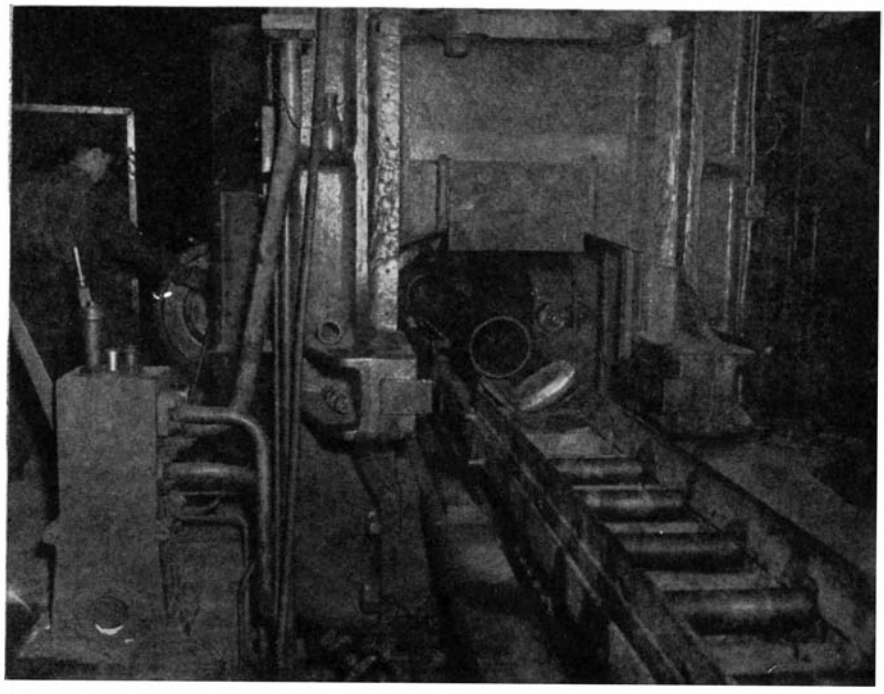
Just as radio in the early 20's heralded a new and mighty industry, so does television today. But many a bleached skeleton is going to line the path of progress. Brains, dollars, and faith must back the development. And the public must *want* the benefits of television—and be willing to pay for them—if the industry is to prosper.

ADHESIVES ON A GRAND SCALE

THOSE who still look askance upon synthetic resins as a reliable bonding agent for wood will find many of their questions answered by work going forward on the 200-ton flying boat nearly completed by the Hughes Aircraft Company. Here, a group of adhesives—liquid and film—are being used to make the millions of glued joints required in the mammoth aircraft. Tests extending over a three-year period have proved the efficacy of the bonding materials. And the lessons learned will flow readily into other industries, from the production of boats and furniture to pre-fabricated houses and junior's toys.

FOR FUTURE REFERENCE

RAISINS reported to have better flavor are now being produced in a matter of seven minutes by drying with infra-red, as compared with some 17 hours by hot-air methods. . . Air freight is growing by leaps and bounds (or should we say hops?); food products, flowers, electric irons, radio sets, machine parts, and other dissimilar cargoes are flying to destinations, helped by new low tariffs and simplification of bills of lading. . .Five million dollars of government money (peanuts by some criteria) is going into a gamble that alumina can be produced cheaply from Oregon clay; ultimate gain in view is complete independence of the United States in aluminum production, if an international emergency in the future should cut off ocean-borne supplies of bauxite. . . The whole aluminum picture today is a peculiar one; production capacity is greater than national needs, yet scrap aluminum is scarce. . . The scrap gap can be filled—more than filled—by obsolete and disabled war planes, if the problem of getting them to smelters can be solved; secondary aluminum, made from scrap, must sell for two-thirds the price of primary aluminum if its uses are to be fully exploited. . .New uses for cotton fibers and by-products are being eagerly sought by the Department of Agriculture.



Nickel alloy tubing, formerly made by piercing and cold drawing, leaves the extrusion die. Temperatures as high as 2200 degrees, Fahrenheit, may be used

METALS IN INDUSTRY

Extrusions Push Ahead

Product Designers and Manufacturers Will Find New Raw Materials in the Extrusions that Are Now Available. Recent Advances in Extrusion Techniques have Opened this Materials-Forming Method to Many of the Stronger and Tougher Metals that Formerly Could Not be Extruded

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

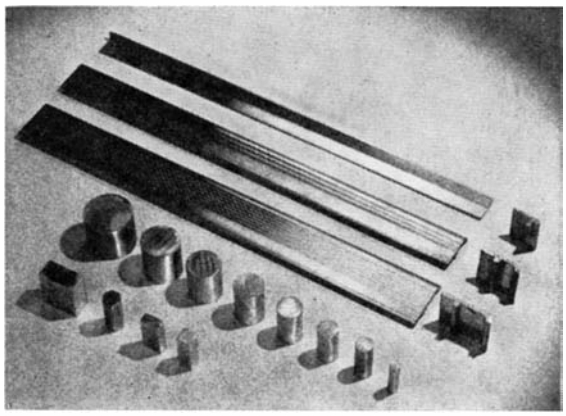
EXTRUDING of metals has been described in non-technical terms as a process of "squeezing" hot metal through an orifice so that it emerges thinner and much longer than it was originally. This essentially accurate description strongly suggests that the process is limited to the soft (or "squeezable") metals like lead and tin and that stronger and harder materials had best be fabricated by some other methods.

Actually this situation was generally true until the past few years. The metals commonly extruded were lead, tin, brass, and bronze—and more recently aluminum and magnesium. Strong copper alloys, nickel alloys, stainless steels, and even zinc were not commercially available as extrusions. But the war years witnessed the development of larger extrusion presses and of special press and die designs that have placed these stronger, tougher metals on the market in extruded forms. An entirely new series of raw materials has thus been presented to the product manufacturer.

Strictly speaking, the term "extrusions" covers several classes of products—very long pieces of round, tubular, or special-shaped cross sections (regular extrusions), as well as relatively short cup-shaped cylinders closed at one end and open at the other (impact extrusions). Although light metal impact extrusions are extremely interesting because of their increasing importance as competitors for stamped and drawn parts, they are a separate story by themselves and will not be further discussed here; primary concern now will be with the "long-drawn-out" extrusions and their recent progress as it affects industry in general.

A good picture of the state of development of soft metal extrusion

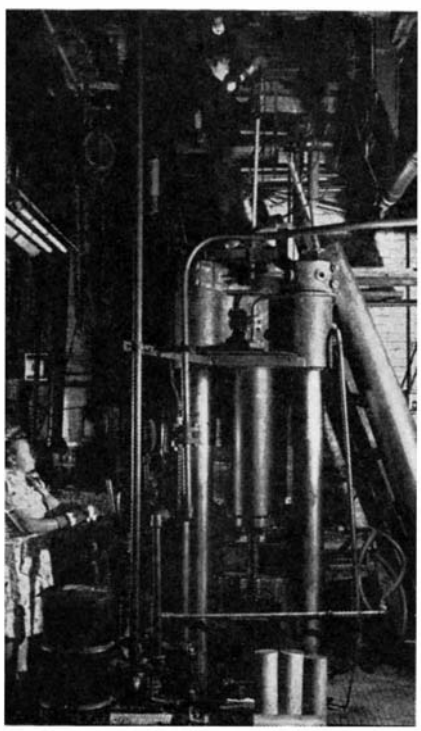
is found in the manufacture of lead pipe for chemical (sulfuric acid) processing equipment. Traditional lead-pipe production commonly resulted in eccentricity or variations in wall thickness, inclusions, laminations, and internal longitudinal welds, all of which reduced the resistance of the pipe to its corrosive environment. Modern presses, however, eliminate most of these drawbacks just by being much larger and by the provision of guided columns and other aids to geometric accuracy.



Extruded shapes in zinc alloy. Long extrusions are sliced to make intricate small parts

NO LAMINATIONS — Thus, one large Robertson lead extrusion press at an American Smelting and Refining Company plant has a 1500-ton capacity and can make, for example, a continuous 22-foot-long piece of 12-inch-diameter, ¾-inch-wall lead pipe weighing 3250 pounds without laminations or welds anywhere along its length. The lead press operates vertically, the molten lead being poured around a steel core placed vertically in the center of the press cylinder. After the lead is solidified the ram and cylinder are forced upwards through a die fixed to the upper part of the press. With the older, smaller presses, such long lengths could be produced only by introducing several charges of molten lead, with consequent "laminations" along the length wherever the lead charges met.

Modern extruded lead is considered superior by the chemical industry because its freedom from laminations and welds does away with points of local chemical attack and areas of mechanical weakness that shorten the service life of lead extruded in smaller, less accurate presses.



This vertical press extrudes zinc shapes from billets in foreground

Lead extrusions are common; but in the case of aluminum bronze, extrusions are not common and their production was a notable achievement which made available all the strength, hardness, and corrosion resistant advantages of this copper alloy in a new form.

At an Ampco Metal plant, aluminum bronze is extruded on a Schloemann horizontal hydraulic 2275-ton press. Rods, tubes, and shapes are produced in diameters up to about five inches and lengths up to 14 feet. The best type of aluminum bronze for extrusion appears to be the high-iron high-aluminum type containing 2½ to 5 percent iron, 8½ to 15 percent aluminum, and the remainder copper.

The press for producing aluminum bronze extrusions consists essentially of a ram, a hot-billet container with an opening at each end, a die and holder with a taper fit so as to be self-alining when seated into one end of the container, a gate lock which holds the die and die-holder firmly against the pressure developed in extrusion, a ram for exerting the pressure against the rear face of the billet, and a shear for severing the butt or unextruded portion of the billet at the face of the die. The latter, with its holder, is retractable from the container.

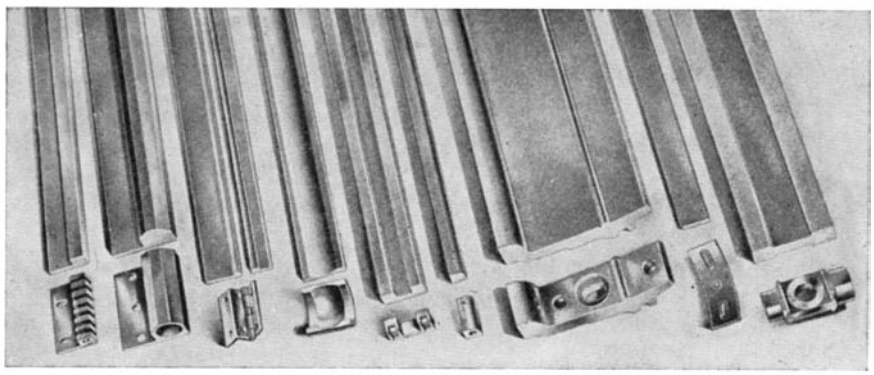
ALUMINUM BRONZE—Tube extrusion of aluminum bronzes employs slightly different attachments, particularly a piercing attachment consisting of a mandrel and holder actuated horizontally and centrally through a hollow ram. In tube extrusion the billet is placed in the container against the face of the die. The ram remains stationary, sealing the rear of the container, while the mandrel pierces the center of the hot billet; a cylindrical slug of metal is ejected through the die and then continues to advance along with the ram, the pressure of the latter causing extrusion while the mandrel and die form the inside and outside surfaces of the tube, respectively.

The most important requirement in making aluminum bronze extrusions, especially tubing, is to maintain press alinement as nearly perfect as possible. Worn containers, wear plates, guide keys, rim slippers, pressure rings, or column nuts must be corrected or replaced systematically to avoid high scrap losses. Die wear and maintenance is also a problem; dies are made of 10 percent tungsten tool steels, which satisfactorily resist the wear at the high temperatures to which extrusion dies are subjected.

Extruded aluminum bronzes are used for aircraft engine parts, landing gear components, and controllable or variable pitch propeller parts; their applications are certain to extend to other industrial products such as machinery parts, bushings, sleeves, bearing elements, forging-rod for the manufacture of bronze forgings, bar stock for making screw machine products, and so on. The advantages of extruded aluminum bronze over production by other methods are the finer structure and greater strength as compared to aluminum bronze sand castings, and a frequent saving in material, tool cost, and finishing expense as compared with forgings and die castings. The surface finish of extruded aluminum bronze is similar to that of a rough-machined material.

ZINC EXTRUSIONS — For many years the possibilities of extruded zinc and zinc alloys have been appreciated, but the difficulties in making the product prevented its commercial development. During 1945, however, the first commercial extrusion of zinc alloys and of high-purity zinc metal was achieved by the White Metal Rolling and Stamping Corporation, and a new industrial raw material was made available.

Zinc extrusion is done on conven-



Use of formed mill stock (above) in manufacture of irregular shaped articles (below) often eliminates complicated machining operations and wasted material

tional vertical presses such as are used for magnesium and aluminum. Round rods 3/16 to 2 inches in diameter, as well as flats, squares, hexagons, and irregular shapes have been extruded. Tubing can be manufactured in diameters up to 1½ inches with walls at least ⅛ inch thick. Zinc extrusions may be as long as 14 feet.

In the vertical extrusion press used at White, the die is in the lower end of a tubular ram. A cast, hot billet, 5 inches in diameter and about 18 inches long, and weighing 85 pounds, is placed in the cylinder. The latter, on the lower platen of the press, is elevated and applies the heavy pressure needed for extrusion, which varies according to the shape of the section being produced.

The zinc extrusions have somewhat higher tensile strength and impact strength than zinc alloy die castings and are therefore expected to find use in mechanical applications such as rods or tubes for screw machine production. Zinc is a highly machinable material and the availability of long lengths of strong zinc alloys held to close tolerances and with the good surface finish that is characteristic of extrusions is expected to be welcomed by manufacturers of machined products generally.

Actual applications of zinc extrusions are still limited because of their very recent availability. The Navy has used large amounts for "wasting pencils" in heat exchangers which are used to inhibit the corrosion of steel surfaces in sea-water through the preferential electrolytic corrosion of the zinc in contact with the steel. A similar application is the cathodic protection of steel pipe buried in the earth through the use of extruded zinc.

The white color of zinc alloys may make them useful for screw machine products where brass may be considered more expensive or where aluminum may be thought too difficult to solder or plate. Welding rod and wire for metallizing are other suggested applications. Furniture moldings and the like can be extruded and may compete with equivalent rolled sections on a cost basis. Door saddles and shapes designed for molding in terrazzo floors are possibilities.

Very large presses for the extrusion of aluminum and magnesium have been built in recent years and are in current use. These metals lend themselves exceptionally well to extrusion because of their hot workability. Aluminum and magnesium extruded products find a ready and wide market because of their lightness and rigidity and because both materials are so easily machined. The aircraft industry, of course, has been the heaviest user but peace-time applications are expected to include structural components of railway, truck, bus and trailer equipment, textile machinery, architectural and building sections, moldings, and so on, and as raw material for mechanical parts to be produced on automatic screw machines.

TAPERED SHAPES — "Stepped extrusions" in aluminum are a recent development of especial interest to designers and production men. A stepped extrusion increases in cross-section in steps from one end to the other. The chief advantage is in the production of long tapered shapes whose cross-section changes gradually from one end to the other. Although considerable machining is required to reduce the steps to a smooth taper (for example for aircraft "spar gaps" or wing beams) the machining is still much less than if the part were to be initially produced by conventional extruding or rolling.

In addition to the aircraft field, applications will develop wherever a long tapered light metal part—for example, masts for small boats, flag poles, metal furniture parts, and similar items—are required. A general-purpose extrusion alloy, 63S, is now widely used because of its high strength, corrosion resistance, brilliant color, and freedom from cloudiness after anodizing.

Not quite so large as the largest aluminum press (5500-ton) but still respectable in size is a 4000-ton Hydro-Press, Inc., unit used for extruding high melting-point metals such as nickel, Monel, Inconel, gilding metal, and copper tubing. Previously, tubing made of these materials was produced in this country by piercing and cold drawing, but some of the alloys—for example, "K" Monel—cannot be pierced. Using the 4000-ton extrusion press, tubes of nearly nine inches outside diameter and eight inches inside diameter can be produced in any of these materials.

The press is a horizontal hydraulic unit. One of its chief features is a preliminary cupping operation on the hot billet, causing the metal to extrude back over the mandrel without loss of the metal slug that would otherwise go through the large die (as with aluminum bronze extrusions, described above). After cupping, the billet is lifted out and the die placed against the container, permitting piercing and extrusion. Temperatures as high as 2200 degrees, Fahrenheit, are used when working some materials on this press.

NEW USES—The outstanding application of the extrusions made in this press has been revolving shell bands made of gilding metal for the Navy, for which the tubular extrusions were simply sliced into shell band sizes. Beyond this, the nickel alloy extrusions are expected to find many applications in heat exchanger, process industry, and sea-going equipment where their resistance to corrosion and high temperatures and their excellent mechanical properties can be used to the betterment of the final product.

During the last four or five years the extrusion process has moved ahead by leaps and bounds. Because of it tubing is now available in materials that could not be produced as seamless tubing a few years ago (for example, "K" Monel). The advantages of extrusions—strength, close tolerances, good surface finish, and availability in a variety of cross-sectional shapes—have now been extended to materials such as Inconel, aluminum bronzes, and zinc alloys that were formerly commercially available only in other forms. Today's product designer and parts manufacturer is finding in extrusions a new type of raw material that can be adapted advantageously to the requirements of many and varied peace-time products.

Plastics In Radio

A Large Percentage of the Radio Receivers to be Made During the Coming Year will Use a Variety of Plastics in a Variety of Ways. Moldings, Extrusions, Castings, and Wire Insulations All Find Places in an Industry that Faces a Greatly Expanding Future

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

TWENTY-FIVE million radio receivers to be produced in the first full post-war year! Such are the expectations of the radio industry. This estimate is based upon a belief that the market for small radio sets is a long way from saturation because many pre-war sets are either worn out or obsolete, and because Americans generally use more than one radio set per family. At present, 30,500,000 homes in the United States—83.5 percent of all homes—have about 46,300,000 radio sets of which 7,100,000 were not in working order in April 1944, according to WPB surveys.

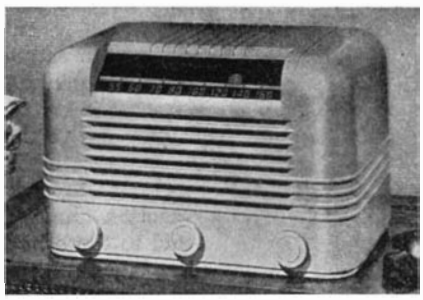
To a considerable extent, much of the growth of the radio industry has been due to the development of better plastics and to the better use of available plastics. This fact is backed up by the accompanying chart which shows a steady increase from 1937 through 1941 in the number of plastics cabinets produced.

The figures are from the production records of the radio industry; the estimates are those of radio manufacturers based on their own records. And these men further estimate that between 70 to 80 percent of the table and personal radio models sold in 1946 will have plastics cabinets.

There are a number of reasons for the widened use of plastics in radios. Most important of all, perhaps, is the general improvement in cabinet design which has resulted from the closer co-operation of radio makers and plastics molders in developing good looking housings with the proper structural qualities. The development of a loud speaker using Alnico No. 5 magnets has also contributed to the increased use of plastics materials. This unit, which is much smaller, lighter, and more efficient for use in small cabinets than the older speakers, is relatively unaffected by the housing in which it is placed.

The radios that are even now hitting the market incorporate a number of other improvements, many of which are made of plastics material. Take, for example, Viewtone's five-tube model housed in a molded urea-formaldehyde case. It makes use of an engraved vinyl dial placed near the top of the cabinet where it can be seen from any position. Some manufacturers—RCA among others—use printed rather than engraved extruded vinyl strips for their dials. Of course, more and more of the electrical wiring is vinyl coated, but this also holds true for other industries besides radio.

Viewtone: Molded case



RCA: Printed plastics strip dial

Any number of companies are beginning to use two differently colored plastics materials in their cabinets. Usually, the case is of one color and the speaker grille or louvres of another, the two pieces being produced separately and attached together in assembly. One of Emerson's table models features a cast phenolic housing with a compression-molded grille of methyl methacrylate. Then there is Garod's cast phenolic case with contrasting louvres, and Stewart-Warner's two-

An Emerson receiver with cast housing and compression-molded grille

Year	Total radio sets (including phonographs, automobile sets, and table models)	Table models	Plastics Cabinets
1937	8,083,000	3,580,000	904,000
1938	7,141,000	3,474,000	1,420,000
1939	10,759,000	5,400,000	3,200,000 (est.)
1940	11,859,000	5,516,000	3,600,000 (est.)
1941	13,642,000	5,988,000	4,000,000 (est.)
1942	4,307,000	...	...

Tabulation showing increased use of plastics cabinets for radio receivers

Stewart-Warner's two-toned model

toned model in which both the housing and grille are cast from phenolic.

Color contrast is also being achieved in some plastics radio cabinets through the simple expedient of spraying one color over masks on housings of another color, molded in a single piece. This procedure is less expensive, of course, than the method described in the preceding paragraph.

Perhaps the newest and most unusual plastics application in table model radio sets is a molded backplate. Emerson Radio and Phonograph Corporation have developed this plate which it plans to use in all its small radios in place of the older fiber boards. Some of these back covers are compression molded of phenolic or urea while others are injection molded of polystyrene. Their adoption by this company is in line with its increased use of plastics materials.

There are, of course, many other plastics parts in the average radio receiver. Thus, plastics are standard for tube bases, coil forms, capacitors, insulation bushings, sockets, terminal strips, and, as mentioned before, wire insulation.

The overall picture of the future of plastics in the radio industry is a bright one, indeed, and one which accurately portrays the versatility of these synthetic products. Their multiple usefulness—brought about through ease of fabrication, electrical characteristics, strength, beauty, and durability—make them particularly adaptable to the widely diversified demands of radio set construction.

Garod: Cast case, contrasting louvres

PLASTICS HANDLING

Assists in Reconditioning of Service Men

THE value of plastics in the reconditioning work the Army is carrying on in hospitals throughout the country may be judged by the fact that a course for plastics technicians is now being taught to Medical Corps personnel at the Ordnance School at the Aberdeen Proving Ground. Here enlisted men and women from all kinds of Army hospitals are being trained to handle the material so that they, in turn, can instruct wounded veterans in this medium.

The Army's use of plastics began some time ago when pieces of acrylic were among the scrap materials received from plane factories for occupational therapy work. These transparent plastics offer one distinct advantage over wood, a traditional material for this work. They are cleaner and cause less dust. This is extremely important in the case of patients suffering from tuberculosis or similar diseases.

There is a wide range of exercises involved in making plastics articles. At the simplest level there are the cigarette boxes. Flat pieces, cut to the proper sizes, are given to bed patients who glue them together. When the patient is strong enough to start, corrective and reconditioning work is undertaken. Then ordinary tools are modified in order to suit a particular injury and to give a specific exercise.

In addition to its value in the physical reconditioning of men with muscle and nerve injuries, work with plastics has a therapeutic value for other patients. It furnishes activity and interest to counteract the boredom and depression to which patients may be subject.

NYLON DRESSING

Used to Cover Severe Wounds and Burns

ONE OF the unique medical discoveries of the war involves the use of woven nylon as a dressing for wounds and burns.

Surgeons have long been plagued by the tendency of surgical dressings to adhere to raw wound surfaces. All of the problems involved seem to be allayed with the introduction of nylon surgical gauze which evolved as a result of experiments by Army surgeons with dressings improvised of nylon window screening. Sections of the screening, after being cut, washed, and sterilized, were used in both the operating rooms and in the wards. It was tested under both field conditions and in the finest modern hospitals constructed by the Army in the Russel Islands, in Espiritu Santo, in the New Hebrides, and in Luzon.

