INSTRUCTION BOOK
MODEL 600A
FM BROADCAST FREQUENCY
AND
MODULATION MONITOR

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MODEL 600A MONITOR

Summary of Changes

1. The duo-diode detector, V-3, has been changed to a type 6H6 tube. This change, combined with structural changes in the discriminator transformer assembly, Z-2, results in greatly improved stability of the frequency indication meter.

2. The audio output circuit (tube V-6) has been changed to remove d.c. voltage from the output terminal, #12. A high impedance, higher voltage output is also connected to terminal #13. This latter output must not be terminated in an external impedance lower than 100,000 ohms. The low impedance output provides about 0.7 volts RMS and the high impedance output about 7 volts RMS for plus/minus 75 kc deviation.

3. A limiter tube has been added between the mixer tube V-1 and the limiter-driver tube, V-2. This change makes for stability of monitor characteristics with relatively wide variations on r.f. input. Required drive, as measured by V-2 grid current, is still 0.5 ma (or 1,000 cycles on zero center meter). When putting the monitor into service the coupling to the transmitter should be increased to slightly beyond the point at which the drive reading no longer increases with increase of coupling. The drive reading should then be adjusted to exactly 0.5 ma (or 1,000 cycles) by means of the new control, R-67.

4. In early Model 600 monitors which used a jack for making drive measurements, a "Drive-Operate-Shunt" switch has been added. The "Drive" position of this switch converts the zero center meter into a 1 - 0 - 1 ma. and switches it into V-2 grid for measuring this current. Correct drive reading is thus 1,000 cycles on this meter. The "Shunt" position simply reduces the zero center meter sensitivity by a factor of about 10 to protect the meter movement. This switch must be in the "Operate" position for normal monitor use.

5. Wiring has been re-routed in some instances to improve the signal to noise ratio of the instrument. The inherent distortion introduced by the monitor has also been reduced by minor circuit changes. These two changes make the instrument useful for system performance checks when used with the suitable measuring equipment.

NOTICE

This REL Model 600A FM Broadcast Frequency and Modulation Monitor, serial number__________, was recalibrated at the factory on__________ mc. The serial numbers of the crystal oscillator units now are:

Y-1:____________, Freq:____________

Y-2:____________, Freq:____________

Referring to STEP 9, Section II, the exact setting for maintenance of calibration accuracy is ±__________cycles, applicable to this instrument only.

In re-installing the monitor observe all original precautions, and in particular, if a new carrier frequency is involved, STEP 3 of Section II. Since standing waves exist on the connecting cable a frequency change may require a change in the coupling at the transmitter end. In any case, retune C29 for maximum drive on 6AG7 grid as indicated by the meter.

______________________________ SIGNATURE

DATE______________________

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SECTION 1

GENERAL DESCRIPTION

The REL Model 600A FM Broadcast Frequency and Modulation Monitor provides means for continuous monitoring of average carrier frequency and instantaneous percentage of modulation in either direction. The monitor is completely crystal controlled and designed to operate on any one frequency in the 88.1 to 107.9 megacycle band. It is furnished completely aligned with crystals for operation on ONE specified frequency in the above band.

Also included is an over-modulation alarm which may be adjusted to flash at some preset modulation level in the range of from 50 to 120% modulation.

ASSEMBLY AND INSTALLATION

Tubes and crystals removed for shipment should be reinstalled. Particular attention should be paid to insure correct placement of individual tubes. Any tube that has been removed will be found to have a symbol number marked upon it. TUBES MUST BE REPLACED IN THE SOCKETS HAVING CORRESPONDING SYMBOL DESIGNATION. LIKEWISE WITH CRYSTALS.

It is recommended that the equipment be permanently installed near enough to the transmitter so that the connecting coaxial cable will not exceed 50 feet in length.

PRIMARY POWER CONNECTION

115 volt, 60 cycle power should be brought into terminals #9 and #10 on the rear of the main chassis. This line should be "ALIVE" 24 hours a day so that the two crystal ovens which connect to the line prior to the "POWER" switch will be energized continuously.

INPUT CONNECTIONS

RF input to monitor is made to jack J-1 located at the rear of the main chassis. A 50 or 70 ohm solid dielectric cable with vinyl jacket is recommended. Standard cable connectors are furnished with equipment.

RF input requirements for satisfactory performance are: Normal, 10 volts RMS; minimum, 3 volts; maximum 25 volts. Means should be provided at the transmitter end to insure that once set the input level to the monitor is constant.

ACCESSORY DATA

For connection of remote over-modulation alarm indicator, "MAKE" contacts are brought out to terminals #7 and # 8 on rear of main chassis.

Audio output for aural monitoring may be obtained by connecting a 600 ohm terminated line between terminals #11 and #12 with #11 being at ground potential. Output level of about 0 DBM for plus or minus 75 Kc. deviation is obtained. A high impedance output is brought to terminal #13. This connection gives about 7 volts RMS for plus/minus 75 Kc. deviation but it must not be terminated in less than 100,000 ohms. Both outputs include 75 micro-second de-emphasis.

SECTION 2

INSTALLATION PROCEDURE

WARNING: Before connecting power to the monitor make sure that the following precautions are observed:

1. "Power" switch off.
2. "Drive - Operate - Shunt" switch at Drive position.
3. Rotate "Alarm Set" control to the full clockwise position.
4. "Cal 1 - Operate - Cal 2" switch at Operate position.
5. Rotate "Alarm Cal" control to the full counter-clockwise position past the switch point.
6. Adjust coupling to transmitter tank to minimum.

STEP 1

Connect 115 volt, 60 cycle power to terminals 9 and 10. Lights on Zero center meter will light and after several minutes will begin to flicker. This indicates that the crystal ovens have come up to temperature and are starting to cycle.

