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M-5693  
MODULATION MONITOR

M-5693 MODULATION MONITOR  
PATENT APPLIED FOR  
FCC APPROVAL NO. 3-109



**GATES RADIO COMPANY**  
*Subsidiary of Harris-InterType Corporation*  
**QUINCY, ILLINOIS**

INSTRUCTION BOOK  
M5693 MODULATION MONITOR  
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## INDEX

	Page
I. SPECIFICATIONS .....	1
II. INTRODUCTION .....	4
III. INSTALLATION.....	4
A. Rack Installation & Transmitter Connections .....	4
B. Monitor Amplifier Connection .....	5
C. External Meter Connections .....	5
1. Local Meter .....	5
2. Remote Meter .....	6
D. Overshoot Adjustment .....	6
IV. PRE-OPERATION .....	7
A. Preliminary Checks .....	7
B. Accessory Meter .....	7
V. DAILY OPERATION .....	8
A. Use of Operating Controls.....	8
B. Calibration Instructions .....	8
D. Interpretation of the Monitor's Indications.....	9
VI. THEORY OF OPERATION .....	11
A. Theory of Amplitude Modulation ....	11
B. Theory of M5693 Monitor .....	13
1. Input and Detector Circuits ...	13
2. Modulation Meter Circuits .....	14
3. Flasher Circuits .....	15
4. Power Supplies .....	15
VII. MAINTENANCE .....	16
A. Tubes .....	16
B. Diodes .....	16
C. Modulation Meter .....	16
D. Fidelity Measurements .....	16
VIII. TROUBLE SHOOTING .....	17
A. Conditions of Test .....	17
B. Malfunction and Remedies .....	17
IX. PARTS LIST .....	1 - 3
X. GUARANTEE .....	1 - 2
XI. PHOTOS	
XII. SCHEMATIC - D-22474	M5693 Modulation Monitor Patent Applied for

GATES RADIO COMPANY

I. SPECIFICATIONS FOR M5693 MODULATION MONITOR

Frequency Range 540 - 1600 KC

R.F. Input

Impedance Level Approximately 50 to 75 ohms.  
Approximately 10 volts.

Modulation Range

Meter 0% to 100% on negative peaks.  
0% to 110% on positive peaks.

Flasher 50% to 100% on negative peaks  
in steps of 5%.

Response

Meter -0.2 db @ 50 cps.  
0 db @ 1000 cps.  
-0.2 db @ 15,000 cps.

Flasher 0 db @ 20 cps.  
0 db @ 1000 cps.  
-0.3 db @ 5000 cps.  
-0.6 db @ 7500 cps.

Accuracy

Meter  $\pm 2\%$  of full scale at 1000 cps. for  
any percentage of modulation.

Flasher  $\pm 2\%$  of full scale dial calibration  
at 1000 cps.

Response Time

Meter Meter responds to 90% of correct reading  
with a 50 millisecond pulse of modulation.  
The meter overshoots 2 to 3% on a step  
function signal. Needle returns to 10%  
of reading in 500 to 800 milliseconds  
after signal is removed.

Flasher Responds to a 15 ms. pulse of modulation.

6/9/59

-1-

M5693

## Circuits

### Meter

1. Direct coupled amplifier responds correctly to non-symmetrical modulation waveform.
2. High speed meter.
3. Self-calibration.

### Flasher

1. Direct coupled flasher shows accurately negative peaks of modulation regardless of waveform.
2. Self-calibration.
3. The flasher also serves as a carrier-failure alarm.

### Detector Linearity

Negative peak clipping in the detector diode is very low for frequencies up to 7500 cps. and does not exceed 5% at 10 KC and 100% modulation.

### Monitoring Output

When feeding a 600 ohm unbalanced load:

Level - -20 DBM at 100% modulation.  
Response -  $\pm$  0.2 DB from 50 to 15,000 cycles with 1000 cycle reference.  
Distortion - less than 0.25% from 20 - 15,000 cycles, (not including detector distortion).  
Noise - at least 65 DB below maximum output of -20 DBM.

When feeding an open circuit (grid):

Level - 0.75 V. R.M.S. at 100% modulation.  
Response -  $\pm$  0.2 DB from 50 to 15,000 cycles with 1000 cycles reference.  
Distortion - less than 0.1% from 20 - 15,000 cycles (not including detector distortion).  
Noise - at least 65 DB below maximum output of 0.75 V.  
Loading effect of 1000 mmf. (12 ft. of single conductor shielded cable rated at 85 mmfd. per ft.) at 15,000 cycles is about 0.1 DB.

Fidelity Measuring Output

When feeding a load of 100,000 ohms or more, shunted by 500 mmf. or less, the response is  $\pm 0.5$  DB from 20 to 30,000 cps. Distortion is less than 0.5% and noise is at least 75 DB below maximum output of 4.5 V. R.M.S.

Power Supply

105 to 125 V. (or 115 to 135 V.)  
50/60 cycles. Power consumption is 70 watts.

Auxiliary Outputs

Connections at the rear of the instrument for either a local or a remote percentage modulation meter.

Tubes Used

1 - 6X4	1 - 6OC2
2 - 12B4A	1 - 5687
1 - 5879	1 - 12AU7
3 - 0A2	1 - 2D21
1 - 0B2	1 - 8-4

Mounting

Rack mounted. 19" X 8-3/4" panel  
11-1/2" depth behind panel.

Weight

25 lbs.

## II. INTRODUCTION

The Gates Modulation Monitor M5693 is designed to continuously monitor the percentage of modulation of a broadcast transmitter. The modulation meter responds correctly to very short peaks of modulation. The modulation meter and over-modulation lamp circuits may be calibrated easily without the use of an oscilloscope. This monitor is approved by the Federal Communications Commission for use in AM broadcast stations.

This instruction book affords valuable information for persons who will install, operate or maintain a Gates M5693 Modulation Monitor. The following should be studied so that the procedures will be well in mind while doing the actual work.

## III. INSTALLATION

### A. Rack Installation and Transmitter Connections.

Check the packing list for materials. Check for screws that may have shaken loose during shipment. The monitor is designed to be installed in a rack cabinet. If the temperature inside the rack cabinet exceeds 130° F, ventilate the cabinet by using an exhaust fan at the top of the cabinet and louvres at the bottom for a cool air inlet. The life of the tubes and the reliability of all the equipment in the rack will be greatly increased if the heat is exhausted from the cabinet. Keep the cabinet from the direct rays of the sun. Install parts which have been removed for shipment. Select and install the RF transformer which covers the transmitter frequency. The transformer plugs into a 4 pin socket behind the front panel.

Turn off power to the rack cabinet, connect the 115V AC line to terminals TB2-1&2 provided on the left side of the monitor just inside the drop-down front panel. If the line voltage is consistently above 120 V. use the 125 V. tap on the power transformer (See schematic of monitor). Turn the monitor POWER switch off. Power to the rack cabinet can now be turned on again. The monitor has been designed to operate from a standard EIA monitor output connection which will provide an output of 10 V. into a load of 75 ohms. Transmitters not provided with a monitor output connection may be fitted with a coil of a few turns close to the power amplifier tank circuit. Use a coaxial cable of approximately 75 ohms impedance, such as RG59/U for connection of the transmitter to the RF input terminals on the monitor. A ground should be applied to only one end of the coaxial cable outer conductor; this connection is made at the monitor by means of the RF input terminals. Ground the top terminal of TB1 to the rack cabinet ground. If the pickup coil in the transmitter is adjustable, adjust it for minimum coupling before turning RF power into the monitor for the first time. This precaution protects diodes CR1 and CR2 and the CARRIER potentiometer against accidental burn out. If the pickup coil is not adjustable

connect a variable resistor across the coil as a voltage divider as shown in Fig. 1. Adjust the variable resistor for minimum output.

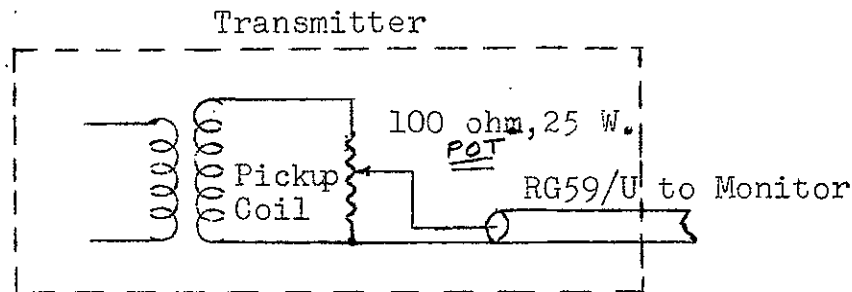


Figure 1. Connections for pickup coil which is not adjustable.

B. Monitor Amplifier Connection

A loudspeaker amplifier may be connected to the terminals at the rear of the instrument marked MON. AMP. The upper terminal is ground. If the input to the amplifier is 600 ohms, leave the 750 ohm resistor connected to the MON AMP terminals. If the amplifier input is a grid or a high resistance volume control remove the 750 ohm resistor.

C. External Meter Connections.

An external meter may be connected after the monitor has been checked with power on and found to be operating properly. First perform the operations found in the "PRE-OPERATION" section. Two types of external meters are available - one to be used in the same building with the monitor; the other, to be used over a telephone line of several miles in conjunction with remote control.

1. Local Meter

If an external meter is to be used in the same building with the monitor, use the remote metering kit M5836A. Remove R23 and connect the meter to these same terminals (marked LOCAL METER). Use a two-conductor shielded cable of less than 50 feet long for the meter connections. Connect the .005 mfd. capacitor across C29 as shown on the schematic. Check monitor calibration. The meter overshoot must now be readjusted. See "Overshoot Adjustment". The external meter may not agree exactly with the meter in the monitor. At any time when the external meter is not connected, the monitor circuits must be restored to normal; put R23 back in place, disconnect the .005 mfd. capacitor from C29, recheck calibration and readjust overshoot.

