PV500 LM

OPERATION

&

SERVICE

MANUAL

FOLDER 110-440

PV-500-L SERIES TRANSMITTERS.

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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.

SPECIAL NOTICE

Owing to wartime material restrictions beyond our control, it has been necessary, in many cases, to use components different from those listed in the Parts List of this Instruction Folder. The substitute components employed do not prejudice operation of the unit in any way, but in some instances may detract from the neat appearance which was intended.

Should a replacement of any of these substitute components be necessary at any time, the proper types as specified in the Parts List should be ordered. These will be supplied if they are then available.

Canadian MARCONI Company,
Montreal, September 21, 1942.

ADDENDUM TO INSTRUCTIONS 471

The main body of the instructions contained under this cover details the installation and operation of the PV 500 series transmitters. Inasmuch as the basic design and circuit layout of the transmitter has not been changed these same instructions will apply in the cases of the PV 500 LM2 and PV 500 LM3. The changes involved are all mechanical and change the operating procedure in the following manner.

The mechanical feature that was used to reset the variable condensers C3 and C14 in the PV 500 LM and PV 500 LM1 transmitters has been removed on the PV 500 LM2 and PV 500 LM3 transmitters. In place of the mechanical feature these condensers are now coupled to vernier dials mounted on the IO and PA units and the front cover has been modified to permit them to be operated without the removal of the cover. The band switching feature has been retained and the tap switches that select the four bands are still driven by means of a handle on the left of the main panel of the transmitter.

The antenna loading coil has been modified to provide increased flexibility of operation by providing additional taps on the lower section of the coil used for fine tuning. These taps are numbered for easy reference and are connected to the bus bars from the switch with flexible leads fitted with hook type lugs to enable the tap settings to be changed with the utmost speed.

The procedure for setting up the transmitter does not differ materially from that described in the body of the instructions, except that those sections which deal with setting up and adjustment of the mechanical device on condensers C3 and C14 no longer apply. The general procedure for setting up the transmitter may now be summarized into the following steps.

1. Decide in which band the transmitting frequency required is located.
2. Set the coil taps and padding condensers to the correct combinations.
3. Adjust the IO for the highest frequency in this band.
4. Adjust the PA for resonance, with the coupling and antenna circuits open.
5. Tune the antenna circuit and couple up for the maximum output at this frequency.

6. Set the taps on the fine tune section of the antenna coil to provide the highest output at all the other frequencies within this band upon which the transmitter will work.

7. Repeat for the other three bands and log all the settings of the controls on the charts provided on the front of the unit.

The normal operating procedure for the transmitter can now be summarized as follows:-

1. Set the MO dial to the correct frequency (As logged).

2. Set the PA dial to the correct frequency (As logged).

3. Set the tap on the lower section of the antenna coil to the correct position (As logged).

4. Switch the transmitter on with the power switch in the adjust position and check that there are no untoward effects.

5. Switch to full power and commence to transmit.

If it is desired to obtain frequencies that were not set up and logged at the time of installation reference to the body of the instructions and to the calibration charts at the rear of this folder will provide the information as to the correct combinations of padding condensers and coil taps to use for any frequency within the range of the transmitter. If, at the time of installation the transmitter is so set up that the tap positions on the coils and the padding condensers used cover the maximum possible range on each of the four positions of the master wavechange switch, such manoeuvers will seldom be required in normal service.

The PV 500 LM3 transmitter is electrically the same as the PV 500 LM2 but in addition has a build up cage for use on shore installations where it would not be possible to use a bulkhead to complete the screening of the antenna coil. Full details of the gate assembly are shipped with each equipment to enable it to be re-erected in the field. As the PV 500 LM3 is intended for shore use it is extremely unlikely that any rotary converter will be used and the apparatus will operated from the AC lines so that the sections concerning the rotary converter can be disregarded in addition to the sections covering the wavechange mechanism and the resetting of the variable condensers C3 and C14.

- FOREWORD -

These instructions are primarily intended to cover the PV-500-LM, but are also applicable to the PV-500-LM-1 (serials 101-105) which differs from the PV-500-LM type 96385 in the following respects. On the PV-500-LM-1 type 110-925, the filament compensator circuit is arranged to use a General Radio type 30-B "Variac" variable auto-transformer in place of the filament compensating resistor R24. In all other respects the two transmitters are identical, both as to appearance and electrical characteristics. The function of the Variac, designated T7 on the circuit drawing 105-904 and in the parts list, is exactly the same as that performed by R24. In order to take advantage of the range of control provided by the Variac, the transformers supplying the filaments have a different input voltage and for that reason, although in outward appearance identical with those in the PV-500-LM transmitter, bear different type numbers. Reference to the circuit drawing and the parts lists will show that type numbers for these units are shown in duplicate and reference is made to which transmitter each set of transformers is applicable.

The procedure of compensating the filament voltages as described in paragraphs 4.13 and 4.29 in these operating instructions is the same for both types of transmitter. Other than the points noted above, there is no difference in the performance of the two types of transmitter. These operating instructions will therefore be applicable to both types of transmitter.

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INSTALLING & OPERATING INSTRUCTIONS 471

FOR MARCONI PV-500-LM & PV-500-LM-1 TRANSMITTERS

PV-500-LM TYPE 96385
PV-500-LM-1 TYPE 110-925

INTRODUCTION

1.1 The Marconi PV-500-LM radiotelegraph transmitter is designed to provide c-w and i-c-w transmission on low frequencies, and is primarily intended to be used on vessels of small tonnage such as minesweepers, where the operating space is limited. It can, however, be used with equal facility on larger vessels or ashore.

EQUIPMENT

2.1 This radio transmitting equipment is designed for operation from either 110 or 220 volts d-c supply. A rotary converter is supplied with the transmitter to provide 110 volts 60 cycles from which the transmitter is required to operate. (With certain installations this item is in duplicate.)

2.2 The dimensions and weights of the components which comprise the complete equipment are as follows:

	Height inches	Width inches	Depth inches	Length inches	Weight pounds
Transmitter Unit	63	37	26 1/4		625
Antenna Tuning Inductance	60	24	24		120
Rotary Converter	17 1/2	16 1/2		22 1/4	285
Gate Assembly 93915	63	27	2		95

2.3 The following valves are employed in this equipment and are individually packed in separate containers for shipment.

3 - RVC 810 (V1, V2, V3)
2 - " 872A (V6, V7)
1 - " 807 (V5)
1 - " 5Z3 (V4)

DESCRIPTION

3.1 General Discussion

Each equipment consists essentially of a radio transmitter unit with its antenna tuning inductance and a rotary converter unit. A gate assembly is also provided which will be built around the antenna tuning inductance.

3.2 The main equipment is furnished in a suitably finished sheet steel cabinet perforated for purposes of ventilation. All components are accessible through the front of the unit by removing the front shields. Those shields apt to be removed most often (for changing valves, general inspection, etc,) are fitted with quick-acting fasteners. The floor of the cabinet is raised above the deck level to protect the equipment from the effect of free water on the cabin floor.

3.3 In the main transmitter cabinet is located the power equipment, with the heavier components such as power transformers at the bottom, the power controls, and above, all the radio-frequency equipment with the exception of antenna tuning inductance (L11) and part of the wavechange mechanism, which is located on the left-hand side of the transmitter cabinet. The antenna tuning inductance, which is a separate unit, will be installed behind the transmitter in a screened enclosure. The antenna lead-in insulator is located at the top of the antenna tuning inductance.

3.4 Frequency Range - Power Output

The radio transmitter unit is capable of operation on any frequency in the band 100 to 500 kilocycles. The transmitter has a nominal power output of 500 watts; the actual power will vary somewhat with frequency and with the type of antenna employed.

3.5 Both c-w and i-c-w transmission are provided for. Three modulating frequencies are available which may be selected at will by means of a switch (S4). Protection is afforded operating personnel by means of a system of safety switches (S8, S10, S11) operating when the front covers are removed and the door of the a-t-i safety enclosure is opened. These switches remove the high tension only, leaving the filaments alight. These safety switches may be shorted out for adjustment purposes by means of a lock switch (S9).

3.6 Antenna

The antenna used with this equipment should be the best that space limitations aboard ship will permit.

3.7 Transmitter Unit (Fig. 1.)

The r-f portion of the transmitter consists basically of a master oscillator and power amplifier, both utilizing triode valves supplied at 2,000 volts d-c derived from the 110-volt 60-cycle supply, which may be obtained from a rotary converter or other source. A rectifier of the hot-cathode mercury-vapour type is employed. The power amplifier (see Figs 3 & 15) together with its tuning condensers (C14, C15, C16, C17, C18) and inductance (L5) is located on a shelf at the top of the unit, and below it is the master oscillator unit (see Figs 4 & 15) with its associated components also on a shelf. These shelves, the top of the unit, and also the lower front shield, are perforated to allow cooling air to enter the cabinet and to leave at the top. The circulation of air is assisted by a fan that operates when the high-voltage rectifier is in operation.

3.8 A small magnesium - copper sulphide rectifier (CU1) is employed to provide approximately 12 volts d-c for the operation of the keying relay. This rectifier is located just below the master oscillator unit.

3.9 The terminal panel for external connections and panels carrying the various control relays are located in the lower section of the unit. The h-t rectifier (see Figs 7 & 17) with its transformers (T4, T5) and smoothing system is also located in the lower section.

3.10 Meters

At the top of the unit there is a group of four meters clearly designated which read:

M4 - Filament line volts. (This meter is provided with a red line indicating the correct setting.)

M3 - Power amplifier cathode current.

M2 - Master oscillator cathode current.

M1 - Antenna current. (This meter is provided with a short-circuiting link for use in cases where a low resistance antenna will give excessively large antenna currents.)

Behind this group of meters is located a bank of resistors (R12, R13, R14, R15, R16, R17, R18) used as bleeder for the h-t rectifier, and the break-in relay E1.

3.11 Controls

A recessed front panel carries the following clearly designated controls:

(1) S5 - Switch for selecting CW or ICW.

(2) S13 - Filament on and off pushbutton type switch.

(3) S14 - High-tension on and off switch.

(4) S3 - Valve conditioning switch.

(5) P1, P2, P3 - Three pilot lights, one green, one red and one white, indicating, respectively, filaments on, high-tension on, and valve conditioning supply on.

(6) R24 - Filament voltage control.

(7) R22 - Filament voltage compensating control. (See Foreword to these instructions)

(8) S4 - Switch for selecting one of three tones for i-c-w, viz, 400, 700 or 1000 cycles.

(9) - Overload reset button.

(10) S6 - Adjust-Operate switch for reducing power during the adjustment process.

3.12 The handle which operates the wavechange mechanism is located to the left of and above the control panel.

3.13 A sub-panel at the lower right-hand side of the cabinet carries the various relays and contactors incidental to the control circuits. The various line fuses (F1, F2, F3) are located in holders just above the main terminal panel.

3.14 Valve Conditioning Circuit

A valve conditioning transformer (T8) and two valve sockets are incorporated on the left-hand side of the lower part of the transmitter for the purpose of conditioning a pair of 872A valves. The 110-volt supply is connected to the transformer by means of switch S13, and the white pilot light P3 on the control panel lights when the conditioning supply is switched on.

3.15 Wavechange Circuit

The tuned circuits permit setting up to any four spot frequencies in the specified frequency band extending from 100 to 500 kc. These instructions carry calibration charts as an aid to setting closely to the desired frequency. The frequency may be further adjusted as closely as desired, the limit of accuracy being the accuracy of the measuring device.

It is intended that the calibration charts in this folder be employed for the preliminary setting, and that the frequency be finally adjusted with a good wavemeter or other similar device.

The following are adjustments which are affected by change of frequency:

Master Oscillator: Fine Tuning Variable Condenser C3.

Fixed Condensers C6, C7, C8. (These are selected by the switches S1-4, S1-5)

Reaction Tap on Inductance L2, operated by switch S1-2.

Tap on the high-potential end of Inductance L2, which is selected by switch S1-1.

Power Amplifier: Fine Tuning Variable Condenser C14.

Fixed Condensers C15, C16, C17, C18, which are selected by switches S2-1, S2-2, S2-3, S2-4.

Tap on Inductance L5, operated by switch S2-5.

Tap on Coupling Coil of L5, operated by switch S2-6.

Antenna Tuning Inductance: Coarse tap on top section operated by switch S15-1, and fine tap on lower section operated by switch S15-2.

3.16 The wavechanging operation is effected by a single handle located on the front panel of the left-hand section of the transmitter. The handle must be pulled out before it can be rotated. This disconnects the h-t from the transmitter.

When pulled out, the handle can be rotated to any one of four positions. The handle is linked by gears and a chain and sprocket system to the switches S1-1, S1-2, S1-3, S1-4, S1-5 on the master oscillator, to switches S2-1, S2-2, S2-3, S2-4, S2-5, S2-6 on the power amplifier, and to switches S15-1, S15-2 on the antenna tuning inductance. The handle is also linked to the variable condensers C3 and C14 which have a system of rack and pinion drives with movable stops on their spindles by which any four positions between maximum and minimum capacity can be selected for each condenser. Pushing the handle in reconnects the high-tension if this was connected when the handle was pulled out.

3.17 Keying System

A full break-in keying system is employed (see Fig. 16). This makes use of a keying relay E1 whose contacts, operating in the ground lead at the base of the antenna system, transfer the circuit to the receiver input and control the carrier. The contact sequence is such that, upon opening the manipulating key, oscillations stop before transfer is made. The keying relay also carries a pair of contacts which close before the others and open after the others. These are intended to close the circuit to a receiver muting relay, if the receiver in use is so fitted. Both master oscillator and power amplifier are keyed together. Keying is accomplished by means of a bias blocking arrangement. The h-t circuit carries a group of bleeder resistors R12, R13, R14, R15, R16, R17 and R18. The filament return circuits of the master oscillator and power amplifier valves are carried through cathode meters M2 and M3 to a tap on this bleeder at the junction between R16 and R17. The power contact on the break-in relay E1 short-circuits R16 and R17, thus grounding the cathodes. Under these circumstances the m-o is able to oscillate and the p-a to amplify. If the key is up R16 and R17 are not short-circuited and a portion of the h-t appears across them. The cathodes of the valves are therefore at a positive voltage in respect to ground, so that the grids are at sufficient negative voltage with respect to the cathode to prevent their drawing any appreciable grid current. Under these circumstances the m-o will fail to oscillate. An auxiliary relay E2 is employed to compensate the filament voltage as the set is keyed, i.e. to offset the effect of line voltage regulation on the filament voltage. The keying and compensating relays operate in series from 12 volts d-c obtained from a keying rectifier of the dry type.

3.18 I-c-w Transmission

For the transmission of i-c-w an audio oscillator (see Figs 6 & 14) is employed by which the carrier is modulated. The oscillator consists of a pentode valve V5 with its own h-t supply and associated equipment. The generated audio-frequency voltage is impressed on the grid circuit of the power amplifier, thus varying the effective r-f drive at an audio-frequency rate. This

results in essentially negative modulation. Three modulation frequencies are available and may be selected at will. When on c-w this oscillator is rendered inoperative, and when on i-c-w the valve V5 is keyed together with the r-f valves.

The h-t rectifier for the audio-frequency oscillator employs a vacuum tube V4 (type 5Z3) which is supplied by transformer T1. This rectifier delivers 500 volts. The entire tone generator unit is located just below the master oscillator unit.

3.19 H-t Supply

High tension for the m-o and p-a at 2,000 volts is obtained from a single-phase full-wave rectifier employing two hot-cathode mercury-vapour valves V6 and V7 (type 872A) (see Fig. 17). These are supplied by the power transformer T5 which is tapped for 100, 110 and 120 volts. The resulting d-c is smoothed by choke L7 and condenser C30. The negative return circuit includes an overload relay E7 which can be reset by pressing a button marked "OVERLOAD RESET" on the front panel of the unit.

3.20 The main rectifier valves are provided with a heater, working directly from the ship's mains, which serves to maintain the ambient temperature in the vicinity of the valves above a minimum value. A thermostat is employed to cut off the heater when the ambient temperature reaches approximately 75 degrees F.

Two heaters are employed which are connected in series or in parallel according to the ship's voltage, i.e. 220 or 110 volts.

3.21 Filament Supply

The filaments of all valves are lighted from transformers T3 and T4, arranged with a variable resistor R24 in series with the primary circuits to allow the voltage to be adjusted to the correct value. The filament line voltmeter M4 carries a red line indicating the correct setting. R24 is replaced by a variable auto-transformer in the LM-1 series (see Section 6).

3.22 Antenna Tuning Inductance (Fig. 8)

The antenna tuning inductance is in two sections, a lower portion composed of edgewise wound copper strip for fine tuning, and an upper portion tapped for coarse tuning. The blades on S15-1 and S15-2 short-circuit the unused portions of the coil. By moving the flex leads inside the lower portions of the coil any part of any turn can be reached, and by attaching the external flex leads to the various taps on the upper portion of the coil any desired part can be shorted out. Sufficient inductance is included in the loading system to resonate to any antenna of apparent capacity of .00045 to .001 uf and resistance of from 3 to 12 ohms, within the frequency range of 100 to 500 kc.

3.23 Protective System

An auxiliary switch S9 is provided by means of which the h-t may be applied to the transmitter with the front covers off and the door of the antenna tuning inductance open. The object of this switch is to save time while adjustments are being made by the proper personnel. When the covers are replaced and the antenna tuning inductance door closed, the switch S9 is automatically opened and the protection restored.

3.24 Switch S7 is incorporated in the wavechange mechanism. This removes the h-t from the transmitter when the wavechange handle is pulled out prior to changing frequency. The h-t is connected again when the handle is pushed back.

3.25 The main 110-volt line carries switch S12, designated MAIN SWITCH which, when opened, completely disconnects the 110-volts a-c from the transmitter.

3.26 An auxiliary switch S6 is incorporated which permits operation of the transmitter on low power during adjustment. Operation of this switch connects resistance R23 in series with the 110-volt supply to the main rectifier transformer, thus reducing the plate voltage applied to the transmitter.

3.27 The various protective switches S7, S8, S10 and S11 are in the coil circuit of the main power contactor E5. The latter will open, if closed, and fail to close, if open, when the circuit at any of the switches is broken. Likewise, E5 will open if the overload relay E7 has been tripped.

3.28 The main 110-volt a-c line is protected by fuse F2, the filament circuits by fuses F3, and the h-t rectifier circuits by fuses F4.

3.29 Rotary Converter (Fig. 18)

The rotary converter is of the semi-enclosed protected construction type. It is rated at 2,500 volt-amperes and delivers 110 volts 60 cycles single-phase at full load. The machine is provided with ball bearings and runs at 1800 rpm. An automatic counter-emf starter (see Fig. 10) is provided, with a pushbutton for remote control. The converter is supplied for either 110 or 220 volts d-c as required. A hash filter is supplied with the machine to mitigate r-f interference. This complete equipment of rotary converter and filter is frequently supplied in duplicate, one machine as a working generator and the other as a standby.

3.30 Terminals

The terminals on the main terminal panel at the bottom front of the unit are numbered as follows: (See Fig. 7).

Terminal No.	Function
1 and 2	110-volt a-c supply
3 and 4	Manipulating key. (Terminal 4 is grounded to the transmitter frame)
5 and 6	110 or 220-volt d-c ship's mains supply, for warming the air around the rectifier valves. Polarity is not important. (If the transmitter is operated directly from a 110-volt a-c supply, these terminals will be connected to terminals 1 and 2)
7 and 8	Interlock. (These terminals are connected to a gate switch in the enclosure housing the antenna tuning inductance)
15 and 16	Receiver muting circuit.

Holes are provided in the bottom shielding of the transmitter to allow wiring to come up from underneath. In addition, the lower portion of the side shield is notched to allow wiring to pass underneath from the side.

INSTALLATION & ADJUSTMENT

4.1 Unpacking

In unpacking and handling the units, care should be exercised to prevent damage to the equipment. This applies especially to the antenna tuning inductance. On no account must this unit be handled by the upper guard ring, as the insulators supporting it are easily broken if unduly strained.

4.2 Location of Units

Careful attention must be given to the location of the transmitter unit. The location selected should afford adequate illumination and accessibility for operating and servicing. A space of about 40 inches must be provided behind the transmitter to accomodate the antenna tuning inductance L11 (see Fig. 8). This should be installed with the terminal side nearest the wave-change switches S15-1 and S15-2 (see Fig. 11). A metal cage must

be built around the antenna tuning inductance, as shown on drawing 105-809 (see Fig. 13), which will include the framework of the transmitter, the gate assembly 105-805 (see Fig. 9) and may include the ship's bulkhead. Care must be taken that this cage forms an electrical loop of very low resistance. Where two metal surfaces are bolted together, the paint must be well scraped from them and at least six strong bolts used. If the cage is not well bonded electrically, much power will be wasted in it, especially at the lower frequencies.

4.3 Reassembly of the Transmitter

The transmitter is normally shipped in a partly dismantled state, the main h-t transformer, i-c-w tone generator, master oscillator and power amplifier being removed. These must be replaced in the transmitter, in the order given above, after the transmitter frame has been placed in position. Great care must be exercised in replacing the h-t transformer, as if carelessly handled damage may be caused to the apparatus in the bottom of the cabinet. The transformer will, of course, be lowered into position from above.

4.4 Wavechange Mechanism

When the transmitter units are correctly reassembled and the wiring connected up in accordance with wiring diagram 105-904, the wavechange mechanism may be reassembled. Actually, all that is required is to replace the main driving chain, which may readily be done by connecting it up in accordance with the sketch shown in Fig. 35.

First set the switches S15-1 and S15-2, S1 and S2 to position 1 on switches S15-1 and S15-2; this will bring the contact arm to the lower left-hand contact (with the transmitter viewed from the front). On switches S1 and S2 the contacts are numbered on the terminal strips above the switches, so that the correct positions may be easily located. The clamping nuts on the m-o and p-a condensers should be tightened up so as to avoid accidental movement of switches S1 and S2 which are locked to the condenser spindles by the auxiliary driving chains (these chains are not removed for shipment). The indicator above the operating handle should be pointing to the right and be pushed home. Slack off the nut holding the idler sprocket so that this is able to move freely up and down. Now pass the driving chain over the sprocket on the switch S2 so the joining link of the chain will fall just above the sprocket on S1. The other end of the chain should be passed under the driving sprocket, over the sprocket on S15-2, under the sprocket on S15-1, over the idler sprocket and under the sprocket on S1. The two ends of the chain should now be joined. In order to locate the chain correctly around the different sprockets without leaving any slack between them, it may be necessary to move them around a few degrees - for this purpose the clamping nut on the condenser C3 may have to

be slacked off. When the ends are joined, check that the condenser switches and the indicator are in position 1. Push the idler sprocket up to take up the remaining slack and tighten up the nut to secure it in place. Slack off the clamping nuts on the condensers C3 and C14 and check the operation of the wavechange mechanism.

4.5 Rotary Converters (See Fig. 18)

It is preferable to instal the rotary converter at some distance from the transmitter unit, in another compartment if at all possible. Bolt the converter to the deck with the machine pointing fore and aft. Allow sufficient space around the machine to facilitate maintenance. In cases where more than one converter is supplied, the location of the second machine will be dependent on the space available and the dictates of safety. In all cases the leads to the machine should be as short as is practical, all other considerations being taken care of.

4.6 Cabling

The power which the rotary converter will draw from the ship's mains under various conditions is as follows:

Condition	220-v d-c	110-v d-c
Starting	3.75 kw peak	3.75 kw peak
C-W Key Down	3.3 " "	3.25 " "
I-C-W Key Down	3.0 " "	2.9 " "

This information may be used as an aid in the selection of suitable wire sizes. The wire sizes will depend on the distance between the various units. Too large a voltage drop may affect the performance of the set.

The maximum a-c power drawn by the transmitter is about 1.8 kw, while the heating circuit for the rectifier valves will draw an additional 200 watts from the ship's mains. When the transmitter is operated from a 110-volt a-c supply, i.e. in locations not on board a vessel, the a-c supply may be connected directly to terminals 1 and 2 through a suitable service switch, and the rectifier valve heater circuit will be run directly from the same supply by connecting terminal 1 to terminal 5 and terminal 2 to terminal 6. Before applying any voltage from either a d-c or an a-c source to the unit, make sure that resistors R20 and R21 are connected in series for 220 volts or in parallel if the supply is 110 volts. Failure to verify this may result in blowing the fuses or in burning out the resistor or in generating insufficient heat. The transmitters are normally shipped with these resistors connected in series for 220-volt operation.

4.7 Antenna Lead

The antenna lead should be made of 3/8 or 1/2 inch copper tubing. This should be kept at least one foot away from grounded objects. Sharp bends in this lead should be avoided and care taken that there are no sharp edges, which may occur if it is handled roughly in a vise or with pliers. Such irregularities in the surface may cause brushing and consequent loss of power.

