TABLE OF CONTENTS

	Page
DESCRIPTION	1
A. Receiver	1
B. Power Unit	3
C. Loud Speaker	3
INSTALLATION	4
CIRCUIT DESCRIPTION	5
A. Special Features	5
OPERATING INSTRUCTIONS	7
A. Controls	7
B. C.W. Reception	9
C. M.C.W. Reception	10
D. Reception With The Crystal Filter	10
E. Measurement Of Signal Strength	12
ALIGNMENT	12
A. Intermediate Frequency Amplifier Alignment	12
B. High Frequency Oscillator Alignment	14
C. R.F. Amplifier Alignment	15
D. Tracking Of The H.F. Oscillator and R.F. Amplifier Circuits	15
E. Band Spread Alignment	16
MAINTENANCE - FAILURES AND REMEDIES	17
TABULATION OF PARTS	19
JOINT ARMY-NAVY TYPE DESIGNATIONS	23
PHOTOGRAPHS	25
CIRCUIT DIAGRAMS	31
POWER UNIT TYPES	33
LOUD SPEAKER TYPES	33
ADDENDA OR NOTES	34

DESCRIPTION

A. RECEIVER

The HRO-5 Radio Receiver is a high-frequency superheterodyne suitable for C.W. and M.C.W. reception throughout the frequency range of 50 to 430 Kcs., and 480 to 30,000 Kcs. This range of frequencies is covered in nine bands as follows:

50 - 100 KC. Band.	Type J Coil Set
100 - 200 KC. Band.	Type H Coil Set
180 - 430 KC. Band.	Type G Coil Set
480 - 960 KC. Band.	Type F Coil Set
900 - 2050 KC. Band.	Type E Coil Set
1.7 - 4.0 MC. Band.	Type JD Coil Set
3.5 - 7.3 MC. Band.	Type JC Coil Set
7.0 - 14.4 MC. Band.	Type JB Coil Set
14.0 - 30.0 MC. Band.	Type JA Coil Set

The receiver may be obtained in either table or rack mounting models. Plug-in coil set Types JA, JB, JC, and JD are normally supplied with the receiver, and coil set Types E, F, G, H, and J may be obtained in addition, as desired. The receiver is designed for use with an external power unit capable of supplying 240 volts D. C. at 70 milliamperes and 6.2 volts A. C. at 3.4 amperes, although lower plate supply voltages down to 135 volts may be used with some sacrifice in performance.

The circuit employed on all bands comprises two tuned stages of radio frequency amplification, a tuned first detector stage, a high frequency oscillator employing a tube separate from the first detector tube, a first intermediate frequency amplifier stage employing a crystal filter, a conventional second intermediate frequency amplifier stage operating at 456 kilocycles, a combined second detector - automatic volume control - first audio stage, an audio output stage, and a beat frequency oscillator coupled to the second detector to provide for C.W. reception.

The antenna input circuit is suitable for use with a transmission line, a doublet antenna, or a single wire antenna. The antenna input impedance averages approximately 500 ohms at frequencies higher than 1700 Kc.

Two audio output circuits are provided:

(1) Loud speaker terminals, in the form of tip jacks, are located at the rear

left-hand side of the receiver. Normally, the plate circuit of the output tube is brought directly to these tip jacks and a separate permanent magnet type loud speaker having a 5000 to 7000 ohm input impedance is required. The output transformer, in this case, is associated with the loud speaker and carries the plate current of the output tube. An output transformer can be included within the receiver to provide any specified output impedance from a few ohms to 20,000 ohms.

(2) A phone jack is mounted on the front panel. This jack is wired into the output of the first audio stage. When the phones are plugged in, the signal input to the last tube is completely disconnected.

The crystal filter located in the first intermediate amplifier stage provides a convenient means of obtaining adjustable selectivity when receiving any frequency in the tuning range of the receiver. The PHASING control associated with the crystal filter enables the operator to easily suppress interfering signals which may produce objectionable heterodynes. The crystal filter may be used advantageously in either C.W. or M.C.W. reception.

Automatic volume control and an associated signal strength meter are provided for use in M.C.W. reception.

The tubes employed in the HRO- Radio Receiver are located in the circuit as follows:

	HRO-M	HRO-5
First R.F.	6D6	6K7
Second R.F.	6D6	6K7
First Detector	6C6	6J7
High Frequency Oscillator	6C6	6J7
First I.F.	6D6	6K7
Second I.F.	6D6	6K7
Diode Detector, AVC, First Audio	6B7	6SQ7
Second Audio	42	6V6GT/G
Beat Frequency Oscillator	6C6	6J7

Net weights of the various models of the HRO-5 Receiver, are as follows:

Table Model Receiver with 9 Coil Sets	51 lbs.
Rack Model Receiver with 9 Coil Sets	53 lbs.
Empty 3 Coil Set Container (wooden)	1-3/4 lbs.
Empty 5 Coil Set Container (wooden)	2-1/4 lbs.

Overall dimensions of the various units of the HRO-5 Receiver are as follows:

Table Model:	width	17-1/4 in.
	height	9 in.
	depth	12 in.
Rack Model:	width (panel)	19 in.
	width (cabinet)	17 in.
	height	8-3/4 in.
	depth	12 in.
3 Coil-set Container: (wooden)	width	11-1/4 in.
	depth	8-3/8 in.
	height (empty)	4-3/4 in.
	height (with coil sets)	5-3/4 in.
5 Coil-set Container: (wooden)	width	11-1/4 in.
	depth	13-1/2 in.
	height (empty)	4-3/4 in.
	height (with coil sets)	5-3/4 in.

B. POWER UNIT.

Power units for operation from 230 A.C., 115 volts A.C., 6 volts D.C., or 12 volts D.C., are available for use with the HRO-5 Receiver.

These power units may be obtained in either rack or table mounting styles.

Special connections in the vacuum tube heater circuits located within the receiver are required for operation from a 12 volt D.C. source.

In all cases the circuit of the power unit consists of a transformer (with vibrator for D.C. models), a rectifier, and filter circuits.

C. LOUD SPEAKER

Loud Speakers in rack or table mounting styles can be supplied for use with the HRO-5 Radio Receiver. Normally the speaker is of the permanent magnet type and the transformer should have an input impedance of 5000 to 7000 ohms. The speaker transformer carries the plate current of the Receiver output tube. In installations where an output transformer is included within the Receiver, the speaker transformer must of course match the Receiver output impedance. A dynamic speaker may be used, although a means for the speaker field excitation must be provided.

INSTALLATION.

The receiver, power unit, and loud speaker may be arranged in any desired positions although it is not recommended that the loud speaker be placed on top of the receiver as in some cases undesirable microphonic noises may result.

The audio power output terminals are located at the rear left-hand side of the receiver. Phone tips on the loudspeaker cable and tip jacks mounted on the receiver chassis provide a convenient means for connecting the loud speaker to the receiver. Connect the loud speaker to these terminals, or if no speaker is to be used, insert a jumper in the tip jacks to connect them together. If this precaution is neglected, the output tube may be damaged due to excessive screen current.

Insert the receiver power plug in the power socket of the power unit. Connect the power unit to the proper supply source.

The radio frequency input circuit of the HRO-5 Receiver is arranged for operation with either single-wire or doublet type of antenna. There are two R.F. input binding posts located at the left-hand end of the receiver. When using a single-wire antenna, connect the lead-in to the binding post nearest the front panel and clamp the short flexible lead, which is connected to the chassis, under the remaining binding post. An external ground connection may or may not be necessary, depending upon the particular installation. When a doublet antenna is used, connect the antenna feeders or a balanced transmission line directly to the input terminals and do not use the flexible ground connection mentioned above.

The radio frequency upon which reception is desired will determine the coil set to employ, in accordance with the individual charts on each coil set panel. Select the proper coil set and plug it into the opening in the front of the receiver.

The receiver is now ready for use. Turn the receiver on by means of the toggle switch located on the power unit. Complete the receiver B+ circuits by means of the toggle switch located on the receiver front panel directly above the R.F. GAIN control. A pair of terminals at the rear of the receiver chassis is wired to the B+ switch on the front panel. These terminals provide a convenient means of connecting a relay or switch for remote control of the B+ circuits.

For further instructions refer to the section of this book entitled Operating Instructions.

CIRCUIT DESCRIPTION.

A. SPECIAL FEATURES.

Several special features have been included in the HRO-5 Radio Receiver which result in high quality performance. These special features provide receiver characteristics which enable the operator to adjust the receiver for optimum reception under a variety of receiving conditions.

The radio frequency amplifier stages are so designed that the receiver gain is essentially uniform throughout the tuning range of the receiver. The impedance of a typical R.F. tuned secondary circuit decreases as the L/C ratio decreases, thus tending to reduce stage gain as the low frequency end of the tuning band is approached. Compensation for this effect is obtained by the use of high inductance primary coils in the interstage R.F. transformers. The high inductance primary is designed so that the primary circuit, as a whole, resonates broadly at a frequency outside the low frequency limit of the coil set tuning range. The primary circuit will, therefore, show increasing impedance as the tuning of the receiver approaches the low frequency end of the band. This resonant characteristic of the primary increases gain at low frequencies, over-compensating for the decreasing impedance of the secondary. In order to obtain the proper amount of compensation, a small coupling capacity is placed between the plate of the preceding tube and the grid of the following tube. This capacity is most effective at the higher frequency end of the band and combined with the resonant characteristic of the primary provides uniform gain throughout the band.

A slightly different arrangement for gain compensation is employed in the 14-30 Mc. band. The interstage R.F. coupling transformers have three windings all closely coupled together. The primary winding connected in the plate circuit of the first R.F. tube is interwound with the tuned secondary winding and both have approximately the same number of turns. A third winding which feeds the control grid of the following R.F. amplifier tube is so designed that its natural period (or resonant frequency) falls just outside the low frequency end of the frequency band covered by the coil set. The impedance of this resonant secondary increases as the low frequency end of the tuning band is approached, thus tending to compensate for the unfavorable L/C ratio of the tuned secondary in much the same manner as the resonant primary system used in other coil sets. The self resonant secondary arrangement is preferable, in the 14-30 Mc. band, as the resonant primary system is inadequate in its

levelling action. It is not practical to include any gain compensation system in the coil sets for the 50 to 100 Kc. band.

The plug-in coil sets regularly supplied with the HRO-5 Radio Receiver do not have any provision for band spread. Coil sets can be supplied which include the band spread feature, if desired. Band spread is accomplished by switching small capacitors in series with each section of the main tuning capacitor thus reducing its effective range of capacity change. This system provides band spread of the frequencies received at the high frequency end of each coil set tuning range. The frequency bands chosen for band spread are those of the 10, 20, 40, and 80 meter amateur bands. Coil sets which contain the band spread feature are designated as Type A, B, C and D rather than JA, JB, JC and JD.

