EC Mark I

Technical Manual

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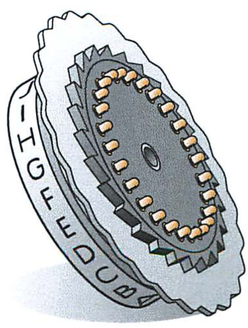
Project Easy Chair



T E C H N I C A L   M A N U A L

CONTENTS

THE TRANSMITTER

General

The circuit diagram is given in figs. 1 and 2. The transmitter circuit proper consists of a tuned-plate-tuned-grid oscillator exciting another tube as an amplifier which in turn excites the antenna at a power level of at least 30 Watts maximum.

Mechanical vibrations of tube elements, tuned circuits and the cover give rise to a certain amount of microphony which is intolerable for this specific application. Therefore an anti-microphony-circuit has been included which removes any amplitude modulation (microphony, hum) to a substantial degree from the carrier. This circuit can be regarded as a r.f.-a.f. negative feedback system.

The power supply delivers all voltages needed for the transmitter and associated circuits.

A number of switching and monitoring facilities are included.

Description of circuits

The oscillator of the transmitter is of the tuned-plate-tuned-grid variety. The double-tetrode oscillator tube V_1 has built-in neutralizing capacitors which means that external feedback capacitors C_4 and C_5 between anode and grid of each tetrode have to be provided. These capacitors consist of two pieces of metal strip, soldered to the grid connections on the ceramic socket, and running parallel to the anodes inside the tube.
The oscillator grid circuit is essentially an electrical half wave line, open at both ends. The neutral electrical midpoint is quite close to the grid connection on the socket. The internal leads to the grids and the capacitance of these grids to the surrounding electrodes form an electrical quarterwave line on one side of the neutral point. External metal strips and a splitstator capacitor C_1 form the electrical quarterwave line on the other side of the neutral point. The tuning of this whole circuit is accomplished by varying the value of the compression-type teflon-insulated split-stator capacitor C_1.

The oscillator tube V_1 is self-biased by its grid current which during oscillation flows through the 47.000 ohms resistors R_1 and R_2 between each grid and the common cathode.

The anode circuit of the oscillator tube V_1 is galvanically and electrically common to the grid circuit of the amplifier tube V_2. In this way only one tuned circuit was necessary as a coupling element and the difficulty of coupling capacitors was eliminated. The amplifier grid circuit is tapped down on the oscillator anode circuit. As the generated frequency is governed largely by the oscillator anode circuit the coupling with the amplifier grids is chosen such that the loading by the amplifier grids is not too heavy and that a possible resonance of the amplifier grid circuit is not in the vicinity of the oscillator frequency.

The bias of the amplifier is supplied by a voltage drop over a resistor R_4 through which the anode current of the oscillator is flowing. This anode current is fairly constant in value due to the stabilizing effect of a high series resistor R_3 in the oscillator screen grid supply lead, even in a non-oscillating condition.

The anode circuit of the amplifier again consists of an electrical half-wave line, at one end terminated in a split-stator teflon-insulated variable tuning capacitor C_{11} of the compression-type.

H.T. is supplied by a pair of r.f. chokes connected at or nearly at the electrical neutral points along the lines.

R.f. power is taken out by a coupling loop to the r.f. output plug P_1. A 50 ohms load will provide an optimum match.

R.f. power output is controlled by the screen grid voltage of the amplifier, which voltage is controlled by the anti-microphony circuit.

The anti-microphony-circuit begins with a pick-up loop, coupled to the transmitter output circuit, which feeds a silicon crystal rectifier. The rectified output contains all amplitude-modulated components of the carrier. This a.m. information is amplified in two successive stages and injected on the screen grid voltage of the r.f. amplifier V_2 in such a polarity that the initial amplitude modulation is counteracted and thus decreased by about 25 to 35 decibels. The output tube V_4 of the antimicrophony circuit is connected as a d.c. and a.c.

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shunt across the screen grid of the r.f. amplifier V_2, the positiveoperating voltage being derived from a resistor R_{12} between screen-grid and + 500 Volts line.

The average operating current of the anti-microphony output tube V_4 is variable by means of a variable cathode resistor R_{10}. Varying this resistor (marked "output" on the front panel) changes the screen grid voltage of the r.f. amplifier V_2 and thus the r.f. output of the transmitter.

In the vicinity of both oscillator and amplifier anode circuits a small incandescent lamp is mounted, which by means of a pick-up probe receives sufficient r.f. energy to light up when normal r.f. energy levels are present in the circuits mentioned. The temperature rise of the filaments causes their d.c. resistance to increase. In test switch positions 1 and 3 these filaments are connected as d.c. shunts across the test meter M_1 through which a d.c. current is flowing due to the presence of resistors R_9, R_{10} and R_{11} connected between one meter terminal and the + 500 Volts line. The deflection of the test meter is therefore dependent on the d.c. resistance of the filament, which in turn depends on the r.f. energy being dissipated in the filament and gives an indication of the r.f. voltage at the r.f. tuning circuits being monitored. Adjusting these circuits to maximum meter deflection means therefore tuning these circuits to maximum r.f. voltage.

The power supply delivers two separate 6.3 Volts voltages for the filaments of the oscillator and for the filaments of the amplifier, anti-microphony circuit and pilot lamps. The filament supply for the oscillator is at a -500 Volts level, the filament supply for the amplifier is at ground level.

The H.T. is again split up in a negative and a positive 500 Volts supply, each being obtained from a separate winding on the power transformer T_1, a full wave bridge rectifier and a smoothing circuit, consisting of a π-filter with one choke and two capacitors. Each capacitor is made up of two series connected electrolytic condensers to meet the safe working voltage requirements of these condensers. Shunt resistors across these capacitors preserve the right voltage division across them.

A H.T. switch S_1 and fuses F_1 and F_2 are inserted in the transformer-to-rectifier leads.

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Indication of the H.T."on" position is obtained by a red pilot lamp P_1, which is fed from the second 6.3 Volts voltage via a resistor R_{13}, which pilot lamp is short-circuited in the "off" position of the H.T.-switch. This way of switching "on" and "off" the pilot lamp was necessary because of a shortage of switching contacts on the H.T. switch S_1.

The amplifier anode current is indicated by the test meter M_1 when the test switch S_2 is in position 2, in which case the meter is connected across a shunt resistor R_{12} in series with the negative lead of the +500 Volts rectifier SR_2. In fact the meter indicates the sum of anode current of the r.f. amplifier, screen grid current of the r.f. amplifier, anode current of the anti-microphony circuit and the current drawn by the power-monitor circuits. The full-scale value of the meter is 200 mA.

Indication of the "fil.on" position is obtained by direct connection of a green pilot lamp P_2 across the second 6.3 Volts supply.

The switch S_4 marked "fil" makes or breaks the connection between primary of the power transformer and mains. A fuse F_3 is incorporated.

The primary of the transformer is made up of two equal windings for 110 Volts each, which can be switched in parallel or in series for operation from a 110 Volts or a 220 Volts power line. The switching is done by a slightly recessed tumbler switch S_3 which is located at the back of the cabinet near the power line input connection.

Supply wires on the transmitter chassis are decoupled for radio frequencies with capacitors and r.f. chokes. The r.f. chokes are made up of about 7 inches of enamelled wire, the gauge depending on the current to be passed and/or the size which can be accommodated.

Peculiarities of the circuits used

A few unusual circuit details, which in itself will not present any major difficulty, will be made clear to facilitate any maintenance or servicing of the equipment.

The galvanical coupling between oscillator and amplifier has the consequence of rather unexpected d.c. voltages on a number of points. The cathode and grid circuit of the oscillator have a potential of about -550 Volts with respect to chassis and proper care should be taken to avoid accidental touching of these parts.

The oscillator grid circuit tuning should not be adjusted exactly for maximum test meter deflection on test position 1. A more stable adjustment is reached when the oscillator grid circuit is tuned slightly lower in frequency than the anode circuit.

Therefore it is advised in the operating manual to tune for maximum meter reading and then to turn the tuning rod for about one eighth of a turn clockwise. Due to some feedback from amplifier anode circuit to amplifier grid circuit it is advised also to decrease the amplifier output during this adjustment to the minimum value. This feedback may vary somewhat for different tubes because of the inherent assymmetry of these tubes, but will not be serious enough to cause instability. This feedback also makes it desirable to adjust the frequency of the amplifier anode circuit under a condition of decreased though not minimum output from the amplifier.

The ultimate frequency generated by the transmitter after proper adjustment is governed by the tuning circuit between oscillator and amplifier. This circuit has no tuning facilities but the frequency can be changed by changing the insertion depth of the oscillator anode pins in the anode clips.

The power monitors are non-linear in such a way that especially in the upper half of the test meter scale gradual limiting occurs which causes a decrease of differential sensivity. On the lower half of the meter scale the response time of the filaments is longer. For tuning a compromise is found at about two thirds of full scale deflection. The r.f. power absorbed by the filaments under normal conditions can be adjusted to this point by bending the pick-up probes of the power monitor closer to or farther away from the tuned circuit.

