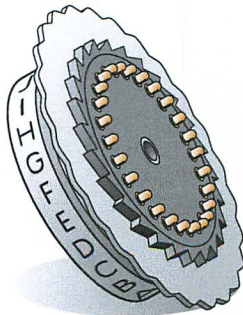


EC Mark I
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Project Easy Chair



PART B
TECHNICAL MANUAL
OF
EC. 02 - EQUIPMENT

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I.

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 V₁ has built-in neutralizing capacitors which means that external feedback capacitors C₄ and C₅ 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 C₁ 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 C₁.

The oscillator tube V₁ 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 probe, 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 anti-microphony-circuit is connected as a d.c. and a.c.

shunt across the screen grid of the r.f. amplifier V₂, the positive operating voltage being derived from a resistor R₁₂ between screen-grid and + 500 Volts line.

The average operating current of the anti-microphony output tube V₄ is variable by means of a variable cathode resistor R₁₀. Varying this resistor (marked "output" on the front panel) changes the screen grid voltage of the r.f. amplifier V₂ 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 M₁ through which a d.c. current is flowing due to the presence of resistors R₉, R₁₀ and R₁₁ 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 T₁, 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 S₁ and fuses F₁ and F₂ are inserted in the transformer-to-rectifier leads.

Indication of the H.T. "on" position is obtained by a red pilot lamp P₁, which is fed from the second 6.3 Volts voltage via a resistor R₁₃, 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 S₁.

The amplifier anode current is indicated by the test meter M₁ when the test switch S₂ is in position 2, in which case the meter is connected across a shunt resistor R₁₂ in series with the negative lead of the +500 Volts rectifier SR₂. 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 P₂ across the second 6.3 Volts supply.

The switch S₄ marked "fil" makes or breaks the connection between primary of the power transformer and mains. A fuse F₃ 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 S₃ 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 enameled 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 asymmetry 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 sensitivity. 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 asymmetry 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 ser-

vicining 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 R₁₀ 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 taking out a number of flatheaded metal screws fixing the bottom panel. Removal of this bottom panel gives access to the electrolytic capacitors, the selenium rectifiers, the switches, the 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 V₁ 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 C11 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 discrepancies are expected with any other similar instrument.

Oscillator cathode voltage	-550 Volts
Oscillator screen grid voltage	-425 Volts
Oscillator anode voltage	- 45 Volts
Oscillator anode current	55 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 36 (anti microphony circuit)	+150 Volts
Anode voltage of ECC82 (" " ")	+ 60 to + 200 Volts

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

THE RECEIVER

II.

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 P₁ an asymmetrical strip-line runs to the silicon crystal detector 3C (Type CS2A).

A choke RFC is connected across the input to short-circuit interfering signals of lower frequency and hum.

The rectified output of the crystal detector is filtered and taken to the primary of the amplifier input transformer T₁. 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 V₁. The d.c. content of the rectified output from the crystal is monitored by a meter M₁ 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 V₁ is fed, via a volume control R₃ 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 R₁₁, R₁₂, 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 S₁ on the front panel ("low" or "high").

The output of this low-pass filter is terminated in a suitable terminating resistor R₁₃ and fed to V_{2B}, which is a pre-amplifier for the power output tube V₃. An out-

put transformer T₃ 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 J₁ and J₂, 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 three places in the amplifier.

First, the secondary of the input transformer T₁ is shunted by a series-connected resistor R₃ and capacitor C₂₁.

In the second place, the anode of V₁ is shunted by a series-connected resistor R₇ and capacitor C₆.

In the third place, the feedback path across the output stage is made frequency-dependent by the inclusion of resistor R₁₈ and capacitor C₁₆.

These circuits give a gradually sloping gain-frequency characteristic, the difference in gain between 400 c/s and 7000 c/s being about 20 db.

The condenser C₈ across the cathode resistor R₉ of V_{2A} compensates for high-frequency losses in the input transformer T₁.

The power supply consists of a single power transformer T₂, a selenium bridge rectifier SR and a smoothing filter L₃, R₂₂, C₁₈, C₁₉ and C₂₀.

A red pilot lamp PL is connected across the 6.3 Volts winding of the power transformer T₂. The primary of this 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 S₂ which is located at the back of the cabinet near the power line input connection.

For switching-on and protection a tumbler switch S₃ 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.

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 discrepancies 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

QOE 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	-			

III.

THE PASSIVE ELEMENT

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General

The passive element contains a dipole antenna, a silicon crystal detector, a three-stage transistorized audio amplifier and 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 amplifier 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 audio amplifier has been molded in opaque epoxy resin. Connections are made by means of colour-marked miniaturized receptacles.

The circuit diagram is given in fig.4. All transistors are operating in the grounded-emitter way, the coupling impedances for transistors T₁ and T₂ being inductances L₁ and L₂. The load impedance as seen by the output transistor T₃ 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 T₁ and T₂. This filtering is done with inductance L₄ and capacitor C₄. 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 T₂ and T₃. The most efficient and compact solution was found in the insertion of inductance L₃ and capacitor C₃ which decouples the transistor T₂ 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 R.F. part consists of a dipole and a crystal rectifier. The rectified current is fed to two miniaturized receptacles via R.F. chokes.

The crystal rectifier is a cartridge type crystal 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 obtain a better match to the impedance of the crystal. The inductance due to the increase in length at the same time matches 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.

Constructional details and dimensions are given in Fig. 5. The dipole is made of insulated wire. This has the advantage that the dipole can be bent somewhat, whereby the performance will not be reduced seriously. The insulation reduces attenuation by objects to which the dipole is mounted. The crystal rectifier can be replaced easily.

The red dot on the perspex housing marks the positive receptacle.

Whenever soldering near the crystal is necessary, care should be taken, not to heat the crystal or even better, the crystal should be taken out.

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. In addition it is recommended to keep the dipole perpendicular to the rods of the transmitting antenna when the dipoles are not in use.

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

IV.

