Scientific American

JANUARY
1947

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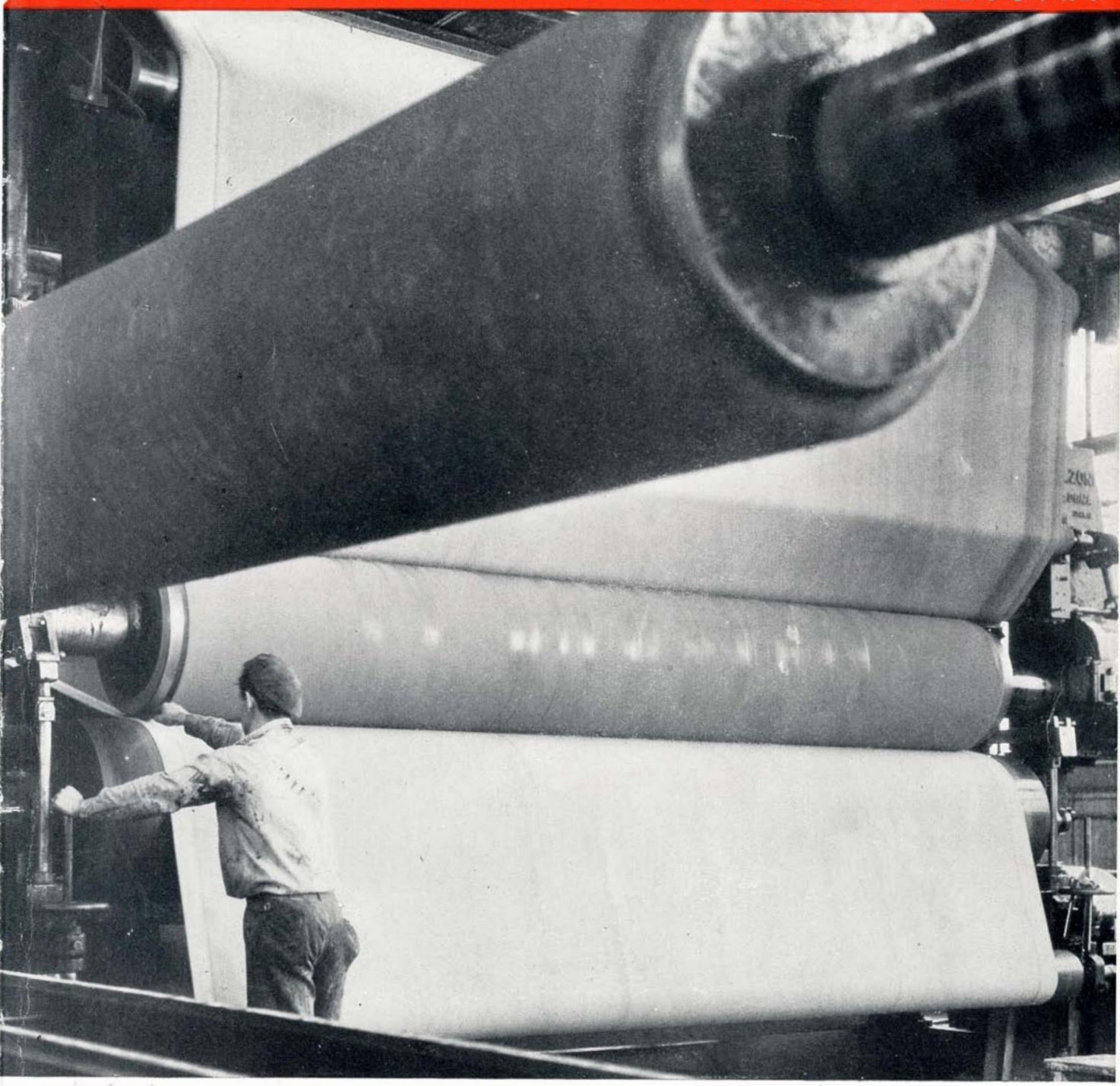


"Trouble-Free" Pipe Made on a Mandrel . . . See page 2

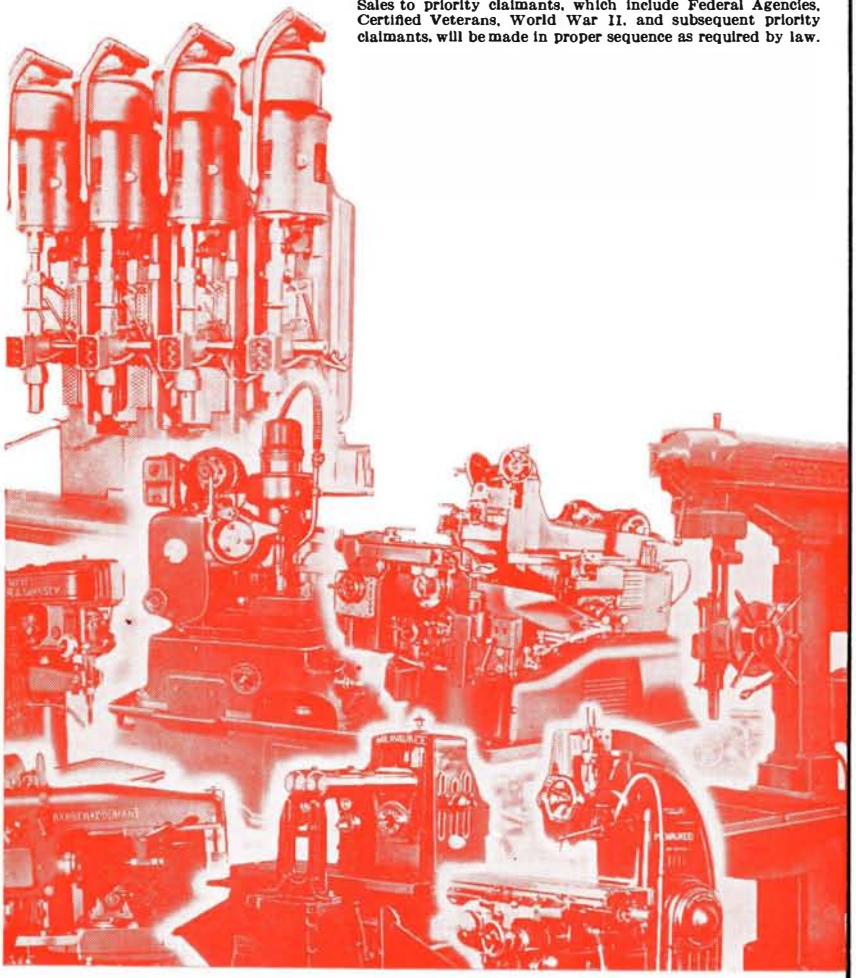
...NOW 25% average

TYPICAL CASE— MILLING MACHINE

Here is how War Assets Administration's new price has been set for a typical machine; Model 2K Kearney and Trecker Milling Machine, vertical knee action; War Assets Administration S.C. Code 3417-23-20-28.

Price (New)	$7,054.00
Previous W.A.A. Sales Price (based on depreciation primarily)	4,091.00
Average Market Value	2,556.00
New W.A.A. Sales Price	2,045.00
Available for rebuilding	511.00

Sales to priority claimants, which include Federal Agencies, Certified Veterans, World War II, and subsequent priority claimants, will be made in proper sequence as required by law.



31 TYPES OF GENERAL PRODUCTION TOOLS REPRICED

- Boring Machine—Horizontal, Precision, Bridge Type, Single and Double End
- Chucking Machine—Automatic, Vertical, Multiple Spindle Type
- Chucking Machine—Single Spindle Automatic, Horizontal Turret Type Machine
- Chucking Machine—Six Spindle Automatic, Horizontal
- Drilling Machine or Drill Press—Bench or Floor, Single or Multiple Spindle
- Gear Cutting Machine for Straight Bevel Gears, (Not Planer Type)
- Gear Hobber—Horizontal
- Gear Hobber—Vertical, Universal
- Gear Shaper—For External Spur Gears Only
- Gear Shaper—For Spur Gears, External or Internal
- Gear Shaper—For Spur and Helical Gears, External and Internal
- Gear Tooth Shaver—For External and Internal Gears (Rotary Type Machine)
- Gear Tooth Grinder—Generating Type, for Spur and Helical Gears
- Gear Tooth Grinder—For Spur Gears, External and Internal (Formed Wheel Type Machine)
- Grinders—Centerless
- Grinder—Crank Pin Grinders
- Grinders—Plain External Cylindrical Grinder
- Grinder—Internal, Cylindrical, Automatic Sizing
- Grinder—Internal Cylindrical (Hydraulic Feed Machine)
- Grinder—Internal Cylindrical, Hydraulic Feed, for Hole and Face Grinding
- Grinder—Surface, Rotary Table Type
- Lathe—Multiple Tool, Not Automatic, Manufacturing Type Production Lathe
- Milling Machine—Automatic and Manufacturing Knee Type
- Milling Machine—Plain Bed Type, Horizontal Spindle Machines
- Milling Machine—Vertical, Knee Type (Not Including Bench Type)
- Polishing and Buffing Machine—Bench and Floor
- Profiling Machine—Vertical, Fixed Bed Type, Single and Multiple Spindle
- Tapping Machine—Vertical, Single or Multiple Spindle
- Thread Grinding Machines
- Thread Milling Machine
- Turret Lathe—Ram Type, Plain and Universal

MACHINE TOOL

SALES DIVISION

BELOW MARKET

NEW "FIXED PRICE" POLICY ESTABLISHED ON 31 TYPES OF SURPLUS MACHINE TOOLS

Here is good news indeed for the man who is trying to purchase general purpose production tools for replacement, reconversion or new enterprises. Now you can go into any of War Assets 33 Regional Offices, any machine tool site sale in the United States, or any approved War Assets Administration dealer and buy at the same fixed price, everywhere, the tools in these 31 groups listed at the left. No waiting for complicated figuring of prices, checks against priorities or other delaying factors. The tools are available in such quantity that your purchase can be cleared on the spot, and immediate delivery arranged.

But even more important is the principle under which the new low prices have been set. As the scale at the right indicates each price takes into consideration your costs of rebuilding the tool to new condition, engineering, service, etc. It is set well below the current market price for similar equipment sold on a full service basis. The differential is approximately 25% below market—enough for men with tooling "know-how" to realize a neat "extra" profit and at the same time acquire modern machine tools.

Plan now to check at once the detailed price and specifications list—now available in every War Assets Administration office (machine tool sales division) and the offices of your approved W.A.A. machine tool dealers.

FOR DETAILED PRICE CATALOG

WRITE, WIRE OR PHONE:

1. *Your Regular Machine Tool Dealer*
   War Assets Administration has appointed more than 3,000 "approved" dealers throughout the U. S.
2. *W.A.A. Machine Tool Sales Division*
   In any of the 33 War Assets Administration Regional Offices listed below.

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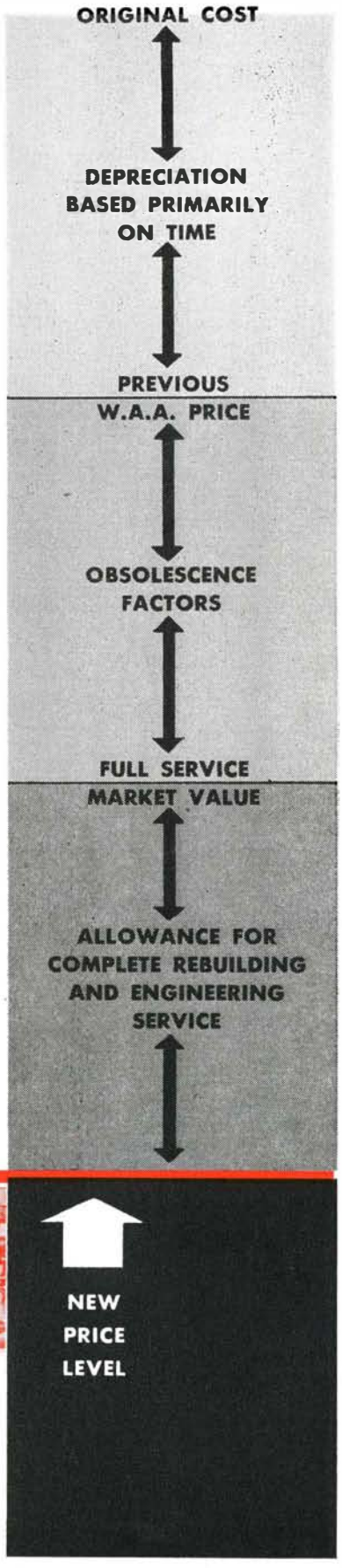
W. A. A.'s NEW PRICING PRINCIPLE



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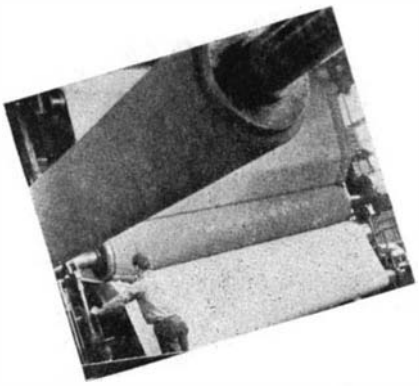
GOVERNMENT OWNED SURPLUS

Offices located at: Atlanta • Birmingham • Boston • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Fort Worth • Helena • Houston • Jacksonville • Kansas City, Mo. • Little Rock • Los Angeles • Louisville • Minneapolis • Nashville • New Orleans • New York • Omaha • Philadelphia • Portland, Ore. • Richmond • St. Louis • Salt Lake City • San Antonio • San Francisco • Seattle • Spokane • Tulsa



INDUSTRIAL DRAMA: Pipe of asbestos and cement, and with a number of outstanding physical characteristics, is made on the machine illustrated on our front cover. In this Johns-Manville photograph, a completed length of pipe, ready to be taken from the mandrel and cured, is shown in the foreground. See article on page 27.

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Founded 1845

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Previews of the Industrial Horizon

DIESELS, FUEL, AND POWER

By A. P. Peck

MANUFACTURERS of the most efficient machines known today for converting oil to useful energy—Diesel engines—are faced with a serious problem. Their engines, by some mistakenly thought to thrive on almost any kind of fuel that is fed to them, deliver their peak efficiency only when operated on the right fuel. (See also "A New Diet for Diesels?" page 21, this issue.)

But here's the present catch: The best grades of Diesel fuel, formerly a by-product of petroleum refining which the refiners were glad to get rid of at a reasonable price, now loom large in the production of high-octane gasoline. Catalytic cracking is the answer. Cat-crackers take in good Diesel (and furnace) oil in the process of turning out gasoline at a higher profit. So it looks as though, if this trend continues, Diesel users are facing the possibility of constantly increasing fuel costs.

Of course, it is probable that Diesels could be redesigned to use the poorer grades of gasoline-production by-products that result from cat-cracking processes, but this would tend to obsolete some 97 million installed horsepower of Diesels now rendering good service. Also, the poorer fuel oils would vitiate many of the advantages of the Diesel that are just becoming recognized.

Disregarding, for the purposes of this discussion, any selfish motives of either the Diesel engine manufacturers or the producers of Diesel fuel, there is one single point of interest and importance to every man, woman, and child in the United States. This point involves the conservation of oil supplies. The Diesel—whether on board ship, in a locomotive, doing humble service in a power plant, propelling a heavy-duty truck on the highway, of whatever—is turning out the greatest amount of energy per gallon of crude removed from the bowels of the earth. And these gallons are limited in number. It is simple logic, then, to conserve them by putting them to the most efficient use.

Gasoline is essential to our national economy, of course. But so are the Diesels, and increasingly so. There must be a meeting of minds in the Diesel and petroleum industries, to the end that each will benefit to the other's advantage.

N.B.—American Diesels today consume a billion and a half dollars worth of fuel annually. Some 64 percent of the world's shipping is propelled by Diesels. American trucking is wide-open to Diesels; as yet only less than 1 percent of the trucks on our highways are Diesel equipped, leaving a fertile market if engine makers and fuel producers can see eye-to-eye for the future conservation of petroleum as a power producer.

HOW DOES IT SMELL?

DOES THE product of your company have a characteristic odor? If it does, you may not even be aware of it. But it is quite possible that customers and potential customers are—and therein may lie the difference between a rising sales curve and one doing a nose-dive.

It is really astonishing to find what effects odors can have on ultimate purchasers, and this applies to hard-boiled purchasing agents as well as to members of the fair sex selecting their stockings and filmy undergarments in their favorite store.

Here are a few cases in point: Female employees in an industrial plant objected to a permeating odor around their machines. Specialists investigated, found an oil to be the offender. Addition of a chemical odor-suppressor saved the day. Plastics handbags sell better in department stores if they are first treated to remove their natural odor. Scented hosiery is bought in preference to unscented hosiery but, oddly enough, a survey has shown that purchasers are not consciously influenced by the odor; they imagine that the scented goods have a better texture or a more appealing color, although texture and color are identical. Here the nose obviously over-rules the other senses.

The list lengthens. Manufacturers of such diversified things as carbon-paper, shoe-polish, paints, textiles, waxes, rubbers, and so on, are applying the odor-improving technique to their products with increasingly effective results.

NEW PRODUCTS FROM OLD

TAKING things apart and putting the parts together again to form entirely new products is a favorite pastime of the industrial researcher. Now M. W. Kellogg Company has come up with a new process, using liquified propane gas at a pressure of 500 pounds per square inch as a solvent, for separating a vast number of useful products from fish and vegetable oils. At this pressure, a variation of one or two degrees, Fahrenheit, can mean the difference between producing a vitamin, a better soap ingredient, a paint that dries quicker, or more salad dressing. Into the process can go fish oils, soybean oil, tallow, cottonseed oil, and the like. Out of it comes refined products of greatly increased value, at a relatively low cost per pound for processing.

STRAWS IN THE WIND

KEEP AN eye on Brazil as an important future source of raw materials for industry in the United States: as these lines go to press, the writer is leaving for an extended tour of the non-ferrous mines and mills of Brazil; report will appear next month. . . Thin wood, held together with cotton tape and adhesives, is making its mark in the wooden box industry, where thick sections of materials were formerly thought indispensable. . . . A new chemical, sprayed on trees and plants, seals out insects and fungus organisms, expands with growth, and is reported to have no deleterious effects on fruits or vegetables.

50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of January, 1897)

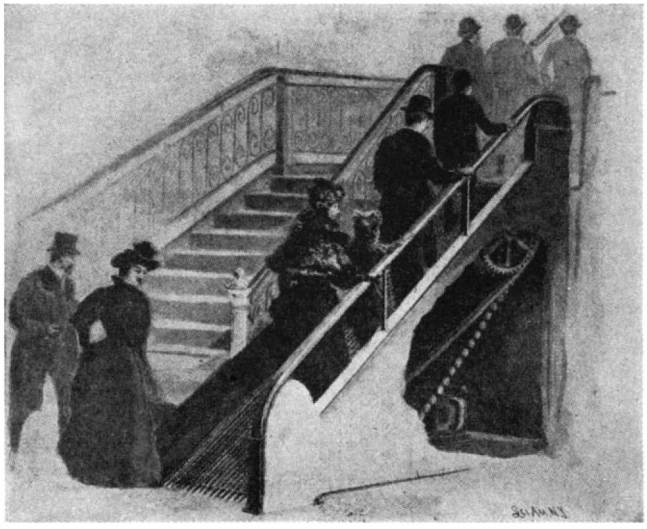
NICKEL STEEL — "Outside of the application of nickel steel by the United States Navy to armor, angles, rods, thin plates, engine shafting, hull plates, an experimental gun, the barrels of small arms, torpedo netting, etc., may be mentioned its application to bicycle frames and handle bars, steam boilers, and difficult steel castings. In fact, wherever a tough metal of high resistance and low corrodibility is wanted, this alloy is applicable."

WELDED RAILS — "The first efforts to secure a continuous metallic joint in railroad rails were made by electrical welding and this was followed by what is known as cast welding. . . As to the question of expansion and contraction of the rails due to change of temperature, it was proved in an experimental test at Johnstown, a few years ago, and in subsequent tests, that the elasticity of the steel is capable of accommodating such changes of length as take place. . . . Mr. W. K. Bowen, superintendent of the Chicago City Road . . . stated that, of the 17,000 cast welded joints made on his road in 1895, only 154 were lost, and these breakages were due to flaws in the metal. Comparative tests have shown the joint to be 'far stronger than the rail itself.'"

GLASS BRICK — "A feature of the recent Stuttgart exhibition was a display of buildings which were constructed of what is known as the Falconnier's blown glass brick. The bricks are blown hollow in the same way as a bottle, the color which is most commonly used being a very light bottle green, bottle glass being the strongest; though yellow brown or other shades of green may be used if desired. . . Perhaps the most valuable feature of these bricks is that the air which they contain is an excellent non-conductor of heat, and tends to keep a house cool in summer and warm in winter."

PAPER CLOTHING — "The Japanese have for a long time been making underclothing of their finely crisped or grained paper after the sheets have been pasted together at the edges so as to form large pieces."

ESCALATOR — "The accompanying engraving shows the working of a new style of elevator which is being put to a practical test by the trustees of the Brooklyn Bridge. . . The elevator is placed to the right of one of the stairways that lead to the station platform. The belt, or movable flooring, has an inclination of 25 degrees, the vertical lift being 7 feet, and it travels at the speed of 80 feet per minute. Broadly stated, the device is an inclined belt conveyor, similar in its action to those which are used for raising baggage from a steamer's deck to the dock level. It consists of an endless belt, made up of transverse cast iron slats. . . The capacity of an elevator 20 inches wide is 3,000 persons per hour."



EXPORT — "There is no doubt that the American manufacturers of labor-saving machinery and implements are devoting more attention to the possibility of building up and extending an export business with foreign countries than they have done for many years."

PIGEONS — "The use of homing pigeons as messengers is said to have received considerable attention at the United States Naval Academy. . . Many newspapers use pigeons as messengers with decided advantage for the transmission of news, and so some of the recent election returns were brought in by carriers. Improvements in method and apparatus follow the new uses of the birds. The old way of attaching a quill with the message to the tail feather of the homer has been improved recently by an invention of Prof. Henri Marion, of the Naval Academy, a small water tight aluminum message holder, weighing less than eight grains, which can be fastened to the pigeons in an instant."

PATENT ATTORNEYS — "The public, it is to be hoped, are awaking to the fact that the personal element in patent practice needs purification. Under existing conditions, inventors themselves must do the purifying by selecting reputable firms for their representatives in Patent Office proceedings."

100 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of January, 1847)

BULLETS — "There is a machine employed in St. Louis in making bullets, of which it turns out 180 per minute.—Two millions of balls have been shipped for the seat of war within two weeks."

UNION STATION — "A movement is being made at Worcester, Mass., to erect a new central depot which will accommodate and concentrate the business of all railroads, and promote the convenience of the public by enabling all the railroads coming into Worcester to centre at one point."

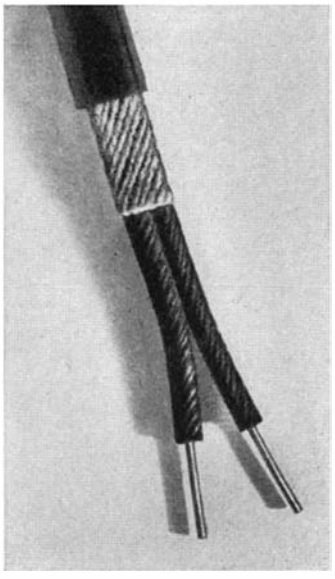
WAR SHIP — "There is now before Congress the plan of a fireship, made by Mr. Brown, of Illinois, for marine and harbor defence. It is so constructed as to reflect off shot, while it is capable of enveloping in a single moment, an enemy's ship in a sheet of inextinguishable fire."

BRIDGE — "An iron bridge, in size and magnificence, perhaps, never before equalled, is about to be erected, with a corresponding viaduct across the Tyne, from Gateshead to Newcastle-upon-Tyne, for the Newcastle and Berwick railway. . . It is to consist of six cast iron circular arches, with a curved approach at each end. The span of the arches will be 125 feet, supported on pillars 21½ feet high, and 14 inches square."

STEAMER — "We learn from Pittsburgh that the iron steam-frigate Allegheny, will be completed and ready to launch in February next."

Drop-wire undergoing abrasion tests in birch thicket "laboratory." Below, the new drop-wire, now being installed.

WE'RE GLAD THAT BIRCH TREES SWAY



The telephone wire which runs from the pole in the street to your house is your vital link with the Bell System. More than 17,000,000 such wires are in use.

The wire becomes coated with ice; it is ripped by gales, baked by sun, tugged at by small boys' kite strings. Yet Bell Laboratories research on every material that goes into a drop-wire—metals, rubbers, cottons, chemicals—keeps it strong, cheap, and ready to face all weathers.

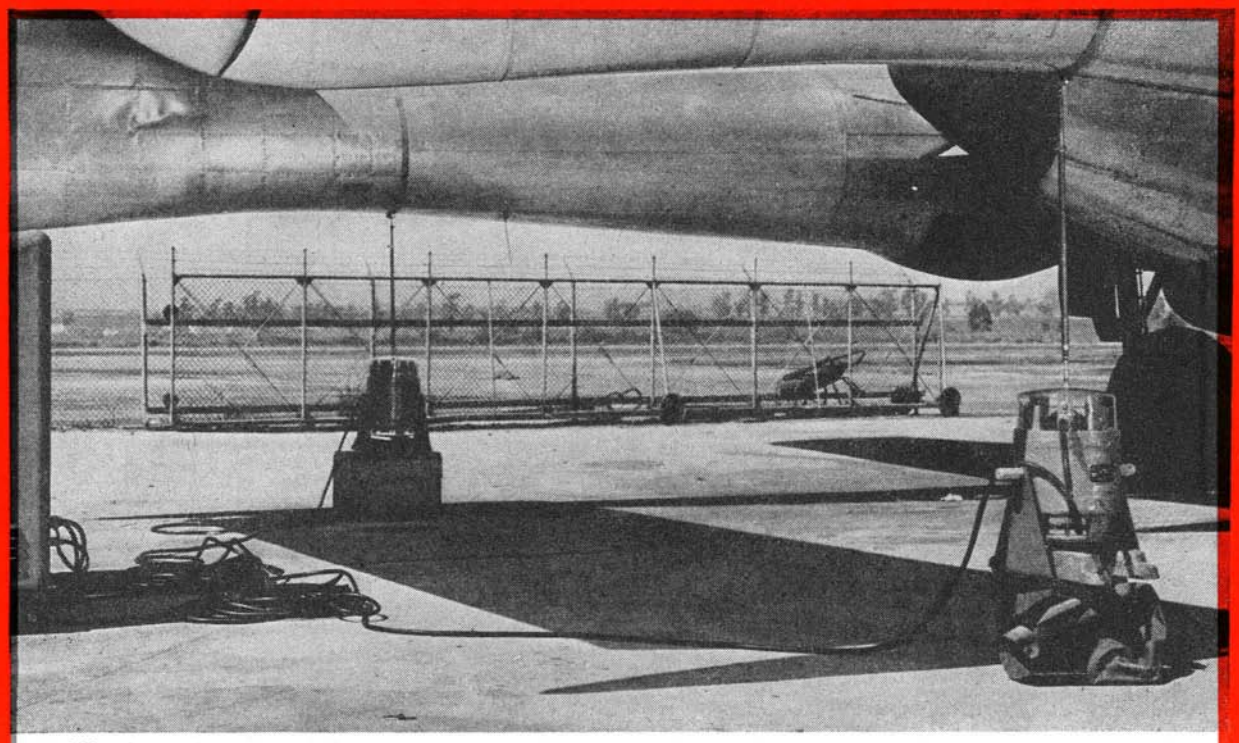
Now a new drop-wire has been developed by the Laboratories which lasts even longer and will give even better service. It has met many tests, over 6 or 7 years, in the laboratory and in field experiments. It has been strung through birch thickets —rubbed, winters and summers, against trees, and blown to and fro by winds. In such tests its tough cover lasts twice as long as that of previous wires.

House by house, country-wide, the new wire is going into use. Wire is only one of millions of parts in the Bell System. All are constantly under study by Bell Telephone Laboratories, the largest industrial laboratory in the world, to improve your telephone service.