The perforated cover is indispensable for normal operation of the transmitter. Operating the transmitter without this cover cannot do any harm, but serious radiation will occur and feedback will be serious due to the assymmetry in the surroundings of the tuned circuits (taking off the perforated cover leaves the front panel in position). As a result tuning is changed and even after retuning output is low and adjustment unstable. This way of operation is only recommended for some servicing situations.

Servicing

For servicing the r.f. part of the transmitter the perforated cover can be taken off by loosening a number of screws on the front panel and at the sides of the cover, and a number of sheet metal screws at the back of the cover. When the cover is mounted again, be sure that these screws are fixed tightly to ensure good electrical contact, otherwise microphony and/or noise may result. Note that amongst the sheet metal screws at the back of the cover two shorter screws are used for holes just opposite the tube socket brackets.

To reach the interior of the power supply the silver-plated r.f. chassis has to be taken out after removal of the perforated cover. A number of screws have to be loosened as well as the variable resistor R_{10} marked "output" on the front panel. The silver-plated chassis can then be taken out carefully for about 5 inches, limited by the length of the connecting wires.

Further steps to disassembly can be taken by unsoldering two red, two blue and one black wire connecting the bottom panel to the main chassis and taking out a number of flatheaded sheet metal screws. The bottom panel can then be taken off. On this bottom panel the electrolytic capacitors are mounted on a bracket. Removal of this bottom panel gives access to the selenium rectifiers, switches, test meter and the major part of the wiring. The power transformer can only be taken out after removal of the front panel.

For exchanging the oscillator tube V_1 the following procedure is recommended. After taking off the perforated cover the screws fixing the mounting bracket of the oscillator socket are loosened for about 2 turns. The oscillator anode clips are loosened by turning the knurled nuts counterclockwise, being careful not to exert too much stress on the oscillator tube anode seals. After this the oscillator tube, bracket and grid tuning circuit can be withdrawn as a whole until the anode pins are well clear from the anode clips. The oscillator tube can be taken out of its socket and be replaced by a new one. After this the reverse procedure should be followed. A clearing of about one sixteenth of an inch should be kept between the glass envelope and the end of the anode clips.

The perforated cover is replaced and fastened and the transmitter is tuned as prescribed. If possible the frequency should be checked with a frequency meter and if necessary be adjusted to the nominal value by changing the insertion depth of the anode pins of the oscillator tube in the anode clips. Always fasten these clips well.

For exchanging the amplifier tube V_2 the procedure is as follows.

The perforated cover is taken off and the knurled nuts of the anode clips of the amplifier are loosened. The tuning nut of the split-stator capacitor is turned counterclockwise for about 5 turns and the two screws in the sides of the teflon body of the split-stator capacitor C_{11} are taken out.

The front screw can only be reached through a hole in the front panel after taking out the button type cap. The anode lines can then be withdrawn from the tube and the tube be replaced by a new one after which the reverse procedure is followed for assembly. Care should be taken not to damage the r.f. chokes soldered to the center of the anode lines. Retuning as prescribed in the operating manual is necessary.

Voltages and currents

All voltages and currents have been measured with an AVO multirangemeter, 20.000 ohms per volt, but no serious discrepencies are expected with any other similar instrument.

Oscillator cathode voltage	-550 Volts
Oscillator screen grid voltage	-450 Volts
Oscillator anode voltage	- 45 Volts
Oscillator anode current	45 mA
Amplifier bias	- 45 Volts
Amplifier screen grid voltage	+60 to +200 Volts
Amplifier anode voltage	+550 to +450 Volts
Total amplifier anode current	40 to 130 mA
Anode voltage of EF 86 (anti microphony circuit)	+150 Volts
Anode voltage of ECC 82 (" " ")	+ 60 to + 200 Volts

Some voltages are dependent on the "output" control setting.

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THE RECEIVER

General

The receiver consists of a r.f. silicon crystal detector followed by an a.f. amplifier with an output stage able to deliver an audio power of 2 Watts to a built-in speaker or to an external load via two jacks. The bandwidth of the amplifier is limited by high-pass and low-pass filters to decrease hum and noise level. Corrections in the gain-frequency characteristic have been included to make up for the deficiencies of the microphone in the passive element.

A power supply is built-in, as well as a meter for monitoring the r.f. level.

Description of the circuit

The circuit diagram is given in Fig.3.
From the r.f. coaxial input connector P_1 about 5 inches of 125 ohms cable runs to the silicon crystal detector SC, acting as a matching device to the 50 ohms source impedance. The rectified output of the crystal detector is filtered and taken to the primary of the amplifier input transformer T_1. The audio content of the rectified output is stepped up by this transformer by a factor of 22 to the grid of the first amplifying tube V_1. The d.c. content of the rectified output from the crystal is monitored by a meter M_1 with full scale deflection of 2 mA, connected between the lower side of the input transformer T1 primary and ground.

The audio frequency anode voltage from V_1 is fed, via a volume control R_8 to the grid of V_{2A} whose anode feeds the bandwidth-limiting filter. This filter consists of a T-type high pass filter with a cut-off frequency of 400 c/s, a resistive matching pad R_{11}, R_{12}, and a π-type low-pass filter with a cut-off frequency of either 4 kc/s or 7 kc/s, depending on the position of the bandwidth switch S_1 on the front panel ("low" or "high").

The output of this low-pass filter is terminated in a suitable terminating resistor R_{13} and fed to V_{2B}, which is a pre-amplifier for the power output tube V_3. An output transformer T_3 with a step-down ratio of 36 matches a load of 5 ohms. The output is connected to a 5-inch loudspeaker and two telephone-jacks J_1 and J_2, one of which will silence the speaker when a plug is inserted.

About 25 decibels of negative feedback is applied from the output to the cathode of V_{2B}. This feedback decreases the internal output impedance of the amplifier to the extent that the output voltage does not change more than a few percent if the loudspeaker is connected or disconnected.

To compensate for deficiencies in the frequency characteristics of the microphone used in the passive element, bass boost is incorporated at two places in the amplifier.

First, the anode of V_1 is shunted by a series-connected resistor R_7 and capacitor C_6.

In the second place the feedback path across the output stage is made frequency-dependent by the inclusion of resistor R_{18} and capacitor C_{16}.

This boost enhances the gain for frequencies below about 1000 c/s.

The condenser C_8 across the cathode resistor R_9 of V2A compensates for high-frequency losses in the input transformer T_1.

The power supply consists of a single power transformer T_2, a selenium bridge rectifier SR and a smoothing filter R_{22}, R_{23}, C_{18}, C_{19} and C_{20}.

A red pilot lamp PL is connected across the 6.3 Volts winding of the power transformer T_2. The primary of this transformer is made up of two equal windings for 110Volts each, which can be switched in parallel or in series for operation from a 110 Volts or a 220 Volts power line. The switching is done by a slightly recessed tumbler switch S_2 which is located at the back of the cabinet near the power line input connection.

For switching-on and protection a tumbler switch S_3 and a fuse F are inserted between the transformer primary and the mains input. These components are mounted on the front panel.

Servicing

The wiring and components can be reached when the bottom lid is removed by taking out 6 flat-headed sheet metal screws.

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The crystal can be exchanged by turning the cap of the crystal holder counterclockwise. The crystal holder is located on the front panel directly above the test meter.

Voltages

All voltages have been measured with an AVO multirange meter, 20.000 ohms per volt, but no serious discrepencies are expected with any other similar instrument.

V_1	anode voltage	+ 85 Volts
	screen grid voltage	+ 50 Volts
	cathode voltage	+ 1,1 Volts
V_{2A}	anode voltage	+ 225 Volts
	cathode voltage	+ 1,1 Volts
V_{2B}	anode voltage	+ 110 Volts
	cathode voltage	+ 1,0 Volts
V_3	anode voltage	+ 220 Volts
	screen grid voltage	+ 245 Volts
	cathode voltage	+ 8,5 Volts

Alternative tube types

QQE 06/40	-	5894	-	CV 2797
EF 86	-	6267	-	CV 2901
ECC 82	-	12 AU 7	-	CV 491
ECC 83	-	12 AX 7	-	CV 492
EL 84	-	6 BQ 5	-	CV 2975
CS 2 A	-			

THE PASSIVE ELEMENT

General

The passive element contains a dipole antenna, a silicon crystal detector and a three-stage transistorized audio amplifier with a microphone.

The r.f. field set up by the transmitter activates the dipole and detector, the resulting rectified voltage being used to supply the d.c. power needed for operation of the audio amplifier.

The microphone voltage is amplified in the audio am-

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plifier and the last transistor is connected as a direct load across the rectifier output, the value of which load is modulated by the amplified microphone signals. The load variations on the crystal detector cause the r.f. impedance offered to the dipole to change accordingly. This means that the amount of absorbed or reflected power by the dipole is modulated also.

Circuit description of the audio amplifier

The circuit diagram is given in fig.4. All transistors are operating in the grounded-emitter way, the coupling impedances for transistors T_1 and T_2 being inductances L_1 and L_2. The load impedance as seen by the output transistor T_3 is the internal impedance of the rectifier d.c. output circuit. This rectifier output circuit at the same time delivers the d.c. supply power necessary for operation of the transistors. The amplified microphone voltage however is at the same time superimposed on this d.c. voltage and has to be removed before the supply voltage can be used for feeding the transistors T_1 and T_2. This filtering is done with inductance L_4 and capacitor C_4 During development however a strong tendency to low-frequency oscillation became evident due to the decreasing efficiency of the filter circuit for lower frequencies. The feedback loop was located around transistors T_2 and T_3 The most efficient and compact solution was found in the insertion of inductance L_3 and capacitor C_3 which decouples the transisor T_2 from the ground wire.

