SECTION P

OLD SPARK AND ARC TRANSMITTING SETS.

MARCONI ½ K.W.

First used for Naval purposes as a standard set.-	1930. Commercial
Frequency range:-	Designed 500 - 1,000 kc/s. Modified to include 1,384 kc/s.
Power supply.-	100 volt, ¾ KW Rotary Converter (Vertical Type).
Type of circuit.-	Spark Transmitter.
Approximate distance range.-	40 to 50 miles.
Associated Receivers.-	1492B or 89.

The Marconi ½ KW is a low power spark transmitter and is fitted in Drifters and other small Fleet Auxiliaries where the space available is limited. The power supply is obtained from a small steam dynamo supplied for the purpose. In many cases it will be found that Navigation and Lighting circuits are also taken from this supply and it may be necessary to break these circuits when power is required for W/T.

The D.C. supply from the dynamo is connected to the D.C. supply switch (1) and thence to the motor end of a rotary converter (4) controlled by a motor starter (2) and field regulator (3). A guard lamp (6) is connected in parallel with the motor armature to allow a path for any stray oscillatory currents which may be set up in the motor armature or field windings due to the close proximity of the machine to the oscillatory circuit. Another guard lamp (8) is fitted to protect the A.C. end of the converter.

The A.C. supply is obtained from the ¾ KW rotary converter (4) which, together with the impedance coil (10), main transformer (12), protecting coils (13), synchronous spark gap (14) and one transmitting condenser (18) are contained in a sound proof box fitted to reduce machine noises when receiving with the machine running.

The converter (4) is an 8-pole shunt wound machine with a disc discharger or spark gap (14) mounted on the upper end of the converter shaft.

The spark gap (14) has 8 revolving studs and 2 fixed electrodes. The electrodes can be adjusted so that they are exactly opposite the studs at the instant that the condensers (17) (18) are fully charged, and the gap between the electrodes and studs is so arranged that the spark occurs just before this instant. (See Admiralty Handbook of W/T (1931) paragraph 452). To carry this out in practice the fixed electrodes should be moved round until the revolving studs appear to be standing still when the spark is passing.

A double pole A.C. switch (7), an A.C. ammeter (5) and fuses (9) are fitted on a board in the cabinet.

The impedance coil (10) is adjustable from 5 to 17½ millihenries. One lead is connected permanently to the terminal marked 1 and the adjustable tapping to one of the other terminals. The correct setting is obtained by pressing the morse key (11) and adjusting the impedance coil until as large a current as possible is registered in ammeter (5) without unduly slowing down the motor.

The morse key (11) makes and breaks the A.C. supply to the primary of the main transformer (12). Back contacts are fitted to the key and were used when crystal receiving gear was employed but they are not now connected.

The main transformer (12) is air cooled and has a step-up of 20.6 to 1. The secondary of the transformer is protected from stray oscillatory currents from the primary circuit by the protecting coils (13).

The primary tuning coil (16) consists of 4 turns of insulated cable and has two tappings marked 300 and 600 respectively referring to wavelength to indicate the settings for 1,000 kc/s and 500 kc/s. A fine tuning coil (15) is provided.

The transmitting condensers (17) (18) are each of 7.85 jars capacity and are oil-cooled. For 1,384 kc/s the two condensers (17) (18) are used in series, but for 500 kc/s and 1,000 kc/s condenser (17) is short-circuited by a link (19).

The aerial circuit is coupled to the primary by the mutual coil (21). This coil has 20 turns and has five tappings with one turn between each and three tappings with five turns between each. The terminal marked E indicates the bottom of the coil and should be joined to the centre of the earth arrester (22). The aerial lead can be plugged into any of the other terminals according to the amount of inductance required. The top of the coil is marked A. Care must be taken that the amount of coupling is not so great that the insulation of the aerial or deck insulator systems is broken down. This insulation resistance to earth is often very low due to saturation with salt water.

An aerial coil (20) and earth arrester (22) are fitted. The latter consists of a thin sheet of mica separating two brass plates one of which is connected to the bottom of the mutual coil (21) and the other to earth. The receiving gear is shunted across the two parts of the arrester (22). When receiving, the signal has insufficient voltage to jump across the arrester (22) and so passes through the receiver. When transmitting, the impedance of the receiving gear causes the current to spark across the arrester (22). The receiver is thus protected.

In certain tugs this set was modified by A.F.O. 284/3? to include 375 kc/s.

Tuning The set is normally only tuned to 300, 1,000 and 1,781 kc/s. The tuning position for the wavemeter coupling coil is not critical when tuning the primary and sufficient coupling can normally be obtained with the coupling coil upright and about six inches from the primary. A suitable factory position for the coupling coil when tuning the aerial is on top of the aerial coil (20) standing upright.

A tuning lamp (24) and inductance (23) are connected across a portion of the earth lead. To tune the aerial coil with the lamp (24), cut out the inductance (23) until the lamp just glows. Then adjust the aerial circuit to increase the brilliancy of the lamp (24) (using the inductance (23) to prevent the lamp burning out). When the lamp is glowing the aerial circuit is in tune with the primary and radiation should therefore be taking place.

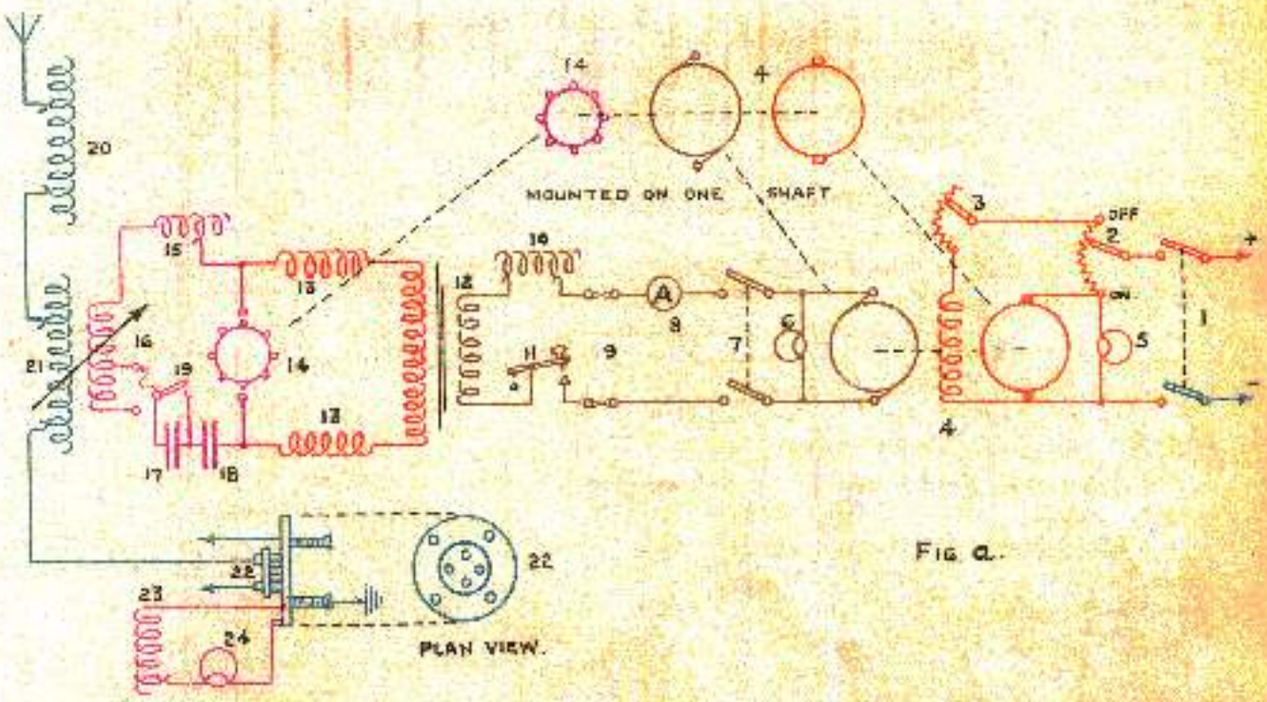


FIG a.

