

# the GENERAL RADIO Experimenter



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Since 1915 — Manufacturers of Electronic Apparatus for Science and Industry

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## THE TYPE W5 VARIAC® — A NEW AND BETTER VARIABLE AUTOTRANSFORMER

*JDO*  
*file*

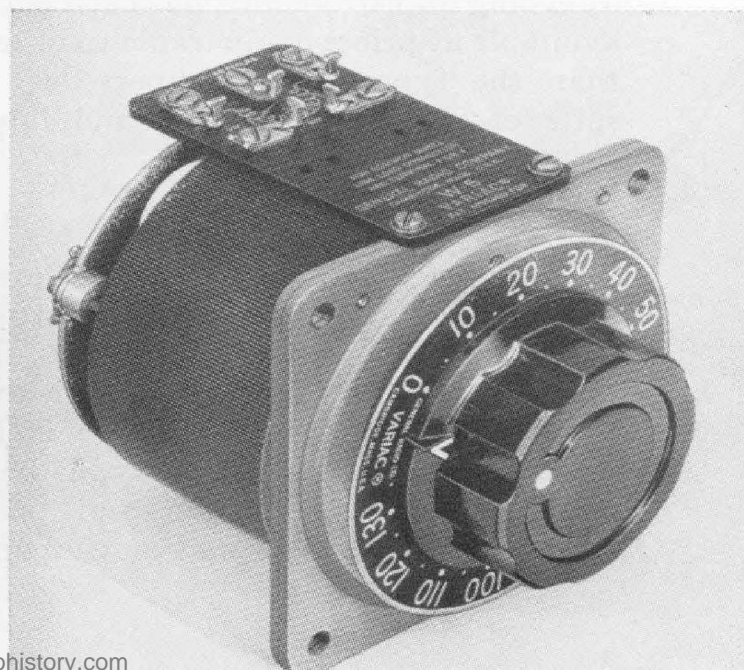
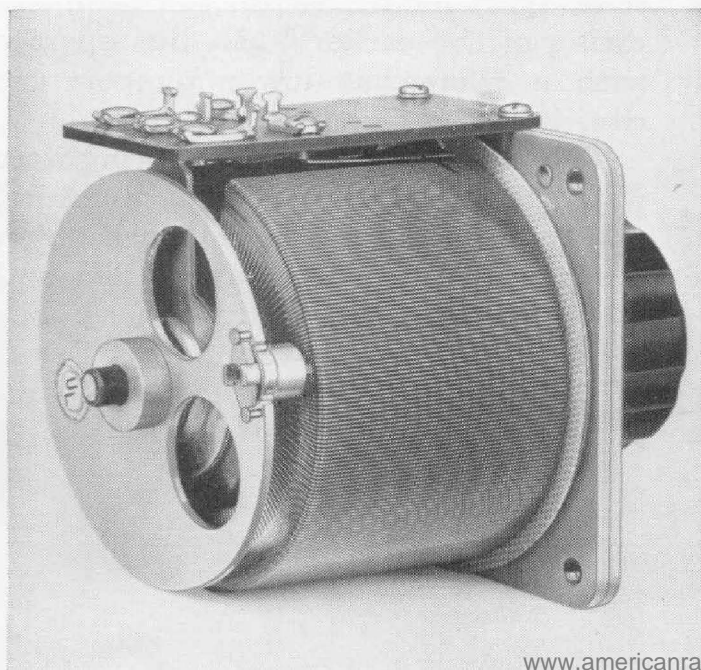
To maintain leadership, today's product must keep abreast of the times. Small changes in design and construction, to upgrade quality, are made continually, but major improvements dictate a new design.

The new TYPE W5 Variac® represents the second basic model change since the adjustable autotransformer was introduced by the General Radio Company over twenty years ago. The new design incorporates the latest features which customer experience has shown to be useful, and it reflects progress in the fields of metallurgy,

dielectrics and metal working as well as General Radio's more than twenty years of experience in the design and manufacture of continuously-adjustable autotransformers.

The important improvements include Underwriters Laboratories listing, military ruggedization, and counterbalanced rotating parts. The basic open unit, TYPE W5, has an increased rating and an extended rectangular flange mounting. An additional feature of the cased models is total enclosure, with ready accessibility to the interior. Cased models also include new wall mounting

Figure 1. Two views of the new Type W5 Variac.



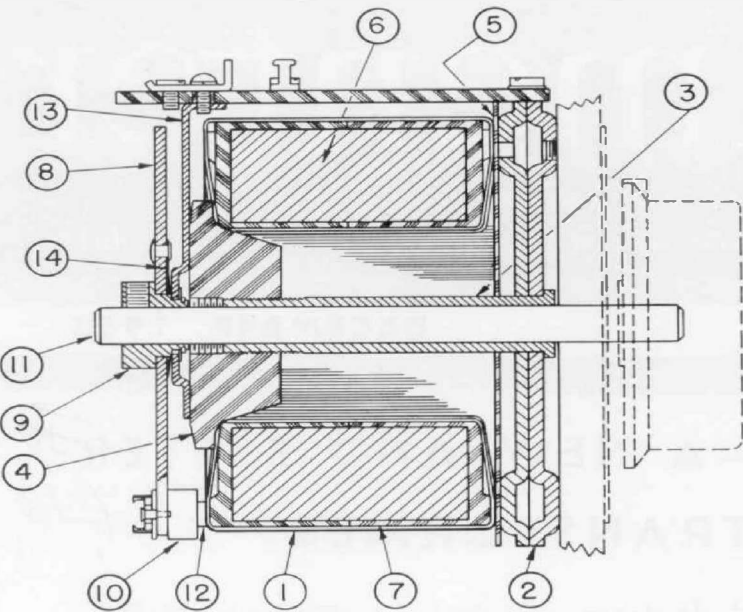


Figure 2. Sectional view of the Type W5 Variac, showing details of design and construction.

types with conduit knockouts, for ganged assemblies as well as for individual units. A new portable model, which can be used in either a horizontal or a vertical position, has a built-in overload protector and is equipped with a carrying handle. This type is available with the new three-wire grounded cord set and receptacle, as well as in the usual two-wire arrangement.

By a careful choice of fabricating methods and materials, plus extensive tooling, the whole series, including the foregoing improvements, has been made available at prices comparable to or less than the types that it supersedes, in spite of increased material and labor costs.

