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ELECTRICAL COMMUNICATIONS TECHNIQUE AND ITS APPLICATIONS IN ALLIED FIELDS

MIXER CONTROLS FOR DYNAMIC AND RIBBON MICROPHONES

IN June, 1931, the General Radio Company announced the TYPE 652 Volume Control for microphone mixer and general gain-control work in all sorts of voice circuits. Since that time, many hundreds of these units have been sold and operated with uniform success. Their performance has proved to be so reliable that they are widely used in talking motion-picture recording installations. The requirements for this service are particularly rigid since any failure in the mixer circuits may ruin completely an expensive shot.

The advent of the dynamic and ribbon microphones has brought up a new consideration in the design of microphone mixer controls and a new General Radio unit for this work.

Condenser microphones having a very high impedance necessarily work into the grid of a vacuum tube. Their output therefore is always pre-amplified before reaching the mixers. Incidental to this amplification has been the fact that the mixing is done at a relatively high level. The ribbon and dynamic microphones both have a low impedance, and, for this reason, it is desirable to arrange the mixers so that they operate directly from the microphones. This system does away with the all pre-amplification and the microphone volume controls operate at a much lower level than is the case with condenser microphones. This accentuates the necessity for a noiseless mixer control.

The new TYPE 653 Volume Control has been designed with the following most important requirements in mind:

(1) The most noiseless electrical operation possible.
(2) Rigid mechanical construction to eliminate any possibilities of mechanical or electrical breakdown.
(3) Ease of installation and maintenance.
(4) Good frequency characteristic.
(5) Small physical size and low weight for portable installations.
(6) Low price.

The greatest cause of electrical noise is a minute potential generated between

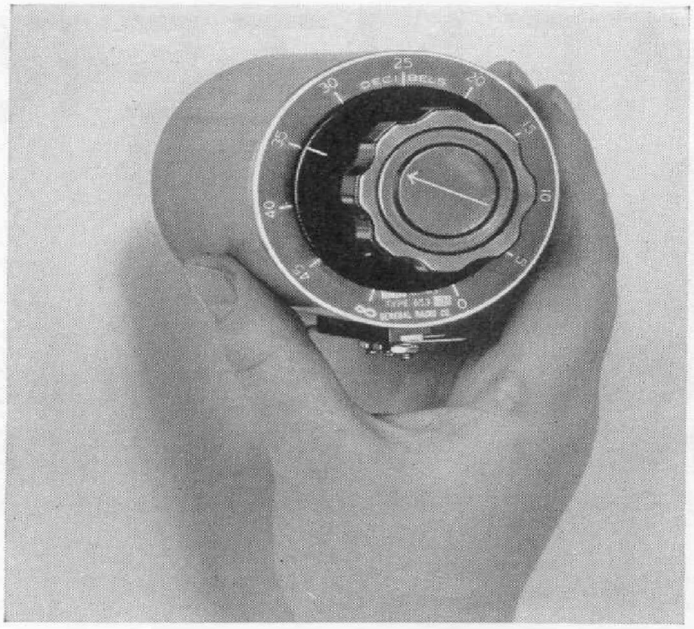


FIGURE 1. The new TYPE 653 Volume Controls give a smooth increase in attenuation from zero to cutoff at a noise level lower than the background-noise level in the quietest of amplifiers. They are interchangeable with other controls, having two mounting holes spaced 1½ inches apart

the contacts due to the fact that unlike metals in contact in air generate a small electrical potential. Another important source of noise is due to insecure connection between the switch arm and the contacts. The older TYPE 652 Volume Control is a slide-wire device in which an Advance metal slider operates across a resistance form wound with Advance wire. By using identical metals in this way, the contact noise was reduced to a very low value. Inherent, however, in slide-wire controls, is the difficulty in obtaining a sound contact between the slider and the resistance form. The new TYPE 653 Volume Control is a step-by-step device. A three-bladed switch slides over the contact points, making a firm and unvarying connection with each one. The best material available for such a switch is phosphor bronze. It would be ideal to make the switch contacts also of phosphor bronze, but this is not practicable, from the standpoint of wear, as the two metals do not operate well together mechanically. The contacts are made of a bronze alloy, which has been developed as a result of long experience in making precision decade boxes. The combination of these two metals results in no detectable contact potential, and the use of a well designed and stiff 3-leaf switch provides a firm mechanical contact. After thousands of operations, the contacts show no appreciable wear.

The resistance units are wound on cylindrical spools which are a part of the bakelite moulding carrying the contacts. This results in a rigid construction that will withstand any kind of rough usage which may be encountered in field work. Reference to Figure 3 will show the details of this mechanical construction. The whole assembly is interchangeable with the TYPE 652 Volume Control and other standard controls. The dial plate which carries the calibration in decibels serves as a drilling template for the mounting.

The circuit is a ladder network. Thirty-three steps are used and the attenuation is about 1.5 decibels per step. Actually, the switch bridges two contacts in its travel, approximately halving these steps. This increment is much smaller than can be detected by ear and it provides, therefore, a very smooth regulation of the volume. The ladder network is designed so that the attenuation is linear with angular rotation of the control knob for the first 29 contacts. Towards cutoff or infinite attenuation, the attenuation characteristic has an increasingly steeper slope, the attenuation per step rising above about

45 decibels. By this means a program can be faded out completely without introducing an abrupt cutoff.

The electrical circuit is such that the output impedance remains constant over the useful part of the scale. The output impedance remains at the nominal value up to infinite attenuation which is valuable, because if several mixers are set at zero output (that is, infinite attenuation) they will cause no impedance change in the mixer system.