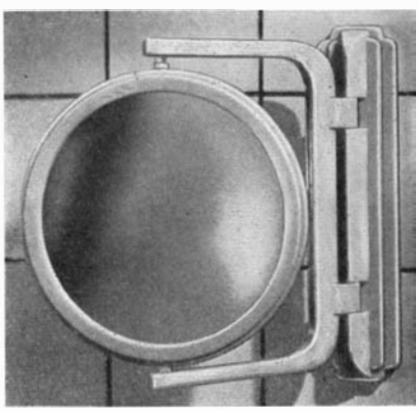
A total of 60 cases were treated with these nylon bandages and kept under observation. Surgeons and patients were pleased at the ease and freedom from pain with which these nylon dressings could be changed. Since the screen was flat and slightly stiff, the granulation tissues in irregular wound cavities would grow out to the screen to form a smooth, level surface—ideal for the placement of skin grafts. The absence of surface bleeding as a result of dressing changes was remarkable and fewer sponges were required. There were no cases of skin sensitivity or irritation attributable to the nylon screen.

The fabric that was finally selected as a result of this work was an undyed, unstiffened, smooth, soft, opalescent-white, glossy cloth with a weave of strands of twisted nylon thread. When a stiffened cloth is desired for covering small wound cavities and skin grafts, a finish of 2 percent solution of nylon, type 6, dissolved in isopropyl alcohol, is specified.

MIRROR FRAMES

Easily Converted to Peace-Time Style

THE INDUSTRIAL switch from war to peace has caused many a headache, but not for the Consolite Corporation at least so far as their two-sided mirrors are concerned. Developed for the Navy, the mirror was designed with an inner frame



Plastics bracket holds the mirror

which could be fitted into an injection-molded Tenite II swivel wall bracket just as well as into the heavy metal wire frame that made it practical for use by the military. In its war-time garb, the mirror is suitable for campers or others who make their temporary home outdoors, since it can be propped up on a shelf at any desired angle or hung from a nail. And in its civilian dress, affixed to the bathroom wall, it can be adjusted to any angle or turned completely around to reveal the magnifying side. Nasco Plastics Division of National Organ Supply Company does the molding.

PLASTICS BOXES

Display and Protect Badges and Jewels

DECORATIONS are meant for display, whether they are badges of honor, such as the Purple Heart, or sparkling jewels. Yet, too often, they are shut away from sight in conventional velvet or satin lined boxes most of the time.

All this will be changed when Lucite and Plexiglas boxes are adopted by jewelers just as they have been accepted by the Armed Services for all Army and Navy medals and decorations. The transparent tops of these cases put decorations on permanent display, set off by the solid blue of the bottom half of the boxes.

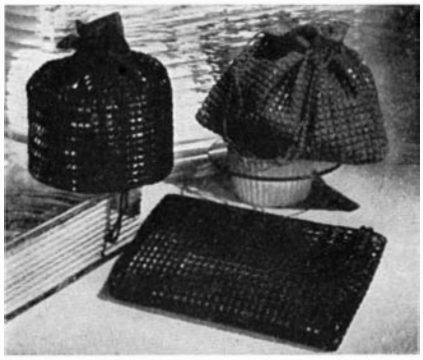
There is another novel feature of these injection-molded two-piece plastics boxes. A small hole in the shape of a keyhole is molded through the solid blue bottom, approximately three quarters of the way toward the end that would be termed the top should the case be stood on its edge. This opening makes it possible for the owner of the decoration to hang the box and its contents on the wall. There it can be on permanent display, yet be protected from dust and moisture.

PLASTICS DIAMONDS

Are Injection Molded Through Cloth

FLEXIBLE sheets of plastics, fabrics woven from plastics monofilaments, and fabrics coated with plastics are an old story to the handbag manufacturer. Now he has a new plastics medium in which to express himself —a cloth wherein plastics faceted diamond shapes are injection molded right through the material. By a special molding technique developed and patented by Plastocraft Company, cellulose acetate is forced through the cloth into a mold which creates the desired pattern. Then the finished mats, measuring approximately 9½ by 15 inches, are cut, sewn, and shaped into handbags.

In addition to its novel appearance, this material has a number of advantages. Since the individual plastics beads are integral parts of the fabric backing, they won't chip or drop off and are sufficiently close together so that dirt can't gather



Plastics molded through cloth

between them. Moreover, there is no lacing between the cubes to soil or break. The plastics surface is colorfast and the material is flexible, light in weight, and capable of withstanding rough handling.

TRAY COVERS

Aid Inspectors When Made Of Transparent Plastics

PLASTICS have found a new outlet in the cigarette manufacturing business. At the factory of Stephano Brothers, Lucite is being used for tray covers in packing machines. The advantage of plastics in this application is that inspectors can easily see through the methyl methacrylate sheets and spot damaged cigarettes before they jam the machines.

WOOD AND PLASTICS

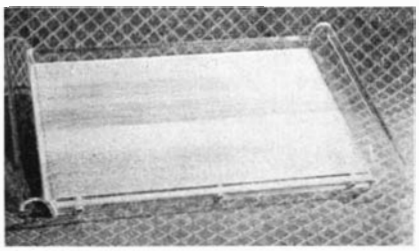
Combine in Mass Production Of Household Objects

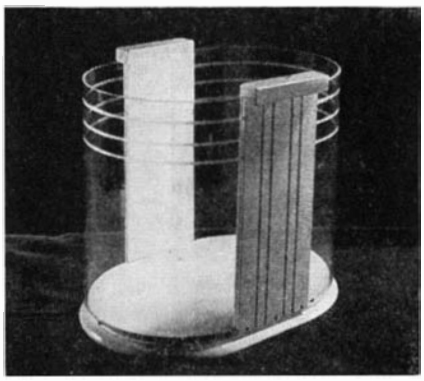
THE EASE and grace with which transparent acrylics combine with other materials is not the only point of difference in a new line of household accessories just introduced by the Plastics Manufacturing Company. These include trays, wastebaskets, and magazine stands—to mention but a few—designed by Sundberg and Ferar, industrial designers who developed these items so that they could be mass produced on machines formerly devoted to the manufacture of blown acrylic and molded phenolic aircraft parts. The object was to turn out the articles in the assembly-line manner with a minimum of plant retooling.

The designers also envisioned the production of accessories that would fit any interior decoration or color scheme. This they succeeded in doing, partly because of the adaptability of transparent acrylic sheet and partly because of the many different colored woods they employ. Sometimes maple is selected; again, mahogany or blond wood is employed.

The serving tray and waste paper basket are typical of this new line. Acrylic sheets can be formed readily into complicated shapes, but containers like the waste basket are achieved in wood only after painstaking machine and hand work. It was logical, then, to make the curved sections of transparent plastics and the base and straight sides of wood.

The acrylic material arrives at the plant in long sheets to be cut and shaped on a special high speed tool. The plastics cut-out is then heated to approximately 240 degrees, Fahrenheit, and placed on a forming die where it cools into shape. Since the acrylic sheet is heated to such a high temperature, it retains its shape indefinitely even should the article be placed near a radiator as it well might be in the home. Plastics cement is used to attach the Plexiglas or Lucite parts to the wood. This eliminates unsightly fastenings that often mar an otherwise attractive design. When a frosted effect is desired in a piece of acrylic to enhance its decorative charm, the transparent plastics is run lightly over a high speed tool which has been developed specially for this purpose.





Examples of possible combinations of plastics and wood. Curved-end serving tray (above) and wastebasket (below)

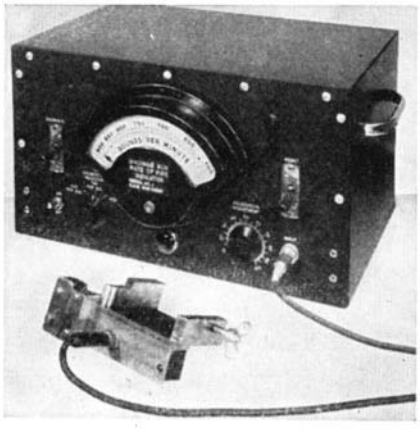
Electronic Inspection

Visible Quality Curves Traced on Cathode-Ray Tube Screens Provide Inspection and Testing Equipment that Eliminates the Human Factor. Increased Reliability in Precision Mechanical and Electrical Units May be Obtained by Applying Proved Methods of Electronic Checking

By VIN ZELUFF
Associate Editor, *Electronics*

WHEN the exacting demands of the battle-front called for an unvarying quality in the finished products, refinements in existing testing and inspection techniques became mandatory. The percentages of rejects encountered when many firms first undertook military production were staggering and engineers soon looked to electronics for methods of speeding up such inspection, making it more efficient and as automatic as possible. Although there are a great many applications of electronics to inspection and testing, representative examples can be selected which have the broadest implications to future production.

Telephone handset receivers, loudspeakers, and microphones require the best in inspection methods



Operating rates of machine tools, or other rapid-moving equipment, may be readily checked with an adaptation of this electronic gun-fire rate tester

because they have performance specifications with comparatively narrow tolerance limits. This makes it necessary to check the performance of each unit produced.

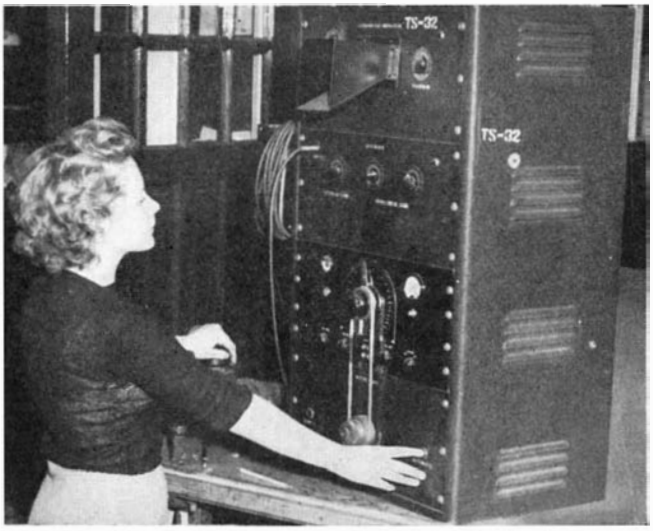
An electronic tester, developed by Great American Industries, Inc., that produces the output-*vs*-frequency curve of these units on a cathode-ray tube screen, is the most practical solution to this particular production testing problem. The sound-producing devices are energized by a signal produced by a variable-frequency generator, so that the testing sound changes gradually from a low hum, through the entire audio range, to a high-pitched squeal. A crystal microphone serves as the artificial ear that listens to these sounds. The microphone output is amplified and made to move the electron beam of the cathode-ray tube vertically on the screen by an amount that is proportional to loudness, while a mechanical linkage sweeps the beam horizontally in proportion to frequency. The result is the response curve of the instrument under test, traced as a glowing curve on the screen.

For tests of microphones—sound *pick-up* devices—the procedure is reversed, with the generator feeding a loudspeaker that serves as an artificial sound source having known characteristics, while the test microphone is arranged to listen to the sounds. Curves obtained in this way tell how well the microphone picks up sounds.

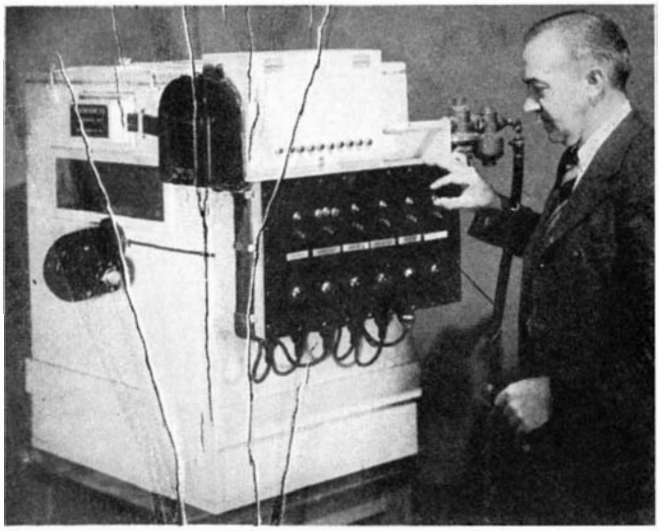
By shading all parts of the cathode-ray tube screen above and below two curves that represent permissible limits, even unskilled operators can tell at a glance whether a unit passes its test. For good units, the entire response curve will be visible, while for bad units a part or all of the electronically traced curve will be hidden behind the shaded areas.

This electronic curve tracer has withstood the rough handling of assembly-line usage for a period of over five years while testing well

An electronic balancer, combined with a stroboscopic light to measure speed of rotation, detects the amount and location of unbalance in a rotating part



Telephone handset receiver, in tester's left hand, is tested with sounds of known value. Its response curve is electronically reproduced on the cathode-ray tube screen within the funnel-like light shield



Plastics and rubber materials undergo a high-speed weather-resistance test in this machine. Ten times faster than nature, the device uses electronically actuated instruments for "spot" production checks

over a million units, thus certifying the ability of even complex electronic equipment to take punishment in a factory. Other quality control applications for which it is suited include production testing of radio receivers, hearing aids, phonograph amplifiers, dictating and transcribing machines, magnetic wire recorders, and a host of additional acoustical devices.

CRACKS IN METALS—Determination of the quality of a metal product has frequently been a laborious process where it has been necessary to rely on fatigue tests and the study of micro-sections of samples. Such procedure is slow, costly, and conducive to waste in production. A new solution to the problem of high speed production testing for cracks in metal wire, tubing, and bars is based on the electrical characteristics of the metal under test. A compact electronic instrument has been designed for this purpose by Salford Electrical Instruments, Ltd., a subsidiary of General Electric Company, Ltd., of England. In this instrument, a coil is arranged in an electronic oscillator circuit so that it induces eddy currents in the test sample at right angles to its axis. Then, if the frequency is such that the current penetration is deeper than the deepest crack, the effect will be to provide a short-circuited turn and an effective variable resistance in the coil, which will act like the secondary of a transformer transfering its load to the primary. If the oscillator frequency is now measured, using a crack-free sample to act as a short-circuited turn, the frequency will be found to change because of the change in the oscillator inductance when a crack in the piece under test enters the field of the coil.

A portion of the oscillator voltage is passed through filter circuits and an indicating instrument so that a variation in frequency, caused by a crack, has the effect of causing a large variation in output voltage as shown on a meter. To avoid worker fatigue and to insure against missing short flicks of the meter pointer, a neon lamp flashes at the same time.

The fact that cracks are rarely uniform in depth for more than a fraction of an inch, or may be full of oxide, has not been found to affect the operation of the instrument seriously. The instrument gives indications of cracks from 0.0005 to 0.25 inch deep. The lower limit is set, not by the apparatus, but by the surface condition of the sample. Material from 0.125 to 0.5 inch and from 0.5 to 6.0 inches in diameter respectively can be tested in two standard instruments.

To make the operation entirely automatic, a relay in the anode circuit of one electronic tube operates a small compressed-air paint sprayer, which marks the faulty material over the crack. The relay closes when the neon lamp flashes.

BALANCE TESTING — Production line testing of tiny parts that rotate at high speed, and must therefore be accurately balanced, is another job where electronic tubes far outshine the human senses.

In the electronic balance-tester developed by Gyro-Balance Corporation, the rotor to be tested and corrected is mounted on a seismically suspended platform where it is brought up to speed and held there by means of a compressed-air-driven turbine wheel. Its speed is measured by a phototube tachometer that watches a black spot on the rotating system and counts electronically the number of times the spot revolves per minute. The revolving rotor is supported in a rigid frame which is deflected no more than a few millionths of an inch even at the highest unbalance possible. Unbalance forces are transmitted to load-sensitive capsules incorporating quartz-crystal disks and there are translated into piezoelectric voltages. Amplified through suitable electronic circuits, these voltages appear on the screen of a cathode-ray tube as curves telling the location and amount of unbalance in ounce-inches or in the depth of a drilled or milled hole neccessary for correction.

Milling cutters or other correction tools can be mounted directly on the balancing platform so that the rotor can be corrected and then rechecked without being removed from the equipment.

Stroboscopic light was useful in the exact balancing of rotating parts in the Norden bomb-sight where tolerances were kept within 20 millionths of an inch. Timed light flashes permitted precise determination of rotating speeds and visual study of unbalance during laboratory tests.

Gas-filled electron tubes called "strobotrons," have been developed recently by Sylvania Electric Products, Inc., for use as sources of stroboscopic light. They can produce up to 240 flashes per second, which is fast enough to give stop-motion effects for continuous visual inspection of moving textiles and printing from high-speed rotary presses, precise timing of cams, shafts, fly-wheels, gears, pulleys, fan

blades, spindles, and shuttles, and many other rotating or reciprocating parts. The tubes also permit visual study of a complete operation by creating stop, reverse, or slow motion which may be photographed for permanent record. The frequency of flashing can be readily controlled and calibrated over wide limits.

ELECTRONIC "WEATHER" — In a technique developed at Wright Field during the war, accelerated weathering is applied to plastics and rubber materials for spot checks on the quality of production, with results being measured by photoelectric equipment. The weatherometer simulates the conditions of rain and sunlight by providing a treatment of two hours of wetting, two hours of irradiation, two more hours of wetting, and 18 hours of irradiation continued through 10 cycles or 240 hours.

The weathering conditions are provided by two infra-red lamps for heat, ultra-violet lamps for irradiation, and a sprinkler for wetting. Three sunlight lamps are used for the ultra-violet source because a flaming arc was found to cause radio interference. The likely changes in the physical condition of the samples after testing are crazing, discoloration, blooming, and warping.

A wire rack is fitted inside the cabinet so that the sample material is centered at a point where water spray, light rays, and an air current from a blower meet.

In the photoelectric weathering equipment, the light source is a six-volt automobile-type bulb mounted in front of a reflector. A Weston Photronic cell with a Viscor filter is connected to a microammeter. A variable resistor is used to adjust the light intensity.

For test samples, strips of cellulose nitrate material 0.125 inch in thickness were subjected to the weatherometer cycle and to outdoor exposure. The amount of discoloration was measured on exposed samples each day by light transmission methods. The test samples were then cleaned of dust and grease and used as calibration standards. The acceleration factor of the instrument was found to be about ten times that of outdoor exposure.

OPERATING RATE — In industrial plants it is often desirable to have a direct indication of the rate at which a punch press, printing press, or other machine is operating. An instrument developed during the war for checking the rate of fire of machine guns can be used without change for applications like these if the action being monitored is in the range of 600 to 900 movements per minute. The only attachment required on the machine is a simple switch that operates once for each movement to be counted. For higher or lower rates, the circuit can readily be modified and a new meter scale calibration obtained.

Other possible industrial applications include monitoring of life tests and acceptance tests of electromagnetic devices such as relays and solenoid valves.

The rate-of-fire indicator was developed at the San Diego Naval Air Station to fill the need for an instrument which could be used where testing operations require a large number of measurements to be made rapidly. The instrument consists essentially of an electronic counter, an electronic timer, a vacuum-tube voltmeter, and a voltage-regulated power supply.

The mechanical switch unit is clamped to the top cover, directly over the belt-feed slide assembly of a .50-caliber machine gun. The reciprocating action of the slide mechanism actuates a Micro-Switch to initiate generation of a saw-tooth voltage pulse each time a round of ammunition is fired. Firing the gun thus generates a series of periodic saw-tooth wave forms. These pulses trigger the counter circuit. The timing is controlled by the counter in such a manner as to start and stop the timing action according to the time required to fire 17 rounds. This time interval is thus a direct measure of the rate of fire. A timing capacitor is charged for the exact duration of the counting period, and the resulting potential is measured by a delayed vacuum-tube voltmeter which is calibrated to read in rounds per minute. Any number of rounds between 17 and 32 can be fired but only the first 17 are counted and timed.

Actually, electronic devices have been applied to inspection and testing problems in so many ways that discussion of them all is impossible. However, it should be noted that speed and accuracy are the two outstanding characteristics common to the majority of electronic installations. Whenever a job arises where high speeds or extreme accuracy requirements make manual or mechanical controls unsatisfactory, there is always an excellent possibility of applying electronic equipment.

SKEW CORRECTION

Becomes Automatic When Phototubes Are Used

In the textile industry, a beam of light from exciter-lamp and phototube scanning units counts the number of weft threads at each side of a continuously moving web of cloth, compares them to detect skew, and provides impulses by which automatic correction is made. The controls, made by General Electric Company, are used in conjunction with weft-straightening equipment made by Windsor and Jerauld Manufacturing Company.

When weft threads are askew, a light spot at one side of the cloth strip intercepts more threads than does one at the opposite side. For skew in the opposite direction, the opposite situation prevails. The electronic phototubes and their amplifiers are located in cylindrical housings mounted above the moving cloth, where they receive impulses at the frequency of the passing threads. These are equal if the weft is straight, but unequal in case of a skew.

The outputs of the amplifiers are fed to a frequency-sensitive circuit in which a voltage output is produced proportional to the magnitude and also the direction of the skew. This voltage is used to control the operation of a straightening motor through the action of suitable electron tubes without mechanical contactors being used in the gear.

METAL-TO-GLASS

Seal Produced by Electronic Means

The metal contact that makes electrical connection to the coating inside the bulb wall in several types of cathode-ray tubes is sealed into the glass by electronic heating.

The technique consists of placing the bulb on a fixture that holds a small chrome-iron cup against the inside wall. The cup is placed in the field of a one-turn coil supplied with radio-frequency power from an electronic generator and heated until it drops through the glass, leaving a hole. The contact is then placed in the hole and likewise heated until the surrounding glass flows and seals to the metal. Annealing of the glass removes strains set up during the operation.

With the new technique, developed by RCA Victor Division of RCA, the whole process takes about half the time required by the gas-flame method formerly employed.

Amino Acids: In Quantity

Now Produced in Industrial Quantities, Life-Saving Protein Nutritional Elements Provide Medical Science with a New Weapon. Chemical Technology Removes Amino Acids from the Test-Tube Stage by Breaking Down Food Proteins with Acids, Alkalies, or Enzymes

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

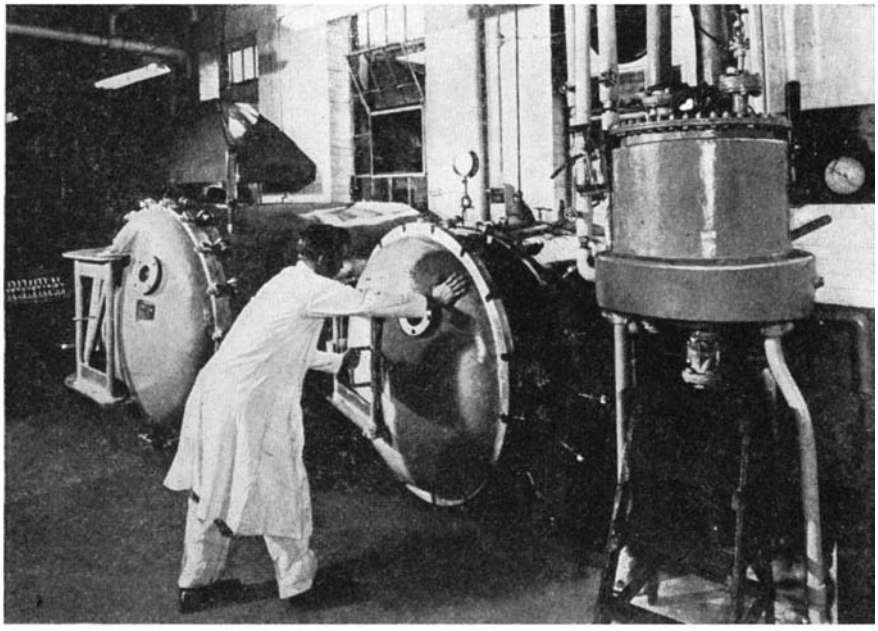
AMINO ACIDS, rivaling vitamins in their importance to life and health, are the foundation of a new phase of chemical industry. Ever-increasing quantities of these protein "building blocks" are required as scientists unveil the many secrets of the role amino acids play in human nutrition.

