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Colin Hinson
In the village of Blunham, Bedfordshire.

AIR PUBLICATION

101B-1902-1C

(Formerly A.P.4505B, Vol.1, Book 3)

VULCAN B Mk.2 AIRCRAFT

AIRCRAFT SERVICING MANUAL

INSTRUMENT, WIRELESS AND RADAR INSTALLATIONS

BY COMMAND OF THE DEFENCE COUNCIL

L. T. Dunnett

Ministry of Defence

FOR USE IN THE ROYAL AIR FORCE

(Prepared by the Ministry of Aviation)

Issued with A.L.33, Dec.66

NOTE TO READERS

The subject matter of this publication may be affected by Defence Council Instructions, or by Servicing Schedules (Vol.4), or General Orders and Modification Leaflets in this A.P., in the associated publications listed below, or even in some others. If possible, Amendment Lists are issued to correct this publication accordingly, but it is not always practicable to do so. When an Instruction, Servicing Schedule or Leaflet contradicts any portion of this publication, the Instruction, Servicing Schedule or Leaflet is to be taken as the overriding authority.

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Each leaf, except the original issue of preliminaries, bears the date of issue and the number of the Amendment List with which it was issued. New or amended technical matter will be indicated by triangles positioned in the text thus:-◀---▶ to show the extent of amended text, and thus:- ▶◀ to show where text has been deleted. When a Section or Chapter is issued in a completely revised form, the triangles will not appear.

If more than one copy of this publication is held, each set of covers should be given an identifying number and be kept together.

The reference number of this publication was altered from A.P. 4505B to A.P.101B-1902 in November 1966. No general revision of page captions has been undertaken, but the code number appears in place of the earlier A.P. reference on new or amended leaves issued subsequent to that date.

LIST OF ASSOCIATED PUBLICATIONS

	A.P.
Aircraft pressurising and air conditioning equipment	4340
Aircraft pressure fuelling equipment	4511
Aircraft refuelling in flight	4611
Aircraft undercarriage equipment	1803E
Aircraft undercarriage equipment Dowty Rotol	1805V
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Hydraulic equipment	1803
Instrument manual	1275
Missile storage, preparation, transportation, loading and off loading	2852B
Olympus Mk.20101, Mk.20201 and Mk.20301 engine change units	4712A, B & C
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Powered flying control units and equipment	4603
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Access panels and drain holes	7086Q
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Jet efflux - danger areas	7086X
Miscellaneous lubrication	7086B
Pneumatic systems	7086P

◀ LAYOUT OF A.P. 101B-1902 ▶

VULCAN B. MK.2 AIRCRAFT

◀ Code No.	Title	Previous designation
101B-1902-1	Aircraft servicing manual	A.P.4505B, Vol.1
Issued in three books as follows:-		
101B-1902-1A	*Sect.1 to 5*	*A.P.4505B, Vol.1, Book 1*
101B-1902-1B	*Sect.6*	*A.P.4505B, Vol.1, Book 2*
101B-1902-1C	*Sect.7 to 9*	*A.P.4505B, Vol.1, Book 3*
101B-1902-2	General orders	A.P.4505B, Vol.2
101B-1902-3A	Illustrated parts catalogue	A.P.4505B, Vol.3, Part 1
101B-1902-3B	Appendix 'A'	A.P.4505B, Vol.3, Part 2
101B-1902-3C	Scales of unit equipment	A.P.4505B, Vol.3, Part 3
101B-1902-3D	Scales of servicing spares	A.P.4505B, Vol.3, Part 4
101B-1902-4	Planned servicing schedule	A.P.4505B, Vol.4
101B-1902-5	Not applicable	A.P.4505B, Vol.5
101B-1900-6A	Aircraft repair manual	A.P.4505, Vol.6
101B-1902-7	Modifications list	A.P.4505, M.L.
101B-1902-12	Ground handling notes	A.P.4505B-G.H.N.
101B-1902-15	Pilot's notes	A.P.4505B-P.N.
101B-1902-16	Operating data manual	A.P.4505B-O.D.

NOTE...

Until notice of the changeover is promulgated in D.C.I's the required A.P. should be requisitioned under the old A.P. number. ▶

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Section 3 - Airframe ... ...) **PUBLISHED SEPARATELY** - refer to A.P.101B-1902-1A
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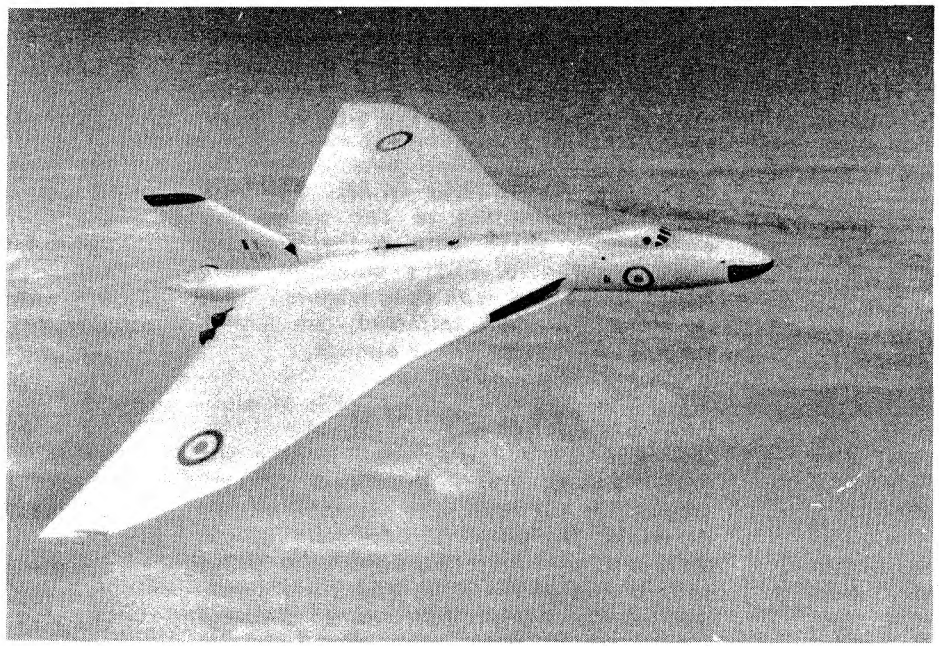
" 7 - A.R.I. 5959 - T.F.R. installation
◀ " 8 - A.R.I. 5952 - Tail warning installation Mk.2 ▶

INTRODUCTION



1. The VULCAN B Mk.2 is an all metal medium bomber with a tailless delta wing configuration, and is powered by four turbo-jet engines. It has long range, a very fast cruising speed and a high operational ceiling, and can carry a heavy and extensively variable bomb load. Provision is made for flight refuelling, as a receiver aircraft. A comprehensive radar and radio installation and other electronic aids are provided for navigating and bombing. No defensive armament is fitted.

2. The FUSELAGE is a light-alloy stressed skin structure, and is manufactured in four separate sections, which are:-

(1) Nose fairing, which houses the radar scanner. The upper half is of orthodox metal construction, and the lower half is made of sandwich material which is transparent to radar signals.

(2) Front section - comprises the crew's pressure cabin, of circular cross section with a canopy over the cockpit and an air bomber's blister and crew's entrance door in the under surface. The structure of this section is stressed to a working pressure differential of 9 p.s.i.

(3) Centre section - is integral with the main plane, the width encompassing the four engines and the bomb bay, and the length extending from the rear cabin bulkhead to a point aft of the rear spar. Two strong ribs form the side walls of the bomb bay, separating it from the inboard engine bays; these ribs extend forward of the front spar to enclose a box structure housing two large fuel tanks. Between this structure and the pressure cabin is the nosewheel bay, which houses pressurisation control gear, radio and radar equipment and two additional fuel tanks. The bomb bay is a single large compartment occupying the full length of the fuselage between front and rear spar.

(4) Rear section - a light former-stringer-skin structure forming a fairing for the jet pipe tunnels. Attached to this structure are the jet pipe end caps and the tail warning radar scanner cone.

3. SEATS for five crew members are all located in the pressurised cabin in the forward end of the fuselage. The two pilots sit side by side in ejector seats on a raised platform at the forward end of the cabin, and the remaining three crew members sit side by side in

bucket-type seats facing aft, at a single table extending the full width of the cabin. A prone bombing station is provided in a blister below the cabin.

4. The ENTRANCE DOOR, situated in the lower part of the fuselage below the crew's compartment, opens outwards, entry being made by a folding ladder secured to the inside of the door. A further ladder is provided in the cabin for access to the pilots' position. Manually and pneumatically-operated mechanisms are fitted, the latter being utilised to open the door in flight against the airstream, thus forming a windbreak for emergency exit.

5. The TWO-SPAR MAIN PLANE consists of a centre section integral with the fuselage, and port and starboard outer wings. The complete main plane, which has sufficient depth in the vicinity of the root break joints to accommodate the engines and the alighting gear, tapers in plan and elevation to the wing tips. The skin covering is of aluminium alloy stiffened by Z-section and T-section stringers. Ten compartments are provided, five in each outer wing, to accommodate bag-type flexible fuel tanks.

6. The CONTROL SURFACES consist of four elevons on each outer wing, and a rudder. The outboard elevons are mass balanced by means of mass balances carried on outrigger arms situated near each hinge, and the inboard elevons and rudder embody Westland-Irving type forward sealed balances. Each elevon is operated independently by its own electro-hydraulic power unit, two further units being provided for the rudder. Electrically-operated, rotating-slat-type air brakes are mounted in the main plane above and below the engine air intakes.

7. The PILOTS' FLYING CONTROLS consist of single-grip control handles and conventional rudder pedals provided at each pilot's position. Push-pull control tubes are used throughout from the cockpit controls to the power units actuating the control surfaces. Further controls for pilot use are housed on three consoles in the cockpit. Artificial feel is provided to give a variation of stick force with control movement from the trimmed position.

8. The ALIGHTING GEAR, which is retractable, consists of two main-wheel units, each fitted with a four-wheeled, eight-tyred bogie, and a steerable nose-wheel unit fitted with twin wheels. All three units, when retracted, lie within the normal contours of the aircraft.

9. The HYDRAULIC SYSTEM is electrically controlled and operates the alighting gear, bomb doors, wheel brakes and nose-wheel steering. A reserve pressure supply for the brakes is retained by two accumulators charged from the main hydraulic system. An electro-hydraulic power pack is available for the emergency operation of the bomb doors and to recharge the brake system when the hydraulic pumps are not operating. When certain special stores are carried an independent electrically driven hydraulic power pack is fitted in the bomb bay.

10. A COMPRESSED AIR SYSTEM is installed to lower the alighting gear in an emergency. A further compressed air system is provided to open or close the main entrance door and also to initiate jettisoning of the canopy.

11. An AIR CONDITIONING SYSTEM is installed to maintain the air in the crew's compartment at reasonable temperatures and pressures. Air from the engine compressors is used for pressurisation and heating, the flow of air being automatically maintained by flow controllers. Air conditioning equipment in the nosewheel bay controls the temperatures of the air entering the cabin, and the pressure in the cabin is maintained by pressure controllers which regulate the amount of air allowed to pass to atmosphere through discharge valves. Provision is also made for cabin ventilation during unpressurised flight. A further air conditioning system, supplied with engine compressor air, is fitted in the bomb bay when certain special stores are carried.

12. A VENTILATED SUIT SYSTEM is provided for the five crew members, the air for which is tapped from the main cabin pressurisation system. The inlet air temperature to the individual suits may be varied by manually controlled electric heaters fitted in each supply line, and accessible to each crew member.

13. A thermal DE-ICING SYSTEM provides protection against ice accretion on wing, fin and engine air intake leading edges; hot air for the systems is bled off the engine compressors and mixed with cold air to give a controlled temperature for distribution. A further system, utilising de-icing fluid, is provided for the pilots' and air bomber's windscreens.

14. The ENGINES are housed in pairs inside the main plane centre section, between the front and rear spars. Installation of the engines is by the use of four manually-operated winches from underneath the aircraft, which enables the upper surface of the wing to be maintained as a smooth unbroken surface and avoids the use of large long-jib cranes and slinging gear.

15. FUEL is carried in fourteen bag-type tanks contained in magnesium-alloy compartments, four tanks in the fuselage and five in each outer wing. Each tank is equipped with contents gauge transmitters, electrically-operated fuel pumps, a maximum fuel level cut-off switch and refuelling valves. In addition, No.1 and No.7 tanks each have a transfer pump which can be used to balance the fuel load should the aircraft become nose or tail heavy. The tanks are arranged in groups

so that each engine is normally fed by a particular group of tanks. Cross-feed cocks are provided so that in emergency any engine may receive fuel from any tank or group of tanks. All tanks are pressurised to prevent vaporisation and consequent loss of fuel at altitude, air from the engine compressors being used for this purpose. A pressure refuelling system is provided, in which the distribution of fuel load amongst all the tanks is automatically controlled to ensure correct aircraft loading.

16. FIRE PROTECTION consists of two separate methyl-bromide installations, one for the engines and the other for the fuel tank bays. Hand-operated water-glycol extinguishers are disposed at convenient positions in the crew's compartment.

17. ADDITIONAL AIRBORNE EQUIPMENT is mounted in the rear fuselage. Temperature control of the E.C.M. cannisters is effected by water/glycol and vapour cycle heat control systems, whilst the tail warning unit, which forms the fuselage rear cone, is provided with pneumatic and cooling systems. Three doors on the underside of the rear fuselage give access to this equipment. Counterpoise plates of honeycomb construction are mounted below the starboard centre engine rib, between the jet pipe curvatures.

18. Electrical power is supplied by four 40 kVA, 200-volt, 3-phase, 400 c/s. a.c. engine-driven alternators, arranged to supply independent load or in parallel via a synchronising ring main system. Reserve power is supplied from the auxiliary airborne power plant or the ram air turbine at 200-volt, 3-phase, 400 c/s, a.c. Power at 115-volt, 3-phase, 400 c/s, a.c. is provided, through various transformers, from the 200-volt system, and from the same source by means of two frequency changers, a supply at 115-volt, single phase, 1600 c/s, a.c. is also available. D.C. power is provided at 28 volts through two 7.5 kVA transformer rectifier units, and a single 24-volt battery provides sufficient power for crash and emergency services. Two ground supply plugs, one for 200 volts a.c. and one for 28 volts d.c. are provided on the port side of the rear fuselage. In addition a 28-volt d.c. ground servicing plug for the refuelling circuits, is provided on the starboard outer side of the nose wheel bay. In the unlikely event of failure of all four alternators, sufficient power to maintain control would be available from the auxiliary power units.

19. LIGHTING in the cabin consists of ultra-violet, red and anti-dazzle for the pilots, while for the crew four red fluorescent tubular elements are provided and an angle-poise lamp at each crew position. Lighting to assist servicing personnel is provided in the nose-wheel and main-wheel bays, in the bomb compartment, in the compartment aft of the bomb bay and in the compartment below the fin post.

20. EMERGENCY EQUIPMENT includes ejection seats for the first and second pilots, a signal pistol, first-aid outfits, fire axes, asbestos gloves and hand-operated fire extinguishers. For use after ditching, each member of the crew has a seat dinghy and there is also a type H dinghy stowed in the fuselage underneath the canopy.

21. WIRELESS equipment consists of a general purpose H.F. transmitter-receiver, a combined V.H.F./U.H.F. transmitter-receiver, V.H.F. transmitter-receiver and I.L.S. installation. A high/low F.M. radio altimeter provides indication for, and is controlled by, the first pilot and is an integral part of the automatic landing system. A high range radar altimeter provides indication for, and is controlled by, the navigator/air bomber. A.D.F. equipment is fitted and operated by the navigator/plotter. Intercommunication between crew members is provided by a separate system, with switching facilities for introducing radio signals and conference intercom.

22. RADAR installations consisting of Green Satin, Tail Warning, I.F.F., Tacan, N.B.S. (comprising H.2.S and N.B.C.), E.C.M. and T.F.R. are fitted.

23. Special instrument systems, namely M.F.S. and H.R.S. are installed and may be integrated with each other and other systems in the aircraft to provide automatic flight, automatic landing, bombing manoeuvres and accurate navigational information.

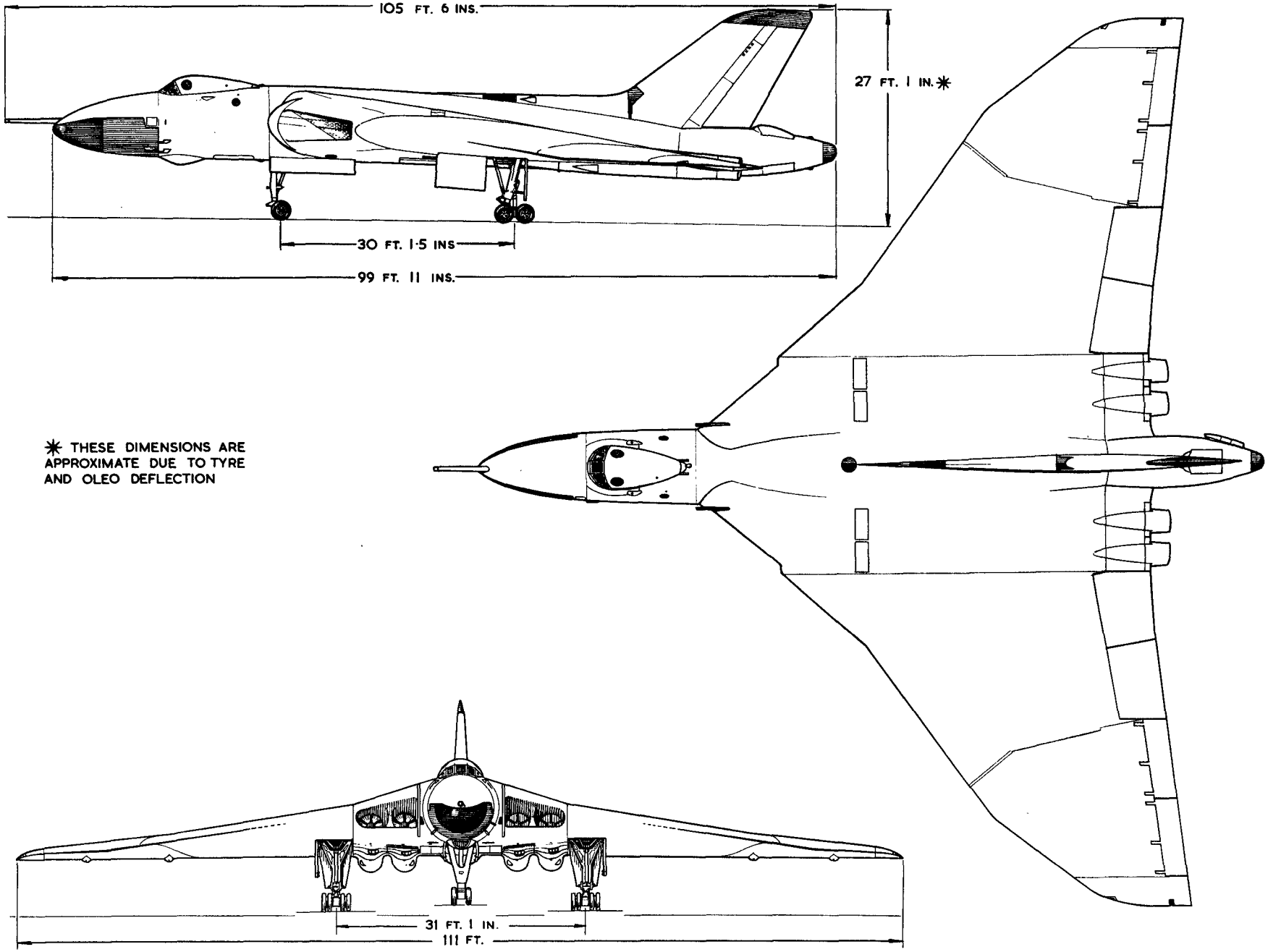


Fig. 1 General arrangement

LEADING PARTICULARS

NAME	VULCAN B, MK.2
TYPE	DELTA WING MONOPLANE
DUTY	HIGH ALTITUDE, MEDIUM BOMBER
CREW	FIVE, INCLUDING TWO PILOTS

GENERAL DATA AND CONTROL SURFACE AREAS

For main aircraft dimensions refer to Fig.1 - General Arrangement. For settings and range of movement of control surfaces refer to Sect.3, Chap.4.

MAIN PLANE DATA

Aerofoil section at root	N.A.C.A.0010
Aerofoil section	Modified R.A.E.104, 5%
Chord (mean) standard	35·712 ft.
Chord at wing tip	10 ft.
Chord (root)	63·4 ft.
Incidence	5 deg.
Dihedral	0 deg.
Sweepback (leading edge at wing joint)	49 deg. 54 min.
Elevons, mean chord (aft of hinge line)	
Inboard inner	6·562 ft.
Inboard outer	6·571 ft.
Outboard inner	2·776 ft.
Outboard outer	2·776 ft.
Main plane areas (in sq. ft.)	
Gross, including elevons (from aircraft centre line)	3,964
Nett, excluding fuselage	3,384
Elevons (aft of hinge line)	
Inboard inner (each)	63·726
Inboard outer (each)	57·164
Outboard inner (each)	28·079
Outboard outer (each)	26·788
Gross, port and starboard	351·514

FIN AND RUDDER DATA

Fin sweepback, leading edge	49 deg. 30 min.
Fin sweepback, trailing edge	25 deg. 30 min.
Areas (in sq.ft.)	
Fin and rudder	224
Fin (nett)	160·065
Rudder (aft of hinge line)	63·395

ALIGHTING GEAR

MAIN-WHEEL UNITS

Type	Dowty - Two rearward retracting units with four-wheeled, eight-tyred bogies Dowty Part No. 2.00031.029 (port) and 2.0003/.030 starboard
Shock-absorber strut	Dowty Part No.2.000211.005
Type	Liquid spring
Oil	OX-16 Ref.No.34B/9423149
Retracting strut unit	Dowty Part No.2.000176.001 (port) and 2.000176.002 (starboard)
Jack assembly	Dowty Part No.1.001296.003 (port) and 1.001296.004 (starboard)
Wheels	Dunlop Part No.A.H.50722
Tyres (tubeless)	Dunlop D.R./0099T (Ref.No.NIV) or Goodyear 6A/2240 (Ref.No.27A/4111) or Firestone ZA/201 (Ref.No.27A/4652)
Brakes	Front port inner and front starboard outer A.H.50723 Front port outer and front starboard inner A.H.50724 Rear port inner and rear starboard outer A.H.51711 Rear port outer and rear starboard inner A.H.51712
Brakes working pressure	2,500 p.s.i.
Maxaret units	Front port inner and front starboard outer A.C.61682 Front port outer and front starboard inner A.C.61676 Rear port inner and rear starboard outer A.C.61680 Rear port outer and rear starboard inner A.C.61678

NOSE-WHEEL UNIT

Type	Dowty - Rearward retracting steerable Part No.2.00065.007

Shock-absorber strut	*Part No.2.00066.004*
Type	*Liquid spring*
Fluid	*OX-16 Ref.No.34B/9423149*
Retracting jack	*Dowty Part No.1.01299.013*
Retracting struts	*Dowty Part No.2.00051.003*
Wheels	*Dunlop Part No.AH.50734*
Tyres (tubeless)	*Dunlop Part No.DC.9484*

POWER UNITS

ENGINE	
Name	*Olumpus 201, 202 or 301*
Type	*Turbo-jet*
Number	*Four*
OIL SYSTEM	
Type	*Integral with engine*
Oil OX-38 (Ref.No.34A/9100591) N.A.T.O. Code No.O-149	
Tank capacity (201 & 202 engines)	*4·5 gall. oil, 1·5 gall. air space*
Engine capacity	*2·25 gall.*
Total oil capacity	*6·75 gall.*
Tank capacity (301)	*3·875 gall. oil, 1·125 gall. air space*
Engine capacity	*2·25 gall.*
Total oil capacity	*6·125 gall.*
STARTING SYSTEM	
Olympus 201 & 202	*Rotax (low pressure air) Type CT.0806 (one per engine)*
Olumpus 301	*Rotax (combuster) Type CT.1303 (one per engine)*
ENGINE-DRIVEN AUXILIARIES	
Hydraulic pumps (1, 2 & 3 engines)	*Dowty - Part No.1.00500.010 or 1.00500.011*
Alternators	
Type (201 & 202 engines	*AE.2039*
Type (301 engine	*AE.2039 Mk.2*
Constant speed drive unit	*AE.8004*
C.S.D. lubrication system	*Oil - OX-38*
Tank capacity	*11 Pints oil - 3·5 pints air space*
Total capacity of system	*12·75 pints*
AIRBORNE AUXILIARY POWER PLANT	
Type	*ROVER 15/60 Gas turbine*
Number	*One*
Lubrication system	*Oil (sump type) integral with engine*
Oil	*OX-38*
Sump capacity	*5·5 pints*
Starting system (A.A.P.P.)	
Normal	*Electric - Rotax C1050 (28V)*
Emergency	*Cartridge, electric (Ref.No.12K/1288)*

FUEL SYSTEM

FUEL	*AVTAG (Ref.No.34A/9100448) N.A.T.O. Code No. F-40 or AVTUR/40 (Ref.No.34A/9100449) N.A.T.O. Code No.F-30 or AVTUR/50 (Ref.No.34A/9431771) N.A.T.O. Code No. F-34*
Fuel pumps, main	*P.A.C. 1200 Mk.3*
Fuel pumps, auxiliary	*P.A.C. 100 Mk.3*
Fuel transfer pumps	*P.A.C. 500 Mk.3*
Fuel pumps - A.A.P.P.	*P.A.C. 20 Mk.2*
Fuel L.P. warning switch setting	*5 p.s.i.*
Refuelling valves	*F.R. Mk.40*
Rate of flow (each)	*75 gall. per min.*
Tanks - Wing	*14*
Bomb bay	*2*
A.A.P.P.	*1*

HYDRAULIC SYSTEM

PUMPS	
Type	*Dowty 1.00500.011 Ref.No.37V/8002 or Type 1.00500.010*
Number	*Three*
Working pressure	*3,600 p.s.i.*
Off-load pressure	*4,000 p.s.i.*
Peak pressure	*4,400 p.s.i.*
Reservoir	*Dowty - A.67857 (Ref.No.27Q/1401*
Capacity (to filling level)	*2¼ gall. approx.*
Fluid	*Oil OM-15 (Ref.No.34B/9100572) N.A.T.O. Code No.H-515*
System capacity	*12 gall. approx.*

EMERGENCY AIR SYSTEM

CYLINDERS	*Mk.5F (Ref.No.6D/9429887*
Number	*Two*
Charging pressure	*2,000 p.s.i.*
Capacity (each)	*1,250 litres*

PNEUMATIC SYSTEMS

ENTRANCE DOOR	
Cylinders	*Mk.5F (Ref.No.6D/9429887)*
Number	*Two*

Charging pressure	2,000 p.s.i.
Capacity (each)	1,250 litres
T4 BOMBSIGHT	
Cylinder	Mk.5F (Ref.No.6D/9429887)
Number	One
Charging pressure	2,000 p.s.i.
Capacity	1,250 litres
N.B.C. Mk.1A & H.2.S.	
Cylinders	Mk.5D (Ref.No.6D/9429885)
Number	Two
Charging capacity	1,800 p.s.i.
Capacity (each)	750 litres

NITROGEN PURGE-FLIGHT REFUELLING

CYLINDER	Mk.5D (Ref.No.6D/9429890)
Number	One
Charging pressure	1,800 p.s.i.
Capacity	750 litres

AIR CONDITIONING SYSTEM

TURBINE UNIT	
Type	B.T.15 Mk.2A (Ref.No.27UA/493)
Lubrication	Oil OX-38 (Ref.No.34B/9100951) N.A.T.O. Code No.0-149
Capacity	210 c.c.

