Only change made was dwg. for figure 1.

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# OPERATING INSTRUCTIONS
FOR
# TYPE 731-B
# MODULATION MONITOR

FORM 495-A

GENERAL RADIO COMPANY
CAMBRIDGE A, MASSACHUSETTS

## PATENT NOTICE

The Type 731-B Modulation Monitor is manufactured and sold under the following United States Patents and license agreements:

1,999,869
2,012,291
2,069,934

# OPERATING INSTRUCTIONS
# FOR
# TYPE 731-B
# MODULATION MONITOR

## 1.0 DESCRIPTION

### 1.1 Function

The Type 731-B Modulation Monitor performs two functions: it gives a continuous indication of percentage modulation on either positive or negative peaks and an indication of over-modulation peaks in excess of any predetermined modulation level.

### 1.2 Indicators

Percentage modulation is indicated on a high-speed meter whose scale is calibrated from 0 to 110%. Positive or negative peaks, as desired, are selected by means of a switch.

An additional decibel scale is provided to facilitate adjusting the transmitter input. This scale can be used for measurements of the over-all frequency characteristic of the transmitter if a beat-frequency oscillator is available.

The over-modulation indicator is a lamp which flashes whenever the percentage modulation exceeds the value at which the NOMINAL MODULATION PEAKS dial is set.

### 1.3 Audio-Frequency Response

The frequency response of the meter indication is constant within less than 0.5 db between 40 cycles and 15,000 cycles.

### 1.4 Accuracy

The over-all accuracy of measurement at 400 cycles is within 2% at modulation percentages of 0% and 100%. The possible error rises to a maximum of 4% at 50% modulation.

### 1.5 Carrier Frequency Range

The carrier frequency range of the Type 731-B Modulation Monitor can be either 0.5 Mc to 8 Mc or 3 Mc to 60 Mc, depending on which set of input coupling coils is being used with the instrument.

### 1.6 Principle of Operation

#### 1.61 Schematic Circuit Diagram

The operation of the Type 731-B Modulation Monitor is shown by Figure 1.

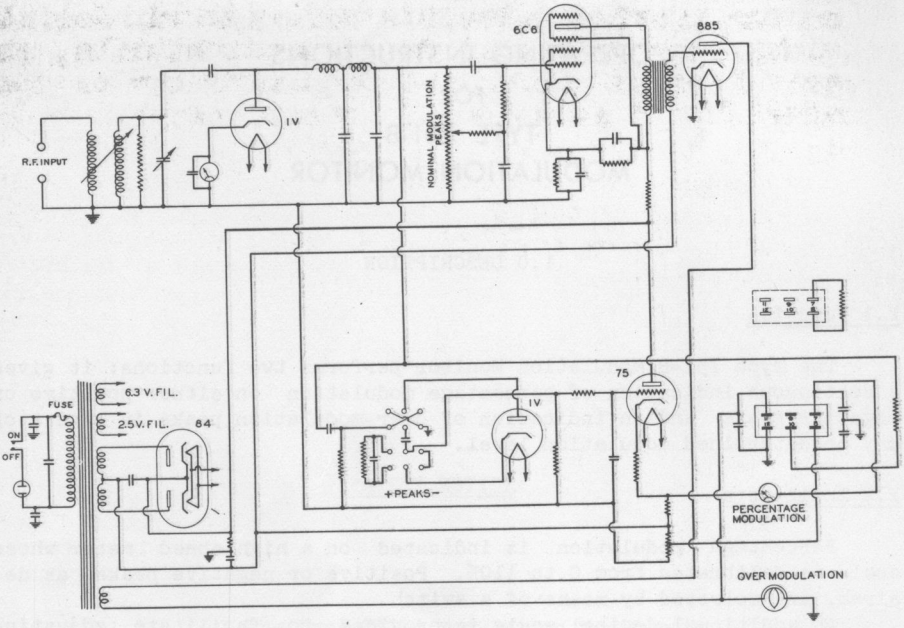


FIGURE 1. Schematic Wiring Diagram of Type 731-B Modulation Monitor

1.62 Radio-Frequency Circuit

A modulated radio-frequency voltage, applied to the input terminals, is coupled to a tuned circuit and to a diode rectifier. The carrier level is indicated on a d-c meter in series with the diode rectifier and is adjusted by varying the coupling to the tuned circuit. The positive half of the modulated radio-frequency wave is demodulated by the diode and passed through a filter which removes the radio-frequency components.