The power requirements for the audio amplifier had to be as low as possible and therefore no temperature compensation or frequency characteristic corrections have been included. As a result the characteristics are to a certain amount governed by circumstances, but normal ranges of temperature and component tolerances will give no rise to any trouble.

Description of the R.F.part

The passive elements are produced in two different types. The R.F.part is either carried out as a seperate unit with connecting wires, of a length up to 10 meters or more, to the audio part or as an integral unit with the audio part incorporated. Examples of the first type of construction are shown in Fig.5A and Fig.5B, while the

latter construction is shown in Fig.5C.
The R.F. part consists of a dipole and a crystal rec. fier. The rectified current is fed to two soldering tags via R.F. chokes. The crystal rectifier is a coaxial crys tal type CS2A (British Thomson Houston). Other types of r.f. crystal-rectifiers such as the 1N22 can be used as well whereby attention should be paid to the polarity.
The dipole is made longer than half a wavelength to obta an increase in impedance in view of matching the impedan of the crystal. The inductance due to the increase in length matches at the same time the stray capacitance of the crystal. The nature of the substance wherein the dipole is suspended determines the optimum length of the dipole. In general it can be said that the optimum length of a dipole suspended in a non conducting substance with relative dielectric constant K is $\frac{1}{\sqrt{K}}$ times the optimum length in free space.
The separate R.F. units are shaped in two different form In one form the dipole made of normal insulated wire is imbedded in wood.
Constructional details and dimensions are given in fig.5 This unit is provided with a normal mains type plug for easy connection with the supplied meter to form a field strength monitor the operation of which is described in the operating manual.
The antenna of the second R.F. unit (Fig.5B) can be consi ered as a dipole in free space. The dipole again is made of insulated wire. This has the advantage that the dipol can be bent somewhat whereby the performance will not be reduced seriously. The insulation reduces attenuating effects of objects to which the dipole is mounted. In fig.5B the construction is shown and the dipole length i given. To ruggedize the construction the centre of the dipole, the crystal rectifier and the chokes are imbedde in expanded P.V.C. which is covered and compressed by shrink sleeve.
Proper functioning of this R.F.part may be checked by connecting it to the supplied meter and bringing the dipole in the field of the transmitter antenna. Normal met deflection should be obtained. Care should be taken not t overload the crystal.

The dipole wires are soldered to the crystal. If sol ering has to be carried out, care should be taken not to overheat the crystal, otherwise the crystal will be spoi

ed. In the process of soldering the metal part of the crystal to which the connection is made has to be clamped in a vice or in a pair of pliers with plain jaws to achieve proper heat conduction.
Crystal-rectifiers will be damaged by mishandling or exposure to strong radio frequency fields. Care should be taken therefore to keep the dipoles away from the transmitter antenna when power is switched on.

The integrated type of passive element is shown in Fig.5C. Although not essential the antenna is in this case of an other type and can be regarded as an excentre-fed dipole, the audio part forming the short leg of the dipole.
The longer part is made of silver tube and can be plugged into the unit. Overloading of the crystal can be prevented by pulling out this antenna element in case the device is exposed to strong R.F.fields.
Constructional details and dimensions are given in fig.5C.

Testing of the audio amplifier of the passive element

Whenever it is necessary to test the audio amplifier of the passive element the test set-up of fig.6 is recommended.
Connections to microphone and crystal rectifier are disconnected.
The potentiometer across the battery is adjusted to a voltage across the output terminals of the audio amplifier of either 0,25 Volts or 0,50 Volts. The voltage required across the potentiometer output will be about 0,6 Volts respectively 1,2 Volts.
A 1000 c/s signal of about 30 microVolts r.m.s. is applied to the microphone terminals of the audio amplifier and the resulting output voltage is measured with the sensitive v.t.v.m. The r.m.s. output voltage can be expected to be between 15 and 45 mV, respectively between 40 and 120 mV.

The input voltage is increased until limiting is clearly visible on the oscilloscope. The output voltage should have a peak-to-peak value of about 350 mV respectively 900 mV.

The gain-frequency characteristic can be tested with an input signal of 30 microVolts r.m.s. of adjustable frequency. The audio output voltage should not deviate

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more than 3 decibels from the 1000 c/s value for frequencies between 500 and 7000 c/s.

ANTENNAS

General

The antenna is built up of four driven elements in a combined broad-side and end-fire array with a plane sheet reflector.
The antenna and matching sections are specifically designed for optimum gain as far as consistent with the available storage space.
The direction of the main lobe is perpendicular to the plane of the reflector. The measured gain is 12.5 dB. The beam width between half power points is approximately 45 degrees in both planes. The front to back ratio is 13 dB. The centre frequency of the antenna is 376,5 Mc/s. The V.S.W.R. of the antenna is less than 1,4 irrespective of the pair of elements used.

Design details

A complete antenna comprises the following units (see Fig.7):
2 radiating elements (A and B).
A radiating element support.
A sheet reflector.

Each radiating element comprises two half wave folded dipoles forming an end-fire array.
Both radiating elements (A and B) are in broadside configuration and interconnected by the radiating element support.
The antenna is fed through the connector in the short stub in the centre of the radiating element support.
The radiating element is of a sturdy construction to facilitate the connecting of a radiating element to the radiating element support.

A closer inspection of fig.7 will learn how the interconnections between the dipoles of the radiating elements are made. Furthermore it will be clear that the radiating elements A and B are not identical as far as the inter-

connecting parallel feeding lines are concerned.
To prevent errors in assembling the antenna arrays the radiating elements which are to be used together are identically marked (red or blue dots).

Matching

In each radiating element the dipoles are matched to the standard "General-Radio" panel connector P_1 and P_4, type 874-PB, with a characteristic impedance of 50 ohms.

Matching is performed in the following way:

1. Using folded dipoles.
2. Stepping up the diameters of the dipole rods.
3. Tapering the parallel strip transmission lines running from the connector to the folded dipoles.
4. Using two lumped capacitances C of 5 pf each which are symmetrically soldered at the input side of the parallel strip transmission lines.

The radiating element support is in fact a matched coaxial T-section which shows 50 ohms impedance at each terminal provided that the remaining terminals are terminated by an impedance of 50 ohms. For this purpose the long end of the radiating element support is a coaxial line of 70 ohms characteristic impedance and a total length of $\frac{1}{2}$ wavelength. The connectors P_2, P_3 and P_5 are "General-Radio" basic connectors type 874-B.

In case doubt arises as to the proper functioning of the antenna the following points should be considered. If excessive crackling sounds are observed in the output of the receiver when the antenna system is touched, this may be due to loose or bad contacts in the antenna system. These may arise in the screw type connections of inner and outer conductors of the connecting plugs or at the places of soldered joints. When servicing to one of the connectors becomes necessary careful attention should be paid to the instructions contained in the "Assembly instructions" for General Radio connectors as included in this manual.

N.B. This type of interference can also be produced by causes outside the system. Metal parts as tools, screws etc. in the field of the antenna and making intermittent contact give rise to the same sort of trouble.

An intelligent interchanging of the antenna-elements will be helpful in locating the source of eventual trouble. The field strength distribution in front of the transmitting antenna can be checked by a simple folded dipole of approximately 37 cm length, provided with a small bulb of e.g. 6 V, ½ W, which should light up evenly when this dipole is moved across the aperture of the antenna array.
If proper measuring equipment is available the voltage standing wave ratio (V.S.W.R.) of the antenna can be measured. When the antenna system is situated reasonably free from reflecting objects the V.S.W.R. should be less than 1.5 for the centre frequency of the antenna (376.5 Mc/s). A higher standing wave ratio will result in some reduction in working range of the system. If a V.S.W.R. of 3 or more is measured a loose or bad contact is the most likely cause.

Warning

1. All connections involving coaxial connectors should be tight.
2. Care should be taken that the connectors are kept clean.
3. When replacing one of the capacitors C, capacitors of the same type and construction should be used. The soldering should be carried out in exactly the same way as in the original model.
4. When soldering at the parallel lines inside the perspex cover of one of the radiating elements has to be done the line spacings should be kept exactly as in the model i.e. 2 mm at the folded dipole end and 4 mm in the vicinity of the coaxial line.
5. When soldering at one of the connectors has to be done care should be taken not to overheat the inner conductor or to prevent softening of the insulating bead (874.70). If possible remove this insulating bead temporarily.

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CONNECTING CABLES

With the equipment 5 connecting cables are supplied:
2 R.F. coaxial cables
2 mains cords
1 extension cord.

Each R.F. coaxial cable is made of "General Radio" coaxial cable type 874A2 and is provided with two General Radio cable connectors type 874-C.

The General Radio assembly instructions fo the various connectors used in the equipment are attached to this manual.

The mains cords are made of rubber insulated two core cable and provided with a Bulgin two pole female plug at one end and a normal European type mains plug at the other end.