BELL TELEPHONE LABORATORIES

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

Scientific American
JANUARY • 1947



Vibration exciters on each fuselage boom of Northrop F-15 plane are energized by electronic unit just visible at left

Little Shakers Test Big Structures

Vibration Effects, Sometimes Revealed by Structural Failures, and Always Hard to Evaluate In Design, Are Accurately and Safely Tested by Electromagnetic Vibrators. With These Units, Forces of Controlled Amplitude and Frequency are Conveniently Used on Critical Members

By JOHN MARKUS
Associate Editor, *Electronics*

With a distinct trend in industry toward light metals and high speeds for machines as well as motor vehicles and aircraft, vibration testing becomes an important field of investigation. As speeds go up, flutter tests become increasingly more valuable, and are absolutely essential in aircraft and rockets approaching or exceeding the speed of sound.

Great bridges, designed to withstand static loads with an ample margin of safety, have crashed to destruction once set in vibration by gusts of wind; critical moving members of machines have failed mysteriously after long periods of satisfactory service, simply because metals get tired or fatigued when subjected to apparently insignificant vibration for a long period of time.

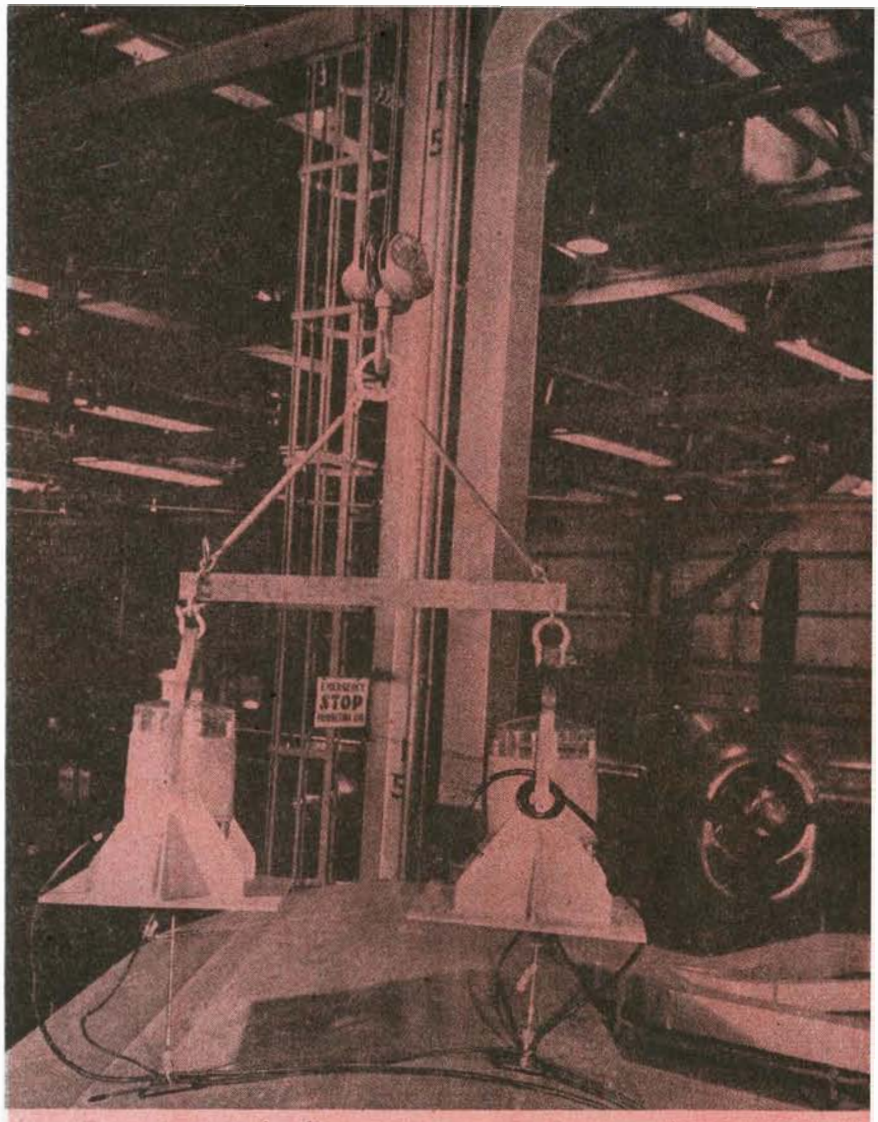
Exposing experimental structures to electronically produced and controlled vibrations at accelerated rates is a simple and effective way of determining beforehand whether designers have properly allowed for

• LOOKING AHEAD •

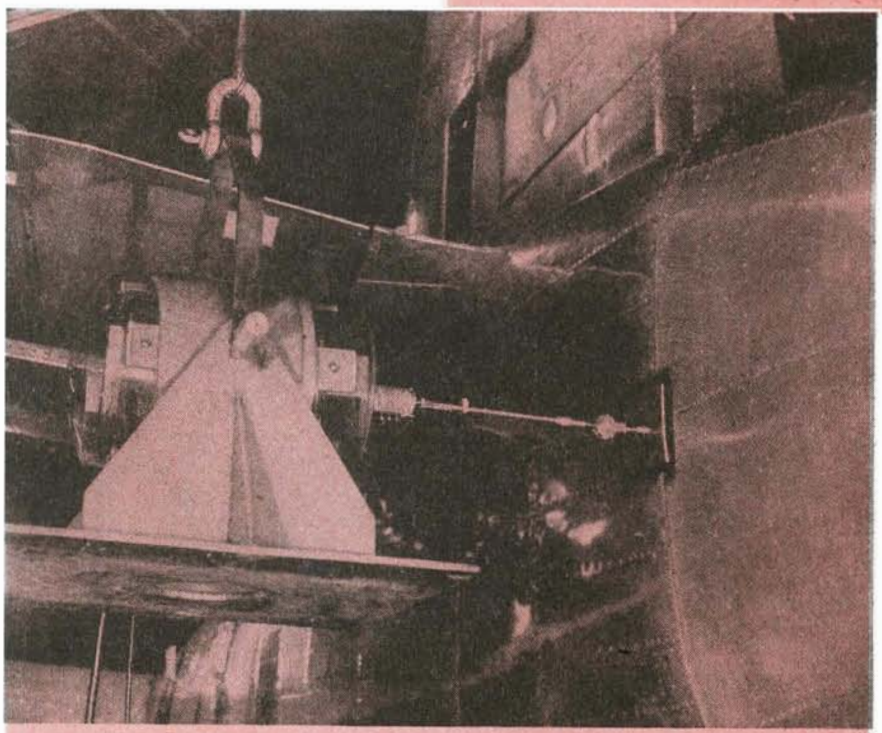
Fewer mysterious structural "accidents". . . Longer life for machinery subjected to vibration. . . More efficient, lighter designs through elimination of unneeded "beef". . . Smoother riding buses and trains on better spring suspensions.

the most severe conditions of vibration that might be encountered in actual use. Thousands of dollars can be saved and many human lives and injuries can be spared by making such failures occur before a single production model has left the factory, and by correcting design faults before they can take their toll.

To accomplish such testing, the principle of resonant vibration is now being utilized in an electronic vibration exciter for structural tests. One or more shaker units, each essentially like a radio loudspeaker without the latter's paper cone, are positioned near the automobile body, structural beam, aircraft fuselage, or other structure to be tested. The moving element of each shaker is coupled to a metal rod that fits onto a rubber suction cup attached to the structure. Thus the shaker need only be energized at the natural vibrating frequency of the structure in order to produce, in a few minutes, vibrating forces so strong that iron beams snap in two, huge aircraft fuselages pop or "oilcan" like a child's toy cricket, and 30-ton bombers actually bounce off their landing wheels.



Two exciter units rigged to create complex vibration patterns in plane wing



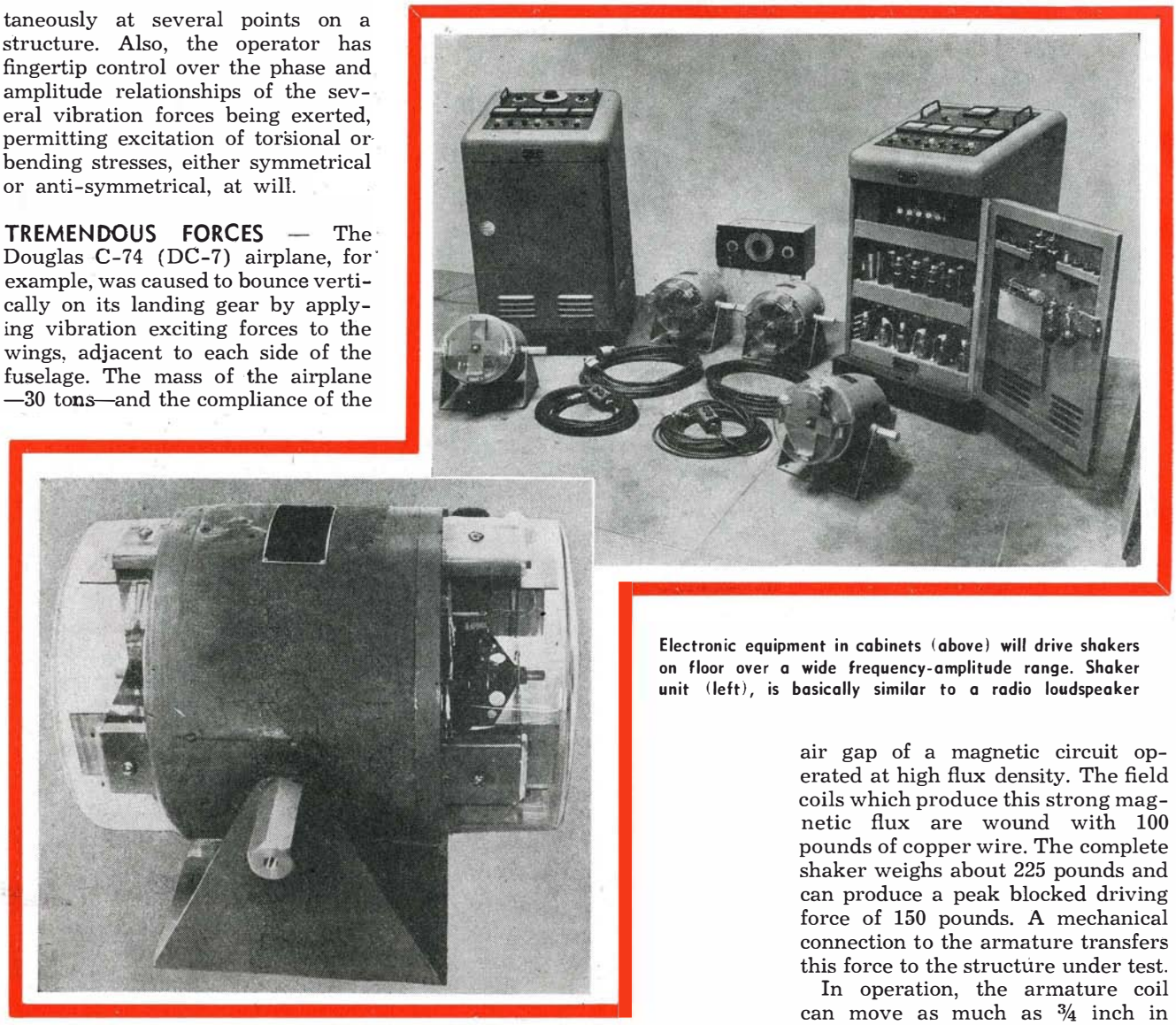
Cable suspension for exciter permits vibration of almost any part or location

Finding the right vibrating frequency and supplying sufficient power to the shakers at that frequency is the job of the two electronic cabinets which constitute the heart of this new structural testing equipment. Made by The Rollin Company, the electronic vibrator is primarily designed for making flutter tests on large aircraft structures. It provided separately exciting vibration at each mechanical resonant frequency of the unit under test, as contrasted to brute-force mechanical apparatus by which vibration is created through the use of a rotating unbalanced mass driven by a constant-speed motor.

In comparison with such mechanical systems, the electronic method offers a much greater flexibility and far more accurate control over the vibration forces being applied. When desired, vibration forces may be established accurately and simul-

taneously at several points on a structure. Also, the operator has fingertip control over the phase and amplitude relationships of the several vibration forces being exerted, permitting excitation of torsional or bending stresses, either symmetrical or anti-symmetrical, at will.

TREMENDOUS FORCES — The Douglas C-74 (DC-7) airplane, for example, was caused to bounce vertically on its landing gear by applying vibration exciting forces to the wings, adjacent to each side of the fuselage. The mass of the airplane —30 tons—and the compliance of the tires resonated at a frequency of 114 cycles per minute. Two electromagnetic shakers were used and the peak force required to produce the vertical bouncing was only 45 pounds per shaker. Thus, tremendous mechanical forces can be developed through the phenomenon of resonance.



Electronic equipment in cabinets (above) will drive shakers on floor over a wide frequency-amplitude range. Shaker unit (left), is basically similar to a radio loudspeaker

In another test, the wing of a large airplane was excited by anti-symmetrical bending forces. These imparted a torsional motion to the fuselage, causing the entire tail assembly to whip from side to side and making the fuselage produce loud snapping sounds like those of an oilcan being pressed on the bottom.

The equipment is also ideally suited for making accelerated repeated load or fatigue tests—to the point of failure or destruction—to determine the physical properties of various structural members or certain materials. A resonant force of 200 pounds, for example, may be exerted alternately in tension and compression on a sample structural member for 80,000 cycles in two hours. A similar test employing motor-driven, cam-operated apparatus operating at the rate of 10 cycles per minute would require well over 100 hours.

An outstanding factor in this method of fatigue testing is that incipient failure of the sample throws the system off resonance. The resonant frequency is reduced and continuing reduction is an indication of impending failure of the sample material.

The driving force of the testers is produced by electromagnetic vibration motor or shaker units employing the same principle as the electro-dynamic loudspeaker of a radio set. These shakers are energized by a vacuum-tube oscillator and power amplifier. The frequency of the oscillator can be controlled over a range from two cycles per second to over 500 cycles per second.

A shaker unit comprises a movable armature coil suspended in the air gap of a magnetic circuit operated at high flux density. The field coils which produce this strong magnetic flux are wound with 100 pounds of copper wire. The complete shaker weighs about 225 pounds and can produce a peak blocked driving force of 150 pounds. A mechanical connection to the armature transfers this force to the structure under test.

In operation, the armature coil can move as much as ¾ inch in either directions from the rest position, less than five pounds of pull being required to move it all the way. A unique copper suspension system keeps the coil centered in the air gap during motion.

PHASE RELATIONSHIPS — Many vibration tests require means for applying vibration forces of different phase to two points on a structure, such as for creating torsional types of vibration. For this reason, two identical electronic exciters are provided, each in its separate cabinet and driving its own pair of shakers. If only one pair of shakers is required the unused unit then serves as a standby set, a desirable feature since interruption of tests on a large structure is quite expensive.

In addition to controlling the phase, the amplitude relationship between the two cabinets and pairs of shaker units can be continuously controlled to the point where one pair of shakers produces a relatively low driving force while the other pair is producing a high driving force. In this manner, sweeping

of the point of application of the vibration force being applied to a structure may be varied at will. The equipment is flexible, and the various types of tests which can be set up is limited only by the ingenuity of the operator.

Smaller shakers are available for testing small structures and for use in locations where it is difficult to mount the standard shaker units.

Symmetrical bending forces may be produced in a structure by attaching the two shaker units adjacent to but slightly beyond the nodal points in the vibrating structure and operating the shaker units in phase. Symmetrical wing bending in an airframe, for example, is obtained by attaching one shaker unit to the left wing and the other shaker unit to the right wing at a point inboard from each wing tip equal to approximately one third the total wing span of the aircraft. Antisymmetrical bending, on the other hand, is obtained by attaching the two shaker units to approximately the same point as for symmetrical bending, but with the shaker units operated 180 degrees out of phase. By changing the phasing switch on the electronic control panel from zero to 180, either symmetrical or anti-symmetrical bending can be quickly obtained.

Simple bending stresses in a cantilever beam are obtained by attaching a single shaker unit at a suitable point along the length of the beam. The greatest resonant forces are produced and the largest force is exerted by the shaker unit when it is attached to the beam at a point adjacent to the fulcrum at a distance equal to not more than one fourth the total length of the beam.

Torsional vibration may be obtained by attaching the shaker units to opposite edges of the structure. The two shakers are then operated with an 180-degree phase relation so a rotational motion is imparted to the structure under test. In testing the wing of an aircraft, one shaker unit is attached adjacent to the leading edge and the other adjacent to the trailing edge of the wing, and the frequency dial of the oscillator is adjusted until torsional resonance occurs.

CONVENIENT APPLICATIONS — The shaker units are most conveniently attached to a structure by means of rubber suction cups. A cup between four and six inches in diameter, having a short length of metal shaft ⅜ inch in diameter extending from the rear of the cup, is usually satisfactory.

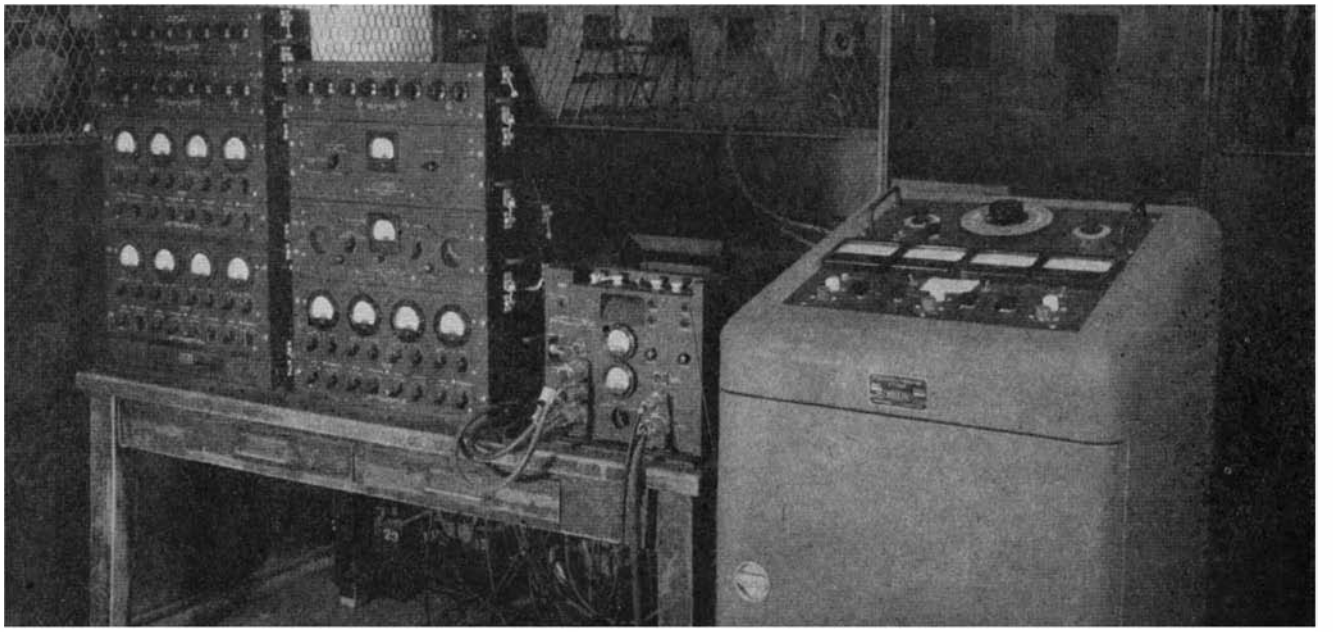
The shaker units may be mounted on movable platforms of such height as to provide for their attachment to a desired point on the structure being tested. These platforms must be rigidly constructed to prevent resonance from occurring which might cause the platform to collapse. In certain cases, when it is not convenient to employ a movable platform for mounting the shaker units, they may be suspended by ropes so as to act as a pendulum having an extremely low-frequency resonant period. When so mounted, the lengths of the ropes are such that the resonant period of the pendulum is below the lowest frequency at which the structure is to be tested and the shaker units are guyed to prevent them from tending to rotate. Resonant periods in the suspension ropes and the guy ropes do occur but they are dampened out by bags of lead shot suitably placed along the length of the ropes.

A special brittle metal coupling rod is employed for connection between the armature and the structure, to prevent damage to the armature coil through lateral misalinement. It is more economical to ruin one of these mechanical fuses than to damage an armature coil.

The vibration at various points on the structure under test may be measured by suitable strain-gage equipment and recorded on an electronic multi-channel recorder. Such records permit accurate determinations of the stresses developed in a structure at each frequency. Twelve different locations on a structure can readily be monitored simultaneously with this recording equipment, including locations that would not be accessible to an observer during a test.

Similarly, in the automotive industry, the electronic exciter can be used to induce shimmying action in front wheels to see which part of the steering system will fail first; in buses, streetcars, or railroad cars it can sweep through all the bump frequencies that might be encountered on the road to see if any can induce annoying sympathetic vibrations in the frame of the vehicle; in any other structure inherently capable of shaking itself to pieces, this electronic exciter can simulate such vibration in the safety of the test laboratory, under illumination of stroboscopic flash lamps so that engineers can actually see what goes on during each phase of the test.

Thus, where electronics heretofore served principally in tests aimed at



Multi-channel recording equipment on table provides permanent record of vibration effects obtained with electronic exciter

eliminating vibration in structural members, it is now coming into its own as a stimulator of vibrations. Industrial applications for this new testing technique are limited only by the imagination.

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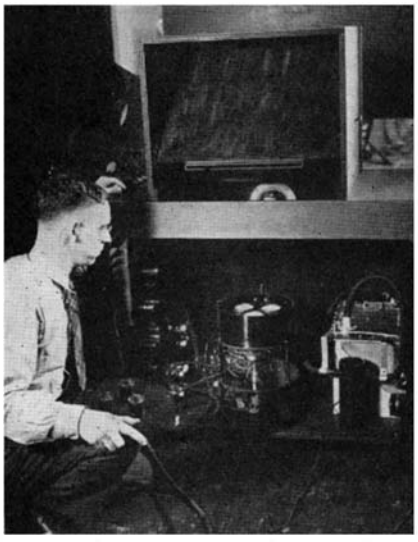
TELEVISION COLOR

Transmitted Electronically In Laboratory Demonstration

RECENTLY demonstrated in experimental form, all-electronic color television successfully transmitted color slides and a color movie cartoon over wires to receivers that reproduced them on a 15 by 20-inch screen in natural color. The transmitter of the all-electronic system splits the scene to be televised into three colors—red, green, and blue—by means of color-separating mirrors. Each color is then fed to a photoelectric cell to convert it into corresponding electrical impulses, a feature made possible by use of a scanning cathode-ray tube as the light source for the film. The three signals formed by the impulses are transmitted simultaneously instead of in sequence as mechanical systems have done in the past.



All-electronic television receiver (above) houses "Trinoscope" assembly in lower cabinet, projects images to form colored picture on screen. Diagrams (below) show theory of three-channel sender and receiver

In the receiver, the three signals are fed to separate projection-type cathode-ray tubes, called a Trinescope. The three images are projected onto a translucent screen so that the three colors are precisely superimposed to produce the final complete color scene, according to the demonstrators, RCA Laboratories.

Buyers of current television receivers may, if the Federal Communications Commission establishes standards for color television based on this electronic method, use present receivers to view future color broadcasts in black and white by addition of a converter costing from $25 to $40. This converter would tune to the higher frequencies—480 to 960 megacycles—for which color-television operation is planned. By the same token, buyers of future color receivers would be able to receive the present lower-frequency black-and-white broadcasts on the green channel of their color receivers. However, commercial color television is not expected to have all the bugs removed until about 1950, when many of the present black-and-white receivers will be due for trade-in anyway.

HIGH-FREQUENCY STOVE

Cooks or Defrosts Foods in Record Time

USING a radar-transmitter tube and a horn antenna, an unusual cooker, called Radarange, bakes biscuits and gingerbread in 29 seconds, cooks hamburgers with onion in 35 seconds, and grills a frankfurter and roll in eight to ten seconds. A package of frozen food can be defrosted in a few seconds, and cooked almost as fast.

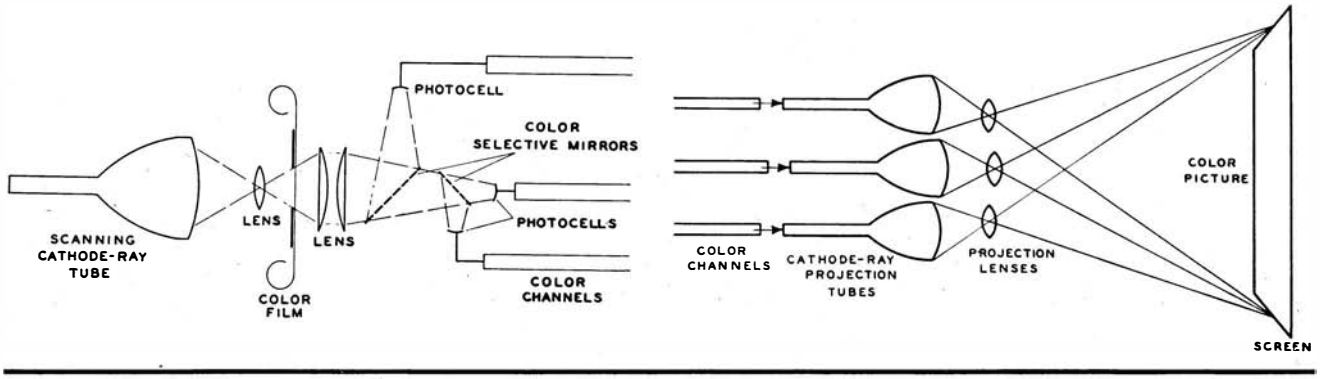
The equipment has the magnetron and horn assembly mounted above the cooking area, so as to beam the radio-frequency output into the food being cooked. In operation, a timer is set for the desired cooking time and a button pressed. When cooking is completed, the timer automatically shuts off and the food is ready to eat, according to the Raytheon Manufacturing Company. The power supply is located in the base of the cabinet.

Radio-frequency cooker, side panels removed, is demonstrated on hot-dog in "oven." Cooking takes 10 seconds

RADIO PLANE TIMER

Operates Regardless of Weather, Altitude, or Speed

INSTALLED at two Army Air Forces speed courses, a radio-beam speedometer for aircraft employs three parallel radio beams at right angles to the charted course of the plane. As the plane crosses each beam a signal is flashed to a central recording station, and the time elapsed between signals is measured against the known distance between beams to show the speed at which the plane is traveling. The radio-beam system operates accurately in any weather and any altitude and is the first system capable of measuring speed at or above the speed of sound.



Taking THE STRESS out of STYRENE

Annealing Polystyrene Plastics Parts Requires a Simple but Specific Technique. Controlled-Cycle Water Baths and Fixed-Temperature Ovens are Practical if Results are Checked By the "Kerosine" Test

By CHARLES A. BRESKIN
Editor, *Modern Plastics*

As a means of preventing failure of polystyrene plastics parts due to thermally or mechanically induced stresses, more and more molders of this material are annealing their finished products. The importance of this technique stems, in part, from the broadening range of applications to which styrene is being put. Many molded articles are subjected to considerable abuse, sharp knocks, and so on. Refrigerator freezer doors, for example, or brush backs, or mixing units for the kitchens, all commonly made of styrene, are often treated in a manner that requires them to be free of built-in stresses if satisfactory service is to be had. And polystyrene sometimes suffers from erratic behavior in use as a result of stresses induced by its high coefficient of expansion—10 to 15 times that of steel. Other factors affecting applications of this plastics are its low long-time strength and its susceptability to some chemicals and vapors.

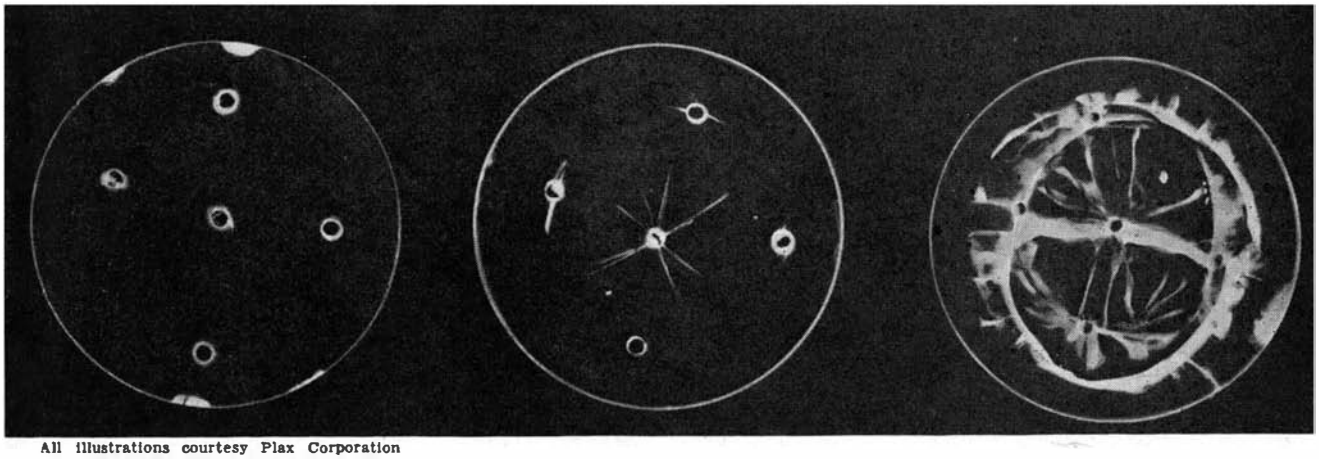
Because of the tremendous volume of polystyrene now being produced, assurance of satisfactory performance in consumer goods and therefore its proper annealing, has become vital to all users and producers of plastics. Polystyrene was, according to figures supplied by the Plastics Materials Manufacturers Association, Inc., being made at the rate of 53,700,000 pounds per year during the first seven months of 1946. But since then many new plants have gone into operation.

