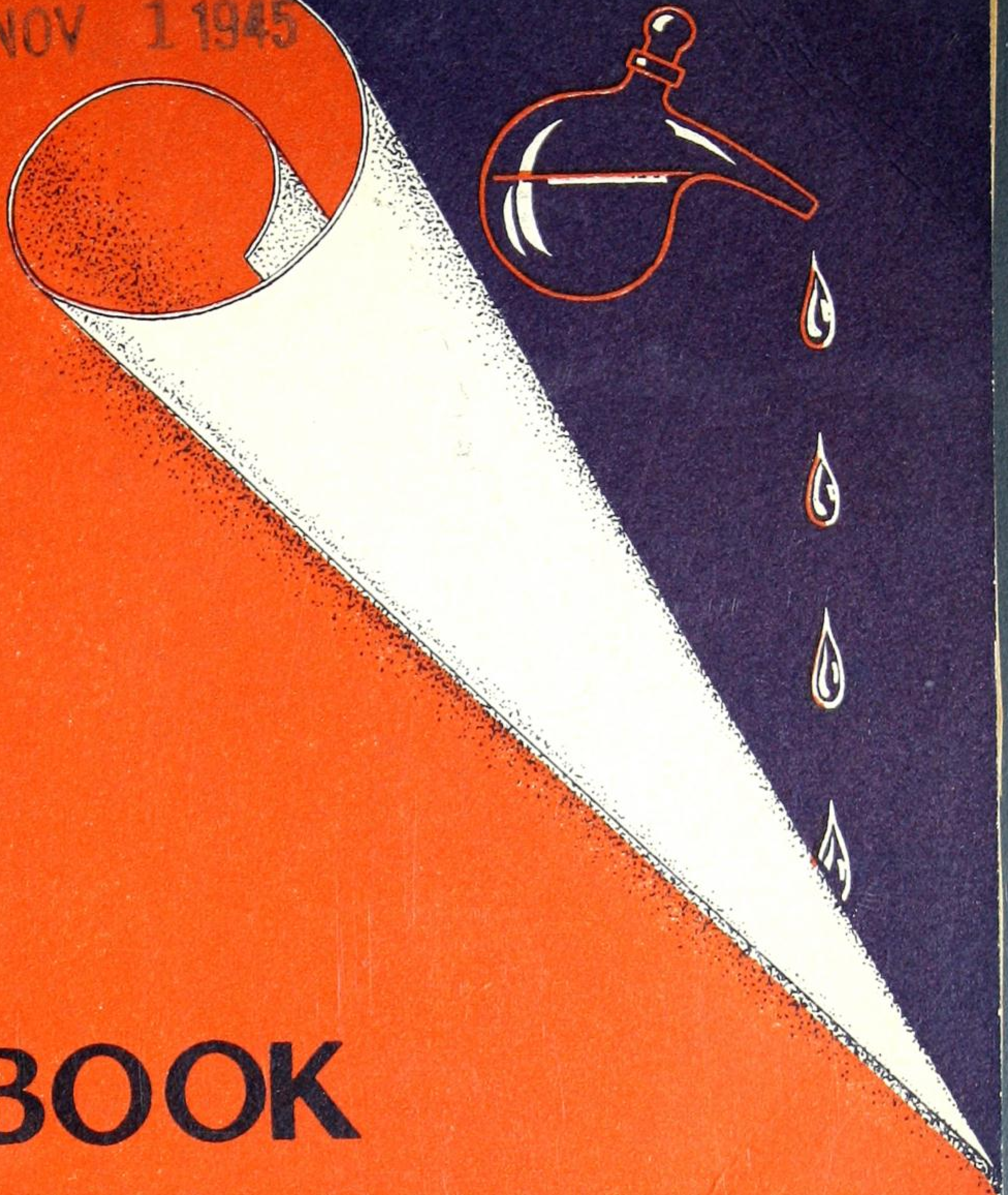


THE WATERTOWN BOOK OF PLASTICS

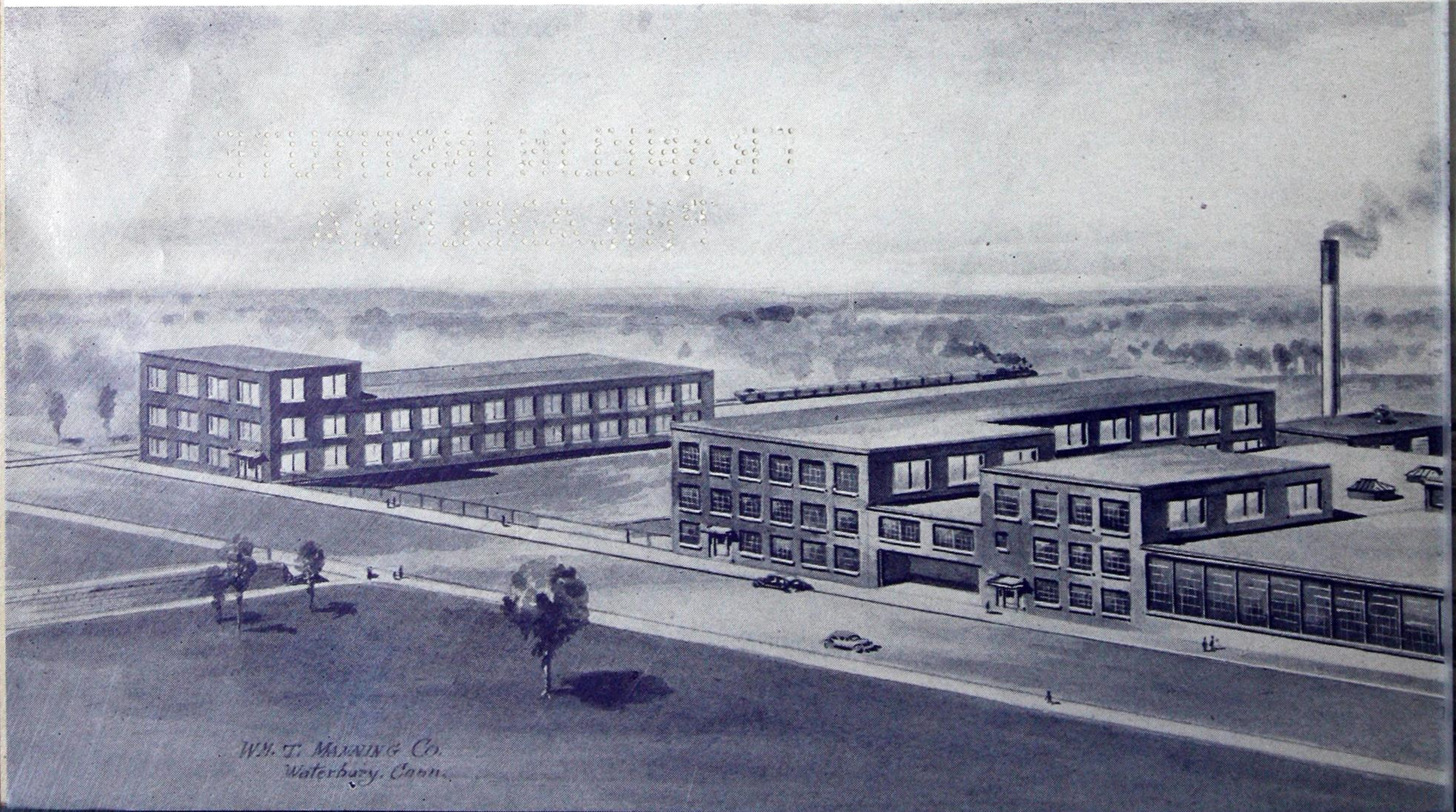
[BLANK PAGE]

THE WATERTOWN BOOK OF PLASTICS

THE WATERTOWN MANUFACTURING COMPANY
WATERTOWN, CONNECTICUT
UNITED STATES OF AMERICA

BRANCH OFFICE • Cleveland, Ohio
SALES OFFICES • New York • Chicago • Detroit • Milwaukee • Hawaii

INDEX



WATERTOWN • A Name as Old as the Plastics Industry

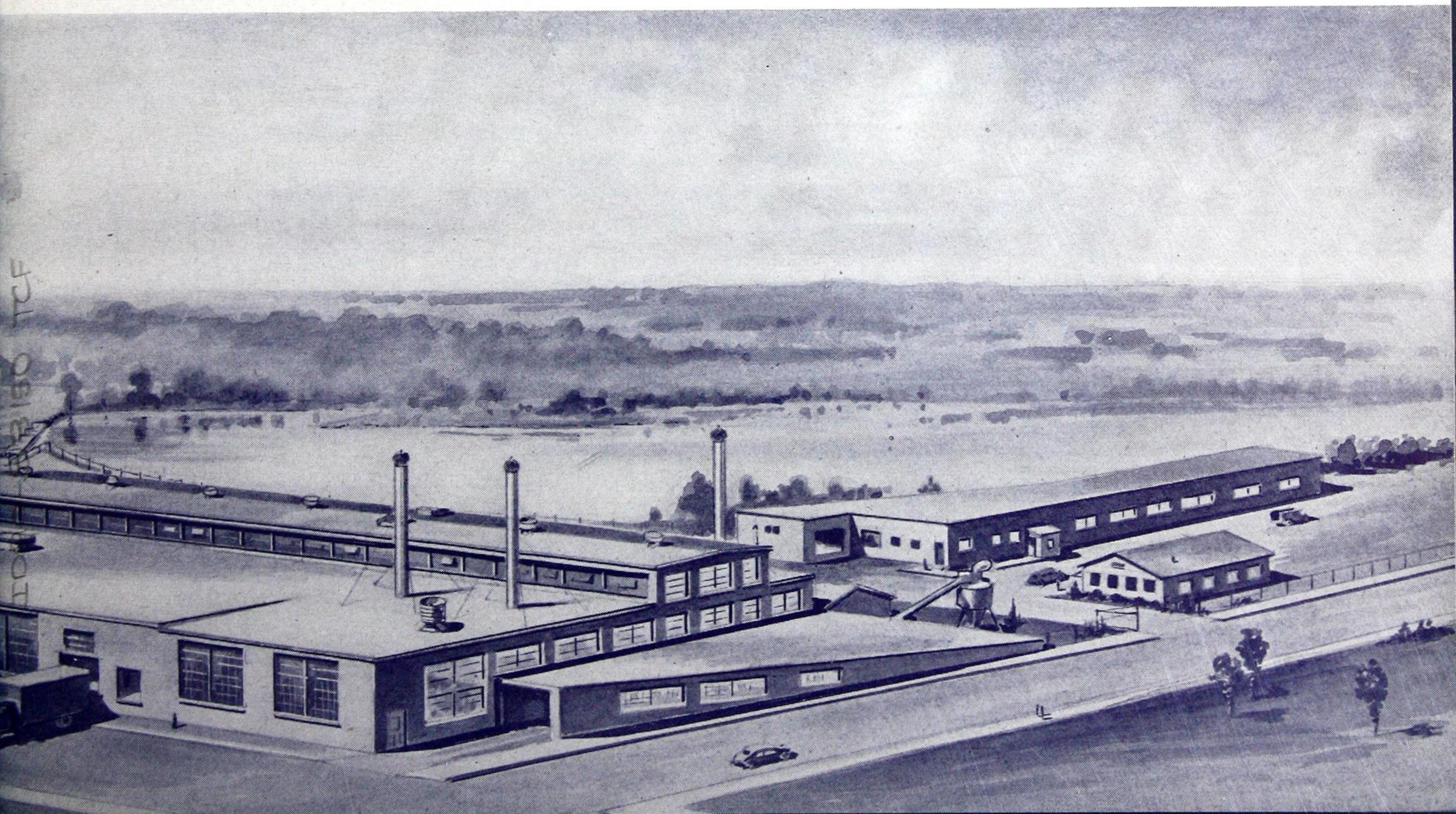
In 1915, The WATERTOWN MANUFACTURING COMPANY was formed for the molding of shellac compounds. Although the plant was small, it was a highly successful venture. When phenolics became commercially practicable, the plant was enlarged and compression presses were established for molding thermosetting materials.

It was at this time that J. R. Neill, now the President, joined Watertown and initiated the formulation of Neillite—his own phenolic molding powder. Watertown also started making its own basic resins, in order that Neillite might be a completely tailor-made material adaptable to precise specifications.

With the introduction of injection molding to the United States, Watertown installed new machinery and increased their custom molding to include the new thermoplastic materials becoming commercially available. As new methods were adopted the plant grew until now it is ten times its original size.

In order to offer a complete custom service, Watertown equipped two complete finishing and assembly departments, one for the compression molded products and one for the thermoplastics. In these departments all finishing, buffing, necessary machining and assembling of individual parts is accomplished.

The growth of the company and its equipment has been steady and its policies have remained soundly conservative. The Watertown Manufacturing Company has taken advantage of each new development as soon as it was demonstrably useful and has kept pace with the newest reliable manufacturing procedures in plastics. It has never striven for spectacular expansion, preferring to maintain the high standards of service and complete accuracy of molding that has made the name Watertown synonymous with excellence in plastics. The highly trained men at Watertown have become well known for their ability to produce unusual and diffcult shapes with uncanny precision.



WATERTOWN'S COMPLETE SERVICE

Companies may be measured by the men who compose them—from the executives who create the policies and establish the working principles, to the men who perform the special functions of the organization. Watertown prides itself on its men of experience, many of whom have worked with plastics for thirty years or longer. J. R. Neill, the President, developed Neillite, a commercially useful phenolic material, in 1915 (about the time Bakelite first made its debut). He is a chemical engineer long interested in synthetics and heads a highly competent staff of "plastics old-timers." Assistant General Manager Alves, an accomplished engineer with a wide knowledge of molding methods, has developed a special press for transfer molding that has greatly increased efficiency in this method of molding.

Watertown's engineering staff includes men capable of designing and engineering shapes for manufacturers and consumers, and developing molds to handle all the thermoplastic and thermosetting materials with maximum accuracy and economy.

Men skilled by long service with Watertown, control the giant and smaller compression presses and the speedy injection molding machines. Many of the men in the resin plant and those in charge of the formulation of carefully tailored materials have seen service at Watertown since the inception of the company.

Custom service at Watertown is everything the name implies. If a manufacturer in any industry requires a part made of plastic, he consults with Watertown engineers, presenting a drawing or blueprint of the type of shape he wants and acquainting them with the properties required in actual use. The type of plastic material best suited to these working conditions is chosen by Watertown's chemists. Engineers and draftsmen then design a mold to produce in that material the ultimate shape to be formed. The choice of material is critically important and only experts should decide on the material and exact formula. If the perfect material for the purpose is not available, Watertown's completely equipped laboratory is called into service to tailor a material to the end use.

After design and material are decided upon the intricate and delicate construction of the mold follows. Here, expert engineers are required to perfect multiple or single cavity molds that produce the maximum in fine tolerances. Molding methods are determined partly by the material used and partly by the efficiency of the chosen press in handling the material and type of mold.

In addition to molding Neillite, Watertown handles every standard thermoplastic and thermosetting material. In its many huge compression presses and battery of modern, fast injection machines, Watertown molds Bakelite, Chemaco molding materials, Durez, Lumarith, Lustron, Resinox, Tenite and every other powder, from Lucite and Plexiglas to Styron, Nylon and Cerex—the newest of molding powders.

After molding, the assembly of sections, cleaning, buffing, polishing and fitting are done by a corps of dextrous employees in the finishing rooms. Completed parts are tested for perfection in Watertown's well-equipped laboratory before being shipped. X-rays, Tinius Olsen Plastiversal machine and impact and strain tests combined with other physical and electrical tests determine that each part shipped is satisfactory before it leaves the factory. Watertown offers a ***complete*** custom service.

NEILLITE

J. R. Neill developed Neillite in 1915 while searching for a new waterproofing material. With Bakelite, it was one of the first phenolic compounds to be used commercially and it has been subject to constant research, development and improvement for the last 30 years.

Neillite is made for the sole purpose of "tailoring" the compound to suit each individual requirement. Watertown tailor-makes finished moldings, starting with the basic phenol-formaldehyde resin and regulating all the various types and amounts of fillers, according to the end use of the completed molding.

Neillite is made with varying degrees of flow for either the compression or transfer type of press. The flow is controlled so that the material will "flow" easily into the various interstices of the mold cavities and produce a part that is homogeneous throughout.

By laboratory checking the material in the Watertown plant, it is possible to adjust materials to meet different requirements, thus facilitating earlier development of superior molded products.

Neillite is made in comparatively small batches of material so that uniformity of the molding powder is closely controlled. It is amenable to the formation of very large and very small pre-forms and with the introduction of electronic heating, which is utilized at Watertown, a completely non-porous molding of extremely large dimensions can be accomplished. One large Neillite section, weighing over 5 pounds in a single shot, has been successfully molded (see page 39). Still other sections weighing up to 16 pounds, with elaborate shapes have been engineered at Watertown.

Formulations are checked and double checked in Watertown's completely equipped laboratory where molded sections are also subjected to every conceivable physical and electrical test to determine performance of material and part as well, under actual operating conditions. Because of the thoroughness with which tests are carried out, customers of Watertown service are able to predetermine the action of their parts under stress and determine the ultimate point of breakdown from any possible cause.

Neillite is a phenolic-formaldehyde molding material. It is available in various types —general purpose, impact, surgical, heat resistant and electrical. Neillite has a wide range of flows for compression or transfer molding.

The physical data was obtained by using A.S.T.M. methods wherever possible.

PROPERTIES OF MOLDING POWDER

APPARENT DENSITY

The apparent density is a measure of the fluffiness or volume of the material in an unmolded condition. The figure in grams represents the weight of 1 cc of material. The method used is A.S.T.M. Designation D 392-38.

BULK FACTOR

The bulk factor is the ratio of the volume of any given quantity of loose molding material to the volume of the same quantity of material after molding. The method used is A.S.T.M. Designation D 392-38.

POWDER POURABILITY

The powder pourability test is intended to determine how readily molding powder will feed through the hoppers and deliver uniform weights of material into the dies of tableting machines, by measuring the time of flow in seconds, of a standard quantity, through a standard funnel. This test is generally adapted qualitatively, only to materials having a bulk factor of 3.0 or less. Materials with a bulk factor of 3.0 or more do not flow through this funnel and such materials may be tableted only with some difficulty.

PREFORMING

This term is used to characterize the ability of a material to be formed in an automatic tableting machine.

FLOW RANGE

The flow of material, mobility, softness or plasticity is that property of a molding powder which measures its ability to flow into the various interstices of a mold and fill out the mold. It is a function of a material that cannot theoretically be expressed in a simple term. However, the figures used may be broken down into various classes; 40-80 being considered a hard flow, 80-120 a medium flow, 120-150 a soft flow.

NEILLITE MOLDING COMPOUNDS

PROPERTIES IN MOLDED PARTS

SPECIFIC GRAVITY

Specific gravity is the ratio of the weight of the molded piece to the weight of an equal volume of water. A.S.T.M. Designation D 392-38.

FLEXURAL STRENGTH

The method used is A.S.T.M. Designation D 650-42T. The test specimen is the ½ x ½ x 5 inch bar. The load is applied parallel to the direction of the molding pressure. The unit is expressed in pounds per square inch.

TENSILE STRENGTH

The method used is A.S.T.M. Designation D 43-43T of hot molded materials, using the ¼ inch specimen. The unit is expressed in pounds per square inch.

COMPRESSIVE STRENGTH

The method used is A.S.T.M. Designation D 695-42T. The ½ inch cubes are built up to a height of one inch, so that the compressive load is applied parallel to the direction of the molding pressure.

IMPACT STRENGTH

The method used is A.S.T.M. Designation D 256-43T (Izod). The specimen used is the ½ x ½ x 5 inch bar. The notch is milled into the side parallel to the direction of the application of the molding pressure. The data is given as foot pounds energy to break, foot pounds per inch of notch, foot pounds per inch square.

WATER ABSORPTION

The method used is A.S.T.M. Designation 48-43T. The specimen is a four inch disc ⅛ inch thick. 24 hour immersion.

DIELECTRIC STRENGTH

The method used is A.S.T.M. Designation D 48-43T. The specimen used is a four inch disc. The unit is voltage per mil and the instantaneous method is used.

POWER FACTOR-DIELECTRIC CONSTANT-LOSS FACTOR

The method used is A.S.T.M. Designation D 150-41T. The specimen is a four inch disc. The values are determined at a megacycle.

VOLUME RESISTIVITY

The method used is A.S.T.M. Designation D 257-38. The specimen used is a four inch disc. The unit is expressed in ohm-centimeter.

GENERAL CHARACTERISTICS

EXCELLENT CHEMICAL RESISTANCE TO:

Weak acids
Reducing and organic acids
Alkali in dilute concentrations
Organic solvents (bleed proof materials)

EFFECT ON METAL INSERTS—NIL

MECHANICAL PROPERTIES

Machining qualities are fair to good, depending on filler used.

LIGHT WEIGHT

Specific Gravity 1.36 to 1.9, depending upon filler.

STRENGTH

Depends on type and amount of filler used. See chart.

ELECTRICAL PROPERTIES

High dielectric strength
Low power factor
Excellent electrical resistance

Formulations have been developed with extremely high resistance to boiling water. These are used for medical and surgical apparatus that require sterilizations.

TESTED USES AND APPLICATIONS

- Agitators for washing machines
- Automotive and Aircraft Parts
- Battery box casings
- Bomber tooling kits
- Cautery pistols and tips
- Clock cases
- Closures
- Containers
- Domestic appliance parts
- Flatiron handles
- Handles for cooking equipment
- Handles for electrical equipment
- Headlight parts
- Hypodermic equipment
- Ignition Parts
- Insulator parts
- Knobs
- Light meters
- Midget motor parts
- Opthalmascope front and back plates
- Otoscope speculae
- Physicians and surgical equipment
- Radio cases
- Razors
- Smoking equipment
  - Ashtrays
  - Cigarette cases
  - Cigarette holders
  - Lighter cases
- Socket handles
- Steam meter housings
- Terminal blocks
- Thermometer cases
- Toggles
- Transformer housings
- Trays
- Wiring harnesses

NEILLITE PROPERTIES CHART

	No. 20	No. 25	No. 300	No. 60	No. 60-17	No. 60-50	No. 60-100
Physical properties—powder							
Bulk factor	2.2:1	2.2-2.3:1	2.2-2.4:1	2.25-2.50:1	2.25-2.50:1	3.2:1	3.6:1
Apparent density (grams)	0.60	0.60-0.64	0.58-0.66	0.520-0.60	0.520-0.60	0.42	0.37
Pourability	25 Sec.	25 Sec.	20-25 Sec.	22-28 Sec.	22-28 Sec.	Pours thru std.	opening poorly
Preforming characteristics	Good	Good	Good	Good	Good	Fair	Fair to poor
Flow range	50-150	60-120	80-140	60-150	60-150	40-150	40-150
Physical properties molded							
Specific gravity	1.43	1.40	1.43	1.36	1.36	1.36	1.36
Weight per cubic inch (grams)	23.3	22.9	23.3	22.3	22.3	22.3	22.3
Tensile strength PSI	6500	5500	6100-6900	6500-7000	6500-7500	6400-7000	6700-7000
Impact strength (Ft. lbs. energy to break-Izod)	0.18	0.14	0.17	0.20	0.20	0.25	0.38
Impact strength (Ft. lbs. per in. of notch-Izod)	0.36	0.28	0.34	0.40	0.40	0.50	0.76
Impact strength (Ft. lbs. per in. square-Izod)	2.25	1.79	2.13	2.45	2.45	3.01	4.86
Compressive strength PSI	32,600	27,300	29,200	31,300	32,000	22,200	22,800
Flexural strength PSI				10,000	10,000	9,900	9,500
Water absorption %	0.55	0.75	0.65	0.65	0.64	0.65	0.52-0.65
Mold shrinkage in. per in.	0.008	0.007	0.008	0.009	0.009	0.006	0.006
Electrical properties molded							
Dielectric strength (60 cycles-inst.) vpm	375	Electrical properties	375	400	400	375	400
Dielectric constant (1 megacycle)	4.95	are	4.65	4.25	4.25	4.20	4.15
Power factor (1 megacycle)	0.039	not	0.035	0.023	0.023	0.026	0.024
Loss factor (1 megacycle)	0.195	controlled	0.165	0.098	0.098	0.1105	0.0992
Volume resistivity (ohm-cent.)	$4.6x10^{12}$		$3.3x10^{12}$	$3x10^{13}$	$3x10^{13}$	$6.1x10^{12}$	$1.0x10^{13}$

The above physical and electrical properties were obtained following A.S.T.M. or standard methods using A.S.T.M. or standard test pieces. These pieces were molded under carefully controlled conditions so as to obtain the best properties. Since the properties of the molded piece are appreciably affected by molding conditions as well as mold design, no guarantee is implied that molded articles using this material will have the above properties.

No. 20—General purpose brown material equivalent to standard brown materials but with higher impact strength.

No. 25—General purpose black material with rapid cure and good finish.

No. 300—General purpose black equivalent to standard general purpose materials, but with higher impact strength. Molded pieces have a high gloss and good mechanical properties.

No. 60—High quality black general purpose material. Molded pieces have excellent mechanical strength, high surface lustre and electrical properties superior to those of other general purpose materials. Also furnished in extra soft grade suited to transfer molding.

No. 60-17—Has been prepared to meet Navy Spec. 17-P-4, Type C.F.G.

No. 60-50—Black medium impact material. Molded pieces have high gloss and excellent mechanical properties. Electrical properties exceptionally high.

No. 60-100—Black improved impact with shock resistant superior to other impact materials. Molded pieces have high gloss and excellent all around mechanical properties. Electrical properties are exceptionally high.

THERMOSETTING MATERIALS

Thermosetting materials are heat setting materials that take form under combined heat and pressure. They undergo a curing period during which a definite chemical reaction occurs that sets them in permanent form during the compression or transfer molding process.

PHENOLICS

Phenolic molding powders are made by the interaction of phenol with formaldehyde in the presence of a suitable catalyst and in combination with various types of fillers. The filler in a specific compound is chosen because of the qualities it will impart to the finished molded shape. Among those used are a number of wood flours, cloth (cut, shredded or chopped), paper, asbestos, diatomaceous silica, baryte, mica and graphite. Fillers provide increased molding facility, add body and lend additional strength, resistance to fire and impact, and greatly improve dielectric strength and dimensional stability. Special compounds have been developed for resistance to shock, heat and high electrical voltage. Among the standard phenolics molded by Watertown are Bakelite, Durez, Durite, Neillite and Resinox.

UREAS

Urea-formaldehydes are lightweight plastics yielding hard-surfaced shapes which are rigid, dielectrically strong, odorless and tasteless. Although, under heavy impact, urea parts will break, they have adequate strength for most applications and are excellent for diffusing light. Being capable of taking both pastel and vivid colors, these compounds are used for many decorative purposes and make excellent buttons, closures and light reflectors. Like most plastics they are poor conductors of heat. Watertown molds Beetle, Plaskon and Bakelite Urea.

MELAMINES

Melamine compounds, in appearance, are similar to the ureas in their hard, glossy surfaces but are superior in resistance to abrasion, impact, chemicals, staining and in withstanding heat and hot liquids. The excellent dielectric qualities, arc and track resistance and low moisture absorption have made them an important material in the electrical field. They have also become the approved material for dishes and tableware for Army, Navy and airlines because of their stain resistance, ability to withstand boiling liquids, non-toxicity and because they may be sterilized. Melamine has also been used for the upper bowl or vessel for coffee makers of the Vaculator type, prescribed for use on shipboard by the Navy. Among the melamines molded by Watertown are Plaskon and Melmac.

THERMOPLASTIC MATERIALS

The thermoplastics are materials that are cold-setting. They experience no chemical reaction during the molding process either by injection or extrusion and are set, without "curing," by cold drafts of air or the introduction of some liquid cooling element. All thermoplastics may be molded by compression but in general, injection for shapes and extrusion for the production of parts with limited areas of even cross section in long lengths, is the accepted practice. All thermoplastics, since they retain their basic chemical form in molding may be reground and remolded.

CELLULOSE ACETATE

Among the thermoplastic materials, cellulose acetate, like phenol formaldehyde among the thermosetting materials, is considered the "workhorse of plastics." It is a highly adaptable material, combining most of the useful qualities of all the thermoplastics, in some degree. Especially notable for its wide color range, highly lustrous surfaces and ease of molding and machining, cellulose acetate has lent itself to the widest variety of applications, from tooth brush handles to electrical parts. In common with other plastics, the dielectric qualities are good, the material is reasonably stable under most operating conditions and it possesses superior toughness and impact strength. High acetyl acetate has been formulated to admit or resist the passage of ultra violet rays and can be made reasonably weatherproof for outdoor application. Among the basic molding compounds used by Watertown are Bakelite, Chemaco, Fibestos, Lumarith, Nixonite, Plastecele and Tenite I.