TRANSMITTER

V_1, V_2	Philips QQE 06/40 - 5894 - CV 2797
V_3	" EF 86 - 6267 - CV 2901
V_4	" ECC 82 - 12AU7 - CV 491
C_1, C_{11}	split-stator tuning capacitor, see text
C_4, C_5	feedback capacitor, see text
C_2, C_3, C_9, C_{12}, C_{13}, C_{15}, C_{19}, C_{21}, C_{23}	capacitor 500 pF ceramic Stettner
C_6, C_7, C_8, C_{10}, C_{22}	capacitor 500 pF mica feed-through, T.C.C.
C_{14}, C_{20}	electrolytic capacitor 25 μF 12,5 Volts, Philips
C_{16}	capacitor 22.000 pF, Philips
C_{18}	capacitor 25 pF ceramic, T.C.C.
C_{17}	capacitor 0,1 μF, Philips
R_1, R_2	resistor 47.000 ohms, 0,25 W, Vitrohm
R_3	resistor 330.000 ohms, 1 W, Erie
R_4	resistor 1000 ohms, wire-wound, 6 W, Painton
R_5	resistor 4700 ohms, 0,5 W, Erie
R_6	resistor 820 ohms, 0,5 W, Erie
R_7	resistor 390.000 ohms, 1 W, Erie
R_8	resistor 2,7 Megohm, 1 W, Erie
R_9	resistor 820.000 ohms, 1 W, Erie
R_{10}	variable resistor 15.000 ohms, log., LESA
R_{11}	resistor 27 ohms, 0,5 W, Erie
R_{12}	resistor 56.000 ohms, wire-wound, 6 W, Painton
L_1, L_2	incandescent lamp, 6 Volts 0,05 Amp., Philips
P_1	output plug, coaxial, modified 874-PB, GeneralRadio
SC	silicon crystal detector, CS 2 A, B.T.H.

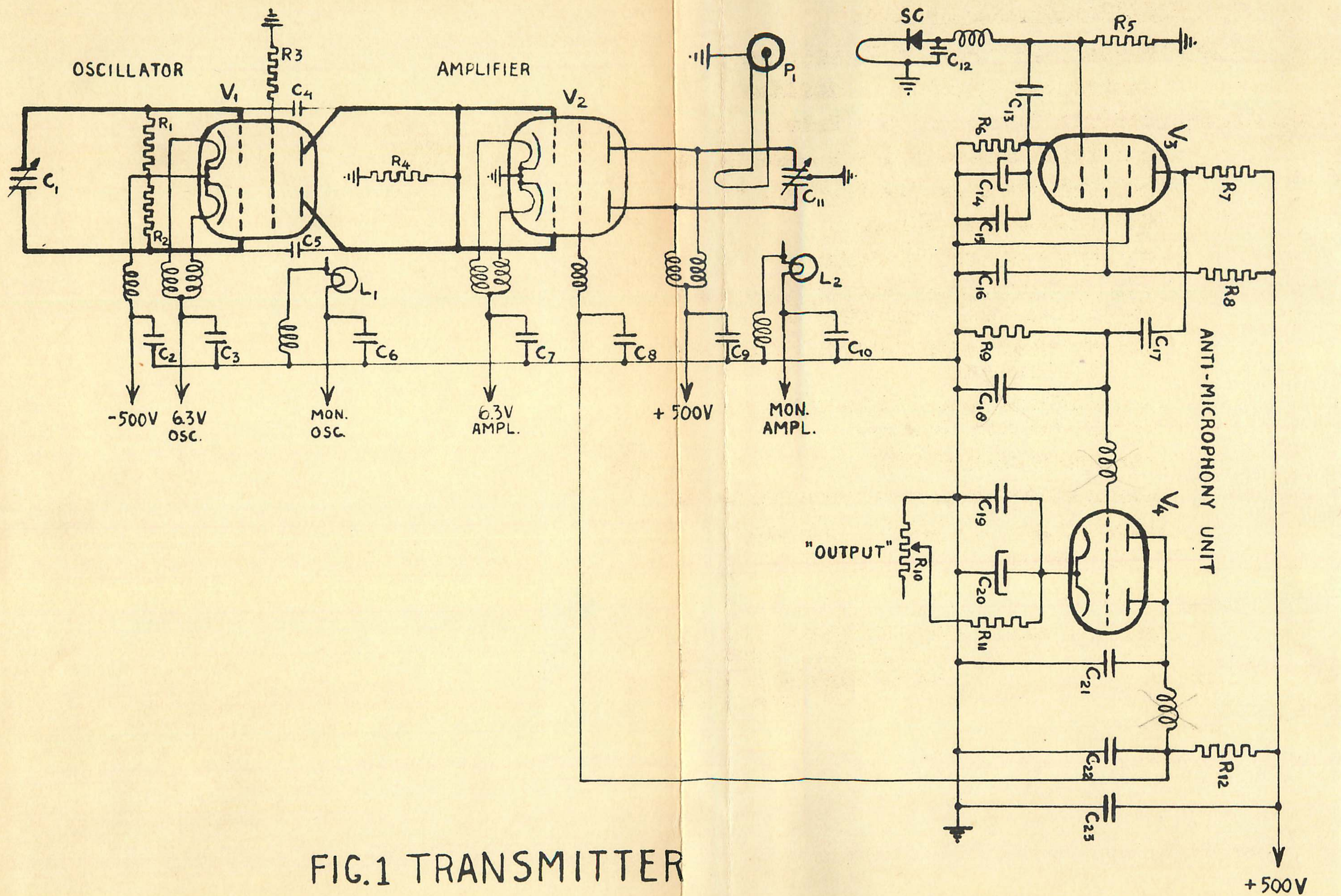


FIG.1 TRANSMITTER

TRANSMITTER POWER SUPPLY

C_1, C_2, C_3 .....C_8	100 µF 450 V D.C. W.V. Philips
L_1, L_2	chokes 8 H 225 ohms Philips
R_1, R_2, R_3.....R_8	270.000 ohms 10% 1 W Erie
R_9	2 x 150.000 ohms 10% 1 W Erie in parallel.
R_{10}, R_{11}	2 x 270.000 ohms 10% 1 W Erie " "
R_{12}	meter shunt for 200 mA
R_{13}	15 ohms W.W. 5% 6 W Painton
M_1	moving-coil meter, full scale deflection 0,5 mA 275 ohms Simpson
SR_1	4 rectifiers type E 250 C 85 in bridge-circuit Siemens
SR_2	4 rectifiers type E 250 C 130 in bridge-circuit Siemens
S_1, S_3	tumbler switches DPDT
S_2	wafer switch 3 pos. 4 contacts Mallory
P_1, P_2	pilot lamps 6 V 0,05 A Philips
F_1, F_2	fuse 300 mA
F_3	fuse 2A
T_1	power transformer primary: 2 x 110 V 50-60 c/s secondary: 2 x 430 V 2 x 6,3 V.