STEP 2

Turn "Power" switch on. Lights on modulation meter will light. Allow time for tube heating before proceeding.

STEP 3

Slowly increase the coupling to the transmitter. It will be found that the zero center meter reading will increase with coupling until it reads plus 1000 cycles but will go no higher with increasing coupling. The coupling should be left at a point just slightly tighter than that required to produce the reading of plus 1000 cycles.

STEP 4

Change "Cal 1 - Operate - Cal 2" switch to Cal 2 position.

STEP 5

Change "Drive - Operate - Shunt" switch to Shunt position.

STEP 6

Adjust "Det Cal" control to make zero center meter read zero.

STEP 7

Change "Cal 1 - Operate - Cal 2" switch to Operate position. The zero center meter will now read less than plus or minus two hundred cycles if the transmitter is within 2000 cycles of the assigned carrier frequency.

STEP 8

Change "Cal 1 - Operate - Cal 2" switch to Cal 1 position and change "Drive - Operate - Shunt" switch to Operate position.

STEP 9

Adjust "RF Gain" control to obtain the reading of the zero center meter that is given on the calibration card for your monitor. (1375)

STEP 10

Return "Cal 1 - Operate - Cal 2" switch to Cal 2 position. Rotate "Alarm Cal" control until modulation meter reads the percentage of modulation at which alarm operation is desired.

STEP 11

Turn "Alarm Set" control counter-clockwise until the lamp flashes and a relay buzz is heard. Leave the "Alarm Set" control in this position and return the "Alarm Cal" control to the full counter-clockwise position, past the switch operation point.

STEP 12

Re-adjust "Det Cal" control to obtain a zero reading on the zero center meter, if required.

STEP 13

Return "Cal 1 - Operate - Cal 2" switch to the Operate position. The zero center meter now reads the frequency deviation of the transmitter and the alarm circuit will operate on modulation peaks for which the monitor has been set in steps 10 and 11.

OPERATIONAL PROCEDURE

Upon completion of the above installation procedure the monitor is set up for continuous observation of transmitter center frequency deviation and modulation percentage. During the course of the day's operations, however, the monitor will drift slightly due to variations of room ambient. This condition is corrected for by use of the "Cal 1 - Operate - Cal 2" switch and the "Det Cal" control. For a precise center frequency reading the procedure outlined below should be followed:

(1) Turn "Cal 1 - Operate - Cal 2" switch to the Cal 2 position and adjust "Det Cal" control until the zero center meter reads exactly zero; (2) return "Cal 1 - Operate - Cal 2" switch to the Operate position and read average carrier frequency. This procedure is the same as that followed in steps 12 and 13 of the Installation Procedure.

Daily checks should be made on the RF input and the slope setting (Cal 1) calibration. RF input to the monitor is checked with the "Drive - Operate - Shunt" switch in the Drive position and the "Cal 1 - Operate - Cal 2" switch in the Operate position. If this reading is lower than plus 1000 cycles it will be necessary to repeat step 3 of the installation procedure to insure that the input has not fallen below the saturation point. If the input is sufficient, then the reading should be brought to normal by adjustment of R-67. If the correct reading cannot be obtained by R-67, V-15 should be replaced.

Repeat step 8 of the installation procedure for slope setting calibration check and step 9 if adjustment is necessary.

It must be remembered that the monitor is not a frequency standard but rather a frequency comparison for the transmitter. It is the responsibility of the user to insure that accuracy is maintained by periodic independent checks. This can be done by use of the WWV transmissions and a secondary standard or the monitor can be set to agree with the transmitter frequency when the transmitter frequency is measured by a frequency measuring service if such service is available.

The latter method is quite simple and can be done as follows:

1. While frequency is being measured by the measuring service, repeat the steps outlined for a precise center frequency reading (steps 12 and 13 of Installation Procedure).

2. When the transmitter frequency deviation has been stated by the measuring service return the monitor to the normal "Operate" condition and by means of C-26 adjust the frequency of Y-1, the heterodyne crystal, to make the frequency reading agree with that stated by the measuring service. The transmitter frequency may then be corrected, if desired, using the monitor as the reference.

MISCELLANEOUS NOTES AND WARNINGS

1. Do not use this instrument with a transmitter whose average carrier frequency is likely to change more than plus or minus 20 Kc. (as for example during experimental work) without having the "Drive - Operate - Shunt" switch in the Shunt position.

2. If it becomes necessary to change V-13 the following adjustments should be made.

   a. With no modulation on transmitter adjust R-52 to make M-2, the modulation meter, read zero. (Do not adjust the mechanical zero on this meter except with monitor power off).

b. After adjustment of R-52 then adjust R-46 to make M-2 reading agree with an accurately known transmitter deviation (plus/minus 75 Kc deviation is 100% - small black mark near right end of percent modulation scale corresponds to 100 Kc. Deviation or 133-1/3% modulation).

3. If the modulation meter zero has a tendency to drift widely the fault will probably be found to be excessive heater-cathode leakage in V-13. If tube replacement does not correct the condition it may be due to high heater voltage as a result of high line voltage. For best results it is preferable that the average line voltage be not higher than 120.

4. As a result of high level mixing the detector output and hence the auxiliary audio output may contain beats at higher than audible frequencies. When using this output for noise or distortion measurements the output of the noise or distortion analyzer should be examined with an oscilloscope. If such super-audible tones are observed they should either be removed or allowed for in the reading. It is generally possible to reduce them to negligible values, if present, by connecting a de-emphasis network between the high impedance output of the monitor and the input of the analyzer. Such a network should have a time constant no greater than 10 microseconds and may consist of a 47,000 ohm series resistor followed by a 100 mmfd shunt condenser.

