NORTHERN RADIO COMPANY

Incorporated

143-149 WEST 22nd ST., NEW YORK, N.Y. 10011

Phone: (Area Code 212) 929-9117

pace-setters

in quality

communication

equipment

In Canada: Northern Radio Mfg. Co., Ltd., 1950 Bank St., Ottawa, Ontario.

GUARANTEE

All items of equipment and material used in this unit are guaranteed against material defects, workmanship or manufacture, for a period of one year from date of the installation, except that the items of equipment and material are not guaranteed for a term longer than two years from the date of shipment.

Under the terms of this guarantee, all items which fall within the periods defined will be replaced F.O.B. point of installation without cost to the purchaser. The company will pay transportation charges of any defective part which it desires to have returned to its plant. If, upon examination of the defective item the company can show that failure was not due to any defective workmanship, material or manufacture, the company will bill the purchaser for the cost of replacement, including transportation charges.

NORTHERN RADIO COMPANY, Incorporated
NEW YORK, NEW YORK

TABLE OF CONTENTS

1. GENERAL

Purpose:

The Type 159 Model 1 Receiver is used in a dual spaced diversity receiver in high speed radio teleprinter, telegraph or telephone service. The receiver is a Hammarlund SP-600J Receiver, specially modified for dual diversity application. This receiver will receive any one of the commonly used modulations, such as frequency shift, CW or Voice (telephone) communications.

When used in conjunction with other frequency shift equipment or special terminal equipment as manufactured by Northern Radio Company, the unit can be used for radio teleprinter reception, undulator tape recording and program reception, Multiplex teleprinter circuits, or for remote service where the intelligence is to be transmitted via land line or UHF link.

Description:

All essential circuits of the Hammarlund SP-600J Receiver are modified so that the receiver may be used conveniently in dual or triple diversity receiving systems.

The HFO and BFO circuits are modified so that operation with either the receiver's built-in oscillators or external oscillators (usually oscillators common to two or more receivers) is possible by front panel switching. The AVC and second detector circuits are brought outside at the rear for external use or interconnection in diversity service. The output of the IF amplifier is available for external use at the rear of the receiver.

The IF crystal filters and amplifiers are realigned to 455 KC ± 25 cps. to provide receivers interchangeable in any diversity combination.

All the circuit changes are made so that the receiver's original performance is retained, and practically not affected by the added external connections.

Technical Data:

Frequency Ranges:	540 kilocycles to 54.0 megacycles in six bands.
Band 1	.54 to 1.35 mc
Band 2	1.35 to 3.45 mc
Band 3	3.45 to 7.40 mc
Band 4	7.40 to 14.8 mc
Band 5	14.80 to 29.7 mc
Band 6	29.70 to 54.0 mc

Technical Data: (cont'd)

Output:

Max. Undistorted Output:	Approximately 2.5 watts
Impedance:	600 ohms balanced, split winding
Phone Jack Winding:	Delivers 15 milliwatts into an 8000 ohm resistive load, when the audio output to the 600 ohm power load is adjusted to 500 milliwatts.

Performance: (Approx. values)

Sensitivity:	2.3 microvolts or better, throughout entire frequency range, for a signal to noise power ratio of 10:1.
Image Rejection Ratio:	Better than 90 db, throughout entire frequency range.
I. F. Rejection Ratio:	2700 to 1 at 600 KC.
AVC Action:	Will maintain output constant within 12 db, when input is increased from 2 to 200,000 microvolts.
Dimensions:	19" wide x 10-1/2" high x 16-1/2" deep for mounting in standard 19" relay rack cabinet.

Controls:

Front

1. Tuning Dial
2. Tuning Lock
3. Tuning Meter
4. Band Change
5. Selectivity Switch
6. Phasing Control
7. Beat Frequency Oscillator
8. Noise Limiter Switch
9. Send-Receive Switch
10. AVC-Manual Switch
11. R. F. Gain Control
12. Audio Gain Control
13. BFO Local-External Switch
14. AVC External-Internal BFO

Rear

15. AVC Local-Diversity Switch
16. 3.5 MC Oscillator Switch
17. I. F. Gain Control

Technical Data: (cont'd)

Power Requirements:		95, 105, 117, 130, 190, 210, 234, 260 volt taps, 50-60 cycles. 130 watts, 1.25 amps at 117 volts maximum.	
Tube Complement:	V1	6BA6	1st RF Amplifier
	V2	6BA6	2nd RF Amplifier
	V4	6J6	High Frequency Oscillator
	V5	6BE6	1st Mixer
	V6	6BE6	2nd Detector
	V7	6BA6	Gate
	V8	12AU7	3.5 MC Oscillator
	V9	6BA6	1st IF Amplifier
	V10	6BA6	2nd IF Amplifier
	V11	6BA6	Driver
	V12	6BA6	Buffer
	V13	6J6	Beat Frequency Oscillator
	V14	6AL5	2nd Detector and AVC
	V15	6AL5	Limiter & Output Meter
	V16	12AU7	Cathode Follower & Audio Amplifier
	V17	6V6/GT	Output
	V18	0A2	Voltage Regulator
	V19	5R4GY	Rectifier
	V20	6AL5	C-Rectifier

2. DESCRIPTION OF OPERATION

1. General Description:

The Type 159 Model 1 Communications Receiver is a Hammarlund Model SP-600J General Purpose Communications Receiver specially modified to Northern Radio Company specifications to permit its use as an integral component of NRC diversity receiving system. The following technical information concerning the description and operation of the receivers has been obtained from the Hammarlund Instruction Book, modifications being made where required.

The SP-600J is a 19 tube Radio Communications Receiver with self-contained power supply. The J suffix in this model number denotes that this receiver is made in accordance with JAN specifications, with the exception of the use of a few capacitors and resistors where special design considerations require special values and tolerances not included in the JAN preferred value lists or where space limitations do not permit their use. The special components so used are equal or superior to the JAN components in quality.

1. General Description: (cont'd)

The receiver is supplied for mounting in a standard 19 inch relay rack cabinet.

The self-contained power supply is designed for operation from a single phase, 50 to 60 cycle alternating current power source. The power transformer primary is provided with taps covering a line voltage range from 95 to 260 volts. The power consumption is 130 watts.

The receiver is suitable for either headphone or loud speaker reception of AM radio telephone, CW-telegraph of MCW telegraph signals.

The receiver provides continuous coverage over a frequency range from 0.54 to 54.0 megacycles in six bands. The large easily operated band change control knob, on the front panel, selects the desired frequency band and a band indicator visible through a small front panel window indicates the frequency band in use. This control also aligns the dial frequency indicator with the proper dial scale.

In addition to the frequency scales, the main dial has an arbitrary scale which in conjunction with the band spread dial provides continuous band spread scales over each frequency band for extremely accurate logging and resetability.

The single tuning control is large and of special design to permit maximum traverse speed as well as exceptional operating ease. It controls both the main and band spread dials. An anti-backlash gear train provides extremely close calibration accuracy and completely accurate resetability. A tuning lock provides positive locking action without affecting the frequency setting.

The tuning ratio from the tuning control to the main dial is 50 to 1 and the ratio from the band spread dial to the main dial is 6 to 1.

An ingeniously designed rotary turret is employed to change bands and to place the coil assemblies of the RF amplifier, Mixer and First Heterodyne Oscillator stages directly adjacent to their respective sections of the four gang tuning capacitor and their respective tubes. This assures maximum sensitivity at high signal to noise ratio.

Two stages of tuned radio frequency amplification are provided on all bands. The circuit for single conversion, used on frequencies up to 7.4 megacycles, includes a mixer, heterodyne oscillator, four stages of IF amplification, detector and AVC rectifier, noise limiter and meter rectifier beat frequency oscillator, beat frequency buffer amplifier, IF output, AF amplifier and output power stage. The circuit for double conversion, employed for frequencies above 7.4 megacycles, includes a second mixer and a second heterodyne crystal controlled oscillator. The power supply system includes a B power rectifier, C bias rectifier and a voltage regulator.

1. General Description: (cont'd)

The two scale tuning meter normally indicates the relative strength of the received signal in db from 1 microvolt, when operated on AVC and with the RF and IF gain controls at maximum. A rear control is provided for adjustment at the plus 20 db scale reading with an RF signal input of 10 microvolts. On depression of the panel meter switch, the lower scale of the meter indicates the audio output power level in db from 6 milliwatts. A rear control is provided for adjustment of the 0 db reading.

The AVC circuit is provided with separate time constants for CW and MCW operation. The local beat frequency oscillator employs a high capacity Colpitts circuit which gives a high order of frequency stability and minimizes oscillator harmonics. The beat frequency oscillator voltage is introduced into the detector through a buffer amplifier which eliminates oscillator lock-in. This feature makes it possible to tune signals sharply to zero beat and permits the inclusion of the rear control for adjusting the beat oscillator injection to suit operating conditions. A front panel control varies the audio beat frequency from 0 to plus or minus 3 KC.

The noise limiter circuit effectively limits the interference from ignition systems or other sources of pulse type noise. The limiter switch permits optional use of the limiter.

The antenna input circuit is designed for use with a balanced line. The input impedance is nominally 100 ohms. The receiver may also be operated with a conventional single wire antenna.

The audio output circuit is designed for a 600 ohm load or line and is provided with a four terminal split winding for balanced load operation. Undistorted power output is approximately 2.5 watts. The headphone circuit when referred to an 8000 ohm load provides signals attenuated approximately 15 db below the 600 ohm power output.

An RF gain control is provided for the manual control of sensitivity in the presence of strong signals and operates on either MANUAL or AVC.

The send-receiver switch desensitizes the receiver but leaves the power on to provide for instant reception between transmission periods. A rear receptacle provides for the connection of an external relay.

The selectivity control provides three degrees of crystal and three degrees of non-crystal selectivity ranging from sharp (.2 KC) to broad (13. KC).

2. Circuit Description:

General:

The circuit is shown schematically in Dwg. No. 159101. A block diagram, Dwg. No. A-159107, is provided to more clearly show the arrangement and functions of the various circuit sections. The location of the various tubes is shown in Dwg. No. A-159108. The circuit for single conversion, used for single frequencies up to 7.4 mc consists of two stages of RF amplification V-1 and V-2, First Mixer V5, First Heterodyne Oscillator V-4, four stages of IF amplification V-7, V-9, V-10 and V-11, Detector and AVC rectifier V-14, Noise Limiter V-15, Beat Frequency Oscillator V-13, IF output and AF amplifier V-16-A and V-16-B, Output Power stage V-17 and the Power Supply system which includes B Power Rectifier V-19, C Bias Rectifier V-20 and Voltage Regulator V-18.

In the circuit for double conversion, used for signal frequencies above 7.4 mc, the Second Mixer V-6 and Second Heterodyne Oscillator V-8 are substituted for the Gate Tube V-7.

Input Coupling:

The antenna coupling is designed to provide optimum coupling from a 100 ohm transmission line. A balanced doublet or straight wire antenna may be used.

RF Amplifier:

A rotary turret is employed to change bands and to place the coil assemblies of the RF amplifier V-1 and V-2, Mixer V-5 and First Heterodyne oscillator V-4 stages directly adjacent to their respective sections of the four gang tuning capacitor and their respective tubes. This assures maximum sensitivity at high signal to noise ratio.

First Heterodyne Oscillator - (Variable V-4):

The high frequency oscillator has been modified to permit receiver operation with either local or external HFO. A coaxial HFO connector is mounted at the rear of the receiver and the HFO control switch is mounted at the receiver front panel. A BFO trap in the external HFO input line prevents possible interfering IF frequency from entering into the HF circuits for external HFO operation.

2. Circuit Description: (cont'd)

First Heterodyne Oscillator - (Variable V-4): (cont'd)

The oscillator tube has been changed to a 6J6 dual triode, one section of which is the local oscillator; the other section is used as an amplifier for external HFO input.

The rotary turret band change switch (advanced design of the four gang, twin section, variable tuning capacitor) and rugged construction throughout, provide frequency stability and dial calibration accuracy to a previously unattained degree.

