OPERATING INSTRUCTIONS
FOR
TYPE 604-B
TEST-SIGNAL
GENERATOR

FORM 311-C

GENERAL RADIO COMPANY
CAMBRIDGE A, MASSACHUSETTS

PATENT NOTICE

The Type 604-B Test-Signal Generator is manufactured and sold under United States Patent No. 1,542,995.

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PART 1
DESCRIPTION

USES The Type 604-B Test-Signal Generator is a general purpose instrument designed for use at high frequencies. By means of easily accessible plug-in coils, it covers a frequency range of from 3 to 100 megacycles (100 to 3 meters). It is designed to have the widest possible application in the measurement of receiver characteristics and transmitter field strength. Additional coils can be furnished to extend the range downward to 300 kc. Eight additional coils are necessary to cover this range.

The test-signal generator is suitable for determining the sensitivity of high-frequency radio receivers and, when modulated by an external oscillator, it may be used in measuring over-all fidelity characteristics. When used in connection with a radio receiver, an output meter, and an antenna of known characteristics, it can be used in the measurement of field intensity.

PRINCIPLE OF OPERATION The Type 604-B Test-Signal Generator consists, essentially, of a shielded radio-frequency oscillator designed specifically to have good stability and modulation characteristics at high frequencies. A 400-cycle oscillator is included to modulate the output of the radio-frequency oscillator. Provision is made for determining the percentage modulation and for adjusting accurately the radio-frequency output voltage. An output jack and a shielded cable are provided for connecting the generator to a receiver, and a three-section rod-type antenna which plugs into the tube of the instrument is also furnished.

Figure 2 is a complete wiring diagram.

FIGURE 1. Type 604-B Test-Signal Generator showing the smallest of the three rod-type antennas in place

ADVANTAGES In spite of the fact that this instrument operates at very high radio frequencies, easily accessible plug-in coils are used. The calibration curves of the individual coils are nearly linear since only a small range is covered by each coil. This makes it possible to set the oscillator accurately to any desired frequency.

The instrument is completely shielded so that no appreciable external field exists outside the cabinet. This shielding is so arranged that coils can be changed conveniently and rapidly.

The carrier frequency can be modulated at 30% at modulating frequencies as high as 200 kilocycles, provided the modulating frequency does not exceed 1% of the carrier frequency. An internal source of modulation at 400 cycles is provided. For modulation at other frequencies an external oscillator should be used. Fixed frequency modulating circuits at any other frequency in the audio range can be supplied. These units are of the plug-in type and are easily changed.

All batteries can be mounted within the cabinet, making the test-signal generator easily portable.

The use of the antenna output system will be found extremely useful for receiver testing at higher frequencies. This permits testing any receiver with its own antenna and selection of the antenna best suited for any particular receiver.

PART 2
INSTALLATION

TUBES AND BATTERIES The Type 604-B Test-Signal Generator requires the following vacuum tubes and batteries. Tubes are furnished; batteries are not.

2 31-type vacuum tubes
2 1.5-volt dry cells (Burgess #6 or Eveready #7111)
4 45-volt block batteries (Burgess #5308 or Eveready #762)