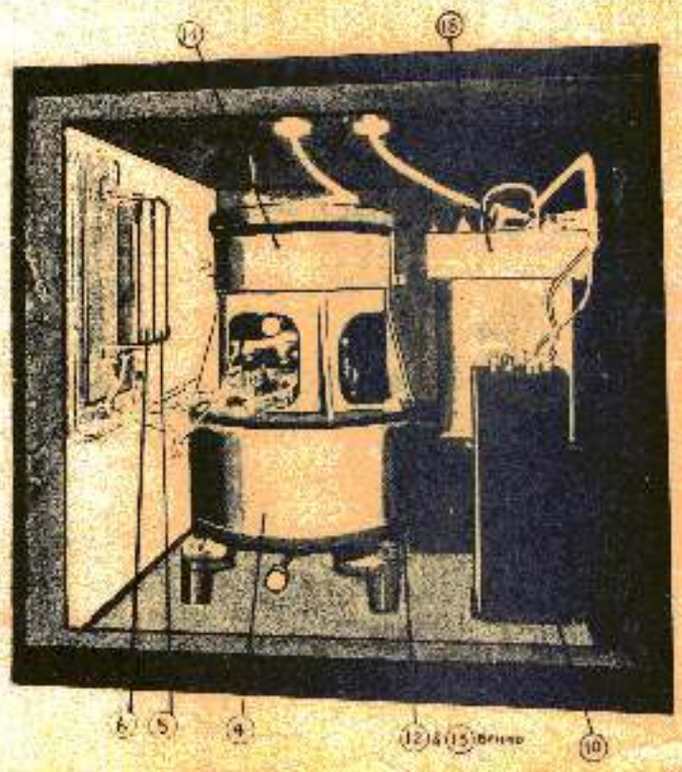


FIG. b

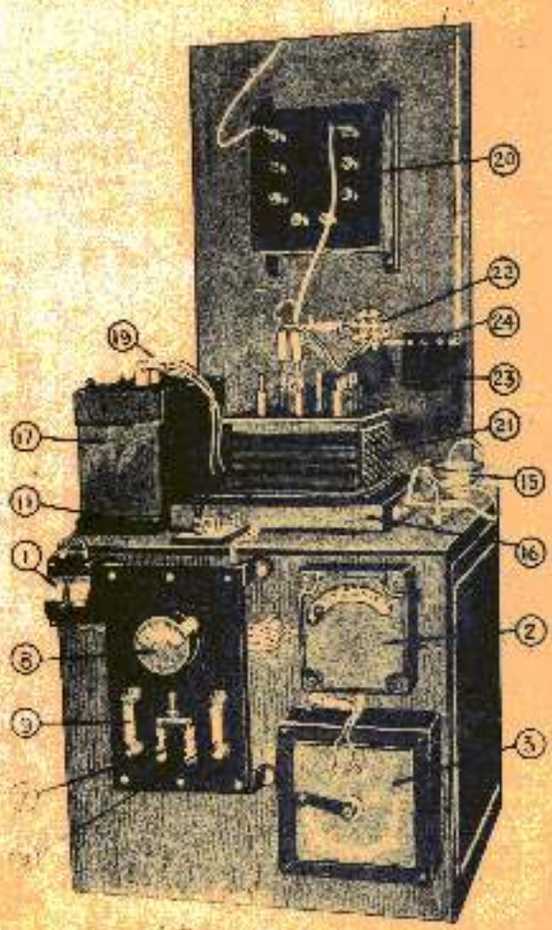


FIG. c.

TYPE 2.

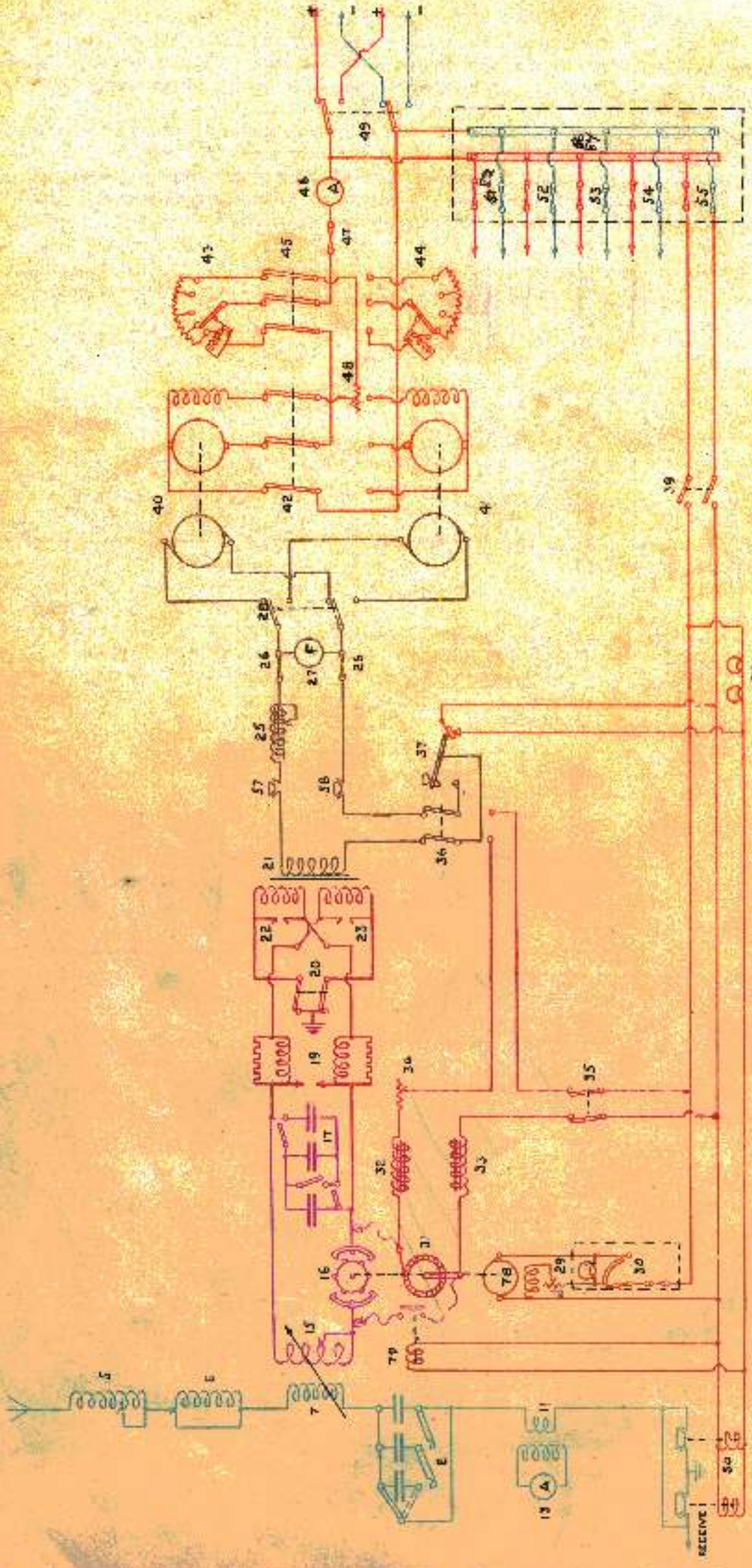


Fig. 2

TYPE 2.

