the GENERAL RADIO Experimenter

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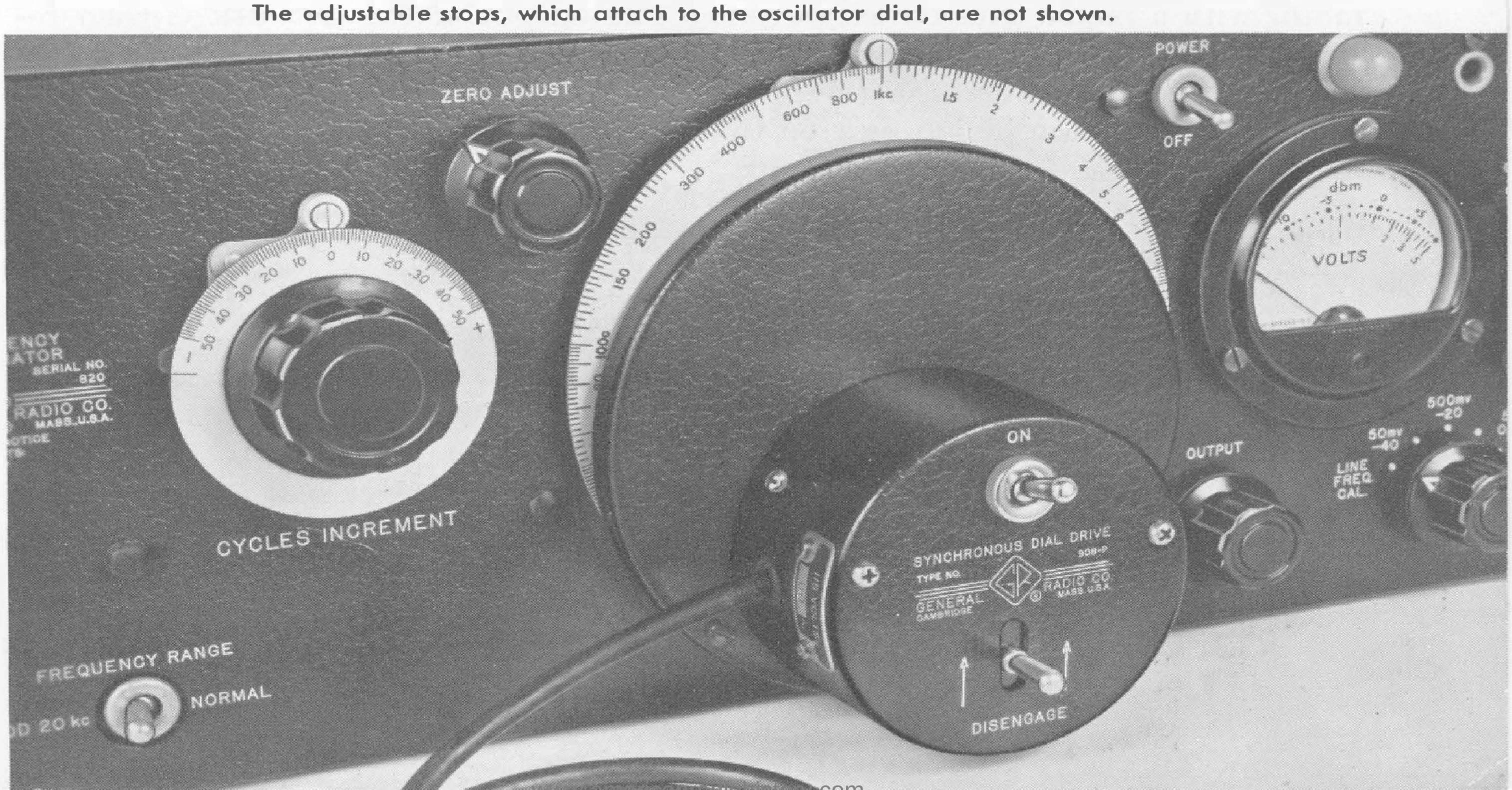
MOTOR DRIVES FOR PRECISION DIALS AND BEAT-FREQUENCY OSCILLATORS

● **GENERAL RADIO** beat-frequency oscillators, as well as a number of other General Radio instruments developed in the past few years, use as frequency controls the Type 908 or Type 907 Gear-Drive Precision Dials. These dials are so designed that a motor drive can be easily attached in place of the knob.

Shown in Figure 1 is a simple, low-cost motor drive unit for use on the dials. Available in two models with different speeds, the Type 908-P1 and Type 908-P2 Dial Drives have been designed particularly for use on the Types 1304-A and 1304-B Beat-Frequency Audio Generators and the Type 1303-A Two-Signal Audio Generator, but they can also be used on General Radio Unit Oscillators and Standard-Signal Generators, as well as on other instruments equipped with the Type 908 or Type 907 Gear-Drive Precision Dials.