FIELD-STRENGTH MONITOR

The field-strength monitor consists of a 100 μ A miniature meter, a dipole, crystal detector, R.F. chokes and series resistor.

Constructional details are given in Fig. 5.

The minimum power level necessary for proper response of the passive element corresponds with about 20 μ A meter deflection with the passive element antenna replaced by the field-strength monitor.

A power level corresponding to more than full scale meter deflection might spoil the crystal detectors of power monitor and passive element antennas.

Although not necessarily, as far as meter sensitivity is concerned, the length of the dipole is made equal to the length of the passive element antenna to keep circumstances equal when monitoring the power level.

For proper indication of power level, care should be taken, not to touch the dipoles and to keep the dipole ends as far as possible from the body.

V.

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 in the horizontal and in the vertical plane is 62 degrees and 37 degrees respectively. The front to back ratio is 13 dB. The centre frequency of the antenna is 378.5 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 interconnecting parallel feeding lines are concerned.

To prevent errors in assembling the antenna arrays, the radiating elements are marked with green and yellow dots. Each antenna has to be assembled with differently marked elements. Equally marked elements of different sets can be exchanged.

Matching

In each radiating element the dipoles are matched to the standard "General-Radio" panel connector P₁ and P₄, 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 P₂, P₃ and P₅ 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.

H.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, $\frac{1}{4}$ 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 (378,5 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 to prevent softening of the insulating bead (874.70). If possible, remove this insulating bead temporarily.

VI.

CONNECTING CABLES

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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 for 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 QQK 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	capacitor 500 pF mica feed-through, T.C.C.
C ₂₂	capacitor 500 pF mica feed-through, T.C.C. and capacitor 6800 pF, Philips, in parallel.
C ₁₄ , C ₂₀	electrolytic capacitor 25 μ F 12,5 Volts, Philips
C ₁₆	capacitor 22.000 pF, Philips
C ₁₇	capacitor 0,1 μ F, Philips
R ₁ , R ₂	resistor 47.000 ohms, 0,25 W, Vitrohm
R ₃	resistor 220.000 ohms, 1 W, Resista
R ₄	resistor 820 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
R ₁₃	resistors 270 ohms and 820 ohms in series, 1 W, Erie
L ₁ , L ₂	incandescent lamp, 6 Volts 0,05 Amp., Philips
P ₁	output plug, coaxial, modified 874-PB, General Radio
SC	silicon crystal detector, CS 2 A, B.T.H.

