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REPORTING THE PROGRESS OF SCIENCE AND INDUSTRY

Is DDT Poisonous? . . . See page 5

IRONING OUT A MATERIALS PROBLEM

A typical "postwar" item is this Silex Steam Iron illustrated. Like so many new products which are a part of our long-awaited civilian economy, this revolutionary home appliance makes prudent use of Durez phenolic plastics.

Why Plastics?

Notice the eye-appealing, heat-resistant handle. Exhaustive tests proved that plastics were better suited for this purpose than any other material known. Their use resulted not only in a better finished product but also in a product which could be produced very economically.

Why Phenolic Plastics?

Of all plastics, the phenolics are the most versatile. Naturally, this makes them the logical starting point for the design engineer with a materials problem. The handle of this Silex Steam Iron, for example, called for heat resistance, smart appearance, pleasant and hand-fitting "feel," moisture resistance, and excellent moldability . . . all inherent characteristics of phenolic plastics.

Why Durez Phenolic Plastics?

The more than 300 multi-propertied Durez phenolic molding compounds available today are the direct result of a quarter century's continuing research and product development on the part of Durez laboratory technicians. This rich background and the high quality of the materials themselves are convincing reasons why manufacturers in every field of industry look to Durez for the plastics that fit their jobs.

Experienced Assistance Available

Do you have a plastic materials problem? If so, see your custom molder. Wartime developments have endowed him with many new molding methods and processes so that his services are even more valuable than before. Should further assistance be necessary, the competent advice of experienced Durez service engineers and a wealth of proved product development data await your request.

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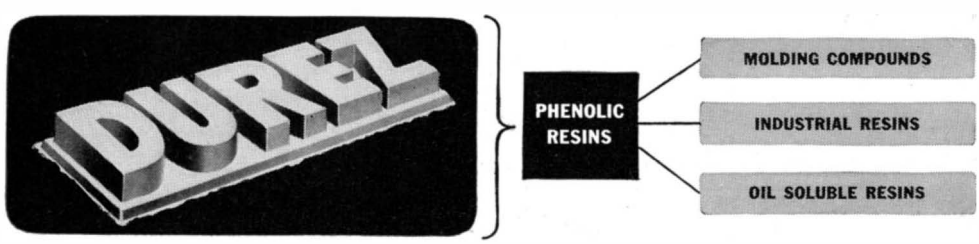

PLASTICS THAT FIT THE JOB

Scientific American

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Our Cover: Wide use is being made of various DDT compounds for insect control. Our cover picture, used by courtesy of Geigy Company, Inc., shows a power method of application. The general subject of DDT is discussed in the article starting on page 5.

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50 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of January, 1896)

X-RAY — "There have been received from Europe by cable very insufficient accounts of a discovery attributed to Professor Roentgen, of Wurzburg University. By the use of a radiant state of matter tube, a Crookes tube, it is stated that he has succeeded in obtaining photographic effects through opaque objects. . . Metals cutting off all rays alike would produce a shadow, so that a metallic object in a box or embedded in the human system could be made to give some kind of an image. The operations are said to have been conducted without a lens, entirely by shadow."

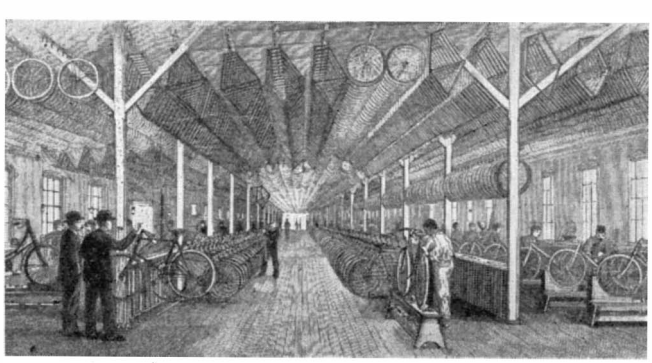
TRANSPORTATION — "Electric street traction has continued to grow in favor. In 1887 there were only 13 electric roads in the United States; today there are 850 roads with a total mileage of 10,000, representing an investment of $400,000,000. In this connection it is interesting to note that the possibilities of canal towage have been tested in both the old and new worlds; here in the form of a traveling motor, working separately from the boat, and in France by the use of a motor upon the boat itself, hauling upon a chain laid in the bed of the canal."

SUBMARINE — "A new submarine boat, the Goubet, resembles a whale in shape, being spindle shaped and measuring 26 feet in length and about 5 feet 6 inches in diameter in the middle, with a capacity of 10 tons. . . The boat is propelled by a screw, which also serves the purpose of a rudder, the shaft being pointed to enable of its being moved right or left. . . The motive power is supplied by an electrical battery."

HELIUM — "N. A. Langlet has succeeded in obtaining helium perfectly free from nitrogen, argon, and hydrogen, when tested spectroscopically. This gas, when weighed in the usual manner, proves to be exactly twice as heavy as hydrogen, the usual standard, its density in relation to air being 0.139."

TAXI! — "M. Roger, manufacturer of automobile carriages, has made application to the police authorities of Paris for permits to run a number of horseless carriages on the streets; for hire at the regular legal rate of 30 cents a drive or 40 cents an hour. . . That horseless carriages can be run cheaply enough to compete with the regular fiacres is thus shown."

BICYCLES — "Within the past three years, the American bicycle industry has grown up to dimensions which fairly entitle it to be considered representative of the country and of the day. . . The industry has brought about an enormous development in the manufacture of special tools and of parts of bicycles. . . For the production of the absolutely high grade American bicycle, a factory is required which will turn out practically all the parts of the wheel manufactured, for unless such is done one concern cannot be answerable for the perfection the whole machine."



A bicycle assembly line of 1896

CAR WEIGHT — "Railway cars could be lightened in their construction by the substitution of high grade steel for timber. The use of nickel steel for the floors and side trusses, with thin plating for sides and roof, would result in a light, but very stiff and strong car. By furnishing the interior with rattan or basket work chairs and lounges, such as are to be found on some lines today, a further saving of weight could be effected."

NIAGARA POWER — "The generators at the Niagara Falls Electric Power Plant, which may be termed a genuine triumph of electrical engineering, are of the Tesla vertical type, and were built by the Westinghouse Electric Manufacturing Company. For each generator there is a turbine wheel. The axis of the generator comes directly in line with the axis of its own turbine, situated 150 feet below it."

ENGINES — "Gas, gasoline and petroleum oil engines are daily becoming more popular, and not only is the number of regular manufacturers becoming very large, but many amateurs are trying their hands at the production of engines of this class. . . One of the most difficult problems is that of providing an efficient means of igniting the explosive charge in the cylinder at the proper instant without intermissions or failures. . . The electric spark, taken all in all, is probably the best igniter."

RESONANCE AND ECHO — "Architects should keep in mind the rule that resonance, such as is to be obtained by thin elastic linings, or even by masses of air judiciously distributed, is a thing to be sought in designing rooms for hearing music, or for public speaking, while echo, such as is produced by hard unyielding surfaces, is to be avoided as much as possible."

100 Years Ago in . . .

SCIENTIFIC AMERICAN

(Condensed from Issues of January, 1846)

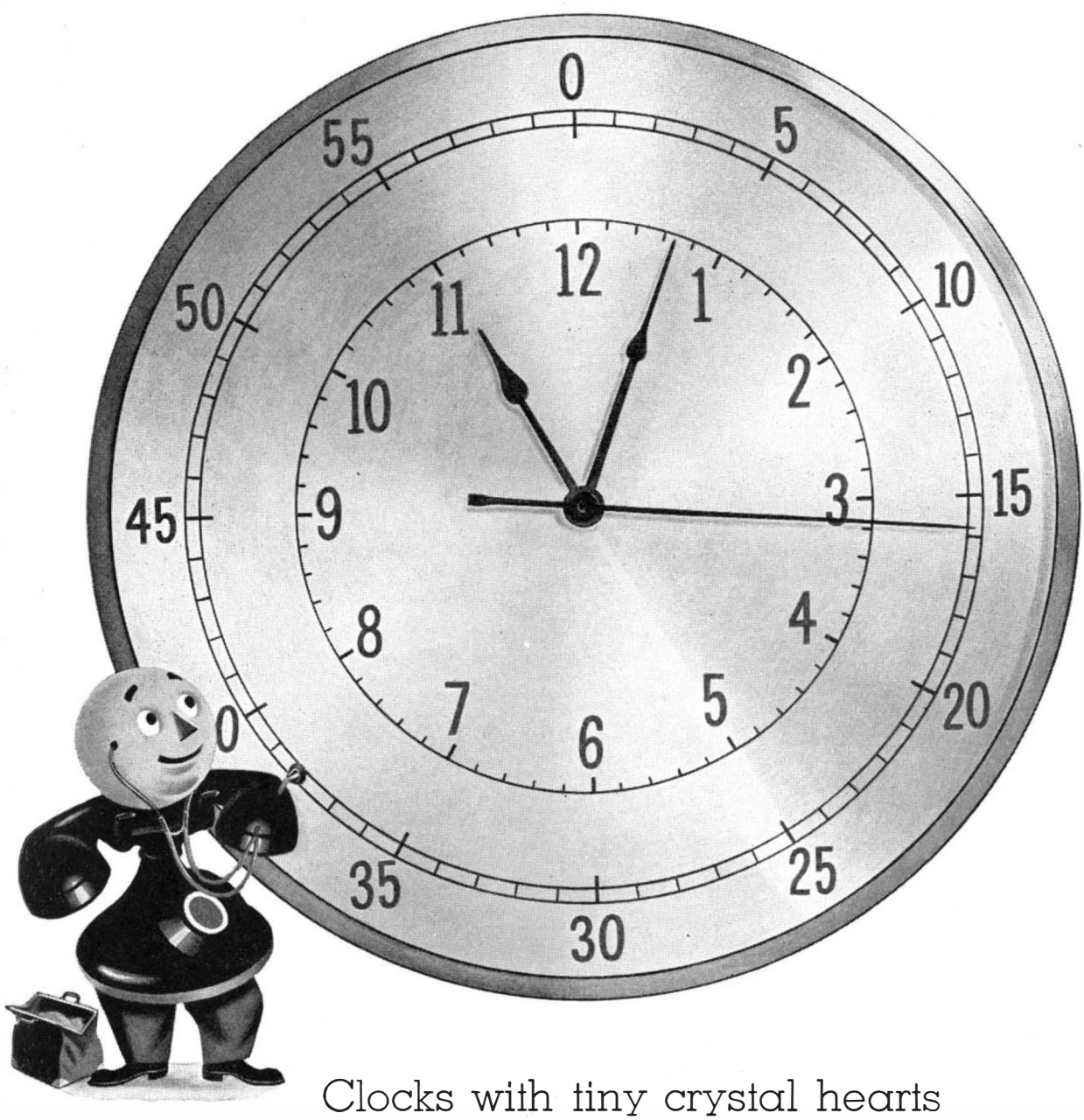
ELEVATED — "We have heretofore alluded to the constructing of Elevated Railroads over the centers of some of the principal streets of this city; since which we have more attentively examined the subject, and are fully convinced of the practicability not only of constructing such roads, but of rendering them unobjectionable to the citizens resident on those streets."

MAGNETISM — "Galvanic Electricity, under certain circumstances, is capable of inducing magnetism more powerful in its effects than that of any permanent magnet."

RAILROADS — "Every railroad company . . . should be made to know that they are in some measure dependent on the public; and all travelers, and men of business, should from principle refrain from patronizing companies who neglect due accommodation of the public."

TELEGRAPH — "The magnetic telegraph line between Philadelphia and Norristown commenced operations about a week since. The line between this city and Philadelphia is finished and has commenced operations."

BELLS — "We learn that 258 bells averaging 534 lbs. each have been cast at the extensive foundry in West Troy during the past year—just 113 more than in 1844."



Clocks with tiny crystal hearts that beat 100,000 times a second

CRYSTAL HEARTS beat time in Bell Telephone Laboratories, and serve as standards in its electronics research. Four crystal clocks, without pendulums or escapements, throb their successive cycles without varying by as much as a second a year.

Precise time measurements may seem a far cry from Bell System telephone research, but time is a measure of frequency, and frequency is the foundation of modern communication, whether by land lines, cable, or radio.

These clocks are electronic devices developed by Bell Laboratories, and refined over years of research. Their energy is supplied through vacuum tubes, but the accurate timing, the controlling heart of the clock, is provided by a quartz crystal plate about the size of a postage stamp.

These crystal plates vibrate 100,000 times a second, but their contraction and expansion is submicroscopically small—less than a hundred-thousandth of an inch. They are in sealed boxes to avoid any variation in atmospheric pressure, and their temperatures are controlled to a limit as small as a hundredth of a degree.

Bell Laboratories was one of the first to explore the possibilities of quartz in electrical communication, and its researches over many years enabled it to meet the need for precise crystals when war came. The same character of research is helping to bring ever better and more economical telephone service to the American people.

BELL TELEPHONE LABORATORIES *Exploring and inventing, devising and perfecting for continued improvements and economies in telephone service.*

Previews of the Industrial Horizon

By A. P. Peck

TELEVISION ON THE MARCH

TECHNICAL advances in television transmitting and receiving equipment are encouraging for the future of the industry. Already available are the image orthicon super-sensitive camera tube, described on page 11, and developments in microwaves (page 28) that now permit high-power operation on television wave-lengths. These, together with small yet brilliant cathode-ray tubes for receivers, which permit construction of relatively low priced equipment, should boom the television market in the very near future.

BETTER RUBBER

SIX TIMES as fast as conventional methods, and capable of turning out better rubber products, is the way electronic curing and drying of rubber is characterized by Westinghouse engineers. Under "For Future Reference," this page, July 1945, electronic vulcanization of rubber was pointed to as an important probability. Now the process is here to stay (see also page 32, this issue) and is being applied not only to tires but to mattresses, cushions, elastic threads, rubber wheels for industrial trucks, and so on.

FUNDAMENTAL RESEARCH

GUIDING purpose of the Stevens Research Foundation, established as a non-profit corporation by Stevens Institute of Technology, will be to investigate any promising fields pertaining to industry that will improve the technical and economic life of the country. Here is not just another organization to conduct routine test work or to engage in factory "trouble-shooting." In fact, problems of these natures will be passed along to the many groups already available for such work; Stevens Foundation will concern itself with more fundamental projects. Thus the Foundation will make available a means of investigating problems of industrial significance which, if left to individual companies, could be tackled only by those of the highest order of magnitude—those with relatively unlimited resources that can afford to concern themselves with matters which have no immediate probabilities of profits.

FOOD FOR THE FUTURE

ASK ALMOST any returned G. I. for his opinion of dehydrated food. His reply, stripped of the almost inevitable profanity that accompanies discussion of Army or Navy chow, will probably indicate that, for his part, dried foods of all kinds are out—definitely out—of his life forever. Perhaps much of this attitude can be attributed to the relatively poor quality of dehydrated foods that were supplied in the first rush of the early days of the war. Perhaps another large part of it is the contempt that accompanies familiarity. In any event, it appears that, of the 141 food dehydrators in the United States at the peak of war demand, only about a quarter of them intend to try to stay in business.

But now comes Clarence Birdseye, of quick-frozen-food fame, with the announcement of a new "anhydrated" food process that differs from ordinary dehydrated food in much the same manner as quick-freezing differs from slow-freezing. In the new Birdseye process, the foods—a wide variety of them, including carrots, broccoli, and mashed potatoes—are quick-dried to reduce weight and volume and then packaged for sale. The time of drying is reduced from the usual 16 hours or so to about 90 minutes. At the same time, the foods are partially cooked during the drying process and require only a few minutes—four to ten—for final preparation before they are put on the table.

Result of the anhydrating process is a reduction of from 88 to 95 percent in weight and a corresponding saving in bulk. To the store-keeper this means reduced storage space plus longer keeping time for vegetables; to the housewife will accrue similar advantages, with the added factors that the vegetables are ready for use and have minimum waste.

Regardless of the G. I. opinion of dried foods, many of them are going to eat the new anhydrated foods in the future—and like them, if this writer's experience in eating (and preparing them) is any criterion.

FOOD PACKAGING

BEFORE leaving the three-times-a-day important subject of food, passing mention must be made of a new packaging method for quick-frozen foods that has definite industrial implications for tomorrow. The new package, developed by Continental Can Company, has a treated paper body and metal ends. Flat and rectangular in shape, it conserves space; because of its construction, it offers maximum protection against dehydration (not desirable in frozen foods), oxidation, loss of flavor, acquisition of off-flavors, leakage, and loss of vitamins. Of industrial importance is the new package's adaptability to automatic filling and closing operations, with consequent reductions in labor costs.

AIRPLANE POWERPLANTS

IMPORTANT on the airplane horizon, and becoming more so every day, is the jet engine, used either for its reaction thrust alone or for combined thrust and conventional propeller operation. There is no doubt that these prime movers will be in the big-business class in the very near future. Both General Electric and Westinghouse, for example, are busily exploring their possibilities and exploiting their potentialities. Thus, a G. E. engineer has predicted a 10,000 horsepower unit for the future but has cannily refused to place this figure as the upper limit. A Westinghouse technologist looks to gas turbines of 5000 to 8000 horsepower "within the next few years."

The probabilities are that the gas turbine, no matter how its power is applied, is the coming prime mover for aircraft of large size and high speed. But the aircraft field is certain to be shared for many years to come by the turbine and the more familiar reciprocating engine. These latter will continue to power planes of small size and relatively slow speed, while the turbine will extend greatly both the top speeds and cruising range of larger commercial ships.

FOR FUTURE REFERENCE

BIGGEST PROBLEM of the rubber industry in the immediate future is the adjustment of the nation's huge synthetic output to the increasing supply of natural rubber. . . Aluminum Company of America, with its enormously increased wartime productive capacity, is girding for battle for expansion in fields where it had pre-war holds, as well as in brand-new markets for its products. . . Ford's new foundry methods bring the molds to the molten metal, instead of vice versa, with resulting economies in time and labor. . . Those manufacturers who conduct continuing research in product improvement, instead of waiting until competition forces them into improvements, are the ones who keep on top of the pile; it is too late to start research when compelled to do so by loss of business.

CHEMISTRY IN INDUSTRY

Is DDT Poisonous?

Legends of All Kinds Have Been Built Around this Newest of Insecticides. It is Poisonous, but . . . Many of the Troubles are Traceable to the Solvents Used. There is Nothing to Fear if the Material and Products Containing it are Handled With Respect

By D. H. KILLIFFER
Chemical Engineer

TREMENDOUS publicity and intense general interest have already built up numerous legends around DDT, the new war-proved insecticide. Unquestionably effective in many important applications, DDT owes its value to its toxicity, a fact which many people seem surprised to discover. Because of its toxic character, DDT will kill insects and for the same reason it will cause disagreeable symptoms, if not death, in warm blooded animals and persons under certain circumstances. That seems elementary. But reports of the effectiveness of the insecticide have grown to be barely less fantastic than baseless tales passed around, which presumably confirm the hazards incurred through using it.

Typical is the story of Henry's dog. It seems that Henry's dog had a prolific crop of fleas during the summer of 1945 and that Henry sought to relieve the animal's suffering by dusting it with DDT. Later the dog died and apparently became at once a martyr. As I heard the story first it went something like this:

After the dusting with DDT, the animal lived on in comfort for about a month. At the end of that time, Henry was called out of town for a time and left the animal at a nearby kennel in his absence. The veterinarian in charge noticed that the dog was dirty and instructed the attendant to give the dog a bath. That was done using a high grade castile soap shampoo, and as soon as the dog had been completely lathered, it died right in the attendant's hands. Such was the interest of veterinarians in the dire fate of Henry's dog that no less than four from the surrounding countryside were present at the autopsy and saw indisputable proof that the animal had died of poisoning from the DDT dusted on its coat a month previously and only now activated by being emulsified by the copious lathering.

CIRCUMSTANCES CHANGE—That is a pretty dreadful fate for a dog and so I inquired of Henry himself as to what had happened to his pet and what were the circumstances. I learned: (1) that the dog was well along in years; (2) that the bath was given two days after the dusting and with a strong pine oil preparation intended to assist in clearing up a skin irritation that had troubled the dog for some time; and (3) that the dog survived the bath by a month. I also learned that it was reasonably certain, on the basis of the veterinarian's report, that the dog's death was due to apparently natural causes far less spectacular than DDT. And thus the object lesson in caution with which I had hoped to start this article collapsed.

Courtesy Westinghouse
A DDT "bomb" in the home

Several other stories of DDT's harmful tendencies similarly petered out when an earnest effort was made to confirm them. Like the one about the lady in New York City who suffered serious frost bite on two fingers from using an aerosol bomb that she couldn't shut off and who blamed the injury on DDT. So many were traced out and found baseless that I have come fully to believe that one must try hard to be harmed by DDT.

RELEASE SUFFERINGS—Like many other novelties growing out of the war, DDT suffers from its sudden release from war-time censorship and restricted production. Many factors set the American stage in the best possible manner for the mushrooming of fantastic tales: partial information allowed to be published during the war years; the demonstrated high value of the stuff against body vermin; tremendous demand for the meager output of American plants to meet war demands; lack of men, materials, and, above all, time to extend investigations of the material into all fields interesting to civilians; and the reports spread by enthusiastic GIs of the magical effectiveness and extraordinary safety of DDT as they have used it. Now authentic information from reliable sources sounds a warning note of caution, and suddenly the slightest mishap is magnified into a great calamity. Any harm to man or beast connected with DDT is reported in expanding

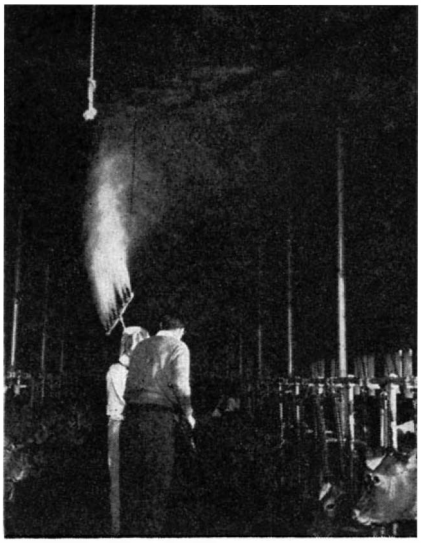
detail by scaremongers as tending to show that DDT should be banned.

Meanwhile, demand has built up for the product during its restriction to military use. This demand overwhelmed legitimate producers soon after the ban on DDT's use by civilians was lifted. The excess of demand over supply created opportunities for every shyster and marginal manufacturer to produce and market DDT. It is all very confusing and much in need of clarification.

First clarification should be to define DDT. It is a white crystalline chemical compound rejoicing in the name of 2, 2 Bis (p-Chlorophenyl) 1, 1, 1, trichloroethane. It can be produced without great trouble by chemical manufacturers by the reaction of chlorobenzene with chloral in the presence of sulfuric acid. No patent covers the preparation but the hazards of handling the intermediates and the product require that only skilled and experienced persons in properly equipped plants should undertake the synthesis. It is decidedly not an enterprise for neophytes. The reaction that produces DDT at the same time gives rise to other compounds which also seem to possess insecticidal value.

But DDT as produced is in a form by no means satisfactory for use against insects. It must be extended with other things to make it fully useful. Some aspects of its applications are covered by a United States patent issued to Paul Mueller, a citizen of Switzerland (U.S.P. 2,329,-074 of September 7, 1943). It may be used in the form of a dust diluted with talc or other powders. In solutions or emulsions, it may be applied to many purposes. It may also be included in the aerosol bomb. Each of these forms has its particular values.

TOXICITY—The questions of toxicity of such preparations are most effectively answered by official



Courtesy Geigy Company, Inc.

"Neocid" barn spray, containing DDT, may be used as a residual type spray against flies and mosquitoes or as a dip against cattle and goat lice and sheep ticks. This insecticide is supplied in a wettable powder form that is stable in water suspension

statements from those best qualified to know. Dr. H. O. Calvery of the Food and Drug Administration and Dr. Paul A. Neal of the National Institute of Health have issued this joint statement:

"The extensive animal experimentation and investigative agricultural uses indicate quite clearly, we believe, that DDT is a deleterious substance. On the other hand, the use of DDT by the armed forces as well as the above experimental work on animals has shown that DDT insecticide can be used safely when properly labeled and handled with adequate precaution. DDT is not a caustic poison, a primary irritant, and probably not a sensitizing agent. For example, it is not dangerous like carbolic acid, thallium, strychnine, bichloride of mercury, aniline, methyl bromide, cyanides, fluorides, arsenic trioxide, caustic acids and alkalies, and so on. This group of chemicals are so dangerous that they must be handled with extreme care and the labeling must be so distinguishing as to thoroughly warn the handler and user. If substances like DDT are classed with these and the individual learns that he can submit to considerable exposure without eye irritation, skin irritation, or any subjective signs of harm, he instinctively but unconsciously begins to disregard such warning labels and the hazard to health is vastly increased. Therefore, it is our opinion that DDT does not belong in the class of compounds usually labeled "Poison" with the skull and cross-bones. DDT does, however, warrant the exercise of caution in its handling and use and as a result we as toxicologists feel that such caution statements as are recommended by the Insecticide Division are appropriate."