2* 1 only 1 method
2 No motor buzzer in this transmitter

Date of design:- 1914.
Frequency range:- 150 - 1304 kc/s.
Power supply - 1½ KW rotary converter.
Type of circuit - Spark transmitter.
Approximate distance range - 250 - 300 miles.
Associated wavemeters. - Pattern 1492F or 39.
Reference:- Admiralty Handbook of W/T (1931) paragraph 456. et seq.

Type 2 is a medium power spark transmitter which was originally fitted as the main set in Cruisers and Flotilla Leaders. With the introduction of the arc for transmitting C.W. Type 2 was fitted in conjunction with Type 16. Valve transmitters later replaced the arc sets and Type 2 was then fitted in conjunction with Type 34, the latter obtaining its power supply from Type 2.. Transmitter 5C is also fitted with Type 2 as an H/F attachment and uses the Type 2 power supply. (See page CA2).

When fitted in Second Offices of Heavy Ships the set is modified, having one rotary converter, motor starter, etc., and no motor buzzer is fitted. The set is then known as Type 2*.

The combination of sets and their uses are as follows:-

Type 2 - 12 Main office of Cruisers and Flotilla Leaders.
Type 2* - 84 Second office of Heavy Ships.
Type 2 and T/P attachment 5C. Main office of miscellaneous vessels.

The power supply is obtained from the ring main C.C.S. (49) which is connected to the change over switch for starters (45) and the change over switch for machines (42). Two rotary converters (40)(41) and two hand starters (43)(44) are fitted. Either starter can be used with either machine but the two machines cannot be switched on together. A motor field regulator (43) is connected to the machines C.C.S.(42) for use with either machine. A separate switch (29) changes over the A.C. supply from the rotaries and it is therefore necessary to ensure that the A.C. C.C.S.(29) is switched to the machine which is running. As the A.C. output voltage from the rotary converter depends on the D.C. input voltage from the ships mains (See Admiralty Handbook of W/T (1931) paragraph 254) the impedance coil (25) has different values and the main transformer (21) different step up ratios for ships with 100 volt and 200 volt D.C. supplies. The values and ratios used are as follows:-

100 volts Impedance Coil, 6½, 8 and 10 millihenries
Transformer ratios, Series position 1 to 200.
Parallel position 1 to 100.

200 volts Impedance Coil, 12½, 30 and 50 millihenries.
Transformer ratios, Series position 1 to 90.
Parallel position 1 to 45.

Cage door contacts (57) and (58) act as a safety device by breaking the A.C. supply when the cage doors are opened. A frequency meter (27) is connected across the A.C. fuses (26) to indicate the frequency of the A.C. supply.

The secondary windings of the main transformer (21) are wound in two parts which can be connected in series or parallel by the series-parallel switch (20). In the series position the series parallel switch (20) earths the secondary windings at the centre point. In all cases the transformer (21) must be used in the series position when the condensers (17) are in series and in parallel when the condensers are used in parallel as explained in Admiralty Handbook of W/T (1931), paragraph 449).

Protecting coils (19) with carbon rods protect the transformer secondary from stray oscillatory currents from the primary circuit. The primary circuit consists of the main condensers (17) the primary tuning coil (15) and spark gap (12). The main condensers are 27 jars each and can be connected to give various values as follows:-

3 IN PARALLEL
51 JARS

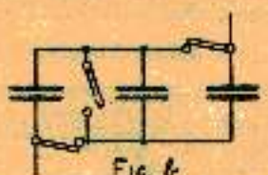


Fig. b

3 IN SERIES
5⅔ JARS

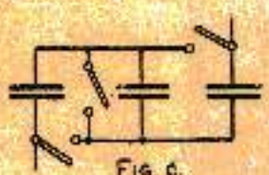


Fig. c.

2 IN SERIES
8½ JARS.

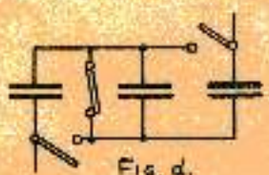


Fig. d.

The condensers will be short circuited if all switches are closed.

The primary tuning coil (15) is adjusted by a revolving arm (31) which is connected to the coil by a clip. To obtain efficient coupling to the mutual coil when using frequencies for which a very small part of the primary coil is required it is necessary to short circuit the revolving arm (31). This is done by a shorting clip (30) which is mounted on the copper tube connecting the primary coil to the condenser.

TYPE 2.

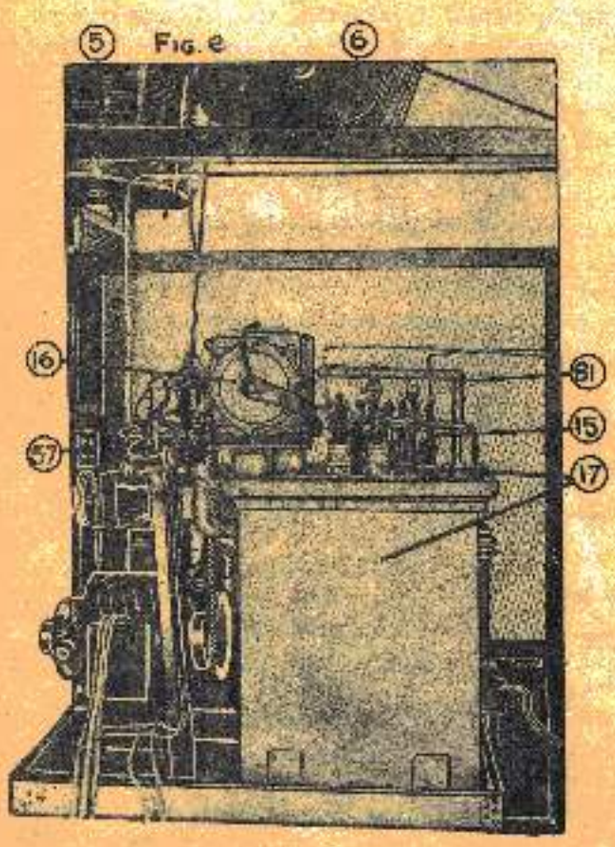
The spark gap is mounted on the top of the condenser tank and consists of a copper wheel with six electrodes which revolve between six fixed electrodes (see Admiralty Handbook of W/T(1931), paragraph 453.) The wheel is revolved by a ½ H.P. motor fitted in the cage and controlled from the receiving cabinet. An extension on the shaft of the spark gap wheel carries the motor buzzer wheel.