The increased production of this plastics material has been phenomenal during the past few years, the 1945 rate being 32 times that in 1939. And with this greater availability has gone, as mentioned above, a proportional expansion in the applications to which it is put. From gadgets it has spread to the industrial, gift, fashion, and home-appliance fields. It is now to be found in synthetic jewels, refrigerators, brushes, cosmetic containers, and a multitude of other end products.

One of the big factors in the growing use of polystyrene has been its relatively low cost. And, because of the resulting quantity that is being produced, it is in better supply than many other plastics materials although the demand-supply ratio was recently estimated at 2½:1. In any case, the present volume of polystyrene passing through molding plants points to the importance of a wider knowledge of its annealing technology.

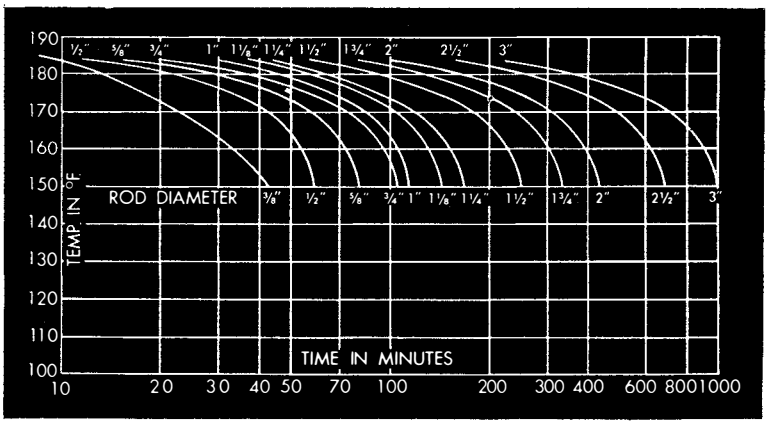
WHAT ANNEALING MEANS — J. H. DuBois, in his book entitled "Plastics," has suggested an accelerated test to determine whether or not a molded styrene article will "craze;" if it does, it is an indication that the piece may be improved by an annealing operation. Mr. DuBois stipulates that a small hole be drilled in a sample of the finished piece, followed by the application of a drop of kerosine. Any tendency to

Information on the annealing operations was supplied by James Bailey of the Plax Corporation.



All illustrations courtesy Plax Corporation

Polystyrene disks, after kerosine test, show (left to right): proper annealing, unsatisfactory annealing, and an unannealed piece



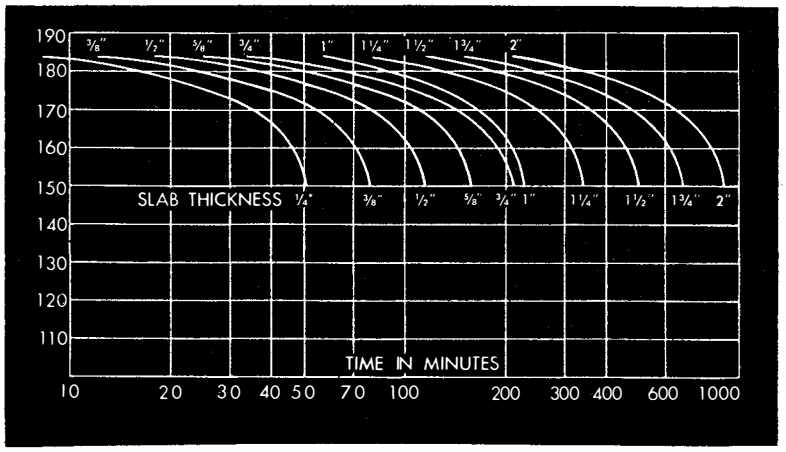
Standard annealing cycles for round polystyrene rods (above) and for slabs of the same plastics (below) may be modified to suit actual production problems

inch and under, for example, present this problem. To prevent this warping, the styrene may be packed in a metal-slat rack which allows the pieces very limited motion and keeps them straight during the annealing process.

Standard annealing cycles for round rods and molded slabs are presented in the accompanying graphs. For round rods in Figure 2 and for slabs in Figure 3 the ordinates are bath temperature in degrees, Fahrenheit, while the abscissas are elapsed time in minutes from the initial equilibrium temperature of the bath. These cycles have been tested over a period of

• LOOKING AHEAD •

Fewer consumer "gripes" about plastics articles that disintegrate in use. . . Application of low-cost styrene to more "quality" products when stress problems are understood. . . Developments of faster production-annealing systems.



craze will show up very quickly.

The definition of annealing does not mean the same thing in all arts. In the metal industry the term refers to the soft state of the material which is usually achieved by heat treatment. As for the annealing of glass, there are two schools of thought. The more general idea defines annealing as a cooling cycle, starting at a high-temperature stress-free state, which permits the glass to reach equilibrium at room temperature with small internal stresses. The newer concept regarding the annealing of glass includes not only a condition free from mechanical stresses and double refraction but a condition in which the glass is established in equilibrium as regards its molecular state.

The analogy between annealing glass and annealing polystyrene plastics is rather close, although the basic structures of the two materials are not the same. Styrene differs from glass in that it has long-chain molecules with few cross links. It is not truly viscous, as is glass, even at high temperatures. But it does have a yield point of a sort; that is, its viscosity varies at constant temperature as some function of the speed of flow—being lower at high speeds.

ANNEALING PROCEDURES—During the past several years, one manufacturer of polystyrene, the Plax Corporation, carried on a study of the annealing of this plastics. This company's annealing is done in a water bath which is circulated by a propeller and whose temperature is controlled automatically. The stainless-steel tank used for annealing is constructed with two sets of coils, one for steam to heat the bath and one for cold water to cool the tank in short cycles.

According to the needs of a particular polystyrene part being annealed, the finished plastics piece is heated and then cooled for specified periods of time. The cycle is established on sample annealing runs, after which a master cam is constructed which will automatically hold the controller regulating the bath to this particular cycle of heating and cooling. When the end of a cycle is reached, the polystyrene parts being annealed are removed. A new load may then be placed in the tank at once and allowed to heat up with the bath, or the bath may be started up and the plastics parts placed in later when some higher temperature has been reached. The new charge of parts and their holding rack lowers the temperature of the bath somewhat and the cycle controller must not be started until the charge and the bath are in equilibrium.

In certain styrene parts there is a tendency toward warping because of orientation strains. Rods of ¾ time and found satisfactory. They are designed to give the shortest possible time for the required degree of annealing with a computed safety factor of two.

The four parts of each annealing cycle include the holding time at 184 degrees, Fahrenheit; the initial slow cooling rate, 184 to 170 degrees, Fahrenheit; the next slightly faster cooling rate from 170 to 160 degrees, Fahrenheit; and the final slightly faster cooling rate, 160 to 150 degrees, Fahrenheit. At 150 degrees, Fahrenheit, the parts are removed and allowed to air cool.

With both the round rods and the molded slabs as charted, the theory is that the time required during any cycle will vary as the square of the diameter, if the stress at the center is kept constant. The time for a slab four-inches thick would be four times that of a two-inch thick slab, and 16 times that of a one-inch slab. A slab, incidentally, requires twice the time of a round rod of the same thickness.

Working on the basis just demonstrated, any other cycle can be derived very simply if any one of the factors is known. It can be seen in Figure 2, however, that the cycles for one-inch diameter rods and under are gradually lengthened over what would be required by the

square law, and that the shortest cycle is for ⅜-inch diameter, with a total time of 43 minutes. This departure from the formula is due to the fact that the annealing bath cannot be made to follow faster cycles with accuracy, and that small temperature lags in the cycle for less than one-inch diameter rods require a greater safety factor.

MACHINED PARTS—Even in parts machined from annealed styrene stock there are problems of further annealing because of machining stresses. These, however, are usually confined to a comparatively thin layer of material immediately adjacent to the machined surface. Here, the annealing is merely a matter of removing the stresses in the surface layer only, no large body strains being involved.

To carry out the annealing system described by the Plax Corporation, all that is needed is a simple heat treatment for a short period of time. The machined parts are loosely piled in ¼-inch wire-mesh baskets to a depth of about four or five inches. The basket can be of any size that will fit a small tank stirred by a small propeller. Also, the basket should have a cover to prevent the parts floating out while submerged in the water bath.

The loaded basket is lowered into the bath so it is covered by at least one inch of water and allowed to remain for 20 minutes. It is then lifted into the upper part of the tank to a position about one inch above the liquid. In this position the parts drain for 20 minutes. They are then removed and allowed to cool in the air until all the parts have cooled to a temperature of 150 degrees, Fahrenheit, or below.

Because water evaporates very rapidly when maintained at a temperature of 184 degrees, Fahrenheit, ethylene glycol is often added to the bath. If it is used, the annealed styrene parts must be carefully washed after their treatment to remove any trace of glycol since the latter is not a very good electric insulator and does not dry readily from the plastic. Swishing the baskets in several changes of water held at a temperature of about 140 degrees, Fahrenheit, will usually do the rinsing satisfactorily.

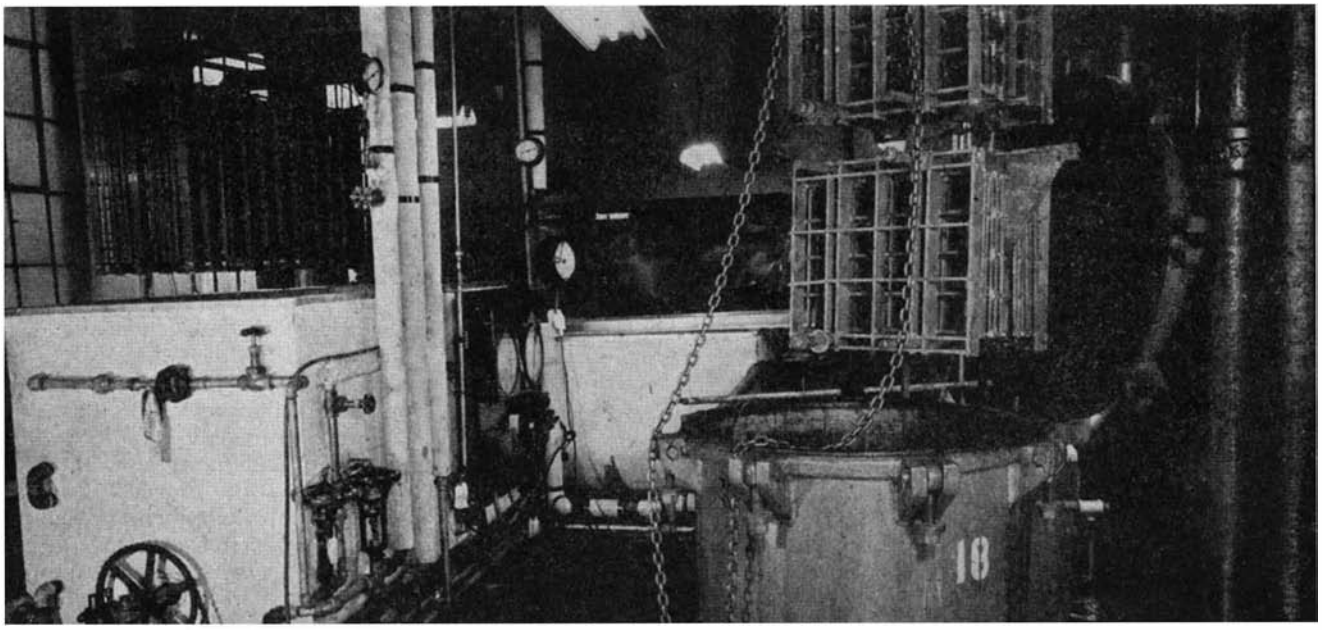
ANNEALING TESTED — Early in the research work, it was found that in order to ascertain whether or not the annealing work was being done satisfactorily it was necessary to develop a quick, easy, and reliable test of the finished pieces. Consequently the "kerosine" test was worked out. In this test a representative piece of the annealed styrene is immersed in kerosine for one minute at room temperature —20 degrees, Centigrade, plus or minus five degrees—then removed without wiping and observed for results. If the piece is free from cracks at the end of 30 minutes after its removal from the kerosine the annealing is considered satisfactory. This test is applied only to such pieces as will not receive any subsequent machining.

In the case of long rods which will be machined later, however, the kerosine test is applied to a crosswise sample cut from the rod at a point distant about three diameters from one end and at least ¼ inch thick measured in the direction of the original length of the rod. Four small holes are drilled through the sample in the axial direction—one at the center, and the other three spaced at radial distances of ¼ of the radius, ½ the radius, and ¾ the radius from the center. The exact location of the holes is not too important, and the holes themselves may vary from 1/16 to 1/6 inch in diameter.

A wet saw and drills are are used in cutting out the specimen and in drilling the holes to avoid the introduction of stresses by these operations. Small cracks around the ends of the drilled holes which show no tendency to spread into the main body of the material when the piece is given the kerosine test may be disregarded and attributed solely to the drilling. The same is true of surface crazing along saw cuts. If a sample indicates deep body cracks, even though small, when given the kerosine test, a second test is made using more care during the preparation of the sample. If this piece also cracks, the annealing is not satisfactory. An accompanying photograph shows a properly annealed sample, a borderline case, and an unsatisfactory annealing job.

OTHER TECHNIQUES — The Bell Telephone Laboratories, among others, have worked upon the styrene annealing problem and specified a procedure for certain items. In this company's specification the procedure calls for an oven treatment at a single temperature of 170 degrees, Fahrenheit, followed by cooling in still air at room temperature. The maximum diameter of the part allowed for in this system is 1¾ inches, and the piece must be heated in an air oven at the specified temperature for 16 hours.

The advantage of this method is that the air oven employs a simple



Annealing tank set-up in molder's plant. Rack arrangement holds pieces firmly to prevent warping

single-temperature thermostat instead of an expensive cycle controller as with the Plax water-tank method. The temperature can be easily adjusted to some other temperature corresponding to a different plastics piece. The system has the obvious disadvantage, however, of requiring 2.85 more time than the water-bath method.

Mr. DuBois, mentioned previously, suggests that styrene pieces which show a tendency to craze may be improved by an annealing operation in which the part is baked one hour at 160 degrees, Fahrenheit, one hour at 175 degrees, Fahrenheit, and six hours at 180 degrees, Fahrenheit. It is his opinion that thin pieces should be annealed at the highest temperature at which dimensional accuracy may be maintained. Tests indicate that parts up to 1¾ inches in diameter will pass the kerosine test after the foregoing treatment but may suffer some unmolding.

Patent literature contains other methods of annealing, many of which are quite tricky and would be rather difficult to operate on a commercial basis. Most of them are based upon a sudden change in the cooling cycle, intended to reverse the stresses due to cooling at some critical point in the cycle.

The relieving of stresses in styrene by annealing should not be confused with orientation or with any considerable change in state. Annealing for use with polystyrene is simply defined as the reduction of internal stresses from whatever cause to a point where the residual stresses after annealing can be borne safely by the material during its service life without crazing or cracking.

WIPE-CLEAN CLOTH

Owes Properties to Plastics Finish, Does Not Glisten

THERE have been reports for a long time of plastics-coated tablecloths that would look just like untreated cloths yet could be wiped clean of almost any type of spot or marking with a damp rag. Now such cloths are on the market and are just as practical as the forecasts promised. Their introduction, and the immediate acceptance given them, opens the door to the use of plastics in a similar manner in a host of other goods. Luncheon cloths, dressing-table covers, mats, and centerpieces are just a few of the applications that most resemble the tablecloth in use.

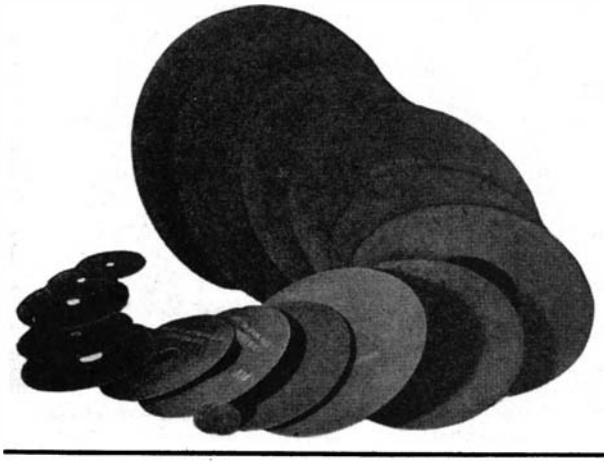
The easy-to-clean feature of these tablecloths is imparted by a thin, almost invisible coating of Monsanto vinyl butyral. Tough and flexible, there is no shine to the coating, a characteristic resulting from the inclusion of finely divided, sub-microscopic silica particles which scatter light waves instead of reflecting them. This coating can be given the cloths at a very small increase in cost, and one which will quickly be wiped out by the saving in laundry bills. The coating is applied to but one side.

The Monsanto Chemical Company, who first announced these cloths, is the supplier of the vinyl butyral. Also, it supplies the technology on the application of the finish. The coating is for mill application only.

PLASTICS-BONDED ABRASIVES

Matched to Operating Conditions, Precisely Sized

FOR THE deep-grooving of metal, grinding wheels have been developed in which Durez resins are used to bond the abrasive particles to the wheels. So that the wheels will be able to meet all types of operating conditions, the phenolic resins have been specially formulated to match the size grain of the abrasive used, the temperature necessary for bonding, and the pressure used in the process. The wheels are supplied in many sizes, grains, and grades, and have a guaranteed tolerance of plus or minus 0.005 inch, according to the developers, the J. G. Sandstrom Grinding Wheel Company.



Wide selection of sizes, grains and grades, makes these precision-type wheels adaptable to many jobs

KNIFE SETS

Produced of Special Wood

RESIN - IMPREGNATED compressed wood, which gave a good account of itself during the war in airplane propellers, has started to make its appearance in domestic products. Uses include holders for kitchen and table knife sets such as those produced by Adams Plastics Company from Compregwood.

Useful compressed-wood articles

REFLECTING PLASTICS

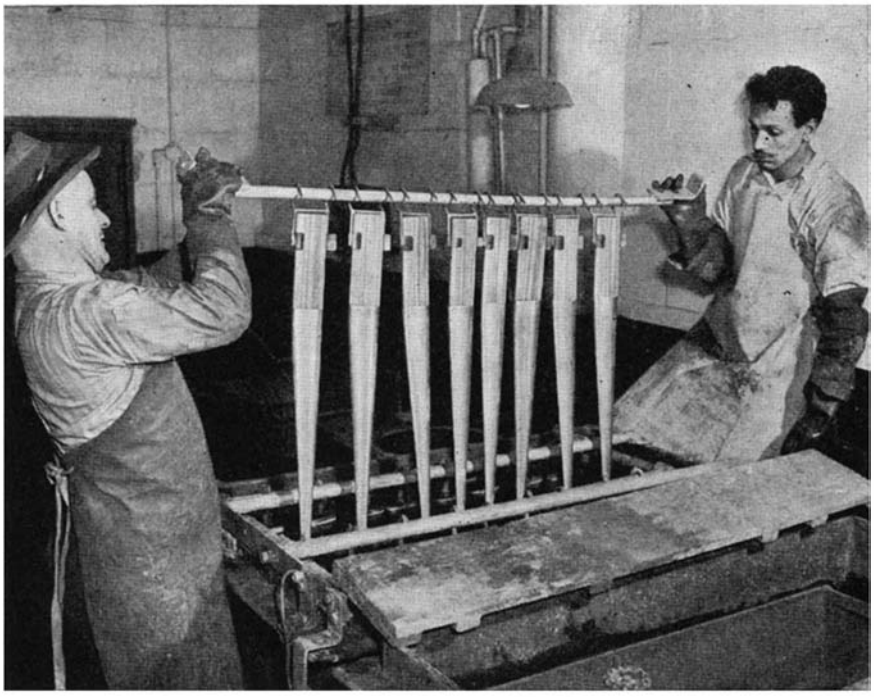
Make Night-Visible Signs By Small Molded-In Lenses

HOUSE signs that show up at night are not new, but a street sign that is as easy to see by night as by day is a welcome innovation. And that is the latest use which has been worked out for an acrylic sign material called Reflexite.

The ability of these signs to show up clearly is a function of thousands of minute lenses which are molded into one side of thin transparent Lucite sheets. There are about 2500 of these lenses to each square inch of plastics surface. The back of each sheet is polished smooth, acting as a focal plane of the molded lens areas on the other side. Reflecting characteristics are determined by the thickness of the acrylic pieces.

Individual letters are applied to the back of the acrylic piece by silk screening with a special acrylic ink containing aluminum powder. The background color—any color—which provides contrast is then applied.

The completed sign is made by forming a metal or other suitable support for the letters which are to be combined. The letters are held in the holder by an adhesive.



Lifting electroformed antenna masts from tank; tapered matrix can now be removed

ELECTROFORMING for Precision

When Production Quantities of Accurately Contoured Parts are Needed, And Finishes are Specified in Micro-Inches, the Answer May Be Electroforming. Unusual Metal Density is Added Feature

By H. R. CLAUSER
Associate Editor, *Materials & Methods*

SOMETHING new in metal parts production methods entered the industrial picture with the development of the Ekko process for producing rubber-tire molds by electroplating. Here, a thick film of iron is plated on a suitable matrix. Separating the matrix from the electrodeposit gives an accurately and intricately shaped tire mold possessing excellent finish, long life properties, and attractive economy as compared with conventional tire mold making methods.

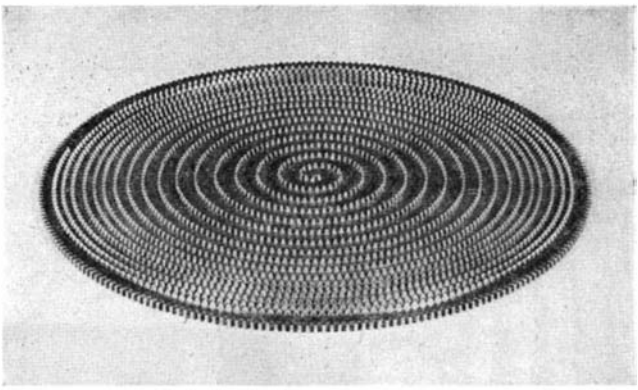
During the last few years the same general technique, called electroforming, has been applied to a wide variety of other types of parts, often using other metals than iron. Many plants outside the tire industry came to use either the products or the process itself. Now, electroforming has emerged from this development period as a highly promising method of making certain types of precision metal parts.

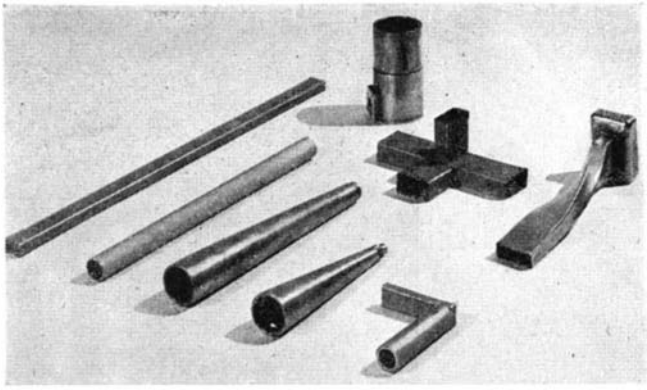
Electroforming is actually an extension of electroplating. But decorative or protective plating generally involves deposits of metal of only about .0001-inch thickness on previously formed parts. Electroforming, on the other hand, is principally concerned with the primary shaping of a part by the build-up of electrodeposited metal on a mold or matrix.

In a typical application a die or mold is made from a master pattern of the part to be formed. This mold is termed the matrix. It is a negative impression of the finished part and serves as the base for electrodeposition of the metal. The matrix is placed in an electroplating bath where the form of the part is built up by electrodeposition. After the metal has been deposited on the matrix to the required thickness, the plated matrix is removed from the bath and separated from the electrodeposited metal. The resulting electroformed part is an exact duplicate in metal of the master pattern.

MATRIX TECHNIQUES—The making and use of the matrix is probably the most important step in the electroforming process. Three different techniques are possible. One of these makes use of matrix material with a melting point of 200 to 500 degrees, Fahrenheit; bismuth-lead alloys are the most widely employed. After the deposited metal has built up to the desired thickness, the matrix is melted away from the electroformed part.

Another technique makes use of a steel mandrel as the base for the electrodeposition of the metal. The mandrel is machined or ground to





Electroforming can produce intricate pieces almost impossible to machine. Computing cam (above) and angles and tapers (above right) are typical. The radar feed horn (right) required an interior smoothness and accuracy that proved unobtainable when using conventional sheet-metal structures

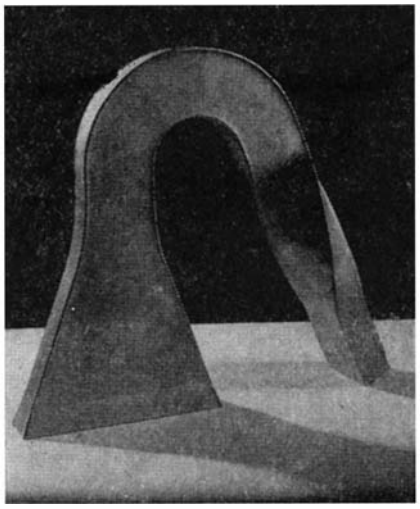
the shape, dimensions, and finish desired. Because parting compound is used to prevent the locking of the mandrel to the electrodeposited metal, the mandrel is made from .0002 to .001-inch undersize. A wide variety of parting compounds can be used: these include thin films of low-temperature melting metal, such as tin or cadmium, and films of wax or lacquer.

The mandrel method can be used for any part whose shape permits the mandrel to be withdrawn from the electroformed part. Depending upon the design of the part, one or several mandrels may be used. When more than one is used, they are interlocked in such a way that each can be drawn independently.

To separate the mandrel from the part, heat is first used to melt the parting-compound film; then pressure is applied and the mandrel is forced away. Because the same mandrels may be used to produce a quantity of the same parts, they are usually made of hardened steel.

A third method is the use of a soluble matrix. The technique is essentially the same as that for the low-temperature melting matrix. The matrix can be made of any material that will not attach itself to the electrodeposit and which can be dissolved by an acid or an alkali. Materials which have been used successfully include aluminum, zinc, and magnesium.

All three of these techniques have distinctive characteristics which suit them to particular types of electroforming work. The steel mandrel and the soluble-matrix methods are applicable to very close tolerance jobs and to applications where extremely high surface smoothness is required. Parts accurate to within .0004 inch are attainable as compared to a .004-inch range possible with the low-temperature melting matrix method.



• LOOKING AHEAD •

Parts electroformed from a wider range of metals. . . Greater use of remarkably dense iron deposited by this method. . . Substitution for expensive machine-contouring in some cases. . . More metal-covered plastics.

The low-melting matrix method is the cheapest of the three, while the soluble-matrix technique is used only in designs where steel mandrels are not adaptable because of the shape and complexity of the part, and where the desired tolerances and finish cannot be achieved by the low-temperature melting matrix procedure.

FORMS UNIQUE METALS — At present, the metals which can be electroformed most practically are iron, copper, and nickel. Chromium can also be electroformed, but is used only where high hardness and abrasion resistance are required. To meet special surface requirements, however, any of the regular plating metals may be plated on the electroformed part.

In some cases parts have been built up by electroforming several laminations of different metals on the matrix. So far little advantage has been demonstrated for this method of electroforming because of the extra operations and the care required. Ordinarily, a satisfactory part can be produced with somewhat less effort using a single material.

