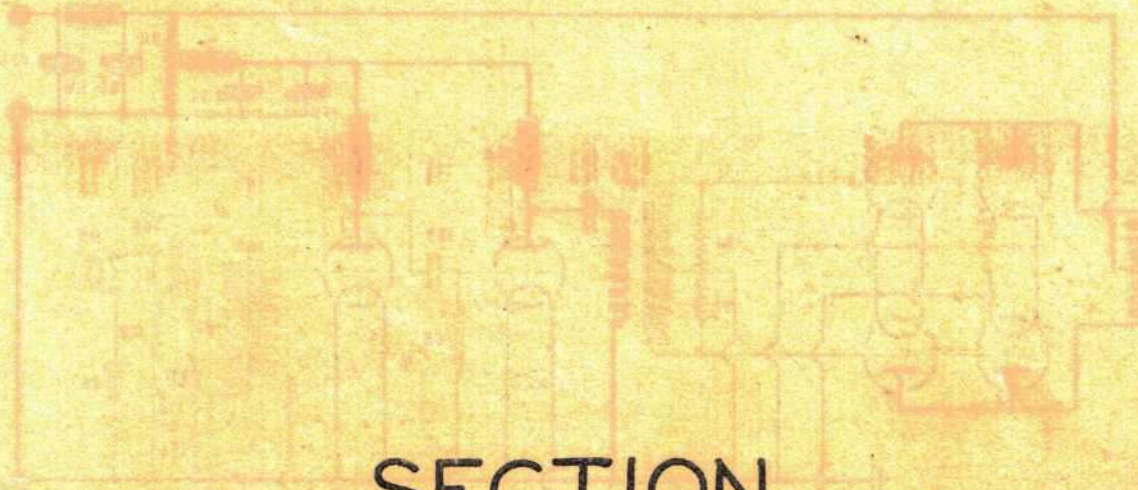


TYPE 401
EQUIVALENT CIRCUITS
SPEECH POSITION



SECTION

V

W_A/T SETS

TYPE 401

PAGE V2

TYPE 402

PAGE VI6

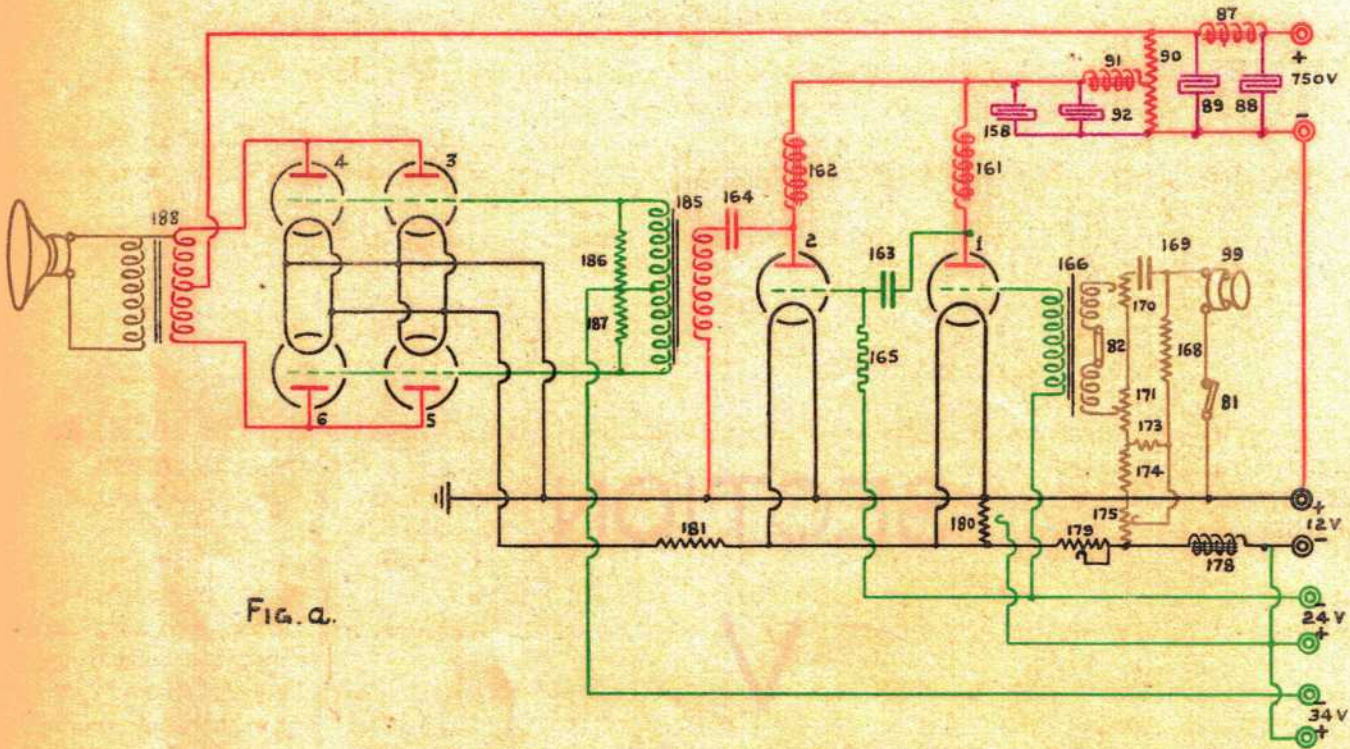
TYPE 403

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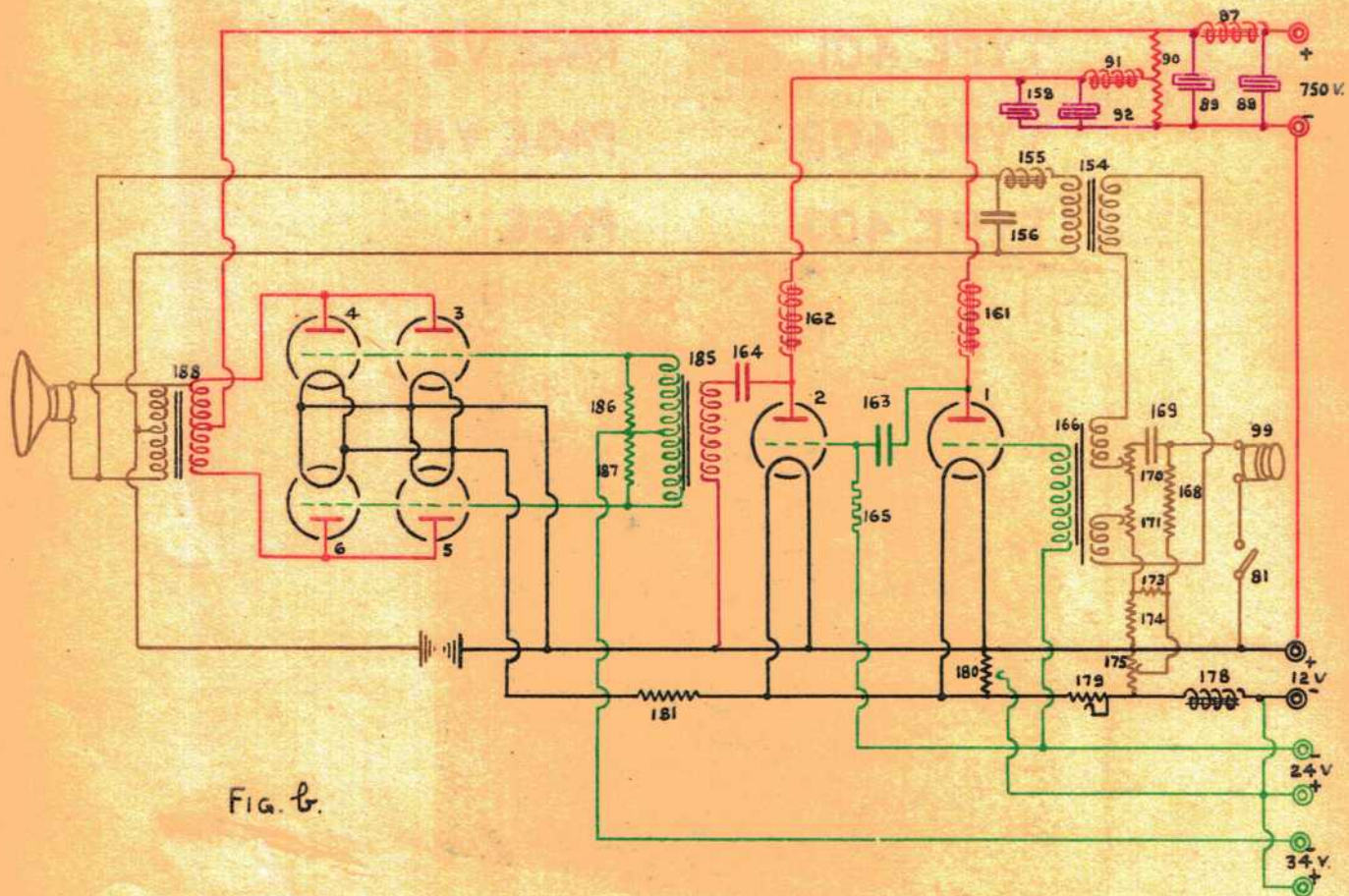
TYPE 401

EQUIVALENT CIRCUITS

"SPEECH" POSITION



"HOWL" POSITION



TYPE 401

V3

Date of design:- 1927 - 1933.
 Valves used:- Two No. 4205D (will be replaced by 4205E which is less microphonic).
 Four No. 4211D Standard Telephones & Cable Co., Ltd.,
 Power supply:- Two double purpose generators Nos. 1 and 3 giving 750 and 12 volts.
 Two double purpose generators Nos. 2 and 4 giving 24 and 24 volts.
 or in some cases
 12 volt, 22 volt and 350 volt batteries.
 20 volt mains for certain relays.

GENERAL DESCRIPTION.

Type 401 is a W/T set consisting of input and output amplifier, five groups of loud speakers, and two or five transmitting and alarm boxes.

The amplifiers and the necessary switch panels, relay panels etc., are mounted in two racks as shown in figures p. and q. and fitted in the main W/T office, or near the ships' main switchboard. In some cases the whole outfit is fitted in one rack.

A power board figure c. contains the machine change over switches (39)(46), fuses (212)(213), voltmeters (47)(48) and ring main C.C.S. (45), and *machine starting relays (7)*.

The five groups of speakers are as follows:-

- | | |
|------------------------|--------------------------|
| (a) Officers Quarters. | (d) Communication Group. |
| (b) Engine Room Group. | (e) Armament Group. |
| (c) Crew Spaces. | |

The set is fitted in certain battleships, cruisers and aircraft carriers. It differs in various details such as the power boards, power supply, valves, racks and the number of transmitter and alarm boxes, depending on the class of ship in which the set is fitted. The set as described in these notes is applicable to H.M.S. "NEPESON" and H.M.S. "RODNEY".

In cases where only two pairs of transmitter and alarm boxes are fitted one pair is situated on the compass platform for use at sea, and the other in a convenient position (Quartermasters' Lobby) for use in harbour. When five transmitter and alarm boxes are fitted, the additional positions are, Fire Control Room, Main Exchange and Upper Conning Tower. The transmitter and alarm box at each station is controlled by a separate 14 pole switch (207)(208)(209)(210)(211)(see figure r.). These switches are connected in parallel and are fitted in No. 1 rack. They enable any transmitting station to be isolated from the set. As they are normally made, they have been shown in this position in the diagrams.

Each transmitter and alarm box is so designed that, provided no essential switches have been broken at the set and the rack doors are closed, the act of opening either of the boxes switches on the motor generators (see figure b.). This is described under "Machine Starting Relay Circuit" (page V9).

In each transmitter box there are five group switches which are made as required by the person using the set. Each switch controls one of the five groups of speakers.

As the circuits for the transmitter and alarm boxes are identical (all similar circuits being in parallel) No. 1 boxes only will be described in these notes.

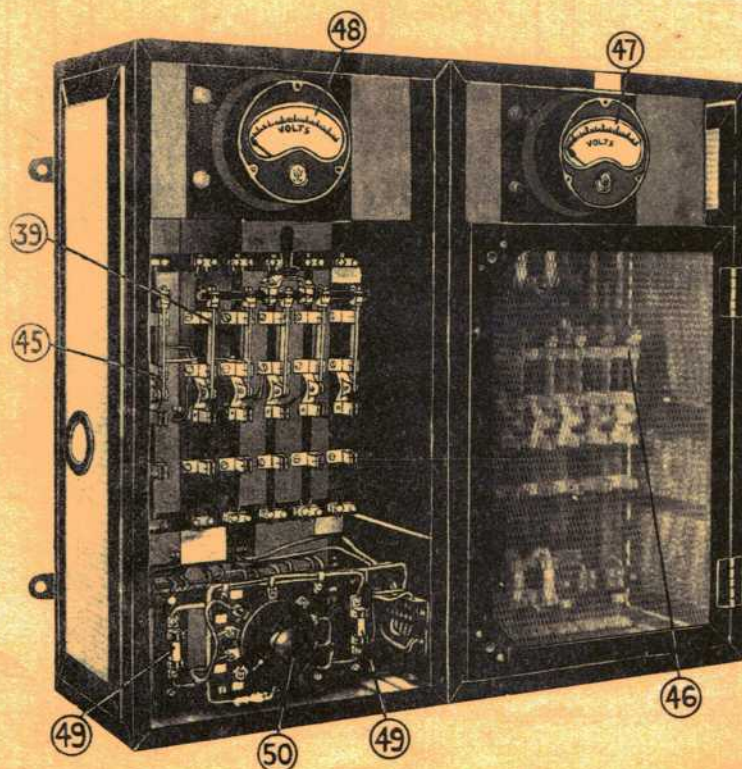


FIG. C.

POWER SUPPLY

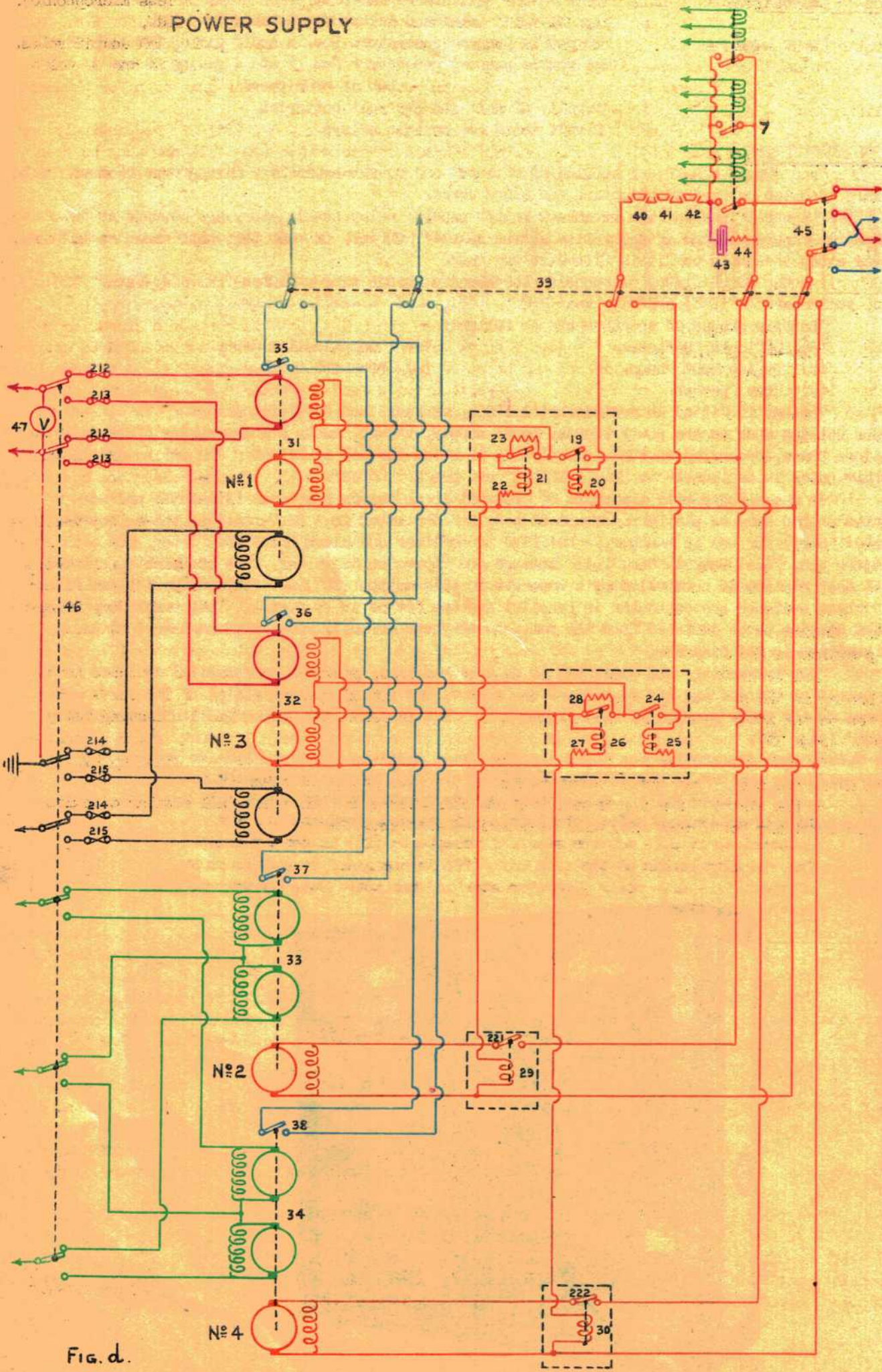


Fig. d.



POWER SUPPLY.

Motor Generators Four double purpose motor generators are fitted

Nos. 1 and 3 machines (31)(32) each have an output of 750 volts at 0.6 amps for H.T., and 12 volts at 18 amps for valve filaments microphone circuit, machine running indicating lamp circuit and the "In use" disc circuit and relay.

Nos. 2 and 4 machines (33)(34) each have an output of 24 volts for grid bias for the input amplifier and 34 volts for grid bias for the output amplifier.

Nos. 3 and 4 machines (32)(34) are alternatives to Nos. 1 and 2 (31)(33) respectively and the change over is effected by the input switch (39) and output switch (46). It can thus be seen that the change over from No. 1 machine (31) to No. 3 (32) also effects a change over from No. 2 (33) to No. 4 (34).

Each machine has its own starter.

Certain sets, originally fitted with 12 volt, 22 volt and 350 volt batteries are now being fitted with generators in lieu.

D.C. Supply The D.C. supply for the generators and starters in use is from the ring main C.O.S. (45) to the Machine and Starters C.O.S. (39).

The C.O.S. (39) is a 5-pole, 2-way switch, and the D.C. supply is connected direct to 2 poles. These two poles connect the negative supply direct to the machines it is intended to use, and the positive supply to a contact of the starting switches (19)(221) or (24)(222). A third pole is used in the machine starting circuit, as described below, and the other two are used for the Machine Running Indicating Lamp Circuit, (see figure i.)

Throughout these notes it will be assumed that No. 1 and No. 2 machines (31)(33) are in use.

As stated above, the D.C. supply is connected direct to the C.O.S. (39). In addition the positive supply is connected to the switches on the starting relays (7). These relays are operated from either a transmitter or alarm box or from the local switch (8) (see figure h.), and when operated, the positive supply is connected to a third pole of the C.O.S. (39) via the safety switches (40)(41)(42).

The safety switches (40)(41) each represent two switches, one pair of which is fitted on the front and back of the Nos. 1 and 2 rack doors respectively. The safety switch (42) is fitted on the cover of the 7 pole C.O.S. (46). It will therefore be noted that if either rack door is open or the cover of the C.O.S. (46) is removed the set becomes inoperative. A condenser (43) and resistance (44) are connected across the make and break of the starting relay switches (7), to prevent arcing when they make and break.

The third pole of the C.O.S. (39) connects the positive supply to the H.T. - L.T. motor-generator starter bobbin and resistance (20). The bobbin (20) is thus energised and makes the switch (19). This switch connects the 220 volt positive supply to the H.T. - L.T. motor generator (31) through the starting resistance (23) and the motor starts.

Connected across the brushes of the H.T. - L.T. motor are a bobbin (21) and resistance (22). As the motor speeds up and the back E.M.F. rises to a predetermined value, the bobbin (21) is energised and the arm attached to it cuts out the starting resistance (23) in one movement. The starting bobbin of the grid bias (29) is energised by the movement of the H.T. - L.T. motor generator starting contact. Both motors start at the same time.

Output Supplies The output supplies from the machines are taken to the 7 pole C.O.S. (46) the cover of which has a safety switch (42) fitted to it. Four poles of the C.O.S. (46) change over the H.T. and L.T. supplies and three poles the grid bias supplies.

The 750 volt supply from each generator has a pair of fuses (212)(213) connected in the supply leads between the generator and the C.O.S. (46). Each supply is connected to two contacts of the C.O.S. (46). A voltmeter (47) is connected between the 750 volt contacts of the C.O.S. (46) to indicate the H.T. voltage.

The 12 volt supply from each generator has a pair of fuses (214)(215) connected in the supply leads between the generator and the C.O.S. (46). Each supply is connected to two contacts of the C.O.S. (46), and the positive 12 volt supply is connected to earth.

The positive supplies from the grid bias 24 and 34 volt generators are made common at the machines. The common positive supply and the 24 and 34 volt negatives of each machine are connected to 3 contacts of the C.O.S. (46).

The output supplies from the 12, 24, and 34 volt generators are also connected from the C.O.S. (46) to a 4 way C.O.S. (50). Connected across the centre of this C.O.S. (50) is a voltmeter (48) with a pair of fuses (49) connected in the supply leads. By moving the C.O.S. (50) to the appropriate position, the voltmeter (48) is connected across the 12, 24 or 34 volt supply, and that particular output voltage is indicated in the voltmeter (see figure r.).

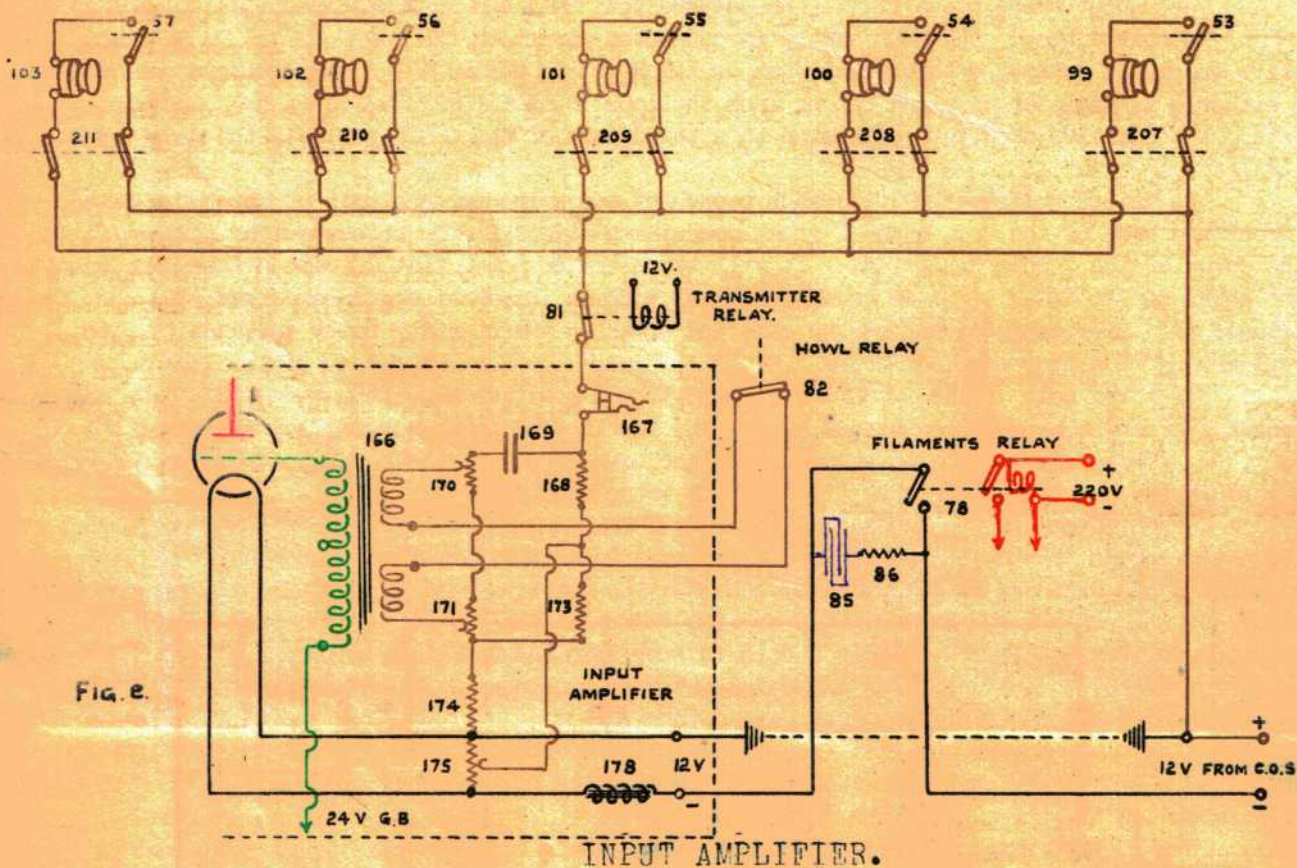
MICROPHONE CIRCUIT.

Reference:- Admiralty Handbook of W/T (1931) paragraph 638 (3).

On making the "To Talk" switch (53) the circuit is completed from the 12 volt positive supply through the isolating switch (207), the microphone (99), the transmitter relay (81) (see page V11) the resistances (163) and (175) to the 12 volt negative lead. The act of speaking into the microphone causes alterations in its resistance and hence in the current through it. These variations of current through the resistance (163) produce voltage variations across the primary of the transformer (166), the secondary of which is connected between grid and filament of the valve (1) of the input amplifier. The resistance (175) is adjusted by a handle marked "transmitter". It controls the steady current through the microphone which if much in error causes distortion. A jack (167) is fitted, into which may be inserted the plug of a milliammeter (225) on the meter panel. The normal operating current is 20 mA but a tolerance of 6 mA may be allowed on either side of this value.

Resistances (170)(171) are variable and are adjusted together by one handle. This adjustment alters the amplitude of the voltage variations applied across the primary of the transformer (166), and is consequently a volume control.

Resistances (173) and (174) are rendered necessary by the fact that a different type of microphone is now in use from that for which the circuit was originally designed.



The input amplifier (see figure f.) consists of two stages of amplification, choke capacity coupled.

H.T. Supply. The H.T. required for this amplifier is 350 volts, which is obtained from the 750 volt supply. The 750 volt contacts of the C.O.S. (46) are connected to a filter panel, and one arm of the anode relay (79) completes the circuit. A by-pass condenser (83) is connected across the supply. The positive 750 volt lead is connected through a choke (87) to the variable resistance (90). This resistance reduces the 750 volts to 350 volts, which is taken through a choke (91) to the anode chokes (161)(162) and anodes of the valves (1)(2). A second arm of the anode relay (79) completes this circuit. As the anode relay bobbin (79) circuit is controlled by one arm of the filament relay (78), the valve filaments are heated before the H.T. is applied, (see page V10 "Master Relay"). The condensers (89)(92) and chokes (87)(91) are connected in the H.T. supply to smooth out generator commutation ripple.

A 0.1 amp fuse (157) is provided to protect the anode circuit. A by-pass condenser (153) is connected between the positive supply and earth. The jacks (159)(160) are connected one in each valve (1)(2) anode circuit. The milliammeter (225) (see figure r.) is fitted with a plug, which can be inserted in the jacks, and the anode current read off. The anode current of each valve should be 35 - 40 milliamps.

INPUT AMPLIFIER (CONT.)

Filament Supply. The filament supply is from the 12 volt contacts of the C.O.S.(46). The normal current of each valve (1)(2) is 1.6 amps. As the 12 volt positive is at earth potential the 12 volt positive terminal from the valve filaments is also earthed. The negative supply is connected to the filaments via one arm of the filament relay (73)(see figure k.). Connected across the make and break of this relay is a condenser (85) and resistance (86) to prevent arcing when the circuit is made or broken. A 4 amp fuse (176), jack (177), choke (178) and rheostat (179), are connected in the negative supply. The fuse (176) protects the valve filaments, and the jack (177) enables a current reading to be taken with the ammeter (226)(see figure r.). The choke (178) is used to steady the filament current, by smoothing out commutation ripples, and the rheostat (179) controls the filament current of the input amplifier valves(1)(2) and also the output amplifier valves (3)(4)(5)(6) (see figure g.).

The milliammeter(225) and ammeter(226) cannot be plugged into the wrong supplies as the jacks and plug for each instrument are of different sizes.

Grid Bias. The input amplifier requires 24 volts grid bias which is supplied from the 24 volt contacts of the C.O.S.(46). The positive is connected direct to the filament negative, and also to a centre fixed tap resistance (130), connected across the filament supply. This resistance controls the grid bias voltage. The negative is connected, via a filter, to the grid of the valve(1) through the secondary of the transformer (163), and to the grid of the valve(2) through a resistance (165). The filter consists of a choke(93) connected in the negative supply and two condensers(94)(95) connected across the 24 volt supply. This filter smooths out any generator commutator ripples.

Oscillatory Circuit. The grid of the valve (1) is connected to the negative grid bias through the secondary of the transformer (163). The primary of the transformer (163) is connected in the microphone circuit (see figure a. page V2) or to the howler transformer(154) (see figure b.) Choke capacity coupling is employed between valves (1) and (2) and between the valve (2) and the output transformer (185). The secondary of this transformer (185) is connected to the grids of the output amplifier valves (3)(4)(5)(6).

Howler Circuit. One arm of the howl relay (82)(see figure m.) is connected in series with the primary windings of the input transformer (166) of the first amplifier. This arm normally makes contact thereby short circuiting the output coil of the howler transformer (154). The input to the howler transformer (154) is fed from half the auto transformer (191) supplied by the output amplifier transformer (133). Normally this lead is broken. When the howler relay(82) bobbin is energised the short circuit is broken and the input lead connected up. A condenser (156) across the input of the howler transformer (154) gives an audio frequency oscillation, which is amplified by both amplifiers, and then supplied to the loudspeakers and also to the howler transformer again. To prevent this amplification continuing to undesirable limits a retarding coil (155) is inserted in series with the howler transformer input (see figure b.).

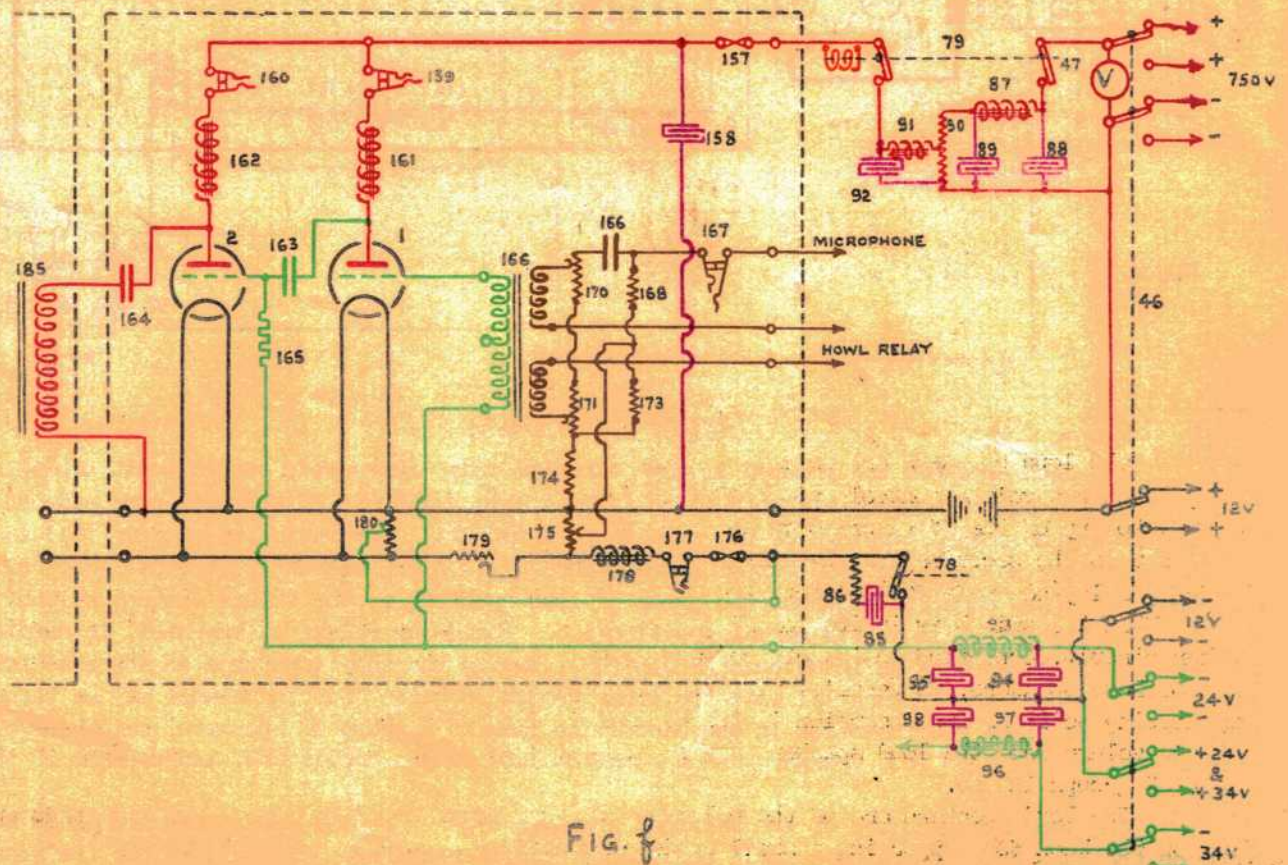


FIG. f

OUTPUT AMPLIFIER.

