the GENERAL RADIO Experimenter

Copyright 1955 · GENERAL RADIO COMPANY, Cambridge, Mass., U.S.A.

Since 1915 — Manufacturers of Electronic Apparatus for Science and Industry

VOLUME XXIX No. 11 APRIL, 1955

A NEW SYSTEM FOR AUTOMATIC DATA DISPLAY

Today's shortage of new engineers points up the increasing importance of more efficient use of our available engineering man-hours. Just as improvements in tooling have extended the productivity of the factory worker, so will improvement in the tools of the research worker enable him to do more work in less time. Automation in production has its counterpart in new techniques for automatic data presentation designed to save time for the engineer and to augment his productivity.

One of the simplest and most useful improvements in measuring techniques is the replacement of point-by-point measurements by data displayed as continuous functions of the independent variable. Very commonly, the independent variable is frequency, and sweep oscillators to serve as generators for these measurements are coming into widespread use. These sweep techniques are helping the development engineer to simplify measurements, are suggesting new solutions to complicated problems, and are speeding up adjustment and testing of components and circuits in production. Sweep oscillators for these uses change frequency as a function of time and provide a voltage that is a known function of that frequency

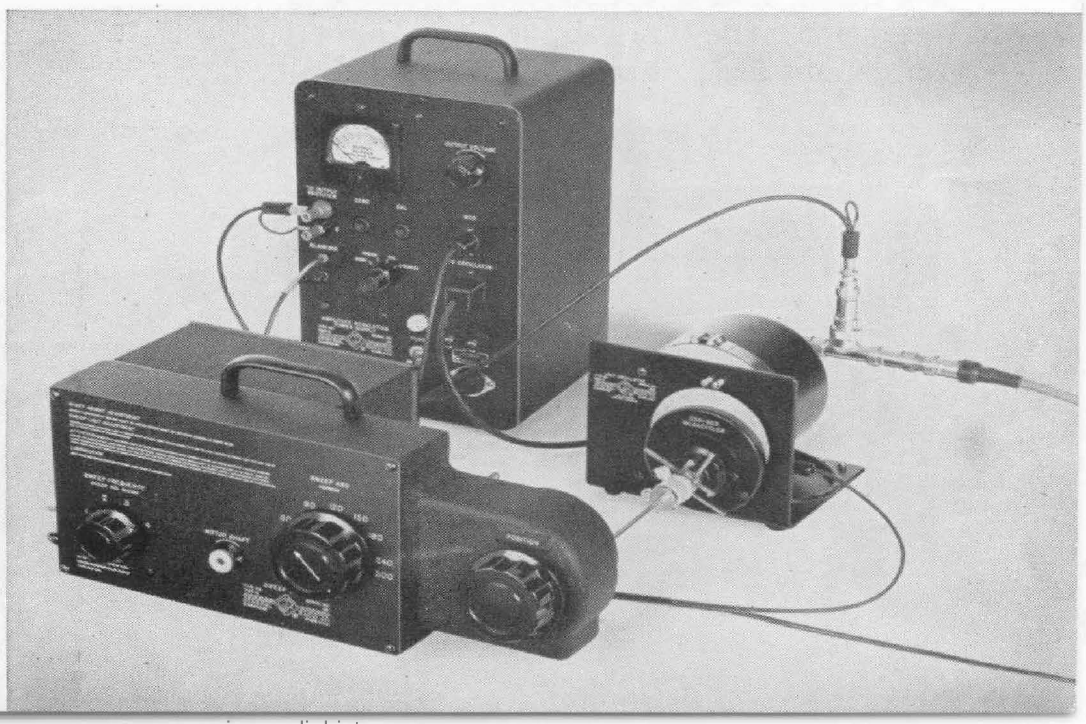


Figure 1. View of the new General Radio Sweep Drive and Amplitude-Regulating Power Supply set up to sweep a Type 1209-B Unit Oscillator.

See also "Automatic Sweep Drive for the Slotted Line," page 10.

www.americanradiohistory.com

Also
IN THIS ISSUE

to serve as a horizontal deflection voltage for a graphic recorder or cathode-ray oscilloscope.

Electronic or mechanical sweep oscillators covering various frequency ranges are available on the market. To avoid flicker when used with CRO display, they employ relatively fast repetition rates, usually related to the power-line frequency. The frequency of the electronic type is varied by a voltage-sensitive element in the frequency-determining circuit. In mechanical types, the frequency is similarly varied by a displacement-sensitive element. Large fractional variation in frequency is difficult to obtain with either of these systems. Although the electronic types are quiet, and insensitive to shock and vibration, they are limited in sweep range and are not suitable for high frequencies. Mechanical types, on the other hand, can be made to cover all frequencies, although the types using small vibrator-driven circuit elements usually suffer from similarly restricted sweep ranges. At audio frequencies, where very wide ranges must be considered, slow mechanical dial drives are sometimes used in connection with synchronized recorders. A speed of 3 decades in 2½ minutes is common. General Radio's previously announced synchronous dial drives[1] are suitable for this service and provide speeds as fast as 6⅔ seconds per octave to permit oscilloscope displays of data at audio frequencies.

At high frequencies, where the required sweep range is usually smaller, speeds should be high enough to give a continuous trace on an oscilloscope with a long-persistence screen, but not so high that extraneous transient effects occur when the performance of a high-Q circuit is being observed.

Intermediate between the speeds of 30 or 60 cycles per second, which do not produce flicker on a 'scope, and the lower speeds of the audio recorder, are the speeds around 1 cycle per second, which are fast enough to produce a satisfactory trace on a cathode-ray tube

[1] Littlejohn, H. C., "Motor Drives for Precision Dials and Beat-Frequency Oscillators", *General Radio EXPERIMENTER*, Vol. XXIX, No. 6, November 1954, pp. 1–3.

Figure 2. Front panel view of the Type 1750-A Sweep Drive, showing the SWEEP FREQUENCY, SWEEP ARC, and POSITION controls.

www.americanradiohistory.com

with a long-persistence screen and to permit observation of pattern changes without excessive delay. Most conventional oscillator dials can be turned back and forth at these speeds without damage to the oscillator. The new General Radio Sweep Drive shown in Figure 1 is designed to perform this function.

The new drive is unique because it adapts manually operated equipment to automatic sweep applications. It can be attached to the tuning knob of any oscillator to operate as an artificial hand, turning the oscillator dial back and forth over the desired frequency range and supplying a horizontal sweeping voltage proportional to shaft angle.

A very important requirement of any sweep generator is that the output voltage be constant with frequency, since any variation shows up as a part of the displayed curve. The problem of maintaining an adequate degree of flatness of output increases with the range to be covered, and, for wide sweep ranges, output regulation is usually necessary. General Radio Unit Oscillators cover very wide frequency ranges and are therefore particularly suitable for use with the Sweep Drive. Since they use separate power supplies, they are easily adaptable to output regulation. The new TYPE 1263-A Amplitude-Regulating Power Supply is designed primarily for use with these oscillators to maintain constant output.

TYPE 1750-A SWEEP DRIVE

The new sweep drive shown in Figure 2 can be attached to shafts, knobs or dials to drive them in reciprocating motion at speeds between 0.5 and 5 cycles per second. Two independent controls are provided to adjust the sweep arc and the center position of the sweep while the drive shaft is in motion. The sweep arc is adjustable between 30 and 300 degrees, and the position control has a range of nine full turns of the drive shaft between adjustable stops.

The height of the drive shaft is adjustable from 2½ to 4⅞ inches above the bench. The drive shaft can be coupled directly to shafts whose diameters are ¼ inch and ⅜ inch, and a universal clutch is provided for attachment to knobs and dials up to 4 inches in diameter.