### Design Features

Specific features can best be shown by a detailed discussion of the construction. Fig. 1 shows the basic TYPE W5 Variac. The first new distinguishing characteristic to catch the eye is its square base. This flange-type base permits surface mounting and post-type ganging, which makes the unit

more easily adaptable to motor drives and to an ever-increasing list of similar special structures.

The base assembly is built up of two identical stamped pieces of wrought aluminum alloy and is substantially stronger and more resistant to impact than the die-cast base of its predecessor. In addition to the four corner mounting holes, three interior mounting holes, matching those of the older TYPE V5, are provided. Thus, in the majority of installations, the new TYPE W5 is interchangeable with the TYPE V5.<sup>1</sup>

Fig. 2 is a sectional view and shows how the coil (1) is clamped to the base (2) with a hollow sleeve bolt (3) and a molded phenolic nut (4) of thick section. This simple, direct attachment to the heavy gauge base provides a structure that withstands most military shock and vibration tests. The coil and base are in contact over a large annular surface, with a glass-cloth insulator (5) between them so that good thermal conductivity is maintained.

The improved thermal coupling between coil and base allows an increase in rating of the TYPE W5 of twenty per cent versus that of the TYPE V5. Underwriters Laboratories, Inc., list the basic (uncased) unit for 6-amperes rated current. W5H models retain the 2-ampere rating of the earlier V5H, but operate with a somewhat lower temperature rise.

The advantages of higher rating were weighed against those of total enclosure, and total enclosure was the decision on the merits of excluding dust, dirt and other harmful outside influences. For this reason, the cased models, TYPES W5M and W5MT, are rated at 5 amperes for continuous duty.

<sup>1</sup> For those few applications where it may not be, manufacture of the V5 will be continued as required.



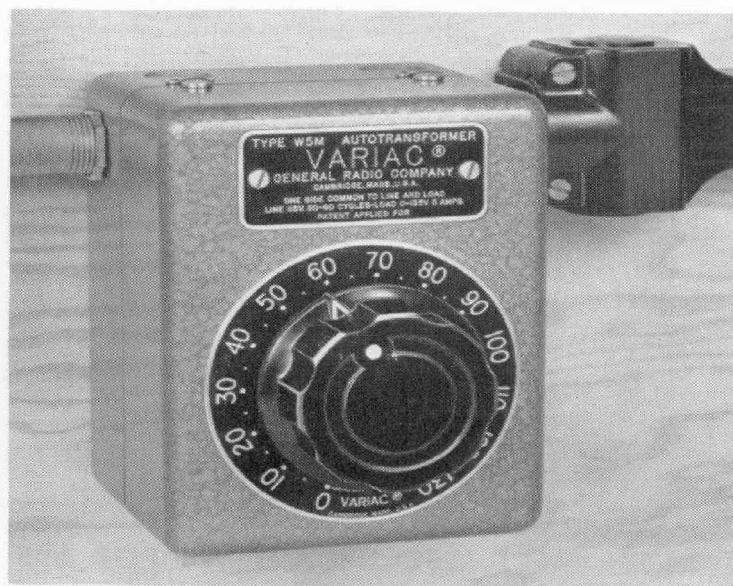
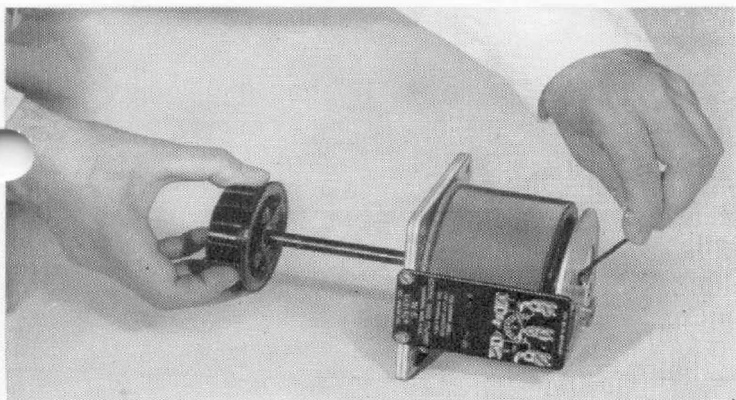
The low-loss, high-silicon core material now used in Variacs can be operated at flux densities believed impossible only ten years ago, and still shows lower losses than earlier cores at far lower flux densities. Wire insulation and coil insulation are steadily being improved in the interest of longer life under adverse operating conditions. The coil is wound with triple-Formvar-coated copper to provide adequate breakdown strength between banked turns at elevated temperatures.

The core (6) is completely encased by two identical winding forms (7) of molded phenolic in the shape of annular cups. Precision molded grooves in these forms insure positive positioning of turns and a smooth, uniform banked winding at the inner radius. The butt joint between cups is sealed when the coil is dipped in baking varnish, so that the core is completely enclosed with high-dielectric-strength material.

After baking, the brush track is ground in several successive steps to an extra fine finish for smooth operation and long brush life. The *Duratrak* finish is then applied to give maximum thermal and electrical performance plus high corrosion resistance.

The terminal leads to the winding are tapped in a few turns from the winding end to permit the brush to reach zero or maximum voltage without traversing the end turn.

**Figure 4. The shaft can easily be adjusted or replaced without disturbance to the rest of the assembly.**



**Figure 3. View of the Type W5M Variac in typical installation.**

The terminal board (15) is imprinted with terminal numbers, wiring diagram and other pertinent information. The 115-volt model has five terminals to permit wiring for 115-volt or 135-volt maximum output in either direction of rotation. The 230-volt model has two extra terminals, thereby providing taps at 115 volts or 230 volts from either end of the 270-volt winding. The terminals are equipped with both screws and solder lugs, and all leads to the coil run behind the terminal board from the bottom of the coil, so that there are no vulnerable and unsightly external joints or wires.

The radiator assembly is an aluminum disc (8) with screw-machine bosses (9) and (10) to receive the shaft (11) and the unit brush (12). This full disc construction protects the brush track against damage and provides counter-balance and radiating surface.

The whole assembly is made loosely captive to a brass take-off connector (13), which is rigidly attached to the phenolic coil-clamping nut and to the terminal board. A polished phosphor-



bronze leaf spring (14), riveted to the radiator disc, carries current to a polished section of the brass connector.

Although all rotating parts are firmly guided by the shaft, the captive radiator construction permits shaft adjustment or replacement for ganging, etc., without disturbing the Variac assembly.