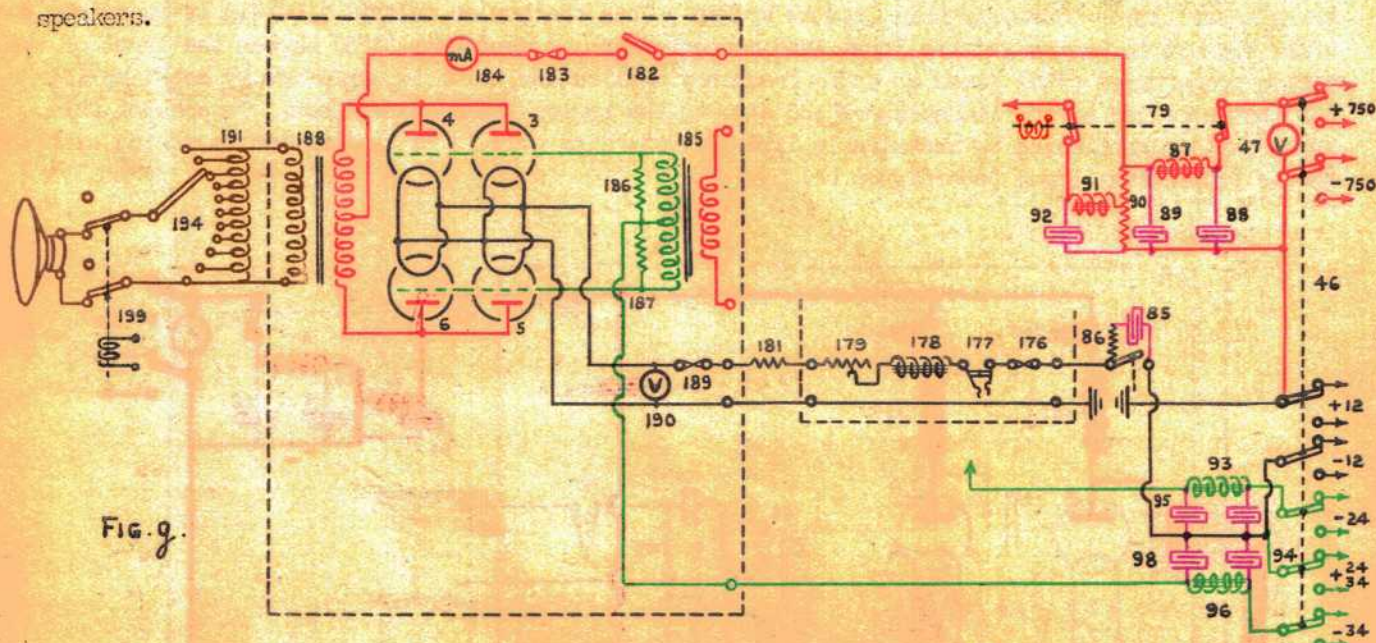
The output amplifier (figure g.) consists of one stage only, and uses four valves connected in parallel "Push Pull" (See Admiralty Handbook of W/T (1931) paragraph 595).

H.T. Supply. The H.T. required for the output amplifier is 750 volts which is obtained from the 750 volt contacts of the C.C.S. (46). The positive supply is connected to the filter panel, and the negative to the 12 volt positive which is earthed. The supply to the filter panel is through a choke (87) with one arm of the anode relay (79) completing the circuit. Two condensers (88) (89) are connected, one each side of the choke (87), to the negative supply. The condenser (89) and choke (87) are to smooth out commutation ripple, and the condenser (88) is a by-pass condenser across the H.T. supply. The H.T. supply is connected from the filter to the centre point of the primary of the output transformer (182) and through one half of the primary to the anodes of the valves (3) (4) and the other half to the anodes of the valves (5) (6). A local switch (182), 0.5 amp fuse (183) and milliammeter (184) are connected in the circuit. The switch (182) allows the H.T. to be isolated from the valves, the fuse (183) protects the circuit, and the milliammeter indicates the total anode current of the four valves. This current should be 200 - 340 milliamps.

Filament Supply. The filaments of the output amplifier valves are connected in parallel with the filaments of the input amplifier, thus the rheostat (179), jack (177) and choke (178) are in the circuit, the uses of which, are described under "Input Amplifier" (see page V6). As the valves (3) (4) (5) (6) require 10 volts at 3 amps each, a resistance (181) is connected in series between the input and output amplifier filament supplies to reduce the 12 volts to the required amount, with a 15 amp fuse (189) to protect the filaments. A voltmeter (190) is permanently connected across the filament terminals of the amplifier to indicate the filament voltage on the valves.

Grid Bias. The grid bias voltage required is 24 volts, which is obtained from the 24 volt contacts of the C.C.S. (46). The positive 24 volt supply is connected to the 12 volt filament negative. The negative supply is connected through a filter to the centre point of the output amplifier input transformer (185) secondary. The filter, consisting of a choke (93) connected in the negative supply, and two condensers (94) (95) connected across the 24 volt supply, assists in smoothing out commutator ripple. Connected across the secondary of the input transformer (185) are two resistances (186) (187), the centre point of which is also connected to the negative grid bias.

Oscillatory Circuit. The secondary of the input transformer (185) is connected between the grids of the valves (3) (4) and (5) (6). The anodes of the valves are connected to the primary of the output transformer (182), the secondary of which is connected to the auto transformer (191) and the loud speakers.



LOUD SPEAKERS.

The loud speakers are grouped in five circuits (see figure r.), each circuit obtaining its supply through a volume control switch (192) to (196). This switch is of the dial type and can be adjusted to any of the 11 tapings of the auto transformer (191). The auto transformer (191) is connected across the secondary of the output transformer (182). A D.P. switch (197) to (201), controlled by the group relay (see page V11) connects the group of loud speakers to the volume control switch (192) to (196). When the switch is in its normal position (i.e., the group relay not operated) it completes another circuit, connecting an inductance (202) to (203), having the same impedance as its associated group of loud speakers, in parallel with the other groups in use. This inductance may be termed a compensating coil, as its insertion in the circuit in lieu of a group of speakers, maintains a constant volume from the loud speakers and a constant load on the amplifiers, independent of the number of groups in use.

The loud speakers are of the balanced armature type. Special resistance mountings are provided on the back for supporting a small resistance coil, if required. This allows for the insertion of a resistance in series with the windings, to cut down the volume output of a particular speaker, if desired. These resistance terminals are normally short circuited.

Graham Type loud speakers (as fitted in Type 402) are now fitted in certain exposed positions as they stand up to the shock of gunfire better than the balanced armature type.

MACHINE STARTING RELAYS.

The machine starting relays (7) are fitted in No. 2 rack. The supply for these relays is from the 220 volt mains.

The centres of the relay bobbins are connected to the negative 20 volt supply. Each end of the bobbins is connected, through the isolating switches (207) to (211) to the transmitter boxes door switches (9) to (13) or alarm boxes door switches (14) to (18) and thence to the positive 20 volt supply. It will be noted that each transmitter or alarm box uses half of a relay bobbin to operate a starting relay. If either of these doors are opened, the door switches (9) or (14) (fitted in that particular box) are closed, and the supply is completed through one half of a starter relay bobbin to the negative supply.

The bobbin operates a switch which completes the positive 220 volt supply to the generators starters, as described under "D.C. Supply" (Page V5). The switch (8) is a local switch, fitted on No. 1 rack, and is used for testing purposes as it enables the motors to be started from that position. It is connected in parallel with the transmitter and alarm boxes door switches. Used in conjunction with the local switch (52) fitted on No. 2 rack (See page V10 Master Relay Circuit) the whole set can be put into operation from the control position.

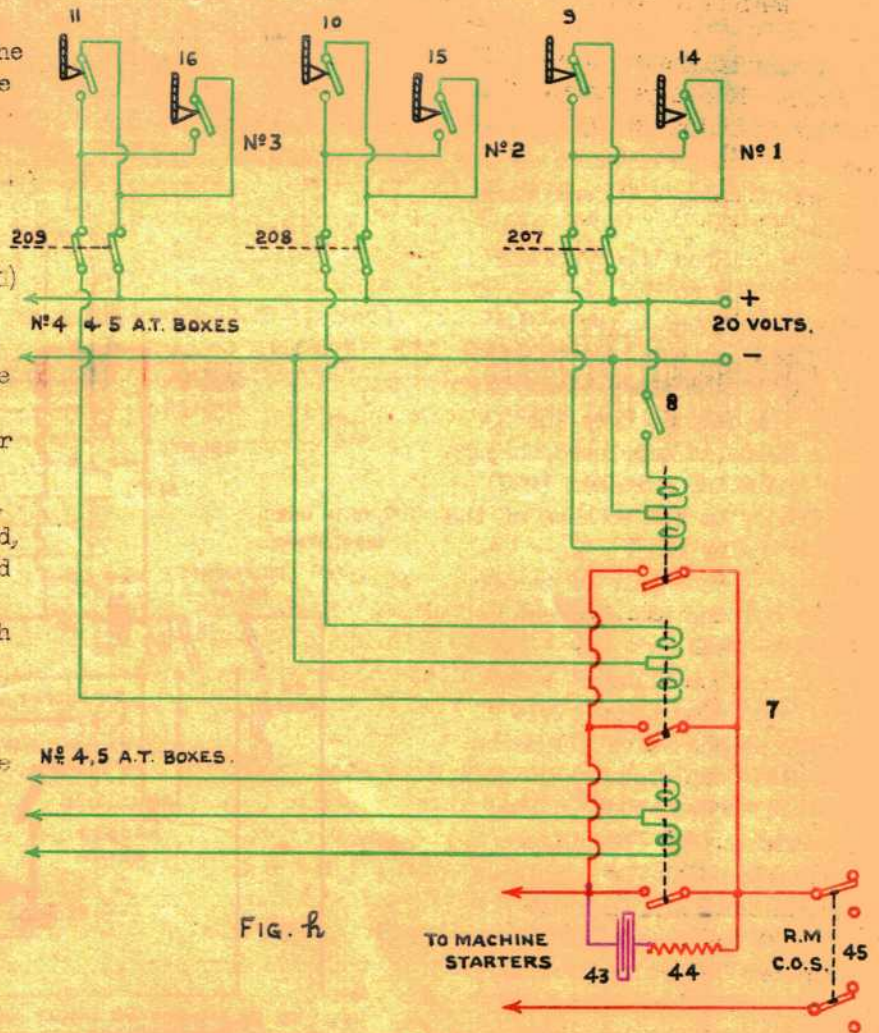


FIG. h

MACHINE RUNNING INDICATING LAMP CIRCUIT.

The machine running indicating lamp circuit informs the person using the set whether both H.T. - L.T. and grid bias machines are running or not.

Each machine has a governor which closes a contact (35) (36) (37) (38) when the machine has reached a certain speed. The contacts of each pair of machines, (i.e., (35) (37) and (36) (38)) are connected in series.

When these contacts (35) (37) or (36) (38) close, the 12 volt supply from the switch (46) is completed, through the C.O.S. (39) and the isolating switches (207) to (211), to the Machine Running Indicating Lamps (58) to (37) which light. It will be noted that as all these lamps are in parallel they will all light provided that none of the isolating switches (207) to (211) are broken.

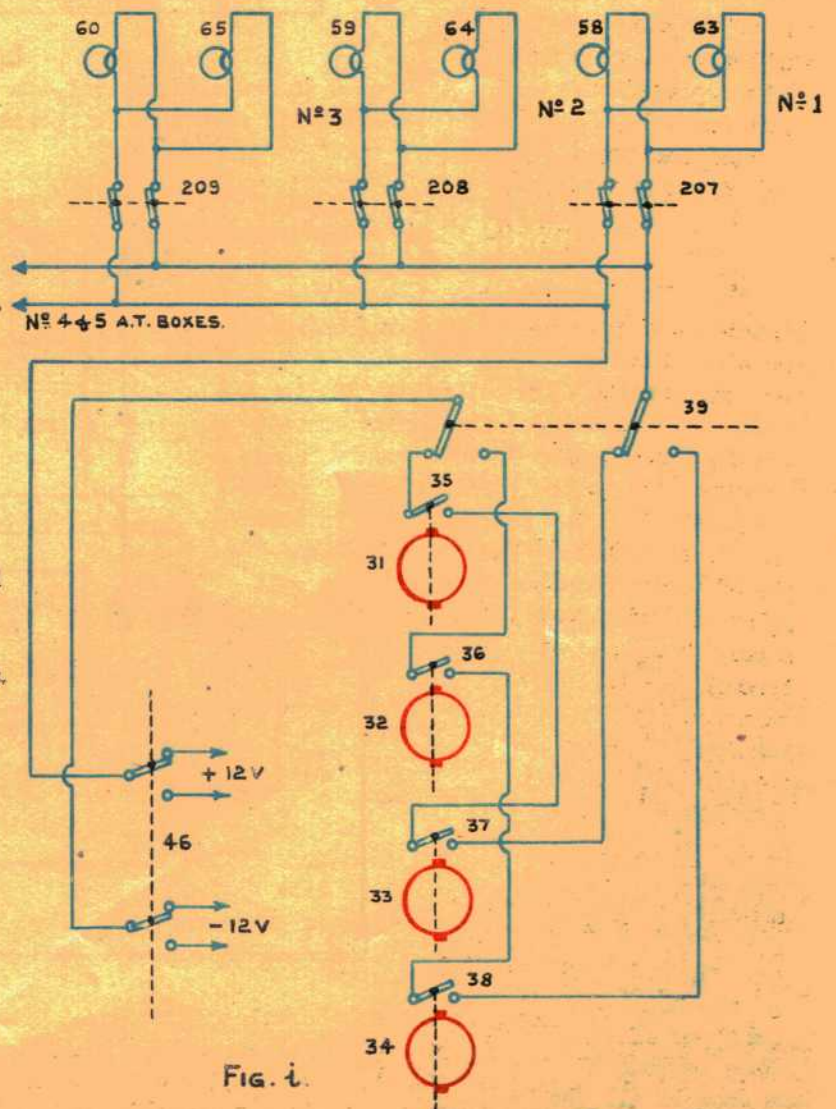


FIG. i

TYPE 401

MASTER RELAY.

The Master Relay (51) controls all relays except the Machine Starting Relays (7). It completes the 220 volt circuit and the bobbin circuits of the filament relay (78) and anode relay (79).

When the "To Talk" switch (53) to (57) in any of the transmitter boxes or the "Signal" switch (129) to (133) in any of the alarm boxes is made the circuit from the 20 volt mains is completed, through the isolating switches (207) to (211), to the bobbins of the master relay (51).

Each pair of master relay bobbins has a common negative lead.

The filament relay (78) completes the 12 volt supply to the valve filaments and also completes the 12 volt circuit through the "In Use" disc relay (80) (see figure k.) The anode relay (79) completes the 750 volt and 350 volt H.T. supplies to the output and input amplifiers respectively.

A local switch (52) is fitted on the set, and enables the master relay (51) to be operated from that position. The local switch (52) used in conjunction with the local switch (2) for the machine starting relays, (see page V9) enables all relays to be operated and all supplies to the set to be completed for testing purposes.

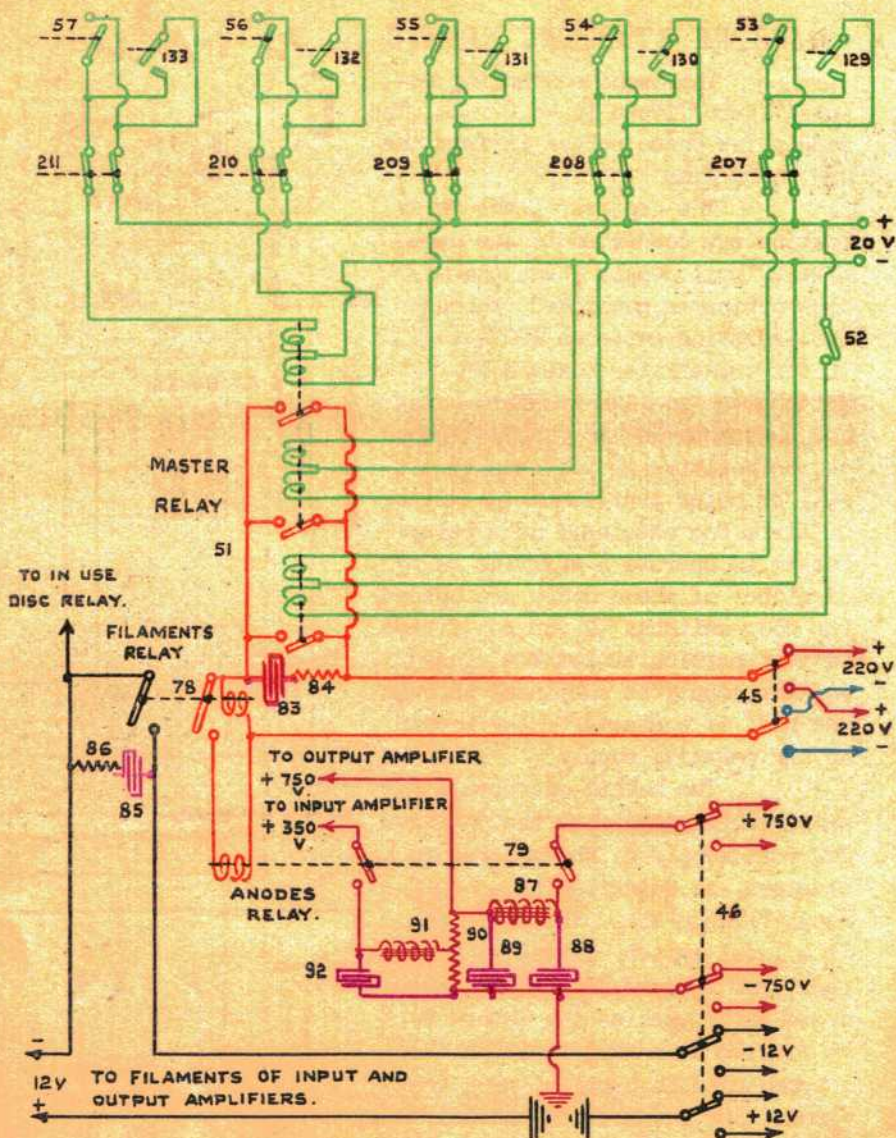


FIG. j

IN USE DISC RELAY.

The "In Use" disc is a white disc visible at the window of each transmitter and alarm box when the set is being operated from any position.

When the filament relay (78) is operated (see figure j.) its second contact completes the negative 12 volt supply from the switch (46) to the bobbin of the "In Use" Disc relay (80). The positive lead is completed through earth. The "In Use" Disc relay (80) when made, completes the 12 volt supply from the switch (46), through the isolating switches (207) to (211) to bobbins (68) to (73). These bobbins pull down an arm which then shows a white disc attached to it.

It will be seen above that the filament relay (78) is controlled by the "To Talk" (53) to (57) or the "Signal" (129) to (133) switches. Consequently when any one of these switches is made the "In Use" discs show in all the Transmitter and Alarm Boxes.

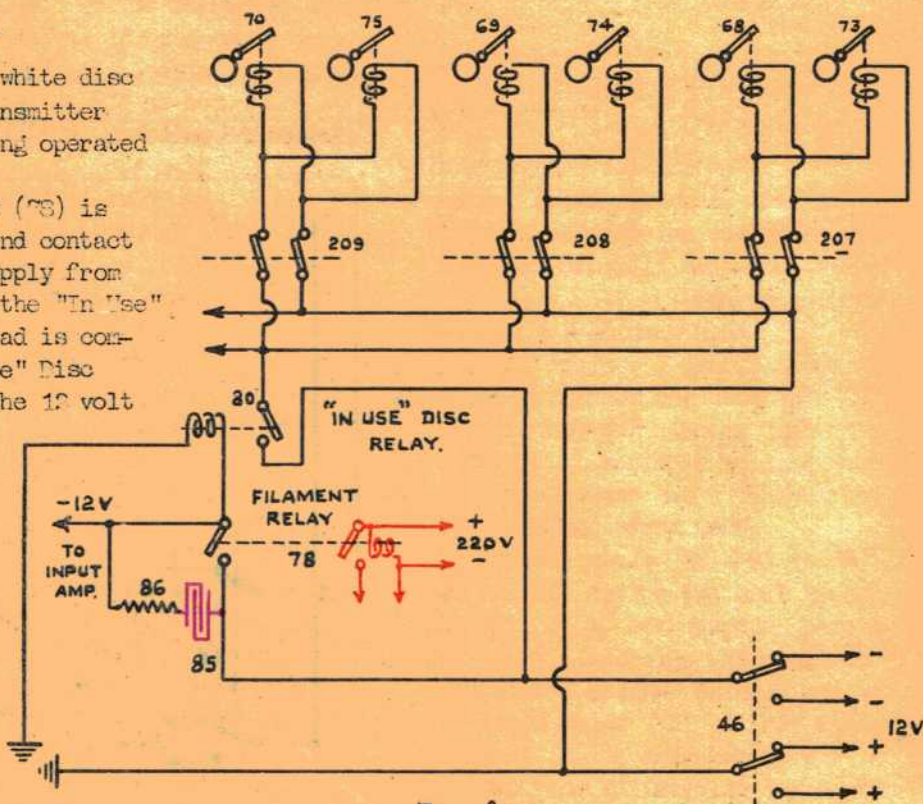
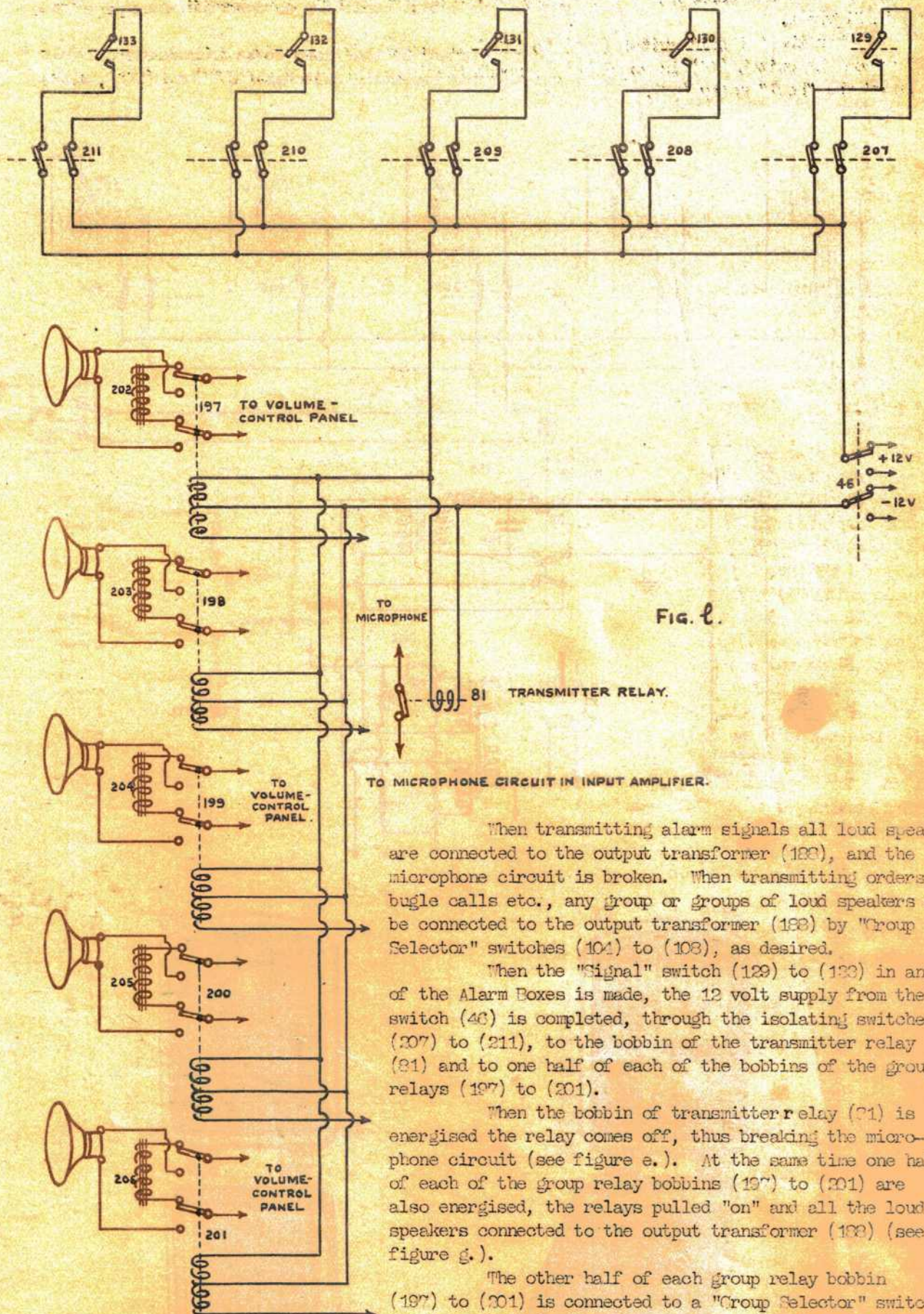


FIG. k.

TRANSMITTER & GROUP RELAY CIRCUITS



When transmitting alarm signals all loud speakers are connected to the output transformer (188), and the microphone circuit is broken. When transmitting orders, bugle calls etc., any group or groups of loud speakers can be connected to the output transformer (188) by "Group Selector" switches (104) to (108), as desired.

When the "Signal" switch (129) to (133) in any of the Alarm Boxes is made, the 12 volt supply from the switch (46) is completed, through the isolating switches (207) to (211), to the bobbin of the transmitter relay (81) and to one half of each of the bobbins of the group relays (197) to (201).

When the bobbin of transmitter relay (81) is energized the relay comes off, thus breaking the microphone circuit (see figure e.). At the same time one half of each of the group relay bobbins (197) to (201) are also energized, the relays pulled "on" and all the loud speakers connected to the output transformer (188) (see figure g.).

The other half of each group relay bobbin (197) to (201) is connected to a "Group Selector" switch (104) to (108) in the "Transmit boxes" (see figure r.), so that any desired group of loud speakers can be used when broadcasting orders etc. The switches (104) to (108) complete the 12 volt supply from the switch (46), through the isolating switches (207) to (211), to these half bobbins (197) to (201) (see figure r.).

HOWL RELAY CIRCUIT.

The howl relay (82), when operated, removes the short circuit from the primary of the transformer (154) and connects the secondary to the output amplifier as described on page V7 and shown in figure n.

When the "Signal" switch (129) to (130) in any of the Alarm boxes is made the 12 volt supply from the switch (40) is completed, through the isolating switches (207) to (211), to the hobbin of the "howl" relay (82).

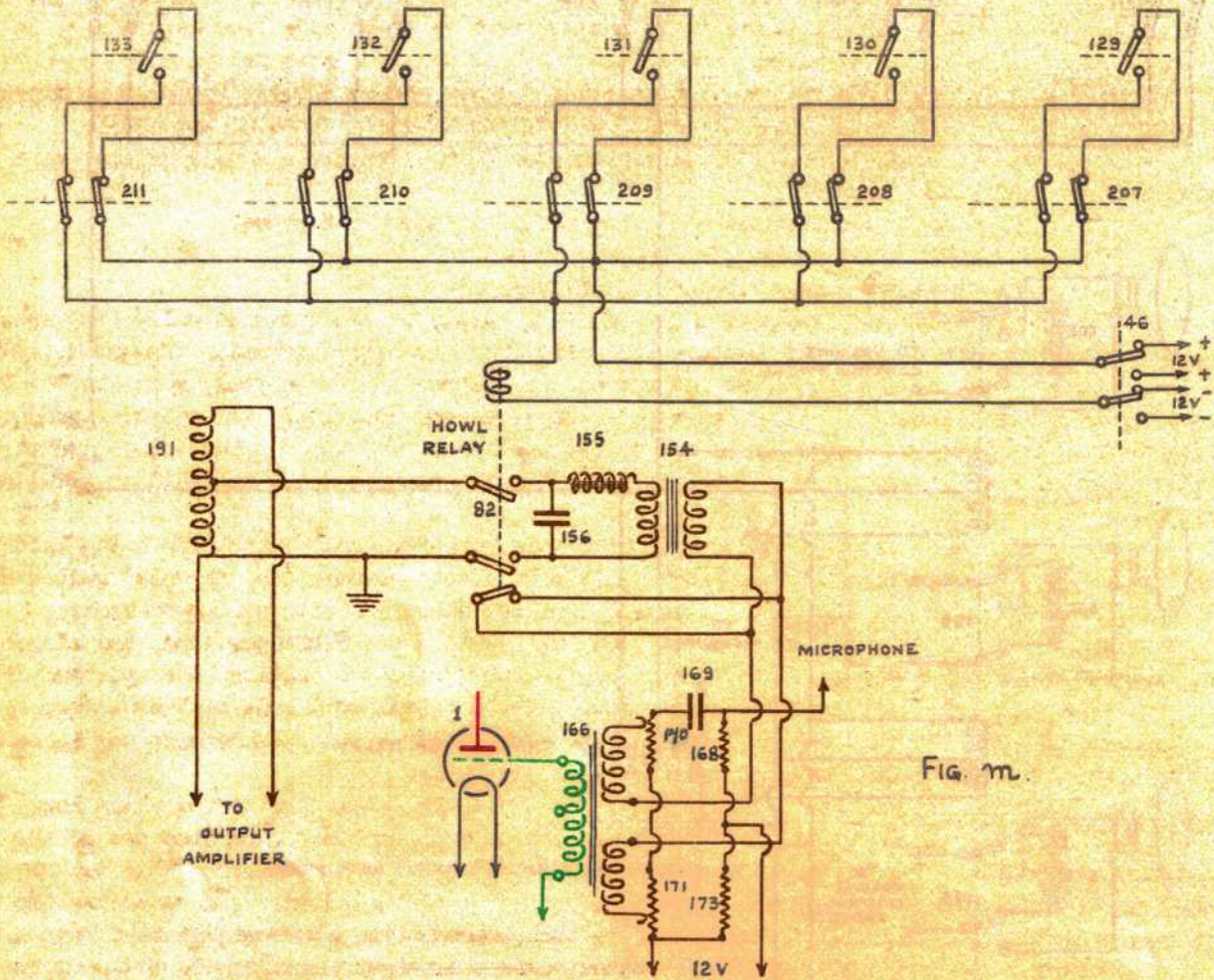


Fig. m.

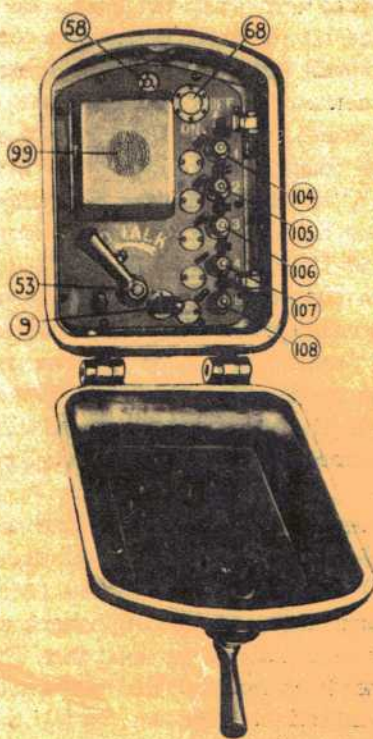


Fig. n.

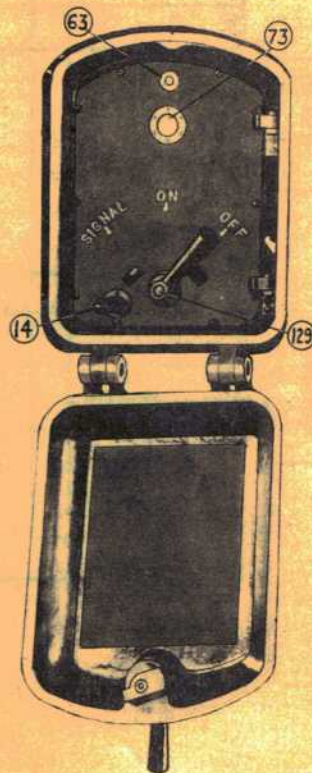


Fig. o.

OPERATION.

Speech Conditions (Using No. 1 Transmitter Box). Open the outer door of the transmitter box. If the "In Use" disc (33) shows white, it denotes an announcement is being made from one of the other transmitting stations. The action of opening the door closes the switch (9). This switch completes the 20 volt circuit through the starting relays (7), which operates and completes the 220 volt supply to the machines and starters and the two generators start (see figures h. and d.)

Wait for the lamp (52) to light, as this denotes that both machines have run up to speed, and the various supplies are available to operate the set (see figure i.)

Make the group selector switch or switches (104)(105)(106)(107)(108) corresponding to the group or groups of loud speakers at which the announcement is to be made (see figure r.), to the "ON" position. These switches connect the respective loud speaker group relays (197) to (201) to the "To Talk" switch (53). The relays when operated connect the particular group of speakers to the output amplifier (see under "Loud Speakers" and "Group Relays", pages V8 and V11).

Make the "To Talk" switch (53) to the extreme left. This is a 3 pole switch, each pole completing the following circuits:-

- (1) Supply to group switches and group relays as described above.
- (2) 12 volt microphone circuit (see figure e.).
- (3) 20 volt master relay circuit (see figure j.).

The master relay (51) completes the 220 volt supply to the filament relay (78) which in turn completes the 220 volt supply to the anode relay (79) (as described under "Master Relay") and the 12 volt supply to the "In Use" disc relay (80) (see figure k.). Therefore when the "To Talk" switch is made, the filament, H.T. and microphone supplies are completed, the required group or groups of loud speakers are connected to the output amplifier, and the "In Use" discs are visible at all the other Transmitter and Alarm boxes, providing the control switches (207) to (211) are made.

An announcement or bugle call may now be made, the "To Talk" switch (53) being held in the "Talk" position the whole time. After making an announcement, release the "To Talk" switch which will automatically return to its normal position, and the above circuits are again broken.

Return all group selector switches (104) to (108) to the "OFF" position, and close the outer door of the transmitter box. This breaks the switch (9) and the machines are switched off.

Some Wa/T sets have an arrangement which gives a preliminary call or buzz before an announcement is made. In this set it is not the case, but some local arrangements can be made, such as a whistle being blown into the microphone.

"Alarm" or "Howl" Conditions (Using No. 1 Alarm Box). Open the outer door of the alarm box. If the "In Use" disc (73) shows white, it denotes an announcement is being made from one of the other transmitting stations. The action of opening the door, closes the switch (14). This switch completes the 20 volt circuit through the starting relays (7), which operates and completes the 220 volt supply to the machines and starters, and the two generators start (see figures h. and d.).

Wait for the lamp (63) to light, as this denotes that both machines have run up to speed, and the various supplies are available to operate the set (see figure i.).

Make the "Signal" switch (129) to the "ON" position and wait until the "In Use" disc (73) shows white. As previously mentioned the Master Relay (51) completes the filament relay (78) bobbin circuit, the filament relay completes the anode relay (79) and "In Use" disc relay (80) bobbin circuits, therefore when the disc shows white it indicates that the above relays are operated and the supplies are connected to the amplifiers. In addition with the "Signal" switch (129) to the "ON" position a circuit is completed through one half of ALL the group relay bobbins (197) to (201), and therefore all loud speakers are connected to the output amplifier (see under "Group Relay" page V11 and figure r.).