Mechanical System

The diagram of Figure 3 shows the operation of the drive. The Sweep Drive is powered by a 5000-rpm universal motor, operated with fixed field supply and adjustable armature supply, (SWEEP FREQUENCY control) as in the General Radio Type 1701-AU Variac® Speed Control. A crank is driven through two belts to provide

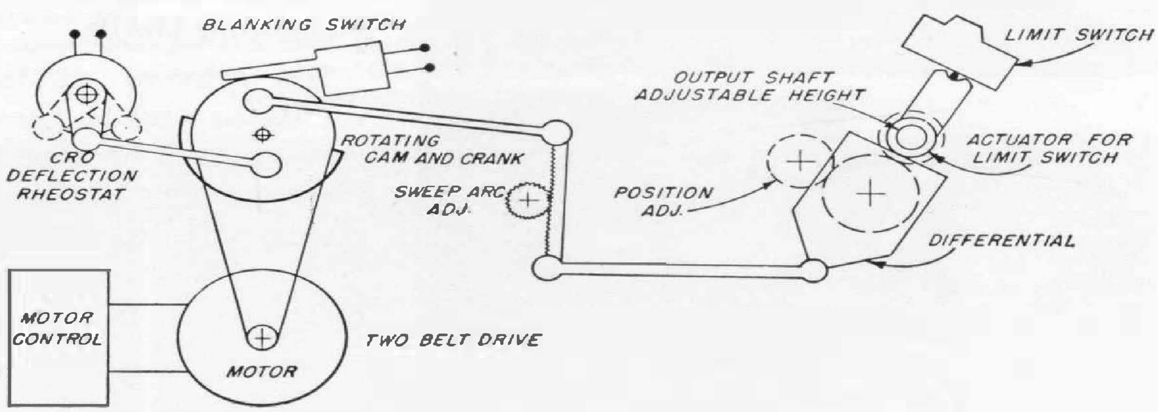


Figure 3. Elementary mechanical diagram of the Sweep Drive.

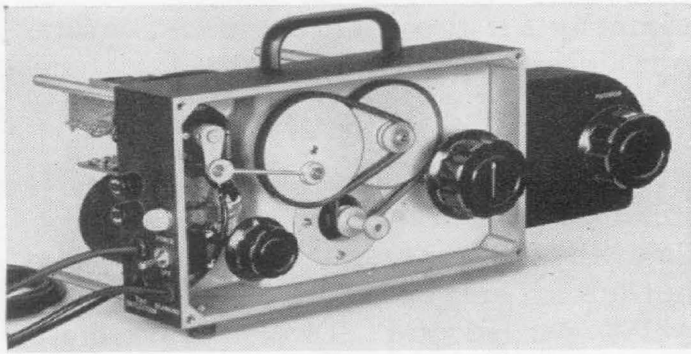


Figure 4. View from front with panel removed. The potentiometer that supplies the horizontal sweep voltage can be seen in the upper left-hand corner.

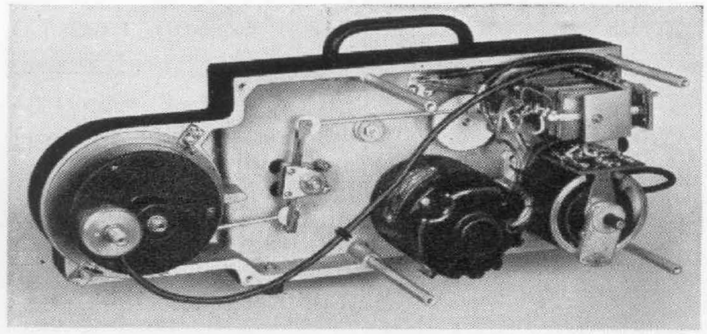
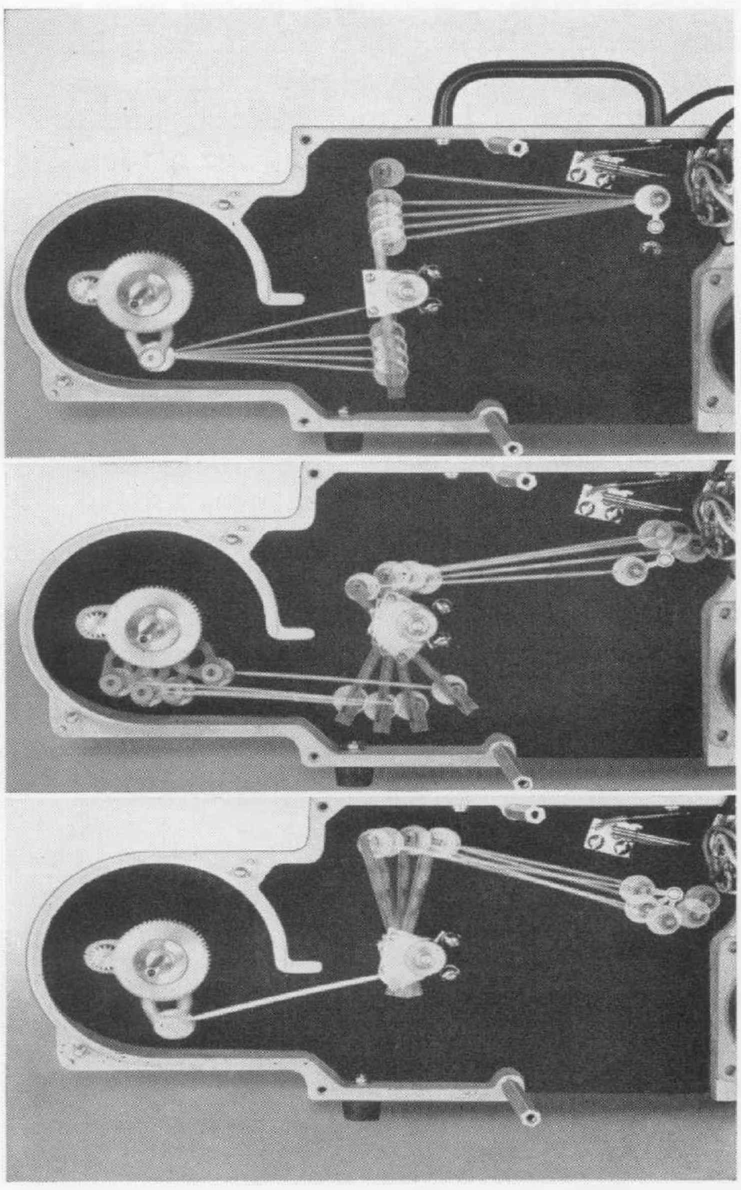


Figure 5. Rear view with cover removed, showing motor, motor control circuits, driving crank, and adjustable rack.

Figure 6. Multiple exposure views showing the action of the sliding rack. The upper view shows the driving mechanism at rest in the center of its stroke, and the range over which the rack can be adjusted by means of the position control. The center view shows the drive in motion at maximum sweep arc, and the lower view similarly shows the operation at minimum arc.



the necessary speed reduction. Operated from the crank through a connecting rod is a rack, adjustable in position by the SWEEP ARC control. At the opposite end of the adjustable rack is a second connecting rod, which operates through a differential (the POSITION control) to turn the output shaft.

Figure 4 shows the motor shaft, pulleys, and belts through which the speed reduction is obtained. In Figure 5, a view from the rear of the assembly, the motor, main driving crank, and sliding rack are visible. Figure 6, a series of multiple exposure photographs, shows the sliding rack in different positions and illustrates how the sweep arc is changed by adjustment of the point at which the rack pivots. At the left is the differential. In Figure 7, are shown the output coupling shaft, with its two flexible couplings, and details of the universal clutch.