Of the metals applicable to electroforming, iron is the most widely used. Because of its unique characteristics, electroformed iron might justly be considered a new engineering material. Electroformed iron is 99.8 percent pure. In the as-electroformed state the iron has a hardness of around 250 Brinell and a tensile strength of 50,000 to 55,000 pounds per square inch. In the fully annealed condition the hardness drops to around 140 Brinell, but there is no change in the tensile strength, and the ductility increases as indicated by an increase of 10 percent in elongation.

A significant characteristic of electroformed iron is that it approaches absolute density. The virtual absence of porosity is evidenced by the fact that, on a vacuum test that has been running for several months, a sample of electroformed iron has proved to be less porous than a piece of glass submitted to the same test.

In its weldability and heat-treating characteristics, electroformed iron is similar to low-carbon steel. Its machinability resembles that of brass, although it is harder and tougher than cold rolled steel. The tool settings are about the same and the shavings have the stringy apperance generally associated with machining brass.

GREAT ACCURACY — The two outstanding characteristics of electroforming are the extremely high surface smoothness attainable and the very close tolerances to which it can work. There is almost no limit to the surface smoothness or the dimensional tolerances possible. These two characteristics of finish and tolerances are almost solely dependent upon the matrix quality. It has been pointed out previously that toler-

ances on the order of .0004 inch are possible. Surface finishes around five micro-inches are easily obtainable; there have been applications in which finishes with a value of two micro-inches were achieved. No additional finishing operations are required to secure these extremely smooth surface finishes; they are inherent in the electroforming operation.

Another important characteristic of the electroforming process is its ability to produce accurately and economically parts having very intricate or minute details. An example of this is found in computor cams for artillery-ranging devices. Producing parts such as this, with hundreds of projections—each one placed slightly different—would be a tedious and costly job by machining methods; only by electroforming can quantities of the part be produced at reasonable speeds.

Electroforming can be employed for parts with sections up to ½-inch thick but there is almost no limit to the thinness of section which can be formed. Parts of electroformed foil .00008-inch thick have been produced successfully. Further, there are no definite limits in size of parts possible. The maximum dimensions are limited only by the size of the tanks available for the electroforming operation.

As for shapes, the process is most applicable to parts with flat contour shapes and to tubular or hollow products. There are practically no restrictions as to cross-sectional designs in tubular products; tapered, round, rectangular, elliptical sections, and so on, can all be electroformed. There is one limitation to be observed in electroforming parts with recesses in the design. Metal cannot be effectively electrodeposited in recesses which are deeper than they are wide.

While electroforming is a high-precision metal forming method, production costs are relatively high. It cannot compete with other processes in the mass production of parts where the tolerances are large or moderate and where high surface smoothness is not required. There is possibly one exception to this: In small-quantity production it will compete with die casting.

MEETS SPECIAL NEEDS — Electroforming has a set of virtues which fit it best for certain specific applications in the field of metal forming. Examples of such applications include parts requiring an extra high surface finish, especially where that finish is required on internal surface contours such as tubing, flow and venturi nozzles, and complex bends and elbows as found in radar antenna and horns; high-precision parts in which tolerances on the order of .004 inch and less must be met; and products that require absolute accuracy of shape or form. Examples of the latter are wave-meter cavities for radar work in which adjacent interior faces must be absolutely normal to each other.

Electroforming is also an answer to problems involving parts having intricate details which cannot be made by any other method or which would otherwise require hand or extended machining methods. Typical products in this category are computing cams for calculating machines, surface roughness comparators, and heat exchangers. Other applications of this method extend to parts where the quantities required are too small to use die casting, economically to resizing and coating applications such as electrodepositing metal on plastics for improving the plastics' properties, and to building up of worn machine parts.

In comparison with other metal-forming methods, electroforming can do some things that the others cannot do; at the same time it cannot match some of the others in certain specialized respects. Thus it supplements and extends machining practice. Electroforming has sometimes been called "cold casting" because it competes with casting, but does not require allowances for shrinkage in the pattern work. Electroforming, however, lacks casting's versatility with respect to alloys, and suffers from certain design limitations. And, in competition with sheet-metal forming methods, electroforming must definitely be considered for such parts as reflectors, propeller blades, and so on, where internal surface contouring is required in conjunction with high accuracy and surface smoothness.

"SUPER-ALLOY"

Promises Unusual Results In Brass-Casting Dies

THE SPECIAL 16 chromium, 25 nickel, 6 molybdenum alloy steel developed and extensively used for stressed parts of gas turbines and turbo-superchargers operating at temperatures up to 1500 degrees, Fahrenheit, has been used in the construction of dies for die casting of brass.

Results to date are described as "spectacular." Previously, with standard die materials, short life and high cost made for small use of brass die castings. If the Timken 16-25-6 "super-alloy" turns out to be "super" for brass die castings it might prove to be revolutionary in that industry.

PHONE LINE SHEATHS

Made of New Alloy For Better Cable Protection

AN IMPROVED lead alloy has been developed for the flexible tube that stretches from one telephone pole to another, enclosing a group of wires. It is an arsenical lead, containing small amounts of tin and bismuth and is suitable for underground installations as well as over-head suspension.

The sheathing is characterized by strong, tough welds; outstanding resistance to bending fatigue; and excellent creep resistance and bursting strength. A successful cable, it is said, depends more on the sheath than the insulation.

CHROMIUM-BASE ALLOYS

Seen Promising for Turbo, Jet-Engine Applications

ONE OF the most interesting results of the nation-wide search for new and better high-temperature alloys for jet engines and gas turbines is the development of chromium-base alloys to be used for such purposes.

Two such alloys, one containing 60 percent chromium, 25 percent molybdenum, and 15 percent iron. and the other containing 60 percent chromium, 25 percent iron, and 15 percent molybdenum, were developed by metallurgists of Climax Molybdenum Corporation and are still considered in the experimental stage. Work on them is now being carried on under government sponsorship at Battelle Memorial Institute. Although these alloys have the highest stress-rupture properties at elevated temperatures of all the "super-alloys" developed for high temperature use, their utility for other applications is impeded by their brittleness.

Successful production procedures for the chromium-base alloys include vacuum melting and pouring to eliminate oxygen, nitrogen, and other gases and their compounds, from the metal. Although the alloys are expensive, their perfection as practical, serviceable high-temperature materials, if achieved, will certainly lead to their use in small amounts for certain turbo or jet-engine parts where the utmost in high-temperature properties will pay handsome dividends in operating efficiencies.

Apprenticeship vs Mechanization

Damned by Some and Praised by Others, the Old Apprentice System Had Much in Its Favor—For Those Times and Machines. Modern Equipment Does Automatically Much of What Apprentices Learned to Do by Skill; Efficient Training Now Takes Days Instead of Years

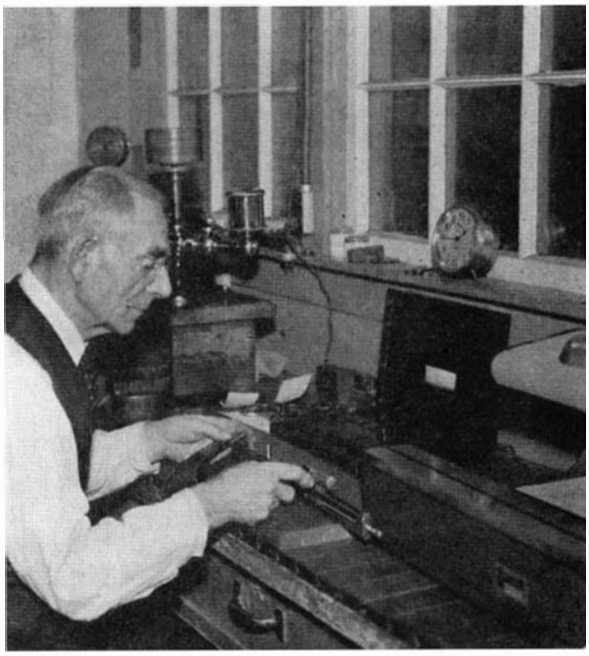
By EDWIN LAIRD CADY

BACK in the 1880's, when the apprenticeship system was at its height, a young man named Schatz entered a *Machinefabrique* (machinery manufacturing plant) in Weingarten, Wurttemberg. His sons tell about his career.

Schatz signed an indenture which promised him small amounts of money but large chunks of hard work. There were two periods, his papers said, at which either he or the shop could cancel that contract. One was at the end of six weeks, the other after a subsequent six months. If he outlasted those two periods he had to stick, and the shop had to keep him.

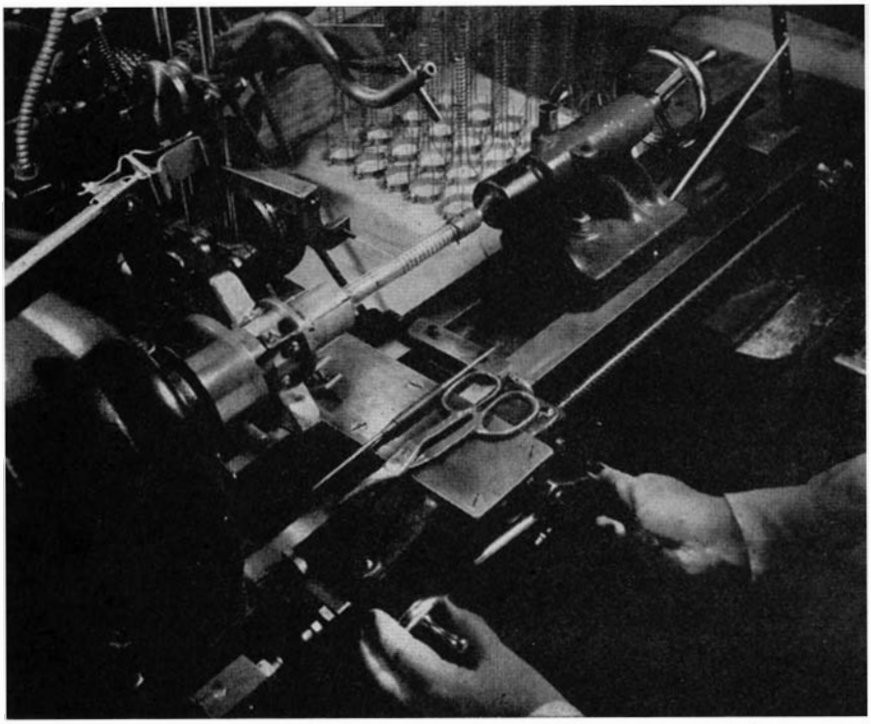
During those first six weeks he just walked around the shop, making up his mind whether or not he really wanted to learn the machinist's trade. He saw how hard the men worked, observed how industrial accidents happened and how painful they were, listened to the kicks of the well advanced apprentices. More than one boy who started with him decided that he would rather be a barber or a brick layer.

Long years were spent in developing skilled hands of "old school" toolmaker (right). This man maintains precision gages for thousands of the modern "specialized" workers. Simple tools and specially rigged lathe (below) make long training of operator unnecessary, but machine designers are highly trained men



Courtesy Fairbanks Morse and Company

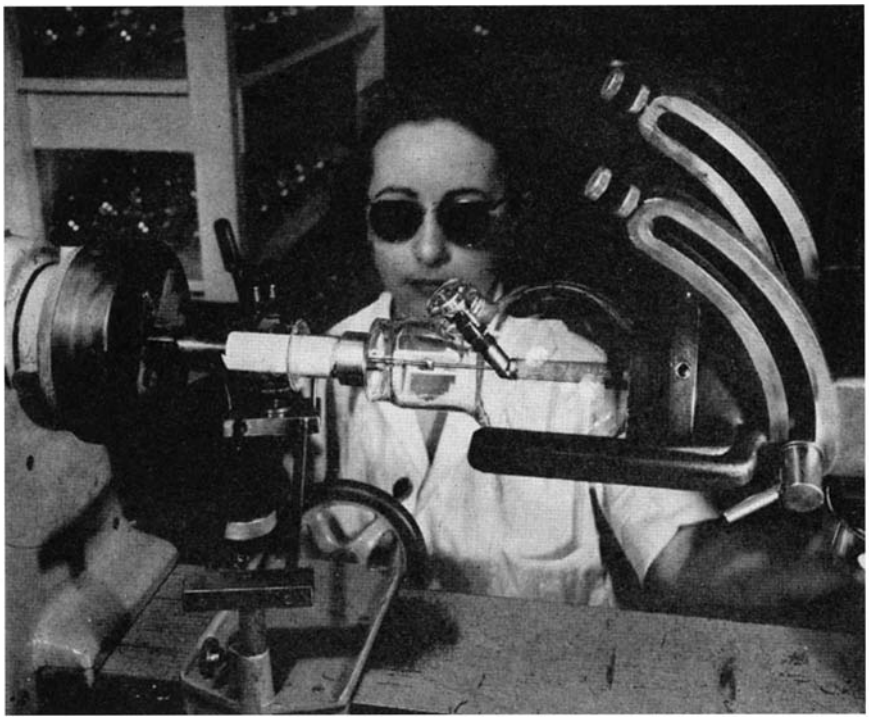
Courtesy Machlett Laboratories



After that six weeks young Schatz was given a bench, a vise, and a drawer full of files. He had to get that bench and vise level and square. A clout on the head from the foreman was his punishment if his equipment got out of level or square, or if any of his tools were not kept in order.

Next he was given several pieces of steel. He could have all of these he needed. There were round bars, square bars, flat pieces with round holes and with square holes in them.

In his drawer was a full equipment of files. They were of at least a dozen shapes, sizes, and grades. He was shown how to grasp a file by the handle with his right hand and



Tube-sealing job demands great care but no knowledge of prior production steps

• LOOKING AHEAD •

No return to prolonged apprentice training plans. . . Further use of "machines that think" in fields still dependent on slowly acquired skills. . . . Establishment of more vocational training schools for industrious individuals. . . Expansion of varied training programs for ambitious seekers of key industrial positions.

by the tip with his left and, bending the file so it made a slight arc, to start the stroke with a very light pressure against the steel and to keep the stroke perfectly steady and straight. With time, a file became like a musical instrument in his hands.

By the end of six months the apprentice was required to file a round hole into a square one, file a round bar into a square shape, and get them both so closely to the same size that the bar would pass smoothly through the hole but be light-tight all the way. He also had to file a square hole to a round shape and a square bar to fit it. He spoiled plenty of steel before the foreman could pass each bar through its fitted hole and not see daylight between them.

Schatz worked at this for six hours a day, six days a week, for nearly six months. He went to school for another four hours a day.

ALL-AROUND STUDIES — His studies were to last throughout the four years of indenture. They included something of a general education, and a great deal of physics, chemistry, geometry, and algebra. But most of all he learned the exquisitely accurate mechanical drawing which his company used at that time.

Few modern engineers ever have seen such drawings. If a machine were three feet square by four feet high then the drawings for it made a pile three feet square, plus margins, and four feet high. That pile could be separated at any point and right there would be a complete plan-view cross section of the machine at that point, all worked out in colored inks, with working speeds and the materials of all parts plainly shown.

Obviously, drawings like that could not be made for every device. The apprentice learned how to make free-hand sketches from the most meager of descriptions, and how to visualize and produce complex parts when he had no sketches at all. And he went on to learn how to operate every machine and process in the plant.

A young man so trained would never disrespect his own person nor any good machine or tool throughout his life. His fellow apprentices at Brown and Sharpe in the United States, and in other shops all over the world, were following much the same courses of study. Character building came first with their teachers, working skills second. They were in every known trade. And they were to flood the world with factories. Schatz himself founded the company which later became the Federal Bearings Company.

Compare all this with what would be most likely to happen if the same young man were to enter a large American factory today.

He would not stand around for six weeks just finding out whether he was likely to be happy at his work or not. An expert personnel counselor, highly trained in industrial psychology, would tell him that.

No foreman would hit him on the head for failing to keep his hands and clothes clean and his hair combed, nor for any other reason whatever. He never would know whether or not his equipment was in or out of level and square. The chances would all be against his handling a file for any but very minor operations; one can walk through hundreds of machine shops today without ever seeing a man who really knows the art of filing. Today's young factory worker would never make or see a blue print unless he became either a foreman or a draftsman. Not only would he never learn what every part of his machine is and how it works, but probably there would not be any one man in his entire department who knew.

SPECIALISTS TODAY — From his first minute he would begin to be a specialist on some one kind of work. There would be other specialists all around him, and he would depend upon them. Even if he showed such mechanical aptitude as to be trained as a tool maker he would not find every man doing all of his own work as used to be the case. Rather, the tool room would have lathe experts to do all or nearly all of the turning for the tool makers, and beside them would be filing-machine men, band-saw men, welders and brazers, and heat-treatment specialists.

The training of the new man would be by personal instruction, and if his job were difficult, by motion pictures and still pictures.

A motion picture would show him a skilled operator at work on that task. With his foreman or other instructor at his elbow the new man would be encouraged to run that picture for himself, reduce it to slow motion so he could see everything the other man did, even run it backward. Later on a motion picture might be taken of himself at work, and he might be encouraged to go all alone into a projection room and compare his "movie" side by side on the screen with that of a man more skilled than himself. On less intricate or complex jobs a series of still

Operator has little knowledge of her expensive machine. Automatic controls, however, would prevent serious damage if she should make a mistake

pictures would do all of this for him.

Time-and-motion study men would help his foreman to teach him. Within five days, or at the most a few weeks, he would be a reasonably skilled operator at his job. And under a modern incentive system, with every increase in skill would come an automatic reward in higher pay.

Employee selection and training systems like these took millions of completely unskilled men and women during the war and turned them into the most effective labor force ever known to industry. They proved that—with modern mechanization of almost every process, the modern way of putting the brains into the machine design instead of requiring them of the operator—the old conception of apprenticeship training for machine operators has gone by the board.

In spite of this, the fundamental philosophy of apprenticeship is not obsolete. All that has changed is its application.

BASIC FOUNDATION — When young Schatz began his work he was given a foundation. He was not required to make his own files or to roll his own steel. It was taken for granted that others could do this better for him. Their work was the foundation upon which he began.

The problems of machine-tool design and of the functionings of machine parts have similarly been worked out for present-day beginners. Young Schatz worked with machines made of simple and comparatively weak gears, wheels, levers, slides, and structural members. He had to be careful about how he handled them. The modern beginner works with strong, electrically controlled, highly protected machine tools which are designed to withstand almost anything that a human being can do to them and to be proof against almost any false motion that a reasonably well-instructed operator might make. Standing upon the foundation of such machine design there is no real need for the beginner to have any deep understanding of the machines he runs.

Young men who are able to start today with the modern machine basis and go on through what amounts to an apprenticeship, are college trained or else have spent long hours in night schools and in self education. Also, they have to spend at least four years in preparation and to work long hours just as Schatz did. It is a rare engineering-school graduate who gets through on less than 70 hours a week of lectures and study. And the shop man who puts in his 40 hours a week at his machine and then goes to night school for 15 hours more will certainly hit the 70 hours a week mark by the time he gets his studying done.

Thousands of leading industries are picking up college men and self-trained men and putting them through shop-wide or entire company-wide courses which are highly parallel with the training given to old time apprentices. International Nickel does this, and Aluminum Corporation, United States Rubber, Bryant Chucking Grinder, Standard Oil of New Jersey, General Motors, and Carbon and Carbide Chemicals, to mention only a few. Like the apprentices of old, the survivors of these training courses are expected to find their specialties and become the leaders of the future.

EDUCATION CHANGES — There was a time when in some industrial towns a grammar school diploma was a sufficient certificate of preparation for apprenticeship. In many towns, up until about 1905, a grammar school education included a few months of physics, elementary descriptive chemistry, physiology, plane geometry, and simple algebra, all of which an apprentice might need. In many a New England mill town the primary school curriculum included teaching little fingers to tie weavers knots. Now the grammar school is mere preparation for high school and little fingers do not need an apprenticeship in weavers knots which are much better tied by machines.

Before the war it was believed that arc welding needed a long apprenticeship. But during the war thousands of arc welders were trained, and in very little time.

Here and there are industries in which the old apprenticeship system still is needed. Foundries are an example. It takes time to learn how and when to pour hot iron so it goes straight into the down sprue and entraps no air, and when to use a swirling motion which slows down the flow for better progressive solidification and permits the entrapped air to escape via the open risers. But even so the apprenticeship does not need to last four years nor any other fixed period of time.

Modern training of employees does not ordinarily require the devotion of any great amount of time to schooling. Efficient educational methods, well developed training aids, and the great mechanical perfection of the machines themselves obviate many of the laborious learning processes once thought essential. The nostalgic yearnings of some of the old timers for the return of the apprentice indenture system will be satisfied in only a very few instances. For those men who show a real desire to progress and learn, however, training courses equally arduous and highly similar to the old-time methods are still open and in many cases represent the pathway to the top.

BETTER FIRE BRICK

Step Up Furnace Production, Save on Fuel

AT THE National Bureau of Standards and by agencies co-operating with the American Society for Testing Materials thousands of tests of fire brick have been made. Good books on refractories and their chemistries are rare and most developers of fire brick have had to follow paths which were but poorly charted, and it is only by standard testing and patient development that they have gotten such results that forging furnaces lined with brick can now be heated up in 35 minutes as compared to a previous 210 minutes, with a fuel consumption for heating-up reduced more than 80 percent, and that the number of pieces heated for forging per working hour is up more than 40 percent.

A New Diet For Diesels?

The Slow-Speed Predecessors of Today's Ubiquitous High-Speed Diesels Could, and Often Did, Burn Almost Anything. Now the Sound and Fury of Diesel-Fuel Evaluation is at a Peak. As Usual in Such Cases, the Answer is a Compromise of Technical, Economic, and Practical Factors

By MARSHALL J. WATERS
Shell Oil Company, Inc.

• LOOKING AHEAD •

Continued growth and extension of Diesel applications. . . Better performance with reduced smoke and smell. . . Cleaner engines, lower maintenance cost. . . Greater care by users on matching of fuel to specific engines.

MODERN high-speed Diesel engines have evolved over a period of many years from the early slow-speed stationary and marine engines. Diesel engines were developed originally with the thought of burning powdered coal and theoretically, at least, such engines could be produced. For various practical reasons, however, petroleum fuels are thus far used exclusively and their availability has permitted the progress of the Diesel to the position it occupies today.

Fuel problems are comparatively simple in the large, slow-speed units. Generally, these will burn satisfactorily any clean fuel which has sufficient lubricity to protect the fuel pumps and injectors, and atomizes properly when sprayed into the cylinders. Many such engines, operating at speeds of 100 to 300 revolutions per minute, have satisfactorily burned heavy, viscous, bunker fuel oils, heated to facilitate pumping and atomization.

Unfortunately, the fuel requirements of high-speed engines—those operating at speeds in excess of 800 revolutions per minute—are not so easily met. The reasons for this are several, the most important being the small combustion chambers, the extremely short time available for injection and combustion, the smoothness and flexibility required, and the need for minimum smoke and odor. The last named factor has recently assumed great importance in truck, bus, and railroad service where the majority of high-speed Diesel engines are used. In fact, some municipalities have passed ordinances limiting the smoke output of Diesel engines used in highway transport service.

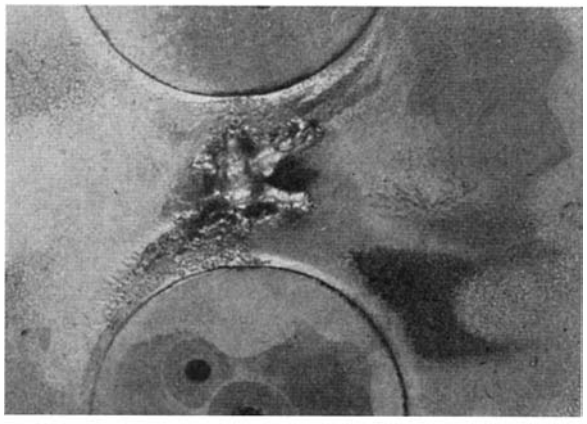
FUEL PROPERTIES EVALUATED—An examination of the properties which affect service performance in high-speed Diesel engines brings out the fact that although fuel specifications consist of an imposing array of laboratory tests, only a few of the properties evaluated have any real significance insofar as performance of the fuel in an engine is concerned. Flash point, for example, is of value only in demonstrating the safety of the fuel in handling; pour point indicates the lowest temperature at which the oil will flow; ash, water, and bottom-settling-and-water tests all indicate the degree of cleanliness—admittedly a most important point in any Diesel fuel. The carbon-residue test is useful mainly in detecting the presence of heavy residual components which are undesirable in high-speed fuels.

From the performance viewpoint, the most significant properties are gravity, volatility, viscosity, and cetane number. These have been investigated by the Coördinating Fuel Research Committee as represented by several engine manufacturers and petroleum refiners, and their findings were published in the *SAE Journal*, March 1945.

The American Petroleum Institute gravity of Diesel fuel is an important yardstick in determining fuel economy and power. Although low-gravity fuels have a somewhat lower heat content per pound, their greater weight per gallon results in increased heat content per unit volume and thus greater potential energy per dollar. It also results in better economy and increased power output, since a given volume of charge injected into the cylinder contains a greater heat content when low API-gravity fuels are used.

Viscosity and volatility must be considered together since they are inter-related. The CFR committee found that less viscous and, correspondingly, more volatile fuels gave cleaner combustion (less smoke) and less deposition in high-speed engines. Excessive volatility can cause rough running in certain engines, however, so this property must be carefully controlled by the fuel supplier. Also, less viscous fuels normally give poorer economy than the heavier ones.

The fuel viscosity permissible for use in Diesel engines has been made the subject of intensive study. The maximum viscosity is usually controlled by factors such as distillation range. On the other hand, if the



Carbon deposition on injection nozzle. Six carbon horns can be seen projecting from orifices. Fuel passed through channels in horns but spray characteristics were unsatisfactory. Carbon forming is but one of many Diesel fuel factors

fuel is kept clean, fuels having a viscosity as low as 32 second Saybolt Universal at 100 degrees, Fahrenheit, appear to be satisfactory from the standpoint of pump and injector wear. Increased viscosity provides some protection against abrasive wear due to dirty fuel but cannot eliminate it. Fuels must be kept clean!

The viscosity and volatility of fuels are closely controlled by the refiner to give optimum performance in the intended service.

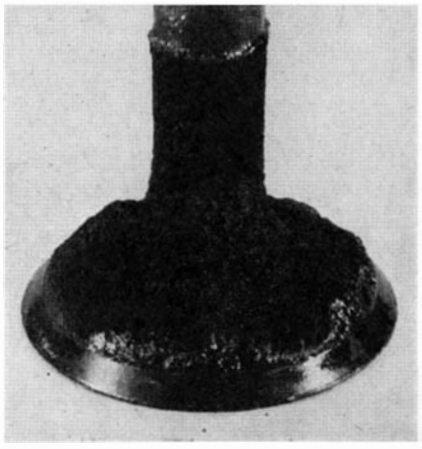
IS CETANE IMPORTANT?—In recent years, the general lack of understanding of the real significance of cetane number has resulted in undue emphasis being placed on this property. This has had the direct effect of increasing production costs and restricting the potential availability of otherwise satisfactory fuels. Cetane number is a measure of the ignition delay or lag which occurs when a fuel is injected into the cylinder—the length of time which elapses between the time of injection and the start of combustion. It is dependent largely upon the chemical composition of the fuel. In the practical engine, a small delay is desirable for maximum production of power and the permissible delay is also a function of engine speed. Hence, there are so many factors involved that only an actual trial will determine the suitability of a given fuel in a given engine. Cetane number is certainly not the answer.

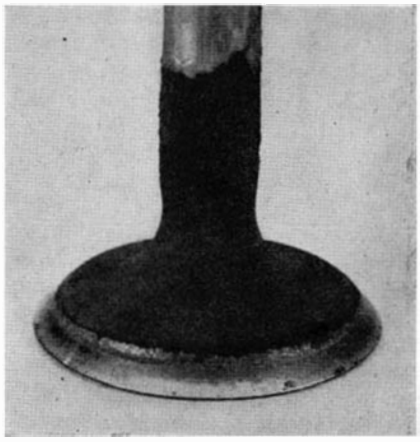
In blending Diesel fuels for high-speed engines, the petroleum refiner is limited by the quantities of suitable stocks available. In the past, Diesel fuels have been prepared largely from selected intermediate gas-oil cuts obtained from the distillation of crude oil. This fraction also supplied domestic heating oils. The lighter fractions of the crude went into the manufacture of gasoline and kerosine, while the heavier cuts were used for lubricating oils, residual fuels, and so on. As gasoline requirements increased, thermal cracking came into extended use, converting heavy residue and some gas-oil into gasoline, cracked gas-oil, and heavy fuel oil. More recently, catalytic cracking has been generally adopted and has provided a very definite drain on the supplies of straight-run gas-oil. In addition, new offtakes for intermediate oils are being developed, the most striking at the present time being the growing demand for fuel for gas turbines as typified by the jet engine for aircraft use. Fortunately, among the products of cracking are gas-oils which, with proper treatment, are well suited for use in Diesel fuels. The main difference between these and straight-run gas-oils from the same crude is a somewhat higher cetane number for the straight-run material, although it is not uncommon for cracked-gas oil from one crude to have a higher cetane number than straight-run gas oil from a different crude.