The question of defining in quantitative units the noise level of a volume control is rather difficult. A pair of high-resistance head telephones bridged across a circuit operating at zero level (0.006 watts) will provide an extremely loud signal. A level of about 40 decibels below this will still give quite an appreciable signal in the phones. If, as often happens, an amplifier having a gain of 100 decibels precedes the circuit just mentioned, a noise having a level of —140 decibels will still be detectable in the headphones. For this reason a volume control which is used in low-level mixer circuits must have an inherent noise level less than 140 decibels.

The nature of the noise from a volume control depends upon the manner in which it is used. However, it is generally most objectionable when the control is turned very rapidly. By using great care in the design of a high-gain amplifier this noise can be amplified to a point that will just indicate on the most sensitive meters. The measurement is complicated by the fact that a carefully designed volume control will have a noise level so low that it is largely overridden by tube noise and extraneous pickup in the amplifier.

We can assume an arbitrary value for noise so detected which is known to be too low to interfere with voice-circuit operation even when worked in a dynamic microphone mixer at the micro-

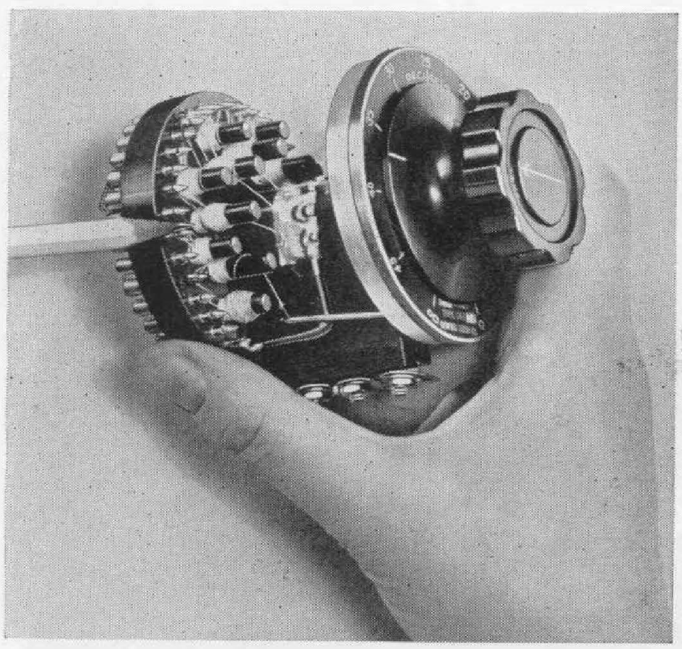


FIGURE 2. This unique construction guarantees ruggedness and a flat frequency characteristic for all settings over the entire attenuation range. Note that the shaft is insulated and that the frame is at ground potential

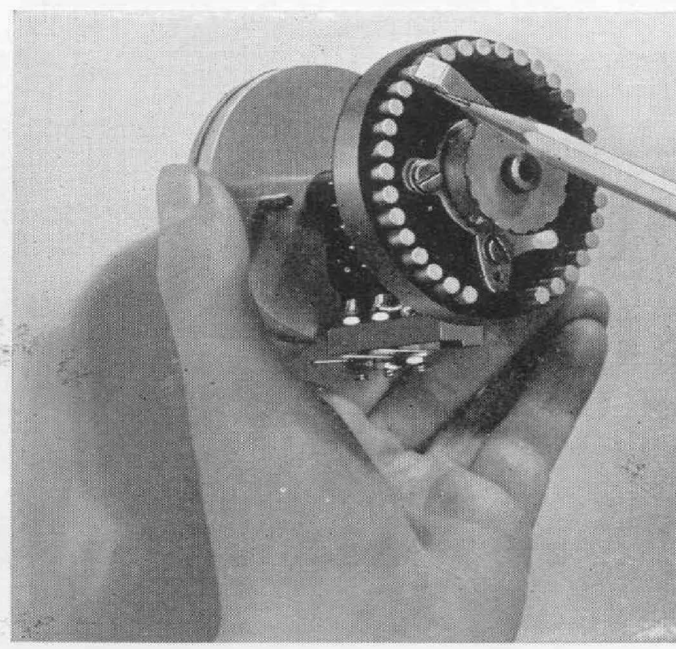


FIGURE 3. Noise has been practically eliminated from TYPE 653 Volume Controls through the use of a precision-type switch assembly and alloy contacts having a negligible contact potential with the switch blade