The unit brush is the same as that used in the TYPE V5, thus retaining interchangeability in service replacement.

Each unit comes equipped with an

easy-to-grip phenolic knob with a white-filled index pointer and a readily visible large white dot for quick reference, and a reversible dial-plate calibrated on one side for 115-volt maximum output and on the other for 135 volts. Screws for mounting both Variac and dial-plate are furnished.

### Cased Model—Type W5M

A typical installation of the new totally enclosed TYPE W5M is shown

## SPECIFICATIONS FOR W5 VARIACS

Type	Description	Rated Input Voltage		Rated Output Current in Amperes	LINE-VOLTAGE CON-	
					Output Voltage Range	Maximum Output Current in Amperes
W5	Uncased		115	6	0-115	7.8
W5M	Completely enclosed, with Conduit knockouts		115	5	0-115	6.5
W5MT*	Bench model, completely enclosed, with overload protector, switch, carrying handle, two-wire cord, plug, and outlet		115	5	0-115	6.
W5MT3*	Bench model, similar to Type W5MT, but with 3-wire, cord, plug, and outlet		115	5	0-115	6.
W5H	Uncased		230 115	2 1	0-230	2.6
W5HM	Similar to W5M		230 115	2 1	0-230	2.6
W5HMT*	Similar to W5MT		230	2	0-230	2.4
W5G2 W5G2M	Two-gang W5 Two-gang W5 with case	Series Circuit	230	6	0-230	7.8
			230	5	0-230	6.5
W5G3 W5G3M	Three-gang W5 Three-gang W5 with case	3-Phase Wye	230	6	0-230	7.8
			230	5	0-230	6.5
W5HG2 W5HG2M	Two-gang W5H Two-gang W5H with case	3-Ph. Delta Series	230	2	0-230	2.6
			460	2	0-460	2.6
W5HG3 W5HG3M	Three-gang W5H Three-gang W5H with case	3-Phase Wye	460	2	0-460	2.6

\* MT models are shipped with overvoltage connections, but can be supplied wired for line voltage.  
† Dial has overvoltage scale on one side, line-voltage scale on the other.



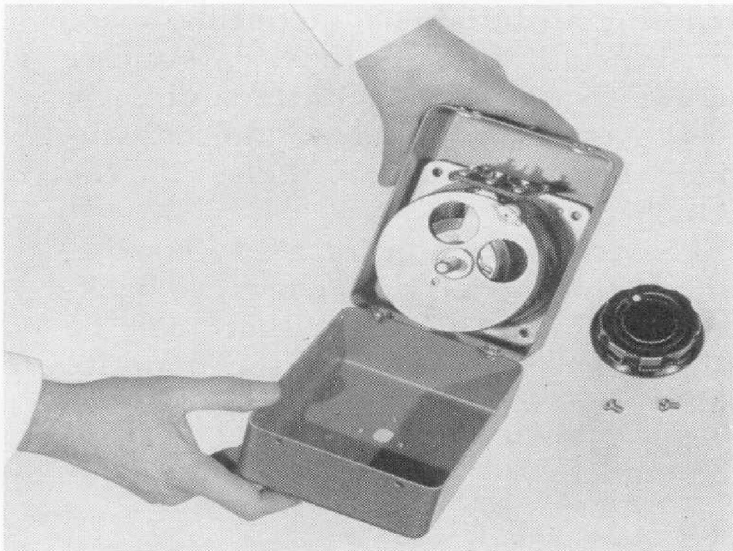
in Fig. 3. The smooth, gray, round-cornered case is provided with four knockouts for  $\frac{1}{2}$  in. conduit or armored cable, two on the end and one on each side, plus ample inside wiring space for ease of installation. Complete access for wiring, maintenance, etc., is accomplished by loosening two set screws in the knob and removing two screws in the cover. The front half of the case can then be removed easily,

exposing all terminals, mounting holes, brush, and brush track. Mounting screws to wall or panel attach directly to the structural flange of the unit inside through clearance holes in the attached case.

Provision is made for ready conversion of this model, by the user, to back-of-panel mounting. The shaft can be adjusted to extend from the opposite side of the case by loosening two set

SECTION	OVERVOLTAGE CONNECTION †		60 No-load loss—watts	Driving Torque ounce— inches	Net Weight pounds	Code Word	Price
	Output KVA at Maximum Output Volts	Output Voltage Range					
0.9	0-135	6	9	10-20	6 $\frac{3}{4}$	COTAL	\$17.00
.75	0-135	5	9	10-20	7 $\frac{1}{2}$	COTER	21.50
.69	0-135	5	9	10-20	8 $\frac{1}{4}$	COTIC	26.50
.69	0-135	5	9	10-20	8 $\frac{1}{4}$	COTOM	28.50
.6	0-270 0-270	2 1	9	10-20	6 $\frac{1}{2}$	JOBAL	19.00
.6	0-270 0-270	2 1	9	10-20	7 $\frac{1}{4}$	JOBER	23.50
.55	0-270	2	9	10-20	8	JOBIC	28.50
1.8	0-270	6		20-40	14 $\frac{1}{4}$	COTALGANDU	41.00
1.5	0-270	5			15 $\frac{3}{4}$	COTALBONDU	49.00
3.1 2.6	Not recommended			30-60	21 $\frac{1}{4}$ 23 $\frac{1}{4}$	COTALGANTY COTALBONTY	61.00 69.00
1. 1.2	0-270 0-540	2 2		20-40	14 15 $\frac{1}{2}$	JOBALGANDU JOBALBONDU	45.00 53.00
2.1	Not recommended			30-60	20 $\frac{3}{4}$ 22 $\frac{3}{4}$	JOBALGANTY JOBALBONTY	67.00 75.00

age connections on special order.



**Figure 5.** The front half of the case is easily removed for access to terminals, mounting holes, and brush.

screws; two more set screws and three self-tapping screws will release the knob and dial-plate for relocation on a panel; and two holes are provided for moving the nameplate over the shaft hole left in the cover.