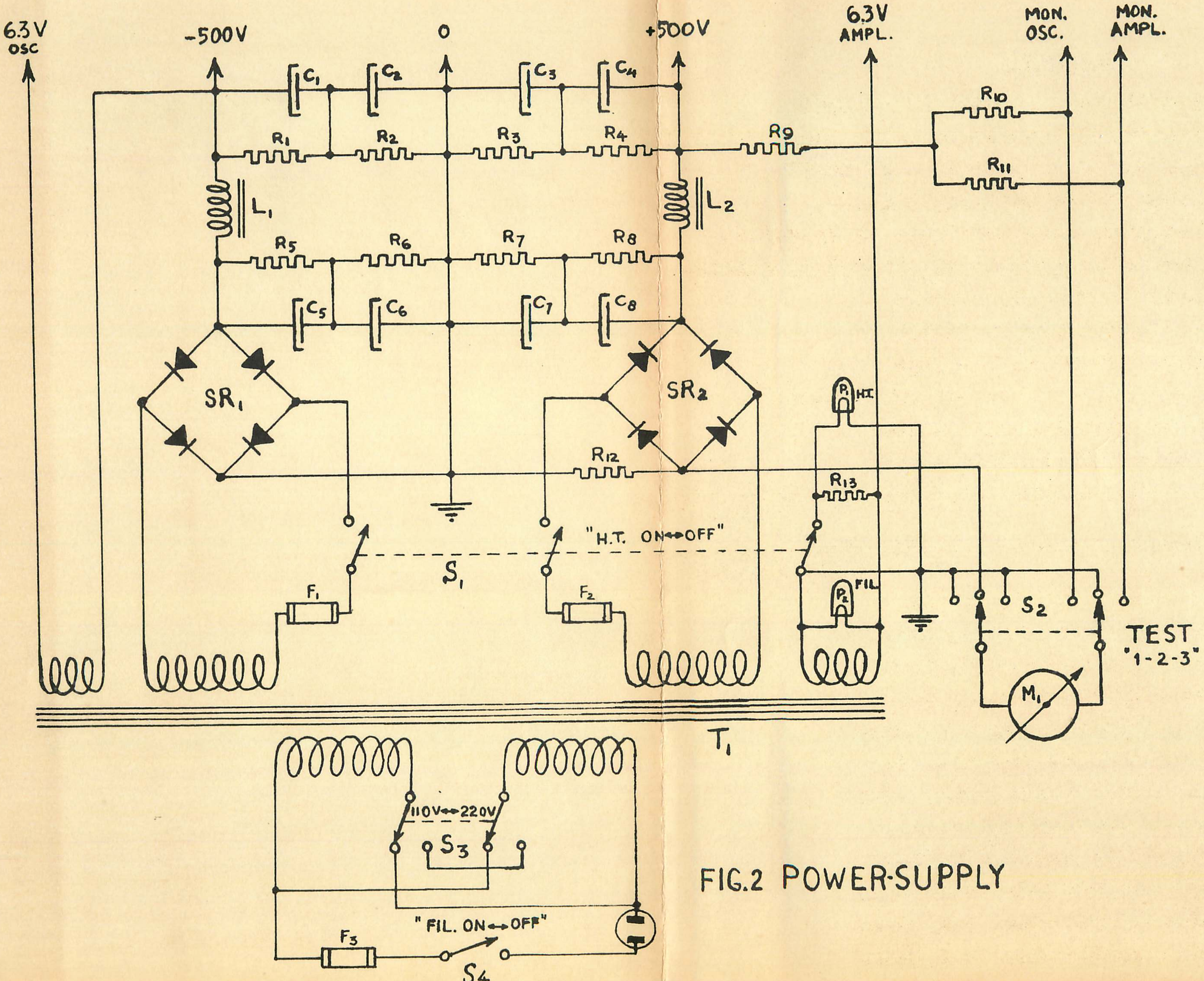


FIG.2 POWER-SUPPLY

RECEIVER

V_1	Philips EF 86 - 6267 - CV 2901
V_2	Philips ECC 83 - 12 AX 7 - CV 492
V_3	Philips EL 84 - 6 BQ 5 - CV 2975
C_1, C_2	capacitor 680 pF ceramic, T.C.C.
C_3	electrolytic capacitor 10 µF 12 V, S.K.F.
C_4, C_{17}	electrolytic capacitor 25 µF 12,5 V, Philips
C_5, C_{16}	capacitor 10.000 pF, Philips
C_6, C_7, C_{15}	capacitor 2.200 pF, Philips
C_8	capacitor 22.000 pF, Philips
C_9, C_{10}	capacitor 10.000 + 47.000 pF, Philips
C_{11}, C_{14}	capacitor 500 pF mica, L.E.M.
C_{12}, C_{13}	capacitor 1500 pF mica, L.E.M.
C_{18}, C_{20}	electrolytic capacitor 12,5 µF, 450 V D.C. W.V., Philips
C_{19}	electrolytic capacitor 25 µF, 450 V D.C. W.V., Philips
R_1	resistor 330 ohms 0,5 W, Erie
R_2	resistor 150 ohms 0,5 W, Erie
R_3, R_6	resistor 2,2 Megohm 1 W, Erie
R_4	resistor 2200 ohms 0,5 W, Erie
R_5, R_{16}	resistor 330.000 ohms 1 W, Erie
R_7	resistor 100.000 ohms 1 W, Erie
R_8	potentiometer 1,0 Megohms, LESA
R_9	resistor 1200 ohms 0,5 W, Erie
R_{10}	resistor 8200 ohms 0,5 W, Erie
R_{11}	resistor 12.000 ohms, 1 W, Erie
R_{12}	resistor 27.000 ohms, 1 W, Erie
R_{13}	resistor 39.000 ohms, 1 W, Erie

R_{14}	resistor 3.300 ohms, 0,5 W, Erie
R_{15}	resistor 1,0 Megohms, 1 W, Erie
R 17	resistor 4.700 ohms, 0,5 W, Erie
R_{18} wijz.	resistor 18.000 ohms, 1 W, Erie
R_{19}	resistor 100 ohms, 0,5 W, Erie
R_{20}	resistor 10.000 ohms, 0,5 W, Erie
R_{21}	resistor 220 ohms, 1 W, Erie
R_{22}	resistor 2700 ohms, 1 W, Erie
R_{23} wijz.	resistors 2 x 470 ohms, 1 W, in parallel, Erie
R_{24}	resistor 470.000 ohms, 1 W, Erie
T_1	input transformer 1:22, Unitran
T_2	power transformer, primary 2 x 110 Volts 50-60 c/s secondary 220 Volts 6,3 Volts
T_3	output transformer 36:1 and 31:1 Philips
L_1, L_2	inductor 1,8 H on ferroxcube core, Philips
M_1	moving coil test meter, full scale deflection 0,5 mA, 500 ohms, Simpson
P_1	input plug, coaxial 874-PB, General Radio
SC	silicon crystal detector, CS 2 A, B.T.H.
LS	5 inch loudspeaker, Philips
J_1, J_2	telephone jacks, Bulgin
SR	selenium bridge rectifier, B 250 C 90, Siemens
PL	pilot lamp 6 Volts 0,05 A, Philips
F	fuse 300 mA
S_1	wafer switch, 2 pos. 2 contacts, Mallory
S_2, S_3	tumbler switch DPDT

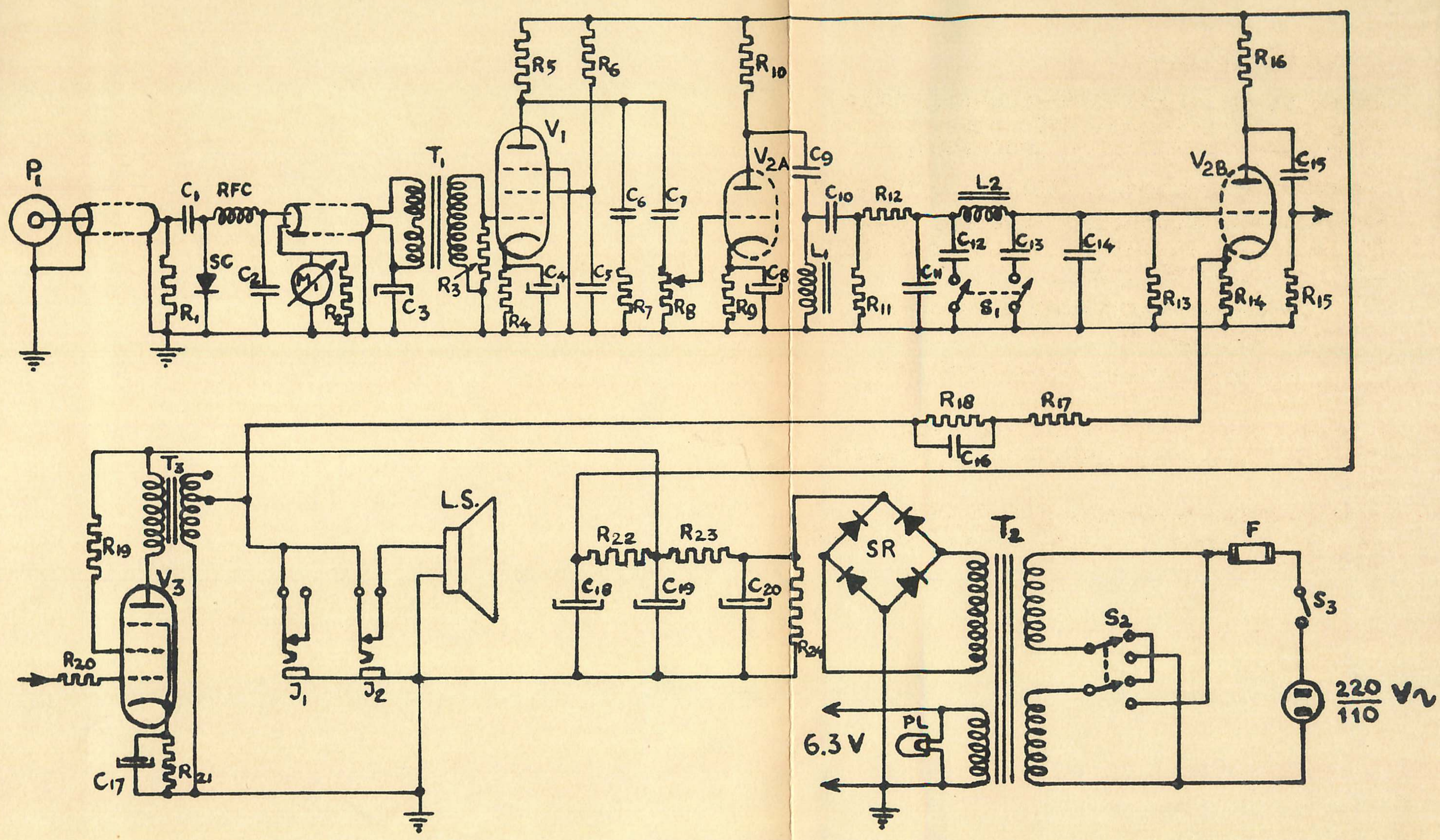


FIG. 3 RECEIVER

<u>PASSIVE ELEMENT</u>

M	Magnetic microphone, Fortiphone, type FM 5 d.c. resistance 1000 ohms, impedance at 1000 c/s: 2500 ohms.
T_1, T_2, T_3	Junction transistor, Philips, type OC 71
L_1, L_2, L_3, L_4	Inductance, Fortiphone, special type EX 192, d.c. resistance about 150 ohms, inductance about 2 H.
R_1, R_2	Vitrohm carbon composition resistor 270.000 ohms 0,25 W
R_3	Vitrohm carbon composition resistor 22.000 ohms 0,25 W
C_1, C_2, C_4, C_5	electrolytic condenser T.C.C. type CE 58 A, capacity 2 μF, max. d.c. voltage 8 V.
C_3	electrolytic condenser T.C.C. type CE 68 AA, capacity 10 μF, max. d.c. voltage 3 V.