The receiver is compensated for frequency drift due to temperature changes occurring in circuits which may detune the receiver from the desired signal. While variations in room temperature are usually so gradual that drift resulting from this source is not objectionable, it is minimized through the use of air dielectric trimmer and tuning condensers, and the use of coil form material which has a small temperature coefficient. The cause of most objectionable frequency drift is the change of inductance of the high frequency oscillator coil as the interior of the receiver is heated by the tubes. To minimize heating the R.F. coils, the receiver is designed so that the coil sets are plugged into the very bottom of the receiver, underneath the chassis in a separate shielded compartment. The heat from the tubes will of course rise toward the top of the receiver and the R.F. coils will remain nearly at room temperature.

A Crystal Filter is included in the HRO-5 Radio Receiver as a means of providing adjustable selectivity. The use of the Crystal Filter also enables the operator to easily suppress an interfering signal by means of the PHASING control. With the Crystal Filter switch in the off position the receiver band width is approximately 3 Kc., at two times down. Switching the Crystal Filter into the circuit gives a band width of approximately 2.5 Kc. in the broad position and about 200 cycles in the sharp position of the SELECTIVITY control. The PHASING control can be adjusted to suppress interfering signal frequencies differing from the desired signal frequency by 300 cycles or more. The Crystal Filter employs a bridge type circuit which makes use of the high rate of reactance change with changes in frequency provided by a crystal to give the desired sharpness of selectivity. The reactance vs. frequency characteristic of the crystal is modified by damping, or loading the crystal by means of the tuned in-

put circuit. When the input circuit is detuned, its effective resistance decreases and damping is greatly reduced, producing maximum selectivity. Detuning the input circuit does not materially affect the amplification of the receiver at the resonant frequency of the crystal since the series impedance of the circuit becomes very low when damping is reduced.

Automatic volume control is provided for use only with M.C.W. reception. When the beat oscillator is turned on for C.W. reception it provides sufficient signal to operate the A.V.C. system and renders the receiver extremely insensitive.

A beat oscillator, which operates at or near the intermediate frequency is coupled to the second detector. The signal from this oscillator and the desired C.W. signal heterodyne at the second detector and produce an audio beat note thus providing a means for C.W. reception.

The main tuning dial located at the center of the front panel permits swift, accurate tuning and precise logging. This type of dial has an effective scale length of twelve feet and is direct reading to one part in 500. The dial drives the four-gang main tuning capacitor through a worm drive having a reduction ratio of 20 to 1. Backlash is eliminated by the use of a spring loaded split worm wheel which assures positive drive in either direction at all times.

OPERATING INSTRUCTIONS

A. CONTROLS.

The main tuning dial is located at the center of the front panel. The dial is so arranged that the frequency to which the receiver tunes increases as the dial reading increases. Each coil set is fitted with a calibration chart showing the relationship between dial reading and frequency. An additional chart for band spread calibration is provided on coil sets which include the band spread feature. Observation of each coil set tuning chart will show that the calibration is very nearly linear which characteristic eliminates considerable reference to the coil charts.

The R.F. GAIN control is located at the lower right-hand corner of the front panel and serves to adjust the amplification of the second R.F., first I.F. and second I.F. amplifier stages. Maximum sensitivity is obtained by rotating the control knob to the extreme clockwise position, or 10, on its circular scale. In this position all tubes are operating at maximum gain with minimum bias. As the control is turned counter-clockwise, increasing bias is applied to the second R.F., the first I.F.,and

the second I.F. tubes, thus reducing their amplification.

Directly above the R.F. GAIN control is a two position toggle switch. This switch is connected in the positive lead of the power supply circuit and its purpose is to shut off the receiver during periods of transmission OR WHEN CHANGING COIL SETS. This last function is important. The B+ circuits are complete when this switch is pushed to the right. Series connected with the B+ switch and mounted at the rear of the chassis is a pair of contacts, marked B.S.W., intended for use with relay control of the receiver.

Immediately above the B+ switch is the PHASING control and the Crystal Filter switch. When this control is rotated to 0, the Crystal Filter is disconnected. When the control is at any other setting between 1 and 10, it acts as a PHASING control with the Crystal Filter connected in the circuit. The PHASING control is used to balance the crystal bridge circuit in eliminating interfering signals.

The SELECTIVITY control is located above the PHASING control. With the Crystal Filter in use, minimum selectivity will be found with the pointer nearly vertical where receiver background noise is a maximum. Rotating the knob in either direction from this point will progressively increase selectivity. When the filter is not in use, this knob acts as an ordinary I.F. trimmer and should be set at the point giving maximum volume and sensitivity.

The C.W. OSC. switch and vernier tuning control is located at the lower left-hand side of the front panel. The C.W. oscillator is used to obtain an audible beat note when receiving C.W. signals or to locate the carrier of a weak M.C.W. station. Rotating the C.W. OSC. knob in a clockwise direction switches B+ voltage to the plate and screen of the C.W. oscillator tube. Further rotation of the knob from 0 on the scale to 10 varies the frequency over a range of approximately 3 kc. The C.W. oscillator tunes to the intermediate frequency at 9 on the scale.

The automatic volume control switch is located above the C.W., OSC. control. The automatic volume control circuits are in operation when the toggle switch is pushed to the left.

The AUDIO GAIN control is located directly above the AVC-MVC switch. Clockwise rotation of this control increases the signal applied to the triode section of the first audio tube. This control adjusts the volume level of the signal at both phone jack and loudspeaker terminals.

The S-meter for indicating carrier intensity or signal strength is in the upper left-hand corner. Just below it, and to the left, is a switch which connects the

S-meter in the circuit.

The phone jack is located just below and slightly to the right of the S-meter. When a phone plug is inserted into the phone jack, the loud speaker is automatically silenced.

Inspection of the coil set terminal panels which include the band spread feature will show several small rectangular metal pieces. There are two of these pieces or terminal blocks on each coil which will accommodate a small flat-head machine screw. With the screws in the left-hand positions, the coil range will be that shown in the left-hand, or general coverage chart. If it is desired to change the calibration to band spread, as shown on the right-hand chart, it is only necessary to move each of the four screws to the right-hand terminal block of each coil.

B. C.W.RECEPTION.

After the HRO-5 Receiver is properly installed it is put in operation by turning both the Power Unit switch and the Receiver B+ switch to the on position. The C.W. OSC. control should be turned on and the A.V.C. switch must be pushed to the right to render the A.V.C. circuits inoperative. If the A.V.C. switch is turned on with the C.W. oscillator in operation, the receiver will block and become extremely insensitive. The Receiver is now adjusted for C.W. reception and will tune in accordance with the frequency calibration of the coil set in use.

Although the settings of the R.F. GAIN and A.F. GAIN controls will depend to some extent upon operating conditions, it is recommended that the A.F. GAIN control be set about 5 and the R.F. GAIN control advanced as may be required to provide a satisfactory audio signal. Advancing the R.F. GAIN control too much may cause I.F. or second detector overload. Such overload is indicated by a change in pitch of the C.W. beat note over the duration of a code character, or by excessive "thumping".

The best setting of the C.W. OSC. control will also depend upon operating conditions. When the received signal is free from interference and is sufficiently strong to override static and circuit noise, it is recommended that the C.W. OSC. control be set at the position which tunes the C.W. oscillator to the intermediate frequency of the receiver. This setting will normally be between 8 and 10 on the C.W. OSC. dial. As the control is turned toward 0, the C.W. oscillator is progressively detuned from the intermediate frequency of the receiver.

The operator can determine the extent of this deviation by listening to the characteristic pitch of background and circuit noises. When this pitch is 2000 or 3000

cycles per second, it will be found that the receiver has definite "single signal" properties such that on one side of the carrier, the audio beat note of a received signal will be considerably louder than that of the other side. This characteristic is helpful in receiving weak signals through interference and utilizes the maximum available sensitivity of the receiver.

C. M.C.W. RECEPTION

The initial adjustment of the HRO-5 Receiver for M.C.W. reception is the same as for C.W. reception except that the C.W. oscillator control should be turned off. In M.C.W. reception the C.W. oscillator may be useful in locating the carrier of a weak phone or broadcast station. After the phone carrier has been found the C.W. oscillator is, of course, turned off.

With A.V.C. off the settings of the A.F. GAIN and R.F. GAIN controls will depend to some extent upon operating conditions. It is recommended that the A.F. GAIN control be set at about 5 and the R.F. GAIN control advanced as may be required to provide a satisfactory audio signal. When receiving weak signals, best signal-to-noise ratio will be obtained by retarding the A.F. GAIN control and advancing the R.F. GAIN control to a point as near maximum as receiving conditions permit. The operator must be careful to avoid overloading the I.F. or second detector stages under these conditions. Overload will be indicated by excessive audio distortion.

To receive M.C.W. signals with automatic volume control, the A.V.C. switch must be pushed to the left, i.e., the on position. The R.F. GAIN control should be advanced to a point as near maximum as receiving conditions permit. Audio output should be controlled entirely by means of the A.F. GAIN control. When the noise level is high, the R.F. GAIN control may be retarded to limit the overall sensitivity to a definite maximum. The operator should remember, however, that the full range of A.V.C. action cannot be obtained unless the R.F.GAIN control is fully advanced.

D. RECEPTION WITH THE CRYSTAL FILTER.

The crystal filter may be used advantageously in both C.W. and M.C.W. reception to adjust the selectivity of the receiver and also to suppress interfering signals.

For M.C.W. reception the crystal filter is switched into the circuit by turning the PHASING control knob from 0 to 1 as indicated by its dial. The insertion of the crystal filter reduces the receiver gain slightly and as a result it will be necessary to advance both A.F. and R.F. GAIN controls to compensate for this loss in gain. The

PHASING control should then be turned to the center of its range which effectively removes its action from the band of frequencies being received. The SELECTIVITY control may be adjusted for minimum selectivity by turning it to a position (near the center of its range) where background noise is the loudest. The receiver may now be tuned to M.C.W. signals in the usual manner, but it will be found that the selectivity is very high, with the result that all audio frequency tones above a few hundred cycles are comparatively weak when the receiver is tuned exactly to the M.C.W. carrier. Normally this loss of high frequency audio tones would result in low intelligibility of received signal, but since the background noise, static, etc., have been reduced much more, the net result is usually an improvement. Selectivity may be increased for use in extreme cases of interference by turning the SELECTIVITY control in either direction from the minimum selectivity position. Under these conditions, tuning is very critical and care must be exercised to assure proper tuning.

An interfering signal which produces undesirable heterodynes may be greatly suppressed by means of the crystal filter PHASING control. It will be found that the point of maximum attenuation for signals with a frequency near the desired frequency will occur near one extreme or the other of the PHASING control rotation depending on whether the frequency of the undesired signal is above or below the frequency of the desired signal. Undesired signals with frequencies further removed from the desired signal frequency can be suppressed with settings of the PHASING control which occur nearer the center of its range.