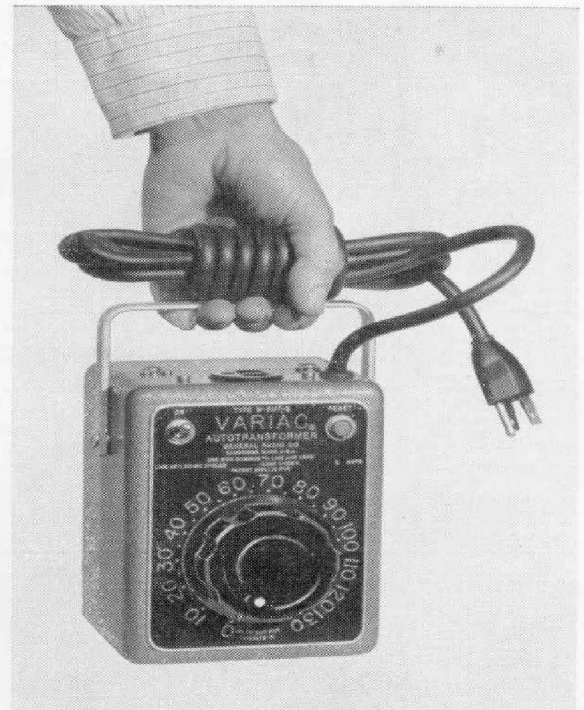
The new cased model is offered at a price substantially lower than that of its nearest functional equivalent (TYPE V5MTC) in the superseded V5 series.

**Portable Model—Type W5MT**

The bench and portable version, TYPE W5MT, shown in Figure 6, offers a number of new features over previously available units. Outstanding among these is a resettable thermal overload protector in the brush lead. Operating partly on ambient temperature and partly on load current, this permits short-time overload, which the *Duratrak* Variac is capable of withstanding, but opens on sustained overloads or abnormal internal case temperature. It can be reset only if the condition which caused the interruption has been rectified, thus assuring continued protection. Current-time and current-temperature characteristics are shown in Figs. 8 and 9.

The case is made of two identical drawn aluminum boxes with embossed feet on both back and end. When the unit is used on its back, with the dial-plate horizontal, the input and output cords will run toward the back of the bench.

**Figure 6a (left).** View of the Type W5MT3 Variac for bench and table use. Type W5MT is identical in appearance. **Figure 6b (right).** The portable model is equipped with a convenient handle and so is easily carried around in the test shop or laboratory. Both the 2-wire and 3-wire models are equipped with overload protector.



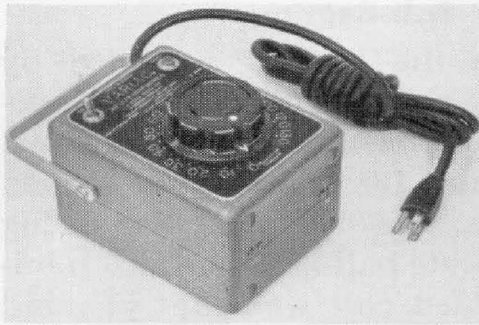


Figure 7a. The portable model can be used either vertically (Figure 6) or horizontally as shown above.

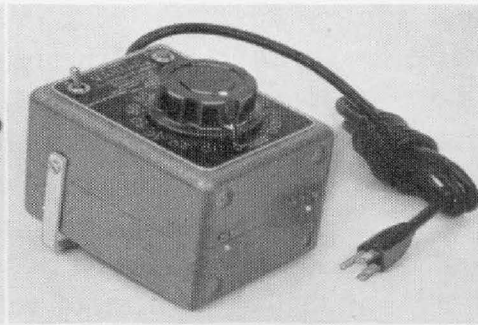


Figure 7b. In the horizontal position, the handle can be used to give the panel a slight incline.

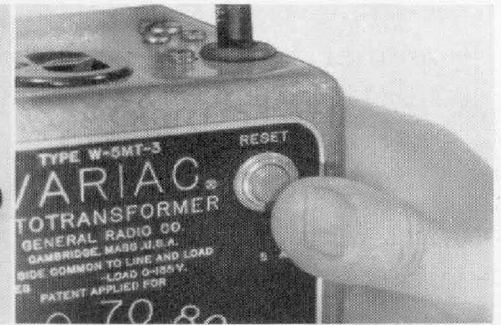


Figure 7c. The overload protector, a new feature of the T-models, is easily reset from the front panel.

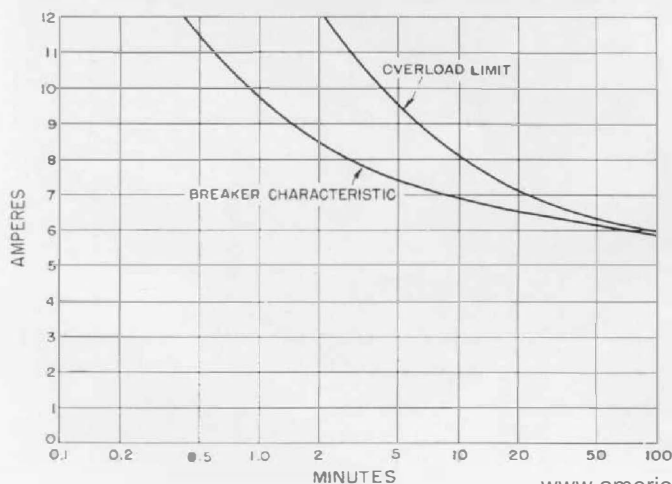
The knob, switch, and reset button are all conveniently grouped on a single surface, which is free from cords and other obstructions. The removal of only two screws, in this model, permits withdrawing half of the case, exposing the interior for inspection and maintenance.

Both two-wire (TYPE W5MT) and three-wire (TYPE W5MT3) models for 115-volt service are offered. The TYPE W5MT3 uses the new NEMA three-wire output receptacle and plug and will be welcomed by the many laboratories wired in the new standard three-wire system with separate grounding wire. For 230-volt service, a two-wire model, TYPE W5HMT, is available.