FLYING CONTROL SYSTEM

POWER UNITS	
Type	Hydraulic
Outer elevons (four)	P.135
Inner elevons (four)	P.132
Rudder (two)	P.138
Fluid	Oil OM-15 (Ref.No.34B/9100572)
Capacity (each)	4 pints
Outer elevons	4 pints
Inner elevons	8 pints
AIR BRAKES	
Gearbox lubrication	Oil OX-14 (Ref.No.34B/9100589) N.A.T.O. Code No.0-147

DE-ICING SYSTEMS

AIR BOMBER'S WINDOW	
Tank capacity	12 gall. fluid, 0·5 gall. airspace
Fluid	Alcohol AL-8 (Ref.No.34B/9100475) N.A.T.O. Code No.S-738

FIRE PROTECTION SYSTEMS

EXTINGUISHERS	
Engine bay	System operated
Type	Mk.13A methyl bromide (Ref.No.27N/99)
Number	Four
Wing tanks	System operated
Type	Mk.14A methyl bromide (Ref.No.27N/102)
Number	Twelve
Fuselage tanks	System operated
Type	Mk.13A, Methyl bromide (Ref.No.27N/99)
Number	Four
Leading edge	System operated
Type	Mk.13A, Methyl bromide (Ref.No.27N/99)
Number	Six
A.A.P.P. Installation	System operated
Type	Mk.4AX, Methyl bromide (Ref.No.27N/152) (or 27N/100)
Number	One
Bomb bay	System operated
Type	Mk.13A, Methyl bromide (Ref.No.27N/99)
Number	Eight
Crew's cabin	Hand operated
Type	Mk.34H, Bromochlorodifluoromethane (B.C.F.) (Ref.No.27N/299)
Number	Five
External compartment	Hand operated
Type	Mk.34H, Bromochlorodifluoromethane (B.C.F.) (Ref.No.27N/299)
Number	One

AIR SPEED INDICATING SYSTEM

PRESSURE HEADS	Mk.8W, (Ref.No.6A/3820)
Number	Two
Position	Underside of fuselage at forward end of cabin, port and starboard

OXYGEN SYSTEM

Type	Mk.21B, demand system
Cylinders	Mk.10A, (Ref.No.6D/9429900)
Number	Twelve
Charge pressure	1,800 p.s.i.
Capacity (each cylinder)	2,250 litres

SAFETY EQUIPMENT

EJECTION SEATS
- *First pilot ... ... Type 3KS1 Mk.2 (Ref.No.27L/50147)*
- *Second pilot ... ... Type 3KS2 Mk.2 (Ref.No.27L/50148)*

CREW SEATS
- *Outboard seats ... ... Swivel and sliding (pneumatically assisted) (Ref.No.27H5/3730) with (Part No.S1.003.1 and S1.003.2)*
- *Centre seat ... ... Sliding (pneumatically assisted) (Part No.1/N3288)*

DINGHY M.S.5., Mk.1 (Ref.No.27C/2324)

ADDITIONAL AIRBORNE EQUIPMENT

PNEUMATIC SYSTEM
- *Cylinders ... ... Mk.5F (Ref.No.6D/9429887)*
- *Number ... ... Two*
- *Charging pressure ... ... 3,000 p.s.i.*
- *Capacity ... ... 1,250 litres*

WATER/GLYCOL SYSTEM
- *Reservoir ... ... Dowty (Part No.1.00467.101)*
  - *Capacity (filling level) ... ... 7·5 pints*
  - *Air space ... ... 110 cu.in.*
  - *System capacity ... ... 7·5 gall. approx.*
- *Fluid ... ... AL-26 (Ref.No.34B/1407)*
- *Pumps (with U.P.V.) S.P.E.16291*
- *Number ... ... Two*
- *Capacity (each) ... ... 300 g.p.h. at 10 p.s.i.*

REFRIGERATION SYSTEM
- *Cooling pack ... ... Godfrey Type V.C.P.1 Mk.1 (Part No.159102)*
- *Refrigerant ... ... Arcton 11 or Freon 11*
- *Weight of refrigerant ... ... 11 lb.*
- *Oil ... ... OM-11 (Ref.No.34A/9105055) N.A.T.O. Code No.0-135*
- *Oil capacity ... ... 300 c.c.*
- *Condenser D1177/2A*

ELECTRICAL SYSTEM

- *Wiring system ... ... Insulated and earth return*
- *Type ... ... Avro*
- *A.C. generators (four) ... 200-volt, 3 phase, 400 c/s, 40kVA, Type 158B (Ref.No.5UA/6491)*
- *Transformer-rectifier units, 7.5 kW (Two).. (Ref.No.5UB/6428)*
- *Main transformers 3kVA (two) ... ... (Ref.No.5UB/6429)*
- *Battery (one) ... ... Type K, 24-volt, 40 c.h.*
- *Frequency changers (two) B.T.H. Type 270 (Ref.No.5UB/6430)*

BOMBING GEAR

A.V.179 Septuple carrier ... ... (3 off)
or
A.V.176 Special carrier plus A.V.258 fittings ... ... (1 off)
No.1, Mk.2 Special carrier (Ref.No.11A/4759) ... ... (15/P)
or
No.2, Mk.1 Carrier (Ref.No.11A/4759) ... ... (1 off)
with
Adapter assembly No.1, Mk.1 (Ref.No.11A/4763)
Blue Steel carrier beam and associated (Mod.200) fittings (Part No.1/Z10005) for aircraft with Mod. Nos. 108, 199, 525 and 748 embodied.

SECTION 7

INSTRUMENT INSTALLATION

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2. Flying instruments
3. Engine instruments
4. Miscellaneous instruments
5. Armament instruments
6. Auto controls
7. Military flight system
8. Test equipment
9. Automatic landing system
10. Heading reference system Mk.2
◀ 11. F95 camera ▶

Chapter 1

GENERAL INFORMATION AND PITOT-STATIC SYSTEM

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Introduction

1. This section contains descriptive and servicing information for the complete aircraft instrument installation. Seven chapters are contained within the section and are arranged according to the services of the installation. Each chapter describes a particular instrument system and provides information on the servicing and removal of the components. Illustrations showing the location and layout of the various instrument services are included, together with routing charts for the circuits of electrically operated instruments. The routing charts will be found at the end of each chapter.

2. Electrically operated instruments bearing the same circuit code letter will generally be found under the same chapter heading. The 1275 series of Air Publications contains detailed information on the various types of instruments described in this section and reference is made to these publications where it is considered necessary.

3. Only a brief outline of the power supplies for electrically driven instruments is provided in this section. For more detailed information reference should be made to Section 6. Instruments forming part of the radio installation are dealt with in Section 8 of this publication.

4. This chapter (Chapter 1) provides information of a general nature, and in addition gives information on the pitot-static system and the removal of instrument panels. The location of all instrument panels and main services is shown in fig.1, while fig.2, gives a layout of the pitot-static system. All the instruments and equipment connected to the installation are shown in fig.3, which provides a speedy reference to associated equipment and the location of drains.

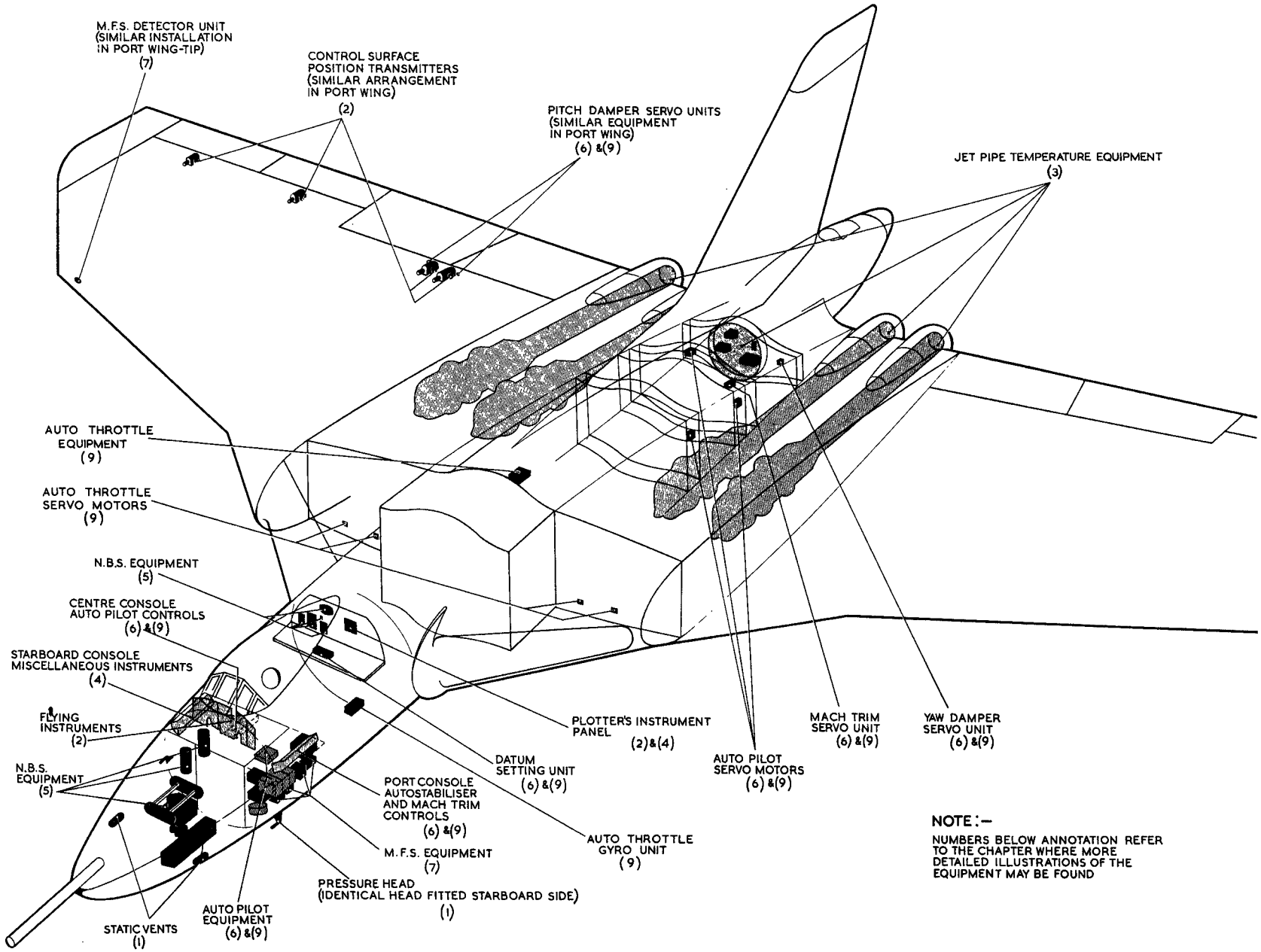

Fig. 1 Location of equipment.

DESCRIPTION AND OPERATION

PITOT-STATIC SYSTEM

5. The pitot-static installation embraces two independent systems, one port and one starboard. Light alloy tubing is used for both the pressure and static pipe lines, with unions connecting the various pipe lengths together. Where pipes branch off for connection to components, 'T' pieces and cross pieces are fitted.

6. At convenient intervals, each pipe line in both systems is identified by labels as being either pressure or static and at numerous points throughout the system, drains are fitted to trap and remove moisture from the pipelines. Connection to the various instruments is made by short lengths of Maricon tubing, Type H, secured at each end by Type AGS606E clips. A description of the flying instruments connected to the system will be found in Chapter 2 of this section; all the instrument services are dealt with in their respective chapters to which reference is made in the following paragraphs.

PIPE RUNS

7. Mounted in the upper nose structure at former 456 are two static vents, one each side of the fuselage. Two pipes running across the nose connect the the apertures of each plate and from these pipes 'T' joints are made which connect to the port and starboard static lines. From the static vents the pipes run aft until they join the pressure lines at former 358 where the pressure heads are mounted. The two systems then pass under the pilots' floor where 'T' connections are made for supplies to the pilots' panels.

8. Both systems then continue aft until they reach former 344 where the starboard system connects to the N.B.S. calculator Type 3, the auto pilot pressure unit, the M.F.S. manometric unit and the bombsight computor. The pipe runs then continue to the crews' floor where, at former 260, the starboard system supplies the monitor panel. Also under the crews' floor at former 218 the starboard system supplies the navigator's panel and the mach trim panel. Supplies are also taken at this point from the port system to the monitor and mach trim panels.

9. From the cabin both systems continue aft until they reach the air intakes. At this point the starboard system supplies the A.M.U. and both systems pass through their respective intakes to the front spar. At the front spar the starboard system connects to the bomb fuze switch and the ground test valve. Both systems then run along the bomb bay where at bomb arch 95.967 the fatigue meter airspeed switch is fed by the starboard system. Further along the bomb bay at bomb arch 123.015 the starboard system supplies the V.G. recorder. Both systems then pass to the aft end of the bomb bay where the port system crosses to the artificial feel warning switches and the starboard system feeds the three artificial feel units.

DRAIN PIPES

10. To prevent the accumulation of water in the installation drain pipes are fitted at 20 points throughout the installation, 8 in the port system and 12 in the starboard. These sealed pipes can be easily uncoupled to allow any trapped moisture to drain from the system. The location of all drain pipes in the installation is given in fig.3.

PRESSURE HEADS

11. Two electrically heated pressure heads Mk.8W are fitted, one each side of the fuselage undersurface at former 358. Each pressure head is mounted into a mast assembly which projects from the fuselage and holds the pressure head parallel with centre line of the aircraft. A short length of Maricon tubing connects each head to its respective pressure pipe-line. Each pressure head is provided with a filament heater controlled by a switch on the pilots' panel. Details of the heating circuit will be found in Book 2, Sect.6, Chap.13. A full description of the Mk.8W pressure head will be found in A.P.1275A, Vol.1, Sect.27, Chapter 8.

STATIC VENTS

12. Two static vents are fitted in the aircraft, one each side of the fuselage at former 456. Each vent plate has two apertures with pipe runs connecting the port and starboard apertures to make two balanced static supplies as shown in fig.2. The starboard system supply pipe runs from the starboard upper aperture to the port bottom aperture. The port system supply pipe runs from the starboard bottom aperture to the port upper aperture.

INSTRUMENTS

13. The instruments mounted on the first pilot's panel are supplied from the port system and are connected as follows:-

Pressure - A.S.I. and machmeter

Static - A.S.I. machmeter, altimeter and rate-of climb indicator

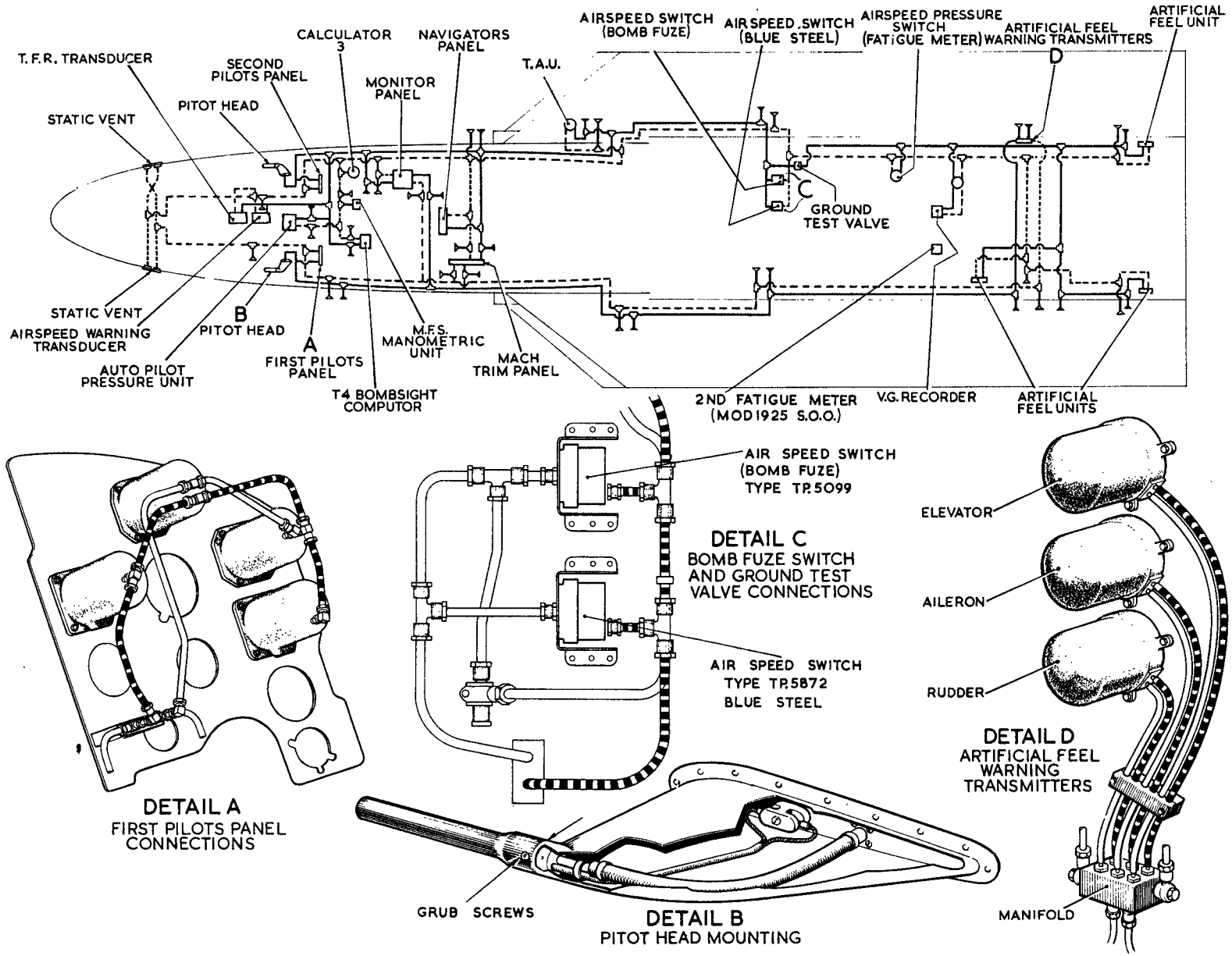

Fig. 2 Pitot-static system

A duplicate set of these instruments is installed on the second pilot's panel, which is supplied by the starboard system. Short lengths of flexible Maricon tubing connect the supply pipes to the panels which are provided with anti-vibration mountings.

NAVIGATORS' INSTRUMENTS

14. An airspeed indicator and an altimeter are mounted on the plotter's instrument panel at the navigation station. The panel is anti-vibration mounted and connected to the starboard system by Maricon tubing.

ARTIFICIAL FEEL WARNING TRANSMITTERS

15. Three of these units are mounted at former 225 on the starboard side of the bomb bay. The three units are supplied from a distribution block which is connected to the port pitot-static lines. Maricon tubing is used for connecting the units, and drain pipes are provided at the distribution block. The transmitters are used in connection with the artificial feel failure warning system further details of which will be found in Book 2, Sect.6, Chapter 10.

V.G. RECORDER

16. The V.G. recorder is fitted on the aft face of the starboard side of bomb arch 123 in the bomb bay. A pressure and static supply is fed from the starboard system and controlled by a 4-way cock mounted alongside the recorder. The recorder can be isolated from the supply by turning the cock to 'OFF'. Further information on the V.G. recorder is given in Chapter 4.

TRUE AIRSPEED UNIT

17. The True Airspeed unit (T.A.U.), Ref.No.6B/3013, is mounted below the starboard air intake. Further details may be found in Chap.5 of this section.

AIRSPEED PRESSURE SWITCHES

Bomb fuzing

18. The airspeed pressure switch, Type TP.5099, associated with the bomb fuzing is mounted at the starboard side of the bomb bay aft of the front spar. The switch is connected to the starboard pitot-static system as shown in fig.2 and forms part of the bomb fuzing and release circuit described in Vol.1, Book 2, Sect.6. Further details will also be found in Chap.5 of this section.

Fatigue meter

19. The airspeed pressure switch, Ref. No.6A/8165, associated with the fatigue meter is mounted in the bomb bay adjacent to bomb arch 95.967, and is connected to the starboard system. Further details of the fatigue meter will be found in Chapter 4 of this section.

Blue steel

20. The airspeed pressure switch, Type TP.5872, associated with the "Blue steel" installation is connected in tandem with the pressure switch mentioned in para.18 as shown in fig.2, and forms part of the refrigeration control circuit for the "Blue steel" installation. Further details will be found in Vol.1, Book 2, Sect.6, Chap.23 of this publication.

T4 BOMBSIGHT COMPUTOR

21. This computor which operates in conjunction with the T4 bombsight is connected to the starboard system and is located beneath the first pilots' floor. Further information on the T4 bombsight will be found in Chapter 5.

N.B.S. CALCULATOR TYPE 3

22. This calculator is located beneath the second pilot's floor between formers 316ins. and 330ins. and is connected to the static side of the starboard system. Further details of the calculator will be found in Chapter 5.

M.F.S. MANOMETRIC UNIT

23. The M.F.S. manometric unit is part of the Smith's Military Flight System and is located under the first pilot's floor. The unit is connected to the static side of the starboard system. Further details will be found in Chapter 7.

ARTIFICIAL FEEL UNITS

24. Three artificial feel units are situated at the aft end of the bomb bay and fed from the starboard system via flexible tubing. The units are linked to the flying control rods and their action is controlled by actuators operating in conjunction with transmitter units which are sensitive to airspeed. Further information on the artificial feel units will be found in Book 2, Section 6, Chapter 10.

AUTOPILOT

25. The Mk.10A or 10B autopilot installed under the pilot's floor between formers 358 and 372 is supplied with pressure and static from the starboard system. The Mk.10A and 10B autopilots are described in Chap.6 and Chap.9 respectively.

MONITOR PANEL

26. This panel which forms part of the auto-stabilisation system is installed under the aft end of the crews' floor on the starboard side between formers 232 ins. and 268 ins. A pressure and static supply is fed to the panel from both the port and starboard pitot-static systems. Further details of the auto-stabilisation system will be found in Chapter 6 of this section.