Intermediate Frequency Amplifier:

Single conversion to 455 kc is employed for signal frequencies below 7.4 mc. There are four stages of IF amplification incorporating the crystal filter circuit. Six positions of selectivity provide 6 db band widths of .2, .5, 1.3, 3, 8 and 13 kc. On the three narrower bandwidth positions, the crystal filter is in operation. The crystal phasing control provides extreme selectivity for the high attenuation of closely adjacent interfering signals.

Double conversion is employed for signal frequencies above 7.4 mc. The signal is heterodyned to 3.955 mc by the First Mixer V-5 and Heterodyne Oscillator V-4 for high image rejection. The 3.955 mc signal is then heterodyned to 455 kc by the Second Mixer V-6 and the 3.5 mc Fixed Crystal Controlled Oscillator V8, for selectivity.

The 3.5 mc crystal oscillator has been redesigned to permit single or diversity receiver operation. One section of the dual triode V8 is used as the crystal controlled oscillator with trimmer capacitor C101 to permit adjustment of oscillator frequency to exactly 3.5 MCS. The second section of V8 is used as a buffer amplifier to provide low impedance oscillator output and to insure oscillator stability for dual diversity receiver operation. A coaxial connector provides means for interconnecting the oscillator circuits of two receivers as required for high stability diversity operation.

Detector and AVC:

The V-14 tube is used as a high level Detector and AVC Rectifier. The AVC circuit is provided with separate time constants for CW and MCW operation.

2. Circuit Description: (cont'd)

Detector and AVC: (cont'd)

For dual diversity operation, both receivers are made to operate into a common detector load resistance. Accordingly, the detector-load connection of the receiver is broken and brought to terminal strip E19 at the rear of the receiver. Choke L54 is required so that the tuned IF plate circuit of the Driver V11 remains undisturbed. For single receiver operation terminals #4 and #5 of E19 are joined together.

Likewise, for diversity operation, it is often required to operate the receivers with combined AVC. Accordingly the AVC line of the receiver is brought to terminal 3 of E19. RF filter L55 - C175 in the AVC line prevent receiver interference caused by pickup or RF injection voltages.

Beat Frequency Oscillator:

The beat frequency oscillator employs a high capacity Colpitts circuit which gives a high order of frequency stability and minimizes oscillator harmonics. The beat frequency Oscillator V-13, is coupled into the detector circuit through Buffer Amplifier V-12, which eliminates oscillator lock-in and permits variation of the beat oscillator injection by means of a control located on the rear of the chassis. A front panel control varies the audio beat frequency, from zero beat to plus or minus 3 kc.

As with the high frequency oscillator, the beat frequency oscillator has been modified to permit receiver operation with either local or external BFO. The coaxial BFO connector is mounted at the rear of the receivers; the BFO control switch at the front panel. The BFO oscillator tube, V-13, has been changed to a 6J6 dual triode. One section of V13 is used as the local oscillator for normal BFO operation; the second section as an amplifier for externally supplied BFO frequency.

Noise Limiters:

The noise limiter circuit V-15 limits the noise interference for ignition systems or other sources of pulse type noise. A separate control switch S-6 permits optional use of the limiter on any mode of operation when pulse type interference is present.

Audio Frequency Amplifier:

A resistance coupled amplifier triode V-16-B amplifies the audio frequency signal from the detector.

2. Circuit Description: (cont'd)

Audio Output:

The audio output tube V17 is transformer coupled through a split, balanced winding to deliver 2.5 watts undistorted output to a 600 ohm load. The split balanced winding permits balancing of the direct current in the output circuit, as used for teletype or similar services. A separate secondary winding provides attenuated audio signal output for headphone operation. This winding will deliver an output of 15 milliwatts into an 8000 ohm resistive load when the 600 ohm power secondary is delivering 500 milliwatts to a 600 ohm resistive load.

IF Output:

A buffer amplifier V-16-A provides a low impedance source of intermediate frequency (455 kc) signal to the connector on the rear skirt of the chassis.

Power Supply:

The power supply is an integral part of the receiver. It includes the B rectifier V-19 and the C rectifier V-20, together with their respective low pass filters and the Voltage Regulator V-18. The power transformer is provided with screw terminal primary taps, covering a power line source range of 95 to 260 volts, 50 to 60 cycles. The power transformer is protected by a fuse F1 in the primary circuit and by fuse F2 from the center tap of the transformer high voltage secondary to ground.

Tuning Meter:

The tuning meter is used on AVC operation to indicate the accuracy of tuning and the relative strength of received signals. Depression of the Meter Switch converts the meter circuit for indication of output level in db from 6 milliwatts.

RF Gain Control and Power Switch:

The RF gain control is provided for manual control of sensitivity to prevent overloading on strong signals when operating with the AVC-MANUAL switch in the "MANUAL" position. The Power "ON-OFF" switch is operated at the counter-clockwise extremity of the RF gain control.

2. Circuit Description: (cont'd)

Send-Receive Switch:

The send-receive switch desensitizes the receiver but leaves the power "ON" to provide for instant reception between transmission periods. A receptacle is provided on the rear of the receiver for the external connection of a relay.

Convenience Outlet:

A convenience power outlet is provided on the rear of the chassis for the connection of an accessary such as a lamp or electric clock.

Radiation:

Advance design and shielding of the high frequency, second conversion crystal and beat frequency oscillators has reduced radiation to a negligible point so that interference of this nature, common in multi-receiver installations, is reduced to minimum.

3. INSTALLATION

1. Electrical Installation:

Power Supply:

Make sure that the primary tap load on the power transformer is connected to the transformer tap which most nearly agrees with the 50 to 60 cycle power source voltage.

Headphones:

Either low or high impedance headphones may be used in the phone jack. The high impedance type is recommended. The phone jack is located at the lower left side of the front panel.

1. Electrical Installation: (cont'd)

Antenna:

The input impedance at the antenna terminals is designed to match a 100 ohm transmission line. The angle plug adapter and connector supplied with the receiver, is designed for use with a small diameter "TWIMAX" transmission line, which should be used with a balanced antenna installation. If it is desired to operate with a single wire antenna, the antenna lead-in wire should be connected to one terminal of the connector plug and a ground lead may be connected from the other terminal of the connector plug to the ground terminal which is adjacent to the antenna input receptacle at the rear of the tuning unit.

The choice of an antenna is usually governed by the space available for installing it and the type of service (frequency bands, directivity, etc.), in which the receiver is to be used. While the high sensitivity of these receivers makes the antenna problem less critical than it would be for a less sensitive receiver, a good antenna system assures maximum satisfaction to the user. The following comments are offered as a guide to some basic antenna design considerations. Detailed information on antennas has been widely published and should be consulted for answers to special problems.

For space diversity operation, each receiver must have its own antenna system. The location of the two antennas can only be determined from the local conditions of reception and the available space. However, it is recommended that there be a minimum separation of 200 feet between antennas to insure optimum results from spaced diversity operation.

For the broadcast frequencies up to about 2 mc, adequate signal strength is usually available. Consequently, non-critical lengths of wire properly spaced for diversity may be used with satisfactory results.

For short wave reception in the range from 2 to 30 mc, diversity becomes of great importance. Directive antenna such as half wave radiators like the folded doublet, or preferably, the rhombic, V, and fish bone antenna are useful in that they discriminate against undesired signals, reduce noise, energy pick-up, and increase the intercept area in the favored direction of reception. The rhombic, consisting of an array of 4 non-resonant wires arranged in a diamond or rhomboid shape, and the fish bone consisting of a series of antennas arranged in cellinear pairs, loosely coupled to a transmission line by small capacitors, are essentially non-resonant or wide band antenna and are useful over a frequency range of 2:1 without any readjustment whatever. The rhombic antenna, remote from ground, has a power gain of 43 and 21 for legs 4 and 2 wavelengths long respectively, while the fishbone antenna has the added advantage of being free from minor lobes.

3. Electrical Installation: (cont'd)

Antenna: (cont'd)

Resonant or narrow band antenna such as the folded doublet and the V formed by two long resonant wires at an angle to each other are extremely useful when operation over a small band of narrow frequencies is desired. Improved reception is brought about by a decrease in noise pick-up and discrimination against unwanted signals.

For VHF reception above 30 mc, the principal problem is the abstraction of a sufficient energy from the passing radio waves. Highly directive, resonant V's rhombic antennas, and arrays of half wave radiators, must always be used.

4. DESCRIPTION OF CONTROLS

Tuning Dials:

The main dial is to the left and the band spread dial is to the right. The main dial has six frequency band scales, calibrated in megacycles and an arbitrary outer scale. The band spread dial has an arbitrary, 0 to 100, scale. The numeral under the fixed pointer of the main dial indicates the number of revolutions that have been made by the band spread dial at any setting. Thus, if the pointer, for the outer scale of the main dial indicates over the figure 4 and the band spread dial indicates 87.6, the reading to log for this setting is read 487.6. This precise mechanical band spread system divides the rotation of the main dial over each frequency band into approximately 600 band spread divisions, with one half division calibration points. Since it is easy to estimate one tenth divisions, on the band spread scale, this divides each frequency band into approximately 6000 readable settings. This permits extreme accuracy in the logging of stations.

HFO "Int-Ext" Switch, S12:

The HFO switch provides means of operating the receiver with either its own internal high frequency variable oscillator or with an externally supplied variable high stability or crystal oscillator such as is available from the NRC Variable Master Oscillator, Type 115 Model 1. When in the external position, the oscillator section of V4, is biased beyond cut-off. Externally supplied signals are then amplified by the second section of V4. When set for internal operation, the amplifier section is disabled and the oscillator operates in a normal manner.

3.5 MC Oscillator Switch, S13:

The 3.5 MC Oscillator Switch, mounted at the rear of the receiver, permits flexibility of operation of the receivers for either single or diversity operation on bands #4, #5, or #6. When in position #1 the oscillator functions and the oscillator output may be obtained at the 3.5 mc connector. The oscillator is disabled when in position #2 and 3.5 mc frequency must be externally supplied. For position #3, the oscillator again functions but no oscillator output is available.

For dual diversity operation, the two 3.5 MC Oscillator connectors are joined together and proper diversity or single receiver operation is obtained by proper switch settings. Following are the possible choices of operation:

Mode of Operation	Switch Positions	
	Receiver #1	Receiver #2
Diversity: Rec. #1 Supplying 3.5 MC	#1	#2
Diversity: Rec. #2 Supplying 3.5 MC	#2	#1
Single receiver operation Rec. #1 and Rec. #2 Supplying own 3.5 MC	#3	#3

Tuning Lock:

The tuning lock, located to the right of the tuning knob provides a positive locking for the tuning mechanism without affecting the frequency setting, when it is desired to prevent accidental shifting of the tuning or when the receiver is operated under a severe condition of vibration.

Tuning Meter:

The tuning meter at the upper left on the front panel is useful in accurately tuning a signal and provides an indication of the relative strength of the received signal in db from 1 microvolt. The "METER ADJ RF" control at the rear of the chassis provides adjustment of the plus 20 db reading on the RF scale, with a 10 microvolt input signal. Depression of the "METER SWITCH" converts the meter circuit for indication of the AF output power level in db from 6 milliwatts. This switch is spring returned to the RF scale circuit position when released and SHOULD NOT BE DEPRESSED FOR THE AF SCALE UNLESS THE AUDIO OUTPUT HAS BEEN ADJUSTED FOR LOW POWER OUTPUT, BY MEANS OF HEADPHONES OR SPEAKER. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN DAMAGE TO THE METER. The "METER ADJ AF" control at the rear of the chassis provides adjustment of the 0 db reading on the AF scale, which should be made when the AF output power from the 600 ohm audio output terminals is 6 milliwatts or 1.9 volts across a 600 ohm load.

Band Change:

The large knob to the left is the band change control. Each revolution of this control turns the turret, containing the RF and HF oscillator coil, trimmer and switch contact assemblies, from one frequency band to the next. The turret has no stops and may be turned in either direction desired. A positive detent mechanism assures correct location of the various bands. The band change control simultaneously operates the small frequency band dial, located at the center of the panel and aligns the dial frequency indicator with the proper scale.