4.8 Ground Connection

The ground connection must always be made to the bolt at the top of the unit. The receiver antenna is connected to the small insulator near the ground bolt.

4.9 Transformer Taps

Before applying any voltage to the unit, all transformers must have their primary taps set to the correct places for the line voltage in use. The rotary converter normally supplied with the equipment delivers approximately 110 volts 60 cycles on full load when the ship's d-c supply voltage is 110 or 220 volts. If it is found that the ship's voltage is lower or higher than this value, the converter will deliver a correspondingly lower or higher voltage on the a-c side. If it is found that it is impossible to adjust or maintain the line voltage to this figure, the transformer taps should be adjusted to correspond to the mean value.

The transmitter is shipped out by the manufacturer with the taps adjusted for 120-volt operation. For other voltages the taps are as follows:

On PV-500-LM-1 Transmitters

T8 (97635), T1 (89036), T5 (89056), use taps
1 and 2 for 100 volts
1 and 3 for 110 volts
1 and 4 for 120 volts.

T3 (89199), T4 (89306), T6 (89308), use taps 1 and 3.

These are 110-volt taps and yield the correct filament voltages when the voltmeter is adjusted to read 110 volts (on the red line).

The secondary taps on T6 (89308) are for rectifier aging, and taps 5 and 7 should be used for a start. Later, it should be verified that with the key down the voltage delivered by the rectifier associated with T6 should be between 12 and 14 volts and the taps finally set to correspond, using 5 and 6, 5 and 7 or 5 and 8.

On PV-500-LM Transmitters

T8 (97635), T1 (89036), T5 (89056), use taps
1 and 2 for 100 volts
1 and 3 for 110 volts
1 and 4 for 120 volts

T3 (97652), T4 (97651), use taps 1 and 3 only (tap 2 is blank)

The taps on the rectifier transformer T6 (97695) have been set by the manufacturer so that the voltmeter reads 110 volts (on the red line) when the filament transformers T4 and T3 have 90 volts applied and the filament voltages are correct. The tap on T6 terminals 3, 3A and 3B should not be disturbed unless it is known that the filament voltages are incorrect due to error in the voltmeter. This should be rechecked if for any reason the voltmeter is replaced. The secondary taps on T6 are for rectifier aging, and taps 4 and 6 should be used for a start. Later, it should be verified that with the key down the voltage developed by the rectifier associated with T6 lies between 12 and 14 volts, and the taps finally set to correspond, using 4 and 5, 4 and 6 or 4 and 7.

4.10 Caution

DANGEROUS VOLTAGES EXIST INSIDE THE EQUIPMENT. TO AVOID THE POSSIBILITY OF FATAL INJURY WHILE WORKING INSIDE THE UNIT WITH THE COVERS REMOVED, ALWAYS SEE THAT THE POWER IS OFF AND THAT THE RED PILOT LIGHT IS OUT BEFORE TOUCHING ANY PART. IT IS POSSIBLE TO APPLY HIGH VOLTAGE WITH THE FRONT COVERS OFF BY CLOSING SWITCH S9, BUT BEFORE MAKING ANY ADJUSTMENTS ALWAYS RETURN THE HIGH-VOLTAGE SWITCH S14 TO OFF AND WATCH THE RED PILOT LIGHT. EVEN WITH THE HIGH-VOLTAGE SWITCH OFF THE 110-VOLT CIRCUITS ARE STILL ALIVE, AND IF IT IS NECESSARY TO WORK IN THE LOWER PORTION OF THE UNIT WHERE THESE VOLTAGES EXIST, OPEN THE MAIN SWITCH S12 AND THE D-C SUPPLY FROM THE SHIP'S MAINS (APPEARING ACROSS FUSES F1) OR SHUT DOWN THE ROTARY CONVERTER.

4.11 Put the ADJUST-OPERATE switch S6 on the main terminal panel to ADJUST and remove resistor R23 from its socket. This ensures that no high tension will appear as the preliminary checks of the power control circuits are made.

4.12 Rectifier Valve Heaters

Apply the d-c from the ship's mains and verify that the valve heaters R20 and R21 function properly. The thermostat E6 should cut them off when the temperature rises to approximately 75 degrees F. and connect them if the temperature falls below 75 degrees.

4.13 Filaments

Insert a set of valves in the marked sockets. Start the rotary converter and close the main switch S12. Put the filament switch to ON, when the green pilot light P1 and the valve filaments should light. Manipulating the filament control R24, or Variac, should vary the filament voltage as indicated on meter M4. Manipulating the filament compensating control R22 will also raise or lower the filament voltage. R22 should be turned until the voltage is highest and then the main filament control readjusted until the meter reads on the red line at 110 volts.

4.14 When the filaments come on the keying voltage should appear and, by manipulating the transmitting key, the operation of the break-in relay E1 may be checked.

4.15 At least 30 seconds must always be allowed to elapse after switching on the filaments before switching on the h-t, otherwise damage will be caused to the 872A rectifier valves. When the transmitter is first installed, the 872A valves should be run for a period of 30 minutes before applying h-t in order to disperse any particles of mercury which may have been splashed on to the cathode or anode during shipment.

Before spare valves are put into use, or if the valves have been removed from the transmitter and shaken up or have been stored in any position except the vertical, they must be run at normal filament voltage for at least 30 minutes before applying the h-t. The valve conditioning circuit is provided for this purpose. Spare 872A valves may be conditioned here and left in the sockets until such time as they are required.

4.16 Control Circuits

To check the control circuits, put S5 to the CW position and make sure that R23 is removed from the socket and that S6 is open (ADJUST). Close main switch S14. The main contactor will then close, unless either overload relay E7 or safety switch S9 is open. High tension cannot be applied if the doors are off or if

S9 is not closed. At the same time that the main contactor closes the fan should start up and the red pilot lamp P2 should light, but h-t will not appear if S6 is open and R23 removed. It should be noted that switching off the filaments by means of S13 also disconnects the h-t, but that the red pilot lamp will remain alight as a warning to the operator not to switch on the filaments with the h-t switch ON.

4.17 The equipment may now be shut down by opening the h-t switch S14 and the filament switch S13, and resistor R23 replaced. Switch S6 should be left open (ADJUST) to reduce the h-t while preliminary adjustments are made.

4.18 Master Oscillator & Power Amplifier (See Fig. 15)

By reference to the calibration data, the approximate condenser and coil tap settings on the p-a and m-o can be ascertained for each of the four frequencies. Usually, the unit is shipped adjusted to four spot frequencies and the exact settings for these are noted in the test data. In any case, these settings should be verified with a good wavemeter. An antenna circuit calibration is of little use as the properties of antennas vary between the various types of ships, and it is not difficult to resonate the antenna, even though a calibration is not available. The approximate tap positions may be judged by experience or obtained from similar installations.

4.19 The usual procedure is to first adjust the m-o to its correct frequency with high tension off the p-a valves and the antenna circuit opened by removing the taps on the p-a coupling coil; then to tune the p-a tank with the antenna open, and lastly to resonate the antenna. It is suggested that positions 1 and 4 be made to correspond to the highest and lowest operating frequencies respectively. It is also suggested that everything be tuned up on all four frequencies as far as the antenna circuit and then locked up, as they do not require any further adjustment while the antenna is being tuned.

4.20 For each of the four frequencies desired, set up the required condenser and coil taps on the m-o and p-a and slack off the fingers on the spindles of the mechanisms operating condensers C3 and C14, setting these condensers to the dial settings required for the lowest frequency by means of the clamps on the condenser dials.

4.21 Master Oscillator (See Fig. 4)

Disconnect the h-t lead attached to terminal 1 on the p-a section. This is most easily done by opening the lead to choke L14 rather than removing the heavy h-t cable. This keeps the h-t off the p-a section until the m-o is set to its correct frequency.

The lowest frequency should be set up first. Place the wavechange mechanism on position 4, and close switches S12 and S13 so that the filaments are lighted. Adjust to the correct voltage. After allowing 30 seconds for the cathodes to heat up, the h-t may be switched on by means of switch S14. If the key is up no cathode current will be indicated on either M2 or M3.

Pressing the key should start the m-o and cathode current should appear on M2. Meter M3 will also read as it is in the cathode circuit of the p-a valves, but it will read only grid current as the h-t lead has been disconnected. This shows evidence of oscillation, but due to the lowered h-t (with S6 open) the m-o cathode current will be almost any value up to 30 ma. Switch S6 may now be closed (OPERATE) applying the full high tension. Since there is no other load the h-t will be higher than normal, so that the cathode current will also be higher. The following currents can be expected in this position:

M-o cathode	-	50 to 70 ma
P-a "	-	110 to 130 ma

These currents will both fall somewhat as the p-a is loaded up.

4.22 Check the frequency with a wavemeter and adjust the m-o tuning condenser C3 until the exact frequency is obtained. Lock these settings by means of the clamp on the dial. Switch off the h-t and tighten the finger on the mechanism firmly against the stop. The dial must then be unclamped, as damage to the mechanism will result if it is operated with the clamp on. This setting should be logged for future reference. Final frequency adjustment will be made after all four frequencies have been set up and the covers are in place. By employing a similar procedure, first with S6 open, then closed, all the four frequencies may be set up on the m-o from the lowest to the highest, being careful to shut down the h-t every time that it is necessary to work on the positions of coil taps, condensers, etc. The tap positions on the coil and condenser group have a minor effect on the frequency, so that it may be necessary to recheck once or twice.

4.23 Power Amplifier (See Fig. 3)

To tune the p-a, shut down and restore the h-t connection to terminal 1. Remove the taps to the antenna coil so that the antenna circuit is open. Set the wavechange mechanism to the lowest frequency (position 4). Now, with S6 open (ADJUST), start up the transmitter and cautiously press the key. If the p-a tank is badly out of tune a high reading will be observed on the p-a cathode meter M2. By rotating the fine tuning condenser C14, a position may be found where this reading drops suddenly to a minimum. This is the correct position, and having found it switch S6 may be closed (OPERATE). When S6 is closed, if the setting of the variable

condenser is not reasonably correct, the variable condenser is liable to flash over. It will be found that the minimum current is quite sharp and will have a value of 120 to 175 ma, depending on the frequency. It should be remembered that this meter reading includes the grid current, so that the actual plate current is about 100 ma less. It will be observed that on the lower frequencies the point of minimum is not as sharp as on the higher frequencies, being seemingly spread over several scale divisions on the dial. This arises from the fact that the variable condenser is only a small portion of the total circuit capacity on these frequencies. On the higher frequencies, where the setting is the sharpest, great care should be taken to obtain the correct setting. Having found the setting, the dial may be clamped and, after removing the h-t, the finger on the operating mechanism may be tightened on its shaft firmly against the stop. The dial must then be unclamped. All frequencies may be set up in a similar manner, with S6 first open and then closed, and the settings locked on the wavechange mechanism. The settings should not be changed (unless it is necessary to reset the m-o when the final frequency check is made) since this setting represents the highest tank circuit impedance and ensures that the p-a becomes completely unloaded should the antenna circuit fall badly out of tune as, for example, in the case of damage to the antenna.

4.24 Frequency Check

At this stage, for a final check of the frequency, the wavemeter may be coupled to the p-a tank. If the frequency is slightly away from the correct value, the m-o tuning condenser may be unloosened and shifted slightly. The p-a plate current should not be allowed to go too far away from its minimum value while shifting the m-o frequency without a corresponding resetting of the p-a condenser.

4.25 The process may be considered complete when the m-o is set up and locked in its four positions and the p-a feed is set for minimum on each one and its condenser locked. These controls should not be disturbed after locking and all subsequent tuning should be done in the antenna circuit. Switch S6 may now be left closed (OPERATE) as the m-o and p-a are now in tune, and unless the key is held down for long periods no harm will result.

4.26 The next process is to bring the antenna circuit into tune and to couple it to the p-a. Here again it is best to start at the lowest frequency, as the tuning of the antenna is affected to a certain extent by the position of the taps on the coil. The tap on the lower section of the antenna tuning coil may be set to the centre of the edgewise wound copper strip section while the approximate tune is found by moving the taps on the upper section of the coil. Subsequently, the taps on the lower portion of the coil will be used to bring the circuit exactly into resonance.

The taps on the coupling coil are somewhat critical for the higher frequencies, only one or two turns being required, and it is usually necessary to move the tap along the coil a quarter of a turn at a time. On the lower frequencies ten to twelve turns are required and the adjustment is less critical. It is suggested that for 100 kc eight turns be used, for 200 kc five turns, for 300 kc two turns and for 500 kc one turn. This gives a sufficiently loose coupling for preliminary work.

From about 350 kc upwards, depending on the type of antenna employed, only the lower portion of the antenna tuning inductance is used, the upper section being shorted out. Each tap on the upper section is well overlapped by the range of the tap on the lower section. A short lead with test clips is of assistance in moving quickly from one turn to the next in the lower section while approximate tune positions are found. The permanent leads should be installed for fine tuning after the approximate tune has been found.

4.27 Resonance of the antenna circuit is indicated by a rise in the antenna current and in the p-a cathode current. When the approximate position of the lower tap has been found, it is advisable to mark its position with a paper clip or other device, then move the tap a few inches at a time, noting the antenna and p-a cathode current for each setting. If the latter current is low when the tune point has been found, it will be necessary to increase the coupling by adding a fraction of a turn to the coupling coil L5, and then to retune the antenna. This process should be continued until the p-a cathode current is around 550 ma. If this current is too high the turns in the coupling coil must, of course, be reduced. S6 should be closed (OPERATE) during this process, with the tap on the power transformer T5 set to correspond with the line voltage under normal load conditions. The figure of 550 ma given above corresponds to adequate drive to the p-a and it will be found that, if the drive is inadequate, further tightening of the coupling will result in higher cathode current with no increase of antenna current. However, if the m-o cathode current is correct and the ground tap on the m-o tank coil is also correct, as recommended in the calibration data, the drive should be adequate.

Before drawing full power from the transmitter, any temporary test clips used to find the tune point should be removed and permanent connections made. The leads to the switches and the taps should be bent away clear from each other and from the loading coil and ground, as they may flash over. They should also be shortened if necessary by looping them, pressing the loop flat, and tying the loop with a piece of cord or tape. In particular, the leads should be kept well clear of the upper portion of the coil, as a flashover is liable to damage it. The leads should also be disposed so as not to interfere with the motion of the blades of the wavechange switches.

4.28 The leads to the taps on the coupling coil L5 are fitted with fish spine beads which allow flexibility. They may be allowed to touch each other as the voltages are fairly low, but they must not lie against the leads to the p-a tank coil nor the terminal board of the tank condensers C15 to C18. They should be bent out of the way and tied up if necessary with cotton cord. Care should be taken to see that the clips at the ends of the taps are correctly in place, as it is easy to have them shorting adjacent turns. The thumb nuts should be tightened up firmly, also the lug connections to the terminal connections, so that there is no danger of contact between the conductors proper. The fish spine beads afford adequate insulation between conductors. The other three frequencies may be set up in the manner described above.

4.29 If, with the transmitter fully loaded, it is observed that the filament voltage varies more than about 5% with the key down, the filament compensator resistor R22 requires adjusting. In any event, it is advisable to carry out this adjustment before the equipment is considered ready for service. Resistor R22 is varied and R24 readjusted until the meter M4 reads on the red line whether the key is up or down. The poorer the regulation the more resistance is required in R22 with a correspondingly higher setting of R24. In cases where the transmitter in use is the PV-500-LM-1 type 110-925, the procedure of setting up is exactly the same as outlined above regarding the manipulation of the controls, but it must be understood that where R24 is referred to, the control being operated is actually T7, which is the General Radio Variac with which these transmitters are fitted.

4.30 I-c-w Service

Final readings can now be taken and the settings logged. The transmitter may be keyed and the general performance checked. It may be run on i-c-w and the three tones checked. It will be observed that the p-a cathode current and the antenna current will be considerably lower, depending to a certain extent on the frequency and the antenna characteristics. This is due to the fact that the equipment is designed for negative modulation and the power is less than the original c-w power.

4.31 The p-a valves should not exhibit any visible heat, beyond a barely perceptible glow in a dimly lit room, with the key held down for a minute or two. If they overheat, they are not receiving sufficient drive, the coupling is too tight, or the filament voltage is incorrect. The antenna current reading is of limited significance as the total antenna resistance is variable with different ships and on different frequencies. It is not apt to be steady, especially when the ship is at sea, but it will be observed that if the tuning process has been carried out as described, any change in antenna constants resulting in lower antenna current will also result in lower p-a cathode current.

If the antenna is removed entirely or detuned completely, the effect will be a removal of the load on the power amplifier. The antenna current will normally be of the order of ten amperes at 500 kc and will decrease to about six amperes at 100 kc. There is a progressive decrease in current with decrease in frequency. These figures are subject to wide variations and must not be taken as other than representative.

If the reading on the antenna ammeter is greater than ten amperes, the meter must be short-circuited by the link provided. It will be observed that a meter reading is still obtainable but that it will generally be lower than that with the shorting link removed.

4.32 Test and Calibration Data

The calibration data given below supplements the calibration curves which show the coil taps, variable condenser settings and padding condensers to be connected in for any frequency. It will be observed that on the p-a tank inductance L5, the fixed taps on the coils are brought out to a terminal strip and numbered 1 to 8. The flex leads connect as required to these terminals and the wavechange switch S2-5 short-circuits the unused portion of the coil (between the selected tap and the end of the coil).

Recommended p-a tap positions are:

Frequency kc	Tap Number
95 - 125	8 (whole coil)
120 - 153	7
140 - 185	6
180 - 225	5
220 - 275	4
270 - 335	3
325 - 415	2
400 - 520	1

It will be noticed that there is an overlap between the various bands. If the frequency desired is in this overlap, the higher numbered tap should be used, e.g. for 183 kc use tap 6 in preference to tap 5.

4.33 Master Oscillator Tank Inductance

On the m-o tank inductance L2, two groups of fixed taps are brought out to a terminal strip. The left-hand group, numbered 1 to 14, are the ground taps and are selected by the flex leads. The higher the number of the tap the more turns will be included in the coil. As this coil is connected between grid and ground, the greater will be the excitation and cathode current on the oscillator.

The proper tap to employ is listed below and results in grid current of from 65 to 90 ma to the p-a stage (when loaded). The next higher or lower tap is not recommended as the valve may fail to oscillate or, if it does, insufficient drive may be obtained. The right-hand group is numbered 1 to 8. The flex leads connect to the required terminals and the wavechange switch S1-1 short-circuits the unused portion of the coil.

Recommended m-o tap positions are:

Frequency Kc	Ground Tap	Tank Tap	Remarks
95 - 125	12	8	Whole coil
120 - 153	10	7	
148 - 185	8	6	
180 - 225	7	5	
220 - 275	6	4	
270 - 335	5	3	
325 - 415	4	2	
400 - 520	3	1	

It will be noticed that there is an overlap between each band. If the desired frequency is in this overlap, the higher numbered tap should be used, e.g. for 183 kc use tank tap 6 and ground tap 8. It should be noted that the calibration charts are only accurate within a few kilocycles. In setting to a frequency other than those to which the equipment is adjusted at the factory, the m-o may be set up to the calibration and the frequency later checked with wavemeter or other means such as establishing communication. The p-a calibration is to be used only as a guide; the p-a is in exact tune only when it is set for minimum cathode current as described previously.

4.34 Padder Condensers

Reference to curves Figs. 19 - 34 will show that, for a given frequency band, they only differ by the capacity required in the padder condensers. The curve next above any given curve requires a capacity of .00025 uf less, and the curve next below requires a capacity of .00025 uf more than that required for any given curve. If the required setting for any given frequency is found to be near the maximum of the variable, i.e. the tune point is apparently beyond the maximum, it will be found that the addition of .00025 uf more capacity in the padders will shift the tune to the next curve below. In a similar manner, if the tune point is beyond minimum, the subtraction of .00025 uf will raise it to the next curve above.

As an example, suppose that the padder combination is .00075 uf made up of a .0005 unit and a .00025 unit and it is desired to increase this by .00025 uf. All that is necessary is to

disconnect the two units in use and to connect in place of them one condenser of .001 uf. Thus, the combination has been increased by .00025 uf. This will cause the tune point, if it was near or past maximum with the .00075 combination, to move towards the minimum.

4.35 Typical C-w Readings

Typical readings on c-w are as follows: (Note that the antenna current will differ from the figures given as the antenna characteristics differ)

	Key Up	Key Down	Key Down	Key Down	Key Down
Frequency kc		107	138	405	500
H-t volts	2010	1830	1830	1830	1830
P-a cathode ma		540	550	540	530
P-a grid ma		74	84	72	72
P-a plate ma		466	466	468	458
M-o cathode ma		61	64	50	52
M-o grid ma		21	23	19	21.5
M-o plate ma		40	41	31	30.5
A-c line volts	115	113	113	114	114
Antenna amps		6.7	7.6	9.5	10

4.36 Typical I-c-w Readings

Typical readings for i-c-w transmission are as follows:

	Key Up	Key Down			Key Down		
Frequency kc		107	107	107	500	500	500
Modulating frequency cycles		400	700	1000	400	700	1000
Main h-t volts	2010	1920	1930	1950	1900	1900	1900
Tone generator h-t volts	670	530	570	575	530	560	570
M-o cathode ma		58	58	59	50	51	51
M-o grid ma		22.5	22.9	23	23	23	23
M-o plate ma		35.5	35.1	36	27	28	28
P-a cathode ma		280	340	220	340	340	340
P-a grid ma		50	50	50	46	47	49
P-a plate ma		230	290	170	294	293	281
T-g cathode ma		89	80	79	87	78	78
T-g screen volts		290	315	315	280	310	310
Antenna amps		4.1	3.4	3	7.8	7.8	7.4

4.37 Additional Meters

The meters on the unit only read cathode currents in the m-o and p-a valves. With a test milliammeter and a high-resistance voltmeter (1000 ohms per volt) the other voltages and currents may be read as follows:

P-a grid current	- Volts across R5 (2,000 ohms) or milliammeter in series at the low-voltage end of R5.
M-o grid current	- Volts across R1 (1,000 ohms) or milliammeter in series at ground end of R1.
T-g cathode current	- Milliammeter in series with cathode return circuit at terminal 11 on tone generator.
T-g h-t volts	- Voltmeter across R6.
T-g screen volts	- Voltmeter across R7 (screen end) and terminal 11.
Main h-t volts	- Voltmeter (0-2,500 v) across C30.

CAUTION SHOULD BE EXERCISED WHILE TAKING THE READINGS AS DANGEROUS VOLTAGES MAY EXIST ON THE METERS UNLESS SUITABLE PRECAUTIONS ARE TAKEN.

4.38 The readings given above for c-w and i-c-w are typical and represent nearly the maximum power obtainable. In general, if the line voltage is 110 volts, the various voltages and currents should not be far outside the following limits:

C-w

Main h-t - 1900 to 2050 volts key down. Key up about 150 volts higher.

P-a cathode current - 550 ma maximum, or less depending on coupling and drive.

P-a grid current - 50 to 65 ma, depending on frequency in use and power output.

M-o cathode current - 18 to 23 ma, depending on frequency in use and output.

I-c-w

Main h-t - 1950 to 2050 volts key down. Key up about 150 volts higher

T-g h-t - 500 to 580 volts key down. 630 to 660 volts key up.

P-a cathode current - 200 to 350 ma, depending on frequency used for modulating and coupling and drive.

P-a grid current - 45 to 55 ma, depending on frequency in use and power output.

M-o cathode current - 50 to 60 ma, depending on frequency in use and power output.

M-o grid current - 20 to 30 ma, depending on frequency and power output.

T-g cathode current - 70 to 90 ma, depending on modulation frequency.

T-g screen voltage - 250 to 320 volts, depending on modulation frequency.

4.39 Actual test readings on each particular set are included, with the tuning dial settings for the four spot frequencies on which the set was adjusted before shipment, in an envelope attached to the transmitter.

4.40 The links forming the movable connections to the terminals on the terminal board should be tightened down. If, for instance, a given condenser is used on frequencies 2, 3 and 4 but not on 1, the idle link should be doubled with one of the others to avoid danger of flashovers. If all four do not require a certain condenser, no link is required between the middle terminals and outer terminals of a group and the link can be attached under adjacent terminals. This will keep the condenser out of circuit at all times.

4.41 Filament Voltages

The following are the correct filament voltages for the various valves used in the transmitter. Care should be taken that the variation does not exceed 5%, as otherwise the valves will either have a short life or there will be loss of power.

M-o and P-a	- RVC	816 -	10 volts
Rectifier	- "	872A -	5 "
Tone Generator	- "	807 -	6.3 "
Tone Generator	- "	5Z3 -	5 "

MAINTENANCE

5.1 General

The equipment should be gone over periodically for cleaning and general inspection in order to detect incipient trouble. All insulation should be kept free of dirt, dust or salt deposit, and screws and nuts should be tightened up.