The motor drives make possible the use of these instruments with recording systems as, for example, in recording the response of a network as a function of frequency. They can also be used as sweep drives and for producing warble

Figure 1. View of the Type 908-P2 Synchronous Dial Drive installed on a Type 1304-B Beat-Frequency Oscillator. The adjustable stops, which attach to the oscillator dial, are not shown.



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Also
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tones. When installed on a Type 1304 Beat-Frequency Audio Generator, as shown in Figure 1, this type of drive can sweep the oscillator automatically back and forth over a range of frequencies. This technique has applications in many kinds of measurements. For example, with a cathode-ray oscillograph as a visual indicator, the study and adjustment of audio-frequency networks is accomplished rapidly and conveniently. Another example, in the field of mechanics, rather than electronics, occurs in vibration testing. When the beat-frequency oscillator is used to drive a shake table, the automatic sweep is helpful in spotting resonances.

The dial drive consists essentially of a small, synchronous, 115-volt, 60-cycle motor with a pinion gear on the output shaft. This motor drive is readily fastened in place of the knob drive of the precision dial so that the pinion gear on the motor shaft engages the dial ring gear.

A disengage lever, as well as a power switch, is provided. The lever can be used to lift the pinion off the ring gear and thus disengage the drive.

The drives reverse the direction of rotation whenever a stop is encountered. It is this feature that makes possible their use as sweep drives and their use to produce warble tones. Stops, which are provided, can be readily attached to the dial to limit the sweep to the desired part of the range.

With these adjustable stops the maximum angle of dial rotation is limited to 80° for the Type 908 Dial and 65° for the Type 907 Dial. The full range of dial rotation can be obtained when these stops are not used. Other types of stops to give intermediate angles of rotation can be devised by the user.

USE WITH RECORDERS

Because the drives are synchronous, they are readily used with recording systems. For example, the response of a network as a function of frequency can often be recorded very easily by applying to the network the output of a Type 1304-B Beat-Frequency Generator driven by a Type 908-P1 Dial Drive. The output of the network is then recorded as a function of time. Since the oscillator frequency and time are di-

Figure 2. Simple discriminator circuit for supplying the horizontal axis signal to a cathode-ray oscillograph.

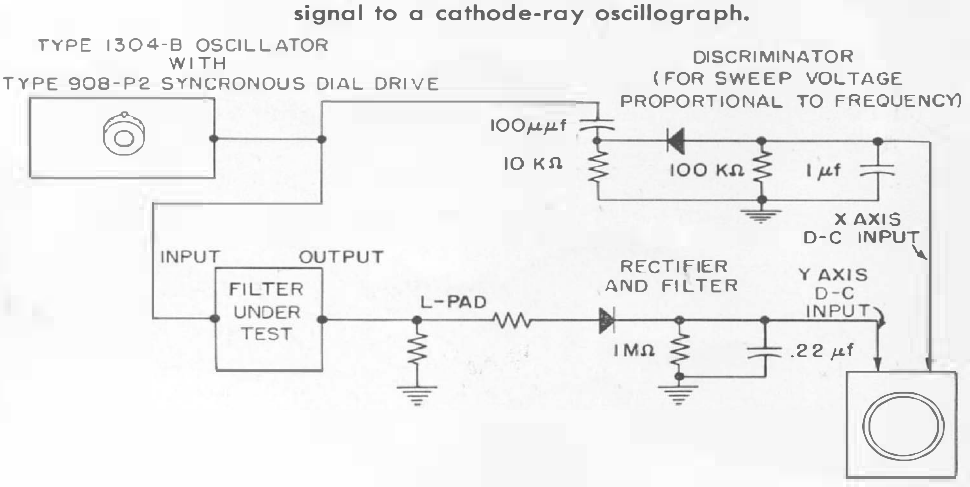
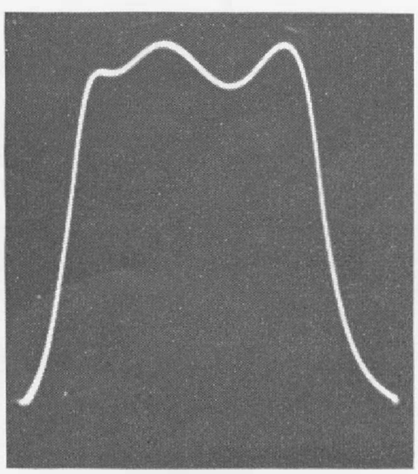


Figure 3. Oscillogram of the response characteristic of a filter as displayed by means of the arrangement of Figure 2.



