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DESIGN
DATA

DATA COPY

J. DORLEY
PROOF - FOR CHECKING

ADMIRALTY SIGNAL ESTABLISHMENT.

PRELIMINARY NOTES ON

CHAPTER I.

GENERAL DESCRIPTION

1. GENERAL.

D/F Outfit FH3 is an H/F direction finding set which employs a fixed aerial system consisting of two crossed, screened loops (Bellini-Tosi system) used for D/F, and a vertical open aerial terminated at the lower end by a counterpoise used for sense determination. The outfit covers a frequency range of 1-20 Mc/s.

Frame Coil S.25 is employed in this outfit. In a few ships, however, a modified S.17 Frame Coil was fitted before the S.25 became available.

The connection between aerial system and D/F office is made by three identical screened H/F feeder cables.

The principal components in the office of D/F Outfit FH3 are Tuner-Amplifier B21A and Radiogoniometer S.29, together with their associated switches, supplies, etc.

A wiring diagram and details are given in Fig. 1.

2. POWER SUPPLIES.

A mains supply of 230-volts, 50 cycles A.C. is required to operate Tuner-Amplifier B21A. The correct power unit is Patt: 1204B Rectifier Unit, Design 'B'.

The rectifier unit should be fitted with the correct stabilisers (NS2) to supply 195-200 volts H.T.

A separate Patt: 1204B Rectifier Unit must always be used with Tuner-Amplifier B21A, since H.T. negative of the power unit must not be connected to earth ^{either} by the link provided for that purpose, ^{or in any other manner.}

The heater transformer contained in the B21A supplies 6.3 volts for the heater supply.

Internal power supplies are dealt with in detail in Chapter III.
para. 2.

CHAPTER II.FRAME COILS AND SENSE AERIALS.1. FRAME COIL S25.

The loops of Frame Coil S25 are 3-ft. square, each consisting of one turn of rubber-insulated cable enclosed in a metal tube. The ebonite insulator at the top of the loop screens, and all other insulating bushes in the frame coil should be kept clean and **MUST ON NO ACCOUNT BE PAINTED OVER.** A semi-conducting layer over these insulators may result in serious errors in the D/F bearings. The bases of the tubes enclosing the loops ~~are~~^{are} fixed to a transformer box containing the sense aerial transformer, two 1000-ohm phasing resistances and the balancer and trimmer condensers.

The sense aerial consists of a rod mounted vertically above the loops and wire running down vertically inside the loops to the transformer box, and the counterpoise is made up of a square framework constructed in such a manner as to form a pyramid with its apex at the transformer box. The assembly is supported at the four corners by insulating spacer rods.

2. FRAME COIL S17.

The loops of Frame Coil S17 are 4 ft. 6 ins. square and each consists of one turn of rubber-insulated cable wound on ebonite spacers inside a metal tube framework. The four tubes enclosing the frame coil windings are interrupted near the top by moulded ebonite insulators. **THE INSULATORS MUST ON NO ACCOUNT BE PAINTED OVER.** The tubes are mounted on a transformer box, which contains the sense aerial transformer, two 1000-ohm phasing resistances and the balancer and trimmer condensers.

The sense aerial consists of a rod mounted vertically above the loop aerials and a counterpoise made up of four rods mounted equi-distant horizontally on a collar which is clamped to but insulated from, an extension tube on which the frame coil assembly is mounted.

3. THE COUNTERPOISE.

The counterpoise circuits of both S25 and S17 are identical. The counterpoise is connected to earth through a balancing condenser, which is adjusted on installation and should require no further adjustment. This balancing condenser serves to reduce a minimum the pickup by the sense aerial of R/F which may be induced in the mast on top of which the aerial system is fitted.

The sense aerial transformer has an electrostatic screen between the primary and secondary windings. The inductance of the secondary winding is made equal to the inductance of the loop aerial, and a small adjustable condenser connected across the secondary winding is set to equalise the self-capacity of the loop.

This ensures that the apparent impedance of the sense aerial circuit is equal to that of each of the loop circuits, throughout the whole of the frequency band.

A circuit diagram of the aerial system is given in Fig. 2.

4. TRANSMISSION LINE SYSTEM.

The loop aerials and sense aerial circuit terminate in terminal boxes at the base of the frame coil assembly. From this point the loops and sense aerial are led to the D/F office by three Type BAA3RB cables, which terminate at three Patt: W3215 Junction boxes, whence Patt: 5107 cables are run to the B21A receiver. W3125

As all three cables (two loop cables and sense cable) connecting the aerial system to the receiver are of identical length, identical electrical characteristics, and are terminated at each end by identical impedances, the phase shift occurring in each cable is identical, i.e., there is no relative phase shift and amplitude variation is identical along each cable, so the loop to sense aerial signal ratios are the same throughout the whole frequency band.

The requirements as to the matching of these cables are very critical for resonant frequencies, but this difficulty is reduced by shunting resistances fitted in the B21A, which must have the same value within $\pm 1\%$, though they may differ from their nominal value of 300 ohms by $\pm 10\%$.

CHAPTER III.

COMPONENTS AND OPERATION.

1. RADIOGONIOMETER S29. (Figs. 3 and 4).

This instrument has been designed for use on high frequencies and consists of a small rectangular search coil which can be rotated (on a spindle) inside two field windings. The search coil is enclosed in an electrostatic screen consisting of a number of 22 s.w.g. enamelled copper wires wound on two halves of a cylindrical former. Two leads are run inside the spindle to connect the search coil to the slip-rings and brush gear fitted at the bottom of the goniometer.

The field windings are wound on a former which is fitted over the electrostatic screen and are connected to a terminal block on the top of the goniometer. This terminal block is fitted with links which can be removed for isolating aeriels or goniometer field windings as desired during testing operations.

As shown in the photograph, Fig. 4, the slip-ring connections to the search coil consist of two pairs of fine wires maintained in tension by means of adjustable springs. These springs and wires should seldom require attention or adjustment, but if in the course of time it is found that noises are produced in the receiver by imperfect contact at the slip rings, they should be cleaned and lightly oiled and the adjustment of the springs checked. Access to the slip-ring gear is gained by removing the bottom plate of the goniometer.

The goniometer is fitted with a dial bearing indicator, which consists of two scales. One scale is fixed and is marked 0-130 degrees, red and green; the other is a rotating scale, marked from 0-360 degrees, driven by the ship's master gyro compass.

The fixed scale enables relative bearings and the rotating scale true bearings to be read.

The dial bearing indicator is identical with that used on modern H/F goniometers and has fittings for cam correctors. These correctors are not used with H/F and, in consequence are not fitted in this goniometer. The white (cam) pointer is secured so that it reads the same bearing as the black fixed pointer.

A photograph of the dial bearing indicator is given in Fig. 5.
(Note:- The angle dividing mechanism shown is being omitted in present manufacture,).

2. TUNER-AMPLIFIER B21A.

Tuner-Amplifier B21A is a Marconi RG.42 commercial superheterodyne receiver, which has been adapted as a high frequency D/F receiver and modified for use in conjunction with a fixed loop aerial arrangement incorporating a sense aerial and counterpoise and Radiogoniometer S29. The valves used are as follows:-

1st R/F valve	NR64 (1)
2nd R/F valve	NR64 (2)
Frequency Changer valve	6K26 NR32 (3)
1st I/F valve	NR36 (4)
2nd I/F and R.I.S. valve	NR32 (5)
3rd I/F valve	NR36 (6)
2nd Detector and 1st A/F valve.....	NR63 (7)
2nd A/F valve	NR35 (8)
2nd Heterodyne Oscillator valve	NR86 (9)

(Note:- Table I, Chapter IV, for American equivalents).

The receiver consists of two tuned R/F stages, a frequency changer, three stages of I/F amplification, a second detector / A/F amplifier and an output stage. A separate heterodyne oscillator valve is provided for the reception of C.W. signals.

The frequency range of the receiver is from 1 to 20 megacycles. This range is covered in four overlapping frequency bands, selected by means of a range switch which operates a turret containing the R/F and first heterodyne oscillator coils ~~and which also controls the D/F and aerial circuits.~~

Tuning within each frequency band is effected by means of a single tuning control, which operates the four tuning condensers simultaneously. A pointer controlled by the tuning control travels over a scale calibrated in approximate frequencies in Megacycles (Mc/s). This scale is changed by the operation of the range switch, so that an appropriate calibration for the range in use is shown.

Provision is made for the introduction of noise-suppression voltages from Outfit R.I.S.

A method of sense-finding is employed which injects into the search coil circuit, simultaneously with the loop aerial signal, a vertical aerial signal to produce a "cardioid" response curve in place of the "figure-of-eight" obtained when the loops alone are used.

This injection is effected by setting the "Search-D/F-Sense" switch to the "Sense" or "Reversed Sense" position. When this is done, the connections of the loops to the field coils of the radiogoniometer are altered to turn the field produced by the field coils through 90 degrees. This operation produces a cardioid having its maximum and minimum on the bearing to which the radiogoniometer is set, instead of perpendicular to this direction.

When the "Search-D/F-Sense" switch is switched from the "Sense" to the "Reversed Sense" position, the phase of the 'loop' signal is changed through 180 degrees, thus reversing the cardioid, so that by switching from one "Sense" position to the other, the amplitudes of the maximum and minimum of the cardioid may be directly compared.

This sense finding arrangement, which does not need rotation of the search coil, allows rapid sense finding, even when the cardioid obtained is not perfect.

A complete circuit diagram of Tuner-Amplifier B21A is shown in Fig. 6, simplified diagrams of the input circuit in Figs. 7 and 8 and the construction of the model is shown pictorially in Figs. 9, 10, 11 and 12.

Mechanical Construction. The components of the receiver are mounted on a steel chassis, which is fitted on runners in a steel cabinet so that it may be withdrawn for inspection. (See Figs. 13 and 14.)

The filament transformer, a unit containing R/F filters (which are connected in the supply and external telephone leads; and the ~~D/F~~ ~~aerial range switch~~ are mounted in the cabinet.

~~Sense switch for the field coils~~

To withdraw the receiver from the cabinet, it is necessary first of all to remove the cover plate at the bottom left-hand side of the front panel and disconnect the search coil of the radiogoniometer and sense leads from the terminals thus revealed. The search aerial must also be disconnected.

By lifting two catches on the runners, the chassis may be completely withdrawn from the cabinet for inspection of the components on the underside of the chassis.

When replacing the chassis, it is necessary to align the dots on the sleeve and spindle of the Search-D/F-Sense switch (216) before sliding the chassis into the cabinet.

Internal Power Supplies. The 200-volt H.T. supply from the Patt: 1204B Rectifier Unit, Design 'B' passes through an R/F filter consisting of 50-ohm resistances (186)(187) and 0.01 mfd. condensers (188)(189), fitted in the decoupling unit. A 650-ohm resistance (176), fitted in the transformer unit, is connected in the negative lead to reduce the voltage applied to the receiver to 160 volts.

A 300-ohm resistance (161) is connected between the H.T. negative terminal and the earth line in order to provide the grid bias for the valves. This resistance is shunted by a 50-mfd. electrolytic condenser (162).

The H.T. supply to the anodes of the valves is taken from the H.T. positive terminal via the meter shunts (26)(39)(62)(73)(89)(103)(124)(132)(150) respectively. The meter (194) may be connected across these by means of the meter switch (195) to read the anode current of each valve.

The screen grid supplies to the first R/F and frequency changer valves are obtained from a potentiometer consisting of 10,000-ohm and 30,000-ohm resistances (159)(160) connected in series between the H.T. positive terminal and the earth line.

The screen grids of the remaining valves are fed from a potentiometer consisting of a 6,666-ohm resistance (157) and a 10,000-ohm resistance (158) connected in series between the H.T. positive terminal and earth.

The total H.T. voltage applied to the receiver is measured by the meter (194), which is connected across the H.T. supply in series with a resistance (196), when the meter switch (195) is in Position 3.

The grid bias voltage developed across the 300-ohm resistance (161) is applied to a potentiometer consisting of a ~~10,000~~ 10,000-ohm resistance (163), a 7500-ohm resistance (164) and four 1000-ohm resistances (165)(166)(167)(168) connected in series. The junctions of each pair of resistances are connected to earth via 0.1-mfd. condensers (169)(170)(171)(172)(173).

The first R/F, frequency changer and first A/F valves (1)(3)(7) are supplied with fixed grid bias from the junction of resistances (168) and (167), which is approximately 1 volt negative from the earth line.

The second R/F valve (2) and the three I/F valves (4)(5)(6) are supplied with grid bias of between -2 and -13 volts from a variable 50,000-ohm potentiometer connected across the four resistances (163)(164)(165)(166).
(174)

The second A/F valve (8) is supplied with negative grid bias of approximately 9 volts from the junction of resistance (163) and (164).

All the valves used in Tuner-Amplifier B21A are of the 6.3-volt indirectly heated type.

The heater current is derived from the secondary winding of a 230/6-volt transformer (177) fitted in the receiver cabinet. One side of the heater wiring is earthed. The two windings of the transformer are separated by an earthed screen.

The primary winding of the transformer is shunted by C.2-mfd. condensers (178)(179), with the centre-point earthed. The 230-volt supply, which is controlled by the A.C. supply switch of the Patt:1204B Rectifier Unit, is fed to the transformer through an R/F filter consisting

of chokes (182)(183) and condensers (184)(185) fitted in the decoupling unit.

Two 6-volt lamps (197)(198) are wired in parallel across the heater supply and serve to illuminate the calibration scale.