BALANCED FUELS — In any case, for the high-speed Diesel engine it is necessary to balance all properties in the fuel rather than try to obtain just a high cetane value alone. To incorporate such balance in the finished fuel it is necessary to compromise and consider all the chemical and physical properties which affect engine performance.

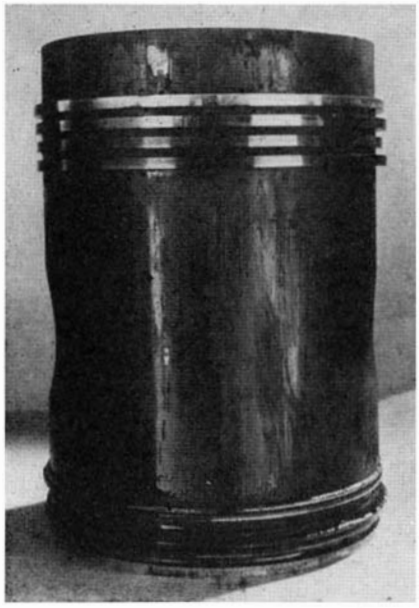
Viscosity is controlled to give fine atomization at the injector nozzles, yet still provide good lubrication of the fuel-pump plungers. Volatility is limited to the fractions giving rapid and complete evaporation once the fuel is injected into the cylinders, without the risk of vapor lock occurring between the fuel pump and injectors. Ignition quality is made as high as possible for the whole of the fuel—not merely the most volatile part which evaporates first. Heat value is maintained as high as possible to give the maximum amount of power from every gallon of fuel, thereby reducing the fuel consumption. Flashpoint is maintained high enough to reduce fire risks in the fuel storage system. Pour point is kept to the lowest possible value so as to eliminate sluggish flow or restriction to the fuel pumps in winter time. For completeness of combustion and absence of carbon deposits in the engine, the high-boiling-point fractions must be limited and the ash kept to a minimum. Finally, in view of the close fit of the fuel-pump plungers and injector parts a good filtering system is always incorporated in high-speed Diesel engines and this necessitates the fuel being supplied clear, clean, and free from all impurities.

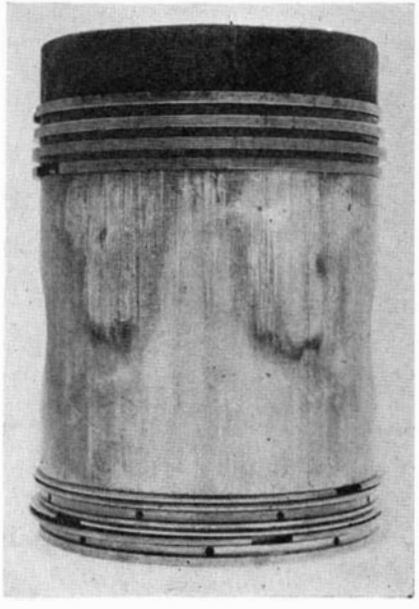
The engine and fuel industries are continuing their co-operative studies





Dirty valve (above) and piston (below) compare with relatively clean valve and piston to demonstrate the importance of selecting proper fuel for a given engine





of requirements for the purpose of adapting the engine to the fuel, as well as the fuel to the engine. This must inevitably result in furthering the spectacular development of the Diesel engine and deeply entrenching its position in our national economy.

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PREMIUM OIL

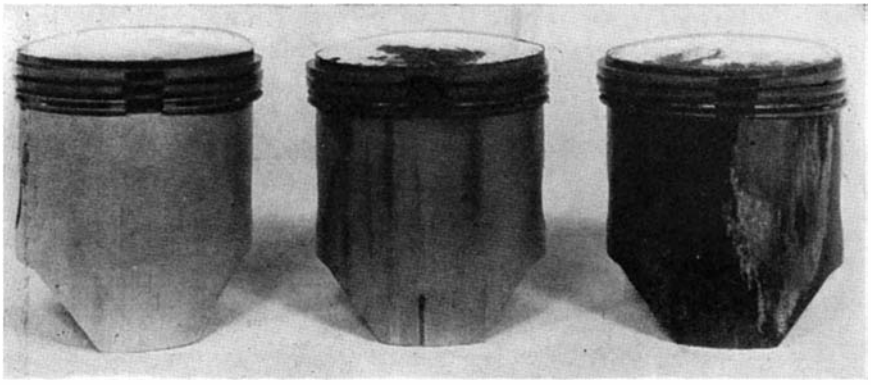
Cleans Engine, Keeps It Clean, Improves Performance

HIGHLY refined, a new treated lubricating oil to which certain patented ingredients which increase its usefulness have been added, has recently been placed on the market. It is made by taking a choice fraction of selected crude and extracting all but the most desirable constituents. The refined base stock is treated in various ways to improve its purity, and the several new ingredients are then added in relatively small amounts but with major effects on the properties of the oil.

The resulting motor oil has all the basic properties considered desirable in any good lubricant, including the ability to reduce friction between moving parts to a minimum. In addition, it is claimed, it has the special capacity to protect against varnish deposits on pistons, cylinders, and other vital engine parts; against sludge deposits; against bearing corrosion; and against deterioration or breakdown of the oil itself.

These four capacities are prime requisites in any motor oil meeting the "premium" standards established by the American Petroleum Institute. The new oil, called Permalube, has certain other characteristics which its developers, Standard Oil Company (Indiana), call "plus properties." As claimed, these are that it cleans engines and keeps them clean; is superior in lubricating during the break-in period of a new or reconditioned engine; assures easy engine starting and ready lubrication of frictional surfaces; protects unusually well against engine wear; reduces ring sticking; keeps oil consumption to a minimum; shows a minimum of carbon formation in cylinder combustion chambers; increases the effective life of oil filters; helps to solve the problem of water sludge; and protects against the difficulties caused by foaming.

After loosening engine deposits of soot, carbon, varnish, and sludge, the particles are held in suspension so they cannot pile up into masses of sludge which may block vital passages. Instead, they are dispersed in the oil and drain out when the oil is changed. With regular use, the new oil will gradually clean an engine and keep it clean.



Test pistons, 36-hour run (left to right): Permalube, quality oil, regular oil

COLD-WEATHER FUELS

Start Aircraft Engines Without Pre-Heating

PROBLEMS involved in starting aircraft engines in sub-zero temperatures have long troubled the aviation industry. In sub-zero weather, ordinary aviation gasolines will not start aircraft engines. These gasolines cannot be permitted to contain the light ends or low boiling fractions—necessary for cold-weather starting—because of the dangers of vapor-lock in flight. Therefore, elaborate and cumbersome pre-heating equipment has generally been necessary for all Canadian, Alaskan, and other sub-Arctic operations.

Recently, a newly developed cold-starting fuel for aircraft operating in sub-zero temperatures was announced by The Texas Company, which is said to slice the time required for preparation and starting from as long as six hours to two minutes. This fuel is designed to replace high-octane gasolines for only the brief interval required to start. The fuel is used in regular aviation carburetor and priming systems. A portable external tank or bottle is attached to the aircraft's fuel lines, which are shut off from the main fuel tanks, and the special fuel is allowed to flow for about two minutes. After engine is warmed up, the portable external tank may be disconnected by ground crew; the engine then draws its fuel from the aircraft's gasoline tanks.

The cold starting fuel is liquid at all atmospheric temperatures and can be shipped in regular containers, making special high-pressure containers unnecessary. Although development of these cold starting fuels is important from a military standpoint, it also suggests itself as an invaluable peace-time aid for transpolar and bush flying, and feeder lines operating in extremely cold climates.

External tank connected for starting

PHTHALIC ANHYDRIDE

Paint and Varnish Ingredient, Now Made from Petroleum

ONE of the most important chemical materials used in the manufacture of modern, high-quality paints and varnishes can now be made from petroleum sources instead of from coal, it was stated at a recent meeting of the American Institute of Chemical Engineers.

This development promises to free a vital industrial chemical known as phthalic anhydride from utter dependence upon coal mining and coke oven operations. Making this chemical is the Oronite Chemical Company plant, described as the first of its kind in the world to use a petroleum raw material for this basic paint substance.

The plant uses a raw chemical known as orthoxylene. Vapors of this substance are mixed with heated air and passed through the "converters" at a high temperature. The crude product formed is purified by crystallization and other means, and is then ready for use in the special paints and varnishes for refrigerators, automobiles, ranges, and so on.

SOAPS THAT

• LOOKING AHEAD •

New industrial uses for flammable gels. . . Paint that doesn't form pigment layers in storage containers. . . . Further improvement in heavy-duty, metallic soap greases. . . Solutions to "impossible" problems.

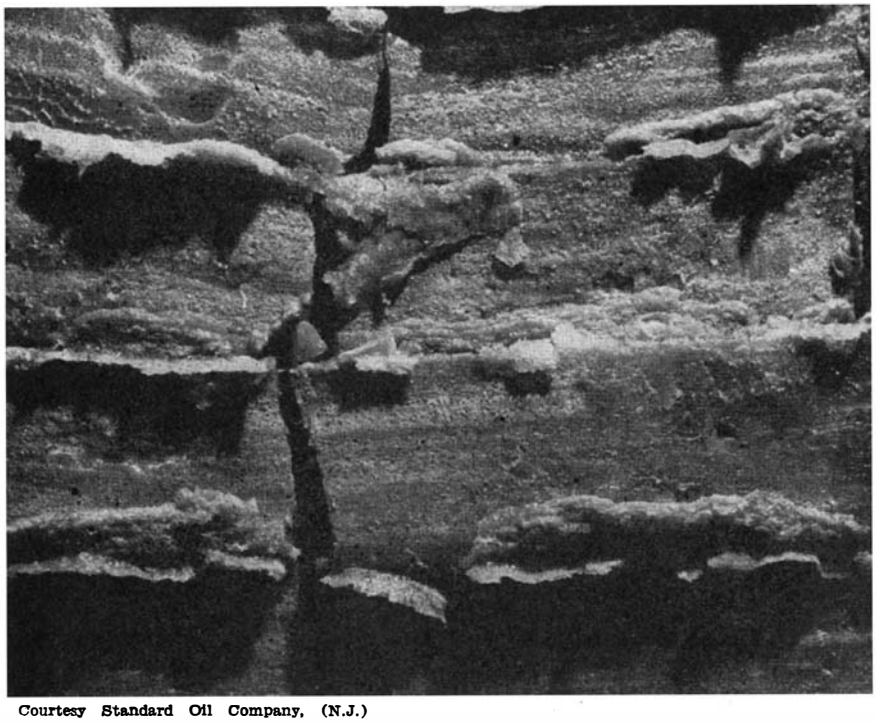
By D. H. KILLEFFER
Chemical Engineer

METALLIC soaps are a family of true soaps which above all are not soapy, and hence are better entitled to be called "soapless soaps" than the modern soapy synthetics. Best known, and most useless, of this extremely useful soap family is the ring in the family bath tub. But the annoying ring is a blacksheep and contrasts sharply with other highly useful members of the group that perform the most diverse, even contradictory, tasks. "Paradox" is the middle name of the metallic soaps. Among them, for example, a water-soluble waterproofing agent; friction producing materials and lubricants; adhesives and parting agents that promote separation; flammable flame-retarding compounds; emulsifiers and demulsifiers; polishes and flatting agents; gel-formers and gel-breakers—truly a package of paradoxes, but every one useful.

When a solution of a salt of an appropriate metal is mixed with a solution of a soluble soap, the metallic soap curds out. The basic process of manufacture is essentially that, although not quite so simple. Most applications of the metallic soaps depend more on physical than on chemical properties and therefore even minor modifications in the conditions of manufacture can cause differences in product quite out of proportion to their apparent importance. Small variations in concentrations of the solutions, their temperature, the vigor of mixing and stirring, the degree of acidity or alkalinity of the mixture during precipitation—all of these and other conditions control the properties of the product and thus establish its specific usefulness.

Most important members of this valuable family are the stearates of aluminum, ammonium, calcium, magnesium, and zinc. These are the tonnage products in the group, which includes numerous others also highly useful but in lesser quantities.

Many of the commercial members of the family are compounds of the metals with mixtures of stearic acid, the fatty acid predominant in animal fats, and palmitic acid, similarly predominant in vegetable oils. Often the mixed fatty acids produce metallic soaps better adapted to specific purposes than those made with the pure acids.



Courtesy Standard Oil Company, (N.J.)
Cakes of newly made grease; lubricant world is a major user of metallic soaps

MAKE OILS "STAY PUT"—"Soaps without soapiness," are basically old and the beginnings of their importance extends back to the early years of the industrial revolution when an expanding variety of machines of growing complexity needed something better and more specific than animal fats and whale oil to lubricate them. Thus came about the earliest use of a metallic soap—calcium stearate—to convert fluid oils into semi-solid grease that would remain in bearings.

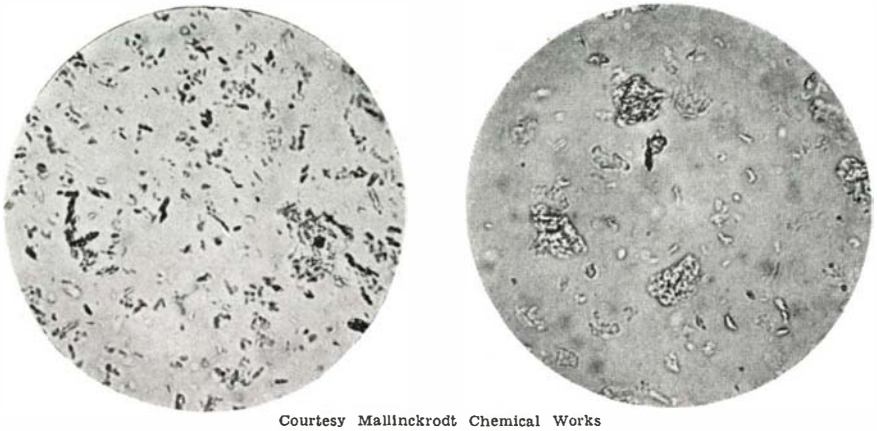
Next came the use of zinc stearate in cosmetic powders, alone or mixed with rice flour or talcum powder. A strange contrast, typical of metal-soap uses, between industry's heavy bearings and a baby's tender skin. Today, these comparatively simple early developments have grown into a valuable industry supplying the keys to unlock many puzzling industrial problems.

Nowhere is the paradoxical nature of metallic soaps so apparent as in their behavior toward friction. The bases of most frictioning compounds applied to power belts to prevent them from slipping on their pulleys are metallic soaps, and other members of the same family provide non-skid surfaces between rugs and highly polished waxed floors. Yet, under quite different conditions, soaps such as zinc stearate behave as effective lubricants between metal surfaces that are too hot for an ordinary oil or grease to stay on. Moreover, the ability of metallic soaps to form gels with fluid oils is fundamental to lubricating most bearings in equipment ranging from ancient ox carts to journal bearings in high speed machine tools.

The function of the metallic soap is to hold the oil in place so that it can properly lubricate the surfaces. Grease so made is able by its basic structure to maintain itself, to stand up, sometimes under considerable

WASH NOTHING

Lubricating Bearings, Powdering a Baby, and Waterproofing a Brick Wall are All In a Day's Work for the Metallic Soap Family. Other Surprising and Paradoxical Abilities of These Old-Yet-New Materials Are Constantly Appearing as Answers to Baffling Industrial Problems



Courtesy Mallinckrodt Chemical Works

Minor variations in making metallic soaps cause distinct differences in their properties. Zinc stearate, viewed at 300X, shows fine, uniform particles (left) and each gram has 19,000 square centimeters of film area. Other sample (right) is non-uniform, has 7500 square centimeters of film area per gram. To users, such factors may be vital

heating, and this property it owes to the potential ability of the metallic soaps to form gels with even thin oils. Apparently metallic soaps bear somewhat the same relation to oils, and even gasoline, that gelatin and pectin do to water. All form more or less solid gels.

GELS THAT STICK—The oldest application of metallic soaps—the production of grease gels—achieved extraordinary importance during the recent war in tremendously enhancing the effectiveness of fire bombs and flame throwers. This use stemmed from the fact that flames of gasoline or oil thrown by a flame thrower or bomb may not ignite the target because the burning gas, which is the flame, cannot adhere to it. An answer was sought in a gelled fuel that would adhere to the target, whatever it might be, and continue burning with a flame hot enough to be effective. Early attempts were based on gels of gasoline with raw rubber. This mixture, although it forms effective gels, was not practical because no rubber could be spared for this purpose.

Then metallic soaps came into the picture. The development of a gasoline gelled in this way was by no means simple, for the very diversities of character that make metallic soaps so interesting also create a virtual labyrinth of possibilities that must be explored to find the answer to any specific problem.

With the clue that even thin lubricating oils can be gelled by calcium stearate and others, and that such gels cling to bearings, researchers set out to discover what soap or combination of soaps would convert gasoline into a gel of just the right consistency and of strong adhesiveness to cling to combustible targets and set them afire. Even the initial consistency of the fuel was possibly less important than the ability of the flaming product to retain its clinging characteristic until the target was well ignited.

The final solution was found in aluminum soaps made from a mixture of the fatty acids of coconut oil with napthenic acids from petroleum. It was called Napalm. While the original objective was to use this product in fire bombs to be dropped from the air, its most remarkable success was realized in the flame throwers. Clearly the need for such a material as a military weapon is now very small, but the possibilities of peace-time use of a similar technique are likely to be important.

FLAMEPROOFING—This control of fuels by metallic soaps contrasts sharply with the effectiveness of the same agents in suppressing flammability. The fire hazard from many types of textile fabrics, for example, lies in the easy ignition of surface lint and the low ignition temperature of the fibers themselves. Extremely small amounts of metallic soaps spread in an even but very thin layer on the cloth fibers effectively changes the nature of the surface of hangings and draperies. Such a procedure affords considerable protection against flash fires.

The metallic soap tends to hold stray fibers against the threads, thus reducing their flash potential, and at the same time the extremely thin layer of the compound substitutes its relatively high ignition temperature for the lower one of the fiber itself. Although this is not complete fireproofing by any means, it at least suppresses the extreme hazard of flash firing which constitutes a dominant hazard in public places. The metallic soap itself will ultimately burn, but it is quite difficult to ignite—an important factor in fire hazards.

PARTING COMPOUNDS — The principal effectiveness of the Napalm fuel is the adhesiveness imparted to the gasoline by the addition of metallic soaps. But this adhesive quality is a quality of this particular type of gel, and is not

Checking consistency of fresh grease

"Gel-gas" has surprising stickiness and probably has more than one use

necessarily inherent in the metallic soaps themselves.

Actually, an important field of usefulness of these "non-soapy" soaps is in parting preparations employed to assist in separating molded plastics articles from the molds in which they are formed. Minimum amounts of aluminum or zinc stearate added to the molding compound or dusted separately into the mold cavity ahead of the charge allows the finished product to be ejected much more easily at the proper point in the cycle. In addition, the compound assists the flow of the plastics into the fine features of the mold, thus improving the finish of the final molded piece.

A similar application of magnesium stearate or calcium stearate assists pharmaceutical manufacturers in pressing tablets of certain remedial agents which are otherwise difficult or even impossible to mold on modern machines. Typical are lozenges stamped from mixtures containing large proportions of sugar or dextrose, and tablets of ferrous sulfate.

GREAT VERSATILITY — Metallic soaps are useful constituents of the wax mixtures used for polishing purposes, since their gelling action suppresses the tendency of some waxes, notably paraffins, to crystallize. On the opposite end of this scale, addition of metallic stearates to oil varnishes suppresses the gloss of the dried coating and without exertion gives the finished work a dull surface resembling that attained by rubbing.

The suppression of crystallization of paraffin waxes effected by metallic soaps is also important in the preparation of wax coatings to be applied to paper and similar flexible materials. The layer of a compounded wax possesses far greater flexibility and a much reduced tendency to crack or to separate from the base materials on flexing.

The gelling quality of metallic soaps can also be effective in holding heavy pigments in suspension in paint vehicles when they would ordinarily separate out as heavy layers in the can or barrel. This effect of additions of 1 or 2 percent of the appropriate metallic soap to a paint vehicle is particularly useful where differences in settling rates of several mixed pigments may change the color of the paint as it stands, a change not always easy to reverse with the ineffective stirrers available in the field. Mixtures of heavy lead pigments with organic lakes as tinting agents are particularly troublesome in this way.

Additions of metallic soaps to suspensions of pigments in vehicles also assist in emulsifying the resin-oil-pigment mixture in water as practiced in the newer types of water emulsion paints. This action is the antithesis of that expected of metallic soaps in breaking and preventing emulsification.

Ammonium stearate, unlike the other metallic soaps, is soluble in water, but it is also a valuable waterproofing agent. The advantage of this technique lies in the ease of application of the ammonium stearate in water solution to brick or plasterwork, for example, as compared with the necessity of employing a much more expensive organic solvent to spread stearic acid alone. Furthermore, the difference in spreading power of the organic solution and the water solution are important in achieving the final result. Other metallic soaps, particularly zinc stearate, also repel water and thus serve in many applications where a surface is to be protected from wetting.

Clearly, the metallic soaps are shown by even these few examples to be remarkable, versatile, and useful materials. In their peculiarly paradoxical properties are to be found solutions for many pressing problems of industry. At least they are worth careful investigation when problems arise that seem impossible to solve.

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SHIP FOULING

May be Reduced by Changing Electrical Charge

RESEARCH conducted in Germany, and abandoned because of the war, included a project that suggests a new attack on the age-old problem of fouling of ships' bottoms. The new basic theory is that the seeds and larval forms of the organisms involved in fouling are attracted to the ship's bottom by an opposite electrical charge. Furthermore, this theory is supported by the failure of fouling organisms to attach themselves to certain natural inhabitants of the sea—seaweed, and jellyfish, for example—that carry like charges.

Preliminary tests with certain insoluble alginate salts showed them capable of imparting a charge to objects in the sea coated with them and to repel fouling organisms in their rudimentary stages. Investigation along this line is expected to be resumed or undertaken by others and may well lead to entirely new types of non-toxic anti-fouling compositions to protect shipping in the future.

CESIUM-VAPOR LAMPS

Throw Little Visible Light, Strong Infra-Red

HIGHLY valued, not for their efficiency as illuminators but rather because their light cannot be seen easily, cesium-vapor lamps are similar in principle to the efficient sodium-vapor lamps employed in lighting highways. They emit radiation strong in infra-red, which is invisible, but weak in visible light.

Consequently these lamps have found important applications in secret communication, particularly when the freedom of this type of communication from interference by static or jamming is vital. The lamps are filled with a mixture of argon and cesium vapor.

MOVABLE ALCOHOL PLANT

Converts Crops at Farm Site by Continuous Process

BUILT in a series of mobile units to be taken to farms for processing surplus and sub-standard crops on the spot, a new alcohol plant, when complete, occupies a five-car railroad train. It is designed around the latest continuous processes of fermentation and distillation so that the highest efficiency of conversion and largest output can be obtained with a minimum of equipment.

The processes have been lately developed and have been demonstrated on a pilot-plant scale as well as in stationary plants. The system was demonstrated at a recent National Chemical Exposition and it is expected that a full-size demonstration unit will be built by next season.

PIPE with a future

Asbestos-Cement Pipe, In Addition to Being Highly Resistant to Under-Ground Corrosion, Is Free of Tuberculation and Excessive Ground-Water Infiltration. Added Up, These Features Mean Long Useful Life

By JEROME CAMPBELL

WHEN the city-fathers of a given municipality decide to spend some of the taxpayers' money for a new sewage-disposal or water-supply system, and when the engineers entrusted with designing get down to brass-tack estimating, one of the first questions that arises is: "What kind of pipe will be the most efficient for this job—both now and in the years to come?"

The "years to come" part of that question is often the most vital part. Water pipe that serves adequately for a short time and then because of internal corrosion starts to require more and more pumping pressure, and eventually heavier pumping equipment, is not economical. Neither are sewer lines that infiltrate thousands of gallons of ground water which must pass through the treatment plant along with the sewage.

As a result of these factors, and a multitude of others, the log of piping materials that have been tried with varying degrees of success is a long one. But one type of piping, made from asbestos and cement, has been standing at or near the top of the list for many years. Despite its existing record, asbestos-cement pipe is not widely known and is even now just being "discovered" by persons involved in today's extensive building programs—industrial and domestic.

The ability of asbestos-cement pipe to meet the demands of long-range planning for water and sewer systems, its freedom from various types of corrosion, and its internal smoothness that keeps flow capacity at a peak through the years, are responsible for this material's excellent record in underground service. Sewers and water mains, however, are not the only fields where long, grey tubes of asbestos and cement are doing a good job. It is also nicely suited for flue-pipe, vent stacks and ducts, and electrical conduits.

BUILT-UP PIPE—The material of which the pipe is made could be called a compounded mineral. Two mineral substances, asbestos and cement, are blended and integrated to make a smooth, hard, close-textured piping, stone-like in durability, but not brittle or easily broken. This pipe can be cut with ordinary saws to accurate dimensions and machined to close tolerances.

In manufacturing it, asbestos fibers are first selected and blended to obtain maximum durability and toughness. Then in pre-determined proportions, the fibers are mixed with cement and a sufficient volume of water is added to disperse the fibers uniformly through the mixture.

This mixture or slurry, as it is called, flows into a tank where a revolving drum of fine wire mesh deposits it in a coating about 1/100 of an inch thick, on a broad, endless felt band. The moving felt carries the thin coating in a wide ribbon over vacuum chambers, which remove excess moisture from the mixture and then transfers it to a revolving polished steel mandrel. Here the coating builds up continuously under the pressure of heavy hydraulically loaded rolls which compress it into a dense, homogeneous structure.

In this way, a pipe the length of the mandrel is built up until the desired wall thickness is reached. After the pipe is removed from the mandrel and put through an extensive curing process, the asbestos-cement walls are found to be smooth and hard, with great toughness and durability, yet surprisingly light in weight. Modern equipment forms asbestos-cement pipe in 13-foot lengths, in diameters ranging from three to 36 inches, and in four pressure or strength classes. Which of these sizes and strengths is selected by the user depends, of course, on the application. Lighter weights, for example, are more generally used for flues and stacks than for underground installations where overhead loads are a factor.

Asbestos-cement pipe in 13-foot lengths is joined together by sleeve couplings made of the same material. Hydraulically operated puller is used to draw the coupling over the ends

• LOOKING AHEAD •

Wider knowledge and greater appreciation of asbestos-cement pipe. . . Extensive use in "hurry-up" building projects where ease of installation is vital. . . Savings in terms of critical metal supplies. . . Better municipal sanitation at lower cost.

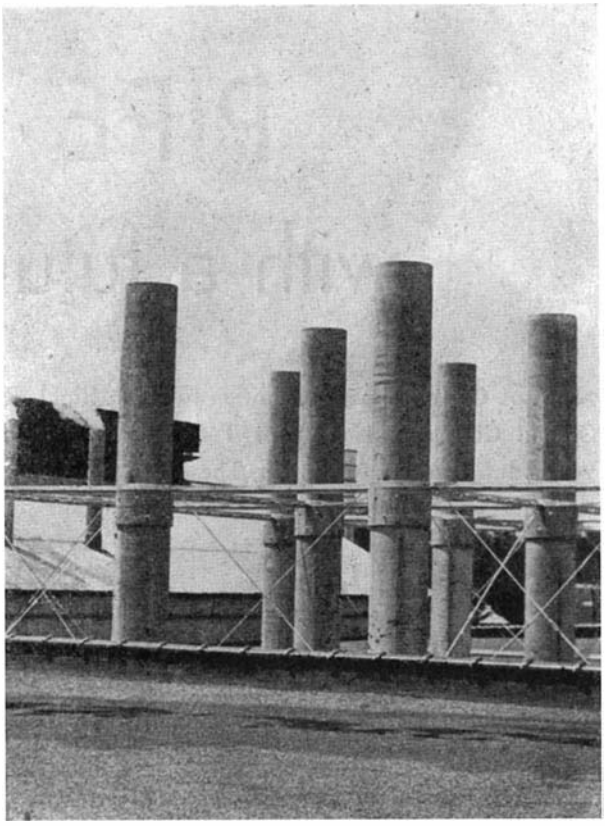
LONG LIFE—Most water and sewer pipe lines are generally buried in the soil. Here, broadly speaking, two types of corrosion can take place—chemical and electro-chemical. Chemical corrosion is caused by the acids and salts encountered in the soil. Although these active agents would be able to leach out the free lime in neat cement, asbestos-cement pipe is so cured as to convert the free lime in its composition to insoluble silicates. This insolubility gives the pipe a high resistance to the leaching tendencies of the soil. Electro-chemical corrosion, on the other hand, is an extremely complex process when it occurs in metallic pipe installed underground and is analogous to the action which takes place in a dry cell. In brief, certain areas of the

pipe surface which are shielded from oxygen begin to function as anodes and become corroded. Other areas behave as cathodes and do not corrode. Asbestos-cement pipe, being non-metalic, does not conduct electricity. Hence it is entirely free from electro-chemical corrosion.