## 2. Remote Meter.

If it is desired to use a remote meter over a telephone line connect to the terminals marked "REMOTE METER", using the M5837 remote metering kit. Set the LOCAL-REMOTE switch to LOCAL and the meter switch to CALIBRATE REF. and check calibration of the % MODULATION meter on the monitor (calibrate to 100%). Then turn the LOCAL-REMOTE switch to REMOTE and have someone at the remote point adjust the potentiometer on the remote meter panel so that the remote meter reads 100%. (NOTE: When switched to REMOTE, the local meter will not indicate). REMOTE METER overshoot must now be adjusted. It is done in the same manner as described above for the LOCAL meter, except that C11 is the overshoot adjustment instead of C29.

### D. Overshoot Adjustment.

"Overshoot" means that the % MODULATION meter needle does not rise to the steady state value and stop, but goes past it, and then drops back to the steady state value. For checking overshoot, 100% was chosen as the steady-state value because of greatest accuracy and convenience. The overshoot must be adjusted to between 2 and 3%. That is, the needle rises to about 102 or 103%, then drops back to 100%. The easiest and most accurate way to see the overshoot is to hold a card against the face of the % MODULATION meter so that it hides the lower portion of the scale from view. The right hand edge of the card should line up with the meter scale at 102%, as shown in Figure 2. The amount of overshoot can now be easily read. After the monitor has been calibrated carefully, turn the meter switch to CALIBRATE ZERO. Now turn the switch repeatedly from CALIBRATE ZERO to CALIBRATE REF. (each time you switch to CALIBRATE ZERO, allow the needle to return all the way to zero before again switching to CALIBRATE REF.) Without the use of the card, note the approximate amount of overshoot, if any. If there is no overshoot, tighten the adjustment screw of padder C29 about one turn. If there is too much overshoot, loosen the screw. When C29 has been adjusted to give approximately 2 or 3% overshoot, then use the card over the face of the meter in order to read the overshoot exactly.

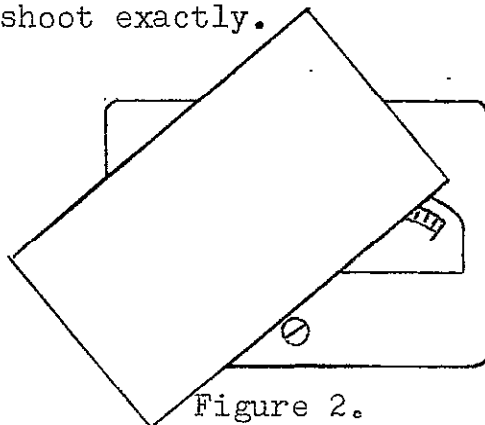


Figure 2.

## IV. PRE-OPERATION

### A. Preliminary Checks

Read these instructions carefully before the monitor is turned on for the first time.

1. With the POWER switch off, check to see that both meters read zero. If they do not, adjust them for zero with a small screwdriver.
2. Set the CARRIER control to about 2/3 clockwise, turn on the transmitter and adjust the TUNE MAX control for maximum deflection of the CARRIER meter. If the CARRIER meter reads much beyond 100, turn off the transmitter immediately and decrease the coupling to the monitor. On the other hand, if the meter reads much below 100, increase coupling. The CARRIER control and diodes CR1 and CR2 may be damaged by feeding too much power into the monitor. See that the monitor is not tuned to a harmonic of the transmitter frequency by tuning for the lowest frequency which will give the greatest indication on the CARRIER meter.
3. Check to see that all tubes are in place. Turn the meter switch to CALIBRATE ZERO. Turn the POWER switch on. The % MODULATION meter lamps should light. During warmup the % MODULATION meter needle may go off scale but will return to zero in a couple of seconds.
4. Turn the meter switch through all of its positions noting the readings on each position. The CALIBRATE REF and CALIBRATE CARRIER positions should read about 20. The READ NEG. and READ POS. positions should read about zero. If the readings are much higher than these values, do not proceed to the next step until the trouble has been located, as the meter amplifier has sufficient power to permanently damage the meter.
5. If all is well, turn the POWER switch off. Remove the 15,000 ohm resistor from the two terminals of TBL, marked "Local Meter". This resistor was for meter protection during initial checks. In its place put the 1500 ohm resistor which will be found taped to a nearby electrolytic condenser. Turn the POWER switch on again. The monitor is now ready for calibration. See "Calibration Instructions in the DAILY OPERATION section.

### B. Accessory Meter

After calibration is successfully performed an accessory meter may be connected as described in the INSTALLATION section.



## V. DAILY OPERATION

### A. Use of Operating Controls

All of the controls for normal operation, except the power switch, are located on the front panel of the modulation monitor. Calibration controls and the POWER switch are located behind the small panel.

1. Turn the POWER switch on. In about 10 seconds the needle of the % MODULATION meter needle may move off scale, but within a few seconds it will return to near zero. A 10 minute warm-up is necessary before the monitor is accurate.

2. Check the input tuning by turning the TUNE MAX control to the point where the CARRIER meter reads maximum. Adjust the CARRIER control for a reading of 100 on the CARRIER meter.

3. To read negative modulation peaks on the % MODULATION meter set the meter switch to READ NEG. To read positive modulation peaks set the meter switch to READ POS.

4. Set the % NEG PEAKS switch to the percentage of modulation at which you want the NEG PEAKS lamp to flash. The flasher always operates from the negative peaks of modulation and will agree with the meter if the meter switch is set to READ NEG. If the positive and negative peaks of modulation are unequal as shown by the % MODULATION meter, the flasher will not agree with the meter if the meter switch is set to READ POS. If the transmitter is turned off or fails, the NEG. PEAKS lamp will light, thus serving as a carrier-failure alarm. The lamp may not flash when the switch is in the 100% position as few transmitters are capable of being modulated 100% negative.

### B. Calibration Instructions.

1. With the POWER switch and transmitter off, check to see that the meters read zero. If they do not, adjust them for zero with a small screwdriver.

2. Turn the POWER switch and transmitter on. Allow the monitor at least 15 minutes warm-up time before calibration.

3. Turn the meter switch to CALIBRATE ZERO. Adjust the ZERO control located behind the small panel so that the % MODULATION meter reads zero.

4. Turn the meter switch to CALIBRATE REF. Adjust the REF control so that the % MODULATION meter reads 100. Adjust the FLASHER REF. control so that the NEG PEAKS lamp lights.

Approach setting clockwise slowly several times to be sure of the exact setting. Set it at the point where the flasher just lights.

5. Turn the meter switch to CALIBRATE CARRIER. (The transmitter cannot be modulated during this adjustment.) Adjust the TUNE MAX control for maximum deflection of the CARRIER meter. Adjust the CARRIER control so that the % MODULATION meter reads 100. Adjust the CARRIER METER control so that the CARRIER meter reads 100.

6. Close the small panel. Turn the meter switch to either READ NEG or READ POS.

### C. Interpretation of the Monitor's Indications.

The accuracy of the monitor may actually cause concern, by showing the presence of various minor transmitter and equipment troubles not readily discernible by other means. In order to avoid confusion and to assure that these things will not be wrongly ascribed to monitor malperformance, some of them are described. All of them can be verified by using an oscilloscope, with carefully calibrated vertical scale, provided the scope is not subject to "base line shift" troubles.

1. Very few, if any transmitters will actually modulate 100% negative. They usually "square off" from 1 to 5% below the theoretical maximum. The % MODULATION meter will show this, on tone, by coming up slightly short of 100% negative, and refusing to advance farther, regardless of any increase in transmitter audio gain. The NEG PEAKS lamp will not light, when the % NEG PEAKS switch is set on 100% with such a transmitter.

Using an R.F. envelope oscilloscope display, this affect can be seen only when the vertical height of the pattern is expanded so as to place the positive modulation peaks well beyond the limits of the screen. Then the "line" normally thought to represent 100% negative modulation will be seen to have appreciable "thickness", showing that 100% has not quite been reached.

This transmitter trouble is generally caused by less-than-perfect neutralization of the modulated R.F. amplifier, or other things which may allow unmodulated R.F. to appear, unwanted, in the output circuits.

2. Very few transmitters are truly symmetrical in their modulating characteristics. Previously available monitors do not give a correct relative indication of positive and negative peaks when measuring an unsymmetrical wave such as a test tone from a transmitter with carrier-shift, because R-C or transformer coupling elements used in them create "base line shift". This

tends to cause the meter readings of positive and negative peaks to be more nearly equal than the peaks actually are. The oscilloscope can give the right answer only if the vertical scale is accurately calibrated and carefully read. The THEORY OF OPERATION section may be helpful toward a better understanding of the above difficulties.

The M5693 Modulation Monitor employs direct-coupling, and therefore, will read the true values of positive and negative peaks, regardless of the presence of carrier shift. Note that  $1/2$  the difference of the two modulation peaks, shown on the % MODULATION meter, is equal to the percentage carrier shift shown by the CARRIER meter, for tone modulation.

CAUTION; For the correct relationships to exist always set the CARRIER control to give a red-line CARRIER meter indication with no modulation. Do not readjust the CARRIER control to get a red-line reference after modulation has been applied.

3. The % MODULATION meter furnishes an indication of peak level that is useful for program monitoring, but it does not give a VU indication. Its readings will not agree with those of a VU meter, which indicates average level.