Oscillatory Circuits. The circuit diagram of Tuner-Amplifier B21A is shown in Fig. 6. It will be seen that there are three tuned R/F circuits and seven tuned I/F circuits.

The frequency range of 1 to 20 Mc/s is covered in four bands by bringing appropriate sets of coils into circuit in the R/F stages. This is effected by means of the range switch, which rotates a turret containing the coils so as to bring the coil contacts on the turret into contact with those fitted on the chassis. The ranges are as follows:-

<u>Switch Position.</u>	<u>Frequency Range.</u>
I	1 - 2 Mc/s.
II	2 - 4.4 Mc/s.
III	4.4 - 10 Mc/s.
IV	10 - 20 Mc/s.

Overlaps between the ranges are, of course, provided.

D/F Aerial Circuits. The loop aerials (214)(215) consist of shielded loops and are connected through shielded, twin cables and the "Search-D/F-Sense" switch (216) to the field coils of the radiogoniometer (217). At the receiver, the cables are shunted by 300-ohm resistances (218)(219).

The search coil of the radiogoniometer is connected to the input transformer primary winding (15) of the receiver either direct or via the split secondary winding of the sense input transformer (212), according to the setting of the "Search-D/F-Sense" switch (216). In both the "Sense" positions of the switch the search coil is shunted by an inductance coil (220) in order to reduce the amplitude of the loop signal to equality with that from the sense aerial.

The inductance coil (220) has six separate windings, giving a suitable range of inductances. Increasing the inductance increases the loop signal. For the S25 loop aerial assembly the inductance marked '4' is used.

Insertion of the shunt coil and secondary winding of the sense input transformer in the search coil circuit reduces the apparent self-capacity of the search coil circuit, this in turn altering the tuning of the input circuit for frequencies above 10 Mc/s. This is compensated for by an adjustable condenser (221) (set to about 20-mmfd.) connected across the input transformer primary winding (15).

Search Aerial Circuit. Switching arrangements for a search aerial are provided, but in general this aerial will not be fitted.

The aerial is connected to earth through a 1-megohm protecting resistance (11) and, when the "Search-D/F-Sense" switch (216) is set in the "Search" position, to the input tuned circuit of the receiver via the differential condenser (12) and fixed condenser (13).

Search-D/F-Sense Switch Circuits. The "Search-D/F-Sense" switch (216) has four positions, the circuit conditions given by each being as follows:-

<u>Position</u>	<u>Condition.</u>
Search	Search aerial connected to input, otherwise as for "D/F".
D/F	Loop Aerials (213)(214) connected normally to corresponding field coils of radio-goniometer (217). Conio. search coil direct to receiver input transformer primary. (See Fig. 7).
Sense.	Loop aerials connected to field coils are switched 90° anticlockwise, referring to the goniometer dial (i.e., F terminal of loops connected to S terminal of field coils, S to A, A to P and P to F). Secondary of sense input transformer (212) shunting coil (220) and balancing condenser (221) inserted in the search coil circuit. (See Fig. 8).
Reversed Sense.	As for "Sense", but search coil leads reversed. (See Fig. 8).

First R/F Stage. The first R/F stage of the receiver employs an NR64 indirectly heated pentode valve (1), with tuned grid and transformer coupled anode circuits.

The input to the grid of the valve is taken from the tuned circuit, consisting of the secondary winding (16) of the input transformer, a tuning condenser (17) of maximum capacity 225-mmfd., (which is one section of a 4-ganged condenser) and an adjustable trimming condenser (13), via a 100 mmfd. condenser (19). The first stage trimming condenser (13) is provided to allow small misganging effects due to the search coil inputs to be eliminated.

The grid of the valve is connected to the grid bias supply line through a 500,000-ohm grid leak resistance (20) and 50,000-ohm decoupling resistance (21). The junction of these two resistances is connected to earth by a 0.01-mfd. condenser (22).

The R/F output of the valve is fed to the grid of the second R/F valve through the R/F transformer (23)(29). The H.T. supply to the anode of the valve (1) is taken from the H.T. supply line through the meter shunt resistance (26), 5000-ohm anode decoupling resistance (25) and transformer primary winding (23). The H.T. end of the transformer winding is decoupled to earth via a 0.01-mfd. condenser (24).

The screen grid of the valve is connected to earth via a 0.01-mfd. condenser (23) and to the screen grid supply line through a 5000-ohm resistance (27). The suppressor grid and cathode are connected to earth.

Second R/F Stage. The Second R/F stage also employs an NR64 valve (2) with tuned grid and transformer-coupled anode circuits.

The input to the grid of the valve (2) is taken from the tuned circuit, consisting of the secondary winding (29) of the R/F transformer (23)(29), a preset trimmer (31) and tuning condenser of a maximum capacity of 255-mmfd. (30), via a 100-mmfd. condenser (32).

The grid is connected to the grid bias supply through a 500,000-ohm grid leak resistance (33) and 50,000-ohm decoupling resistance (34). The junction of these two resistances is connected to earth via a 0.01-mfd. condenser (35).

The R/F output from the valve is fed to the grid of the frequency changer valve (3) by the R/F transformer (36)(42). The H.T.

supply to the anode of the valve (2) is taken from the H.T. supply line through the meter shunt resistance (39), 5000-ohm decoupling resistance (38) and R/F transformer primary winding (36). The H.T. end of the transformer winding is decoupled to earth by a 0.01-mfd. condenser (37).

The screen grid of the valve is connected to earth via a 0.01-mfd. condenser (41) and to the screen grid supply line through a 5000-ohm resistance (40). The suppressor grid and cathode are connected to earth.

6K8G Frequency Changer Stage. The frequency changer stage employs an ~~NR32~~ triode-hexode valve (3), the triode portion of which acts as the first heterodyne oscillator.

The signal grid of the hexode portion of the valve is connected through a 100-mmfd. condenser (45) to the tuned circuit, which consists of the secondary winding (42) of the transformer (36)(42), a 255-mmfd. tuning condenser (43) and preset trimming condenser (44).

The anode of the hexode section of the valve is connected to the H.T. supply line through the primary winding (59) of the R/F transformer (59)(65), 5000-ohm decoupling resistance (61) and meter shunt (62). The H.T. end of the transformer winding is decoupled to earth by a 0.1-mfd. condenser (60).

The screen grid of the hexode section is connected to earth via a 0.01-mfd. condenser (64) and to the screen grid supply line through a 5000-ohm resistance (63).

130-150 The injector grid of the hexode section is internally connected to the grid of the triode section, which is in turn connected through a 25-ohm anti-parasitic resistance (55) and 100-mmfd. condenser (54) to the oscillator tuned circuit and to earth through a 50,000-ohm grid leak resistance (56).

The tuned circuit consists of the grid circuit inductance (50), a tuning condenser (51) of a maximum capacity 225 mmfd., trimming condenser (52) and padding condenser (53). On ranges II and IV only, a resistance (199) having values of 10,000 ohms and 5000 ohms respectively is shunted across the tuned circuit.

The anode of the triode section is connected to the H.T. supply line through the anode circuit inductance (49), which is coupled to the grid circuit inductance (50), and a 5000-ohm resistance (58). The H.T. end of the anode circuit inductance is decoupled to earth by a 0.01-mfd. condenser (57).

The cathode of the valve is connected to the earth line.

First I/F Stage. The first I/F stage employs an NR36 pentode valve (4), with grid and anode circuits tuned to the intermediate frequency of 600 kc/s.

The grid of the valve is connected to a tuned circuit, consisting of the secondary winding (65) of the R/F. transformer (59)(65) and a 500-mmfd. condenser (66). The other end of the tuned circuit is connected to earth via a 0.01-mfd. condenser (68) and to the grid bias supply line through a 500,000-ohm resistance (67).

The anode of the valve is connected to the H.T. supply line through the anode circuit tuned inductance (69), which is tuned by a 500-mmfd. condenser (70), a 5000-ohm resistance (72) and meter shunt (73). The H.T. end of the tuned circuit is decoupled to earth by a 0.1-mfd. condenser (71).

The screen grid of the valve is connected to the screen grid supply line through a 5000-ohm resistance (74) and to earth via a 0.1-mfd. condenser (75).

The suppressor grid and cathode are connected to earth.

Second I/F and R.I.S. Stage. The second I/F stage is also used for the introduction of noise suppression voltages from Outfit R.I.S. An NR32 triode-hexode valve (5) is employed, the grid and anode of the triode section being strapped and used as an injection grid for the suppression voltages.

The I/F signals are applied to the signal grid of the valve from the tuned circuit consisting of an inductance (76), coupling coil (77) and 500-mmfd. condenser (78). The bottom end of the tuned circuit is connected to earth via a 0.01-mfd. condenser (80) and to the grid bias supply line through a 500,000-ohm resistance (79).

The anode of the valve is connected to the H.T. supply line through the anode tuned circuit inductance (85), which is shunted by a 500-mmfd. condenser (86), a 5000-ohm resistance (88) and meter shunt (89). The H.T. end of the tuned circuit is decoupled to earth by a 0.1-mfd. condenser (87).

The injector grid of the valve is internally connected to the grid of the triode section, which is strapped to the triode anode and connected ~~to earth through a 500,000-ohm resistance (84)~~ and to the slider of the Suppressor Control 100,000-ohm potentiometer (82) ~~via a 0.01-mfd. condenser (87)~~. The R.I.S. pulses are applied to the potentiometer (82) via a jack (81) into which the lead from Outfit R.I.S. is plugged.

The screen grid of the valve is connected to the screen grid supply line through a 5000-ohm resistance (90) and to earth via a 0.1-mfd. condenser (91).

The cathode of the valve is connected to earth.

Third I/F Stage. This stage employs an NR36 pentode valve (6) with tuned grid and anode circuits.

The grid of the valve is connected to the tuned circuit, consisting of an inductance (92), coupling coil (93) and 500-mmfd. condenser (94). The bottom end of the tuned circuit is connected to earth via a 0.01-mfd. condenser (96) and to the grid bias supply line through a 500,000-ohm resistance (95).

The anode of the valve is connected to the H.T. supply through the anode tuned circuit inductance (97) and coupling coil (98), which are tuned by a 500-mmfd. condenser (99) and shunted by a 100,000-ohm resistance (100), a 5000-ohm resistance (102) and meter shunt (103). The H.T. end of the tuned circuit is decoupled to earth by a 0.1-mfd. condenser (101).

The screen grid of the valve is connected to the screen grid supply line through a 5000-ohm resistance (104) and to earth via a 0.1-mfd. condenser (105).

The suppressor grid and cathode of the valve are connected to earth.

Second Detector and First A/F Stage. This stage employs an NR63 Double-diode-triode valve (7) of which one diode only is used.

The I/F signals are applied to the diode anode from a tuned circuit consisting of an inductance (106) tuned by a 500-mmfd. condenser (107) and shunted by a 100,000-ohm resistance (108). The bottom end of the tuned circuit is connected to earth through a filter circuit, consisting of 50,000-ohm resistances (109)(110) and 50-mmfd. condensers (112)(113)(114), and a 500,000-ohm resistance (111).

The grid of the triode is fed from the top of the resistance (111) via a 0.0005-mfd. condenser (115) and is connected to the grid bias supply line through a 2 megohm grid leak resistance (116) and ¹⁰⁰50,000-ohm decoupling resistance (117). The junction of these two resistances is decoupled to earth by a 0.1-mfd. condenser (118).

The anode of the triode is connected to earth via a 500-mmfd. R/F by-pass condenser (119) and to the H.T. supply line through a 3000-ohm load resistance (122), 50,000-ohm decoupling resistance (123) and meter shunt (124). The inter-valve transformer (121) is shunt-fed via a 0.2-mfd. condenser (120). The H.T. supply is decoupled by a 1-mfd. condenser (125).

The cathode and unused diode anode are connected to earth.

Second A/F (Output) Stage. The second A/F amplifier stage employs an NR85 critical distance tetrode valve (8).

The grid of the valve is fed from the secondary winding of the inter-valve transformer (121), the bottom end of which is connected to the grid bias supply through a 50,000-ohm resistance (126) and decoupled to earth by a 0.1-mfd. condenser (127).

The anode of the valve is connected to the H.T. supply through the primary winding of the 10:1 output transformer (128) which is shunted by a 0.001-mfd. condenser (129) and 50,000-ohm resistance (130), a 2000-ohm decoupling resistance (131) and meter shunt (132). The screen grid of the valve is also fed through the resistance (131) and is connected to earth via a 4-mfd. condenser (133).

The A/F output is taken from the secondary winding of the transformer (128) through 1000-ohm resistance (135)(136) to two telephone jacks (134)(134A). A potentiometer consisting of a 200-ohm resistance (137) and a 50-ohm resistance (138) is also connected across the transformer secondary and supplies the "External Phones" terminals through an R/F filter fitted in the decoupling unit and consisting of R/F chokes (190)(191) and 0.001-mfd. condensers (192)(193).

Heterodyne Oscillator Stage. The heterodyne oscillator stage employs an NR86 pentode valve (9). A tuned circuit, tuned to approximately 601 kc/s., is connected between grid and earth. The cathode of the valve is connected to a tapping on the tuned circuit inductance to provide the necessary feed-back for self-oscillation.

The tuned circuit consists of a tapped inductance (139) shunted by a 0.0005-mfd. condenser (140), a trimming condenser (141) and a 25,000-ohm. resistance (142).

¹⁰⁰ The grid of the valve is connected to the tuned circuit via a 50-mmfd. condenser (144), which is shunted by a ~~100,000~~ ^{50,000} ohm grid leak resistance (143).