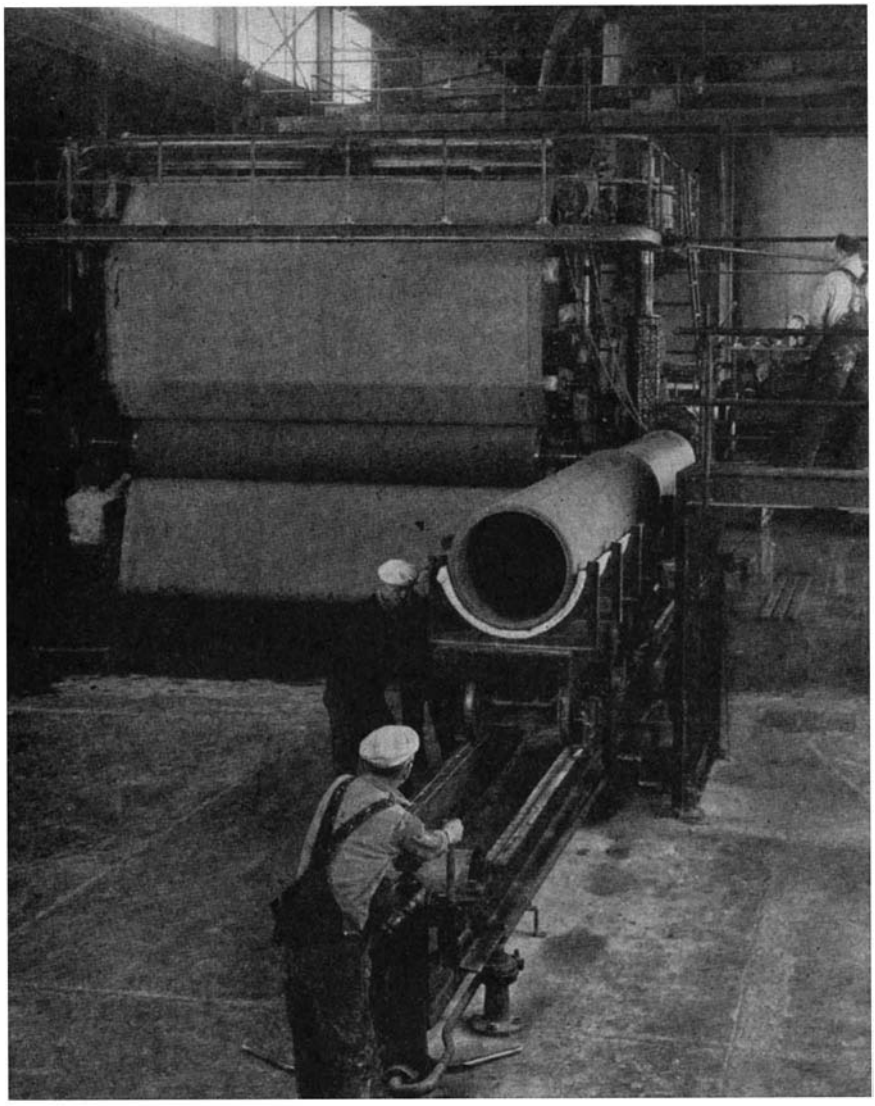
An equally important advantage of asbestos-cement pipe is its high flow capacity, stemming from the smooth interior surface imparted to the pipe by the polished steel mandrel on which it is built up. Water flows easily along this smooth surface, permitting high carrying capacities and low pumping costs.

Tying in with these two factors of flow capacity and pumping costs, is the freedom of asbestos-cement pipe from tuberculation. This is the technical term for an evil that often effects serious reductions in the carrying capacity of cast iron and steel pipe. The word is derived from the "tubercles" or stalactite-like nodules that multiply on the interior surface of ferrous pipe. There they cling tenaciously, increasing the resistance of the pipe to the water flowing through it. The increased friction and turbulence of flow diminishes the efficiency of the pipe and in some cases gradually reduces the effective interior diameter until there remains only a small fraction of the pipe's original water-carrying capacity.

Corrosion-resistant asbestos-cement pipe is used for ventilating ducts on the roof (right) of a large chemical plant

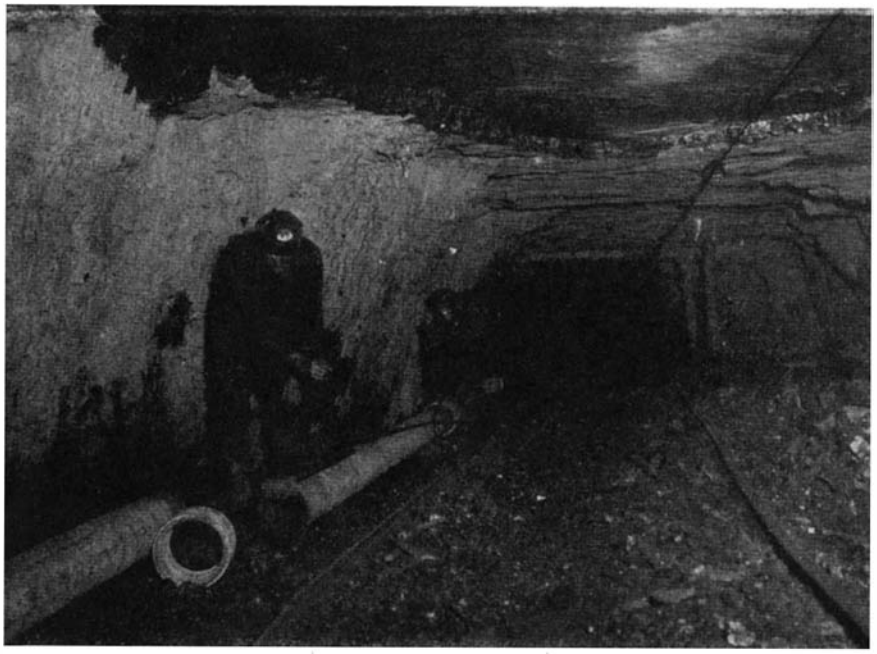


Workmen (below) are shown operating the carriage which slides a finished length of pipe from the mandrel, while on the machine in the background pipe is being rolled on an alternate mandrel



Because these tubercles do not "grow" on the interior surface of asbestos-cement pipe, its carrying capacity, over years of service, remains undiminished. Clearly, this advantage is important to the engineer designing a water system. Pipe sizes and pump pressures can be determined on the basis of present and estimated future water requirements of the community. There is no need to specify larger pipe and higher pumping pressures so as to make provision for future deterioration in the line's carrying capacity as a result of tuberculation. Also, because smaller pipe can be used, it is often possible to provide for more extensive pipe installations without increasing costs.

FLEXIBLE INSTALLATION—When used in water lines, asbestos-cement pipe is joined by a sleeve coupling, of the same material as the pipe, fitted over the abutting ends of the two lengths to be coupled. Two rubber rings seal the space between pipe and sleeve. Quickly assembled without the use of molten lead caulking or similar hot compounds, the sleeve coupling makes a leakproof and flexible joint. For sewer pipes a somewhat different coup-



In coal mine installations, asbestos-cement pipe has demonstrated its ability to resist for relatively long periods the corrosive actions of highly acid mine waters which sometimes eat away metallic pipe in a matter of days

ling is used, but coming in 13-foot lengths, this pipe has fewer joints than other kinds of sewer pipe which are made generally in three and four foot lengths.

The flexibility of the coupling, plus the high crushing strength of asbestos-cement pipe, enables water lines made of it to resist the weaving and shifting of the soil, as well as the weight of passing traffic.

LOW INFILTRATION — Fewer joints, in addition to simplifying installation, mean less infiltration of ground water into the asbestos-cement pipe, since nearly all seepage of ground water into sewer lines occurs at the couplings. Reduced infiltration, in turn, makes for more economical and efficient operation of treatment plants. Ground water infiltrating into sewer lines is considered by treatment-plant operators and sanitary engineers to be one of the major problems of sewage treatment.

Generally speaking, when a new sewer is installed and tested, the allowable amount of infiltration is fixed at not more than one gallon per hour per inch of pipe diameter per 100 feet of line. For eight-inch pipe this amounts to an allowable infiltration of approximately 10,000 gallons per mile per day. Infiltrating ground water costs virtually as much to process at a treatment plant as raw sewage. Hence, the low infiltration rate prevailing in sewer lines of asbestos-cement pipe brings down treatment plant operating costs and sometimes permits the erection of smaller plants at correspondingly smaller expenditures.

Aside from the foregoing uses, asbestos-cement flue pipe is finding application for venting gas-burning appliances. Durability, pleasing appearance, and a relatively low heat conductivity that retards the rate of drop in flue-gas temperature, all contribute to its suitability for this field. Draft conditions are improved and condensation reduced because of the heat-conductivity factor.

Similarly, the light weight and corrosion resistance of asbestos-cement pipe make it convenient for venting industrial fumes and gas when it is installed as ducts, vents, and stacks. Metal heating and melting operations; grinding and polishing of glass, stone, or metal; and chemical processing that gives rise to corrosive fumes or gases, are cited as a few of the applications where asbestos-cement vent piping has made good. Because of its strength and corrosion-resistant qualities, this type of ventilating pipe may be used on the outside of industrial buildings without painting.

The new homes, new roads, and new factories now building or planned will increase the demand for a durable, quickly assembled, and long-lasting pipe to bring supplies of pure water, to carry away sewage, and for drainage and ventilating purposes. In helping to fill this demand asbestos-cement pipe promises to make a growing contribution to the country's domestic and industrial well-being.

CONTINUOUS RAIL

Increases Life of Rolling Stock; Wider Use Expected

Now 16 years old, welded, or "continuous" railroad rail is a youngster in the railroad family, but some authorities expect this method of track construction to be used more widely in the future. At present, continuous rails account for a negligible percentage of all the track laid in the United States. Reliable estimates place the total in the neighborhood of 100 miles. About 33 miles of this is in special installations over bridges and grade crossings, through tunnels and stations, and in city streets. The remainder is open track.

According to railroad experts, long sections of welded rail have certain advantages over the standard track made of 39-foot sections. These advantages include reduced shock on rails, rolling stock, and freight; reduced noise for passengers; lessening of impact of bridge loads, as much as 50 percent in some cases; and where long sections are used at crossings and in city streets, damage to pavement near the track is reduced.

The first continuous rail was laid through a tunnel by the Central of Georgia in 1930. Today at least 17 roads have installed varying amounts of welded track up to a total of 42 miles on one road. The lengths range from a few hundred feet up to 7000 feet, the longest single piece now in use in open track.

On the rail itself, a temperature variation from one season to another of 100 degrees, Fahrenheit, is commonplace in many sections of the country. Unrestrained, a single section of steel rail one mile long would lengthen about 41 inches during a temperature rise of 100 degrees. The largest single holding force is the friction that exists between the rail and the tie plate that holds the rail upon the tie. The ballast in the road holds the tie and rail. Extra clamps are placed at each end of the continuous section to control any movement.

Best results are obtained by laying the rail at a time when the temperature lies midway between the expected high and low for that section of the country. This cuts the possible expansion or contraction about in half. Railroad engineers say that by using these methods no more expansion is noticed than can be taken care of by the bolt clear-

ances in the plates that connect the separate sections. This is no more than is normal in the standard rail.

Proponents of continuous rail believe that this method of construction holds a promise of higher speeds, greater comfort for passengers, and increasingly long life for railroad equipment.

COAL MINE HAZARDS

Reduced Greatly by Use of New Devices, Explosives

More than 100 different safety devices, machines, and methods have been introduced into United States coal mines in the past 20 years. Costing more than $100,000,000, the safety measures are credited by the Bituminous Coal Institute with reducing accidents by nearly one half during this period, or at the rate of about 4 percent per year on a basis of production.

Since World War I, a widespread change from the use of black powder and dynamite to the use of permissible modified explosives producing reduced flames and reduced temperatures is said to have diminished one of the major hazards of mining by more than 50 percent. Coal miners are the largest peace-time users of explosives and 180 different brands conforming to safety standards approved by the United States Bureau of Mines or an accepted testing agency are said to be used now.

Though many miners themselves are reported to have objected to the original change from oil or carbide to electric safety lamps made mandatory by the coal operators, and to the compulsory introduction of hard hats, hard-toed shoes, safety belts, and safety appurtenances, the general use of these devices is said to have precluded many thousands of accidents. Over 20 automatic signals, alarms, and gages are stated to be in use now to record water pressures mechanically, detect the presence of gases, break electrical circuits, and otherwise afford instant protection from operating hazards.

The prevention or spread of underground fires has been decreased sharply by the extensive use of calcium chloride in allaying accumulations of coal dust; by fire-proofing ventilation guides, housings for electrical equipment, shaft lines, mine entrances, overcasts; and the erection of fire-proof doors in the mines.

The first safety director for a coal mine is said to have been appointed in 1910 but now one or more such specialists in accident prevention are on the staff of every major coal mining company in the nation.

ROLLER-BEARING FOUNDATION

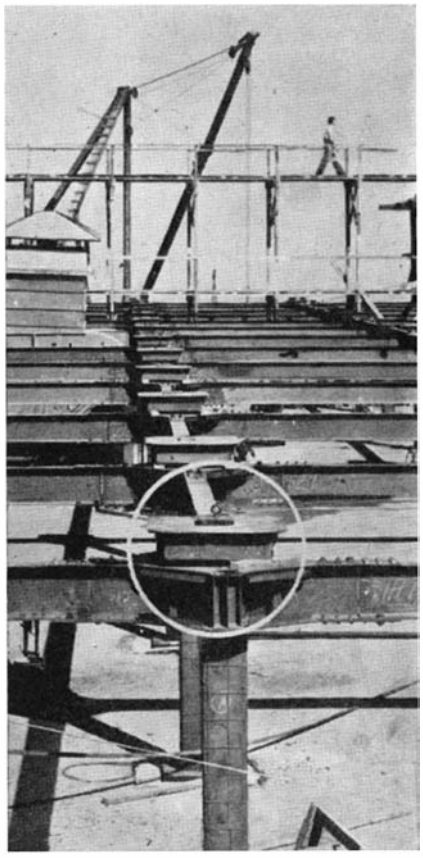
Permits Six-Inch Building Shift During Earthquakes

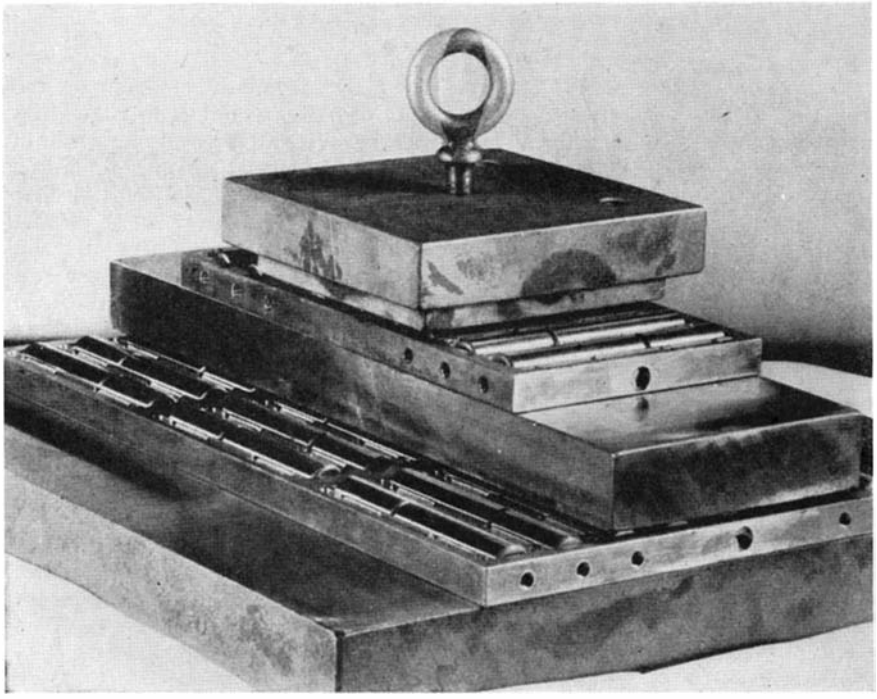
Enabling a building to "roll with the punch" of an earth tremor, anti-earthquake roller bearings are being installed under a new west-coast building. Weighing 600 pounds each, 65 sets of these specially designed bearings are being used to protect from earth shocks a three-story addition atop an existing six-story building. Placed under the main pillars of the addition, each bearing assembly supports a load of 250,000 pounds and, acting together, they permit the addition to move six inches in any direction.

This unique roller-bearing construction was necessary because the six-story structure upon which the new addition rests was built before a now existing building code was adopted. This code demands construction which takes into account earthquake stresses. It was found that any attempt to strengthen the present building would result in excessive costs, and also prohibitive disruption of company activities.

By "floating" the three-story addition on roller bearings, the vertical loads, due to gravity, are divorced from the horizontal forces exerted by the ground waves of an earthquake. Each anti-earthquake bearing consists of three steel plates with two interposed sets of steel rollers placed at right angles to each other. The rollers between the bottom and center plate roll in a north-south direction, while those above move east and west. If a diagonal shock is encountered, both sets of rollers operate.

Each group of rollers is hermetically sealed so no foreign matter can penetrate, and lubricated with a special type of oil. Because of the tremendous weight they carry, the rollers, and the steel plates upon which they move, are made of tough





Sealed and lubricated for life, 600-pound bearings can move any direction

steel, ground and polished to mirror-like smoothness and precise measurements according to their manufacturer, the Torrington Company.

AUTOGYRO GLIDER

May be Towed by Plane, Holds Commercial Possibilities

A MOST unusual development in the glider field, an odd-looking wingless craft which works like an autogyro without a power source,

has recently been developed at the General Electric Flight Test Center.

Known as the Gyro-Glider, the craft is supported by two nine-foot rotating blades atop the fuselage. Weighing 120 pounds ready to fly, it is capable of lifting nearly 300 pounds—pilot and cargo—in addition to its own weight.

The Gyro-Glider can land in extremely small areas, requiring a landing field not more than 60 feet is diameter, according to the company's design engineers.

Expected to have wide commercial application as a means of reaching isolated areas without adequate landing fields, the Gyro-Glider is one third the weight of a standard fixed-wing glider, and can be steered within limited range and land on any spot of the pilot's choice. For such use, the glider would be towed by an airplane and released like a standard glider. It has a descending speed less than than that of a parachute and can be landed with such ease that it is not likely that damage would be caused to the cargo.

Like an autogyro, the new glider makes a forward roll of 20 to 30 feet when landing. The rotating blades, can be easily removed so that the craft can be transported from home to airport in the rear of a station wagon, which also can serve as its towing agent. The new

Simplified controls, high lift—300 pounds plus own weight—spell promise for this craft. With pilot replaced by cargo, and radio control, glider could make deliveries in tight fields

craft is equipped with a tricycle landing gear.

According to Mr. David C. Prince, one of the designers, an independent means of bringing the rotor up to speed would eliminate the tow run at take-off.

UNSTABLE GLASS

Has High Light Transmission Speed

LIGHT TRAVELS faster through beryllium-fluoride glass than through any other glass, solid, or liquid, the American Optical Company reported recently in announcing that the optical properties of the new glass have been successfully measured for the first time.

The report said that light travels through space at the rate of 186,000 miles per second, and through the beryllium-fluoride glass at 146,000 miles per second. In comparison, light travels through water at 140,000 miles and through spectacle glass at 122,000 miles per second.

The measurements also showed that the beryllium-fluoride glass separates light into its component colors far less than any previously known substance. Accordingly, if it could be used in making a lens it would produce less color aberration.

The glass-forming properties of beryllium fluoride, a material used in making beryllium metal, which in turn is employed to harden copper and other metals were first predicted and demonstrated in 1927 by V. M. Goldschmidt, a German scientist. He predicted that the glass would have a low refractive index (light-bending power) and a low color dispersion, but apparently never measured these optical properties.

Special steps had to be taken to measure the glass because it is extremely hygroscopic. When exposed to air, it absorbs moisture so rapidly that a prism made of it collapses into a puddle. As a result, such prisms could only be polished by means of techniques specially developed for the investigation.

In composition, the beryllium fluoride differs from ordinary sand glass in that fluorine, a poisonous gas related to chlorine, replaces oxygen and beryllium replaces silicon. The samples measured were made by the Brush Beryllium Company.

RESISTANCE WELDING

Accomplished by Battery Power, Carbon-Pile Control

IN MANY industrial localities, the power facilities available have not permitted use of fast and low cost resistance welding for the fabrication of metal products. In addition, resistance welding has grown so rapidly in recent years that power supply difficulties have been experienced even in major industrial areas. At a recent meeting of the American Society of Mechanical Engineers, Mr. John D. Gordon of the Progressive Welder Corporation pointed out one solution to this problem involving the use of car-

bon's characteristic ability to conduct electricity better when under pressure than when no pressure is applied.

Here, the question was the storage of electrical energy in some manner in the time interval between welds, the most obvious method of storing energy being the storage battery. However, no one until recently had found any way of interrupting the enormous low-voltage currents when using batteries. The answer was finally evolved, according to Mr. Gordon, in the "carbon pile rheostat"—a very common device but not previously considered in this connection. The device makes it possible to interrupt current flow simply by releasing the pressure used to press two discs of carbon together.

Storage battery welders, it was added are no longer experimental today. They are being used to weld almost everything from thin sections of ordinary steel or stainless steel, to heavy sections of aluminum. When welding those materials which require exceptionally heavy currents it is only necessary to add more battery cells.

The storage batteries are kept charged between welding operations by battery chargers similar to those used to charge automobile batteries.

CARBIDE PLANER TOOLS

Allow Higher Output; Take Interruptions Successfully

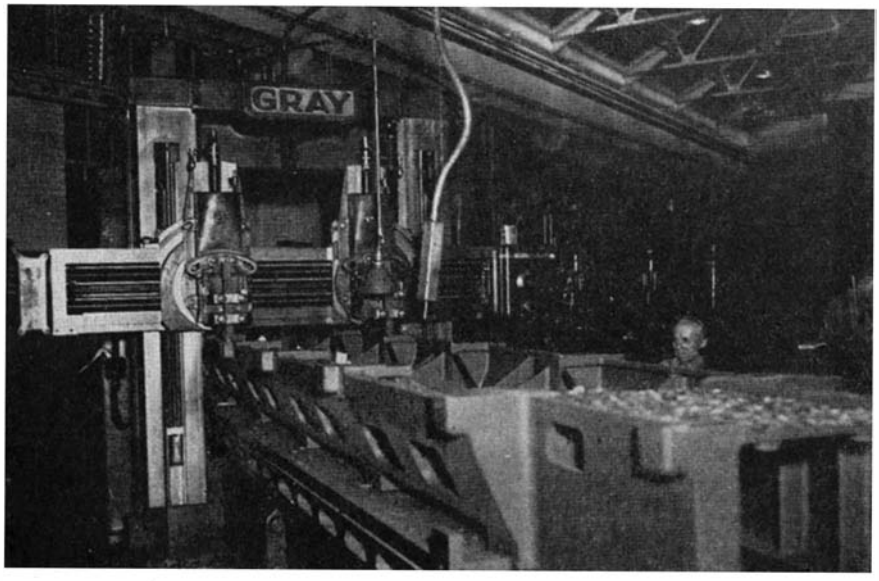
THAT the relatively slower speeds of most planers—measured in SFPM—make this type of machine tool less adaptable to carbides is a theory not supported by facts. Routine planing with carbide tools of such ferrous castings as turret-lathe pedestals, turret slides and saddles, cross slides, and cross-slide carriages, for example, has been successfully accomplished by one manufacturer over a five-year period.

The company states that with good tool practice and good operators, carbides are preferred for most planing operations since not only greater output—on the newer planing machines capable of 200 SFPM—but also better size and finish is obtained than with high-speed steel tools. The steel tools are still used, however, on exceptionally deep hogging cuts—over ⅝ inch depth of cut—and those cuts, usually in slotting, in which depth of cut would exceed the lift of the clapper box.

The users, Warner and Swasey Company, report that their experience appears to indicate that Carboloy tools can take severe interruptions, in cutting. In planing the large bed for a textile machine, for example, many interruptions are caused by the necessity of internally bracing the machine base to provide the rigidity required in the finished machine. Here, planer speeds of about 200 SFPM are used.

Further, experience to date indicates that available planer speeds—usually on the "low" side when general carbide machining practice is considered—present no difficulties. Good results are being obtained with Carboloy tools even on older machines with top practical speeds of as low as 70 feet per minute or less. When used on these older machines, carbides have the advantage of longer service life between grinds. On the newer machines, 200 SFPM is standard shop practice, and usually from 4 to 24 pieces are planed in a single set-up.

In setting up for planing any kind of iron casting at the user's plant, reference is made in the shop to simple tooling data sheets which cover the general classes of planing. These sheets provide needed data on number of cuts, types of tools, feed, depth of cut, speed of cutting, and speed of return. In general, cutting recommendations are based on the slowest planer which might be used for this type of work.

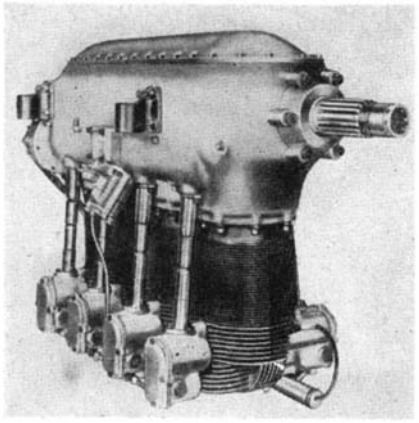


Large machine bed with many interruptions is planed at 200 SFPM with carbide bit

IN-LINE AERO ENGINE

Features Light Weight, Internal Cylinder Cooling

DESIGNED for the personal-plane field, a new light-weight, four-cylinder, in-line, air-cooled engine develops 125 horsepower at 2500 revolutions per minute and 110 horsepower at 2200 revolutions per minute. Designated the Cameron C4-I-E1, the engine is said to be particularly desirable for twin-engine installations, as well as for single-engine airplanes, due to its minimum frontal area. Total dry weight of the production model will be under 200 pounds, or approximately 1½ pounds per horsepower.



Valves serviced; cylinders remain on

In addition to extreme light weight and minimum frontal area, other features of the engine include positive fuel injection; internal cooling of cylinders through an unusual design feature; accessibility of valves and seats for servicing with cylinders remaining on the engine; and a deep-groove ball thrust bearing.

Since the Cameron engine utilizes a full-pressure, dry-sump lubrication system, it may be mounted in inverted or upright position to obtain the desired relation between thrust line and engine center of gravity.

MESABI CO-OP IRON

Will Try State-Private Conversion of Ore Waste

IN A CO-OPERATIVE program which may set the pattern for future development of natural resources, a modern plant is being built on the Mesabi Iron Range of northern Minnesota for the conversion of iron carbonate slate to pure iron powder. The slate, heretofore a waste product, overlies the iron-ore forma-

tion and is present in great abundance, is uniform in composition, and is easily accessible.

In a continuous chemical process, susceptible to close control, the iron is dissolved out of the ore by acid, precipitated as crystals of iron sulfate, and preferentially roasted to iron oxide of high purity. This product is then reduced to iron powder of controlled physical characteristics with a purity of over 99 percent.