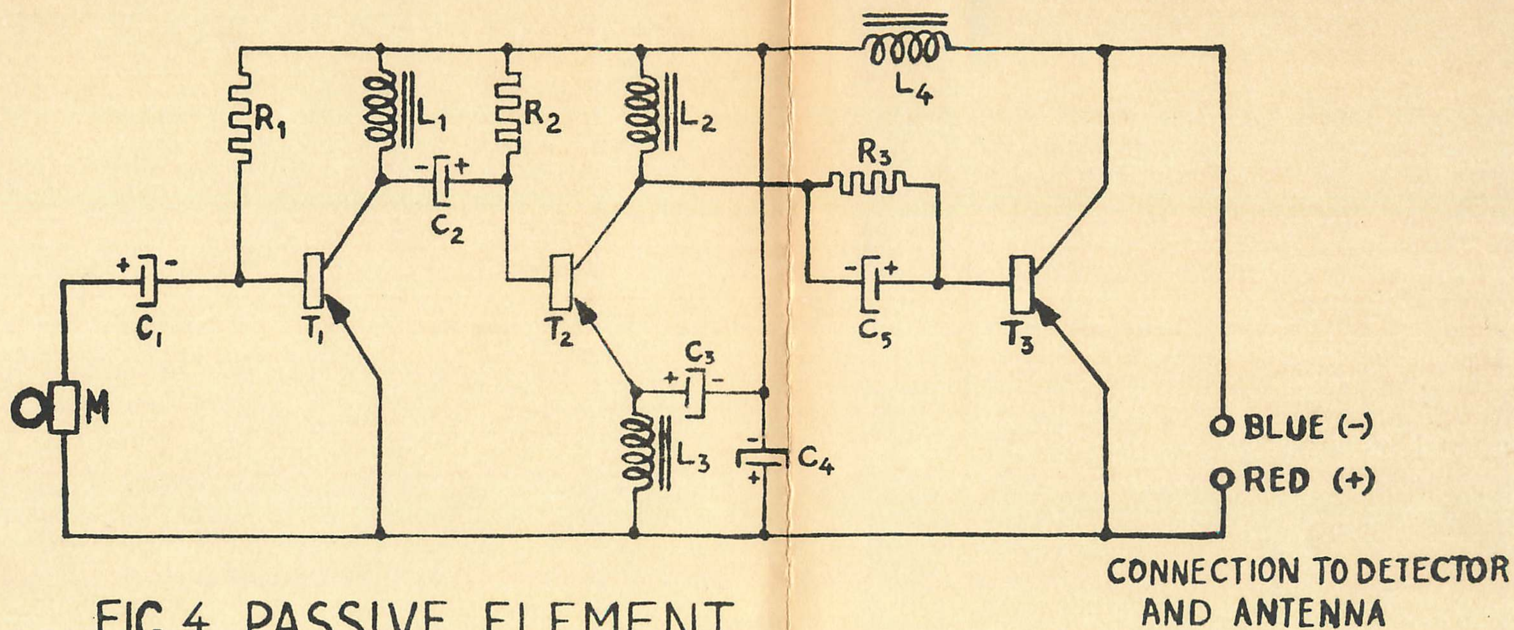


FIG. 4 PASSIVE ELEMENT

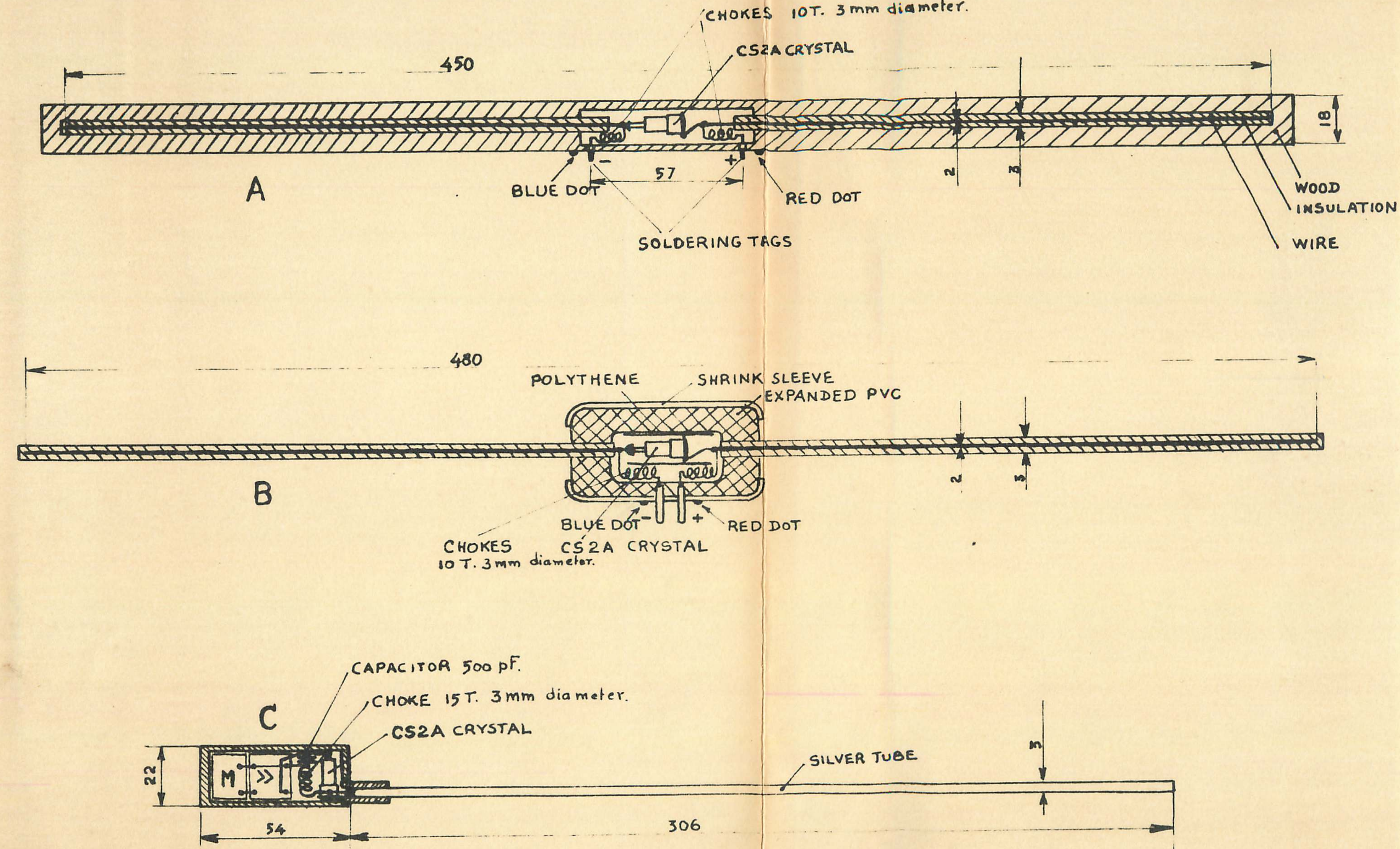


FIG. 5 PASSIVE ELEMENTS (ALL DIMENSIONS IN m.m.)

