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AUTOMATIC DIRECTION FINDING INSTALLATION
(MARCONI AD 360)

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

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Ministry of Defence

FOR USE IN THE

ROYAL AIR FORCE

(Prepared by the Ministry of Technology)

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PRELIMINARIES

CONTENTS OF VOLUME 1

PART 1

LEADING PARTICULARS AND GENERAL INFORMATION

MODIFICATION RECORD

The following record confirms that this publication incorporates all technical changes necessitated by the modifications listed below. Information on modification titles, classification categories and Mark applicabilities is given in Topic 2.

LIST OF MODIFICATIONS INCLUDED

Note ...

(1) This list includes all modifications to items covered by this A.P., up to the latest Amendment.

(2) Some of these modifications are of a purely mechanical nature and may not have necessitated any change or warranted an immediate change to text and/or illustration: in such instances the Mod. No. is enclosed in parentheses

Mod No	Main unit	Sub-unit	Brief details
8675/5	Receiver,radio 6407M	R.F. unit 5940-99-970-3310	To increase circuit stability the tap on transformer 3L5 is moved to reduce the gain on range 3. The transformer assembly is rotated through 180° and the connections to it reversed.
8676/3	Receiver,radio 6407M	Goniometer electrical 5950-99-970-3309	Pressure on the cursor causes friction between the cursor and gonio scale. A new cursor is fitted and the dust cover is modified.
8677/1*	Equalizer, Cable 5826-99-970-2197 (M.type XSA3967)		To prevent the penetration of dust into the unit, dust covers are fitted at each end.
8678/1*	Q.E. corrector and Cable equalizer 5826-99-970-2195 (M.type XSA3966)		To prevent the penetration of dust into the unit, dust covers are fitted at each end.
8679/1* Connected with Mod. 8680/1 to receiver	Control direction finder 5826-99-970-2199 type 6409M		(a) To effect better control of the audio gain, the wiring from PLA pins 12 and 17 is modified and a link added between SWD3 and SWD4.
8679/1*			(b) To prevent i.f.instability a capacitor 1C1, (1μF) is added across 1SWD2.

* Modification embodied by contractor in production.

Mod No	Main unit	Sub-unit	Brief details
			(c) The value of resistor 1R4 is changed and a new resistor 1R5 is added across contacts of SWD5 to equalize gain when switched to ANT-LOOP position.
8679/2* Connected with Mod. 8680/2 to receiver sub-assembly			To effect better control of the audio gain, resistor 1R6 is added across 1SWD3. The screened lead from PLA pin 12 to 1SWD5 is deleted and likewise the connection between 1SWD3 and 1SWD5. The value of resistor 1R2 is changed to 1.5 kilohm.
8679/3*			To effect better control of the R.F. gain a resistor 1R7 is added across SWD4 tag 5 and SWD5 tag 1. The resistor R3 once connected to 1SWD5 tag 1 is now connected to 1SWD4 tag 5. Values of resistors 1R2, 1R3, 1R4 and 1R5 are changed.
8680/1* Connected with Mod. 8679/1	Receiver, radio type 6407M	Receiver sub-assembly 5826-99-970-4805	(a) To prevent radiation of crystal oscillator frequencies, five 0.022 µF capacitors and associated mounting bracket are added. (b) The wiring from 1TR2 to plug PLA is modified and resistor 1R15 added across pin 1 and 3 of 1TR2 to improve audio gain control. (c) To facilitate the operation of 1RV1 the slot is modified and the spindle lengthened.
8680/2* Connected with Mod. 8679/2	Receiver, radio type 6407M	Receiver sub-assembly 5826-99-970-4805	To effect better control of the audio gain, resistor 1R15 is deleted and wiring between 1TR1, 1TR2 and plug PLA is modified.

* Modification embodied by contractor in production.

Mod No	Main unit	Sub-unit	Brief details
8680/3*	Receiver,radio type 6407M	Receiver sub-assembly 5826-99-970-4805	The Oddie fastener is modifie to provide earthing and prevent excessive cover movement.
8680/4*	Receiver,radio type 6407M	Receiver sub-assembly 5826-99-970-4805	To correct the working of adverse tolerance Zener diodes the resistor 1R12 is decreased in value from 82Ω to 47Ω.
8680/5* Connected with Mod. 8679/3	Receiver,radio type 6407M	Receiver sub-assembly 5826-99-970-4805	To suppress the spikes on the 18 volt supply, which could cause the r.f. unit carriage to stop at an incorrect position, a capacitor 1C16 (9μF) is connected from the junction of 1R9 and 1MR1 to earth.
8680/6* Connected with Mod. 2 to goniometer, electrical	Receiver,radio type 6407M	Receiver sub-assembly 5826-99-970-4805	On some receivers the servo gain is too high, requiring the servo gain setting to be at minimum. This defect is prevented by changing the value of resistor 1R14 to 220 ohms.
8680/1*	Receiver,radio type 6407M	R.F. unit 5950-99-970-3310	Numerous minor changes are made to bring the unit up to production standard.
8680/2*	Receiver,radio type 6407M	R.F. unit 5950-99-970-3310	(a) To prevent the coupling of aircraft electrical interference into the tuned circuit, the earth lead from 3C34 is re-routed. (b) To remove earth loop to the crystal unit, the screen pigtail of lead from 3PLC pin 24 to 3SWC tag 10 is deleted.
8680/3*	Receiver,radio type 6407M	R.F. unit 5950-99-970-3310	To improve the a.g.c., two diodes 3MR14 and 3MR15 are added to the emitter circuit of 3VT4, and the value of resistor 3R26 is changed to 1 kilohm.

* Modification embodied by contractor in production.

Mod No	Main unit	Sub-unit	Brief details
8680/4*	Receiver,radio type 6407M	R.F. unit 5950-99-970-3310	Traces of incipient oscillation in the sense aerial input circuits, are removed by adding a resistor 3R4, in series with the supply to transformers 3TR5, 3TR6, 3TR7 and 3TR8. A capacitor 3C45 (1μF) is fitted between earth and the junction of 3R4 and the transformers.
8680/1*	Receiver,radio type 6407M	Amplifier, i.f. 5826-99-970-2185	Numerous minor changes are made to bring the unit up to production standard.
8680/1*	Receiver,radio type 6407M	Goniometer, electrical 5950-99-970-3309	Numerous minor changes are made to bring the unit up to production standard.
8680/2* Connected with Mod. 6 on receiver, sub-assembly	Receiver,radio type 6407M	Goniometer, electrical 5950-99-970-3309	(a) To prevent variation of gain of the fixed phase amplifier the connections to transformer 2TR3 are reversed, and value of resistor 2R20 is changed to 680 ohms. (b) A resistor 2R25 is added to the emitter lead of 2VT1 to prevent the servo gain, on some receivers from going too high.
8680/1*	Receiver,radio type 6407M	Control, frequency selector 5826-99-970-5043	Numerous minor changes are made to bring the unit up to production standard.
8680/2*	Receiver,radio type 6407M	Control, frequency selector 5826-99-970-5043	The period of the monostable multi-vibrator is reduced by changing the value of resistor 5R141 to 3.3 kilohms.
8680/3* Connected with Mod. 5 on receiver sub-assembly	Receiver,radio type 6407M	Control frequency selector 5826-99-970-5043	To suppress the voltage spikes on the supply to relays 5RLF and 5RLG which cause the r.f. unit carriage to stop at an incorrect position, resistor 5R164 is added in series with the relay supply and a capacitor 5C118 is added between the relays and earth. The earthing of the outer screen of the lead between 5VT9 and 5R109 is reversed.

* Modification embodied by contractor in production.

MARCONI AD 360

LEADING PARTICULARS
(Completely revised)

Purpose of equipment

An airborne automatic direction-finder giving continuous indication of the bearing of a ground transmitter relative to the aircraft heading once the airborne equipment is tuned to the frequency of the transmitter.

NOMENCLATURE CONVERSION

Unit	J.S. Nomenclature	Cat. No.
ADF receiver 6407M	Receiver, radio	5826-99-970-2200
Chassis assembly XSA3348	Receiver, sub-assembly	5826-99-970-4805
Gonio unit XSA3349	Goniometer, electrical	5950-99-970-3309
R.F. unit XSA3350	Radio frequency unit	5950-99-970-3310
I.F. unit XSA3351	Amplifier, intermediate frequency	5826-99-970-2185
Crystal unit XSA3352	Control, frequency selector	5826-99-970-5043
Controller 6409M	Control, direction finder	5826-99-970-2199
Controller 6409MB	Control, direction finder	5826-99-955-7822
Controller 6409MD	Control, direction finder	5826-99-955-0915
Loop 6410M	Aerial	5826-99-970-2198
Loop 6410MB	Aerial	5826-99-955-0034
Loop 6410MB-1	Aerial	5985-99-618-0456
Q.E. and loop equalizer unit XSA3966	Q.E. corrector and cable equalizer	5826-99-970-2195
Sense equalizer unit XSA3967	Equalizer cable	5826-99-970-2197

Note ...
In the text of this publication the items will be referred to by their Marconi name and the abbreviation ADF will be used to represent the words automatic direction-finder.

Services ... ... M.F. automatic direction-finding
M.F. communications reception

Facilities ... ... Automatic indication of the bearing relative to the aircraft heading of any suitable selected transmitter, with simultaneous aural reception of the radiated signal. Provision for manual override of the automatic control of the goniometer search coil. Aural reception of A1, A2 and A3

	transmissions. (R/T, MCW, CW). Provision for manual control of the goniometer search coil to permit direction finding by the aural null-signal method.
Frequency coverage and tuning accuracy	100 kHz to 1799.5 kHz in steps of 0.5 kHz ± Hz (-55°C to + 55°C) (Typical accuracy ± 50 Hz).
Automatic tuning time:	
Normal conditions	4 seconds maximum
Extreme temperatures	10 seconds maximum
Speed of taking bearings:	
Automatic	6 seconds maximum for rotation from 175° off the correct bearing to within 5° of the correct bearing.
Manual	Variable speed up to 360 degrees in 6 seconds.
Bearing indication	26V 400 Hz synchro output suitable for up to three remote-bearing indicators or R.M.I. Scale provided on the receiver for check purposes.
Bearing accuracy	±2° at signal strengths greater than 50 μV/m above 200 kHz. ±3° below 200 kHz. (Typical accuracy within ±2° at signal strengths greater than 3μV/m at 1700 kHz and 20 μV/m at 120 kHz).
Aerial system:	
Loop aerial	Fixed ferrite-cored crossed-loop aerial.
Loop feeder cable	Full length 50 ft. Q.E. and loop cable equalizer XSA3966 compensates for shorter lengths down to 12 ft.
Q.E. correction	Installed loop aerial provides + 12½°, Q.E. and loop cable equalizer provides up to ±12° (adjustable in 1° steps).
Sense aerial	Externally mounted. Nominal sensitivity product 10 metre-picofarads. (ADF operation satisfactory with any value between 5 and 15 metre-picofarads).
Sense aerial capacitance	100 pF ±5 pF.

Mod No	Main unit	Sub-unit	Brief details
8767/6	Receiver,radio type 6407M	Amplifier, r.f. 5950-99-970-3310	To provide lightning protection, a diode XR642 is connected across the emitter and base of 3VT1.
(9556/3)	Receiver,radio type 6407M	Amplifier, i.f. 5826-99-970-2185	The b.f.o. can cause interference which is picked up by inductor 4L9 and passed down the i.f. chain. 4L9 is repositioned and re-orientated to eliminate this pick up.
(9624/1)	Bridge set, capacitance 6625-99-953-2121		Modification record and identification labels are fitted to the instrument panel.
9625/2	Receiver,radio type 6407M	Amplifier, i.f. 5826-99-970-2185	The resistor 4R37 is changed in value to 5.6 kilohm to ensure that the b.f.o. switches off, when the supply voltage is low.
9626/1	Test rig, electrical 6625-99-952-0760		A wiring correction is made by transferring the lead from socket SKB/46 to the right hand side of the fuse FS1.
9674/4	Receiver,radio type 6407M	Amplifier, i.f. 5826-99-970-2185	To increase the gain in the i.f. amplifier the values of resistors 4R21, 4R32 and 4R46 are changed to 4.7 kilohms, 680 ohms and 4.7 kilohms respectively.
0877/5*	Receiver,radio type 6407M	Amplifier, i.f. 5826-99-970-2185	To provide better switching off of the b.f.o. the diode 4MR3 is switched harder by reducing the resistor 4R37 to 2.7 kilohm and increasing the capacitor 4C36 to 15 μF.
1110/6*	Receiver,radio type 6407M	Amplifier, i.f. 5826-99-970-2185	The b.f.o.signal can be picked up by the inductor 4L9 and subsequently amplified by the i.f. amplifier. To eliminate this, inductor 4L9 is replaced by a 2.2 kilohm resistor 4R47 and the associated transistor VT1 debiased to compensate by changing the value of the resistor 4R5 to 10 kilohm.

* Modification embodied by contractor in production.

Mod No	Main unit	Sub-unit	Brief details
A2143/7	Receiver,radio type 6407M	Receiver, sub-assembly	Capacitor 1C16 replaced and repositioned on component board.
▶ A2861/8	Receiver,radio 6407M	Receiver sub-assembly 5826-99-970-4805	To prevent over-dissipation of resistor 1R9 the wattage rating is increased to 1.5W. Also diode 1MR5 is replaced by an improved Tyre-Texas 156020A-20V.
(A2923/9)	Receiver,radio 6407M		Stainless steel washer introduced between socket 1SKH and chassis to prevent galvanic action.
A3183/7	Receiver,radio 6407M	Amplifier i.f. 5826-99-970-2185	Diode 4MR3 replaced by improved type to M-E Drg. A-33-0111-50. This mod. is connected with Mod No 0877/5.
A3298/4	Receiver,radio 6407M	Control, frequency selector 5826-99-970-5043	1200 pF capacitor fitted between 5V719 base and earth to overcome effect of 'spike' produced by bottom microswitch of tuning rack.
A4406/5	Receiver,radio 6407M	Control, frequency selector 5826-99-970-5043	Replacement of transistors type 2N1225 (no longer available) with transistors NSN 5961-99-116-9440 (Amperex) requires component changes: SC5 and SC15 changed to 180 pF, SC26 changed to 200 pF. This mod. carried out on failure of any one 2N1225.
(A6736/2)	Control unit 6409MD		Different locking washer fitted to changeover switch and wire to illumination lamps secured to main cableform.
A4709/7	Receiver,radio 6407M	Radio frequency sub-assembly 5826-99-970-3310	Original type of variable capacitor (3C16/JC24 or 3C39/JC47) no longer available. Replaced when faulty with alternative type. ◀

Sense feeder cable:	
Normal installation (100 pF aerial)	Full length 60 ft.
Length compensation	The sense cable equalizer compensates for shorter cables as follows: Type XSA3967 26 ft to 57 ft
Sense aerial circuit input capacitance	830 pF at receiver input. The sense cable equalizer provides means for trimming the capacitance measureable at the receiver input to 830 pF precisely.
Automatic gain control	Less than 8 dB output change with input change from 10 μV to 50 mV.
Sensitivity:	
Sense aerial	6 dB signal-plus-noise/noise ratio for 5 μV input signal modulated 30% at 1000 Hz over entire tuning range except 450-460 kHz.
Loop aerial	6 dB signal-plus-noise/noise ratio for 100 μV/m input signal modulated 30% at 1000 Hz for all frequencies above 200 kHz except 450-460 kHz.
Selectivity:	
Broad	Bandwidth 3000 Hz ± 700 Hz at 6 dB down Bandwidth 5000 Hz ± 1000 Hz at 60 dB down
Sharp	Bandwidth 1300 Hz ± 300 Hz at 6 dB down Bandwidth 4000 Hz ± 1000 Hz at 60 dB down
Spurious responses:	
Image rejection	Better than 80 dB, below 1000 kHz Better than 60 dB, above 1000 kHz
I.F. rejection	Better than 80 dB, except between 415 kHz and 500 kHz
Other responses	Better than 80 dB
Audio output	300 mW into 100 ohms or 500 ohms at standard modulation
Power supply requirements ...	27.5V d.c. (receiver circuit and controller lamps) 26V a.c. 400 Hz (for synchros)
Receiver consumption	27.5V d.c. x 1.5A maximum (channel selection) 27.5V d.c. x 1.0A normal (ADF operation) 26V a.c. x 150 mA per synchro
Maximum operating height (unpressurized)	60000 ft (18.300m)

Compass safe distance	Receiver	21 in.	(53.25 cm)
	Controller	16 in.	(40.5 cm)
	Loop aerial	-	-
	Q.E. and		
	Loop cable equalizer	3 in.	(7.5 cm)
	Sense cable equalizer	3 in.	(7.5 cm)

Temperature range	Operating range °C	Maximum range °C
Receiver	-55 to +55	-55 to +71 (+71 for 30 mins)
Controller	-55 to +55	-55 to +71
Loop aerial	-65 to +71	-65 to +71
Q.E. and loop cable equalizer	-65 to +71	-65 to +71
Sense cable equalizer	-65 to +71	-65 to +71

OVERALL DIMENSIONS AND WEIGHTS

Units	Height	Width	Depth	Weight
Receiver	$7\frac{3}{4}$ in. (20 cm)	5 in. (12.75 cm)	17 in. (43.25 cm)	18.0 lb (8.16 kg)
Controller	$4\frac{1}{2}$ in. (11.5 cm)	$5\frac{3}{4}$ in. (14.5 cm)	$5\frac{1}{8}$ in. (13 cm)	3.0 lb (1.37 kg)
Loop aerial (excluding connector plug)	$\frac{3}{4}$ to $\frac{7}{8}$ in. (1.9 to 2.2 cm)	$20\frac{1}{2}$ in. (52 cm)	$9\frac{5}{8}$ in. (24.5 cm)	8.75 lb (3.98 kg)
Q.E. and loop cable equalizer	$2\frac{1}{8}$ in. (5.25 cm)	$5\frac{1}{2}$ in. (14 cm)	$2\frac{3}{8}$ in. (6 cm)	0.4 lb (0.18 kg)
Sense cable equalizer	$1\frac{5}{8}$ in. (4.25 cm)	$5\frac{1}{2}$ in. (14 cm)	$2\frac{1}{4}$ in. (5.8 cm)	0.35 lb (0.16 kg)
Changeover switch unit	$10\frac{1}{2}$ in. (26.7 cm)	$3\frac{3}{8}$ in. (8.6 cm)	4 in. (10.1 cm)	2.7 lb (1.2 kg)

Chapter 1

INTRODUCTION AND GENERAL DESCRIPTION

(Completely revised)

CONTENTS

INTRODUCTION

1 The AD360 is an airborne automatic direction-finder system, operating on the medium frequencies, giving automatic indication of the bearing of any suitable transmitter, relative to the aircraft heading, on the selected frequency. The system comprises the units shown in fig. 1 and listed in Table 1, the manufacturer's description being used throughout this publication Block diagrams of the system are shown in fig. 2 and 3.

TABLE 1 MAIN UNITS OF ARI.23119

Unit	J.S. nomenclature	R.A.F. prefix	Nato Cat. No.
Loop aerial 6410M	Aerial	10B/	5826-99-970-2198
Loop aerial 6410MB	Aerial	10B/	5826-99-955-0034
Loop aerial 6410MB-1	Aerial	10B/	5985-99-615-0456
Q.E. and loop cable equalizer XSA3966	Q.E. corrector and cable equalizer	10B/	5826-99-970-2195
Sense equalizer unit XSA3967	Equalizer cable	10B/	5826-99-970-2197
Receiver 6407M	Receiver, radio	10D/	5826-99-970-2200
Controller 6409M	Control, direction finder	10K/	5826-99-970-2199
Controller 6409MB	Control, direction finder	10B/	5826-99-955-7822
Controller 6409MD	Control, direction finder	10B/	5826-99-955-0915
Sense aerial	(Aircraft fit)	10B/	
Mounting	(Aircraft fit)	10AJ/	
Connectors	(Aircraft fit)	10HA/	
Indicators	(Aircraft fit)		
Changeover switch unit			5826-99-955-7008

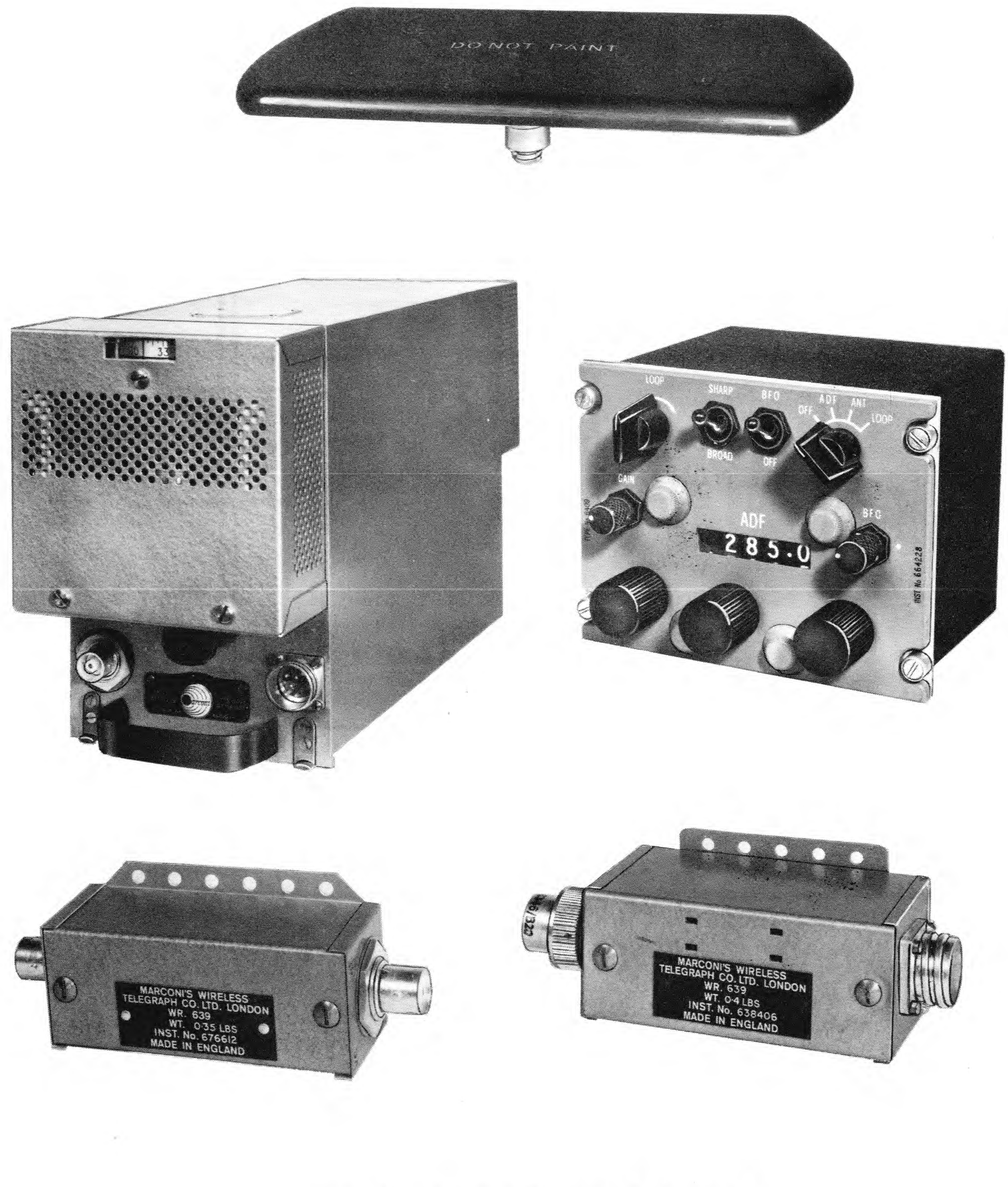


Fig. 1 Main units of ARI.23119

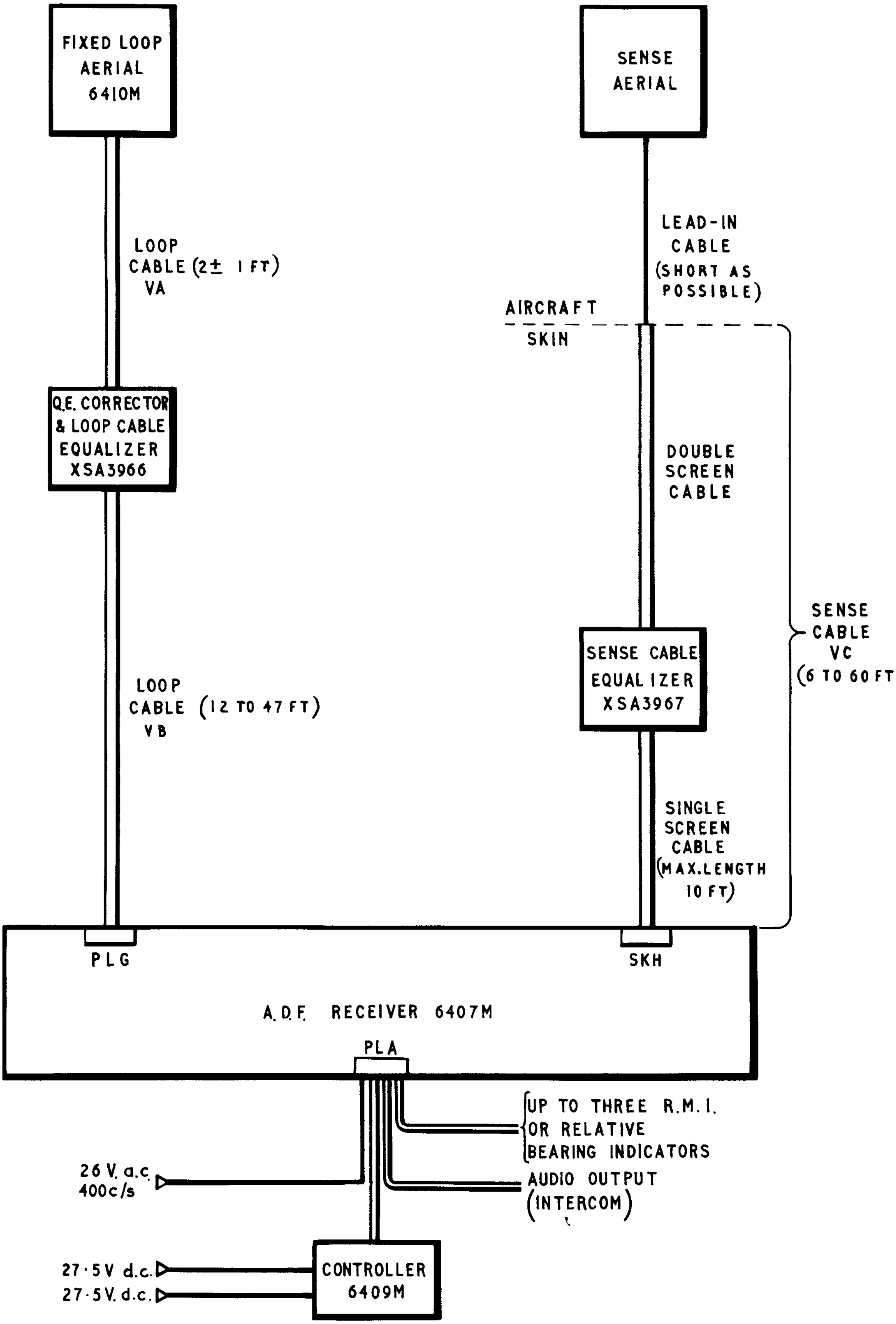


Fig. 2 ARI.23119 : system block diagram
(single control installation)

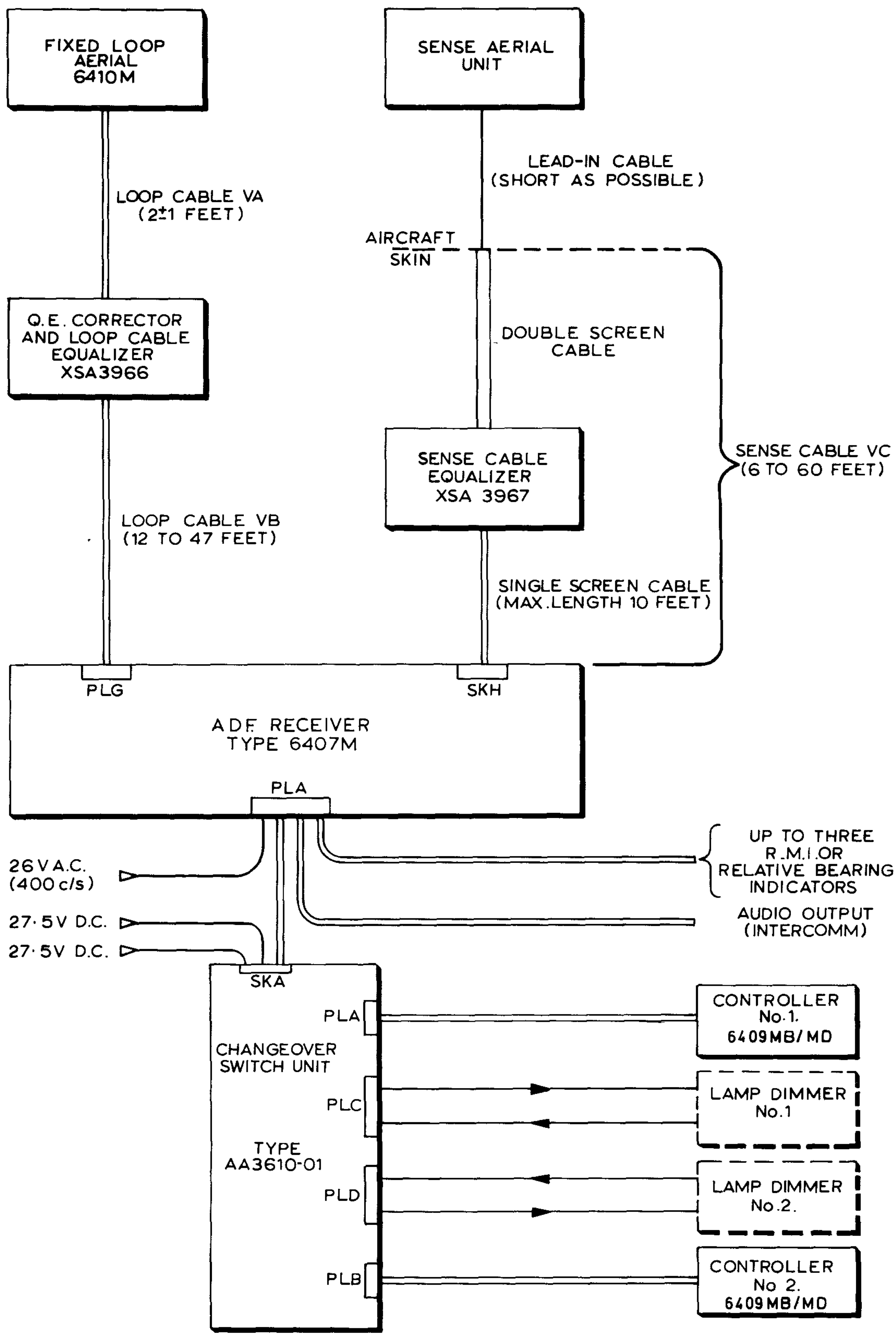


Fig. 3 ARI.23119 : system block diagram (dual control installation)

2 The loop aerial, tuned capacitively, consists of two ferrite-cored loops crossed at 90°, and when mounted on the aircraft provides for +12½° fixed quadrantal error (Q.E.) correction. The Q.E. and loop cable equalizer inserts into the loop aerial circuit a passive network to compensate for cable lengths shorter than the full length of 50 ft and also to provide for additional Q.E. correction of up to ±12°. Similarly the sense cable equalizer compensates for sense cable lengths shorter than 60 ft and also finely adjusts the total sense aerial capacitance to the exact value required for correct tracking of the inductive tuning system.

3 The receiver is a single-conversion superhet automatically tuned over the range 100 kHz to 1799.5 kHz in steps of 0.5 kHz using diode switching to select the crystals required. The output is fed to one or more R.M.I. pointers or relative bearing indicators.

4 The ADF receiver is controlled by a control unit, mounted within easy reach of the pilot. All the controls are mounted on a front panel with the control functions engraved in white lettering. The frequency indicator is illuminated when the equipment is switched on, but provision is made for the red edge-lit panel illumination to be controlled from the general cockpit-lighting system.

5 A brief description of the units is given in the following paragraphs. Constructional details are given in Chap. 2 of this Part and more detailed information on the aerial systems in Chap. 3 of this Part.

GENERAL DESCRIPTION

Fixed loop aerial system

6 The fixed loop aerial is a sealed unit suitable for external mounting and consists of two coils, crossed at 90°, wound on the same ferrite core. Connection to the aerial is made via a 6-way Cannon-type WK-6-32S plug. The aerial is connected to the Q.E. and loop cable equalizer by the cable identified as VA in fig. 2, while the cable VB connects the Q.E. and loop cable equalizer to the receiver.

7 The Q.E. and loop cable equalizer provides additional Q.E. correction and also inductance and capacitance to compensate for cables whose total length (VA plus VB) is less than 50 ft. Adjustment of the equalizer is carried out by the manufacturer to suit the cable length and Q.E. correction required. Provision is made for Q.E. correction (additional to that provided by the loop) of from +12° to -12° in steps of 1° and compensation for various VB cable lengths of 12 ft to 47 ft.

8 Three types of loop aerial are available designated 6410M, 6410MB and 6410MB-1. The M and MB types differ in the angle at which the connector is mounted and the MB-1 type has improved encapsulation.

9 The sense aerial is supplied as part of the aircraft installation. The sense aerial cable, identified as VC in fig. 2, consists of a special version of Uniradio 64 and may be divided into two sections to suit the installation. The sense cable equalizer provides capacitance and inductance to compensate for sense cables that are shorter than the full length of 60 ft and also provides a means of trimming the total sense aerial capacitan measured at the receiver input, to the required value of 830 pF necessary

for the correct tracking of the receiver tuning system. The equalizer XSA3967 is suitable for use with cables 26 to 60 ft long.

ADF receiver 6407M

10 The receiver, a block diagram of which is shown in fig. 4, is fully transistorized and requires a power supply of 27.5V d.c., the power consumption during normal ADF operation being approximately 22 watts. During channel selection the consumption increases to a maximum of approximately 42 watts due to the operation of the various relays and clutches and the motor that drives the tuning capacitors and inductors. Connections to the receiver are made via a back-plate junction box and two aerial plugs on the front of the receiver; a six pole plug for the loop aerial and a single-pole plug for the sense aerial. The receiver is a single-conversion superhet with an intermediate frequency of 455 kHz and covers the range 100 kHz to 1799.5 kHz in four bands:

Band 1	100 kHz	to	199.5 kHz
Band 2	200 kHz	o	419.5 kHz
Band 3	420 kHz	to	899.5 kHz
Band 4	900 kHz	to	1799.5 kHz

Amplified a.g.c. is supplied to the first four of the five stages of i.f. amplification and to the permeability-turned r.f. stage immediately preceding the mixer. A functional description of the receiver is given later in this chapter (para. 14) and a complete circuit description in Part 4, Chap. 1.

Controllers 6409M, 6409MB and 6409MD

11 The controllers contain the switches and potentiometers for controlling the ADF system. Three versions are available; 6409M for single control installations and 6409MB and 6409MD for dual control installations. The only difference between the MD and MB types is in the colour of the front panel, grey for MB and black for MD. The controls are as follows.

11.1 Frequency selection. There are three frequency selection controls arranged below an in-line frequency indicator. The left-hand knob selects hundreds of kHz from 1 x 100 kHz to 17 x 100 kHz the centre knob selects tens of kHz from 0 x 10 kHz to 9 x 10 kHz and the right-hand knob selects unit kHz and half kHz from 0 kHz to 9.5 kHz.

11.2 Function sleection. This is controlled by the OFF/ADF/ANT/LOOP switch. In the ADF position the bearing of the received station is taken and indicated automatically, in the LOOP position the bearing is obtained manually by operation of the LOOP control, and in the ANT potition the receiver is used for normal communication purposes.

11.3 GAIN control. The function of the GAIN control is governed by the position of the function selector switch. In the ADF position the GAIN control functions as an a.f. gain control and in the ANT and LOOP positions it functions as a r.f. gain control.

11.4 LOOP control. The loop control provides for manual control of the speed and direction of rotation of the goniometer search coil.

11.5 Selectivity switch. The receiver selectivity is controlled by a switch having two positions marked BROAD and SHARP. In the BROAD position the receiver has a band-width of 3 kHz and in the SHARP position an additional crystal filter is brought into the i.f. circuit to reduce the bandwidth to about 1.2 kHz.

11.6 Reception of C.W. A two-position switch marked B.F.O. and OFF controls the operation of the beat-frequency oscillator in the receiver. A separate knob identified B.F.O. operates a potentiometer which controls the pitch of the B.F.O. note. With the knob turned fully clockwise the B.F.O. gives zero beat and with the knob turned fully counter-clockwise the B.F.O. note rises to about 1400 kHz. With the knob set approximately mid-range so that the white dot on the knob is adjacent to the white dot on the panel, the B.F.O. note is 1000 Hz.

11.7 Changeover switch. The changeover push-button switch is fitted only on the 6409MD and 6409MB controllers. This switch is located below the B.F.O. control and its operation at a particular controller connects the ADF receiver to that controller.

11.8 A full circuit description and circuit diagram of the controllers are given in Part 4, Chap. 2.

Mounting

12 The mounting for the receiver 6407M, normally installed in the radio bay, will differ from aircraft to aircraft. In the V.C.10, for example, the mounting is integral with the mountings for other radio units. The common feature of all types of mounting is that they will be of the back-plate junction box type and will conform to the ARINC 404 specification.

Connectors

13 The connectors will differ from aircraft to aircraft, the only critical connectors in respect of length being those associated with the loop and sense aerials. Full details of these are given in Chap. 3.

Indicators

14 Special indicators have not been designed specifically for this installation the receiver being capable of driving three standard 26V, 400 Hz R.M.I. or R.M.S. indicators or can supply ADF information to the aircraft flight system.

FUNCTIONAL DESCRIPTION

Note ...

Readers not familiar with the principles on the fixed loop ADF system are advised to read the Appendix to this Chapter.

Frequency selection

15 The required frequency is selected on the controller by means of three frequency selection switches. Tuning and band selection are then carried out automatically by a single servo motor in the receiver which operates a four-position bandswitch and the ganged tuning capacitors and inductors through a gearbox and three electrically-operated clutches. The bandswitch clutch is

controlled by a wafer in the bandswitch, this being interconnected with the controller frequency selection switches in such a way that the bandswitch clutch remains engaged until the band containing the required frequency is selected by the bandswitch. Control of the servo motor and the slow and fast clutches is by a system of relays and micro-switches, the latter reversing the direction of rotation of the servo motor at the limits of the tuning range in the selected band. The relays control the operation of the servo motor, engage the appropriate clutch and finally stop the motor, disengage the clutch and apply the brake when the receiver is tuned to the selected frequency.

16 The frequency to which the receiver is tuned is determined by three crystal-controlled oscillators and a crystal gate (fig. 3). Frequency selection involves selecting suitable crystals for the three oscillators and choosing one of two crystals for the crystal gate. Three knobs on the controller select the required frequency in three stages. The left-hand knob selects hundreds of kHz from 1 x 100 kHz to 17 x 100 kHz the centre knob selects tens of kHz from 0 x 10 kHz to 9 x 10 kHz and the right-hand knob selects unit kHz and half kHz from 0 kHz to 9.5 kHz. Each of the three knobs operate a selector switch which is interconnected with the corresponding kHz x 100, kHz x 10 and kHz x 1 crystal bank in the receiver. The primary function of each selector switch is to select the required crystal from the corresponding crystal bank and connect it to control the associated oscillator. A detailed description of how this is done is given in Part 4, Chap. 2.

17 The local oscillator signal, 455 kHz higher than the frequency to which the receiver is tuned, is passed through a buffer-amplifier 5VT1 and is then successively mixed with the outputs of the three crystal-controlled oscillators Bandpass filters after each of the three mixers block the passage of the signal until the local oscillator is mechanically tuned to approximately the required frequency. The last bandpass filter is a tuned transformer and passes a narrow band of frequencies centred on 88.75 kHz. The output from this is passed either to an 88.5 kHz or an 89.0 kHz crystal according to whether a half-kilocycle or a whole kilocycle has been selected on the controller.

18 The output from the 88.5 kHz or 89.0 kHz crystal controls a transistor 5VT19 which in turn triggers a monostable multivibrator when the servo motor drives the tuning system through the required frequency. The output from the multivibrator consists of a single pulse that switches the control relays so that they disengage the fast clutch and engage the slow clutch. The slow clutch operates through a reversing gear which causes the tuning system to be driven back to the required frequency again, where the multivibrator is once more triggered. The single pulse produced causes the control relays to stop the motor, disengage the clutches and apply the brake. Simultaneously a change-over relay 5RLF disconnects the selected 88.5 kHz or 89.0 kHz crystal from the trigger transistor controlling the multivibrator and reconnects it to an automatic frequency control circuit which then finely tunes the local oscillator to precisely 455 kHz above the selected frequency, and corrects any subsequent tendency to drift.

Frequency control

19 The automatic frequency control circuit consists of a phase bridge and a reactance transistor. The output from the final bandpass filter (para. 16) is applied via 5VT10 to the phase bridge as the variable-phase signal where it is compared with the fixed-phased signal provided by an oscillator

attitude of the search coil in the goniometer and the direction of arrival of the signal at the fixed loop aerial, there is a phase difference of either +90° or -90° between the control phase signal and the reference phase signal at the gonio servo motor. These signals together drive the gonio search coil to the 'null' position, i.e. to the position where there is no pick-up from the loop aerial.

Note ...

It should be noted that in this description the incidental phase shifts introduced by the receiver circuits have been ignored. The receiver circuits have been designed so that these stray phase shifts total 180° and therefore do not interfere with the ADF operation.

Function selection

23 The principal receiver circuits are controlled by the function switch on the controller (see Part 4, Chap. 2, fig. 6). When the switch is set to any one of the three positions ADF, ANT or LOOP a 27.5V d.c. supply is connected to the receiver power supply circuit and the controller dial lamps are switched on. The panel lights are controlled separately by a cockpit dimmer switch.

24 Set to ADF, the loop signal circuit consists of the loop amplifier, phase splitter, balanced modulator phase corrector and buffer amplifier, feeding into the r.f. amplifier where the sense signal is added to the loop signal. Set to ANT, the loop amplifier and phase splitter are rendered inoperative thus preventing any output from the loop circuit. The function of the buffer amplifier 3VT3 is now to prevent feedback of the sense signal into the loop circuit. At the same time the function switch disconnects, from the balanced modulator, the 135 Hz switching voltage supplied by the reference phase amplifier. When the function switch is set to LOOP, the loop amplifier, phase splitter, balanced modulator and buffer amplifier are rendered operative but the function of the phase splitter is changed and it now acts as an additional r.f. amplifier in the loop signal circuit. The 135 Hz reference phase switching voltage is disconnected from the balanced modulator and the latter is opened to allow the passage of the loop signal from the phase splitter to the buffer amplifier. The control phase amplifier is also disconnected from the pre-amplifier, and hence from the ADF detector output, and reconnected instead, via the LOOP manual control and a 90° phase-shifting element, to the reference phase amplifier output. A dummy aerial is substituted for the sense aerial to maintain correct tracking of the permeability tuning.

25 The function switch also determines the use of the GAIN control potentiometer in the controller either for receiver r.f. gain control or for receiver audio gain control. In the ADF position the gain control operates in the audio circuit but in the ANT and LOOP positions it controls the a.g.c. voltage and hence the amount of r.f. gain.

26 The function switch also provides a facility for controlling a VOR/ADF indicator if required. Such an indicator might be used when the same R.M.I. is shared by an ADF and a VOR system. When the function switch is set to ADF the line to the VOR/ADF indicator is earthed; in all other positions it is disconnected from earth. The LOOP manual control, which consists of a switch ganged with a potentiometer spring-biased to a centre OFF position, provides a means of manually controlling the speed and direction of rotation of the servo motor that drives the search coil in the goniometer.

Selectivity control

27 When the selectivity control switch in the controller is set to BROAD, only one crystal filter is connected in the i.f. circuit giving a bandwidth of about 3.0 kHz. When set to SHARP, an additional filter is brought into circuit reducing the bandwidth passed by the i.f. circuit to about 1.2 kHz.