Phasing Control, C111:

The phasing control permits high attenuation of closely adjacent channel interference on either side of the signal frequency, when the crystal selectivity positions are used.

Selectivity Switch, S5:

The selectivity switch provides three crystals and three non-crystal degrees of selectivity, ranging from extremely sharp, for CW reception, to broad for good fidelity MCW operation.

Beat Frequency Oscillator, V13:

The beat frequency oscillator is turned "On" for CW signal operation by the "MOD-CW" switch. The beat frequency dial should be set at zero for tuning to zero beat and then adjusted to give the desired audio pitch. The beat frequency oscillator injection voltage is adjustable by the "BFO INJ" control on the rear skirt of the chassis.

AVC Switch (BFO), S14:

The AVC switch has the following four positions:

1. Internal BFO Slow
2. Internal BFO Fast
3. External BFO Slow
4. External BFO Fast

When set to either of the external BFO positions the Beat Frequency Oscillator section of V13 is biased beyond cutoff. External crystal BFO applied to the external connector is then amplified by the other section of V13. For either of the internal positions, the amplifier section is disabled

AVC Switch (BFO), S14: (cont'd)

and normal oscillator operation is obtained. The slow and fast positions of the switch control the AVC time constant for proper receiver operation with either phone or CW signals.

Noise Limiter, V15:

The noise limiter switch is independent of other controls and is useful in greatly attenuating noise interference from ignition or similar pulse type sources, regardless of the mode of operation.

Send-Receiver, S9:

The send-receive switch permits desensitizing the receiver during transmission periods to prevent damage to the receiver, when operated in proximity to the transmitter and provides instant return to reception between transmission periods.

Relay Receptacle, J4:

The relay receptacle, on the rear of the receiver, is connected in parallel with the send-receive switch and provides for the connection of an externally connected relay, to perform the send-receive operation. When the relay is used the send-receive switch is left in the "open" or "send" position.

AVC-Manual Switch, S8:

The AVC-Manual Switch permits the choice of either AVC or Manual sensitivity operation as desired. The AVC has a delay bias, which insures maximum sensitivity for weak signals.

RF Gain Control, R93:

The RF gain control provides adjustment of the sensitivity for signals of various strength, when under the "manual" operating condition, in order that the receiver sensitivity may be adjusted to suit the signal strength and prevent overloading. This control is also in the circuit when operating on AVC, in order that the sensitivity may be adjusted to reduce undesirable noise during "off" periods in the transmission of the received signal. When it is desired to use the tuning meter for indication of relative signal strength, the RF gain control should be at maximum.

IF Gain Control, R128:

The IF gain control at the rear of the receiver controls the gain of the 1st and 2nd IF amplifiers of the receiver. An improvement in the receiver signal to noise ratio may thereby be realized. An optimum setting of the control is such that 4 to 5 volts D. C. is available at the cathodes of V9 and V10.

Audio Gain Control, R84:

The audio gain control adjusts the audio input to the audio amplifier tube. It should be adjusted for the required audio output when operating on AVC and is best left at or near maximum when operating on MANUAL control.

Phone Input, E1:

Terminals are provided on the rear of the receiver for phonograph or other audio frequency source input to the audio frequency amplifier.

Convenience Outlet, J5:

A power outlet receptacle is provided on the rear of the receiver chassis for operating an accessary, such as an electric clock or lamp.

AVC Switch, S15:

The AVC switch at the rear of the receiver allows the AVC line to be brought to terminal #3 of E19 for "diversity" operation. The AVC line is broken for "local" operation to prevent interference between the two receivers when tuned to signals of different strengths.

5. MAINTENANCE

The following technical information concerning the maintenance of the Receivers has been obtained from the Hammarlund Instruction Book, modifications being made where required.

General:

This Receiver is designed for continuous duty and should normally require little attention beyond the replacement of tubes. An occasional cleaning of the gear teeth in the gear train is recommended to prevent a heavy accumulation of dust which may cause calibration error and improper operation of the gears. This may be done with a small stiff bristle brush, turning the controls to obtain access to the different portions of the gears. No grease or oil should be used on the gears. Operation and maintenance of the Receiver will be greatly facilitated if the contents of this Instruction Book are thoroughly digested.

Some sectionalizing of faults is possible, if the fault is not existant on all of the frequency bands. Non-operation of the three lower frequency bands, with normal operation on the three higher frequency bands, indicates that the fault is associated with the circuits of tube V7. If only the three higher frequency bands are affected, the fault is associated with the circuits of V6 or V8. If only one single band is affected, refer to HF Oscillator and RF Coil Assemblies in this section.

Visual evidence of trouble is usually a burned or darkened resistor, which if found, is likely caused by excessive current due to a short circuited capacitor or tube element at the load side of the resistor. In such a case, both the capacitor or tube and the resistor should be replaced as indicated. Refer to the Wiring Diagram, Dwg. No. D-159-1-45, and Parts List for location and values of components. If the checks on tubes, fuses and visual inspection fail to disclose the fault, the tube socket voltages and resistances should be measured and checked against the values given in the Table of Tube Socket Voltages. Any appreciable departure beyond a normal variation of approximately 15% from the values in this table will generally indicate the component or circuit at fault. If the foregoing does not reveal the fault, then a stage by stage check of amplification should be made. Any great difference from the values of input shown in the Table of Approximate Signal Input at IF and AF Stages for 20 Volts Output will indicate the stage at fault. If a tuned circuit component, such as an IF transformer, RF or HF oscillator coil assembly is found defective and replaced, only the replaced unit need be realigned. Follow the alignment procedure in Section 6, for the unit involved.

The IF Transformers, Crystal Filter, Beat Frequency Oscillator and the 3.5 MC Crystal Controlled Oscillator assemblies are each mounted on the chassis independently of their respective shields. The shield can assemblies are easily removed for inspection of these units, without disturbing the soldered connections. In replacing these shields, make sure that the grounding springs are in place on the inductance adjuster screws before the shield is installed.

Vacuum Tubes:

Weak or defective vacuum tubes are the most common cause of decrease in sensitivity, faulty performance or failure of operation in a receiver. In case of such faults, first remove the tubes and check them in a tube tester of reliable design. If a tube tester is not available, substitution of a new tube for each tube type and position should be tried. Such substitution is best made, one tube at a time in order that the faulty tube may be detected by the improvement or restoration of performance by the new tube.

Locating Faults:

If the dial lamps do not light when the power switch is turned on, check for a blown line fuse, F1 and replace it at the rear of the Receiver from the spare fuses. An open circuit in the line cord or plug may be checked by plugging a lamp first in the power source receptacle and then in the AC receptacle on the rear of the Receiver. If the dial lamps light but there is no sound at all in the headphones or speaker, check for a blown -B fuse, F2 and if blown, replace it with a spare fuse. In replacing fuses, make sure that only a 1.6A Fusetron is inserted in the line fuse holder and that only a 3/8 ampere fuse is inserted in the -B fuse holder. Should neither fuse be blown, nor replacement of the fuses restore operation, the Receiver should be removed from its cabinet or rack and inspected for visual signs of trouble. The table model receiver is held in the cabinet by two screws through the cabinet bottom and by the four screws through the slotted holes at each side of the front panel. The rack model receiver is provided with bottom and top cover plates which should be removed for purposes of inspection and repair.

IF Transformers:

If a fault is traced to one of the variable coupled IF Transformers, T4 or T5, check whether the fault exists on all positions of the selectivity switch S5, or only on one position of this switch. If the faulty operation occurs on only one switch position, check for continuity of the coupling coil associated with that position, check for imperfect soldered connections at the coil and switch terminals and check the switch contact involved. If faulty operation localized at one transformer exists on all positions of the selectivity switch, make the continuity check on the plate coils, on the main grid coil and on the wiring associated with these coils. Transformers T4 and T5 and Crystal Filter T3 have additional inner shield assemblies that are held in place by the tension nuts on the adjusting screws. To remove these shields, hold the adjusting screws with a screw driver to prevent turning the screws and losing the alignment adjustment and loosen the tension nuts, using another small screwdriver engaging one of the slots. When replacing these shields and tension nuts, employ the same method and tighten the tension nuts just enough to prevent the adjusting screws from working loose.

Beat Frequency Oscillator:

To remove the beat frequency oscillator T6, if the receiver is equipped with the Crystal Frequency Control Unit T34, it will be necessary to set the crystal selector switch S2, on its No. 3 position and loosen the four set screws in the rigid shaft coupling and the two set screws in the disc on the selector switch shaft. Slide the switch shaft forward through the coupling and disc.

Beat Frequency Oscillator: (cont'd)

It may be necessary to remove burrs, caused by the set screws, from the switch shaft in order to slide the shaft through the disc. Now loosen the four set screws of the flexible coupling on the BFO shafts and slide the coupling forward on the BFO drive shaft in the front panel. Remove the BFO shaft bearing bracket by taking out the two screws holding it to the chassis. Unsolder the leads from the six terminals of the BFO unit at the underside of the chassis, being careful to not overheat the wire of the shielded cable since this wire is insulated with polystyrene and is easily damaged by heat. Note that if this cable wire is grounded to its shield, there will be no beat frequency voltage input to the buffer tube V12 even though the beat oscillator is functioning properly. Therefore, with the shielded lead disconnected from the lug of the BFO unit, check with a continuity or ohmeter the connection of this wire to the buffer tube V12 and its freedom from the chassis. Carefully observe the wiring of the BFO unit for correct replacement. Now remove the two screws holding the BFO shield can to the chassis and the two screws at the underside of the chassis and remove the BFO unit. When replacing the unit, follow the reverse procedure. Before tightening the two screws holding the unit to the chassis and the two screws holding the shaft bearing bracket, adjust the unit and shaft bracket to obtain alignment of the two shafts at the coupling. Make sure that the shield grounding spring is in place, with the bow of the spring downward against the tension nut, before replacing the shield can assembly.

Adjustment of BFO:

With the AVC-MAN switch on AVC, and the SELECTIVITY control on the 0.2 KC position, tune in an unmodulated signal for maximum tuning meter reading. Set the CW-MOD switch to CW and with the BEAT OSC dial at 0, adjust the top screw of the BFO unit for zero beat. Turn the BEAT OSC dial to each 3 KC position and check the output beat frequency against a known audio frequency source such as a good audio oscillator. If the beat frequencies obtained at each 3 KC position is not within the range between 3 and 3.5 KC, loosen the set screws of the BFO shaft coupling and turn the shaft of the BFO with respect to the drive shaft and repeat the above, resetting the zero adjustment by the top screw of the BFO unit each time until the above range is realized. One set screw should be used just tightly enough to allow the drive shaft to operate the BFO shaft until the range is correct and then tighten both screws.

Crystal Switch Adjustment:

If the mechanical drive of the crystal control switch has been disturbed, it should be adjusted as follows: Carefully slide the switch shaft through the disc and into the rigid coupling and being careful not to turn the switch, tighten the four set screws in the rigid coupling, with the knob indicator on the No. 3 position as originally set under Beat Frequency Oscillator. Now set the crystal switch on the No. 1 position and holding the disc in a counter-clockwise direction, so that the end of the slot in the disc is against the drive pin, lightly fasten the set screws of the disc. When this disc is properly adjusted on the shaft, with the switch in the No. 1 position, the connecting bar between the two discs should not be under tension and should exhibit a slight amount of play when tried with the thumb and forefinger. When so adjusted, tighten the set screws.

HF Oscillator and RF Coil Assemblies:

If faulty operation occurs in only one frequency band of the Receiver, the trouble should be found in one of the four coil assemblies for that band in the tuning unit turret. For example: Coil assemblies T13, 19, 25 and 31 should be examined if band 7.4 to 14.8 MC only, does not perform normally. To remove these coil assemblies, stand the Receiver on its right or left side and remove the bottom cover plate from the tuning unit. Turn the band change control to place the band in question in its normal operating position and then turn the band change control 2-1/2 revolutions counter-clockwise. This will place the band coil assemblies parallel and at the bottom of the tuning unit. Now remove the two springs holding one coil assembly in the turret and carefully remove it by sliding it towards you and off the tongues of the shields. It is best to remove only one coil assembly at a time and inspect it for defects or substitute a replacement assembly if available. CAUTION: Make sure that the coil base is firmly seated and secured by its retaining springs before going to the next assembly or turning the band change control. Failure to do this may damage the switch spring contacts beyond repair.

