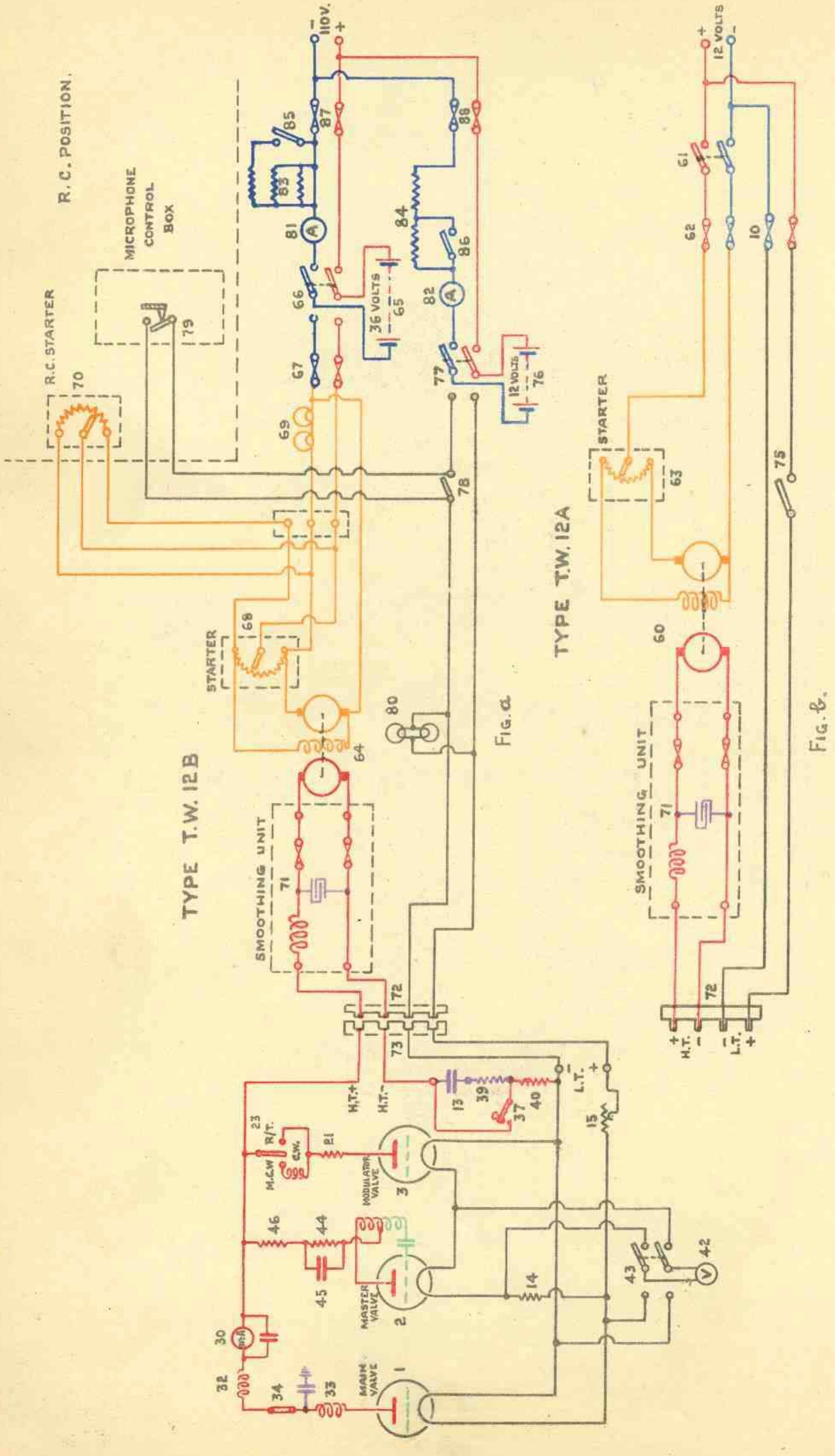
SUB - SECTION

RY

TYPE TW 12 A AND TW 12 B PAGE RY1

TYPE TW12A AND TW12B

POWER SUPPLIES



Date of Design:- 1935.

Transmitter TW12 and its associated receiver 394E are commercial sets which have been adopted for Naval use in small craft. Type TW12A consists of transmitter TW12 and receiver 394E, the supplies for which are obtained from rotary converters driven from the ship's 12 volt D.C. supply. This set is fitted in motor torpedo boats, motor M/S boats, etc.

Type TW12B consists of transmitter TW12, receiver 394E and Naval receiver outfit CSB (see page C19). This is fitted in A/S, M/S trawlers, etc., and obtains its supplies as follows:-

Transmitter H.T. from rotary converter driven by 36 volt battery.
Transmitter filament from 12 volt battery.
Receivers H.T. from 144 volt battery.
Receivers filament from 2 volt battery.

Transmitting Set.

Frequency range:-	M/F 375-500 kc/s.
	I/F 1200 - 3000 kc/s (seven pre-selected frequencies).
Valves used:-	One NT39 (main valve).
	Two NT40 (master and modulator valves).
Power Supply:-	H.T. from rotary converter 1500 volts.
Filament Supply:-	TW12A, Ship's 12 volt D.C. mains.
	TW12B, 12 volt battery, pattern 5503 cells.
Associated Wavemeter:-	G9 (see page GA11).
Approximate range in miles:-	M/F 200 miles.
	I/F Variable up to about 1000 miles.
Wave form:-	C.W., M.C.W. and R/T.

(Note:- Since this is a commercial set and the markings on it do not conform with Service nomenclature, the term "I/F" has been used to denote the higher frequency range, which is actually contained in the Service M/F band.)

POWER SUPPLY

D.C. Input Supply.

Type TW12A (see figure b). Power supply to the rotary converter (60) is obtained from the ship's 12 volt mains via the main supply switch (61), 25 amp fuses (62) and a hand starter (63).

Type TW12B (see figure a). Power supply to the rotary converter (64) is obtained from a 36 volt battery (65) consisting of pattern 6038A cells, via a charge-discharge switch (66), 15 amp fuse (67) and a hand starter. Two 20 volt 16 c.p. indicating lamps (69) in series are connected in parallel with the armature of the rotary converter (64); they glow when the starter is moved and reach full brilliancy when the machine is running at full speed. This effect is due to the effective resistance of the armature increasing as the converter gathers speed. A second starter (70) is fitted in the remote control position and is connected in parallel with the W/T office starter.

H.T. Supply.

Types TW12A and B. The 1500 volt output from the rotary converter is connected through a smoothing unit (71) to two points of a four point power plug (72) on the side of the transmitter. The plug and the cover of the smoothing unit should not be removed while the machine is running.

L.T. Supply.

Type TW12A. The filament supply to the transmitting valves is obtained direct from the ship's 12 volt mains, and is connected to the H.T. and L.T. power plug (72) through 10 amp fuses (10). A single pole tumbler switch (75), fitted on the operator's bench, breaks the positive filament supply.

Type TW12B. The filament supply is obtained from a 12 volt battery (76) consisting of pattern 5503 cells, via a charge-discharge switch (77) and a single pole tumbler switch (78). The latter is fitted on the operator's bench and breaks the positive filament supply. A door switch (79) on the microphone control box in the remote control position is wired in parallel with switch (78) and completes the supply when the door is opened. This is indicated to the operator in the W/T office by two 20 volt lamps (80) wired in parallel across the L.T. supply.

The filament of the main transmitting valve (1) is fed in parallel with the filaments of the master oscillator valve (2) and modulator valve (3) which are in series. A resistance (14) of approximately 1 ohm is connected in series with the two latter valves. Final adjustment of the filament voltage of all valves is provided by the filament rheostat (15). A voltmeter (42) and change-over switch (43) enable the voltage of either the main or master valve to be read.

The L.T. supply also provides current for the keying circuit and, when using R/T, for the microphone circuit.

Battery Charging Circuits (see fig. a).

In type TW12B, the 36 and 12 volt batteries are charged from the ship's 110 volt mains via charge-discharge switches (66)(77), fuses (87)(88) and charging resistances (83)(84). The charging rate is controlled for normal and maximum charge, by the tumbler switches (85)(86) and indicated by ammeters (81)(82).