The output from the oscillator is taken from the anode of the valve through a 5-mmfd. condenser (147) to the second detector diode anode in valve (7)

By-passed ~~screen~~ through a 50 mfd condenser and

The anode of the oscillator valve (9) is connected to the H.T. supply line through a 30,000-ohm resistance (145), 1000-ohm decoupling resistance (148), the C.W.-I.C.W. switch (151) and meter shunt (150).

The junction of the anode load resistance (145) and decoupling resistance (148) is connected to earth via a 0.01-mfd. condenser (153) and to the screen grid of the valve through a 30,000-ohm resistance (149). The screen grid is decoupled to earth by a ~~0.01~~ ^{0.1} mfd. condenser (154).

The suppressor grid of the valve is connected to the cathode.

The unearthed side of the heater supply has a filter, consisting of an R/F choke (155) and a 0.01-mfd. condenser (156) connected in it to prevent any R/F voltage from passing to other valves via the heater leads. The oscillator components as a whole are also carefully screened.

When the detector stage is switched off, a bleeder resistor (152) of 50,000 ohms is switched into circuit to compensate for the change in H.T. consumption.

Output Meter. The Meter (194) which reads the H.T. voltage and valve anode currents may also be used as an output meter, to facilitate the tuning of the receiver.

When the meter switch (195) is set to Position '2' the meter is connected to the output from a full-wave bridge-connected metal rectifier (203), the input to which is taken from the secondary winding of the output transformer (123).

As the receiver is not fitted with A.V.C. the reading of the output meter will vary with the signal strength in the output circuit, i.e., with the tuning position of the receiver, the maximum reading being given when the receiver is correctly tuned to a station.

3. GENERAL OPERATION AND TUNING.

To use Tuner-Amplifier B21A the following procedure should be adopted:-

- (i) Make the A.C. supply switch on the Rectifier Unit, Design 'B'. The lamps illuminating the calibration dial should now light.
- (ii) Set Meter Switch (195) to Position 3 and check H.T. voltage, which should be about 160 volts.
- (iii) Check the anode currents of the valves which should be as shown in Table I.
- (iv) Set the "Search-D/F-Sense" switch (216) to the "Search" position if a search aerial is fitted, or to the "D/F" position when a search aerial is not fitted.
- (v) Set the range switch (15) to the required frequency range.
- (vi) Set the calibration pointer to the required frequency on the scale.
- (vii) Set the gain control (174) to approximately three-quarters of its travel.

Note:- A very strong signal may overload the second detector stage. The control should therefore be set, once the signal is picked up, to the minimum setting which gives a good, readable signal.

(viii) Set the C.W.-I.C.W. switch (151) to "C.W.".

(ix) Tune the set slightly either side of the expected tuning position until the desired signal is heard.

Note:- Tuning may be facilitated by setting the meter switch (195) to position '2', which connects the A/F output through a metal rectifier to act as an output meter. As there is no A.V.C. in this receiver the output will be a maximum when a signal is correctly tuned in.

(x) If the signals being received are I.C.W., the C.W.-I.C.W. switch (151) should now be set to "I.C.W.".

- (xi) If Outfit RIS is in use, the Suppressor Control (82) should now be adjusted until the interfering signals are suppressed.
- (xii) In certain cases when in the "Search" position of switch (216) a strong local signal is causing overloading of the early stages of the receiver, the Input Control (12), which is located behind a cover plate on the front panel, may be reduced from its normal maximum setting.

4. METHOD OF TAKING A BEARING AND SENSE FINDING.

With the receiver tuned as described in para. 3 above, the sequence of operations for taking a bearing and sense finding are:-

- (a) Set the "Search-D/F-Sense switch (216) to "D/F" and rotate the radiogoniometer until the signal is a minimum. This is the D/F bearing or its reciprocal.
- (b) With the radiogoniometer in the minimum position, set the "Search-D/F-Sense" switch (216) to "Sense" and "Reversed Sense" and compare the signal strength.

If the weaker signal is obtained in the "Sense" position the bearing on the radiogoniometer is the actual bearing of the signal; if the "Reversed Sense" position gives the weaker signal the actual bearing is the reciprocal of that on the radiogoniometer.

The 90° rotation of the field in the radiogoniometer produced when the "Search-D/F-Sense" switch (216) is set to the "Sense" position gives a 'Figure-of-8' response curve having a maximum on the bearing of the transmission being received, instead of the minimum obtained by the normal D/F process, and this, in conjunction with the circular response curve from the sense aerial, gives a cardioid with its minimum at the bearing of the radiogoniometer. (See Fig. 15).

Owing to the reversal of the search coil leads, the cardioid obtained when the switch (216) is in the "Reversed Sense" position has its minimum at the reciprocal of the bearing of the radiogoniometer.

Thus, when a bearing has been obtained with the switch (216) in the "D/F" position, the sense of the signal may rapidly be determined by putting the switch first to "Sense" and then to "Reversed Sense" without moving the search coil.

On some frequencies, due to re-radiation from ship's structure the behaviour of the sensefinder may be reversed or uncertain. In this case it will be clearly indicated on the calibration chart by the words "Sense Reversed" or "Sense Uncertain" respectively.

H/F calibration is strongly affected by alteration of ship's aerial and rigging. Correct H/F D/F can only be expected if rigging and aerials remain as they were during calibration.

5. OBTAINING TRUE BEARING. (Fig. 15).

- (a) For Ships fitted with a Gyro Compass. When the search coil is in the minimum position, the reading must be taken on both inner and outer goniometer scales, the former giving the relative bearing and the latter the gyro bearing - both uncorrected. The relative D/F bearing is necessary for determination of correction.

Read off the value and sign of correction from the appropriate part, either green or red, of the calibration curve for that particular frequency.

This correction must be added to or subtracted from the uncorrected gyro D/F bearing (according to sign of correction). The result gives the true bearing of the transmitter within the estimated accuracy stated in the calibration report.

- (b) For Ships without a Gyro Compass. When the search coil is in the minimum position, the reading must be taken only on the inner scale. Simultaneously, a compass reading must be taken on the Bridge. Read off the value and sign of correction from the appropriate part - red or green - of the calibration curve provided for that particular frequency. Add to or subtract the correction from the uncorrected bearing. Communicate this reading to the bridge to calculate the True Bearing.
- (c) Correction for an Irregular Part of a Calibration Curve. On some frequencies the calibration curve may be very steep in places, or may even reverse in direction. In such places the complicated part of the real calibration curve is replaced by simplified dotted lines (not to be confused with the blurring curve, which is also dotted) and the correction is to be read from this line. This correction gives the least probable error in bearing. The accuracy of these sectors of relative bearings is much reduced; it may be $\pm 10^\circ$ to $\pm 30^\circ$, depending upon the size of the 'kink' in the curve. Bearings in the region of the bow and stern are normally subject to smaller deviations and errors than those taken on the beam.
- (d) Correction for an Uncalibrated Frequency. In such cases the approximate correction can be obtained by interpolation from the appropriate curves for neighbouring frequencies. The results will not be accurate, however, since the shape of the calibration curves varies rapidly from frequency to frequency and calibration on the actual frequency required should always be carried out if practicable.
- (e) Blurring Curve. Blurring is measured as the smallest angle on either side of the minimum which will give an appreciable increase of signal intensity. This is plotted on the calibration chart as a function of the relative D/F bearing. If the observed blurring exceeds this value greatly, the presence of sky wave is indicated and the observed transmitter is probably at a considerable distance.

Fig. 16 is a diagram illustrating True and Relative Bearings.

Note:- Ascertain, before setting D/F watch, that the ship's rig is in the normal condition stated in the calibration report, aerials properly connected and (for Merchant ships) derriks are in stowed positions with topping lifts lowered.

CHAPTER IV.

MAINTENANCE AND TESTING.

1. READJUSTMENT OF SECOND HETERODYNE OSCILLATOR.

This operation should be carried out only by a responsible rating.

When a C.W. station is tuned in at maximum signal strength it may be found that the best obtained from the second heterodyne oscillator is not of the desired frequency. If this occurs, the following procedure should be adopted:-

- (a) Slide the chassis forward on its runners, first undoing four screws on terminal block (search coil of radiogoniometer and sense leads) and remove the search aerial lead.
- (b) Place the search aerial lead, or other conductor as temporary aerial (reaching outside screened office), near the first R/F valve.
- (c) Tune in a strong signal, having C.W.-I.C.W. switch (151) in "I.C.W." position, preferably near the 1 Mc/s end of the frequency range.
- (d) Switch C.W.-I.C.W. switch (151) to "C.W." position and adjust the tuning control (141) of the second heterodyne oscillator until the desired beat frequency is obtained, relocking the control carefully when the correct position has been found.
- (e) Replace the chassis in the cabinet and re-connect the search aerial, radiogoniometer and sense leads.

2. REPLACEMENT OF VALVES BY AMERICAN EQUIVALENTS.

It is possible to replace the NR valves in the receiver by American types in case of emergency. The American type number for each valve is given in Table I.

It will be found that there is a certain loss of sensitivity when American valves are substituted for the NR types.

TABLE I.

Valve	Type	Anode Current mA.	American Equivalent.
1st R/F	NR64	6 - 7	6K7G
2nd R/F	NR64	* 3 - 4	6K7G
Frequency Changer	NR82 6K8G	0.5 - 1	6K8G
1st I/F	NR86	* 3 - 4	6K7G
2nd I/F and RIS	NR82	* 2	6K8G
3rd I/F	NR86	* 3 - 4	6K7G
2nd Detector and 1st A/F	NR68	0.5 - 1	6Q7G
2nd A/F	NR85	* 8-13 †	6F6G
2nd Heterodyne Oscillator.	NR86	4 - 5	6K7G

* These currents should be read at maximum gain control.

† Multiply readings on meter by 3 to get this current readings.

3. ROUTINE TESTS.

(a) Aerial System. The following tests should be carried out every week or more frequently in bad weather.

(i) Test for insulation resistance (using bridge megger). This should be more than 1 megohm for each loop.

(ii) Test continuity resistance of each loop. This should be less than 0.5 ohms for all positions of the ~~input control~~ and the difference between port and starboard and fore and aft should not exceed 10%. In the case of discontinuity in the loops or feeders this value will be 300 ohms which is the value of the parallel resistance inside the receiver.

Note:- The above tests may be carried out by opening the cover of the goniometer terminal box after unscrewing one of the links in each field coil circuit.

(iii) Test sense aerial circuit by opening cover of terminals on the bottom left-hand side of the receiver panel and pull forward receiver chassis to break circuits. The two upper terminals belong to the sense feeder. Insulation resistance to earth must not be less than 5 megohms. Measure the resistance of the sense feeder across the upper terminals attached to the box of the receiver. This value must be less than 0.5 ohms; then measure the resistance across sense input terminals and this should not be greater than 0.5 ohms.

Note:- The sense aerial system must not be painted, nor must the top junction box of the frame coil where the loaded ebonite spacers are inserted. The S₁ counterpoise system below the frame coil may be painted, with the exception of the ring support and ebonite or wooden insulating blocks.

(b) Radiogoniometer. The following tests should be carried out periodically as stated.

(i) From the goniometer terminal box, measure the resistance of the field coils. This value should be 0.1 ohm. Continuity resistance of both windings should be appreciably the same (within 5%). This test should be carried out every two weeks.

(ii) Check the alignment on radiogoniometer using receiver with switch (216) in "D/F" position on any convenient station. Disconnect the links in Goniometer on fore and aft coil and check zeros at 90° GREEN and 90° RED. Repeat on port and starboard loop to give zeros at 0° and 180°. This test should be carried out every two weeks.

(iii) At the commencement of each watch check gyro repeater scale with bridge.

(c) Tuner-Amplifier B21A. The following tests to the receiver should be carried out as stated:-

(i) Check reception on I.C.W. and C.W. on all four ranges of the receiver. (If it is necessary to withdraw the receiver from its casing, care should be taken that the contacts on the coil drum are not damaged. Sliding contacts should be cleaned with petrol and no abrasive materials should be used). This test should be carried out weekly.

- (ii) Check sense on the known control station using the frequency in use for that hour. No adjustments to the controls of the sensefinder should be made without expert assistance. This test should be carried out at every opportunity at least once every week. *and not less frequently than*

Note:- It may be found that on Range 4, (10 to 20 Mc/s) the mixer valve may easily cease to oscillate. The results of this are:-

- (a) No signal can be picked up.
- (b) Mixer valve current as indicated by meter, increases to about two milliamps.

The possible causes are :-

- (a) Dirty contacts on the coil turret.
- (b) Insufficient heater voltage.
- (c) Low emission in mixer valve.

Note:- Regular disconnecting of the feeder terminals can cause trouble due to breaking of the conductors or insufficiently tight connections. Removing the chassis avoids the possibility of any harm being done to the circuits.

4. CALIBRATION.

D/F Calibration should be carried out in new ships after completion and in existing ships:-

- (a) When a new D/F outfit is fitted
- (b) If the position of the frame coil is changed.
- (c) If any alteration to the ship's structure in the vicinity of the frame coil is made.

Check calibrations should be carried out at intervals not exceeding ~~12~~ 4 months.

When the D/F set requires calibration, application should be made to the Senior Officer present. Full D/F calibrating facilities exist at the following ports:-

Scapa, Greenock, Liverpool, Barrow, Humber, Portsmouth and Devonport.

Special calibrating vessels are stationed at these ports and Admiralty Signal Establishment officers carry out the calibration.