Operating Limits

To prevent damage to the driven oscillator and to the sweep drive itself, speeds must be kept at safe values. The forces acting on the driven device increase with the moment of inertia of the

www.americanradiohistory.com

moving parts and with their angular acceleration. The accelerating forces increase 1000:1 when the controls are changed from 30° and 0.5 cycles per second to 300° and 5 cycles per second. In any specific application, the sweep arc is determined by the requirements of the measurement to be made. The highest speeds should be used only with small-angle sweeps, with the speed being decreased correspondingly as the arc increases.

In reciprocating motion, forces vary harmonically and reverse gradually two times each cycle. In practice, small clearances between the shafts and bearings prevent a gradual reversal. This small play, which can never be eliminated, is the cause of backlash in manual operation and of pounding in the motor drive. The rated maximum torque of the drive shaft is 24 ounce-inches. No definite limit can be specified for the accelerating forces. Their effect can be estimated by the amount of pounding they cause. As a protection of the driven device, excessive force (about five times rated torque) will cause slipping in the POSITION control.

For additional protection, a built-in limit switch disconnects and brakes the motor when the preset limits of shaft travel are accidentally exceeded. The two limits can be set apart by nine full turns of the output shaft, which is useful

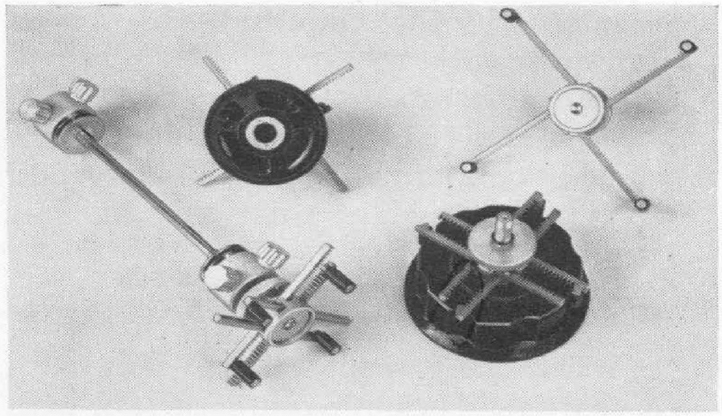


Figure 7. View of the coupling attachments furnished with the Sweep Drive. At left is the coupling shaft, to which has been attached the universal clutch. The other views show the clutch and the clutch attached to a knob.

when the drive is coupled to the slow-motion drive shaft of an oscillator.

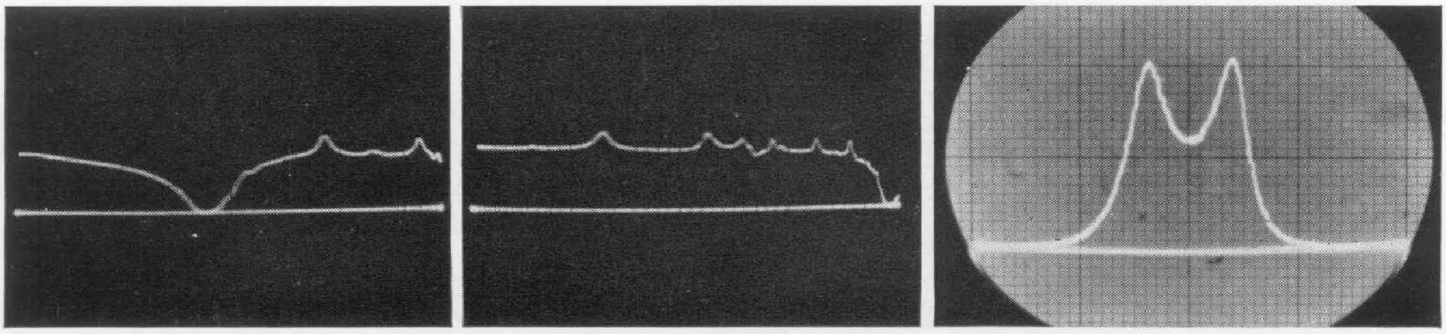
Use With Unit Oscillators

Current models of General Radio Unit Oscillators can all be used with the Sweep Drive. These oscillators are:

Type No.	*Frequency Range*
1211-A	0.5 to 5 Mc and 5 Mc to 50 Mc
1215-B	50–250 Mc
1209-B	250–920 Mc
1208-B	65–500 Mc
1218-A	900–2000 Mc

The last two models, TYPES 1208-B and 1218-A have sliding contacts in the tuned circuit, and, while not recommended for high-speed sweeping over long periods, they are satisfactory for use at low speeds with the Sweep Drive. The TYPE 1208-B, however, cannot be

Figure 8. Oscillograms of typical amplitude-frequency characteristics as displayed by the Sweep Drive. Left, Characteristic of a Type 874-FR Rejection Filter tuned to 76 Mc; sweep range is 48 to 260 Mc. Center, characteristic of same filter for the 250- to 900Mc range. Right, characteristic of a television front-end tuner set to channel 7; sweep range is 160 to 200 Mc. Vertical scale is square law for all of these oscillograms.



www.americanradiohistory.com

regulated by the Amplitude-Regulating Power Supply.

The older models, the TYPES 1208-A, 1209-A and 1215-A, were originally designed for manual operation only and therefore should be used only at slow speeds.

Use With Other Oscillators

When the Sweep Drive is used with oscillators of other manufacture, or with other General Radio oscillators, the same precautions should be taken. Sweep arcs should be held within safe limits, and speeds should be adjusted to conform to the mechanical limitations of the oscillator.

Calibration

The horizontal deflection voltage for the oscilloscope is obtained from a potentiometer, driven by a fixed crank, which can be seen in Figure 4. This voltage is proportional to the angle through which the oscillator shaft is turned. Owing to the geometry of the various linkages involved, the relation is closely linear in one direction but does not repeat on the return trace. A blanking contact is provided to suppress the return trace and to replace it by a zero reference axis.

The frequency distribution on the oscilloscope screen repeats the frequency distribution of the swept oscillator, but the actual frequencies corresponding to ordinate lines on the screen depend upon the settings of the arc and position controls. Accuracies comparable to the calibration accuracy of the swept oscillator are readily obtained by transferring the oscillator calibration to the screen. To facilitate this transfer, the end of the motor shaft has been extended through the panel of the sweep drive. With power on, and with the speed control at zero, an oscillator coupled to the output shaft can be set manually to a desired frequency by rotation of the motor shaft. The spot on the oscilloscope indicates the ordinate at which this frequency appears.

Applications

The flexibility of this new sweep drive, the fact that it can be used with manual-drive oscillators, and the consequent wide sweep ranges that can be obtained open up many new applications for sweep techniques. While the obvious uses are those involving the sweeping of an oscillator to display amplitude-frequency characteristics, the drive is not limited to these. It can be used in the display of any electrical quantity as a function of shaft angle, or of any other quantity, mechanical, for instance, that can be converted to an electrical voltage.

— EDUARD KARPLUS

TYPE 1263-A AMPLITUDE-REGULATING POWER SUPPLY

In sweep techniques, it is essential that the amplitude of the applied signal remain constant as a function of frequency. Since General Radio Unit Oscillators, like most high-frequency oscillators do not meet this condition when operated from a power supply with fixed-plate voltage, the Amplitude-Regulating Power Supply has been designed to maintain constant oscillator output.

The Type 1263-A Amplitude-Regulating Power Supply compares the d-c potential developed by the oscillator output rectifier with a d-c reference potential and applies a correction to the oscillator plate supply to minimize the difference. A maximum of 300 volts at 30 milliamperes is available for the oscillator plate. The d-c reference poten-

www.americanradiohistory.com

tial is adjustable from zero to 2.5 volts, which corresponds to an r-f output of zero to 2 volts with the Type 874-VR Voltmeter Rectifier. With an oscillator capable of producing at least 2 volts output with a 300-volt, 30-milliampere plate supply at all frequencies within its range, this power supply will maintain any preset level within 2 per cent over the entire frequency range.

