CANADIAN MARCONI

PV 500L and PV 500H

COMBINATION

MANUAL

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.

I N D E X

SECTION "A" EQUIPMENT GENERALLY

SECTION "B" LOW FREQUENCY W/T TRANSMITTER PV-500L

SECTION "C" HIGH FREQUENCY W/T TRANSMITTER PV-500H

LIST OF ILLUSTRATIONS

ADDENDUM NO.1

TO INSTRUCTIONS 597

W/T TRANSMITTERS TYPES PV-500H & PV-500L

The following amended instructions are to be used in place of those now making up paragraph 5-10 of section A in the attached instructions in the case of PV-500L transmitters with serial numbers 145 to 175 inclusive.

5-10 The references below are to drawing 91975C and the instructions here are to supplement the notes presented on the drawing. The outer control number plate is not shown on this drawing.

(I) To assemble switch driving chain, item 56 on drawing:

1. Place chain over upper sprockets so that connector with red mark will be located between p-a unit and m-o unit.

2. Before connecting chain, make certain that all switches agree and correspond with pointer on selector wheel as indicated on control number wheel.

(II) To assemble 5/32 diam cable, item 58, which operates two condensers and the variometer by means of the actuating lever:

1. Rotate the condensers and the variometer by means of the hexagon knob on forward end of shaft until all dials read from 3° to 5° less than zero and maintain these positions by means of knurled thumb nuts.

2. Place actuating lever in extreme clockwise or unlocked position as shown on drawing 91975C.

3. This 5/32 diam cable is in three pieces joined with connectors (item [illegible]). This is to permit separation of cable and unwrapping from p-a unit or m-o unit to permit removal of these or other units.

Take first piece of cable (about [illegible]" long) and fix end in slot of control pulley at "C" (actuating lever may be rotated momentarily to facilitate fastening), wrap ½ turn clockwise, draw cable to right through holes in flange and partition and apply ½ turn on pulley as shown in view PC.

Fix securely in slot under screw (item 39), continue ½ turn on inside of pulley and draw down vertically to first connector. Take second piece of cable (about 70" long), fix end in connector, draw down and apply about ¼ turn on inside of pulley, fix in slot under screw, continue ½ turn on outside, draw back through partition and over idler pulley (item 12) and continue through bakelite guide to pulley on variometer. Apply on inside of pulley and fix in slot under screw, continue one turn on outside and draw up to second connector. The third piece of cable (about 30" long) must first be fixed in slot of control pulley at "C", wrapped ¼ turn counter-clockwise and drawn down over small roller in mechanism through bakelite guide to be joined at connector. Slack is taken up by adjustment of idler pulley (item 12).

4. Release all knurled thumb nuts and operate.

(III) To assemble cable and chain, items 37 and 51, which actuate screw shafts and movable stops by means of selector wheel:

1. Rotate all screw shafts so that the movable stops are in the forward or channel 4 position (see view XY).

2. Rotate selector wheel to extreme clockwise position, that is, pointer on selector wheel should be precisely at marker 4 on outer sub-panel diagram.

3. Make certain of above position by turning actuating lever to locked position. If the selector wheel is not in correct position, the actuating lever cannot be moved. The wheel and number plate may now be removed to make the pulley accessible.

4. Take first piece of cable (about 19" long), fix end in thread hole in periphery of 4" diam selector pulley at about "E" by threading through hole and balling the end. Wrap about one turn counter-clockwise and draw through holes "F" in partition and connect with chain (item 51) which is placed over 10 tooth sprockets and then connected with second piece of cable (about 23" long. The latter is then drawn back through hole in partition to central control pulley, wrapped about ½ turn and fastened at about point "D" by threading through hole and fixing under screw and washer, wrapping to the left to prevent loosening of screw.

(IV) To assemble chain marked item 52 on drawing:

1. This chain is assembled by freeing link in ladder chain and pressing back in place after assembling.

   It must be noted that on account of reverse direction of driver, channel numbers reverse from those shown in view XY.

Figure 9A, which is actually a copy of drawing 91975C referred to above, will be found after figure 9 in the plates located in the centre of this book.

Canadian MARCONI Company,
Montreal, August 14, 1941.

SECTION "A" - EQUIPMENT GENERALLY

1-0 GENERAL

1-1 The complete equipment provides for c-w & i-c-w telegraphy on both low and high frequencies, and is primarily intended for use in small quarters, on Naval vessels of low tonnage such as minesweepers. It, can, however, be used with equal facility on larger vessels, or ashore, and the low-frequency and high-frequency transmitters included in the equipment may be used together or separately. The equipment as a whole is intended to fulfil all provisions of specification N-40 of the Naval Service, Department of National Defence, covering this equipment.

2-0 COMPONENTS UNITS & WEIGHTS

2-1 The complete equipment includes the following:

(1) Low-Frequency W/T Transmitter PV-500L (86795)
(2) High-Frequency W/T Transmitter PV-500H (86790)
(3) Two Rotary Converters, each with automatic counter-emf starter, push buttons for remote control, transfer switch and filter unit.
(4) Two manipulating keys.
(5) One set of valves for Low-Frequency Transmitter.
(6) One set of valves for the High-Frequency Transmitter.
(7) One set of 4 crystals for the High-Frequency Transmitter.

The rotary converters are supplied as specified to operate from a ship's mains voltage either 110 or 220 volts d-c. The crystals are supplied ground and adjusted to four specified frequencies.

2-2 Dimensions and Weights (Completely Assembled)

Low Frequency Transmitter	5'6" high overall
	4'4½" wide overall
	2'2" deep overall
	approximate weight 865 lbs.
High Frequency Transmitter	5'6" high overall
	2'11¼" wide overall
	1'11" deep overall
	approximate weight 650 lbs.
Rotary Converter	16¼" high overall
	22¼" long overall
	14" wide overall
	approximate weight 300 lbs.

The Low-Frequency Transmitter is separable into two sections and when stripped for shipment each section has overall dimensions 5' 3½" high x 2'4" wide x 1'11" deep.

2-3 Power Demand

The two transmitters are each designed for use with 100 to 120-Volts 60-cycle single-phase supply obtained, in this instance, from the rotary converter working off the d-c ship's mains. The approximate demand from the mains is as follows, when supplying the filament of both transmitters and the plate supply of one transmitter and when transmitting on c-w.

Standby	- both transmitters together (filaments only)	11 amps at 110V.d-c. 6 amps at 220V.d-c.
"Key up"	- Low-Frequency Transmitter including filaments of high-frequency transmitter	14½amps at 110V.d-c. 7½ amps at 220V.d-c.
"Key up"	- High-Frequency Transmitter including filaments of low-frequency transmitter.	14½amps at 110V.d-c. 7½amps at 220V.d-c.
"Key down"	- Low-Frequency Transmitter including filaments of high-frequency transmitter	26 amps at 110V.d-c. 13 amps at 220V.d-c.
"Key down"	- High-Frequency Transmitter including filaments of low-frequency transmitter	26 amps at 110V.d-c. 13 amps at 220V.d-c.

In addition, an intermittent added drain of 4 amperes at 110 volts d-c, or 2 amperes at 220 volts d-c is taken by the heaters in the transmitters when the ambient temperature is low.

When transmitting on i-c-w, the "key down" power demand is somewhat less than the above figures.

If the equipment is used ashore where 110-volts 60-cycle energy is often available, and the convertors are not used, the power demand is as follows, at 110 volts.

Stand by -	Low-Frequency Transmitter -	340 V.A.
	High-Frequency Transmitter -	325 V.A.
"Key up" -	Low-Frequency Transmitter -	790 V.A.
	High-Frequency Transmitter -	850 V.A.
"Key down"-	Low-Frequency Transmitter -	2000 V.A.
	High-Frequency Transmitter -	1970 V.A.

2-4 Valves required

Low-Frequency Transmitter:	3 type 810.
	2 type 872A.
	1 type 807.
	1 type 5Z3.
High-Frequency Transmitter:	2 type 810.
	5 type 807.
	1 type 6V6.
	2 type VR-150-30.
	2 type 866A.
	2 type 872A.

3-0 ELECTRICAL CHARACTERISTICS

3-1 Power Output

Each transmitter is capable of delivering (on c-w) at least 500 watts of r-f energy to the antenna circuit on any frequency within the specified bands.

The actual power delivered to the antenna proper is dependent on the constants of the antenna. In the case of the high-frequency transmitter, at least 500 watts of r-f energy can be delivered to an antenna which is sensibly non-reactive and has a resistance 40 ohms, on any frequency within its band. In the case of this low-frequency transmitter, with an antenna equivalent to a capacity of 0.001 uf, and resistance 10 to 12 ohms, at least 500 watts can be delivered to the antenna proper at the upper frequency in its band (500 kc) and at least 300 watts at the lower frequency (100 kc).

3-2. Frequency Range

Low-Frequency Transmitter - 100 to 500 kc (3000 to 600 metres)
High-Frequency Transmitter - 2.2 to 14.0 Mc
(136 to 21.4 metres)

Each transmitter is capable of pre-adjustment to any four spot frequencies in the specified bands, these four frequencies lying in the band without any necessary relation between them. Selection of any preset frequency is carried out by a four-position wavechange mechanism which alters the various circuits as required.

3-3 Frequency Control

Low-Frequency Transmitter - master oscillator.
High " " - master oscillator or crystal control.

3-4 Antenna

In the case of the High-Frequency Transmitter, the antenna tuning and coupling circuits permit adjustment for maximum power over the whole frequency band. The tuning circuits are arranged to allow adjustment to an antenna whose apparent constants range between (1) a capacitive reactance of 500 ohms and resistance 10 ohms on the lower frequencies and (2) and inductive reactance of 1000 ohms and resistance 150 ohms on the higher frequencies. Antenna constants within the limits given above can usually be obtained by adjusting the antenna length to that which is appropriate to the frequencies selected.

In the case of the Low-Frequency Transmitter, the antenna tuning and coupling circuits allow adjustment over the whole frequency band, to an antenna whose apparent capacity lies between 0.00022 and 0.001 uf, and apparent resistance 4 to 12 ohms. The lower value of capacity represents approximately the minimum antenna, such as may be used on small vessels of the minesweeper class, i.e., a four-wire flat top approximately 54 feet long and 35 feet above the main deck. The higher value of capacity represents approximately the maximum antenna such as may be used on very large vessels or ashore at a fixed location.

3-5 Rotary Converters

The two rotary converters are of semi-enclosed, protected construction. Each machine is rated at 2500 V.A., and delivers 110-volts 60-cycle single-phase a-c at full load. The machines are provided with ball bearings and run at 1800 rpm. For each machine, there is provided an automatic counter-emf starter, with push button station for remote control. An enclosed switch is also provided to select the one machine or the other as power supply. Each machine, with its starter, is supplied as required for 110 or 220 volts d-c ship's mains supply. Associated with each machine is a small filter unit, to attach to the top of the frame and connect to the brushes on the d-c side. This helps mitigate commutator interference.

4-0 INSTALLATION PROCEDURE

High-Frequency W/T Transmitter PV-500H
Low-Frequency W/T Transmitter PV-500L

4-1 The usual arrangement in small cabins is for the Low-Frequency Transmitter to be at the operator's right and the High-Frequency Transmitter to his left. This arrangement need not be adhered to in other cases, but this suggested arrangement is recommended where the quarters are small.

4-2 The two transmitters should be bolted to the deck and to the bulkhead behind. This forms a rigid arrangement and helps support the equipment as the angle of the deck changes. The back of the sets should be spaced out from the bulkhead by one inch or so to clear all protuberances, such as rivet heads, piping, etc., which may lie along the flat surface. If the deck is not flat and level, suitable shims are required under the legs or, better, a hardwood packing strip may be laid underneath to level up the equipment.

4-3 The Low-Frequency Transmitter carries its terminal board for wiring at the lower front. Holes are provided in the shield to allow wiring to come up from underneath. In addition, the lower portion of the side shields are notched to allow the wiring to pass underneath from the side.

4-4 The external wiring for the High-Frequency Transmitter may be brought through holes at the rear of the sides of the unit or may alternatively be brought up through holes under the main terminal panel. If wiring is to be brought from the rear holes, it is necessary that this be completed before the power unit is placed in the cabinet. The small porcelain insulator at the top of the cabinet is to be connected to the antenna terminal on the receiver. The ground stud should be connected solidly to the ship's hull or earth.

4-5 Recommended gauge and insulation of the wiring is given on Diagram 88473-4248, figures 45 and 46, which shows all connections and interconnections. The wiring, where lead covered, should be supported on saddles, and at places where it enters the set should be bound to avoid chafing.

4-6 Most heavy equipment has been dismounted and packed separately for shipment. It is recommended that the cabinets be set up and bolted in place and the external wiring run in before the parts are reassembled. The Low-Frequency Transmitter has been divided into two sections to afford easier entry through the cabin doors. When in place, the two sections should be tightly bolted together.

4-7 The various parts dismounted may be reassembled. Wiring which has been disconnected has been tagged with the terminal number on which they belong. Before assembling any unit into place, all loose nuts and screws and other connections should be tightened, and the equipment inspected generally for damage. The equipment should be handled carefully, especially those parts on ceramic insulators, as they are apt to break under abnormal stresses.

4-8 Care should be taken that all external wiring is correct and tested out, as an error is sometimes difficult to trace and may result in damage should an attempt be made to apply voltage.

4-9 The rotary converters, with their starters, should be bolted down. No fixed rules can be laid down as to their location, except that they should be kept away from locations where there is danger of water dripping on them. The push buttons associated with the starters, and the two manipulating keys, may be set up convenient to the operator. The metallic base of the key should be at ground potential. This will be so if connection is made to terminal 4 rather than terminal 3 on the transmitter. Otherwise, although there is only 12 volts on the key, there is an inductive "kick" from the keying relays which can be annoying should the operator come in contact with the metallic portion of the key.

4-10 The antenna lead-in should be brought straight and direct to the lead-in insulator, via the antenna grounding switch, which should be so located that excess length of conductor is avoided. Where these switches are not available on the earlier installations, a flex lead should be improvised to ground the antenna when not in use as a protection against lightning. More especially in the case of the Low-Frequency Transmitter, clearances should be as generous as possible with no sharp bends in the wiring. This will tend to mitigate corona or flash-over as, on the lower frequencies with small antennae, the voltage is high.

4-11 The wavechange mechanisms will have been partly dismantled for shipment. Their descriptions and method of operation are covered in section 5 following this section. These mechanisms should be set up and adjusted at the end of installation before commencing adjustment, as the various cords and chains are apt to interfere with the removal or insertion of some of the components.

4-12 External diagram of connections 88473-4248 (figure 45) shows all external connections between the transmitters, receivers, antennae, etc. etc. For special cases where the equipment is set up using one transmitter only, or ashore using a local source of 110-volts a-c, external connections may be made using a suitable modification of these external connections. The terminal designations are given in paragraph 1-18 section B, and paragraph 1-2 section C, of these instructions.

5-0 WAVECHANGE MECHANISM

(GENERAL DESCRIPTION - METHOD OF OPERATION - METHOD OF ASSEMBLY)

5-1 This mechanism is the same in general form and method of operation in both the Low-Frequency and the High-Frequency Transmitters.

5-2 Each wavechange switch is arranged to be operated by a four-position selecting wheel, and the various variable condensers or variometers are positioned to pre-selected spots by an associated actuating lever. The actuating lever has two positions - "lock" being counter clockwise and "unlock" being clockwise. If it is desired to change wavelength, the procedure is to pull out the actuating lever, move it to the "unlock" position, set the selecting wheel to the position desired, then move the actuating lever back to the "lock" position. The operation of pulling out the actuating lever shuts off the h-t, and restores it when the lever is relocked.

5-3 It will be observed that attached to each variable condenser or variometer shaft is a device comprising a movable stop, which is set to one of four positions by the selecting wheel, and a group of movable stops or fingers on the condenser shaft which can be unclamped from the shaft and set to any position with reference to the position of the plates of the condenser.

5-4 As the actuating lever is moved to the "unlock" position, all condensers move to "zero", i.e. with the plates "full out" or zero capacity. As the actuating lever is moved to the "lock" position, all condensers move towards maximum, but if the fingers are tight on the shaft, motion of the condenser proper will cease, but the drum at the shaft end will continue to turn, winding up a spring within. The tension of this spring keeps the finger tight against the stop so that the condenser is held in that position.

5-5 By this arrangement, all condensers can be pre-set to any position between minimum and maximum capacity, and as the actuating lever is moved to its "lock" position, the springs are wound up to a greater or lesser degree.

5-6 During preliminary setting up, the fingers are all to be loosened on their shafts. The condenser can then be rotated by hand (using the tool supplied) to obtain the desired setting against the springs, before locking up the fingers. Each condenser carries a subsidiary lock which holds it in position temporarily before the fingers are tightened against the stops, so that the transmitter may be completely tuned throughout to one of its four frequencies. After a channel is completely tuned up, the fingers are locked up tightly against their stops and the temporary locks released.

5-7 Briefly, to change from one wavelength to another, proceed as follows (assuming the four wavelengths have been set up).

(1) Pull out the actuating lever and move it as far as it will go to the right.

(2) Turn the selecting wheel until the pointer is opposite the number desired.

(3) Move the actuating lever as far as it will go to the left. At the end of its motion, it must be pushed into place.

5-8 To set up on any wavelength, in process of initial tuning:

(1) Unlock all fingers from the shafts.

(2) Pull out the actuating lever and move it as far as it will go to the right.

(3) Turn the selecting wheel until the desired number appears on the mark.

(4) Move the actuating lever as far as it will go to the left.

(5) Each variable control can now be independently rotated by hand, with the aid of the special tool, against its springs. When the correct position has been found, lock it up with the temporary dial locks while setting all the other controls to their correct position as tuning proceeds.

(6) Move the fingers up against the stops and tighten them hard against their stops.

(7) Release the temporary dial lock.

Always see that the temporary dial locks are disengaged before attempting to move the mechanism.

5-9 On the low-frequency transmitter, in order to pack units for shipment, the cable and chain will have been removed and tagged for identification. As an aid to reassembling, drawings 91975 for low-frequency and 91931 for high-frequency are included in these instructions (Figs. 9 and 37).

5-10 The references below are to drawing 91975 (low frequency) and the instructions here are to supplement the notes presented on the drawing. The outer control number plate is not shown on this drawing.

(I). To assemble switch driving chain, item 36 on drawing:

1. Place chain over upper sprockets so that connector with red mark will be located between p-a unit and m-o unit.

2. Before connecting chain, make certain that all switches agree and correspond with pointer on selector wheel as indicated on control number plate.

(II) To assemble 3/32 diam cable, item 38, which operates two condensers and the variometer by means of the actuating lever:

1. Rotate the condensers and the variometer by means of the hexagon knob on forward end of shaft until all dials read from 3° to 5° less than zero, and maintain these positions by means of knurled thumb nuts.

2. Place actuating lever in extreme clockwise or unlocked position as shown on dwg 91975.

3. This 3/32 diam cable is in three pieces joined with connectors (item 20). This is to permit separation of cable and unwrapping from p-a unit or m-o unit to permit removal of these or other units. Take first piece of cable (about 32" long) and fix end in slot

of control pulley at "C" (actuating lever may be rotated momentarily to facilitate fastening), wrap $\frac{1}{2}$ turn clockwise, draw cable to right through holes in flange and partition and apply $\frac{3}{4}$ turn on pulley as shown in view PQ. Fix securely in slot under screw (item 39), continue $\frac{1}{2}$ turn on inside of pulley and draw down vertically to first connector. Take second piece of cable (about 70" long) and fix end in connector. Draw down and apply about $\frac{3}{4}$ turn on inside of pulley, fix in slot under screw, continue $\frac{1}{2}$ turn on outside, draw back through partition and over idler pulley (item 12) and continue through bakelite guide to pulley on variometer. Apply on inside of pulley and fix in slot under screw, continue one turn on outside and draw up to second connector. The third piece of cable (about 30" long) must first be fixed in slot of control pulley at "C", wrapped $\frac{3}{4}$ turn counter clockwise and drawn down over small roller in mechanism through bakelite guide to be joined at connector. Slack is taken up by adjustment of idler pulley (item 12).

4. Release all knurled thumb nuts and operate.

(III) To assemble 1/16 diam cable, item 37, which actuates screw shafts and movable stops by means of selector wheel:

1. Rotate all screw shafts so that the movable stops are in the forward or channel 4 position (see view XY).

2. Rotate selector wheel to extreme clockwise position, that is, pointer on selector wheel should be precisely at marker #4 on outer sub-panel diagram.

3. Make certain of above position by turning actuating lever to locked position. If the selector wheel is not in correct position, the actuating lever cannot be moved. The wheel and number plate may now be removed to make pulley accessible.

4. Take first piece of cable (about 50" long) and fix end in thread hole in periphery of 4" diam selector pulley at about point "E" by threading through hole and balling the end. Wrap about one turn counter clockwise and draw through holes "F" in partition and apply to small pulley on screw shaft as shown in view XY. Apply about $1\frac{1}{2}$ turns before threading through hole and about $4\frac{1}{2}$ turns after threading. Fix connector (item 22) and second piece of cable (about 56" long) and draw up to pulley above and apply likewise. Continue back to central control pulley, wrap about $\frac{1}{2}$ turn and fasten at about point "D" by threading through hole and fixing under screw and washer, wrapping to the left to prevent loosening of screw. Connector (item 22) must be located to permit not less than 9" of travel before reaching pulley above, that is, when mechanism is in channel 4 position.

(IV) To assemble 1/16 diam cable marked item 40 on drawing:

1. Fasten end of cable in hole at "F" on pulley marked item 13. After wrapping about one turn clockwise, draw to small pulley and apply as above and as shown in view XY. Then take end of cable and fasten to pulley 13 at about the point "G" by threading through hole and fixing under screw.

5-11 The following instructions refer to drawing 91931.

(I) To assemble 3/32 diam cable which actuates the four variable condensers by means of the actuating lever:

1. Rotate all condensers by means of the hexagon knob on forward end of shaft until all dials read about 3° to 5° less than zero, and maintain these positions by means of knurled thumb nut.

2. Place actuating lever in extreme clockwise or unlocked position as shown on control cable assembly drawing 91931.

3. Fasten end of cable by pulling through hole at "A", draw cable to left and wrap once around forward side of pulley as shown in plan view of drawing 91931, and then clamp securely in slot under binding screw

at "B". (It is necessary to release thumb nut in this case to place cable under screw.) Draw cable to second pulley from left. Wrap around as shown and secure in slot under binding screw at "C". Draw cable off forward side of pulley, wrap on third pulley, secure in same manner at "D". Take cable off rear side of pulley, draw to rear side of fourth pulley, wrap $\frac{3}{4}$ turn. Secure in slot under screw at "E", complete turn, drawing cable off forward side to central control pulley. Wrap around and fasten securely under screws alternately at "F". Cable should be only taut, not stressed.

4. Release all knurled thumb nuts and operate.

(II) To assemble 1/16 diam cable which actuates screw shafts and movable stops by means of manual selector wheel:

1. Rotate all screw shafts so that all movable stops are in forward or channel 4 position.

2. Rotate selector wheel to channel 4 which is extreme clockwise position. Maintain this position by turning actuating lever anti-clockwise. This lever is interlocked with selector wheel and cannot be moved unless the selector shaft and associated switches are in correct position. The selector wheel and number plate may then be removed to make cable pulley accessible.

3. Fix end of cable at "K" by threading through hole and knotting. Wrap around pulley and draw to right-hand side as shown, wrap $1\frac{1}{2}$ turns on small pulley and thread through hole at "L". Continue 5 turns on cable, then draw to next pulley and apply in the same manner, 2 turns on inside and 5 turns on the outside of pulley. Care must be taken in each case that movable stops remain in channel 4 position. After applying cable on the four small pulleys, draw to large control pulley and fasten at "M" by threading through hole and

fixing under screw and washer. Fix cable under screw from left so that pull will not loosen screw.

(III) To assemble drive chain between r-f unit and switch on oscillator unit:

The red tooth of switch sprocket serves as a pointer to numbers 1, 2, 3, 4 appearing on the back plate of the oscillator unit. These numbers refer to the four channels and this setting must agree with other settings of the mechanism. An adjusting screw is used on this chain to properly fit for length. This screw and square sleeve naturally must travel only between the sprockets and should always be replaced on the same side to avoid possible variation of setting.

5-12 When reassembling or replacing cables, care should be taken to keep the cut ends from unravelling. Any free ends of the cable should be neatly finished off by touching the ends with a drop of solder to avoid unravelling and the free ends laid back along the cable and sewed tightly with fine wire. This will insure against slippage of the cable and form a neat finish.

SECTION B

Low-Frequency W/T Transmitter PV-500L (86795)

1-0 CONSTRUCTION AND LOCATION OF PARTS

1-1 The photographs included in these instructions may be consulted (figures 1 to 7) to assist in studying the equipment and locating the parts. The transmitter proper is in two sections, which can be separated into two parts sufficiently small to pass through small doors and passage ways. When in place, the two sections are bolted together to form a rigid assembly. It is intended that the assembly fit close to the wall or bulkhead and be bolted to bulkhead and deck to avoid shifting in position or undue strains due to the motion of the vessel in a heavy sea.

The equipment is housed in a suitably finished sheet steel cabinet, pierced for ventilation. All components are accessible through the front of the unit, access to them being afforded 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.

1-2 The right-hand section carries power equipment, with the heavier components such as transformers at the bottom, and above, all the radio-frequency equipment with the exception of the antenna tuning inductances and the main portion of the wavechange operating mechanism. All power controls are also on this section. The left-hand section contains the antenna loading inductances and the main portion of the wavechange mechanism. The lead-in insulator is at the top of this section.

1-3 The radio-frequency portion of the transmitter consists basically of a master oscillator and power amplifier, utilizing triode valves supplied at 2000 volts d-c derived from the 110-volts 60-cycle supply, or obtained from the rotary converter or other source. A rectifier of the hot-cathode mercury-vapour type is employed. The power amplifier, together with its tuning condensers and inductance, is located on a shelf at the top of the unit, and below it is the master oscillator with its associated components, also on a shelf. These shelves, the top of the unit, and also the lower front shield, are pierced to allow cooling air to enter at the bottom and emerge at the top. Air circulation is assisted by two fans, one of which circulates air upward through the transmitter proper, and the other circulates air upward around the antenna tuning inductances. These fans only operate when transmitting and not during standby periods.

1-4 A separate audio-frequency oscillator is located just below the master-oscillator shelf. This oscillator provides the necessary audio frequency for the production of i-c-w. A small rectifier of the "dry" type is employed to provide low voltage for keying relays.

1-5 The terminal panel for external connections, and panels carrying various control relays, are located in the lower section of the unit. The h-t rectifier, with its transformers and smoothing system, is also located in the lower section.

1-6 At the top of the unit there is a group of four meters clearly designated which read:

(1) Filament Line Volts. This meter is provided with a red line indicating the correct setting.

(2) P-A Cathode Current.

(3) M-O Cathode Current.

(4) Antenna Current. This meter is provided with a short-circuiting switch.

Behind this group of meters is located a group of bleeders resistors for the h-t rectifier and the break-in relay.

1-7 A recessed front panel carries the following clearly designated controls:

(1) A switch for selecting either CW or ICW.

(2) A pair of push buttons for "ON" and "STANDBY".

(3) Three pilot lamps, one green, one red, one amber, to indicate filaments on and which transmitter is in operation.

(4) A filament voltage control.

(5) A filament keying-compensator control.

(6) A switch for selecting one of three tones for i-c-w viz: 400, 700 or 1000 cycles.

(7) A filament control switch.

(8) An overload reset push button.

1-8 The actuating lever and selector wheel of the wavechange mechanism are located to the left of and above this control panel. A fuller description of this mechanism has been covered in section A paragraph 5 above.

1-9 A sub-panel at the lower right side of the cabinet carries the various relays and contactors incidental to the control circuits. The various line fuses are located in holders just above the main terminal board.

1-10 Matters are arranged so that, should either transmitter be in use, the other may be brought into operation by pressing its ON push button. This returns the other to STANDBY and the pilot lamps light to indicate the condition.

1-11 The tuned circuits permit setting up to any four spot frequencies in the frequency band. 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 being the accuracy of the frequency measuring device available. It is intended that the calibration charts be employed for preliminary setting up, and the frequency finally adjusted with a good wavemetre or similar device.

1-12 A full "break-in" system is employed. This makes use of a keying relay whose contacts, operating in the ground lead at the base of the antenna tuning system, transfer the circuit to the receiver input and control the carrier. The contact sequence is such that, upon closing the manipulating key, the transfer is made just before oscillations start, and upon opening the key, the oscillations stop before antenna transfer is made. The break-in relay also carries a pair of contacts which close before the others and open after the others. These contacts 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 removing and applying high grid bias to the valves which reduces the plate current to zero when key is up. An auxiliary relay 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 break-in and compensating relays operate in series from 12-volts d-c obtained from a keying rectifier of the "dry" type.

1-13 Either c-w or i-c-w may be emitted. For the production of energy which modulates the carrier for i-c-w, an audio-oscillator is employed consisting of a pentode valve 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 the obtaining of essentially negative modulation. Three modulating frequencies are available which may be selected at will. When on c-w this oscillator is rendered inoperative, and when on i-c-w the oscillator valve is keyed along with the radio-frequency valves.

1-14 A single-phase full-wave rectifier is employed for production of h-t for the valves. This rectifier employs two hot-cathode mercury-vapour valves with appropriate smoothing system and delivers 2000 volts d-c. It is provided with an overload relay and time-delay device which delays application of h-t until the filaments of the valves have come up to temperature. This time delay is of the order of 30 to 45 seconds and is necessary only when starting up. During standby periods, these filaments, those of all other valves, and those of the companion high-frequency transmitter, are kept at full voltage in readiness for transmission without loss of time. The audio-oscillator valve is supplied with h-t from a smaller rectifier, employing a high-vacuum rectifier valve and associated filter and delivers 500 volts d-c. The hot-cathode mercury-vapour valves are provided with a heater working from the ship's mains, which serves to maintain the ambient temperature in the vicinity of the valves above its minimum value. A thermostat is employed to cut off the heater when the ambient reaches a value of approximately 75° F. Two heaters are employed, to be connected in series or parallel according as the ship's mains voltage is 220 volts or 110 volts d-c.

1-15 Filaments of all valves are lit from transformers arranged with a variable transformer or regulator to allow the filament voltage to be adjusted to the correct value. The filament line voltmeter carries a red line indicating the correct setting. When this voltmeter indicates on the red line, all actual filament voltages are correct. The filament transformers carry power taps for 100 and 110-volts 60-cycles a-c and the power transformer has taps for 100, 110, and 120-volts 60-cycles a-c.

1-16 Full protection is afforded operating personnel by means of a system of safety switches operating when the front covers are removed. These switches remove the h-t. To permit the application of h-t with the covers removed (to save time while testing or adjusting by the proper personnel), an auxiliary switch is incorporated inside the upper cover. This auxiliary switch is operated when the cover is replaced and this restores protection. A switch is included which operates in conjunction with the wavechange mechanism to shut off the h-t while the frequency is being changed from one channel to another. The various power circuits also carry line fuses, and the main 110-volts a-c line carries a main switch which, when opened, completely deadens the 110-volts circuits in the unit. This permits the set to be serviced without affecting the operation of the companion high-frequency transmitter. An auxiliary switch is also incorporated which permits application of low power for adjusting purposes. This switch short circuits a resistor in the supply to the main h-t rectifier for normal operation.

1-17 This Low-Frequency Transmitter is complete in itself and does not depend for its operation on any component in the companion High-Frequency Transmitter. It may thus be used alone, or ashore, in installations involving either no high-frequency transmitter, or one of another type. It may also be used on any 110-volts 60-cycle supply whether obtained from the rotary converter or otherwise. When used alone, it is only necessary to rearrange the external connections to suit.

1-18 Terminal designations on main terminal panel. This supplements dwg 90960-4363 (figure 8).

1&2 - 110-volts 60-cycle supply.
3&4 - Manipulating key. Terminal 4 is grounded to the cabinet.
5&6 - 110-volts or 220-volts d-c ship's mains supply for rectifier valve heaters. Polarity not important.
7&8 - Interlock terminals to companion High-Frequency Transmitter.
9&10 - Interlock Terminals to companion High-Frequency Transmitter.
11&12 - Pilot lamp circuit from companion High-Frequency Transmitter.
13&14 - Pilot lamp circuit to companion High-Frequency Transmitter.
15&16 - Circuit to muting relay in receiver.

1-19 When this transmitter is used alone, terminals 9,10,11,12,13,14 are not used. Terminals 7 & 8 require to be joined with a short jumper. This correctly alters the interlock circuits.

1-20 When this transmitter is used directly from the 110-volts a-c supply i.e. in locations not on shipboard, the a-c supply may be connected to terminals 1 & 2 and the rectifier heaters run from the same supply by wiring terminal 6 to terminal 2 and terminal 5 to terminal 1.

1-21 The ground connection is always to be made to the bolt at the top of the unit. The antenna is attached to the large insulating bushing, and the receiver antenna input to the small insulating bushing near the ground terminal.

2-0 THEORY OF OPERATION

Low-Frequency W/T Transmitter PV-500L

2-1 The basic theory of operation can best be understood by referring to the diagram of connections 90960-4363 (figure 8). In addition to showing schematically the various connections and identifying the components by circuit symbols, the diagram also shows the color coding of the wire making up the connections. This is of assistance in tracing the circuits and clearing faults.

2-2 The basic source of radio-frequency energy is the master oscillator. The valve V1 employed is a triode, type 810, in a parallel-fed circuit commonly known as the "Hartley". The oscillating circuit proper consists of the inductance L2 and the fixed and variable condensers C3, C6, C7 and C8. The h-t at 2000 volts is fed to the valve through choke L1, and direct current is blocked out of the oscillating circuit by condenser C1. The grid receives excitation from the oscillating circuit or "tank", through condenser C2. Resistance R1 is the grid leak, which serves to produce a working bias on the valve, and choke L8, in series with the grid leak, exhibits a high impedance to the radio-frequency voltage appearing on the grid and thus lightens the load on theoscillating circuit otherwise due to R1. Resistor R2 in series with the grid, serves to prevent spurious oscillations from being set up in the valve. Condensers C4 and C5 serve to bypass radio-frequency currents from the valve filament to ground.

2-3 The condenser C3, forming part of the total capacity of the oscillating circuit, is a variable unit and is for fine tuning. It is operated by the wavechange mechanism so that it takes up any one of four preset positions as the mechanism is operated. Condensers C6, C7 and C8 are fixed units, and are connected in as required by switches S1-3, S1-4, and S1-5. With each of these condensers is associated a small terminal board with movable links. This allows any given condenser to be brought into circuit on any or all of the four positions of the wavechange switches. This permits the use of any combination of the condensers to be set up.

2-4 The oscillating circuit inductance, L2, is tapped. The left-hand group of taps, selected by wavechange switch S1-2, determines the "reaction" i.e. the proportion of the total r-f voltage appearing across the oscillating circuit which is impressed in reversed phase on the grid of the valve. The greater the number of turns included between grid and ground (the blade of S1-2) the greater is the grid excitation and vice versa. Too much excitation forces the valve to draw a heavier load, and the drive to the power amplifier increases beyond the allowable value. In addition, the emitted frequency is not so stable. Too little excitation gives insufficient drive to the power amplifier, with consequent loss of conversion efficiency. The correct tap for a given frequency range is listed in the calibration data, or can be set by observation of m-o plate current and drive, as shown in the adjustment procedure given elsewhere.

Any tap can be associated with any position of wavechange switch S1 2, to permit the setting to the correct positions corresponding to the four emitted frequencies.

2-5 The right-hand group of taps is selected by wavechange switch S1-1, and determines the total inductance of L2, required for each frequency in use. It will be observed that S1-1 short circuits the unused turns of L2, and that any tap may be used on any of the four positions of S1-1.

2-6 The purpose of tapping L2 and selecting the condensers C6, C7 and C8, is to keep a reasonably constant L/C ratio through the whole frequency range. The correct taps and condenser combinations to be used at various frequencies are listed in the calibration data. Other than the listed values may sometimes be used, but if the inductance is decreased and the capacity increased too far from the values listed, the circulating current in the condensers and inductance is apt to exceed rating and result in increased losses. If the inductance is increased and the capacity decreased too far from the values listed, the circulating current is low and the stability of oscillation is impaired.

2-7 The power amplifier serves to raise the power delivered by the master oscillator. It consists essentially of two triode valves V2 and V3, type 810, in parallel. Radio-frequency energy from the master oscillator drives the grids through coupling condenser C9. Working bias is developed in the grid leak R5 bypassed by condenser C10. Choke L3 offers a high impedance to radio-frequency and this lightens the load on the master oscillator otherwise due to R5. Resistors R3 and R4 in the grid circuit serve to suppress possible spurious oscillations.

2-8 High tension is fed to the valves through choke L4, and the direct current is blocked out of the tuned circuit by condensers C13 and C34.

2-9 The associated tuned circuit comprises inductance L5 with its associated antenna coupling coil, and the group of fixed and variable condensers C14, C15, C16, C17, C18, and C35. The variable condenser is for fine tuning and is moved to its preset positions by the wavechange mechanism. The correct combination of fixed condensers and the correct tap on the coil L5, are selected by the wavechange switches S2-1, S2-2, S2-3, S2-4, S2-5 in similar fashion to that on the m-o, and the correct antenna coupling tap by switch S2-6.

2-10 As in the case of the master oscillator, any coil tap and any combination of condensers may be selected for any given frequency in accordance with the calibration data, so that a reasonably constant L/C ratio may be attained throughout the frequency range.

2-11 The coupling coil is arranged on the outside of L5 and is in the antenna circuit. By varying the number of turns included in it, the coupling to the antenna may be varied. One end of the coupling coil is connected through antenna ammeter M1 and its short-circuiting switch S-3, and through the contacts of break-in relay E1 to ground.

2-12 The loading system is located in the left-hand section of the unit and consists of a group of three loading coils L12, L13, and L14, together with the variometer L11. Each of these coils is tapped and the correct taps may be selected by the wavechange switches S15-1, S15-2 and S15-3. Unused turns on the coils are short-circuited to avoid "dead end turn" effects and any portion or all of any loading coil may be brought into use on any frequency. The variometer L11 is for fine tuning and is rotated by thewavechange mechanism to its preset adjustment. Sufficient inductance is included in the loading system to resonate to any antenna of apparent capacity 0.00022 to 0.001 uf, over the frequency range 100 to 500 kc. The taps on the inductances are arranged so that a smooth variation of total inductance may be obtained with the aid of the variometer, with generous overlaps. The higher inductance coils are "bank" wound in order to conserve space and yet keep losses low.

2-13 The master-oscillator and power - amplifier valves are keyed by means of a bias blocking arrangement. The h-t circuit carries a group of bleeder resistances R12, R13, R14, R15, R16, R17, R18. The filament return circuits of the m-o and p-a valves are carried, through cathode current meters M2 and M3, to a tap on this bleeder at the junction between R16 and R17. The power contact on break-in relay E1 short-circuits R17 and R18 thus grounding the cathodes. Under these circumstances, the m-o is able to oscillate. If the key is up, R17 and R18 are not short-circuited, and a portion of the h-t appears across them. The cathodes of the valves are then at a positive voltage with respect to ground, so that the grids are at a correspondingly negative voltage with respect to cathode and the m-o valve is prevented from oscillating. The p-a valves, having a high negative bias, draw little or no plate current.

Condenser C29 and resistor R19 serve to mitigate sparking at the relay contacts and keying surges.

2-14 The break-in relay carries three sets of contacts which operate in a definite sequence. When the relay closes i.e. when the key is down, a pair of contacts (connected to terminals 15 and 16) are shorted and mute the receiver through its auxiliary relay. Next, the receiver contacts close, short-circuiting the receiver input. Last, the power contacts close, causing carrier to appear. When the relay opens the reverse sequence takes place, the carrier disappearing first before the receiver is rendered operative. The arrangement thus permits full "break-in" or automatic antenna changeover operation.

2-15 For the production of i-c-w an audio-frequency tone generator is employed. It consists essentially of a pentode valve V5, type 807, in an oscillating circuit comprising transformer T2 and condensers C24, C25, C26. By means of switch S4, these condensers can be selected in combination to give frequencies of 400, 700, or 1000 cycles-per-second. The secondary of the transformer, together with resistor R11, is connected in the grid circuit of the power-amplifier valves so that the audio frequency is impressed therein, varying the grid voltage at an audio-frequency rate and thus modulating the carrier. Switch S5-1 short-circuits this transformer and resistance when c-w transmission is desired. Condenser C23 blocks the d-c plate voltage from the grid and the "reaction" is governed by resistors R9 and R10.

2-16 High tension, at 500 volts, for the oscillating valve is obtained from a single-phase full-wave rectifier employing a high-vacuum rectifier valve V4 (type 5Z3) supplied by transformer T1 which is tapped for 100, 110 and 120 volts. The resulting d-c is smoothed in condensers C19 and C20, and choke L6. R6 is a bleeder resistor, and the screen of the oscillating valve is supplied through resistor R7, bypassed by condenser C21. Resistor R8 provides cathode current bias for the valve. When on i-c-w, the a-f oscillator valve is keyed along with the m-o and p-a valves, using the same bias blocking arrangement. When the key is up, i.e. E1 open, the grid is negative with respect to the cathode by that portion of the 2000-volts h-t which appears across resistor R17. The valve is thus unable to oscillate. When the key is down, i.e. E1 closed, the cathode is grounded and the valve oscillates. When c-w is desired, S5-2 is operated, opening the 110-volts a-c supply to transformer T1. Switches S5-1 and S5-2 are ganged to operate together. The filaments of V4 and V5 remain on when on c-w transmission to avoid the necessity of waiting until the valve heaters come up to temperature.

2-17 High tension for m-o and p-a,at 2000 volts, is obtained from a single-phase full-wave rectifier employing hot-cathode mercury-vapor tubes V6 and V7 (type 872A). These are Supplied by power transformer T5 which is tapped for 100, 110 and 120 volts, and the resulting d-c is smoothed in choke L7 and condenser C30. The negative-return circuit includes an overload relay E7 which can be reset by pressing a button on front of the unit. Chokes L9 and L10 in the plate circuit of the rectifier valves, serve to mitigate interference in the receiver due to possible transient oscillations in the circuit.