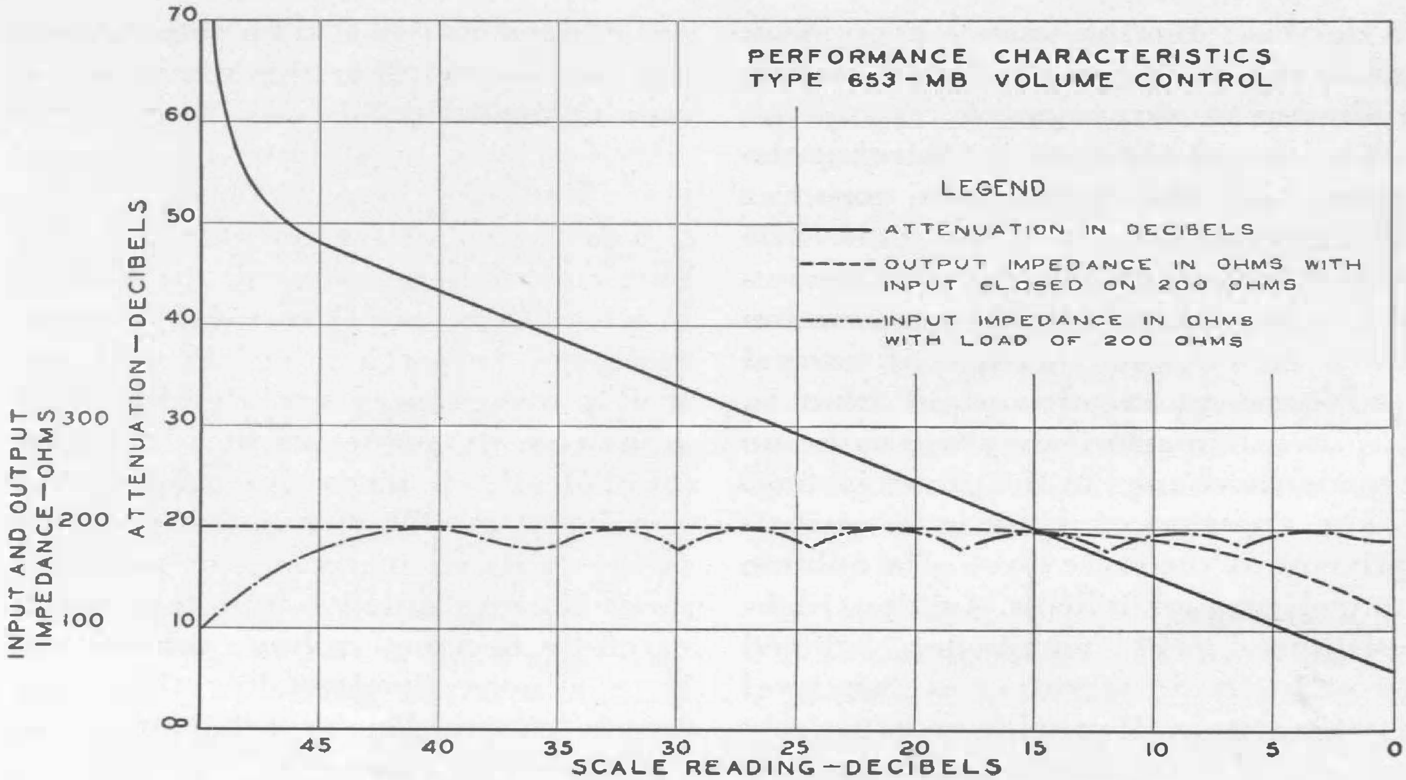


FIGURE 4. The ladder-type network used in TYPE 653 Volume Controls gives the linear attenuation characteristic and constant terminal impedances shown in the accompanying curves. The attenuation increases by increments of approximately 0.8 db per step so that the volume change is, for all practical purposes, continuous

phone level. Each General Radio TYPE 653 Volume Control is given such a test before it is shipped. If the noise indicated exceeds this arbitrary level, the control is rejected In this way, it will be known that the noise is below its in-

FIGURE 5. Inspecting TYPE 653 Volume Controls for noise. Every General Radio volume control is individually tested for noise, attenuation, and impedance, as well as the usual mechanical inspection

terference point so that when it is put in service no difficulties will arise.

In addition to this noise test the controls are also individually tested for the important mechanical and electrical characteristics.

The frequency characteristic is remarkably good. A series of experiments conducted in our laboratory indicates that a given control has no measurable change in its attenuation characteristic by comparison with a precision attenuation network for any frequency between 1000 and 10,000 cycles. The impedance also does not vary with frequency.—A. E. THIESSEN

TYPE 653 Volume Controls are made for use in 50-, 200-, and 500-ohm circuits as follows:

TYPE 653-MA	50 ohms
TYPE 653-MB	200 ohms
TYPE 653-MC	500 ohms

Price: $12.50, each

TRIAL OFFER—Send us your order for one or more of these new volume controls. Try them out for 10 days. Then, if you don't want to keep them, send them back in good condition and we'll either cancel the invoice or refund your money if you paid cash.

RECEIVER TESTING IN THE ULTRAHIGH-FREQUENCY BANDS

RECENT developments have indicated that the radio-frequency transmission band around 56 megacycles (5 meters) holds many interesting possibilities. The general usefulness in communication work of higher frequencies than those now commonly used has led many radio receiver designers into the investigation of the band above 30 megacycles.

To meet the need for an inexpensive instrument for measuring and testing the receivers at these ultrahigh frequencies, the General Radio Company has developed a new standard-signal generator embodying many interesting design features. It will operate at frequencies from 3 megacycles (100 meters) to as high as 100 megacycles (3 meters). Careful consideration of the requirements for a standard-signal generator to work in this band shows that part of the problems that are encountered in the design of the signal generator involve both the signal generator and the operation of the receiver under test when connected to it.

One difficulty, very serious at high frequencies and almost negligible at broadcast frequencies, is that the performance of a receiver depends, to a large extent, on the impedance of the antenna connected to its input terminals. In the more elaborate broadcast receivers, that influence is purposely minimized by careful design involving some sacrifice of sensitivity. Conditions are different in receivers using regenerative systems, at high frequencies in particular. It is for this reason that the TYPE 604-B Test-Signal Generator is arranged for coupling to the receiver under test by means of an antenna as well as the conventional shielded cable.

When using the one and one-half-foot low-inductance cable, particularly at frequencies above 50 megacycles, it must be kept in mind that the input voltage at the receiver may be different