A previous statement by Dr. Calvery also has a direct bearing on the subject:

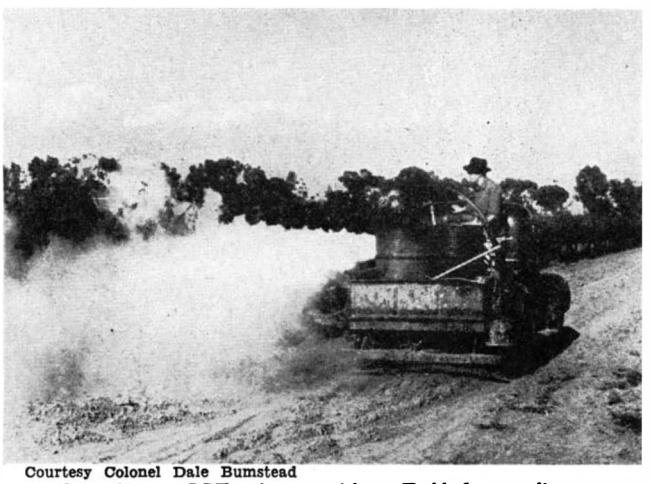
"DDT, the much publicized insecticide, is a toxic substance. The toxicity of DDT to humans is of a sufficiently low order to permit the use of DDT without danger to personnel if reasonable precautions are taken. In spite of the extensive employment of this insecticide to date, there has been no reported established case of poisoning. This is, in large part, the result of observing previously published precautions and should not be interpreted as an indication that any relaxation in the observation of those precautions is warranted. . .

"None of us has yet seen a case of anyone poisoned by DDT, but our laboratory tests show that poisoning is possible. . .

"We receive many reports of poisoning blamed on DDT. One told of dizziness from spraying all day. Most DDT spray solutions have been based on kerosine and the reported dizziness is a perfect textbook picture of kerosine poisoning. As true with many reports, the public are

Courtesy Todd Shipyards Corporation

DDT rids beaches of annoying insects



Courtesy Colonel Dale Bumstead

Spreading a DDT mixture with a Todd fog applicator

just not aware of the toxicity symptoms of commonly used materials. To date we have not seen a case of anyone poisoned by DDT."

BEST INFORMATION—In a letter on the subject of DDT toxicity, Dr. Neal quotes the following statements summing up the best and latest information available:

"Although DDT is deadly to many insects, it is not harmful to man if properly applied. DDT is definitely less toxic than Paris green and sodium fluoride — long in use as common insecticides. But, as with any insecticide, there are certain precautions which must be taken to avoid any possible harmful effects.

"In spite of its toxicity, no harmful effects have been observed in animals exposed in rooms containing many times the recommended insecticidal concentration of DDT in sprays or dusts. But careless use and exposure to abnormally high concentrations of DDT may cause toxic effects. Therefore, it is essential to follow carefully the directions for its use as a household insecticide.

"It is very unlikely that food contaminated with DDT from ordinary home use will cause toxic effects in man, but such contamination should be avoided by removing food from the room or covering it during spraying.

"DDT in *dust form* is not absorbed through the skin unless greases, oils, or greasy skin lotions are already present on the skin. Nevertheless, DDT powders should not be allowed to remain on the skin, and excessive inhalation of the powder should be avoided. Since the diluted dust (if uncolored) may be mistaken for flour or other foodstuffs, the material should be carefully labeled and every precaution taken to keep it away from children. Any danger of food contamination should be avoided.

"DDT in *oil solution* is readily absorbed through the intestines and is also absorbed directly through the skin. Therefore, DDT-oil solutions should not be allowed to remain on the skin or saturate clothing. Wash the hands and exposed skin with warm soapy water; and if oil solutions or concentrates are spilled on the clothes, change them promptly. Avoid inhaling the mist and contaminating food with the spray. *Never use it on the skin or coat of animals.* If the solvent is inflammable don't use it near a fire.

"It should be pointed out that many of the solvents (kerosine and so on) used in preparing DDT insecticides in themselves may cause irritation of the skin and other harmful effects when handled carelessly. By observing proper precautions and cleanliness, these can be avoided.

"If a good deal of spraying is to be done it is advisable to wear gloves, goggles, and a respirator to avoid excessive contact and inhalation of DDT and its solvents."

NO ACTUAL POISONINGS — A subsequent statement by the Industrial Hygiene Division, U. S. Public Health Service contains the following:

"Before the Army's release of the insecticide for field use by its personnel, extensive tests of biologic effects were made by this laboratory. No case of poisoning actually due to DDT has occurred in the United States, reports the Chief of the laboratory. In more than two million persons exposed to DDT in its use by the Army for control of insect-borne diseases, no case of poisoning is known to have occurred.

"Those cases of toxicity which have occurred to the present time have been found to be due to the solvents used in the DDT mixture. Many of these solvents, such as kerosine, xylene, and others in themselves may cause irritation of the skin and other harmful systemic effects when handled carelessly. Such effects may be avoided by observing proper precautions and strict personal cleanliness. It is recommended that the chlorinated hydrocarbons, with the possible exception of methylene chloride and trichlorethylene, should not be used as solvents for DDT."

Obviously, when properly handled, DDT is one of the safest of the various dangerous substances used by the American people and there is nothing to fear if the material and products containing it are handled with proper respect. Clearly, too, the great value of DDT fully justifies proper precautions in its use. One such precaution is to use the products of trustworthy manufacturers and to avoid fly-by-night products having no responsible sponsor.

Yes, DDT is poisonous . . . but it is extremely useful if you treat it right.

⊕ ⊕ ⊕

DRYING OILS

Obtained by Electrolytic Reduction of Glucose

SORBITOL, an alcohol containing six hydroxyl groups and made by the electrolytic reduction of glucose, has been found to yield drying oils of uniquely valuable properties when combined with the fatty acids of linseed oil, replacing the glycerol naturally present. Glycerol, the alcohol naturally present in fats and oils, has three hydroxyl groups as compared with four in pentaerythritol and six in sorbitol. Each of these polyhydric alcohols imparts valuable properties to drying oils and apparently the greater the number of hydroxyl groups, the quicker drying is the product. Varnishes made with the sorbitol oils are reported to dry to a hard finish.

YEAST VS. FAMINE

Special Product Is High in Vitamin B

GROWTH of a special yeast high in protein and the B vitamins is being undertaken in the West Indies with the expectation that the highly concentrated nutriment of the product may be especially valuable in war-torn Europe. The yeast product has a protein content of 40 to 50 percent and is expected to cost about 12 cents per pound, when produced from sugar cane grown in Jamaica. The average person's daily requirement of protein and B vitamin is reported to be met by about half an ounce of the concentrated yeast.

PRESERVATIVE

May be Perfected From Penicillin

PENICILLIN, heralded for its feats in conquering infections, has been suggested by United States Department of Agriculture scientists as a possible preservative of foodstuffs. Tests have shown the drug's effectiveness against many types of microbes, but not all, and while it seems likely to have value, much more research is necessary to show how it should be used. Tests on milk are promising but not conclusive.

ARTIFICIAL FALL

Aids in Harvesting Many Crops

CHEMICAL dusting of cotton plants to cause their leaves to fall when desired in order to allow mechanical pickers to handle the crop has proved successful and is now moving into other fields of usefulness. Similar dusting defoliates tomato plants and lets the sun reach the fruit to ripen it as the season advances. Removal of the leaves from vines is reported to simplify harvesting soy beans. Other applications of the new technique are expected to benefit those who can't wait for Nature to bring on Fall in due course. Active principal of the dust used is calcium cyanamide.

Boron Carbide: A Challenge

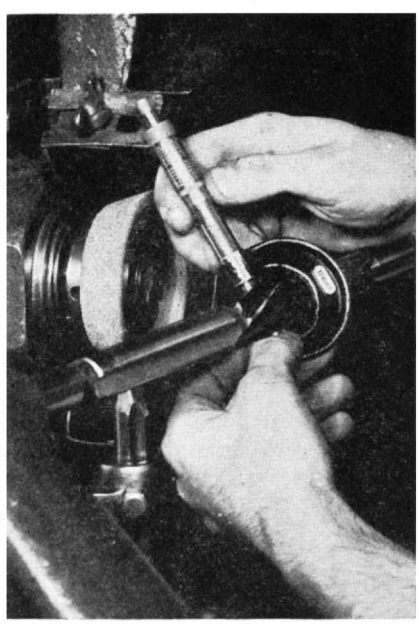
Industry Has Available a Material which Can Be Put to Many Production Uses, When Means Are Found to Capitalize Fully on its Advantages and Overcome its Weaknesses. Already Boron Carbide is Being Used in Blast Nozzles, Gages, and Specialized Cutting Tools

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

IF EVER an industrial material could be said to be "noble" then boron carbide is that material. The word "noble" in the industrial argot means "not susceptible to attack by other materials," as in the case of gold, which is not readily attacked by acids, and pure silver, which does not oxidize at room temperatures. And boron carbide is less susceptiable to attack than almost any other material known to industry. Acids will not etch it; only diamonds will cut it (and then only very slowly); alkalies do not bother it; water will not rust it; heat at temperatures ordinarily found in industrial furnaces will not melt it; intense cold will not weaken it; and electrostatic charges will not gather on it. It cannot be swaged, forged, or extruded.

It has just one weakness. Solid boron carbide is brittle. And the individual grains that make up the solid form also are brittle. Boron carbide shapes should not be hit with hammers nor dropped on the floor. Boron carbide grains cannot be used as the abrasive in a grinding wheel; their sharp points will break off and leave the wheel glazed and useless.

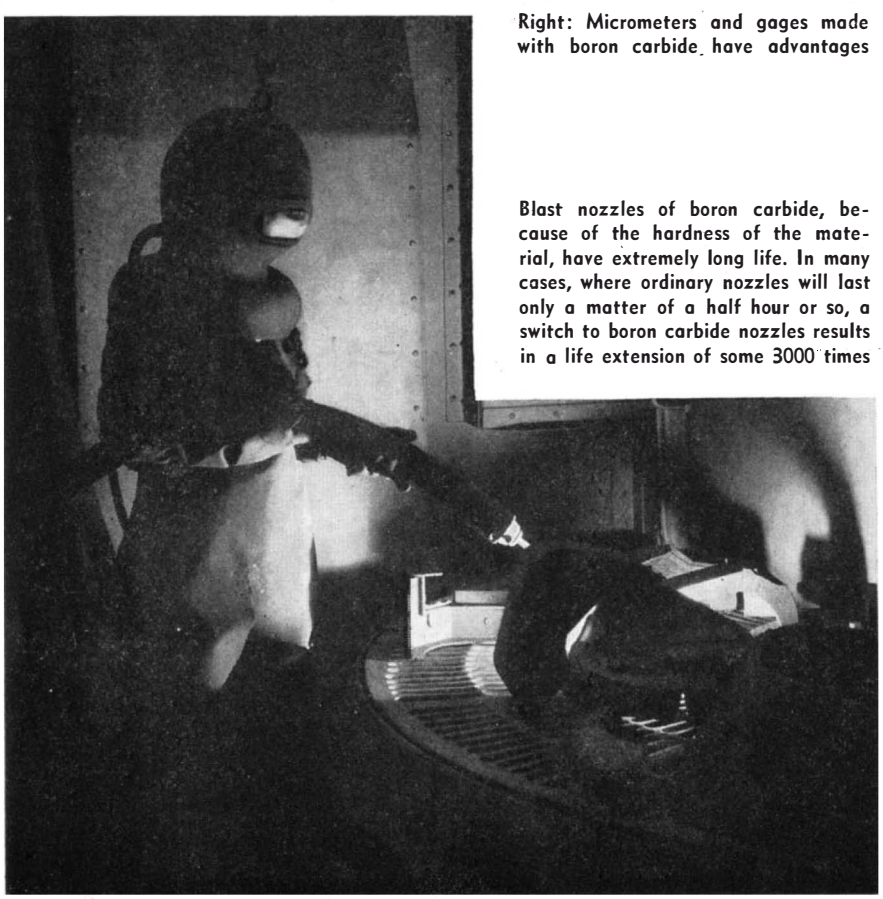
And this is the challenge of boron carbide, a challenge which has been too tough for most industrial designers to accept during the ten years or more that the material has been on the market. Fabrication always involves processes which are either deforming or destructive:



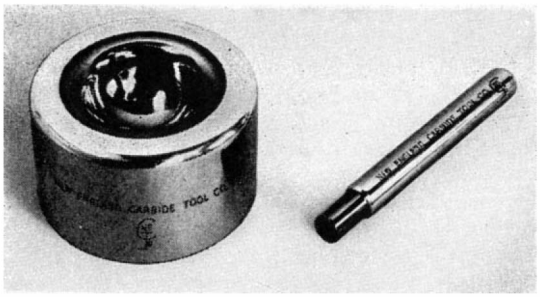
Right: Micrometers and gages made with boron carbide have advantages

processes which cut away, eat away, melt away, or squeeze away some parts of the material being fabricated. Wear and other damage in service are caused by exactly the same processes. With the exceptions of cutting by diamonds and breaking by rough handling, boron carbide defies all such processes. Let industry learn how to fabricate boron carbide and to so design products that their boron carbide parts are protected against breakage, and some of the most durable products known to man can be made.

A few industrial designers and production men have met this challenge, and with startling results. The boron carbide parts often outwear the ones they displace hundreds and even thousands of times

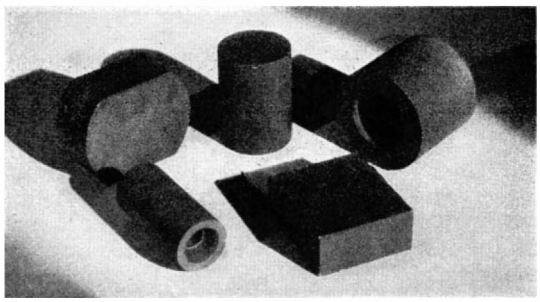


Blast nozzles of boron carbide, because of the hardness of the material, have extremely long life. In many cases, where ordinary nozzles will last only a matter of a half hour or so, a switch to boron carbide nozzles results in a life extension of some 3000 times



Left: Boron carbide inserts in this mortar and pestle are held in stainless steel.

Right: some of the more common shapes into which boron carbide can be formed



over. In fact, the boron carbide parts have been known to bring whole new industrial developments into being. Here are some examples.

BLAST NOZZLES—Ordinary chilled iron blast nozzles for handling abrasives are likely to last only 30 minutes in service, whereas those made of boron carbide may have 3000 times that life.

With the boron carbide nozzles, many a sand blaster has had to change his whole conception of his job. He had been used to having his nozzle start with a small orifice which delivered a small and controllable stream of sand with minimum use of compressed air, but having the nozzle rapidly wear larger at the orifice with the sand becoming less and less controllable and the air wastage greater and greater until he had to discard the nozzle. During this 30-minute period he had to accommodate his blasting technique to changes in the blast stream. But with his boron carbide nozzle the blast stream and the air consumption remain constant, hour after hour, day after day; eight weeks of 40 hours a week steady service will pass before he has to change a nozzle. His work is done more rapidly and is accordingly of higher quality.

Thousands of abrasive blasting operations are done by automatic machines today. It would have been impossible to develop some of the best of these machines if the long lived boron carbide nozzles had not been available to keep them in constant operation. The machines could not have compensated for rapid nozzle wear the way the operators of manually directed blast nozzles do.

GAGE PARTS—Gages which are used for inspecting extremely accurate metal parts are subject to many ailments. They can wear to smaller dimensions or to false shapes. The metal in them can creep or warp out of shape. They can pick up electrostatic charges which cause bits of metal or of abrasive to cling to them. They can be scratched by work-hardened steel chips or by bits of abrasive. They can scratch the parts which are being inspected, especially if bits of metal or of abrasive cling to them.

One result of such troubles is false gaging. Another is that metal gages may have to be called in at the end of every eight hours of use so they can be checked for accuracy and for damage.

Boron carbide gage parts lack some of those ailments entirely, and have others only in much lesser degrees than do the tool steels of which gages ordinarily are made.

The boron carbide parts wear only at a fraction of the rates of steel ones. They will not warp or creep. They will not pick up or hold electrostatic charges, therefore chips or grits are not likely to cling to them. They will not scratch the work. They cannot be scratched by any steel chips nor abrasive particles.

One result of this superiority is that boron carbide gages often are called in for inspection only once for every 40 hours of service or even longer; they have been known to reduce gage inspection costs by 99 percent. Another is much lower gage life; in extreme cases, such as the gaging of rough porcelains, boron carbide gages have been known to last 4200 times as long as the gages they displaced. A third result is the elimination of false gaging which can be caused by gages wearing to false sizes or false shapes.

In spite of these boron carbide advantages, the great majority of gages are, and will continue to be, made of steel, tungsten carbide, and other materials. The boron carbide is too costly when only a few thousand pieces of a size are to be gaged, and there is no point in risking the penalties of boron carbide brittleness on easy jobs. But where the boron carbide is needed its advantages are likely to be overwhelming.

MORTAR AND PESTLE — When mortar linings and pestle tips are made of boron carbide they are not affected chemically by the materials being ground up and will not acquire scratches which might hold tiny particles of material and prevent completely clean washing. Therefore, the chemist never has his materials contaminated by chemical reactions with the mortar lining or the pestle tip, or by previously ground materials which stayed in scratched places when he was cleaning his equipment.

Moreover, the boron carbide parts can be supplied with different surface finishes, ranging from highly polished to satin. Each of these finishes has a different coefficient of friction and therefore a different speed at which grinding can be done.

CUTTING TOOLS—Boron carbide is too brittle for use in ordinary metal-cutting tools. But it can be used on glass-bearing plastics, on porcelains, and on other materials where the abrasiveness of the material being cut is a hard problem and the shear resistance is not.

BLASTING MASKS—When glass, wood, plastics, and other comparatively soft materials are to be sand blasted to produce special patterns and finishes on them, the areas which are not to be blasted often have to be masked to keep the flying abrasive particles from striking and marring them. Most masking materials are rapidly worn away and have to be replaced at frequent intervals. If the masks are of intricate or closely controlled shapes this replacement may be costly.

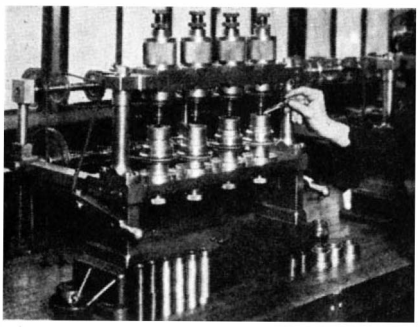
Boron carbide masks are not affected by the blasts in most cases, and when they are affected the wear is so slow as to be negligible. Their use is permitting much fancy pattern blasting which would otherwise never be attempted.

EXTRUSION DIES—Many abrasive materials are extruded to shape. Since extrusion involves heavy pressure to squeeze the materials to shape, the wear on the die can be rapid. Leads for pencils have this problem, and so do abrasive rods, coatings extruded on welding rods or on cables, and many others. The superior resistance to abrasion of boron carbide permits great savings in these dies. And not the least of the savings is in the fact that as a die wears larger it extrudes more material per lineal foot of extruded prod-

uct with consequent wasteage of the material.

Other industrial parts that are subject to extreme wear exist by the thousands. The problem is to fabricate the boron carbide to the necessary shapes and sizes.

First attack on this problem is being made by the Norton Company whose Norbide is the best known commercial boron carbide. The attack begins with the first steps in boron carbide production.



Diamond dust as a lapping agent has been replaced, in many applications, by boron carbide in the powder state

Norbide is made from the finest boric acid crystals combined with ash-free petroleum coke. The mixture is heated to a temperature very near to 5000 degrees, Fahrenheit, in an electric furnace. This results in cinder-like chunks of boron carbide. These pieces are ground to a fine powder, and the powder in turn is heated to over 4000 degrees, Fahrenheit, and pressed into solid shapes. No binder is needed.

Experiments in pressing the powder into larger and larger rods, tubes, and other shapes are continually in progress. Many special shapes are made so the final diamond cutting operations will be held to a minimum.

Sometimes the pressed shapes can be used without further finishing, as is the case with some abrasive blast nozzles.

When finishing is needed for accuracy or because the shape cannot be produced by pressing a powder at such temperatures, the fabricator can learn how to do the work himself or he can turn to houses like the New England Carbide Tool Company which have made a specialty of this art. Full instructions for procedure are available, and the sales engineering behind this product is high quality, but nevertheless it sometimes is best to turn to a house which already has acquired the know-how.

Learning how to use boron carbide, and especially how to fabricate it, is difficult. But any engineer who masters that art can proceed in the knowledge that he is using the hardest material ever made by man and one of the noblest materials known to industry.

BERYLLIUM STEEL

Retains Spring Properties Up to Red Heat

A RECENTLY developed alloy of possibly interesting but still undetermined future is beryllium steel, actually a "stainless steel" containing 12 percent chromium, upwards of 8 percent nickel, and 1 percent beryllium. The alloy has high-temperature oxidation resistance but an outstanding additional advantage is the fact that the beryllium steel can be age-hardened at around 1350 degrees, Fahrenheit, and that the consequent good spring properties of the material are retained at operating temperatures up to a red heat.

HEATING ELEMENTS

Improved by Addition of Small Amounts of Thorium

GERMAN workers in the field of electrical resistance alloys of the 80 percent nickel, 20 percent chromium type (used for heating elements in home appliances and industrial electrical furnaces) recently reported that the addition of thorium to such alloys improves their life at 2000 degrees, Fahrenheit, by 500 to 600 percent.

Thus at 1920 degrees, Fahrenheit, a wire with 0.02 percent thorium had a 75-hour life; with 0.1 percent thorium, 140 hours; with 1 percent, 325 hours; and with 2 percent, 400 hours. The increase in life seems to continue with additional thorium beyond 2 percent, but the alloys then become very difficult to work.

HIGH-TEMPERATURE STEELS

Out-Do Best Pre-War Materials Many Times Over

AMONG the most significant wartime developments from the point of view of planners of peace-time engineering products are the new high-temperature steels and alloys developed for gas turbines, superchargers, and so on.

Falling into the class of high-alloy stainless steels with special additions such as molybdenum, these modern alloys can operate successfully at 1500 degrees, Fahrenheit, and 15,000 pounds per square inch stress or pressure. Best pre-war materials lasted only 100 hours; steady improvements in the last five years have resulted in alloys that now operate successfully for 9000 hours under the same conditions.

Developed primarily for gas turbines, which are expected to find use in the future in aircraft, electric power plants, locomotives, ships, and perhaps even autos, the alloys may also find service in steam turbines, where the higher temperatures and pressures they permit will provide increased efficiency.

WIND-TUNNEL STEELS

Point Way for Other Applications At Low Temperatures

THE NEW and unique sub-zero, high-altitude wind tunnel at the engine research laboratory of the National Advisory Committee for Aeronautics, Cleveland, Ohio, requires for its walls a material that is highly resistant to impact and to the embrittling effects of low temperatures, as well as easy workability and reasonably low cost.

The material finally selected was one of the "low-alloy" steels (actually Youngstown's "Yoloy," a low-carbon nickel-copper alloy steel) that are also finding increased use for their weight-saving advantages in transportation and construction equipment. This newest application in low-temperature work (the temperature of the 500 miles per hour wind in the tunnel is 48 degrees below zero, Fahrenheit) suggests many possible uses for such low-alloy steels in aircraft themselves and in air-conditioning and refrigeration equipment—especially if the latter are to be portable or used in transportation equipment.

POT CLEANERS

Will Use Extruded Monel Metal Ribbons

POT CLEANERS made of meshed metal strip, a war-time civilian casualty, will be made of more durable and corrosion-resistant metals when converted production really gets rolling.

Dairy-industry needs led to the study of Monel metal (nickel-copper alloy) for pot cleaners, but difficulties in extruding the alloy in ribbon form and then weaving it delayed the application. With the recent solution of these manufacturing problems, pot cleaners made of this bright, non-rusting, long-lasting material are a reality, and not only Mrs. America but also whole industries (such as chemical-processing and food-manufacturing) will be putting them to effective use.

Television In The Dark

Image Orthicon Tube Has Tremendously Increased Sensitivity, Especially in the Infra-Red. It Points to Perfected Television and to Military Applications in Television-Controlled Pilotless Planes

By VIN ZELUFF
Associate Editor, *Electronics*

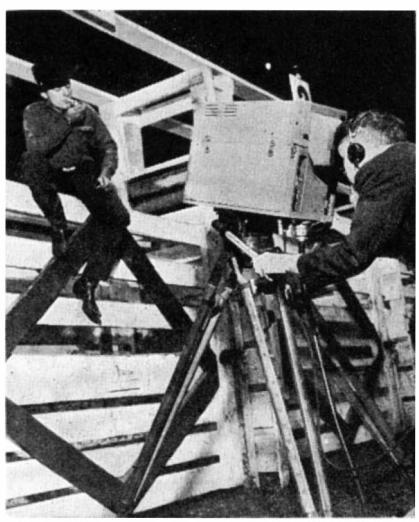
COUPLED with other recent technical improvements, a new television camera tube recently announced by Radio Corporation of America is expected to provide television pictures that will completely satisfy the public and thus allow the carefully nursed industry to find a firm footing.

