THE General Radio EXPERIMENTER

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ELECTRICAL MEASUREMENTS AND THEIR INDUSTRIAL APPLICATIONS

A VOLTAGE MULTIPLIER FOR THE VACUUM-TUBE VOLTMETER

Also IN THIS ISSUE

● **A 10:1 VOLTAGE MULTIPLIER** is now available to extend the range of voltage measurement of the Type 1800-A Vacuum-Tube Voltmeter to a maximum of 1500 volts.

This multiplier is a capacitive voltage divider which provides a 10:1 reduction between the voltage applied to the multiplier and the voltage appearing across the voltmeter terminals. The multiplier screws on to the end of the voltmeter probe, adding about two inches to its length.

Since the input capacitances of the voltmeters differ slightly, an error in multiplier ratio of ±2% is possible, but an adjustment is provided by means of which the ratio can be adjusted to ±1% for any Type 1800-A Vacuum-Tube Voltmeter. When a multiplier and a voltmeter are ordered together, this adjustment is made at the factory.

The effective parallel input resistance of the multiplier is of the order of 100 times that of the voltmeter probe alone, and the effective parallel capacitance is 1.5 μμf. When the cap and center plug are used, approximately 0.5 μμf is added.

The resonant frequency of the probe, 1050 Mc, is not changed by the ad-

Figure 1. Exploded view of probe, multiplier, and cap.

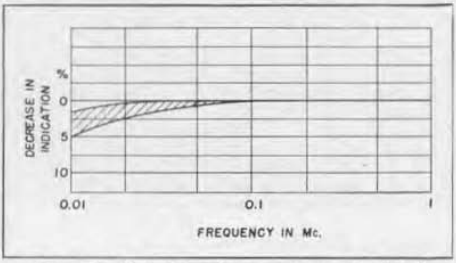


Figure 2. Plot of low-frequency error for the Type 1800-P2 Multiplier. The high-frequency correction for the voltmeter is unchanged by the addition of the multiplier.

dition of the multiplier. The multiplier frequency error is plotted in Figure 2. The multiplier is not recommended for use at frequencies below 100 kc.

SPECIFICATIONS

Multiplier Rates: 10 to 1.

Dimensions: (Length) 2⅝ x (diameter) 1⅝ inches, over-all.

Net Weight: 4 ounces.

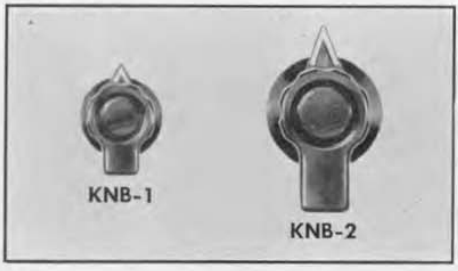
Type		*Code Word*	*Price*
1800-P2	**Multiplier**	ABODE	**$18.00**

NEW STANDARD PARTS

The new look that has lately been evident on General Radio instruments reflects the improvement in appearance of our standard parts. Designed to be attractive as well as useful, these knobs and dials are also available separately to those who make their own laboratory equipment.

KNOBS

TYPE KN Knobs, which replace the TYPE 637 series, are uniform in general appearance and application and were designed primarily for use on General Radio instruments. All are similarly fluted and have matching narrow skirts, so that a unity of design is achieved when different types are used on the same panel. Pointer models have large white V-shaped indicators for good visibility.



Two new types are now available, the bar knobs, KNB-1 and KNB-2, which are especially convenient for use on rotary switches, and the spinner knob, KNU-3, for rapid rotation of the control shaft on slow motion drives.

Each knob is made of black phenolic resin with a molded-in brass insert, and is fitted with two setscrews, 90° apart, which are threaded through the metal insert. The boring of the shaft hole is performed as a final operation on a precision machine, especially set up for the purpose, so as to insure an accurately sized hole which is concentric with and perpendicular to the molded portion. Holes are bored to fit a ⅜-inch diameter shaft and are equipped with removable bushings to adapt to ¼-inch diameter shafts.