Next move the "Signal" switch (129) to the "SIGNAL" position, and as long as the switch is in that position the set will transmit a continuous howl. When the switch is moved to the "SIGNAL" position, the circuit through the transmitter relay (51) bobbin is completed. This relay disconnects the microphone circuit from the input amplifier (see under "Transmitter Relay" page V11). The circuit through the howl relay (82) bobbin is also completed. This relay removes the short circuit on the primary of the transformer (154) and connects the secondary of the same transformer to the output transformer (185). This action is fully described under "Input Amplifier" (Howler circuit page V7) and "Howl Relay" (page V12). If it is required to telegraph (transmit morse code) it can be accomplished by operating the "Signal" switch (129) between the "ON" and "SIGNAL" position. When the signal switch is released it automatically returns to the "OFF" position and breaks all the above relay circuits.

Close the outer door. This breaks the switch (14) and the machines are switched off.

It will be noted that the only differences in the circuits used for "Speech" or "Howl" are that in the former the transformer (154) primary is shorted and the secondary disconnected, and in the latter the transformer (154) primary and secondary are connected to the amplifiers and the microphone disconnected. In addition "speech" may be transmitted through any selected group of loud speakers, but "howl" is transmitted through all groups. The amplifier circuits for "speech" conditions are shown in figure a., and for "howl" conditions in figure b.

TYPE 401

TESTING.

A regular routine test to be carried out consists of checking the currents. For this purpose the front door of No. 2 rack must be opened, and the safety switch on the volume control panel operated by some local means. As the operation puts the safety device out of action, great care should be taken to avoid danger from shocks.

Make the local switches (8) and (52), the former starts the machines and the latter completes the Master Delay (51) lockin circuit, as previously described.

Check the Output Amplifier filament voltage and H.T. current with the voltmeter (190) and milliammeter (184) respectively. The former should be 10 volts and the latter 200 - 340 milliamps.

Check the Input Amplifier filament and H.T. current by inserting the ammeter (226) and milliammeter (225) plugs into the jacks (177) and (159)(160) of the respective circuits. The filament current should be 3.2 amps and the H.T. current of each valve 35 - 40 milliamps. The filament current can be adjusted by the rheostat (179).

If the voltage and current values vary considerably from the above, the voltage at the generators should be checked up on the power board.

The "gain" or ratio of energy output to energy input is regulated by the 9 point potentiometer (170)(171), so that when the set is in use, the H.T. current indicated in the milliammeter (184) of the output amplifier remains constant. A temporary kick, not exceeding 7 milliamps on either side of the steady value is permissible.

The various relay adjustments will be found in the book supplied with the set.

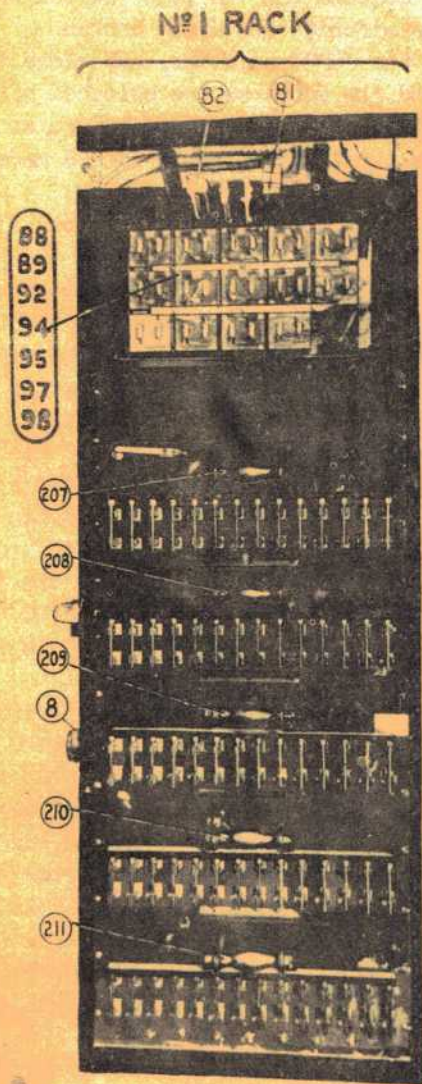


Fig. p

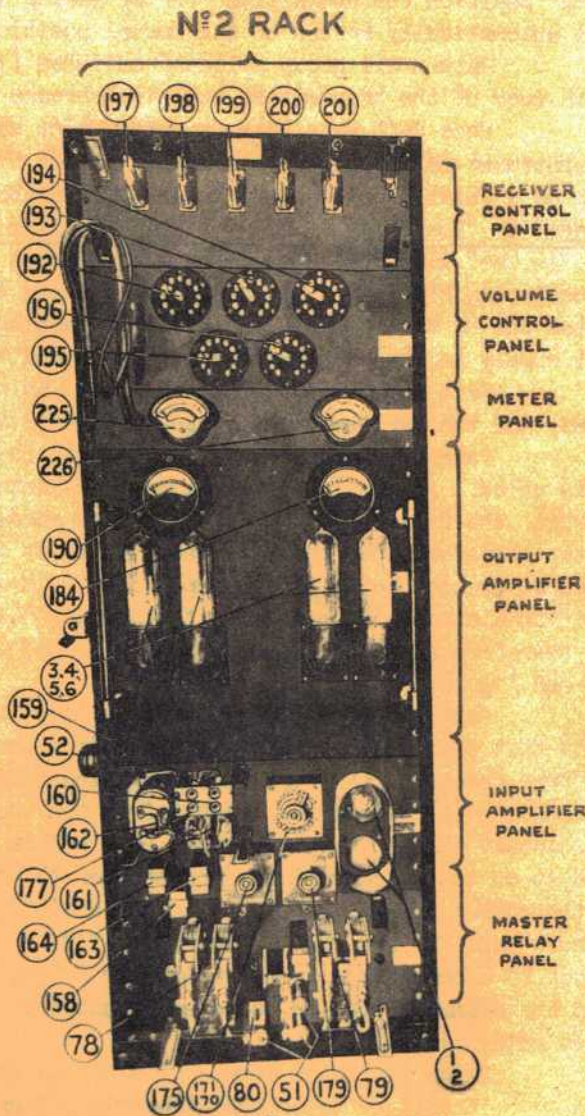


Fig. q

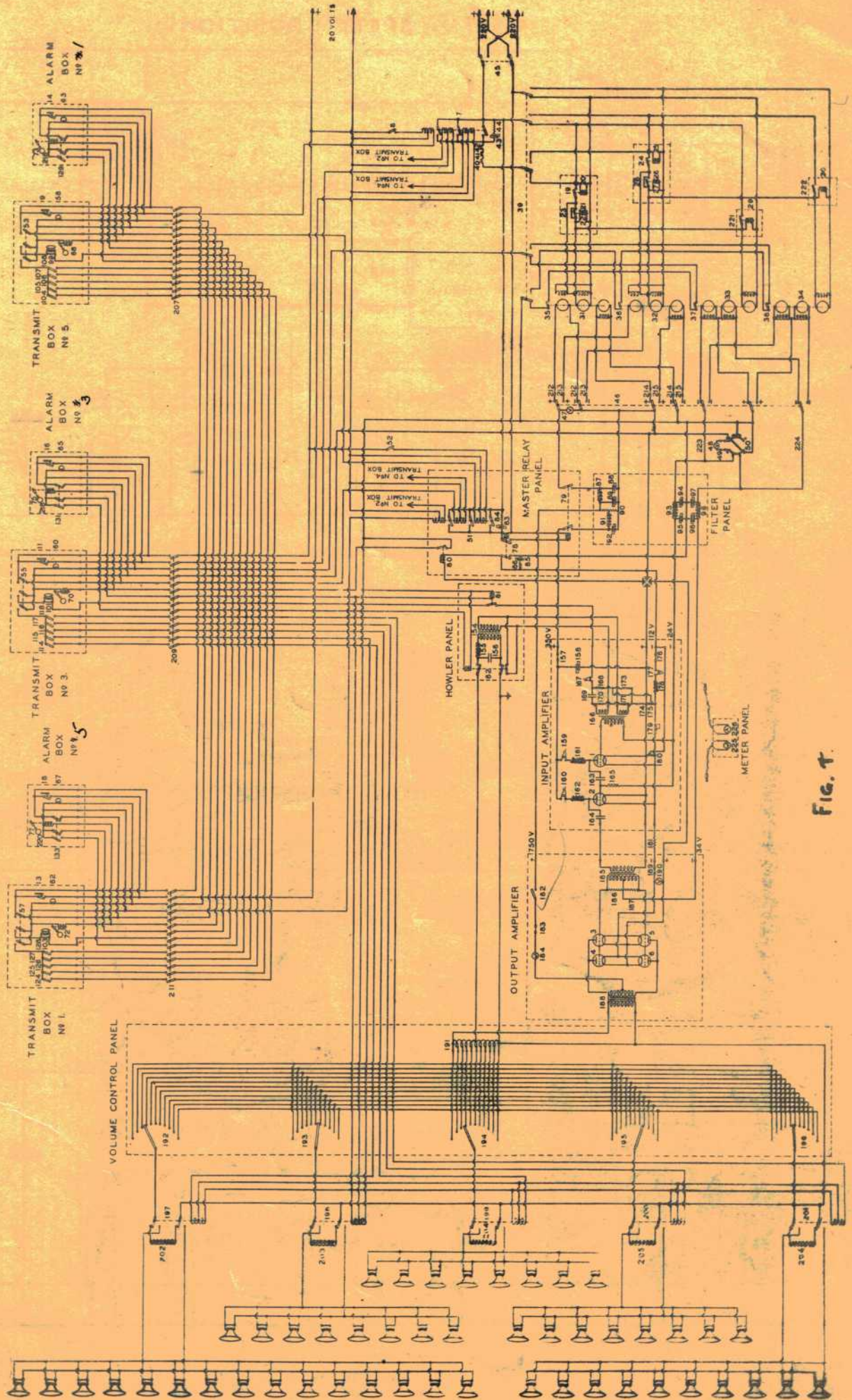


Fig. 1

EQUIVALENT CIRCUITS

SPEECH POSITION

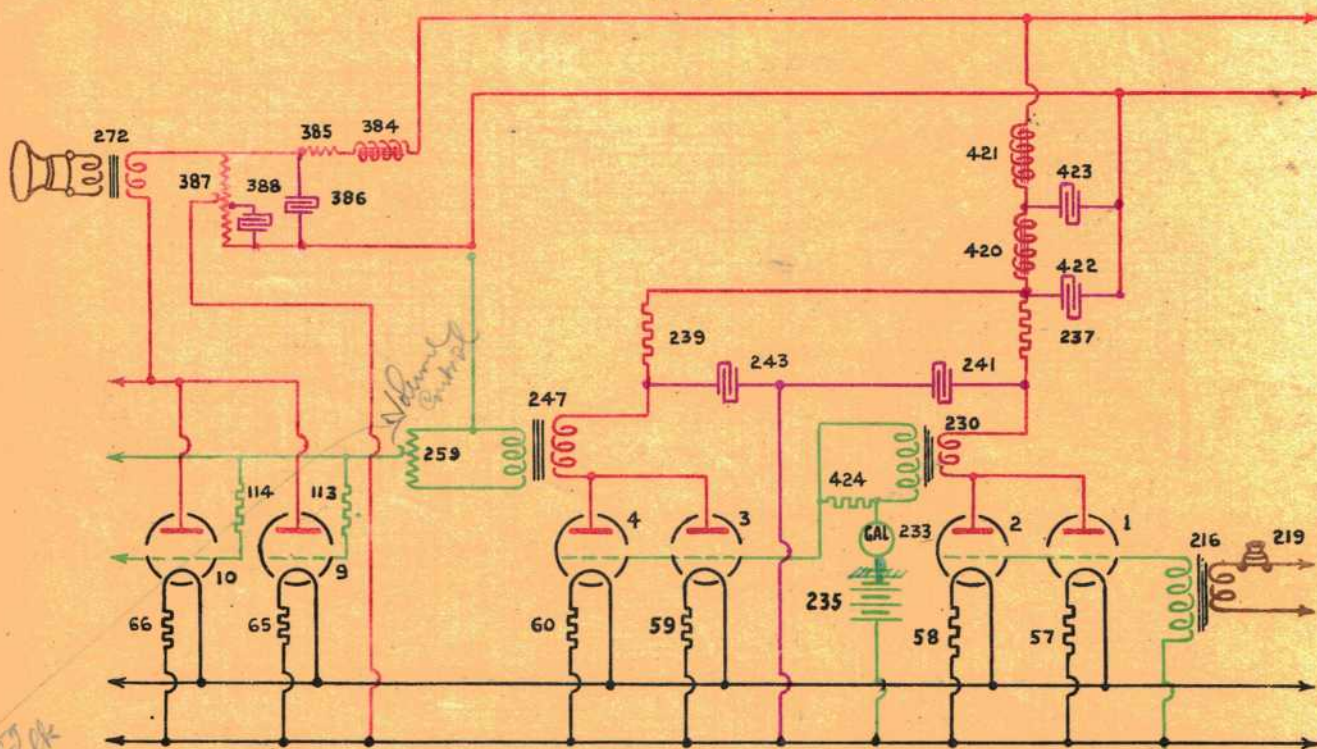


FIG. a.

*Substituting
input grid with
2 amplifier.*

HOWL POSITION

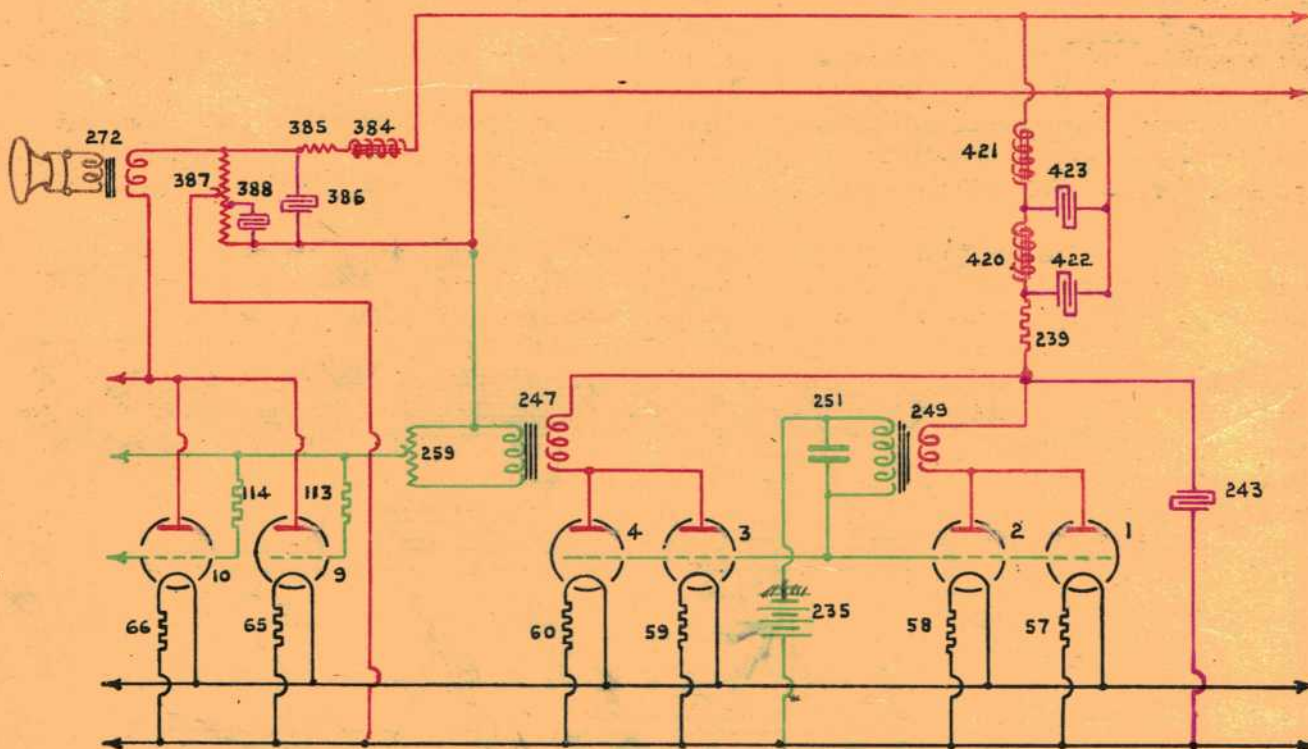


FIG. a a.

New Cruisers

Date of design:- 1929.
 Valves used:- NR15A in Primary Amplifiers.
 NR16A in Group Amplifiers.
 Power supply:- Two 500 watt generators giving 6 volts for filament lighting and certain relays, and 20 volts for control circuits and microphone.
 20 volt main or 20 volt battery for machine starting circuit.
 220 volts from ship's mains for H.T. and input to generators.

Type 402 is a Wa/T Set consisting of:-

- Two A.T. (Alarm-Transmit) boxes.
- Two Primary Amplifiers, the one being alternative to the other.
- Four or five output Group Amplifiers fed from the Primary Amplifier in use.
- Four or five groups of loud speakers (distinguished as A, B, C groups etc.)

It provides for the transmission from either of two transmitting positions of:-

- (a) A preliminary call (a low-pitched note), followed by
- (b) Speech, piping, bugle calls, etc., or
- (c) An alarm signal (a high-pitched note).

Two A.T. (Alarm-Transmit) boxes are fitted, one situated in the quartermaster's lobby aft, the other in the boatswain's mate's position on the bridge, for use in harbour and at sea respectively. The one in use is thus under the immediate control of the officer of the watch. Each A.T. box is so designed that, provided no essential switches have been broken at the set, the act of opening the door automatically switches on the supply generator and renders the set ready for use. The person using the set makes the group switches situated in the A.T. box for connecting up the particular groups of loud speakers he wishes to use. The loud speakers are grouped according to the ship's requirements. A typical grouping system is as follows:-

- A. Officers' messes and cabins.
- B. Seaman's and Marines' living space.
- C. Engine and boiler rooms, auxiliary machinery spaces, stokers' living spaces.
- D. Turrets and fighting positions.

By depressing and releasing the "Preliminary Call Switch" fitted inside the box, a distinctive low pitched note is transmitted as a warning that an order is about to be passed. By a mechanical escapement fitted to this switch the preliminary call is sustained for about five seconds after the switch has been released.

Speech or a bugle call, etc., can then be transmitted through a microphone fitted in the A.T. box by means of the control switch marked "Press While Speaking". A lamp in the A.T. box is used to indicate when the set is ready for use, or whether it is already in use from the other A.T. box.

When it is required to transmit an urgent warning signal, such as a gas alarm, all groups are connected to the set by a suitable switch and a distinctive high-pitched note can be transmitted to all groups. The alarm switches are housed inside a special cover within the A.T. box, which prevents their inadvertent use. After use, the action of closing the door of the A.T. box switches off the generator.

Amplifying Circuits. Figures a. and aa. show in simplified form the three stages of valve amplification when transmitting a preliminary call or "Speech" and an "Alarm" or "Howl" signal respectively. One group amplifier only is shown with two of its valves (9)(10).

The primary amplifier (see page V20) provides two stages of amplification, each stage having a pair of valves in parallel. Figure a. shows the stages (in the "Speech" position) coupled by means of transformer (230), and the output coupled to the group amplifier by the transformer (247).

The final stage is contained in the group amplifiers and consists of a group of valves connected in banks of four to each output transformer (272) (see page V22). The valves in each bank are in parallel and the outputs of all banks in each group are also in parallel.

Figure aa. shows the "Howl" position. The secondary of the transformer (249) is introduced into the grid circuit, and is tuned with the condenser (251) to the howl note frequency of 750 cycles. As the tuned grid is coupled by the transformer (249) to the anode circuit of valves (1) and (2), continuous oscillations are produced. As all grids are now connected together, and the output of valves (3) and (4) remains as it was, the howl note is amplified and passed on to the group amplifiers by the transformer (247).

TYPE 402 POWER SUPPLY

The H.T. supply for the anodes of all valves is obtained from the 230 volt ring main C.O.S. (170), the group and primary amplifier anode relays completing the circuit to their respective amplifiers (see figures g. and h.) As only one of the two primary amplifiers is required, the H.T. supply to either is controlled by two poles of the primary amplifier C.O.S. (203). The return for the anode current is taken via the L.T. contacts of the primary amplifier change over switch (203) to the group amplifier filaments, the negative L.T. of which is connected to negative H.T. through the grid bias potentiometer resistances (397)(392)(397) and (402)(403) with (404)(see figure dk.). No direct connection is made between L.T. and negative 220 volts at any point in the set, as this would have the effect of short-circuiting the grid bias resistances enumerated above (see figure da.)

The other supplies necessary to work the set (i.e., filament and relay supplies) are obtained from a double purpose motor generator giving outputs of 6 and 20 volts, and from the 20 volts ship's mains or a stand-by 20 volt battery. The 20 volts ship's mains supply the machine starting relay (161) only (see figure f.).

Power Boards. The power boards are contained in two panels (Panels 9F Upper and Lower Controlling) fitted one on top of the other (see figures la. and lb.).

Panel 9F Upper Controlling (figure la.) contains the ring main C.O.S. (170) and fuses(171), machine fuses(428)to(429), and the 20 volt output C.O.S. (210) and fuses(211).

Panel 9F Lower Controlling (figure lb.) contains the machine input ammeter (172) and push(173), starting relay(161), 200 volt and 6 volt C.O.S. (174), and the field regulator(177)or(178) for either machine, also the 6 volt output voltmeter (184), ammeter(183) and fuses (186).

Relay Panel. The power relays, i.e., relays controlling the H.T. and filament supplies, are fitted in one panel (Panel 9B Upper Relay)(see figure b.).

This panel contains the group and primary amplifier anode relays (200)and(191) respectively, filament relay(201), M.R. lamp relay(187) and P.V. lamp relay(204). A M.R. lamp(188)and P.V. lamp(205)are also fitted on this panel as an indication to a person testing the set from the local switch (193), that the machine is running and the supplies to all valves are made (see figures g. and h.).

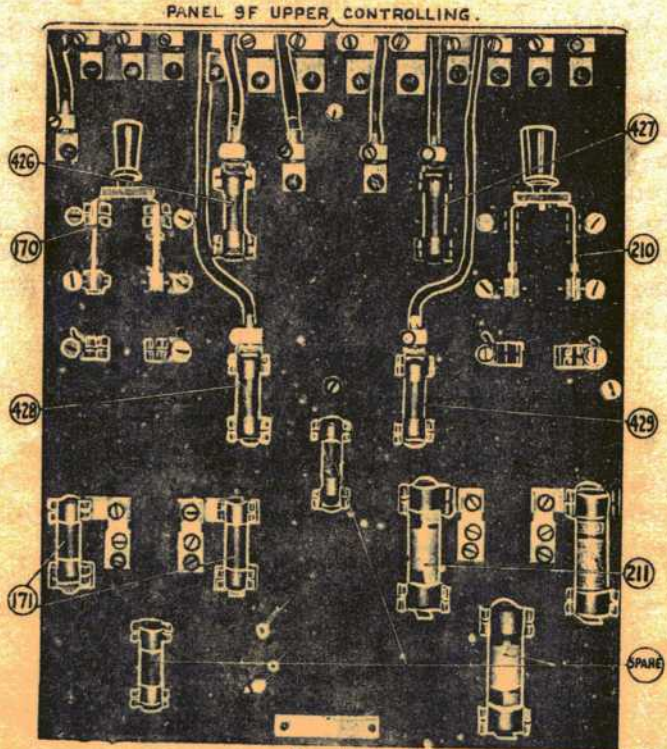


Fig. b a.

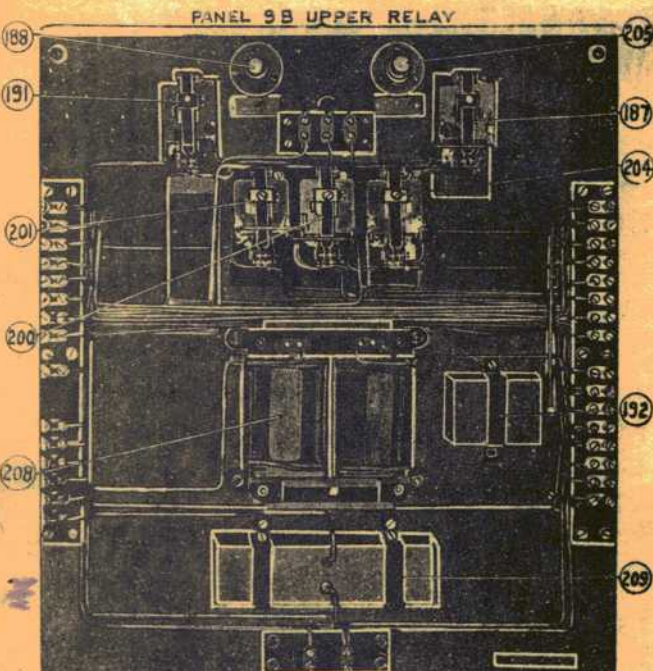


Fig b

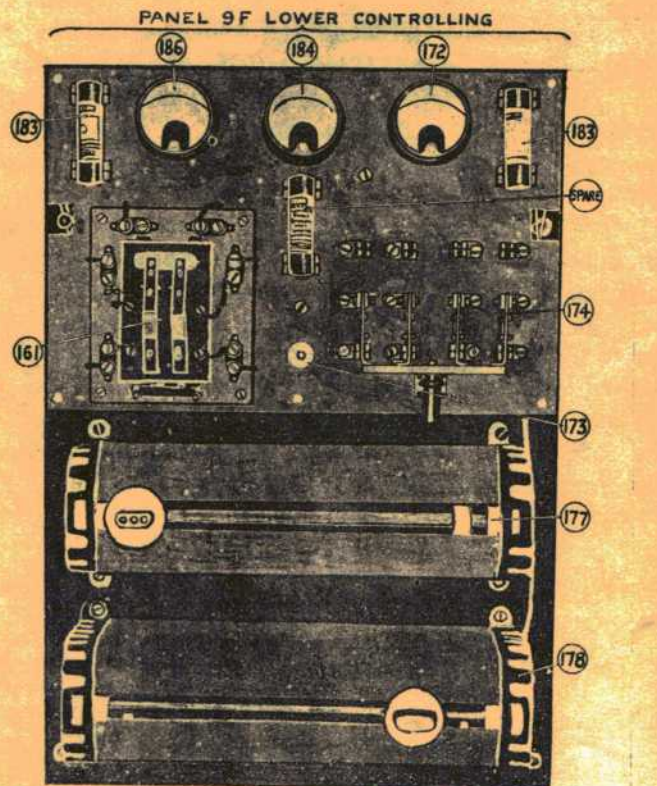


Fig bb.

POWER SUPPLY (CONT)

Motor Generator. Duplicate machines (175)(176) with the necessary change over switches are fitted. A four pole C.O.S. (174) changes over the 220 volt input and 6 volt output, and a two pole C.O.S. (210) changes over the 20 volt output.

The 220 volt input to the motor is connected direct from the ring main C.O.S. (170) to the machine in use, the supply being completed by the machine starting relay (161). An ammeter (172) is connected in the supply. Owing to the fact that there is no starting resistance in the circuit a shunt key (173) is connected in parallel with the ammeter. This prevents the momentary large flow of current when the machine is starting, from passing through the ammeter. It is therefore necessary to press the shunt key (173) to obtain a reading of the input current. The machine reaches full speed in five seconds.

The 6 volt output supplies the filaments of all valves and the "machine running" and "power on valves" relays (187)(204) (see figure g.). The supply from the machine in use is connected by the C.O.S. (174) direct to the filaments of the group amplifier valves and to the primary amplifier C.O.S. (208) for the valves of the amplifier in use. The circuit is completed by the filament relay (201). A choke (208) and condenser (209) are connected in the filament supply to the primary amplifier as a smoothing unit. The choke (208) also reduces the filament voltage of this amplifier to 4 volts. A voltmeter (184) is connected across the supply, and the field regulator (177) or (178) is adjusted to give a 6 volt reading. The ammeter (186) indicates the total output current of the 6 volt generator.

The 20 volt output supplies the group and primary amplifiers anode and filament relays (figure h.), group relays (figure i.), and howl relays (figure j.). It also supplies the microphone (figure e.) and the "machine running" and "power on valves" indicating lamps (figure g.). The supply from the machine in use is connected to the above circuits by the C.O.S. (210). A smoothing unit consisting of the chokes (214)(215) and condenser (212) are connected across the supply. 20 volt mains and 20 volt battery. The 20 volt mains or 20 volt battery supply the power for the bobbin of the starting relay (161) (see figure f.). The supply is taken from the Board of Charging (see page N86). The battery is used as an alternative to the 20 volt mains, the supply from either being controlled by a D.P. switch. Separate and additional isolating switches (168) (169) for either A.T. box are connected in the positive supply.

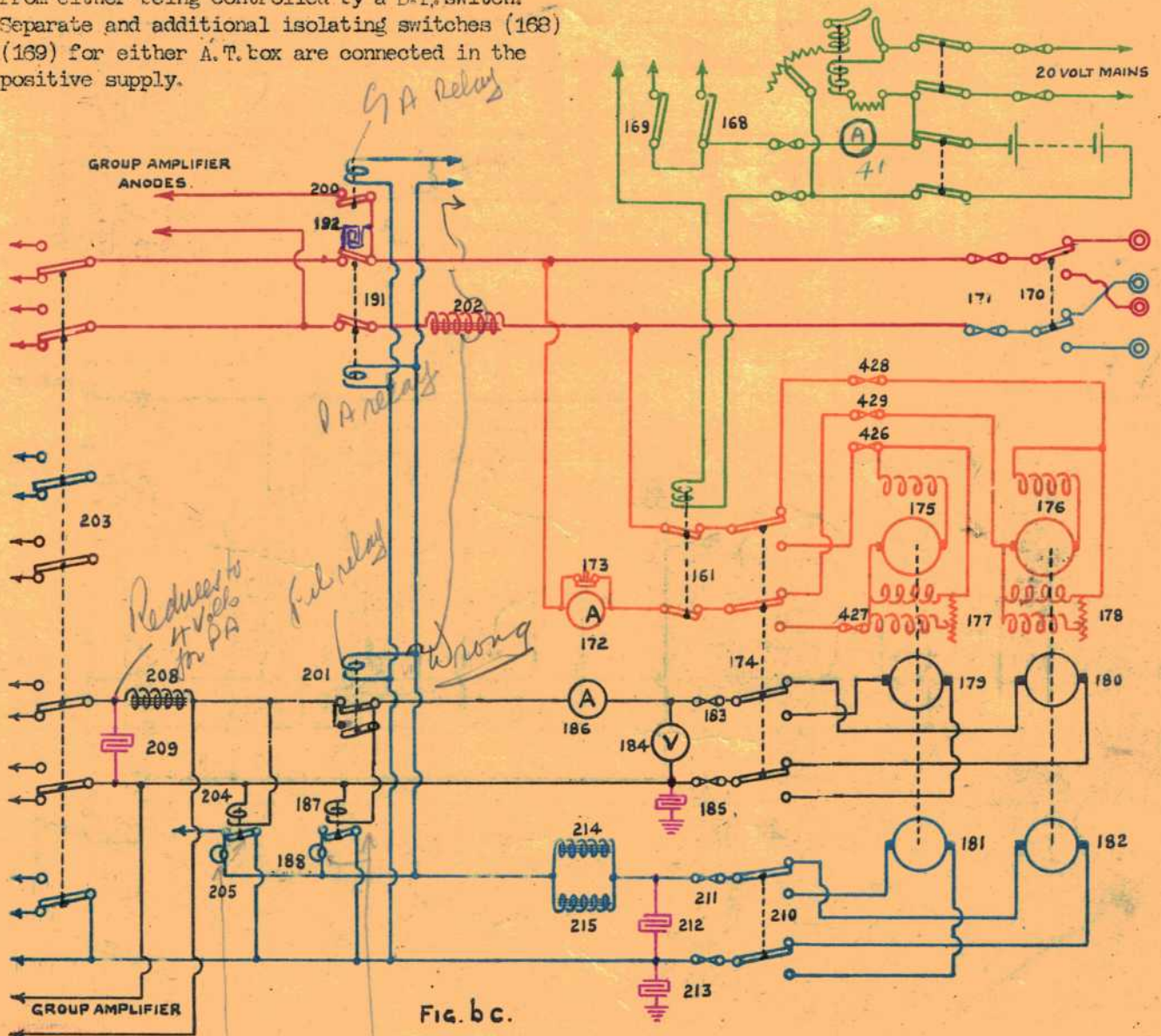


Fig. b.c.

TYPE 402 PRIMARY AMPLIFIER

Reference:- Admiralty Handbook of W/T (1931) paragraphs 586, and 682).