CELLULOSE ACETATE BUTYRATE

Cellulose acetate butyrate most nearly resembles cellulose acetate. Manufactured in much the same way, the addition of butyric acid renders this material somewhat lower in specific gravity and gives it additional dimensional stability by cutting down the percentage of water absorption. Formulae have been developed that are impervious to ultra violet rays and have practically no loss in impact strength and flexibility after long immersion in water. Among the most important uses for cellulose acetate butyrate are hearing aid cases which demand dimensional stability, resistance to impact and uniformity. For the Sonotone Hearing Aid case (shown on page 36) made by Watertown, Tennessee Eastman's Tenite II is used.

ETHYL CELLULOSE

This comparative newcomer in the cellulosic group is the most unusual in its range of physical properties. Formulae have been developed to give extraordinary strength to shapes whose working temperatures run as low as —50 degrees F. The inherent toughness and impact strength of the material have made it a prime favorite for essential war applications ranging from submarine to airplane parts where adaptability to temperature variations and humidity changes are of prime importance. Dimensional stability, dielectric strength, great flexibility and moldability mark ethyl cellulose for a multitude of functional applications. Watertown molds Chemaco Ethyl Cellulose, Lumarith EC, Ethocel and Nixon Ethyl Cellulose.

THERMOPLASTIC MATERIALS

POLYSTYRENE

Polystyrene is the most glasslike of all the plastic materials. Although naturally it is possessed of unusual clarity, it can be formulated in an unlimited range of tints and colors from the lightest transparent shades to dark opaques. It is an exceptionally light plastic, having a low specific gravity and has excellent chemical and electrical resistance.

Its resistance to water is so great that it is almost impossible to measure its water absorption, tests resulting usually in 0.0% absorption. This, together with other factors, lends it great dimensional stability with no noticeable tendency to cold flow.

Its uses range from insulation parts to laboratory equipment and it has been especially successful for containers and closures in cosmetic and chemical fields because it is unaffected by most acids, alkalis and alcohols. Polystyrene may be attacked by some oxidizing acids and is soluble in aromatic and chlorinated hydrocarbons, but it is resistant to most chemicals, oils and other ingredients in cosmetic and alcoholic preparations.

The high index of refraction and unusual clarity of polystyrene also make it useful in lighting, lenses and instrument parts. It is non-toxic, odorless and tasteless and consequently can be used in implements for food preparation and in refrigerators. Among the materials molded by Watertown are, Bakelite Polystyrene, Chemaco Polystyrene, Loalin, Lustron, Styramic and Styron.

ACRYLICS (Methyl Methacrylate)

The acrylic resins are remarkable for dielectric strength, chemical resistance high impact strength and notable optical properties. Only the highest concentrations of alkalis and oxidizing acids will attack this material, and it is unaffected by parafinic and olefinic hydrocarbons, amines, alkyl monohalides and most esters. It is tasteless, odorless, non-toxic and compatible with body tissue. Hence, its uses range from food utensils to bone splints and skull plates for head injuries. The exceptional beauty of the material also makes it popular in decorative fields, and it lends itself to costume jewelry, hand bags and hair ornaments, as well as to decorative home and table items. Dresser sets, cosmetic containers, furniture parts, displays, clock cases, bookends, lighting fixtures and even piano standards have successfully employed methyl methacrylate. In its more utilitarian aspects, it is used for P-T boat turrets, bomber noses and windows, edge-lighted dials, gauge covers, three dimensional displays, blackout lenses, fuel gauges, and automotive and aircraft instruments. Watertown injection molds Plexiglas and Lucite.

VINYL COMPOUNDS

The vinyl compounds embrace a diversified family of resins including vinyl acetate, vinyl chloride and copolymers of vinyl chloride-vinyl acetate. Although these resins are used in rigid form, much of their greatest utility has been found in the extremely flexible formulations. Because of their remarkable dielectric strength, chemical resistance and their insulation value, their use in laboratories is recommended. Materials are available in transparent, translucent and opaque tints and colors and they are popular in both industrial and consumer fields. In addition to their electrical and chemical uses, vinyl compounds are also molded for distributor cap nipples, grommets for automotive and aircraft fields, binocular cases, gas mask parts, wiring terminal insulating sleeves, combs, toothbrush handles and a great variety of machine parts. The vinyls that can be handled at Watertown are Chemaco Vinyl Compounds, Vinylite and Koroseal.

NEW MATERIALS

SARAN

The vinylidene chloride resins, now known generally as Saran, are made from the basic raw materials—petroleum and brine. These resins can be injection molded and extruded, although they are not entirely restricted to molding. They are also used as an effective bond modifying agent. They are outstanding for their high tensile strength, resistance to living organisms (mold, bacteria, etc.), their toughness, high dielectric strength and resistance to fatigue and abrasion as well as to water and chemicals. Saran has been used for abrasive wheels, funnel tips, valve seats, lacquer pump pistons, hose connections, fuel pump parts, battery cases and medical vials. A great many different types of pipings and fittings are also made from Saran. Trade names are Saran, Velon, Vec and Mills Plastic.

HEAT RESISTANT LUCITE

This is a new formulation of Dupont's Methyl Methacrylate molding powder. This new acrylic maintains approximately the same mechanical, electrical and optical properties as the regular grades of methyl methacrylate. It varies mainly in its ability to take higher working temperatures than the usual acrylics, or indeed most other thermoplastics. Although test pieces have been successfully immersed in boiling water, this new Lucite should not be used for articles whose constant working temperatures are in excess of 200°F.

CEREX

This is another new material which has a high heat distortion point, providing parts that can operate at continuous temperatures of from 200 to 300°F. The material has unusual dimensional stability and an almost non-existent water absorption percentage. The mechanical properties of Cerex are about equal to those of polystyrene. It has good dielectric strength, extreme clarity and a wide color range, and has excellent chemical resistance. The more heat resistant the formulation, the more suitable this material is for compression molding because compression avoids premature setting and Cerex can be more safely handled at the increased temperatures necessary for successful molding. Monsanto formulates Cerex.

NYLON

Development in the last few years has yielded an exceptional injection and extrusion molding powder in Nylon. Although research is endeavoring to provide a range of tints and colors in Nylon, it is usually furnished in a translucent light cream color. This is one of the toughest of the plastics and is capable of withstanding elevated temperatures. Moldings of Nylon have great impact strength and resistance to abrasion. The material is not brittle and will take considerable abuse in actual use. The mechanical properties are excellent and it can be successfully injected in thin sections and is particularly successful with the use of metal inserts. Its resistance to water is good, but its dimensional stability under moist conditions is dependent largely on the shape of the mold, as the material picks up moisture rapidly and the type of molded surface determines the absorption point to a marked degree. Nylon is made by Dupont.

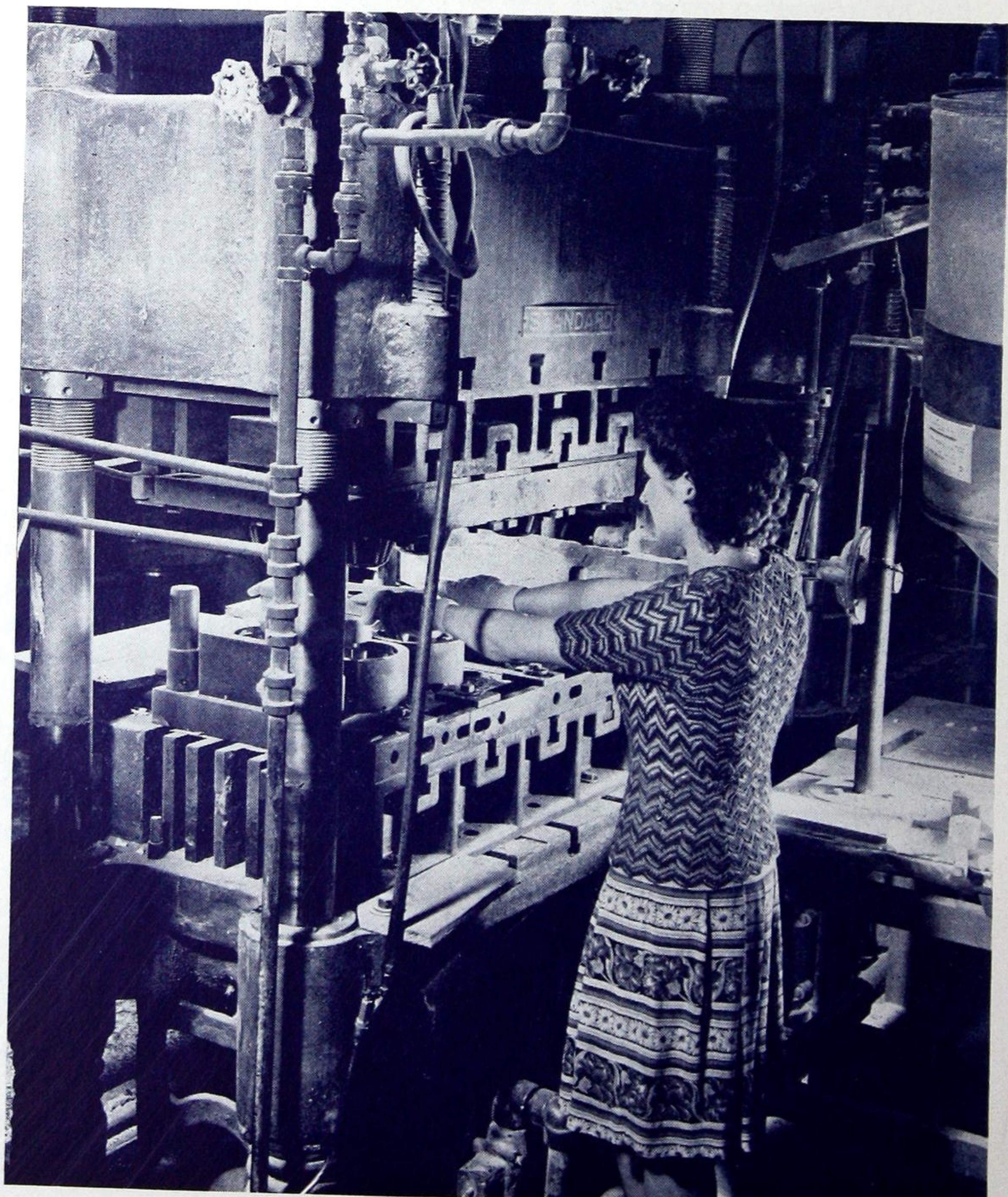
POLYETHYLENE

This is a remarkable new material whose full potentialities are not as yet realized. Like other plastics, these resins present excellent electrical insulation, and they are superior to other materials for use with ultra high frequency wiring cables. They are available in many colors, although the natural resin is a translucent white. Formulations are inherently flexible—the degree of flexibility being essentially independent of the average molecular weight of the resins. Polythylene resins possess extreme machineability and have a low moisture diffusion constant. They also maintain tensile strength and flexibility at sub zero temperatures.

MOLDING METHODS

COMPRESSION

Compression molding, the technique for handling thermosetting materials, and occasionally used for thermoplastics, requires the application of high heat and pressure. The compression department headed by Walter Fox, has more than sixty automatic compression presses and among them are several that will exert pressures up to 400 tons. Several of the presses have an extraordinarily long stroke making it possible to mold shapes that measure 18 inches high. The techniques developed over a period of over 30 years have made possible the molding of such unusual shapes as a spiral washing machine agitator—the only one of its kind so far molded from plastics—and a single piece of army equipment weighing 16 pounds. Watertown was one of the first molders to handle melamine successfully. In phenolics, literally thousands of intricate shapes have been molded, many of them containing up to 30 or more metal inserts.



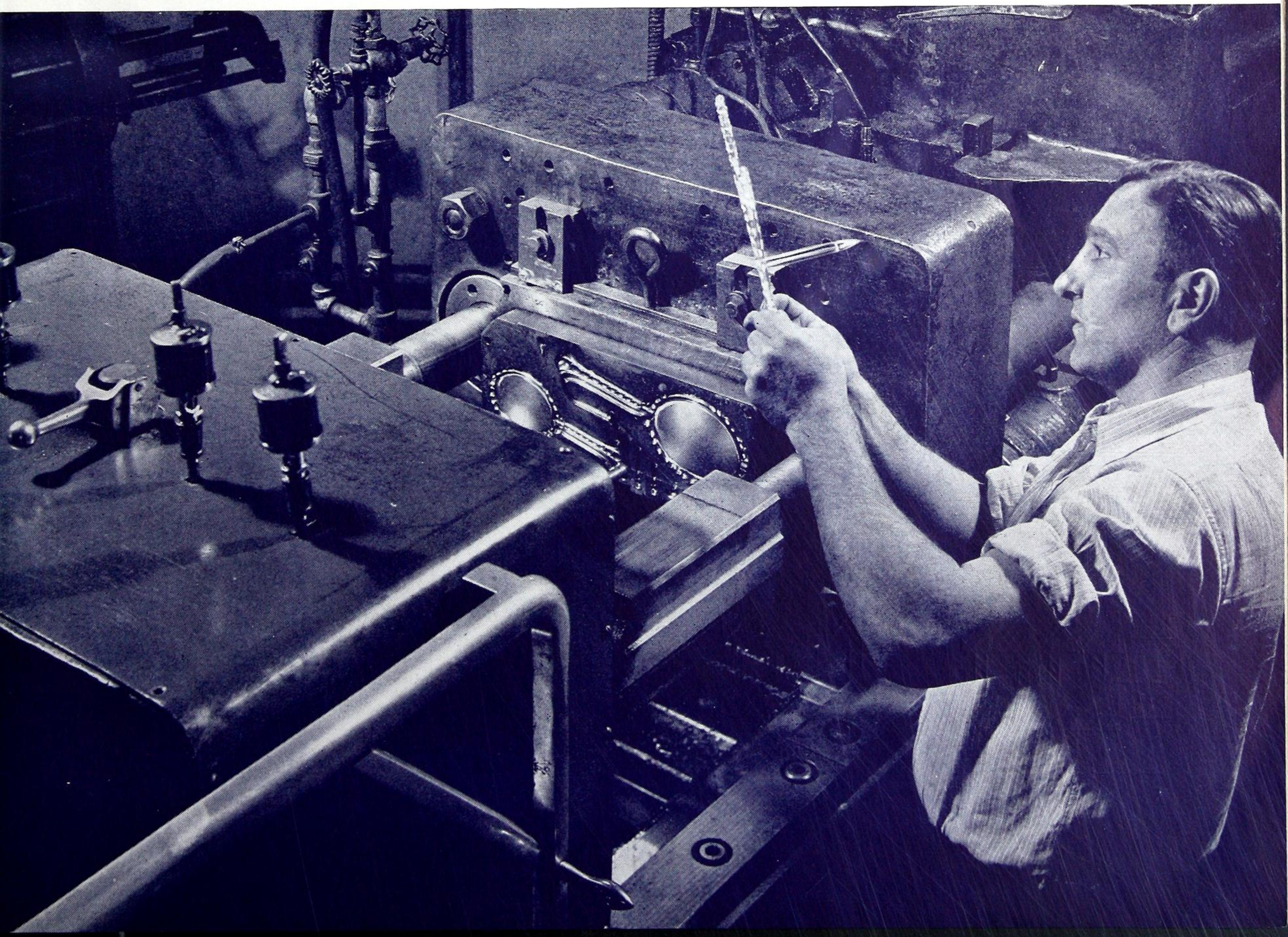
This view of one of the large compression presses at Watertown shows an operator removing a piece of molded Watertown Ware from one of the huge presses. The die is open and the operator's gloved hands are lifting the hot, finished dish from the female section of the die.

MOLDING METHODS

INJECTION

Watertown's battery of injection presses, under the management of Eric W. Soderberg, have handled all the thermoplastics and they have produced everything from novelty combs and goggles to coil forms and housings for radar equipment. The injection machine customarily employs multiple cavity molds which will produce anything from one to forty finished items at a single shot. The operation of the modern injection machine is speedy, streamlined and efficient. The material, usually in granular form, enters the machine through a feeding hopper where carefully controlled heat converts it to a thick viscous mass which is injected into the mold cavities. The mold opens and the molded articles, connected by gates and runners, drop out and are immediately detached from the connecting runners and marked for the finishing department.

This complete dresser set, molded from methyl methacrylate, has just been removed from the injection mold. While the next set is being molded, the operator will cut these pieces from the gate.



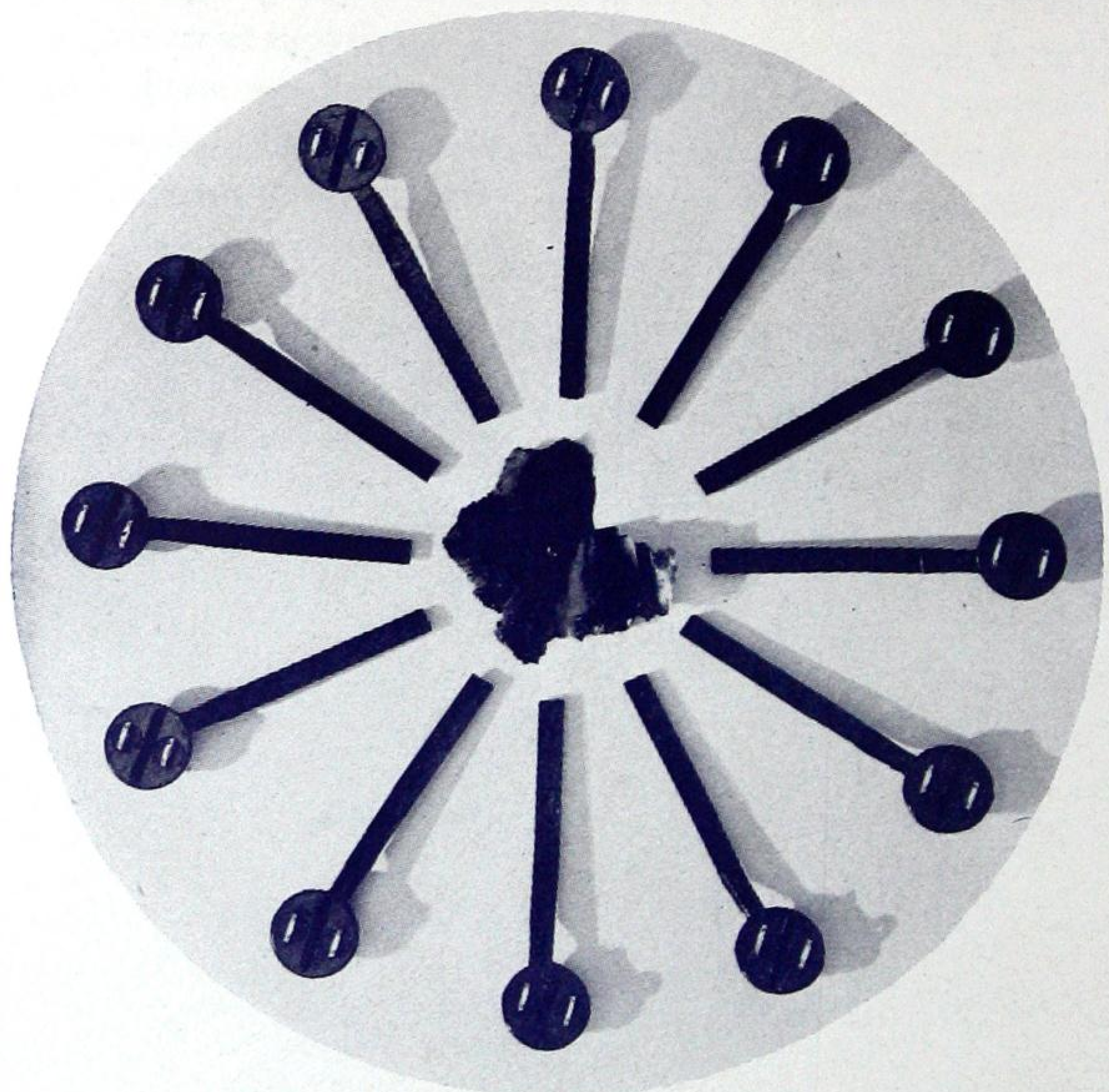
MOLDING METHODS

TRANSFER

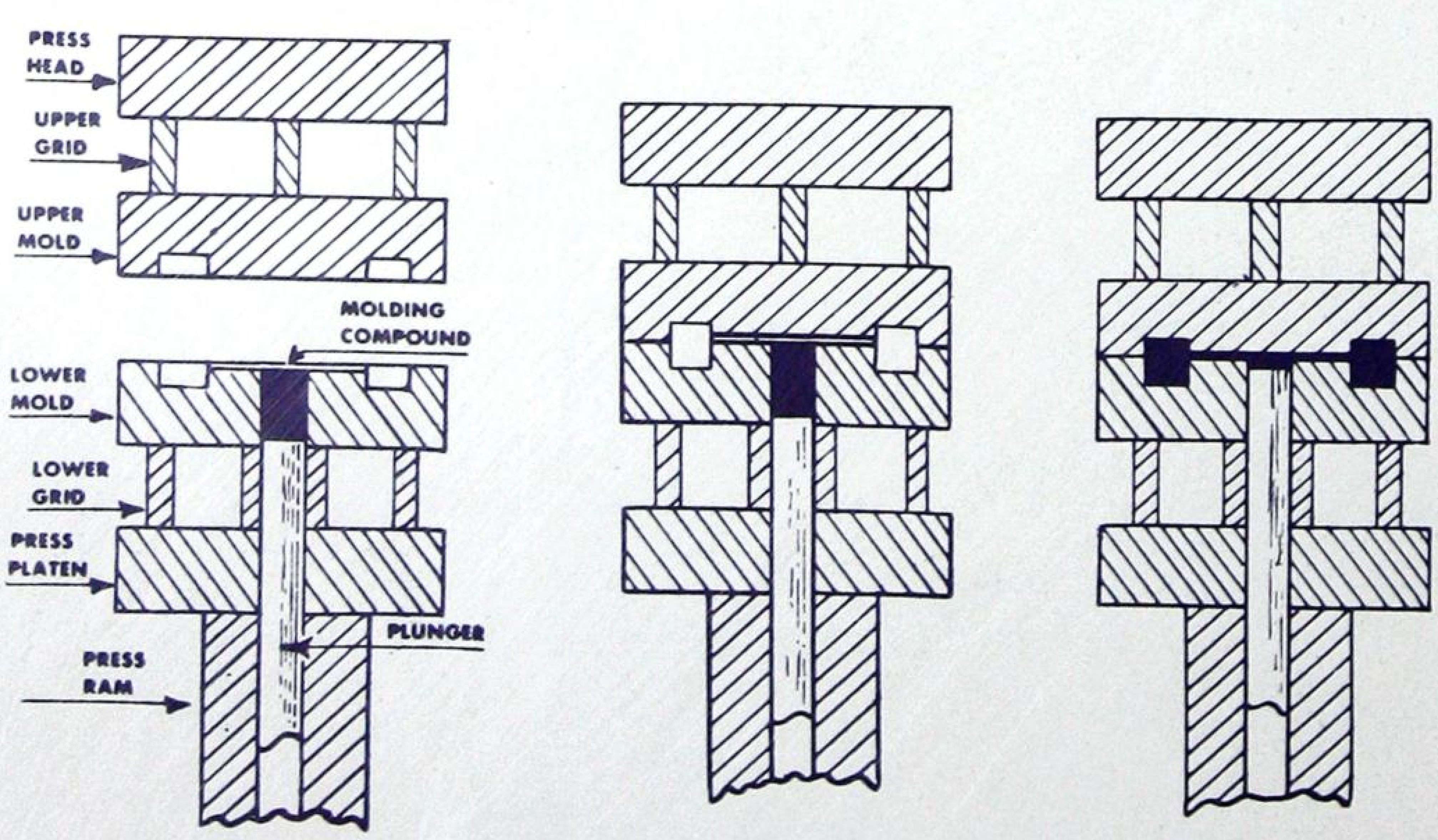
Transfer molding is used for handling thermosetting materials and is customarily employed when extremely close tolerances must be held on small or medium sized shapes. A transfer mold may have anything from one to thirty cavities, employing inserts or not, as the application indicates. Preheated preforms are frequently used in transfer molding at Watertown, particularly for electrical parts. The high frequency electronic preheating (the Megatherm) is particularly useful when a small but intricate shape embodies many metal inserts, since the previously softened material eliminates a great deal of breakage.

NEW TECHNIQUE

Over a period of several years, Alexander L. Alves, Watertown's Assistant General Manager, has developed and perfected a new type of press for transfer molding. This press utilizes a new principle, including a plunger within the press ram which offers a great many improvements in transfer molding and effects a new efficiency. Not only does this method practically eliminate flash and fins, but it cuts the travel stroke considerably and yields moldings of unusual accuracy.



The photograph shows an exceptionally intricate molding from a twelve cavity die, each separate part embodying two metal inserts. The flake-like piece in the center shows the very small amount of flash resulting and the runners to each round part are so thin as to be insubstantial. The runners and excess flash were so small that it was difficult to photograph them. The drawings shown below illustrate the general principles of the press with the mold open and closed.



THE NEW PRESS:

- Utilizes full stroke of press
- Enables operator to clean dies readily
- Enables operator to place inserts easily
- Minimizes breakage of insert pins
- Cuts tooling costs
- Eliminates nozzles
- Eliminates transfer bushings
- Cuts friction losses
- Utilizes lower molding pressures

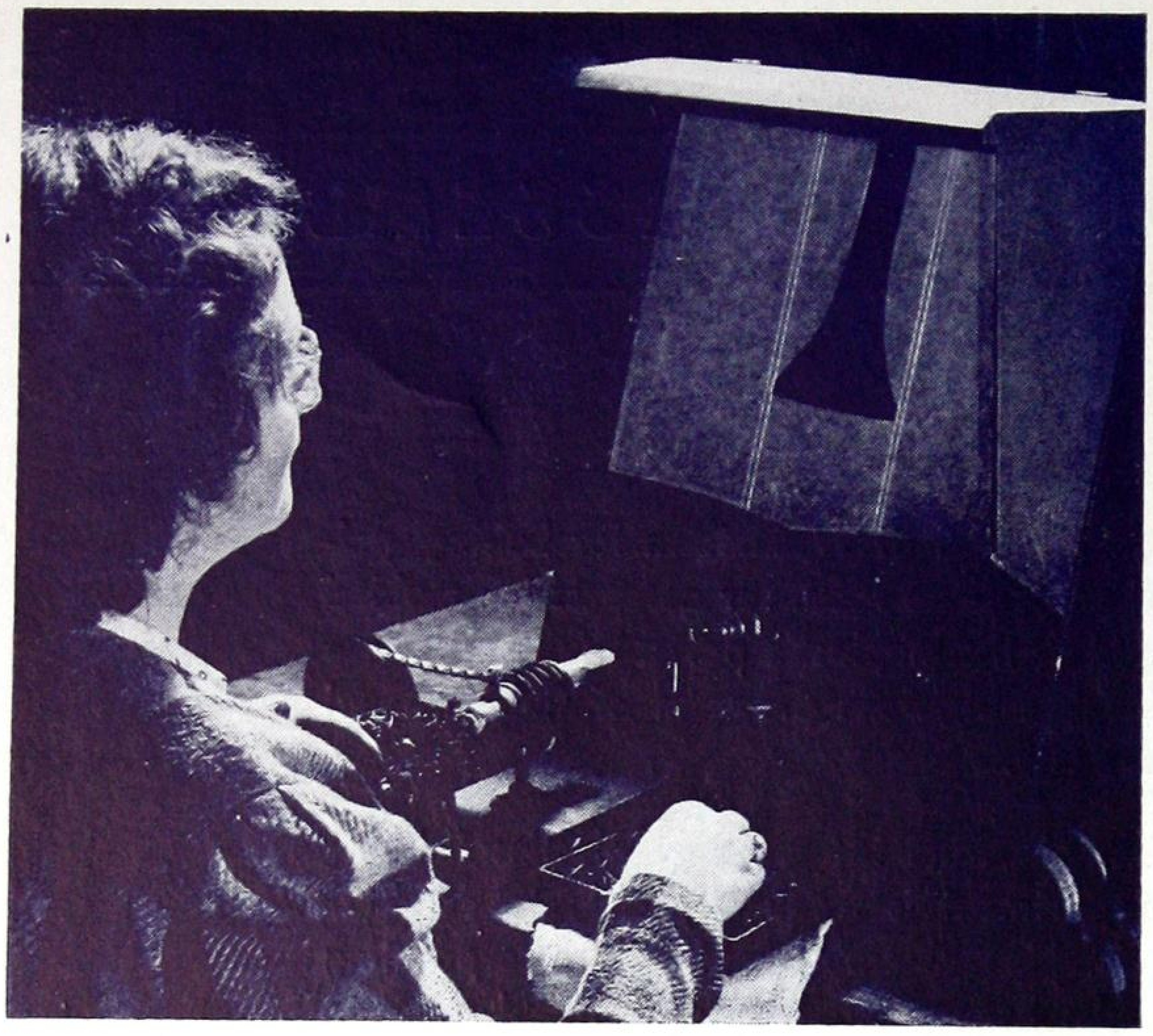
BUFFING ● FINISHING ● ASSEMBLY

Two complete finishing departments are maintained at Watertown for buffing, polishing, finishing and assembling of molded parts—one room for compression molded parts and the other for the injection molded or thermoplastic parts. When parts are ready for shipment they have been through a rigorous program of finishing and inspection that insures highest quality in each one.