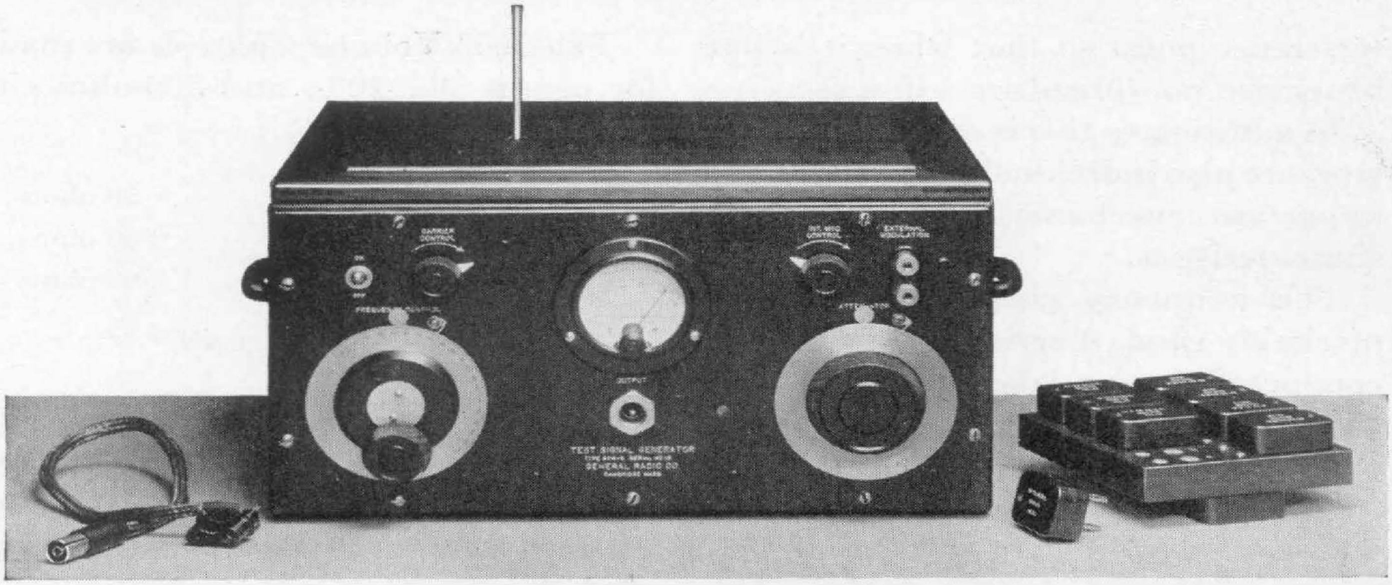


FIGURE 1. A TYPE 604-B Test-Signal Generator showing the smallest of the three rod-type antennas. Voltage can also be delivered to the receiver under test by means of the cable, the jack for which is on the panel. The coil-mounting rack and the 13 coils supplied with the instrument can be stored in a compartment inside the cabinet

from the output voltage of the signal generator. Depending upon the impedance of the cable and the impedance of the receiver, the input voltage to the receiver may be higher or lower than the voltage at the signal generator. For any definite frequency, however, accurate comparative values can be obtained, as long as the receiver input impedance is unchanged.

It is to avoid many of these difficulties that a rod-type antenna is provided. By connecting any one of three antennas to a second output terminal in the cover of the generator, and by changing the distance between test-signal generator and receiver, a wide range of field-strength values can be obtained at the receiver. This method of testing has the advantage that the receiver can be used in connection with its proper antenna and, further, makes it possible to choose the best antenna for a receiver.

Figure 2 shows a functional schematic wiring diagram of the TYPE 604-B Test-Signal Generator, consisting essentially of the oscillating circuit, the attenuator, and the modulating system.

The oscillator is a 31-type tube, with anode voltages adjustable between 50 and 150 volts. The higher plate voltages are necessary only to obtain sufficient amplitude at the highest frequencies. The variable condenser of the tuned circuit has a maximum capacitance of 60 $\mu\mu$f. The capacitance in the circuit limits the frequency range of the coil to about 1 to 1.4 and to somewhat less at the highest frequency. The inductors are plug-in coils with plugs designed to have a small inductance. Thirteen coils are supplied to cover the entire range between 3 and 100 megacycles, space for the twelve spares being provided inside the cabinet.

A micro-ammeter is connected in series with the grid-leak of the radio-frequency oscillator. This is used for measuring the carrier amplitude. The actual control of amplitude depends upon the voltage applied to the plate and is adjusted by means of a potentiometer provided for this purpose. The method of amplitude indication depends upon the fact that the amount of rectified grid current will depend upon the grid swing of the tube, independent of frequency. The grid current is always set at one value, that corresponding to an attenuator input voltage of 10 volts.

It has been found by careful test that, over the entire range of frequencies, no error greater than 10% will be made. This error is inconsiderable when it is remembered that inaccuracies of this order of magnitude can be expected at frequencies as low as 25 megacycles when thermocouples are used.

The most complicated problem in the design of the TYPE 604-B Test-Signal Generator was the attenuator and output system. The best resistance attenuators operate quite satisfactorily up to perhaps 30 megacycles but, due to unavoidable inductance and capacitance of the resistors, they are not usable over the higher frequency ranges.

A capacitance attenuator was selected as the best available, because of its small frequency error and simplicity of construction. It is built up in two stages, the first of which reduces the voltage from 10 volts to 1 volt for application to the antenna terminal.

The second stage consists of two condensers, one adjustable by the output-control dial and the other fixed. The jack for the output cable is connected in parallel across the fixed condenser. The maximum voltage available at this jack is 10,000; minimum, 5 microvolts.

Capacitances of the order of 0.001 μf, such as are required for the attenuator, cannot be used without elaborate precautions. The variable-condenser-attenuator is operated by means of the large dial at the right of the panel. Through a rack and pinion-gear arrangement, the dial drives a conical plunger that moves in and out of a recessed plate which is the stator of the condenser. The distance between the plunger and the plate determines the effective capacitance of the system. The capacitance variation is such that the output voltage from the attenuator varies almost logarithmically with angular rotation of the dial control. The electrical parts of the attenuator are carried in a cast aluminum housing.