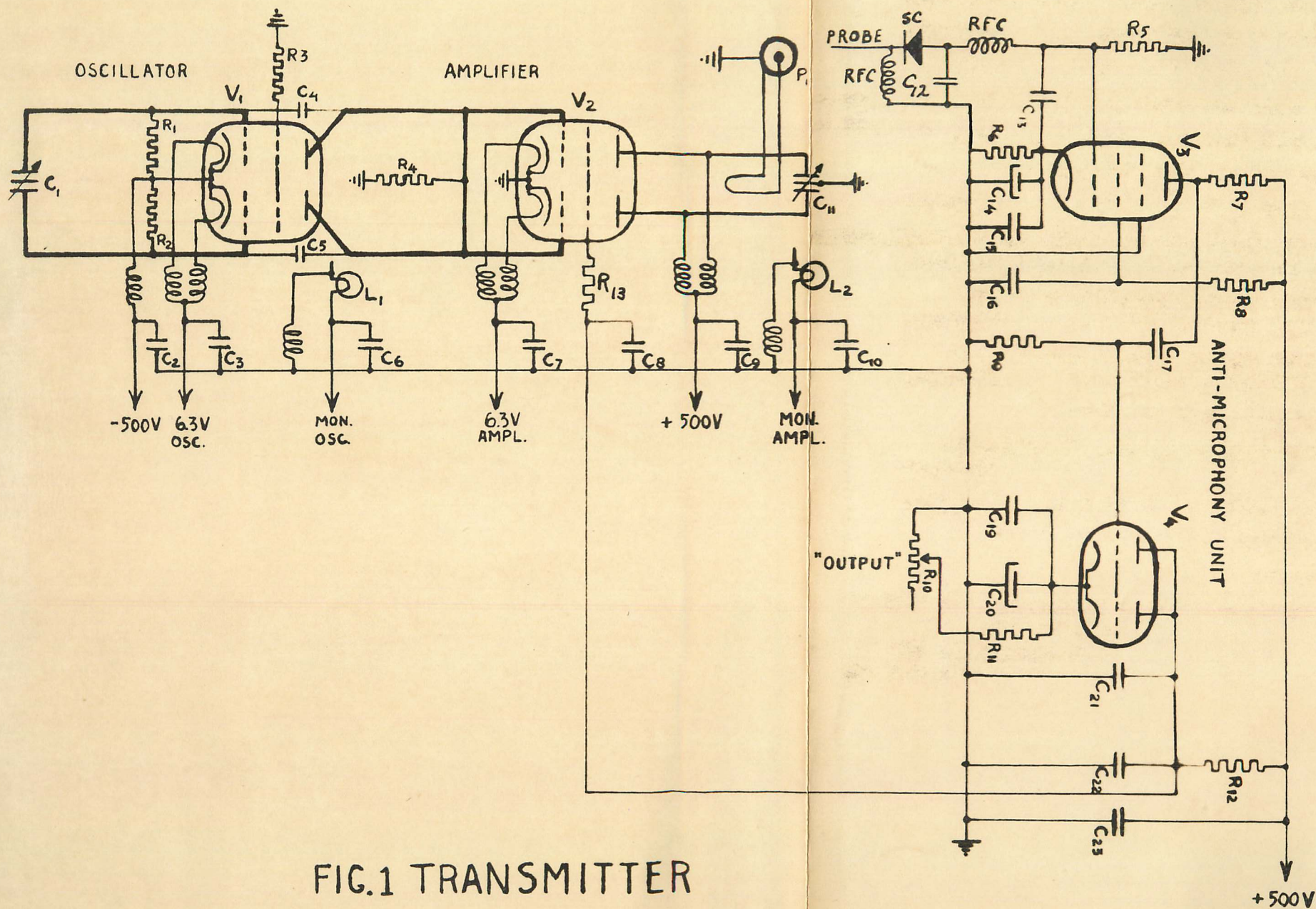
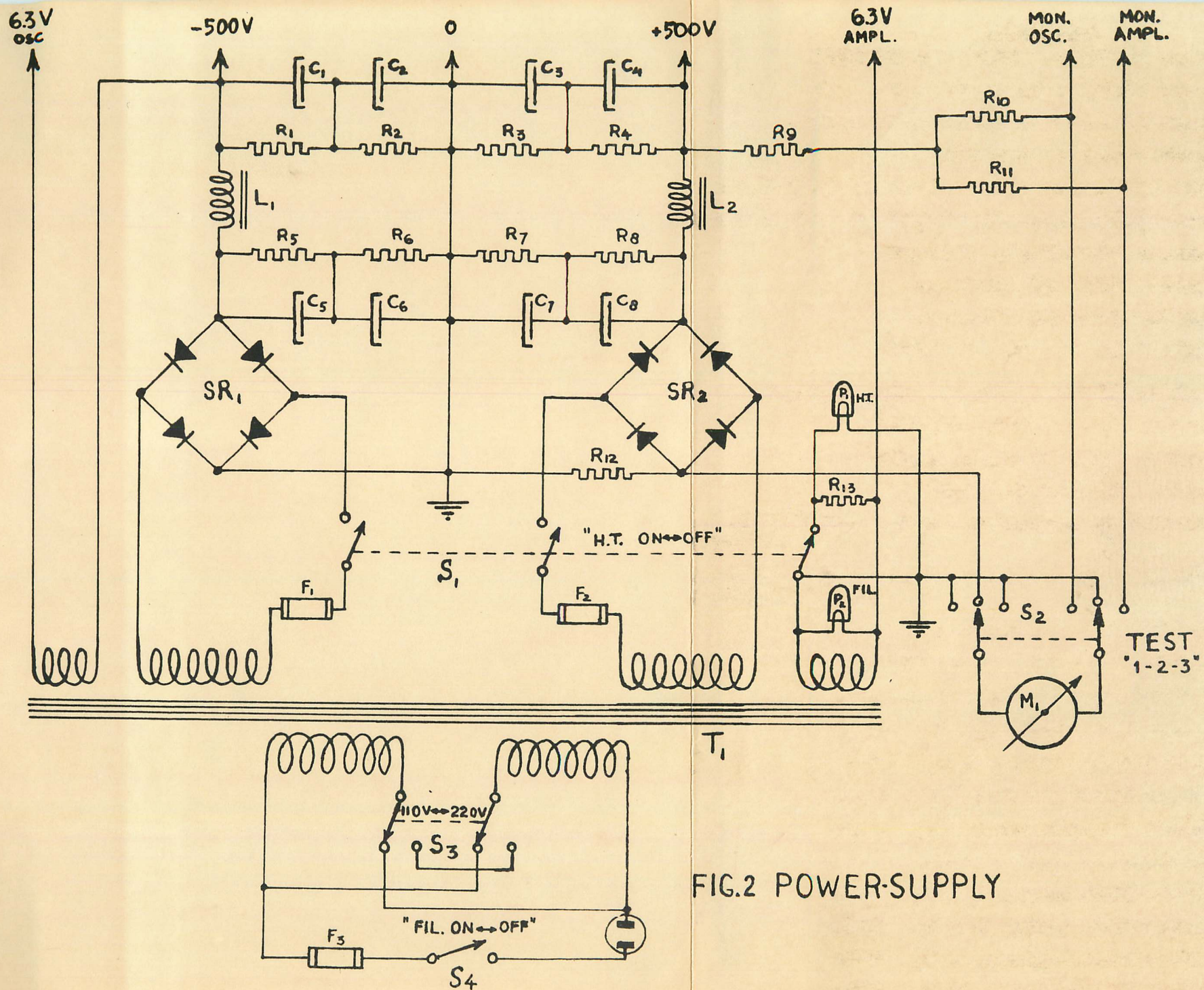


FIG.1 TRANSMITTER

TRANSMITTER POWER SUPPLY

$C_1, C_2, C_3 \dots C_8$	100 μ F 450 V D.C. W.V.	Philips
L_1, L_2	chokes 8 H 225 ohms	Philips
$R_1, R_2, R_3 \dots R_8$	270.000 ohms 10% 1 W	Erie
R_9	2 x 150.000 ohms 10% 1 W	Erie in paral-
R_{10}, R_{11}	2 x 270.000 ohms 10% 1 W	Erie " "lel.
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, 66 ohms,	Ernest Turner
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 2x 430 V 2x 6,3 V.	



RECEIVER

V ₁		Philips 6F 86 - 6267 - CV 2901
V ₂		Philips 6CG83 - 12 AX 7 - CV 492
V ₃		Philips 6L 84 - 6 BQ 5 - CV 2975
C ₁	C ₂	capacitor 680 pF ceramic, T.C.C.
C ₃		electrolytic capacitor 10 μ F 12 V, S.K.F.
C ₄	C ₁₇	electrolytic capacitor 25 μ F 12,5 V, Philips
C ₅		capacitor 10.000 pF, Philips
C ₆		capacitor 1000 pF, Philips
C ₇	C ₁₅	capacitor 2200 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 ₁₆		capacitor 22.000 pF, Philips
C ₁₈	C ₂₀	electrolytic capacitor, 8 μ F, 450 V D.C. W.V., Philips.
C ₁₉		electrolytic capacitor, 8 μ F, 450 V D.C. W.V., Philips.
C ₂₁		capacitor 400 pF, Ducati
R ₂		resistor 22 ohms, 1 W, Erie
R ₃		resistor 470.000 ohms, 1 W, Erie
R ₄		resistor 2200 ohms 0,5 W, Erie
R ₆		resistor 2,2 Megohms, 1 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	resistor 27.000 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 2.700 ohms, 1 W, Erie
R ₂₃	resistor 15 ohms, 1 W, Erie
R ₂₄	resistor 470.000 ohms, 1 W, Erie
T ₁	input transformer 1:22, Unitram
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
L ₃	choke 5 H 425 ohms, Philips
M ₁	moving coil test meter, full scale deflection 0,5 mA, 66 ohms, Ernest Turner.
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