Called the image orthicon, the new tube picks up scenes by candle- and match-light, and can even produce an image from a blacked-out room in which invisible infra-red rays are being radiated. In an RCA-NBC demonstration of the new tube, all lights were turned out in the studio where the audience was assembled. Unseen infra-red lamps were turned on, but it was still so dark that members of the audience could not see one another. Television receivers in the studio were operated and their screens showed bright images of a dancer and other persons who were in the same room, yet were otherwise invisible to the audience. This was made possible by the high sensitivity of the pickup tube to infra-red rays.

HOW IT WORKS—The new tube contains an electron image surface, a scanning section smaller and simpler than those built before the war, and an electron multiplier section. This latter element amplifies the relatively weak video signals before transmission and is based upon principles that led to the design of the multiplier phototube. The high sensitivity of that tube depends on secondary electron emission, in which electrons are directed toward a target called a dynode. When an electron hits the dynode, two or more electrons are emitted for each electron striking it. These, in turn, can be directed to another dynode and so on through a series to provide still further multiplier action.

An optical lens system is used to pick up light from the scene to be transmitted and focus this light on a photosensitive surface in the camera tube. Electrons are emitted from each illuminated area of the surface in proportion to the intensity of the light striking the area.

A grid placed behind the photosensitive surface forces streams of electrons to flow from the back of the photosensitive element to a scanning target. The resulting bombardment causes secondary electrons to be thrown off the target and leaves on it a pattern of varying positive charges which corresponds to the image of the scene being televised.



RCA's new supersensitive television camera should solve many of the illumination difficulties of the art

A beam of electrons from a conventional electron gun in the base of the tube scans the target. Electrons in the beam slow down and stop just short of the scanning target and return to the base of the tube, except when they approach a section of the target that has a positive charge. Then enough electrons are deposited on the back of the target to neutralize the charge, after which the beam again fails to reach the target.

The returning beam thus has a varying loss of electrons left behind on the target, and the beam current corresponds with the picture information on the photosensitive surface. The beam is amplified in a cascade electron multiplier that consists of a series of dynodes near the base of the tube. On weak signals when the camera tube is illuminated by only

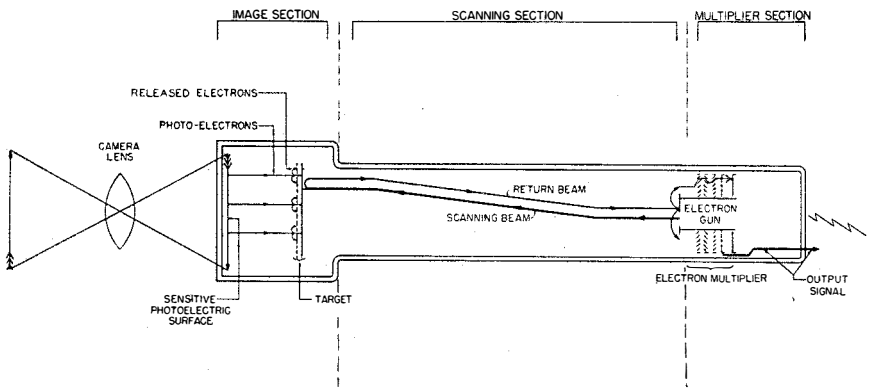
Official United States Navy photograph of a "Glomb"—a television-controlled glider-bomber that can "see" its target ahead and be guided to it from some remote point

.01 candle per square foot, the multiplier has an amplification of about 100. At a 10-candle level, this value drops to about 10; this feature provides an action similar to automatic volume control in home radio receivers. This is an advantage in television since it prevents strong lighting in the scene from blotting out weakly-lit portions.

Television cameras fitted with the new tube are expected to be ready for delivery to television broadcasters in about six months. The high sensitivity of the new tube simplifies the lighting problems of producing television programs and makes it possible to obtain clearer television images under changing light conditions than is possible using the older camera tubes.

The image orthicon is 15 inches long and three inches in diameter at its widest section. In addition to high sensitivity, it provides greater depth of field and inclusion of background that might otherwise be blurred. It may be used in conjunction with a telephoto lens for long shots.

PILOTLESS PLANE "EYES" — The image orthicon tube has been a military secret until now. Some of the uses to which it can be applied will probably remain secret for some time, but one application of television techniques that the Navy has disclosed is that of acting as the "eyes" of a pilotless torpedo plane.



Simplified drawing of the image orthicon tube. See description in text

As early as 1940, successful demonstrations of pilotless aircraft had been made with a torpedo plane which was radio-controlled and television-directed from a control plane 10 miles distant. The "ghost" plane's torpedo was successfully launched squarely into a maneuvering destroyer. Similarly, a dive bomber was made to plunge through the center of a moving target. From these experiments several types of pilotless assault ships were developed, a number of which were used against the Japanese base at Rabaul.

For such use, the television camera "sees" ahead of the guided missile and transmits the scene back to the control plane. If the missile is properly aimed, the desired target appears on the screen of the television receiver in the control plane. If the target is not visible or not accurately centered, the flying path of the pilotless plane is corrected by radio signals from the control plane or base.

According to the Navy, future wars will be fought in the air by pilotless planes that will "home" by electronics on their targets. Defense against these will consist of anti-aircraft missiles that will have an electronic brain to guide them with precision. That such missiles are entirely practical is proved by the results obtained by use of the electronic proximity fuze in anti-aircraft shells that detonates the shell only when it is in the vicinity of the target. To develop future weapons, the United States Navy's new Office of Research and Inventions has initiated the enlargement of the airborne electronic facility at the Naval Research Laboratory. About 25 percent of the efforts of the laboratory and its personnel will be directed toward airborne electronic developments required by the Navy.

100,000,000 Electron Volts

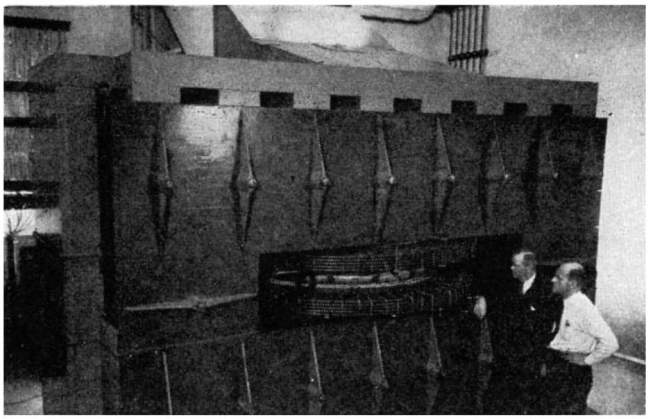
New Super X-Ray Generator Makes Possible Transmutation of Elements and Opens New Fields for Extended Research in Nuclear Physics

By JOHN MARKUS
Associate Editor, *Electronics*

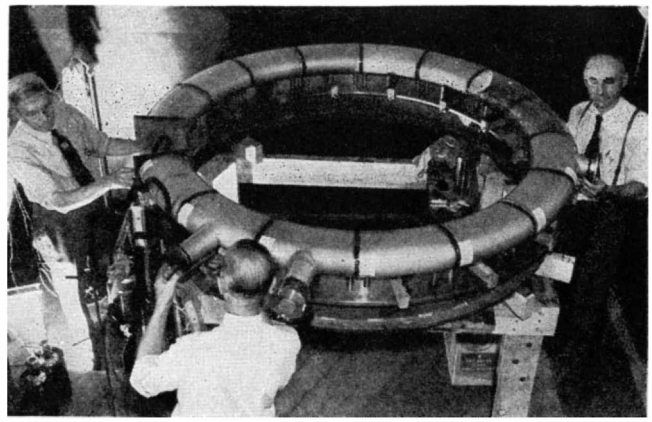
WITH A ROAR approximating the blast of the Queen Mary's fog horn, the hundred-million-volt betatron or electron accelerator constructed at the General Electric Research Laboratory emerged recently from behind two years of war-time censorship to show what it had been doing. Among other feats, the new electronic machine can actually create matter from energy, duplicating the process of creation of the universe from atomic particles.

When the operating switch is closed, the 130-ton electromagnet of the unit vibrates with ground-shaking intensity, but the sound effects are incidental to the action of the magnetic field in making electrons whirl through the inside of a doughnut-shaped glass tube at a speed approaching that of light. At the critical moment, the electrons are deflected against a target, generating super X-rays of 100,000,000 electron volts that, in turn, can be changed into newly-born negative and positive electrons—particles of matter created from energy and nothing else.

The new betatron produces X-rays far stronger than could ever be produced before, capable of making sharp, high-speed radiographs through 12 inches of steel. It is the first man-made machine that can duplicate the effects of cosmic rays. The tremendously powerful beams can even destroy the uranium atom (the active substance in atomic bombs), and can change one element to another by transmutation in a



The huge electromagnet of the electron accelerator



Doughnut-shaped glass vacuum tube of the betatron

successful though not economical realization of the dreams of alchemists.

The betatron is located in a special building with concrete walls three feet thick as a protection from the dangerous rays. The principal part is the huge electromagnet, made of laminated silicon steel arranged as a block 9 feet high, 6 feet wide, and 15 feet long. In a rectangular opening passing through the magnet from front to back are the pole faces, 76 inches in diameter, surrounded by large coils of insulated 1-inch copper conductor. These coils are energized from a bank of 24,000 volt capacitors in an upstairs room and the resultant intense magnetic field is concentrated in the 74-inch diameter doughnut-shaped glass vacuum tube positioned between the pole faces.

Projecting into the doughnut at one point is an electron gun, similar to that in a television cathode-ray tube. This gun shoots out a beam of electrons with an initial speed of several thousand electron volts. The magnetic field bends the beam into a fixed circular orbit that clears the side walls of the doughnut and boosts their speed and energy at a rate of 400 electron volts for each trip around the tube.

When the machine is operating at full power, the electrons make 250,000 revolutions and reach a speed of 100,000 electron volts in 1/240th second, after which a pulse of current passes through two smaller auxiliary coils on the pole faces. This causes the electrons to spiral away from their orbit and to hit a tungsten target which they previously missed, generating X-rays that emerge from the doughnut in a pencil-like beam only two degrees in diameter.

Einstein showed theoretically in his relativity theory that matter and energy are equivalent and that one may be changed to the other. With the betatron, this equivalence can be demonstrated and proved in both directions. In the atomic bomb only the conversion from matter to energy is utilized. The reverse change has been observed in studies of cosmic rays and rays from radioactive elements. A small amount of matter corresponds to an enormous amount of energy, however, so only minute quantities of matter can be produced even with the expenditure of huge quantities of energy.

MATTER CREATED—The reverse process in the betatron, called "pair formation," occurs when high-intensity X-rays pass close to the nucleus of an atom. By some process not yet understood the X-rays then cease to exist and there is created instead a new electron and a positron (an electron with a positive charge). The positron quickly gets together with some other electron, so they both change to radiation. The new electron is still there, however, and, since it has mass, it is a unit of matter.

An ordinary silver half dollar gives off rays like those of radium after a few minutes exposure to the intense X-ray stream produced in the betatron, demonstrating dramatically that transmutation of elements is possible, even though expensive and impracticable. A Geiger counter is used to show the effect. The counter normally clicks about 30 times a minute, due to cosmic radiation, and the coin before irradiation had no effect. When the half dollar is inserted in the counter after being bombarded with super X-rays, the clicks step up to about 10,000 per minute. After a few minutes, however, this slows down and finally ceases, as a result of the decay of the radio-activity.

What happens is that rays from the betatron knock a neutron from the nucleus of a silver atom. This changes it from ordinary silver, with mass of 109 units, to an unstable silver isotope weighing only 108 units. The isotope gives off an electron, which increases its positive electrical charge by one unit and transmutes it to cadmium, since it is the electrical charge of the nucleus that determines what element it is.

The electrons given off during this transmutation are responsible for the increased response of the Geiger counter. Simultaneously, another isotope of normal silver, of mass 107, changes to silver 106 and thence to palladium, and some of the copper in coin silver changes from its normal mass of 63 to 62, then to nickel. Since all of these activities die off rapidly, the coin is no longer dangerously radio-active after an hour or so. Although these changes involve huge numbers of atoms, they are exceedingly small in proportion to all the atoms in the coin, and no chemical test could detect the cadmium, nickel, or palladium produced.

Control of the betatron is entirely from a neighboring room because it is dangerous for anyone to be near when the machine is operating. An elaborate series of switches and dials enable the operators to tell what is happening.

The big machine was placed in operation in the summer of 1943 but Government secrecy orders on all work related in any way to the field of nuclear physics, designed to protect the atomic bomb project, prevented its details being revealed earlier.

BIRD TRACES

Have Been Observed On Radar Tubes

ONE possible use for radar equipment is the study of the flight characteristics of different species of birds. Albatrosses and other large birds have been found to cause spots or traces on the screens of the cathode-ray tubes used as indicators of radar units, according to a report of an ornithologist now in the Navy.

Standards For Versatility

Industrial Standards Can and Will Give the Whole World a Better Standard of Living. But Complete International Co-Operation Must be Gained Before Such Standardization Can be Fully Realized. Industry Faces Many and Diversified Problems in the Process

By EDWIN LAIRD CADY

A PHYSICIAN-SCIENTIST in New York, experimenting with the relief of pain, ran head on into an international standard. He was working with a diathermy machine, and in the process was broadcasting radio waves that by some freak of the upper atmosphere were jamming short-wave broadcasts in England and California simultaneously, although having little effect anywhere else.

He had his machine readjusted, of course, the minute he found out what he was doing. The authorities told him what steps to take, and they in turn based their instructions on international radio standards.

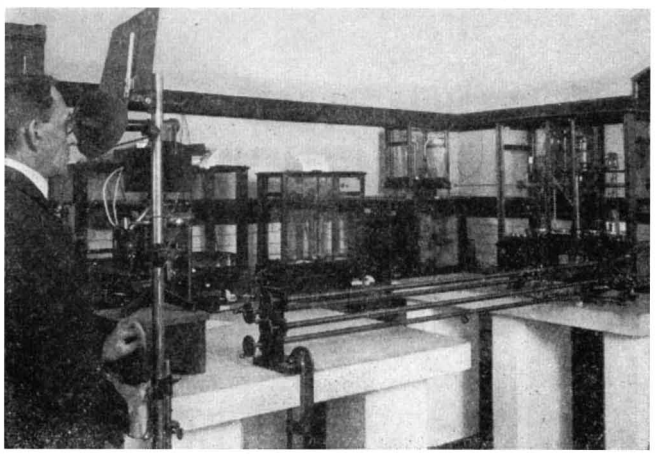
Problems like this caused scientists from all over the world to meet in New York a few weeks ago and do the spade-work for a brand new international standards body. They called themselves the "United Nations Standards Coördinating Committee" and they came from Australia, Belgium, Brazil, Canada, China, Denmark, France, Great Britain, Mexico, Netherlands, New Zealand, South Africa, and the United States.

Other nations will co-operate. There will be a formal organization meeting in London early in the spring, and then or soon thereafter the whole world will have to join in. There are too many problems which recognize no national boundaries, too many situations that will not wait, for any important nation to fail to recognize the importance of standards work.

Radio is just one example. Without agreed-upon international standards, radio broadcasting stations in any nation could be made so powerful that those in other lands all over the world would be jammed off the air. A little retaliation, and broadcasting would be at an end everywhere.

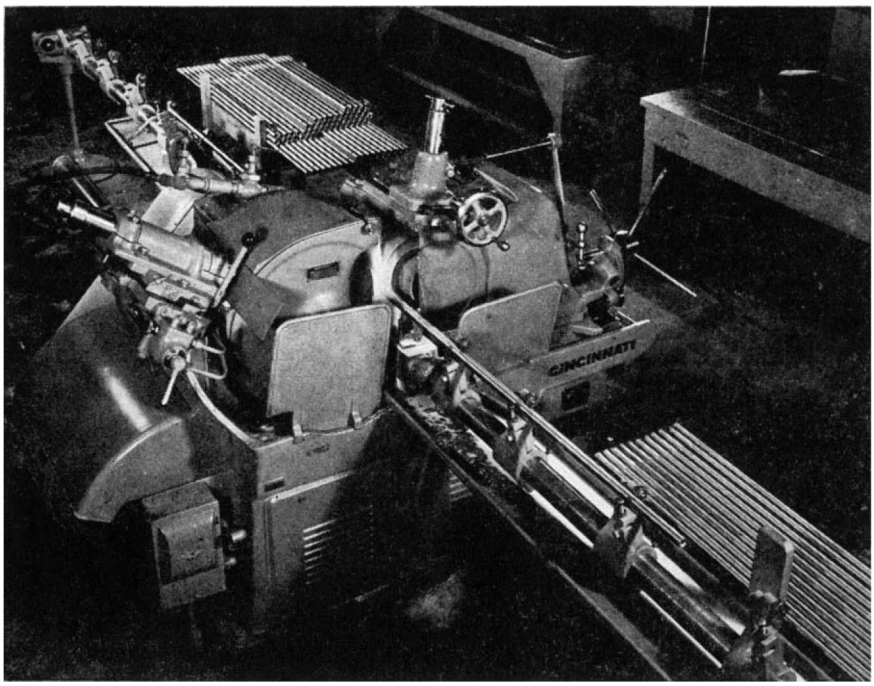
RADIO HEADACHES—The question is: Where are standards which have the force or the effect of law to begin and stop? The humble vacuum cleaner is an example of the problems which cause the standards makers to scratch their perplexed heads. There is many a radar device which could enormously increase the safety of aircraft if it were not for the fact that an old and worn vacuum cleaner running in some housewife's parlor could broadcast on a wavelength that would throw the plane completely off the beam. Passing a law to control the new cleaners and other small motors as they leave the manufacturers production line would be easy enough, but passing one to control the old ones would be political suicide for many a senator, especially if the ladies did not like his radio voice anyhow! And to be much good the law would have to be international; it at least would have to get over the borders into Canada and Mexico. Enough large cities are close enough to the borders of those two nations for their vacuum cleaners to misdirect our aircraft and for ours to draw theirs' off their intended routes.

Added to this problem are wide differences in national ideas about what standards should be enacted into laws. In the United States we try to trust the force of public opinion as much as possible, to enact standards into laws only as a last result. In England and plenty of other nations the standards are matters of legislation and become laws. But, it is whispered, England



Comparing two kilogram weights. The high precision balance is accurate within one part in one hundred million

Standard gages, accurate within one millionth of an inch, are used as masters to check shop's production gages



Although a few non-standard parts give this machine tool some special motions, hundreds of standard parts make up bulk of the machine and allow great versatility of use

allows her manufacturers the latitude of "shop customs" and her actual observance of standards is less than ours. And, it is retorted, our standards for the most part are only minimum ones, and we exceed them so continually that they are likely to be obsolete before they are passed. The arguments go on from there.

Two things make Americans the standards leaders of the world. The first is that standards increase versatility of product design rather than inhibit it. The second is that standards work has to be done slowly and open mindedly, with all attention concentrated on team work.

Americans did not invent the idea of standards. Not by the stones of King Solomon's temple, the short swords of the Roman soldiers, and the bluff British threads of Whitworth. But we have gone further with their use than anyone else. And we have learned that standards are to product design what fundamentals are to football or finger exercises are to a pianist. Get the fundamentals fully under control and the original ideas work perfectly. Ignore the fundamentals and everything costs too much.

Standardized parts in automobiles get the basic costs of the cars down so low that the designers have plenty of spread between those costs and the selling prices, and with that spread they can develop plenty of new ideas. A machine tool has a new and better control motion. Everybody studies that motion, knowing that the rest of the machine is made of standard parts and of materials tested by standard methods and that the new idea is supported by parts which are sure to function.

ONLY 800 STANDARDS—It is the standards, then, that make versatility possible at a price which the market can afford to pay. But, we have also learned, those standards have to be developed slowly. Sometimes, it seems, with exasperating slowness; our 33 years of really organized standards work under the American Standards Association have given us only a few more than 800 standards, including the wartime emergency ones.

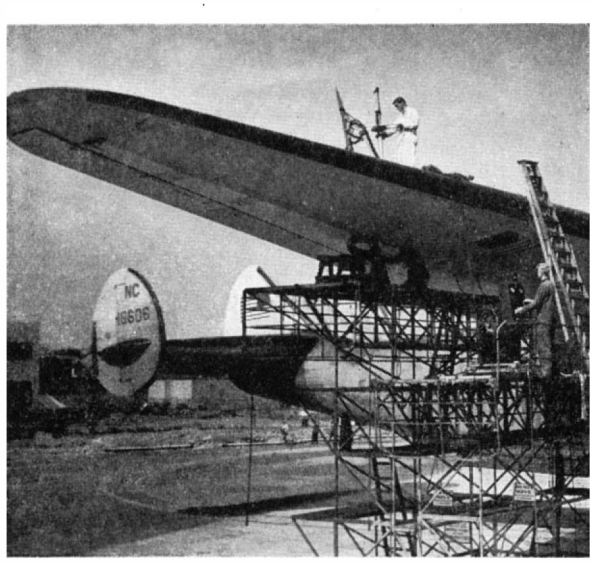
The making of an American Standard is a tedious business. Its formal study may take anywhere from one to six years, and if anyone wishes to look back far enough into the formal development he may find that that part took 16 or even 60 years to emerge into standard form.

First of all, something new has to be developed and be good enough so a great many begin making and using it. The taper method of holding drills and other tools would be a good example. With time the best taper angles begin to work their way to the top of the welter of conflicting ideas on the subject, and large numbers of manufacturers begin using ones which are very nearly alike. This is the informal stage of standards development.

After a while the manufacturers feel a need to agree among themselves so that anybody's shank will fit into anybody else's socket, thus saving everybody the cost of continually making shanks or sockets of special taper angles. Some of the larger makers get together with large users, perhaps under the auspices of an engineering society such as the American Society of Mechanical Engineers. The American Standards Association (ASA) is not a formal party to this, although it may supply advice and trained secretarial help. And thus the formal part of building a standard begins.

The meeting appoints a committee and the committee works out a satisfactory tentative standard. This is submitted to the ASA and the real formal part of standardization is under way.

The ASA does nothing but coördinate. But there is plenty of that to be done. The National Bureau of Standards may have highly scientific ideas on the subject. Labor unions have a voice in standard after standard; their members may have their jobs and skills affected. The National Safety Council is called in; the new standard must promote safety. The air forces, the navy, and the army are important; the stand-



Circles on the ground are safety standards. No one may go within these circles when X-ray (on wing) is being used for structural inspection

ard must be workable for devices in the air, afloat, and ashore. Large users are asked to vote; they may have big and costly inventories of tools or parts that will be affected by a new standard.

The standard has to be complete. A recent experience with wooden poles is an example of what can happen to an incomplete standard.

Courtesy New Departure Division, General Motors Corporation

Ball bearing sizes are controlled by international standardization

This one was laid down for the minimum sizes for specific strengths of poles made of the woods commonly used for this purpose. Poles of the same sizes but inferior strength woods began coming onto the market. The standard had to be revised to cover wide varieties of wood so the user could buy his poles by standard strength figures and not by size alone. This added greatly to the versatility of forest products; timber men could sell poles of woods that buyers had not previously used and could prove their values by citing the standards. But it all took time.

NEW IDEAS—Out of the chaos of conflicting opinions new ideas emerge. These are discussed with one interested party after another. The standard begins to take formal shape, often on wider and much more complete lines. The final vote is taken, and a new American Standard emerges. It often covers hundreds of items and their details may occupy more printed pages than the average shop manual. But, few items or many, it always carries the authority of agreement among highly influential parties and it always is worth following.

Some matters are progressing too rapidly for this procedure to keep up. Cylindrical fits of parts used in the automobile and aircrafts industries is one of them. For some 30 years these industries have been trying to work out standards which could be used and understood alike by all assembly lines, parts makers, repair men, and designers. But every time a new rod or sleeve comes along with new differences in thermal expansions, abilities to lubricate, and likelihoods of wear, the cylindrical fits usages of some manufacturer or manufacturers change. Everybody sees the need for a new standard on cylindrical fits, but so many are unsure about just what to do that nobody is accomplishing anything.

In other cases standards studies are being forced by desperate situations. Men who work around highly radio-active devices may be sterilized if proper safety standards precautions are not worked out, or the men themselves may be able to procreate but their sons be born sterile. The wide spread use of the X-ray in industry, the rapid increase in the use of devices exuding noxious fumes, are other examples of situations requiring heroic measures.

Consumers' standards are being built around the "one hoss shay" idea. Rubber soled sneakers not only will be true to their size numbers, but the standard types will be so designed that the soles will wear out almost exactly as fast as the uppers instead of one part wearing out while the other still is good.

FROM ALL NATIONS—All of this work is going to be taken abroad now, tested, and widened by the ideas of men from all the other nations, and brought back to give the whole world a better standard of living. Nobody knows how much world-wide coördination can be done by just talking things over. But standards do not depend upon talk. Standards are like great ground swells of industrial and public opinion which break up old customs and allow the building of better ones. World-wide industry has learned that without standards there is little versatility and without versatility there is little industry.