MASTER OSCILLATOR CIRCUITS

SIMPLIFIED DIAGRAMS

M/F

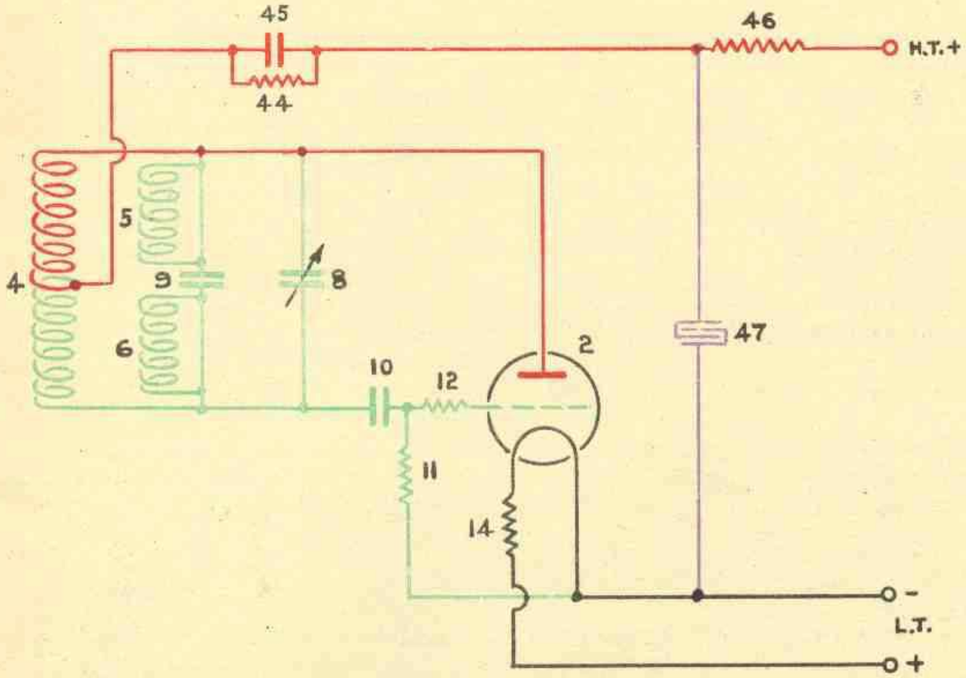


FIG.C

I/F

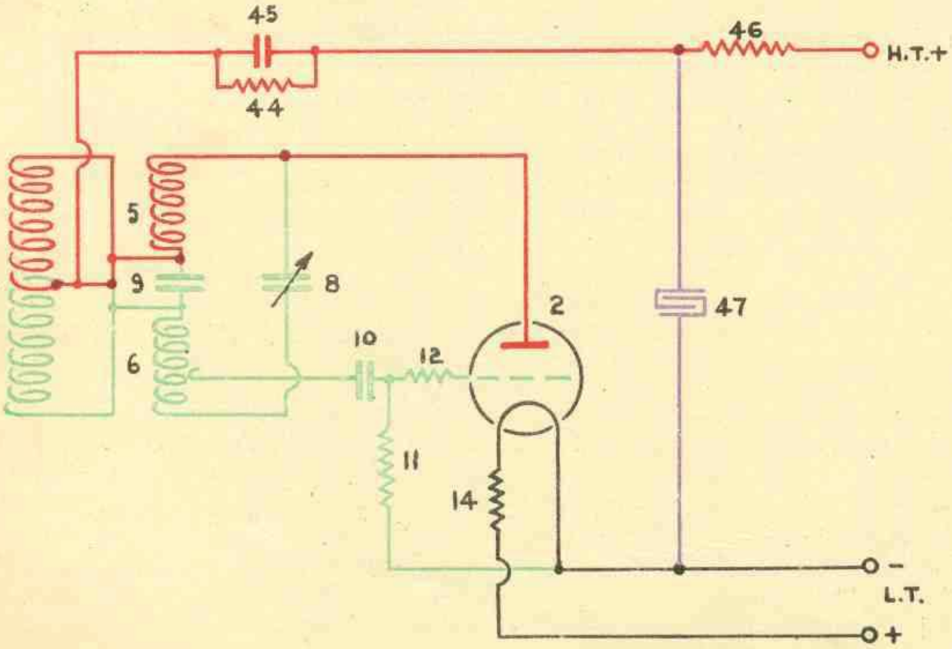


FIG.d

TYPE TW 12A AND TW 12B

OSCILLATORY CIRCUITS

Reference:- Admiralty Handbook of W/T (1938) Para. K39.

Wave form	Method of Producing Oscillations.	Nature of Circuit		Grid Excitation		Feed		Aerial Excitation	High Oscillating Potential Electrode
		Master.	Main.	Master.	Main.	Master.	Main.		
C.W M.C.W. or R/T	Master Controlled	Tuned circuit between anode and grid	Tuned circuit between anode & filament	Direct Inductive	Inductive from master circuit.	Series	Parallel	Direct Inductive	Anode

The transmitting circuit consists of a master oscillator circuit capacity coupled to a single valve amplifying stage. A modulator circuit can be capacity coupled to the grid circuit of the main transmitting valve (1).

Fig. 1 is a diagram of the complete transmitting circuits.

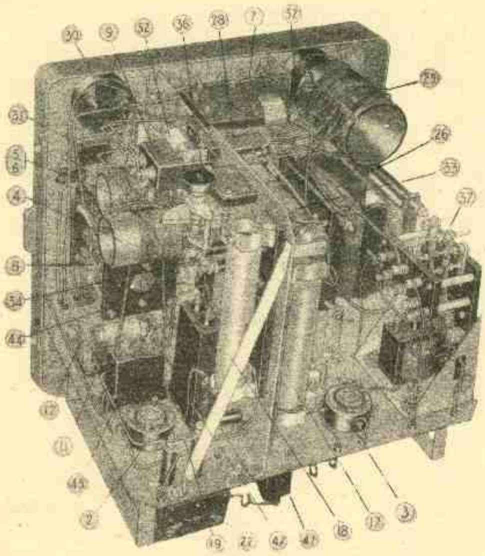


FIG. e

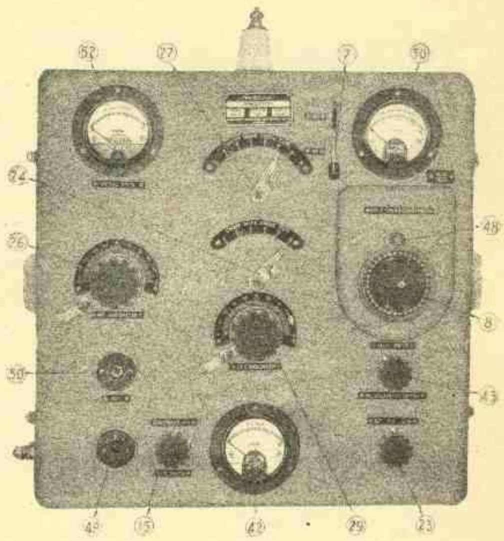


FIG. f

Master Circuit. On the M/F band (see fig. c) the circuit consists of the M/F tuning coil (4) and a 0.00039 μF variable condenser (8) in parallel with a 0.0003 μF fixed condenser (9). Both the I/F tuning coils (5)(6) are short circuited.

On the I/F band (see fig. d) the circuit consists of the two I/F tuning coils (5)(6) in series, tuned by the variable condenser (8). Both the M/F tuning coil (4) and fixed condenser (9) are short circuited.

Change over from the M/F band to the I/F band is effected by two contacts of the 5 pole frequency band C.O.S. (7).

The anode of the master valve (2) is connected direct to one end of the tuning coil, the grid of the valve being connected through a 30 ohm anti-parasitic resistance (12) and a grid condenser (10) to a tapping on the I/F tuning coil (6). When on the M/F band, this may be considered as being connected to the end of the M/F tuning coil (4) as the I/F coil is then short-circuited. A 30,000 ohm grid leak resistance (11) is connected to L.T. negative. The H.T. supply is fed to the centre of the tuning coils, through two resistances (44)(46) of 300 and 30,000 ohms respectively. A 0.0002 μF condenser (45) is fitted in parallel with resistance (44) and a 1 μF condenser (47) is connected to earth from a point between the two resistances as a R/F earth. Resistance (44) serves to damp out oscillations tending to unbalance the neutralizing circuit (see fig. 1). Since these oscillations are more prevalent on low frequencies, the impedance is made to increase with decreasing frequency, by shunting the resistance with condenser (45).