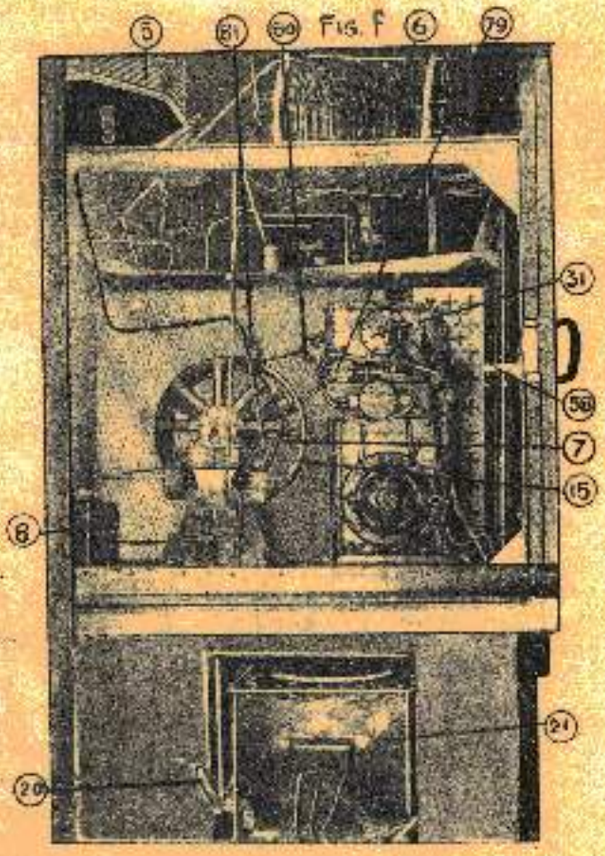
The aerial circuit is coupled to the primary by a mutual coil (7) which slides along the bar on which the primary tuning coil (15) is mounted. Two aerial coils (5)(6) are fitted but the coarse 2 coil (6) is usually short circuited. Aerial series condensers (8) can be connected in the aerial circuit by links if required.

Motor Buzzer. See Admiralty Handbook of W/T (1931) paragraphs 441 and 443. A flexible lead of concentric cable is used to connect the buzzer wheel (31) to the primary circuit. The cable is plugged into sockets at the ends of the spark gap (16). The transformer series parallel switch (20) must always be broken when using motor buzzer to prevent a short circuit on the main condensers (17) through the transformer secondary. If the buzzer wheel stops with both brushes bearing on the copper part of the wheel a closed tuned circuit is left coupled to the aerial circuit which would weaken reception. To prevent this the automatic switch(79) makes and breaks one lead from the spark gap (16) to the buzzer wheel(31) with the motion of the motor key.

Tuning. The aerial coil should be disconnected and the primary first tuned by coupling the wavemeter mutual to the primary tuning coil (15) with the condenser switches in the appropriate positions for the frequency required. Final adjustment is made on the primary tuning coil (15). If a motor buzzer is fitted this should be used for tuning the aerial circuit by coupling the wavemeter to the aerial coil and adjusting the inductance of the aerial coils (see Admiralty Handbook of W/T (1931)paragraph 880) When a motor buzzer is not available the aerial circuit is then tuned by wavemeter using main power (See Admiralty Handbook of W/T (1931) paragraph 885). The aerial ammeter (19) will show a maximum reading when the tuning is correct.

Motor Buzzer Tuning. The leads from the spark gap (16) to the motor buzzer wheel add a little inductance to the primary circuit and this must be compensated for by altering the tapping on the primary tuning coil (15). The correct position is found by retuning with the wavemeter and separate sets of adjustments are therefore used with the main power and motor buzzer.





TYPES 14, 15, & 16.

Date of design:- 1915 - 16
Frequency range:- 100 - 180 kc/s.
Power supply:- 100 volt Motor Generator.
220 volt Motor Booster.
System:- Arc.
Associated wavemeters:- 1492B or G9.

The arc transmitting sets still fitted in some vessels are Types 14, 15 and 16. The general principles of the working of these sets are the same, and the oscillatory circuits are practically identical in each case. The three types will therefore be described under one heading Type 16, and the differences between Types 14 and 15 and this set will be explained.

An arc set is fitted with a spark set, and the type of arc set fitted, depends on the class of vessel and the spark set fitted in conjunction. The following combinations are fitted, the first number of each denoting the spark set.:-

Submarines 10 - 14, Gunboats & Destroyers 4 - 15, Cruisers & Sloops 1 or 2 - 16

The frequency range varies somewhat in each set, but this again is attributable to the class of vessel in which it is fitted (i.e., large or small aerial).

The Admiralty Handbook of W/T (1951) Chapter 9 explains the principles and characteristics of the arc transmitter.

POWER SUPPLY.

The D.C. supply is from each side of the ring main to the ring main C.O.S (102). In a 220 volt ship the supply is connected to a C.O.S. (99) which in turn connects to the motor booster or direct to the arc (figure a.). With 100 volts the supply from the C.O.S. (102) is connected direct to the motor generator starter.

The machine fitted varies according to the ship's voltage, with 100 volts supply a motor generator is fitted (figure b.) and with 220 volts a motor booster (figure a.), both having a separate motor starter (100) and field regulator (101). With 220 volts the ship's mains can be connected direct to the arc by the C.O.S. (99). As stated above, Type 16 is fitted in the larger ships with a 220 volt ship's mains, so that invariably Type 16 has a motor booster and Types 14 and 15 a motor generator.

In the case of submarines where large variations of ship's voltage are experienced a combined starter and regulator is fitted, and a 30 ohm resistance can be connected in the motor field to maintain the machine speed when the voltage falls.

In cases where the motor generator is subject to overheating, connections can be altered so that the generator acts as a booster (figure c.) and to maintain 400 volt output only 300 volts are required from the machine plus the 100 volts ship's mains.

In some cases duplicate machines are fitted with the necessary change over arrangements.

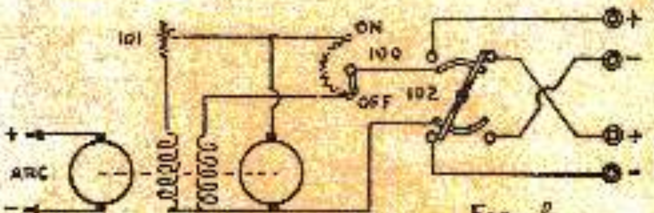


Fig. b.