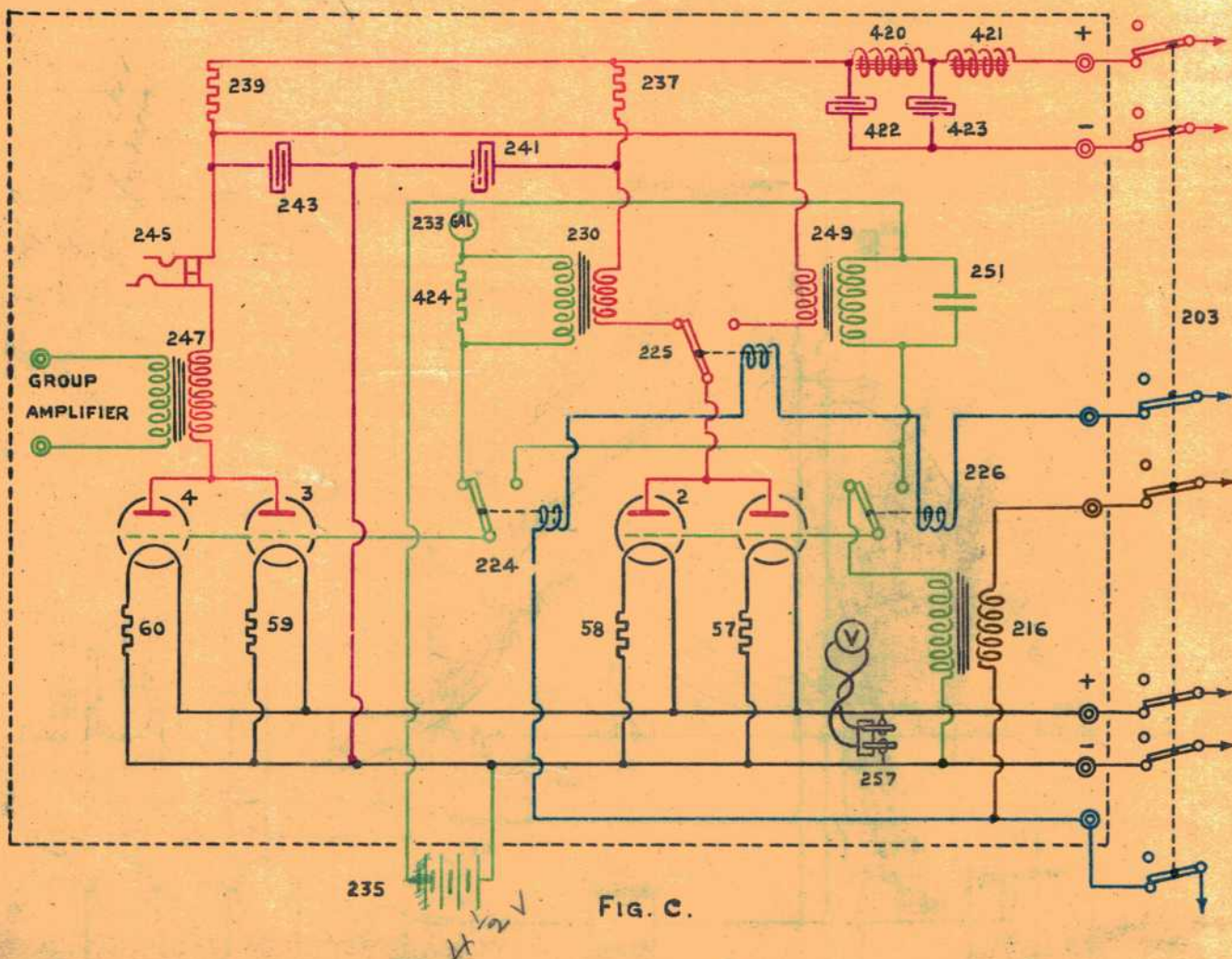
Two primary amplifiers are supplied and are fitted in Panels 9A and 9B Lower amplifying (see figure m.). Either can be brought into use by a 7 pole C.O.S. (203). The amplifier has two stages, transformer coupled, with two valves connected in parallel in each stage. In emergency either stage can be used with one valve only.

H.T. Supply. The H.T. supply is taken from the 220 volt contacts of the C.O.S. (203). A filter circuit, consisting of two chokes (421)(420) in series, and two condensers (422)(423) in parallel, is connected in the supply. The H.T. supply for the first stage of the amplifier is fed through a 30,000 ohm resistance (237) and the primary of transformer (230) for "Speech", and through a 12,500 ohm resistance (239) and primary of the transformer (249) for "Howl". The supply for the second stage passes through the 12,500 ohm resistance (239) and primary of the output transformer (247). The resistances in the supply are to reduce the 220 volts to the voltage required in either stage. Two by-pass condensers (241)(243) in series, with the centre point connected to the filament negative, are connected between the anodes of the two stages when in the "Speech" position.

Filament Supply. The filament supply is from the 6 volt contacts of the C.O.S. (203). The filaments of the valves (1)(2)(3)(4) are in parallel and a 3 ohm resistance (57), (58), (59) or (60), is connected in series with each valve filament to reduce the 6 volts to the 3.8 volts required. *(2 volts being lost in choke (208))*

Grid Bias. In the "Speech" position (figures a. and ca.) a 4½ volt battery (235) supplies grid bias to the second stage valves (3)(4) and in the "Howl" position (figures aa. and ct.) to the valves of both stages.

Oscillatory Circuit. The amplifier has two separate functions depending on the position of the three howl relays (224)(225) and (226). These relays are normally in the "Speech" position but can be moved to the "Howl" position by depressing the alarm signalling key (418) or (419) in the A.T. box in use (see figure j.).



TYPE 402 PRIMARY AMPLIFIER (CONT)

"Speech" position (figures a. and ca.) In this position the first stage is coupled to the second by means of the coupling transformer (230). A stabilising resistance of 500,000 ohms (424) is connected across the secondary of the transformer. The output from the anodes of the second stage valves (3)(4) is connected to the primary of a 1 - 1 output transformer (247).

In this position therefore, two stages of valves amplify either speech from the microphone (218)(219) or the 400 cycle note of the preliminary call buzzer (220)(221), both of which are situated in the A.T. box (see figure e.). The microphone or buzzer is connected in series with the primary of the input transformer (216) by means of one contact of the control switch (196)(197) or one contact of the preliminary call switch (194)(195) respectively.

A galvanometer (233) is fitted in the grid circuit of valves (3) and (4) in the "Speech" position for the purpose of giving visual indication of serious distortion. If grid current flows distortion will be introduced (see Admiralty Handbook of W/T (1931) paragraph 578) and the galvanometer needle will be deflected.

"Howl" position (figures a. and ct.). The change over to "Howl" is effected by depressing the alarm signalling key (418)(419) which actuates the three howl relays (see figure j.). One relay (225) connects the anodes of the valves (1)(2) through the primary of the oscillator transformer (249) to the anode resistance (239). The other two relays (224) and (226) connect the grids of the valves (1)(2) (3)(4) of both stages together, and introduce the transformer (249) and condenser (251) in the grid circuit. The anodes of valves (3)(4) remain connected through the primary of the output transformer (247) to the H.T. supply via the resistance (239).

The secondary of the transformer (249) is tuned with the condenser (251) to the howl note frequency of 750 cycles, the two thus forming a fixed tuned grid circuit with grid bias supplied by the battery (235). In the "Howl" position, therefore, the tuned grid circuit is coupled by the special oscillator transformer (249) to the anode circuit of the first stage valve (1) and (2) and continuous oscillations are produced. As the grids of the valves (1)(2)(3)(4) of both stages are now connected together, and the output of the second stage valves (3)(4) remain unchanged, the howl note is amplified and passed on to the group amplifier by the transformer (247).

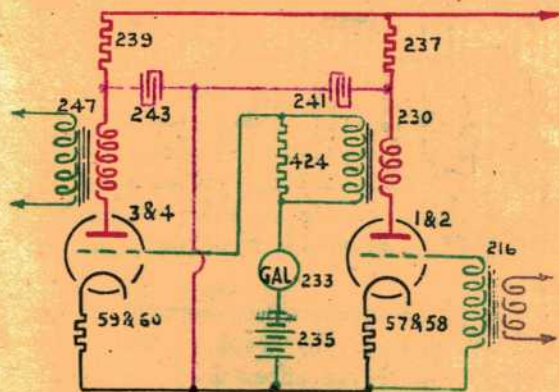


FIG. ca.

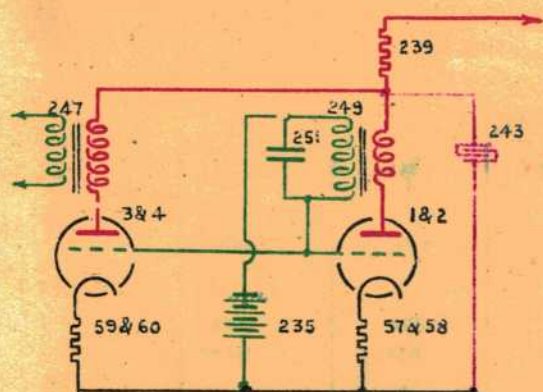


FIG. cb.

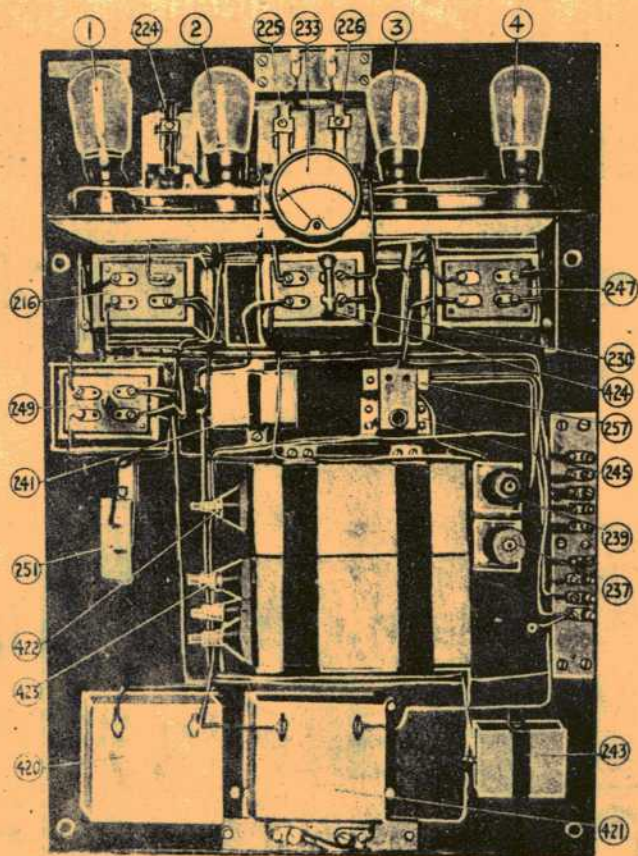


FIG. cc.

TYPE 402 GROUP AMPLIFIER

Reference:-- Admiralty Handbook of W/T (1931) paragraph 591.

Each group of loud speakers has its own amplifier. Each amplifier is fitted in a separate panel (Panels 9C, D, E etc., Upper and Lower Power valve) (see figure m.). The number of valves in each group amplifier depends on the number of loud speakers which are supplied by that amplifier. A rough rule is that one valve is required for each loud speaker. After installation it is not possible, without the set being parted, to increase the number of valves, but an increase in loud speakers up to 50% more than there are valves can be accepted without detriment to the set.

The valves are connected in parallel in tanks of four with a D.P. tank isolating switch (270)(271) etc., in the primary and secondary of the output transformer (272)(273) of each tank. This isolating switch allows any tank of valves to be isolated should any fault occur in that particular tank. Its functions are described below. Only two tanks of valves are shown in figure d.

H.T. Supply. The H.T. supply is from the 220 volt mains and is paralleled to all group amplifiers. The group anode relay (200) and one contact of the primary amplifier anode relay (191) complete the circuit (see figure h.)

A filter unit containing a smoothing choke (384), resistance (385), condenser (386) and the potentiometer (387) with its by-pass condenser (388) is fitted in each group amplifier.

The H.T. supply for each tank of four valves is supplied through the primary of an output transformer (272)(273) via one contact of the isolating switch (270)(271). To avoid fluctuations in the H.T. load when a tank of valves is switched out by means of its tank isolating switch (270)(271), etc., the contact in the primary circuit switches in three resistances (274)(275)(276), or (277)(278)(279), in series between H.T. positive and L.T. negative to compensate for this. The total value of these resistances is 3000 ohms.

Filament Supply. The filament supply of all group amplifiers is connected in parallel with the primary amplifier filaments. The filament relay (201) (see figure h.) completes the supply. As the filament supply for the group amplifiers is not connected through the 0.5 henry choke (203) (see figure bc), resistances of 9 ohms (65) to (72) are connected in series with each valve to reduce the voltage to 3.8 volts.

Grid Bias. Figure da. shows how 24 volts negative grid bias is provided for each group amplifier by its filter unit. In effect a potentiometer (387) is connected across the filtered side of the 220 volt supply. A tapping is then taken off at such a place that the positive potential above the negative 220 volt lead is of the order of 24 volts. As the current flowing from this tap to 220 volt negative will depend on the number of valves in use, (15 milliamps per valve), the tap will be different for each amplifier. The correct filter circuit must therefore be used. The circuits are referred to by the emission current of their particular group amplifier. This tapping is connected to the negative of the filament supply. The grids of the valves (9) etc., are connected to the 220 volt negative lead via the grid resistances (113) etc., and the volume control potentiometer (259), and, as the negative filament lead is connected to the 24 volt G.B. positive tapping on the H.T. potentiometer (387) it follows that the grids must be at 24 volts negative potential to the filament.

Figure db. is the equivalent circuit showing how all the potentiometers are controlled by connecting one variable resistance (267) across the grid bias resistance of any group. The potentiometers are connected in parallel across the 220 volt supply, the resistances used for grid bias being in parallel between L.T. negative and 220 volt negative. The alteration of the variable resistance (267) will clearly alter simultaneously the grid bias applied to all groups.

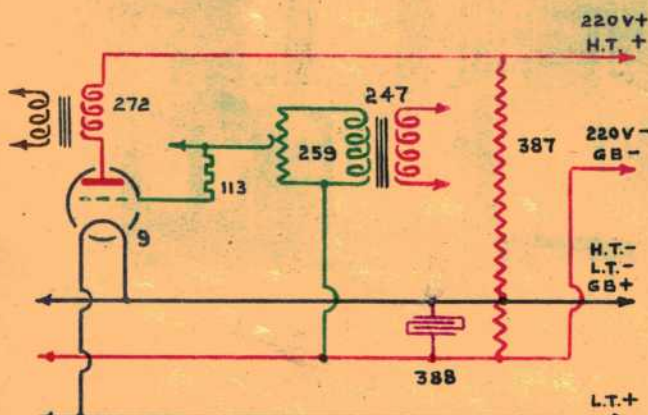


Fig. da

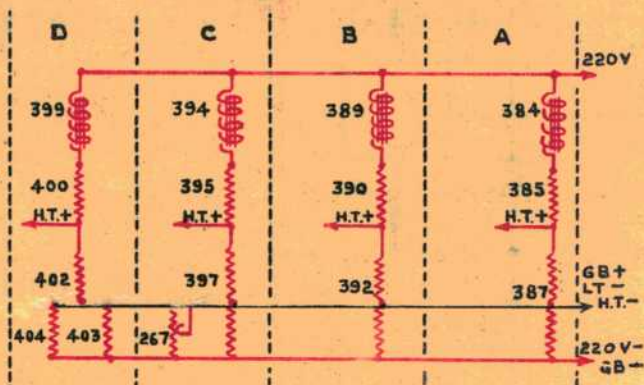


Fig. db.

TYPE 402 GROUP AMPLIFIER (CONT)

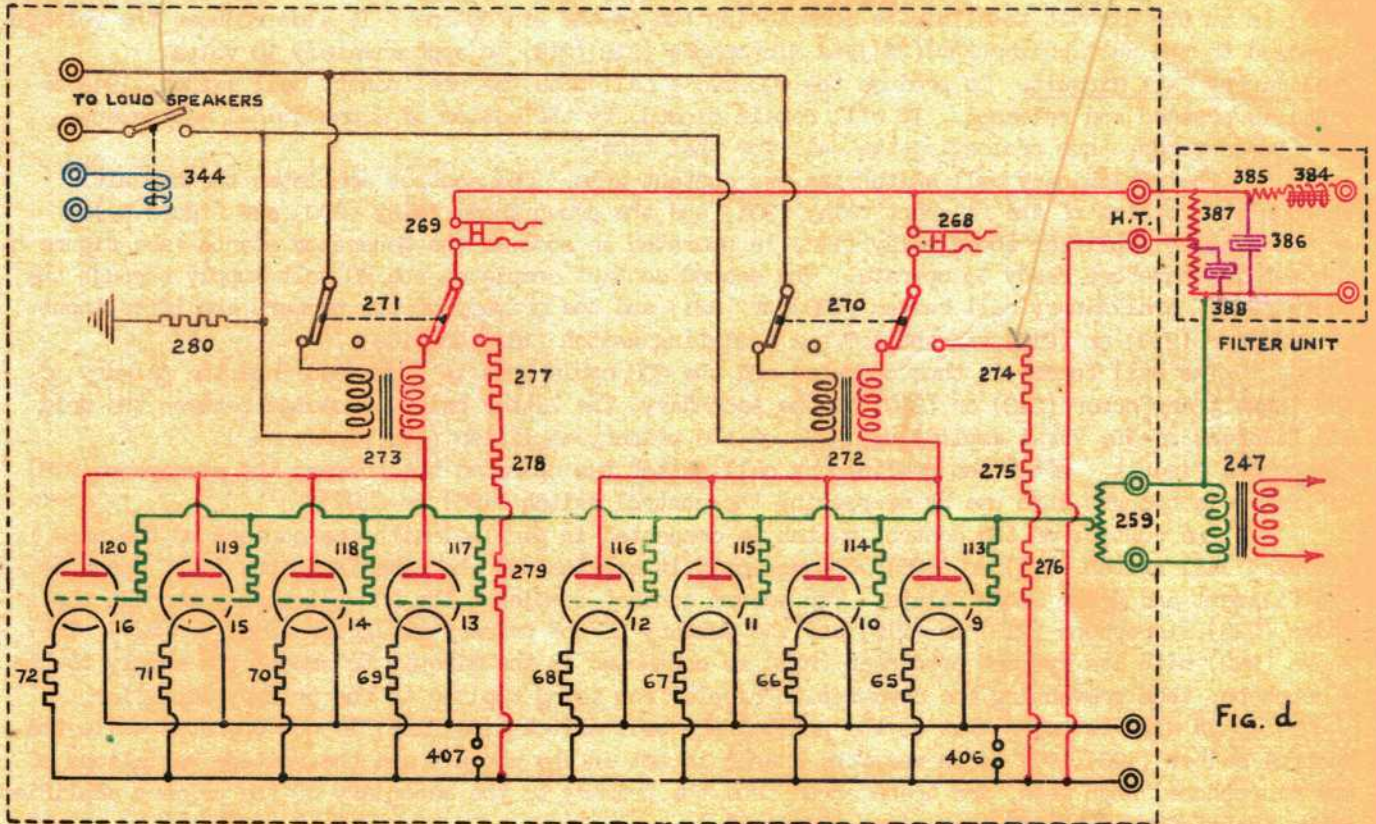


Fig. d

Oscillatory Circuit. The output from the primary amplifier output transformer (247) or (248) is taken to four (or five) 500,000 ohm potentiometers (259) to (262) in parallel, as shown in figure 1. Each of these potentiometers acts as a volume control for its own group amplifier. The potentiometer tapping is connected to the grid of each valve through separate 50,000 ohm grid resistances (113) to (120). These resistances are necessary to minimise the risk of self oscillation.

The secondary of each group amplifier output transformer (272)(273) etc., is coupled to the anode supply of each bank of valves. The secondaries of each bank of valves output transformers are connected in parallel, the whole being connected to the particular group of speakers by the appropriate group relay (344) etc. One side of the speakers is kept at earth potential through a 100,000 ohm resistance (280).

It will be noted that all the group amplifiers are always switched on automatically when the set is working but the output of any group amplifier is only connected to its loud speakers when the appropriate group relay (344)(345)(347) is operated by means of the corresponding group selector switch (348)(349)(350) or (351), and (352)(353)(354) or (355), (see figure i.). It thus follows that the volume obtained from any individual group of loud speakers is always the same irrespective of the number of groups being operated.

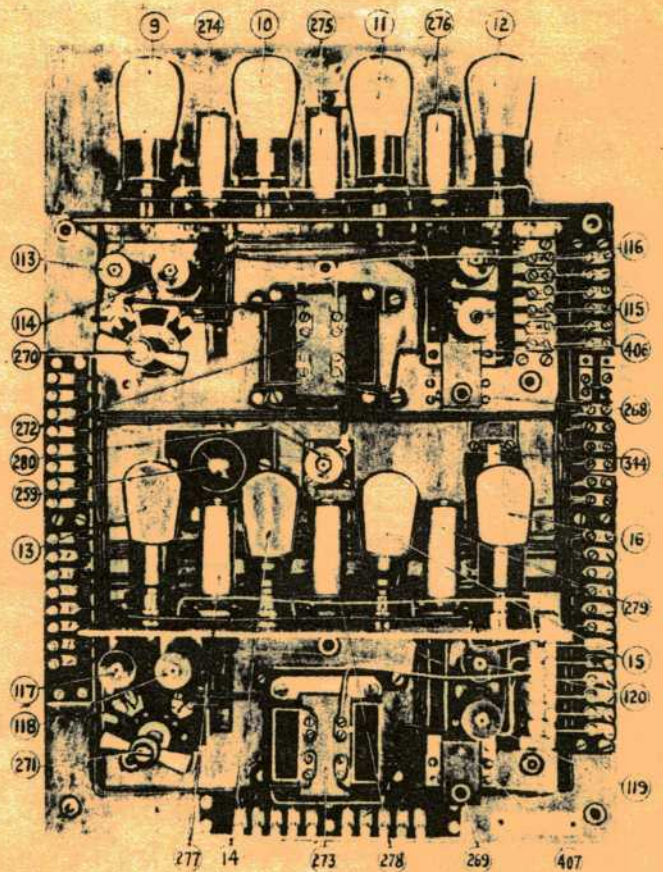


Fig. d e

TYPE 402

PRELIMINARY CALL AND MICROPHONE CIRCUITS

These circuits are supplied from the 20 volt generator output. A 30 henry filter choke (222) is in the circuit to eliminate commutation hum in the microphone. It also reduces the voltage supplied to the call buzzer (220)(221) and microphone (218)(219) to approximately 10 volts.

Preliminary Call Circuit. To produce the 400 cycle call note the preliminary call switch (194) or (195) is pressed and released. It will remain closed, by the action of a mechanical escapement, for four seconds, thus prolonging the call for that time.

The preliminary call switch has two contact arms. One contact completes the circuit through the bobbins of the filament relay (201) and the group anode relay (200) (see figure h.). As the primary amplifier anode relay (191) is operated as soon as the generator starts (see figure h.) the set is therefore ready to operate. The second contact completes the 20 volt supply through the choke (222), preliminary call buzzer (220) or (221) and the primary of the primary amplifier input transformer (216) or (217) via the A.T. box isolating switch (162) or (163).

The call buzzer is thus operated and the 400 cycle note is impressed from the primary of the input transformer (216) or (217) to the secondary, the latter being connected between the grid and filament of the first amplifying stage of the primary amplifier (see figure ea.)

Microphone Circuit. After the preliminary call switch has operated the buzzer, the microphone (218) or (219), is brought into use by depressing the control switch (196) or (197).

One contact of the control switch is connected in parallel with one contact of the preliminary call switch (194) or (195), consequently it carries out the same function, i.e., operates the filament and group anode relays. The second contact completes the 20 volt supply through the choke (222), microphone (218) or (219) and the primary of the primary amplifier (216) or (217). The choke (222) with its by-pass condenser (223) is connected in the circuit to smooth the supply to the microphone, thus preventing the commutation ripple from being applied to the primary amplifier.

It will be noted that as the preliminary call switch (194)(195) is not operated while the control switch (196)(197) is in use, the buzzer is not in the circuit, and the voltage variations of the microphone, when used, are transferred from the primary to the secondary of the primary amplifier input transformer (216) or (217) (see figure et.).

Admiralty Handbook of W/T (1931) paragraph 667 explains the principles of the microphone and its circuits.

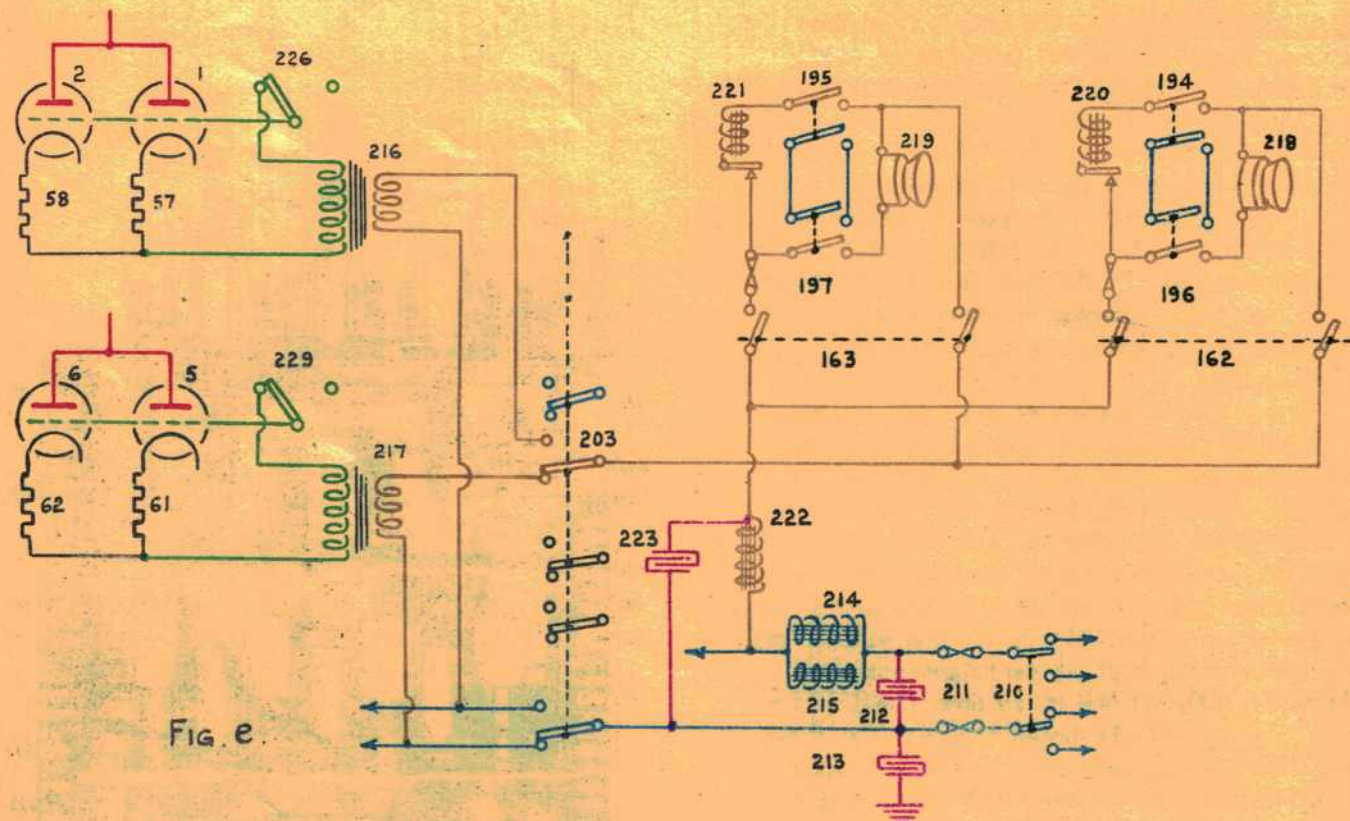
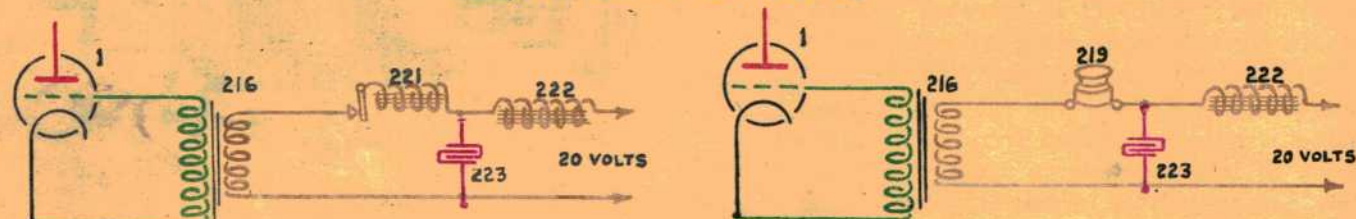


Fig. e.

EQUIVALENT CIRCUITS



PRELIMINARY CALL

Fig. ea.

SPEECH

Fig. eb

OPERATING CIRCUITS

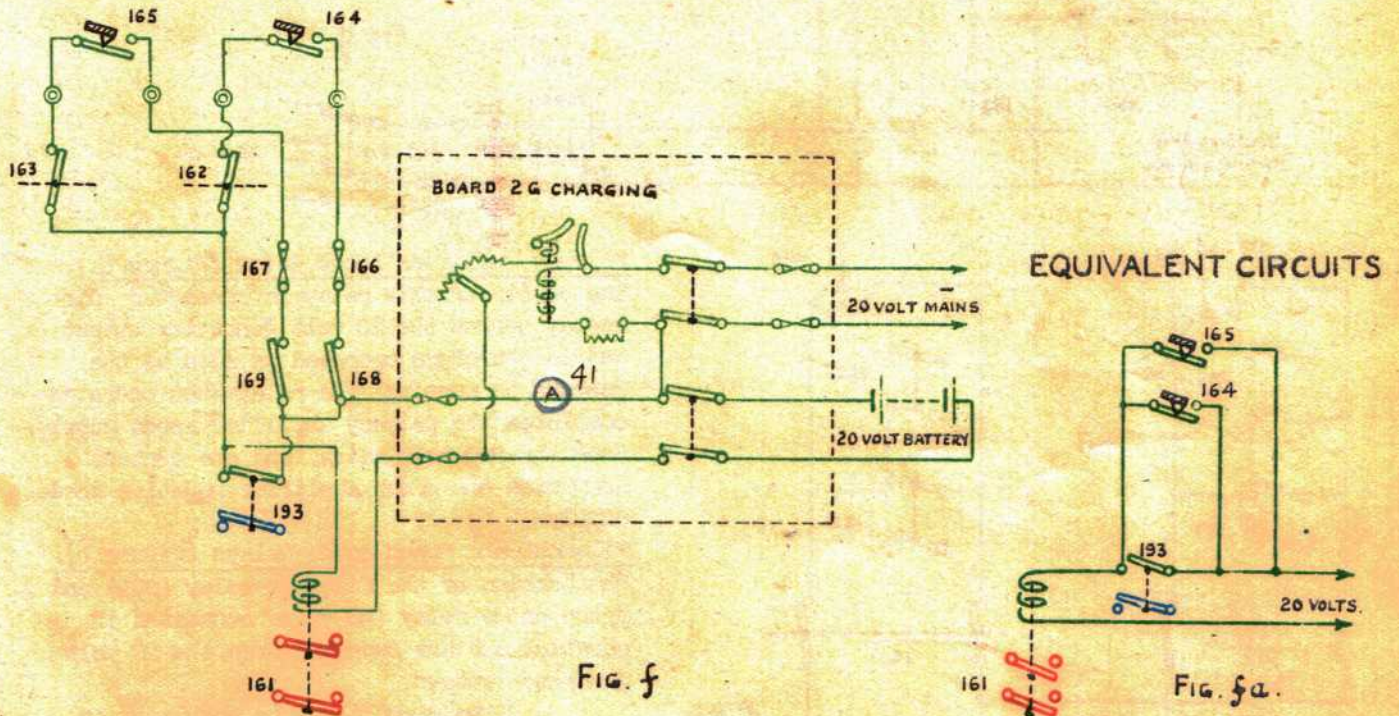
The various operating circuits are supplied from the 20 volt and 6 volt generator outputs, or the 20 volt mains with alternative 20 volt battery. All circuits are controlled from either A.T. box, but the power supplies to the amplifiers can be applied by using the local starting switch (193) (see figures f. and h.). This switch is fitted near the set and is primarily used for testing purposes. It does not complete the group relay circuits.

Machine starting relay circuit. (figure f.). The machine starting relay bobbin circuit is supplied from the 20 volt mains or 20 volt battery. The necessary switches for changing from mains to battery are fitted on Board 2G Charging. (See page NB6). The relay is fitted on Panel 9F Lower Controlling (see figure tt.).

The circuit of the starting relay (161) is completed by the door switch (164) or (165) operated by a spring. These switches are connected in parallel and are fitted in either A.T. box. When the door of the A.T. box is opened the spring closes the switch which completes the bobbin circuit and operates the relay (161). One contact of the local switch (193) is also connected in parallel with the door switches (164) (165) and will therefore also complete the starting relay circuit (see page V29).

The supply can be isolated from either door switch (164) (165) by one contact of the isolating switch (162) or (163) and by two additional isolating switches (168) (169) thus forming a complete break in both supply leads. The local starting switch (193) cannot be isolated. The circuit through each door switch is protected by a fuse (166) (167).

When the starting relay has closed, 220 volts is applied direct from the ring main C.O.S. (170) and fuses (171) to the motor generator in use (175) or (176) (see figure hc.).



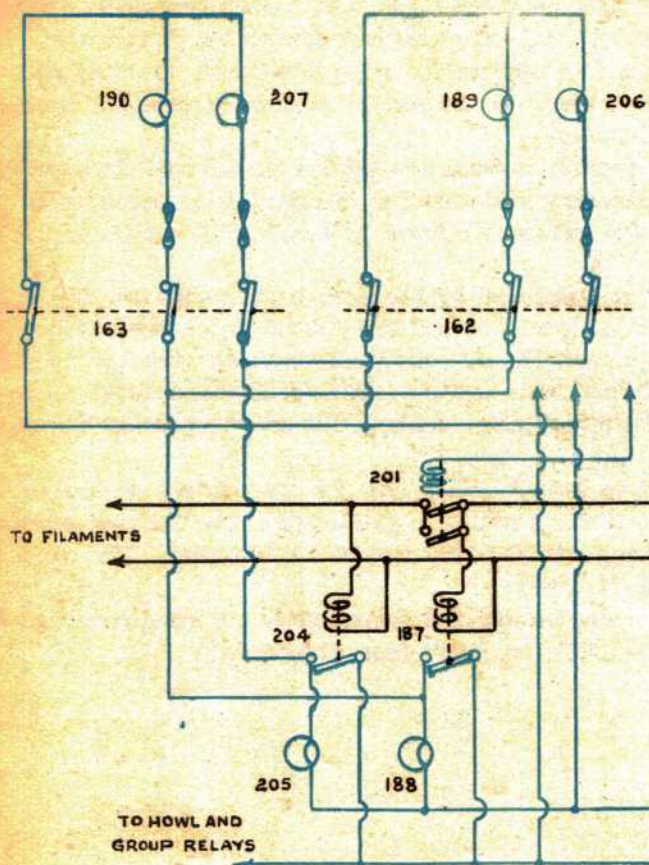
Machine Running and Power on Valve Relay Circuits (figure g.). The 6 volt output from the generator supplies the current for operating the M.R. (Machine Running) relay (187) and P.V. (Power on valve) relay (204). The relays are fitted in Panel 9B Upper Relay (see figure b.). The indicating lamps for each circuit are supplied from the 20 volt generator output.