MAIN OSCILLATORY CIRCUITS

SIMPLIFIED DIAGRAMS

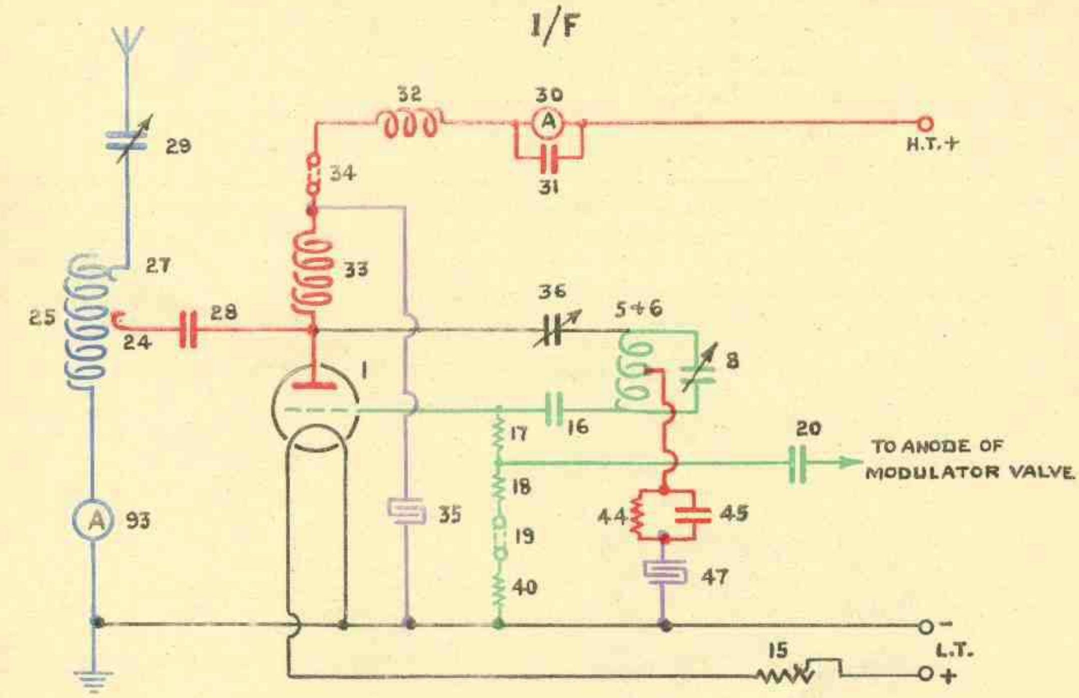


FIG. g.

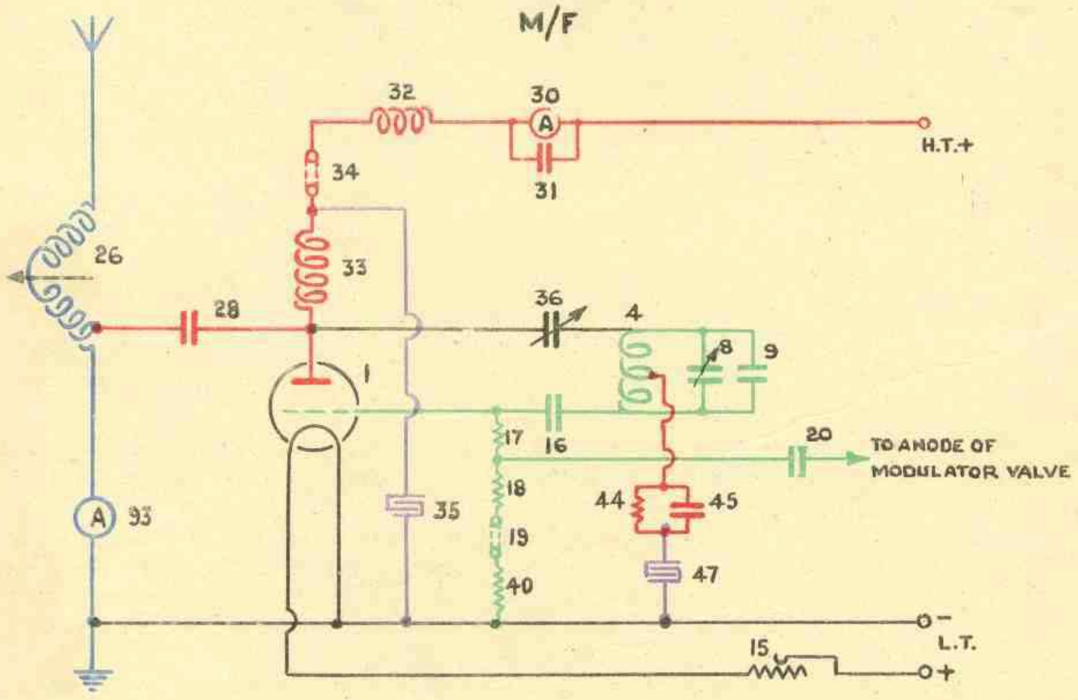


FIG. h.

Main Circuit (see figs. g & h). The output from the master circuit is coupled to the main valve (1) through the grid condenser (16). A 6000 ohm grid leak (17) is connected in series with a 5000 ohm resistance (18) to provide negative grid bias. A link (19) is provided to allow the insertion of a milliammeter to measure grid current when neutralizing with condenser (36). The anode of the valve is connected through the anode blocking condenser (28) and, according to the position of one contact of the frequency band C.O.S. (7), to either the variable anode tap (34) on the I/F aerial coil (25) or the fixed anode tap on the M/F aerial tuning variometer (26). The low potential end of the I/F aerial coil is connected to earth through the aerial ammeter (93). The low potential end of the M/F variometer is connected via a contact of the switch (7) to the end of the I/F aerial coil. When the switch (7) is in the I/F position it short circuits the M/F variometer.

The aerial is connected to the main circuit by one contact of the magnetic key (37) which operates as a send-receive switch, and by one contact of the frequency band C.O.S. (7). When this is to M/F the aerial is connected direct to the M/F variometer. When it is to I/F the aerial is connected through the aerial tuning condenser (29) to a variable tap (27) on the I/F aerial coil.

The H.T. supply for the main valve is fed through the anode ammeter (30) with its R/F by-pass condenser (31) and the two anode chokes (32)(33). A link (34) is provided to enable the H.T. supply to be broken when neutralizing. A R/F earth is provided via a 1 μF condenser from a point between the two anode chokes.

MODULATOR CIRCUITS SIMPLIFIED DIAGRAMS

M.C.W.

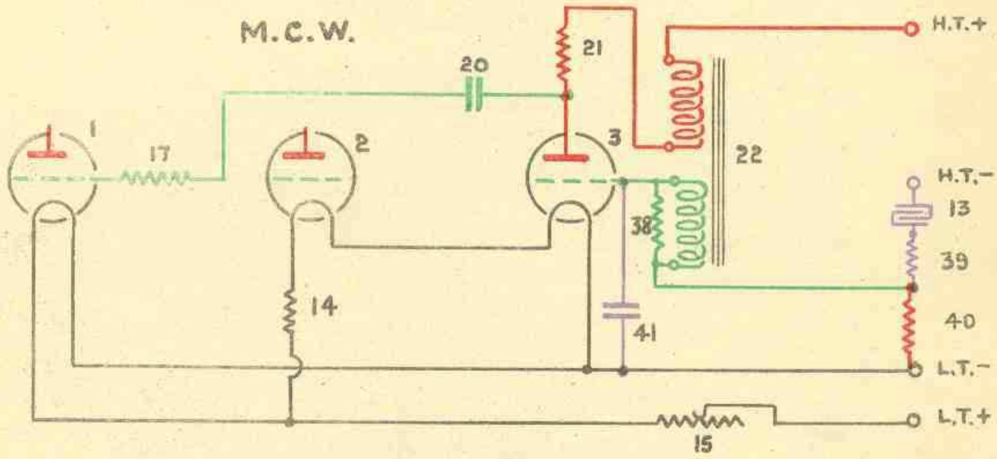


FIG. i.

R/T.

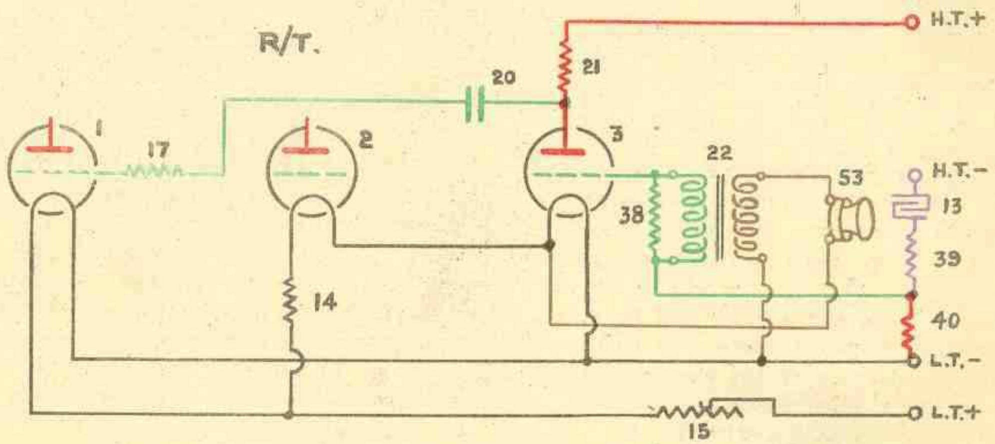


FIG. j

Modulator Circuit. The choice of modulation is controlled by the C.W.-M.C.W.-R/T switch (23). The functions of the circuit in the various positions of the switch are as follows:-

C.W. The anode circuit of the modulator valve (3) is disconnected and the microphone circuit is disconnected from the L.T. positive supply. The modulator valve will continue to burn at full brilliancy.

M.C.W. (See fig. i). Modulation of the transmitted frequency is by the grid control method (see Admiralty Handbook of W/T (1938) Para. N23). The switch (23) connects a 0.01 μF condenser (41) in parallel with the grid primary of the modulator transformer (22). This transformer has three windings. The H.T. supply to the modulator valve is fed through the anode secondary of the transformer and a 30,000 ohms resistance (21); the windings of the two secondaries are of such a value that a 1000 cycle note is produced. The output is resistance capacity coupled to the grid of the main valve (1) through the resistance (21), 0.5 μF coupling condenser (20) and grid resistance (17).