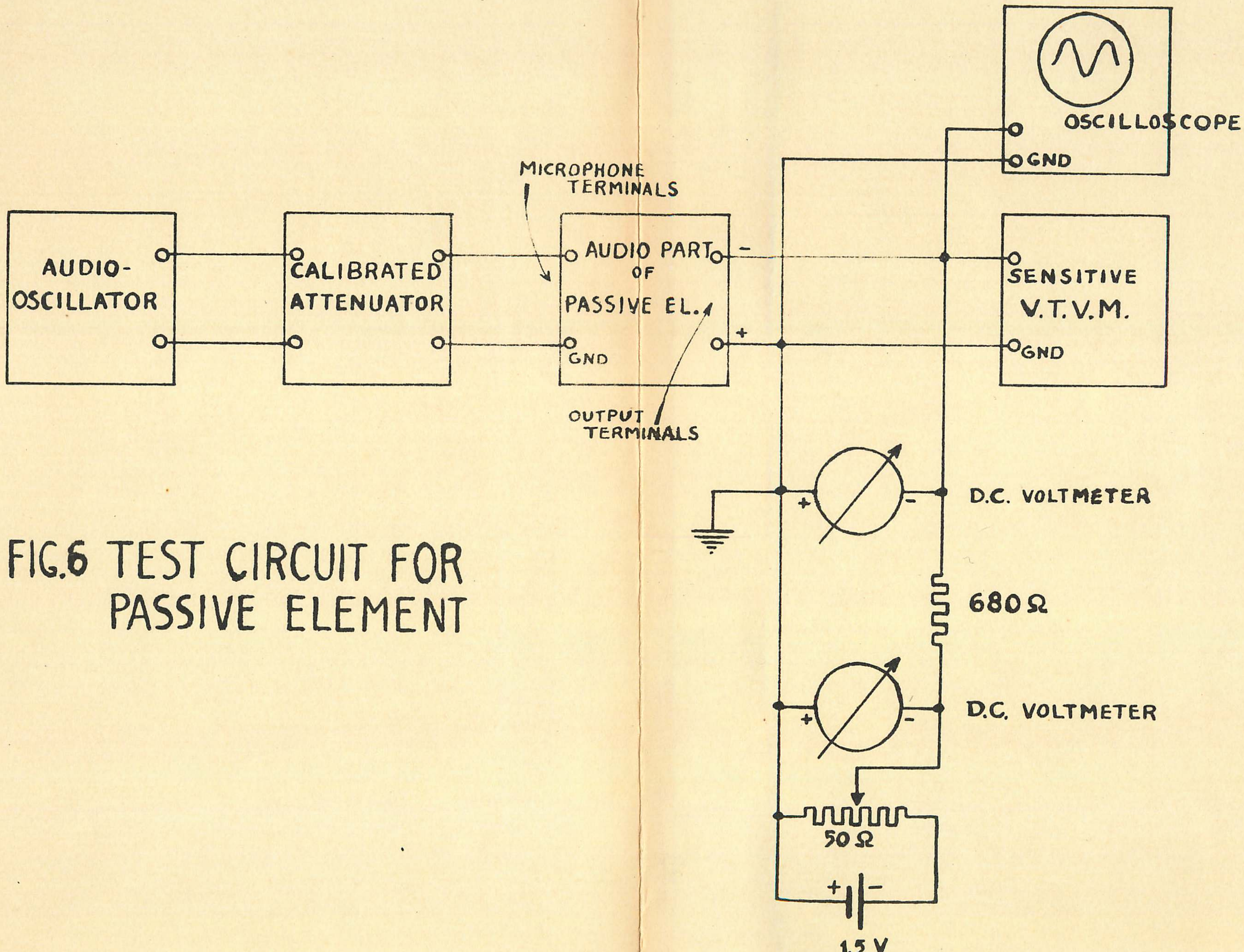


FIG.6 TEST CIRCUIT FOR PASSIVE ELEMENT

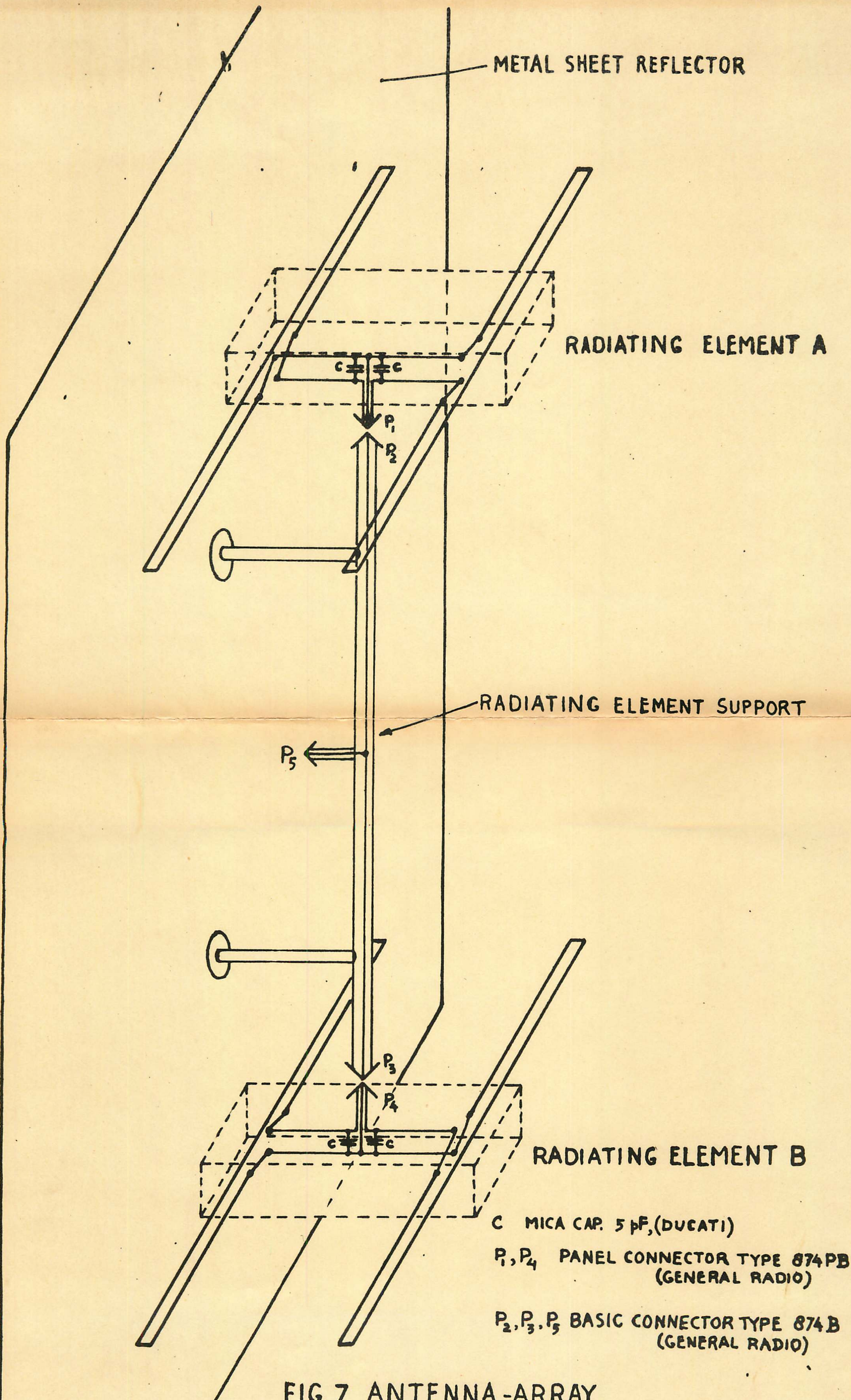
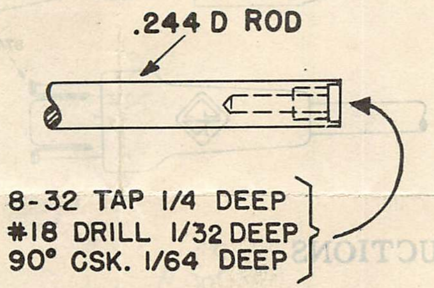
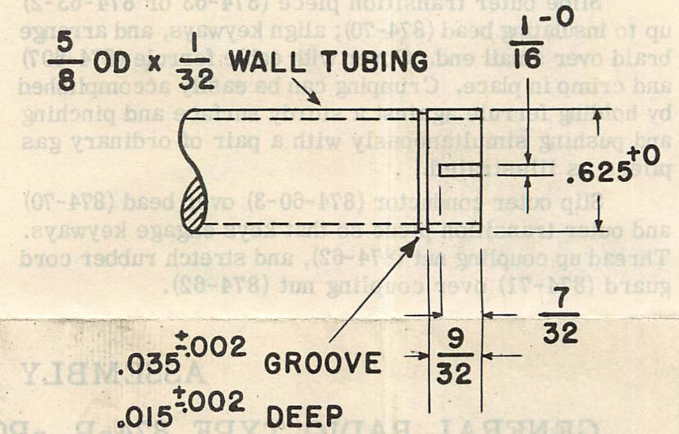


FIG. 7 ANTENNA-ARRAY

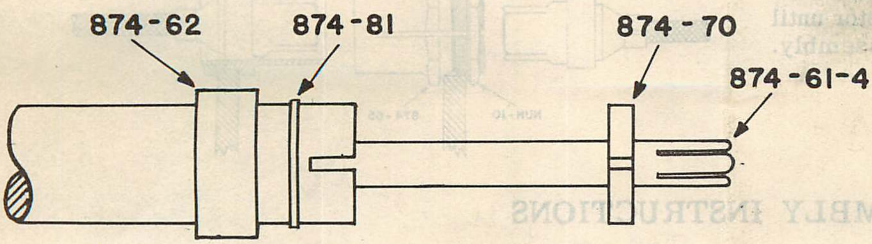
ASSEMBLY INSTRUCTIONS GENERAL RADIO TYPE 874-B BASIC CONNECTOR

Cut rod and tube to make ends flush, and machine as illustrated. If connectors are used on both ends of tube, 1/16 keyways should be oriented 90° apart.

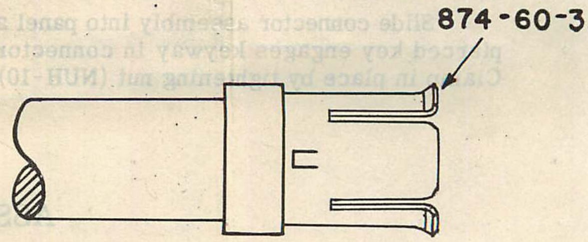




Slide on coupling nut (874-62) and install snap ring (874-81) on tube end. Insert inner conductor (874-61-4) in insulating bead (874-70) and thread into rod end.