Repeat this procedure until the faulty assembly is found. In checking these assemblies, first check for continuity of the coils, particularly the small primary coils as in the RF Input assemblies, where they are liable to damage if the Receiver is operated in the presence of very strong transmitter signals. In replacing these coil assemblies be careful that the end of the assembly nearest the coil is toward the front of the Receiver.

Mixer Plate Coil Assembly:

Trouble in the Mixer Plate Coil Assembly T1, is indicated if the input required at Pin 7 of V5 is found to be greatly different than the values shown in the Table of Approximate Signal Input at IF and AF Stages for 20 Volts Output, and the gain from Pin 7 of V6 is normal. The cover plate and shield of T1 may be removed for replacement of a defective component. If the entire assembly is to be replaced, it will be necessary to unsolder all of the leads at both the bottom and top terminal boards of the unit.

RF Tube Platform:

If the Receiver fails to perform normally on any of the six frequency bands and the previous tests indicate that performance of the IF and audio frequency amplifiers is normal, including the gain check in accordance with the Table of Approximate Signal Input at IF and AF Stages for 20 Volts Output for the input to Pin 7 of V5, the fault is indicated to be in the RF Tube Platform or in the main tuning capacitor. Before removing the RF Tube Platform, it is advisable to remove the top shield cover and inspect the main tuning capacitor connections. Observe that the tuning capacitor is operating properly when the tuning control is rotated. Using a miniature tube adapter, apply a modulated RF test signal successively to Pin 1 of V1 and V2 and to Pin 7 of V5. For each of these positions of the adapter and signal, tune through the proper dial setting for the signal frequency used. Gain of the order of 5 or 6 should be indicated for each stage and loss of signal will indicate the section to be investigated for the fault. No signal output, when the input signal is applied to Pin 7 of V5, will indicate trouble in the HF oscillator section of the unit. With the covers removed from the tuning capacitor

RF Tube Platform: (cont'd)

and T1, unsolder the blue, white-black, red-white, red-green, yellow-black and blue-red leads that come from the tube platform at the top of T1. Unsolder the leads from the tuning capacitor rotors, stators and ground straps at each section. Turn the Band Change control one-half turn from any band position in order to have the band switch contacts disengaged and leave the band switch in this position until the RF Tube Platform is replaced, otherwise irreparable damage to the switch contacts will occur. Remove the four screws at the corners of the top of the platform and the four screws at the side flange and carefully remove the platform. In handling be careful to prevent damage to the switch contacts of this assembly. When the unit is ready to be replaced, follow the reverse of the above procedure.

Main Tuning Capacitor:

If it is necessary to replace the main tuning capacitor, the procedure is as follows: Remove the top cover and unsolder the leads of the capacitor as described under RF Tube Platform. Bring the capacitor to full mesh by means of the tuning control. Carefully remove the spring and drive link at the front of the capacitor. Remove the single screw that secures the capacitor frame front plate to the gear plate, looping a piece of small wire around the spacing washer between the capacitor and gear plate. The front capacitor plate is located and held in position by two dowel pins and will not move when the front screw is taken out. Now hold the capacitor by its frame with one hand and remove the rear supporting screw and spacer. The capacitor may now be moved to the rear, to disengage the dowel pins, and lifted from the Receiver. Follow the above procedure in reverse when replacing the capacitor.

Communications Receiver

APPROXIMATE SIGNAL INPUT AT IF AND AF STAGES
FOR 20 VOLTS OUTPUT

BAND SWITCH	FREQUENCY	INPUT TO	APPROX. INPUT
Any	Audio 400 cycles	Pin 5, V17	3.5 volts
Any	Audio 400 cycles	Pin 2, V16B	.3 volts
1.35 - 3.45 mc	Mod RF 455 kc	Pin 1, V11	.35 volts
1.35 - 3.45 mc	Mod RF 455 kc	Pin 1, V10	6000 microvolts
1.35 - 3.45 mc	Mod RF 455 kc	Pin, V9	110 microvolts
1.35 - 3.45 mc	Mod RF 455 kc	Pin 1, V7	40 microvolts
1.35 - 3.45 mc	Mod RF 455 kc	Pin 7, V5	65 microvolts
7.40 - 14.8 mc	Mod RF 3.955 mc	Pin 7, V5	40 microvolts
7.40 - 14.8 mc	Mod RF 3.955 mc	Pin 7, V6	250 microvolts

Output measured across a 600 ohm resistive load at output terminals of receiver. RF signals modulated 30 percent at 400 cycles. Signals applied to tube grids through a .01 mfd capacitor. Selectivity switch at 3 kc, AVC-MAN switch on MAN. CW-MOD switch on MOD, RF Gain and Audio Gain at maximum. BFO switch at Internal; AVC switch at Int. BFO, Fast; 3.5 MC Osc. switch at position #3.

6. COMMUNICATIONS RECEIVER ALIGNMENT

The alignment of a modern communications receiver requires precision instruments and a thorough knowledge of the circuits involved. This receiver, being a double super-heterodyne, the alignment procedure is even more involved than is usual.

Under normal service the receiver will stay in alignment for extremely long periods of time, consequently realignment should not be attempted unless all other possible causes of a particular trouble have been eliminated. When it has been determined that any realignment should be attempted, a great deal of caution should be exercised in making the adjustments, as any required readjustment should not entail more than a slight angular motion of the adjusting screw.

Alignment of the IF Stages:

The low frequency IF should be aligned first. The recommended method for aligning the low frequency IF involves the use of a sweep frequency signal generator and an oscilloscope. Since these instruments are not available at the average service station the alternate method using an amplitude modulated signal generator and an output meter will be described first. The additional information required for the visual alignment method will be covered in a later paragraph.

The signal generator should be coupled to the grid of the mixer tube V5 through a capacitance of approximately .01 mfd. A miniature tube adapter will be required to make the mixer grid connection available. Such an adapter is manufactured by the Alden Manufacturing Co. An output meter should be connected across the output terminals of the receiver or the speaker voice coil. The receiver controls should now be set as follows:

Control	Position
Selectivity	See text
Send - Receive	Receive
CW - Mod	Mod
Phasing	Arrow
AVC - Man	Man
Audio Gain	Set for approx. 20 volts
RF Gain	See text
Band Switch	1.35 - 3.45 mc
Dial	2.5 mc
HFO	"Int."
AVC	"Int." BFO: Fast
3.5 mc Osc.	#3
IF Gain	Max. CCW

Alignment of the IF Stages: (cont'd)

The signal generator should be modulated 30 percent at 400 cycles. Turn the selectivity switch to the 3 kc position and advance the RF Gain Control to maximum. Set the signal generator frequency to 455 kc and adjust its output until some deflection is noted on the output meter. Refer to Dwg. No. A-159108 for the location of the various alignment adjustments. Adjust L42, L41, L39, L38, L36, and L32 for maximum output, reducing the signal generator output and the RF Gain control as required to prevent overload or excessive output. Now turn the selectivity switch to the narrowest position, .2 kc, and adjust the signal generator frequency for the maximum output. This establishes the correct signal frequency by the 455 kc crystal for the IF amplifier and the frequency of the signal generator should not be disturbed for the remainder of the low frequency IF alignment, unless it should be to recheck this establishment of crystal frequency to make sure that the signal generator frequency has not drifted during the alignment. The selectivity switch is now turned to the 3 kc position and L42, L41, L39, L38, L36, and L32 are again adjusted for maximum output. Now turn the selectivity switch to the 1.3 kc position and adjust L37 for maximum output. Before changing this set-up the BFO should be turned on by throwing the CW-Mod switch to CW and checked for zero beat with the BFO knob dial at its zero reading. If necessary L44 should be adjusted for zero output. This check and adjustment of the BFO should be done with the signal generator carrier unmodulated.

The procedure for the visual method of aligning the low frequency IF should be the same as the above except that the adjustments are made for both maximum amplitude and coincidence of the oscilloscope images. The oscilloscope vertical input should be connected across the diode detector load resistance, from the junction of R64 and R65 to chassis.

The 3.5 mc crystal oscillator used in the second conversion oscillator circuit may be accurately adjusted to frequency by use of oscillator trimmer condenser C101. To adjust the oscillator frequency zero beat a harmonic of a 500 kc or 100 kc crystal with WWV at 2.5 or 5 mcs. A crystal harmonic may then be used as a secondary standard against which the 3.5 mc crystal may be zero beat.

The high frequency IF should be aligned next. Set the band switch to the 7.4 - 14.8 mc band. The selectivity switch should be in the 3 kc position. Adjust the signal generator frequency to 3.955 mc and adjust L31, L33, and L34 for maximum output.

Alignment of the IF Stages: (cont'd)

The 3.5 mc crystal used in the second conversion oscillator circuit may be used as a frequency standard at multiples of 3.5 mc from 10.5 mc upwards. In order to do this, in view of the complete shielding against radiation from this oscillator, it will be necessary to temporarily connect a two foot length of insulated wire to the antenna terminal and dress the free end of this lead around the tube shield on the 3.5 mc oscillator tube V8. This test lead should, of course, be removed except while in use as a frequency standard.

Alignment of the RF Amplifier and HF Oscillator:

To adequately align the RF Amplifier and HF Oscillator an accurately calibrated signal generator and an output meter are required. The frequencies required are shown below. The location of the adjustments is shown in Dwg. No. A-159108. Use of this drawing should be made in following this part of the alignment which will now be described for one frequency band. The same procedure should then be followed for the other frequency bands.

To align the .54-1.35 mc band the signal generator is coupled to the antenna input terminal through a 100 ohm carbon resistor. The generator should be modulated 30 percent at 400 cycles and the output meter connected across the receiver output terminals. The receiver controls should be set as follows:

Controls	Position
Selectivity	3 kc
Send-Receive	Receive
CW-Mod	Mod
AVC-Man	See text
Audio Gain	Set for approx. 20 volts
RF Gain	See text
Band Switch	Set for band to be aligned
Limiter	Off
BFO	Internal
AVC	Int. BFO, Fast
3.5 MC Osc.	#3
IF Gain	Max. CCW

Alignment of the RF Amplifier and HF Oscillator, (cont'd)

Set the receiver and signal generator dials to .56 mc. The RF Gain control should be set at maximum and the AVC-Man switch set on AVC. The HF Osc. L adjustment shown below should now be set for maximum output. Then the Ant., 1st RF and 2nd RF L adjustments should be set for maximum output. The receiver and signal generator dials are now set to 1.3 mc and the C adjustments, shown below, should be adjusted for maximum output in the same order, beginning with the Osc. C adjustment and then making the C adjustments for the Ant., 1st RF and 2nd RF. This procedure should be carefully repeated until no increase in output can be realized.

Following the frequencies shown below, align the remaining bands using the same procedure as above.

RF AND HF OSCILLATOR ALIGNMENT FREQUENCIES AND ADJUSTMENT DESIGNATIONS

Freq. Band in MC	.54-1.35	1.35-3.45	3.45-7.4	7.4-14.8	14.8-29.7	29.7-54.0
RF & HF Osc. Adjust L at:	.56	1.4	3.75	7.5	15.0	30.0
RF & HF Osc. Adjust C at:	1.3	3.4	7.15	14.5	29.0	52.0

7. COMMUNICATIONS RECEIVER TUBE SOCKET VOLTAGES

Voltage to chassis. Measurements made with Weston Model 663 Volt-Ohmmeter, except those indicated by asterisk were made with Measurements Corp. Model 62 VTVM, and those indicated by + were made with RCA Volt Ohmyst. Line voltage 117, no signal input. Audio Gain Control at minimum and CW-MOD switch on "CW".