R/T. (See fig. j). The modulator valve (3) is used in conjunction with the modulator transformer (32) as a microphone amplifier. When switch (23) is set to R/T, the H.T. supply is fed to the modulator valve through a 30,000 ohm resistance (21), and the microphone (53) is connected in series with the primary winding of the modulation transformer (22) across the filament supply to the valve (3). The speech frequency current variations from the microphone circuit are applied via the modulation transformer (22) between grid and filament of the valve, the amplified output from which is resistance capacity coupled to the grid of the main valve (1) through the resistance (22) and coupling condenser (20). A 100,000 ohm resistance (38) is connected in parallel with the grid secondary winding of the modulator transformer to ensure the stability of the modulator circuit. The grid of the modulator valve is connected to L.T. negative through a 300 ohm grid bias resistance (40). Since R/T was added after the initial design of the set, the microphone is fed in parallel with the filament of the modulator valve. As the latter is in series with the master valve filament, it follows that current variations due to speech pass through this filament giving rise to distortion.

SIGNALLING

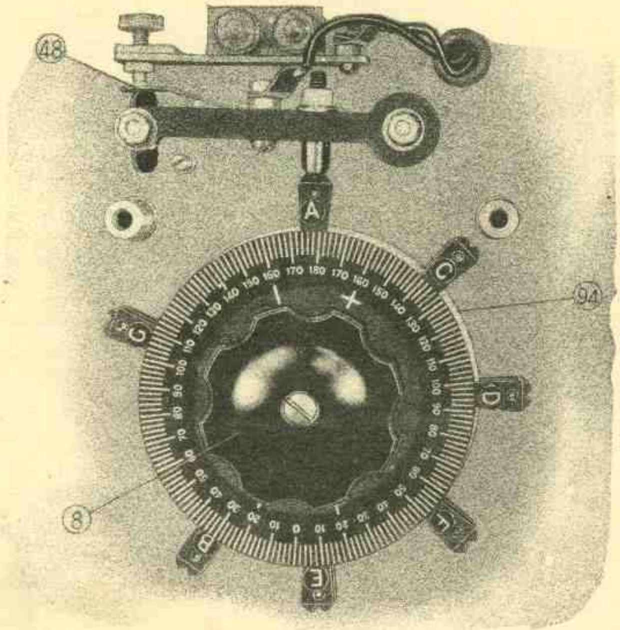


FIG. k

The transmitter is keyed by a magnetic key (37); the operating bobbin of the key is energised from the L.T. supply and controlled by a Morse key (89) or by a finger switch (52)(91) fitted on the microphone (neophone) handset. The microphone finger switch is connected in parallel with the morse key when the microphone seven point plug (51) and socket connection (49) is made.

The positive L.T. supply to the magnetic key (37) is fed through two spring contacts (48) in the "Spot frequency" switch (see fig. k). This switch is used only on I/F and is operated by one of seven "cam stops" marked "A" to "G" and arranged round the edge of a circular plate (94) mounted on the spindle of the master tuning condenser (8). These cam stops can be set to any position on the circumference of the plate corresponding to any selected condenser reading and consequently to any selected frequency. When the master tuning condenser is set to any of positions "A" to "G" for one of the seven "spot frequencies", the point on the plate to which the appropriate "cam stop" has been adjusted is uppermost, and the spring-fingers (48) are closed. Transmission on the I/F band can thus only take place on a pre-selected frequency as, in any intermediate position of the master condenser, the spring fingers are open. On M/F the fingers are permanently closed by the mechanical action of the frequency band C.O.S. (7) as there is no "spot frequency" tuning on the M/F band.

The magnetic key (37) has three contacts, one of which operates as a send-receive switch to enable listening through to be carried out (except on R/T), while the other two key the transmitter. When they make, they complete the grid-filament circuit of the main valve (1) and connect H.T. negative to L.T. negative through the 300 ohm bias resistance (40) by short-circuiting the key condenser (13) and resistance (39).