4. This monitor will give correct peak indications on single program pulses as short as approximately 50 milliseconds. It will measure the true peak amplitude of program or tone, virtually regardless of the waveforms encountered.

## VI. THEORY OF OPERATION

### A. Theory of Amplitude Modulation.

A review of the definitions associated with amplitude modulation is in order before proceeding to the actual theory of this monitor.

Figure 3a shows an unmodulated R.F. carrier wave of a given amplitude as it would appear on an oscilloscope.

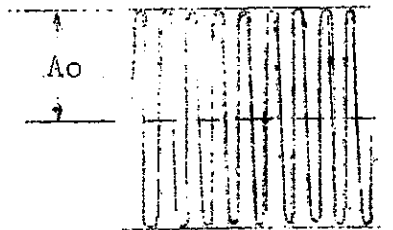


Fig. 3a.

Figure 3b shows a sine wave of audio frequency which will be used to modulate the carrier.

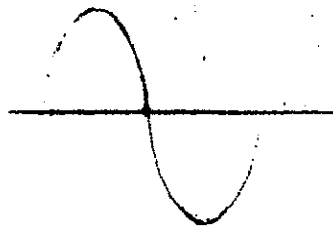


Fig. 3b.

Figure 3c shows a carrier modulated with one cycle of the sine wave audio frequency.

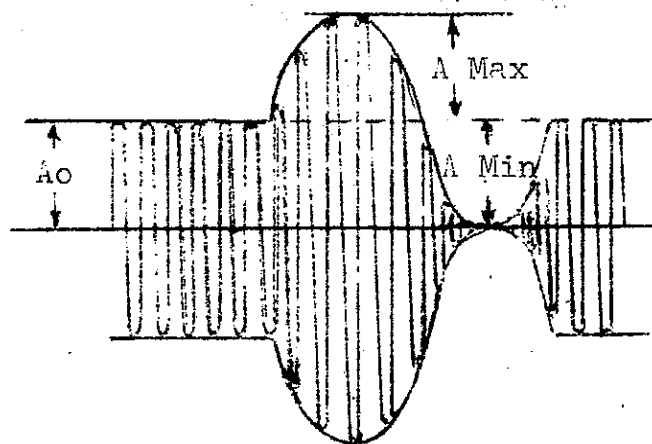


Fig. 3c.

$A_0$  represents the carrier amplitude when unmodulated.  
 $A_{max}$  represents the amount by which the wave exceeds  $A_0$ .  
 $A_{min}$  represents the amount that the wave drops below  $A_0$ .

Positive modulation is defined by

$$M_p = \frac{A_{Max}}{A_0} \times 100\%$$

Negative modulation is defined by

$$M_n = \frac{A_{Min}}{A_0} \times 100\%$$

For example, assume that  $A_0 = 10$  volts,  $A_{max} = 10$  volts, and  $A_{min} = 10$  volts.

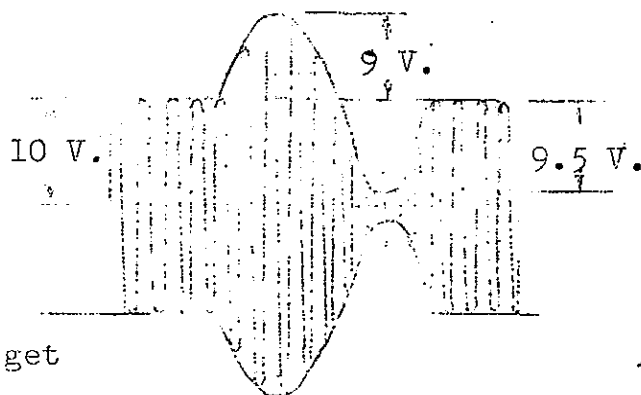
$$M_p = \frac{10}{10} \times 100\% = 100\%$$

$$M_n = \frac{10}{10} \times 100\% = 100\%$$

Hence we have 100% modulation, both positive and negative.

It can readily be seen that negative modulation could never exceed 100%, since  $A_{min}$  can never exceed  $A_0$ . In actual transmitters,  $A_{min}$  never quite reaches the value of  $A_0$  due to the fact that the transmitter cannot cut its power completely off at that instant. There is always some carrier power leaking through due to incomplete neutralization or inadequate shielding. Therefore, the % MODULATION meter will never quite reach 100 on negative peaks and the NEG. PEAKS lamp will not flash when the % NEG. PEAKS switch is set to 100.

Another example is shown in Fig. 3d.



Solving the formula, we get

$$M_p = \frac{9}{10} \times 100\% = 90\%$$

and

$$M_n = \frac{9.5}{10} \times 100\% = 95\%$$

Fig. 3d.

In this case the positive and negative peaks are not equal, which indicates that the modulating wave was not sinusoidal, or that the transmitter is introducing carrier shift. Carrier shift means that the average amplitude of the carrier has changed when modulation was applied.

This same method of measurement applies also to the wave below the centerline. The corresponding parts of the wave above and below the centerline have the same amplitude; that is the lower wave is a mirror image of the upper wave.

## B. Theory of the M5693 Monitor.

### 1. Input and Detector Circuits.

This monitor uses both the upper and lower portions of the modulated carrier wave. The upper portion is used for the audio monitoring and fidelity measuring outputs. The lower half is used for the meter and flasher indications.

The RF input transformer is tuned to resonance with the transmitter by the TUNE MAX variable condenser. The two detectors, CR1 and CR2 rectify the carrier wave and the following filters recover the audio modulation and DC components.

Detector diode CR2 is used only for the audio outputs. When using a noise-distortion meter in conjunction with the monitor, audio is taken from the filter output. However, for monitoring purposes a cathode follower is used as a low impedance source.

Figure 4a represents output of CR1 (if a resistor were substituted for the filter). Figure 4b represents the waveform at the output of the filter. The RF is filtered out, but the audio and DC components pass on through the filter.

The voltage developed by CR1 causes the junction of C5 and L2 to be about 39 volts negative with respect to the  $\swarrow$  side of the CARRIER meter. R10 applies a bucking voltage of 39 V. positive to the  $\swarrow$  side of the CARRIER meter with respect to ground. These two voltages, being equal and opposite, cancel each other so the junction of C5 and L2 is at ground potential with unmodulated carrier. See Figure 4b, point #1.

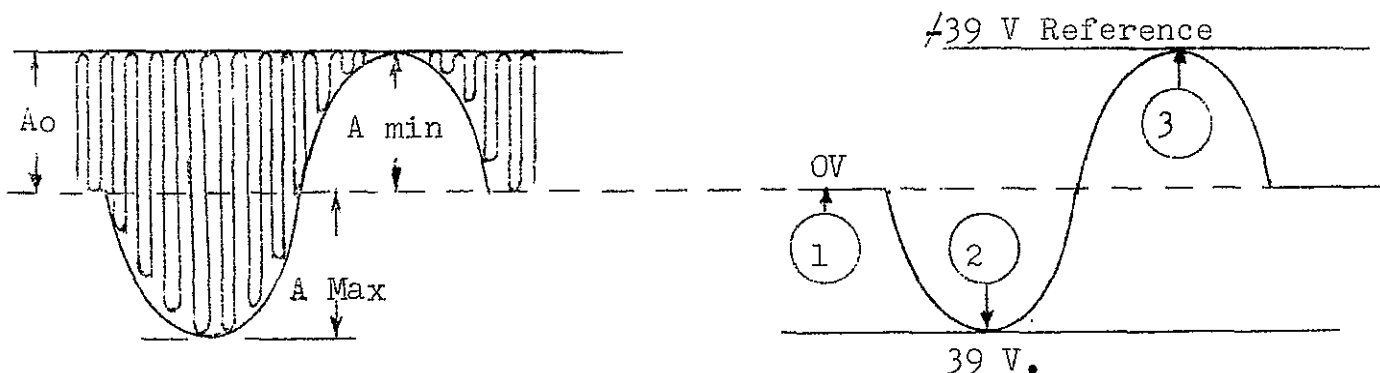


Fig. 4a.

Fig. 4b.

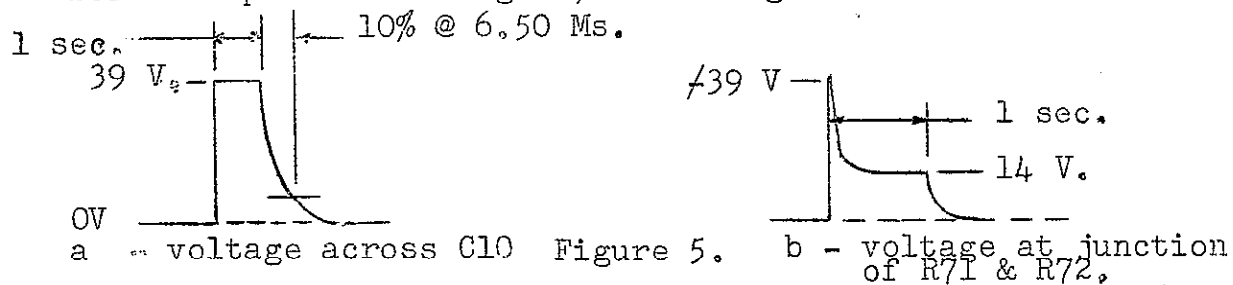
## 2. Modulation Meter Circuits

If the meter switch is set to READ POS., the diode CR3 is connected so that it conducts to charge C10 only on peaks which go negative, as in 4 b, point #2. This seeming contradiction arises because we are using the part of the carrier wave below the centerline. Point #2 represents increased transmitter power and is therefore a positive modulation peak. The -39 volt charge on capacitor C10 is divided by R71, R72, R13, and R14, applied to the meter amplifier, and causes the meter to read 100% (considering a repetitive wave which would keep C10 charged.).