Well balanced diets contain all of the amino acids in quantities sufficient for health, but such conditions as severe burns, surgery, starvation, ulcers, and wounds that fail to heal properly may call for excess amino acids in an easily digestible form.

The extent of industrial growth in the production of amino acids is apparent when it is realized that ten years ago no amino acids were produced commercially; within the last few months, tons of the life-giving substances were flown to Europe to help restore the health of the half-starved inhabitants of war-devastated countries. Just as sulfa drugs, vitamins, and penicillin have outgrown their test tubes, so have amino acids progressed far beyond the laboratory stage.

Proteins are combinations of several of the 23 naturally occurring amino acids joined together by chemical linkages. Often proteins contain other components such as fat molecules, sugar residues, or phosphorous compounds in addition to amino acids. The arrangement of all of these elements is so complex that no natural protein has ever been duplicated by synthesis.

The functions of the proteins themselves have been generally appreciated for years, but it is only within the past decade—since Rose's discovery of threonine, one of the essential amino acids, in 1935—that any significant progress has been made in understanding their specific nature. Since the complex protein structures did not lend themselves easily to study, it was necessary to examine the individual "bricks" or amino acids of which they were made. As has been said, proteins themselves cannot be synthesized, but the simpler amino acids can be, and, indeed, many of them are now commercially available. Nutritional studies with the pure individual acids have led to the conclusion that at least 8 of the 23 are essential to human life.

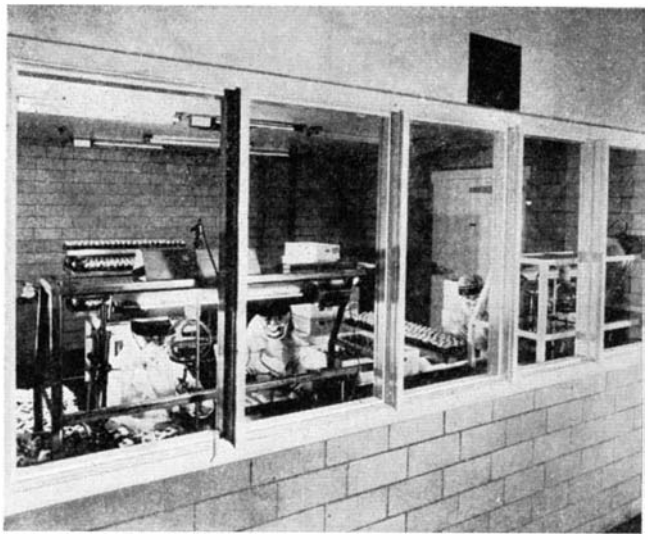


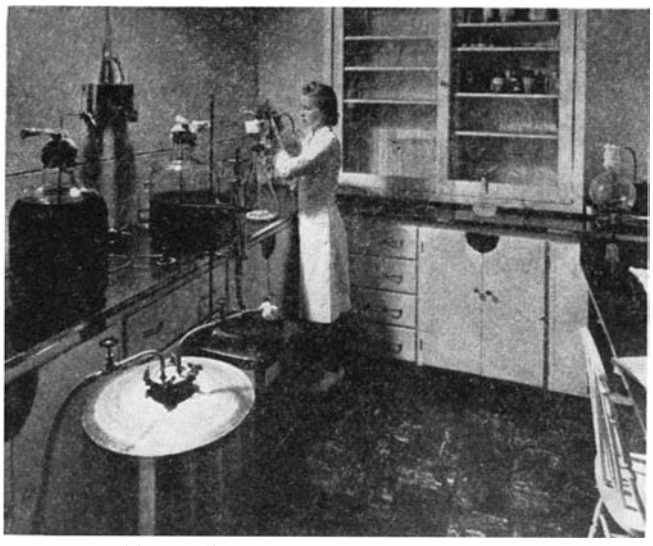
Amino acids must be sterile; steam autoclaves sterilize equipment and containers

PRODUCTION—For some medical uses a mixture of the pure synthetic amino acids in a suitable medium would be ideal. Even if enough of the essential acids were available, however—which is not the case—only a millionaire could afford such a remedy, since some of them cost as much as 400 dollars a pound. Synthetic amino acids are used for fundamental research, but it is not practicable, even if it were possible, to provide them for general medicinal use.

But it *is* possible to prepare a fairly pure mixture simply by breaking down a natural protein such as casein, the protein in milk, which contains all of the necessary acids, into its components. When correctly prepared, such a mixture is suitable for any of the various means of administering it to the patient and is equivalent in nutritional value to a pure synthetic mixture. Moreover, it can be prepared for a small fraction of the cost of the synthetic amino acids.

During the early development of these products, proteins of liver, blood, milk, horn, hair, and several others were investigated as possible sources of amino acids. Today, read-





Photographs courtesy Frederick Stearns & Company, Division Sterling Drug, Inc.

ily obtainable milk protein, purer than most natural proteins, and containing all the essential acids, is generally used.

Proteins can be broken down by acids, alkalies, or by enzymes. Each of these methods has inherent advantages and disadvantages, and at least two—acid and enzymatic—are used by the 25 or more manufacturers who have entered the field.

The main disadvantage of using acids to break down the protein is that one of the essential amino acids, tryptophane, is completely destroyed. Pure tryptophane is stable insofar as the acid is concerned, but certain other chemicals present in natural proteins cause it to solidify and form a resin. Consequently, synthetic tryptophane must be added to the amino acid preparations, if they are made by the acid method, in order to make them complete. The advantages of the acid method are thought by some manufacturers to outweigh this disadvantage since the final amino acids are purer; the acid used for the protein breakdown is, for all intents and purposes, completely removed; micro-organisms and fever-producing substances are destroyed, giving a safer final product; and the method is simple.

Alkaline protein breakdown does not destroy tryptophane, but some of the amino acids are altered in their chemical configurations in a manner that is tantamount to destroying half of them.

Protein breakdown by enzymes (catalysts produced by living cells) retains the amino acids in their natural form, but the final product contains a good deal more than amino acids. Undigested or only partially digested proteins, decomposition products of the enzymes or proteins, and non-protein fragments of the original material may be present. Thorough purification is absolutely necessary, then, for while amino acids are perfectly compatible with blood proteins, foreign proteins in the blood lead to serious complications. Micro-organisms, moreover, are not destroyed by enzymatic digestion, and the fever-producing substances cannot be readily removed from the final product.

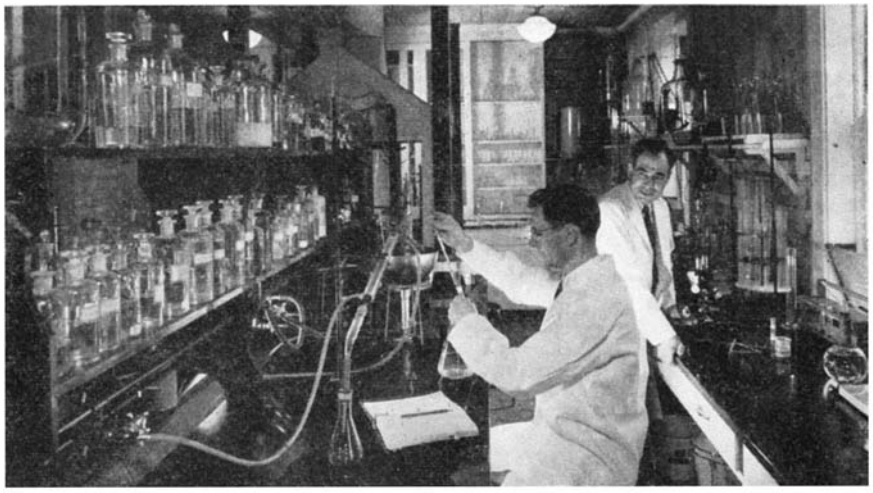
Constant tests (above right); packaging in sterile rooms (above left); and rabbit reaction trials (right) ensure final quality of amino acids

ACID METHOD—In the preparation of one commercial product, milk protein is treated with 20 percent sulfuric acid at a temperature of 120 degrees, Centigrade, for 16 hours. This treatment effectively breaks down all the proteins into their component amino acids, although the tryptophane is destroyed. The sulfuric acid is removed for the most part by slaked lime, the calcium sulfate being removed by filtration. The filtered material is then placed in a still to concentrate it and at the same time remove free ammonia, and the ammonia-free product is then saturated with carbon dioxide, using dry ice, to remove excess calcium as calcium carbonate. The remaining calcium is removed, after filtration of the calcium carbonate, by the addition of oxalic acid to form the highly insoluble calcium oxalate. A very small amount of calcium, to the extent of 10 to 20 milligrams per 100 milliliters of solution, is allowed to remain in order to avoid the presence of oxalic acid. The calcium oxalate is filtered off, and a barium salt is added to remove the last traces of sulfate.

When this process is completed, all that remains to be done is to adjust the concentration of the solution to 15 percent amino acids and to add tryptophane to the extent of 1 percent of the total amino acid content. The final amino acid solution is passed through a filter and packaged.

STERILITY—It goes without saying that any product intended for human medical use must be absolutely free of any disease-producing organisms.

In order to render the amino acids perfectly sterile, they are passed through a porous porcelain filter, the passages of which are so fine that all bacteria or other micro-organisms are held back. This is done in a sterile room equipped with ultra-violet lamps. Not less than ten bottles from each batch of 1000 bottles are taken at random by inspectors and sent to a bacteriological



Biochemists, in research laboratories like this one, synthesized amino acids, but larger quantities are produced by chemical breakdown of natural proteins

control laboratory for sterility testing according to standard medical methods. If one or two bottles do not meet the test, ten more bottles are similarly tested. If sub-standard results are obtained on any of these, the whole lot is rejected.

In addition to sterility testing, each lot is tested on rabbits for fever-producing substances. Finally, samples of each lot are sent to a hospital for testing on man. Only when all these tests are passed satisfactorily is the lot pronounced acceptable.

OTHER METHODS—After weighing the relative merits and drawbacks of the three types of amino acid manufacture discussed here, some manufacturers have chosen the acid method. Another large manufacturer has modified the procedure in such a way that not all of the tryptophane is destroyed; about half of it is lost, but the remainder is available for nutritional requirements. Still another manufacturer uses the enzymatic method with success.

A different type of purification, still in the development stage, employs the so-called ion-exchange resins. Here the protein solution is passed through a special type of synthetic resin. The amino acids are selectively adsorbed by the resin and the impurities pass along and are discarded. The acids are then simply dissolved off the surface of the resin, giving a solution of pure amino acids.

The experience of the last few years, particularly with respect to wounds and malnutrition resulting from the war, has demonstrated conclusively that amino acid preparations can save lives given up for lost; and increasing knowledge of their power will undoubtedly expedite their use as standard equipment to combat death and disease.

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MOTOR FUEL

Possibilities Found by Russians in Turpentine

TURPENTINE is the raw material for "Uratol," a new aviation gasoline anti-knock compound developed in the Ural division of the Russian Academy of Sciences and said to be twice as effective as iso-octane.

It is also stated in the Russian literature that turpentine is being employed to some extent as a regular motor fuel for trucks, tractors, and other motorized equipment used in the lumber industry, although at present its principal function in this role appears to be starting engines which operate on producer gas.

The use of turpentine as a motor fuel, one authority states, is attended with difficulties—particularly acidity and gum formation; and larger carburetor jets are necessary because turpentine is more viscous than gasoline. The fuel-air mixture, moreover, must be preheated to 140 degrees, Fahrenheit. Another author contends, however, that Soviet-made tractor engines designed for gasoline require no change to burn turpentine.

The study of turpentine utilization as a motor fuel is still in progress, and such processes as cracking are being investigated.

DURABLE BAGS

Proved by Trip Over Niagara Falls

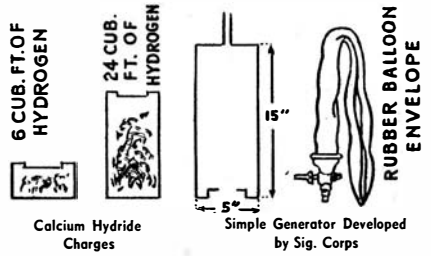
WAR-TIME developments in high wet strength imparted to paper by resins were given dramatic proof in recent test in which the new paper bags were dumped into the Niagara River and later recovered intact after dropping over the Falls. The bags were heavy-duty, multi-wall shipping containers and they were loaded with 50 pounds of flour each. After seven and a half hours' immersion and the hazards of passing through the rapids, the Falls, and the Whirlpool, the bags were still intact and the flour in perfect condition.

"CANNED HYDROGEN"

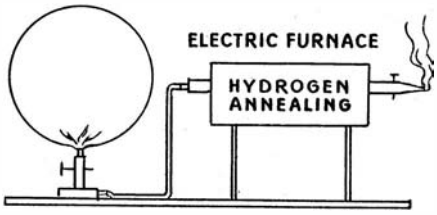
Can be Stored Indefinitely, Used When Needed

LARGE quantities of hydrogen were needed during the war for inflating meteorological balloons, but it often was not feasible to transport heavy cylinders of the gas through jungles or over rough terrain. To meet this need, "canned hydrogen" was developed in the form of cannisters of calcium hydride, which reacts with water to produce the hydrogen gas.

Various sized tins of the grayish-white material will deliver from 6 to

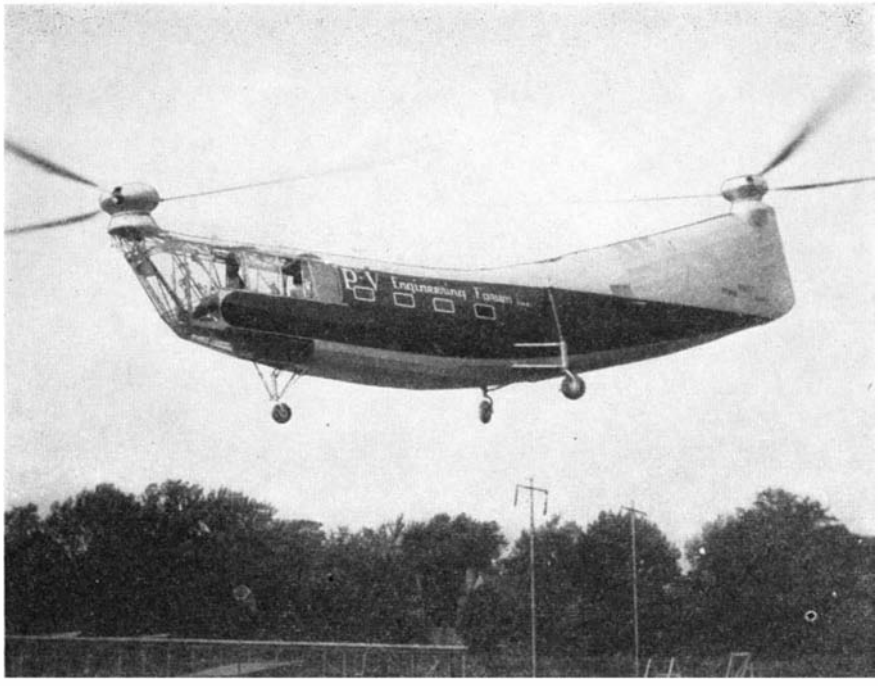


Above: Two sizes of "canned hydrogen" containers and the generator. Below: One industrial use of the gas



24 cubic feet of the gas simply by punching holes in the container, submerging it in water, and collecting the hydrogen in a rubber balloon which acts as a simple gasometer. The unopened tins may be preserved indefinitely.

Tons of the hydride were made for military use, and now it is available to all who need a convenient source of hydrogen gas that can be kept on stockroom shelves. The chemical can also be obtained in bulk for use in acetylene generators to produce hydrogen. Here, the calcium hydride is used to produce hydrogen exactly as carbide would be to generate acetylene.



Progressive helicopter designs, such as the PV-2—10 passengers and 110 miles per hour—bring fast local service and short inter-city air hauls nearer reality

Helicopters in Civil Aviation

Will the Helicopter Find Immediate Application in Civil Aviation and Industry; or Will Engineering Limitations, Landing Area Problems, and the High Degree of Pilot Skill Required Restrict its Utility? Present Indications Point to Wide Operational Fields When Problems are Solved

By ALEXANDER KLEMIN

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

INTEREST in the helicopter is general, but the American public is particularly anxious to know how soon, and in what manner, the versatile helicopter will be put into service in civil aviation. These questions are difficult to answer—yet a broad survey of the helicopter's characteristics and its applications should provide a reasonable estimate of the immediate future of rotary-wing aircraft.

Although the helicopter's performance is improving more rapidly than did the performance of early airplanes, Igor Sikorsky, the eminent rotary-wing aircraft designer, advises that it is likely to remain a short range, slow speed, craft that will never compete with the airplane in speed or load carrying capacity. But vertical flight, the helicopter's special characteristic, is so attractive that even its present low speed and small load capacity can be discounted in some applications. There are, however, other limitations to commercial helicopter operation.

LIMITATIONS—Dynamic and static stability, normally present in commercial airplanes, are not normal characteristics of a helicopter and the pilot, who must constantly be on the alert, enjoys neither a feeling of security nor physical or mental relaxation. To facilitate hovering and landing, the fore-part of the cockpit is usually equipped with a large transparent area to allow complete vision. But this very completeness of vision tends to create a sensation of vertigo which, associated with an apparent lack of structural protection, again increases the sense of insecurity. Control stick shaking is prevalent in many types of helicopters, and vibration, both on the ground and in high speed flight, has not quite been eliminated. Instrument location, rather unsatisfactorily adapted from airplane practice, is apt to interfere with the pilot's vision or impose a strain on his eyes.

The conventional airplane's three surface controls (elevator, rudder, and ailerons) and the throttle, contrast with the helicopter's similar controls plus a pitch change lever. Pushing the stick forward and opening the throttle, from a hovering condition, does not give level forward flight, as it would in a conventional airplane, but instead, causes the helicopter to climb. Only by lowering the pitch control level can forward speed without climb be obtained, and this involves a difficult problem in control coördination for the pilot. When a tail rotor is employed to offset main rotor torque, more power, and hence more torque, imparted to the main rotor means

that more balancing force is required from the tail rotor. Here again, there is an immediate problem in control coördination.

While one of the prime advantages of the helicopter is its ability to rise and descend vertically, the rate of descent with power off is so high that damage, if not injury, is likely in a truly vertical power-off landing. However, experienced helicopter pilots explain that power-off landings need not be straight down since the helicopter can descend along a slanted glide-like path in a manner similar to an autogiro. Just before landing, the machine can be "flared" or forced into a nose-high attitude so that for an instant it will be reconverted into a helicopter with the inertia of the rotor blades substituting for engine power. This extra lift cushions the landing. But regardless of such special techniques, these limitations do make the helicopter more difficult to operate, even though safer, than the airplane. Its use in transport work would require highly skilled pilots and it is doubtful whether it has yet reached a stage where free utilization by the general public is feasible.

Inherently versatile, helicopters may be ideal for police work, forest patrol, and like jobs. Governor Dewey, riding in an experimental Bell craft, symbolizes official interest

PROGRESS — Limitations notwithstanding, the helicopter in principle should be the easiest of all aircraft to fly. Low visibility—and other weather restrictions that ground airplanes—apply in less force to the helicopter. The safety inherent in the ability to use small landing areas and the convenience of mid-air stops and hovering should, with technical progress, make the helicopter easier to fly and adaptable to a wide range of purposes.

Improved landing gears with unusually long shock travels are promised to make vertical landings safer, while designers report that the cockpit will be improved with a line of visual reference to eliminate the vertigo. Structural strength at the nose of the cockpit will be made available without loss of vision. Throttle and pitch lever will be suitably synchronized so that the pilot will have one less control to think of, or, more likely, a governor will take care of the pitch while the pilot will control the throttle manually. The stabilizing tail rotor, with its attendant difficulties, may be supplanted by other rotor configurations such as the tandem, the side by side, or the coaxial type. With the latter, two rotors, one above the other, turn on a single shaft, thus avoiding the asymetrical forces of the tail rotor. Helicopter stability in forward flight will be improved by suitable aerodynamic design and, in hovering or vertical ascent, by the use of either an inertia stabilizer, of the type already used successfully on the Bell helicopter, or an automatic-pilot type stabilizer with a gyroscopic indicator similar to that used in the airplane.

Difficulties in learning to fly a helicopter may exist for the airplane pilot who is apt to treat the "whirligig" with contempt and is impatient of learning a new technique. But a reasonably well coördinated man who is not an airplane pilot should be able to fly a helicopter after just a few hours training.

COMMERCIAL USE — Experienced rotary-wing aircraft men have recently recommended to the Civil Aeronautics Administration that helicopters be permitted to fly at low altitudes, under conditions of poor visibility, and that navigation by "natural guides" such as railroads, highways, rivers, and so on, should be allowed. Thus there is every indication that the helicopter will fear fog, darkness, gusts, and snow, much less than other aircraft and will continue to operate when all other aircraft are grounded.

Moreover, applications to the Civil Aeronautics Administration for operations between cities that are not far apart, and from the centers of cities to local airports, have been numerous, and eventually such craft as the PV-2 helicopter, built by the PV Engineering Forum, will make these operations practical. The PV-2, a tandem machine with a one man crew and a ten passenger capacity, has one rotor placed far behind and above the other. This disposition of rotors gives ample room for the passengers and reduces aerodynamic interference due to downwash, since the rear rotor is above the front rotor. Because the passengers are located at the center of gravity, the PV-2 helicopter can fly lightly or heavily loaded without the trim or balance being overly disturbed. The cruising speed of such a craft, when powered with a 450-horsepower engine, is estimated at 110 miles per hour. The maximum *vertical* rate of climb is 700 feet a minute with a maximum rate of climb *on an inclined path* of 1000 feet per minute. It is a curious fact, supported by all aerodynamic theories, that a helicopter will climb faster on an inclined path than when going straight up.

Mr. Frank Piasecki, President of the PV Engineering Forum, and Harry Pack, computed the cost of a typical operation between the heart of New York City and the airport at Idlewild as 5.19 cents per seat mile. A twelve minute trip to Idlewild, with all due allowances, would cost $1.75 per passenger—somewhat higher than the fare charged by an airport limousine or bus, but one which would be entirely reasonable in view of the comfort and speed that could be offered.

There is one difficulty which has to be faced: where in the heart of most cities could a helicopter airport or terminal be located? Artist's conceptions of roof-top helicopter airports are found in many publications, and such airports are quite possible in the sense that there will be no structural difficulties in taking up landing shocks on the roof or in providing ramps, elevators, administrative offices, and parking space for the rotary-wing machines

themselves. But experienced pilots foresee other problems in the gusts created by the man-made canyons of large cities, and they dread the hazards to the machine itself and to the occupants of adjoining office buildings. It has been suggested that roof-top landings be made on platforms built over two adjacent piers or like structures when the relatively undisturbed surroundings of a waterfront are available to a city.