TRANSMITTER TW12

CIRCUIT DIAGRAM

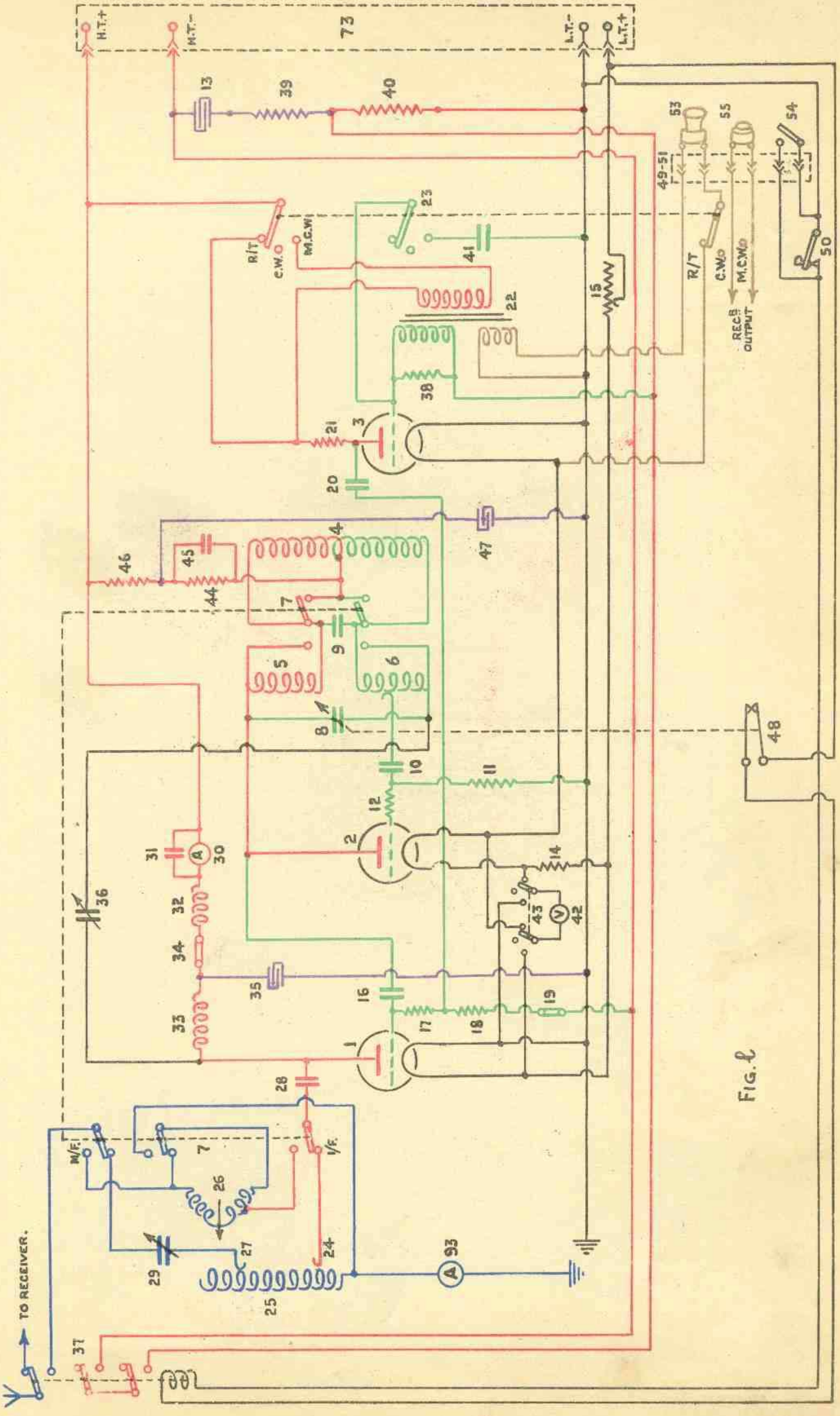


FIG. 2

TYPE TW12A

REMOTE CONTROL CIRCUITS

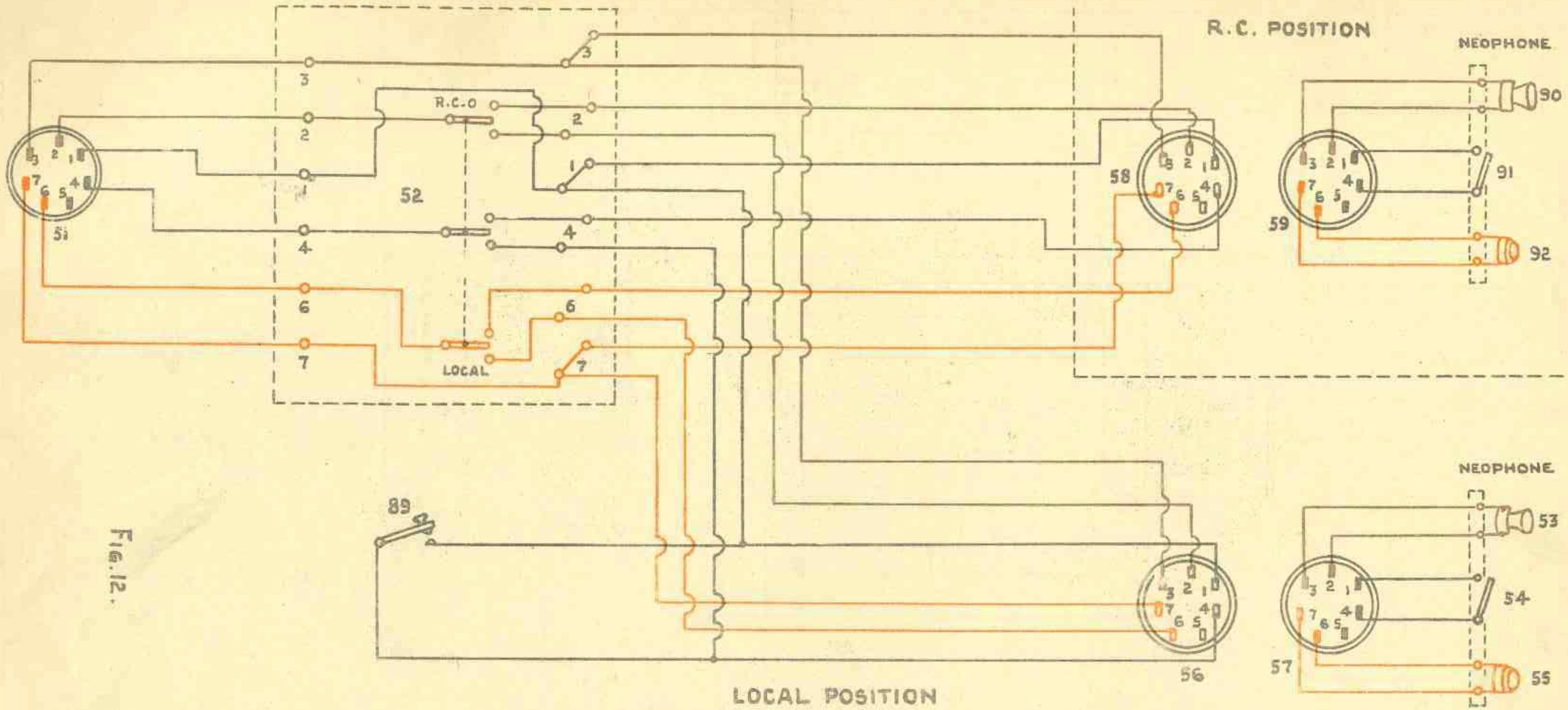


Fig.12.

Fig. m.

The Morse key lead plugs into a socket (50) on the front of the transmitter. The transmitter can also be controlled for R/T transmission only from both the local and remote control positions (see figs. m & n). A plug (51), which fits into the socket (49) on the front of the transmitter, is connected by a six core cable to a C.O.S. (52), which puts the transmitter in either local or remote control. The output from the C.O.S. (52) is connected to two seven-point sockets (56)(58) fitted in the local and R.C. positions in type TW12A, and to a seven point socket (56) in the local position and a microphone control box in the R.C. position of type TW12B. A microphone (Neophone) hand set is fitted in each of the positions. The set consists of a microphone (53)(90), telephone receiver (55)(92) and finger switch (54)(91) and is connected to a seven-point plug (57)(59) which fits into the socket (56)(58). Stowage clips are provided for the hand set and care must be taken to see that these do not foul the finger switch as, if the set is switched on, the carrier wave will be radiated and the receiver aerial disconnected. The microphone control box in the R.C. position of type TW12B is fitted with a door switch (79), which is connected in parallel with the local position filament switch (78) and serves to complete the L.T. supply from the R.C. position when the door is opened. This door must be closed and the R.C. starter switched off when not transmitting to avoid unnecessary discharge of the batteries.

TYPE TW12B

REMOTE CONTROL CIRCUITS

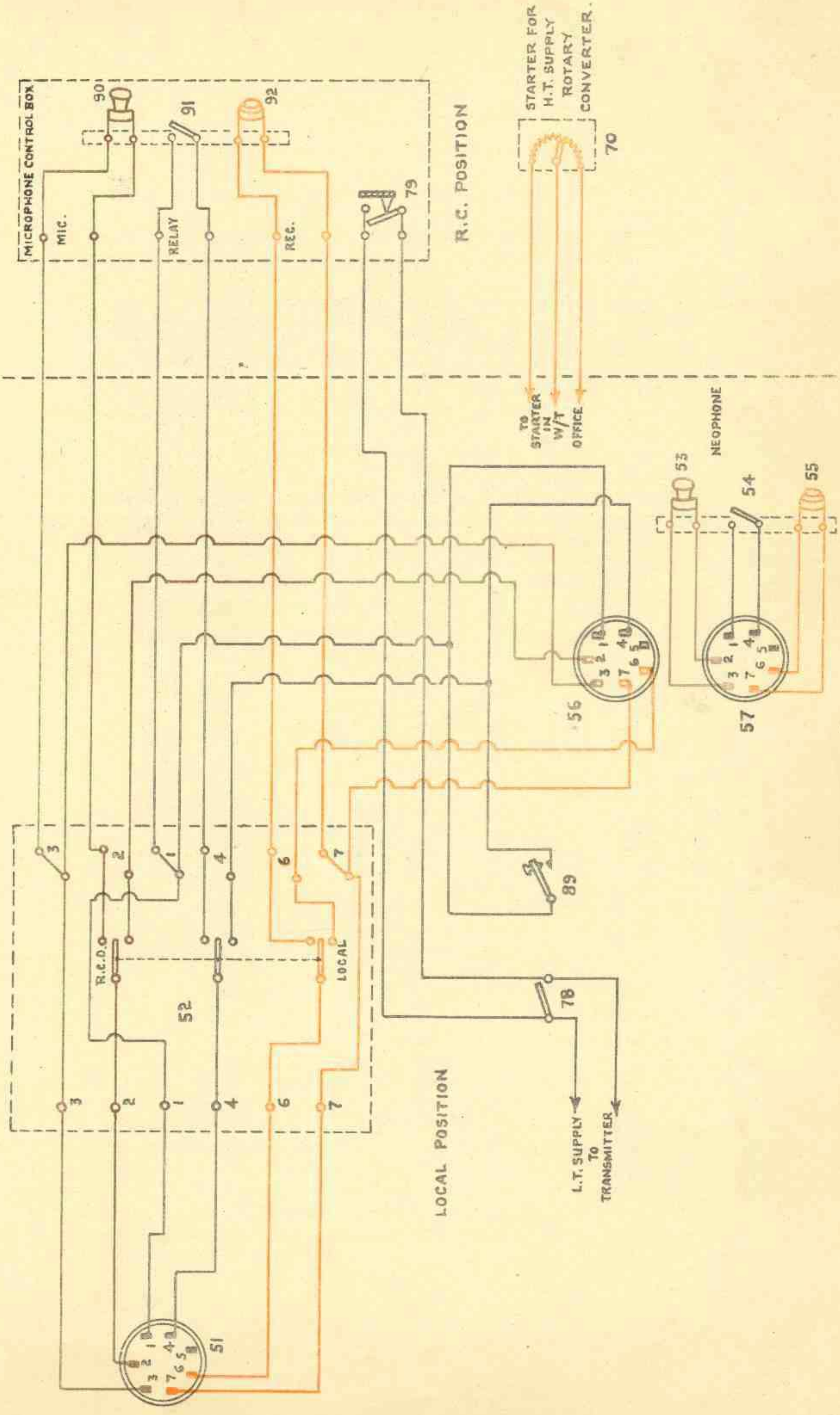


Fig. 11.

Tuning. A list of typical adjustments is supplied with each transmitter by the manufacturers but tuning should be carried out on first installation and subsequently as necessary. The procedure is as follows:-

I/F. (1) Switch on the transmitter and set it to "C.W.".

(2) Set the frequency band C.O.S. (7) to I/F.

(3) Slack back the nut securing the spot frequency cam selected and set the cam groove so as to close the spring-fingers (48).

(4) Press the key and tune the master circuit to the wavemeter by means of the master tuning condenser (8).

(5) Adjust the I/F aerial tapping switch (27) until a decrease in anode current is observed in the milliammeter (30).

(6) Tune the aerial circuit for minimum anode current by means of the I/F aerial tuning condenser (29).

(7) Adjust the I/F anode tapping point switch (24) to give maximum aerial current.

(8) Make the final adjustments to the master tuning condenser (8) and the I/F aerial tuning condenser (29).

(9) Finally, tighten up the nut securing the spot frequency cam stop.

The above procedure should be carried out for each of the seven selected "Spot frequencies" and the cam stops adjusted accordingly.

M/F. (1) Switch on the transmitter and set it to "C.W.".

(2) Set the frequency band C.O.S. (7) to M/F.