5.2 The contact surfaces of relays and contactors should be examined for burning or pitting and kept clean. Crocus cloth or contact burnishing tools ONLY should be used for this purpose and under no circumstances should sand or emery cloth be used. The valve pins should likewise be examined and cleaned, as losses may occur here due to the high currents and low voltages.

5.3 The switches and mechanism making up the wavechange device should also be examined and lubricated when necessary. The contact surfaces of the switches should be kept clean and free from corrosion.

5.4 Rotary Converters

The rotary converters should be inspected periodically. Lubrication data is supplied with each machine. Commutators and slip rings should be cleaned with a dry cloth or possibly very fine sandpaper. If they become badly pitted or irregular, the commutators and slip rings may require to be turned down in a lathe. The brushes should be inspected for wear and renewed when worn to any degree. The active surface of the brush should bed down correctly on the commutator or slip rings.

5.5 P-a and M-o Valves

The valves will, in time, come to the end of their useful life, and evidence of age will probably be noticed in the p-a valves first of all. P-a valves which have reached the end of their life will show reduced output and cathode current for normal drive, while a failing m-o valve will result in lowered drive to the p-a stage with lower grid and plate current than normal. Substitution of new valves should at once indicate if the trouble is in the valves themselves or elsewhere in the circuit.

5.6 Rectifier Valves

The rectifier valves will in time accumulate a deposit inside the glass rendering them almost opaque. This is not an indication of failure. A failing valve may be detected by a change in the character of the glow inside the valve which will become paler and take on a purplish hue in place of the normal bright blue. When these valves are replaced, care must be taken that they are replaced by conditioned valves, and for that reason it is always advisable to substitute from the conditioning circuit sockets and to refill the conditioning circuit at once.

The 523 rectifier in the tone generator rectifier will often show blue glow between the cathode and anode as it ages and the glass runs hotter than normal. The rectifier output is also reduced. If it is suspected that this valve is at fault, the substitution of a new one will at once disclose if the trouble is in the valve or the circuit. The remedy in the case of the valve is replacement, while further search must be made for circuit troubles.

5.7 Tone Generator Valve

The 807 valve used in the tone generator sometimes exhibits a bluish glow inside and near the surface of the glass when in operation. This is normal with this type of valve and is not an indication of a "soft" valve. Failure of this valve is noted by the absence or low output power of the audio frequency. Here also, the best remedy is the substitution of a new valve.

5.8 Dry Rectifier

After prolonged service the dry rectifier may age, resulting in lower d-c output voltage and loss of positive action in the keying circuit. The secondary taps on transformer T6 may be rearranged to permit the resumption of proper operation. As originally supplied this transformer is connected to the circuit by terminals 5 and 7; moving to taps 5 and 8 will raise the voltage to the rectifier about 5%.

5.9 Relay Clearances

The following are the correct clearances for keying relay E1 and compensating relay E2.

Keying relay E1:

Receiver muting contacts	- 1/64"
Antenna contacts	- 1/32"
Power contacts	- 3/64"

Compensating relay E2: - 1/32"

6.1 FAULT TRACING

The following is intended to serve as a guide to the location of faults that may occur in the operation of the equipment. It is not intended to serve as a catalogue of the most likely faults to occur, but merely to indicate the method and general path of some of the more important circuits through the set. Once the fault has been traced to any particular unit it will then rest with the skill and ingenuity of the operating personnel to locate and correct such faults that may have occurred. It must be borne in mind that during all these tests there is a necessity of operating with the safety devices rendered inoperative, and for that reason extreme caution should be exercised when using test instruments. The absence of certain readings does not indicate that there is no voltage applied to the transmitter, but it does indicate that trouble of some sort can be expected; therefore considerably more care than normal in the carrying out of these tests is advised. It is expected that such tests as are carried out will be made using the simplified circuit diagrams in these instructions in conjunction with the main diagram Fig. 12.

The following are some of the general paths to follow in checking the circuits of the transmitter.

6.2 Filaments & Pilot Lamps Will Not Light

(a) Check that main supply switch is closed.

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

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

(d) That fuses F2 are not blown.

(e) That switch S13 is on and that it is making contact.

(f) That the arm on R23 is making contact with the resistance and that the resistance is not open. (On the LM-1 type transmitter, check that the brushes on the General Radio Variac are not broken and that there is a circuit to the output side of the Variac.)

(g) That there is voltage on the terminals of transformer T3.

(h) That there is voltage on the filament pins of the valves and that the valves are not burned out, and that the pilot lamp is O.K.

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

6.3 Filaments Light but High Tension Cannot Be Applied

(a) Check that fuses F4 are not blown.

(b) That contactor E5 closes and that there is a circuit between the two sides of the relay.

(c) Gate switches are all closed and the lock switch has also closed if the transmitter is being operated with gates off.

(d) That the overload relay has not operated and requires resetting.

(e) That voltage is applied to the input terminals of T5.

(f) That there is a connection between the centre tap of transformer T4, through choke L7 to the bleeder resistor at the top of the set, and from the bleeder to the plate circuits of the valves.

(g) That pilot lamp P2 has not burned out. If burned out, h-t may be on but not indicated.

6.4 Filaments and H-T Come On but There Is No Other Indication of Operation

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

(b) Voltages are applied to the elements of the m-o valve V1 (810).

(c) That the key is closed.

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

(e) That the taps on coil L2 are set up in accordance with the instructions and that there are no shorted turns in the coil between sections. Shorted turns result in high plate current but no output.

(f) That condensers C6, C7 and C8 are set up according to the calibration charts for the frequency in use.

(g) That switches S1-1 and S1-2 are making contact.

(h) That meters M2 and M3 are operating.

6.5 Meter M3 Reads but There Is No Reading On Meter M2

(a) Check that lead from L2 to C2 and C9 is connected.

(b) That grid and plate caps are connected to valves V3 and V4.

(c) That voltage is applied to the elements of the valves.

(d) That meter M2 is operating.

6.6 Meters M2 and M3 Read but There Is No Sign of Tune On Meter M2

(a) Check that the taps on coil L5 are set according to the instructions for the frequency in use.

(b) That condensers C15, C16, C17 and C18 are set to the correct values according to the calibration charts.

(c) That the master oscillator is set up on the correct frequency.

(d) That there are no shorted turns in the coil and that the switches S2-1, S2-2, S2-3, S2-4, S2-5 and S2-6 are making good contact.

6.7 Master Oscillator and Power Amplifier Tune Correctly but There Is No Sign of Output Into 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 taps on coupling coil L5 are correctly set for the frequency in use and that switch S2-6 is in the correct position and making good contact.

(c) That the taps on coil L11 are making good contact and are connected in the correct positions.

(d) That switches S15-1 and S15-2 are at the right positions and are making good contact.

(e) That the contacts of break-in relay E1 are making good contact.

(f) That the antenna ammeter is operating and that the shorting link is making good contact if it is used.

(g) That all leads passing through trunks are connected to the set.

(h) That the antenna is connected to the set through the trunks.

6.8 Line Voltage Cannot be Adjusted to the Correct Value as Shown by the Line on M4

(a) Check the line voltage applied to the input terminals (1 and 2 on the power unit) and adjust the voltage from the converter. If this is not possible, readjust the taps on the transformers on the transmitter as outlined in Section 4.9 of these instructions. If there is no reading on the meter, check that it is connected and that it will operate when the correct voltage is applied to it.

6.9 Set Will Operate on C-W but Fails to Modulate on I-C-W

(a) Check that there is voltage applied to terminals 1 and 2 on the tone generator.

(b) That S5-1 and S5-2 have operated correctly and that there is a circuit through them.

(c) That there is voltage applied to the valves V4 and V5.

(d) That the contacts of break-in relay E1 are making good contact.

(e) That V5 has not become unsuitable for this application and will not function. This is done by substituting a spare valve for it.

6.10 Heaters Stay On All the Time or Fail to Come On At All

(a) Check the operation of E6.

(b) That fuses F1 are not blown.

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

(d) That the resistors have not burned out.

6.11 Switching to "Adjust" Causes Transmitter to Cease Operation

(a) Check that R23 is not open.

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

6.12 Overload Trips When the Key is Pressed

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

(b) Remove lead to terminal 1 in power amplifier and recheck.

(c) Remove lead to terminal 1 in master oscillator and recheck.

(d) If condition still exists after checking as above, examine filter section of the power unit.

(e) Examine overload relay and check that the adjustment has not been tampered with.

(f) Shorted coil turns may overload set sufficiently to blow the breaker.

6.13 Fuses F4 Blow Frequently

(a) 872A valves are defective. Change them.

6.14 Break-In Relay Does Not Operate With Positive Action

(a) Measure voltage across the coil, which should be between 12 and 14 volts.

(b) If voltage is low, adjust the taps on T6 as described in the instructions.

(c) See that there is no oil or grease on the relay to slow down the action.

7.1 PARTS LIST

Symbol	Part	Description	Type No.	Maker
Condensers				
C1	M-o plate blocking	.005-uf 6000-v	9-FAS-62050	C-D
C2	" grid	.005-uf 5000-v	9-AS-52050	"
C3	" tank	350-uuf 6000-v	91717	Marconi
C4	" filament bypass	.01-uf 1000-v	4S-11010	C-D
C5	" " "	.01-uf 1000-v	4S-11010	"
C6	" tank	.00025-uf 5000-v	364-6S	"
C7	" "	.0005-uf 5000-v	272-6S	"
C8	" "	.001-uf 6000-v	463-6S	"
C9	P-a grid coupling	.005-uf 5000-v	9-AS-52050	"
C10	" " bypass	.001-uf 2500-v	4S-22010	"
C11	Not used			
C12	" "			
C13	P-a plate blocking	.005-uf 6000-v	9-FAS-62050	"
C14	" tank	350-uuf 6000-v	91717	Marconi
C15	" "	.00025-uf 6000-v	586-59	C-D
C16	" "	.0005-uf 6000-v	544-59	"
C17	" "	.001-uf 6000-v	545-59	"
C18	" "	.002-uf 6000-v	572-59	"
C19	Tone generator rectifier smoothing	4-uf 1000-v	TJ-10040	"
C20	Ditto	4-uf 1000-v	TJ-10040	"
C21	T-g screen bypass	.5-uf 1000-v	DY-10050	"
C22	" grid bypass	.01-uf 1000-v	4-S-11010	"
C23	" " coupling	.1-uf 1000-v	DY-10010	"
C24	" tank	.02-uf 2500-v	9-AS-21020	"
C25	" "	.02-uf 2500-v	9-AS-21020	"
C26	" "	.1-uf 1000-v	DY-10010	"
C27	Meter bypass	.01-uf 1000-v	4-AS-11010	"
C28	" "	.01-uf 1000-v	4-AS-11010	"
C29	Keying spark suppressor	2-uf 600-v	DY-6200	"
C30	H-t smoothing	2-uf 2500-v	TJ-25020	"
C31	Keying spark suppressor	.5-uf 600-v	DY-6050	"
C32	Thermostat spark suppr.	.1-uf 600-v	CY-6010	"
C33	Meter bypass	.01-uf 1000-v	4-AS-11010	"
C34	P-a plate blocking	.005-uf 6000-v	9-FAS-62050	"
C35	" tank	.00015-uf 6000-v	587A-59	"
Relays				
E1	Break-in		Type 202, 6-v d-c coil approx 4.4 ohms	Leach
E2	Keying compensating		Type 101, 6-v d-c coil approx 4.4 ohms	"

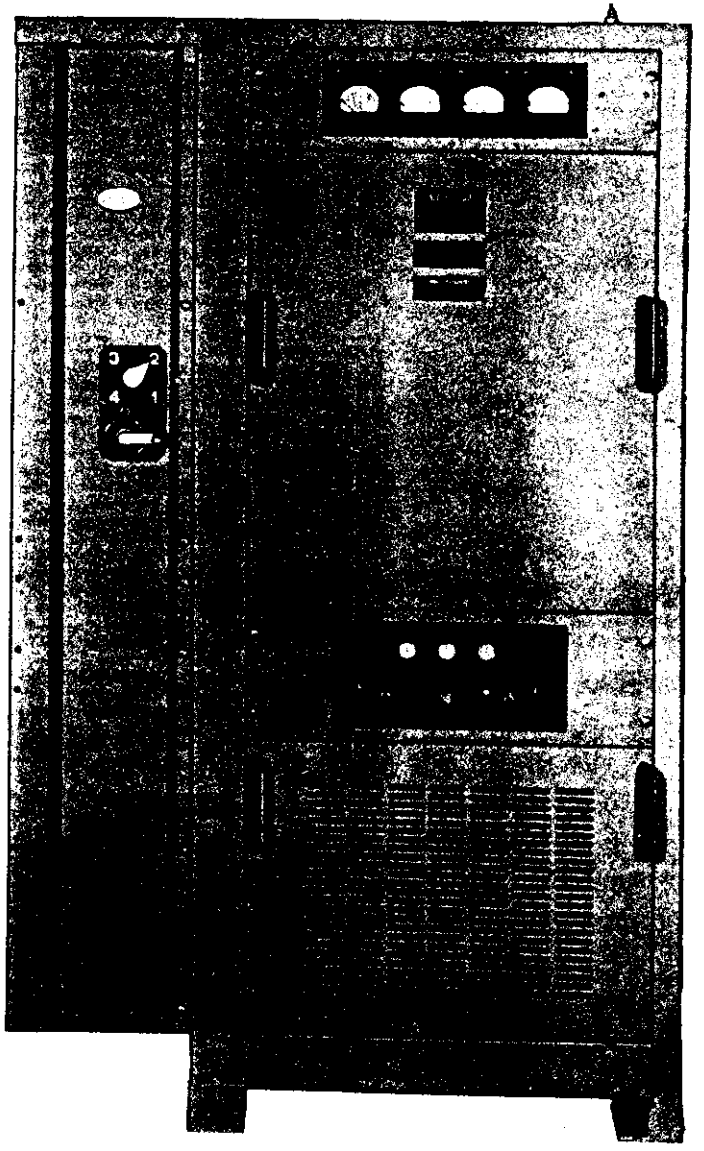
Symbol	Part	Description	Type No.	Maker
E3	Not used			
E4	" "			
E5	Main contactor		Bull.700AC open type, 110-v 60-c coil A209	Allen-Bradley
E6	Thermostat		Type M8-D8-2B normally closed self regulating 75° F +-5°	T.A. Edison Inc
E7	Overload		Type 1040 trip current .75 amp d-c coil #351 2.5 ohms	Leach
Fuses				
F1	Heater (2)	5-amp 250-v	AF533	Economy
F2	Main line (2)	30-amp 250-v	AF3033	"
F3	Filament (2)	5-amp 250-v	AF533	"
F4	Power (2)	25-amp 250-v	AF2533	"
Inductances				
L1	M-o plate choke		88959	Marconi
L2	" tank		91175	"
L3	P-a grid choke		90899	"
L4	" plate choke		90893	"
L5	" tank		90900	"
L6	T-g rectifier smoothing choke		91126	"
L7	H-t " " "		89361	"
L8	M-o grid choke		90899	"
L9	H-t rectifier suppressor choke		84900	"
L10	" " " "		84900	"
L11	Antenna tuning variometer		103-040	"
Meters				
M1	Antenna ammeter	0-15-amps r-f	37S	Simpson
M2	M-o cathode milliam.	0-150-ma d-c	27S	"
M3	P-a " "	0-1000-ma d-c	27S	"
M4	Filament line voltm.	0-150-v 60-cycles red line at 110-v	57S	"
Lamps				
P1	Pilot lamp	120-v 6-w	S6 clear	C.G.E.
P2	" "	Ditto	Ditto	"
P3	" "	Ditto	Ditto	"

Symbol	Part	Description	Type No.	Maker
Resistors				
R1	M-o grid leak	10,000 ohms	CE "C" coating #5 terminals	I.R.C.
R2	" parasitic suppr.	125-ohms	AB "C" coat. #1 term.	"
R3	P-a " "	125-ohms	Ditto	"
R4	" " "	125-ohms	Ditto	"
R5	" grid leak	2,000-ohms	FJ "C" coat. #5 term.	"
R6	T-g rect. bleeder	50,000-ohms	FB "C" coat. #5 term.	"
R7	" screen resistor	40,000-ohms	CE "C" coat. #5 term.	"
R8	" cathode resistor	250-ohms	AB "C" coat. #1 term.	"
R9	" grid resistor	15,000-ohms +-5%	BT-1	"
R10	" " "	35,000-ohms +-5%	BT-1	"
R11	P-a grid resistor	3,000-ohms	FD "C" coat. #5 term.	"
R12	H-t bleeder	4,000-ohms	HE "C" coat. #5 term.	"
R13	" "	4,000-ohms	Ditto	"
R14	" "	4,000-ohms	Ditto	"
R15	" "	4,000-ohms	Ditto	"
R16	" "	4,000-ohms	Ditto	"
R17	" "	2,000-ohms	HA "C" coat. #5 term.	"
R18	" "	2,000-ohms	Ditto	"
R19	Keying spark suppress.	1,000-ohms +-10%	AB "C" coat. #1 term.	"
R20	Rectifier heater	Enclosed heater unit	100-w 115-v	Chromalox
R21	" "	Ditto	Ditto	"
R22	Keying compensator	7.5-ohms 100-w	Model K #0445	Ohmite
R23	Power reducing resistor	Straight core heater element, screw base	660-w 110-v	P.M. Wright Electric
R24	Filament compensator	15-ohms 300-w	Model N #0659	Ohmite
Switches				
S1	M-o wavechange		91756	Marconi
S2	P-a "		91710	"
S3	Conditioning on-off		81009	A H & H
S4	Tone selector		92373	Marconi
S5	CW-ICW		91136	"

Symbol	Part	Description	Type No.	Maker
S6	Adjust-Operate		8425	A H & H
S7	H-t interlock		20595	"
S8	" "		3591	"
S9	" "		3597	"
S10	" "		3591	"
S11	Door switch		6161	"
S12	Line		6465	"
S13	Filament		8421	"
S14	On-Standby		81009	"
S15	Antenna wavechange		91960	Marconi
Transformers				
T1	Tone generator rectifier power		89036	"
T2	" " oscillator		89301	"
T3	Filament	(on LM)	97657	"
		(on LM-1)	89199	"
T4	Filament	(on LM)	97652	"
		(on LM-1)	89306	"
T5	H-t rectifier power		89056	"
T6	Keying rectifier	(on LM)	97695	"
		(on LM-1)	89308	"
T7	Filament control	(on LM-1 only)	30-B Variac	Gen.Radio
T8	Conditioning valve		97635	Marconi
Valve Sockets				
V1	Valve socket (810)		Type 211 white	Johnson
V2	" " "		" " "	"
V3	" " "		" " "	"
V4	" " (5Z3)		SS-4	Amphenol
V5	" " (807)		SS-5	"
V6	" " (872A)		Type 211 white	Johnson
V7	" " "		" " "	"
V8	" "		" " "	"
V9	" "		" " "	"
Miscellaneous				
CU1	Keying rectifier		F-28-C-1	Mallory
	Cooling fan		#800 BMC	Air Cond. & Engrg Corp.

Canadian MARCONI Company,
Montreal, April 14, 1943.

W/T TRANSMITTERS
LOW FREQUENCY TYPE
PV-500-LM



FRONT VIEW

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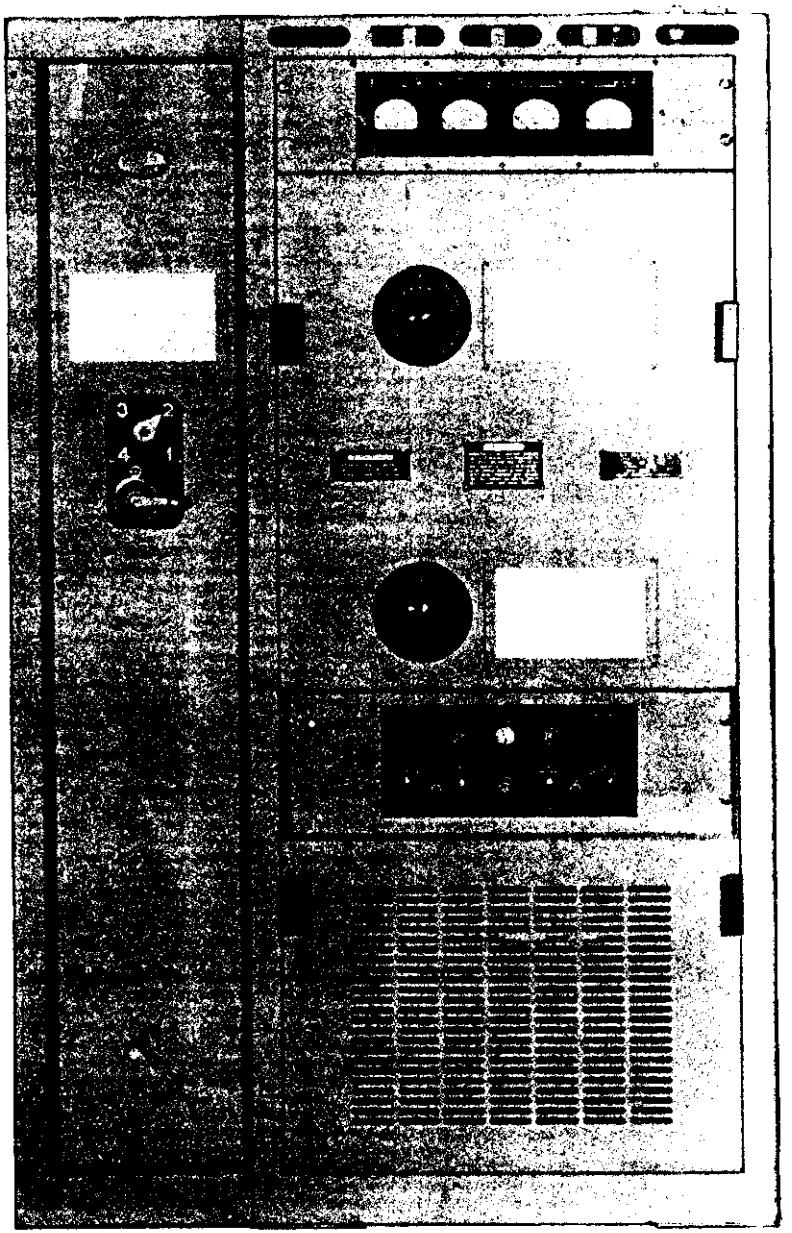
FIG. 1

W/T TRANSMITTERS
LOW FREQUENCY TYPE
PV-500-LM2 & LM3



FRONT VIEW

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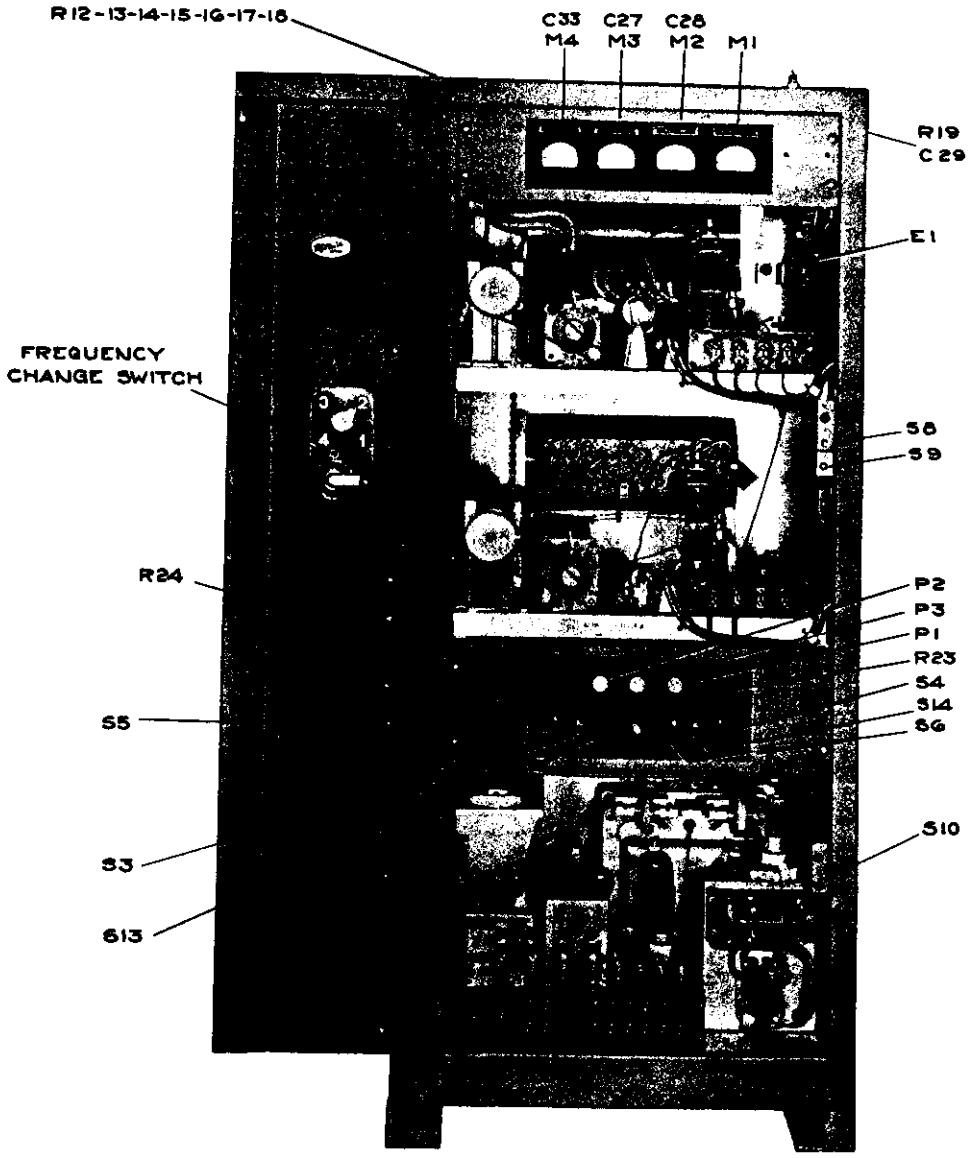
FIG. 1A

