B.R.C.N. 542

INSTALLING & OPERATING INSTRUCTIONS

PV-500-HM2 HIGH-FREQUENCY TRANSMITTER

(TYPE 96395 MODIFIED BY CANADIAN AVIATION ELECTRONICS LIMITED FOR EXTENDED FREQUENCY RANGE AND STABILIZED KEYING)

DEPARTMENT OF NATIONAL DEFENCE - OTTAWA
PROPERTY OF
H.M. CANADIAN
NAVAL SERVICE

W A R N I N G

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE VALVES OR MAKE ADJUSTMENTS INSIDE EQUIPMENT UNTIL ASSURED THAT THE VARIOUS AUTOMATIC OPERATING DEVICES HAVE FUNCTIONED PROPERLY.

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INSTALLING & OPERATING INSTRUCTIONS

FOR PV-500-HM2 HIGH-FREQUENCY TRANSMITTER

SECTION 1 - GENERAL DESCRIPTION

1.1 The PV-500-HM2 is a high frequency transmitter designed to provide radio-telegraph transmission on high frequencies. The equipment provides for transmission on any desired frequency within the range of 3 to 28 mc/s. The nominal power output is 500 watts from 3 to 19 mc/s, and 300 watts from 19 to 28 mc/s. It is possible to key the PV-500-HM2 at high speeds (up to 100 words/minute) without break-in facilities, and up to about 30 words/minute using break-in facilities. The input power to the transmitter is from a source of 110-volt 60-cycle alternating current, approximately 2 K-VA being drawn from the line. When used aboard ship, an appropriate rotary converter is supplied to provide the necessary 110-volts A.C. from the D.C. ship's mains.

Space requirements of the units are as follows:

Transmitter Unit		Rotary Converter	
Height	63 inches	Height	$17\frac{1}{2}$ inches
Width	37 "	Width	$16\frac{1}{2}$ "
Depth	$26\frac{1}{4}$ "	Length	$22\frac{1}{4}$ "
Weight	695 pounds	Weight	285 pounds

The transmitter unit is entirely self-contained in a sheet steel cabinet. The cabinet is totally enclosed, but is provided with removable front covers to give access to the units for service and maintenance purposes. These front covers are provided with safety gate switches for the protection of operating personnel, and are so arranged that the unit cannot be operated with the covers removed. The unit is provided with a fan to assist in ventilation. This internal fan draws air from the outside at the bottom of the transmitter and discharges it at the top. Both inlet and outlet openings are screened to prevent the ingress of insects, etc.

1.2 The equipment is arranged to feed directly into an antenna of between 5 and 200 ohms resistance and having a reactive component of between + 200 and -200 ohms. These are not absolute limits, but within this range of resistance and reactance the maximum transfer of energy to the antenna will take place. Outside of this range transfer of energy will still take place, but the efficiency of transfer will be impaired. Due to the fact that any given length of antenna will, over a frequency range as large as that covered by the present transmitter, exhibit characteristics that will vary between the extremes of reactance and resistance as each successive half-wavelength is passed, it is not possible to predict the performance of the transmitter into any given length of antenna without first knowing the exact frequencies to be used. For this reason, it is advisable to consider the optimum length of antenna and its location with reference to those frequencies it is desired to transmit. It will usually be found that certain of these are in constant use, and the length of the antenna should be so chosen that its characteristics fall within the limits mentioned above.

on these frequencies. This will ensure that the frequencies which are in constant use will operate at the highest efficiency, while those that are used for less urgent work will be operated under conditions that may not provide maximum efficiency. The link coupling circuit in this transmitter provides for the maximum possible adjustment of the antenna circuit in order to meet the condition of many different frequencies on the same antenna, but in order to achieve maximum output from the transmitter the antenna must be chosen with considerable care, taking into account all the factors mentioned above.

1.3 Frequency control of the transmitter is effected either by means of four crystals, chosen for the particular service for which the transmitter is destined, or by means of a calibrated master oscillator. The master oscillator has a series of ranges which cover the complete frequency range from 3 to 28 mc/s in seven bands. This is achieved by using the harmonics of the two fundamental ranges of the oscillator. A large calibration chart of the master oscillator is placed on the front panel, by means of which the setting up of any frequency in the total range is facilitated. The remaining circuits are tuned by clearly designated controls on the front panel, and a smaller chart is also provided on the front panel to log the readings of these controls. Once any frequency has been set up and the readings inscribed on the chart, it is an extremely simple matter to tune the transmitter to that frequency again.

At the time of installation, the frequencies which will be used most often are set up and the settings logged on the chart. Thereafter the change from one frequency to another becomes a routine adjustment of the controls to the settings marked on the calibration record. The actual time taken to change frequency will be dependent upon the skill of the operator and whether the desired frequency has been previously logged or is entirely new.

1.4 In certain applications, this transmitting equipment will be used in conjunction with the Marconi PV-500-LM transmitting equipment and provision is made to allow the two units to function as a pair.

1.5 The valve line-up of the transmitting equipment described in this folder is as follows:

V1	-	Crystal oscillator	-	6V6
V2	-	Master oscillator	-	807
V3	-	Multiplier	-	807
V5	-	Voltage regulator	-	VR150-30
V6	-	" "	-	VR150-30
V7	-	Driver	-	807
V9	-	Power amplifier	-	4-125A
V10	-	" "	-	4-125A
V11	-	Rectifier	-	866A/866
V12	-	"	-	866A/866
V13	-	"	-	872A/872
V14	-	"	-	872A/872
V15	-	"	-	5Y3GT
V16	-	Voltage regulator	-	VR150/30

These valves are normally supplied in duplicate, one set as a working set and the other as spares, but in certain cases the number of spares may be increased or decreased in accordance with the wishes of the customer.

SECTION 2 - INSTALLATION

2.1 For purposes of shipment, the larger and heavier of the units comprising the equipment have been removed and are packed separately. When reinstalling the equipment at the final site, it is advisable to follow the procedure outlined hereunder, as it will be found a definite routine which will simplify matters to some extent. Unpack all the units forming any one complete shipment and examine them carefully for damage in transit. Check all wiring connections and nuts, bolts and screws, tightening any that may be loose. Clean out all dust and packing material and place the units under cover until they are ready to be placed in the transmitter cabinet. Place the cabinet in the location that it will occupy, paying due regard to the matter of access for purposes of servicing. If the unit is placed on a ship in such a location that there is any danger of free water in the cabin, the unit should be raised as high as possible above the floor. It will be noticed that the top of the unit is free of any projections and can therefore be placed against the deckhead if the exigencies of the service so demand. Bolt the cabinet securely to the ship's frame, using shims to level up the unit. If possible, a space of twelve inches should be left at the right side of the transmitter to allow maximum circulation of air to the input of the fan.

2.2 In certain installations this transmitter will be used in conjunction with the Marconi PV-500-LM transmitter type 96385, and in that case the location will be as outlined in the attached drawing 105-809, Fig. 16. In this case, the PV-500-HM2 will be mounted to the left of the PV-500-LM and will form part of the enclosure around the antenna loading coil for the low-frequency transmitter. Great care must be taken to ensure that the bonding around the coil is properly carried out and that the two transmitters and the expanded metal form a complete metallic bond around the whole. Since the ship's bulkhead will also form part of the cage, care must be taken to ensure that this bonding is well made.

2.3 When the equipment is used in a shore installation, the transmitter will be connected through a service switch and 30-ampere fuses to the main 110-volt 60 cycle supply. When used on board ship the main supply will be either 110-or 220-volts d-c, and the equipment will be operated from a rotary convertor. This part of the total installation is, in the case of shipboard installations, supplied in duplicate or as specified by the customer. The converter or converters are customarily located at some distance from the W/T office, or as convenient. The controlling push buttons are located either on or under the operating table, or in some other convenient place in the W/T office. In cases where two machines are used, the switch selecting either machine should likewise be located in the W/T office.

2.4 The external wiring for the transmitter may be brought in through any one of the holes provided in the cabinet. If the right side of the cabinet is used for this purpose the wiring should be supported on the channel along the rear of the set. The connections to the terminals are as follows:

1 and 2	-	110 volts, 60 cycles
3 and 4	-	Key (The key terminal which is connected to the base plate should be connected to terminal 3)
5 and 6	-	220-volt or 110-volt d-c supply in ship installations. (On shore installations this will be 110 volts, 60 cycles)
7 and 8	-	High speed and remote keying.
9 and 10	-	Receiver muting relay.

The connections to terminals 1 and 2 should be not smaller than #8 wire, while the remainder will be not less than #14.

2.5 For high speed keying (no break-in) the keying device is attached to terminals #7 and 8. Short-circuit terminals #3 and 4 together and remove connection from #3 (bottom right-hand) on relay E1. When the PV-500-HM2 is used for shore installations, it will often be necessary to use remote keying and the break-in circuit will seldom be required. For remote keying, the contacts of the remotely controlled keying relay will be connected to terminals #7 and 8 (Terminal #7 is ground) and the above changes will be carried out as for high speed keying.

2.6 The antenna lead-in should be connected to the transmitter insulator with copper tubing. The frame of the transmitter should be grounded to the hull in the case of ship installations, or to an adequate buried ground at shore installations. The main ground connection is made to the frame of the set at the ground stud provided behind the antenna insulator.

2.7 After the unit has been satisfactorily located in the position it will occupy and has been secured in the proper manner, the external wiring is completed. Next, the units that were removed for shipment are replaced and the inter-unit wiring reconnected. While doing this, reference should be made to the tagging system employed on the leads, which is set up during the packing process, and also to the wiring diagram in this folder (Fig. 15). Great care must be exercised during this process to see that correct connections are made, as any misconnections will probably cause damage to the transmitter when power is first applied.

2.8 Before shipment, the resistors (R49 and R50) that are used as heaters for the rectifier valves are connected in series for use on 220 volts. When the supply voltage is 110 volts, they must be connected in parallel. Likewise, the connections to the plate transformers

T1 and T3 should be verified. These are shipped by the manufacturer connected for 115-volt operation, as the voltage of the rotary converters is usually in excess of 115 volts. For other voltages the taps will be set up as listed below.

A-c Supply Voltage	T3 Taps	T1 Taps
Below 105 volts	0 and 1	105
Between 105 and 115	0 and 1	110
Above 115	0 and 2	115

The normal condition of the taps as shipped out is therefore seen to be 0 and 2 and 115 volts.

2.9 WARNING: DANGEROUS VOLTAGES EXIST WITHIN THE APPARATUS WHEN THE RED LIGHT IS ON.

To avoid fatal injury while working inside the unit with the covers removed, always see that the HT switch (S13) is in the OFF position. The filaments may be left on if desired, but the red pilot light is an indication that the high voltage is applied to the set. With the key open, no meters will read even though the high voltage is still connected. When all the covers are in place, the removal of any one of them will automatically disconnect the high-voltage rectifier. In the case of the top section, a lock switch is supplied to permit operation of this unit with the cover removed, but the lower units are not so fitted and therefore the covers must be in place before the high-voltage rectifier can be operated. If it is ever essential that the covers be left off the two lower units and the set operated in this condition, terminals 24 and 25 on the power unit may be connected together. This completely nullifies all protection for operating personnel, and this practice must only be resorted to in cases of extreme emergency.

2.10 Place all the valves in their sockets. Note that the socket for the final grid regulator valve is at the left hand rear of the uppermost chassis.

2.11 Before applying voltage from the main power supply, check the following points:

(a) P-A and DRIVER knife switches on the inside upper left wall of the cabinet are closed.

(b) H-T switch is in the OFF position.

(c) Filament voltage control (FIL VOLTS) is in the minimum position (full anti-clockwise).

(d) Filament compensator (FIL COMP) control is in the maximum position (full clockwise).

(e) ADJUST-OPERATE control to ADJUST.

2.12 Apply voltage to terminals 5 and 6 from the appropriate source of supply. If the temperature surrounding the valves is less than 75°F the heaters will start to warm up, and when the temperature reaches 75°F the thermostat E7 will operate and disconnect them. When the surrounding air temperature falls below this value, the thermostat will reconnect the heaters and the cycle will be repeated.

2.13 Power may now be applied from the main source. Close the filament switch (S12) and adjust the FIL VOLTS control until the FIL LINE VOLTS meter indicates exactly 110 volts. After the filament voltage has been applied, operation of the keying relays should be checked. All three relays (E1, E2 and E3) should operate together with a positive action. If they appear to be sluggish, the operating voltage should be checked. The key-down voltage across terminals 20 and 22 in the control unit should be 12 volts d-c. If this voltage is incorrect and if the FIL LINE VOLTS meter is indicating 110 volts, the taps of transformer T6 will require adjustment. One primary lead is connected at all times to terminal 4 and the other to either 5, 6 or 7, which are in increasing order of line voltage.

2.14 A slow-release relay (E8) is used to key the oscillator. When normal low-speed keying is used, the oscillator cathode is keyed by relay E8, which takes approximately $\frac{1}{2}$ second to open after the key is released. The purpose served is to reduce "chirps" when keying. Relay E8 may need adjustment if it ever becomes sluggish in releasing. An adjustment set-screw at the top of this relay armature serves to separate the pole piece from the armature. This separation has been adjusted to approximately 0.005 inches. Increasing the separation will reduce the time lag between "key up" and oscillator "off" condition.

2.15 Adjustment of the break-in relay should be checked during the installation period and frequently during service. There are three sets of contacts on this relay and they must operate in a definite sequence. This sequence is indicated on the diagram of connections, Fig. 15. The travel of the armature should first be adjusted, by means of the thumbscrew at the top of the relay, so that the power control (lower front) contacts will have a gap of about 3/64" when the relay is not energized. The small contacts which operate the muting relay must close first when the key is closed, and the gap here should be as small as is practicable. It is important that the locking nut on this adjustment be kept very tight, as this contact has a tendency to loosen. The grounding contacts (#2) should close next, and this gap should be about 1/32". When the relay is properly adjusted, the receiver muting relay will close first and prevent any click from the initiation of the r-f power in the transmitter, and the ground circuit will be completed before the power contacts close, thus preventing arcing at the ground contacts. If the relay is improperly adjusted so that the power contacts (#3) close before the ground contacts, the overload breaker may trip during keying and serious arcing may take place across the ground contacts, resulting in damage to the relay. The antenna relay E2 shorts the antenna coils during reception and must therefore be completely open before the transmitter delivers power to the antenna. The auxiliary contacts on this relay should not close before the main contacts

are at their maximum travel. The filament compensating relay (E3) in the oscillator-control unit should have its contacts adjusted for a gap of approximately 1/32".

2.16 When the transmitter is being operated for the first time, the mercury-vapour valves must be "conditioned" at normal filament voltage before applying the H-T. This will evaporate any particles of mercury that may have been splashed on the cathode or anode. This treatment need not be repeated after the valves have been placed in service unless they are removed from the sockets and placed in any position other than the vertical.

2.17 CAUTION: THE H-T SWITCH MUST NOT BE CLOSED UNTIL AT LEAST 30 SECONDS AFTER THE FILAMENT VOLTAGE HAS BEEN SWITCHED ON.

This transmitter has not been provided with automatic time-delay protection for the mercury-vapour valves. It is therefore necessary for the operator to wait at least thirty seconds after the filaments have been switched on before the high tension is applied. The high voltage will come on, if the gate switches are all closed and the overload relay has not tripped, when the switch marked HT is closed, which will energize the plate contactor E4. When the contactor closes, high tension will be applied, the fan will start and the red indicating light will be illuminated.

2.18 The switches and controls may now be adjusted to the values shown in the calibration data on the card fastened to the front panel. All the settings will be the same as those on the chart except, of course, those pertaining to the antenna circuit, which must be set up for the particular antenna in use. These latter controls may be set up if the required positions are known from experience on similar installations using the same type and size of antenna. In this case the procedure of setting up will be greatly simplified and the instructions detailed in Para. 2.27 may be followed.

2.19 If some frequency is required that has not previously been adjusted, either by the manufacturer or at the time of installation, the procedure should be as follows. The RANGE switch should first be set to the position that includes the desired frequency. The RF GENERATOR switch should then be set to the corresponding range. If the RANGE switch is set to a red sector, the red ranges should be used for the RF GENERATOR. If the RANGE switch is set to a black sector, a black range should be used for the RF GENERATOR. Ranges A, C and E are marked in red and ranges B, D, F and G in black. When using a red range, either #1 or #2 coil can be used, and in this connection it is customary to use one of these controls for the most used frequency and the other will then be used for those frequencies that are not used as much. In the same manner, the coils #3 and #4 are marked black and either of these coils may be used.

2.20 If it is desired to use crystal control and the correct crystal for the desired frequency is available, it should be placed in

the socket corresponding to the RF GENERATOR selected, and the switch marked XTAL-MO turned to XTAL. The bakelite retainers for the crystals should be turned with the buttons facing inwards for use with Marconi 97140 or similar crystal holders, and facing outwards for use with Bliley type VP-4 holders. If Bliley crystals are used, the instructions concerning the unlocking of the pressure plate by adjusting the locking screw (between the prongs) should be carried out. These instructions are usually packed in the box with the crystal. The crystal prongs may be inserted in the socket in either direction. When placing crystals in the sockets, or removing them, use may be made of the special tool supplied so that the necessity of working in the somewhat confined space of the crystal unit may be overcome. The corresponding RF GENERATOR coils should now be turned to the value indicated on the frequency counter calibration on the top front panel. Note especially that the crystal frequency may be the same, one-half, one-third or one-quarter the operating frequency.

The ranges are as tabulated below:

Range				Crystal Frequency
A	3.0 - 4.3	Mc/s		Same as output
B	4.3 - 6.0	"		" " "
C	6.0 - 8.0	"		One-half output
D	8.0 - 11.0	"		" " "
E	11.0 - 15.0	"		One-third output
F	15.0 - 19.0	"		" " "
G	19.0 - 28.0	"		One-quarter output

2.21 It is possible to use crystals of one-third the output frequency in the range 9.0 to 11.0 mc, and in this case it would be necessary to use RF GENERATOR 1 or 2 and range D. In like manner, it is also possible to use crystals of one-half the output frequency in the band 11.0 to 13.0 Mc, and in this case it would be necessary to use RF GENERATOR 3 or 4 with range E, in place of the range indicated. In any case, the counter should be set to the value marked on the calibration scale for the appropriate range, even though the RANGE switch is on another band.

2.22 When the crystal is in place and the counter set to the approximate value, place the multimeter switch S16 in position 2, switch on the HT and close the key. CAUTION: DO NOT HOLD THE KEY DOWN FOR MORE THAN TEN SECONDS AT A TIME UNTIL THE DRIVER STAGE IS RESONATED as described in Para. 2.24. If the stages preceding the driver cannot be quickly resonated, remove the top cover and open the switches marked DRIVER and PA. Adjust the coil for minimum plate and screen current as indicated on the multimeter. It will be noted that the counter reading will not be exactly the same as for master oscillator operation.

2.23 If no crystal is available for the desired frequency, switch the XTAL-MO control to MO. The counter must now be set to the value indicated on the calibration scale. Care must be taken that the coil is not turned down below 0015 as there is danger of the wheel

running off the end of the coil if it is turned too far. If the wheel is accidentally run off the end of the coil, remove the coil from the oscillator box and place the wheel back on the end of the coil nearest the rings. The counter should now be reading the number that is stamped on the coil casing. It should never be necessary to adjust any of the coils to a reading of less than about 0200. The calibration will be correct within one-half of 1%. Although the oscillator frequency is doubled on ranges C and D, tripled on ranges E and F, and quadrupled on range G, the actual counter readings are used on the calibration chart, so that the labour of calculation is overcome. When the counter is set and locked, switch the multimeter to position 1, switch on the HT, close the key, and check that the multimeter reads between 2.0 and 2.5 ma, which indicates that the oscillator is operating in a satisfactory manner.

2.24 Switch the multimeter to position 4, and quickly adjust the MULTIPLIER to the value shown on the attached calibration curves (Figs. 24 to 29) or until the multimeter, when reading driver grid current, indicates 3 ma. It will be found that on the lower frequencies the value of the driver grid current at resonance of the MULTIPLIER stage will exceed 3 ma. Tune the MULTIPLIER stage off resonance until the required value is reached. To obtain the correct reading on the calibration chart, the condenser must always be set to the high capacity side of resonance, otherwise the calibration will not be correct. The multiplier valve circuits are so arranged that there is no danger of damaging the valve by tuning the plate circuit away from resonance, and the primary object is to obtain the correct value of driver grid current. On some ranges it will be found that there are two tune positions of the control that give an indication of grid current. One of the points will be at double the oscillator frequency and the other will be at triple the frequency. Note that on range D the lower dial reading is used, while on range E and F the higher reading is correct. As an example, if the transmitter is on range D and the oscillator at 4.0 Mc, manipulating the MULTIPLIER control will give a large indication of driver grid current at about 40 on the condenser, corresponding to 8.0 Mc, which is the correct setting. Rotating the control still more towards the low capacity end will disclose another indication corresponding to 12.0 Mc. In the same manner, on range E, if the oscillator is on 5.0 Mc the multiplier condenser will give an indication of drive at about 96 on the dial, and also at the high capacity end corresponding to 10 Mc. In this case, the correct reading is that obtained at the lower capacity setting, and it will also be found that the actual value of the drive current is less at 15.0 Mc, which is the desired frequency. If the multiplier is set to the wrong value it will most likely be found that either the driver or the power amplifier will not resonate properly, but care should be taken to avoid this possibility by using the reference curves in this folder as a guide to the exact settings. (See Figs. 24 to 29). Now close the DRIVER and PA switches in the interior of the unit, if they had been opened as described in Para 2.22 and replace the top cover.

2.25 Adjust the DRIVER control for maximum P.A. grid current (multimeter position 5). Now, carefully adjust the multiplier control

for exactly 25 ma in the P.A. grids, or for a maximum if it is found that 25 ma cannot be obtained. When operating on the higher frequencies (ranges E, F and G) it may be found that the driver grid current falls to less than 2 ma, but this is satisfactory on these frequencies. The P.A. condenser is initially tuned to "dip" indication on the P.A. cathode meters when the "operate-adjust" switch is at "adjust". When this switch is at the "operate" position, the P.A. condenser is <u>not</u> necessarily tuned to dip; it is tuned until the final tubes glow the least, or alternatively for maximum antenna current. The plates of the final tubes normally operate at a cherry-red colour; they can be viewed through the viewing window in the front panel provided for this purpose.

2.26 Since there is a wide variation in antenna characteristics, exact figures for adjustment of the antenna circuit cannot be given, but the following description of the general behaviour of the antenna circuit is intended to serve as an aid to the operating personnel to obtain the correct settings.

(1) In general, readings of the antenna circuit controls will increase with frequency, except at range G.

(2) The coupling control increases coupling as the control is decreased.

(3) Coupling is increased as the antenna loading control is increased.

(4) The antenna tune condenser should be set to a high value for low frequencies and a low capacity (high dial reading) for high frequencies.

2.27 The general procedure for tuning the antenna circuit is as follows:

CAUTION: DO NOT TURN ANY SWITCHES WITH THE HT ON AND THE KEY DOWN.

(a) Set the ANTENNA condenser to 0, and the antenna meter range switch to 0.5 ampere range.