(3) Press the key and tune the master circuit to the wavemeter by means of the master tuning condenser (8).

(4) Tune the M/F aerial circuit by adjusting the M/F aerial variometer (26) for a minimum anode current and maximum aerial current.

(5) Make final adjustments to the master tuning condenser (8) and aerial variometer (26).

Neutralising. The adjustment of the neutralising condenser (36) is made before the transmitter leaves the manufacturers and a mark is made in pencil on the moving vanes. This adjustment should not normally require alteration but if re-adjustment becomes necessary, details of the method will be found in the Handbook supplied with each set.

RECEIVER 394E

Date of Design:- 1936.
Frequency range:- 150-3160 kc/s.
Valves and method of coupling:- Two R/F amplifiers (1)(2) ARS8 - Tuned choke capacity.
One cumulative grid detector (3) NR42.
Transformer coupled.
One A/F amplifier (5) NR39.

Receiver 394E is a tuner amplifier for use with type TW12A and TW12B. It uses two stages of R/F amplification, a detector and one stage of A/F amplification. Capacity controlled magnetic reaction is used.

From the aerial terminal (5) on the outside of the case a lead is taken to a plug and socket connection in the side of the transmitter which connects it to the receive contact of the magnetic key (37). Inside the case a lightning arrester in the form of a 250,000 ohm anti-static resistance (6) is connected between terminal (5) and the earthed case. From terminal (5) a lead is also taken through two fixed condensers (7)(8) to a plug and socket connection (10)(11) and thence to one end of the tuning inductance (12). On the side of the receiver is a "local distant" switch which, in the "distant" position short-circuits the smaller of the two condensers (9) during distant reception. In the "local" position this condenser increases sensitivity.

RECEIVER 394E CIRCUIT DIAGRAM

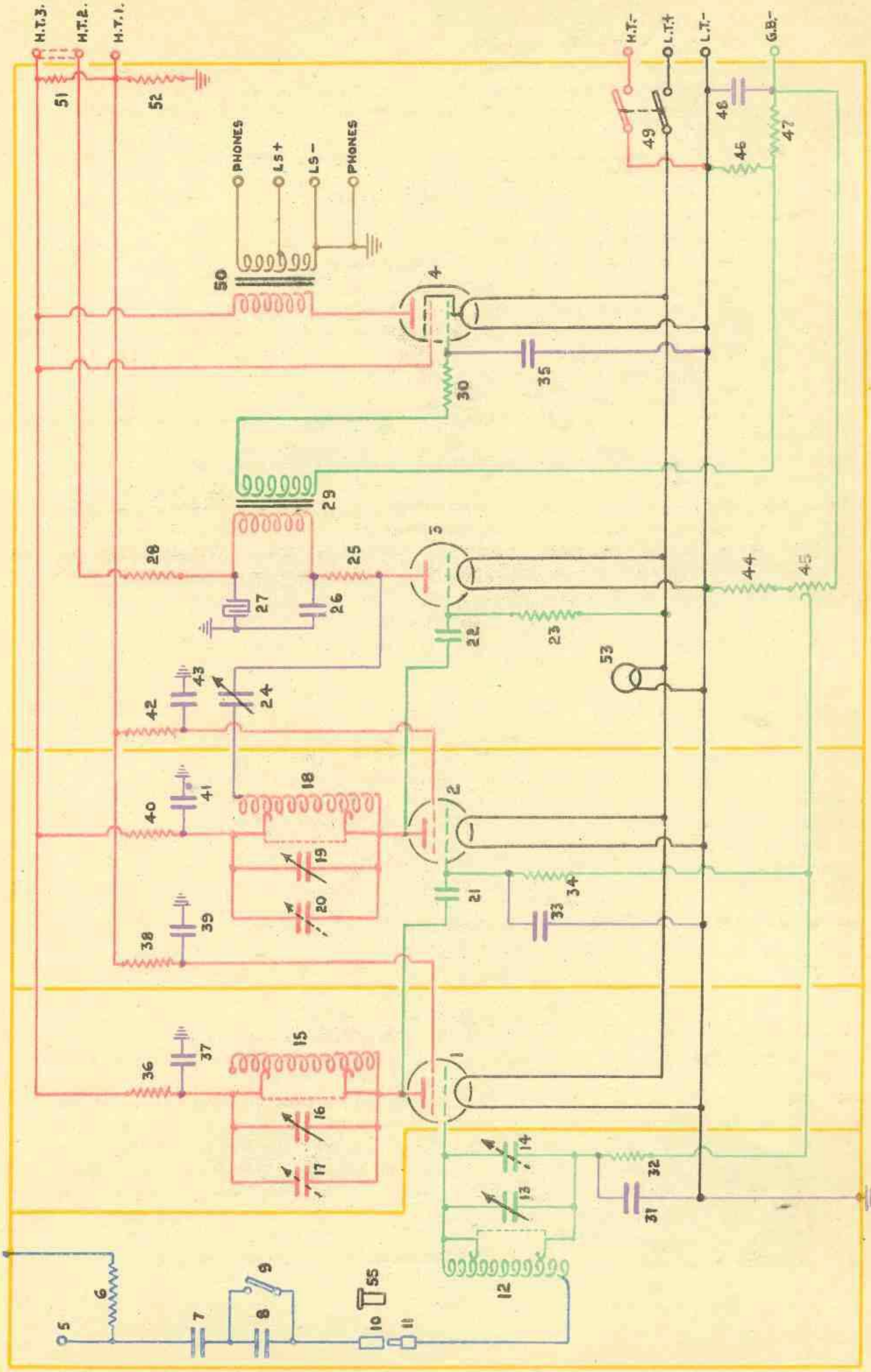


FIG. O

TYPE TW 12A AND TW 12B

The tapping switch on the tuning inductance (12) not only selects the appropriate part of the inductance to be used in the tuned grid circuit of the first R/F valve (1), but also connects a part of the unused inductance as an aerial coupling coil, thus maintaining a suitable coupling on all frequency ranges.

Three tuned R/F stages are used, these are:-

(i) Tuned grid circuit of first R/F valve (1).

(ii) Tuned anode circuit of first R/F valve (1).

(iii) Tuned anode circuit of second R/F valve (2).

All these circuits are identical and the tappings on the three inductance coils (12)(15)(18) are controlled by a single range switch (54) with four positions. The switch is marked in metres and the ranges are as follows:-

Range.	Range in Kc/s.	Switch marking in metres.
1	150 - 333	900 - 2000
2	333 - 705	425 - 900
3	705 - 1500	200 - 425
4	1500 - 3160	95 - 200

The three inductance coils, which are screened in metal cylinders, are tuned by three variable condensers (13)(16)(19) which are ganged and controlled by a single slow motion dial. There is a small semi-adjustable trimmer condenser (14)(17)(20) in parallel with each tuning condenser. These are set by the makers and should not be altered.

The coupling between the first and second R/F stages, and between the second R/F stage and the detector, is tuned choke capacity via condensers (21) and (22). Both the R/F valves are of the variable-mu screened grid type and H.T. is fed to them through the 1000 ohm resistances (36)(40). The screen potential is fed through resistances (38)(42), from a potentiometer consisting of two resistances (51)(52) connected between H.T.+ and earth. These resistances (36, 40) (38, 42) with their by-pass condensers (37, 41) (39, 43) constitute the decoupling arrangements.

The detector valve (3) operates on the cumulative grid principle and the grid leak (23) is connected to L.T.+;the H.T. supply to the valve is fed through a 5000 ohm resistance (28), the primary of the output transformer (29) and the reaction resistance (25). This resistance is used instead of the more usual choke to ensure smooth reaction over the whole range of the model. Reaction is controlled by the variable condenser (24) and is fed to a reaction coil consisting of part of the inductance (18) which is not used for tuning the output circuit. The size of this reaction coil is varied by the tapping switch, giving appropriate coupling for the range in use (cf. aerial coupling in tuned grid circuit of first R/F stage). An R/F by-pass condenser (26) is connected to earth before the primary of the output transformer (29) to reduce to a minimum the amount of R/F voltage passed on to the output stage. Resistance (30) is an R/F stopper.

The A/F amplification stage is transformer coupled to the detector stage. The valve (4) is normally an output pentode. If it is desired to use an output triode an NT82 should be used. The H.T. supply is fed through the primary of the telephone transformer (50), this has a step-down of 15:1 and is also tapped to give a step-down of 45:1. The 15:1 ratio terminals are connected to the telephones; the 45:1 ratio to the loudspeakers. The loudspeakers are connected by plugs and sockets in both local and R.C. positions and may be disconnected by this means when not required.

POWER SUPPLIES

Type TW12A (See fig. p).

L.T. Supply. The filaments of the valves are supplied in parallel from one of two alternative 2 volt batteries (1)(2). These batteries can be charged from the 12 volt ship's mains via a charging board (3) on which is fitted a charge-discharge switch (4), a 12 volt, 36 watt resistance lamp (6) a supply fuse (7) and an output fuse (8). Connections are made from the charging board to the L.T.+ and L.T.- terminals on the receiver. The L.T.- lead is earthed at the board.