If the meter switch is set to READ NEG. the diode CR3 is turned so that it conducts to charge C10 only on peaks which go positive, as in 4b point #3. Point #3 represents a decrease in transmitter power and is therefore a negative modulation peak. The +39 V. charge on C10 causes the meter to read 100%. The meter connections are reversed by the same switch which reverses CR3, always applying the correct polarity to cause the meter to read up scale.

One thing which contributes to very fast pointer response of the % MODULATION meter is the "spike" voltage formed by the network consisting of C27, C28, C29, R71, R72, R13 and R14. (With the switch in the REMOTE position, some different components are switched in.) Assume that the transmitter is modulated 100% for one second with a tone from an audio oscillator. The voltage at the top of C10 follows the curve of Fig. 5a. At the instant that 39 volts is applied to C10, the same voltage will appear at the junction of R71 and R72. Then as C27, C28 and C29 charges, the voltage at the junction of R71 and R72 quickly drops to a value determined by the voltage divider ratio, or about 14 V. as shown by Fig. 5b. The lower part of the divider R13 and R14 feeds a grid of V1 with the same wave shape described above, but of smaller amplitude. The other grid of V1 is held at a constant value. The voltage difference developed between the cathodes is applied to the series combination of R23 and the % MODULATION meter. The sharp "spike" voltage overcomes the inertia of the meter movement to start the needle off fast. By the time that the needle reaches 100%, the spike has dropped to a "plateau" level, which holds the meter needle at 100%. At the end of the one second pulse of modulation C10 discharges slowly, causing the needle to slowly return to zero. The very fast upswing of the meter needle gives the monitor the capability of indicating correctly rather short pulses of modulation, and will indicate 90% of the correct reading on a modulation pulse of only 50 milliseconds duration.

C29 is adjusted for a charging rate to suit the individual meter. It is adjusted to give a slight overshoot of the meter needle for a step function signal, as in Fig. 5a.



6/9/59

The circuits are D.C. coupled all the way from the detector through the meter. This eliminates the error introduced by resistance-capacity or transformer coupling as in previous monitors when reading a non-symmetrical waveform. If the transmitter is modulated 90% positive and 95% negative, an R-C or transformer coupled monitor will tend to average out the two readings, giving perhaps readings of 92% positive and 93% negative modulation. However with D.C. coupling, the values of modulation are read correctly.

### 3. Flasher Circuits

A resistive network made up of R46 through R59 delivers a given percentage of the R.F. detectors D.C. output component to the control grid of thyatron of V12 depending upon the setting of the % NEG PEAKS switch. Capacitor C21 by-passing the % NEG PEAKS switch applies a fixed part of the detector's audio component to the thyatron control grid.

A power supply voltage, adjustable by means of the FLASHER REF control applies an initial bias to V12 at its cathode, so as to cause the thyatron just to conduct when its grid-ground voltage is 39 V. When conduction occurs, the NEG PEAKS lamp flashes. V12 plate voltage is supplied from a separate transformer winding. Compensation for voltage variation in this winding due to line voltage variations is furnished by R41 which increases the bias on V12 whenever the AC line voltage increases. The NEG PEAKS lamp will seldom flash when the % NEG PEAKS switch is set to 100% even though the transmitter appears to be modulated 100%. The reason for this is that the flasher reads the negative peaks of modulation and few, if any, transmitters will actually modulate 100% negative. At negative peaks of modulation some RF energy leaks through the modulated stage due to incomplete neutralization or insufficient shielding. When the transmitter is turned off, the NEG PEAKS lamp will flash, serving as a carrier-failure alarm.

### 4. Power Supplies.

The plate voltage for V1 is supplied by a series regulated power supply. The positive side of the supply is clamped at 180 V. above chassis ground and the voltage at the negative terminal of this supply is adjustable by means of R36 in the vicinity of -120 V. with respect to ground.

A separate supply uses voltage regulator tubes for shunt regulation. This supply furnishes two reference voltages and V2 plate voltage. The filament voltage of V12 is regulated by ballast RT1.



## VII. MAINTENANCE

### A. Tubes

When replacing tubes, turn off the POWER switch. The meter may be permanently damaged if V1 or tubes in the series-regulated power supply are replaced while power is on.

If any of the tubes V4 through V7 are replaced, check the voltage at the negative side of C17. Adjust R36 for -120 V. at C17. If either V12 or RT1 are placed, V12 filament voltage must be checked. Connect an A.C. voltmeter between the slider of R63 and pin 7 of RT1. Adjust R63 slider so that the meter reads 6.3 V. Recheck this voltage after about 100 hours of operation. (This also applies to a new monitor).

### B. Diodes

If it becomes necessary to replace any of the germanium or silicon diodes CR1 - CR6, do not attempt to unsolder the diode. Clip the leads as close to the terminals as possible and connect the new diode. While the new diode connections are being soldered keep the heat from being conducted to the diode by holding the diode lead with a pair of pliers to carry away the heat.

### C. Modulation Meter

If the % MODULATION meter is replaced, the selected resistor across R14 may have to be changed or removed entirely. Need for a change of resistance is indicated when the calibrating controls behind the drop panel do not have sufficient range to calibrate the monitor. The new meter may also require "overshoot" adjustment. See "Overshoot Adjustment" in the INSTALLATION section.

### D. Fidelity Measurements.

When making connections to the MEASURE FIDELITY terminals on the back of the monitor, note that the upper terminal of the two is ground. The leads should be shielded and as short as possible.

## VIII. TROUBLE SHOOTING

### A. Conditions of Test

The voltage shown on the schematic were taken with normal line voltage, unmodulated RF input and the monitor carefully calibrated. In the following notes, where an abnormal condition is described, it is assumed that all of the other circuits are operating normally.

CAUTION -- Before replacing any tubes, read "Tubes" in MAINTENANCE section.

### B. Malfunction and Remedies.

1. Monitor completely inoperative; meter lamps and tubes do not light when POWER switch is turned on.

A. Check fuse F1.

B. Check for line voltage at TB2.

2. Meter lamps do not light when POWER switch is on. (Carrier meter is not illuminated.)

A. Remove the two screws from the front of the % MODULATION meter case. Pull off the front cover of the case and check or replace lamps. When replacing the front cover, be sure that the zero-set toggle fits into place properly.

B. Check for voltage at small meter terminals. (Use caution not to short or touch test leads to large meter terminals.)

3. V4 and V5 do not light.

A. The filament of these two tubes are in series; if one tube is open, neither tube will light.

4. V12 does not light.

A. Check V12 for open filament.

B. Check ballast tube RT-1 for open filament

5. All power transformer secondary voltages either too high or too low.

A. Check AC line voltage. If line voltage is between 105 and 120 V. use 115 V. tap. If line voltage is between 120 and 135 V. use 125 V. tap.

6. Incorrect or no voltages at C17C. (Should be about 300 V. across C17C. The voltage shown on the schematic is referenced to ground.)
  - A. Check or replace tubes V3 through V7.
  - B. See if V12 glows.
  - C. Check voltage across C17A and across C17B. Should be about 370 V. and 355 V. respectively with normal AC line voltage.
7. Incorrect voltage at V8, pin 1 to ground.
  - A. See if V8 and V9 both glow.
  - B. Check voltage on V1 at pin 3 and at pin 6.
  - C. Check or replace V1.
8. Voltage at V10, pin 1 is high.
  - A. Replace V10 and V11. Check all voltages back to CR6. Check V2 voltages.
9. Voltage at V10, pin 1 is low.
  - A. Determine whether V2 is drawing excessive current by measuring voltage across R30. Should be about 8 or 9 volts.
  - B. Check voltages between CR6 and V10.
10. CARRIER meter does not indicate (transmitter on).
  - A. See if % MODULATION meter reads 100% when meter switch is set to CALIBRATE CARRIER.
  - B. Check voltage from  $\neq$  side of CARRIER meter to L2. Should be about -39 V. at L2.
  - C. Check voltage from  $\neq$  side of CARRIER meter to L4. Should be about  $\neq$ 39 V. at L4. If there is voltage at L4 and not at L2, CR1 may be bad, L1 or L2 may be open, or C3, C4 or C5 may be shorted.
  - D. Check for metal filings in the plates of the TUNE MAX capacitor.
  - E. Remove the plug-in RF transformer and check continuity of each winding. Check for open circuit between windings. Remove transmitter cable from RF INPUT terminals. Input terminals should read about 97 ohms. Measure from arm of R1 to ground. Should measure about 97 ohms with CARRIER control full clockwise and 47 ohms with CARRIER control fully counterclockwise.