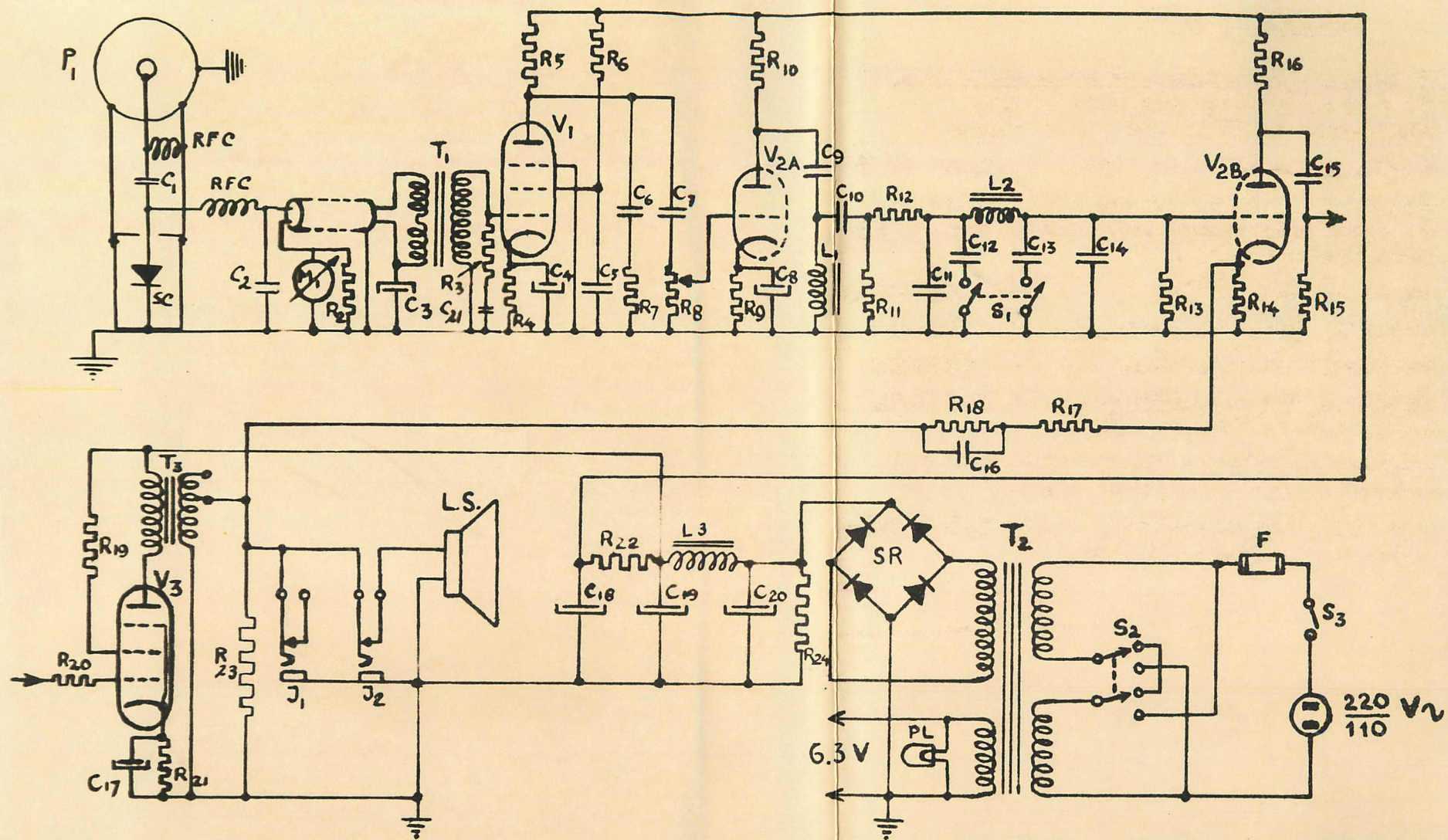
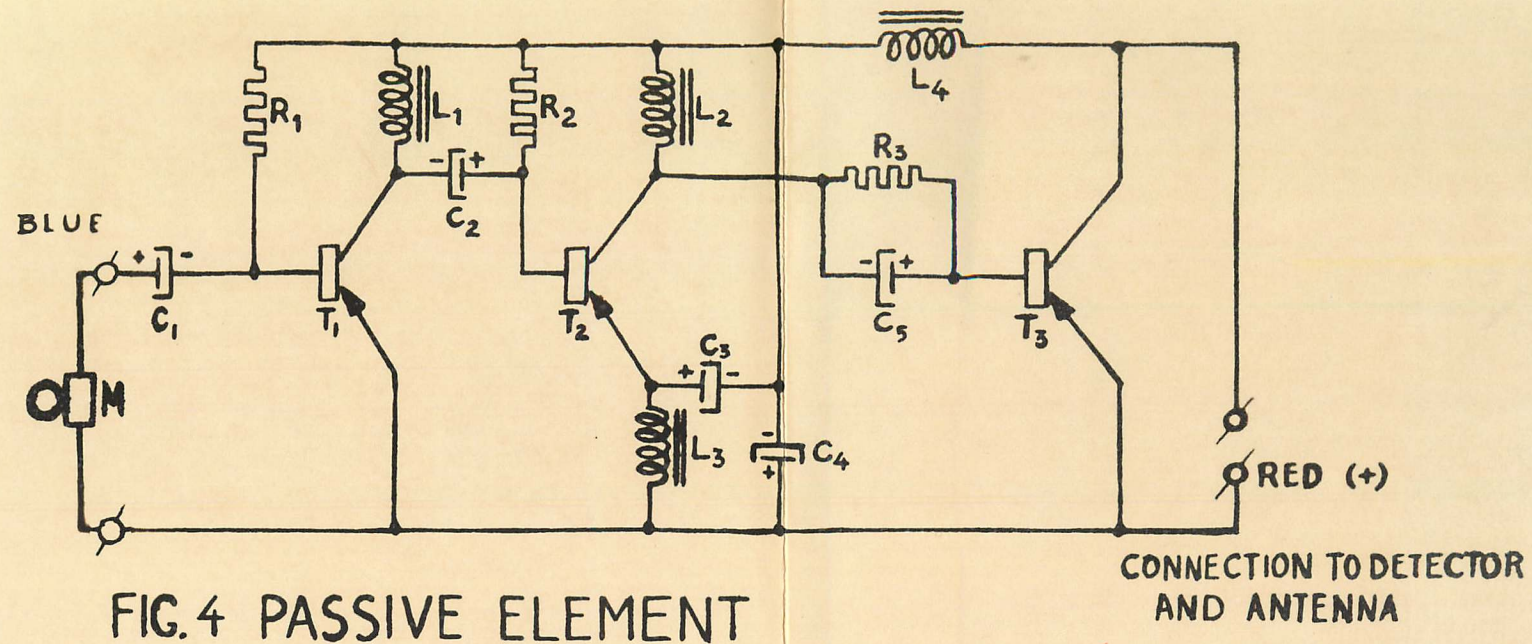
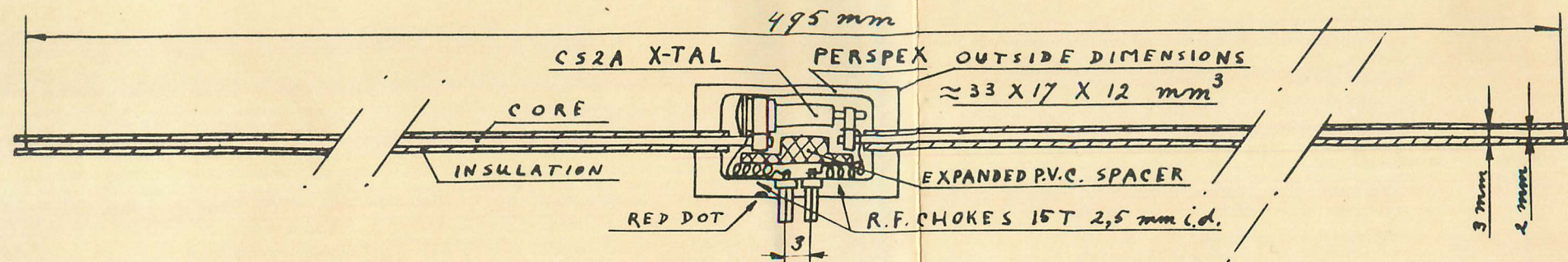