2-18 The filaments of the m-o and p-a valves are lit by transformer T3, which also supplies heater current for the tone generator valves V4 and V5. The rectifier valves V6 and V7 are supplied from transformer T4. Both these transformers are tapped for 100 and 110 volts, and are supplied from the line through variable transformer T7. This latter serves to adjust the filament voltages to their correct value, as indicated by means of a red line on voltmeter M4. In series with the filament line is the variable resistor R22. An auxiliary relay E2, working in conjunction with the keying relay E1, short-circuits this resistor so that when the load comes on the 110-volts line and its voltage tends to fall, the filament voltage is kept reasonably constant. A green pilot lamp P1 is lit whenever the filaments are energized.

2-19 For the operation of the keying relays, a small magnesium copper-sulphide rectifier CU-1 is employed. It is supplied by transformer T6, which carries primary taps for 100, 110 and 120 volts and three secondary taps to offset effects of ageing in the rectifier. The rectifier delivers approximately 12-volts d-c.

2-20 Associated with the hot-cathode mercury-vapour rectifier valves is a pair of heaters R20 and R21. These serve to raise the ambient temperature in the vicinity of the valves to approximately 75° F, in order that the condensed mercury temperature does not fall too low under conditions of low room temperature, or while the equipment is idle. These heaters are governed by the thermostat E6 which opens the circuit for temperatures above 75°F. These heaters are permanently on the ship's d-c mains and are protected by fuses F1. In installations where the ship's d-c mains are at 110 volts,the heaters are connected in parallel. In certain cases, where the ship's mains are at 220 volts d-c, they require to be reconnected so as to be in series.

2-21 Two cooling fans are employed, which run only while h-t is on the set. One of these directs a stream of air into the antenna loading section and the other upwards through the m-o and p-a sections. These serve to improve air circulation and carry away the heat generated during long periods of use.

2-22 The hot-cathode mercury-vapour valves require a time delay of 30 to 45 seconds, after the filaments are lit, before h-t is applied. This is accomplished by relay E3. When the filaments are lit by manipulating switch S13, a small heater in the assembly heats a bimetallic strip which, when warm, bends and completes a contact to the holding coil of relay E3. This coil closes a contact which permits application of h-t and at the same time cuts off the heater and allows the bimetallic strip to restore to its normal position.

2-23 The equipment is brought into operation by closing switch S13, providing S12 is already ON. All filaments light up, and 30 to 45 seconds later the time delay relay E3 closes. At the same time, keying voltage appears. After E3 has closed, pressing the ON button of switch S14 energizes relay E4, which closes and locks electrically. A pair of contacts on E4 is arranged to open the circuit to the corresponding relay on the companion high-frequency transmitter, so that if it is not on STANDBY, its h-t will be removed. This arrangement ensures that h-t is not on both transmitters at the same time. When E4 locks in, it can only be unlocked by pressing the STANDBY button of switch S14, or by pressing the ON button on the companion high-frequency transmitter.

2-24 When E4 is energized, the main power contactor E5 closes and applies line voltage to the power transformer T5, and h-t appears. The equipment is then ready for keying. A red pilot lamp P2 lights on this and on the companion high-frequency transmitter to indicate the condition. An amber pilot lamp P3 lights when the high-frequency transmitter h-t is on, hence the operator can ascertain at a glance which transmitter is in operation. The filaments remain on at all times that switch S13 is closed.

2-25 The various protective switches are in the coil circuit of contactor E5. E5 will open, if closed, or fail to close if any of the switches S8 or S10 are open. These switches are closed only if all front covers are in place. Likewise, E5 will open if the overload relay E7 has tripped. Switch S7 is also in the circuit to drop out E5 and remove h-t as the wavechange mechanism is moved from one position to the other. Switch S9 allows h-t to be applied with the covers removed for adjustment purposes. It is closed by hand to permit this, but it is opened to restore protection when the covers are replaced.

2-26 The main 110-volts a-c line is protected by fuses F2, the filament circuits by fuses F3, and the h-t rectifier circuits by fuses F4. A main switch S12 is included to allow the whole transmitter to be made "dead" for inspection, cleaning, etc. without the necessity of shutting down the companion high-frequency transmitter.

2-27 In the primary circuit of the h-t power transformer is a resistance R23 and a shorting switch S6. This switch, when opened, reduces the h-t to allow preliminary adjustments to be made without danger of accidental heavy overloads. The resistor limits the current in the power transformer to a safe value. When preliminary adjustments are complete, this switch may be closed for normal operation or to make final adjustments.

3-0 ADJUSTMENT PROCEDURE

Low-Frequency W/T Transmitter PV-500L

3-1 Before proceeding, the construction and method of operation of the wavechange mechanism should be carefully studied. This mechanism is described in detail in a separate section. It should be noted that the mechanism operates switches S1, S2, and S15 directly, but the variable condensers C3 and C14 and variometer L11 are operated by special mechanisms with movable fingers which come against stops which limit the motion of the shafts in accordance with the position of the fingers and stops. It should also be noted that the shafts carry dials, and a locking device to hold them against the springs within the drums while setting up. The four fingers should be unclamped from the shaft to permit rotating the shafts (against the torque of the springs) for quick adjustment. When the correct setting has later been found, the shafts are temporarily locked up, and when all adjustment on any one frequency is complete, the fingers may then be tightened against the stops and the temporary locking removed. It is a good plan to note the dial settings in case the shafts are disturbed by locking up. If the equipment is shipped set up to its four frequencies, the condensers will have been locked up to the correct spots, so that the dial settings should be carefully noted for future reference before unlocking the fingers.

3-2 It is assumed that all wiring to the a-c and d-c supplies, and to the companion high-frequency transmitter, and all other external wiring is checked and correct. This also applies to any components which have been removed for shipment and subsequently replaced. It is also recommended that the equipment be gone over generally for parts which may have been misplaced or broken in shipment, and also to tighten up all screws, connections, etc, which may have come loose.

3-3 Before applying any voltage from d-c or a-c line to the unit, make sure that the resistors R20 and R21 are connected in series for 220-volts d-c ship's mains, or in parallel for 110-volts d-c ship's mains. Failure to verify this may result in blowing the fuses or in burning out of the resistors, or in their generating insufficient heat.

3-4 Before applying any voltage from d-c or a-c line to the unit, all transformers must have their primary taps correctly set. The rotary converters supplied with the equipment deliver approximately 110-volts 60-cycles a-c on full load when the ship's mains voltage is 110 or 220 volts d-c, as the case may be. If it is found later that the ship's mains voltage is lower or higher, the machine will deliver a correspondingly higher or lower voltage. If the ship's mains voltage cannot be adjusted to 110 or 220 volts d-c, the a-c voltage delivered by the rotary converter should be measured. The no-load voltage will be about 10 volts higher than the full-load voltage, so that the full-load voltage may be estimated and taps set on the power transformers to correspond.

The taps are as follows on T1 and T5:

1 and 2 - 100 volts
1 and 3 - 110 volts
1 and 4 - 120 volts

The taps on T3, T4, and T6 should be set for 110 volts (taps 1 and 3), as the variable transformer T7allows adjustment to the exact value. The secondary taps on T6 are for rectifier ageing, and taps 5 and 7 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 should be not less than 12 and not over 14,and the taps finally set to correspond, using 5 and 6, 5 and 7 or 5 and 8.

3-5 CAUTION: DANGEROUS VOLTAGES EXIST WITHIN THE EQUIPMENT.

To avoid possibility of fatal injury while working inside the unit with covers removed, always see that the power is off and the red pilot lamp out before touching any part. It is possible to apply h-t with front covers off by closing S9, but before making any adjustment always return S14 to the STANDBY position and watch the red pilot lamp. Even with the standby switch off, the 110-volts circuits are still live, and if necessary to work in the lower portion of the unit where those voltages exist, open the main switch S12 and the d-c supply switch to the ship's mains (appearing across fuses F-1), or shut down the rotary converter.

3-6 Open S6 on the main terminal panel and remove resistor R23 from its socket. This ensures no h-t will appear as the preliminary checks of power control circuits are made.

3-7 Apply the d-c ship's mains voltage and verify that the valve heaters R20 and R21 function properly. The thermostat E6 should cut them off when the ambient rises above approximately 75°F., and place them on if the temperature is below about 75° F.

3-8 Insert a set of valves in their marked sockets. Start the rotary converter and close the main switch S12. Place the filament switch S13 to ON when the valve filaments should light. Manipulating the filament control T7 should vary the filament voltage as indicated on the meter M4. Manipulating the filament compensating resistor R22 will also raise or lower the filament voltage. It should be turned until the voltage is highest and then the main filament control T7 readjusted until the meter reads on the red line (the red line is at 110 volts).

3-9 When the filaments come on, the keying voltage should appear, and by manipulating the transmitting key, the operation of break-in relay E1 and filament compensating relay E2 may be checked. The green pilot lamp should also light when filaments are lit.

3-10 Approximately 45 seconds after the filaments are put on, the time delay relay E3 should close. The timing of this may be checked and the adjusting screw manipulated as necessary if the timing is less than 30 or greater than 45 seconds. If the ambient temperature is low or high, it may take a little longer or shorter time to close, but should be never less than 30 seconds.

3-11 Before applying h-t the hot-cathode mercury-vapour valves must be aged to disperse any particles of mercury that may be on the cathode or anode. They should be run at normal filament voltage for a period of 30 minutes before placing h-t on them. Subsequently, this treatment is not necessary unless the valves have been removed and stored in any position other than upright. Once aged, the valves then only require the normal delay of 30 to 45 seconds.

3-12 To check the control circuits, place S5 to the CW position, and make sure that R23 is removed and S6 open; press the ON button. The auxiliary relay E4 will close. The main contactor E5 will close, unless the overload relay E7 is open, or the safety bypass switch S9 is not closed. H-t cannot be applied with the safety switches open unless S9 is closed. At the same time E5 operates, the fans should start up and the red pilot lamp light. H-t will not appear if S6 is opened and R23 removed.

Note that E4 will not lock closed unless the companion high-frequency transmitter is connected up, as the absence of a connection across terminals 7 and 8 prevents E4 from locking up, i.e, E4 will drop out as soon as the finger is removed from the ON switch S14. In the absence of the corresponding high-frequency transmitter, or if it is not yet connected up, a short temporary jumper may be placed across terminals 7 and 8.

3-13 Pressing the STANDBY switch S14 unlocks relay E4 and drops out contactor E5. The equipment may now be shut down by opening filament switch S13 and the resistor R23 restored. Switch S6 should be left open to reduce h-t while preliminary adjustments are made.

3-14 By reference to the calibration data, the approximate condenser and coil tap combinations on the m-o and p-a circuits can be ascertained for each of the four desired frequencies. Usually the unit is shipped adjusted to four spot frequencies, and the exact settings have been noted in the test data. In any event, these settings should be verified with the aid of a good wavemeter. An antenna circuit calibration is of little use, as the properties of the antenna vary between the various types of ships, and it is not difficult to resonate the antenna even though no calibration is available. The approximate tap positions may be placed by experience if similar installations have been previously made.

3-15 The usual procedure is to first adjust the m-o to its correct frequency with the p-a high tension off and the antenna circuit open by removing the taps on the p-a coupling coil, then the p-a tank with antenna open, and lastly the antenna circuit proper. It is suggested that positions 1 and 4 on the wavechange mechanism correspond to the highest and lowest frequencies. It is also suggested that everything be tuned up on all four frequencies as far as the antenna circuit, and locked up, as they do not require any further adjustment as the antenna is being tuned.

3-16 For each of the four frequencies desired, set up the required condenser and coil tap combinations on m-o and p-a, and unlock the mechanism on C3 and C14 to permit rotating them by hand on their shafts.

3-17 Disconnect the h-t lead attached to terminal 1 on the p-a section. This is most easily accomplished by opening the lead to L4, rather than removing the heavy h-t cable. This keeps h-t off the p-a section until the m-o is set on its correct frequency. The lowest frequency should be set up first. Place the wavechange switch on position 4, close switches S12 and S11, and light the filaments by manipulating S13. Adjust to correct voltage. After allowing sufficient time for the time-delay relay to act, press the ON button. If the key is up, no cathode currents will be read on either M2 or M3. Pressing the key should start the m-o, and cathode current should appear, as noted on M2. Meter M3 will also read, as it is in the cathode return circuit of the p-a valves, but will read only grid current in them since the h-t lead has been disconnected.

This shows evidence of oscillation, but due to the lowered value of 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, applying full h-t. Since there is no other load, the h-t will be higher than usual, so that m-o cathode current and p-a grid current will be higher than on full load. M-o cathode current of 50 to 70 ma and p-a grid current of 110 to 130 ma may be expected, providing the "ground" or excitation tap has been set in accordance with the calibration data. This grid current and the m-o cathode current will fall as the p-a is later brought into tune and loaded.

3-18 Check wavelength with the aid of a wavemeter, and adjust the m-o tuning condenser C3 until the exact desired wavelength is found, and lock the setting by means of the hand lock on the dial to hold it. Switch off the h-t, and tighten the finger on the mechanism firmly against its stop and then the dial may be unlocked. The setting should be logged for future reference. Final frequency adjustment is made after all four frequencies have been set up and checked with the front shields in place. By employing a similar procedure, first with S6 open, then closed, all 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 it is necessary to work on the coil taps, condensers, etc. The tap positions on the coil and the condenser group have a minor effect on the wavelength, so that it may be necessary to recheck once or twice.

3-19 To tune the p-a shut down and restore the h-t connection previously removed from terminal 1. Remove the taps from the coupling coil so that the antenna circuit is open. Set the wavechange mechanism to the lowest frequency position (#4). <u>With S6 open</u> to lower the h-t, start up and cautiously press the key. If the p-a tank is badly off tune, a high reading will be observed in the p-a cathode meter. By rotating the fine tuning condensers, a position will be found where this reading dips sharply to a minimum. This is the correct position and, having found it, switch S6 may be closed. If S6 is closed and the setting is not reasonably correct, the variable condenser is apt to flash over. It will be found that this minimum current is quite sharp and should be approximately 120 to 175 ma depending on the frequency. It should be remembered that this current reading includes grid current, so that the actual plate current is about 100 ma less than this figure. It will be observed that on the lower frequencies, the point of minimum cathode current 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 is a small portion of the total capacity. On the higher frequencies, when the setting is sharpest, it should be carefully set.

Having found the setting, it may be locked up on the dial, and after removing h-t, the finger on the mechanism may be tightened on its shaft firmly against the stop. All frequencies may be thus similarly set up, with S6 first open, then closed, and the settings locked up on the wavechange mechanism. The settings should not be changed (unless it is necessary to reset the m-o when final frequency check is made) since this represents highest tank 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.

3-20 At this stage, for final check of wavelengths, the wavemeter may now be coupled to the p-a tank. If the wavelengths are slightly away from correct value, the m-o tuning condenser may be unlocked and shifted a little. The p-a plate current should not be allowed to go too far from its minimum while thus shifting the m-o, without correspondingly resetting the p-a condenser.

3-21 The process can be considered complete when the m-o is set up and locked in its four positions, and the p-a is set for minimum feed on each position and its condenser locked up. These controls should not be subsequently disturbed, and all subsequent tuning should be done on the antenna circuit. Switch S6 may now be left closed, 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.

3-22 The next process is to bring the antenna into tune and to couple it to the p-a. Again, it is better to start at the lowest frequency (longest wavelength) and work upwards towards the highest frequency, as the tuning of the antenna is affected to a certain extent by the position of the leads to the taps on the loading coils. The approximate settings may be found, and then final adjustments made on the variometer as the coil taps approach their correct positions. The tap to the coupling coil on L5 is rather critical for the higher frequencies, only one or two turns being necessary, and it is usually necessary to move the tap along a quarter of a turn at a time. On the lower frequencies upwards of 10 to 12 turns are required, but the adjustment is not so critical. It is suggested that for 500 kc, one turn be used; for 300 kc, 2 turns; for 200 kc, 5 turns; and for 100 kc, 8 turns, be used for a start. This gives a coupling sufficiently loose for preliminary work.

For frequencies around 500 kc., only L12 will probably be used in the loading system. For 300 kc., L12 and part of L13, while for frequencies around 150 kc., or less, coil L14 will be required to be brought in.

In this loading system, each tap on L12 is well overlapped by the sweep on the variometer L11, each tap on L13 is well overlapped by L12, and each tap on L14 is well overlapped by L13. It will be observed that L11 carries an additional tap designated "A", in order to reach 500 kc on large antennas, and this should be used only if necessary. A few test clips on short leads are of assistance in quickly moving from tap to tap on the loading coils in order to obtain the correct position; then the permanent leads may be fastened on before high currents are expected.

Several combinations of taps on the three loading coils may be found, each representing the same inductance. It is recommended in the interests of keeping losses down, especially on the lower frequencies and on small antennas, that as much of the loading as possible be used on coil L12, using L13 only if required, and then L14 only if required. In other words, it is recommended that the larger coils be brought into use only when it is impossible to obtain the desired tuning on the small coils.

3-23 The method of finding tune is to unlock the variometer L11 from the wavechange mechanism, and to rotate it through its travel, at the same time watching the antenna ammeter and p-a cathode meter, while holding the key down for short intervals. The fine taps on L12 may be tried first, then the coarser taps on L13 and L14; changing the inductance in small steps until, as the variometer is rotated, some indication of antenna current is observed. This indication is quite sharp and some patience is often required to find the setting. As resonance is approached, the antenna current will rise sharply and also the p-a cathode current. If the variometer is near the end of its travel, the next higher or lower tap on L12 may be used to bring the variometer setting somewhere around mid-scale.

3-24 Having located the tune point, the p-a cathode current may be observed as the variometer is rotated. The maximum antenna current will occur at or near maximum p-a cathode current, and the setting is correct when maximum antenna current is obtained for least p-a cathode current.

Should this current be low, it will be necessary to increase the coupling by adding a fraction of a turn to the coupling coil by means of the movable taps, and retuning until the p-a cathode current is not over 550 ma. This current, if high, may be reduced by subtracting turns on the coupling coil. S6 should be closed throughout this adjustment, with the tap on the power transformer T5 set to correspond with the line voltage under load conditions. This figure of 550 ma 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 for a given antenna current. However, if the m-o cathode current is correct and the ground tap on the m-o tank coil is 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 roughly find the tune point should be removed, and permanent connections made. The leads to the switches should be bent away clear from each other and from the loading coils and ground, as they may flash over. They should also be shortened, if necessary, by looping them, pressing the loop flat, and tying with a piece of cord. In particular, the leads should be kept clear of the coils, as a flashover to the coil is apt to damage it. The leads should also be so disposed as not to interfere with the motion of the blade on the wavechange switch.

3-25 Having found the correct variometer setting and coupling tap for normal output and valve cathode current, the setting may be locked up similarly to the method used on the m-o and p-a. The coupling taps are provided 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 or the terminal board on the tank condensers. They should be bent out of the way and tied up if necessary with cotton cord. Care should be taken to see that the clip at the end of the taps is correctly in place, as it is easy to have it short-circuit two turns. The thumb nut should be tightened up firmly, also the lug connections to the terminal board, so that there is no danger of contact between the conductors proper. The fish-spine beads afford adequate insulation between conductors.

3-26 The four frequencies may be set up in similar manner to the above. It will be found that placing the front shields over the loading coils has an effect on tuning and output, especially on the low frequencies. The upper shields may be put in place, leaving that over the variometer off, and the tune point and coupling taps readjusted. Placing the shield over the variometer does not affect the tune point much when the variometer alone is in circuit. Its effect should be allowed for by setting the dial a little off, and ascertaining if placing the shield in place raises or lowers the antenna current. If, when the shield is put in place, the antenna current and p-a cathode current come back to normal, sufficient allowance has been made. This is a "cut-and-try" process and requires a little patience. The shield cover may be also put on the m-o and p-a sections. It has negligible effect on tuning but, again, can be allowed for if necessary.

3-27 If, during the above, it is observed that the filament voltage varies more than about 5% with key down, the filament compensator resistor 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 T7 readjusted, to have M4 read on the red line whether the key is down or up. The poorer the regulation, the more resistance is required in R22, with a correspondingly higher setting for T7.

3-28 Final readings can now be taken and settings logged. The transmitter may be keyed and general performances checked. It may be placed on i-c-w and the three tones checked. It will be observed that the p-a cathode current and antenna current will be considerably lower, depending to a certain extent on the wavelength and antenna characteristics. This is due to the fact that this equipment is designed for negative modulation, so that the net carrier and sideband power is less than the original c-w carrier power.

3-29 The p-a valves should not exhibit any visible heat beyond a just perceptible redness in a dim room, with the key held down for a minute or two. If they overheat, they are not receiving sufficient drive, or 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 wavelengths. It is not apt to be steady, especially if the ship is at sea, but it will be observed that, providing the tuning process has been carried out as described, the change in antenna constants resulting in lower antenna current also results in lower p-a cathode currents.

Indeed, if the antenna is completely detuned, the effect will be a removal of the load on the p-a. The antenna current can be expected to be of the order of 7 amperes on 500 kc., and a lower reading as the frequency is decreased to about 3.5 amperes on 100 kc. These figures are subject to considerable variation and must not be taken as other than representative.

3-30 A complete set of typical readings is included in the test and calibration data. Meters are not provided for the separate measurement of grid currents, or voltages in the tone generator, but if a high resistance (1000-ohms-per-volt) d-c voltmeter is available reading up to 750 volts, it is possible to read m-o and p-a grid currents by measuring voltages across R1 and R5 respectively, and dividing by known value of resistance. The tone generator plate voltages may be read directly across R6.

4-0 MAINTENANCE

Low-Frequency W/T Transmitter PV-500L

4-1 The equipment should be gone over periodically for cleaning and general inspection. Such a procedure often locates incipient faults. In particular, all insulation, especially the ceramic pillars in the loading coil section, should be kept free of dirt, soot, or salt deposit. Screws and nuts which may tend to loosen after a time should be kept tight.

4-2 The contact surfaces of the relays and contactors should be examined periodically for burning or pitting, and kept clean. Crocus cloth or a contact burnishing tool should be used. Coarse sandpaper, files, and other rough abrasives should be avoided. The valve pins should be periodically examined for poor contact, expecially the rectifier valves whose filaments carry heavy current. They may be brightened with fine sandpaper.

4-3 The switches and mechanisms making up the wavechange device should be periodically examined, and lubricated if necessary. The contact surfaces of the switch blades should not be allowed to become dirty. The cords which actuate the mechanism should be kept free of corrosion by a light coat of vaseline.

4-4 The rotary converters should have a periodical inspection. Lubrication data is supplied with them. The commutator and slip rings should be kept clean with the aid of a rag, or very fine sandpaper. Small pits and irregularities may be removed by using a piece of very fine sandpaper. If badly pitted or irregular, the commutator may require returning. The brushes should be periodically inspected for wear, and renewed if necessary. The active surface should bed down correctly to the rounded surface of the commutator or slip rings.

4-5 The valves will,in time,come to the end of useful life, and evidence of age will be probably visible in the p-a valves before the others. P-a valves which are coming to the end of life show up a reduced output and cathode current for normal drive, h-t, and coupling. A failing m-o valve also results in lowered cathode current and low drive. If it is suspected that valves need replacing, substitution of fresh valves may be made and results noted. If output, currents, etc, are approximately the same after such a substitution, it is an indication that the valves replaced are still serviceable.

The 872-A rectifier valves will, in time, accumulate a deposit on the inside of the glass rendering them almost opaque. This is not necessarily an indication of end of life. Failing valves may be observed by a change in colour and extent of the characteristic blow glow inside the bulb. It becomes paler and changes to a pinkish tinge. If these valves are replaced, they must be aged 30 minutes at normal filament voltage with h-t off to properly distribute the mercury.

The 5Z3 rectifier valve in the tone generator often shows blue glow in the space between cathode and anode as it ages, and the bulb runs excessively hot. The h-t is also reduced. Failure of the h-t results in failure of the tone generator to oscillate. If it is suspected that the valve is coming to the end of life, the voltage may be read (across R6 with a high-resistance d-c voltmeter), a fresh valve substituted and the difference in performance noted.

The 807 tone-generator valve sometimes carries a bluish coloration inside and near the bulb when in operation. This is a form of fluorescence and is not necessarily an indication of an old or "soft" valve. Failure of the valve is accompanied by feeble or no oscillations in the tone generator as the set is keyed on i-c-w. Again, the best test is the substitution of a fresh valve.

4-6 After prolonged operation, the dry rectifier element may "age", resulting somewhat in lower d-c voltage and loss of snappy keying-relay action. The secondary taps on transformer T6 may be rearranged. As first supplied, taps 5 and 7 are used; taps 5 and 8 will raise the voltage by about 5%.

5-0 PARTS LIST

Low-Frequency W/T Transmitter FV-500L

Circuit Symbol	Part	Description	Type Number	Maker
Condensers				
C1	M-o plate blocking	0.005 uf 6000 v	9-FAS-62050	C.D.
C2	M-o grid	0.005 uf 5000 v	9-AS-52050	"
C3	M-o tank	350 uuf 6000 v	91717	Marconi
C4	M-o filament bypass	0.01 uf 1000 v	4S-11010	C.D.
C5	M-o " "	0.01 uf 1000 v	4S-11010	"
C6	M-o tank	0.00025 uf 5000 v	364-6S	"
C7	M-o "	0.0005uf 5000 v	272-6S	"
C8	M-o "	0.001 uf 6000 v	463-6S	"
C9	P-a grid coupling	0.005 uf 5000 v	9-AS-52050	"
C10	P-a grid bypass	0.001 uf 2500 v	4S-22010	"
C11	Not used			
C12	" "			
C13	P-a plate blocking	0.005 uf 6000 v	9-FAS-62050	"
C14	P-a tank	350 uuf 6000 v	91717	Marconi
C15	P-a "	0.00025 uf 6000 v	586-59	C.D.
C16	P-a "	0.0005 uf 6000 v	544-59	"
C17	P-a "	0.001 uf 6000 v	545-59	"
C18	P-a "	0.002 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	0.5 uf 1000 v	DY-10050	"

Circuit Symbol	Part	Description	Type Number	Maker
Condensers				
C22	T-g grid bypass	0.01 uf 1000 v	4-S-11010	C.D.
C23	T-g grid coupling	0.1 uf 1000 v	DY-10010	"
C24	T-g tank	0.02 uf 2500 v	9-AS-21020	"
C25	T-g "	0.02 uf 2500 v	9-AS-21020	"
C26	T-g "	0.1 uf 1000v	DY-10010	"
C27	Meter bypass	0.01 uf 1000 v	4-AS-11010	"
C28	" "	0.01 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	0.5 uf 600 v	DY-6050	"
C32	Thermostat spark suppr.	0.1 uf 600 v	DY-6010	"
C33	Meter bypass	0.01 uf 1000 v	4-AS-11010	"
C34	P-a plate blocking	0.005 uf 6000 v	9-FAS-62050	"
C35	P-a tank	0.00015 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, 6v d-c coil, Approx 4.4 ohms	"
E3	Time-delay	110 v 60-cycle coil Delay 20 seconds to 1 minute	1154T	"
E4	Auxiliary		FQA 110-v 60-cy coil. Contacts 2A,1B code #4	Can. Tel. & Supplies

Circuit Symbol	Part	Description	Type Number	Maker
Relays				
E5	Main contactor		Bul.700AC open type,110-v 60-cy coil A209	Allen Bradley
E6	Thermostat		Type M8-D8-2B normally closed self regulating 75° F. $\not+$ -5°	A. Edison Inc.
E7	Overload		Type 1040, trip current 0.75 amp d-c coil #351 2.5 ohms.	Leach
Fuses				
F1	Heater (2)	(Refill)	3 amp 250 v	Economy
F2	Main line (2)	"	30 amp 250 v	"
F3	Filament (2)	"	5 amp 250 v	"
F4	Power (2)	"	25 amp 250 v	"
Inductances				
L1	M-o plate choke		88959	Marconi
L2	M-o tank		91175	"
L3	P-a grid choke		90899	"
L4	P-a plate choke		90893	"
L5	P-a tank		90900	"
L6	T-g rectifier smoothing choke		91126	"
L7	H-t rectifier " "		89361	"
L8	M-o grid choke		90899	"
L9	H-t rectifier suppressor choke		84900	"
L10	H-t " " "		84900	"
L11	Antenna tuning variometer		90930/4362	"

Circuit Symbol	Part	Description	Type Number	Maker
Inductances				
L12	Antenna tuning		91075	Marconi
L13	" "		91076	"
L14	" "		91077	"
Meters				
M1	Antenna ammeter	0-10 amps r-f	37S	Simpson
M2	M-o cathode milliammeter	0-150 ma d-c	27S	"
M3	P-a " "	0-1000 ma d-c	27S	"
M4	Filament line voltmeter	0-150 v 60-cycles Red line at 110 v	57S	"
Lamps				
P1	Pilot lamp		120 v 6W-S6 clear	C.G.E.
P2	" "		Ditto	"
P3	" "		Ditto	"
Resistors				
R1	M-o grid leak	10,000 ohms	CE,"C" coating #5 terminals	Intl. Resis. Co.
R2	M-o parasitic suppressor	125 ohms	AB,"C" coating #1 terminals	"
R3	P-a "	125 ohms	Ditto	"
R4	P-a "	125 ohms	Ditto	"
R5	P-a grid leak	2,000 ohms	FJ,"C" coating #5 terminals	"
R6	T-g rectifier bleeder	50,000 ohms	FB, "C" coating #5 terminals	"

Circuit Symbol	Part	Description	Type Number	Maker
Resistors				
R7	T-g screen resistor	40,000 ohms	CE, "C" coating #5 terminals	Intl. Resis. Co.
R8	T-g cathode resistor	250 ohms	AB, "C" coating #1 terminals	"
R9	T-g grid "	15,000 ohms +-5%	BT-1	"
R10	T-g " "	35,000 ohms +-5%	BT-1	"
R11	P-a grid "	3,000 ohms	FD, "C" coating #5 terminals	"
R12	H-t bleeder	4,000 ohms	HE, "C" coating #5 terminals	"
R13	H-t "	4,000 ohms	Ditto	"
R14	H-t "	4,000 ohms	Ditto	"
R15	H-t "	4,000 ohms	Ditto	"
R16	H-t "	4,000 ohms	Ditto	"
R17	H-t "	2,000 ohms	HA, "C" coating #5 terminals	"
R18	H-t "	2,000 ohms	Ditto	"
R19	Keying spark suppressor	1,000 ohms +-10%	AB, "C" coating #1 terminals	"
R20	Rectifier heater		Enclosed heater unit 100-w 115-v	Chromalox
R21	" "		Ditto	"
R22	Keying compensator	7.5 ohms 100 watts	Model K, stock #0445	Ohmite
R23	Power reducing resistor		Straight core heater element, screw base, 660-w 110-v	P.M. Wright Electric

Circuit Symbol	Part	Description	Type Number	Maker
Switches				
S1	M-c wavechange		91756	Marconi
S2	P-a "		91710	"
S3	Antenna ammeter shorting		91209	"
S4	Tone selector		92373	"
S5	CW-ICW		91136	"
S6	Low power		6464	A H & H
S7	H-t interlock		20595	"
S8	H-t "		3591	"
S9	H-t "		3597	"
S10	H-t "		3591	"
S11	Not used			
S12	Line		6465	"
S13	Filament		6900	"
S14	ON-STANDBY		6848	"
S15	Antenna wavechange		91960	Marconi
Transformers				
T1	Tone generator rectifier power		89036	"
T2	Tone generator oscillator		89301	"
T3	Filament		89199	"
T4	"		89306	"
T5	H-t rectifier power		89056	"
T6	Keying rectifier		89308	"
T7	Filament control		Variac 30B	General Radio

B32 Circuit Symbol	Part	Description	Type Number	Maker
Valve Sockets				
V1	Valve socket (810)		Type 211 white	Johnson
V2	" " (810)		Ditto	"
V3	" " (810)		Ditto	"
V4	" " (5Z3)		SS-4	Amphenol
V5	" " (807)		SS-5	"
V6	" " (872A)		Type 211 white	Johnson
V7	" " (872A)		Ditto	"
Miscellaneous				
CU-1	Keying rectifier		F-28-C-1	Mallory
	Cooling fans		#800	B.M.C. Air Cond.& Engrg.Corpn.

6-0 CALIBRATION AND OPERATING DATA

Low-Frequency W/T Transmitter PV-500L

6-1 This supplements the calibration curves which show the coil taps, variable condenser settings, and padder condensers to be connected in for any required frequency. It will be observed that on the p-a tank inductance L5, 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 thus short circuits the unused portion of the coil (between the selected tap and the end of the coil).

Recommended p-a tap positions are as follows:

KC	TAP NUMBER
95-125	8 (whole coil)
120-153	7
148-185	6
180-225	5
220-275	4
270-335	3
325-415	2
400-520	1

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

6-2 On the m-o tank inductance L2, two groups of fixed taps are brought out to a terminal panel. The left-hand group, numbered 1 to 14, are the "ground" taps and are selected by flex leads. The higher the number of the tap to which the lead is connected, the more turns are included between grid and ground, and the higher the excitation and m-o cathode current. The proper tap to employ is listed below, and results in 65 to 90 milliamps grid current to the p-a stage (when loaded). The next higher tap gives 75 to 105 milliamps grid current. The next lower tap is not recommended, as the valve may fail to oscillate, or if it does, insufficient drive is 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 as follows:

KC	GROUND TAP	TANK TAP
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 noted that there is an overlap between each band. If the desired frequency is on this overlap, the higher numbered taps 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 on test, the m-o may be set up to the calibration and the frequency later checked with a good wavemeter, or by 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 given in the section under adjustment.

Reference to the curves will show that, in a given frequency band, they differ only in the capacity required in the padders. The curve next above a given curve requires a capacity 0.00025 uf less, and the curve next below requires a capacity 0.0025 uf more. If the required setting for a certain frequency is near the maximum capacity on the variable, it may be found that the tune seems to come beyond the maximum. This is usually due to small variations in condenser capacity and coil inductance. If such is the case, it is only necessary to add 0.00025 uf in the padders i.e. move to the next curve below. Tune will then be found with the variable near minimum. Similarly, should the required setting seem to be near the minimum, it is only necessary to subtract 0.00025 uf in the padders.

As an example, suppose the padder combination is 0.0005 plus 0.00025 and the variable seems to require a setting slightly beyond "100". To add 0.00025 to this, it is necessary to disconnect the 0.0005 and 0.00025 units and connect in the 0.001 unit only. The variable will now require to be set near zero. The padder total was 0.00075, and is now 0.001 i.e. has been increased by 0.00025.

6-3 Typical readings on c-w are as follows. The actual antenna current will differ from the figures given below as the antenna characteristics will differ.

	Key Up	Key Down	Key Down	Key Down	Key Down
Frequency (kc)		111	325	475	500
H-t volts	2175	2000	2000	2000	2000
P-a cath.current (ma)		570	545	550	545
P-a grid current (ma)		75	69	74	73
P-a plate current (ma)		495	476	476	472
M-o cath. current (ma)		60	50	55	55
M-o grid current (ma)		23	21	23	24
M-o plate current (ma)		37	29	32	31
A-c line volts.	112.5	111.5	111.5	111.5	111.5
A-c line current (amps)	7	17.5	17.5	17.5	17.5
Antenna current (amps) (10.5 ohms, 0.001 μf on External r-f meter)		6.1	7.0	7.1	7.1

6-4 Typical readings on i-c-w are as follows, with conditions otherwise as for c-w reading above.

	Key Up	Key Down			Key Down		
Frequency		111	111	111	500	500	500
Modulating freq.(cycles)		400	700	1000	400	700	1000
Main h-t (volts)	2150	2025	2025	2025	2025	2025	2025
T-g h-t (volts)	670	528	530	540	528	530	540
M-o cathode current (ma)		57	57	57	52	52	52
M-o grid current (ma)		23	24	24	25	25	25
M-o plate current (ma)		34	33	33	27	27	27
P-a cathode current (ma)		360	330	300	360	355	350
P-a grid current (ma)		46	48	50	46	47	48
P-a plate current (ma)		314	282	250	314	308	302
T-g cathode current (ma)		75	78	70	75	78	70
T-g screen volts.		320	265	280	320	260	280
Ant current (amps)		4.6	4.25	3.95	5.6	5.5	5.5

6-5 The meters on the unit only read cathode currents in m-o & p-a. With a test milliammeter and high-resistance (1000-ohms-per-volt) d-c voltmeter, the other voltages and currents may be read as follows:

P-a grid current - Volts across R5 (2000 ohms) or milliammeter in series at low-voltage or ground end.

M-o grid current - Volts across R1 (10000 ohms) or milliammeter in series at ground end.

T-g cathode current - Milliammeter in series with cathode return circuit (at terminal 11 on t-g)

T-g screen volts - Voltmeter between screen end of R7 and terminal 11.

T-g h-t volts - Voltmeter across R6.

Main h-t - Voltmeter (0-2500 volts d-c) across C30.

CAUTION SHOULD BE EXERCISED in taking any of these readings, as dangerous voltages may exist on the meters used unless suitable precautions are taken.

6-6 The above readings are typical and represent nearly 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 - 1900-2050 volts key down - Key up, approximately 150 volts higher, depending on regulation.

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

P-a grid current - 65-90 ma, depending on frequency in use and on output.

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

M-o grid current - 18-28 ma, depending on frequency in use and on output.

I-C-W Main h-t - 1950-2050 volts (key down) - Key up, approximately 150 volts higher, depending on regulation.

Tone generator h-t - 630-660 volts key up - 500-540 volts key down.

P-a cathode current - 300-375 ma depending on radio and audio frequencies in use, antenna constants, etc.

P-a grid current - 45-55 ma depending on r-f and a-f, antenna constants, etc.

M-o cathode current - 50-60 ma depending on r-f and a-f, antenna constants, etc.

M-o grid current - 20-30 ma depending on r-f and a-f, antenna constants, etc.

T-g cathode current - 70-80 ma depending on r-f and a-f, antenna constants, etc.

T-g screen volts - 250-320, depending on r-f and a-f, antenna constants, etc.

6-7 Actual test readings on a particular transmitter are included, together with tune dial settings for the assigned frequencies and other pertinent information, in an envelope attached to the unit prior to shipment.

6-8 The links forming the movable connections to the terminals on the terminal board above the padder condensers should be tightened down. If, for example, a given condenser is used on wavelengths 2, 3, and 4, but not on 1, the idle link should be doubled with one of the others. This will avoid a free link which is apt to become loose or lost.

If all four wavelengths do not require a certain condenser, no link is required between the middle terminal of a group and the outer terminals. In such a case, the four idle links may be attached under two adjacent terminals, e.g. 3 and 4. This avoids loosening and possible loss, and it will be observed that, so long as the central terminal is free, the condenser is never connected in circuit on any position of the wavechange switch.

SECTION "C"

High-Frequency W/T Transmitter PV-500-H (86790)

1-0 CONSTRUCTION AND LOCATION OF PARTS

1-1 The transmitter is entirely self-contained in a unit small enough to pass through small doors and passage-ways. The unit should fit close to the wall or bulk-head and may be bolted to the deck. All units can be removed from the front of the cabinet. Removable front shields permit access to the interior, and these are provided with quick acting thumb fasteners. The floor of the cabinet is raised above the deck level to protect the equipment from the effect of water on the cabin floor. There should be at least twelve inches clearance at the right side of the cabinet to permit free circulation of air to the fan.

1-2 The main terminal panel is located at the bottom of the cabinet. External cabling is brought in through holes at the rear of the cabinet or through holes in the bottom of the cabinet just under the main terminal panel as convenient. If brought through the rear holes, the cabling should be completed before the power unit is placed in position. The main line switch, line fuses and heater fuses, are located at the right of this panel. This panel is designated #91778 on the diagram of connections (Fig.36). The terminal panel connections are as follows:

1 & 2 - 110-volt 60-cycle supply.
3 & 4 - Manipulating key. Terminal 4 is grounded at the cabinet.
5 & 6 - 110 or 220-volt d-c ship's mains supply for rectifier valve heaters. Polarity not important.
7 & 8 - Connect to terminals 7 and 8 on companion low-frequency transmitter. Interlock contacts.
9 & 10 - Connect to terminals 9 and 10 on companion low-frequency transmitter. Interlock contacts.

11 & 12 - Connect to terminals 13 and 14 on companion low-frequency transmitter. Red pilot light.

13 & 14 - Connect to terminals 11 and 12 on companion low-frequency transmitter. Amber pilot light.

15 & 16 - Connect to muting relay coil terminals on receiver.

1-3 The Power Unit type 91780, which is at the bottom of the cabinet just above the main terminal panel, includes two high-voltage rectifiers and their associated filters and also the control relays. The relays are mounted on a bracket above the power unit terminal panel. At the extreme left is the time delay relay, and to the right of this is located the control relay. Next to this are two overload relays, one in the low-voltage rectifier circuit and the other in the high-voltage rectifier circuit. These can be reset through a lever mechanism by means of a push button which is located on the control panel. The reset mechanism can be readjusted by means of the small screws on the horizontal bar. These should be set so that when the button is fully depressed, the set screws are pushing the bakelite reset strips just far enough to permit the relay armatures to reset. To the right of the overload relays is the power relay and at the extreme right is the high-power/low-power switch. Behind the relay panel are located the transformers, chokes and condensers. The low-power resistor, which is located just to the left of the main high-voltage power transformer, is a screw-type resistor and can be easily removed when preliminary tuning adjustments are being carried out.

Between the rectifier valves are located heater resistors and a thermostat which come into operation when the ambient temperature drops below 75° F. and protects the valves from the effects of starting up at low ambient temperatures. Damage would result were power applied at very low temperatures unless the normal 30 to 45 minutes time delay were extended considerably.

CONTROL UNIT

1-4 Above the power unit is located control unit 91970. This includes a panel carrying all pilot lights, control switches, "Variac" and filament compensating controls. On this unit the tone generator is also located. A small copper-oxide rectifier and its associated transformer provide keying voltage for the filament compensator relay and the main keying relay. The compensator relay is located on this unit and the main keying relay is at the top of the cabinet. The variable transformer or "Variac" is located at the back of the unit. To the left of this are the voltage-regulator valves. The controls and switches on the control panel are as follows:

(a) Filament compensator control.
(b) Filament voltage control.
(c) A pair of push buttons for ON or STANDBY.
(d) A switch for selecting either CW or ICW.
(e) A switch for selecting an i-c-w tone of 400, 700 or 1000 cycles.
(f) An overload reset button.
(g) A filament control switch.
(h) Three pilot lights, one green, one red and one amber to indicate filaments "on" and which transmitter is in use.

1-5 Above the control unit is the r-f chassis which includes r-f unit 91930 and oscillator unit 91923. This chassis is mounted on rubber to minimize vibration effects. If it becomes necessary to work on the oscillator unit, it will be most convenient to remove the entire r-f chassis before attempting to separate the oscillator unit from the r-f unit. In order to remove the oscillator unit from the main chassis it will first be necessary to remove the chain. The chain has one removable link and can be removed when the spring clip holding this link in place has been taken off. After the chain has been removed it will then be necessary to remove the back plate. All studs which hold the oscillator unit to the main chassis will then be accessible for removal.