1-INCH DIAMETER — WITH BAR

Type	*Net Weight for 5*	*Code Word*	*Package of 5*	*Package of 20*
KNB-1	**3¾ oz.**	BARKNOBONE	**$3.50**	**$13.00**

1⅜-INCH DIAMETER — WITH BAR

Type	*Net Weight for 5*	*Code Word*	*Package of 5*	*Package of 20*
KNB-2	**6 oz.**	BARKNOBTWO	**$3.75**	**$14.00**

2-INCH DIAMETER

Type	Net Weight for 5	Code Word	Package of 5	Package of 20
KNSP-8	8 oz.	NURLNOBATE	$4.25	$16.00

2-INCH DIAMETER — WITH SPINNER

Type	Net Weight	Code Word	Unit Price
ZKNU-3	2¾ oz.	SPINNOBTRE	$3.00

1⅜-INCH DIAMETER

Type	Net Weight for 5	Code Word	Package of 5	Package of 20
KNSP-6	5½ oz.	NURLNOBSIX	$3.00	$11.00

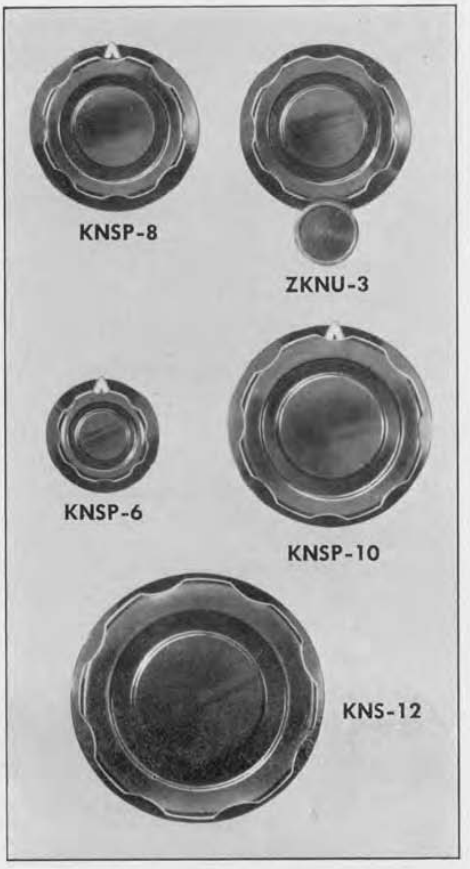
2⅜-INCH DIAMETER

Type	Net Weight for 5	Code Word	Package of 5	Package of 20
KNSP-10	12½ oz.	NURLNOBTEN	$5.50	$21.00

2⅞-INCH DIAMETER — WITHOUT POINTER

Type	Net Weight for 5	Code Word	Package of 5	Package of 20
KNS-12	17 oz.	NURLNOBDOZ	$5.75	$22.00

The TYPE KN Fluted Knobs are shown approximately one-half actual size in the illustration.



KNOB AND DIAL ASSEMBLIES

A new line of photo-etched dials with frosted-chrome surfaces replaces the older nickel-silver models. The TYPES 901, 902, and 904 dials are available with or without friction drives and in two or more scale lengths. These dials were designed for applications requiring simple, direct shaft positioning of moderate precision. Dials are assembled on standard TYPE KN knobs and therefore mount on the same size of shaft. The punched brass dial is accurately located on the knobs by bosses, from which the shaft hole is concentrically bored, and is also insulated from the shaft insert by the phenolic material of the knob.

Each dial is photo-etched and finished with black lines on a frosted-chrome plated background. This background finish has a silvery white color, furnishing excellent contrast with the black lines, and has diffuse reflecting properties, making it possi-

ble to view or illuminate the dial from any angle without objectionable glare.

The parallax-free indicator, which is designed to hug the rim of the dial and to remain flush with its surface, is finished in matching frosted-chrome plate with a black index line.

Friction-drive models are intended for use when the accuracy of a photo-etched dial is satisfactory, but when settings must be made more precisely than can be done with a direct drive. The speed-reducing drive grips the rim of a separate disc behind the dial, so that the dial surface is not marred, and the driving shaft is mounted on the panel in an eccentric bushing which permits lateral adjustment to the smoothest operating position.

2-INCH DIAMETER — TYPE 901 DIALS

Type	Dial Arc	Dial Divisions	Drive	Net Weight	Code Word	Price
901-HD	180°	100	Direct	2 oz.	DILOG	$2.75
901-JD	270°	100	Direct	2 oz.	DILAP	2.75
901-LD	360°	100	Direct	2 oz.	DILID	2.75

2¾-INCH DIAMETER — TYPE 902 DIALS

902-HD	180°	100	Direct	2½ oz.	DIMAP	$2.75
902-JD	270°	100	Direct	2½ oz.	DIMID	2.75
902-HF	180°	100	Friction, 3.3:1	4 oz.	DIMOB	3.75
902-JF	270°	100	Friction, 3.3:1	4 oz.	DIMUG	3.75