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rectly related by the dial drive, the response as a function of frequency is readily obtained. To facilitate the use of recorders in such applications, the speed of TYPE 908-P1 Drive has been selected to cover in 15 seconds a frequency interval of an octave on the TYPE 1304-B Generator. This rate is widely accepted as a standard. The TYPE 908-P2 Drive is particularly suitable for limited-sweep applications, with observations of the response on a cathode-ray oscillograph with a long persistence-screen. As a natural consequence of the higher speed, however, the torque available from the TYPE 908-P2 is small. Therefore, in order to avoid erratic operation, the driven part should generally use ball-bearing supports, as in the TYPES 1304-A, 1304-B, and 1303-A Oscillators.

For some recording applications, an output voltage is desired that is proportional to the angle of rotation of the dial. To do this, a linear potentiometer having low torque requirements can also be driven by the shaft on which the dial is mounted. Naturally, this arrangement is usable only if the complete system can be arranged so that the required torque does not exceed the torque that can be delivered by the drive. The linear potentiometer can then be energized by a constant d-c voltage, and the voltage between the tap and one end will be proportional to the dial rotation.

When a limited sweep is used to vary the frequency of an oscillator, a discriminator system can often be used to give a signal proportional to the instantaneous frequency. The output of the discriminator can then supply the voltage for one axis of an oscillographic display, for example. The circuit of a very simple type of discriminator, suitable for use with the TYPE 1304-B Generator, is shown in Figure 2. The output of this discriminator is used to supply the X-axis signal of a cathode-ray oscillograph having a d-c amplifier and a long persistence-screen.

The oscillogram of Figure 3 shows the response characteristic of a filter as displayed on an oscillograph screen by means of the arrangement of Figure 2.

In experimental work on audio-frequency circuits, sweep methods will save much valuable engineering time as compared to point-by-point methods. The availability of this economical motor drive for General Radio beat-frequency generators makes possible the application of sweep methods to existing laboratory equipment.

—H. C. LITTLEJOHN

SPECIFICATIONS

Speed:*

Type	*Pinion*	*908 Dial*	*907 Dial*
908-P1	4 RPM	4/15 RPM or 225 secs/rev	4/10 RPM or 150 secs/rev
908-P2	30 RPM	2 RPM or 30 secs/rev	3 RPM or 20 secs/rev

On logarithmic frequency dials used on TYPES 1304-A, 1303-A Oscillators, the sweep times are as follows:

908-P1 50 sec/frequency decade or 15 sec/octave

908-P2 6⅔ sec/frequency decade or 2 sec/octave

Pinion on Output Shaft: 48 D.P., full involute, 20° pressure angle, 10 teeth.

Torque at Pinion: 908-P1 5 inch-ounces
908-P2 ⅔ inch-ounce

Power Supply: 105 to 125 volts, 50-60 cycles, 3 watts.

Dimensions: 3⅝-inch diameter x 3 inches deep, overall, but excluding power line connecting cord.

Weight: 1 pound, 3 ounces.

*Data are for 60-cycle operation. On 50 cycles, speeds will be 5/6 of those given above and drive times will be 6/5 of those listed.

Type		*Code Word*	*Price*
908-P1	**Synchronous Dial Drive**	SYNDO	**$27.50**
908-P2	**Synchronous Dial Drive**	SYNKA	**27.50**

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HISTORIC FIRSTS—THE R-C OSCILLATOR