Although a particular problem may be remote from the average plastics finishing job, Eugene Beadle, supervisor of this department is frequently able to establish methods that will yield satisfactory results. Line assembly methods, incorporating power tools, are used wherever possible and subsequent savings are passed along to the client. Among the operations handled with infinite care by trained and skillful employees are definning in barrels, drilling, tapping, machining, assembling and thorough inspection. With each year of custom molding, Watertown has added new functions and new methods to their finishing rooms and in many cases have invented special machinery for handling exacting jobs.

The bomber tool box (illustrated on page 38) is a good example of efficiency in line assembly (see picture following page). Hinge and lock holes were drilled and tapped, the cover and base were assembled, the completed unit inspected and packed at one long table, the parts being passed from one position to the next. Valuable time was saved in eliminating all unnecessary handling of the large sections.

The modern anti-aircraft shell utilizes a phenolic plastic hammer on which the Navy requires rigid inspection. Specifications call for chucking .150 of the stem and indicating the eccentricity at the head. The total reading must not be in excess of .020. It was necessary to design a quick but accurate method of inspection and a shadowgraph is employed. The part is placed into a chuck for rotation of the pin and the



This illustration shows the Shadowgraph which measures the concentricity of the very tiny firing pins. The Shadowgraph enlarges the pin 30 times and any section extending beyond the white line means that the pin must be rejected.

(Continued from page 15)

size of the hammer is multiplied 30 times in the shadowgraph. When the hammer rotates, its shadow moves across the screen between fixed lines and any measurements exceeding specifications reflect outside the fixed lines and can be immediately spotted and the part rejected (see illustration above).

Another Watertown innovation was the molding and assembly of an efficient light meter, one very real contribution of the plastics industry to the field of photography. The meter contained many intricate parts which were molded, assembled with other components, inspected and packaged ready for distribution.

The final cost of finishing plastics parts varies greatly in accordance with the standard of quality desired by the customer. One illustration of this is the two very distinct finishes required by different classes of articles. Flat iron handles, radio cabinets, clock cases, cooking utensil handles and knobs may be very satisfactory to one customer with the high lustre produced by the compression press and well polished molds. Another customer who manufactures deluxe models of the same items may require a mirror finish, which is produced by a series of operations designed to obliterate seams and to polish. The cost of these operations varies depending on the molders interpretation of "deluxe standard". At

This is a roll automatic stamping device for labeling and numbering molded sections of either thermoplastic or thermosetting materials.

An illustration of assembly line inspection and assembling of the two heavy sections, lid and base, of the bomber box.

(Continued from page 16)
Watertown when "deluxe standard" is specified the ultimate in polishing is furnished.

It is important that a clear understanding with the molder and finisher be established on required standards of quality at the inception of any job. It will eliminate mid-order price increases and insure satisfactory, ready-to-use parts. The Sonotone Hearing Aid Case (illustrated on page 36) is an excellent example of the highest standards of buffing and accuracy in assembly and inspection.

In addition to Shadowgraph inspection for perfect concentricity, each firing pin undergoes rigid inspection. Porosity or any imperfection is quickly detected.

Here the gate is being removed and the spot polished on Lucite mirror and brush handles.

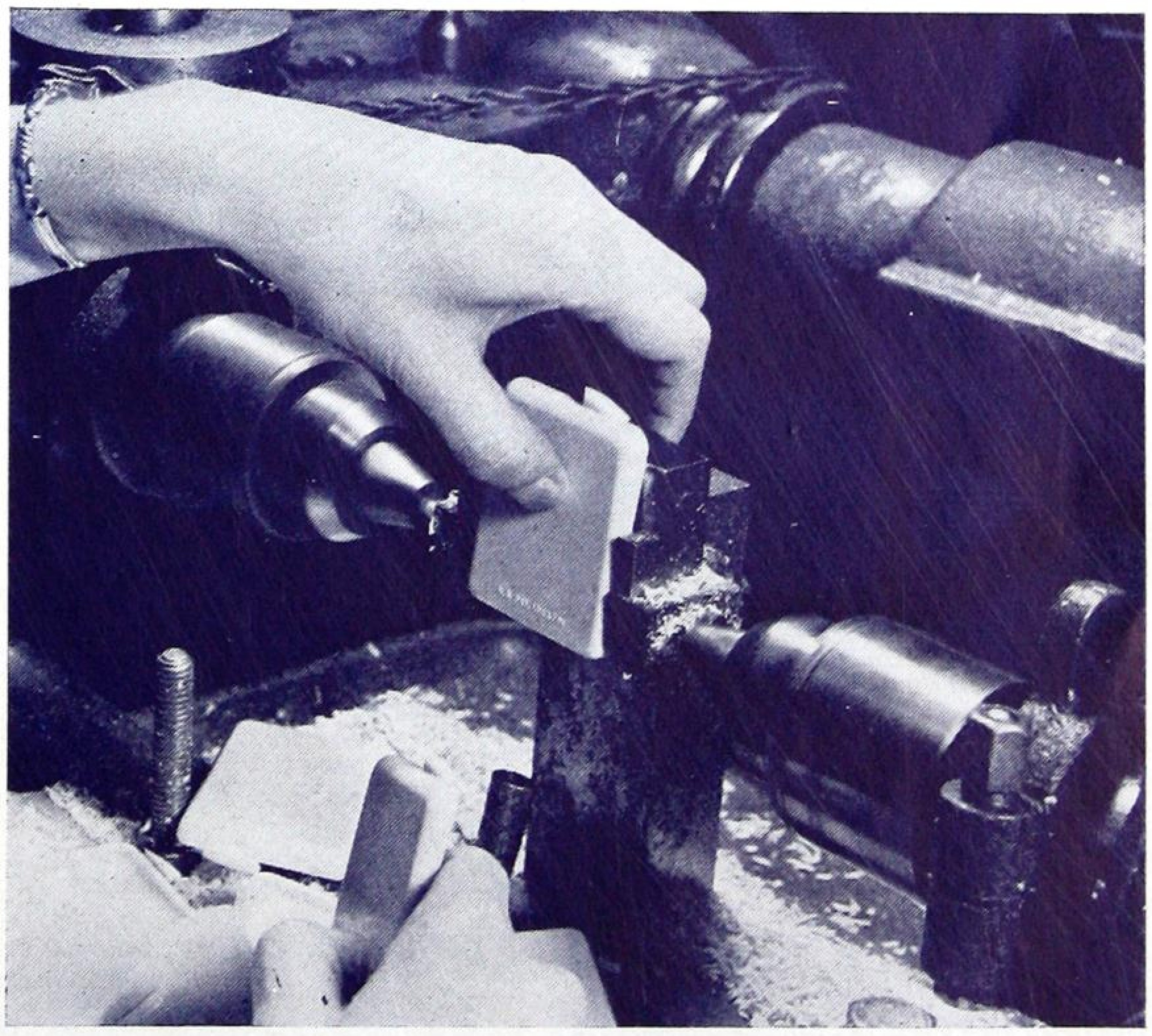
1945 SPECIFICATIONS

Rigid standards are maintained and among the many specifications that are met, the following are noteworthy:

Drilled hole sizes can be kept to a tolerance $\pm .001$ in. Tapped holes can be held to American National Class No. 2 fit. Machining tolerances are held to $\pm .0005$ in.

Parts molded and finished by Watertown are reliable. Inspection insures that threads will be true, fittings exact and holes will have the required measurement and position. The cost of extra operations, that insures accuracy and satisfaction, is saved many times over by eliminating work stoppages, extra drilling, tapping or gauging in the customer's own plant.

Watertown's finishing and assembly rooms have many other functions than those illustrated here and employ various methods including line assembly, manual and automatic devices initiated at the Watertown plant. Several very ingenious machines have been developed, which are exclusive with Watertown to perfect and speed up inspection and finishing. Because of their exclusive design they cannot be illustrated.



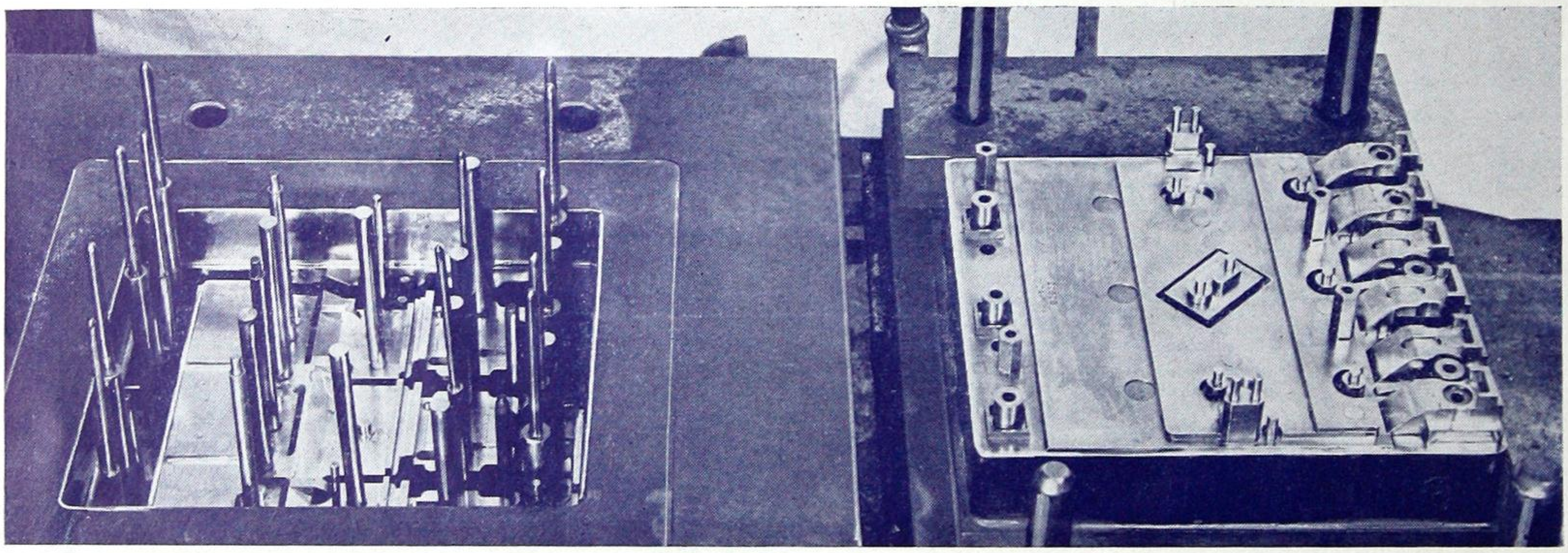
In this illustration very fine holes are being drilled to accommodate a hinge where two molded parts are to be assembled into a small case.

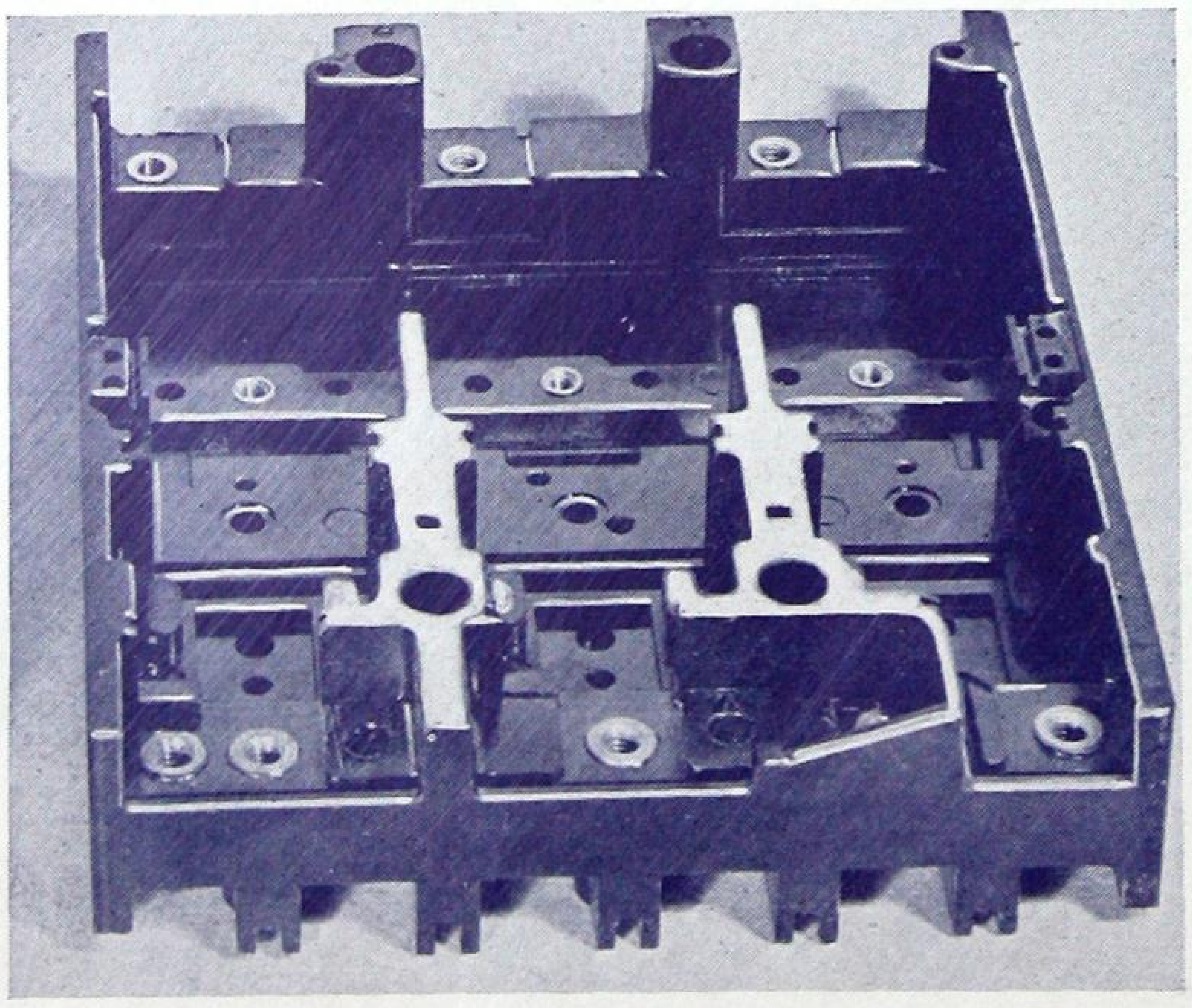
ENGINEERING

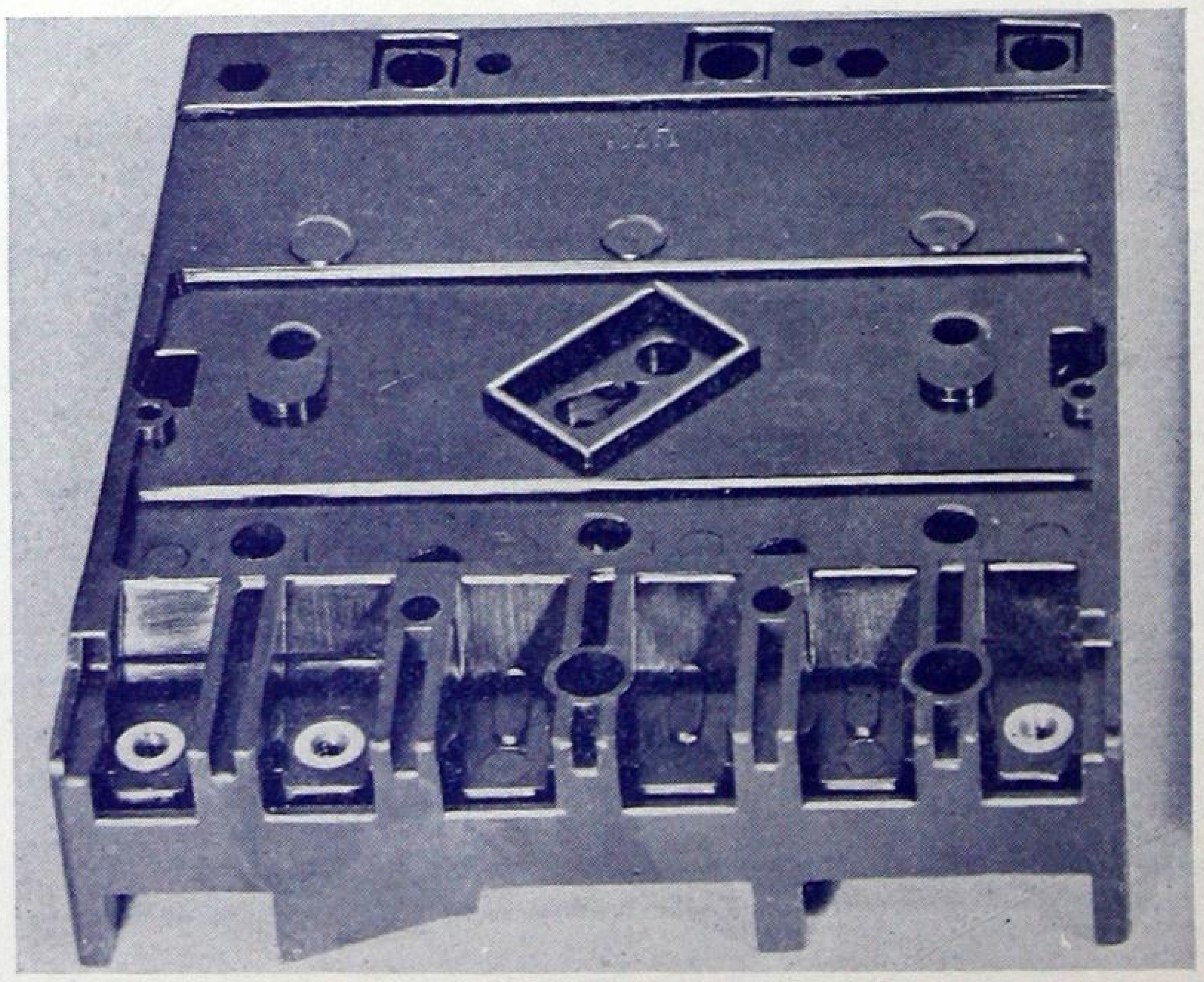
The design of an article is the first consideration of Watertown engineers and this involves not only consideration of dimensions and form but choice of material as well. Design is the most important factor in the success of any molding because poor basic design is often the cause of lagging production. A slight change in design may cut the cost of building a mold, molding the part or finishing. Tooling up for the job is made much easier when preceded by intelligent planning and sound design. The preliminary steps include discussion of the part to be molded, agreement between customer and molder on tolerances and the selection of correct material and formula. The actual design of tools has then been simplified and many headaches eliminated at the outset. In handling a molding job at Watertown the accustomed procedure is as follows:

Discussion of design and functions of the part with the customer and building a model.
Choosing material and formula.
Construction of a single cavity mold.
Testing the molded part from this cavity to insure satisfactory performance under actual operating conditions.
Construction of the multiple cavity mold based on estimated requirements of production and experience obtained from the sample cavity.
Actual molding of the article by compression, injection or transfer, which ever method is most suitable for the part and to the material involved.
Finishing and assembling.

Below are shown pictures of a very intricate mold and the phenolic part that was molded. This section is a 3 pole switch designed and molded for the Trumbull Electric Company for a permanent industrial installation. Molded in a single cavity mold of Durez material, the part contains 11 metal inserts and as many intricate ridges and cavities, including 13 deep tubular openings.





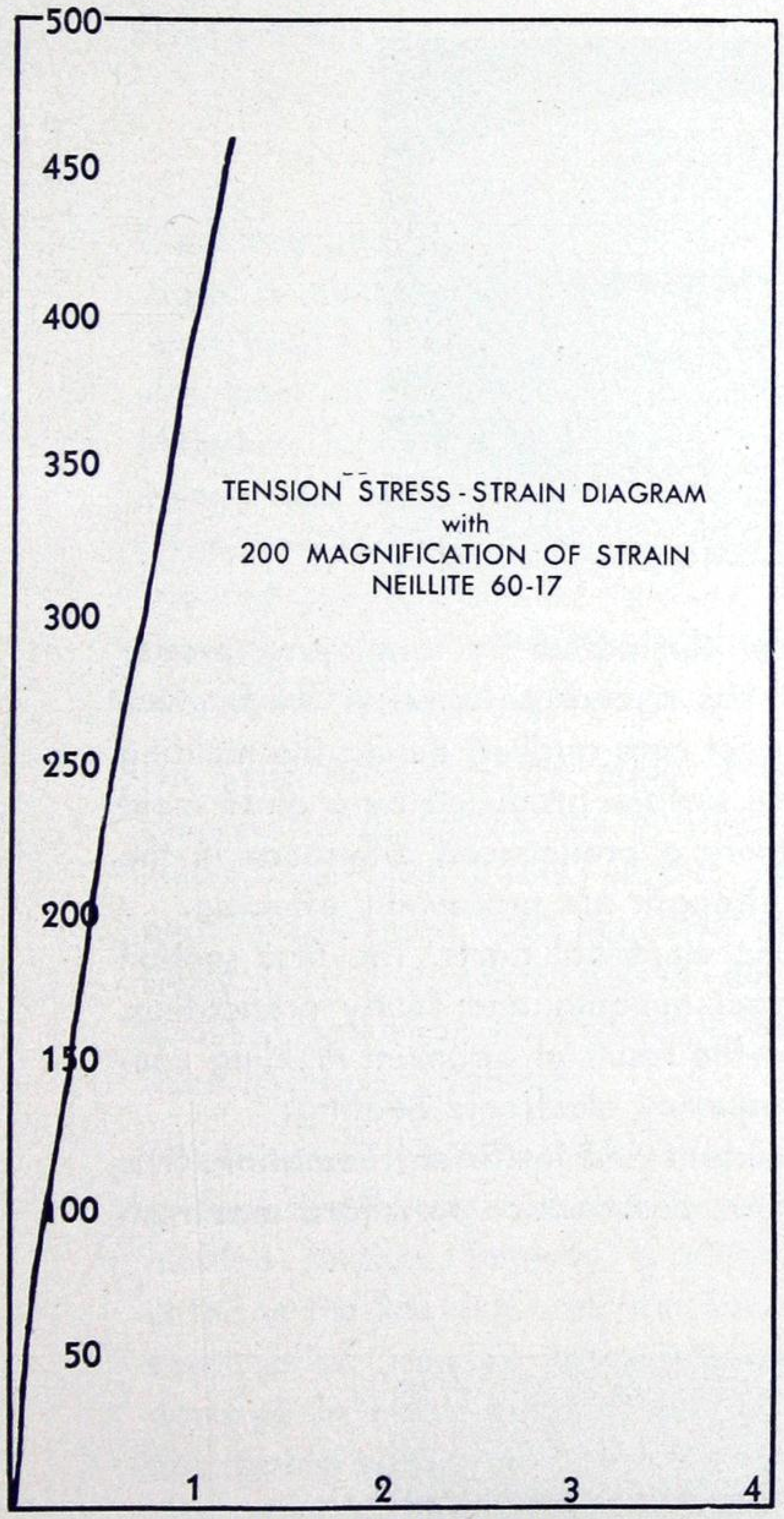


ENGINEERING

GRAPH I

STRESS-STRAIN CURVE

This stress-strain curve was obtained using a Tinius Olsen Plastiversal with a 200 magnification extensometer. The material used was Neillite, woodflour filled. By the use of such magnification it is possible to evaluate more closely the stress-strain relations of phenolic material. This particular material had an elongation of 0.005 of an inch per inch just before the tensile piece reached its ultimate strength. It is obvious that such a degree of magnification (or greater) is necessary in order to get a stress-strain curve suitable for analysis. It is only through basic knowledge that the physical properties of material can be adequately determined.

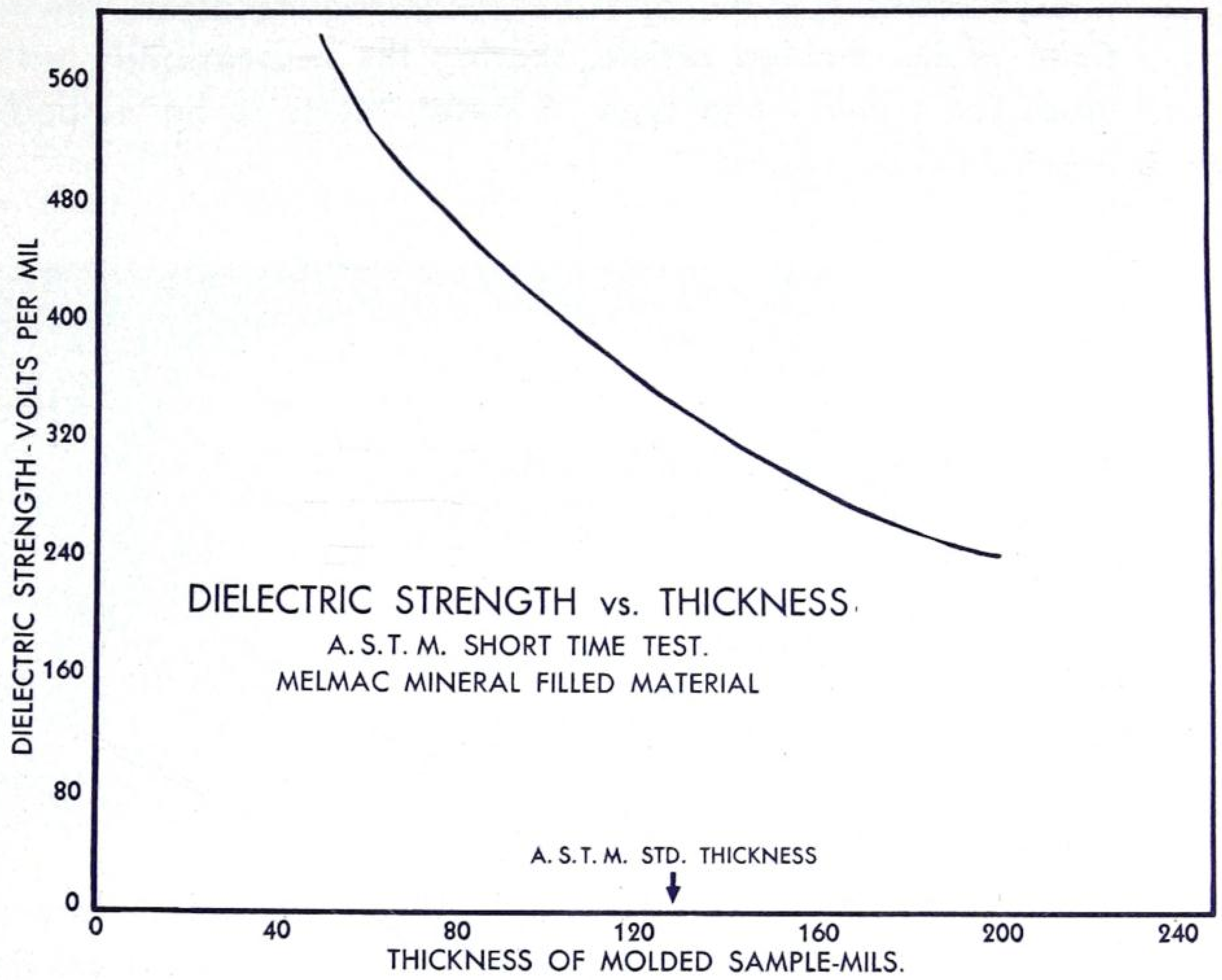


Using the Tinius Olsen Plastiversal with the high magnification extensometer with different types of fillers and resins at various temperatures, basic information is obtained relative to the use of these materials in designing applications where various stresses and fatigue considerations must be obtained in order to deliver a consumer item with adequate functionality.