(b) Set the other controls as follows:

Frequency	Coupling	Ant. Loading	Ant. Tune	Coupling Band G.
3.0 - 3.5	1	SER or 1	2	100
3.5 - 4.0	2	" " 2	3	"
4.0 - 5.0	3	" " 3	4	"
5.0 - 7.0	4	" " 4	5	"
7.0 - 9.0	5	" " 5	6	"
9.0 - 11.0	6	" " 6	7	"
11.0 - 13.0	7	" " 6	7	"
13.0 - 15.0	8	" " 7	8	"
15.0 - 17.0	8	" " 7	8	"
17.0 - 19.0	8	" " 8	9	"
19.0 - 28.0	8	" " 8	9	25

(c) Set the antenna loading control first to SER. This will connect the loading and the tuning condenser in series.

(d) Switch on the transmitter with the ADJUST-OPERATE switch in the ADJUST position and retune the power amplifier condenser for exact resonance. Rotate the ANTENNA condenser until there is a rise in the antenna current. If no such indication is observed, the ANTENNA TUNE control should be moved up or down one position and the condenser again rotated. If there is still no indication, the SER TUNE control should be tried; if this is ineffective, the coupling should be increased by moving the ANT COUPLING control to a lower setting.

(e) If there is still no indication of plate current rise, the controls should be returned to the positions shown in the tables but with the ANT LOADING control in the alternative position instead of SER. This will connect the loading coil and tuning condenser in parallel. If the plate circuit still shows no indication of resonance in the antenna circuit, the ANT LOADING control should be increased.

(f) On range G, it may be necessary to try combinations of the ANT TUNE and COUPLING controls to obtain such a rise in antenna current.

(g) When an indication of resonance is obtained in the antenna circuit, the ANTENNA or SER TUNE control reading (whichever caused the antenna current rise) is reduced slightly, and on range G the link control brought to 0, AND THE ANTENNA METER TO THE 10-AMP RANGE.

(h) Move the ADJUST OPERATE switch to the OPERATE position. It is now necessary to make final adjustments to the circuit so that the maximum cathode current to either valve does not exceed 250 ma. It is desirable to reduce the coupling (move to a higher figure) on range G reduce link) or to reduce the antenna loading (move to a lower figure) or so that the cathode currents just rise to 250 ma when the antenna circuit is tuned through resonance. However, it will be found in many cases that in one position of the coupling control on the p-a cathode current is too high, while on the next it will be too low when the antenna circuit is exactly in resonance. In this case the switches should be left in the position of maximum current and the antenna circuit detuned by means of the ANTENNA condenser until a value of 250 ma per cathode is reached. Switch the multimeter to position 5 and check that the drive to the final stage is 25 ma. If it is not, retune the Multiplier stage until 25 ma. is reached.

(i) It may be found that, particularly on the lower frequencies, the antenna condenser will flash over as the antenna circuit is brought into resonance. This can occur for either of two reasons. First, if the ratio of capacity to inductance in the antenna circuit is too low. To correct this it is only noces-

sary to move the ANTENNA TUNE control to a higher value and to reset the condenser to a lower value. Second, if the ANTENNA LOADING control is advanced too far, this control should never be more than one number less than the ANTENNA TUNE control, and if there is more than two numbers difference the tendency to flash over will be most marked. For example, if the ANTENNA TUNE control is on position 4, the ANTENNA LOADING control may be on position 3, 4, 5 or 6. If the condenser flashes, reduce the ANTENNA LOADING control and bring the plate current back up by increasing the COUPLING control.

(j) On the higher frequencies, the ANTENNA TUNE control should be set so that the ANTENNA condenser tunes at as high a value as possible. On frequencies above 12.0 Mc there may be excessive heating losses in the coil and switches if the ANTENNA condenser is tuned to a high value of capacity (low dial reading), while there will be greater power output and less danger of damage to components due to excessive heating if the condenser is tuned to the high dial reading. The use of position 9 on the ANTENNA TUNE control for frequencies below 15.0 Mc is not recommended for the reasons quoted above.

(k) It will be found that on some frequencies the p-a cathode current readings are considerably unbalanced. This condition is not serious, as an unbalance of 100 ma can be tolerated. In other words, one meter may read 250 ma (but not more) and the other 150 ma, but some attempt should be made, however, to balance the cathode currents. There are three methods that can be used when a bad unbalance occurs. A combination of all three methods will usually be found to clear up the unbalanced condition on any one frequency. These are: First, to adjust the small screwdriver-adjusted condenser located above the driver valves. It is not intended that this condenser should be adjusted every time that a frequency is changed, but it is usual to set this up to provide the best compromise position on all operating frequencies. This condenser is designated C34, and can only be adjusted with the front covers off. It is well to make only small adjustments to this condenser, checking on each frequency. Second, it will be found that some retuning of the driver stage will at times balance up the cathode currents. It will be found that on the highest frequencies it will be necessary to adjust the driver condenser for the highest possible grid current to obtain the highest final stage efficiency. Third, a readjustment of the antenna circuit will sometimes alter an unbalance in the plate currents of the power amplifier. When it has been found necessary to detune the antenna circuit to balance the plate currents, it will often be found that the unbalanced plate current condition will be improved by tuning the condenser on one side or other of the resonance point. To give a specific example: Assume that it is found that the antenna circuit resonates at a dial reading of 55, but gives plate current readings that are too high. Reducing the COUPLING control results in cathode current readings that are considerably below 250 ma. Therefore,

it is necessary to reduce the ANTENNA condenser to 50, but this results in cathode currents of 175 ma for the front and 250 ma for the rear. It may be found that if the condenser is set to 60, which is on the other side of resonance, that the cathode currents will now read 250 for the front and 220 for the rear, which is a much better adjustment.

2.28 The general adjustment procedure is tabulated hereunder:

a) Select the correct RANGE according to frequency.

b) Select the correct colour of R-F GENERATOR.

c) Select XTAL or M-O.

d) for XTAL, adjust coil for minimum oscillator plate and screen current (multimeter position 2).

e) For M-O, adjust coil to correct reading for frequency as shown on the scale.

f) Adjust MULTIPLIER for maximum driver cathode current.

g) Adjust DRIVER for maximum grid current to the final. Re-adjust MULTIPLIER for 25 milliamperes of final grid current.

h) Adjust P-A condenser for minimum cathode currents.

i) Adjust ANTENNA condenser, ANT. TUNE, LOADING, SER. TUNE, and COUPLING controls for maximum antenna current (on 0.5 amp. range) when the power amplifier is tuned and the ADJUST-OPERATE switch in the ADJUST position.

j) Switch the ANTENNA METER to the 10 amp. range, switch to OPERATE and adjust loading until either of the P.A. cathode meters reads 240 ma. when the P.A. condenser is tuned to maximum antenna current. With the multimeter on position 5, check that the grid current to the final tubes is 25 milli-amperes (or maximum, if under 25 ma.).

k) If the cathode currents are badly unbalanced, correct according to the instructions in paragraph 2.27 (k).

2.29 Since the filaments of the valves must be kept within 5% of the rated value for maximum life, provision has been made for adjustment. With the key down and the amplifier fully loaded, the FILAMENT VOLTS control should be adjusted so that the FILAMENT VOLTMETER reads at the red line or 110 volts. Then, with the key up, the FILAMENT COMPENSATOR control should be so adjusted that the voltmeter again reads 110 volts. This acts to compensate for the variation of voltage during keying.

SECTION 3 - FAULT TRACING

3.1 The following section is intended to serve as a guide to the location of faults that may occur during routine operation of the equipment. It is not intended to serve as a catalogue of the most likely faults to be encountered, but merely as a guide to indicate the method and general path of the more important circuits through the transmitter. Once a fault has been traced to any specific unit or part thereof, it will then rest with the skill and ingenuity of the operating personnel to locate and correct the trouble. It must be borne in mind that during all these tests there exists the necessity of operating with the safety devices rendered inoperative. Therefore, extreme caution must be exercised when making any tests. The absence of certain readings does not indicate that there is no voltage applied to the transmitter, but it does indicate that there is trouble of an uncertain nature, and for this reason considerably more care than normal is required during the process of carrying out the various tests. It is expected that all such tests will be carried out using the simplified circuit diagrams supplied with this folder (Figs. 12, 13 and 14) in conjunction with the main circuit diagram (Fig. 15). The following are some of the general paths to follow when carrying out tests on this transmitter.

3.2 Filaments and Pilot Lamps Will Not Light.

(a) Check that main supply switch is closed.

(b) That converter, if used, is running.

(c) That the voltage at terminals 1 and 2 on the power unit is 110-volts 60-cycles a-c.

(d) That main line fuses F3 are not blown, and S33 is closed and making good contact.

(e) That switch S12 is on and that it is making contact.

(f) That the arms on resistors R18 and R19 are making contact with the resistances and that the resistors are not open.

(g) That there is voltage on the terminals of transformers T7, T9, and T2.

(h) That there is voltage on the filament pins of the valves and that the filaments of the valves are not open, and that pilot lights are not burned out.

(i) That the filament pins of the valves are making good contact with the sockets.

3.3 Filaments Light but the HT Cannot Be Applied.

(a) Check that fuses F1 are not blown.

(b) That contactor E4 closes and that there is a circuit betwoen the two sides of the relay when the contactor is closed.

(c) That the gate switches are closed or that the covers are firmly in place. If the top cover is open, check that the lock switch is in the ON position.

(d) That the overload relay has not operated and requires re-setting.

(e) That voltage is applied to the input terminals of transformers T1 and T3.

(f) That there is a circuit between the centre taps of transformers T1 and T3 through the chokes L20, L21, L22 and L23 to the bleeder resistors at the top of the set, and from the bleeder resistors to the plates of the valves through the components of the plate circuits.

(g) That R48 is in its socket and is not open (with switch S14 at ADJUST).

(h) That pilot light P3 is not burned out. If it is, high tension can be applied but will not be indicated.

3.4 Filaments and HT Come On, but There Is No Other Indication of Operation.

(a) Check that all plate caps are on the valves.

(b) That voltages are applied to the crystal valve V1 and the m-o valve V2.

(c) That the key is closed.

(d) That keying relays E1 and E8 are operating and that there is a circuit through the contacts.

(e) That the crystals are in place in the sockets and that switch S7 is in the XTAL position.

(f) That the rollers of coils L1, L2, L3 and L4 are not off the end of the coil.

(g) That meters M1 and M2 are operating.

(h) That the ground connection of the oscillator box is made to the remainder of the transmitter.

(i) That switch S16 is making good contact and that none of the multiplying resistors are defective.

3.5 Meter M2 Shows No Sign of Tune.

(a) Check that range selection switch is in the correct position for the frequency of the oscillator.

(b) That the plate cap is on the driver valve.

(c) That there is voltage on the elements of the driver valve.

(d) That there are no shorted turns on coil L12 or L12A.

(e) That there is no short between the plates of C35.

(f) That the multiplier is operating at the correct multiple of the oscillator frequency.

(g) That the switch marked DRIVER in the top left-hand side of the cabinet is closed and making good contact.

3.6 Meters M4 and M5 Show No Sign of Current.

(a) Check that the switch marked PA at the top left-hand side of the cabinet is closed and making good contact.

(b) That plate caps on the p-a valves are connected.

(c) That there are voltages applied to the elements of these valves.

(d) That there is grid current showing in position 5 of the Meter M1.

3.7 Meters M4 and M5 Show Current but No Sign of Tune.

(a) Check that the range switch is in the correct position for the frequency the oscillator is working on.

(b) That the multiplier is working at the correct multiple of the oscillator frequency.

(c) That there are no shorted turns in coil L17 or L17A.

(d) That there is no short between the plates of condenser C40.

3.8 Master Oscillator and All Other Stages Tune Correctly but There Is No Sign of Tune in the Antenna.

(a) Check that the transmitter is connected to the antenna and that the antenna changeover switches are in the correct position for the antenna in use.

(b) That the components in the antenna circuit are correctly set up for the frequency in use. (See Para. 2.27 for the correct values.)

(c) That switches S24, S25, S26, S27 and S28 are making good contact and that they have not been damaged by an arc-over.

(d) That the contacts of the break-in relay are making good contact.

(e) That the antenna ammeter is operating.

(f) That all leads passing through trunks are connected to the set and to the antenna.

3.9 Line Voltage Cannot be Adjusted to the Correct Value As Shown by the Line on M3.

(a) Check the voltage applied to the input terminals 1 and 2 and adjust the voltage from the converter. If this is not possible, readjust the taps on the transformers as outlined in Para. 2.8.

3.10 Heaters Stay On All the Time or Fail to Come On at all.

(a) Check operation of E7.

(b) That fuses F2 are not blown.

(c) That there is voltage applied to terminals 5 and 6 in the power unit.

(d) That the resistors are making good contact in the sockets and have not burned out.

3.11 Switching to ADJUST Causes the Transmitter to Cease Operation.

(a) Check that R48 is not open.

(b) That it is screwed firmly into its socket.

3.12 Overload Trips When the Key is Pressed.

(a) Switch to ADJUST and check that condition still exists.

(b) Open power amplifier switch in the top section of the cabinet and recheck.

(c) Open DRIVER switch in the top section of the cabinet and recheck.

(d) If condition still exists after checks as above, examine filter section of rectifier.

(e) Examine overload relays and check that adjustments of the shunting resistors have not been changed and that the resistors are not open.

3.13 Fuses F1 Blow Frequently.

(a) 872A/872 valves are defective - change them.

3.14 Break-in Relay Does Not Operate With Positive Action.

(a) Measure the voltage across the coil which should be between 5 and 6 volts.

(b) If the voltage is low, adjust the taps on the transformer as outlined in Para. 2.14

(c) Check that the coil circuit of E2 is not open.

(d) Check that there is no oil or grease on the relay to slow up the action.

SECTION 4 - TECHNICAL DESCRIPTION OF UNITS

4.1 The following description is intended to outline the general paths of the circuits and components of the transmitter. It is advisable to study this section in conjunction with the main circuit diagram and the simplified circuits that accompany this foldor (Figs. 12, 13, 14 and 15). An intonsive study of these, in conjunction with the following description, should provide technical personnel with sufficient information to maintain the transmitting apparatus in first class condition at all times. Reference should also be made to the illustrations in the folder in order that all the parts may be located and the functions of each thoroughly understood.

4.2 The transmitter consists of three basic units which are mounted in the cabinet. These units are, from top to bottom, the R-f Unit, Oscillator-Control Unit and Power Unit. Each of these units is arranged on a steel chassis and is provided with a terminal board at the front to which the inter-unit connections are mado. The front of the cabinet is covered by removable screens that protect the apparatus from dirt and dust and, through the interlocking switches provided, the operating staff from accidental contact with the high voltages that exist in a transmitter of this type. When all the covers are in place, the cabinet is totally enclosed and there is no chance of accidental contact with these voltages. To assist in cooling the components in the unit, a fan is provided which draws air from the outside of the cabinet at the bottom and circulates it through the set to the top, where it is discharged through openings which are screened to prevent the ingress of insects and other foreign material.

4.3 At the lower part of the cabinet is located the power unit, which supplies the d-c voltages for the rest of the transmitter. To the left of this and slightly above it is placed the main terminal panel type 109-708. This panel carries those terminals which are connected to the external source of power supply, the key and other auxiliary apparatus. On this panel also are located the fuses, and the disconnect switch S33 which completely removes all power from the set if it

is desired to work inside the unit. The fuses are all cartridge type and are provided with screwed ends which enable the fusible links to be replaced after they have blown. The ratings of these fuses are:

F1 - High tension - 250-volts 25-amps (Economy)
F2 - Valve heaters - " " 5 " "
F3 - Filaments - " " 5 " "

It is intended that the fuses in the service switch box will be of the correct size to provide all the protection required for the whole transmitter.

4.4 Power Unit (See Fig. 10)

This unit is mounted on a sheet steel base, cadmium plated against corrosion. It consists basically of three rectifiers. Two utilize hot-cathode mercury-vapour valves, each with its own filter system, together with the necessary contactors, to control the power circuits of each rectifier. The third is a C-supply rectifier. The H-T contactors, three in number, are located in the centre of the chassis above the inter-unit terminal panel. The functions of these relays are as follows:

(a) E6 - at the left - Dunco ADBY 5N, low-voltage overload, .75-amp trip

(b) E5 - in the centre - Dunco ADBY 5N, high-voltage overload, 2.0-amp trip

(c) E4 - at the right - Allen-Bradley A209, high-voltage contactor.

The two relays E5 and E6 are of the electrical reset type and are provided with coils that, when energized, will reclose the contacts that may have been opened by an overload. To adjust the current rating of these relays, resistors R51 and R52 are shunted across the operating coils. Relay E4 is a two-pole contactor, and when closed completes the circuit to the high and low-voltage rectifier transformer primaries. The contacts of the overload relays are in series with the operating coil of this relay, and thus disconnect the input voltage when an overload occurs.

4.5 An additional relay E7 is located on this unit and is placed close to the rectifier valves. It is thermostatically operated and works at a temperature of 75°F. Its purpose is to provide a means of heating the air in the vicinity of the rectifier valves so that the operating temperature of these valves is within the limits specified by the manufacturer. When the ambient temperature falls below 75°F, this relay will close and apply voltage to the heater resistors R49 and R50. When the ambient temperature has risen above 75°, the thermostat will again operate to remove the voltage from the resistors. If the temperature falls below this value the cycle will repeat. In connection with these resistors, it should be noted that they are normally

connected in series for use with 200-volt supplies, but must be connected in parallel for use on 110 volts.

4.6 The low-voltage section of the rectifier contains transformer T1 which supplies high voltage a-c to the plates of two 866A/866 valves, the filaments of which are energized from the #1 winding of the secondary of filament transformer T2. Two r-f chokes L20 and L21 are provided in the plate circuits of these valves to minimize the effects of hash from the possible oscillation of the mercury-vapour valves. The output from the rectifier is fed to a choke-input filter made up of L25, C53, and C54. A Bleeder and dropping resistor are provided in the top of the cabinet, and supply the driver stage and the oscillator unit with the correct value of high tension. Overload relay E6 is connected in the centre tap of transformer T1 and is provided with the shunting resistor R52 to shunt the coil so that it may be set at the correct tripping current of .75 ampere.

4.7 The high-voltage rectifier is made up of transformer T3 and a pair of 872A/872 valves whose filaments are heated by means of the #2 secondary winding on T2. A pair of r-f chokes L22 and L23 are provided to serve the same purpose as those used in the low-voltage section of the rectifier. A conventional two section choke input filter, consisting of L28, C55, L26, C57 and C58 is provided to filter the output of the rectifier. A bleeder resistor is located in the top section of the cabinet, while the overload relay is connected in the negative lead of transformer T3 with the shunt resistor R51 across its coil to enable the correct tripping current of 2.0 amperes to be exactly set.

4.8 The grid-bias supply is made up of transformer T8, valve V15, a portion of T1, and a filter system. The filter system is a conventional choke input type, consisting of L27 and C59.

4.9 When placing new mercury-vapour valves into service, a conditioning process must be carried out before high tension is applied to the valves for the first time. This process consists of running the valves at normal filament voltage for 30 minutes before application of plate voltage. Once this process has been carried out, the valves may be stored in a vertical position and placed in service without the necessity of pre-heating. It is well to take considerable care when moving valves to avoid splashing the cathode or anode with mercury and thus nullifying the effect of the conditioning.

4.10 Oscillator-Control Unit.

This unit, as its name implies, consists of two units mounted on a common chassis. Viewed from the front, the components comprising the oscillator take up the left half of the unit, while those used in the control circuits are grouped at the right.

4.11 The control unit proper is made up of a number of switches and pilot lights which are used to control relays and contactors throughout the set. These are all grouped on a black panel at the right-hand

side and are arranged as follows:

Top Row - Left to Right

R18 - Filament componsator control.
P2 - Pilot light indicating filaments ON.
P3 - Pilot light indicating HT ON.
R19 - Filament voltage control.

Lower Row - Left to Right

S12 - Filament voltage switch.
S10 - Overload reset pushbutton switch.
S14 - ADJUST-OPERATE switch for reducing HT during tuning up.
S13 - HT on and off switch.

At the rear of the panel will be found the keying componsator E3 and also T6 which, with C01 (a small copper-oxide rectifier), supplies the low-voltage d-c to operate E3 and the keying relays in the upper part of the unit. At the extreme rear of the chassis will be found V5 and V6 which are used for voltage regulation in the high-tension supply of the oscillator. These valves maintain the high tension to the oscillator stage at a steady voltage regardless of the load on the rectifier, and thus help to maintain the stability of the note when the transmitter is keyed. Slow-release relay E8 is mounted on the side of the oscillator control unit. The contacts of this relay serve to keep the oscillator on steadily while keying at normal speeds, thus helping to stabilize the note.

4.12 The oscillator unit is placed at the left side of the chassis, and contains all the circuits connected with the generation of r-f power at the correct frequency. This unit contains three valves, the functions of which are:

V1 - Crystal oscillator (6V6)
V2 - Master oscillator (807)
V3 - Multiplier (807)

These are all located behind the outer cover of the unit and are accessible by removing the front cover. Grouped around the crystal valve will be found the sockets for four crystals. There are two switches provided, one marked XTAL-MO which is arranged to change from crystal control to master oscillator operation, while the other is designated RANGE CONTROL and selects the correct range coils for the frequency desired. Coils L1, L2, L3 and L4 in the plate circuit of the master oscillator valve (which is also used as an amplifer when the method of frequency control is by a crystal) are grouped around the crystal valve and the crystals.

4.13 The crystal valve utilizes the untuned plate - untuned grid type of circuit and is provided with a small amount of reaction

by means of condenser C3 so that the crystal will start readily when keyed. When the transmitter is switched to MO, this valve is cut out of circuit and the control of frequency is taken over by V2 which functions as a master oscillator. When used as an oscillator, the grid of this valve is so connected that some voltage is fed back from the plate circuit and the arrangement then resembles a shunt-fed Colpitts circuit.

The plate circuit is tuned with inductances L1, L2, L3 and L4 in conjunction with condensers C10, C11, C12, C13, C14 and C15. These are fixed condensers, and the adjustment of frequency is accomplished by varying the number of coil turns in circuit. This type of tuned circuit is less subject to variation from the effects of vibration than one using a variable condenser and fixed inductance, and it is also more stable, since the L/C ratio becomes lower as the frequency is increased. The frequency of the master oscillator can be set with good accuracy by means of the calibration curves or the chart on the front panel. The variable inductances, which consist of coils connected so that they can be rotated, are connected to counters which count 30 for each revolution of the coil. As the coil rotates, a small contact wheel turns along the coil, thus varying the inductance in circuit. Rotation of the coils and the arrangement of the counters is such that an increase of frequency is reflected in an increase of counter reading. To avoid the constant use of curves, a calibration of the master oscillator coils is carried on a large chart on the top front panel of the unit. It will be noted that there are two scales provided, one red and one black. These correspond to the two ranges of the master oscillator coils. The four coils themselves are identical, but the condensers are different on ranges 1 and 2 from those used on ranges 3 and 4. To ensure that the ranges of both coils of each pair are exactly the same, the condensers C12 and C15 on ranges 1 and 4 respectively, are made semi-variable. They are situated at the rear of the oscillator unit, and are set at the factory when the unit is tested before shipment and then locked to prevent any possible shift in the calibration of the ranges. As a further aid to accuracy of calibration, the coils are adjusted to close tolerances by setting the counters to a number which is stamped on the side of the coil case.

In addition to the above precautions to ensure stability and ease of calibration, the plate voltage is maintained at the rated value by means of the voltage-regulator valves and the oscillator unit is mounted on the chassis with vibration absorbing pads. To prevent parasitic oscillations, r-f suppression resistor R5 is added to the grid circuit of the oscillator valve.