B.F.O. control

28 The beat frequency oscillator, which feeds into the audio detector circuit is controlled by a B.F.O. ON/OFF switch and a B.F.O. tone-control switch in the controller. The tone control consists of a potentiometer as a variable resistor to control the current through the transistor in the B.F.O. oscillator circuit. This transistor operates near the common emitter cut-off frequency, and, varying the current, varies the phase shift across the transistor. As the total phase shift around the oscillator loop needs to be 360° to maintain oscillation, the circuit oscillates at the frequency where the phase shift across the L-C element in the collector lead plus the phase shift across the transistor gives the required total phase shift of 360°

Outputs

29 The synchro output from the ADF receiver is suitable for the operation of up to three R.M.I. pointers or relative bearing indicators fitted with standard 26V 400 Hz synchros. The audio output is 300 mW into a load of either 100 or 500 ohms.

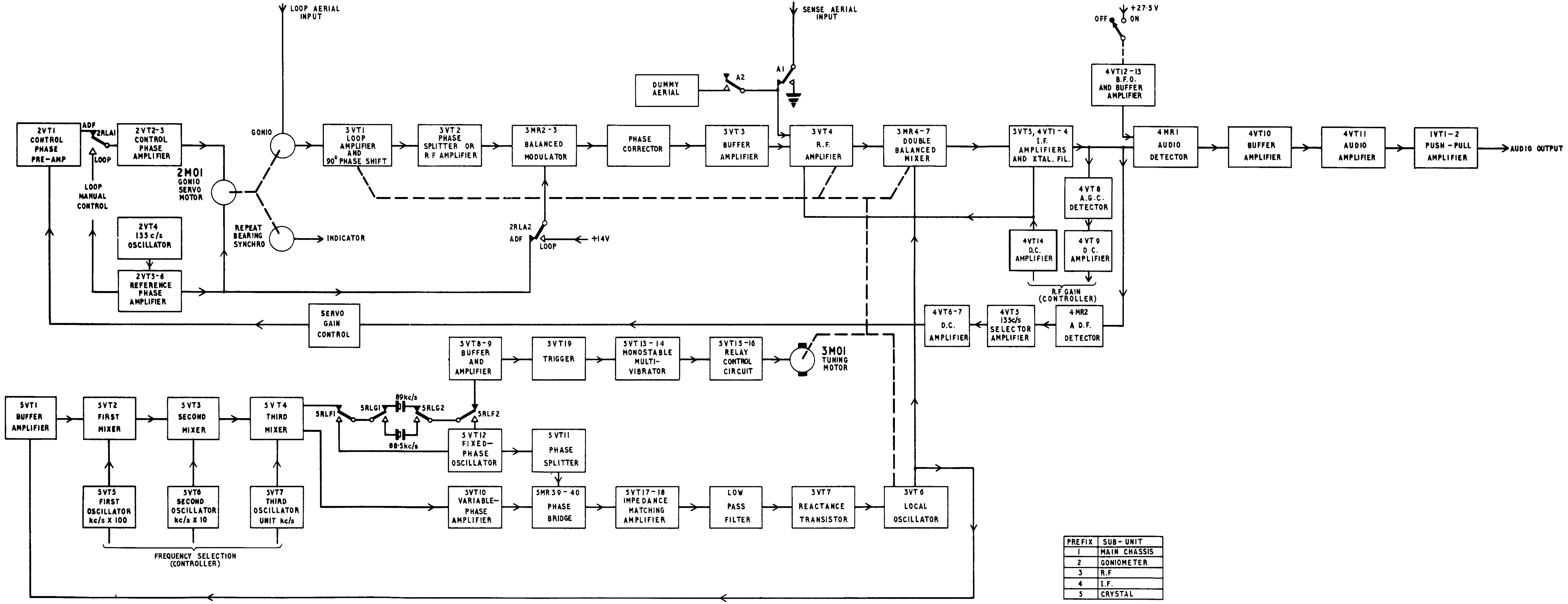
Power distribution

30 The 27.5V d.c. supply for the receiver circuits is connected via a wafer of the function switch on the controller as is the supply to the dial lamps. The panel lamps are unswitched but may be controlled by the addition of a dimmer if required. The 26V 400 Hz supply for the bearing indicator synchro in the receiver is connected directly and is not switched.

<Dual control installation

31 The changeover switch unit (5826-99-955-7008) contains a single multi-wafer rotary switch operated by a Ledex solenoid motor and is used to connect the ADF receiver to either one of two 6409MB (or 6409MD) controllers in a dual control installation. The 6409MB (or 6409MD) controller differs from the 6409M controller in that it has an additional press-button changeover switch located below the BFO switch. Operation of this switch causes the ADF receiver connection to be transferred to the local controller via the changeover switch unit. The ADF receiver is connected to the changeover switch unit via a 55-way socket, and connections to the two 6409MB (or 6409MD) controllers are through two 55-way plugs. Two 6-way plugs are provided for connections to the dial and panel lamps of the two controllers and permit re-arrangement of the lighting control circuits to suit different operating conditions. The solenoid motor is controlled by the changeover switch on the controller that is not in use. When the switch is pressed, the solenoid motor is energized and drives the rotary changeover switch round to a new position where the controller originally connected to the receiver is disconnected and the other controller is connected in its place. In this configuration, one of the wafers in the rotary switch also disconnects the solenoid motor from the changeover switch of the controller now in use and

reconnects it to the changeover switch of the controller that is out of us
The solenoid motor therefore stops and the controller in use remains connected unless the push button switch on the other controller is pressed



PREFIX	SUB-UNIT
1	MAIN CHASSIS
2	GONIOMETER
3	R.F
4	I.F.
5	CRYSTAL

Receiver, radio 5826-99-970-2200: block diagram.

Fig. 4

AIR DIAGRAM-MIN
116B 0101 MD14
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 1 Prepared by the Ministry of Technology

D.840948. R.C.963

Appendix 1

PRINCIPLES OF ADF

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

PRINCIPLES OF ADF AERIA

1. An automatic direction finder automatically indicates the direction from which the electromagnetic field radiated by a suitable selected m.f. transmitter arrives at the ADF aerials.

2. Suitable m.f. transmitters radiate a 'vertically polarised' electromagnetic field. In a vertically polarised electromagnetic field the direction of action of the electric component is vertical and the direction of action of the magnetic component is horizontal. Both components act at right-angles to the direction of travel of the field (fig. 1).

3. An inductive aerial consisting of one or more loops of wire may be constructed so that it will

tic component of the
ch an aerial about its vertical axis the amount of coupling may be varied. By turning the aerial to a point of minimum coupling it can be used to indicate the line of action of the magnetic component and therefore the line of travel of the electromagnetic field (fig. 2).

4. If a loop aerial is turned through 360 degrees in azimuth in a vertically polarised electromagnetic field, the r.m.s. magnitude of the different voltages induced in the loop as it is turned may be plotted against the loop's orientation in the form of a polar diagram (fig. 3).

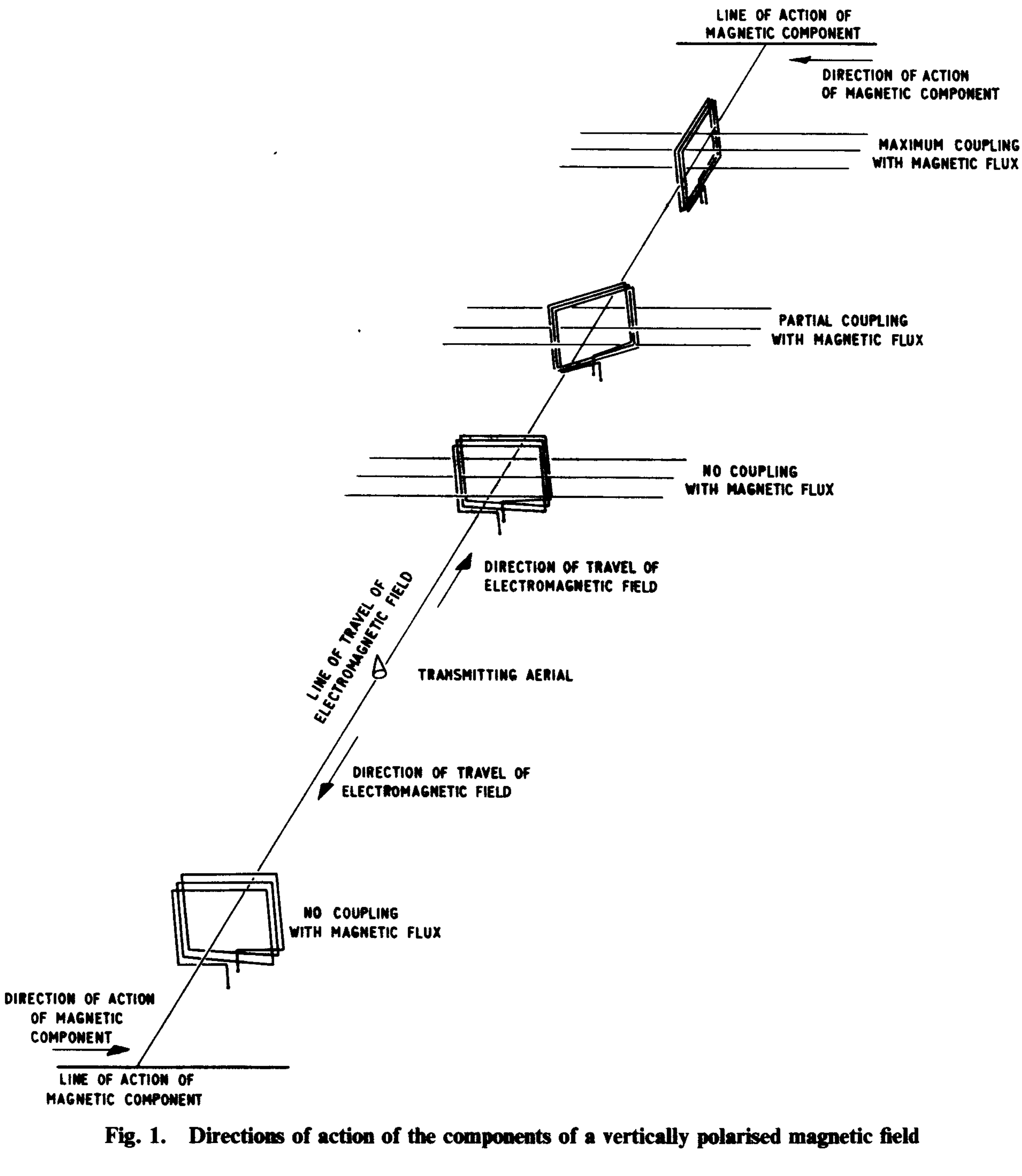


Fig. 1. Directions of action of the components of a vertically polarised magnetic field

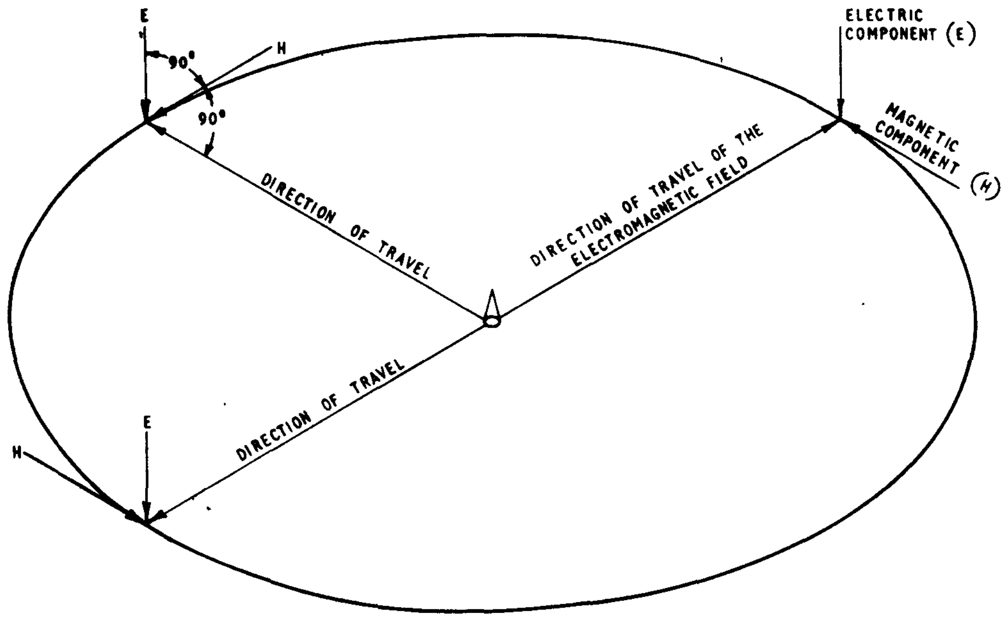


Fig. 2. Indication by a loop aerial of the line of travel of an electromagnetic field

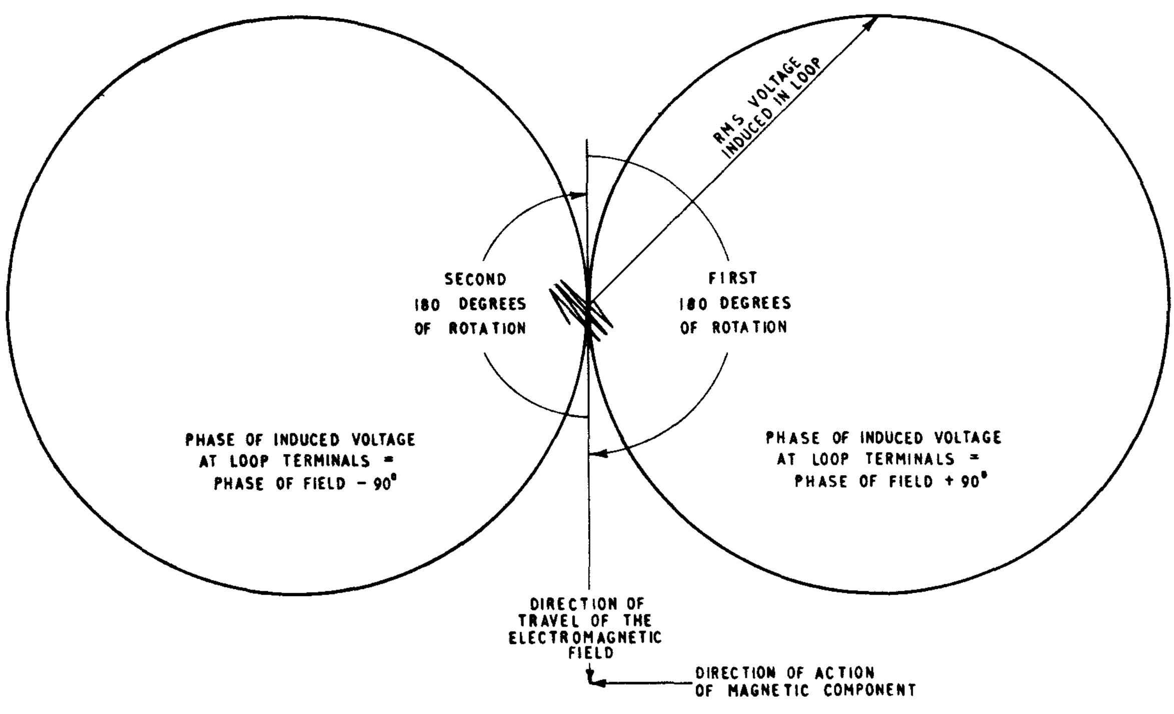


Fig. 3. Polar diagram

5. The polar diagram shows that ther points of zero induced voltage (corre with two positions of minimum coupling with the magnetic flux) as the loop aerial is turned through 360 degrees. If one of these points is used as the reference point from where the rotation of the loop is measured, the phase of the voltages induced in the loop during the first 180 degrees of rotation is exactly opposite to the phase of the voltages induced during the second 180 degrees rotation. This indicates that there are abrupt reversals of the phase of the induced voltage as the loop turns through the two positions of minimum coupling.

6. At any instant, the voltage induced in the loop is proportional to the rate of change of the density of the magnetic flux coupling with the loop. The magnitude of the magnetic flux density varies sinusoidally with time. The rate of change of the magnetic flux density also varies sinusoidally with time but its phase leads the phase of the magnitude variation by 90 degrees. Consequently the phases of the voltages appearing at the loop terminals either lead or lag behind the phase of the electromagnetic field by 90 degrees according to the attitude of the loop, i.e. whether it is orientated in the first 180 degrees or the second 180 degrees of rotation as measured in fig. 3.

7. The electric component of the electromagnetic field acts in a vertical direction and is therefore independent of the direction of travel of the field (fig. 1). A capacitive aerial may be constructed so that it will couple only with the electric component of the field. The voltage generated between the two 'plates' of the capacitive aerial is in phase with the electromagnetic field. The 'sense aerial' of an ADF system is a capacitive aerial; one 'plate' consists of the aerial unit, the other 'plate' consists of the aircraft structure.

THE ADF RECEIVER

8. In an ADF receiver (fig. 4) the phase of the loop voltage is advanced by 90 degrees in an early stage of the receiver so that according to the attitude of the loop aerial, the loop signal is either in phase with or 180 degrees out of phase with the electromagnetic field that is acting on both the loop aerial and the sense aerial. A phase splitter then feeds the phase-advanced loop signal and its reciprocal to the 'balanced modulator' consisting of two electronic switches. The switches are opened alternately at each half-cycle of the 'control frequency' (135 c/s in the example given in fig. 4) to release blocks of loop signal which are alternately in phase with and 180 degrees out of phase with the electromagnetic field acting on the aerials. These blocks of loop signal are applied to an input circuit of the r.f. amplifier to which the signal from the sense aerial is also applied. The amplitude of alternate blocks of loop signal is augmented or diminised by the addition of the sense signal according to whether

or 180 degrees out of from the r.f. amplifier has a 135 c/s modulation envelope whose depth depends on the relative magnitudes of the sense and loop signals at the common input. As the loop aerial turns through the 'null' points (of zero voltage) the modulation envelope 'inverts' as shown in fig. 4. Consequently, when the 135 c/s voltage is extracted by the receiver's 'control detector', it is either in phase with or 180 degrees out of phase with the original 135 c/s control frequency according to the attitude of the loop aerial.

9. This 'vari-phase' output of the receiver's control detector is phase-shifted 90 degrees in the control amplifier and used to control the magnitude and phase of the power supplied to one coil of a two-phase motor which serves to rotate the loop aerial. The other coil of the two-phase motor is fed with power in phase with the original 135 c/s control frequency. Operation of the motor depends on there being a supply of power to both coils. This in turn depends on there being a loop voltage. Direction of rotation of the motor depends on whether the phase of the power supplied to one coil leads or lags behind the phase of the power supplied to the other coil. Therefore the loop motor always turns in one direction when the loop is orientated somewhere in the first 180 degrees of rotation (see fig. 3) and in the opposite direction when the loop is orientated somewhere in the second 180 degrees of rotation. Consequently the loop is always turned to the same one of the two 'null' positions and never to the other null position. One end of the loop aerial may be suitably marked so that this one null position can be used to indicate the direction from which the electromagnetic field appears to be arriving at the aerial.

QUADRANTAL ERROR

10. When the m.f. electromagnetic field arrives at an aircraft fitted with an ADF system, it causes m.f. alternating voltage gradients to appear not only in the ADF aerial circuits, but also in the aircraft's structure and in external appendages to the aircraft such as any other aerials. The voltage gradients thus created by the 'primary' electromagnetic field cause m.f. alternating currents to flow in the aircraft's structure and appendages. These in turn create 'secondary' electromagnetic fields which may couple with the ADF aerials and affect the ADF performance. By careful choice of the position on the aircraft where the loop aerial is stationed, only the secondary fields due to the currents flowing in the aircraft's wings and fuselage need have a significant effect on the ADF performance. Their effect is to cause bearing errors which vary with the direction of arrival of the primary field relative to the aircraft. Because of the symmetry

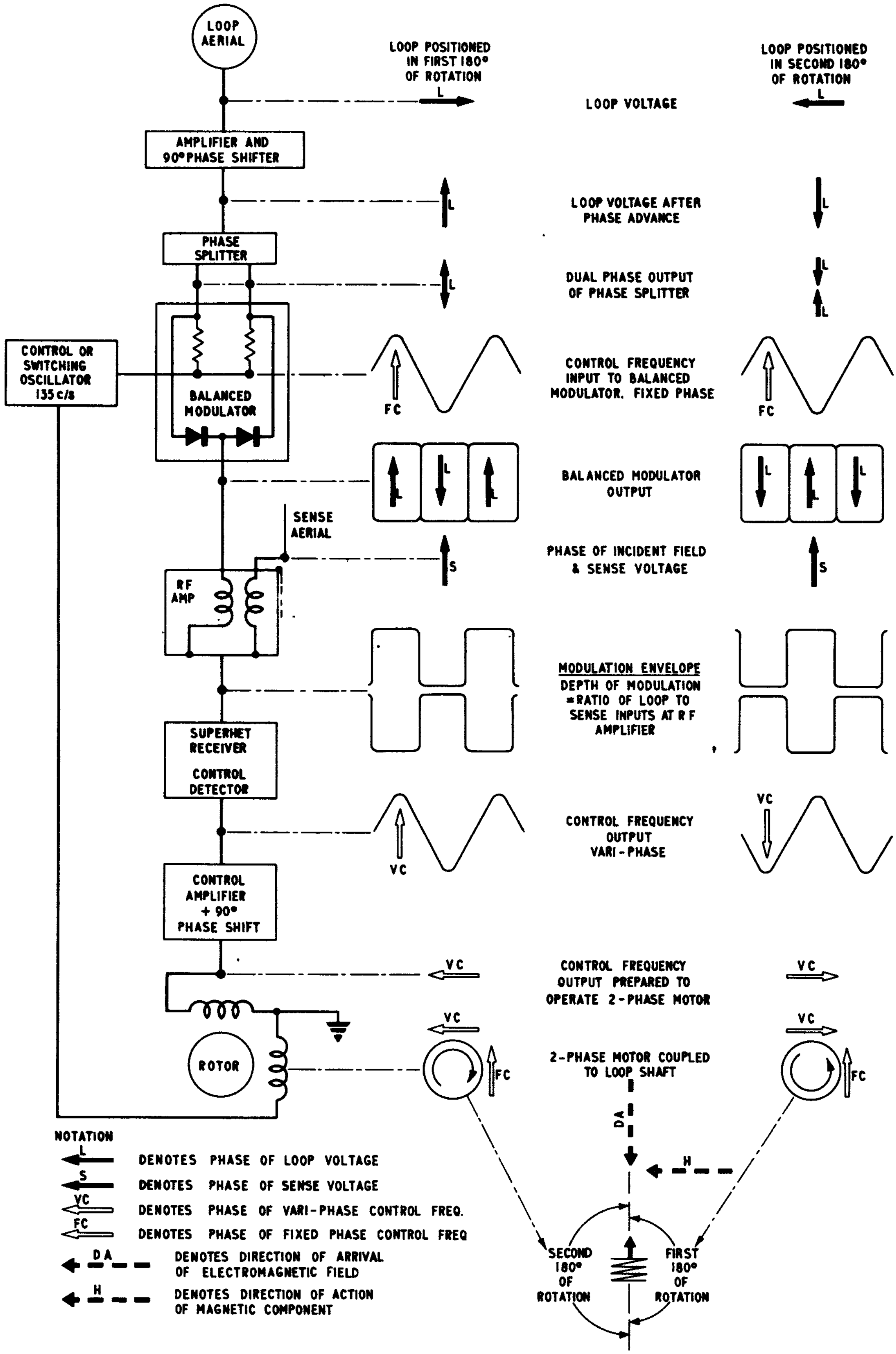


Fig. 4. Principles of operation

of the aircraft the variation of bearing repeated every 90 degrees as the relative direction of arrival of the primary field is changed through 360 degrees; consequently this form of bearing error is known as quadrantal error.

11. Quadrantal error can be compensated for, usually by the use of a device known as a Q.E. corrector. The method of introducing the compensation depends on the design of the loop aerial circuit.

12. On modern high-speed aircraft it is not practicable to fit a rotatable loop aerial on the exterior surface of the aircraft. Instead, the electromagnetic field at a suitable position outside or just inside the aircraft is sampled by a device known as a 'fixed loop aerial'. This device consists of two small coils of wire wound on cores of a material such as 'ferrite' that has a high magnetic permeability. The two coils are connected to two smaller coils similarly arranged at right-angles in an instrument known as a coils reproduce the characteristics of the magnetic field sampled by the coils of the fixed loop aerial. In the goniometer a miniature loop aerial known as a 'search coil' is used to probe the reproduced field in the same way as a rotatable loop aerial could have been used to probe the original field at the position where the fixed loop aerial is stationed.

13. The use of aerial system containing a goniometer and fixed loop aerial facilitates the introduction of compensation for Q.E. A fixed amount of compensation can be introduced by designing the fixed loop aerial so that one loop coil is more 'sensitive' than the other, e.g. it could be provided with a larger core so that it would couple with more magnetic flux.

14. A variable amount of compensation can be introduced by fitting suitable attenuators in the cables connecting the fixed loop aerial coils to the goniometer coils. These attenuators are usually housed in a single 'Q.E. corrector' unit.

Chapter 2

CONSTRUCTION

(completely revised)

CONTENTS

RECEIVER 6407M

1 The receiver chassis is housed in a short ½ ATR case with a projecting doghouse at the rear end, the case being secured to the chassis with a single quick-release fastener. A second doghouse, containing the goniometer sub-unit and displaying the built-in bearing indicator, is attached to the front panel of the receiver and has a separate cover held in place by three captive screws. Beneath the front doghouse the front panel of the receiver carries a connector for the sense aerial cable, a connector for the loop aerial cable, the servo gain control (protected by a removable hemi-spherical plastic cap), two hold-down hooks and a handle for easy manipulation of the receiver when inserting it into, or removing it from, the mounting tray. Apart from the aerial connections, which are made at the two connectors on the front panel, all other electrical connections to the receiver are made at a 57-pin Cannon plug fitted beneath the rear doghouse. The plug mates with a corresponding socket fitted to the backplate.

2 Two hold-down pins fitted to the backplate pass through two holes in the rear end of the receiver case and enter two similar holes in the receiver chassis to secure the rear end of the receiver in the mounting tray. Two additional pins may be fitted to the backplate to locate in two index holes in the rear end of the receiver case in order to prevent a different equipment of similar size being accidentally substituted for the ADF receiver. Two hold-down hooks, fitted at the front end of the receiver chassis, engage with thumbscrews fitted to the front of the mounting tray to secure the front end of the receiver.

Main chassis

3 The receiver main chassis consists of a single horizontal platform supported between a front vertical panel and a rear vertical panel secured together by two H-shaped side plates. Attached to the main chassis by captive screws are four plug-in sub-units: the goniometer sub-unit, the r.f. sub-unit, the i.f. sub-unit and the crystal sub-unit. The main chassis carries all the inter sub-unit wiring and those parts of the receiver circuit that are not contained in the other sub-units, including the 89 kHz filter circuit, the audio output circuit and the power supply circuit.

4 The components of the 89 kHz filter circuit are mounted beneath the horizontal platform on the left-hand flange of the rear panel, the right-hand flange carrying the de-coupling capacitors for the bandswitch control wires. The components of the audio output circuit are mounted on brackets behind the rear vertical panel and occupy the rear doghouse together with the components of the power supply circuit.

Goniometer sub-unit

5 The goniometer sub-unit is a four-sided, open-ended structure secured to the front panel of the receiver main chassis by four captive screws which enter four internally-threaded pins, the four pins also serving to locate the sub-unit correctly on the main chassis and ensure proper mating of the plug on the sub-unit with the socket on the main chassis. The goniometer sub-unit contains the goniometer, the goniometer servo motor, a relative bearing indicator and a synchro transmitter that can operate up to three remote bearing indicators. The built-in indicator is provided primarily for setting-up purposes. The sub-unit also contains the circuits that provide the 135 Hz reference phase and control phase supplies for the gonio servo motor.

R.F. sub-unit

6 The r.f. sub-unit is secured to the upper side of the main chassis by three captive screws. Two plugs placed one under each end of the sub-unit mate with corresponding sockets on the main chassis. This sub-unit contains all the r.f. circuits, including the mixer and the local oscillator. It also contains the first i.f. stage which matches into the BROAD crystal filter in the i.f. sub-unit, and the reactance transistor which operates in conjunction with the phase bridge in the crystal sub-unit to provide automatic frequency control of the local oscillator. The chassis consists of a horizontal base carrying two vertical partitions which divide the upper side of the base into three sections. The front partition is simply a metal plate with a flange to secure it to the base, but the rear partition is a thin box and contains the gear train that conveys drive to the tuning mechanism from the tuning motor.

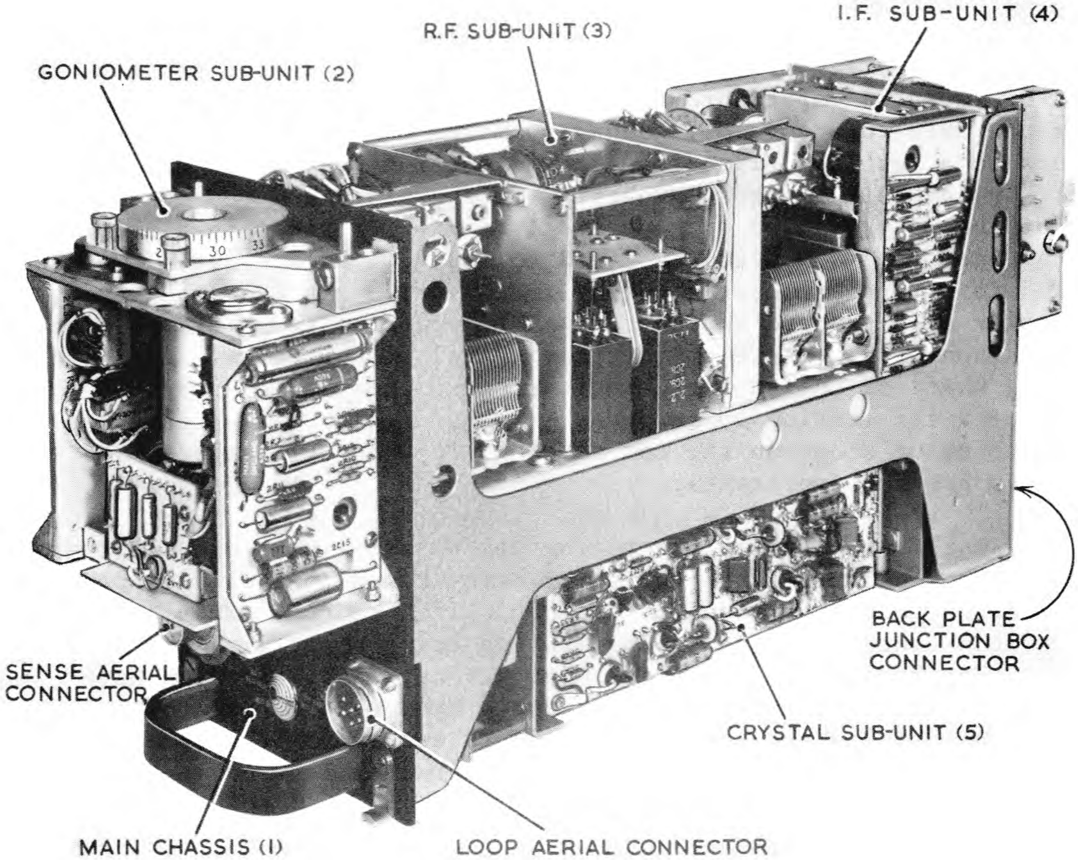


Fig. 1 ADF receiver 6407M : cover removed, right-hand view

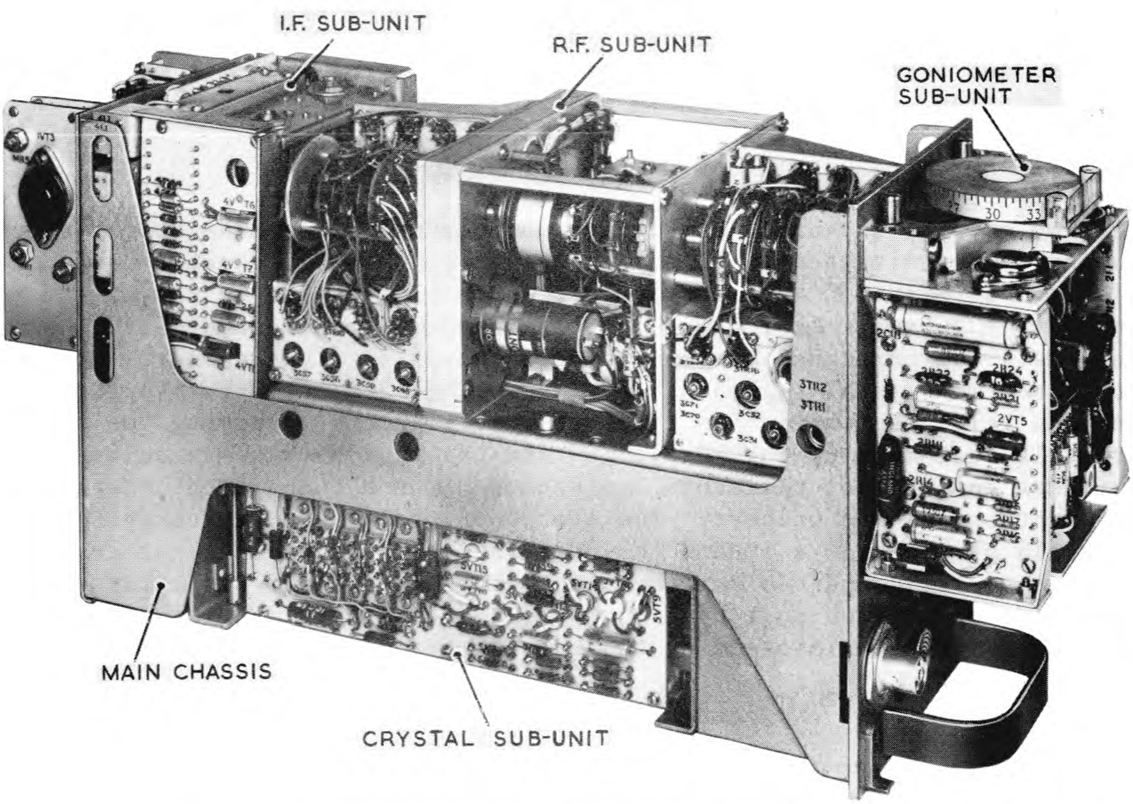


Fig. 2 ADF receiver 6407M : cover removed, left-hand view

7 The tuning mechanism consists of two ganged air-spaced variable capacitors in the front section, two similar ganged capacitors in the rear section and four ganged variable inductors in the centre section, the two sets of variable capacitors being ganged on a common driving shaft. The four variable inductors are ganged by means of a plate joined to a rod which slides in a vertical guide tube. The four inductor cores are attached to the plate by adjustable wires. Rotation of the plate and rod assembly in the guide tube is prevented by a vertical rail which rides in a slot in the edge of the bracket. The plate is moved up and down by a curved lever assembly linked to a further lever attached to the drive shaft of the tuning capacitor. A striker arm attached to the core plate operates two micro-switches set one at each end of the range of vertical travel of the plate. A cam on the driving shaft of the tuning capacitors has stops and notches to engage with a pin used for setting up purposes. The pin is normally retracted to clear the setting up stops on the cam although it can still engage with the end stops to prevent overtravel.

8 The motor that drives the tuning mechanism is also used to operate the bandswitch, the drive from the motor being taken through a gear wheel outside the gearbox to a gear wheel on the bandswitch clutch. When energized, the bandswitch clutch engages the bandswitch drive shaft with the driven gear wheel. The bandswitch comprises nine wafers, eight of which have contacts on both sides. A click-switch, operated by a nylon-toothed wheel on the bandswitch drive shaft, provides an earth return for the bandswitch clutch energizing current until the switch is correctly located in the required position.

I.F. sub-unit

9 The i.f. sub-unit contains the BROAD and SHARP crystal filters that control selectivity, the beat frequency oscillator, the audio, a.g.c. and ADF detectors and all the i.f. amplifier stages except the first. This sub-unit is secured to the upper side of the main chassis by three captive screws, and a single plug under the rear end of the sub-unit mates with a corresponding socket on the main chassis.

Crystal sub-unit

10 The crystal sub-unit, containing the circuits that make up the automatic tuning system, is secured to the underside of the main chassis horizontal platform by means of four captive screws, a single plug on top of the rear end of the sub-unit mating with a corresponding socket underneath the main chassis. The principal components are mounted on five tagboards which comprise two crystal tagboards, the mixer tagboard, the phase bridge tagboard and the relay tagboard. The first crystal tagboard, carrying the seventeen crystals that make up the kHz x 100 crystal bank and the associated diode switches and control resistors, is secured to the top side of the sub-unit by eight screws and washers. The second crystal tagboard, carrying the crystals of the kHz x 10 and the unit kHz crystal banks together with the associated silicon diode switches and control resistors, is secured to the underside of the sub-unit by eight screws and washers and is protected by a plastic cover held in place by the same screws.

11 The mixer board, carrying the oscillator transistors 3VT5 to 7, the three mixer transistors 3VT2 to 4 and the band-pass filters associated with 3VT2 and 3, is held in place on the right-hand side of the sub-unit by six screws. The phase bridge board, carrying the band-pass filter associated with 3VT4 and the components that comprise the phase bridge circuit, is attached to the front end of the crystal sub-unit and is protected by a metal cover held in place by four screws and washers. The two crystals 5XL1 (89 kHz) and 5XL2 (88.5 kHz), one of which is used for the control of the fixed-phase oscillator when the automatic frequency control circuit is operating, are mounted behind the phase bridge board with the two relays 5RLF and 5RLG that control their selection and application. The relay board, carrying the relays that control the operation of the automatic tuning system (5RLE, 5RLA, 5RLD, 5RLB and5RLC) and the remainder of the control circuitry including the monostable multivibrator and the associated trigger transistor, is attached to the left-hand side of the crystal sub-unit by six screws.

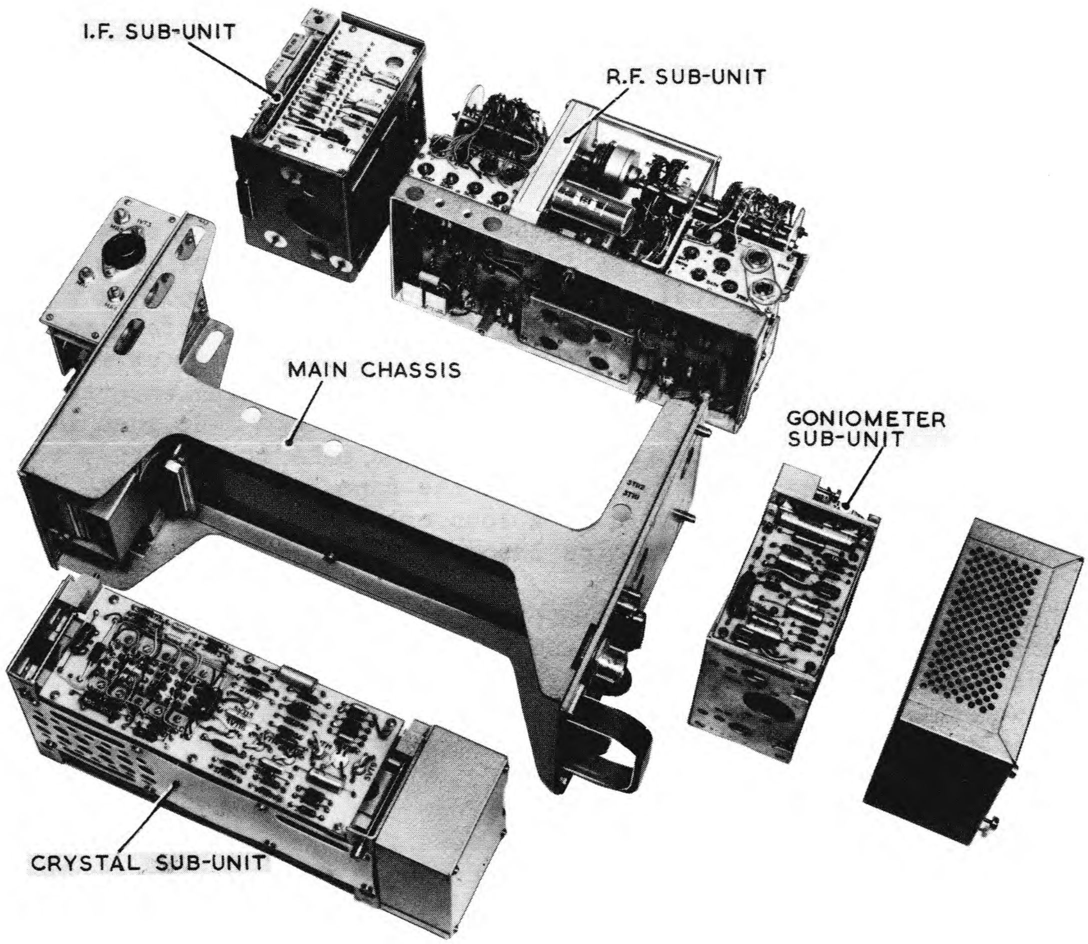


Fig. 3 ADF receiver 6407M : sub-units

LOOP AERIAL 6410M

12 The loop aerials are of the Bellini-Tosi-type and consist of two fixed loops crossed at 90 degrees. The assembly is contained in a low-drag housing suitable for external mounting on the top or bottom exterior surface of the fuselage of an aircraft. When used in an AD360 installation the aerial provides a fixed quadrantal error correction of ±12½ degrees. Three versions of the aerial are available designated 6410M, 6410MB and 6410MB-1. The M and MB versions are partially encapsulated and the MB-1 version is fully encapsulated with improved fibreglass bonding. Differences between the M and MB versions are in the angle at which the connector is mounted.

13 The loops comprise two centre-tapped coils wound at right-angles to each other on a single common core made up of twelve ferrite bars assembled together in the form of a rectangular slab. Connections to the coils are made at a 6-way Cannon plug mounted on a pillar attached to the core. The aerial coil is contained in a resin-bonded glass fibre housing shaped like an inverted dish. Four hollow pillars anchored to the housing pass through holes in the core of the aerial assembly, which is secured in place by nuts on the protruding threaded ends of the pillars, the complete assembly in the housing being encapsulated in polyester resin. The base of the resin-filled housing is protected by a metal base plate held in place by sixteen self-tapping screws and the glass-fibre housing itself is finished with an erosion-resistant conductive coating.

14 Two notches in opposite edges of the glass-fibre housing serve as an alignment guide when the aerial is installed in an aircraft. The notches lie on the fore-and-aft electrical axis of the aerial which should be parallel with the aircraft fuselage. The Cannon plug connector is offset to one side of this axis and normally the loop aerial should be mounted so that the connector is on the port side of the electrical centre line when the loop is mounted on the top of the aircraft and on the starboard side when the loop is centrally mounted. If structural considerations make it necessary to reverse the aerial so that the connector falls on the opposite side to the above positions then a suitable version of a loop cable VA in which the connections to the fore and aft and athwartships loops have been reversed should be used.

15 The fore-and-aft loop consists of five turns of Litz wire wound around the short axis of the ferrite core and the athwartships loop consists of six turns of Litz wire wound around the long axis of the ferrite core (fig. 5) the inductances of the two coils being equal. The sensitivities of the two coils, in terms of the output voltages measureable at the terminals when each coil in turn is orientated for maximum magnetic coupling with a given signal, are different. The athwartships loop is more sensitive than the fore-and-aft loop and this difference in sensitivity provides the fixed correction for quadrantal error of +12½ degrees. The two ends of the fore-and-aft loop are connected to pins 1 and 2 of the Cannon plug, the centre tap being connected to pin 3. The two ends of the athwarthships loop are connected to pins 4 and 5 and the centre tap to pin 6.

Q.E. AND LOOP CABLE EQUALIZER XSA3966

16 The Q.E. and loop cable equalizer unit is constructed on a metal baseplate to each end of which is spot-welded a flanged side piece. These two side pieces carry the plug and socket connectors for the loop cables. Between each connector and the associated side piece a flanged plate acts as a shield

to prevent dust entering through the small spaces between the side pieces and the cover. The outer face of each of the two dust shields is marked with the letters VA or VB to indicate which part of the loop cable mates with the adjacent connector. The tagboard carrying the electrical components is attached to two brackets by four panhead screws, the brackets being riveted to the rear flange of each of the two side pieces. The inner side of the tagboard is divided into four compartments by one horizontal and two vertical plates attached by tabs that pass through slots in the tagboard and are bent over on the reverse side. The two vertical plates are also secured to the horizontal plate by similar tabs and slots. The two inductors L1 and L2 that determine the amount of Q.E. correction provided by the unit are mounted on the tagboard in the two compartments adjacent to the socket connector SKA which mates with the loop cable VA. The two inductors L3 and L4 that provide lumped inductance compensation for loop cables that are shorter than the full length are mounted on the tagboards in the other two compartments. Mounted on the tagboard adjacent to L3 and L4 are the capacitors that provide lumped capacitance compensation for cables shorter than full length. The unit is completed by a protective metal cover held in place by two turnlock fasteners which enter holes in the two side pieces and engage with catch springs riveted to the inside. The edges of the baseplate project outside the cover and are each drilled with five holes for mounting the unit in the aircraft.