There are some interesting studies yet to be made in the design of roof-top airports: studies in aerodynamics, in the streamlining of the terminal itself, and perhaps in the streamlining of the adjoining buildings!

OTHER USES—But if there is some uncertainty regarding roof-top terminals and short-haul transportation, there seems to be no uncertainty regarding the immediate employment of the helicopter in other industrial and commercial applications. Although the helicopter will be burdened with the cost of transmission, clutch, over-riding devices, and so on—a four- or five-place machine will cost $25,000 rather than $5000—for certain uses these costs will be secondary, provided the results can be achieved. During the war helicopters flew 30,000 hours on all kinds of missions, principally in ambulance and rescue work, and similar peace-time uses are highly probable. Mr. Sikorsky, reporting the use of the helicopter as an instrument of pest control, says: "Insecticide released under the helicopter rotor disk is driven downwards among foliage which is so agitated that the undersides of the leaves, the stems, and the stalks can be reached by the chemical."

Governor Thomas A. Dewey, who recently made a flight in a Bell Aircraft machine, said that the machine would be most useful in rescue work by the state police and in fighting forest fires. Helicopter builders suggest that the "whirligigs" may also be used for crop dusting, pipe line patrol, suburban ambulance service, department store rural deliveries, geological surveys, mining work where the terrain makes access difficult, and in the laying of wires and cable.

FUTURE—Predictions of the helicopter's immediate future are difficult, but the following points seem fairly well established:

1. The opportunities for industrial application of the helicopter have been partially explored. By the end of 1946 or early in 1947, when one or two manufacturers have secured certificates from the CAA, taken out some of the "bugs" that still remain, and achieved some degree of production, they will be filling orders for machines for industrial purposes.

2. An excellent market is indicated for short-haul work. In the hands of well trained personnel, with adequate capital, such operations should be economically feasible and probably more immune to weather than airplane operation. The problem of city landings remains to be attacked in a serious spirit.

3. It will take more time for the helicopter to become a family or private flying machine. High prices and certain difficulties in operations must disappear before the predictions of optimistic writers can be fulfilled. Yet, eventually, the helicopter should be unexcelled for private flying.

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FASTEST TRANSPORT

Will Cruise at Over 400 Miles an Hour

BUILDER of the P-47 Thunderbolts, Republic Aviation Corporation claims that their new transport model, the Rainbow RC-2, will be the world's fastest transport airplane. The top speed will be 450 miles an hour, and guaranteed cruising speed will be over 400 at an altitude of 40,000 feet. There are a number of factors which allow the designers of the Rainbow to give this guarantee with confidence. First there is the tremendous power—four engines of 3250 horsepower each, giving a total of 13,000 horsepower for a gross weight of 113,250 pounds. This is a horsepower loading of only 8.75 pounds per horsepower. Another factor is the utilization of the thrust-producing power of the exhaust. No longer is the exhaust of the engines shot out into the atmosphere as just so much useless burned gas. It is claimed that the utilization of the jet adds 200 horsepower to the effectiveness of each engine.

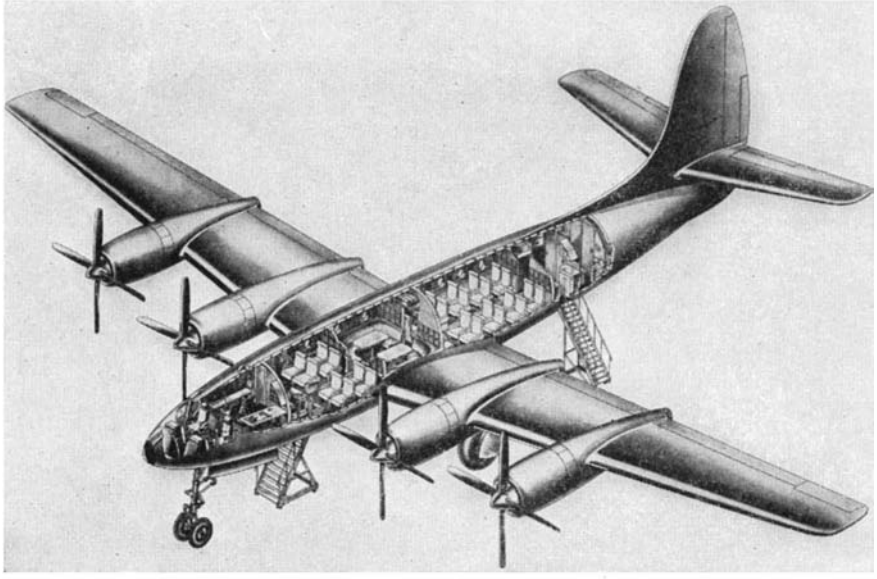
It will be noted that there is concentration of purpose on carrying a relatively small number of passengers and little cargo at top speed and in luxury. Modern styling pressurized and noise-proof cabin, complete dining facilities, lounge, ample bar, plane-to-shore telephone, motion pictures, and so on are to be part of the appointments.

FLYING WIND-TUNNEL

Tests Wing Designs Under Flight Conditions

ALTHOUGH the wind-tunnel has played a vital part in aviation research and will continue to do so, wind-tunnels cannot do all the experimental work since some tests are best made under actual flight conditions. Therefore, Lockheed Aircraft has converted one of its P-38's, the Lightning Swordfish, into the world's fastest flying wind-tunnel to be used for testing the wings of fighters and transports in the 500-mile-an-hour speed range.

Envelopes, or false wings, are mounted over the permanent wing structure. A series of static tubes arranged behind each envelope, and pressure distribution holes in the envelope surface, connect, respectively, with drag and lift measuring instruments in the cockpit. Various blower and suction slots in the false wing are employed to investigate boundary layer control problems. All test instrument readings are recorded by an automatic camera.



Propellers work in conjunction with jets at rear of engine nacelles

Never-Ending Studies

Time and Motion—All-Important Factors in Industrial Processes—Have Been Studied for Years and Will Have to be the Subject of Eternally Continuing Studies. Every New Industrial Change Must be Geared to the Ever-Present but Never-Changing Human Being

By EDWIN LAIRD CADY

JUST a few weeks ago, the methods engineer of an electrical products manufacturing company finished the six months observation period during which he had measured the results of his time and motion study in the assembly department, and found that labor costs per assembly had gone down 50 percent while output per man hour had gone up 100 percent. The superintendent of a continuous pouring foundry had just told his management board that an accident record which looked black when a new process was installed a year ago has been reduced to the vanishing point by time and motion studies.

Statements similar to those two could have been made as well in 1896 as in 1946 and will still be made in 1996. Yet, strangely enough, these studies which keep on changing industrial pictures are based on the one thing in industry which does not change: the speed with which human eyes can see with certainty and human muscles can work with comfort and safety.

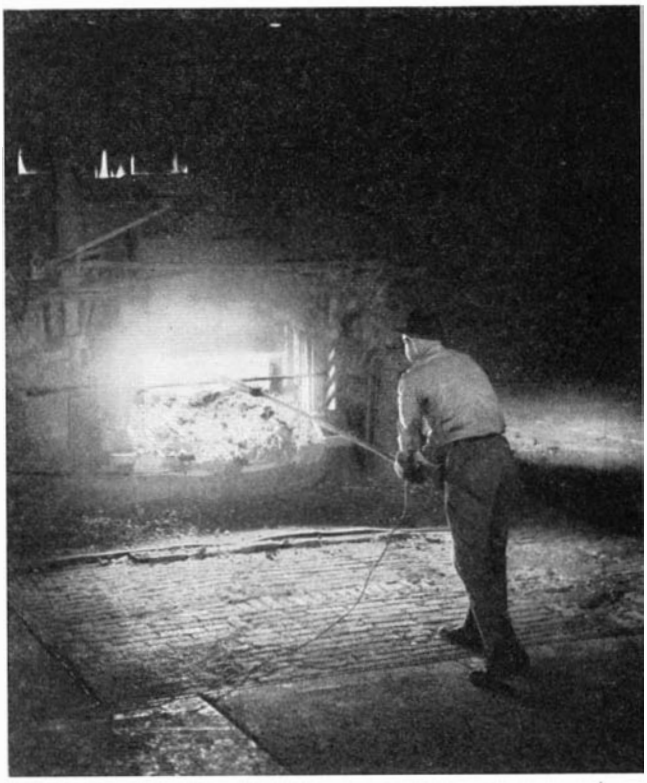
Men who make these studies with the greatest success are experts in human nature first and in mechanical processes second. They are great teachers but greater co-operators.

In an electrical products assembly department it took weeks of painstaking observation to find where any improvements at all could be made. Hourly records showed that production fell off during the closing hours of shifts, and this only could mean worker fatigue. But the exact factors causing that fatigue had to be isolated.

Analysis of the work spoiled in those "end of shift" hours was made first. The first effects of tiredness, of taking a physical beating, are almost always found in those operations which require slightly unnatural motions of the muscles or eyes. When the methods engineer knows what motions are causing spoiled work he also knows the primary sources of fatigue.

The fitting of a split ferrule onto a glass tube and the bolting of this to a reflector was causing the most breakage. The answer was that the right hand of the operator became fatigued from handling the powered bolt and nut setter, and the left hand from holding the assembly in place. A change was made so the operator did five assemblies right-handed,

Two men working on one weld must have their operations timed so they can work efficiently without mutual interference



When a pyrometer is thrust into molten steel at 3300 degrees, Fahrenheit, handling and timing by the operator must be exact

A precision instrument can be slow or rapid to operate; the optimum speed is determined by means of a series of time and motion studies

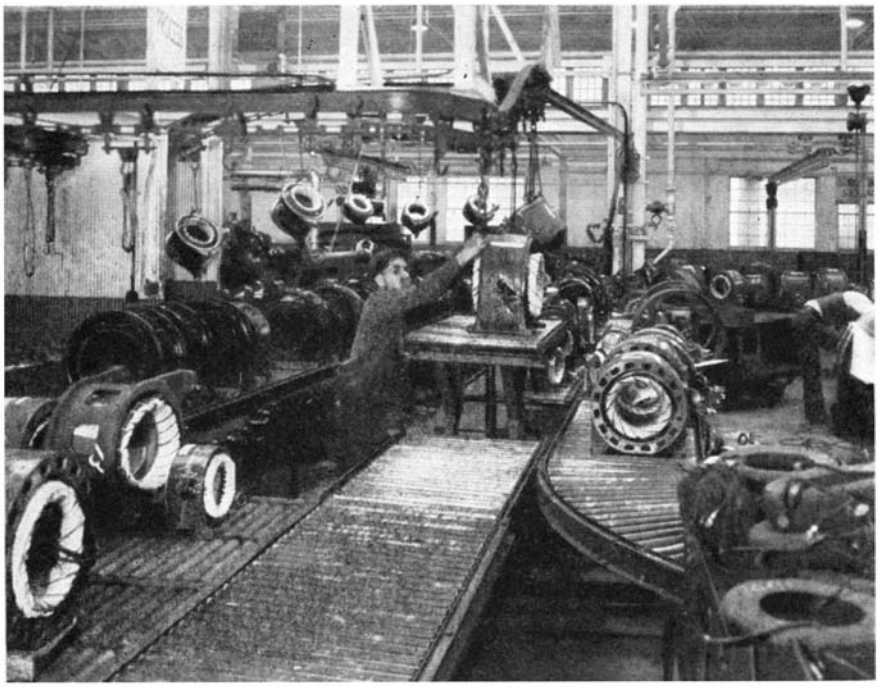
then three left-handed, and kept up this alternation. The procedure slowed down production in the early hours but raised the all day performance. And, of course, other spoilage-causing operations were tracked down until the overall speed was up but the fatigue was low.

In the foundry, observation showed that tired men had a tendency to carry the bowls of their ladles behind them instead of keeping them in sight. The cure was to teach the men how to hold the hot ladle handles for better balance and use a handling method that would put the weight on their legs and rest their backs. This reduced the accidents; it also raised production.

Every change in machinery, every new safety device, every new product, means new time and motion studies. Better equipment means that mechanical motions will perform operations with speeds that human hands and eyes cannot attain; safety devices remove inhibitions and let men reach speeds that they had not previously dared; new products need new work habits. Time and motion studies cause factories to install better lighting, better conveyors, better air-conditioning. To every industrial change must be geared the human body, which does not change, but that changeless human element is the greatest cause of industrial change.

Every new materials-handling system requires new time and motion studies. Such studies often result in new systems and the cycle continues to improve production

Westinghouse photograph



LIGHT-WEIGHT CONTEST

Scheduled for Materials Suppliers in Textile Field

SHIPPING of "warps" from factories which make rayon threads and yarns to mills which weave fabrics is in its "just beginning" or "infancy" stage right now, but it is growing rapidly. And it is presenting a new field to makers of lightweight metals, woods, and other materials; a new arena for battles among the materials which are sold on the strength-for-weight basis.

The warp is made up of the lengthwise or "strength" threads of a fabric, the crosswise threads (which are woven into the fabric by the shuttles) being known as the "woof" or the filler. All the warp threads for a single loading of a loom are wound side by side on a mandrel which is called the beam. Light weight is essential to the beam since heavy weight means inertia and inertia can cause breaking of threads. Therefore the supplying of materials of which the warping beams are to be made is a competitive field among makers of magnesium, aluminum, stainless steel, hydrolized or laminated woods, plastics, and glass.

When the warps are shipped from plant to plant they must be wound on beams to hold the threads in place. Sometimes these beams are warping beams which will fit the machinery in the receiving plant, and sometimes they are special shipping beams from which the warp will be removed before installation in the loom, the shipping beams then being returned to the thread manufacturing company. Warping beams also may be returned.

A single truck load may contain dozens of warps. Therefore the weights of the beams are highly important in shipping costs.

The beams also must be able to stand the handling methods which truck loaders are apt to use, and the shocks and stresses of transportation. This calls for care in structural design as well as in the selection of materials which can withstand abuse.

Structural strength problems can be still greater in patented beams which are made demountable or in separable parts to solve problems of transferring warps from shipping to warping beams and to reduce the shipping space needed for return trips.

In addition to meeting such requirements the beam materials must be corrosion resistant to the extremely high humidities which are maintained in textile mills and to the chemicals which are found in some threads.

Cotton warps also are being shipped. Altogether, this market promises to be highly interesting to the makers of the materials which are most likely to compete for it.

FIRE PROTECTION

Needs Careful Study by Communities and Industry

FIRE DEPARTMENTS are marking fire hydrants with color and other codes to show how many gallons of water per minute can be pumped from each hydrant at full flow. Hydrants rated at less than 500 gallons per

minute receive one marking, 500 to 1000 a second, and 1000 or over, a third.

Many an industrial plant which depends upon the local fire department for protection may find that the growth of its community has exceeded that of the water supply and that there would be insufficient water supply at the nearby hydrants if the factory were to suffer a serious fire. This is especially true in towns which expanded greatly during the war.

The answers of fire departments to these situations are: more careful studies of water supplies and pressures, use of pumpers rather than depending upon hydrant pressures, and, in some cases, requiring the factories themselves to erect more adequate water tanks or to equip their premises with ponds.

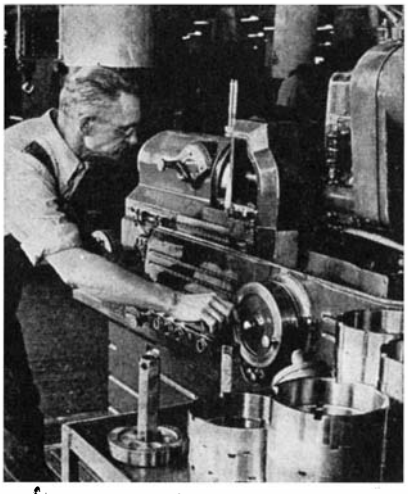
MACHINING SPEEDS

Increasing Rapidly as New Techniques are Developed

ARRANGING a thread-grinding machine so that the diamond dressers automatically true up the wheel at predetermined cycles, then stepping up the spindle speed to 15,000 revolutions per minute has enabled the DeSoto Division of the Chrysler Corporation to cut in 8 minutes threads which formerly required 32 minutes.

This is only one example of what is going on in the redesigning of machine tools to take advantage of high spindle speed possibilities. Just now, this field is having the same kind of growing pains that bothered the automatic screw machine field in 1920 and the tungsten carbide field in 1930. Single problems keep recurring in all new applications; the problem most common to high machine speeds being that the operator does not have time to observe and correct tool wear before the work is spoiled. Consequently these functions must be accomplished by automatic mechanisms built into the machine.

When a few more techniques of automatic control have been worked out, speeds will go much higher. Thus, in the forseeable future machines of the kind shown here will work at more than 100,000 revolutions per minute.



Automatic wheel dressing has stepped up the speed of this thread grinder

FINE THREADS

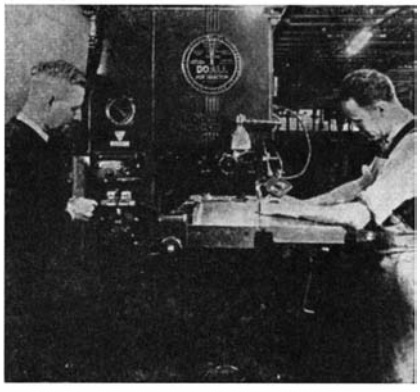
Now Produced By Stamping

STAMPING has now joined cutting, rolling, and extruding as a method for producing fine threads to precision tolerances.

SET-UP WELDING

Handles Difficult Machining Problems

THE CASUAL way in which accurate electrical welding can be handled today is illustrated by the rejoining by welding of saws after they have been separated for inside contour sawing; this rejoining being done by self-contained welding mechanisms which are mounted as parts of the sawing machines.



A saw-welding mechanism is mounted as part of this production band saw

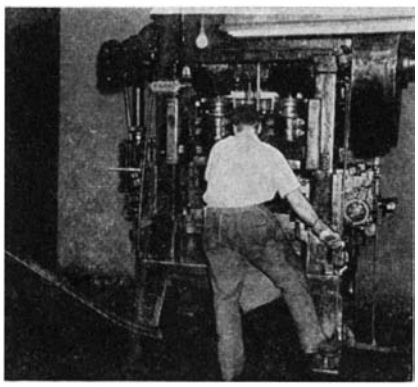
There are many other tool and guide parts which must be set up on machine tools under circumstances which make it difficult to use bolts, screws, clamps, magnetic plates, or any other of the more common set-up devices. Use of welding to handle such problems is quite new at the present but will become familiar within the next few years.

EJECTION MECHANISMS

Aid in Eliminating Production Troubles

PROBLEMS of materials handling and even of product assembling are being solved by better machine tool ejection mechanisms.

In the example of a high speed automatic Bliss press in the plant of the Owen Dyneto Corporation, armature laminations are turned out at the comparatively high rate of 220 per minute and yet they come out of the ejection tube shown at the left of the picture correctly stacked.



Correctly stacked armature laminations are delivered by tube at left

FASTER HEATING

Possible When Thermostats Are Adequate

WHEN thermostats are quick acting and adequate, more electricity can be fed to heating elements, larger gas flames can be used, heat sources of higher Btu capabilities can be employed. The higher capability heat sources heat up the work more rapidly, bring it to working temperature more quickly, restore temperatures as Btu's are lost to the work faster. The heat balance is one of more heat units available to the work, kept in check by quick acting and durable thermostats.

Soldering irons are using this principle. They reach working temperature in 90 seconds after being plugged in, maintain the temperature needed by the kinds of metals being soldered and by the structural shapes of the work and by the types of solder, and they do not over-heat.

ZINC COATS

Protect Wire, Solder Better Than Tin

METALS coated with copper or with tin for easy soldering are an old story. During the war the supply of tin became short and threatens to remain short for the first several years of peace. The problem, then, was to find a tin substitute.

Wire makers turned to alloys of zinc. And zinc coatings for wire have been developed to the point where they have two to three times the rust resistance of the old tin coatings, are excellent lubricants, and even stand up well in severe acid or gas fumes. They solder better than the tin.

The Public And The Engineer

Realism, Not Ivory-Tower Gadgetry, Keynotes the Thinking of Successful Automotive Designers. Economic Trends, Production Problems, and Public Tastes Sometimes Outweigh Engineering Considerations; While Research In Apparently Unrelated Fields Answers Baffling Questions

By LESLIE PEAT

WHENEVER a group of automotive engineers gets together in discussion of the car of the future, you can count on several realistic suggestions that the broader phases of the industry's economics and other non-engineering factors may be more important than technical design considerations. The day of rugged isolationism in engineering is about done for, despite considerable current pressure supporting the philosophy of specialization.

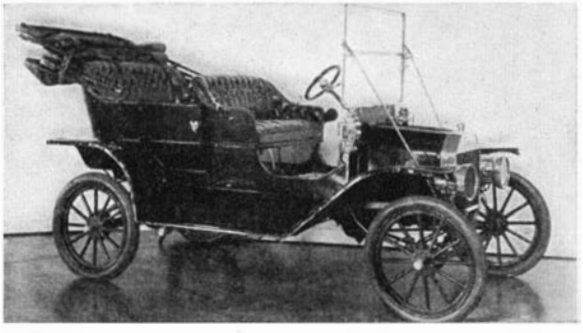
The meshing of the industrial gears required to produce automobiles, trucks, and buses in this country is something wonderful to behold. One of the larger corporations reports that it buys materials, parts, and services from more than 10,000 American firms. These include, of course: rail, water, highway, and air transportation; consulting engineering talent; attorneys not on the corporation's payroll; architects and industrial engineers; and the plethora of skills, buildings, and equipment needed in the complex structure of a single company.

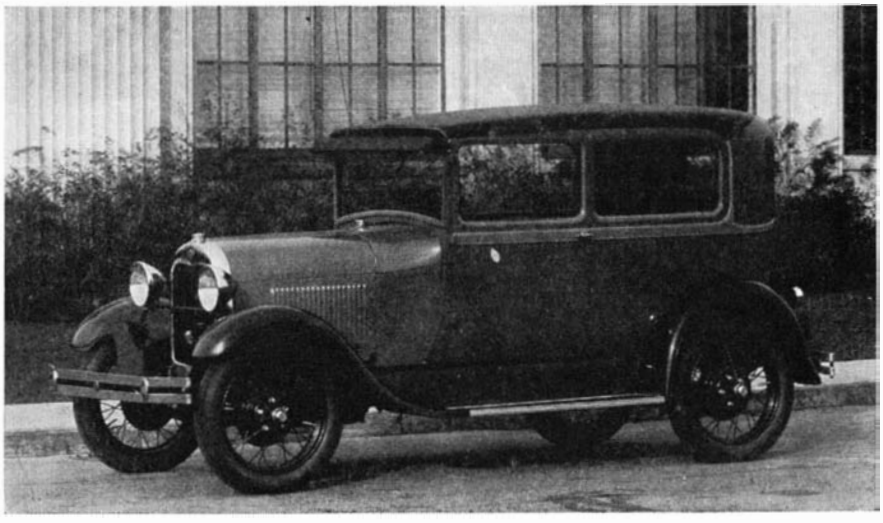
The realistic engineer knows that a wild-cat strike, a war, or a depression will throw the entire manufacturing structure out of gear. Except in his role of a citizen, such impacts are beyond his control. But he has learned, in the automotive industry at least, that he must keep up with mass-production manufacturing developments if he is to succeed as an engineer. And he is riding for a hard fall unless he also keeps up with competitive developments and knows in a general way what is being done in at least some fields of heretofore unrelated research.