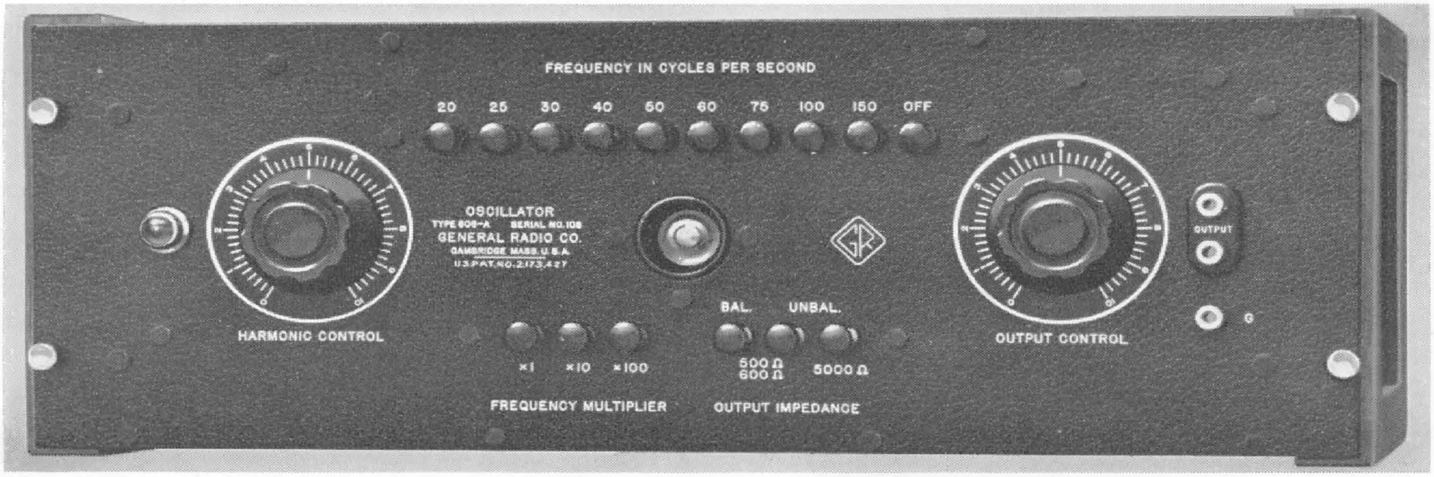
The development of the resistance-capacitance-coupled oscillator in 1937 by the General Radio Company filled a recognized need in the industry. Although lacking some of the advantages[1] of the beat-frequency oscillator, it is capable of generating low frequencies with good stability and of covering wide frequency ranges with simpler switching and with less expensive and less bulky components than the L-C type.

The basic oscillator circuit, which combines a sharply selective R-C circuit with a degenerative, or inverse-feedback, amplifier, was first described in an article submitted to the Institute of Radio Engineers in 1937 and published in the *Proceedings* in 1938.[2] A patent application on the oscillator form of this circuit was filed in August, 1937, and U. S. Patent No. 2,193,427 was issued in September, 1939, and assigned to the General Radio Company. Practically all commercial R-C oscillators now on the market use this basic circuit. The General Radio Company today manufactures several R-C oscillators using the circuits described in this patent and also licenses other manufacturers to do so.

The instrument shown below is the first R-C type produced commercially and was used principally as an audio source for distortion measurements on equipment in broadcasting stations. It was first placed on the market in 1938. It has been superseded by improved models, two modern units being the TYPE 1301-A Low-Distortion Oscillator and the TYPE 1302-A Oscillator.

[1] "Oscillator Considerations," *General Radio Experimenter*, Vol. XXVIII, No. 6, November, 1953.

[2] H. H. Scott (Engineer, General Radio Company), "A New Type of Selective Circuit and Some Applications," *Proc. IRE*, Vol. 26, No. 2, February, 1938, pp. 226-235.



The first commercial R-C Oscillator — General Radio Type 608-A.

THREE-PHASE OPERATION OF AUTOMATIC VOLTAGE REGULATORS

Since publication of the article describing the new General Radio Automatic Voltage Regulator,[1] several readers have inquired about the possibility of using these regulators on three-phase circuits. Several connections are possible which will maintain the three output voltages to a ¼ per cent of the desired

[1] M. C. Holtje, "An Accurate, High-Speed, Automatic Line-Voltage Regulator," *General Radio Experimenter*, Vol. XXIX, No. 2, July, 1954.

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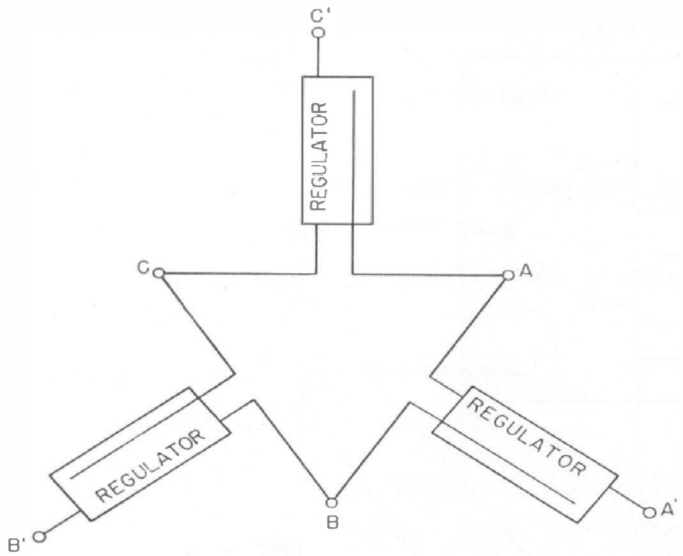

Figure 1. Circuit arrangement of three Type 1570-A Automatic Voltage Regulators for delta operation.