An interim report of the calibration will be prepared and left in the ship by the calibrating officers for use until the official report is received. The official report will be prepared in the Admiralty Signal Establishment and forwarded to the ship concerned. This report contains details of the aerial equipment and can be used as a guide for refitting the aerials if this becomes necessary.

If a calibration is carried out using local resources, and no Admiralty Signal Establishment officer is present, a Report of the Calibration should be forwarded through Administrative Authority to Admiralty, a copy being sent direct to the Captain Superintendent, Admiralty Signal Establishment.

TUNER-AMPLIFIER B21A.

LIST OF IDENTITY NUMBERS.

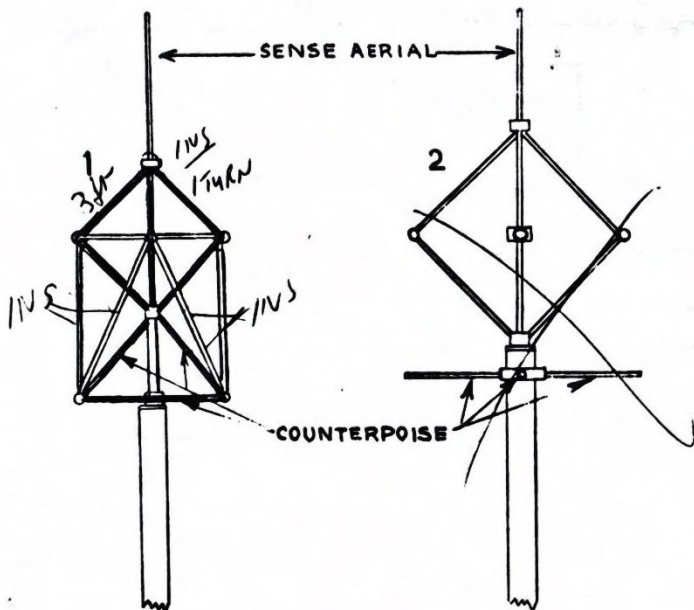
- 1st R/F valve, NR64, (6K7G).
- 2nd R/F valve, NR64, (6K7G).
- Frequency Changer valve, NR32, (6K8G).
- 1st I/F valve, NR86, (6K7G).
- 2nd I/F and R.I.S. valve, NR32, (6K3G).
- 3rd I/F valve, NR86, (6K7G).
- 2nd Detector and 1st A/F valve, NR68, (6Q7G).
- 2nd A/F valve, NR85, (6F6G).
- 2nd Heterodyne valve, NR86, (6K7G).
- ~~Search D/F Switch.~~ RANGE SWITCH
- Resistance rod, 1 megohm, $\frac{1}{2}$ -watt.
- Differential condenser, 100-mmfd.
- Condenser, fixed, 5-mmfd.
- Frequency Range switch.
- Input transformer primary winding.
- Input transformer secondary winding.
- 1st stage tuning condenser, 255-mmfd. ganged with (30)(44, and (51).
- Trimming condenser, 25-mmfd.
- Condenser, fixed, 100-mmfd.
- Resistance rod, 500,000-ohms, $\frac{1}{2}$ -watt.
- Resistance rod, 50,000-ohms, $\frac{1}{2}$ -watt.
- Condenser, fixed, 0.01-mfd.
- Transformer primary winding, (Secondary (29)).
- Condenser, fixed, 0.01-mfd.
- Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
- Resistance, 500-ohms, $\frac{1}{2}$ -watt.
- Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
- Condenser, fixed, 0.01-mfd.
- Transformer secondary winding.
- 2nd stage tuning condenser, 255-mmfd.
- Trimming condenser.
- Condenser, fixed, 100-mmfd.
- Resistance rod, 500,000-ohms, $\frac{1}{2}$ -watt.
- Resistance rod, 50,000-ohms, $\frac{1}{2}$ -watt.
- Condenser, fixed, 0.01-mfd.
- Transformer primary winding (secondary (42)).
- Condenser, fixed, 0.01-mfd.
- Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
- Resistance rod, 500-ohms, $\frac{1}{2}$ -watt.
- Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
- Condenser, fixed, 0.01-mfd.
- Transformer secondary winding.
- 2nd detector tuning condenser, 255-mmfd.
- Trimming condenser.
- Condenser, fixed, 100-mmfd.
- Resistance rod, 500,000-ohms, $\frac{1}{2}$ -watt.
- Resistance rod, 50,000-ohms, $\frac{1}{2}$ -watt.
- Condenser, fixed, 0.01-mfd.
- Transformer primary winding.
- Transformer secondary winding.
- 1st Heterodyne tuning condenser, 255-mmfd.
- Trimming condenser.
- Padding condenser.
- Condenser, fixed, 100-mmfd.
- Resistance rod, 25-ohm, $\frac{1}{2}$ -watt. (130 ohms for 6K8G)
- Resistance rod, 50,000-ohms.
- Condenser, fixed, 0.01-mfd.
- Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
- Transformer primary winding, (secondary (65)).
- Condenser, fixed, 0.1-mfd.

61. Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
62. Resistance rod, 500-ohms, $\frac{1}{2}$ -watt.
63. Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
64. Condenser, fixed, 0.01-mfd.
65. Transformer secondary winding.
66. Condenser, fixed, 500-mmfd. $\pm 1\%$.
67. Resistance rod, 500,000-ohms, $\frac{1}{2}$ -watt.
68. Condenser, fixed, ~~0.01-mfd.~~ 0.5 mmfd.
69. Tuned circuit inductance.
70. Condenser, fixed, 500-mmfd, $\pm 1\%$.
71. Condenser, fixed, 0.1-mfd.
72. Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
73. Resistance rod, 500-ohms, $\frac{1}{2}$ -watt.
74. Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
75. Condenser, fixed, 0.1-mfd.
76. Tuned circuit inductance.
77. Coupling coil, coupled to (69).
78. Condenser, fixed, 500-mmfd., $\pm 1\%$.
79. Resistance rod, 500,000-ohms, $\frac{1}{2}$ -watt.
80. Condenser, fixed, 0.01-mfd.
81. R.I.S. jack.
82. R.I.S. Potentiometer, 100,000-ohms.
83. ~~Condenser, fixed, 0.01-mfd.~~
84. ~~Resistance rod, 500,000-ohms, $\frac{1}{2}$ -watt.~~
85. Tuned circuit inductance.
86. Condenser, fixed, 500-mmfd. $\pm 1\%$.
87. Condenser, fixed, 0.1-mfd.
88. Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
89. Resistance rod, 500-ohms, $\frac{1}{2}$ -watt.
90. Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
91. Condenser, fixed, 0.1-mfd.
92. Tuned circuit inductance.
93. Coupling coil, coupled to (85).
94. Condenser, fixed, 500-mmfd. $\pm 1\%$.
95. Resistance rod, 500,000-ohms, $\frac{1}{2}$ -watt.
96. Condenser, fixed, 0.01-mfd.
97. Tuned circuit inductance.
98. Coupling coil, coupled to (106).
99. Condenser, fixed, 500-mmfd., $\pm 1\%$.
100. Resistance rod, 100,000-ohms, $\frac{1}{3}$ -watt.
101. Condenser, fixed, 0.1-mfd.
102. Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
103. Resistance rod, 500-ohms, $\frac{1}{2}$ -watt.
104. Resistance rod, 5000-ohms, $\frac{1}{2}$ -watt.
105. Condenser, fixed, 0.1-mfd.
106. Tuned circuit inductance.
107. Condenser, fixed, 500-mmfd., $\pm 1\%$.
108. Resistance rod, 100,000-ohms, $\frac{1}{2}$ -watt.
109. Resistance rod, 50,000-ohms, $\frac{1}{2}$ -watt.
110. Resistance rod, 50,000-ohms, $\frac{1}{2}$ -watt.
111. Resistance rod, 500,000-ohms, $\frac{1}{2}$ -watt.
112. Condenser, fixed, 50-mmfd., $\pm 1\%$.
113. " " " "
114. " " " "
115. " " 0.0005-mfd.
116. Resistance rod, 2 megohms, $\frac{1}{2}$ -watt.
117. Resistance rod, 100,000-ohms, $\frac{1}{2}$ -watt.
118. Condenser, fixed, 0.1-mfd.
119. Condenser, fixed, 500-mmfd. $\pm 1\%$ *10 mmfd.*
120. Condenser, fixed, 0.2-mfd.
121. A/F Transformer.
122. Resistance rod, 3000-ohms, $\frac{1}{2}$ -watt.
123. Resistance rod, 50,000-ohms, $\frac{1}{2}$ -watt.
124. Resistance rod, 500-ohms, $\frac{1}{2}$ -watt.
125. Condenser, fixed, 1-mfd.
126. Resistance rod, 50,000-ohms, $\frac{1}{2}$ -watt.
127. Condenser, fixed, 0.1-mfd.

128. Output transformer, 10:1.
129. Condenser, fixed, 0.001-mfd.
130. Resistance rod, 50,000-ohms, $\frac{1}{2}$ -watt.
131. Resistance rod, 2000-ohms, $\frac{1}{2}$ -watt.
132. Meter shunt resistance, (meter reading X 3).
133. Condenser, fixed, 4-mfd.
134. Telephone jack.
134. Telephone jack.
135. Resistance rod, 1000-ohms, $\frac{1}{2}$ -watt.
136. " " " "
137. " " 200-ohms, $\frac{1}{2}$ -watt.
138. " " 50-ohms, $\frac{1}{2}$ -watt.
139. Inductance coil, tapped.
140. Condenser, fixed, 0.0005-mfd. $\pm 1\%$
141. Trimmer condenser, air, 20-mmfd.
142. Resistance rod, 25,000-ohms, $\frac{1}{2}$ -watt.
143. " " 150,000-ohms, $\frac{1}{2}$ -watt.
144. Condenser, fixed, 100-mmfd, ~~50~~.
145. Resistance rod, 30,000-ohms, 1-watt.
146. Condenser, fixed, 50-mmfd., $\pm 10\%$.
147. " " 5-mmfd., $\pm 25.0-25.0$ -mfd.
148. Resistance rod, 1000-ohms, $\frac{1}{2}$ -watt.
149. " " 30,000-ohms, $\frac{1}{2}$ -watt.
150. " " 500 1000-ohms, $\frac{1}{2}$ -watt.
151. C.W. - I.C.W. switch.
152. Resistance rod, 50,000-ohms, $\frac{1}{2}$ -watt.
153. Condenser, fixed, 0.01-mfd.
154. " " 0.1-mfd.
155. R/F Choke.
156. Condenser, fixed, 0.01-mfd.
157. Resistance rods, 10,000-ohms and 20,000-ohms, $\frac{1}{2}$ -watt, in parallel.
158. Resistance rods, 20,000-ohms, $\frac{1}{2}$ -watt, 2 in parallel.
159. Resistance rod, 10,000-ohms, $\frac{1}{2}$ -watt.
160. " " 30,000-ohms, $\frac{1}{2}$ -watt.
161. " " 300-ohms, 2-watt.
162. Condenser, electrolytic, 50-mfd. 25-V peak.
163. Resistance rod, 75,000-ohms, $\frac{1}{2}$ -watt.
164. " " 75000-ohms, $\frac{1}{2}$ -watt.
165. " " 1000-ohms, "
166. " " " "
167. " " " "
168. " " " "
169. Condenser, fixed, 0.1-mfd.
170. " " " "
171. " " " "
172. " " " "
173. " " " "
174. Potentiometer, 50,000-ohms.
175. Condenser, fixed, 0.1-mfd.
176. Resistance, 650-ohms.
177. Transformer, 230/6-volts, 50-cycles.
178. Condenser, fixed, 0.2-mfd.
179. " " " "
180. Fuse, 5-amp.
181. " " " "
182. R/F Choke.
183. " " " "
184. Condenser, fixed, 0.01-mfd.
185. " " 0.01-mfd.
186. Resistance rod, 50-ohms. $\frac{1}{2}$ WATT
187. " " " $\frac{1}{2}$ WATT.
188. Condenser, fixed, 0.01-mfd.
189. " " " "
190. R/F Choke.
191. " " " "
192. Condenser, fixed, 0.001-mfd.
193. " " " "
194. Meter. 0-10 m/a.