As mentioned before, two sets of output terminals are available on the TYPE 604-B Test-Signal Generator. The antenna terminal is set for a constant

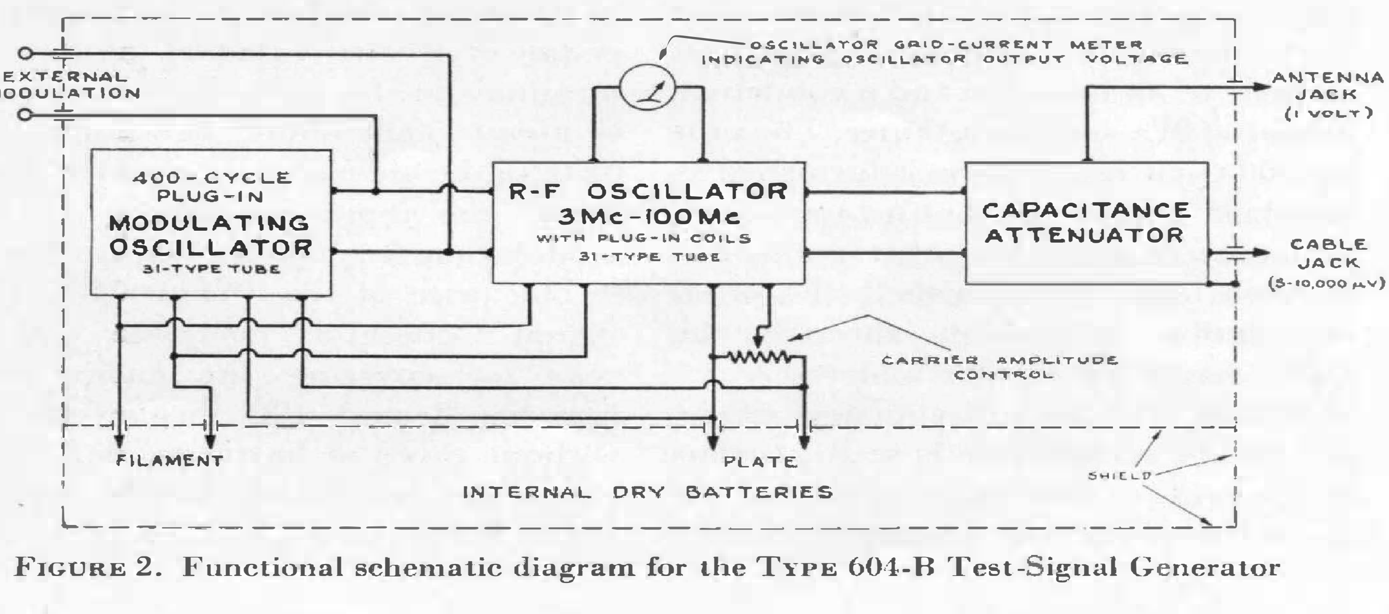


FIGURE 2. Functional schematic diagram for the TYPE 604-B Test-Signal Generator

value of 1 volt, and has an internal output impedance corresponding to a capacitance of about 90 $\mu\mu$f. This terminal is used to connect the plug-in vertical antenna. It is located almost in the center of the cabinet cover. In this way, the metal lining of the cabinet acts as a counterpoise and provides for a uniform field. The antenna is divided into three sections, the lengths of which are so chosen that the second and third ones give 10 times and 100 times the field strength obtained with the first. The total length for the three sections of the antenna is 15 inches.

The second output terminal is the jack located in the center of the panel. The internal output impedance corresponds to a capacitance of 200 $\mu\mu$f and is independent of attenuator setting.

The TYPE 604-B Test-Signal Generator is carefully shielded and the stray field is so small that it will not affect the accuracy of any measurement on a receiver within the output voltage range of the instrument.

Internal and external modulation are provided for the TYPE 604-B Test-Signal Generator. The internal modulation circuit consists of a 31-type tube and a plug-in oscillator unit that determines the modulation frequency. This unit consists of an inductor and a condenser mounted in a single container. The unit for 400-cycle modulation is furnished as standard equipment, but on special order, plug-in units for other audio frequencies can be furnished. External modulation is possible through the audio range up to 200 kilocycles.

Within the audio-frequency range, percentage modulation is set by means of the grid-current micro-ammeter. At higher modulating frequencies, the

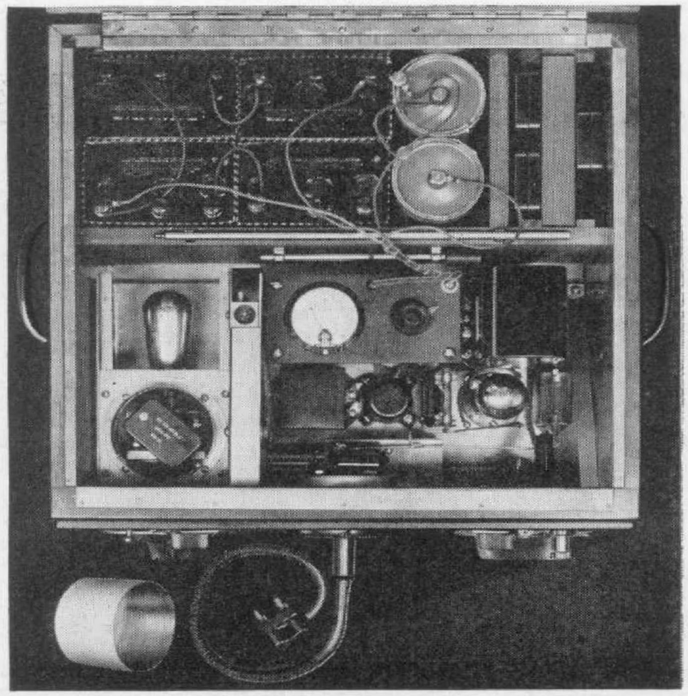


FIGURE 3. All batteries for the TYPE 604-B Test-Signal Generator can be mounted inside the cabinet. Note the capacitance attenuator, the antenna output jack, and the provision for coil storage. The cap-type shield on the table in front of the instrument was removed from the carrier-frequency coil in the left-hand corner of the cabinet

voltage applied to the external modulation terminals is to be set to a value corresponding to the calibration chart furnished with every instrument (5 volts is an average). In both cases, the modulation will be 30%. The modulation frequency should be less than 1.5% of the carrier frequency. The input impedance of the external modulation terminals in the audio-frequency range is about 5000 ohms. Inasmuch as a 0.002-$\mu\mu$f condenser is connected across them, the input impedance at high modulation frequencies will be less.