Already proved in the laboratory as a means of producing iron powder thoroughly adaptable to powder-metallurgy fabrication, the process has not yet been operated on a scale large enough to determine production rates and operating costs. The benefiits resulting from the establishment of a year-around metallurgical industry in the Mesabi-Range area, and the possibility of development of a new resource, are the state of Minnesota's incentives for the sharing of the risk of the new enterprise with a private industrial organization, Continental Machines, Inc.

RUBBER LABORATORY

Carries On Extensive Work in Synthetic Field

Fifty new kinds of synthetic rubber have been made in a research laboratory, operated at the University of Illinois for the past three years in connection with the governments synthetic rubber program. In addition to developing the new rubbers, the laboratory's other projects have included: Establishment of the effect and importance of purity of materials going into synthetic rubber; study and improvement of the soap used in the rubber-making process; and devising analytical methods for controlling production and quality of rubber during its manufacture. The laboratory at the University is devoted entirely to research on improvements in rubber manufacturing and new types of rubber, and involves no work in compounding, vulcanizing, or tire building.

While all rubber now being used for tires is made through an emulsion process, the chemists also studied a Russian process using sodium in place of soap emulsion, and compared results of the two processes. From this they have learned how to make a better sodium-rubber which in preliminary tests revealed "marked superiority" in resistance to heat build-up and to cracking, the two greatest faults of present synthetic rubber.

Professor Carl S. Marvel, head of the laboratory, pointed out that today's synthetic-rubber passenger auto tires are practically equivalent in wear to pre-war tires made from natural rubber. They have been improved from 3000 miles of wear at 30 miles per hour to 55,000 miles at 50 miles per hour. Greater improvement is expected, and also improvement in heat resistance, which is the difficulty in using present synthetic rubber in heavy-duty tires. He believes that in not more than two more years, synthetic rubber will be well superior to the natural product, and the United States will be permanently free of dependence on foreign rubber sources.

Synthetic rubber is generally made in batches at the present time. The chemists at the University are studying chemicals which will enable rubber to be made by a continuous process. Many catalysts and activators are being examined, and success will increase rubber-plant capacity by making improved methods of production possible.

Another current problem is the study of dehydrogenated rosin soap as an ingredient in synthetic rubber. This has been shown to produce superior rubber, and its use relieves the need for more expensive soap, but it slows production. The problem is to avoid the slowdown, and progress on such lines is reported.

New Products and Processes

RADIATION CALCULATOR

Eliminates Tedious Figuring In Planning Heating Systems

FOR MEASURING radiation for steam and hot water heating systems a new calculating device has been announced. It is claimed this new calculating device, called Heat-O-meter and physically a round dial with three concentric celluloid printed disks, eliminates the tedious figuring usually necessary to determine the correct amount of radiation. Just the simple turning of a dial and the correct answer is received.

The dial contains sizes of mains, returns, risers, radiator sizes and capacities, round and sectional boiler net ratings, chimney flue sizes and capacities with minimum and maximum heights, hot water tank sizes and capacities, fuel-oil tank sizes and capacities, hot water generator capacities and other valuable heating information enabling plumbers, steamfitters, architects, builders, oil-burner and heating salesmen, and all individuals who come in contact with heating problems to have the correct answers at their finger tips.

INDUSTRIAL CLEANERS

Gain Effectiveness, Safety, With Emulsifier Additive

DESIGNED for use with kerosine and other petroleum cleaning agents to insure greater safety, efficiency, and economy, a new emulsifying agent is intended for removing very heavy deposits of oil and light grease from all kinds of metal parts and equipment. In solution with petroleum cleaning agents the product, called Mulsirex, adds to the cleaning potency of these agents through its deep penetrating qualities and, at the same time, because of its high flash point of 180 degrees, Fahrenheit, greatly increases the margin of safety for the operator. The emulsifying characteristics make foreign substances readily soluble in water, a feature that permits the deposits to be flushed away after application of the cleaning agent with a simple cold-water rinse.

Because Mulsirex can be used in dilutions as high as 1 to 10 with solvents, the manufacturer, Turco Products, Inc., points out that it is economical to use. Applied with a spray, brush, or mop, or as a cold-tank immersion solution, it is said to be harmless to metals and enameled surfaces.

Efficiency, safety, and range of cleaners are increased by additive

VACUUM GAGE

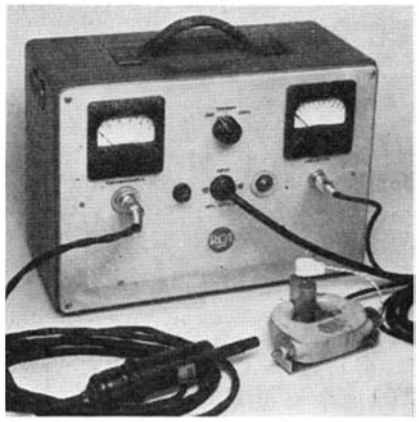
Combines Sensitivity, Ruggedness, and Portability

DESIGNED for operations requiring continuous and accurate measurements of reduced pressures as low as 0.1 micron, a new vacuum measuring gage is said to be made virtually indestructible through the use of non-burn-out elements.

Originally a component of the RCA Electron Microscope, the gage has now been developed as a separate, easily portable unit, designed especially for modern vacuum systems in which rotary pumps are used to back oil diffusion pumps. Vacuum systems of this type are used in the dehydration of penicillin mold, in the preparation of freeze-dry specimens, in metal sputtering and lens coating, and in vacuum distillation processes, both in the laboratory and in industry.

The new gage, for example, will continuously indicate the pressure while the mechanical pump is "rough" pumping, and serve to show the somewhat critical point at which the diffusion pump should be connected. The repetitive accuracy of the meter reduces the time usually lost in calculating error, and permits maximum time to be employed in actual operation.

The vacuum measuring unit, called type EMG, incorporates two types of gages, a thermocouple gage and a discharge gage. These gages have standard pipe fittings for connecting to a vacuum system and readings on the meters in the control unit are easily translated into accurate terms of pressure. All controls are on the front panel. Cables and connectors carrying the power supply for both gages also extend from the front panel. A rotary switch is used for operation of either gage.



For laboratory or production use

The thermocouple gage, used to make the higher pressure measurements, is housed in an all-metal enclosure to prevent any accidental mechanical damage. The discharge gage is the cold-cathode, diode type of ionization gage and is used to give current indications for very low pressure measurements. It contains no filament to burn out and is quite durable.

A special feature of the EMG vacuum gage makes it possible to use the same meter-control unit with any number and combination of gages. The gages can be permanently installed in the vacuum pumping units and the portable meter control unit can be plugged-in at any desired position to obtain a pressure reading.

The new instrument weighs only 18 pounds complete with gages and cables. It measures 10 inches high, 13½ inches wide, and 8¾ inches deep.

LUMINESCENT "LUCITE"

May be Fluorescent or Phosphorescent in Many Colors

ACRYLIC-resin sheeting containing luminescent pigments—a fluorescent type which glows when exposed to ultra-violet light, and a phosphorescent type which glows in the dark after exposure to ordinary light—promises wide use on highways, airlanes, and sea lanes. Phosphorescent acrylic, or "Lucite," is being investigated for large bands on channel markers and buoys to light them at night without necessitating maintenance or replenishment of a power supply. The plastics has dem-

onstrated durability on exposure to severe weather or salt water.

The afterglow of the phosphorescent sheeting is claimed to be outstanding in the field of plastics. After exposure to light, the sheeting gives light of maximum brilliance for a matter of minutes, and then continues for ten or twelve hours to give light sufficient to be seen by an eye adapted to the dark. The fluorescent sheeting, on the other hand, does not necessarily store light, but glows brilliantly while subjected to ultra-violet.

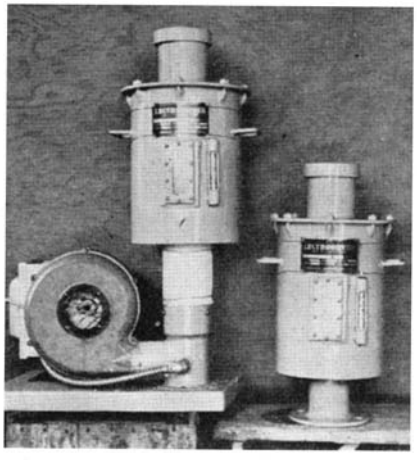
Sheeting of both types is expected to be used in advertising signs. Other potential uses include parts of lamps, baseboards, and panels for light switches used in bedrooms, directional signs of all types, house numbers, Christmas-tree ornaments, dial faces and airplane instrument panels, theater-exit signs, parts of radios and television sets, architectural panels, and entire walls and sections for bars.

The sheets can be manufactured in a wide range of colors, in all of the standard sizes of regular "Lucite" sheeting, and in a variety of thicknesses.

TANK BREATHER

Reduces Damage to Tank and Contents by Moist Air

SPECIALLY designed for industrial organizations employing storage tanks, a new line of improved breathers is now offered to help alleviate current difficulties in replacing corroded and outworn chemical and oil storage tanks, the latter conditions emphasizing the necessity of protecting the contents of



Air dried before entering tank

such tanks against pollution and spoilage by atmospheric moisture.

The breathers, in production at the Pittsburgh Lectrodryer Corporation, carry the name of Lectrobreathers and can either be mounted directly over a tank's vent or be piped to it. Incoming air is thoroughly dried by its passage through activated aluminas contained in the breather, which is equipped with a color indicator for determining when the aluminas are in need of reactivation and when reactivation is complete.

The manufacturer of this dehumidification equipment produces breathers in several standardized sizes, but advises that several factors be considered before any specific size or type is installed. These factors include: How frequently and how fast a tank is emptied; how many cubic feet the tank contains; the nature of the tank's contents; and weather conditions.

PIRANI TUBES

Measure Gas Pressure By Filament Resistance

SUITABLE for pressure gages and leak detectors in evacuating apparatus and automatic pressure-recording equipment, electronic tubes designed with special tungsten filaments having a high temperature coefficient of resistance permitting direct readings of gas pressures are now available. A change in gas pressure produces a change in thermal conductivity, filament temperature, and filament resistance. Measurement of filament resistance, calibrated in terms of pressures for individual gases, is indicated on an 0-1 milliameter placed in a simple bridge circuit.

Matched pairs of these devices, called Pirani tubes, are recommended for greater accuracy according to the makers, Sylvania Electric Products, Inc. One tube is sealed directly into the evacuating system while the second or compensating tube is left open to surrounding air or filled with a specific gas to a standard pressure. The tubes are usually mounted in close proximity

to provide the same ambient conditions and the installation is generally shielded from radiant heat or air currents.

Readings may be obtained with plus or minus 5 percent accuracy within a pressure range of 1 to 1000 microns. The tubes are supplied in nonex glass envelopes with tubulation for direct sealing into the apparatus. The overall length of the tube is approximately eight inches. They are designed to operate at 1.5 volts, 100 milliamperes. Cold resistance of the filament is 6.6 ohms. Hot resistance at 100 milliamperes in an evacuated tube ranges from 15.5 to 17.0 ohms.

LIGHT-WEIGHT WIRE

Uses Aluminum Conductor, Glass-Rubber Insulation

REPORTED to save 200 pounds of weight in the Consolidated Vultee B-36 bombing plane, a new electrical wire has an aluminum conductor and a fire-resistant insulation known as Neolay.

The insulation consists of a layer of glass to insure circuit integrity and a fire-resistant synthetic rubber applied by a special dipping process developed by the United States Rubber Company.

FORMABLE MAGNETS

Shaped from New Alloys for Difficult Jobs

SOFT enough to be machined rather than ground two new magnet metals may be made into any size, shape, or form. Called cunico and cunife, the new metals can be made in the shape of plates, in the form of screws, punched out in various square and circular shapes, and even drawn out in the form of wire, according to General Electric Company.

Cunico, which gets its name from components of copper, nickel, and cobalt, has been used during wartime on tachometers, small timing motors, and in gyroscopes, where cunico magnetic screws effect extremely fine magnetic adjustments.

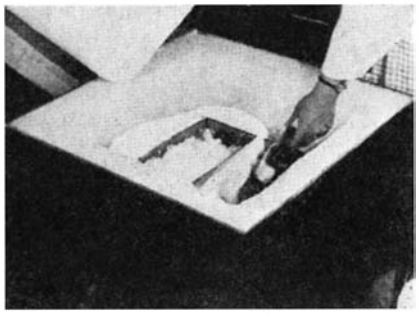
Cunife, made from components of copper, nickel, and iron, has been used as a meter magnet in aircraft devices.

Both new metals, because of their versatility in size and shape, are expected to find applications where magnets have never been able to be used before.

PLASTICS FOAM

Insulates Effectively, Is Light, Resists Water and Rot

A NEWCOMER in the low-temperature insulation field, Styrofoam—Styron plastics expanded 40 times—is a pure white, light weight, multicellular mass of foam-like material with low thermal conductivity, good structural strength, and an excellent ability to resist moisture and water. The plastics is tasteless, odorless, and has good resistance to mold and rot. Also, atmospheric exposure does not affect it adversely and



it does not lose its strength at low temperatures. Another feature is that it shows no tendency to disintegrate or settle.

The physical structure of Styrofoam, according to the maker, The Dow Chemical Company, consists of a mass of small "walled" or sealed cells and it is the continuous wall of the individual cells which prevents water permeation and freezing within the structure.

TRACTOR TIRES

Take Deeper Bite, Shed Mud, With New Tread Design

TREMENDOUS pulling power even under the worst soil conditions, and automatic shedding of mud and litter as it rolls,

Individual cell walls seal out water, prevent insulating plastics freezing on inside. Girl holds equal weights of solid and expanded Styron plastics

are features of a new tractor tire for farm use. In addition, smoother riding is reported from the continuous-tread design.

Made by Firestone, the tire embodies several innovations in design and construction. The wedge-shaped spaces between the curved tread bars continuously widen from the center of the tread to prevent clogging. The tread pattern is free of bar ends at the center around which litter can wrap or clog; the tread bars are higher, and an improved cross-section design makes the tread deeper at the shoulders.

Pulling power is increased through the cleaning advantages of the design, since a tread with a higher bar depth grips the soil firmly at all times. Another feature of the Champion Ground Grip tire is its versatility. In loose earth, the deeper bars penetrate to low levels where the shear value of the soil is better, while in firm soils or muddy-top conditions, they are forced to greater depths. And on paved roads and other hard surfaces, the wider, continuous tread width provides a greater area of contact.

Several factors are said to contribute to the longer life of the new tire. The bars, triple-braced near the center of the tread to insure stability, are up to 25 percent higher. Curving of the bars adds strength and reduces wiping and scuffing, and the design contains additional traction bar length ranging up to 73 inches more in the 9-24 size. The latter increases traction and affords greater protection for the tire body.

New tire tread on front tractor outpulls older tread on tractor being towed

LITHIUM VAPOR

Prevents Furnace Scale Formation on Metal in Process

HEAT treating by a new system using lithium is reported to combine the work of two departments in one: heat treat-

ing and and surface scale prevention and removal.

In one production operation, the process is claimed to have cut the cost of removing surface scale on steel forgings, which in many cases runs as high as $12 per ton of work treated, to approximately 65 cents.

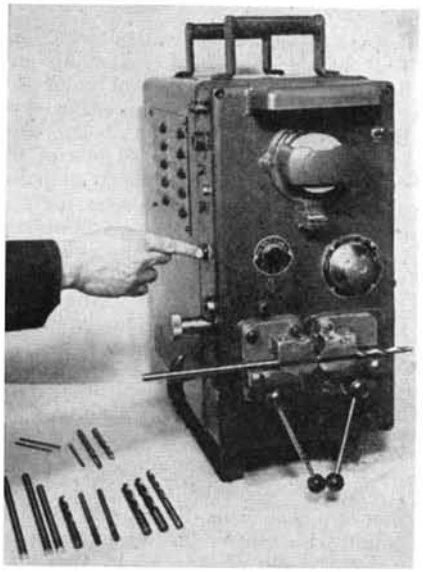
The system, as explained by The Lithium Company, hinges on induction of a vapor form of the chemical element lithium into the furnace's heating chamber. Through atomic action, lithium not only prevents formation of scale during annealing, but renders the scaly crust formed in previous forging and heating of the metal harmless for subsequent machining operations. Work emerges tempered by the annealing and ready for the machine shop after the one operation. The time saved by eliminating the necessity for cleaning is also an important item.

Another economy is anticipated in increased tool life. Expensive machine tools and fixtures are protected from abrasive particles left on the work by sandblasting and the fact that lithium never allows scale to form means that this danger to cutting tools is eliminated before it stars.

FLASH BUTT WELDER

Handles Many Jobs; Uses Standard Current

PROVIDING a quick and economical method of joining most metals so joints are strong and flexible, a new portable welder designed for production welding of bar and round stock up to 5/16 inch diameter is said to be capable of a



Built-in grinder, controlled material feed, and an automatic welding cycle

multitude of uses such as repairing small tools, butt welding tool-bit extensions and shanks, and joining band-saw blades from 1/16 to 1¼ inches in width.

Features of the Do-All Company's welder include a grinder for weld dressing, automatic motor-controlled feed of material making it easy for inexperienced operators to obtain good welds, and a cam-operated lever method of clamping which speeds up the

welding operation. Welding is fully automatic, the complete cycle being controlled by a single pushbutton switch.

In addition to welding, annealing, and flash dressing, an etching attachment provides a means of permanently identifying workmen's tools, templates, attachments, jigs, fixtures, dies, and so on.

Designed for standard 220-volt, single phase 50/60 cycle operation, the welder, either pedestal type or in a metal carrying case, can be supplied for other voltage requirements.

RUBBER MOLD LIQUID

Reproduces Detailed Parts For Plaster Casting

A WAY of making permanent, flexible rubber molds to form any number of plaster reproductions of intricate art objects, is now available at a very low cost. The complete outfit for this work consists of a can of a thin, blue-tinted rubber-chemical mixture for the face of the mold, several brushes, and another can of powdery white particles that provide the durable body of the mold, plus a sample model.

No experience or skill is necessary, according to the manufacturer, So-Lo Works, Inc., and no heating or special tools are needed. In use, the first material, called So-Lo Go-Ma Number 1 forms an elastic film over the selected form. Several coats are applied, with 10 minutes drying between each. Powdered So-Lo Go-Ma Number 2 is then dusted on to give the mold its required strength and stiffness, the number of applications determining the eventual thickness of the mold. Dried, the mold is removed from the model and is ready to make plaster castings.

First step in making mold: spreading mixture over object to be reproduced

IDENTIFICATION MARKS

In Metal Parts, Inked for Improved Visibility

SIZE numbers, steel stamped into metal, are often not readable except upon close examination; now a new machine designated as Acroprinter No. 600S has been developed to fill these numbers with black or other color ink or enamel so they can be read at a glance. The ink or enamel is saturated into a special grade of felt cut in the form of a ring and set in a brass cup-shaped form that can be rotated from a central axis to maintain a fresh supply of ink.

A synthetic, metal-molded, rubber die is used to apply the filling and an adjustable fixture for the variety of parts to be filled is mounted in the stamping position. In operation, the user makes a forward movement of the hand operating lever to ink the die; the return stroke accomplishes the filling.

Letters inked in two strokes

This machine can also be used for metal-ink printing of size numbers on parts if it is unnecessary to impress the mark into the part. Acromark inks are available for marking aluminum, brass, steel, plastics, and other materials.

PAINT COLOR

Resists Sunlight Better With Newly Developed Toner

FADING of chintzes, wall papers, and wall paints should be materially reduced when the new paint color developed in the research laboratories of the Polytechnic Institute of Brooklyn comes into use. The sun is one of the greatest enemies of brilliance in paint, dyes, and bright colored inks used in producing many widely used materials, but when processed with the newly developed color, it is said that the materials will have a better chance of a longer "light-fast" life. Equally important, the new color costs less than relatively ineffective compounds now in use.

The cause for the greater resistance to fading, which is not obtained at the expense of the brightness and color strength, is reported to be the formation of a chromium-Rhodamine B compound which, after its formation, forms a metallic salt of an organic color containing chromium. By boiling this metallic salt after its manufacture, it

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

was found that while it is usually bright and has an intense color, it could be made more light-fast.

The development of this new method of making colors on a large scale eliminates several expensive processes necessary in the previous methods of development, it was pointed out. This effects a substantial saving in the manufacturing costs with a resultant saving to the retailer and purchaser of the final materials.

The new colors, promise to be applicable for all purposes where other toners have been used and some more because of the greater resistance to fading by sunlight.

TWO-CYCLE ENGINE

Offers Light Weight, Vertical Power Drive

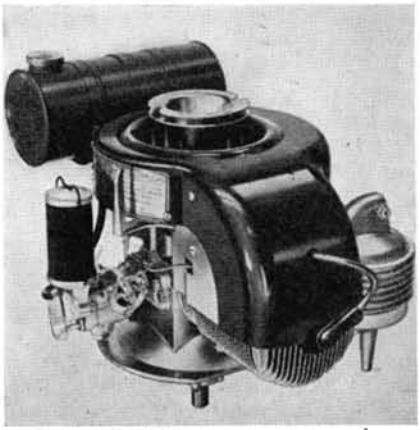
A LIGHT-WEIGHT industrial gasoline engine of the single-cylinder, two-cycle, air-cooled type, weighs only 24 pounds, yet develops a rated 2.5 horsepower at 2500 revolutions per minute. It possesses the advantages of the two-cycle engine—small size, simplicity, fast acceleration, and low maintenance—and, in addition, features easy starting and smooth idling.

These operating advantages, which are unusual for a two-cycle engine, are said to be due to a "reverse-flow" scavenging system. This design permits the use of flat-top, non-deflection pistons and directional control of the incoming fuel charge is achieved through the use of guide vanes in the intake ports, rather than through piston-top deflectors. Hence, detonation resulting from hot spots on piston tops is greatly reduced.

The angled intake ports, it is claimed, accurately control and focus the intake fuel flow. This results in improved scavenging, better fuel efficiency, better cylinder-wall lubrication, and consistently cleaner spark plugs.

The light weight of the Model 1200D engine, is partly due to the two-cycle design and partly to the extensive use of die castings. The entire engine, with the exception of the forged-steel crankshaft and rod, and the hardened-steel cylinder insert, is built of high-pressure aluminum-alloy die castings.

The engine, made by McCulloch Motors Corporation, is a vertical-crank-



Two-cycle, 2.5 horsepower, 24 pounds

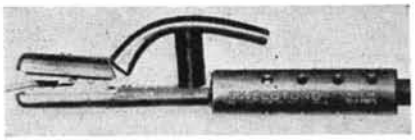
shaft type, and was designed for such applications as vertical pumps, rotary-type lawn movers, various types of farm equipment, and other devices and implements requiring a vertical power drive.

All bearings are the anti-friction type. The engine is air cooled and has a flywheel magneto and a rope starter. Bore and stroke are two by two inches; displacement is 6.28 cubic inches, and over-all dimensions, including gas tank and spark plug, are 14.6 inches high, 17.8 inches long, and 14.2 inches wide.

ELECTRODE TONGS

Thoroughly Insulated and Protected from Heat

A NEW line of manual, arc-welding electrode holders feature durable, molded-laminate, glass cloth Bakelite insulation keyed to the holder casting. The tensioning spring seats on fiber upset washers and is protected from



Tension spring shielded from spatter

spatter by non-binding Neoprene tubing. A well ventilated fiber handle, together with a secure cable connection, are claimed to assure a cool-running holder. All parts are replaceable.

Known as Twecotong, the line includes full-insulated and semi-insulated models rated at 300 amperes, for ¼ inch electrode capacity; and 500 amperes, for ⅜ inch electrode capacity.

DEHYDRATOR UNIT

Controls Temperature and Moisture in Processing Operations

OPERATING on the principle of a heat transfer unit for the heating of both air and gases, as well as for the superheating of steam, a recently developed device handles temperatures up to 1000 degrees, Fahrenheit, maintaining control of exit temperatures within plus or minus 1 degree, Fahrenheit.

Called the Goodyer Aridizer, the unit will be of particular interest in food processing and for use in rubber, chemical, petroleum, and printing industries. The heating of compressed air for dehydrating is made possible by a bilateral fin design.

The effect of dehydrating by compressed air, whereby moisture from the product being processed is removed by absorption with expansion and continuous air movement, permits full control to any degree of moisture content of the product being processed. By this method, it is explained that the temperature of the compressed air for a dehydrating process can be considerably lower than if the dehydrating were done by a conventional space-heater type dryer.

These lower temperatures, in combination with the continued air movement around all particles of the mate-

rial being processed, produce a finished product not discolored from burning and, in food processing, permit the retention of essential food elements.

The Aridizer unit is small and compact with accessibility to all vital parts. Heating may be effected by electric calrods or oil or gas burning equipment. The Aridizer, according to the manufacturer, Goodyer Industries, Inc., can be adapted to existing drying or dehydrating systems, or complete dehydrating or drying systems can be engineered to meet any requirements by utilizing it.

WATER SOFTENER

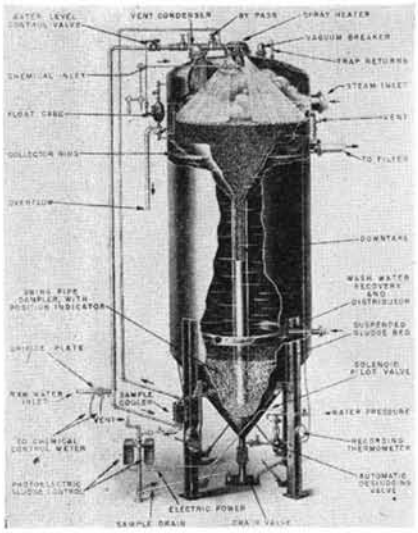
Reduces Chemicals Used, Desludges Automatically

IMPROVED boiler-feed water and substantial savings in chemicals required for water softening are the two chief features of a new type of hot-process water softener described as incorporating a sludge-blanket design. This new equipment, developed by The Permutit Company and built in four models for use with various types of steam generators, also reduces the turbidity of softened water, lessens the load on filters, reduces the amount of backwashing, and lowers the amount of silica left in the water.

In the tank, suspended sludge forms a bed which acts as a filter screen for fine particles. This bed, coupled with the slow rate of upward flow throughout the full cross section of the settling tank, is said to give an effluent lower in turbidity than that obtained in older types of softeners. The low turbidity in the settled water places a relatively light load on filters and this in turn produces a corresponding reduction in frequency of backwashing.

In addition, the sludge blanket reduces the amount of lime required to soften water, since unconsumed lime is retained in the blanket until it reacts with water hardness. In conventional types of hot-process softeners, the unconsumed lime is often wastefully removed during blow-offs with the sludge that has settled on the bottom of the tank.

Another unusual feature of this ap-



Suspended sludge acts as filter screen

The Editors Recommend

PROCEDURES IN EXPERIMENTAL PHYSICS — *By John Strong, Ph.D.* A wealth of useful data of a practical kind for the constructor, experimenter, and skilled craftsman. **$7.10**

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

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

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

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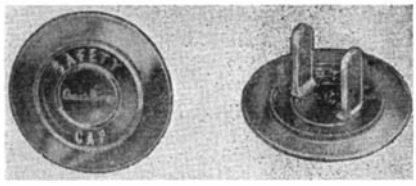
paratus is the automatically operated desludging valve which controls the depth of the sludge bed. The desludging valve is actuated by an electronic turbidity detector which continuously measures a water sample passing through the bed and between a light source and photo-electric tube. If the continuous sample of water has enough suspended matter to operate the sludge control unit, a solenoid valve is energized which, in turn, opens the desludging valve until the turbidity has been reduced to the desired value. Intervals between blowing off usually vary from one to eight hours dependent on the flow of soft water required.

ELECTRICAL OUTLETS

Less Hazardous When Capping Device Is Used

For protection against the ever-multiplying number of electrical outlets on walls, floors, baseboards, work benches, and similar spots, a light, plastics safety cap has been developed.

The Amerline Safety Cap, of one-piece construction, fits snugly the



Excludes dirt, lint, moisture, fingers

standard 110 or 220 volt openings, yet is easily removable. Being transparent, it does not disturb color schemes and it can be used to distinguish between 110 and 220 volt openings.

Suggested for plants, mills, workshops, display rooms, schools, institutions, offices, and homes, the safety-cap is claimed to exclude lint, dust, grit, moisture, and so on which might affect current flow. It can be wiped clean with a cloth.

Children can safely play around outlets so closed because they cannot insert pins or wires into the openings.

GLUED LOADS

Prevent Breakage of Goods in Transport

Especially designed to keep shipments from sliding about in railroad cars, trucks, and steamships, thus cutting transit losses, a new adhesive is automatically applied in two parallel strips to the bottom surface of each shipping container, which is then lifted off the loading and glueing conveyor and *glued* into the unitized load. Called Load-Lok, the adhesive has a high sheer strength which prevents sidewise or lengthwise shifting of the stowed units, yet a single sharp upward blow of the hands against its low tensile strength releases each container for easy unloading.