FIG.3 RECEIVER

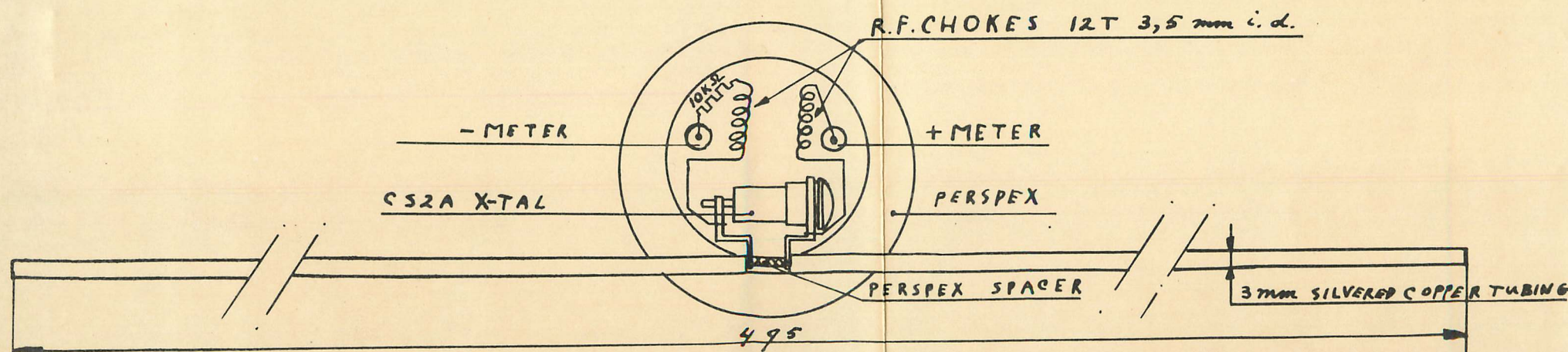
PASSIVE ELEMENT

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	resistor 330.000 ohms, 0,25 W, Vitrohm
R ₂	resistor 220.000 ohms, 0,25 W, Vitrohm
R ₃	resistor 22.000 ohms, 0,25 W, Vitrohm
C ₁ , C ₂ , C ₅	electrolytic capacitor, 2 μ F, 8 V D.C. W.V., T.C.C. type CE 58 A.
C ₄	electrolytic capacitor, 4 μ F, 4 V D.C. W.V., T.C.C. type CE 58 AA.
C ₃	electrolytic capacitor, 6 μ F, 1,5 V D.C. W.V., T.C.C. type CE 58.