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PLATING TANKS

Can Now be Protected With Colored Coatings

ONE TROUBLE which electroplaters have always experienced is the dark colors of most of the coatings with which the exteriors and interiors of their tanks have been protected.

Such coatings must resist temperatures up to 160 degrees, Fahrenheit, in the presence of strong caustics and of such acids as hydrochloric, sulfuric, phosphoric, and chromic. Finding coatings which will stand up for reasonable lengths of time has been problem enough without also worrying about their colors.

Now, coatings can be had in various bright colors and with highly superior resistances to the chemicals. The colors will dress up the plating room, make adequate lighting easier to achieve, permit the readier use of color codes to identify tanks and their purposes and dangers, afford color contrasts with various kinds of platings and solutions so the operators can more readily judge the qualities of the work they are turning out. The new coatings do not stain under the action of the plating chemicals, they can be scrubbed clean with clear water, and their color advantages are easy to maintain.

LIFT TRUCKS

Serve Admirably as Special Tools

A FEW pieces of structural steel, a few hours of welding, and many a lift truck can be made into a time-saving, special-purpose tool.

Modified and amplified lift trucks are handling cable reels, dies for setting up presses, heavy forgings for mounting in lathes, rolls of paper for printing presses, barrels of oil for filling the sumps of large machines, tanks of chemicals for loading process vats, lengths of pipe or shafting for installation, precast concrete shapes for placing, and so on.

In most cases, the special equipment is permanently attached to the lift truck. But there are a surprising number of occasions on which the special device is "false work," to be used only once and then dismantled. The false work may be of lumber; it is extremely handy when installing power transmission shafting and other cumbersome equipment overhead.

A special purpose lift truck applied to handling large reels of cables

The practice of using partly worn lift trucks as special purpose tools will increase as more and more of them are retired from their present duties.

Motorless Flight

Towed Gliders, Proved in Military Uses, Are Now the Subject of Intensive Study for Future Commercial Uses. Special Jet Motors can Help to Get Them off the Ground. But the Greatest Competitor of the Cargo Glider is the Developing Type of Cargo Plane Itself

By ALEXANDER KLEMIN

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

GLIDERS did very well during the war and served the Allies in a new method of warfare but will gliders and gliding have any importance or significance in peace? The Motorless Flight Conference, recently held at the Polytechnic Institute of Brooklyn under the auspices of the Soaring Society of America, gave answers to this question, indicated the remarkable range of activities in which the glider is concerned, and also brought to light some interesting devices and ideas.

Thus, when Howard Burr, of Schweizer Aircraft, discussed the use of a shoulder harness for glider pilots and passengers, he dealt with a topic which concerns safety in all aviation, powered as well as motorless. However well designed aircraft may become and however skilful pilots may be, there will always be crashes and head-on landings. In the case of a crash landing, the five major sources of injury are due to structural collapse, the location of the instrument panel in front of the pilot, the back of the front seat in a two seater tandem airplane, belt failures, and striking the control wheel.

When the airplane crashes on landing, a high value of forward acceleration is created. Even though the body is held in the seat by the lap safety belt, the upper part of the body and the head may be thrown forward and serious injuries or death be the result. The dangers attendant on crash landings when the lap belt is used have been confirmed by many studies.

On the other hand, when the shoulder harness has been employed, in experiments where the pilot was exposed to a forward acceleration of 8 G (which simply means eight times the ordinary force of gravity acting in a forward direction on the body and spells 1600 pounds for a two hundred pound man) no injury and hardly any discomfort followed. Shoulder harness has frequently been used in England and Germany. There are disadvantages in the shoulder harness: more webbing and more hardware are required, and the shoulder harness is harder to fasten. But it should most certainly pass from the experimental stage to serve in gliders and in airplanes which are at all likely to be subjected to dangerous crash conditions. It is also probable that the use of shoulder harness in sailplanes will be the spear-head of more extensive use.

A towed glider leaves the ground; elastic tow line absorbs the initial shock

TOW LINES—A paper presented by Captain R. S. Barnaby, of the Philadelphia Navy Yard, on "Gliding's Contribution to the War and Vice Versa," dealt particularly with nylon tow lines connecting towed gliders and "tug" planes. This amazing material is light and strong, has a surprising amount of stretch, and, because of its slow return or hysteresis, has the ability to absorb shock without causing surge. No wonder nylon has had to leave stockings to take up war duty! A good tow line is essential in straight flying. But the best of tow lines will not take care of blind flying, or flying at night when the glider pilot cannot see the towing airplane. Nor is the tow line primarily designed to correct for gusts nor to transmit signals for banking or turning. Hence there have been perfected automatic pilots which keep the glider in a constant position with reference to the tug. The actual character of the device has not been revealed as yet, but readers can use their imagination constructively.

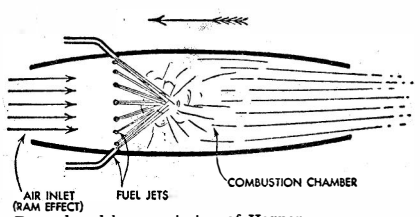
Some of Captain Barnaby's philosophy regarding "trailplanes" is as follows:

"It is easy now to cite how towed aircraft was a natural and logical development—how man had learned

early in his civilization that he could drag more than he could carry, to cite the horse drawing a wagon versus the pack-horse, the tug-boat with its tow, the auto-trailer, and, of course, the most startling example of all—the modern freight train . . . but the more I tried to draw analogies, the more confused I became. Afloat, tows are common for short hauls, but for long hauls the large single-unit ship is more common. On the road the auto-trailer is used principally for long hauls, the single unit truck for short hauls. The railroad uses the train whether the haul be long or short." Obviously, analogies are difficult to draw when considering aerial flight.

It will certainly be agreed that the glider exponents have much on which to base their hopes for a bright glider future, but the most important question discussed at the Conference concerned what the cargo glider can do in commercial operation?"

CARGO GLIDERS—To begin with, the cargo glider can help establish air transportation in China and in other regions where railways are almost non-existent and where the whole industrial future of the country is tied up with air operations.



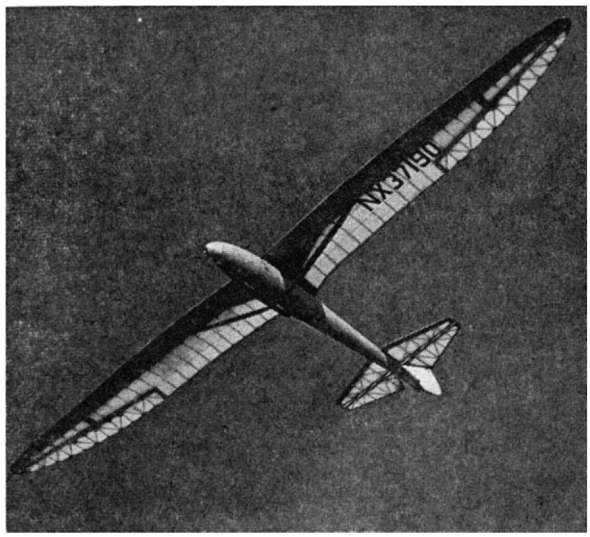
Reproduced by permission of Harper and Brothers from Pendray's "The Coming Age of Rocket Power"

The athodyd, a simple reaction type motor that may aid glider launching

Major A. E. Blomquist, of Eastern Airlines, reported that all China's essential services could be operated with a hundred large transports; that trunk line airports, within reach of cities and rivers, are available; and that the glider train would bring the benefits of air travel and cargo to hundreds of Chinese communities that are now without airports.

Major Blomquist is hopeful of the future of glider trains in China, if these trains are coupled with pick-up and delivery gear. Here is his splendid definition of the proposed service: The gliders would be designed with flight characteristics that would permit their landing in very small fields and in rough terrain. A plane like the Douglas DC-3 would be perfectly suitable for the tug; the DC-3 has been thoroughly tested in tow service. The gear for picking up gliders up to 16,000 pounds in weight has been developed and tested. The pick-up gear for snatching 8000-pound gliders has been in the field for some time and its potentialities have been fully realized. The same gear can be used for dead-weight pick-up.

After pick up, the glider gains altitude quickly. Note clean aerodynamic design of this glider



Automatic delivery gear has been developed for use with the DC-3's. This gear permits parachute packs to be loaded prior to flight or in flight and to be dropped accurately by simply throwing a switch in the pilot's cabin or cargo cabin. The DC-3's would operate from a central point on a daily schedule, deliver mail and parcels to points on a given circuit, and do the same in pick-up.

Major Blomquist's conclusions in regard to China are not likely to be questioned. But there is much more scepticism to be encountered as regards the use of the towed glider in the United States. Thus John W. Laister, of Laister-Kaufman Glider Company, in his paper "The Development of the Cargo Glider and the Practical Post-War Outlook for It," suggested some special uses which seem quite likely. In his opinion, gliders could be used immediately in *specialized* applications. The Forestry Department, for example, could use towed gliders in fighting forest fires and in moving men and equipment to danger areas. Fires appear in unpredictable places, where the airplane itself could not possibly land. The moving of mining and oil-well equipment into inaccessible areas would be another ideal application for the glider.

A frequent argument for the sky train is that, because of the enormous freight load which it can carry, the cost per ton mile will be very low. There seems to be an error here, because the cost per ton mile will probably be lower for the properly designed cargo plane than for any possible sky-train combination. The sky train will be much slower; costs in aviation go down as the speed increases—at least for many items such as pilot's pay, insurance, depreciation, and so on. And this factor holds good despite the enormous cargo-carrying capacity of the sky train.

Richard H. Rush, of All-American Aviation, Inc., was more hopeful and more specific in regard to the sky train. For a cargo glider of ten-tons payload capacity, the lowest possible operating cost will be ten cents a ton mile. Rail express moves at an average rate of 9.2 cents a ton mile. Truck freight averages 5.5 cents a ton mile. Railroad freight in carload lots goes down to one cent a ton mile. So the cargo glider would not be too far out of line on costs. Perishables such as fruits could be very conveniently carried. Materials that have to be packed in very heavy wooden containers for rail shipment would need less handling by air than by rail and hence would be a potential air-cargo market. Refrigerated freight is very well suited to cargo glider service. While Mr. Rush is hopeful about the future of air cargo via gliders, he also concedes that the cargo plane itself is the most formidable competitor of the towed glider.

ASSISTED GLIDERS—The "athodyd" is one of the most intriguing possibilities for increasing cargo-glider use. Thus Zygmunt Fonberg termed his paper "The Athodyd as a Velocity Transformer" and gave an actual demonstration of this plausible device as a means of launching gliders in a simple manner. The device is a "ram jet motor." The motor which was demonstrated was nine inches long and two and a quarter inches in diameter, and contained no valves or moving parts. It consisted of a small cylindrical pipe, which appeared to be empty. The lining of the tube tapered from an inch and an eighth in diameter at the front

end, to a large end of two and a quarter inches, in the fashion of a cone. The space on either side of the lining and the outer wall contained the fuel, which ran into a nozzle at the forward opening of the cylinder. Air rams into the cone, and mixes with the fuel coming through the small holes of the nozzle during combustion. According to Mr. Fonberg, an engine 40 inches long by 9 inches in diameter would be sufficient to launch a glider. The question arises of how efficient in producing thrust an engine would be which depends only on the ram of the air for its compression, particularly at slow launching speeds. But, in view of the German V-1 and V-2, jet engines, ram engines, and all Athodyds are deserving of careful study.

Gliding and soaring are usually thought of as sports which are conducted only in fair and clear weather. But Bob Taylor, of Schweizer Aircraft Corporation, discussed "Blind Flying" in some detail. Apparently it is perfectly possible to fly a glider "blind" in clouds, for example. Unfortunately, clouds are not yet equipped with radio beams, but Mr. Taylor gave convincing arguments for the possibility of flying blind and soaring to great heights—provided the pilot is suitably trained for blind flying, and provided that he has at his disposal such aids as a sensitive altimeter, gyro bank and turn indicator, compass, oxygen equipment, and so on.

Another thought injected into the proceedings of the Motorless Flight Conference, by William Schweizer, was that gliders should be designed for mass production so that they can be sold inexpensively. This would be in marked contrast to the slow, handicraft methods in vogue prior to the war!

Here, then, is the conclusion as to the future of the commercial glider: In countries with few airports, few railroads, and rough terrain, the sky train should be invaluable, with China as a splendid example. Aside from military uses, the towed glider will find special applications in the United States. Its use in sky trains, with the latest devices to help, is entirely feasible in transportation, in direct competition with other methods of freight transportation, but its greatest competitor will be found in the cargo-carrying airplane itself.

AVIATION POLICY

Stresses Obvious but Entirely Sound Points

SOME valuable recommendations were made in the recent report to NPA by William A. M. Burden, Assistant Secretary of Commerce for Air, and Chairman of the Aircraft Committee of the National Planning Association. They are entirely sound. They are also such as might have been expected. It is their very obviousness and inevitability which makes them all the more valuable.

Commerical and military aircraft manufacturing complement and help one another and should therefore both be encouraged, says Mr. Burden. Military aviation is *not* superseded by the atomic bomb, which becomes simply another element of air power. Military aviation should not be abandoned but should receive continued support in research in sufficient production of successful types for service test purposes, in continued aircraft planning, and in production maintained at such a level as to keep the industry ready for military needs. In civil aviation, Mr. Burden says that encouragement should be given to air transportation, domestic first class mail should be carried mainly by air, and that local inter-community services are to be encouraged. International air transport should be based on the principle of regulated competition, not monopoly.

AIR EDUCATION

Shows Rapid Advances In All Branches

A SURVEY of air education in the United States has been made by The Air Transport Association. Of course, the Association, like all trade associations, is optimistic of advances in its sphere. But making every possible allowance for over-enthusiasm, the situation still appears to be a brilliant one.

The survey points out that between five and six million persons have become air-minded through flight or ground service in the Army, Navy, or Marines. About 96 percent of colleges and universities in the United States recognize aeronautics as an elective science. At least 399 of the higher educational institutions have or will offer academic work in aviation and related fields. Half the pupils in 28,000 American secondary schools have access to aviation instruction.

More than $38,000,000 worth of surplus aircraft equipment has been turned over to non-profit schools throughout the United States since October 1944 in an AAF project and more obsolete equipment, aircraft instruments, engines, and complete aircraft will be made available to schools throughout the country.

MID-OCEAN AIRDROMES

Use Buoyant Cans to Support Landing Strip

A NEW BRITISH invention seems to remove all limitations on size of mid-ocean airports. The inventor is R. M. Hamilton who served as a Petty Officer in the Royal Naval Patrol Service. The invention is termed the "Lily" because of its resemblance to a carpet of lily leaves on a pond. It consists of numbers of buoyancy cans with hexagonal surfaces, so linked together that they "give" in a controlled manner to the motion of the sea from any direction. Yet these hexagonal surfaces, because they are put in tension when linked together, or create their own tension—as it has been expressed in British reports—are rigid enough to uphold heavy aircraft.

A 520-foot-long "Lily," undulating with waves caused by a passing boat

The surface of the landing strip is so flexible that it will not break up, but this flexibility is controlled by under-water dampers. It is necessary to apply more than three tons pressure to move the surface at all, and the inventor claims that "Lily" will remain usable in waves up to 36 feet from crest to crest.

This latest development opens up two possibilities: placing of an ocean seadrome anywhere, and the construction of immensely long bridges. J. S. Herbert, the mathematician who helped the inventor in his calculations, speaks calmly of a 22-mile bridge across the English channel!

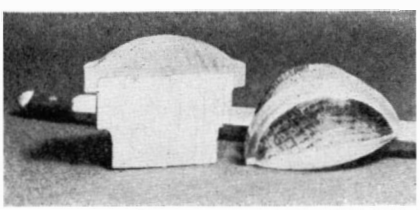
Frictional Heat

Welding, Bonding, and Molding of Plastics is Speeded by a New and Simple Process That Will Greatly Extend the Utility of these Materials in Many Applications. By Use of Friction, Plastics can be Permanently Bonded to Wood, Glass, Metals, Ceramics, and Other Non-Plastics

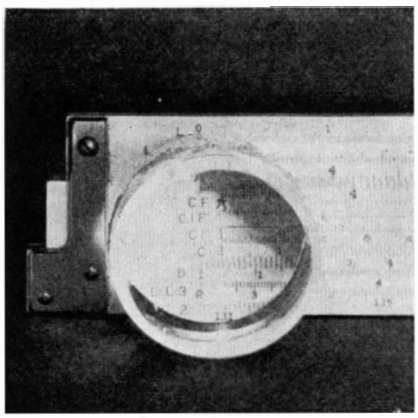
By CHARLES A. BRESKIN
Editor, *Modern Plastics*

LITTLE by little the new plastics materials and processes worked out during the war are coming to light. One of the latest processes to be released from the blanket of war-time censorship involves the use of friction—and the resulting heat—in welding like thermoplastics, in bonding thermoplastics and solid non-softening materials, and in localized molding of thermoplastics. Details of this development were presented at a recent meeting of the Society of the Plastics Industry by Robert N. Freres, mechanical engineer of the Rochester Button Company, the company responsible for this new use of frictional heat.

WELDING—There are several advantages to welding thermoplastic parts by this method. One of the most important is that the part welded in this manner possesses a tensile strength approximately that of the solid material; furthermore, light transmission qualities, in the case of transparent pieces, are practically unimpaired by the weld. Then, too, the weld line is remarkably clean and the slight amount of brittle flash is easily removed by buffing or tumbling. This contrasts with the hot-plate method of welding plastics, where a heavy flash is formed that must be ground off.



Frictional heat can also be used to bond thermoplastics to non-plastics materials. This knob cross-section shows a secure bond between a methyl-methacrylate top and a wooden base

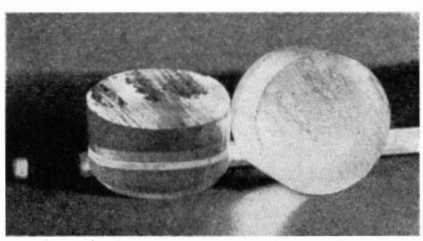


After the two pieces shown at right are welded together, the composite part is as clear as the original rod

In its simplest form, friction welding of thermoplastics means generating heat at the surface by rubbing two plastics parts together and applying pressure. Because of the high speed—6000 revolutions per minute for a one-inch diameter methyl methacrylate rod—a welding temperature is reached very rapidly. The absence of air at the heated surfaces prevents heat losses, decomposition, burning, contamination, and bubbles. The fact that most thermoplastic materials are relatively poor heat conductors also acts to prevent the surface heat from being dissipated.

When the required temperature is reached, the thermoplastic material becomes soft and takes on the characteristics of a lubricant, lowering the frictional resistance. Usually the correct welding temperature is assumed to have been achieved when the softened material begins to flow from between the hot surfaces. This displacement of material carries with it any oil, dirt, or other contamination which may have been on the surface. Thus, two pieces of acrylic cut with a hack saw can be welded together to form a clear and homogeneous part, the original rough sawed surfaces having disappeared as the material reached the welding temperature.

Pressure as well as sufficient heat is needed to bring the heated surfaces into intimate contact. However, both the heat and the pressure are applied in the same machine, pressures of about 300 pounds per square inch being applied for a few seconds.



Two pieces of rough-cut thermoplastic rod prior to friction welding

As yet not all thermoplastic materials presently being manufactured and marketed have been tested in friction-welding, but every thermoplastic material submitted to Rochester Button Company has been successfully welded. Dissimilar thermoplastic combinations, such as polystyrene-to-acrylics, have not yet been welded but only a few such materials have been tested up to the present time.

If the materials are of the same chemical composition, there is no difficulty in obtaining a weld. Any combination of compression molded, injection molded, or cast parts can be used. Similar materials, but of

	Solid rod	Friction weld	Cemented
Tensile strength, p.s.i.	7500	7200	4170
Charpy impact strength, ft. lb./in. of notch	6.9	6.1 outer section of rod 4.8 inside section	3.1 2.1
Light transmission, total visible illuminant "C"	92.4	92.3	92.2

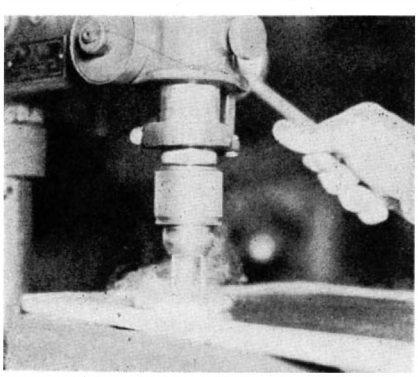
Comparative physical properties of welded and cemented joints in plastics

different colors, have a clean line of demarcation when welded together. Multi-colored parts can thus be fabricated into a homogeneous structure.

Comparative tests have been made of cemented and friction-welded methyl methacrylate butt joints. The results obtained by a leading supplier, shown in the accompanying table, indicate the improvement in physical properties when welding is used.

EQUIPMENT NEEDED—Most plants are equipped with the machines required for friction welding. For example, circular parts can be welded in a drill press or lathe. Irregular shapes, however, require a reciprocating motion. A circular part is chucked in a drill press and rotated against the stationary part until the materials begins to flow and smoke at the weld line. The power is then released and downward pressure applied to the spindle. A few seconds after the motion has stopped the weld is at full strength.

The reciprocating or oscillating motion necessary for irregular-shaped articles that cannot be rotated is imparted by vibrating air cylinders, the oscillation of an ec-



Thermoplastic rods and tubes can be welded in a drill press, the pressure being applied by the spindle

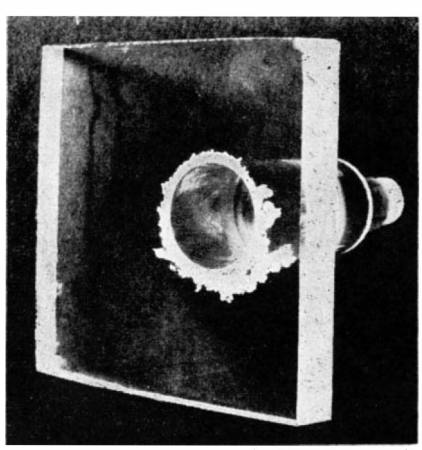
centric, or other means. Even should a certain area not receive its share of the rubbing force, this will automatically be corrected. As the remaining area becomes heated and lubricated by the hot semi-liquid plastics, the normal pressure is increased on the cooler surfaces, thus increasing the frictional heat.

There are many applications for this type of welding. Take optical lenses, for example. A lens of this type is often composed of several polished parts. When glass is replaced by accurate compression-molded plastics, the problem of cementing may present difficulties. On the other hand, plastics lenses have been friction-welded together in close alignment to form a transparent homogeneous whole. The operation does not affect the delicate lens surfaces because only the weld area is heated. Assembling is no longer a bottleneck; the parts are welded faster than they can be molded.

Containers that must be filled completely with liquid, excluding all air bubbles, can be welded closed while submerged in the liquid. The quality of the weld does not suffer even though the operation takes place in a liquid, and inflammable liquids can be used in spite of the high welding temperature because there is no air present for combustion.

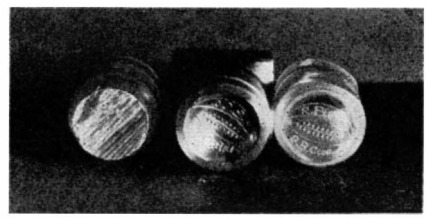
BONDING—The second use of frictional heat in plastics fabrication is in the bonding of composite structures. In this way a decorative plastics knob can be bonded to a wooden handle merely by rotating the knob against the wood until the plastics flows, and then applying pressure. Being under intense frictional heat, the plastics becomes a hydraulic fluid under pressure and transmits its pressure in all directions.

This process is particularly good



Friction welds have good transparency; the light flash is easily removed

where undercuts are involved. A hot thermoplastic, obeying the laws of a fluid under pressure, will flow into the undercuts and produce a strong mechanical bond. Should it be necessary, for example, to permanently fasten a nylon rod to one of acrylic, this could be achieved by bonding a common brass tube to the rods. The tube should have suitable underouts, such as knurling, grooves, or notches. As it is rotated against the plastics at high speeds, the brass tube cuts its way in. When the rotation is stopped, pressure is applied, forcing material into the undercuts. The plastics, with tube bonded into it, can then be ro-



Localized molding of thermoplastics is successfully accomplished by use of frictional heat. The rough surface of the plastics (left) takes a perfect, clean impression (right) of the metal die shown in the center

tated against the second member to produce a strong permanent bond. The brass cuts its own path under frictional heat. This is not the same as forcing a hot piece of brass with undercuts into the plastic. With friction the displaced material has an opportunity to escape, producing a condition that reduces stress at the insert.

By using this principle of flowing a plastics into an undercut, any thermoplastic material can be bonded to wood, glass, steel, or ceramics, to suggest but a few of the non-plastics materials that can be thus combined with plastics.