Crystal Filter operation for C.W. reception is similar to that for M.C.W. with the exception that maximum selectivity may be employed without the loss of intelligibility experienced in M.C.W. reception. When maximum selectivity is employed, tuning is very critical and care must be exercised to assure proper tuning. When the receiver is slowly tuned across the carrier of a received signal, the beat note produced will be very sharply peaked in output at a particular audio pitch. This peak in response indicates the correct receiver dial setting. The setting of the C.W. OSC. must provide a beat note peak well within the audible range so that receiver peak response may be readily observed. A C.W. OSC. dial setting near 7 is recommended. After the receiver has been correctly tuned, the pitch of the beat note peak may be adjusted by means of the C.W. OSC. control to provide an audio tone which is pleasing to copy, or coincides with any response peaks in the speaker or headphones. Under these conditions the receiver will exhibit pronounced single signal properties

which may be demonstrated by tuning the receiver dial to the other side of "zero beat" so that the pitch is the same as before and observing the marked reduction in output. This dial setting is not recommended for use other than to demonstrate the single signal properties of the receiver. The operation of the PHASING control in suppressing an undesired signal is the same for either C.W. or M.C.W. reception.

E. MEASUREMENT OF SIGNAL STRENGTH.

The S-meter can be used to measure the strength of received signals when the receiver is adjusted for M.C.W. reception employing automatic volume control. With no signal input the S-meter should read zero with the R.F. GAIN control set at about 9.5. The setting of the AUDIO GAIN control is unimportant when measuring signal strength. The Crystal Filter should be disconnected from the circuit and the SELECTIVITY control set for maximum S-meter reading. The S-meter may be used to measure the strength of either C.W. or M.C.W. signals provided that the beat oscillator is not used.

ALIGNMENT

Should realignment of the HRO-5 Radio Receiver become necessary the following alignment data should be carefully studied before making any circuit adjustments. It is important that the operator understands the function of each circuit element so that correct alignment may be obtained quickly and accurately. Adjustments referred to by number are shown in the various receiver photographs.

The complete alignment of the Receiver may be divided into five steps:

(A) Intermediate Frequency Amplifier alignment including Crystal Filter adjustments.

(B) High Frequency Oscillator alignment.

(C) Radio Frequency Amplifier alignment.

(D) Tracking of High Frequency Oscillator and Radio Frequency Amplifier circuits.

(E) Band Spread adjustments.

A. INTERMEDIATE FREQUENCY AMPLIFIER ALIGNMENT.

A-1 The operator is cautioned against making any adjustments indiscriminately, and he should not realign any circuit unless tests definitely indicate that realignment is necessary.

A-2. The alignment of the Intermediate Frequency Amplifier may be easily checked in the following manner. The receiver should be adjusted for normal operation with no antenna, AVC off, R.F.GAIN at 9, Crystal Filter on, PHASING control at 5, SELECTIVITY maximum, and the C.W. OSC. turned on. The setting of the A.F. GAIN control does not affect the measurement and may be adjusted to provide sufficient output to make the required observations. The C.W. OSC. control should then be turned until a point is found where the predominant pitch of the background noise is lowest and a crystal ring is heard. This setting of the C.W. OSC. control should occur near 9 on the C.W. OSC. scale and the exact setting should be noted. The Crystal Filter should then be disconnected from the circuit by turning the PHASING control to 0 on its scale and the SELECTIVITY control adjusted for maximum background noise. The C.W. OSC. control should again be adjusted for the lowest predominant pitch of background noise and this new setting noted. If the I.F. Amplifier is properly aligned, the setting of the C. W. OSC. control should be the same for both tests outlined above. The I.F. Amplifier should not be realigned, however, unless the test shows appreciable maladjustment of the I.F. Amplifier.

A-3. When it is found necessary to realign the I.F. Amplifier, the following procedure should be used:

(a) Adjust the receiver as explained in paragraph A-2, with the Crystal Filter connected into the circuit and set for maximum selectivity.

(b) Connect an antenna to the receiver and tune in a steady C.W. signal so that it is tuned exactly on the crystal peak response frequency.

(c) Adjust the C.W. OSC. to provide a beat note well within the audio range.

(d) Adjust I.F. Amplifier trimmers, numbers 10, 11, 12, 13, and 14,for maximum response. Avoid second detector or audio overload by reducing the signal input to the receiver as required. Such overload makes various I.F. Amplifier adjustments appear considerably less critical than they actually are. Do not reduce signal level by retarding the R.F.GAIN control but rather by reducing the input to the antenna terminals.

(e) Check the alignment of the I.F.Amplifier as explained in paragraph A-2 to assure that it has been properly aligned to the crystal frequency.

A-4. After the I.F. Amplifier has been properly aligned, the tuning of the C.W. OSC. should be checked. This may be readily accomplished by repeating the test of paragraph A-2 with the Crystal Filter disconnected from the circuit and the SELECTIVITY control adjusted for maximum background noise. If the setting of the C.W. OSC.

control does not occur at or near 9, with this test, turn the C.W. OSC. control to 9 and adjust trimmer number 15 or 16, or both, for the lowest pitch of background noise.

B. HIGH FREQUENCY OSCILLATOR ALIGNMENT.

B-1. The need for realignment of the High Frequency Oscillator of any band is indicated when the frequency calibration of the receiver dial is in error by more than 3% (plus or minus) at the high frequency end of the band in question. If there is doubt concerning the necessity for High Frequency Oscillator realignment, this portion of the circuit should not be adjusted as correction can be made by R.F. Amplifier trimmer adjustments.

B-2. If the frequency calibration of a coil set is in error by more than 3%, it should be corrected in the following manner:

(a) Adjust the receiver for normal operation as follows: R.F. GAIN at 9, C.W. OSC. off, A.V.C. off, Crystal Filter off, (PHASING control at 0), SELECTIVITY control at the position of maximum background noise, and the A.F. GAIN set to provide a suitable signal level for the required observations.

(b) Adjust an accurately calibrated test oscillator, frequency meter, or signal generator to provide a signal which should be tuned in near 490 on the receiver dial according to the general coverage calibration chart for the coil set in use.

(c) Tune the Receiver to the test signal and compare the dial reading with the calibration chart.

(d) When the Receiver dial reading is too low, more circuit capacity is required and is supplied by adjustment of trimmer, number 8; When the Receiver dial reading is too high, less circuit capacity is required and is removed by adjustment of trimmer, number 8.

B-3. It is particularly important that the High Frequency Oscillator circuits operate at a higher frequency than that of the R.F. Amplifier circuits. This can be checked by tuning in the test signal, as an image which is normally 912 kilocycles lower on the Receiver dial. The image signal should be considerably weaker if the R.F. Amplifier is correctly aligned and a stronger test signal may be required before the image can be found. If the image signal appears at a higher dial setting rather than a lower setting, the H.F. oscillator circuit is incorrectly adjusted and the capacity of trimmer, number 8, must be decreased until the real signal and image signal appear at the proper points on the dial.

C. R.F. AMPLIFIER ALIGNMENT.

C-1. The term R.F. Amplifier alignment, as used in this section, includes alignment of both R.F. Amplifier and First Detector circuits.

C-2. The R.F. Amplifier may be aligned in the following manner:

(a) Adjust the receiver as explained in (a) of paragraph B-2. No antenna is needed.

(b) Turn the Receiver dial to 490.

(c) Adjust trimmers, numbers 2, 4 and 6, for maximum background noise, which is the setting for maximum gain.

D. TRACKING OF THE H. F. OSCILLATOR AND R. F. AMPLIFIER CIRCUITS.

D-1. Tracking of the H. F. Oscillator and R. F. Amplifier circuits may be readily checked by observing the background noise while tuning throughout the range of the coil set in use. The background noise should not vary greatly as the dial is turned toward the low frequency limit of the coil set tuning range. The actual tracking of each stage near the low frequency limit of the tuning range may be checked by pressing the outside rotor plates of the main tuning condenser section toward or away from the stator, but not far enough to short the condenser or permanently bend the rotor plates. Any change in capacity should decrease the background noise indicating decreased sensitivity, if the stage is tracking properly. Coil sets which may require precise adjustment of circuit elements are provided with adjustable series padders in the High Frequency Oscillator portion of the coil set, which can be adjusted to track with the average adjustment of the R. F. Amplifier coils. This series padder is mounted inside the coil and is adjustable from the rear by means of a screw driver. It should be remembered that the series padders found in the coils of coil set Types A, B, C and D are Band Spread series padders and should not be adjusted except during Band Spread alignment.

D-2. After calibration and alignment at the high frequency end of the coil set have been adjusted as explained in paragraphs B-2 and C-2, the tracking may be adjusted as follows:

(a) With the Receiver adjusted as in part (c) of paragraph C-2, turn the Receiver dial to 20.

(b) Test the tracking of each stage in turn by bending the outside rotor plate of each section of the main tuning capacitor and note any maladjustment. DO NOT bend the rotor plate of any section to such an extent that it will not spring back to its original position.

(c) Adjust the High Frequency Oscillator series padder to its optimum tracking position when step b (above) gives indication of poor tracking.

(d) Turn the Receiver dial to 490 and adjust trimmer number 8 to give the proper calibration with the new value of series padder.

(e) Repeat a, b, c, and d until best tracking is obtained.

(f) Note any slight tracking errors occuring in the R.F. Amplifier stages so that if the same error occurs in a majority of the coil sets, the outside rotor plate may be permanently bent to provide the best tracking for the stage involved.

E. BAND SPREAD ALIGNMENT.

E-1. The Band Spread feature may or may not be included in the particular coil sets supplied depending on the type of coil set purchased for the receiver. The following alignment data applies only to coil sets which include the Band Spread feature.

E-2. Adjustments made for general coverage will affect the Band Spread adjustments, but the separate Band Spread adjustments may be made without changing the general coverage alignment.

E-3. The four screws used to switch from general coverage to Band Spread, as explained under Operating Instructions, must be shifted to the right-hand terminal blocks before any Band Spread alignment adjustments are made.

E-4. The need for realignment of the High Frequency Oscillator section of any coil set is indicated when the frequency calibration of the Receiver dial is in error by more than 30 divisions (plus or minus) at the high frequency end of the band in question.

E-5. If the frequency calibration of a coil set is in error it should be corrected in the following manner.

(a) Repeat the procedure of Paragraph B-2 with the exceptions that a test oscillator frequency is chosen which should be tuned in at 450 on the Receiver dial as indicated by the Band Spread tuning chart and correction for calibration error is made by adjustment of trimmer number 7.

E-6. The alignment of the R.F. Amplifier for Band Spread operation is similar to that for general coverage so the procedure of Paragraph C-2 should be repeated with the exception that the Receiver dial should be turned to 450 and trimmers, numbers 1, 3, and 5 should be adjusted for maximum background noise.

E-7. The adjustment of and method of checking Band Spread tracking is not similar to that for general coverage. The following procedure should be used for Band

Spread tracking adjustments.