The price of the TYPE 604-B Test-Signal Generator, complete with 13 coils for covering the entire range between 3 and 100 megacycles but without tubes or batteries, is $300.00. Frequency calibrations can be supplied for an extra charge. — E. KARPLUS

THE EDGERTON STROBOSCOPE AT THE NEW YORK AUTO SHOW

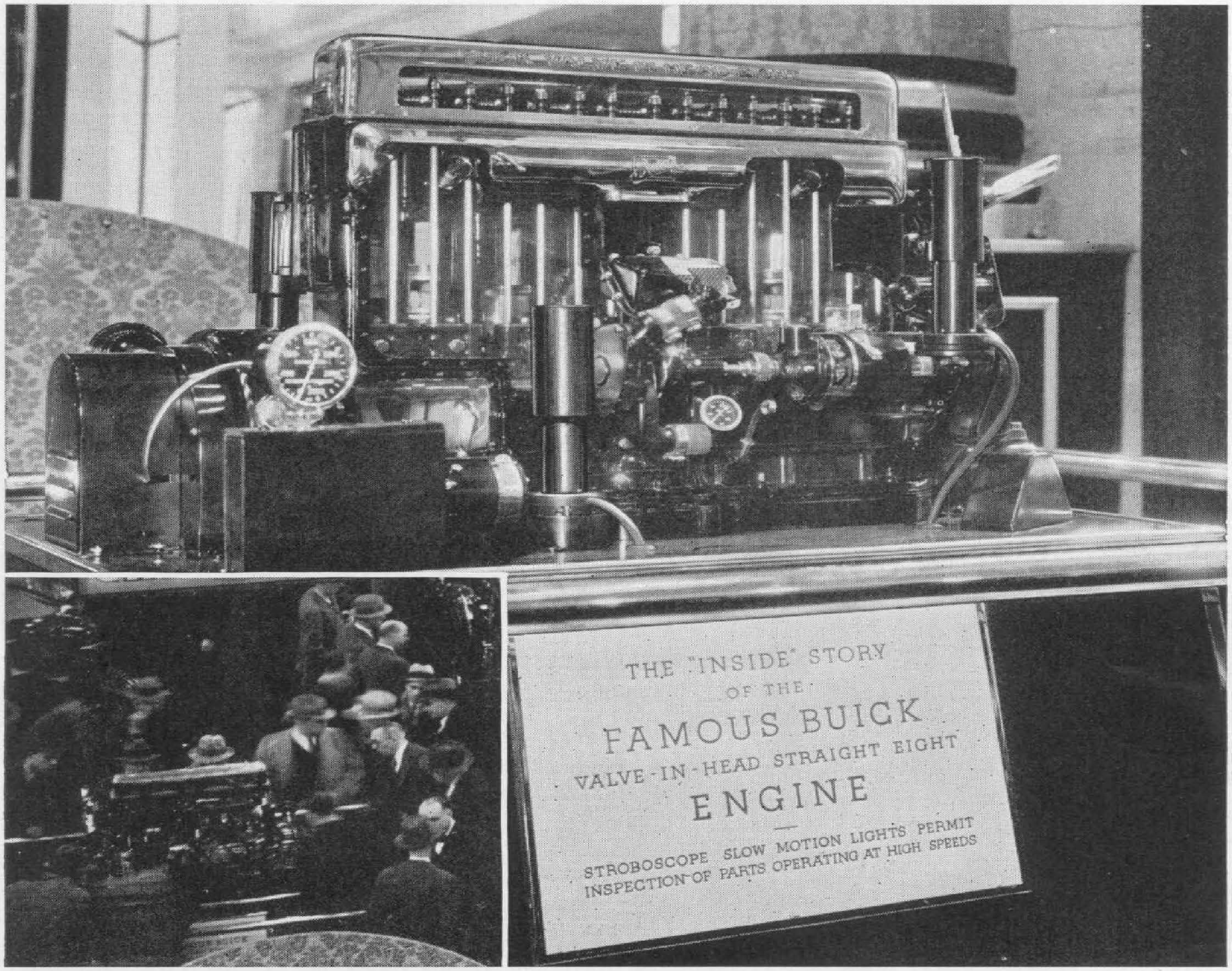


PHOTO BY WIDE WORLD

THE General Motors Corporation capitalized on the interest of every automobile buyer in the operating mechanism of his engine by demonstrating a cutaway Buick engine in stroboscopic slow motion. The demonstration was part of the General Motors exhibit at the New York Auto Show and, later, at the Chicago Show. The stroboscopic illumination was supplied by four Edgerton Stroboscopes mounted at strategic points around the engine block. The four stroboscopes gave sufficient illumination so that there was no difficulty in seeing the stroboscopic action in the brilliantly lighted exhibition hall.