4-INCH DIAMETER — TYPE 904 DIALS

904-HD	180°	100	Direct	5 oz.	DIPAR	$3.25
904-JD	270°	200	Direct	5 oz.	DIPOD	3.25
904-HF	180°	100	Friction, 5:1	8 oz.	DIPEN	4.25
904-JF	270°	200	Friction, 5:1	8 oz.	DIPUT	4.25

FRICTION-DRIVE PRECISION DIALS

TYPES 905 and 906 Precision Dials replace the TYPES 704 and 706. They have fine black lines exactly positioned, by an automatic precision engraving machine, on a frosted-chrome background. The spacing of the lines is chosen to give the maximum accuracy of setting consistent with readability.

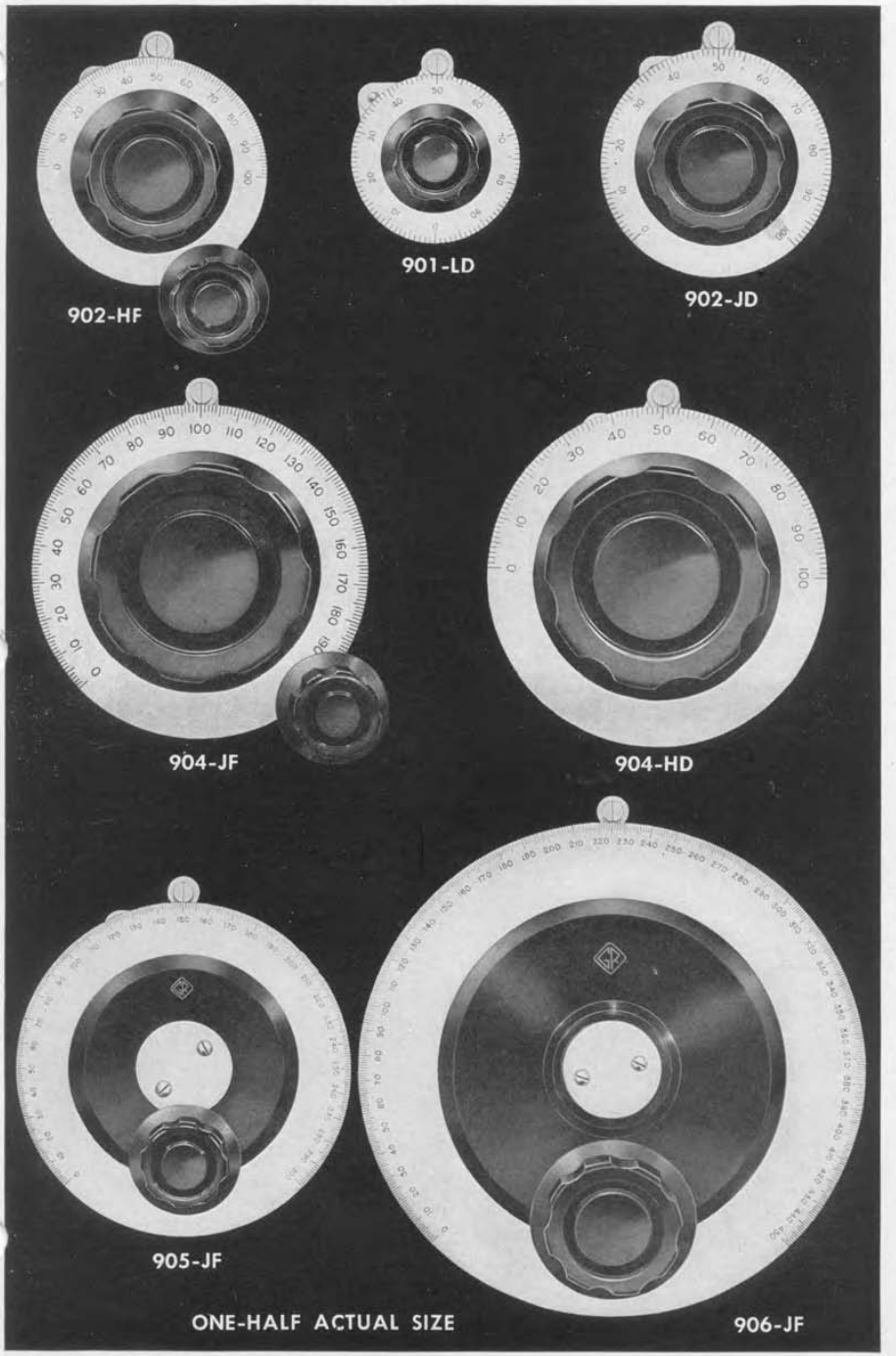
Each dial has a lathe-turned rim to insure concentricity, and is attached to a machined brass hub, which is fastened to the shaft by two setscrews, accessible from the front of the dial. The friction drive, which is fully adjustable, operates on the outer edge of a horseshoe-shaped slot in the dial, so that the slow-speed knob turns in the same direction as the dial and so that the drive mechanism all comes within the dial proper.