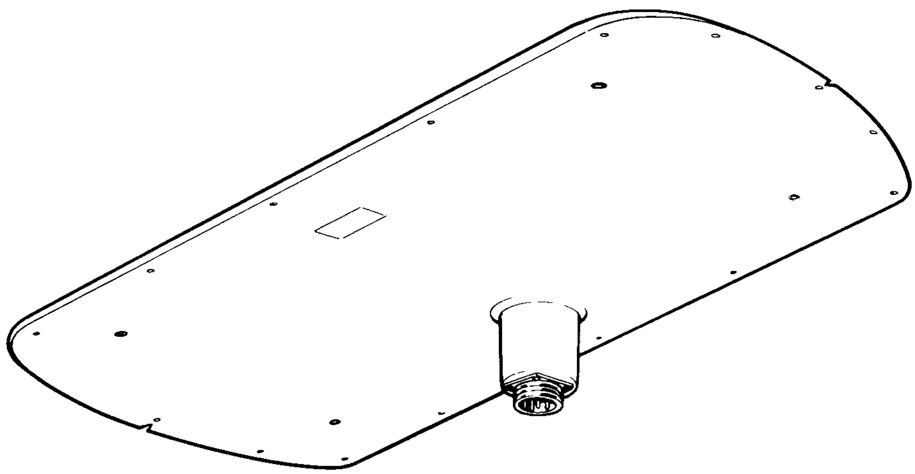


Fig. 4 Typical loop aerial

SENSE CABLE EQUALIZER XSA3967

17 The sense cable equalizer provides lumped capacitance and inductance to compensate for the reduction in the distributed capacitance and inductance of sense aerial cables that are shorter than the full length of sense aerial cable VC with which the ADF receiver is designed to operate. The electrical components are mounted on the underside of a tagboard supported by four pillars attached to the base of the unit by panhead screws. The components include an air dielectric trimmer capacitor, the adjusting screw of which is accessible through a hole in the tagboard. The base consists of an oblong piece of metal to each end of which is spot-welded a flanged side piece each carrying a coaxial connector. Between each connector and the associated side piece is a flanged plate which serves as a dust shield to prevent dust

entering the complete unit through the small gaps between the side pieces and the cover. The outer face of each of the two dust shields is marked, adjacent to the connector, with the letters VC REC or VC AE to indicate that cable VC from the RECeiver or from the AErial mates with the connector so identified. The unit is completed by a metal cover secured in place by two turnlock fasteners which enter holes in the two side pieces and engage with catch springs riveted to the inside. The sides of the metal baseplate extend beyond the cover to form fixing flanges and each side is drilled with six holes for fixing the unit to the aircraft.

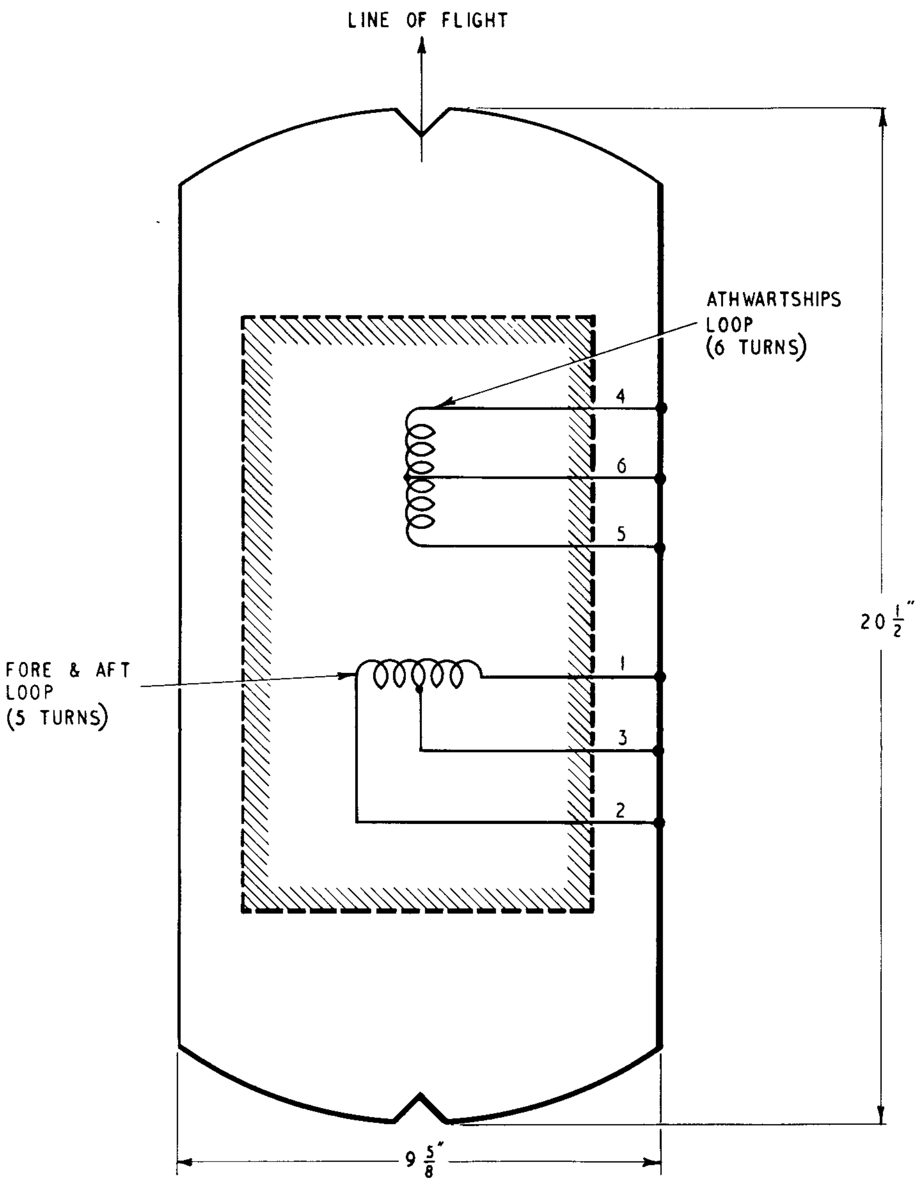


Fig. 5 Loop aerial : circuit diagram

CONTROLLERS

18 The three controllers (type 6409M, 6409MB and 6409MD) are similar in construction consisting of a box-like chassis assembly (fig. 6) carrying the various switches and circuit elements, the single 50-way plug connector, and the engraved plastic front panel with the associated control knobs. It is protected by a metal cover held in place on the chassis by a single quick-release fastener at the rear. The side members of the chassis assembly are two aluminium alloy retaining plates with the front and rear edges bent inwards to form fixing flanges. The aluminium alloy front panel of the chassis assembly is secured to the front flanges by eight 4-40 UNC shoulder screws and the switch mounting plate is secured to the lower rear flanges by four similar screws. The rear plug panel is fixed to the upper rear flanges of the side plates by two similar screws. The metal front panel of the chassis assembly carries four turnlock fasteners, one adjacent to each corner, for securing the controller to an instrument panel. The engraved plastic front panel is secured to the metal front panel of the chassis assembly by the various switch retaining nuts.

19 The three frequency selector knobs are held by grub-screws on to shafts that pass through the front panel and chassis assembly to operate three multi-wafer frequency selector switches mounted on the rear of the switch mounting plate. Between the front panel and the switch mounting plate each shaft has pinned to it a helical gear to transmit drive from the frequency selector knobs to the frequency indicating rotating counters, the common axis of which is parallel to the front panel. The frequency indicating rotating counters are arranged in three groups to correspond with the three frequency selector knobs and switches. The left-hand group contains two rotating counters indicating 1000 kHz and 100 kHz increments, the centre group consists of one counter indicating 10 kHz increments and the right-hand group contains two counters indicating 1 kHz and 0.5 kHz increments. In each of the two-counter groups, the right-hand counter is the primary driven member, drive being transferred to the left-hand counter by a slotted transfer wheel and two ganged spur gears. The slotted transfer wheel is pinned to the side of the right-hand counter but the ganged spur gears are carried by a separate shaft. The figures on the frequency indicating counters are viewed through a window in the front plastic panel formed by a small rectangular area where the opaque outer coating and the translucent under coating have been removed from the plastic to expose the transparent base material. The figures are illuminated by two lamps set in the spaces between the frequency selector knobs, the light being conducted from the lamps to the frequency indicator by a transparent plastic prism set in a shallow recess in the back of the plastic panel. The inside surfaces of the recess are coated with an opaque paint to prevent light from the dial lamps reaching the panel engraving as the latter is illuminated by two separate lamps.

20 The engraving on the front plastic panel identifies the various switch functions. This engraving cuts through the opaque outer coating of the plastic to reveal the translucent under coating and is illuminated by two lamps set one on each side of the frequency indicator window. Light from the lamps is conducted to all the panel engraving by the transparent base material of the plastic panel. The edges of the lamp apertures in the plastic panel adjacent to the frequency indicator window are coated with an opaque paint to prevent light from the panel lamps illuminating the frequency indicator. Near the left-hand and right-hand edges of the plastic front panel, adjacent to the two panel lamps, are the GAIN control knob and the BFO. note control knob. The GAIN control knob operates, via a flexible drive, a

potentiometer mounted at the rear of the chassis assembly and the BFO. control knob similarly operates a variable resistor also mounted at the rear of the chassis assembly. Above the GAIN control knob is the LOOP manual control knob that operates a ganged wafer switch and potentiometer mounted behind the front panel of the chassis assembly. A detent assembly between the front panel and the wafer switch contains a torsion spring which mechanically-biases the control knob and the associated switch and potentiometer to the centre OFF position. The transformer associated with the LOOP manual control is mounted near the potentiometer at the back of the switch assembly. Above the BFO. control knob is the function selector knob operating a four-position multi-wafer switch mounted behind the front panel of the chassis assembly. Between the LOOP manual control knob and the function selector knob are two single-pole toggle switches, the left-hand switch for selectivity control, its two positions being marked SHARP and BROAD, and the right-hand switch for BFO. on/off control, its two positions being marked BRO. and OFF. The 6409MB and 6409 MD controllers have an additional push-pull changeover switch mounted beneath the BFO. switch.

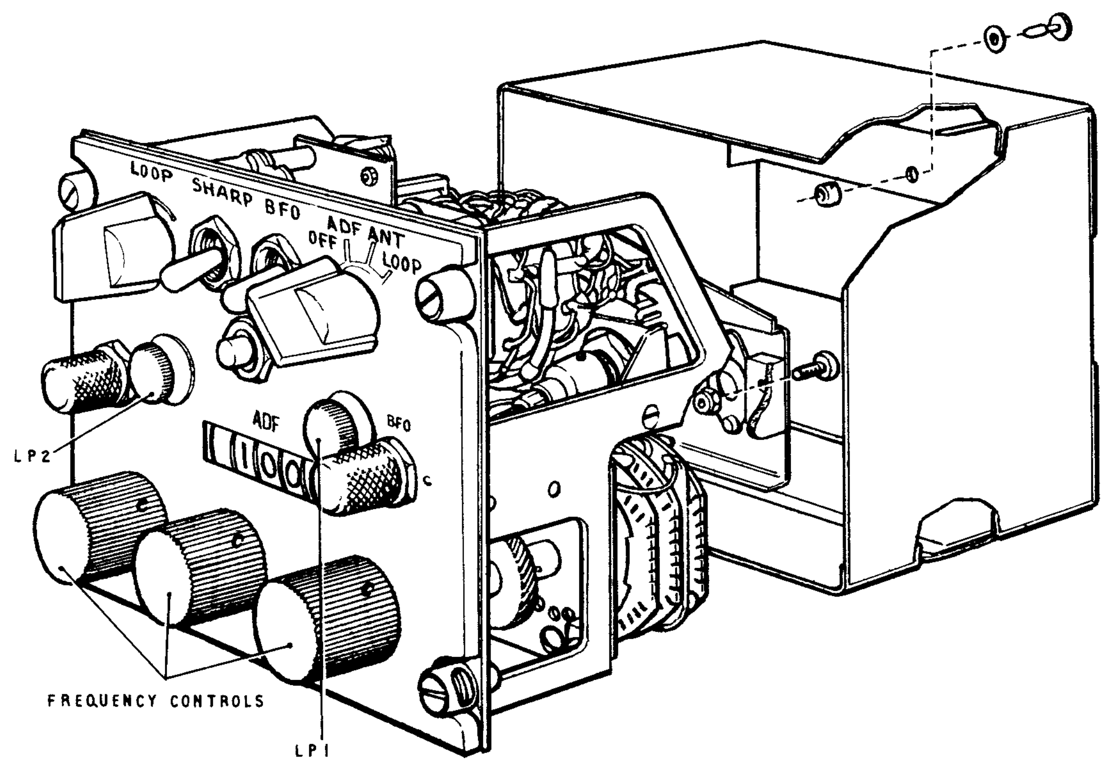


Fig. 6 Controller 6409M or 6409MD : cover removed

Chapter 3

INSTALLATION, SETTING UP AND OPERATING INSTRUCTIONS

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

INSTALLATION

General

1. The performance of the ADF system can be seriously degraded by r.f. and a.f. noise originating from other electrical equipment on the aircraft. It is recommended that the following precautions be taken to minimize interference:—

(1) Adequately suppress all other electrical equipment.

(2) Avoid running the loop aerial cables and sense aerial cables close to electrical cables carrying large currents, particularly cables used for supplying such equipments as inverters and fuel pumps.

(3) Ensure that all electrical equipment, radio mounting racks and mounting trays are adequately bonded to the aircraft structure. Bonding checks should be made before cables are attached to equipments in order to ensure that bad bonds are not concealed by the existence of parallel paths through the connecting cables.

A block diagram illustrating the interconnections of the system is shown in Part 1, Chap. 1, fig. 2 and more detailed information in para. 14 of this chapter.

Loop aerial

2. The loop aerial 6410M has built-in compensation for quadrantal error (Q.E.) of +12·5°, and in the AD360 installation it is used in conjunction with a separate Q.E. and loop cable equalizer unit to provide additional Q.E. compensation of from +12° to —12°. Consequently the minimum Q.E. that can be compensated for is +0·5°, but a Q.E. of so small a magnitude is unlikely to be encountered in aircraft, the average error being the 12·5° allowed for in the design of the aerial loop. The loop may be mounted above or below the aircraft and generally may be placed at any position along the longitudinal axis of the fuselage although the following positions should be avoided:—

(1) Near the nose or tail.

(2) Near where large structures such as fins, rotors, engine pods and wings are attached to the fuselage.

(3) Near large moveable or rem attachments such as drop tanks and external freight.

The loop must be mounted with its longitudinal electrical centre line (indicated by two notches in the edge of the loop housing) on or parallel with the longitudinal centre line of the fuselage to within ±0·25°. If the aerial is mounted parallel with but not on the fuselage centre line, the maximum distance from the centre line at which it may be mounted depends upon the type of fuselage. When mounted the loop aerial should be horizontal with the aircraft in flight trim.

3. If it is desired to suppress the aerial, great care should be taken to avoid attenuation of the loop signal and to avoid the introduction of abnormal values of Q.E. Attenuation will occur if the aerial is mounted too low in the cavity and abnormal Q.E. will be caused by an asymmetric cavity or by mounting the loop asymmetrically in the cavity. The diameter of the cavity should be at least 24 in. and the loop should not be more than 0·5 in. below the level of the aircraft skin. If the only position available for the aerial is within a large existing aperture in the aircraft such as beneath a cockpit canopy, apparatus below the aerial should be symmetrically disposed about the aerial centre or a metal screen fitted beneath the aerial.

4. It is essential that a good electrical connection exists between the aircraft structure and the conductive coating on the glass-fibre part of the loop housing via the aluminium baseplate of the aerial. If a rubber gasket is used between the aerial and the aircraft skin, the rubber should be conductive and its electrical resistivity should not be greater than 5000 ohms per sq. in. The aerial should be securely bolted to the aircraft structure with four 0·25 in. bolts, these bolts being either electrically bonded to or electrically insulated from the aircraft structure in order to prevent intermittent contacts which could cause interference.

Caution . . .

Do not distort the aerial by excessive tightening of the fixing bolts as this may damage the ferrite core and alter the performance of the loop aerial.

Loop aerial cable

5. The loop aerial cable should be installed in such a manner that it is as far away as possible from the sense aerial cable and other electric cables, and any excess length should not be coiled but should be distributed in the form of a bight. The cable is in two parts identified VA and VB. Part VA connects the loop aerial to the Q.E. and loop cable equalizer and its length must be between 1 and 3 ft. Part VB connects the Q.E. and loop cable equalizer to the ADF receiver and its length must be such that the total length of VA + VB is 12, 15, 19, 22·5, 26, 29, 33, 35·5, 40, 43, 47 or 50 ft.

6. This unit may be mounted in any attitude but a first-class electrical bond between the unit and the aircraft structure is essential. Access to the unit is not normally required during its service life as no *in situ* adjustments are possible. The Q.E. correction and cable length compensation provided by a particular Q.E. and loop cable equalizer is indicated by two suffixes to its number, e.g. XSA3966/N2/426, XSA3966/P3/426. In these two examples N2 indicates 2° negative Q.E. correction, P3 indicates 3° positive Q.E. correction and 426 indicates compensation for a cable 426 in. long.

Sense aerial

7. The sense aerial is supplied as part of the aircraft installation and choice of the most suitable form is governed by such things as aircraft type, size and performance, and the location of the aerial on the aircraft. The ADF installation requires that the sense aerial plus lead-in should present a capacitance of 100 pf to the aerial end of the sense aerial cable.

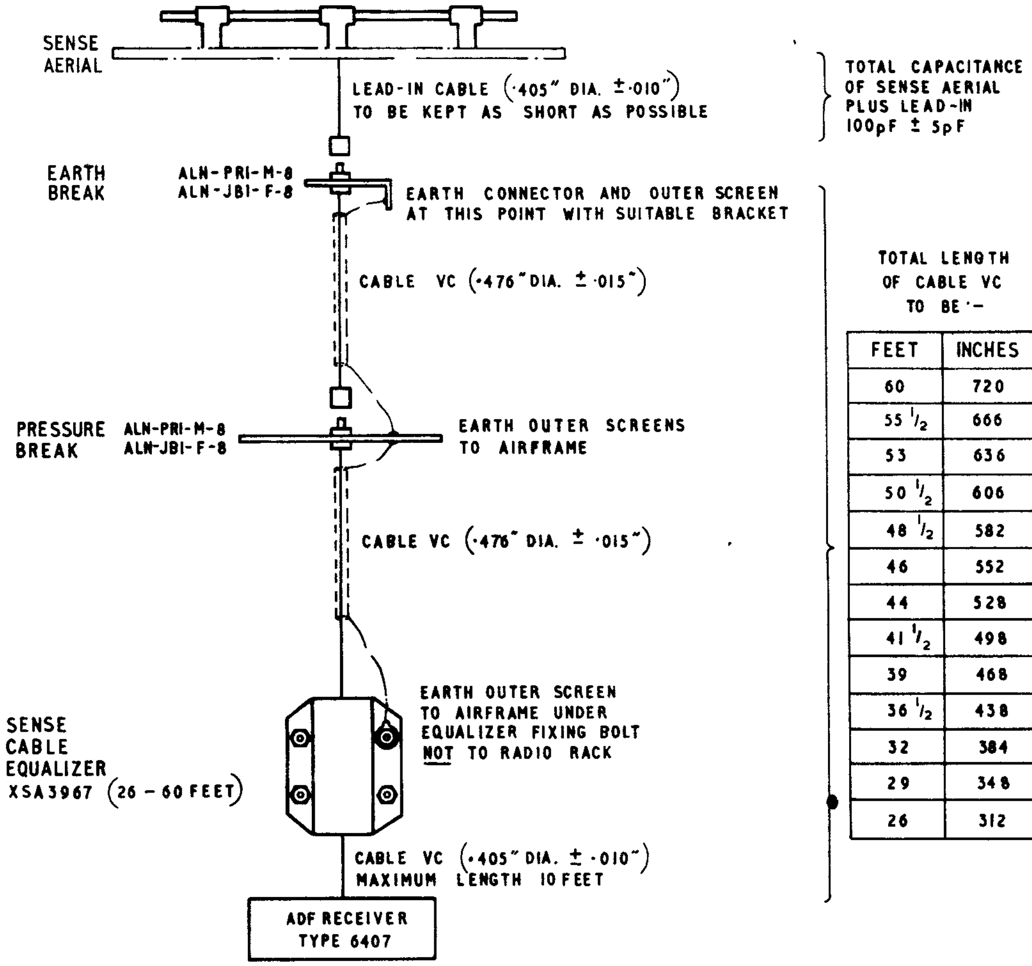
Sense aerial cable

8. The sense aerial cable, a Skydrol-proof version of uniradio 64, should be installed so that it is as far away as possible from the loop aerial cable and from other electric cables. Any excess length of cable should not be coiled but should be distributed in the form of a bight. The cable, identified VC, is in two parts to allow for the insertion of the sense cable equalizer, the part that connects the equalizer to the ADF receiver being supplied with a single screen and of a maximum length of 10 ft. The second part of the cable, connecting the aerial lead-in to the equalizer, is supplied with a double screen and may be separated into two more parts if required to allow for the junction between presurized and unpressurized zones on pressurized aircraft. The total length of the sense aerial cable VC used with the sense cable equalizer XSA3967 must be 26, 29, 32, 36·5, 39, 41·5, 44, 46, 48·5, 50·5, 53, 55·5, or 60 ft.

9. The outer screen of the double screen cables should be earthed as shown in fig. 1. Earthing tails are provided at each end of each part of the cable for attachment to the nearest point on the airframe. The inner screens will be earthed automatically by the connectors but a suitable earthed bracket must be provided for the connector at the aerial end of the cable.

Sense cable equalizer XSA3967

10. The sense cable equalizer may be mounted in any attitude provided that the cover can be easily removed for adjustments to be made to the trimmer capacitor inside (fig. 2). A first-class electrical bond between the unit and the aircraft structure is essential. The unit is adjusted during manufacture to suit the total length of cable VC which may have a total length of between 26 and 60 ft.



TOTAL LENGTH OF CABLE VC TO BE:-

FEET	INCHES
60	720
55 ½	666
53	636
50 ½	606
48 ½	582
46	552
44	528
41 ½	498
39	468
36 ½	438
32	384
29	348
26	312

Fig. 1 Sense aerial cable installation

Note . . .

The total length of cable VC for which the sense cable equalizer is set up does NOT include the aerial lead-in cable or any capacity match cable provided to pad the sense aerial capacity to the required value of 100 *pf.*

11. The length of cable for which any particular sense cable equalizer is set up is indicated by a suffix to its number, e.g. XSA3967/528 indicates that the unit is set up for a cable VC of total length 528 in. After installation of the sense aerial, the sense aerial cable and the sense cable equalizer, the trimmer capacitor C1 in the equalizer may require adjustment to give the correct capacitance at the receiver end of VC (see para. 18).

Receiver 6407M

12. The receiver, which requires an anti-vibration mounting, is contained in a short ½ATR standard case. Parts of the receiver case are perforated to allow for the passage of cooling air and these parts must be unobstructed to allow the air to circulate freely. Connections to the receiver are made via three plug and socket connections, one each to the loop and sense aerial cables, and the remaining one to the controller, intercom circuit, remote indicators and a.c. supply.

Controller 6409M

13. The controller should be fitted so that it is conveniently placed for operation. The only connections required are a 27·5V supply and the connecting cable to the receiver.

INTERCONNECTIONS

14. Interconnections between the ADF receiver, the aerials and the cable equalizers are made using the cables described in para. 5 and 8. All other interconnections are made using either:—

(1) Wiring fitted to the aircraft during its construction ('production fit').

(2) Ready-made cables fitted to the aircraft after its construction is completed ('retrospective fit').

15. Production-fit installations may | single-control installations, dual-control installations or twin installations. Details of interconnections for a single-control installation are given in fig. 3. Details for a dual-control installation are given in fig. 4. A twin installation is simply two separate installations in one aircraft.

16. Retrospective-fit installations are designed to suit specific requirements. Details of a typical retrospective-fit installation are given in fig. 5. This installation makes use of a junction box assembly (Marconi AA3612–1) to connect the various ready-made cables to the ADF receiver 6407M. Details of the junction box assembly are given in figs. 6 and 7.

SETTING UP

General

17. The receiver 6407M is set up and tested prior to installation and no further adjustment of the pre-set controls should be made after installation in the aircraft. No setting up is required for the loop aerial, Q.E. and loop cable equalizer or the controller.

Sense cable equalizer

18. The trimmer capacitor in the sense equalizer requires adjustment after installation to obtain the correct value of capacitance at the receiver end of cable VC and for this purpose a test bridge set capacitance 6625–99–953–2121 is required. The necessary adjustments are carried out as follows:—

(1) Set the meter decade knobs so that each dial reads zero.

(2) Connect the meter input cable to the socket on the front panel of the meter and connect the test bridge adapter to the free end of the input cable.

(3) Turn the SET ZERO control on the meter away from the OFF position and check that the balance meter pointer moves.

Note . . .

If the pointer does not move, the internal the internal battery may be exhausted. The battery should be changed if the p.d. between the output terminals of the battery is less than 1·5V.

(4) Adjust the SET ZERO control until the balance meter indicates BAL (balance).

(5) Disconnect the sense aerial cable VC from the receiver and connect the free end to the metal adapter.

(6) Set the meter decade dials to 830 pf.

(7) Remove the cover from the sense cable equalizer unit and adjust the trimmer capacitor C1 (fig. 2) until the meter indicates balance, then proceed with step (12). If balance cannot be obtained proceed instead with step (8).

gives a grid dip indication. Consequently as the balance point is approached (from either side) the meter indication slowly increases to a maximum value before, very close to the balance point, it rapidly diminishes to a minimum value indicating balance.

(8) If balance cannot be obtained in step (7), check whether the vanes of capacitor C1 are fully in mesh or fully out of mesh.

(a) If the vanes are fully in mesh, the total capacitance of the sense aerial plus cable VC is less than the value for which that particular sense cable equalizer was manufactured and the installation should be checked for errors or faults, which must be corrected before repeating this setting up procedure.

(b) If the vanes are fully out of mesh, take C2 out of circuit by cutting the link identified C2 in fig. 2.

(9) After taking C2 out of circuit, re-adjust C1 until the meter indicates balance.

(10) If balance cannot be obtained in step (9), take C3 out of circuit by cutting the link identified C3 in fig. 3.

(11) Re-adjust C1 until the capacity meter indicates balance.

(12) Replace the cover on the sense cable equalizer unit and secure it in place. Remove the capacity meter and re-connect the sense cable VC to the receiver.

Note . . .

No further adjustment of C1 should be required in service unless any part of the sense aerial circuit, external to the receiver is changed.

OPERATING INSTRUCTIONS

Preliminary

19. Ensure that the appropriate circuit breakers and switches in the aircraft installation are closed, that power is available (27·5V d.c. and 26V 400 c/s a.c.) and that the gyro-magnetic compass system in the aircraft is operating.

Tuning

20. If the installation is dual-controlled, press the CHANGEOVER switch of the controller to be used. The following procedure then applies to all installations:—

(1) Set the selectivity switch to BROAD and the BFO/OFF switch to BFO for the reception of keyed c.w. signals, or to OFF for the reception of voice-modulated or tone-modulated signals. If the BFO switch is set to BFO, the dot on the BFO note control knob should be set against the dot on the panel to obtain a 1000 c/s note.

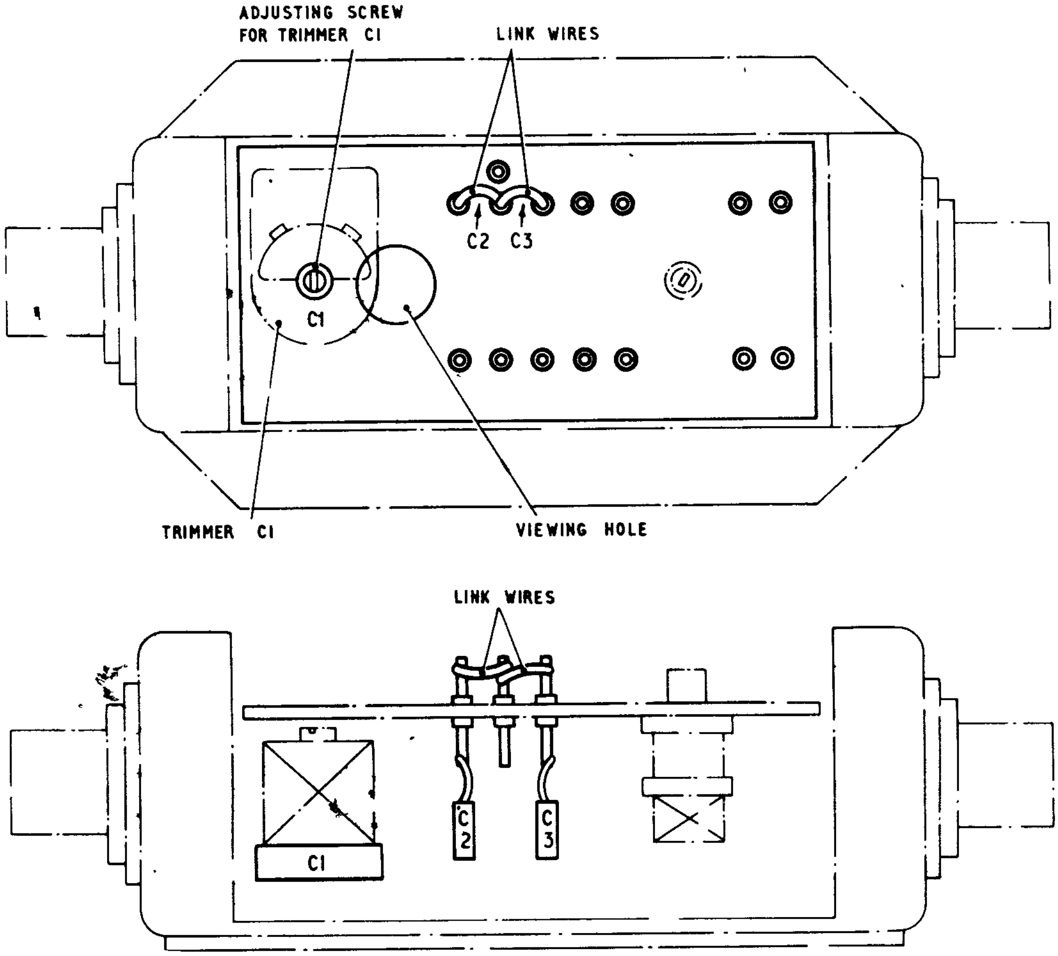


Fig. 2 Access to sense cable equalizer trimmer capacitors

(2) Select the desired station frequency (or the nearest frequency if the required frequency is not a multiple of 0·5 kc/s).

(3) Set the function switch to ANT and the receiver will automatically tune to the selected frequency, the audio output being muted until tuning is completed.

Note . . .

The receiver also tunes automatically on function LOOP *and function* ADF. *However, in conditions of normal external noise, identification of weak signals is usually easier on function* ANT *than on* ADF. *On function* LOOP *the* LOOP *control has to be used to drive the goniometer search coil to the position of maximum coupling with the signal for station identification.*

(4) Adjust the GAIN control setting to obtain the desired audio level and, if necessary to reduce interference, set the selectivity switch to SHARP.

(5) Check that the station required has been correctly tuned by listening for the callsign or other means of station identification.

(6) If the required station is not identified and is thought to be off frequency:—

(a) Set the BFO note control knob fully clock wise and set the BFO switch to BFO if it was previously set to OFF.

(b) Search in 1 kc/s steps and finally in 0·5 kc/s steps until the lowest note is obtained, and at this stage the receiver is correctly tuned.

(c) Return the BFO note control knob dot to dot for a 1000 c/s note and return the BFO switch to OFF if not required.

Re-tuning

21. To re-tune the receiver to a new frequency simply select the new frequency on the dials. The receiver will then automatically re-tune. If the receiver has been switched off (either at the controller or by interrupting the 27·5V supply) for longer than about 30 seconds, it will auto re-tune to the frquency set on the con ... soon as it is switched on again or when the power supply is restored.

Communications reception

22. Tune the receiver as described in para. 20, but if interference is so great or the signal so weak that, with the function switch set at ANT, the communication content of the signal is not intelligible, re-set the function switch to LOOP. Using the LOOP manual control switch drive the goniometer search coil to a position where maximum signal strength is obtained. This operation usually reduces the amount of external noise entering the receiver and hence improves the signal-to-external-noise ratio.

Radio range reception

23. Tune the receiver as described in para. 20, set the selectivity switch to BROAD and identify the station received. With the function switch set to ANT adjust the GAIN control on the controller until the audio volume is at a minimum level consistent with good signal intelligibility. Maintain this audio level by re-adjustment of the GAIN control as the aircraft approaches the radio station. Transit of the aircraft over the radio range is indicated by the loss of signal as the aircraft enters the 'cone of silence'.

Automatic direction finding (homing)

Single installation

24. Tune to the required station frequency as described in para. 20 with the function switch set to ADF, and identify the station received. Turn the aircraft until the R.M.I. pointer controlled by the the ADF receiver points to the R.M.I. lubber line, and adjust the GAIN control for satisfactory audio level. The aircraft should be flown so that the R.M.I. pointer remains on the lubber line, transit over the radio station being indicated by a rapid reversal of the R.M.I. pointer position away from the lubber line.

Note . . .

Using this method of homing, the ground track of the aircraft only follows a great circle (a straight line over the earth's surface) when there is no wind or when the wind is dead ahead or dead astern. When there is a cross wind the ground track of the aircraft follows a curved line over the earth's surface and the aircraft's true heading changes continuously throughout the flight. To compensate for a cross wind so that the aircraft flies a great circle track it is necessary to alter the initial heading of the aircraft. The angle between the new heading and the great circle track is called the drift angle. The drift angle is calculated from information obtained from other sources.

25. A twin AD300 installation makes it possible for the aircraft to fly a great circle track between two radio stations and home on to either of them without the necessity of calculating the drift angle. The procedure is as follows:—

(a) Tune ADF No. 1 to the frequency of the station on which it is desired to home. Identify the station received.

(b) Set the function switch of ADF No. 1 to ADF.

(c) Turn the aircraft until the R.M.I. pointer controlled by the ADF No. 1 is near the R.M.I. lubber line.

(d) Tune ADF No. 2 to the frequency of the other radio station.

(e) Set the function switch of ADF No. 2 to ADF.

(f) Fly the aircraft until the R.M.I. pointer controlled by ADF No. 2 is in line with the first R.M.I. pointer but pointing in the opposite direction. Maintain the two pointers 180 degrees apart to home on the selected station.

Note . . .

The angle between the R.M.I. lubber line and the R.M.I. pointer controlled by ADF No. 1 equals the drift angle.

Position fixing

Single installation

26. The aircraft's position at any time may be fixed on a chart by taking the bearings of two or more radio stations and plotting the reciprocal bearings as position lines on the chart. The aircraft's approximate position at the time the bearings were taken is indicated on the chart by the intersection of the position lines. To keep to a minimum the effect on the 'fix' of any inaccuracies in taking or plotting the bearings, the bearings should be separated by between 30 degrees and 150 degrees. The procedure is as follows:—

(a) Tune to the frequency of a station whose reciprocal bearing can be conveniently plotted on the chart of the area in which the aircraft is flying. Identify the station.

(b) Set the function switch to ADF.

(c) Record the magnetic bearing from the aircraft of the selected station, indicated by the R.M.I. pointer against the R.M.I. card.

(d) As quickly as possible, repeat (a), (b) and (c) for one or two more stations whose bearings are expected to differ from each other and from the bearing of the original station by between 30 and 150 degrees.

(e) Convert the magnetic bearings into true bearings.

(f) On the navigation chart of the area in which the aircraft is flying, lightly draw through the positions of the appropriate radio stations the corresponding bearing lines and extend the reciprocal bearing lines until they intersect. The point or triangle of intersection indicates the approximate position of the aircraft at the time the last ADF bearing was recorded.

Note . . .

If the chart is drawn to the Mercator or similar projection it is necessary to apply the appropriate conversion angle to each true bearing so that it may be drawn as a straight line (rhumb line) on the chart.

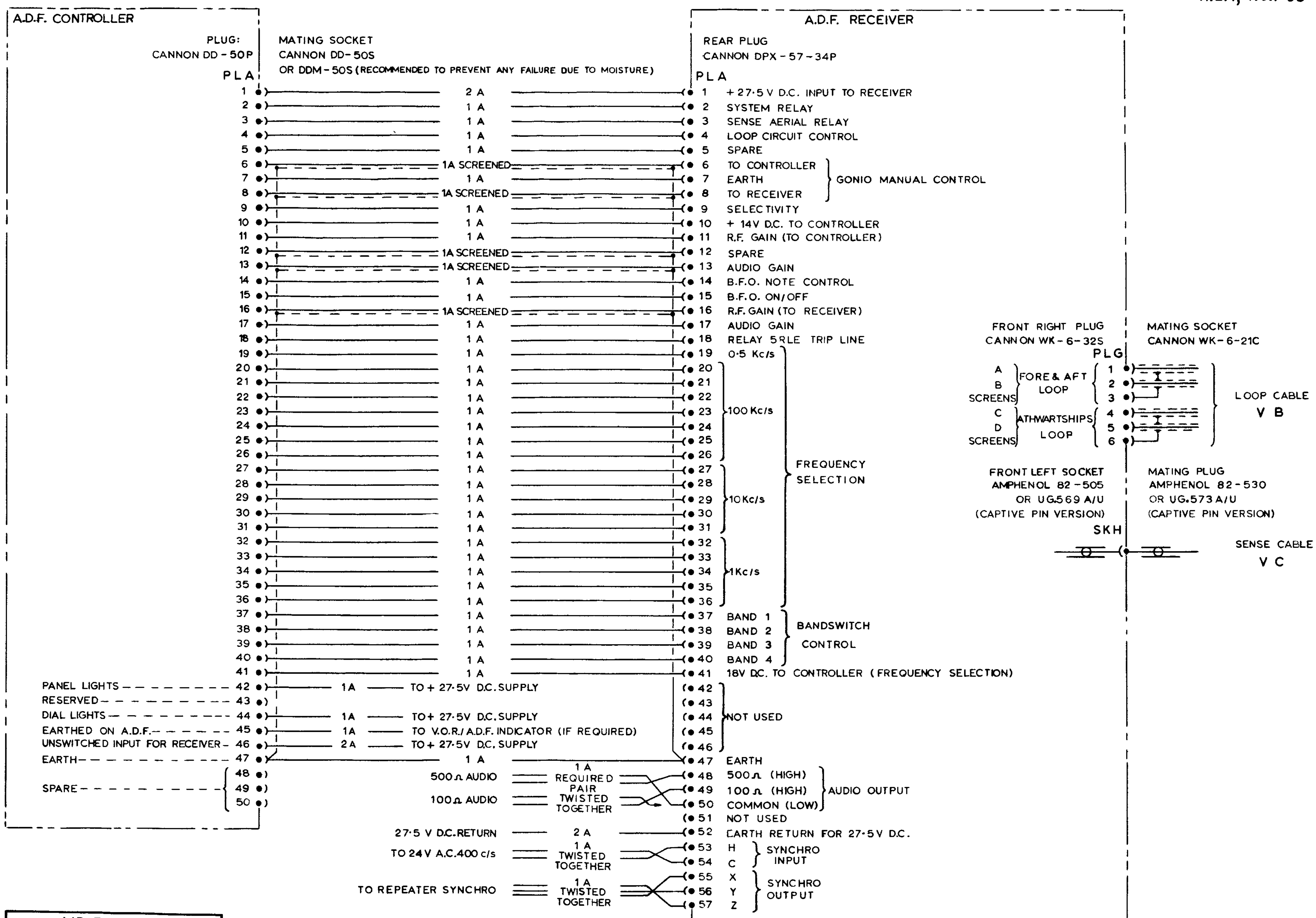
Twin installation

27. Follow the general procedure detailed in para. 26, but make use of the second installation to take the bearings of two different radio stations simultaneously.

Manual direction finding

28. On function LOOP the indicated bearing of the radio station may be either the approximate magnetic bearing or its reciprocal. This ambiguity does not matter for position fixing because position lines drawn on a chart are simply extended one way or the other until they intersect. If used for homing, however, the ambiguity of the indicated magnetic bearing must be resolved and this can be achieved by first fixing the approximate position of the aircraft on a chart.

29. Operation on function LOOP is required in conditions where the noise entering the receiver via the sense aerial is greater than that entering via the loop aerial, e.g. when the aircraft is being electrified by precipitation static. In such conditions bearing indications on function ADF may be erratic. Operation on function LOOP, by eliminating the noise entering the receiver via the sense aerial, gives bearings of greater stability and definition. Use of the BFO makes it easier to locate the null position if the level of general noise remains high.