### Ganged Assemblies

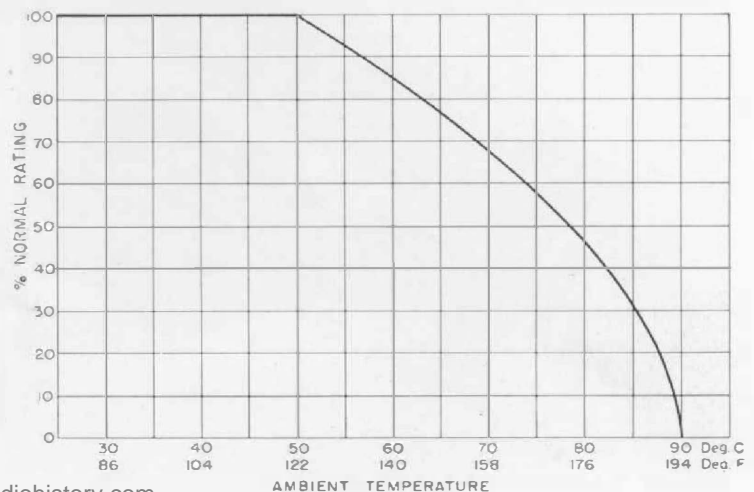
Ganged assemblies provide greater flexibility in mounting than did pre-

Figure 8. Current-time characteristic of the overload protector at 57.5-volt output is shown by the lower curve. Upper curve shows permissible overload as a function of time. Note that the breaker always operates before the limit is reached.



vious designs. One unit in each gang is reversed, so that there is a mounting base at each end of every assembly. Thus there is no distinction between "panel" and "base" mounted units. Fig. 10 shows a typical ganged assembly and illustrates the sturdy simplicity of construction gained by the square flanged base and four posts. The posts are attached to the end units by means of special steel bolts whose heads are tapped for screws. This yields four tapped mounting holes in each end of a gang so that it can be mounted to a panel, supported at its far end, or attached to angle brackets, which are supplied as a part of the standard hardware with each assembly. Because of the many voltages encountered in applying ganged Variacs, the dial-plate is not calibrated but carries an arbitrary 0-10 scale.

Figure 9. Standard temperature derating curve for Variacs. The overload protector operates partly on ambient temperature and will open the circuit before these values are reached.



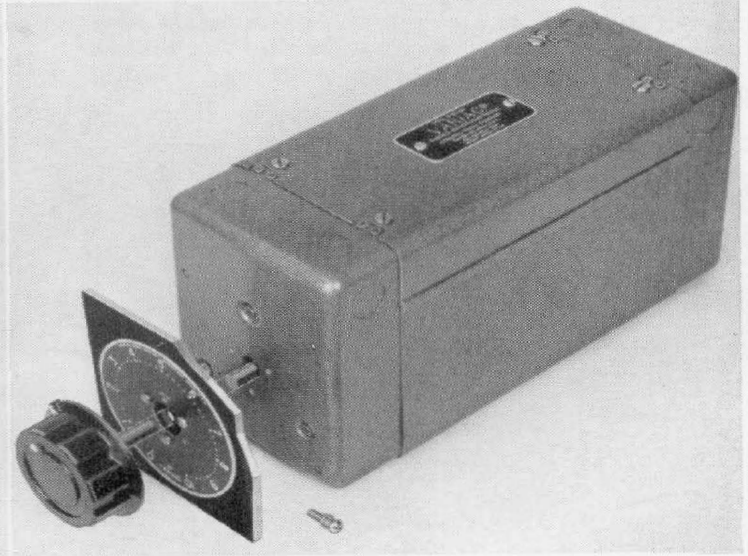
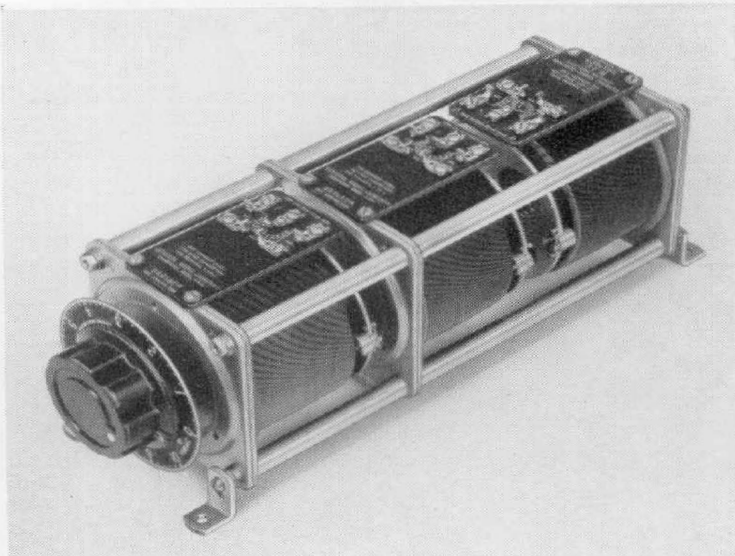
The two end mounting plates together with the connecting posts at each corner provide protection for the coils and brush tracks against gross mechanical abuse. Nevertheless, a case (see Figure 10) for the assembly is available for applications where complete enclosure of Variacs and wiring is desired. The case is made up of two drawn boxes with conduit knockouts as used in the TYPE W5M. These boxes are affixed to the assembly, and the enclosure is completed by two U-shaped covers, in matching gray finish, which are readily removable for installation and service. Clearance holes permit access to the four tapped holes in each end of the assembly inside, so that the unit can be mounted in the same manner as the uncased model.

**Special Modifications**

The flexibility and versatility of the new design has already been demonstrated by the variety of modifications that have been developed for special applications. Several of the special modifications are described below.

<sup>2</sup>Standard listings of ball-bearing and motor-driven Variacs will be announced in forthcoming issues of the *Experimenter*. The other modifications described are available on special orders only.

**Figure 10. Views of uncased and cased models of a 3-gang, Type W5 Variac. The L-shaped foot brackets shown on the uncased model are supplied as accessories but are not installed before shipment.**



**Ball-Bearings <sup>2</sup>**

Although the bearing provided by the phenolic shaft turning in the sleeve-bolt is entirely adequate for all manual operation and for many motor-driven applications, the desirability of being able to provide ball-bearings at a minimum of added cost was kept in mind during the development of the new design. In high-speed servo applications such as the GR TYPE 1570-A Automatic Line-Voltage Regulator more precise alignment, lower and more constant torque, and longer life can be obtained with ball bearings. Fig. 11 shows how ball bearings are accommodated in a W5-type Variac very simply by using a larger sleeve-bolt, in each end of which a ball bearing is mounted.