4-INCH DIAMETER — TYPE 905 PRECISION DIALS

905-HF	180°	200	Friction, 6:1	9 oz.	DIRUG	$10.00
905-JF	270°	300	Friction, 6:1	9 oz.	DIRIM	10.00

6-INCH DIAMETER — TYPE 906 PRECISION DIALS

906-HF	180°	300	Friction, 8:1	15 oz.	DIROT	$12.00
906-JF	270°	450	Friction, 8:1	15 oz.	DIRAP	12.00



GEAR-DRIVE PRECISION DIALS

Two entirely new units, the TYPES 907 and 908 Gear-Drive Precision Dials, were designed for the most exacting applications and combine the fine-line accuracy of a machine-engraved dial with a positive, fixed-ratio reduction drive. The dial is furnished in frosted-chrome plate with contrasting black lines, and its hub is attached directly to the shaft by two setscrews.

The gear has internal teeth, so that the knob, driving a stainless steel pinion, turns in the same direction as the dial. The pinion is held in a collet in the knob so that it may be readily adjusted to project through any panel, up to 5/16 inch thickness, by simply loosening the setscrews in the knob. This drive assembly runs in a floating bronze bushing that is spring guided to hold the gears in proper mesh without backlash and that also obviates the need for precise panel drilling.

The pinion and gear teeth are especially designed to run smoothly together and are cut on a precision gear shaper to insure uniformity. The 10:1 ratio permits calibrating the knob as a vernier.

The front-of-panel assembly requires only two 6-32 panel holes for mounting, and the large holes for the window and drive of the back-of-panel model are round, so that they can be readily put in with a punch, hole-saw, or flycutter.

The anti-parallax floating indicator is supplied with a dull-black back-up plate, which fills the window on the back-of-panel types.

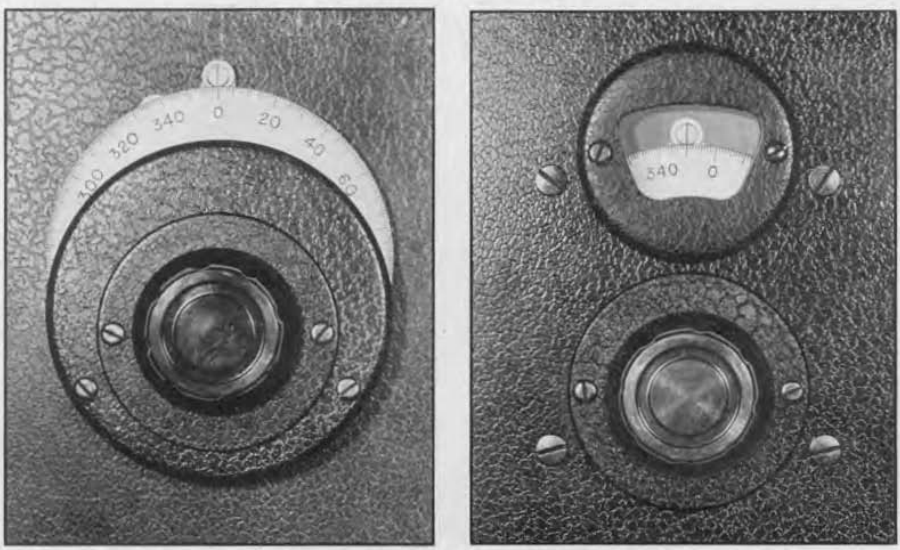
4-INCH DIAMETER GEAR-DRIVE PRECISION DIALS

Type	*Mounting*	*Dial*		*Gear-Drive Ratio*	*Net Weight*	*Code Word*	*Price*
		Arc	*Divisions*				
907-LA	**Front-of-panel**	**360°**	**360**	**10:1**	11 oz.	DITAB	**$9.50**
907-LB	**Back-of-panel**	**360°**	**360**	**10:1**	11 oz.	DITOP	**9.50**

6-INCH DIAMETER GEAR-DRIVE PRECISION DIALS

908-LA	**Front-of-panel**	**360°**	**360**	**10:1**	21 oz.	DIVAT	**$11.00**
908-LB	**Back-of-panel**	**360°**	**360**	**10:1**	19 oz.	DIVIM	**11.00**

(*Left*) Type 907-LA; (*Right*) Type 907-LB, approximately half size.