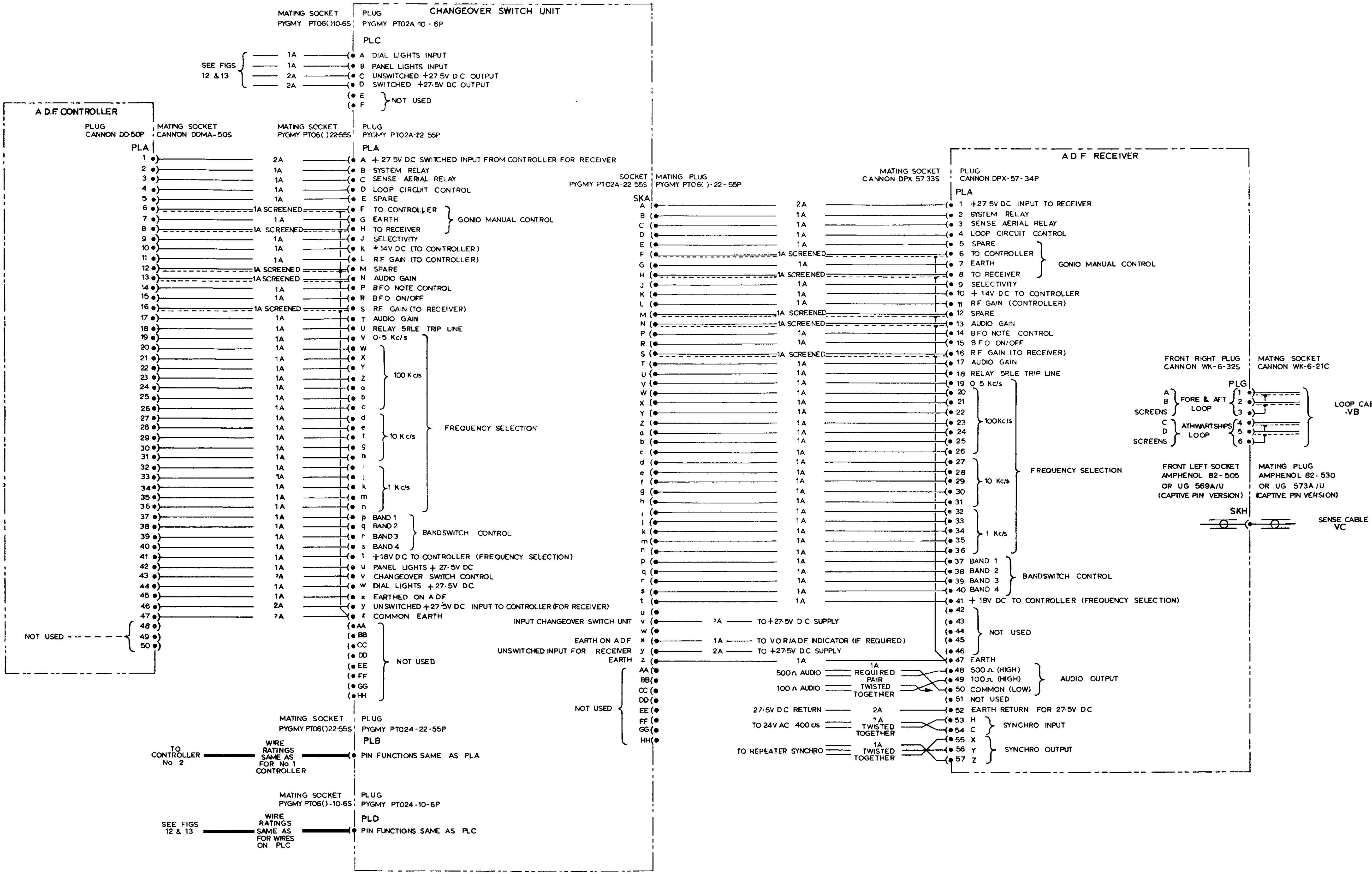


AIR DIAGRAM
116B-0101-MD6

ISSUE 1.
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
(Prepared by the Ministry of Aviation)

ARI. 23119 : single-control installation

Fig. 3

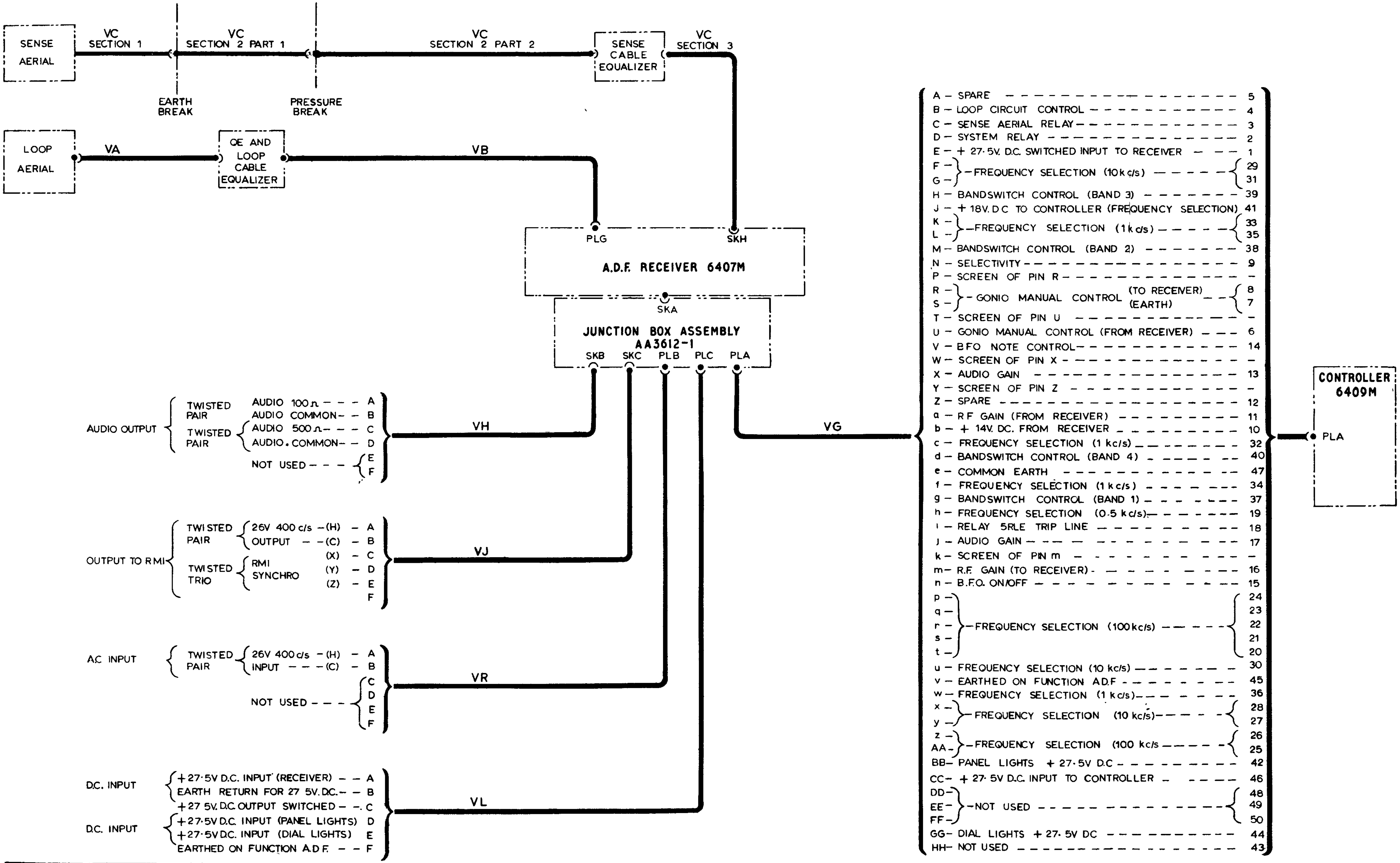


AIR DIAGRAM 116B-0101-MD7
ISSUE 1.
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE (Prepared by the Ministry of Aviation)

ARI. 23119: dual-control installation

Fig. 4

D713060 260 7/69 A(W)Ltd Gp956/3 523M

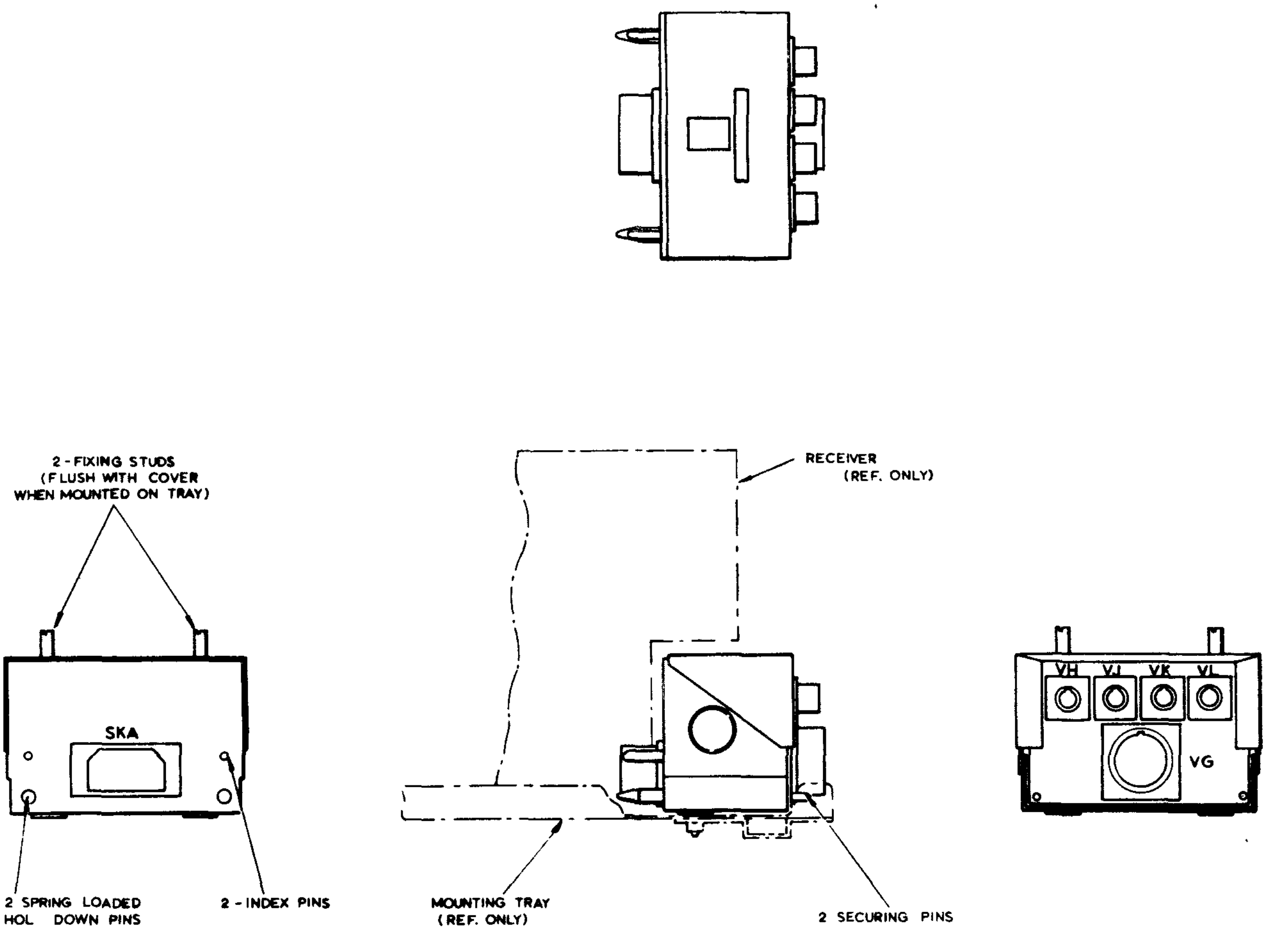


AIR DIAGRAM
116B-0101-MD8
ISSUE 1.
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE (Prepared by the Ministry of Aviation)

A.R.I. 23119 : retrospective-fit installation

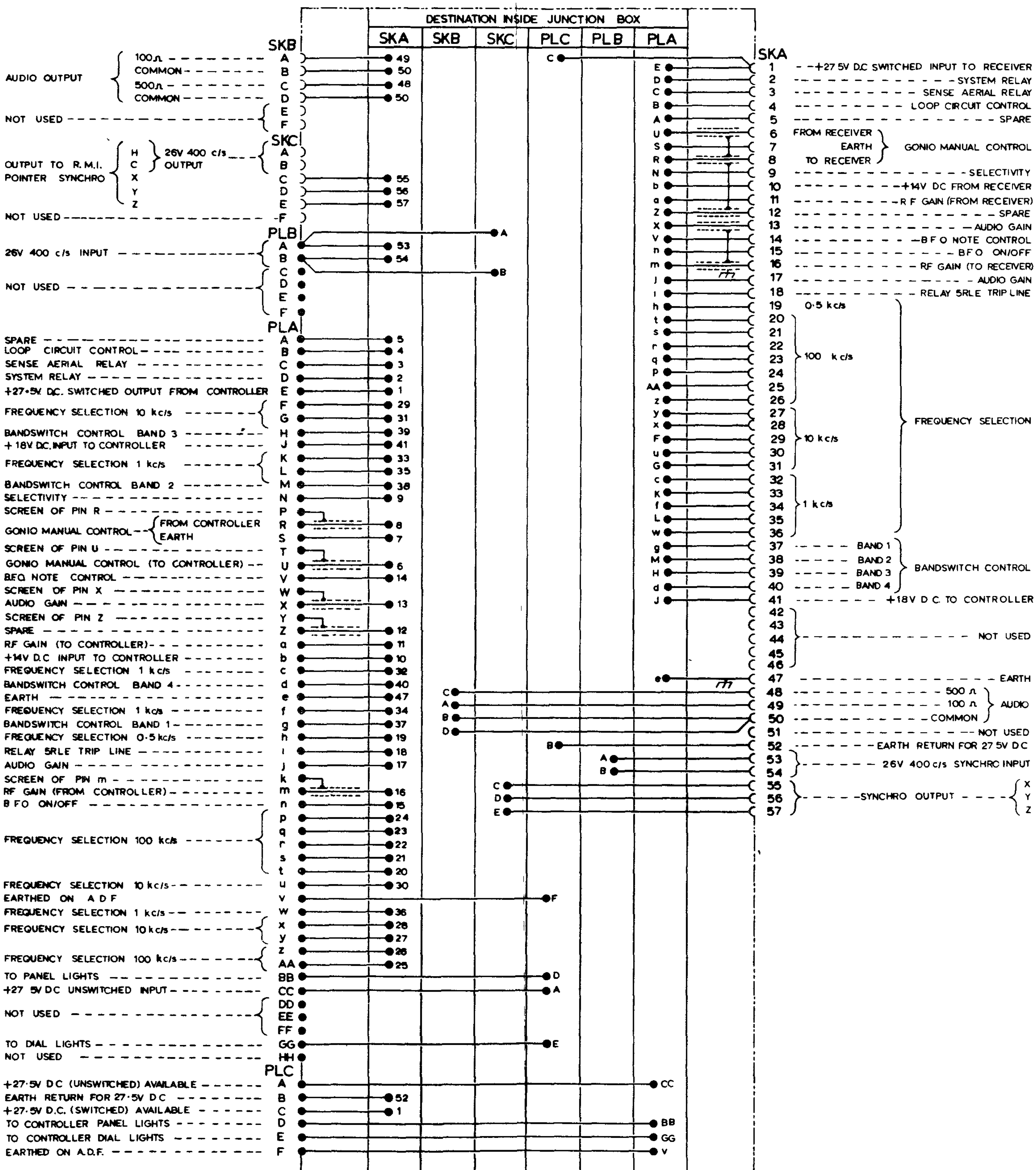
Fig. 5

D713060 260 7/69 A(W)Ltd Gp956/3 523M



CCT REF	CABLE CODE	CONNECTOR ON JUNCTION BOX
SKA	—	CANNON DPXAMA-57-33S OR DPX-57-33S
SKB	VH	CANNON-PVOR-10B-6SNC OR KPTMOOE-10-6S
SKC	VJ	CANNON-PVOR-10B-6SWC OR KPTMOOE-10-6SW
PLA	VG	CANNON-PVOR-22B-55PNC OR KPTMOOE-22-55P
PLB	VK	CANNON-PVOR-10B-6PWC OR KPTMOOE-10-6PW
PLC	VL	CANNON-PVOR-10B-6PNC OR KPTMOOE-10-6P

Fig. 6. ~~Junction box assembly AA3612-1~~ AL10 · Fig 6
CONTROLLER, 6409 MB OR 6409 MD.
(COVER REMOVED).



AIR DIAGRAM
116B-0101-MD9
ISSUE 1.

BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
(Prepared by the Ministry of Aviation)

Junction box assembly AA3612-1 : circuit

Fig. 7

PART 2

TECHNICAL INFORMATION (SERVICING)

SECTION 1

TEST EQUIPMENT

Chapter 1

(Completely revised)

SCALE OF TEST EQUIPMENT

CONTENTS

General

1 The test equipment required to carry out first and second line servicing of the complete ADF AD360 system is given in the following tables. Table 1 lists the items required to carry out first line servicing and Tables 2 and 3 list the common user and special test equipment required for second line servicing. Descriptions of the special test equipment listed in Table 3 will be found in the following chapters of this Section.

TABLE 1 TEST EQUIPMENT - 1ST LINE

Item No.	Ref. No.	Item
1	6625-99-943-2134	Multimeter CT511
2	6625-99-953-2121	Test bridge set capacitance (TE101)
3 to 5		Not allocated

TABLE 2 COMMON USER TEST EQUIPMENT - 2ND LINE

Item No.	Ref. No.	Item
6	6625-99-105-7049	Multimeter CT498A or Multimeter CT498
7	6625-99-999-9604	Signal Generator, Type 16728

TABLE 2 COMMON USER TEST EQUIPMENT - 2ND LINE (Cont'd)

Item No.	Ref. No.	Item
8	6625-99-106-1341	Voltmeter, valve CT568 or
	6625-99-106-5334	Voltmeter, set, electronic TF2600
9	6625-99-952-0550	Counter, electronic frequency or
	6628-99-114-1768	Counter, electronic frequency
10	6625-99-914-9811	Wattmeter, absorption, a.f. (TF893A)
11	6625-99-199-2562	Oscilloscope set, CT531 or
	6625-99-913-8018	Oscilloscope set, CT436
12	6625-99-900-8337	Signal Generator set, CT452A
13	6625-99-955-6255	Multimeter electronic CT471C or
	6625-99-943-8384	Voltmeter valve CT429
14 to 19		Not allocated

TABLE 3 SPECIAL TEST EQUIPMENT - 2ND LINE

Item No.	Ref. No.	Item	Remarks
20	6625-99-913-9483	Coupler, signal generator	TM6123
21	6625-99-591-0797	Cable assembly composite	Gonio extension cable A.30-4478-01
22	6625-99-952-0760	Test rig, electrical	Described in Part 2, Sect 1, Chap 4 Marconi AA-3611-1)
23	6625-99-951-0786	Cable assembly set electrical consisting of:	
23/1	6625-99-951-0790	Cable assembly radio frequency	Sense aerial cable VCG/24 W.101618
23/2	6625-99-951-0789	Cable assembly radio frequency	Sense aerial cable VCT/696 W.103762
23/3	6625-99-951-0792	Cable assembly special purpose, electrical	Loop aerial cable VAF/24 W.101598
23/4	6625-99-951-0791	Cable assembly special purpose, electrical	Loop aerial cable VBG/576 W.101599

TABLE 3 SPECIAL TEST EQUIPMENT - 2ND LINE (Cont'd)

Item No.	Ref. No.	Item	Remarks
23/5	6625-99-951-0788	Cable assembly special purpose, electrical	115V a.c. supply cable VKA/72 W.104787
23/6	6625-99-951-0787	Cable assembly special purpose, electrical	28V d.c. supply cable VLA/72 W.104788
23/7	5826-99-834-2007	Socket electrical	Coaxial connector XC.3617
24	10AG/9532523	Trimming tool set consisting of:	
24/1		Tool trimming inductor, XT515	
24/2		Tool trimming capacitor, XT64	
24/3		Tool trimming inductor XT749	
24/4		Tool trimming inductor XT750	
25	6625-99-952-0925	Equalizer cable	Sense aerial XSA.3967/720
26	10L/9702199	Controller 6409M	
27	5826-99-970-2200	Receiver 6407M	
28	10Q/16314	Indicator Type 1630	
29	5905-99-022-2025	Resistor 1.5 kilohms	
30	5910-99-011-8321	Capacitor 100 pF	
31	5910-99-012-0116	Capacitor 0.04 μF	
32	5910-99-918-8025	Capacitor 0.1 μF	
33	10D/9532122	Simulator loop signal	Type M12

Chapter 2

TEST BRIDGE SET CAPACITANCE 6625-99-953-2121

List of Contents

GENERAL DESCRIPTION

1. The test bridge set capacitance, 6625-99-953-2121, is a test instrument for determining:-

(1) Unknown capacities of from 0 to 999pF.

(2) Adjusting an external variable capacitor to a required value of capacitance (as is required with the Marconi AD360 ADF system).

The instrument is contained in a weather proof case with a separate compartment in the base for the stowage of a co-axial connector and adapter(s). It is powered by a 1·5V dry cell of the U2 type fitted internally. To renew the battery the instrument should be withdrawn from the case after loosening the two retaining screws. Opening the top cover of the instrument exposes the instrument panel on which are mounted the indicating output meter, three decade switches, a trimmer combined with an ON/OFF switch and a co-axial socket.

2. The instrument is, in effect, a tuned voltmeter, comprising a transistorized oscillator operating at 210 kc/s through a crystal filter. The value of the capacitance in the oscillator tuned circuit is determined by three decade switches, and fine tuning is carried out by means of a small variable capacitor. When the fine tuning is correctly adjusted with all the decade switches set to zero (i.e. maximum capacitance in the oscillator circuit) a null (BALANCE) reading is indicated on the output meter. If a capacitor of unknown value is now connected externally the oscillator will no longer be tuned to the crystal frequency of 210 kc/s and the decade switches must be operated to remove capacitance from the oscillator circuit until the circuit is again in tune as indicated by a null (BALANCE) reading on the output meter. The value of the capacitance removed from the oscillator circuit by the operation of the decade switches will equal the value of the external capacitor.

OPERATION

3. (1) Set the capacity decade switches to read 0 0 0.

(2) Connect the co-axial lead provided to the socket on the front panel.

(3) Connect the appropriate adapter to the free end of the co-axial lead.

(4) Turn the SET ZERO control away from the OFF position and observe that the output meter gives some indication (if it does not, check the internal battery).

(5) Adjust the SET ZERO control to obtain a null (BALANCE) reading on the meter.

Note . . .
As the balance point is approached from either side the meter indication slowly increases towards a maximum; very close to the balance point a sharp drop in indication occurs - zero reading (arrow to arrow) indicates true balance.

If it is desired to find the value of an unknown capacitance continue from (6); if it is required to adjust an external capacitance to a particular value continue from (10).

(6) Connect the unknown capacitor to the free end of the co-axial adapter.

(7) Adjust the capacitance decade switches in the order hundreds, tens, units to obtain balance as indicated on the output meter.

(8) Read off the unknown capacitance directly in picofarads as indicated in the windows above the decade switches.

(9) Switch off the instrument by tuning the SET ZERO control fully counter-clockwise to the OFF position.

(10) Connect the external capacitance to the free end of the co-axial adapter.

(11) Adjust the capacitance decade switches until the required capacitance is indicated in the windows above the decade switches.

(12) Adjust the external capacitor until balance is indicated on the output meter.

(13) Switch off the instrument by tuning the SET ZERO control fully counter-clockwise to the OFF position.

CAUTION . . .

> Under no circumstance must adjustments be made to the internal components of the capacity meter.

Chapter 3

SIMULATOR, LOOP SIGNAL TYPE M12

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LIST OF ILLUSTRATIONS

Introduction

1. One problem encountered in the testing of airborne D/F equipment is the provision of a reliable "direction" signal which can be orientated throughout the azimuth scale. This is particularly troublesome when handling "fixed-loop" D/F equipment such as the AD360 ADF system. The loop signal simulator Type M12 is an item of test equipment designed to provide, in conjunction with a signal generator, the type of output voltages normally obtained from the crossed-loop and sense aerials of Marconi receivers AD360, AD712 and AD722.

2. With the loop signal simulator, the loop aerial quadrantal error corrector unit and sense aerial are not required in a test rig. A signal generator is used to provide an input to the loop signal simulator and the simulator provides two output signals, one to be coupled directly to the sense aerial input circuit and the other to be coupled directly to the loop aerial input circuit.

3. The loop and sense signals obtained from the simulator are in the correct proportion for normal receiver operation, and the loop output signal may be adjusted by manual rotation of a control so as to give continuously-variable azimuth signals. This provides the required test of the correct functioning of the D/F circuits of a receiver at all azimuth angles.

Principles of operation

4. A normally-propagated wireless signal will induce into a loop aerial and into a co-sited open-wire aerial, e.m.fs. which are in phase quadrature (the magnetic and electric components of the wave being in time phase). Thus for testing a Bellini-Tosi-type of D/F receiver, the signals to the sense and goniometer inputs should be in phase quadrature. In the loop signal simulator, the sense input signal is derived from a capacitive potential divider (so that the source impedance is similar to the sense aerial impedance) while the goniometer input signal is derived from a pair of crossed pick-up coils which may be rotated in the vicinity of a "line". The "line" consists of a pair of parallel wires, accurately positioned in relation to the crossed coils. An electrostatic screen is interposed between the "line" and the coil assembly. The "line", and capacitive potential divider are both supplied from a common point (a signal generator) thus fulfilling the required phase conditions. The circuit constants of the crossed pick-up coils are similar to those of the loop aerial of a normal installation, this gives normal operating conditions for the receiver.

5. The "line" and the crossed pick-up coils form in effect a variable-coupling transformer having two outputs whose relative positioning is such that when the assembly is orientated for maximum coupling in one coil, the other coil has minimum (zero) coupling. This corresponds with the conditions in the crossed loop aerial when normal signals are being received.

General description

6. The loop signal simulator (shown in fig. 1) is constructed in a metal box, the input, and sense aerial circuit components and the line (for loop signal coupling) being contained at the bottom of the box. The variable-coupling coil assembly (for the loop signal output) is mounted in the top panel of the box. This panel is affixed by screws to provide access to the interior.

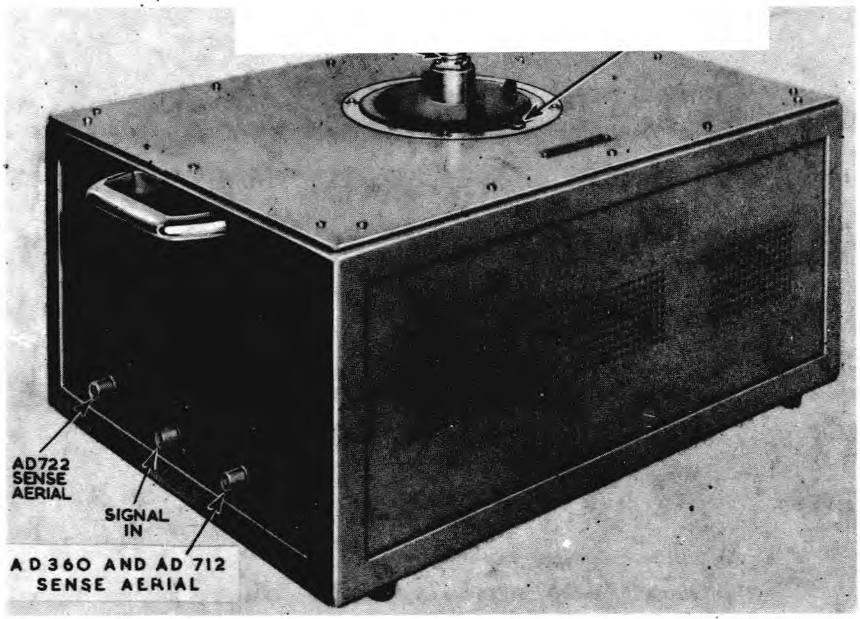

Fig. 1. Simulator, loop signal Type M12

7. One face of the box holds three cable terminations:

(1) A socket for coupling in the output from a signal generator.

(2) A socket for coupling-out the sense signal for the receiver AD360 and the receiver AD712.

(3) A plug for coupling out the sense signal for the receiver AD722.

A switch is fitted for the selection of the circuits appropriate to different receivers. If a position for the receiver Type AD360 is not marked, the position marked AD712 should be used.

8. The loop output connector termination (loop signal out, fig. 1) is built into the centre of an azimuth scale and is affixed to the crossed-coil assembly with which it rotates.

9. Control of the azimuth signal is by manual rotation of the assembly which includes the loop output connector. In use, the loop output connector must be free to turn with the azimuth control. A locking screw is provided on the azimuth scale for clamping the scale in any desired position (fig. 1).

10. Although reference has been made to the "top" and the "bottom" of the box, the simulator may be used in any convenient attitude, the only restriction being that the loop signal output connector must be free to allow rotation of the azimuth control. In use, the selector switch (AD712 – AD722) will be set to suit the type of equipment under test, and access to this switch is not normally required during tests.

11. The case of the instrument is finished in a grey paint. Ventilation holes are provided in the sides of the case.

Circuit description

12. A circuit diagram of the simulator is given in fig. 2. The signal generator input point is SKB. The capacitors C1, C2–3–4 and C5 form the sense aerial potential divider and coupling circuit for the receiver AD360. The capacitor C1 and the paralleled group C2–3–4 provide a step-down in voltage of 100 : 1. This gives the correct level of sense signal relative to the loop signal obtained via the coupling circuit LINE/AE1 of fig. 2. The output impedance of the sense signal circuit is virtually the reactance of the 100 pico-farad capacitor C5. The socket SKA is the sense signal output point for the receiver AD360. Similarly, the capacitors C6, C7 and C8 form the potential divider and output circuit for the AD722 receiver, PLB being the output point.

13. The loop signal is obtained from the coupling coil assembly AE1 via the "line". The values of inductance of the coupling coils are similar to the values of the corresponding windings used in the loop aerial but as no significant quadrantal error is introduced by the coil assembly AE1, no provision is made for correction by balancing the relative sensitivities of the two coils of AE1. The centre-tapped loop output signals are coupled to the equipment under test via the plug PLA which is mechanically linked to the coil assembly and the azimuth scale.

14. The "line" consists of a pair of wires situated along the bottom of the instrument case. A group of "load resistors" (R1–2–3–4 of fig. 2) is located at the end of the "line" remote from the signal generator input point (SIGNAL IN of fig. 1). Current from the signal input flows along the "line" and via the load resistors to earth. The "line" current sets up a magnetic field at signal frequency to link with the loop aerial coupling coils (AE1 fig. 2). Maximum induction occurs when one coil of AE1 is positioned with its windings in the plane of the "line", the other coil will then be at right angles to the "line" and no induction will exist with this coil. Under these conditions the receiver will indicate a "signal" at one of the points 0°, 90°, 180°, 270°. Intermediate indications are given when the orientation of AE1 provides some degree of coupling with the "line" to both coils.

Output voltage

15. The output voltage from the loop simulator is quoted in terms of the voltage available from an installation loop aerial situated in a field of given strength. The sensitivity of the D/F installation is necessarily required in terms of field strength, and it is therefore natural to quote test figures in the same terms. In using the simulator, it is necessary to know the factor (referred to as the "attenuation constant"), by which the signal generator voltage input to the simulator is modified, to provide the equivalent loop voltage from a given field strength. The factor for the instrument under consideration is one-tenth. This means that the signal generator output voltage must be divided by ten to obtain the equivalent field strength. Thus, for measuring sensitivity, quoted for example as 100μV per metre, the signal generator must be set to provide 1000μV.

Instrumental accuracy

16. The bearing setting accuracy of this instrument varies to some extent with the setting of the azimuth scale. At the points 0°, 90°, 180° and 270°, the accuracy is comparable with the instrumental accuracy of the receiver AD360 (±2°). At other points of the scale, small errors occur. These may be compensated by the use of a tabulated set of calibration figures supplied with each model.

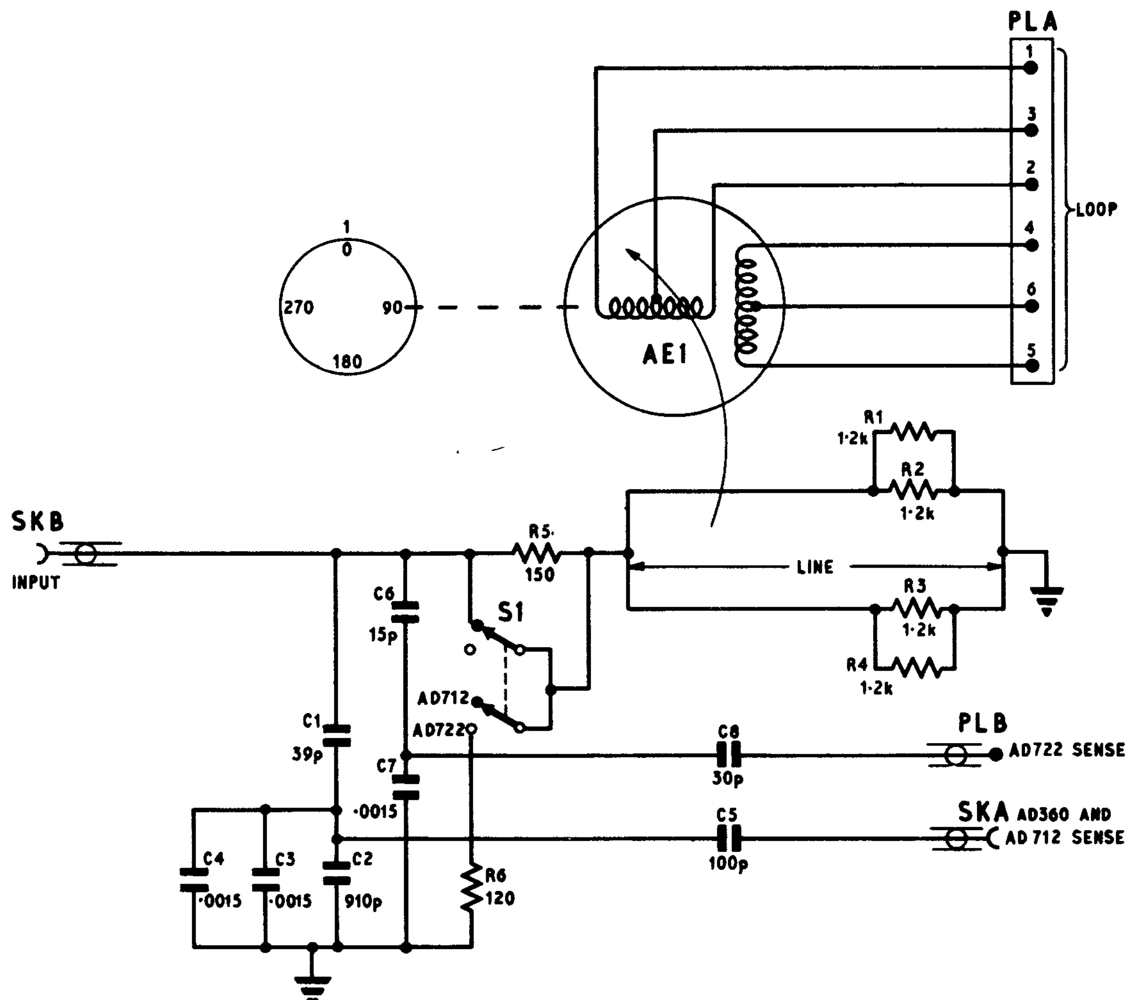

Fig. 2. Simulator, loop signal Type M12: circuit diagram

These figures are available at interv
degrees and direct interpolation may l
obtain intermediate points.

17. The following CAUTION applies to the simulator whether used for checking AD712, AD722 or AD360 equipment.

Caution . . .

Where signal-to-noise ratio measurements

e a screened room, it
filter all the power
supplies for the ADF receiver.

In areas that experience severe electrical noise it may not be possible to make accurate signal/noise measurements even with filtered power supplies. In such areas the simulator should be used in a screened test room.

Chapter 4

TEST RIG, ELECTRICAL 6625-99-952-0760

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LIST OF ILLUSTRATIONS

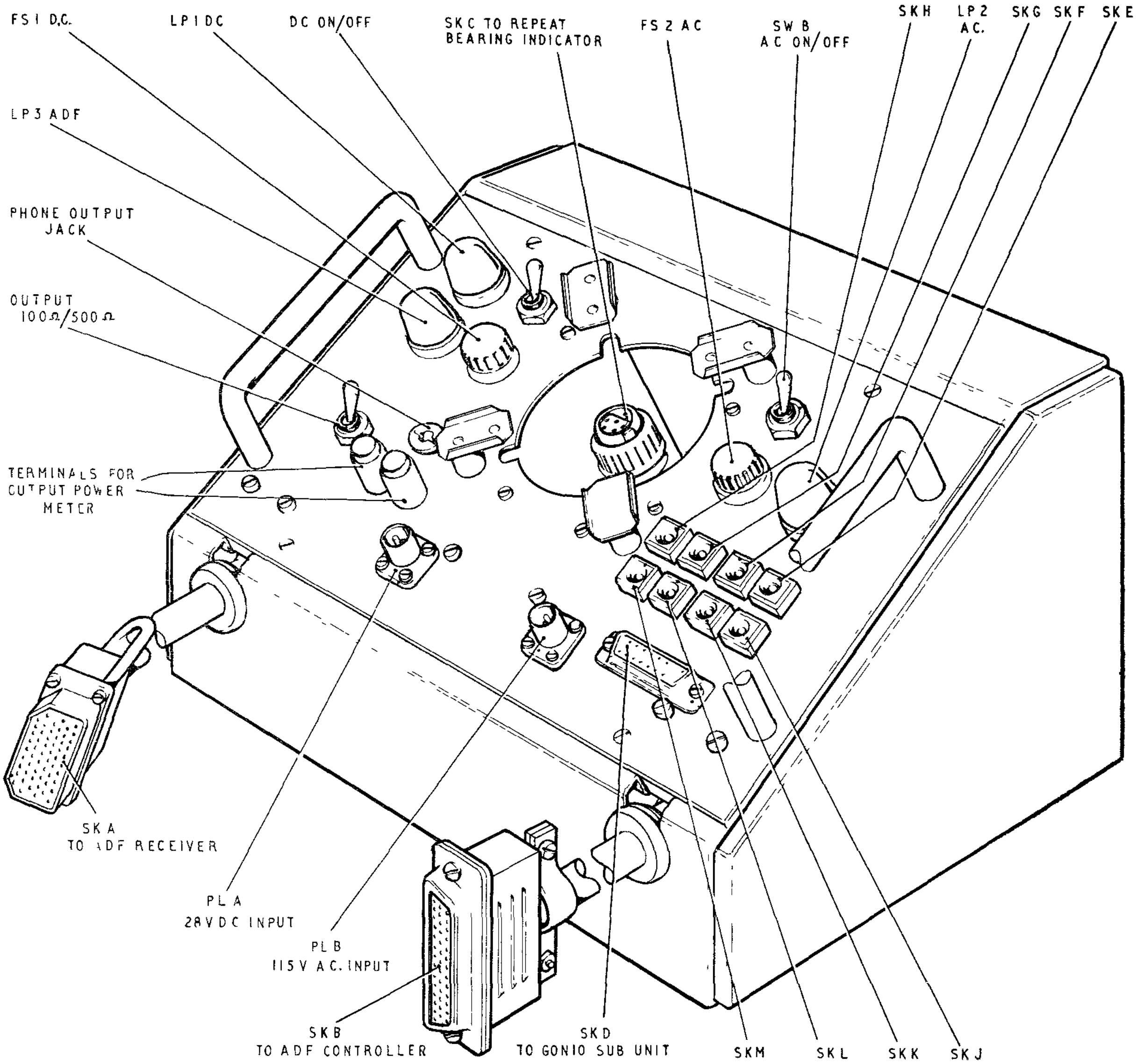

Fig. 1. Test rig, electrical 6625-99-952-0760: general view

General description

1. The test rig electrical 6625-99-952-0760 (Marconi AA-3611-1) is a junction box for connecting together an ADF receiver, a controller and a repeat bearing indicator together with the necessary power supplies. It also provides facilities for connecting headphones and an output power meter to the audio output from the receiver, and for connecting test apparatus to the goniometer sub-unit of the receiver. Input plugs (PLA and PLB) are provided for the connection of 28V d.c. and 115V 400 c/s a.c. supplies. The 115V a.c. input is fed to the primary winding of a transformer via a switch SWB and a fuse FS2 rated at 500mA. The secondary winding provides a 26V supply for the synchros in the receiver and the repeat bearing indicator. An indicator lamp LP2 is connected across the 26V secondary winding of the transformer. The 28V d.c. input is controlled by a switch SWA and protected by a fuse FS1 rated at 2A. An indicator lamp LP1 lights when the d.c. supply is switched on. A further indicator lamp LP3 lights when the controller function switch is set to ADF.

External connections

2. Connectors for the controller and the receiver pass through the front of the test rig and terminate in multi-way sockets. A space is provided on the sloping front panel for mounting the repeat bearing indicator, connection to which is made via socket SKC. A jack socket JK1 for headphones and terminals for an output power meter are connected via a change-over switch (SWC) to the lines carrying the audio output from the receiver. The change-over switch selects either the 100-ohm or 500-ohm audio output connections. A 25-way socket SKD and a group of eight sockets SKE to SKM are provided for use when aligning the goniometer and the bearing synchro transmitter in the gonio sub-unit of the receiver. The gonio sub-unit is connected to socket SKD by means of the goniometer sub-unit extension cable (cable assembly composite 5826-99-951-0797) and when aligning the goniometer, as described in Sect. 2, Chap. 2 of this part, the signal generator is connected to sockets SKG and SKH and the oscilloscope is connected to sockets SKL and SKM. When aligning the synchro, the multimeter is connected to sockets DKE and SKF and the oscilloscope is connected to sockets SKJ and SKK.

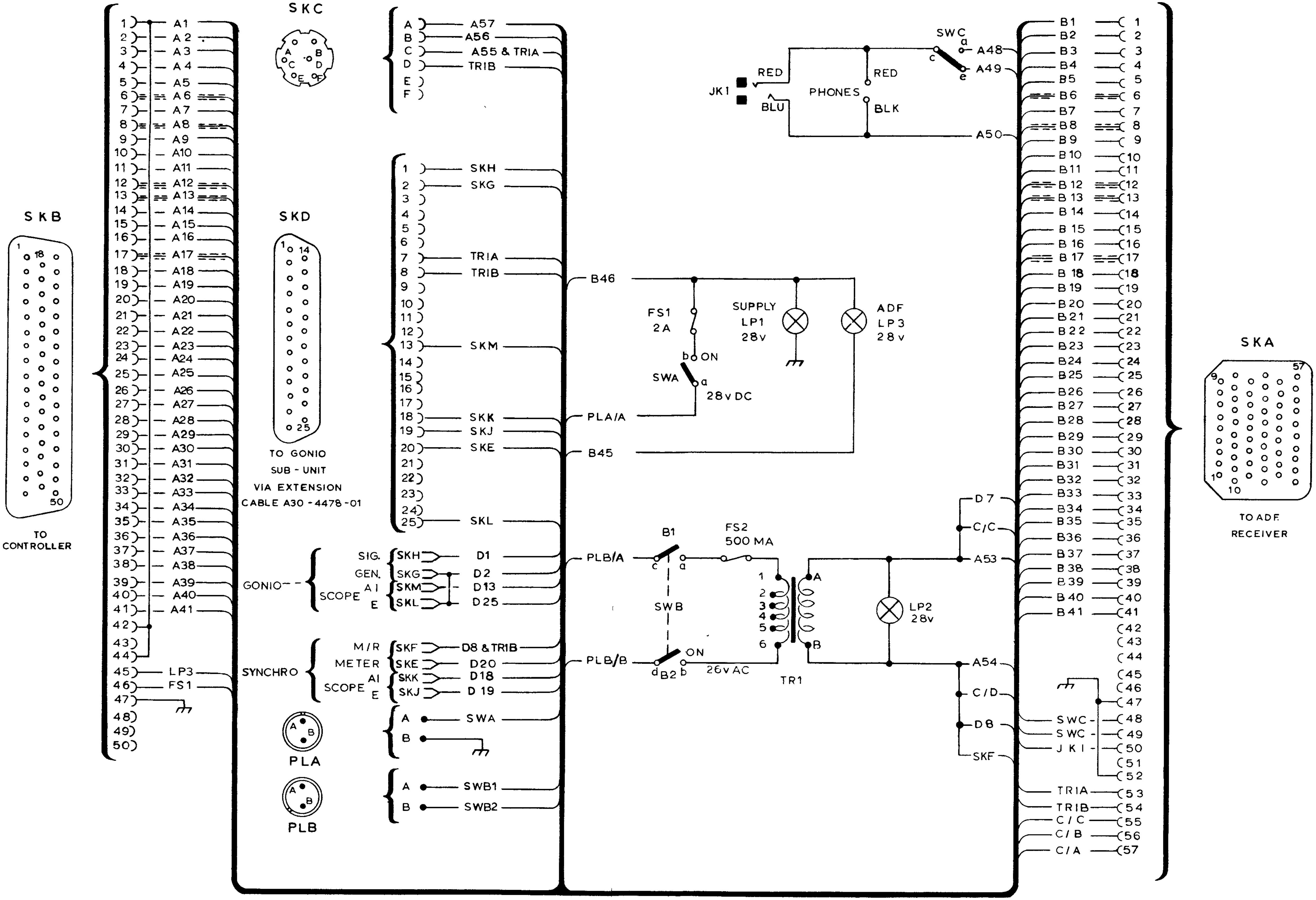

Fig. 2 Test rig, electrical 6625–99–952–0760 : circuit Fig. 2

D713060 260 7/69 A(W)Ltd Gp956/3 523M

SECTION 2

SERVICING

Chapter 1

AIRCRAFT SERVICING

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LIST OF TABLES

GENERAL

1. After the initial installation of the equipment in an aircraft has been completed the functional tests detailed in para. 4 should be carried out. Subsequent system maintenance consists of carrying out routine checks to ensure that the performance of the system is maintained at the required standard. When a check shows that the performance of a system has deteriorated, or if a fault is reported in service, it is recommended that the procedure detailed in Table 1 is followed. This will assist to localize the source of the trouble and may save changing a major unit unnecessarily.

AIRCRAFT SYSTEM ROUTINE CHECKS

Visual checks

2. (1) Check for any temporary changes to the aircraft structure and attachments that might affect ADF performance during the functional checks, such as the removal or opening of hatches and access panels, connection of a ground supply unit, hydraulic test rig, tractor towing arm, etc.

(2) Check for recent modifications to the aircraft that might affect ADF performance in service such as the fitting, removal or re-siting of other aerials and radio equipment.

(3) Check that the static discharge wicks on the aircraft are in good condition and correctly trimmed.

(4) Check the fixed loop aerial to ensure that:—

(a) It is not contaminated with paint, oil, waste water, etc.

(b) The aerial gasket is undamaged and the fixing bolts are secure.

(c) The plug and plug pins are clean and undamaged.

(d) There are no signs of conducting lines or tracks over the dielectric fairing.

(5) Check the sense aerial to ensure that:—

(a) It is complete and undamaged.

(b) It is not contaminated with paint, oil, waste water, etc.

(c) If the sense aerial contains more than one element, the connections between the elements are clean and secure.

(d) There are no signs of conducting lines or tracks over the stand-off insulators.

(6) Check the condition of those parts of the loop aerial and sense aerial cables that are accessible to ensure that:—

(a) They are not contaminated with condensation, hydraulic fluid, etc.

(b) The cables are not chafed or kinked.

(c) There are no signs of damage due to the proximity of heated items such as food warmers, water heaters, floor warmers, etc.

(d) All connectors are clean and undamaged.

(7) Check the Q.E. and loop cable equalizer and the sense cable equalizer for freedom from damage, security of mounting, cleanliness, security and condition of connectors.

(8) Check that the receiver and its anti-vibration mountings are secure and undamaged.