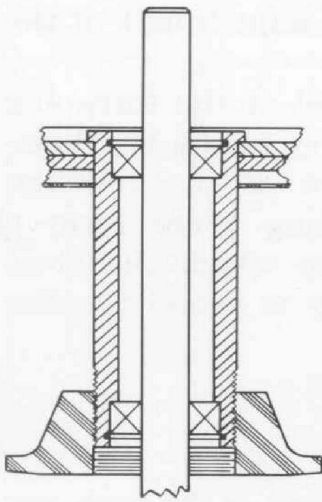
**Motor-Drives <sup>2</sup>**

Fig. 13 shows a servo motor mounted on a W5 Variac. The structure is somewhat similar to that of a ganged Variac assembly. The motor mounting plate is attached to the base by four posts. The motor is gear-coupled to the Variac shaft.

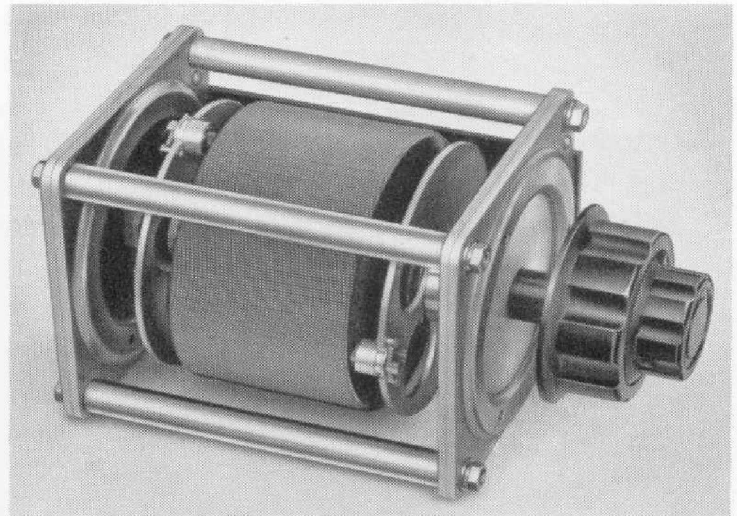
**Continuous Rotation**

Certain specialized applications have called for continuous, 360° rotation.





**Figure 11. Section drawing showing how larger sleeve bolts are used when ball bearings are installed.**



**Figure 12. A W5 Variac with two brushes, one at each surface of the winding.**

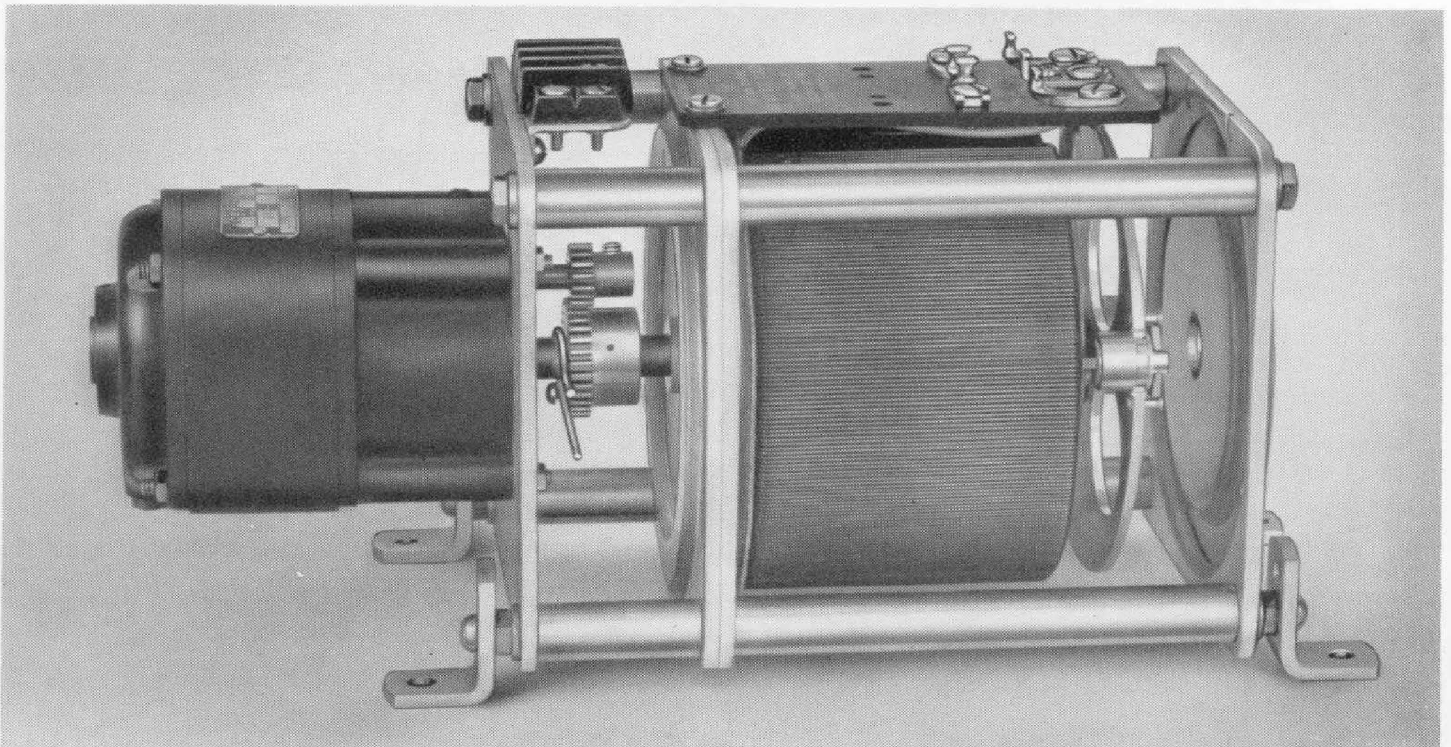
The new W5 design allows ready modification for this purpose. As shown in Figure 14, the take-off connector, which normally serves also as stop for the usual 320° operation, can be cut off to permit traverse of the brush through the "keystone" gap in the winding. The brush lead is brought down through the center of the toroid and out to the terminal plate in the same manner as the tap leads.