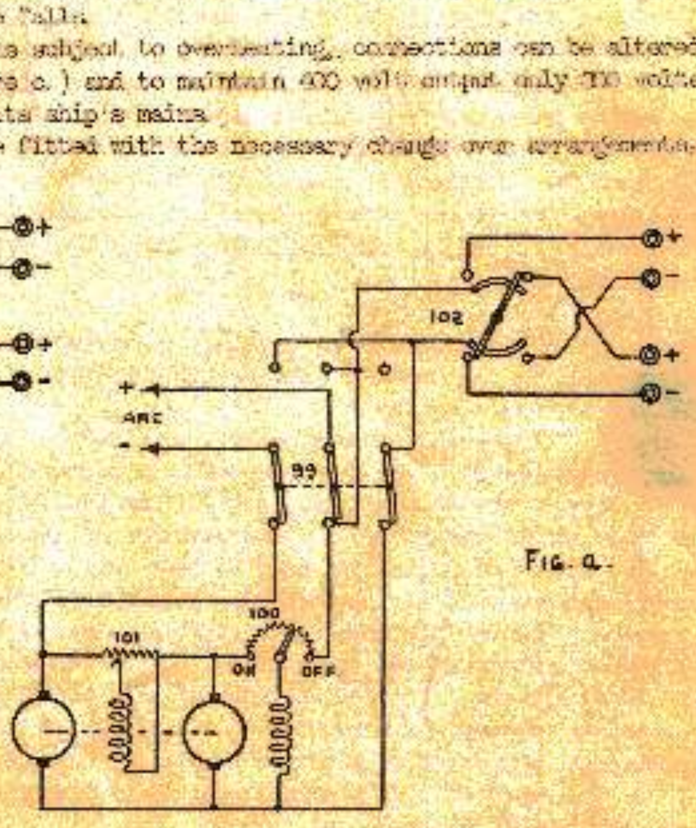


Fig. a.

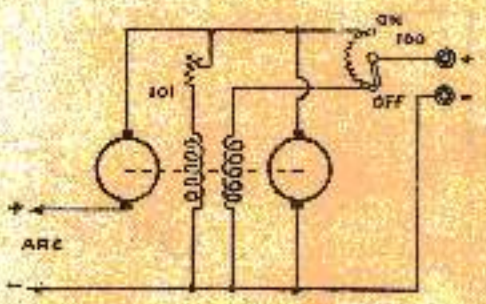


Fig c.

ARC D.C. SUPPLY.

The supply to the arc is from a motor generator in the case of Types 14 and 15, and a motor booster or 220 volt mains in the case of Type 16.

The supply is connected to the arc starter (91) with adjustable 1.7 ohm steadying resistances (93)(94) in each lead, and a 50 amp fuse (90) in the negative supply. The resistances (93)(94) have three functions:-

(a) Steadying the supply voltage while the arc is burning.
(b) Checking an overload, should the arc electrodes (110)(111) be closed with the arc starter (91) in the "ON" position.
(c) A means of regulating power.

Connected across the supply and fitted near the machine are two Belsby condensers(96)(98) and two 16 c.p. 200 volt lamps(97)(95) in series, with the centre point of the circuit earthed. They form a protecting circuit for the machine and prevent an accumulation of high oscillating potential between the two mains or between either main and earth.

A voltmeter (92) is connected across the supply to the starter (91) and indicates the output voltage of the machine.

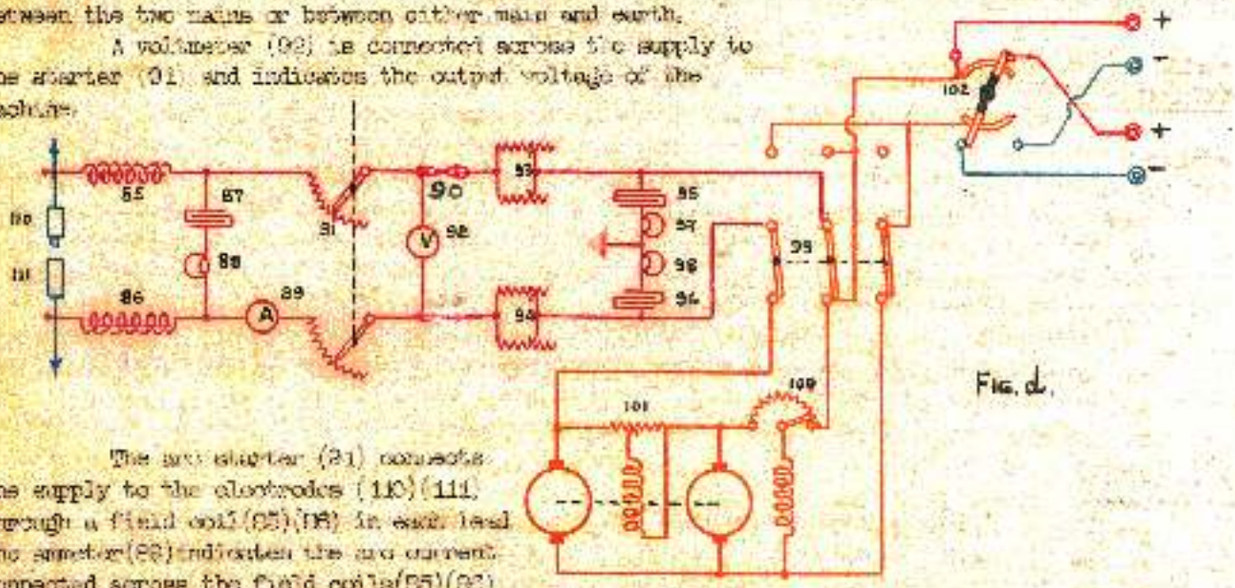
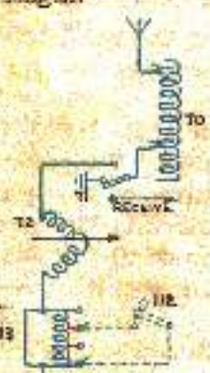


Fig. d.

The arc starter (91) connects the supply to the electrodes (110)(111) through a field coil(85)(98) in each lead. The ammeter(88)indicates the arc current. Connected across the field coils(85)(98) is a circuit consisting of a Belsby condenser(97) and a 16 c.p. lamp(93) in series. This protects the D.C. supply circuit and machine by acting as a by-pass for the arc oscillatory current. The arc starter(91) consists of a 30 ohm resistance in each lead, which is gradually cut out as the arc length is extended (see under "Working and Tuning"). The electrodes are positive(110), negative(111). The positive or anode is a water cooled copper tip, a water nyster(figure h.)being employed, which cools the arc chamber and the anode. The negative or cathode is a carbon, which is revolved by the motor(40). Care should be taken that when a new copper anode tip is fitted, the plug which is soldered into it, should be on the underside.

The field coils(85)(98) are mounted on pole pieces and fitted to each side of the arc chamber. The pole pieces are ¼ inches apart beneath the two electrodes(110)(111)and as the coils(85)(98)are energised they become powerful magnets. This magnetic field bows the arc causing it to burn steadily and on the side of the cathode (111). This bow also increases the arc length.

The anode(110) is connected to the centre contact of the magnetic key (41)and the cathode(111)is connected to earth. The Belsby condensers (78)and(77) are connected either side of the arc, the former to prevent an earth on the negative arc D.C. supply, the latter to isolate the aerial from the positive arc D.C. supply.



AERIAL CIRCUIT.

The aerial circuit consists of an adjustable resistance(74) spacing wave coil(73) variometer(72)and aerial coil(70). It is connected to one contact of the magnetic key(41).