11. % MODULATION meter does not zero when turning ZERO control with the meter switch in CALIBRATE ZERO position.
- Check voltages at each end of ZERO control to ground.
  - Check V1 voltages.
  - Check voltage at junction of R21 and R22.
  - Replace V1.
12. % MODULATION meter does not indicate in any position of meter switch.
- Replace V1.
  - Check meter; turn off POWER switch. Connect a  $1\frac{1}{2}$  V. dry cell from pin 3 to pin 6 of V1. Turn meter switch for upscale reading. Should read about 85%.
  - Turn power on again. Check tube and power supply voltages.
  - Set meter switch to CALIBRATE REF. The voltage across R14 should be about 2.2 V. The voltage across C10 should be about 39 V. The voltage from the arm of R10 to ground should be about 39 V.
  - If CR3 was replaced, perhaps it was installed with the wrong polarity.
13. % MODULATION meter reads down-scale in CALIBRATE REF. and CALIBRATE CARRIER positions of meter switch and reads down with modulation in READ NEG. and READ POS. positions.
- Meter terminals are reversed.
14. % MODULATION meter reads zero in CALIBRATE ZERO position of S1, but reads off scale in CALIBRATE REF position.
- Check voltage at the arm of the REF control (if meter bangs against stop, insert 15K resistor at LOCAL METER terminals in place of R23 until the trouble is located).
15. % MODULATION meter reads zero in CALIBRATE ZERO position of S1, but reads off scale in both CALIBRATE REF. and CALIBRATE CARRIER positions. (See Item 14 for precaution to protect meter.)
- Set S1 to CALIBRATE REF. Voltage across R14 should be about 2.2 V. and across C10 about 39 V.
16. % MODULATION meter reads off scale either up or down for any position of S1.
- Take precaution to protect meter as in Item 14. Perform test shown in item 9.

17. % MODULATION meter needle seems sluggish or swings wide.
  - A. First calibrate monitor (see Calibration Instructions in PRE-OPERATION section). Check meter overshoot (see "Overshoot Adjustments" in INSTALLATION section).
18. No output from MON. AMP. terminals when transmitter is modulated.
  - A. Note that normal output into a 600 ohm load is -20 dbm. This is only about .07 V RMS.
  - B. Replace V2.
  - C. Check for audio output at MEASURE FIDELITY terminals with a pair of high impedance headphones.
  - D. Check V2 circuit DC voltages.
19. Output from MON. AMP. terminals seem distorted.
  - A. Perform steps B and D in 18 above.
  - B. Check distortion at MEASURE FIDELITY terminals with a Distortion Analyzer.
  - C. Check distortion at MON. AMP. terminals; disconnect load and 750 ohm resistor if feeding a 600 ohm load. This gives enough voltage to measure distortion on some distortion analyzers.
  - D. Check distortion of external amplifier by using an audio oscillator and distortion analyzer.
20. NEG. PEAKS lamp will not flash under any conditions.
  - A. If V12 does not light, remove V12 and RT1 and check their filaments for continuity.
  - B. Replace NEG. PEAKS lamp, A1.
  - C. Check voltage at cathode of V12.
  - D. Check AC voltage between orange wires of power transformer.
21. The NEG. PEAKS lamp does not agree with the % MODULATION meter when the meter switch is set to READ NEG and the % NEG. PEAKS switch is set to 50.

- A. Carefully calibrate the monitor (see "Calibration Instructions" in the PRE-OPERATION section). Set the meter switch to READ NEG. and the % NEG. PEAKS switch to 50. Modulate the transmitter with a 1000 cycle tone from an audio oscillator. Gradually increase the oscillator output until the NEG. PEAKS lamp flashes. Note the reading of the % MODULATION meter and decrease the oscillator output. If the reading was below 50%, loosen the locking nut on R46 (hold the base of the locking assembly with a wrench while turning the top nut) and turn the R46 shaft slightly counterclockwise. Again gradually increase the oscillator output until the NEG. PEAKS lamp flashes and note the % MODULATION meter reading. If the meter should read higher than 50% when the lamp flashes, turn R46 shaft clockwise. After final adjustment of R46 is made, carefully tighten the locking nut, holding the base of the locking assembly so that it doesn't turn.

Make a final check at 50% modulation to be sure that tightening of the lock nut has not changed the setting of R46.

## WARRANTY

This equipment is warranted by Gates Radio Company of Quincy, Illinois to be free from defects in workmanship and material and will be repaired or replaced in accordance with the terms and conditions set forth below:

1. Gates Radio Company believes that the purchaser has every right to expect first-class quality, materials and workmanship and has created rigid inspection and test procedures to that end, and excellent packing methods to assure arrival of equipment in good condition at destination.
2. Gates Radio Company will endeavor to make emergency shipments at the earliest possible time giving consideration to all conditions.
3. Gates Radio Company warrants new equipment of its manufacture for one (1) year and (six (6) months on moving parts), against breakage or failure of parts due to imperfection of workmanship or material, its obligation being limited to repair or replacement of defective parts upon return thereof f.o.b. Gates Radio Company's factory, within the applicable period of time stated. Electron tubes shall bear only the warranty of the manufacturer thereof in effect at the time of the shipment to the purchaser. Other manufacturers' equipment covered by a purchaser's order will carry only such manufacturers' standard warranty. These warranty periods commence from the date of invoice and continue in effect as to all notices, alleging a defect covered by this warranty, received by Gates Radio Company prior to the expiration of the applicable warranty period.

The following will illustrate features of the Gates Radio Company warranty:

Transmitter Parts: The main power or plate transformer, modulation transformer, modulation reactor, main tank variable condensers all bear the one (1) year warranty mentioned above.

Moving Parts: As stated above, these are warranted for a period of six (6) months.

Electron Tubes: As stated, electron tubes will bear such warranty, if any, as provided by the manufacturer at the time of their shipment. Gates Radio Company will make such adjustments with purchasers as given to Gates Radio Company by the tube manufacturer.

All other component parts (except as otherwise stated): Warranted for one (1) year.

Abuse: Damage resulting from abuse, an Act of God, or by fire, wind, rain, hail, in transportation, or by reason of any other cause or condition, except normal usage, is not covered by this warranty.

4. Operational warranty - Gates Radio Company warrants that any new transmitter of its manufacture, when properly installed by purchaser and connected with a suitable electrical load, will deliver the specified radio frequency power output at the output terminal(s) of the transmitter, but Gates Radio Company makes no warranty or representation as to the

coverage or range of such apparatus. If a transmitter does not so perform, or in the event that any equipment sold by Gates Radio Company does not conform to any written statement in a contract of sale relative to its operating characteristics or capabilities, the sale liability of Gates Radio Company shall be, at the option of Gates Radio Company, either to demonstrate the operation of the equipment in conformance with its warranty, or to replace it with equipment conforming to its warranty, or to accept its return, f.o.b. purchaser's point of installation and refund to purchaser all payments made on the equipment, without interest. Gates Radio Company shall have no responsibility to the purchaser under a warranty with respect to operation of equipment unless purchaser shall give Gates Radio Company a written notice, within one (1) month after arrival of equipment at purchaser's shipping point, that the equipment does not conform to such warranty.

5. Any item alleged by a purchaser to be defective, and not in conformance with a warranty of Gates Radio Company shall not be returned to Gates Radio Company until after written permission has been first obtained from the Gates Radio Company home office for such return. Where a replacement part must be supplied under a warranty before the defective part can be returned for inspection, as might be required to determine the cause of a defect, purchaser will be invoiced in full for such part, and if it is determined that an adjustment in favor of the purchaser is required, a credit for an adjustment will be given by Gates Radio Company upon its receipt and inspection of a part so returned.

6. All shipments by Gates Radio Company under a warranty will be f.o.b. Quincy, Illinois or f.o.b. the applicable Gates Radio Company shipping point.

7. Gates Radio Company is not responsible for the loss of, or damage to, equipment during transportation or for injuries to persons or damage to property arising out of the use or operation of Gates equipment. If damage or loss during transportation occurs, or if the equipment supplied by Gates Radio Company is otherwise damaged, Gates will endeavor to make shipment of replacement parts at the earliest possible time giving consideration to all conditions. It is the responsibility of a purchaser to file any claim for loss or damage in transit with the transportation company and Gates will cooperate in the preparation of such claims to the extent feasible when so requested.

8. Gates Radio Company, in fulfilling its obligations under its warranties, shall not be responsible for delays in deliveries due to depleted stock, floods, wars, strikes, power failures, transportation delays, or failure of suppliers to deliver, acts of God, or for any condition beyond the control of Gates that may cause a delayed delivery.

9. This warranty may not be transferred by the original purchaser and no party, except the original purchaser, whether by operation of law or otherwise, shall have or acquire any rights against Gates Radio Company by virtue of this warranty.

10. Gates Radio Company reserves the right to modify or rescind, without notice, any warranty herein except that such modification or rescission shall not affect a warranty in effect on equipment at the time of its shipment. In the event of a conflict between a warranty in a proposal and acceptance and a warranty herein, the warranty in the proposal and acceptance shall prevail.