Socket Pin Numbers

TUBE	1	2	3	4	5	6	7	8	9	MODE OF OPERATION
V-1	*-1	---	*6.3 AC	---	200	90	---	---	---	RF Gain Max.
V1	*-54	---	*6.3 AC	---	260	235	---	---	---	RF Gain Min.
V-2	*-1	---	*6.3 AC	---	210	100	---	---	---	RF Gain max.
V-2	*-54	---	*6.3 AC	---	260	240	---	---	---	RF Gain min.
V-3	---	*6.3 AC	---	---	---	0	---	265	---	RF Gain Max. - VFO Operation
V-3	---	*6.3 AC	---	---	---	150	---	265	---	RF Gain Max. - Crystal Freq. Control
V-3	---	*6.3 AC	---	---	---	0	0	290	---	RF Gain min. - VFO Operation
V-3	---	*6.3 AC	---	---	---	150	0	280	---	RF Gain min. - Crystal Freq. Control
V-4	+152	+152	*6.3 AC	+0	+-42	+-5	+0	---	---	"Internal" HFO
V-4	+143	+143	*6.3 AC	+0	+-1.8	+-42	+0	---	---	"External" HFO
V-5	---	+-6	*6.3 AC	---	140	110	0	---	---	RF Gain Max. or Min.
V-6	0	0	*6.3 AC	---	225	---	*-1	---	---	RF Gain Max. Freqs. below 7.4 mc.

Socket Pin Numbers (cont'd)

TUBE	1	2	3	4	5	6	7	8	9	MODE OF OPERATION
V-6	0	0	*6.3 AC	---	260	---	*-1	---	---	RF Gain min.-Freq. below 7.4 mc.
V-6	0	0	*6.3 AC	---	225	90	*-1	---	---	RF Gain max.-Freqs. above 7.4 mc.
V-6	0	0	*6.3 AC	---	260	105	*-1	---	---	RF Gain min.-Freqs. above 7.4 mc.
V-7	*-11	---	*6.3 AC	---	225	170	---	---	---	RF Gain max.-Freqs. below 7.4 mc.
V-7	*-11	---	*6.3 AC	---	260	190	---	---	---	RF Gain min.-Freqs. below 7.4 mc.
V-7	*-11	---	*6.3 AC	---	225	0	---	---	---	RF Gain max.-Freqs. above 7.3 mc.
V-7	*-11	---	*6.3 AC	---	260	0	---	---	---	RF Gain min.-Freqs. above 7.4 mc.
V-8	+0	+0	+0	+0	+0	+0	+0	+0	*6.3 AC	Freq. below 7.4 mc.
V-8	+28	+4.5	+0	+0	+0	+185	+0	+7.5	*6.3 AC	3.5 mc. osc. Sw. Pos. #1 & #3 Freq. above 7.4 mc.
V-8	+0	+0	+0	+0	+0	+0	+0	+0	*6.3 AC	3.5 mc. osc. Sw. Pos. #2 Freq. above 7.4 mc.
V-9	*-1	---	*6.3 AC	---	205	90	---	---	---	RF Gain max.
V-9	*-54	---	*6.3 AC	---	260	235	---	---	---	RF Gain Min.
V-10	*-1	---	*6.3 AC	---	205	90	---	---	---	RF Gain Max.
V-10	*-54	---	*6.3 AC	---	260	235	---	---	---	RF Gain min.

Socket Pin Numbers (cont'd)

TUBE	1	2	3	4	5	6	7	8	9	MODE OF OPERATION
V-11	*-11	---	*6.3 AC	---	210	145	---	---	---	RF Gain Max.
V-11	*-11	---	*6.3 AC	---	240	145	---	---	---	RF Gain Min.
V-12	---	---	*6.3 AC	---	210	40	---	---	---	RF Gain max. BFO Injection max.
V-12	---	---	*6.3 AC	---	240	45	---	---	---	RF Gain Min. BFO Injection max.
V-13	+32	+32	*6.3 AC	+0	+-42	+-4.8	+0	---	---	"Internal" BFO
V-13	+54	+54	+* 6.3 AC	+0	*-2	+-42	+0	---	---	"External" BFO
V-14	0	---	*6.3 AC	---	*22	---	---	---	---	RF Gain max. or min.
V-15	---	---	*6.3 AC	---	---	---	---	---	---	RF Gain max. or min.
V-16	50	0	1.5	---	---	210	0	6.4	*6.3 AC	RF Gain max.
V-16	52	0	1.6	---	---	240	0	7.4	*6.3 AC	RF Gain min.
V-17	0	---	260	228	0	---	*6.3 AC	12	---	RF Gain max.
V-17	0	---	280	265	0	---	*6.3 AC	13	---	RF Gain min.
V-18	150	0	---	0	150	---	0	---	---	RF Gain max. or min.
V-19	---	300	---	300 rms	---	300 rms	---	300	---	RF Gain max. -*5V AC Pin 2 to Pin 8
V-19	---	320	---	300 rms	---	300 rms	---	320	---	RF Gain min. -*5V AC Pin 2 to Pin 8
V-20	150 rms	*-96	*6.3 AC	---	150 rms	---	*-96	---	---	RF Gain max.
V-20	150 rms	*-97	*6.3 AC	---	150 rms	---	*-97	---	---	RF Gain min.

8. COMMUNICATIONS RECEIVER TUBE SOCKET TERMINAL RESISTANCE TABLE

Resistance to chassis. Measurements made with Weston Model 663 Volt-Ohmmeter, except those indicated by asterisk were measured with RCA Volt-Ohmyst.

Tube removed from socket under measurement. Audio Gain Control at maximum, RF Gain Control at minimum. Limiter Switch "OFF". CW-MOD Switch on "CW". AVC-MAN Switch on "AVC".

Socket Pin Numbers

TUBE	1	2	3	4	5	6	7	8	9	MODE OF OPERATION
V1	1.8M	0	---	0	48K	80K	0	---	---	
V2	1.8M	0	---	0	48K	80K	0	---	---	
V3	0	---	0	47K	0	46K	---	46K	---	Crystal Freq. control pos. 1-6.
V4	30K	30K	---	0	55K	80K	0	---	---	External
V4	30K	30K	---	0	80K	47K	0	---	---	VFO operation (Internal)
V5	20K	150	---	0	40K	45K	500K	0	---	
V6	22K	0	---	0	46K	Inf.	100K	---	---	Freq. bands below 7.4 mc.
V6	22K	0	---	0	46K	70K	100K	---	---	Freq. bands above 7.4 mc.
V7	115K	0	---	0	46K	Inf.	0	---	---	Freq. bands above 7.4 mc.
V7	115K	0	---	0	46K	80K	0	---	---	Freq. bands below 7.4 mc.
V8	Inf.	47K	0	0	0	Inf.	470K	1.6K	---	Freq. bands below 7.4 mc.
V8	140K	47K	0	0	0	38K	470K	1.6K	---	Freq. bands above 7.4 mc.
V8	Inf.	47K	0	0	0	Inf.	470K	1.6K	---	Freq. above 7.4 mc., 3.5 mc Pos. 2
V9	1.3M	0	---	0	40K	70K	0	---	---	IF Gain max.
V9	1.3M	0	---	0	40K	70K	1K	---	---	IF Gain min.
V10	1.3M	0	---	0	40K	70K	0	---	---	IF Gain max.

Socket Pin Numbers (cont'd)

TUBE	1	2	3	4	5	6	7	8	9	MODE OF OPERATION
V10	1.3M	1K	---	0	40K	70K	1K	---	---	IF Gain min.
V11	125K	0	8	0	48K	50K	0	---	---	
V12	0	0	---	0	48K	145K	*	---	---	*0 to 1K (BFO Injection control)
V13	180K	180K	---	0	140K	100K	0	---	---	AVC - Int. BFO
V13	180K	180K	---	0	120K	140K	0	---	---	AVC - Ext. BFO
V14	0	770K	---	0	16K	0	220K	---	---	E19 Term. #4 & #5 connected.
V15	94K	Inf.	---	0	Inf.	0	220K	---	---	
V16	150K	500K	1K	0	0	46K	470K	680	---	
V17	0	0	46K	46K	470K	Inf.		360	---	
V18	118K	---	---	---	78K	---	0	---	---	
V19	---	27K	0	55	---	55	---	27K	---	
V20	43K	65K	---	0	43K	0	65K	---	---	

9. ELECTRICAL PARTS LIST

Symbol	Description	Mfr.	Part No.
C1A, B, C, D, E, F, G, H	Capacitor, variable, 8 sections	HAM	34001-G1
C3, 5, 19, 20, 21, 22, 23, 24, 27, 29, 40, 41, 42, 43, 44, 47, 49, *61, *64, 66, 68, 70, 71, 72, 73, 74, 98, 100, 102, 103, 104, 105, 106, 108, 109, 115, 116, 118, 121, 122, 123, 127, 135, 136, 146, 148, 153, 154, 155, 156, 157	Capacitor, 0.01 mfd	HAM	23034-8
C6, 30, 50	Capacitor, 20 mmf	HAM	23003-41-C
C8, 32, 52, 132	Capacitor, 2400 mmf	HAM	23011-40-C
C9, 33, 53	Capacitor, 33 mmf	HAM	23003-45-C
C11, 17, 35, 55	Capacitor, 1500 mmf	HAM	23011-62-C
C12, 138, 145	Capacitor, 7 mmf	HAM	23061-168-F
C14	Capacitor, 1000 mmf	HAM	23011-58-C
C15, 139	Capacitor, 15 mmf	HAM	23061, 155-J
C18, 25, 45, 75, 110, 112, 113	Capacitor, 100 mmf	HAM	23003-94-C
C37, 57, 67	Capacitor, 85 mmf	HAM	23071-59
C39, 59, 99, 134	Capacitor, 51 mmf	HAM	23003-87-C
*C60, 88	Capacitor, 12 mmf	HAM	23023-65-UJ
*C62	Capacitor, 2200 mmf	HAM	23011-17-C
*C63	Capacitor, 39 mmf	HAM	23003-47-C
*C65	Capacitor, Variable	HAM	11726-G109
C69, 107, 117, 124	Capacitor, 220 mmf	HAM	23003-102-C
C77	Capacitor, 3300 mmf	HAM	23011-69-C

Symbol	Description	Mfr.	Part No.
C78	Capacitor, 404 mmf	HAM	23071-67
C79, 80	Capacitor, 5 mmf	HAM	23023-8-UJ
C82	Capacitor, 810 mmf	HAM	23072-53
C83	Capacitor, 10 mmf	HAM	23003-2-B
C85	Capacitor, 1200 mmf	HAM	23011-60-C
C87	Capacitor, 120 mmf	HAM	23071-50
C89	Capacitor, 190 mmf	HAM	23071-64
C91	Capacitor, 92 mmf	HAM	23071-71
C92	Capacitor, 51 mmf	HAM	23023-45-UJ
C93	Capacitor, 379 mmf	HAM	23071-63
C95	Capacitor, 42 mmf	HAM	23071-69
C96	Capacitor, 610 mmf	HAM	23072-52
C97	Capacitor, 65 mmf	HAM	23071-58
C111	Capacitor, Variable	HAM	11776-G1
C114	Capacitor, 270 mmf	HAM	23003-104-C
C119, 125	Capacitor, 300 mmf	HAM	23003-105-C
C120, 126	Capacitor, 1300 mmf	HAM	23011-61-C
C128, 151, 158, 159, 160	Capacitor, 10 mfd, 100 volt, HS Can, electrolytic	HAM	15462-1
C129A, 129B	Capacitor, 2x.05 mfd, HS Can, paper	HAM	15461-1
C130	Capacitor, 27 mmf	HAM	23023-71-UJ
C131, 133, 187	Capacitor, 430 mmf	HAM	23003-109C
C137	Capacitor, 0.25 mfd 200 volt	HAM	23911-79-E
C140	Capacitor, 1000 mmf	HAM	23015-27-A
C141, 142	Capacitor, 100 mmf	HAM	23024-24-SL