W/T TRANSMITTERS
LOW FREQUENCY TYPE
PV-500-LM



FRONT VIEW
COVERS REMOVED

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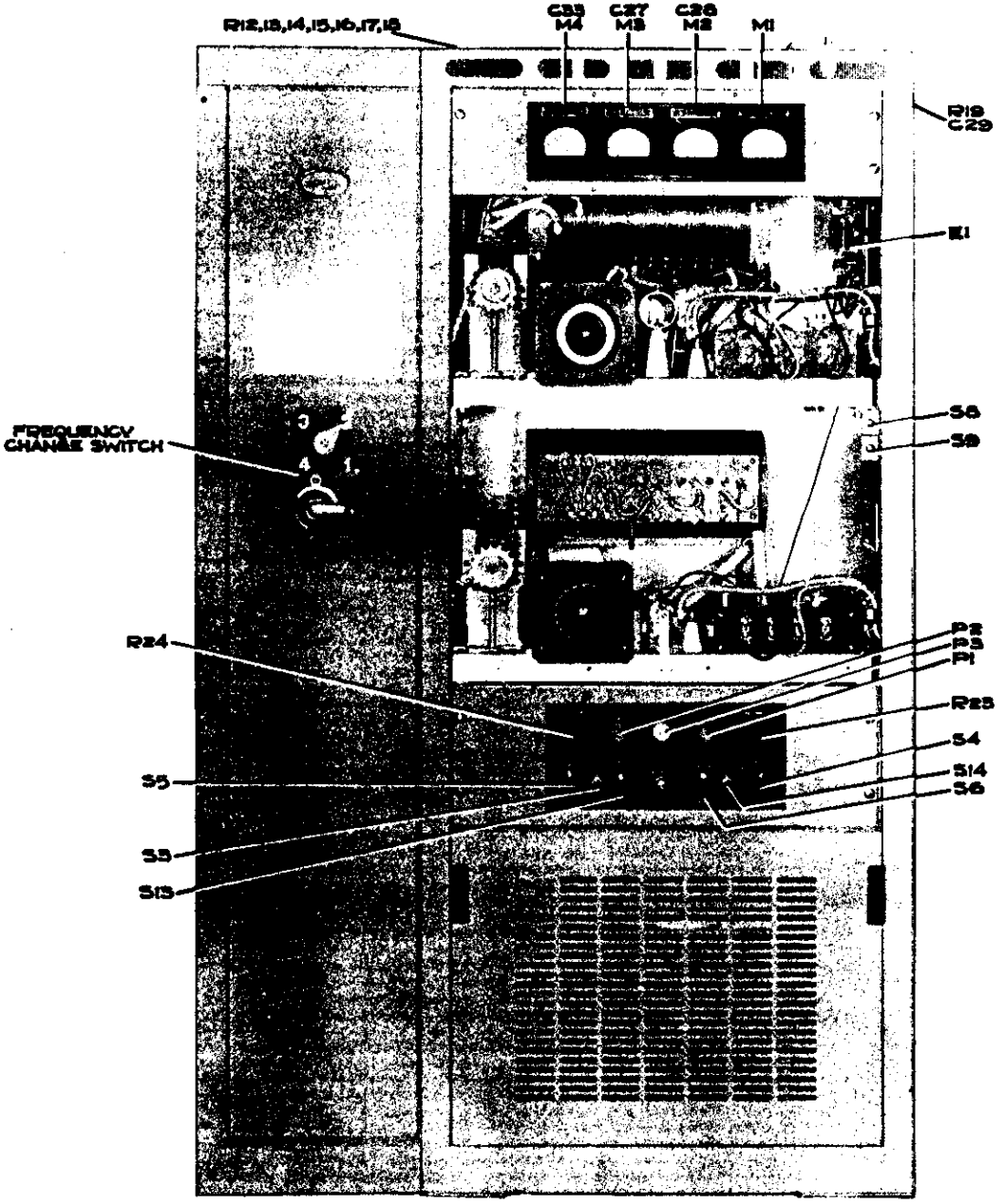
FIG. 2

W/T TRANSMITTERS
LOW FREQUENCY TYPE
PV-500-LM2 & LM3



FRONT VIEW
COVERS REMOVED

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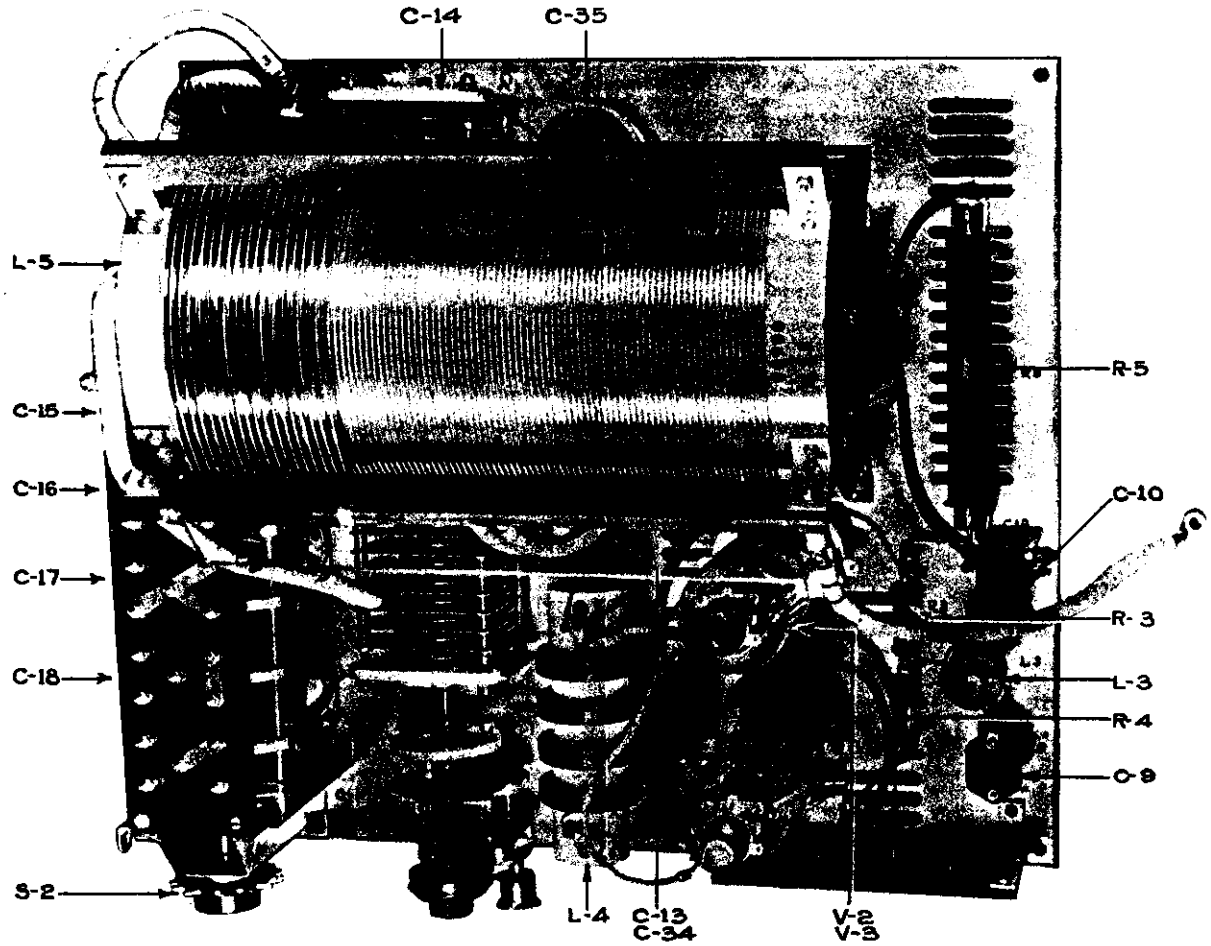
FIG. 2 A



POWER AMPLIFIER SECTION
TOP VIEW

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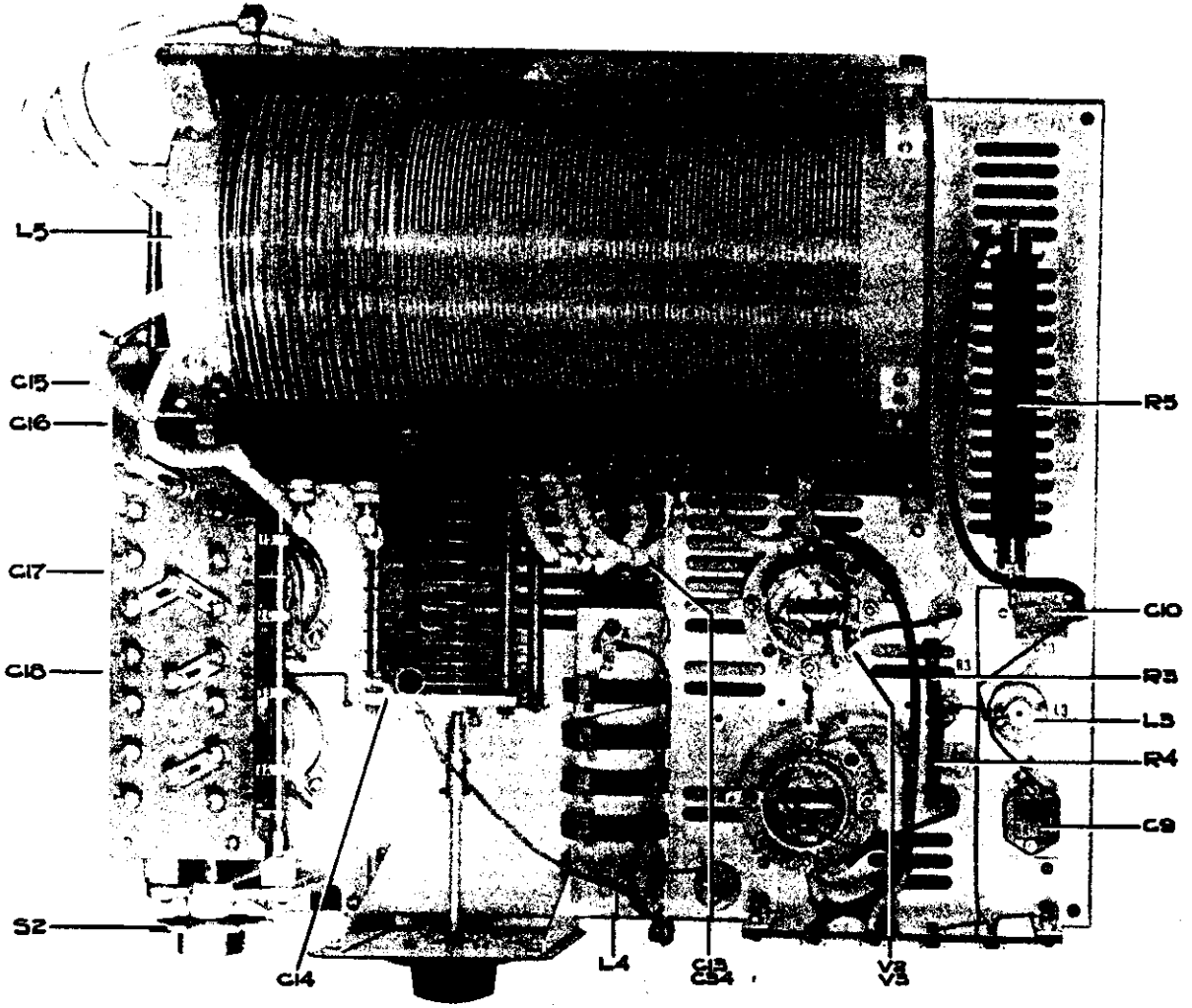
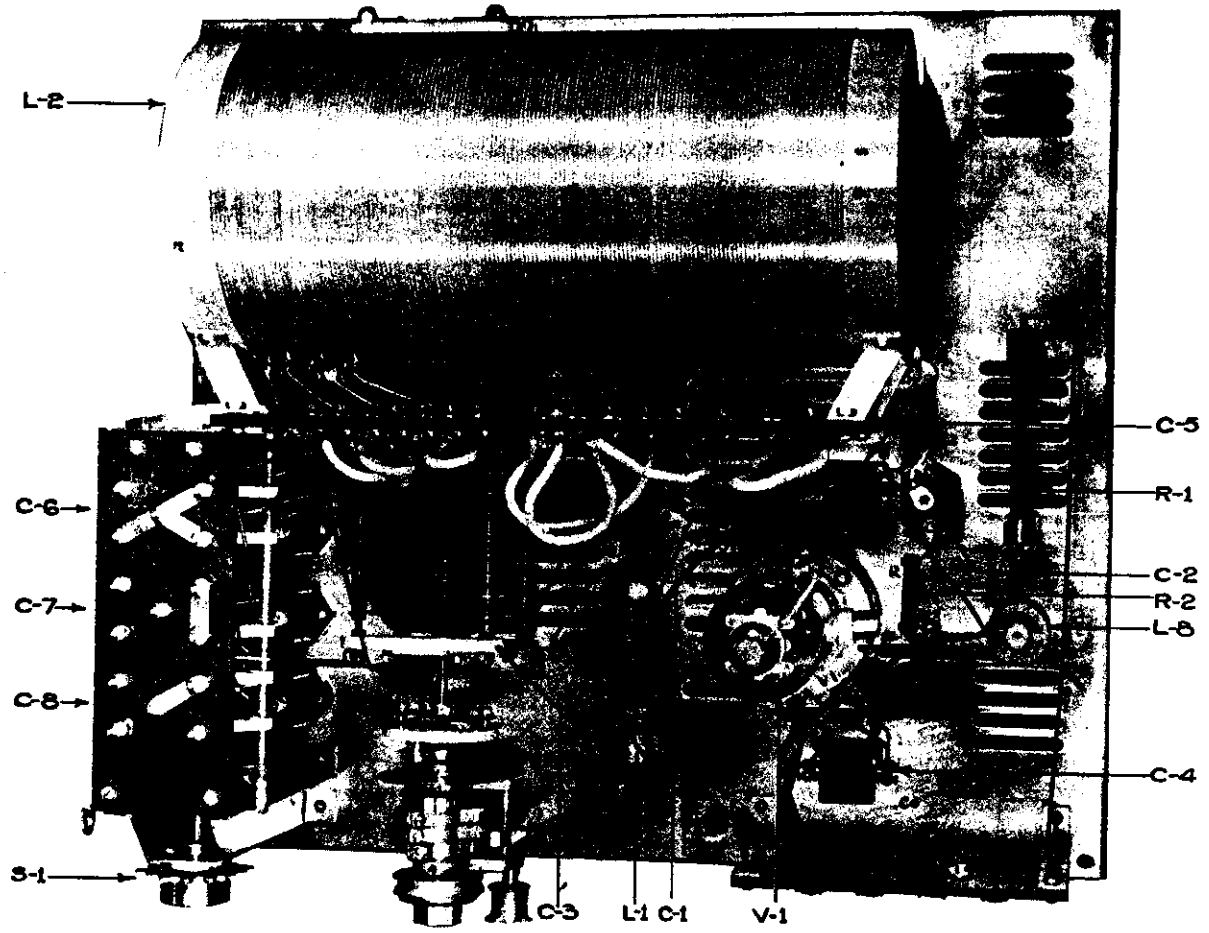
FIG. 3



POWER AMPLIFIER SECTION
TOP VIEW

CANADIAN Marconi COMPANY

FIG. 3A



MASTER OSCILLATOR SECTION
TOP VIEW

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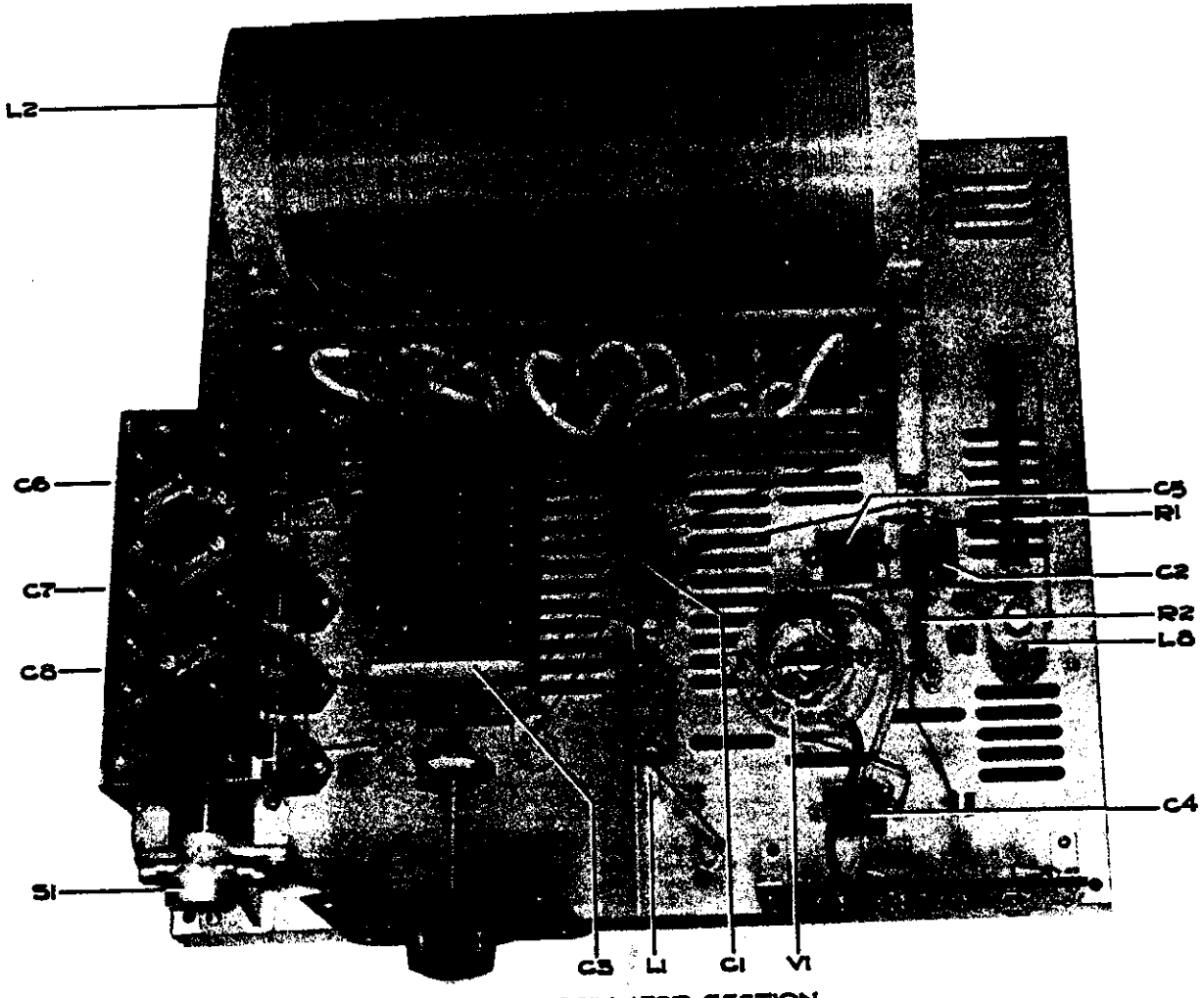
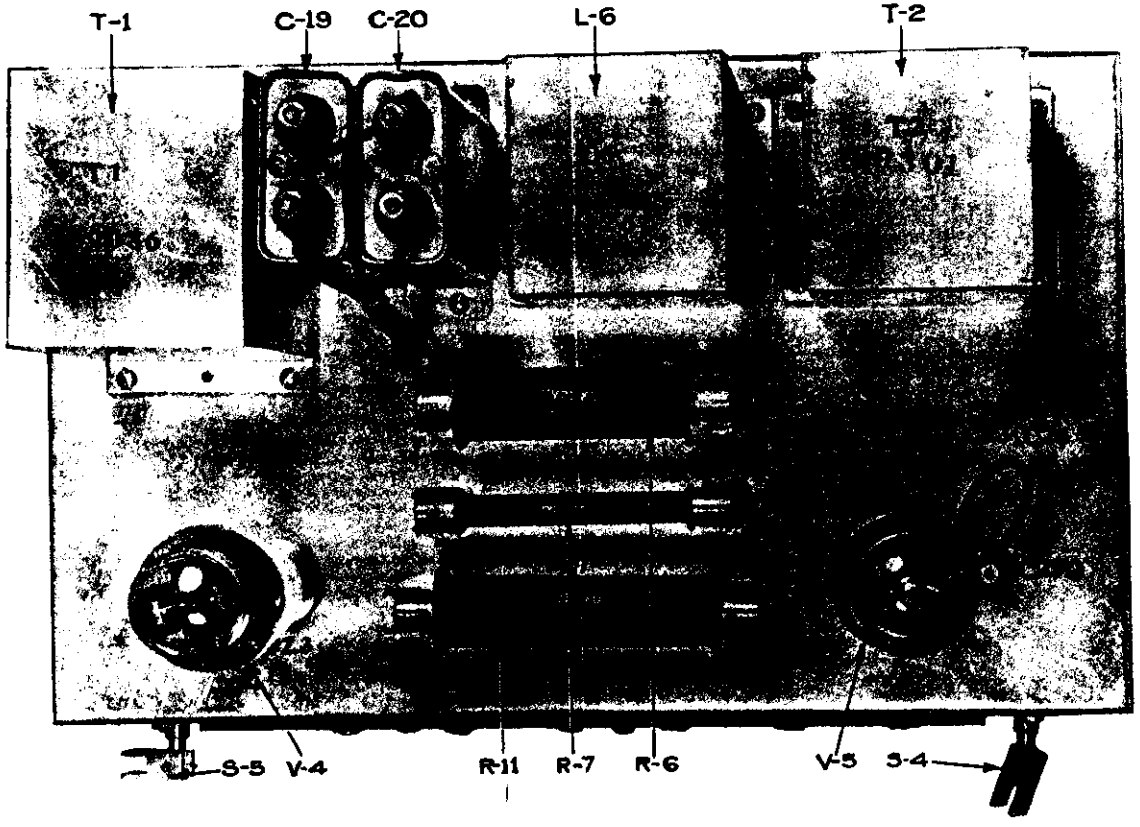
FIG. 4