4.14 The master oscillator stage is followed by the multiplier. The actual keying of the transmitter is done in the cathode of this stage which includes a key click filter consisting of L31, C70 and R59. When using high speed or remote keying, the oscillator is held on continuously by the contacts of relay E8. When using normal keying, relay E8 closes on the first impulse of the keyed character and does not release for approximately 1/2 second (delay set by residual screw, Para. 2.13). The major portion of the circuit components of this valve, designated V3, are contained in the oscillator unit, only the plate

circuit being in the main chassis of the r-f unit. This valve functions as an amplifier as well as a multiplier. On the lower frequencies it functions as an amplifier, while on the higher ones it is used either to double or triple the oscillator frequency. (In the range 19-28 mc/s both multiplier and driver stage operate as doublers.) Since a calibration of the master oscillator is provided on the front panel of the unit, the doubling or tripling of the frequency is carried out right on the chart, and all that is necessary to obtain the correct frequency is to set the range switches to the correct ranges and the calibration of the master oscillator to the correct counter readings. Thus it will be seen that the matter of either doubling or tripling is automatically taken care of in the range switching. On the lower frequencies, when the multiplier stage is tuned to resonance, it will be found that the grid current to the driver stages is in excess of 3 ma, which is the maximum allowable for the driver valves. For this reason, it is usual to set the plate circuit of the multiplier valve off resonance to some extent, so that the grid drive to the drivers is reduced to the required value of 3 ma. When this is done, the higher capacity side of resonance must be used, as otherwise it will be found that the calibration charts in this folder will not be correct.

4.15 The total grid currents of the crystal oscillator, master oscillator and multiplier valves are read on the multimeter when the controlling switch is placed in position 1. The normal reading for this position is 2.5 ma. Tuning of the multiplier stage is accomplished by means of C30, which is designated MULTIPLIER on the front panel of the r-f unit.

4.16 R-f Unit.

This unit contains four major parts - the plate circuit of the multiplier, the driver stage, the power amplifier stage and the components forming the antenna tuning circuit. As with other units of the transmitter, it is built on a sheet steel base. A small front panel carries the following controls (from left to right); MULTIPLIER plate condenser, DRIVER plate condenser, FREQUENCY RANGE master switch, POWER AMP tuning condenser, ANTENNA condenser. Above the antenna condenser are four controls; the lower is the ANTENNA TUNE switch and above it are the ANTENNA LOADING, SERIES TUNE and COUPLING controls. With the main front cover of the transmitter removed, it will be found that the stages are shielded from possible interaction with each other, and that the controls are so located that each stage is directly behind the control pertaining to that stage. It will be seen that the FREQUENCY RANGE switch controls a number of switches throughout the whole of the chassis and that the connections between the main shaft and the various switches are made by means of a chain and sprocket drive. All the circuits are, therefore, switched at the same time and consequently there is little chance of setting the transmitter to a wrong frequency. To further obviate this, the sections of the frequency range are clearly marked around the switch in alternate black and red sectors to correspond with the two sections of the r-f generator. One section of this chassis has already been discussed, viz. the multiplier plate circuit. The remainder of the units follow from left to right.

4.17 The driver stage is capacity coupled to the previous stage by means of condenser C29, and consists of an 807 valve. The plate circuit of this valve is for the most part conventional, being made up of the variable condenser C35, which is designated DRIVER on the front panel, the tapped coil L12 and auxiliary (range G) coil L12A. The taps on coil L12 are switched by means of the main master range switch. It will be noted that a small variable condenser C34 is connected between one side of the plate circuit of this valve and ground. This serves to balance the r-f voltages on each side of inductance L12, and thus applies equal voltages to the grids of the p-a stage so that these valves will have equal excitation, as otherwise it is found that there will be a considerable difference in excitation on the higher frequencies and that one of the valves will be much more heavily driven than the other. This control is set at the time of testing and usually need not be readjusted in service. For this reason, it is not brought out to the front panel, and adjustment is made by means of a screwdriver with the front panel off. It will be noted that all components of the driver stage are kept as far as possible in the same compartment and are laid out as symmetrically as possible to provide increased efficiency on the higher frequencies.

4.18 The output from the driver valve is fed through the vertical shield separating the driver from the power amplifier to the fixed drive condensers C36 and C37, and then through the parasitic suppressors R29 and R30 to the grids of the final stage valves. The grid return of these valves is made via the two chokes L13 and L14 and voltage regulator valve V16 which stabilizes the P-A.grid bias to ground. The final stage valves are type 4-125A and are worked in push pull with a series-fed plate circuit. The arrangement of the plate circuit permits the use of more compact components in the tuned circuit, as there is no d-c potential difference across the plates of the P-A tuning condenser.

4.19 The plate circuit of the final stage is made up of condenser C40, which is designated POWER AMP on the front panel, inductance L17 and auxiliary (range G) inductance L17A. The inductance L17 is tapped at the proper points for the various bands and is switched to the correct tap by the master range switch. D-c supply for the plates of the final valves is taken from the main 2750-volt rectifier and feeds to the plates via R-F choke L30, and inductance L17. It will be noted that coil L17 is wound in three sections. The two outer sections are of heavy gauge wire, while the inner section is made of copper tubing to decrease losses on the higher frequencies. Switches S22 and S23 used for tapping the coil are mounted under it and between the condenser and coil. Over the centre of the coil is wound the coupling coil L18, which is made of only two turns of heavy copper tubing and provides the means to transfer energy to the components of the antenna circuit. On range G, inductance L17A is placed in parallel with the complete inductance L17, while at the same time, auxiliary coupling coil L18A is switched into circuit.

4.20 The antenna circuit is coupled to the power amplifier by a system of link coupling, which provides the most efficient means to

couple the final stage to the varying characteristics of an antenna operated over such a wide range of frequencies as is provided in the present transmitter. The components of the antenna circuit are coils L18, L18A and L19 and condensers C45 and C45A. Coil L19 is tapped at various pre-determined points, these taps being brought out to the antenna circuit switches. These are: S24 designated ANT COUPLING, S25 designated ANT LOADING, and S26, S27 and S28 which are all ganged together and designated ANT TUNE. Condensers C45 and C45A are brought out to the front panel and bear the designations ANTENNA and SER TUNE. These controls provide a flexible method of matching the impedance of any antenna to the power amplifier. The coil L19 is used as an auto-transformer to couple the relatively low impedance of the link circuit coil L18 or L18A to the antenna. The switches which are grouped under the control marked ANT TUNE connect the antenna condenser in the correct manner for the various taps. For some frequencies the condenser is connected in circuit as a series element and for others it is connected in parallel, both in conjunction with the correct taps. Condenser C45A is always connected in circuit as a series element, and switch S35, on the condenser shaft, serves to short-circuit this condenser when desired. The control marked ANT LOADING also varies the taps on the coil and serves to load up the transmitter by changing the ratio of the turns in the two halves of the autotransformer.

4.21 The controls for the components of the antenna circuit are all provided with numbered scales to facilitate the logging of readings on the frequencies that will be used. It will be found that, in general, the readings of the antenna circuit controls will increase with frequency, except on band G. This means that the higher the frequency, the higher all controls will read. This is a useful guide to setting up frequencies that have not been previously adjusted. When setting up a new frequency, it is advisable to remember that the ANT COUPLING control increases coupling as the control is decreased, and that the coupling is also increased as the ANTENNA LOADING control is increased. It will also be found that the antenna condenser will have to be set to a high value of capacity for the lower frequencies and to a low value of capacity for the higher frequencies.

4.22 When tuning up the transmitter into an antenna, it is advisable to exercise considerable caution and to avoid applying the full power of the set until such time as all adjustments are known to be correct. This will avoid flashovers and possible damage to the circuit components. Always make all preliminary adjustments with the ADJUST-OPERATE switch in the ADJUST position, switching to OPERATE only when assured that the set is correctly loaded. At no time change the positions of the tap switches of the antenna circuit with the power on and the key down, as this will cause an arc-over in the switches and will probably damage them.

4.23 At the top of the transmitter is provided a metering panel which enables operation of the transmitter to be checked. At the left-hand end of the panel is M1 - a 0-25 ma meter designated MULTIMETER - which is provided with switch S16 to select the ranges and positions that the meter is used to measure. In series with each of the circuits to be measured is a resistor whose value is so chosen that

the correct multiplication factor of the range is obtained. The switch connects the meter across each of these resistors in turn, and thus the current in any stage can be read. The meter is arranged to read the following currents:

Position 1 - Oscillator-multiplier grid current (reading x 1)

Position 2 - Master oscillator plate current (reading x 2)

Position 3 - Multiplier plate current (reading x 4)

Position 4 - Driver grid current (reading x 1)

Position 5 - Power amplifier grid current (reading x 10)

Next to the multimeter will be found the DRIVER CATHODE meter which reads the total cathode current to the driver valve. To arrive at the correct value for the plate and screen currents for this valve, it is necessary to subtract the grid current (given in position 4 of the multimeter) from the reading of this meter.

The third meter is a voltmeter known as the FILAMENT VOLTMETER. This meter is marked with a red line at 110 volts, and the voltage should be adjusted so that the needle is at this point whether the key is up or down, thus setting the voltages on all the transformers throughout the set and keeping the filaments of the valves at the correct rated voltages, thereby increasing their life. Adjustment of the voltage is carried out by means of the resistors in the control unit marked FIL VOLTS and FIL COMP.

Next to the voltmeter will be found two meters M4 and M5 which are designated PA CATHODE REAR and PA CATHODE FRONT respectively. These read the cathode currents to the two power amplifier valves.

On the extreme right is the ANTENNA AMMETER. This meter is a 0.5 ma DC meter and is connected to a sampling loop and rectifier circuit. A small metal box mounted near the antenna bowl insulator contains the sampling circuit. A switch (S34) on the front panel enables small antenna currents to be read by using the 0.5 amp. range of this meter. This meter is very useful in tuning the transmitter when S14 is at ADJUST.

The meter will not be used as an indication of the absolute power in the antenna, due to the fact that the resistance of the antenna will vary over the frequency spectrum, and the addition of trunks or other auxiliary apparatus will not give a true indication of the resistance of the antenna proper. It is, however, very useful as an indication of the maximum transfer of energy from the transmitter antenna circuit to the radiating system. The transmitter must always be adjusted

so as to provide maximum antenna current on any given frequency, regardless of the magnitude of the reading. This will ensure that the most efficient transfer of energy to the radiating system has been attained. It may be noticed that on certain frequencies the antenna current is low, while on others it will be extremely high. This does not mean that the set is functioning less efficiently on one frequency than on another. It merely shows that the effective resistance of the antenna has altered. The set, when properly adjusted, delivers nearly constant power to the antenna circuit at all frequencies at which it can be operated.

4.24 Typical Resistance Measurements.

All switches OFF and S14 to adjust unless otherwise stated.

Terminals				Ohms	Conditions
#1	Lower	to #3	Lower	0	
12	"	" 13	"	0	
13	"	" 25	"	0	
14	"	" 15	"	0	Fil. & HT. SW. Closed
17	"	" 24	"	0	E5 & E6 Closed
18	"	" 19	"	0	OP.-ADJ. SW. Operate
18	"	" 19	"	40	" " " Adjust
19	"	" 29	"	0	E4 Closed
21	"	" 29	"	0	E4 Closed
24	"	" 25	"	0	S29, 30, 31 Closed
24	"	" 25	"	∞	" " " Open
30	"	" 32	"	0	E4 Closed
30	"	" 32	"	∞	" Open
31	"	" 32	"	0	P.A. Knife SW. Closed
31	"	" 32	"	42	" " " Open
4	"	" 8	Middle	7000	
5	"	" 4	"	2500	
6	"	" 6	"	0	
9	"	" 23	"	0	
12	"	" 24	"	0	
16	"	" 14	"	0	
17	"	" 15	"	0	
18	"	" 16	"	0	
11	Middle	to 15	"	200	HT. SW. Closed
11	"	" 15	"	∞	" " Open
14	"	" 24	"	0	O.L. Reset Closed
14	"	" 24	"	∞	" " Open
Gnd.	"	" 1A	Top	1000	(Adjust bias tap) Band SW. A to F.
Gnd.	"	" 1A	"	1750	" " " " " G

4.25 Typical Voltage Measurements.

All switches OFF and S14 to adjust and key up unless otherwise stated.

Terminals	Volts	Conditions
Lower Chassis		
# 1 to 6	640 DC	Mains, Fil. HT. On
10 " 12	85 AC	(Fil. Meter to 110V) Mains, Fil. On.
13 " 14	110 AC	Mains On.
29 " 30	110 AC	Mains, Fil. On
29 " 31	110 AC	S14 to Adjust, Mains, Fil. On. S18 Closed.
Centre Chassis		
1 to 2	300 DC	Mains, Fil. HT. On
1 " 4	440 DC	" " " "
1 " 8	300 DC	" " " "
18 " 19	6.3 AC	" " On.
Upper Chassis		
Gnd.o 1A	75 DC	Band A-F. Mains, Fil. HT. On
Gnd." 1A	125 DC	Band G " " " "
Gnd." 2	225 DC	Mains, Fil. HT. On.
Gnd." 7	150 DC	" " " S17 On.
Gnd." 14	2900 DC	Key up. Mains, Fil. HT. S18 On
8 " 9	115 AC	Mains, Fil. On.
10 " 11	6.3 AC	" " "

SECTION 5 - PARTS LIST

Symbol	Part	Description	Type No.	Maker
Capacitors				
C1	Xtal osc. grid reaction	30-uuf 500-v	5WS	C-D
C2	" " screen bypass	.002-uf 500-v	3WS	"
C3	" " plate blocking	.002-uf 500-v	3WS	"
C4	M-o cathode bypass	.01-uf 300-v	3WS	"
C5	" heater bypass	.01-uf 300-v	3WS	"
C6	" screen bypass	.002-uf 500-v	3WS	"
C7	" plate bypass	1.0-uf 600-v	DY6100	"
C8	" " blocking	.002-uf 500-v	3WS	"
C9	" grid reaction	50-uuf 500-v	3WS	"
C10	" tank	.00025-uf 5000-v test, ± 2%	9H	"
C11	" "	.0005-uf 5000-v test, ± 2%	9H	"
C12	" "	30-uuf variable	HF30X	Hammarlund
C13	" "	.00015-uf 5000-v test, ± 2%	9H	C-D

Symbol	Part	Description	Type No.	Maker
C14	M-o tank	.00025-uf 5000-v test, ± - 2%	9H	C-D
C15	" "	30-uuf variable	HF30X	Hammarlund
C16	Multiplier drive	15-uuf 500-v	5WS	C-D
C17	" cathode bypass	.01-uf 300-v	3WS	"
C18	" screen bypass	.002-uf 500-v	3WS	"
C19	R-f filter	.002-uf 500-v	3WS	"
C20	" "	.002-uf 500-v	3WS	"
C21	" "	.002-uf 500-v	3WS	"
C27	Keying rect. filter	.5-uf 600-v	DY6050	"
C28	Driver coupling	.002-uf 600-v	4S12020	"
C29	" grid coupling	100-uuf 500-v	5WS	"
C30	" tank tuning	150-uuf variable	7115	Hammond
C31	" cathode bypass	.01-uf 500-v	3WS	C-D
C32	" screen bypass	.002-uf 600-v	4S12020	"
C33	" tank coupling	.002-uf 1200-v	4S22020	"
C34	" " balance	30-uuf variable	HF30X	Hammarlund
C35	" " tuning	200-uuf variable	8820	Hammond
C36	P-a grid drive	250-uuf 600-v	4S13025	C-D
C37	" " "	250-uuf 600-v	4S13025	"
C40	" tank tuning	200-uuf variable	15730	Hammond
C45	Antenna tune	250-uuf 4000-v	16126	"
C45A	Series tune	355-uuf 4600-v	9335	"
C47	P-a plate bypass	.002-uf 3000-v	726-15LS	C-D
C48	Meter bypass	.002-uf 600-v	4S12020	"
C49	" "	.002-uf 600-v	4S12020	"
C50	" "	.002-uf 600-v	4S12020	"
C51	" "	.002-uf 600-v	4S12020	"
C52	" "	.002-uf 600-v	4S12020	"
C53	Low-voltage filter	4.0-uf 1000-v	TJ10040	"
C54	" " "	15-uf 1000-v	1009D	Aerovox
C55	High-voltage filter	4.0-uf 3000-v	3009D	"
C56	Thermostat bypass	0.1-uf 600-v	DY6010	C-D
C57	H.V. Filter	4.0-uf 3000-v	3009D	Aerovox
C58	H.V. Filter	4.0-uf 3000-v	3009D	"
C59	Bias Filter	10-uf 600-v	609D	"
C60	P-a screen bypass	.5-uf 600-v DYR	6050J	C-D
C61	Final grid bypass	.002-uf 500-v	1467	Aerovox
C62	Final screen grid bypass	.01-uf 600-v	1445	"
C63	" " " "	.01-uf 600-v	1445	"
C64	P-a filament bypass	.002-uf 600-v	1445	"
C65	" " "	.002-uf 600-v	1445	"
C66	" " "	.002-uf 600-v	1445	"
C67	" " "	.002-uf 600-v	1445	"
C68	R-F Meter bypass	.01-uf 300-v	1467	"
C69				
C70	Key click filter	0.5-uf 600-v	DYR 6050	C-D
C71	Current X'fmer bypass	.001-uf 1000-v		

Fuses

F1	High tension	25-amps 250-v	AF2533	Economy
F2	Filament	5-amps 250-v	AF533	"
F3	Heater	5-amps 250-v	AF533	"

Symbol	Part	Description	Type No.	Maker
Inductances				
L1	M-o variable		105-818	Marconi
L2	" "		105-819	"
L3	" "		105-257	"
L4	" "		105-258	"
L5	" plate choke		106-200	"
L6	R-f filter		106-200	"
L7	" "		106-200	"
L8	" "		106-200	"
L9	Multiplier plate		106-200	"
L10	" tank		110-101	"
L11	Driver plate		1506	Hammond
L12	" tank		110-500	Marconi
L12A	Aux. Driver tank		A-500A-95	C.A.E.
L13	P-a grid		1504	Hammond
L14	" "		1504	"
L17	" tank		110-502	Marconi
L17A	Aux. P-a tank		A-500A-94	C.A.E.
L18	Coupling		110-502	Marconi
L18A	Adjustable Link		B-500A-53	C.A.E.
L19	Antenna		110-501	Marconi
L20	Rectifier plate		94760	"
L21	" "		109-326	"
L22	" "		94738	"
L23	" "		94738	"
L25	L-v filter		89378	"
L26	H-v filter		24198	Hammond
L27	Bias filter		10-100X	"
L28	H.V. filter		A-500A-143	C.A.E.
L29	P-a screen choke		1504	Hammond
L30	P-a plate choke		R-175	National
L31	Keying shaping choke		A-500A-45	C.A.E.
L32	R-f filter		P.C.79115C	R.C.A.
Meters				
M1	Multimeter	0-25 ma d-c	27S	Simpson
M2	Driver cathode	0-250 ma d-c	27S	"
M3	Fil.line voltmeter	0-150-v a-c, red line at 110-v	57S	"
M4	P-a plate	0-500 ma d-c	27S	"
M5	" "	0-500 ma d-c	27S	"
M6	Antenna ammeter	0-5 ma d-c	B500A-55	C.A.E.
Pilot Lights				
P2	Filaments	120-v 6-w	S6 clear	C.G.E.
P3	High tension	120-v 6-w	S6 clear	"

Symbol	Part	Description	Type No.	Maker
Resistors				
R1	C-o grid leak	50,000-ohms 1/2-w	BT-1/2	I.R.C.
R2	" screen	500,000-ohms 1/2-w	BT-1/2	"
R3	" plate	30,000-ohms 4-w with C coating #1 terms.	AB	"
R4	M-o grid leak	50,000-ohms 1-w	BT-1	"
R5	" parastic suppr.	100-ohms 1/2-w	BW-1/2	"
R6	" cathode	220-ohms 2-w		Ohmite
R7	" screen	30,000-ohms 1-w	BT-1	I.R.C.
R8	" "	100-ohms 1/2-w	BW-1/2	"
R9	Mult.parasitic suppr.	100-ohms 1/2-w	BW-1/2	"
R10	" grid leak	50,000-ohms 1-w	BT-1	"
R11	" cathode	220-ohms 2-w		Ohmite
R12	" screen	100-ohms 1/2-w	BW-1/2	I.R.C.
R13	" screen	40,000-ohms 2-w	BT-2	I.R.C.
R18	Filament compensator	7.5-ohms 100-w	0445 Mod.K	Ohmite
R19	" regulator	15-ohms 300-w	0657	"
R21	Driver grid	22,000-ohms 2-w C coating	BT-2	I.R.C.
R24	" "	50-ohms 1-w	BW-1	"
R27	" screen	79000-ohms 25-w	0226	Ohmite
R29	P-a grid	Suppressor	A-500A-165	C.A.E.
R30	" "	Suppressor	A-500A-165	"
R31	Multimeter shunt	500-ohms 1/2-w	BT-1/2	I.R.C.
R32	" "	9-ohms 1% tol.	WW6	"
R33	" "	3-ohms 1% tol.	WW6	"
R34	" "	500-ohms 1-w	BT-1	"
R35	" "	1-ohm 1% tol.	WW6	"
R36	" series		91850	Marconi
R37	Series protector		95735	"
R38	" "		95736	"
R39	" "		95736	"
R40	Low-v dropping	7,000-ohms 26-w C coating	HY	I.R.C.
R42	" " bleeder	6,000-ohms 34-w C coating	FJ	"
R43	" " "	2,500-ohms 200-w C coating	HO	"
R44	High-v bleeder	10,000-ohms 60-w C coating	HE	"
R45	" " "	10,000-ohms 60-w	HE	"
R46	" " "	10,000-ohms 60-w	HE	"
R47	" " "	10,000-ohms 60-w	HE	"
R48	Adjust resistor	40-ohms 300-w		P.M. Wright
R49	Heater	120-ohms 100-w		Chromalox
R50	"	120-ohms 100-w		"
R51	Relay shunt	10-ohms 25-w	0363	Ohmite
R52	" "	15-ohms 25-w	0364	"
R53	Bias bleeder	3000-ohms 80-w	ESA	I.R.C.
R54	Parasitic suppressor	27,000-ohms 2-w		Ohmite

Symbol	Part	Description	Type No.	Maker
R55	Bias dropping	8200-ohms 2-w	BT-2	I.R.C.
R57	R-f meter multiplier	22,000-ohms 1-w	BT-1	"
R59	Key click filter	270-ohms 1-w	BW-1	"
R60	Suppressor		A-500A-98	C.A.E.
R61	Suppressor		A-500A-98	"
R62	Current X'fmer Dropping	470-ohms 1/2-w		
R63	" " "	27-ohms 1/2-w		
R64	Multiplier plate "	7500-ohms 25-w	0214	Ohmite
R65	Suppressor		P-300	"
	Switches			
S1	M-o wavechange	Marconi 109-540	86A	Communication Products
S2	" "	Marconi 109-540	86A	" "
S3	" "	Marconi 109-540	86A	" "
S4	" "	Marconi 109-540	86A	" "
S5	" "	Marconi 109-540	86A	" "
S6	" "	Marconi 109-540	86A	" "
S7	Xtal m-o	Marconi 105-568		Centralab
S10	Overload reset		3591	A H & H
S12	Filaments on-off		6900	"
S13	High tension on-off		81009	"
S14	Adjust-Operate		8425	"
S16	Multimeter		107-296	Marconi
S17	Driver disconnect		783	Trumbull
S18	P-a disconnect		783	"
S20	Multiplier range	CAE C-500A-58	86S	C.P.
S21	Driver range	CAE C-500A-58	86S	"
S21A	Aux. driver range	CAE C-500A-58	86S	"
S21B	" " "	CAE C-500A-58	86S	"
S21C	Bias tapping	CAE C-500A-58	86S	"
S22	P-a range	CAE D-500A-60	88S	"
S22A	Aux. P-a range	CAE D-500A-60	88S	"
S22B	Link selector	CAE D-500A-60	88S	"
S23	P-a range	CAE D-500A-60	88S	"
S23A	Aux. P-a range	CAE D-500A-60	88S	"
S23B	Link selector	CAE D-500A-60	88S	"
S24	Coupling	Marconi 109-546	88	"
S25	Antenna loading	Marconi 109-545	88	"
S26	" "	Marconi 109-545	88	"
S27	" tune	Marconi 109-545	88	"
S28	" "	Marconi 109-545	88	"
S33	Main switch		6465	A H & H
S34	Antenna multiplier		1004	Cutler-Hammer
S35	Series tune	CAE C-500A-62		

Symbol	Part	Description	Type No.	Maker
Transformers				
T1	Low-v rectifier	CAE A-500A-136	24720	Hammond
T2	Rectifier filament		97638	Marconi
T3	High-v rectifier		795-60	Hammond
T6	Cuprox rectifier		97695	Marconi
T7	R-f unit filaments		24719	Hammond
T8	Bias filament		165-60	"
T9	Autotransformer		168B	"
T10	Antenna current X'fmer	A-500A-65		
Relays				
E1	Keying relay	6-v DC 4.4 ohms	202	Leach
E2	" "	12 V.D.C. 42 Ohm.	#1427-S9	"
E3	Fil. comp. relay	6 V.D.C. 4.4 Ohm.	#101	"
E4	H.V. Contactor		A209	Allen-Bradley
E5	H.V. Overload	2.0 amp. trip	ADBY-5N	Dunco
E6	L.V. Overload	.75 amp. trip	ADBY-5N	"
E7	Thermostat		S-7194	R.C.A.
E8	Osc. Keying relay	EA-6487	A18258	Bendix.