1-6 The oscillator unit includes the entire crystal-oscillator and master-oscillator stages and part of the multiplier circuit. The four crystals are mounted on the front of the unit. Bakelite retaining strips are provided for holding either large or small type crystals. These may be turned over when the larger crystals are used.

The crystal-oscillator valve, a metal-type 6V6 valve which is located above the crystals, is mounted in a horizontal position, but the seven prongs are sufficient to hold it in place without additional retaining clamps. The master-oscillator valve is also mounted horizontally. This is a glass type 807 valve and a bakelite retaining ring has been provided to hold it in place. Between the two valves is the MO - Crystal Switch. Mounted vertically on top of the unit is the multiplier valve, the top of which protrudes through the r-f unit so that its plate can be connected directly to the tuned circuit which is located on that unit. The four master-oscillator coils are grouped around the oscillator unit and are removable for inspection. They are not interchangeable and the band 1 coil must be removed before the band 4 coil below it can be removed. Similarly it is necessary to remove the band 2 coil before attempting to remove the band 3 coil. These coils are arranged so that the counters read 0000 when the inductance is all in circuit, i.e. the wheel must be exactly at the end of the coil nearest the counter when it reads 0000. The slip rings are made of coin silver and the wheel, shaft, and brushes, are silver plated. Tension on the wheel is maintained by means of small steel springs at the ends of the shaft. Lock nuts are provided on the counters so that they can be locked in position. External electrical connections to the oscillator unit are taken through a cable which plugs into the top of the unit.

1-7 The r-f unit includes all r-f multiplier and amplifier components not included in the oscillator unit. At the extreme left is the multiplier plate circuit, and at the rear left is the multiplier plate coil which is mounted in a vertical position. Taps from this coil are taken to a terminal panel which also has terminals connected to the wavechange switch, and by connecting links between the correct terminals, the wavechange switch can be made to select the required taps. To the right of the multiplier stage are the two driver valves. The driver plate coil is mounted in a horizontal position to the right of the driver valves and is provided with a terminal panel similar to that on the multiplier plate coil. On the right of the shield is mounted the neutralizing condenser, for the adjustment of which a tool is provided. This tool is held on clips at the back of the top front panel when not in use. At the right of the vertical shield are the two type 810 amplifier valves. The power amplifier plate coil is mounted above the plate tuning condenser and the coupling coil is inside the plate coil. At the extreme right is the antenna tuning condenser, and the antenna coil is above the main wavechange switch and behind the p-a plate coil.

All components are mounted above the chassis with the exception of the driver cathode bypass condenser (C21) which is mounted below the chassis just under the driver valves. The entire wavechange mechanism is located on the r-f chassis and this is described in section A part 5. As on the low-frequency transmitter, it permits setting up on any four frequencies within the frequency range of the transmitter. To assist in the setting-up process, these instructions carry calibration charts which permit all taps and controls with the exception of the antenna coil taps and the antenna condenser, to be set fairly closely. Components in the r-f unit can be clearly identified by reference to the photographs included in the instruction folder.

1-8 At the top of the cabinet are five meters. At the left of the meters is the multimeter selector switch, and to the right is the antenna meter shorting switch. The meters are designated from left to right as follows:

(a) Multimeter.

(b) Driver cathode.

(c) P-a cathode.

(d) Filament line volts.

(e) Antenna current.

When the panel covering the meters is removed, the whole meter panel can be swung out far enough to permit the r-f chassis to come out without being obstructed.

1-9 Inside the cabinet at the top are located the bleeder and potential-dividing resistors which are mounted in clips and can be easily removed. On the side of the cabinet, at the right, is located the keying relay which is of the break-in type and permits "listening through" operation.

1-10 Full protection is afforded operating personnel by means of a system of safety switches which operate when the front covers are removed and switch off all voltages except filament and keying voltages. If the cover in front of the power unit only is taken off, it is not possible to get the power voltages on again unless the safety switch is held closed.

If, however, the top panel covering the r-f unit is removed, the power voltages can be switched on again by means of a master switch which is located just above the ordinary safety switch. When this is pulled out, the safety switches are short circuited and tuning adjustments can be carried out with the covers off. If the covers are replaced, this shorting master switch will be automatically switched off and next time the covers are taken off it will again be necessary to pull out the master switch. A switch is included on the wavechange mechanism which is in the safety switch circuit and the power is automatically switched off whenever the wavechange mechanism is operated. The master switch does not short out this switch.

1-11 Three terminals are located on top of the cabinet. The largest one is the antenna insulator and the small porcelain insulator is provided for connection to the receiver. The third terminal is the ground stud.

1-12 This high-frequency transmitter carries no components in common with the companion low-frequency transmitter and may therefore be used alone. For installations ashore or where no low-frequency transmitter is used, a 110-volt 60-cycle supply capable of delivering 20 amperes is connected to terminals 1 and 2 on the main terminal panel. Jumpers are connected from terminal 1 to terminal 5, terminal 2 to terminal 6 and from terminal 9 to terminal 10. The key is connected to terminals 3 and 4. No connections are necessary to the remaining terminals with the exception of 15 and 16 which may be connected to the receiver muting relay if required.

2-0 THEORY OF OPERATION

2-1 The basic theory of operation canbest be understood by referring to the diagram of connections (Fig.36). In addition to showing schematically the various connections and identifying the components by circuit symbols, the diagram also shows the color coding of the wire making up the connections. This is of assistance in tracing the circuits and clearing of faults.

2-2 The power supply and control circuits will be dealt with first. The main 110-volt 60-cycle supply is taken in at terminals 1 and 2 on the main terminal panel and this is first connected to 30 ampere fuses F2 which in turn are connected to the main supply switch S24. When the filament switch S21 in the control unit is switched on, the green pilot light will come on, and the coils of time-delay relay E3 and Variac T4 will be energized.

The output of the Variac is connected to the primaries of all filament transformers, the primary of the keying rectifier transformer, and the filament line voltmeter. The filament-line voltage can then be adjusted to exactly 110 volts by means of the Variac. A variable series resistor R41 is connected in series with the filament transformer primary circuits. This is the filament compensating resistor and is shorted out by relay E2 when the key is pressed. This is to compensate for drop in the rotary converter output voltage when the key is pressed and the transmitter is taking its full input power.

2-3 Thirty to forty-five seconds after the filament switch S21 is closed, time-delay relay E3 should close. This is a thermal type of time-delay relay and permits the mercury-vapor valves to reach a suitable temperature before the high voltage is applied. When the relay has operated, the thermal element is disconnected and the relay locks itself closed.

2-4 When the ON button is pressed, E4 will close and lock itself through the normally-closed contacts in the corresponding relay E4 in the low-frequency transmitter and the stand-by switch. When the ON button on the low-frequency transmitter is pressed, the locking circuit will be interrupted and relay E4 will open. Similarly, as soon as E4 on the high-frequency transmitter operates, the corresponding relay on the low-frequency transmitter will open if it has been locked closed. If relays E3 and E4 are both closed, and if neither of the over-load relays E7 or E8 has been tripped, and if the safety switches and the wavechange mechanism interlocking switch are closed, relay E5 will close. This connects 110 volts to the primaries of the low and high-voltage power transformers and also starts the fan. At the same time, the amber pilot light on both high-frequency and low-frequency transmitters will come on.

2-5 Both low and high-voltage rectifiers are of the single-phase full-wave type and employ mercury-vapor valves. All rectifier valves have "hash" suppression chokes in their plate leads. In the negative lead of each of the rectifiers is an overload relay which is set to trip at 750 ma. The value of current which trips these relays can be adjusted by means of the small set screws, a reduction being effected by releasing the screw.

2-6 Both rectifiers make use of single-section choke-input filters which provide sufficient filtering to keep the hum on the output signal to less than 3%. The low-voltage rectifier has two separate filters. The L17-C45 combination is for the supply which operates the driver, multiplier, and audio-oscillator stages, while the output of the L18-C44 filter is connected only to the plate circuit of the master-oscillator. L18 is a high-inductance choke. The output of this filter is connected through resistance R40 to the regulator valves V13 and V14 and also to the plate circuit of V2. These regulator valves have the characteristic that if the current through them has any value between the limits 5 and 30 ma, the voltage across each valve will be exactly 150 volts. Thus the voltage applied to the master-oscillator plate circuit is always exactly 300 volts. The separate filter for this circuit provides better filtering and also isolates the master-oscillator from any plate voltage variations on the amplifier valves.

2-7 The output of the low-voltage rectifier is connected across resistors R33, R34, and R35 in series. Plate voltage for the multiplier valve is taken from the junction of R34 and R35. The junction between R33 and R34 is grounded and the other end of R33 is connected to all grid return circuits and one side of the keying relay, the other side of which is grounded. Thus when the key is up, the grids of all oscillator and amplifier valves are negatively biased. This is sufficient to stop the oscillator and keep the static plate current to zero on all oscillator and amplifier valves. When the key is pressed, R33 is shorted out and since the grid return paths are now all grounded, the only bias on the valves will be that developed across the grid-leak resistors in each circuit, plus the cathode bias in the case of the master-oscillator, tone generator, multiplier and driver valves.

2-8 When the high-low switch is in the low position, a resistor having a value of approximately 40 ohms is connected in series with the primary of the high-voltage power transformer. When this resistor is in circuit the output voltage will vary over fairly wide limits, depending on the adjustment of the power amplifier circuit, but will be 300-400 volts when the amplifier is adjusted for normal output with normal plate voltage.

2-9 The keying rectifier, which is located in the control unit, is of the dry-disc type and its normal output is 12 volts with key down. The main keying relay and the filament compensating relay have their coils connected in series, and for normal operation there should be 6 volts across each coil.

2-10 The oscillator unit type 91923 embodies the complete crystal oscillator, master oscillator and part of the multiplier stage. To avoid reaction from succeeding amplifiers, incoming supply leads (except heater supply) are provided with filters consisting of small r-f chokes and bypass condensers. One side of the heater circuit is grounded and the other side is well bypassed to ground. Heater leads are shielded inside the unit.

2-11 The crystal oscillator, which is of the untuned grid-plate type, utilizes a type 6V6 beam power-amplifier valve. Sufficient reaction to permit the crystal to start at keying speeds is provided by C1 which is a 30-uuf mica condenser. Both sides of the crystals are switched so that unused crystals are completely disconnected from the circuit.

2-12 The master-oscillator valve V2, which is a type 807 beam power tetrode, is used both when the frequency is crystal-controlled and when master-oscillator controlled. When the CRYSTAL - MO switch is in the CRYSTAL position, the master-oscillator stage is connected as an amplifier and the plate circuit must be tuned to the crystal frequency. When the switch is in the MO position, the grid is connected so that some voltage is fed back from the plate circuit and the arrangement resembles a shunt-fed Colpitts circuit. The plate circuit is tuned with fixed capacities having a 2% tolerance, and variable inductances, which are selected by means of the wavechange switch. This type of tuned circuit is less subject to vibration effects than a fixed inductance and variable condenser arrangement and 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 reasonable accuracy by means of the calibration curves. The variable inductances, which consist of coils which can be rotated, are connected to counters which count 10 for each complete revolution. As the coils are rotated, a small contact wheel rolls on the wire and shorts out varying portions of the coil depending on its position, and at the same time the counter reading is changed, an increase corresponding with an increase of frequency. Several precautions have been taken to increase the stability of this oscillator. The plate voltage is maintained at a constant value of 300 volts with the key up or down, by means of voltage-regulator valves.

The fixed condensers C9 and C10 in the oscillator tuned circuit are special high-stability units fabricated in low-loss bakelite, temperature aged and sealed, and have a very low capacity-temperature coefficient. A parasitic oscillation suppression resistor R5 is included in the grid circuit of the oscillator.

2-13 The master-oscillator stage is followed by the multiplier stage. The screen, grid, and cathode circuits of this stage are included in the oscillator unit, but the plate circuit is in the r-f unit. In this stage the output frequency of the preceding stage is doubled, tripled, or merely amplified, depending on the output frequency required. Its functions at the various frequencies are shown in the following table.

Output Frequency	Oscillator Frequency	Function of Multiplier
2.2 - 4.4 Mc	2.2 - 4.4 Mc	Amplifies
4.4 - 6.6 Mc	2.2 - 3.3 Mc	Doubles
6.6 -14.0 Mc	2.2 - 4.7 Mc	Triples

Since the oscillator is calibrated and operates satisfactorily as high as 4.7 Mc, it would be possible to use the multiplier as a doubler at output frequencies as high as 9.4 Mc. This, however, is not recommended and the relationships given in the table above should be adhered to in order to operate the master-oscillator at as low a frequency as possible. The multiplier valve is a type 807 and is provided with parasitic oscillation suppression resistors in both the screen and grid circuits. The grid return circuits of the multiplier, master-oscillator, and crystal oscillator valves, are all tied together and brought out to position number 1 on the multimeter, where total grid current in the oscillator and multiplier stages can be read. This is normally about 2.5 ma. The plate circuit of the multiplier is tuned by means of condenser C19 which is the extreme left condenser on the r-f unit. Taps are selected on the multiplier plate coil in accordance with the output frequencies to be used. When the multiplier is acting as an amplifier, it is not tuned to resonance because the driver grid current will be too high. The driver grid current should not exceed 5 ma and the multiplier plate circuit is detuned until this value of grid current is obtained. The plate and screen voltages are so arranged that plate and screen currents will not exceed safe values even if the plate circuit is off resonance.

2-14 The driver stage consists essentially of two type 807 valves in parallel. The output of this stage is always at the same frequency as the output of the multiplier stage and always acts as a straight amplifier. The plate circuit is tuned by condenser C24. Again, this stage has parasitic suppression resistors in both screen and grid circuits. The driver stage should always be tuned exactly to resonance as indicated by minimum cathode current on the driver cathode milliameter. The driver plate tuning condenser C24 is of the split stator type, so that a voltage can be taken off the lower end of L12 for neutralizing the power amplifier.

2-15 Grid neutralization of the power amplifier is employed. When correctly neutralized, the power amplifier will remain neutralized throughout the entire frequency range. High voltage d-c is kept off the neutralizing condenser by means of condenser C27.

2-16 The valves used in the power amplifier are type 810 triodes which have a rated plate dissipation of 125 watts each. The inductance of the plate coil is changed to suit the frequency by the action of the appropriate section of the main wavechange switch which short-circuits turns at the ground end. The circuit is series fed and the plate coil is at a potential of 1900 volts d-c above ground. In order to keep the circulating current in the plate tank circuit at reasonable values, a certain definite number of turns in the plate coil should be used, although it is possible to obtain resonance with a different value of inductance. The recommended number of turns for each frequency is given in the calibration curves in the appendix (Figs. 41 to 44). The two amplifier valves are connected in parallel with parasitic oscillation suppressors connected in series with each grid. These special suppressors consist of a few turns of heavy wire in parallel with a 300-ohm resistor. The few turns of heavy wire offer a high impedance to any ultra-high-frequency currents which might tend to start parasitic oscillations if permitted to flow. The output coupling coil is placed inside the plate tank coil and has its turns so arranged that the last turn at the bottom of the coil is in line with the last turn at the bottom end of the tank coil. Both coils are shorted down from the top ends by means of connections to the main wavechange switch, so that if, for example, only two turns are in circuit in each coil, these will be the bottom two turns.

2-17 The antenna impedance is matched to the coupling coil impedance by means of what may be called a "T" matching network. This network consists essentially of two inductances which will be referred to as "right" and "left" (looking at the front of the transmitter), and a variable condenser which is connected between the junction of the two inductances and ground. Actually, the antenna coil L16 includes both inductances, and the condenser is connected to this coil at a convenient point by means of a clip lead. The turns in circuit on either side of the condenser tap (tap marked "C") are the "right" and "left" inductances. The condenser tap remains in the same position for all frequencies, but the taps to the right and left coils are connected to sections of the wavechange switch so that any desired number of turns in either section can be left in circuit. The right section resonates with a certain percentage of the total capacity of the condenser (C37) and also with the antenna, the impedance of the antenna being converted to some value of apparent resistance across C37. The remaining part of the condenser resonates with the left section and the coupling coil in such a way as to convert the apparent resistance across C37 to that value of resistance in series with the coupling coil which will properly load the power amplifier.

2-18 Operation on i-c-w is accomplished by means of the tone generator which is located on the control unit chassis. The tone generator makes use of a type 807 valve (V8) in an oscillator cirauit comprising transformer T6 and condensers C40, C41, and C42. C39 is the feed-back condenser. By means of switch S16, these condensers can be selected in combination to obtain output frequencies of 400, 700, or 1000 cycles. The secondary of the transformer is connected in series with resistor R31 and the grid circuit of the power amplifier valves, so that the grid bias is varied at an audio rate, thus modulating the carrier. Switch S15 short circuits the transformer and resistance R31 and also removes plate and screen voltage from V8 when c-w operation is required.

2-19 Metering facilities are provided in all important circuits. Oscillator and multiplier plate currents and all grid currents are measured on a common meter which is referred to as the "multimeter". This is a 0-25 d-c milliameter. There is a series resistor in each metered circuit and the value of this series resistor determines the multiplication factor that must be applied to the meter. Switch S13 connects the meter in parallel with the series resistor in the circuit to be checked. When reading oscillator-multiplier grid current or driver grid current, the meter reads directly. In these cases the meter is shunted by a 500-ohm resistor when connected to that circuit, but this value of resistance has a negligible effect on the meter reading.

When the meter is out of circuit, this resistor has a negligible effect on the grid bias. When reading master-oscillator plate current, the readings must be multiplied by two, and for multiplier plate current and power-amplifier grid current, it must be multiplied by four and ten respectively. Separate meters are provided for driver cathode and power-amplifier cathode currents. It should be pointed out that in the case of the driver, the cathode current includes grid and screen current in addition to plate current, and in the case of the power amplifier the cathode current is the sum of grid and plate currents. An a-c voltmeter is included on the meter panel to indicate input voltage to the filament transformers. It does not indicate primary voltage on the power transformers. There is a red line on the meter at 110 volts. Each of the four above-mentioned meters has an r-f bypass condenser connected across it for protective purposes. The antenna ammeter is provided with a switch which is arranged so that the meter reads when the switch is in the ON position. This switch will avoid damage to the meter if heavy static discharge currents should flow from the antenna to earth, and the switch should be left in the OFF position unless readings are being taken.

3-0 ADJUSTMENT PROCEDURE

3-1 Before proceeding, the construction and method of operation of the wavechange mechanism should be carefully studied. This mechanism is described in detail in section A part 5. The mechanism directly operates switches S1, S2, S3, S4, S6, S7, S8, S9, S10 and S11. The variable condensers C19, C24, C30, and C37, are operated by special mechanisms with movable fingers which come against stops. The stops are moved to any one of four positions by means of the wavechange handle, and the fingers can be set to stop the condensers at any desired position. The shafts carry dials and a locking device to hold the condensers in any required position when the fingers are unclamped. If the equipment is shipped set up to its four frequencies, it should only be necessary to retune the antenna circuits and the fingers on the antenna condenser should therefore be unclamped. If an entirely new set of frequencies is to be set up, all fingers on all variables should be unclamped.

3-2 Before d-c is applied to the transmitter, resistors R42 and R43 should be correctly connected. The equipment will normally be shipped with these resistors connected in parallel for 110-volt d-c operation, but if the ship's main supply is 220 volts they must be reconnected in series.

3-3 Before applying a-c voltage to the transmitter, all transformers must have their primary taps correctly set. The transmitters are shipped with the taps connected for 110-volt operation and the rotary converters will deliver 110-volts 60-cycles on full load when the applied voltage is 110 or 220-volts d-c, as the case may be. If it is found that the supply voltage is not in the vicinity of 110 or 220 volts, the rotary converter output voltage should be measured and taps reset accordingly. The full-load rotary converter output voltage will be about 10 volts lower than the no-load voltage. The taps should be set as follows on power transformers T1 and T3:

Taps	A-C Voltage
1 and 2	100 volts
1 and 3	110 volts
1 and 4	120 volts

Transformers T2, T5 and T7 have their primaries supplied from the Variac T4. If it happens that the output of the rotary converter is low and it is impossible to adjust the Variac to get 110 volts on the primaries of these transformers, taps are provided for 100-volt operation. In such cases the lead on tap 3 should be moved to tap 2. Since it is not likely that the rotary converter output voltage will be so much higher than 120 volts that the Variac cannot reduce it to the proper value, no tap 4 has been provided on these transformers.

3-4 CAUTION - DANGEROUS VOLTAGES EXIST WITHIN THE EQUIPMENT.

To avoid possibility of fatal injury while working inside the unit with covers removed, always see that the power is off (filaments may be left on) and the amber pilot light is out before touching any part. It should be pointed out that when the key is up the high voltage is still on, and although all milliameters will be reading zero, the high voltage is still on the valves and coils and the transmitter is no less dangerous than with the key down. Removing the front covers automatically opens switches which cut off the high voltage rectifiers, but in order to permit adjustments to be made with the covers off, a shorting switch (S17) has been provided.

Before touching any coil or component in the transmitter, both the shorting door switch (S17) and the STANDBY switch (S22) should be switched off. The reason for this is because if only the STANDBY switch (S22) is switched off, and the cover is off the power unit, there is a chance that the operator may fall against the control relay E4 and this will put on the high voltage and lock itself, even if S22 has not been touched. This cannot happen when both S17 and S22 are off.

3-5 Before making preliminary checks on the power control and filament circuits, remove fuses F4. This opens the supply circuit to the primaries of the power transformers.

3-6 Apply the d-c voltage to the transmitter. If the temperature surrounding the valves is less than 75° F. the heaters will start to warm up. The thermostat E6 should cut them off when the temperature reaches 75° F.

3-7 If all external connections to the transmitter have been completed and all valves are in place, the rotary converter may be started. Close main switch S24 and switch S21 to ON. The green pilot light should come on and the voltage applied to the filament transformer primaries should be indicated on the filament line voltmeter. Adjust the FIL COMP control until the meter reads highest, and adjust the FIL VOLTAGE control until it reads at the red line. If, however, the supply voltage was found to be low and the transformer taps were set on taps 1 and 2, the FIL VOLTAGE control should be adjusted so that the meter reads 100 volts instead of 110 volts.

3-8 When the filaments come on, the keying voltage should appear and the break-in relay E1 and filament compensating relay E2 should operate. If the relays appear to be sluggish, the voltage should be checked. The key-down voltage across the coil of each relay should be 6-7 volts and it may be adjusted by changing the secondary taps on transformer T5. One lead should always be connected to terminal 5 and the other lead to terminals 6, 7 or 8 which are in increasing order of voltage. If necessary, the break-in relay should be adjusted. There are three separate sets of contacts which must operate in a definite sequence. The travel of the armature should first be adjusted by means of the thumb screw at the rear of the relay. The travel should be adjusted 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 at the rear which operate the muting relay in the receiver must close first when the relay is energized and the gap should be as small as is practical. The coupling coil grounding contacts should close next and the gap here will 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 r-f power in the transmitter, and the antenna circuit will be completed before the power contacts close thus preventing any arcing at the antenna contacts. If arcing does occur at the antenna contacts it is more likely to be due to the fact that the power amplifier is oscillating with the key up (as may occur if badly out of neutralization) than due to incorrect adjustment of the keying relay. The filament compensating relay in the control unit should have its contacts adjusted for a gap of approximately 1/32". One side of the keying rectifier is grounded at the frame and terminal 4 should be connected to the key terminal which is connected to the base plate.

3-9 Between 30 and 45 seconds after the filaments are switched on, the time-delay relay E3 should close. If the time required is less than 30 seconds or more than 45 seconds, some adjustment should be made. Turning the adjusting screw clockwise shortens the time delay. The adjustment is critical and the screw should not be turned more than a fraction of a turn.

3-10 Before applying h-t, the hot-cathode mercury-vapour valves should be "aged" to disperse any particles of mercury that may be on the cathode or anode. They should be operated at normal filament voltage for a period of 30 minutes before switching on the high voltage. This treatment is not necessary again unless the valves are taken out and placed in any but a vertical position.

3-11 Now remove resistor R44 from its socket in the power unit (see Fig. 34 for location) and switch S23 to "L" or OFF. Also remove leads from terminal 17 on the r-f unit and clip them together. If, however, the transmitter has been shipped tuned up to the required frequencies and crystals are in position, it will not be necessary to remove leads from terminal 17. Do not fail to remove resistor R44 in any case. Now replace fuses F4 and press the ON button. The control relay E4 will close and lock itself closed if the companion low-frequency transmitter is interconnected. If the high-frequency transmitter is being used alone, terminals 9 and 10 on the main terminal panel should be jumpered in order to hold E4 closed. If the overload relays E7 and E8 are not tripped and if the safety switch shorting switch S17 is closed (pulled out), power contactor E5 will close. The amber pilot light will then come on and the fan will start.

Now switch the power off by pressing the safety shorting switch S17 and the STANDBY switch. The procedure in the following seven paragraphs (12-18 inc.) need not be carried out if the transmitter has been shipped adjusted on the frequencies to be used. The adjustments should be understood, however, and meter readings checked before proceeding with paragraph 19.

OSC 3-12 The oscillator unit should now be set up for the frequencies to be used. The ciruuits are so arranged that for any output frequency the crystal or master-oscillator frequencies will always be between 2.2 and 4.7 Mc. For output frequencies higher than 4.4 Mc, the multiplier stage will double or triple the oscillator frequency. The oscillator frequencies will be as shown in paragraph 2-12. Appropriate crystals should be placed in the sockets and the master-oscillator coils should be adjusted to the correct dial readings as indicated on the calibration sheets (Figs. 38, 39 and 40). If pressure-type crystals with locking screws, such as the Bliley type VP-4, are used, the locking screw (located between prongs) should be loosened one turn before placing the crystal in the oscillator unit. Taps on subsequent stages are arranged so that it will be more convenient if the lowest output frequency is on band 1 and the bands arranged in increasing order of output frequency. If, however, it is at any time required to quickly replace a high frequency with a low one, it will not be impossible to put a low frequency on bands 2, 3 or 4. Similarily the highest frequency could be used on band 1.

3-13 Links are provided on the multiplier and driver coil terminal panels, and the switch terminals which are marked 1, 2, 3, and 4 should be connected to the coil tap terminals which are marked 2A, 3A and 4A as follows:

Output Frequency	Coil Tap
2.2 - 3.6 Mc	No connection
3.6 - 6.1 Mc	2A
6.1 - 9.0 Mc	3A
9.0 - 14.0 Mc	4A

Special links are provided incase it is necessary to connect 2A to 4, or 1 to 4A, or other terminals which the small links will not fit. In most cases the small links will make the necessary connections satisfactorily. The p-a coil taps should also be placed in accordance with the calibration sheets (Figs. 41 to 44).

3-14 The XTAL - MO switch should be switched to XTAL if crystal-controlled operation is to be used, and the CW - ICW switch should be turned to CW. The power may now be switched on and the key closed.

If master-oscillator control is to be used, the XTAL - MO switch should be left in the MO position and the master-oscillator coil locked at the setting indicated in the calibration sheets or else adjusted by means of a calibrated receiver. If crystal control is used, the multimeter should be turned to position 2 (m-o plate) and the master-oscillator coil adjusted for minimum plate current and locked in position. This should be repeated for all four bands. The oscillator and multiplier grid current (multimeter position 1) should be about 25 ma and master-oscillator plate current should be between 25 and 40 ma. (NOTE: Although the master-oscillator stage acts as an amplifier and not as an oscillator when the frequency is crystal controlled, it is, in these instructions, referred to as the "master oscillator" for convenience).

3-15 The multiplier stage may now be adjusted. Switch the multimeter to position 4 and adjust the multiplier plate condenser until the driver grid current is a maximum but not more than 5 ma. It will be necessary to detune the plate circuit considerably to reduce the drive to 5 ma on the lower frequencies, but on the higher frequencies the maximum obtainable drive may not be greater than 1.5 ma. It may be necessary to retune the multiplier slightly when the driver has been correctly adjusted and therefore the multiplier should not be permanently locked up at this point. The calibration sheets should be consulted during this adjustment to avoid any possibility of tuning the multiplier to triple frequency instead of double frequency or vice-versa. There will nearly always be a difference of a few degrees between the actual dial settings and those indicated on the curves, but a discrepancy of the order of 60 or 70 degrees indicates that a tap has been incorrectly placed or other fault. The multiplier plate current (multimeter position 3) should be about 52 ma. When the correct setting for the multiplier condenser has been found, lock it in position with the thumb nut but do not lock the finger in place.

3-16 The leads which were removed from terminal 17 on the r-f unit should now be replaced. These carry plate and screen voltage to the driver valves. Now observe the driver cathode current and adjust the driver plate condenser (C24) until this current is a minimum. Switch the multimeter to position 5. The power amplifier grid current should reach a maximum value when the driver cathode current is a minimum. At some frequencies minimum driver current and maximum grid current may not exactly coincide. In such cases the correct adjustment is for minimum driver cathode current. The driver condenser setting should check reasonably closely with the calibration curves. Lock this condenser with the thumb nut when the correct setting has been found.

3-17 The power amplifier should now be checked for neutralization. This can be done by observing the p-a grid current (multimeter position 5) and swinging the p-a tank condenser (C30) through resonance. If the grid current does not change as the plate condenser passes through resonance, the amplifier is neutralized. If there is a noticeable dip, the neutralizing condenser should be adjusted until this effect disappears or is at a minimum. Usually the neutralizing condenser will not require adjustment since it is set at the factory. Neutralization can also be performed with a neon indicator if one is available. The power-amplifier tank condenser should be tuned to resonance and the neutralizing condenser adjusted until the neon indicator shows a minimum r-f voltage on the power-amplifier valve plate caps. Neutralization is, of course, carried out with plate voltage still off the power amplifier. It may be necessary to readjust the driver stage for exact resonance after neutralization has been completed. The neutralizing condenser should be locked up when adjustment has been completed.

3-18 The p-a is now ready to have plate voltage applied. A temporary ground connection should be placed on the antenna insulator. Switch to STANDBY and replace R44, leaving S23 in the "L" position. Now open the key before switching on the power. After this point, the power should not be switched on with the key down, since the initial condenser charging current together with the cathode current will be sufficient to trip the overload breakers. Switch on power, press the key and adjust the p-a tank condenser to resonance as indicated by minimum p-a cathode current. The off-resonance plate current will be quite low due to the limiting action of R44.

This protects the p-a valves from damage during the tuning process. When C30 has been tuned to resonance, S23 may be switched to "H". Resonance should be checked and then the condenser should be locked in position with the thumb nut. Now lock the appropriate fingers on each of the three condensers (C19, C24 and C30) and loosen all the thumb nuts. It is very important that these be loosened before any attempt is made to move the wavechange mechanism. Operate the wavechange mechanism, and check that the condensers return to their correct positions and that operation is otherwise satisfactory. Now repeat the process on the other frequencies. Key the transmitter on each frequency and check that all meters are exactly zero (except line voltmeter) when the key is up. If the p-a cathode meter is indicating, the p-a is oscillating and the neutralizing condenser is not correctly adjusted. Now switch off and remove the temporary ground from the antenna insulator terminal.

3-19 Up to this point it will usually not be necessary to make any tuning adjustments since the transmitter is shipped with the controls locked in the correct positions for the specified frequencies. It will always be necessary, however, to readjust the antenna condenser (C37) and most of the antenna coil taps. Before attempting to tune the antenna, the length of the antenna should be checked. The tuning network will match any antenna whose impedance lies between 10 and 150 ohms resistive and between plus and minus 500 ohms reactive. These are general limits and one or other limit can usually be extended on any particular frequency so that on the higher frequencies resistances and reactances higher than 150 and 500 ohms could be matched. This means that any length of wire can be used for an antenna provided it is at least one-sixth wavelength long at the lowest frequency and provided also that it is not close to one-half wavelength or multiple thereof at any frequency. One-half wavelength in feet is approximately equal to 467.4 divided by the frequency in megacycles. For example, if one of the frequencies is 13 megacycles, the length of antenna which will be one-half wavelength is 35.9 feet. Therefore, the antenna should not be close to 35.9, 72, 108, or 144 feet long. This length is measured from the antenna insulator to the end of the antenna. If the antenna cannot be coupled because of the fact that its length approaches half-wavelength multiples, it should not be necessary to lengthen or shorten it more than three or four feet. For the four frequencies shown in the list of sample readings (section C paragraph 6-4) an antenna which is equivalent to a 60-ft vertical wire should be satisfactory. If the total length of wire from the antenna insulator on the transmitter to the end of the flat-top section (which will be necessary if the top of the mast is less than 60 feet above the top of the transmitter) is about 63 feet, this will be a sufficiently close approximation.

If a set of frequencies is chosen so that it is difficult to select a length which is sufficiently far away from half-wavelength multiples of the various frequencies to permit correct loading, conditions can be improved if the impedance of the antenna is lowered by using a cage type of antenna. This can also be done if it is not convenient to have the antenna longer than one-sixth wavelength at the lower frequencies. Such conditions would rarely be encountered.

3-20 No specific tap positions for the antenna coil can be given since there are so many varying factors such as stays, position of funnels, and height above sea level, that affect the antenna impedance. In general, however, the number of turns required on both sections of the antenna coil will decrease as the frequency is increased and the number of turns in the right section will be about three times the number of turns in the left section for purely resistive antennas (quarter wavelength and odd multiples). For inductive antennas (between one-quarter and one-half wavelength and between three-quarters and one wavelength) less than this number of turns will be required, and for capacitive antennas (less than one-quarter wavelength and between one-half and three-quarters wavelength) more than three times the number of turns in the left section is likely to be required in the right section. The transmitter is shipped tuned up to the four specified frequencies and with the antenna coil taps adjusted for operation with a 38-ohm purely resistive antenna load. It is suggested that tuning be started with these tap positions. All taps should be on the coil, even if at random positions, when the first frequency is being adjusted. The "C" tap should be about 10 turns from the left end of the coil, but at frequencies near the lower limit of the range it may be necessary to increase this. This tap should not be any further to the right than is necessary. Readjustment of the other taps will affect both the tune point of the complete circuit and also the effective coupling to the power amplifier. Adjustments should be started on the lowest frequency.

Switch on the power and while observing the p-a cathode current, rotate the antenna condenser (C37) through its range. A rise in the p-a cathode current will indicate that the antenna circuit is coming into resonance. If the maximum current occurs at minimum capacity of C37, turns should be taken out of circuit in either section of the antenna coil.

Similarly, if maximum cathode current is indicated when C37 is in its maximum position, an insufficient number of turns on L16 is indicated. When resonance has been found, the next step is to adjust the network for correct loading of the power amplifier. A coarse adjustment of loading is obtained by moving taps on the coupling coil (L15). The four leads from terminals 12, 13, 14 and 15, on the mycalex plate on top of the p-a plate coil, correspond to bands 1, 2, 3 and 4 from left to right. Coupling is increased by moving the flexible lead to a terminal having a higher number. The terminals are arranged in increasing order counter-clockwise. A closer adjustment of loading can be effected by adjusting the taps on L16. An increase in the number of turns included in the right-hand or antenna end of the coil will, in general, affect the coupling more than the tune of the complete circuit. With a purely resistive or a resistive and inductive antenna load, an increase of turns in the right section will effectively tighten the coupling, but for a capacitive antenna, increasing the number of turns may either increase or decrease the loading, depending on which side of series resonance the combination of coil and antenna happens to lie. Loading adjustments should be made so that the p-a plate current is between 450 and 500 ma. To obtain the plate current, the grid current (multimeter position 5) must be subtracted from the p-a current reading.

When a position is found that loads the p-a to the required value, further adjustments should be made as follows. For a given antenna there are many combinations of tap positions on L15 and L16 which will couple the antenna to the power amplifier sufficiently to obtain the desired output, but the best results will be obtained for those adjustments in which the maximum number of turns in L15 are active. This is because in these circumstances, currents are low and the voltage across the antenna condenser C37 is not excessive. If the latter is too high, flashover between the plates will occur. On the other hand, if the circuit formed by L15, L16, C37 and the antenna impedance is too heavily damped, and the coupling to the power amplifier coil is thus of necessity made close, it will not be possible to ground or break the antenna circuit without momentarily overloading the output valves. In other words, as many turns as possible should be used on the coupling coil L15, but the coupling should not be so tight that the power amplifier circuit is detuned when the antenna circuit is brought into tune.

When the antenna circuit has been adjusted to give the desired plate current, C37 should be locked and the adjustment of C30 checked. It should tune to resonance at the same position as it did when the antenna terminal was grounded as in paragraph 3-18.

If it is found necessary to retune C30 for resonance, the coupling of L15 to L14 is too tight and the number of turns in use in L15 should be reduced, and loading increased again by adjustment of the taps on L16. When making adjustments on L15 and L16, only one tap should be moved at a time and this only one turn at a time. The adjustments should be made so that C37 is meshed about the same amount as C30. If, on the lower frequencies, C37 has too low a capacity, the voltage across it may be high enough to flash across the plates. If this occurs, the number of turns in the right section of L16 should be reduced and C37 retuned to resonance. If this reduces the coupling too much, the coupling of L15 should be increased one turn or, alternatively, the number of turns in the left section of L16 reduced. If, on the higher frequencies, C37 has too large a capacity, the circulating current in the left section of L16 and in C37 will be excessive and heat losses may result. Similarly, if the number of turns in the left section of L16 is too small, excessive current will flow, and heat losses will occur. This condition can be remedied by increasing the turns in the left section and restoring loading by increasing the coupling of L15 or, alternatively, by increasing the number of turns in the right section. The temperature of L16 may be checked by comparing it with L14. At the higher frequencies, the plate tank coil L14 (bottom three or four turns) normally runs quite warm. It will be considered satisfactory if the turns on the left section of L16 are never any warmer than those on L14 on the same frequency.

The network should always be adjusted so that C37 is tuned to resonance. In other words, if the p-a plate current is too high, it is not desirable to reduce it to the required value by detuning C37, although this might be tolerated in an emergency. The correct method is to reduce coupling by moving one of the taps. When the four frequencies have been set up, it will be necessary to go back and make slight readjustments to C37 on the other three frequencies if any extensive change in the arrangement of the taps has been made. The condenser fingers should all be locked up tight and the thumb nuts loosened. The frequency should be checked on a wavemeter or receiver to ensure that the multiplier stage is multiplying the correct number of times.

3-21 For normal operation on crystal, the m-o setting will not correspond exactly with the crystal frequency because of the added capacity of C11 when S5 is moved to m-o. If it is desired to use the m-o to avoid possible interference on the crystal frequency, listen to the signal on a receiver, and with the switch in the m-o position, adjust the m-o coil so that the frequency is slightly above or below the crystal frequency. Provided that the m-o frequency is not more than a few kilocycles from the crystal frequency, it will not be necessary to retune the subsequent stages. In order to change frequency a few kilocycles, then, it will only be necessary to turn the MO - XTAL switch.

3-22 The setting of the filament compensator control should now be checked. When the key is down and full power output is being obtained, the control marked FIL VOLTAGE should be adjusted so that the FIL VOLTMETER reads 110 volts. Then, when the key is up, the FIL COMP control should be adjusted so that the voltmeter again reads 110 volts. It is not possible to adjust the controls to entirely prevent the voltmeter from flickering when the transmitter is being keyed, because the converters take a certain time to slow down when the key is pressed. This slight voltage variation is not serious.

3-23 For operation on i-c-w no adjustments are required. It is merely necessary to switch the CW - ICW control to ICW and turn the tone switch to the required audio tone.

4-0 MAINTENANCE

4-1 The equipment should be gone over periodically for cleaning and general inspection. In particular, all insulation should be kept free of dirt or other deposits. All screws and nuts should be kept tight.

4-2 The contact surfaces of the relays and contactors should be examined periodically for burning or pitting. Contacts should be cleaned with a burnishing tool or very fine sandpaper. Coarse sandpaper, files, or emory cloth should never be used. Particular care should be exercised when working with the control relay E4 as it is very important that the contact springs are not bent. Contacts on this relay should not be touched unless they are known to be giving trouble. The valve pins should be periodically examined for poor contact, especially the rectifier valves whose filaments carry heavy currents.

4-3 The switches and mechanisms making up the wavechange device should be periodically examined and nuts and screws tightened up and lubrication applied if necessary.

4-4 The oscillator coils should be taken out periodically for inspection. It may be necessary to lubricate the main axle, but the rod which holds the wheel should never be lubricated. If the wheel is accidentally taken off the wire during such an inspection, the counter should be wound back to 0000 and the wheel replaced on the winding exactly at the front end. The contact springs should be tight against the slip rings.

4-5 Valves have a definitely limited life and will have to be replaced periodically. Replacement of the type 810 valves is indicated when they deliver reduced output and cathode current is low for normal drive, d-c voltage, and coupling. In order to remove the rear 810 valve it will first be necessary to remove the front valve. The type 872-A rectifier valves will, in time, accumulate a deposit on the inside of the glass rendering them almost opaque. This is not necessarily an indication that the valve needs replacing. Failing valves may be detected by a change in colour and extent of the characteristic blue glow inside the bulb. It becomes paler and may change to a pinkish tinge. If these valves are replaced, they must be aged thirty minutes at normal filament voltage to properly distribute the mercury before the high voltage is applied. The type 866-A valves should be checked by a measurement of the d-c output voltage. The type 807 valves will sometimes show a slight bluish tinge, but this is not an indication of a defective valve. The plate currents of these valves should be checked periodically. The tone-generator valve plate current may be checked by inserting a 0-100 d-c milliameter in series with the leads to terminal 25 on the control unit. This should be 75-85 ma. Failure of the type VR150-30 regulator valves will be indicated by a change in the characteristic glow. If, however, both valves should suddenly fail to glow, it is more likely that the 866A valves or some other component is giving trouble. Failure of the type 6V6 crystal-oscillator valve will be indicated by lack of grid current at the multiplier and driver grids.

4-6 The Variac (T4) may require occasional attention. The sliding surface should be kept free from corrosion or other deposit. Trouble with this component will be indicated by flickering of the filament-line voltmeter as the control is adjusted. The brushes may require renewal after a long period of use.

4-7 The dry-rectifier element CU1 may "age", resulting in a somewhat lower d-c voltage and loss of snappy keying-relay action. To bring the voltage up to compensate for this effect, the taps on transformer T5 may be moved. Increasing the secondary tap or decreasing the primary tap will increase the output voltage. For example, the highest voltage is obtained when the primary leads are on terminals 1 and 2 and the secondary leads are on terminals 5 and 8. The leads to terminals 1 and 3 should never be moved.