H.T. Supply. This is obtained from an anode-converter with an output of 150 volts D.C. The input supply of 12 volts is taken from the ship's 12 volt mains via the same pair of fuses (10) as the transmitter filament supply and is controlled by a single pole tumbler switch (11) on the operator's bench. The output from the machine is connected to the H.T.3 and G.B. - terminals on the receiver. The terminals H.T.2 and H.T.3 are connected together by a link. Terminals H.T.1 and H.T.- are not used. The reason for this arrangement of terminals is that the receiver was originally intended to be used with a dry H.T. battery from which tappings were taken to provide the various voltages required.

Grid Bias Supply. (See fig. o). The G.B. potentials are automatically obtained from resistances connected between L.T.- and G.B.-. H.T.- and G.B.- are also connected by these resistances which are therefore in the return path of the anode current. Grid bias for the A/F amplifier (4) is obtained by means of resistances (46) and (47). Grid bias for both the R/F amplifiers (1) and (2) is obtained by means of resistances (44) and (45), the latter of which is a 1000 ohm variable potentiometer which provides a means of volume control. The purpose of the 100 ohm resistance (44) is to prevent the potential on the grids becoming more positive than -1 volt. It should be noted that the L.T.- and H.T.- supplies are not made common. If H.T.- was earthed, the automatic grid bias would not be obtainable.

TYPE TW12A

RECEIVER H.T. AND L.T. SUPPLIES AND BATTERY CHARGING CIRCUITS

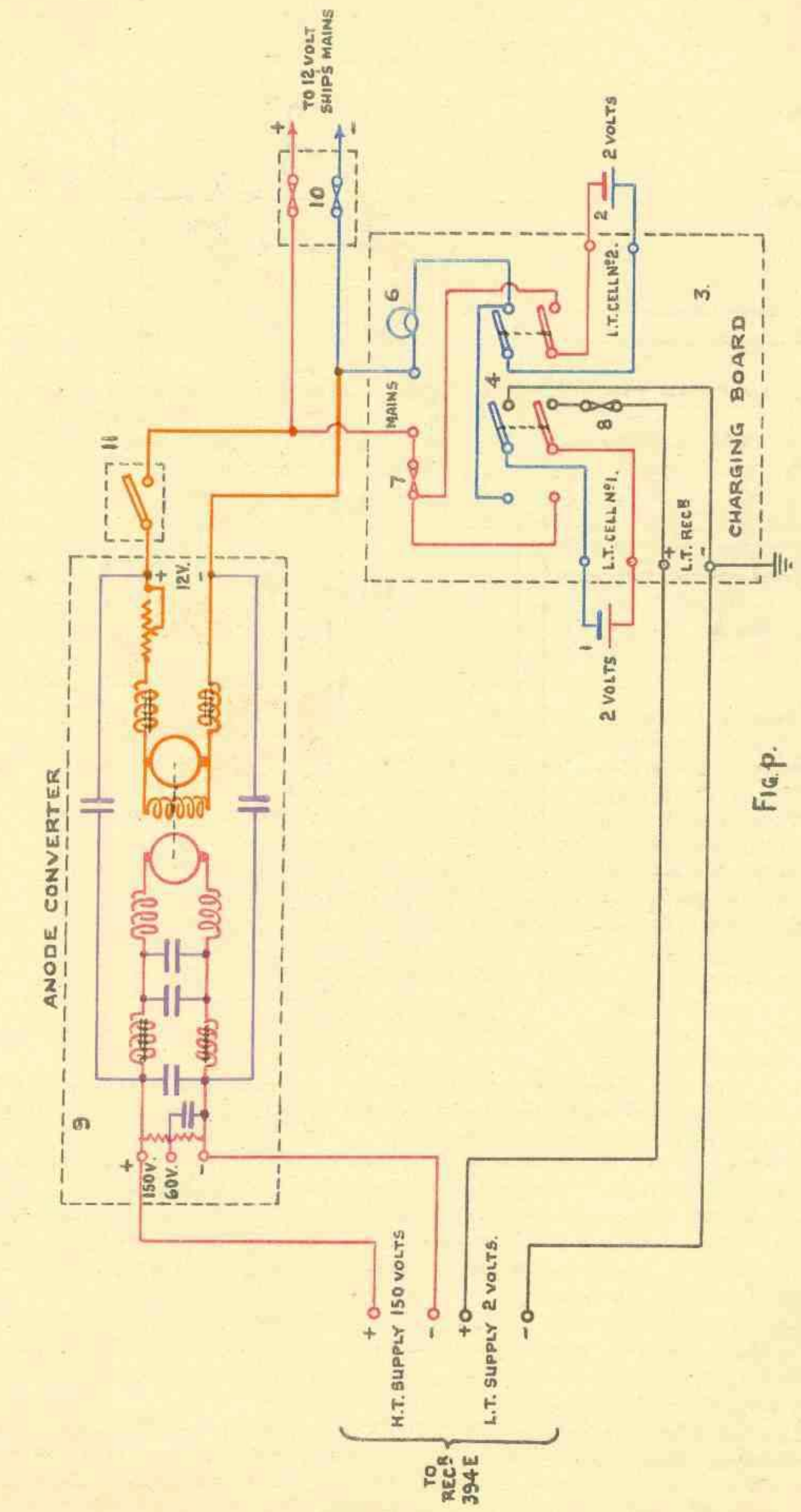


FIG. P.

TYPE TW12B

RECEIVER H.T. AND L.T. SUPPLIES AND BATTERY CHARGING CIRCUITS

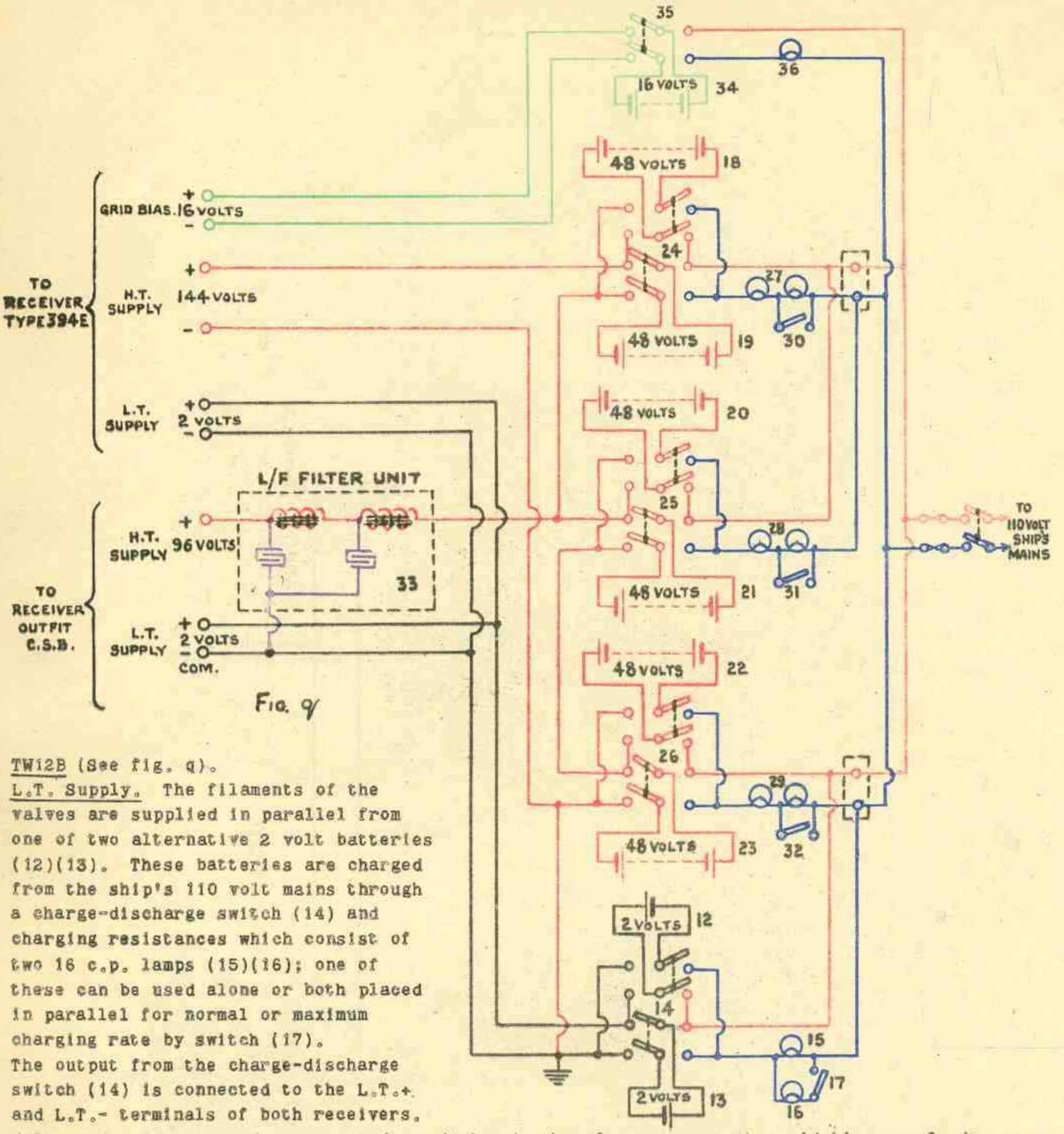


Fig. 9

TW12B (See fig. q).