Symbol	Description	Mfr.	Part No.
C143, 147, 149	Capacitor, 5100 mmf	HAM	23015-16-A
C144	Capacitor, 0.05 mfd	HAM	23911-77-E
C150	Capacitor, 2500 mmf, 800 volt	HAM	23070-40
C152A, 152B	Capacitor, 0.01 mfd	HAM	23072-11
C161A, B, C	Capacitor, 3x20 mfd, 450 volt, HS Can, electrolytic	HAM	15463-1
C101	25 mmf variable air trimmer	HAM	APC-25
C162	0.007 mfd ± 5% 300 volt mica	SAN	C 06270
C163	0.007 mfd ± 5% 300 volt mica, matched to within 1% of C162	SAN	C 06270
C164	100 mmf ± 10% 500 volt mica	SAN	K 1310
C165	100 mmf ± 5% 500 volt silver mica	SAN	KR 1310
C166	0.01 mfd ± 20% 300 volt mica	SAN	C 06110
C167	100 mmf ± 5% 500 volt mica	SAN	K 1310
C168	10 mmf ± 5% 500 volt mica	SAN	K 1410
C169	0.01 mfd ± 20% 300 volt mica	SAN	C 06110
C170	0.001 mfd ± 10% 500 volt mica	SAN	K 1210
C171	0.01 mfd ± 20% 300 volt mica	SAN	C 06110
C172	0.01 mfd ± 20% 300 volt mica	SAN	C 06110
C173	0.25 mfd ± 10% 120 volt molded paper	MIC	345
C174	0.01 mfd ± 20% 300 volt mica	SAN	C 06110
C175	300 mmf ± 10% 500 volt mica	SAN	K 1330
± C176	0.01 mfd ± 20% 300 volt mica	SAN	C 06110
C180	0.01 mfd ± 20% 300 volt mica	SAN	C 06110
C181	0.001 mfd ± 10% 500 volt mica	SAN	K 1210
C182	0.001 mfd ± 10% 500 volt mica	SAN	K 1210
C183	0.1 mfd ± 20% 200 volt paper tubular capacitor	AER	Type P82

Symbol	Description	Mfr.	Part No.
C184	0.1 mfd ± 20% paper tubular capacitor	ABD	Type P82
C186	0.25 mfd 600 volt	HAM	23915-1
E1	2 screw terminal, phone input	HAM	4904-5
E2	4 screw terminal, audio output	HAM	31141-1
E19	5 lug terminal screw type binding post	SMT ICA	905 2405
F1	Fuse, 3 amp	HAM	15928-8
F2	Fuse, 1/4 amp pigtail	HAM	15889-1
	Fuse holder	HAM	15923-1
	Fuse holder, spare	HAM	15923-1
I1, 2, 3, 4	Dial lamp, No. 47 Mazda	HAM	16004-1
	Dial lamp socket assembly	HAM	31453-1
J1	Antenna input socket	HAM	15959-1
J2	IF output socket - monitor	HAM	16111-1
J3	Phone jack	HAM	5066-1
J4	Relay receptacle	HAM	35013-1
J5	AC outlet	HAM	35013-1
J6	Coaxial receptacle	AMP	83-1R
J7	Coaxial receptacle	AMP	83-1R
J8	Coaxial receptacle	AMP	83-1R
J9	Single phono jack	CIN	81-A
± J10	Coaxial receptacle	AMP	83-1R
L1	RF input assembly, includes C2, C3, L1 and switch contacts for S1A	HAM	31387-G-1
L2	RF input assembly, includes C4, C5, L2 and switch contacts for S1A	HAM	31390-G-1

Symbol	Description	Mfr.	Part No.
L3	RF Input assembly, includes C6, 7, 8, L3 and Switch contacts for S1A	HAM	31393-G1
L4	RF Input assembly, includes C9, 10, 11, L4 and switch contacts for S1A	HAM	31396-G1
L5	RF Input assembly, includes C12, 13, 14, L5 and switch contacts for S1A	HAM	31399-G1
L6	RF Input assembly, includes C15, 16, 17, L6 and switch contacts for S1A	HAM	31405-G1
L7, 14, 24, 35	RF Choke, 192 microhenries	HAM	15612-G1
L8	RF Transformer assembly, includes C26, 27, L8, R7 and switch contacts for S1B	HAM	31386-G1
L9	RF Transformer assembly, includes C28, 29, L9, R8 and Switch contacts for S1B	HAM	31389-G1
L10	RF Transformer assembly, includes C30, 31, 32, L10 and switch contacts for S1B	HAM	31392-G1
L11	RF Transformer assembly, includes C33, 34, 35, L11, R10 and switch contacts for S1B	HAM	31395-G1
L12	RF transformer assembly, includes C36, 37, L12 and switch contacts for S1B	HAM	31398-G1
L13	RF Transformer assembly, includes C38, 39, L13 and switch contacts for S1B	HAM	31404-G1
L15	Same as L8, includes C46, 47, L15, R17 and switch contacts for S1C	HAM	31386-G1
L16	Same as L9, includes C48, 49, L16, R18 and switch contacts for S1C	HAM	31389-G1
L17	Same as L10, includes C50, 51, 52, L17, R19 and switch contacts for S1C	HAM	31392-G1
L18	Same as L11, includes C54, 53, 55, L18, R20, and switch contacts for S1C	HAM	31395-G1
L19	Same as L12, includes C56, 57, L19, and switch contacts for S1C	HAM	31398-G1

Symbol	Description	Mfr.	Part No.
L20	Same as L13, includes C58, 59, L20, and switch contacts for S10	HAM	31404-01
*L21	RF Choke, 1 millihenry	HAM	15617-01
*L22	RF Choke, 10 millihenries	HAM	15618-1
*L23	RF Choke, 25 millihenries	HAM	15619-1
L25	HF Osc, assembly includes C76, 77, 78, L25 and switch contacts for S1D	HAM	31385-01
L26	HF Osc, assembly, includes C81, 82, L26 and switch contacts for S1D	HAM	31388-01
L27	HF Osc. assembly, includes C83, 84, 85, L27 and switch contacts for S1D	HAM	31391-01
L28	HF Osc. assembly, includes C86, 87, 88, 89, L28 and switch contacts for S1D	HAM	31394-01
L29	HF Osc. assembly includes C90, 91, 92, 93, L29 and switch contacts for S1D	HAM	31397-01
L30	HF Osc. assembly includes C94, 95, 96, L30 and switch contacts for S1D	HAM	31403-01
L47	RF Choke, 3.8 millihenries	HAM	15616-01
L48	RF Choke, 2 ohms dc	HAM	15611-1
L49, 50	RF Choke, 2.7 ohms dc	HAM	15613-1
L51	1st filter choke 8.5 Hy., 170 ohms dc	HAM	31030-2
L52	2nd filter choke 20 Hy., 440 ohms dc	HAM	31031-2
L53	IF Output Transformer	HAM	31488-1
L54	50 millihenries RF iron core choke, 100 ma	MIL	958
L55	80 millihenries RF choke	MEI MIL	19-2709 694
L58	23-54 microhenries "Yellow Dot" adjustable iron core coil	NRC	A-159118
M1	Tuning Meter	HAM	4903-2

Symbol	Description	Mfr.	Part No.
P1	Power plug and cord	HAM	6143-1
P2	Antenna Input Plug	HAM	16016-1
P3	Antenna Adapter connector	HAM	15987-1
+P4	Coaxial plug AN-PL259	AMP	83-1SP
+P6	Coaxial plug AN-PL259	AMP	83-1SP
+P7	Coaxial plug AN-PL259	AMP	83-1SP
+P8	Coaxial plug AN-PL259	AMP	83-1SP
+P9	Single phone plug, 1/8" diameter nickle plated	CIN	13A
+P10	Coaxial plug AN-PL259	AMP	83-1SP
R1, 13, 26	Resistor, 510K ohms 1/3 watt	HAM	19317-76BF
R2, 12, 44, 52, 57, 82, 90, 91, 70, 92	Resistor 10K ohms 1/2 watt	HAM	19309-278BF
R3, 14, 39, 48, 53	Resistor, 33K ohms 1/2 watt	HAM	19309-282BF
R4, 6, 16, 29, 30, 83, 102	Resistor, 1000 ohms 1/2 watt	HAM	19309-49BF
R5, 15, 32, 103 to 110	Resistor 510 ohms 1/2 watt	HAM	19309-170BF
R7, 8, 17, 18	Resistor 51 ohms 1/2 watt	HAM	19309-193BF
R9, 19	Resistor 24 ohms 1/2 watt	HAM	19309-189BF
R10, 11, 20, 21	Resistor 22 ohms 1/2 watt	HAM	19309-9BF
R22, *23, 64, 65, 77	Resistor 47K ohms 1/2 watt	HAM	19309-89BF
*R24, *25	Resistor 180 ohms 1/2 watt	HAM	19309-31BF
R27	Resistor 150 ohms 1/2 watt	HAM	19309-259BF
R28	Resistor 6800 ohms 1/2 watt	HAM	19309-69BF
R31, 37, 41, 49, 54, 58, 80	Resistor 2200 ohms 1/2 watt	HAM	19309-57-BF

Symbol	Description	Mfr.	Part No.
R33	Resistor 1500 ohms 1/2 watt	HAM	19309-53BF
R34, 35, 38, 43, 51, 56, 62, 67, 68, 75, 76, 81, 100	Resistor 100K ohms 1/2 watt	HAM	19309-97BF
R96	Resistor 22K ohms 1/2 watt	HAM	19309-178BF
R40	Resistor 20K ohms 1 watt	HAM	19310-179BF
R42, 50, 55	Resistor 10 ohms 1/2 watt	HAM	19309-1BF
R45	Resistor 240 ohms 1/2 watt	HAM	19309-201BF
R46, 94	Resistor 1100 ohms 1/2 watt	HAM	19309-208BF
R47, 66	Resistor 18K ohms 1/2 watt	HAM	19309-79BF
R59	Resistor 2200 ohms 1 watt	HAM	19310-57BF
R60, 61	Resistor 1 megohm 1/2 watt	HAM	19309-121BF
R63	Resistor 27K ohms 1/2 watt	HAM	19309-83-BF
R69, 74	Resistor variable 1000 ohms	HAM	15363-1
R72	Resistor 20K ohms 1/2 watt	HAM	19309-218BF
R73	Resistor 56K ohms 1 watt	HAM	19309-186BF
R78, 98	Resistor 470K ohms 1/2 watt	HAM	19309-113BF
R79	Resistor 680 ohms 1/2 watt	HAM	19309-45BF
R84	Resistor variable 500K ohms	HAM	15342-11
R85	Resistor 2500 ohms 10 watt	HAM	19396-1
R95	Resistor 82K ohms 1/2 watt	HAM	19309-287BF
R87, 88	Resistor 120K ohms 1/2 watt	HAM	19309-181BF
R93	Resistor variable 50K ohms includes switch S10	HAM	15342-21
R97	Resistor 3.3 megohms 1/2 watt	HAM	19309-133BF
R99	Resistor 360 ohms 1 watt	HAM	19310-211BF

Symbol	Description	Mfr.	Part No.
R101	Resistor, variable, 25K ohms	HAM	15342-4
R36	47K ohms ± 5% 1/2 watt comp. res.	ALB	EB 4735
R86	68K ohms ± 10% 1/2 watt comp. res.	ALB	EB 6831
R89	68K ohms ± 10% 1/2 watt comp. res.	ALB	EB 6831
R111	470 ohms ± 20% 1/2 watt comp. res.	ALB	EB 4712
R112	500 ohms potentiometer, 1/4" shaft, screwdriver slot, 1/4" long, wirewound	IRC	W-500
R113	75 ohms ± 5% 1/2 watt comp. res.	ALB	EB 7505
R114	47K ohms ± 10% 1/2 watt comp. res.	ALB	EB 4731
R115	20K ohms ± 5% 1/2 watt comp. res.	ALB	EB 2035
R116	220K ohms ± 10% 1/2 watt comp. res.	ALB	EB 2241
R117	10K ohms ± 10% 1/2 watt comp. res.	ALB	EB 1031
R118	10K ohms ± 10% 1/2 watt comp. res.	ALB	EB 1031
R119	470K ohms ± 10% 1/2 watt comp. res.	ALB	EB 4741
R120	10K ohms ± 10% 1 watt comp. res.	ALB	GB 1031
R121	1.6K ohms ± 5% 1/2 watt comp. res.	ALB	EB 1625
R122	20K ohms ± 5% 1/2 watt comp. res.	ALB	EB 2035
R123	75 ohms ± 5% 1/2 watt comp. res.	ALB	EB 7505
R124	100K ohms ± 10% 1/2 watt comp. res.	ALB	EB 1041
R125	470K ohms ± 10% 1/2 watt comp. res.	ALB	EB 4741
R126	22K ohms ± 10% 1/2 watt comp. res.	ALB	EB 2231
R127	10K ohms ± 10% 1/2 watt comp. res.	ALB	EB 1031
R128	1K 2 watt composition potentiometer, linear taper, screwdriver adjustment	ALB	JA1L040S102UC
R129	68K ohms ± 10% 2 watt comp. res.	ALB	HB 6831
R130	100K ohms ± 10% 1/2 watt comp. res.	ALB	EB 1041
R133	100 ohms ± 10% 1/2 watt comp. res.	ALB	EB 1011