(9) Check that the controller is secure and undamaged.

Electrical checks

3. (1) Using a multimeter 6625-99-943-2134 set to the Ω/100 range, carry out the following d.c. resistance checks on the loop aerial circuit (i.e. the loop aerial plus Q.E. and loop cable equalizer plus loop cables), taking all measurements at the connector on the receiver end of the loop cable.

(a) Check that the resistance measured between pin 1 and pins 3 and 6 is equal to the resistance measured between pin 2 and pins 3 and 6.

(b) Check that the resistance measured between pin 4 and pins 3 and 6 is equal to the resistance measured between pin 5 and pins 3 and 6.

◄(c) Check that the insulation resistance between the plug housing and each pin is greater than 25k ohm.►

(2) Using the test bridge set capacitance 6625-99-953-2121, as described in Part 1, Sect. 1, Chap. 2, check that the capacitance of the sense aerial circuit as measured at the connector on the receiver end of the sense cable is 830 pF.

Functional checks

Note . . .

The following checks (1) *to* (5) *may be carried out in the hangar if required as a strong r.f. signal is not necessary. Checks* (6) *to* (11) *should be carried out in the open, if possible, as an r.f. signal is required.*

4. (1) Ensure that 27·5V d.c. and 26V 400 c/s a.c. supplies are available, close the appropriate circuit breakers and switches in the aircraft power distribution system and check that the controller panel lights come on.

(2) Select the ADF system on the intercom controller. Set the ADF controller function switch to ADF, the B.F.O. switch to OFF, the selectivity switch to BROAD, and the GAIN control fully clockwise (maximum gain). Check that the controller dial lights come on and that noise and/or a signal is audible on the intercom.

(3) Reset the function switch first to ANT and then to LOOP and check that at each position noise and/or a signal is audible on the intercom. Reset the GAIN control for a comfortable audio level.

(4) With the function switch at LOOP, rotate the goniometer search coil by operating the LOOP manual control. Check that when the LOOP manual control is turned to the right, the bearing scale on the ADF receiver moves past the cursor to the right (i.e. the indicated bearing increases) and vice versa. Check that the associated repeat bearing indicators and/or R.M.I. move in unison with the bearing indicator on the ADF receiver. Check that the speed and direction of rotation of the goniometer search coil, as represented by the various bearing indicators, is controlled smoothly by the LOOP manual control. Check that at the maximum rotational speed of the goniometer search coil (LOOP manual control fully right or fully left the time taken to complete a rotation of 360° is not longer than 6 seconds.

(5) Select several different frequencies, spread over the full tuning range of the receiver, at intervals of 6 or 7 seconds between each selection and check that the audio output from the receiver is muted while the automatic tuning mechanism is in operation. Check that the time taken to change frequency is not longer than 4 seconds.

(6) Select the frequency of a local m.f. transmitter that is suitable for ADF test purposes and switch on the B.F.O. Set the B.F.O. control knob to the dot-to-dot position and check that the note sounds like 1000 c/s and that the pitch of the note increases when the knob is turned counter-clockwise and decreases to zero beat when the knob is turned clockwise.

Note . . .
If zero beat is not obtainable the transmitter may be off frequency. Search for the actual transmitter frequency by increasing or decreasing the controller frequency setting in 1 kc/s or 0·5 kc/s steps. Zero beat should be obtainable when the actual transmitter frequency is selected.

(7) With the receiver tuned to a m.f. transmitter as in (6), set the function switch successively to ANT, LOOP and ADF. At each position check, by listening to the B.F.O. note as the GAIN control is operated, that the GAIN control functions smoothly.

(8) With the receiver still tuned to a local m.f. transmitter, and with the function switch at ADF, check that the bearing indicators settle quickly on a definite bearing.

Note . . .
This and the following checks are NOT checks on ADF accuracy; their purpose is simply to establish that the system is functioning.

(9) With the receiver tuned to a local m.f. transmitter an in (6) and with the function switch set at ADF, operate the LOOP manual control and check that it overrides the ADF controlled bearing. Check that when the LOOP manual control is restored to the centre OFF position the bearing indicators turn through less than 180° to within 5° of the original ADF bearing in not more than 6 seconds.

(10) Set the function switch to LOOP and use the LOOP manual control to obtain a bearing of the selected transmitter by locating an aural null. Check that a second aural null occurs on the reciprocal bearing. Check that one of the two bearings coincides with (or lies within 5° of) the bearing previously indicated on function ADF.

(11) Switch off the B.F.O. and set the function switch to ANT. Check that the selectivity switch is functioning by listening for a change in the character of the noise and/or signal as the setting is changed from BROAD to SHARP and then back to BROAD.

AIRCRAFT SYSTEM TROUBLE SHOOTING

5. To localize the source of a fault in the aircraft system use should be made of the information given in Table 1. Where checks of individual items of the system are suggested in this table they should be carried out as described in the following paragraphs.

LOOP AERIAL CIRCUIT

6. (1) Carry out the visual checks detailed in para. 2 followed by the electrical checks detailed in para. 3 (1). If the latter checks show either pair of resistances to be unequal, check whether the inequality is due to the loop cable or the loop aerial by repeating the resistance checks on the loop aerial alone.

(2) The capacitance of each core of the loop cable should be checked using the test bridge set capacitance, and for this check the loop cable should be disconnected from both the loop aerial and the receiver. The capacitance of each core should be measured at the receiver end of the cable by connecting the capacity meter between earth and each core in turn, i.e. between pins 1 and 3, 2 and 3, 4 and 6, 5 and 6. A suitable connecting cable fitted with crocodile clips is supplied with the capacity meter for this purpose. The measured capacitance should be between 500 pF and 700 pF.

(3) If there is a fault in any core that reduces the r.f. resistance of its insulation (normally greater than 500 kilohms) it will be made apparent by the sharpness of the response of the meter near the balance point. A shunt r.f. resistance of 330 kilohms will reduce the meter sensitivity by half and a shunt r.f. resistance of 75 kilohms will make the meter inoperative.

SENSE AERIAL CIRCUIT

7. (1) Carry out the visual checks as detailed in para. 2.

(2) Using the test bridge set capacitance, as described in Part 1, Sect. 1, Chap. 2, check that the capacitance of the sense aerial circuit as measured at the connector on the receiver end of the sense cable is 830 pF.

(3) If there is a fault in the cable or in the aerial that reduces the r.f. resistance of the insulation (normally greater than 500 kilohms) it will be made apparent by the sharpness of the response of the meter near the balance point. A shunt r.f. resistance of 350 kilohms will reduce the meter sensitivity by half and a shunt r.f. resistance of 75 kilohms will make the meter inoperative.

REPEAT BEARING INDICATORS

8. Compare the response of the repeat bearing indicators with the response of the reference indicator on the receiver as the LOOP manual control is operated to drive the goniometer search coil to various positions. Check that the rotation sense is the same, i.e. all bearings increase or decrease together. If they do not, the synchro connections are transposed.

RECEIVER

9. Temporarily substitute another receiver that is known to be serviceable and check whether or not the trouble disappears.

CONTROLLER

10. Temporarily substitute another controller that is known to be serviceable and check whether or not the trouble disappears.

TABLE 1

Aircraft system fault location

Symptom	Action
No audio output on ADF, ANT or LOOP.	Check power supplies for correct voltage and polarity, i.e. 27•5V d.c. +10% to -20%, 26V a.c. 400 c/s. Positive d.c. should be shown at controller PLA pins 42, 44 and 46; negative d.c. at controller PLA pin 47 and receiver PLA pins 47 and 52. Check intercom. Check ADF receiver.
No audio output on ANT.	Check sense aerial circuit.
No audio output on LOOP.	Check loop aerial circuit.
No audio output on ADF.	Check ADF receiver.
No bearing indication by repeat bearing indicators.	Check that the reference indicator on the receiver is giving correct bearing indications. Check that the repeat bearing indicators are correctly connected to the receiver and the 26V supply. Check bearing indicators for serviceability. Check loop aerial circuit. Check receiver.
Erratic bearing indications:	
on ground only.	Check test environment.
in flight only.	Check interference from other equipment.
on ground and in flight.	Check both aerial systems.
Slow bearing response.	Check repeat bearing indicators. Check receiver.
Bearing errors:	
on ground only.	Bearing errors on the ground are to be expected.
in flight.	Check aircraft for structural or equipment changes that might affect reception at the ADF aerials. Check the loop aerial circuit. Check the sense aerial circuit. Check the receiver.

TABLE 1 (Cont'd)

Symptom	Action
Bearing indications on LOOP:-	
not coincident with indications on ADF.	Check loop aerial circuit.
aural nulls not 180° apart	Check the loop aerial circuit. Check the receiver.
aural nulls indefinite.	Check the test environment. Check the loop aerial circuit. Check the receiver.

Chapter 2

(Completely revised)

BENCH SERVICING

LIST OF CONTENTS

LIST OF ILLUSTRATIONS

Note . . .

In this chapter, item numbers refer to the lists of test equipment in Tables 1, 2 and 3 in Part 2, Section 1, Chapter 1.

GENERAL

Introduction

1. The AD360 ADF receiver circuits are accurately aligned before despatch and are designed to retain their alignment indefinitely. Preset components should not be re-adjusted unless performance checks indicate misalignment.

2. When the receiver is removed from an aircraft for routine bay servicing (2nd line) the overall performance of the receiver should be checked as detailed in paras. 13 to 26. If, as a result of the checks, the receiver meets the minimum performance specification detailed in para. 27 it may be issued for further service. If the receiver does not meet the specification, the faulty sub-units should be replaced with serviceable items and the overall performance re-checked. Sub-units can be tested at 2nd line to the extent detailed in para. 8 to 12.

3. If the receiver is removed from an aircraft for the correction of a fault, the faulty sub-unit should be identified (Part 3) removed and a serviceable sub-unit fitted. The overall performance should then be checked as detailed in para. 13 to 26.

Dismantling

4. The sub-units are removed from the main chassis as follows:—

(1) Release the quick-release fastener at the rear of the chassis and remove the case.

(2) Release the three captive screws that secure the cover of the front doghouse and remove the cover.

(3) Release the four captive screws, marked by a green spot, that secure the goniometer sub-unit to the front panel of the main chassis and remove the sub-unit.

(4) Release the three captive screws, marked by a green spot, that secure the r.f. sub-unit to the upper side of the main chassis and remove the sub-unit.

(5) Release the three captive screws, marked by a green spot, that secure the i.f. sub-unit to the upper side of the main chassis and remove the sub-unit.

(6) Release the four captive screws, marked by a green spot, that secure the crystal sub-unit to the under side of the main chassis and remove the sub-unit.

Inspection

5. Examine the main chassis and all sub-units for:—

(1) Insecurity of attachment of components.

(2) Cracks or fractures.

(3) Corrosion, contamination or deterioration.

(4) Distortion.

(5) Chafing or fraying of cables or looms.

(6) Undue wear.

Cleaning

6. Remove dust from the main chassis and sub-units by air blast and clean each item including plugs, chassis, wiring, relays, switches, etc., using white cotton rag dampened with Inhibisol. Printed circuits should be cleaned with a camel hair brush only.

Assembly

7. Replace the sub-units and the cover of the front doghouse by engaging and tightening the appropriate captive screws.

TEST OF SUB-UNITS

Main chassis

8. Details of the equipment required for the following tests are given in Section 1 of this part:—

(1) Circuit checks:—

(a) Remove the four sub-units from the main chassis (para. 4).

(b) Using the multimeter (item 6) set to the ohms range and with the negative lead connected to the chassis, check the following socket pole to chassis resistances:—

B3	open circuit
B5	1100 ohms approx
B10	1100 ohms approx
B12	open circuit
B16	open circuit
B17	1100 ohms approx
B24	open circuit
C7	open circuit
E4	1000 ohms approx
E14	1100 ohms approx
E17	open circuit
F2	1200 ohms approx
◄F5	1000 ohms approx►

(c) Check that the resistance between E17 and C7 is approximately 1500 ohms.

(2) The 89 kc/s filter circuit:—

(a) Connect poles E16 and C8 to earth.

(b) Connect the signal generator (item 7) between E17 and earth and the valve voltmeter (item 8) in parallel with a 1·5-kilohm resistor between pole C7 and earth.

(c) Set the signal generator output to 500 mV and the valve voltmeter to the 300 mV range. Using the frequency counter (item 9) tune the signal generator to 88·75 kc/s.

(d) Using the trimming tool (item 24/4), tune 1L1 for a minimum reading on the valve voltmeter, increasing the input from the signal generator up to 20V and reducing the range of the valve voltmeter when necessary.

Caution . . .

Do not use the 1 mV range of the valve voltmeter.

(e) Tune 1L3 for a minimum on the valve voltmeter, again increasing the input from the signal generator and reducing the range of the valve voltmeter when necessary.

(f) Tune 1L2 for a minimum. Note that the tuning will be very flat.

(g) Set the valve voltmeter to the 3 mV range. Tune the signal generator to 20 c/s and set the output level so that the output meter indicates −10dB with the attenuation switch set to the 20 mV (−40dB) range. Call this level the reference level. Note the reading of the valve voltmeter and then slowly increase the frequency of the signal generator so that it sweeps through the entire frequency range up to 200 kc/s. If necessary, adjust the output level of the signal generator to maintain the same reading on the valve voltmeter. Check that increases in the output level above the reference level are as follows:—

Below 60 kc/s ...	less than 1 dB
Between 65 kc/s and 75 kc/s ...	greater than 3 dB
88·75 kc/s ...	greater than 70 dB
Between 88·75 kc/s and 200 kc/s ...	greater than 30 dB

(h) Remove the signal generator and valve voltmeter and disconnect the earth connections from poles E16 and C8.

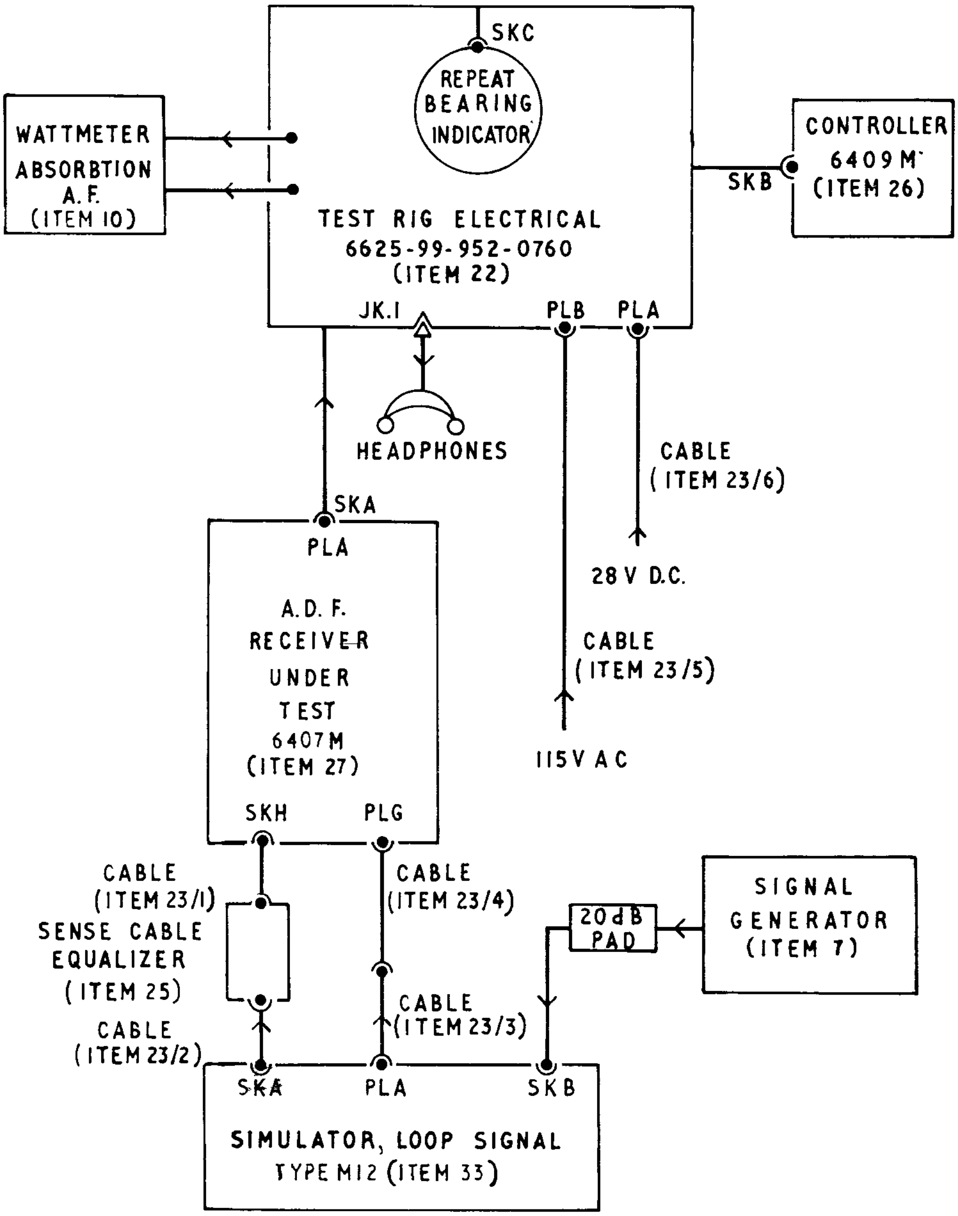

Fig. 1. Receiver test rig

(3) Power supplies.

(a) Connect the test rig, electrical as shown in fig. 1. Plug the receiver chassis into the test rig, switch on the 27·5V supply and set the controller function switch to ANT.

(b) Check the following socket pole voltages:—

B10	...	27·5V
◄B5	...	17·7V +1·3V, −0·7V►
◄B17	...	17·7V +1·3V, −0·7V►
◄E14	...	17·7V +1·3V, −0·7V►
E4	...	17·7V ± 1·0V
E6	...	14V ± 1V
F5	...	7V ± 0·5V

(4) Audio circuit.

(a) Connect the signal generator between socket pole F1 and earth. Connect the oscilloscope (item 11) across the output wattmeter in the test rig. Set the output wattmeter to 500 ohms.

(b) Check that the output is greater than 300 mW for not more than 6·5V r.m.s. input at 1 kc/s and that it appears reasonably sinusoidal.

(c) Switch off the 27·5V supply, remove the signal generator and oscilloscope and replace the sub-units.

Goniometer sub-unit

9. (1) Circuit checks.

(a) Remove the goniometer sub-unit from the receiver main chassis, the latter remaining connected to the test rig as detailed in sub-para. 8(3)(a).

(b) Using the multimeter set to the ohms range and with the negative lead connected to the goniometer sub-unit chassis, check the following plug pole to chassis resistances:—

B5 ... 100 ohms
B6 ... 15 kilohms
B10 ... 100 kilohms
B17 ... 100 ohms

(c) Check that plug pole numbers B3, B12, B16 and B24 are connected together but not to the goniometer sub-unit chassis.

(d) Using the multimeter set to the ohms/100 range, check that the resistance between the chassis and the collectors of 2VT3 and 2VT6 is approximately 20 ohms in each case.

(2) Function checks.

(a) Using the goniometer sub-unit extension cable (cable assembly composite, item 21) connect the goniometer sub-unit to the receiver main chassis.

(b) Switch on the 27·5V supply and set the controller function switch to ADF.

(c) Turn the controller LOOP control knob fully clockwise and check that the goniometer bearing scale rotates in a degrees decreasing direction at a speed of not less than 1 revolution in 6 seconds.

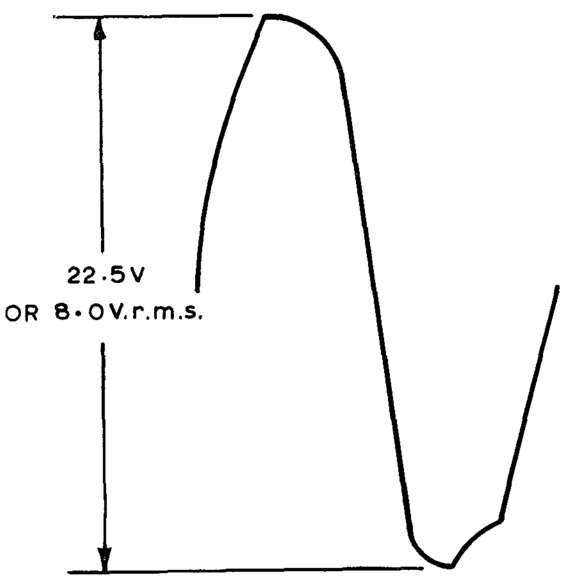

Fig. 2. Waveform of supplies to gonio servo motor

(d) Connect the oscilloscope and the valve voltmeter between the collector of 2VT6 and the goniometer sub-unit chassis. Check that a waveform of the approximate shape and amplitude shown in fig. 2 is indicated.

(e) Disconnect the oscilloscope and the valve voltmeter and re-connect them between the collector of 2VT3 and the goniometer sub-unit chassis. Check that a waveform of the approximate shape and amplitude shown in fig. 2 is indicated when the LOOP control is turned right or left.

(f) Disconnect the oscilloscope and the valve voltmeter.

(g) Set the controller function switch to ANT and check that relay 2RLA is energized by listening for the click of the relay as the function switch is operated, and by checking with the multimeter that there is 14V d.c. between socket pin C21 and the goniometer sub-unit chassis when the relay is energized.

(3) Frequency setting of the 135 c/s oscillator.

(a) Set the controller function switch to ADF and connect the frequency counter between the collector of 2VT6 and the goniometer sub-unit chassis.

(b) Using the trimming tool (item 24/3) adjust the core of 2L2 until a frequency of 135 c/s ±0·5 c/s is obtained.

Caution . . .

Do not damage the core thread by attempting to turn the core clockwise if it has already been screwed fully in.

(c) Remove the frequency counter.

(4) Goniometer alignment.

(a) Disconnect the goniometer sub-unit extension cable from the receiver main chassis and re-connect it to socket SKD on the test rig.

(b) Set the controller function switch to OFF.

(c) Set the goniometer bearing scale zero accurately to the cursor line and check that the marks on the goniometer barrel and the rotor shaft are approximately aligned with the cursor line.

Note . . .

The mark on the rotor shaft is on the 'back' end furthest from the scale.

(d) Connect the signal generator (item 12) to sockets SKG and SKH (identified GONIO, SIG. GEN.) and the oscilloscope to sockets SKL and SKM (identified GONIO, SCOPE) on the test rig.

(e) Set the signal generator to give an output of 1V unmodulated at 300 kc/s.

(f) Slacken the goniometer clamping screws and rotate the barrel to give a minimum output on the oscilloscope (with the A1 gain at maximum), checking that the goniometer bearing scale does not move away from the cursor line.

(g) Re-tighten the goniometer barrel taking care not to rotate it while tightening the clamping screws.

(h) Remove the oscilloscope and signal generator.

(5) Synchro alignment.

Note . . .

It is assumed that the goniometer has already been aligned in accordance with the procedure detailed in sub-para. (4).

(a) After removing the four fixing screws, swing back the tagboard TB2.

(b) Slacken the synchro clamping screws.

(c) Set the goniometer scale zero accurately to the cursor line.

(d) Connect the oscilloscope to sockets SKJ and SKK (identified SYNCHRO, SCOPE) and the multimeter (set to the 100V a.c. range) to the sockets SKE and SKF (identified SYNCHRO, M/R METER) on the test rig. Switch on the 26V 400 c/s a.c. supply.

(e) Rotate the synchro barrel in either direction until a minimum is obtained on the oscilloscope. Note the multimeter reading and identify it V_a.

(f) Rotate the goniometer scale 180° to obtain a second minimum on the oscilloscope. Note the multimeter reading and identify it V_b.

(g) Check that V_a is smaller than V_b.

(h) Reset the goniometer scale zero accurately to the cursor line and disconnect the multimeter.

(j) Rotate the synchro barrel slightly in either direction to obtain an accurate minimum on the oscilloscope.

Note . . .

The minimum may be best observed when the oscilloscope time-base frequency is set for a high sweep speed, e.g. 50 μ sec/cm. The minimum may then be taken as the narrowest width of the trace.

(k) Re-clamp the synchro barrel, taking care not to rotate it as the clamping screws are tightened. Replace and secure tagboard TB2.

(l) Disconnect the oscilloscope and the gonio sub-unit extension cable from the test rig.

(m) Re-connect the gonio sub-unit extension cable to the receiver main chassis.

(n) Rotate the goniometer bearing scale and check that the direction of rotation of the pointer of the repeat bearing indicator corresponds.

(o) Set the goniometer scale to 0° and check that the repeat bearing indicator reads 0° ±0·5°.

(p) Switch off the 27·5V d.c. and the 26V a.c. supplies. Remove the extension lead and screw the goniometer sub-unit on to the receiver chassis.

I.F. sub-unit

10. (1) Circuit checks.

(a) Remove the i.f. sub-unit from the main chassis.

(b) Check the wiring for continuity visually or, where necessary, by the use of the multimeter.

(c) Using the multimeter set to the ohms range and with the negative lead connected to the i.f. sub-unit chassis, check the following plug pole to chassis resistances:—

F2	greater than 800 ohms
F5	greater than 35 kilohms
F13	greater than 11 ohms
F24	greater than 1 kilohm.

(d) Reset the multimeter to the ohms × 100 range and check the following pole to chassis resistance:—

F10 greater than 500 kilohms.

R.F. sub-unit

11. (1) Circuit checks.

(a) Remove the r.f. sub-unit from the receiver main chassis.

(b) Using the multimeter set to the ohms range and with the negative lead connected to the r.f. sub-unit chassis, check the following plug pole to chassis resistances:—

D4	greater than 1900 ohms
D9	greater than 2500 ohms
C10	greater than 55 kilohms
C11	greater than 2500 ohms.

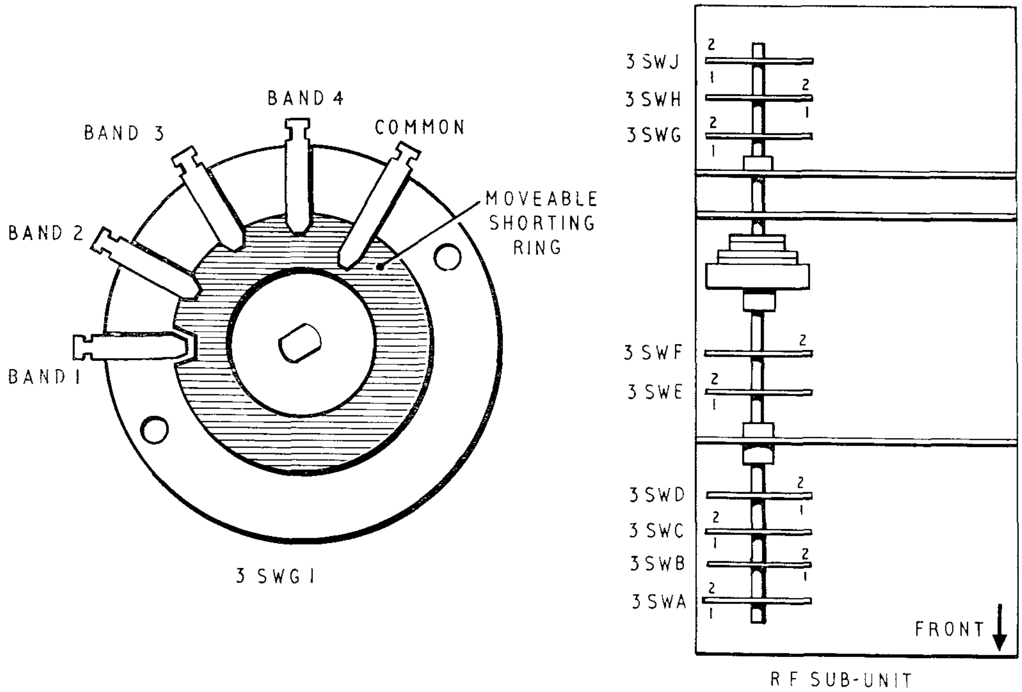

Fig. 3. Bandswitch setting

(c) Using the multimeter set to the ohms range check that the resistance between plug poles D3 and C10 is 945 ohms ± 10 per cent.

(2) Microswitch checks.

(a) With the tuning indicator core bracket assembly positioned so that neither microswitch is operated, check the following using the multimeter:—
C20 to C19 open circuit
C20 to C22 short circuit
C17 to C18 short circuit.

(b) With the core bracket assembly lowered so as to operate the bottom microswitch, check the following:—

C20 to C19 short circuit
C20 to C22 open circuit
C17 to C18 short circuit.

(c) With the core bracket assembly raised so as to operate the top microswitch, check the following:—
C20 to C19 open circuit
C20 to C22 short circuit
C17 to C18 open circuit.

(3) Bandswitch click mechanism check.

(a) Turn the bandswitch shaft manually to the band 1 position so that the band 1 contact on wafer 3SWG1 is in the centre of the gap in the movable shorting ring (fig. 3).

(b) Using the multimeter set to the ohms range check that the resistance between the chassis and the common contact on 3SWG1 is greater than 55 kilohms.

(c) With the bandswitch set successively in the band 2, band 3 and band 4 positions repeat operation (b) in each position.

Crystal sub-unit

12. (1) Circuit checks.

(a) Remove the crystal sub-unit from the reciver main chassis.

(b) Using the multimeter set to the ohms range and with the negative lead connected to the crystal sub-unit chassis, check the following plug pole to chassis resistances:—

E2, 16, 17, 33	short circuit
E20 to 31 inclusive	greater than 100 kilohms
E34 to 38 inclusive	greater than 100 kilohms
E4	greater than 800 kilohms
E10	greater than 1·5 kilohms
E14	greater than 20 kilohms.

(c) Check that the resistance between plug poles E7 and E10 is 975 ohms.

TEST OF COMPLETE RECEIVER

Tuning system pre-set gain control

13. (1) Connect the receiver to the test rig and switch on the 27·5V supply. Set the controller as follows:—

Function	ANT
B.F.O.	OFF
Frequency	1700 kc/s

(2) Turn the pre-set gain control 5RV1 in the receiver fully clockwise.

(3) Connect the valve voltmeter (item 8) to the emitter of 5VT1.

(4) Turn 5RV1 counter-clockwise until the receiver just fails to tune; then turn 5RV1 clockwise until the receiver just tunes. Switch off the 27·5V d.c. power supply and de-couple the collector of 5VT5 with a 0·04μF capacitor, switch on the 27·5V d.c. and note the valve voltmeter indication which will be of the order of 1 or ◄2·5 mV.► Remove the de-coupling capacitor and check that the receiver tunes on 1700·5 kc/s; then retune to 1700 kc/s.

(5) Turn 5RV1 clockwise until the valve voltmeter indicates a value six times greater than that measured and noted in sub-para. (4) or, if this value cannot be obtained, until 5RV1 is turned fully clockwise.

◄(6) Set the controller to each of the following frequencies and check that the local oscillator frequencies are within 1% of the figures given in the table. (Connect the frequency counter Type CT463 between the wiper of RV1 and chassis).

Controller frequency	Local oscillator frequency
100	555
160	615
390	845
460	915
1447	1902
1700	2155►

(7) Turn 5RV1 counter-clockwise until the valve voltmeter indicates a value three times greater than that meausred and noted in sub-para. (4). Lock the adjusting screw at this new setting, switch off the 27·5V d.c. supply and remove the valve voltmeter.

Tuning system checks

14. (1) Tuning speed check.

(a) With the receiver connected to the test rig, switch on the 27·5V supply. Set the controller as follows:—

Function	ANT
B.F.O.	OFF

(b) Check that the time taken by the receiver to re-tune, after the controller frequency setting has been changed in accordance with the following table, is not longer than the corresponding time given in the table:—

Controller frequency setting		Receiver
From	To	re-tuning time
100 kc/s	100·5 kc/s	1 sec
900 kc/s	400 kc/s	2 sec
400 kc/s	800 kc/s	1·5 sec
800 kc/s	400 kc/s	3 sec

(c) Switch off the 27·5V d.c. supply.

(2) Tuning accuracy check.

(a) With the receiver connected to the test rig, switch on the 27·5V supply. Set the controller as follows:—

Function	ANT
B.F.O.	OFF

(b) Connect the frequency counter, Type CT463, between earth and the end of 5R5 remote from 5RV1.

(c) Plug the headphones into the telephone jack on the test rig.

(d) Select frequencies on the controller in accordance with the following table. Check that the frequency counter indicates the corresponding input frequency as given in the table. Check that the audio output is muted while the receiver is tuning.

Controller setting	R.F. input frequency
100 kc/s	555 kc/s ±200 c/s
200 kc/s	655 kc/s ±200 c/s
1000 kc/s	1455 kc/s ±200 c/s
1799·5 kc/s	2254·5 kc/s ±200 c/s

(e) Set the controller successively to each of the following frequencies and check that the frequency counter indicates frequencies 455 kc/s higher than each set frequency ±200 c/s.

100 kc/s to 109 kc/s in steps of 1 kc/s
110 kc/s to 190 kc/s in steps of 10 kc/s
200 kc/s to 1700 kc/s in steps of 100 kc/s

(f) Switch off the 27·5V supply and remove the frequency counter.

(3) Frequency locking check.

(a) With the receiver connected to the test rig, switch on the 27·5V supply. Set the controller as follows:—

Function	ANT
B.F.O.	OFF

(b) Connect the Y1 trace of the oscilloscope to the collector of 5VT10 and connect the Y2 trace to the collector of 5VT11.

(c) Set the controller to 100 kc/s and check that the two waveforms lock together.

(d) Repeat (c) with the controller set to 200 kc/s, 500 kc/s and 1799·5 kc/s.

(e) Switch off the 27·5V d.c. supply and remove the oscilloscope.

(4) Trigger drive reduction circuit check.

(a) With the receiver connected to the test rig, switch on the 27·5V d.c. supply. Set the controller as follows:—

Function	ANT
B.F.O.	OFF

(b) Connect the multimeter, set to the 10V d.c. range, between earth and the junction of 5MR52 and 5C96.

(c) Set the controller to various frequencies in bands 1 and 2 (100 to 419·5 kc/s) and check that while the receiver tuning mechanism is operating the multimeter indicates 1V.

(d) Set the controller to various frequencies in bands 3 and 4 (420 to 1799·5 kc/s) and check that while the receiver tuning mechanism is operating the multimeter indicates 5V.

(e) Switch off the 27·5V d.c. supply.

Servo gain control

15. (1) Connect the following items as shown in fig. 1:—

Signal generator (item 12)
Loop signal simulator (item 33)
Sense cable equalizer (equalizer, cable item 25)
Sense cable VCG/024 (cable assembly, radio frequency, item 23/1)
Sense cable VCT/696 (cable assembly, radio frequency, item 23/2)
Loop cable, VAF/024 (cable assembly, special purpose ,electrical, item 23/3)
Loop cable, VBG/576 (cable assembly, special purpose, electrical, item 23/4)

The four latter items are part of cable assembly, set, electrical, item 23).

(2) Set the trimmer C1 in the sense cable equalizer so that the capacitance measured across the free end of the cable VCG/024 is 830 pf $\pm$ 1 pf in accordance with the instructions given in Chap. 3, para. 15.

(3) Connect the free end of cable VBG/576 to the loop aerial input plug PLG on the receiver and the free end of cable VCG/024 to the sense aerial input plug PLH on the receiver.

(4) With the receiver connected to the test rig, switch on the 27·5V supply. Set the controller and signal generator as follows:—

Function	LOOP
B.F.O.	OFF
Selectivity	BROAD
Frequency	1700 kc/s

Signal generator:—

Frequency	1700 kc/s
Modulation depth	30 per cent
Modulation frequency	400 c/s
Output level	◄1V►

Caution . . .

When a signal generator (item 12) is used with an attenuator pad Type TM6123/1 (item 20) allowance should be made for the 10 to 1 attenuation of the signal by the pad.

(5) Set the output wattmeter to 500 ohms.

(6) If a Marconi 6419A loop simulator is being used, set the changeover switch to AD712.

(7) Adjust the controller GAIN control until the output wattmeter on the test rig indicates 20 mW.

(8) Adjust the signal generator tuning for a peak indication on the output wattmeter, simultaneously adjusting the controller GAIN control to keep the indication at about 20 mW.

(9) Switch off the modulation. Set the controller function switch to ADF.

(10) Adjust the servo gain control 1RV1 until the goniometer servo motor just 'hunts'.

(11) Tune 4L6 and 4L7 for maximum activity of the servo motor, maintaining it in a state of 'just hunting' by simultaneous adjustment of the servo gain control 1RV1.

(12) When 4L6 and 4L7 are adjusted, set the servo gain control 1RV1 so that when the goniometer is allowed to return to the null position, after being motored off by means of the LOOP control, it overshoots the null position twice before settling.

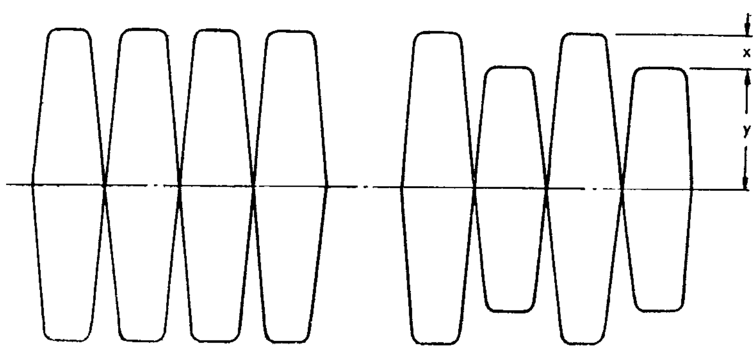

Fig. 4. Waveform of balanced modulator output

Balance of the balanced modulator

16. (1) With the receiver connected to the test rig, switch on the 27·5V supply.

(2) Connect the oscilloscope to the cathode (i.e. the r.f. end) of the detector diode 4MR2 via a screened lead.

(3) Set the controller function switch to LOOP and, using the LOOP control, motor the goniometer to zero degrees; then short out 2MR1 on the goniometer sub-unit to prevent the goniometer being driven to a null position.

(4) Unlock the bearing scale of the loop simulator and set it to 90°.

(5) Set the controller function switch to ADF and disconnect cable VCG/024 from the sense input plug PLH.

(6) Set the signal generator to 300 kc/s unmodulated at an output level of 100 mV. Check that the waveform traced on the oscilloscope is similar to that shown in fig. 4 with not more than 10 per cent unbalance.

◄$\text{Percentage unbalance} = \frac{x}{y} \times 100$►

(7) Switch off the 27·5V d.c. supply, remove the oscilloscope and disconnect cable VBG/576 from the loop input plug PLG.

Bearing transmitter synchro

17. (1) With the receiver connected to the test rig, switch on the 27·5V d.c. and the 26V a.c. supplies and set the controller function switch to ADF.

(2) Using the LOOP control on the controller, drive the goniometer bearing scale on the receiver to zero degrees. Check that the repeat bearing indicator on the test rig is also driven to zero degrees.

(3) Using the LOOP control on the controller, slowly drive the goniometer bearing scale on the receiver through 360°. Check that the repeat bearing indicator on the test rig follows the goniometer in the same sense.

(4) Switch off the 27·5V d.c. and 26V a.c. supplies.

I.F. selectivity

18. (1) With the receiver connected to the test rig, switch on the 27·5V supply.

(2) Set the controller as follows:—

Function	ANT
B.F.O.	OFF
Selectivity	BROAD
Frequency	100 kc/s

(3) Connect the electronic multimeter (item 13), set to the 400 mV d.c. range, to the anode of 4MR2.

(4) Connect the signal generator to the tuning capacitor 3C47 in the r.f. sub-unit.

(5) Set the signal generator to 100 kc/s unmodulated at a level of 1 mV. Monitor the frequency with the frequency counter and note the electronic multimeter reading.

(6) Increase the output level of the signal generator to 2 mV (i.e. 6 dB above the level set in (5).

(7) De-tune the signal generator first above 100 kc/s and then below 100 kc/s until the electronic multimeter indicates the value noted in (5). Note the two frequencies where this occurs and identify them F1 and F2.

(8) Increase the output level of the signal generator to 1V (i.e. 60 dB above the level set in (5)).

(9) Repeat operation (7).

(10) Re-set the controller selectivity switch to SHARP and repeat operations (5) to (9).

(11) Check that the i.f. bandwidths indicated by the difference between F1 and F2 are as follows:—

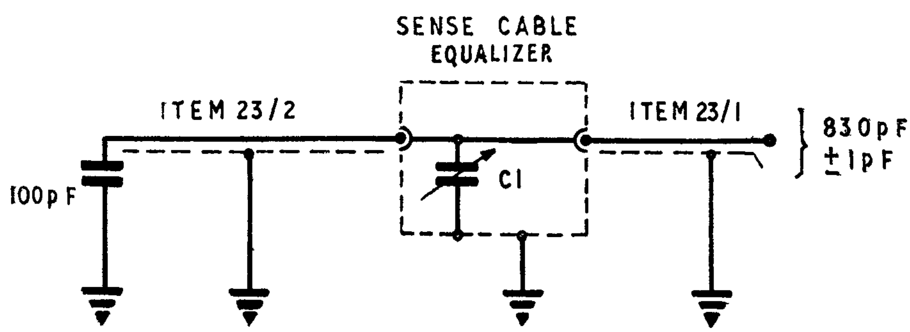

Fig. 5. Sense cable equalizer and capacitor

BROAD	
Bandwidth at 6 dB	2·7 kc/s ±0·5 kc/s
Bandwidth at 60 dB	5·0 kc/s ±1·0 kc/s
SHARP	
Bandwidth at 6 dB	1·2 kc/s ±0·2 kc/s
Bandwidth at 60 dB	3·5 kc/s ±0·7 kc/s

(12) Switch off the 27·5V d.c. supply, remove the signal generator and the electronic multimeter.

Sense aerial sensitivity

19. (1) With the receiver connected to the test rig, switch on the 27·5V supply.

(2) Disconnect the sense aerial cable VCT/696 from the loop signal simulator and reconnect it to the signal generator via a 100 pF capacitor.

(3) Measure the capacitance at the free end of VCG/024 and adjust C1 in the sense cable equalizer as necessary to obtain a capacitance of 830 pF ±1 pF.

Note . . .

When measuring the capacitance, temporarily disconnect the 100 pF capacitor from the signal generator and reconnect it to earth so that it is in parallel with the capacitance of the sense cable (fig. 5).

(4) Connect VCG/024 to the sense input plug PLH on the receiver.

(5) Set the controller and the signal generator as follows:—

Function	ANT
B.F.O.	OFF
Selectivity	BROAD
Frequency	120 kc/s
Signal generator	
Frequency	120 kc/s
Modulation frequency	400 c/s
Modulation depth	30 per cent

(6) Set the output power meter to 500 ohms and adjust the tuning of the signal generator as necessary to obtain a peak indication on the output wattmeter.

(7) Adjust the output level of the signal generator and the controller GAIN control setting until the output wattmeter indicates 50 mW or some other convenient reference level below 50 mW.

(8) Switch off the modulation and observe the resultant change in level indicated by the output wattmeter.

(9) If the change in output power level is greater or less than −6 dB, increase or reduce the output level of the signal generator as appropriate and then switch on the modulation again.

(10) Adjust the GAIN control on the controller to restore the level indicated by the output power meter to the reference level chosen in (7).

(11) Repeat operations (8), (9) and (10) until the output of the signal generator has been set to such a level that there is a −6 dB change in the level indicated by the output wattmeter when the modulation is switched off.

(12) Check that the output level of the signal generator is not greater than 5 μV.

(13) Repeat the operations (6) to (12) substituting in (6) and (12) the appropriate values as follows:—

Frequency kc/s	Signal generator level μV
120	5
150	5
190	5
210	3
310	3
410	3
490	3
690	3
890	3
1000	3
1300	3
1700	3

I.F. rejection

20. (1) Repeat the steps (1) to (11) of the sense aerial sensitivity checks described in para. 19, but substitute 415 kc/s in place of 120 kc/s at operation (5).

(2) With the modulation switched on, note the output level of the signal generator and the level indicated by the power wattmeter.

(3) Re-tune the signal generator to 455 kc/s. Increase the output of the signal generator to its maximum level. Adjust the tuning of the signal generator for a peak indication on the output wattmeter.

(4) Reduce the output of the signal generator until the output wattmeter indication is restored to the level noted in operation (2). Check that the output level of the signal generator is not less than 80 dB above the level noted in (2).

(5) Repeat operations (1) to (4) substituting 500 kc/s in place of 415 kc/s.

Image frequency rejection

21. Repeat four times operations (1) to (4) of the intermediate frequency rejection check described in para. 20, but at each repetition substitute different values in operations (1), (3) and (4) as follows:—

Repetition number	Controller frequency (kc/s)	Signal generator Frequency (kc/s)		dB change in output level
		Initial	After re-tuning	
1	900	900	1810	more than 80 dB
2	1000	1000	1910	more than 80 dB
3	1300	1300	2210	more than 80 dB
4	1700	1700	2610	more than 70 dB

A.G.C.