GRAPH II

DIELECTRIC STRENGTH vs. THICKNESS

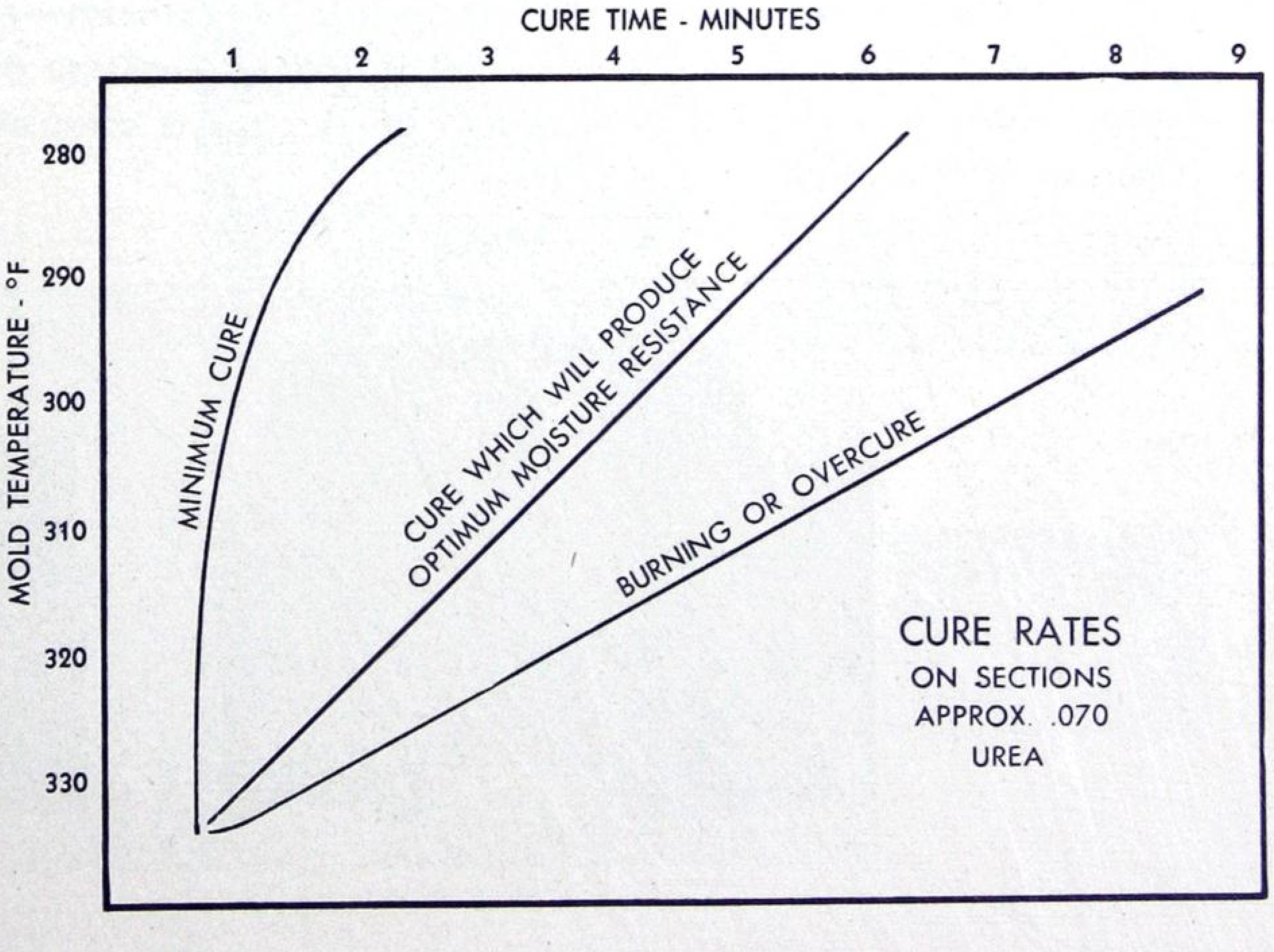
This graph indicates the variation of dielectric strength with thickness. The type of material used was a melamine formaldehyde resin with a mineral filler. The method used was A.S.T.M. short time test. This indicates quite clearly that the dielectric strength, expressed in volts per mil, varies considerably with the thickness of the molded sample. This factor has to be taken into consideration in the design of a molded article which is subjected to dielectric strength stress, since the data given in the properties chart is obtained with 0.125 inch thick disc.



GRAPH III

CURE RATE ON A SECTION APPROXIMATELY 0.070 THICK

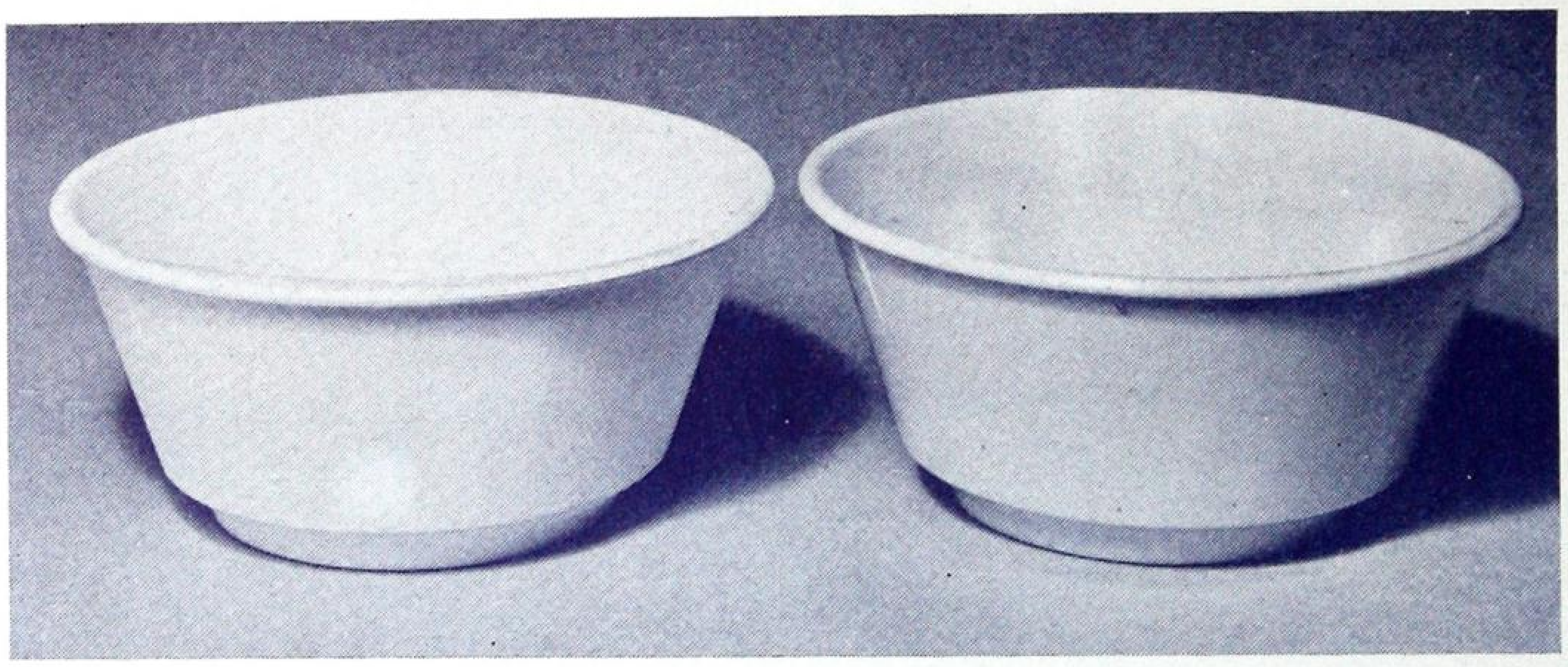
It is possible in the case of urea materials to overcure the piece, resulting in the lowering of the physical properties. So, therefore it is quite important in the molding of urea material that the proper cure time at a given temperature be used in order to get the optimum moisture resistance. Moisture resistance is an excellent criterion of good molding of urea material. These cure rates are all based on sections approximately 0.070 of an inch thick.



ENGINEERING AND TECHNIQUE

Watertown's tool room, headed by Richard Van Riper, is completely furnished with modern equipment, such as a Gorton Duplicator and the latest precision grinders, lathes, milling machines and all the tools necessary in a modern plastics tool room. Everything necessary to accomplish the most difficult hobbing is available. Watertown toolmakers can successfully construct all of the tools which are handled by injection, compression, and transfer presses.

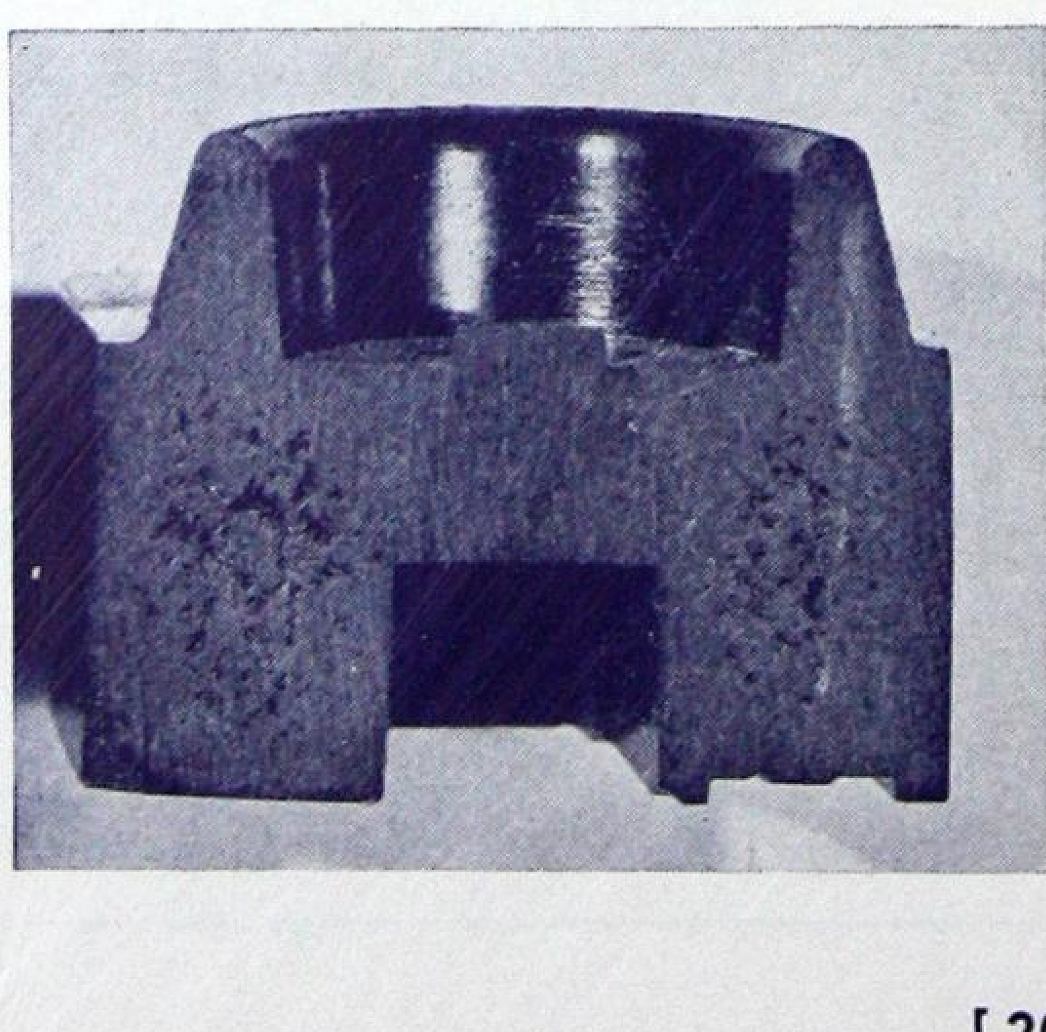
Specially developed techniques are necessary in the handling of each different material and these must be taken into consideration when the mold is designed and made. Each material has its own idiosyncrasies that demand particular consideration. The surface of the mold helps to determine the finish of the molded article, sharing the responsibility with the characteristics of the basic material used. The number and type of metal inserts to be embodied in the article, and their position also require consideration.

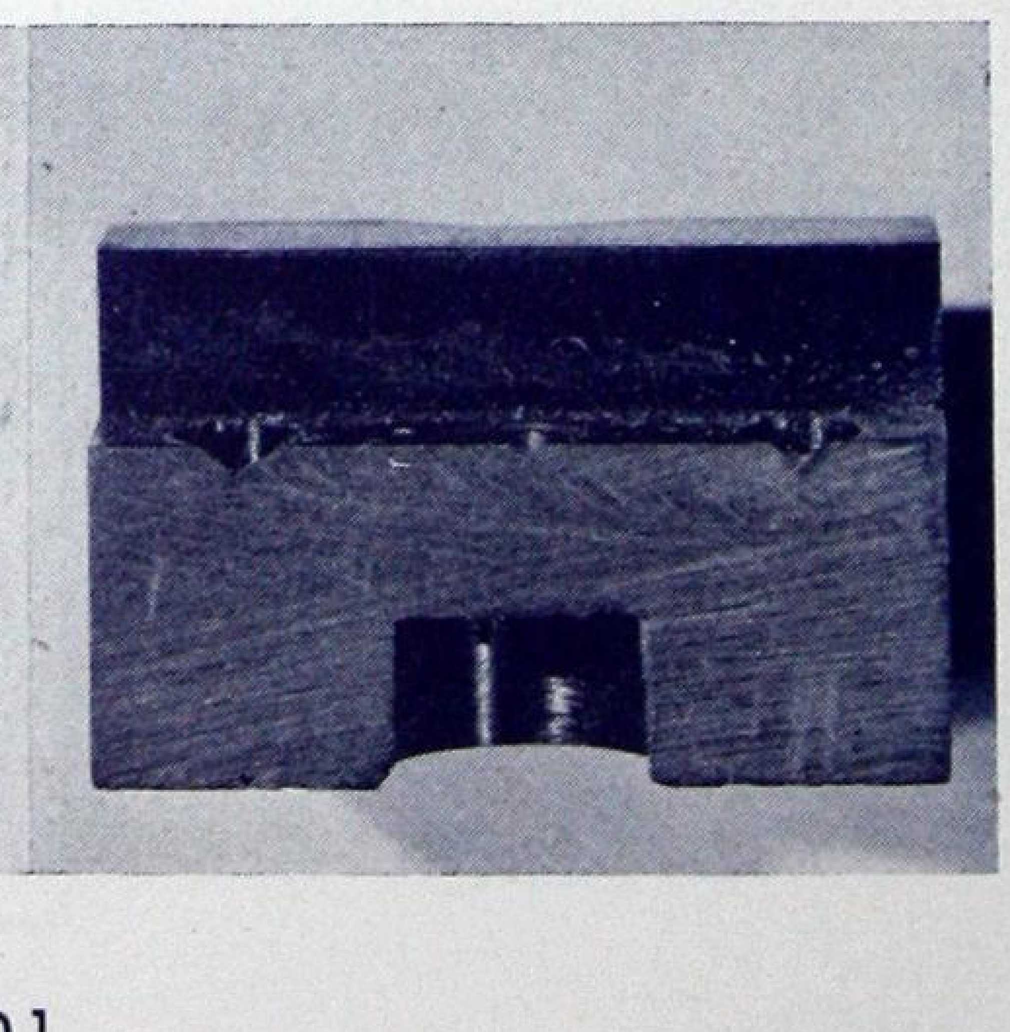


In these pictures we illustrate two molding faults that can be eliminated by employing proper techniques. In the upper picture the Melamine bowl on the left has a chalky, lustreless finish which was caused by a combination of poor mold surfaces and incorrect cure applied during the molding process. The bowl at the right shows the highly lustrous, handsome surface produced by a good mold and the correct application of heat and pressure. Not only is there a pronounced difference in the finish of the two bowls but the utility and wearing qualities and strength are profoundly affected.

The second picture shows a cross-section of two molded phenolic electrical parts. The first section indicates definite porosity throughout the section due to incorrect molding and faulty preheating. The right hand part shows a completely homogeneous structure—the result of optimum molding conditions and preheating accomplished with Megatherm—high frequency electronic heating.

Porosity, particularly in electrical parts, causes leakage of the current and inefficient insulation. It is particularly important that electrical parts have a completely dense construction to afford maximum service in operation.





ENGINEERING AND X-RAY

The Norelco Searchray—an idustrial X-ray machine especially adapted for plastics—is used in the Laboratory as a new tool in Watertown's search for perfection in plastics production. The Searchray quickly detects molding faults, incorrect position of inserts and structural defects in intricate molded parts. It is possible to determine density in a molded section. One big advantage of X-ray examination is that the part does not have to be destroyed or cut open to detect flaws in the finished article. It also shows up any foreign metal particles that may have found their way into the part, which might reduce the electrical resistance of a section and lower its insulation value in actual operation.

The X-ray pictures shown here indicate one of the many tests applied to Watertown moldings. The negative of the socket shows the absolute uniformity of the inside structure and the accuracy of the position of the inserts. It insures uniform electrical qualities in operation because the material is homogeneous throughout.

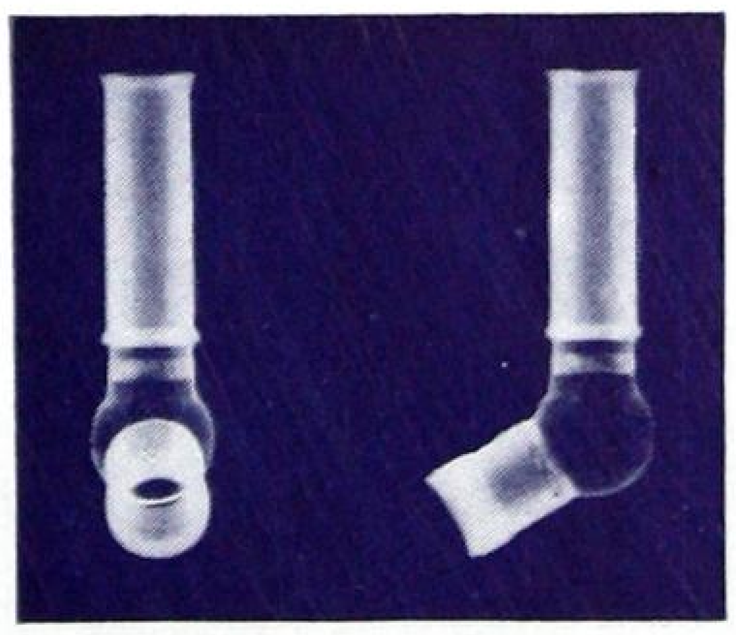
The X-ray photograph of the small elbows shows a molding that is really a plastics insert molded within a metal housing. This was part of a wiring harness made of Melamine inside a metal elbow. The X-ray reveals the continuity of the molded material and shows that it is uniformly distributed and contains no voids or fissures. The only way such a molding could possibly be checked is by using X-ray.

The little knob with the metal insert was checked to determine the position of the metal insert within the plastic, and the photograph shows that the insert is absolutely true and will therefore not cause strain in operation as it would if the insert were improperly seated.

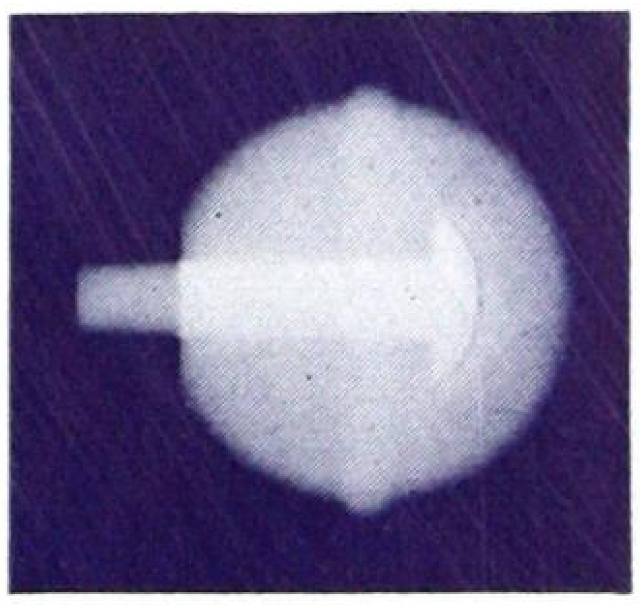
The X-ray of the contact block shows up a pronounced change of density within the molded section. Porosity is clearly indicated in the less dense section. Such faulty construction could cause considerable damage in many parts that require certain stable properties in continuous operation. Here again is another case where a molding on the surface seems adequate and its faults can only be determined by X-ray or by cutting through the complete length to determine the structure of the material.

SOCKET

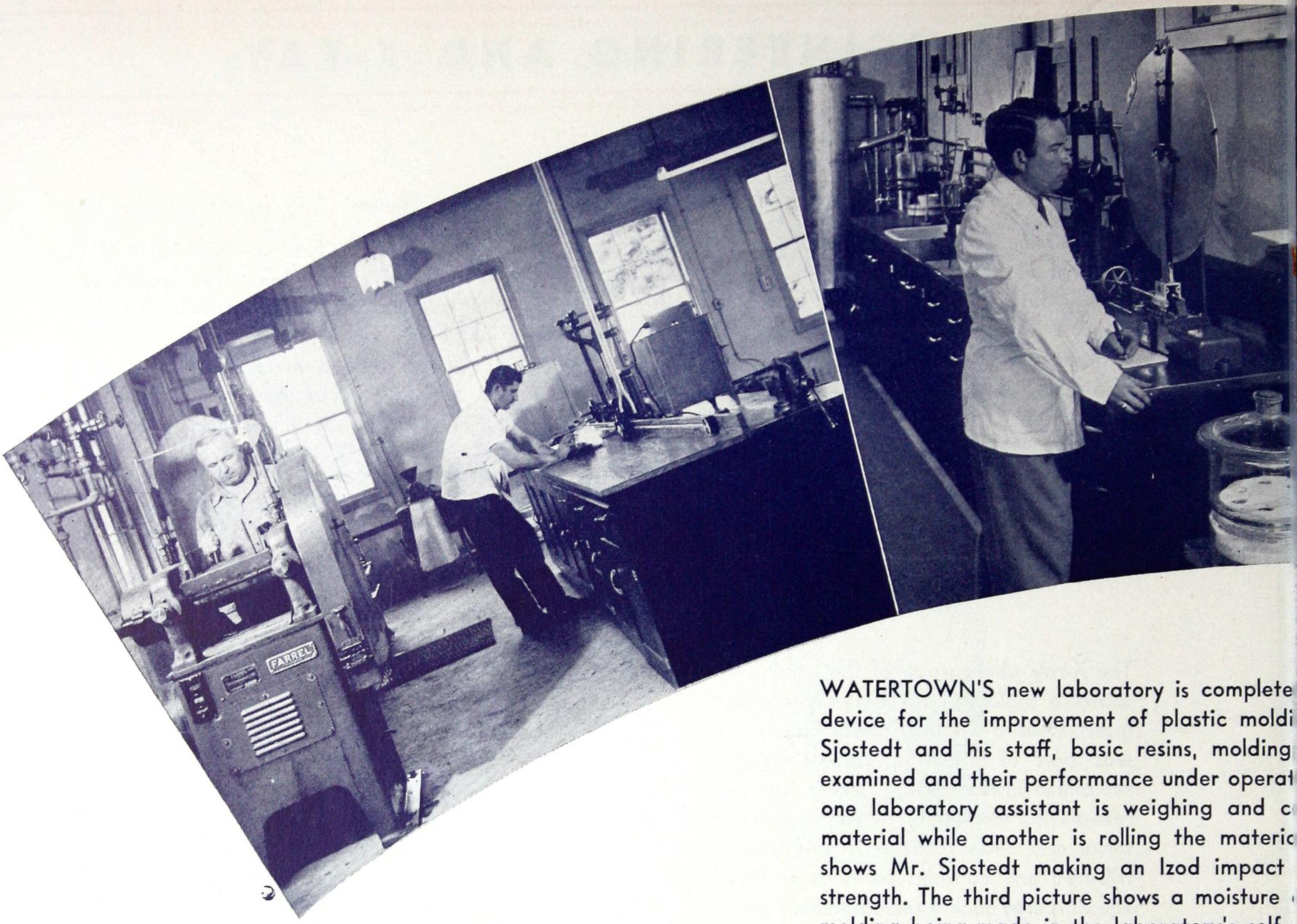
ELBOW



KNOB

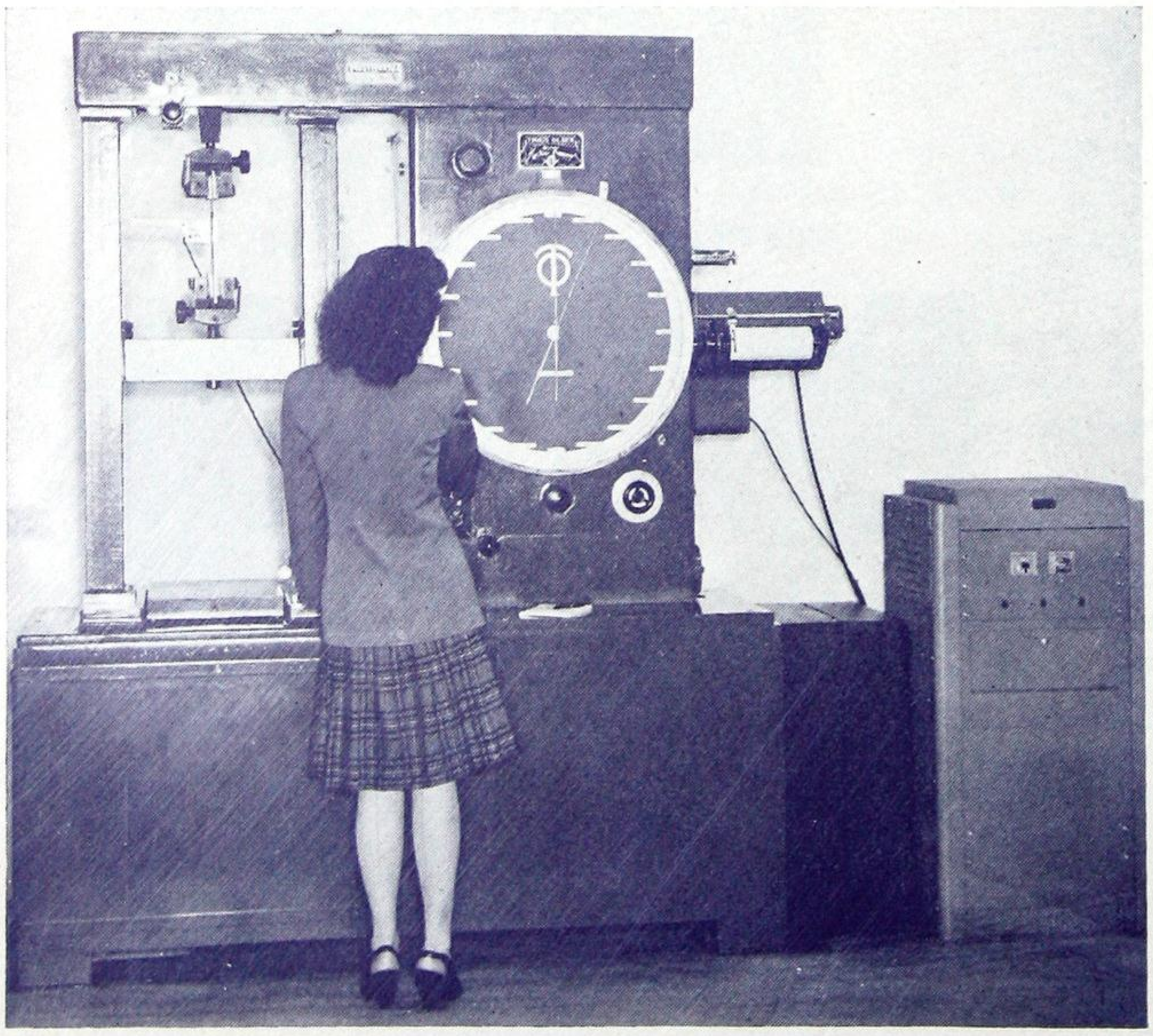


CONTACT BLOCK



WATERTOWN'S new laboratory is complete
device for the improvement of plastic moldi
Sjostedt and his staff, basic resins, molding
examined and their performance under operat
one laboratory assistant is weighing and c
material while another is rolling the materic
shows Mr. Sjostedt making an Izod impact
strength. The third picture shows a moisture
molding being made in the laboratory's self