Inventors of gadgets, revolutionary powerplants, and vehicles alike feel that they have no time for "extraneous" mental activity. The automotive engineer, if he is a man of experience, tempers his hopes for his brain child with an understanding of the complex mechanism of the end product; and frequently he will further temper his aspirations with some consideration of public acceptance, ease of repair and maintenance, and check his design with production engineers with a view to modifications that will permit ease of manufacture.

More and more vehicle engineers are learning more and more about fleet operation, yet important spokesmen of the automotive engineering fraternity openly declare that the designer knows too little about the use to which his product is going to be put. In the early days it was relatively easy to keep track of customers' complaints, and to get a measure of prospective customers' needs. Buyer and designer would sit down together and work out the design to the satisfaction of the former, and with some degree of certainty that the latter could and would produce it. The late Alexander Winton used to tell of some of these sessions in the early days of his career, and he recounted with gusto the sound ideas that he got in that manner.

Obviously, customer research and





Separated by 21 years of automotive progress, the Model "T" Ford (left) and the Model "A" (below) show how public's tastes influenced the designers

public opinion surveys must suffice in these days of millions of users and potential users of products produced in large volume. But the design engineer most likely to succeed is the man who is adept in adopting good ideas and who successfully applies them to his own design.

EXPERIMENTAL ERA—Taken because of its clarity, the history of the Ford Motor Company delineates the pattern of growth in the industry from the standpoint of coördinating design with production techniques. This pattern is just as true with the other older companies, such as Studebaker, Packard, White, and Mack, as well as the older component and parts companies.

The first published description of a Ford car, with photographs, was a single seater, with high, buggy type wheels, tiller steering, and an open flywheel on the engine just aft of the seat. It was a horseless-carriage with a bicycle acetylene lamp for a headlight, born in a small brick blacksmith shop. The Ford outgrew its buggy look through a series of models up to 1907 when it had become a six in the model "K" version, with the four-cylinder models "R" and "S." This was the era of mechanical experimentation, and sounding out public tastes in motor cars.

In the meantime other manufacturers were experimenting day and night, taking the pulse of public opinion. Some specialized in large, hand-made, expensive vehicles. Other firms concentrated on small cars for the low price bracket. But all of the cars of that period showed clearly that advances had to be made in metal working techniques before prices could be reduced. Fenders and hoods had riveted seams. Body panels were produced on metal bending brakes. Only the expensive cars boasted of running boards, while for years the carriage step sufficed. Expensive cars had surrey tops, with fringe and all the trimmings, and were the pride of the carriage builders who ventured into the new and unexplored field of the horseless-carriage.

FIRST MASS PRODUCTION—Then, beginning in 1908, came the era of the famous model "T", with its jokes, with its reputation for getting there and back home again; and with the wedding of the interests of the designers and the men in the shop. The beginnings of mass production in that era made the Ford a vehicle of universal transportation, a fact its maker advertised in every land where streets were at least dirt roads, and where towns were connected with roadways a little better than cow paths—sometimes.

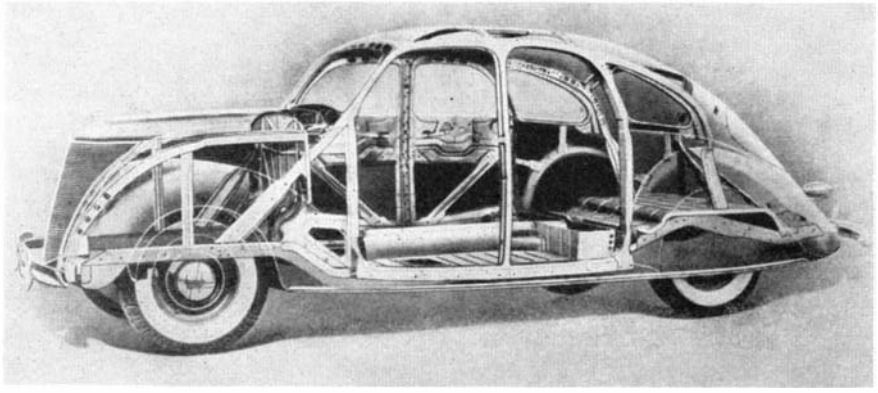
The problem paramount in that period was to make a sturdier car at less cost. Factories were small, and designers and shop foremen called each other by nicknames. Simplification in design was the watchword and it became a credo. Many a designer was told by his boss: "That looks all right, Son, but ask Joe in the shop if he can make it—and for how much."

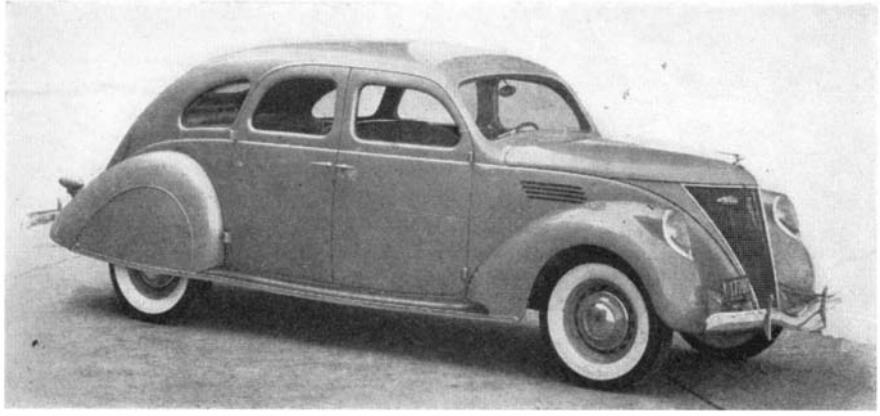
Thus the production engineer emerged as the wonder boy of an era of American industry, and the designer found out all he could about how products were made if he remained on the payroll. With the name of Henry Ford, the names of William S. Knudsen, Charles E. Sorenson, Walter P. Chrysler, K. T. Keller—and a host of others—emerged in newspapers and became a part of America's vocabulary. More and better jobs were provided through the techniques developed by these men despite the detractors who loudly protested that a mechanized age would reduce wages, cut employment, and decimate the American standard of living.

Because no vehicle is completely manufactured by the maker, but is assembled from a vast industry of more than 3500 companies supplying fabricated materials, parts, component sub-assemblies, chemicals, paint, tires, and other supplies, every participating manufacturer or supplier either had to get on the correct side of the mass-production philosophy or go out of the automobile industry altogether. They, and the vehicle manufacturers, stimulated the machine tool industry to produce increasingly faster machine tools and presses with automatic features.

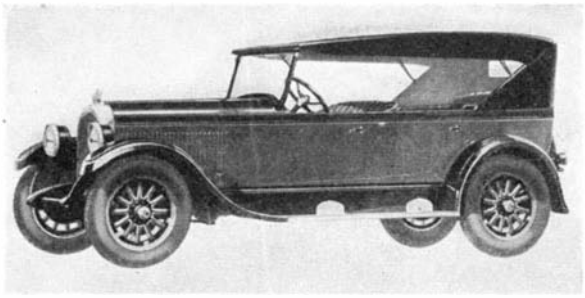
The basic elements of mass production depended on obtaining parts built of the correct materials and finished to dimensions set by the producer of the end product. Dimensional tolerances had to become an inviolate rule so that interchangeability could become a fact. The day of the file and hand fitting of parts was doomed as the glimmerings of a mass-production economy were brightening the industrial horizon while war clouds were gathering in 1913 and 1914.

A case in point was the production program of the Liberty engine of World War I. The planners of the project envisioned many American machine shops working on parts, which would be shipped to a few large engine plants for assembly, test, and shipment to Europe. To achieve this laudable goal, dimensional tolerances had to be held to





All steel body design, incorporating a rugged underlying structure (above), and emphasizing (below) clean, eye-pleasing, exterior contours, allows the automobile designer great license and represents many years of experiments



Advancements in sheet-metal working techniques were apparent in the curved body-panels and fenders of the first Chrysler car

a minimum. But too few shops had the machine tools or the know-how to hold parts they built to sufficiently close tolerances to finish the program. Some factories, which were large enough to build the parts themselves, produced the engine satisfactorily, although the projected goal was never met.

MODERN TECHNIQUES — The third important automotive design and production era may be said to have begun in 1924 with the introduction of the first Chrysler. By that time, manufacturing techniques had caught up with the designers' dreams. Streamline styling was possible on a mass-production scale because enough experience had been gained in sheet metal pressing and stamping to produce the required curves. This period also falls roughly in the third era of the Ford, with the introduction of the model "A" in 1929 and closing with cessation of production on the eve of World War II.

It was in this period that color was introduced and the highways glistened with colorful low-priced cars. Again, the stylists had to wait for the chemist to produce a finish which could be applied at a low cost. The vast amount of research in synthetic resins and even iridescent finishes containing ground fish scales, resulted in a resplendency of automobiles and trucks which were beyond the fondest dreams of the veteran natural varnish finishers insofar as low cost and permanency were concerned.

Such men as Alfred P. Sloan had a hard time to get their associates to believe that the man-on-the-street and Mr. Average Motorist would prefer a colored car to a black one. With the color finishes came rainbows of upholstery hues, chromium plated grilles and hardware; metal trim reflected the sun's rays from coast to coast. The magic of chemistry made all this possible, and the designer who failed to grasp this opportunity and seek more acceptable color combinations to intrigue customers, missed an important boat.

The buying public clamored for more. So the stylist's version of streamlining came along as soon as the machine tool industry, the steel mills, and the welding experts had developed presses, proper types of steel, and fabricating improvements to turn the blue prints into a vehicle. Giant presses dwarfed their predecessors as the development of the Fisher all-steel body came along. Deep drawing of low carbon steel was an "impossibility" that took time and money to lick. A number of steel mills actually constructed new continuous sheet and strip rolling plants where but a short time before the tall corn grew. Millions of dollars were invested to rehabilitate existing plants to produce miles of wide, mirror-like steel sheets. One of the ramifications involved in producing the designers' dreams was an intense research in the deep drawing qualities of low carbon steels in steel mill metallurgical laboratories, and another was a remarkable achievement in butt welding the thin sheets; a project to which fabricators and resistance welding equipment manufacturers made notable contributions.

FUTURE CARS—It is against this background, and the telescoping of several decades of manufacturing developments and materials researches during the recent war, that the inventor must place his ideas and the designer his prospective product. The development, manufacture, and merchandising of a product as simple as an improved fountain pen is a project of major dimensions these days, as compared with the pioneering era which made the name Waterman a household word.

It appears that the post-war era of the American automotive industry will have plenty of room for sound, ingenious engineering thinking. Many an older idea, long since discarded because materials research and manufacturing developments were not ready, will be dusted off and adapted to improve the automobiles of tomorrow. Competition in ideas will be keener because the nation and the world is more "science conscious" than ever before in the history of mankind. But in view of the structure of our industrial economy, the engineer who achieves success will be the man or woman who realizes that the days of the chaste and isolated ivory tower of engineering are gone, and whether he likes it or not, the engineer must widen his viewpoint to include economic and industrial factors that may have heretofore appeared to have been none of his business.

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FLYING CARS

Require Radical Changes in Design

FURTHER development of the idea of a hybrid flying automobile is in its test stage by the Stout Research Division of Consolidated Vultee Aircraft Corporation. Although the present version is designed chiefly as an airplane and secondarily as an automobile, some of the engineers working on the project hope to improve the suspension for greater roadability. In the air and on the road, it is driven with a pusher propellor, recalling the earlier days of aircraft design.

A feature of this version of the Stout Skycar is the wing design which eliminates the need for ailerons, rudder, and elevators.

PLASTICS WINDOWS

Seen as Possibilities in Automotive Vehicles

AUTOMOTIVE engineers and plastics experts are exploring the possibilities of transparent plastics for glazing automobiles. The Safety Code for Safety Glass, developed several years ago by the American Standards Association, has become the basic document for state regulations. Advent of transparent plastics, some engineers believe, may result in additions to the ASA code, or may require a new code covering the new materials.

Automotive engineers have asked plastics specialists to compile the physical properties of various materials, which they will study with a view to making recommendations as to the prospective use of some of these plastics in automobile and bus windows.

According to current opinion, none of the plastics materials will be suitable for windshields, due to the abrasive effects of windshield wipers. The plastics experts have indicated, however, that a number of improvements in the materials are looming on the horizon.

Industrial Uses Of Atomic Energy

Will Future Automobiles, Trains, and Ships be Powered by the Often Mentioned "Spoonful" of Material that can be Converted Into Useful Energy by Atomic Fission? Size of Power Plant, Economics of Power Source, and Other Factors, Enter the Picture

By LEONARD I. KATZIN

EDITOR'S NOTE: The accompanying article was prepared at the suggestion of the "Atomic Scientists of Chicago," one of the groups which collaborated in the construction of the atomic bombs. In the text is given a calm and dispassionate evaluation of the probabilities of future uses of atomic power, as viewed by men of science closely associated with current developments. Every effort has been made to free this discussion from the hair-trigger sensationalism that has been attached to the subject since the first atomic bomb fell on Japan on August 6, 1945.

PRE-WAR prospectuses of the benefits to be expected of atomic power included automobiles with power supplies built in for the life of the machine or, alternatively, "power pills" good for at least 2000 miles of travel. Small black boxes were envisioned to supply power to light, heat, and air-condition the city home, or to furnish all the power needed on the farm. Similar black boxes were to power airplanes which would then circumnavigate the globe without stopping or might even make trips to the moon. Coal-mining was to be a relic of the past, and prosperity was to be the lot of all.

On August 6, 1945, came the official announcement that the "Atomic Age" was actually here. It then became necessary to retrace our steps and to re-evaluate our judgment on the future.

One pound of U-235 = 11,400,000 kilowatt-hours = 1500 tons of coal = 250,000 gallons of fuel oil = 80,000,000 cubic feet of artificial gas = 40,000,00 cubic feet of natural gas.

EINSTEIN FIRST—Since 1905, when Albert Einstein first formulated the equivalence of mass and energy, scientific imagination has been busily exploring the possibilities of obtaining practically unlimited supplies of energy from the transformation of small amounts of common materials. The discovery of nuclear transmutation reactions by Rutherford, in 1919, indicated one possible means of causing this interconversion. It was found that in many nuclear transformations a net loss of mass occurs, which is equivalent to the amount of energy released in the transformation. This source of nuclear or "atomic" energy has been investigated extensively but has been found to be of no practical significance because of the small scale on which transformations could be accomplished. Only a few atoms could be metamorphosed at a time. In many cases, the bombarding particles necessary to accomplish these transformations could be produced only with the expenditure of very considerably larger amounts of energy.

In 1938, the experiments of Hahn and Strassmann in Berlin proved that the so-called "transuranic elements" produced by Fermi, in 1934, upon bombardment of uranium and thorium with neutrons, were actually radioactive isotopes of elements from the middle of the periodic table. This indicated that the reaction occurring was a totally new one; namely, fission of the uranium or thorium nucleus into large particles. Further physical investigations showed that energy was released in this process corresponding to about 200,000,000 electron volts (about 0.00032 ergs) per fission. This amount of energy, corresponding to conversion of approximately one quarter mass unit per atom, is the largest single nuclear reaction energy known. For comparison, the heat of combustion of a molecule of TNT is only about 35 electron volts.

Further investigations showed that the disintegration process releases, in addition to the fission fragments, from one to four neutrons. The possibilities are thus present for a chain reaction, in which the fission of one uranium nucleus by a neutron gives rise to more neutrons, which in turn may be absorbed by other uranium nuclei to give a self-propagating chain of energy release. This represents the first type of nuclear reaction found that justified consideration as a practical source of energy from the interconversion of mass and energy.

U-235 AND U-238—The further discovery was made that it was the scarce isotope of uranium, U-235, present to about 0.7 percent in natural uranium, which was the one readily undergoing fission. It was realized that isolation of this isotope would solve most of the problems involved in devising a chain-reacting unit, but it was equally evident that the separation of heavy isotopes with such a small difference in mass could be extremely difficult, and that such a separation on a large scale would be a major undertaking. The use of natural uranium itself was an intriguing possibility, but the problems introduced by the relatively inert abundant isotope, U-238, made it uncertain whether a chain-reaction could be achieved using unseparated uranium.

It was vaguely recognized by a number of workers that the use of some slowing-down material to keep the neutrons in the vicinity of the uranium, and to take advantage of the increased capture reaction of the U-235 with slow neutrons, would be helpful. At this point, war-time security curtains were dropped on the discussion of atomic energy and on the work underway on its development.

With the partial lifting of the secrecy curtain again in August, 1945, it was revealed not only that U-235 had been separated from the common isotope, U-238, and could

be used to give an explosive chain-reaction, but that the problem had been solved of obtaining a chain reaction with unseparated, natural uranium. A few comments may be made on the basic principles of the chain reaction thus revealed.

It is typical of all known chain-reacting fission systems that there is a minimum or "critical" size below which they will not function. This critical size is influenced by the shape of the structure, and by its composition—that is, whether it is pure U-235, or U-235 mixed with U-238 and/or other substances. (In the discussion from here on one may read plutonium-239—the new synthetic isotope, which is similar in many of its properties to U-235—instead of U-235.) The physical picture for this is rather simple. To maintain a chain reaction, a portion of the neutrons given off in fission must be recaptured by U-235 atoms to give at least an equal number of "second generation" fissions. The neutrons are given off in all directions, and may be lost by leakage from the structure. If the volume-to-surface ratio is high enough, the neutron loss through leakage is below the critical amount, and the chain reaction may maintain itself. In order to help keep this surface leakage down in non-explosive applications, a "slowing-down" medium or "moderator" (graphite, beryllium, heavy water) is used to keep the neutrons in the vicinity of the uranium. This in turn lowers the critical amount of uranium to be used, compared to that when no moderator is used.

"Atomic power plants . . . must be reserved for the special purposes for which other types of power are not so well suited."

ABSORPTION OF NEUTRONS—In addition to the loss of neutrons through external leakage, some may be lost through what may be called "internal leakage." This is the absorption of neutrons in the chain-reacting structure in such fashion that fission does not occur. One such loss is by absorption in the moderator, another is by absorption in the U-238 (if present), and a third is by an occasional absorption in the U-235 which does not lead to fission. A fourth source of loss is in chemical impurities in the uranium which may absorb disproportionate numbers of neutrons. It is readily seen that if these "internal leaks" are high enough, the chain-reacting condition will not be reached even with a structure of infinite size. In non-explosive uses of the chain reaction, advantage of this behavior is taken to control the structure. Highly absorbing strips of cadmium or boron steel are inserted to the point that only one neutron per fission is left to give another fission. In this fashion, a steady power level may be maintained.

From this extremely brief description one outstanding fact emerges: It is not proper to think in terms of a power source of a gram or a fraction of a gram of U-235. No matter whether one wants much power or little power, the same irreducible minimum of U-235 must be used. From the official Smyth Report on atomic energy for military purposes it is learned that the critical amount for pure U-235 is somewhere between two pounds and 220 pounds for an explosive reaction. If use is made of one of the moderators mentioned earlier, the critical amount of uranium may be expected to be somewhat less than for the metal alone. For unseparated uranium, it is necessary to multiply the critical values by a factor of 140, the ratio of the weight of U-238 in the mixture to the weight of U-235, so the limits become 300 pounds and 11 tons, respectively. This weight, of course, does not include the moderator.

Any savings in uranium weight due to the use of a moderator are more than counter-balanced by the "poisoning" effects of neutron absorption by the U-238. The Smyth Report tells that, with a graphite moderator, over six tons of uranium metal together with an unspecified amount of uranium oxide are needed to achieve the chain-reacting condition, so the 11-ton upper limit may be near the truth for this moderator. The weight of the graphite in the structure could not be much less than this, so the minimum weight of a chain-reacting graphite-moderated "pile" (to give the structure its common name) must be taken as on the order of 20 tons. The unit working with pure U-235 may be considerably less, but can hardly be less than several hundred pounds.

RADIATION HAZARD — Another extremely important factor affecting the size of the atomic-power structure is the radiation hazard. A chain-reacting pile, operating at even low power levels, is the source of tremendously intense beta-, gamma-, and x-radiation, in addition to neutrons. The equivalent is that of many pounds and even tons of radium. Shielding is necessary and, for a high-energy pile, consists, at a minimum, of two or three feet of steel, or several times that amount of concrete. Such shielding adds to the weight and bulk of the pile.

A third item which makes the pile a sizeable machine is the very necessary cooling system. Without efficient removal of the heat generated, temperatures high enough to fuse the structure of the pile would be readily attained, if the power level were designed to be more than just a few watts.

"Not only will it be impossible to have an indefinitely small nuclear power source based upon fission of uranium, but any such power source must be heavy and awkward, and quite dangerous. . ."

Summarizing these points, it becomes clear that not only will it be impossible to have an indefinitely small nuclear power source based upon fission of uranium, but any such power source must be heavy and awkward, and quite dangerous in case of mishap of one sort or another. These points of themselves rule out the pre-war dreams of the automobile with the life-time power-supply built in, or of the power pill which could be substituted for gasoline. Any visions of individual atomic power units for every home or farm must also be abandoned, so long as uranium fission is to be the source. Bulk and weight of the atomic power plant make equally illusory its use in airplanes for the purpose of eliminating the decrease of the useful load capacity by the fuel load. In fact, it is questionable whether any conveyance should carry such a dangerous type of power-plant. Railroad engines certainly do not need it, being adequately driven by the usual heat engine, electricity, or the mercury vapor turbine. It might perhaps be a moot question whether an atomic power plant would prove useful on a seagoing vessel. This would depend primarily upon the extent to which increases in useful cargo space at the present time are limited by required increases in the propelling mechanisms. It has been estimated that fuel costs are only 12 percent of the operating costs of a 17,000-ton liner.

In a negative fashion, perhaps, it has been indicated that the possible use of atomic power plants is at present best restricted to stationary, high-power units. An idea of the possibilities of the pile in this direction may be gained in rough fashion by comparing the size of Mussel Shoals, Boulder Dam, or Grand Coulee, with, say, a big-city power

substation. Although perhaps not precise, this comparison gives an idea of the comparative magnitude of the physical installations involved for million kilowatt power outputs through water power and uranium fission, respectively. Besides the lesser physical size of the atomic power installation, there are the advantages of its independence of large and constant sources of flowing water, a condition which automatically determines the location of water-power plants.

ATOMIC POWER INDEPENDENCE One of the biggest virtues of an atomic energy power plant is its essential independence not only of natural restrictions, such as watercourses, but of large fuel supplies

"It is questionable whether any conveyance should carry such a dangerous type of power plant."

and of the large-scale transportation these make necessary. As will be pointed out, the energy output of a pound of U-235 is about that of 1500 tons of coal. The relative transportation problems need no further elaboration. This freedom from the demands of large-scale supply makes possible exploitation of the values inherent in building power installations close to the sites where they will be most useful, diminishing power distribution costs in some cases, and perhaps, in others, opening up to development many regions which are rich in natural resources but which otherwise might not be readily tapped. It therefore becomes necessary to consider the economic aspects of atomic power development.

A pound of uranium-235, completely consumed by fission, will give a total of some 11,400,000 kilowatt-hours of energy. This is roughly equivalent to half a day of operation at a power level of one million kilowatts, a power level that Professor Robert Oppenheimer has said he believes commercially attainable within five years time. It must be pointed out that this figure for energy release by fission is some 0.1 percent of the total energy-equivalent of the mass involved, because only about one quarter of a mass unit is consumed in the fission process, out of a total of 236 units (235 plus the neutron). Equivalent amounts of energy are released by combustion of roughly 1500 tons of coal, 250,000 gallons of fuel oil or gasoline, 80,000,000 cubic feet of artificial gas or 40,000,000 cubic feet of natural gas.