SECTION 3

THEORY OF OPERATION

Refer to Block Diagram B-753

The Model 600 monitor is a low sensitivity superheterodyne FM receiver which uses a current balance discriminator to indicate average carrier frequency deviations of the r.f. input signal from the frequency to which the receiver has been "tuned".

The receiver is "tuned" by the use of the two crystals Y-1 and Y-2. Crystal Y-1 and the succeeding multipliers provide the heterodyning signal to the mixer state V-1. Tube V-4 is a double triode, one section of which is used as a crystal oscillator at the Y-1 crystal frequency (usually about four megacycles). The other section of V-4 is either a tripler or quadrupler and this section drives tube V-14 which is always used as a tripler. The output of V-14, at nine or twelve times the Y-1 crystal frequency, is injected on the control grid of V-1, the mixer tube. Since second harmonic injection is used, twice this frequency (eighteen or twenty-four times the Y-1 frequency) will be at i.f. frequency below the carrier frequency to be monitored (i.f. frequency is always two times the Y-2 crystal frequency).

Mixing of the transmitter frequency and the local injection frequency, derived from Y-1, is accomplished in V-1. The resultant i.f. frequency is coupled by means of Z-3 to a limiter tube, V-15, and thence by means of Z-1 to the limiter-driver tube, V-2. The latter tube drives the discriminator, Z-2, and the detector, V-3.

Accurate indication of the transmitter center frequency as measured by the zero center meter (m-1) is dependent upon the discriminator transformer Z-2 being tuned exactly to the i.f. frequency; i.e., the difference frequency of the transmitter and the multiplied Y-1 heterodyne frequency. This is accomplished by the use of the Y-2 crystal and the "Det Cal" control. One section of double-triode V-5 is used as a crystal oscillator at one-half the i.f. frequency and the other half functions as a doubler, using Z-3 as the plate tank circuit. This provides a signal for tuning Z-2 by means of the "Det Cal" fine tuning control.

Recovered audio from the output of detector V-3 is applied (without de-emphasis) to amplifier V-12 which drives one section of V-13 as a half wave rectifier. The other section of V-13 is used as one arm of bridge which, with no modulation, is balanced by adjustment of R-52 to obtain a zero reading on modulation meter, M-2. When the carrier is modulated the recovered audio is rectified by V-13A and applied as a d. c voltage to the grid of V-13B. This serves to unbalance the bridge, which in turn causes current to flow through M-2. The sensitivity of M-2 is adjusted by R-46 to indicate the percentage of modulation represented by the recovered audio. Switch S-4 in conjunction with variable resistor R-54 applies an artificial unbalance to the bridge in order that the alarm circuit may be set to trip at the desired percentage of modulation.

The alarm circuit is set by variation of the cathode voltage applied to the alarm thyratron tube, V-7. A voltage from the modulation meter bridge circuit is applied to the grid of this same tube and causes the tube to fire when the percentage modulation exceeds that for which the cathode voltage has been set. When V-7 fires its plate current (supplied by T-2) is drawn through the coil of a relay and the drop across this coil is used to light the alarm lamp. Since the plate supply voltage for V-7 is a.c. and the relay is designed for d.c. operation, the relay will buzz on over-modulation peaks. Both a visual and aural overmodulation indication is thus obtained.

The recovered audio from the detector is also applied, through a de-emphasis network, to V-6, the aural output stage. This is a dual triode, one section of which is used as a voltage amplifier and the other section as a cathode follower to provide a low impedance output. The cathode follower output connects to terminal 12 through a blocking condenser (terminal 11 is low side of audio output) and this output delivers at least 0.7 volts r.m.s. into a 600 ohm load for a deviation of plus/minus 75 Kc. A high impedance output is available at terminal 13 which delivers at least 7 volts r.m.s. for the same deviation. This terminal must not be terminated in an impedance lower than 100,000 ohms.

The power supply is a conventional full wave rectifier and filter followed by a series type regulator. The voltage can be adjusted by variation of the control tube (V-10) bias which is set by R-36. This is adjusted at the factory for 270 volts.

SWITCH OPERATION

S-1 (modulation up or down) - Selects the polarity of modulation applied to the modulation meter circuit.

S-2 - A.C. power switch.

S-3 (Cal 1 - Operate - Cal 2) -

Cal 1 - Used to set discriminator slope with R-6 ("RF GAIN" control) to obtain the prescribed reading on zero center meter, M-1.

Operate - Normal position.

Cal 2 - Feeds multiplied output of crystal Y-2 into i.f. amplifier for "tuning" discriminator to center by means of C-18 ("Det. Cal" control).

S-4 (Part of Alarm Cal control, R-54) - Used with Alarm Set control, R-27, to set the desired tripping point of the overmodulation alarm.

S-5 (Drive - Operate - Shunt) -

Drive - This switch position converts the zero center meter, M-1 into a 1-0-1 ma. meter and switches it in series with the V-2 grid leak to measure r.f. drive applied to the monitor.

Operate - Normal position

Shunt - This switch position provides normal operation of all monitor circuits but reduces the sensitivity of the zero center meter by a factor of about 10 in order to protect the meter movement.

VOLTAGE READINGS

NOTE: As a general rule, good operation is secured with variations of as much as plus/minus 25% from the values given.

Line voltage 117. Switch S-3 in "Cal 2" position unless noted. Volt-ohmyst used with 100,000 ohm, 1/2 watt resistor as probe.