Symbol	Part	Valve	Socket
Valves & Sockets			
V1	Crystal Oscillator	6V6	Amphenol RSS8
V2	Master oscillator	807	" RSS5
V3	Multiplier	807	" RSS5
V5	Voltage regulator	VR150-30	" RSS8
V6	" "	VR150-30	" RSS8
V7	Driver	807	" RSS5
V9	Power amplifier	4-125A Eimac	Johnson 122-275
V10	" "	4-125A Eimac	" 122-275
V11	Rectifier	866A-866	Amphenol RSS4
V12	"	866A/866	" RSS4
V13	"	872A/872	Johnson 211 White
V14	"	872A/872	" 211 "
V15	"	5Y3GT	Amphenol RSS8
V16	Bias voltage regulator	VR150/30	" RSS8

SECTION 6 - LIST OF SPARE EQUIPMENT FOR BATM ORDERS

Qty	Part	Description	Type No.	Maker
Spare Valves PV-500-HM/LM				
12	Valves		810	RVC
14	"		807	"
12	"		872A/872	"
6	"		866A/866	"
4	"		6V6	"
4	"		5Z3	"
6	"		VR150-30	"
Set of Spare Condensers				
2	Condensers	.005-uf	9-FAS-62050	C-D
1	"	.005-uf	9-AS-52050	"
3	"	.01-uf	4S-11010	"
1	"	.00025-uf	364-6S	"
1	"	.0005-uf	272-6S	"
1	"	.001-uf	463-6S	"
1	"	.001-uf	4S-22010	"
1	"	.00025-uf	586-59	"
1	"	.0005-uf	544-59	"
1	"	.001-uf	545-59	"
1	"	.002-uf	572-59	"
2	"	4.0-uf	TJ-10040	"
1	"	.5-uf	DY-10050	"
2	"	.1-uf	DY-10010	"
2	"	.02-uf	9AS-21020	"
1	"	15-uuf	1468	Aerovox
2	"	.01-uf	4AS-11010	C-D
1	"	2.0-uf	DY-6200	"
1	"	2.0-uf	TJ-25020	"
2	"	.5-uf	DY-6050	"
1	"	.1-uf	DY-6010	"
1	"	.00015-uf	587A-59	"
1	"	30-uuf	5WS	"
4	"	.002-uf	3WS	"
2	"	.01-uf	3WS	"
1	"	1.0-uf	DY-6100	"
1	"	50-uuf	5WS	"
1	"	250-uuf, 2% tol. 5000-v test	9H	"
1	"	500-uuf, 2% tol. 5000-v test	9H	"
1	"	150-uuf, 2% tol. 5000-v test	9H	"
1	"	4.0-uf	TJ-25040	"

Qty.	Part	Description	Type No.	Maker
3	Condensers	.002-uf	4AS-12020	C-D
1	"	.002-uf	4S-12020	"
1	"	100-uuf	5WS	"
1	"	.002-uf	4S-22020	"
1	"	250-uuf	4S-13025	"
1	"	.002-uf	217-6S	"
1	"	.002-uf	726-15LS	"
	Set of Spare Resistors			
1	Resistor	10,000-ohms C coating #5 terminals	CE	IRC
2	"	125-ohms C coating #1 terminals	AB	"
1	"	2,000-ohms C coating #5 terminals	FJ	"
1	"	50,000-ohms C coating #5 terminals	FB	"
1	"	40,000-ohms C coating #5 terminals	CE	"
1	"	250-ohms C coating #1 terminals	AB	"
1	"	15,000-ohms ± - 5%	BT-1	"
1	"	35,000-ohms ± - 5%	BT-1	"
1	"	3,000-ohms C coating #5 terminals	FD	"
3	"	4,000-ohms C coating #5 terminals	HE	"
1	"	2,000-ohms C coating #5 terminals	HA	"
1	"	1,000-ohms ± - 10%, C coat, #1 terminals	AB	"
2	Heater elements		91853	Marconi
1	Rheostat	7.5-ohms 100-w	Mod.K #0445	Ohmite
1	Heater element	560-w 110-v straight core		P.M. Wright Electric
1	" "	600-w 110-v cone shaped		"
1	Resistor	7,000-ohms C coating #5 terminals	HY	IRC
1	"	2,750-ohms C coating #5 terminals	HZ	"
1	"	6,000-ohms C coating #5 terminals	FJ	"
1	"	2,500-ohms C coating #5 terminals	HE	"
1	"	10,000-ohms C coating #5 terminals	HE	"
1	"	50,000-ohms	BT-1/2	"
1	"	500,000-ohms	BT-1	"

Qty.	Part	Description	Type No.	Maker
1	Resistor	30,000-ohms C coating #1 terminals	AB	IRC
1	"	50,000-ohms	BT-1	"
3	"	100-ohms	BT-1/2	"
1	"	250-ohms	BT-2	"
1	"	30,000-ohms	BT-2	"
1	"	40,000-ohms	BT-2	"
1	"	10,000-ohms	BT-2	"
1	"	2,000-ohms C coating #5 terminals	FB	"
1	Rheostat	15-ohms 300-w	Mod.N #0657	Ohmite
1	Resistor	500-ohms	BW-1/2	IRC
1	"	9-ohms	WW-3	"
1	"	500-ohms	BW-1	"
1	"	3-ohms, 1% tolerance	WW-3	"
1	"	1-ohm, 1% tolerance	WW-3	"
1	"		91850	Marconi
1	Meter filter assy		95735	"
1	" " "		95736	"
1	Resistor	10,000-ohms C coating #1 terminals	AB	IRC
1	"	250-ohms C coating #5 terminals	HX	"
1	"	50-ohms	BT-1/2	"
1	"	20,000-ohms C coating #5 terminals	HX	"
1	"	2,000-ohms C coating #5 terminals	HX	"
1	"		P-300	Ohmite

Set of Spare R-f chokes

1	Choke		1504	Hammond
		or	106-200	Marconi
1	"		1506	Hammond
1	"		110-405	Marconi
1	"		94760	"
1	"		94738	"
1	"		94720	"
1	"		88959	"
1	"		90899	"
1	"		90893	"

Set of Spare Transformers

1	Transformer		89036	"
1	"		89301	"
1	"	(supplied with first 5 equips)	89199	"
1	"	" " " " "	89306	"

Qty.	Part	Description	Type No.	Maker
1	Transformer		89308	Marconi
1	"		89056	"
1	"		97635	"
1	"		97637	"
1	"		97646	"
1	"		97695	"
1	"		89307	"
1	"		97638	"
1	"		89325	"
1	"		97634	"
1	"	(supplied with last 15 equipts)	97651	"
1	"	" " " " "	97652	"
1	Variac transformer 60-cycles (supplied with first 5 equipts)		80-B	Gen. Radio

Set of Spare Indicating Instruments

1	R-f ammeter	0-15 amps r-f	37-S	Simpson
1	Milliammeter	0-150 ma d-c	27-S	"
1	"	0-1000 ma d-c	27-S	"
1	Voltmeter	0-150-v 60-cycles, red line at 110-v	57-S	"
1	Milliammeter	0-25 ma d-c	27-S	"
1	"	0-250 ma d-c	27-S	"
1	"	0-500 ma d-c	27-S	"
1	R-f ammeter	0-10 amps r-f	37-S	"

Set of Spare Relay Coils

1	Coil for Leach #202 relay, 6-v d-c 4.4-ohms	
1	" " " #1427-S9 relay, 12-v d-c	
1	" " " #101 relay, 6-v, d-c 4.4-ohms	
1	" "	Allen-Bradley Bull. 700 a-c contactor type A-209, 110-v 60-cycles
1	" "	Struthers Dunn type ADBY5N d-p s-b relay, release coil to operate at 1-amp d-c continuous duty
1	" "	Struthers Dunn type ADBY5N d-p s-b relay, reset coil to operate from 110-v 60-cy momentary duty
1	" "	Struthers Dunn type ADBY5N d-p s-b relay, release coil only, to operate at 750-ma d-c, continuous duty.
1	" "	Leach #1040 relay, coil #351, trip current .75-amp d.c 2.5-ohms

Qty.	Part	Description	Type No.	Maker
Set of Spare Fuses				
4	Fuses	Economy cartridge 25-amp 250-v	AF-2533	Economy
		Admiralty pattern	S-5504	
2	"	Economy cartridge 30-amp 250-v	AF-3033	"
		Admiralty pattern	S-5504	
8	"	Economy cartridge 5-amp 250-v	AF-533	"
		Admiralty pattern	S-5541	
Set of Spare Fuse Refills				
40	Refills for Economy cartridge fuse 25-amp 250-v Economy #AF-2533, Admiralty pattern S-5504			
20	" " " cartridge fuse 30-amp 250-v Economy #AF-3033, Admiralty pattern S-5504			
80	" " " cartridge fuse 5-amps 250-v Economy #AF-533, Admiralty pattern S-5541			
Set of Spare Relay & Contactor Contacts				
2	Complete sets Contacts for Leach #202 relay			
1	" " " " " #1427-S9 relay			
2	" " " " " #101 relay			
2	" " " " Allen-Bradley Bull. 700 a-c contactor 110-v 60-cycles			
2	" " " " Struthers Dunn type ADBY5N relay			
1	" " " " Leach #1040 relay			
Set of Spare Pilot Lamps				
6	Pilot lamps 120-v 6-w type S-6, candelabra base, clear			CGE
Set of Additional Miscellaneous Parts				
1	Thermostat, normally closed, self-regulating, temperature setting 75° F ±-5°. Load 1-amp resistive 220-v. Ferrule to be stamped 110-200. To be set and tested to G.M. test #122 as per Marconi drawing 91771.			
2	Sets Brushed for General Radio Model 80-B Variac (supplied with first 5 equipments)			
1	Valve Socket, Johnson 211			
1	" " Amphenol SS-4			
1	" " " SS-5			
1	" " " SS-8			

Qty	Part	Description	Type No.	Maker
4	Complete sets Brusholder Springs for rotary converter, Leland Electric Company, 220-v d-c to 115-v a-c 60-cycles single-phase 2500-va (or equivalent).			
2	Complete sets Brushes for above machines.			
2	Complete sets Brusholders for above machines.			
2	Complete sets Contacts for Starters as supplied with above machines.			
2	Complete sets Slide Brushes or Fingers for above starters.			
2	Complete sets Springs for above starters.			
2	Complete sets Resistors for above starters.			

Set of Spare Insulators

1	Insulator		981-A	Isolantite
1	"		981-B	"
7	"		394 x 1-1/2"	"
3	"		73245	Marconi
3	"		71621	"
1	Bushing	Porcelain	10	Smith & Stone
2	Insulators		1174	Am. Lava
1	"		1175	"
2	"		395 x 5/8"	Isolantite
1	"		50 White	Johnson
3	"		397 x 1"	Isolantite
1	"		380 x 2-1/2"	"
1	"		394 x 1"	"
1	"	Less hardware	44	Johnson
1	"		379	Isolantite
3	"		397 x 1"	"
1	"		394 x 1-1/2"	"
1	"		379	"
2	"		432 x 1"	"
1	"		65	Johnson
2	"		40	"
2	"		323 x 3/4"	Isolantite
3	"		337 x 5-1/2"	"
1	"		348 x 6"	"
4	"	1" square x 6" long	333	"
1	"		323 x 3-1/2"	"
3	"		337 x 5"	"
1	"		333 x 6"	"
1	"		323 x 4"	"
1	"		337 x 4"	"
7	"		323 x 1-1/2"	"
2	"		42	Johnson
2	"		337 x 3-1/2"	Isolantite
1	"		432 x 1"	"
1	"		337 x 1"	"
1	"		1173	Alsimag

Qty	Part	Description	Type No.	Maker
4	Insulators		323 x 1"	Isolantite
2	"		65	Johnson
2	"		1169-00 Part One	General Ceramics
2	"		1168-00 Part Two	"
2	"		337 x 4"	Isolantite
2	"		395 x 1"	"
4	"		395 x 1/2"	"
1	"		981-E	"
4	"		432	"
1	"		507	"
11	"		394 x 1"	"
Set of Spare Switches				
1	Switch	S-pole s-throw 6" leads	3597	A.H.& H.
1	"	Momentary contact normally open	3591	"
1	"		92373	Marconi
1	"		91136	"
1	"		96212	"
1	"	3-amp 250-v double pole with solder lugs & threaded sleeve for single mounting hole with On-Off plate	81009	A.H.& H.
1	"		8425	"
1	"		6800	"
1	"		6465	"
1	"		20595	"
1	" assembly		96213	Marconi
1	"	(modified to 105-568)	91920/4386	"
1	"		91135/4387	"
1	"		6900	A.H.& H.
1	"	S-p s-t knife, unmounted	783	Trumbull
Miscellaneous				
16	Fuses	Economy cartridge 30-amp 250-v. Admiralty pattern	AF-3033 S-5504	Economy
1	Pilot lamp	6-w 220-v S-6 bulb, bay base for series #100 socket		Dial Light Company
1	" "	3-w 6-v S-6 bulb or smaller		"
8	Fuses	15-amp 250-v cartridge		Economy
8	"	30-amp 250-v cartridge		"
8	"	5-amp 250-v cartridge		"
20	"	10-amp 250-v cartridge		"

Qty	Part	Description	Type No.	Maker
2	Pilot lamps	6-w 220-v S-6 bulb bay.base for series #100 socket		Dial Light Company
8	Fuses	5-amp 250-v cartridge Admiralty pattern S-5541	AF-533	Economy
2	Pilot lamps	6-w 110-v S-6 bulb, candelabra base, clear		CGE

SECTION 7 - LIST OF SPARE EQUIPMENT SUPPLIED WITH RCN ORDERS

Qty	Part	Description	Type No.	Maker
Spare Valves for PV-500-LM Transmitter				
1	Valve		5Z3	RVC
1	"		807	"
2	"		872A/872	"
3	"		810	"
Spare Valves for PV-500-HM Transmitter				
2	Valves		6V6	"
10	"		807	"
4	"		4-125A	"
4	"		866A/866	"
4	"		872A/872	"
4	"		VR150-30	"
Set of Spare Condensers				
2	Condensers	.005-uf	9-FAS-62050	C-D
1	"	.005-uf	9-AS-52050	"
3	"	.01-uf	4S-11010	"
1	"	.00025-uf	364-6S	"
1	"	.0005-uf	272-6S	"
1	"	.001-uf	463-6S	"
1	"	.001-uf	4S-22010	"
1	"	.00025-uf	586-59	"
1	"	.0005-uf	544-59	"
1	"	.001-uf	545-59	"
1	"	.002-uf	572-59	"
2	"	4.0-uf	TJ-10040	"
1	"	.5-uf	DY-10050	"
2	"	.1-uf	DY-10010	"
2	"	.02-uf	9AS-21020	"
2	"	.01-uf	4AS-11010	"
1	"	2.0-uf	DY-6200	"
1	"	2.0-uf	TJ-25020	"
2	"	.5-uf	DY-6050	"
1	"	.1-uf	DY-6010	"
1	"	.00015-uf	587A-59	"
1	"	30-uuf	5WS	"
4	"	.002-uf	3WS	"
2	"	.01-uf	3WS	"
1	"	1.0-uf	DY-6100	"
1	"	50-uuf	5WS	"
1	"	250-uuf 2% tolerance 5000-v test	9H	"
1	"	500-uuf 2% tolerance 5000-v test	9H	"

Qty	Part	Description	Type No.	Maker
1	Condenser	150-uuf 2% tolerance 5000-v	9H	C-D
1	"	15-uuf	1468	Aerovox
1	"	4.0-uf	TJ-25040	C-D
3	"	.002-uf	4AS-12020	"
1	"	.002-uf	4S-12020	"
1	"	100-uuf	5WS	"
1	"	.002-uf	4S-22020	"
1	"	250-uuf	4S-13025	"
1	"	.002-uf	217-6S	"
1	"	.002-uf	726-15LS	"

Set of Spare Resistors

1	Resistor	10,000-ohms C coating #5 terminals	CE	IRC
2	"	125-ohms C coat #1 term.	AB	"
1	"	2,000-ohms C " #5 "	FJ	"
1	"	50,000-ohms C" #5 "	FB	"
1	"	40,000-ohms C" #5 "	CE	"
1	"	250-ohms C" #1 "	AB	"
1	"	15,000-ohms ±-5%	BT-1	"
1	"	35,000-ohms ±-5%	BT-1	"
1	"	3,000-ohms C coat #5 term.	FD	"
3	"	4,000-ohms C " #5 "	HE	"
1	"	2,000-ohms C " #5 "	HA	"
1	"	1,000-ohms ±-10% C coat #1 terminals	AB	"
2	Heater elements		91853	Marconi
1	" "	Cone shaped 600-w 110-v		P.M.Wright
1	Resistor	7,000-ohms C coat #5 term.	HY	IRC
1	"	2,750-ohms C " #5 "	HZ	"
1	"	6,000-ohms C " #5 "	FJ	"
1	"	2,500-ohms C " #5 "	HE	"
2	"	10,000-ohms C " #5 "	HE	"
1	"	50,000-ohms	BT-1/2	"
1	"	500,000-ohms	BT-1	"
1	"	30,000-ohms C coat #1 term.	AB	"
1	"	50,000-ohms	BT-1	"
3	"	100-ohms	BT-1/2	"
1	"	250-ohms	BT-2	"
1	"	30,000-ohms	BT-2	"
1	"	40,000-ohms	BT-2	"
1	"	10,000-ohms	BT-2	"
1	"	2,000-ohms C coat #5 term.	FB	"
1	"	500-ohms	BW-1/2	"
1	"	9-ohms	WW-3	"
1	"	500-ohms	BW-1	"
1	"	3-ohms 1% tolerance	WW-3	"

Qty	Part	Description	Type No.	Maker
1	Resistor	1-ohm 1% tolerance	WW-3	IRC
1	"		91850	Marconi
1	Meter filter assy		95735	"
1	" " "		95736	"
1	Resistor	10,000-ohms C coat #1 term.	AB	IRC
1	"	250-ohms C " #5 "	HX	"
1	"	50-ohms	BT-1/2	"
1	"	20,000-ohms C coat #5 term.	HX	"
1	"	2,000-ohms C " #5 "	HX	"
1	"		P-300	Ohmite

Set of Spare R-f Chokes

4	Chokes		106-200	Marconi
1	"		1506	Hammond
1	"		110-405	Marconi
1	"		94760	"
1	"		94738	"
2	"		94720	"
1	"		88959	"
1	"		90899	"
1	"		90893	"

Set of Spare Fuses

8	Fuses	25-amp 250-v cartridge Admiralty pattern S-5504	AF-2533	Economy
4	"	30-amp 250-v cartridge Admiralty pattern S-5504	AF-3033	"
16	"	5-amp 250-v cartridge Admiralty pattern S-5541	AF-533	"

Set of Spare Pilot Lamps

12	Pilot lamps	120-v 6-w S-6 bulb, candelabra base, clear	CGE

Set of Spare Relay Coils

1	Coil for Leach #202 relay	6-v d-c 4.4-ohms
1	" " " #101 "	6-v d-c 4.4-ohms
1	" " " #1427-S9 relay	12-v d-c
1	" "	Allen-Bradley Bull. 700 a-c contactor type A-209, 110-v 60-cycles
1	" "	Struthers Dunn type ADBY5N d-p s-b relay, release coil only, to operate at 1-amp d-c, cont. duty
1	" "	above relay, reset coil only, to operate from 110-v 60-cycles, momentary duty
1	" "	above relay, release coil only, to operate at 750-ma d-c, continuous duty.