1.63 Audio-Frequency Circuit

The filter output voltage consists of an a-c component (corresponding to the varying envelope of the original modulated signal) superposed on a d-c component produced by rectification of the carrier. The ratio of amplitudes of the a-c and d-c components is identical with the ratio of the amplitudes of the a-c component of the envelope and average carrier in the original signal.

1.64 D-C Circuit

The d-c component, $E_o$, is used to supply a negative grid bias for the amplifier tube, 6C6. The a-c component is applied directly to the amplifier grid. The grid bias is variable between zero and the full value of $E_o$ and is controlled by the NOMINAL MODULATION PEAKS dial, given fractions of $E_o$ corresponding to the same values of fractional modulation, that is, half scale corresponds to 50% modulation.

1.65 Lamp Operation

Whenever the peak value of the a-c component exceeds the grid bias, the grid becomes positive, and plate current flows, tripping the Type 885 gas-filled triode and flashing the over-modulation lamp.

1.66 Meter Operation

The percentage modulation indicator is fed from the output of the radio-frequency filter. The a-c voltage is rectified by means of a diode and its amplitude indicated by a vacuum-tube voltmeter device. A phase reversing switch for selecting either positive or negative a-f peaks is provided.

## 2.0 INSTALLATION

2.1 Vacuum Tubes

All tubes are supplied with the instrument. Markers on the sockets indicate tube locations. All tubes become accessible from the rear of the instrument by removing the small shield which is held in position inside the instrument by means of four screws.

2.2 Input Coupling Coils

2.21 Two sets of coils are available to cover the carrier frequency range. One set, consisting of the Type 731-P5-1 Tuning Coil and the Type 731-P5-2 Coupling Coil, covers the 0.5 to 8 Mc portion of the range. The other set, consisting of the Type 731-P6-1 Tuning Coil and the Type 731-P6-2 Coupling Coil covers the 3 to 60 Mc portion of the range.

The tuning coil of each set covers its portion of the range in four steps as selected by the setting of a connecting strap on the coil.

2.22 The set of coils provided with the MONITOR can easily be removed and replaced with the set for the other frequency range.

The coupling coil of a set is mounted with two screws on the mounting block of the carrier control shaft.

The tuning coil is mounted with two thumb nuts on the brackets either side of the shaft. A plug on the tuning coil must be inserted in a corresponding jack on the instrument.

2.23 Side-band clipping varies directly with tuning capacitance. While side-band clipping will in any event be less than 0.5 db for modulating frequencies below 15 kilocycles, it is advantageous to use the lower tuning capacitance when there is a choice because of overlap in coil ranges.

2.3 Mounting

When used with the other instruments in a Class 730 Transmission Monitoring Assembly, install panels in the following order: Type 733 at the top, Type 731-B in the middle, and Type 732-B at the bottom.

2.4 Caution

It is important that no appreciable a-c hum from the assembly be picked up by the speech input equipment. This can be determined by listening to the output of the speech amplifier with phones and turning on and off the a-c supply to the transmission monitoring assembly. If the difference in level is large, the location of the assembly, or its orientation with respect to the speech input equipment, should be changed.

2.5 Caution

Connector furnished with the instrument must be inserted at rear of Type 731-B Modulation Monitor. This connector contains a dummy 500-ohm resistor which can be replaced by an external indicator. See Section 4.2.

2.6 Power Supply

Connect panel to 115-volt, 40-60 cycle line by means of cord-and-plug combination supplied. If any difficulty with a-c hum is encountered, reverse the line plug.

2.7 Ground

Be sure to ground the low side (G terminal) of the carrier input. This grounds panel and frame as well.

2.8 Coupling to Transmitter

2.81 The most convenient way to couple the Type 731-B Modulation Monitor to the transmitter is to install a small coil of a very few turns close to the antenna lead or to the tank circuit. This coil is then connected to the monitor input terminals. An ordinary rubber-insulated single-conductor concentric cable of around 20 ohms impedance has been found convenient. This forms a low-impedance link circuit with the coil mounted in the instrument.

2.82 Sufficient coupling must be provided so that when the instrument is turned on, the CARRIER meter can be SET TO 100 after the signal has been tuned to resonance by means of the TUNE FOR MAXIMUM control. Some margin in the setting of the carrier SET TO 100 control knob must be allowed to care for changes in the transmitter output or in the coupling system. The TUNE FOR MAXIMUM control must be very carefully set to resonance to avoid side-band clipping.