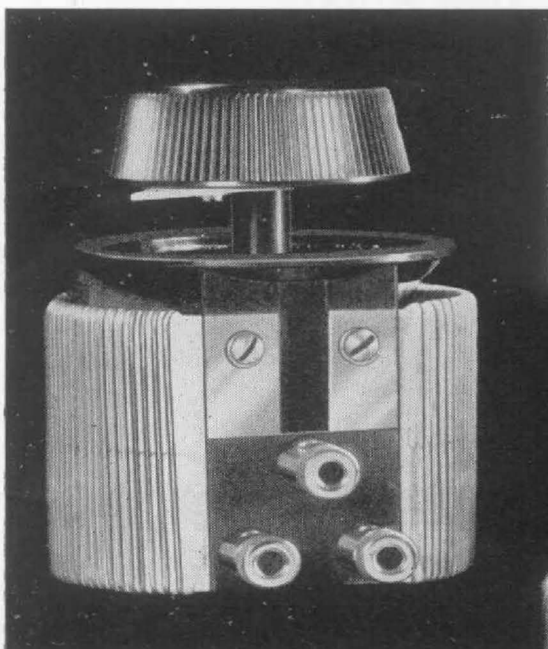
The engine was driven by an adjustable-speed electric motor, and the contactor mechanism, by means of which the timing of the stroboscope flashes was effected, was an integral part of the drive assembly. This exhibit, we are informed, will be shown in many of the larger cities, probably as part of a local Buick distributor's demonstration rather than in the public auto shows, the season for which is already well advanced.

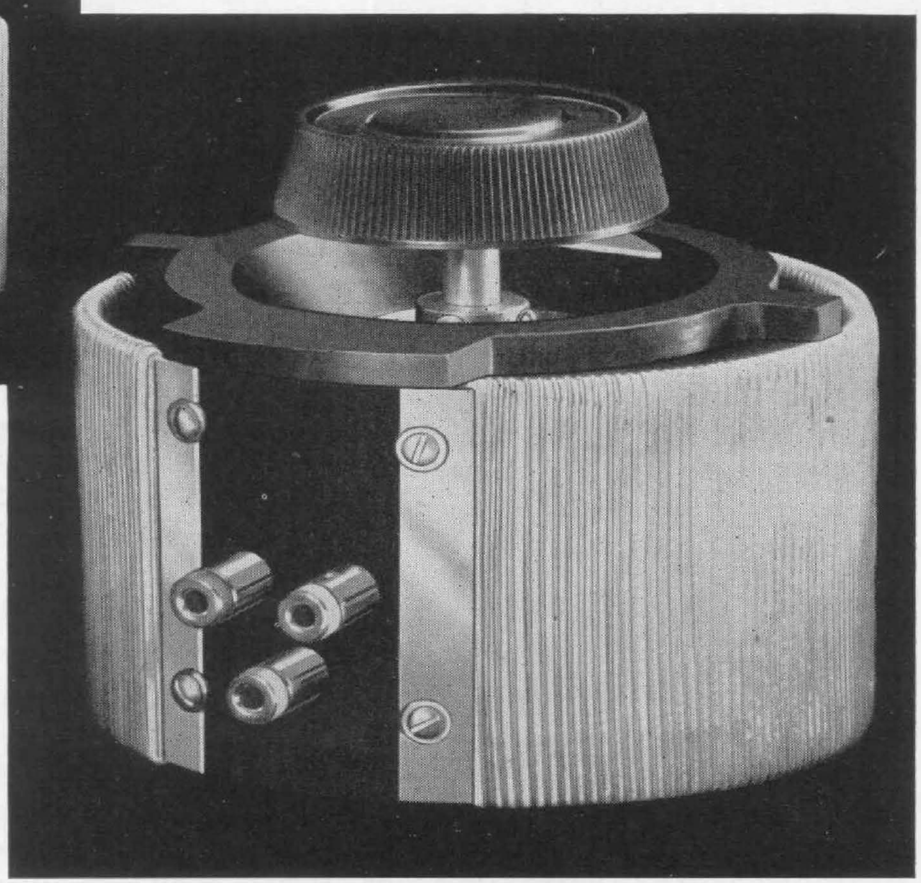
TWO NEW RHEOSTAT-POTENTIOMETERS FOR HEAVY DUTY SERVICE

Two new series of rheostat-potentiometer units which combine the advantages of earlier models with a high power dissipation rating are now available. The smaller of the two, Type 333, has a power rating of 100 watts; the larger, Type 533, has a rating of 500 watts.

Both units are similar in general detail of design to the six other General Radio rheostat-potentiometer series. They can be mounted either behind the panel or on the table top, and each is fitted with three terminals so that it can be used as a rheostat for either direction of rotation or as a voltage divider.

The resistance wire is wound on an asbestos-covered aluminum form, thus assuring a maximum of heat radiation





The two new heavy-duty rheostat-potentiometers assembled for panel mounting. By loosening two collars and pushing through the shaft, the knob may be mounted on the other end for table mounting.

Left: Type 333-A, 100 watts.

Right: Type 533-A, 250 watts

and the elimination of hot spots when only a portion of the resistor is in use. Supporting frames are moulded from a bakelite compound having the ability to withstand operating temperatures well in excess of requirements.

The TYPE 333 Rheostat-Potentiometers are identical in over-all dimensions with the TYPE 371 and TYPE 471 Rheostat-Potentiometers. They have four times the power rating of the former.

The TYPE 533 Rheostat-Potentiometers are 5$\frac{3}{16}$ inches in diameter and 3$\frac{1}{2}$ inches in height, exclusive of the knob which adds $\frac{13}{16}$ inch to the over-all height. The shaft is of steel, and the contact arm is especially designed for low contact resistance so that troubles due to overheating at the contact have been definitely eliminated.

These two units will find their principal application in the control of voltage and current in power circuits where their convenient mounting, flexibility, and low cost will make them desirable where it has formerly been necessary to use the tubular type of rheostat.

Each unit is fitted with three jack-top binding posts arranged on the standard $\frac{3}{4}$-inch spacing, a decided convenience in temporary set-ups by students and workers in research laboratories.