- 195. Meter switch.
- 196. Meter H.T. series resistance.
- 197. Lamp, 6-volt.
- 198. " "
- 199. Resistance rod, ~~10,000-ohms~~, $\frac{1}{2}$ watt.
- 200. Tuning condenser control knob.
- 201. Tuning Indicator.
- 202.
- 203. Output meter bridge-connected metal rectifier.
- 204.
- 205. Sense aerial.
- 206. Sense aerial transformer.
- 207. Sense aerial counterpoise.
- 208. Phasing resistance, 1000-ohms, $\frac{1}{2}$ -watt. For S2S only
- 209. " " " " "
- 210. Balancing condenser, adjustable, 5-30 mmfd.
- 211. Matching condenser, adjustable, 5-50 mmfd.
- 212. Sense input transformer.
- * 213. Damping resistance, 300-ohms, $\frac{1}{2}$ -watt.
- 214. F/A loop aerial.
- 215. S/P loop aerial.
- 216. "Search-D/F-Sense" switch.
- 217. Radiogoniometer S29. Patt. 5329.
- * 218. Damping resistance, 300-ohms, $\frac{1}{2}$ -watt. ← note & part in 2
- * 219. " " " "
- 220. Shunting inductance coil.
- 221. Compensating condenser, adjustable, 5-30 mmfd.
- 222. A.C. Voltmeter multiplier resistor, 300-ohms, $\frac{3}{4}$ watt.
- 223. Rectifier load resistor, 500 ohms, $\frac{1}{2}$ watt

* These must be matched to ± 195 . To: 195.0



ITEM Nº	PATTERN Nº	DESCRIPTION	Nº OF
1	W2610	FRAME COIL S25	1
2	5653	FRAME COIL S17 (MODIFIED).	1
3	~~W3214~~ W3214	JUNCTION BOX FOR 2-TWIN CABLES.	3
4	~~W3115~~ W3115	JUNCTION BOX FOR 1-TWIN & 2 SINGLE CABLES.	3
5	X1516A	TUNER AMPLIFIER B21A.	1
6	1204B	RECTIFIER UNIT, DESIGN 'B'.	1
7	5329	RADIOSONIOMETER S29	1

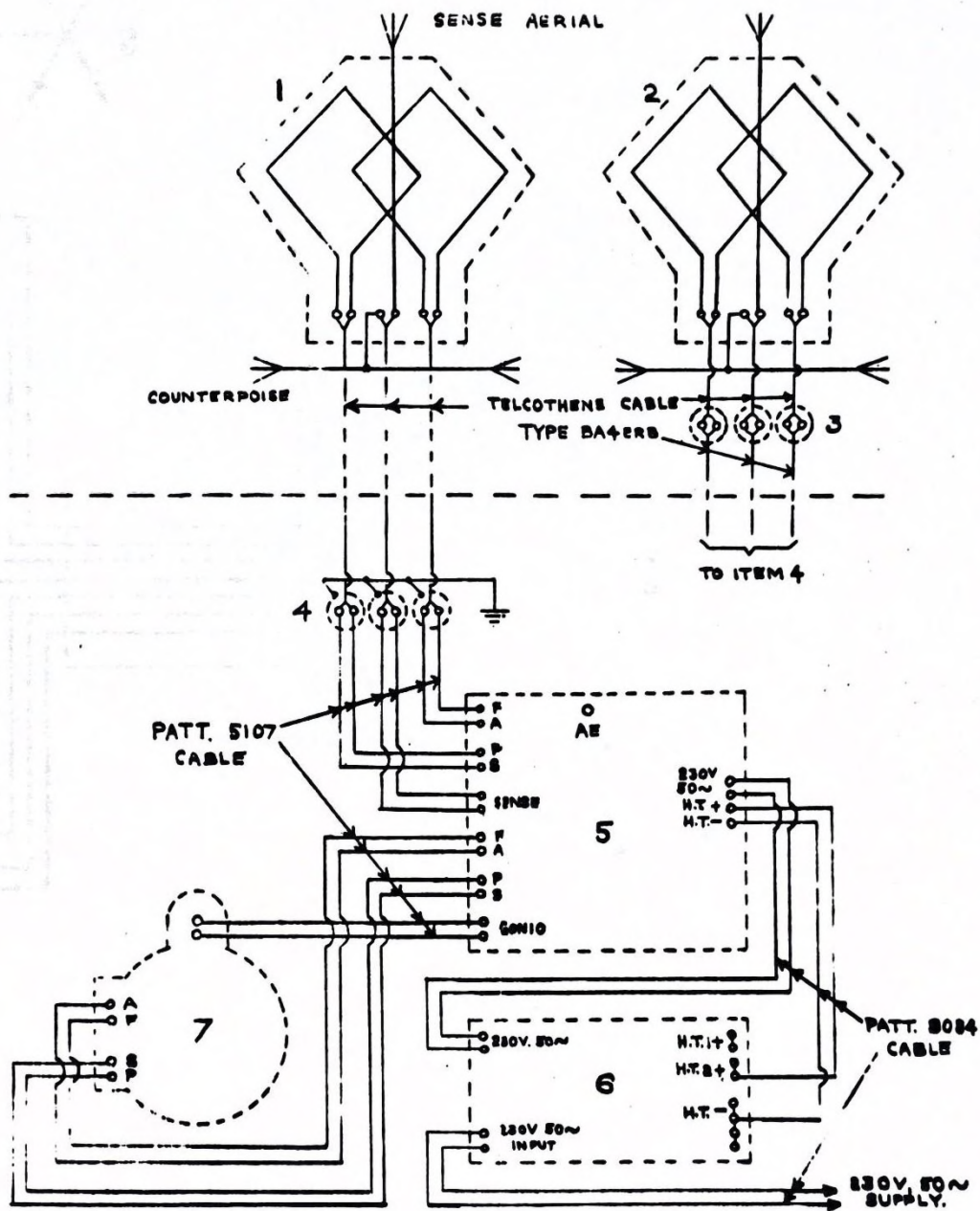


FIG. 1

AERIAL SYSTEM (CIRCUIT DIAGRAM)

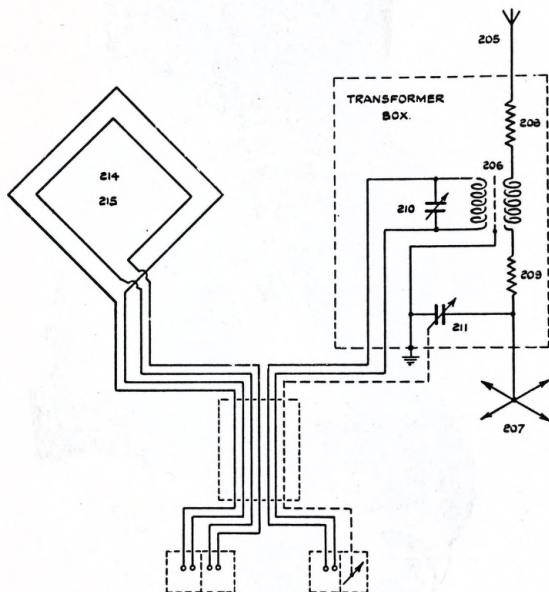


FIG. 2.

GONIOMETER S29.

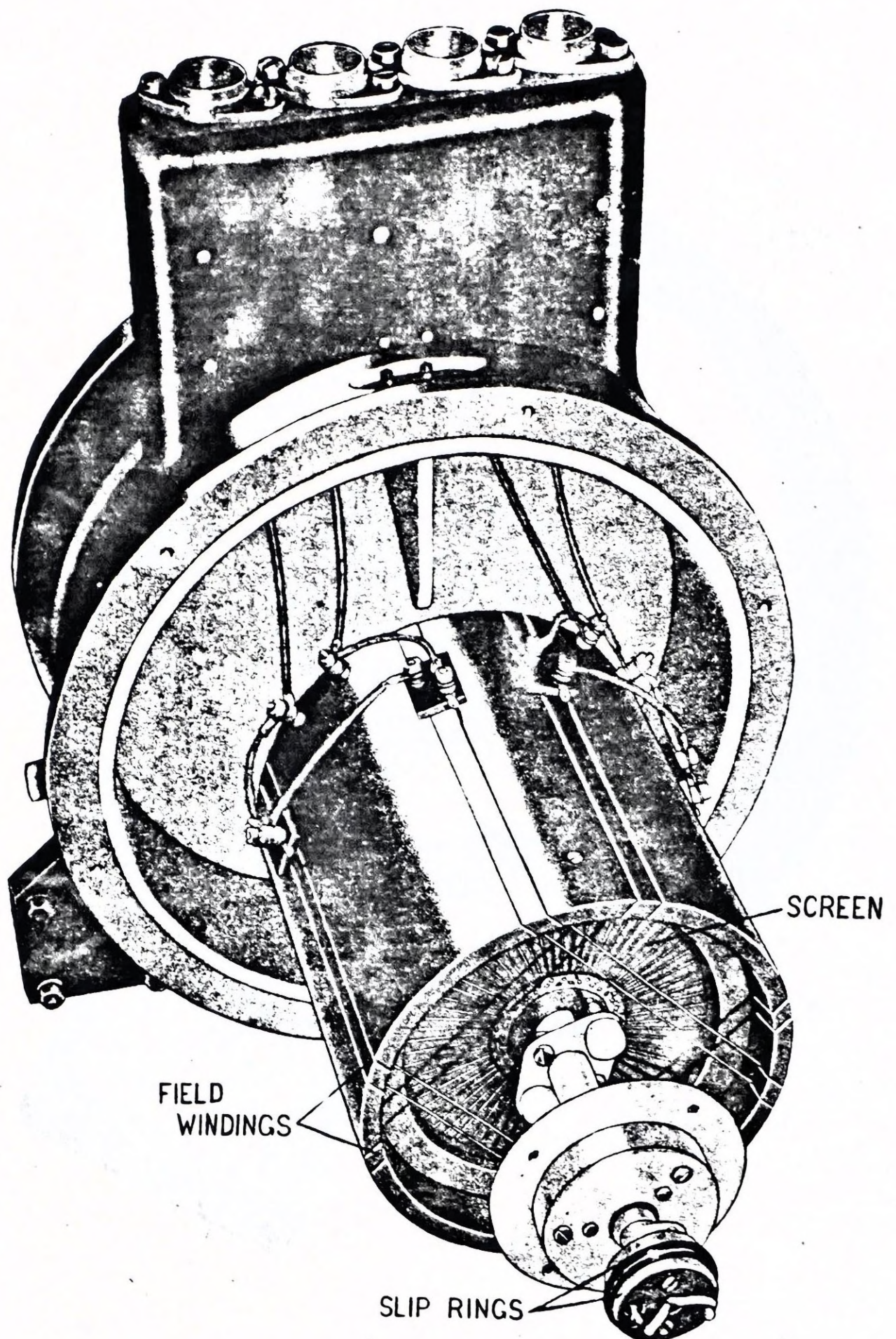


FIG. 3.

GONIOMETER S29.