Qty	Part	Description	Type No.	Maker
1	Coil for Leach #1040 relay, coil #351, trip current .75-amp d-c, 2.5-ohms			
2	Complete sets Contacts for Leach #202 relay			
1	" " " " " #1427-S9 relay			
2	" " " " " #101 relay			
2	" " " " Allen-Bradley Bull.700 a-c contactor 110-v 60-cycles			
2	" " Contacts for Struthers Dunn ADBY5N relay			
1	" " " " Leach #1040 relay			
4	" " Brushes for rotary converter			

Set of Spare Insulators

1	Insulator		981-A	Isolantite
1	"		981-B	"
7	"		394 x 1-1/2"	"
3	"		73245	Marconi
3	"		71621	"
1	Bushing	Porcelain	10	S & S
2	Insulators		1174	Am. Lava
1	"		1175	"
2	"		395 x 5/8"	Isolantite
1	"	White	50	Johnson
3	"		397 x 1"	Isolantite
1	"		380 x 2-1/2"	"
1	"		394 x 1"	"
1	"	Less Hardware	44	Johnson
1	"		381	Isolantite
3	"		397 x 1"	"
1	"		394 x 1-1/2"	"
1	"		381	"
2	"		432 x 1"	"
1	"		65	Johnson
2	"		40	"
2	"		323 x 3/4"	Isolantite
3	"		337 x 5-1/2"	"
1	"		348 x 6"	"
4	"	1" square x 6" long	333	"
1	"		323 x 3-1/2"	"
3	"		337 x 5"	"
1	"		333 x 6"	"
1	"		323 x 4"	"
1	"		337 x 4"	"
7	"		323 x 1-1/2"	"
2	"		42	Johnson
2	"		337 x 3-1/2"	Isolantite
1	"		432 x 1"	"
1	"		337 x 1"	"
1	"		1173	Alsimag

Qty	Part	Description	Type No.	Maker
4	Insulators		323 x 1"	Isolantite
2	"		65	Johnson
2	"		1169-00 Part One	General Ceramics
2	"		1168-00 Part Two	"
2	"		337 x 4"	Isolantite
2	"		395 x 1"	"
4	"		395 x 1/2"	"
1	"		981-E	"
4	"		432	"
1	"		507	"
11	"		394 x 1"	"
	Set of Spare Switches			
1	Switch		91136	Marconi
1	"		96212	"
1	"	3-amp 250-v d-p, with solder lugs & threaded sleeve for single mtg hole with ON-OFF plate	81009	A.H.& H.
1	"		6022	"
1	"		8421	"
1	"		6465	"
1	"		20595	"
1	" assembly		96213	Marconi
1	"	s-p s-t 6" leads	3597	A.H.& H.
1	"	Mom. contact norm-open	3591	"
1	"		92373	Marconi
1	" "		109-540	"
1	" "		105-568	"
1	" "		91135/4387	"
1	" "		6900	A.H.& H.
2	"	s-p s-t knife unmounted	783	Trumbull
1	" "		91809/4377	Marconi
1	" "		109-557	"
1	" "		109-552	"
1	" "		109-545	"
1	" "		109-547	"
2	"	Mom. contact norm-open	3591	A.H.& H.
1	"	3-amp 250-v d-p, with solder lugs & threaded sleeve for single mtg hole & with ON-OFF plate.	81009	"

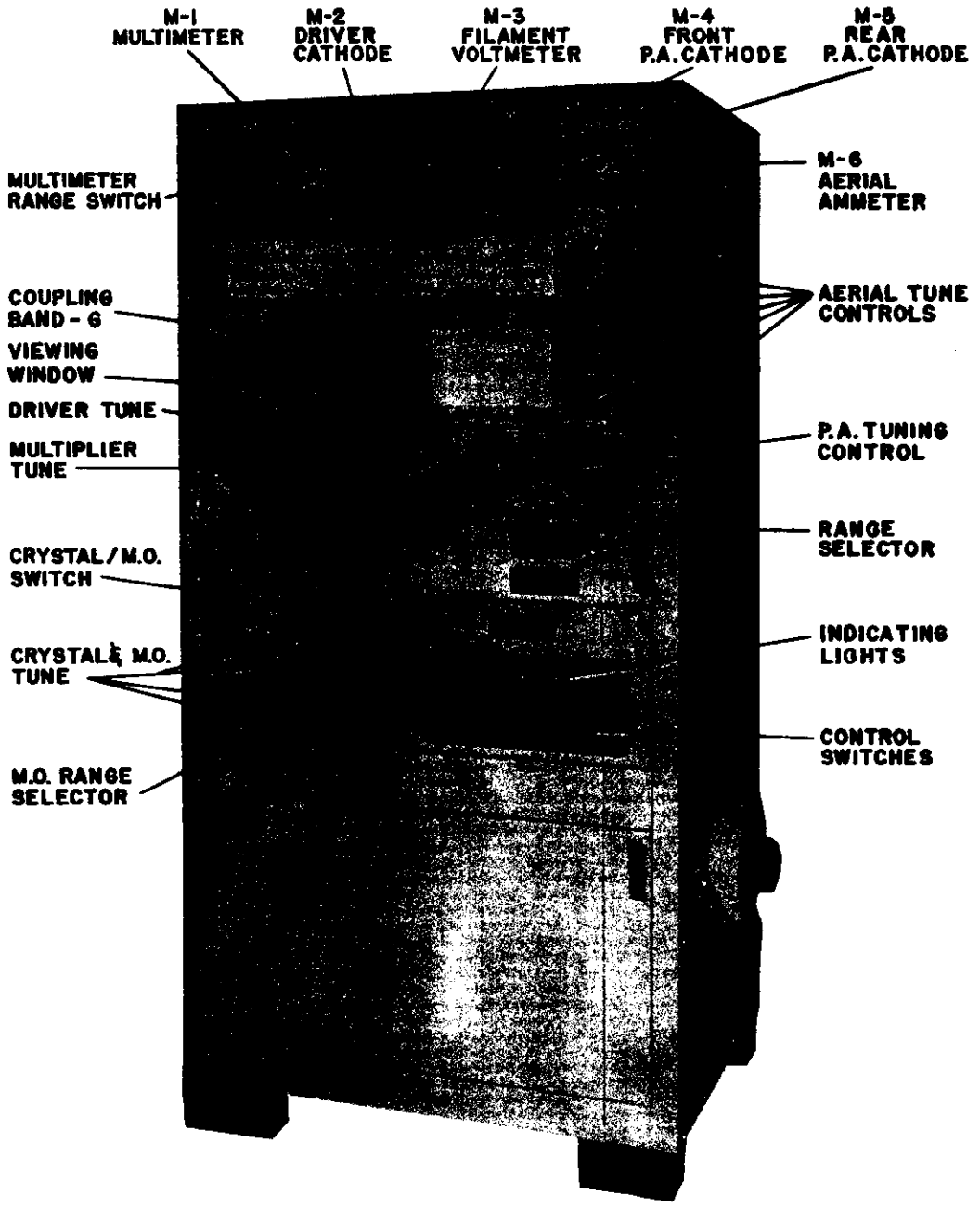
SECTION 8 - LIST OF SPARE VALVES FOR PV-500-HM2