MASTER OSCILLATOR SECTION
TOP VIEW



TONE GENERATOR SECTION
TOP VIEW

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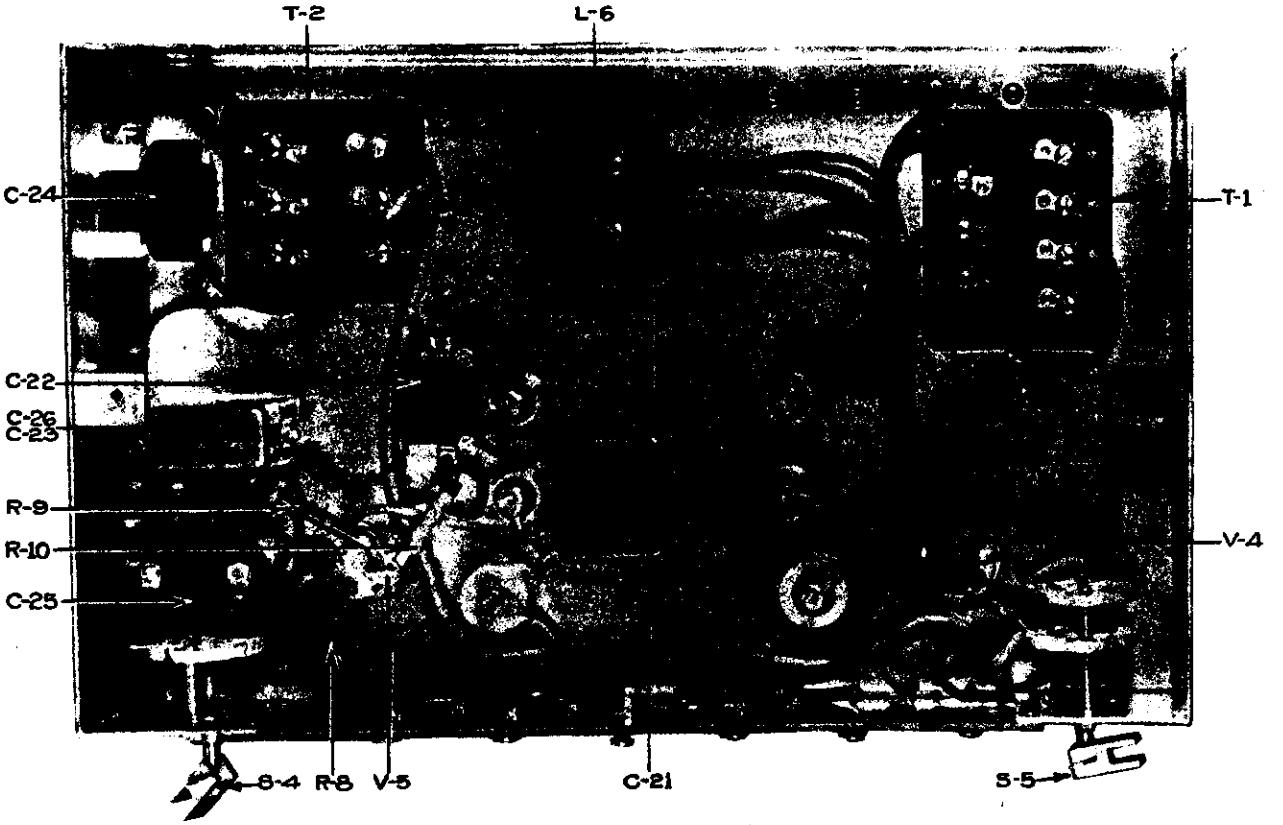
FIG. 5

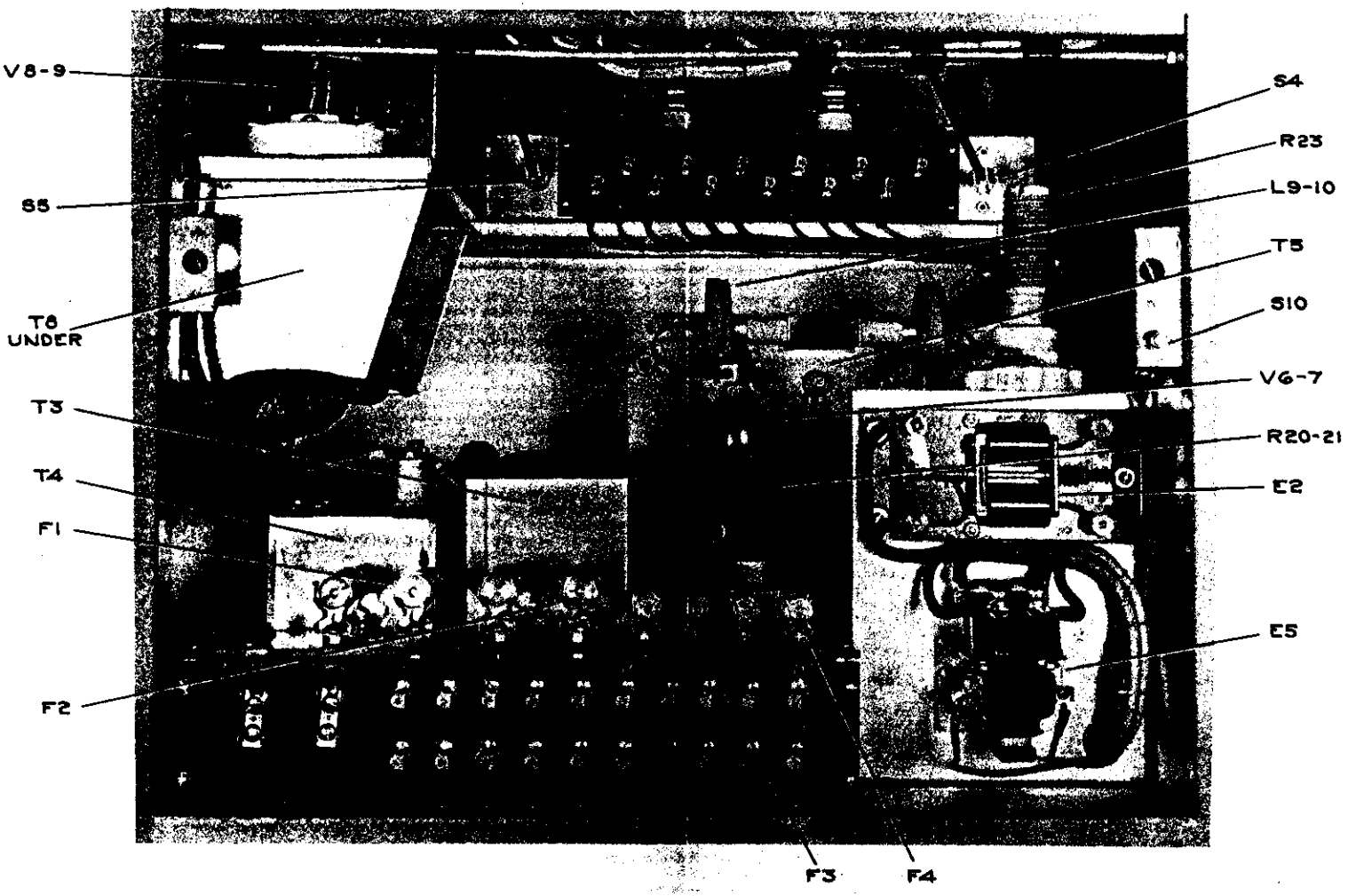
W/T TRANSMITTERS
LOW FREQUENCY TYPE
PV-500-LM



TONE GENERATOR SECTION
BOTTOM VIEW

CANADIAN Marconi COMPANY

FIG. 6

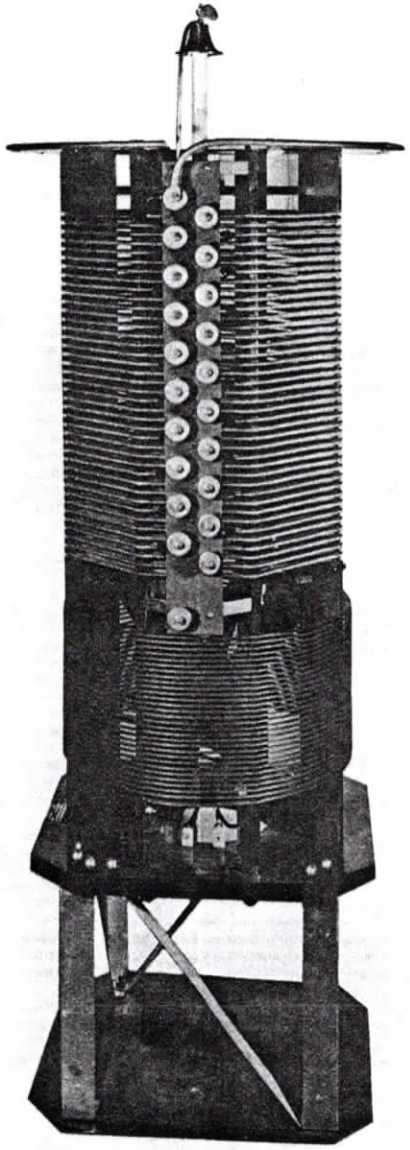


POWER SUPPLY SECTION
FRONT VIEW

CANADIAN Marconi COMPANY

FIG. 7

T TRANSMITTERS
LOW FREQUENCY TYPE
PV-500-LM

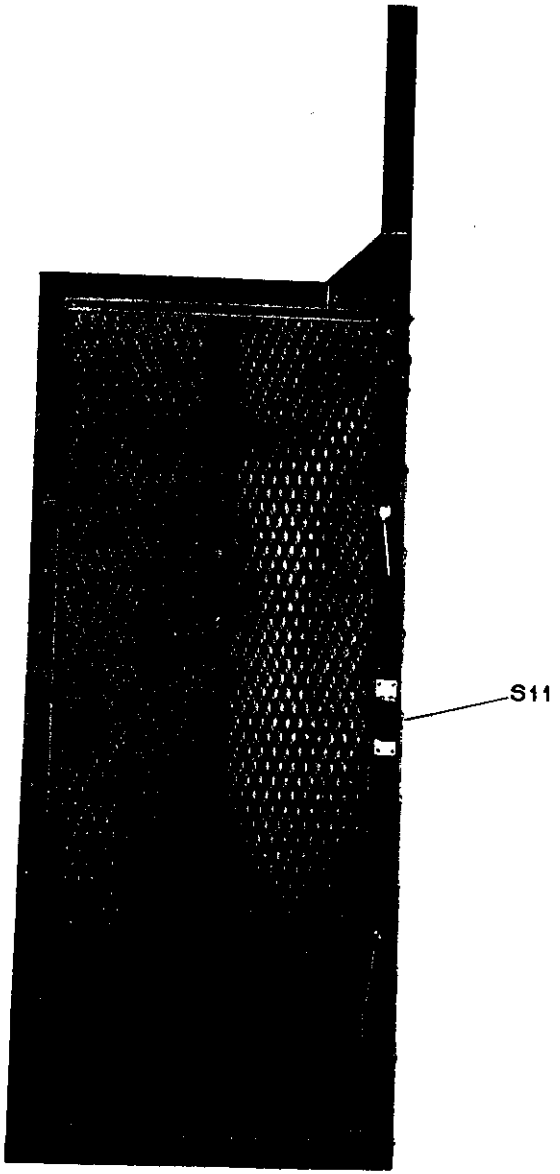


ANTENNA LOADING COIL 103-040
GENERAL VIEW

CANADIAN Marconi COMPANY

FIG. 8

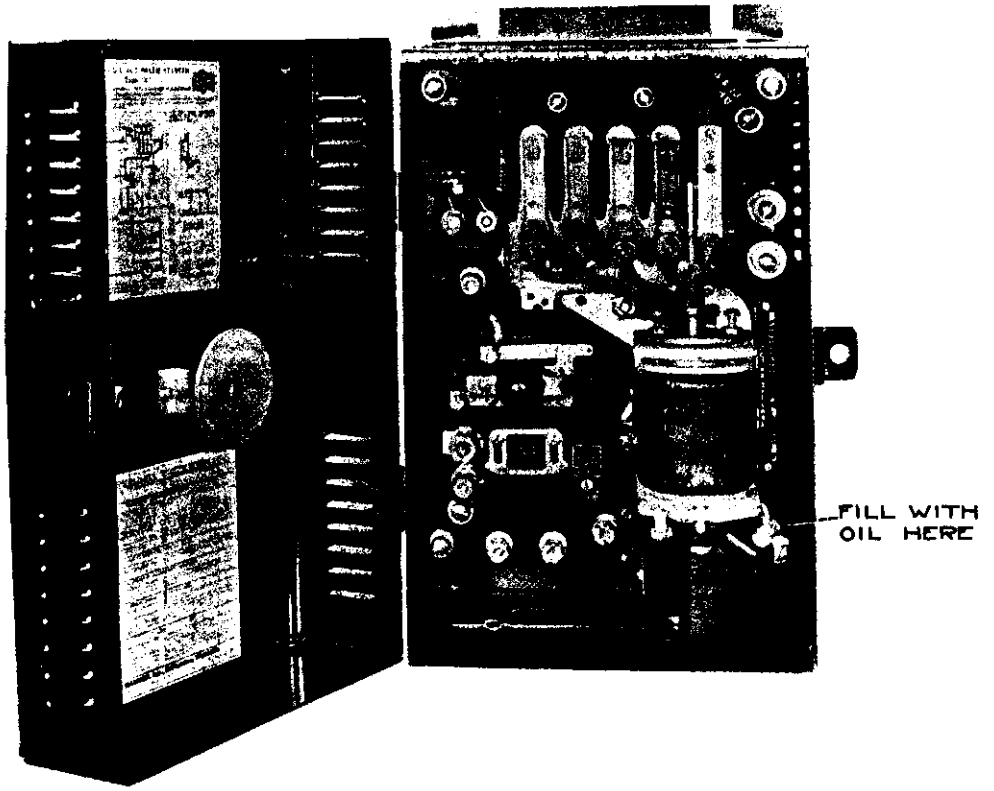
W/T TRANSMITTERS
LOW FREQUENCY TYPE
PV-500-LM



SAFETY GATE
TYPE 93915

CANADIAN Marconi COMPANY

FIG. 9



STARTER BOX
COVER OPEN

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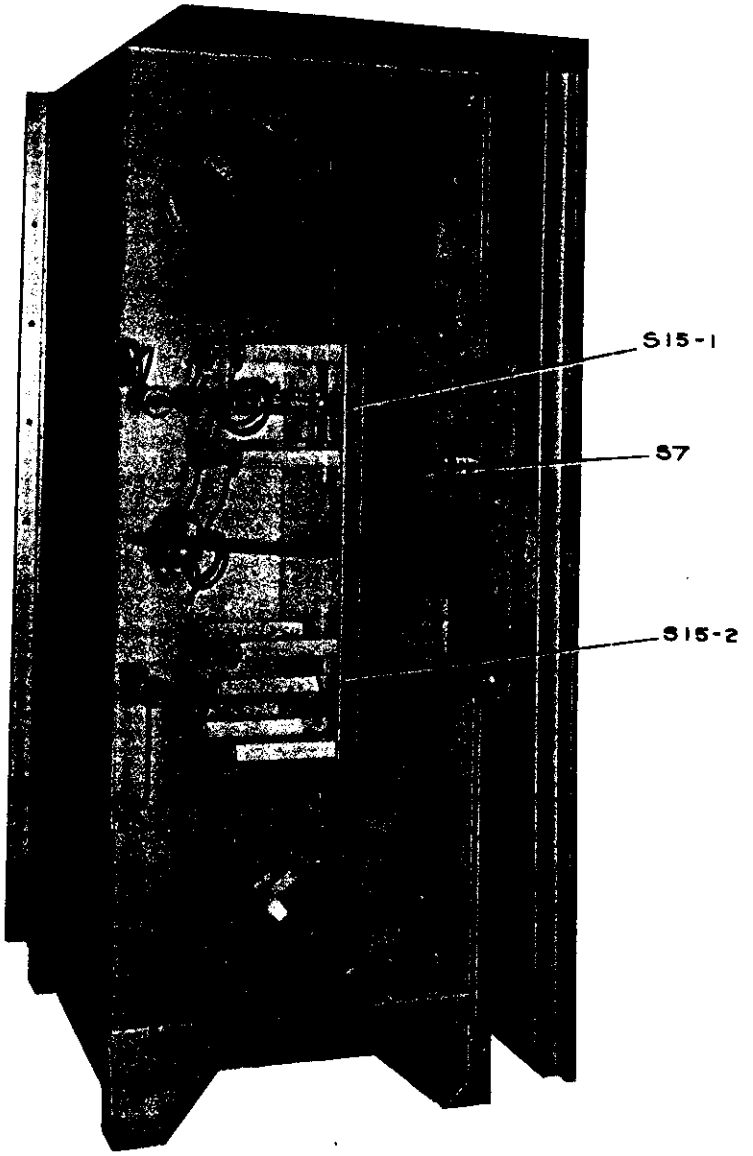
FIG. 10