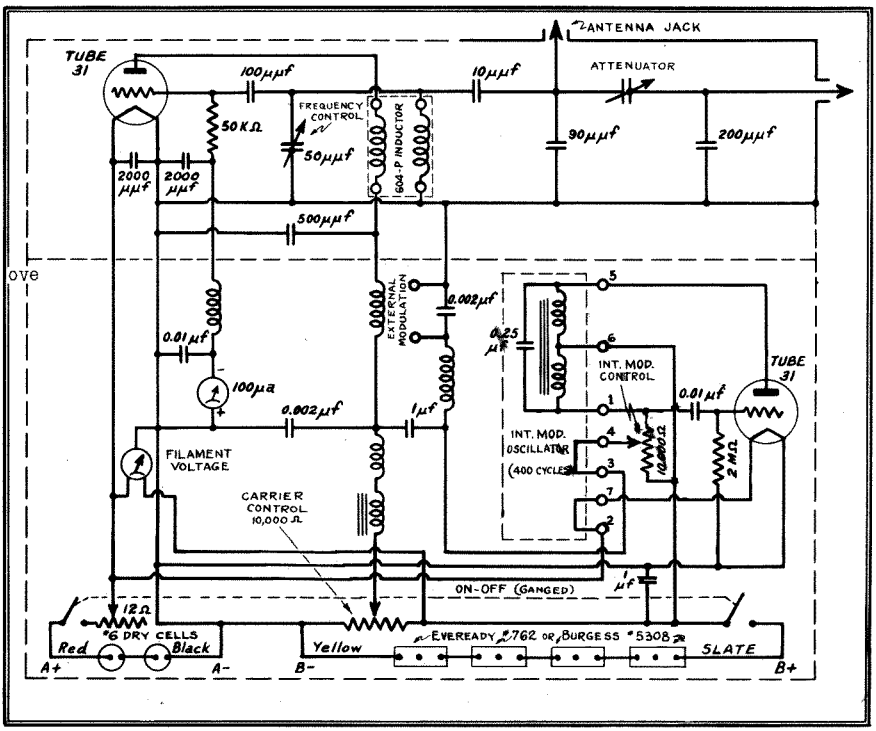

FIGURE 2. Wiring Diagram for Type 604-B Test-Signal Generator

INSTALLATION OF BATTERIES The four block batteries are placed at the left-hand side of the battery compartment and the two dry cells at the right-hand side. Connections are to be made as indicated in the wiring diagram of Figure 2. Before making connections to the B+ terminal (the slate lead) see instructions on page 4.

CAUTION: Before installing batteries and tubes, make sure that the ON-OFF switch is in the OFF position and that the FILAMENT CONTROL, CARRIER CONTROL, and MODULATION CONTROL knobs are turned as far in a counterclockwise direction as possible.

INSTALLATION OF TUBES The oscillator tube is soldered permanently in the oscillator tube socket at the left-hand side of the cabinet, since it is not possible to insure good contact at the high frequencies with the usual plug-in type of mounting. Install the modulator tube in the socket provided in the right-hand section of the cabinet.

PART 3
OPERATION

RADIO-FREQUENCY OUTPUT Two types of output systems are provided in the Type 604-B Test-Signal Generator. The voltage available at the antenna terminal at the tube of the instrument is 1 volt. A second voltage, adjustable between 5 microvolts and 10,000 microvolts, depending upon the attenuator setting, is provided at the output jack on the panel.

CONNECTION OF ANTENNA The antenna can be inserted in the plug mounting at the top of the instrument by pushing aside a small disc which covers the hole in the top of the cabinet. The antenna consists of three parts threaded in order that different lengths can be used. The antenna is stored on clips in the partition that separates the instrument from its batteries. Three antenna lengths are obtained by (1) using the plug-in part alone, (2) by attaching the small extension, and (3) by joining all three pieces for use as a single antenna. The lengths are so proportioned that the radiated field is increased by a factor of approximately 10 each time the length is increased.

USE OF SHIELDED OUTPUT CABLE A concentric shielded cable for connecting the output of the attenuator to a receiver under test is provided. When using this connection, the ground side of the cable must be connected directly to the receiver ground with the shortest possible lead.

OPERATION UNMODULATED To operate the test-signal generator without modulation proceed as follows:

(1) Plug a radio-frequency oscillator coil of the desired frequency into the jacks at the left-hand side of the cabinet. Replace the coil shield.

(2) Remove the modulating unit in the black case at the right-hand side of the cabinet. This automatically opens the filament circuit of the modulator.

(3) Set the FILAMENT RHEOSTAT and CARRIER control as far counterclockwise as possible. Throw the ON-OFF switch to the ON position. Set the filament voltage to 2 volts.

(4) Adjust the plate battery voltage to the value indicated in Table I. This can be measured by depressing the button on the voltmeter. Since the anode voltage of the oscillator tube is supplied through a potentiometer, it is advisable not to use more plate battery than necessary.

(5) Close the cover of the instrument and turn the CARRIER control in a clockwise direction until the grid-current meter in the center of the front panel reads 90 micro-amperes (second red mark). The zero adjustment of this meter has been set and sealed to give accurate output when set to the red marks.

(6) The frequency of the oscillator is varied by means of the FREQUENCY CONTROL dial. The frequency is increased by increasing the dial setting. The two frequencies engraved on the oscillator coils will usually be found near 40 divisions and 180 divisions, respectively, which allows adequate overlaps between coils. Usually, after changing the frequency, a slight readjustment of the CARRIER CONTROL knob will be necessary.