The aerial resistance(74) is fitted in Type 16 only and acts as a damping resistance when the aerial current is higher than desired for a minimum supply voltage. The spacing wave coil(73) has four tappings, some of which are shorted. It is used for an alternative method of signalling as described below. The variometer(72) and aerial coil(70)are used for tuning purposes. The aerial discharge coil(83)consists of a resistance, inductance and spark discs. It is connected in the aerial circuit between the spacing wave coil(73) and earth and prevents an accumulation of charges in the aerial which would tend to puncture the Belsby condensers (77). The ammeter(76)indicates aerial current when the arc is burning on the aerial circuit.

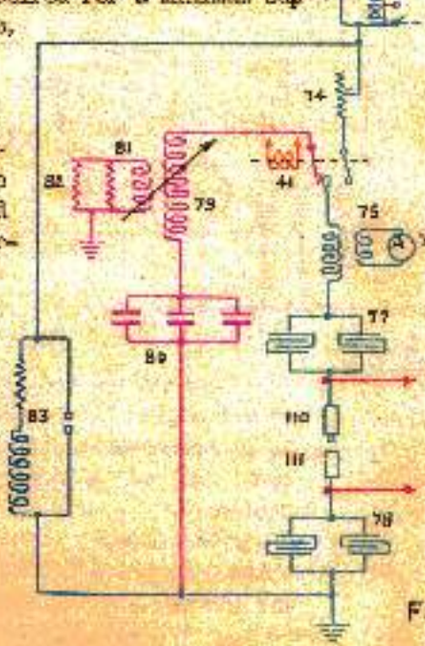


Fig. e

BACK STOP CIRCUIT.

The back stop circuit consists of a coil(79) and condensers(80). It is connected between the "rest" contact of the magnetic key(41) and earth. Only two condensers are fitted with Type 14 and 15. The coil (81) is a rotating coil fitted inside the coil(79) and has four 30 ohm set resistances (82) connected across it. The resistances are connected two in series, two in parallel. This is a damping device, and is used to

damp the circuit until the current indicated in the ammeter (76) is approximately the same as when the arc is burning on the aerial circuit. If sufficient damping cannot be obtained with the coil (81), the resistances (83) can all be connected in parallel.

It will be noted that the ammeter transformer (79) and ammeter (76) are in either the aerial or back shunt circuit according to the position of the magnetic key (41).

METHODS OF SIGNALLING.

As the arc must burn during the whole period of signalling two methods of signalling are employed.

(1) As stated, the anode(110) is connected to the centre contact of the magnetic key(41) and the back shunt circuit to the "rest" contact. The arc is therefore struck and able to continue oscillating on the back shunt circuit. The aerial contact of the magnetic key (41) must make before the back shunt contact breaks, or the arc, having no circuit to oscillate on, will go out.

The aerial circuit is connected to one contact of the magnetic key (41) and each time the morse key in use (36)(38) or (51) is pressed the bobbin of the magnetic key is energised and the anode of the arc is connected to the aerial which radiates at the frequency to which it is tuned. This is the normal method used for signalling.

(2) Spacing wave. The aerial contact of the magnetic key(41) is permanently connected to the centre contact which, as stated above, is connected to the anode(110). The short on the tapping of the spacing coil(79) is removed, and a morse key (112) connected in lieu. As the arc is now connected direct to the aerial circuit, the latter will radiate as soon as the arc is struck; the radio frequency will, however, have been reduced(about 8 kc/s) owing to the extra inductance of the spacing coil (79). This wave is called the "Spacing Wave".

When the hand key(112) is pressed the turns of the spacing coil(79) are short circuited, and so the correct frequency, known as the "Marking Wave" is radiated. These methods are described in Admiralty Handbook of W/T (1924) paragraph 402.

The disadvantage of this method is that the aerial is always radiating so long as the arc is burning.

A.C. AUXILIARY AND SIGNALLING CIRCUITS

The supply for the A.C. auxiliary and signalling circuits is from a junction box, and is controlled by a D.P. switch(55). The auxiliary circuit supply is again controlled by the D.P. switch (40) which is connected direct from the A.C. supply switch(55). The carbon drive and circulating motor(49) is connected direct to the D.P. switch(40) and will start as soon as the switch is made, thus enabling the water cooling arrangement to be in operation whilst receiving.

The auxiliary circuits, consisting of the drip feed bobbin(43) and lamp(42), are completed by the auxiliary switch (44) as the arc starter(21) is switched on. The functions of this circuit are described under "Working" and "Tuning".

The signalling circuit consists of the magnetic key(41) lamp (42) and either morse key (36) or (38). The supply is connected to one contact of the power buzzer switch(18) and the key C.C.S. (37). The power buzzer switch (18) connects the morse key to the arc magnetic key (41) or the A.C. mains of the spark transmitter. The key C.C.S.(37) connects either the morse key(51) or (38) in the circuit. The morse key in use forms a break in the circuit and each time it is pressed the circuit is completed and the bobbin of the magnetic key (41) energised. The morse keys(36)(38) are fitted in separate receiving keys.

The set can be remote controlled by the morse key(51). The morse keys(36)(38) are each fitted with a remote control attachment(54)(55). The supply for this circuit is taken to the centre contacts of a D.P. C.C.S.(53), with a pair of fuses(49) in the morse key(51) leads. The key (51) and lamp(42) are connected in one lead. The attachments (54)(55) are connected one to each side of the C.C.S.(53). When the morse key (51) is pressed it completes the circuit through one of the attachments, depending on the position of the C.C.S.(53). The circuit being completed through either of the attachments (54) or (55) the bobbin is energised and operates the morse key (36) or (38) to which it is attached.

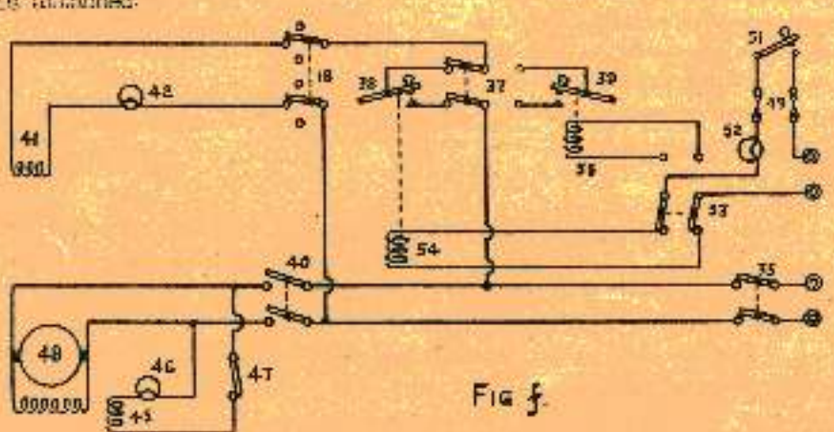


FIG 5.

TYPES 14, 15 & 16.

ARC STEADYING CIRCUIT.

The arc steadying circuit(figure 9) is fitted with "type 1" in existence. It consists of a condenser(106), wavemeter(100), and an adjustable resistance (109) of 4, 7.5 or 15 ohms connected to earth. The circuit is connected in series with the aerial circuit between the spacing coil(70)and the aerial contact of the magnetic key(71) when the switch (69) is broken. An anode transformer (107) is connected to the circuit, and the current of the arc or arc steadying circuit is indicated on the ammeter(72) depending on the position of the switch(69). The circuit is used in submarine when spray continually washing over the aerial insulator would put the arc out. (See Admiralty Handbook of W/T(1931) para 128).