W/T TRANSMITTERS
LOW FREQUENCY TYPE
PV-500-LM



SIDE VIEW SHOWING WAVE
CHANGE SWITCHES S15-1, S15-2

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FIG. 11

PV-500LM TONE GENERATOR
DIAGRAMMATIC

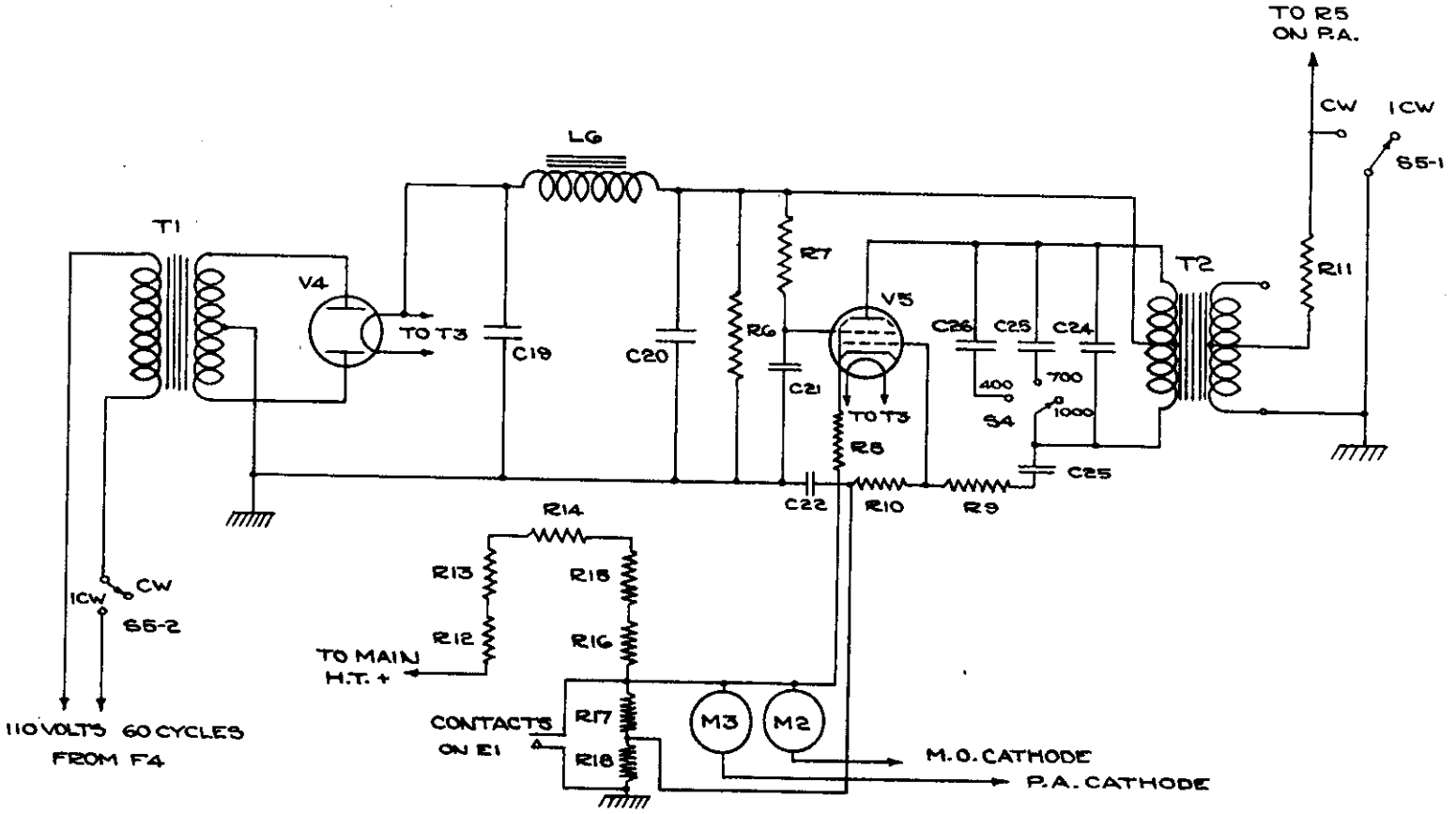

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FIG. 14

PV-500LM RADIO FREQUENCY CIRCUITS-DIAGRAMMATIC

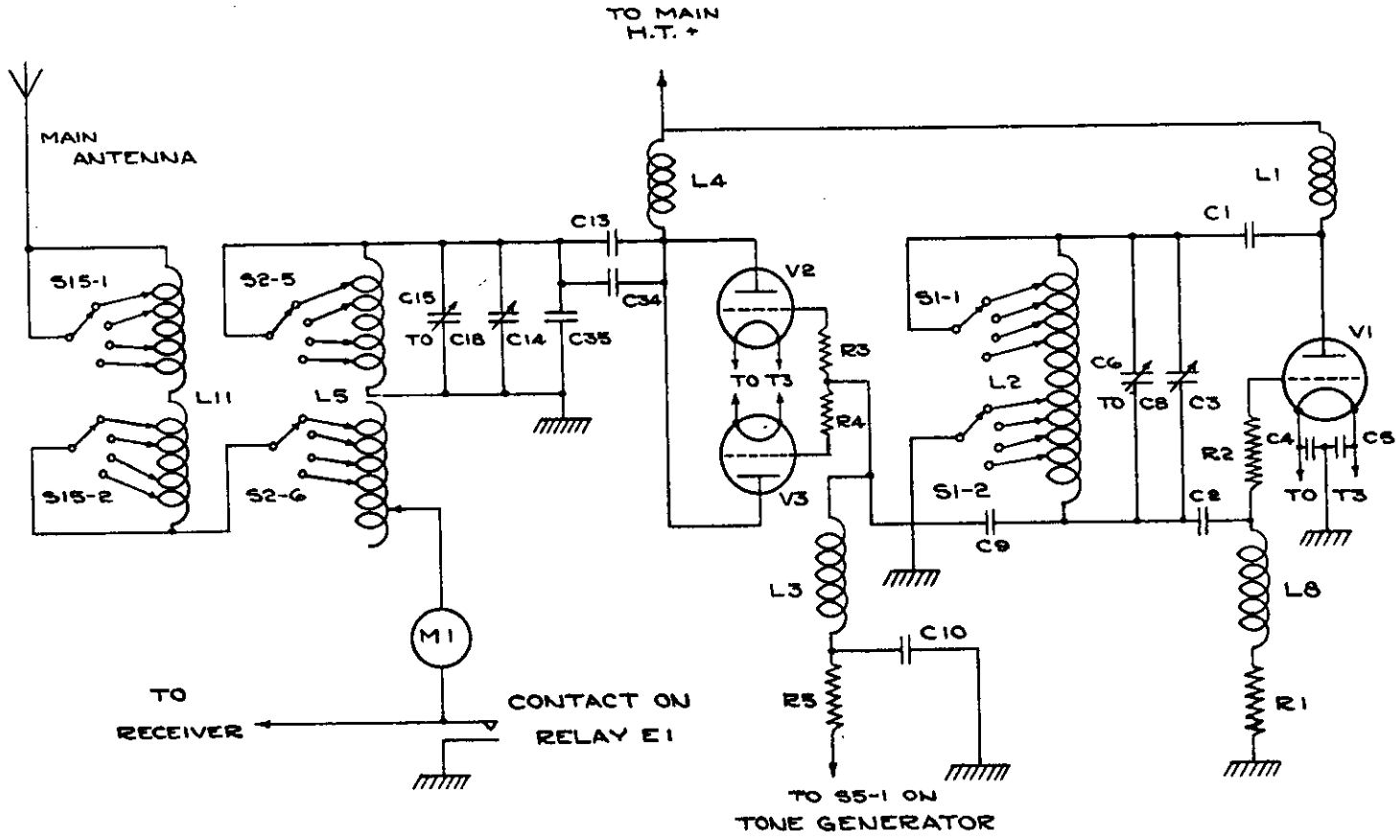

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FIG. 15

PV-500LM KEYING CIRCUITS
DIAGRAMMATIC

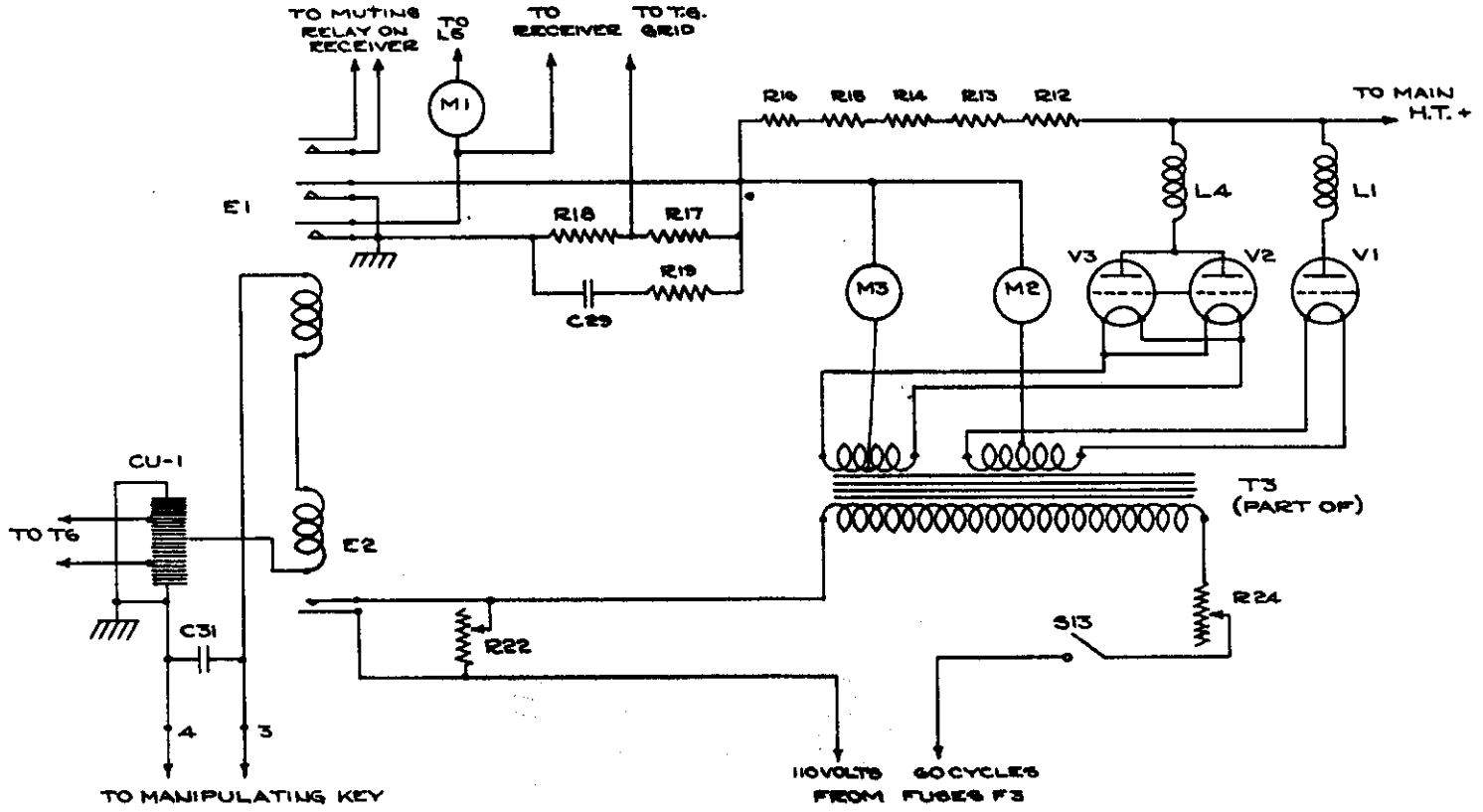

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FIG. 16

PV 500LM POWER SUPPLIES
DIAGRAMMATIC

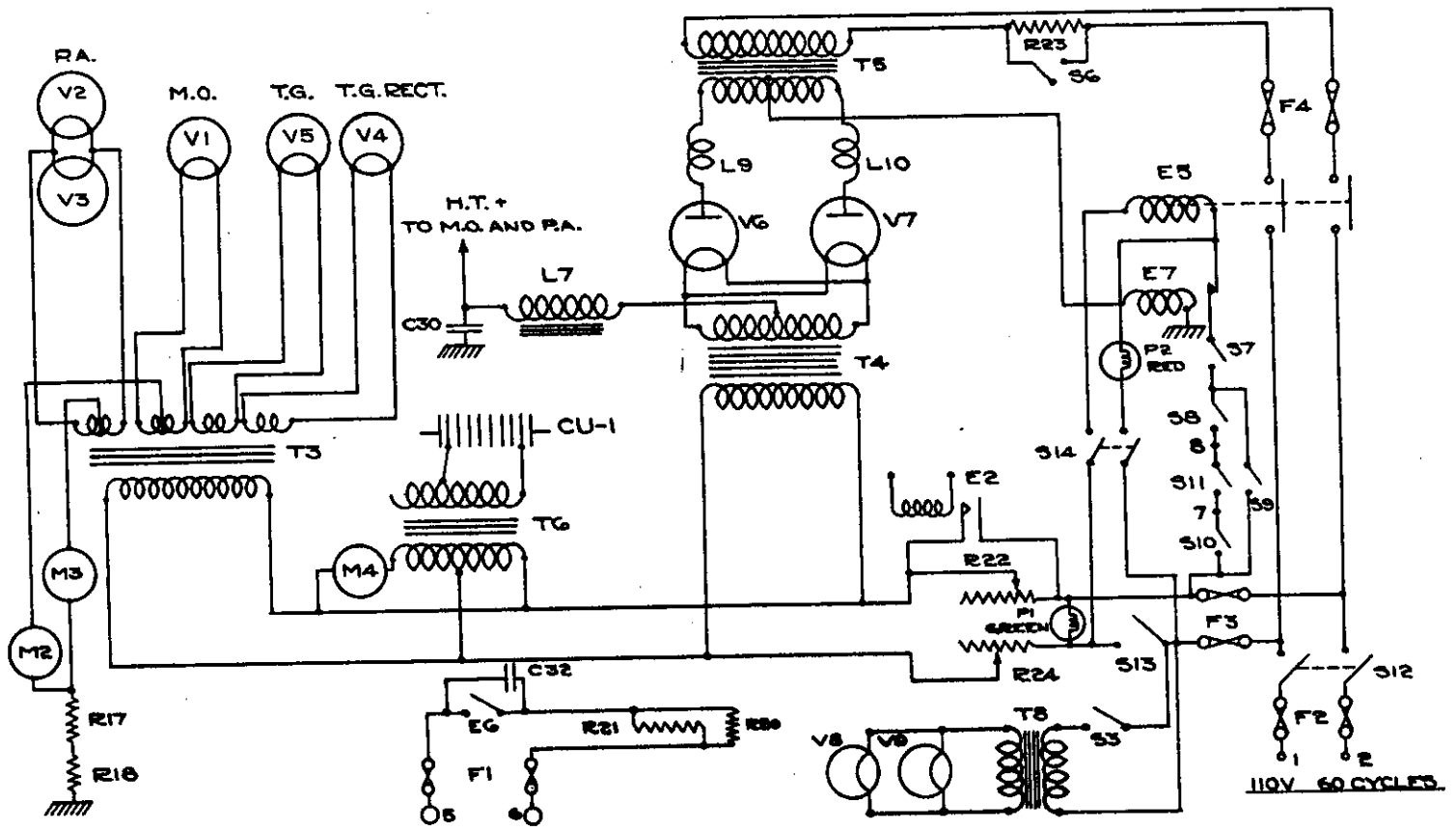

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FIG. 17

W/T TRANSMITTER

LOW FREQUENCY - TYPE PV 500 LM

DIMENSIONS & MOUNTING CENTRES. ROTARY CONVERTERS.