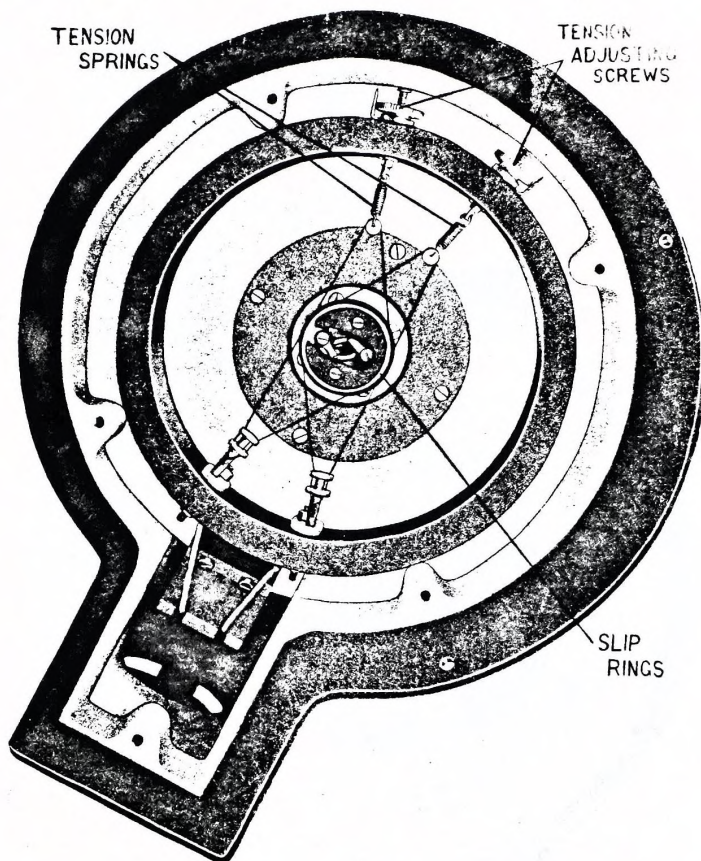
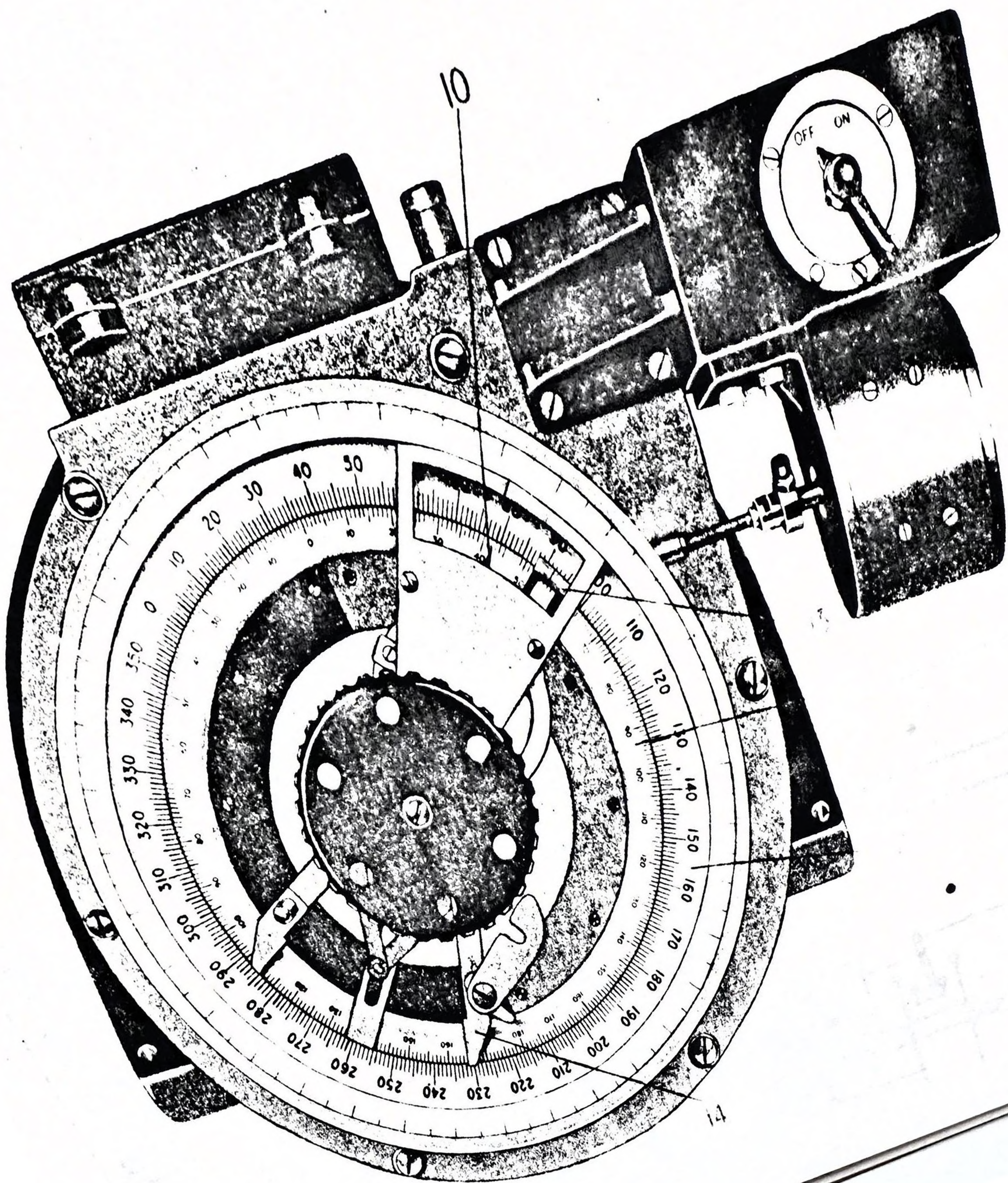
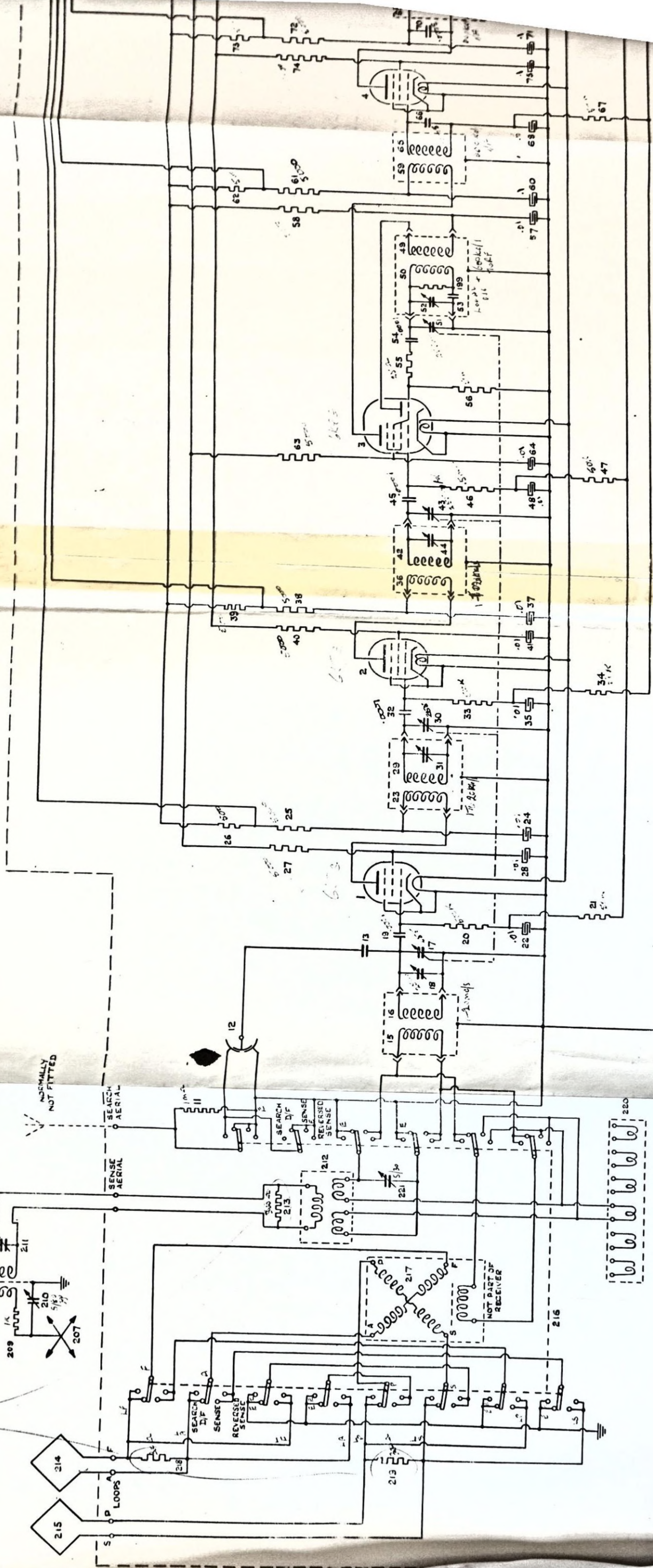


FIG.4.

DIAL BEARING INDICATOR



COMP



NORMALY NOT FITTED

SEARCH AERIAL

SENSE AERIAL

SEARCH
D.F.
SENSE
REVERSED
SENSE

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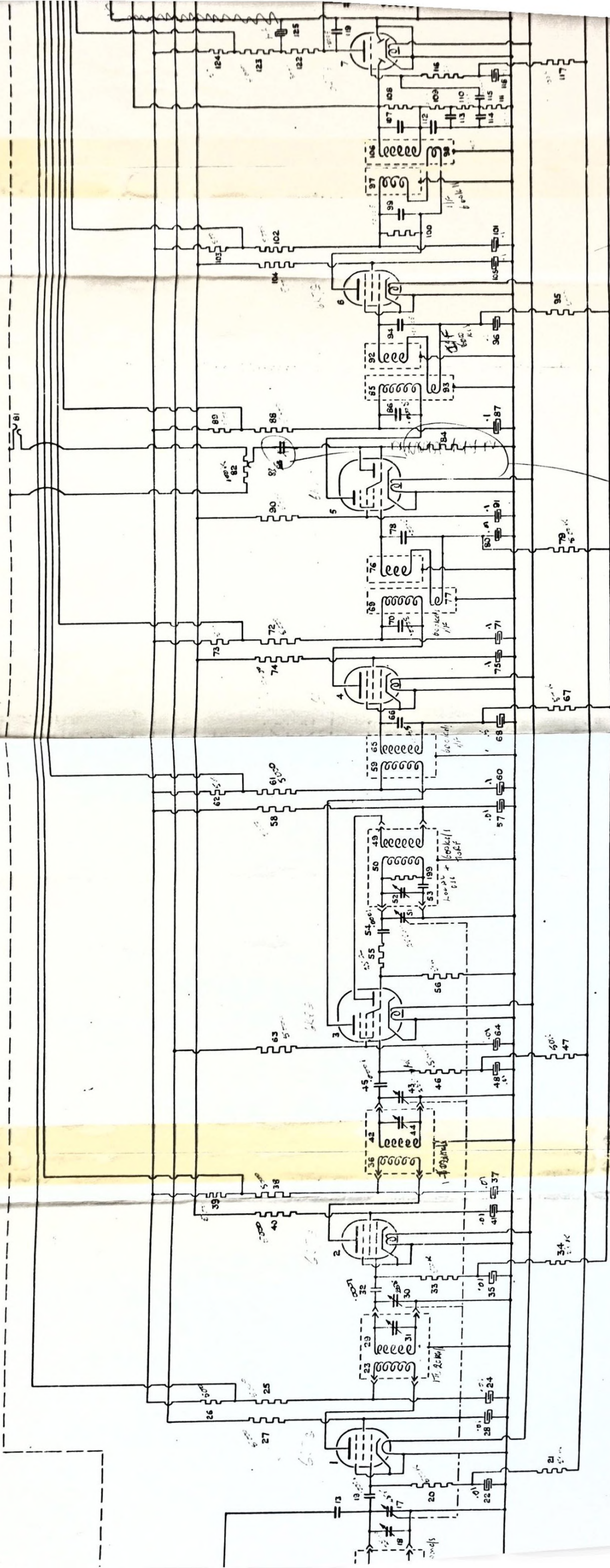
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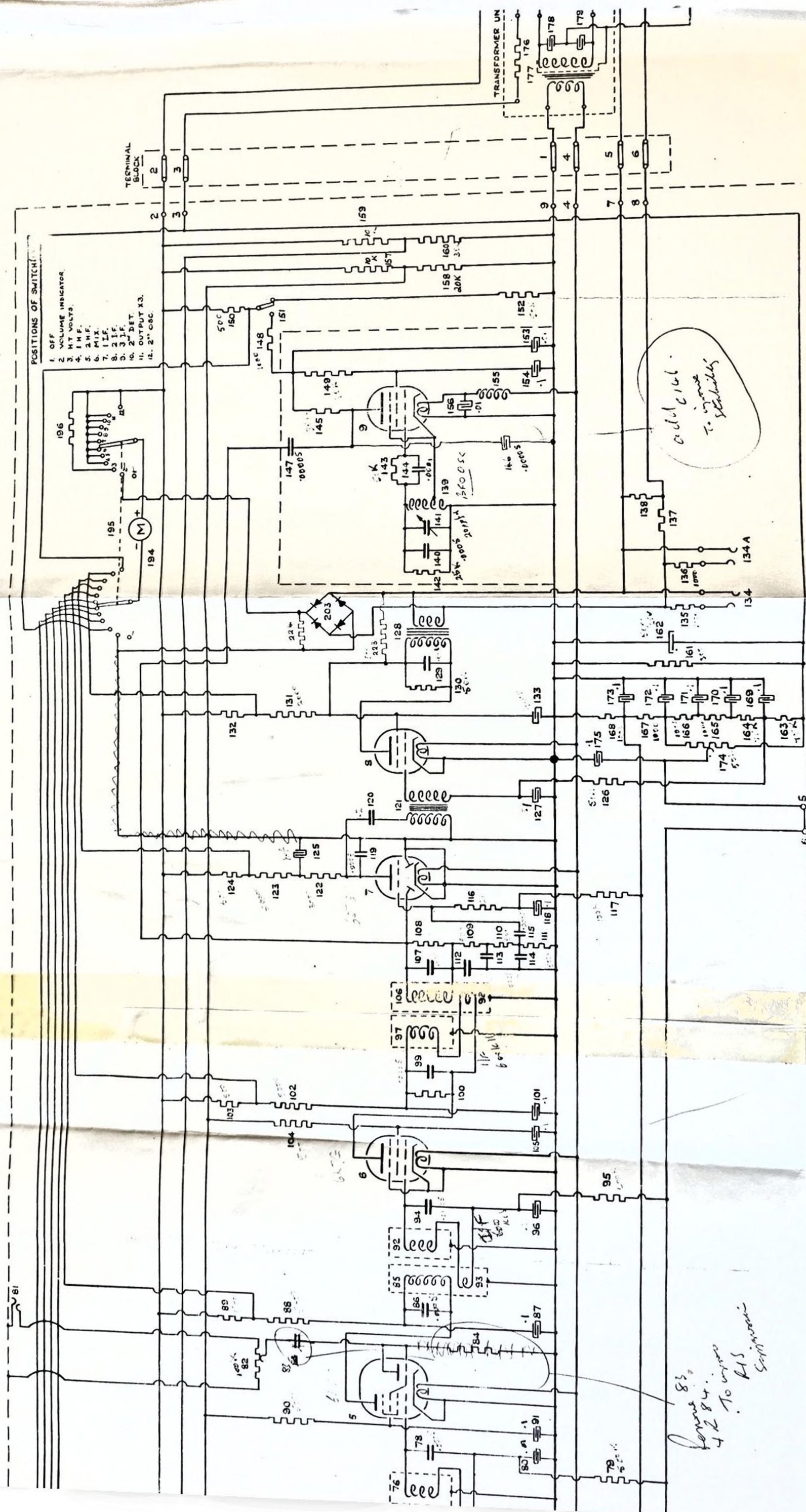
UNIT AMPLIFIER DCIA COMPLETE CIRCUIT DIAGRAM