5-0 PARTS LIST

High-Frequency W/T Transmitter PV-500H (86790)

Circuit Symbol	Part	Description	Type Number	Manu facturer
Condensers				
C1	Crystal osc. grid reaction	30 uuf 500 v	5WS	C.D.
C2	C-o screen bypass	.002 uf 500 v	3WS	"
C3	C-o plate blocking	.002 uf 500 v	3WS	"
C4	M-o cathode bypass	.01 uf 300 v	3WS	"
C5	M-o heater bypass	.01 uf 300 v	3WS	"
C6	M-o screen bypass	.002 uf 500 v	3WS	"
C7	M-o plate bypass	1 uf 600 v	DY6100	"
C8	M-o plate blocking	.002 uf 500 v	3WS	"
C9	M-o tank	500 uuf ≁ - 2% 5000 v	9H	"
C10	M-o tank	1000 uuf ≁ - 2% 5000 v	9H	"
C11	M-o grid reaction	50 uuf 500 v	5WS	"
C12	Mult. grid blocking	30 uuf 500 v	5WS	"
C13	Mult. cathode bypass	.01 uf 300 v	3WS	"
C14	Mult. screen bypass	.002 uf 500 v	3WS	"
C15	R-f filter	.002 uf 500 v	3WS	"
C16	R-f "	.002 uf 500 v	3WS	"
C17	R-f "	.002 uf 500 v	3WS	"
C18	Mult. plate blocking	.002 uf 1000 v	4S-12020	"
C19	Mult. plate tank	150 uuf .0375" spacing	7115	Hammond
C20	Driver grid blocking	100 uuf 500 v	5WS	C.D.
C21	Driver cathode bypass	.01 uf 300 v	3WS	"
C22	Driver screen bypass	.002 uf 1000 v	4S-12020	"

Circuit Symbol	Part	Description	Type Number	Manufacturer
Condensers				
C23	Driver plate blocking	.002 uf 2500 v	4S-22020	C.D.
C24	Driver plate tank	200 uuf .0375" spacing	8820	Hammond
C25	P-a grid blocking	250 uuf 1000 v	4S-13025	C.D.
C26	P-a neutralizing	6.2 uuf 6000 v	8602	Hammond
C27	Neutralizing isolation	100 uuf 5000 v	4S-53010	C.D.
C28	P-a filament bypass	.01 uf 1000 v	4S-11010	"
C29	P-a " "	.01 uf 1000 v	4S-11010	"
C30	P-a tank	200 uuf ,130" spacing	Special 92245	Hammond
C31	P-a plate bypass	.002 uf 6000 v	9FS-62020	C.D.
C32	Multiplier bypass	.002 uf 1000 v	4AS-12020	"
C33	Driver cathode meter bypass	.002 uf 1000 v	4AS-12020	"
C34	P-a cathode meter bypass	.002 uf 1000 v	4AS-12020	"
C35	Fil. line voltmeter bypass	.002 uf 1000 v	4AS-12020	"
C36	Keying rectifier filter	.5 uf 600 v	DY6050	"
C37	Antenna tuning	500 uuf .080" spacing	9350	Hammond
C38	Tone-g screen bypass	.5 uf 600 v	DY6050	C.D.
C39	T-g grid reaction	.1 uf 1000 v	DY10010	"
C40	Tone generator tank	.1 uf 1000 v	DY10010	"
C41	" " "	.02 uf 2500 v	9AS-21020	"
C42	" " "	.02 uf 2500 v	9AS-21020	"
C43	Not used			
C44	Low-v rectifier filter	4 uf 1000 v	TJ10040	"
C45	" " "	4 uf 1000 v	TJ10040	"

Circuit Symbol	Part	Description	Type Number	Manu-facturer
Condensers				
C46	High-v rectifier filter	4 uf 2500 v	TJ25040	C.D.
C47	Thermostat spark suppr.	.1 uf 600 v	DY6010	"
Relays				
E1	Break-in keying	6 v d-c coil 4.4 ohms	202	Leach
E2	Compensating	6 v d-c coil 4.4 ohms	101	"
E3	Time delay	110 v 60-cy coil, delay 20 secs to 1 minute	1154T	"
E4	Control	110 v 60-cy coil contacts 2A,1B, code #4	FQA	Can. Tel.& Supplies
E5	Power contactor	110 v 60-cy coil open type	Bull. 700 A209	Allen-Bradley
E6	Thermostat	Normally-closed, self regulating 75° F. ± 5°	M8-D8-28	Thos.A Edison Inc.
E7	Low-v overload breaker	Trip current .75 amp d-c	1040, coil #351 2.5 ohms	Leach
E8	High-v overload breaker	Trip current .75 amp d-c	1040, coil #351 2.5 ohms	"
Fuses				
F1	Heater (2)	(Refill) 3 amp 250 v		Economy
F2	Main line (2)	" 30 amp 250 v		"
F3	Filament (2)	" 5 amp 250 v		"
F4	Power (2)	" 25 amp 250 v		"

Circuit Symbol	Part	Description	Type Number	Manu-facturer
Inductances				
L1	M-o plate choke		1504	Hammond
L2	M-o variable		92032	Marconi
L3	M-o "		92031	"
L4	M-o "		92263	"
L5	M-o "		92264	"
L6	R-f filter		1504	Hammond
L7	R-f "		1504	"
L8	R-f "		1504	"
L9	Multiplier plate choke		1504	"
L10	" " coil		92030	Marconi
L11	Driver plate choke		1506	Hammond
L12	" " coil		90392	Marconi
L13	P-a grid choke		1504	Hammond
L14	P-a tank coil)		91792	Marconi
L15	P-a coupling coil)			
L16	Antenna coil		91800	"
L17	Low-voltage filter choke		89378	"
L18	M-o supply filter choke		89365	"
L19	High-voltage filter choke		89379	"
L20	L-v rectifier hash suppression choke		91665	"
L21	L-v " " " "		91665	"
L22	High-v rectifier hash suppression choke		91665	"
L23	" " " " "		91665	"

Circuit Symbol	Part	Description	Type Number	Manufacturer
Meters				
M1	Multimeter	0-25 ma d-c	27S	Simpson
M2	Driver cathode	0-250 ma d-c	27S	"
M3	P-a cathode	0-1000 ma d-c	27S	"
M4	Antenna ammeter	0-10 amp r-f	37S	"
M5	Fil. line voltmeter	0-150 volts a-c Red line at 110 v	57S	"
Pilot Lamps				
P1	Pilot lamp	120 v 6-w S6 clear		C.G.E.
P2	" "	Ditto		"
P3	" "	Ditto		"
Resistors				
R1	C-o grid leak	50,000 ohms ½ watt	BT½	I.R.C.
R2	C-o screen	500,000 ohms ½ watt	BT½	"
R3	C-o plate	30,000 ohms 4 watts	AB with "C" coating, #1 terminals	"
R4	M-o grid leak	50,000 ohms 1 watt	BT1	"
R5	M-o parasitic suppressor	100 ohms ½ watt	BT½	"
R6	M-o cathode	250 ohms 2 watts	BT2	"
R7	M-o screen	30,000 ohms 2 watts	BT2	"
R8	Mult. grid leak	50,000 ohms 1 watt	BT1	"
R9	" " " parasitic suppressor	100 ohms ½ watt	BT½	"
R10	Mult. cathode	250 ohms 2 watts	BT2	"
R11	" screen parasitic suppressor	100 ohms ½ watt	BT½	"
R12	Mult. screen	40,000 ohms 2 watts	BT2	"

Circuit Symbol	Part	Description	Type Number	Manu-facturer
Resistors				
R13	Driver grid	10,000 ohms 4 watts	AB with "C" coating, #1 terminals	I.R.C.
R14	Driver grid parasitic supp.	50 ohms ½ watt	BT½	"
R15	" " "	Ditto	BT½	"
R16	Driver screen " supp.	100 ohms ½ watt	BT½	"
R17	" " "	Ditto	BT½	"
R18	Driver cathode	250 ohms 20 watts	HX with "C" coating, #5 terminals	"
R19	" screen	20,000 ohms 20 watts	Ditto	"
R20	P-a grid parasitic supp.		P300	Ohmite
R21	" " "		P300	"
R22	P-a grid leak	2,000 ohms 40 watts	HA with "C" coating, #5 terminals	I.R.C.
R23	Multimeter shunt	500 ohms ½ watt	BW½	"
R24	" "	9 ohms, 1% tolerance	WW3	"
R25	" "	3 ohms, 1% tolerance	WW3	"
R26	" "	500 ohms ½ watt	BW½	"
R27	" "	1.0 ohm, 1% tolerance	WW3	"
R28	Tone-g screen	40,000 ohms 12 watts	CE with "C" coating, #5 terminals	"
R29	" cathode	250 ohms 4 watts	AB with "C" coating, #1 terminals	"
R30	" grid leak	10,000 ohms 2 watts	BT2	"

Circuit Symbol	Part	Description	Type Number	Manufacturer
Resistors				
R31	P-a grid series	2,000 ohms 18 watts	FB with "C" coating, #5 terminals	I.R.C.
R32	Not used			
R33	Keying bias	2,750 ohms 38 watts	HZ with "C" coating, #5 terminals	"
R34	Low-v potential divider	6,000 ohms 34 watts	FJ with "C" coating, #5 terminals	"
R35	" " "	2,500 ohms 60 watts	HE with "C" coating, #5 terminals	"
R36	High-v bleeder	10,000 ohms 60 watts	Ditto	"
R37	" "	Ditto	Ditto	"
R38	" "	Ditto	Ditto	"
R39	" "	Ditto	Ditto	"
R40	Voltage regulator series	7,000 ohms 26 watts	HY with "C" coating, #5 terminals	"
R41	Filament compensator	7.5 ohms 100 watts	0445 model K	Ohmite
R42.	Heater unit		Encl. heater unit, 100 w, 115 v	Chroma-lox
R43	" "		Ditto	"
R44	Power reducing		300 w 110 v, straight core heater element	P.M.Wright Elect.
R 45	Multimeter series		91850	Marconi

Circuit Symbol	Part	Description	Type Number	Manu-facturer
Switches				
S1	M-o wavechange		90563	Marconi
S2	M-o "		90563	"
S3	M-o "		90563	"
S4	M-o "		90563	"
S5	Crystal/m-o		91920	"
S6	Mult. plate coil tap		91926	"
S7	Driver plate coil tap		91926	"
S8	P-a coil tap		92236	"
S9	Coupling coil tap		92236	"
S10	Antenna coil tap		92236	"
S11	" " "		92236	"
S12	Not used			
S13	Multimeter selection		91211	"
S14	Antenna ammeter shorting		---	

Switch S15 should be type 91232

Switch S16 should be type 91135

	[illegible] selector		92373	"
S17	Safety switch shorting		3597	AH&H
S18	Safety		3591	"
S19	"		3591	"
S20	"		3591	"
S21	Filament		6900	"
S22	Standby		[illegible]	"
S23	High-low power		6464	"
S24	Line		6465	"

Circuit Symbol	Part	Description	Type Number	Manu-facturer
Switches				
S25	Wavechange h-t interlock		20595	AH&H
Transformers				
T1	Low-voltage power		89307	Marconi
T2	Rectifier filament		89309	"
T3	High-voltage power		89325	"
T4	Variac		80B 60-cy	General Radio
T5	Keying rectifier		89308	Marconi
T6	Tone generator		89301	"
T7	Filament		89305	"
Valves & Sockets				
V1	Crystal oscillator		6V6	R.V.C.
	Socket		SS8	Amphenol
V2	Master oscillator		807	R.V.C.
	Socket		SS5	Amphenol
V3	Multiplier		807	R.V.C.
	Socket		SS5	Amphenol
V4	Driver		807	R.V.C.
	Socket		RSS5	Amphenol
V5	Driver		807	R.V.C.
	Socket		RSS5	Amphenol
V6	Power amplifier		810	R.V.C.
	Socket		211 White	Johnson
V7	Power amplifier		810	R.V.C.
	Socket		211 White	Johnson
V8	Tone generator		807	R.V.C.
	Socket		SS5	Amphenol
V9	Low-voltage rectifier		866A	R.C.A.
	Socket		RSS4	Amphenol

Circuit Symbol	Part	Description	Type Number	Manu-facturer
Valves & Sockets				
V10	Low-voltage rectifier Socket		866A RSS4	R.C.A. Amphenol
V11	High-voltage rectifier Socket		872A 211 White	R.C.A. Johnson
V12	High-voltage rectifier Socket		872A 211 White	R.C.A. Johnson
V13	Voltage regulator Socket		VR150-30 SS8	R.C.A. Amphenol
V14	Voltage regulator Socket		VR150-30 SS8	R.C.A. Amphenol
Crystals				
X1	Crystal	Frequency to be specified. Temp. coeff. 3 cy per Mc per deg. C.	VP4 or CF3	Bliley Stone
X2	"	Ditto	Ditto	Ditto
X3	"	Ditto	Ditto	Ditto
X4	"	Ditto	Ditto	Ditto
Miscellaneous				
CU1	Keying rectifier	F-23-C-1		Mallory
	Fan		#800 B.M.C.	Air Cond. & Engrg Corp.

6-0 CALIBRATION AND OPERATING DATA

6-1 This supplements the calibration curves which show the master-oscillator dial, multiplier, driver and p-a condenser and coil tap settings for any desired frequency. The master-oscillator calibration is shown on Figs. 38, 39 and 40. The relation between oscillator and output frequencies is indicated on the calibration sheets. The curves show two calibrations; one for the oscillator coils marked bands 1, 2, and 4, and one for the coil marked band 3. With the aid of these curves it should be possible to set up a transmitter within better than 2% of any specified frequency. Closer adjustment is possible if a calibrated receiver or frequency meter is available.

6-2 The multiplier and driver plate coils have fixed taps brought to terminals on a terminal panel which also has terminals connected to the wavechange switches. The correct taps to be used for any frequency are indicated on the calibration sheets (Figs. 41-44). The calibration sheets show where the multiplier condenser should be set to obtain correct drive at any frequency. The values given in the sheets are approximate only and will depend to some extent on what taps are used on the other three switch positions.

6-3 Power-amplifier condenser settings and coil tap positions are shown on the same sheets (Figs.41-44). Actual condenser settings will vary somewhat from the calibrated values, but the suggested coil tap settings should be satisfactory.

6-4 Following is a list of typical readings and dial settings:

Switch position	1	2	3	4
Emitted frequency	4172	8532	12920	13230
Crystal frequency	4172	2844	4306.65	4410
Oscillator dial	0267	0170	0272	0277
Mult. condenser (C19)	43	25	22	18
Driver condenser (C24)	60	24	20	18
P-a condenser (C30)	60	32	3	3
Ant. condenser (C37)	77	28	16	16
Mult. coil taps	2A	3A	4A	4A
Driver coil taps	2A	3A	4A	4A
P-a coil taps	$10\frac{1}{4}$	$4\frac{1}{4}$	$3\frac{1}{4}$	$3\frac{1}{4}$
Tap "C" turns from left end of L16	10	10	10	10
Turns from "C" to left-hand tap	6	4	1	1
Turns from "C" to right-hand tap	22	12	3	3

Following readings taken on c-w with key down:

Osc. mult. grid	2.5 ma	2.7 ma	2.0 ma	2.4 ma
M-o plate	34 "	26 "	36 "	36 "
Multiplier plate	52 "	52 "	52 "	52 "
Driver grid	4.8 "	4.9 "	1.5 "	1.7 "
P-a grid	104 "	102 "	83 "	86 "
Driver cathode	127 "	114 "	163 "	157 "
P-a cathode	598 "	480 "	483 "	465 "
Antenna amps	3.6	3.68	3.69	3.75
Antenna watts	492	515	518	535

Following readings taken on i-c-w with key down:

P-a grid	62 ma	60 ma	60 ma	62 ma
Driver cathode	108 "	123 "	158 "	132 "
P-a cathode	460 "	440 "	440 "	440 "
Antenna amps	3.1	3.1	3.1	3.1
Antenna watts	365	365	365	365

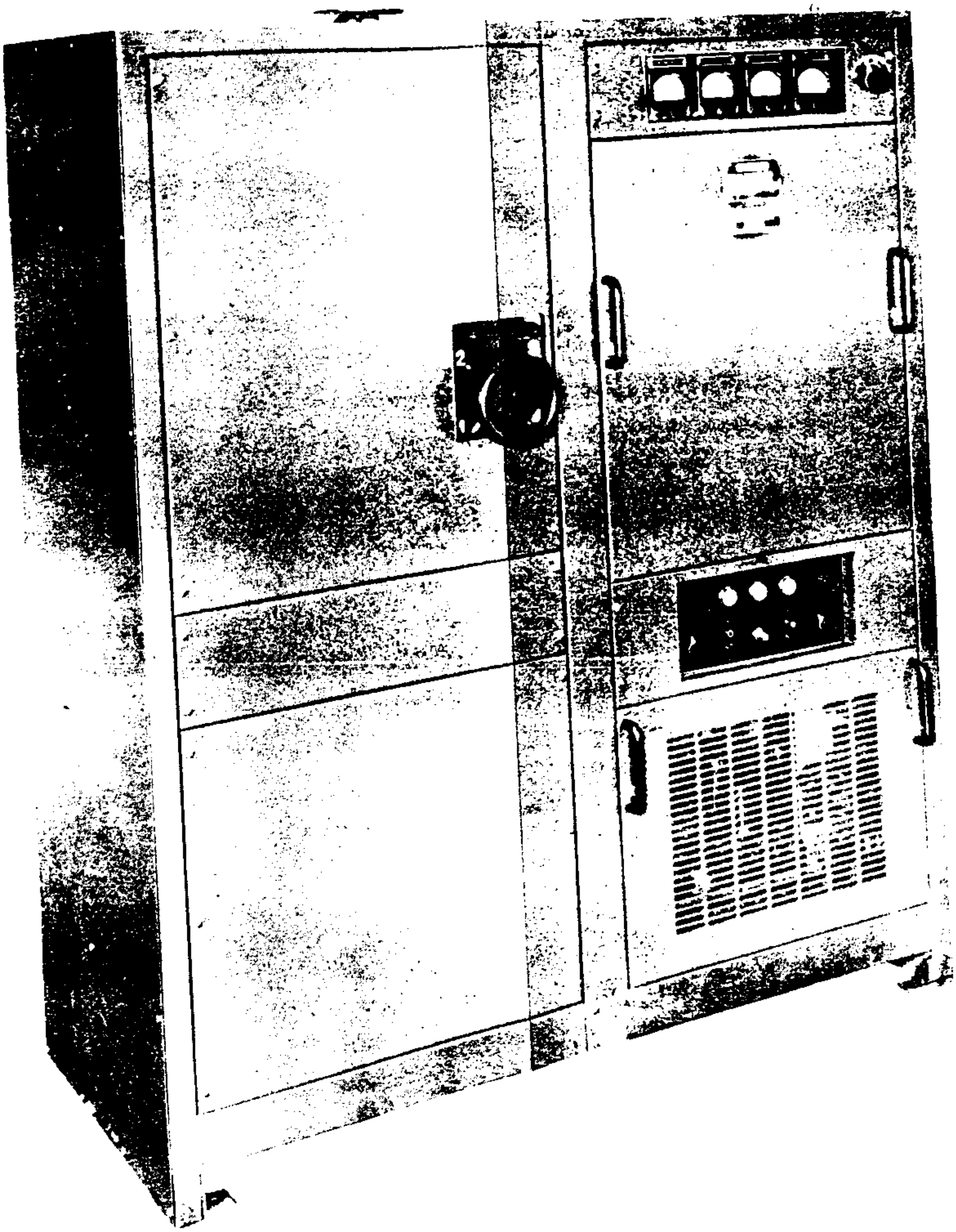
Above readings were taken with an antenna resistance load of 38 ohms.

Following is a list of miscellaneous readings:

Key down, high voltage	1900 volts
Key down, m-o plate voltage	300 "
Key up, m-o plate voltage	300 "
Key down, low-v output to ground	625 "
Key up, low-v output to ground	470 "
Key up, grid blocking voltage	210 "
Key down, mult. plate voltage	320 "
Key down (c-w), p-a grid bias	175 - 230 volts
Key down (i-c-w), p-a grid bias	250 - 330 "
V8 screen to cathode	225 - 300 "
V8 plate and screen current	60 - 90 ma
Line current, filaments only	3 amps (114 volts)
Line current, h-t on, key up	9 " (113 ")
Line current, key down	18 " (110 ")
Crystal oscillator plate	70 volts
Crystal oscillator screen	60 "
Master oscillator screen	170 "
Multiplier screen	200 "
Driver screen	300 "
Carrier ripple	2%
Crystal r-f current	30 - 50 ma
866A filament voltage	2.5 volts
872A filament voltage	5.0 "
810 filament voltage	10.0 "
807 heater voltage	6.3 "
6V6 heater voltage	6.3 "
Keying relay voltage	6.0 "
Keying rectifier output (key down)	12.0 "

Montreal, February 10, 1941

W/T TRANSMITTER
LOW FREQUENCY TYPE PV-500L



FRONT VIEW

FIG. 1

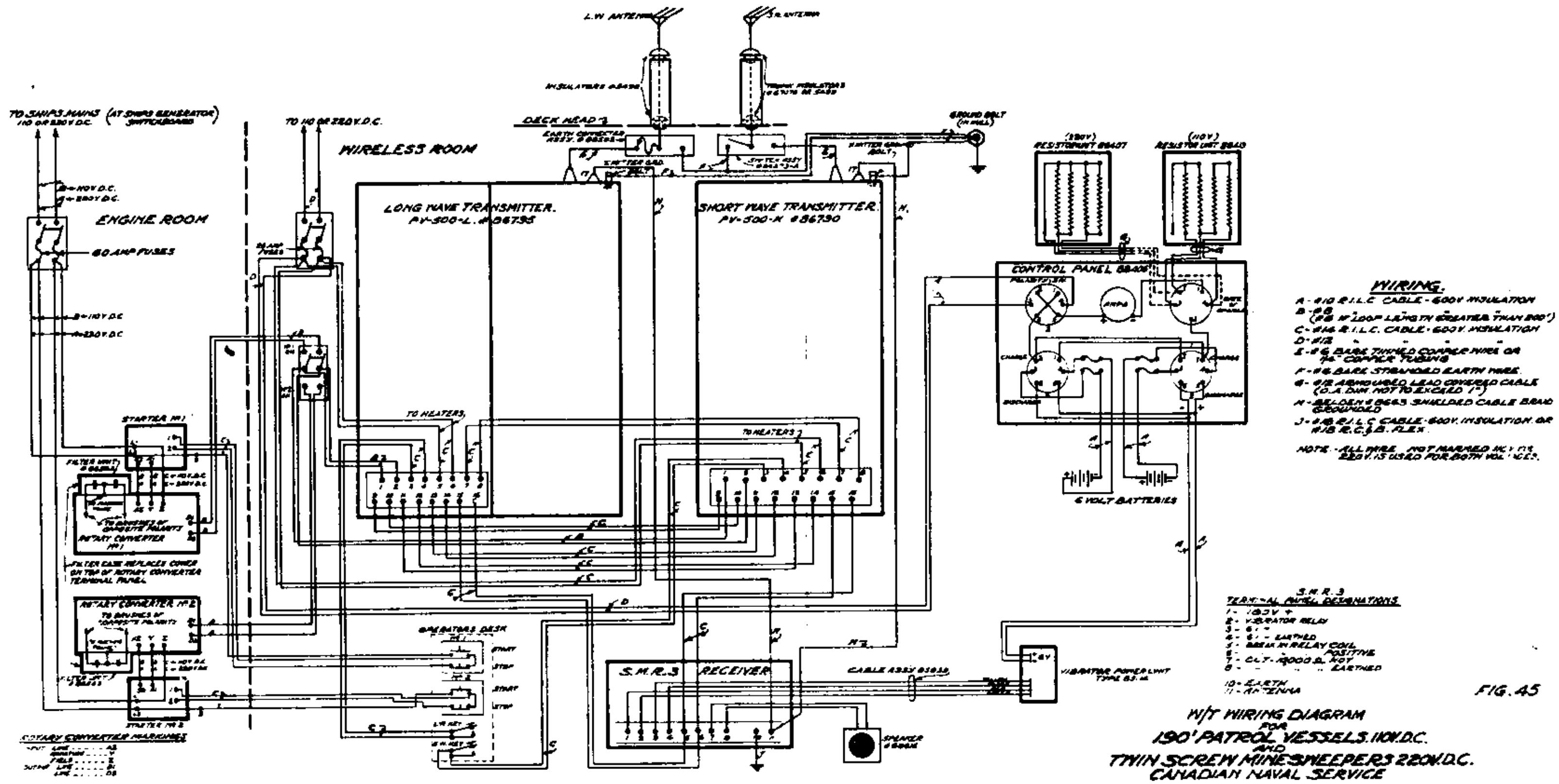
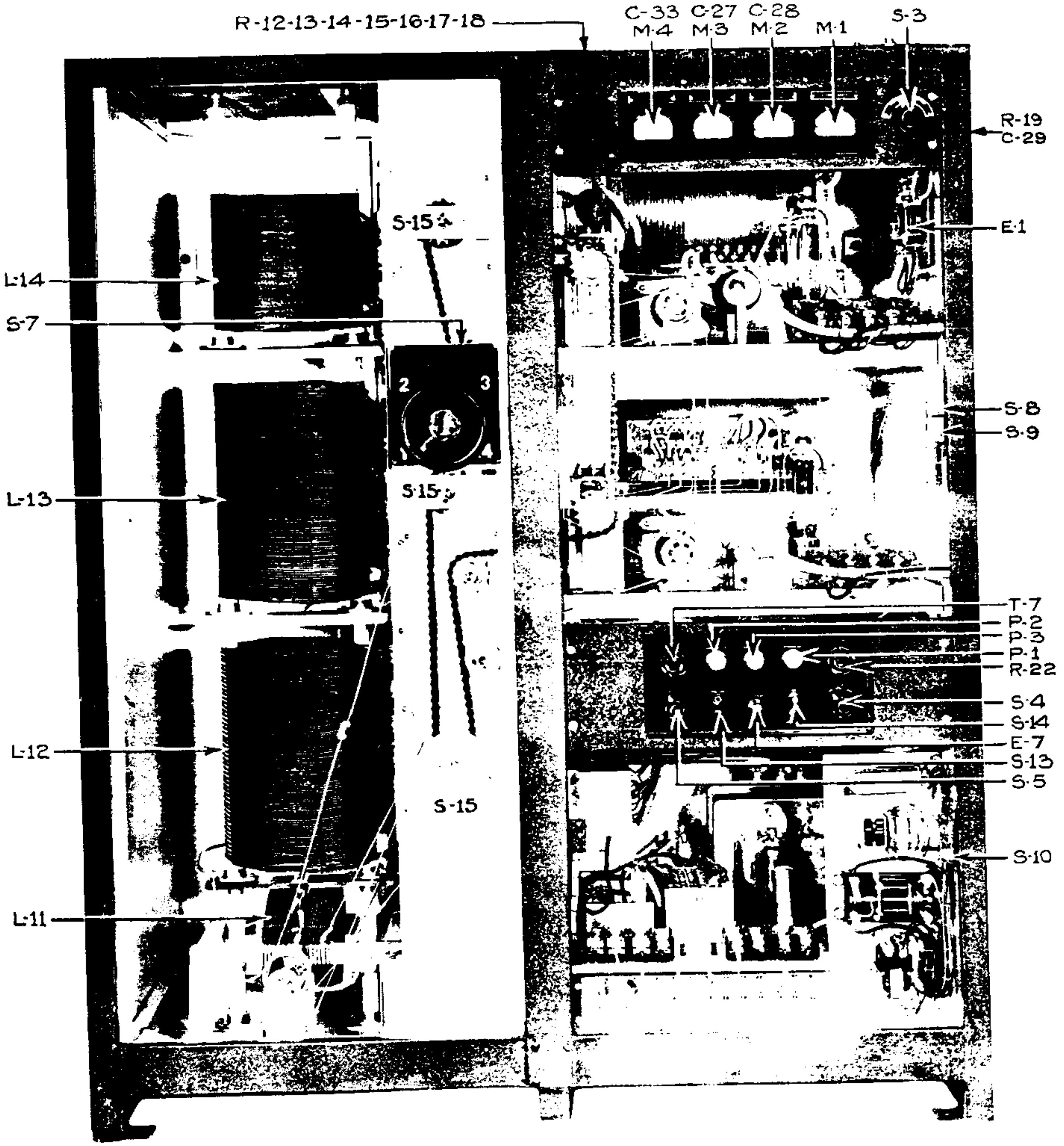


FIG. 45

W/T WIRING DIAGRAM
FOR
190' PATROL VESSELS 110V.D.C.
AND
TWIN SCREW MINESWEEPERS 220V.D.C.
CANADIAN NAVAL SERVICE

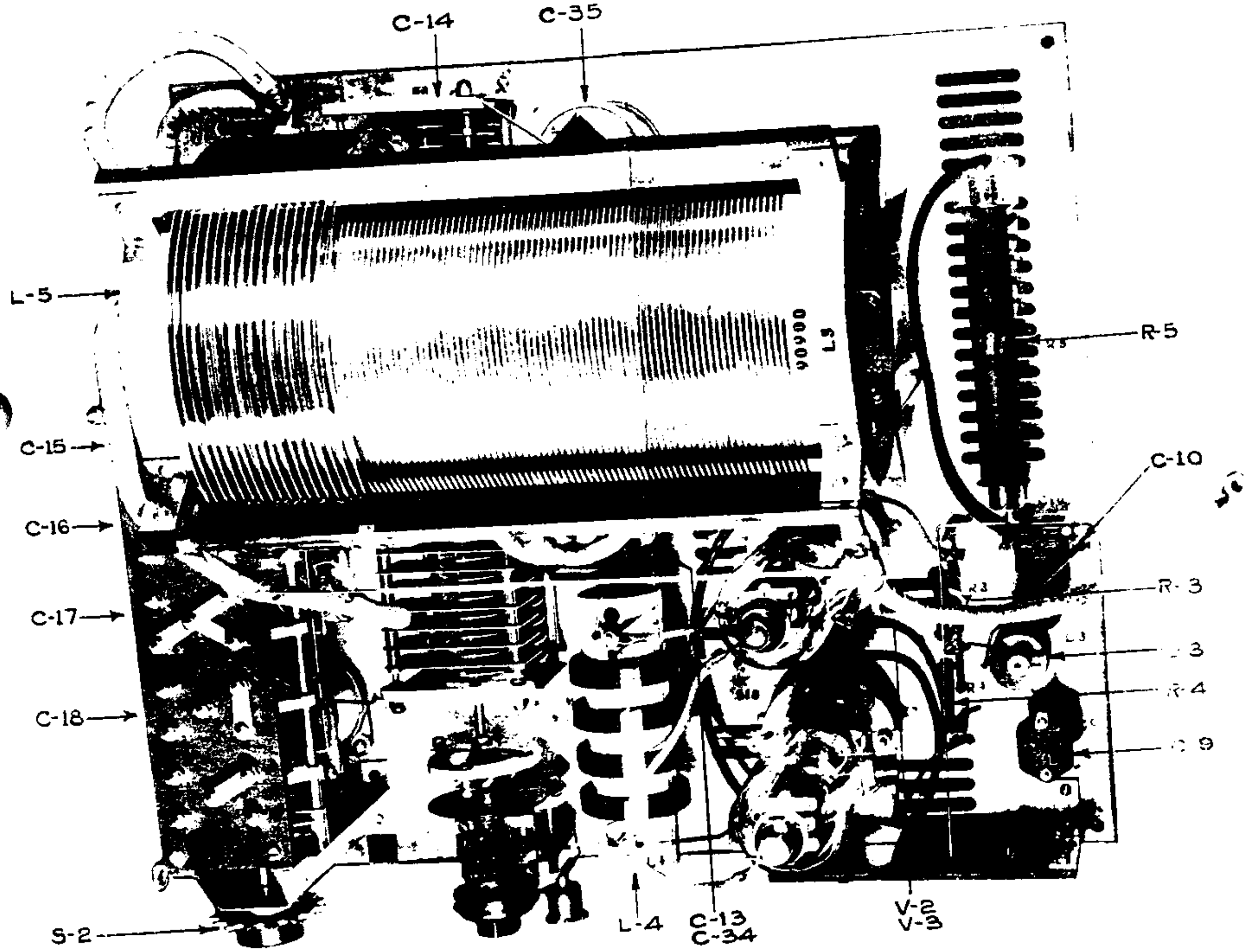
W/T TRANSMITTER
LOW FREQUENCY TYPE PV-500L



FRONT VIEW
FRONT SHIELD REMOVED

FIG. 2

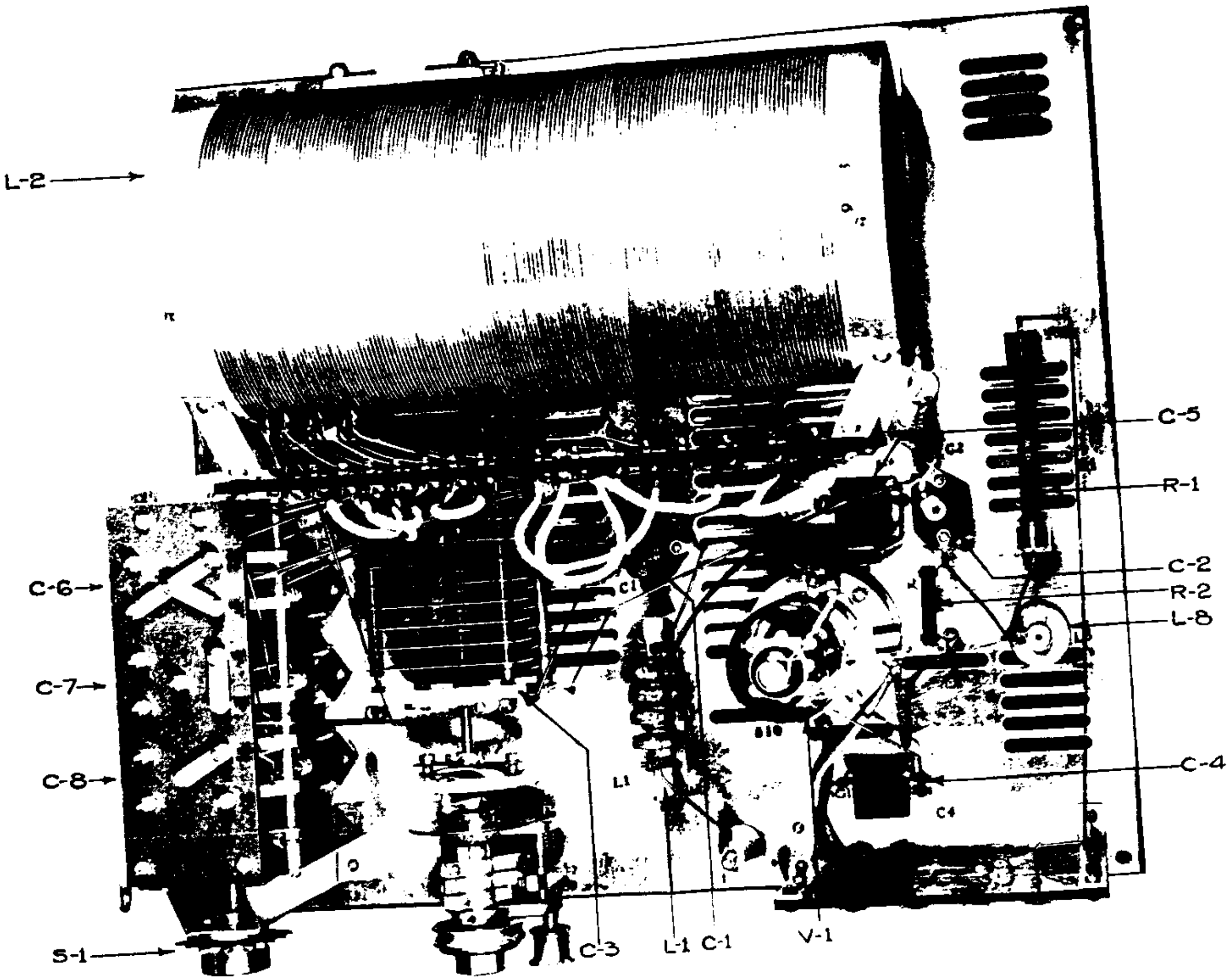
W/T TRANSMITTER
LOW FREQUENCY TYPE PV-500L



POWER AMPLIFIER SECTION
TOP VIEW

FIG. 3

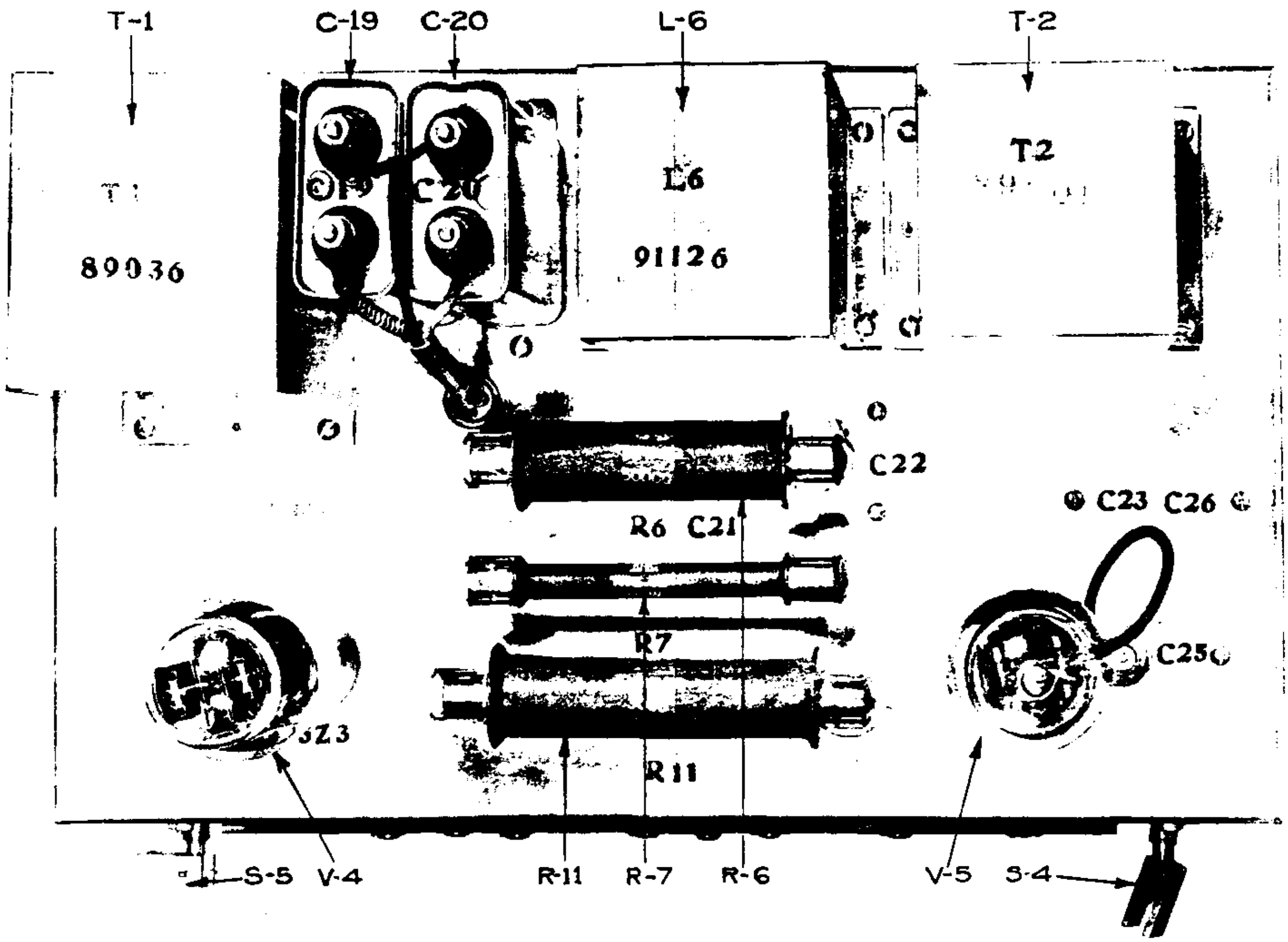
W/T TRANSMITTER
LOW FREQUENCY TYPE PV-500L