The tuned circuit in the instrument is damped by two 10,000-ohm resistors in parallel. If one of the resistors is removed, somewhat less power will be required to operate the instrument but side-band clipping will be increased, although not to a serious extent unless more than half the available tuning capacitance is in circuit. See Section 2.23.

## 3.0 OPERATION

3.1 Turn on power switch.

3.2 With the power on and no carrier applied, the carrier meter should read zero. The mechanical adjustment should be used, if necessary.

3.3 With power on and no carrier applied the percentage modulation meter should read zero. The mechanical adjustment on the meter may be used to bring it to zero. This check can be made with the carrier input to the instrument, if the carrier is unmodulated. If this is done, be sure the modulation due to noise is not sufficient to deflect the meter. CAUTION: On some of the instruments a variable resistor has been included for factory adjustments. This must not be disturbed. It is not for zero adjustment.

3.4 With the carrier applied but with no modulation, TUNE FOR MAXIMUM reading of the CARRIER meter. For this adjustment, the SET TO 100 carrier control should be set back sufficiently so that the meter reading does not exceed 100. After the instrument has been tuned for resonance, the SET TO 100 control may be advanced to obtain a reading of 100 on the meter. Retune if necessary. With the circuit correctly tuned to resonance and with the meter reading 100, all direct-reading scales are standardized. When modulation is applied, any shift in carrier amplitude may be read directly in percent on the CARRIER meter.

3.5 If the transmitter is now modulated, the PERCENTAGE MODULATION meter will read the instantaneous percentage modulation, and readings for either positive or negative peaks can be obtained by means of the PEAKS switch.

3.6 The NOMINAL MODULATION PEAKS dial can be set at the maximum value of percentage modulation at which it is desired to operate, and the OVER MODULATION lamp will flash whenever this percentage is exceeded. The lamp operates on negative peaks.

## 4.0 SUGGESTIONS FOR USE

In addition to the instantaneous readings of modulation the following uses are valuable for periodic tests.

### 4.1 Fidelity Measurements

If a beat-frequency oscillator (such as General Radio Types 513, 613 or 713) is available, the over-all frequency characteristic of the transmitter can be taken on the Type 731-B Modulation Monitor. Modulate the transmitter at the desired level by means of the beat-frequency oscillator, holding the input level at a constant value with a volume indicator. The variation of transmitter output level with frequency is then read directly from the decibel scale on the percentage modulation meter. The measurement is accurate within $\pm$0.5 db over the range from 40 to 15,000 cycles.

### 4.2 External Indicators

Terminals 11 and 12 are provided on the 6-point plug-connector at the rear of the Type 731-B Modulation Monitor for connecting an additional flashing lamp. If it is desired to use an auxiliary meter, this should replace the 500-ohm dummy resistor connected between terminals 7 and 8 inside of the plug. Terminal 7 is positive, 8 negative. This meter should be set to zero mechanically in the same manner as the meter on the panel, as outlined in Section 1.32.

4.3 Recording

An audio-frequency voltage proportional to the percentage modulation is also available at the 6-point connector at the rear of the modulation monitor, which can be used to operate a continuous recorder, if desired. This voltage is obtained at terminals 10 and 12.

## 5.0 SERVICING

5.1 Tubes

The calibration of the Type 731-B Modulation Monitor is independent of the tubes used. The Type 885 gas-filled triode is, however, of much shorter life than high vacuum tubes and it will be found necessary to replace it occasionally.

5.2 Fuse

A fuse is required in the Type 731-B Modulation Monitor. . It is Bussman Manufacturing Company, Type 7AG, one ampere.

5.3 Auxiliary Plug

Should the Type 731-B Modulation Monitor cease to operate, make sure that the auxiliary plug is firmly in place. This plug contains a 500-ohm resistor which is in series with the meter. This is provided so that it may be replaced by a series meter for remote observation of the percentage modulation.

5.4 Flashing Lamp

Should the lamp in the Type 731-B Modulation Monitor cease to operate, the lamp itself may be burned out, in which case an ohmmeter measurement between terminals 11 and 12 of the plug receptacle, with the instrument turned off, will show open circuit.

5.5 Switch Contacts

If trouble occurs due to poor switch contacts, clean the contacts with crocus cloth and wipe with carbon tetrachloride, then apply a thin film of high quality vaseline.