M.R. relay circuit. As soon as the machine is running, the M.R. relay (187) (the bobbin of which is connected directly across the 6 volt supply) operates, and completes a contact in the 20 volt circuit which lights the three M.R. lamps (188) (189) (190). These three lamps are connected in parallel and are fitted one in each A.T. box and one in a panel of the set (see figure b.) They give a visual indication to the person using the set that the machine is running.

P.V. relay circuit. The 6 volt supply to the bobbin of the P.V. relay (204) is completed by the filament relay (201) (see figure h.). When the P.V. relay operates it completes a 20 volt circuit which lights the three P.V. lamps (205) (206) (207). The lamps are connected and fitted in a similar manner to the M.R. lamps. As the P.V. relay does not operate until the filament relay (201) has closed, (the latter also being in parallel with the group anode relay (200) (see figure h.)) the lamps are therefore an indication that the power supplies to all valves are complete.

The P.V. lamps are also an indication at an A.T. box that the set is in operation from the other A.T. box or is being tested from the local position by the switch (193) (see figures f. and h.).

TYPE 402 OPERATING CIRCUITS (CONT)



EQUIVALENT CIRCUITS

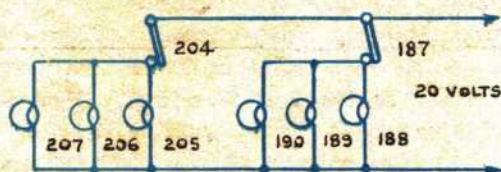


FIG. g a.

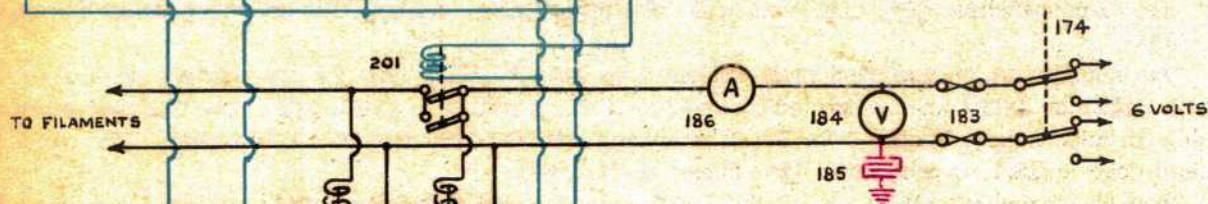


FIG. g.

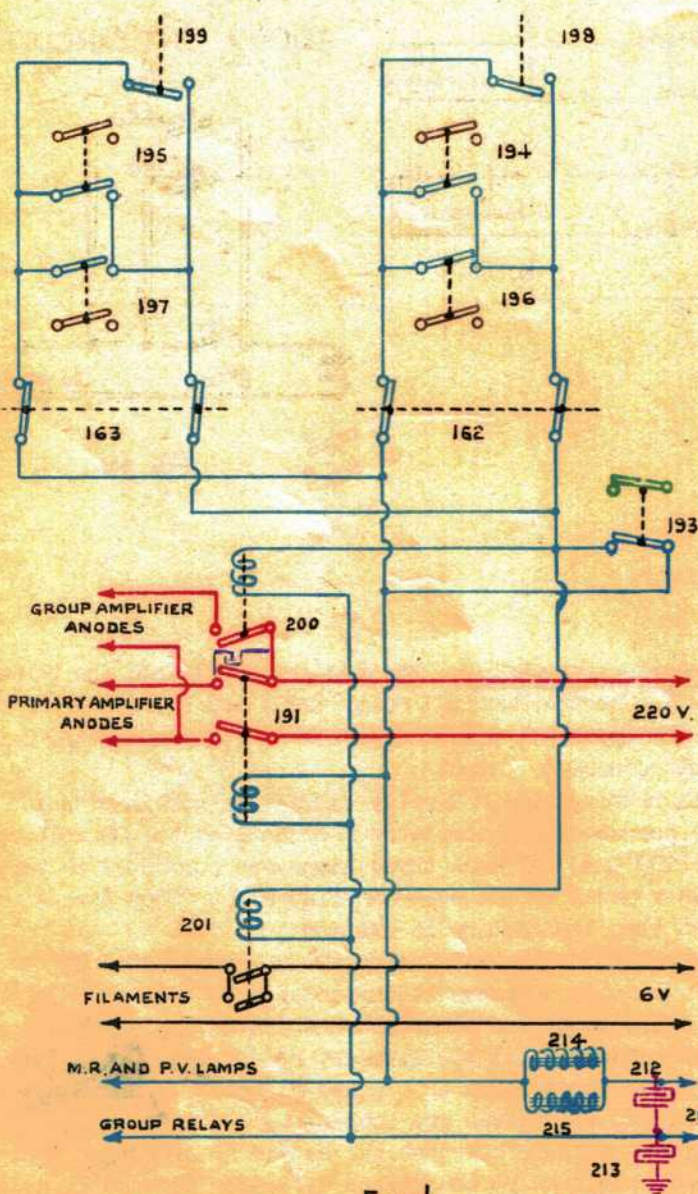
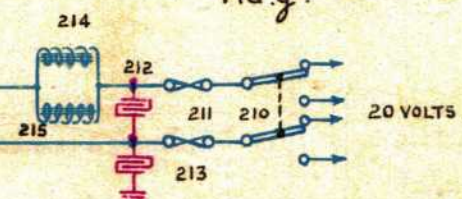


FIG. h.

Primary Amplifier Anode Relay (Figure h.).
The bobbin of this relay is connected directly across the 20 volt generator output and is therefore operated as soon as the machine is running. The relay when operated completes the primary amplifier anode supply from the 220 volt mains, and one contact completes the group amplifier negative anode supply.

Filament and Group Anode Relays (figure h.).
The bobbins of the filament relay (201) and group anode relay (200) are connected in parallel and are supplied from the 20 volt generator output.

The circuit can be completed by four separate switches:-

- (a) By one contact of the preliminary call switch (194) or (195) when giving the 400 cycles note preliminary call (see figure e.).
- (b) By one contact of the microphone control switch (196) or (197) when pressing to speak or transmit a huggle call (see figure e.).
- (c) By one contact of the alarm group switch (198) or (199) when using the set for Alarm or Howl conditions (see figure i.).
- (d) By one contact of the local starting switch (193).

The filament relay (201), when operated, completes the 6 volt supply to the P.V. relay (204)(see figure g.) and the filaments of all valves.

The group anode relay (200) completes the positive 220 volt anode supply to all group amplifiers. The negative supply is completed by one contact of the primary amplifier anode relay (191).

TYPE 402 OPERATING CIRCUITS (CONT)

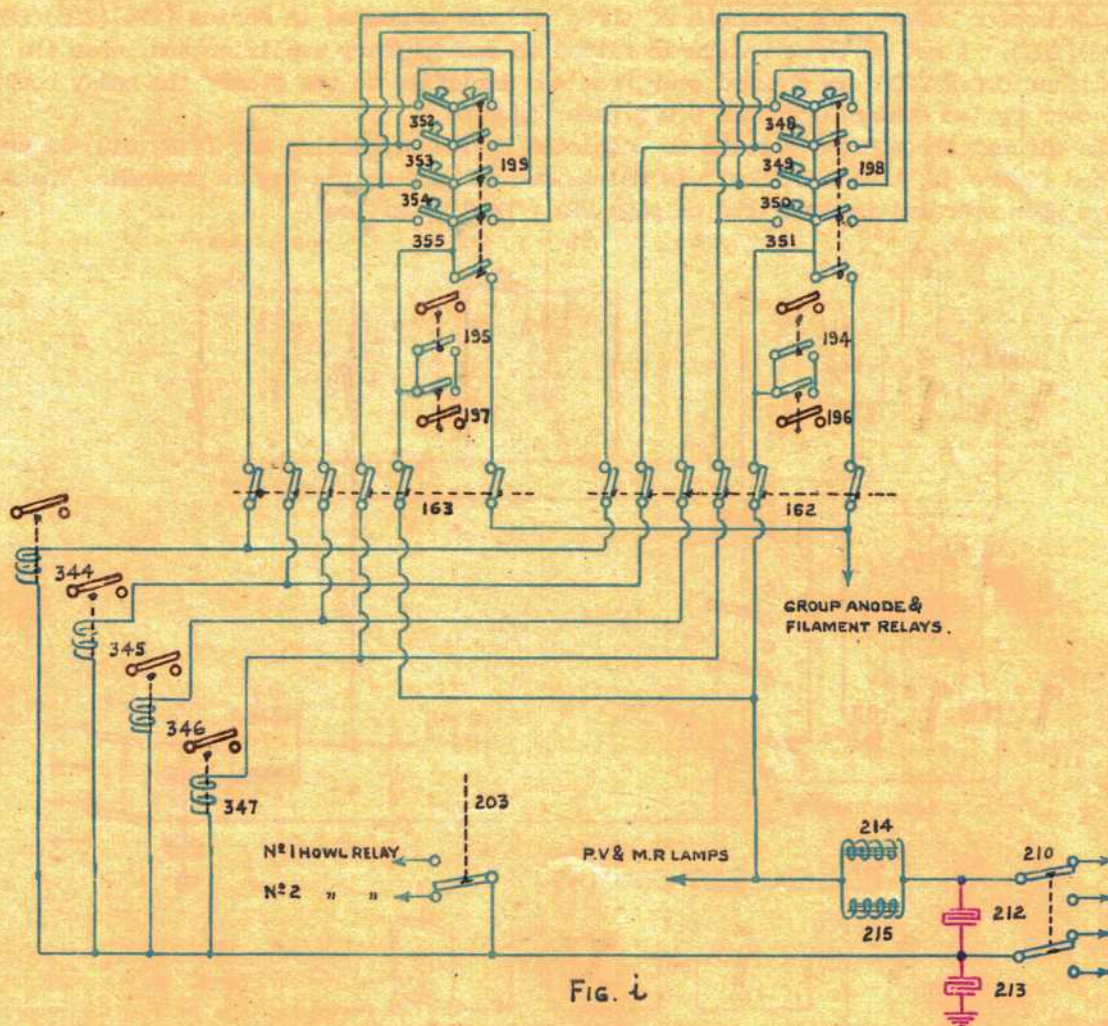
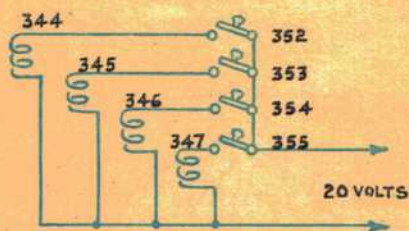


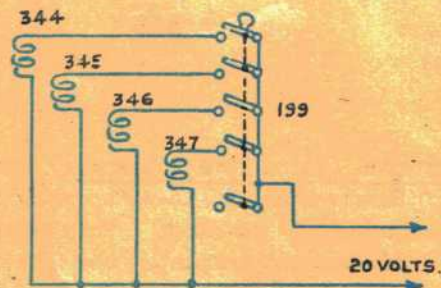
FIG. i

EQUIVALENT CIRCUIT



GROUP SELECTOR SWITCHES

FIG. i a



ALARM GROUP SWITCH

FIG. i b

Group Relays Circuit (Figure i.). The group relays (344) to (347) are supplied from the 20 volt generator output. Each relay connects one group of loud speakers to the output of its particular group amplifier (see figure 1.).

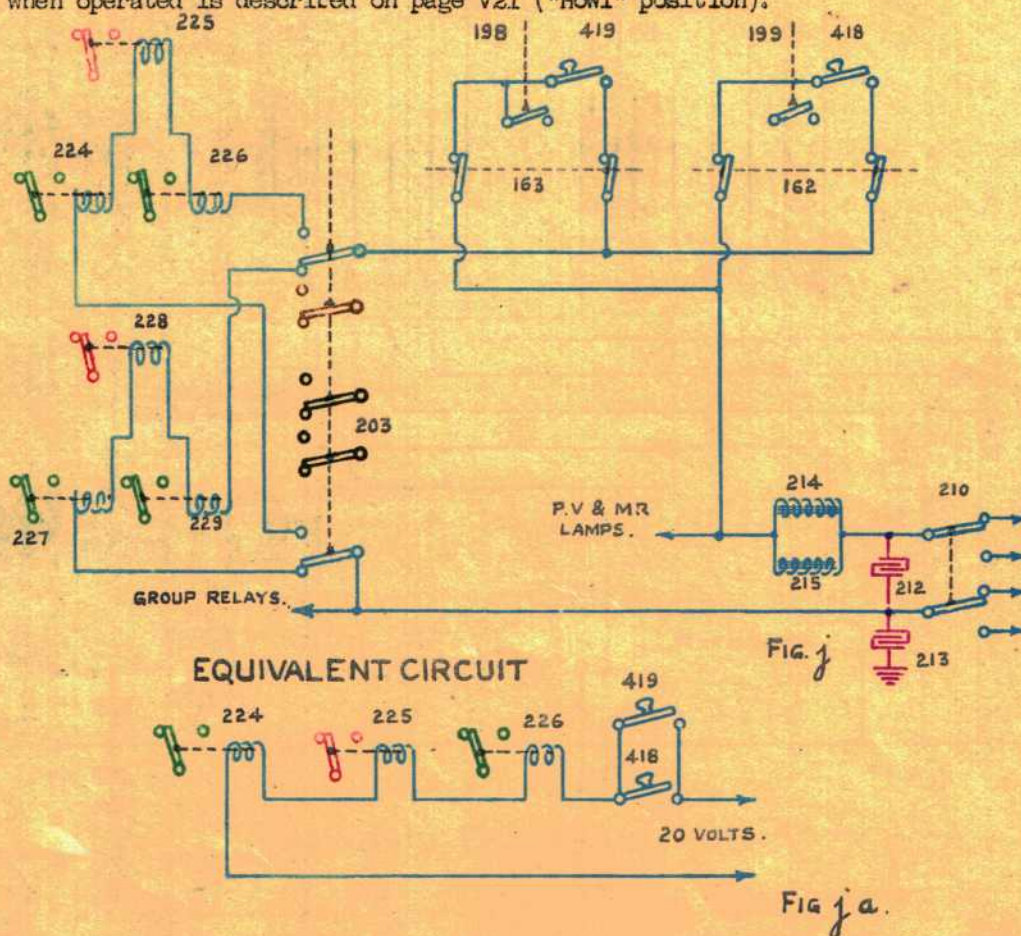
The circuit through each relay bobbin can be completed by its corresponding group selector switch (348) to (355), thus allowing the operator to select a group or groups to whom he desires to transmit (see figure ia.).

The whole of the group relays can be operated by one switch (198)(199). This is the "Alarm Group" switch, and, when made, connects the whole of the group relays in parallel (see figure ib.) It is always used when giving the 750 cycle "Alarm" or "Howl" signal, thus ensuring the signal is transmitted through all groups of speakers. One contact of the switch (198)(199) carries out the same functions as one contact of the preliminary call switch (194)(195) and microphone control switch (196)(197) i.e., it operates the group anode relay (200) and filament relay (201) (see figure h.). The reason for this is that when giving an "Alarm" the call buzzer and microphone are not required.

TYPE 402 OPERATING CIRCUITS (CONT)

"Alarm" or "Howl" relays circuit (figure j.) The "Alarm" or "Howl" relay circuit is supplied from the 20 volt generator output, and consists of three bobbins connected in series (224)(225)(226) or (227)(228)(229). A set of three relays is fitted to each primary amplifier and, when the primary amplifier C.O.S. (203) is changed over from one amplifier to the other, the relay bobtins are changed over by two contacts of this C.O.S. (see figure c.).

The circuit through the bobtins is completed by the signalling key (418)(419) as shown in the simplified figure ja; thus the "Howl" is maintained as long as the key is pressed. The action of the relays when operated is described on page V21 ("Howl" position).



OPERATION

Speech Conditions (Using Fore A.T.Box). Open the door of the A.T. box. If the P.V. lamp (207) is burning it indicates the set is in operation from another position. The action of opening the door allows the switch (165) to close. This completes the 20 volt circuit through the starting relay (161) which operates and completes the 220 volts supply to the machine (see figure bc.)

Wait for the M.R. lamp (190) to light, as this will denote that the machine has run up to speed, and also that the 6 and 20 volt outputs are correct as the 6 volts operates the M.R. relay (187) which completes the 20 volt supply to the M.R. lamp (190) (see figures bc. and g.)

Make the appropriate group selector switch or switches (352) to (354) corresponding to the group or groups of loud speakers through which the announcement is to be made. Each switch completes the circuit for a particular group relay (344) to (347) (see figure ia.).

Press and release the preliminary call switch (195). One contact of this switch completes the 20 volt circuit of the group anode relay (200) and filament relay (201) (figure h.). The group anode relay completes the anode supply to all group amplifiers. The anode supply of the primary amplifier is already completed by the primary amplifier anode relay (191) which operates as soon as the machine is running. The filament relay completes the filament supply to all valves and the 6 volt supply to the P.V. relay (204) (see figure g.). The P.V. relay operates, and P.V. lamp (207) lights, thus indicating that all supplies to the set are complete. The second contact of the call switch (195) completes the preliminary call buzzer circuit through the primary of the primary amplifier input transformer (216) or (217), and the 400 cycle note is transmitted (see figure ea.). By a mechanical escapement the call switch (195) will remain closed for 4 seconds. If the P.V. lamp (207) ceases to burn, it is an indication that the switch is again broken, and the amplifiers supplies and call buzzer circuit are not complete.

Press the microphone control switch (197). One contact of this switch carries out the same functions as one contact of the preliminary call switch (195), and the P.V. lamp (207) will again light, indicating the amplifiers supplies are made. The second contact of the microphone control switch completes the microphone circuit through the primary of the primary amplifier input transformer (216) or (217), and speech or hagle calls may now be transmitted (see figure et.). The microphone control switch must be kept pressed during the transmission.

TYPE 402 OPERATION (CONT)

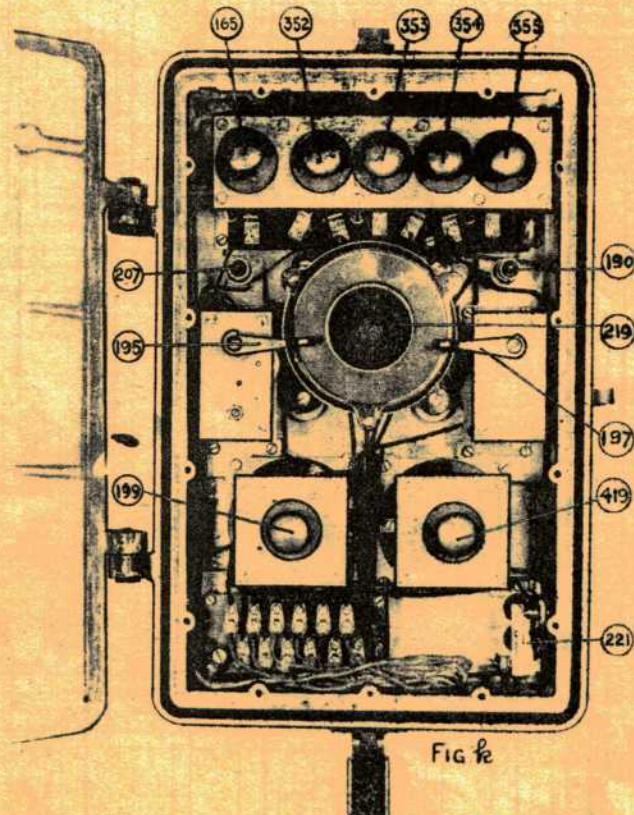
V29

After making an announcement or bugle call, close the door of the A.T. box. This breaks the door switch (165), and any of the group selector switches (352) to (355), which had been made. The former stops the machine, and the latter breaks the group relays circuits. Howl Conditions (Using Fore A.T. Box). Open the door of the A.T. box, and wait for the M.R. lamp to light. As described above the action of opening the door starts the machine, and the lamp indicates that it has run up to speed.

Open the small door and make the alarm group switch (199). This switch completes the circuits of ALL group relays (344) to (347), and therefore all loud speaker groups are connected to their group amplifiers (see figure it.). One contact of this switch also carries out the same functions as one contact of the preliminary call switch (195) and microphone control switch (197), i.e., it completes the group anode and filament relays etc., and lights the P.V. lamp (207) (see figures g. and h.). Thus by one movement of the alarm group switch all groups of speakers are connected, the supplies to all amplifiers are completed and the set is ready to operate.

Make the signalling key (419). This completes the circuit through the three howl relays (224)(225)(226) which operate (see figure ja.) and the 750 cycle "Alarm" or "Howl" signal is transmitted. The signal is sustained during the period the signalling key (419) is made. The functions of the three relays when operated are described on page V21 (Howl position).

After giving the alarm, close the door of the A.T. box. This breaks the switch (165) and the alarm group switch (199). The former switches off the machine, the latter breaks all group relay circuits.



Testing. For testing purposes the generator may be started by closing the local starting switch (193) which is fitted at the set. (see figure f.). One contact of this switch completes the locking circuit of the machine starting relay (161) in the same manner as the door switches (164) and (165). A second contact carries out the same functions as the second contact of the preliminary call switches (194)(195) and microphone control switches (196)(197), i.e., operates the group anodes and filaments and lights the P.V. lamps (see figures g. and h.). The filament voltage at the primary amplifiers and group amplifiers is then tested by inserting the plug of the portable voltmeter in the appropriate sockets (257)(258) or (406)(407)(408)(409) etc (see figure l.).

The anode current of the last two valves (3)(4) or (7)(8) in the primary amplifier can be measured by inserting the plug of the portable milliammeter in the jacks (245) or (246) (see figures c. and e.). This current should be 2-4 milliamps. The anode current of the first two valves cannot be measured and if one should lose its emission this can be verified by exchanging valves (1) and (2) with (3) and (4).

The anode current taken by each bank of four valves in the group amplifiers is measured by inserting the plug of the portable milliammeter in the jacks (268)(269) etc., of the valves under test (see figures d. and l.) It should be remembered that the reading given is for four valves in parallel and a faulty valve can only be located by replacing each valve in turn with a sound valve.

An ammeter (172) shorted by a switch (173) is fitted in the 220 volts positive lead to the generators, to indicate the supply taken by the machine (see figure ba.). The switch (173) is provided to protect the ammeter (172) when the machine is started. The switch should not be broken to insert the ammeter until the machine is running at full speed as the ammeter may be damaged by the high initial starting current.

V30

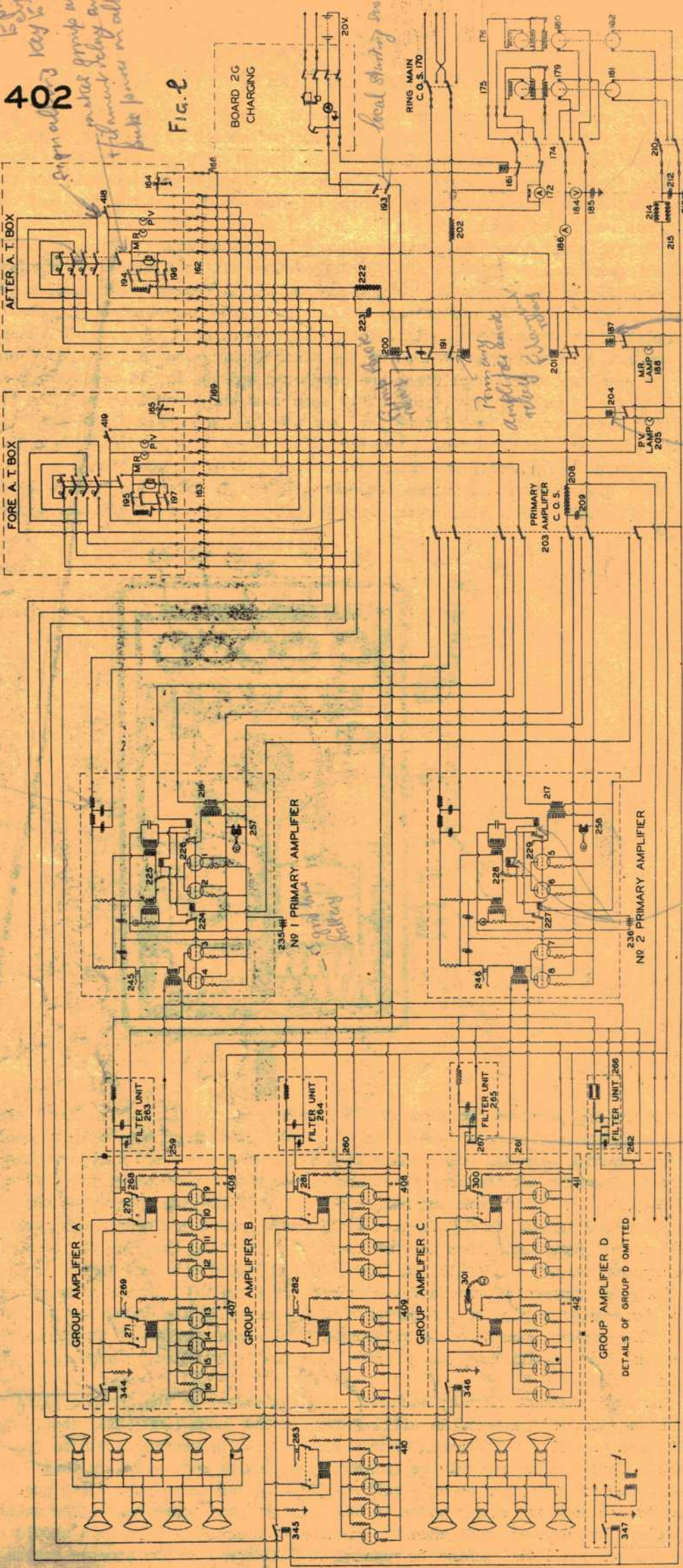
TYPE 402

FIG. 2

194 or 196 made notes 200 and 201

Signal cable
key to
+ filter unit relay and
+ filter unit relay and
+ filter unit relay and
+ filter unit relay and

Connects all outputs to
their groups or spans
from alarm



local starting switch

Primary amplifier relay

main relay

supply relay

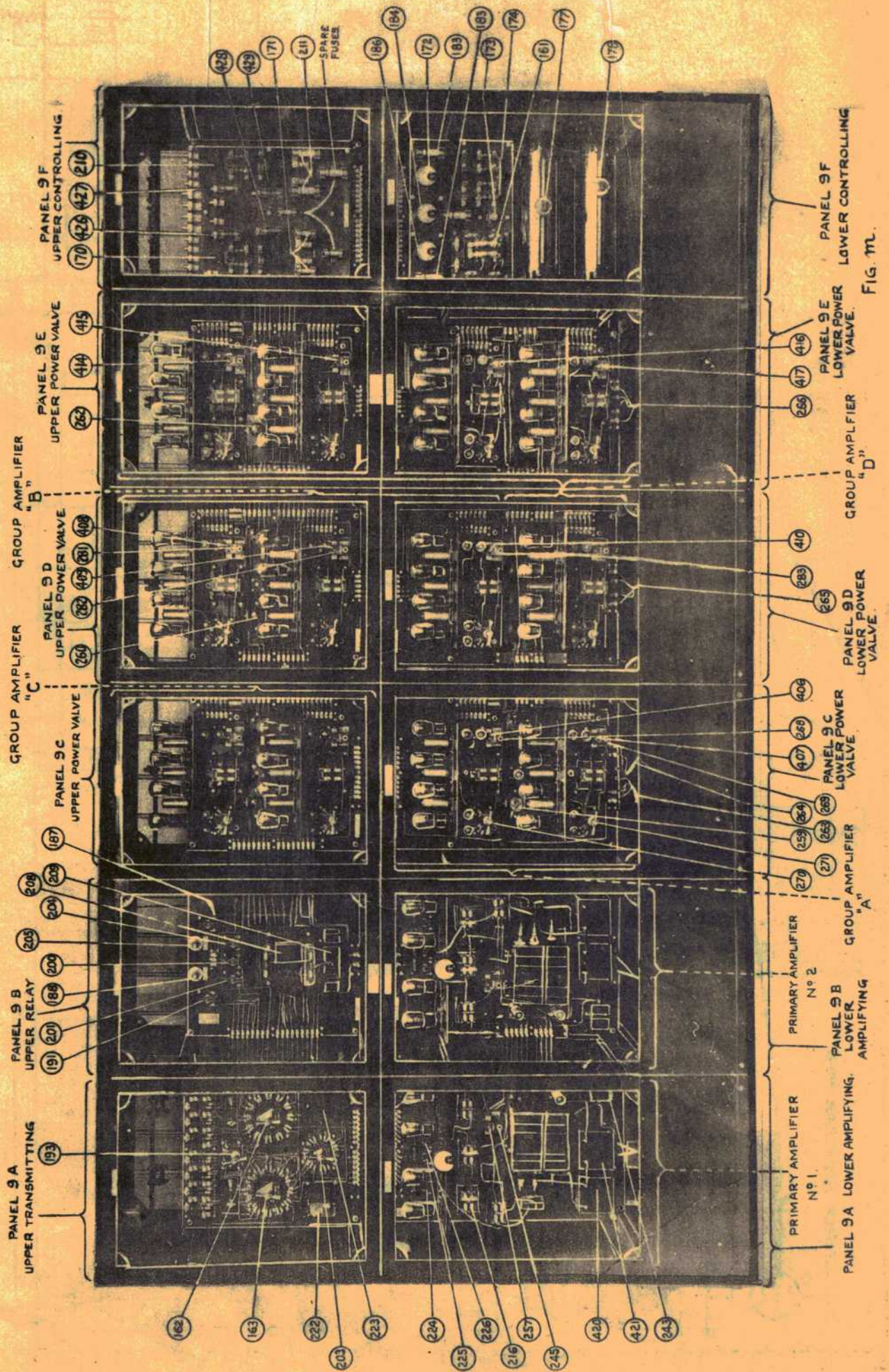
floor relays

95 adjustment

group relay

LOUD SPEAKERS

from Busbar



EQUIVALENT CIRCUIT

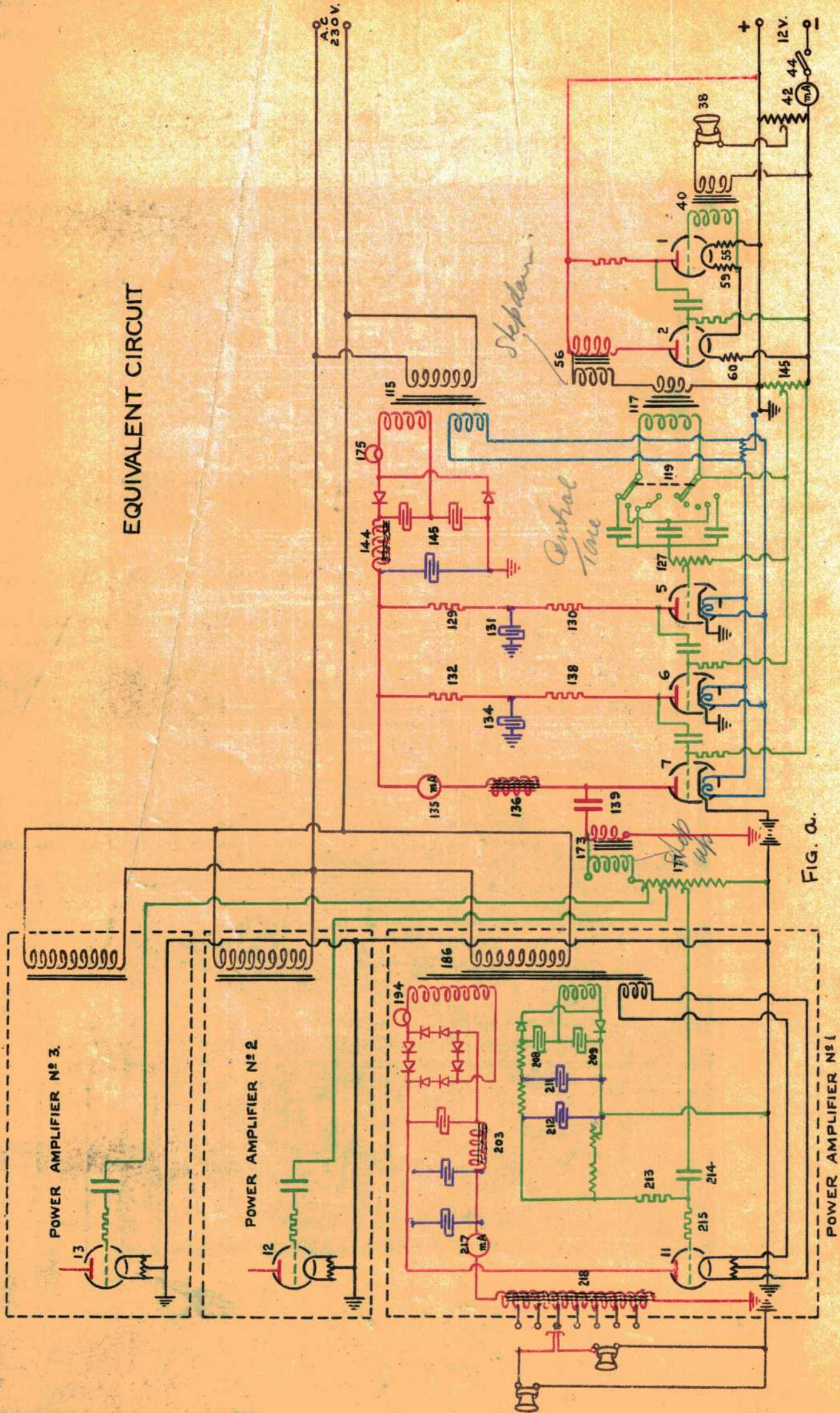


FIG. a.



Date of design:- 1930
 Valves used:- Microphone Amplifier Two NR28.
 Intermediate Amplifier Two NR26 and One NR27.
 Power Amplifier One NT1B.
 Power supply:- Two 800 watt alternators, giving 230 volts, A.C., for H.T. and filament heating for the Intermediate Amplifiers and H.T., filament heating and grid bias for the Power Amplifiers.
 Two 1/3 H.P. Alarm machines (commutator type), for supplying A/F power to loud speakers independently of amplifying apparatus.
 Two 12 volt batteries for supplying H.T. filament heating and grid bias to the Microphone Amplifiers, grid bias to the Intermediate Amplifiers and for operating the various relays, indicating lamps, etc.
 230 volts from ship's mains; input to alternators and alarm generators.
 20 volts from ship's 20 volt supply for charging batteries only.

Type 403 is a Wa/T set consisting of:-

Two A.T. (Alarm-Transmit) boxes, each containing a microphone amplifier, volume control and other control switches.