MACH TRIM PANEL

27. The mach trim panel is installed

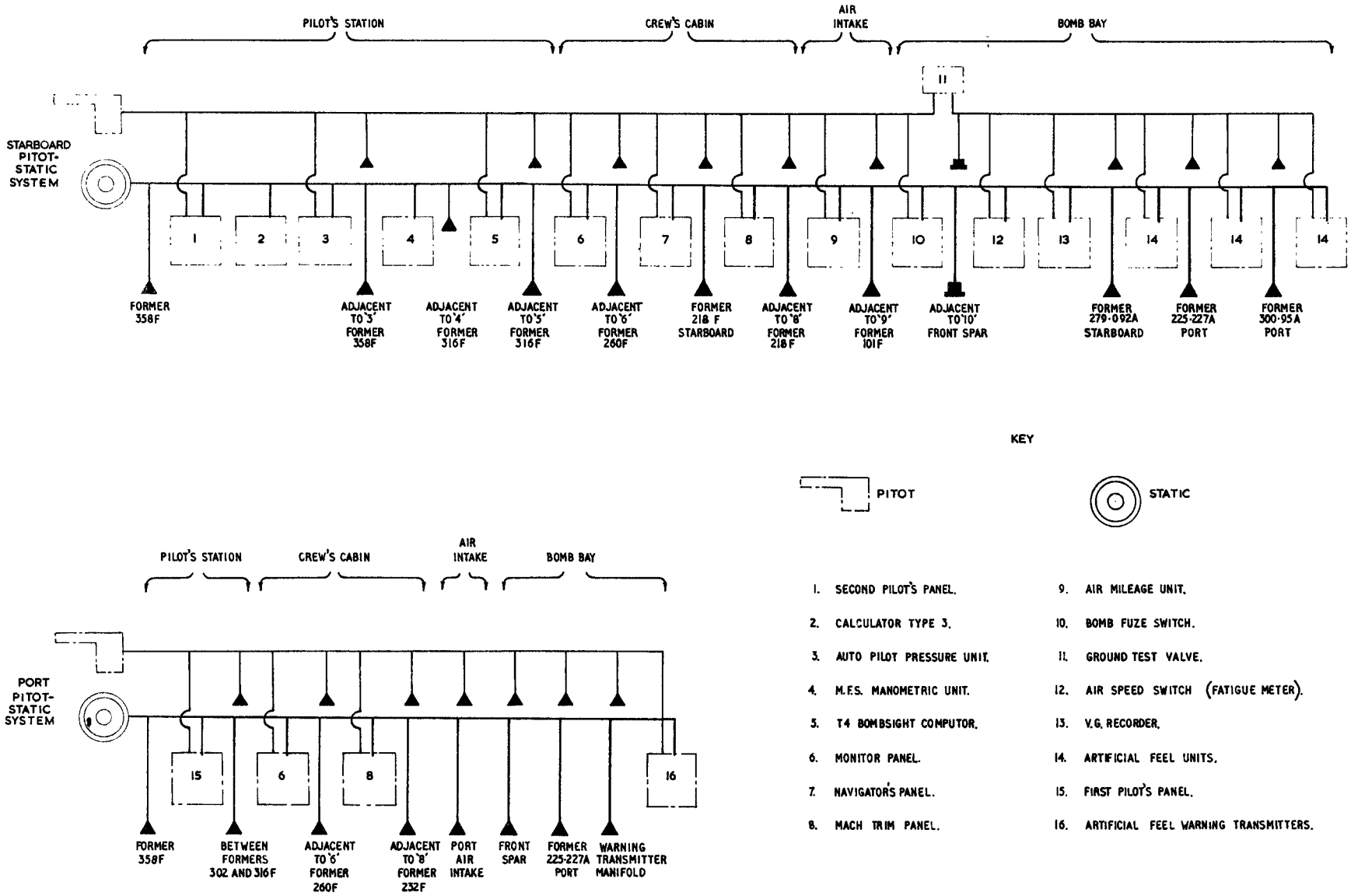

Fig.3 Diagram of drains

under the aft end of the crews' floor on the port side between formers 218 ins. and 232 ins. and forms part of the auto-stabilisation system. Pressure and static supplies from both pitot-static systems are fed to the panel. The auto-stabilisation system is described in Chapter 6 of this section.

SERVICING

28. Whenever the installation is suspect, or any part of the system has been disturbed, the leak tests laid down in A.P.1275A, Vol.2, Leaflet A9 should be carried out. During adverse weather conditions it may be necessary to dry out the system in accordance with the instructions given in A.P.1275A, Vol.2, Part 1, Leaflet A10.

DRAIN PIPES

29. At the intervals stated in the servicing schedule, or whenever it is suspected that moisture has accumulated in the system the drain pipes and plugs should be removed and the system allowed to drain. All drains throughout the system are readily accessible, many being located adjacent to the equipment supplied.

PRESSURE HEADS

30. The pressure heads should be examined to ensure that the pitot orifices are free from obstruction. It is important that no sharp metal tool be used in clearing the orifices since enlargement or burring of these will render the pressure heads unserviceable.

31 Functional testing of each pressure head should be carried out by switching on the appropriate control switch on the pilot's starboard console and checking that the pressure head begins to warm up. The head should be switched off immediately it becomes too hot to hold with the naked hand otherwise the element may be damaged through overheating in still air.

32. When the aircraft is not required for flight, protective covers should be placed over the pressure heads. Full servicing instructions for the Mk.8W pressure heads will be found in A.P.1275A, Vol.1, Sect.27, Chap.8.

STATIC VENTS

33. The apertures should be examined for freedom from obstruction and the plates checked for security of attachment. When the aircraft is grounded the vents should be blanked off by means of the rubber plugs which are part of the aircraft equipment.

34. It is essential that extreme care and attention be exercised when disconnecting the instruments or removing their associated panels. Gyroscopic instruments are particularly sensitive and easily rendered unserviceable by jarring. Removal instructions for individual instruments are given under the chapter heading wherein the instrument is described.

REMOVAL AND INSTALLATION

PILOTS' INSTRUMENT PANELS

35. The pilots' centre panel is secured at each side by two brackets from each of the flight instrument panels. The four fastening studs must first be unscrewed to release the centre panel before the other two panels can be removed.

36. The flight instrument panels can be detached from the resilient mountings by unscrewing the three fastening studs in each case. Should any difficulty be experienced in the removal of any of the instruments on the second pilots' flight instrument panel, the following procedure is recommended:-

(1) Remove the nut and bolt securing the second pilot's rudder pedal adjustment knob (the nut and bolt are located immediately behind the knob).

(2) Remove the adjustment knob from its tube.

(3) At the support brackets behind the instrument panel, disconnect the two pitot-static pipes clipped to the flexible rubber tubing. (These operations will allow the panel to be released without obstruction).

(4) Remove the two bolts securing the centre instrument panel, the panel can now be swivelled downward to its fullest extent. It is important at this stage that a suitable strain cord be employed to take the weight of the panel.

(5) Remove the three attachment bolts from the second pilot's panel and withdraw the panel to a convenient position, ensuring that no undue strain is placed on the cables and connectors. The instruments should now be accessible for disconnection and removal.

PLOTTER'S INSTRUMENT PANEL

37. The plotter's instrument panel is fixed to the plotters main panel by four brackets on resilient mountings. Access to the back of the instrument panel is gained when the main panel is unscrewed at the top and lowered. When the necessary instrument services have been disconnected the instrument panel can then be unbolted from the resilient mountings and removed.

PRESSURE HEADS

38. When it is necessary to remove a pressure head, the recommended procedure is as follows:-

(1) Remove the sixteen screws securing the pitot head mast to the fuselage.

(2) Gently lower the mast and pressure head until the pitot pipe coupling and heater cable terminal block are accessible.

(3) After disconnecting the heater cables and uncoupling the flexible tubing from the pipe coupling, it will then be possible to remove the mast and pitot head from the aircraft.

(4) To remove the pressure head from the mast two grub screws should be removed. The grub screws are located as shown in fig.2.

39. The fitting of a pressure head to the aircraft is carried out by reversing the procedure outlined in para.38. It should be noted that "Locktite" should be used to lock the grub screws when fitting the pitot pressure head to the mast assembly.

NOTE...

If the maricon tubing in the pressure head is to be replaced ensure that the replacement tubing is 9.75 in. in length to avoid the possibility of kinking when re-fitting the pressure head to the aircraft.

STATIC VENTS

40. Removal of the vent plates is straightforward and no special instructions are required.

Chapter 2

FLYING INSTRUMENTS

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Introduction

1. This chapter contains descriptive and servicing information for the aircraft flying instruments and associated controls. These instruments provide indication of the aircraft's performance and attitude in flight and are installed on the pilots' panels and the plotter's instrument panel at the navigation station. The instruments used are of the fluorescent type and include the following:-

(1) Airspeed indicators

(2) Altimeters

(3) Rate-of-climb indicators

(4) Machmeters

(5) Slip indicators

(6) Artificial horizon indicator

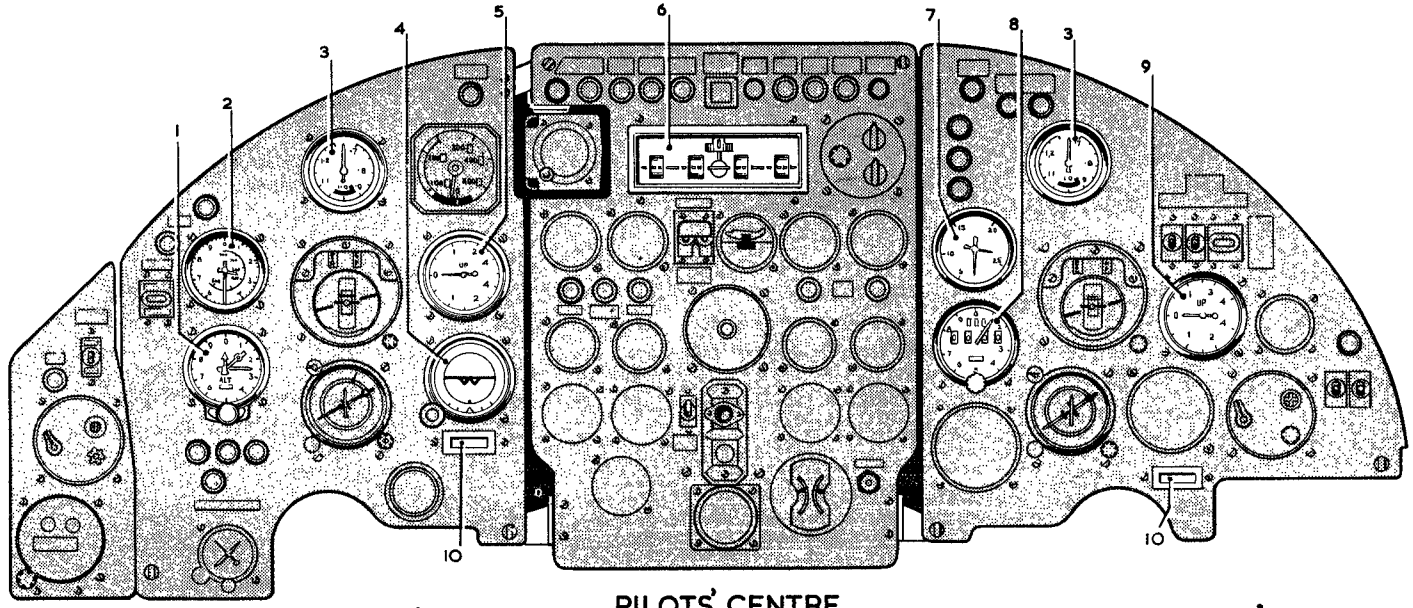
(7) Control surface indicator

The panels bearing the instruments are anti-vibration mounted and the instruments are arranged as shown in fig.1.

2. Short lengths of Maricon tubing Type H, secured at each end by Type AGS606E clips, connect the pitot-static instruments to the pitot static supply lines. The pitot-static system is described in Chapter 1.

3. A brief outline of the power supplies for the electrically operated instruments is provided in this chapter, together with the relevant routing charts, which are included at the end of the text. For more detailed information on the power supplies, reference should be made to Book 2, Sect.6.

4. Complete information on the instruments in this chapter, including operating and servicing instructions, will be found in the 1275 series of Air Publications. Table 1 gives a list of the instruments and their associated publication.

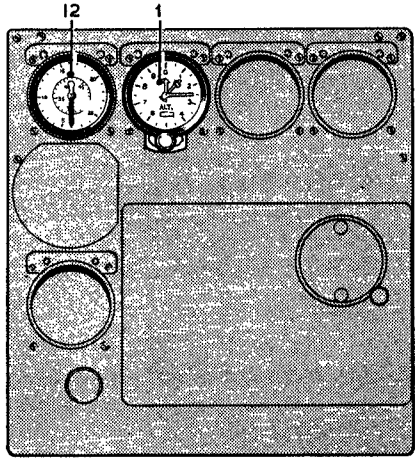


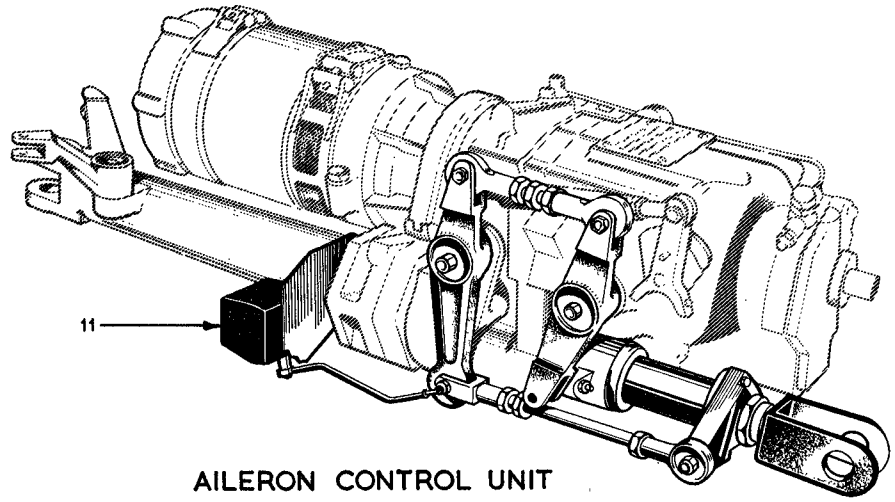
FIRST PILOT'S INSTRUMENT PANEL

PILOTS' CENTRE INSTRUMENT PANEL

SECOND PILOT'S INSTRUMENT PANEL

PLOTTERS INSTRUMENT PANEL





AILERON CONTROL UNIT

Fig.1 Arrangement of flying instruments.

◀ *Pilots panels, Mods. 1696 and 1888 added* ▶

KEY TO FIG.1

Arrangement of Flying instruments

1. *ALTIMETER MK.19F*
2. *AIRSPEED INDICATOR*
3. *MACHMETER TYPE 3A*
4. *ARTIFICIAL HORIZON MK.6B OR MK.5A*
5. *RATE OF CLIMB INDICATOR MK.3Q*
6. *CONTROL SURFACE POSITION INDICATOR, TYPE 167*
7. *AIRSPEED INDICATOR, TYPE KAB. 0506.*
8. *ALTIMETER MK.22*
9. *RATE OF CLIMB INDICATOR Mk.3Q*
10. *SIDE SLIP INDICATOR*
11. *CONTROL SURFACE POSITION TRANSMITTER, TYPE S132*
12. *AIRSPEED INDICATOR TYPE KAB. 0505K*

DESCRIPTION AND OPERATION

AIR SPEED INDICATORS

5. Three air speed indicators are fitted in the aircraft, one on each pilots' panel and one on the plotters panel at the navigation station. The first pilot's instrument is a Type AS/PC sensitive type instrument with two pointer presentation and a range of 50-600 knots.

6. The second pilot's and plotter's instruments are Type KAB.0506 and KAB.0505K respectively. These two instruments are essentially the same except that the second pilot's, Type KAB.0506, indicator is fitted with a magnetic indicator flag. The flag is used to warn the pilot to lower the alighting gear when the aircraft is approaching the normal landing speed. The range of both instruments is from 50 to 490 knots.

Second pilot's warning indicator

7. The warning indicator is controlled by an air speed switch fitted in the back of the instrument. Also at the back of the instrument is a two pin plug to which the electrical connections are made. The switch works in conjunction with the main and nose wheel DOWN switches and forms part of the alighting gear indication circuit which is described in Book 2, Sect.6, Chap.11. When the speed of the aircraft has dropped to 160 knots the contacts of the airspeed pressure switch will close. Should the main wheel units then be at any position other than locked down, the warning flag will appear in the upper part of the instrument scale.

ALTIMETERS

8. Three altimeters are fitted in the aircraft, one on each pilots' panel and one on the plotter's instrument panel as shown in fig.1. The first pilot's and the plotter's instruments are Kelvin Hughes Mk.19F sensitive altimeters with vibrator units clamped to the rear end of the case. The working range of the altimeters is rated from 0-60,000 ft. These instruments are conventional in operation and are supplied with static from the port and starboard pitot-static system respectively. A radio altimeter also fitted to the first pilot's panel is fully described in Sect.8 of this publication.

Vibrator unit

8A. A vibrator unit, Ref.No. 6A/7041 is clamped to the rear end of each altimeter Mk.19F, and is used to improve the performance of the altimeters especially at the upper altitude ranges by imparting vibration to the altimeter mechanism. The vibrator operates on a 115-volt, 400 c/s single phase supply and vibrates at a frequency of 3,200 c/s. A routing chart is contained in fig.5.

Sensitive altimeter, Mk.22

9. An electrically operated Mk.22 sensitive altimeter is fitted in the second pilot's panel. The instrument is fed with a 115-volt, single phase, 400 c/s a.c. supply from fuse 245R (24P) and with static from the starboard pitot-static system. The electrical supply is fed to the instrument via a Mk.1 amplifier which is fitted under the second pilot's floor at former 358. Power failure warning is indicated by the word OFF appearing in three windows in the upper part of the instrument face. A complete description of the altimeters will be found in A.P. 1275A, Vol.1, Sect.22. A routing chart of the Mk.22 altimeter is provided in fig.2.

MACHMETERS

10. A Mk.3A machmeter is fitted on each pilot's panel. Pressure and static supplies are fed to each instrument from their respective pitot-static systems i.e., first pilot's instrument from the port system, second pilot's instrument from the starboard system. Both meters operate to give a continuous indication of the ratio of true air speed to the speed of sound and function over a range of 0·7 to

TABLE 1

Flying instruments

Component	Mk.No.	No. off	A.P. details
Air speed indicator, Type AS/PC	-	1	1275A, Vol.1,Sect. 21
Air speed indicator, Type KAB/0506	-	1	1275A, Vol.1,Sect. 21
Air speed indicator, Type KAB/0505K	-	1	1275A, Vol.1,Sect. 21
Sensitive Altimeter	19F	2	1275A, Vol.1,Sect. 22
Sensitive Altimeter	Mk. 22	1	1275A, Vol.1,Sect. 22
Machmeter	3A	2	1275A, Vol.1,Sect. 21
Rate of climb indicators	3Q	1	1275A, Vol.1,Sect. 22
Artificial horizon	◀ 6B or 5A ▶	1	1275A, Vol.1,Sect. 13
Side slip indicators		2	1275A, Vol.1,Sect. 13
Control surface position indicator Type 167		1	1275A, Vol.1,Sect. 16

1·3 Mach. Further details will be found in A.P.1275A, Vol.1, Sect.21.

RATE OF CLIMB INDICATORS

11. Two Mk.3Q rate of climb indicators are fitted in the aircraft, one on the first pilot's panel and the other on the second pilot's panel. The indicators, Ref.No. 6A/5845, are fed with static from the main pitot-static systems and operate on the rate of change of pressure principle. Both indicators have a range of up to 4,000 ft. per minute and are fully described in A.P.1275A, Vol.1, Sect.22.

SIDE SLIP INDICATORS

12. Two side slip indicators, Type B Stores Ref.6A/6762, are fitted in the aircraft. The indicators are installed one on each pilots' panel as shown in fig.1. Further details of these indicators will be found in A.P.1275A, Vol.1, Sect.13.

ARTIFICIAL HORIZON

◀ 13. Mounted on the first pilot's panel is a Mk.6B or Mk.5A artificial horizon which is used as a standby instrument to the M.F.S. director horizon described in Chapter 7. The Mk.6B instrument is a conventional electrically driven gyroscope providing an indication of the aircraft's attitude in pitch and roll relative to the vertical axis. A routing chart is contained in fig.3. The Mk.5A instrument, introduced by Mod.2105, is similar to the Mk.6B but houses two potentiometers which in turn provides pitch and roll signals relative to the vertical axis. These signals are connected to the A.R.I. 5952 installation (Mod.2017) via a 6-pole socket. Further information may be found in Sect.9, Chap.8 of this book and the relative routing chart is contained in fig.6.

Power supplies

14. The Mk.6B or Mk.5A instrument is connected to the 115-volt, 3-phase, 400 c/s a.c. supply via fuses 328R and B, and T.B.1156D in panel 71P, the control panel, Ref.No.6A/5526, which is mounted on the first pilot's floor at former 372 and the pilot's panel plug break 233. A striped flag appears in the upper edge of the instrument face and serves as a warning of a.c. power supply failure.

Fast erection push-switch

15. The fast erection push-switch, fitted on the front flange of the instrument, should only be used when the gyro has toppled and fails to settle after being switched on. Further details of the push-switch and associated instrument may be found in A.P.1275A, Vol.1, Sect.13. ▶

CONTROL SURFACES INDICATOR

16. To provide an indication of the position of the aircraft's powered flying control surfaces, a Type 167-1 ratiometer indicator is fitted on the pilots' centre panel. Two datum lines, one vertical and one horizontal, are marked on the face of

the instrument to represent a rear view of the aircraft. The horizontal datum is marked TAKE OFF but the vertical datum is unmarked. Three Mk.4 plugs fitted to the back of the instrument provide electrical connections and are colour coded to mate with the aircraft socket connections.

17. Each control surface is represented on the face of the instrument by one of nine fluorescent arms. These arms move across the datum lines to simulate movement of their respective control surfaces, the direction of movement being governed by a control coil. The surfaces represented are the rudder, the inner and outer inboard elevons and the inner and outer outboard elevons.

Position transmitters

18. A Type S132 position transmitter is connected by a mechanical linkage to each control surface. Each transmitter takes the form of a toroidal resistance winding connected to three terminals. Within the assembly a wiper arm, which is connected to the No.3 (positive supply) terminal, is driven across one side of the winding by an operating shaft.

19. A further two adjustable arms make contact on the other side of the potentiometer and are controlled by two knurled knobs, B and C, which project from the transmitter housing. A locknut is provided to lock the arms in any selected position. The arms are electrically connected to terminals 1 and 2 which in turn are connected to the pilots' indicator.

20. The operating shaft of each transmitter is mechanically linked by an operating rod and lever to it's respective control surface. Movement of the control surface will cause a corresponding movement of operating shaft of the transmitter and thus vary the current flow through the operating coil of the indicator. This change of current flow will cause the indicating arm to take up a new position and thus indicate the new position of the control surface. The indicator arms representing the elevons will move up or down from the TAKE OFF position while the indicator arm representing the rudder will move to the left or right of the vertical datum. A routing chart of the circuit is provided in fig.4.

SERVICING

21. It is essential that complete co-operation be maintained between instrument and electrical tradesman during the servicing and circuit functioning of electrically operated instruments. Power supplies to any instrument suspected of being unserviceable must be checked prior to the removal of the instrument.

AIR SPEED INDICATORS

22. The Standard Serviceability Test for each type of airspeed indicator will be found in the appropriate appendices of A.P.1275A, Vol.1, Sect.21.

Second pilot's indicator

23. With a suitable manometer connected into the pitot-static system, the airspeed pressure switch can be tested to operate the magnetic warning flag. Opportunity should be taken to carry out these tests during retraction tests of the alighting gear by other trades. The procedure for checking the switch is as follows:-

(1) Connect a suitable manometer into the starboard pressure line.

(2) Apply pressure equivalent to an indicated airspeed of 170 knots and check that there is no movement of the flag throughout the full range of alighting gear movement.

(3) Decrease the pressure to 160 knots ± 4 knots and check that the flag operates to show U/C at all positions other than fully locked down.

(4) In the fully locked down position check that the flag has returned to its original position and is no longer in view.

(5) Remove the manometer from the pitot-static system.

ALTIMETERS

24. At suitable intervals the altimeters should be checked for accuracy. If any instrument should require adjusting by more than 50 ft. it is probable that the mechanism has been damaged in some way. In this case further checks should be made in accordance with the instructions given in the Appendix to the appropriate chapter of A.P.1275A, Vol.1, Sect.22.

RATE OF CLIMB INDICATORS

25. The indicators should be examined

for security of fitting and for signs of damage to the casings or cover glasses. Complete instructions for servicing the instruments will be found in the appropriate chapter of A.P.1275A, Vol.1, Sect.22. The Standard Serviceability Test will be found in the Appendix 1 to the same chapter.

MACHMETERS

26. Instructions for servicing the machmeter Mk.3A will be found in A.P.1275A, Vol.1, Sect.21. The Standard Serviceability Tests will be found in the Appendix 1 to the same chapter.

SIDE SLIP INDICATORS

27. Instructions for servicing the side-slip indicators will be found in A.P.1275A, Vol.1, Sect.13.

ARTIFICIAL HORIZON INDICATOR

28. The artificial horizon Mk.6B or Mk.5A has been specially designed to operate for long periods without attention. In addition to this a power failure warning flag is fitted to provide indication of a breakdown of any of the supply phases. Whenever the serviceability of the instrument is suspect it is essential that the a.c. supply to the instrument be first checked for correct voltage and frequency by means of a suitable testmeter. Details for testing the a.c. supplies for the instrument will be found in Book 2, Sect.6, Chap.4. Complete servicing instructions for the Mk.6B artificial horizon will be found in A.P.1275A, Vol.1, Sect.13.

CONTROL SURFACE INDICATOR

29. The indicator should be checked periodically for security of fixing and freedom from damage. The plug and socket connections at the back of the instrument should also be checked for tightness. No other servicing of this instrument is permitted.

30. Whenever ground tests of the powered flying controls are being carried out by the airframe and electrical tradesmen, the instrument should be checked for correct functioning. Failure of any of the nine indicating arms to respond to movement of its associated control surface may be due to an unserviceable fuse. The fuses for the transmitter are located in the 28-volt distribution panel (26P) and are numbered 469 to 477 consecutively.

31. Whenever a defective indicator is being replaced by a serviceable indicator, care should be taken to ensure that the plugs and sockets are matched in accordance with their identifying colours. If, when a new indicator is fitted, the control surface movement is not accurately shown, it will be necessary to calibrate the instrument in accordance with the instructions given in paragraphs 34 to 36.

Position transmitter

32. The position transmitter, Type S132, is designed to operate without routine servicing. Correct functioning of the transmitter will be shown during normal testing of the flying control movements. Should failure of any control surface indicating circuit occur, the fuse supplying the respective transmitter should be checked and replaced if unserviceable.

Initial setting of transmitters

33. When it is necessary to fit a new transmitter, the associated control surface should be in the TAKE OFF position (para.34-36). The operating rod and lever should then be connected to the transmitter shaft so that the pointer on the shaft is in line with the engraved markings on the transmitter body. Part of the operating rod is threaded to allow for adjustment of the lever. The calibration instructions outlined in the following paragraphs should then be carried out. It will also be necessary to follow these instructions whenever adjustment of the indicating system is required.