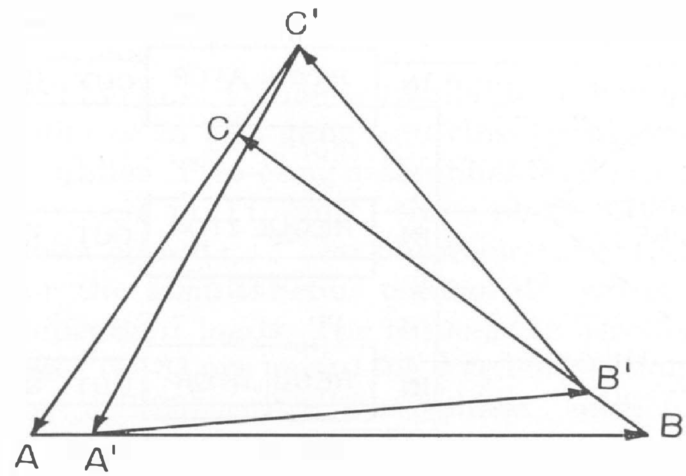

Figure 2. Vector diagram for the system of Figure 1. The unbalanced voltages AB, BC, and CA are the input voltages of the three regulators. The regulator outputs are in phase with their inputs and must lie along the lines AB, BC, and CA. The correction voltages being added are AA′, BB′, and CC′. These output voltages are A′B, B′C, and C′A. If the sensing circuits of the regulators are moved from their normal positions, A′B, B′C, and C′A, to the positions A′B′, B′C′, and C′A,′ these latter voltages will be held constant. Since they are delta-connected, the angles must also be equal.

value. In addition, for some connections the phase angles can be maintained accurately at 120 degrees.

If the voltages to be regulated are in a three-wire delta connection, a regulator can be connected as shown in Figure 1 to maintain each line-to-line voltage constant. In this connection, both the magnitudes and phase angles are held constant. Thus, the regulators can supply balanced voltages, even if both input line and load are unbalanced.

The vector diagram (Figure 2) shows how three regulators, acting as transformers with automatically adjustable turns ratios, can correct both the magnitudes and phase angles to give a balanced output from an unbalanced input. The unbalanced delta input voltages are shown as the vectors AB, BC, and CA. Since each regulator output must be in phase with its input voltage, the correction voltages must be along the vectors AB, BC, and CA. These correction voltages are shown as the vectors AA′, BB′, and CC′. Thus the output voltages from the regulators are A′B, B′C, and C′A. Normally, the regulators would maintain these voltages constant. However, by a change in the connections to the sensing circuits, the regulators can be made to maintain the voltages A′B′, B′C′, and C′A′ constant. This results in a delta-connected output with equal voltage magnitudes and equal phase angles.

If the voltages to be regulated are in a four-wire wye connection, a regulator can be connected between each input line and neutral, thus maintaining each line to neutral voltage constant. Since the regulator is in effect an adjustable turns ratio between input and output, only the magnitude of the voltages can be corrected. Thus the system is regulated as far as a wye-connected load is concerned but is not necessarily regulated for a delta-connected load. If the input voltage angles are incorrect, the output angles will also be incorrect, and the line-to-line voltages will not be regulated.

If it is necessary to use the regulators wye-connected and to maintain correct

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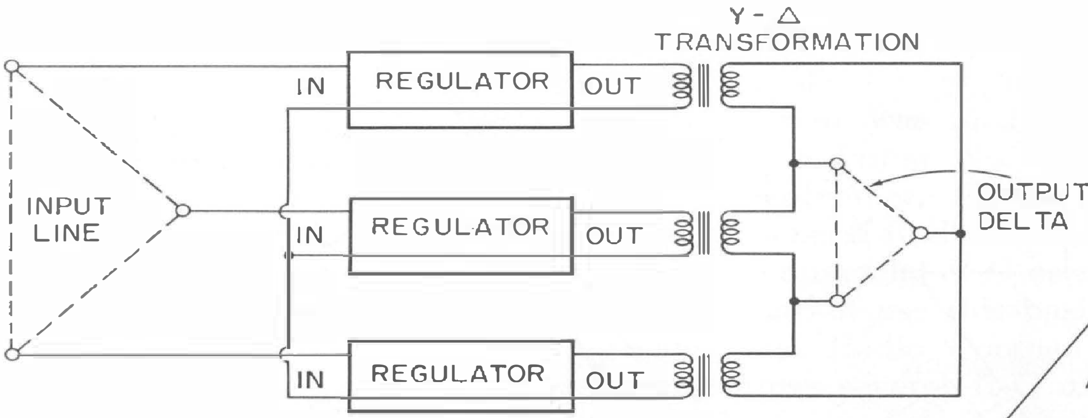


Figure 3. Circuit for wye-connected regulators with transformer for wye-delta transformation.

phase angles as well as magnitudes, the connection shown in Figure 3 can be used. The common connection of the three regulators is not connected to the input neutral but is left floating. The three regulators produce a wye system of equal voltages. The wye-delta transformation produces a completely-balanced delta system with the floating neutral in the regulator input shifting to such a position that only a small circulating current flows in the output delta. The operation of the system can be demonstrated by the vector diagram of Figure 4.