MOLDING—The third application of frictional heating involves localized molding. In one example, a cast rod which is cut to three-foot lengths, requires a complex molded surface on the ends, but machining, polishing, and buffing would be expensive. By rotating the required mold at high speed against the rod, it is possible to mold the ends locally in a few seconds to a high polish. Heat is supplied only by friction on the surface. When rotation is stopped, the cooling cycle begins, accompanied by a pressure of only 100 to 200 pounds per square inch. The cooling is rapid since only surface heat is to be removed. When a large amount of material is to be removed, a heavy tool which is a good heat conductor should be used. Many useful applications can be

found for this localized molding process, especially in the fabrication of sheets and rods.

It would thus appear that friction, usually a factor to be combated in most machining operations, may prove helpful to manufacturers contemplating the use of plastics—particularly plastics combined with other materials.

PLASTICS DISHES

Expedite Handling of Food on Quantity Bases

SPECIALLY designed plastics dishes —17 different items in all—have been introduced recently by Devine Foods, Inc. for the serving, storing, and delivery of either hot or cold foods on a quantity basis to hospitals, hotels, railroads, factories, and

Plastics compartment tray and several of the new plastics dishes with lids

so on. The entire line includes a coffee cup with handle, a cup without handle, a saucer, a coffee-cup cover, a creamer, a mixer cup, a tumbler, cafeteria tray, compartment tray, covered dishes with capacities of one half pint, one pint, one quart, two quarts, and four quarts, and a food container complete with two one-gallon dishes. Except for the cafeteria tray and the food container housing, which are molded of a Durez phenolic material, all the wares are of Melmac. The selection of this last material for all but two items—and these the ones not in direct contact with food —was the result of a long period of experimentation.

The test work was carried out, for the most part, on the food container —the first items developed by this company. Experiments were conducted with a number of different plastics compounds, and the results led to a decision to mold all dishes from melamine since this plastics is completely odorless and tasteless and, therefore, has no effect upon food. In addition, it is easy to keep clean; the smooth surface of the moldings can be quickly washed in boiling water and requires no scouring or polishing.

Since handling problems bulk large in most establishments where these products are used, the company departed from tradition in its design for many of these plastics dishes. The cup is molded with straight, slightly slanting sides and a wide border around the drinking edge which has a thicker wall than the rest of the cup. The handle, too, is changed—flattened at the top and lined up with the top of the cup body. By virtue of this design the cups nest one within the other, and when stacked there is no tottering tower with handles slanting in all directions.

Even when filled, these cups can be stacked. The covers are grooved on the underside to fit the drinking edge. On the top is a raised section that matches the shape of the bottom of the cups. Thus, a cup may be filled with coffee, the cover put in position and another cup placed firmly on top of this cover. The Melmac serving dishes and covers are similarly designed—and for the same purpose.

PLASTICS COMPASS

Is Economical to Make, Easy to Use

A REMARKABLE example of the way in which plastics can be used in a precision instrument while the price remains under the two-dollar mark is a wrist compass developed, molded, and assembled by DePage Plastics Company and marketed by Harold S. Schwartz and Associates.

Featured as an ideal gift for Boy and Girl Scouts and for hunters, campers, and sailing enthusiasts, the compass design is based on the dial-type liquid compasses that were produced by DePage for the Army Air Corps during the war. The instrument weighs approximately one ounce and consists of three Tenite II or Lumarith parts—the case (which is made of either red, white,

The complete plastics compass and, at lower left, its component parts

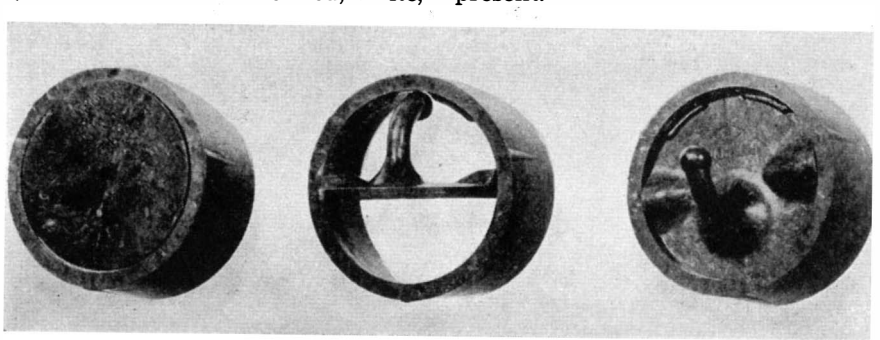
or black plastics material), the dial, and the window.

Directions for using the instrument are simple. The phrase "You are looking" is stamped on the edge of each plastics base just underneath the white line that extends halfway across the transparent window. To find his directions, the user of the compass need only face this white line while holding the instrument in a level position so that the directional dial revolves easily within the liquid case. In almost no time the dial will stop. The direction in which the wearer is facing will appear at the white line.

CLOTHES HOOK

Turns to Disappear Into the Wall

ONE problem of unsightly fixtures has been solved by the New Plastic Corporation, with the development of the Nupla hook which is molded of Beetle or any all-purpose phenolic molding material. This part is so designed that the center section supporting the hook turns inside the circular housing. Thus the hook can be made to disappear into the wall with but the light touch of a finger. This development is applicable to closets, doors, and automobiles. The resistance of the plastic material to the effects of humidity makes the hook ideal for use in laundries and bathrooms where steam is apt to be present.



A disappearing clothes hook made of plastics

Story of Hydroforming

Research Engineers in Efforts to Improve the Engine Performance of Low-Grade Gasoline Discovered an Inexpensive and Unlimited Source of Toluene and Other Aromatic Compounds. Useful in War, They are Also Raw Materials From Which Many Industrial Products are Manufactured

By LUTHER HILL
Director, Process Engineering Department, The M. W. Kellogg Company

THOSE gasoline fractions which are commonly referred to as naphthas and which have low octane numbers, have long been a problem to oil refiners. Such fractions have various molecular structures, but in general the normal straight-chain paraffinic hydrocarbons and a group called naphthenes characterized by a saturated ring configuration predominate. Both of these types have low octane ratings and produce knock when used as engine fuel.

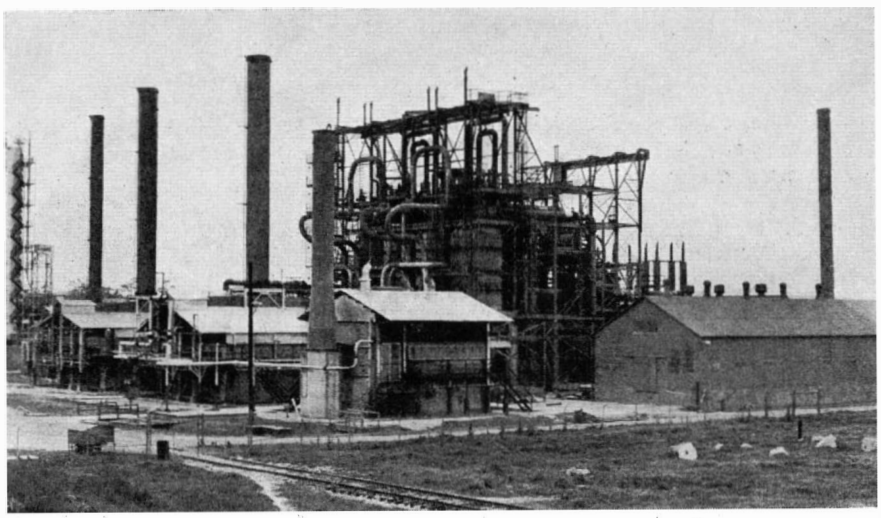
Some years ago the petroleum refining industry became interested in the use of catalysts to achieve chemical transformation of these and other petroleum hydrocarbons. Research engineers knew that those hydrocarbons known as "aromatics" had an unusually high octane rating. The molecular structures of these aromatics are characterized by a hexagonal ring of six carbon atoms, well known in chemistry as the benzene ring. Therefore a search was begun for a suitable catalyst and treatment to increase the octane rating of low-grade gasolines by transforming straight-chain and naphthenic petroleum molecules into aromatic ones.

One of the pioneers in this work was the M. W. Kellogg Company, in whose laboratories initial tests were carried out literally on a half-pint scale. A number of small units were set up consisting of catalyst containers through which oil vapors could be passed and from which the resulting product could be withdrawn. Hundreds of catalysts and dozens of oil stocks were tested under various temperatures, pressures, and atmospheres. Natural or straight-run gasolines, with an octane rating of from 20 to 50 and containing practically no aromatics, were used in these initial tests. Types of gasoline from leading American petroleum producing fields were included. In the course of the tests, successively better catalysts were developed. The researchers eventually determined that a mineral known as molybdenum oxide, when dispersed in activated alumina and used as a catalyst in an atmosphere of hydrogen under certain temperatures and pressures, altered the molecular structure of the low-grade gasoline molecules most effectively. This new catalyst changed about 50 percent of the molecules into benzene-ringed or aromatic molecules. Tests showed that the octane rating of many low-grade gasolines was almost doubled by the catalytic treatment.

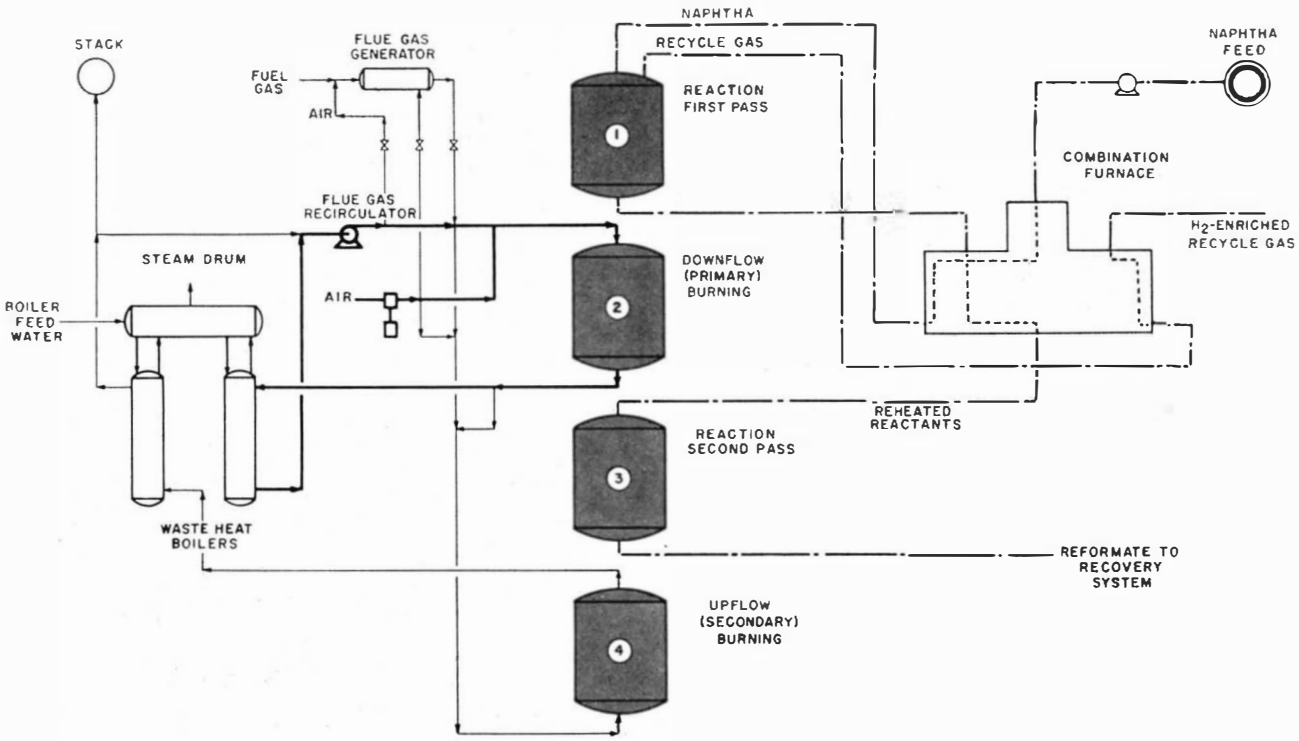
Because this reforming reaction (technically called dehydrocyclization), took place in an atmosphere of hydrogen, the term "Hydroforming" was coined for the newly discovered process. The liquid product, which contained over 50 percent by volume of high-octane aromatics, was termed "Hydroformate."

AVIATION GAS—Development advanced swiftly through the laboratory to the pilot-plant stage, with four major oil companies contributing technical data. These companies were Shell Oil Company, Standard Oil Company (Indiana), Standard Oil Company of New Jersey, and Pan-American Refining Corporation. By 1939 the process was ready for commercial application. Designed and constructed for Pan-American by the Kellogg company, primarily for gasoline production, the first commercial unit went "on steam" in 1940.

It was found that, in addition to increasing the octane rating of the low grade gasoline, Hydroforming had three other advantages. First, it had the effect of desulfurizing naphthas almost completely, a feature which not only removed a corrosive element from the resulting motor gasoline but also enhanced the susceptibility of the product to "leading." Second, because the product contained almost no olefins or hydrogen-deficient compounds, it was unusually stable, and could be blended directly into finished gasoline. This stability, which minimizes formation of gum in the engine, is one of the most important properties required of a high-grade motor fuel; it is the gum resulting from fuel combustion which, among other

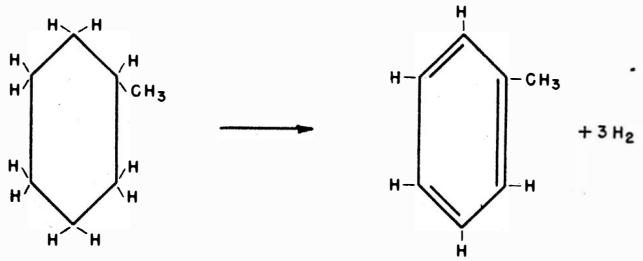


Hydroforming unit of the Humble Oil and Refining Company

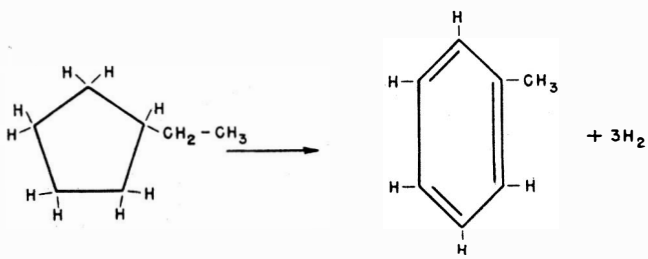


Simplified Flow Diagram of The Hydroforming Process: Low grade gasoline or naphtha feed is heated to reaction temperatures, first by heat exchange with the products and then by a furnace. At the entrance to the reactor the hot vapor is joined by recycle gas which may contain 40 to 80 percent by volume of hydrogen, depending on the feed stock, catalyst, and conditions of operation. The combined stream passes through one of the reactors (1) where the catalyst is disposed and where dehydrogenation and partial conversion takes place. Reaction products are then reheated and pass through a second stage (3) where some cyclization and hydrogenation occurs. Products are then cooled and condensed and the gas is separated from the liquid. Some of this gas is recirculated while the remainder is released as necessary to maintain the desired pressure on the system. The liquid product is stabilized by removing the lighter hydrocarbons and further fractionated to eliminate a small percentage of high-boiling polymers.

In spite of the fact that coke formation is quite small it is necessary to regenerate the catalyst at regular intervals. To permit continuous operation, four reactors are provided, two of which (2 and 4) are regenerating while the other two (1 and 3) are on reaction. Regeneration of the catalyst is accomplished by burning off the accumulated carbon by means of air diluted with spent regeneration gas.



An example of dehydrogenation occurring in the Hydroforming reaction. The ringed molecule at the left is methyl cyclohexane, a typical naphthenic hydrocarbon of low octane rating. Toluene, at the right, is obtained by knocking off hydrogen atoms to produce an aromatic hydrocarbon



Another naphthenic hydrocarbon, ethyl cyclopentane, is pictured at the left. In Hydroforming to produce toluene (at the right), not only does dehydrogenation occur but the carbon atoms are rearranged so that a six-membered hydrocarbon ring is obtained from a five-membered ring

things, causes valves to stick, piston rings to clog, carburetors to plug, and which impairs the efficiency of other parts. Third, it provides, as a by-product, a gas which is rich in hydrogen. Hydrogen is expected to be an important raw material in many future operations as, for example, the production of ammonia from air and the preparation of cooking fats from fish oils.

Hydroforming, by changing the molecular structure of low-grade gasolines, guaranteed our war-time airplanes and those of our Allies vast quantities of high-octane gasoline, far superior to any in use by the enemy, and at reasonable cost.

TOLUENE—The story of Hydroforming is an outstanding example of how research in one field not only accomplished its initial purpose but also uncovered a second important field.

In routine analysis of the high-octane Hydroformate, chemists discovered that the product contained from 15 to 25 percent of toluene by volume. By using selected petroleum fractions as feed material, the toluene yield could be maintained close to the maximum, that is about a quart of toluene could be obtained from a gallon of gasoline. Crude petroleum contains on the average about 0.5 percent toluene.

Toluene, used commercially for the manufacture of TNT (trinitrotoluene), the major high explosive for bombs, shells, and mines, had heretofore been obtained as a by-product of the coke industry. In normal times, coke-oven toluene had been ample for the requirements of the solvents, synthetic dye, and explosives industries, but after Pearl Harbor that source hadn't a ghost

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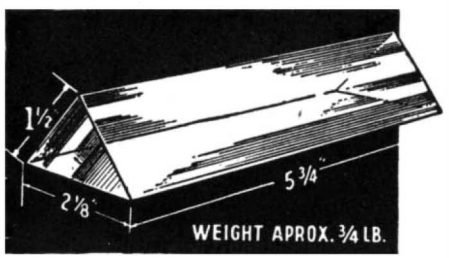

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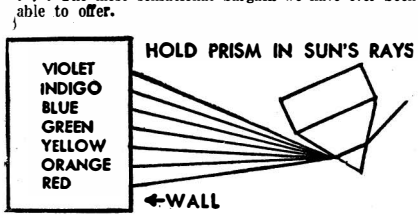

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of a chance to keep pace with the tremendous amounts of military toluene required. Being a by-product of coke-oven operation, toluene production was geared to the steel industry's demand for coke. More coke-ovens wouldn't solve the problem, even forgetting the cost, because less than half a gallon of toluene can be produced from a ton of coal.

Since approximately one quart of toluene can be produced from every gallon of Hydroformate, *two gallons of low grade gasoline could thus yield more toluene than a ton of coal.* It therefore became evident that one good-sized Hydroformer could supply more toluene than the entire American coke processing industry. The facts were clear and the Government acted promptly. The Ordnance Department in 1941 contracted for the construction at Baytown, Texas, of a large Hydroformer to be operated by the Humble Oil and Refining Company for the specific production of vitally needed toluene, with high-octane gasoline as a secondary consideration. This unit was the nation's first Hydroformer designed and constructed for toluene production.

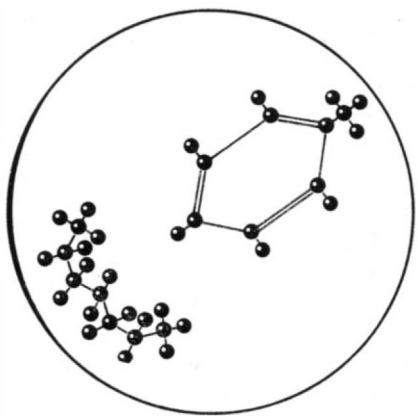
From that point on, the petroleum industry's total Hydroforming capacity rose rapidly. By 1944 eight Hydroforming plants were in operation with a total naphtha feed capacity of 21.7 million barrels yearly, capable of producing over five times as much toluene as the total production from all other sources. All of these plants were devoted primarily to toluene, though their contribution to the high-octane gasoline program amounted to hundreds of millions of gallons.

Certain straight run and natural gasoline fractions contain varying amounts of methyl cyclohexane, ethyl cyclopentane, and dimethyl cyclopentane, three members of the naphthenic group, whose molecules each contain seven carbon atoms, the same number as toluene. As indicated by the prefix "cyclo," these naphthenic molecules are characterized by a ring configuration and as a result contain two less hydrogen atoms than the straight-chain paraffinic molecules of the same number of carbon atoms. All are readily converted to toluene in the Hydroformer.

For commercial toluene production the naphtha is first prefractionated into a narrow-boiling "cut" (190 to 260 degrees, Fahrenheit), in which are concentrated all of the C-7's originally existing in the naphtha. During the war, most of the major oil refineries co-operated in the preparation of this "heart cut" and shipped concentrates to Hydroforming units scattered over the land.

The overall yield of toluene based on the naphthenic constituents of the concentrate is greater than 100 percent, showing that, in addition to quantitatively converting the naphthenes to toluene, the Hydroformer also converts some other part of the concentrate to toluene.

The toluene is separated in a recovery plant which is a separate unit from the Hydroformer. By an efficient system of heat exchange it is possible to provide all of the heat required to operate this plant by exhaust steam from the Hydroforming section, which contributes materially to the low cost of the resulting toluene.



These molecular models show how, in Hydroforming, a straight-chain hydrocarbon molecule having zero octane rating is converted to a ringed aromatic compound (toluene) by the action of a catalyst, high temperature, and pressure. The process is known as dehydrocyclization or cyclization

Another outstanding feature of the recovery unit is the unconventional method evolved by the Shell Development Company, of separating toluene from compounds close to it in boiling point. Ordinary distillation techniques would require a prohibitive amount of equipment to separate the toluene from its close-boiling neighbors. However, by the use of phenol, the volatility ratio of the toluene and non-toluene hydrocarbons is changed so that their separation can be effected with an economical set-up. The phenol leaves the processing column with the toluene and is separated by ordinary distillation in another column from which it is returned to the original column.

It must not be forgotten that the Hydroforming process is a flexible one. If, for example, high-grade motor fuel instead of toluene is the desired end product, the naphtha, without any preliminary treatment, is fed directly into the catalytic reactors. A clear, stable, 80-plus octane fuel containing over 50-percent aromatics is then obtained which is very susceptible to leading; the addition of only one cubic centimeter of tetraethyl lead per gallon of this Hydroformed gasoline gives a five-point increase in octane rating.

In addition, Hydroforming has attractive possibilities for use in the preparation of basic materials for many chemical industries. By altering the Hydroformer feed to include primarily those compounds having only six carbon atoms, benzene may be produced; by using molecules of eight carbon atoms, the production of xylenes and ethyl benzene is possible. From toluene and these other aromatic compounds can be manufactured such products as synthetic rubber chemicals; various plastics, including the styrenes; phenol and phthalic anhydride; medicinals such as saccharine and aspirin; paints, lacquers, and dyes; photographic developers; water-proof finishes for textiles; linoleum; dry cleaning chemicals; glues and cements; ink; artificial leather; perfumes; insecticides; preservatives for canning; paper sizing chemicals; resins; and many other products. The result is that Hydroforming gives more complete integration to the refiner and producer of crude oil. Not only can they now get "the last squeal out of the pig" by producing more gasoline and a greater number of useful products from a barrel of crude oil but the supply of petroleum is thereby conserved. Certainly the process offers attractive applications in industry by proving that crude oil is the most prolific and versatile raw material for the rapidly expanding chemical industry.

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GAS STATIONS

Will Feel Effects of Research

SERVICE stations of the future will be built along strictly functional lines, and will market a far wider variety of merchandise than most stations have ever marketed before, according to the Shell Oil Company, Inc.

The new stations, as visualized by Shell, will be a product of more than two years of research and study on the part of marketing experts and service station dealers, working with industrial designers and guided by public preference as ascertained in a survey of 180,000 motorists.

Now—MATCH THEIR BEST WITH YOUR MOST IN THE VICTORY LOAN!

Top off your good work on your Payroll Savings Plan with an outstanding showing in the Victory Loan—our last all-out effort!

Help bring our boys back to the homes for which they fought—and give our wounded heroes the best of medical care—by backing the Victory Loan! You know your quota! You also know by past war-loan experience that your personal effort and plant solicitation are required to make your quota.

Sell the New F. D. Roosevelt Memorial $200 Bond through your PAYROLL SAVINGS PLAN!

In rallies, interdepartmental contests, and solicitations, promote the new Franklin Delano Roosevelt Memorial $200 Bond! Better than "cash in hand," Victory Bonds enable the buyers to build for the future—assure a needed nest egg for old age.

Keep on giving YOUR MOST to the Victory Loan! All Bond payroll deductions during November and December will be credited to your quota. Every Victory Bond is a "Thank You" to our battle-weary men overseas—also a definite aid in making their dreams of home come true! Get behind the Victory Loan to promote peacetime prosperity for our returning veterans, your nation, your employees—and your own industry!

The Treasury Department acknowledges with appreciation the publication of this message by

Scientific American

VICTORY LOAN

This is an official U. S. Treasury advertisement prepared under auspices of Treasury Department and War Advertising Council

Microwaves On The Way

Extremely Short Radio Waves Made Possible the War-Time Miracle of Radar. In Peace-Time, These Same Waves Will Bring New Impetus to Television as Well as to Radio Telephony, Telegraphy, and Facsimile. Microwave Beams Can Change Our Whole Communications Pattern

By HARLAND MANCHESTER

Courtesy Radiation Laboratory, M.I.T.