Calibration

34. The calibration instructions that follow should be carried out in conjunction with the airframe and electrical tradesmen. Since it will be necessary to operate the powered flying controls, power supplies of 200-volt a.c. and 28-volt d.c. should be available at the aircraft ground supply plugs as indicated in Book 2, Sect.6, Chap.6.

35. The transmitters should be set so that the position of the flying control surfaces will be indicated on the pilots' instrument as follows:-

(1) Rudder at neutral showing neutral.

(2) Elevons at take-off position showing TAKE-OFF.

36. The following instructions for calibration are applicable to all nine position transmitters.

(1) Switch on the motors for the required set of flying controls.

(2) Ensure that the control surfaces are trimmed to the TAKE-OFF position by using the elevator

trim. At the same time ensure that the aileron trim is at neutral. This will be done by the airframe tradesman as described in Book 1, Sect.3, Chap.4.

(3) Ensure that the transmitter shaft is connected as detailed in para.33.

(4) Loosen locknut A on the transmitter. Rotate knob B fully clockwise and knob C fully anti-clockwise.

(5) Operate the flying control surface to one end of its travel, checking that the associated indicating arm in the pilots' instrument moves in the desired direction.

(6) With the control surface at the end of its travel, rotate knob B or C to bring the indicating arm to the end scale position.

(7) Move the control surface to the opposite end of travel and rotate the other knob to bring the indicating arm to the opposite end scale position.

(8) Repeat operations (6) and (7) until correct readings are obtained.

(9) Lock the adjusting device by means of lock-nut A.

(10) Switch off the flying control motors.

REMOVAL AND ASSEMBLY

37. Removal of the flight instruments and the control surface indicator is straightforward and no special instructions are required. During removal it is essential that the instruments be handled with care, gyroscopic instruments in particular being extremely susceptible to damage from jarring and rough handling.

PILOTS' INSTRUMENTS

38. The pilots' instruments can all be easily disconnected and removed once the panels have been detached as detailed in Chapter 1.

NAVIGATOR'S INSTRUMENTS

39. The altimeter and airspeed indicator can be disconnected and removed when the plotter's instrument panel has been disconnected and lowered from the plotter's main panel.

POSITION TRANSMITTERS

40. The position transmitters are mounted on the powered flying control units adjacent to the motors and are readily accessible when the hinged panels covering the units are lowered.

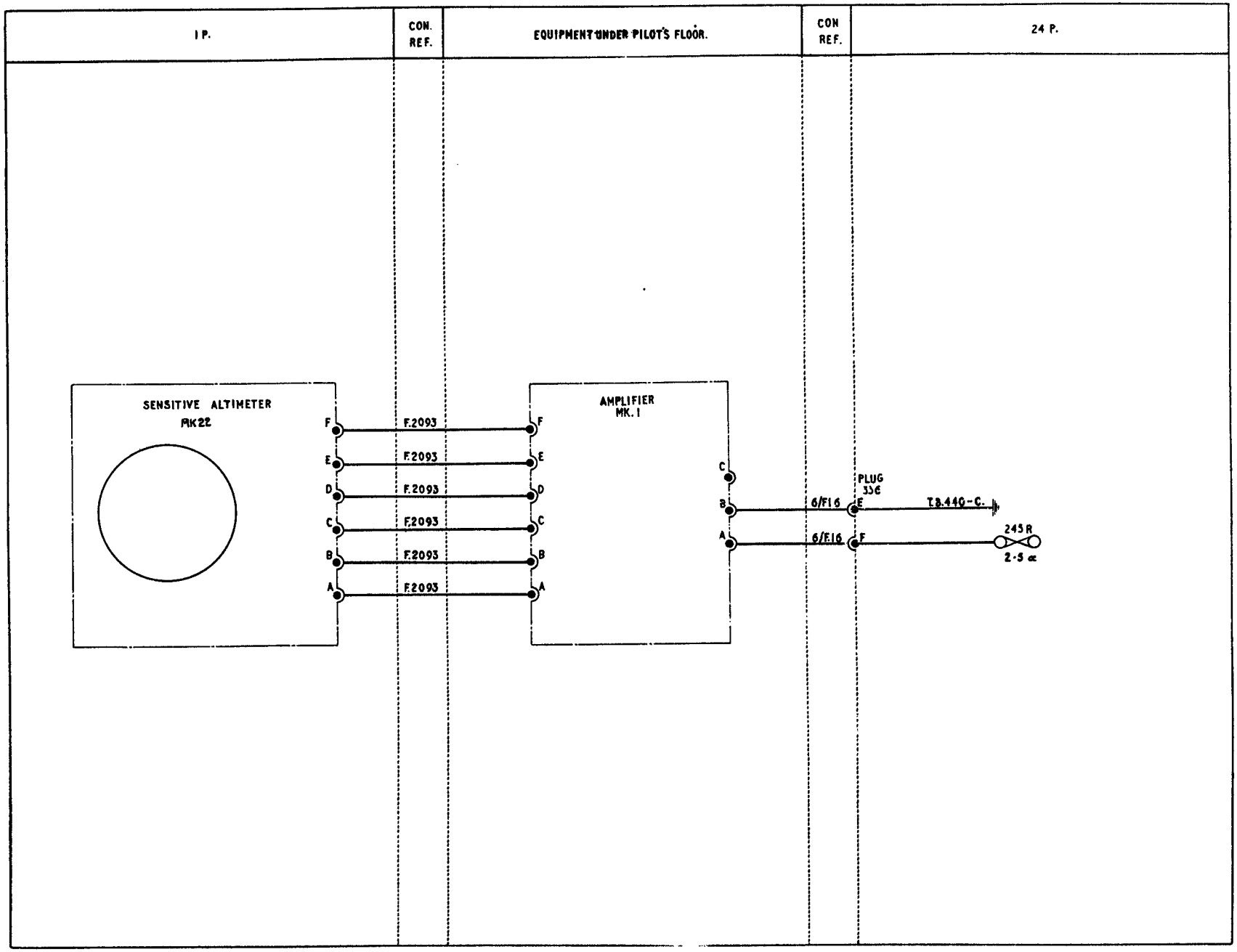


Fig. 2. Sensitive altimeter MK. 22.
◀ *Amplifier now Mk. 1* ▶

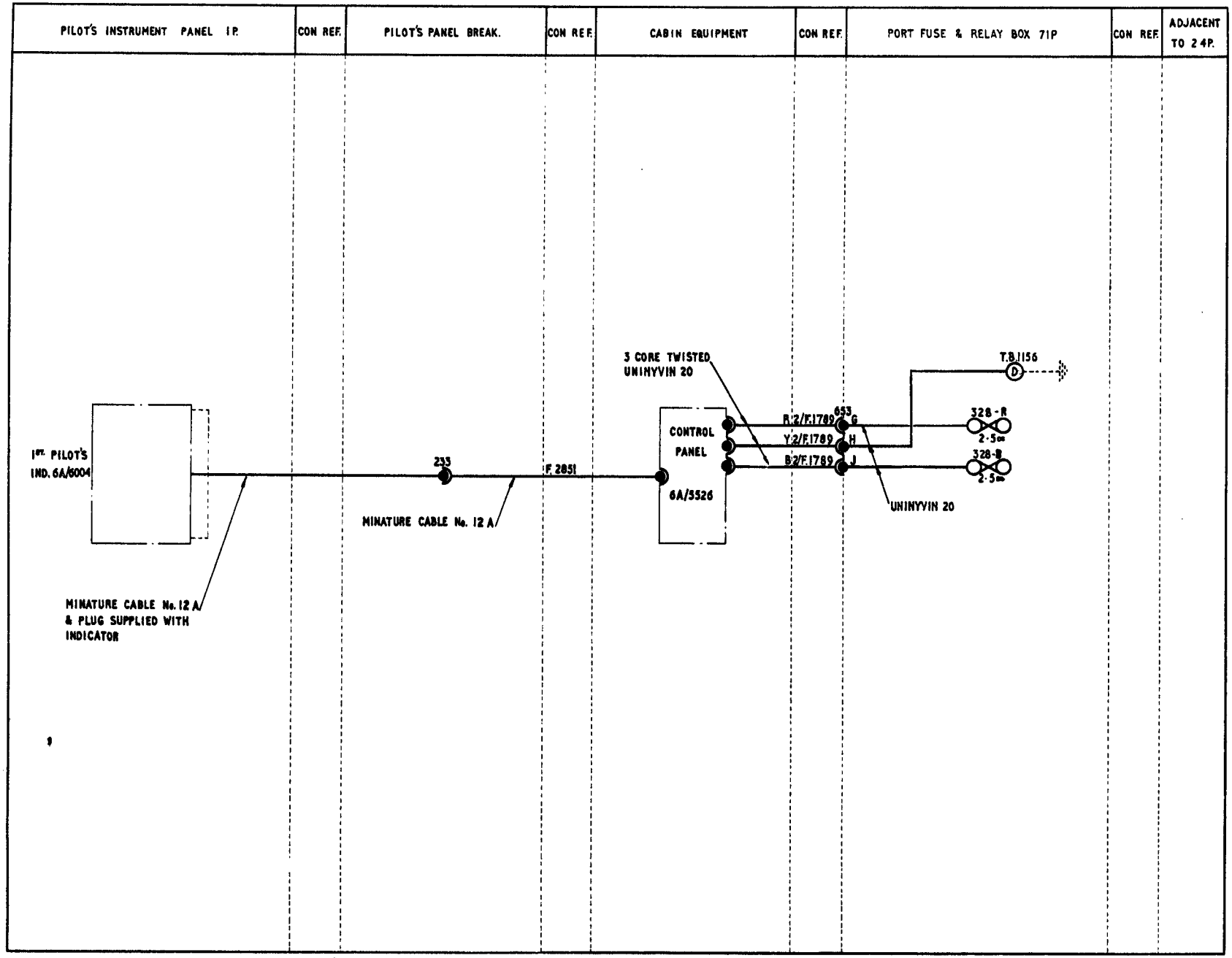


Fig. 3. Standby artificial horizon MK. 6B.

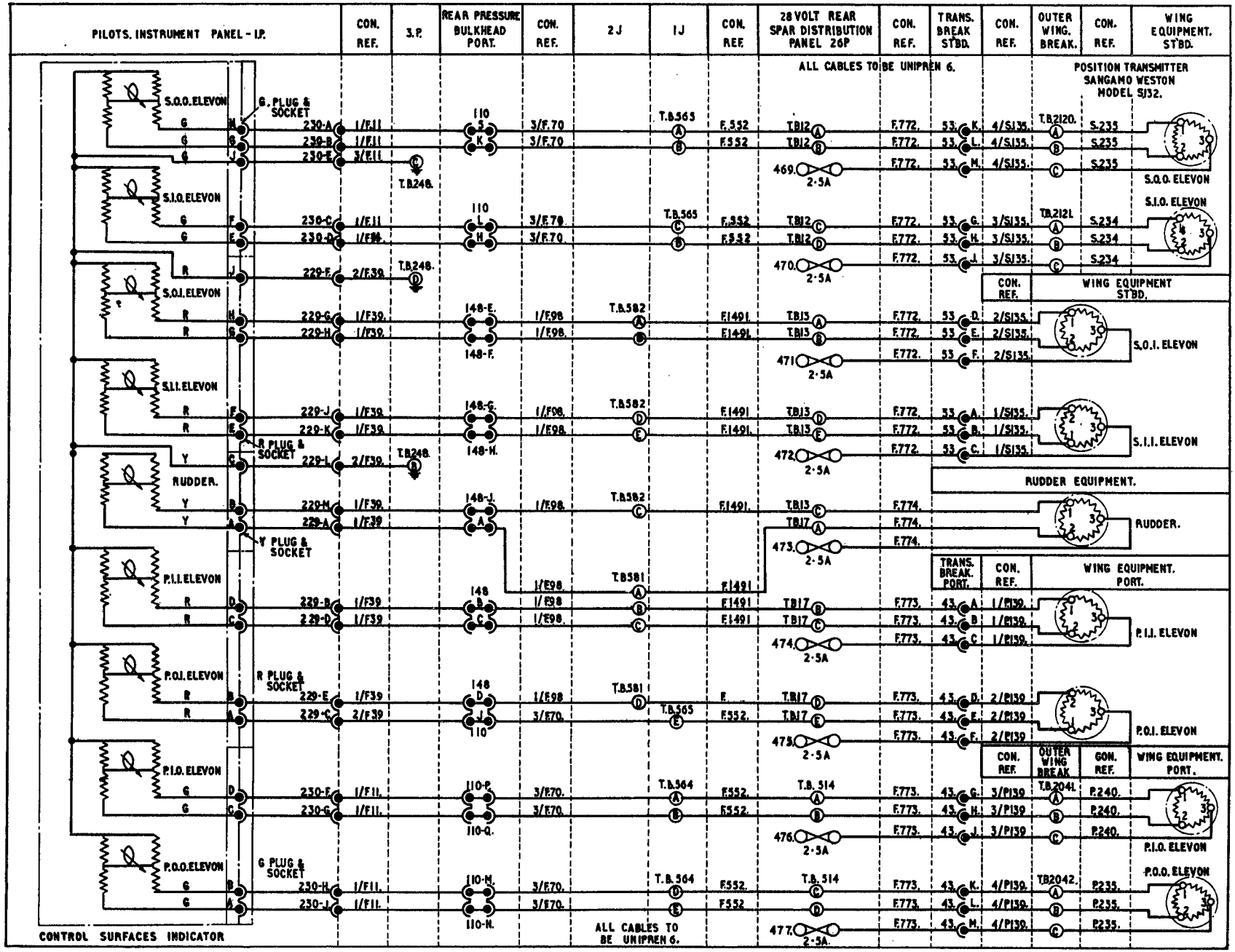


Fig.4 Control surface indicator

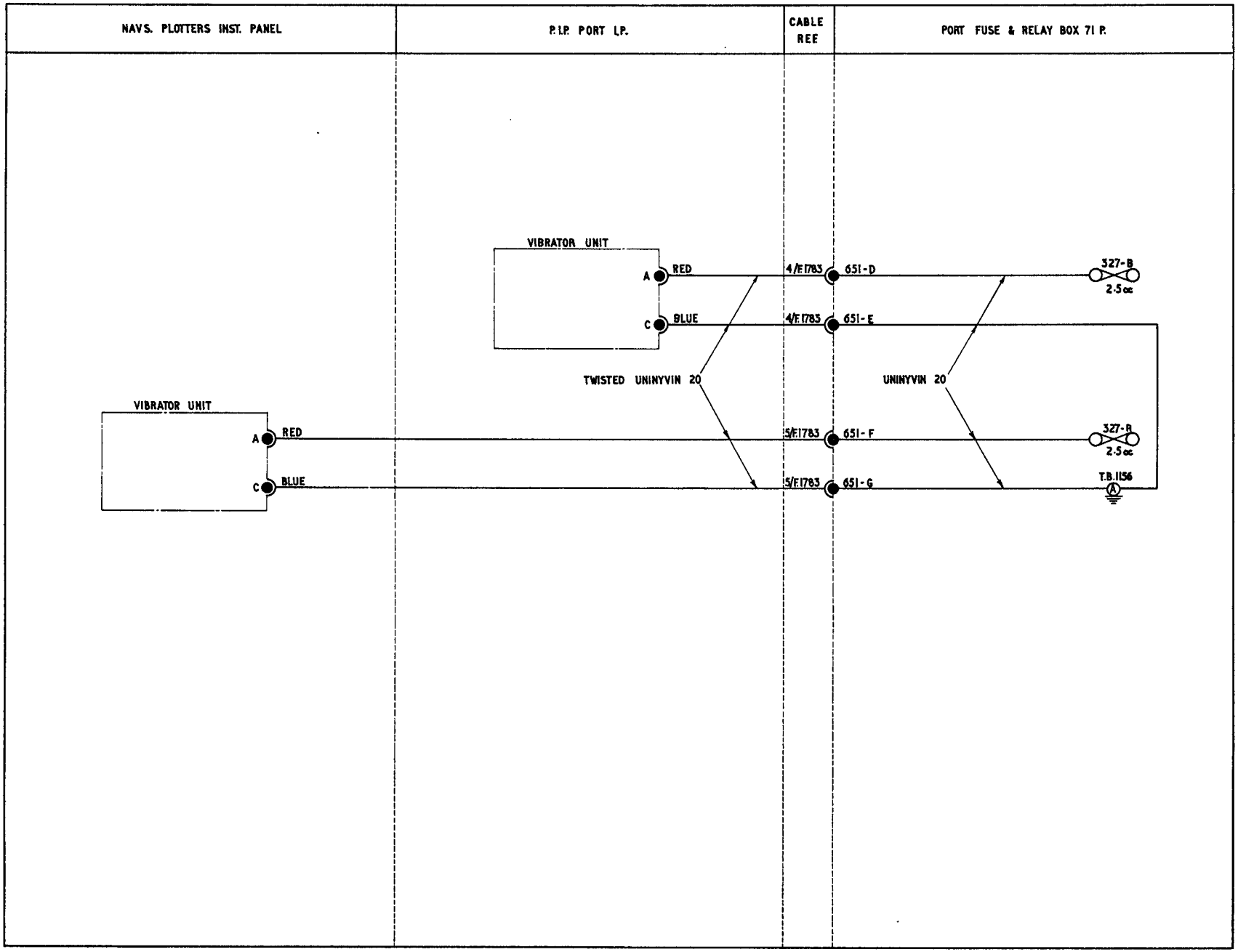


Fig. 5. Vibrator unit control.

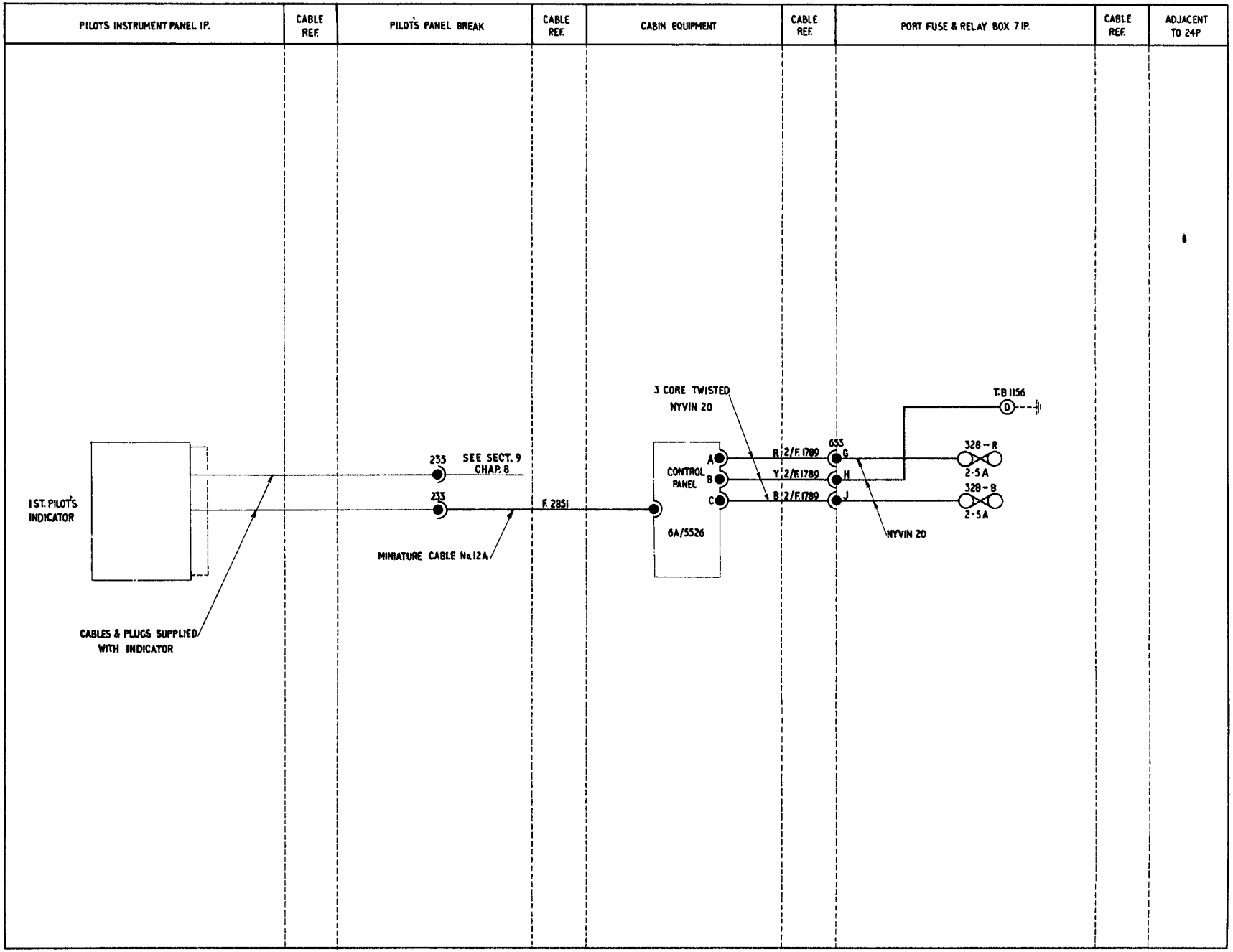


Fig.6 Artificial horizon Mk. 5A

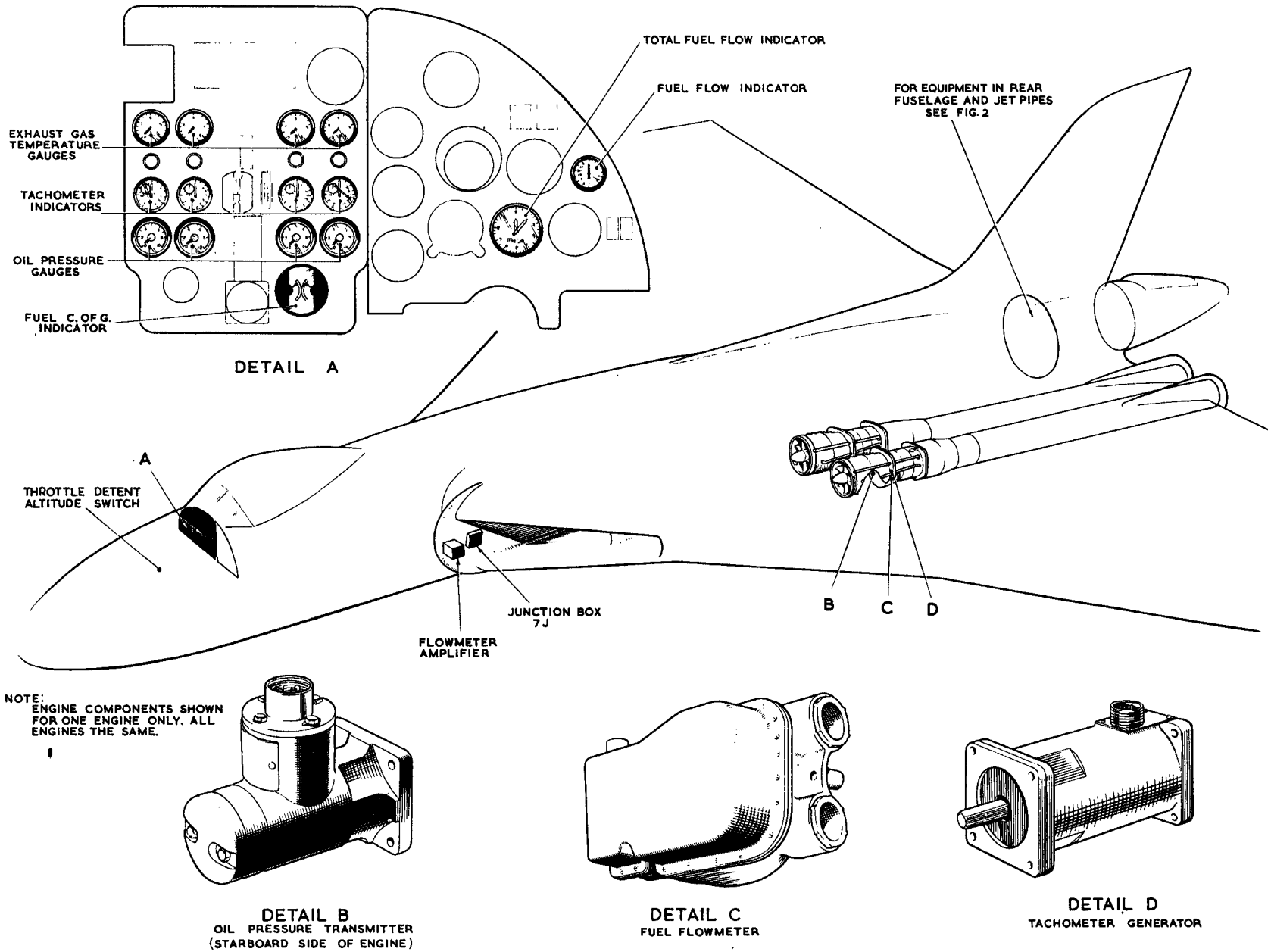


Fig.1 Location of engine instruments

(◀ *Throttle detent altitude switch added* ▶)

DESCRIPTION AND OPERATION

ENGINE TACHOMETERS

4. Four Mk.11 indicators are fitted in the pilots' centre panel to provide engine speed information for both pilots. The instruments are of the synchronous motor type and indication is by means of a main scale graduated in divisions of 10 per cent, and a subsidiary scale in divisions of 1 per cent, of the maximum engine speed.

5. Mounted on the port side of each engine, aft of the forward bulkhead is a Mk.11 tachometer generator. Each of these generators is connected to it's respective instrument on the pilots' panel by means of a self-contained circuit. When the engines are running, 3-phase a.c. is developed by the generators, at a frequency proportional to the engine speed, and fed to the indicators which record the engine speed according to the rise and fall of the generator output frequencies. A full description of the tachometer and its associated generator will be found in A.P.1275A, Vol.1, Sect.26, Chap.12.