A.T. Box Isolating Switch, which normally connects both A.T. boxes to the main equipment but is arranged to disconnect either or both in case of damage etc.

Two Intermediate Amplifiers, the one being alternative to the other.

Four Power Amplifiers fed from the Intermediate Amplifier in use.

Four groups of Loud Speakers (distinguished as A, B, C and D groups).

The amplifiers, together with switch units, relay units, etc., are mounted in two racks, as shown in figure 2. and fitted near the main W/T office.

The set provides for the transmission of:-

- (a) A preliminary call (tuzzer note).
- (b) Speech, piping, bugle calls etc.
- (c) Local signals, using a gramophone pick-up, a portable microphone, radio-receiver etc.
- (d) An alarm signal (very low pitched note).

Two A.T. (Alarm-Transmit) boxes are fitted, one situated in the quartermaster's lobby aft, the other in the boatswain's mate's position on the bridge, for use in harbour and at sea respectively. Each A.T. box is so designed that, provided no essential switches have been broken at the set, the act of opening the door automatically switches on the supply alternator and renders the set ready for use. The person using the set makes the group selector switches situated in the A.T. box for connecting up the particular group of loud speakers he wishes to use. The loud speakers are grouped according to the ship's requirements. Normally only four groups of loud speakers are required but six group selector switches are fitted in the A.T. box to enable one or two extra groups to be fitted if necessary.

By depressing and releasing the "Preliminary Call Key" fitted inside the box a buzzer note of approximately 450 cycles/sec is transmitted as a warning that an order is about to be passed. By a mechanical escapement fitted to this switch the preliminary call is sustained for about 4 seconds after the key has been released.

Speech or bugle call, etc., can then be transmitted through a microphone fitted in the A.T. box by means of the control key, marked "Press While Speaking". A lamp in the A.T. box is used to indicate when the set is ready for use or whether it is already in use from the other A.T. box.

Provision is made for using the set to transmit music, etc., from a gramophone pick-up, microphone or radio receiver by means of the local input circuits. The necessary connections for doing this are made at the set and the circuits so arranged that the local input is out off when either A.T. box is opened to make an announcement.

When it is required to transmit an "urgent" warning signal, such as a gas alarm, all groups are connected to the alarm machine by an alarm switch and a distinctive low pitched note, similar to a klaxon horn or rattler, can be transmitted to all groups. The alarm circuits are independent of the amplifier circuits as explained in "Alarm Circuit" (page V45). The alarm switches are housed inside a special cover within the A.T. box which prevents their inadvertent use. After use the action of closing the cover of the alarm switches breaks the supply to the alarm machine.

Amplifying Circuits. Figure a. shows, in a simplified form, the six stages of valve coupling when using the microphone (38). Speech is amplified by the two valves (1) and (2) in the microphone amplifier with a step-down auto-transformer (56) connecting the output to the Intermediate Amplifier. A "Tone Control" (119) is provided in the input of the Intermediate Amplifier, which can be adjusted to improve the "speech" quality. The Intermediate Amplifier has three stages of valve amplification (5)(6) and (7) using resistance capacity inter-valve coupling, the output valve (7) being connected to the Power Amplifier by a step-up auto-transformer (173). A resistance (177) across the output of this transformer (173) has tapings which are connected to the Power Amplifiers. Each Power Amplifier has a single valve (11)(12)(13)(14), with a tapped output choke (218) etc., for supplying the groups of loud speakers. The various outputs from the Power Amplifiers are connected to the Remote Group Control Output Unit which has plug and jack connections for connecting the loud speaker groups as required.

TYPE 403 POWER SUPPLY

The H. T. supply for the anodes of all valves in the intermediate and power amplifiers is obtained from transformers, with metal rectifiers, fitted in the amplifier panels.

Separate windings on the transformer supply the filament current for the valves and an additional winding is used to provide grid bias in the power amplifiers.

The intermediate amplifiers obtain their grid bias supplies from the 12 volt battery.

The A.C. supply to the transformers is obtained from a motor alternator as described below.

Remote Control Power Supply Unit. All the power supplies are centralised in this unit together with the switches and relays which control them. Figure b. is a rear view photograph of the unit and figure d. a diagrammatic sketch of the circuits. A front view of the unit is shown in figure z.

The 220 volt ring mains are connected to the ring main C.O.S. (311) which supplies 220 volts to the motor alternator C.O.S. (34), the alarm signalling relay (333) and alarm machine starting relay (334). One contact of the alternator C.O.S. (34) completes the 220 volt supply, through the machine starting relay (20) to the operating coil of the automatic starter in use when the starting relay (20) is operated from the A.T. box or by the local starting switch (17). (see figure m.)

The A.C. switch (36) is a three pole "ON - OFF" switch. One arm completes the 12 volt negative supply to the intermediate amplifier C.O.S. (114) when the machine starting relay (20) is made. The other two arms connect the A.C. output from the alternator to the intermediate amplifier and the power amplifiers (see figure y.) A 220 volt lamp (343) is connected across the output side of the A.C. switch (36) which indicates that power is on the set by illuminating a glass panel marked "APPARATUS IN USE".

A voltmeter (35), connected across the A.C. contacts of the motor alternator C.O.S. (34), indicates when the correct voltage is obtained from the alternator by the adjustment of the alternator field regulator (105) or (106). These regulators (105)(106) are fitted on the bulkhead near the panels. The bobbin of the no volt relay (23) is connected across the A.C. supply from the alternator C.O.S. (34) and the action of this relay is given on page V43. The base of the panel has a double row of fuseholders containing the following fuses:-

- Four 15 amp fuses (335)(336)(337)(338) in the 220 volt supply to the motor alternators (101)(102).
- Four 15 amp fuses (339)(340)(341)(342) in the 220 volt supply to the alarm generators (30)(31).
- One 6 amp fuse (33) in the 20 volt battery charging circuit.
- One 2 amp fuse (37) in the A.C. supply to the Intermediate Amplifier.

These fuses are shown in figure z.

20 volt mains and 12 volt battery (Figure c.). The 20 volt mains supply the power for charging the 12 volt batteries (26)(27). The battery C.O.S. (25) is a four pole switch and, in conjunction with the charging switch (32), provides for the use of either battery on the set whilst the idle battery may be charged at will. One 6 amp fuse (33) is connected between the charging switch (32) and the battery C.O.S. (25) in the negative lead from the ship's 20 volt mains. In the positive lead to the battery C.O.S. (25) are a metal rectifier (30), a 4-amp ammeter (29) and an adjustable resistance (28). The metal rectifier (30) prevents any rush of current from the battery, back to the 20 volt mains, in the event of a failure in the 20 volt charging circuit while a battery is on charge. The ammeter (29) indicates the charging current through the adjustable resistance (28).

The 12 volt batteries (26)(27) supply the power for the bobbins of all relays, (except the "No volt" relay (23)), the microphone amplifiers (see figure e.), the "No volt" indicating lamp (24), the "Ready for Use" lamps (37)(38) (see figure o.), and grid bias for the intermediate amplifiers (see figure f.)

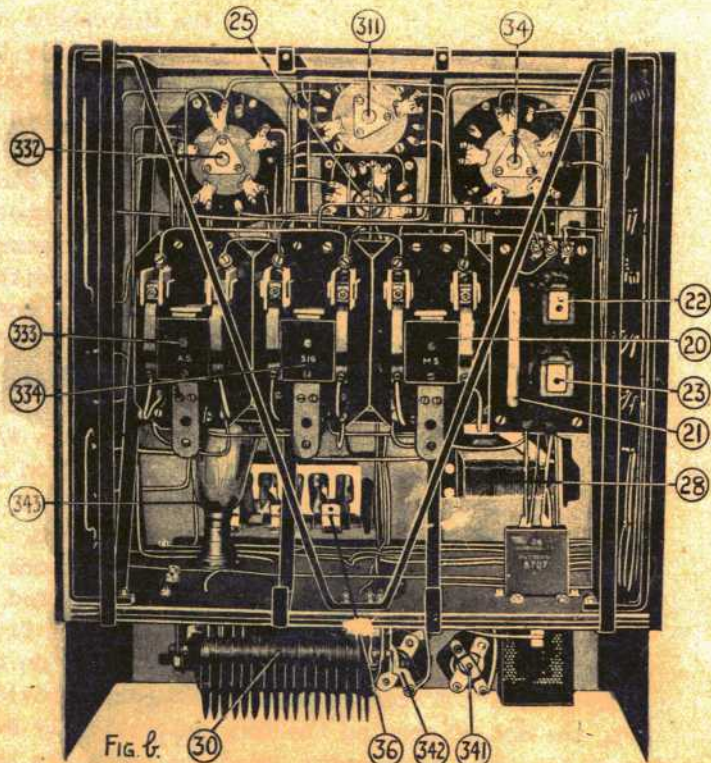


FIG. b.

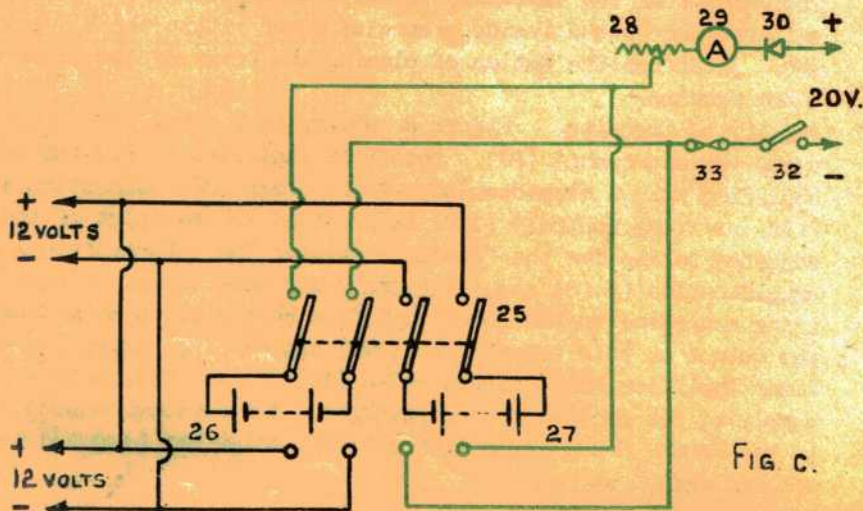


FIG. c.

TYPE 403 POWER SUPPLY

V35

Motor Alternator. Duplicate machines (101)(102) are fitted and each machine has its own automatic starter (103)(104). No provision is made for using either starter with either machine. The 220 volt supply to the starter arm and alternator is made by the alternator C.O.S. (34) through a pair of fuses (335)(336) or (337)(338). The circuit to the operating coil of the automatic starter in use is completed by one contact arm of the machine starting relay (20) (see figure d.) When this relay is made the arm of the automatic starter moves to the full "ON" position in approximately 3 seconds.

Alarm Motor Generator. Duplicate machines are fitted with a 5 pole C.O.S. (332). The 220 volt input to the motor is connected direct from the ring main C.O.S. (311) to the machine in use, the supply being completed by the alarm machine starting relay (334) (see figure d.). The machine reaches full speed in 4 seconds. Motor field regulators (80)(81) are fitted to control the speed of the generators. The armature of the motor is mechanically connected to a set of commutator rings which are used for generating the alarm signal by the action of the alarm signal relay (333) as described under "Alarm Circuit" (see page V45).

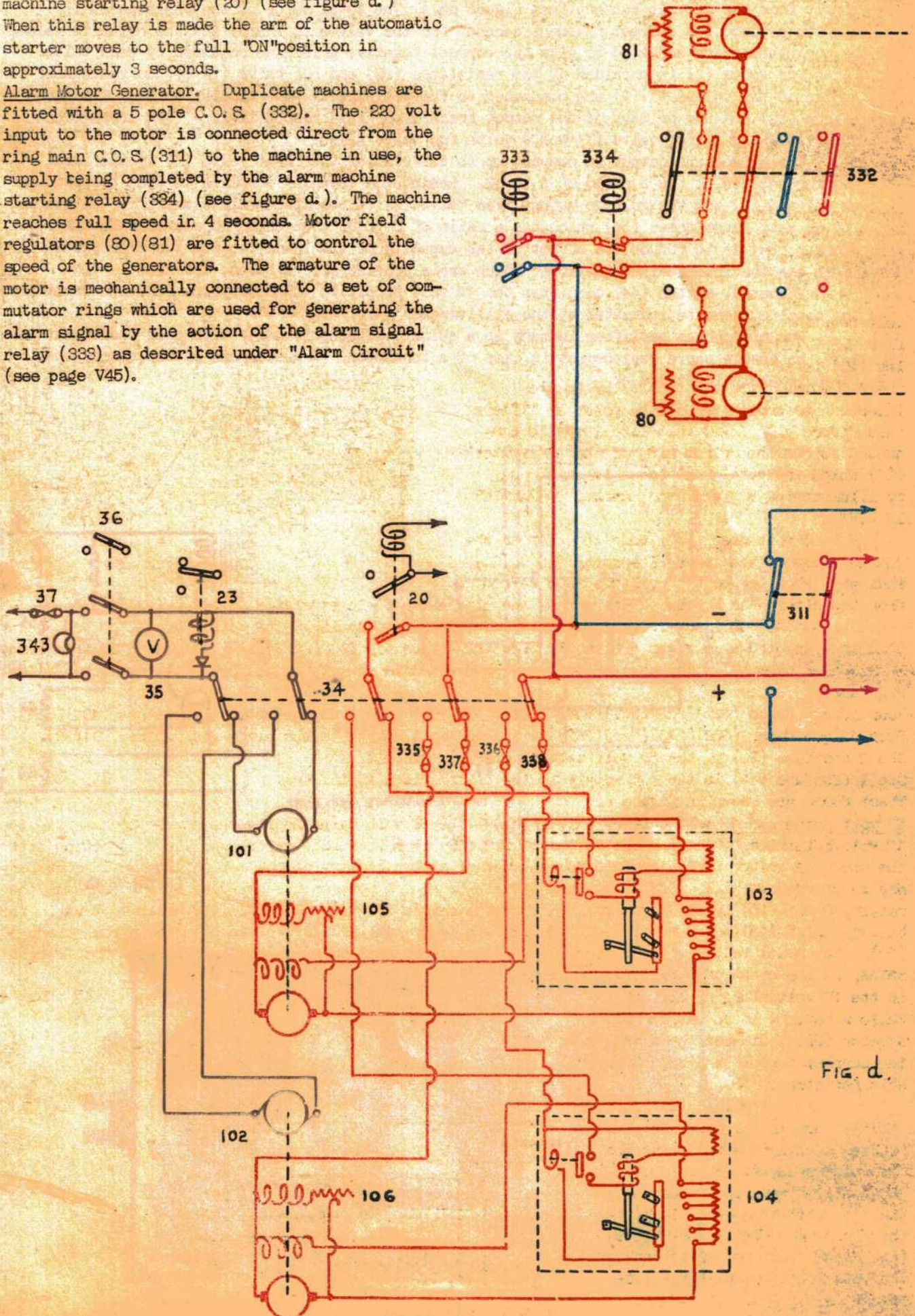


Fig. d.

TYPE 403

MICROPHONE AMPLIFIER

Microphone Amplifier. Each A. T. box has a microphone (38)(39) of the transverse carton type with a two stage valve amplifier (see figure e.) The microphones (38)(39) and amplifiers obtain all current supplies from the 12 volt battery in use. The microphone current is controlled by a potentiometer resistance (46) connected in series with the primary of the input transformer (40). This resistance (46) is fitted in the A. T. box (see figure w.) and is used as a volume control by the operator. The valve filaments are connected in series with three resistances (58)(59)(60) to the supply from the 12 volt battery (see figure ea.) The total value of the resistances is arranged to produce the correct filament current for the valves (0.2 amp) and the relative values of the resistances are adjusted to give the correct negative grid bias required by each valve. Grid bias for valve (1) is provided by the resistance (59) and for valve (2) by the resistance (60). The anodes of the valves (1)(2) are connected to the positive 12 volt supply, through the anode resistance (50) and the primary of the output transformer (56) respectively. This arrangement provides 7 volts H. T. for valve (1) and 9 volts for valve (2).

The microphone output is stepped up to the grid of the first valve (1) by the input transformer (40) which has a ratio of 1 to 13. Resistance capacity coupling is used between the valves (1) and (2) and the voltage output from valve (2) to the intermediate amplifier is stepped down by an auto-transformer (56) which has a ratio of 6 to 1. The chief object of this step-down transformer (56) is to reduce the effect of the capacity of the leads between the microphone amplifier and the intermediate amplifier which are a considerable distance apart.

A control switch (44) completes the 12 volt supply to the microphone (38) and amplifier and the total current is indicated by the milliammeter (42).

The microphone amplifier is made as a quickly detachable unit, with plug and socket connections, to enable rapid replacement in case of a breakdown. A photograph of the microphone amplifier is shown in figure et.

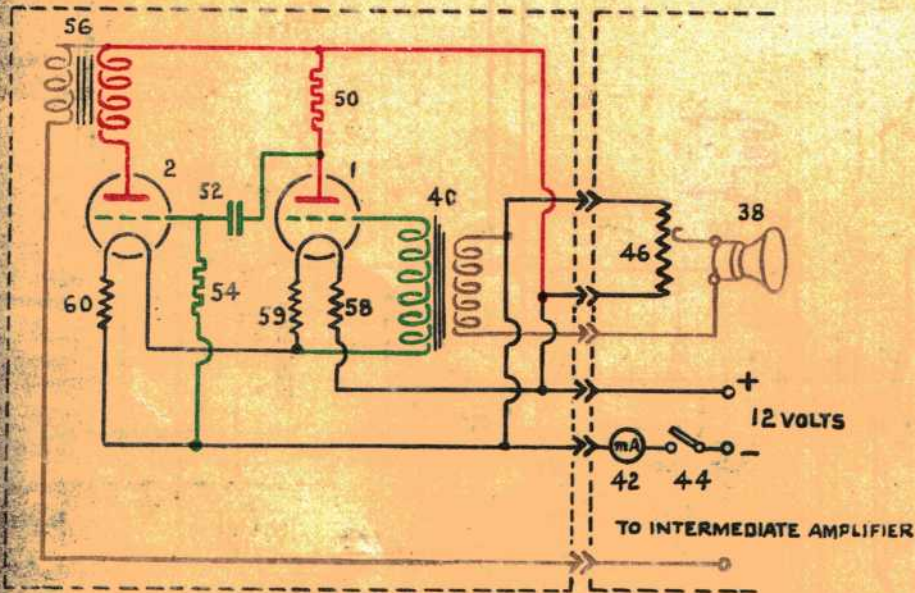


Fig. e.

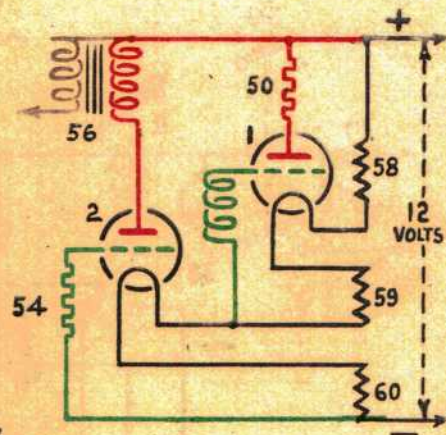


Fig. e. a

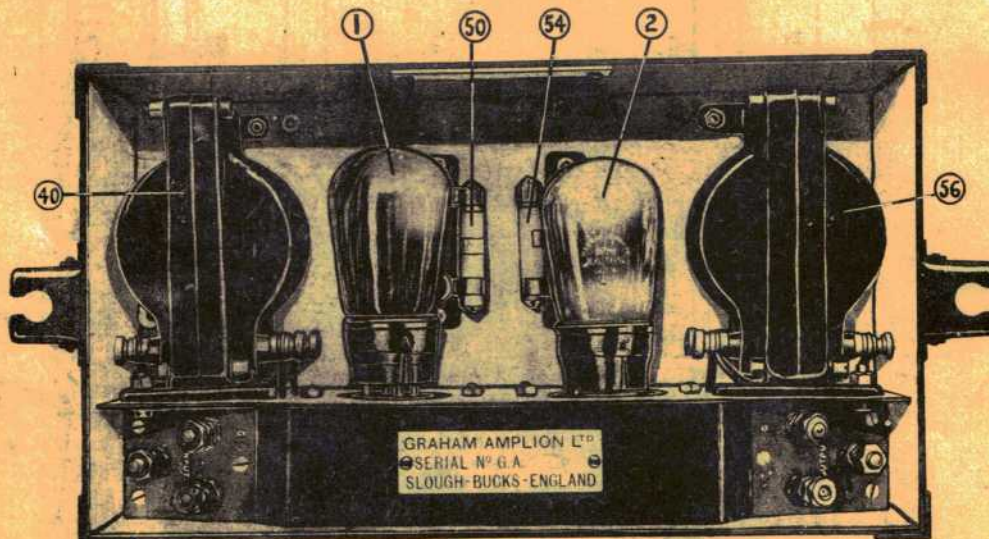


Fig. e. t.

INTERMEDIATE AMPLIFIER

Intermediate Amplifier. (Figures f, fa. and fc.) The H.T. supply (180 volts D.C.) for the valves (5)(6) and (7) is obtained from a transformer (115) with a rectifying and smoothing system (see Admiralty Handbook of W/T (1931) paragraph 651). A fuse lamp (175) is connected in series with the H.T. secondary windings of the transformer (115). The valves are of the indirectly heated type and the heater filament current is obtained from a separate step-down winding on the H.T. transformer (115). Grid bias is obtained from the 12 volt battery supply. The full negative 12 volts potential is applied to the grid of the output valve (7). A grid bias of about one volt negative for valves (5) and (6) is obtained from a tapping on the resistance (143) placed across the 12 volt battery supply. A voltmeter (149) marked "L.T. Volts", indicates the 12 volt battery voltage. There is no voltmeter in the heater circuit.

A potentiometer resistance (127) with 20 tapings is connected across the secondary of the input transformer (117) to act as a volume control. The potentiometer resistance (127) should be adjusted to such a value that the power amplifiers produce their maximum undistorted output under normal operating conditions. The volume of loudspeaker reproduction should be adjusted by this control and should be set so that the milliammeter (135) does not fluctuate more than one or two milliamps during speech. If the volume is increased beyond this point, distortion will occur (see Admiralty Handbook of W/T (1931) paragraph 682). The three amplifying valves (5)(6) and (7) are resistance capacity coupled, the output valve (7) being connected to the output terminals by a step-up auto-transformer (173), the latter being choke capacity fed to keep the D.C. anode current out of its windings. The output transformer (173) couples the output valve (7) of the intermediate amplifier to the power amplifiers. The output transformer (173) is designed to deal with a load of four or more power amplifiers, a centre connection being provided for use with smaller loads.

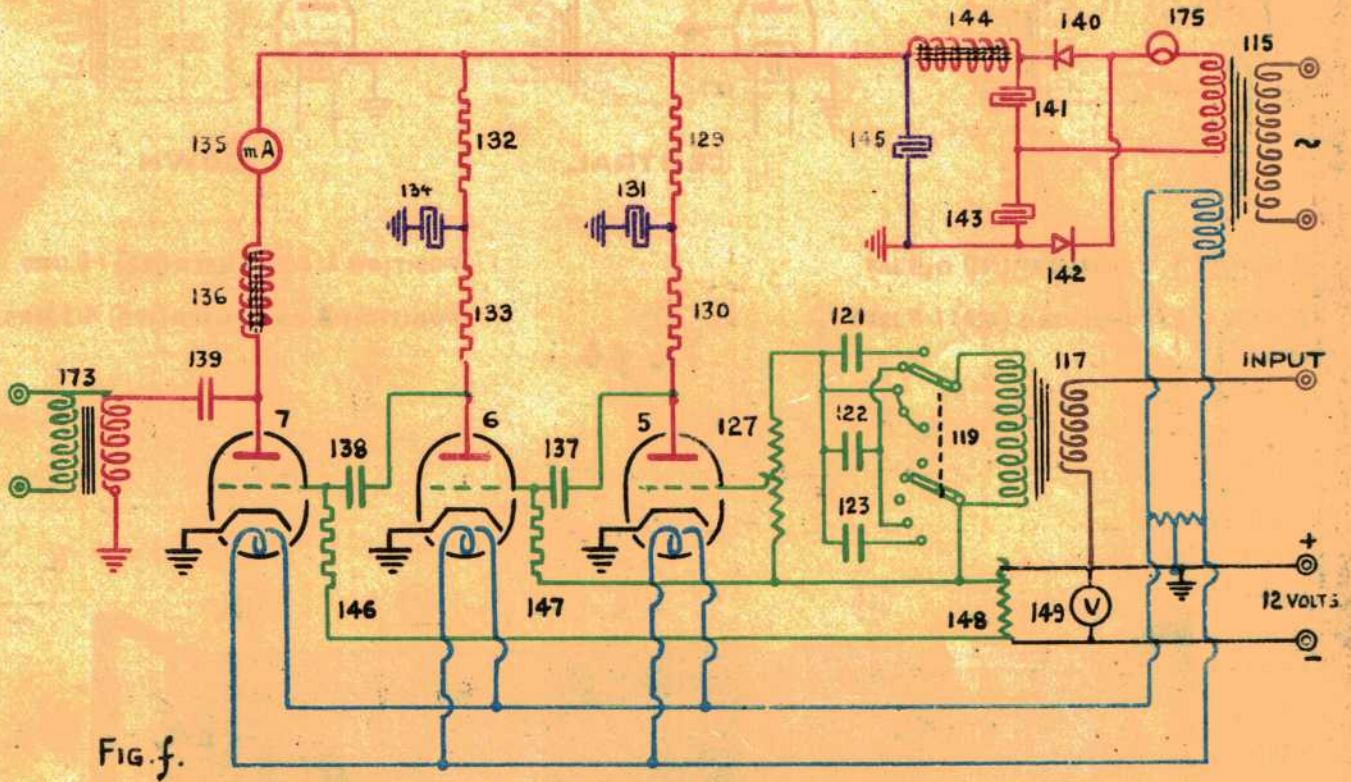


FIG. f.

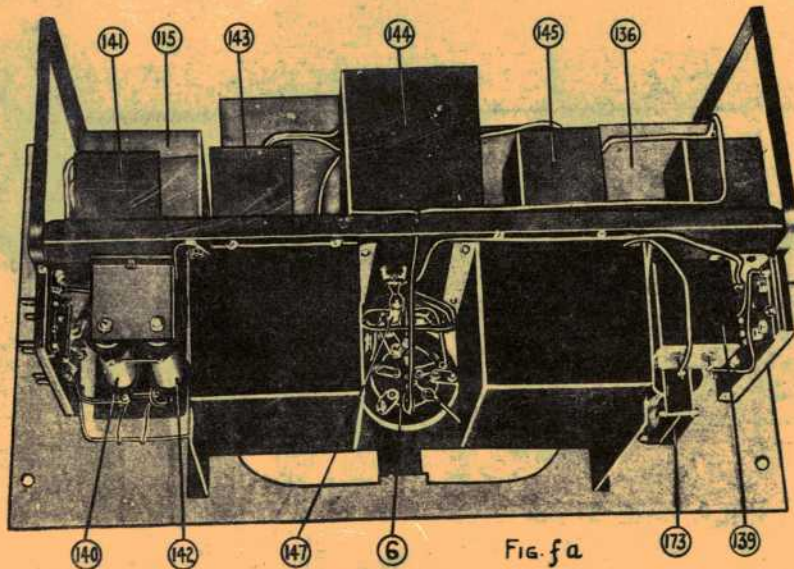


FIG. fa

TYPE 403

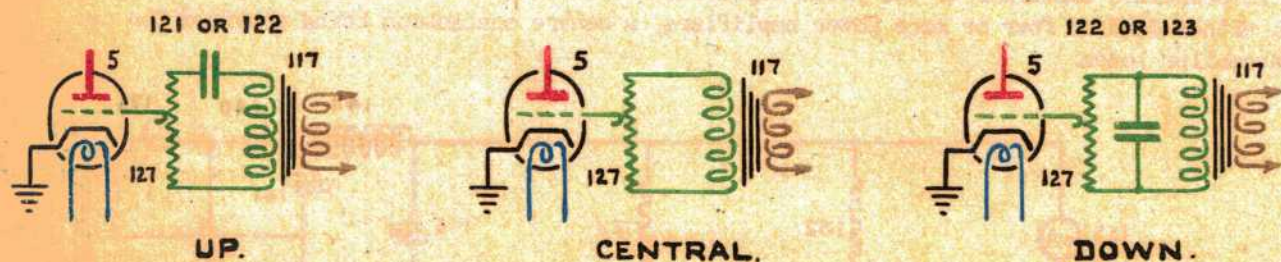
INTERMEDIATE AMPLIFIER (CONT.)

Tone Control. A tone control is connected between the secondary of the input transformer (117) and the volume control (127). The tone control consists of a double pole switch (119) to which are connected three condensers (121)(122) and (123) of 0.9, 1.3 and 4.5 jars respectively (see figure ft.). The tone control switch has a "CENTRAL" position in which the condensers are disconnected.

There are two "UP" positions of the switch (119) in which capacities of 0.9 jar and 1.3 jars respectively are connected in series with the transformer secondary, thus reducing the proportion of lower frequencies.

There are also two "DOWN" positions of the switch (119) in which capacities of 1.3 or 4.5 jars are connected in parallel with the transformer secondary, thereby reducing the higher frequencies (see Admiralty Handbook of W/T (1931), paragraph 662).

For the average male voice "1 UP" will usually be found to be the most suitable position.



POSITION 1. CONDENSER (121) 0.9 JAR.

POSITION 2. CONDENSER (122) 1.8 JARS.

POSITION 1. CONDENSER (122) 1.8 JARS.

POSITION 2. CONDENSER (123) 4.5 JARS.

FIG. f b.

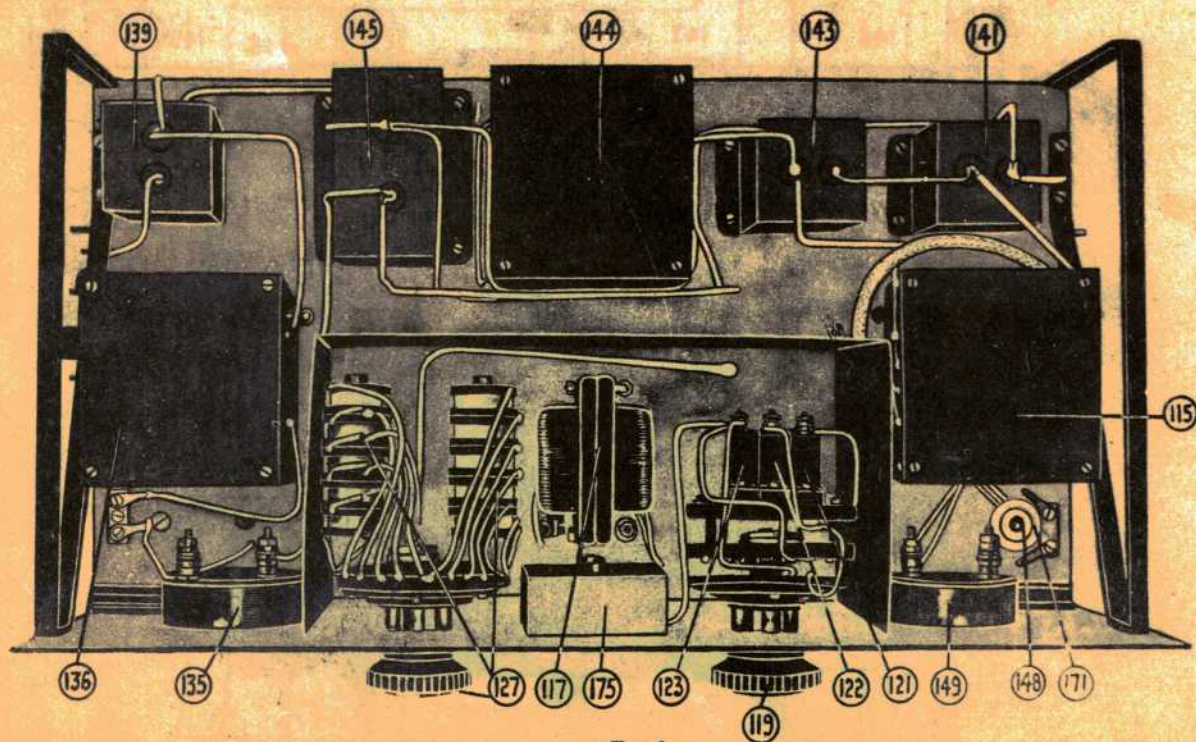


FIG. f c.

INTERMEDIATE AMPLIFIER (CONT.)

Amplifier Control Unit. (Figure g.) The potentiometer resistance (177) is fitted in the amplifier control unit and is connected to the studs of four separate switches (178)(179)(180) and (181). The contact arms of these switches are connected to the grid input terminals of the four power amplifiers 1, 2, 3 and 4 respectively. This enables any desired proportion of the output voltage of the Intermediate Amplifiers to be applied to the various power amplifiers. Thus the output of any one or more of the power amplifiers can be adjusted, without affecting the remainder, by means of the switches (178)(179)(180) and (181) on the amplifier control unit, whilst the volume of the set as a whole is controlled from the volume control (127) or (128) on the Intermediate Amplifier in use.

The amplifier control switches (178) to (181) should be adjusted as necessary to balance the relative outputs of the power amplifiers.