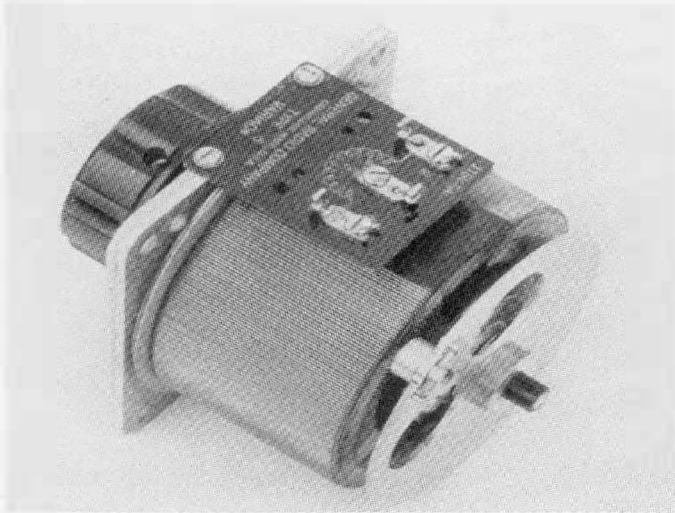
### Double Track

One of the most interesting special models encountered to date is the

double-track unit shown in Fig. 12. Since the two winding forms for the coil are identical, it is possible to form a brush track at each end of the coil. A radiator and take-off structure is mounted at each end in a manner requiring no special parts except a modified sleeve bolt. The coil structure is mounted between two standard bases which serve in this case as bearing supports for the rotating structure. The unit shown is a coaxial design, which

**Figure 13. Servo motor and gear coupling can be installed without complicated structures.**





permits independent adjustment of the two brushes.

By planning for all of the foregoing features and flexibility in the W5 Variacs at the inception of the redesign program, the resulting types form a well-integrated group which the General Radio Company is proud to offer to its customers.

Figure 14. Complete traverse of the brush over 360° can be provided. The winding covers 320°.

**CREDITS:** Engineers contributing to the development include G. Smiley, C. A. Tashjian, H. S. Wilkins, and H. M. Wilson. Credit is also due to G. C. Oliver and A. W. Chase for their suggestions in the course of drafting and model making, respectively. The project was under the direction of Ivan G. Easton.

The cased models, TYPES W5M, W5MT and W5MT3, are listed under the reexamination service of the Underwriters Laboratories and may be installed in any normal locations. The uncased TYPE W5 is listed for use in applications where the installation is approved.

FOR COMPLETE SPECIFICATIONS AND PRICES, SEE PAGES 4 AND 5.

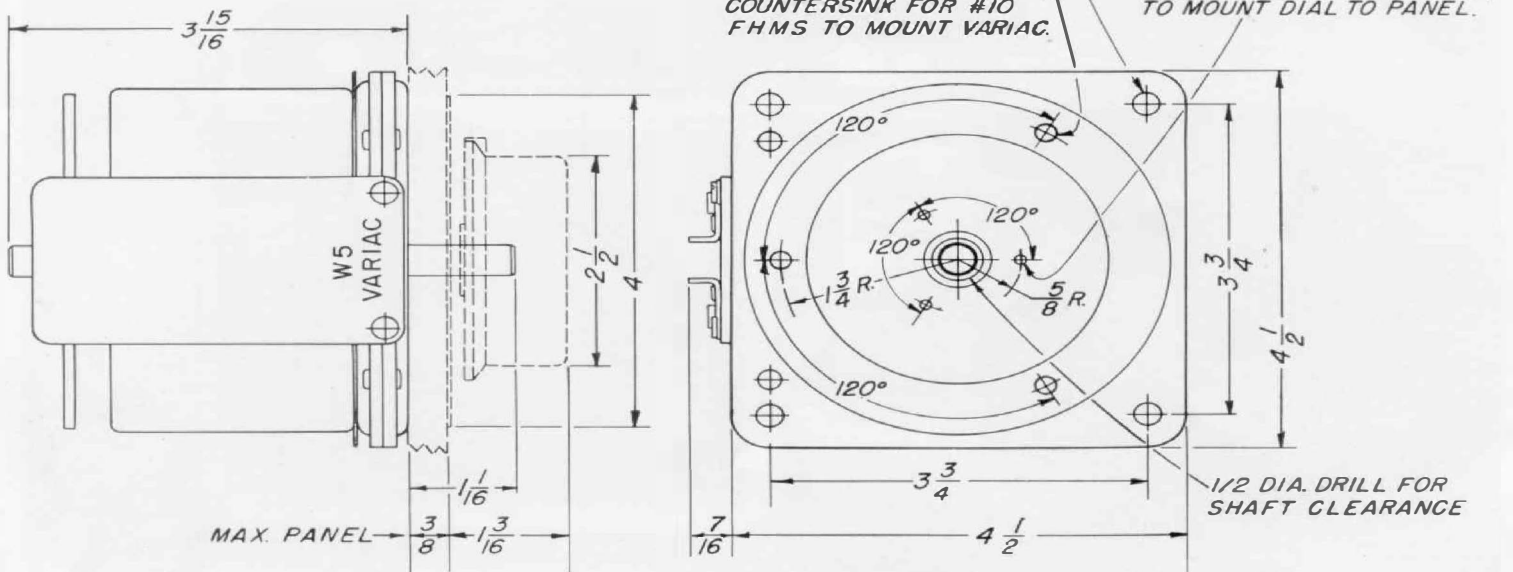
**DIMENSIONS OF TYPE W5 AND TYPE W5H VARIACS**

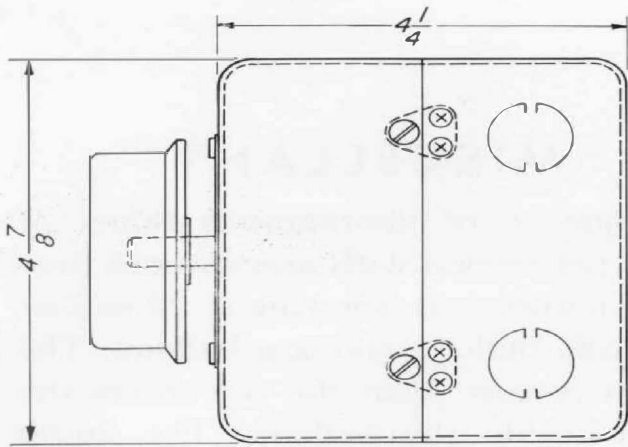
4 HOLES 9/32 DIA. DRILL OR TAPPED 1/4-28 AS PREFERRED TO MOUNT VARIAC.