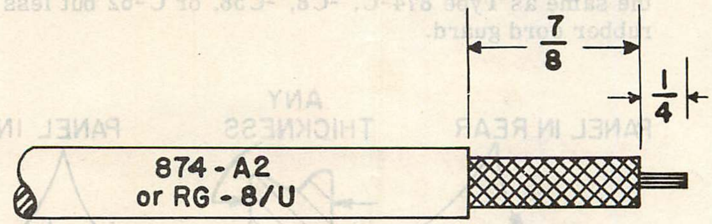
Align keyway in insulating bead (874-70) with keyway in tube end. Slip outer conductor (874-60-3) over bead and tube end so that key engages keyway, and thread up coupling nut (874-62).

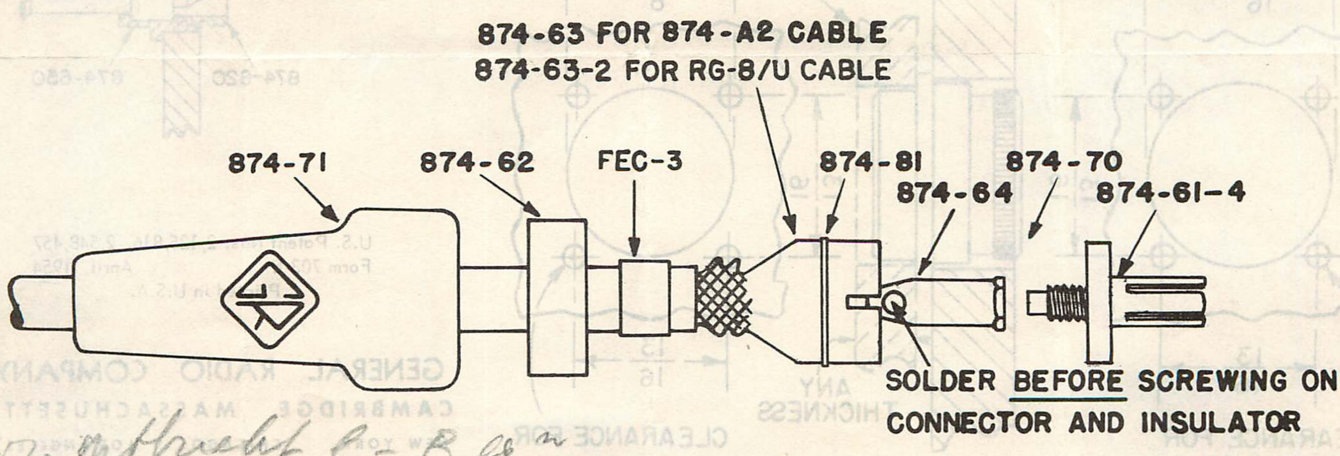


ASSEMBLY INSTRUCTIONS GENERAL RADIO TYPE 874-C or -C8 CABLE CONNECTOR

Remove cable jacket and insulation to expose braid and inner conductor to dimensions shown.

Slip on cord guard (874-71) using talc if necessary, coupling nut (874-62) and cable ferrule (874-607). Slide outer transition piece (874-63 or 874-63-2) under braid as far as possible. Slip inner transition piece (874-64) over inner cable conductor until end touches cable insulation; then solder. Install snap ring (874-81). Insert inner conductor (874-61-4) in insulating bead (874-70) and screw into inner transition piece (874-64). CAUTION: Insulator will melt if inner conductor and insulating bead are screwed on before soldering cable.

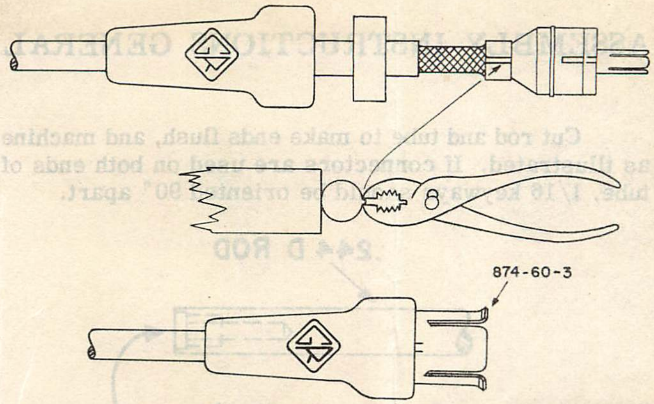




ASSEMBLY INSTRUCTIONS GENERAL RADIO TYPE 874-C or -C8 CABLE CONNECTOR (Cont.)

Slide outer transition piece (874-63 or 874-63-2) up to insulating bead (874-70); align keyways, and arrange braid over small end. Cover with cable ferrule (874-607) and crimp in place. Crimping can be easily accomplished by holding ferrule against a sturdy surface and pinching and pushing simultaneously with a pair of ordinary gas pliers as illustrated.

Slip outer conductor (874-60-3) over bead (874-70) and outer transition piece so that keys engage keyways. Thread up coupling nut (874-62), and stretch rubber cord guard (874-71) over coupling nut (874-62).

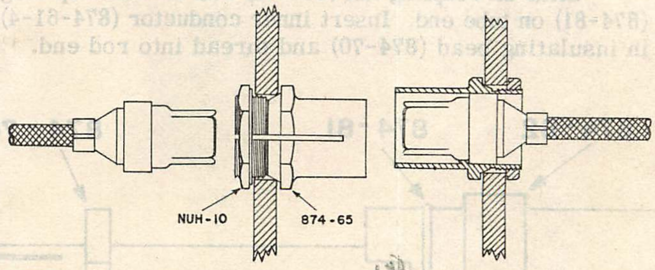


ASSEMBLY INSTRUCTIONS

GENERAL RADIO TYPE 874-P, -PC, -P8, or -PC8 PANEL CONNECTOR

Assemble connector to cable same as 874-C or 874-C8 but less rubber cord guard. Mount panel adaptor (874-65 without cap, 874-211 with cap) through 15/16-inch clearance hole in panel, leaving nut (NUH-10) loose.

Slide connector assembly into panel adaptor until pierced key engages keyway in connector assembly. Clamp in place by tightening nut (NUH-10).



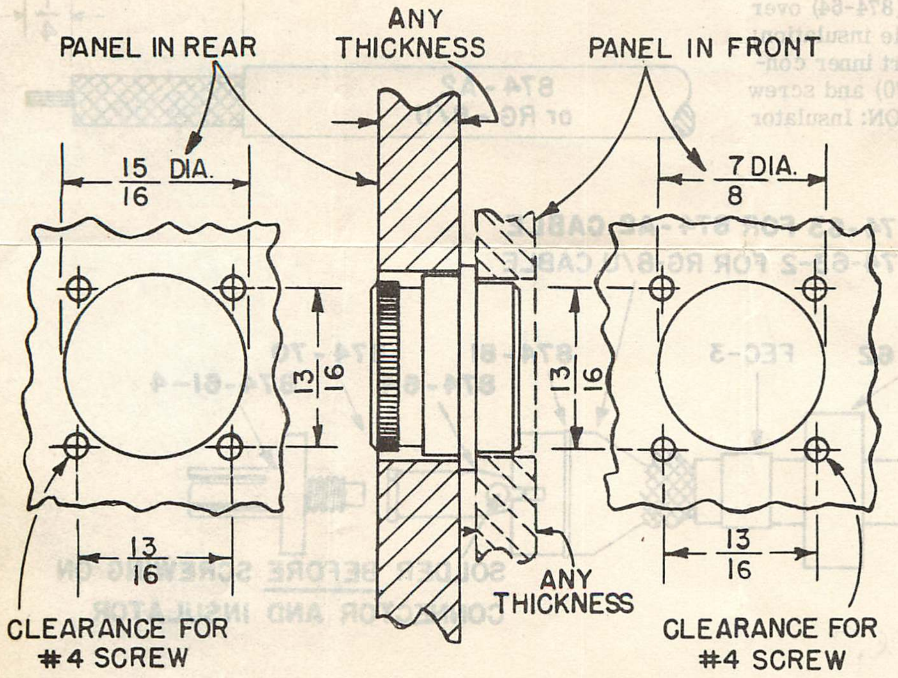
ASSEMBLY INSTRUCTIONS

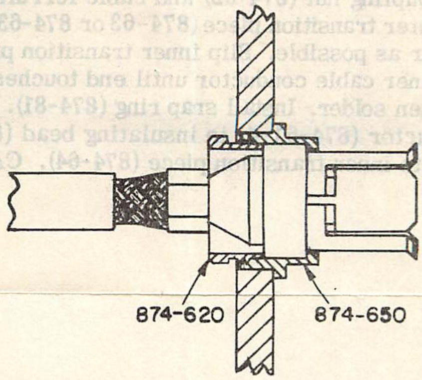
GENERAL RADIO TYPE 874-PB, -PB8, -PB58, or -PB62 PANEL CONNECTOR

Mount panel adaptor through 15/16-inch (panel in rear) or 7/8-inch (panel in front) clearance hole as shown in the diagram, using four #4 screws provided.

Remove the knurled retaining nut and slide this nut back over the cable. Then assemble connector to cable the same as Type 874-C, -C8, -C58, or C-62 but less rubber cord guard.

Slide connector assembly into the panel adaptor as far as it will go. Take care that the Type 874 Connector is properly oriented so that the panel adaptor tooth engages the longer slot on the side of the cable connector. Tighten up knurled retaining nut (see diagram).





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