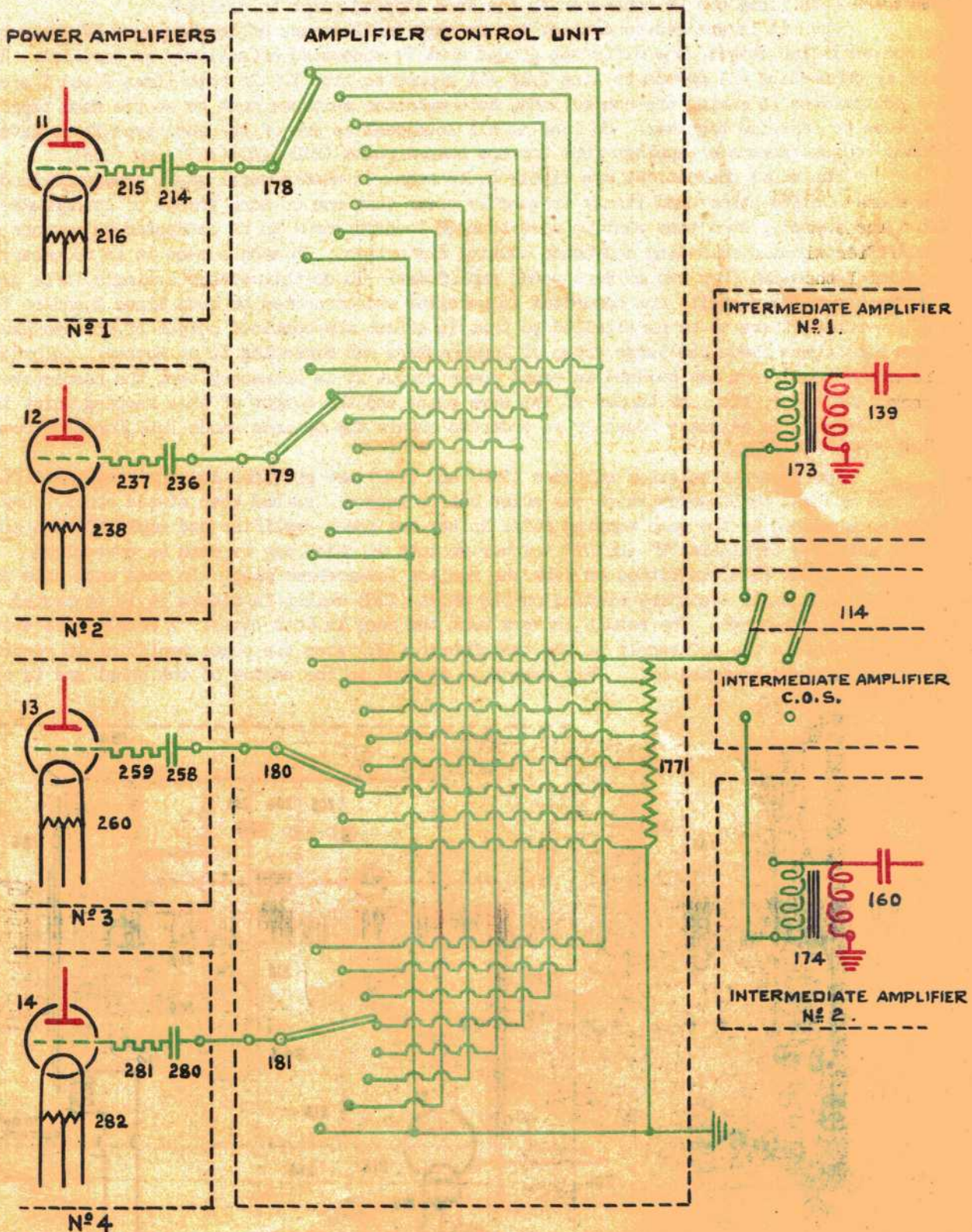


Fig. g.

TYPE 403

POWER AMPLIFIER

Power Amplifier (Figures h. and ha.) The power amplifier consists of a single valve stage, with H. T., grid and filament voltages all supplied from one transformer (186) with separate windings for each. Rectifying and smoothing systems are used for the H. T. and grid supplies, which are about 500 volts and 90 volts respectively. The filament is directly heated by A. C. at 6 volts. A grid leak (213) is fitted to maintain grid bias, and a series grid resistance (215) prevents self-oscillation. Grid bias for power valves (11)(12)(13)(14) is controlled by adjusting screws, (344)(345)(346) and (347) respectively. (See figure z.) These screws are fitted at the bottom right hand corner of each power amplifier. As the grids of the valves in all the power amplifiers are fed from a common potentiometer resistance (177) in the amplifier control panel, grid insulating condensers (214)(236)(258) and (280) are fitted to prevent the grid bias of one power amplifier being applied to the grids of the other amplifier valves (see figure g.)

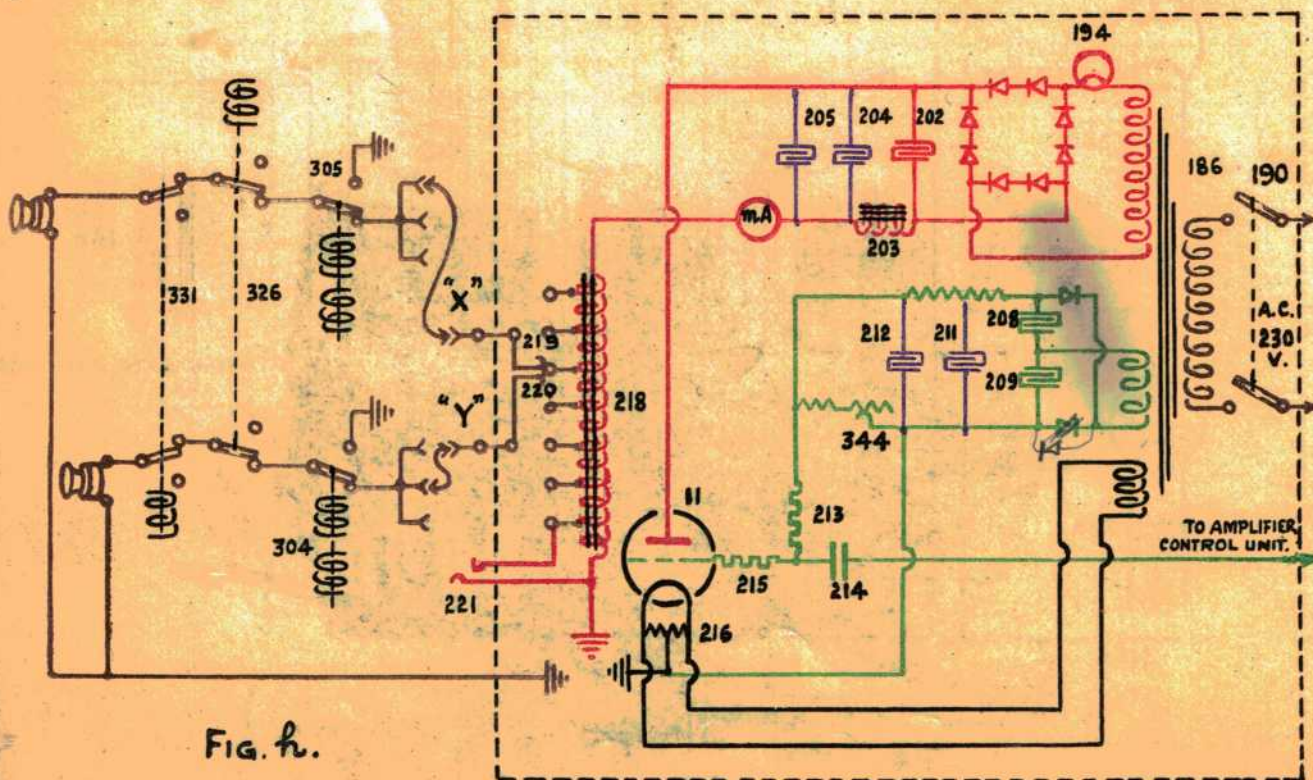
The anode circuit of the output valve (11), etc., of each power amplifier is coupled to a loudspeaker group (or groups) by an auto-choke (218) etc. This, is fitted with several step-down ratios and any ratio can be selected by two independent stud switches (219)(220) and applied to two external terminals labelled "Line X" and "Line Y". By this means any fraction (within limits) of the choke (218) can be applied independently between "Line X" and "Earth" and between "Line Y" and "Earth". Both lines can be connected to the same tapping point if desired.

When it is desired to connect two or more small groups of loudspeakers of the same type to one amplifier output, the different groups must be connected effectively in parallel. This is done by connecting all groups to line X or all groups to line Y. If both lines X and Y are used for convenience in making the connections, both selector switches must be at the same tapping point and must be adjusted together. So long as all loudspeakers are of the same type it is never necessary to take separate tapings from any one output choke (218)(240)(232) and (234).

The above connections are likely to be required when several small groups of loudspeakers are used. On the other hand it may frequently occur that one or more groups of loudspeakers are too large (namely, when they contain more than 26 loudspeakers) to be connected to any one power amplifier without overloading and hence causing distortion. In such a case it is necessary to parallel the output from two or more power amplifiers. To do this either a single large group, or a large group and a small, are connected in parallel and connected to both lines X and/or Y of the two power amplifiers to be paralleled so that in effect the combined output of the two paralleled power amplifiers feeds one large group of loudspeakers not exceeding 52 in number. In order that both power amplifiers may produce an equal power output it is necessary that the respective output chokes (218)(240), etc., be tapped at the same point and the height of this tapping point in both amplifiers must be adjusted together in order to obtain the optimum anode load for each power valve (11), (12), etc.

Two separate selector switches (219) and (220) are provided in each power amplifier to meet any unusual contingency which may arise but in general, as has been stated above, they must both be connected to the same tapping point in any one power amplifier and employed as a single switch with two terminals "X" and "Y", either or both of which may be used as convenient.

A jack (221) is fitted to take the monitor loudspeaker plug. In some sets this jack is connected to a small secondary winding on the choke (218) whilst in others it is connected to a small tap on the choke. The result is very much the same in both cases. A double pole switch (190) disconnects the A. C. supply to the transformer (186) when the power amplifier is required to be permanently switched off. This switch is mounted in the centre of the panel and is of the push button type.



PRELIMINARY CALL CIRCUIT

Preliminary Call Circuit (Figure i.) To produce the preliminary call buzzer note the preliminary call key (82) or (83) is pressed to operate the tottin circuit of the preliminary call relay (93) (see figure p.)

This relay has two contact arms. One contact completes the circuit through the buzzer (97) which has two resistances (94)(95) in series with a condenser (96) connected across the make and break contacts. The second arm connects the buzzer circuit to the primary of the input transformer (117) or (118) of the Intermediate Amplifier in use. The two resistances (94)(95) and condenser (96) act as a potentiometer to control the voltage applied to the input transformer (117) or (118). The resistances (94)(95) are not adjustable. Their correct ohmic value is predetermined by the makers.

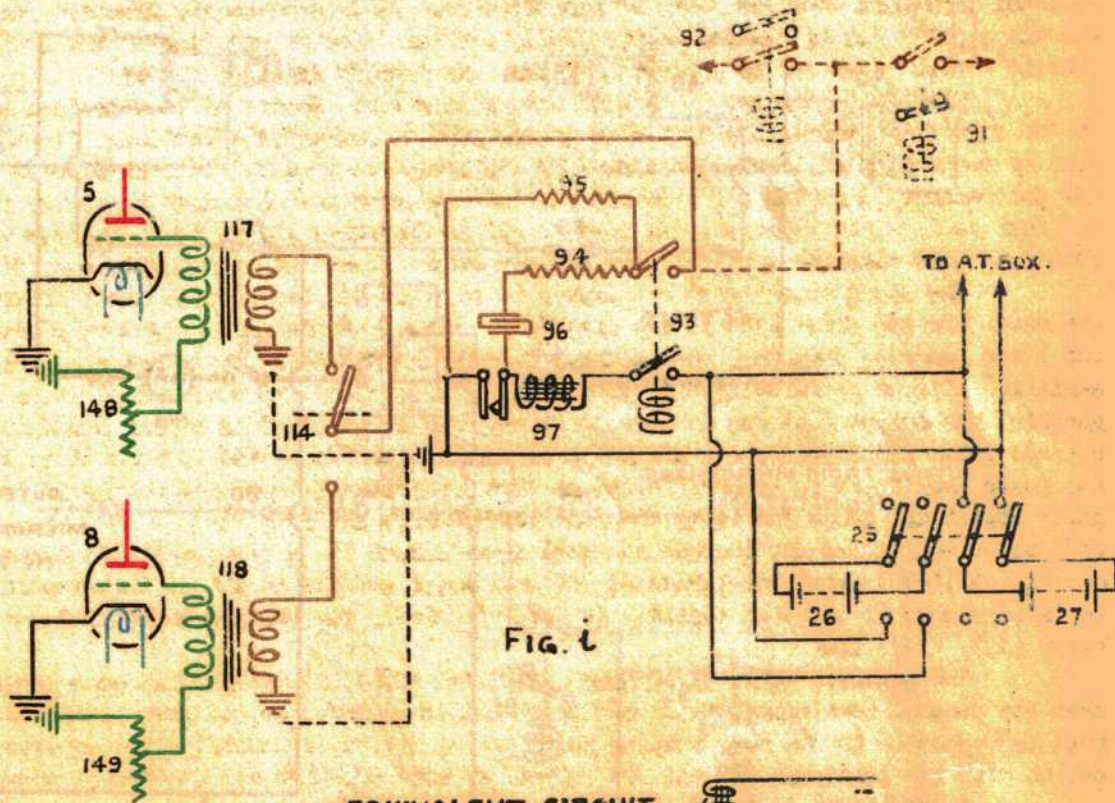


FIG. i

EQUIVALENT CIRCUIT

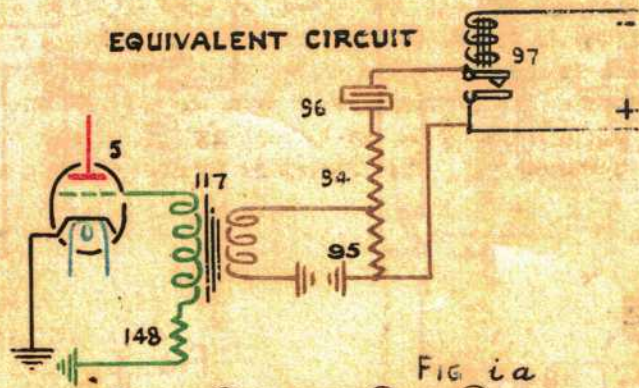


FIG. ia

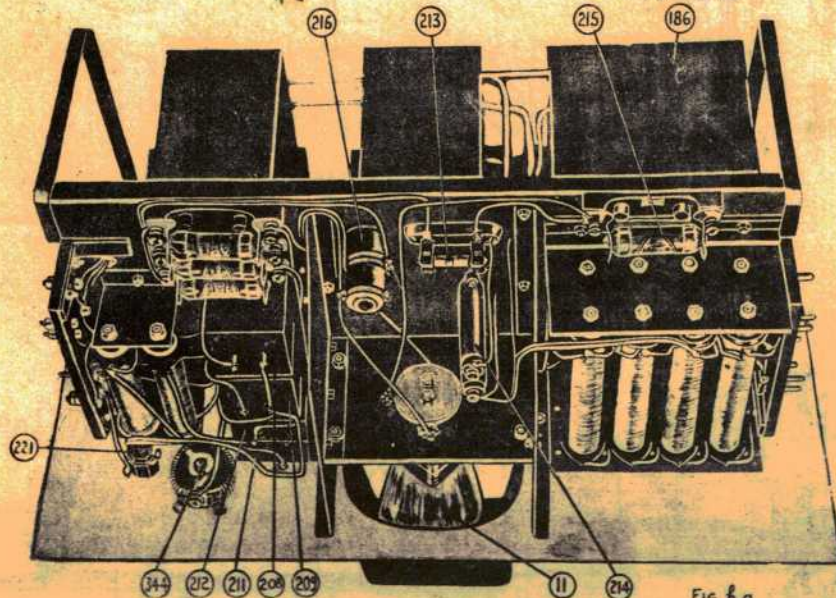
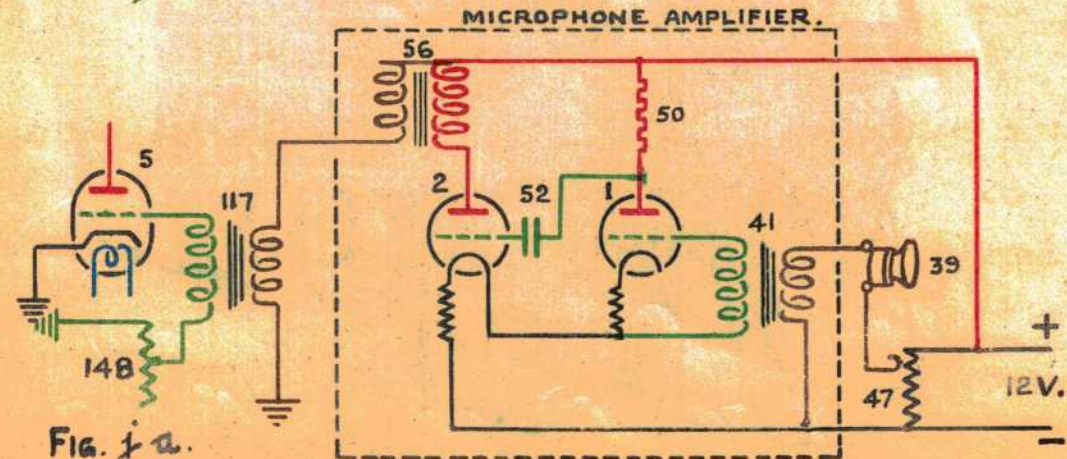
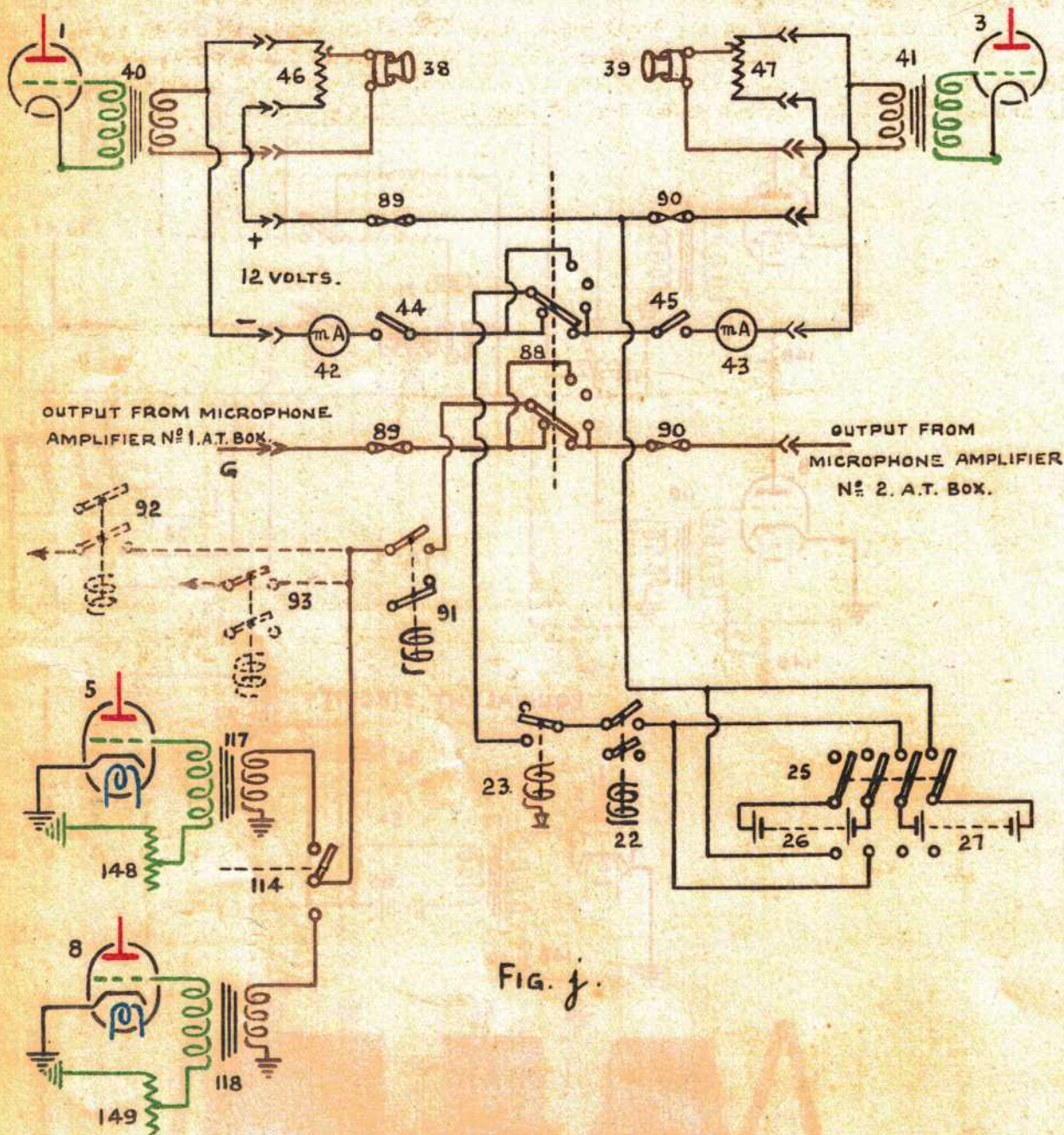


FIG. 2a

TYPE 403 MICROPHONE CIRCUIT

Microphone Circuit (Figure j.) After the preliminary call key has operated the ruzzer, the microphone (38) or (39) is brought into use by depressing the control key (44) or (45). (The complete circuit of the microphone amplifier is shown and explained on page V33). The control key (44) or (45) completes the 12 volts battery supply to the microphone (38) or (39) and the microphone amplifier (see figure e.) after the delay action relay (22) (see figure m.) and the no-volt relay (23) (see figure o.) have operated. The output from the microphone amplifier is connected through the A. T. box isolating switch (88) to the local input out-off relay (91). This relay has two contact arms. One contact arm connects the microphone amplifier output to the intermediate amplifier input transformer (117) or (118). The second contact arm breaks the circuit to the bobbin of the local input relay (92) (see figure t.)

A simplified diagram of the microphone circuit, including the microphone amplifier, is shown in figure ja.



Local Input Circuit. The local input circuit is used for the transmission of any form of local signals, e.g., gramophone records, portable microphone, radio receiver, etc.

Two sets of terminals, three in each set, marked "G", "+" and "-", are fitted on the top of the Remote Control Input Unit. These terminals can be used for connecting a portable microphone or gramophone pick-up or both to the set. A typical arrangement of the connections for a local microphone and gramophone pick-up is shown in figure k, but the circuit can be arranged to suit any type of microphone or microphone amplifier, etc., it is desired to use.

Two terminals, which are normally short circuited by a link (99), are provided for connecting an additional battery to the local circuit if necessary.

The local input relay (92) has two contact arms. One arm connects the local input circuit to the primary of the input transformer (117) or (118) of the intermediate amplifier.

The second arm connects the 12 volt battery supply to the local group selector switches (313) to (323) (see figure s.).

The bobbin circuit of the local input relay (92) is broken by the local input cut-off relay (91) when either of the door switches (18) or (19) is operated by opening the A.T. box (see figure t.) This enables the operator at the A.T. box to cut off the local input transmission at any instant when it is required to use the set from the A.T. box position.

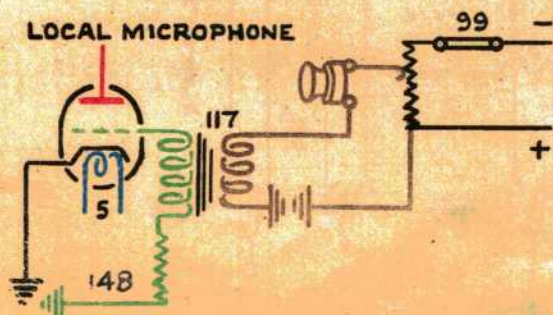
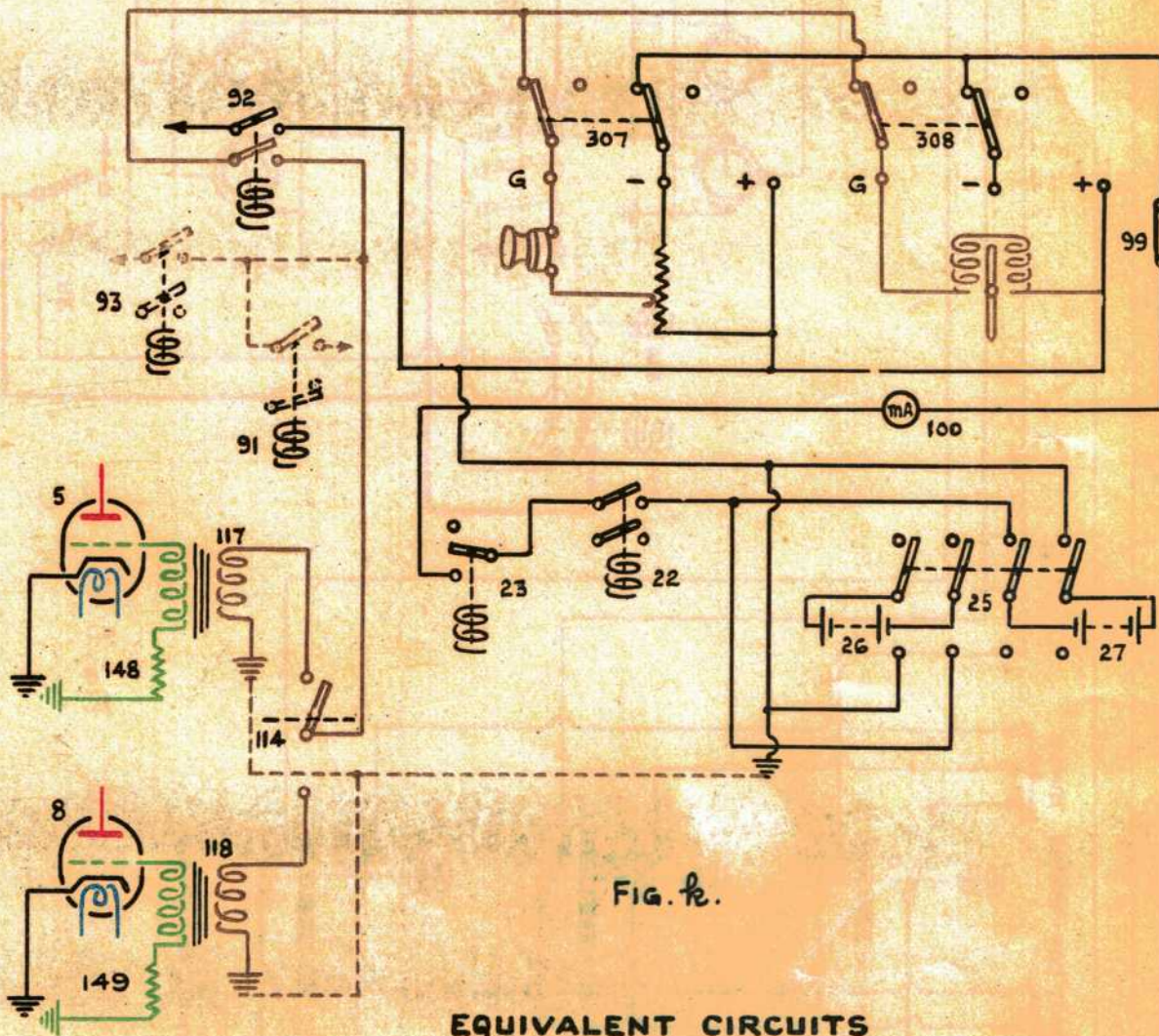


FIG. k.a.

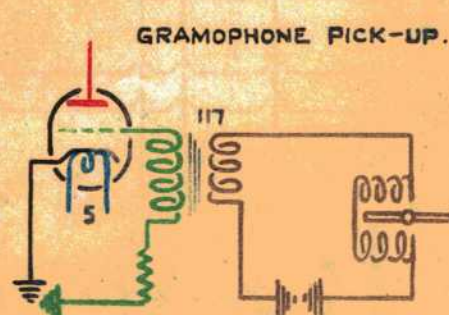


FIG. k.b.

TYPE 403 ALARM CIRCUIT

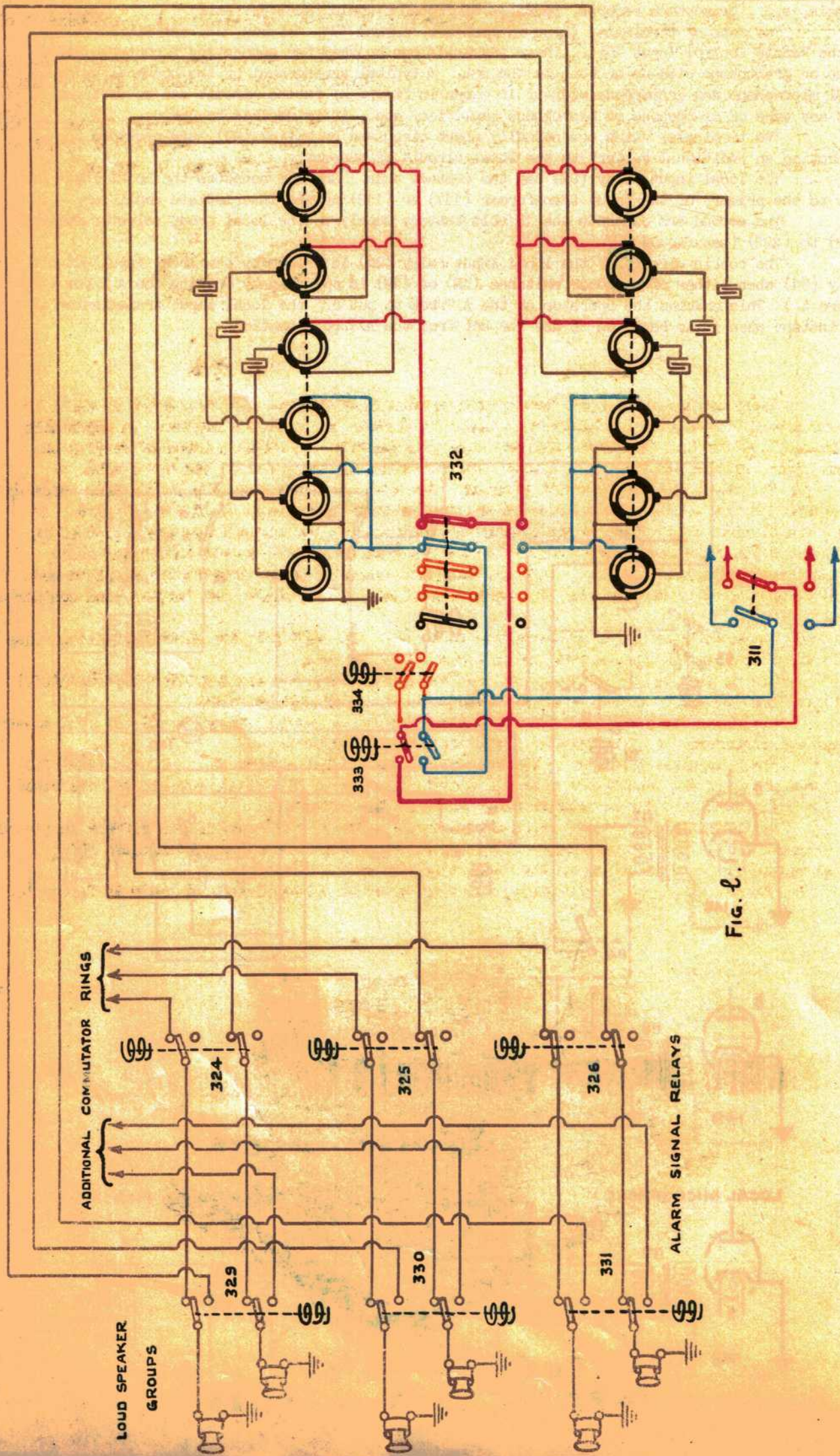


Fig. 2.



ALARM CIRCUIT

Alarm Circuit (Figure 1.) The alarm signal is produced by the alarm machine and is independent of the intermediate and power amplifier circuits.

The alarm circuit consists of banks of condensers which are alternately charged from the ship's 220 volt mains and discharged through the loud speakers by the commutator rings which are revolved by the alarm machine motor.

The commutator rings have conducting segments which connect the condensers either to the ring mains, for charging, or to the loud speaker groups for discharging. (Simplified diagrams of the condensers in the "CHARGE" and "DISCHARGE" positions are shown in figures 1a. and 1b.)

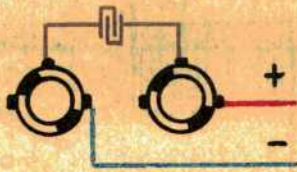


FIG. 1 a.

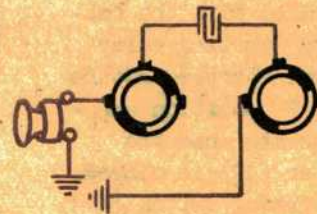


FIG. 1 b.

There are two discharges during each revolution of the machine, the speed of which is approximately 2200 r.p.m. The alarm note will therefore be about 72 cycles/sec. An adjustable resistance (80) or (81) in series with the supply to the motor provides a means of varying the speed of the machine (within small limits) and thus altering the pitch of the alarm note.

For the normal requirements of a ship the total condenser capacity is 108 mfd., made up of eighteen 6 mfd. units. The condensers are divided into four groups of 54 mfd., 24 mfd., 18 mfd., and 12 mfd., where four groups of loud speakers are fitted and will operate groups of 26, 12, 9 and 6 loud speakers respectively. The current from the alarm circuit is approximately 100 mA through each loud speaker. In order to reduce sparking at the brushes two complete sections, i.e., four commutator rings, are connected in parallel to supply the largest loud speaker group.

The commutator rings are connected to the 220 volt supply by the alarm signalling relay (338) which is operated by a switch in the A.T. box (see figure w.)

The condensers are connected to the loud speakers and the alarm group relays (324)(325)(326) or (329)(330)(331) by the commutator rings (in the discharge position).

The alarm group relays connect the alarm machine commutator rings to all the loud speaker groups and disconnect the loud speakers from the power amplifiers.

The relays are arranged in two sets with three relays in each set. One set (329)(330)(331) connects all the loud speakers to the commutator rings of No. 1 alarm machine and the other set (324)(325)(326) to the commutator rings of No. 2 alarm machine.

Three sets of commutator rings are shown connected to the alarm signal circuit in figure 1. In practice six sets of commutator rings are fitted and are connected to the alarm group output relays by the connections marked "Additional Commutator Rings".

The alarm machine, commutators, fuses and motor field regulator are shown in figure 1c.