DRYING OUT CONDENSER.

A drying out condenser is fitted with "type 14 in existence. It is of 0.1 jars and connected between the section of the deck insulator and earth. Its use is to dry the deck insulator when the arc will not burn on the aerial owing to a wet deck insulator surface. (see Admiralty Handbook of W/T(1931) paragraph 478).

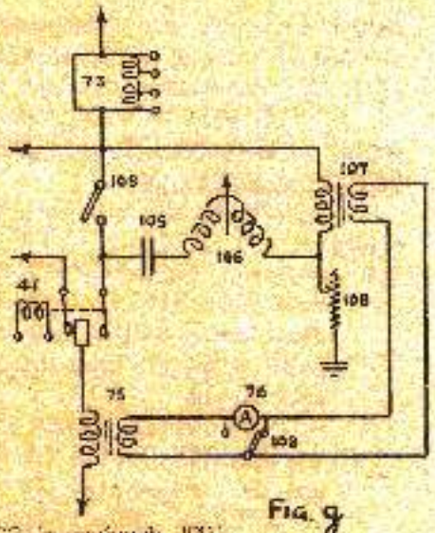


Fig. 9

STARTING AND TUNING.

The machine is started, and adjusted by the field regulator(90) to the required voltage as indicated by the voltmeter(92). The distance between the electrodes(110)(111)can be varied as the cathode(111) is adjustable in a forward or backward direction. The electrodes (110)(111) are closed until nearly touching, then as the arc starter(91) is slowly moved to the "ON" position the arc is struck by pressing an insulated spring push(112)attached to the cathode(111) sheath. When the arc is burning, as indicated by the ammeters(89) and (90), the resistance of the arc starter(91) is slowly cut out of the arc D.C supply, and the arc is lengthened by adjusting the cathod (111). The auxiliary switch(47) and send-receive switch(71) are mechanically connected to the arm of the arc starter (91), so that as the starter moves to the "ON" position, the auxiliary switch(47) is made, and the send receive switch(71) connects the aerial to the transmitting aerial circuit, first passing over an earthed stud. When the switch(47) is made it connects the D.C auxiliary supply to the switch(47) and starts the carbon drive and circulating motor(48). The switch(47) completes the circuit through the bobbin (45) and lamp(46) of the drip feed(115). The motor(48) is a pump and circulates the water in the cooling arrangement (figure 4.) and in addition it slowly rotates the cathode (111) by means of a flexible mechanical connection (114). The drip feed (115) is a methylated spirit container fixed to the arc chamber and supplies methylated spirit to the anode(117) to form a hydrogen vapour (see Admiralty Handbook of W/T (1931)para graph 479). The drip feed has a needle valve which can be opened electrically by the bobbin (45) or by hand. The flow of methylated spirit can be regulated by adjusting the needle valve by means of a screw(116) on the top of the drip feed. An expansion chamber is attached to the arc chamber by a rubber tube. Inside the expansion chamber is a thin rubber diaphragm and at the bottom a small hole for the gas escape which must be kept clear. The rubber diaphragm expands with the gas pressure, and also keeps the gas pressure constant. It will be noted from the above, that as the arc starter (91) is moved and the arc struck, so the water commences to circulate, the cathode to revolve, and the drip feed to function. Care should be taken that the supply of water to the circulator motor (48) is obtained from the bottom connection on the tank. Otherwise the water will not flow and the anode tip will melt.

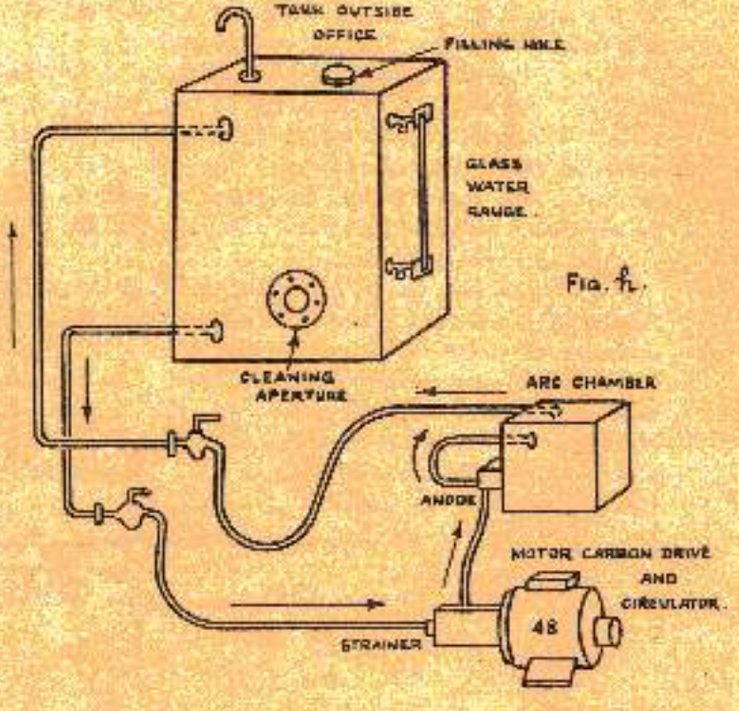


Fig. 4.

For tuning, the wavemeter current is placed over the aerial coil(70). The arc is struck and connected to the aerial circuit by the magnetic key (71). The aerial coil(70) is adjusted until the required frequency is obtained. As the aerial coil (70) can be adjusted to one turn very little fine tuning is required, but any fine tuning can be carried out on the wavemeter(72) by altering the angle of the two coils as required. The tappings to be short circuited on the spacing wave coil (72) depend on the frequency required.