Speed of Response

In sweep applications, rapid variations of the oscillator output are likely to occur, particularly in the u-h-f range. The Type 1263 Amplitude-Regulating Power Supply will change the plate current supplied at a rate of 3 milliamperes per millisecond or faster. For an oscillator requiring 30 milliamperes at 300 volts, this corresponds to a change of 30 volts per millisecond. Such an oscillator must not be swept at a speed that requires a rate of plate-supply variation exceeding this value. General Radio Unit Oscillators can be swept through their entire ranges in a sinusoidal manner at rates up to one cycle per second. With the Type 1750-A Sweep Drive, the maximum speed recommended for mechanical reasons is, incidentally, also one cycle per second for full-range sweeping. Fractional parts of the oscillator ranges can, of course, be swept at correspondingly more rapid rates.

Blanking

Phone-tip jacks on the panel permit connection to be made to an external contactor to cut off the oscillator plate supply. This connection is useful for blanking the oscillator output in sweep applications to eliminate the return sweep and to provide a reference base line on the cathode-ray oscilloscope. The Type 1750-A Sweep Drive is provided with a blanking contactor.

Calibration

An internal d-c vacuum-tube voltmeter, calibrated in terms of r-f output voltage, indicates the voltage at the output rectifier. The meter scale is quasi-logarithmic and covers an output voltage range of 0.1 to 2. An internal calibration means permits the meter to be standardized with a particular output rectifier. The calibration and zero adjustments are convenient, thumb-set controls on the panel of the instrument.

Circuit

The elementary schematic diagram (Figure 10) illustrates the principle of operation of the Type 1263-A Amplitude-Regulating Power Supply. The output rectifier develops a negative d-c potential proportional to the r-f amplitude at the oscillator output. This potential is applied to the voltmeter amplifier and to one grid of the first dif-

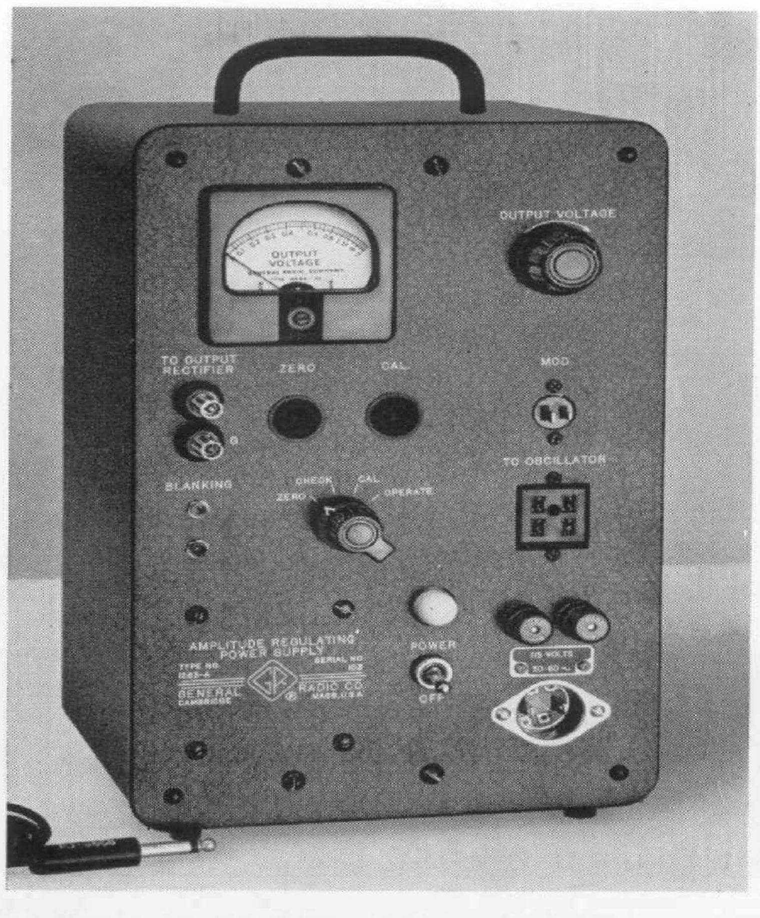


Figure 9. Panel view of the Type 1263-A Amplitude-Regulating Power Supply.

www.americanradiohistory.com

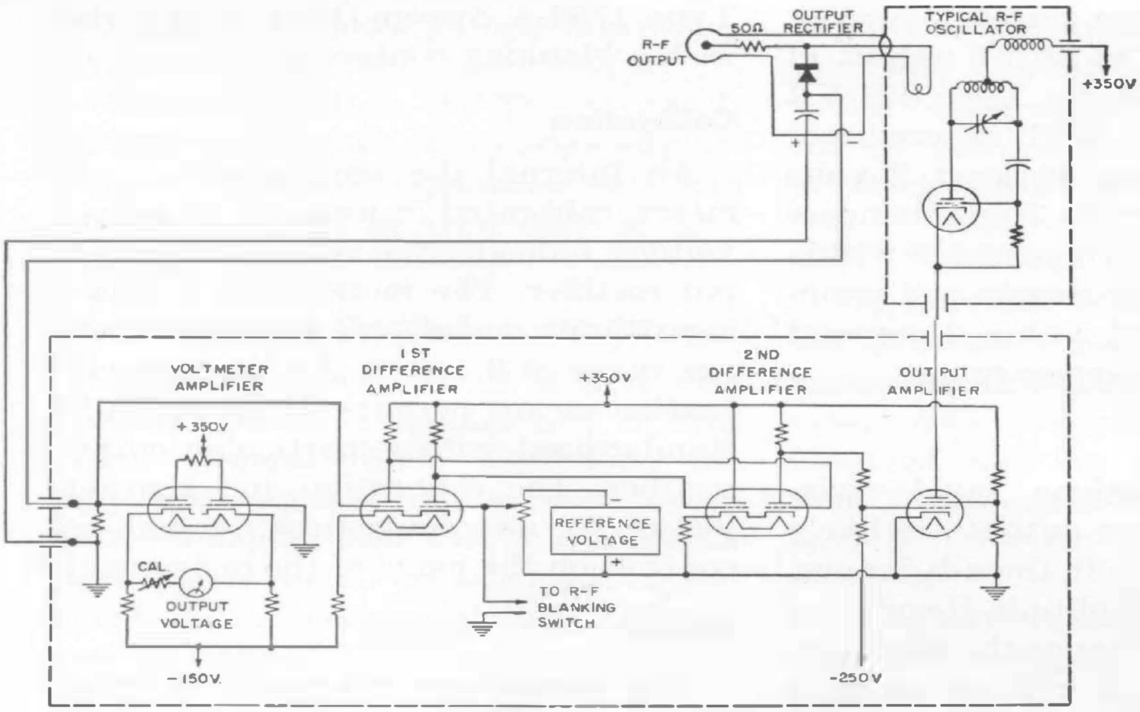


Figure 10. Elementary schematic circuit diagram of the Power Supply connected to an oscillator.