By making the possibly incorrect assumption that the U-235 is consumed with the same efficiency as are the combustion fuels with which it is being compared, and assuming that its efficiency of conversion to electrical energy is the same (see below), we may obtain the following rough comparisons: In order to compete with bituminous coal at $5 a ton (approximately the 1942 wholesale average), a pound of U-235 must cost not more than $7500. To compete with fuel oil at three cents a gallon, it must again be as low as $7500. Competition with 15 cent gasoline is effective at $39,000 a pound. To compete with artificial gas costing fifty cents a thousand cubic feet it may still cost $39,000 a pound, while natural gas at the same price would demand a competitive price of about $20,000 a pound. Present information does not allow estimation of the cost of pure isotope U-235 in routine mass production; the government figures released on the costs of the atomic bomb projects give no indication of this. It may therefore be better to consider the cost of unseparated natural uranium, which may be readily used in some kinds of piles.

URANIUM COST — The pre-war market price of uranium, in the form of the nitrate, was about $7 per pound of element. Uranium metal, which was a rarity before the

"No matter whether one wants much power or little power, the same irreduceable minimum of U-235 must be used."

war, and which the Smyth Report indicates is necessary in especially pure form for pile operation, may be several times more expensive. Using, for a round number, an arbitrary $20 per pound as the cost of metal ready for the pile, and remembering that 140 pounds of uranium are needed for one pound of U-235, the apparent cost of a pound of U-235 is perhaps on the order of $2800. This does not include any additional cost of processing, nor allow for plant installation costs. However, the Smyth Report indicates that part of the U-235 consumed in the pile is replaced by plutonium-239 which is formed from U-238 following capture of a neutron. The formation of the fissile plutonium isotope acts to raise effectively the "fuel value" of the uranium by indirectly consuming part of the U-238. It is guesswork to estimate the extent of this effect without more information, but it is not impossible that the effective amount of U-235 is thus doubled or even trebled. Operating in the opposite direction, of course, are unknown factors determined by operations or conditions peculiar to the pile. The extent of influence of these factors can not be estimated without further information.

FAVORABLE COMPETITION — On the basis of the discussion so far, U-235 would appear to be a power source capable of competing quite favorably with the conventional coal and petroleum fuels. It is necessary to indicate, however, that the largest factor in costs of power delivered to the consumer is that of distribution costs, and the costs of the manufacture itself are usually estimated as only 15 to 20 percent of the total. Thus even a marked decrease in the cost of production of power would not necessarily result in a proportionate decrease in the cost of power distributed to the consumer.

It is important further to consider the total fuel consumption of the United States. Thus, in 1942, according to the publications of the Bureau of Mines, approximately 640,000,000 tons of coal were mined and consumed. On the basis of 1500 tons of coal being equivalent to one pound of U-235, this would correspond to a consumption of about 220 tons of U-235. The production of natural gas for the year 1942 was 3,000,000 million cubic feet, or the equivalent in energy of approximately 40 tons of U-235. Similar figures may be calculated for petroleum products. Turning attention to electrical power, it is found that for 1942 the capacity of the electrical generating plants of the United States was about 46,000,000 kilowatts. This corresponds to a consumption of four pounds of U-235 every hour or some 18 tons of U-235 in the course of a year.

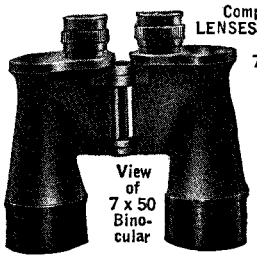
Published estimates of the uranium in sight from the several large pre-war producers of this mineral (the United States, Czechoslovakia,

"Any visions of individual atomic power units for every home or farm must . . . be abandoned, so long as uranium fission is to be the source."

Belgian Congo, Canada, and Russia) indicate a total of about 20,000 tons of uranium readily available. About half of this estimated, immediately-foreseeable uranium is present in the United States and Canada. It is clear that even if it proved practical to consume more than 0.7 percent of the uranium in fission, the long-time importance of uranium as a

SENSATIONAL WAR BARGAINS *in* LENSES & PRISMS

NOW! MAKE YOUR OWN BINOCULARS!



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ALL ARE ACHROMATIC LENSES

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6161-S	24	48	1.25
6162-S	25	122	1.25
6164-S*	26	104	.80
6165-S	27	185	1.00
6166-S	29	54	1.25
6168-S	29	76	1.25
6169-S	31	122	1.50
6171-S	32	171	1.00
6173-S*	34	65	1.00
6176-S*	38	131	1.00
6177-S*	39	63	1.10
6178-S*	45	189	1.50
6179-S*	46	78	1.25

*ASTERISKED ITEMS are uncemented, but FREE cement and Directions included with uncemented sets.

USES:—Use these Lenses for making Projecting Lenses, Low Power Microscope Objectives, corrected Magnifiers, substitute enlarging Lenses, Eye-Piece Lenses, Macrophotography, Gadgets, Optical Instruments, etc., etc.

MISCELLANEOUS

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4009-S	Heat Absorbing Glass 4" x 5". Each.	.35
4010-S	Heat Absorbing Glass 2" x 2". Each	.10
523-S	Six Threaded Metal Reticle Cells	.25
26 S	First Surface Aluminized Mirror, Diam. 1¼". Each.	.25
624-S	Neutral Ray Filter size 4¾" x 2½".	.25
3022-S	Round Wedge 65 mm. Diam. Each.	5.00
22-S	Inclinometer—Aircraft type. Each.	.25
1030-S	2" Diam. Reducing Lens. Each.	.25
1031-S	Perfect 6 Power Magnifier—Diam. 28 mm. Each	.25
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Consisting of Prism, Mirror and Condensing Lens. You can use these on your Microscope to project screen images . . . with magnification power of 400 and up according to screen distance.
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If you mount right angle Prism in front of Camera Lens and point camera straight ahead, you can take shot to left or right side without subject's knowledge. Technique successfully used by famous Press Photographers.

Stock No.	Type	Base Width	Base Length	Price
3049-S	Right Angle	69 mms.	167 mms.	$10.00
3047-S	Right Angle	53 mms.	103 mms.	4.00
3038-S	Roof Prism	18 mms.	34 mms.	2.50
3042-S	Right Angle	41 mms.	40 mms.	1.00
3045-S	Right Angle	70 mms.	168 mms.	8.00
3001-S	Lens Surface	20 mms.	14 mms.	2.00
3009-S	Porro	52 mms.	25 mms.	1.00
3016-S	Pentagon	45 mms.	22 mms.	.75
3029-S	Dove	16 mms.	65 mms.	1.25
3036-S	80 Degree Roof	60 mms.	36 mms.	4.00

ALL ITEMS FINELY ground and Polished but Edges Slightly Chipped or Other Slight Imperfections Which We Guarantee Will Not Interfere with their Use. Come Neatly Packed and Marked.

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One ream of Lens Cleaning Tissue (480 sheets) size 7½" x 11".
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Rugged, strong, originally constructed for U. S. Tank Corps. Consists of 2 fine Periscope Mirrors mounted in metal and plastic. Perfect condition. Only plywood body frame is required to finish this exceptional Periscope. First surface mirror is well protected by glass windows. Set weighs 2¾ lbs. Overall length of mount 6⅛", width 2⅛". Would normally retail at $40 to $50.
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source of ordinary power in competition with coal, oil, and gas fuels would be minor. Atomic power plants, therefore, must be reserved for the special purposes for which other types of power are not so well suited, as has already been suggested above.

MAINLY HEAT ENERGY — The question is often asked, whether there is any peculiarity of the energy released by nuclear fission which enables it to be more efficiently used than energy available from more familiar sources. For the present, at least, the answer must be that fission energy is mainly heat energy liberated through collisions of the extremely energetic fission fragments and neutrons. A rather minor portion of the fission energy is due to other radiation given off in the pile. As heat energy, it is susceptible to the classical methods of conversion of heat into work.

The unique characteristic of heat generated by the pile is that the temperature which may be attained is limited only by the operator's desire to maintain the physical characteristics of the materials of construction. With ordinary fuels, the heat of reaction and rate of combustion set limits on the temperature which may be reached. In the case of the pile, the problem is to keep the temperature down to the limits set by the physical structure. Because of this characteristic, it is theoretically possible to operate a power cycle at such an elevated temperature that the efficiency of the conversion of heat into work is greatly increased.

In summary, it may be said, although atomic power is probably cheap enough to compete with the common fuels as sources of energy, the materials are so scarce as to make uneconomic their random use. Although atomic power installations based on uranium fission are not minute, their power output for unit size can be disproportionately high when compared with other types of sources. The coupling of small size and independence of large fuel supplies or watercourses, however, gives the pile certain unique values in situations in which these characteristics are important.

PROPULSION UNITS

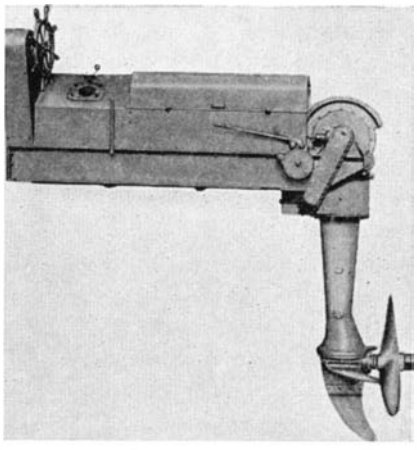
Bring Flexibility of Operation To Many Marine Craft

TAKING a few leaves from outboard-motor history, large propulsion units using Diesel or gasoline engines have been proved in war action all over the world and now offer marine commercial operators a high degree of efficiency of operation and maintenance. These operators can now have the maneuverability they have so often envied in small boats equipped with the conventional sport-type outboard.

The Navy uses these units on "Rhino Ferries" and "Rhino Tugs," and it is probable that they will be used in great quantities as outboards on small barges, scows, lighters, tugs, fishing smacks, dredges, pile-drivers, and many other work vessels, but this is by no means the limit of their applicability. They can be used on any barge or vessel that will allow the submersion of the propeller.

One of the outstanding features of the "Harbormaster," as these units, made by Murray and Tregurtha, are called, is the 360-degree propeller thrust steering. Here, for the first time in commercial marine history, operators have instant control with power by simply turning the large steering wheel. This is possible because steering is done by the thrust of the propeller itself and the propeller can turn through a complete circle, thus avoiding the limitations of rudder steering.

Another feature is the 180-degree elevating mechanism. With this, the



Heavy-duty marine propulsion unit with steerable propeller that can be tilted completely out of water

one-man operator can angle the entire submerged section out and backward to a position directly overhead, if necessary for repair work. The elevating mechanism has another important function in that by angling the submerged section to say 20 or 30 degrees, or even 45 degrees, power and steering can be maintained in shallow or reef-filled water where the craft or vessel itself will float. This ability opens new fields to marine commerce—factories, plantations, towns, and cities which until now have not been "on the channel."

With the Harbormaster, possible damage to propulsion and steering apparatus is cut to a minimum because of a patented shear pin. When an immovable submerged obstruction is struck, this pin shears off, allowing the vertical assembly to ride up and backward *over the obstacle,* free from damage and without the loss of forward motion. In the matter of a minute or so a new shear pin can be inserted while under way!

Harbormaster models, both gasoline and Diesel, range in power from 45 to 300 horsepower.

PUBLIC RELATIONS

Important to Business And Industrial Executives

TOMORROW'S business and industrial executives will need to be "as familiar with human relations involving public attitudes and customer relations as yesterday they were experts in the field of production and sales," declares Paul Garrett, vice president of General Motors Corporation, in an article for the Annual Directory Issue of *The Constructor,* official publication of the Associated General Contractors of America.

"Leaders of industry who are blazing new trails in industrial management are men of this type," he explains. "And 10 years from now business leaders will have become more expert in this new field, just as they have always learned to become expert in every field on which industrial progress depended."

Recent major problems of business have not stemmed directly from the traditional subdivision of business at all, he continues. They have had to do with such things as taxes, labor unions, governmental regulations, community relationships, and so forth. These problems bear about as importantly on business operation today as designing, engineering, or production.

"If there is any secret to success in building good public relations,' Mr. Garrett asserts, "it is that you must start at home and work from the inside out. Good relations outside grow from good relations inside. If the immediate family is not happy and informed, those whom it meets on the outside will not be. To outsiders those who work for a company are the company—and outsiders judge the company by the folks in the company they know.

"The feeling that he is being treated well is almost as important to an employee as to know that he is being well paid.

"Lack of attention to grievances, real or fancied inequalities in treatment, failure to explain whys and wherefores of company policies—these are the things that underlie most troubles.

"How the employment office hires, what the foremen do, how the paymaster pays, and how the management conducts itself—these are the ABC's in the building of harmony in the company family.

"With good relations inside the plant, you have the base for good relations with the public outside. But you can never take those relations for granted. Living right is not enough. People must know you live right.

"The art of public relations is in the art of multiplication—that is, the art of multiplying endlessly the good impressions of a company."

WOOD TREATMENT

Introduces Chemicals Into Sap Stream

SCIENTISTS of the United States Department of Agriculture have developed a method by which farmers and other users of wood-lot trees can introduce chemicals into the sap stream of the wood to increase the length of service of fence posts, bean poles, garden stakes, and other utility poles.

The method is neither difficult nor expensive to use. The fresh-cut saplings are simply allowed to stand in a wooden tub or trough containing the right amount of chemical in solution for a period of about six hours or until they have taken up the required amount of chemical.

Chemicals recommended include chromated zinc chloride, zinc chloride, and copper sulfate (bluestone), of which the chromated zinc chloride is reported to be the best. The chromated zinc chloride is twice as expensive as zinc chloride or copper sulfate, but it protects the wood longer, and is also less corrosive to wire staples than copper sulfate. One pound of either of the chemicals dissolved in a half gallon of water will treat one cubic foot of wood.

Best results are obtained when the saplings are treated immediately after cutting. When it is not possible to treat them soon after cutting, or if the pitch oozes out of the soft woods, about one inch should be sawed from the cut end immediately before treating to permit the chemical solution to enter the sap stream. The lower branches may be removed for convenience in handling, but a few upper branches left attached will hasten the treating process by facilitating sap movement.

Many kinds of both hard- and soft-wood saplings or trees of a size easily handled can be treated by the sap-stream method. Pine trees are more effectively protected against damage by insects and decay than are many hard-woods. The treatment is best applied during the spring and summer, particularly on bright sunny days, when the sap flows most rapidly. Hardwoods can be treated only from early spring to late summer. Pine trees can be treated any time except during freezing weather. Evergreens, treated in winter, require about a day to take up the necessary amount of solution.

The method of introducing chemicals into trees and poles through the sap stream has been known to scientists for years, but until recently the method has not been practicable for use by farmers. The scientists warn that all of the recommended chemicals are poison-

ous and should be kept out of the reach of children, pets, and livestock. None of them should be stored in metal containers. Because copper sulfate is corrosive, it must not be used in metal tubs or troughs.—*Timber Topics.*

EXPLOSIVE RIVET

Can be Set Without "Bucker"

AN EXPLOSIVE rivet especially adapted to meet the demands of

Setting the new explosive rivet

peace-time mass production methods is the latest development in the explosive type of "blind" fasteners used extensively by the aircraft industry during World War II. They are fastened in place by firing a small explosive charge within the shank of the rivet.

Retaining basic features of previous types, the improved design eliminates the necessity for close tolerance drilling and provides rivets which will accommodate a wide range of metal thicknesses. These features are in direct contrast to those of the explosive rivets supplied to aircraft manufacturers where precision tolerances and a wide variety of lengths were required.

After explosive rivets are in place, the tip of an electrically heated iron is applied to the rivet heads. Heat fires the explosive charge within approximately two seconds. The shank of the rivet is thus expanded to fill the hole completely and a barrel-shaped head is formed on the "blind" end to lock the rivet securely in place. The strength of these rivets is only slightly less than that of conventional solid rivets.

These improved rivets are now provided in 1/8, 5/32, and 3/16 inch diameters, the Du Pont Explosives Department says, and will be produced in additional sizes. They are made of various materials including several aluminum alloys, brass, copper, mild steel, and Monel metal.

Explosive rivets will be useful in the automotive industry for construction and maintenance of chassis, bodies, accessories, and parts. In refrigeration—cabinet construction for farm and home freezers, locker plants, commercial refrigerators—explosive rivets will be helpful at many points.

They are well adapted for the construction of prefabricated housing, for attaching paneling and similar applications. They will be suited to the construction and sealing of air-conditioning ducts and in the heating and ventilating field for the fabrication of furnaces, stokers, and housings.

LIGHTER WICKS

Now Braided of Asbestos Yarn

A CIGARETTE lighter wick that practically never requires trimming or replacement is the latest thing to come out of the textile research laboratories of United States Rubber Company.

Made of asbestos yarn, the new wick is tightly braided to prevent fraying and "blossoming" which frequently puts lighters out of operation, the company announced. A small core of glass yarn provides improved capillary action for proper feeding of fluid.

Textile engineers developed the braided wick during experiments with Abeston, a fire-resistant fabric used in ironing board covers. Wicks were formerly twisted instead of braided and they had a tendency to unravel, producing a flickering, smoky flame, the researchers reported.

HIGH-SPEED TIMER

Works to 1/10,000 Second

HOW FAST is pitcher Bobby Feller's "fast one?" How slow is a "slow ball?" How many miles per hour does one of golfer Byron Nelson's drives travel? How fast is one of gridder Sammy Baugh's "bullet" passes?

Long a matter for conjecture on the part of sporting hot-stove leagues, such speeds are just a few of many that can be clocked scientifically by the General Electric time interval meter, versatile electronic device with a variety of uses.

Capable of checking extremely short time intervals, ranging from three seconds down to 1/10,000th second, the time interval meter can measure velocity of any moving body, can determine speed of a camera shutter, can check synchronization of flash and shutter on a camera, and can test electrical relays, according to G-E electronics engineers.

In measuring speed of a moving body, be it a baseball, football, golf ball, or even a rifle bullet, two photo tubes with light sources aimed on them are set up at a known interval apart directly in line of flight of the moving body. The light sources shining on the photo tubes create two beams of light.

The meter begins timing when the moving body in flight breaks the first beam of light and ceases timing when the moving body breaks the second beam. Amount of time consumed between breaking of beams is indicated in milliseconds on the meter dial. With the distance between beams known, the speed of the moving body can be computed accurately.

ALUMINUM PLATES

Reduce Weight In Pianos

A PIANO plate of cast aluminum alloy, 80 pounds lighter in weight than the ordinary iron plate used in these instruments, is now in production. The successful development of the aluminum piano plate by the Aluminum Company of America, and Winter and Company, piano manufacturers, was aided materially by a new stress coat analysis method developed at the Massachusetts Institute of Technology. This method, made commercially available through the facilities of the Magnaflux Corporation, consists essentially in covering the metal with a coating of brittle lacquer and then stringing the plate. The pattern which results when the lacquer

The new light-weight aluminum plate for pianos weighs only 45 pounds as compared with 125 pounds for the older type. This reduction in weight makes for a more easily movable unit

cracks under tension of the piano strings is then analyzed. Strain gages and special electronic equipment are used to complete the analyses. The result of these stress analyses led to a more economical and scientific distribution of the metal which further lightens total weight without sacrificing strength. It was in the development of the aluminum plate, called Alumatone, that this technique of stress analysis was first applied to problems in piano construction. The aluminum plate results in a piano that can be moved around without effort or strain; the light weight of the instrument reduces wear and tear on rugs and carpets.

SANITATION

Increased by Complete Destruction of Bacteria

NEW GERMICIDES tried out in the bacteriological laboratories at the State Experiment Station at Geneva, New York, have resulted in the complete destruction of bacterial life within five minutes after exposure of the organisms to concentrations as low as one part of the germicide in 20,000 parts of water.

The new materials are known as "quaternary ammonium compounds." While not yet generally available, all data so far collected by the Experiment Station food bacteriologists show a definite future for their use in sterilizing procedures in food processing plants. At present some 15 different materials are being tested at various concentrations against 30 to 40 species of bacteria, including types known to be of importance as causes of spoilage and contamination in food industries.

RUBBER FACTS

Hinge on Cost Plus Performance

PRESENT plants will probably produce at least 1,100,000 long tons of synthetic rubber in 1946. They cost 750 million dollars to build. That is an investment of approximately $700 for each ton of annual production. If amortized over 20 years with 3 percent interest charged on capital investment, these plants would show a capital cost of just over four cents per pound of synthetic at the start, shading down to nothing in 20 years. Thus, at the projected selling price of the product of 16 cents per pound under peace-time conditions, the amount available for raw materials, repairs, overhead, and selling costs will start at around 12 cents per pound of product and increase year by year as the capital is written off. Yet, that's only one way of calculating. But with butadiene from petroleum at six to seven cents per pound, synthetics appear competitive with natural rubber. Now, call in the politicians.

Reports from experts who have recently returned from careful examination of German synthetic rubber plants and plans, place the hurriedly constructed American industry well ahead of the older German one in quality of product, efficiency, and production.

For many important uses, rubber processors believe the various synthetics can never be displaced by plantation rubber, even at ruinous sacrifice prices. In other applications, the future surely holds great promise for mixtures of synthetic and natural rubbers, also practically regardless of price. In still other applications the natural product will hold its place, according to informed opinion, even though it should cost 10 cents or so per pound more than its synthetic competitors—an unlikely situation. In the first class fall many uses embraced in the category of mechanical rubber goods and solvent hose. Tires seem probable members of the second class although various parts of tires for different services will fall into both the second and third of these classes. Side walls of balloon tires will require natural rubber for best service. —*The Chemical Digest.*

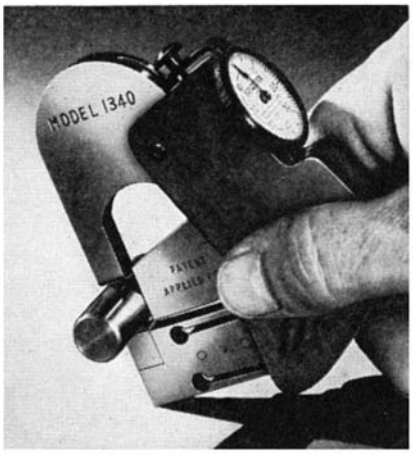
New Products and Processes

DIMENSIONAL VARIATIONS

Measured Visually With Snap-Gage

FATIGUE and differences in the sensory perceptions of the operators are practically eliminated as sources of error with a recently introduced visual-indicating snap-gage. Dimensional variations are read directly in calibrations of .0001 inch on a dial with an .008 inch range.

Operation of the gage, manufactured by the Federal Products Corporation, is based on a flexible lower anvil which transfers the dimensional variation of the workpiece to the dial indicator. Both anvils are tungsten carbide tipped and an insulating finger grip is provided to prevent heat transfers from the user's hand.



Snap-gage substitutes vision for touch

SILICONE VARNISH

Gives New Advantages In Electrical Insulation

A NEW SILICONE varnish known as DC 996, enables all types of electrical shops to realize the new advantage of silicone insulation. Among those advantages are greater protection against failure due to sustained overloads; greatly increased service life of electrical insulation; higher permissible operating and ambient temperatures; increased protection against excessive moisture even after prolonged exposure to elevated temperatures; the elimination of fire hazards resulting from the failure of conventional electrical insulation; and increased power output per unit weight.