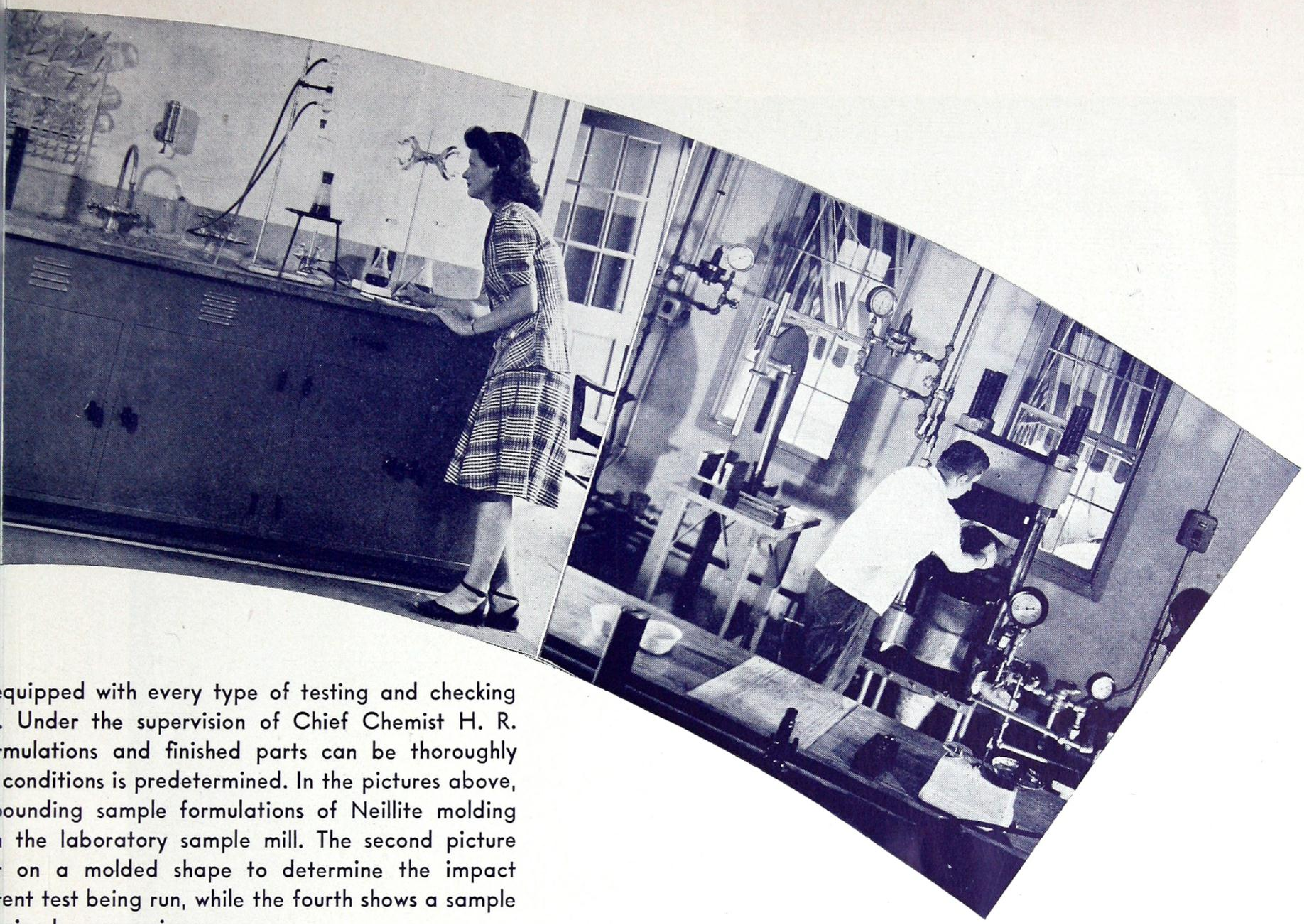
SPECIAL LABORATORY EQUIPMENT



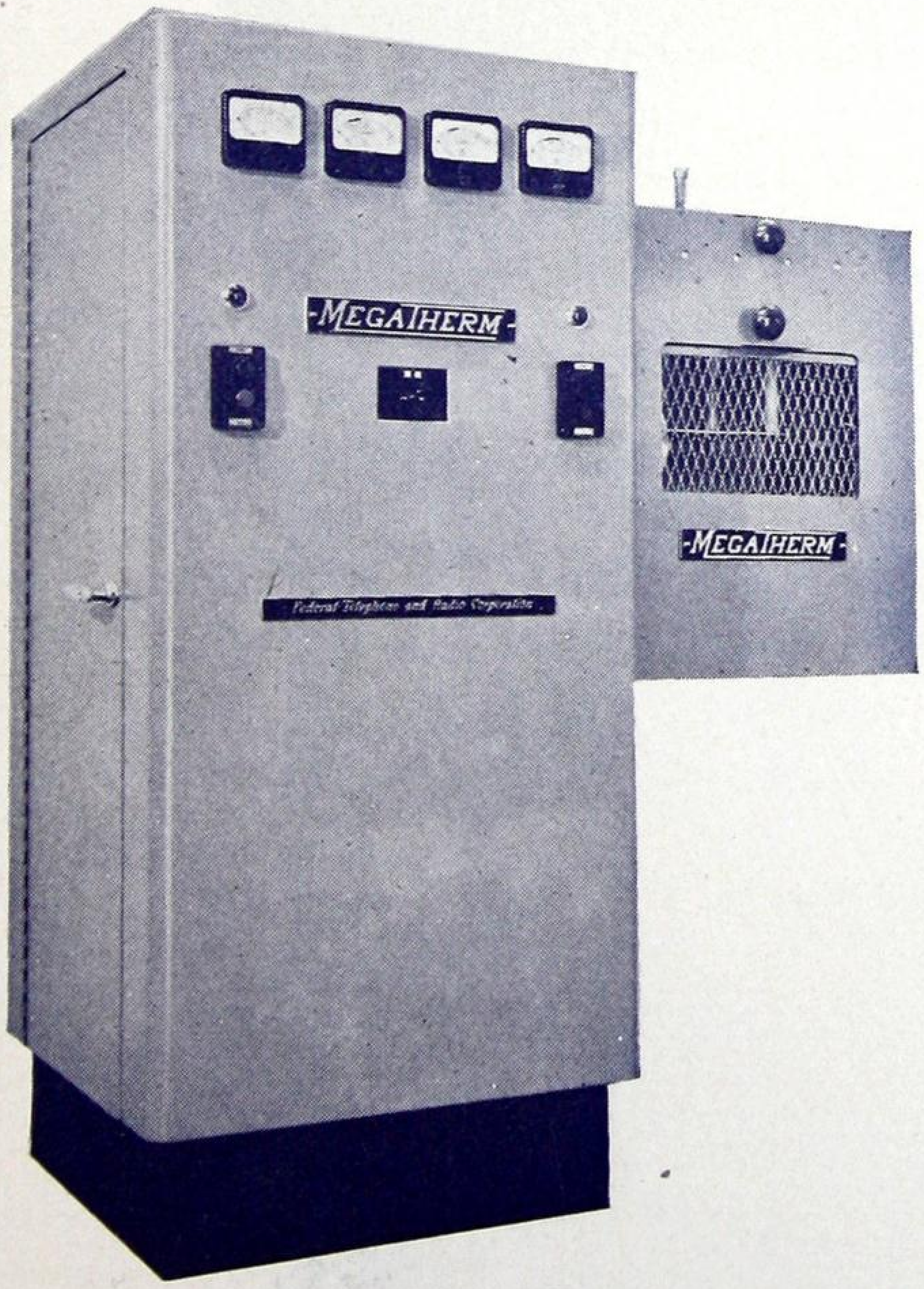
THE TINIUS OLSEN PLASTIVERSAL

The PLASTIVERSAL is a testing machine to determine quickly the various strengths of a molded part. It gives immediate and accurate readings on flexural, tensile, compressive strengths, and stress and strain curves, and the modulae of elasticity. This machine was designed specifically to test plastics and is a highly effective aid in handling fatigue problems.

EW LABORATORY



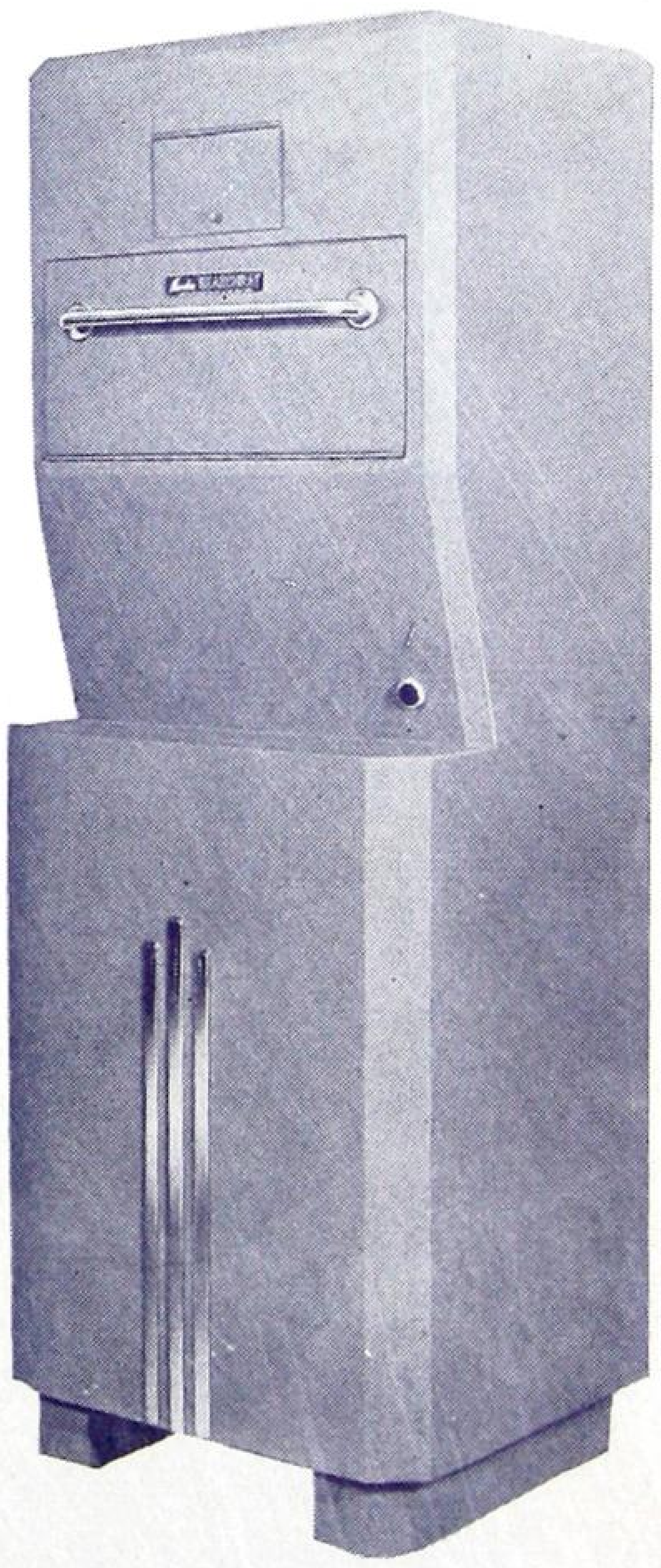
equipped with every type of testing and checking . Under the supervision of Chief Chemist H. R. rmulations and finished parts can be thoroughly conditions is predetermined. In the pictures above, pounding sample formulations of Neillite molding the laboratory sample mill. The second picture on a molded shape to determine the impact rent test being run, while the fourth shows a sample ained compression press.



FEDERAL TEL. & RADIO CORP. MEGATHERM

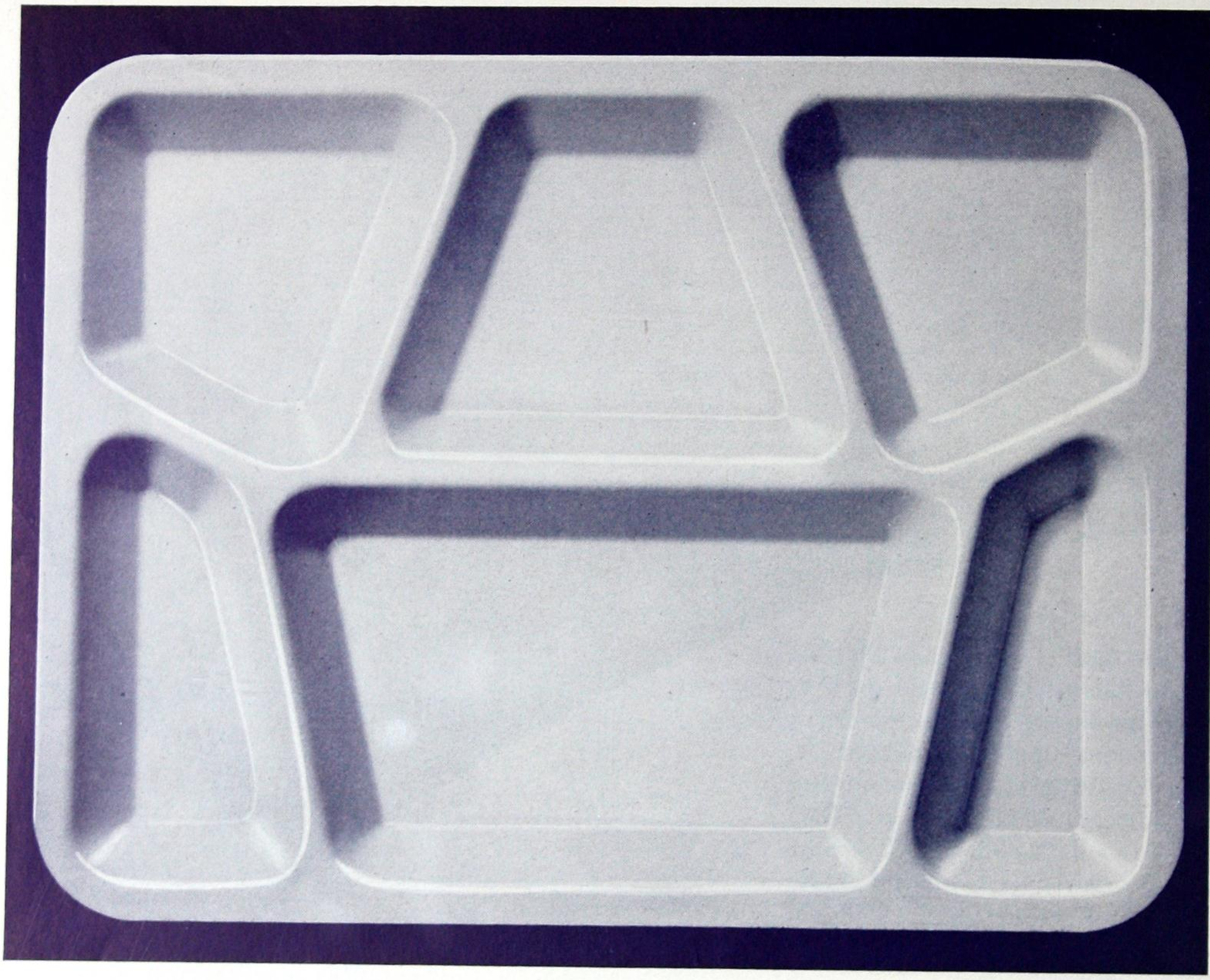
The MEGATHERM is a high frequency electronic machine used for preheating preforms. This new method insures uniform preheating of the molding material, as the heating penetrates the entire preform and does not affect only the surface, as in the oven method of preheating. High frequency preheating aids considerably in producing molded articles with a homogeneous structure and can, in some cases, reduce the curing time.

The NORELCO SEARCH RAY is a new electronic compact X-Ray unit especially designed for the safe, rapid inspection of parts and assemblies. The X-Ray is invaluable in checking plastic parts for it shows up immediately fissures, strains, porosity and stray metal inclusions that might cause damage, particularly in electrical equipment.



THE NORELCO SEARCH RAY

STOCK MOLDS



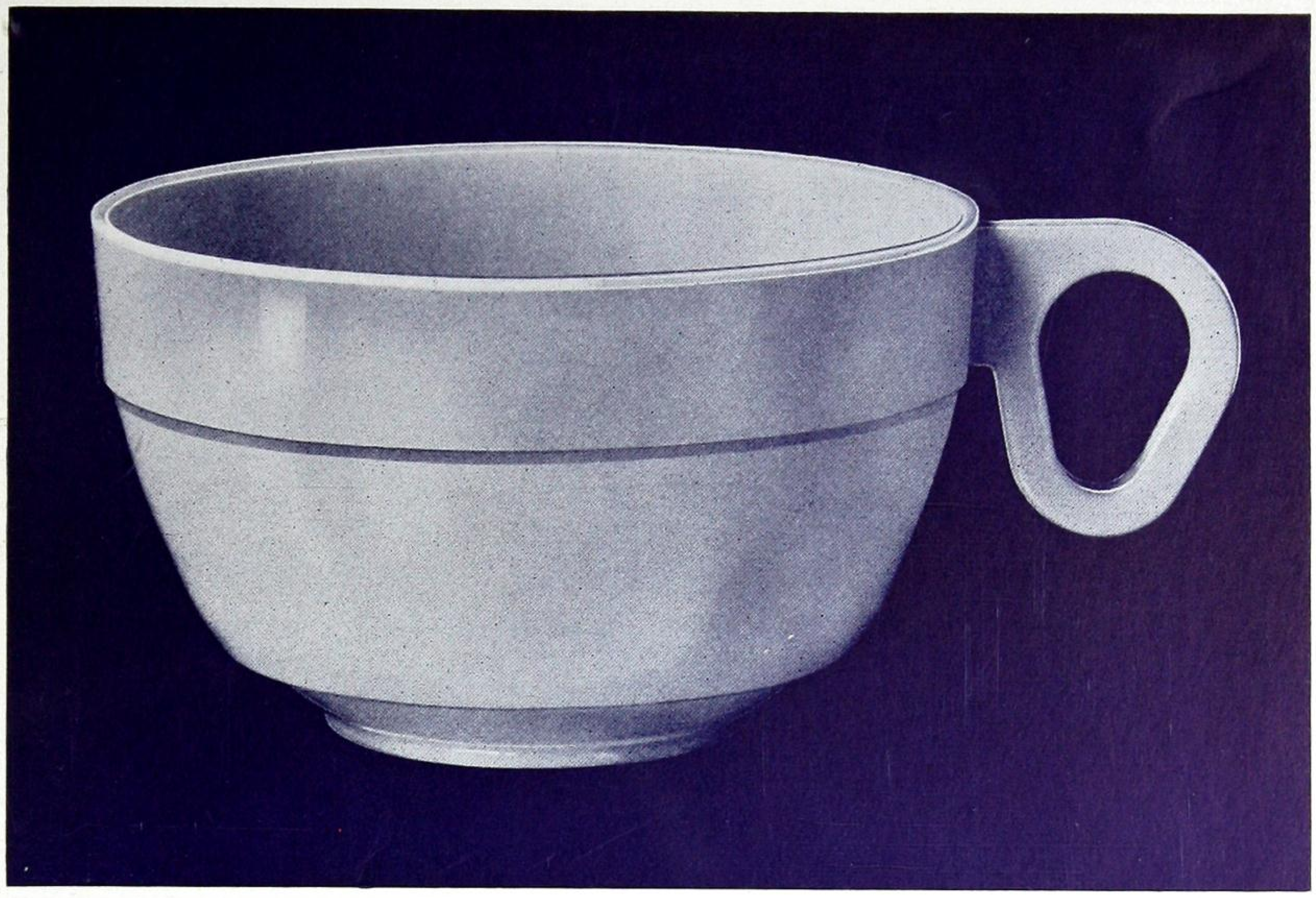
WATERTOWN TABLE WARE. Watertown has three lines of tableware—Watertown Ware, made from Melamine, Echo Ware of Urea and Neill Ware made from Neillite. Watertown Ware and Echo Ware are available in a standard cream color and they may be ordered in pastel shades. Neill Ware comes only in a dark Morocco brown. Each ware is available in complete services, comprising all the necessary individual and serving dishes. The serving dishes are also available in two sizes, one for institutional use and one in a regular family size for home use. Watertown Ware is highly resistant to stain, chipping, and breakage and has a highly lustrous finish. Because the dishes are non-porous and can be sterilized, Watertown Ware is extremely popular for use in hospitals, sanitariums, school lunchrooms, cafeterias, on shipboard, in airplanes, lunchwagons and diners. The airlines have for some time used these light weight attractive dishes for passenger service. Watertown Ware is used by the Navy. Both Echo Ware and Neill Ware are less expensive services and were designed for syndicate distribution.

The divided tray shown above is 15½" long by 11⅝" wide. It is listed as follows:
Watertown Ware No. 120   Echo Ware No. 220   Neill Ware No. 320.

(Opposite page) Coffee or tea cup—3-17/32" top diameter, 2" high. Watertown Ware No. 105   Echo Ware No. 205   Neill Ware No. 305.

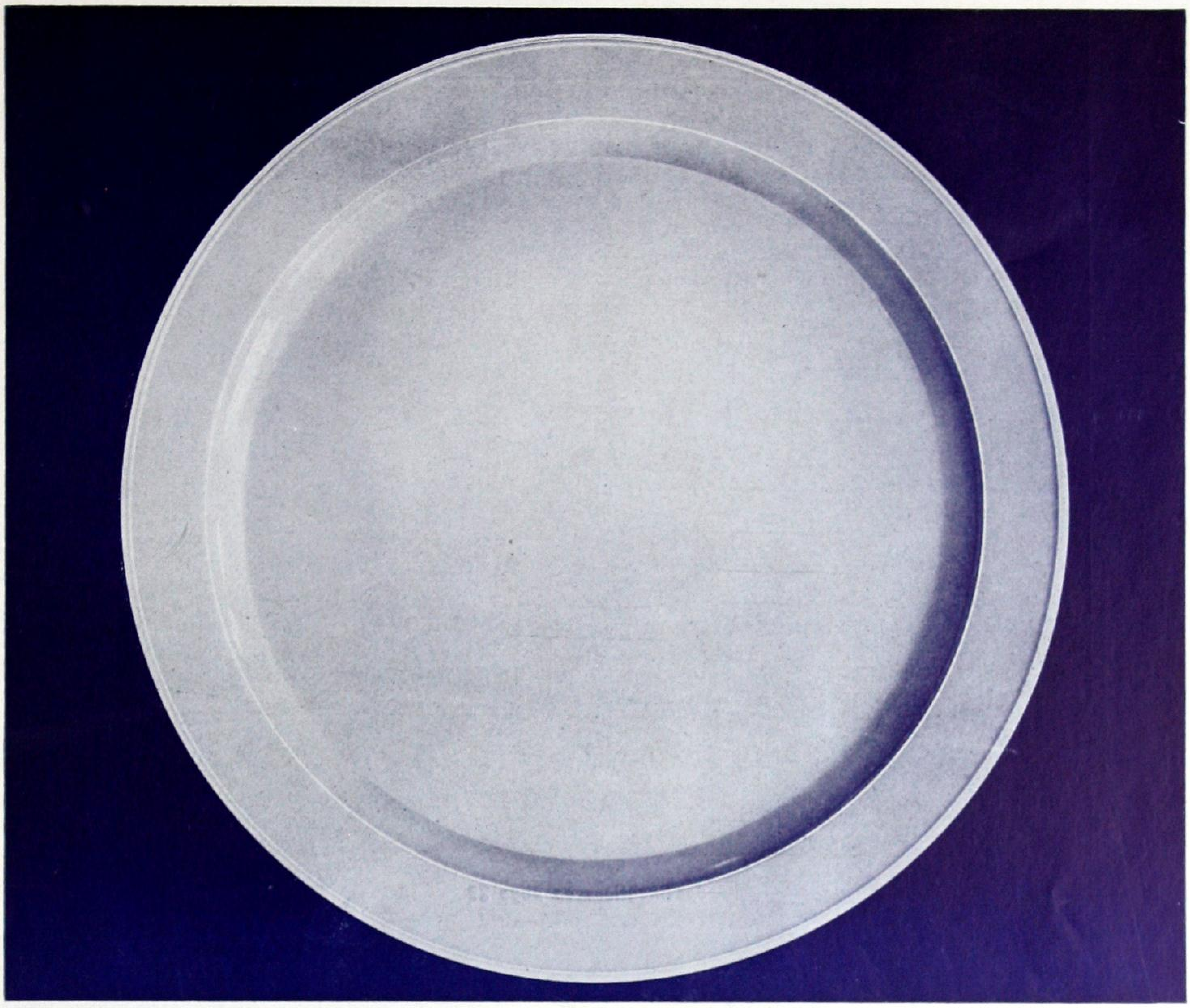
Saucer 5-9/16" diameter. Watertown Ware No. 106   Echo Ware No. 206   Neill Ware No. 306.

ECHO WARE MADE IN U.S.A.   WATERTOWN WARE MADE IN U.S.A.   NEILL WARE MADE IN U.S.A.



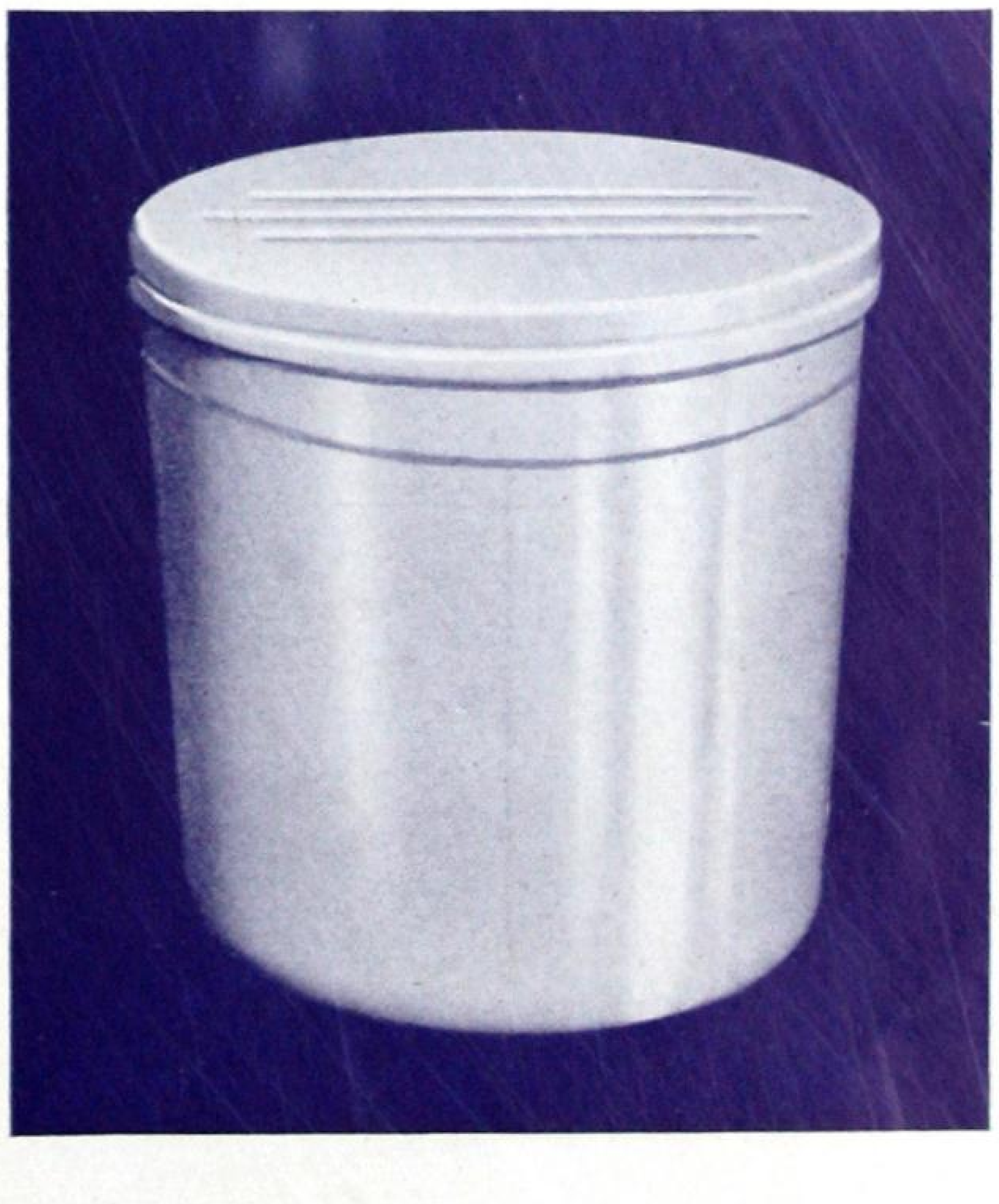
Specifications on page 24

Specifications on page 27



On this page dinner plate is shown

10" diameter.	Watertown Ware	No. 104
	Echo Ware	No. 204
	Neill Ware	No. 304



Icebox food container

3¾" diameter. 3½" high.	Watertown Ware	No. 119
	Echo Ware	No. 219
	Neill Ware	No. 319

On opposite page is the 12 oz. drinking mug

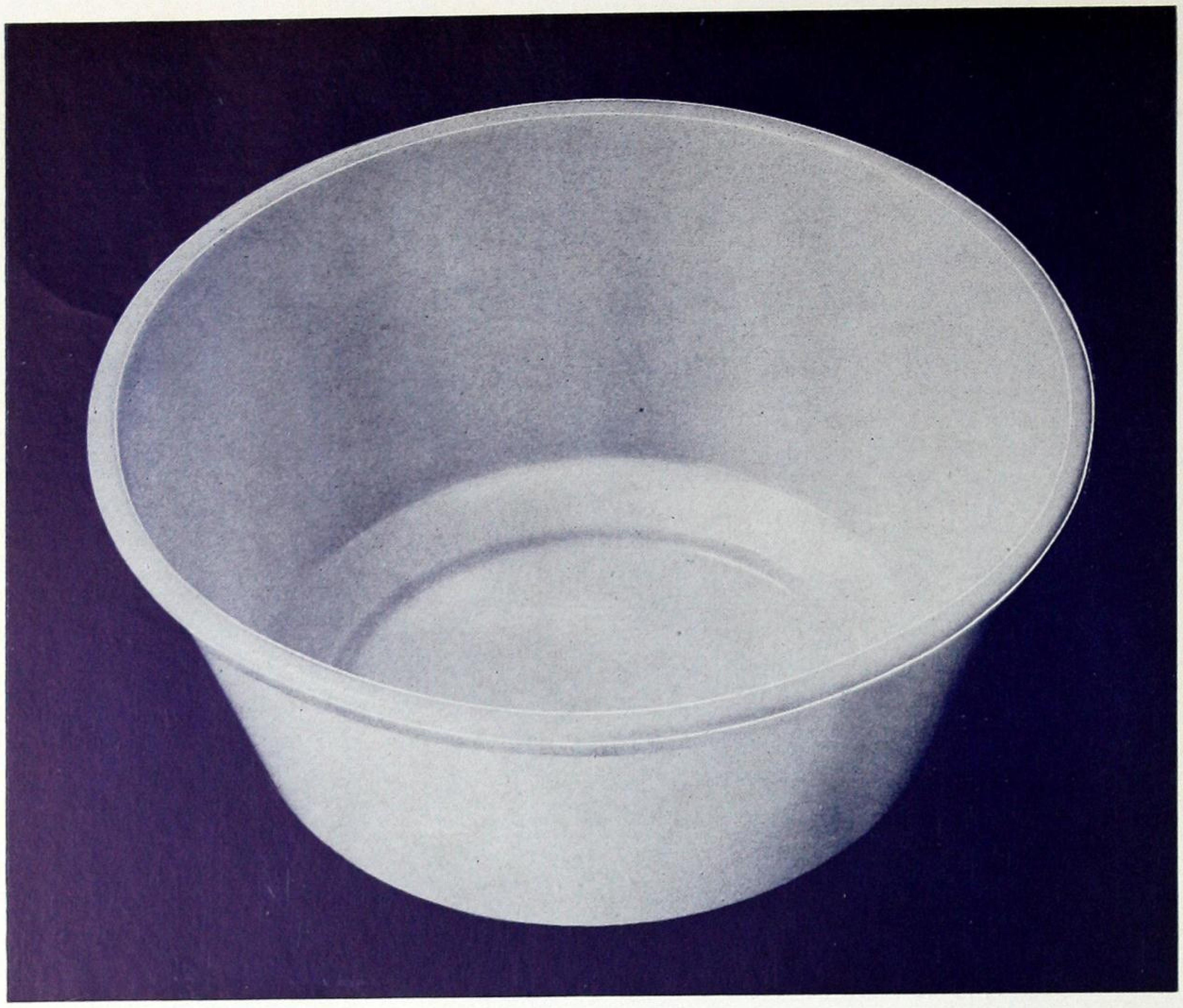
3" top diameter. 3" high.	Watertown Ware	No. 102
	Echo Ware	No. 202
	Neill Ware	No. 302

This mug also comes in a smaller, 8 oz. capacity.