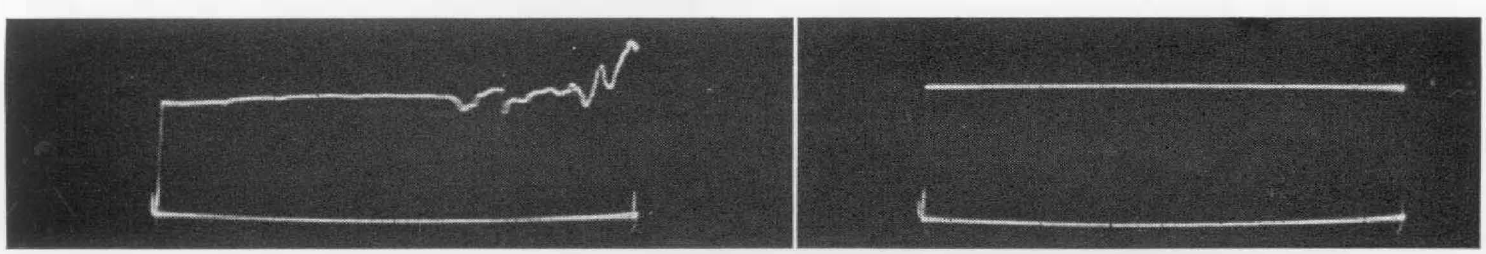
ference amplifier. A negative adjustable reference potential is applied to the other grid of the first difference amplifier. An increase in the negative potential with respect to the reference potential is amplified by the two difference amplifiers and appears as a negative-going potential at the output amplifier grid. This reduces the plate current supply to the oscillator. Conversely, a decrease in output produces an increase in plate current supplied. A closed-circuit feed-back system is thereby established, which holds the output closely to a preset level.

The Amplitude-Regulating Power Supply also furnishes power for the plate and cathode heater of the oscillator. Direct current is used for the heater supply, in order to minimize frequency modulation from hum. The Type 1263-A Amplitude-Regulating Power Supply is designed primarily for use with General Radio Unit Oscillators. Other oscillators can be operated from this instrument if their power requirements are within the allowable range and if a d-c connection can be made to the cathode circuit for applying plate current control. The following oscillators are suitable for use with this power supply:

Type No.	*Frequency Range*
1211-A	0.5–5 and 5–50 Mc
1215-B	50–250 Mc
1209-B	250–920 Mc
1218-A	900–2000 Mc

The earlier "A" models of the Types 1215 and 1209 oscillators will operate satisfactorily with the Amplitude-Regulating Power Supply if the modulation phone plug provided is removed or adapted to connect to the screw-type

Figure 11. Output amplitude characteristic as a function of frequency for the Type 1209-B Unit Oscillator (250–920 Mc), unregulated (left), and (right) when operated from the Amplitude-Regulating Power Supply.



www.americanradiohistory.com

terminals provided on these instruments. The Types 1208-A and 1208-B, however, cannot be used with this power supply.

The General Radio Type 874-VR Voltmeter Rectifier is the recommended output rectifier. It is equipped to plug directly into the output connector of General Radio Unit Oscillators and provides a matched source for 50-ohm coaxial cable.

— W. F. Byers

SPECIFICATIONS

Type 1750-A Sweep Drive

Reciprocating Output Shaft

Center Position: Adjustable within 9 turns.
Sweep Arc: Adjustable 30–300 degrees.
Torque: Rated max. 24-ounce inches.
Sweep Speed: Adjustable 0.5–5 cycles per second. Moment of inertia limits the speed at which a load can be driven.
Height of Shaft: Adjustable from 2½–4⅞ inches over bench.
Flexible Coupling: 5¾ inches long.
Provision for Coupling: Shaft diameters, ¼ and ⅜ inches; knobs and dials, 1 to 4 inches.

Limit Switch: One limit fixed, second limit adjustable within 9 turns.

Sweep Voltage: 2.5 volts peak to peak, ungrounded.

Blanking: Shorting contact closed during clockwise rotation of driven shaft, ungrounded.

Input Power: 115 volts, 50–60 cycles, 60 watts.

Dimensions: 17½″ wide, 9″ high, 8¼″ deep.

Weight: 22½ pounds.

Type 1263-A Amplitude-Regulating Power Supply

General: For use with an oscillator whose output can be controlled by varying plate voltage applied. D-C connection to oscillator cathode must be available for applying modulation.

Plate Supply: 0-250 volts at 25 milliamperes with 105 to 125 line volts (or 210 to 250), as required to maintain preset output level. Up to 300 volts at 30 milliamperes is available above 115-volt line (or 230).

Heater Supply: 6 volts dc at 0.5 amperes at 115/230 volt line (5.4 volts at 0.7 ampere).

R-F Output Regulation: An output control permits the regulating level to be set from 0.2 to 2 volts. The output of an oscillator that is capable of delivering a minimum of 2 volts into 50 ohms within stated plate supply limitation will be regulated within ± 2 per cent of the preset level over its frequency range. Output change with rated line-voltage variation is less than 20 millivolts.

Response Time: Plate voltage is changed at a rate of 30 volts per millisecond.

Output Meter: An internal d-c vacuum-tube volt-meter is provided, which is calibrated in terms of the r-f voltage at the external output rectifier. An internal calibration means is provided for standardization of this meter with the rectifier.

Power Input: 55 watts maximum at 115/230 volts, 50–60 cycles.

Blanking: Phone-tip jacks are provided to which connection to a contactor in the Type 1750-A Sweep Drive can be made for cutting off the oscillator plate supply. This connection is useful for blanking the oscillator output, to eliminate the return sweep and to provide a reference base line on the CRO display.

Terminals: A Jones-type socket is provided for direct plug connection to General Radio Unit Oscillators. A detachable cable terminating in a phone plug is provided for connection to the modulation jack on a Unit Oscillator. Binding posts provide connection for external output rectifier and provide monitoring points for checking the dynamic regulation, in sweep applications, by means of a CRO.

Vacuum Tubes: The following tubes are supplied: 3 12AX7; 1 6V6-GT; 1 0A2; 1 6X4.

Accessories Supplied: Power cord, cable for connecting to modulation jack on unit oscillators, multipoint connector plug, spare fuses.

Other Accessories Required: Type 874-VR Voltmeter Rectifier, Type 274-NF Patch Cord and Type 874-Q6 Adaptor for connecting output rectifier.

Dimensions: Panel, (height) 13¼ x (width) 8¼ inches; depth behind panel, 7¼ inches.

Net Weight: 18½ pounds.

Type 874-VR Voltmeter Rectifier

Maximum Voltage: 2 volts.

Resonant Frequency: Approximately 3800 Mc.

By-Pass Capacitance: Approximately 300 $\mu\mu$f; shunt capacitance of crystal, approximately 1 $\mu\mu$f.

Dimensions: 3¾ x 2½ inches.

Net Weight: 5 ounces.

www.americanradiohistory.com

PRICES

SWEEP DRIVE SYSTEM

Type		*Code Word*	*Price*
1750-A	Sweep Drive *	STUDY	$400.00
1263-A	Amplitude-Regulating Power Supply	SALON	250.00
874-VR	Voltmeter Rectifier †	STANPARGAG	30.00
274--NF	Patch Cord	STANPARGAG	2.00
874-Q6	Adaptor †	COAXCLOSER	2.25

* Patent Applied for.
† U. S. Patents 2,125,816 and 2,548,457

UNIT OSCILLATORS

Type	*Frequency Range*	*Code Word*	*Price*
1211-A	0.5 to 5 Mc	ATLAS	$295.00
1215-B	50 to 250 Mc	ADOPT	190.00
1209-B	250 to 920 Mc	AMISS	235.00
1218-A	900 to 2000 Mc	CARRY	465.00

U. S. Patents 2,125,816 and 2,548,457.

AUTOMATIC SWEEP DRIVE FOR THE SLOTTED LINE

An important branch of high-frequency measurements where automatic operation will be welcomed is in slotted-line measurements of standing-wave ratio and impedance. This method of measurement has the important advantage of accuracy, but a serious disadvantage is the time consumed in making the measurements by manual operation. The probe carriage must be moved to locate a voltage minimum, whose position and magnitude are then recorded. Next, the position and magnitude of the voltage maximum must be located and recorded. From these data, the impedance can be calculated. Even when only the magnitudes are wanted, as in the measurement of VSWR, a