OPERATION WITH 30% INTERNAL MODULATION The operating procedure when using 30% internal modulation is as follows:

(1) Plug the modulating unit into the jacks provided at the right-hand side of the cabinet.

(2) Set the FILAMENT VOLTAGE to 2 volts and turn the INTERNAL MODULATION control as far counterclockwise as possible.

(3) Adjust the plate voltage and set the grid current amplitude to the second red mark, as previously described. This is necessary in order to be sure that the required amplitude of oscillation can be obtained with the plate voltage used.

(4) Turn the CARRIER control counterclockwise to the point where oscillation ceases. This point is easily determined by means of the grid-current meter. When oscillation ceases, the grid-current meter will read approximately 5 micro-amperes.

(5) With no change in the setting of the CARRIER CONTROL knob, turn the INTERNAL MODULATION CONTROL knob clockwise to the point where the grid-current meter reads approximately 10 micro-amperes (first red mark).

(6) Without changing the INTERNAL MODULATION control, turn the CARRIER CONTROL knob clockwise until the grid-current meter reads 90 micro-amperes (second red mark).

OPERATION WITH 30% EXTERNAL MODULATION The operating procedure when using 30% external modulation is as follows:

(1) Remove the modulator unit.

(2) Set the FILAMENT VOLTAGE to 2 volts.

(3) Connect the external modulating oscillator to the terminals in the upper right-hand corner of the front panel. The lower terminal is the ground terminal.

(4) For modulation at audio frequencies the procedure is identical with that described above for internal modulation. The voltage required for 30% modulation is approximately 6 volts. The internal impedance at the EXTERNAL MODULATION terminals in the audio-frequency range is approximately 5000 ohms, but is considerably lower at higher frequencies since a 0.002-μf condenser is connected across these terminals. External volume control must be used for the modulating voltage since none is provided within the instrument.

When the modulating frequency is above the audio-frequency range, proceed as outlined in OPERATION UNMODULATED above. When the grid-current meter reads 90 micro-

TABLE I

Values of Plate Battery to Use with Different Type 604-P Coils

Coil	Frequency Range	Plate-Battery Voltage
604-15	3 to 4 megacycles	45 volts
604-14	4 to 5.5 "	45 "
604-13	5.5 to 7.5 "	45 "
604-12	7.5 to 10 "	45 "
604-11	10 to 13.5 "	45 "
604-10	13.5 to 18 "	45 "
604-9	18 to 24 "	67 "
604-8	24 to 32 "	90 "
604-7	32 to 43 "	67 "
604-6	43 to 56 "	67 "
604-5	56 to 68 "	90 "
604-4	68 to 83 "	135 "
604-3	83 to 100 "	150 "
604-23	300 to 400 kilocycles	45 volts
604-22	400 to 550 "	45 "
604-21	550 to 750 "	45 "
604-20	750 to 1000 "	45 "
604-19	1000 to 1350 "	45 "
604-18	1350 to 1800 "	45 "
604-17	1800 to 2400 "	45 "
604-16	2400 to 3000 "	45 "

amperes, apply the modulating voltage to the EXTERNAL MODULATION terminals. To obtain 30% modulation, measure the voltage at these terminals and adjust it to the value indicated in Figure 3 on page 7.

Applying the modulating voltage should not change appreciably the reading of the grid-current meter. Small changes can be corrected by resetting the CARRIER control.

It is important that the modulating frequency be no greater than 1% of the carrier frequency.

PART 4
OPERATING CHARACTERISTICS

RADIO-FREQUENCY RANGE The Type 604-B Test-Signal Generator is supplied with 13 plug-in coils covering a frequency range of from 3 to 100 megacycles. Special coils can be supplied for frequencies as low as 300 kilocycles. Frequency ranges and type numbers for both standard and special coils are listed in Table I on page 4.

FREQUENCY CALIBRATION Coils are normally supplied uncalibrated, but on request calibration charts, accurate to 1%, can be provided for a charge of $3.00 each. Calibrations should, of course, be ordered with the instrument.

RANGE OF OUTPUT VOLTAGE The output voltage at the antenna terminals is 1 volt. The voltage at the OUTPUT terminal is continuously variable from 5 to 10,000 microvolts.