22. (1) Connect the signal generator to the sense aerial input plug PLH via a 100 pF capacitor and the sense cables and the sense cable equalizer as described in para. 19.

(2) With the receiver connected to the test rig, switch on the 27·5V supply and set the controller and the signal generator as follows:—

Function	ADF
B.F.O.	OFF
Selectivity	BROAD
Frequency	300 kc/s
Signal generator	
Frequency	300 kc/s
Modulation frequency	400 c/s
Modulation depth	30 per cent
Output level	10 μV

(3) Re-tune the signal generator for a peak indication on the output wattmeter and then set the controller GAIN control to give an indication of 50 mW on the output wattmeter.

(4) Increase the output level of the signal generator in steps of 10 dB from 10μV to 50 000 μV. Check that the output power level indicated by the output wattmeter does not decrease at any step and does not increase overall by more than 7 dB.

Note . . .

Changes not greater than ½ dB should be ignored.

(5) Repeat operations (2) and (3) with the controller set to ANT instead of ADF.

(6) Increase the output level of the signal generator in steps of 10 dB from 10 μV to 100 mV. Check that the output power level indicated by the output wattmeter does not decrease more than 1 dB at any step.

Note . . .

The output power level may increase *to a constant value.*

(7) Disconnect the signal generator and the sense aerial cables.

Loop aerial sensitivity

23. The following operations should be carried out in a screened room:—

(1) Using the loop cables VAF/024 and VBG/576 mated together (i.e. without a Q.E. and loop cable equalizer), connect the receiver loop aerial input plug PLG to the loop signal simulator. Connect the signal generator (item 12) to the loop signal simulator socket SKB. If the loop signal simulator is a Marconi 6419A set the changeover switch to AD712.

(2) Unlock the bearing scale of the loop simulator and set it to 90°.

(3) With the receiver connected to the test rig, switch on the 27·5V d.c. supply and set the controller as follows:—

Function	LOOP
B.F.O.	OFF
Selectivity	BROAD

(4) Set the controller frequency at 120 kc/s. Set the signal generator as follows:—

Frequency	120 kc/s
Modulation depth	30 per cent
Modulation frequency	400 c/s
Output level	2·5 mV

(5) Use the LOOP control on the controller to motor the goniometer to a position where the output wattmeter indicates a peak output level.

(6) Adjust the controller GAIN control until the output wattmeter indicates 50 mW or some other convenient reference level below 50 mW.

(7) Switch off the modulation and observe the resultant change in the level indicated by the output wattmeter.

(8) If the change in output power level is greater or less than −6 dB, increase or reduce the output level of the signal generator as appropriate and then switch on the modulation again.

(9) Adjust the GAIN control on the controller to restore the level indicated by the output wattmeter to the reference level chosen in (6).

(10) Repeat operations (7), (8) and (9) until the output of the signal generator has been set to such a level that there is a −6 dB change in the level indicated by the output wattmeter when the modulation is switched off.

(11) Check that the output level of the signal generator is now not greater than 2·75 mV.

(12) Repeat operations (4) to (11) substituting in (4) and (11) the following values:—

Frequency	Signal generator level (mV)
120	2·75
150	2·20
190	2·20
210	1·10
310	0·99
410	0·88
490	0·88
690	0·66
890	0·55
1000	0·55
1300	0·44
1700	0·33

ADF strong signal accuracy

24. (1) Connect the receiver to the loop signal simulator in a screened room using loop cables VAF/024 and VBG/576 and sense cables VCT/696 and VCG/024. The loop cables should be mated together without a Q.E. and loop cable equalizer but the sense cables should be connected together via a sense cable equalizer. Adjust the trimmer C1 in the sense cable equalizer to obtain a capacitance of 830pF ±1pF at the receiver end of VCG/024. Connect the signal generator to the input socket **SKB** of the loop signal simulator. If the loop signal simulator is a Marconi 6419A set the changeover switch to AD712.

(2) Unlock the bearing scale of the loop signal simulator and set it to zero degrees.

(3) With the receiver connected to the test rig, switch on the 27·5V d.c. and 26V a.c. supplies and set the controller and signal generator as follows:—

Function	ANT
B.F.O.	OFF
Selectivity	BROAD
Frequency	120 kc/s
Signal generator	
Frequency	120 kc/s
Modulation depth	30 per cent
Modulation frequency	400 c/s

(4) Set the output of the signal generator at 100 mV and adjust the tuning to obtain a peak indication on the output wattmeter.

(5) Set the function switch on the controller to ADF, and, when the goniometer has settled, check that the bearing indicated by the receiver and the repeat bearing indicator is the same as that set on the loop signal simulator (zero degrees).

(6) Using the LOOP control, motor the goniometer 175° off the original bearing. Referring to the repeat bearing indicator, check that when the LOOP control is restored to the central off position the goniometer returns through the same 175° arc to within ±1° of the original bearing.

(7) Repeat operations (5) and (6) motoring the goniometer through 175° in the opposite direction.

(8) Repeat operations (3) to (7) at the following frequencies in place of 120 kc/s. 150 kc/s, 190 kc/s, 210 kc/s, 310 kc/s, 410 kc/s, 490 kc/s, 690 kc/s, 890 kc/s, 1000 kc/s, 1300 kc/s, 1700 kc/s.

ADF weak signal accuracy

25. Repeat operations in para. 24, (1) to (8) but at steps (4) and (8) substitute the values given below. At step (6) relax the accuracy check to ±3° and also check that the time taken by the goniometer to return to within ±5° of the set bearing is less than 6 seconds.

Frequency (kc/s)	Sig. gen. output Field strength (mV)
120	0·30
150	0·20
190	0·16
210	0·15
310	0·12
410	0·08
490	0·08
690	0·08
890	0·06
1000	0·06
1300	0·06
1700	0·06

Disconnect the aerial cables from the receiver and switch off the power supplies.

B.F.O.

26. (1) Using a 100 pF capacitor and the sense cables plus sense cable equalizer, connect the signal generator to the receiver. Adjust trimmer C1 in the sense cable equalizer to obtain 830 pF ±1 pF at the receiver end of the cables (fig. 5).

(2) Using the frequency counter, tune the signal generator to 301·5 kc/s ±20 c/s. Set the output level of the signal generator to 1 mV.

(3) With the receiver connected to the test rig, switch on the 27·5V supply. Set the controller as follows:—

Function	ANT
B.F.O.	ON
Selectivity	BROAD
Frequency	301·5 kc/s

(4) Plug in the headset to the phone jack on the test rig.

(5) Turn the BFO note control knob fully clockwise and check that the note is near zero beat.

(6) Re-set the controller to 300 kc/s. Check that zero beat is obtainable within the range of travel of the BFO control knob.

(7) Re-set the BFO control knob to the dot-to-dot position.

Minimum performance specification

27. (1) Tuning speed
From 100 kc/s to 100·5 kc/s in 1 second
From 900 kc/s to 400·0 kc/s in 2 seconds
From 400 kc/s to 800·0 kc/s in 1·5 seconds
From 800 kc/s to 400·0 kc/s in 3 seconds

(2) Tuning accuracy
Local oscillator frequency = Selected frequency +455 kc/s
±300 c/s

(3) I.F. selectivity
(a) BROAD Bandwidth at 6 dB = 2·7 kc/s ±0·5 kc/s.
Bandwidth at 60 dB = 5·0 kc/s ±1·0 kc/s.

(b) SHARP Bandwidth at 6 dB = 1·2 kc/s ±0·2 kc/s.
Bandwidth at 60 dB = 3·5 kc/s ±0·7 kc/s.

(4) Sense aerial sensitivity for the ratio signal + noise : noise, to be 6 dB.

◄Test frequency (kc/s)	Input (μV)
120	500
150	500
190	500
210	300
310	300
410	300
490	300
690	300
890	300
1000	300
1300	300
1700	300►

(5) Intermediate frequency rejection ratio: More than 80 dB except between 415 kc/s and 500 kc/s.

(6) Image rejection ratio
More than 80 dB at 900 kc/s
More than 80 dB at 1000 kc/s
More than 80 dB at 1300 kc/s
More than 70 dB at 1700 kc/s

(7) A.G.C. characteristics
With a signal applied to the sense aerial input plug PLH on the receiver through a 100 pF capacitor and full length sense cables plus equalizer adjusted to give 830 pF ±1 pF at the input plug:—

(a) On ADF, not more than 7 dB increase in output when the input signal is increased from 10 μV to 50 mV.

(b) On ANT, not more than 1 dB decrease in output when the input signal is increased from 10 μV to 100 mV.

(8) Loop aerial sensitivity for the ratio signal + noise: noise, to be 6 dB.

◄Test frequency (kc/s)	Signal generator level (μV)
120	2500
150	2000
190	2000
210	1000
310	900
410	800
490	800
690	600
890	500
1000	500
1300	400
1700	300►

(9) ADF sensitivity and accuracy.

(a) Strong signal accuracy ±1°.

(b) Weak signal sensitivity for ±3° mean bearing:—

◄Test frequency (kc/s)	Field strength (μV/m)
120	300
150	200
190	160
210	150
310	120
410	80
490	80
690	80
890	60
1000	60
1300	60
1700	60►

(10) Speed of taking bearings.
At the field strengths specified for different frequencies in sub-para. (9), not more than 6 seconds for the goniometer to return to within 5° of 90° or 270° from ±5° of the reciprocal bearing.

(11) Speed of goniometer rotation with manual control.
With the LOOP control switch fully clockwise or counter-clockwise, less than 9 seconds for 360° goniometer rotation.

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PART 3

FAULT DIAGNOSIS

Chapter 1

FAULT FINDING

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General

1. After installation of the receiver equipment in an aircraft has been completed, the aircraft system routine checks for the equipment should be performed. During these checks, or while the equipment is in service, a fault may be experienced involving the withdrawal of the equipment for bay servicing (2nd line). The receiver equipment comprises five main units as follows:—

(1) Loop aerial.

(2) Sense aerial.

(3) Repeat bearing indicators.

(4) Receiver.

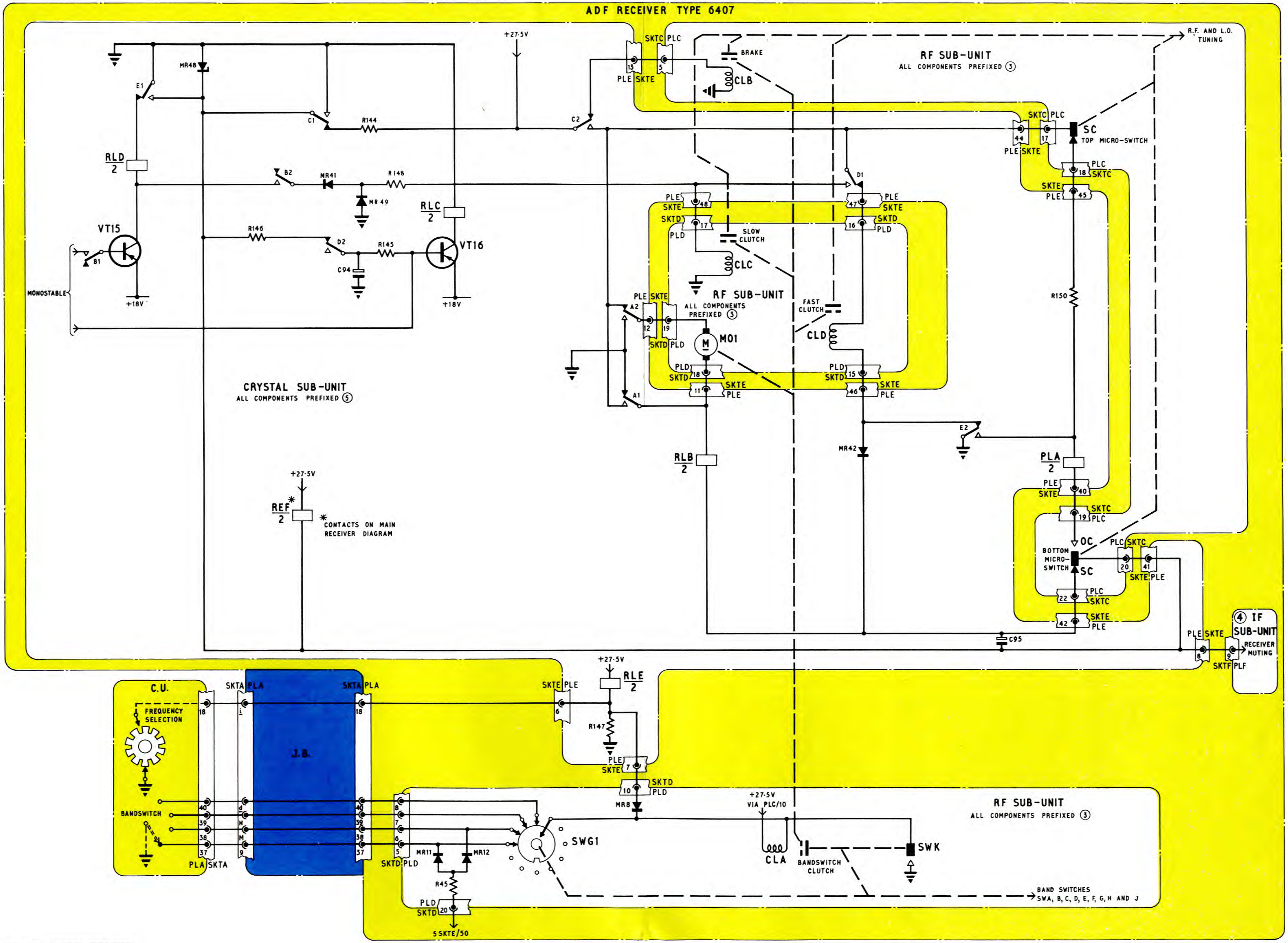
(5) Controller.

2. To aid the isolation of a fault to a particular unit, reference should be made to Part 2, Section 2, Chapter 1 which details aircraft system routine checks, aircraft system trouble shooting and aircraft system fault location (Table 1). It is recommended that the routine checks are performed until a faulty unit is identified. This unit should then be removed from the aircraft for a more thorough investigation on the bench.

Fault finding, bench

3. Where a fault has been traced to the receiver unit, the receiver should be removed from the aircraft and subjected to performance tests.for the complete receiver as detailed in Part 2, Section 2, Chapter 2. If the receiver does not meet the minimum performance specification, any sub-units found unserviceable should be removed and subjected to the appropriate 2nd line servicing tests detailed in Part 2, Section 2, Chapter 2. If a sub-unit is beyond station repair capabilities, it should be exchanged for a serviceable item in accordance with current procedures.

4. To assist in the location of faulty sub-units or interconnections, functional diagrams are given at the end of this Chapter. As experience is gained of the behaviour of this equipment in service it is hoped that this information will be supplemented by descriptions of the location and cure of faults which have actually occurred.



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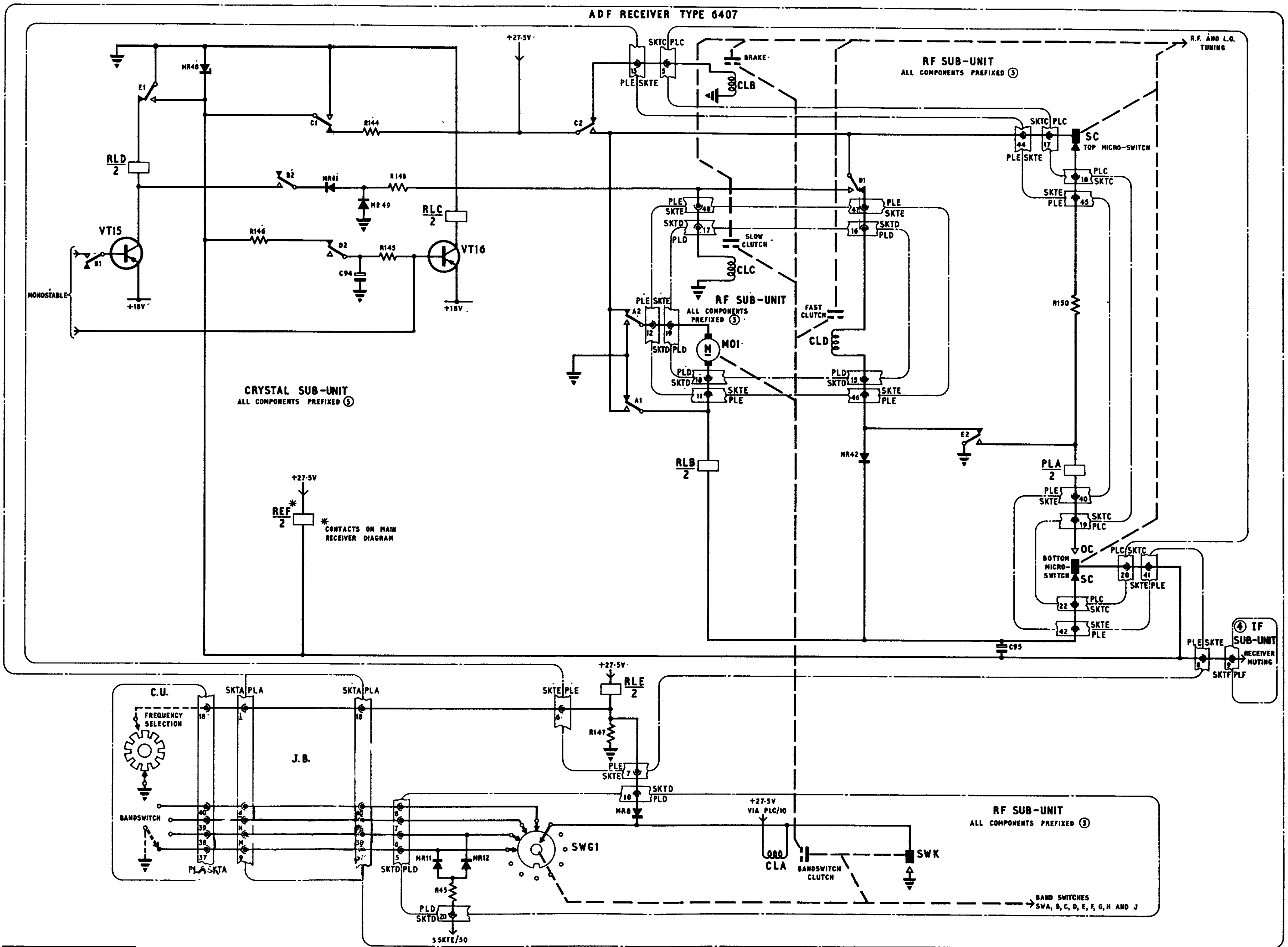
ARI.23119 Band switching and relay circuits : functional diagram

Fig.2



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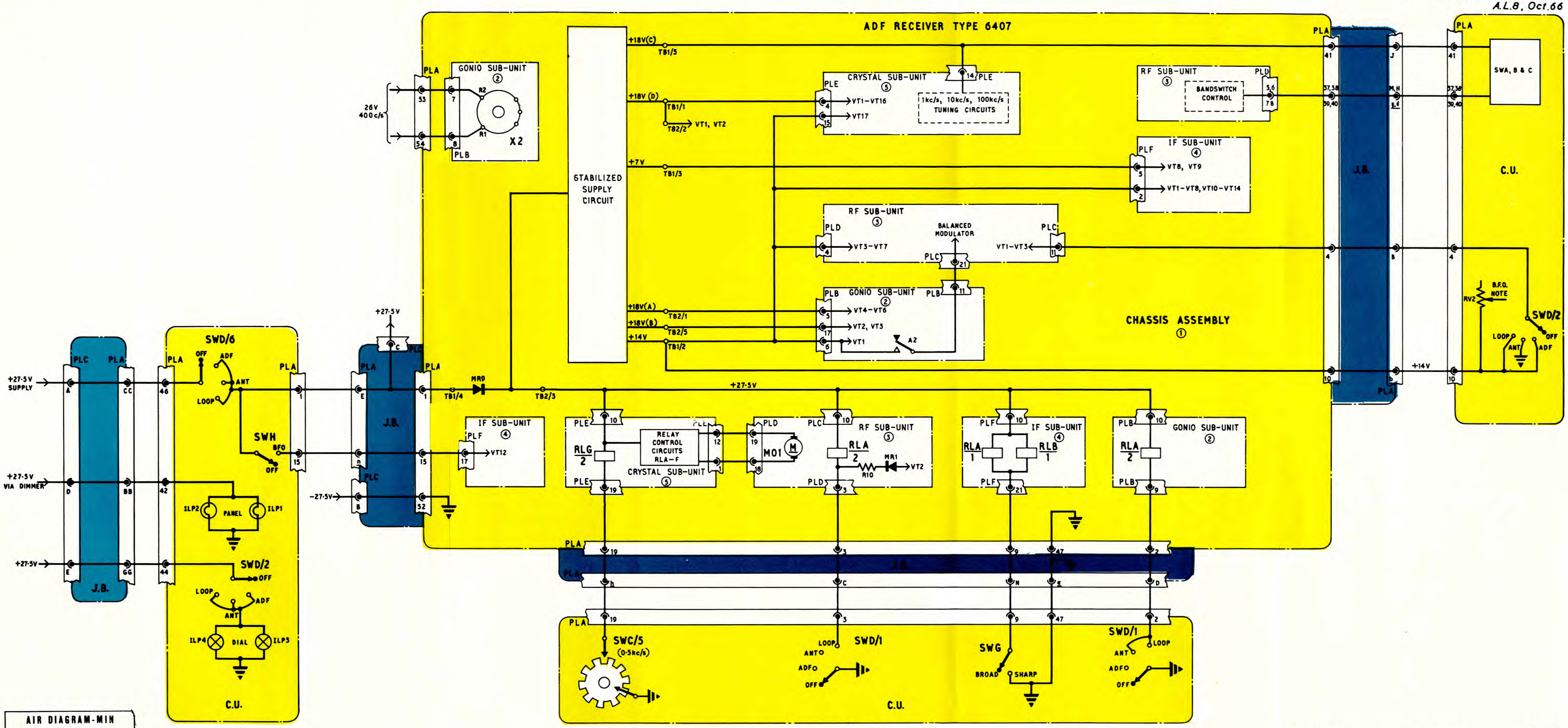
ARI.23119: Band switching and relay circuits : functional diagram

Fig.2

D713060 260 7/69 A(W)Ltd Gp956/3 523M



AIR DIAGRAM-MIN
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ARI. 23119 Power supplies: functional diagram

RESTRICTED

D713060 260 7/69 A(W)Ltd Gp956/3 523M

Fig.3

PART 4

CIRCUIT THEORY

Chapter 1

RECEIVER CIRCUIT DESCRIPTION

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LIST OF ILLUSTRATIONS

INTRODUCTION

1. The ADF receiver 6407M is a single-conversion superhet automatically tunable from 100 kc/s to 1799·5 kc/s in steps of 0·5 kc/s and having an intermediate frequency of 455 kc/s. The automatic tuning is controlled by crystals that are connected, as required, by silicon diode switches operated from a remote controller.

2. The receiver, which also contains a goniometer, is used in conjunction with an external fixed crossed-loop aerial and a capacitive sense aerial. A synchro output is provided for the operation of up to three remote relative-bearing indicators or radio magnetic indicator pointers. The audio output is taken from a transformer with tappings suitable for alternative load impedances of 500 ohms and 100 ohms.

3. The following detailed description of the receiver circuit should be read in conjunction with the circuit diagrams given in fig. 1, 2 and 3. A brief description and a block diagram of the receiver are given in Part 1, Chapter 1.

4. There are four frequency bands, each covered by separate sets of coils (fig. 1). The loop aerial, local oscillator and band-pass pair circuits are capacitively tuned. The sense aerial (antenna) is tuned by permeability-tuned coils as it is a capacitive source. The frequency coverage of the four bands is as follows:—

Band 1	100 kc/s to 199·5 kc/s
Band 2	200 kc/s to 419·5 kc/s
Band 3	420 kc/s to 899·5 kc/s
Band 4	900 kc/s to 1799·5 kc/s

5. Identities of the components used in the r.f. sub-unit are prefixed 3. The functions of the transistors used are:—

3VT1	(AFZ12)	loop amplifier
3VT2	(2N1225)	phase splitter or r.f. amplifier
3VT3	(2N1225)	buffer amplifier
3VT4	(AFZ12)	r.f. amplifier
3VT5	(2N1225)	i.f. amplifier
3VT6	(2N1225)	local oscillator
3VT7	(2N1225)	reactance transistor

Loop amplifier

6. Loop aerial signals are fed from the goniometer search coil into the loop tuned circuit. This circuit is tuned by a variable capacitor 3C24 which is ganged with the tuning elements of all the other tuned circuits. Transistor 3VT1 amplifies the loop signal and, in conjunction with 3C4 and 3L1, advances the phase of the signal voltage by 90 degrees (Chap. 1, App. 1). The phase-advanced signal is then applied to the base of 3VT2.

Balanced modulator

7. When the function switch on the controller is set to ADF, transistor 3VT2 operates as the phase splitter for the balanced modulator. Anti-phased outputs from the collector and emitter of 3VT2 are fed to the two germanium diode rectifiers 3MR2 and 3MR3 which, together with the associated circuitry, form the balanced modulator.

8. A 135 c/s switching voltage, obtained from the reference-phase amplifier in the goniometer sub-unit, is fed into the balanced modulator through 3R20. The switching voltage opens 3MR2 and 3MR3 alternately thus releasing blocks of loop signal at 135 c/s which are alternately in opposite phase.

9. The output signal from the balanced modulator is fed through a phase-corrector network consisting of 3L7, 3C23 and 3R44 to the emitter of 3VT3. The phase-corrector network corrects the phase of the signal at the lower end of the r.f. range where a complete 90 degrees phase shift is not given by the earlier phase-shifting circuit (3VT1, 3C4 and 3L1).

witch on the controller
LA in the goniometer sub-unit is energized and removes the 135 c/s switching voltage from 3R20, replacing it with a d.c. potential which causes 3MR2 to conduct continuously. At the same time the controller function switch earths the side of 3R10 that is remote from 3MR1, causing 3MR1 to conduct and so connect a 1 μF capacitor 3C7 across the emitter load 3R12 of 3VT2. Consequently 3VT2 ceases to operate as a phase splitter and operates instead as an r.f. amplifier.

Buffer amplifier

11. Transistor 3VT3 is a common-base amplifier, also serving as a buffer to prevent sense aerial signals getting into the loop circuits. The output of the amplifier feeds into the base of the r.f. amplifier transistor 3VT4 through a winding coupled to the selected sense aerial input permeability-tuned coil. Diode 3MR13 prevents reverse biasing of 3VT3 during transient voltage conditions.

12. When the function switch on the controller is set to LOOP, relay 3RLA is energized and disconnects the sense aerial from the permeability-tuned coil and substitutes a dummy aerial 3L8, 3C17 and 3C22 so that the permeability-tuned circuit remains tuned and tracks correctly with the other tuned circuits.

13. When the controller function switch is set to ANT, the 14V d.c. emitter supply for transistors 3VT1, 3VT2 and 3VT3 is disconnected, thus rendering the loop circuits inoperative. The 14V d.c. supply to the base of 3VT3 remains connected however, to prevent it conducting when large sense input signals are present as this could result in the clipping of strong wanted signals and cross modulation by unwanted signals.

R.F. amplifier

14. The r.f. amplifier transistor 3VT4 amplifies the loop and sense r.f. signals that are applied to its base through the permeability-tuned coil in use. On function ADF, both signals are applied together, so that the signal appearing on the collector of 3VT4 is the amplified resultant of the algebraic addition of both input signals. This resultant signal has a modulation envelope of 135 c/s due to the reversals of the phase of the loop signal produced by the balanced modulator.

15. The output from 3VT4 is fed into a band-pass pair filter circuit, the two elements of which are inductively coupled. It is then fed to the double-balanced mixer. Automatic gain control voltage is applied to the base of 3VT4 through resistors 3R24 and 3R4 in series. Capacitors 3C85 and 3C45 provide decoupling. Diode 3MR9 prevents reverse biasing of 3VT4 during transient voltage conditions.

16 Diodes 3MR14 and 3MR15 prevent the a.g.c. circuit being overloaded when the receiver is tuned to a high strength signal. At high signal strengths, the forward bias on 3VT4 is further reduced by the increased reverse bias voltage developed across the increased resistance of diodes 3MR12 and 3MR15, thus giving a high degree of attenuation of the input signal. At low signal strengths, the a.g.c. line voltage is well below the h.t. voltage so that the diodes have less effect and the gain is maintained at a high level.

Local oscillator

17 The local oscillator 3VT6 is a normal emitter-tapped oscillator capacitively tuned by the variable capacitor 3C16 which is ganged to the main tuning shaft. The oscillator is finely tuned by the reactance transistor 3VT7 to a frequency 455 kc/s above the signal frequency.

Reactance transistor

18 Transistor 3VT7 is connected directly across the local oscillator coil so that its inductive reactance contributes to the control of the oscillator. The inductive reactance of 3VT7 is controlled by the d.c. output from the phase bridge (para. 60) in the crystal sub-unit, capacitor 3C30 and the resistor 3R37 being the quadrature components.

19 The d.c. output from the phase bridge (in the crystal sub-unit) causes the reactance transistor to pull the frequency of the local oscillator into the correct frequency, immediately after the automatic tuning system has completed the mechanically-driven tuning of the receiver (para. 64). Subsequently the reactance transistor keeps the local oscillator frequency contant, correcting any tendency to drift.

Double-balanced mixer

20 The mixer, consisting of 3MR4, 3MR5, 3MR6, 3MR7 and the associated circuitry is of the double-balanced type. This type gives a better rejection of spurious signals than the normal transistor mixer. The r.f. signal is fed to the mixer from a centre-tapped winding on the secondary of the band-pass pair coil in use. The local oscillator output is fed into the the centre-tap of the same winding and therefore switches the r.f. signal path at the oscillator frequency. The output from the mixer, consisting of the sum and difference frequencies between the r.f. signal frequency and the oscillator frequency, is then inductively fed to an i.f. band-pass pair.

First i.f. amplifier

21 The i.f. band-pass pair, into which the output from the double-balanced mixer is fed, consists of 3TR18, 3C77 and 3C88 capacitively coupled to 3TR19, 3C89 and 3C79 by 3C78. The i.f. band-pass pair circuit feeds into the first i.f. amplifier 3VT5. This first stage of i.f. amplification is placed in the r.f. sub-unit to compensate for the attenuation of the signal by the mixer and the i.f. band-pass pair. It also matches into the crystal filter A in the i.f. sub-unit. The a.g.c. voltage is applied to 3VT5 and this voltage is augmented by the action of 3MR10 which provides a proportional shunting resistance, the value of the resistance altering as the current through 3VT5 changes.

I.F. SUB-UNIT (UNIT 4)

22 Identities of the components used in the i.f. sub-unit are prefixed 4. The functions of the transistors and diodes used are:

4VT1	(2N1225)	second i.f. amplifier
4VT2	(2N1225)	third i.f. amplifier
4VT3	(2N1225)	fourth i.f. amplifier
4VT4	(2N1224)	fifth i.f. amplifier
4MR1	(OA47)	audio detector
4MR2	(OA47)	ADF detector
4VT5	(OC201) (or BCZ11)	135 Hz selective amplifier
4VT6 4VT7	(OC201) (or BCZ11)	135 Hz amplifier
4VT8	(OC201) (or BCZ11)	a.g.c. detector
4VT9	(OC201) (or BCZ11)	first a.g.c. d.c. amplifier
4VT10	(OC201) (or BCZ11)	buffer stage between audio detector and first audio amplifier
4VT11	(GET111)	first audio amplifier
4VT12	(NKT217)	beat frequency oscillator
4VT13	(OC201) (or BCZ11)	buffer stage between B.F.O. and audio detector
4VT14	(OC201) (or BCZ11)	second a.g.c. d.c. amplifier

I.F. amplifiers

23 The 455 kHz i.f. output from the first i.f. amplifier 3VT5 in the r.f. sub-unit is brought into the i.f. sub-unit (fig. 3) through pin 13 of plug PLF and fed to the crystal filter A. This filter is the BROAD (3 kHz) filter and forms the collector load of 3VT5.

24 The second stage of i.f. amplification is provided by 4VT1, the collector load of which consists either of crystal filter B (when the controller is set to SHARP) or the resistance capacity coupling 4R47 and 4C4 (when the controller is set to BROAD). The switching is performed by relays 4RLA and 4RLB. The bandwidth passed when the controller is set to SHARP and both crystal filters A and B are in circuit is 1.2 kHz.

25 Following crystal filter B are three more stages of i.f. amplification provided by 4VT2, 4VT3 and 4VT4. These stages are coupled by single-tuned transformers 4L1 and 4L2. The a.g.c. voltage is applied to 4VT1, 4VT2 and 4VT3 but not to 4VT4.

Audio detector and amplifier

26 The 455 kHz signal is developed across 4L3, the collector load of 4VT4, and 4L3 is loosely coupled via 4C14 to 4L4. A germanium diode 4MR1 detects the audio content of the 455 kHz signal developed across 4L4. Diode 4MR1 is followed by a buffer stage 4VT10 to prevent loading of the detector circuit. The buffer stage 4VT10 is followed by a single stage of audio gain 4VT11 the output from which leaves the i.f. sub-unit via pin 1 of plug PLF and is routed to the final push-pull audio output circuit mounted on the main chassis

ADF detector and 135 Hz selective amplifier

27 Another germanium diode 4MR2 detects the 135 Hz modulation envelope of the 455 kHz signal developed across 4L5. The coil 4L5 is loosely coupled via 4C15 to 4L3 forming the collector load of the last i.f. amplifier stage 4VT4. A resistance-capacitance filter is interposed between the ADF detector load 4R16 and the 135 Hz selective amplifier 4VT5 to eliminate unwanted components from the signal.

28 Transistor 4VT5 provides a single stage of selective amplification. Its load consists of the two coils 4L6 and 4L7 coupled via 4C25 and tuned to 135 Hz. The selective amplifier stage is followed by another stage of amplification provided by 4VT6 and 4VT7 so arranged as to give a high input impedance which thus prevents damping of 4L7. The 135 Hz signal finally leaves the i.f. sub-unit via pin 11 of plug PLF and is routed via the servo gain potentiometer RV1 on the main chassis to the control phase pre-amplifier in the goniometer sub-unit.

A.G.C. detector and d.c. amplifier

29 The a.g.c. detector 4VT8 is fed from a secondary winding of 4L3 (the collector load of the last i.f. amplifier 4VT4). The direct voltage developed across 4R30 is applied to the base of the first d.c. amplifier 4VT9. When the controller function switch is set to ANT or LOOP the low impedance output from the emitter of 4VT9 is taken via 4L11 to the GAIN control RV1 in the controller and then to the base of the second d.c. amplifier 4VT14. The low impedance voltage appearing on the emitter of 4VT14 is used as the a.g.c. line voltage. Resistor 4R45 provides a path for the leakage current in the five controlled stages. Transistor 4VT14 prevents overloading of the i.f. amplifier by large signals in conditions of high ambient temperature.

30 When the automatic tuning system is operating, the receiver is muted by bottoming 4VT8. This is done by earthing pin 9 of plug PLF via the bottom micro-switch. This causes switching diode 4MR4 to conduct, connecting 4R43 across 4R28 and re-biasing 4VT8 so that it is bottomed. When 4VT8 is bottomed 4VT14 is cut off, the a.g.c. line voltage becomes + 14V and all the controlled stages are cut off.

Beat frequency oscillator

31 The beat frequency oscillator 4VT12 is provided for the reception of keyed c.w. signals. Positive feedback from the tuned collector output to the base input is via 4C37. Note control is obtained by varying the current in 4VT12 by means of RV2, the B.F.O. control in the controller. Transistor 4VT12 is of a type selected so that it is operating near its common emitter cut-off frequency, so that when the current through the transistor is varied the phase shift across the transistor also varies. Consequently, the circuit oscillates at the frequency where the phase shift across the L-C tuning element in the collector lead plus the phase shift across the transistor equals 360 degrees. The B.F.O. is switched off by applying 27.5V d.c. to pin 17 of plug PLF. This voltage forward biases diode 4MR3, decoupling the base of 4VT12 to earth. The B.F.O. output is taken via a buffer stage (4VT13 and 4C42 to a tap on 4L4.

GONIOMETER SUB-UNIT (UNIT 2)

32 Identities of the components used in the goniometer sub-unit are prefixed 2. The functions of the transistors used are:

2VT1	(GET111)	control phase pre-amplifier and limiter
2VT2	(GET111)	control phase amplifier driver
2VT3	(OC28)	control phase power output stage
2VT4	(GET111)	reference phase 135 Hz oscillator
2VT5	(GET111)	reference phase amplifier driver
2VT6	(OC28)	reference phase power output stage

Control phase amplifier

33 The 135 Hz signal from the ADF detector and 135 Hz selective amplifier in the i.f. sub-unit is taken via the SERVO GAIN potentiometer 1RV1 on the main chassis to the base of the control phase pre-amplifier transistor 2VT1 in the goniometer sub-unit.

34 After amplification by 2VT1 the signal is fed via relay contacts 2RLA1 to the limiting diodes 2MR1 and 2MR2. The limiting action of the diodes enables 2VT1 to provide the high gain necessary for the very small signals near the goniometer null position without overloading the subsequent stages when the input signal to 2VT1 is large. Following the limiting diodes the

signal is transformer-coupled to the amplifier driver transistor 2VT2, which drives the power output transistor 2VT3. The power output transistor, operating in class A, supplies the control phase winding (terminals 2 and 4) of the goniometer servo motor 2M01. A portion of the standing current in 2VT3 is also passed through the goniometer servo motor control phase winding to provide damping.

Reference phase 135 c/s oscillator and amplifier

35. The 135 c/s oscillator transistor 2VT4 operates in a Hartley circuit of good frequency and amplitude stability. The adjustable core of inductor 4L2 permits the oscillator frequency to be set to within $\pm 0{\cdot}5$ c/s of 135 c/s, the total range being only 131 c/s to 140 c/s approximately. The 135 c/s output from 2VT4 is amplified by 2VT5, which drives the power output transistor 2VT6. The power output transistor, operating in class A, supplies the reference phase winding (terminals 1 and 3) of the goniometer servo motor 2M01. A portion of the standing current in 2VT6 is also passed through the goniometer servo motor reference phase winding to provide damping.

36. The power output transistor 2VT6 also supplies the 135 c/s switching voltage for the balanced modulator and, when required for manual control of the goniometer servo motor, a 135 c/s signal for the control phase amplifier. The 135 c/s switching voltage for the balanced modulator in the r.f. sub-unit is taken via 2C6 and relay contacts 2RLA2 to pin 11 of plug 2PLB. The 135 c/s signal for the manual control of the goniometer servo motor is taken via a 90 degrees phase-shifting element 2C5, 2R6 to the LOOP control in the controller, which may reverse the phase of the signal or attenuate it as required. The 135 c/s signal returns from the LOOP control to the goniometer sub-unit and is taken via relay contacts 2RLA1 to the limiting diodes 2MR1 and 2MR2 and thence via coupling transformer 2TR1 to the control phase amplifier driver transistor 2VT2. The limiting diodes 2MR1 and 2MR2 limit the input signal as necessary to prevent overload of subsequent stages.

Operation of relay 2RLA

37. Relay 2RLA (fig. 1) is energized when ANT or LOOP is selected by the function switch on the controller, and also when the LOOP manual control is operated with the function switch set to ADF. When the relay is energized the primary of transformer 2TR1 is disconnected from the collector of transistor 2VT1 by contacts 2RLA1 and connected to plug 2PLB pin 22. This substitutes the signal from the reference phase 135 c/s oscillator (via the phase-shifting element 2C5, 2R6, the LOOP control and 2PLB pins 21 and 22) for the 135 c/s from the ADF detector and amplifier in the i.f. sub-unit (para. 33), which is routed via the pre-amplifier transistor 2VT1. At the same time, contacts 2RLA2 disconnect the 135 c/s switching voltage supplied by 2VT6 for the balanced modulator and substitute a +14V supply.

Goniometer and synchro

38. The input to the receiver from the fixed loop aerial is taken from the plug on the front panel via screened leads to plug 2PLB pins 1 and 2, and 14 and 15 on the goniometer sub-unit. These pins are connected to the stator windings of the goniometer 2X1. The rotor winding (search coil) of the goniometer 2X1 is connected to the loop amplifier in the r.f. sub-unit via pins 13 and 25 of plug 2PLB. The rotor is driven, through a reduction gear, by the goniometer servo motor 2M01.

Note . . .

An explanation as to how the goniometer is driven to the signal null position by the servo motor is given in Part 1, Chap. 1, App. 1.

39. A built-in bearing indicator scale is directly coupled to the goniometer rotor shaft. Its indications are made against a 'lubber line' engraved on the transparent plastic window which protects the scale and is fixed to the goniometer body. Drive for the rotor of the synchro 2X2 is by 1 : 1 gearing from the goniometer rotor. The 26V 400 c/s supply for the synchro rotor is via plug 2PLB pins 7 and 8. The synchro output to the remote indicators is taken via plug 2PLB pins 18, 19 and 20.

CRYSTAL SUB-UNIT (UNIT 5)

40. The crystal sub-unit (fig. 2) contains the circuits that automatically control the tuning mechanism in the r.f. sub-unit and which automatically stabilize the local oscillator frequency after the mechanical tuning operation is completed. Identities of the components used in the crystal sub-unit are prefixed 5. The functions of the transistors used are:—

5VT1	(2N1225)	buffer amplifier
5VT2	(2N1225)	first mixer
5VT3	(2N1225)	second mixer
5VT4	(2N1225)	third mixer
5VT5	(2N1225)	first oscillator
5VT6	(2N1225)	second oscillator
5VT7	(2N1225)	third oscillator
5VT8	(2N1225)	amplifier
5VT9	(OC201) (or BCZ11)	buffer amplifier
5VT10	(OC44)	variable phase amplifier
5VT11	(OC201)	phase splitter
5VT12	(2N1225)	fixed phase oscillator

5VT13	(OC205	monostable
5VT14	(OC205	multivibrator
5VT15	(OC205)	relay 5RLD control
5VT16	(OC205)	relay 5RLC control
5VT17	(BCZ11) (or OC201)	second d.c. amplifier (phase bridge output)
5VT18	(BCZ11) (or OC201)	first d.c. amplifier (phase bridge output)
5VT19	(BCZ11) (or OC201)	trigger transistor

First oscillator and crystal bank – kc/s $\times$ 100

41. The crystal bank, kc/s $\times$ 100, contains seventeen crystals, 5XL3 to 5XL19, and their associated components. The range in frequency of the crystals is from 4554 kc/s to 6154 kc/s in steps of 100 kc/s. Associated with each crystal is a switching diode controlled by the 'kc/s $\times$ 100' frequency selector switch in the controller. The switching diode of the required crystal is forward biased by the frequency selector switch while all the other diodes are reverse biased. The forward biased diode connects the associated crystal to control the first oscillator 5VT5.

First mixer

42. Part of the output from the local oscillator in the r.f. sub-unit is brought via the tuning system pre-set gain control 5RV1 and the buffer amplifier 5VT1, to the first mixer 5VT2, where it is mixed with the output from the first oscillator 5VT5.

43. The first mixer transistor 5VT2 has a band-pass pair 5L1, 5TR1 in its collector circuit that passes a bandwidth of 100 kc/s from 3899 to 3999 kc/s. When the receiver is correctly tuned mechanically, the difference between the r.f. sub-unit local oscillator frequency and the crystal sub-unit first oscillator frequency lies within this pass-band, so that the difference frequency is passed to the second mixer stage 5VT3.

Second oscillator and crystal bank – kc/s $\times$ 10

44. The crystal bank, kc/s $\times$ 10, contains ten crystals, 5XL20 to 5XL29, and their associated components. The range in frequency of the crystals is from 2000 to 2090 kc/s in steps of 10 kc/s. The required crystal is selected by the 'kc/s $\times$ 10' frequency selector switch in the controller by forward biasing the associated switching diode, all other diodes being reverse biased. The forward biased diode connects the required crystal to control the second oscillator 5VT6.

Second mixer

45. The difference frequency from the first mixer and band-pass pair is mixed with the output from the second oscillator in the second mixer 5VT3. This second mixer has a band-pass pair 5L2, 5TR2 in its collector circuit that passes a bandwidth of 10 kc/s from 1899 to 1909 kc/s. When the receiver is correctly tuned mechanically the difference between the frequencies of the two ixer lies within this pass-band, so that the new difference frequency is passed to the third mixer stage 5VT4.