(a) With the receiver adjusted as in Paragraph E-6, turn the Receiver dial to 50.

(b) Check the receiver calibration at 50 against an accurate test oscillator.

(c) Adjust the High Frequency Oscillator series padder located inside the High Frequency Oscillator coil shield to provide the correct dial calibration.

(d) Turn the dial to 450 and adjust trimmer number 7 to give the proper calibration.

(e) Turn the dial to 50 and check the calibration. Repeat c and d if necessary.

(f) With the Receiver dial at 50 check the settings of trimmers, numbers 1, 3 and 5, for the position of maximum background noise.

(g) If it is found that increasing or decreasing the capacity of trimmer 1, 3 or 5 increases the background noise, adjust the associated series padder located inside the coil shields to provide the desired capacity.

(h) Turn the Receiver dial to 450 and adjust trimmers 1, 3 and 5 for maximum background noise.

(i) Repeat f and h, also g, if necessary.

MAINTENANCE - FAILURES AND REMEDIES

Any repairs in the HRO-5 Receiver which necessitate resoldering of joints should be made with care. The new joint should be such that the pieces to be soldered are firmly connected mechanically before solder is applied.

Failure of a vacuum tube in the Receiver may reduce the sensitivity of the equipment to radio signals, produce intermittent operation or cause the equipment to be completely inoperative. In such cases, all tubes should be checked either in an analyzer or similar tube testing equipment, or by replacement with tubes of proven quality. When any tube is tested, it should be tapped or jarred, to make sure that it has no internal loose connection or intermittent short circuit.

When tube replacements become necessary, substitution of new tubes may alter the alignment of the R.F. or I.F. circuits inasmuch as the replacement tubes may not be identical with those originally employed. The necessity for realignment as well as alignment procedure is discussed in the Alignment Section.

In case of breakdown or failure of the Receiver, the fault must first be localized in one portion of the circuit. This can be often accomplished by observation of some peculiar action of one of the controls. Reference to the circuit diagram will

aid in checking voltages at the various tube elements.

By-pass or filter capacitors which develop poor connections internally, or which become open-circuited, will cause decreased sensitivity, oscillation or poor stability. The defective unit can be located by temporarily connecting a good capacitor in parallel with each capacitor that is under suspicion.

Failure of any by-pass or filter capacitor may seriously overload resistors of the associated circuits. Overloads of sufficient magnitude to permanently damage a resistor will cause the surface of the resistor to be scorched, making the defective unit easy to locate by visual inspection.

Open or short-circuited resistors can be definitely located by testing the resistance of each individual resistor. The wiring diagram should be consulted to make sure that any particular resistor under test is not connected in parallel with some other circuit element which might produce false measurement.

Loose connections which cause intermittent or noisy operation can often be found by tapping, or shaking, any component under suspicion, with the Receiver adjusted for normal operation.

TABULATION OF PARTS

CONDENSERS

Part Symbol Number	Function	Description	Mfr. Type Number	Mfr.
C1	V5 Heater Bypass	.1 Mfd., 400 VDC W	G	Sprague
C2	V5 Grid Filter	.01 Mfd., 600 VDC W	G	Sprague
C3	V3 Cathode Bypass	.1 Mfd., 400 VDC W	G	Sprague
[illegible]	V2 B+ Bypass	.1 Mfd., 600 VDC W	G	Sprague
[illegible]	V4 Screen Bypass	.1 Mfd., 600 VDC W	G	Sprague
C6	V5 Cathode Bypass	.1 Mfd., 400 VDC W	G	Sprague
C7	V4 Cathode to V2 Screen	.01 Mfd., 600 VDC W	G	Sprague
C8	V5 and V6 Plate Filter	.25 Mfd., 600 VDC W	G	Sprague
C9	V6 Grid Filter	.01 Mfd., 600 VDC W	G	Sprague
C10	V6 Cathode Bypass	.1 Mfd., 400 VDC W	G	Sprague
C11	V7 Cathode Bypass	10. Mfd., 50 VDC W	D 9765	Sprague
C12	V7 Diode Filter	.0001 Mfd., 500 VDC W	Class C	Centralab
C13	V7 Diode Filter	.00025 Mfd., 500 VDC W	Class C	Centralab
[illegible]14	V7 Diode to Pentode Coupling	.1 Mfd., 400 VDC W	G	Sprague
[illegible]15	V7 Diode Bypass	.01 Mfd., 600 VDC W	G	Sprague
C16	V7 Plate Bypass	.0005 Mfd., 500 VDC W	Dual C	Centralab
C17	V2 Cathode Bypass	.1 Mfd., 400 VDC W	G	Sprague
C18	V7 to V9 Coupling	.1 Mfd., 600 VDC W	G	Sprague
C19	V9 Cathode Bypass	10. Mfd., 50 VDC W	D 9765	Sprague
C20	V8 Heater Bypass	.1 Mfd., 400 VDC W	G	Sprague
C21	V8 Screen Bypass	.1 Mfd., 400 VDC W	G	Sprague
C22	V1 Cathode Bypass	.1 Mfd., 400 VDC W	G	Sprague
C23	V1,V2,V5 and V6 Screen Bypass	.1 Mfd., 400 VDC W	G	Sprague
C24	V1 Grid Filter	.01 Mfd., 600 VDC W	G	Sprague
C25	V1 B+ Bypass	.1 Mfd., 600 VDC W	G	Sprague
C26	V2 Grid Filter	.01 Mfd., 600 VDC W	G	Sprague
C27	C.W. OSC. Tuning	30 Mmf.,	SA-13	NationalCo
C28	V7 B+ Bypass	.01 Mfd., 600 VDC W	G	Sprague
[illegible]29	V8 Grid Coupling	.001 Mfd., 500 VDC W	1467	Aerovox
[illegible]30	V4 Grid Coupling	.0001 Mfd., 500 VDC W	Class C	Centralab
C31	Crystal Filter Bridge	.0001 Mfd., 500 VDC W	Class C	Centralab

Part Symbol Number	Function	Description	Mfr. Type Number	Mfr.
		CONDENSERS		
C32	Crystal Filter Bridge	.0001 Mfd., 500 VDC W	ClassC	Centralab
C33	V8 to V7 Coupling	2. Mmf., 400 VDC W	B-22	NationalCo
C34	Coil JA-1 or A-1 Antenna Coupling	.00004 Mfd., 500 VDC W	ClassD	Centralab
C35	Coil JA-1 or A-1 Series Padder	.0012 Mfd., 500 VDC W	1467	Aerovox
C36	Coil JA-4 or A-4 Series Padder	.00085 Mfd., 500 VDC W	1467	Aerovox
C37	Coil JB-4 or B-4 Series Padder	.0026 Mfd., 500 VDC W	1467	Aerovox
C38	Coil JC-4 or C-4 Series Padder	.0016 Mfd., 500 VDC W	1467	Aerovox
C39	Coil JD-4 or D-4 Series Padder	.00088 Mfd., 500 VDC W	1467	Aerovox
C40	Coil E-4 Series Padder	.00045 Mfd., 500 VDC W	Dual C	Centralab
C41	Coil F-4 Series Padder	.00035 Mfd., 500 VDC W	Dual C	Centralab
C42	Coil G-4 Series Padder	.0001 Mfd., 500 VDC W	ClassC	Centralab
C43	Coil J-4 Fixed Trimmer	.00005 Mfd., 500 VDC W	ClassD	Centralab
C44	H.F. Osc. Temperature Compensator	10. Mmfd., 500 VDC W	ClassD	Centralab
		KNOBS AND DIALS		
K1	Main Tuning Dial	5/16" Bushing	SA-645	NationalCo
K2	Selectivity Knob	1/4" Bushing	SA-1273	NationalCo
K3	Phasing Knob	1/4" Bushing	SA-7	NationalCo
K4	R.F.Gain Knob	1/4" Bushing	SA-5	NationalCo
K5	C.W.OSC. Knob	1/4" Bushing	SA-6	NationalCo
K6	Audio Gain Knob	1/4" Bushing	SA-4	NationalCo
		RESISTORS		
	R.F.Gain Control	10,000 OHM, 1.5 Watt, Var.	G-60	Clarostat
R2	V-3 Cathode	5,000 OHM, 1/2 Watt	SCI-1/2	Speer
R3	V5 Grid Filter	500,000 OHM, 1/2 Watt	SCI-1/2	Speer
R4	V5 Cathode	300 OHM, 1/2 Watt	SCI-1/2	Speer
R5	V4 Screen Filter	50,000 OHM, 1/2 Watt	SCI-1/2	Speer
R6	V2 Screen Filter	100,000 OHM, 1/2 Watt	SCI-1/2	Speer

Part Symbol Number	Function	Description	Mfr. Type Number	Mfr.
		RESISTORS		
R7	V4 Screen Bleeder	100,000 OHM, 1/2 Watt	SCI-1/2	Speer
R8	V6 Grid Filter	500,000 OHM, 1/2 Watt	SCI-1/2	Speer
R9	V6 Cathode	1000/5000 OHM, 1/2 Watt	SCI-1/2	Speer
R10	V1,V2,V5 & V6 Screen Filter	15,000 OHM, 2 Watt	SCI-2	Speer
R11	S Meter Bridge	2500 OHM, 1/2 Watt	SCI-1/2	Speer
R12	V7 Diode Load	500,000 OHM, 1/2 Watt	SCI-1/2	Speer
R13	V7 Diode Filter	50,000 OHM, 1/2 Watt	SCI-1/2	Speer
R14	V7 Diode Equalizing	250,000 OHM, 1/2 Watt	SCI-1/2	Speer
R15	V1,V2,V5 & V6 Screen Bleeder	30,000 OHM, 2 Watt	SCI-2	Speer
oR16	V7 Screen Bleeder	20,000 OHM, 1/2 Watt	SCI-1/2	Speer
oR17	V7 Screen	100,000 OHM, 2 Watt	SCI-2	Speer
#R18	V7 Plate	50,000 OHM, 1 Watt	SCI-1	Speer
oR18	V7 Plate	100,000 OHM, 2 Watt	SCI-2	Speer
R19	AVC Filter	500,000 OHM, 1/2 Watt	SCI-1/2	Speer
R20	V7 Cathode	800 OHM, 1/2 Watt	SCI-1/2	Speer
R21	Heater Center Tap	64 OHM, 3 Watt	864C	Mallory
R22	V8 Screen Filter	100,000 OHM, 1/2 Watt	SCI-1/2	Speer
R23	V8 Plate	250,000 OHM, 1/2 Watt	SCI-1/2	Speer
R24	V8 Screen Bleeder	100,000 OHM, 1/2 Watt	SCI-1/2	Speer
#R25	V9 Cathode	300 OHM, 2 Watt	SCI-2	Speer
oR25	V9 Cathode	500 OHM, 2 Watt	SCI-2	Speer
R26	V9 Grid	500,000 OHM, 1/2 Watt	SCI-1/2	Speer
R27	V1 Cathode	300 OHM, 1/2 Watt	SCI-1/2	Speer
R28	V1 Grid Filter	500,000 OHM, 1/2 Watt	SCI-1/2	Speer
R29	V2 Cathode	300 OHM, 1/2 Watt	SCI-1/2	Speer
R30	S Meter Bridge	2000 OHM, 1/2 Watt	SCI-1/2	Spe
R31	V2 Grid Filter	500,000 OHM, 1/2 Watt	SCI-1/2	Speer
R32	S Meter Zero Adjusting	1000 OHM, 1 Watt, Var.	E-9029A	Clarostat
R33	Audio Gain Control	500,000 OHM, 1 Watt, Var.	10101635	Centralab
R34	V8 Grid	50,000 OHM, 1/2 Watt	SCI-1/2	Speer
R35	V4 Grid	20,000 OHM, 1/2 Watt	SCI-1/2	Speer