SOCKET PIN NUMBERS

TUBE	1	2	3	4	5	6	7	8
V1	fil.	260[a]	120[a]	0	0	-10[a]	5[a]	fil.
V2	0	fil.	0	-7	0	75[b]	fil.	245
V3	0	fil.	0	20	-20	0	fil.	0
V4	-24	fil.	175	0	27	195	fil.	0
V5	-30	fil.	205	0	30	255	fil.	0 to -2
V6	0	fil.	125	2.7	3.5	210	fil.	0
V7	0	fil.	39[d]	15[c]	19	39	fil.	39[d]
V8	80[c]	400	0	A.C.	270[c]	A.C.	145[c]	400
V9	0	270	400	400	255	255[c]	270	270
V10	fil.	245	245	105	105	100	105	fil.
V11	0	0	A.C.	260[c]	105	14[c]	A.C.	400[c]
V12	0	fil.	135	2.2	2.2	135	fil.	0
V13	16	fil.	16	16	20	270	fil.	16
V14	fil.	270	90	0	0	-4	5	fil.
V15	fil.	45	105	0	0	-11	0	fil.

a. - S-3 in Cal 1 or Operate position with R.F. input disconnected.

b. - Varies with setting of "RF GAIN" control.

c. - Tiepoint

d. - Varies with "Alarm Set" control.

Tube socket voltages differing materially from the tabulated values indicate a defective or altered component. Inspection and the use of an ohm-meter (with all power off the monitor) will generally disclose the defective part. If a resistor, capacitor, or inductor is not found to be at fault, the trouble lies with a tube, in all likelihood the one at whose socket the variant voltage was observed. When replacing a tube consult the table below. The lettered procedures indicated for each tube are those necessary to recover the original calibration, and correspond to the lettered procedures of the second half of these service notes.

V-1 - Procedure C

V-2 - Procedure C and D

V-3 - Procedure D

V-4 - Procedure A

V-5 - Procedure B

V-6 - No recalibrate procedure necessary

V-7 - No recalibrate procedure necessary

V-8 - No recalibrate procedure necessary

V-9 - No recalibrate procedure necessary

V-10 - No recalibrate procedure necessary

V-11 - No recalibrate procedure necessary

V-12 - Procedure E

V-13 - Procedure E

V-14 - Procedure A

V-15 - Procedure C

READJUSTMENT AND RECALIBRATION

WARNING: Several of the operations detailed below are relatively critical, and are so noted, in that improper execution may result in the deterioration of the Monitor's performance beyond the limits allowed. Unless adequate test equipment is at hand, and unless personnel has a working familiarity with the type of procedure indicated, it is strongly urged that the entire instrument be returned to REL for readjustment.

GENERAL - Servicing this equipment can be divided, as follows: Adjustments in both crystal oscillator circuits; adjustments involving the discriminator and associated tubes and components and adjustments in the modulation monitor circuits. These are further sub-divided according to the lettered headings below.

PROCEDURE A - Adjustment of Crystal Y-1 and Associated Circuits. Failure of any part including tube and crystal associated directly with Y-1 may necessitate re-adjustment of the variable elements. It is our experience that replacement of V-4 does not affect the frequency of oscillation of Y-1 by more than about 200 cycles referred to 100 megacycles. However, the basic accuracy of the carrier frequency measuring function depends on this crystal oscillator circuit, and recalibration is indicated if any gross component failure occurs.

The crystal unit Y-1 operates at either 1/18th or 1/24th of the transmitter frequency less the intermediate frequency (twice Y-2 frequency). To adjust the frequency of the crystal oscillator requires a good receiver capable of receiving the crystal frequency or a low order harmonic of it, a secondary frequency standard with multivibrators, an audio oscillator to serve for interpolation, and an oscilloscope. Of course, the secondary standard should be set against the transmissions of the National Bureau of Standards (WWV) or some other primary standard. If this equipment is at hand or conveniently available it goes without saying that the calibration process is familiar, and the details are omitted here.

The correct condition for L-4, which controls the "strength" of oscillation is about 3/4 turn back from the point where oscillations suddenly cease, i. e., where the tank becomes capacitive. With L-4 correctly adjusted, C-26 is the fine frequency control. If C-26 will not bring the frequency to its correct value, the crystal or its holder have been damaged, and should be returned for examination.

The tank circuit containing L-3 is resonated at either the 3rd, or the 4th harmonic of Y-1 and is adjusted to peak the drive on V-14. This peak may be observed by noting the variations in the D. C. cathode voltage of V-14. V-14 always triples the output of V-4, and the resonating element is C-29. This circuit is tuned by observing the cathode voltage of V-1 with the r.f. input cable connected to the monitor but the transmitter off. The cable must be left connected since its capacity may have some effect on C-29 tuning.

PROCEDURE B - Adjustment of Crystal Y-2 and Associated Circuits. Substantially the same as Procedure A, except that here the requirements on exactness of oscillation frequency are not so severe(by about 10 to 1). Tuning of L-6 is best observed by watching the cathode voltage of the doubler section V-5. Here again, the

oscillator tuning (L-6) must be "backed-off" to a stable oscillation condition. C-34 is the fine frequency control on crystal Y-2.

PROCEDURE C - Adjustment of Z-1. This intermediate frequency transformer is overcoupled and is originally adjusted to be flat within plus/minus 1 db for plus/minus 100 Kc. deviation from the intermediate frequency value. Replacement of V-15 or V-2 may require slight readjustment of C-5 or C-7 respectively. The correct setting is that which secures the least change in reading of "Drive" when about 100% tone modulation is keyed on and off. This change should not exceed 0.03 ma. when the whole reading is about 0.5 ma. Incidentally, if a check of "Drive" during programming shows changes on program peaks it is a pretty sure sign that Z-1 is out of adjustment. This should not occur except for change of tubes or mechanical damage to Z-1. Be sure first, however, that the transmitter is free of amplitude modulation when programmed.

Adjustment of Z-3. This tuning is very broad and non-critical because of the heavy damping associated with the circuit and replacement of V-1 or V-15 will have little effect. It is best tuned using "Cal 2" (Y-2 crystal) and adjusting for maximum developed grid voltage on V-15.