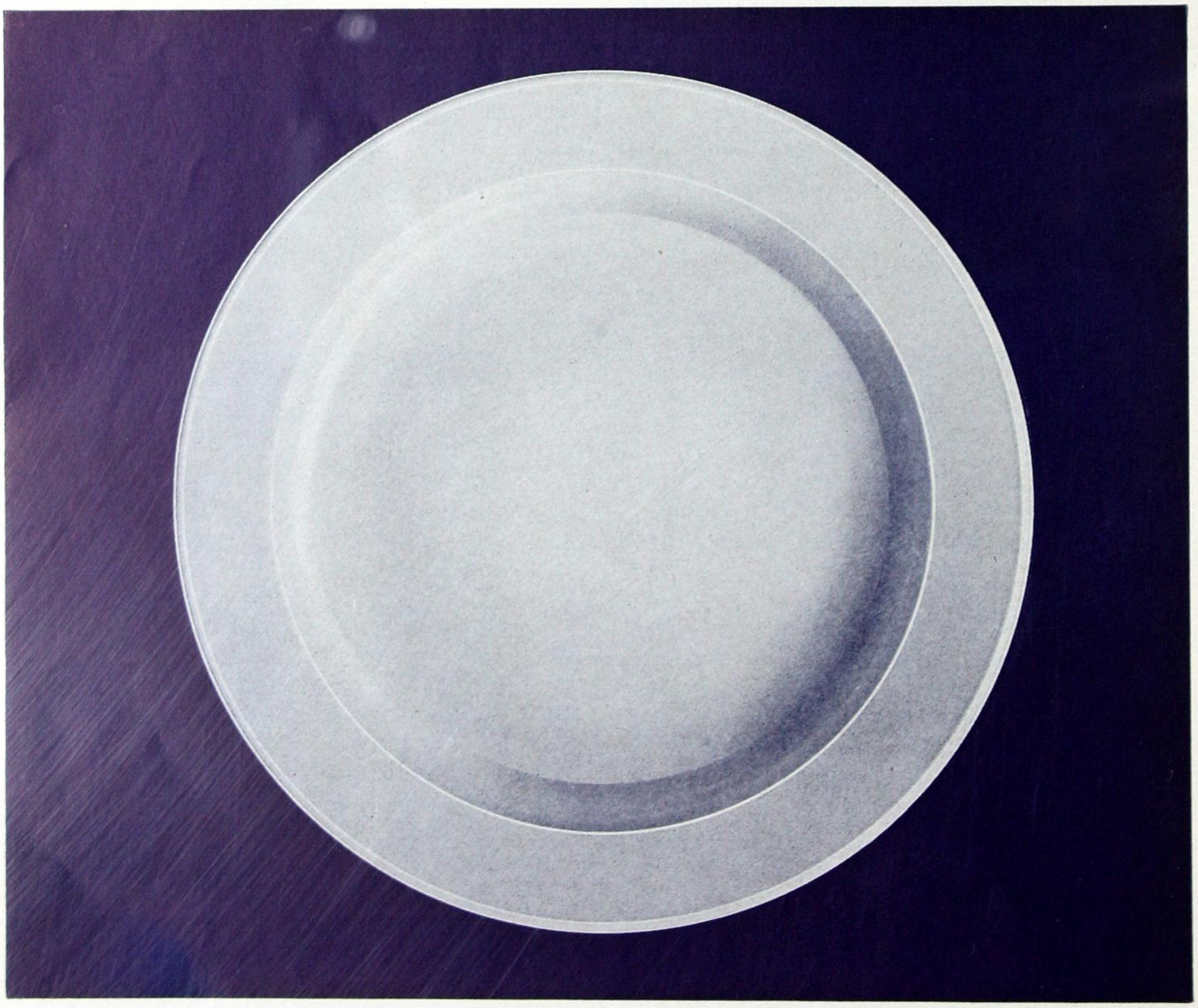
3" Top diam. 2¾" high.	Watertown Ware	No. 115
	Echo Ware	No. 215
	Neill Ware	No. 315

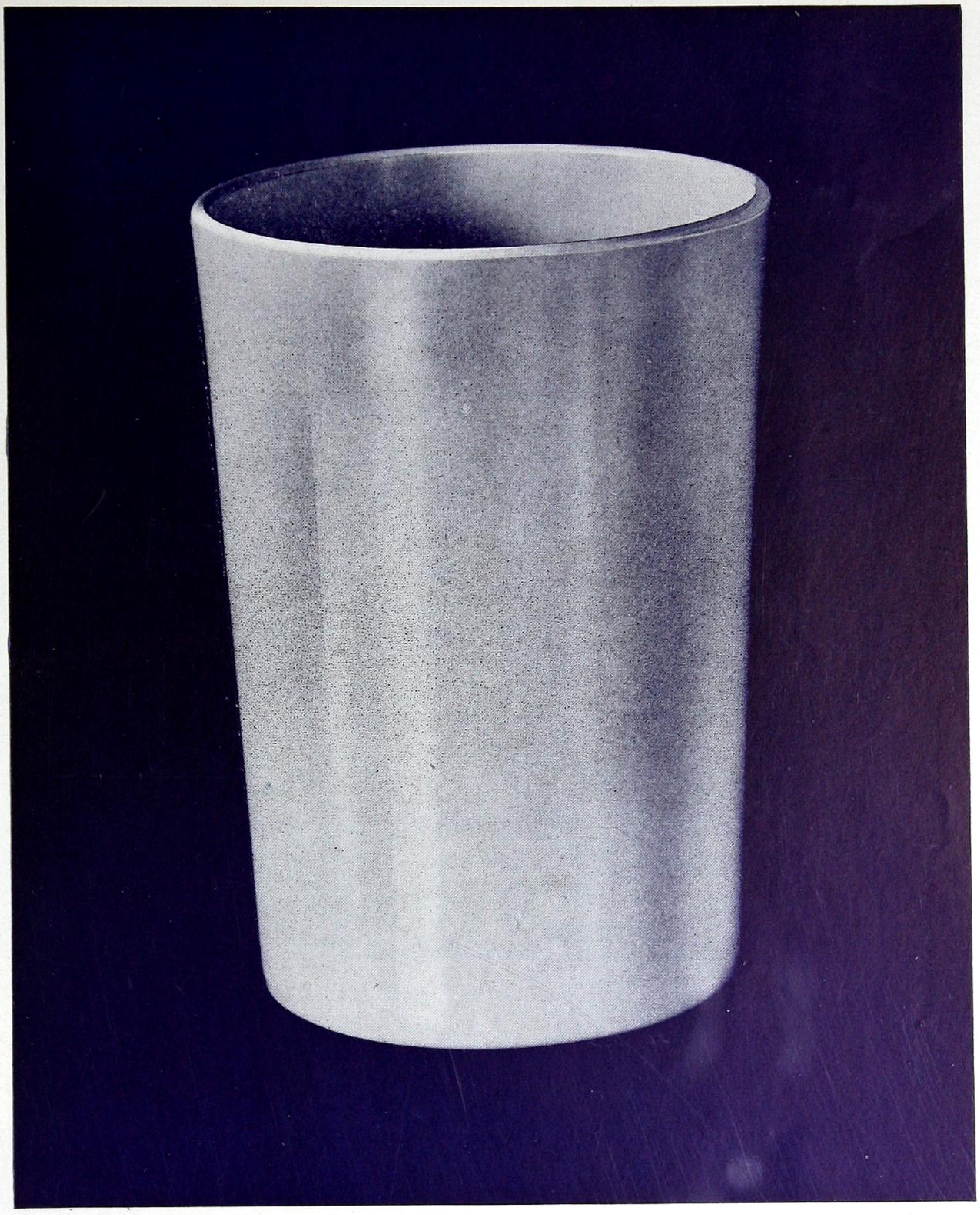
The soup plate on page 26 is

9" diameter.	Watertown Ware	No. 108
	Echo Ware	No. 208
	Neill Ware	No. 308

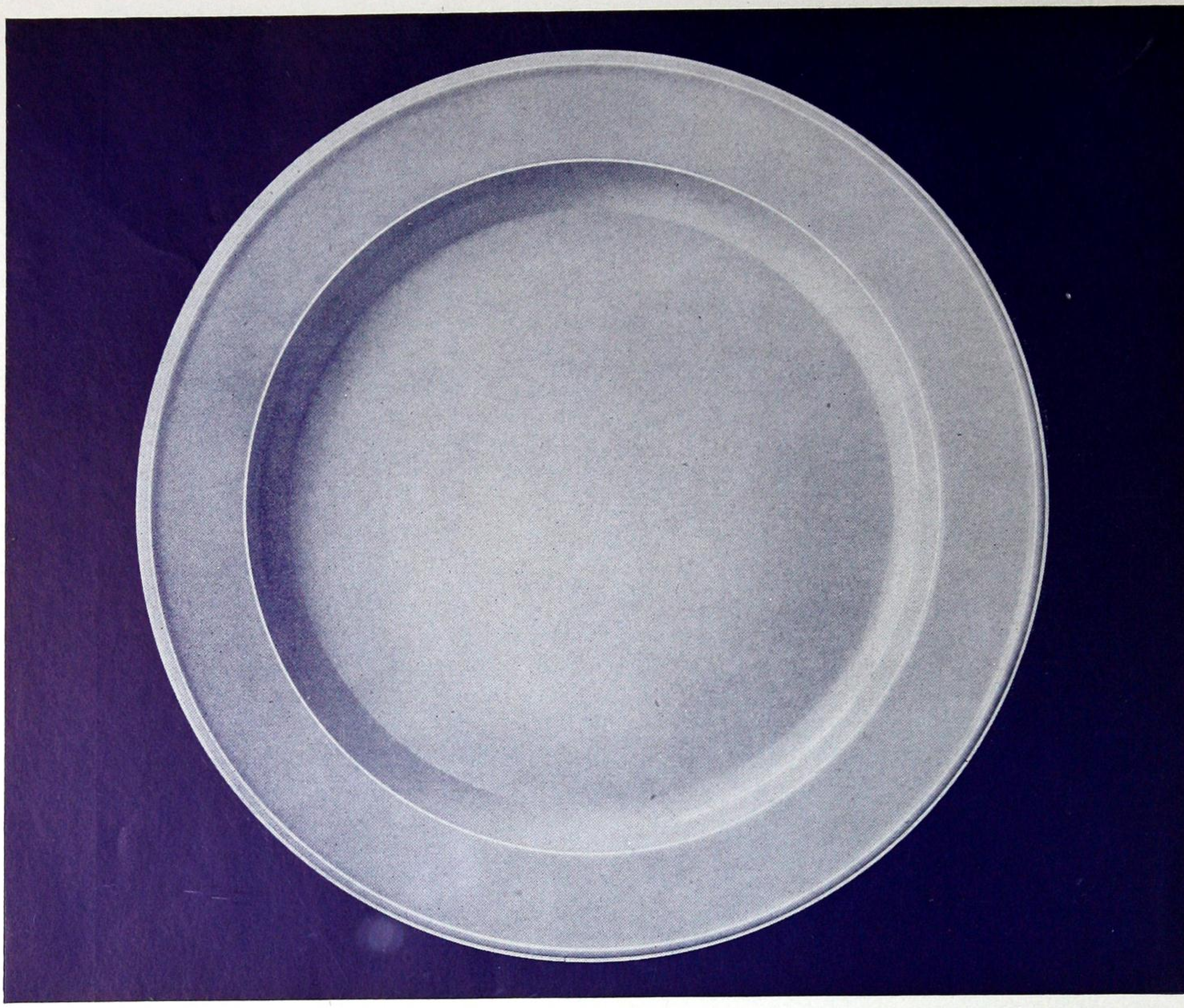


Specifications on page 29





The plastics tumbler on this page is listed as	Watertown Ware	No. 101
8 oz. capacity. 3⅝" high.	Echo Ware	No. 201
2 7/10" top diameter.	Neill Ware	No. 301
On the opposite page the cereal bowl	Watertown Ware	No. 103
5¼" top diameter. 2⅜" high.	Echo Ware	No. 203
	Neill Ware	No. 303
The bread and butter plate,	Watertown Ware	No. 111
lower left, is 6" in diameter.	Echo Ware	No. 211
	Neill Ware	No. 311



The breakfast plate shown above is 8" in diameter
Watertown Ware No. 110   Echo Ware No. 210   Neill Ware No. 310

On page 32 are illustrated the large meat platter and the pickle and celery dish which may also be used as a small meat platter.

Large meat platter—10"x14" oval.

Watertown Ware	No. 112
Echo Ware	No. 212
Neill Ware	No. 312

Pickle and celery dish—7"x10" oval.

Watertown Ware	No. 109
Echo Ware	No. 209
Neill Ware	No. 309

On page 33 are listed the two sizes of vegetable serving dishes. Institutional size—10"x14" oval.

Watertown Ware	No. 107
Echo Ware	No. 207
Neill Ware	No. 307

Home size—7"x10" oval.

Watertown Ware	No. 116
Echo Ware	No. 216
Neill Ware	No. 316

Above—Home size
Sugar bowl

3" diameter. 3" high.	Watertown Ware	No. 118
	Echo Ware	No. 218
	Neill Ware	No. 318

Above—Home size
Cream pitcher

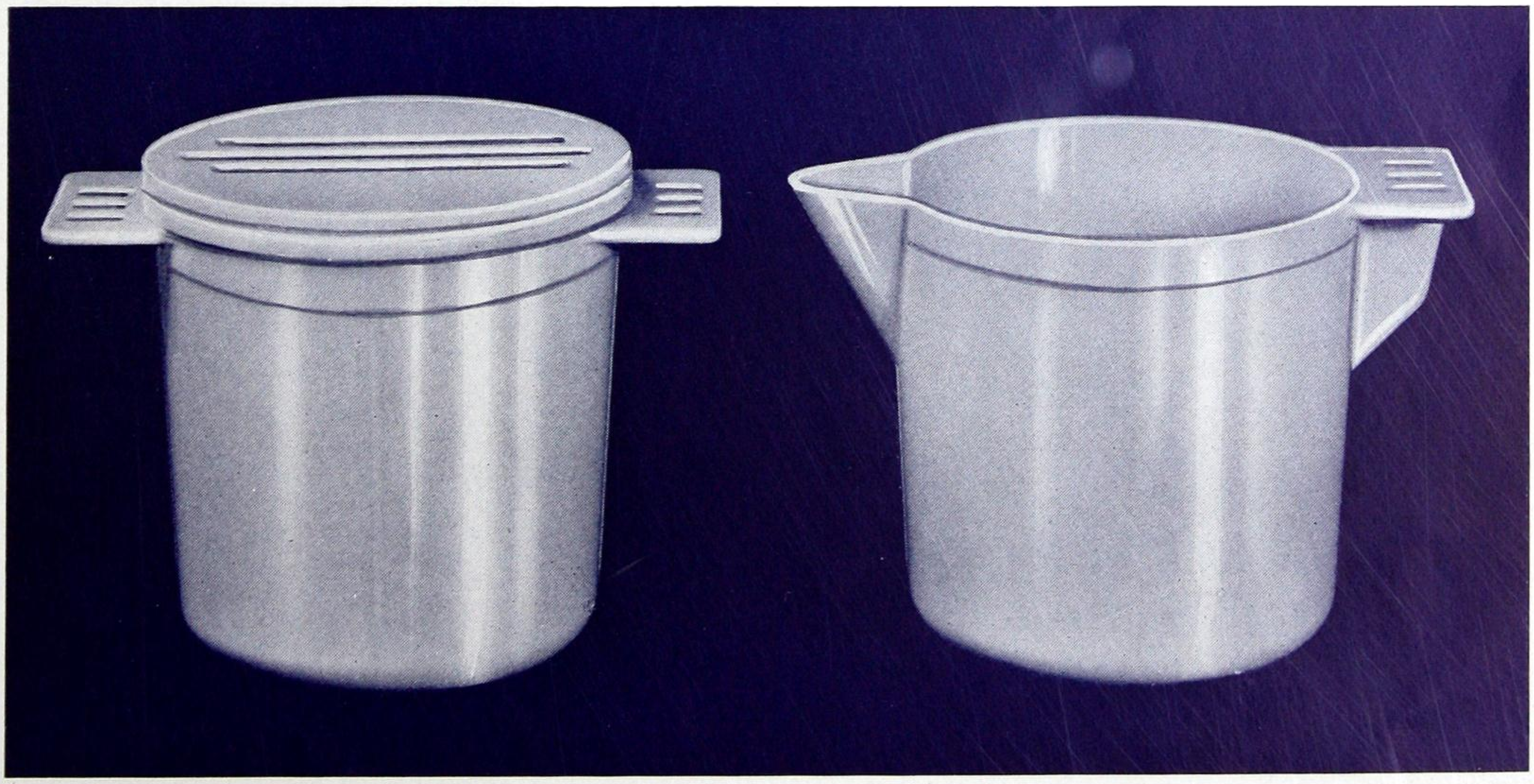
3" diameter. 3" high.	Watertown Ware	No. 117
	Echo Ware	No. 217
	Neill Ware	No. 317

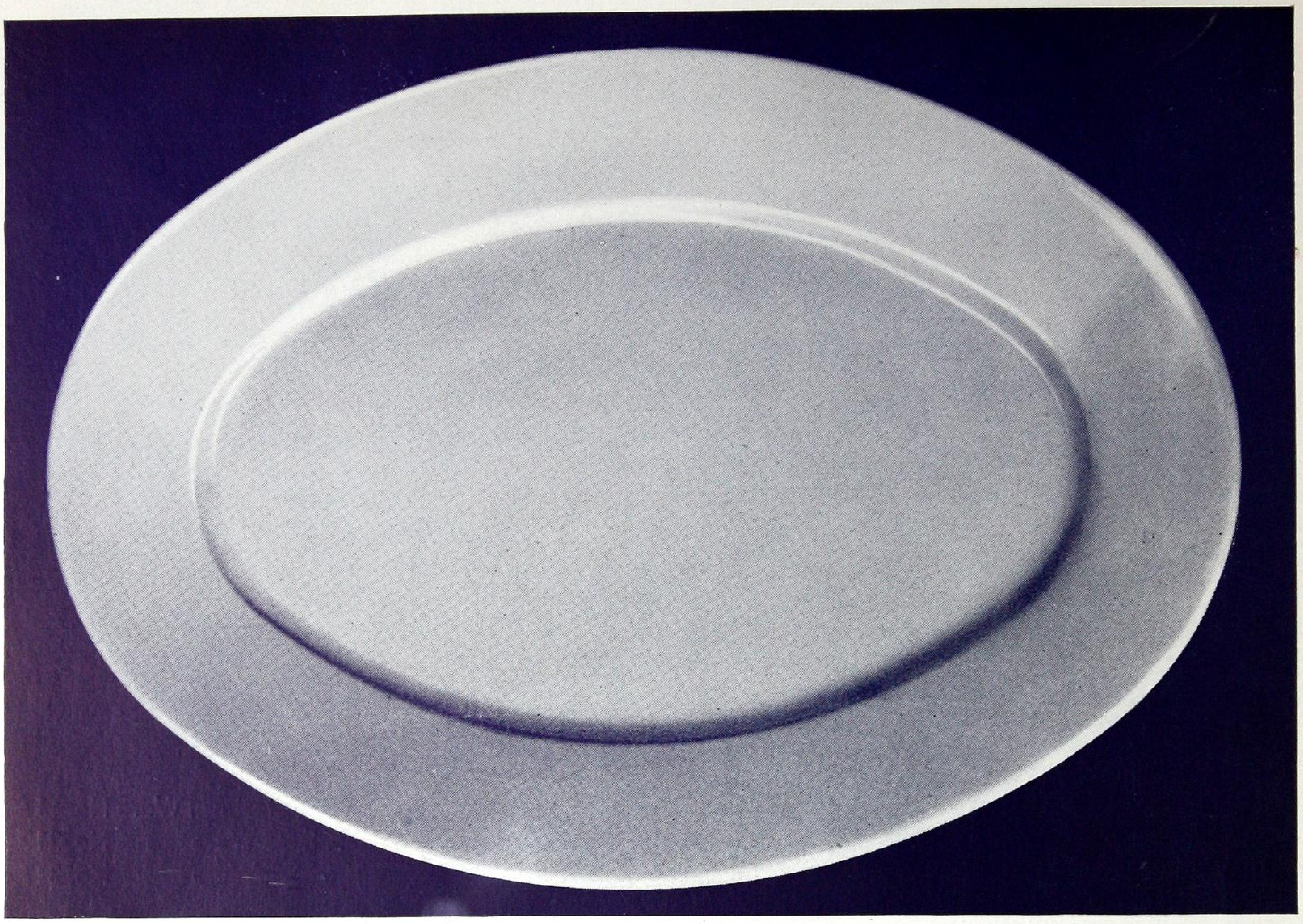
Below—Institutional size
Sugar bowl

3¾" diam. 3½" high.	Watertown Ware	No. 114
	Echo Ware	No. 214
	Neill Ware	No. 314

Below—Institutional size
Cream pitcher

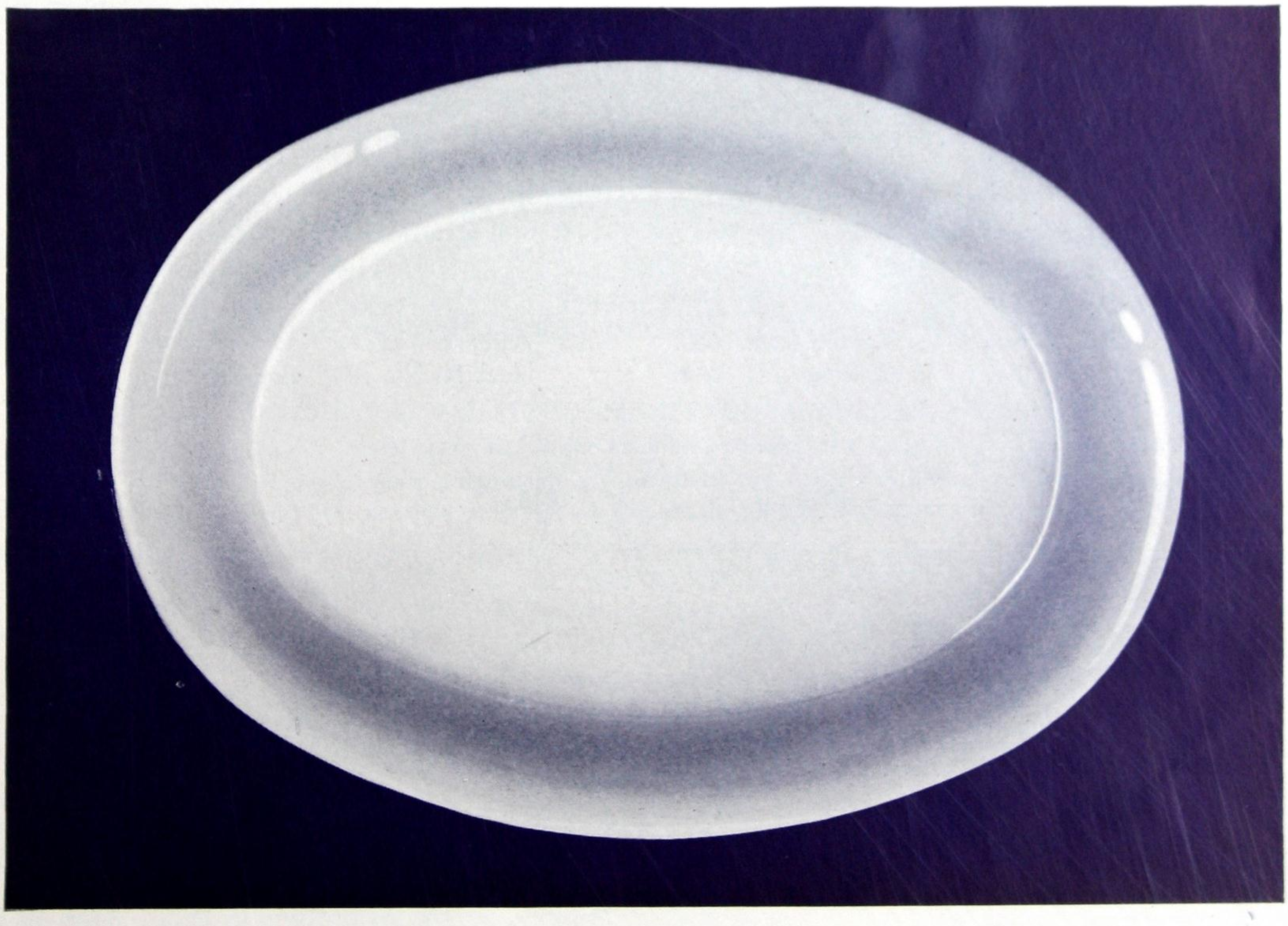
3¾" diam. 3½" high.	Watertown Ware	No. 113
	Echo Ware	No. 213
	Neill Ware	No. 313



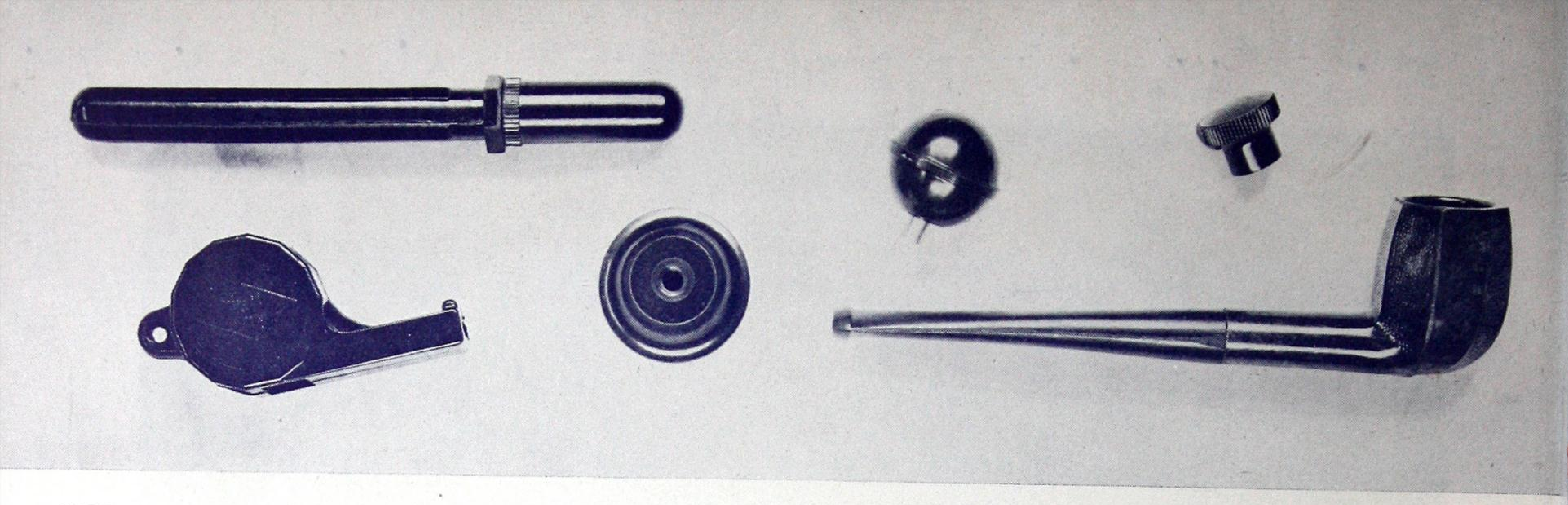


Specifications on page 30

Specifications on page 30



1009 1003 1006 1005 1007 1004



The Watertown Manufacturing Company is best known as custom molders. They make, however, in addition to their Watertown Ware and Echo Ware, several other trade-mark items from stock molds. Several of these articles are illustrated here and can be ordered by the following numbers.