Third oscillator and crystal bank – kc/s $\times$ 1

46. The crystal bank, kc/s $\times$ 1, contains en crystals, 5XL30 to 5XL39, and their associated components. The range in frequency of the crystals is from 1811 to 1820 kc/s in steps of 1 kc/s. The required crystal is selected by the 'kc/s $\times$ 1' frequency selector switch in the controller and connected to the third oscillator 5VT7 in the same way as in the other crystal banks.

Third mixer

47. The difference frequency from the second mixer and band-pass pair is mixed with the output from the third oscillator in the third mixer 5VT4. This third mixer has a single tuned circuit 5TR3 in its collector circuit that is tuned to 88·75 kc/s. When the receiver is correctly tuned mechanically the difference between the frequencies of the two signals supplied to the mixer is either 89·0 kc/s or 88·5 kc/s, depending on whether the receiver is tuned to a 'whole kc/s' frequency or a 'half kc/s' frequency. This difference frequency is passed by 5TR3 to the crystal filter and to the variable phase amplifier for the phase bridge.

Relay 5RLG and crystals 5XL1 and 5XL2

48. Relay 5RLG selects an 89·0 kc/s crystal (5XL1) or an 88·5 kc/s crystal (5XL2) according to whether a 'whole kc/s' or a 'half kc/s' frequency is selected at the controller. When a 'half kc/s' frequency is selected 5RLG is energized and selects the 88·5 kc/s crystal. The selected crystal is connected by 5RLG to the contacts of 5RLF. Crystals 5XL1 and 5XL2 are each shunted by a 1 megohm resistor to prevent rining. In addition, the capacitance of the crystal circuit is neutralized by a pre-set capacitor 5C100 which is similarly shunted by a 1 megohm resistor.

Relay 5RLF (see also para. 79)

49. Relay 5RLF dictates the function of the crystal selected by 5RLG. Relay 5RLF is energized as soon as the automatic tuning control sequence is initiated, and remains energized until the mechanical tuning of the receiver is completed. Whilst energized, the relay connects the crystal selected by 5RLG between 5TR3 and the input to the trigger circuit. The crystal then acts as a series filter passing a bandwidth of approximately 100 c/s at the crystal frequency. When the mechanical tuning of the receiver is completed and relay 5RLF is de-energized, the relay switches the selected crystal into the oscillatory circuit of 5VT12, which is the fixed-phase oscillator for the phase bridge.

Trigger circuit

50. While the receiver is being mechanically tuned, the signal from the crystal filter in the output from 5TR3 is amplified by 5VT9 and

5VT8 and applied to the trigger transistor 5VT19. When the signal reaches a certain level 5VT19 conducts and the mechanical tuning is first slowed down and finally halted (para. 57). Resistor 3R45 in the r.f. sub-unit (fig. 1) is connected to the collector output from 5VT8 via 5MR52 on bands 1 and 2 to reduce the signal level applied to 5VT19 and so 'sharpen' its operation at the lower end of the tuning range.

51. When 5RLF is de-energized a voltage is applied to the base of 5VT9 via 5R110 and 5MR38, and 5VT9 is biased off. This prevents the possibility of spurious signals or transients causing the trigger circuit to operate the monostable multivibrator after the mechanical tuning of the receiver is completed.

Monostable multivibrator

52. Transistors 5VT13, 5VT14 and the cross coupling components 5C92 and 5R139 constitute a monostable multivibrator. In the normal stable condition of the circuit, 5VT14 is bottomed and 5VT13 is cut off. When trigger transistor 5VT19 conducts, 5VT13 is switched on and the collector of 5VT13 goes positive. The base of 5VT14, which is connected to the collector of 5VT13 by the capacitor 5C92, also goes positive and 5VT14 is cut off. The circuit is now in its 'unstable' condition.

53. Capacitor 5C92 now discharges through 5R141 and when the base-emitter voltage of 5VT14 has become approximately 0·4 volt, 5VT14 once more conducts and the circuit resumes its normal stable condition.

Relay control circuits (mechanical tuning sequence)

Note . . .

In following through a typical tuning sequence it is necessary to skip from one relay to another without completely describing the function of each. The relays are described in detail in para. 64 *to* 81.

54. When a new frequency selection is made at the controller, relay 5RLE is momentarily energized via the trip line from whichever frequency selector switch in the controller is operated and initiates the automatic tuning system control sequence. If the newly-selected frequency lies outside the band at which the receiver bandswitch is already set, 5RLE remains energized via 3MR8 and 3SWG1 until the bandswitch has been driven by motor MO1, via the bandswitch clutch CLA, to the band containing the new frequency.

55. Before 5RLE is energized, transistor 5VT16 is held cut off by the voltage applied to its base through 5R145, 5RLD2, 5R146, 5RLC1, 5R144 and 5R164. When 5RLE is energized, 5RLE1 earths the junction of 5R146 and 5RLC1 causing 5VT16 to bottom and energize relay 5RLC. At the same time it prevents 5RLD from being energized by breaking the supply to that relay. Contact 5RLC1 of the energized relay now disconnects 5R144 from 5R146 and substitutes an earth connection, so that 5VT16 remains bottomed and 5RLC remains energized when 5RLE is de-energized. Contact 5RLC2 connects a 27·5V supply to the motor 3MO1 and, via 5RLD1 (de-energized) to the fast clutch 3CLD. If 5RLE is energized (correct band not selected) the earth return from 3CLD is completed via 5MR42, contact SC of 3SWL (the bottom micro-switch) and 5RLE1 (and 5RLC1). If 5RLE is de-energized (correct band selected) the earth return from 3CLD is completed via 5RLE2.

56. The energized fast clutch 3CLD engages the tuning mechanism with the servo motor 3MO1 so that the tuning inductor core bracket is driven downwards until it operates 3SWL (the bottom micro-switch). Provided the correct band has been selected so that relay 5RLE is de-energized, contact OC of 3SWL then completes the circuit that energizes relay 5RLA, i.e. 27·5V, 5RLC2, SC of 3SWM (the top micro-switch) 5R150, 5RLA, contact OC of 3SWL and 5RLC1. The contacts of the relay 5RLA reverse the connections to 3MO1, which consequently reverses its direction of rotation, to drive the tuning inductor core bracket upwards. When the tuning inductor core bracket is raised off 3SWL (the bottom micro-switch) contact SC of 3SWL completes the circuit that energizes 5RLB (i.e. 27·5V, 5RLC2, 5MR45, 5R151, 5RLA1, 5MR44, 5RLB coil, SC of 3SWL and 5RLC1).

57. Contact 5RLB1 of the energized relay 5RLB connects the collector of 5VT14 to the base of 5VT15 via 5R143. While 5VT14, in the monostable multivibrator, is in the normal 'bottomed' condition, the voltage applied to the base of 5VT15 is such that 5VT15 remains cut off, so that 5RLD is de-energized. When the tuning mechanism tunes the receiver through the selected frequency, the monostable multivibrator is triggered and assumes the unstable condition. In this condition 5VT14 is cut off and the voltage now applied to the base of 5VT15 is such that 5VT15 is bottomed and 5RLD is energized. When relay 5RLD is energized 5RLD2 disconnects 5R145 from 5R146 and 5C94 commences to charge through 5VT13. During the brief period that the monostable multivibrator remains in the unstable condition the charge accumulated on 5C94, while not sufficient to cut off 5VT16, is a prerequisite condition for the next stage of the automatic tuning sequence. When the multivibrator resumes the stable condition, 5VT15 is once more cut off but relay 5RLD remains held in by the supply now connected via 5RLC2, 5RLD1, 5R148, 5MR41 and 5RLB2.

58. The energized relay 5RLD connects clutch 3CLC in place of the fast clutch 3CLD. The energized slow clutch 3CLC engages the tuning mechanism with the servo motor 3MO1 *via a reversing gear*. The tuning mechanism, the inertia of which carries the receiver tuning past the selected frequency when the multivibrator is first triggered, slowly re-tunes the receiver back to the selected frequency. When the selected frequency is tuned once more, the multivibrator is triggered for the second time and assumes the unstable condition. In this condition 5VT13 is once more switched on and 5VT14 is cut off. Cutting off 5VT14 causes 5VT15 to bottom but this has no effect on 5RLD as 5RLD is already energized by the hold-in voltage (para. 57), connected via 5RLC2, 5RLD1, 5R148, 5MR41 and 5RLB2. Switching on 5VT13, however, completes the charging of 5C94 so that 5VT16 is cut off and relay 5RLC de-energized. Contact 5RLC1 removes the earth from 5RLF to de-energize it and contacts F1 and F2 connect the crystal selected by 5RLG (5XL1 or 5XL2) into the fixed-phase oscillator of the phase bridge circuit.

Phase bridge circuit

59. Transistor 5VT12 is the fixed-phase oscillator for the phase bridge circuit. Its frequency of oscillation is controlled by the crystal selected by relay 5RLG, so that it oscillates at either 89 kc/s or 88·5 kc/s. Since the output from 5VT12 has a non-sinusoidal waveform, it is taken via 5C85 to the tuned circuit 5L3, 5C91, 5C84 where the waveform is changed to a sine wave. This sine wave is then taken from the centre-tap on 5L3 to the base of 5VT11. Transistor 5VT11 is connected as a phase splitter, the two anti-phased outputs of which are taken to opposite corners of the phase bridge, one via 5C80, the other via 5C81.

60. The phase bridge consists of 5R154, 5MR39, 5R125, 5R126, 5MR40 and 5R155. A standing voltage of approximately 10·5V d.c., derived from the 14V d.c. supply line via the potential divider 5R124, 5R123, and 5R122, is connected to one of the other two corners of the phase bridge together with the variable-phase input signal which is connected via 5C77. The variable-phase input signal is obtained from the third mixer 5VT4 via one of the two secondary windings of 5TR3. The signal is amplified by 5VT10 before being applied to the phase bridge. The output from the phase bridge is taken from the remaining corner (the junction of 5R125 and 5R126) and applied via transistors 5VT18 and 5VT17, and an 89 kc/s low-pass filter on the main chassis to the reactance transistor 3VT7 in the r.f. sub-unit. Transistors 5VT18 and 5VT17 are d.c. amplifiers which together constitute an impedance matching device having a high input impedance and a low output impedance.

61. While the receiver is being mechanically tuned by the automatic tuning system, relay 5RLF is energized and no crystal is connected to is no input into the phase bridge from the fixed-phase oscillator. There is also no input from the variable phase amplifier until the tuning mechanism tunes the receiver through the required frequency for the first time when, for a brief period of time, there is an output from 5TR3 consisting of a single sweep through a narrow band of frequencies about 88·5 kc/s or 89 kc/s. The output from the phase bridge then consists of a small amount of these frequencies superimposed on the standing d.c. The 89 kc/s low-pass filter, which follows the impedance matching device (5VT18 and 5V17) in the phase bridge output, passes the standing d.c. but rejects the superimposed r.f., so that the reactance transistor 3VT7 to which the output is applied experiences no change that can affect its inductive reactance in the local oscillator tuning circuit.

62. When the mechanical tuning of the receiver has been completed relay 5RLF is de-energized and connects to 5VT12 the crystal selected by 5RLG. The fixed-phase input to the phase bridge therefore oscillates at the frequency of the selected crystal. Because of the inertia of the tuning mechanism the receiver tuning is carried slightly beyond the point where it is exactly tuned and where the monostable multivibrator is triggered. Consequently the frequency of the variable phase input signal to the phase bridge, which depends on the local oscillator frequency, differs from the frequency of the fixed phase input signal. This difference will normally be of the order of 50 c/s to 100 c/s and will never exceed 500 c/s.

63. The phase bridge rectifies both input signals and applies them to the standing d.c. Consequently the output from the phase bridge consists of the standing d.c. plus a ripple having a frequency equal to the difference between the frequencies of the fixed-phase and the variable-phase signals. This standing d.c. plus a.f. ripple is passed by the 89 kc/s low-pass filter to the reactance transistor 3VT7, the filter blocking any traces of the r.f. signals from which the ripple was derived. The a.f. ripple on the standing d.c. rapidly varies the inductive reactance of the reactance transistor 3VT7 which consequently swings the local oscillator frequency through the frequency required for correct tuning of the receiver. When the local oscillator frequency equals the required frequency. the frequency of the variable-phase input signal to the phase bridge equals the frequency of the fixed-phase input signal. The two input signals. when rectified by the phase bridge, add together to form a new d.c. voltage superimposed on the standing d.c. plus an r.f. ripple at the fixed-phase crystal frequency. The magnitude of the d.c. output from the phase bridge now depends on the phase difference between the two input signals and the inductive reactance of the reactance transistor is tightly controlled and locks the local oscillator frequency on to the required frequency with an accuracy that is only limited by the accuracies of the various crystals in use.

Relay 5RLA

64. Relay 5RLA controls the direction of rotation of the servo motor 3MO1. In conjunction with 5RLC it also controls the operation of relay 5RLB. During the first part of the automatic tuning control sequence, relay 5RLA is not energized and one terminal of 3MO1 is connected to the 27·5V d.c. supply line via 5RLA, 5R151, 5MR45 and 5RLC2 while the other terminal of 3MO1 is connected to earth via 5RLA1. The servo motor, which is engaged with the tuning mechanism when 3CLD is energized, drives the tuning inductor core bracket downwards until it operates the bottom micro-switch. The bottom micro-switch then completes a circuit that energizes 5RLA, the current flowing from the 27·5V d.c. supply line via 5RLC2, the top micro-switch contact 3SWMSC, 5R150, 5RLA coil, the bottom micro-switch contact 3SWLOC and 5RLC1 to earth.

65. When 5RLA is energized, the connections to the two terminals of 3MO1 are transposed and the motor drives the tuning mechanism in the opposite direction. An alternative earth return for 5RLA is provided via 5MR43 by 5RLA2 so that when the tuning inductor core bracket is raised from the bottom micro-switch 5RLA remains energized. The 27·5V supply via 5RLA1 that is now connected to the terminal of 3MO1 (formerly earthed) is also connected via 5MR44 to the coil of 5RLB. The coil of 5RLB is returned to earth via the bottom micro-switch contact 3SWLSC and contact 5RLC1 of the energized relay 5RLC.

Relay 5RLB

66. Relay 5RLB affects the control of relay 5RLD by transistor 5VT15. In addition it controls directly the application of a hold-in voltage to 5RLD.

67. During the first part of the automatic tuning control sequence, while the tuning inductor core bracket is being wound down to the bottom of its range of travel, relay 5RLB is not energized. Contact 5RLB1 of the de-energized relay disconnects the collector of 5VT14 from the base of 5VT15 and thus prevents relay 5RLD being energized at this stage of the control sequence should the receiver be tuned through the selected frequency and the monostable multi-vibrator triggered.

68. During the second part of the automatic tuning control sequence, while the tuning inductor core bracket is being wound upwards from the bottom micro-switch, relay 5RLB is energized as described in para. 65. Contact 5RLB1 of the energized relay connects the collector of 5VT14 to the base of 5VT15 via 5R143. In the normal stable condition of the monostable multivibrator, 5VT14 is bottomed so that 5VT15 is held cut off and 5RLD is de-energized. When the multivibrator is triggered, 5VT14 is temporarily cut off so that 5VT15 bottoms and 5RLD is energized. When relay 5RLD is energized, contact 5RLD1 connects a hold-in voltage to the coil of 5RLD via 5R148, 5MR41 and 5RLB2. This voltage is derived from the 27·5V d.c. supply line via 5RLC2.

69. During the third part of the automatic tuning control sequence, while the tuning inductor core bracket is being wound slowly downwards by the servo motor operating through the reversing gear engaged by the slow clutch, relay 5RLB remains energized. If the multivibrator fails to be triggered when the receiver is tuning through the selected frequency for the second time, the tuning mechanism will continue to wind the core bracket downwards until it operates the bottom micro-switch. When contact SC of 3SWL (the bottom micro-switch) is opened, the earth return via 5RLC1 for 5RLB is interrupted and 5RLB is de-energized. Consequently 5RLB2 interrupts the supply maintaining 5RLD and 5RLD is de-energized. Contact 5RLD1 of the de-energized relay 5RLD now transfers the 27·5V supply formerly connected to the slow clutch 3CLC to the fast clutch 3CLD and the tuning mechanism starts to wind the core bracket up again. As soon as the core bracket is wound off the bottom micro-switch and contact SC of 3SWL closes, relay 5RLB is energized again and the second part of the automatic tuning control sequence is repeated.

70. Relay 5RLB is normally de-energized when the multivibrator is triggered as the tuning mechanism returns the receiver tuning to the selected frequency for the second time. When the multivibrator is triggered to assume the unstable condition, 5VT13 is switched on and, through the connection between 5VT13 collector and 5VT16 base (5C94 having received a priming charge for the first time the multivibrator was triggered) cuts off 5VT16 so that relay 5RLC is de-energized. Consequently the supply to the coil of 5RLB, via 5RLC2, 5MR45, 5RLA1 and 5MR44, and the earth return from 5RLB via the bottom micro-switch contact SC of 3SWL and 5RLC1 are simultaneously interrupted.

Relay 5RLC

71. Relay 5RLC controls the 27·5V d.c. supply to the brake, the servo motor 3MO1 (via relay contacts 5RLA1 and 5RLA2) and the fast and slow clutches 3CLD and 3CLC (via relay contact 5RLD1). In conjunction with other relays it also controls the operation of 5RLB and 5RLA. When the relay 5RLC is de-energized contact 5RLC2 applies 27·5V d.c. to the brake. At the same time contact 5RLC1 connects the 27·5V

supply via 5R144 and 5R146 to th
5VT16 so that 5V16 is consequently held cut off and 5RLC kept de-energized.

72. When relay 5RLC is energized, as described in para. 55, contact 5RLC2 disconnects the 27·5V d.c. supply from the brake and transfers it to the fast clutch 3CLD (via 5RLD1) and the servo motor 3MO1 (via 5MR45, 5R151 and 5RLA1 or 5RLA2). At the same time 5RLC1 disconnects 5R144 from the junction of 5R146 and the bottom micro-switch and substitutes an earth connection. This provides an earth return through the bottom micro-switch contact SC for current to energize 5RLB through 5RLA1 as soon as 5RLA is energized and 5RLA1 connects a supply to the coil of 5RLB.

Relay 5RLD

73. Relay 5RLD controls the connection of an operating supply to either the slow clutch 3CLC or the fast clutch 3CLD. In conjunction with the multivibrator and relay 5RLE it also controls 5VT16 and consequently controls the operation of relay 5RLC. Before the automatic tuning control sequence is initiated, 5RLD is in the de-energized condition. In this condition, 5RLD2 connects 5R145 to 5R146 in the base circuit of 5VT16. While 5RLE is de-energized, the voltage applied to the base of 5VT16 through 5R145, 5RLD2 and 5R146, holds 5VT16 cut off so that 5RLC remains de-energized.

74. When a new frequency selection is made at the controller, relay 5RLE is momentarily energized and initiates the automatic tuning control sequence. As soon as 5RLE is energized, 5RLE1 earths 5R146 causing 5VT16 to bottom and energize 5RLC. As soon as 5RLC is energized, 5RLC2 connects a 27·5V d.c. supply via 5RLD1 to the fast clutch 3CLD, which then engages the servo motor 3MO1 with the tuning mechanism so that the tuning inductor core bracket is driven downwards. While 5RLE remains energized the earth return from 3CLD is completed via 5MR42, contact SC of 3SWL (the bottom micro-switch) and 5RLE1. Relay 5RLE is de-energized as soon as the bandswitch has been turned to the band containing the selected frequency. If the tuning inductor core bracket has been driven downwards far enough to operate the bottom micro-switch before the bandswitch has been driven to the required band, contact 3SWLSC is opened and disconnects 3CLD from earth so that the tuning mechanism is disengaged from the servo motor. When the bandswitch has been turned to the correct band, 5RLE is de-energized and 5RLE2 provides a new earth connection for 3CLD and the tuning mechanism is once more engaged with the servo motor, the rotation of which has meanwhile been reversed by the operation of relay 5RLA (para. 64). At the same time 5RLE1 provides an earth return for the coil of 5RLD in preparation for 5RLD being energized by 5VT15.

mechanism tunes the receiver through the selected frequency for the first time, the multivibrator is triggered and 5VT14 is cut off. Consequently the voltage applied to the base of 5VT15 via 5RLB1 and 5R143 approaches earth potential and 5VT15 bottoms and energizes 5RLD. When 5RLD is energized, 5RLD1 disconnects the supply from the fast clutch 3CLD and connects it to the slow clutch 3CLC. At the same time, 5RLD1 connects to the coil of 5RLD a 27·5V d.c. supply, obtained via 5RLC2, so that 5RLD remains energized when the multivibrator resumes the stable condition and 5VT15 is cut off. The servo motor 3MO1, operating through the slow clutch 3CLC and the associated reversing gear, now drives the tuning mechanism back to the required frequency. As soon as the receiver is once more tuned to this frequency, the multivibrator is again triggered and 5VT13 is switched on. Consequently 5VT16 is now cut off (para. 70) and relay 5RLC is de-energized.

Relay 5RLE

76. Relay 5RLE initiates the automatic tuning control sequence. It directly or indirectly controls or affects the operation of relays 5RLA, 5RLB, 5RLC, 5RLD and 5RLF. Each of the three frequency selector switches in the controller has a wafer which, when the switch setting is altered, momentarily provides an earth return via the 'trip line' for 5RLE. If the newly-selected frequency lies outside the band containing the previously selected frequency, an additional earth return for 5RLE is provided via 3MR8, the bandswitch clutch control wafer 3SWG1, and the band selection wafers of the frequency selector switches. This additional earth return keeps 5RLE energized until the bandswitch has been turned to the band containing the new frequency, when the earth is removed and 5RLE is de-energized.

77. As described in para. 55, when relay 5RLE is energized contact 5RLE1 earths 5R146, which causes 5VT16 to bottom and energize 5RLC. Contact 5RLE1 also removes the same restrictive positive bias from the base of 5VT9 and provides an earth return for 5RLF. At the same time 5RLE2 earths the junction of 5R150 and the coil of 5RLA, thus preventing the 27·5V d.c. applied via 3SWMSC (the top micro-switch) and 5R150 from energizing relay 5RLA and ensuring that the direction of rotation of 3MO1 cannot be reversed as long as the bandswitch clutch is energized. Contact 5RLE2 also removes the direct earth connection from the fast clutch 3CLD so that it is now only earthed via 3SWLSC (the bottom micro-switch). Consequently if the tuning inductor core bracket opens 3SWLSC before the correct band has been selected, 3CLD will be de-energized and the tuning mechanism will be disengaged from the servo motor until the bandswitch has been driven to the correct position and 5RLE is de-energized.

78. When relay 5RLE is de-energized, contact 5RLC1 of the now energized relay 5RLC provides an alternative connection to earth for the circuits previously earthed by 5RLE1. Contact 5RLE1 of the de-energized 5RLE now provides an earth return for 5RLD. Contact 5RLE2 removes the earth from the relay 5RLA so that 5RLA is now energized by the supply connected via 5RLC2, 3SWMSC (the top micro-switch) and 5R150. At the same time contact 5RLE2 provides an alternative earth return for the fast clutch 3CLD so that when the bottom micro-switch is operated and contact 3SWLSC is opened 3CLD remains energized. Capacitor 5C93 and resistor 5R147 ensure that the receiver is automatically re-tuned following an interruption of the power supply to the receiver (for example, after it has been switched off between flights). When the power supply is restored, the current flowing into 5C93 via 5R147 and the coil of 5RLE is enough to energize 5RLE and thus initiate the automatic tuning control sequence. Zener diode 5MR47 protects 5C93 from high voltage transients on the power supply.

Relay 5RLF and 5RLG

79. Relay 5RLF dictates the function of the crystal selected by relay 5RLG (para. 49). When 5RLF is energized the crystal selected by 5RLG (5XL1 or 5XL2) is connected as the final band-pass filter in the chain of band-pass filters that precede the trigger transistor 5VT19. When 5RLF is de-energized, the selected crystal is connected so as to control the fixed-phase oscillator 5VT12 in the phase bridge circuit which, in conjunction with the reactance transistor 3VT7, provides automatic control of the local oscillator frequency.

80. Relay 5RLF is energized as soon as the automatic tuning control sequence is initiated by 5RLE, and remains energized until the mechanical tuning operation has been completed. A 27·5V d.c. supply is connected via R164 to the coil of 5RLF, which is returned to earth either via contact 5RLE1 of the energized relay 5RLE or via contact 5RLC1 of the energized relay 5RLC. When the tuning mechanism is driven back to the selected frequency for the second or last time, relay 5RLE is already de-energized and 5RLC is de-energized as soon as the selected frequency is tuned and the monostable multivibrator is triggered. When 5RLC is de-energized, 5RLC1 disconnects the earth from the coil of 5RLF which is then de-energized.

81. When 5RLF is de-energized, one side of the selected crystal (5XL1 or 5XL2) is connected by 5RLF1 to the collector of 5VT12 via 5C87 and the other side by 5RLF2 to the base of 5VT12.

MAIN CHASSIS (UNIT 1)

82. Identities of the components used on the main chassis are prefixed 1. The functions of the transistors used are as follows:—

1VT1	(OC205)	push-pull audio output
1VT2	(OC205)	
1VT3	(2N1294)	18V d.c. line voltage stabilizer

The 89 kc/s low-pass filter

83. The 89 kc/s low-pass filter (fig. 2) consists of 1L1, 1L2, 1L3, 1C7, 1C8, 1C9, and 1C10. The response of the filter is level up to about 70 kc/s, then falls off steeply to give an attenuation at 88·75 kc/s of more than 70 dB. Above 89 kc/s the response starts to rise again but it is always at least 35 dB down. The filter follows the impedance matching device (5VT18 and 5VT17) in the line that takes the output from the phase bridge in the crystal sub-unit to the reactance transistor in the r.f. sub-unit. It blocks the r.f. components of the phase bridge output signal while passing on the d.c. and a.f. components to control the reactance transistor.

The audio output circuit

84. The audio output signal from 4VT11 in the i.f. sub-unit (fig. 3) is applied to the primary winding of 1TR1 on the receiver main chassis. The anti-phase outputs from the centre-tapped secondary of 1TR1 are connected directly to the bases of a matched pair of transistors (1VT1 and 1VT2). The output from these two transistors is connected in push-pull across the centre-tapped primary of 1TR2.

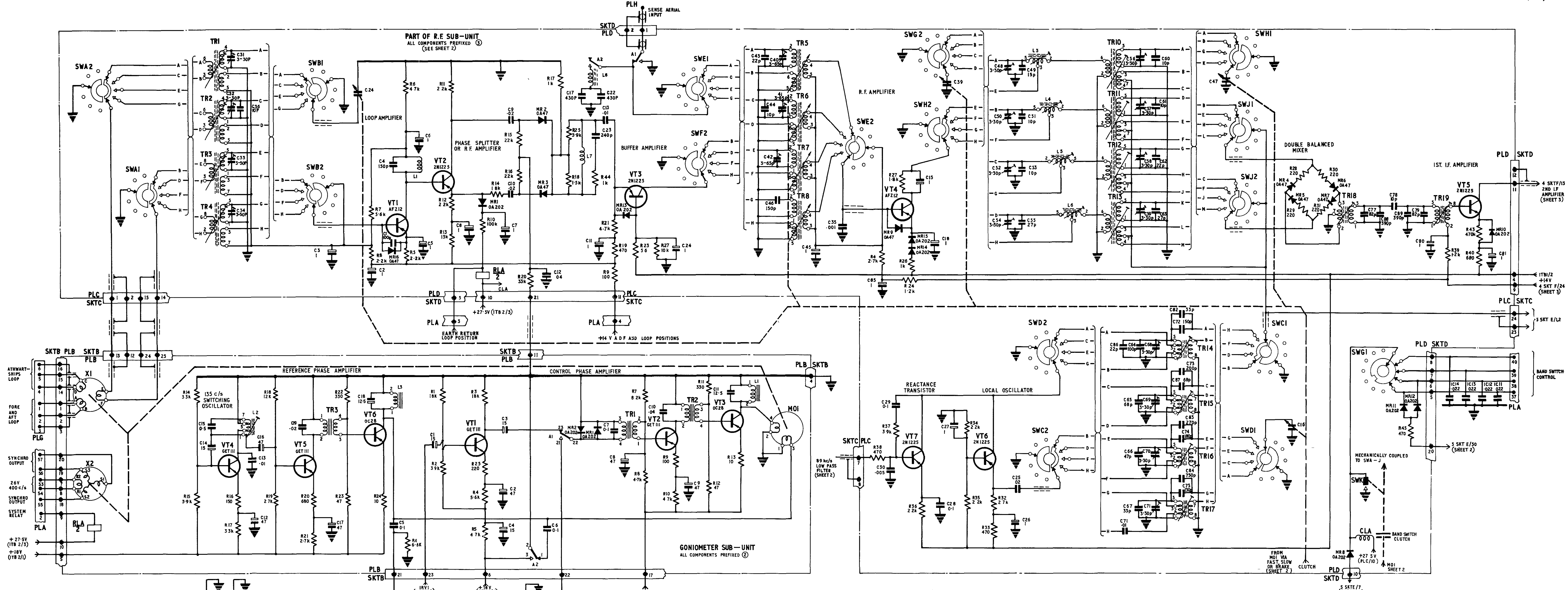
85. The output from the whole of the secondary of 1TR2 is suitable for the connection of a 500-ohm load in the external circuit. A tapping on the secondary is suitable for the connection of an alternative 100-ohm load. The push-pull output transistors will deliver 300 mW into either load. The level of the a.f. output from the receiver is directly controlled on function ADF by the GAIN control RV1 in the controller, which is connected across the primary of 1TR1 in the receiver as a variable shunt resistor.

Power supply circuit

86. Except for the 26V 400 c/s supply for the bearing repeater system, which is connected directly to the synchro in the goniometer sub-unit, all power supplies are derived from the aircraft 27·5V d.c. supply by the power supply circuit (fig. 3). A diode (1MR9) is placed in series with the 27·5V d.c. input line to prevent any negative surges on the supply line reaching the receiver circuits.

87. Four 18V d.c. lines are derive 27·5V d.c. supply. Three of them are filtered by R–C filter networks (1R6 and 1C3, 1R7 and 1C4, and 1R8 and 1C5). A 22V Zener diode across each capacitor protects the capacitor from surges. The fourth 18V d.c. line is fully stabilized by the series transistor 1VT3. The base of 1VT3 is held at 18V by the Zener diode 1MR5. If the emitter voltage of 1VT3 rises above 18V, the transistor receives less base current and so passes less collector current, i.e. its impedance increases and the output voltage falls back to 18V. If the output voltage falls below 18V all the current through 1R10 is available to flow into the base ce its impedance, thus restoring the correct voltage. The Zener diode 1MR1, in conjunction with resistor 1R9, prevents very high voltage surges reaching the transistor when they exceed its collector rating. Capacitor 1C6 suppresses 'spikes'.

88. The more sensitive receiver circuits are fed by a 14V line derived from the fully stabilized 18V line. The 14V line is further stabilized by the Zener diodes 1MR7 and 1MR8. The junction of these two Zener diodes is at 7V and is used for the a.g.c. reference voltage.



SHEET	SUB-UNITS
1	1,2 AND 3
2	1,3 AND 5
3	1 AND 4

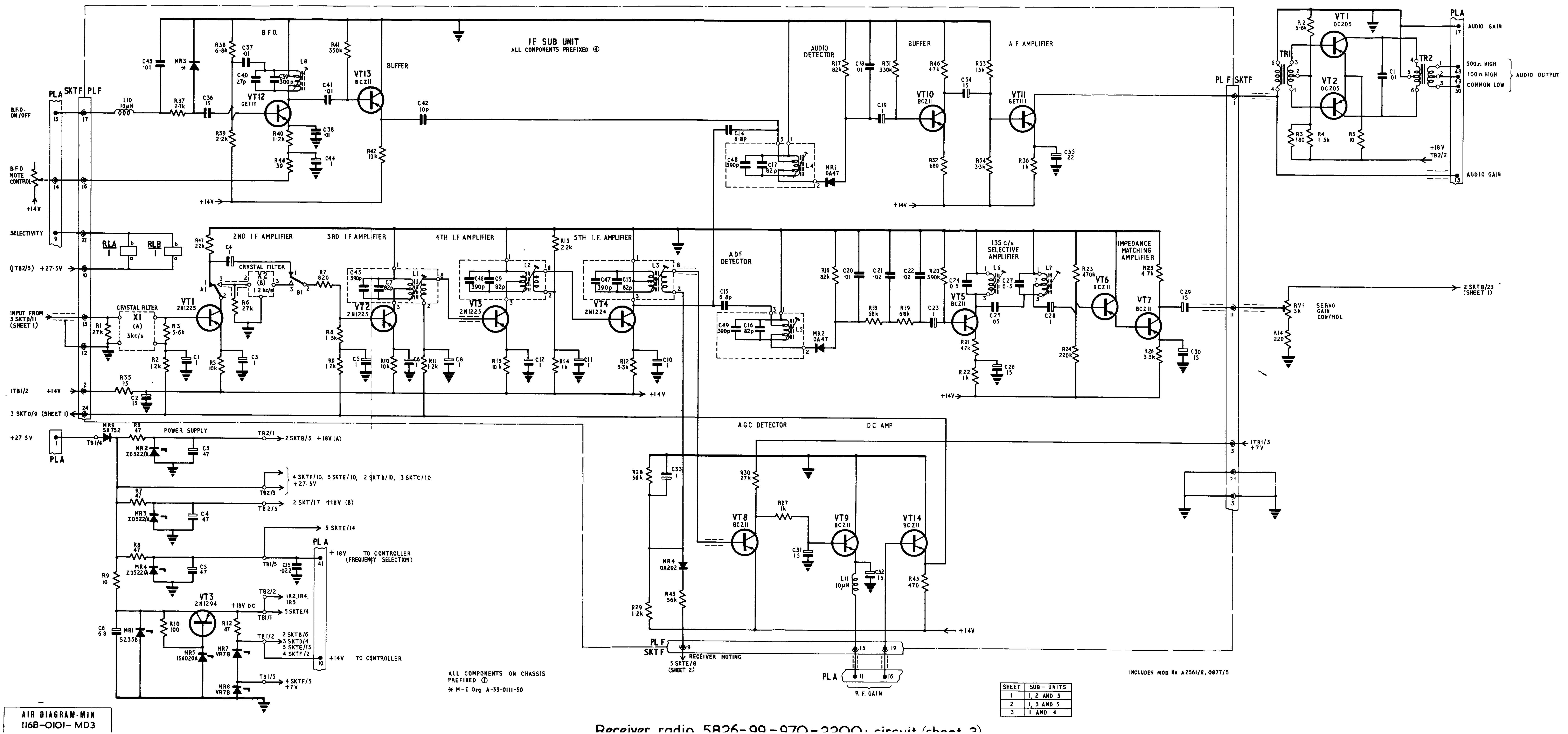
AIR DIAGRAM-MIN
116B-0101-MD1
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE ROYAL AIR FORCE
ISSUE 2 Prepared by the Ministry of Technology

D 840948, R C 963

Receiver, radio 5826-99-970-2200: circuit (sheet 1)

Fig. 1

CRYSTAL SUB-UNIT
ALL COMPONENTS PREFIXED (S)
BUFFER
1ST MIXER
2ND MIXER
3RD MIXER
FROM L.O.
100 kc/s CRYSTAL BANK
10 kc/s CRYSTAL BANK
1 kc/s CRYSTAL BANK
1ST OSC.
2ND OSC.
3RD OSC
AMPLIFIER
TRIGGER
MONOSTABLE MULTIVIBRATOR
CONTROL TRANSISTOR
5RLC CONTROL TRANSISTOR
PHASE SPLITTER
FIXED PHASE OSC.
PHASE BRIDGE
IMPEDANCE MATCHING AMP
VARIABLE PHASE AMP
89 kc/s LOW PASS FILTER
PART OF R.F. UNIT
PREFIX (S) (SEE SHEET 1)
BRAKE
SLOW CLUTCH
RF & LO TUNING
FAST CLUTCH
BOTTOM MICRO-SWITCH
TOP MICRO-SWITCH
TO CLA SHEET 1
RLE TRIP LINE
FREQUENCY SELECTION 0.5 kc/s
RECEIVER MUTING
UP
DOWN
INCLUDES MOD No A3298/4
SHEET | SUB-UNITS
1 | 1,2 AND 3



SHEET	SUB - UNITS
1	1, 2 AND 3
2	1, 3 AND 5
3	1 AND 4

Receiver radio 5826-99-970-2200: circuit (sheet 3)

Chapter 2

ADF CONTROLLERS AND ASSOCIATED CIRCUITRY

(Completely revised)

CONTENTS

Introduction

1 Three types of controller are available designated 6409M, 6409MB and 6409MD. The 6409M version is for single control installations and the 6409MB and 6409MD versions are for dual control installations and have an additional changeover switch mounted on the front panel. The controllers contain the following switches and potentiometers necessary for the operation of the ADF receiver:

Frequency selection
Function selection
Gain control
Selectivity switch
B.F.O. on/off switch
B.F.O. tone control
Loop control
Changeover switch

1.1 Frequency selection is controlled by three multi-wafer switches, the selected frequency being displayed on an in-line indicator.

1.2 Function selection is controlled by a four-position switch marked OFF, ADF, ANT and LOOP. In the ADF position the receiver is set up for automatic direction finding with simultaneous audio reception. In the ANT position the receiver operates from the sense aerial alone as a sensitive communications receiver. In the LOOP position the receiver operates from the loop aerial alone and may be used either for manually controlled direction finding or for communications reception in very noisy regions where manual control of the loop attitude can sometimes improve the signal to external noise ratio.

1.3 Manual control of the loop attitude (i.e. the attitude of the search coil in the goniometer) is given by the LOOP switch. This switch is spring-loaded to the centre off position. When the controller function switch is set to function LOOP, the goniometer servo motor drives the goniometer search coil clockwise or anti-clockwise according to whether the LOOP manual control switch is turned to one side or the other of the centre off position. Speed of rotation of the gonio servo motor is increased progressively as the LOOP switch is turned further away from the centre off position. When the controller function switch is set to ADF, operation of the LOOP manual control switch overrides the automatic control of the goniometer to permit temporary manual control. Automatic control is restored as soon as the LOOP switch is returned to the centre off position. When the controller function switch is set to ANT the LOOP manual control switch is shorted-out to make it inoperative.

1.4 The gain control is a potentiometer which, on ADF, controls audio gain, and on ANT or LOOP controls r.f. gain.

1.5 The selectivity switch is a two-position switch marked BROAD and SHARP. In the BROAD position the receiver has a bandwidth of 3KHz and in the SHARP position the bandwidth is reduced to approximately 1.2KHz.

1.6 The B.F.O. on off switch controls the operation of the beat frequency oscillator.

1.7 The B.F.O. tone control varies the pitch of the beat note. When the control is set approximately half-way, with the white dot on the knob adjacent to the white dot on the panel, the beat note is 1KHz.

1.8 The changeover switch is fitted only to the 6409MD and 6409MB controllers used in dual controller installations. The switch is located below the B.F.O. control and its operation of a particular controller connects the ADF receiver to that controller.

Frequency selection

2 The required frequency is manually set on the controller by the operation of the three knobs that control the selector switches. The left-hand knob operates a 6-bank wafer-switch (SWA) to select hundreds of KHz from 1 x 100 KHz to 17 x 100 KHz, the centre knob operates a 4-bank wafer-switch (SWB) to select tens of KHz from 0 x 10 KHz to 9 x 10 KHz and the right-hand knob operates a 6-bank wafer-switch (SWC) to select unit KHz and half KHz from 0.5KHz to 9.5KHz. The primary function of each of these switches is to select the

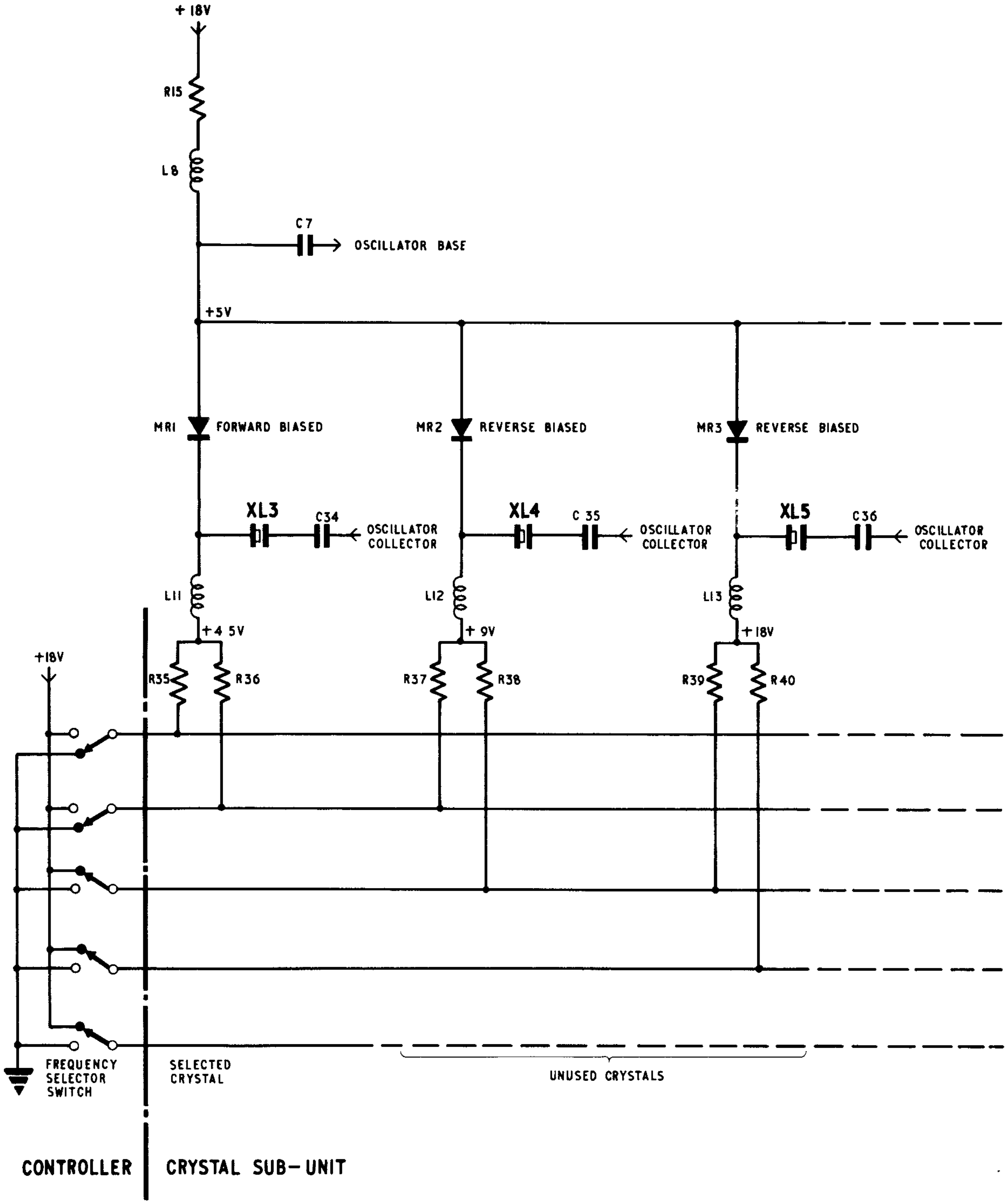


Fig. 1 Crystal selection : simplified circuit

required crystal from the associated crystal bank in the receiver and connect it to control the associated oscillator by means of solid state switching. A simplified circuit diagram showing how this is effected is given in fig. 1 and a complete circuit diagram of the controller in fig. 5.

3 In each of the crystal banks in the receiver (Part 4, Chap. 1) every crystal is connected, in series with a silicon diode, to the oscillator associated with the bank. The anodes of all the diodes are connected to + 18V by a common resistor (5R15, 5R24 and 5R33) in each bank, and the cathodes are separately connected to the junction of their own pair of control resistors, 5R35, 5R36 to 5R107 and 5R108. The other end of each of these control resistors is connected to the corresponding wafer-switch SWA, SWB or SWC in the controller via one of the pins 20 to 36 of plug PLA. Operation of these switches connects the control resistors to either + 18V or earth. When both control resistors are connected to earth the fall in potential from + 18V to earth through the resistor network is such that the associated diode is forward biased by about ½V, consequently the associated crystal is switched into the oscillator circuit. When either or both of the control resistors is connected to + 18V, the associated diode is reverse biased by at least 4V, consequently the associated crystal is switched out of the oscillator circuit. The diode control resistors in each crystal bank are connected to the selector switches in the controller in such a way that when two of the wires are earthed only one diode is forward biased. The sequence in which pairs of wires are earthed by the selector switches (SWA3, SWA5, SWB1, SWC1, SWC3) in the controller is given in Tables 1, 2 and 3. Those wires that are not "earthed" are connected to + 18V via SWA4, SWA6, SWB2, SWC2 and SWC4.