PASSIVE ELEMENT



POWER MONITOR (BACK VIEW)

FIG 5

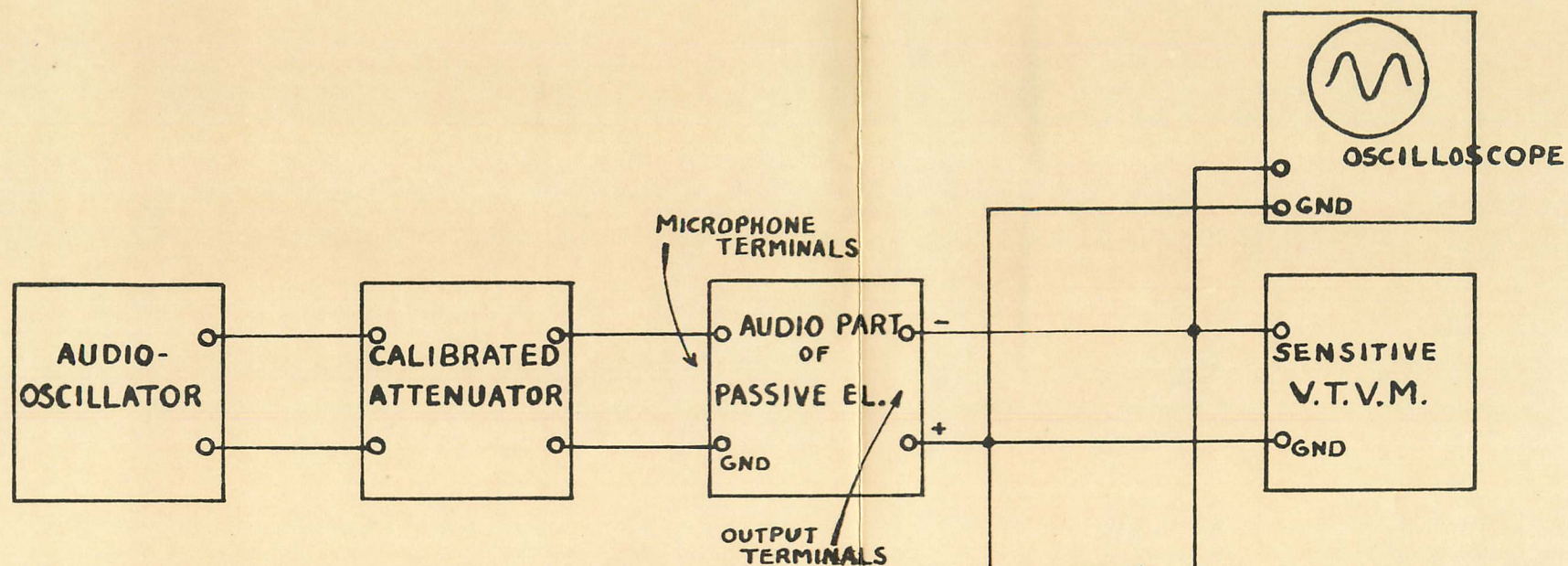
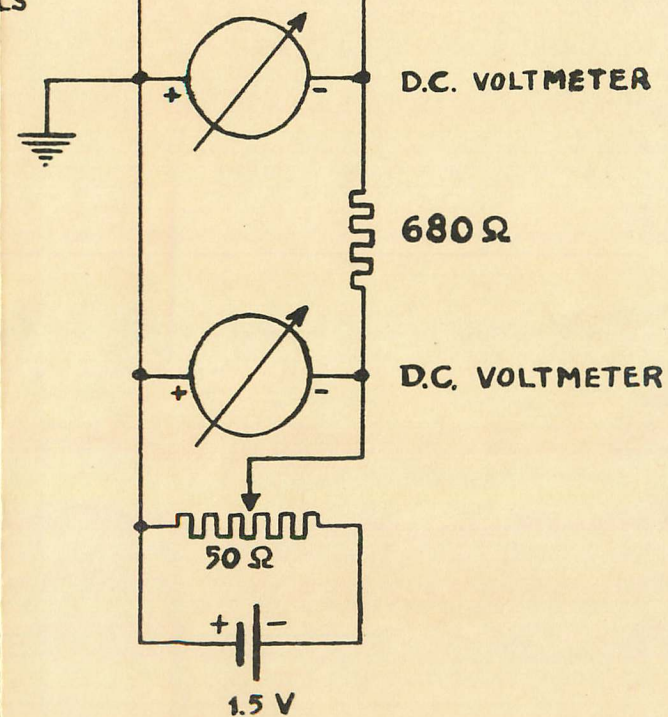