5.6 Spare Parts

The following spare parts are shipped with the equipment:

2 - Pilot lamps, 6-volt, Mazda No. 40, G.R. No. 139-330.
2 - Lamps, 115-volt, 6-watt, Candelabra Base, S6 Mazda, G.R. No. 139-430.
1 - Box 5 fuses (Bussman Manufacturing Company), one ampere, Type 7AG.

## 6.0 VACUUM TUBE DATA

These data were measured in the Calibration Laboratory of the General Radio Company using a Model 772 Weston Analyzer for all d-c and a-c voltages and currents.

Since this analyzer has a 20,000-ohms-per-volt meter, the values in the table below are useful in servicing the instrument but do not in all cases indicate the true operating condition.

Values as given were obtained from a standard Type 731-B Modulation Monitor that was being calibrated for stock. Where voltages and currents are obviously not critical, variations of as much as 20% from these data should be expected.

Operating Conditions

No carrier input. Line voltage 115 volts, 60 cycles.

Voltages and Currents for Vacuum Tubes

| | Tube Type | Heater (ac) | Plate to Cathode | Screen to Cathode | Control Grid to Cathode | Plate Cur. | Screen Cur. | Remarks |
|---|---|---|---|---|---|---|---|---|
| T1 | 1V | 6.3 v | | | | | | |
| T2 | 6C6 | 6.3 v | 120 v dc | 120 v dc | 1.5 v dc | 82 mca | 16 mca | Suppressor connected to cathode. |
| T3 | 1V | 6.3 v | | | | | | |
| T4 | 84 | 6.3 v | 300 v ac<br>300 v ac | | | | | |
| T5 | 885 | 2.5 v | 167.0 v ac | | -55.0 v dc | | | |
| T6 | 75 | 6.3 v | Triode<br>305 v dc | | -1.7 v dc | 260 mca | | |

## PARTS LIST

### CONDENSERS

C-1 = 139-1207
C-2 = 0.001 μf
C-3 = 0.0002 μf
C-4 = 0.0001 μf
C-5 = 0.5 μf
C-6 = 1.0 μf
C-7 = 0.025 μf
C-8 = 0.003 μf
C-9 = 0.02 μf
C-10 = 0.02 μf
C-11 = 0.02 μf
C-12 = 0.02 μf
C-13 = 0.02 μf
C-14 = 0.02 μf
C-15 = 2.0 μf
C-16 = 2.0 μf
C-17 = 2.0 μf
C-18 = 2.0 μf
C-19 = 4.0 μf
C-20 = 0.250 μf
C-21 = 0.0003 μf

### TUBES

T1 = RCA 1V
T2 = RCA 6C6
T3 = RCA 1V
T4 = RCA 84
T5 = RCA 885
T6 = RCA 75

### RESISTORS

R-1 = 10. KΩ
R-2 = 4 Megohms
R-3 = 1 Megohm
R-4 = 200 KΩ ±5%
R-5 = 200 KΩ ±5%
R-6 = 12 Megohms
R-7 = 3 Megohms
R-8 = 100 KΩ
R-9 = 30 KΩ
R-10 = 500 KΩ
R-11 = 500 KΩ
R-12 = 5 KΩ
R-13 = 30 KΩ
R-14 = 2 KΩ
R-15 = 10 KΩ
R-16 = 250 KΩ
R-17 = 200 KΩ
R-18 = 134 KΩ
R-19 = 20 KΩ
R-20 = 500 Ω
R-21 = 10 KΩ
R-22 = 10 KΩ