MASTER OSCILLATOR SECTION
TOP VIEW

FIG. 4

W/T TRANSMITTER
LOW FREQUENCY TYPE PV-500L

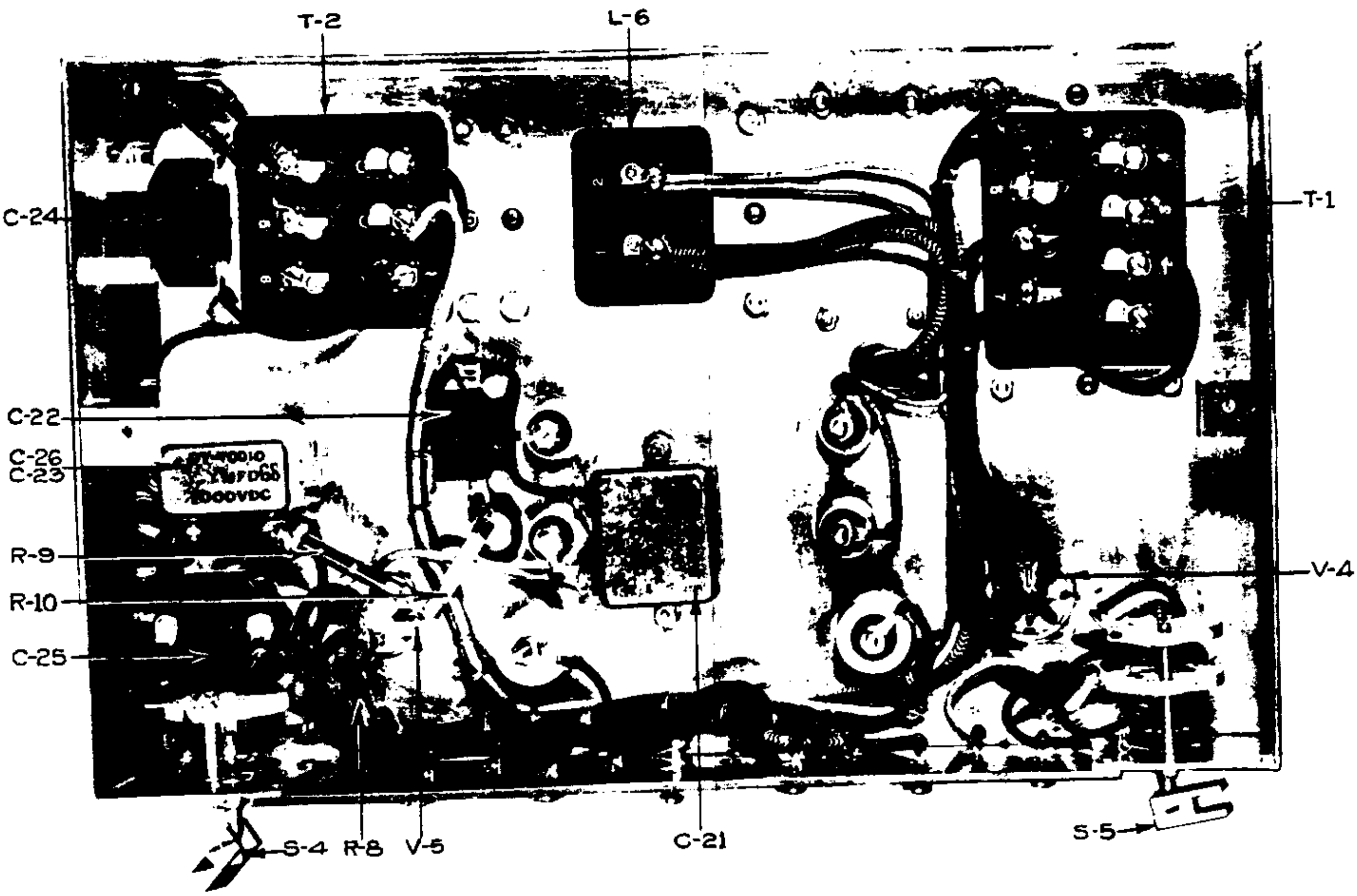


TONE GENERATOR SECTION

TOP VIEW

FIG. 5

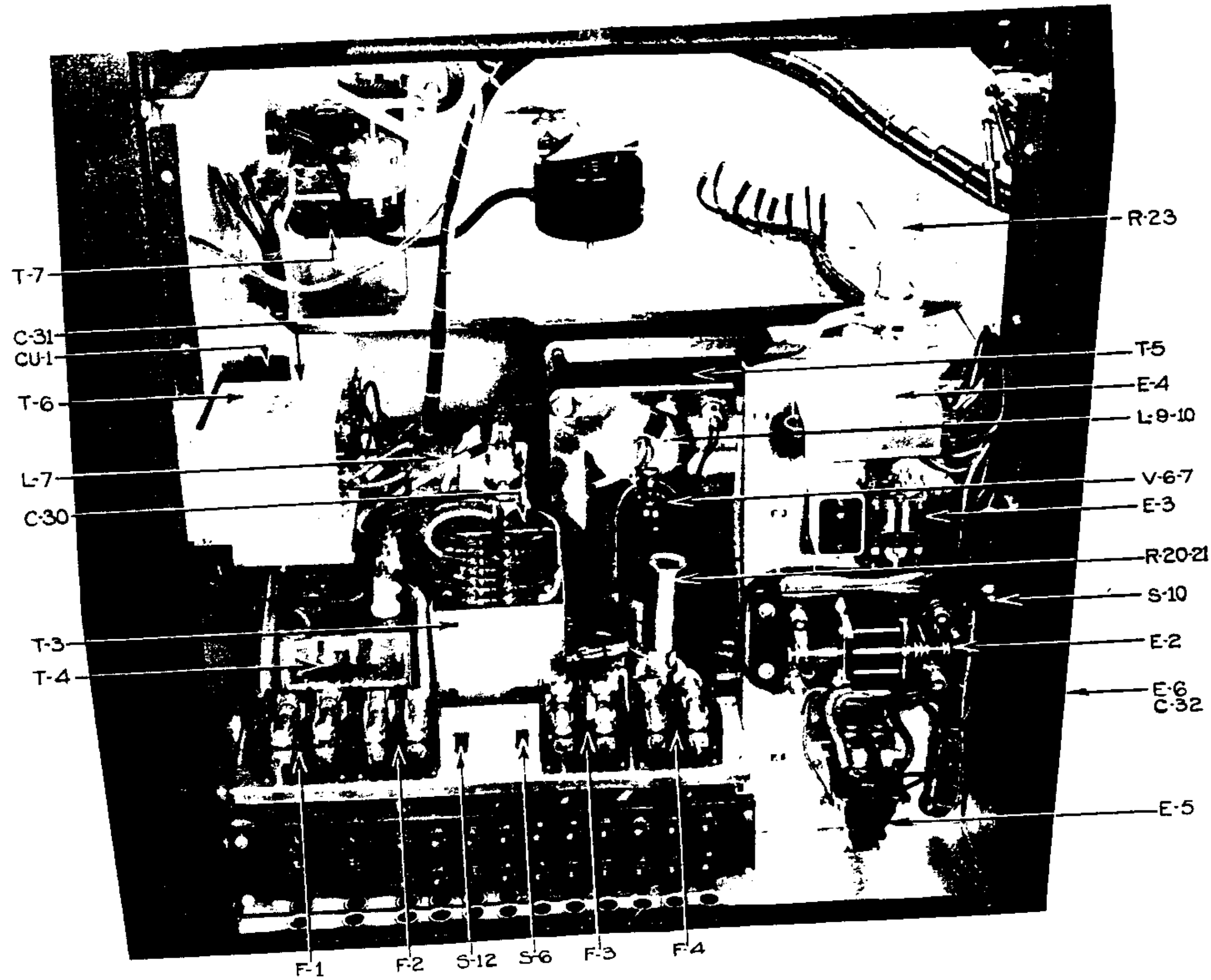
W/T TRANSMITTER
LOW FREQUENCY TYPE PV-500L



TONE GENERATOR SECTION
BOTTOM VIEW

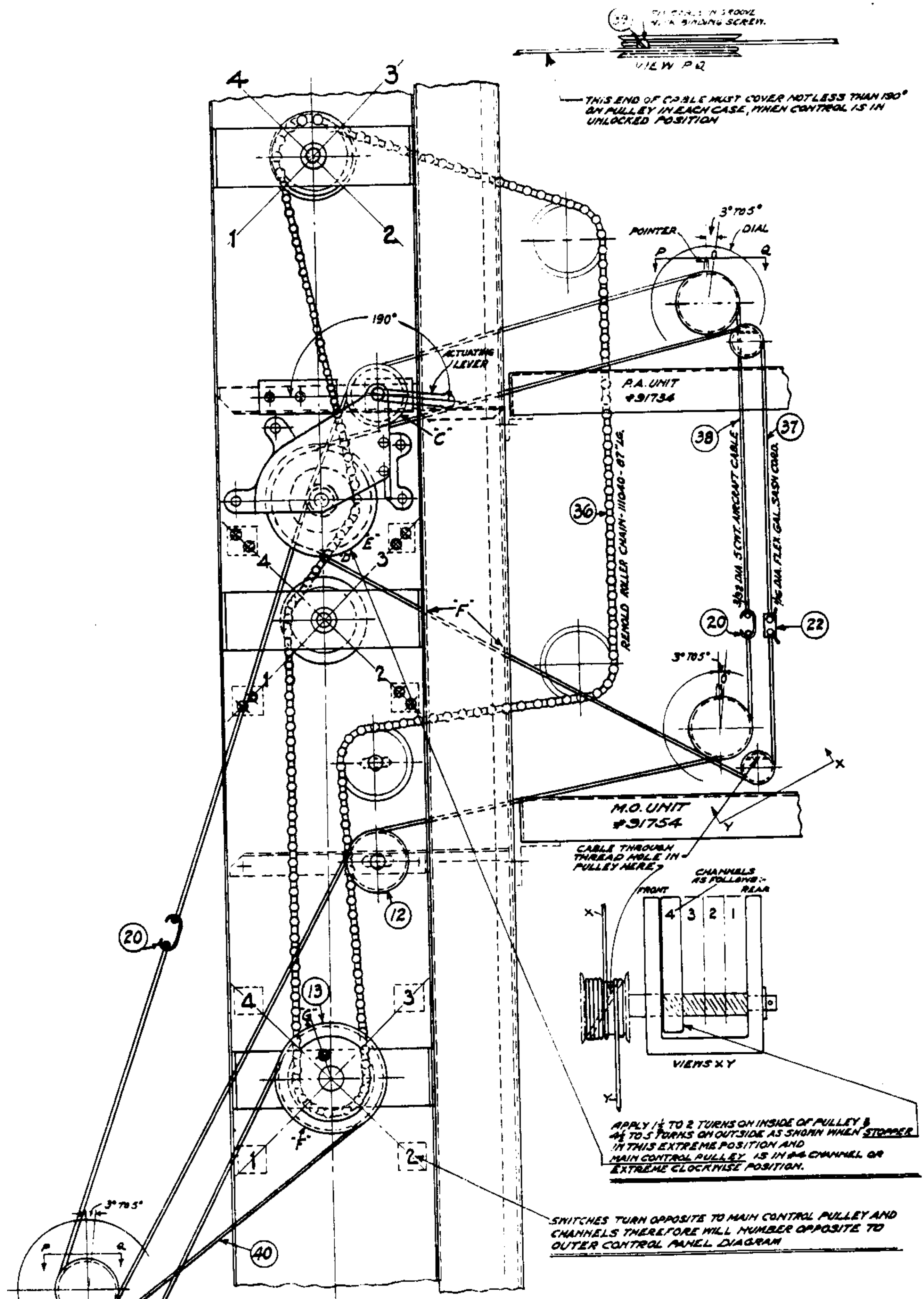
FIG. 6

W/T TRANSMITTER
LOW FREQUENCY TYPE PV-500L



POWER SECTION
FRONT VIEW

FIG. 7



FOR LIST OF PARTS SEE 91975-L
FOR CABLE ASSY. INSTRUCTIONS SEE 91975-A

FIG. 9

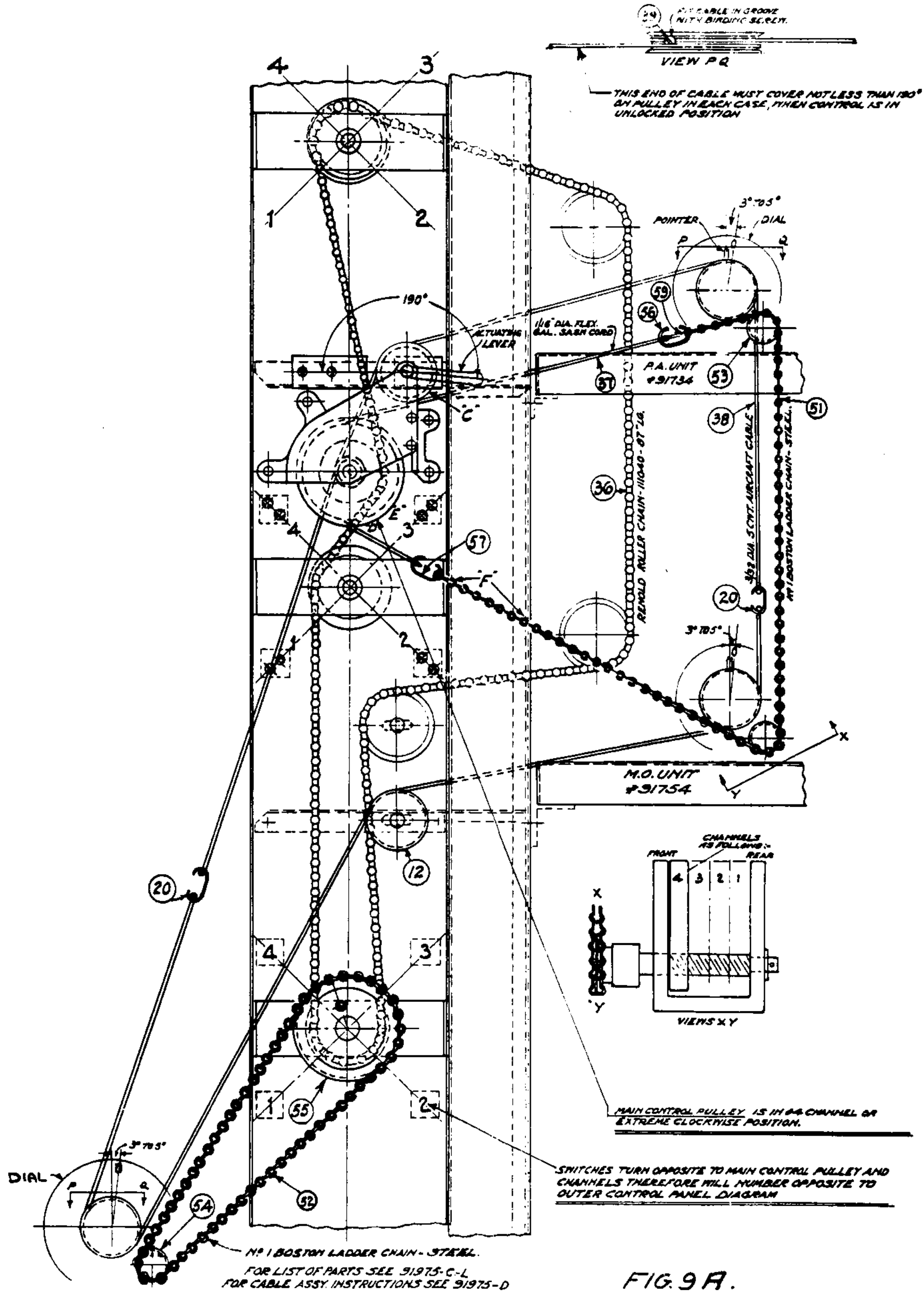
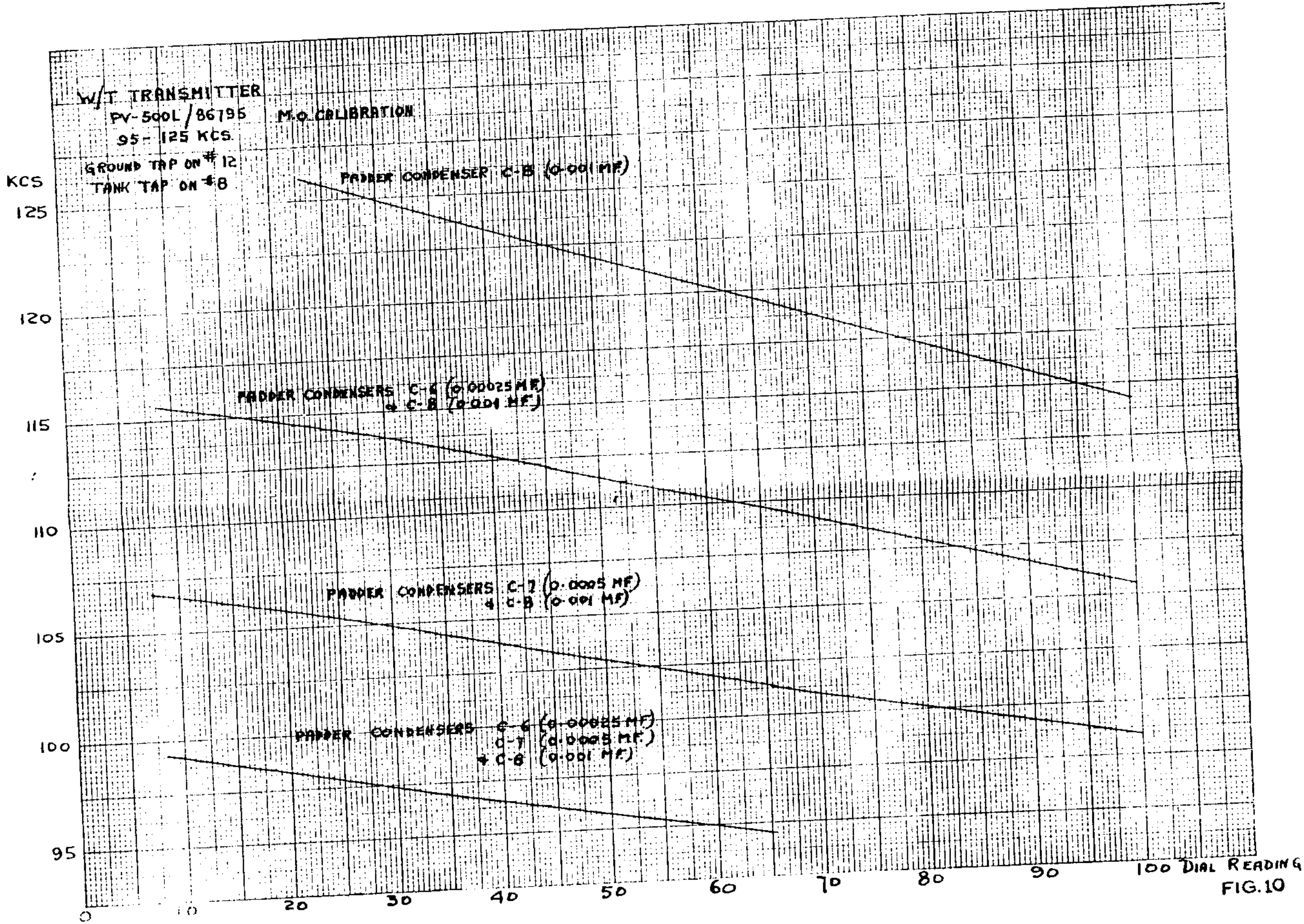
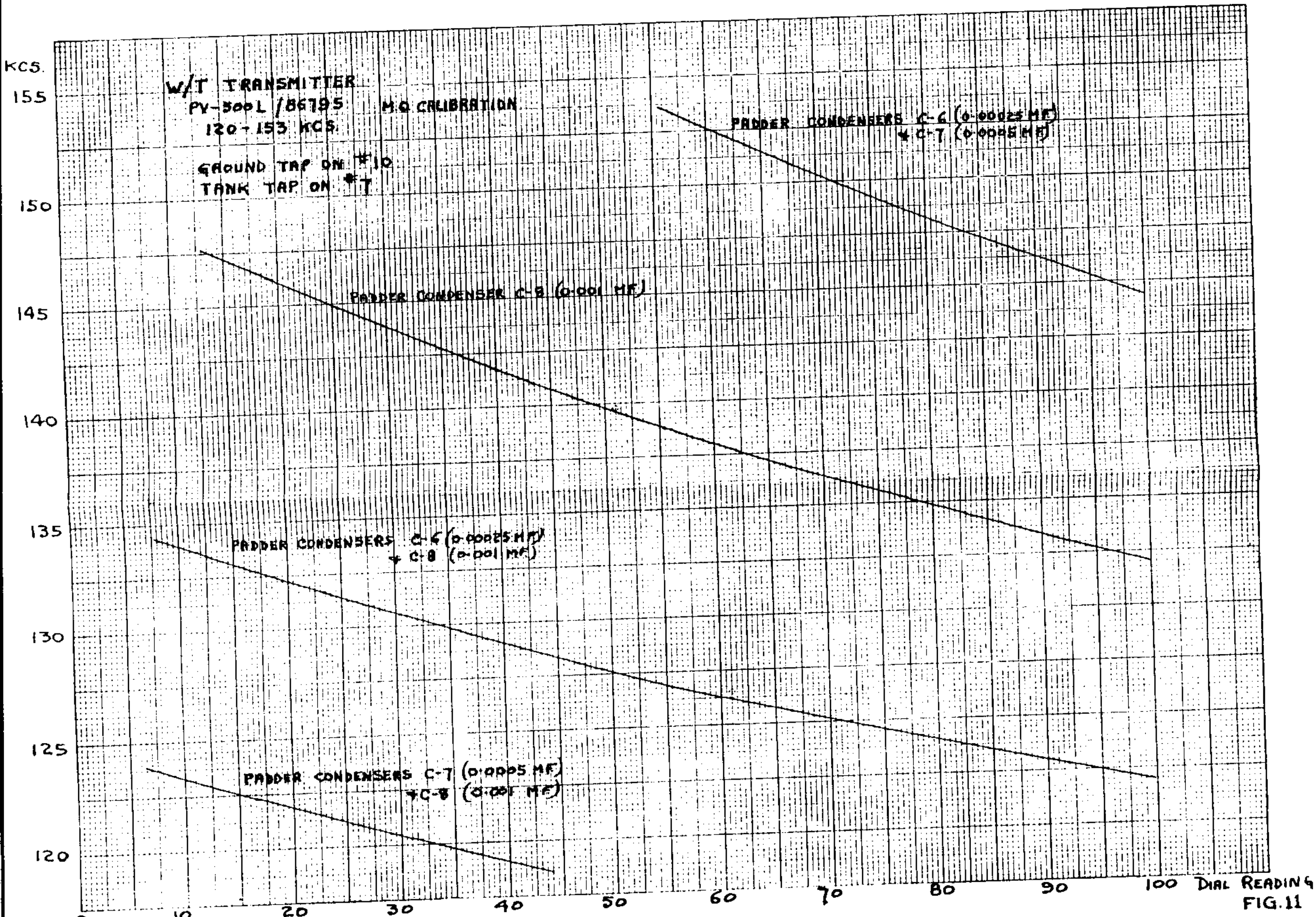

VIEW PQ
THIS END OF CABLE MUST COVER NOT LESS THAN 190° ON PULLEY IN EACH CASE, WHEN CONTROL IS IN UNLOCKED POSITION
4
3
1
2
190°
ACTUATING LEVER
1/16" DIA. FLEX. GAL. SASH CORD
POINTER
DIAL
3° TO 5°
P
Q
59
56
57
P.A. UNIT #31734
53
51
38
C
36
RENOLD ROLLER CHAIN - 111040 - 87 LG.
3/32 DIA. 5 CWT. AIRCRAFT CABLE
No 1 BOSTON LADDER CHAIN - STEEL
E
F
20
X
Y
M.O. UNIT #31754
12
CHANNELS AS FOLLOWS:-
FRONT
REAR
VIEWS XY
MAIN CONTROL PULLEY IS IN #4 CHANNEL OR EXTREME CLOCKWISE POSITION.
SWITCHES TURN OPPOSITE TO MAIN CONTROL PULLEY AND CHANNELS THEREFORE WILL NUMBER OPPOSITE TO OUTER CONTROL PANEL DIAGRAM
55
52
5A
No 1 BOSTON LADDER CHAIN - STEEL.
FOR LIST OF PARTS SEE 91975-C-L
FOR CABLE ASSY. INSTRUCTIONS SEE 91975-D

FIG. 9A.



W/T TRANSMITTER
PV-500L/86795 M.O. CALIBRATION
95-125 KCS.
GROUND TAP ON # 12
TANK TAP ON # 8
KCS
125
120
115
110
105
100
95
PADDER CONDENSER C-8 (0.001 MF)
PADDER CONDENSERS C-6 (0.00025 MF) & C-8 (0.001 MF)
PADDER CONDENSERS C-7 (0.0005 MF) & C-8 (0.001 MF)
PADDER CONDENSERS C-6 (0.00025 MF) C-7 (0.0005 MF) & C-8 (0.001 MF)
0
10
20
30
40
50
60
70
80
90
100 DIAL READING

FIG.10


W/T TRANSMITTER
PV-500L /86795 M.O CALIBRATION
120 - 153 KCS.
GROUND TAP ON #10
TANK TAP ON #T
PADDER CONDENSERS C-6 (0.00025 MF)
+ C-7 (0.0005 MF)
PADDER CONDENSER C-8 (0.001 MF)
PADDER CONDENSERS C-6 (0.00025 MF)
+ C-8 (0.001 MF)
PADDER CONDENSERS C-7 (0.0005 MF)
+ C-8 (0.001 MF)
KCS.
155
150
145
140
135
130
125
120
0
10
20
30
40
50
60
70
80
90
100
DIAL READING
FIG. 11

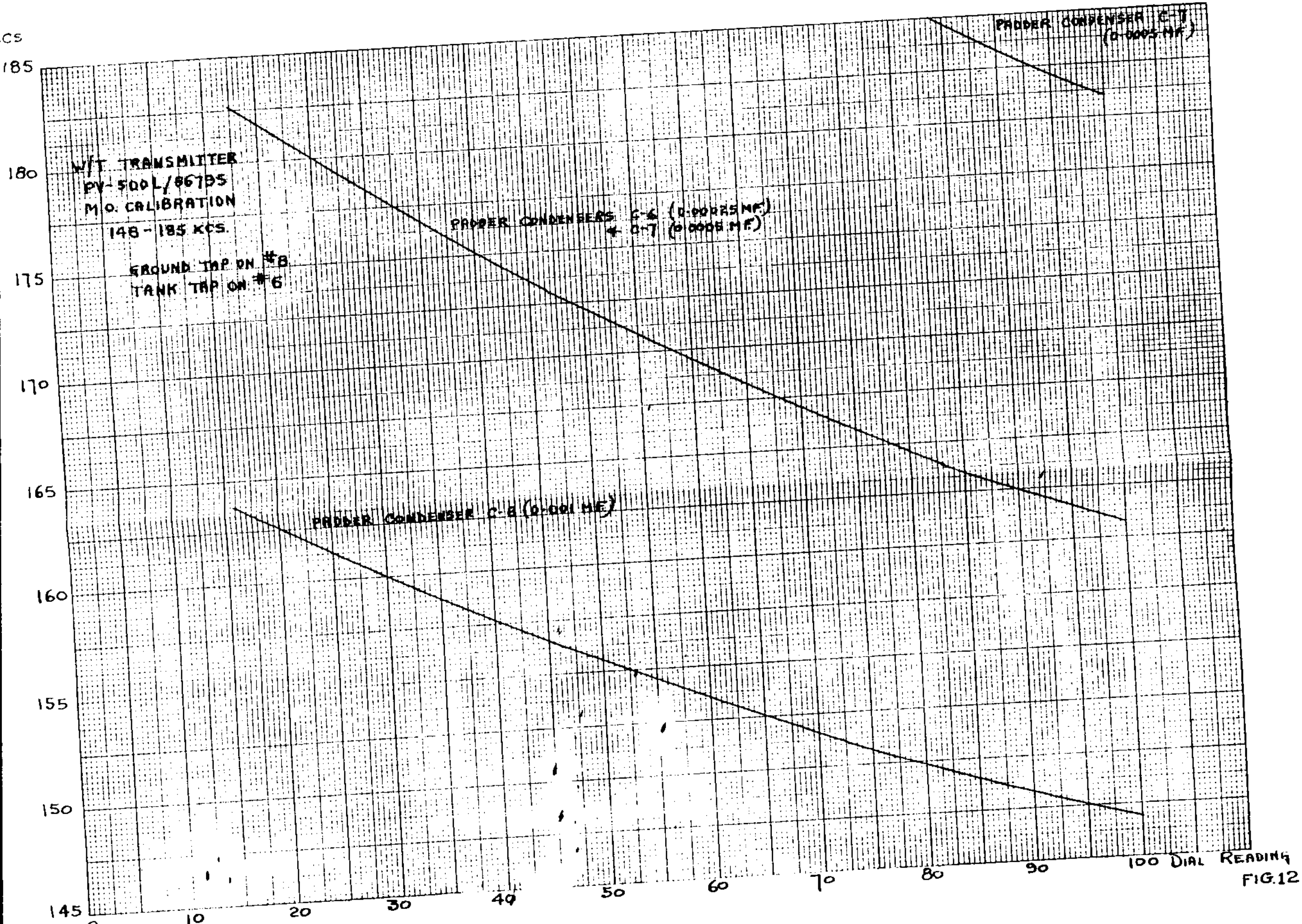
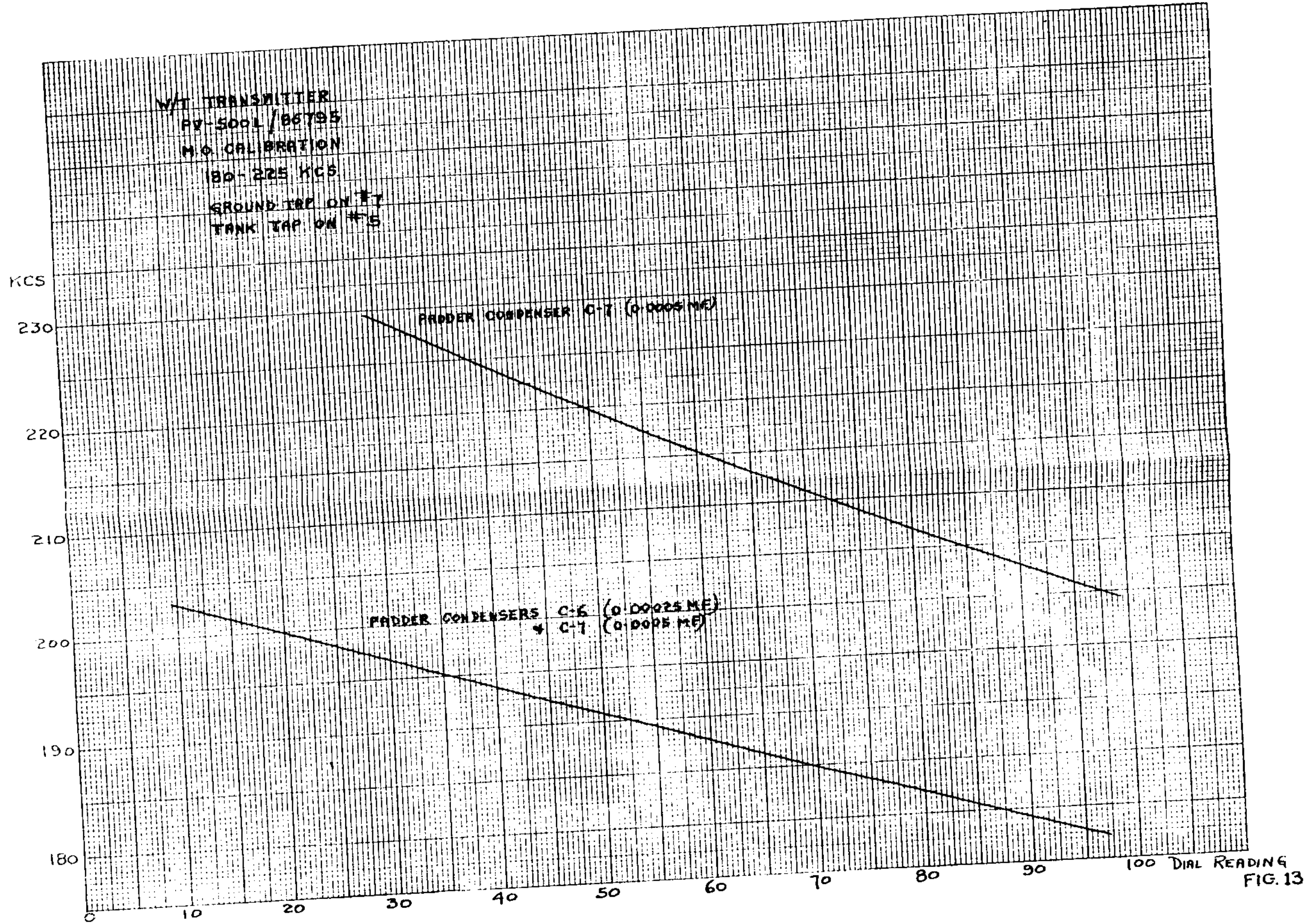

KCS
185
180
175
170
165
160
155
150
145
0
10
20
30
40
50
60
70
80
90
100 DIAL READING
W/T TRANSMITTER
PV-500L/86795
M.O. CALIBRATION
148 - 185 KCS.
GROUND TAP ON #8
TANK TAP ON #6
PADDER CONDENSER C-7 (0-0005 MF)
PADDER CONDENSERS C-6 (0-00025 MF)
+ C-7 (0-0005 MF)
PADDER CONDENSER C-8 (0-001 MF)

FIG.12


W/T TRANSMITTER
PV-500L/86795
M.O. CALIBRATION
180-225 KCS
GROUND TAP ON #7
TANK TAP ON #5
KCS
230
220
210
200
190
180
PADDER CONDENSER C-7 (0.0005 MF)
PADDER CONDENSERS C-6 (0.00025 MF)
& C-7 (0.0005 MF)
0
10
20
30
40
50
60
70
80
90
100 DIAL READING
FIG. 13

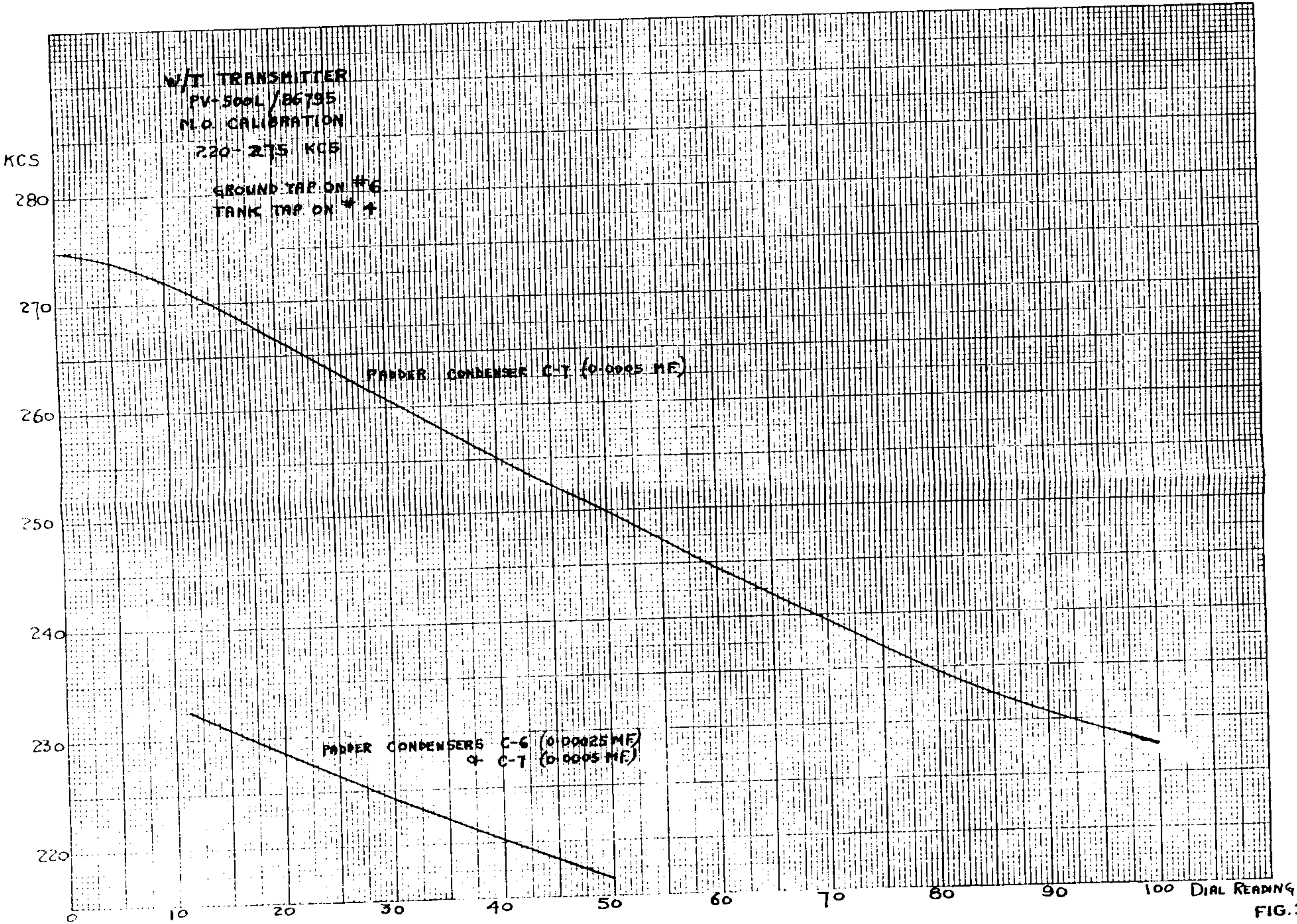
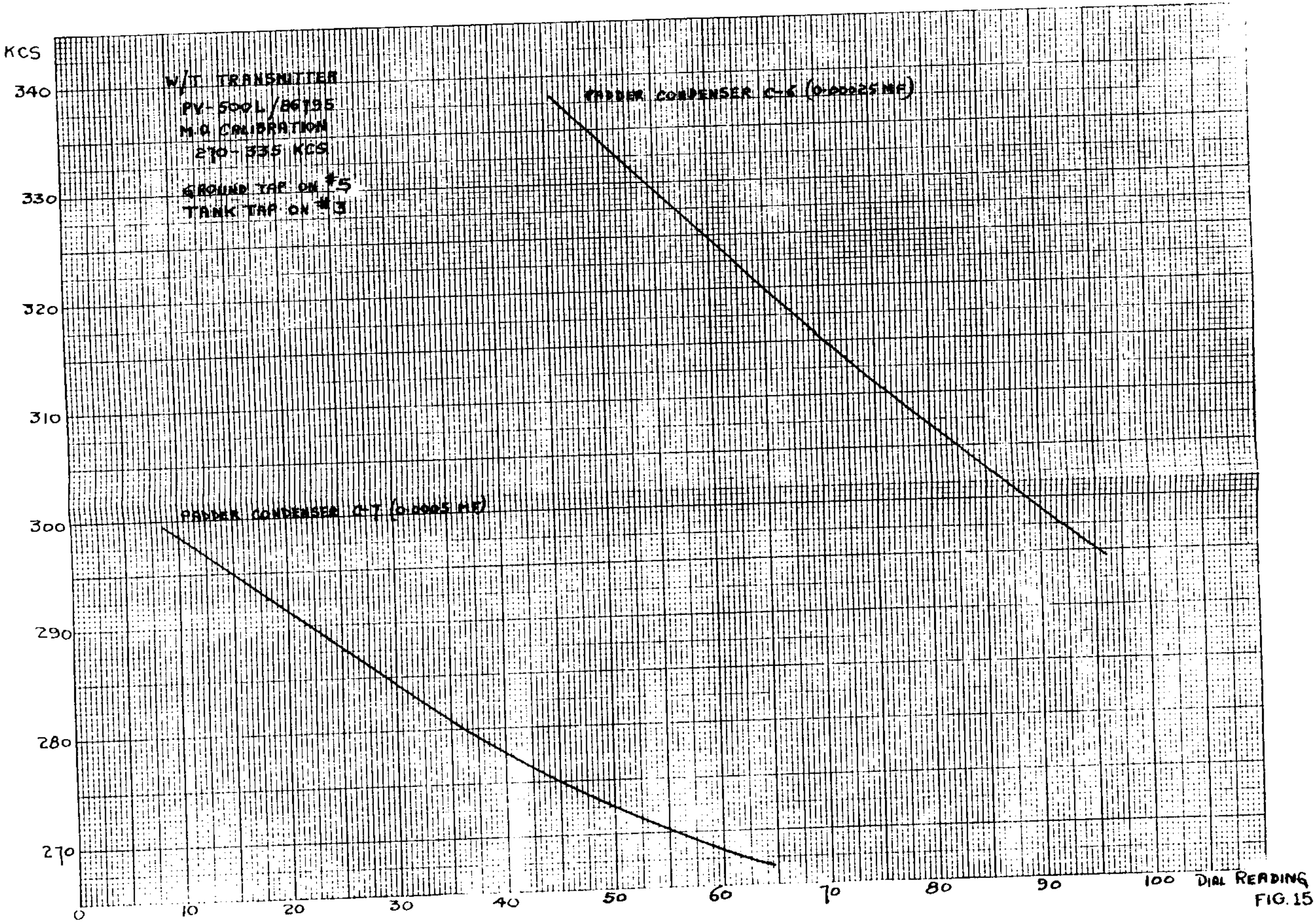
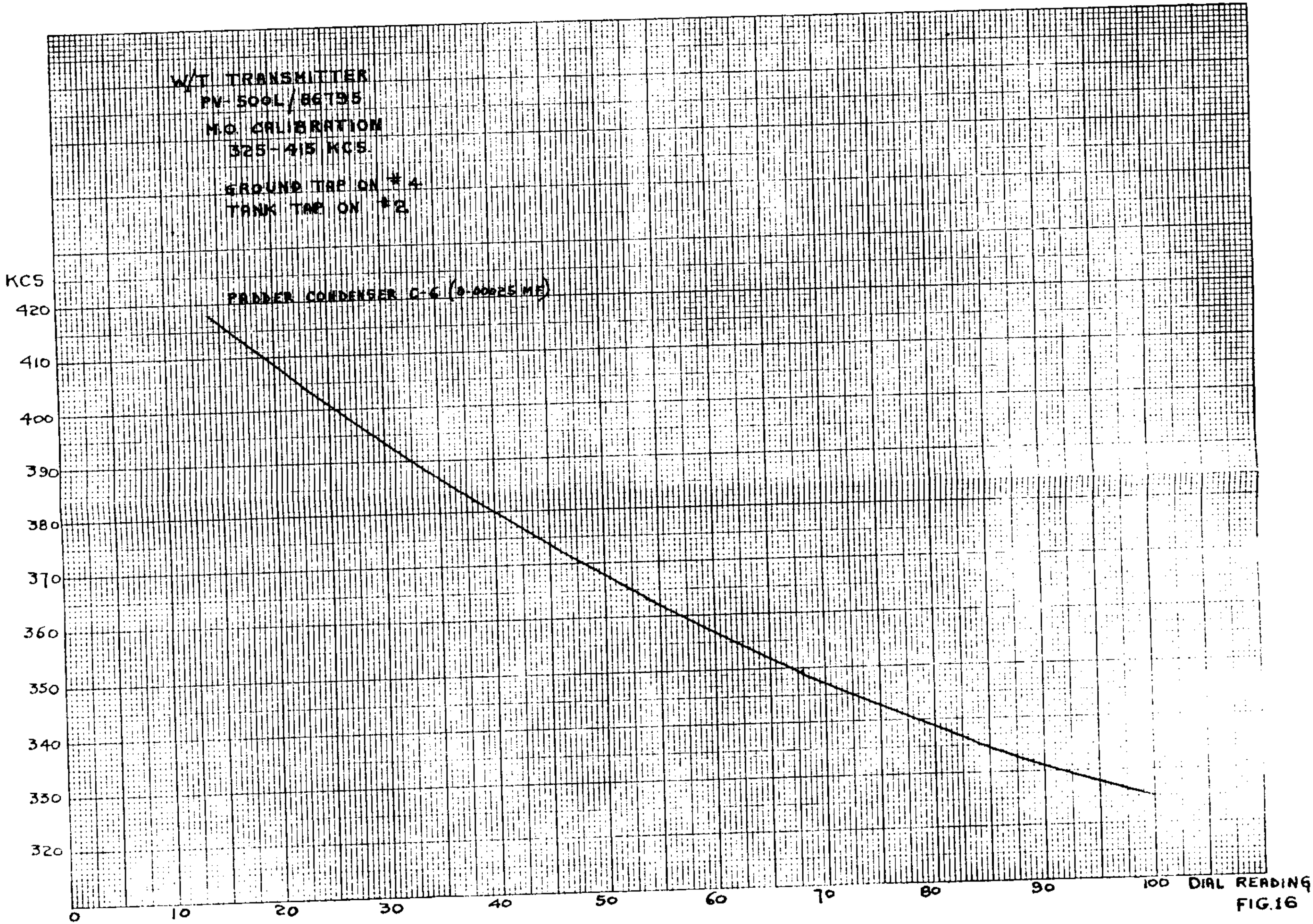