1001 Men's razor for double-edged blade.
Made from Neillite in black and colors.
3¼" long, head 1⅝"x 1".

1002 Ladies' razor for double-edged blade.
Made from Neillite in black and colors.
3¼" long, head 1⅜"x 15/16".

1003 Whistle. Molded from Cellulose Acetate. Standard police type. 2" long.

1004 Junior pipe. Molded from black and wood grained Neillite. 4¾" long.

1005 Button knob. Molded from Neillite. ⅞" in diameter.

1006 Lid knob. Molded from Neillite. 1 5/32" top diameter tapers to ⅝" bottom diameter. Overall height ½".

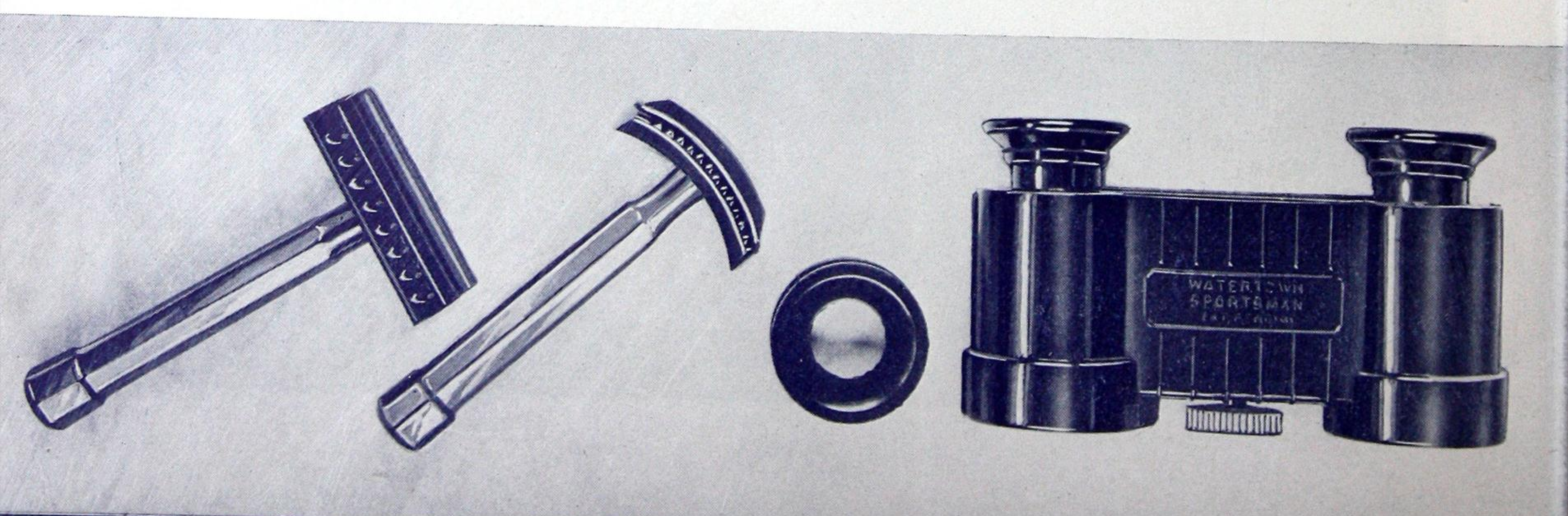
1007 Terminal Nut Knob. Molded from Neillite with inserts of various sizes molded in place. 9/16" diameter.

1008 Miniature binoculars. "Watertown Sportsman." Molded of black Neillite, contains ground glass lenses. 3¾" base 2⅝" (open).

1009 Standard Thermometer Case and Cap. Molded from black Neillite. 4½" long.

1010 Antenna Insulator. Molded from black Neillite. 1⅛" diameter.

1001 1002 1010 1008



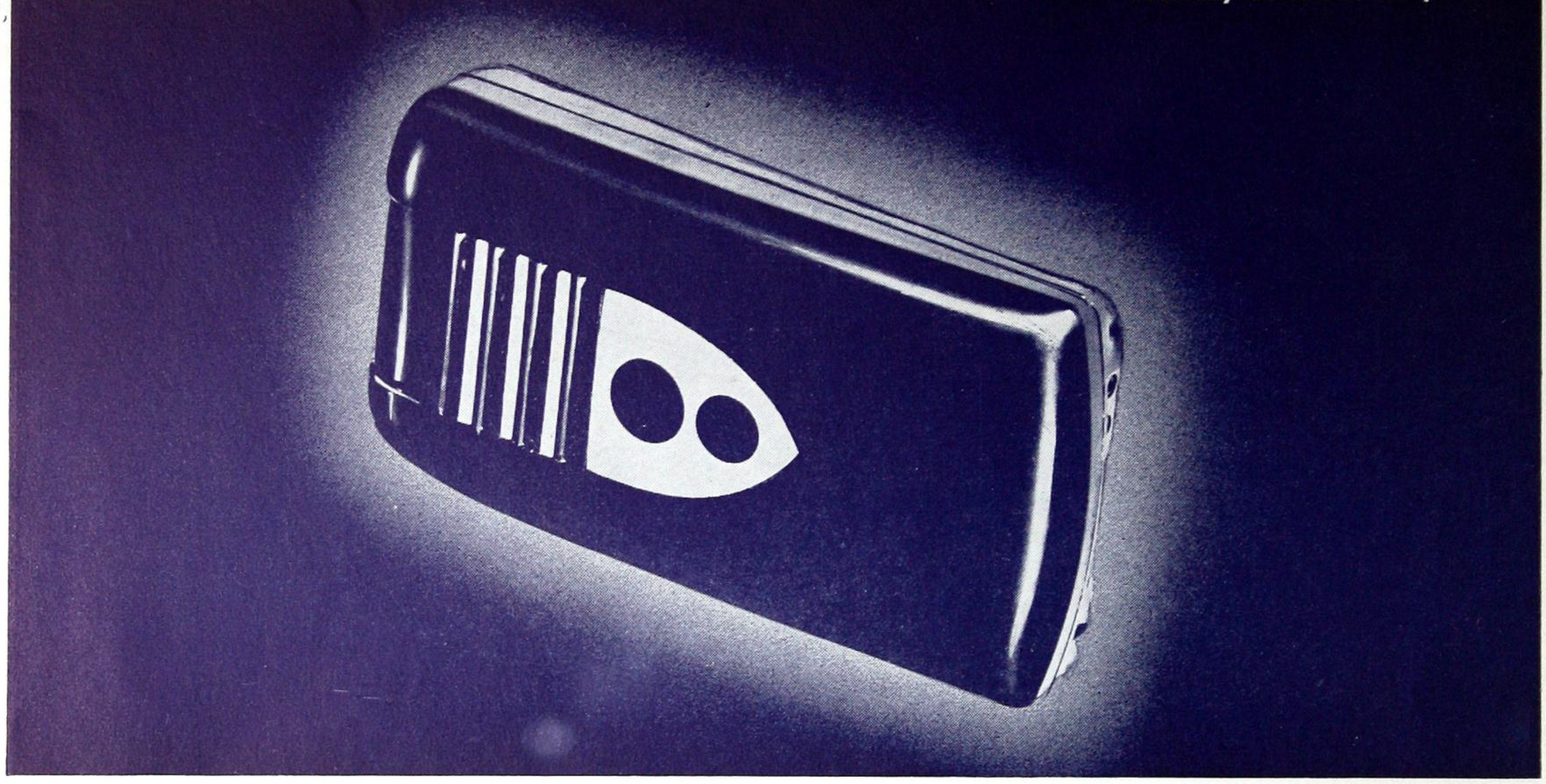
The WATERTOWN MANUFACTURING COMPANY have built many intricate and elaborate molds for injection, compression and transfer presses. Among the sixty or more compression presses there are some with an extraordinarily long stroke, making possible moldings of unusual height and there are other presses capable of yielding parts of considerable bulk and weight.

Owing to the new transfer method developed by Alexander L. Alves, transfer molding efficiency has been increased to the point where small parts can be rapidly produced in molds containing as many as 20 cavities or more.

In the injection room where the thermoplastics are handled, the battery of injection presses turns out a large variety of shapes in all types of materials and formulations. In this section there are shown a few of the many thousands of plastics parts that have been produced by the different methods in a variety of materials.

In the picture above the dresser set, including comb, brush and mirror frame, were injection molded from sparkling crystal Methyl Methacrylate. The pieces required practically no finishing except the removal of the gate and a little buffing.

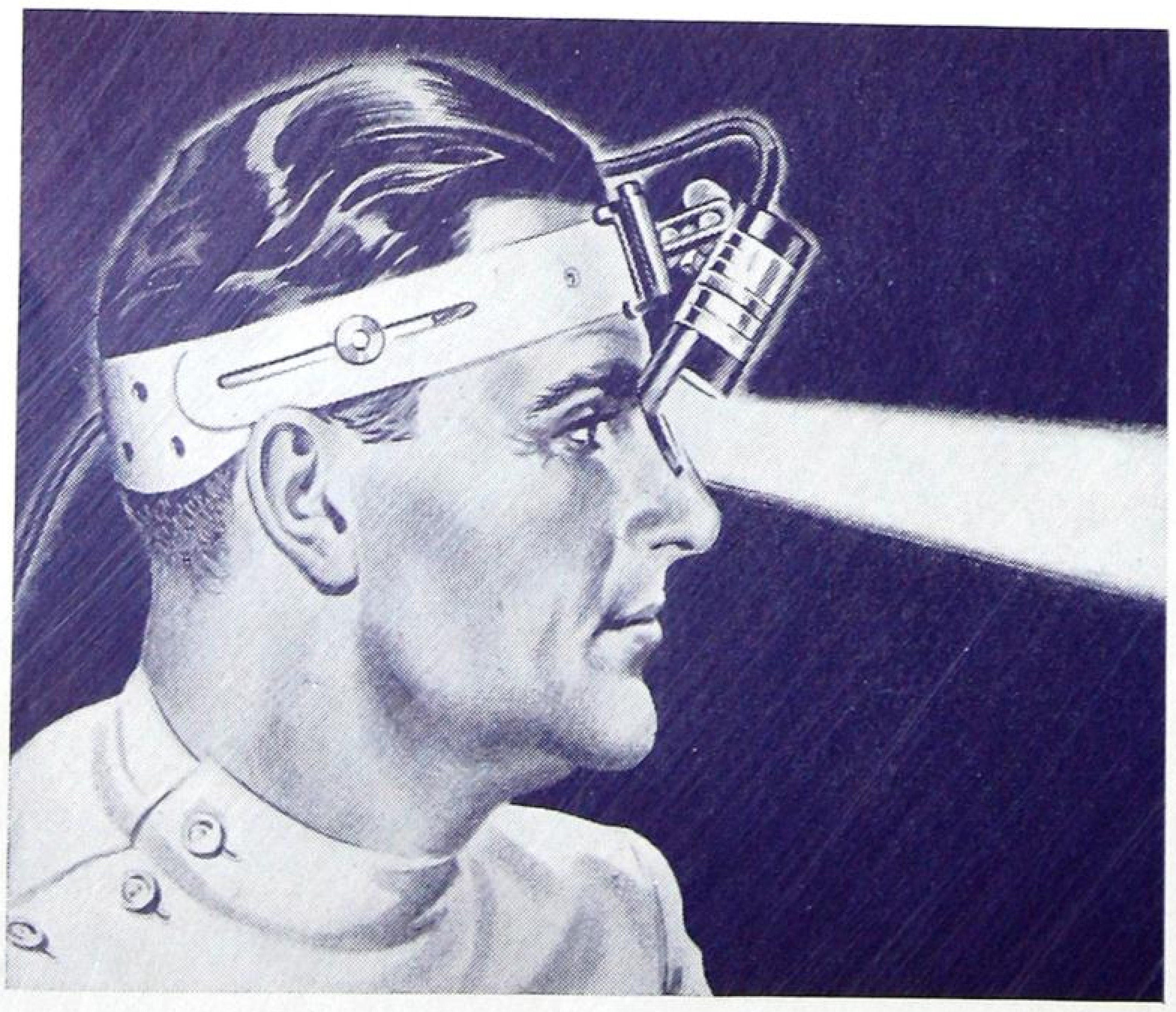
CUSTOM MOLDS



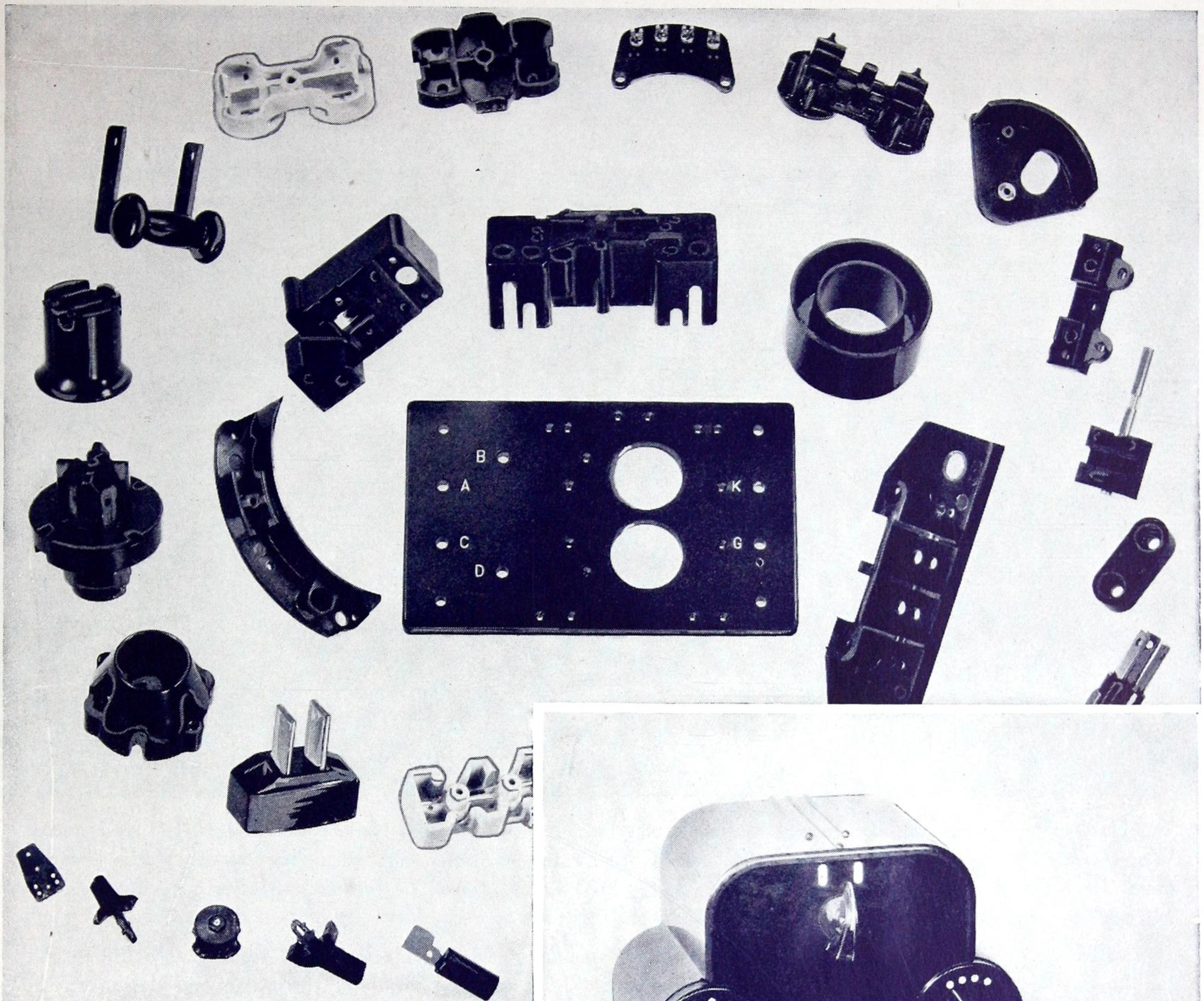
• Courtesy Sonotone Corp.

The Sonotone Hearing Aid case is an injection molded piece made in two parts. The material is Cellulose Acetate Butyrate. This piece requires fidelity to close tolerances, great precision and high lustre finishing which is acquired by buffing and polishing.

The insertion of the mother-of-pearl effect on the face requires extreme care and skill and the assembly of the case itself must be accomplished with high precision. A great deal of the finishing must necessarily be done by hand.



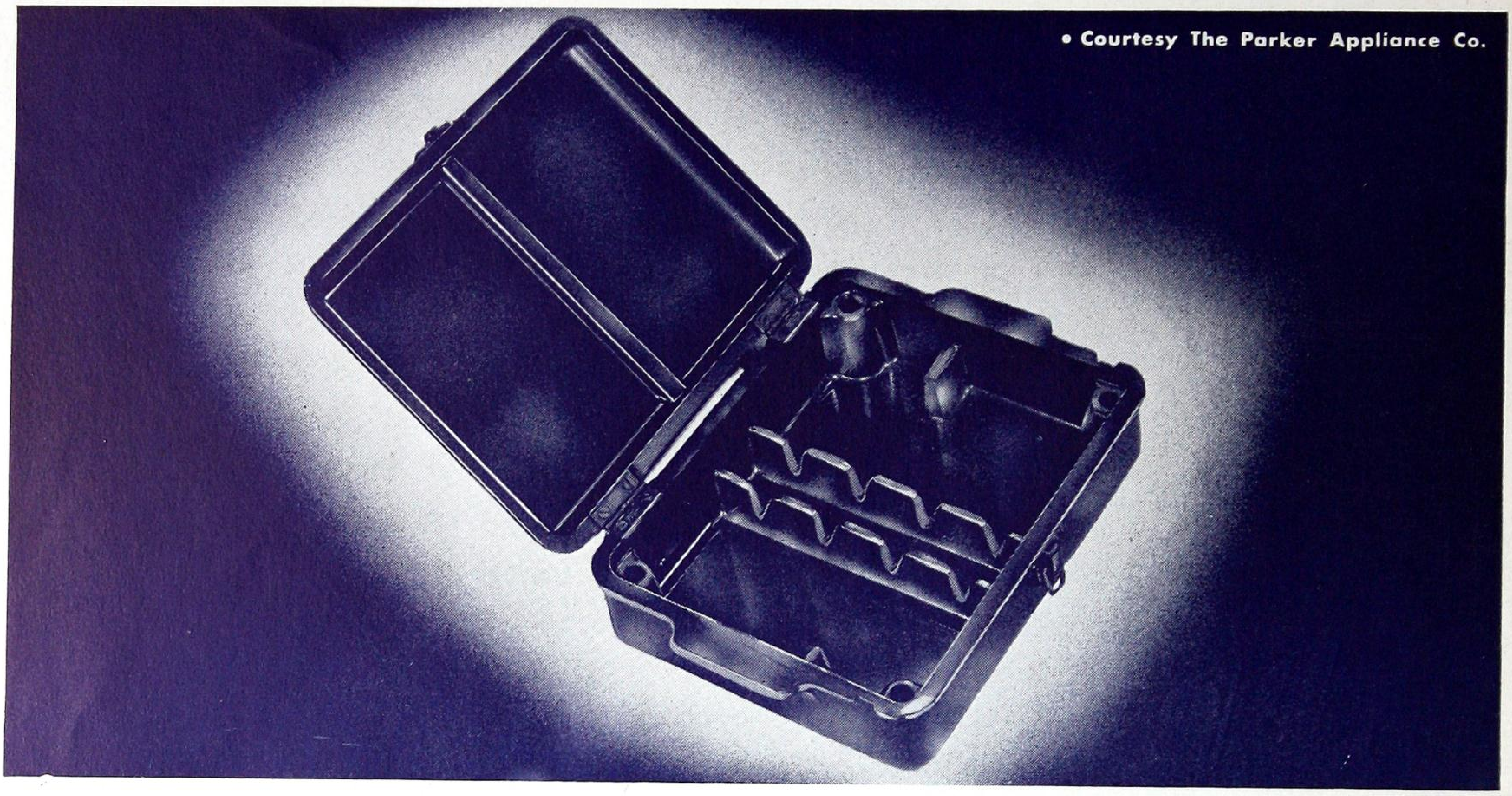
The physicians' head light combines the use of 3 plastics — Neillite, Ethyl Cellulose and Cellulose Acetate. The compression molded Neillite parts are centered in the case itself.



Literally millions of electrical and electronic parts owe their fine precision to Watertown moldings. All the parts shown on this page are compression molded from various formulations of Neillite. The cautery, with transformer housing, cautery pistol and tips (shown lower right), is molded from a formula of Neillite developed especially for the National Electric Instrument Company. Much of the new surgical and diagnostic equipment has utilized plastics because of their clean, non-porous surface, adaptability to design, and accuracy of Watertown's work.

The wide variety of electrical parts manufactured at Watertown includes everything from tiny insulators to large sections embodying many metal inserts.

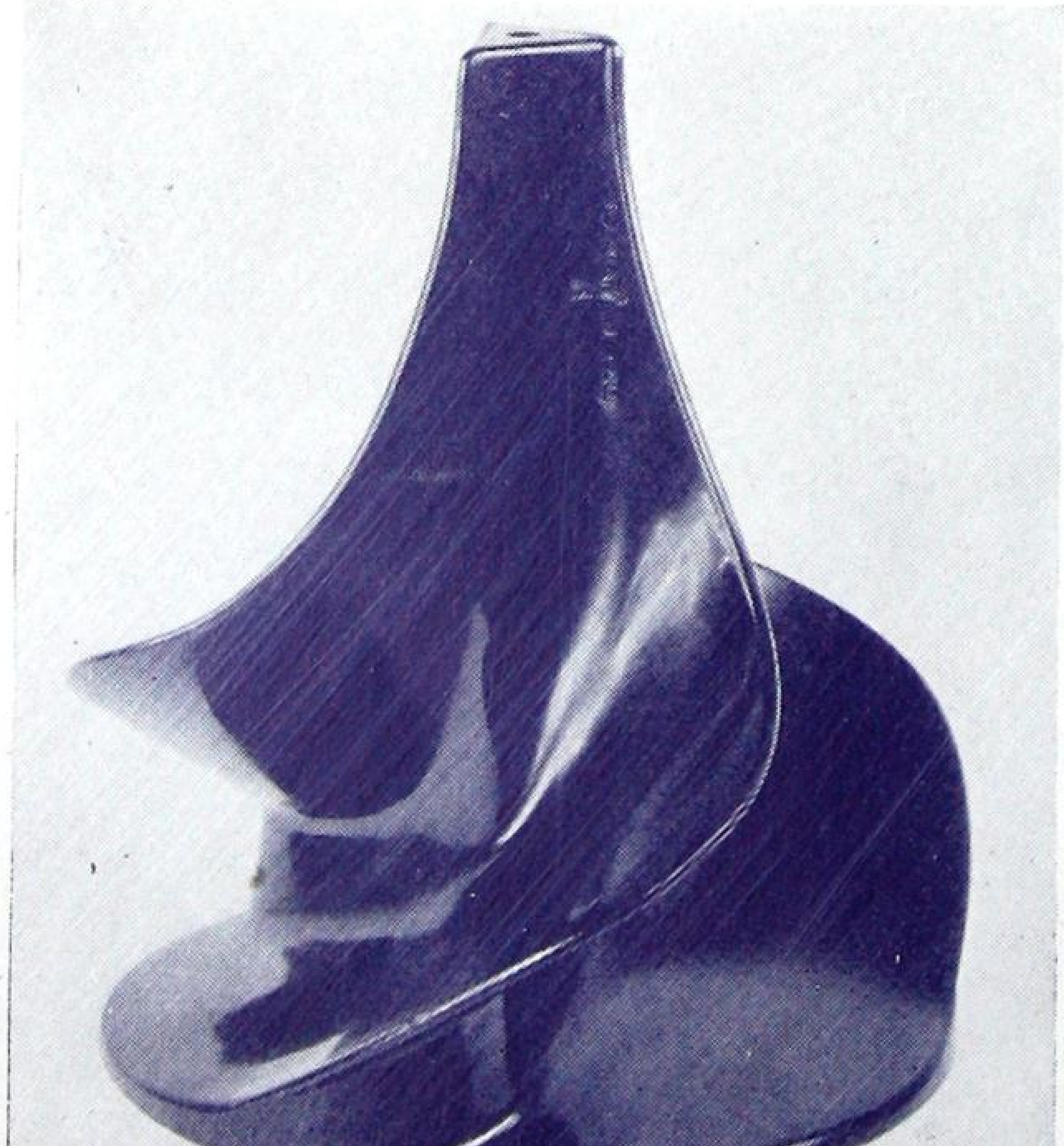
CUSTOM MOLDS



The black phenolic case is compression molded from a special material — Neillite Formula 60-100 designed in Watertown's laboratory by H. R. Sjostedt, Chief Chemist, to provide a required impact strength. The box was molded for The Parker Appliance Company to house their beading tool kit for aircraft. The case is molded in two sections, the two cavity die forming both top and bottom at a single stroke.

These two heavy sections form a sturdy box whose ridges and cavities must conform to rigid specifications. The tubular cavities in each corner illustrate the solution of a ticklish molding problem. The name and design on the cover are molded right into the section and the letters and design are clean cut and precise.