In applying the adhesive, the glue cost is insignificant, and the only equipment required is an inexpensive glue pan installation on the loading conveyor, according to National Adhesives.

CURRENT BULLETIN BRIEFS

Conducted by K. M. CANAVAN

(The Editor will appreciate it if you will mention Scientific American when writing for any of the publications listed below.)

THE SERVICING OF TELEVISION RECEIVERS is a 140-page lavishly illustrated, paper bound book designed to give a clear and easily understandable explanation of the operation of television receiver circuits. It is not designed to replace existing handbooks nor is any space devoted to studio problems or historical material. Complete emphasis is on receiver and antenna installations and the servicing of television equipment in the shop and home. Just enough theory is given to make practice more perfect. *Philco Corporation, Philadelphia, Pennsylvania.—$2.25.*

TOUGH FLOOR PROBLEMS is a folder based on the methods of repair and construction of floors that are subject to acids, greases, oils, and abrasion. Also included is information on the patching of spalled concrete, pointing and resetting of brick or masonry, and the repair and construction of foundation and retaining walls. *Stonehard Company, 403 North Broad Street, Philadelphia 8, Pennsylvania.—Gratis.*

HY-MAC HYDRAULIC POWER UNITS. Describing units that may be adapted to produce any motion desired for new machines or for changeover to hydraulics, this ten-page brochure also covers units that are adaptable for grinding, milling, boring, drilling, pressing, piercing, and riveting. *Hydraulic Machinery, Inc., 12825 Ford Road, Dearborn, Michigan.—Request this brochure on your business letterhead.*

PROTECTIVE STRIP COATINGS OF EASTMAN CELLULOSE ACETATE BUTYRATE. This four-page folder presents in compact detail the preparation and application of continuous, tough coatings to be used for the protection of metal parts of various kinds against corrosion and abrasion in transit or storage. Prices of cellulose acetate butyrate, and sources of equipment and ingredients are listed. *Tennessee Eastman Corporation, Kingsport, Tennessee.—Gratis.*

PROCUNIER QUICK CHANGE CHUCKS AND COLLETS, listed in a two-color brochure, make it possible to complete a series of operations without removing the work from alinement. The way by which tools can be interchanged without slowing the machine is described. *Procunier Safety Chuck Company, 18 South Clinton Street, Chicago 6, Illinois.—Gratis.*

DECKER'S AIRPORT GUIDES. For those who fly in private planes, be they owners, pilots, or mere passengers, these five pocket-sized guides will be attractive and valuable. They are divided into five zones, North Atlantic, South Atlantic, North Central, South Central, and Pacific. The guide will give you, for every airport you are likely to visit, all the information you need—exact location, direction of runways, latitude and longitude, facilities such as repair facilities, meals, cabins, and so on. *Decker Air Service, Fairfield, Connecticut—$1.25.*

DOALL EQUALS TEN PLUS. In 22 pages this booklet gives a pictorial time study of metal fabricating short cuts. Containing many time-saving ideas, it is designed for shopcoat pocket or tool chest, and is available to shop superintendents, foremen, tool and die makers, machinists, and students. *The Do ALL Company, 1301 Washington Avenue South, Minneapolis 4, Minnesota.—Gratis.*

METRO STANDARD CARBIDE TIPPED MASONRY DRILLS is a four-page bulletin containing descriptions, specifications, and prices on new type drills that are reported to last up to 50 times longer than ordinary steel drills and to speed up drilling work by 75 percent. *Metro Tool and Gage Company, 4240 West Peterson Avenue, Chicago 30, Illinois.—Gratis.*

INTEGRAL DUST COLLECTOR. Available in ratings of from 300 CFM to 2100 CFM, the "packaged" collector, described and illustrated in this bulletin, is complete with motor and fan. Request bulletin No. 310. *Thermix Engineering Company, Greenwich, Connecticut.—Gratis.*

FANSTEEL SELENIUM RECTIFIERS is a four-page bulletin describing two types of rectifiers for emergency battery charging and general application. Portable, and with a high charging rate, they are well suited to signal department needs around the shop and in the field, as well as for general industrial use. *Fansteel Metallurgical Corporation, North Chicago, Illinois.—Gratis.*

BOB-CAT—ELECTRIC CABLE HOISTS is an eight-page bulletin which gives descriptions, cross-sectional views, and the outstanding features of these hoists. *Lisbon Hoist and Crane Company, Lisbon, Ohio.—Request this bulletin on your business letterhead.*

ENTHONE EMULSION CLEANER EC-75 is a four-page bulletin outlining the advantages and method of using this emulsifiable cleaner, which is claimed to be safe for use in plating rooms as a precleaner on all types of metals. *Enthone, Inc., 442 Elm Street, New Haven 2, Connecticut.—Gratis.*

K-FIN AIR-COOLED SECTIONS APPLIED TO THE FIN-FAN EXCHANGER. The first section of this eight-page booklet describes the Fin-Fan exchanger for condensing and cooling fluids without the use of water. The second part deals with the design and construction of the K-Fin air-cooled section. Request Bulletin 1230. *The Griscom-Russell Company, 285 Madison Avenue, New York 17, New York.—Gratis.*

Our Book Corner

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

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The Editor

THE INDUSTRIAL REPUBLIC

By P. W. Litchfield

TODAY'S big problems are basically those of industry and production. The creation of more goods and more comforts, and the just division and distribution of the products of industry, are paramount, and failure of the available machinery to solve them satisfactorily is at the bottom of today's social unrest. Mr. Litchfield, who is chairman of the Goodyear Tire and Rubber Company, sets forth in this little book a thoughtful plan for concerted action between and by management and labor for the greater good of all. Unlike most such proposals, this one has been developed in practice and has stood the test of day-to-day operation in a large industrial company. Since the outcome of the present differences between labor and capital will largely decide the future of our civilization, such thoughtful (and workable) proposals provide the basic considerations as this essential for our thinking and planning. Whether one's interest in our industrial problem is that of worker, manager, or mere consumer, this book will prove highly stimulating. (201 pages, 6 by 9 inches, illustrated.) —$4.10 postpaid.—*D.H.K.*

EXPERIMENTAL PLASTICS AND SYNTHETIC RESINS

By G. F. D'Alelio

AIMING to demonstrate the chemical reactions used in the preparation of plastics materials, this complete and informative book presents 97 experiments and 27 test methods, each one carefully worked out to demonstrate basic principles. The text covers practically all the well-known plastics and resins which can be prepared readily, even in a small laboratory. The present volume, an expansion and revision of "A Laboratory Manual of Plastics and Synthetic Resins," published in 1943 and widely acclaimed as a source of specific information, was planned for class-room use. It will, however, be snapped up by many an industrial worker who needs to know more than just a little about the "how" of plastics preparation and by others whose interests lie in the field of plastics in all its ramifications. Explicit directions are given and space is provided for recording results. Many of the experiments can be translated directly or indirectly into industrial production applications. (185 pages, 8 by 11 inches, pertinent drawings, an appendix listing industrial sources of supplies.)— $3.10 postpaid.—*A.P.P.*

BUILDING AN ENGINEERNG CAREER

By Clement C. Williams

THIS second edition of Dr. Williams' valuable vocational guide appears opportunely when thousands of young men are seeking counsel and advice on their futures. The design of the book is much that of a text book intended for college students in their freshman year. The text divides quite naturally into four parts. In the first the characteristics of what may be called the engineering personality and the occupations of engineering are discussed with understanding of both the aspirations and questions of the student and the requirements of the career. The achievements of the several recognized branches of engineering are described to provide the student with means for differentiating them from each other. An appendix of 144 problems illustrates the type of questions which engineers in each category are called upon to answer. Finally, the important matter of visual aids receives deserved attention in a catalog, forming a second appendix, in which those

motion pictures bearing on engineering careers are listed with brief descriptions and sources noted. (309 pages, 5½ by 8 inches, illustrated.)—$2.60 postpaid.—*D.H.K.*

JEEPS IN THE SKY THE STORY OF THE LIGHT PLANE IN PEACE AND WAR

By Lt. Col. Andrew Ten Eyck

WRITTEN by a distinguished and well-informed AAF officer, the book gives a clear and well-balanced story of the many services which light planes performed during the war. They proved useful on an unexpected scale in civil air patrol, artillery reconnaissance, transport of personnel, messenger service, and so on, and were employed in every theater of war. Graphic and sometimes exciting stories are presented and the book also leads up to the possibilities of the light plane in peace time. (152 pages, 8 by 5½ inches, 32 pages of illustrations.)—$3.10 postpaid.—*A.K.*

ELECTRONICS IN INDUSTRY

By George M. Chute

EMPHASIS on the practical applications of electronic tubes to industrial operations makes this book suited to users of equipment produced by leading manufacturers but of little interest or value to the designer or builder of electrical equipment. By first presenting simplified fundamentals and then gradually enlarging into specific applications, the text supplements other books on electronics and encourages the reader to consult these books for more complete coverage of its phases. Essentially, it boils down to an appetizing introduction to a valuable industrial tool. (461 pages, 5½ by 8½ inches, well illustrated with drawings and photographs.)—$5.10 postpaid.—*A.P.P.*

SCIENTISTS AGAINST TIME

By James Phinney Baxter, 3rd

OFFICIAL but far from dull overall account of the war work of the Office of Scientific Research and Development on new weapons. The weapons themselves are not technically described but the narrative account, written by the president of Williams College, of what went on in the half or more of the war that was under censorship wraps gives the reader a sense of having his hand at last on all the threads instead of fragments and parts, half right and half wrong. The total realization comes that this was a war of "scientists against time" even more than most of us knew. (473 pages, 5½ by 8 inches, 74 illustrations.)—$5.10 postpaid.—*A.G.I.*

BACTERIAL CHEMISTRY AND PHYSIOLOGY

By John Roger Porter

ALTHOUGH intended primarily as a college text, this book should be in the library of every large industrial plant. There is no industrial chemist or engineer who sooner or later will not have occasion to use the material which it contains. It makes explanations in language simple enough to be understood by anyone who knows even the rudiments of chemistry, and is richly filled with bibliographies and other reference sources. With a penury of verbiage which wastes none of the reader's time the book tells what bacteria and enzymes do, how they may be controlled, what knowledge has and has not been obtained regarding them, and how their work can be made useful to industry. (1073 pages, 6½ by 9 inches, numerous charts and tables, including three large tipped-in charts.)—$12.25 postpaid.—*E.L.C.*

THE STAR ATLAS AND NAVIGATION ENCYCLOPEDIA

By S. S. Rabl

CONVENTIONAL navigation of windjammer days through to loran and radar. Content: mathematics; speed, distance, bearings; compass; latitude, longitude, and charts; nautical astronomy; time and the nautical almanac; old-time methods; modern methods; plotting the position; sailings; stars; star finding methods; primitive navigation. The 12 large star charts are as suitable for the amateur astronomer as those in astronomical books and 14 other charts show the constellations. (161 pages, 8½ by 11 inches, 93 illustrations.)—$5.10 postpaid. —*A.G.I.*

THE CAR OWNER'S HANDBOOK

By Paul D. Green and Ralph Ritchen

CAPABLE of saving the average motorist a good many dollars and an infinite amount of annoyance, this little book should be of great value to those persons convinced that an automobile is a perverse, if inanimate, creature. Clearly illustrated and carefully explained are the basic principles of the modern automobile plus all the "little things" which spell the difference between trouble-free driving and constant difficulty. System by system—fuel, electrical, cooling, lubrication, and so on—the typical cars of today are laid bare. Although by no stretch of the imagination a repair manual, the book does contain a multitude of hints and kinks on trouble shooting, minor remedies, and good practice. A section on driving is included and should be required reading for all beginners and not a few old-timers. (192 pages, 6 by 8 inches, 120 illustrations.)—$2.60 postpaid.—*E.F.L.*

ANALYTICAL EXPERIMENTAL PHYSICS

By Harvey Brace Lemon and Michael Ference, Jr.

REVISED from the 1943 edition, this remarkably complete and exceptionally well produced physics text book has been brought up-to-date by the inclusion of much new material in the fields of radio, radar, isotopes, artificial radioactivity, and electricity in general. Although the text is graded at

college level, the method of presentation makes it almost ideal for self study. It covers both classical or fundamental physics as well as applications of physical principles to everyday life. Emphasis is largely on experimental aspects, and many of the experiments detailed can be done in the home with readily available or improvised equipment. Included in the text are 66 illustrations taken from motion picture films which give step by step records of laboratory experiments. This large and beautifully printed book is heartily recommended to anyone who wants to brush up on this important phase of science. (588 pages, 9½ by 12 inches, lavishly illustrated with over 600 drawings and photographic prints.)—$8.25 postpaid.—*A.P.P.*

ENGLISH-FRENCH AND FRENCH-ENGLISH TECHNICAL DICTIONARY

By Francis Cusset

OF A convenient size and simplified, legible format, this publication should be a worthwhile investment for all persons whose occupation or interests involve reading French technical papers, or designing and producing for the export market. The coverage of terminology is broad and general, including metallurgy, mining, electricity, chemistry, mechanics, and science. (590 pages, 5½ by 7 inches, conversion tables.)—$5.10 postpaid.—*E.F.L.*

MODERN METALCRAFT

By John L. Feirer

How to make simple objects such as lamps, boxes, and trays out of metals while using the fewest and simplest tools and shop equipment and the least floor space. How to select the metals and the tools and to make many of your own tools. How to sharpen and use a cold chisel, how to solder, etch, obtain decorative effects, bend metal, rivet, measure accurately. A worthwhile book for the home craftsman, the convallescent, the hobbyist, or any father of a growing boy. (288 pages, 6 by 8½ inches, over 200 illustrations and diagrams.)—$3.60 postpaid.—*E.L.C.*

VITAL PROBLEMS OF AIR COMMERCE

Edited by Lucien Zacharoff

THE AIR AGE is here and the United States has many important questions to settle in connection with global and domestic air transportation policy; in airport legislation and construction; in the encouragement of private flying; in the full use of air cargo; and in the application of aviation to agriculture as well as industry. With panels of the Aviation Section of the New York Board of Trade as a starting point, the author has made a well-planned attack on these questions by presenting a series of well-knit, interesting, and appropriate discussions of each phase of aviation, in every case written by an authority. (338 pages, 8¼ by 5½ inches.)—$3.10 postpaid.—*A.K.*

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Telescoptics

A Monthly Department for the Amateur Telescope Maker

Conducted by ALBERT G. INGALLS

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

IN THE LAST stages of telescope mirror grinding the pencil mark test is sometimes resorted to in an endeavor to bring the mirror and its mating tool to full spherical contact, preparatory to polishing. This test is described in "Amateur Telescope Making," page 288, thus: "As finer sizes are used, make the simple pencil mark test for sphericity by carefully drying and cleaning tool and mirror, drawing pencil marks across each, working them dry with a few very short strokes, and observing whether they are in contact by noting where the marks are rubbed thin or entirely off."

Your scribe used this test many times on telescope mirrors, had no troubles with it, and offered it in "A.T.M."—since when the mails have brought occasional wails about scratches and sticking mirrors. Ralph Dietz, of Pasadena, California, wrote that this test "is bad, a mistake, wrong, and you shouldn't do it." Before removing it from "A.T.M." the opinions of others were solicited—still are. Dave Broadhead, Wellsville, N. Y., says: "My vote is to leave it in, as a help to beginners to understand their problem." Fred Ferson, Biloxi, Mississippi, votes: "I have used it often and have never traced a scratch to it." On the other hand, H. H. Selby, in "A.T.M.A.," 117, says: "The pencil test is not recommended, due to danger of scratch formation." Why this test should scratch for some, while for others it hasn't scratched yet, remains a puzzle. Some have testified that it pulled chunks right out of the glass. Can this be true?

To his comment, already quoted, Dietz adds another which opens up a fresh aspect of the same subject. "Anyway," he writes, "two pieces of glass, such as a mirror and its tool, when ground together with abrasive between, should not fit each other exactly. The bottom disk will have the radius of curvature of the top disk minus the thickness of the abrasive used. Therefore, if the pencil lines rub out, something is wrong, not right." This reasoning looks solid, but read on.

In Twyman, "Prism and Lens Making," 62, the same consideration is discussed. Two disks were ground with fine emery well rubbed down to 0.0002" thickness, then cleaned, dried, and put together. They were found to swing very noticeably around the middle. These disks had deep curves, f/3. Twyman points out that the same phenomenon would not be appreciable with shallower curves.

To demonstrate mathematically the truth of this last statement is now our intention. We choose a specific mirror, the common 6" f/8, its f.l. 48", its radius 96". How wide will the edge separation between this mirror and its tool theoretically be after they have been worked to a fit with No. 600 Carbo between them, washed up, dried, and put together? By the old standby, $r^2/2R$, this mirror's sagitta is 192/9, which figures out at 0.046875000". The average grain size of Carbo 600 being 0.00042" ("A.T.M.," 492), we subtract this amount from 96", leaving 95.99958" for the radius of the tool. Having a shorter radius, the tool will have the greater sagitta and so the cleaned up mirror will pivot at its center. (Theoretically, anyway.) We divide 9 again by twice the tool radius, or 191.99916" and get 0.046875205". Subtracting, we get the width of the gap between edges of mirror and tool and this is the amount, an insignificant one five-millionth of an inch, by which "something is wrong" if a mirror of common focal ratio and diameter fits the tool in the pencil test. Here it is:

tool sagitta	0.046875205"
mirror sagitta	0.046875000"
difference	0.000000205"

Not only that but, on seeing the file of letters and papers involved in the exchange, Broadhead adds this: "When the abrasive has been properly worked down at the end of the wet, the grain size will no longer be the 0.00042" it started with but even less."

In passing, note Ellison's cognate argument on page 369, "A.T.M.," where he refers to the loose fit between mirror and tool after a paper polisher 0.01" thick has been removed from the tool. Though the gap is here much larger than in the case worked out above, the misfit still comes out only 0.00001" for a 6" f/8 mirror, which is far from the "gross error" he terms it. It seems probable that Ellison made his statement only on a basis of intuition, as Dietz did, without calculating, and that is what your scribe did when inserting it. This, therefore, must come out of "A.T.M." Why has no one challenged it?

Incidentally, this department has heard extensively from a group of amateurs in Belgium who were making telescopes as a hobby right through the war and who have been using paper polishers, and they claim "at least as good" results with them as with pitch laps. Though most opticians look down the nose at the paper polisher, these Belgian amateurs' claim is so strong that a serious test is in order, not to prove them wrong or even to prove them right but to find the facts. Later we hope to find some workers to make these tests and to provide the correct polishing paper and technique. Will the reader volunteer as a guinea pig? Working instructions are available.

When the above calculations were shown to Dietz he said he was a little surprised at the smallness of the edge gap but still believed the pencil test bad. He also described an experiment which he and many others had often made. Grind two disks together, fine grind them, give them a quick shine polish and test them by interference. Both will be spherical, as shown also by the shine coming up evenly, but usually four or five fringes—say 1/100,000"—from a fit. This is much more than theory calls for but that often happens in shop optics. The present discussion, until farther along, is quite frankly, unashamedly, unapologetically concerned with theory for the pure sake of theory, and this is where Dietz took off for an interesting flight. He pointed out that, strictly speaking, $r^2/2R$ is the formula for the parabola, not the sphere; though, as he added, it makes no practical difference in the present case of the pencil test. For the sphere we should, he added, use another formula which is

$$MN = AB\sqrt{(AB)^2 - (AN)^2}$$

the appertaining figure being the one in "A.T.M.," 312. Perhaps, through using $r^2/2R$ so often because its use is virtually always accurate enough to be practical, we sometimes forget this nice distinction.

Formulas for the sphere appear in numerous optical works and they appear to differ. Some examples:

Ellison in "A.T.M.," 116.	$R = \frac{A^2 + D^2}{2D}$
Haviland in "A.T.M.A.," 243	$R = \frac{r^2 + d^2}{2d}$
Hardy and Perrin, 365	$R = \frac{r^2}{2h} + \frac{h}{2}$
Twyman 21	$r = \frac{s^2}{2d} + \frac{d^2}{2}$
Dévé 185	$x^2 = y\,(2R - y)$
John Pierce in "A.T.M.," 312	$MN = \frac{r}{2R} - MN$

After a little standard algebraic-geometric juggling these all turn out to be identical, and more juggling whips this into the form

$$h = R - \sqrt{R^2 - r^2}$$

which is more convenient to apply to a specific problem, even though it involves remembering how to do square root. Lazybones can, however, use tables or slipsticks, or resort to a calculating machine. This is what your scribe did since it had the advantage of giving correct answers.

It is satisfying to know that $r^2/2R$ (parabola) and the above sphere formula are each complete, concealing no microscopic silent partners.

Where do such formulas as those in "A.T.M.," 257, and "A.T.M.," 5, fit into this picture? They don't. These pertain to edge separations between parabolas and spheres that touch (osculate) as in "A.T.M.A.," 379, Figure 2. Here the formula is an expansion of the root in the sphere formula by Newton's binomial theorem, which gives $h = r^2/2R - r^4/8R^3 + r^6/16R^5$. . . Only the

first two terms are significant in mirror making. This gives depth of glass removed in parabolizing by polishing the outer zones.

What also about things like $r^2/R + r^4/8R^3$, encountered in the literature of optics? These pertain to still another picture, that of longitudinal aberrations along the axis of mirrors, as in the Foucault test, and are a cat of another color; hence, pssst, cat, get out and don't confuse the present argument, which will stay on the paraboloid-sphere basis. (Anybody who wishes to stir up these particular cats may dig out Prof. Wadsworth's article in *Popular Astronomy,* Volume X (1902), 337-348, but, should then hunt up Prof. Hussey's sequel article on "The Longitudinal Aberration of a Parabolic Mirror," in *Publications of the Astronomical Society of the Pacific,* Volume XIV (1902), 179-188, because the latter pointed out basic errors in the former caused by misunderstandings concerning fixed and moving pinhole and knife-edge. Your scribe also has a file of TN exchanges dated 1933, on the longitudinal aberration cat, which may be borrowed by any who suffer from the mathematical itch. There also is an article by Charles G. Rupert, in *Popular Astronomy,* 1918, 525-542, entitled "Mathematics of the Reflecting Telescope." These old articles are virtually unavailable to all except those having access to institutional library files and ought, perhaps, to be reprinted.)

Before going on, we have been told that it is bad mathematics to call a paraboloid a curve, it being a surface, but a parabola is a curve. Pedantry?

If we now apply the sphere formula, the theoretically correct one for an unparabolized mirror, to our same 6" $f/8$ mirror we get—a lot of headaches from doing square root. Your scribe recalled the method but wasn't able to multiply and divide twice alike in trying to spin out the square root of 9207 (mirror sagitta by sphere formula) to a lot of decimal places and then, to get the tool's sagitta, square 95.99958, subtract 9, and take out the square root to an equal lot of places. So The Monroe Calculating Machine Company, Orange, N. J., was asked to do it on one of its machines. These robots don't sweat for two hours over such a problem but sass you right back with the correct answer, and this one came by mail strung out to 17 digits for good measure; these machines being so eager you can't stop them. Of the 17 enough are offered below to show the major deviation between results of the two formulas in the present instance. By the sphere formula

tool sagitta	0.046886656"
mirror sagitta	0.046886450"
difference	0.000000206"

Now let's subtract the parabola formula's findings from the sphere formula's findings:

as sphere	0.000000206"
as parabola	0.000000205"
that big gap	0.000000001"

So we've found at last that the *correct* formula gives us a billionth of an inch more than the "wrong" one. Let's celebrate.

Yet let's not celebrate too hard, for that submicroscopic gap grows mightily with shortened focal ratio and soon enters the realm of the entirely practical. C. R. Hartshorn, Los Angeles, to whom the above data were shown, has explored some of the effects of varied focal ratio on the use of the parabola formula instead of the sphere formula and worked out (didn't lean on any lazy man's crutch) the following table for 6" mirrors of eight focal ratios.

f	R	$R-\sqrt{R^2-r^2}$	$r^2/2R$	diff.
8	96"	.046886"	.046875"	.000011"
7	84	.053589	.053571	.000018
6	72	.06253	.0625	.00003
5	60	.07505	.075	.00005
4	48	.09384	.09375	.00009
3	36	.12522	.125	.00022
2	24	.18824	.1875	.00074
1	12	.38105	.375	.00605

Hartshorn emphasizes that this table is for 6" mirrors alone. Others are not in direct proportion. Its practical purpose is to indicate just where it is time to switch to the sphere formula—for example, on a Schmidt primary. Hartshorn summarizes his findings thus: "Those who think they can read the knife-edge to 0.001" [Chance for another long-winded argument here—see "A.T.M.A.," 21, line 11.—*Ed.*] may start brushing up on their square root at about $f/2$. This checks nearly enough with an old letter from Kirkham: "By calculation it is found that the inaccuracy from using $r^2/2R$ is negligible down to $f/3$." Broadhead, in working on his deep-curved Maksutov telescope wrote, "I found at the outset that $r^2/2R$ was not close enough and avoided a very serious source of error on these telescopes by using the sphere formula." And, by the way, Broadhead nearly finished his Mak, had to set it aside for other work, as have several others.

Shown the above findings, Frank R. Varela, Tenafly, N. J., worked up the following table for two focal ratios and three apertures.

	f	$R-\sqrt{R^2-r^2}$	$r^2/2R$	diff.
8"	2	0.250989"	0.25"	0.00099"
8"	4	0.12512	0.125	0.00012
10"	2	0.313727	0.3125	0.001227
10"	4	0.15640	0.15625	0.00015
12"	2	0.376478	0.375	0.001478
12"	4	0.187680	0.1875	0.00018

"These figures," Varela states, "were computed with 7-place logs and the sixth significant figure may be accepted as correct. As happens where three variables are involved, the errors do not follow a simple law, but must be referred to three planes of reference. They do indicate a rapidly increasing error from using $r^2/2R$ as the focal ratio is shortened. An examination of this table and Hartshorn's indicates that a not too accurate rule can be applied: that the error increases inversely as the cube of the focal ratio."

Early in the above article your scribe said the pencil mark test hadn't scratched yet for him. The article was written, set aside for a long time and almost forgotten. A pair of 10" mirrors were made, and on one of them the pencil test pulled little hunks right out of the glass. Exuent test, with slow, sad music, Dietz and Selby grinning.

How to Avoid Saving Money

by DANNY KAYE

To avoid saving money, the first thing is to cut off all your pockets. (Or throw away your purse and keep your lipstick in your snood.) Thus you will have to carry your money in your hand. Which will insure that you—1. spend it, 2. lose it, 3. get it taken from you—*quicker!*

Also to be avoided like crazy are piggy banks and sugar bowls. Keep these out of your home! The kiddies in particular are victimized by such devices, often saving quite a bale of moolah. Be stern even if the little ones cry—remember what money could do for them! And be sure to avoid budgets. It is best to draw your pay and walk down Main Street buying anything you don't particularly hate.

Above all, don't buy any U. S. Savings Bonds —or it's *impossible* not to save money! These gilt-edged documents pay fat interest— 4 dollars for 3 after only 10 years! There is even an insidiously easy scheme called the Payroll Savings Plan by which you buy bonds *automatically.* Before you catch on, you have closets full of bonds. You may even find yourself embarrassed by a regular income! Get-gat-gittle!

Danny Kaye

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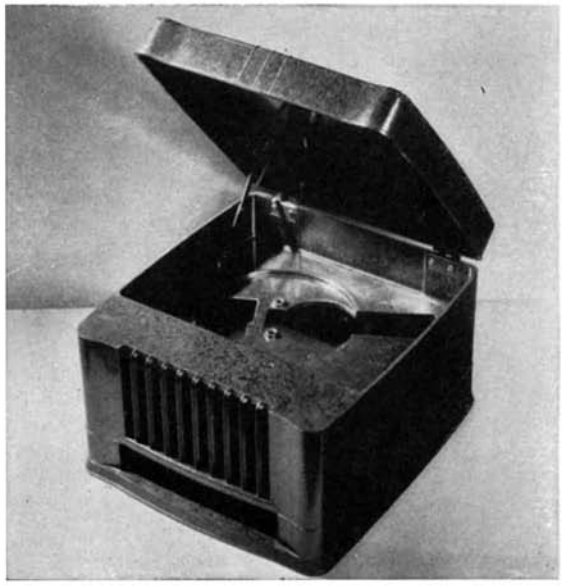

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