OIL PRESSURE INDICATORS

6. Oil pressure information from the four engines is provided by four inductor type oil pressure gauges, Ref.No. 6A/6161, calibrated 0-100 lb./sq.in., mounted on the pilots' centre panel as shown in fig.1. These indicators are operated by four pressure transmitters, Ref.No. 6A/5598, fitted one to the starboard side of each engine. The transmitters are fed from the aircraft 115-volt 400 c/s a.c. supply via four individual auto-transformers which step down the supply to 26-volt 400 c/s. The auto-transformers and supply fuses for No.1 and 2 indicators are fitted in 27P and those for No.3 and 4 indicators in 28P. A routing chart is provided in fig. 5 and a complete description of the indicators and their associated components will be found in A.P.1275A, Vol.1, Sect.16.

EXHAUST GAS THERMOMETERS AND JET PIPE TEMPERATURE SYSTEM

Exhaust gas thermometers Type D

7. In order that the engines may be operated at a safe and efficient temperature four exhaust gas temperature indicators are mounted on the pilots' centre panel. Thermo-couples are provided in each jet pipe and the output from these is fed to the indicators via four a.c. servo-potentiometers.

Thermo-couples

8. Eight thermo couples, Type R.A.E. H70/19/1 are mounted in pairs at the rear end of each jet pipe and at right angles to the exhaust stream. Two pairs are located each side of the jet pipe, one above and the other below the horizontal centre line. Each pair of thermo-couples is connected to a junction box and these in turn are connected by a metal harness to a common junction box mounted on top of the jet pipe.

9. From this common junction box glass braided chromel-alumel leads are taken, via conduits, to the compartment behind the aft power compartment in the rear fuselage. Here they connect to their respective servo-potentiometers, jet pipe temperature limiting amplifiers and ground test plugs.

Servo-potentiometers

10. The servo-pots are all located in the compartment behind the aft power compartment where they are clamped in anti-vibration mountings as shown in fig.2. The purpose of the servo-pots is to produce a high output from the low milli-volt input supplies by the thermo-couple cluster for operation of the indicators. The servo-pots are each fed with a 115-volt, 400 c/s single phase a.c. supply from fuses 298-B, and 299B in panel 28P and fuses 270-B and 271-B in panel 27P.

Indicators

11. The four indicators are installed on the pilots' panel as shown in fig.2. They are moving coil type instruments operating as milliammeters suitably calibrated over a range of 0 to 800 deg.C. Pren cables are used to connect the indicators to the servo pots.

12. A full description of the exhaust gas thermometers Type D will be found in A.P.1275A, Vol.1, Sect.17, Chap.16. Details of the thermo-couples will be found in Chap.10 of the same publication.

Jet pipe temperature limiting system

13. The jet pipe temperature (j.p.t.) limiter and r.p.m. governor systems form a basic part of the Olympus 201 engine fuel system, and the following paragraphs should be read in conjunction with A.P.4712A, Vol.1 and A.P.4343K, Vol.1, Sect.3.

14. To avoid making frequent throttle adjustments when maintaining the engine speed within the combined j.p.t. and r.p.m. limitations during cruising or take-off, a datum selector switch labelled CRUISE/TAKE-OFF is mounted on the engine control pedestal. The selector switch controls a solenoid operated

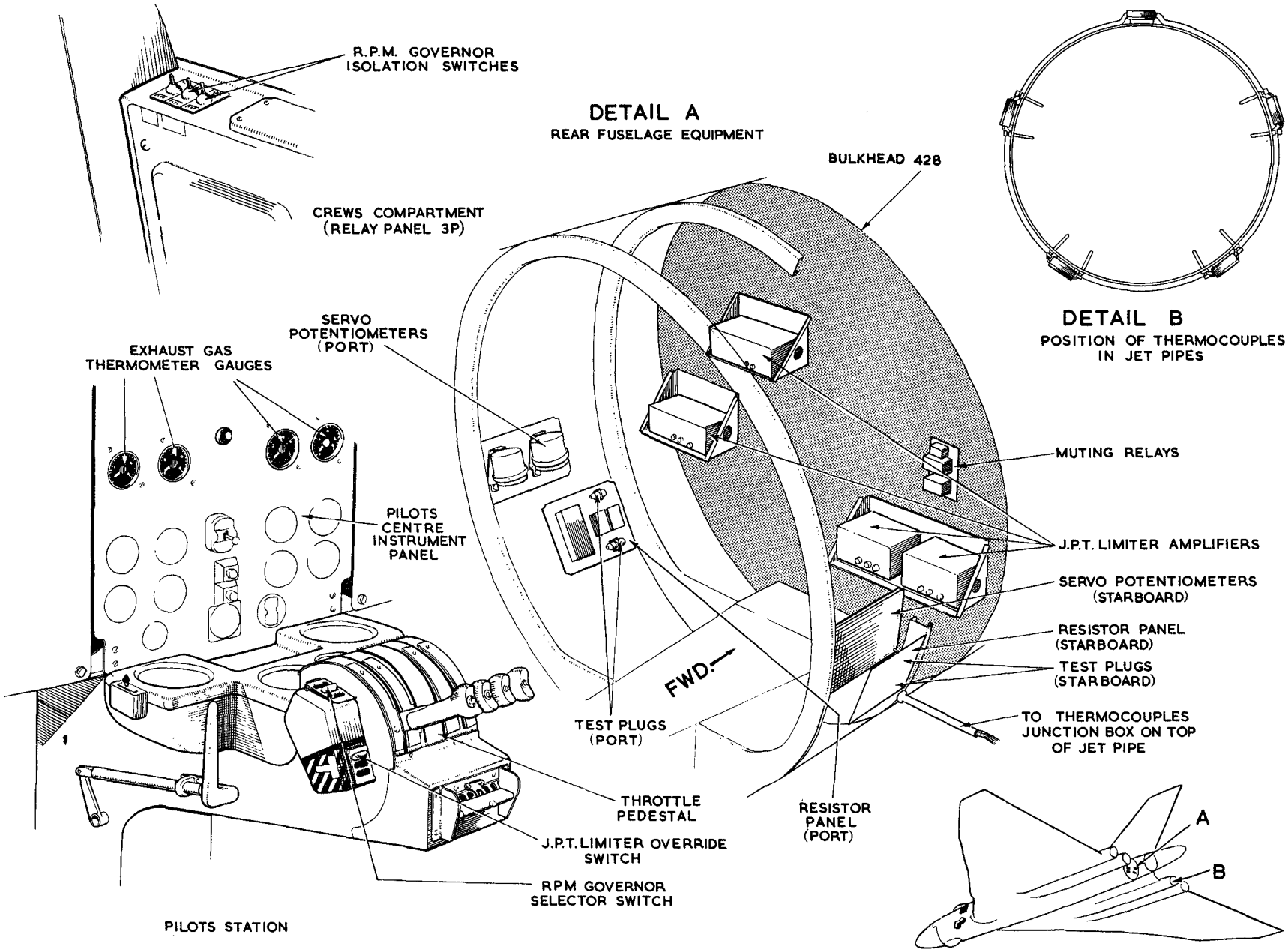


Fig.2 Jet pipe temperature equipment

servo isolator in the lines between the two L.P. compressor/governors on the engines. Thus when the throttles are open either a driven governor (take-off) or a static governor (cruise) may be selected.

15. In addition the selector switch also selects the corresponding cruise or take-off datum for the j.p.t. limiter, so that regardless of the r.p.m. selected at the throttle, the actual engine speed will not increase above that point where the jet pipe temperature begins to exceed the selected datum.

16. Control of the j.p.t. is provided by electro-pressure control units mounted one on each engine. Each of these units is operated by a j.p.t. limiter amplifier, Type A206, which is controlled by the CRUISE/TAKE-OFF selector switch. Basically, the j.p.t. limiter system cuts down the fuel flow to the engine by the action of the electro-pressure solenoid operated ball valve when the j.p.t. rises above the selected datum level.

17. The temperature signal obtained from the thermo-couple cluster on the engine is passed to the amplifier where it is compared with a highly stabilised reference voltage in the amplifier. Should the thermo-couple output prove to be the higher, the resultant error signal will leave the amplifier as a current to operate the solenoid controlled electro-pressure valve. Energising the valve will reduce the fuel flow which will then bring about a corresponding reduction in j.p.t.

18. The level at which the error signal appears can be controlled within the ranges of adjustment, by altering the value of the reference voltage. By this means the desired j.p.t. datum level can be set inside the amplifier via relays and a datum setting resistor network. The amplifier has provision for triple datum settings but in the case of Olympus 201 engines as on Vulcan 2 aircraft, only the CRUISE and TAKE-OFF datums are used, consequently only one of the two relays in the amplifier is employed. Connections to the R.P.M. GOVERNOR switch are made via a five pin plug on the amplifier. Descriptive details for the j.p.t. limiter amplifier, Type A206, will be found in A.P.4343K, Vol.1, Sect.3.

19. Mounted adjacent to the R.P.M. GOVERNOR switch is an OVERRIDE switch. The switch, which is guarded and labelled ON-OFF, is used during ground testing and also if the j.p.t. limiting system should fail during flight. The switch must be in the ON position for take-off.

20. In addition to the OVERRIDE switch two R.P.M. GOVERNOR ISOLATION switches, labelled ON-OUTBOARD and ON-INBOARD are situated on the top of the port fuse and relay panel 3P. These switches are used for ground testing the j.p.t. limiters independent of the r.p.m. governors. Instructions on the use of these switches will be found in A.P.4505B, Book 1, Sect.1, Chap.2.

Power supplies

21. A 115-volt, single phase, 400 c/s, a.c. supply is fed to the amplifiers from fuse panel 27P port and fuse panel 28P starboard. Amplifiers 1 and 4 are fed from 27P, fuses 289-R and 289-B respectively. Amplifiers 2 and 3 are fed from 28P, fuses 311-R and 311-B respectively.

Equipment location

22. The amplifiers Type A206 together with the test plugs and resistances are installed in the compartment aft of the power compartment in the rear fuselage as shown in fig.2. The OVERRIDE switch and the r.p.m. governor CRUISE/TAKE-OFF switches are fitted to the engine control pedestal in the pilots' cabin. Both these switches are of the double-pole change-over pattern. The R.P.M. GOVERNOR isolation switches, which are spring-loaded to their closed positions, are of the single-pole pattern and are installed on the top of panel 3P. The muting relays (No.491 and 492) are installed along with the amplifiers in the compartment aft of the power compartment.

Circuit operation

23. The circuit operation described in the following paragraphs should be read in conjunction with the theoretical diagram of the circuit fig.3. Only the outboard engines No.1 and 4, are described in the following paragraphs as the circuit operation for Nos.2 and 3 engines is similar.

24. It will be seen from fig. 3 that with the J.P.T. OVERRIDE switch in the ON position, the muting relays (491 and 492) are completely isolated from the 28-volt supply and that the feed side of the relay coils are shorted to earth via the linked contacts 1 and 4 of the switch. Also with the R.P.M. GOVERNOR switch at the TAKE-OFF position the double datum governor valve solenoids are isolated from their supply in a similar manner to the muting relays. In this condition the ENGINE CONTROL magnetic indicator is de-energised and presents a black image and the datum level relay within the amplifier (fed from pin 5 in the 5 pin plug) is isolated from its supply. The datum setting resistance will thus be set for take-off j.p.t. limitation.

25. On the output side of the amplifier (two-pin plug, pins A and B) the operating

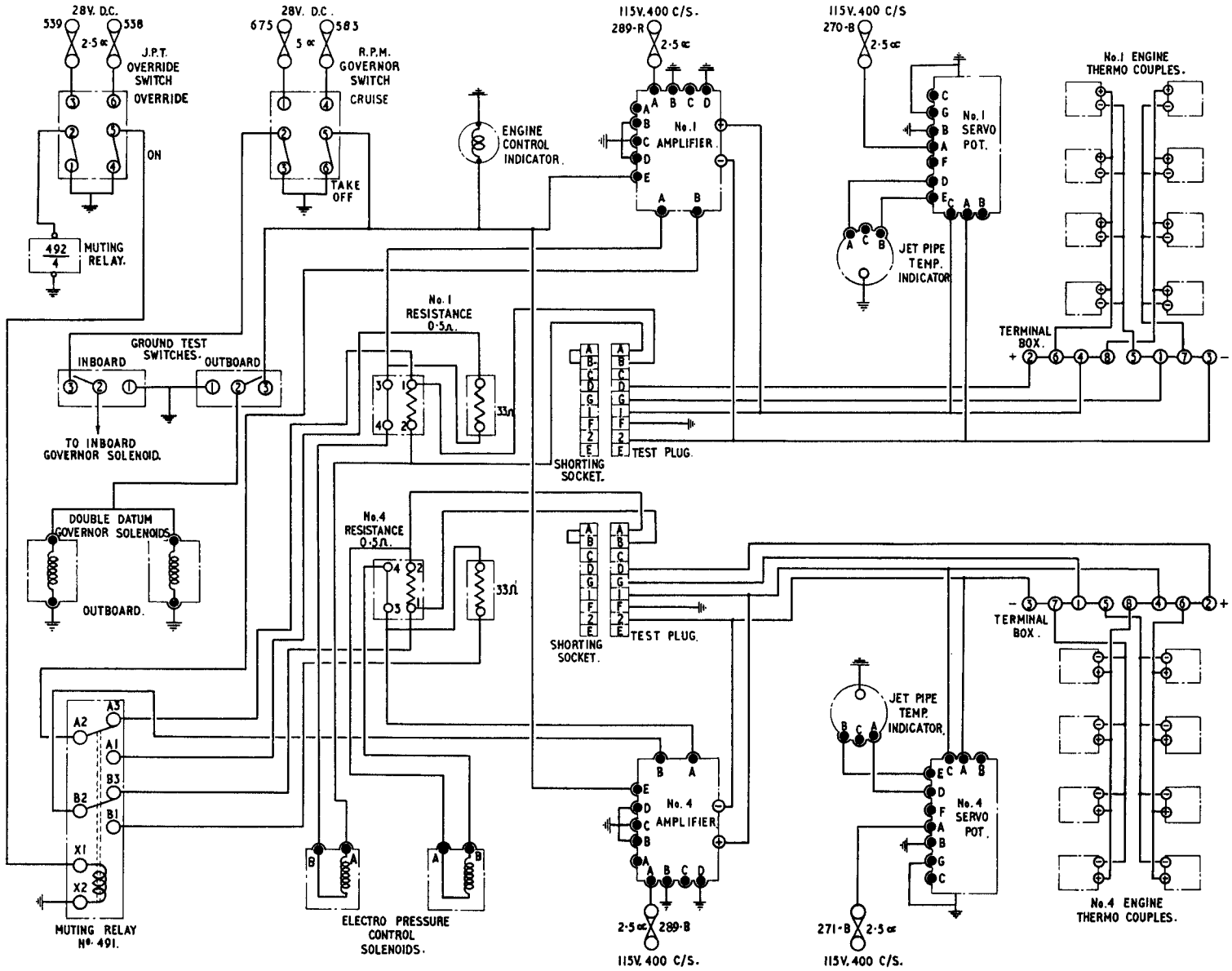


Fig. 3 Jet pipe temperature control.

◀ *Fuses renumbered, No 1 and No 4 amplifier* ▶

current for the electro-pressure solenoid valve will be fed to pin A on the solenoid via (in the case of No.1 engine) relay contacts 491/4 and the shorting link across the No.1 resistance. The resistance is brought into circuit during ground test only. A return path is provided from pin B via the straight link on the resistance back to pin A on the amplifier 2-pin plug.

26. With advancement of the throttle lever, engine speed and j.p.t. will increase. Should the required engine speed be attained without exceeding the pre-set temperature datum then the limiting system will remain neutral. However, should the j.p.t. exceed the datum before the desired engine speed is reached, then the current to the electro pressure control solenoid will rise to operate the solenoid, thus reducing fuel flow to the engine. Further opening of the throttle will produce a slight additional rise in temperature and the fuel system will again be adjusted to reduce fuel flow. By throttling back, the system will return to neutral.

27. If the R.P.M. GOVERNOR switch is now moved to the CRUISE position with the OVERRIDE switch still at the ON position it will be seen that:-

(1) A 28-volt d.c. supply will now be connected via the R.P.M. GOVERNOR switch, and the GOVERNOR ISOLATION switches, to energise the solenoids of the engine double datum governor. This action will now provide an r.p.m. control in the engine fuel system which will ensure that the cruise r.p.m. is not exceeded.

(2) At the same time, the same d.c. supply will be directed (via pin E, 5-pin plug) to the datum level control relay within the amplifier. The relay will be energised to complete the circuit to the CRUISE temperature setting datum resistor.

(3) In addition the d.c. supply will also energise the ENGINE CONTROL magnetic indicator to present a white image and thus inform the pilot that CRUISE j.p.t. and r.p.m. control has been selected.

The engine r.p.m. and j.p.t. will now be automatically controlled to the engine CRUISE limitations.

28. If, during flight, faults should develop or the system become suspect, muting conditions can be applied to the system by use of the J.P.T. OVERRIDE switch. Operation of the OVERRIDE switch to the OVERRIDE position will cause the muting relays (491 and 492) to be energised by the 28-volt d.c. supply.

29. In the case of the No.1 engine (operation of the other engines being similar) relay contacts 491/3 and 491/4 will change over and the following events will take place:-

(1) The opening of relay contact 491/4 will isolate the amplifier output from the electro pressure valve solenoid.

(2) The closing of relay contact 491/3 will insert the 33-ohm resistor across the amplifier output. (This is a dummy resistance which represents the solenoid coil resistance).

This action will cause the j.p.t. limiter amplifier to be isolated and the electro pressure valve will be inoperative. Under these conditions, j.p.t. limitation must be carried out manually by observation of the j.p.t. gauges and manual throttle adjustment.

FUEL CONTENTS SYSTEM

30. The aircraft is equipped with fourteen fuel tanks, five in each wing and four in the front section. The fourteen tanks are divided into two groups, seven each side of the aircraft, port and starboard. Each of these groups is then divided into a further two groups for weight balancing purposes. Groups 1 and 2 comprise the port tanks numbered 1, 4, 5, 7 and 2, 3, 6 respectively, Groups 3 and 4 comprise the starboard tanks in the same sequence.

31. A Smith Waymouth type fuel contents system, operating from the 28-volt d.c. supply is installed in the aircraft. This system calculates, by the use of capacitor units integral with the tank, the quantity of fuel contained in a tank. The value (in pico-farads) of the capacitor units varies with the amount of fuel and air between the plates, and is thus proportional to the mass of fuel in the tank.

32. The capacitor units are fitted upright inside the tanks and connected via a co-axial cable to a trimmer box and amplifier in each case. The output from each amplifier will vary according to the tank capacitance, and this condition for each tank or tank group will be indicated on the associated fuel contents gauges. A description of the system including details of operation is contained in A.P.1275A, Vol.1, Sect.18, Chap. 9 . The complete system of fuel controls is dealt with in Book 2, Sect.6, Chap.9.

Pilots' fuel contents gauges

33. Four fuel contents gauges, one to each tank group, are fitted on the pilot's

panel (2P), located forward of the throttle controls. The gauges, Type A.O.12 and Type A.O.10, have an inner and outer scale calibrated in thousands of pounds of fuel.

34. The inner scale of each instrument automatically records the total amount of fuel contained in the respective tank group whilst the outer scale will record the contents of any tank in the group by means of associated selector switches. The selector switches are mounted on the retractable centre console (5P) and are labelled CONTENTS. When any one of the switches, which are of the push type. is pressed, the contents of that particular tank will be indicated on the outer scale of the associated instrument.

Navigator's fuel contents gauges

35. Four gauges are also provided at the navigator's station and are fitted above the plotter's instrument panel. These four, single scale, instruments give indication of the tank group contents only. The indicators for No.1 and 4 engines are Type AG14 instruments. The other two indicators, for No.2 and 3 engines, are Type AG15.

C.G. indicator S126-5

36. A Type S126-5 fuel C.G. indicator is fitted on the pilots' centre panel (1P). This indicator has two separate scale movements and is designed to give indication of fuel disposition relative to the centre of gravity for each side of the aircraft.

37. The left hand scale of the instrument provides indication of C.G. movement for the port tanks (1 to 7) while the right-hand scale provides a similar indication for the starboard tanks. The fuel C.G. lies between the fuselage tanks and the wing tanks.

38. Each scale is divided into three sections. A central green section marks the safe margin of fuel C.G. movement while either side of this are two red sections marked NOSE HEAVY and TAIL HEAVY respectively. With the instrument at the OFF position the pointers will lie in the bottom red sections.

39. The indicator movements are controlled by the fuel tanks amplifier outputs. These outputs can be switched out of the fuel contents gauge circuits by operating the push-switch labelled C.G., CHECK, fitted adjacent to the indicator. The amplifier will then be connected to the indicator via a resistance network, and, providing the fuel C.G. is being maintained, the instrument pointers will take up a centre scale position. Should NOSE HEAVY or TAIL HEAVY conditions develop the C.G. can be corrected by transferring fuel between No.1 and 7 tanks. Note that while the C.G. switch is pressed the fuel contents gauges will register zero.

40. The C.G. indicator will also be brought into operation during flight refuelling conditions, when the flight refuelling master switch on the starboard console (7P) will be on. A full description of the C.G. indicator, including the relevant routing charts will be found in Book 2, Sect.6, Chap.9, of this publication.

FUEL FLOWMETERS

41. The Mk.3 fuel flowmeter system installed in the aircraft is designed to provide the following continuous indications:-

(1) The rate at which fuel is being consumed by each engine.

(2) The total rate at which fuel is being consumed by all engines.

(3) The total amount of fuel consumed by all engines.

The installation is electrically operated and the main equipment consists of four engine transmitters, an amplifier, a flowmeter and a total fuel flow indicator. The instruments are installed on the second pilot's panel and a full description of the system, including operating details, will be found in A.P.1275A, Vol.1, Sect.18. A routing chart of the circuit (fig. 7) is provided at the end of the text.

Control switches

42. Two main switches control the circuit. The first of these is an electrically operated Ledex selector switch which provides individual selection of engine fuel flow on the flowmeter. This switch is mounted inside junction box 7J on the port side of the nose-wheel bay. The switch is operated by four selector push-switches mounted on the retractable centre console 5P.

43. The second switch is a toggle type switch and is mounted on the second pilots' panel adjacent to the total fuel flow indicator. This switch, which is spring-loaded to a central off position, is labelled RESET-NORMAL. The function of the switch is described in para.52.

Power supplies

44. Single phase, 400 cycles a.c. at 115-volts and 26-volts is required to operate the system. The 115-volt supply is fed direct to the amplifier from fuse 268-B in panel 25P. A second 115-volt supply is taken from fuse 268-R, also in 25P, to an Elliot Type 3B/933 transformer which is mounted adjacent to 25P. This transformer provides a 26-volt output which is fed to the four transmitters and the flowmeter.

45. In addition to the a.c. supplies a 28-volt d.c. supply is used for operation of the Ledex selector switch. The supply is fed to the switch from fuse 649 in 3P, via the associated selector push-switches.

Flowmeter transmitters

46. Four flowmeter transmitters, Type 3D/121, provide the necessary signal information for the indicators listed in para.41. The transmitters are mounted one on each engine and are directly connected into the engine fuel lines.

47. A measuring vane integral with each unit is moved against a callibrated spring by fuel flowing to the engine. Movement of the vane is proportional to the rate-of-flow and is transmitted by mechanical coupling to two Autosyn transformers which provide the output signals to operate the indicators. The pilots' flow meter is fed, via the Ledex switch, from one of the transformers. The signal from the other transformer is used to operate the total flow rate indicator and is fed to the indicator via the amplifier.

Amplifier

48. The amplifier Type 3D/122 is situated on the port side of the nose wheel bay and receives signals from one transformer in each transmitter for operation of the total flow rate indicator.

Flowmeter

49. A fuel flow meter Type 3D 123/1 is fitted on the second pilot's instrument panel. This instrument reproduces the movement of the flow measuring vane in any selected transmitter and thus provides indication of the rate at which fuel is being consumed by any one engine. An expanded type of scale is used, which is calibrated at 5 lb./min. intervals on the compressed part, and at 50 lb./min. intervals on the expanded part.

50. Indication of fuel flow rate for any one engine is obtained by operating the appropriate push-switch on the centre console. The instrument will continue to give indication for the engine last selected until another push-switch is pressed.

Total fuel flow

51. A total fuel flow indicator Type 3D/124/1, is fitted on the second pilot's instrument panel. This instrument provides indication of the total rate at which fuel is being consumed by all engines. The scale has two pointers and is calibrated to read in 10 lb./min. at each major division.

52. An indication of the total weight of fuel consumed is given on a counter which is recessed into the indicator dial. The counter will register the fuel consumption continuously, and can be re-set to zero by using the switch labelled RESET-NORMAL, located alongside the instruments.

Throttle detent solenoids (mod.1649)

53. Aircraft fitted with Olympus Mk. 301 engines have two throttle detent solenoids which provide additional flight idling stops on the No.2 and 3 inboard engines, and are brought into use when flying at 15,000 ft. and above. The detent solenoids are automatically energised at 15,000 ft. via an ambient altitude switch type Pad/A/0/18 fitted in the nose cone of the aircraft. More details concerning the mechanical aspects of the system will be found in Book 1, Sect.4, Chap.1, App.1 of this publication.

54. To check that the system is functioning correctly when the aircraft is on the ground, a test switch is provided adjacent to the starboard console 7P- The test switch when operated by-passes the altitude switch contacts to energise the internal relay of the altitude switch. By this action the internal relay contacts are closed to energise the throttle detent solenoids which in turn push out stops to limit the throttle linkage movement for No.2 and 3 inboard engines, thus allowing the No.2 and 3 inboard engines to idle 10% faster than the No.1 and 4 outboard engines. A routing chart is contained in fig.14.