How radar "sees" New York City and surrounding areas. Rivers and docks are plainly discerned. At time photo was taken, the plane was directly over the dot in the center of the circle. Distance is indicated by the concentric rings around center

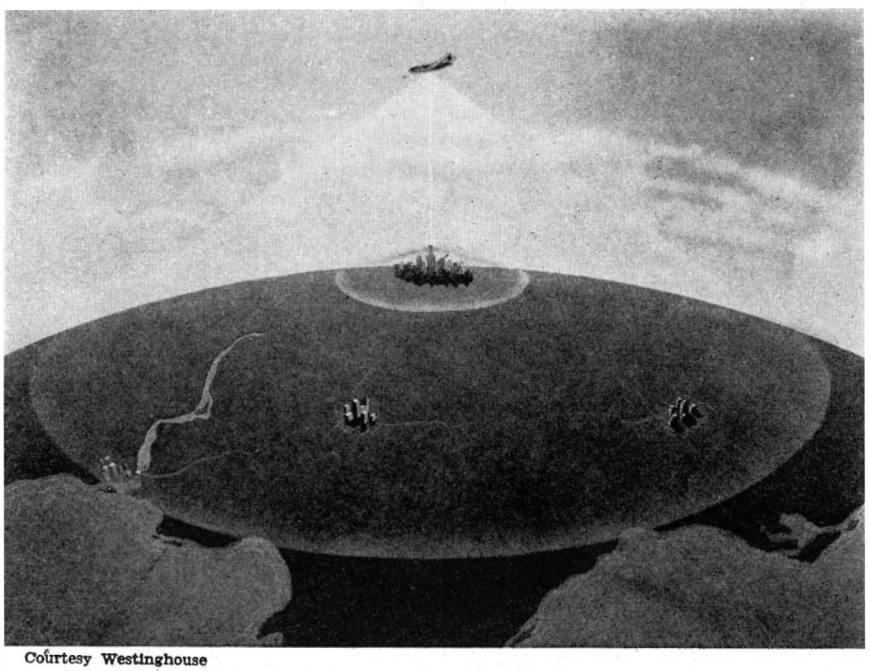
ONE NIGHT during the final days of the campaign in Germany a young fighter pilot, lost in celestial soup and nearly out of gas, radioed an appeal for help. An operator at a newly captured airfield picked up his plea.

"We've got some new radar here," he said. "Just follow directions and I think I can bring you in. You are now 800 feet up. Turn three degrees to the right and keep coming."

In a truck jammed with radar equipment and personnel, the operator watched a little blip of light on a graduated fluorescent screen. That blip indicated the position of the lost fighter plane. A slowly revolving dish-like antenna, mounted on the roof of the truck, was sweeping the sky with tiny invisible waves. With every revolution, some of them hit the lost plane and bounced back, making the blip on the radar screen which showed the plane's exact position. As the plane came closer, a second operator, watching the blip on a more finely scaled screen which showed details of the airfield, took up the coaching. Slowly the plane moved downward, until the roar of motors was heard outside. The plane had landed safely.

Then someone pounded on the door of the truck. It was the fighter pilot. "Show me this new radar!" he demanded. "I couldn't see the ground at all, just felt a bump."

This Ground Controlled Approach radar, which later at Iwo Jima "talked down" many crippled B-29s to safe landings, is only one of an array of revolutionary war-time radar devices based upon ultra-short radiations called microwaves. Behind the curtain of censorship during the war years, hundreds of American and British physicists have been pushing radio upstairs into these new high frequencies. Their work makes possible things that were unheard of at the time of Pearl Harbor.



Courtesy Westinghouse

Airplane television relay stations may extend the horizon of microwaves

Some idea of the nature of microwaves may be obtained by comparing them with the waves which bring in your home radio programs. Suppose you are tuned to a 660-kilocycle station; when the crest of one wave reaches your receiving set, the next crest is more than a quarter of a mile away. But microwaves may be only a few inches long, with billions of vibrations a second instead of the mere hundreds of thousands in the broadcasting band. By means of these tiny waves, enemy planes have been sharply identified at distances of 200 miles. German rockets have been spotted and shot down by radar-directed guns, bombers have pin-pointed factories through cloud and mist,

warships have sunk enemy craft miles away in the dark, and even approaching thunderstorms have been detected hours before the first raindrop hit the roof of the radar building.

MULTIPLE USES—In peace-time, microwaves are slated for an even more spectacular career. Several networks, now being constructed to carry them, promise these amazing things: Private phone calls by the hundreds of thousands sent simultaneously over the same wave band without wires, poles, or cables. Towns where each citizen has his own radio frequency, over which he can get voice, music, and television, and call any phone in the country by dialing. Complete abolition of static and interference from electrical devices and from other stations. A hundred times as much "space on the air" as is now available in the commercial radio band. A high-definition and color television network to cover the country. And, perhaps most important of all, a nation-wide radar network, geared to television, to regulate all air traffic and furnish instantaneous visual weather reports to airfields throughout the land. By such a system, every aircraft over the United States or approaching it could be spotted, identified, and shown simultaneously on screens all the way from Pensacola to Seattle.

Not all these things will come at once, but war-time research has made them all possible and some will be here before we know it.

The nerve center of the great microwave development has been the Radiation Laboratory at Massachusetts Institute of Technology, established in November, 1940. From its war-time staff of 3800 scientists, engineers, and assistants—estimated to include about 20 percent of the nation's top-ranking physicists—came most of the fabulous electronic eyes which enabled the United Nations to outpoint the Axis on land and sea.

Radar was in its crude pioneering stage when this laboratory began work. Scientific explorers knew that tiny radio waves in that part of the spectrum near visible light had curious traits of behavior. They cannot ordinarily travel beyond the horizon, as can the waves from a commercial broadcasting station. Since they are near the spectrum's band of visible light, they behave somewhat like light. Microwaves are stopped and reflected by solid objects, and when a mountain or building stands in the path of their beam, a "radio shadow" is cast by the obstacle. They will not follow

an open wire in the transmitting station, but have to be sent through pipes. And while broadcasting waves travel in all directions from the antenna and can be directed only to a limited extent, microwaves can be bunched by a parabolic reflector and sent out in a sharp beam like that of a searchlight. Microwave communication is practically free from static, because the long waves of both natural and man-made static disturbances are literally tuned out.

MAGNETRONS — The tremendous possibilities of microwaves have long been recognized, but equipment

An antenna installation for the pulse time modulation multiplex radio relay system developed by the Federal Telephone and Radio Corporation as a new method of handling microwaves

to make use of them was lacking. The radio world was waiting for a new kind of tube which would generate waves no longer than a cigarette, that could be beamed powerfully over great distances. The answer came with the "magnetron," a deceptively simple-looking device which must be ranked among the greatest of war-time inventions.

This metal gadget, in some sizes small enough to fit the palm of the hand, was developed by physicists at the University of Birmingham in England, after other nations had failed in attempts to perfect a similar tube. One of these tubes was brought to this country early in the war.

In the hands of Radiation Laboratory's corps of scientific shock troops, working with engineers of the Bell Telephone Laboratories and other firms, the magnetron soon became the heart of modern radar. The exact manner in which the magnetron does its job can be described only in the language of higher physics but its most significant feature is a series of keyhole-shaped cavities in the metal collar which surrounds its source of power. A stream of electrons, shooting past these holes, sets up high-frequency vibrations, something like the way air blown through a whistle with a small cavity creates shrill, high-pitched sound waves. These tubes produce waves as short as one inch, which can be accurately directed in a narrow, pencil-like beam. They generate short pulses of energy at the rate of 2400 horsepower —about half that of a steam locomotive.

Nearly all the radar devices which shortened the war and saved lives by the tens of thousands depended upon these powerfully beamed microwaves. This mighty but supersensitive tool brought new uses. For instance, when Dr. Donald Kerr, of the Radiation Laboratory, was testing a radar set on the roof, in March, 1942, he got "nuisance echoes" in the form of vague, fluffy images on the screen which could not have been caused by planes or other solid objects. Kerr was convinced that these images indicated rain-filled thundercluods, and he told the Army Air Forces about it. Airmen proved his theory by personal visits to the anticipated thunderstorms, and soon the Army was using microwave radar to spot oncoming storms in Panama and the Pacific. A new aid had been discovered for safer air travel.

Months before peace came, several of the country's biggest communications and electrical manufacturing firms had applied to the Federal Communications Commission for permission to set up relay networks to transmit television, static-less radio telephone, facsimile, air-safety data, and anything else that can be heard or seen at a distance. Several such networks are now being built by various companies and there is a land rush for suitable mountaintops where the line-of-sight beams can be picked up and bounced along to the next relay station.

MICROWAVE REVOLUTION—The first leg of a proposed nation-wide all-purpose microwave system, linking New York and Boston, is now being completed by the Raytheon Manufacturing Company. Between the two cities six hilltop relay towers are being erected, some 35 miles apart. Microwave beams, like the rays of a searchlight, travel farther from a high elevation, because of the earth's curvature. Ultimately Raytheon hopes to grid the country with microwave networks to serve all the big population centers and many rural areas with new communication facilities.

Further evidence of the coming microwave revolution is Western Union's announcement that the familiar telegraph pole will eventually be banished from the American landscape. The company's experimental relay network between New York and Philadelphia, using waves about three inches long, can transmit as many as 1280 telegrams simultaneously, and Western Union plans to extend the system over the entire country, making obsolete much of its 2,300,000 miles of wire and underground cable. This project should make possible great savings to the consumer.

Microwaves up to a certain frequency can also be sent through electrical "pipes" under the ground. For several years the American Telephone and Telegraph Company has been working on a system of underground long-distance coaxial cables, through which waves are guided which are much too short to travel along an exposed wire. Through these cables hundreds of simultaneous phone calls, as well as present-day television, FM radio, and other services can be sent. Now A. T. & T. is extending the system to connect the East Coast with Los Angeles, via Atlanta, Dallas, and Phoenix. But the super high frequencies cannot be sent efficiently through coaxial cables and, since these cables are expensive and subject to damage, A. T. & T. is also heading for the hills and is building a microwave relay network between New York and Boston in order to make comparative tests of the two methods of transmission.

Meanwhile, Westinghouse Electric Corporation and the Glenn L. Martin Company have come forward with the most startling project of all. Put television relay stations in high-flying planes, they say, and spray the country with programs picked up by a vertical beam from the ground studio. The best that most microwave broadcasting stations can do is to feed receiving sets

Courtesy Radiation Laboratory, M.I.T.

A laboratory technician struggles with one of the thousands of technical problems which required solution before microwave radar worked well

within a radius of 50 miles. But if a slow-flying plane carrying television and FM transmitting equipment, circles lazily six miles up, it could serve an area of 103,000 square miles. Such a plane over Chicago, for instance, could cover large sections of Michigan, Wisconsin, Iowa, Illinois, Indiana, and Ohio. And if television and FM radio come from the sky, people who live in valleys and near big buildings will not have to worry about shadows or echoes.

All projected microwave systems so far discussed are limited in scope to a single land mass. But how about television across the sea? The International Business Machines Corporation and the General Electric Company, working with the Goodyear Tire and Rubber Company, makers of lighter-than-air craft, may have the answer. The three firms are experimenting with the possibility of placing unmanned dirigibles, controlled by land radar stations, in the stratosphere over the Atlantic to serve as relay stations for microwave fare.

Walter S. Lemmon, I.B.M. executive, predicts that nationwide microwave relays will bring many boons to business. Here's one glimpse: Today, business and professional men by the thousands are making tedious trips to distant cities for conferences which often last no more than an hour. Tomorrow, with television screen in every conference room, groups can confer face to face thousands of miles apart, examine documents, swap stories, and strike bargains. Savings: time, money, sleep.

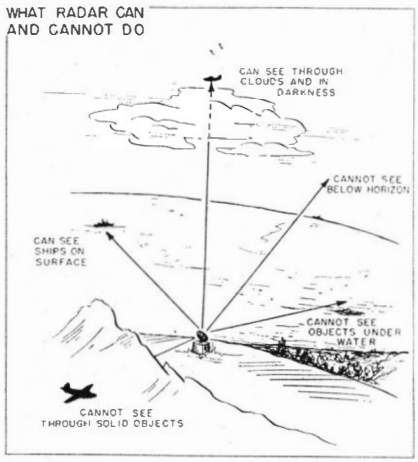
PULSE TIME MODULATION—Another new method of handling microwaves, called Pulse Time Modulation, will have to be reckoned with. At its first public demonstration, 24 newspaper men entered 24 phone booths and put in calls. Their combined conversations, piped to a "dish" antenna on the roof, were hurled through the air in scrambled form on the same waveband over an 80-mile microwave relay network and back to an adjoining series of phone booths, where other visitors took part in clear intelligible two-way conversations. This amazing performance was made possible by a new tube called the Cyclophon, in which a kind of electronic switch revolves around terminals from each of the 24 phones, dipping into each conversation and snatching a sample 8000 times a second. These bits of sound, electronically numbered and tagged, are sent over the air and unscrambled and arranged in the correct order at the other end. The gaps are much too brief to be noticed by the human ear.

Any number of calls up to 250 can be handled by a system of this type, and with enough relay stations the "package" of conversations can travel 3000 miles as easily as 80. Musical programs require more "samplings" to insure high fidelity, but PTM, as it is called, can transmit a dozen or more programs in the same package. This means that a single station could broadcast all the radio programs in most American cities, with a great saving of equipment. The home receiving set, tuned to a single wavelength, would have a new kind of selector to obtain the various programs. PTM also makes it possible to send television and its sound accompaniment on the same wave band.

STILL "EXPERIMENTAL"—At the insistence of the Federal Communications Commission, all microwave networks now being built are labelled "experimental," but success seems already assured. Data obtained in another year or so may be sufficient to guide the commission in setting rates and allocating spheres of activity. Independent experts, surveying the many microwave projects under way, fear that without a coördinated program there will spring up a helter-skelter pattern of networks, like a dozen

railroad lines with tracks of different gages. A standard pattern is imperative as a national defense measure, asserts Dr. M. G. White, Princeton physicist who has been in charge of aircraft radar at Radiation Laboratory.

Another Pearl Harbor might be the last one, warns Dr. White, unless we have a nation-wide radar system connected with microwave relays. Both long-range "early



warning" sets and Ground Control Approach equipment are essential, he says, to spot all planes in the air, regulate traffic, predict storms, and assure safe landings in bad weather, and the microwave network is needed to flash television images of air traffic to a screen in the Pentagon Building in any future emergency. Such a system, he estimates, might cost $200,000,000 for equipment, and require an operating personnel of 75,000. Since national defense would be only one function of such a system, there are many ways to spread the cost. All the nation's communication — telephone, telegraph, television, radio, facsimile, and whatever else the mind of man can learn to send by radio waves— could be easily handled by such a system, with the various domains parceled out to private corporations.

However the goal is reached, it is inevitable that within a few years the country will be laced with microwave beams, with incalculable effects on our habits and ways of livelihood.

ELECTRONIC VULCANIZER

Speeds Production of Many Rubber Units

FIRST commercial electronic vulcanizer is a mass production unit, a three-story device utilizing 125 kilowatts of electronic energy to service two complete Foamex mattress vulcanization chambers. It was designed by Firestone and Westinghouse engineers. In preliminary tests, large double-bed mattresses that previously required a 35-minute cure by the old steam jacket method, were completely cured by electronics in five minutes.

As in experimental laboratory tests, close examination of the full double-bed, electronic-cured mattress revealed that the final product was superior structurally to the old type. This is due largely to instantaneous heat supplied uniformly to all parts of the mattress as contrasted to the conventional steam-heated vulcanization of the foamed rubber slowly from the outside of the mattress to the interior. It was also revealed that the steam method cannot always be precisely controlled and that parts of a steam-cured mattress may be completed and other parts of the same product under-cured.

Electronic curing is being applied to the manufacture of other rubber products at Firestone. Large hard rubber wheels requiring five hours of curing by steam may be vulcanized electronically in 18 minutes; brake blocks are cured by electronic energy in 48 minutes that require seven full hours by steam.

FREEDOM OF RESEARCH

Essential to National Progress

DECLARING that "one of the greatest moral injuries Hitler did to the German nation was to suppress the freedom of fundamental research," Dr. Willis R. Whitney, founder of General Electric's Research Laboratory, said in a recent address that "for fundamental research, which is the most important kind, the scientists need a fifth freedom added to the Atlantic Charter—the freedom of scientific inquiry."

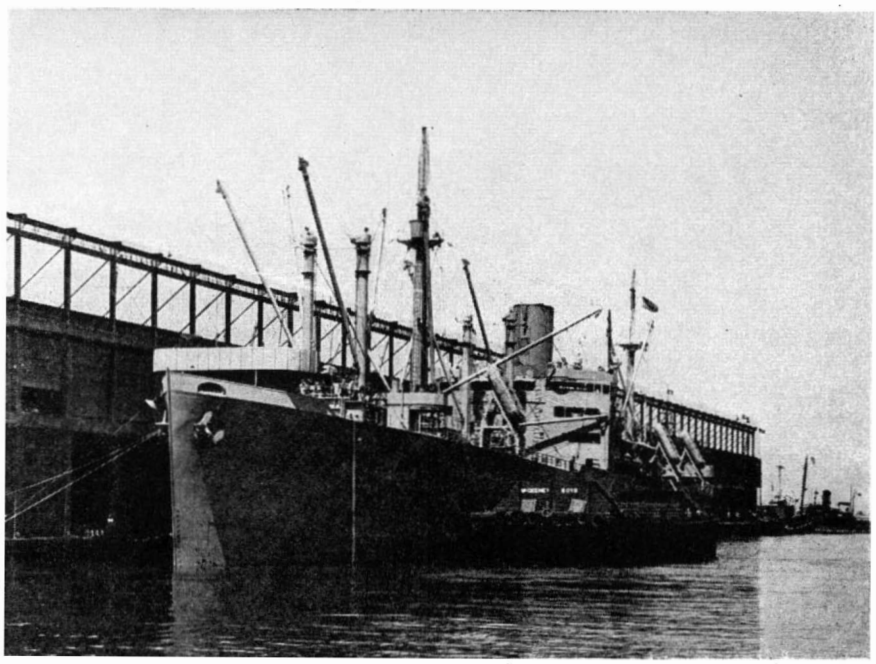
REFRIGERATED SHIPS

Can Carry Any Commodity Requiring Refrigeration

FIRST of five ships of the same design for which the American Export Lines has contracted with the United States Maritime Commission, the S. S. *Exchester* is of approximately 9900 deadweight tons, 473 feet in length overall, and has, in addition to more than 500,000 cubic feet of space for general cargo, approximately 30,000 cubic feet of space for refrigerated cargo. The vessels will be extremely speedy cargo ships, powered to provide a speed of 16½ knots; actual performance has shown that the *Exchester* can exceed this speed. All five are being built by the Bethlehem Steel Company; the refrigeration system is supplied by the Carrier Corporation.

The 30,000 cubic feet of refrigerated cargo space in the *Exchester* is divided into six compartments or "boxes," fitted with the proper insulation to permit the carriage of any commodity needing refrigeration, including all kinds of fresh fruits and fresh meats, having a controlled temperature ranging from 60 degrees, Fahrenheit, down to zero, Fahrenheit.

Refrigeration is provided by means of air cooling, which is supplied by six Carrier Freon-12 compressors, with one spare compressor as a standby. The system is so arranged that each compressor can be used on any cargo box.



United States Army Signal Corps photo of the refrigerated S. S. *Exchester*

Although these refrigerated cargo vessels were designed to be operated in military service of the government, they are built to meet the future requirements of American Export Lines in the company's trade routes to the Mediterranean, the Black Sea, and India.

PATTERNS

Eliminate Need for Elaborate Measurements

A NEW patterning process speeded aircraft and ship production and is expected to apply to many industries in the future. Template reproduction, the newest method of getting information from designer to machinist, may replace scale drawings and blueprints or other reproductions in which dimensions are indicated by figures. It is, in effect, a return to lofting practice used in ship building, where a full-size duplicate of the part to be made is used as a pattern.

With conventional methods there are four steps, each subject to human error, especially in reading dimensions: the engineer's rough design; the detailed layout, drawn to scale and dimensioned; the blueprint; and the full-scale layout made in the factory. With template reproduction the design engineer draws a full-scale pattern on a metal sheet coated with dull white lacquer. Details, including rivet holes, are shown, but only basic dimensions, such as the relation of wing to body in an airplane, are indicated by figures. From this point on, reproductions, all full-scale, are made by mechanical means.

Several methods are used to reproduce the original design on metal sheets which may be cut to form shop templates. In one common method, a glass plate coated with a photographic emulsion is placed against the design and a light is shone through it. After development, the design appears in white lines on a black background. The plate is then placed against a fresh metal sheet coated with the white lacquer and with photographic emulsion. This combination, exposed as in making an ordinary photographic contact print, reproduces the design in black on white on the metal sheet. In a similar method, phosphorescent lacquer pigments on the original design provide the light source, and the negative is a metal sheet. Another method uses two rooms as a camera; a lens in the partition focuses the design on a photosensitive metal sheet, which becomes the negative. Non-photographic methods, including offset lithography whereby an inked design is transferred to a rubber roller and thence to the duplicate metal sheet, are also used.

The metal templates go directly to the factory to be used as models. Jigs are also made directly from such templates without additional layout. One or more of these methods should be especially useful in the future to those industries engaged in manufacturing frequent new models from raw materials in sheet form.

The principal advantage of template reproduction is the reduction of human error after the original design is made. It has been estimated that templates can cut tooling time 60 percent. Assembly time can be reduced by making sub-assemblies of the templates to be used as models. Template reproduction costs little, and the entire process takes less than a half-hour. By comparing the finished part with the original template, the final inspector has a visual check and need not make elaborate measurements. Metal templates can also be sent to subcontractors.

Template reproduction is now being used in many phases of aircraft and ship manufacture, from engines to plastics turrets, and is expected to apply to automotive industries in the future. It has simplified the design

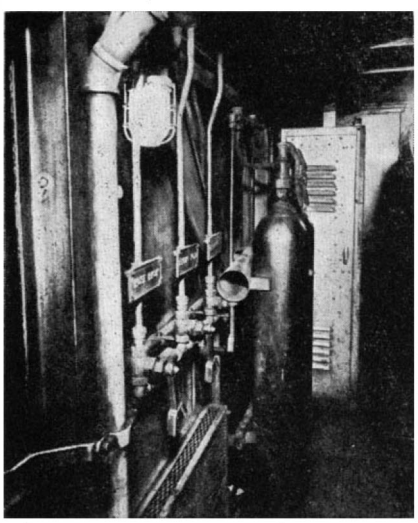
of new models of refrigerators and has been used or proposed for many other products and purposes from plastics lamps and candlesticks to home boat building.—*Industrial Bulletin* of Arthur D. Little, Inc.

EXTINGUISHERS-ON-RAILS

Safe-Guard Streamliners Against Fires

FIRES on Diesel-electric locomotives, that might be whipped to dangerous proportions in the winds caused by "streamliner" speeds, can be promptly detected and extinguished by new equipment installed on the engines that pull such famous Florida trains as the Silver Meteor, Sun Queen, and Palm Land for the Seaboard Air Line Railway. The equipment was developed by the C-O-Two Fire Equipment Company and the Pyrene Manufacturing Company.

The system turns a regular Diesel-electric locomotive into a veritable



Built-in carbon dioxide fire extinguishing equipment on a locomotive

"fire-engine-on-rails," since the apparatus automatically detects both smoldering and fast-burning fires underneath or inside the locomotive, and can kill fires inside the cab while traveling at high speeds or, when the train is stopped, extinguish flames under the train or along the right of way.

Fires over the engines are detected by a thermostatic system which turns on a red "fire alarm" light and sounds a gong. Electronic smoke-detecting apparatus, which it is claimed will function even while the train is traveling 100 miles an hour, reveals fires in the battery boxes or on the under side of the locomotive. Fires at these points result from accumulations of road dust, dry grass, and paper that becomes saturated with oil, and are set aflame by sparks from the brake shoes, and, since the flames are not visible to the crew, considerable damage may result unless some means of fire detection is provided.

In the engine compartment, fire is extinguished by means of a built-in carbon dioxide system which floods the endangered area with a dry, inert gas, which is a non-conductor of electricity and quickly smothers fire. For fires inside or underneath the engine, a carbon dioxide hose reel, hand extinguishers, and foam playpipes are provided. By a simple control, the playpipes may be used to discharge either high expansion mechanical foam for oil and gasoline fires or plain water for wood and brush fires. Oil or brush fires as far as 100 feet from the train along the right of way can be extinguished by means of the playpipes.