VARIAC OPERATION WITH FIXED BRUSH SETTING

Variac adjustable transformers are devices for obtaining any required voltage within their range, quickly, conveniently, and efficiently. Variac voltage output is substantially independent of load current, as contrasted with resistive controls. Usually, Variacs are frequently adjusted to meet changing requirements of speed, illumination, line voltage, etc.

Occasionally, Variacs are required to act as fixed autotransformers, a service for which the latter are more properly suited. Under these conditions, the Variac brush setting remains fixed for long periods under load, and the turns under the brush are subjected to prolonged operation at high temperature.

At this point a brief discussion of the function of and need for "carbon" (actually a mixture of carbon, graphite, and, sometimes, metal) brushes in Variacs is in order. The brush is the secret of successful Variac design. To permit adjustment (i.e., switching) under load without interruption of current, the contacting device must establish contact with an adjacent turn of wire before breaking the contact already established. This means that the contacting device must, perforce, short circuit one or more turns in certain positions. In order to limit the short-circuit current to a safe and reasonable value, the contact must have a certain minimum resistance. Since this resistance is traversed by the load current as well as by short circuit currents, it must not be too high. In effect, we have a tug-of-war between short-circuit losses, which call for a high resistance, and load losses, which call for a low resistance. The compromise is best effected when the two losses are equal. Carbonaceous materials meet the resistance requirements nicely and have lubricating and wear characteristics that are excellent against the copper surface of the exposed brush track.

Because of the load losses which are unavoidably introduced by the brush requirements, the hottest spot on a Variac will always be directly under the brush. This localized heat source is in addition to the uniformly distributed heating of core and copper losses. These latter are maintained at conservative levels in Variac design, but the brush heat, even with generous heat radiator provisions, is still sufficient to raise the temperature of the turns in the immediate vicinity of the brush to a point where the bare copper oxidizes rapidly.

Copper oxide, unfortunately, is a poor electrical conductor, and its formation in the vicinity of the brush further increases the brush heating under load. Thus heat leads to oxide which leads to more heat in an extremely vicious circle. If failure is to be avoided, the circle must be broken.

Two good methods have so far been found to prevent oxide accumulation. One is obvious. Keep the brush track clean, using the fine crocus cloth and carbon tetrachloride cleaning technique outlined in the Variac instruction sheet, at frequent (semi-weekly) intervals. The other is to prevent or slow down oxidation by excluding air from the vicinity of the brush by the application of a thin layer of heat resistant, inert grease to the brush track. Dow-Corning D-C-44 Silicone Grease has been found to be excellent for this purpose. A combination of the two methods, a thorough cleaning and regreasing every two weeks, will permit indefinite operation of Variacs with fixed brush setting.

— GILBERT SMILEY

HONORS — Awarded to Melville Eastham, Chief Engineer and former President of the General Radio Company, the 1948 New England Award, at the annual meeting of the Engineering Societies of New England, at Boston, April 29. A scroll of illuminated parchment suitably inscribed, the New England Award is given each year to "a living engineer, resident in New England, who, by outstanding achievement, shall merit recognition of his accomplished work as well as of his character, by his fellow engineers of New England."

Melville Eastham.

RECENT VISITORS—

From Poland: Przemyslaw, J. Jaros, General Superintendent of Communications, Polish State Railways, Warsaw.

From Brazil: Captain Aldo V. da Rosa, Chief of Technical Division, Brazilian Air Force.

From Chile: William Feick, Professor of Communication Engineering, Universidad Tecnica Federico Santa Maria, Valparaiso.

From Holland: Mr. D. Goedhart and Mr. W. W. Storm of N. V. Philips Telecommunication Industries, Hilversum.

PAPERS presented at the I. R. E. National Convention, New York, March 21-24, 1948 — by H. B. Richmond, Chairman of the Board, "An Engineer in the Electronics Industry — Prospects, Preparation, Pay"; by W. N. Tuttle, Engineer, "Use of Diode Rectifiers with Adjustable Transformers for Motor Speed Control"; by R. F. Field, Engineer, "Losses in Air-Cored Inductors"; by J. K. Clapp, Engineer, "Frequency Measurement by Sliding Harmonics."

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