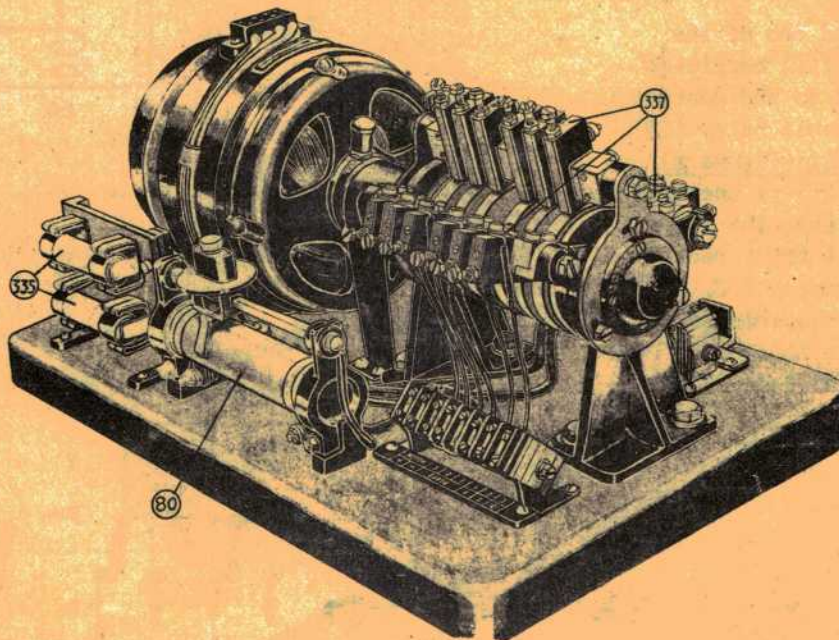


FIG. 1 c.

TYPE 403 OPERATING CIRCUITS

Machine Starting Relay Circuit. (Figure m.) The bobbin circuit of the machine starting relay (20) is completed by the door switch (18) or (19). The door switch is operated by a spring which closes the switch when the door of the A. T. box is opened. The starting relay (20) can also be operated by the local starting switch (17) which is fitted in the Remote Control Power Supply Unit.

The local starting switch (17) must be left in the "OFF" position to enable the door switches (18)(19) to operate the starting relay (20).

Local Input Cut-off Relay Circuit. (Figure m.)

The bobbin of the local input cut-off relay (91) is connected in parallel with the bobbin of the machine starting relay (20) when the local starting switch (17) is in the "OFF" position and will therefore operate when the door switch (18) or (19) is closed. When the local starting switch (17) is used to start the alternator the bobbin circuit of the local input cut-off relay (91) is broken until the door switch (18) or (19) is closed by opening the door of the A. T. box.

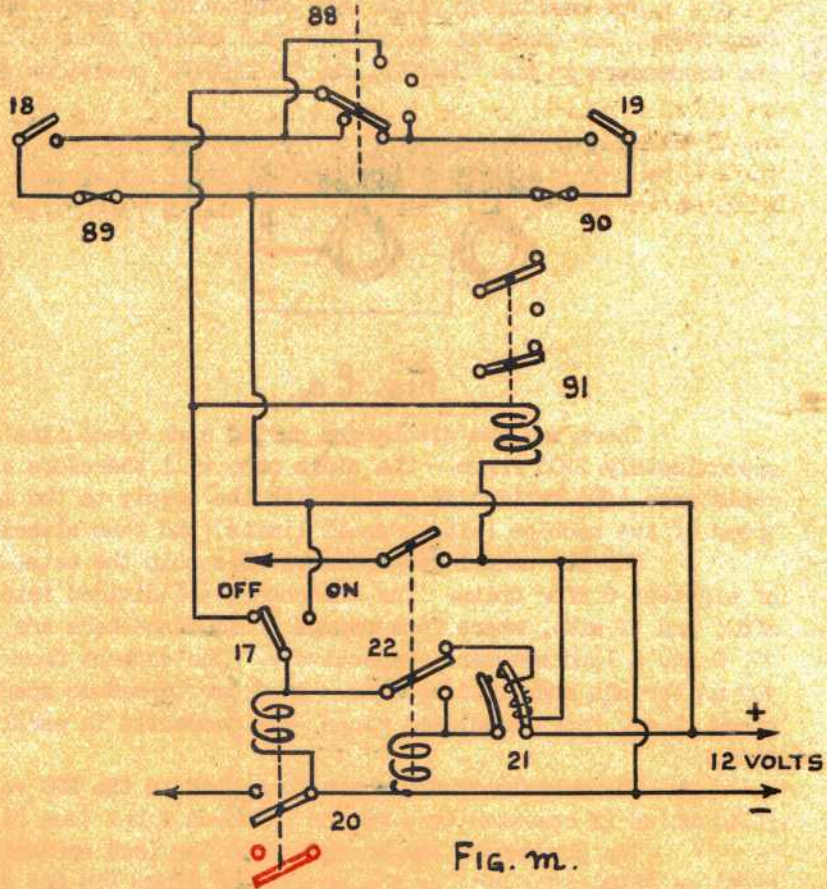
Thermal Relay and Delay Action Relay. (Figure m.)

The circuit through the heater coil of the thermal relay (21) is completed by one arm of the delay action relay (22) (in the "OFF" position). The current through the coil heats a metal strip which expands and makes contact on an adjacent metal strip thus completing the circuit through the bobbin of the delay action relay (22). This relay then closes. One contact arm completes the circuit through its own bobbin and breaks the circuit through the heater coil of the thermal relay (21). The thermal relay then cools and its thermo-actuated contactor breaks. The time taken for the thermal relay to close is approximately 25 seconds.

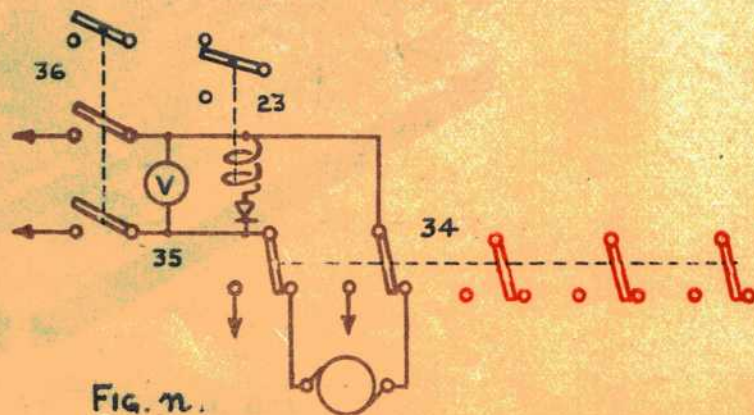
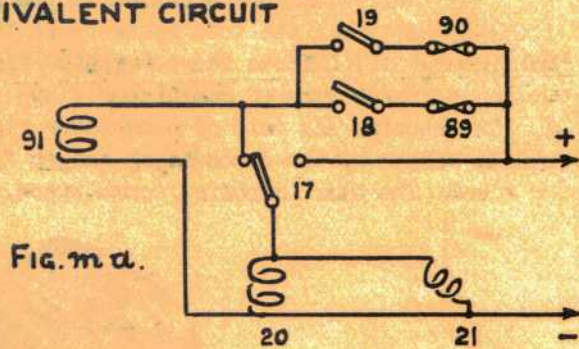
The second arm of the delay action relay (22) completes the 12 volt circuit to the contact arm of the A. C. no-volt relay (23).

No-Volt Relay Circuit (Figure n.)

The no-volt relay (23) is operated by the A. C. output from the motor alternator and has a metal rectifier in series to supply D. C. to the bobbin. This relay completes the circuit to light the "Ready for Use" or "No-volt" lamps (see figure o.)



EQUIVALENT CIRCUIT



TYPE 403 OPERATING CIRCUITS (CONT.)

No-Volt Lamp Circuit (Figure o.). Should the A.C. output from the alternator fail or, if, in the 25 seconds delay, governed by the thermal relay (21), the alternator has not started, the 12 volt battery circuit is completed by the contact arm of the no-volt relay (23) (in the "OFF" position) and delay action relay (22) through the "NO-VOLT" lamp (24). This lamp is fitted above the amplifier panels (see figure z.)

"Ready for Use" Lamp Circuit (Figure o.). When the A.C. output from the alternator is correct the no-volt relay (23) operates and completes the 12 volts battery circuit through the delay action relay (22) and "Ready for Use" lamps (86)(87) in the A.T. boxes.

The heater current for the intermediate amplifier takes approximately 25 seconds to heat the valve filaments to the required temperature. For this reason it is necessary to ensure that the thermal relay (21) is adjusted so that the delay action relay (22) will not operate before the valve filaments are sufficiently heated. If the thermal relay (21) is not correctly adjusted and operates too quickly the "Ready for Use" lamps (86)(87) will light before the set is ready for use.

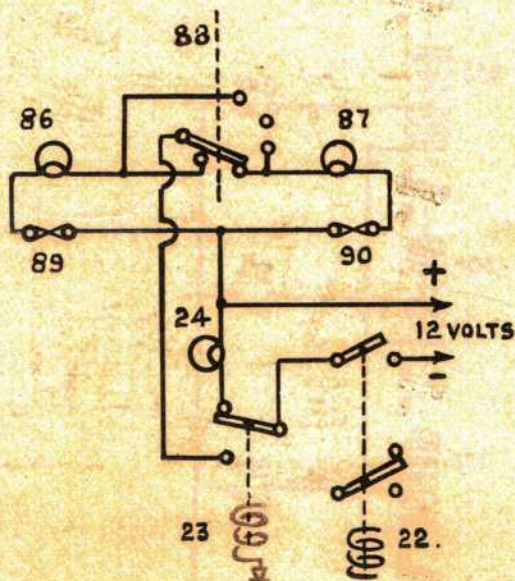


FIG. O

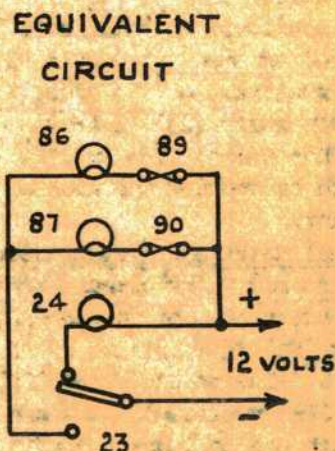


FIG. O a.

Preliminary Call Relay Circuit (Figure p.). The preliminary call relay (93) is used to produce the preliminary call buzzer note (see page V41). The bobbin circuit of the relay (93) is supplied from the 12 volts battery and is operated by depressing and releasing the preliminary call key (82) or (83) in the A.T. box. The relay (93) will remain closed, by the action of a mechanical escapement, for 4 seconds, thus prolonging the call for that time.

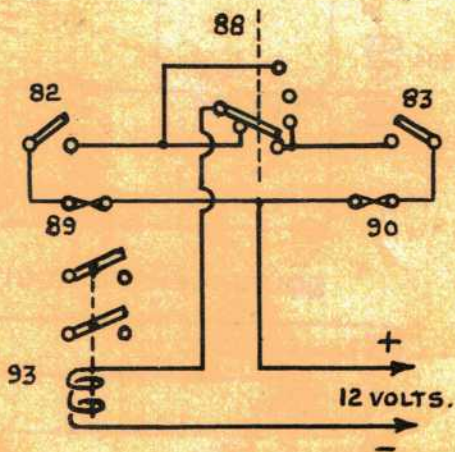


FIG. P.

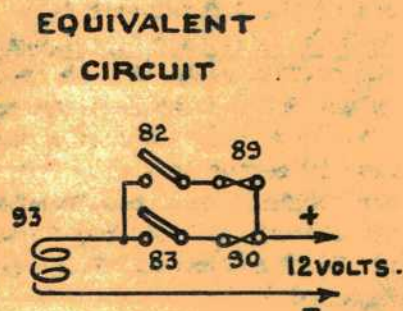


FIG. P a.

TYPE 403 OPERATING CIRCUITS (CONT.)

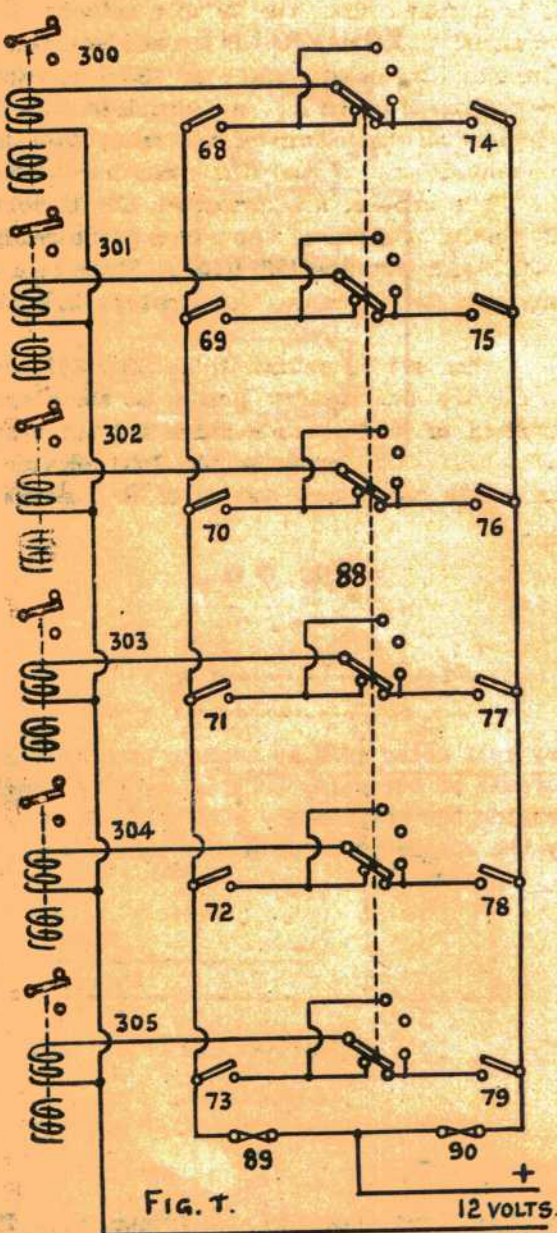
Group Relays Circuit (A.T. box operation) (Figure r.). The group relays (300) to (305) are supplied from the 12 volt battery. Each relay connects one group of loud speakers to the output of its particular power amplifier. (See figure y.)

The circuit through each relay bobbin is completed by its corresponding group selector switch (68) to (73) or (74) to (79) in the A.T. boxes, thus allowing the operator to select a group or groups to whom he desires to transmit (see figure r.).

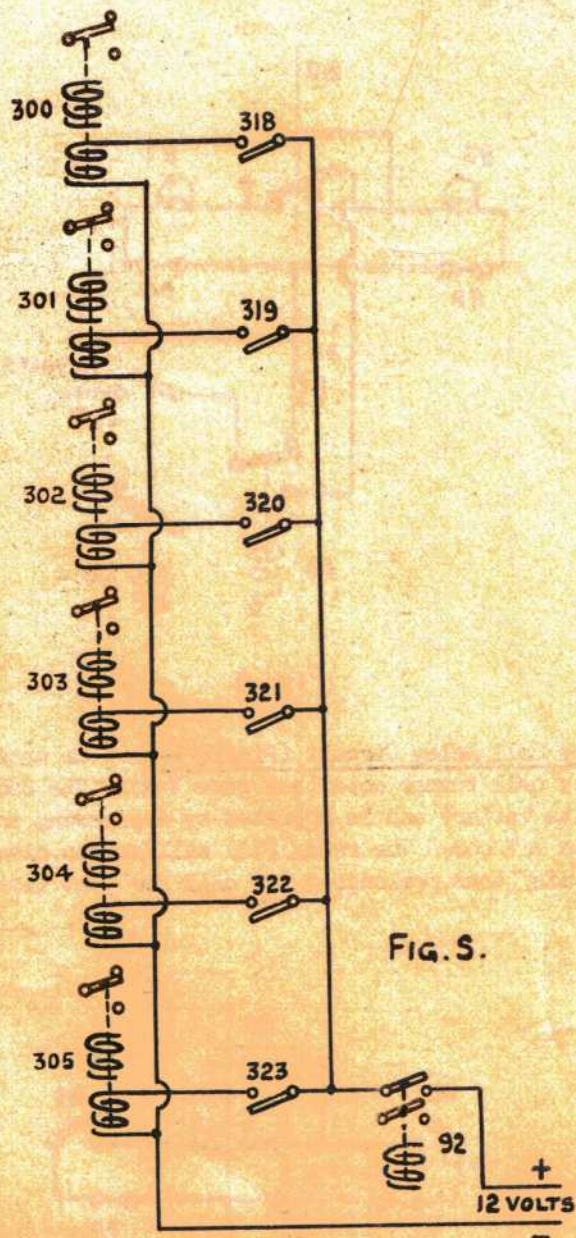
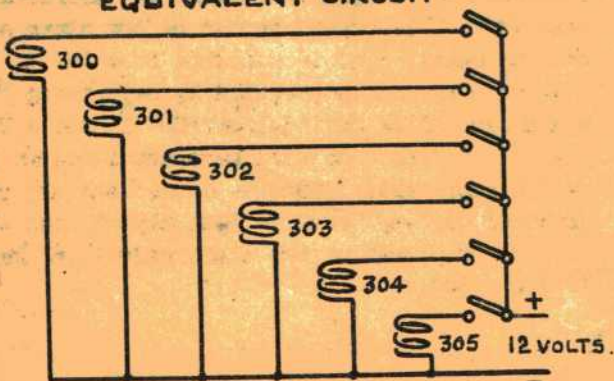
An additional bobbin is fitted to each relay which can be operated from the remote control input unit for local transmissions.

Group Relays Circuit (Local Input Operation) (Figure s.) The additional bobbins on the group relays (300) to (305) are supplied from the 12 volt battery and are operated by push button type local selector switches (318) to (323). These switches are fitted on the remote group control output unit (see figure z.).

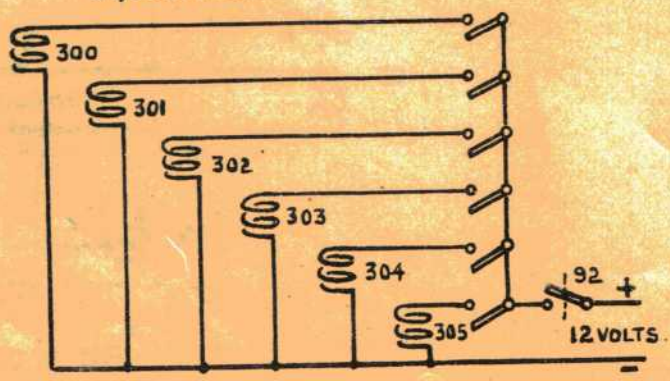
The 12 volt battery supply to the switches (318) to (323) and the bobbins of the group relays is completed by one arm of the local input relay (92).



EQUIVALENT CIRCUIT



EQUIVALENT CIRCUIT



OPERATING CIRCUITS (CONT.)

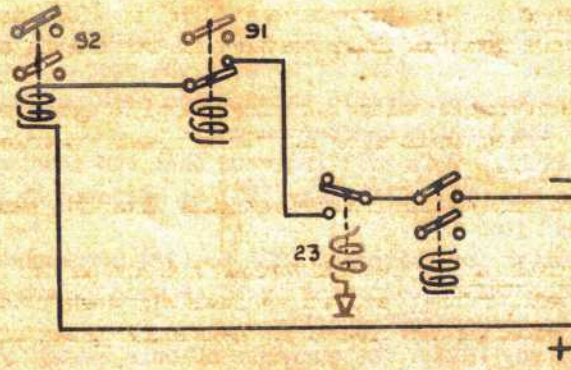


FIG. t.

Local Input Relay Circuit (Figure t.) The bobbin circuit of the local input relay (92) is supplied from the 12 volt battery and is completed by one contact arm of the local input cut-off relay (91) when the latter is in the "OFF" position. When the alternator is started from the A.T. box position the cut off relay (91) closes and breaks the supply to the bobbin of the local input relay (92). The local input circuit and the 12 volt battery supply to the local selector switches are thus cut off and prevented from interfering with any general call or alarm from the A.T. boxes.

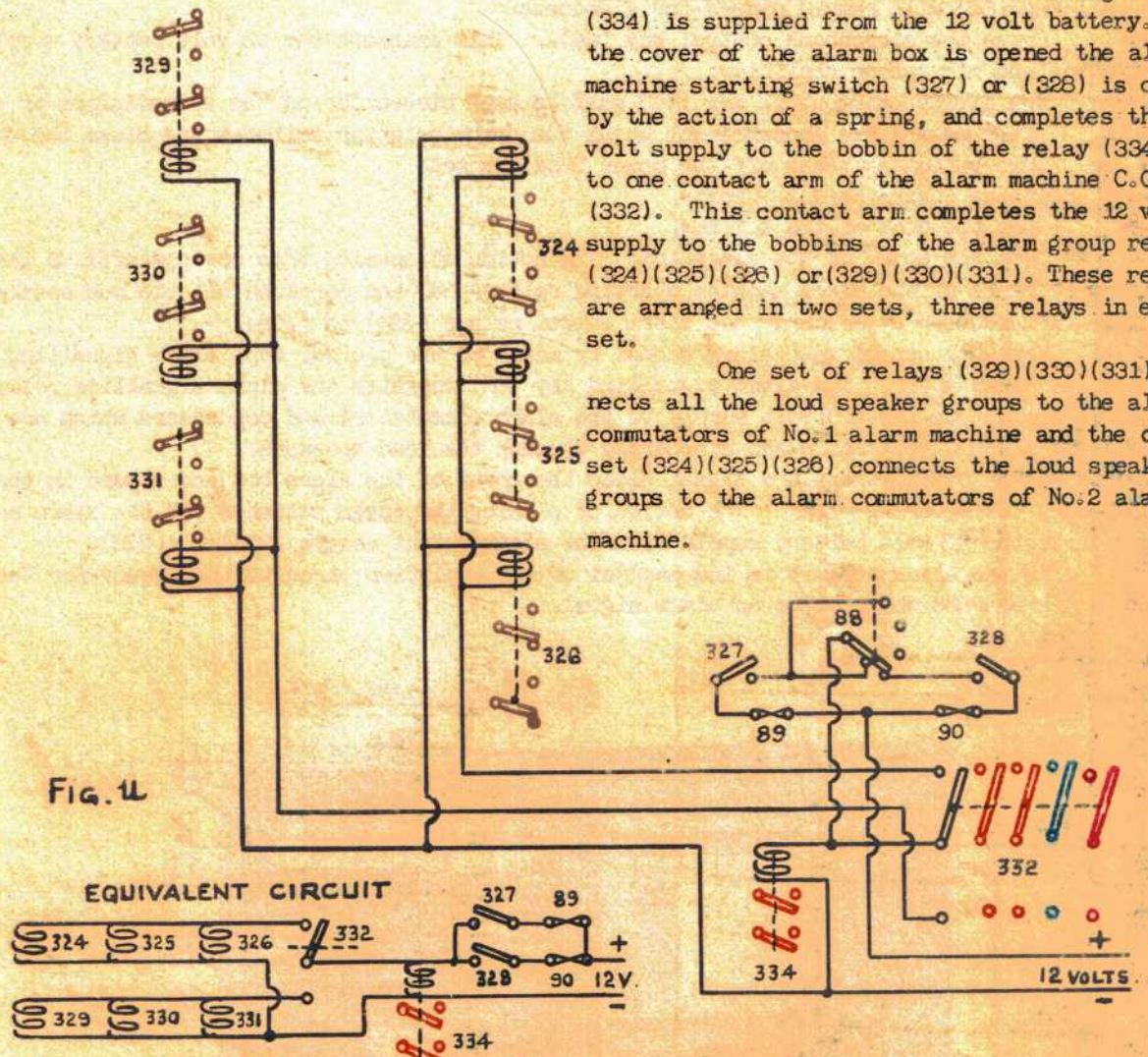


FIG. u.

Alarm Machine Starting Relay Circuit (Figure u.) The bobbin of the alarm machine starting relay (334) is supplied from the 12 volt battery. When the cover of the alarm box is opened the alarm machine starting switch (327) or (328) is closed, by the action of a spring, and completes the 12 volt supply to the bobbin of the relay (334) and to one contact arm of the alarm machine C.O.S. (332). This contact arm completes the 12 volt supply to the bobbins of the alarm group relays (324)(325)(326) or (329)(330)(331). These relays are arranged in two sets, three relays in each set.

One set of relays (329)(330)(331) connects all the loud speaker groups to the alarm commutators of No.1 alarm machine and the other set (324)(325)(326) connects the loud speaker groups to the alarm commutators of No.2 alarm machine.

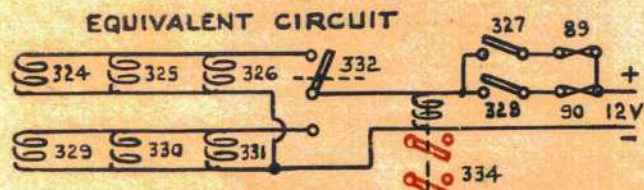


FIG. u a.

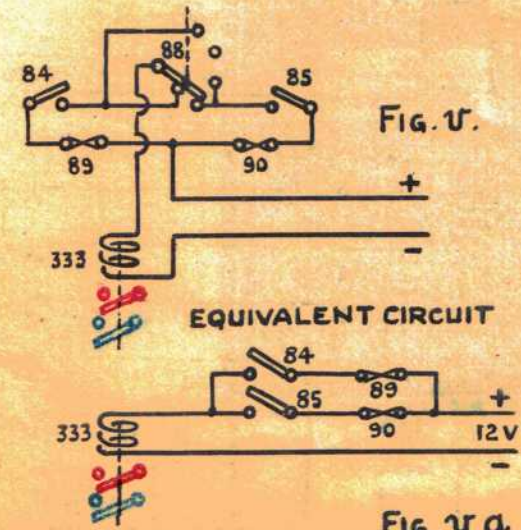


FIG. v.

Alarm Signalling Relay Circuit (Figure v.) The alarm signalling relay connects the 220 volt supply to the alarm commutators as described on page V45. The bobbin circuit of the alarm signalling relay (333) is supplied from the 12 volt battery and is operated by depressing the alarm signalling key (84) or (85) in the A.T. box. The alarm note will be transmitted as long as the alarm relay (333) is closed and any pre-arranged warning, such as "gas alarm", can then be made by operating the alarm signalling key (84) or (85).

FIG. v a.

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OPERATION

Speech Conditions (Using No. 1 A. T. Box).

Open the door of the A. T. Box. If the "Ready for Use" lamp (86) is turning it indicates that the set is in operation from another position. The action of opening the door allows the switch (13) to close. This completes the 12 volt battery circuit through the machine starting relay (20) which connects the 220 volt mains to the machine starter in use.

Wait for the "Ready for Use" lamp to light. This will indicate that the machine has run up to speed and the A. C. supply is correct since the "No-Volt" relay (23) is operated by the A. C. output and, when made, lights the "Ready for Use" lamp (86).

Make the appropriate group selector switch (or switches) (68) to (73) corresponding to the group or groups of loud speakers through which the announcement is to be made. Each switch completes the 12 volt battery circuit through the corresponding relay.

Press and release the preliminary call key (82). The contacts of this switch complete the 12 volt battery circuit through the preliminary call relay (93) which in turn operates the preliminary call buzzer (97). The output from the buzzer (97) is fed into the intermediate amplifier and the call note is reproduced by the loud speakers. By a mechanical escapement the contacts of the call key (82) will remain closed for 4 seconds.

Press the microphone control key (44). This connects the 12 volt battery supply to the microphone and microphone amplifier.

The microphone control key (44) must be kept closed during the transmission of speech.

After making the announcement break the group selector switches and close the door of the A. T. Box. This action switches off the power from the set.

Alarm Conditions (Using No. 1 A. T. Box).

Open the door of the A. T. Box.

Open the cover of the alarm box. The action of opening this cover starts up the alarm machine by means of the alarm machine starting relay (334) and connects all the loud speaker groups to the alarm machine by means of the alarm output relays (324) to (326).

Make the appropriate alarm signal by means of the plunger type alarm signalling key (84) inside the alarm cover. The alarm signalling key (84) operates the alarm signalling relay (333). The latter connects the 220 volt supply to the alarm commutators and condensers which are alternately charged by the 220 volt mains and discharged through the loud speakers.

After making the alarm signal close the cover of the alarm box and secure in the closed position by the securing clip. The action of closing the cover switches off the alarm machine and disconnects the 12 volt battery supply from the alarm output relays (324) to (326).

As the alarm circuit is independent of the amplifier circuits the "Ready for Use" lamp (86) is disregarded when making an alarm signal.

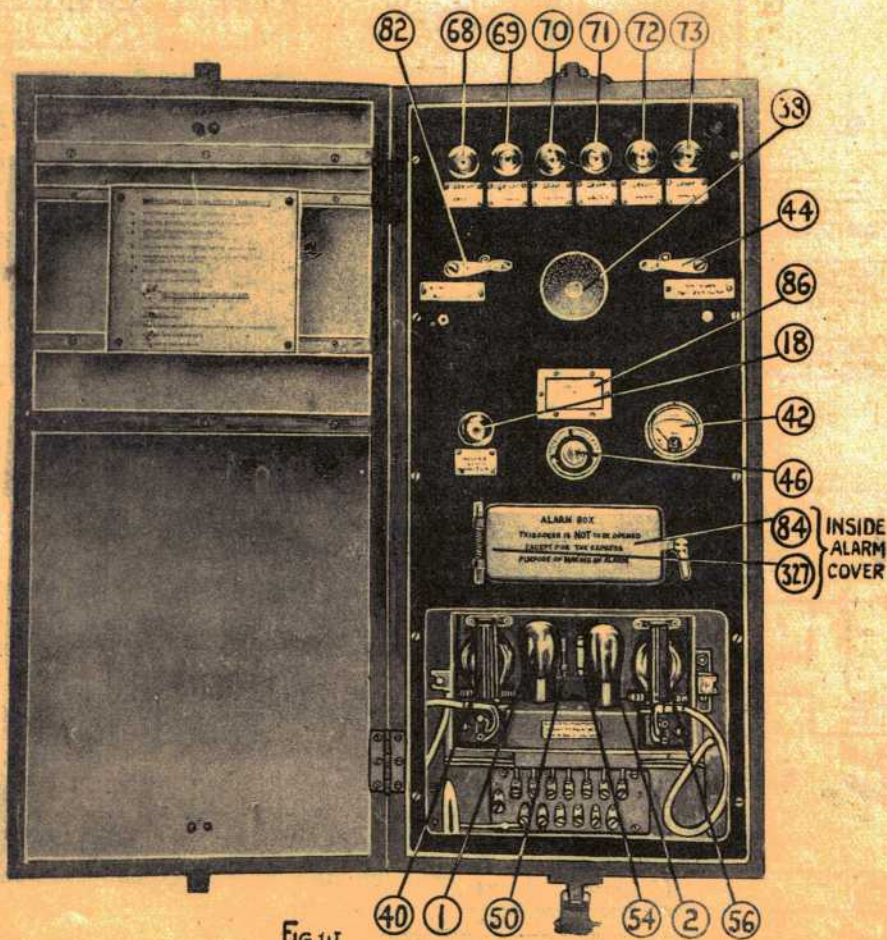
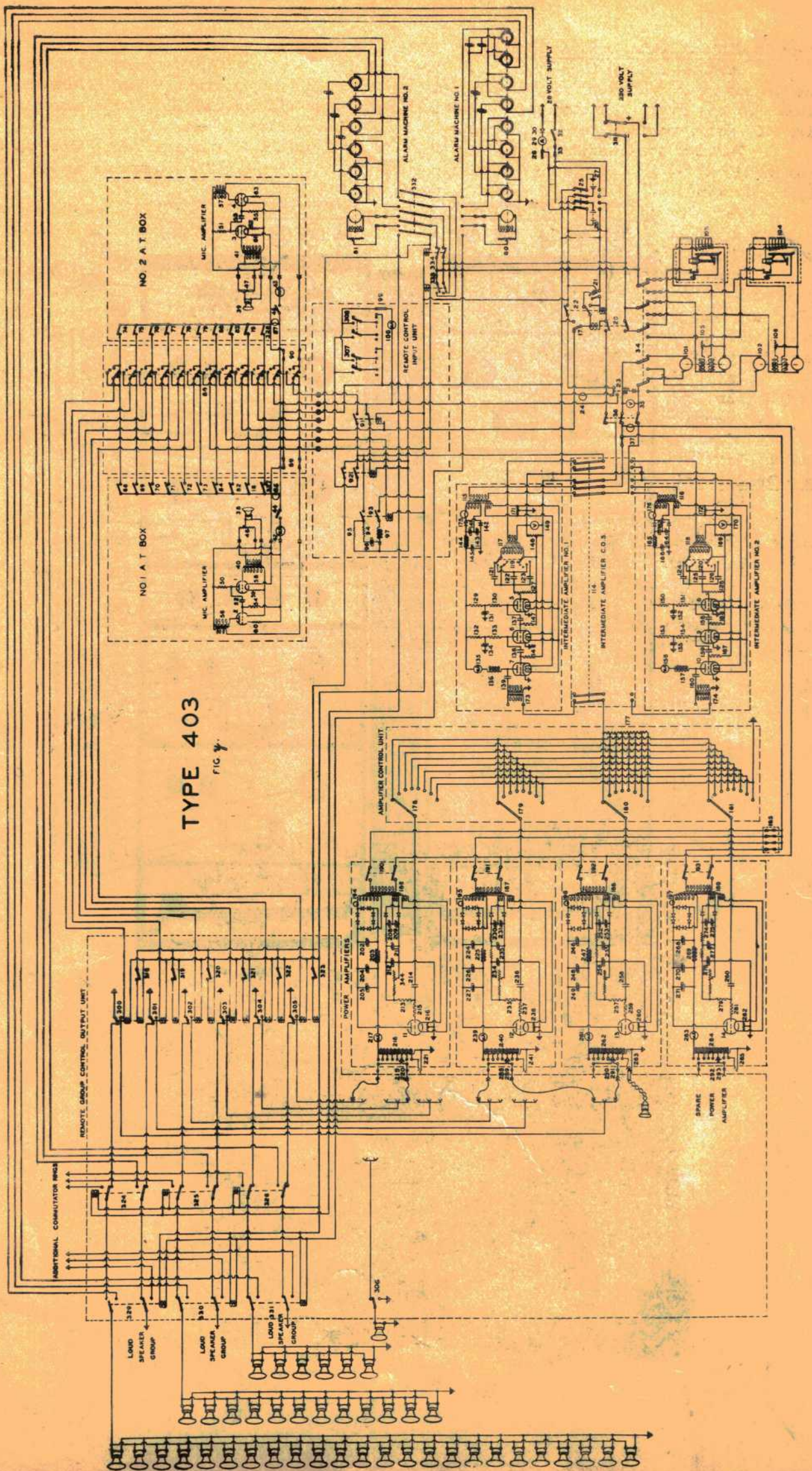


FIG. W



TYPE 403
FIG. 7