Used only on HRO-5 Series

o Used only on HRO-M Series

Part Symbol Number	Function	Description		Mfr. Type Number	Mfr.
		TRANSFORMERS	HRO-5	HRO-M	
T1	Crystal Filter	456. Kc.	SA-2491	SA-81	NationalCo
T2	Second I.F. Transformer	456. Kc.	SA-2492	SA-41F	NationalCo
T3	Second Detector Trans.	456. Kc.		SA-41G	NationalCo
T4	C.W.Oscillator Trans.	456. Kc.	SA-2493	SA-41H	NationalCo
*T5	Output Trans.	Specify			NationalCo
**T6	First I.F. Trans.	456. Kc.		SA-1320	NationalCo
		VACUUM TUBES	HRO-5	HRO-M	
V1	First R.F.	R.F.Pentode	6K7	6D6	RCA
V2	Second R.F.	R.F.Pentode	6K7	6D6	RCA
V3	First Detector	R.F.Pentode	6J7	6C6	RCA
V4	H.F.Oscillator	R.F.Pentode	6J7	6C6	RCA
V5	First I.F.	R.F.Pentode	6K7	6D6	RCA
V6	Second I.F.	R.F.Pentode	6K7	6D6	RCA
V7	Second Detector	Diode-Pentode	6SQ7	6B7	RCA
V8	C.W.Oscillator	R.F.Pentode	6J7	6C6	RCA
V9	Audio Output	A.F.Pentode	6V6GT/G	42	RCA
		CABLES AND PLUGS			
W1	Power Cable and Plug	Four-wire,four prong plug.		C-627	NationalCo
		SWITCHES			
X1	B+ Switch	S.P.S.T.Toggle, 3A.,250 V.		80994	A.H.+H.
X2	C.W.Oscillator Switch	S.P.S.T.Toggle, 3A.,250 V.		20994L	A.H.+H.
X3	A.V.C. Switch	S.P.D.T.Toggle, 3A.,250 V.		21350E	A.H.+H.
X4	S Meter Switch	S.P.S.T.Toggle, 3A.,250 V.		80994	A.H.+H.

This Parts List indicates suitable types, but equivalent alternate types may be employed.

* Specify Output Impedance When An Output Transformer is Desired.

** May be used in place of T-1.

JOINT ARMY-NAVY TYPE DESIGNATIONS

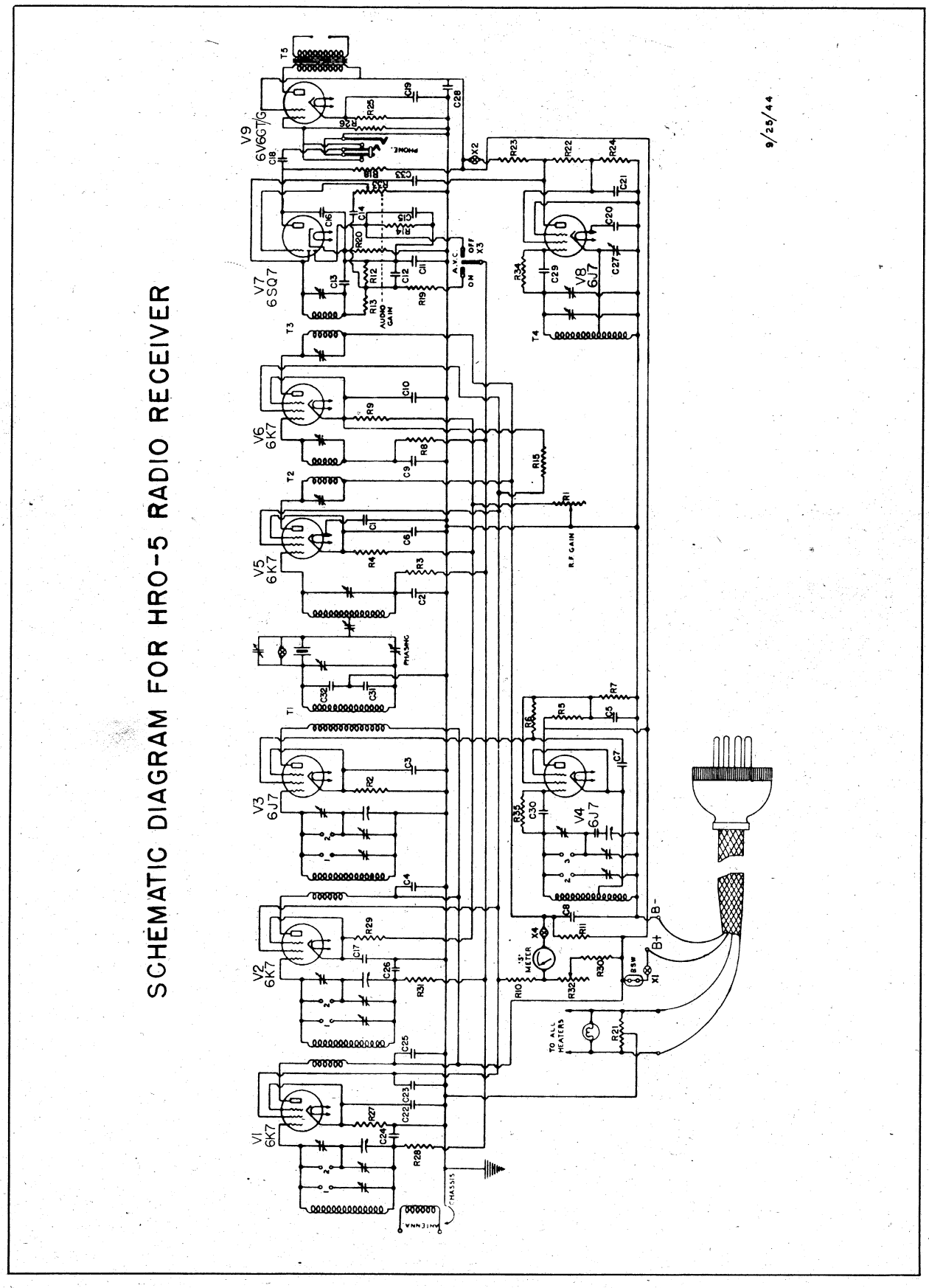
Part Symbol Number	Description	Type Designation
	FIXED CAPACITORS, CERAMIC-DIELECTRIC	
C12	100 Mmfd., 500 V DC W	CC35SL101K
C13	270 Mmfd., 500 V DC W	CC35SL271K
C16	540 Mmfd., 500 V DC W	Dual CC35SL271K
C30	100 Mmfd., 500 V DC W	CC35SL101K
C31	100 Mmfd., 500 V DC W	CC35SL101K
C32	100 Mmfd., 500 V DC W	CC35SL101K
C34	43 Mmfd., 500 V DC W	CC21SL430K
C40	450 Mmfd., 500 V DC W	Dual CC35SL331J and CC35SL121J
C41	350 Mmfd., 500 V DC W	CC35SL351J
C42	100 Mmfd., 500 V DC W	CC35SL101J
C43	51 Mmfd., 500 V DC W	CC21SL510K
C44	10 Mmfd., 500 V DC W	CC21UJ100F
	FIXED MICA-DIELECTRIC CAPACITORS	
C35	1,200 Mmfd., 500 V DC W	CM35C122J
C36	850 Mmfd., 500 V DC W	CM35C851J
C37	2,600 Mmfd., 500 V DC W	CM35C262J
C38	1,600 Mmfd., 500 V DC W	CM35C162J
C39	880 Mmfd., 500 V DC W	CM35C881J
	FIXED COMPOSITION RESISTORS	
R2	4,700 Ohm, 1/2 Watt	RC21BF472K
R3	0.47 Megohm, 1/2 Watt	RC21BF474K
R4	330 Ohm, 1/2 Watt	RC21BF331K
R5	47,000 Ohm, 1/2 Watt	RC21BF473K
R6	0.10 Megohm, 1/2 Watt	RC21BF104K
R7	0.10 Megohm, 1/2 Watt	RC21BF104K
R8	0.47 Megohm, 1/2 Watt	RC21BF474K
##R9	1,000 Ohm, 1/2 Watt	RC21BF102K
##R9	1,500 Ohm, 1/2 Watt	RC21BF152K
##R9	2,200 Ohm, 1/2 Watt	RC21BF222K
##R9	3,300 Ohm, 1/2 Watt	RC21BF332K
##R9	4,700 Ohm, 1/2 Watt	RC21BF472K
R10	15,000 Ohm, 2 Watt	RC41BF153K