Electrical equipment wound with silicone insulating materials and sealed by impregnating with DC 996 will have the high order of thermal stability and the retention of waterproofness characteristic of silicone insulation. Silicone insulating materials impregnated and bonded with DC 993 can be cured at temperatures obtainable in ovens now used for curing organic varnishes.

Another advantage of this new silicone varnish is that electrical equipment can be baked fully assembled without damaging the commutators or the slip rings.

POWERED COAL

Made by "Puffing", Meets Turbine Needs

SIMILAR to the "puffing" of cereals, a new method of pulverizing and drying coal operates on the continuous explosion principle, and involves no moving parts. By simply allowing the coal to pass through a nozzle with steam or air, a high degree of pulverization is obtained with upper pressures of less than 100 pounds per square inch, and with moderate steam temperatures. It is reported that compressed air produces equally effective pulverization, without the necessity of heating the air.

The principle of the pulverizer depends on the steam or air entering the minute pores of the coal so that when the coal passes almost instantaneously through the nozzle—thus greatly reducing the outside pressure—the gas trapped in the pores expands and powders the coal. Drying, accomplished simultaneously with pulverization, results in dry powder; fineness of pulverization depends upon pressure drop and the ratio of gas flow to solid flow.

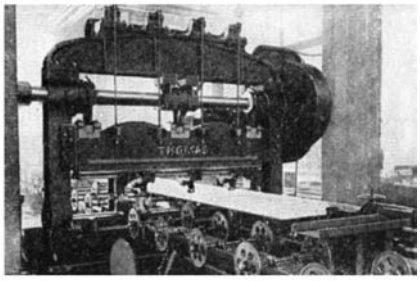
The process appears to be particularly well adapted to the preparation of coal for burning in the open-cycle gas turbine. In this application, the coal must be put under pressure and the air for pulverizing would be obtained from an auxiliary compressor which would take its air from the discharge of the main compressor. The pulverizing air would then serve as primary air to convey the pulverized coal into the chamber. Another application may be the utilization of large tonnages of wet coal fines which are now useless because their excess moisture makes it impossible to burn them in conventional equipment. The "coal atomizer" has demonstrated ability to dry and pulverize this material satisfactorily.

EDGER

Prepares Plates Quickly For Automatic Welding

SUBSTANTIALLY reducing the time required for side edging or trimming of plates preparatory to their being automatically welded, a new trimmer has been perfected which simultaneously trims both side edges in one pass.

The Thomas plate edger, made by Thomas Machine Manufacturing Company, shears the material rather than planes it. The shear cut, in addition to being more rapid, results in a tighter, more accurate joint between two plates than is obtained by any other production method, according to the manufacturer. Two major operational factors assure this result: First, the plate is held perfectly flat while under the shear blades. Thus mill wave, which is present in the majority of plates, is eliminated. Second, the plate is carried through the entire shearing cycle in the same relative position. In consequence, finished plates are removed from the machine with edges parallel within extremely close tolerances, ideal for automatic welding.



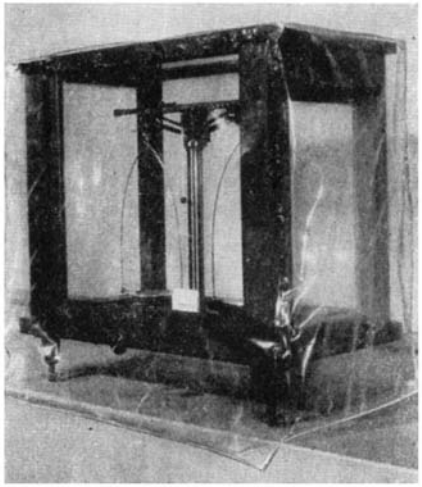
Shear cutting gives accurate edges

The plate edger may be operated by one man, and a high degree of skill is not necessary. In edging the larger and heavier plates, however, it is economical to utilize a helper for loading and unloading. Tool set-up or change may be accomplished by the operator with a wrench and a simple measuring tool.

TRANSPARENT ENVELOPE

Protects Sensitive Precision Instruments

PROTECTION and preservation of valuable precision instruments, vital to accurate performance, is an industrial "must." To insure the precise functioning of delicate parts, instruments must be guarded from dust, lint, fumes, and moisture. For this reason, many makers and users of precision instruments



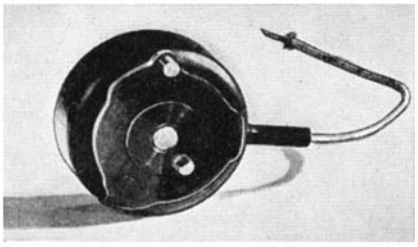
Flexible cover shields delicate scales

have called on the Resistoflex Corporation to "tailor" compar cases or covers, which completely enclose a wide variety of delicate instruments. A vinyl resin derivative, compar shuts out all harmful particles that might interfere with precise performance and preserves the most intricate of working parts. The covers, specially prepared to specifications, retain their transparency, flexibility, and immunity to air-borne dangers throughout an almost unlimited service life.

ROTARY SOLENOID

Has Many Industrial Uses

DEVELOPED and manufactured for use in bomb release mechanisms, a rotary solenoid is applicable to many controls in the aviation, automotive, railway, shipping, communication, and other fields where direct current is available. Known as "Ledex," these rotary solenoids are smaller in diameter than a man's pocket watch and only about twice as thick. Proportionately, they deliver many times the power of conventional solenoids. When the magnet



Solenoid is jar-proof and powerful

is energized by an electric current, a torsional power of the rotating member in excess of four inch-pounds is produced.

Besides saving space due to its compactness, the Ledex solenoid meets government requirements of immunity to accidental operation through shocks. This jar-proof feature is one of the advantages which especially commended the solenoid to aircraft engineers.

WHEEL DRESSER

Contains Over Five Carats of Diamonds

JUST introduced by Industrial Abrasives, Inc., for the metal, ceramic, plastics, glass, and related trades, a new dressing tool, the Super-Cut Circle Set, is especially designed to fulfill the need for a sturdy, efficient, economical abrasive wheel dresser that is built for rugged service on jobs where fast dressing and long life is expected.

Some of the features of the new circle set are listed as follows: The new tool consists of only three parts, the circle set insert, impregnated with diamonds, ⅛ inch deep and ⅛ inch wide, the holder, and one set screw. The insert contains over five carats of specially selected diamonds, uniformly distributed; in case of accident or abuse, only part of the tool is damaged or destroyed instead of an expensive single point diamond. As the

top layer of diamonds wears down, other diamonds are uncovered and come into cutting position so that, at all times, several diamond points are simultaneously in contact with the grinding wheel.

EYE SHIELD

Is Made of Plastics and Weighs Less Than an Ounce

FOR USE in semi-hazardous jobs such as spot welding, light grinding, and woodworking, a plastics eye shield, weighing less than one ounce, has

Shield does not interfere with glasses; is quickly replaceable

been developed by Willson Products, Inc.

A feature of the FeatherSpec, as it is known, is the one-piece plastics lens, gripped tightly in a suspension-lock frame, but interchangeable or replaceable in ten seconds. A slight pull releases the lens from the grooved metal frame and makes it possible to substitute a green lens for a clear lens if the work involves glare.

The new shield can be worn over special prescription lenses with complete comfort and gives added protection to those workers who wear glasses. Only one size is needed to fit any type face because the new nose rest, which is part of the lens, simplifies the job of proper fit.

DEW-POINT RECORDER

Uses Photocell to Detect Moisture Film

CLOSER control of the effects of water vapor in air or other gaseous mixtures is afforded by a new dew-point recorder now offered by Surface Combustion. The recorder is especially applicable for furnaces utilizing prepared gas atmospheres, or wherever dehydrated air or a gas mixture of controlled moisture content is desirable, as in the chemical and food processing industries, drug preparation, and so on.

The recorder can provide a virtually continuous record of humidity within a temperature range of from minus 70 to plus 60 degrees, Fahrenheit. More precise and more frequent adjustments of the various constituent gases in the atmosphere can thus be made to compensate for differences in humidity. Or if humidity control of the air or gaseous atmosphere is used, permanent information concerning its dew point is provided.

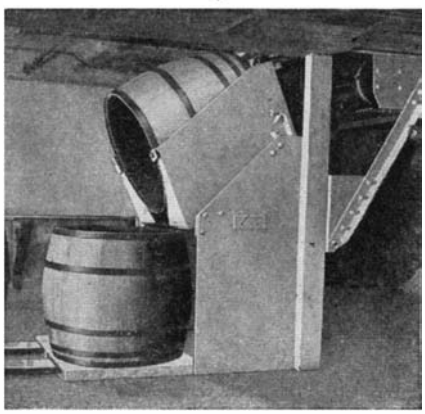
The recorder applies the principle of the dew-point cup, which has long been used in its original form for determining the humidity of air and other gaseous mixtures. Its operation is therefore independent of the nature or composition of the gases making up the atmosphere.

The principal units of the recorder are a dew-point cup with mirrored surface which can be refrigerated at varying temperatures, a thermocouple which is connected to a recording potentiometer, and the refrigerating unit with its associated circulating system. In operation, a stream of the furnace gas, after filtering, is directed against the mirrored surface of the dew-point cup, while refrigerant is circulated within the cup. As the temperature of the refrigerant drops, which in turn decreases the temperature of the mirror, a film forms on the surface when the dew-point temperature of the gas is reached. As soon as the film forms upon the mirror, it intercepts a light beam which has been directed upon the mirror and which is reflected on a photoelectric cell. When this takes place the cell alters the flow of current which in turn shuts off the flow of refrigerant around the mirror, at the same time making an instantaneous point record of that temperature on the recorder chart. This operation is continuously repeated at three minute intervals so that the series of instantaneous recordings forms a virtually continuous "line."

HEAVY VATS

Handled with Trucks And Tilting Device

IN THE packing industry, hams are cured in large open-top wooden vats containing a brine solution which must be changed at intervals. Formerly done by hand, the operation was slow and costly—the filled vats weigh 1600 pounds—and dangerous for men because packing house floors generally are wet and slippery. To make present-day mechanization of packing plants more effective, a vat-dumping unit was designed to elevate and empty the filled



Manpower is replaced by electricity for tilting and moving large vats

vats within a few seconds, eliminating hazards and delays that formerly slowed the entire curing line.

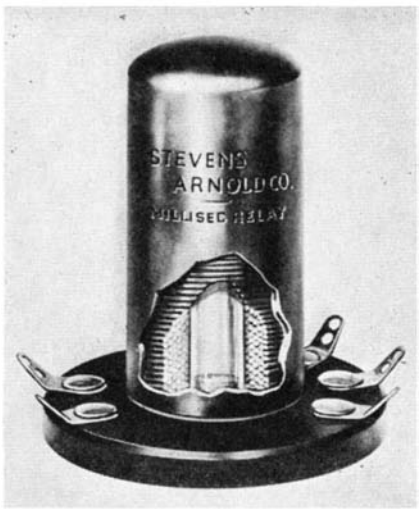
In operation, the loaded vat is transported by means of a fork-type truck and placed in a steel cradle. The cradle is centered in a steel framework to which it is pivoted at its forward end. The cradle with its load is tilted by means of gears and an electric motor. Brine and hams are discharged into another vat placed on a pallet of timbers, so that it may be readily lifted and transported by means of the fork truck.

Heavy loads are thus transferred so quickly and safely that the system, developed in coördination with Elwell-Parker Electric Company, will probably find application in other industries as well.

FAST RELAY

Has Sealed Moving Parts

SPEEDS up to 1000 per second are possible with a recently developed sealed-mechanism type relay. A glass envelope ensures reliability by protecting all moving parts from moisture, dust, or corrosive fumes, as shown in the cut-through illustration. Sensitivities down to ½ milli-watt and current ratings up to five amperes are available, while closing times may be reduced to one



Cutaway view shows compact design of relay mechanism sealed within

milli-second. Compact as well as fast, the Stevens-Arnold "Millisec" relay is three inches high with a 1½ inch base diameter for a 115 volt A.C. one-ampere rating unit.

NON-MINERAL OIL

Makes Cold Weather Starting Easy

HAVING unusual advantages over mineral oil, particularly for cold weather use, a new internal combustion engine lubricant is now being produced in commercial quantities. The lubricant can be manufactured to any desired viscosity and is wax-free. Pour-points vary from —30 to —80 degrees, Fahrenheit. Flash points range from 300 degrees, Fahrenheit, up and densities

approximate that of water. Carbon residue values are less than 0.01 percent, regardless of viscosity. The lubricant is characterized by low change of viscosity with change in temperature, having viscosity indices in the range of 140 to 160.

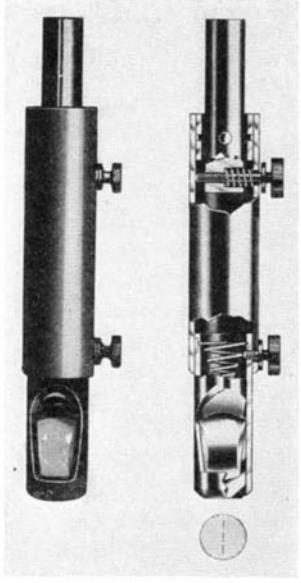
Developed by the Carbide and Carbon Chemicals Corporation, the new lubricant contains no petroleum oils and practically eliminates sludge and varnish formation in the engine. Wear of the moving parts is in line with wear experienced with ordinary mineral oils. Ease of starting in cold weather is an outstanding advantage.

CENTERING PROBLEMS

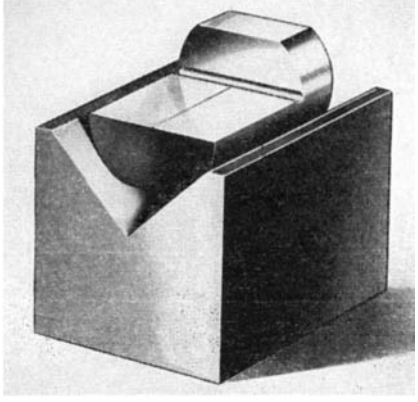
Simplified by New Optical Locating Device

LOCATING layouts, work edges, lines, or punch marks to any revolving spindle axis is simplified with an optical device designed to be used on any vertical or horizontal spindle machine tool. Opti-Locator is easily fitted to standard collets, tapers, or other adapters and a fine threaded "line-up" screw compensates for any spindle run-out present in the machine, according to the Benton Company, its manufacturers.

Since the instrument provides magnified images, visual centering to an



Locator (above) has a line-up screw and focusing screw for setting; lens prism is spring mounted. Datum unit (below) gives center for vee block



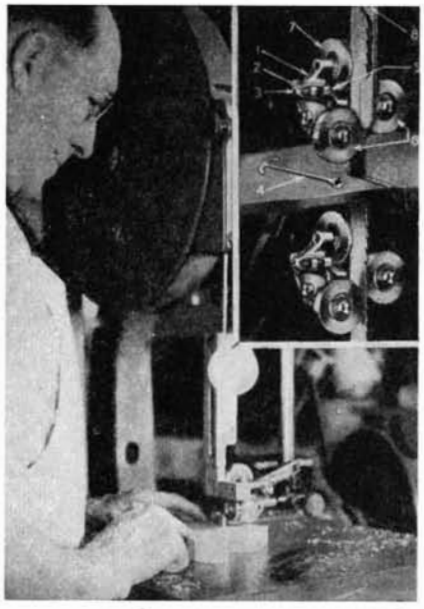
accuracy of .0001 inch is a matter of moments although time and labor are also saved on less critical work.

An accessory datum block increases the magnifying unit's utility by providing a hairline alined to any finished edge, or by centering vee blocks and similar fixtures to a spindle for machining circular stock.

BAND-SAW GUIDE

Uses Permanently Lubricated Wheels

ESPECIALLY adapted to metal and plastics as well as wood, and adjustable to blades ¼ to 1½ inches wide, a band saw guide and metal safety guard is announced by The Boyer-Campbell Company. Side guide wheels mounted in a staggered position to eliminate binding, and a grooved back wheel to hold saw in position—all equipped with permanently lubricated ball bearings—give a smoothness of operation that produces a clean, accurate cut,



Saw guide in use; inset shows details

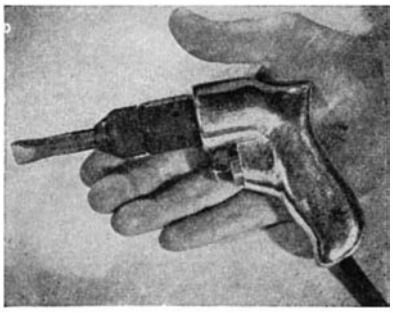
reducing breakage to a minimum. Positive adjustment of mounting arm on supporting bracket is provided by a set screw that exerts pressure against a 90 degree pin that in turn presses against the adjusting screw. This eliminates any tendency to loosening or creeping.

AIR HAMMER

Can be Applied To Many Jobs

SMALL but powerful, a new pneumatic hammer delivers some 13,000 blows per minute and operates on compressed air at 80 to 100 pounds per square inch. Weighing less than two pounds, the hammer, appropriately named the "Bantam Bully," fits easily in the hand. A pistol-grip handle gives the operator comfortable control of the rapid-firing power of the hammer. The valve control, in pistol trigger position, adds to the ease of control.

Tools for the hammer, of which a



Hammer features small size, high speed

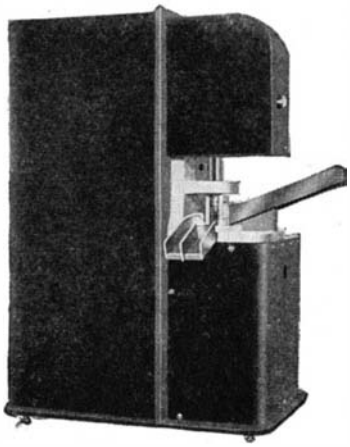
wide variety are available, are loaded in a quick-acting, ball-and-channel locking chuck. A quarter-turn of the knurled nose of the chuck locks or releases any of the tools. The "Bantam Bully" hammer has but only one moving part, the piston striking member, which is precision-fitted in a finely ground cylinder. Travel of the hammer piston is approximately ⅜ inch and normally operates between 12,000 and 14,000 blows per minute, depending upon the trigger regulation and the air pressure available.

Uses for the tool include all kinds of cold chiseling of metals, peening, welding-flash stripping, light scaling, light riveting, forming and finishing, routing of all kinds, paint and rust removal, star-drilling concrete, caulking, template marking, loosening stubborn threaded fastenings by vibration, fender work, wood gouging in pattern making, and many special driving, cutting, and vibrating jobs in electric motor and small machinery assembly.

PHOTOCELL GAGE

Uses Shadow to Check Parts' Accuracy

ORIGINALLY developed to gage the length of the firing pins in ordnance fuzes, a new automatic electronic gaging instrument has been developed which is capable of automatically gaging a wide variety of small parts either metal, plastics, ceramic, glass, or paper. Entirely automatic, the machine can gage the depth of holes, external lengths, and outside diameters to close tolerances with high precision. It operates at a speed upwards of 3300 pieces per hour, eliminating the human equation. Speed of the machine depends upon



Gage inspects, selects, and counts

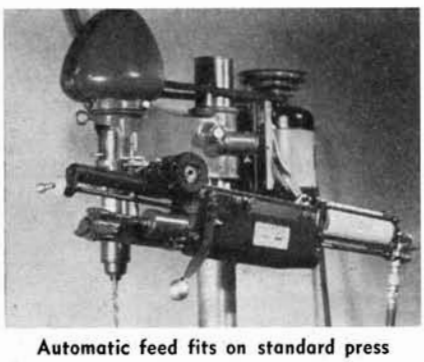
the size, shape, and manner in which the part to be gaged is handled.

Mechanical contact is made at a desired point in the work by a stylus rod to which is attached a razor-like flag. Image of this flag is projected into an optical system by light. A high order of magnification is produced, causing a shadow of this flag to be projected and reflected onto a panel of two photoelectric tubes. Distance between these two tubes represents the tolerance of the dimension being gaged. This distance can be widened or narrowed by micrometer adjustment, according to the tolerance desired. Acting as switches, one tube must be covered by shadow and the other must be in the light to activate the acceptance mechanism. If the dimension being gaged is below the limit both tubes will be in the light, causing the pieces to be rejected. If the dimension of the piece is above the limit, both tubes will be shadowed, also causing the piece to be rejected. According to the makers, The Autotron Company, it is possible to gage accurately dimensions with tolerances as small as .0001 inch.

DRILL PRESSES

Controlled with Air Motor Feed

A STEPLESS-RANGE power feed for use on drill presses, milling machines, surface grinders, and similar equipment advances work or tools a pre-determined distance, under a pre-determined power thrust, and automatically returns to starting position. Incorporating simple and positive precision controls for feed and traverse rate, for power thrust, and length of stroke, the new feed is powered by an air motor that operates on any air pressure up to 160 pounds and delivers a power thrust approximately five times operating air



Automatic feed fits on standard press

line pressure. Two throttle valves permit unlimited variation of feed and retraction speed. Advance may be so slow it is barely discernable, the return as fast as desired.

To assure a smooth, steady feed, without whip, jump, or backlash the Bellows-Senacon Feed may be equipped with an accessory consisting of a hydraulic resistance unit that maintains a constant feeding rate regardless of fluctuations in stock hardness. The Hydro-Check may be used in drilling operations to check the feed at the break-through or to allow a momentary check at the bottom of the cutting

stroke in blind-hole drilling for greater surface smoothness.

The automatic feeds are made in two sizes with 6 inch and 9 inch stroke air motors that give up to one or one and one-half revolutions of the pinion shaft, respectively.

CHANGEABLE BLADES

Make Precision Knife Versatile

AN ALL-PURPOSE knife for artists, photographers, craftsmen, or others who require an extremely keen precision cutting edge is designed to lock surgical steel blades of various specialized

Knife is both durable and attractive

shapes in a quick-operating chuck. The light plastics handle and knurled chromium plated chuck of the "1001" Re-Blade Knife are properly balanced for easy gripping and guiding. Blades are changed by rotating the chuck and inserting a new blade so that special notches in the blade engage the chuck locking mechanism to prevent slippage.

GLASS EDGING

Will Soon Be Provided in Many Colors

THE LONG-FAMILIAR black rubber edging around automobile windows and windshields, and the stripping used as seals and bumpers for doors and hoods, is destined to give way in the future to a new plastics material which will not only do a better job of protection but which can be made in colors to match surrounding paint exactly or to provide contrast.

The new material, an extruded "Vinylite" elastomeric plastics, has special heat-sealing properties for forming into continuous rings with no joints through which water may seep. Slipped around the window or windshield, it acts as a bumper between the glass and the metal frame, giving the glass a soft material on which to ride, preventing breakage of glass, and providing a seal for protection against the elements. The plastics gaskets are superior to natural rubber in resistance to oil, greases, gasoline, acids, alkalies, sunlight, and less affected by extremes in temperature.

SHOCK-PROOF LAMP

Has Many Uses in Industry

EQUIPPED with a rubber cushion base and designed to withstand violent physical shocks, a high-impact filament lamp has been in service since early in the recent war. Except for a thick band of rubber surrounding the neck of the "HI's" bulb, the lamp closely resembles the ordinary household lamp. Remainder of the heat- and shock-resisting rubber skirted insert is firmly locked between the lamp's medium-

screw brass base and the bulb's glass neck. The lamp, developed by General Electric, is rated at 50 watts and, because of its extra sturdy internal construction, might be said to "float" in rubber.