OR

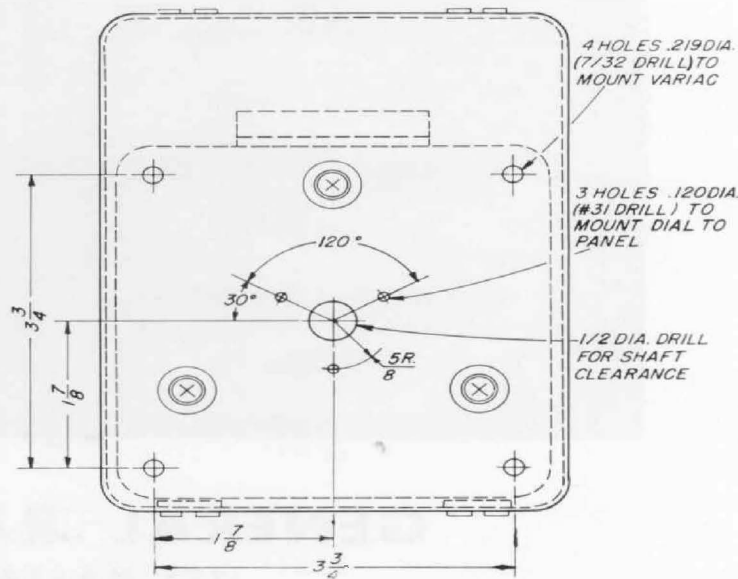
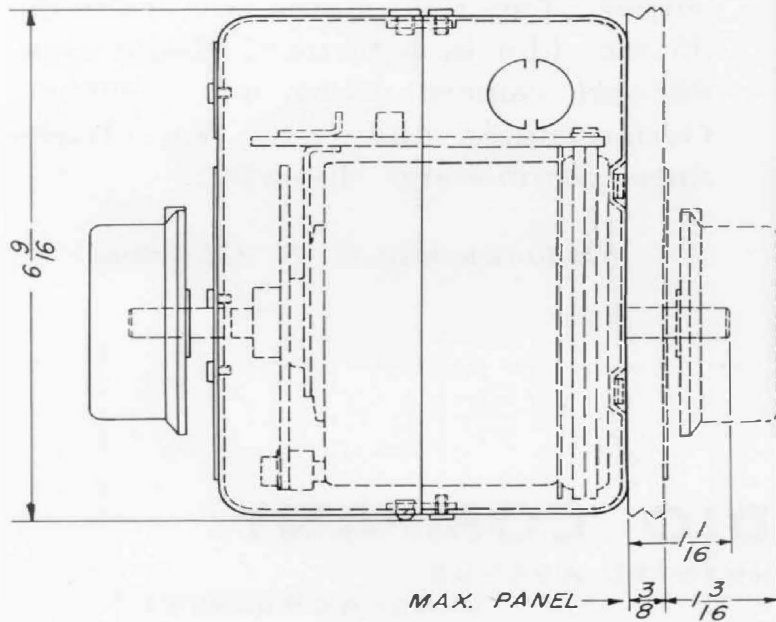
3 HOLES 7/32 DIA. DRILL, COUNTERSINK FOR #10 FHMS TO MOUNT VARIAC.

3 HOLES .120 DIA. (#31 DRILL) TO MOUNT DIAL TO PANEL.





DIMENSIONS OF TYPE W5M AND TYPE W5HM VARIACS

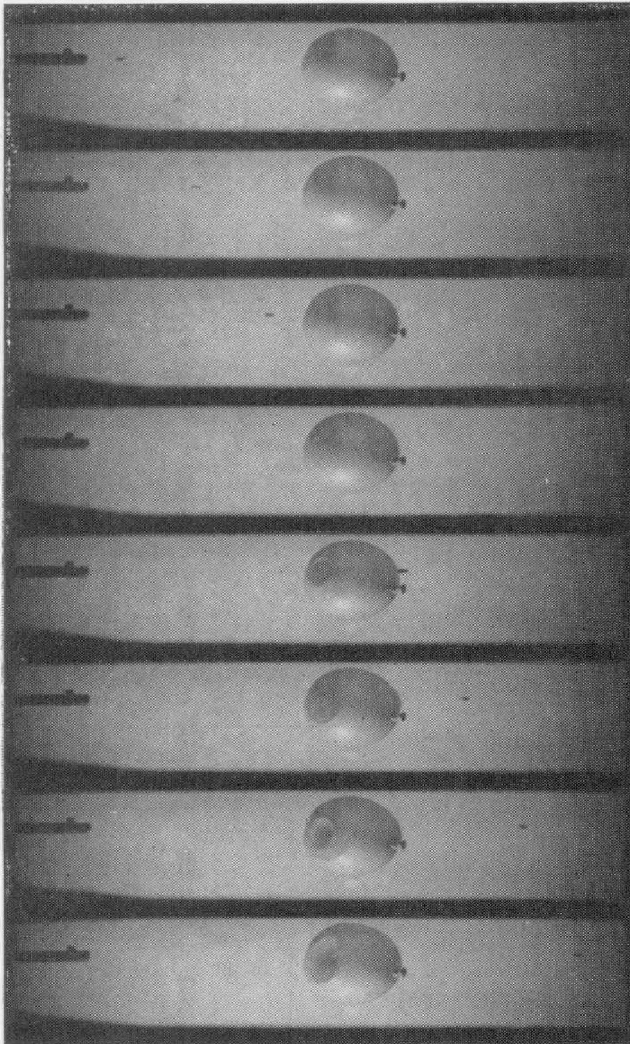


### V5 SERIES VARIAC

Production of the popular V5 Series of Variacs will continue in order to accommodate those who are using the V5 types in applications that will not permit substitution of the new W5 types. Owing to recent increases in the cost of labor and materials, it has become necessary to revise the prices of

some models in the V5 series. Prices effective January 1 are as follows:

Type	Price	Type	Price
V5.....	\$18.50	V5HM...	\$21.00
V5M.....	21.50	V5HMT..	28.50
V5MT...	26.50	V5MTC..	24.00
V5H.....	23.50	V5MTF..	36.00



### MISCELLANY

A sequence of photographs taken at 4,000 per second with an exposure time of 1 microsecond, showing a .22 caliber long rifle bullet striking a balloon. The fourth picture from the top shows the bullet inside the balloon. The bullet emerges from the balloon on the fifth picture. Waves caused by the impact of the bullet and by the muzzle blast from the gun can be seen on the rubber surface. This photograph was made on 35 mm film in a General Radio type 651-AH camera, using an Edgerton, Germeshausen and Grier, Inc. High-Speed Stroboscope, Type 501.

*Photo courtesy H. E. Edgerton*

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