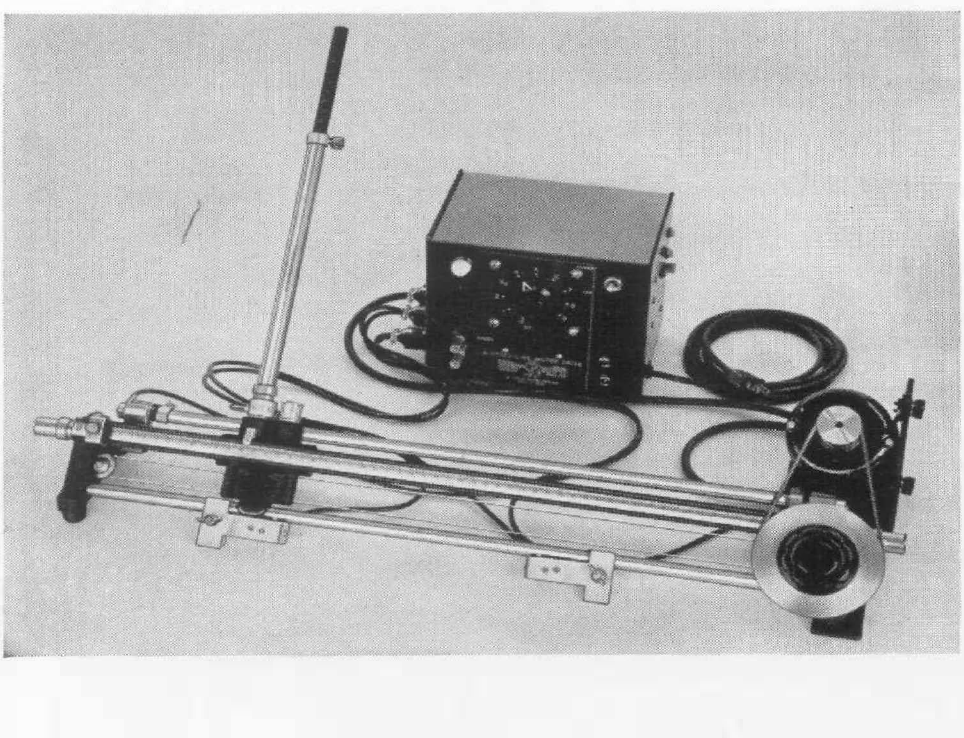


Figure 1. View of the Type 874-LBA Slotted Line with the Type 874-MD Slotted-Line Motor Drive installed. The circuits for motor control, relays, and sweep are housed in the cabinet. The microswitches for reversing the direction of travel can be seen attached to the front supporting rod.

www.americanradiohistory.com

new voltage maximum and a new minimum must be found for each measurement. In the adjustment of a matching transformer, for instance, this procedure must be followed for each change in setting of any element in the transformer.

The new General Radio Type 874-LBA Slotted Line[1] and the Type 874-MD Slotted-Line Motor Drive brings to these measurements the same speed and accuracy of automatic data presentation that is obtainable for amplitude-vs-frequency measurements with the equipment described in the previous article. The motor drive provides an automatic cyclic sweep of the probe carriage along the line, as well as a linear horizontal sweep voltage, so that the standing-wave pattern can be displayed on a cathode-ray oscilloscope.

This automatic display of the standing-wave pattern, greatly speeds up the process of measurement, because the VSWR and the position of the voltage minimum can both be read directly from the oscilloscope screen. Thus, the accuracy of the slotted-line method of measurement can be utilized in production-line tests and adjustments, where a number of similar units are to be adjusted for identical performance. The motor drive is equally useful in the laboratory, where the time required for measurements and adjustments on equipment under development can be shortened many-fold, because the effects of circuit changes and adjustments are shown immediately on the oscilloscope. Even when the problem is the adjustment of VSWR of an antenna or other network at a single frequency, substantial savings in time are realized.

[1] Soderman, R. A., "Improved Slotted Line", *General Radio Experimenter*, Vol. XXIX, No. 7, December, 1954.

The motor-drive attachment consists of the following items:

1. A 1/50th hp. d-c motor, which is mounted on a bracket at the right-hand end of the slotted line.
2. A Variac® Speed Control.
3. A pulley that mounts on the drive shaft of the slotted line.
4. A V-belt for coupling the motor to the drive shaft.
5. Two microswitches, mounted on movable brackets, which clamp on one of the supporting rods of the slotted line. These determine the travel of the carriage.
6. A linear potentiometer, wound on a rod with a sliding contact element that attaches to the carriage. This potentiometer attaches to the rear supporting rod of the slotted line and provides the horizontal-sweep voltage for the oscilloscope.

The motor-control circuits, the relay and relay rectifiers, and the sweep circuits are all housed in the motor-control unit shown in Figure 1. The motor, microswitches, and sweep potentiometer are connected to the control unit by means of cables, which terminate in multipoint connectors. The entire unit can be assembled and installed on any Type 874-LBA Slotted Line in less than 5 minutes.

Motor Drive Unit

The details of the drive can be seen in Figure 1. The motor is mounted on a bracket at the right-hand end of the line and drives the probe carriage through a V-belt and pulley. The pulley has two grooves; one of large diameter, as shown in Figure 1, for the high speeds used in oscilloscope presentation, and another, of small diameter, for the very slow sweeps that are needed when a meter-type standing-wave indicator is to be used. The pulley is equipped

www.americanradiohistory.com

with a knob, so that manual operation is also possible.

Speed Control

Power is supplied to the motor through a Variac Speed Control similar to the General Radio Type 1701-AK. Field voltage is fixed, while armature voltage is supplied from a Variac® and is controlled by a knob on the front panel. With the high-speed pulley, maximum speeds range from one sweep per second for the entire 47 centimeters of line to 5 sweeps per second for very short sweeps. On the low-speed pulley, one sweep in not less than 20 seconds for the whole line can be obtained.

Reversing Mechanism

The motor-drive unit is designed to cycle the probe carriage automatically between two positions on the line. The reversing mechanism is a latching relay whose coils are alternately energized by two microswitches, one for each end of the sweep range. These are mounted on moveable brackets, which clamp on one of the supporting rods of the slotted line. A foot on the base of the carriage casting strikes a roller on a spring, accuating the microswitch and reversing the polarity of the applied armature voltage. The motor reverses very rapidly, as shown by the oscilloscope picture of the speed characteristic of the carriage in Figure 2. The use of a latching relay rather than a single relay or a stepping relay prevents improper reversal caused by double action of a microswitch. The relays are operated on dc to avoid the malfunctioning that may occur at high speeds when ac is used.

The microswitch brackets can be unlocked by means of wing nuts and slid to any desired position on the line, and thus, by proper positioning of the brackets, any particular part of the standing-wave pattern can be swept over. These adjustments can be made while the carriage is in motion. The minimum carriage travel at low speeds, when the two microswitch brackets are as close as possible, is 1 cm, and the maximum travel at low speeds is 47 cm.