Qty.	Type No.
2	4-125A
1	VR150/30
1	5Y3GT

W/T TRANSMITTERS

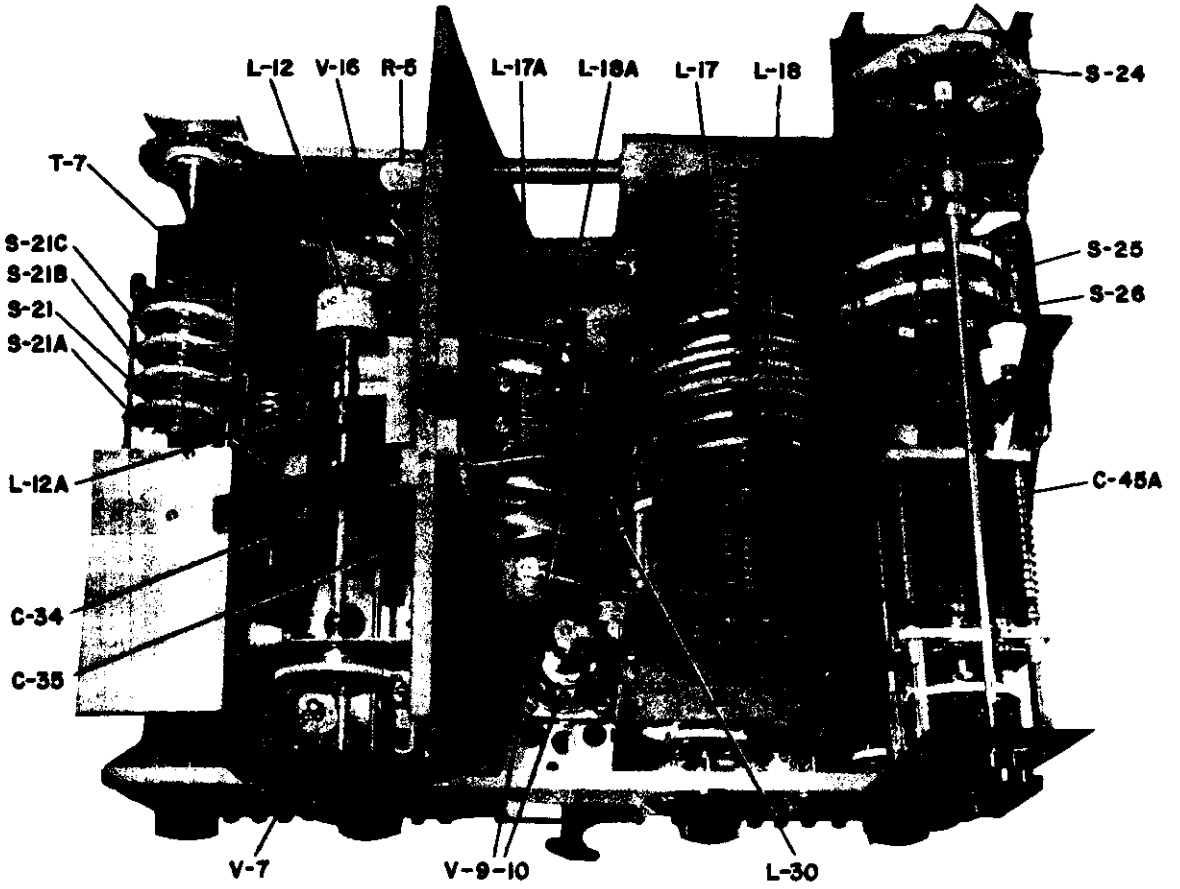
HIGH FREQUENCY TYPE

PV-500-HM2



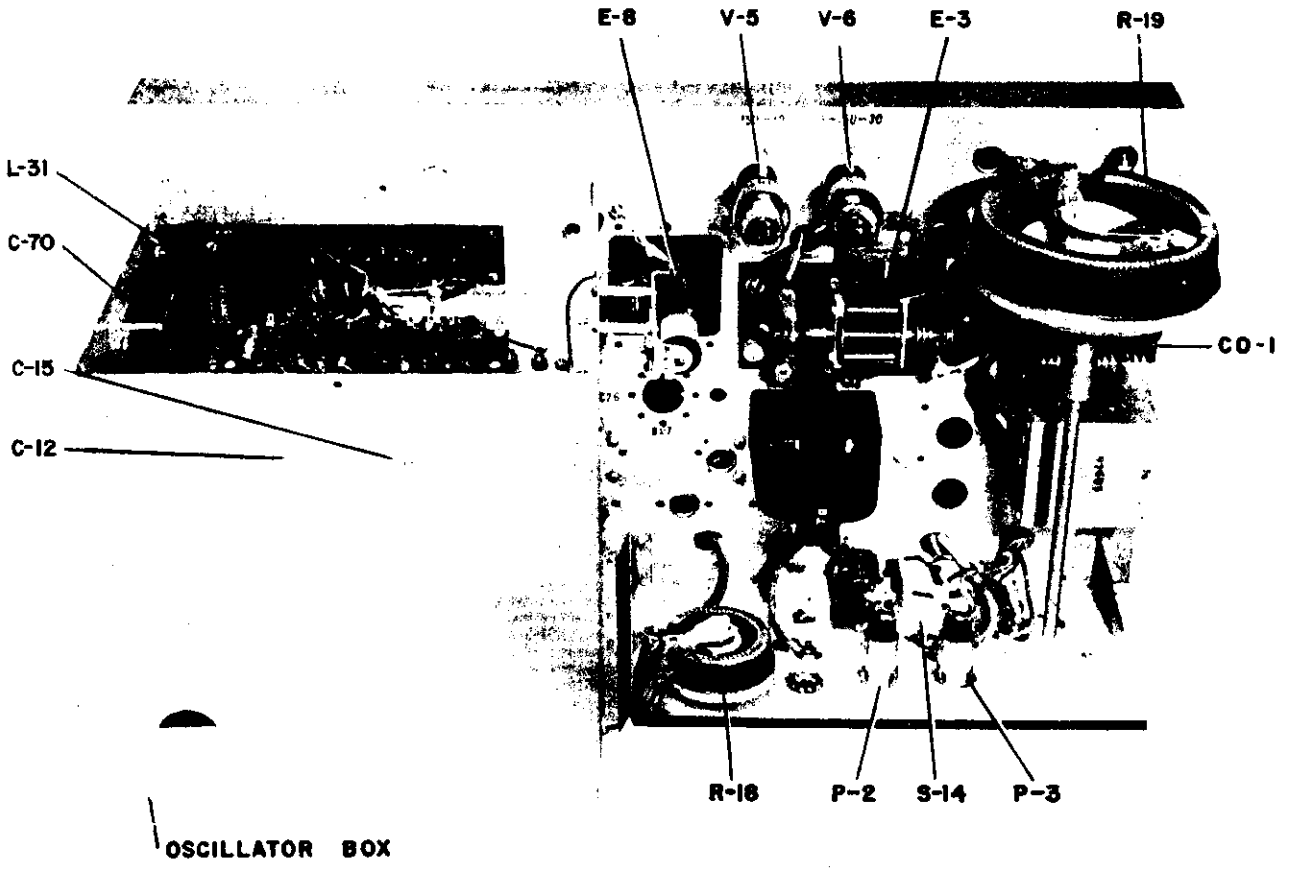
FRONT VIEW

FIG. 1



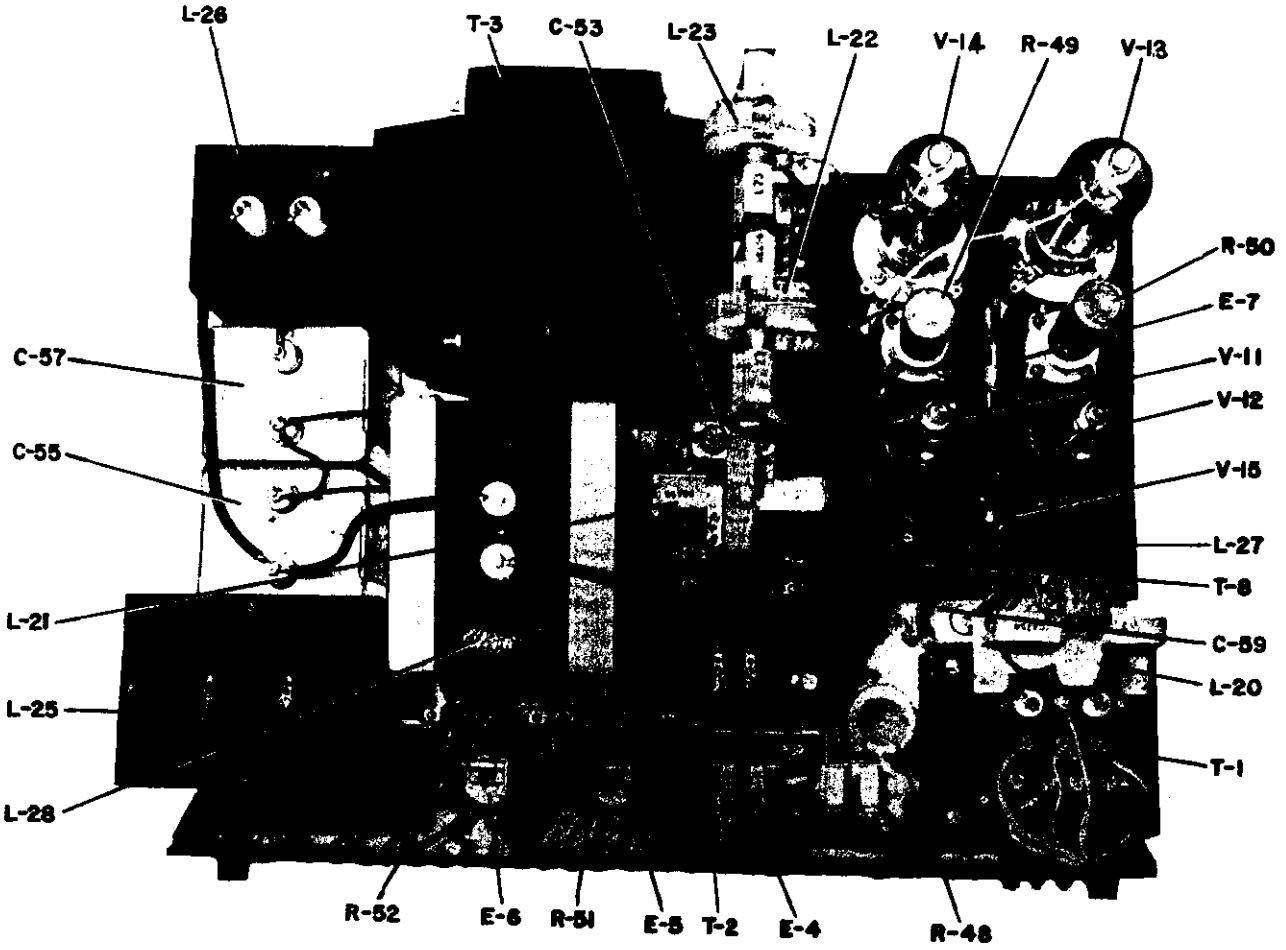
R.F. UNIT—TOP VIEW

FIG. 3



CONTROL UNIT—TOP VIEW

FIG. 8



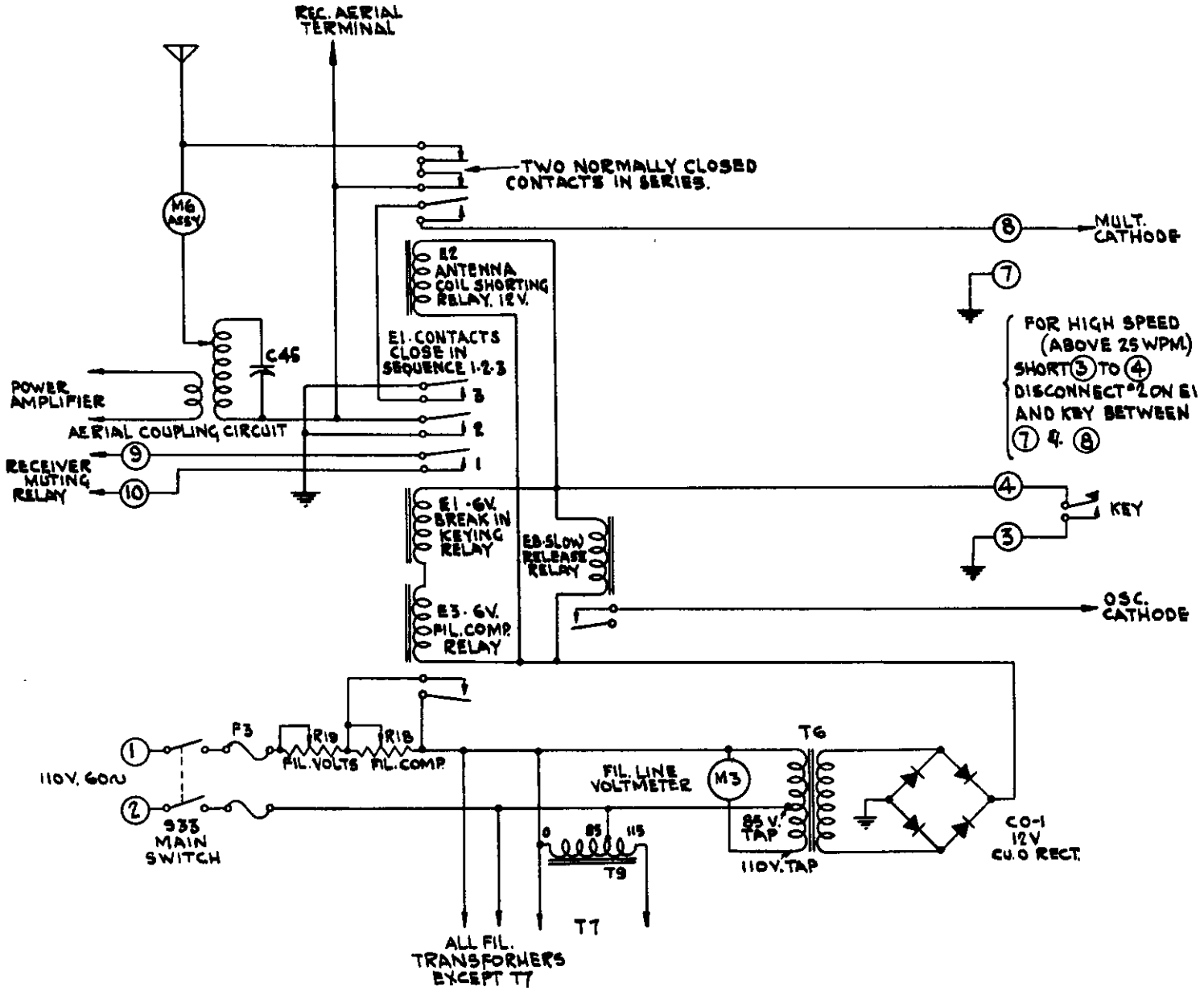
POWER UNIT

FIG. 10

W/T TRANSMITTERS

HIGH FREQUENCY TYPE

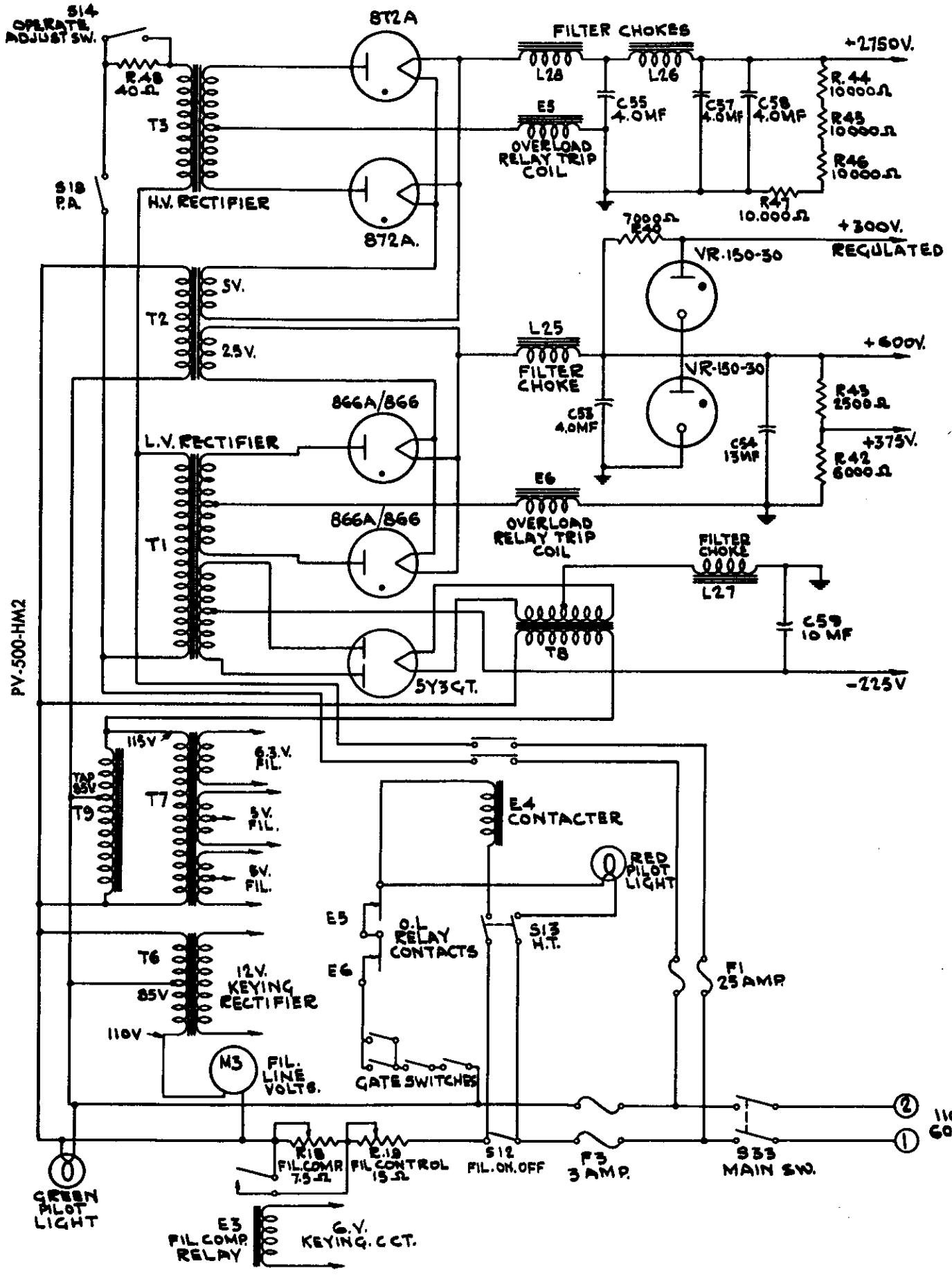
PV-500-HM2



ALL TERMINALS SHOWN ABOVE ON MAIN TERMINAL PANEL

KEYING CIRCUITS FIG. 13

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM2



POWER SUPPLY CIRCUIT FIG. 14

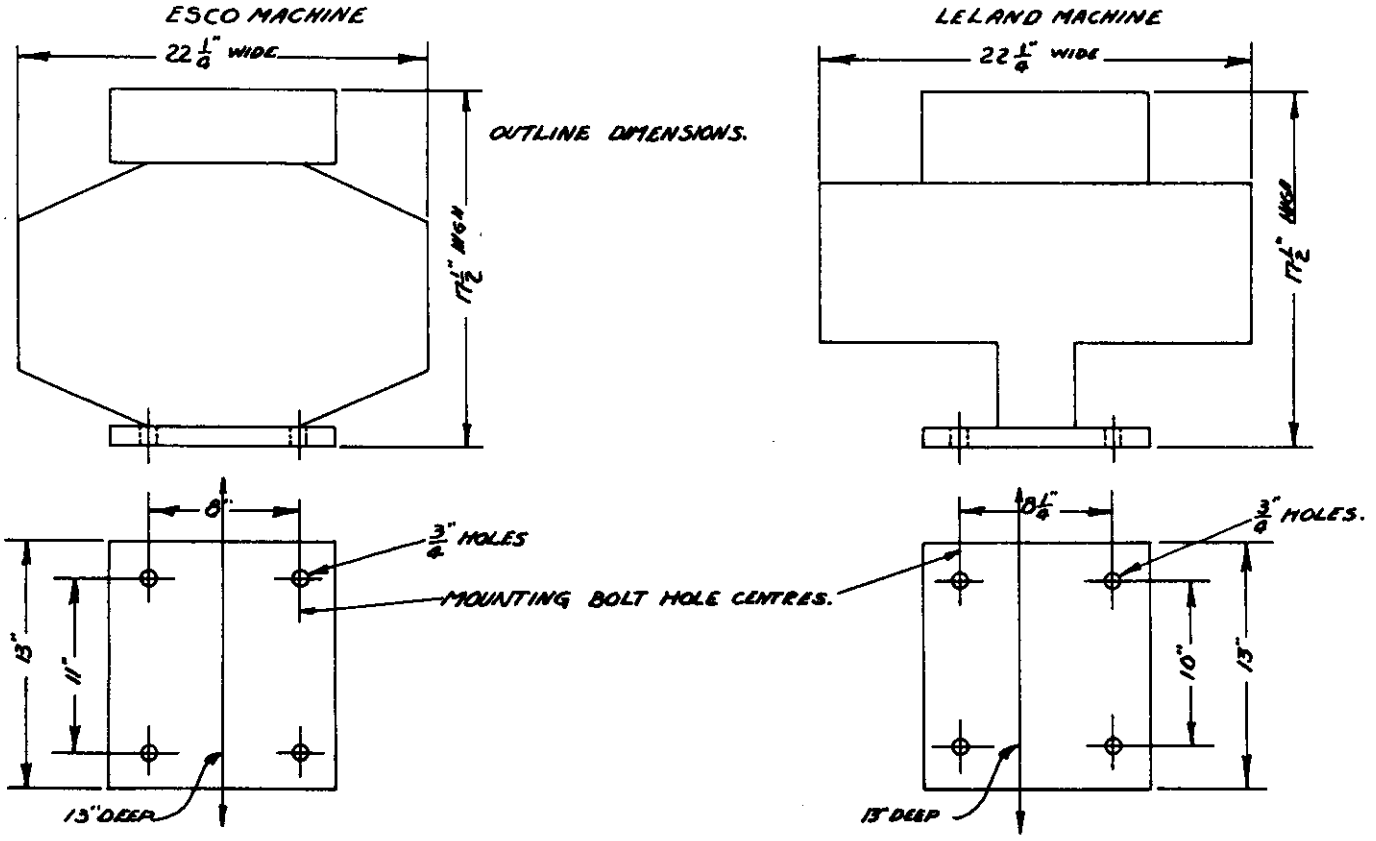
MECHANICAL DIMENSIONS

LAYOUT OF PV500 HM & LM

(intentionally not copied - refer to PV500 HM manual)