##Varies with individual Receivers

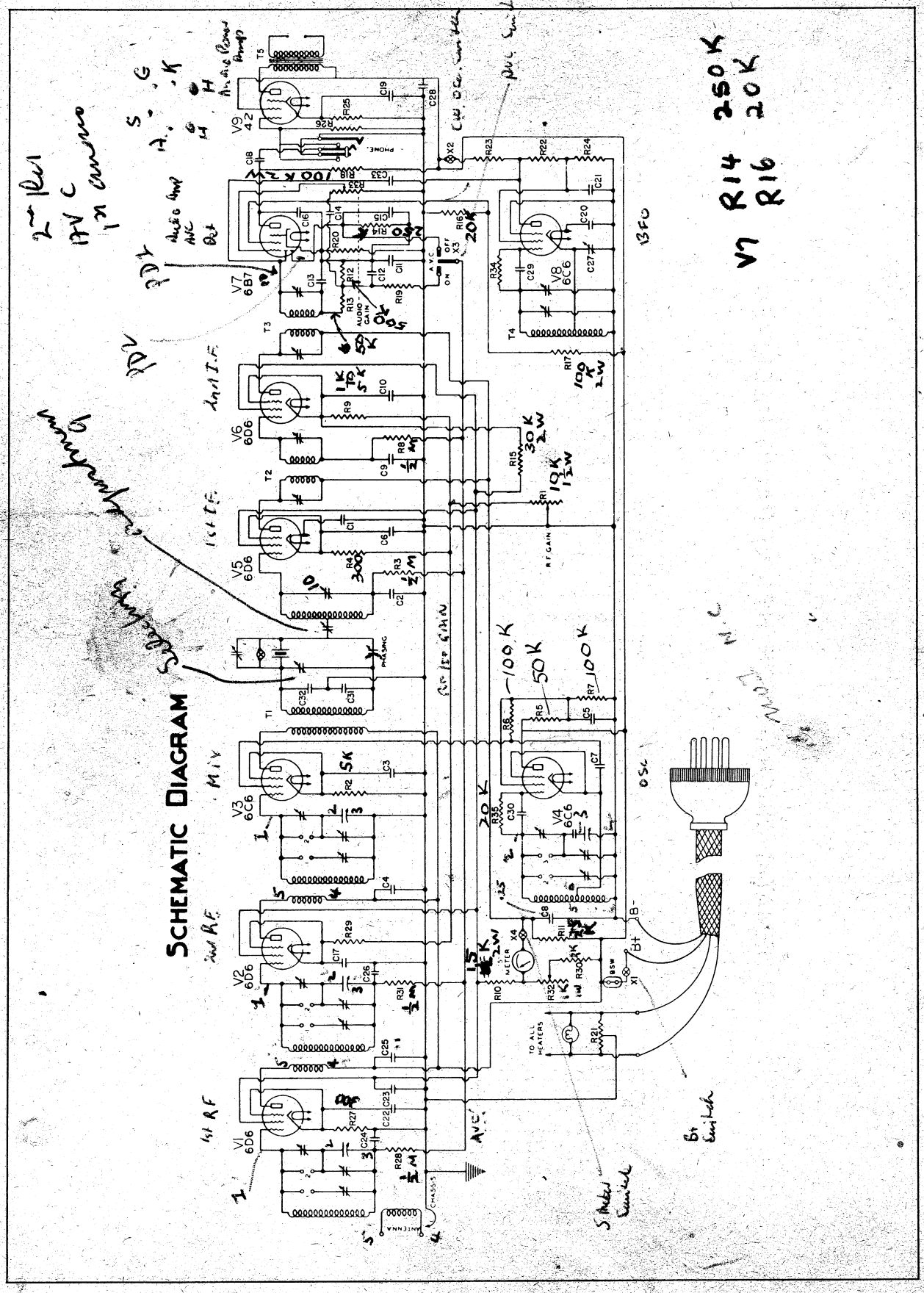
JOINT ARMY-NAVY TYPE DESIGNATIONS

Part Symbol Number	Description	Type Designation
	FIXED COMPOSITION RESISTORS (CONTINUED)	
R11	2,200 Ohm, 1/2 Watt	RC21BF222K
R12	0.47 Megohm, 1/2 Watt	RC21BF474K
R13	47,000 Ohm, 1/2 Watt	RC21BF473K
R14	0.22 Megohm, 1/2 Watt	RC21BF224K
R15	33,000 Ohm, 2 Watt	RC41BF333K
°R16	22,000 Ohm, 1/2 Watt	RC21BF223K
°R17	0.10 Megohm, 2 Watt	RC41BF104K
#R18	47,000 Ohm, 1 Watt	RC31BF473K
°R18	0.10 Megohm, 2 Watt	RC41BF104K
R19	0.47 Megohm, 1/2 Watt	RC21BF474K
R20	820 Ohm, 1/2 Watt	RC21BF821K
R22	0.10 Megohm, 1/2 Watt	RC21BF124K
R23	0.22 Megohm, 1/2 Watt	RC21BF224K
R24	0.10 Megohm, 1/2 Watt	RC21BF104K
#R25	330 Ohm, 2 Watt	RC41BF331K
°R25	470 Ohm, 2 Watt	RC41BF471K
R26	0.47 Megohm, 1/2 Watt	RC21BF474K
R27	330 Ohm, 1/2 Watt	RC21BF331K
R28	0.47 Megohm, 1/2 Watt	RC21BF474K
R29	330 Ohm, 1/2 Watt	RC21BF331K
R30	2,200 Ohm, 1/2 Watt	RC21BF222K
R31	0.47 Megohm, 1/2 Watt	RC21BF474K
R34	47,000 Ohm, 1/2 Watt	RC21BF473K
R35	22,000 Ohm, 1/2 Watt	RC21BF223K
	VARIABLE WIRE-WOUND RESISTORS (LOW OPERATING TEMPERATURE)	
R1	10,000 Ohm 3 Watt	RA25A1R103FK
R32	1,000 Ohm, 2 Watt	RA15A1SA102AK

Used only on HRO-5 Series
° Used only on HRO-M Series



Circuit Diagram of HRO-5 Radio Receiver



Circuit Diagram of HRO-M Radio Receiver

Power Unit And Loud Speaker Types

POWER UNITS

Table Model	6 Volt DC Vibrapack	Type 686-S
Table Model	AC Power Unit 50/60 Cycle (Specify 115V or 230V)	Type 697
Rack Mounting	6 Volt DC Vibrapack	Type SPU-686-S
Rack Mounting	AC Power Unit 50/60 Cycle (Specify 115V or 230V)	Type SPU-697