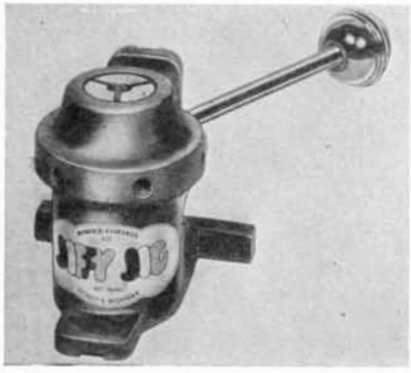
Laboratory tests show that the rubber-cushioned lamp can withstand shocks of 2000 foot-pounds and more. This is equivalent to the impact caused by a 400-pound weight dropping a distance of five feet to a solid object.

Applications for the new lamp are found in industries or equipments where lamps are subjected to unusual physical shock.

VERTICAL JIG

Holds Work Firmly For Accurate Machining

BECAUSE a great number of shops had need for only a vertical set-up when using the "Jiffy Jig," described some months ago in these columns, Monarch Governor Company announces a simplified Model J-10A which provides for its use in this position only. Except for the bracket that allows for horizontal



Jig has only three parts and a lever

set-ups, this new model includes all of the features of the Model J-10 and is readily adapted to various machine tools for drilling, milling, grinding, boring, and so on. The chuck is designed to provide ample chip clearance and when the chuck is either open or closed, the collet has zero axial and rotary movements, giving positive axial and rotary dimensional control.

BEARING GREASE

Easily Applied for Lasting Lubrication

INTENDED for ball and roller bearing motors, an improved grease provides dependable lubrication from 13 to 176 degrees, Fahrenheit, for all speeds up to 3600 revolutions per minute, and for horizontal or vertical operation.

Available in a new eight ounce nasal type tube, the grease, a product of Westinghouse Electric Corporation, is stable, highly resistant to oxidation, and will remain in a bearing for an indefinite period without drying out, caking, or separating. The tube is designed for easy and economical use. It has a large opening in the long nasal spout which fits into a ⅛ inch pipe coupling, and a key with which to wind and exert pressure from the bottom.

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.)

HANDBOOK FOR INDUSTRIAL SAFETY STANDARDS is a 212-page completely indexed manual covering all phases of industrial safety from safety programs and the investigation of accidents through all conceivable industrial hazards to prevention of "off-the-job" accidents. *National Conservation Bureau, 60 Wall Street, New York 7, New York.—75 cents to industrial concerns.*

JOHANSSON GAGE BLOCKS AND ACCESSORIES, in 35 pages, illustrates and discusses a series of standard sets of gage blocks. Also included are a short history of these blocks and a summary of their physical characteristics and uses. Request Catalog Number 17. *Ford Motor Company, 3000 Schaeffer Road, Dearborn, Michigan.—Gratis. Request this booklet on your business letterhead.*

ARMCO PRODUCTS FOR ENGINEERING CONSTRUCTION discusses the use of different types of arches, bridge decks, corrugated pipe, culverts, and metal sheeting, in a wide range of construction projects including airports, buildings, flood control and irrigation, highways, industrial plants, mines, and so on. *Armco Drainage and Metal Products, Inc., Middletown, Ohio.—Gratis.*

A SIMPLIFIED GUIDE TO BAKELITE AND VINYLITE PLASTICS is a 24-page comprehensive catalog which also serves as a businessman's guide to thermoplastic and thermosetting plastics. *Editor of Bakelite Review, Bakelite Corporation, 300 Madison Avenue, New York 17, New York.—Gratis.*

WASHROOM LAYOUTS FROM BRADLEY FILES is a booklet containing 12 pages of blueprint layout reproductions of industrial washrooms. Scale model cutouts for making your own layouts are included. *Bradley Washfountain Company, North 22nd and West Michigan Streets, Milwaukee, Wisconsin.—Gratis.*

HIGH TEMPERATURE FANS, a four-page folder, is based on a line of fans for handling hot gases or products of combustion where temperatures rise as high as 1800 degrees, Fahrenheit. Applications are listed and a novel fan wheel construction is illustrated. Request Bulletin 645. *Michiana Products Corporation, Michigan City, Indiana.—Gratis.*

CORROSION RESISTANT MATERIALS AND EQUIPMENT, a 16-page pamphlet, outlines a wide range of ceramic, metal, natural rubber, synthetic rubber, and plastics materials and equipment offered to industry. Included are tanks and lin-

ing materials, gasket stock, chemical stoneware, mixing equipment, and so on. Request Bulletin H. *The United States Stoneware Company, Tallmadge Circle, Akron, Ohio.—Gratis.*

THERMOCOUPLE DATA BOOK AND CATALOG outlines—in 32 pages of description, tables, and cross-sectional views—the selection of proper thermocouples and installation aids, along with list prices and recommendations. Request Buletin S2-6. *Wheelco Instruments Company, Chicago 7, Illinois.—Gratis.*

BALDWIN-REX ROLLER CHAIN BELTS is an eight-page reference folder containing descriptions, specifications, and prices of popular sizes of chain belts. Request Bulletin Number 45-1. *The Chain Belt Company, Baldwin-Duckworth Division, Springfield 2, Massachusetts.—Gratis.*

MACHINISTS' TOOLS AND GAGES, a four-page folder, describes and illustrates a number of types of gages and specialized precision tools. Request Catalog 11. *Products Engineering Company, 9045 Wilshire Boulevard, Beverly Hills, California.—Gratis.*

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Telescoptics

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

Editor of the Scientific American books "Amateur Telescope Making" and "Amateur Telescope Making—Advanced"

IF YOU are an amateur telescope maker, how many times have you had your whiskers rubbed a little backward by non-astronomical visitors who gratuitously assumed that you must have made your telescope from readymade parts which you had merely assembled, and that "Of course, you didn't make the 'glasses.'" Exercising noble self-restraint—for, after all, it must seem a bit fishy to the uninitiate—you modestly reply that you made the main mirror and most of the rest. Your visitor's eyebrows now go up and so does your stock. You then point out that making the mirror is really the central part of the fun, but that you had about as much fun in concocting the mounting out of various thises and thats which you adopted and adapted. By this time your visitor is on the way to being hooked as another addict of the hobby.

When it comes to using things originally intended for other purposes but kidnapped and re-adapted as parts of a telescope, and doing so neatly, the 10″ instrument shown in Figure 1, made by Warner Williams, a Chicago sculptor and designer and connected with the Culver Military Academy at Culver, Indiana, has a high score. Examining the photograph:

The base is of concrete. Williams first modeled it smoothly in clay—to him as a sculptor a familiar medium—then cast a plaster mold of this model, and finally filled that mold with concrete.

The polar axis is a 6″ artillery shell casing, and it is both clean and rugged—certainly won't shimmy.

The fork arms are made of the two rear axle housings from a car; such parts are steady enough for a jolting car but require stiffening for a telescope jolted only by light breezes. It's a question of just how stiff you require. In this, a telescope is an extreme case.

The declination axis bearings are connecting-rod bearings from a car motor.

The two setting circles are meridian circles taken from geographical globes.

The finder is built around a mailing tube.

The main tube is sheet metal formed on a tinner's brake, and its open section is made of ¼″ water pipe.

The mirror cell is made from a motorcar brake drum.

The driving mechanism embodies a back gear (½ r.p.m.) motor unit such as are used for display tables, gears from a car generator, parts from a player piano and a carburetor. The drive is transmitted to the polar axis drum by means of an endless belt made from a steel tape. "This type of drive," Williams writes, "has the distinct advantage that no special gears need be cut or purchased. The drive wheel can be turned up on a wood lathe to any needed size to give the proper ratio between either standard gears or available junk and the final pulley in the train.

"And thus," he continues, "after a long and fanatically joyful struggle, my telescope is finished and promises years of use and pleasure."

Williams once sculptured a life-sized plaster bas relief plaque of Foucault, illustrated and described in this department in December, 1943.

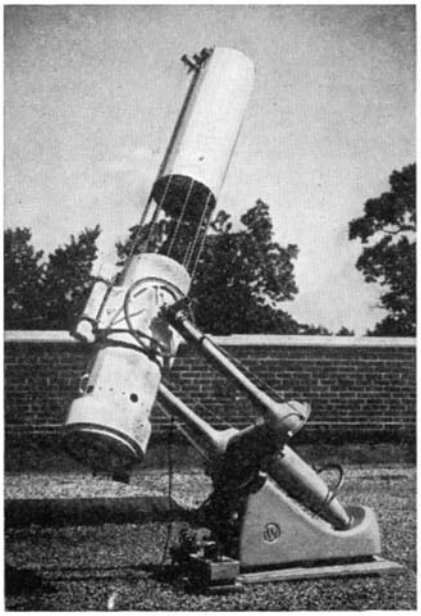

Figure 1: Williams' 10″ telescope

IN THE October, 1945, number of *The Journal of the Royal Astronomical Society of Canada,* 198 College St., Toronto, Ont., Canada, E. K. White, Chapman's Camp, British Columbia, well known to amateurs in this country, a correspondent of your scribe's, and whose telescope (Figure 2), has a surplus of mechanical, optical, and artistic sex appeal, has so cogently brought together various arguments for the long-focus Newtonian telescope that we reprint his entire article here, with courtesy credit to the periodical named.

Judging from casual comments heard, it is suspected that some Yank amateurs think the Royal Astronomical Society of Canada must be composed at least of professional astronomers who, being "royal," all wear crowns. It is, instead, an organization of amateurs—plain folks, uncrowned, unhaloed—like our own amateurs. Obviously, these Canadians are more enterprising than we Yanks, since they have had their amateur astronomical society for 56 years. It includes 11 local city groups which meet regularly. Our long-projected American association still is a thing on paper, but, now that the war is over, it probably won't be long before Charley Federer will be tearing around the terrain helping organize one as per prewar plan. White's paper:

"This paper deals briefly with some advantages found by the writer in the construction and use of Newtonian reflectors with focal lengths about 12 times the aperture, over the more commonly known *f*/8 mirrors.

"In most articles dealing with the making of Newtonian reflectors the amateur is advised to choose a focal length about eight times the aperture of his mirror. Rev. W. F. A. Ellison says, 'I recommend *f*/8 because it combines the easiest figuring with capabilities for excellent performance' (see page 385 in 'Amateur Telescope Making'). Just what accuracy of figure is necessary in an *f*/8 mirror of (say) 8″ aperture to give excellent performance? It is an accepted fact that a mirror will give perfect definition if its surface be figured to one quarter wavelength of sodium light, or about five millionths of one inch. It has been

Figure 2: White's 9″ *f*/11

shown by Mr. F. B. Wright (page 257 in 'A.T.M.') that an 8″ diameter mirror of *f*/8 must have its surface within 33 percent of a perfect paraboloid to give excellent results.

"In the case of an 8″ diameter mirror of *f*/12, Mr. Wright tells us that it can be finished spherical and still give fine definition, for a sphere and a parabolic surface of this dimension are very nearly coincidental. The allowable tolerance from a perfect paraboloid for an *f*/12, 8″ mirror is 110 percent. Most opticians agree that it is less difficult to figure a spheroid than a paraboloid, and the former is most certainly easier to test by the well known Ronchi method (page 264 in 'A.T.M.'). Also there are no r^2/R zones to measure as with the paraboloid.

"The parabolizing of a mirror is necessary to correct the surface for the one aberration found in specula, name-

ly, spherical aberration. In other words a spherical mirror of around *f*/8 proportions will not reflect the marginal and central rays of light from a star to the same focal plane. However, in small mirrors up to about 10" aperture and of *f*/12, this is not the case. The old masters, such as Herschel, With, and Lassell, who made their mirrors before Foucault's knife-edge test was known, realized that longer focal lengths enabled them to make better corrections on their mirrors, which also meant better performance. Thus we find that most of their mirrors were made to *f*/10 and higher, and many of these specula did give very excellent performance.

"Let us discuss further advantages of long-focus mirrors. It has already been shown that they are at least a little easier to finish, and I have found that an *f*/12 mirror 'a little off,' will give better images than an *f*/8 of the same aperture which is about equally imperfect in figure. Turned edge cannot be tolerated in either mirror, but slight zonal errors are not at all serious in the longer focal length.

"Perhaps the most important advantage of long focus is that one can employ a smaller secondary mirror and thereby reduce light loss a little, and diffraction effects a great deal. In my opinion few amateurs realize the bad effects on stellar images a secondary mirror has when its minor axis much exceeds one sixth the diameter of the primary. One has only to place a cardboard disk about one quarter to one third the diameter of the main mirror on the secondary support directly in front of the flat or prism to see the bad effects it will have.

"For finest definition an elliptical secondary mirror that is really flat is superior to anything else.

"The more common types of eyepieces are designed to work best with a slender cone of reflected or refracted rays, and the *f*/12 mirror will give flatter and better fields with Huygenian and Ramsden oculars than will *f*/8 mirrors, which should really employ expensive achromatic eyepieces for best results. Also the *f*/12 mirror will enable one to obtain high magnification, should it be desired now and then, without seeking extremely short-focus oculars at high cost.

"Two further advantages of lesser importance are: first, changes of air temperature actually have little effect on the image quality as a result of temporary changes in the long-focus mirror's shape while in use, but such is hardly true with *f*/8 mirrors of plate glass. Secondly, many amateurs take photographs of the moon, using their reflectors as the camera. With focal lengths a little over 100" the image of the moon at the focal plane of the primary mirror is about 1" in diameter. This is large enough to record quite an abundance of detail on a plate or film, and bright enough for rapid exposures. With such a sizable image the use of an eyepiece may be dispensed with altogether. The writer has taken some fair lunar photographs with an 8¾", *f*/12 mirror on Panatomic film using exposures as short as one hundreth second. These negatives can be enlarged to at least 8", and the resulting prints are quite sharp.

"It can be shown that the disadvantages of the long-focus Newtonian are few and not at all serious. Probably the outstanding one is that a longer tube will be necessary, which will require a well designed and rigidly built mounting, costing little more, however, than a good one for an *f*/8 mirror. Provided the instrument is permanently mounted out of doors, its shelter will also require to be a little larger. The eyepiece position will be somewhat higher, but a good step ladder will bring it within easy reach. These disadvantages will be found to be of little consequence where the mirror is not greater than eight or ten inches in diameter.

"While mentioning the longer tube, one may wonder if tube currents are increased, particularly when a solid metal tube is used. The writer has not found this to be the case with a 9" *f*/11 mirror mounted in a closed metal tube. ('Air Currents Within the Reflector Tube,' *Journal R.A.S.C.*, November 1943).

"The field of view will be smaller when using an *f*/12 mirror, yet with some Ramsden oculars of about 1" equivalent focal length, all of the moon's image can be seen in the field at one time with a mirror of about 100" focus.

"In conclusion, it might be of interest to mention the performance one may expect when using a good, long-focus mirror as compared to that of an *f*/8 mirror on different classes of celestial objects. With double stars there will be a marked improvement in the images of an *f*/12 mirror, and there will be less diffraction effect with bright stars. The images will be crisp even with high magnification (in good seeing), and quite comparable to those seen with a refractor. Nebulae and clusters will appear in the *f*/12 mirror much as through a refractor of equal size; a shorter focal length mirror would of course give brighter images of these objects, provided apertures were the same.

"With planetary and lunar detail the *f*/12 mirror comes into its own, and it is my opinion that such a good mirror will outperform any *f*/8 of the same aperture in this field. I have given an account of my observations of Saturn using a 9" *f*/11 mirror elsewhere. ('Saturn with a Nine-inch Reflector,' *Sky & Telescope*, March 1945.)

"The writer hopes that amateurs who are contemplating the construction of a mirror will give the long focus some thought before deciding upon the usual *f*/8 focal ratio, and the tyro who may dread the difficult task of parabolizing cannot go far wrong in trying out a 6" spherical mirror of about 75" focal length."

HERE'S a good-news note from John W. Lovely, Secretary of the Springfield Telescope Makers, 27 Pearl St., Springfield, Vt.: "We at Stellafane are planning to have a full-scale convention this year on Saturday and Sunday, August third and fourth." More details when they become available.

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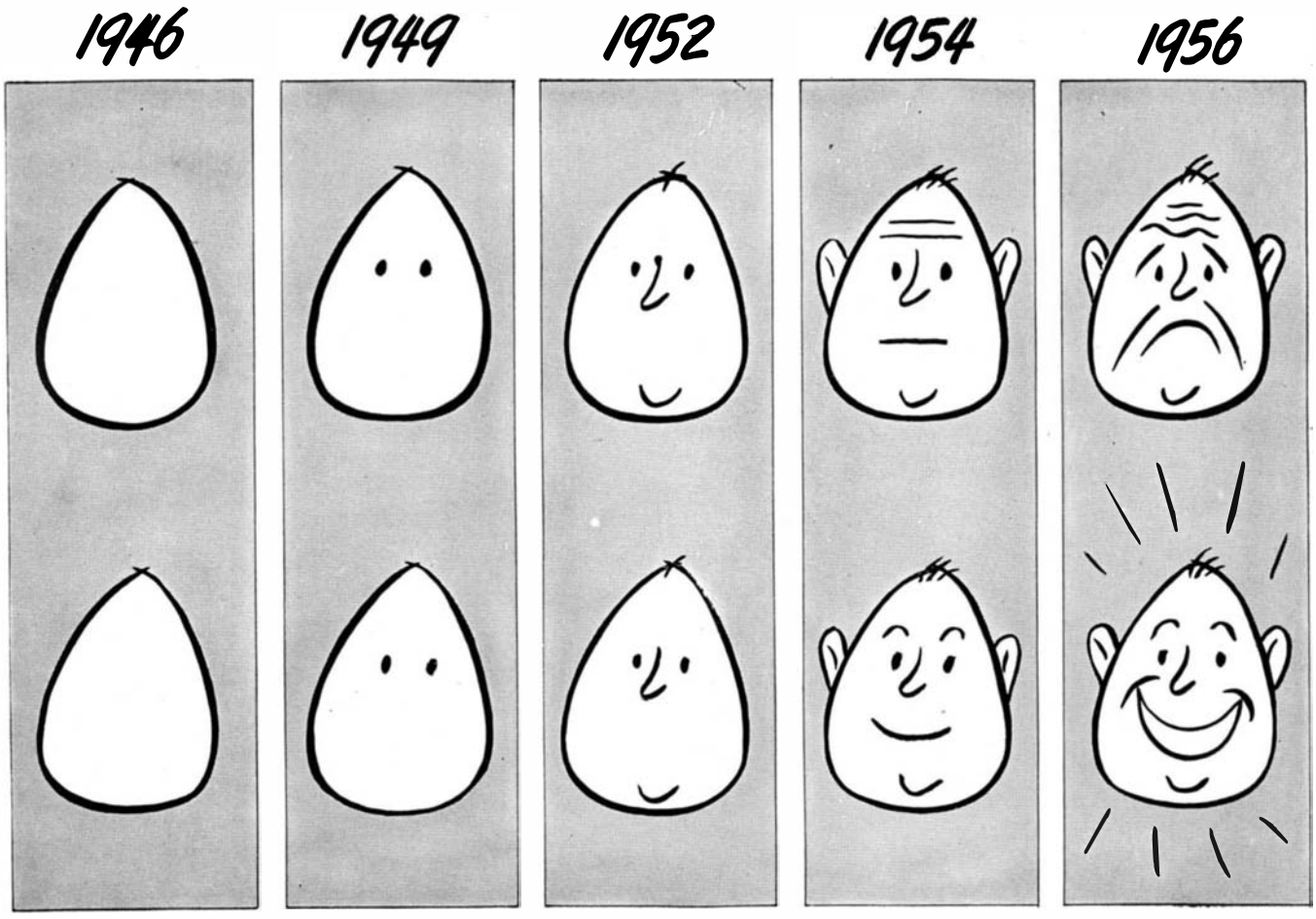

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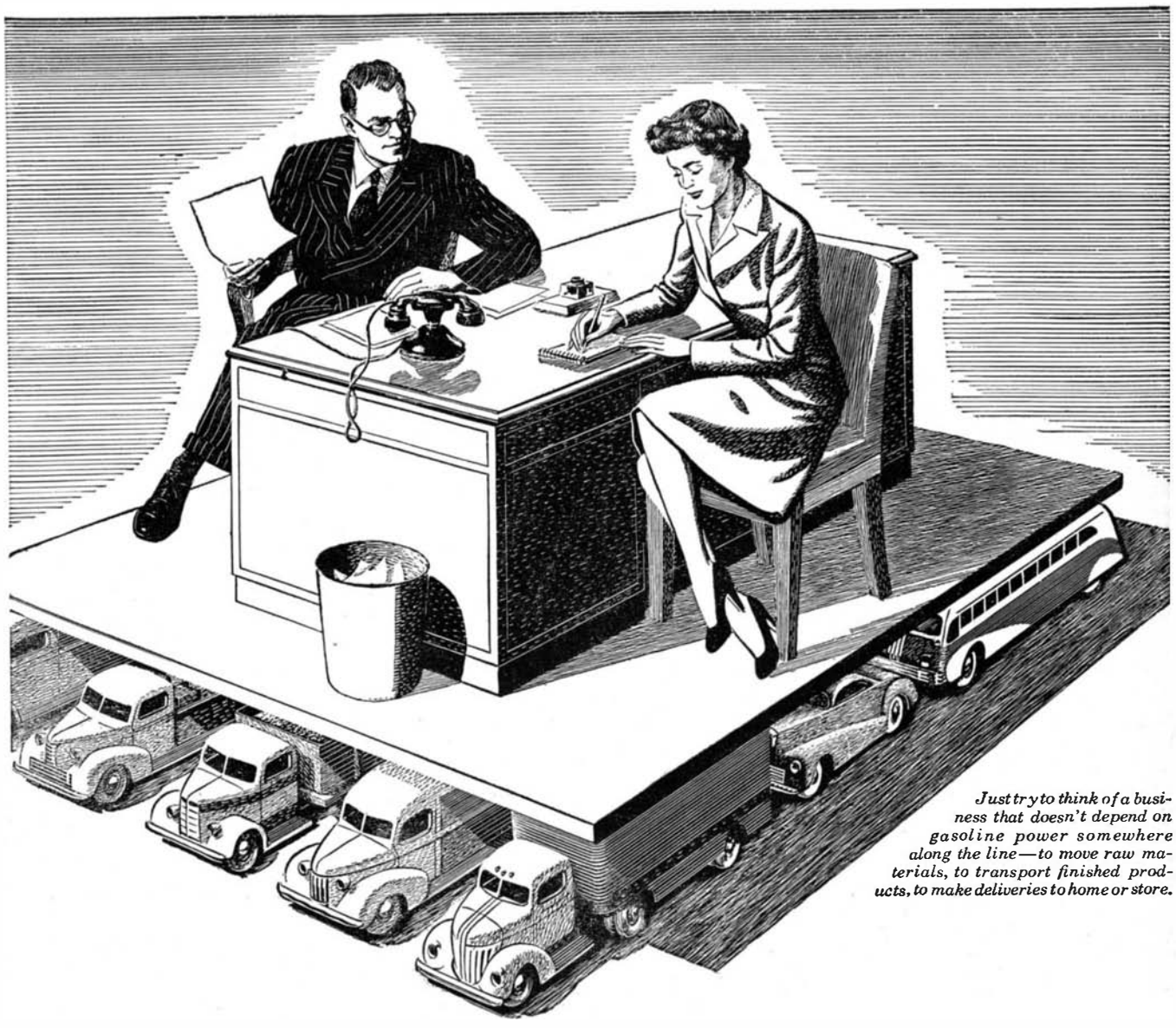

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