### INDUCTORS

L1 = 0.025 h
L2 = 0.050 h
L3 = 731-P5-1 or 731-P6-1
L4 = 731-P5-2 or 731-P6-2

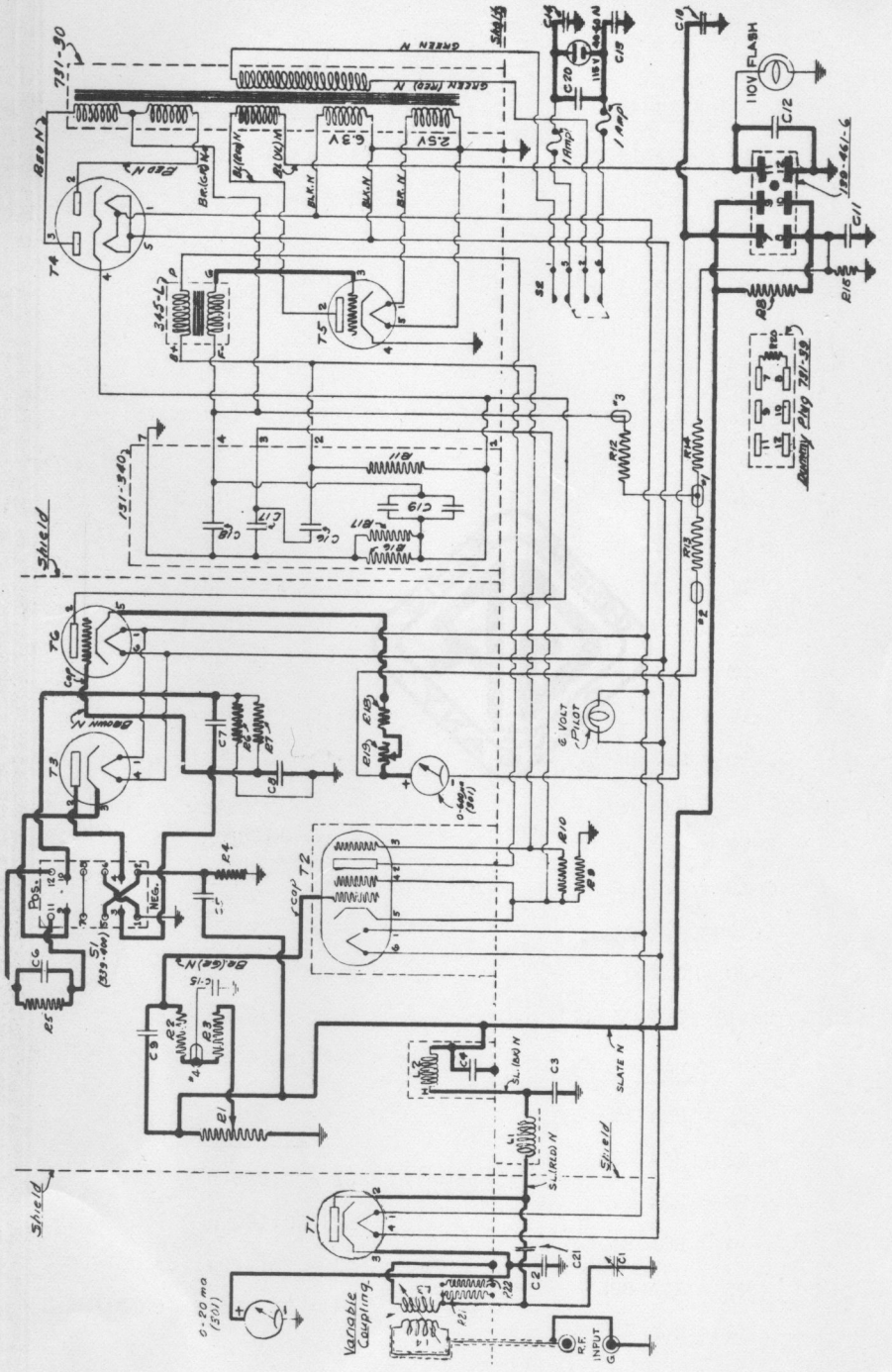


FIGURE 2. Wiring Diagram of Type 731-B Modulation Monitor

**GENERAL RADIO COMPANY INTEROFFICE MEMORANDUM**

| TO | FROM |
|---|---|
| C E W | A S B |

| DATE | Check if this memo. is to go in permanent files | | Check here if report is desired on action taken | |
|---|---|---|---|---|
| 7-13-39 | | | | |

| | | | |
|---|---|---|---|
| To Note. No Further Action Necessary | | Upon completion of indicated action handle attached papers as directed below | |
| See Me Regarding This Matter | | To General Files | |
| To Take Necessary Action | ✓ | Pass To | Changes for next Printing |
| To Take Action Indicated Below | | Return To Me | |
| Submit Proposed Action For Approval | | Destroy | |

— Page 3

Operating Instructions for 731-B.

When these instructions are reprinted, please include the following changes:

2.21 Two sets (alternate) of ..... a connecting strap on the coil. The frequency range for each of the four steps is indicated by engraved numerals adjacent to a terminal on the tuning coil.

When using the Type 731-P6-1 tuning coil, the connecting strap must connect the central terminal of the coil to the terminal for the desired frequency range.

When using the Type 732-P5-1 tuning coil, the triangular connector provided with the coil must connect the central terminal to either one or two of the other terminals, depending on its position and must be oriented so that the arrow on the connector points to the terminal for the desired frequency range.

DEC 4 1939

| Number of papers attached | |
|---|---|

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