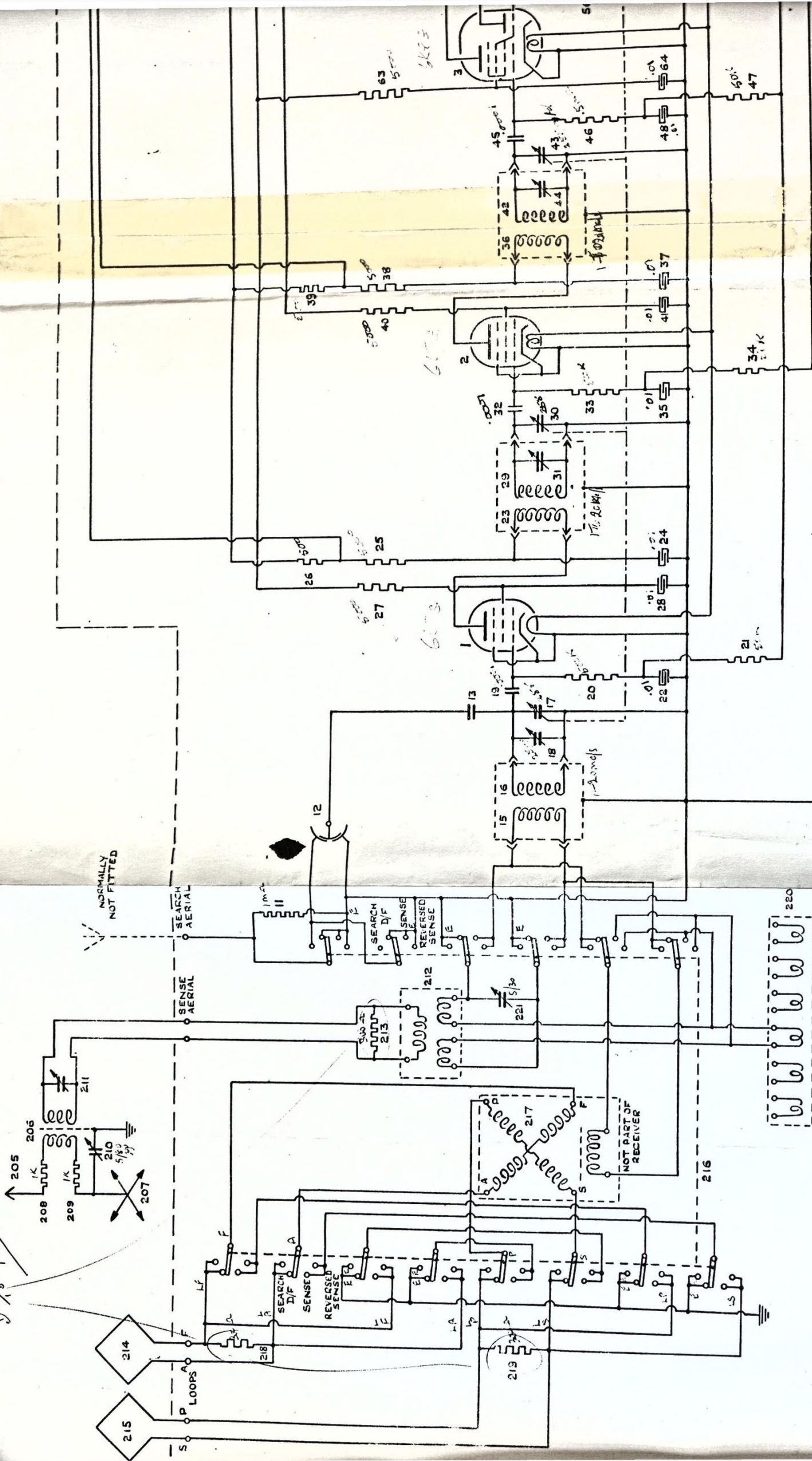
83
4284
10 wires
S. J. J. J.

מאגזין חינוך

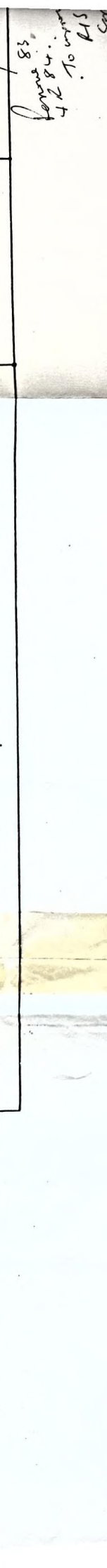
TE CIRCUIT DIAGRAM



Handwritten note: *Handwritten note at bottom left corner.*

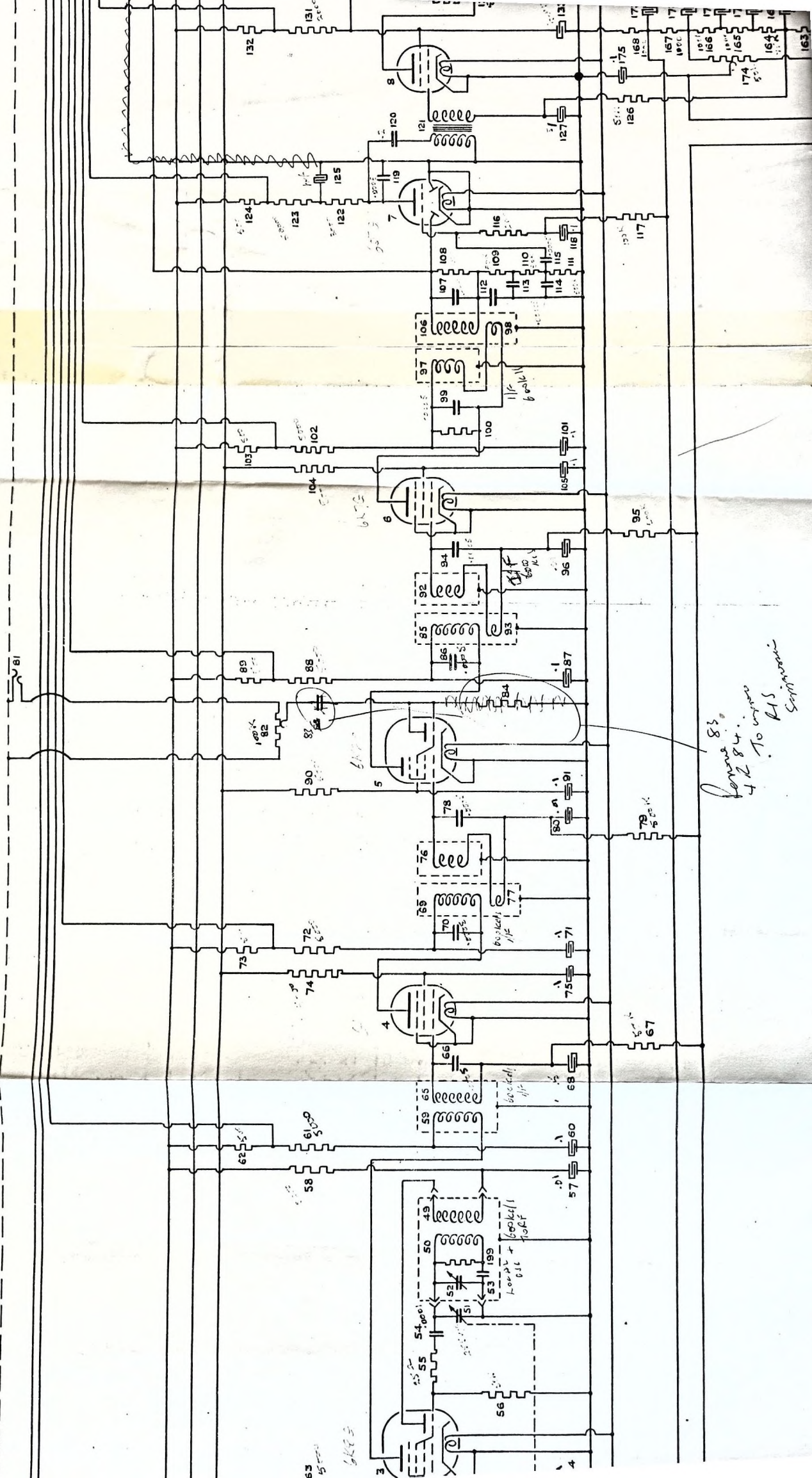


הוא יתן לנו את המענה



UNIVERSITY OF MICHIGAN

COMPLETE CIRCUIT DIAGRAM





SENSE CIRCUITS OF TUNER-AMPLIFIER B21A

SIMPLIFIED DIAGRAM OF INPUT CIRCUITS

SWITCH IN "D/F" POSITION

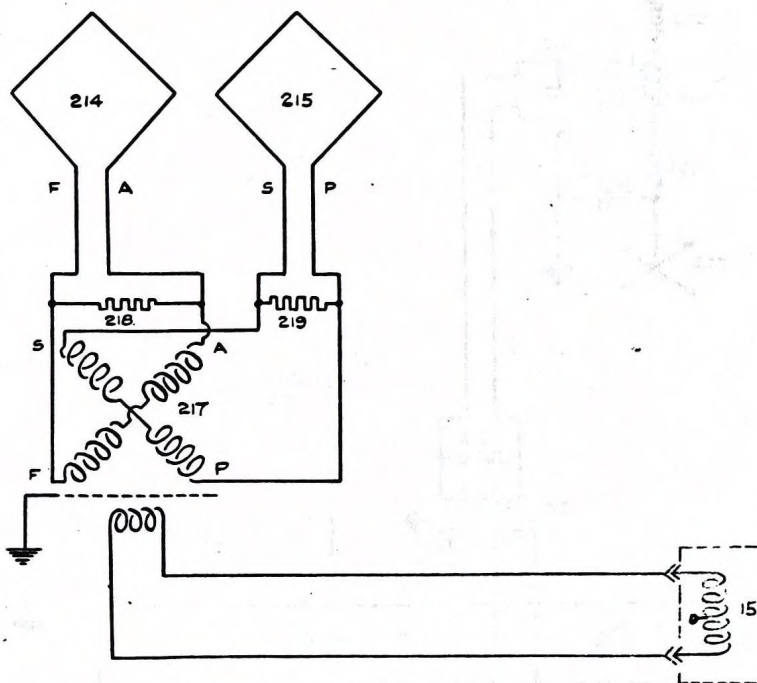


FIG 7

SENSE CIRCUITS OF TUNER-AMPLIFIER B21A

SIMPLIFIED DIAGRAM OF INPUT CIRCUITS.

SWITCH IN "SENSE" POSITION

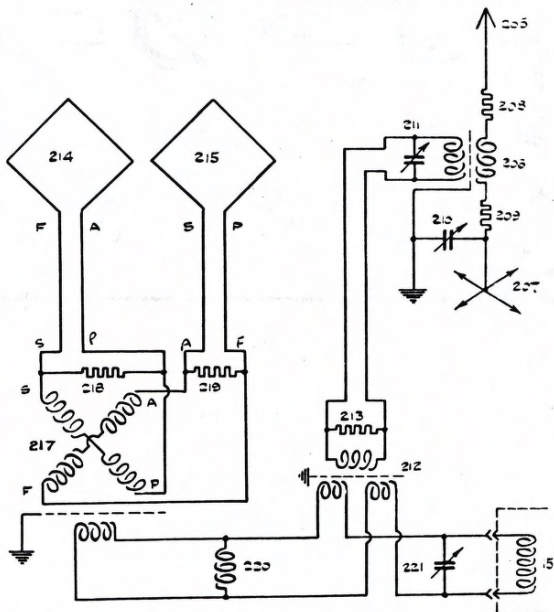


FIG. 8

TUNER AMPLIFIER B21

Following Figures "9 & 14".

Photographs shown are of "Tuner-Amplifier B21," which is similar to
to Tuner-Amplifier B21A, but does not include the Sonarfinder circuit.