—M. C. Holtje

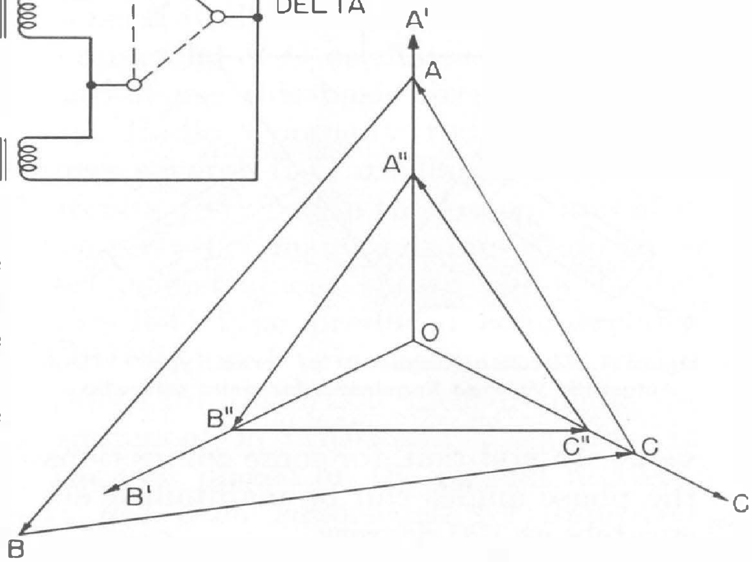
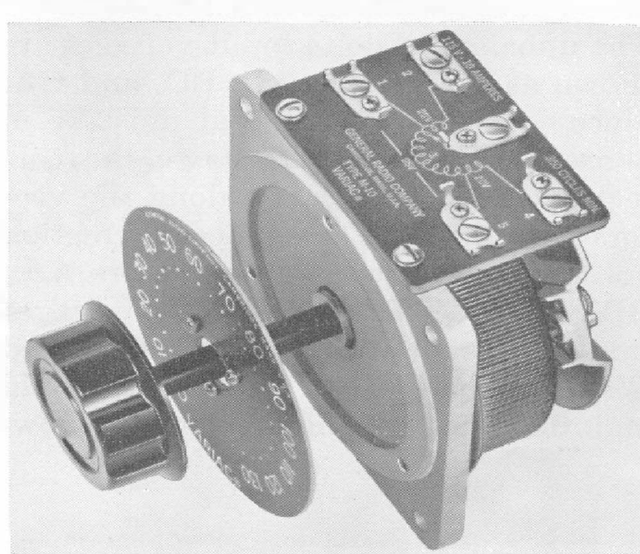


Figure 4. Vector diagram for the three-phase regulator system of Figure 3. The vectors AB, BC, and CA represent a delta line of unequal voltage magnitudes and phases. The wye-connected regulators produce the three equal voltages OA′, OB′, and OC′. The wye-delta transformation, however, resulting in the delta voltages A″B″, B″C″, and C″A″, will produce circulating currents in the transformer secondary if any unbalance exists and, as a result, the floating neutral changes its position to produce balanced phases and minimize circulating currents.

THE TYPE M-10 A 10-AMPERE VARIAC® AUTOTRANSFORMER FOR 350- TO 1200-CYCLE SERVICE

The mechanical and electrical features of Type M-2 and Type M-5 Variac® Autotransformers[1] are now available in a 10-ampere model, the Type M-10 Variac, which will operate on any supply frequency between 350 and 1200 cycles per second.



Among its features are:

(1) Rectangular base for convenient in-

[1]Gilbert Smiley, "New Variac® Autotransformers for 350- to 1200-cycle Service," *General Radio Experimenter*, Vol. XXIV, No. 2, July, 1954.

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stallation, with two sets of mounting holes to facilitate its use as a replacement in existing equipment as well as in new designs.

(2) Simplified ganging, with economy in weight and space.

(3) Counterbalanced radiator for stable settings.

(4) Improved heat dissipation.

(5) *Duratrak* contact surface.