W/T TRANSMITTER
PV-500L/86795
M.O. CALIBRATION
220-275 KCS
GROUND TAP ON #6
TANK TAP ON #4
KCS
280
270
260
250
240
230
220
PADDER CONDENSER C-7 (0.0005 MF)
PADDER CONDENSERS C-6 (0.00025 MF)
+ C-7 (0.0005 MF)
0
10
20
30
40
50
60
70
80
90
100
DIAL READING

FIG.14



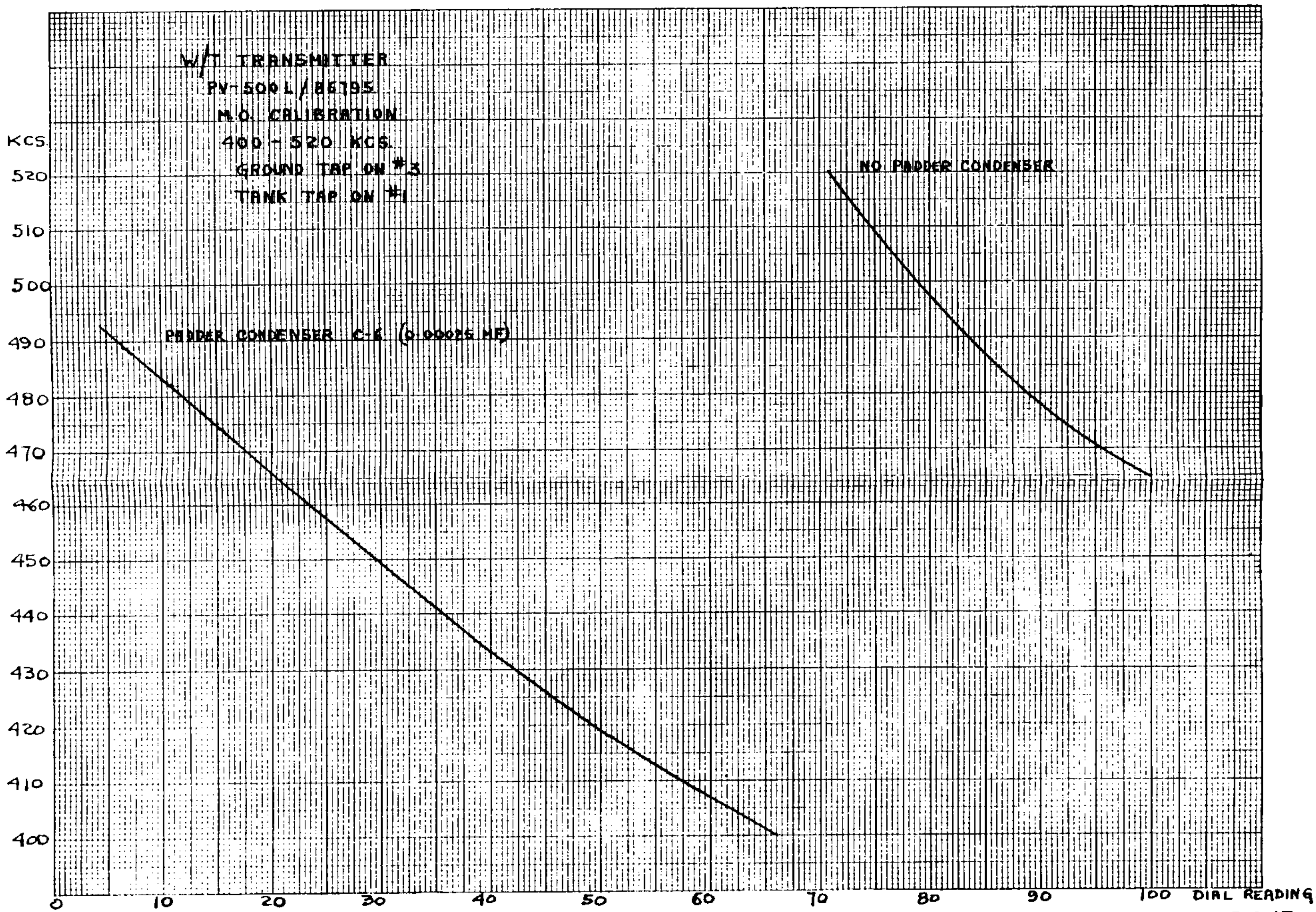
W/T TRANSMITTER
PV-500L/86795
M.O CALIBRATION
270-335 KCS
GROUND TAP ON #5
TANK TAP ON #3
PADDER CONDENSER C-6 (0.00025 MF)
PADDER CONDENSER C-7 (0.0005 MF)
KCS
340
330
320
310
300
290
280
270
0
10
20
30
40
50
60
70
80
90
100
DIAL READING

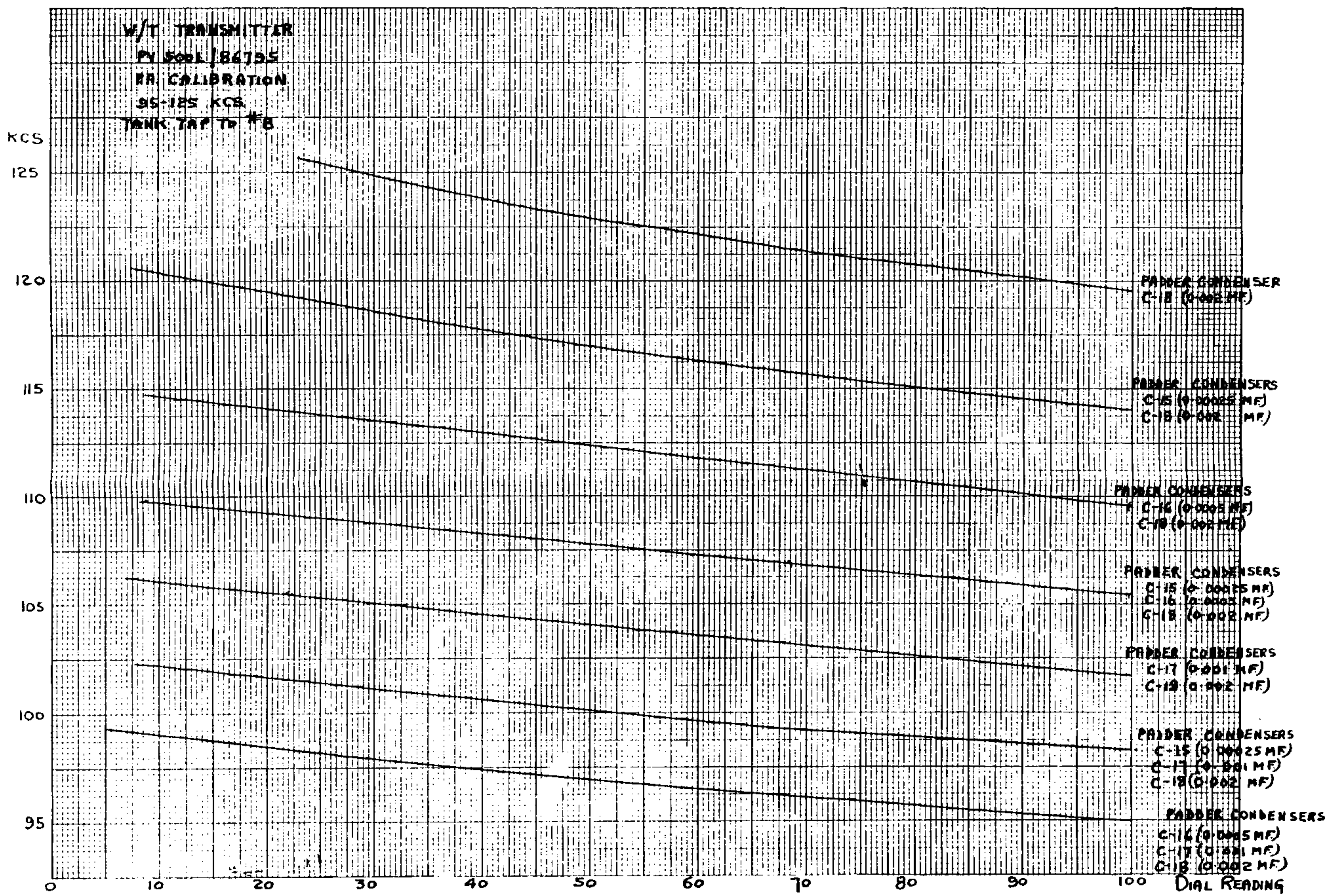
FIG. 15



W/T TRANSMITTER
PV-500L/86795
M.O. CALIBRATION
325-415 KCS.
GROUND TAP ON # 4
TANK TAP ON #2
PADDER CONDENSER C-6 (0.00025 MF)
KCS
420
410
400
390
380
370
360
350
340
330
320
0
10
20
30
40
50
60
70
80
90
100
DIAL READING

FIG.16


W/T TRANSMITTER
PV-500L/86195
M.O. CALIBRATION
400 - 520 KCS.
GROUND TAP ON #3
TANK TAP ON #1
NO PADDER CONDENSER
PADDER CONDENSER C-6 (0.00025 MF)
KCS
520
510
500
490
480
470
460
450
440
430
420
410
400
0
10
20
30
40
50
60
70
80
90
100
DIAL READING.
FIG.17



W/T TRANSMITTER
95-125 KCS
TANK TAP TO #8
KCS
125
120
115
110
105
100
95
0
10
20
30
40
50
60
70
80
90
100
DIAL READING
PADDER CONDENSER
C-18 (0.002 MF)
PADDER CONDENSERS
C-15 (0.00025 MF)
C-18 (0.002 MF)
PADDER CONDENSERS
C-16 (0.0005 MF)
C-18 (0.002 MF)
PADDER CONDENSERS
C-15 (0.00025 MF)
C-16 (0.0005 MF)
C-18 (0.002 MF)
PADDER CONDENSERS
C-17 (0.001 MF)
C-18 (0.002 MF)
PADDER CONDENSERS
C-15 (0.00025 MF)
C-17 (0.001 MF)
C-18 (0.002 MF)
PADDER CONDENSERS
C-16 (0.0005 MF)
C-17 (0.001 MF)
C-18 (0.002 MF)

FIG. 18

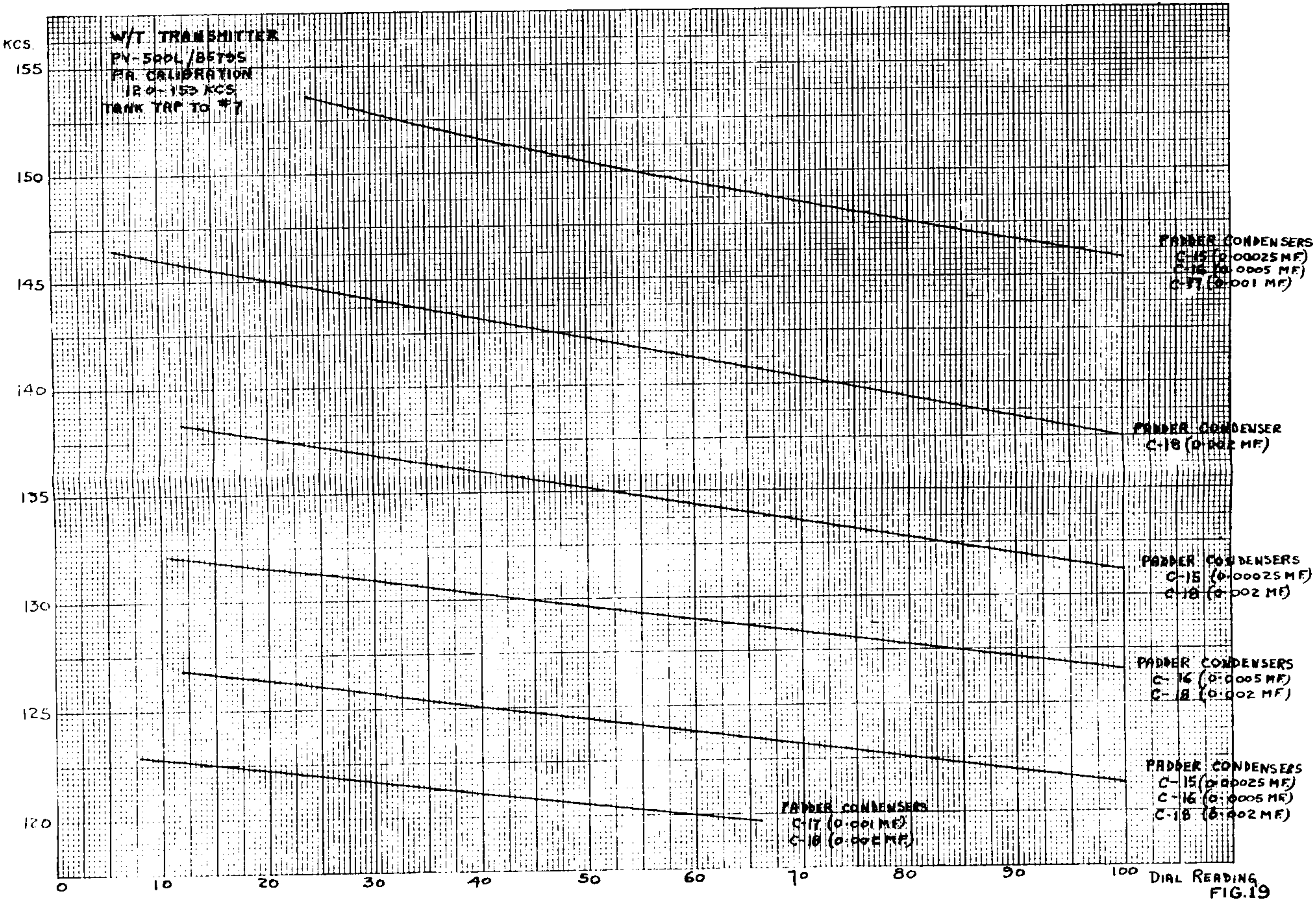

W/T TRANSMITTER
PV-500L/8579S
PA. CALIBRATION
120-153 KCS.
TANK TAP TO #7
KCS.
155
150
145
140
135
130
125
120
0
10
20
30
40
50
60
70
80
90
100
DIAL READING
PADDER CONDENSERS
C-15 (0.00025 MF)
C-16 (0.0005 MF)
C-17 (0.001 MF)
PADDER CONDENSER
C-18 (0.002 MF)
PADDER CONDENSERS
C-15 (0.00025 MF)
C-18 (0.002 MF)
PADDER CONDENSERS
C-16 (0.0005 MF)
C-18 (0.002 MF)
PADDER CONDENSERS
C-15 (0.00025 MF)
C-16 (0.0005 MF)
C-18 (0.002 MF)
PADDER CONDENSERS
C-17 (0.001 MF)
C-18 (0.002 MF)

FIG.19

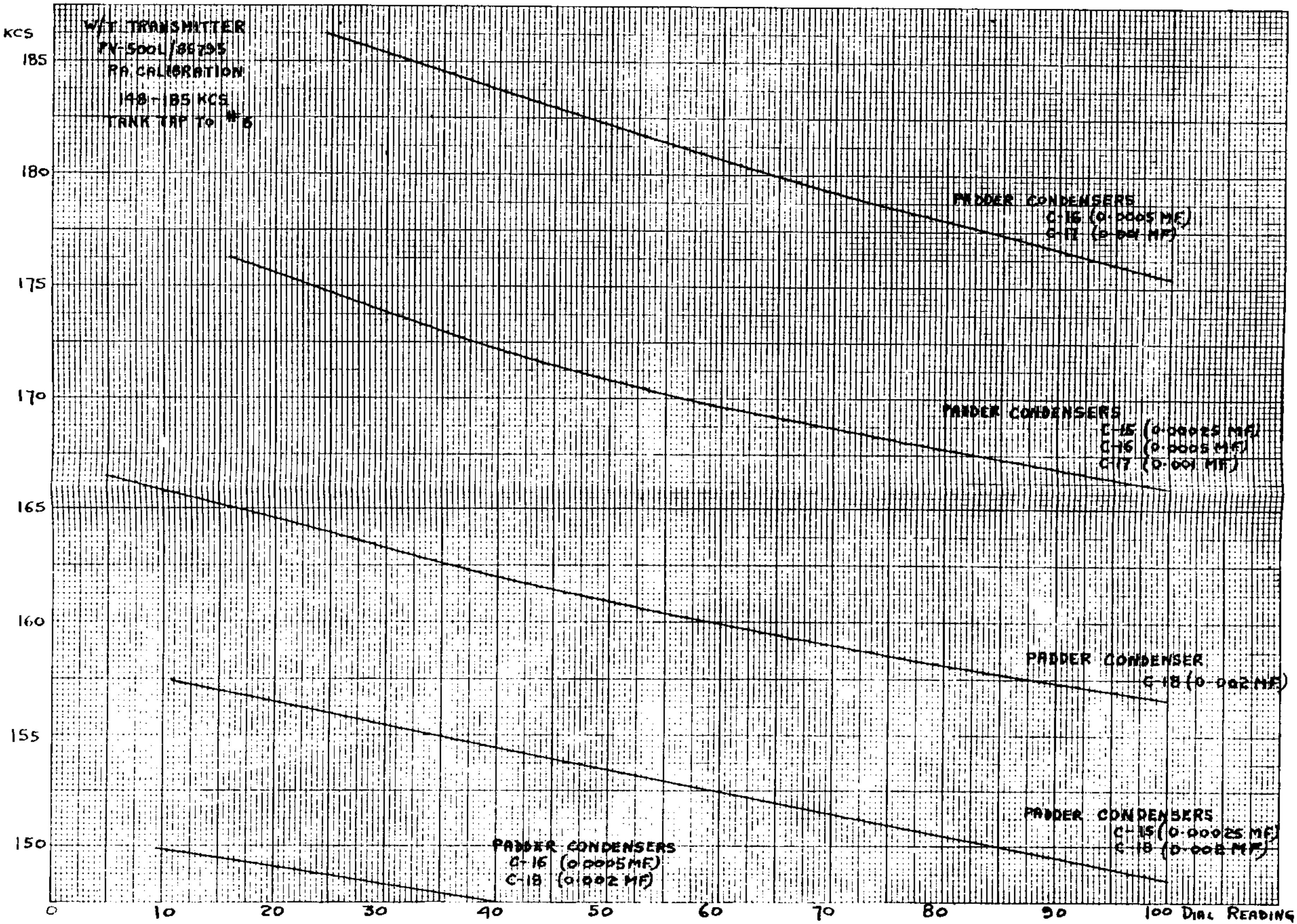
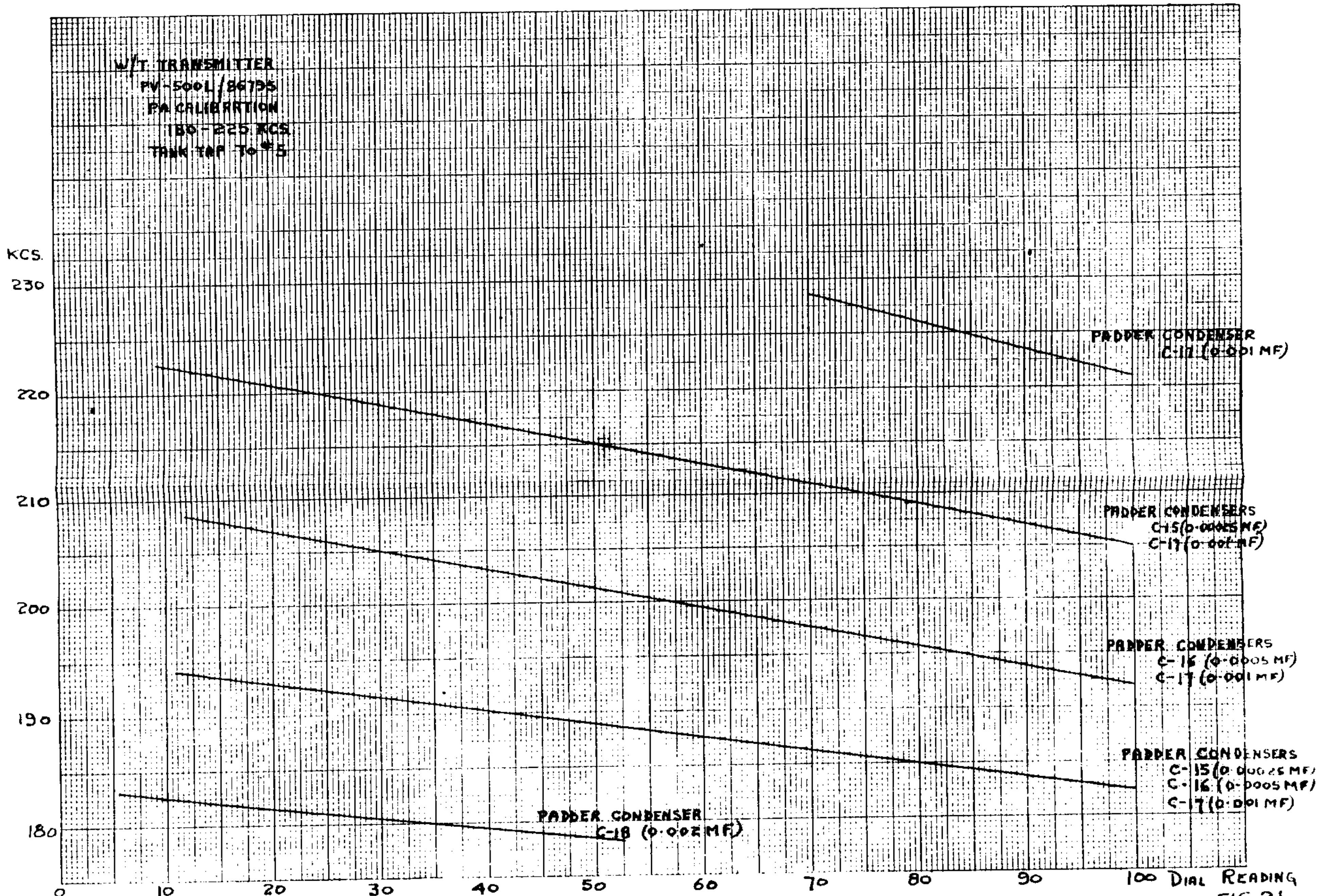
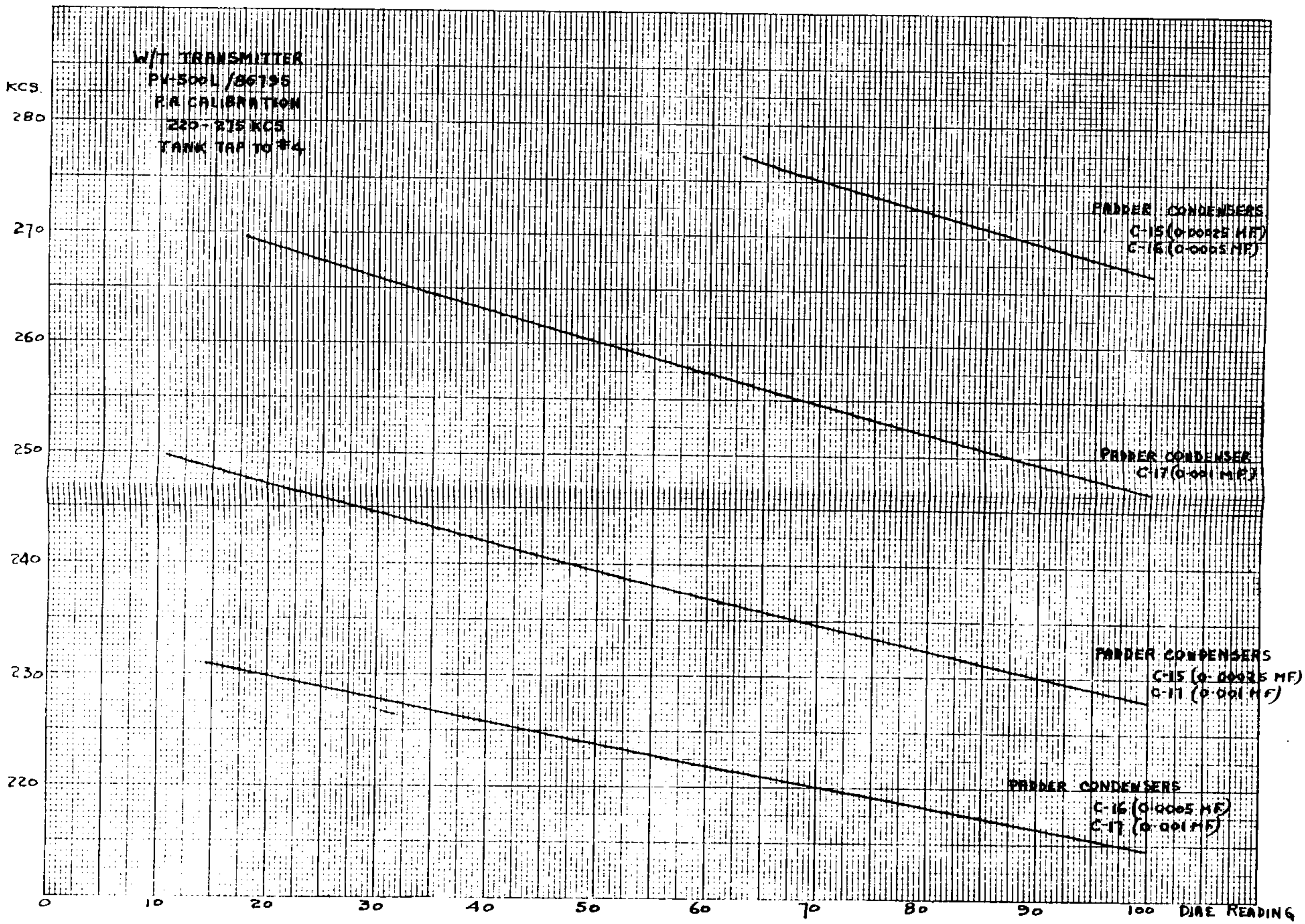

W/T TRANSMITTER
FV-500L/86795
PA CALIBRATION
148-185 KCS
TANK TAP TO #8
KCS
185
180
175
170
165
160
155
150
PADDER CONDENSERS
C-16 (0·0005 MF)
PADDER CONDENSERS
C-15 (0·00025 MF)
C-16 (0·0005 MF)
C-17 (0·001 MF)
PADDER CONDENSER
C-18 (0·002 MF)
PADDER CONDENSERS
C-15 (0·00025 MF)
PADDER CONDENSERS
C-16 (0·0005 MF)
C-18 (0·002 MF)
0
10
20
30
40
50
60
70
80
90
100 DIAL READING

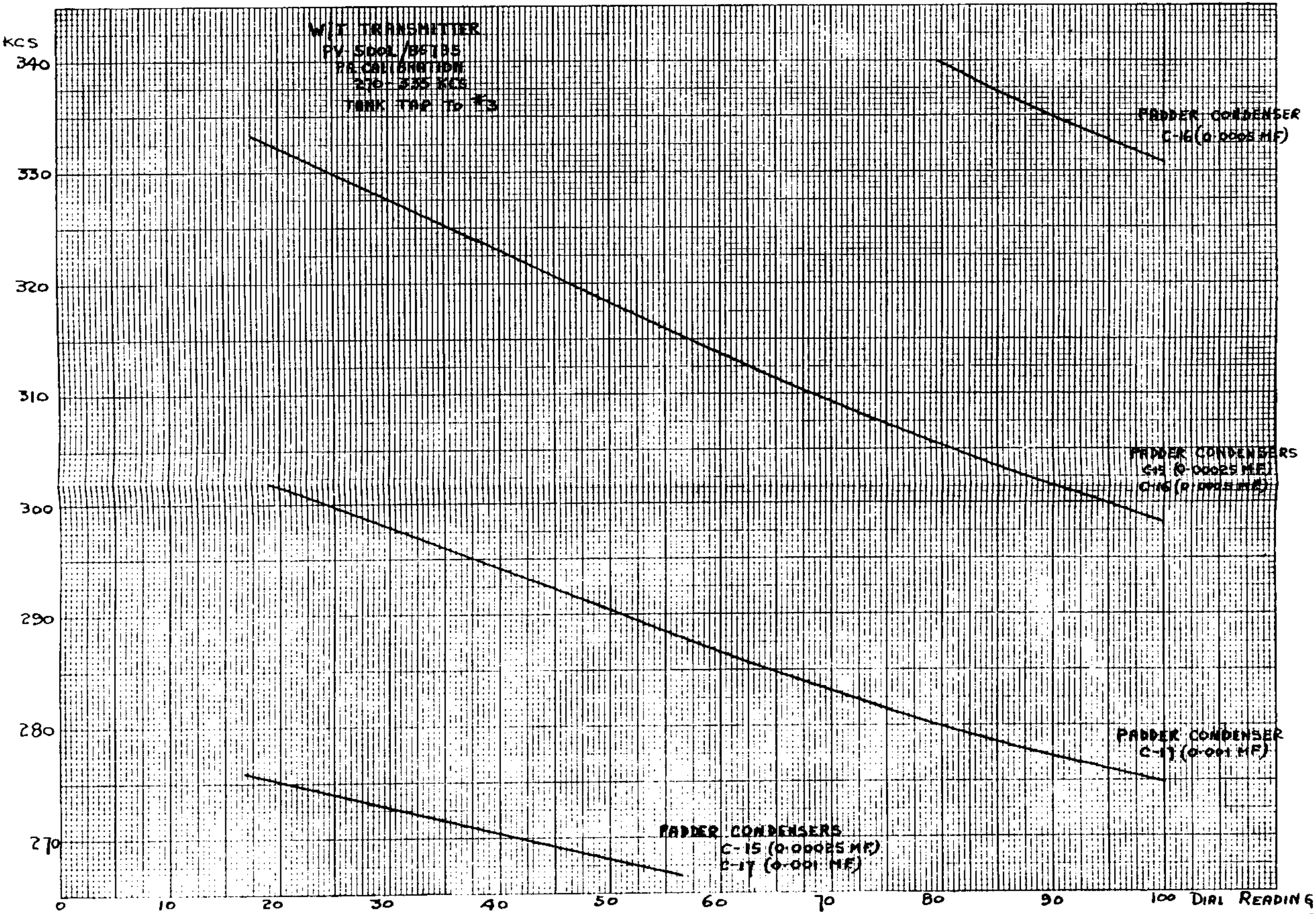
FIG.20


W/T TRANSMITTER
PV-500L/86795
PA CALIBRATION
180-225 KCS.
TANK TAP TO #5
KCS.
230
220
210
200
190
180
0
10
20
30
40
50
60
70
80
90
100 DIAL READING
PADDER CONDENSER
C-17 (0·001 MF)
PADDER CONDENSERS
C-15 (0·00025 MF)
C-17 (0·001 MF)
PADDER CONDENSERS
C-16 (0·0005 MF)
C-17 (0·001 MF)
PADDER CONDENSERS
C-15 (0·00025 MF)
C-16 (0·0005 MF)
C-17 (0·001 MF)
PADDER CONDENSER
C-18 (0·002 MF)
FIG. 21



W/T TRANSMITTER
PV-500L/86795
P.A CALIBRATION
220-275 KCS
TANK TAP TO #4
KCS.
280
270
260
250
240
230
220
PADDER CONDENSERS
C-15 (0.00025 MF)
C-16 (0.0005 MF)
PADDER CONDENSER
C-17 (0.001 MF)
PADDER CONDENSERS
C-15 (0.00025 MF)
C-17 (0.001 MF)
PADDER CONDENSERS
C-16 (0.0005 MF)
C-17 (0.001 MF)
0
10
20
30
40
50
60
70
80
90
100
DIAL READING

FIG 22



W/T TRANSMITTER
PV 500L/B6185
PA CALIBRATION
270-335 KCS
TANK TAP TO #3
KCS
340
330
320
310
300
290
280
270
0
10
20
30
40
50
60
70
80
90
100
DIAL READING
PADDER CONDENSER
C-16 (0.0005 MF)
PADDER CONDENSERS
C-15 (0.00025 MF)
C-16 (0.0005 MF)
PADDER CONDENSER
C-17 (0.001 MF)
PADDER CONDENSERS
C-15 (0.00025 MF)
C-17 (0.001 MF)

FIG. 23

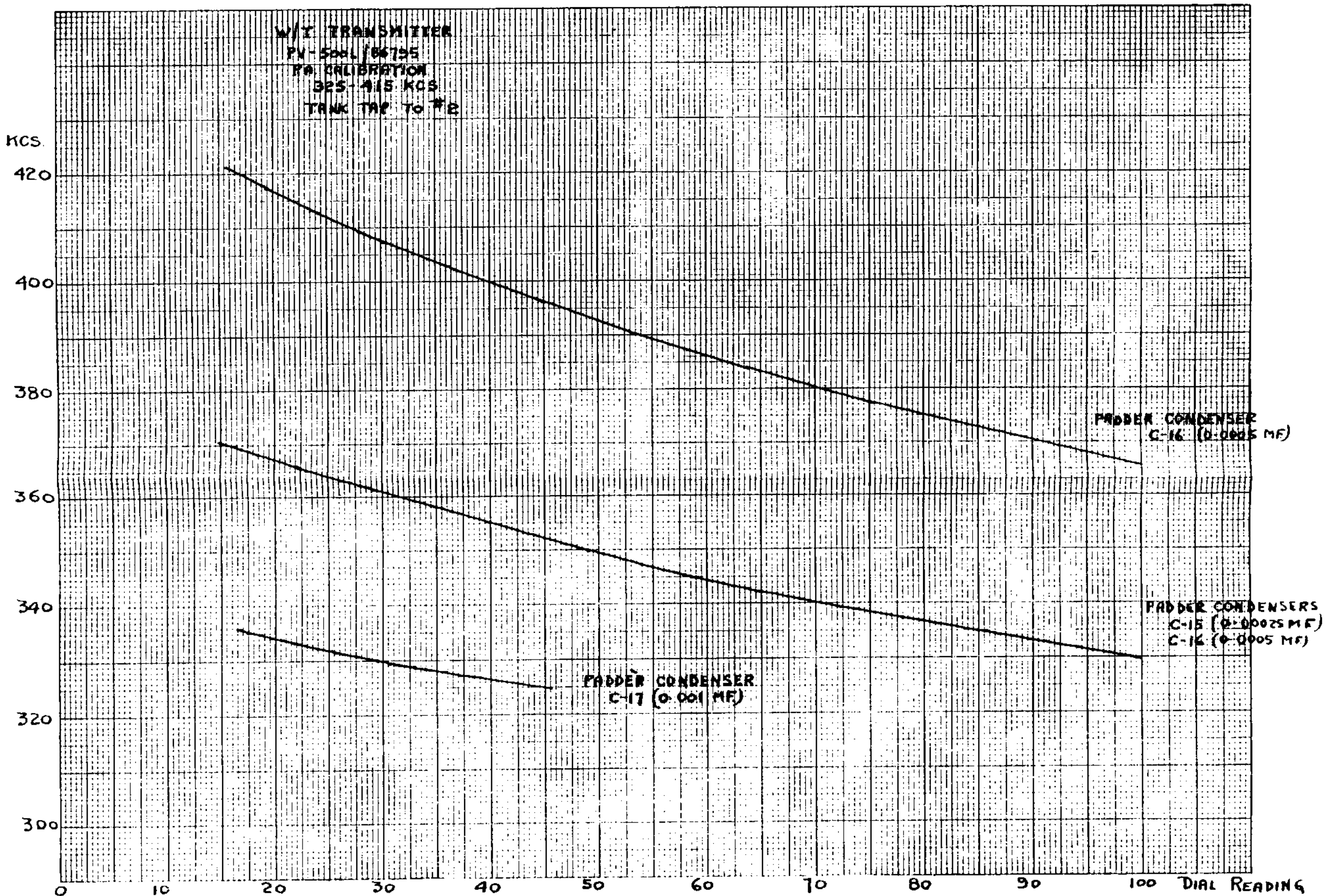
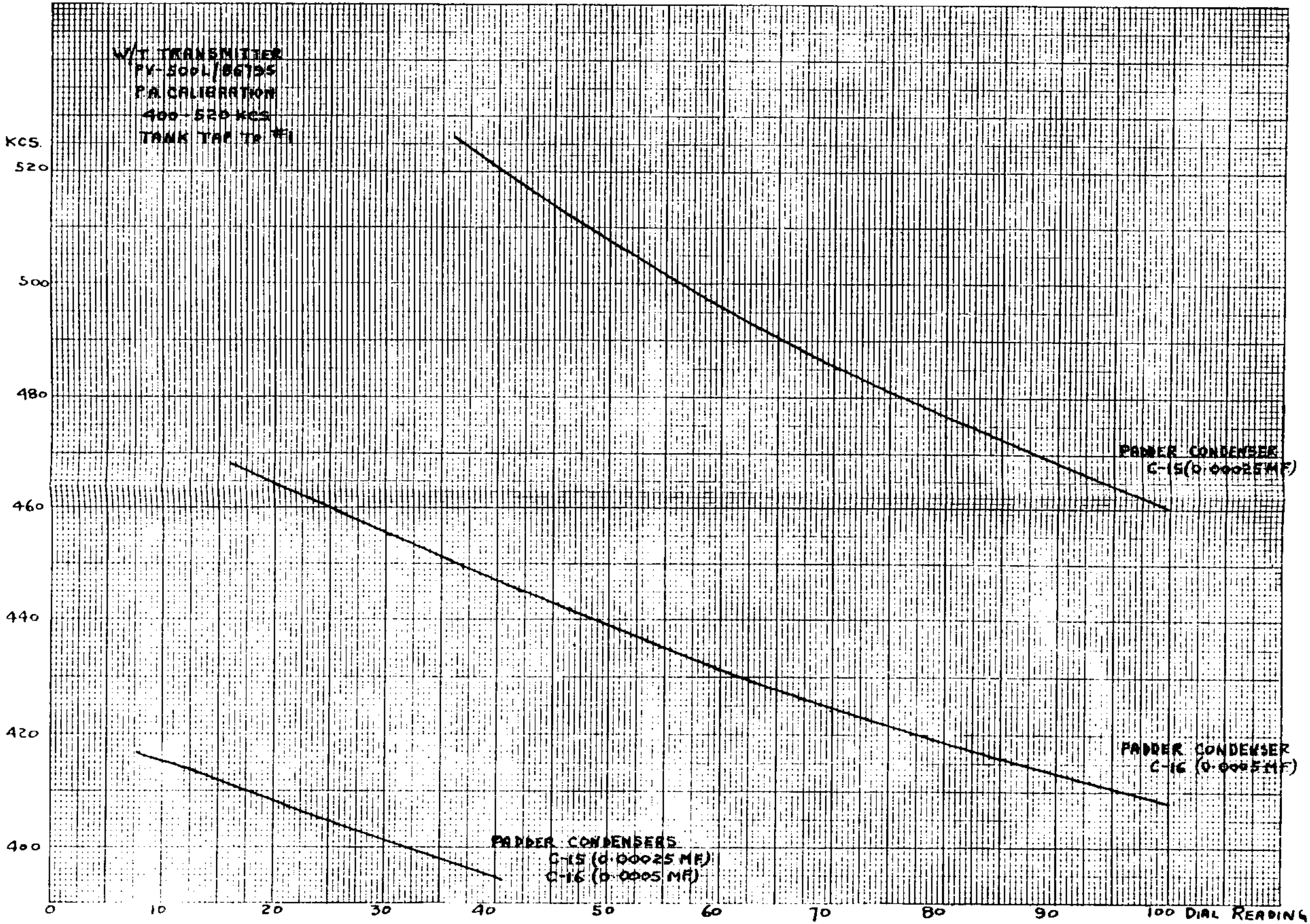
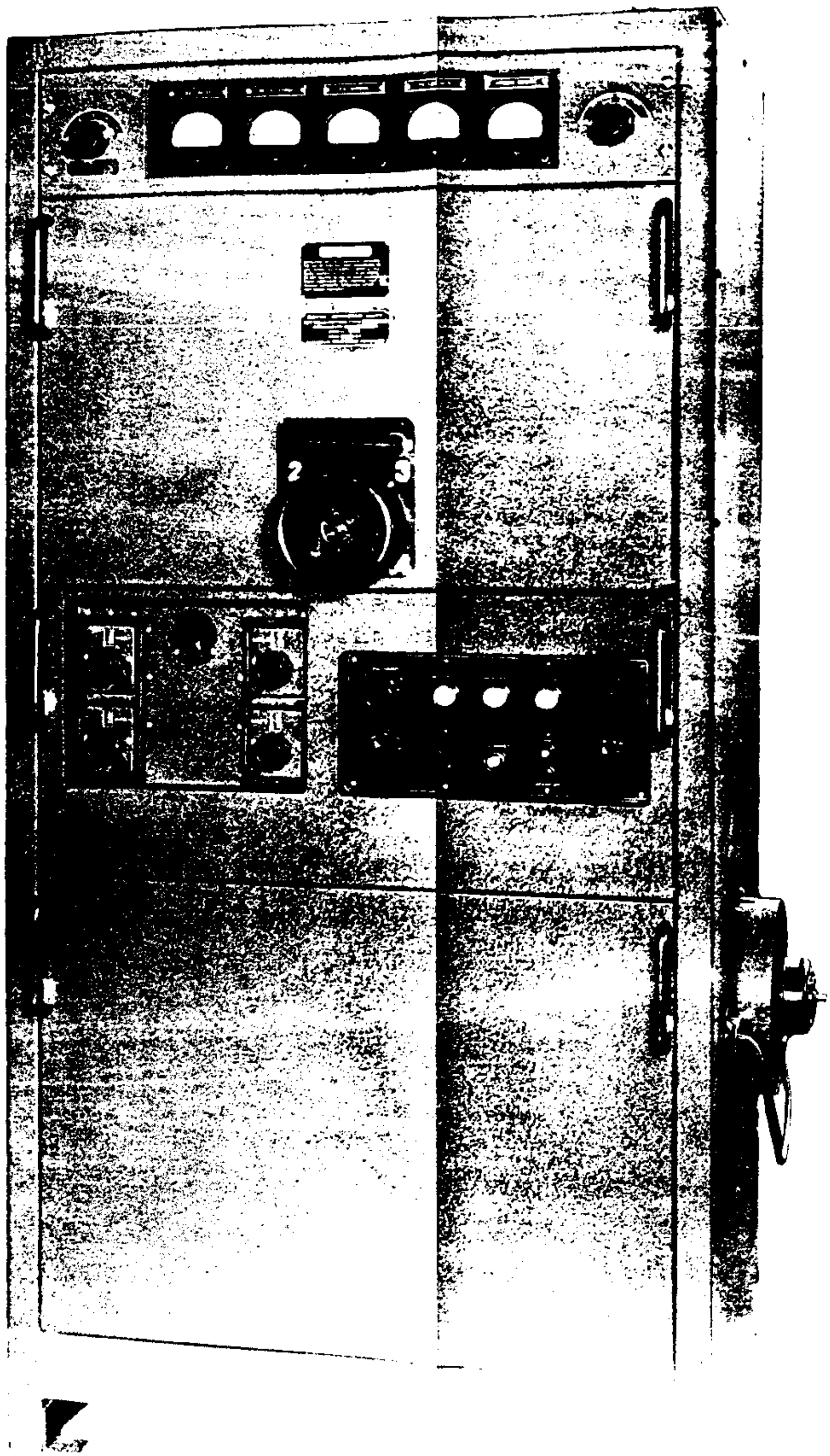