PROCEDURE D - Adjustment of Z-2 and Associated Circuits. The replacement of either V-2 or V-3 will require at the least an inspection to verify whether or not a change in tuning has been made. The primary is in resonance if, with the secondary tuned for zero frequency deviation, the frequency meter exhibits less than plus/minus 200 cycles average shift with 100% tone modulation from the transmitter. As stated elsewhere M-1 is a delicate meter and should always be shunted down when making preliminary adjustments. All final adjustments, however, must be made without the shunt to secure a correct calibration. If it is not otherwise known that there is less than 1/2% distortion in the transmitter then the very soft peak in the reading of the % Modulation meter must be used as an indication of primary resonance. Do not use more than 50% modulation for this adjustment.

After an adjustment of the primary, the secondary will have to be retuned slightly. If it is necessary to retune C-15, the frequency meter should be protected, and it should be done in the Cal 2 condition, and with an insulated tuning tool. The discriminator transformer is slightly overcoupled, and it will be necessary alternately to repeat primary and secondary adjustments.

With Z-2 properly tuned, the Cal 1 condition should be met; that is control of R-6 (panel) should yield the frequency meter reading inscribed on the serial number sheet for the monitor. This adjustment establishes the gradient of the detection circuit at 25 microamperes per kilocycle. Hence, with 100% tone modulation (plus/minus 75 Kc. peak deviation), an audio voltage of .676 volts rms will appear across both R-7 and R-8. Provided the discriminator has not suffered mechanical damage (such as altered coupling), and provided all associated components are of rated value, this provides a basic check of the percent modulation of the transmitter.

PROCEDURE E - Adjustment of Percent Modulation Meter Circuit. Replacement of either V-12 or V-13 will ordinarily not require readjustments. However, such readjustment, if necessary, is straightforward provided the transmitter deviation is

accurately known. If the discriminator is correctly tuned and the monitor in correct operating adjustment, the voltage on R-7 or R-8 may be used as a measure of 100% modulation, as mentioned above in Procedure D. The audio frequency meter used for this purpose should be a good one and should not have an impedance of less than 5000 ohms. For accurate results this will have to be done with no shunt on the frequency meter.

As an entirely independent measurement of deviation the method that follows may be used. It is an adaptation of the so-called "Bessel Function" method, but it is in our experience more accurate and requires less accurate equipment. The items necessary are: a communications type receiver of good stability, capable of tuning to the I.F. frequency of the monitor, and having a BFO; an audio oscillator of reasonably accurate frequency calibration and an oscilloscope. With the transmitter unmodulated and with the receiver loosely coupled to the I.F. of the monitor, tune in the intermediate frequency, using the BFO adjusted to as near zero beat as convenient. Modulate approximately 100% at 15,000 cycles. Slowly tune the receiver away from the I.F. to the 5th zero beat, which will be the 5th sideband of the modulation, and will be accurately 75 kilocycles from the I.F. Change the modulating frequency to a low value, such as 100 cycles. Slowly raise the modulation until one burst of beat note per audio cycle is seen on the scope. It will be observed that for less than 75 Kc. deviation, the burst on the scope will have no zero beat center. At 75 Kc. deviation a zero beat center will appear in the burst, and for more than 75 Kc. deviation there will be signs of the frequency modulated signal swinging twice per audio cycle through zero beat with the receiver. At the single zero beat point the deviation will be plus/minus 75 kilocycles, plus/minus a few hundred cycles, plus 5 times the inaccuracy of the 15,000 cycle setting of the audio oscillator.

SECTION 5

PARTS LIST MODEL 600A FM BROADCAST FREQUENCY AND MODULATION MONITOR

Symbol Ref	REL Part No.	Description
C-1	C-5047	Capacitor - fixed, mica, .001 mfd., 500 VDCW, 20% accuracy
C-2	C-5000	Capacitor - fixed, ceramic, 1200 mmfd., 300 VDCW, 20% accuracy
C-3	C-5247	Capacitor - fixed, ceramic, .005 mfd. GMV, 450 VDCW
C-4		Capacitor - Part of Z-1 assembly
C-5		Capacitor - Part of Z-1 assembly
C-6		Capacitor - Part of Z-1 assembly
C-7		Capacitor - Part of Z-1 assembly
C-8	C-5013	Capacitor - fixed, mica, 220 mmfd., 500 VDCW, 20% accuracy
C-9	C-5171	Capacitor - fixed, mica, .006 mfd., 500 VDCW, ± 20%
C-10		Capacitor - Part of Z-2 assembly
C-11		Capacitor - Part of Z-2 assembly
C-12		Capacitor - Same as C-2
C-13		Capacitor - Same as C-2
C-14		Capacitor - Part of Z-2 assembly
C-14A		Capacitor - Part of Z-2 assembly
C-15		Capacitor - Part of Z-2 assembly
C-16	C-5002	Capacitor - fixed, ceramic, 4.7 mmfd., 500 VDCW, 10% accuracy, zero coefficient.
C-17		Capacitor - Same as C-16
C-18	C-5009	Capacitor - variable, air, split stator, 5-36 sec., 2.5-18 mmfd.
C-19	C-5175	Capacitor - fixed, mica, .005 mfd., 500 VDCW, 20% accuracy
C-20		Capacitor - Same as C-8
C-21		Capacitor - Same as C-8
C-22		Capacitor - Same as C-1
C-23		Capacitor - Same as C-9
C-24	C-5172	Capacitor - fixed, silvered mica, .000047 mfd., 500 VDCW, 10% accuracy
C-25	C-5173	Capacitor - fixed, silvered mica, .00015 mfd., 500 VDCW, 10% accuracy
C-26	C-5026	Capacitor - variable, air, trimmer type, 47 mmfd., .016" nominal spacing.
C-27		Capacitor - Same as C-16
C-28		Capacitor - Same as C-9
C-29		Capacitor - Same as C-26
C-30		Capacitor - Same as C-2
C-31	C-5001	Capacitor - fixed, ceramic, 100 mmfd., 500 VDCW, 10% accuracy