FIGURE 16

W/T TRANSMITTER
HIGH FREQUENCY - TYPE PV 500 HM
DIMENSIONS & MOUNTING CENTRES ROTARY CONVERTERS



CANADIAN Marconi COMPANY

FIG. 17

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM

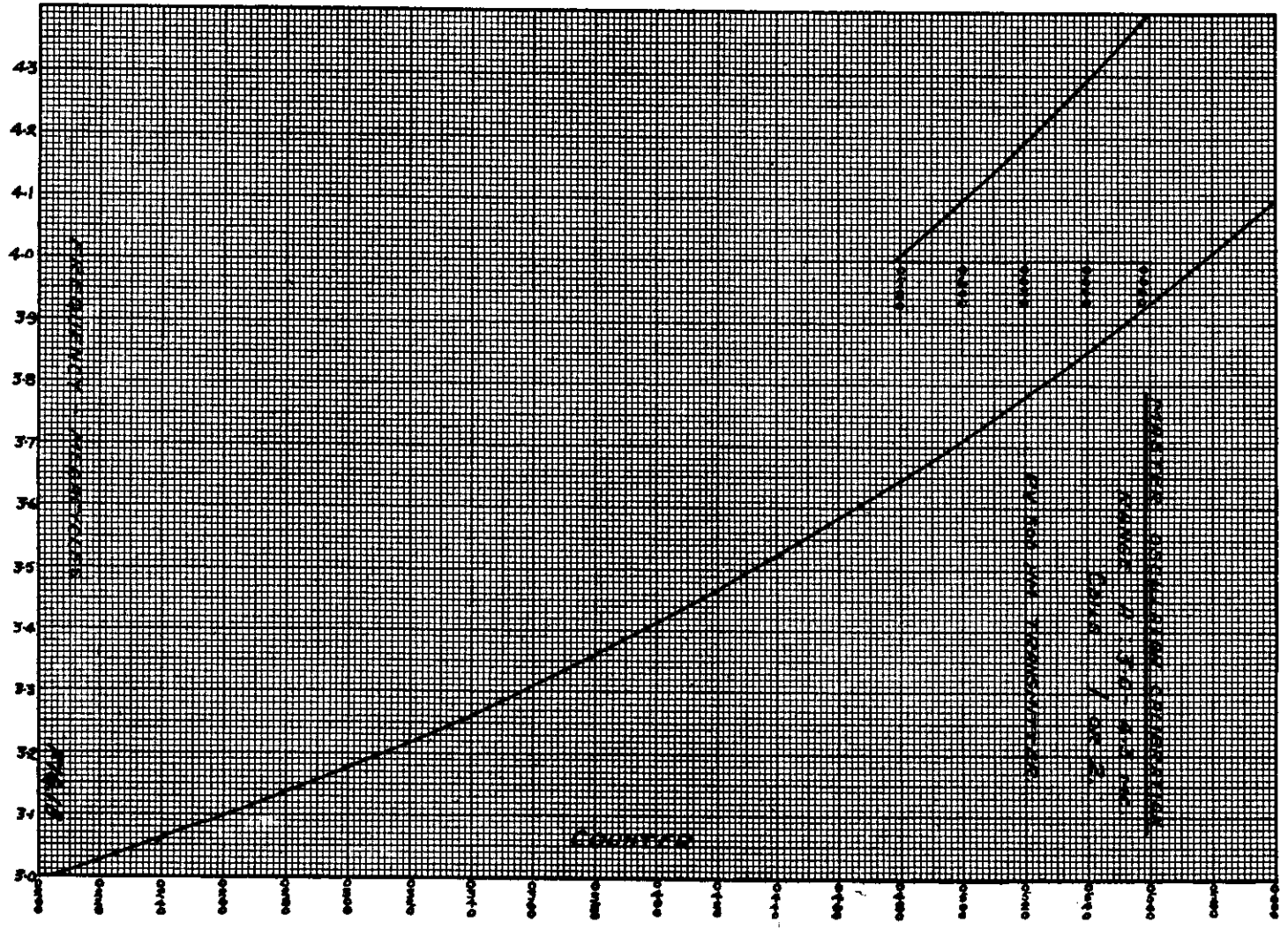


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FIG. 18

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM

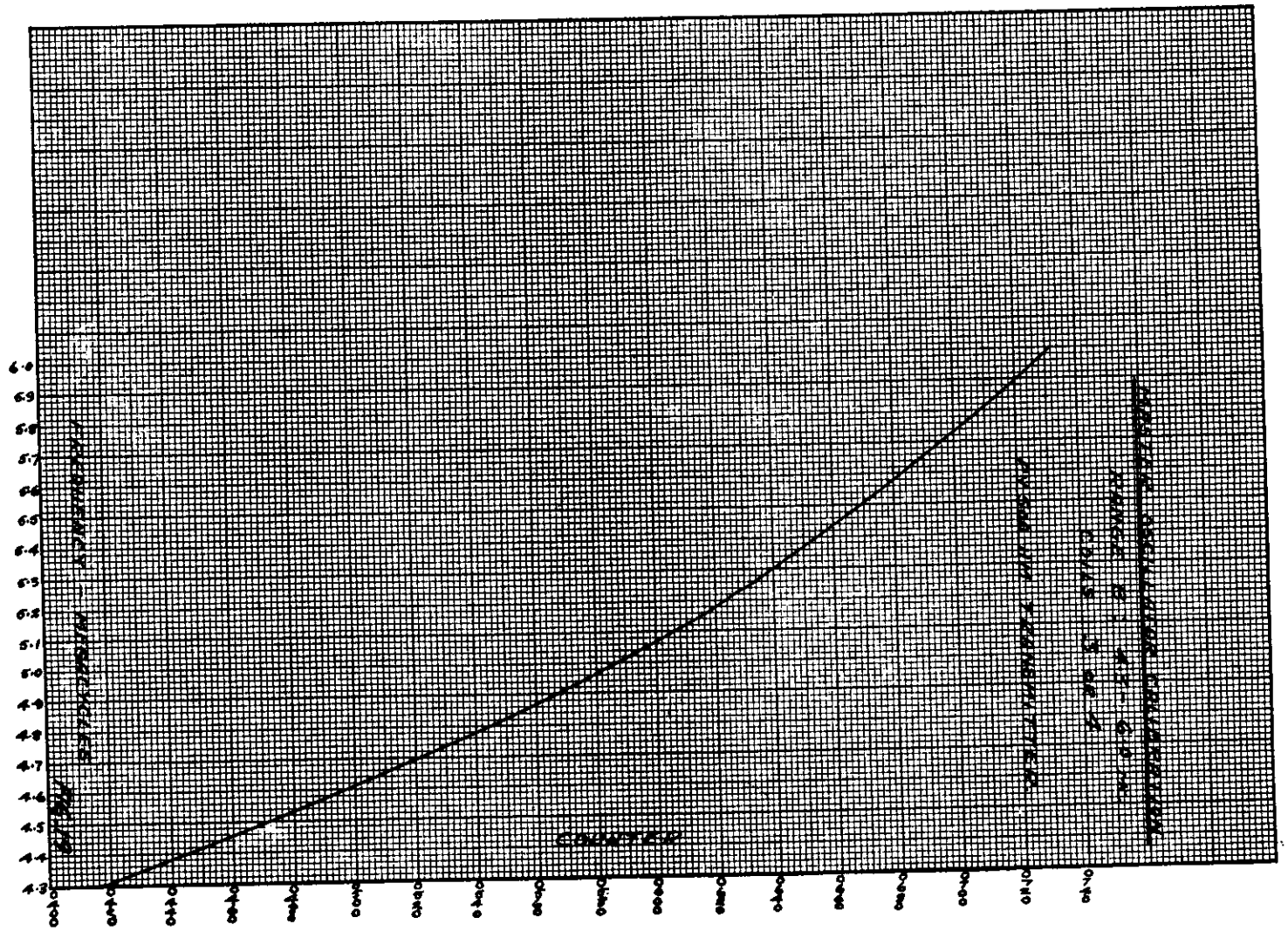

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FIG. 19

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM

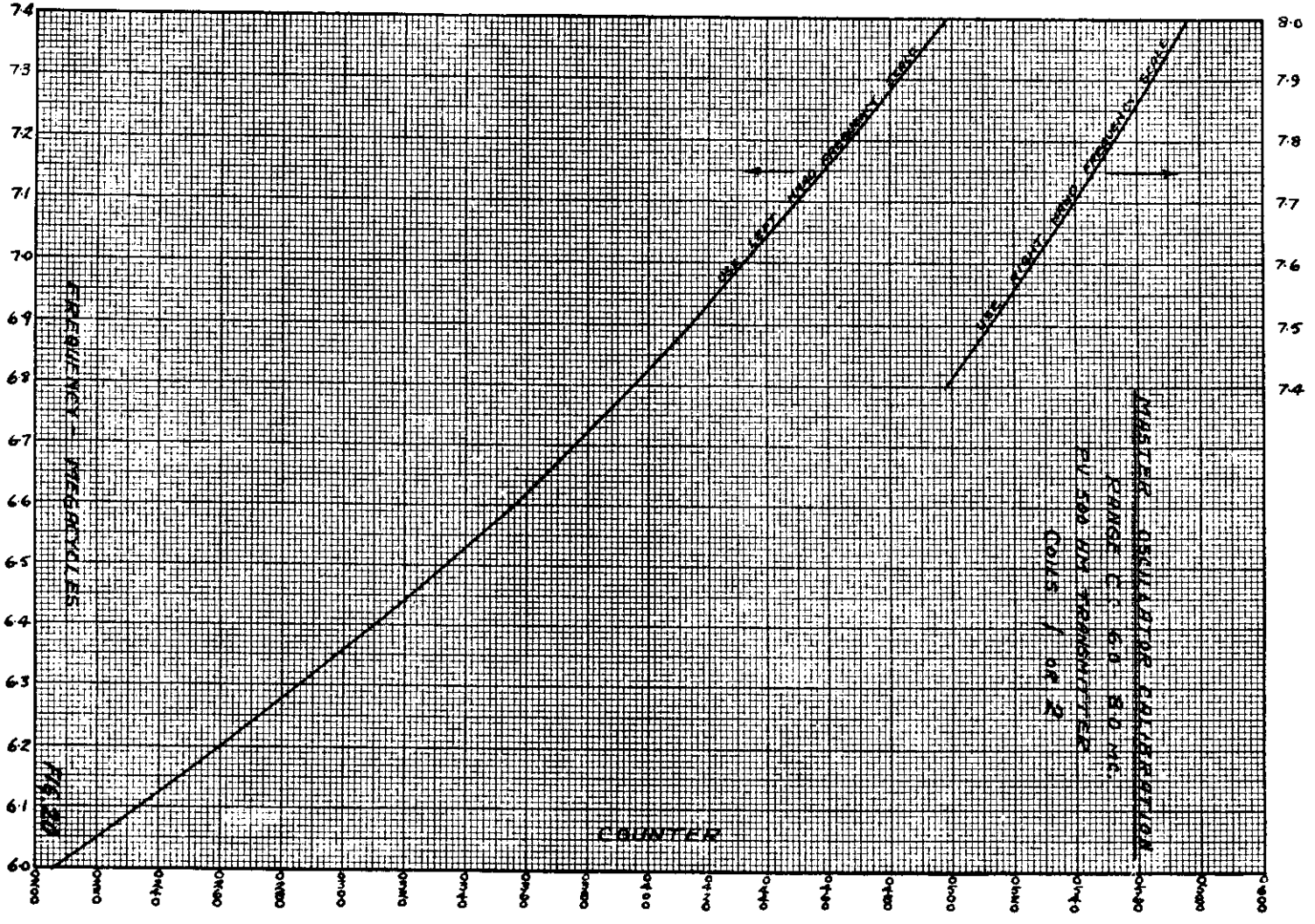

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FIG. 20

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM

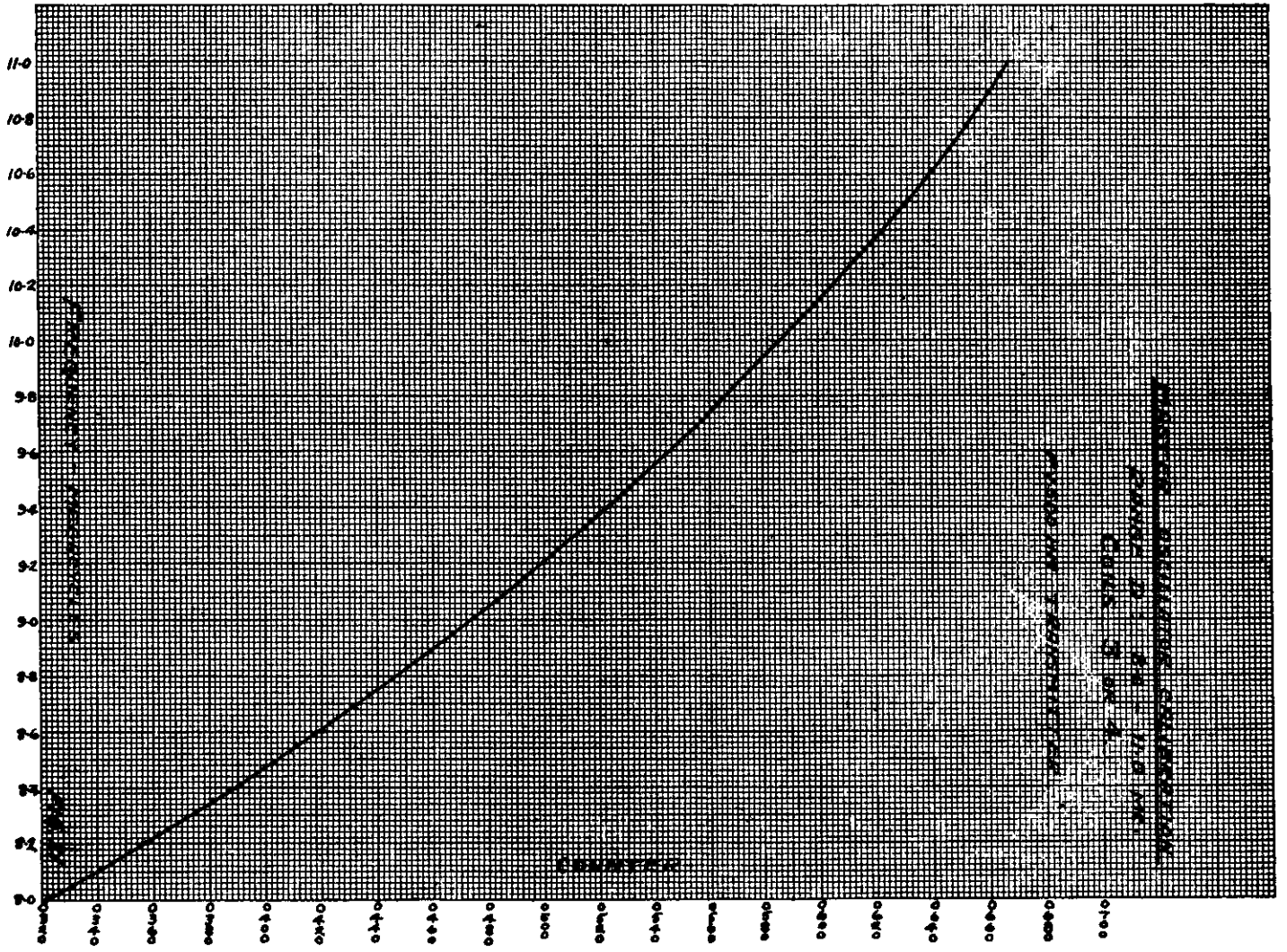

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FIG. 21

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM

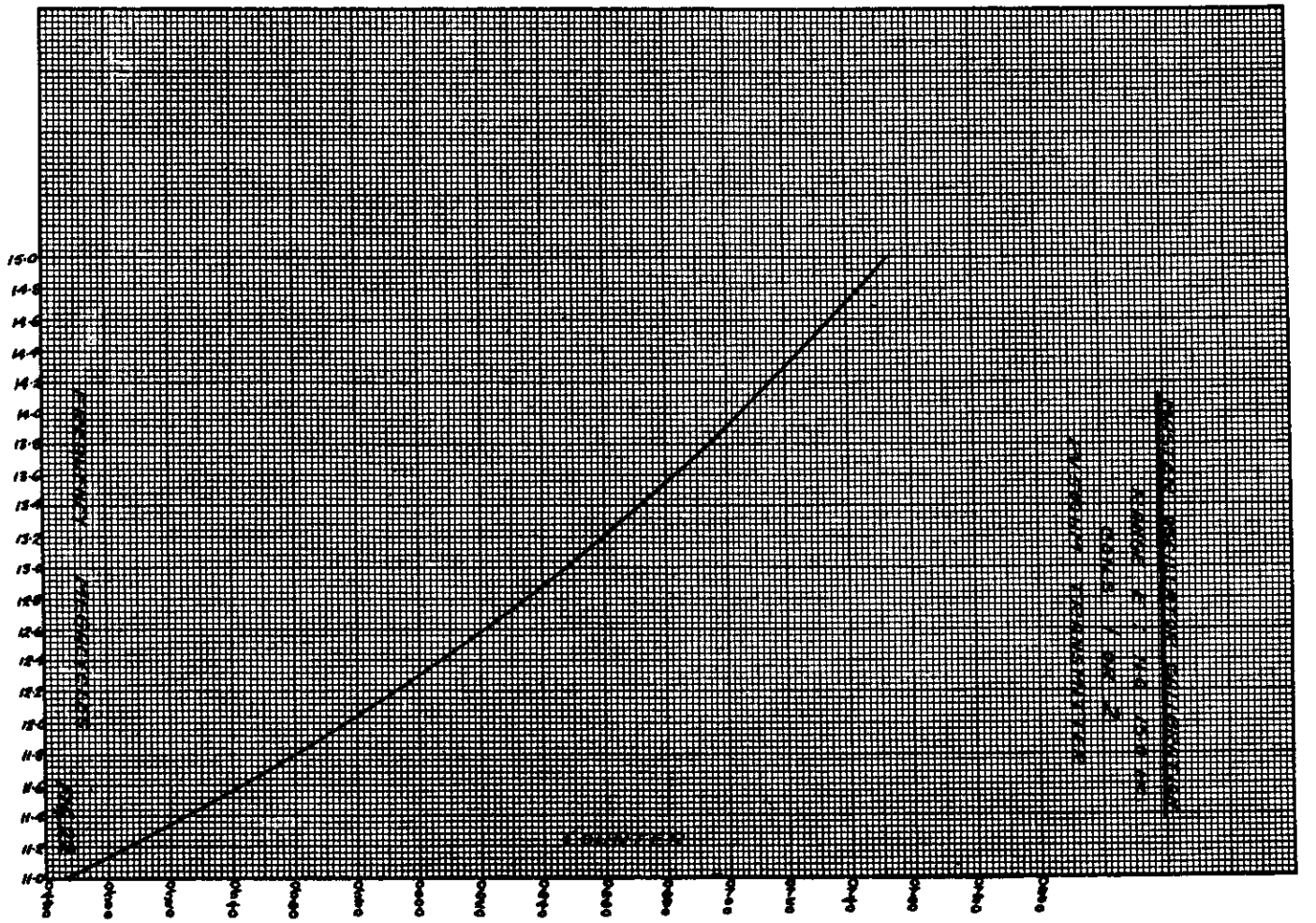

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FIG. 22

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM

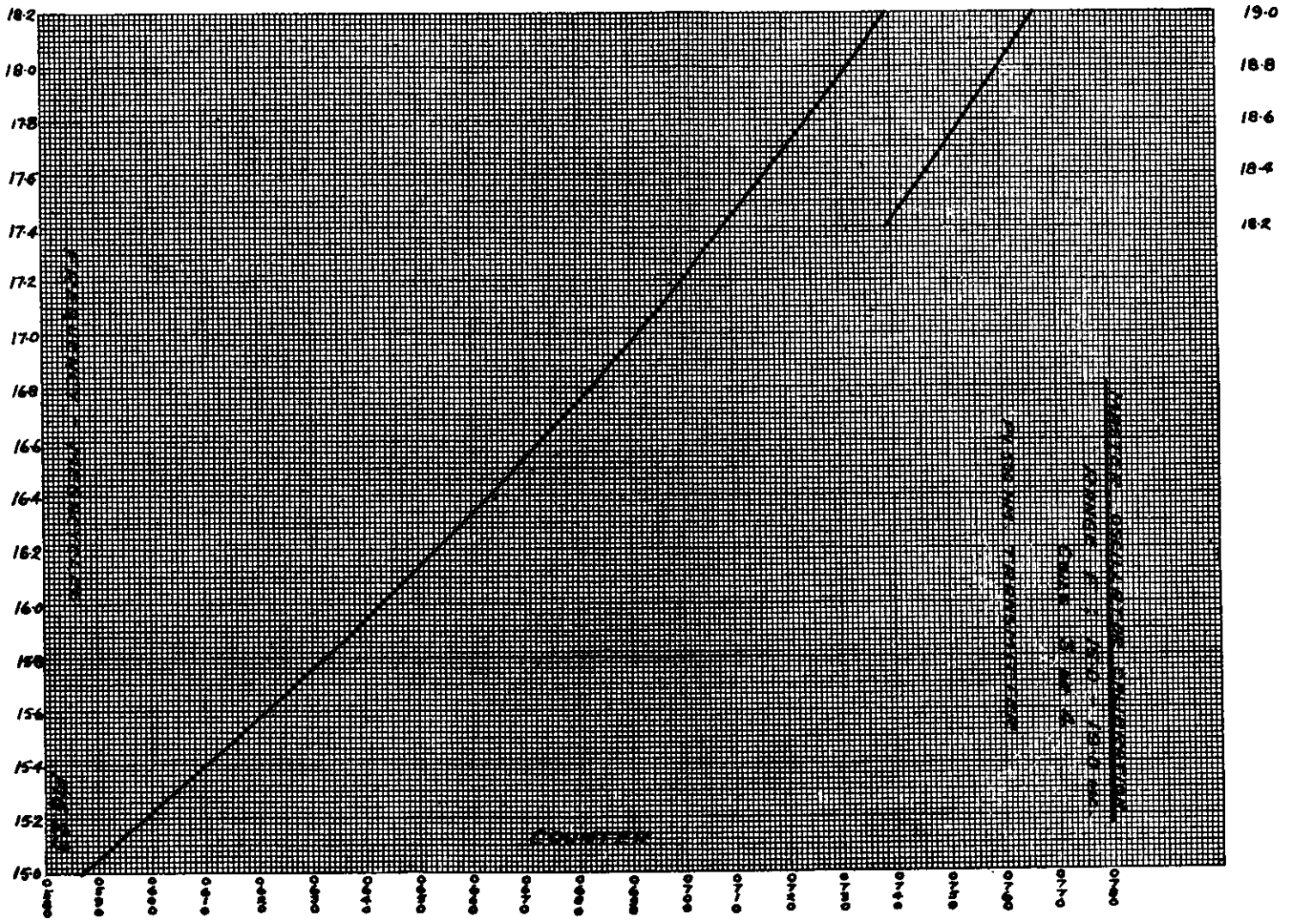

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FIG. 23

W/T TRANSMITTERS

HIGH FREQUENCY TYPE

PV-500-HM2

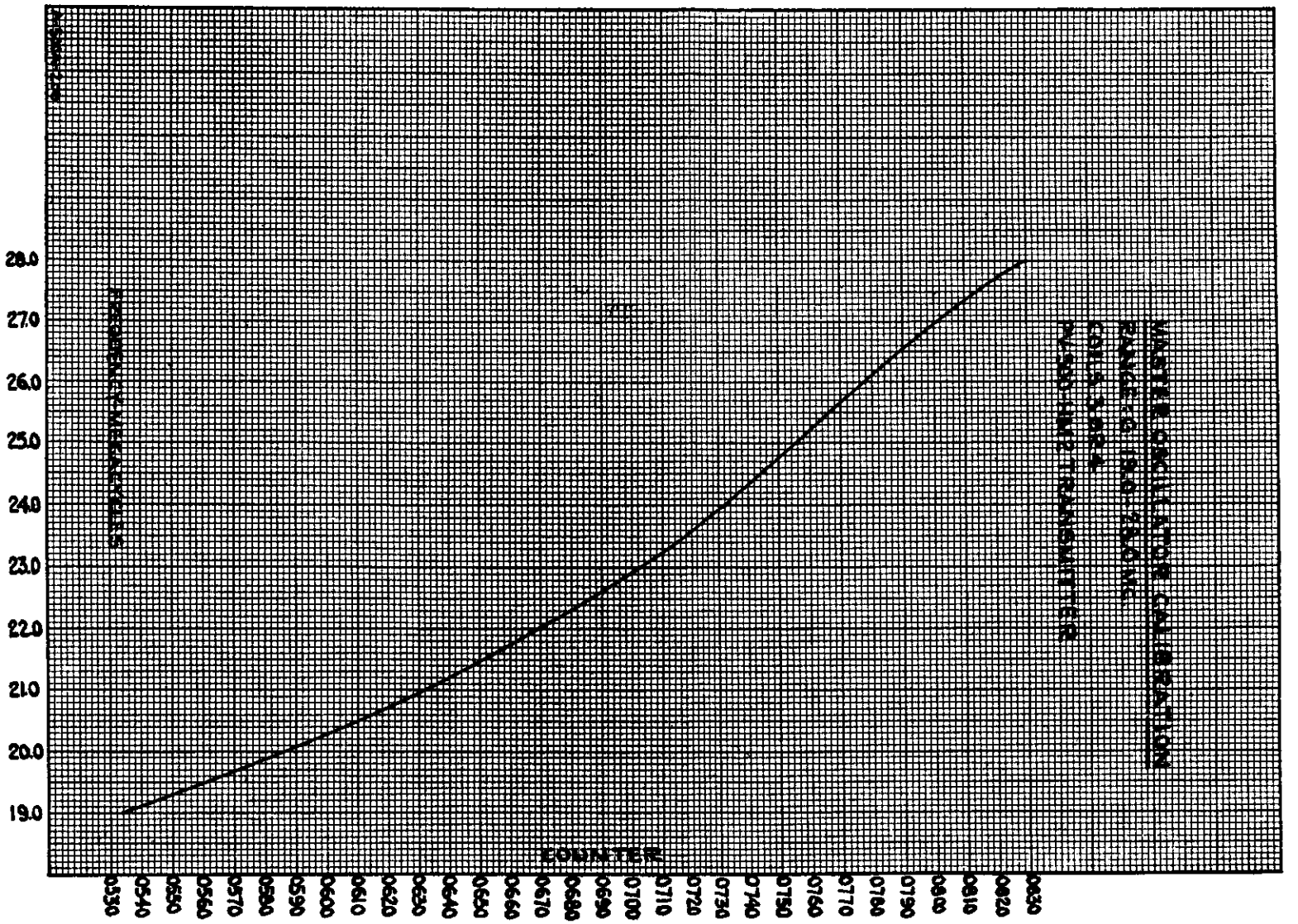


FIG. 24

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM2

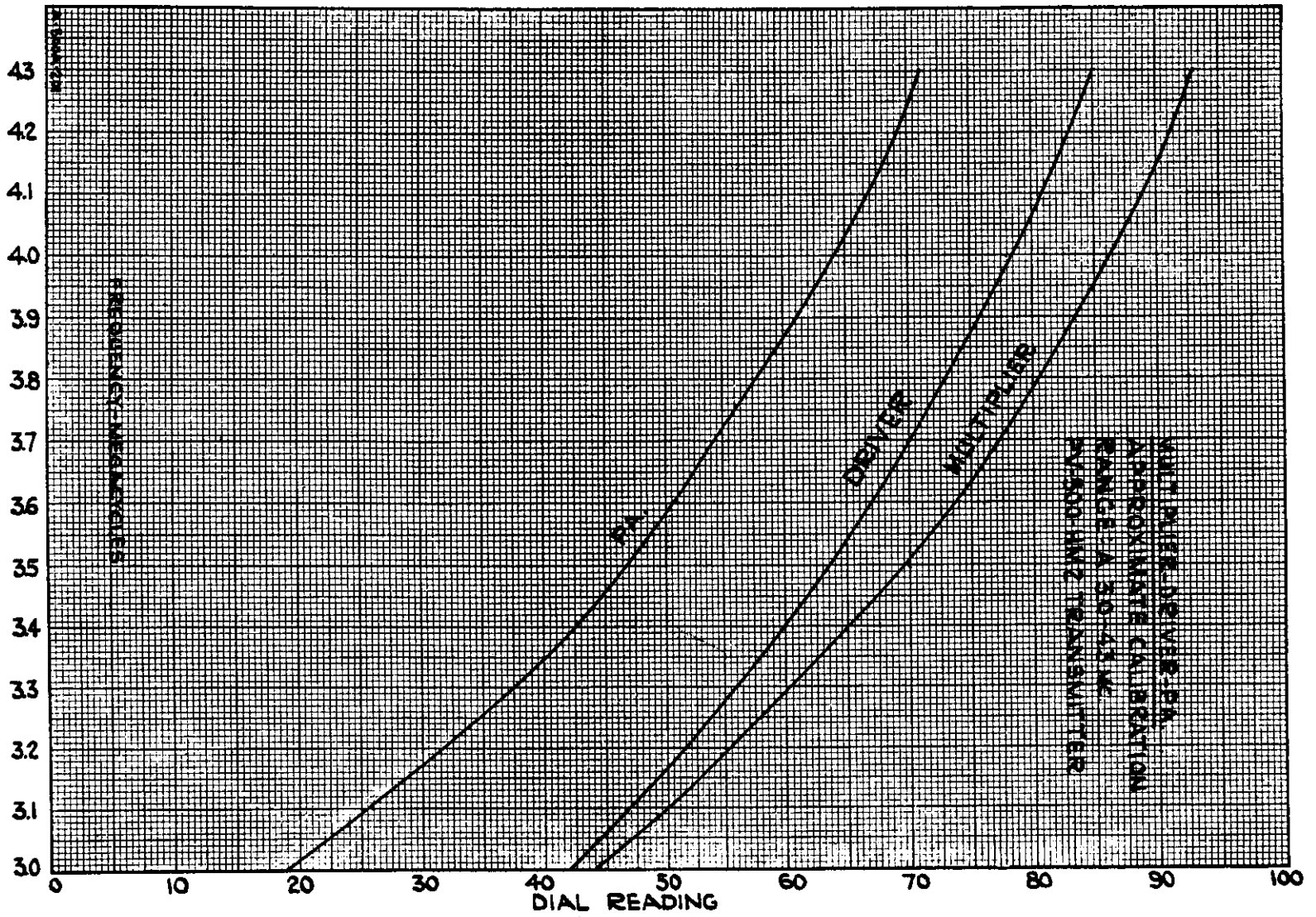


FIG. 25

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM2

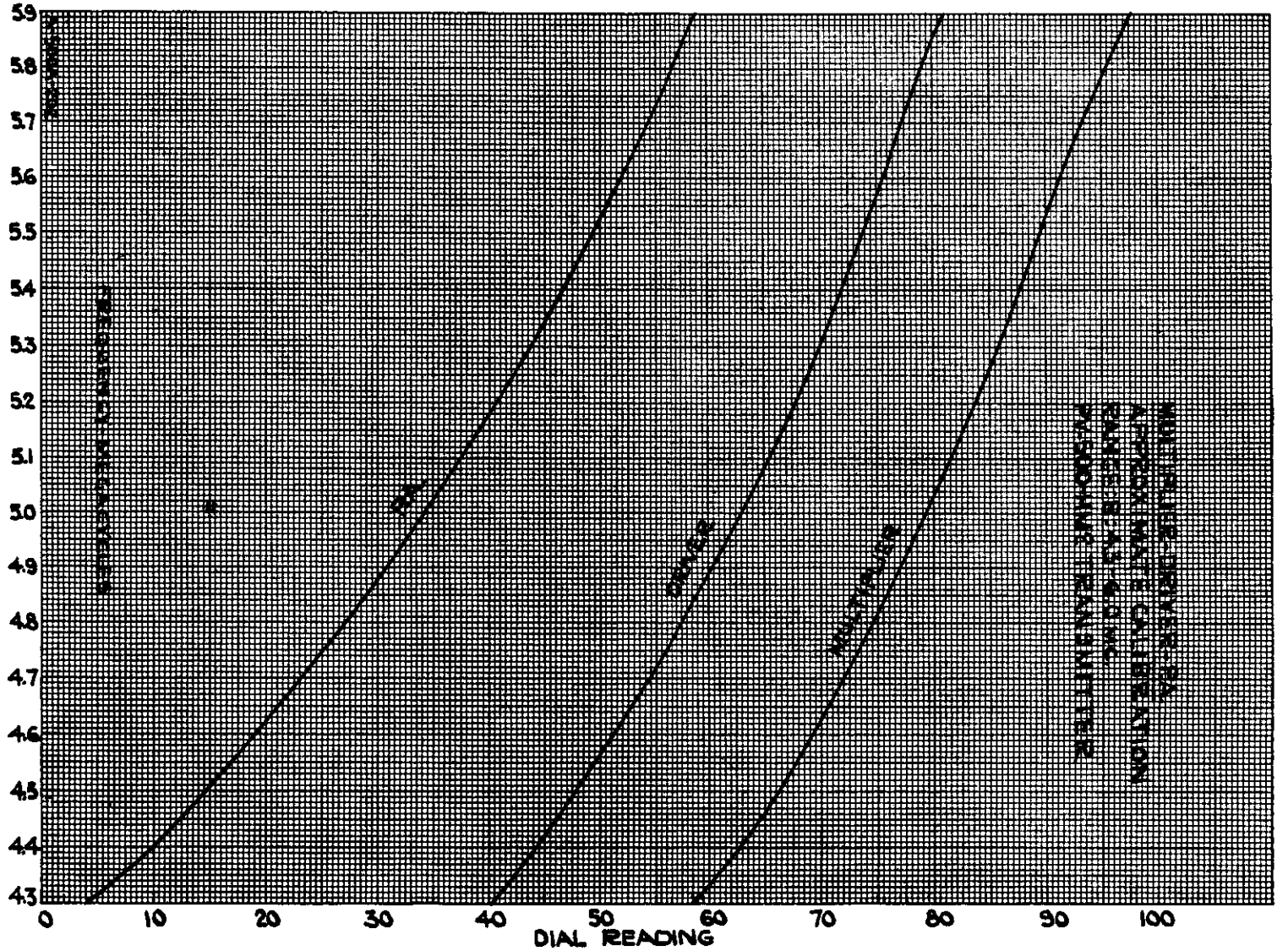


FIG. 26

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM2

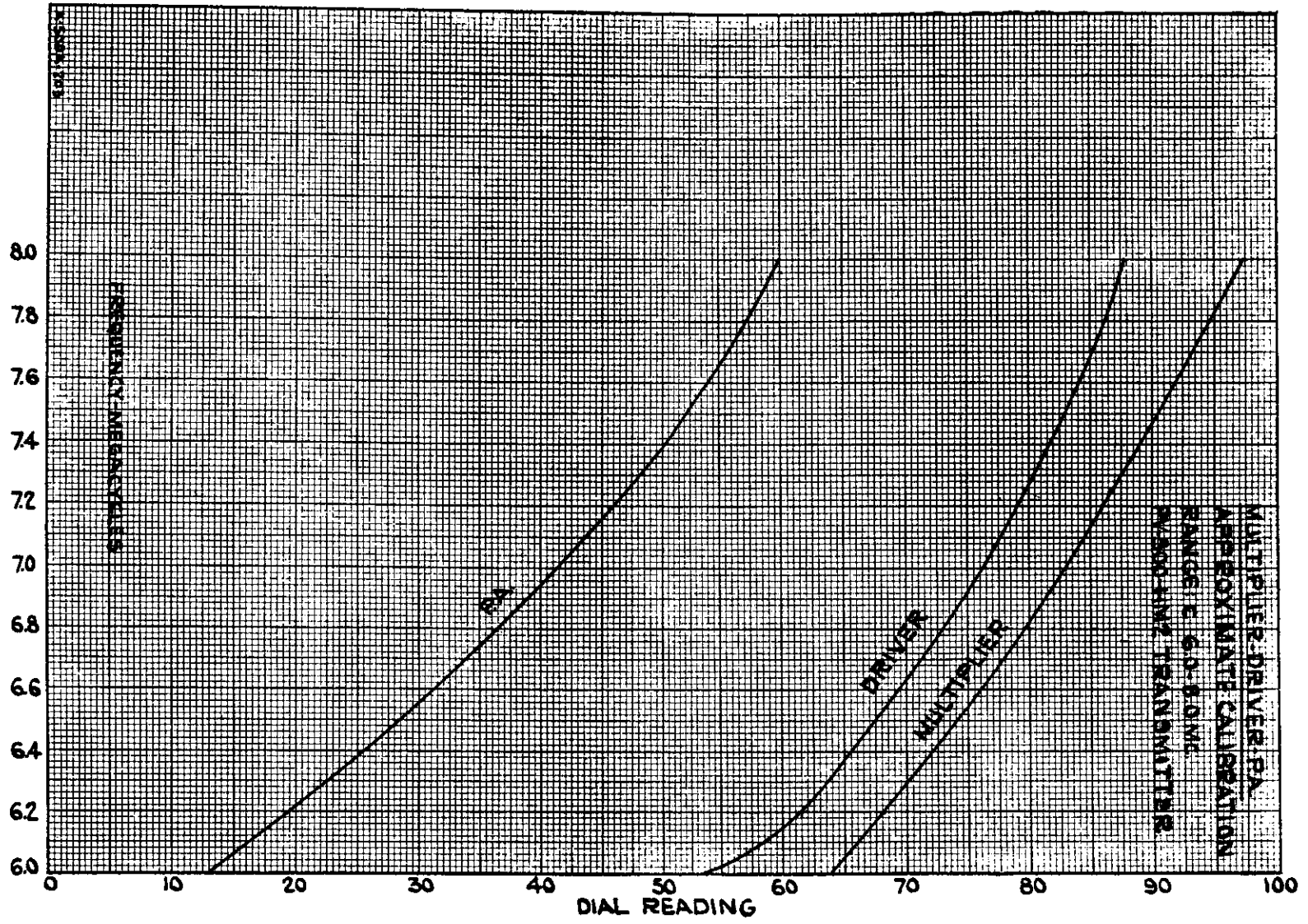


FIG. 27

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM2

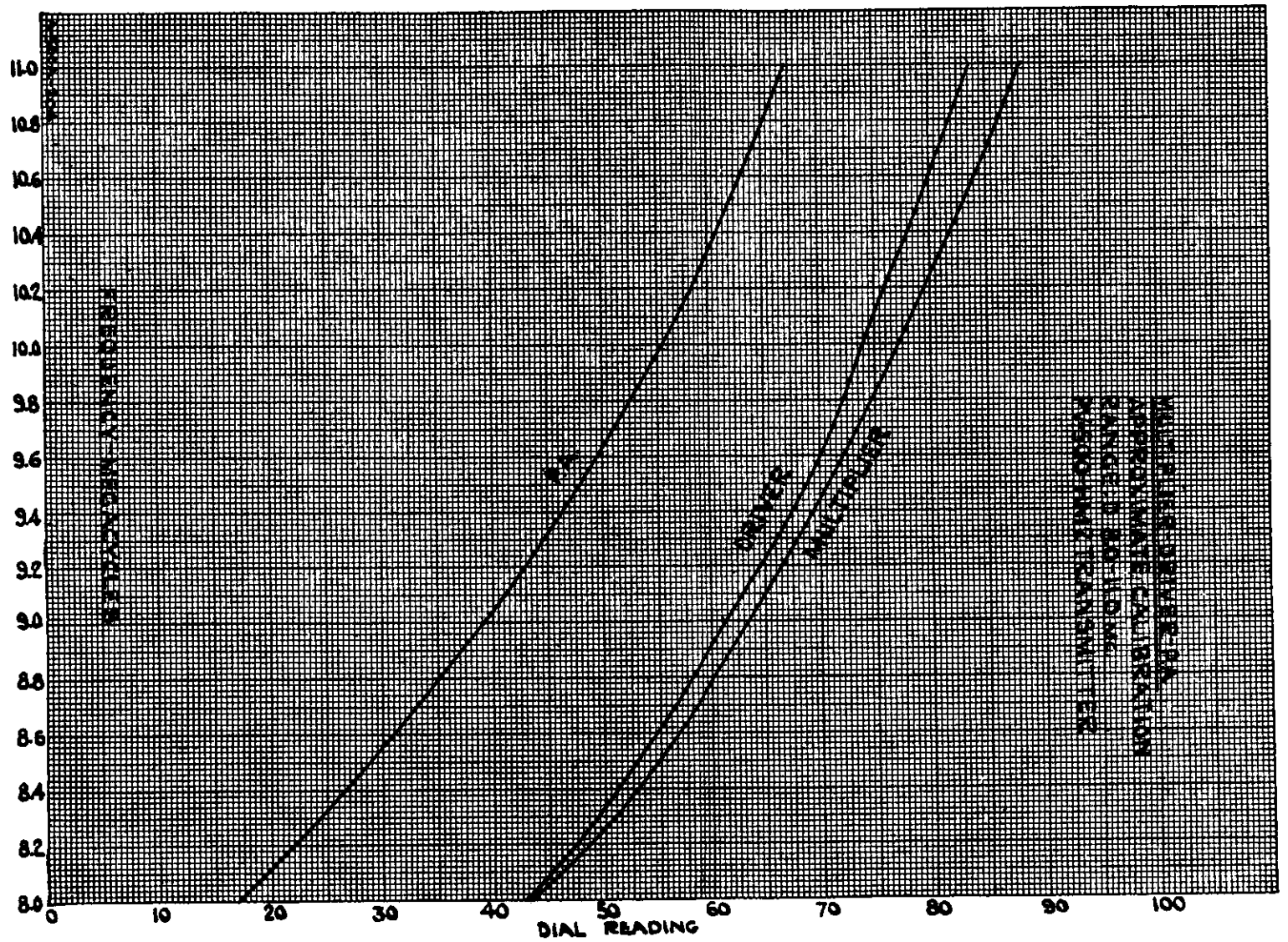


FIG. 28

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM2

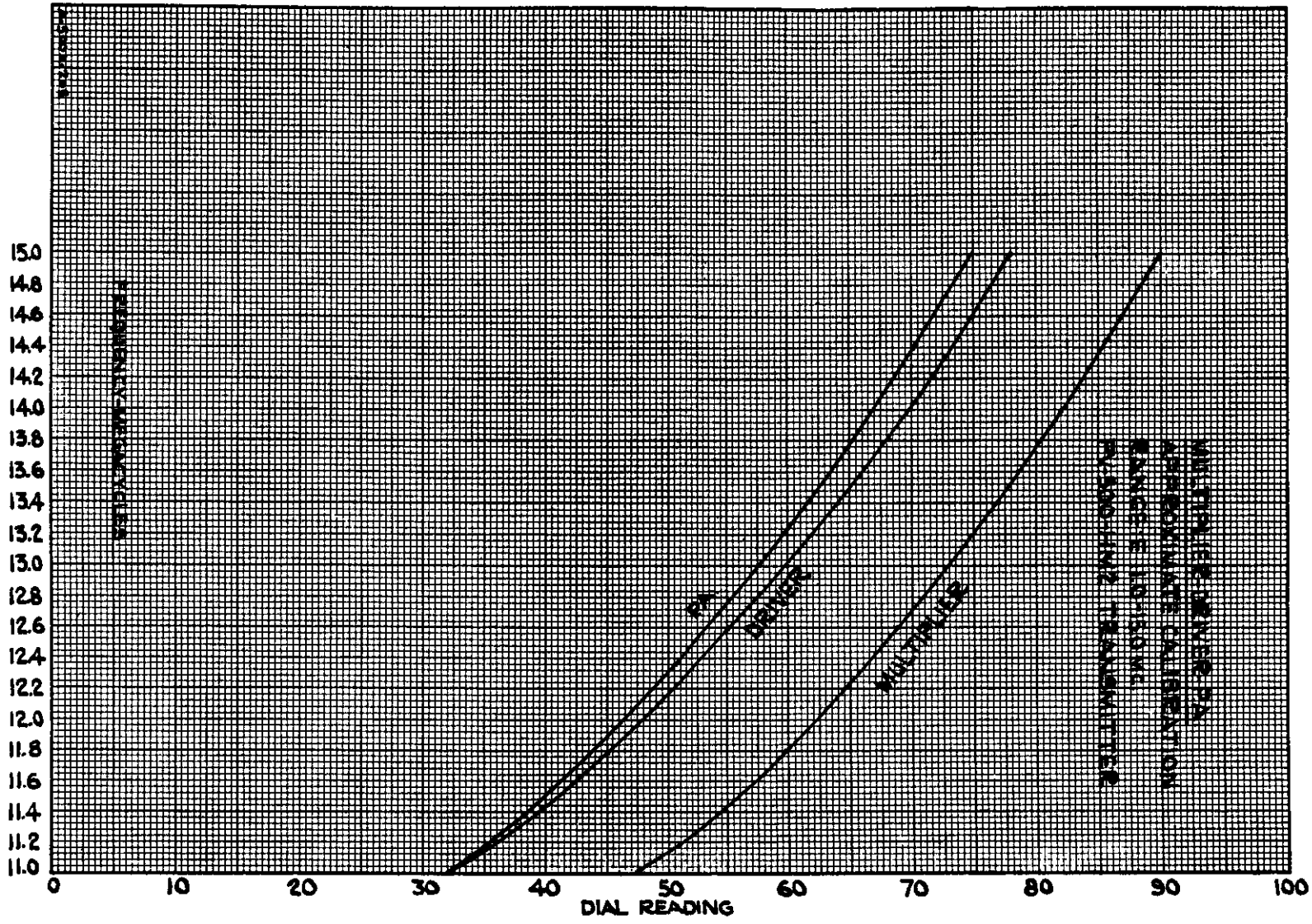


FIG. 29

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM2

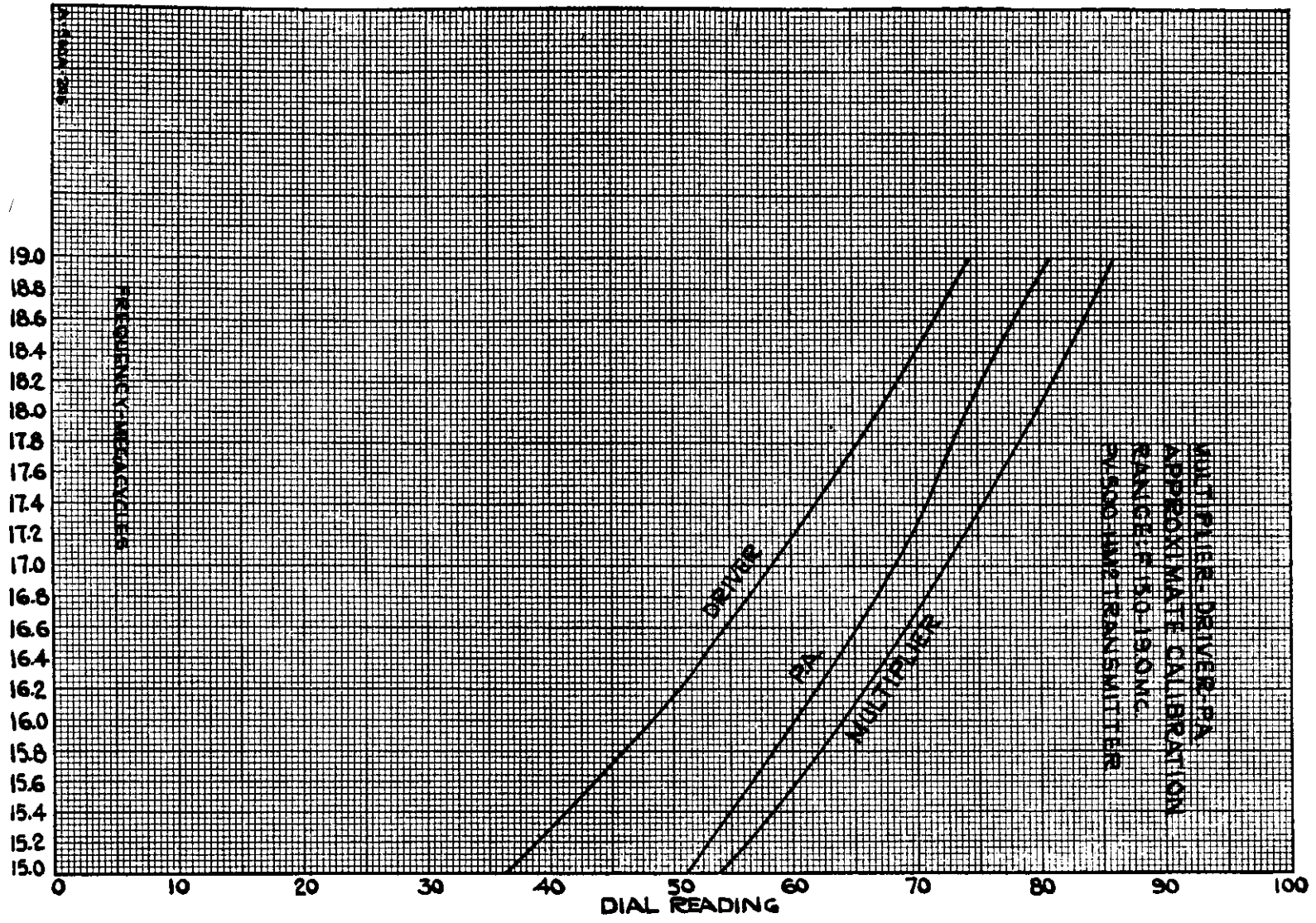


FIG. 30

W/T TRANSMITTERS
HIGH FREQUENCY TYPE
PV-500-HM2

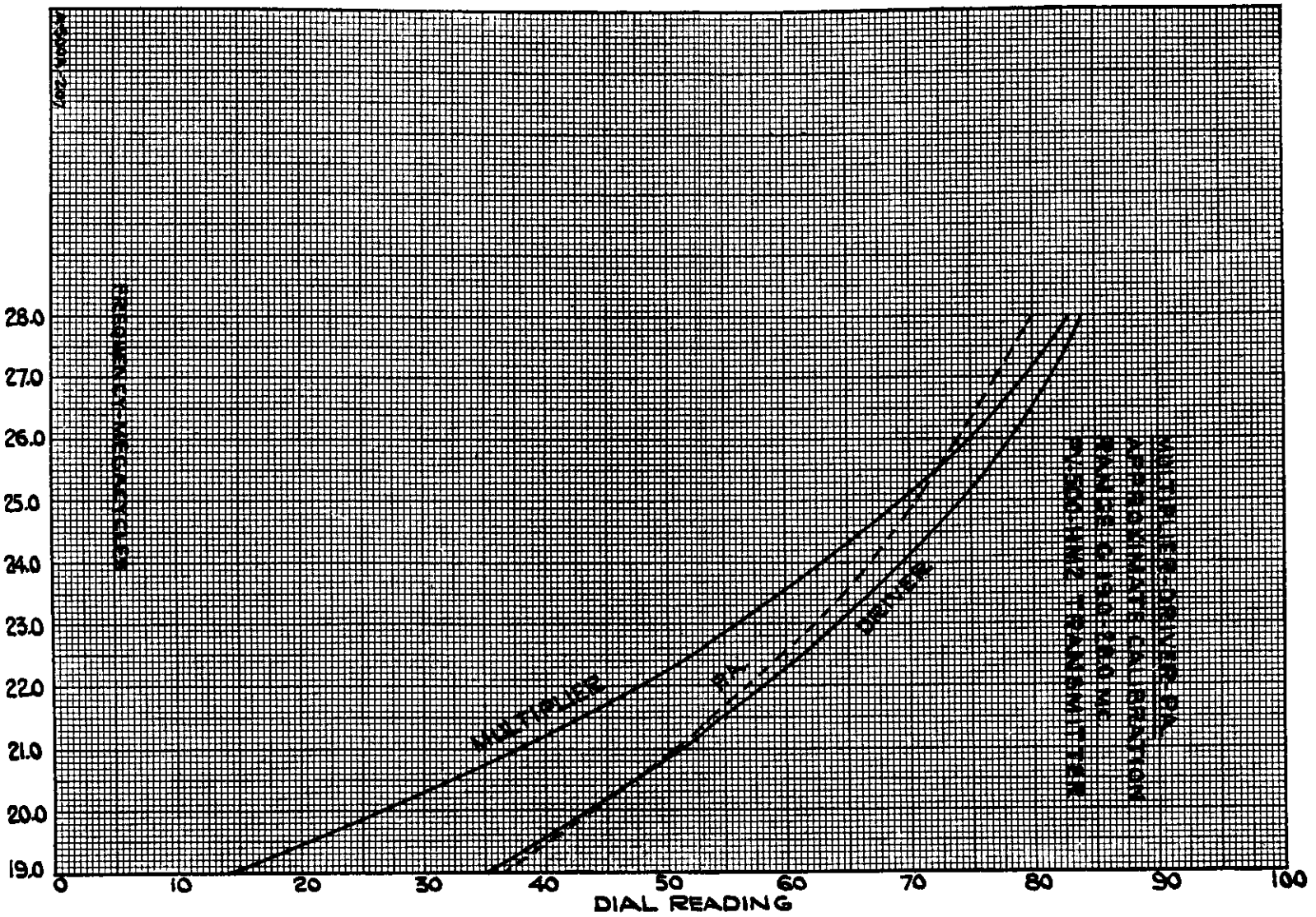


FIG. 31

PIONEER MANUFACTURERS OF ELECTRIC CONTROL APPARATUS
MILWAUKEE, WIS. C-H PRINTED IN U.S.A.

INSTRUCTION SHEET

NO. 307 THERMAL OVERLOAD RELAY

Description

The essential operating parts of this relay are the heater coil, solder tube, control contacts, ratchet mechanism, and the compression spring. Under normal conditions the contacts of the relay are closed. The spring is then under compression and tends to open the contacts, but this is prevented by the outer part of the solder tube holding the ratchet mechanism. When the current to the heater coil becomes great enough to melt the solder film holding the outer part of the tube, this part of the tube rotates and releases the ratchet mechnism to open the control contacts. The opening of these contacts breaks the circuit to the coil of the contactor handling the power circuit and this circuit is opened. As soon as the power circuit is opened the solder film cools and hardens, after which the relay is ready to be reset with the reset button.

How to Install the Heater Coil

1—Remove the screws holding the instruction plate to the overload relay and take off this plate.

2—Remove the cover of the overload relay by sliding it to the extreme upper position and pulling outward.

3—Remove the terminal nuts at the side of the relay.

4—Insert the heater coil in the overload relay base, with the asbestos tube surrounding the coil. Be sure that the heater coil eyes fit over the terminal studs.

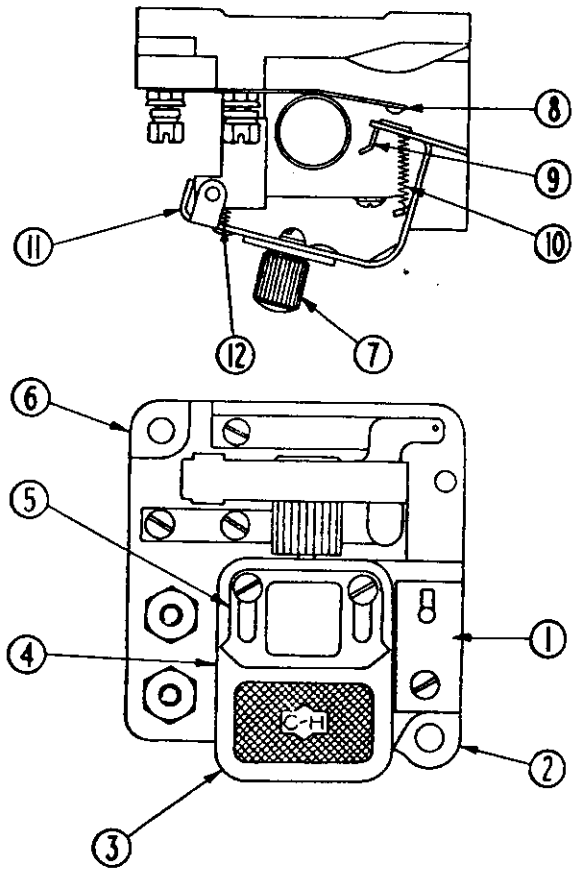
5—Fasten the celluloid calibration plate, which forms a part of the heater coil package, to the front of the overload relay base, using the screw provided for this purpose. Note that the celluloid plate bears a symbol marking which should agree with that on the heater coils.

6—Replace the relay cover which should fit over the heater coil, inclosing all of the coiled portion of the heater.

7—Replace the terminal nuts.

How to Set the Overload Relay

This relay, is adjustable. The pointer on the instruction plate should be set opposite the current marked on the calibration plate, at which it is desired to have the overload relay trip. This can be done by loosening the two screws which hold the instruction plate and the cover of the relay (item 3 on the cut above), and sliding the entire cover until the pointer on the plate is in the proper position.



34908-3

RENEWAL PARTS—Information Required

Parts CANNOT be sent promptly unless you include the FOLLOWING with your order: PUBLICATION NO. 4527, PART NO., DESCRIPTION, and the Number Stamped on the Controller Nameplate.

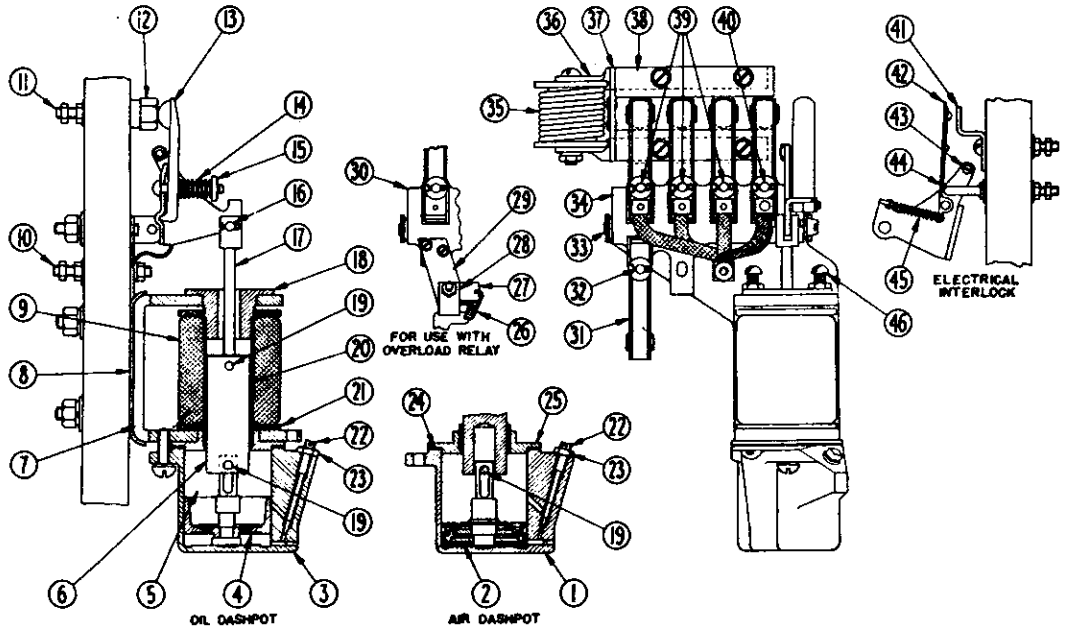
Due to the cost of handling, the minimum net billing charge is $1.00

Item No.	Description	No. Req.	Part No.