Horizontal Sweep Voltage Output

The horizontal deflection of the oscilloscope is proportional to the position of the carriage on the line. The voltage required to drive the horizontal deflection amplifiers is derived from a linear voltage divider wound on a rod and a sliding contact element mounted on the back of the carriage. The rod is mounted above the rear supporting rod of the slotted line by means of two clamps. The two ends of the potentiometer are connected to an ungrounded 7-volt d-c supply, which is housed in the motor-control cabinet. One end of the potentiometer is connected to the ungrounded sweep binding post, which is also located on the control unit. The palladium contact element on the carriage is grounded to eliminate the necessity for an additional connection to the moving carriage. The sweep voltage appearing between the sweep terminal

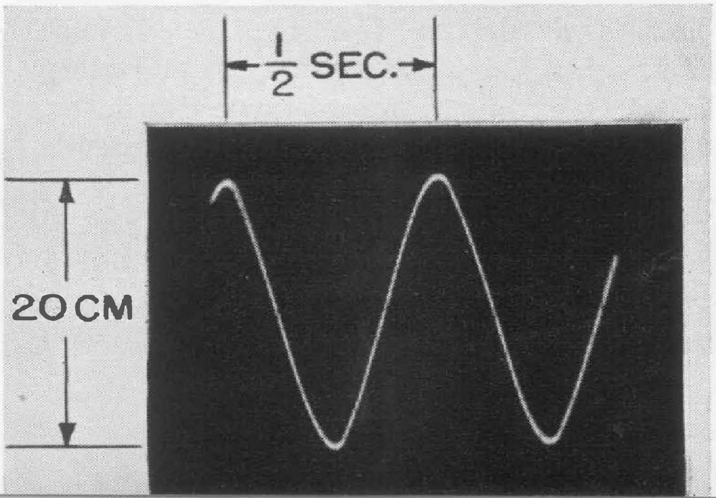


Figure 2. Displacement- vs.-time characteristic of the carriage.

www.americanradiohistory.com

and ground varies from zero to about 7 volts for a full traverse of the line.

Since the controlling element is attached directly to the carriage, the sweep voltage is closely proportional to the position of the carriage, independent of the speed or direction of sweep. All backlash in the driving mechanism is eliminated, and hence both forward and reverse traces can be utilized.

Presentation

The standing-wave pattern appearing on the oscilloscope depends on the type of modulation of the r-f source used and the type of amplifier in the oscilloscope. The preferred arrangement is 100% square-wave modulation and an oscilloscope with d-c amplification. The sensitivity of the oscilloscope amplifier should be at least 10 millivolts (rms) per inch. Two traces appear on the oscilloscope, one a baseline representing zero voltage on the line and the other representing the variation in voltage along the line. The actual voltage at any point in the line is a function of the distance between the two traces at that point. The VSWR can then be easily determined by measuring the amplitudes of the voltage minima and maxima. In this presentation the position of the baseline does not shift as the VSWR is changed, and hence the oscilloscope screen is easy to calibrate and read. Under good conditions a VSWR of 1.01 can be measured on the oscilloscope.

The position of a voltage minimum can be determined with reasonable accuracy on the oscilloscope if a grid-type overlay is used. If the impedance or the phase of the reflection coefficient at a certain point is desired, a short or open circuit can be placed at the point in question and the position of the voltage minimum on the oscilloscope noted. The horizontal gain and centering controls are then adjusted to make the distance between two adjacent minima some exact multiple of 5 on the grid with one minimum positioned exactly on a reference line. When the unknown is connected, the shift in position of the minimum in wavelengths, as well as the VSWR, can be determined on the oscilloscope. Thus, the magnitude and phase of the reflection coefficient at the load, as well as the impedance, can be obtained. Figure 3 shows a typical trace obtained on the oscilloscope when this method is used.

If desired, the vertical grid on the overlay can be calibrated to read VSWR directly when the vertical gain and centering are adjusted to set the baseline and voltage maximum at certain levels. The VSWR is then read directly off the grid at the voltage minimum.

In the frequency range between 900 and 2000 megacycles the TYPE 1218-A Unit Oscillator, with square-wave modulation, is recommended for use as the generator. With oscillators not designed for square-wave modulation, such as the TYPE 1209 and 1215 Unit Oscillators, either of two other methods will give completely satisfactory results.

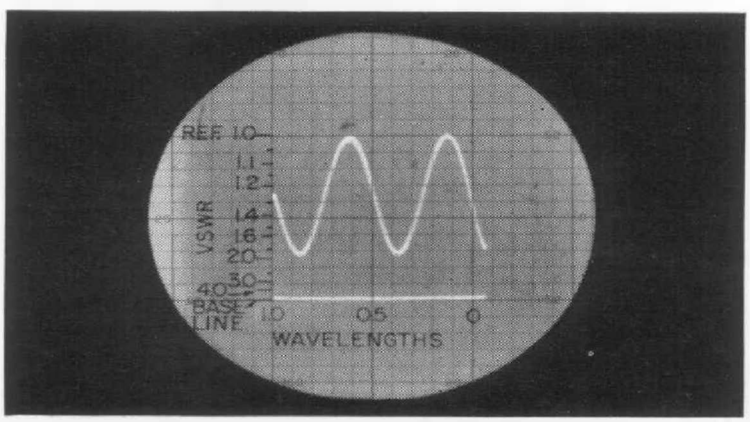


Figure 3. Typical standing-wave pattern obtained when generator is square-wave modulated. The direct-reading scales are on transparent overlays mounted on the face of the oscilloscope tube.

www.americanradiohistory.com

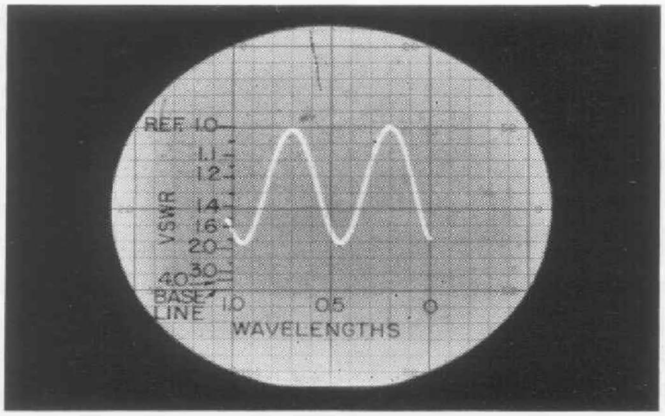


Figure 4. Standing-wave pattern obtained with generator unmodulated. Baseline is not shown.

The first method uses an unmodulated generator and an oscilloscope with d-c amplifier. The output of the probe crystal is applied directly to the oscilloscope vertical amplifier. The oscilloscope pattern is shown in Figure 4. The baseline, however, is not obtained simultaneously with the standing-wave pattern, but appears when the generator voltage is removed. This is only a minor inconvenience, however, because the baseline can be easily established for reference when needed. An important advantage of this method is that it requires a minimum of equipment.

The second method uses a sine-wave-modulated generator, in the circuit of Figure 5. The two crystal diodes in a clamping circuit suppress the lower-half of the typical sine-wave pattern and establish the baseline. The pattern obtained is shown in Figure 6.

Applications

The combination of the Type 874-MD Slotted-Line Sweep and Type 874-LBA Slotted Line make possible tremendous savings in time and convenience, whether measurements are to be made in the laboratory or on the production line. A high degree of measurement accuracy is obtainable with a minimum of effort.

One of the most valuable applications of the motor-driven line is for measurements of the VSWR and angle of the reflection coefficient of a number of similar units. For these measurements the unit under test can be plugged into the line and the VSWR and position of the minimum easily determined. In some cases limit lines can be drawn on the oscilloscope face. When the element under test has to be adjusted to a specific value, the method is even more advantageous.