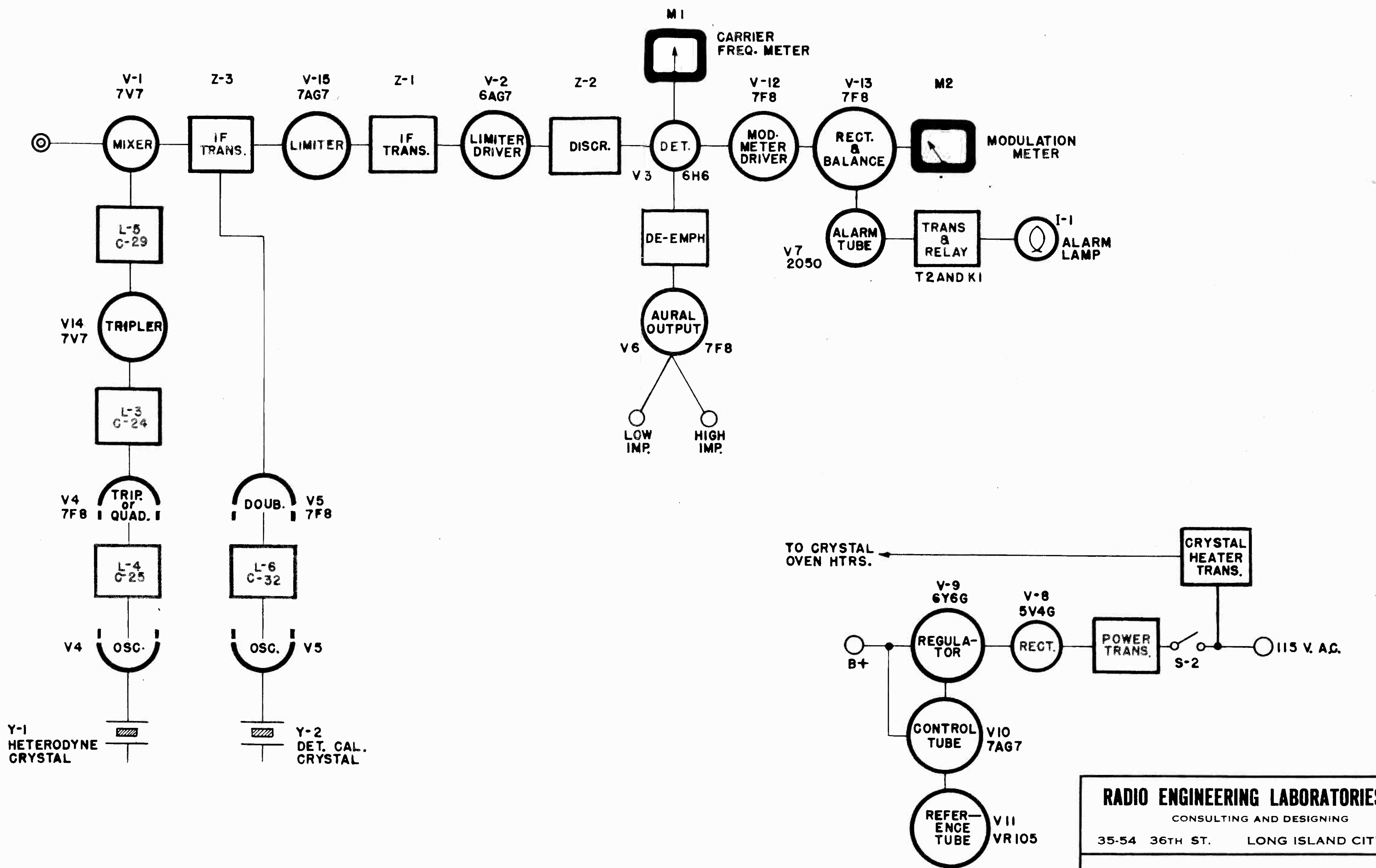
Symbol Ref	REL Part No	Description
C-32		Capacitor - Same as C-31
C-33		Capacitor - Same as C-9
C-34		Capacitor - Same as C-26
C-35	C-5174	Capacitor - fixed, mica, .001 mfd., 500 VDCW, 5% accuracy
C-36	C-5169	Capacitor - fixed, paper, oil filled, 0.25 mfd., plus 20%, minus 10%, 600 VDCW
C-37	C-5168	Capacitor - fixed, paper, oil filled, 1.0 mfd., plus 20%, minus 10%, 600 VDCW
C-38		Capacitor - Same as C-3
C-39	C-5258	Capacitor - fixed, electrolytic, 20 mfd., 525 VDCW
C-40	C-5237	Capacitor - fixed, electrolytic, 40 mfd., 450 VDCW
C-41		Capacitor - Same as C-37
C-42		Capacitor - Same as C-37
C-43		Capacitor - Same as C-31
C-44		Capacitor - Same as C-37
C-45		Capacitor - fixed, paper, oil filled, 0.1 mfd., plus 20%, minus 10%, 600 VDCW
C-46		Capacitor - Part of Z-2 assembly
C-47		Capacitor - Same as C-9
C-48		Capacitor - Same as C-9
C-49		Capacitor - Same as C-31
C-50		Capacitor - Same as C-2
C-51		Capacitor - Same as C-9
C-52		Capacitor - Same as C-9
C-53		Capacitor - Same as C-2
C-54		Capacitor - Same as C-2
C-55		Capacitor - Same as C-2
C-56		Capacitor - Same as C-2
C-57		Capacitor - Same as C-9
C-58	C-5235	Capacitor - fixed, electrolytic, tubular, 50 mfd., 25 VDCW
C-59		Capacitor - Same as C-58
C-60		Capacitor - Part of Z-3 assembly
C-61		Capacitor - Part of Z-3 assembly
C-62		Capacitor - Same as C-3
F-1	F-5000	Fuse - glass enclosed, 1 ampere, 250 volts
F-2	F-5006	Fuse - glass enclosed, 2 amperes, 250 volts
I-1	I-5004	Lamp - pilot light, 115 volts, 6 watt, candelabra base
J-1	J-5001	Jack - female contact, chassis mtg. type
K-1	K-5029	Relay - coil for 100 volts DC with 25 MA. or less, two form A contact sections per relay