1	Calibration plate (supplied with heater coil)	1	Give No. on Bottom of Plate
2	Complete relay with reset button	...	34908-3 Fig.2
3	Cover and ratchet assembled	1	644-204
4	Heater coil	1	Give No. Stamped on Coil
5	Instruction plate	1	4230-151
6	Moulded base with post for item 11	1	17-1308
7	Reset button	1	2222-805
8	Stationary contact finger	2	640-217
9	Latch	1	845-44
10	Tension spring	1	69-262
11	Assembled contact lever includes items 9 and 10	1	34985-1 Fig. 3
12	Spring	1	69-264

INSTRUCTION SHEET

No. 234 and No. 235 D C Dashpot Contactors

Direct Current Time Limit Accelerating Movement—Type "A"—With or Without Lost Motion



15945-1, 15946-1

DESCRIPTION

There are two types of both oil and air dashpots used on these devices. The type of pot used, air or oil, is indicated by a plate attached to the pot. One type has **lost motion** in the dashpot which provides no timing on the first finger, item 13, but does time the closing of the rest of the fingers. The stem of the piston on this type is slotted (see illustration above). The other type **without lost motion**—provides timing on the closing of all of the fingers.

ADJUSTMENT

Adjustment of the rate of acceleration of the motor is made by screwing the valve needle, item 22, in to decrease or out to increase the amount of oil or air which can pass to the under side of the piston in a given time. A minimum period of 1½ seconds and a maximum of 15 seconds can be obtained.

Be sure not to use oil in an air type dashpot.

CARE

1. Lubricate all bearing points occasionally with light machine oil.

2. If the dashpot is of the oil type, keep it filled to the level indicated with Cutler-Hammer dashpot oil, item 5. Never mix the oil furnished with other oils. Clean the dashpot thoroughly before refilling with fresh oil.

3. If the copper contacts become badly roughened, or burned, smooth them with a fine file, taking care to remove as little copper as necessary. Silver faced contacts require no attention during their normal life.

4. If it becomes necessary to replace the dashpot or dashing mechanism we recommend that a complete unit be purchased. See items 1 and 3.

RENEWAL PARTS—INFORMATION REQUIRED

Parts CANNOT be sent promptly unless you include the FOLLOWING with your order: PUBLICATION NO. 7121, ITEM NO., PART No., DESCRIPTION and COMPLETE NAMEPLATE DATA ON THE CONTROLLER. Due to the cost of handling the minimum net billing on any order is **$1.00**.

Item No	Description	No. Req.	Part No.
1	Air dashpot (includes items 2, 19, 22, 23 & 24)	1	
	With lost motion (slotted piston rod)		33609-1 Fig. 1
	Without lost motion (drilled piston rod)		33610-1 Fig. 1
* 2	Piston for air dashpot	1	
	With lost motion (slotted piston rod)		659-1
	Without lost motion (drilled piston rod)		659-2
3	Oil dashpot (includes items 4, 19, 22, 23 & 24)	1	
	With lost motion (slotted piston rod)		699—1519
	Without lost motion (drilled piston rod)		699-1512
* 4	Piston for oil dashpot	1	
	With lost motion (slotted piston rod)		4426W-2
	Without lost motion (drilled piston rod)		4426W-1
5	Dash pot oil (for use in oil dashpot only)	2½ oz.	4-oz. can 637-218
* 6	Plunger	1	951-1406AZ
7	Magnet frame	1	949-1492Z
8	Support	1	979-446Z
▲ 9	Coil (Give No. on Coil)	1	.....
10	Stud	1	
	For 5/8" panel		814-489
	For 1" panel		814-490
	For 1-1/2" panel		814-94
	For 2" panel		814-14
	Nut	3	815-601
	Washer	1	916-641Z
11	Stud	★	
	For 5/8" panel		814-481A
	For 1" panel		814-482A
	For 1-1 2" panel		614-24
	For 2" panel		614-97
	Nut	★	815-601
	Washer	★	916-641Z
▲12	Contact button	★	1331-925
▲13	Contact finger	4	640-7
▲14	Spring	★	969-4
15	Cup washer	★	916-561Z
16	Shaft	1	956-325
17	Link	1	61-122
18	Stop plug	1	939-3121Z
*19	Pin	2	956-266Z
20	Plunger tube	1	829-530
21	Insulating washer	2	1016-220
*22	Adjusting valve needle	1	911-81
*23	Adjusting nut	1	915-18
24	Washer	1	4916-4
25	Base	1	917-2601Z
26	Spring	★	969-464
27	Support	★	35381-1
28	Bracket	★	35382-1
29	Lever	★	56-604
30	Finger support (for use with overload relay)	★	35393-1 Fig. 1
▲31	Contact finger	★	640-8
32	Spring pin	★	913-59Z
33	Shaft	1	956-355Z
34	Finger support	1	679-4
35	Blowout coil (Give No. on coil)	★	.....
36	Pole piece	★	962-45
37	Arc shield	★	73-163
38	Arc shield	★	5073-33
39	Spring pin (on first three fingers)	3	913-1199Z
40	Spring pin (on fourth finger)	1	913-1193Z
41	Contact	★	1321-1003
42	Finger	★	640-5
43	Stop pin	★	913-5Z
44	Post	★	818-3
45	Spring	★	969-643J
46	Coil securing screw	2	911-624Z

▲We recommend that these items be stocked. The quantity to be stocked will depend upon the number in use.
*To insure satisfactory operation these items should be replaced together. See items 1 or 3.
★Quantity as required