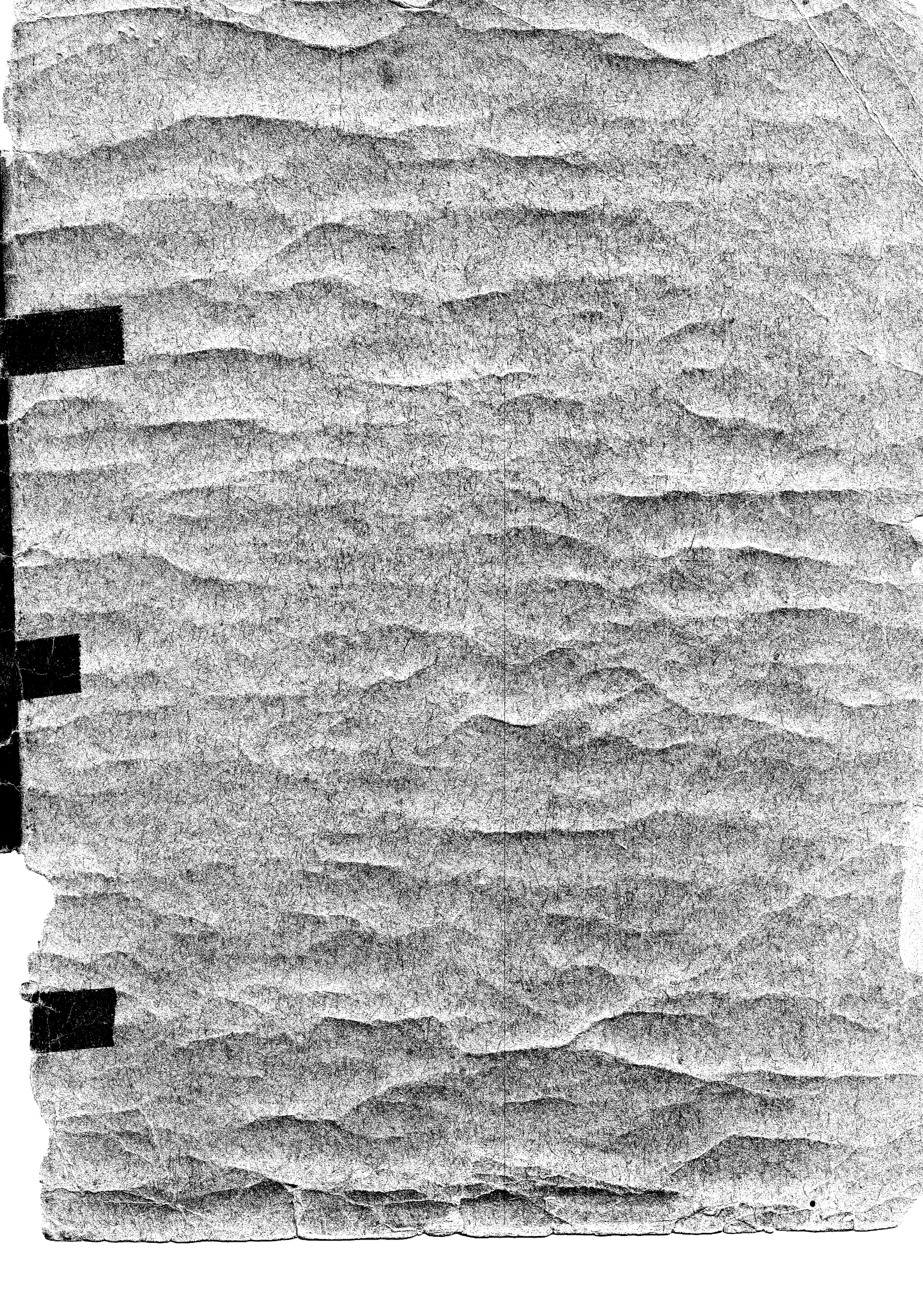
LOUD SPEAKERS

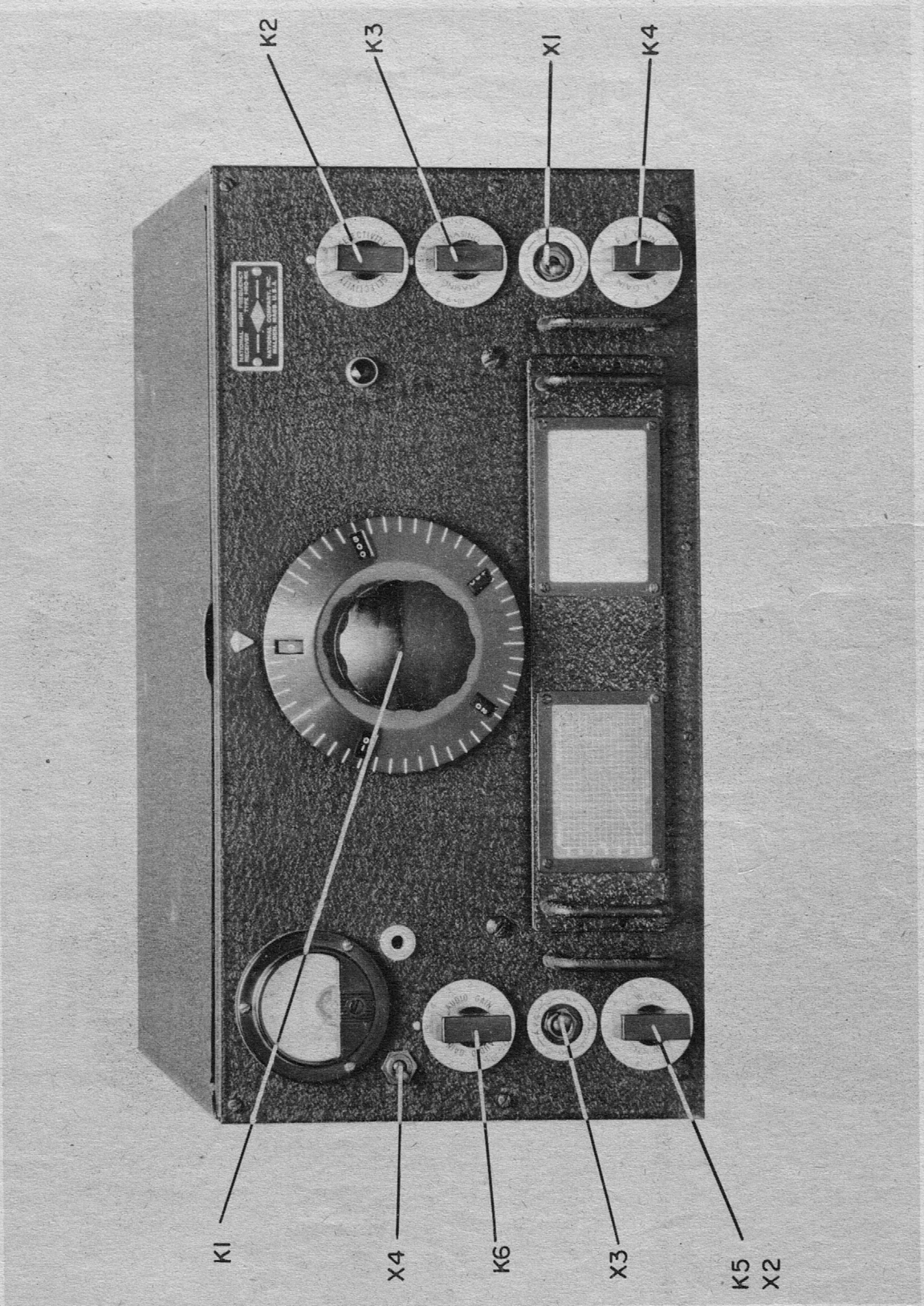
Table Mounting	Loud Speaker	Type MCS
Rack Mounting	Loud Speaker	Type RFSH

MISCELLANEOUS

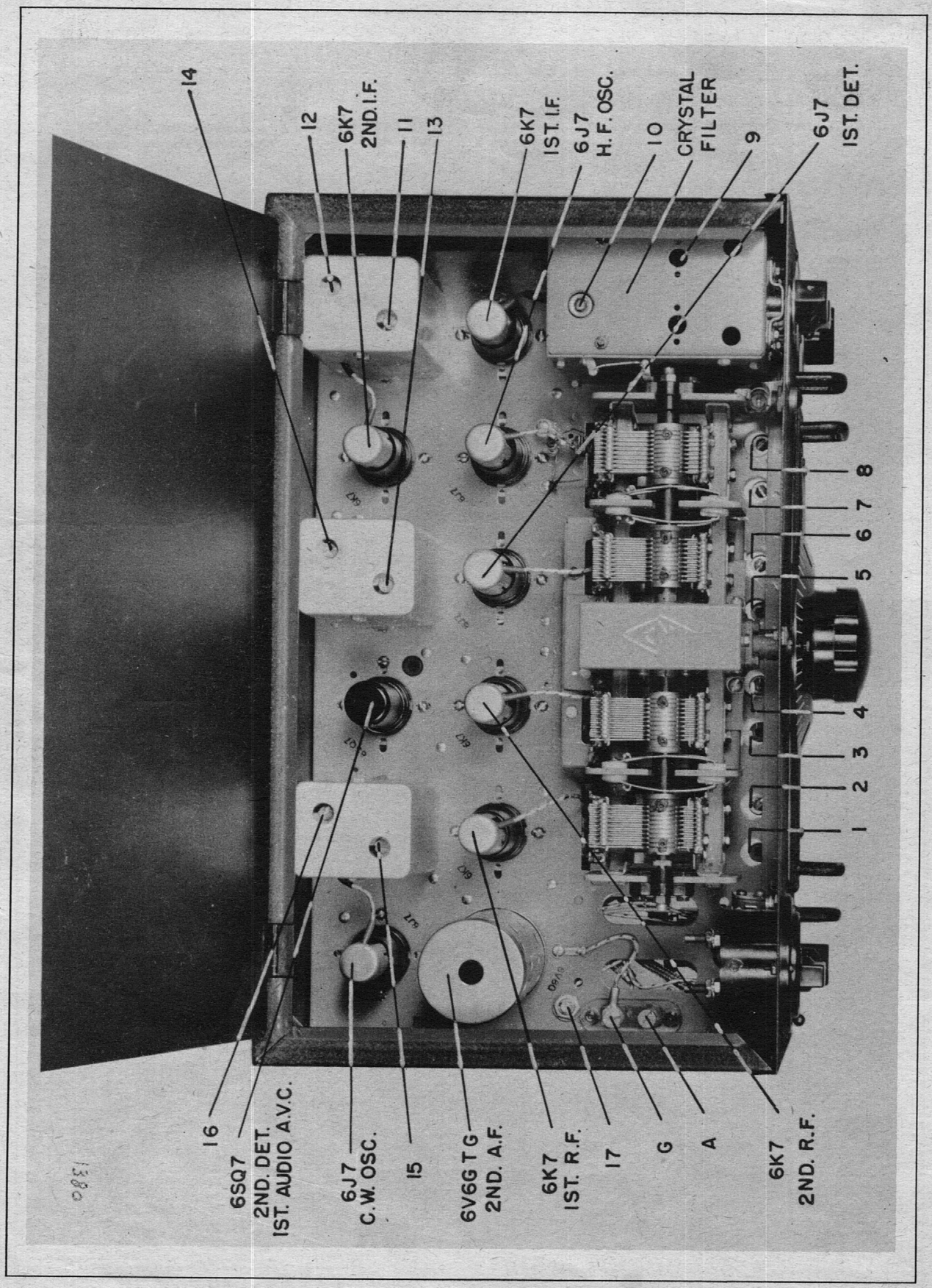
Rack Mounting	Combined Power Unit, Loud Speaker, and Five Compartment Coil Storage Container (Panel Height 15 3/4")	Type SPC
Rack Mounting	Five Compartment Coil Storage Container	Type HCRP

Information concerning available Power Units for other voltages or frequencies will be supplied upon request.