Symbol Ref	REL Part No.	Description
L-1	L-5066	Coil, R.F. - Choke "resistor" type, 1 micro-henry
L-2	L-5028	Coil, radio - choke, inductance 2.5 millihenries, 15% accuracy, multiple pi, ceramic bobbin, wax impregnated
L-3	L-5002	Coil, radio - heterodyne oscillator 1st tripler, integral type, single winding
L-4	L-5051	Coil, radio - oscillator plate tank
L-5		Coil, radio - tripler plate
L-6		Coil, radio - Same as L-4
L-7	L-5033	Choke, filter - 20 henries at 75 MA. maximum DC resistance, 1,600 ohms, hermetically sealed
L-8		Coil - Same as L-1
M-1	M-5020	Meter - DC microammeter, zero center 50-0-50 microampere deflection, special scale and pointer, scale has 40 divisions and plus/minus 2000 cycles on the scale to correspond to plus/minus 50 microamps on the meter, 2% accuracy
M-2	M-5027	Meter - DC microammeter - Movement 0 to 250 microamperes, 1400 ohms, scale as for Model 862 type 30B with 250 microamperes giving full scale (plus 3VU indication and with additional mark at a deflection corresponding to 133-1/3% modulation, damping factor within 16 to 200, time for one complete oscillation of the pointer is from 290 to 350 milliseconds, 2% accuracy
P-1	P-5002	Plug - connector, coaxial, used with J-1
R-1		Resistor - Part of Z-3 assembly
R-2	R-5086	Resistor - fixed, composition, 1000 ohms, 1 watt, 10%
R-3	R-5034	Resistor - fixed, composition, 82,000 ohms, 1/2 watt, 10%
R-4	R-5224	Resistor - fixed, composition, 20,000 ohms, 1/2 watt, 10%
R-5	R-5186	Resistor - fixed, composition, 47,000 ohms, 1 watt, 10%
R-6	R-5219	Resistor - variable, wirewound, 50,000 ohms, 10% accuracy, 3 watts dissipation at full resistance, linear taper
R-7	R-5225	Resistor - fixed, composition, 510 ohms, 1/2 watt, 5%
R-8		Resistor - Same as R-7
R-9	R-5203	Resistor - fixed, composition, 6200 ohms, 1/2 watt, 5%
R-10		Resistor - Same as R-9
R-11	R-5204	Resistor - fixed, composition, 1 meg ohm, 1/2 watt, 10%
R-12	R-5226	Resistor - fixed, composition, 10 ohms, 1/2 watt, 5%
R-13		Resistor - Same as R-2
R-14	R-5200	Resistor - fixed, composition, 100,000 ohms, 1/2 watt, 10%
R-15		Resistor - Same as R-14
R-16	R-5035	Resistor - fixed, composition, 15,000 ohms, 1/2 watt, 10%
R-17		Resistor - Same as R-3
R-18		Resistor - Same as R-16
R-19		Resistor - Same as R-3

Symbol Ref	REL Part No.	Description
R-20	R-5206	Resistor - fixed, composition, 75,000 ohms, 1/2 watt, 5% accuracy
R-21		Resistor - Same as R-14
R-22	R-5302	Resistor - fixed, composition, 27,000 ohms, 1/2 watt, 10%
R-23	R-5208	Resistor - fixed, composition, 2000 ohms, 1/2 watt, 10%
R-24		Resistor - Same as R-11
R-25	R-5134	Resistor - fixed, composition, 15,000 ohms, 1 watt, 10%
R-26	R-5217	Resistor - fixed, composition, 150,000 ohms, 1/2 watt, 10%
R-27	R-5220	Resistor - variable, composition, 100,000 ohms, 20% accuracy, 1/2 watt at full resistance, linear taper
R-28	R-5209	Resistor - fixed, composition, 40,000 ohms, 1/2 watt, 10%
R-29		Resistor - Same as R-16
R-30	R-5222	Resistor - fixed, composition, 300,000 ohms, 1/2 watt, 10%
R-31	R-5112	Resistor - fixed, composition, 100,000 ohms, 1 watt, 10%
R-32	R-5032	Resistor - fixed, composition, 100 ohms, 1/2 watt, 10%
R-33	R-5306	Resistor - fixed, composition, 180,000 ohms, 1/2 watt, 10%
R-34	R-5022	Resistor - fixed, composition, 10,000 ohms, 1/2 watt, 10%
R-35	R-5101	Resistor - fixed, composition, 150,000 ohms, 1 watt, 10%
R-36	R-5221	Resistor - variable, composition, 100,000 ohms, 1/2 watt at full resistance, linear taper, 20% accuracy
R-37		Resistor - Same as R-3
R-38	R-5210	Resistor - fixed, composition, 33,000 ohms, 1 watt, 10%
R-39		Resistor - Same as R-31
R-40		Resistor - Same as R-16
R-41		Resistor - Same as R-2
R-42		Resistor - Same as R-2
R-43	R-5126	Resistor - fixed, composition, 250,000 ohms, 1/2 watt, 10%
R-44	R-5212	Resistor - fixed, composition, 2.7 meg ohm, 1/2 watt, 10%
R-45		Resistor - Same as R-16
R-46		Resistor - Same as R-36
R-47		Resistor - Same as R-3
R-48	R-5213	Resistor - fixed, composition, 5000 ohms, 1/2 watt, 10%
R-49		Resistor - Same as R-4
R-50	R-5207	Resistor - fixed, composition, 47,000 ohms, 1/2 watt, plus/minus 10%
R-51	R-5300	Resistor - fixed, composition, 180,000 ohms, 1/2 watt, 5%
R-52		Resistor - Same as R-36
R-53		Resistor - Same as R-28
R-54	R-5023	Resistor - variable, carbon, .5 meg ohm, rotation counter-clockwise, taper curve A with switch
R-55		Resistor - Same as R-28
R-56		Resistor - Same as R-3
R-57		Resistor - S me as R-2
R-58		Resistor - Same as R-14
R-59		Resistor - Same as R-28
R-60		Resistor - Same as R-2
R-61		Resistor - Same as R-2