The TYPE M-10 is designed to withstand shock, vibration, and environmental tests under MIL-T-945-A specifications.

This new Variac is available in single units or in two-gang and three-gang assemblies. Two-gang assemblies (G-2) can be used in 115-volt, three-phase open delta circuits, in two-phase circuits, and for the simultaneous control of two independent loads. The three-gang assemblies (G-3) are useful for wye connection in 208-230-volt, three-phase service. TYPE M-10 Variacs can be operated at 60 cycles if voltage is limited to 3/8 of rated line voltage.

SPECIFICATIONS

Line-Frequency: 350 to 1200 cps.
Input Voltage: 115 volts, nominal.
Output Voltage: 0 to 135 volts or 0 to 115 volts.
Rated Output Current (for line-voltage connection only): 15 amperes.
No-load Loss at 400 cycles: 12 watts, maximum.
Net Weight: 6 5/8 pounds.
Dimensions: Base 5 3/4 x 5 3/4 inches; depth behind panel, 3 1/16 inches. A dimension drawing is available on request.

Type		*Code Word*	*Price*
M-10	**Variac**	CABIN	**$30.00**
M-10G2	**2-Gang Type M-10 Variac Assembly**	CABINGANDY	**65.00**
M-10G3	**3-Gang Type M-10 Variac Assembly**	CABINGANTY	**98.00**

Patent applied for.

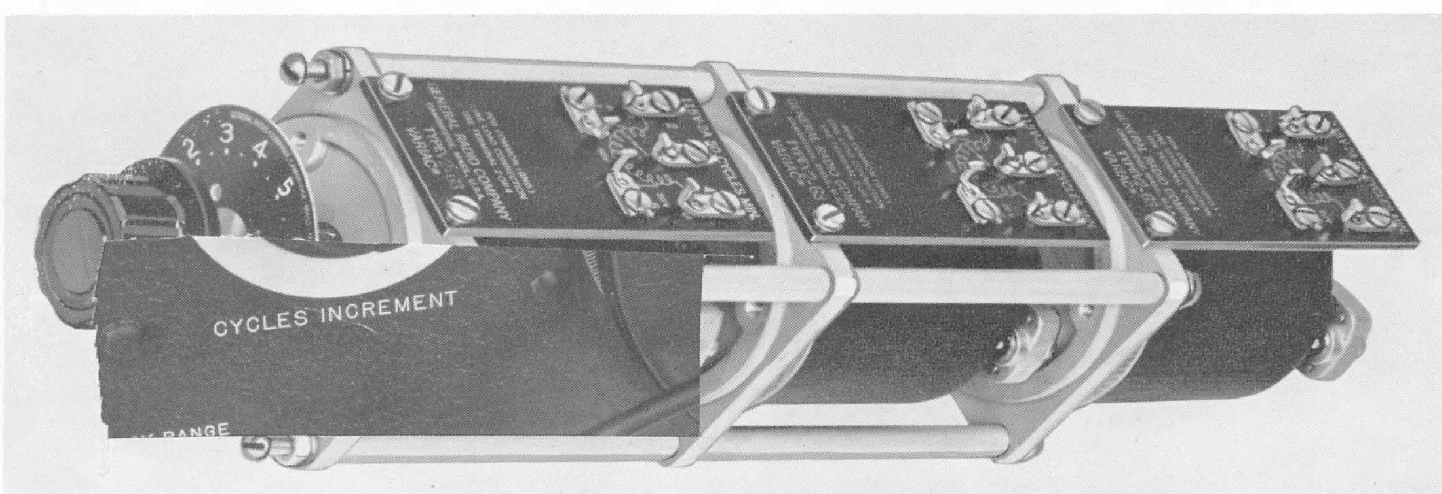
GANGED MODELS OF THE TYPE V-2 VARIAC® NOW AVAILABLE

The TYPE V-2 Variac,[1] which delivers a rated current of two amperes and is designed for 60-cycle service, is now available in two-gang and three-gang assemblies for simultaneous control of separate circuits and for three-phase operation.

[1]Gilbert Smiley, "A New 2-Ampere Variac," *General Radio Experimenter*, Vol. XXVII, No. 12, May, 1953.

Type		*Code Word*	*Price*
V-2G2	**2-Gang Type V-2 Variac Assembly**	BEADYGANTY	**$35.00**
V-2G3	**3-Gang Type V-2 Variac Assembly**	BEADYGANDU	**52.50**

Patent applied for.