11. This warranty shall be applicable to all standard Gates catalog items sold on or after March 1, 1960.

Gates Radio Company  
Quincy, Illinois

1/6/60



IX. PARTS LIST

M-5693 MODULATION MONITOR

<u>Symbol No.</u>	<u>Drawing No.</u>	<u>Description</u>
A1		Lamp, Neon NE-51H
C1		Cap., 24 uuf.,
C2		Tune Max. Cap., 6.7 - 140 uuf.
C3, C6		Cap., 120 uuf.
C4, C7		Cap., 240 uuf.
C5		Cap., 100 uuf.
C8		Cap., 50 uuf.
C9		Cap., 10 uf.
C10		Cap., .02 uf., 400 V., $\pm$ 5%
C11		Variable Cap., 1400-3055 uuf.
C12		Cap., .005 uf., $\pm$ 10% 100 V.
C13		Cap., 2 uf., 200 V.
C14		Cap., 150 uf., 50 V.
C15		Cap., 1 uf., 200 V.
C16		Cap., 20-20 uf., 450 V.
C17		Cap., 15-15-10 uf., 450 V.
C18		Cap., .01 uf., 400 V.
C20		Cap., 10 uf., 50 V.
C21		Cap., 1 uf., 200 V.
C22, C23		Cap., .01 uf., 400 V.
C24		Cap., 20 uf., 450 V.
C25		Cap., .001 uf., 1 KV
C26		Cap., 05 uf., 200 V.
C27		Cap., .005 mfd., 100 V. $\pm$ 10%
C28		Cap., .0033 mfd., 600 V.
C29		Variable Cap., 1400-3055 mmf.
C30		Cap., .005 mfd., 100 V. $\pm$ 10%
CR1, CR2		Germanium Diode
CR3		Silicon Diode, HD6751, Hughes
CR4, CR5, CR6		Silicon Rectifier
E1		Binding Post (Red)
E2		Binding Post (Black)
F1		Fuse, 2 amp., 250 V.
L1, L2, L3, L4		R.F. Choke, 30 mh.
L5		Filter Choke, 10 hy.
M1	A-31796-2	Carrier Meter
M2	A-30574-1	% Modulation Meter

<u>Symbol No.</u>	<u>Drawing No.</u>	<u>Description</u>
R1		Carrier Control, 50 ohms
R2		Res., 47 ohm, 2 W., 10%
R3		Res., 11K ohm, 1/2 W., 5%
R4		Control, 5 ohms, W.W.
R5		Res., 5.6 ohm, 1 W., 10%
R6		Res., 9100 ohm, 1/2 W., 5%
R7, R27		Res., 1600 ohm, 1/2 W., 5%
R8		Res., 390 ohm, 1/2 W., 5%
R9		Res., 120K ohm, 2 W., 5%
R10		Control, 5K ohms, W.W.
R11		Res., 18K ohms, 1 W., 1%
R12		Res., 10 megohm, 1/2 W., 5%
R13		Res., 510K ohm, 1/2 W., 5%
R14		Res., 620K ohm, 1/2 W., 5%
R15, R16		Res., 430 ohms, 1/2 W., 5%
R17		Res., 150K ohm, 2 W., 5%
R18		Control, 10K ohms, W.W.
R19		Res., 100K ohm, 2 W., 5%
R20		Res., 1000 ohm, 1/2 W., 10%
R21, R22, R39		Res., 10K ohm, 5 W., 5%
R23		Res., 1500 ohm, 1/2 W., 5%
R23a		Res., 15K ohm, 1/2 W., 5%
R26		Res., 100K ohm, 1/2 W., 10%
R28		Res., 470K ohm, 1/2 W., 10%
R29		Res., 3600 ohm, 1/2 W., 5%
R30		Res., 1200 ohm, 1/2 W., 10%
R31		Res., 470K ohm, 2 W., 10%
R32		Res., 750K ohm, 1/2 W., 5%
R33		Res., 3900 ohm, 1/2 W., 5%
R34		Res., 20K ohm, 2 W., 5%
R35		Res., 68K ohm, 1 W., 10%
R36		Control, 10K ohm, W.W.
R37		Res., 62K ohm, 1 W., 5%
R38, R45		Res., 1 megohm, 1/2 W., 10%
R40, R66		Res., 1500 ohm, 5 W., 5%
R41		Res., 100 ohm, 2 W., 10%
R42		Res., 130K ohm, 2 W., 5%
R43		Control, 5K ohm, W.W.
R44		Res., 20K ohm, 1 W., 1%
R46		Control, 250K ohm
R47		Res., 470K ohm, 1/2 W., 5%
R49, R50, R51, R52, R53, R54, R55, R56, R57, R58, R59		Res., 56K ohm, 1/2 W., 5%
R60		Res., 680K ohm, 1/2 W., 10%
R61, R62		Res., 43 ohm, 2 W., 5%
R63		Res., Adj. 15 ohm, 10 W.
R64		Res., 100K ohm, 1 W., 10%
R65		Res., 18K ohm, 1/2 W., 10%
R67, R68		Res., 3 ohm, 1 W., 5%
R69		Res., 2200 ohm, 1/2 W., 5%
R70		Res., 750 ohm, 1/2 W., 5%
R71		Res., 7.5 megohm, 1/2 W., 5%
R72		Res., 3 megohm, 1/2 W., 5%
R73		Res., 4700 ohm, 1/2 W., 5%

6/9/59

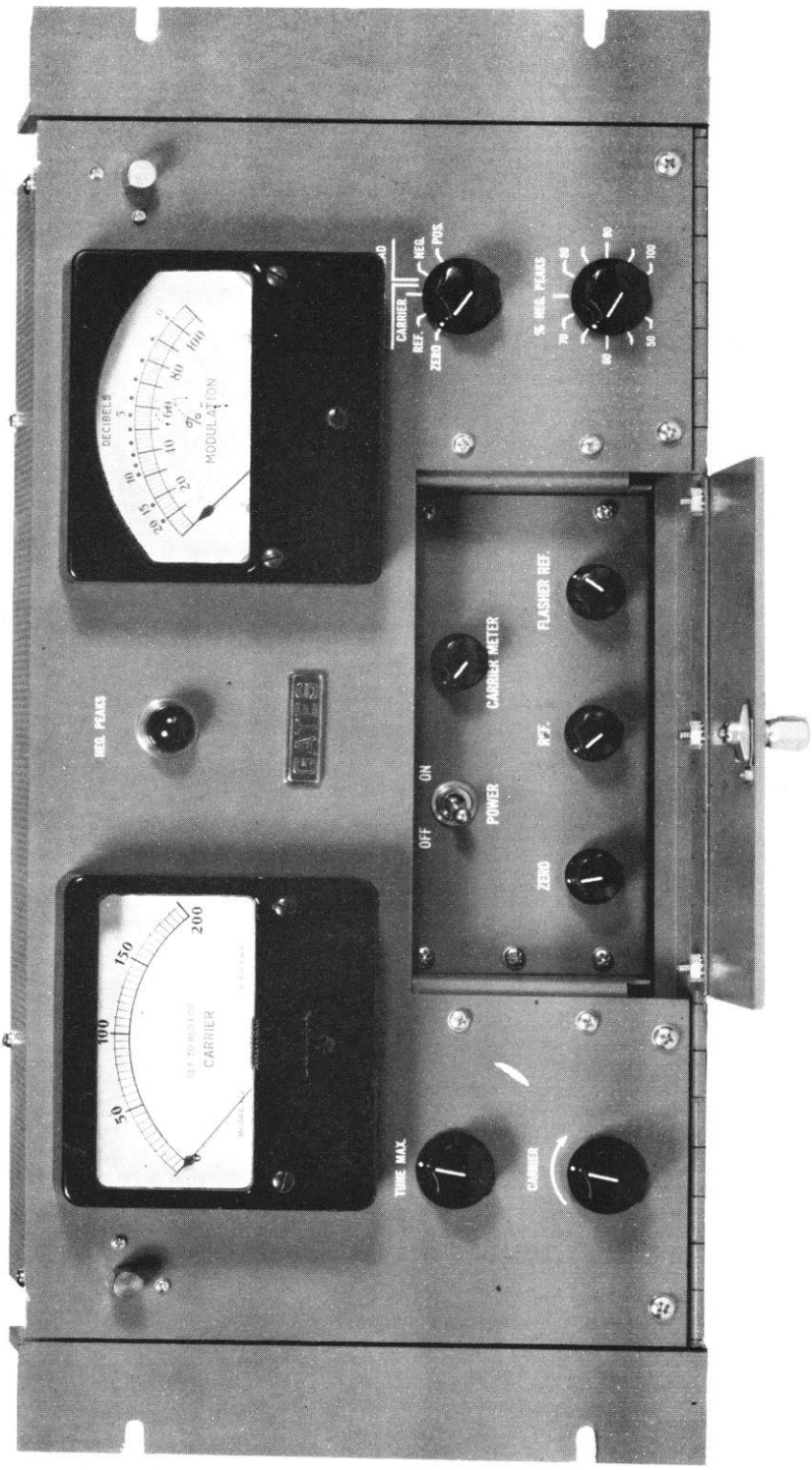
B5693

<u>Symbi Symbol No.</u>	<u>Drawing No.</u>	<u>Description</u>
RT1		Ballast Tube, 8-4
S1		Rotary Switch - Centralab PA-2021 6 Pol.-5 Pos.
S2		Switch <i>Non-shorting steatite</i>
S3		Rotary Switch
S4		Lever Switch
T1	AP-31736	Power Transformer <i>Thorndarson T-53613</i>
T2	A-31850-101	R.F. Transformer (540-900 K.C.)
T2	A-31850-102	R.F. Transformer (900-1600 K.C.)
TB1		Terminal Board
TB2		Terminal Board
V1		Tube; 5687
V2		Tube; 12AU7
V3		Tube; 6X4
V5, V5		Tube; 12B4A
V6		Tube; 5879
V7, V10, V11		Tube; 0A2
V8		Tube; 0B2
V9		Tube; 0C2
V12		Tube, 2D21
XA1		Pilot Light Assembly (Red)
XF1		Fuseholder
XRT1		Socket
XT2		Socket
XV1		Turret Socket
XV2, XV4, XV5		Socket
XV6		Socket
XV9, XV10, XV11		Socket
XV12		Socket