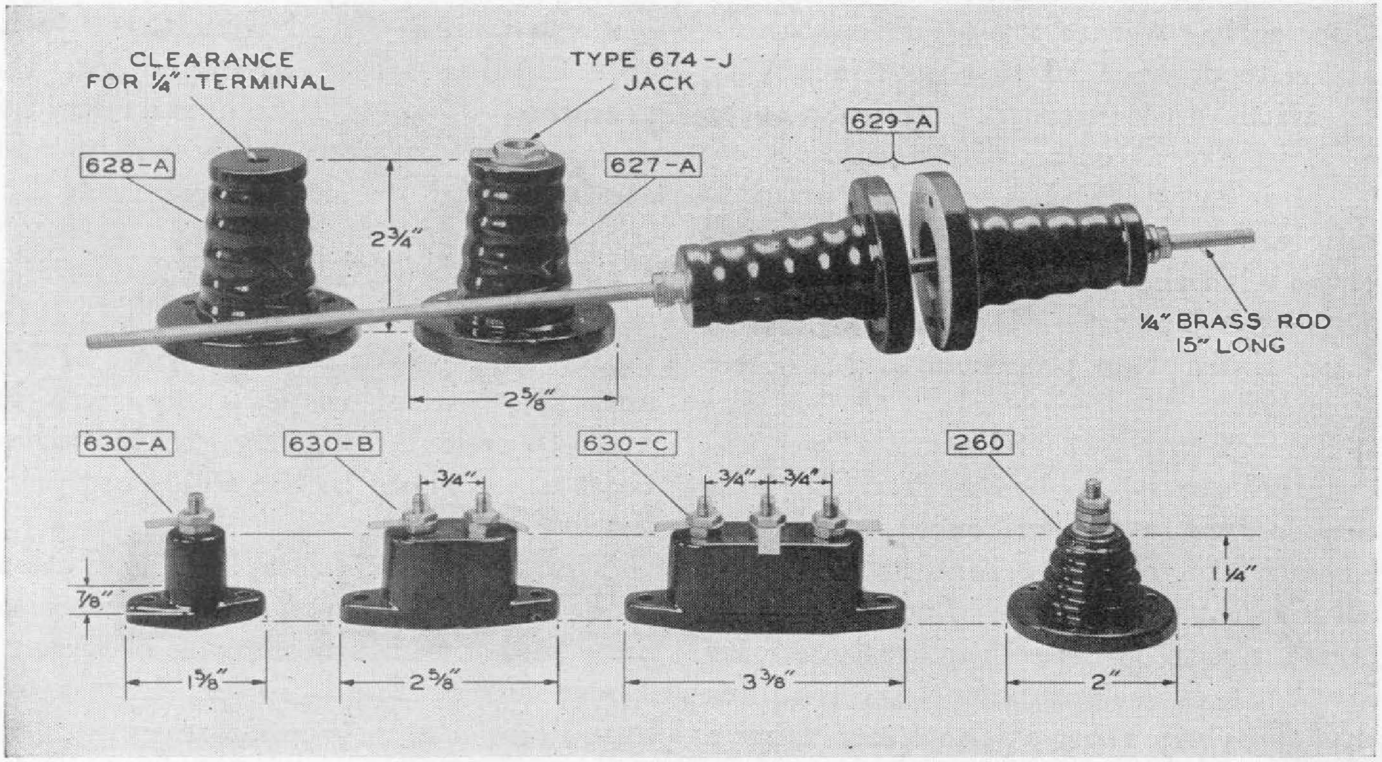
Seven sizes of each model are carried in stock but other resistance values within the power rating limits of 100 and 250 watts, respectively, can be built to order at slightly greater prices than those given in the following price list.

The following table lists the stock models and specifies the total resistance and maximum allowable current. These current and power ratings are based on a 100-degree Centigrade temperature rise where the unit is operated in the open without forced air circulation. Where the unit is to be enclosed, an allowance should be made for the resulting increase in ambient temperature.

SPECIFICATIONS

Type	*Total Resistance*	*Maximum Current*	*Code Word*	*Price*
333-A	1 ohm	10.0 a	VALOR	$4.00
333-A	3 ohms	5.8 a	VAPID	4.00
333-A	10 "	3.2 a	VENUS	4.00
333-A	30 "	1.9 a	VIGIL	4.00
333-A	100 "	1.0 a	VIGOR	4.00
333-A	300 "	0.6 a	VILLA	4.00
333-A	600 "	0.4 a	VIPER	4.00
533-A	1 ohm	15.8 a	MOLAR	6.00
533-A	3 ohms	9.1 a	MONAD	6.00
533-A	10 "	5.0 a	MORAL	6.00
533-A	30 "	2.9 a	MOTTO	6.00
533-A	100 "	1.6 a	MUGGY	6.00
533-A	300 "	0.9 a	MUMMY	6.00
533-A	600 "	0.6 a	MUSTY	6.00

NEW PORCELAIN INSULATOR ASSEMBLIES



Seven new General Radio insulator assemblies for amateur and laboratory use. Each is made of the best grade of glazed porcelain selected for great mechanical strength and a minimum of moisture absorption

SPECIFICATIONS

Type	*Description*	*Code Word*	*Price*
628-A	Insulator	MEDAL	$0.30
627-A	Jack-Top Insulator	MAYOR	.60
629-A	Lead-In Assembly	MERCY	.90
630-A	Single-Terminal Stand-Off Insulator	EDUCE	.10
630-B	Double-Terminal Stand-Off Insulator	EGRET	.20
630-C	Triple-Terminal Stand-Off Insulator	EJECT	.25
260	Wall Insulator	CONIC	.20

All insulator assemblies are supplied with wood screws and the lead washers so necessary to prevent breakage

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