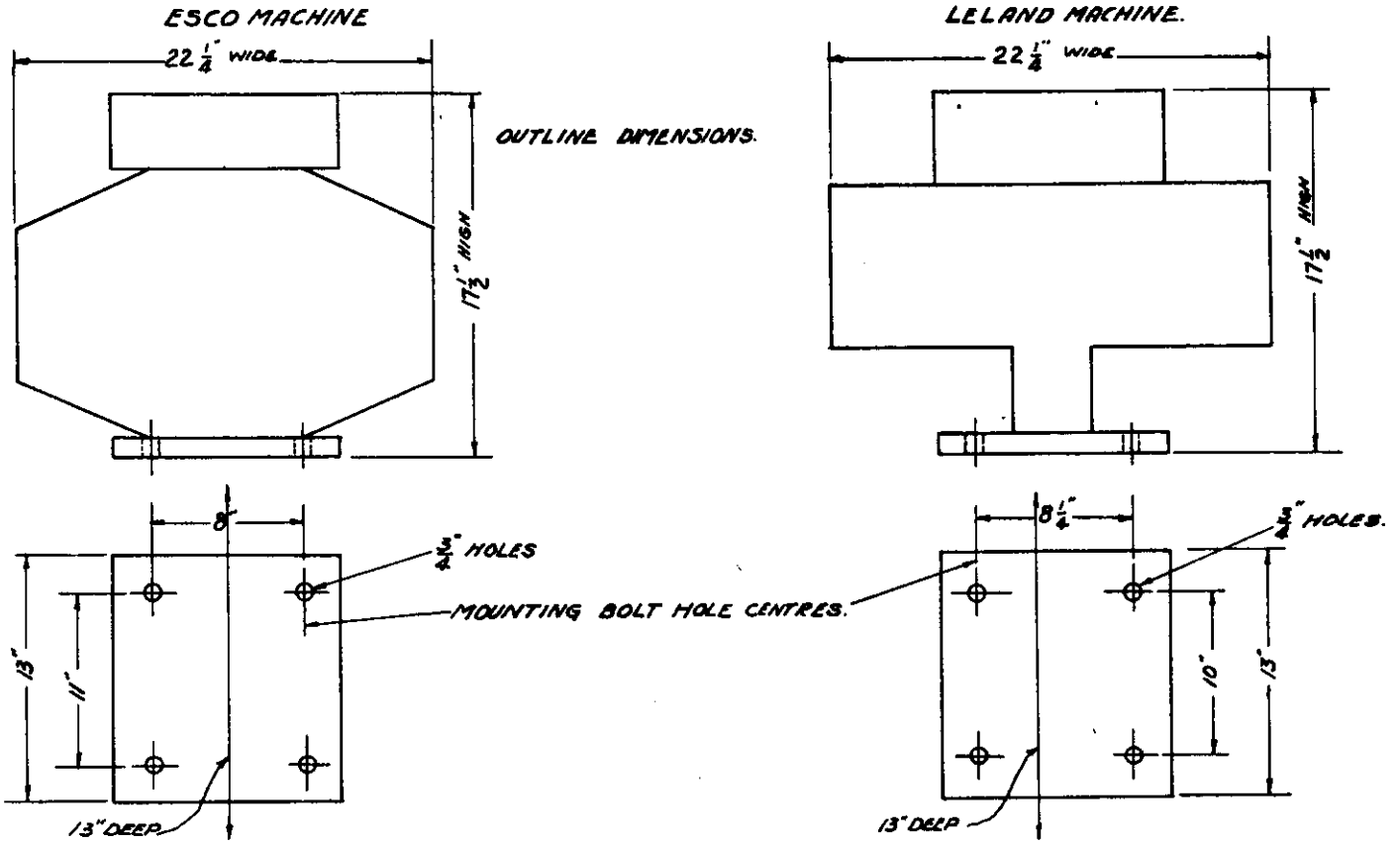

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FIG. 18

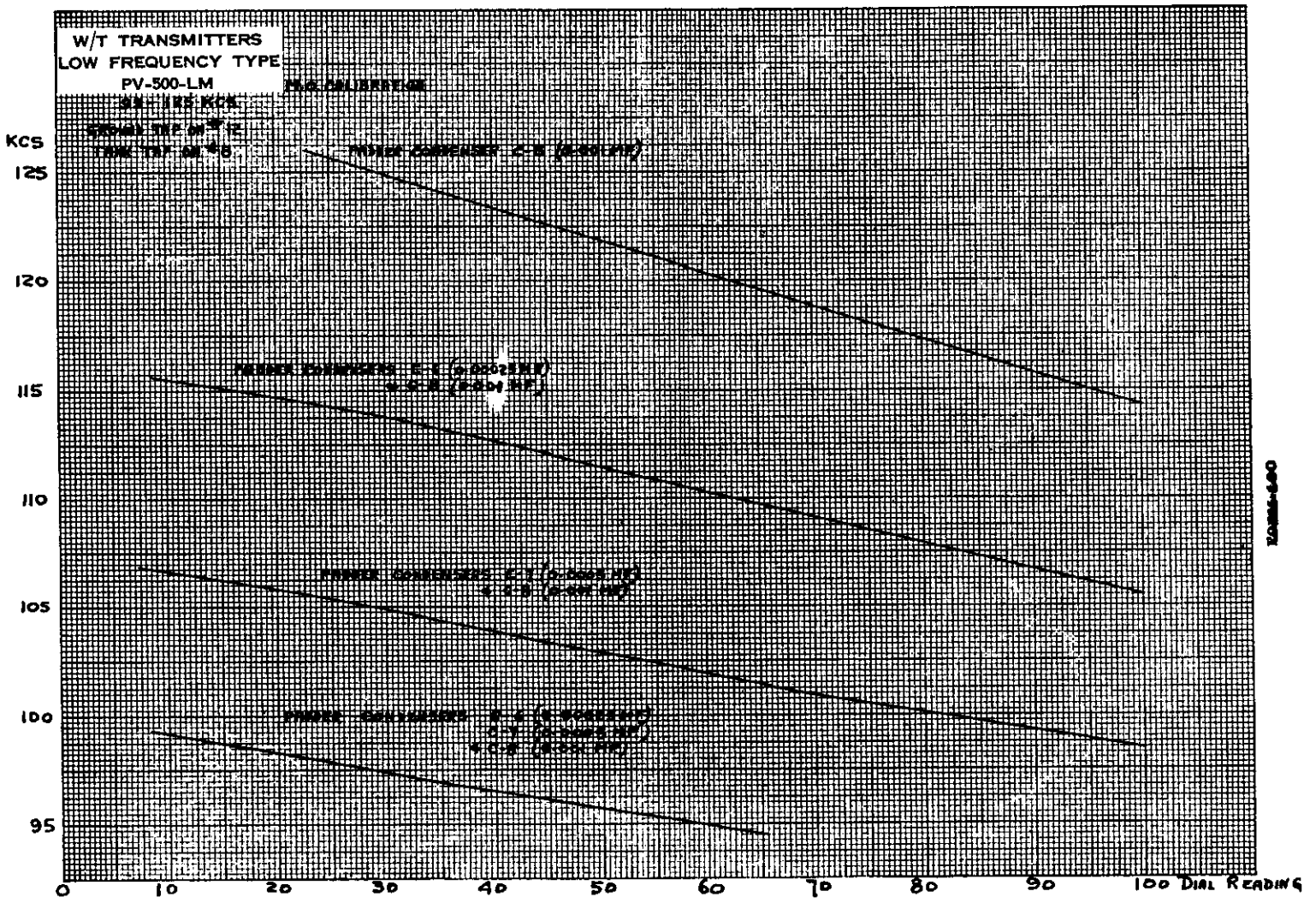

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FIG. 19

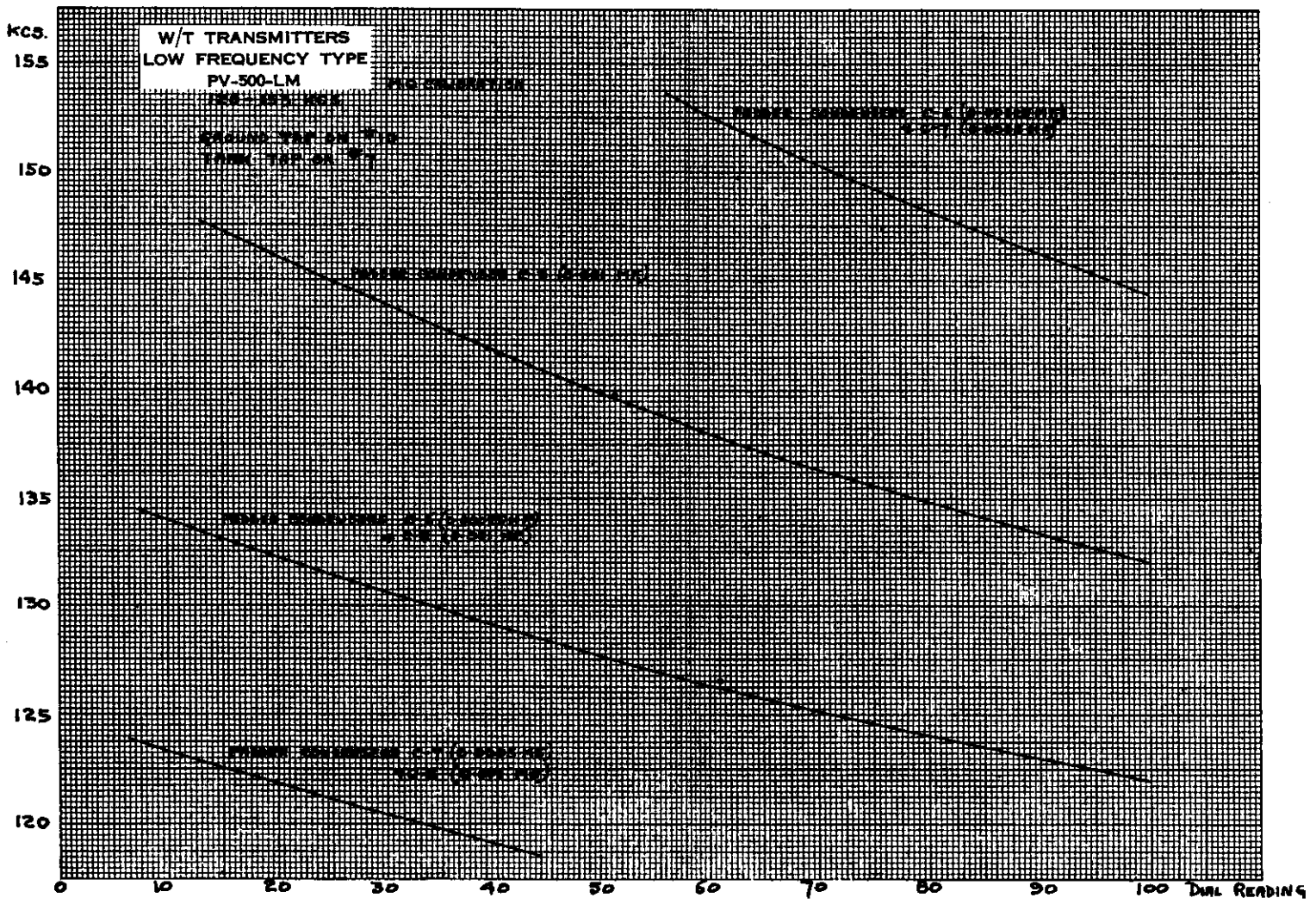

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FIG. 20

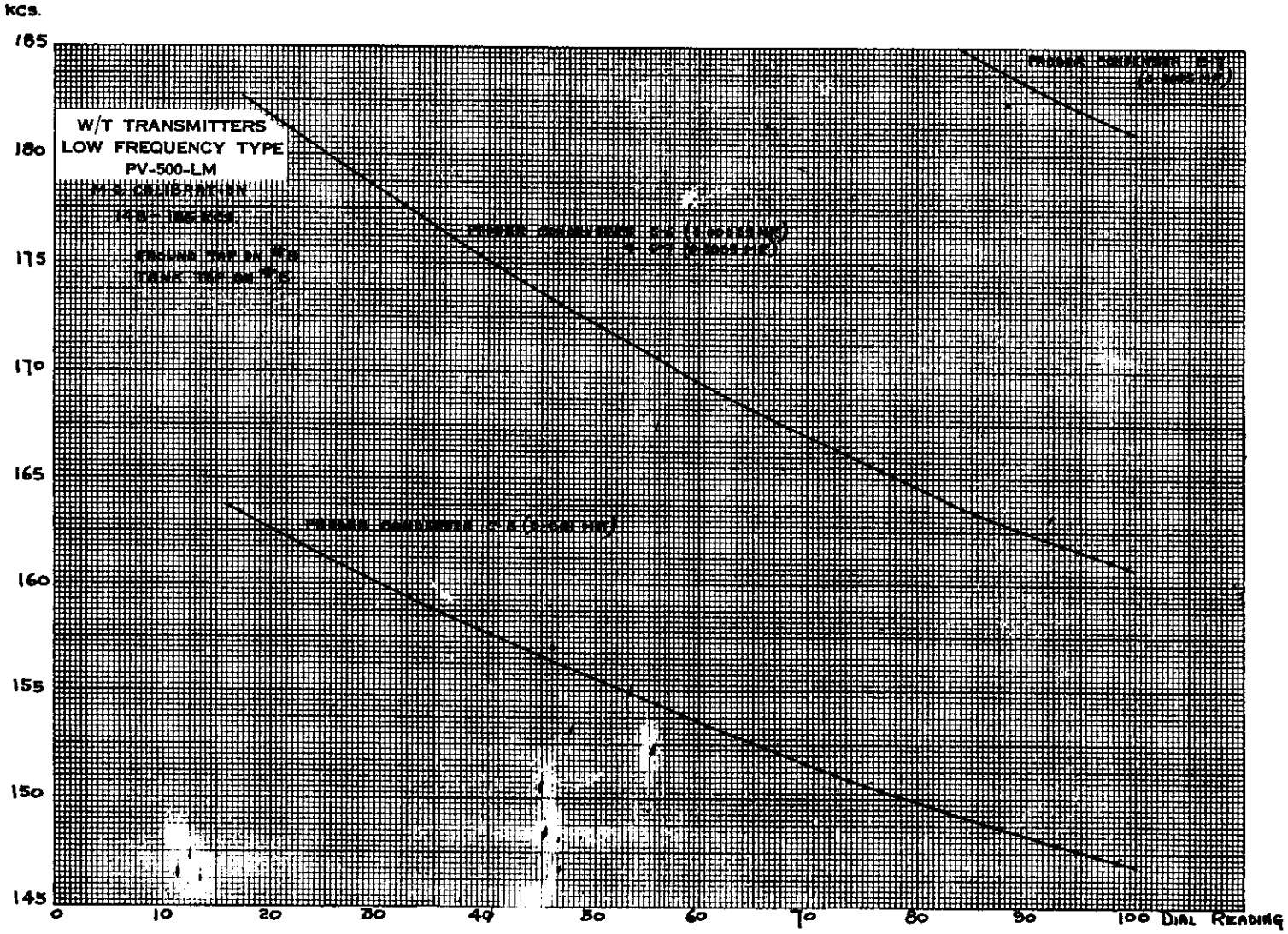

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FIG. 21

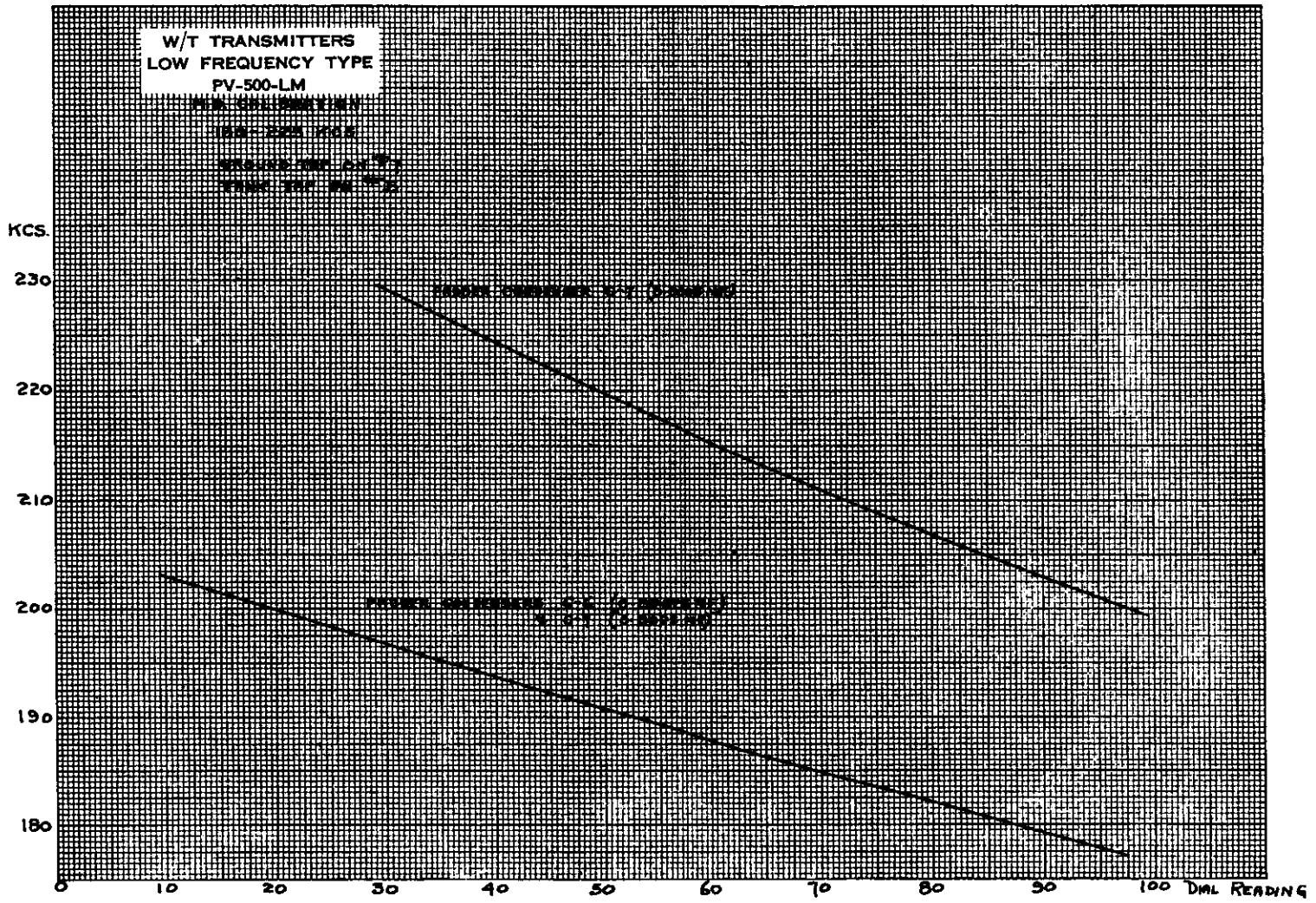

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FIG. 22

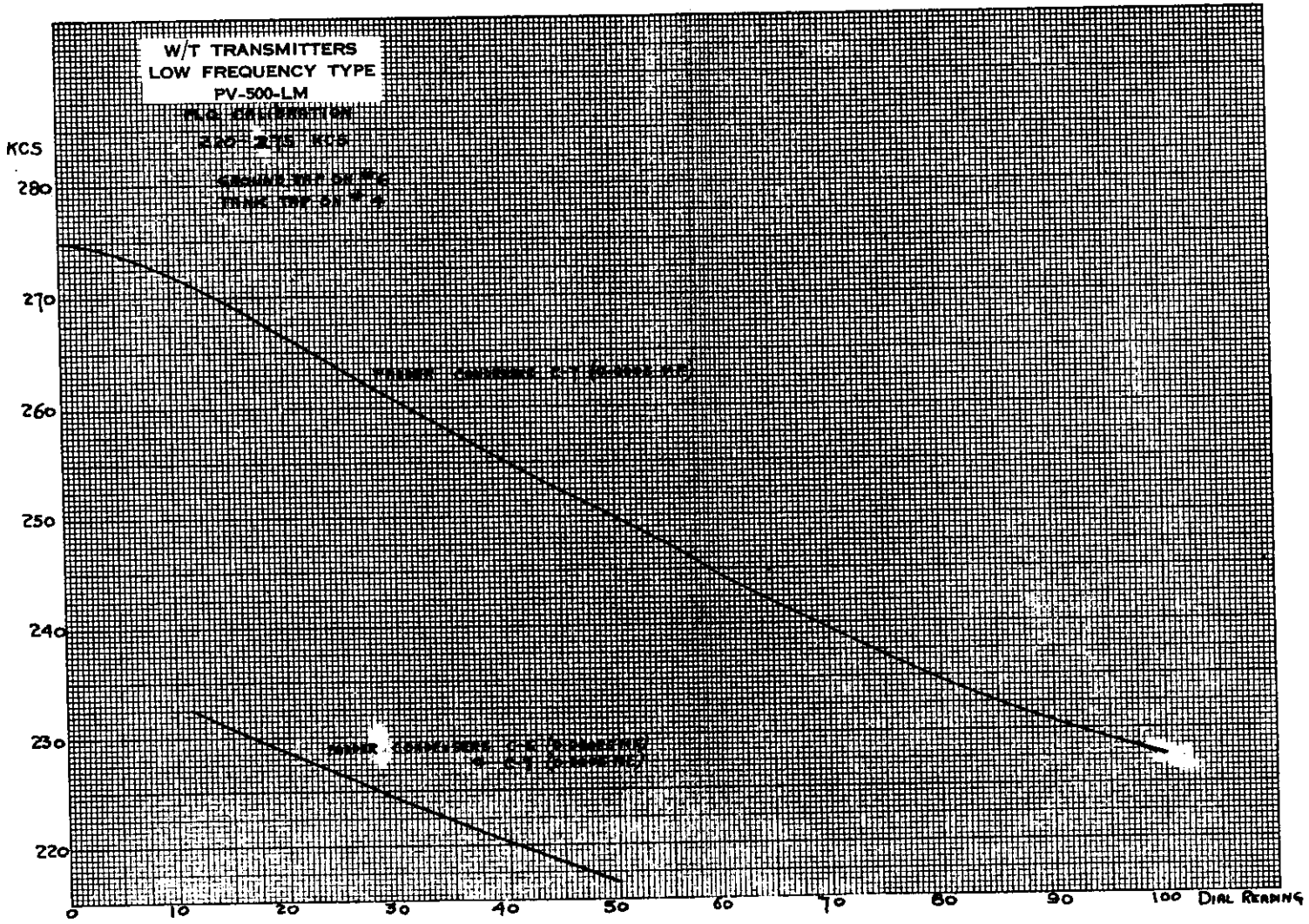

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FIG. 23

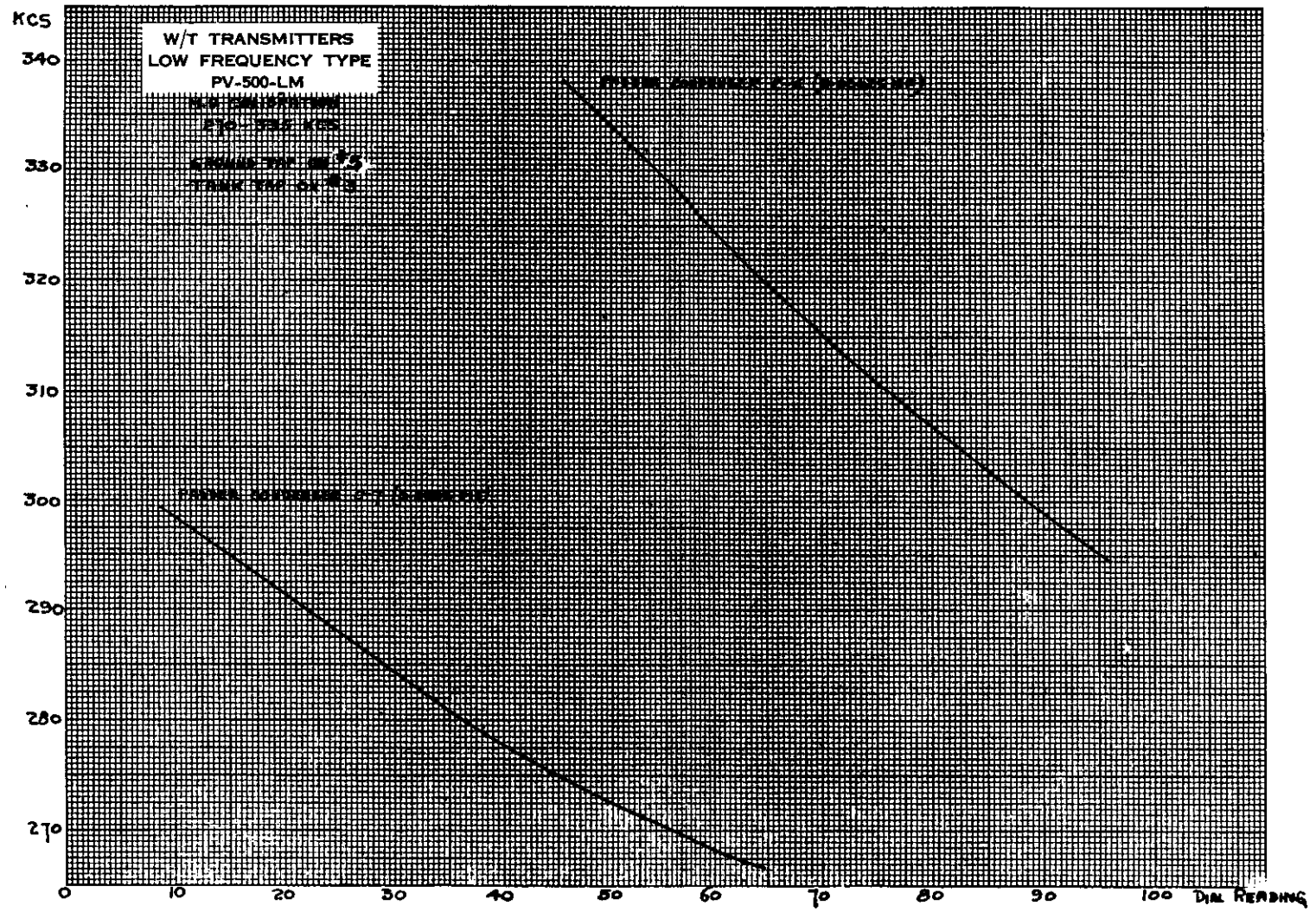

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FIG. 24

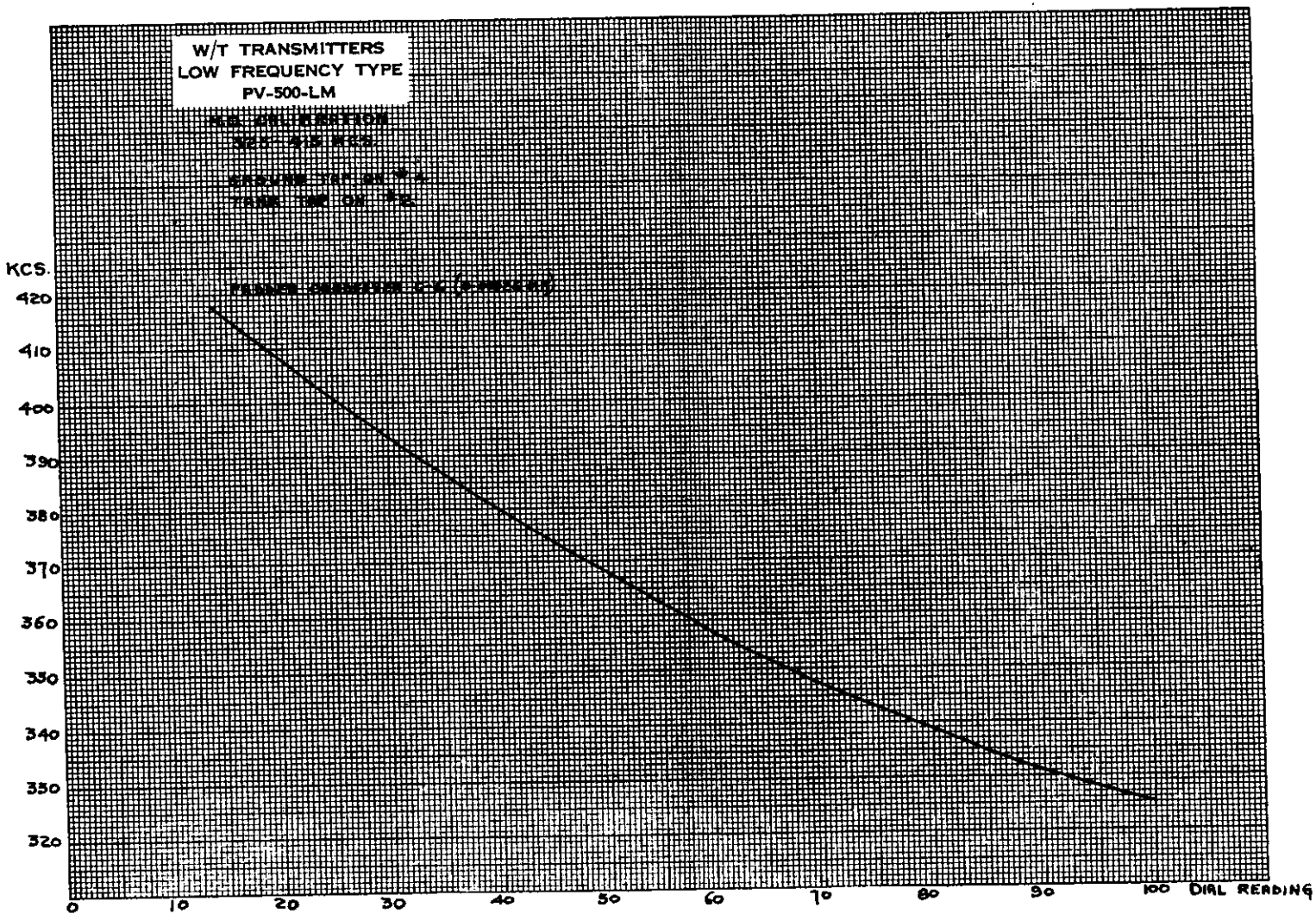

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FIG. 25

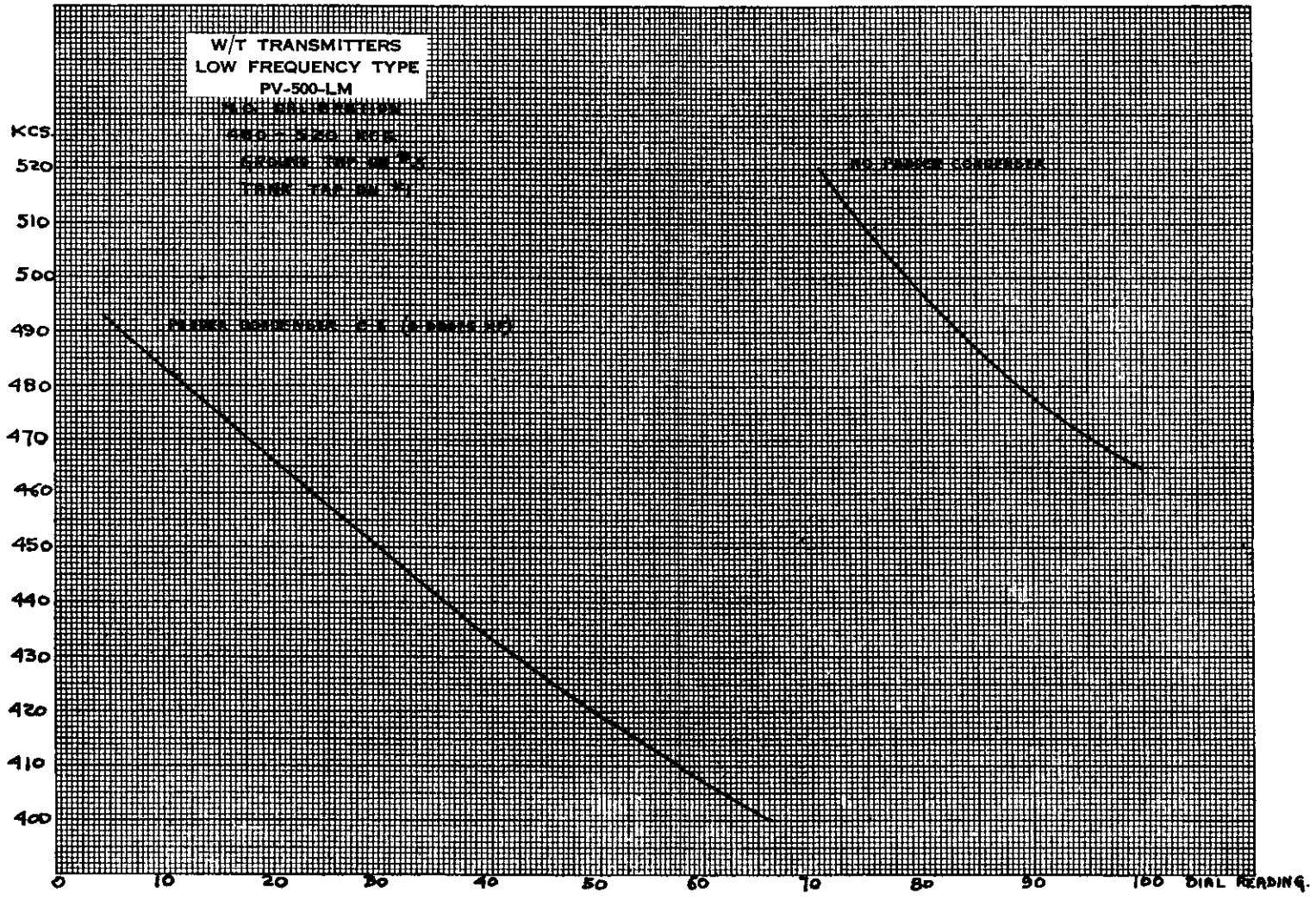

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FIG. 26