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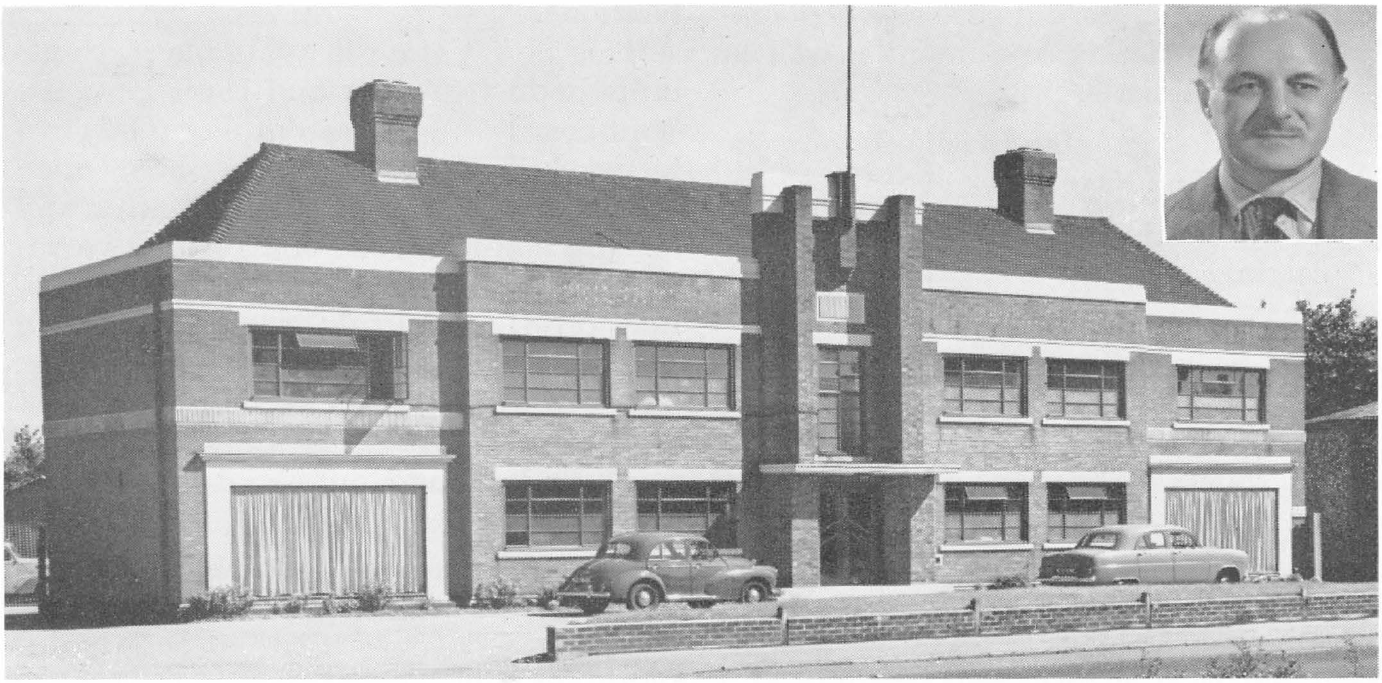
MISCELLANY



The firm of Claude Lyons, Ltd., with office, warehousing, and laboratory facilities in Liverpool, and general sales offices in London, has represented General Radio in Great Britain since 1925. The Liverpool facilities, under the direction of Mr. Alfred Kneen, are spacious and well equipped, but the London offices have not been really adequate for a number of years to handle a steadily growing business. After a long search the firm has been fortunate to find an attractive, new location west of London in Hoddesdon. Here are new calibration and testing laboratories, as well as sales, repair, and stocking facilities. Managing Director of the Lyons firm is Mr. Claude L. Lyons (see insert). The new address is Valley Works, Ware Road, Hoddesdon, Herts, England.

GENERAL RADIO COMPANY

275 MASSACHUSETTS AVENUE

CAMBRIDGE 39 MASSACHUSETTS

TELEPHONE: TRowbridge 6-4400

BRANCH ENGINEERING OFFICES

NEW YORK 6, NEW YORK
90 WEST STREET
TEL.—WOrth 4-2722

LOS ANGELES 38, CALIFORNIA
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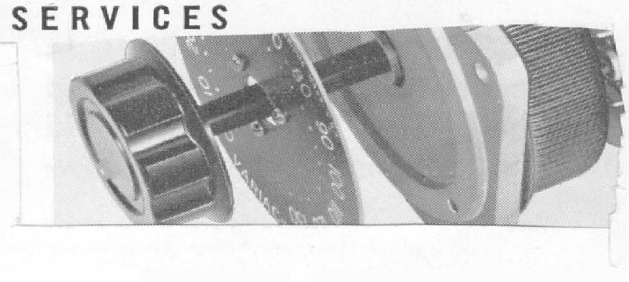

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