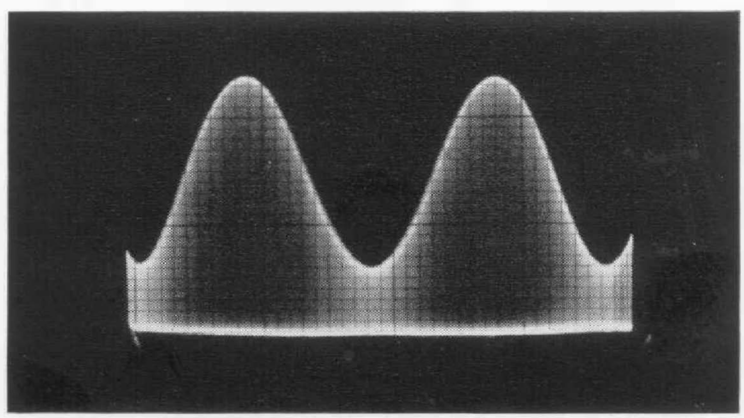
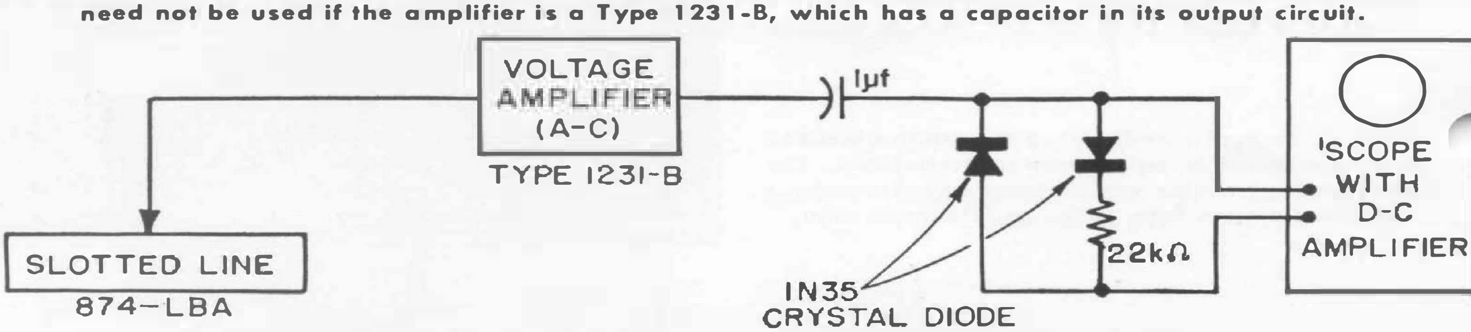


Figure 6. Standing-wave pattern obtained with sine-wave modulation and the circuit of Figure 5. The direct-reading scales shown in Figures 3 and 4 could be used equally well with this pattern.

Figure 5. Circuit for obtaining oscilloscope pattern when generator is sine-wave modulated. The amplifier is necessary to raise the voltage to the point where the diodes operate. The 1-microfarad capacitor need not be used if the amplifier is a Type 1231-B, which has a capacitor in its output circuit.



www.americanradiohistory.com

In adjustments of matching transformers for a particular VSWR or a VSWR as close to unity as possible, the motor-driven line has many advantages, one of which is that the standing-wave pattern can be seen continuously as adjustments are made.

Even for such single-frequency measments as the adjustment of the VSWR of an antenna, valuable time savings are possible through the use of the sweep drive.

— R. A. SODERMAN

SPECIFICATIONS

Length of Sweep: Adjustable, 1 cm to 47 cm.
Sweep Speed Range: For complete sweep (47 cm), from one sweep in 20 seconds to better than one per second; for shorter sweeps, up to 5 per second.
Maximum Sweep Output Voltage: 7 volts.
Power Supply: 115 volts, 50 to 60 cycles.
Net Weight: 16¾ pounds.

Type		*Code Word*	*Price*
874-MD	Slotted-Line Motor Drive	STORY	$220.00
874-LBA	Slotted Line	COAX RUNNER	220.00

U. S. Patents 2,125,816 and 2,548,457.

NEW MODELS OF UNIT OSCILLATORS

The v-h-f and u-h-f Unit Oscillators, TYPE 1215-B, 50 to 250 Mc, and 1209-B, 250 to 920 Mc, replace the older A-models of the corresponding type numbers. Changes and improvements in the new models have been made to make them more easily adaptable to sweep applications with the TYPE 1750-A Sweep Drive and the TYPE 1263-A Amplitude-Regulating Power Supply and with the TYPE 908-P1 and -P2 Synchronous Dial Drives.

External changes consist of:

1. Replacement of screw terminals for modulation by a telephone jack.

2. Addition of back-of-panel stops to the main dial, which operate even when the slow-motion drive is removed to permit mechanical coupling to the main shaft.

3. Modification of the slow-motion drive to permit gear disengagement when the Synchronous Dial Drive is used.

4. Replacement of the edge-riding indicator by a transparent plastic type to reduce acoustic noise when the shaft is motor driven.

5. Rotor has been firmly keyed to shaft in order to eliminate possible slippage when the shaft is motor driven.

The new TYPE 1208-B Unit Oscillator also incorporates all these changes except the ball bearings, which cannot conveniently be installed in this instrument. Since the tuned circuit employs sliding contacts, these, rather than bearings, will be the limiting factor in mechanical life for sweep applications. Although, for convenience, the jack for introducing a modulation voltage has been installed, the oscillator cannot be used with the TYPE 1263-A Amplitude-Regulating Power Supply, because

www.americanradiohistory.com

the polarity of the modulating voltage required is reversed from that used in the other two oscillators.

Prices and other specifications are unchanged from those of previous models.

Type		Code Word	Price
1215-B	Unit Oscillator, 50-250 Mc	ADOPT	$190.00
1209-B	Unit Oscillator, 250-920 Mc	AMISS	235.00
1208-B	Unit Oscillator, 65-500 Mc	AMEND	190.00

U. S. Patents 2,125,816 and 2,548,457.

HOLLAND-BELGIUM REPRESENTATION

It is with great regret that we announce the retirement of Mr. A. A. Posthumus, Baarn, Holland, as our exclusive representative for Holland, Belgium and their colonies, after an association of more than thirty years.

The efficient, business-like and meticulous services always rendered our valued clients by Mr. A. A. Posthumus will be continued by our new representatives, the able and well-known firm of Groeneveld, van der Poll & Co's, De Ruyterkade 41–43, Amsterdam, Holland, whose experience in the importation of technical electrical equipment extends back to 1887.

EGYPTIAN REPRESENTATION

We take pleasure in announcing the appointment of Moustapha Ezzat Abdel Wahab & Company, 106, Mohamed Bey Farid Street, P.O. Box 1537, Cairo, as our exclusive representatives for Egypt.

Dr. M. A. El-Said, one of Egypt's foremost electronics authorities, will act as technical consultant to the firm in connection with the application and sale of all General Radio products. Dr. El-Said has a long background of experience in this field and has spent much time in our main engineering laboratories in Cambridge, Mass., U. S. A.

This appointment was effective on January 24, 1955 upon the resignation of Messrs. Casdagli & Company.

PHOENIX—BOSTON—BETHESDA—DAYTON

In April and May, General Radio products are on display in the Southwest, in the Midwest, and on the Eastern Seaboard. If you are attending any of the following meetings, General Radio engineers extend to you a cordial invitation to visit the GR booth and to talk over your measurement problems.

Seventh Region IRE Conference
Hotel Westward Ho, Phoenix, Arizona
April 28 and 29

New England Radio-Electronics Meeting
Sheraton Plaza, Boston, Mass.
April 29 and 30

Fifth Annual Research Equipment Exhibit and Instrument Symposium
National Institutes of Health, Bethesda, Maryland
May 2 to 5

National Conference on Airborne Electronics
Dayton Biltmore Hotel, Dayton, Ohio
May 9 to 11

GENERAL RADIO COMPANY

275 MASSACHUSETTS AVENUE

CAMBRIDGE 39 MASSACHUSETTS

TELEPHONE: TRowbridge 6-4400

PRINTED IN U.S.A.

www.americanradiohistory.com