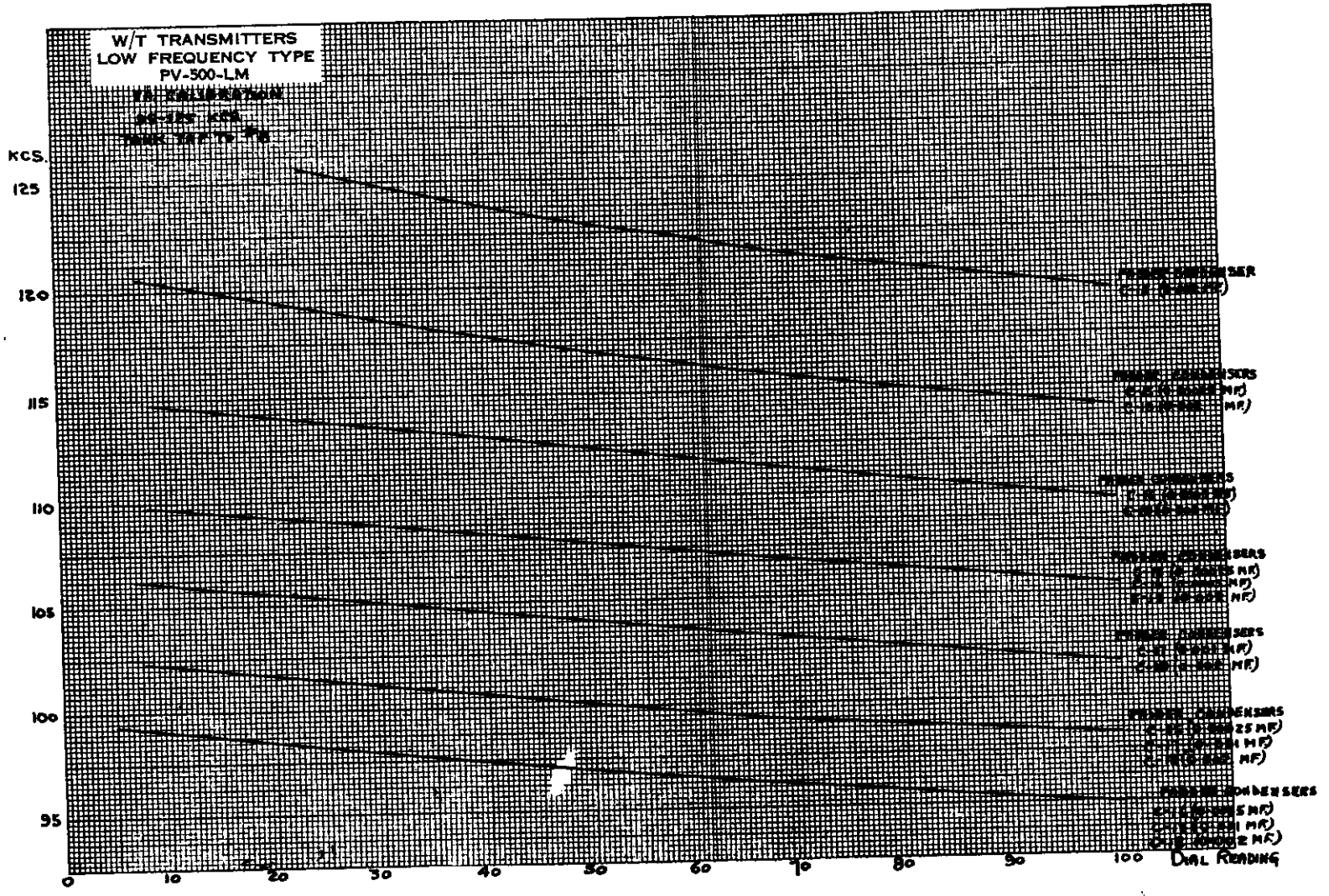

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FIG. 27

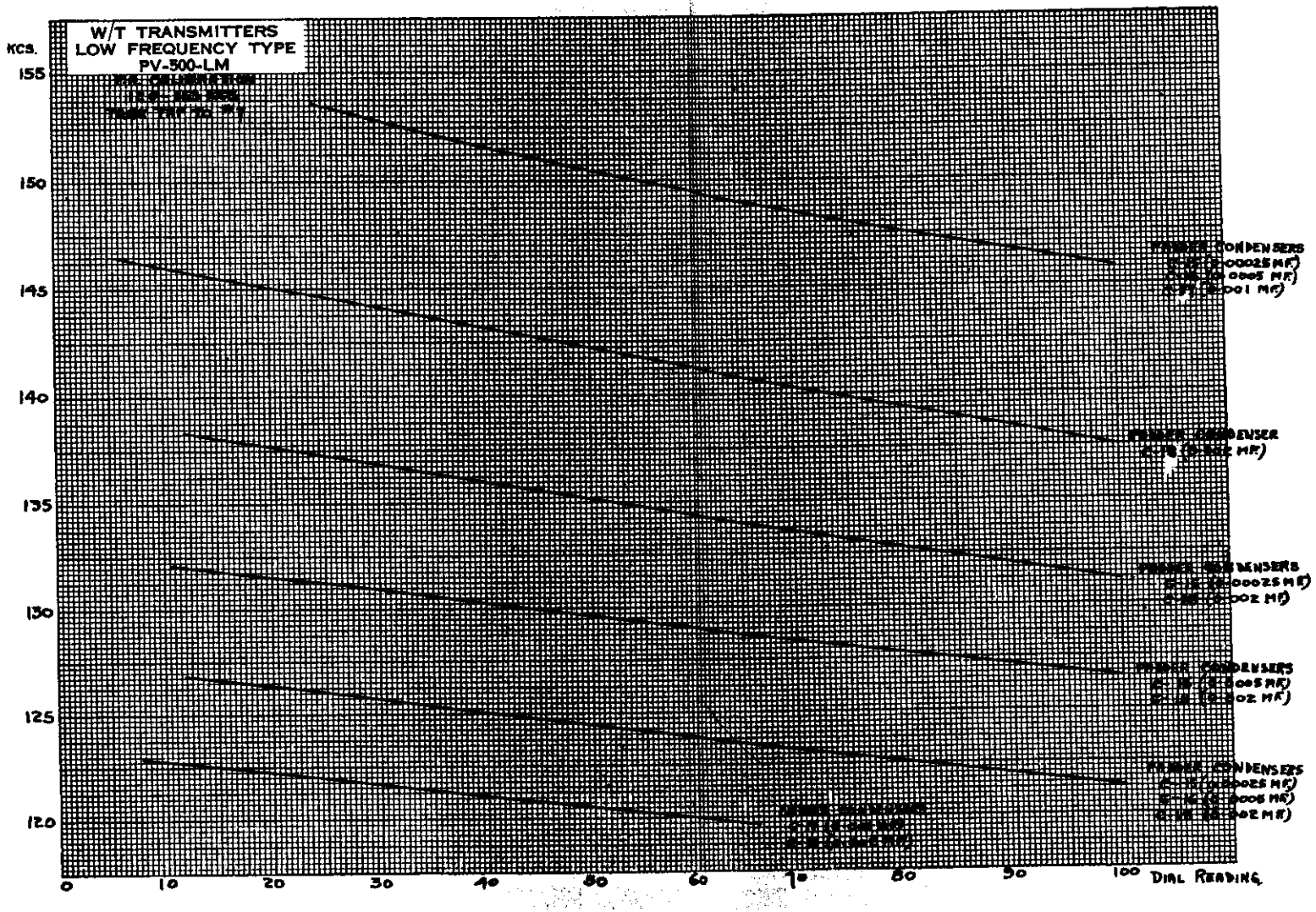

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FIG. 28

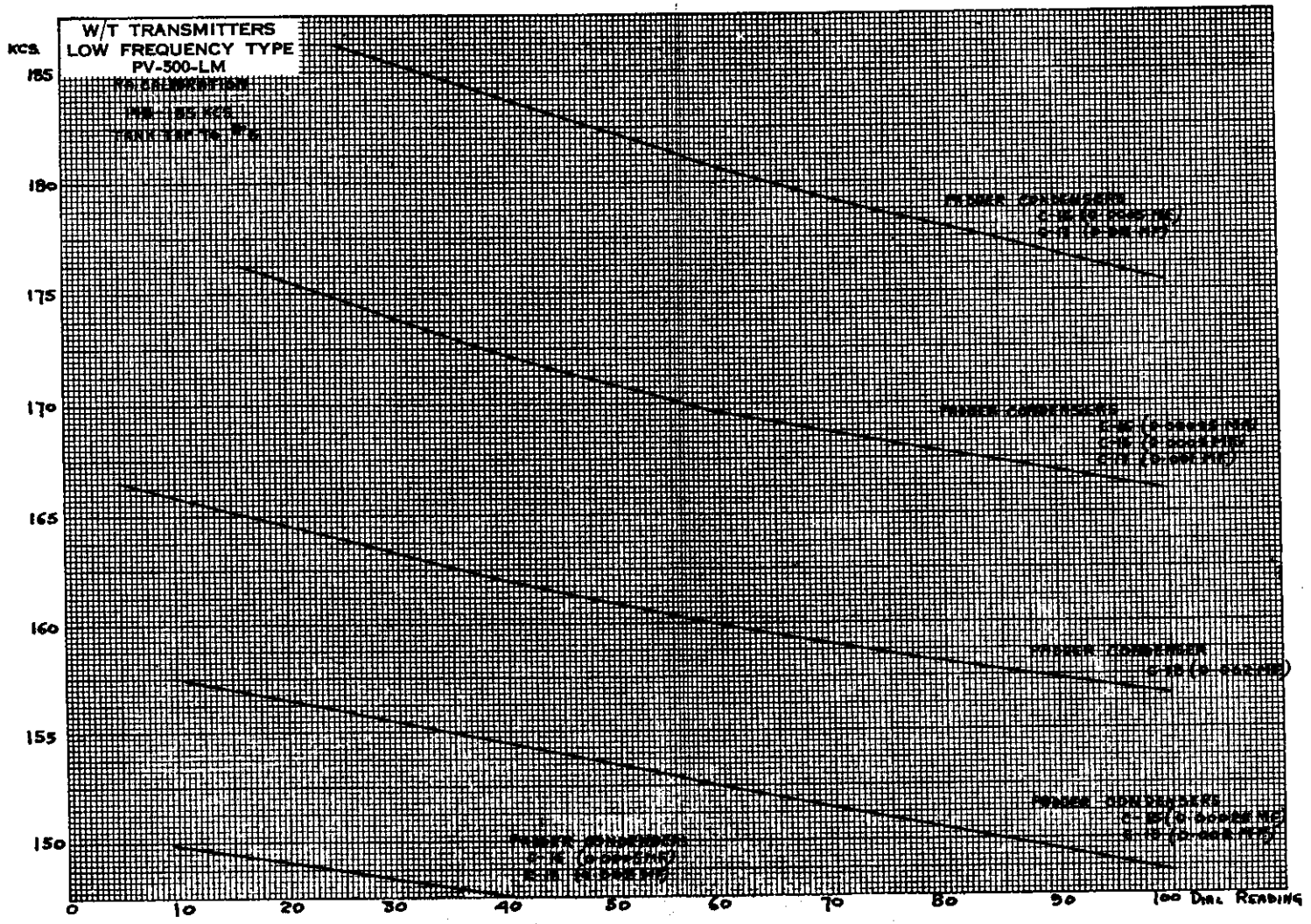

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FIG. 29

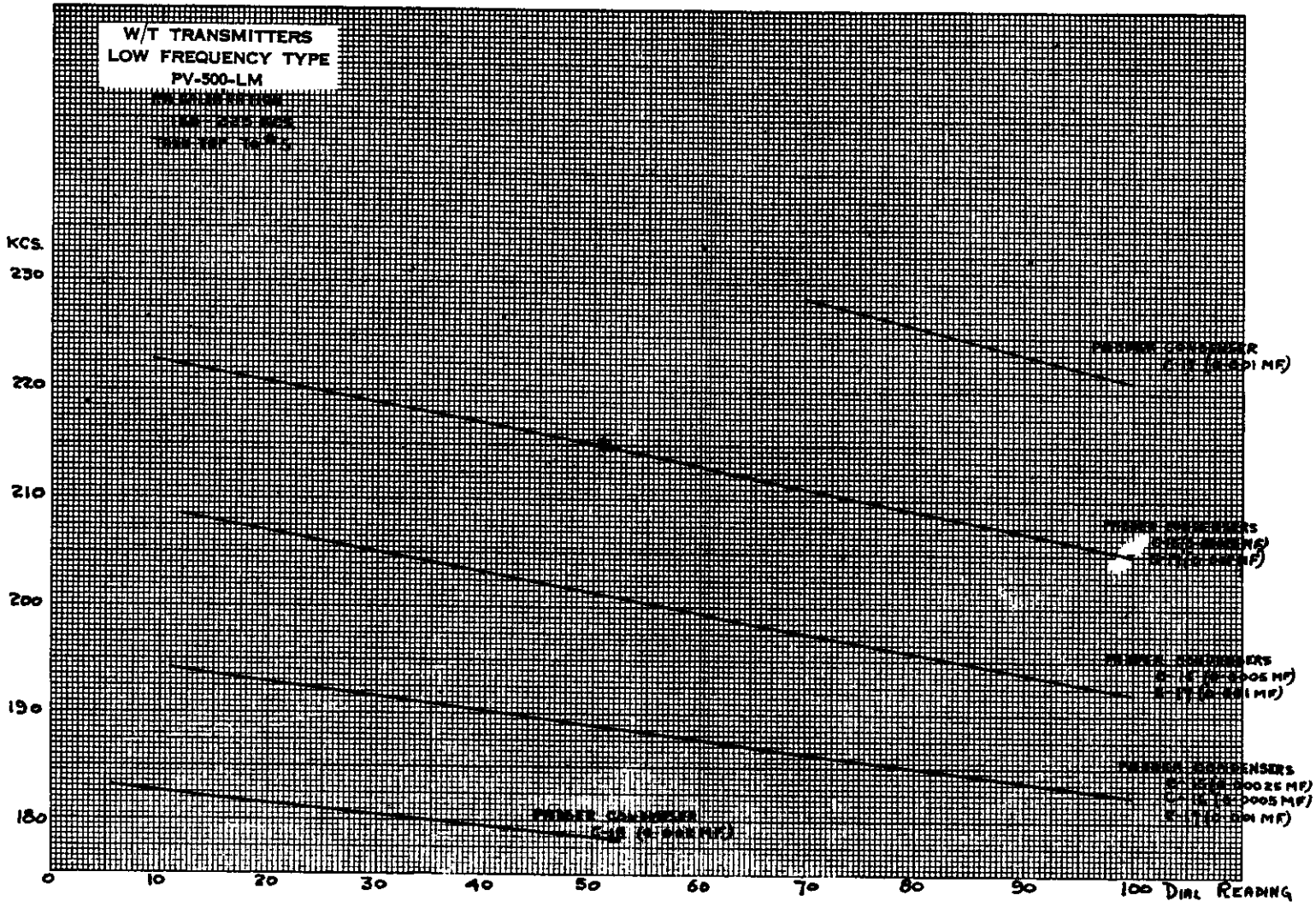

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FIG. 30

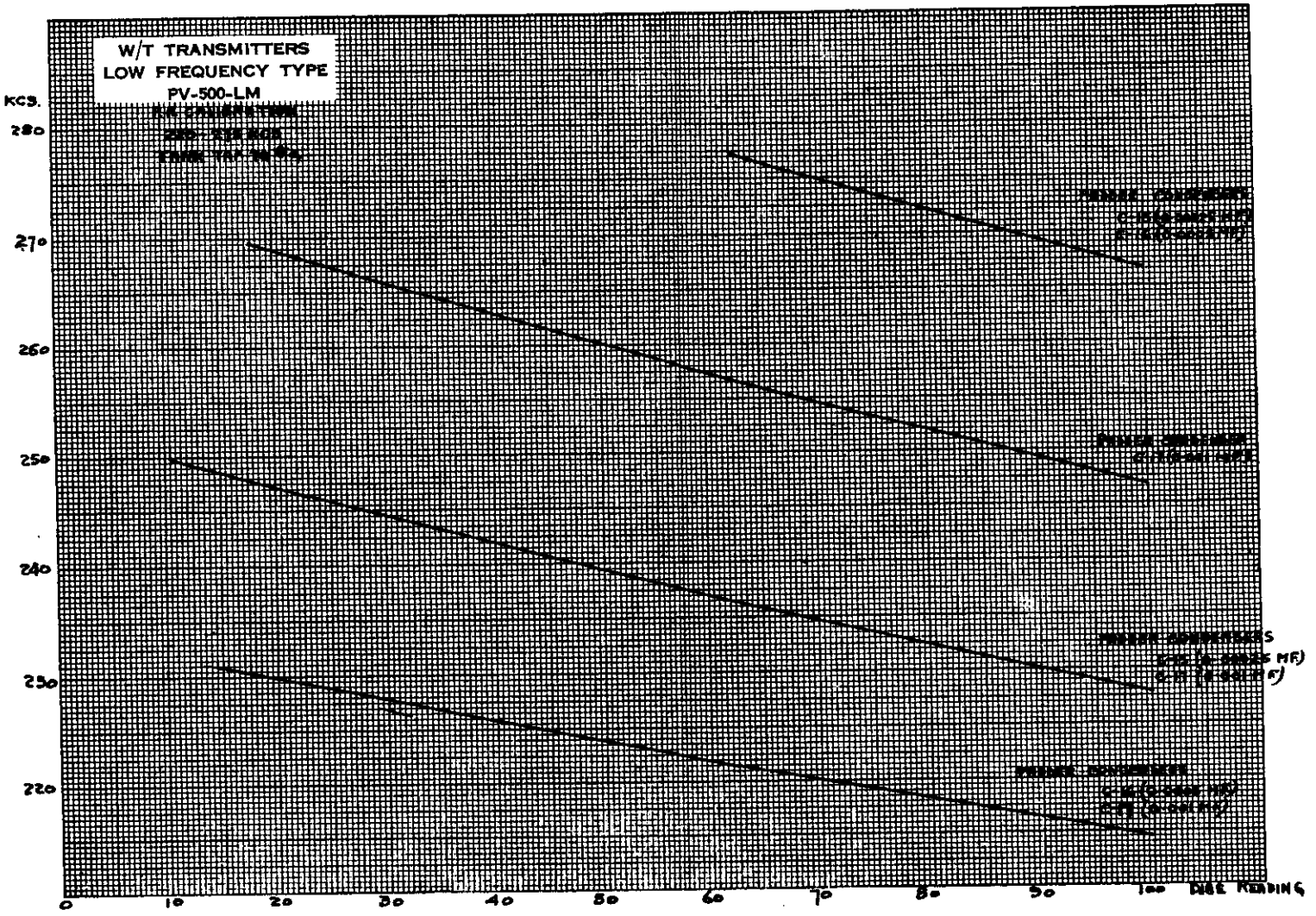

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FIG. 31

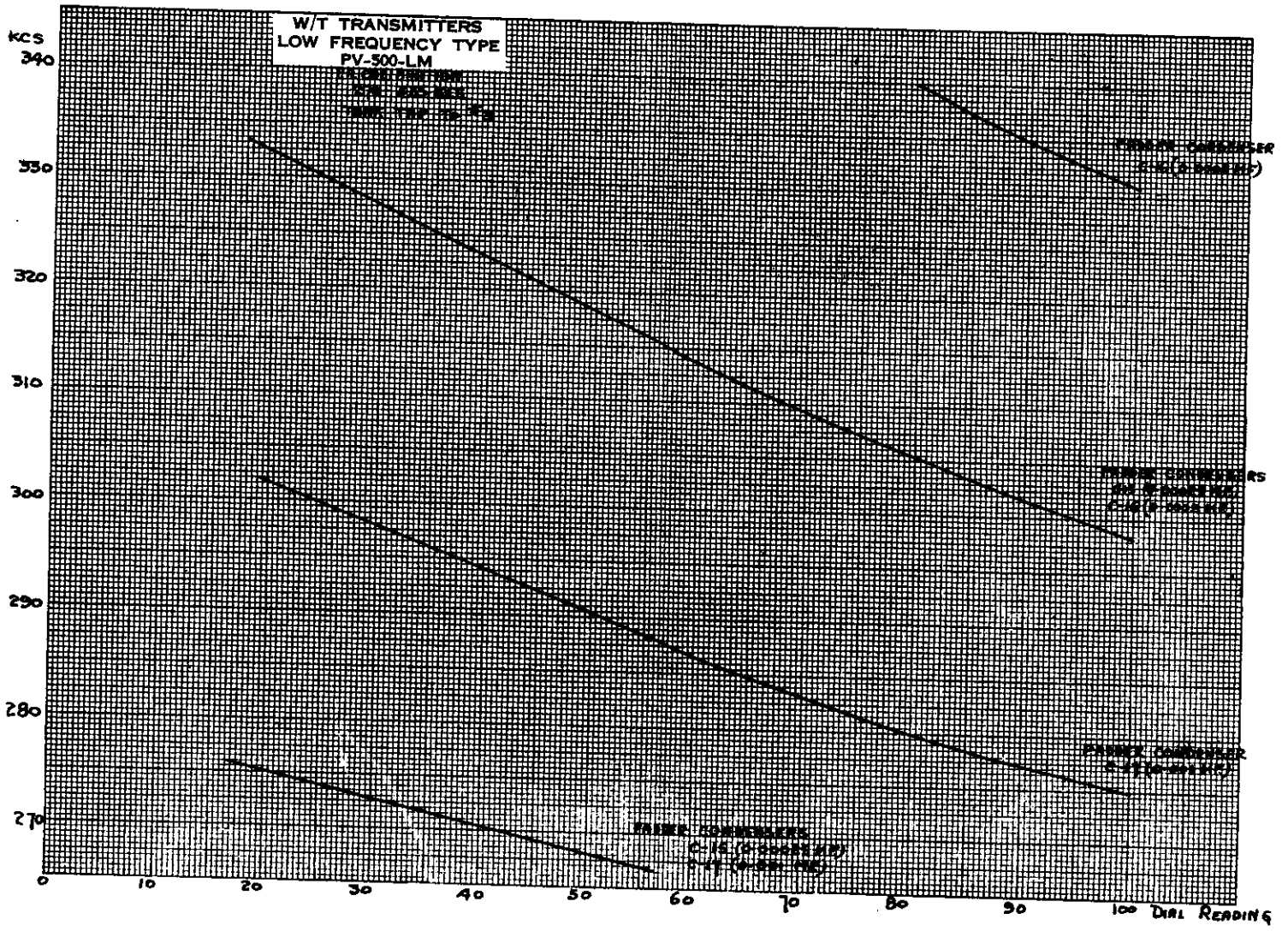

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FIG. 32

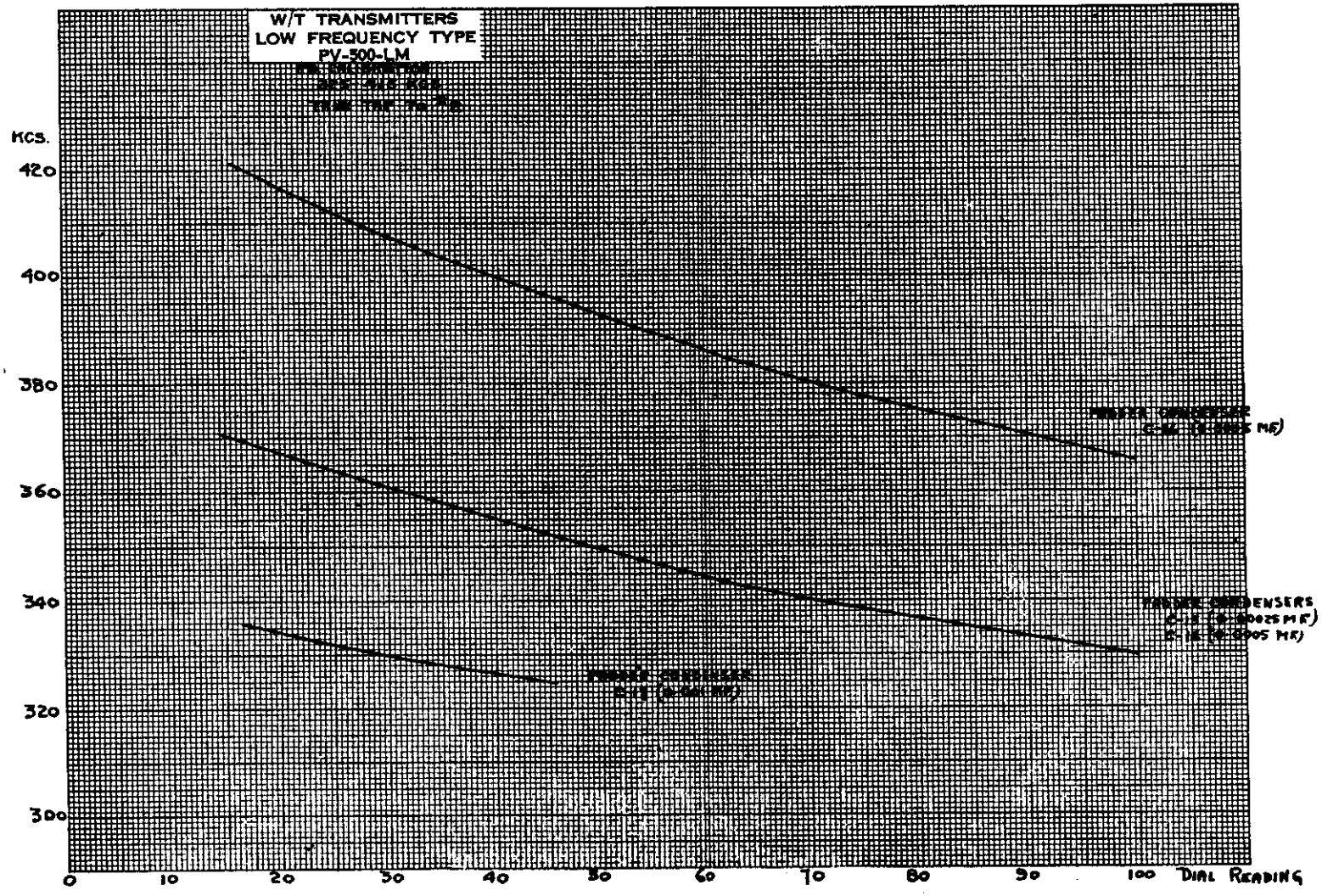

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FIG. 33

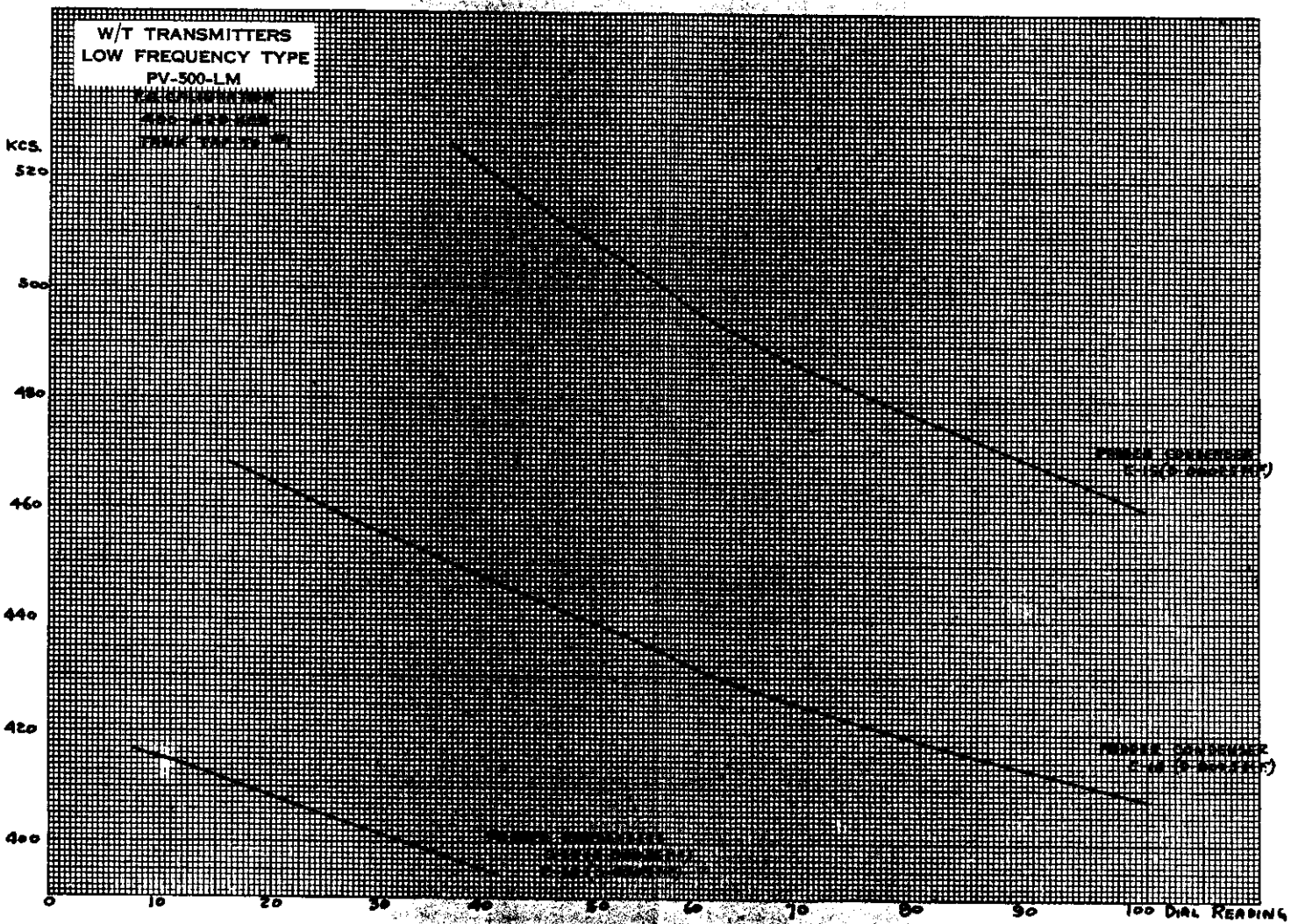

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FIG. 34

PV-500LM WAVE-CHANGE MECHANISM

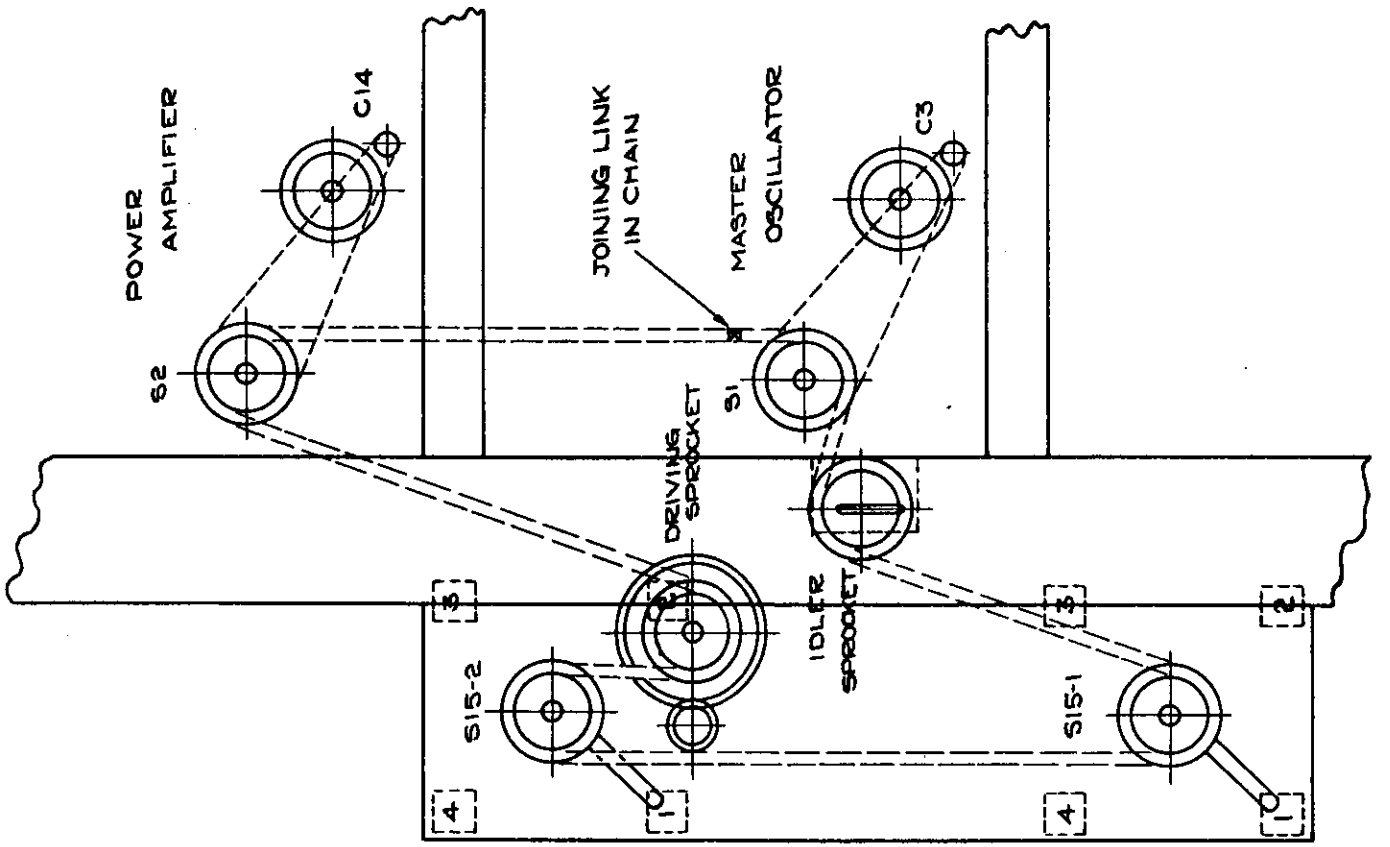

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FIG. 35