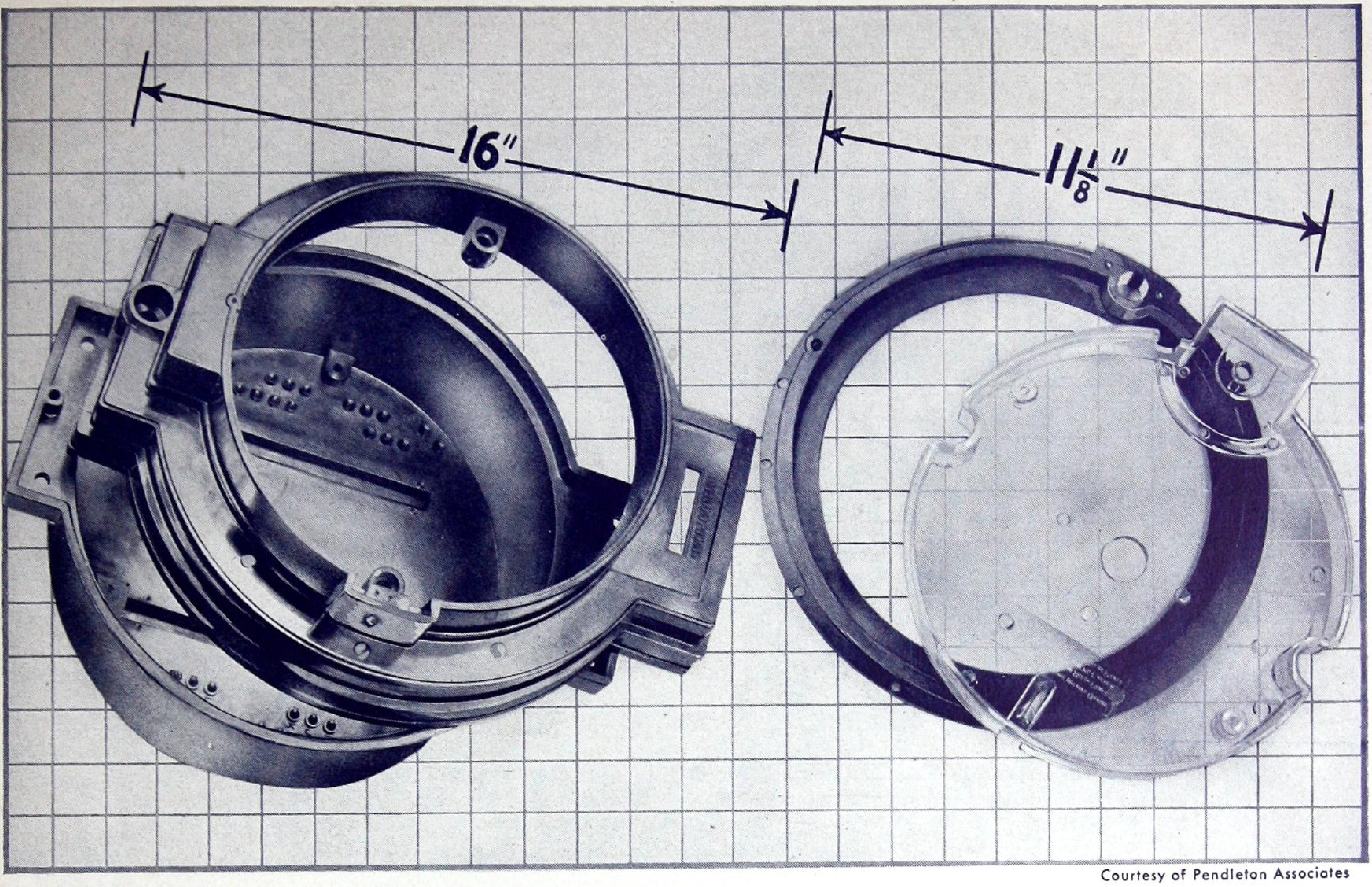
The many steps in the finish and assembly of a case have been solved by line assembly methods which greatly facilitate the handling of so heavy an item. Special buffing, hinging and inspection are accomplished with a minimum of handling and when it leaves the Watertown plant the case is ready to go into active service.



The spiral washing machine agitator, made for Appliance Manufacturing Company of Alliance, Ohio, weighs only 2 pounds and is the only spiral agitator molded from plastics to date.

Developed from a single cavity mold, the agitator measures over 14" in height and presents a most complicated molding problem. Skillful manufacture of the die made it possible to mold the spiral with complete fidelity and produce a part that will give long and rugged service.

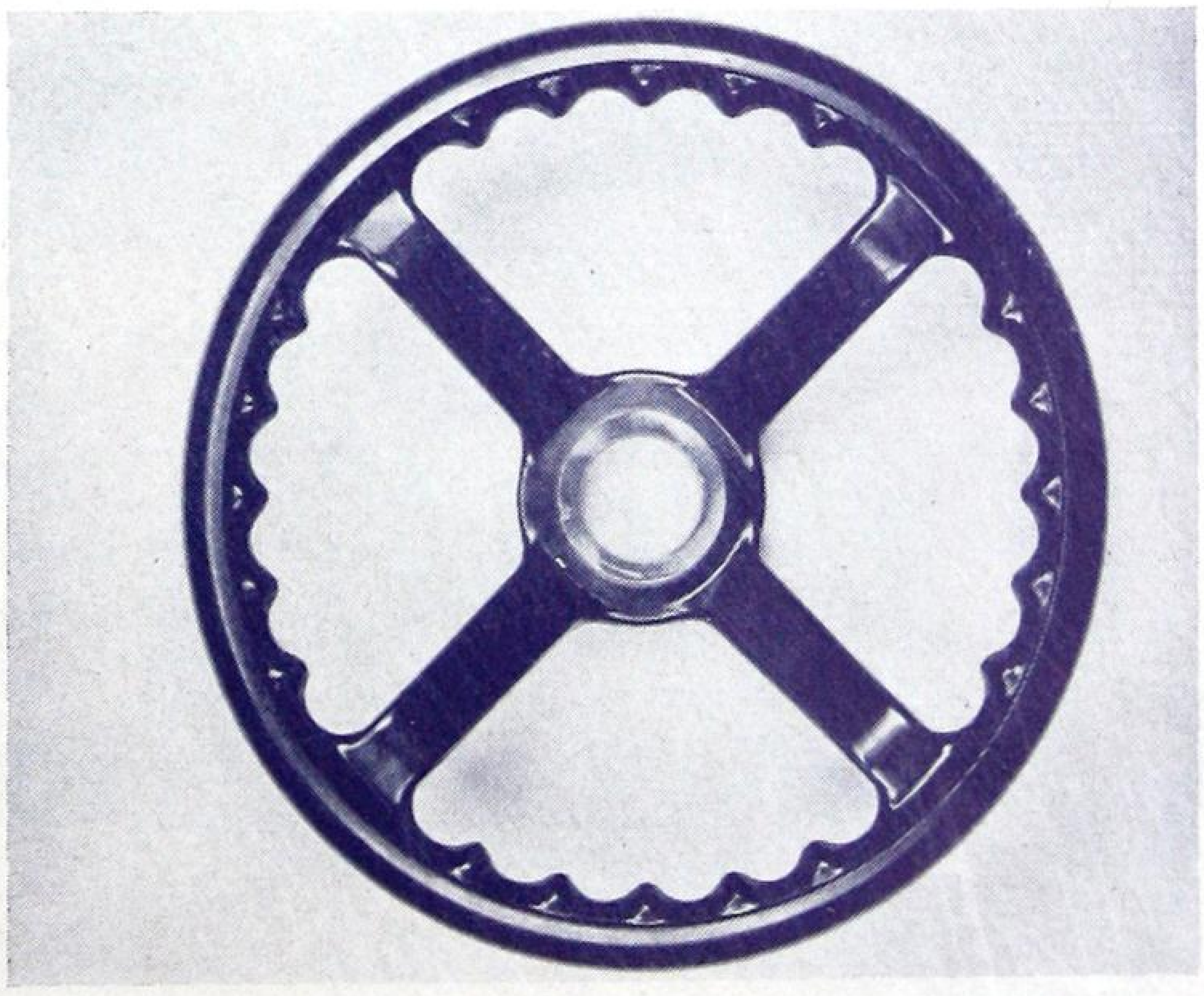
The material chosen for this use is a formulation of Bakelite that will stand repeated immersions in hot, soapy water without deterioration.



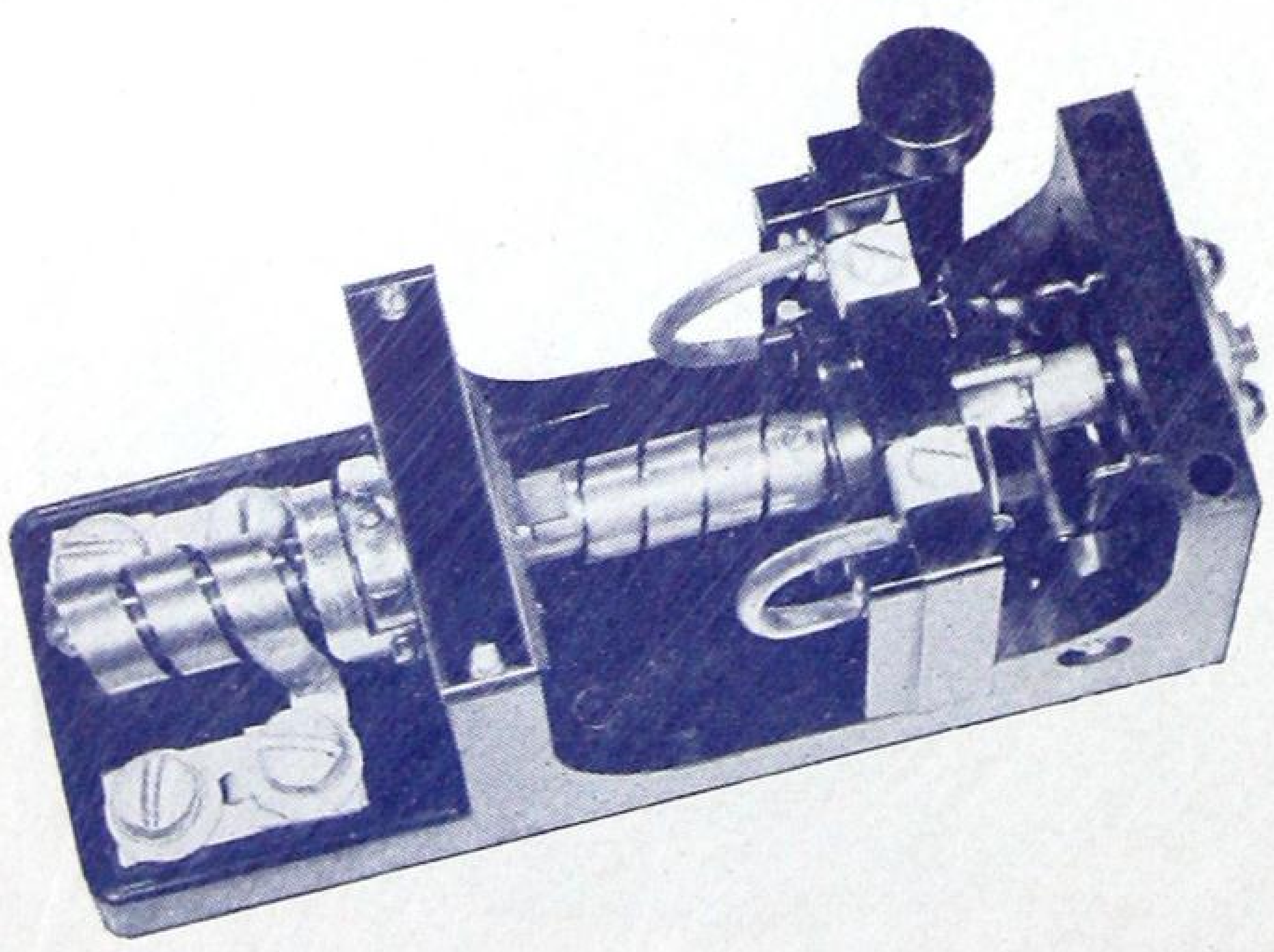
Courtesy of Pendleton Associates

The four parts shown above present a challenge. The three black sections are compression molded of No. 300 Neillite and the transparent dial face is injection molded polystyrene. The two larger sections are some 16" in diameter and the large case is 6" deep. This one part alone weighs five pounds. The material, pre-formed before molding, is pre-heated by high frequency electronic heating. The use of Megatherm for pre-heating eliminates distortion and produces a completely homogenized material to withstand stress. These four large sections are important parts of Precision Meters for steam measurement designed by Pendleton Associates, steam service specialists. Because of their size, each part was molded in a single cavity mold and the phenolic parts all house metal inserts. The case contains two 8" tube-channels, 34 molded contact points and a variety of special cavities. The second largest section required an extremely intricate mold to allow for the many details incorporated in the part and provide for the several metal inserts.

The jig borer hand wheel, which resembles a steering wheel, embodies a heavy metal ring insert and uses 1⅓ pounds of No. 300 Neillite. It is 10" in diameter and the inside scallops provide a firm hand-hold for the operator. Although it is a special tool, the design indicates a number of possible applications for such a part, and its glossy surface is handsome enough for use in a plane or car. The wheel was designed and molded for Moore Special Tool Company, Inc., of Bridgeport, Conn.



PLASTICS IN VITAL MARINE CONTROL EQUIPMENT



These five essential parts for vital marine control equipment are transfer molded to provide maximum accuracy because alignment of the parts is all-important.

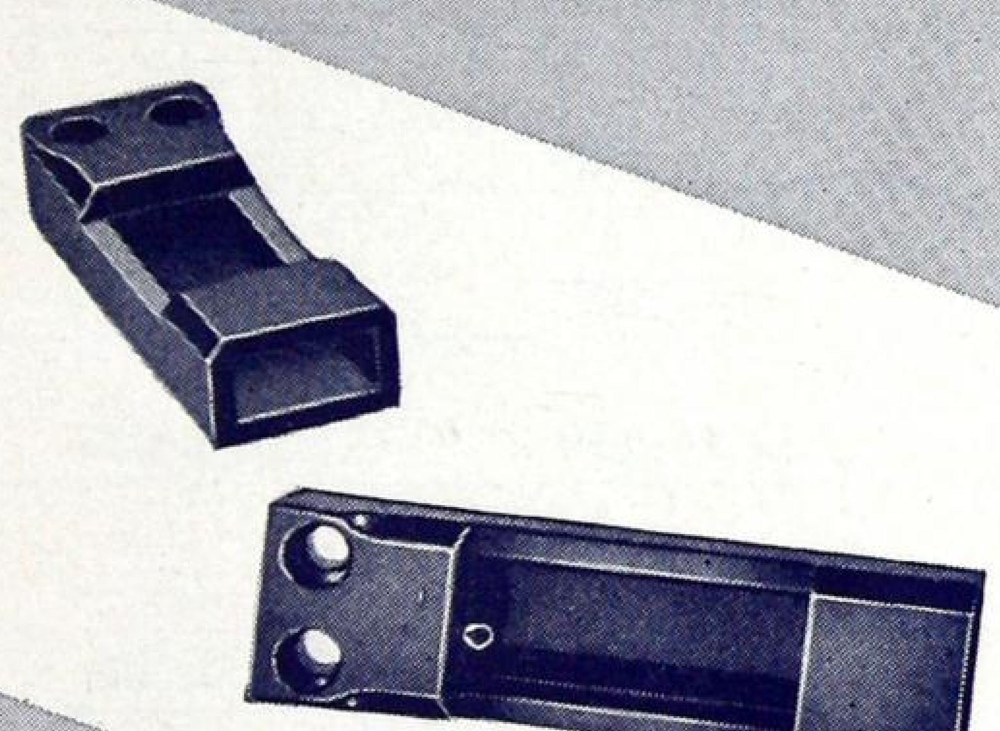
Three different phenolic materials were used—Bakelite, Durez and Resinox. Each part, as can be noted from the picture, embodies multiple inserts and they were all molded in multiple cavity molds. The sections are especially designed to withstand high impact and vibration.

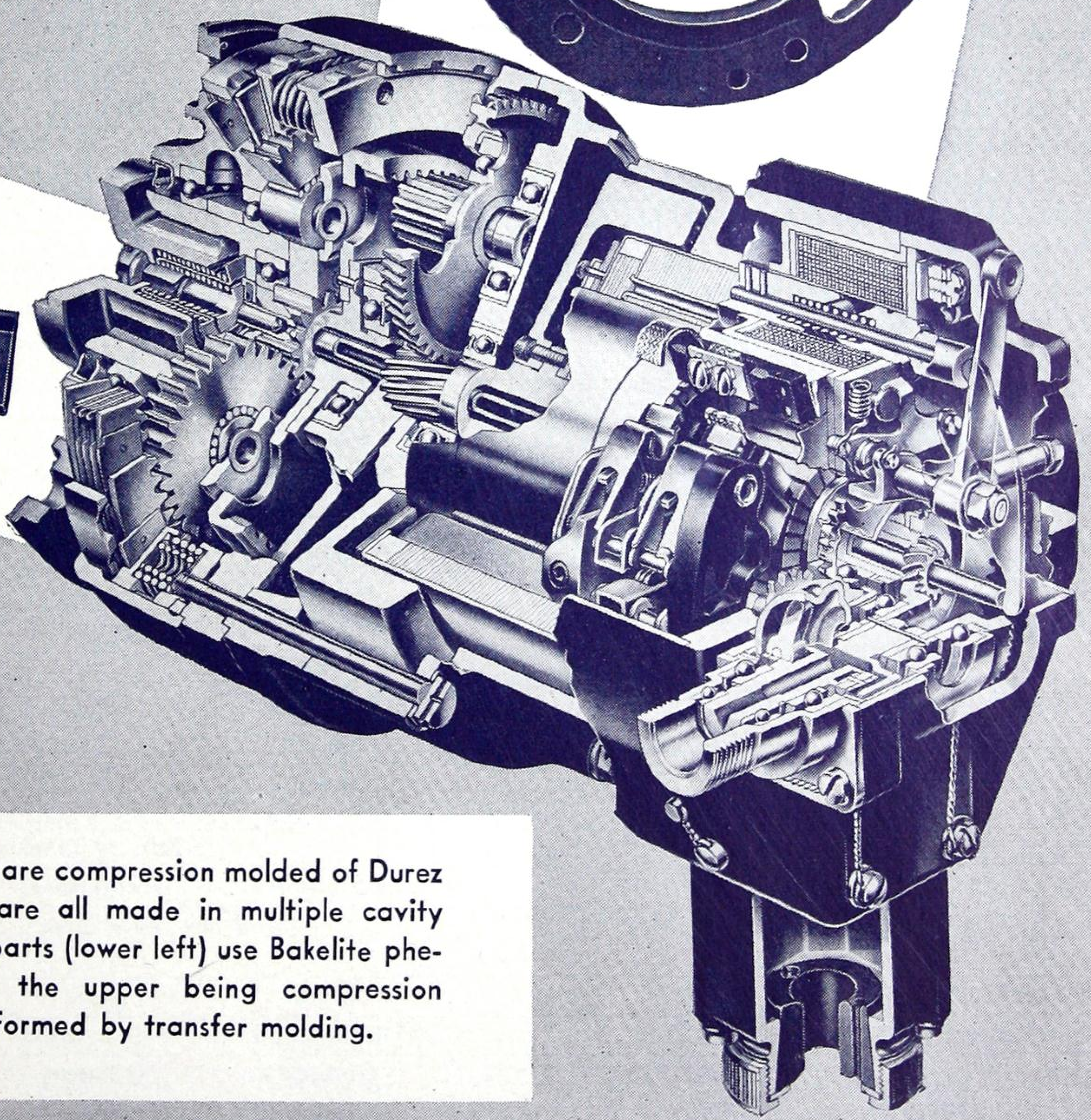
Both transfer and compression molding were employed to provide the best possible moldings. They are visible proof of what engineering skill combined with experienced molding techniques can produce in intricate sections that are held to exacting tolerances.

A view of the assembly is shown at the left.

NO ROOM HERE FOR EXPANSION

Watertown moldings have solved a ticklish problem in aircraft starters. The Jack and Heintz aircraft starter, in use on most types of Army and Navy planes is compact, light and exceedingly rugged. It meets today's stringent requirements for starting under extremes of temperature —and there is no room for expansion and no tolerance for contraction of any of its parts. In choosing the five plastics parts molded by Watertown, the manufacturers were able to build an even more rugged starter as these parts maintain fine dimensional stability and the completed unit is lighter and more compact.





The 3 rings (upper right) are compression molded of Durez phenolic material and are all made in multiple cavity molds. The two oblong parts (lower left) use Bakelite phenolic molding powder, the upper being compression molded and the lower, formed by transfer molding.

PLASTICS PROPERTIES CHART

PROPERTIES	PHENOL-FORMALDEHYDE Woodflour Filler	PHENOL-FORMALDEHYDE Macerated Fabric Filler	UREA-FORMALDEHYDE Alpha Cellulose Filler	MELAMINE-FORMALDEHYDE Alpha Cellulose Filler
Molding Qualities	Excellent	Good to Fair	Excellent	Excellent
Mold Shrinkage, inch per inch	0.006–0.010	0.002–0.007	0.006–0.011	0.008–0.015
Specific Gravity	1.32–1.47	1.37–1.45	1.45–1.50	1.45–1.55
Refractive Index, n_D	—	—	1.54–1.56	—
Tensile Strength, lbs. per sq. inch	6500–9500	5500–8000	8000–13000	8000–13000
Elongation, percent	0.4–0.8	0–7	—	—
Modulus of Elasticity in Tension, lbs. per sq. inch × 10^5	10–15	9–14	12–15	—
Compressive Strength, lbs. per sq. inch	25000–36000	20000–32000	25000-30000	27000–37000
Flexural Strength, lbs. per sq. inch	9000–12000	9000–13000	10000–16000	10000–16000
Impact Strength, ft. lbs. per in. of notch ½ × ½ in. notched bar, Izod test	0.24–0.40	0.8–8.0	0.28–0.32	0.24–0.35
Hardness, Brinell No. (2.5 mm. ball, 25 kg. load)	30–45	32–40	48–54 (500 kg., 10 mm.)	—
Hardness, Rockwell	M110–M120	M110–M120	M110–M130	—
Thermal Conductivity, 10^{-4} cal. per sec. per sq. cm./1 °C. per cm.	4–7	4–7	7.1	—
Specific Heat, cal. per ° C. per gram	0.35–0.40	0.30–0.35	0.4	—
Thermal Expansion, 10^{-5} per ° C.	3.0–4.0	2–3	2.5–3.0	—
Resistance to Heat, ° F. (continuous)	300	250	170	210
Distortion under Heat, ° F.	260–300	250–300	260–280	385
Volume Resistivity, ohm-cms. (50% relative humidity and 25° C.)	10^9–10^{12}	10^9–10^{12}	10^{12}–10^{13}	10^{12}–10^{13}
Dielectric Strength, short-time volts per mil, ⅛ in. thickness	250–375	200–350	300–400	300–400
Dielectric Strength, step-by-step volts per mil, ⅛ in. thickness	200–375	150–300	300–380	—
Dielectric Constant, 60 cycles	5.5–9	6.0–10	7.0–7.4	9.0–9.5
Dielectric Constant, 10^3 cycles	4.8–7.5	5.5–8	—	—
Dielectric Constant, 10^6 cycles	4.5–6.0	4.5–6	6.6–7.7	3.5–7.6
Power Factor, 60 cycles	0.03–0.20	0.08–0.30	0.029–0.032	0.043–0.045
Power Factor, 10^3 cycles	0.03–0.08	0.04–0.12	—	—
Power Factor, 10^6 cycles	0.03–0.06	0.03–0.06	0.027–0.035	0.05
Water Absorption, 24 hrs., %	0.4–1.0	0.5–1.8	0.5–0.7	0.3–0.6
Burning Rate	Very low	Approx. nil	Very low	Nil
Effect of Sunlight	Slight	Slight	None	Slight
Effect of Weak Acids	None to slight			None
Effect of Strong Acids	Decomposed by oxidizing acids only		Decomposes	Decomposes
Effect of Weak Alkalies	Slight to marked			None
Effect of Strong Alkalies	Decomposes	Decomposes	Decomposes	Attacked
Effect of Organic Solvents	None on bleed proof material			None
Effect on Metal Inserts	Inert	Inert	Inert	Inert
Machining Qualities	Fair to good	Fair to good	Fair	Fair
Clarity	Opaque	Opaque	Translucent opaque	Translucent
Color Possibilities	Limited	Limited	Unlimited; pastel shades	Unlimited

Abridged from Plastics Catalog Properties Chart

PLASTICS PROPERTIES CHART

RIGID VINYL CHLORIDE ACETATE RESINS	METHYL METHACRYLATE RESINS	POLYSTYRENE	NYLON RESINS (Molding)	ETHYL-CELLULOSE	CELLULOSE ACETATE	CELLULOSE ACETATE BUTYRATE
Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
0.001 Max.	Compression 0.001–0.005 Injection 0.003–0.006	Compression 0.002–0.005 Injection 0.002–0.008	0.012	0.001–0.011	Positive and injection 0.002–0.003; Semipositive 0.005–0.007; Flash 0.008–0.009	
1.34–1.37	1.16–1.20	1.054–1.070	1.14	1.07–1.18	1.27–1.37	1.10–1.24
1.53	1.49–1.51	1.59	1.53	1.470	1.46–1.50	1.47–1.49
8000–10000	4000–10000	5000–9000	9000–10500	2000–9000	1500–8200	1400–6700
—	1–15	2–5	45–55	5–100	7–80	35–95
3.5–4.1	3–5	1.7–4.7	3.0–3.25	1–5.0	0.6–3.5	0.5–2.0
—	10000–15000	11500-15000	14000–16000	8000–20000	5000–30000	7500–22000
12000–14000	10000–19000	8000–19000	11000–13000	3000–12000	2000–12000	1600–12000
0.4–1.2	0.2–0.4	0.3–0.5	0.9	0.6–11.5	0.4–6.2	0.6–9
12–15	18–20	20–30	—	4.0–11 (10 kg.)	4.5–12 (10 kg.)	6–12
—	M60–M112	M75–M90	M90	R20–R110	R40–R120	R40–R120
4.0	4–6	1.9	6	3.8–6.3	4–8	4–8
0.24	0.35	0.32	0.5	0.32–0.46	0.3–0.45	0.3–0.4
6.9	8–9	6–8	10	10–14	8–16	11–17
130	120–160	150–190	—	140–220	140–220	140–220
140–150	145–190	170–175	170	120–200	100–215	100–180
$> 10^{14}$	10^{15}–10^{19}	10^{17}–10^{19}	10^{13}	10^{12}–10^{13}	10^{10}–10^{12}	10^{10}–10^{12}
400	500	500–700	400	400–600	250–365	250–400
380	400	450–600	300	—	200–300	—
3.26	3.0–3.7	2.5–2.6	4.1	2.5–4.0	3.5–6.4	3.5–6.4
3.21	3.0–3.5	2.5–2.6	4.0	2.5–4.0	3.5–6.4	—
3.08	2.8–3.3	2.5–2.6	3.4	2.0–4.0	3.2–6.2	3.2–6.2
0.008	0.05–0.07	0.0001–0.0003	0.014	0.005–0.015	0.01–0.06	0.01–0.04
0.01	0.06–0.07	0.0001–0.0003	0.02	0.005–0.025	0.01–0.06	—
0.014	0.02–0.03	0.0001–0.0008	0.04	0.007–0.040	0.01–0.06	0.01–0.04
0.05–0.15	0.3–0.5	0.00–0.05	1.5	1.0–2.0	2.0–6.0	1.0–2.4
Nil	Slow	Slow	Self-extinguishing	Slow	Slow	Slow
Slight	Very slight	Slight	Discolors slightly	Slight	Slight	Slight
None	Nil	None	None	Slight	Slight	Slight
None	Attacked by oxidizing acids		Attacked	Decomposes	Decomposes	Decomposes
None	Nil	None	None	None	Slight	Slight
None	Nil	None	None	Slight	Decomposes	Decomposes
Soluble in ketones and esters	Soluble in some	Soluble in some	Resistant	Widely soluble	Soluble in ketones and esters.	
Inert	Inert	Inert	Inert	Inert	Inert	Inert
Good	Excellent	Fair to good	Excellent	Good	Good	Good
Transparent to opaque	Transparent	Transparent	Translucent opaque	Transparent to opaque	Transparent to opaque	Transparent to opaque
Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited

PLASTICS COMPARATOR

Plastic Material	Toughness (Impact Strength)	Flexural Strength	Tensile Strength	Color Stability	Cold Flow	Water Resistance	Acid Resistance	Caustic Resistance	Solvent Resistance	Dimensional Change on Aging	Heat Resistance (Continuous Heat)	Flammability	Heat Insulation	Specific Gravity	Hardness	Loss Factor	Resistivity	Dielectric Strength	Moldability Around Inserts
Phenolic: General Purpose	10	3	3	7	1	5	3	4	1	4	2	3	2	8	5	10	7	4	2
Phenolic: Low-Loss	11	3	7	7	1	2	4	4	1	2	3	1	7	12	3	4	3	3	2
Phenolic: Heat-Resistant	9	4	8	7	1	2	4	4	1	1	1	1	7	13	2		8	8	2
Phenolic: Acid and Alkali-Resistant	10	6	8	7	1	3	2	3	1	5	3	2	2	5	4			7	3
Phenolic: Shock-Resistant	2	1	5	7	1	6	4	5	1	6	3	4	3	10	5		9	8	1
Phenolic: Transparent	7	1	3	7	1	3	3	3	1	5	3	2	2	6	4	7	5	6	3
Urea	8	1	1	1	2	8	4	4	1	7	7	5	5	11	1	9	4	2	4
Polystyrene	7	2	7	4	4	1	1	1	3	3	6	6	1	1	6	1	1	1	6
Cellulose-Acetate	4	6	9	3	8	10	4	6	3	9	5	6	4	7	9	8	6	5	5
Aceto-Butyrate	1	5	10	3	6	7	4	4	3	8	4	6	6	4	8	3			5
Ethyl-Cellulose	3	2	6	6	7	9	4	2	3	8	5	6	4	2	8	2	2	1	5
Methyl-Methacrylate	6	1	4	2	5	4	2	2	3	8	9	6	2	3	7	5		2	6
Vinyl (No Filler)	5	1	2	5	3	1	1	1	2	3	8	5	2	9	7	6	2	1	5

WATERTOWN
WARE

[BLANK PAGE]