Symbol	Description	Mfr.	Part No.
S1A, B, C, D	Switch, base and spring assembly	HAM	31234-G1
*S2	Crystal selector switch	HAM	15879-1
*S3	Crystal switch	HAM	31469-1
S4	DPDT switch 1.4" diameter shaft 1/4" long	CEN	1462
S5, A, B, C	Selectivity switch, 3 section	HAM	15856-1
S6, 9	Toggle switch SPST	HAM	15864-1
S7	Toggle switch DPST	HAM	15866-1
S8	Toggle switch DPDT	HAM	15867
S10	Switch "ON-OFF" part of R93	HAM	———
S11	Switch, DPDT, SPRING RETURN	HAM	15880-1
S12	2 circuit, 2 position rotary switch, 3/8" long	MAL	3222J
S13	4 circuit, 3 position rotary switch, 3/8" long	MAL	3243J
S14	3 circuit, 4 position rotary switch, 3/8" long	MAL	3243J
S15	SPST toggle switch	AHH	
T1	Mixer plate coil assembly includes C67, 69, 70, L31, 32, R31	HAM	31183-G1
T2	IF Transformers assembly, includes C97, 98, 99, L33, 34, R35	HAM	31116-G1
T3	Crystal filter assembly, includes C107, 110, 111, 112, 113, 114, L36, 37, R41, Y8	HAM	31114-G1
T4	IF Transformer, includes C117, 118, 119, 120, L38, 39, 40, R49	HAM	31102-G1
T5	Same as T4, includes C123, 124, 125, 126, L41, 42, 43, R54	HAM	31102-G1

Symbol	Description	Mfr.	Part No.
T6	Beat Frequency Osc. assy. includes C130, 131, 132, 133, 134, L44, L45, L6, R76, 77	HAM	31106-G1
T7	Transformer, Audio Output	HAM	31066-2
T8	Transformer, Power	HAM	31029-2
V1	Standard, Miniature tube	ANY	6BA6
V2	Standard, Miniature tube	ANY	6BA6
V4	Standard, miniature tube	ANY	6J6
V5	Standard, miniature tube	ANY	6BE6
V6	Standard, miniature tube	ANY	6BE6
V7	Standard, miniature tube	ANY	6BA6
V8	Standard miniature tube	ANY	12AU7 A
V9	Standard, miniature tube	ANY	6BA6
V10	Standard, miniature tube	ANY	6BA6
V11	Standard, miniature tube	ANY	6BA6
V12	Standard, miniature tube	ANY	6BA6
V13	Standard, miniature tube	ANY	6J6
V14	Standard, miniature tube	ANY	6AL5
V15	Standard, miniature tube	ANY	6AL5
V16	Standard, miniature tube	ANY	12AU7 A
V17	Standard, tube	ANY	6V6/GT
V18	Standard, miniature tube	ANY	CA2
V19	Standard, tube	ANY	5B4GY
V20	Standard, miniature tube	ANY	6AL5
X1, 2, 6, 7, 9, 10, 11, 12, 13, 14, 15, 18, 20	Tube socket, miniature	HAM	15989-4

Symbol	Description	Mfr.	Part No.
*X3, 17, 19	Tube socket, octal	HAM	16082-1
X8	9 pin miniature molded mica-filled bakelite "NOVAL"	AMP	59-407
X4	Tube socket, miniature, ceramic less center shield	HAM	15989-5
X5	Tube socket, miniature, ceramic with center shield	HAM	15989-3
X16	Tube socket, "NOVAL"	HAM	16100-1
*X21	Crystal socket, ceramic, for crystals X1 to Y6	HAM	16092-5
*Y1, 2, 3, 4, 5, 6	Crystal, order special, specify signal frequency	HAM	31473-Spec.
Y7	Crystal, 3.4 mc	HAM	31130-1
Y8	455,000 ± 50 cps crystal	BLI	Type VX4 or equivalent

* JX models only

+ Part of rack interconnecting cables

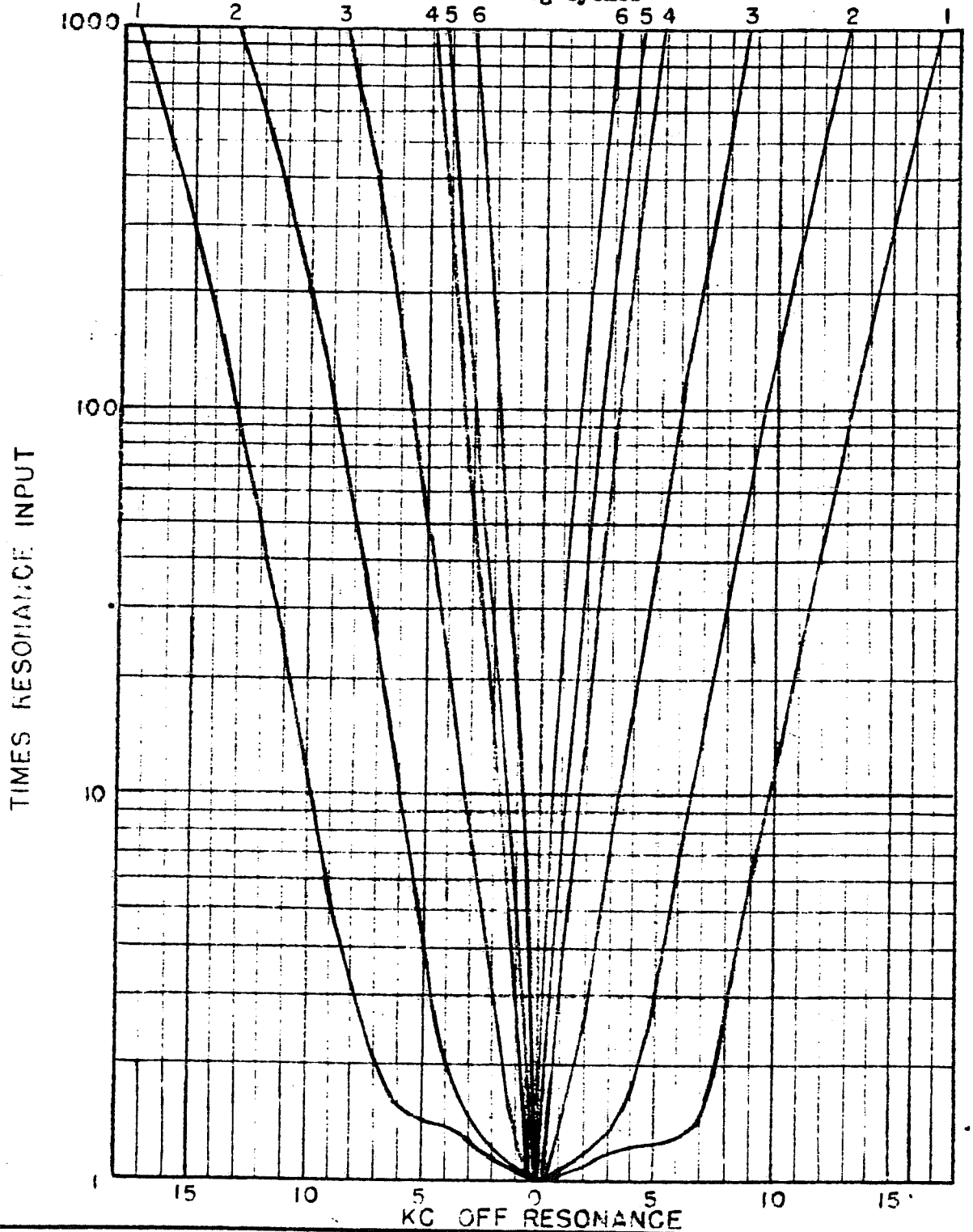
± Supplied only for IF Converter Diversity Systems

MANUFACTURER'S DESIGNATION

Mfr. Code No.	Federal Code No.	Name
AEO	00656	Aerovox Corporation
AHH	04009	Arrow-Hart & Hegeman Electric Company
ALB	01121	Allen-Bradley Company
AMP	02660	American Phenolic Corporation
BLI	71034	Bliley Electric Company, Incorporated
CEN	71590	Centralab
CIN	71785	Cinch Manufacturing Corporation
HAM	80583	Hammarlund Company, Incorporated
IRC	75042	International Resistance Company
MAL	37942	P. R. Mallory & Company, Incorporated
MEI	76384	Meissner Manufacturing, Division of Maguire Industries, Incorporated
MIC	76435	Micamold Electronics Manufacturing Corp.
MIL	76493	J. W. Miller Company
NRC	88183	Northern Radio Company, Incorporated
SAN	00853	Sangamo Electric Corporation
SMT	83330	Herman H. Smith, Incorporated