SERVICING

ENGINE TACHOMETERS

55. Servicing of the Mk.11 indicators is limited to checking the instruments for signs of damage and security of attachment during the normal inspection periods. The generators Mk.11 should be inspected for security and the outer cases kept clean.

56. Lubrication instructions for the instruments will be found in A.P.1275A, Vol.1, Sect.26, Chap.12, together with the Standard Serviceability Test. Defective components should be returned to stores and replaced by serviceable items.

OIL PRESSURE INDICATORS

57. The indicators and transmitters should be checked externally for security of connections and freedom from damage. The transmitters should also be examined for signs of oil leakage. Very little else can be done in the way of routine servicing and defective items should be removed and new ones fitted.

58. Before removing any suspect component the 115-volt supply fuse and the output from the associated auto-transformer should first be checked. For details of the Standard Serviceability Tests reference should be made to A.P.1275A, Vol.1, Sect.16.

59. Testing of the indicators can also be carried out (in situ) by connecting a portable calibrator to the transmitter, when this has been removed from the engine. Descriptive details and full instructions for the operation of the calibrators are contained in A.P.1275T, Vol.1, Sect.3, Chap.8.

JET PIPE TEMPERATURE SYSTEM

60. To maintain the jet pipe temperature system at a high degree of serviceability it is essential that the greatest co-operation be encouraged between the instrument, electrical and engine tradesmen, especially during servicing periods and whenever the system is not functioning correctly.

61. Provided that the system is operating satisfactorily, servicing is restricted to normal routine inspection of the components as laid down in A.P.4505B, Vol.4. Serviceability tests of the exhaust gas thermometers is given in A.P.1275A, Vol.1, Sect.17, Chap.16, App.1.

Test equipment and procedure

62. The equipment required when carrying out tests on the jet pipe temperature system using the Ultra QT223 test set are as follows:-

(1) Ultra test set, Type QT223.

(2) Four core test cable, Type 2216.

(3) Nine core test cable, Type QY2212.

Items (2) and (3) are provided with the test set which is described in A.P.4343K, Vol.1, Sect.3.

63. Before use, the test set must be calibrated by using the calibration unit Type QZ2211, as described in A.P.4343K, Vol.1, Sect.3. If the test set internal supply is to be used, withdraw the battery compartment and ensure that the six cells are connected in series between the positive and negative tags.

64. Ensure that the J.P.T. OVERRIDE switch on the aircraft engine control pedestal is in the ON position.

65. Connect up the appropriate ground supplies and carry out the following tests on each engine in turn:-

(1) Remove the blanking cap from the 9-pin test plug located in the compartment aft of the power compartment and insert the 9-pin socket on the test cable QY2212, into the test plug. Connect the other end of the test cable into the plug on the test set marked TEST LEAD.

(2) Next carry out the test procedure laid down in A.P.4343K, Vol.1, Sect.3. Para.27(3) to para.33(10).

66. Should it be necessary to carry out ground running checks on the j.p.t. limiter system, the correct procedure, using the test set QT223 is laid down in A.P. 4343K, Vol.1, Sect.3. Following an engine or amplifier change, the j.p.t. limiting system must be tested and re-calibrated.

Amplifier datum selector unit

67. The four amplifiers, Type A206, when used in conjunction with Olympus 201 and 301 jet pipe temperature systems, are fitted with a datum selector unit (para.18). The type of datum selector units employed is dependant upon the type of engine used and its modification state. Table 1 contains details of the type of datum selector unit employed on a particular installation. When fitting a replacement amplifier, checks should be made to ensure that the correct datum selector unit is fitted. Further details concerning the datum selector units may be found in A.P.4343K, Vol.1, Sect.3.

REMOVAL AND INSTALLATION

GENERAL

68. Removal of the various engine instruments and associated components is reasonably straightforward and no detailed instructions are required. Instructions for removing the instrument panels, prior to removing engine instrument indicators, will be found in Chapter 1 of this Section, paras.34-36. Every precaution should be taken during removal and replacement of the instruments to prevent damage from shock or jarring.

69. Access to those components fitted on the engines is gained by lowering the hinged access panels below the engines. Instructions for the removal of engine components will be found in the Olympus engine handbook A.P.4501G, Vol.1.

JET PIPE TEMPERATURE SYSTEM

70. The major components of the jet pipe temperature system are all easily removed when necessary. Instructions for the removal of those components fitted on the engine including the jet pipe thermo-couples will be found in A.P.4501G, Vol.6. Panels are fitted on the upper surface of the jet pipe tunnel structure to provide access to the J.P.T. thermo-couple junction boxes. Before removing an engine jet pipe, the chromel-alumel leads to the thermo-couple should be disconnected at the junction box.

TABLE 1

Datum Selector Units

A/C Mod	Engine (Olympus) Type No. and Mod. state	Type No. (Ultra)	Ref.No.	J.P.T. Take-off	J.P.T. Cruise
Mod. 853	201 (Mod.AF/854)	ZR/76/AH	5CZ/6168	670°C.	600°C.
Mod.1478	201 (Mod.AF/1239)	ZR/86/BR	5CZ/6653	665°C.	605°C.
Mod. 906	301 (Mod.AF/1072)	ZR/86/BP	5CZ/7155	625°C.	560°C.
Mod.1695	301 (Mod.AF/1335)	ZR/86/BW	5CZ/7480	620°C.	565°C.
Mod.2145	201 (Mod.AF/1535)	ZA/86/CM	5CZ/8426	670°C	605°C
,,	202 ,,	,,	,,	,,	,,
,,	203 ,,	,,	,,	,,	,,
,,	301 ,,	ZR/86/CP	5CZ/8427	625°C	565°C

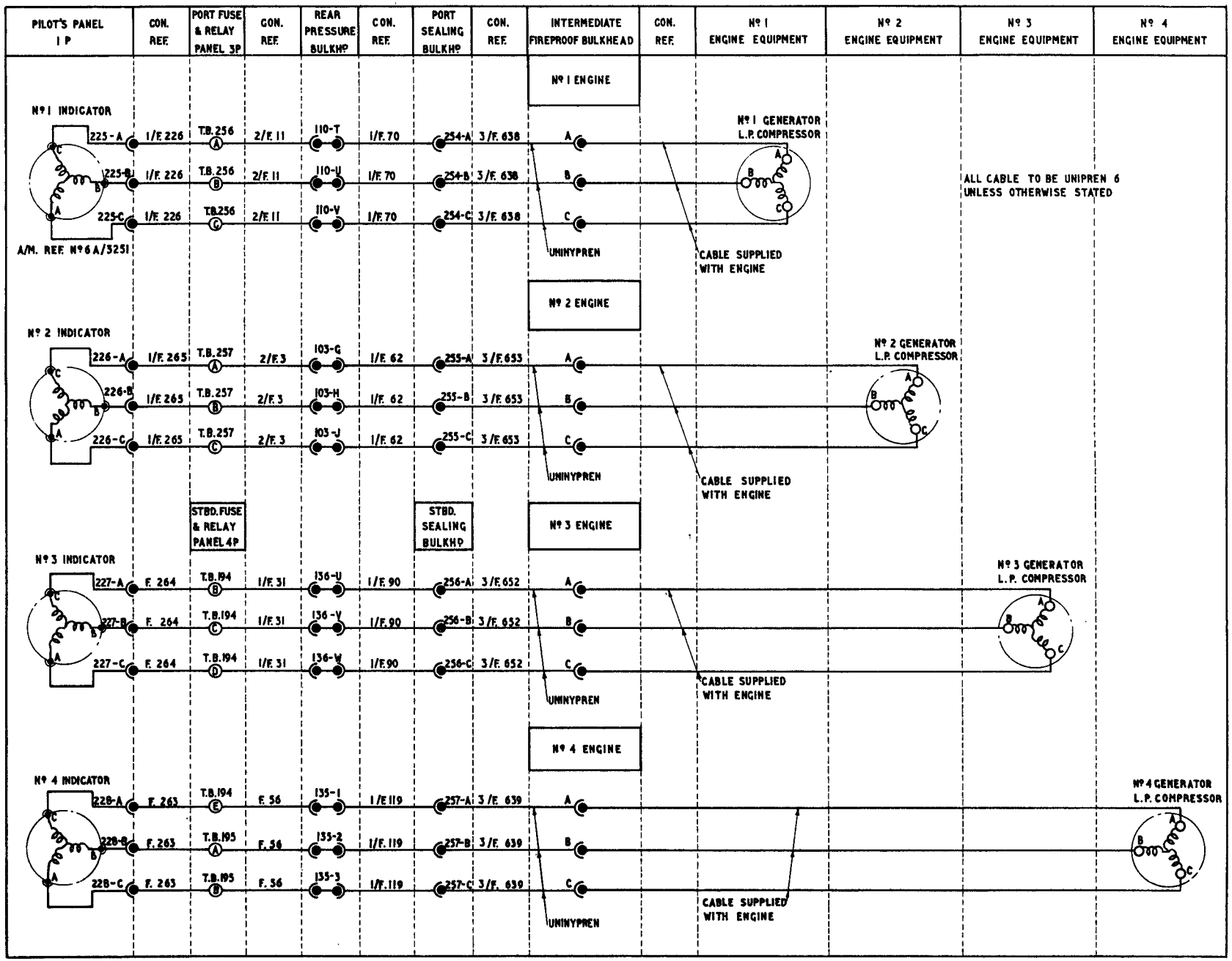


Fig. 4. Engine tachometers.
Change to indicator REF. Nº

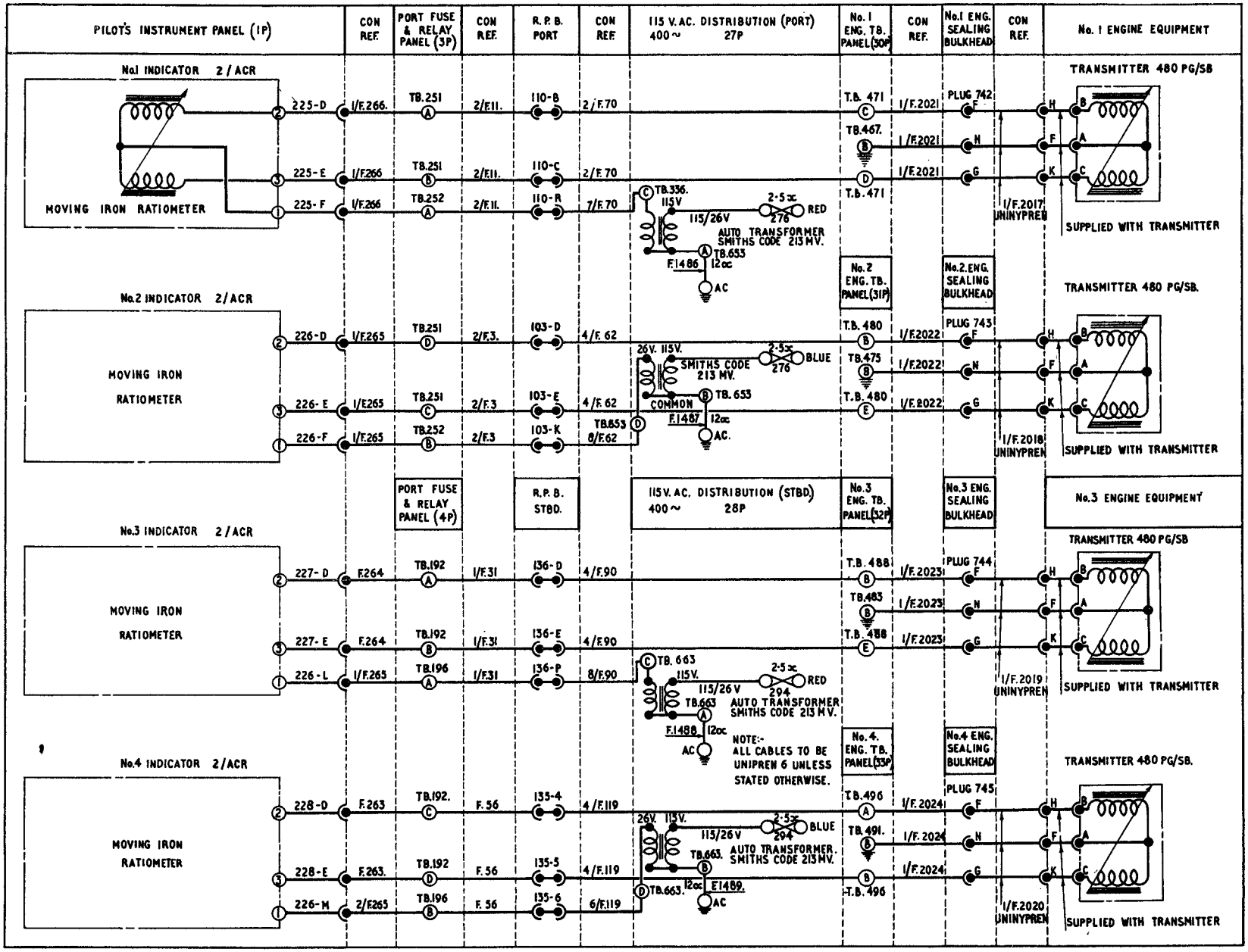


Fig.5 Oil pressure indicators

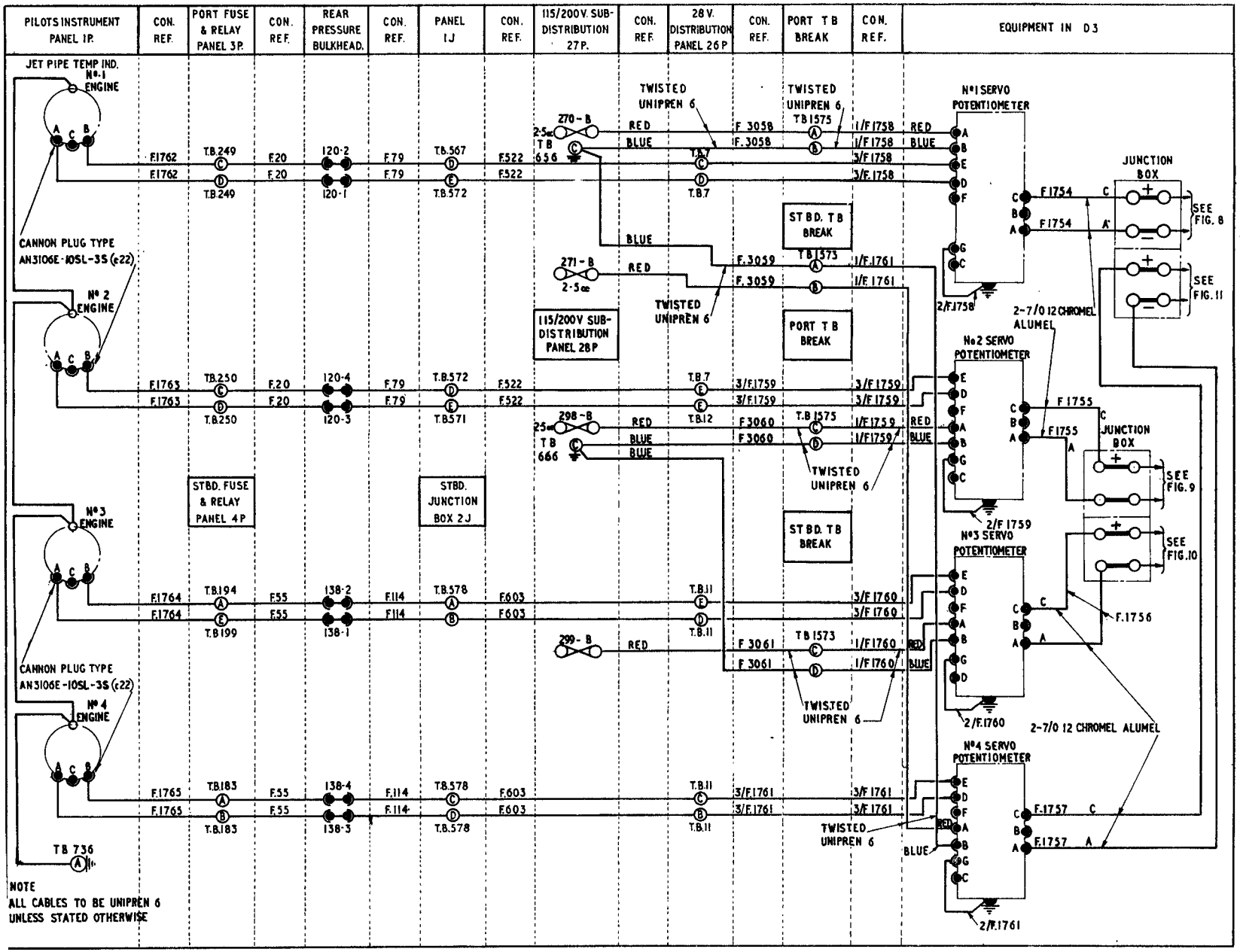


Fig.6 Exhaust gas thermometers

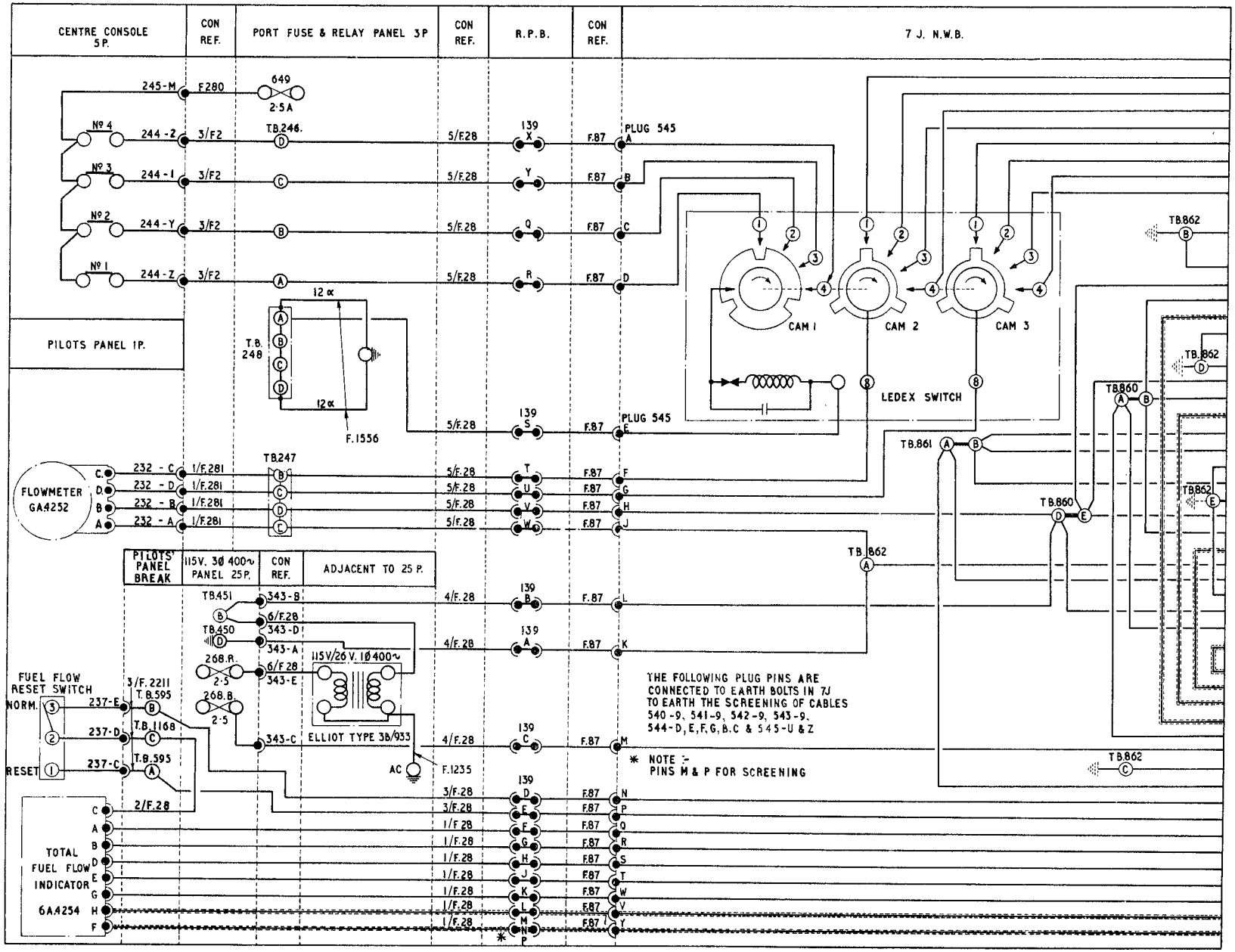


Fig.7(1) Fuel flowmeters

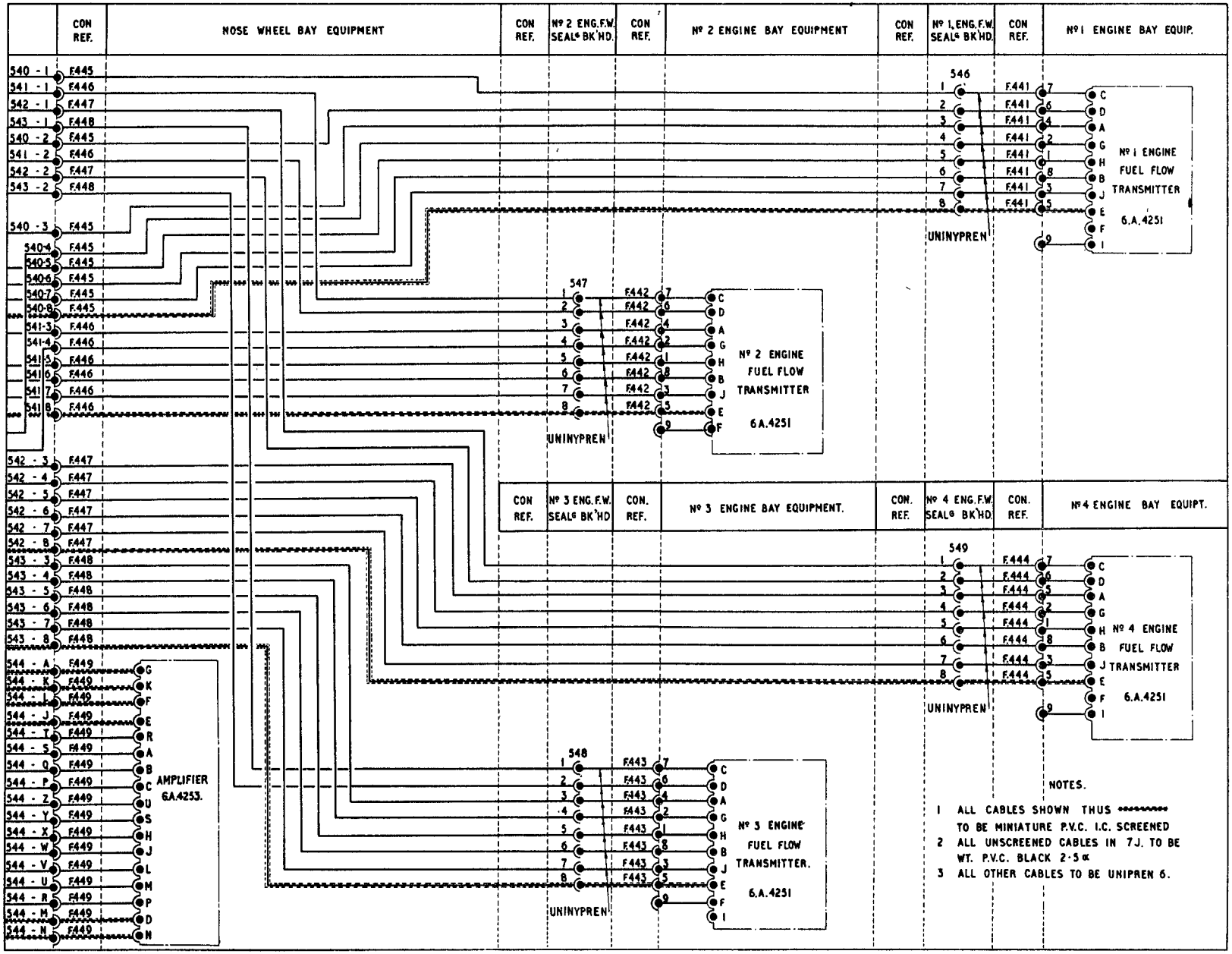


Fig.7(2) Fuel flowmeters

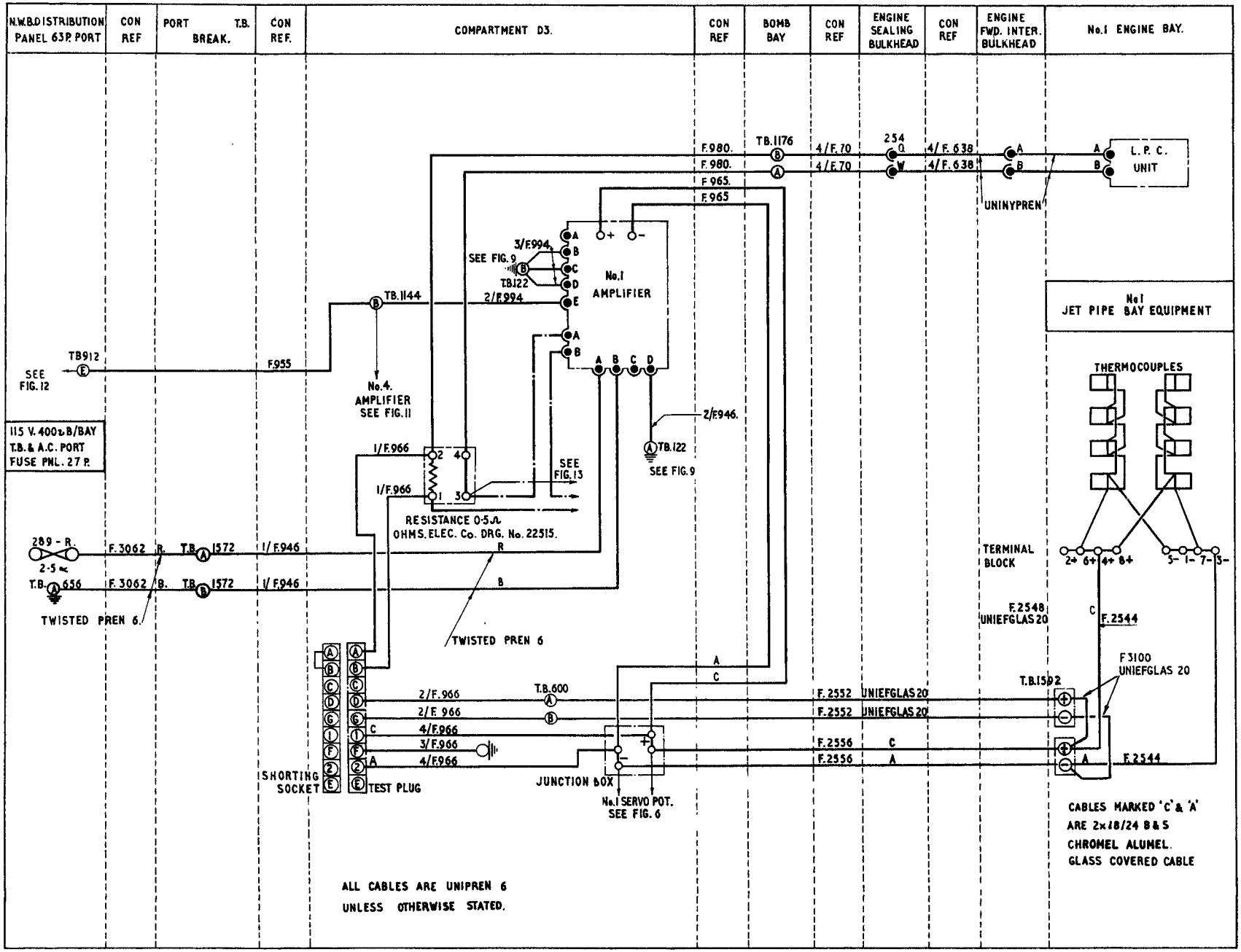


Fig.8. Jet pipe temperature limiters No1.