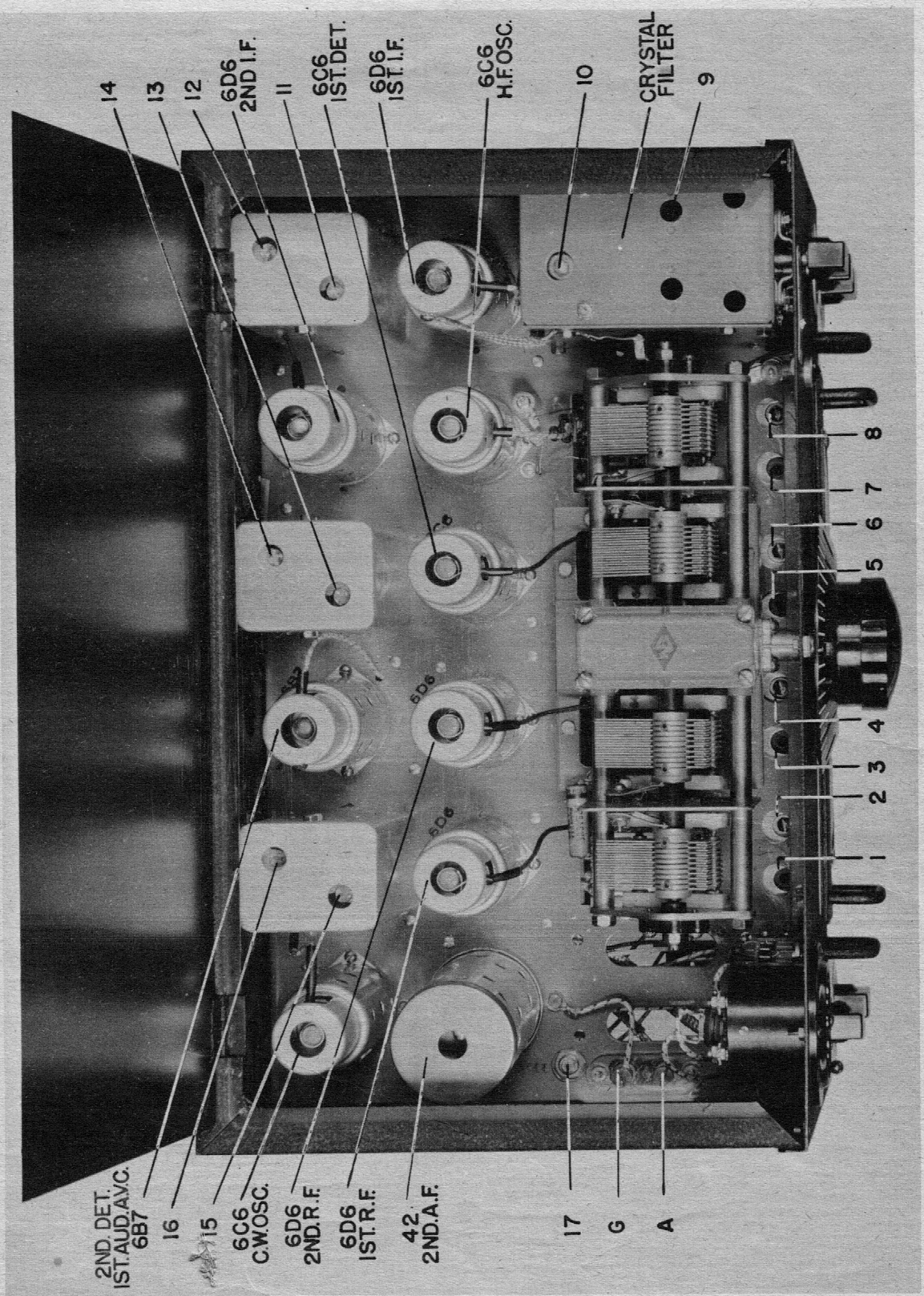




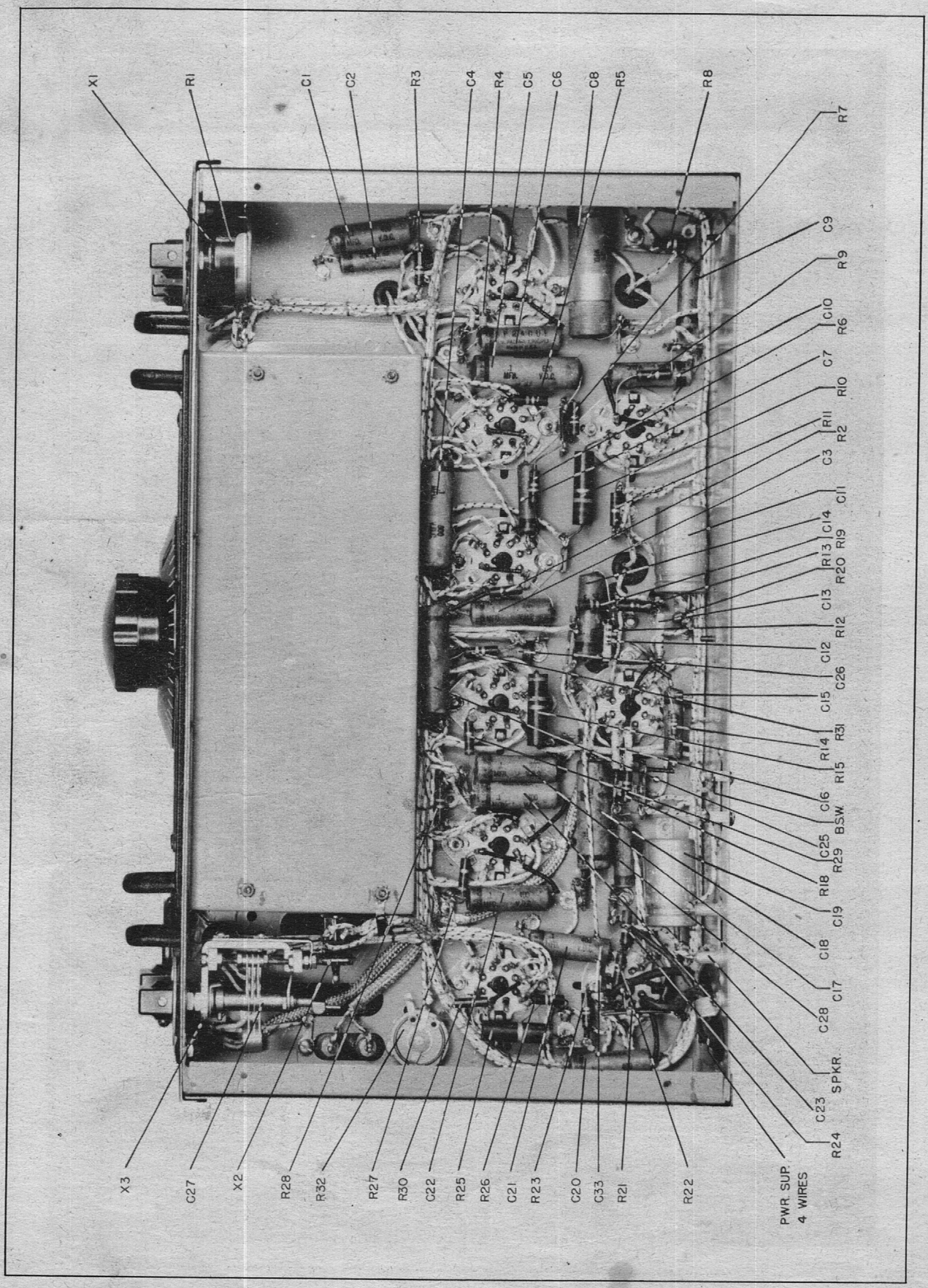
Front View of Radio Receiver



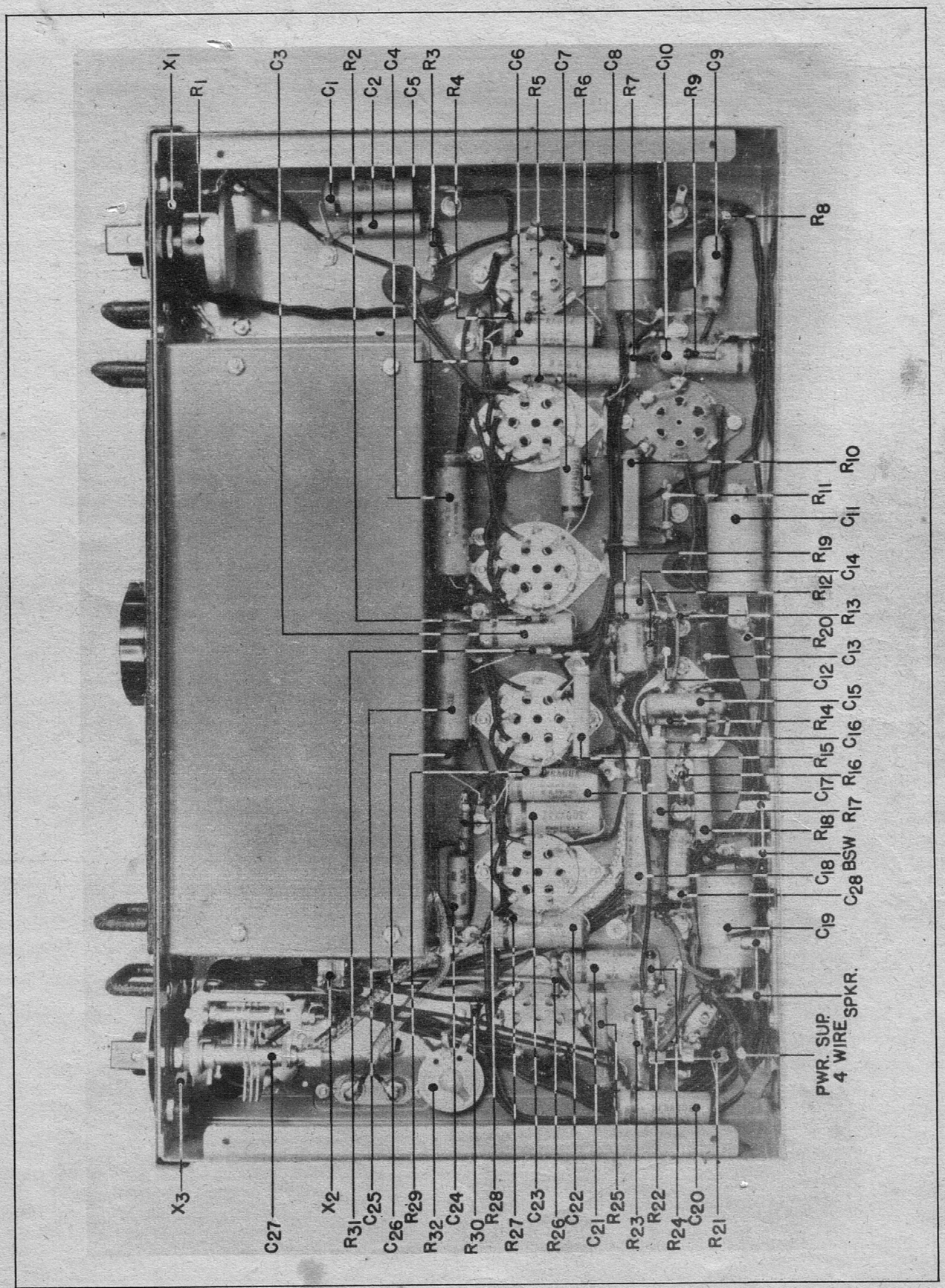
Top View of HRO-5 Radio Receiver



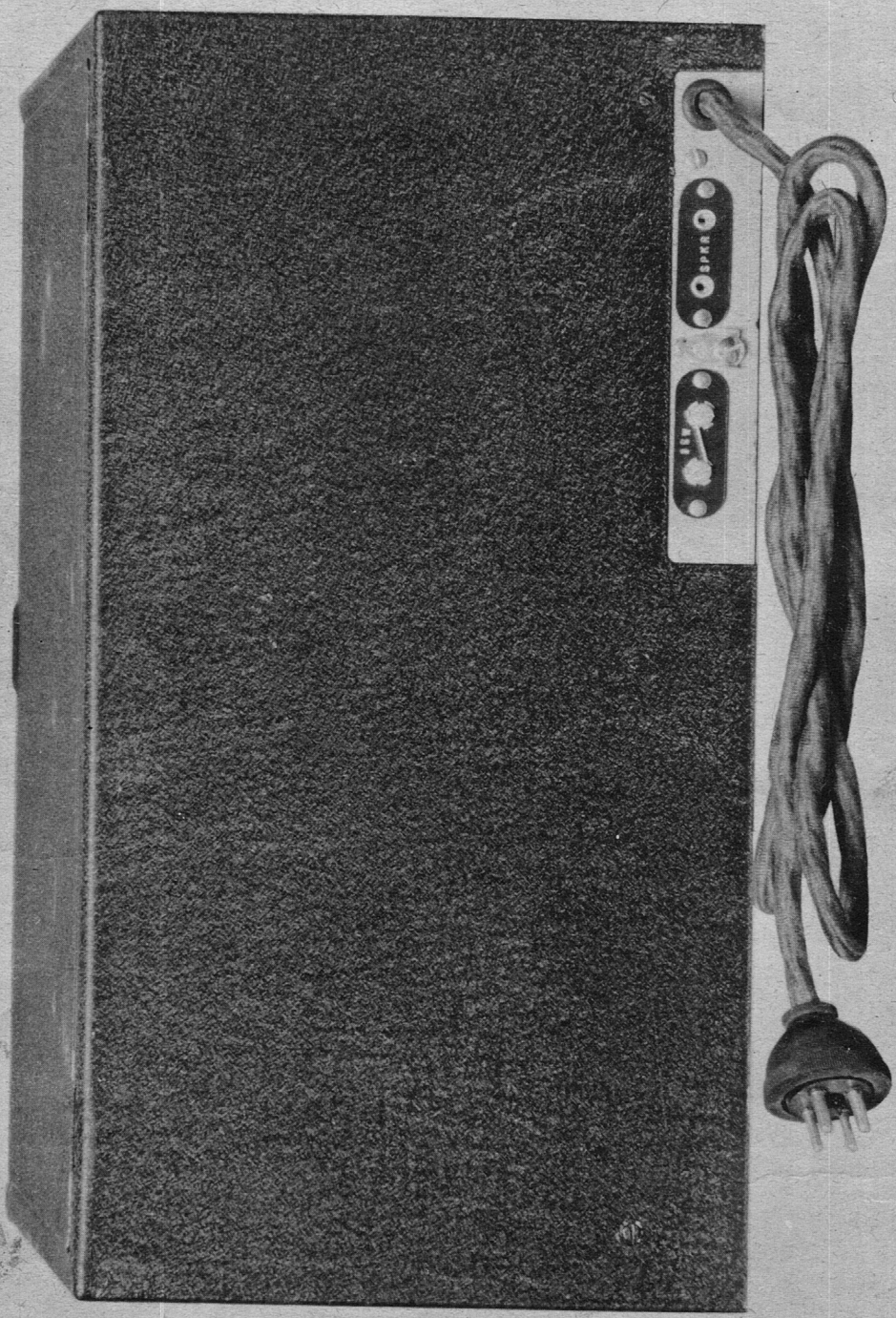
Top View of HRO-M Radio Receiver



Bottom View of HRO-5 Radio Receiver



Bottom View of HRO-M Radio Receiver



Rear View of Radio Receiver