FIG.6 TEST CIRCUIT FOR
PASSIVE ELEMENT



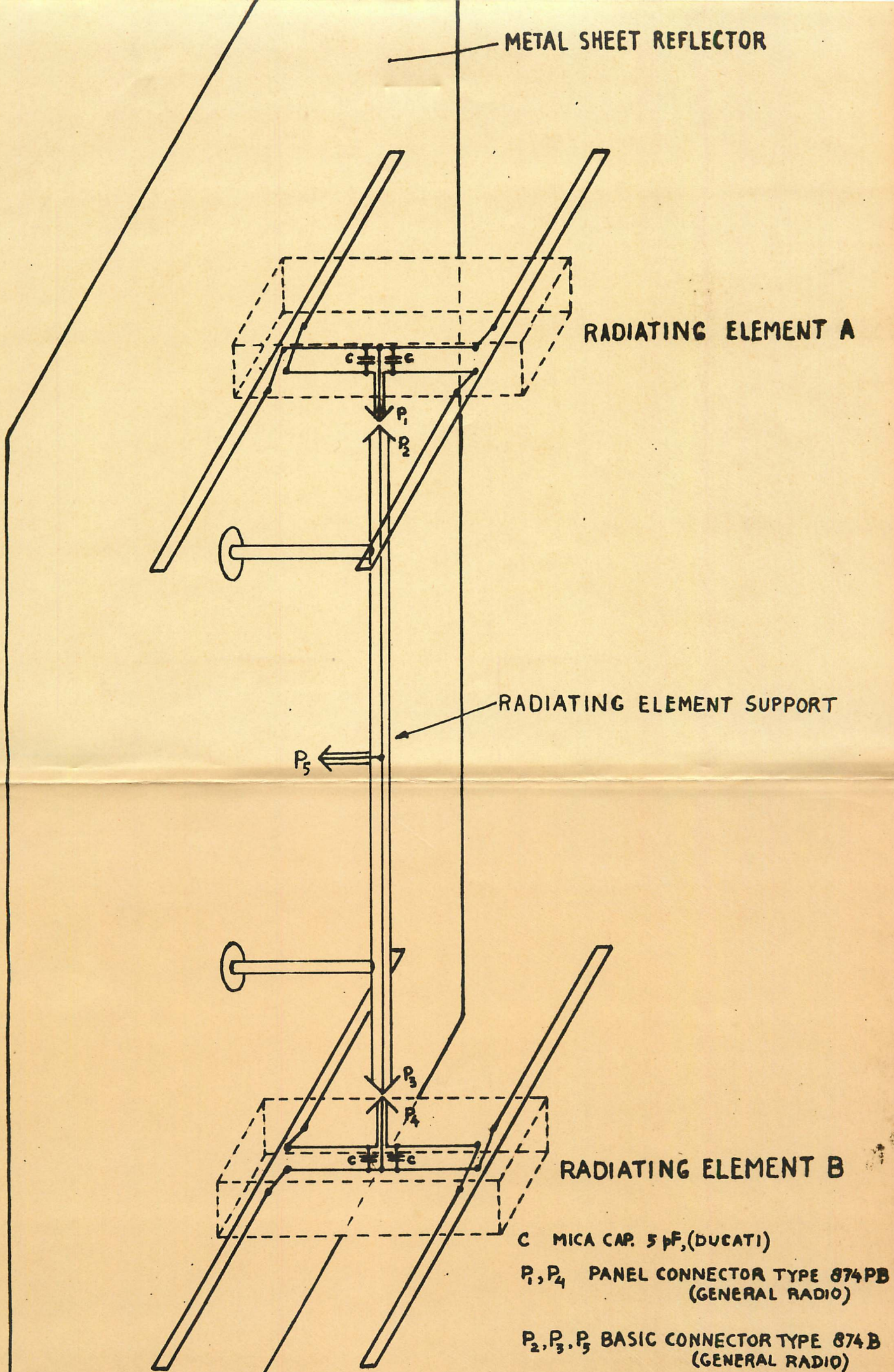
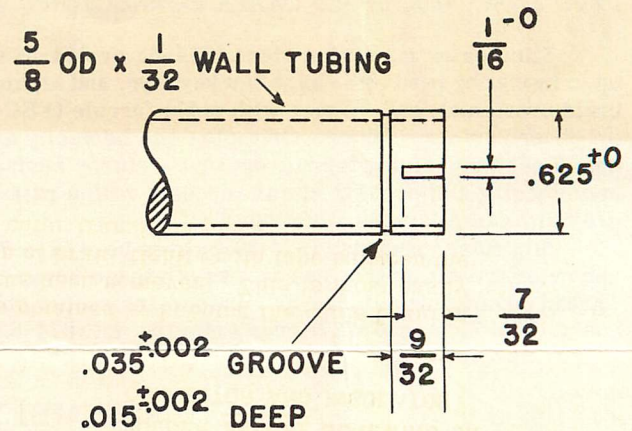
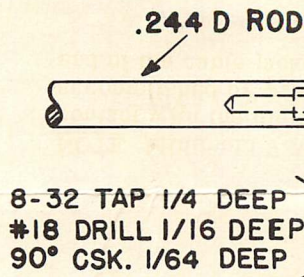


FIG. 7 ANTENNA-ARRAY

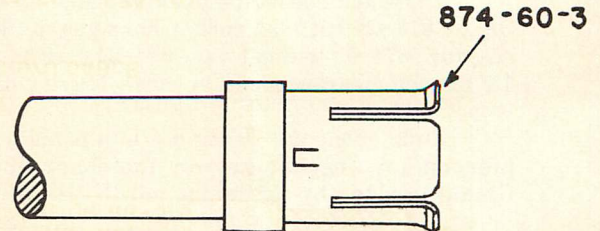
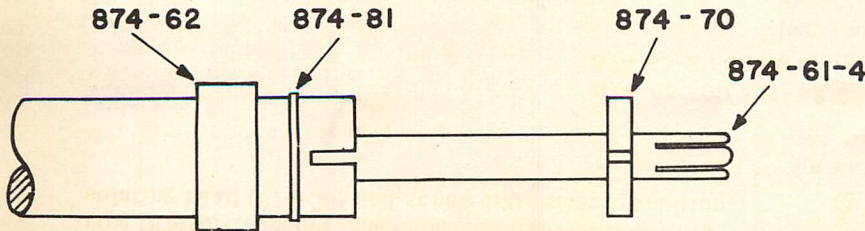
ASSEMBLY INSTRUCTIONS GENERAL RADIO TYPE 874-B BASIC CONNECTOR

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).



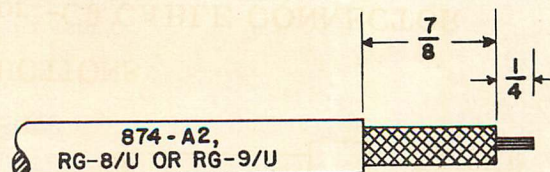
ASSEMBLY INSTRUCTIONS

GENERAL RADIO TYPE 874-C, -C8, or -C9 CABLE CONNECTOR

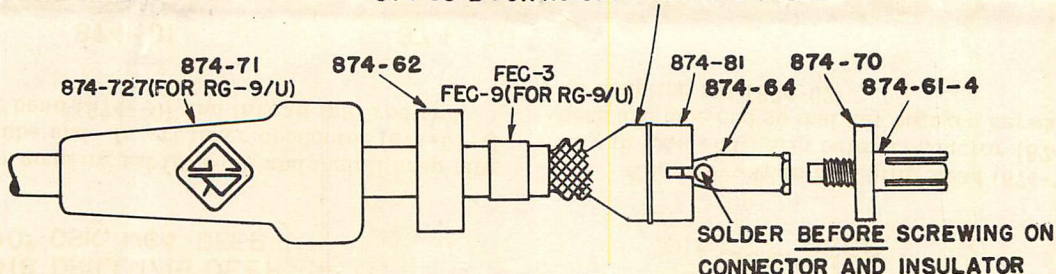
Remove cable jacket and insulation to expose braid and inner conductor to dimensions shown.