ACCURACY OF OUTPUT VOLTAGE The accuracy of voltage at the antenna terminals is ±5% at frequencies below 10 megacycles and ±20% at frequencies below 30 megacycles. At the OUTPUT terminal the accuracy is ±10% at frequencies below 10 megacycles. At frequencies below 30 megacycles the accuracy is ±30%.

OUTPUT IMPEDANCE The output impedances are both capacitive. The capacitance at the antenna terminals is 90 μμf. The capacitance at the output jack is 200 μμf and is independent of the attenuator setting.

INTERNAL MODULATING FREQUENCY The frequency of the internal modulating oscillator is adjusted to 400 cycles ±5%.

ACCURACY OF PERCENTAGE MODULATION When the modulation is set according to instructions given in Part 3, the actual percentage modulation will be between 20% and 40%.

The method used to determine percentage modulation at audio frequencies is based on the fact that the dynamic characteristic of the oscillator is made to be the same over the whole frequency range of the instrument. This has been possible in spite of widely differing coil losses, particularly at the higher frequencies. The increase in coil losses can be seen in Table I on page 4 which shows the plate voltage necessary for different coils.

The method used to determine percentage modulation at higher modulating frequencies is based on data found experimentally at various carrier and modulating frequencies. The percentage modulation in these tests was measured with a high-vacuum cathode-ray oscillograph. The chart on page 7 shows the average curve of all measurements made.

FREQUENCY MODULATION By proper design of coils and oscillating circuit the frequency modulation has been reduced to a minimum. It should be kept in mind that at high carrier frequencies, the actual frequency modulation is difficult to determine. When plate voltage is changed to adjust the amplitude, the carrier frequency will shift instantaneously to a different value, but from that point on the shift will continue as a result of the different temperature assumed by the tube. At high carrier frequencies the second shift in frequency, resulting from changes in tube temperature, can be many times larger than the first shift which alone is the actual frequency modulation.

PART 5
RECEIVER TESTING

TESTING OF LOW-FREQUENCY RECEIVERS

For detailed information on test methods for low-frequency receivers the user is referred to the standardization reports of the Institute of Radio Engineers and to the current technical literature.

Since the internal output impedance at the output jack of the Type 604-B Test-Signal Generator is capacitive and equivalent to 200 μμf, the 200-μμf capacitance may be omitted from the standard low-frequency dummy antenna recommended by the Institute of Radio Engineers. For receiver measurements with this dummy antenna it is necessary only to use a series resistance of 25 ohms and a series inductance of 20 microhenrys in series with the high output terminal.

DIFFICULTIES AT HIGHER FREQUENCIES

Unfortunately, the standard dummy antenna mentioned is not suitable for use at higher frequencies, but no other standard type has as yet been agreed upon. In many cases a non-inductive resistance will be found satisfactory and for this purpose the General Radio Type 418-C Dummy Antenna is recommended. At 30 megacycles and above, however, it is almost impossible to replace an actual antenna with a dummy.

Another difficulty occurs at high frequencies. There is no simple means of connecting the test-signal generator to the receiver and making sure at the same time that the voltage at the output terminals of the signal generator is the same as the voltage obtained at the input terminals of the receiver. The leads used in connecting the two instruments have considerable impedance and act as a transmission line. The voltage obtained at the output terminals of the receiver is determined not only by the voltage setting at the OUTPUT terminals of the signal generator but by the characteristic of the transmission line and by the impedance of the receiver, which is not constant.

USE OF ATTENUATOR AND CONNECTING CABLE

When using the Type 604-B Test-Signal Generator in conjunction with the conventional type of radio receiver at medium high frequencies, the attenuator and connecting cable may be used exactly as is done at lower frequencies. It must be kept in mind, however, that, due to the transmission characteristic of the cable, the input voltage of the receiver may differ widely from the output voltage of the signal generator, but as long as the input circuit of the receiver remains unchanged and the same frequency is used, settings can be repeated accurately and comparisons can be made by means of the attenuator.

USE OF THE ANTENNA

To select the antenna best suited for a high-frequency receiver, to measure a receiver that has a regenerative antenna circuit, or to measure a super-regenerative receiver, the antenna output system of the Type 604-B Test-Signal Generator should be used. Antennas of three different lengths are provided, giving a ratio of field strengths of 1 to 10 to 100. It is not advisable to use antennas of more than 15 inches in length since the internal output impedance of the antenna terminal is only that equivalent to 90 μμf. Obviously, all the difficulties previously enumerated in testing high-frequency receivers are eliminated when the antenna is used.