Change to fuse ident. and thermocouple wiring mod. 1320

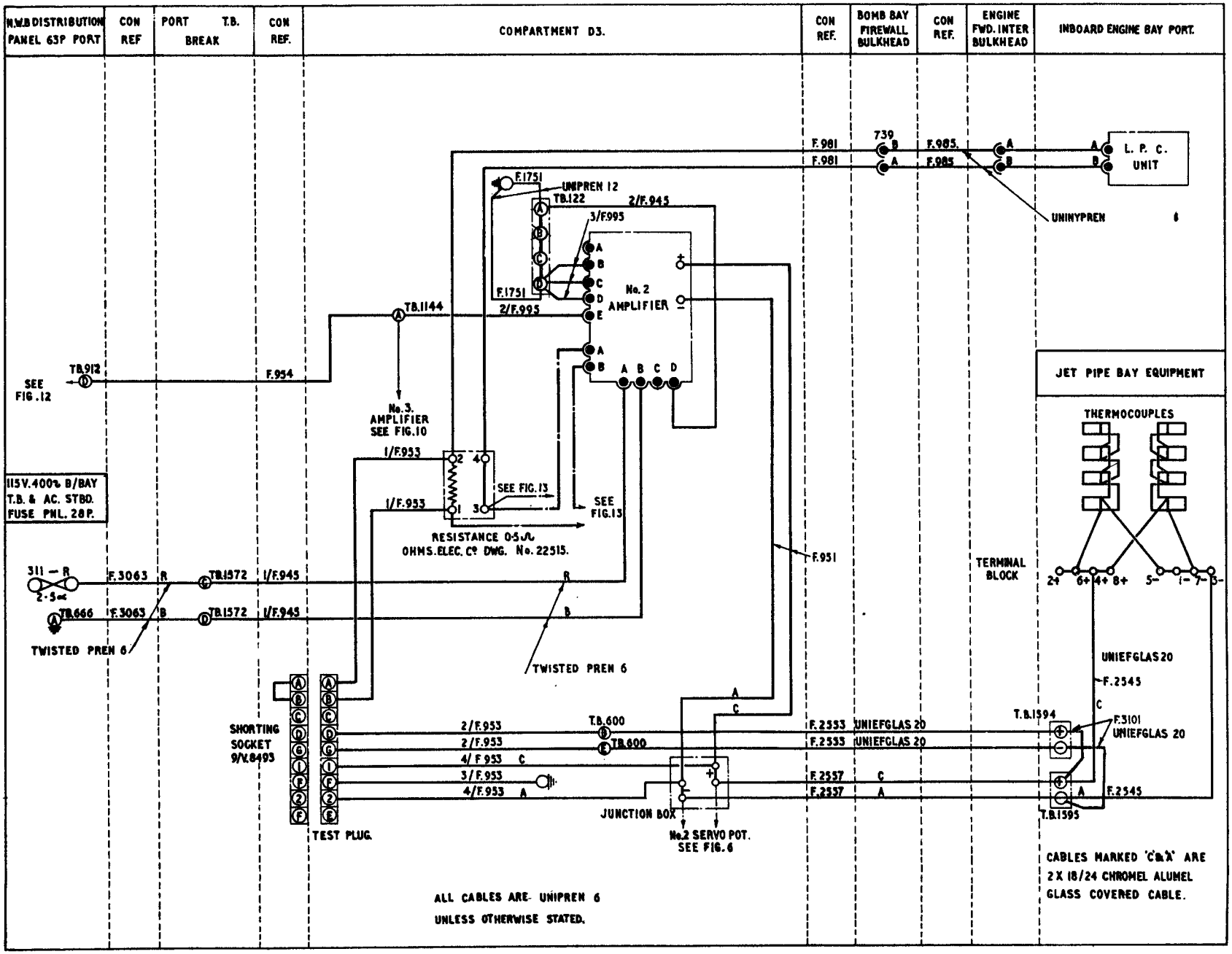


Fig.9. Jet pipe temperature limiters Nº 2.

◀ Change to fuse ident. and thermocouple wiring. mod. 1320 ▶

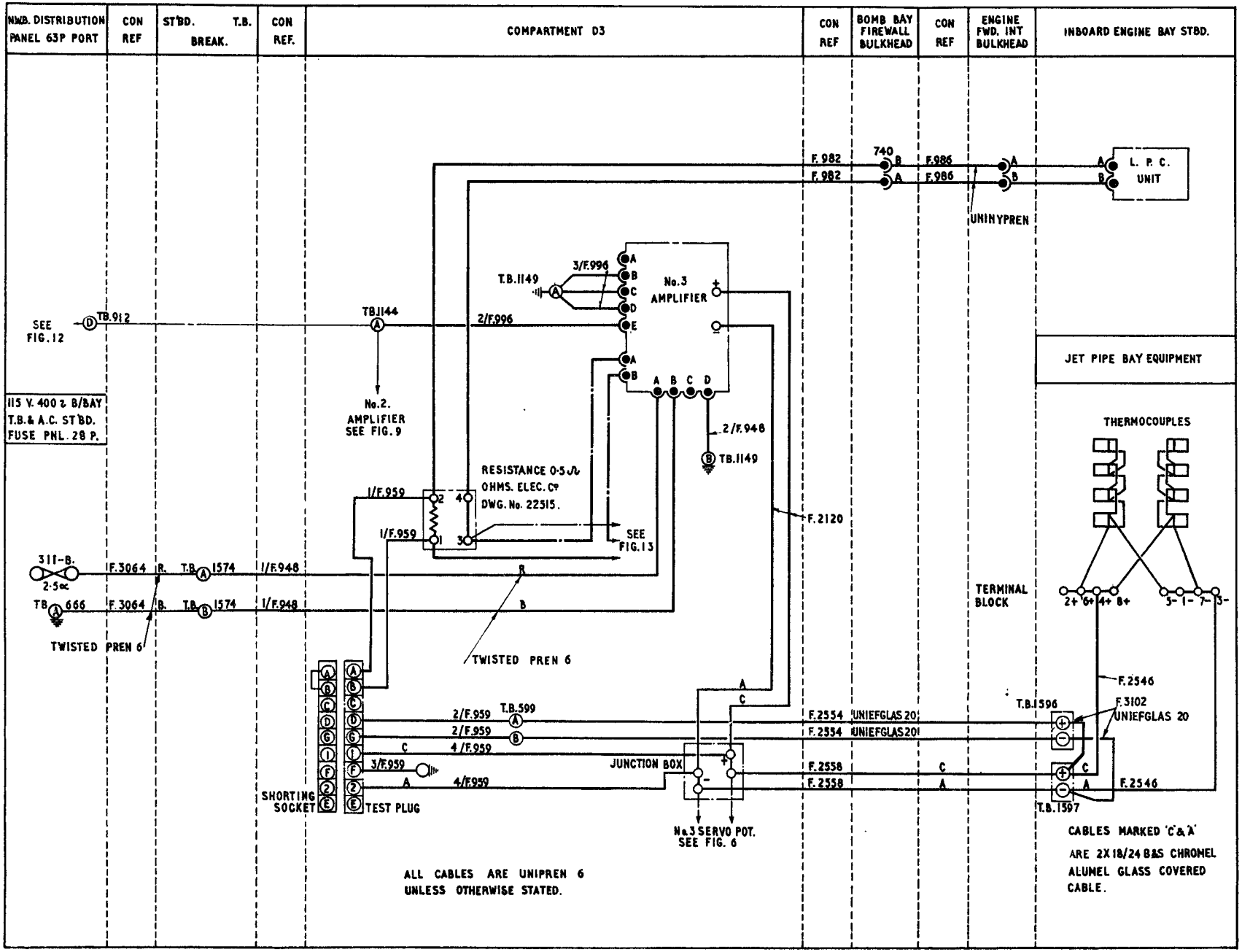


Fig.10. Jet pipe temperature limiters Nº 3.

◀ Change to fuse ident. and thermocouple wiring, mod. 1320 ▶

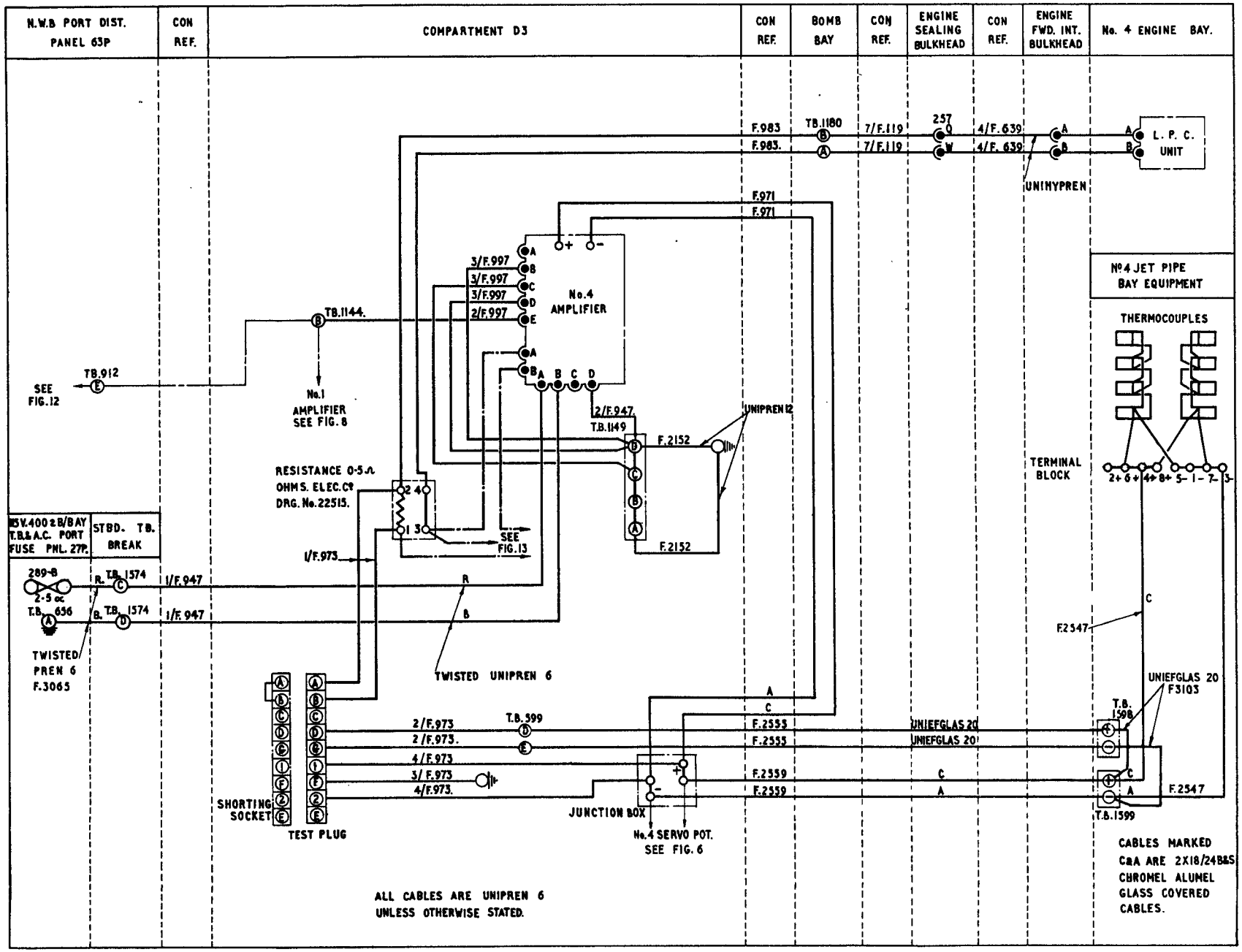


Fig.11. Jet pipe temperature limiters Nº4.

Change to fuse ident and thermocouple wiring. mod 1320

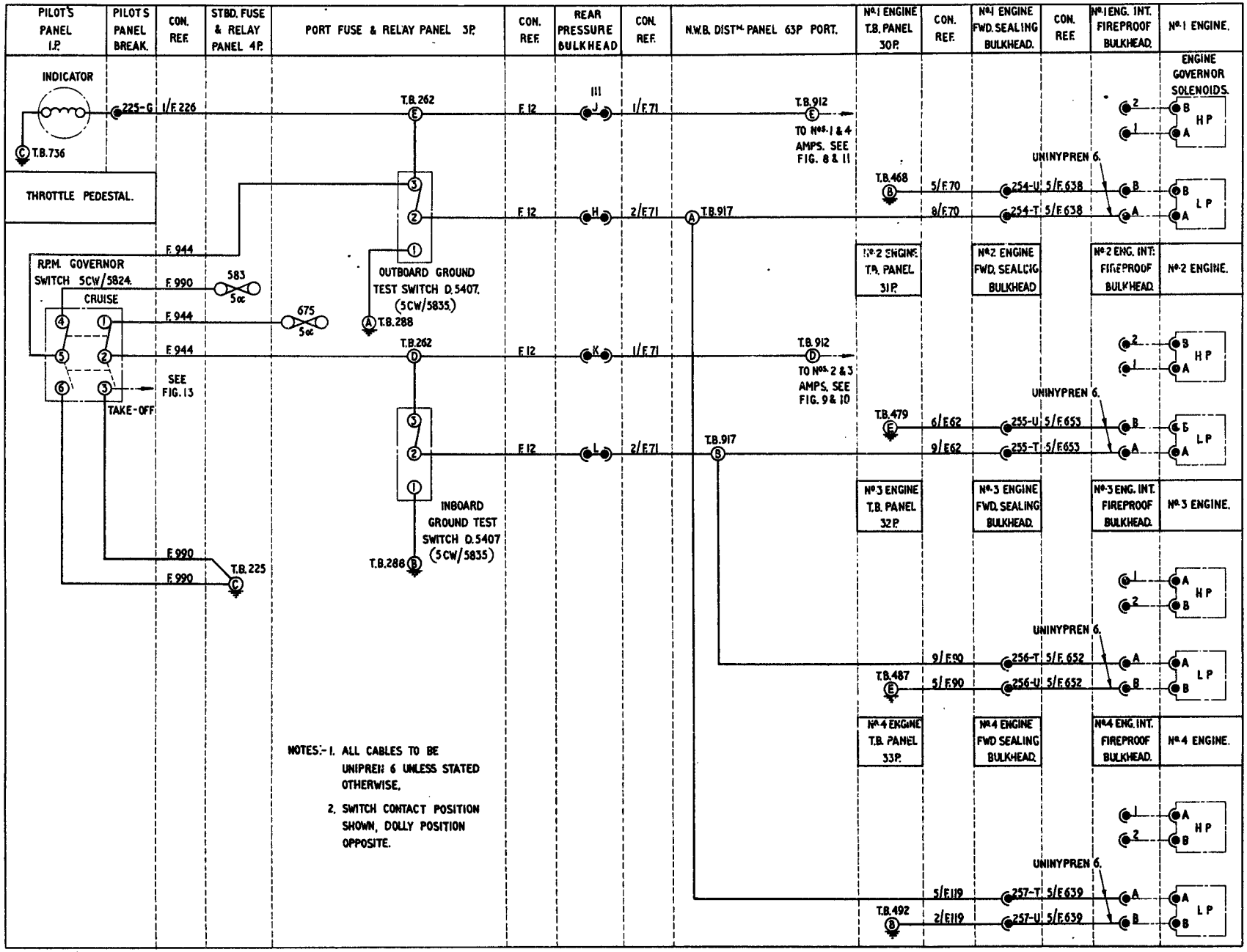


Fig. 12. R.P.M. governors.

◀ T.B 479E was B. T.B. 487E was B ▶

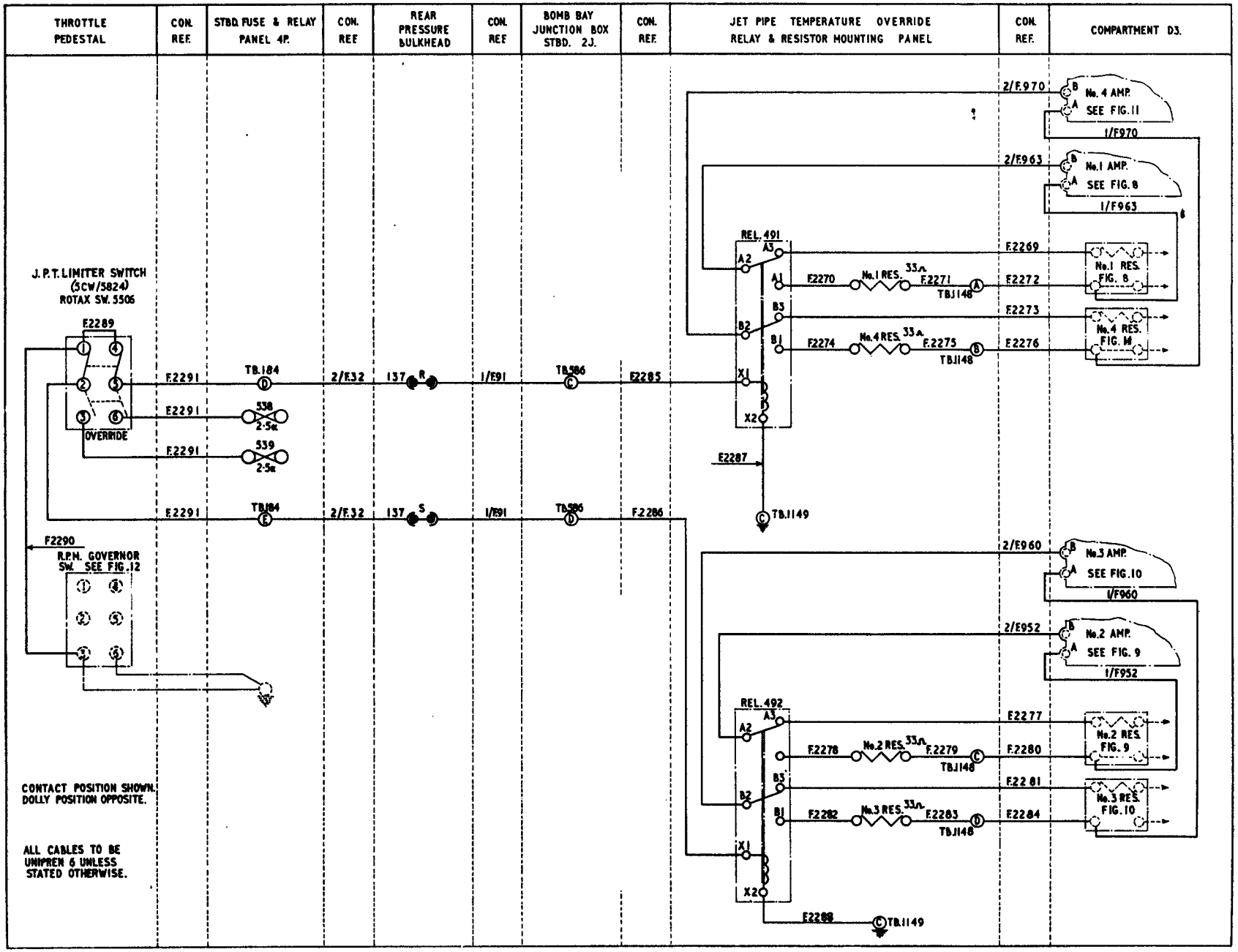


Fig. 13. J.P.T. override switching.
Ref. J.P.T. limiter switch added

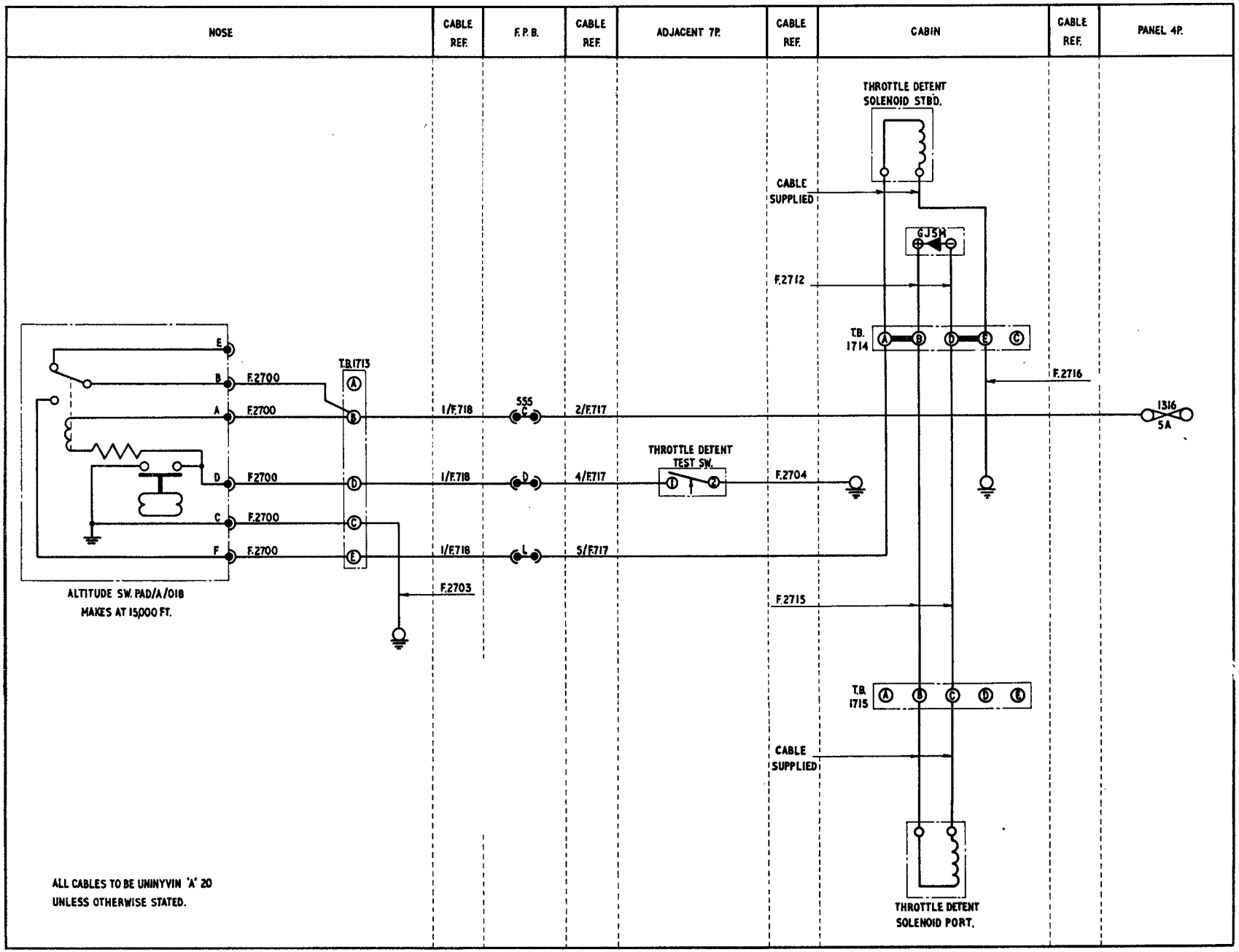


Fig. 14. Throttle detent solenoids.