Slip on cord guard (874-71 or 874-727) using talc if necessary, coupling nut (874-62) and cable ferrule (FEC-3 or -9). 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.



874-63 FOR 874-A2 CABLE
874-63-2 FOR RG-8/U OR RG-9/U CABLE

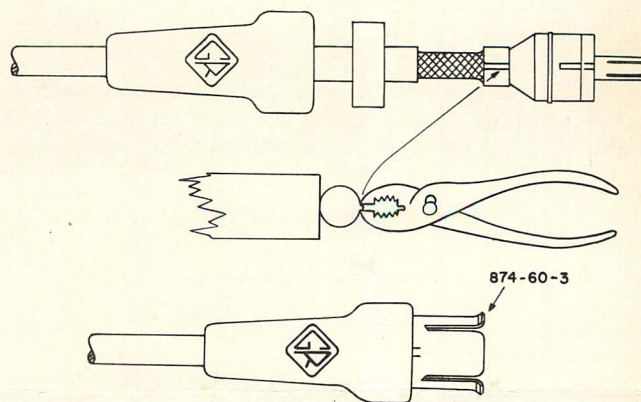


NOTE Minimum VSWR at high frequencies is obtained by keeping the cable braid in contact with the dielectric where the jacket has been removed. This is most easily accomplished by wrapping the exposed portion of braid tightly with tape between the end of the cable jacket and the ferrule on the outer transition piece.

**ASSEMBLY INSTRUCTIONS GENERAL RADIO
TYPE 874-C, -C8, or -C9 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 (FEC-3 or -9) 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.

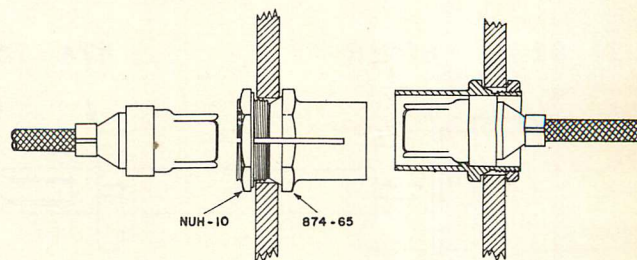
Slip outer conductor (874-60-3) over bead (874-70) and outer transition piece so that keys engage keyways. Thread up coupling nut (874-62), and stretch rubber cord guard (874-71 or 874-727) over coupling nut (874-62).



**ASSEMBLY INSTRUCTIONS
GENERAL RADIO TYPE 874-P, -P8, -P9, -PC, -PC8
or -PC9 PANEL CONNECTOR**

Assemble connector to cable same as 874-C, 874-C8, or 874-C9 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).



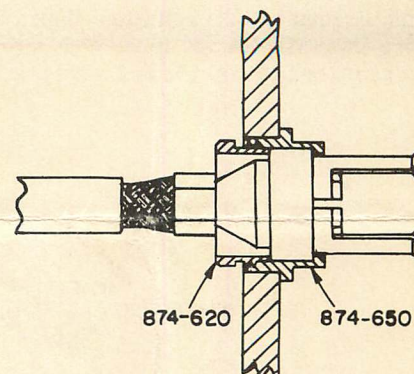
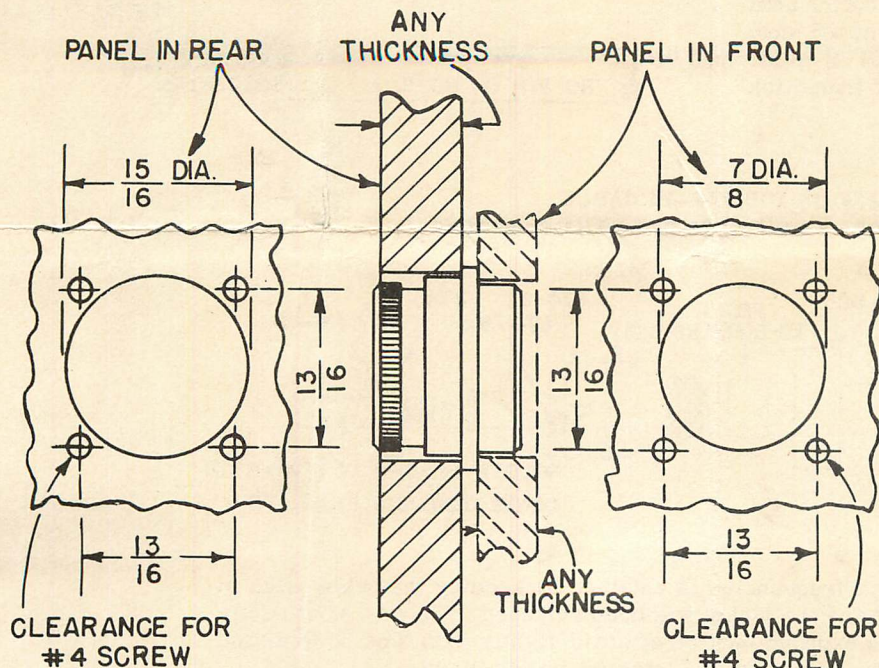
ASSEMBLY INSTRUCTIONS

GENERAL RADIO TYPE 874-PB, -PB8, or -PB9 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, or -C9 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 groove on the side of the cable connector. Tighten up knurled retaining nut (see diagram).



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