6/9/59

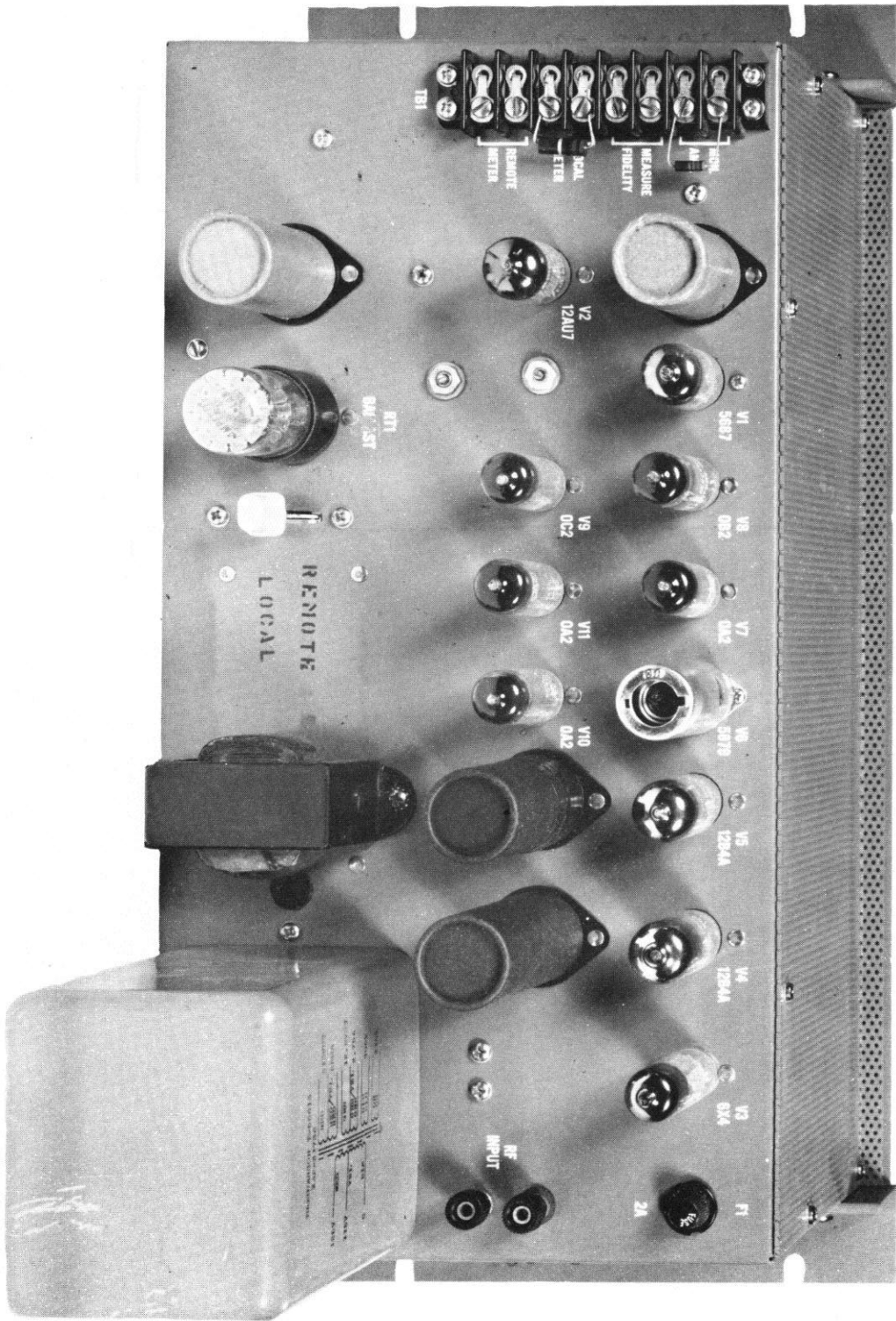
-3-

M5693

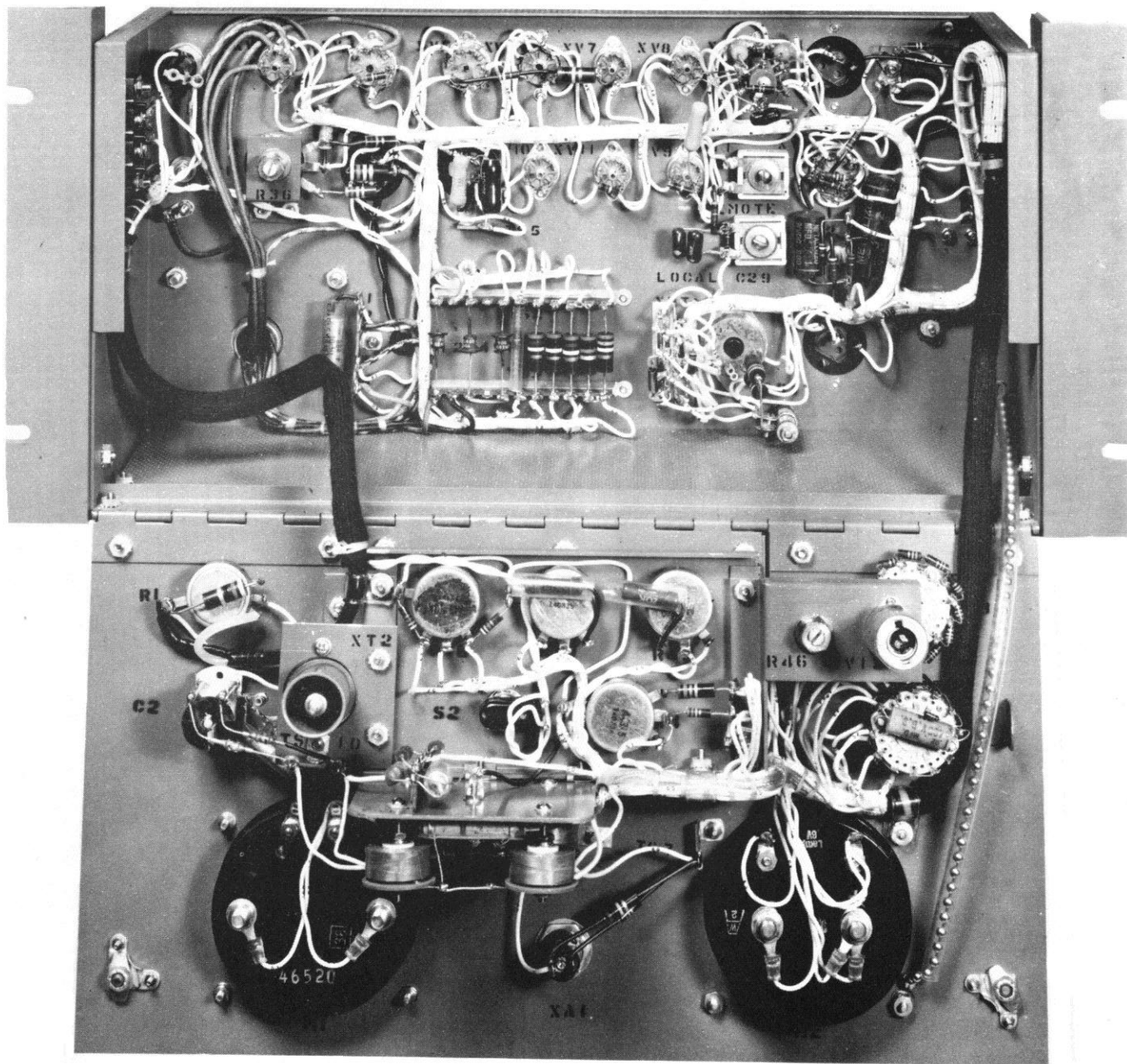


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AX-175

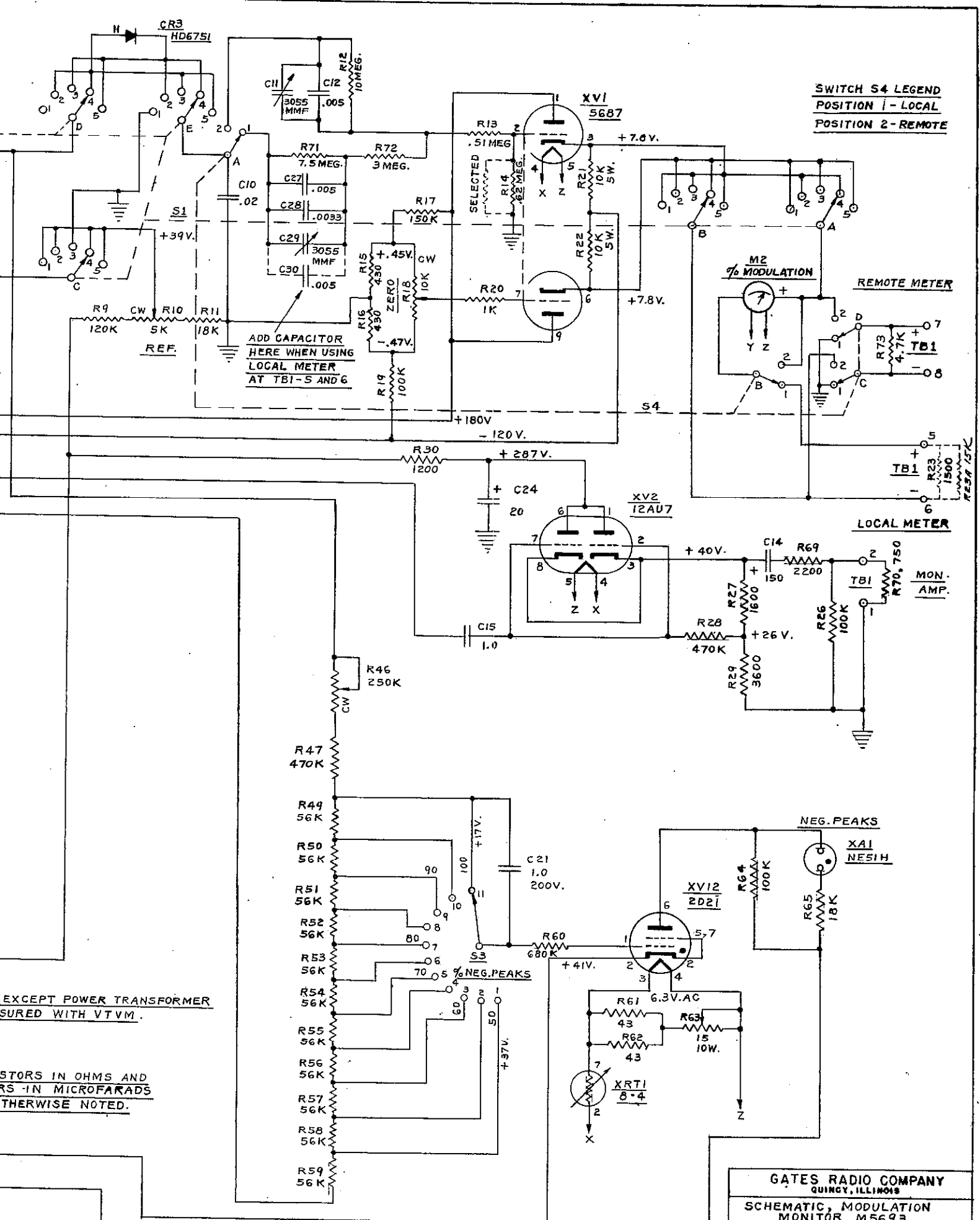


AX-185





AX-183



**SWITCH S4 LEGEND**  
 POSITION 1 - LOCAL  
 POSITION 2 - REMOTE

ADD CAPACITOR  
 HERE WHEN USING  
 LOCAL METER  
 AT TB1-5 AND 6

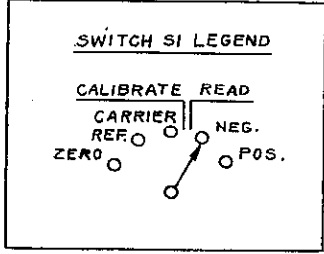
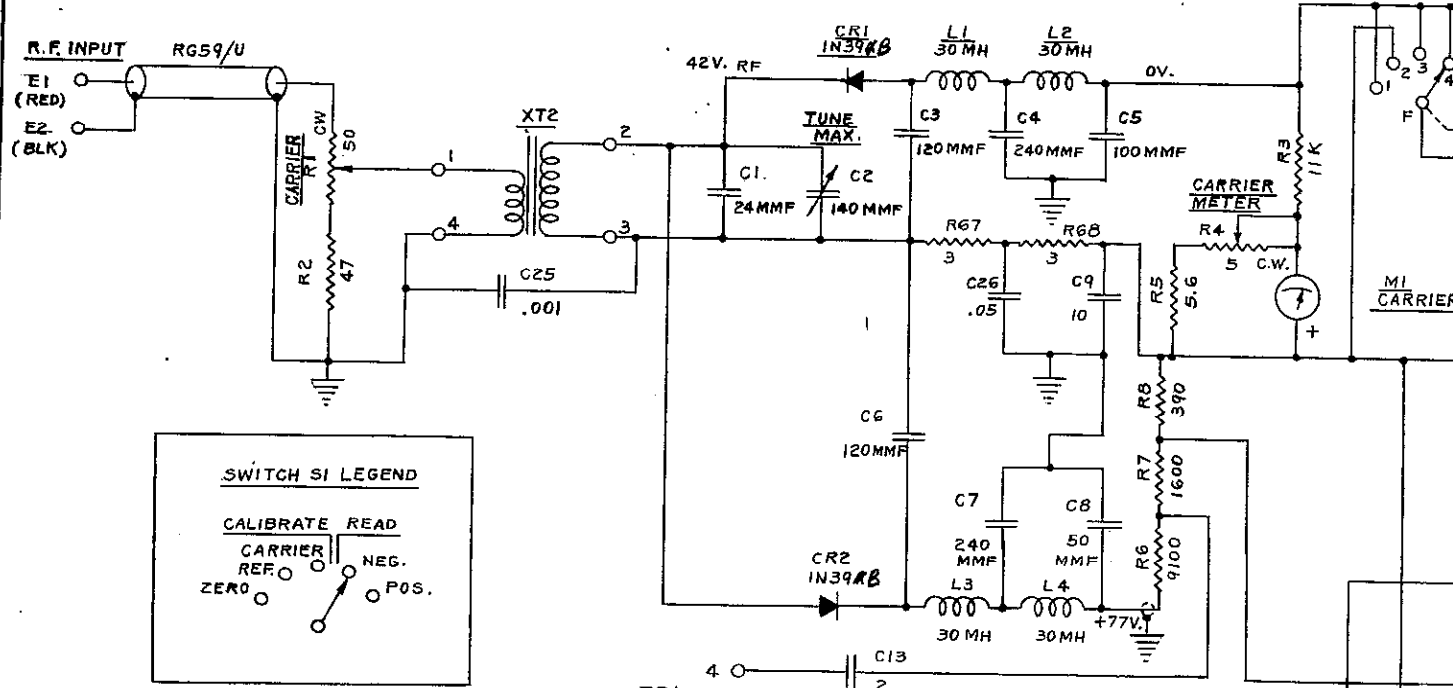