ENGINE STARTER

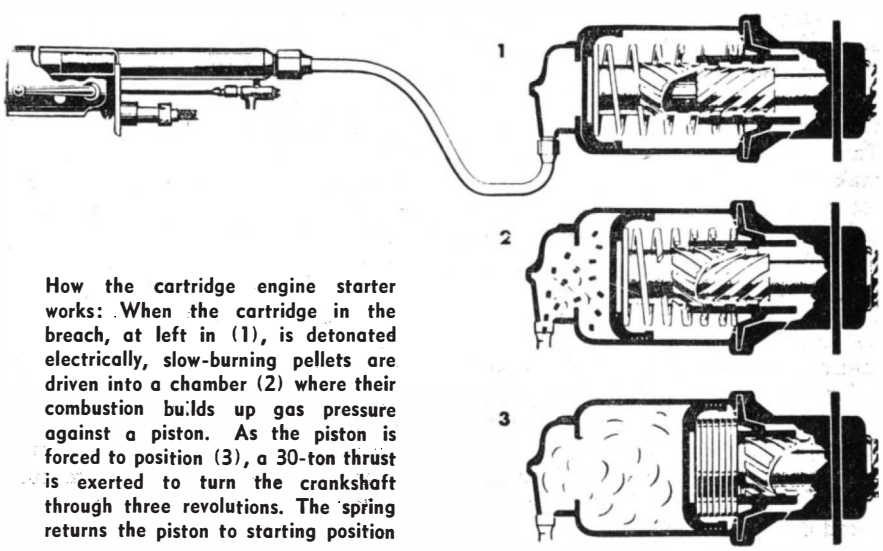
Uses Cartridge to Rotate Crankshaft

STARTING of aircraft engines has long been a source of trouble, especially with modern high-powered engines. Hence the development of the cartridge engine starter, manufactured by Breeze Corporations, Inc., under Coffman patents, has proved valuable to aviation in general. It is possible that this new engine starter will find further use on aircraft which use airports where battery-cart facilities are lacking.

The theory behind this simple engine-starting device is to use the energy of a fuel contained in a cartridge, placed in a specially designed breech mounted in the cockpit or under the cowling, to provide torque to turn the engine over at a speed sufficient for starting.

Its advantages are: (1) ample power, yet minimum torsional shock to the engine parts; (2) the pilot can start the engine quickly without the aid of ground mechanics; (3) no drain on storage batteries, thus enabling light-weight batteries to be used, which increases pay load; (4) since far less priming is required to start, engine life is increased. In operation, the cartridge is placed in the breech; then when electrical contact is made it ignites a quick-burning powder which in turn drives slow-burning pellets into the combustion chamber of the starter. As combustion proceeds it builds up gas pressure against the starter piston. The power stroke begins when the helical splines impart a rotary movement to the clutch jaws. The engine has made three revolutions by the time the power stroke of the starter is completed; a valve then opens and a helical spring returns the starter piston to its original position. A 30-ton thrust is converted to 180 revolutions per minute of the crankshaft.

It is readily apparent that this mechanism is subjected to high stress and shock in its main working parts, and hence must be built of strong and tough alloy steels. Since corrosion-resistance also is a consideration, stainless steel is specified for the cylinder forging, and for parts of the breech mechanism (which are forged and heat treated), for the tubing which connects the breech with the combustion cylinder, and for the more important gears and shafts which are heat treated to a Rockwell C hardness of 38/42.—*Nickel-Steel Topics.*



How the cartridge engine starter works: When the cartridge in the breach, at left in (1), is detonated electrically, slow-burning pellets are driven into a chamber (2) where their combustion builds up gas pressure against a piston. As the piston is forced to position (3), a 30-ton thrust is exerted to turn the crankshaft through three revolutions. The spring returns the piston to starting position

MILLED GLASS FIBERS

Improve Paper, Plastics, Abrasives, and Paint

RESEARCH now being conducted in the laboratories of Owens-Corning Fiberglas Corporation and in the laboratories of other manufacturers points to numerous uses of a new material—Fiberglas milled fibers—as a reinforcing agent for special papers, plastics, and abrasive com-

pounds. The milled fibers have also been employed successfully to improve the special characteristics of sound-deadening paints.

Fiberglas milled fibers are formed by hammermilling Fiberglas continuous yarns into maximum lengths ranging from one thirty-second of an inch to one and one-half inches. Diameter of the fibers, in all lengths, is 25 one-hundred-thousandths (0.00025) of an inch. Appearance of the fibers varies with the maximum fiber length. The shortest lengths are tightly nodulated, while the longest sizes form a loose mass.

The tear strength of explosive paper, used for wrapping dynamite, is materially increased by the addition of 10 percent, by weight, of three-quarter-inch milled fibers. The presence of the glass fibers provides a better bond between the paper and the paraffin used to coat it. Hinging action is minimized. Because dispersion of the glass fibers in the paper gives it more uniform strength, the paper disintegrates after the explosion, instead of leaving small pieces to smolder and perhaps to cause a fire.

Ten percent, by weight, of the milled fibers dispersed in filtering paper gives it more uniform capillarity and speeds the filtering process. The fibers act as veins which conduct moisture rapidly throughout the paper. Because of this characteristic, the same percentage of the fibers in laminating paper speeds impregnation by the resin and reduces curing time.

These milled fibers have been successfully incorporated in high-pressure resins (melamine) to form molded plastics switch boxes. Tests show that the product has increased impact strength, an arc resistance of 183 to 186 seconds of flash in contrast to from two to five seconds of flash when other fillers are used, and that when burned (A.S.T.M. test) there is a weight loss of only 3 percent as compared to the 30 percent weight loss when other fillers are incorporated in the resin. These improved characteristics indicate that the milled fibers are adaptable to many other applications in the high-pressure molded plastics field.

A 300 to 400 percent improvement in impact strength and generally longer life have been given phonograph records by replacing organic filler material with 3 percent, by weight, of the one-eighth-inch Fiberglas milled fibers. Record deterioration is frequently due to the presence of microscopic blisters in the sound track. Such blisters are attributable to swelling of organic filler material, caused by moisture absorption. Since the milled Fiberglas fibers are microscopically fine solid glass rods they can neither absorb moisture nor swell. No increase in the noise level is caused by the presence of the glass fibers.

Strength and performance of abrasive cutting wheels have been improved by incorporation of one-quarter-inch Fiberglas milled fibers in the abrasive grain (chopped silica, carborundum, and so on) which is mixed with a thermo-setting binder and molded into form. Addition of the milled fibers has increased by 25 percent the strength of 12-inch-diameter, one eighth-inch-thick wheels used to cut the bead off molded metal products. Top operating speed has been increased from 15,000 to 17,000 revolutions per minute. The heat generated is dissipated rapidly and less tendency to burn the metal is shown.

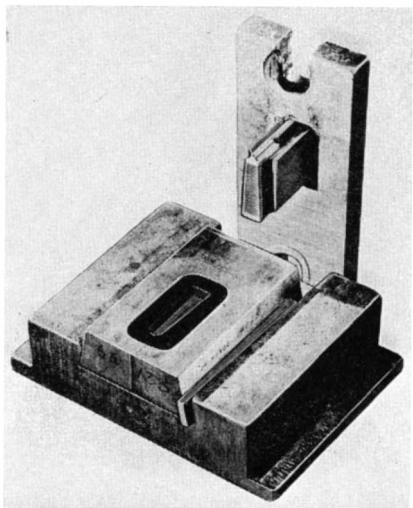
Fiberglas milled fibers ranging from one-sixteenth to one-thirty-second of an inch in length have been incorporated in sound-deadening paints, with a resulting improvement of 100 percent in sound deadening qualities. The paints, sprayed on metal surfaces, "de-ping" the metal by reducing the vibration. Their chief field of use is the automotive industry where they are applied to the interior metal surfaces of passenger cars and trucks.

New Products and Processes

DIE INSERTS

Of Sintered Carbide Have Long Life

BLANKING and forming dies that multiply by 10 to 1000 the number of pieces produced per grind, that save—in down time—from six to eight weeks' production per year, and that are expected to lower production costs on thousands of commodities, are now available to industry. Using inserts of Diecarb, sintered carbide combinations with a Rockwell hardness of from 65 to 73, tests have been underway in a diversified group of industrial plants for some time.



Long-life Diecarb punching die

The life of a Diecarb die has not yet been determined for the reason that each such die manufactured is still in use or in operating condition. The "breakdown" point, where regrinding becomes necessary, of blanking dies with sintered carbide inserts comes only after extremely long usage.

The Firth-Sterling Steel Company manufactures the Diecarb in four grades. In addition, the company is embarking on plans for an educational program to provide engineering assistance on the application of sintered carbides to die-making.

VAPOR TRAP

Salvages Cutting Oils or Coolants

COLLECTING vapor from oil or cutting fluids arising from cutting, grinding, and similar operations and returning it to the source of its supply is the job done by a new Dustkop recently announced by Aget-Detroit Company.

The new vapor collector is for use on virtually any type of high-speed production machine tools employing cutting oils or coolants. It employs a motor-driven multiple blade fan to provide suction to draw the vapor from the vicinity of the operator and the work. The vapor laden air is sent against the inside surface of spun glass filter material where the vapor condenses and is collected in a pan, the cleaned air being recirculated into the working space. This collected fluid is returned to the sump or reservoir of the machine tool through the faucet provided on the pan.

Installation is made with either ordinary sheet metal pipe or flexible metal hose of five-inch diameter which fits the inlet flange of the collector and can be located near the source of the vapor.

ELECTRICAL MICROMETER

Uses Frequency Modulation Principles for Extreme Precision

HAVING a precision never yet required by industry, an unusual type of electrical micrometer measures movements, or changes in position, as small as one-tenth of a millionth of an inch. It can measure rapid changes in position only one thousandth as large as the thickness of the printing ink on a newspaper, or about one fifty-thousandth the thickness of newsprint. It is so sensitive it can record changes much smaller than the wavelength of light, which is the standard used in calibrating it.

This new tool of science utilizes the principle of frequency modulation (FM) radio to measure the position of either slowly or rapidly moving objects without touching the object being measured. It was developed by Battelle Memorial Institute technologists as a research tool and has already been utilized in several important war investigations.

The first application of the new device at Battelle was to measure the errors in high precision lathe spindles used in machining aircraft motor parts. With it minute errors could be determined, and spindles designed on the basis of information given by the instrument have extreme precision.

The instrument is also the heart of an apparatus used for measuring and recording the changes in crystal structure when steel is heated rapidly, as in electric welding. This apparatus provides valuable help in assuring good service from welded structures, such as ships, bridges, and heavy industrial products.

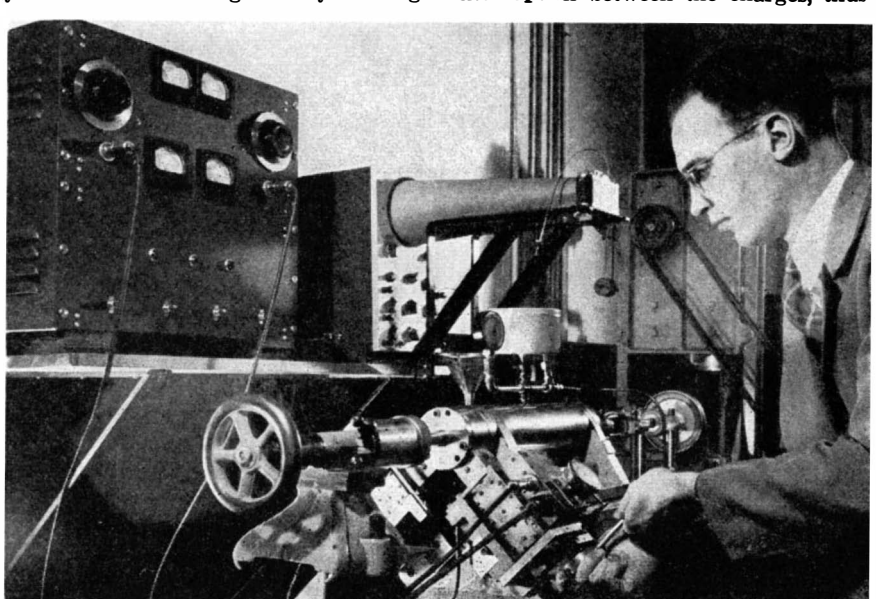
CENTRIFUGAL CASTING

Produces Parts of Virtually Pure Copper

COPPER parts for certain electrical apparatus can be cast centrifugally, obtaining a consistently better quality than would be possible with sand casting and reducing the amount of scrap per casting. Possibility of the occurrence of sand holes and blow holes inherent in the sand casting method is eliminated, and the centrifugal method provides a much denser metal.

As this method is applied at General Electric, the copper is brought up to a temperature of between 1200 and 1250 degrees, Centigrade, or 100 degrees higher than the temperature required for sand casting. Meanwhile, the runner box and die are heated with torches to a temperature of approximately 250 degrees, Centigrade.

After the drosses are skimmed from the surface, the molten copper is poured into the runner box, from which it flows into the spinning die. When more than one crucible is used, the opening between the runner box and die is plugged long enough to prevent any interruption between the charges, thus



Lathe-spindle precision is measured with the electrical micrometer

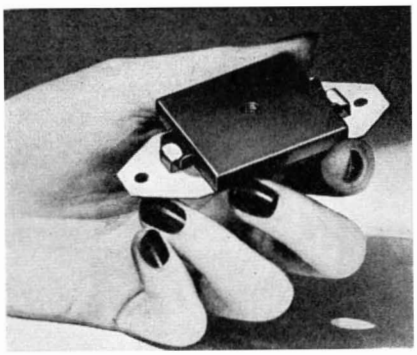
avoiding the possibility of a cold shot.

The die is kept spinning at about 300 revolutions per minute for two minutes. After the casting is removed, impurities remaining at the inside of the ring are removed by machining. The final result is a ring of virtually pure copper.

VIBRATION REDUCED

By Simple Mount That Handles Small Loads

A NEW light-duty mount which will handle loads as low as one pound, eliminates disturbing vibration and noise from small motors, typewriters, business machines, household appliances, and small power tools. It will also isolate delicate instruments, tables, desks, from external vibration. Known as Rexon Mounts and made by Hamil-



High vibration dampening properties

ton Kent Manufacturing Company, the mount design, a departure from conventional practice, combines the high vibration dampening properties of rubber loaded-in-shear, with the safety, durability, and ease of installation of a simple compression mount. With the average shear mount, loads must be carefully calculated as any overload may seriously damage the mount. With Rexon mounts it is reported that no overloading of the shear elements is possible.

UNIVERSAL ADHESIVE

Stems from a Family Of Synthetic Rubbers

DEVELOPED to meet a host of needs wherein an unusually strong and all-purpose adhesive is required, Pliobond, a "universal adhesive," can be applied either as a cold setting cement or under heat and pressure, depending on requirements.

Born in the Goodyear Research Laboratory, Pliobond is an entirely synthetic complex compound with resin-like properties, but also with rubber-like characteristics. It stems from a family of new elastomers, more commonly called synthetic rubbers, and has an amazing affinity for a very wide range of substances.

The new adhesive has already been successfully employed for bonding a variety of materials including metals, plastics, fabrics, ceramic ware, vulcanized rubber, paper, leather, glass, plaster, wood, and Portland cement concrete. It has also proved feasible

to bond, by use of Pliobond, any of these materials to each other. In many cases where Pliobond is used, the bond itself is stronger than the bonded materials, and it has the added advantages of being flexible, water-proof, and resistant to the actions of chemicals, hydrocarbons, and oils or greases.

Shock-resistant and shock-absorbing assemblies have become of increasing importance. Most of our means of transportation involve vibration, which is hard on adhesives and hard on delicate instruments as well as on human beings. Pliobond is reported to be outstanding in shock-resistance, and makes possible rapid assembly of shock-absorbing mountings.

In electronic equipment, there are many places where insulations must be bonded to metal. Pliobond has shown promise of solving some annoying problems in this field.

It produces bonds between fabrics stronger than the fabric itself and, because it is resistant to many chemicals, has shown promise in the assembly of work clothes, handbags, luggage, and other articles wherein fabrics and more rigid material are brought together.

Pliobond bonds metal to metal. It can be used to assemble quickly and accurately jigs and fixtures, because the bonding is simple, the heat is insufficient to cause warping of the metal, and, if necessary, the bond may be disassembled by suitable means that will not harm the assembly. In delicate equipment where riveting, soldering, or welding may be impossible or difficult, Pliobond should serve.

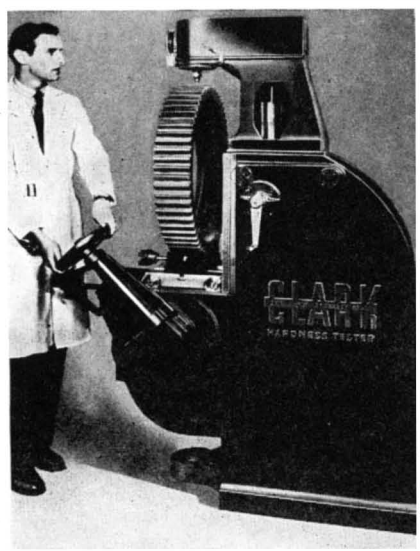
It is obvious that Pliobond can also be an outstanding repair material in shop and home, since it can be used to mend all sorts of flexible and rigid articles and combinations.

HARDNESS TESTER

Adaptable to Large or Small Pieces

GIVING a true "Rockwell" reading, with either a diamond or steel ball penetrator, a new hardness tester can handle parts ranging from ½ inch to 26 inches. The adjustable height table is supplemented by a movable capstan easily varied to match the table height. A roller bearing carriage on the table facilitates positioning of heavy parts.

Operating technique and readings for this Clark Hardness Tester are similar to the familiar "Rockwell" tester.

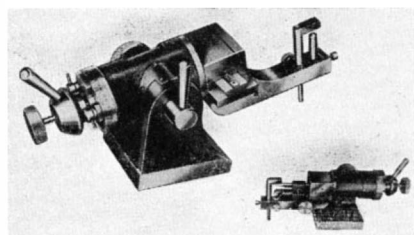


Testing hardness of a large gear

WHEEL DRESSER

Operates to Close Tolerances

AN ANGLE correcting radius dresser that provides complete wheel dressing service in which the operator can dress a radius, an angle, a compound-complex angle, and an angle tangent to a radius, in one operation is announced by the U. S. Tool and Manufacturing Company. When these four operations are performed the primary diamond holder position is used but provision has also been made for forming extremely small or large radii. For this work, an accessory is used which consists of a special diamond holder mounted in a secondary position.



Primary position of radius dresser, with secondary position for large or small radii shown at lower right

To make it practical to dress an angle tangent to a radius and the radius too, in one continuous operation, the dressing arm is provided with a calibrated rack adjustment. This makes the matching of radius and tangent a routine matter, with the diamond in either primary or secondary positions. If these jobs are done as separate operations on single-purpose radius dressers, the most expert handling is required. In this one device, together with the one diamond holder accessory, is embodied all of the equipment that is required for any kind of wheel dressing, and close tolerances may be maintained throughout.

ENGINE HOSE

Resists High Pressures And Temperatures

ENGINES of airplanes will be lubricated and cooled more efficiently as the result of the development of a new synthetic rubber hose which offers increased resistance to heat and pressure. Perfected by engineers of the United States Rubber Company, the improved hose is designed to withstand temperatures up to 250 degrees, Fahrenheit, for use in oil lines and up to 300 degrees for installation in cooling systems.

Resistance to pressure in hose one inch in diameter is double that of hose formerly used. The strength is increased proportionately in the other

sizes, ranging from one-quarter inch to two and one-half inches in diameter.

One of the principal featues of construction is a new high-strength carcass built with Ustex, a chemically-treated cotton yarn which is much stronger than regular untreated cotton yarn. Special heat-resistant synthetic rubber was perfected after extensive research and experimentation in the United States Rubber Company's laboratories.

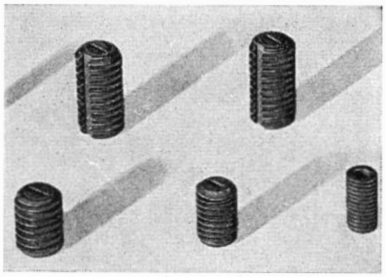
THREADED CORES

Contribute to Compactness Of Radio Receivers

SCREW type molded iron cores for radio transformers, now being made generally available, offer many engineering and constructional advantages by virtue of the fact that the cores themselves are threaded. No brass core screw is necessary for adjustment.

Smaller assemblies are readily possible because the overall length of a coil and screw type core is less than that of the conventional core, machine screw, and bushing. Thus smaller cans can be used and threaded coil forms are unnecessary in many cases. Instead, "C" clips extending through slots in the coil forms can be used to contact the core threads.

The design of i-f and dual i-f transformers for AM and FM is greatly facilitated by screw cores since such



Screw type cores for radio coils

units may be tuned from one end of the transformer-can simply by placing the coils side by side. Antenna, r-f, and oscillator coils for each band of multi-band sets become small and compact by use of these screw cores, made by Stackpole Carbon Company, and may be mounted in groups for each band.

SPONGE RUBBER

Assists Workers in Picking Up Parts

EMPLOYEES in a large industrial plant were having difficulty picking up small metal parts used in the assembly of one product. The assembly line traveled past them faster than they could pick up the parts—but not faster than they could work. The chief trouble was that the workers fumbled the small parts and couldn't get them off the table at the speed necessary to keep up with the production line.

An engineer of The B. F. Goodrich Company suggested that the table be covered with a thin slab of sponge rub-

ber, so the workers could get the tips of their fingers easily around the small parts and place them in the assembly. It worked from the start, and the assembly went off the line on schedule.

The sponge rubber slab can be as thin as ⅛ inch and still enable workers to get their fingers into it to pick up the parts, although different sponge thicknesses and densities may be required for some jobs.

DIP RACK

For Chemical Cleaning of Small Parts

A METAL dip rack has been developed to fit a standard five-gallon container, thus providing a simple means for cleaning small parts by immersion in a self-sealing compound known as Fuzee. According to its manufacturer, Turco Products, Inc., the compound quickly and thoroughly removes stubborn carbon, engine varnish, and other adhesive dirt from pistons, fuel-pumps, and carburetors.

Most effective solvents for removal of dirt have been dangerous to use, being high in volatility, inflammability,

Rack fits a standard container

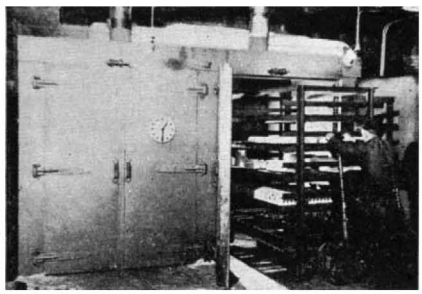
and obnoxious fumes. These solvents are also rendered rapidly useless by corrosive contamination. Turco chemists have overcome these difficulties and dangers in Fuzee by use of a compound on the surface of which a "seal" floats. This seal practically eliminates fumes, and other troubles.

FOUNDRY OVEN

Bakes Cores Rapidly Yet Uniformly

GAS FIRED, a two-section batch type oven, using forced convection and recirculation, has completely eliminated rejects due to faulty baking and has saved considerable floor space in a mid-west foundry. Replacing two older ovens, located in different parts of the foundry, the new Despatch oven consolidates core baking operations and provides ample capacity for present and future production requirements.

A new type of duct with adjustable scoop ports provides uniformity of heating. The C. W. Olson Manufacturing Company reports that since the new Despatch oven has been in operation —about two months—they are baking flywheel cores with perfect uniformity in two hours that previously required three hours to bake (and then some were green and some burned). This represents a saving of 33 percent in



Two older foundry ovens were replaced by this two-section batch type unit

core baking time and no core losses due to baking.

Objectionable fumes have been entirely eliminated from the core room and handling has been reduced to a minimum. Because of the low ceiling in the core room it was necessary to install the oven with direct gas fired heating unit, blower, and automatic controls on the side rather than on the top of the oven as in the conventional manner.

They are able to load the oven with four small racks, two small and one large rack, or two large racks, and all cores, regardless of size, are perfectly baked. This provides maximum loading flexibility to meet production requirements.

DE-IONIZED WATER

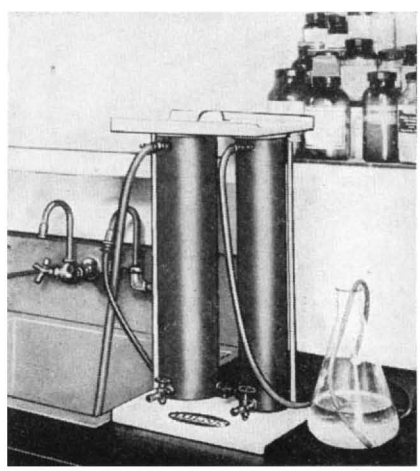
From Laboratory Size Units for Industrial Use

COMPACT laboratory units, producing purified water comparable to distilled water, are now available to laboratories and technicians requiring high flow rates from relatively small-size equipment.

Pure water is produced by this de-ionizing equipment at 1 to 10 percent of the cost of distilled water, according to the manufacturer, Illinois Water Treatment Company.

Portable, a thirty-five pound, 12-gallons-per-hour unit is 22 inches high, 13 inches wide, and 8 inches deep. Larger laboratory units, providing 60-gallons-per-hour and 100-gallons-per-hour are approximately 60 inches high, 30 inches wide, and 20 inches deep.