NORTHERN RADIO COMPANY
INCORPORATED
• NEW YORK 11, NEW YORK •

SELECTIVITY CURVES
Overall at 2 Megacycles

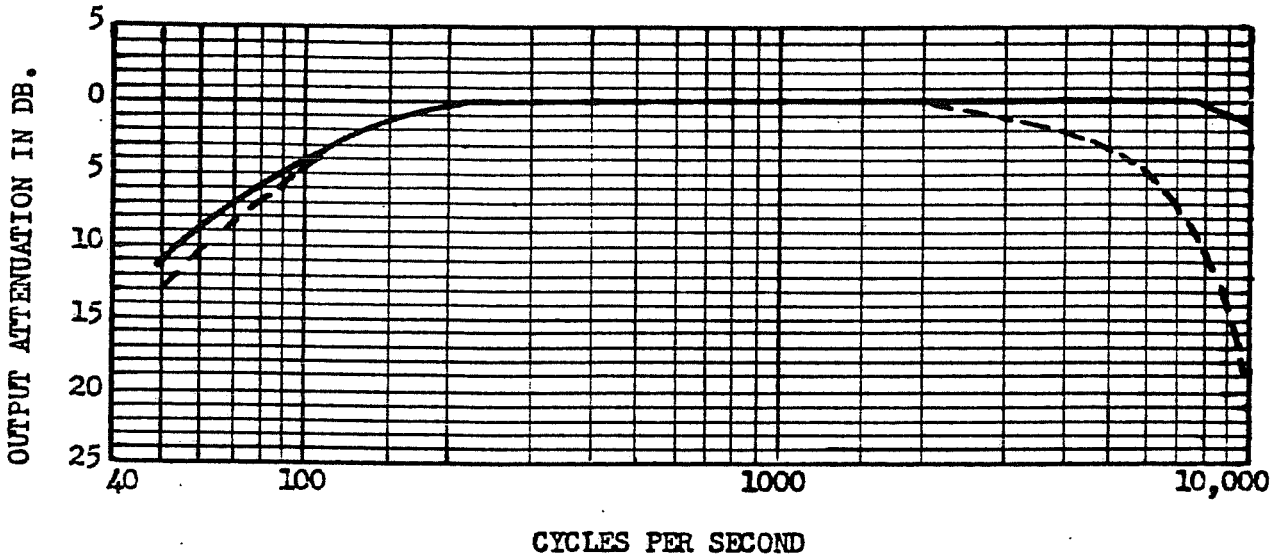


SELECTIVITY CURVES
OVERALL AT 2 MEGACYCLES
COMMUNICATIONS RECEIVER —TYPE 159 MODEL 1

SHEET 1 OF 1
ISSUE 2
DWG. NO. A-159105

DATE 7-6-51	DWN. BY R A	CKD. BY J. Pn.	APP. BY

NORTHERN RADIO COMPANY
INCORPORATED
• NEW YORK 11, NEW YORK •



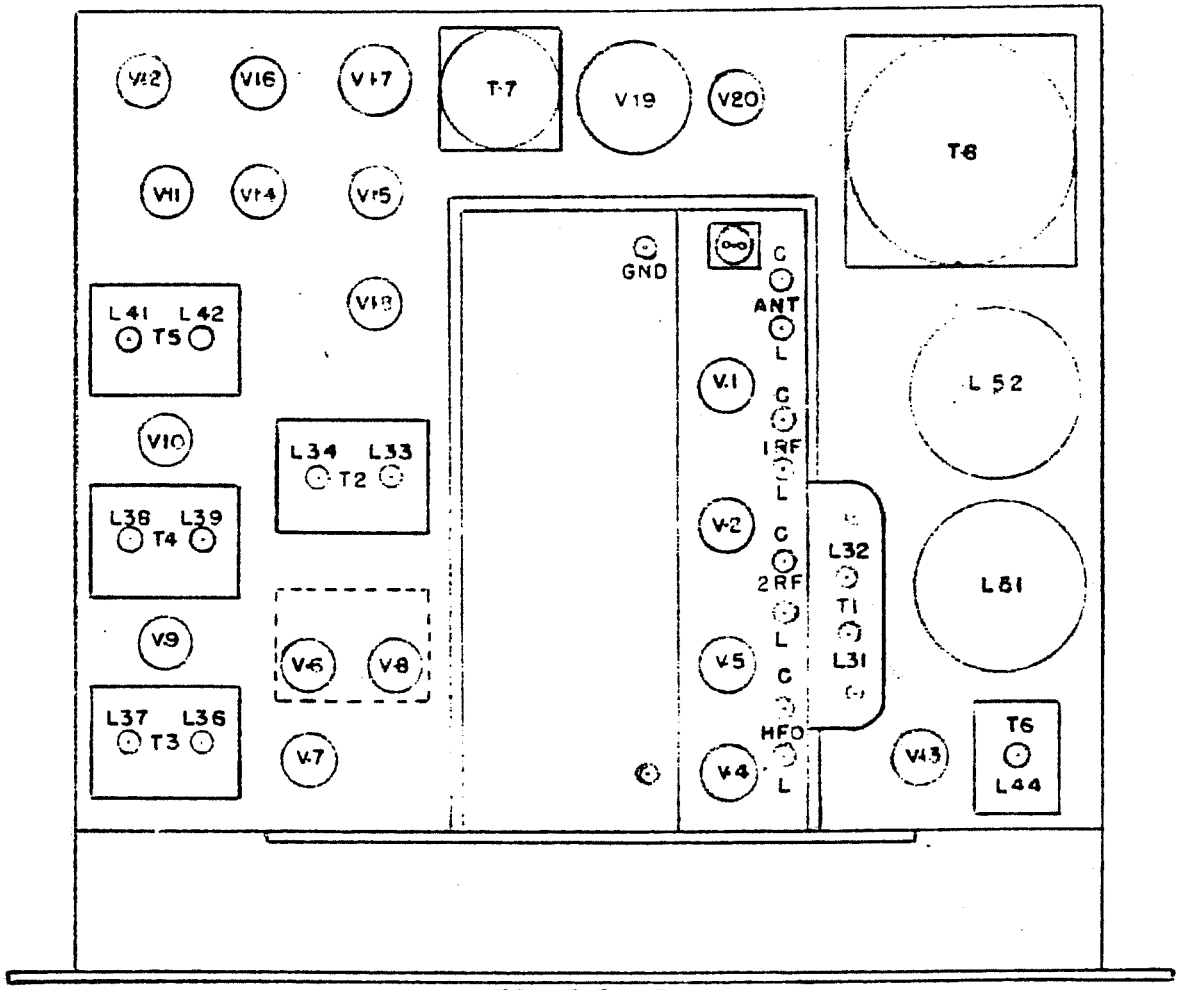
———————— CURVE - Audio frequency amplifier. Input to phono terminals.

— — — — — — CURVE - Overall fidelity at 2.5 mc. Modulation 30 percent. Selectivity switch in 13 kc position. RF Gain set for 20 volts output at 400 cycles.

Output measured across a 600 ohm resistive load. Audio gain control at maximum for both curves.

AUDIO AND OVERALL FIDELITY CURVES Communications Receiver Type 159 Model 1				SHEET 1 OF 1 ISSUE 1.
DATE 7-9-51	DWN. BY R A	CKD. BY	APP. BY	DWG. NO. A-159106

NORTHERN RADIO COMPANY
INCORPORATED
• NEW YORK 11, NEW YORK •



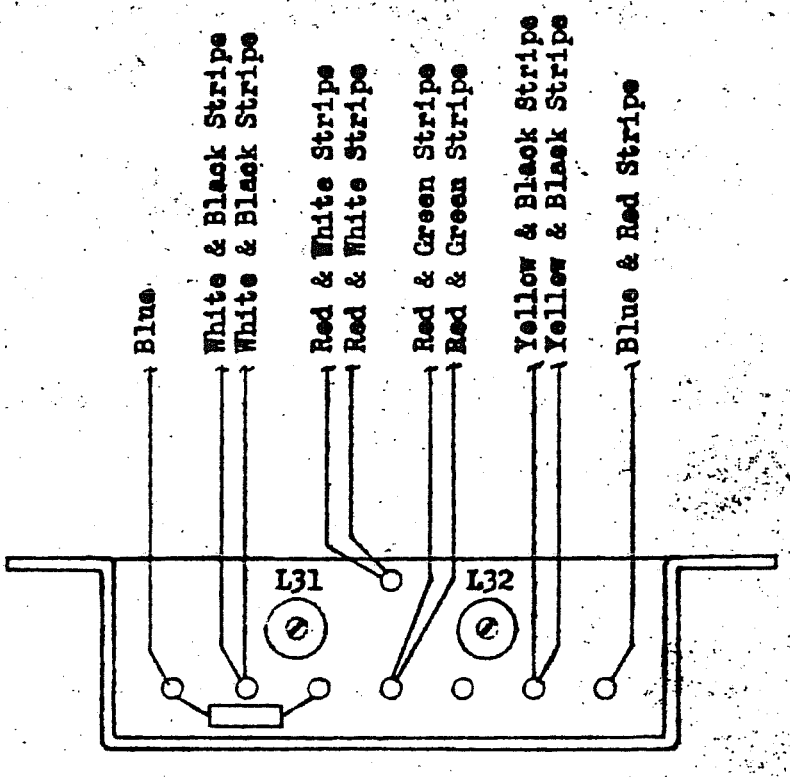
FRONT PANEL

TOP VIEW OF CHASSIS
SHOWING ALIGNMENT ADJUSTMENTS
COMMUNICATIONS RECEIVER - TYPE 159 MODEL 1

SHEET 1 OF 1
ISSUE 2
DWG. NO. A-159108

DATE 7-9-51	DWN BY R A	CKD. BY	APP. BY

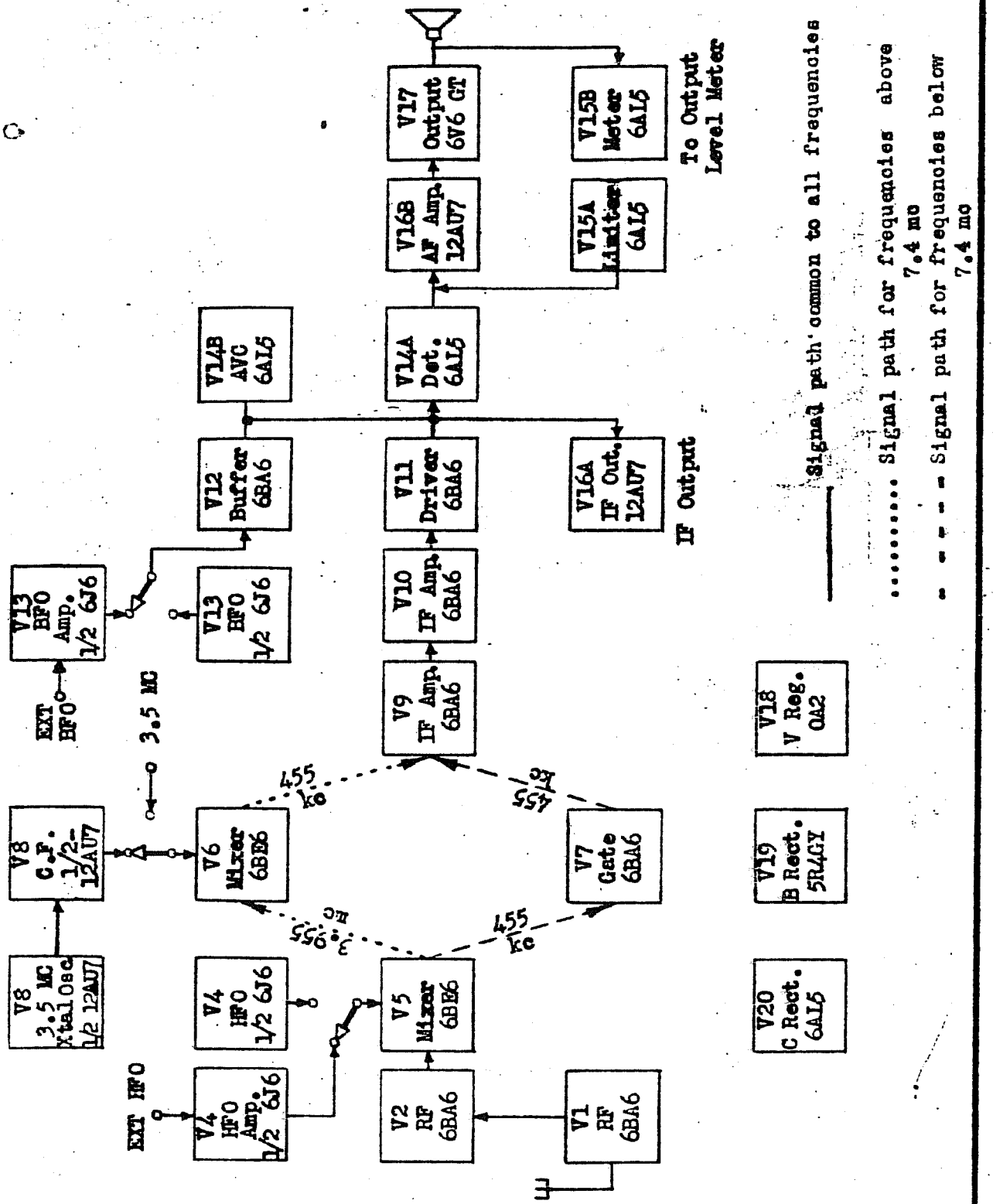
S. A. Barone Co. New York 11, N. Y.



TOP VIEW
COVER PLATE REMOVED

T1 — MIXER PLATE COIL ASSEMBLY WIRING DIAGRAM Hammarluhd Receiver SP-600 J Type 159 Model 1	SHEET 1 OF 1 DRAWING NO. OR ARTICLE NO. A-159104 Issue 1	
DATE 4/20/51J	DRN. BY JM	CHKD. BY J.M. APP. BY

NORTHERN RADIO COMPANY
INCORPORATED
• NEW YORK 11, NEW YORK •



BLOCK DIAGRAM
Communications Receiver
Type 159 Model 1

SHEET 1 OF 1
ISSUE 1
DWG. NO. A-159107

DATE	DWN. BY	CKD. BY	APP. BY
7/10/51	TR	J.m.	