By using the antenna output system of the Type 604-B Test-Signal Generator, it is possible to test any receiver in connection with any kind of antenna and it is possible to compare the efficiency of different antennas when used with the same receiver.

A considerable range of field strength can be obtained by changing the distance between the receiver and the standard-signal generator. To obtain a field-strength range, for instance, of 1 to 10,000, it is necessary only to determine by a single experiment the distance at which the long antenna will give the same field strength that was previously obtained with the short antenna.

It should be remembered that at the high frequencies covered by this instrument, reflection effects may occur. This means that when the antenna is used inside a laboratory, the field will not necessarily be uniform.

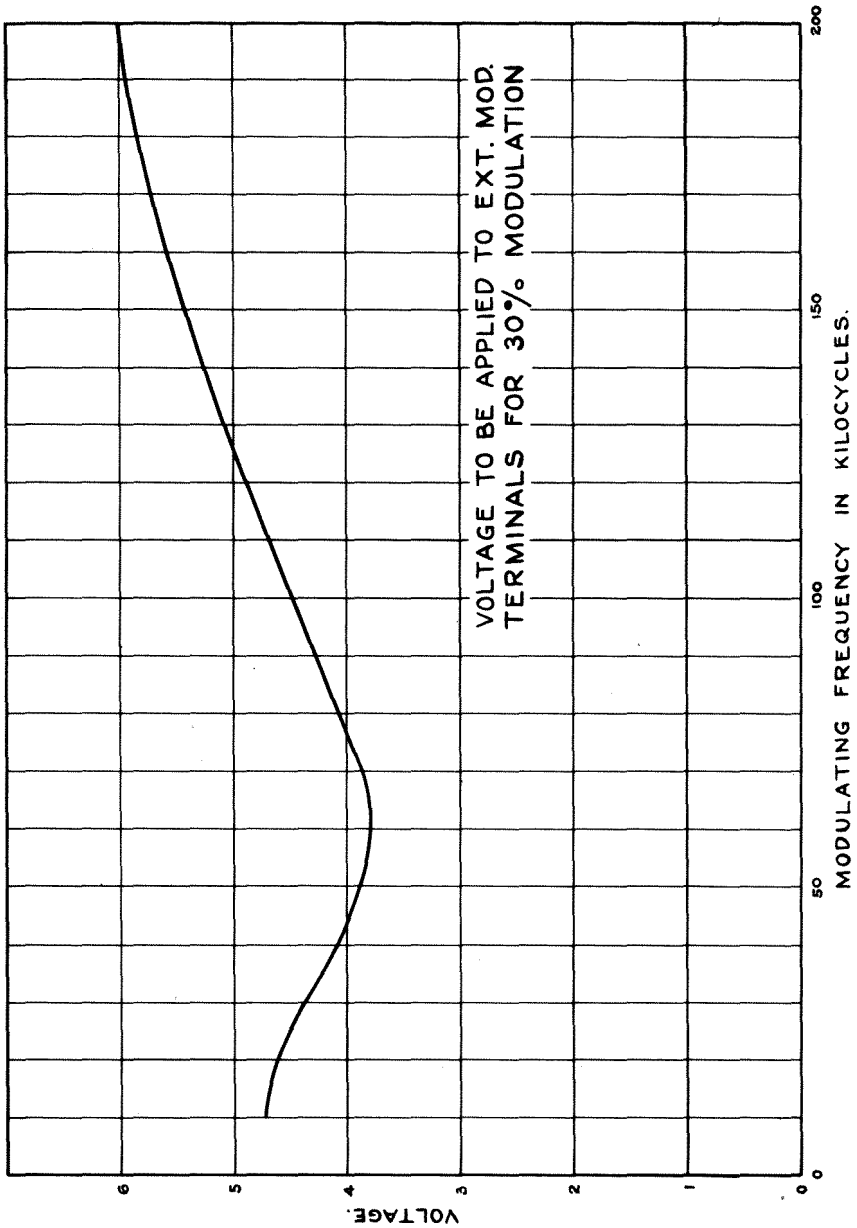

FIGURE 3. Voltage necessary for 30% modulation shown as a function of frequency

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