Water quality is protected throughout



Portable de-ionizer for producing purified water comparable to distilled

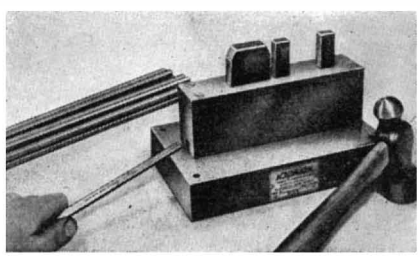
the equipment by Saran plastic and hard rubber.

De-ionizing requires no heat, therefore no fuel, and is entirely automatic in operation between regenerations. The raw water passes through two beds of special synthetic resins, the first of which removes the positive ions, such as calcium, magnesium, sodium, iron, and so on, and substitutes hydrogen. The hydrogen combines with the negative sulfate chloride, and nitrate ions, to form the equivalent acids. This acidic water passes to a second tank where the acids are removed by absorption. The water meets the exacting drug and pharmaceutical standards plus almost all chemical or industrial demands. With average raw water, it is claimed that 10,000 gallons of deionized water can be produced for less than a dollar.

PORTABLE JIG

Ensures Accuracy of Hand Stamping Jobs

PARTICULARLY adapted to limited quantity stamping jobs requiring a fair degree of accuracy, a new Acromark portable stamping jig eliminates chatter marks and provides an improved method of holding marking stamps. Both large and small stamps may be individually pre-loaded to the correct tension. While portable, and relatively inexpensive, the jig can handle marking jobs which would normally require a 50- to 60-ton capacity press.



Stamping jig for small quantities

STROBOSCOPIC

Light Source Provided by Easily Controlled Tube

COLD-CATHODE electron tubes with two internal trigger grids for operation in simple condenser discharge circuits are used as a source of stroboscopic light, providing pulse frequencies up to 240 per second. Applications include continuous visual inspection of moving textiles and printing on high-speed rotary presses; precise timing of cams, shafts, flywheels, gears, pulleys, fan blades spindles, shuttles and other rotating or reciprocating parts. Made by Sylvania Electric Products Inc., these new Strobotrons also provide a simple method for visual study of stress or effect during operation in actual service by creating "stop," reverse, or slow motion which may be photographed for reference or permanent record. Frequency of flashing may be readily controlled and calibrated over wide limits.

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.)

PLASTICS PRIMER, an eight-page booklet about phenolic plastics—the most versatile of all plastics, is especially designed to help clear up any existing doubt and confusion as to what plastics are, the different types, their properties, and applications. *Durez Plastics and Chemicals, Inc., North Tonawanda, New York.—Gratis.*

INDUSTRIAL SAFETY TOMORROW—a pamphlet prepared by 38 co-operating organizations comprised of business, labor, government, and educational leaders—outlines a program for prevention of industrial accidents, techniques which can be used, and the need for coördination of all groups concerned with safety. *National Safety Council, 20 North Wacker Drive, Chicago 6, Illinois.—Gratis.*

BORING CHUCK is a six-page folder describing a new boring chuck which can center drill a hole, bore a hole, and then drill again without removing the boring chuck. Specifications are included as well as information on how to use this tool as an adaptor for special tools like end mills, cutters, keyway cutters, saws, and fly tools. *De Soto Tool Company, 16 Sproat, Detroit 1, Michigan.—Gratis.*

ENGINEERING-DESIGN DEVELOPMENT OF X-RAY SPECTROMETER by J. S. Buhler, is a 12-page booklet covering the basic design principles of the Geiger-Counter X-Ray Spectrometer, a recently developed industrial control tool. *North American Philips Company, Inc., Publicity Department, 100 East 42nd Street, New York 17, New York. —Gratis.*

THE ROMANCE OF THE SMITHSONIAN INSTITUTION is a 32-page booklet describing a set of books which, through leisurely reading, will bring to you all the knowledge and culture of The Smithsonian Institution. *The Series Publishers, Inc., Department SA, 11 West 42nd Street, New York 18, New York.—Gratis.*

MACHINES, PRICES, JOBS, a 12-page booklet, discusses the historical relation between jobs, machines, and prices and tells how improved machinery contributes to a high employment level at good wages. *National Machine Tool Builders' Association, Cleveland, Ohio.—Gratis.*

MOVIES GO TO WORK is a 24-page booklet based on the use of motion pictures as a management tool. Chapters cover: Training Salesmen; Selling Your Product; Increasing Production; Improving Personnel Relations; and In-

terpreting Your Material. *Bell and Howell Company, 7100 McCormick Road, Chicago 45, Illinois.—Gratis to industrial plants and sales organizations.*

THE HYDRIDE PROCESS AND ITS PRODUCTS is an 18-page pamphlet describing the use of various hydrides in the production of pure metals and alloys and in the generation of pure active hydrogen. *Metal Hydrides Inc., 22 Congress Street, Beverly, Massachusetts.—Gratis.*

DIMENSIONAL QUALITY CONTROL PRIMER describes, in 24 illustrated pages, a simplified method for applying statistical quality control to dimensions. Such control constitutes an inspection tool which can find extensive industrial applications. *Federal Products Corporation, 1144 Eddy Street, Providence 1, Rhode Island.—Gratis.*

101 WELDING IDEAS FOR LOW-COST MAINTENANCE is a 16-page booklet that describes, largely in picture form, a wide variety of maintenance jobs that can be adequately handled by arc welding. *The Lincoln Electric Company, 12818 Coit Road, Cleveland, Ohio.—Gratis.*

HYDRAULIC CIRCUITS, a 28-page illustrated booklet, describes a line of hydraulic equipment for industrial applications and shows how standard and special elements may be integrated into unit type circuits to improve machine performance and increase output. *John S. Barnes Corporation, 301 South Water Street, Rockford, Illinois.—Gratis.*

HEATING THE HOME—CENTRAL HEATING SYSTEMS, a 12-page circular, gives general recommendations about heating systems and describes in some detail the various domestic types and their installations. Request Circular G3.1. *Small Homes Council. University of Illinois, Urbana, Illinois.—Gratis.*

DIPWRAP is a four-page folder outlining the uses and specifications of this hot-dip compound which is used to protect sharp-edged metal objects, gears, pinions, and other spare parts against moisture and rough handling. *Paisley Products, Inc., 630 West 51st Street, New York 19, New York.—Gratis.*

PORCELAIN ENAMEL, ITS CHARACTERISTICS AND QUALITIES is an 18-page manual on the manufacture and application of porcelain enamel with particular emphasis on its color, durability, versatility, and economy. *Porcelain Enamel Institute, Inc., 1010 Vermont Avenue, N.W., Washington 5, D. C.—Gratis.*

1900 FOOT CORD CONVEYOR BELT, a four-page folder, presents the details of how a single belt replaced a three-belt system to produce the greatest vertical lift of any conveyor belt in the world. Maintenance costs and principles of construction are included. *The B. F. Goodrich Company, Public Relations Department, Akron, Ohio.—Gratis.*

Our Book Corner

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

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

ATOMIC ARTILLERY AND THE ATOMIC BOMB

By John Kellock Robertson

UNDER the simpler title "Atomic Artillery," this book has been a standard best seller for several years. Now—to its treatment of electrons, protons, positrons, photons, cosmic rays, and the manufacture of artificial radioactivity—has been added a chapter on the atomic bomb itself and some of the difficulties encountered in its production. (173 pages, 5 by 8 inches, 27 illustrations.)—$2.60 postpaid.—*A.P.P.*

URANIUM AND ATOMIC POWER

By Jack Dement and H. C. Dake

MORE technical in treatment than most of the books on atomic power which have appeared since last August, the present volume goes fairly deeply into the underlying principles and theories of the work. Chapter headings are: Atomic Power, The Uranium Minerals, Prospecting for Uranium Minerals, The Physics of Uranium, The Chemistry of Uranium, Methods in Uranometry, Special Methods in Uranometry, Bibliography, Appendices, Index. (343 pages, 6 by 9 inches, a few illustrations.)—$4.10 postpaid.—*A.P.P.*

INDUSTRIAL OIL AND FAT PRODUCTS

By A. E. Bailey

INDUSTRIAL research in the past few years has contributed much to improved techniques in manufacturing of all types of industrial oil and fat products. While this book is primarily a text on oil and fat technology, the author has given particular attention to the edible fats and oils, and their refining, bleaching, deodorization, and hydrogenation. Executives of manufacturing concerns using fats and oils, especially bakery products, will find this book a revelation of up-to-the-minute information on the most improved methods and techniques. Every branch of the fat and oil industry is treated at great length and in gratifying detail. Not only chemists, but everyone in close contact with processing and production of fats and oils should possess this volume; it is an invaluable reference book. (735 pages, 6 by 9 inches, elaborately illustrated with photos and charts, index.) —$10.25 postpaid.—*W.D.A.*

ATOMIC ENERGY IN WAR AND PEACE

By Gessner G. Hawley and Dr. Sigmund W. Leifson

BRIEFLY yet succinctly the running story of atomic energy is presented here in 96 short sections. The aim has been to make the text as easy to read as possible, and simple to use for reference purposes. Coverage is from a brief description of atomic structure through all of the factors involved in the production of atomic energy. (211 pages, 5½ by 7½ inches, 35 illustrations.)—$2.60 postpaid.—*A.P.P.*

THE AIRMAN'S ALMANAC

Edited by Francis Walton

THE Air Age really is upon us when such a book as this one deserves and secures publication. Carefully compiled and edited, well-arranged and up to date, the Almanac presents an enormous range of information, including a review of the year, statistics, records, history, legislation, and so on. There are also presented a number of articles—some long, some short—covering such current aviation topics as flying weather, parachutes, gliding, jet propulsion, air navigation, military aviation, and the like. (512 pages, paper covers.)—$1.10 postpaid.—*A.K.*

HOW TO SOLVE IT

By G. Polya

PRESENTING a phase of mathematics usually neglected—the general method of solving problems—this little book is primarily valuable to teachers

of mathematics; they are the ones most directly interested in the methods explained. But its usefulness is by no means limited to this group. All who have to solve problems requiring scientific reasoning will find this book stimulating and helpful. It is one of the very few presentations of the method of solution of problems, as distinct from either the problems themselves or their solutions. (204 pages, 5½ by 8 inches.)—$2.60 postpaid.—*D.H.K.*

NOVELS OF SCIENCE

By Wells, Taine, Lovecraft, Stapledon

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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"

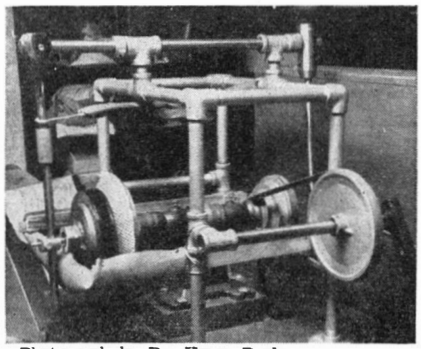
LAST month in this department Dr. Henry Paul, Norwich, N. Y., described the grinding half of his combination grinding and polishing machine for making telescope mirrors, optical flats, and lenses. The polishing part was shown in Figure 2 (in the previous installment) and is shown from another angle in Figure 3. Because it is believed that numerous amateurs will find in this machine one particularly outstanding advantage which they may wish to embody in similar machines, enough space will be devoted to it to afford adequate description.

The action of the polishing part of the Paul machine may best be traced by starting at the motor, under the table, which actuates the grinding part described last month. From a 2" pulley (the remainder of the cone pulley seen in Figure 2 never being used) a V-belt passes up through a slot in the table and drives a 5" pulley which is eclipsed in the illustration. This pulley is attached to a short horizontal shaft, in this instance an old grinding head. On the left-hand end of this shaft (in Figure 3) is a head plate to which the mirror is attached with pitch. *The mirror rotates constantly in a bath of rouge water and therefore requires almost no attention.* This in turn requires that it be turned in an uncommon position—in a vertical instead of the familiar horizontal plane. Speeds of 70, 105, 140, and 175 r.p.m. may be chosen by selecting suitable motor pulleys.

Suspended on an upright pin bar is the lap, which is held against the mirror by means of a spring or large strip of inner tube stretched to the desired tension as measured by a spring scale. The pin bar is actuated, pendulumwise, by the horizontal overhead shaft, and this in turn is kept rocking by a belt-driven jack shaft and crank arm, through an articulated pitman and pitman bar which is hidden in Figure 3 but visible in Figure 2.

Stroke length may be varied by moving the crank pin along the crank arm. Stroke position is altered at will by readjusting a clamp at the top of the pitman. Unorthodox as it at first appears to be, this machine includes all the necessary elements and motions of an orthodox machine and, in fact, it is an orthodox machine turned up on its side in an unorthodox manner in order to make possible the added advantage of the rouge bath. If, for illustration, you take the commercial machine shown on page 83 of the 1944 printing of "A.T.M.A.," (Ferson's new chapter on prism and flat making) and tip it over on its side like a kicked-over table, you then have about the same principle. On the Paul machine, however, polishing is accomplished somewhat more by rotation than by cross stroke.

"THE HORIZONTAL polishing system was first seen in the shop of Dr. Henry Ketcham, Johnson City, N. Y.," Paul states. "It offers certain distinct advantages, the major one being that, after initial adjustments on the job, it requires little attention, being semi-automatic. Since the lower edge of the mirror and of the lap dip as much as half way to their centers in the trough (old inner tube) of rouge water, the bother of applying rouge to the lap by hand is eliminated. It is true, the rouge water splashes all over the mirror and tool but a large washer



Photograph by Dr. Henry Paul

Figure 3: Paul's polishing machine

on the drive shaft, running just inside the trough, keeps most of it where it belongs. Another eliminated factor is temperature gradients due to evaporation effects.

"Turned edges of any consequence have not been encountered (when the system was properly used). An added advantage is the fact that in the earlier stages of polishing, the trough that holds the solution may be moved up close to the mirror, thus keeping all the rouge in operation for rapid polishing. Then, as the end of the polishing is approached, the trough may be lowered, permitting the coarser particles to settle to the bottom so that the later stages of polishing may be accomplished by finely suspended rouge. It is believed that one reason for the outstanding lack of scratches by this method is the fact that heavy particles tend to stay in the bottom. This may also be why ordinary optician's dry rouge (B. and L. 21-90-61) works well. Since much of it is used, five-pound containers are obtained, but at relatively low cost.

"The polishing progresses somewhat slower than by conventional methods, but this is compensated in advance by thorough fine grinding with very fine emery, such as American Optical No. 305, the last application being worked down extremely well. Finest emeries should be levigated and mixed, one-to-one, with levigated drugstore talc. I have never had a scratch from this method of polishing.

"I have often started a mirror polishing in the late evening and leisurely after breakfast stepped down to the shop to find a completely polished surface within a few wavelengths of the ultimate. Thus I call this the night-shift machine; it works while I sleep. (Once I let it run 24 hours. No harm resulted.) To avoid the heartache, only too well known to all mirror makers, of fortuitously reaching a perfect curve before polishing is complete, and then helplessly having to watch its demise, I prefer to do the figuring on a finished polish. A small condenser-bulb pen light and a 7× to 10× magnifier is used to best check for complete polish.

"The free-running lap or mirror under the swinging arm pin is usually made about 5/6 to 9/10 the diameter of the driving lap or mirror on the polishing spindle head. Most often the convex form, whether lap or mirror, is on the driving spindle head and the concave form turns free on its supporting pin. Flats have been made both ways—most often, however, with the flat on the polishing head and the *smaller* polisher free-turning. The center of the free-turning disk is usually kept somewhat above or below the center of the polishing head. Often the edge of the free-turning lap comes within ⅛" of the edge of the disk it is polishing. This tends to avoid turned edge. Laps need only simple channeling—one groove across and three equally spaced channels at right angles to this.

"Between adjustment of the length of the stroke, the position of the sweep across the disk of the polishing head, the size of the outer versus the inner disk, the distance the center of the rotating disk is held above or below the center of the polishing head disk, and the reversal of position of the lap and glass, almost any desired effect in spherical or flat surfaces can be produced.

"No attempt has been made to parabolize or produce aspherical surfaces on this polishing head. All non-spherical surfaces have been made by using small polishers including the thumb and ball of the palm, on the vertical hand-lever spindle on which the grinding was done. Despite the quantity of abrasive lying around, this spindle has been used as a polisher for all types of figuring without a scratch. Abrasive doesn't get up and fly. However, the precaution of cleaning the cross bar and, particularly, the central pin and clamp, must always be observed before using this vertical head in figuring.

"Often, in figuring on the vertical spindle, the small polishers are held in the hand and applied to the spinning glass, using a ruler held in the left hand to gage the place of application. When using the finger alone as a polisher on a narrow zone this must

be done more cautiously, as operation may be rapid. When the pin is used in the back of the lap, effects will vary according to whether the lap is free-spinning, partially braked by the left hand, or totally stopped from rotating. See Dévé, 'Optical Workshop Principles,' pages 70-72.

"The 'trapeze,' or pipe frame, set up to support the moving mechanism of the polishing assembly has worked extremely well. It is constructed of ordinary ½" pipe fittings, the list being 12 6" lengths, four 3-way connectors, ten T's, and four flanges. The respective sides can be constructed as units. Here arises the interesting and slightly humorous problem, sometimes handed to unsuspecting apprentice plumbers, of 'closing a circle' with pipe fittings. The apprentice discovers that screwing one end of the fourth side into one elbow automatically screws the opposite end out of the other elbow. One solution is to screw the left end in extra far, cut off all but two threads from the right end and then turn that end in, completing the square. This will leave the left end a bit loose but a setscrew will tighten it. My less elegant solution was to turn a blow-torch on it and run solder into the threads.

"The cross-connectors are now screwed in and the same problem arises in three other places and is similarly solved. Or the two units may be welded or brazed together.

"The ½" T's drilled out with a ¾" drill serve as bearings. Holes should be drilled in the T's for lubrication. These bearings are very sturdy and *entirely adequate* for these slow-moving parts. Regular ¾" shafting and collars were used throughout.

"The driving crank contains a slot in which slides a bolt which may be clamped at any position and the end of this bolt drives the pitman bar. A crank range of 0" to 3" (6" stroke) is adequate. At the right end of the horizontal overhead shaft (Figure 3) is a sturdy clamp tightened on the shaft with a setscrew which allows change of the position of the stroke in polishing. The stroke is usually less than one half the diameter of the glass disk on the head; the bar pin should never cross directly over the rotating driving center.

"The yoke which permits the bar pin to be swung out in an arc, up, and back overhead out of the way, was carefully machined from solid material, but a ¾" self-alining shaft hanger, if *sturdy,* should work well in its place."

ONE MORE method of making a pitch lap, this one more especially for a deep-curve mirror but equally applicable to other mirrors, is offered the telescope making fraternity with pitch in their hair by John P. Tyskewicz, 142 Seymour St., Hartford 6, Conn., who foresaw that for a deep mirror enough pitch would be squeezed out to start a taffy pulling party. So he devised his "flapjack" lap, precast and uniform in thickness, allowed to cool, and applied warmed-over afterward.

On a sheet of waxed paper he laid a ring of rubber-insulated, twin-conductor type lampcord as a dam for the pitch.

He melted his pitch and let it cool a little so that it would not unwax the paper by melting the wax, poured the dam level full and left it to cool into a flat flapjack, or disk, of uniform thickness.

While the tool was warming he worked the flapjack loose with a long knife, leaving the dam on.

He next warmed the flapjack with radiant heat (water would prevent its adhesion to the tool), swabbed the tool and flapjack with turps, and lowered the flapjack, still in its dam, on the tool, letting it touch first at the center. Gravity plus thermodynamics did the rest.

Now he removed the dam, wet the mirror with soapy water and worked the lap down to perfect fit in the usual manner.

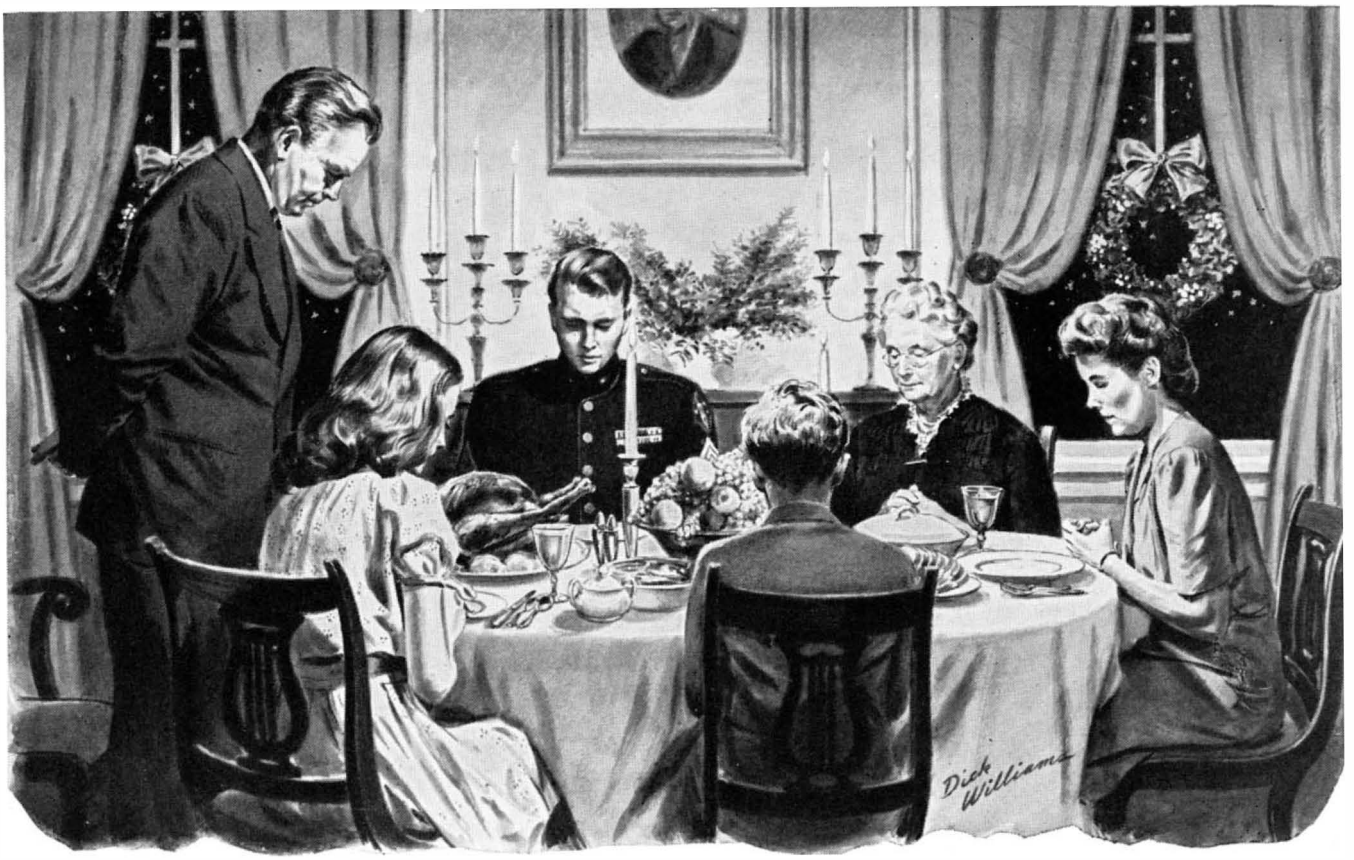
For making channels Tyskewicz uses a 100-watt soldering iron with V-shaped scoop attached, makes plenty of facets not larger than a tenth diameter of lap, and leaves their ends uncut to retain the rougy water longer.

CASUALTIES—(1) "I lent one of our engineers an 8" cast iron flat," a reader reports, "to use as a base for crocus cloth to finish a mechanism. I discovered the man grinding gate valve disks *on* the flat with valve grinding compound." (2) Another reader writes: "Some men at a military field borrowed my flat and, when returning it, remarked with a hint of pride and virtue, 'It got pretty badly scratched up, so we refinished it for you.'" Suspicious and alarmed, the owner asked what technique was used. The casual reply was, "Buffing wheel." (3) A green firm buffed an amateur's mirror, aluminized the ruined figure. At a lawyer's "suggestion" they settled, $100, but still felt injured.

WOODEN tubes for reflecting telescopes suffer from one almost unsurmountable objection, according to F. N. Hibbard, Richmond, Va.; their tendency to warp. "A friend of mine," he writes, "made a 10" reflector with a wooden tube and says he has to readjust the mirror every night he uses the telescope. Even a slight warpage produces flares on one side or the other of the star images.

"The problem is not to eliminate atmospheric unsteadiness. There will be more or less of that practically every night. There will not be a dozen nights a year when 75 or 100 diameters per inch of aperture can be used to advantage. The main problem is to eliminate flares and unsteadiness due to the tube itself.

"I would build any telescope up to 2' in diameter of metal, and line the metal with cork or quarter-inch strips of light wood such as balsam or Douglas fir. The metal would give the necessary strength and solidity to hold the mirror in exact position and the wood or cork would keep the metal temperatures from getting inside."



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