Symbol Ref	REL Part No.	Description
R-62		Resistor - Part of Z-3 assembly
R-63	R-5393	Resistor - fixed, composition, 56 ohms, 1/2 watt, plus/ minus 10%
R-64	R-5032	Resistor - fixed, composition, 100 ohms, 1/2 watt, plus/ minus 10%
R-65		Resistor - Same as R-5
R-66		Resistor - Same as R-5
R-67		Resistor - Same as R-36
R-68		Resistor - Same as R-31
R-69	R-5125	Resistor - fixed, composition, 1000 ohms, 1/2 watt, plus/ minus 10%
S-1	S-5020	Switch - toggle, SPDT, no center position, contacts 3 amp at 125 volts AC
S-2	S-5019	Switch - toggle, DPST, no center position, contacts 3 amp at 125 Volts AC
S-3	S-5018	Switch - circuit selector type, 4 circuits, 3 positions, non-shorting
S-4		Switch - Part of R-54
S-5		Switch - Same as S-3
T-1	T-5035	Transformer - crystal heater - primary 115 volts, 60 cycles, Sec. 6.3 volts rms at 2.0 amps - hermetically sealed
T-2	T-5052	Transformer - Thyratron plate - primary 115 volts, 60 cycles, Sec. 125 volts rms at 80 MA. - hermetically sealed
T-3	T-5034	Transformer - plate - primary 115 volts, 60 cycles - Sec. #1, 310-0-310 volts rms at 75 MA. - Sec. #2, 5 volts rms at 2.0 amps - Sec. #3, 6.3 volts rms at 1.25 amps - Sec. #4, 6.3 volts rms at 4.0 amps CT - hermetically sealed
V-1		Tube - Type 7V7
V-2		Tube - Type 6AG7
V-3		Tube - Type 6H6
V-4		Tube - Type 7F8
V-5		Tube - Same as V-4
V-6		Tube - Same as V-4
V-7		Tube - Type 2050
V-8		Tube - Type 5V4G
V-9		Tube - Type 6Y6G
V-10		Tube - Type 7AG7
V-11		Tube - Type OC3/VR105
V-12		Tube - Same as V-4
V-13		Tube - Same as V-4
V-14		Tube - Same as V-1
V-15		Tube - Same as V-10

Symbol Ref	REL. Part No.	Description
X-1	X-5007	Socket for V-1 - octal, ceramic
X-2	X-5006	Socket for V-2 - octal, ceramic
X-3		Socket for V-3 - Same as X-1
X-4		Socket for V-4 - Same as X-1
X-5		Socket for V-5 - Same as X-1
X-6		Socket for V-6 - Same as X-1
X-7	X-5060	Socket for V-7 - octal, mica-filled bakelite
X-8		Socket - Same as X-7
X-9		Socket - Same as X-7
X-10		Socket for V-10 - Same as X-1
X-11		Socket for V-11 - Same as X-7
X-12		Socket for V-12 - Same as X-1
X-13		Socket for V-13 - Same as X-1
X-14		Socket for V-14 - Same as X-1
X-15		Socket for V-15 - Same as X-1
X-16	X-5010	Socket for Y-1 - 5 prong, ceramic
X-17		Socket for Y-2 - Same as X-16
X-18	X-5013	Socket for I-1 - Pilot light assembly, candelabra base with amber indicator
X-19	X-5027	Fuse holder - for F-1
X-20		Fuse holder for F-2 - Same as X-19
Y-1	Y-5013	Crystal Unit - quartz, frequency specified within range 4566,667 3.75/5.100 mc. accuracy plus/minus Kc .0002% of specified frequency at oven temperature of 75 deg C in model oscillator. Unit stability plus/minus .0001% for ambient range of 25 deg C to 60 deg C - Heater unit operates at 6.3 volts, 1 amp
Y-2	Y-5014	Crystal Unit - quartz, frequency 5.350 mc. accuracy plus/minus .0005% of specified frequency at oven temperature of 75 deg C in model oscillator - Unit stability plus/minus .0001% for ambient range of 25 deg C to 60 deg C. Heater unit operates at 6.3 volts, 1 amp
Z-1		Interstage Tuning Assembly
Z-2		Discriminator Tuning Assembly
Z-3		Interstage Tuning Assembly



RADIO ENGINEERING LABORATORIES, INC.

CONSULTING AND DESIGNING

35-54 36TH ST. LONG ISLAND CITY, N. Y.

MODEL 600A

BLOCK DIAGRAM

DATE– MAY 5, 1949	B-753
SCALE–	
DR. BY– M. M. W.	
APP. BY– W. Thorp	