L.T. Supply. The filaments of the valves are supplied in parallel from one of two alternative 2 volt batteries (12)(13). These batteries are charged from the ship's 110 volt mains through a charge-discharge switch (14) and charging resistances which consist of two 16 c.p. lamps (15)(16); one of these can be used alone or both placed in parallel for normal or maximum charging rate by switch (17).

The output from the charge-discharge switch (14) is connected to the L.T.+ and L.T.- terminals of both receivers. H.T.- and L.T.- are made common and earthed and, therefore, a separate grid bias supply is necessary. It should be noted that when tuner amplifier B13 is used as part of type TW12B valves with 2 volt filaments must be used in it.

H.T. Supply. This is obtained from one of two alternative 144 volt batteries, each of which consists of three 48 volt batteries (18)(19)(20)(21)(22)(23). Three separate charge-discharge switches (24)(25)(26) are fitted to connect the output of the 48 volt units in series, or to charge them separately from the ship's mains via three separate charging resistances (27)(28)(29), each of which consists of two 16 c.p. lamps in series for normal charging rate; one of these can be short-circuited by switches (30)(31)(32) for maximum rate.

The 144 volt battery output from the charge-discharge switches is connected to the terminals H.T.3 and H.T.- on receiver 394E, the terminals H.T.3 and H.T.2 being connected together by a link. A tapping is taken from the centre charge-discharge switch (25) through a filter unit (33) to provide a 96 volt supply for the tuner-amplifier B13.

Grid Bias supply. A separate 16 volt grid bias battery is fitted which can be charged from the ship's mains via a charge-discharge switch (35) and a 2½ c.p. resistance lamp (36). The output is connected to terminals G.B.- and H.T.- on receiver 394E. As the variable potentiometer (45) is in series with the G.B. battery it still acts as a volume control.

"ON-OFF" Switch. In both models an "On-Off" switch (49) is fitted which breaks the H.T.- and L.T.+ supplies. In type TW12B only, this also breaks the H.T.- supply which, since G.B.+ and H.T.- are common, also breaks G.B.+. This is necessary as otherwise the G.B. battery would discharge through resistances (44) and (45) in parallel with (46) and (47). Tuner amplifier B13 must be switched off by its filament rheostat.

A 2 volt lamp (53) is mounted on the front of the receiver both as illumination and to indicate that the receiver is switched on. It is supplied in parallel with the valve filaments.

TYPE TW12A AND TW12B

RECEIVER 394E

INTERIOR VIEW

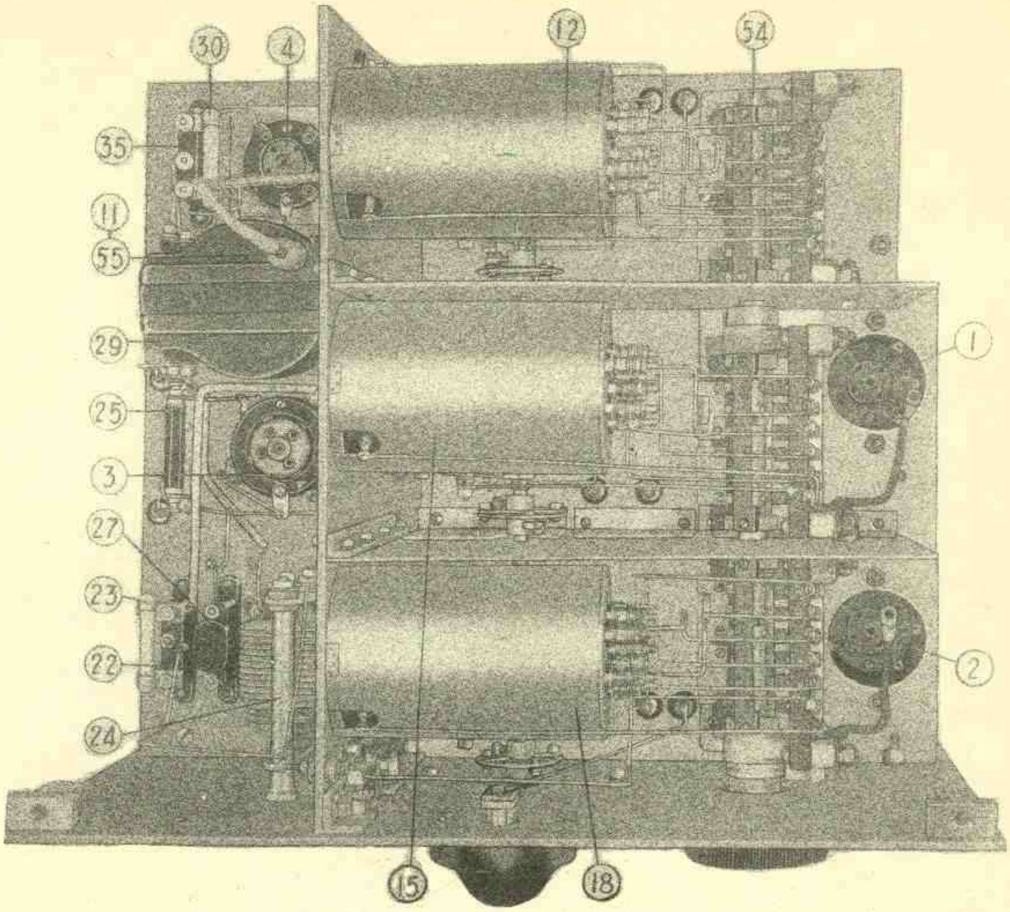


FIG. R.

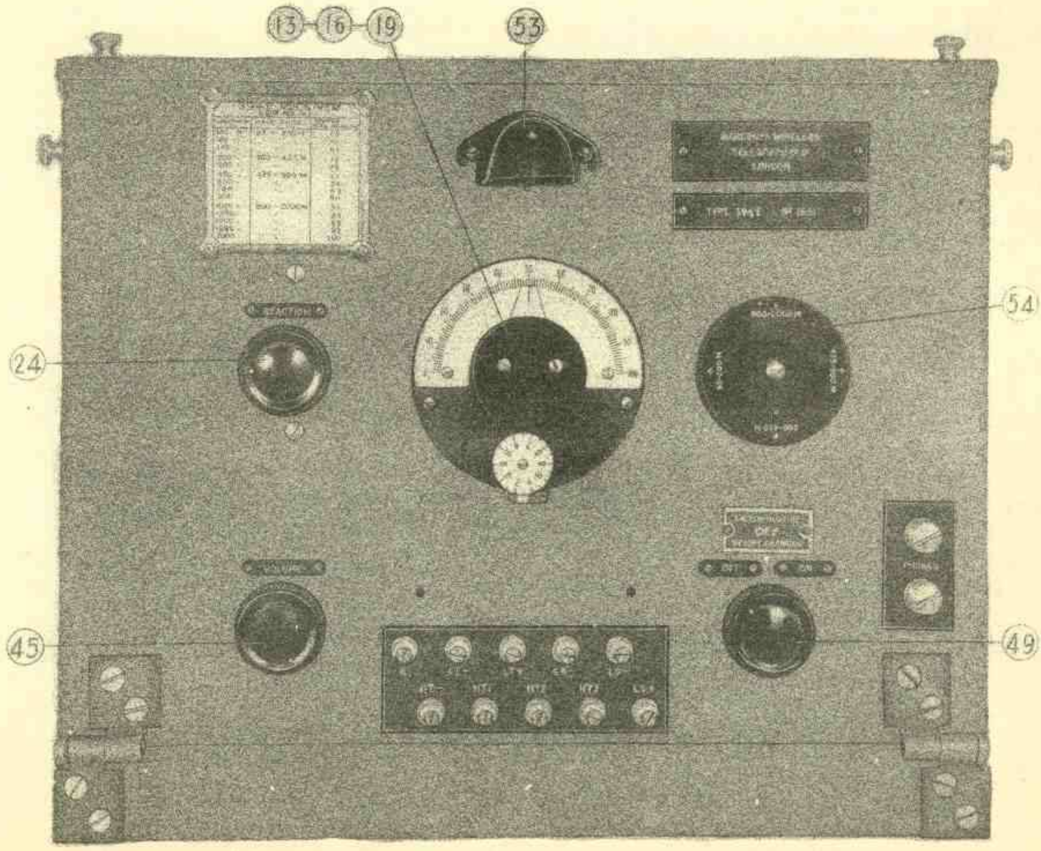


FIG. S.