W/T TRANSMITTER
PV-500L/66795
PA CALIBRATION
325-415 KCS
TANK TAP TO #2
KCS.
420
400
380
360
340
320
300
PADDER CONDENSER
C-16 (0.0005 MF)
PADDER CONDENSERS
C-15 (0.00025 MF)
C-16 (0.0005 MF)
PADDER CONDENSER
C-17 (0.001 MF)
0
10
20
30
40
50
60
70
80
90
100
DIAL READING

FIG. 24


W/T TRANSMITTER
PV-500L/86795
P.A. CALIBRATION
400-520 KCS
TANK TAP To #1
KCS.
520
500
480
460
440
420
400
0
10
20
30
40
50
60
70
80
90
100 DIAL READING
PADDER CONDENSER
C-15 (0·00025 MF)
PADDER CONDENSER
C-16 (0·0005 MF)
PADDER CONDENSERS
C-15 (0·00025 MF)
C-16 (0·0005 MF)
FIG. 25

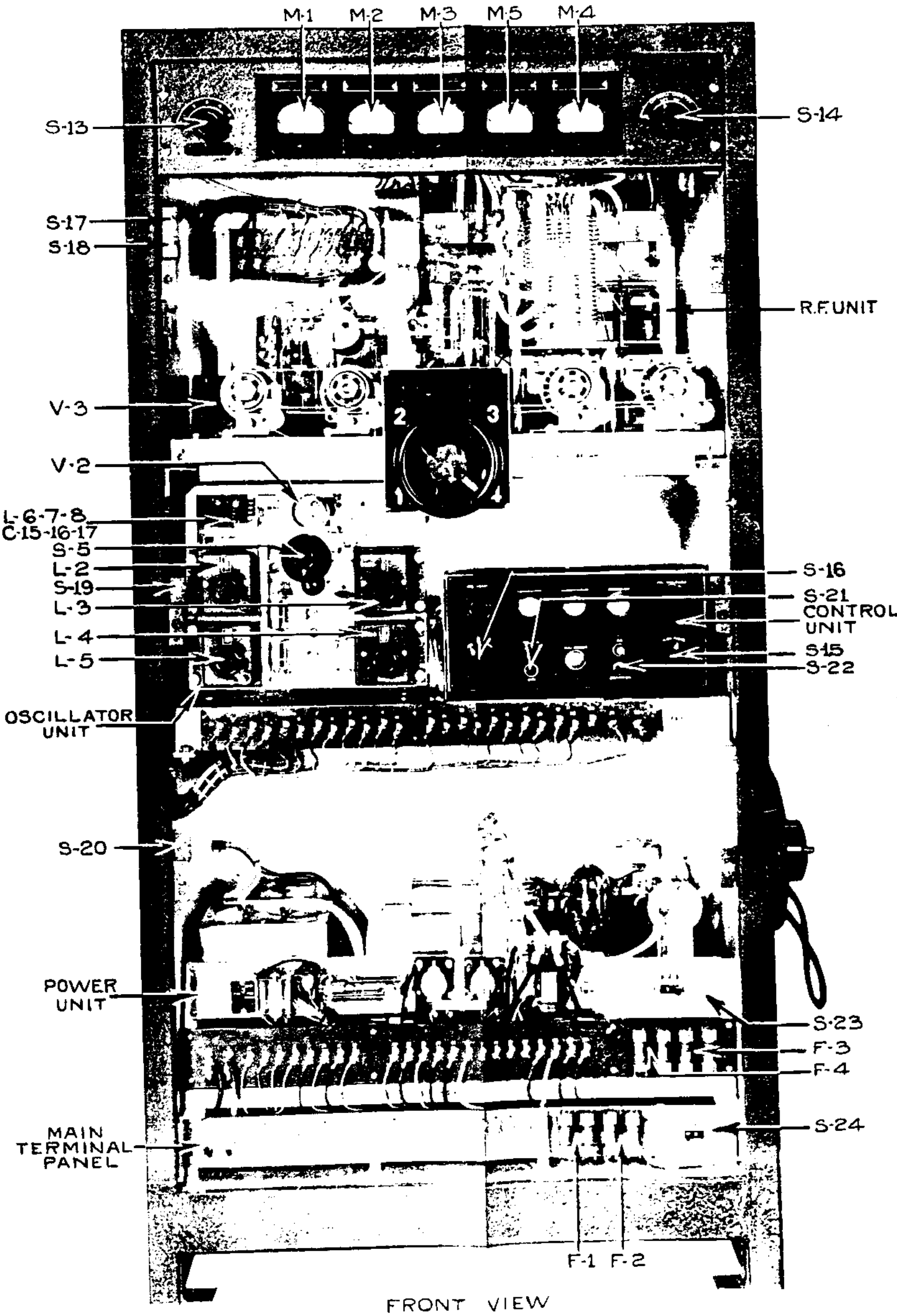
W/T TRANSMITTER
HIGH FREQUENCY TYPE PV-500H



FRONT VIEW

FIG. 26

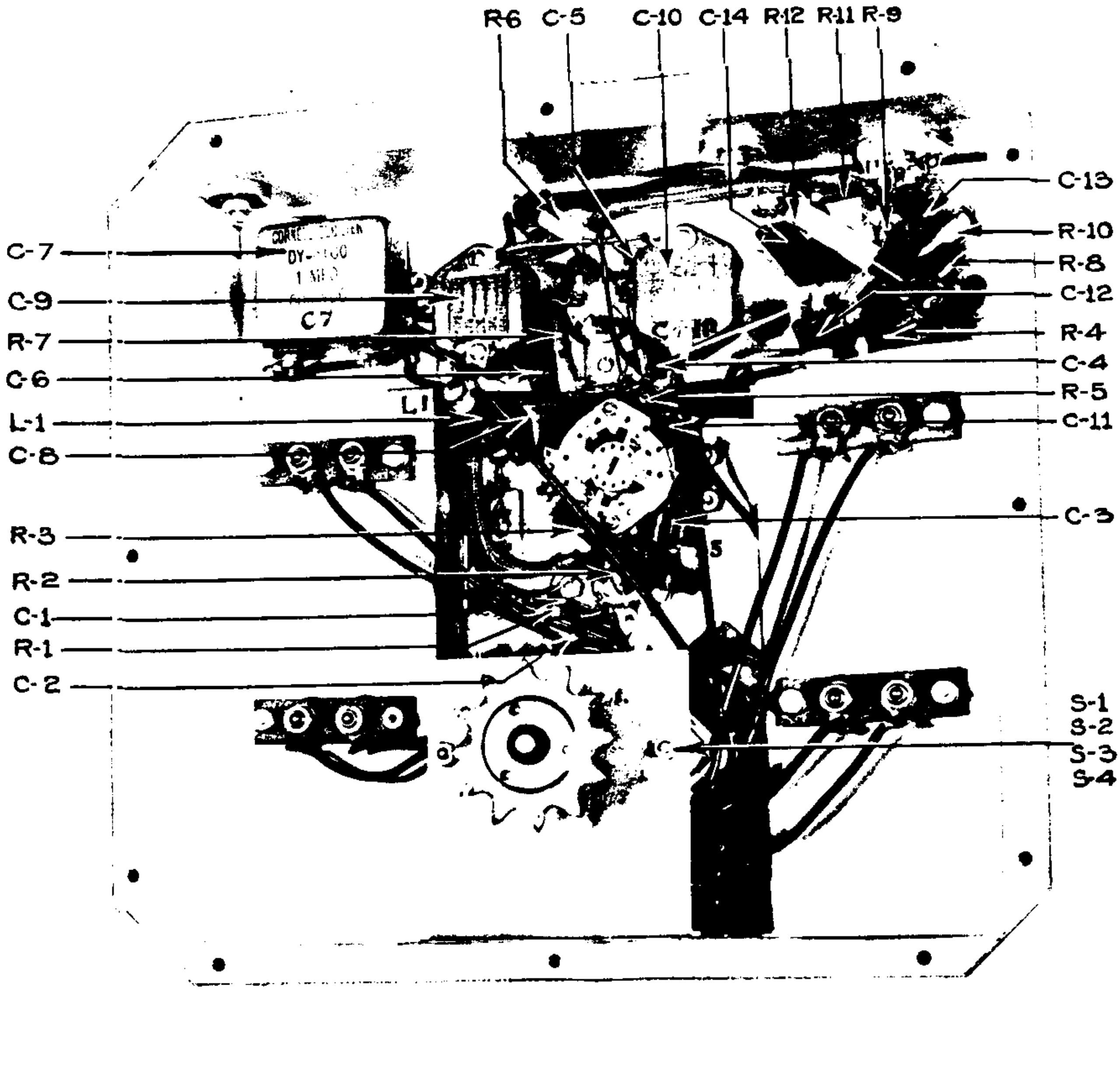
W/T TRANSMITTER
HIGH FREQUENCY TYPE PV-500H



FRONT VIEW
FRONT SHIELD REMOVED

FIG. 27

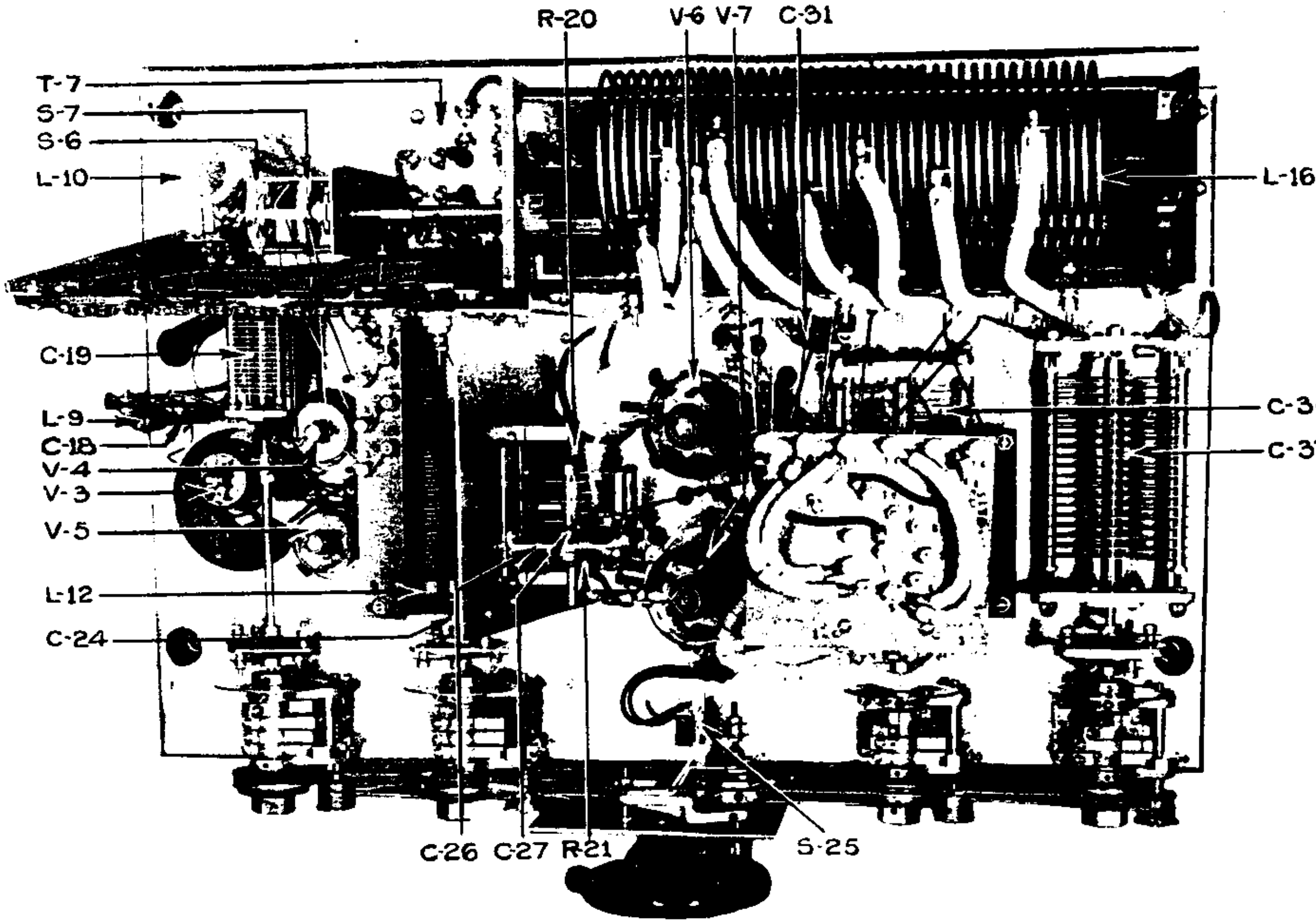
W/T TRANSMITTER
HIGH FREQUENCY TYPE PV-500H



MASTER OSCILLATOR
REAR VIEW

FIG. 28

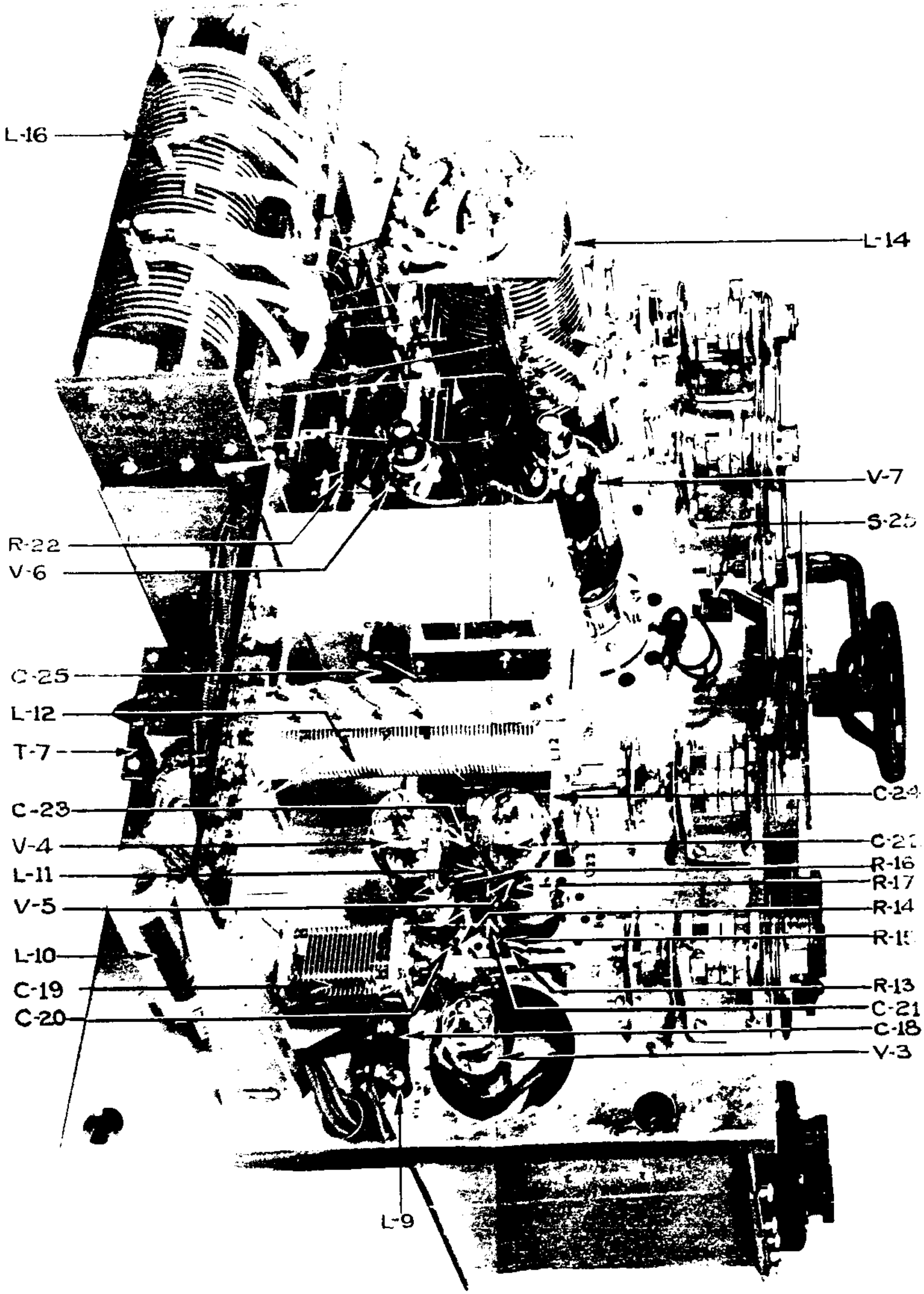
W/T TRANSMITTER
HIGH FREQUENCY TYPE PV-500H



R.F. SECTION
TOP VIEW

FIG.29

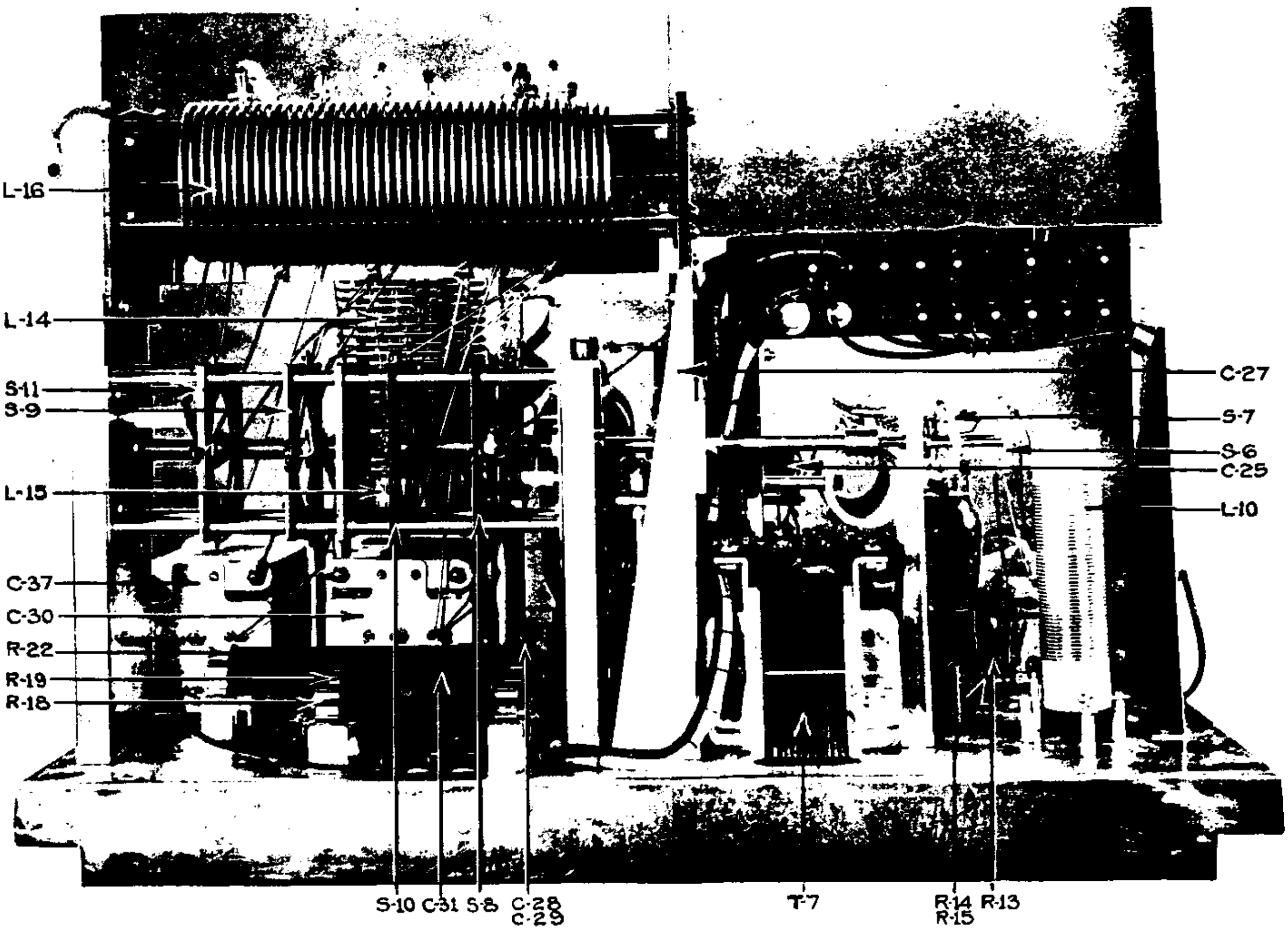
W/T TRANSMITTER
HIGH FREQUENCY TYPE PV-500H



R. F. SECTION
TOP VIEW

FIG. 30

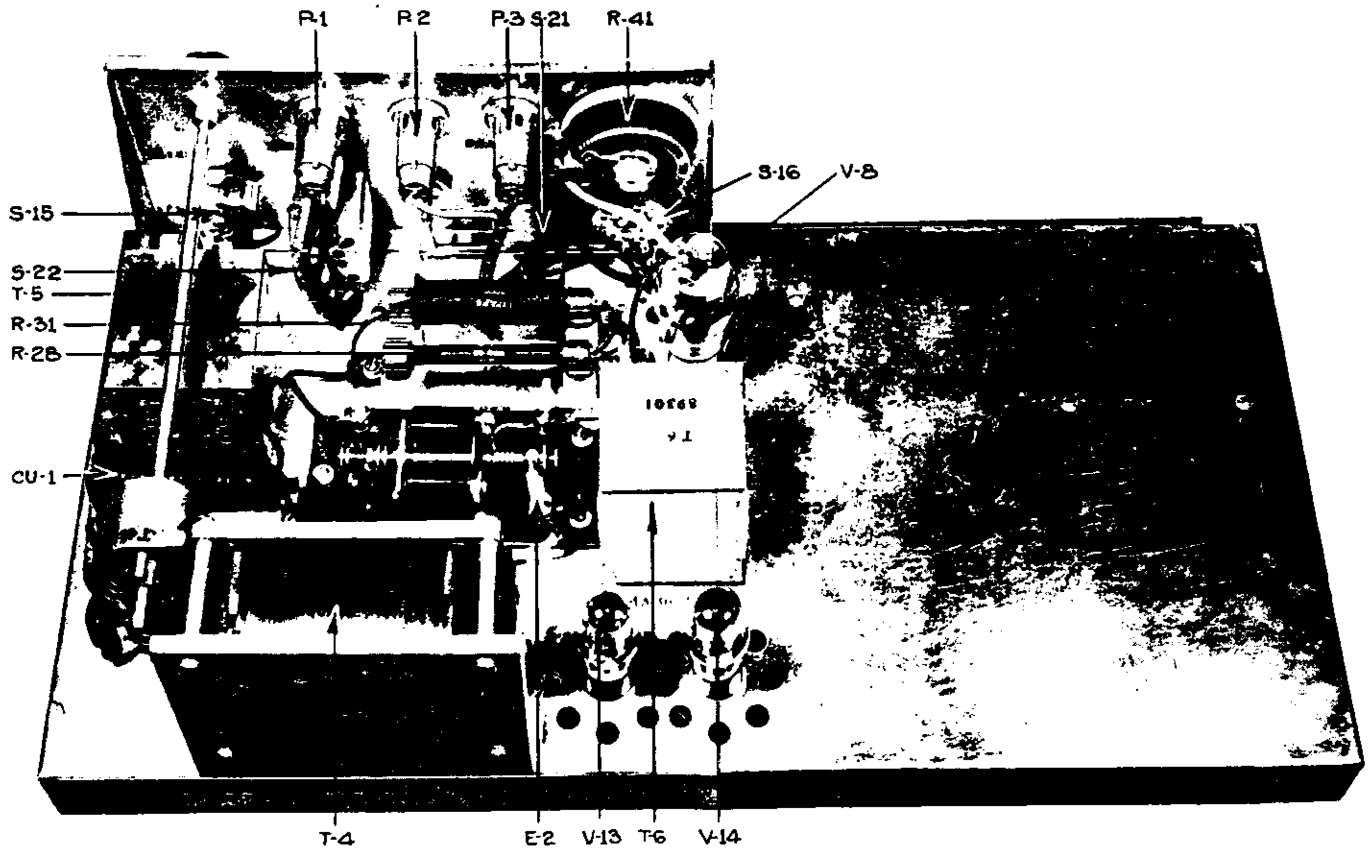
W/T TRANSMITTER
HIGH FREQUENCY TYPE PV 500H



R. F. SECTION
REAR VIEW

FIG. 31

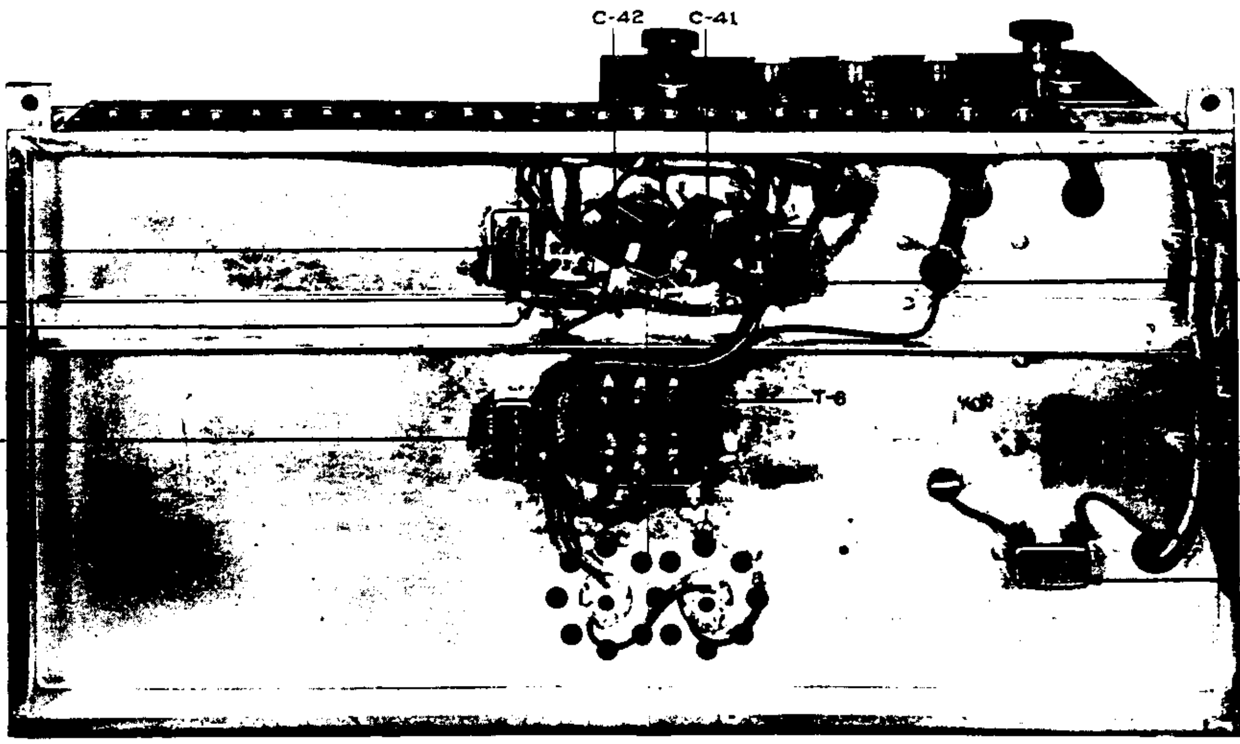
W/T TRANSMITTER
HIGH FREQUENCY TYPE PV-500H



CONTROL SECTION
TOP VIEW

FIG. 32

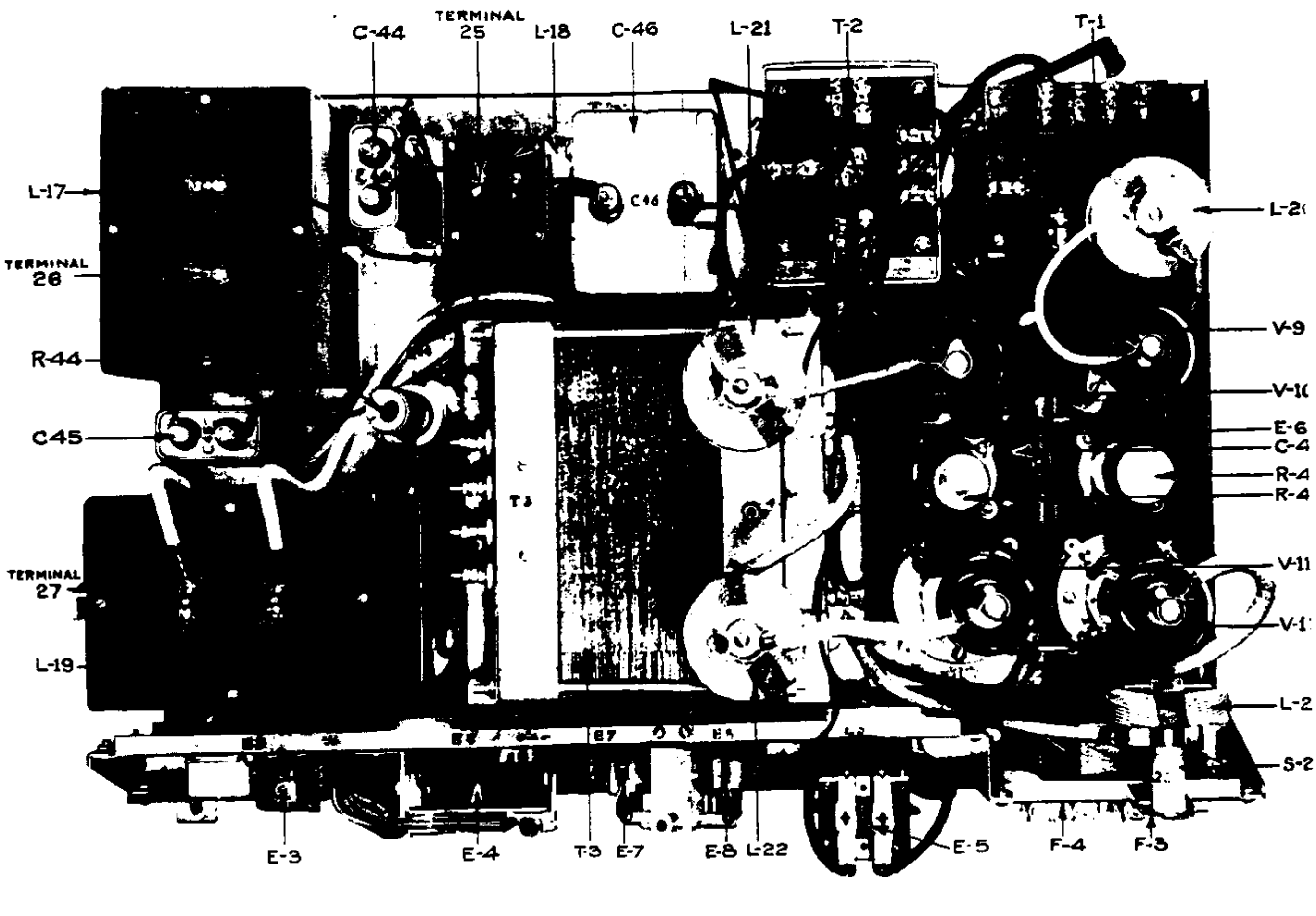
W/T TRANSMITTER
HIGH FREQUENCY TYPE PV-500H



CONTROL SECTION
BOTTOM VIEW

FIG. 33

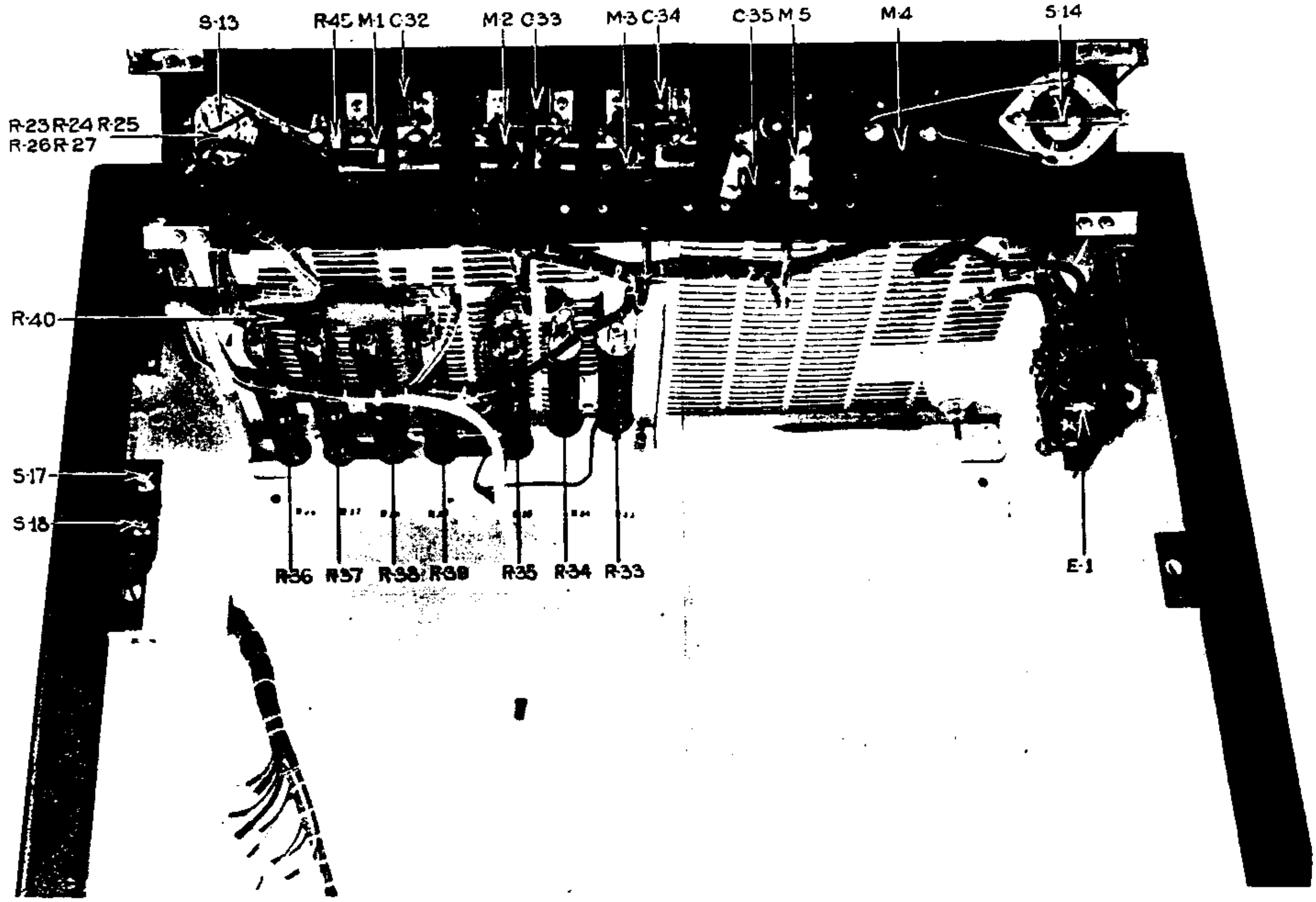
W/T TRANSMITTER
HIGH FREQUENCY TYPE PV-500H



POWER SECTION
TOP VIEW

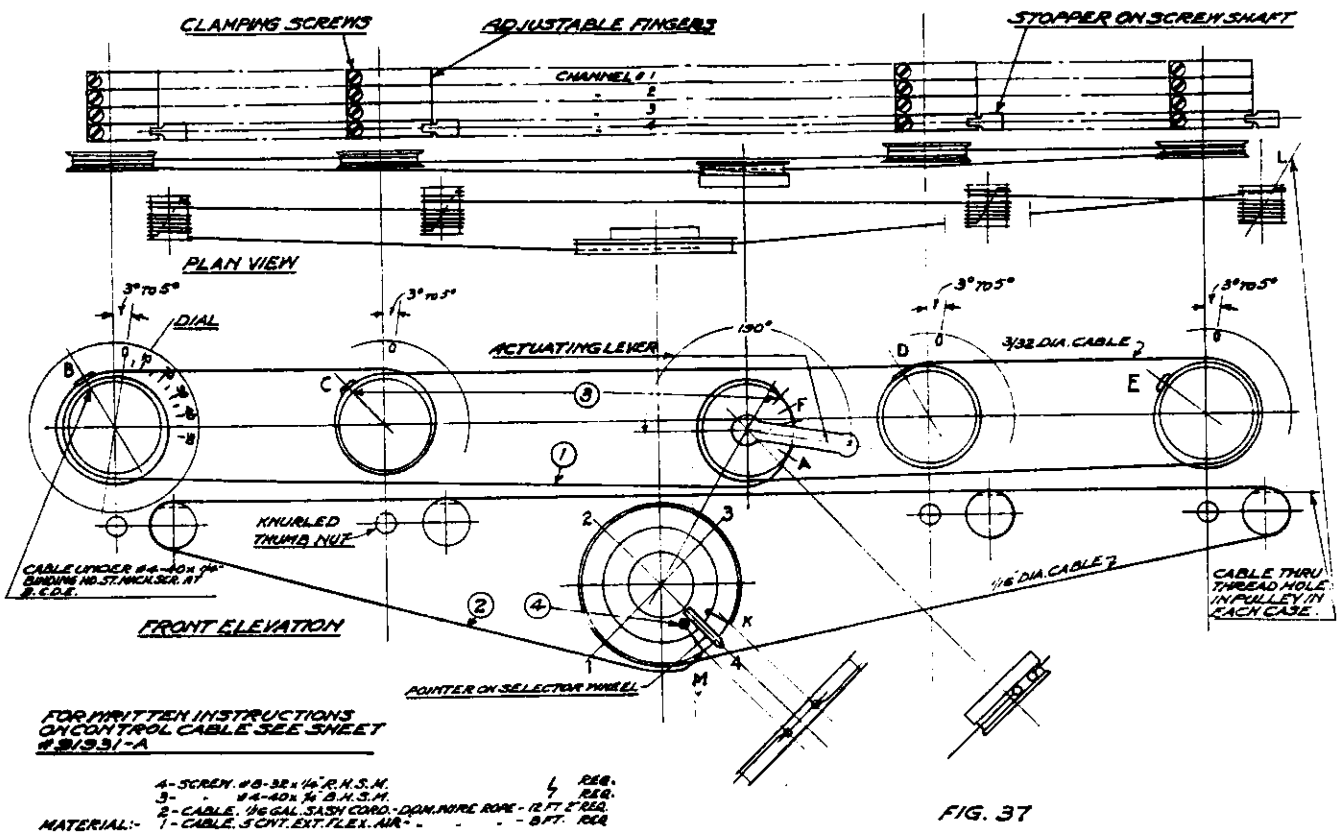
FIG.34

W/T TRANSMITTER
HIGH FREQUENCY TYPE PV500H



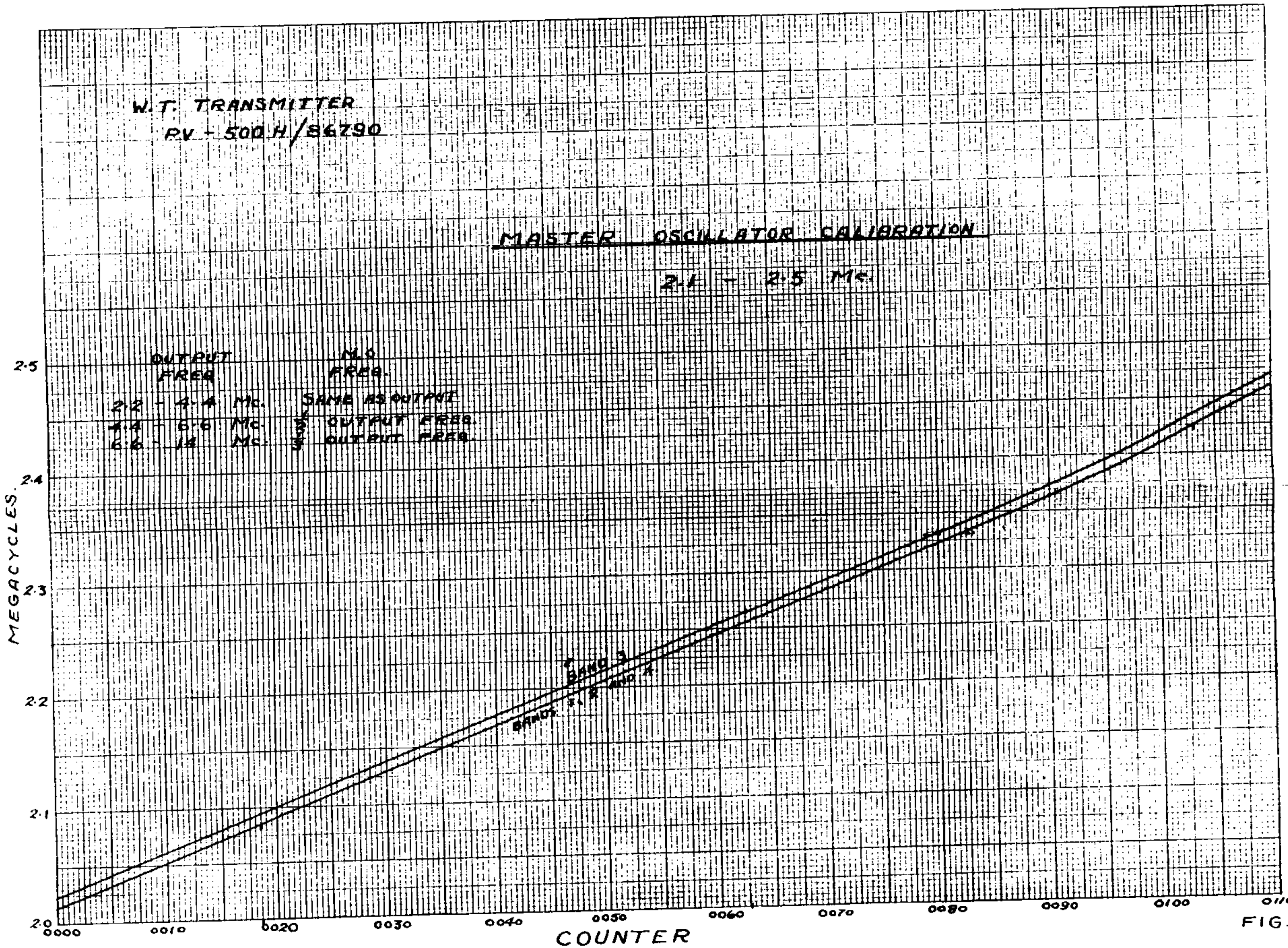
CABINET TOP INTERIOR

FIG. 35



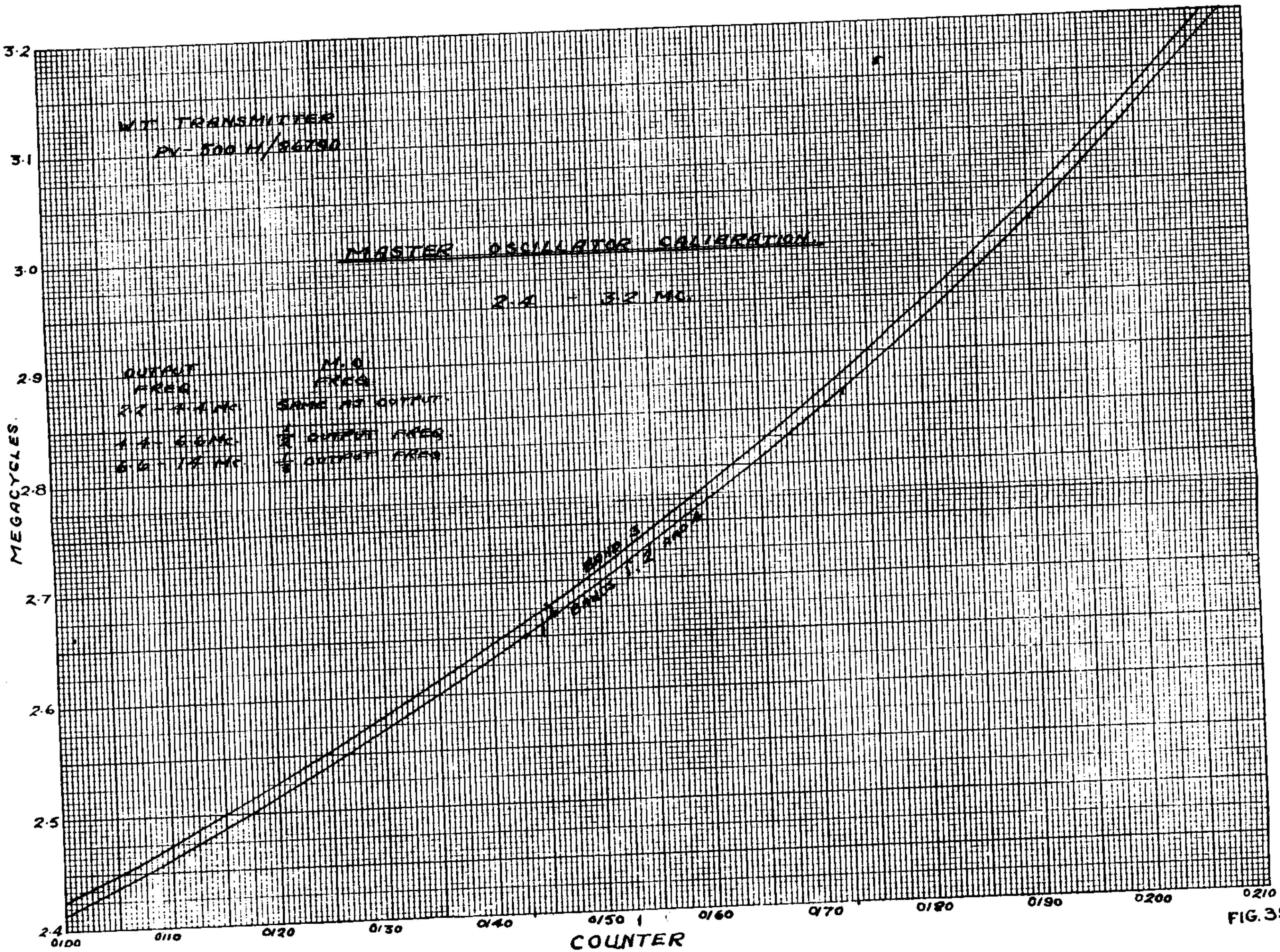
CLAMPING SCREWS
ADJUSTABLE FINGERS
STOPPER ON SCREW SHAFT
CHANNEL # 1
2
3
4
L
PLAN VIEW
3° TO 5°
DIAL
3° TO 5°
130°
ACTUATING LEVER
3° TO 5°
3/32 DIA. CABLE
3° TO 5°
B
C
3
F
D
E
A
1
KNURLED THUMB NUT
2
3
CABLE UNDER #4-40 x 1/4" BINDING HD. ST. MACH. SCR. AT B.C.D.E.
2
4
1/16 DIA. CABLE
K
CABLE THRU THREAD HOLE IN PULLEY IN EACH CASE.
FRONT ELEVATION
1
4
POINTER ON SELECTOR WHEEL
M
FOR WRITTEN INSTRUCTIONS ON CONTROL CABLE SEE SHEET #31331-A
4- SCREW. #8-32 x 1/4" R.H.S.M. 4 REQ.
3- " #4-40 x 1/4" B.H.S.M. 4 REQ.
2- CABLE. 1/16 GAL. SASH CORD.-DOM. WIRE ROPE - 12 FT. 2" REQ.
MATERIAL:- 1- CABLE. 5 CNT. EXT. FLEX. AIR - - - - 8 FT. REQ.