**LOCAL METER**

**REMOTE METER**

EXCEPT POWER TRANSFORMER  
 MEASURED WITH VTVM.

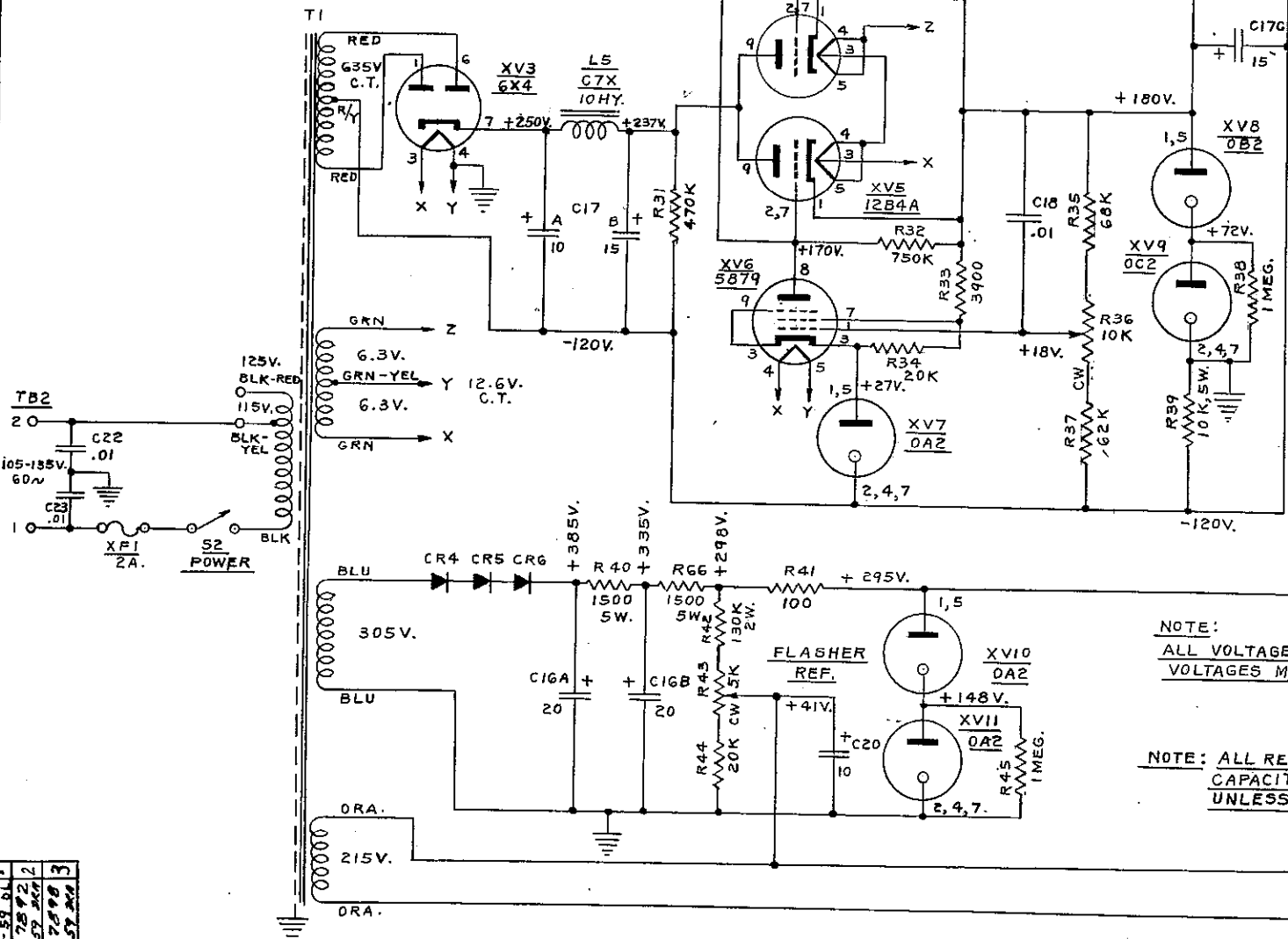
RESISTORS IN OHMS AND  
 CAPACITORS IN MICROFARADS  
 UNLESS OTHERWISE NOTED.

GATES RADIO COMPANY QUINCY, ILLINOIS		
SCHEMATIC, MODULATION MONITOR M5693		
DR. BY D.L.	DATE 1-8-59	D-22474
CH. BY H.I.Z.	ENG. H.I.Z.	



TBI 4 0  
 3 0

**MEASURE FIDELITY**



ECN 7861	1
5-13-59	BL
PCN 7892	2
6-29-59	AK
ECN 7898	3
6-27-59	AK