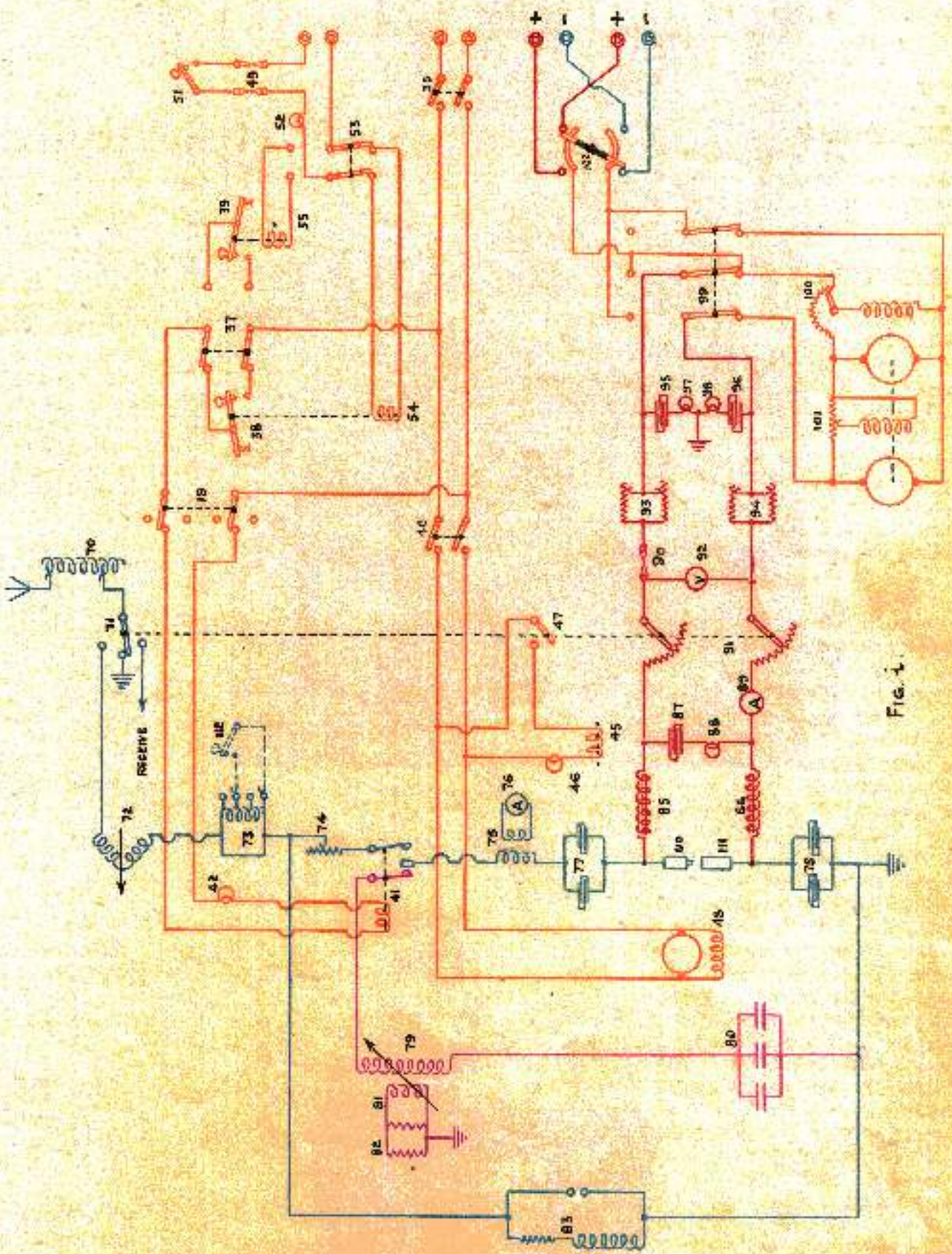


Fig. 1.

TYPES 14, 15 & 16.

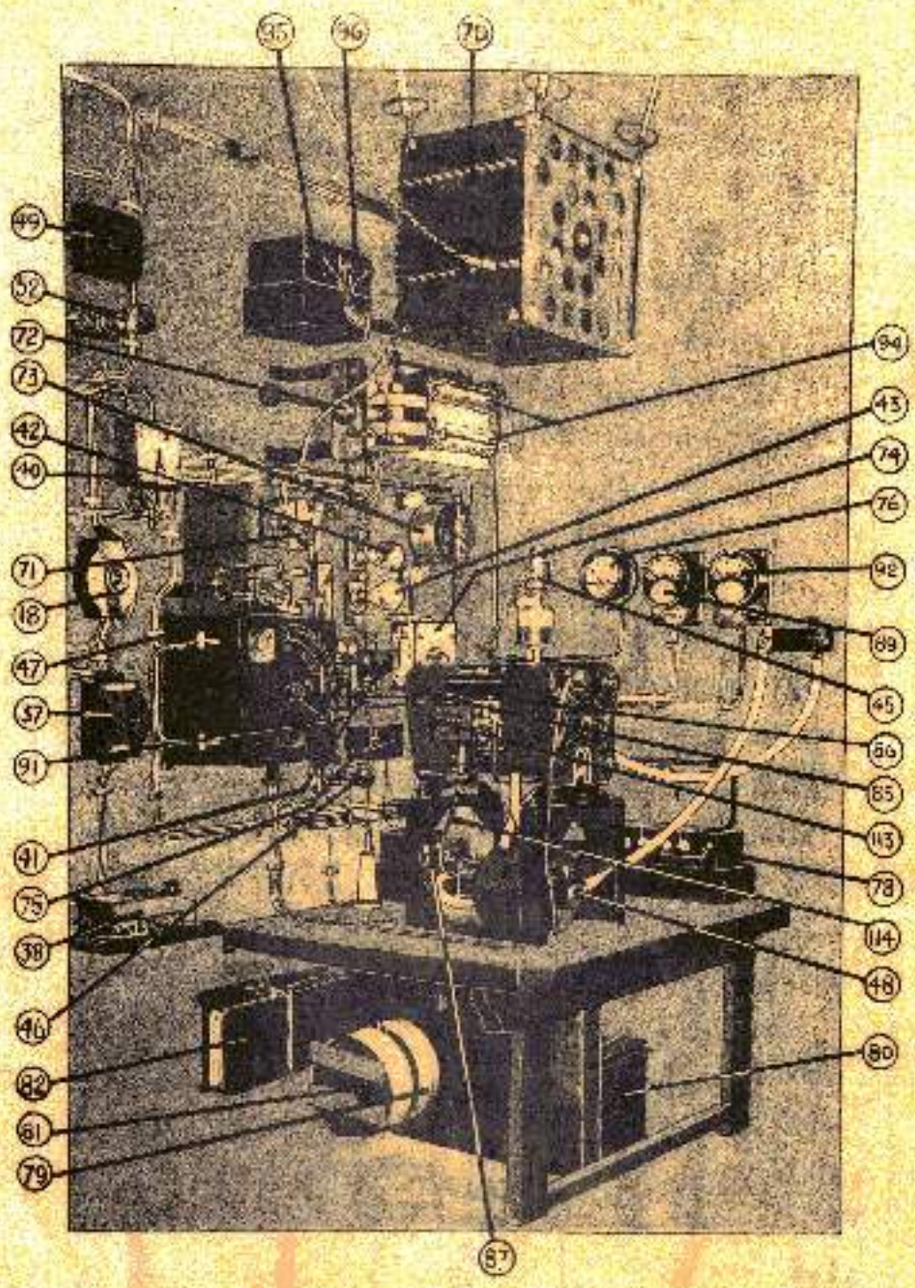


Fig. 7

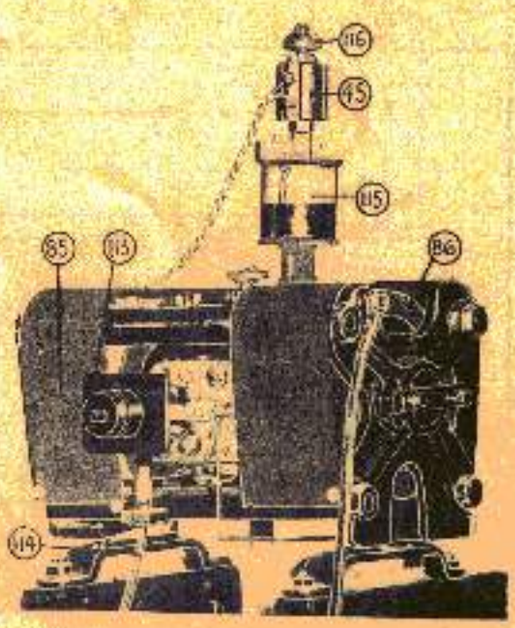


Fig. 8.