FIG. 37



W.T. TRANSMITTER
P.V - 500 H/86790
MASTER OSCILLATOR CALIBRATION
2.1 - 2.5 Mc.
OUTPUT FREQ
M.O FREQ.
2.2 - 4.4 Mc. SAME AS OUTPUT
4.4 - 6.6 Mc. ½ OUTPUT FREQ.
6.6 - 14 Mc. ⅓ OUTPUT FREQ.
BAND 3
BANDS 1, 2 AND 4
MEGACYCLES.
2.0
2.1
2.2
2.3
2.4
2.5
0000
0010
0020
0030
0040
0050
0060
0070
0080
0090
0100
0110
COUNTER

FIG. 38



W/T TRANSMITTER
PV-500 H/96790
MASTER OSCILLATOR CALIBRATION.
2.4 - 3.2 MC.
OUTPUT FREQ.
M.O. FREQ.
2.2 - 4.4 MC. SAME AS OUTPUT
4.4 - 6.6 MC. ½ OUTPUT FREQ.
6.6 - 14 MC. ¼ OUTPUT FREQ.
BAND 3
BANDS 1, 2 AND 4
MEGACYCLES
3.2
3.1
3.0
2.9
2.8
2.7
2.6
2.5
2.4
COUNTER
0100
0110
0120
0130
0140
0150
0160
0170
0180
0190
0200
0210

FIG. 39

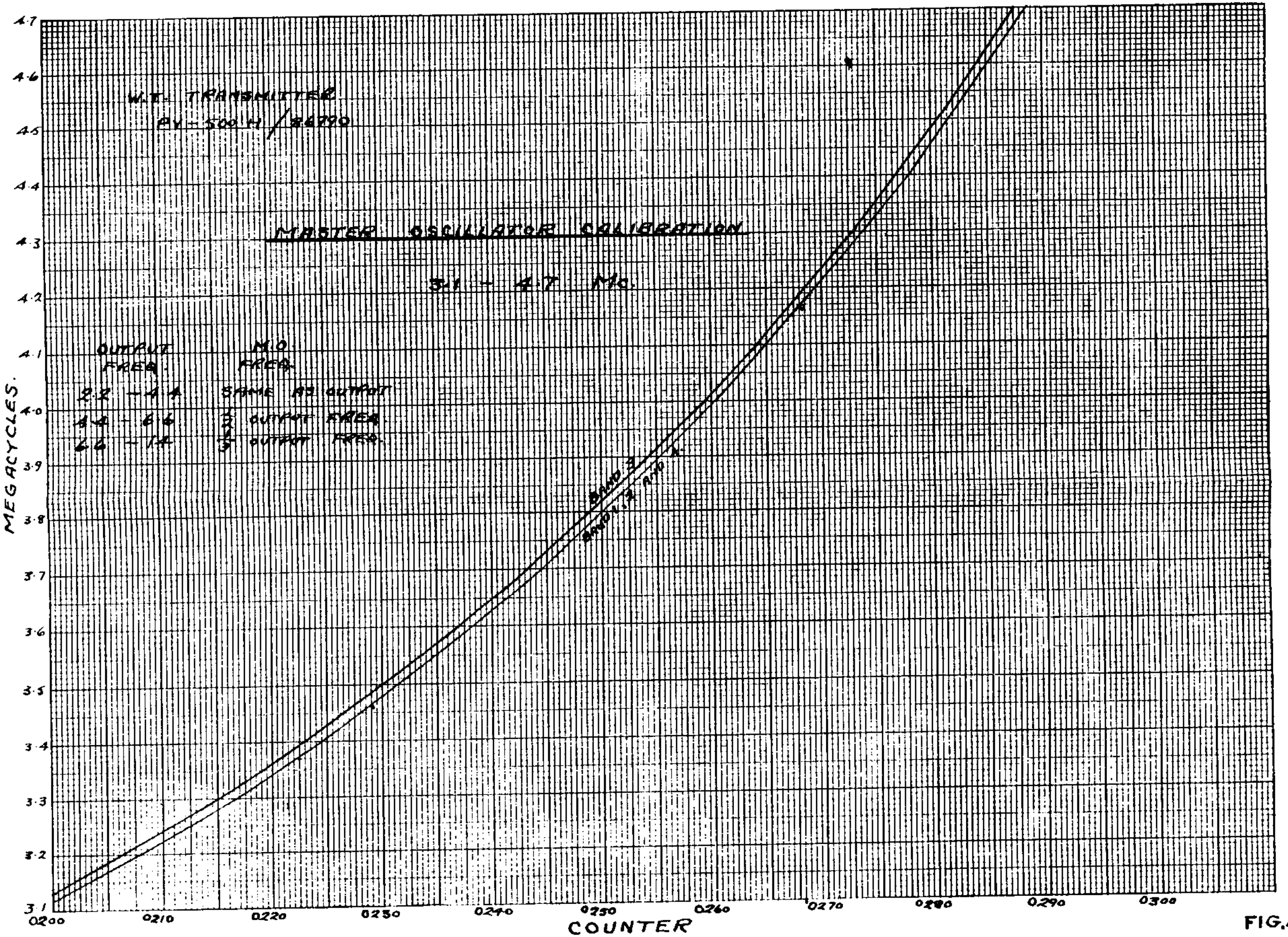
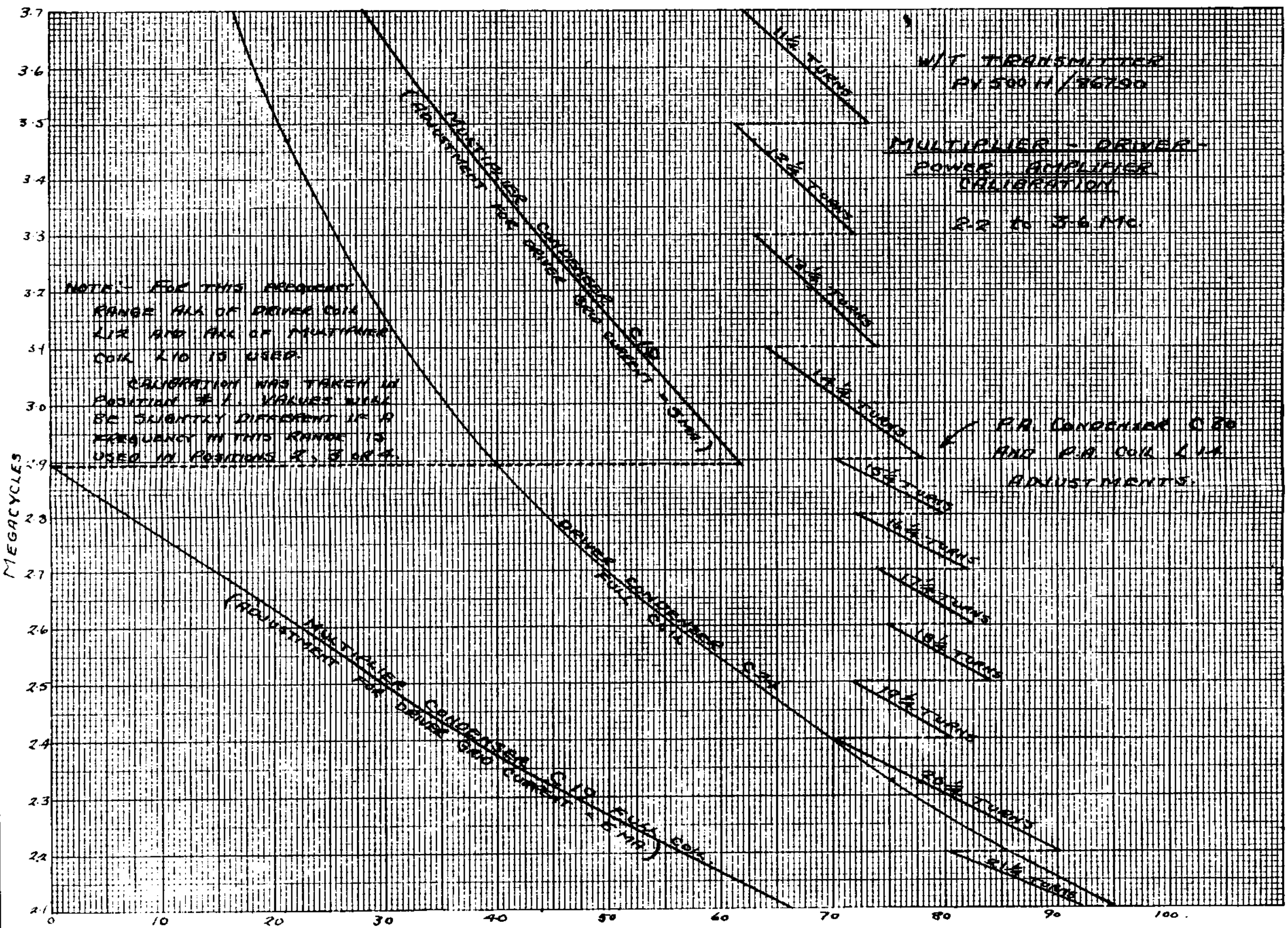

W.T. TRANSMITTER
PV-500 H / 86790
MASTER OSCILLATOR CALIBRATION
3.1 - 4.7 Mc.
OUTPUT FREQ.
M.O. FREQ.
2.2 - 4.4 SAME AS OUTPUT
4.4 - 6.6 ½ OUTPUT FREQ.
6.6 - 14 ⅓ OUTPUT FREQ.
BAND 3
BAND 1, 2 AND 4
MEGACYCLES.
4.7
4.6
4.5
4.4
4.3
4.2
4.1
4.0
3.9
3.8
3.7
3.6
3.5
3.4
3.3
3.2
3.1
0.200
0.210
0.220
0.230
0.240
0.250
0.260
0.270
0.280
0.290
0.300
COUNTER

FIG.40



W/T TRANSMITTER
PV 500 H/36790
MULTIPLIER - DRIVER - POWER AMPLIFIER CALIBRATION.
2.2 to 3.6 Mc.
P.A. CONDENSER C 30 AND P.A. COIL L 14 ADJUSTMENTS.
11½ TURNS
12¼ TURNS
13¼ TURNS
14¼ TURNS
15¼ TURNS
16¼ TURNS
17¼ TURNS
18¼ TURNS
19¼ TURNS
20¼ TURNS
21¼ TURNS
MULTIPLIER CONDENSER C 10 (ADJUSTMENT FOR DRIVER GRID CURRENT = 3 MA.)
DRIVER CONDENSER C 24 FULL COIL
MULTIPLIER CONDENSER C 10 FULL COIL (ADJUSTMENT FOR DRIVER GRID CURRENT = 5 MA.)
NOTE:- FOR THIS FREQUENCY RANGE ALL OF DRIVER COIL L 17 AND ALL OF MULTIPLIER COIL L 10 IS USED.
CALIBRATION WAS TAKEN IN POSITION #1. VALUES WILL BE SLIGHTLY DIFFERENT IF A FREQUENCY IN THIS RANGE IS USED IN POSITIONS 2, 3 OR 4.
MEGACYCLES
3.7
3.6
3.5
3.4
3.3
3.2
3.1
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
0
10
20
30
40
50
60
70
80
90
100.

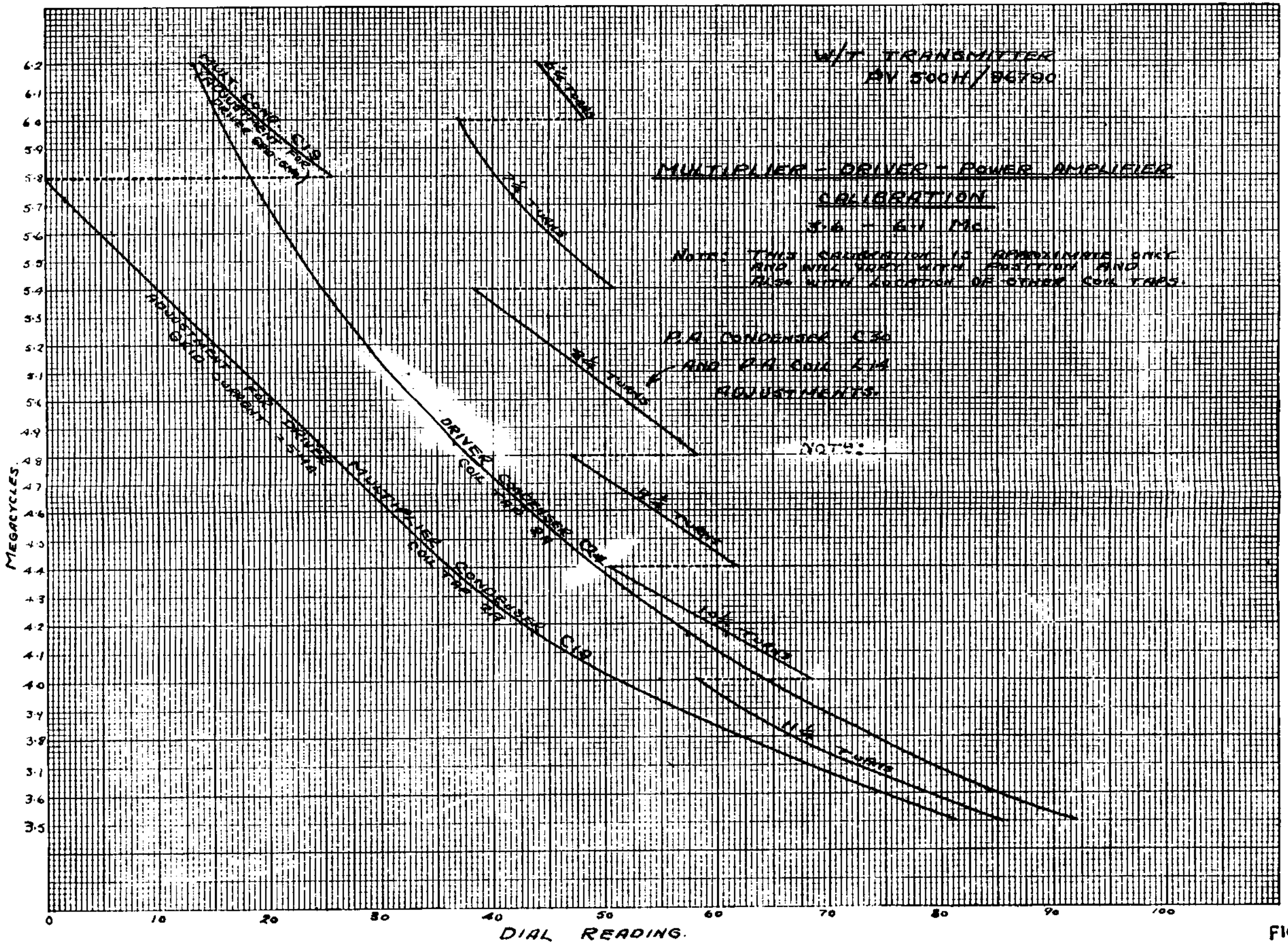

W/T TRANSMITTER
AV 500H/84790
MULTIPLIER - DRIVER - POWER AMPLIFIER
CALIBRATION
3.6 - 6.1 Mc.
NOTE: THIS CALIBRATION IS APPROXIMATE ONLY AND WILL VARY WITH POSITION AND ALSO WITH LOCATION OF OTHER COIL TAPS.
P.A. CONDENSER C30 AND P.A. COIL L14 ADJUSTMENTS.
DRIVER CONDENSER C24
MULTIPLIER CONDENSER C18
ADJUSTMENT FOR DRIVER GRID CURRENT = 5 MA
MEGACYCLES
DIAL READING

FIG.42

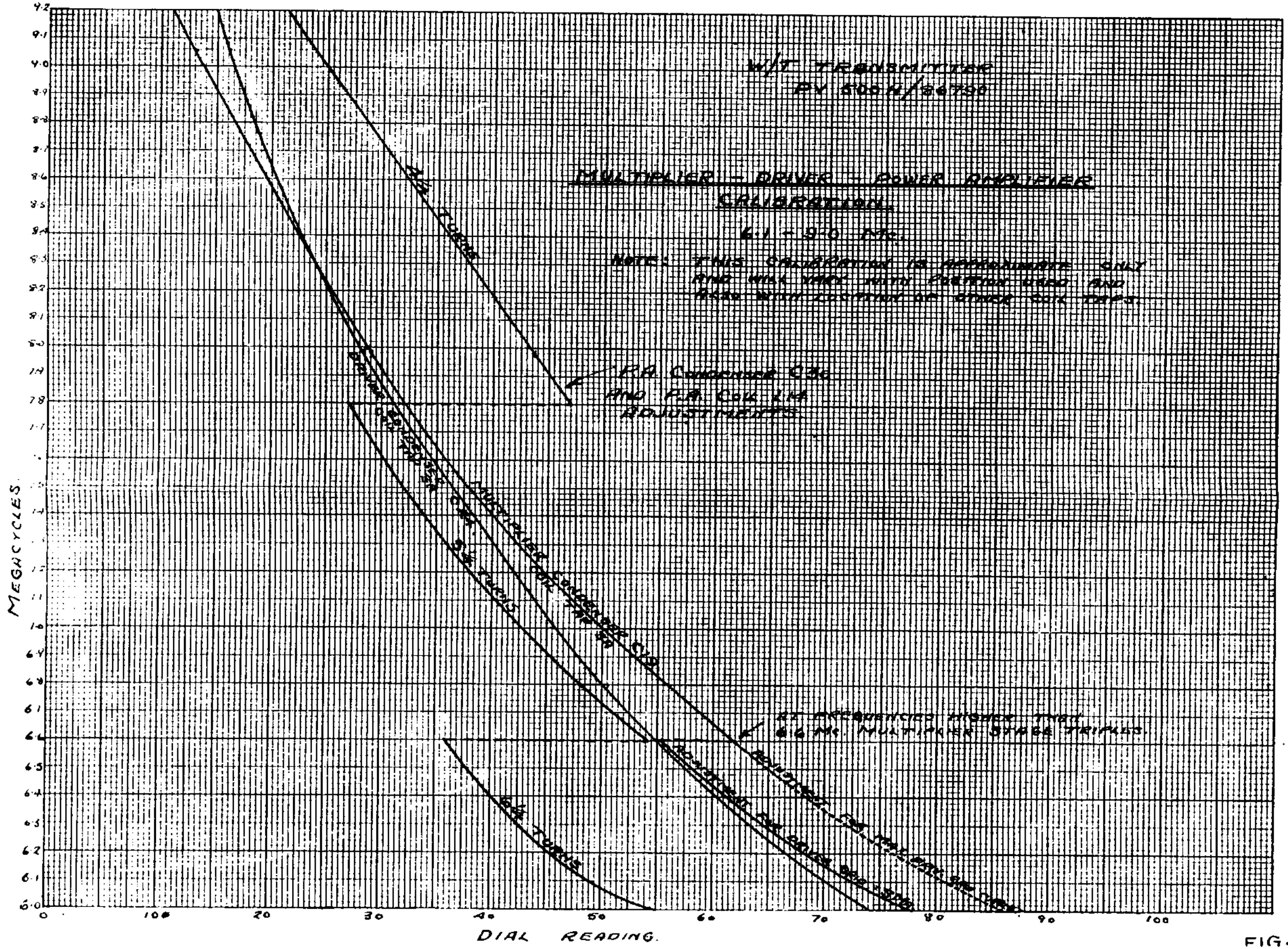

W/T TRANSMITTER
PV 500 N/86790
MULTIPLIER - DRIVER - POWER AMPLIFIER
CALIBRATION.
6.1 - 9.0 MC.
4½ TURNS
P.A. CONDENSER C36
AND P.A. COIL L14
ADJUSTMENTS
5½ TURNS
6¼ TURNS
MEGACYCLES
DIAL READING.

FIG 43

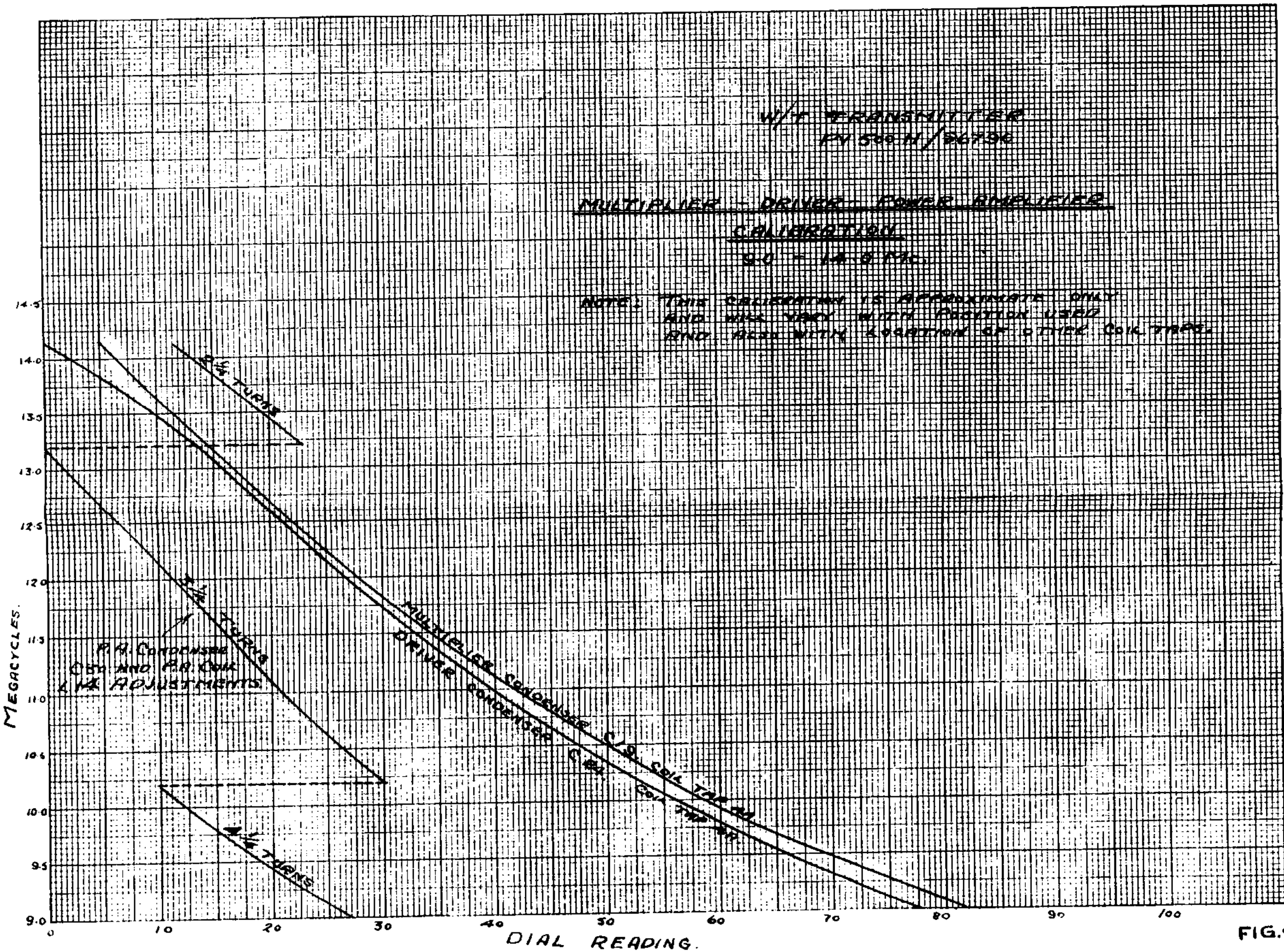
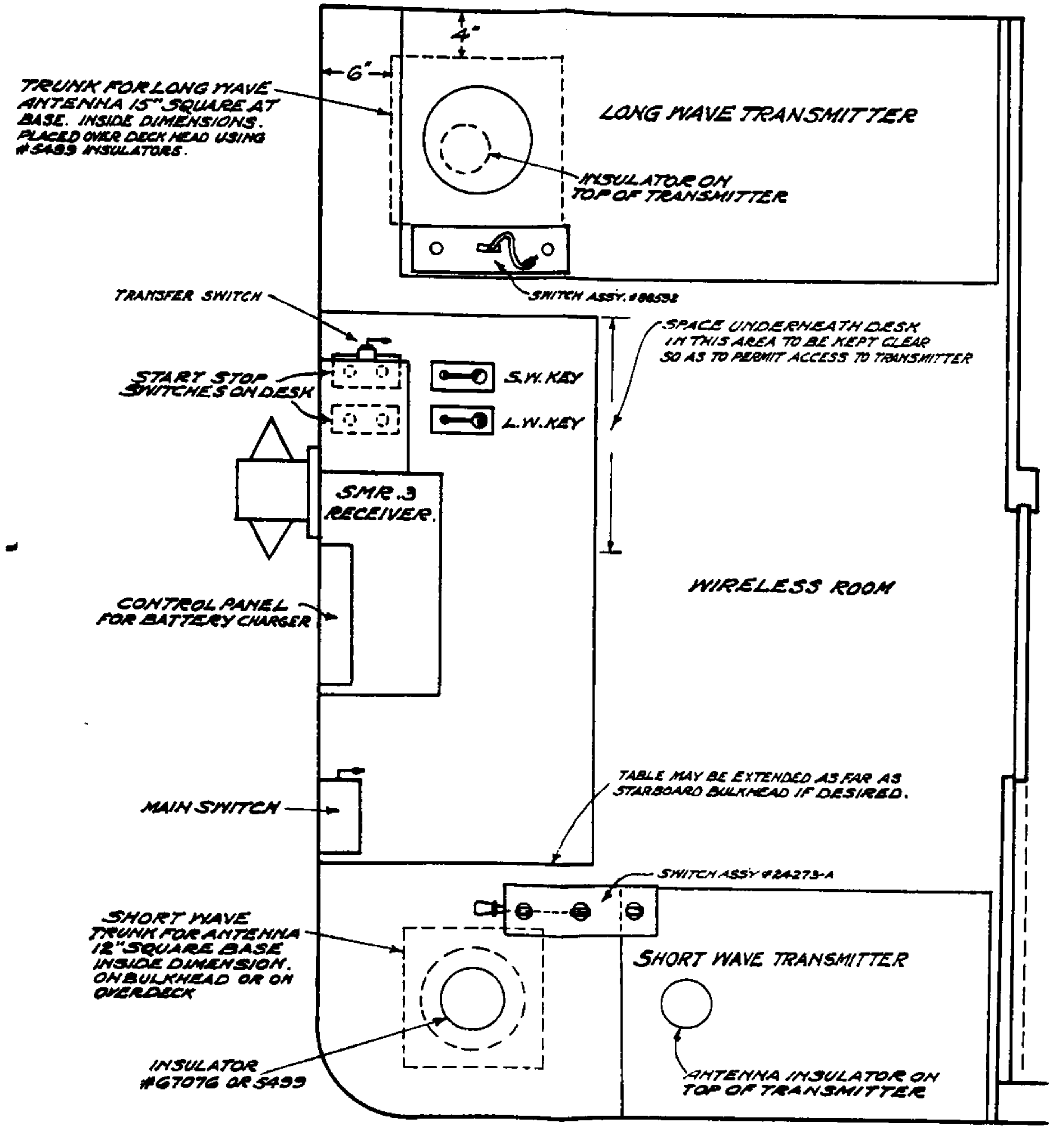
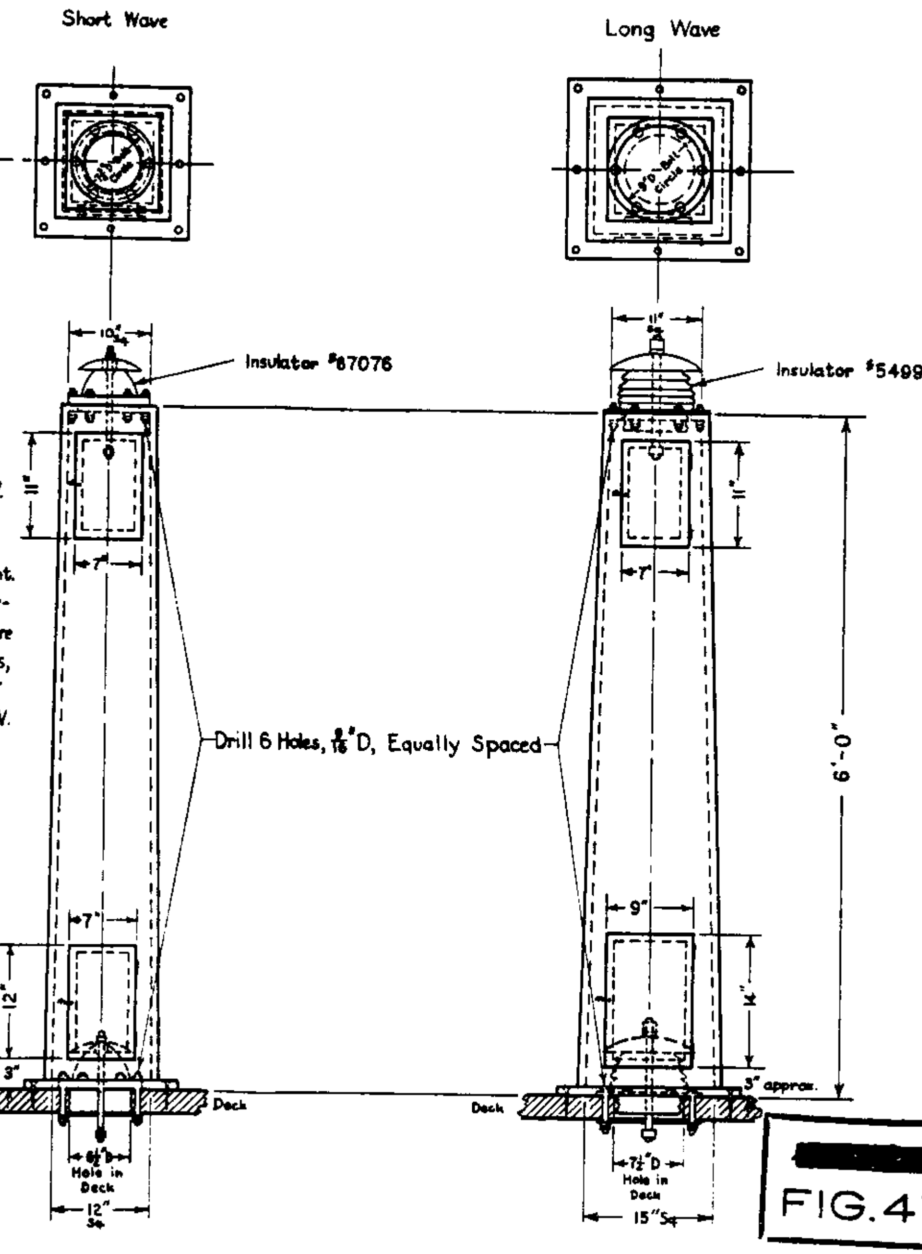

W/T TRANSMITTER
MULTIPLIER – DRIVER – POWER AMPLIFIER
CALIBRATION
9.0 – 14.5 Mc.
NOTE: THIS CALIBRATION IS APPROXIMATE ONLY
AND WILL VARY WITH POSITION USED
AND ALSO WITH LOCATION OF OTHER COIL TAPS.
MULTIPLIER CONDENSER
DRIVER CONDENSER
TURNS
R.A. CONDENSER
AND R.A. COIL
ADJUSTMENTS
MEGACYCLES.
14.5
14.0
13.5
13.0
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
0
10
20
30
40
50
60
70
80
90
100
DIAL READING.

FIG.44



PROPOSED
DECK LAYOUT FOR MINESWEEPER EQUIPMENT
CANADIAN NAVAL SERVICE.

Notes: Drilling for Short W. corresponds to #67076 insulator. If #5499 insulator employed, drill as for L.W.
L. W. trunk is that approximately over ℄ of ship; S.W. trunk is on starboard side. Doors to face front.
Trunks to be of wood and watertight. If not watertight a ½" square scupper is to be provided on 2 sides, at the base. Both trunks may, if desired, be constructed as for L.W.



VARIATIONS ON FINISHED DIMENSIONS UNLESS OTHERWISE MARKED		
BASIC DIMENSIONS	FRACTIONAL DIMENSIONS	DECIMAL DIMENSIONS
Up to 1/2	± 1/128	± .005
Above 1/2 to 6	± 1/64	± .008
Above 6 to 24	± 1/32	± .010
Above 24	± 1/16	± .015

[redacted]

FIG.47

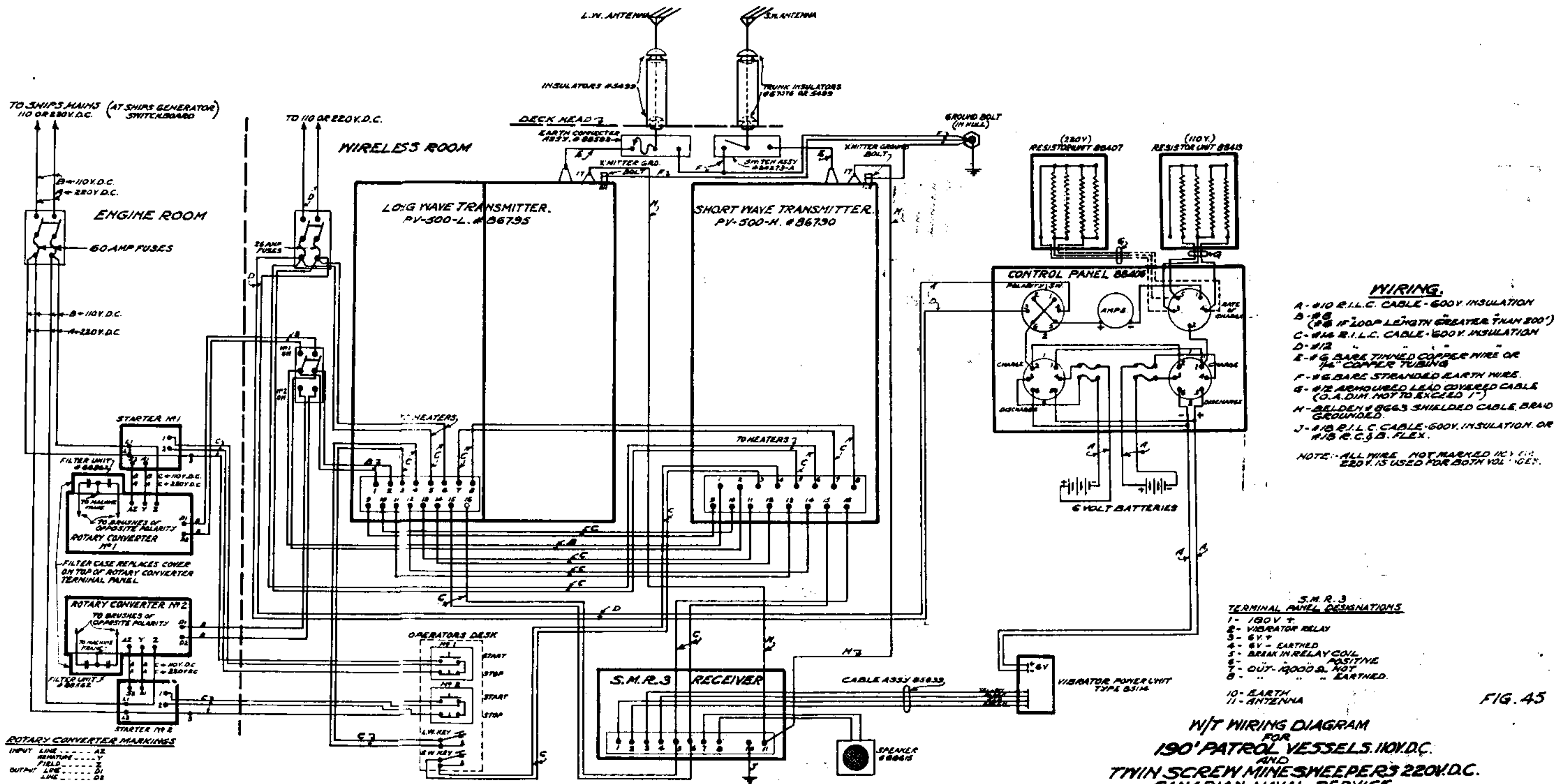


FIG. 45

W/T WIRING DIAGRAM
FOR
190' PATROL VESSELS. 110V.D.C.
AND
TWIN SCREW MINESWEEPERS 220V.D.C.
CANADIAN NAVAL SERVICE