FRONT VIEW

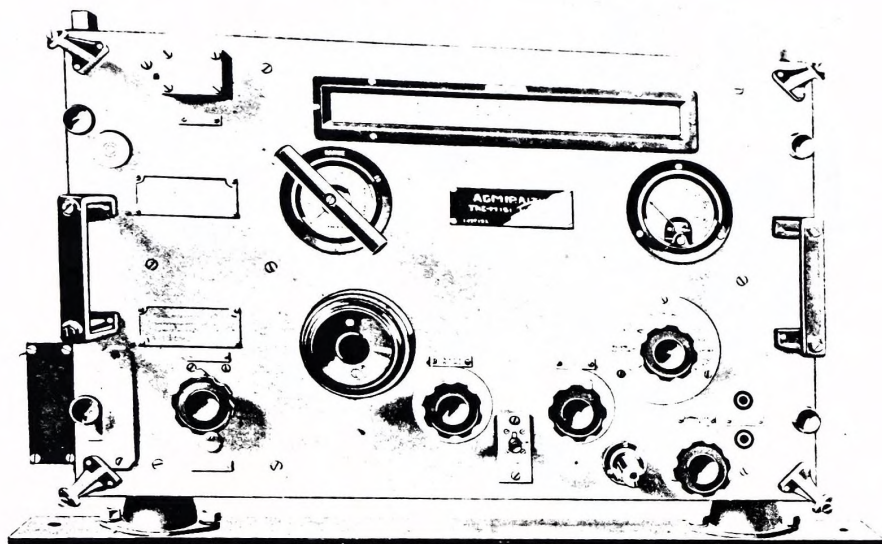


FIG. 9

PLAN VIEW UNDERNEATH

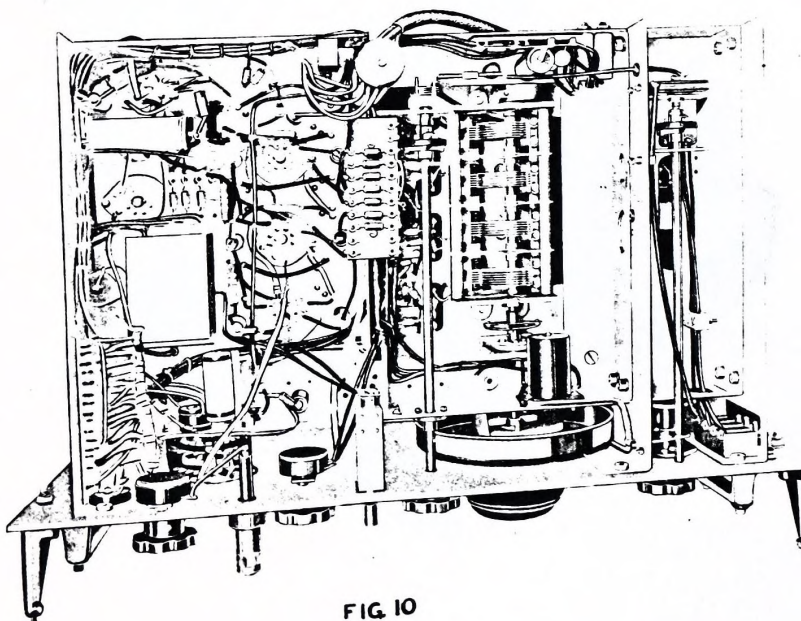


FIG. 10

TUNER AMPLIFIER B21

REAR VIEW

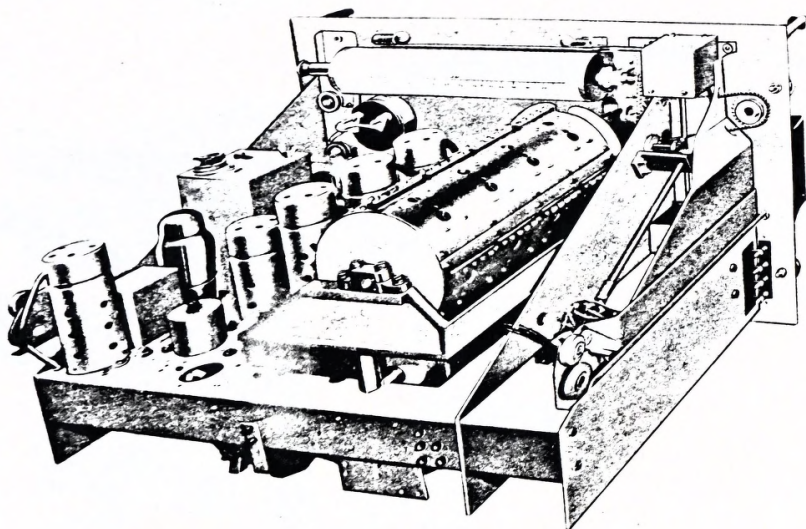
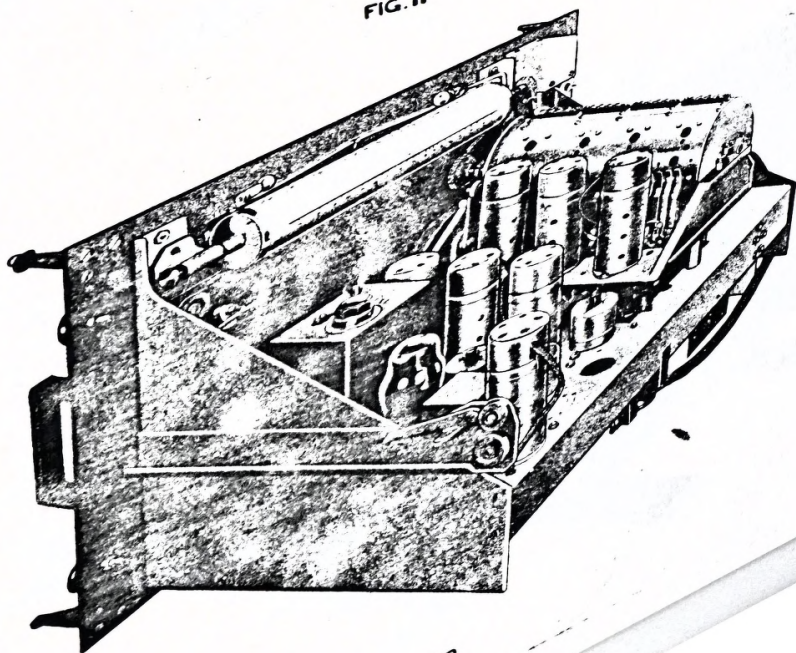


FIG. II



TUNER AMPLIFIER B2I

METHOD OF WITHDRAWAL

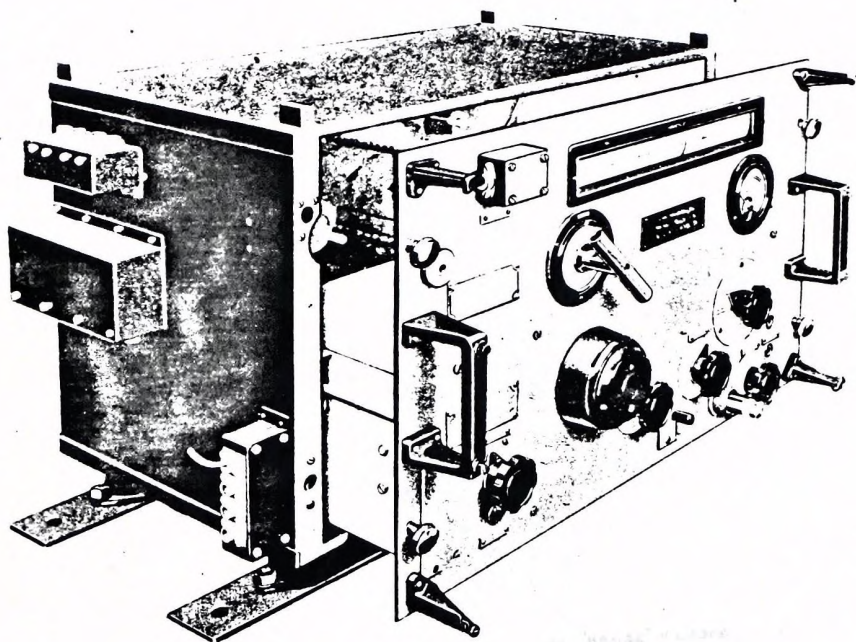


FIG. 13

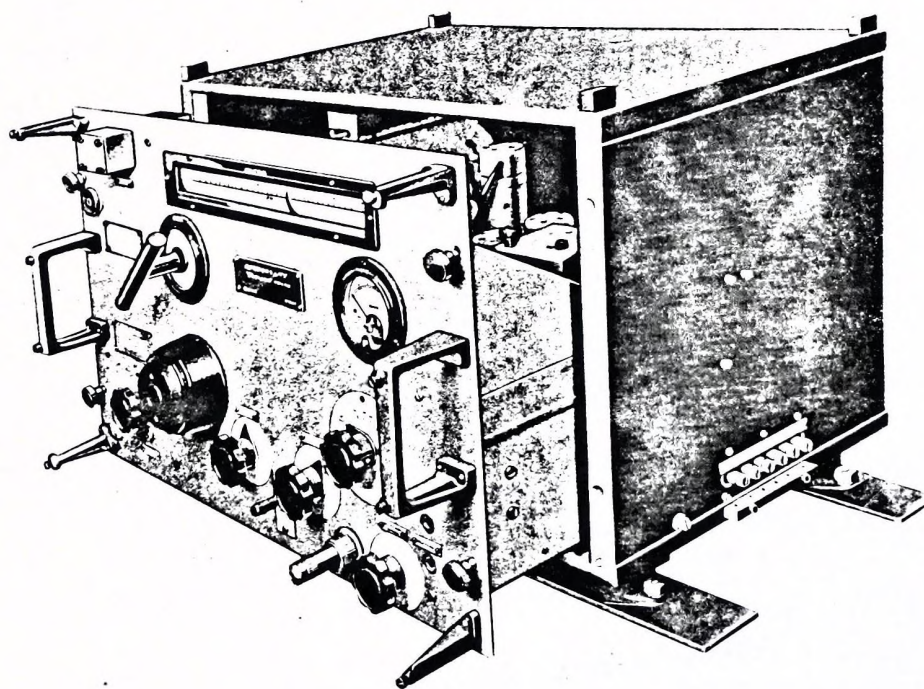
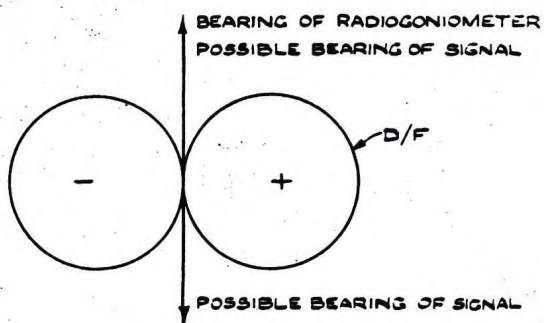


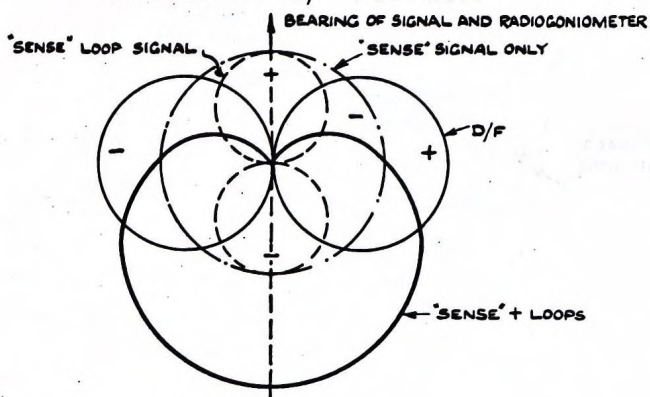
FIG. 14

TUNER-AMPLIFIER B 21A.

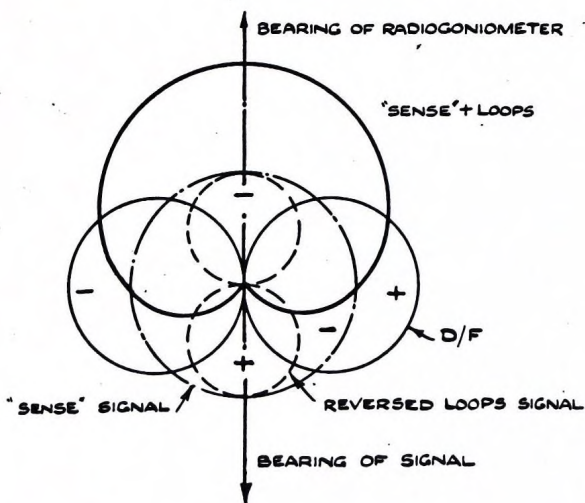
DIAGRAMS OF RESPONSE CURVES.



SWITCH IN "D/F" POSITION



SWITCH IN "SENSE" POSITION



SWITCH IN "REVERSED SENSE" POSITION

TRUE AND RELATIVE BEARINGS.

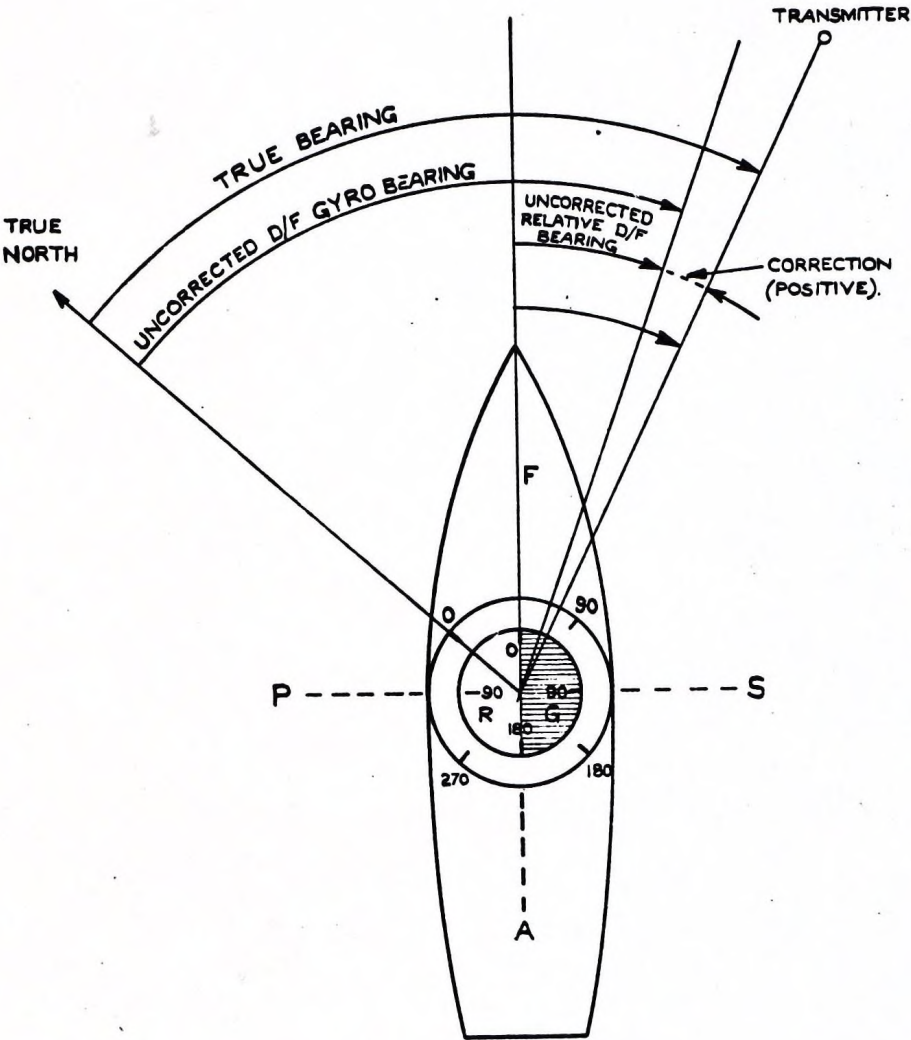


FIG. 16.