TABLE 1 SELECTION OF 100 KHz CRYSTALS

Selected frequency (x 100 kHz)	Selected crystal (kHz)	Pins earthed in Controller (Plug PLA)	Selected frequency (x 100 kHz)	Selected crystal (kHz)	Pins earthed in Controller (Plug PLA)
1	4554	23, 26	10	5454	21, 20
2	4654	24, 26	11	5554	22, 20
3	4754	24, 20	12	5654	23, 20
4	4854	24, 25	13	5754	22, 21
5	4954	20, 25	14	5854	23, 21
6	5054	21, 25	15	5954	24, 21
7	5154	20, 26	16	6054	23, 22
8	5254	21, 26	17	6154	24, 22
9	5354	22, 26	-	-	-

TABLE 2 SELECTION OF 10 KHZ CRYSTALS

Selected frequency (x 10 kHz)	Selected crystal (kHz)	Pins earthed in Controller (Plug PLA)	Selected frequency (x 10 kHz)	Selected crystal (kHz)	Pins earthed in Controller (Plug PLA)
0	2090	27, 28	5	2040	29, 31
1	2080	27, 29	6	2030	30, 31
2	2070	28, 29	7	2020	27, 30
3	2060	28, 30	8	2010	27, 31
4	2050	29, 30	9	2000	28, 31

TABLE 3 SELECTION OF UNIT KHZ CRYSTALS

Selected frequency (kHz)	Selected crystal (kHz)	Pins earthed in Controller (Plug PLA)	Selected frequency (kHz)	Selected crystal (kHz)	Pins earthed in Controller (Plug PLA)
0	1820	32, 33	5	1815	34, 36
0.5	1820	32, 33	5.5	1815	34, 36
1	1819	32, 34	6	1814	35, 36
1.5	1819	32, 34	6.5	1814	35, 36
2	1818	33, 34	7	1813	32, 35
2.5	1818	33, 34	7.5	1813	32, 35
3	1817	33, 35	8	1812	32, 36
3.5	1817	33, 35	8.5	1812	32, 36
4	1816	34, 35	9	1811	33, 36
4.5	1816	34, 35	9.5	1811	33, 36

4 Wafers SWA1, SWA3, SWA5 and SWB3 on the kHz x 100 and kHz x 10 switches control the operation of the band-switch in the receiver. The band-switch is driven, through an electrically-operated clutch, 3CLA, by the motor that drives the tuning capacitors and inductor slugs (fig. 2). The energizing current through the clutch returns to earth via a wafer, 3SWG1, in the band-switch and one or more of the wafers in switches SWA and SWB. The clutch remains energized until the band-switch has been driven to the position where it selects the band containing the required frequency; it is then switched off by the control wafer, 3SWG1, interrupting the earth return circuit. To ensure that the band-switch does not stop as it is moving into the correct position, a separate click-switch, 3SWK, operated by a toothed wheel on the band-switch drive shaft, provides an alternative earth return circuit which is interrupted when the band-switch reaches the centre of the correct position

5 Wafer SWC5 of the unit and half kHz selector switch earths the operating coil of relay 5RLG in the receiver on every half kHz selection (i.e. 0.5, 1.5, 2.5 kHz, etc.) and the energized relay consequently selects the 88.5 kHz crystal, 5XL2, in the crystal bank in the receiver. When a whole kHz selection is made (i.e. o, 1, 2, 3 kHz, etc.) the relay is not energized and the 89.0 kHz crystal is selected.

6 Each of the three frequency-selector switches contains a wafer, SWA2, SWB4, SWC6, which momentarily earths controller pin PLA18 every time a new frequency selection is made. Earthing pin PLA18 energizes relay 5RLE in the receiver and the automatic tuning system relay control sequence is set in operation.

Function selection

7 The function selection switch, SWD, in the controller is a 6-wafer 4-position switch marked OFF, ADF, ANT and LOOP. Referring to fig. 4 it will be seen that all the circuits controlled by this switch are open when the switch is in the OFF position. When the switch is set to any of the other three positions a 27.5V supply is connected to the receiver through PLA46, SWD6 and PLA1, and to the controller dial lamps through PLA44 and SWD2. Set to ADF, the function switch connects a 14V supply to the emitters of 3VT1, 2 and 3, in the loop signal circuit of the receiver through PLA10, SWD2 and PLA4. When so connected, 3VT1 functions as an r.f. amplifier, 3VT2 as a phase splitter feeding into the balanced modulator, and 3VT3 as a buffer amplifier stage between the balanced modulator and the input of 3VT4 where the sense signal is added to the loop signal. Set to ANT, the function switch disconnects the 14V supply to the emitters of 3VT1, 2 and 3, and substitutes a connection to earth rendering the loop signal circuit inoperative. The 14V supply to the base of 3VT3 remains connected and this transistor now functions as a reverse biased diode to prevent feedback of the sense signal into the loop circuits. At the same time relay 2RLA in the receiver is energized through PLA2 and SWD1 in the controller, disconnecting the 135 Hz switching voltage from the balanced modulator. Set to LOOP, the function switch restores the 14V supply to the emitters of 3VT1, 2 and 3, through PLA10, SWD2, PLA4, and "earths" 3R10 through PLA3 and SWD1. Consequently 3VT2 now ceases to function as a phase splitter and operates instead as an additional r.f. amplifier. The function switch also energizes relay 2RLA through PLA2 and SWD1 and relay 3RLA through PLA3 and SWD1. The function switch also controls the use of the single gain control potentiometer RV1 either for receiver r.f. gain or for receiver a.f. gain as explained in para. 9.

Loop manual control

8 The loop manual control provides a means of manually controlling the speed and direction of rotation of the servo motor that drives the search coil in the goniometer. It consists of a 2-wafer-switch, SWE, ganged to a potentiometer, RV3, spring biased to the centre off position. When the function switch is set to ANT or LOOP, or if the loop manual control is operated with the function switch set to ADF, relay 2RLA in the receiver is energized via PLA2, SWD1 or via PLA2, SWE1 and PLA7. When relay 2RLA is energized it disconnects the control phase winding of the two-phase goniometer servo motor from the amplified output of the ADF detector and reconnects it to the output from the reference phase amplifier via the loop manual control and transformer TR1 in the controller. As the centre tap of the secondary of

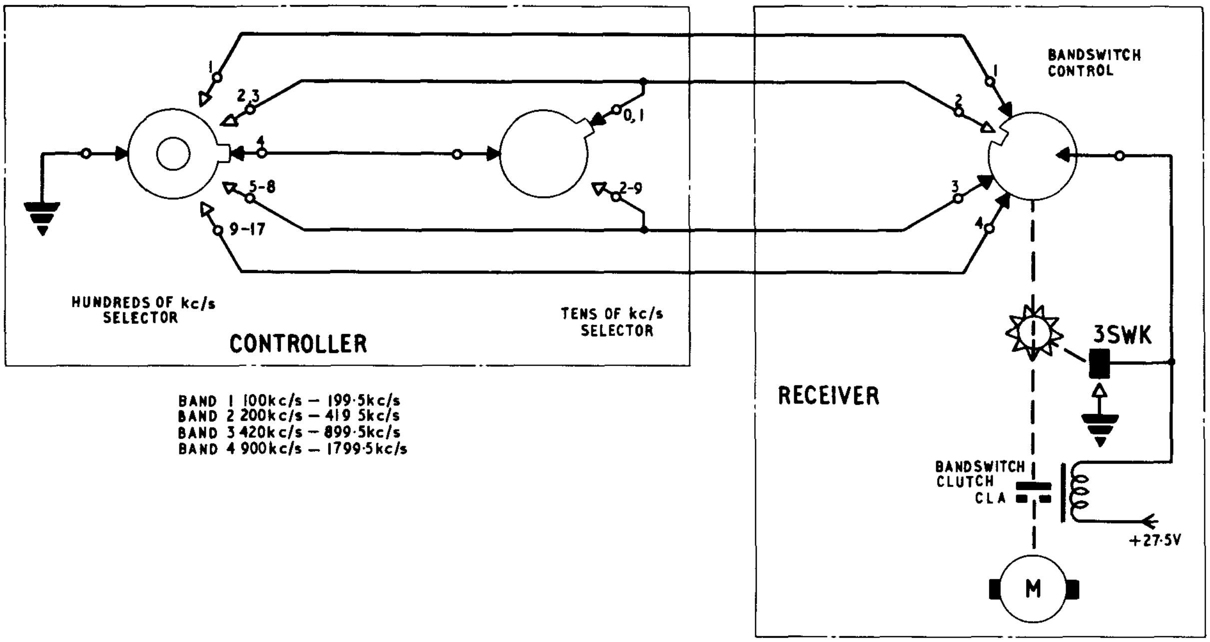


Fig. 2 Bandswitch control : simplified circuit

TR1 is connected to earth, the signal induced in the secondary appears in opposite phases at the two ends of the secondary. Potentiometer RV3 is connected across the secondary of TR1 and the wiper of RV3 is connected to the control phase winding of the goniometer servo motor via PLA8. The magnitude of the signals applied to the control phase amplifier from the two ends of the secondary of TR1 depends upon the position of the wiper of the potentiometer RV3. When the wiper is at the electrical centre of the resistance winding there will be no output as the signals are in opposite phase and of equal magnitude. At any other position of the wiper one of the two signals must pre-dominate. To ensure that no signal is fed to the control phase amplifier when the LOOP manual control is in the centre off position, the second wafer, SWE2, of the switch ganged with the potentiometer earths the wiper of RV3 in this position. SWE2 also connects the wiper of RV3 directly to the appropriate end of the secondary of TR1 at both ends of its range of movement.

Gain control

9 The gain control knob on the controller operates potentiometer RV1. When the function switch is set to ADF, RV1 controls a.f. gain, and when the function switch is set to either ANT or LOOP, RV1 controls r.f. gain (fig. 3). In the ADF position of the switch the wiper and one end of RV1 are connected, via PLA13 and PLA17, across the primary of transformer 1TR1 in the audio circuit of the receiver. RV1 now acts as a variable resistor across 1TR1 and controls a.f. gain. At the same time the function switch connects the output from the a.g.c. amplifier 4VT9 directly to the next stage, 4VT14, in the a.g.c. circuit and applies 14V to the emitter of 4VT9 via the resistor network (fig. 4). In the ANT position the function switch substitutes a fixed

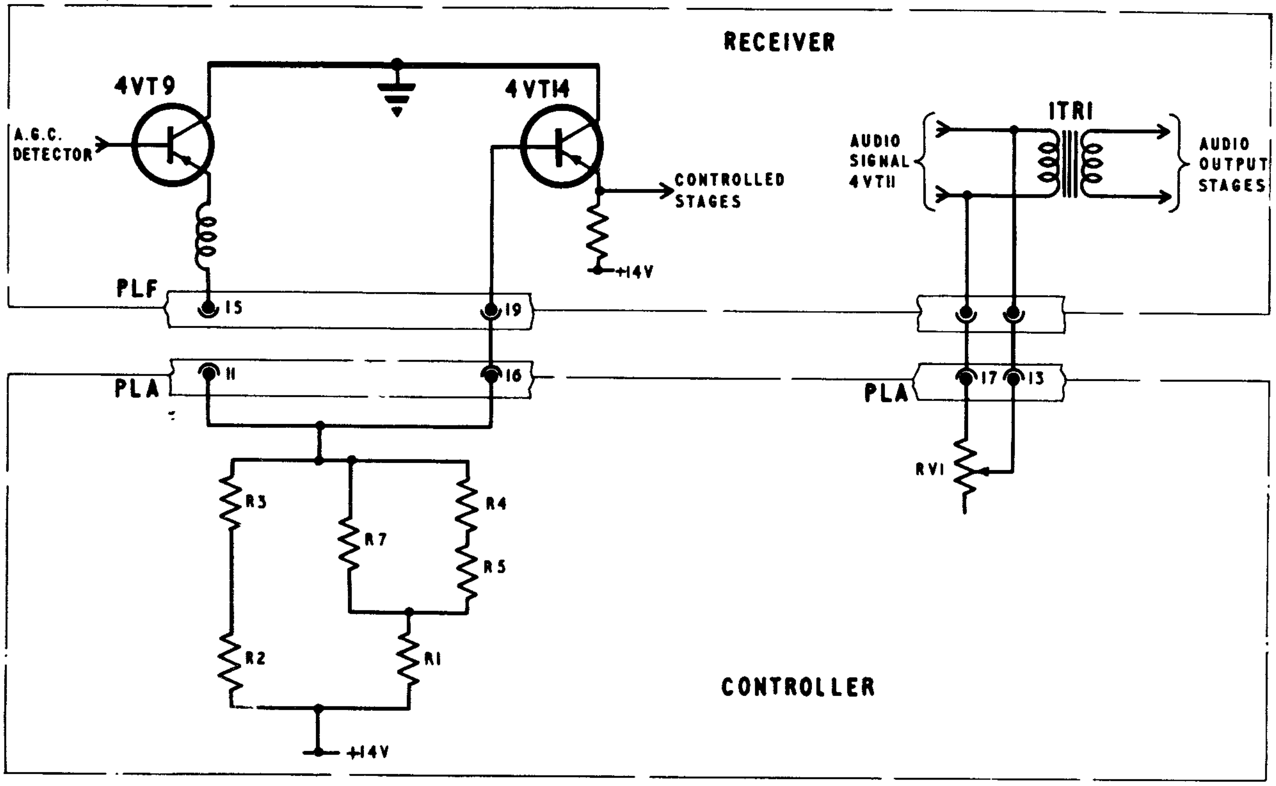
ɜsistor, R6, for the gain control potentiometer RV1 across the primary of ΓR1 in the audio output circuit. The total resistance of RV1 is now ɔnnected in parallel with R3, R7 and R5 (in series) in the 14V supply line ꞉ the emitter of 4VT9, resistors R2 and R4 being connected in series in the ame line. The wiper of RV1 which is connected to the junction of R3 and R7 ꞩ taken to the base of 4VT14, allowing RV1 to control the value of a.g.c. ɔltage fed from the a.g.c. amplifier 4VT9 to the controlled stages via /T14, thus controlling r.f. gain (fig. 4). In the LOOP position, R6 and /1 are connected as in the ANT position but resistor R5 is connected in ɜries with R2 and R4 so that only R3 and R7 are in parallel with RV1. ɔnsequently the range of a.g.c. voltage feedback controlled by RV1 is ljusted to compensate for the increased r.f. amplification provided by /T2 in the loop signal circuit when function LOOP is selected.

ɜlectivity control

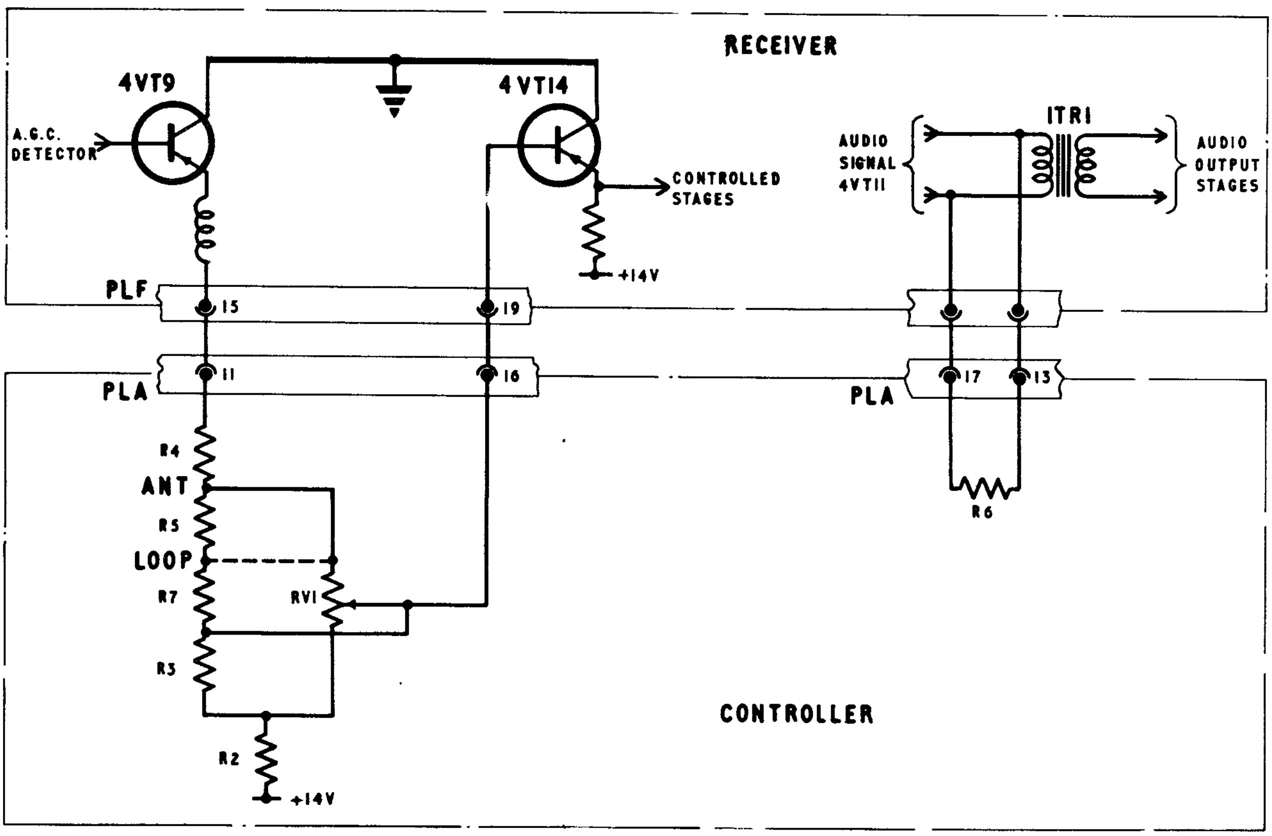
) The selectivity control is a single-pole on/off switch, SWG. When set to IARP the switch is closed and provides an earth return via PLA9 for current ɔ energize relays 4RLA and 4RLB in the receiver. When energized, these ɜlays connect a second crystal (crystal filter B) in the i.f. circuit of the ɜceiver. The addition of the second filter reduces the bandwidth passed by ıe i.f. circuit to about 1.2 kHz. When set to BROAD the selectivity ɔntrol switch is opened and relays 4RLA and 4RLB are de-energized. ɔnsequently crystal filter B is disconnected from the i.f. circuit and the andwidth passed, limited by crystal filter A alone, is about 3.0 kHz.

.F.O. circuit position

l The receiver beat frequency oscillator, which feeds into the audio detector ircuit, is controlled by an on/off switch, SWH, and a tone control potentio-ɜter, RV2, in the controller. In the OFF position switch SWH is closed and ɔnnects a 27.5V d.c. supply to the receiver via PLA1 and PLA15 to forward ias diode 4MR3 in the base circuit of the B.F.O. oscillator transistor 4VT12. ıis forward biased diode decouples to earth the base of the oscillator /T12 and thus prevents oscillation. In the BFO position of switch SWH the ɔntacts are open and 4VT12 oscillates. The B.F.O. tone control consists of potentiometer, RV2, connected as a variable resistor in the 14V supply, via ᴸA10 and PLA14, to the emitter of the B.F.O. oscillator 4VT12. This ransistor operates near the common emitter cut-off frequency and varying the ırrent by the operation of RV2 varies the phase shift across the transistor. ꞩ the total phase shift around the oscillator loop needs to be 360° to aintain oscillation, the circuit oscillates at the frequency where the phase ıift across the L-C element in the collector lead plus the phase shift ꞉ross the transistor gives the required total phase shift of 360°.

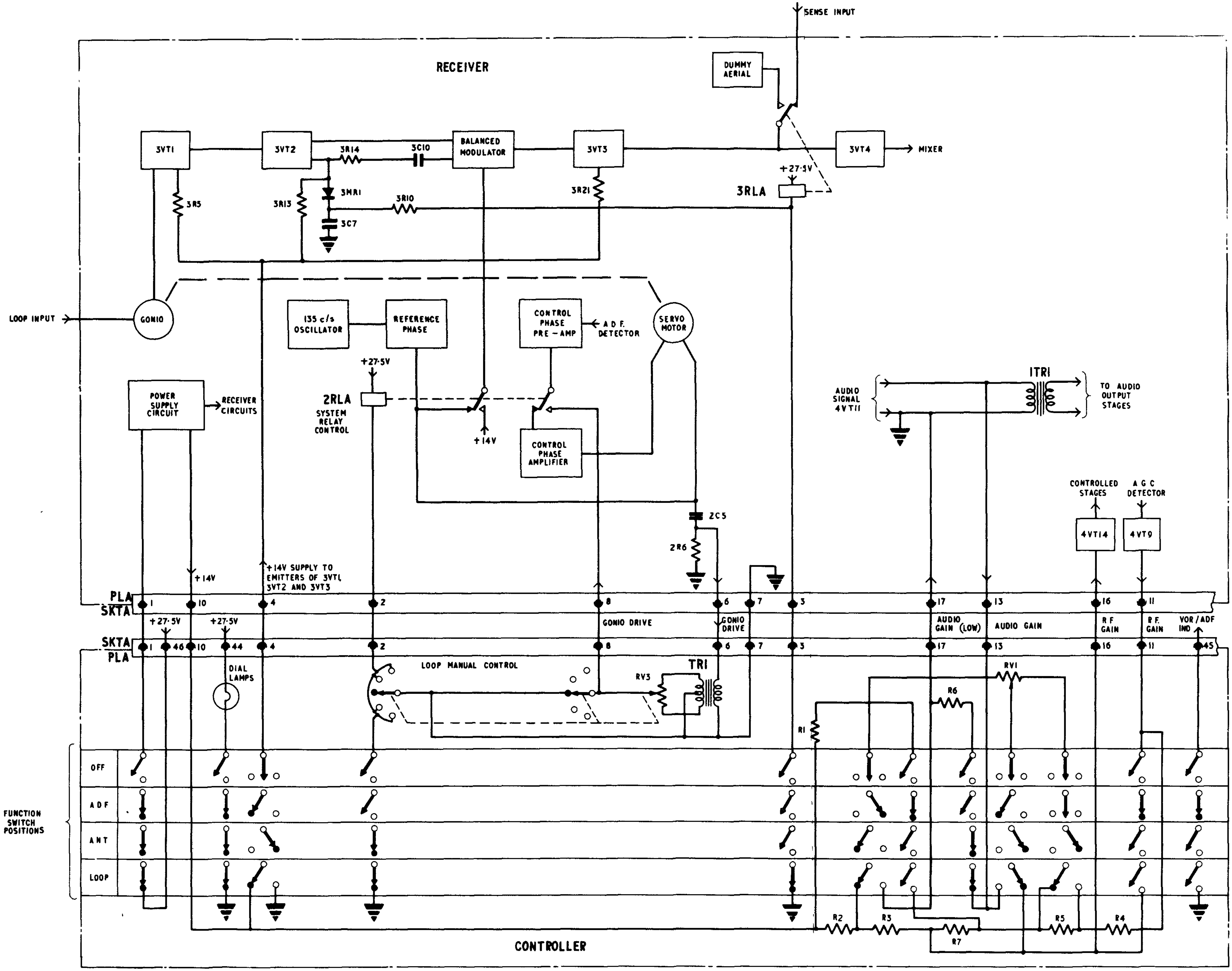


(a) FUNCTION SWITCH SET TO ADF



(b) FUNCTION SWITCH SET TO ANT OR LOOP

Fig. 3. Gain control resistor network : simplified circuit



Function switch, loop and gain controls: simplified circuit

Fig. 4

AIR DIAGRAM
116B-0101-MD5
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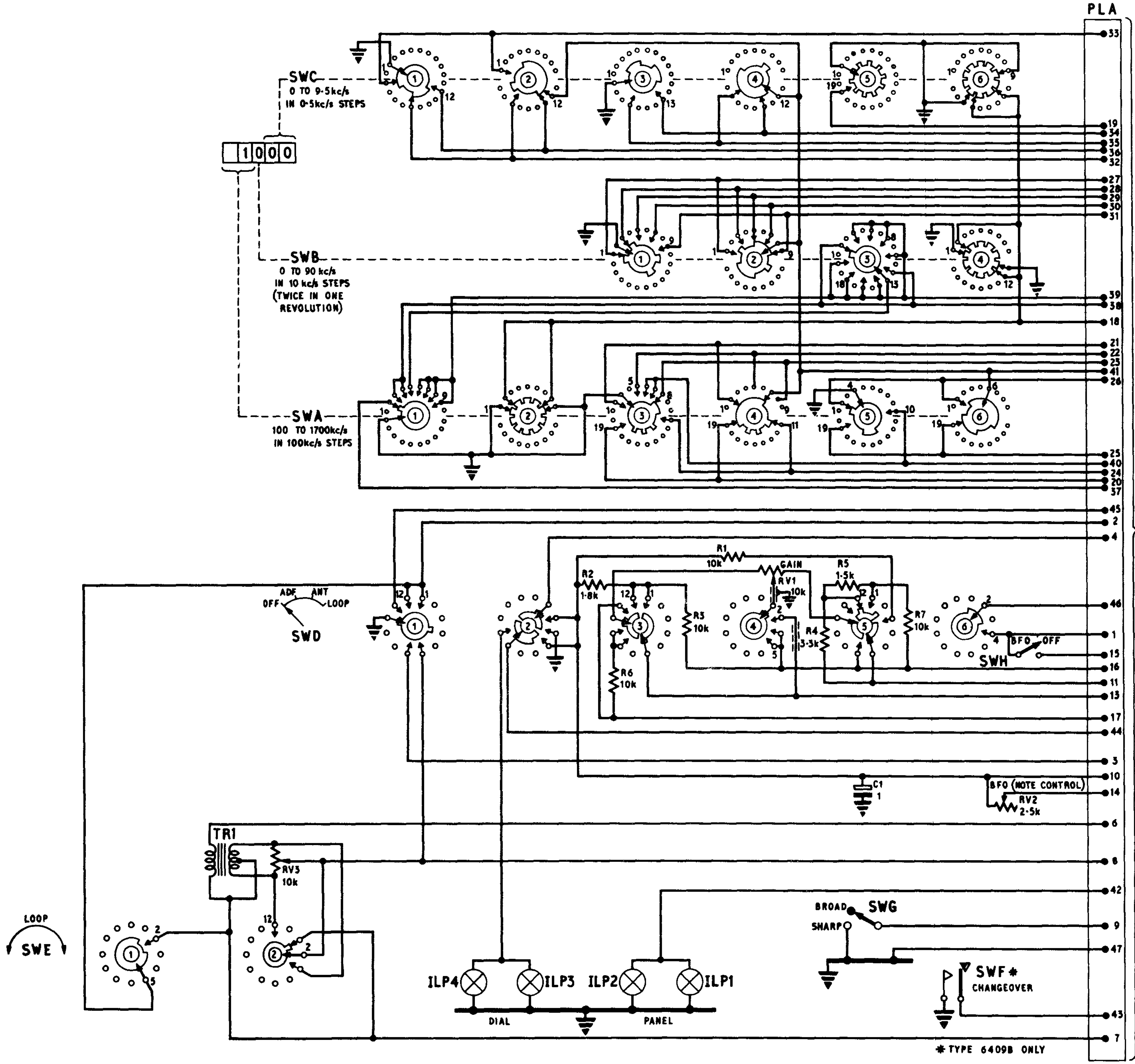
(Prepared by the Ministry of Aviation)



1 +27·5V DC TO RECEIVER
2 SYSTEM RELAY
3 SENSE AERIAL RELAY
4 LOOP CIRCUIT CONTROL
5
6, 7, 8 } GONIO MANUAL CONTROL { FROM RECEIVER / EARTH / TO RECEIVER
9 SELECTIVITY
10 +14V FROM RECEIVER
11 RF GAIN (FROM RECEIVER)
12 SPARE
13 AUDIO GAIN
14 BFO NOTE
15 BFO ON/OFF
16 RF GAIN (TO RECEIVER)
17 AUDIO GAIN (LOW)
18 RELAY 5RLE TRIP
19 FREQUENCY SELECTION (½ kc/s)
20, 21, 22, 23, 24, 25, 26 } FREQUENCY SELECTION (100kc/s)
27, 28, 29, 30, 31 } FREQUENCY SELECTION (10kc/s)
32, 33, 34, 35, 36 } FREQUENCY SELECTION (1 kc/s)
37, 38, 39, 40 } BANDSWITCH CONTROL { BAND 1 / BAND 2 / BAND 3 / BAND 4
41 +18V DC FROM RECEIVER (FREQUENCY SELECTION)
42 +27·5V DC PANEL LIGHTS
43 CHANGEOVER SWITCH UNIT (TYPE 6409B ONLY)
44 +27·5V DC DIAL LIGHTS
45 VOR/ADF INDICATOR
46 +27·5V DC INPUT
47 COMMON EARTH
48, 49, 50 } NOT USED

AIR DIAGRAM
116B-0101-MD5
ISSUE 1.

Control, D.F 5826-99-970-2199: circuit

Fig. 5

Chapter 3

AUTOMATIC TUNING CONTROL OPERATION

LIST OF CONTENTS

Automatic tuning control sequence

1. New frequency selected at the controller:—

(1) The controller earths two lines in each of the three groups of lines connected to the three crystal banks in the receiver. This action forward biases one silicon diode in each crystal bank, thus connecting the appropriate crystal in each bank to control the associated oscillator (5VT5, 5VT6 or 5VT7). For further details refer to Part 4, Chap. 2, para. 2.

(2) When a half kc/s frequency is selected, the controller earths the line connected to PLA19 in the receiver and relay 5RLG is energized. When energized 5RLG selects the 88·5 kc/s crystal 5XL2 and when de-energized selects the 89·0 kc/s crystal 5XL1. For further details refer to Part 4, Chap. 1, para. 47 and Part 4, Chap. 2, para. 5.

(3) The controller earths one of the lines connected to PLA40, PLA39, PLA38 and PLA37 in the receiver. If the bandswitch is set at a band not containing the newly selected frequency, an earth return circuit is completed via 3SWG1 and 3MR8 for current to energize relay 5RLE and the bandswitch clutch 3CLA.

(4) The controller momentarily earths the trip line connected to PLA18 in the receiver. This completes an earth return circuit for current to energize momentarily relay 5RLE if it is not already energized as a result of an earth return circuit via 3SWG1 and 3MR8.

2. Relay 5RLE energized:—

(1) 5RLE1: Completes an earth return circuit to energize relay 5RLF.

(2) 5RLE2: Earths the junction of 5R150 and the coil of relay 5RLA. (5RLA is not yet energized).

3. Relay 5RLF energized:—

Connects the crystal selected by 5RLG to act as a filter between 5TR3 and 5VT9 (the input to the trigger circuit).

4. Relay 5RLC energized:—

(1) 5RLC1: Earths the circuits at present earthed by 5RLE1 so that they will remain earthed when 5RLE is de-energized.

(2) 5RLC2: (a) Connects the 27·5V supply to the tuning mechanism drive motor 3M01 via 5MR45 and 5R151.

(b) Connects the 27·5V supply via 5RLD1 to the fast clutch 3CLD, the other side of which is earthed via 5MR42, the bottom microswitch contact SC and 5RLC1.

(c) Connects 27·5V via the top microswitch contact SC and 5R150 to the junction of 5R150 and the coil of 5RLA (5RLA is not yet energized).

5. Motor 3M01 energized:—

(1) If the bandswitch clutch 3CLA is energized, the motor 3M01 drives the bandswitch to a position where the earthed line on PLA40, PLA39, PLA38 or PLA37 is disconnected by 3SWG1. This interrupts the earth return for 5RLE and 3CLA, 5RLE is de-energized and 3CLA disconnects the motor drive from the bandswitch, which stops.

(2) The motor 3M01 drives the tuning mechanism through the fast clutch 3CLD and lowers the tuning inductor core bracket until it operates the bottom microswitch.

6. Bottom microswitch operated:—

(1) Contacts SC open: Interrupts the earth return to the fast clutch 3CLD disengaging the motor 3M01 from the timing mechanism, and the tuning indicator core bracket stops on the bottom microswitch.

(2) Contacts OC closed: Earths the junction of 5MR43 and 5RLA thus allowing 5RLA to be energized as soon as 5RLA is de-energized.

Note . . .

5RLE remains energized until the band-switch has selected the correct band, which may be before or after the bottom microswitch is operated. While 5RLE is energized, 5RLE earths the junction of 5R150 and 5RLA, thus preventing the application to 5RLA of the 27·5V supply connected via 5R150.

7. 5RLE de-energized:—

(1) 5RLE1: Earths 5RLD.

(2) 5RLE2:

(a) Provides earth return to the fast clutch 3CLD.

(b) Removes earth from the junction of 5R150 and 5RLA which is now energized by the 27·5V supply from PLA10 via 5RLC2, the top microswitch contact SC (closed) and 5R150; the earth return is completed by the bottom microswitch contacts OC (closed) and 5RLC1.

8. 5RLA energized:—

(1) 5RLA1 and 5RLA2: Reverse the polarity of the supply to motor 3M01, thus causing the motor to reverse and, operating through the fast clutch 3CLD, raise the tuning indicator core bracket off the bottom microswitch and drive it upwards.

(2) 5RLA1: Connects the 27·5V supply (from PLE10 via 5RLC2, 5MR45 and 5R151) to 5RLB via 5MR44.

(3) 5RLA2: Provides, via 5MR43, an alternative earth return for 5RLA.

9. Bottom microswitch released:—

(1) Contacts SC closed: Provides an earth return via 5RLC1 for 5RLB.

(2) Contacts OC open: Removes the earth from the junction of 5MR43 and 5RLA, but 5RLA remains energized because of the alternative earth provided by 5RLA2.

10. 5RLB energized:—

(1) 5RLB1: The base of 5VT15 is connected via 5R143 to the collector of 5VT14.

(2) 5RLB2: The slow clutch 3CLC is connected via 5R148 and 5MR41 to the collector of 5VT15.

Tuning indicator core bracket driven upwards

11. The ganged tuning capacitors and inductors sweep all the r.f. tuning circuits except the local oscillator through the band of frequencies selected by the band switch. The local oscillator is swept through a band of frequencies 455 kc/s higher. The band is swept from the low frequency end to the high frequency end. Part of the local oscillator output is tapped off and taken to the crystal sub-unit via 3PLC24 and 5PLE1. When the local oscillator frequency reaches the correct frequency (i.e. 455 kc/s higher than the frequency selected at other tuning circuits), a signal passes through the crystal sub-unit as described in paragraphs 12 to 16.

12. Part of the local oscillator output passes through the buffer amplifier 5VT1 to 5VT2 where it is mixed with the output from the kc/s x 100 oscillator 5VT5. The resultant beat frequency difference is passed by the band-pass pair 5L1, 5TR1, (3899 kc/s to 3999 kc/s) to 5VT3. (Local oscillator frequency minus kc/s x 100 oscillator frequency equals beat frequency difference in band 3899 kc/s to 3999 kc/s.)

13. This beat frequency difference in the band 3899 kc/s to 3999 kc/s is mixed in 5VT3 with the output from the kc/s x 10 oscillator 5VT6 to produce beat frequencies. The new beat frequency difference lies in the band 1899 kc/s to 1909 kc/s and is passed by the band-pass pair 5L2, 5TR2 to 5VT4. (Beat frequency (3899 kc/s to 3999 kc/s) minus kc/s x 10 oscillator frequency equals new beat frequency difference in band 1899 kc/s to 1909 kc/s.

14. The new beat frequency difference in the band 1899 kc/s to 1909 kc/s is mixed up in 5VT4 with the output from the unit kc/s oscillator to produce a final beat frequency difference. This final beat frequency difference is passed by the tuned transformer 5TR3 (centred on 88·75 kc/s) and relay contacts 5RLF1 and 5RLG1 to either 5XL1 or 5XL2 depending on whether a whole kc/s or a half kc/s frequency is selected at the controller. The selected crystal passes a final beat frequency difference of either 89·0 kc/s (5XL1) or 88·5 kc/s (5XL2) to 5VT9. (Beat fequency (1899 kc/s to 1909 kc/s) minus unit kc/s oscillator frequency equals final beat frequency of either 88·5 kc/s or 89·0 kc/s).

15. The 88·5 kc/s or 89·0 kc/s signal applied to 5VT9 causes the trigger transistor 5VT19 to switch the monostable multivibrator (5VT13, 5VT14 and associated components) to the unstable condition. In the unstable condition 5VT14 is cut off.

16. When 5VT14 is cut off, the voltage applied to the base of 5VT15 via 5RLB1 and 5R143 is such that 5VT15 is bottomed, thus energizing 5RLD.

17. 5RLD energized:—

(1) 5RLD1: The 27·5V supply obtained via 5RLC2 is applied to the slow clutch 3CLC instead of to the fast clutch 3CLD. The same supply is also applied via 5R148, 5MR41 and 5RLB2 to the coil of 4RLD. This keeps 5RLD energized when the monostable vibrator resumes the stable condition and 5VT15 is cut off.

(2) 5RLD2: 5R146 is disconnected from 5R145 to prepare 5VT16 for the next stage of the automatic tuning sequence. The charging current of 5C94 prevents 5VT16 being cut off while 5VT13 is still conducting, and 5VT16

remains bottomed when 5VT13 once more resumes the stable cut off condition. Thus 5RLC remains energized.

Slow clutch 3CLC energized in place of the fast clutch 3CLD

18. The motor 3M01 is re-engaged with the tuning mechanism via a *reversing gear* engaged by the energized slow clutch 3CLD. The tuning inductor bracket, having overshot the correct tuning position on its upward travel, is now lowered slowly down again.

Tuning inductor core bracket driven downwards

19. When the local oscillator frequency reaches the correct frequency again a signal once more traverses the crystal sub-unit as described in para. 11 and, emerging from the selected crystal (5XL1 or 5XL2), triggers the monostable multivibrator which then assumes the unstable condition. In this condition 5VT13 is switched on and 5VT14 is cut off. Cutting off 5VT14 causes 5VT15 to bottom but this has no effect on 5RLD as 5RLD is already energized by the hold-in current supplied via 5RLC2, 5RLD1, 5R148, 5MR41 and 5RLB2. Switching on 5VT13 however cuts off 5VT16 as 5C94 is now fully charged, consequently 5RLC is de-energized.

20. 5RLC de-energized:—

(1) 5RLC2:—

(a) Disconnects the 27·5V supply from the motor 3M01 and slow clutch 3CLC and re-connects the supply to the brake 3CLB. Consequently the tuning mechanism stops.

(b) Disconnects the 27·5V supply from 5RLA (via the top microswitch and 5R150) de-energizing 5RLA.

(c) Disconnects the 27·5V supply from 5RLD (via. 5RLD1, 5R148, 5MR41, 5RLB2), de-energizing 5RLD.

(2) 5RLC1: 5R146 is disconnected from earth and re-connected via 5R144 to the 27·5V supply. Consequently:

(a) 5VT16 is held cut-off by the supply through 5R146, 5RLD2 and 5R145 from 5R144 and 5RLF in parallel, thus holding 5RLC de-energized.

(b) 5RLF is de-energized.

(c) 5RLB is de-energized (it was connected to earth via the bottom microswitch contact SC).

21. 5RLF de-energized:—Connects the crystal selected by 5RLG so as to control the fixed phase oscillator 5VT12 in the phase bridge circuit which, in conjunction with the reactance transistor 3VT7, provides automatic control of the local oscillator frequency. This automatic control is fully described in Part 4, Chap. 1.

Automatic repetition of parts of the tuning control sequence

22. If the monostable multivibrator fails to be triggered when the tuning inductor core bracket is being driven upwards on the fast clutch 3CLD (see para. 11), the core bracket will reach and operate the top microswitch. When the top microswitch is operated, contact SC opens and disconnects the supply energizing 5RLA. The de-energized relay 5RLA reverses the polarity of the supply to the motor 3M01 which consequently reverses its direction of rotation and drives the tuning inductor core bracket down again. The conditions described in sub. para. 5 (2) are now restored and the automatic tuning control sequence is repeated from there.

23. If the monstable multivibrator fails to be triggered when the tuning inductor core bracket is driven downwards on the slow clutch 3CLC (see para. 18), the core bracket will reach and operate the bottom microswitch. When contact SC of the bottom microswitch is opened, the earth return for 5RLB is interrupted and 5RLB is de-energized. As a result 5RLB2 interrupts the supply that is holding in 5RLD and 5RLD is de-energized. 5RLD1 transfers the 27·5V supply formerly connected to the slow clutch 3CLC to the fast clutch 3CLD and the tuning mechanism starts to drive the core bracket up again. When the core bracket is driven off the bottom microswitch, contact SC closes and 5RLB is energized again. The conditions described in para. 11 are now restored and the automatic tuning control sequence is repeated from there.

Automatic repetition of entire tuning control sequence

24. If the power supply to the receiver is interrupted (for example when the system is switched off between flights) the entire automatic tuning control sequence is repeated after the power supply is re-connected. The current that flows into 5C93 via 5R147 and 5RLE is sufficient to energize 5RLE and restore the conditions described in para. 2.

Chapter 4

CHANGEOVER SWITCH UNIT (for use in the dual control installation)

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LIST OF ILLUSTRATIONS

Introduction

1. The changeover switch unit (5826-99-955-7008) connects the ADF receiver to either one of two controllers in a dual control installation.

Mechanical description

2. The unit contains a Ledex motor driven rotary switch, mounted on an L shaped chassis and enclosed by an easily removeable cover, held in place by two knurled-head screws. The unit is designed for vertical mounting using four fixing screws; connections being brought out to five Thorn receptacles on one side of the unit.

3. The rotary switch SA, which is driven by the N.S.F. Type 5S Ledex motor, incorporates 15 switch sections numbered from the motor end of the switch rotor shaft. At the switch section nearest the motor, the front face and the rear face of the fixed wafer are used as separate switches. At the second switch section the front and rear face are used as one switch. The subsequent 11 switch sections are used as separate switches employing the front face only of each fixed wafer. The remaining two sections of the switch are not used in this application.

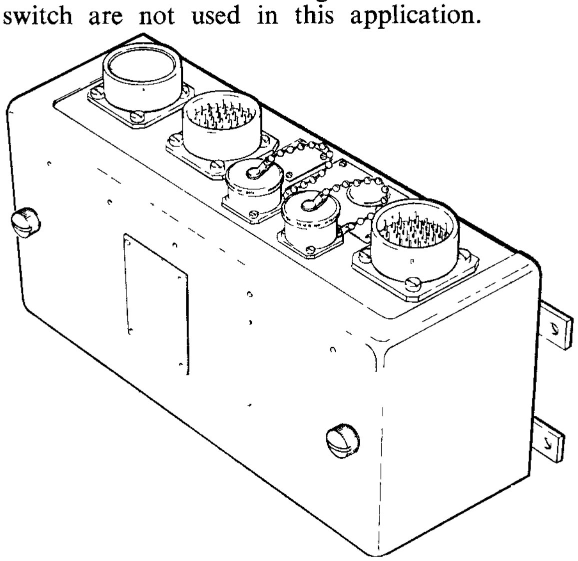

Fig. 1. Changeover switch unit 5826-99-955-7008: mechanical

4. The front face of the first section is the cam-operated commutating switch, connected in the Ledex motor circuit, which breaks the motor circuit at the end of each rotary stroke. The rear face of the first section is the switch control section and has four equally spaced blades, each blade equal in length to two operating positions. The switch shaft thus makes one complete revolution for every eight operating pulses applied and switch positions 3, 6, 9 and 12 are skipped. This circuit arrangement allows the two electrical states of the changeover switch unit to be repeated four times for each complete revolution with a subsequent saving in mechanical movement of the rotor shaft at each changeover.

5. Switch section 2 and the front face of switch sections 3 to 13 are used to connect the various supply and control lines between the receiver and whichever controller is selected.

Circuit description

6. With SA in the position shown in Fig. 2, controller No. 2 (PLB) is connected to the receiver. The 27·5V d.c. supply at SKA/V is connected, via the Ledex motor and the cam-operated switch to the control switch (which is open) and the motor is de-energized.

7. When the changeover switch at No. 1 controller is pressed, the motor circuit is completed to earth in the controller, the motor is energized and the switch shaft rotates until the control switch rotor breaks the circuit to earth. Either one or two rotary strokes are required per selection; the number of strokes being determined by the position of the SA control switch. The receiver control lines, and the panel lamps supply, are now transferred to No. 1 controller.

8. The cam-operated switch breaks the motor circuit at the completion of each rotary stroke and allows the motor armature to return to a starting position against the ratchet mechanism. MR1 and C1 provide a discharge path for the current induced by the collapsing motor field.

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Changeover switch unit 5826-99-955-7008 : circuit

Fig.2