Chapter 4

MISCELLANEOUS INSTRUMENTS

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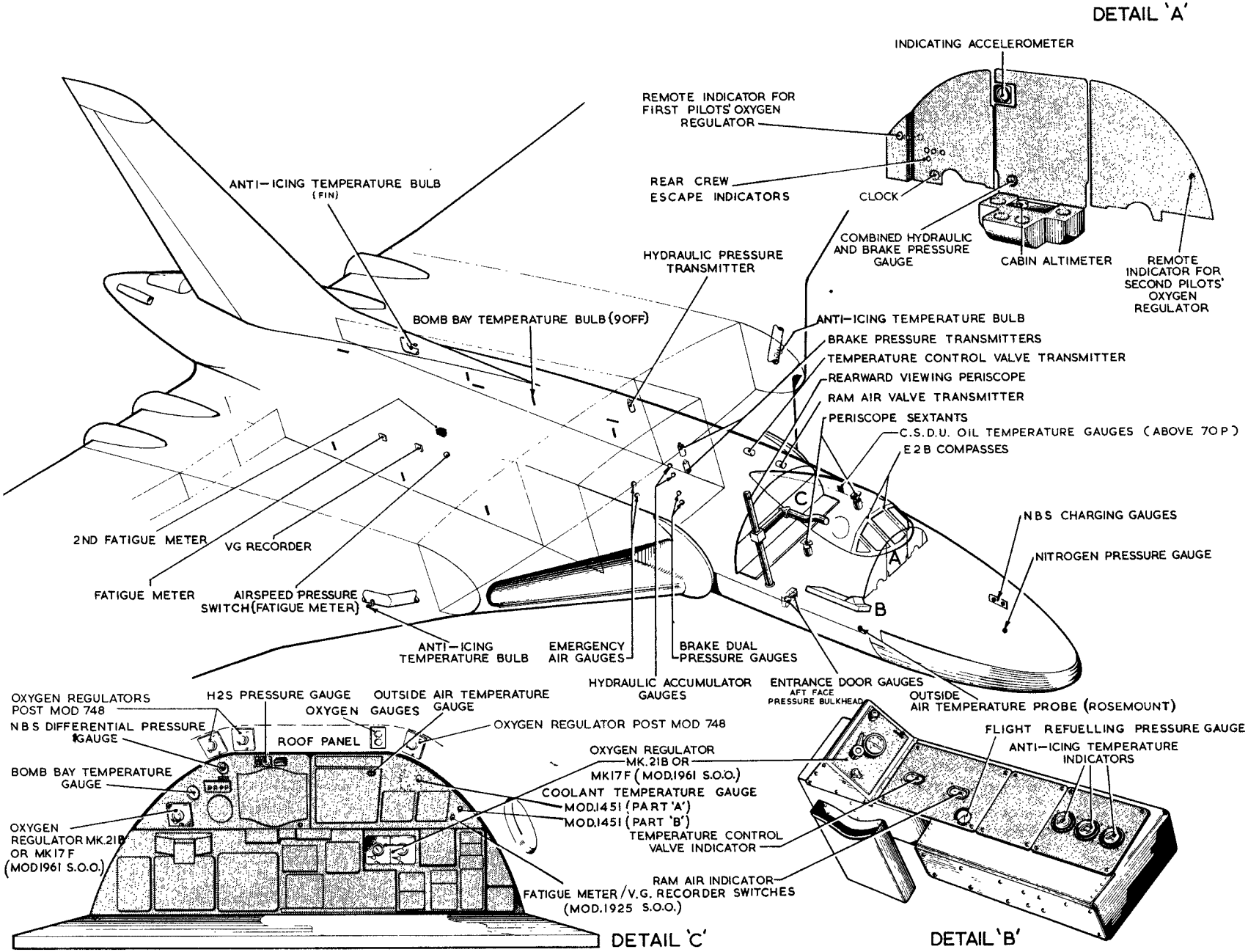

Fig. 1 Location of miscellaneous instruments.

◀ *Mod 2020 embodied* ▶

Introduction

1. This chapter contains descriptive and servicing information for those instruments which are not directly connected with a specific instrument installation. Routing charts for the electrical instruments will be found at the end of the text.

2. A complete description of all the instruments described in this chapter will be found in the 1275 series of Air Publications. In the following paragraphs reference will be made to the appropriate volume for the instrument being described. The location of the various instruments is shown in fig.1.

DESCRIPTION AND OPERATION

THERMOMETERS

3. The temperature indicators fitted in the aircraft are of the ratiometer type, each operated by a suitably positioned resistance bulb element. The indicators provide the pilots or crew with information regarding the temperature of the bomb bay, the outside air and the anti-icing ducts.

Bomb bay temperature indicator

4. A Type S63-5-668 indicator is installed on the radar operator's panel to provide a constant indication of the bomb bay temperature. The indicator has a scale calibrated over a range of -50 to + 50 deg.C. and is operated by nine resistance bulbs, Type S110G-4-505. The bulbs are connected in series-parallel and are situated at various points throughout the bomb-bay to provide an average temperature reading of the entire bomb bay.

5. A 28-volt d.c. supply is fed to the indicator from panel 48P, via fuse 712, as shown in the routing chart fig.2. The position of the indicator and bulbs is shown in fig.1 and a detailed description of the instrument will be found in A.P. 1275A, Vol.1, Sect.17, Chapter 12.

Outside air temperature indicator

6. Mounted alongside the compass repeater on the navigator's instrument panel is a Type S63-5-530 air temperature indicator. The indicator provides the navigator with an accurate indication of the outside air temperature and has a temperature range of from -80 to +80 deg.C. A Rosemount outside air temperature probe, Type 102U2K, is mounted on the starboard side of the aircraft forward of the pilots windscreen as shown in fig.1. The probe incorporates a resistance bulb and a de-icing heater element.

7. A 28-volt d.c. supply via fuse 698 in panel 48P is connected to the instrument as shown in fig.3. The de-icing heater element is switched on only during aircraft flight and is controlled from the starboard pitot head heater switch situated on the starboard console 7P. With reference to fig.3 it will be seen that a 115-volt, 400 c/s a.c. supply from fuse 740R in panel 75P is connected to the heater element via the closed contacts of relay 811 (energised). Relay 811 is energised via fuse 522 (panel 4P), the starboard pitot head heater switch and T.B.1524(C). Further details may be found in Book 2, Chap.13 of this publication. Details concerning the temperature indicator and Rosemount probe may be found in A.P. 1275A, Vol.1, Sect.17, Chap.11 and Chap. 34 respectively.

Anti-icing temperature indicators

8. To prevent the formation of ice along the leading edge of the fin and each wing, hot gasses from the engine are passed through ducting to raise the temperature of these surfaces. Located in each of the three ductings is a Type S110G-3-96 resistance bulb each of which is connected to one of three indicators on the anti-icing control panel on the starboard console. All three indicators are Type S63-4-591 with a temperature range of 0-200 deg.C.

9. The wing resistance bulbs are fitted in the air duct immediately outboard of each air intake whilst the bulb for the fin is located in the duct as it passes from the bomb bay into the fin between bomb arches 225·227 and 243·127.

10. The necessary 28-volt d.c. power supplies are provided from the starboard fuse and relay panel (4P) via three individual 2·5 amp. fuses as shown by the routing chart fig.4. The location of the various items is shown in fig.1 and for a complete description of the indicators and bulbs reference should be made to A.P.1275A, Vol.1, Sect.17. The thermometers form part of the de-icing system controls described in Book 2, Sect.6, Chap.14.

Coolant temperature indicator (Mod.1451)

11. A temperature indicator, Ref.No. 6A/3682, is fitted to the Nav/plotters panel (fig.1). The indicator is supplied from the aircraft 28-volt d.c. system via fuse 717 in panel 48P. Further details may be found in Book 2, Sect.6, Chap.22 of this publication, and details of the temperature indicator may be found in A.P.1275A, Vol. 1, Sect.17, Chap.11, App.8.

C.S.D.U. oil temperature gauges

11A. These four oil temperature gauges are fitted to a panel complete with pillar lighting above panel 70P. Further details may be found in Book 2, Sect.6, Chap.2 of this publication.

HYDRAULIC AND BRAKE PRESSURE GAUGE

12. Mounted on the pilots' centre panel is a combined hydraulic and brake pressure gauge Type S214-1-11. The indicator has a maximum reading of 6,000 p.s.i. and is operated by three transmitter units, Type S122-4-44.

Transmitter units

13. The two brake pressure transmitters

are fitted in the nose wheel bay as shown in fig.1. The main hydraulic transmitter is fitted on the port side of the bomb bay. Each transmitter consists of a Bourdon tube assembly which operates a d.c. potentiometer. Signals to the indicator are passed by special connecting leads Type FD766.

Indicator

14. This instrument is a triple-reading instrument designed to present the pilot with a quickly read indication of the brake and hydraulic pressures. The leads from the three transmitters are lead into the back of the indicator by a Cannon plug and socket and the information is presented by three individual pointer movements, each reading on a separate scale.

15. The indicator is fed with a 28-volt d.c. supply from the port fuse and relay panel (3P) via fuses 630, 631 and 632. A routing chart of the circuit is provided in fig.5. Further details of the indicator and transmitters will be found in A.P.1275A, Vol.1, Sect.16. Reference should be made to Book 1, Sect.3, Chap.6, for details of the hydraulic system.

AIR CONDITIONING INDICATORS

16. Two Desynn Type indicators are fitted on the starboard console to provide the pilot with a visual indication of the positions of the ram air valve actuator and the temperature control valve which are part of the air conditioning system. The air conditioning system is dealt with in Book 2, Sect.6, Chap.12

Control valve indicator

17. This indicator is a Type 423 FL instrument the scale of which is marked TEMP. CONTROL VALVE. The indicator is operated by a Type 135 FL Desynn transmitter which is mounted on the cabin air conditioning unit. The transmitter is mechanically linked to the control valve and will transmit all changes in its position to the indicator. A 28-volt d.c. supply is fed to the transmitter from fuse 793 in panel 16P as shown on the routing chart fig.6. Further details of the transmitter and indicator will be found in A.P.1275A, Vol.1, Sect.16, Chap.2.

Ram air valve indicator

18. The ram air valve indicator is a Type 231 FL instrument marked RAM AIR VALVE and mounted adjacent to the control valve indicator on the starboard console. The Type 135 FL transmitter which operates the indicator is mounted on the ram air valve actuator assembly and is fed with a 28-volt d.c. supply from fuse 826 in panel 19P. Further details of the transmitter and assembly will be found in A.P.1275A, Vol.1, Sect.16, Chap.2. Circuit details will be found in the routing chart for the air conditioning unit which is contained in Book 2, Sect.6, Chap.12.

FATIGUE METER

19. Mounted at the starboard side of the bomb bay at bomb arch 151·919 is a Type 1B fatigue meter. The purpose of the instrument which is of the counting accelerometer type, is to measure and record during flight the number and degree of vertical accelerations to which the aircraft has been subjected. Six electromagnetic counter units on the face of the instrument indicate the number of times that a pre-determined acceleration has been exceeded and this presents information from which it is possible to calculate the remaining fatigue life of the aircraft. An hour meter is provided on the face of the instrument to record the number of hours which the meter has been functioning. More detailed information on the fatigue meter is contained in A.P.1275A, Vol.1, Sect.12, Chap.4.

Airspeed pressure switch

20. To ensure that the fatigue meter operates only during actual flying time and not during take-off, landing and taxying periods the electrical supply to the meter is controlled by an airspeed pressure switch, Ref.No.6A/8165. The switch is mounted in the starboard side of the bomb bay at bomb arch 95·967 and is fed with a pressure and static supply from the starboard pitot-static system as described in Chapter 1.

21. The switch is designed to operate at airspeeds ranging from 165 to 140 knots ± 5 knots and will remain closed at all speeds greater than this range, thus completing the supply circuit for the meter. Reduction of airspeed to a value less than 140 knots will open the switch to break the supply. The 28-volt d.c. supply is fed to the switch from fuse 761 in the 28-volt distribution panel as shown in the routing chart fig.7. A complete description of the switch will be found in A.P.1275A, Vol.1, Sect.21, Chap.15.

Mod.912

22. On aircraft with Mod.912 embodied, the Mk.1B fatigue meter is replaced by a Mk.11 fatigue meter. This instrument provides more precise information for fatigue life calculations and is described in A.P.1275A, Vol.1, Sect.12.

Mod.1925 S.O.O.

22A. Some aircraft are fitted with a second fatigue meter, Ref.No. 6A/6485, mounted on the aft face of bomb arch 123A. A switching facility for both the second fatigue meter and the existing V.G. recorder has been provided, the two switches are positioned on the nav./plotters panel. The relevant routing chart is contained in fig.12.

OXYGEN INSTRUMENTS

Regulators

23. To supply the crew members with the correct ratio of oxygen and air in accordance with the cabin altitude, eight

oxygen regulators Mk.21B or Mk.17F(S.O.O. Mod.1961) are fitted in the aircraft at the following crew stations:-

1st pilot
2nd pilot
Air bomber
A.E.O.
Navigator
Nav. bomber
Sextant, port
Sextant, starboard

A visual indication that the regulator is functioning correctly is provided by a dolls-eye indicator mounted on the face of the regulator. At the three forward crew member positions, where the faces of the respective regulators are not always readily visible remote indicators are provided. The pilots each have an indicator on their respective instrument panels, and the air bomber's remote indicator is mounted above his prone bomb aiming position.

24. Each regulator is fed with an individual 28-volt d.c. supply to operate the indicator circuit. Fuses for the individual supplies are shown on the routing charts figs. 8 and 9. Further details of the regulators will be found in A.P.1275G, Vol.1. The oxygen system is described in Book 1, Sect.3.

Pressure gauges

25. Two Mk.4 pressure gauges are mounted on the navigator's roof panel to provide an indication of the supply pressure from the two oxygen supply sources. The gauges, Ref.No.6D/2237 are of the direct reading mechanical type and are fully described in A.P.1275G, Vol.1.

Mod.748

26. On aircraft with Mod.748 embodied, the three oxygen regulators at the rear crew positions have been moved and are now positioned on the navigators roof panel. Three oxygen indicators have also been added to the rear crew members panel as shown in fig.1 and fig.10.

PRESSURE GAUGES

N.B.S. pressurisation gauges

27. Certain items of N.B.C. and H2S equipment require to be pressurised as indicated in Chapter 5 and described in Book 1, Sect.3, Chap.7. The air is provided from two storage bottles fitted in the nose of the aircraft at the port side. Immediately above the bottles is a charging panel for the system which carries two Mk.14H direct reading pressure gauges. The gauges provide an indication of the pressure in the storage bottles.

28. Two further gauges are provided on the nav. bomber's panel. The first of these, the N.B.S. differential gauge, is a Type K.P.A.0102c twin pointer, direct reading pressure gauge with a range from -3 to+20 p.s.i. The second instrument is a Type K.P.D./0103c direct reading, single pointer pressure gauge with a pressure range from -10 to +20 p.s.i. A complete description of all the N.B.S. pressure gauges will be found in A.P. 1275A, Vol.1, Sect.15.

Emergency air gauges (alighting gear)

29. Two Mk.14LL mechanical pressure gauges are installed on the air charging panel in the nose wheel bay. These gauges register the pressure of the two emergency air supplies to the alighting gear and have a pressure range from 0 to 4,000 p.s.i.

Emergency air gauges (entrance door)

30. Two MK.14KK direct reading pressure gauges are mounted on a panel located on the rear pressure bulkhead in the nose wheel bay. The gauges indicate the pressure of the normal and emergency air supplies to the entrance doors and have a pressure range from 0 to 3,000 p.s.i.

Accumulator gauges and brakes pressure gauges

31. Two Mk.14LL pressure gauges are fitted on the hydraulic panel in the nose wheel bay. Each gauge has a range of pressure from 0-4,000 p.s.i. and indicates the pressure within its associated accumulator. Immediately below these gauges on the same panel are two dual reading Type A.H.O.29130 brakes pressure gauges. The gauges have a maximum scale reading of 3,000 p.s.i. and indicate the pressure in the individual brake lines.

T4 bombsight pressure gauges

32. An air storage bottle fitted beneath the pilot's floor is used to provide a pneumatic supply for the T4 bombsight computor. An indication of the pressure available is provided by a direct reading gauge mounted immediately below the entrance door gauges on the rear pressure bulkhead in the nose wheel bay. The gauge is a Mk.14KK instrument with a pressure range from 0 to 3,000 p.s.i. A second gauge is mounted beside the stop valve on the aft face of the pilot's floor. This gauge is a Mk.14B instrument with a lubber line set at 60 p.s.i.

Nitrogen purge gauge

33. A nitrogen purge system is installed in the aircraft to rid the flight refuelling system of excess fuel after refuelling has been completed. A charging panel for the system is located in the nose of the aircraft at former 470. A Mk.14H pressure gauge is fitted on the panel to indicate the pressure of nitrogen available. The gauge is of the direct reading type and has a pressure range from 0 to 2,000 p.s.i.

33A. A fuel pressure gauge, Ref.No.6A/6173, is mounted on the starboard console and shows the pressure in the fuel line when the aircraft is being flight refuelled.

indicate the cabin pressure in terms of altitude and so enable the crew to adjust their oxygen supply accordingly. The instrument operates on the aneroid principle and has a range from 8,000 to 50,000 ft. Further details of the altimeter will be found in A.P.1275A, Vol.1, Sect.22, Chap.16.

CLOCK

46. A Mk.4 aircraft clock is mounted on the first pilot's instrument panel. The clock has a conventional 8-day movement and is provided with a centre seconds sweep hand and a re-setting knob. The clock is fully described in A.P.1275B, Vol.1, Sect.1, Chap.9.

E2B MAGNETIC COMPASSES

47. Two E2B magnetic compasses are provided in the aircraft for emergency use. The compasses are fitted one at each pilots' station on the windscreen above the instrument panels. A full description of the compasses will be found in A.P. 1275B, Vol.1, Sect.10, Chap.8. Before using the compasses the pilots' leg straps should be removed from their stowages and the windscreen wipers (if in use) switched off.

SERVICING

THERMOMETERS

48. The bomb bay, outside air and anti-icing temperature gauges require little in the way of normal servicing. Where possible the indicators and bulbs should be checked for signs of external damage and all plugs and sockets examined for security and tightness of connections.

49. Items which are suspected of being unserviceable should be tested in accordance with the instructions given in the appendix to the appropriate chapter of A.P.1275A, Vol.1, Sect.17.

HYDRAULIC AND BRAKE PRESSURE GAUGE

50. During the normal inspection periods the three transmitters and the gauge should be examined for signs of damage and security of connections. Providing the gauge is functioning correctly nothing further need be done. Advantage should be taken of checks on the hydraulic and brake systems by other trades so that functioning of the gauge may be observed during actual pressure changes in the systems. Defective items should be removed and returned for repair. Replacement items should then be fitted.

AIR CONDITIONING INDICATORS

51. Servicing of the temperature control valve indicator and the ram air valve indicator is limited to visual examination for security and signs of damage. The operation of the indicators should be checked during functioning of the air conditioning equipment as described in Book 2, Sect.6, Chap.12. A Desynn tester is available for checking the accuracy of the transmitters and indicator when necessary. A description of the tester, Ref.6C/470, together with the method of use is given in A.P.1275T, Vol.1, Sect.5, Chap 1.

FATIGUE METER

52. At the appropriate inspection periods the meter should be checked for security of connections and signs of external damage. After a specified number of flying hours check that the counter readings have altered since the last reading although differences may only be apparent on the counters nearest to 1g. If no difference is apparent reference should be made to the standard serviceability tests in A.P.1275A, Vol.1, Sect.12, Chap.4. Before doing this however the supply to the meter should be checked in accordance with the instructions given in para.53. At the same time ensure that the red transit screws have not inadvertently been left in the meter.

53. The hour meter readings should also be checked to ensure that they approximately tally with the Airframe Log. In the case of any discrepancy reference should again be made to the standard serviceability tests in A.P.1275A, Vol.1, Sect.12, Chap.4. The hour meter will not operate unless the polarity of the supply is correct i.e., Pin A-Ve Pin B+Ve.

Airspeed pressure switch

54. The switch should be examined for security, external damage, and signs of leakage. The switch may be checked by disconnecting from the meter the two pin supply plug, which is fed via the switch. A suitable test lamp should then be connected across the supply plug. By introducing an A.S.I. calibrator into the pressure line of the starboard pitot-static system pressure should be gradually applied to the switch and a note made of the airspeed at which the lamp lights. Pressure should be gradually increased until it approximately reaches the maximum speed of the aircraft. Reduce the pressure and note the airspeed at which the lamp goes out. The airspeeds noted should be within 165 to 140 knots ± 5 knots. Further tests on the switch will be found in Appendix 1 to Chapter 15 of A.P.1275A, Vol.1, Sect.21.

OXYGEN INSTRUMENTS

Mk.21 regulators

55. The regulators should be examined

for security and signs of external damage. The regulators should also be exercised and checked as described in A.P.1275G, Vol.1, Sect.2, Chap.15. If the serviceability of any regulator is suspect it should be removed from the aircraft and subjected to the Standard Serviceability Test which will be found in the Appendix 1 to the aforementioned chapter.

PRESSURE GAUGES

N.B.S. gauges

56. Little in the way of servicing is required by these instruments. A visual inspection of the gauges together with a check of the zero reading is all that is required. Gauges suspected of being unserviceable should be removed from the aircraft and subjected to the tests given in the Appendix to the appropriate chapter of A.P.1275A, Vol.1, Sect.15.

Emergency air gauges

57. The Mk.14 pressure gauges employed in these systems should be visually examined for security and signs of damage. During the normal inspection periods, or whenever their serviceability is suspect, the tests given in the Appendix 1, to Chap.6, of A.P.1275A, Vol.1, Sect.15, should be applied.

Accumulator gauges

58. These gauges should be examined for signs of external damage and tested during normal servicing periods in accordance with the instructions given in A.P.1275A, Vol.1, Sect.15, Chap.6, App.1.

Brakes pressure gauges

59. No repairs to these gauges are permissible and servicing is confined to a visual check for security and signs of damage. Whenever the serviceability of the gauges is suspect the tests outlined in A.P.1275A, Vol.1, Sect.15, Chap.10, App.1 should be applied.

T4 bombsight pressure gauges

60. The gauges should be examined externally for signs of damage and security of mounting. Should any gauge appear to be unserviceable it should be subjected to tests laid down in A.P.1275A, Vol.1, Sect.15, Chap.6.

Nitrogen purge gauge

61. Apart from visual examinations little in the way of servicing can be done for this type of gauge. During the normal inspection periods or whenever the gauge is suspect the tests outlined in A.P.1275A, Vol.1, Sect.15, Chap.6, App.1, should be applied.

V.G. RECORDER

62. Complete information on the care and handling of the V.G. recorder will be found in the Ministry of Aviation leaflet. It is essential that the Vickers 4-way cock be locked in the OFF position whenever the recorder is not fitted.

REARWARD VIEWING PERISCOPE

63. To ensure maximum viewing facilities the window for each head should be kept free from grease and dirt at all times. The controls should be manipulated periodically to check response to mirror rotation and the viewing change-over controls. Instructions for functioning the periscope heaters will be found in Book 2, Sect.6, Chap.13. Full servicing instructions for the periscope will be found in the appropriate volume of A.P. 1275.

INDICATING ACCELEROMETER

64. Under normal conditions the accelerometer requires very little servicing apart from regular visual checks for security and freedom from damage. More detailed instructions for static tests prior to installation will be found in A.P.1275A, Vol.1, Sect.21.

AIRCRAFT CLOCK

65. The 8-day clock should be wound regularly and occasionally checked for correct timekeeping. The chronometer watch (Ref.6B/60) is available for testing aircraft clocks and a serviceability check for clocks prior to installation is contained in A.P.1275B, Vol.1, Sect.1, Chap.9. After a period of twelve months service the clock should be returned to the appropriate depot for re-oiling.

PERISCOPIC SEXTANT

66. Servicing of the periscopic sextant is contined to a visual check of the optical system and a functioning check of the heating and lighting circuits. Any sextant considered suspect should be checked in accordance with the Standard Serviceability Test contained in the Appendix to Chap.6, A.P.1275B, Vol.1, Sect.13, Chap.1.

CABIN ALTIMETER

67. No routine servicing is required by the cabin altimeter. If it is suspected of being defective should be subjected to the Standard Serviceability Test contained in the Appendix 1 to A.P.1275A, Vol.1, Sect.22, Chap.16.

E2B MAGNETIC COMPASSES

68. Apart from a visual examination for security, cleanliness and freedom from damage no servicing is required by the E2B compasses. Faulty or damaged compasses should be removed from the aircraft and replaced by serviceable

items. During compass swinging operations or whenever the compasses are being adjusted always ensure that the pilots' leg straps are removed from their stowage and that the windscreen wipers are not used. Information on compass correction is contained in A.P.1275B, Vol.1, Sect.10, Chap.8. The compass sighting rods are described in Chap.7.

REMOVAL AND INSTALLATION

General

69. Except for certain items detailed in the following paragraphs, removal of the miscellaneous instruments is straightforward and no special instructions are required. To remove instruments from the pilots' and navigator's panels it will first be necessary to remove or lower the actual panels; this is covered in Chapter 1 of this section. Console panels are easily unscrewed to permit removal of the attached instruments.

PRESSURE GAUGES AND TRANSMITTERS

WARNING...

No attempt must be made to remove any gauge or transmitter from pressure pipe lines until the pressure in the system has been relieved in the manner described in the appropriate section of Book 1 of this publication.

70. None of the gauges or transmitters described in paras.25 to 33 should present any difficulty when being removed providing the warning given above has been observed.

ANTI-ICING TEMPERATURE BULBS

71. Two access panels are provided one in each wing for servicing the wing de-icing temperature bulbs. The panels are on the underside of each leading edge immediately outboard of the air intakes. A tab is provided in the heating duct for wire-locking the bulbs in place. When replacing a bulb always ensure that the new bulb is locked to the tab in a secure manner.

PERISCOPIC SEXTANT MOUNTINGS

72. Before attempting to remove the periscopic sextant mountings reference should be made to Book 1, Sect.3, Chap.1 as this operation affects the sealing of the pressurised cabin.

REARWARD VIEWING PERISCOPE

73. The periscope tube must be dismantled and removed in sections. Instructions for the removal and replacement of viewing heads are given in Book 1, Sect.3, Chap.1.

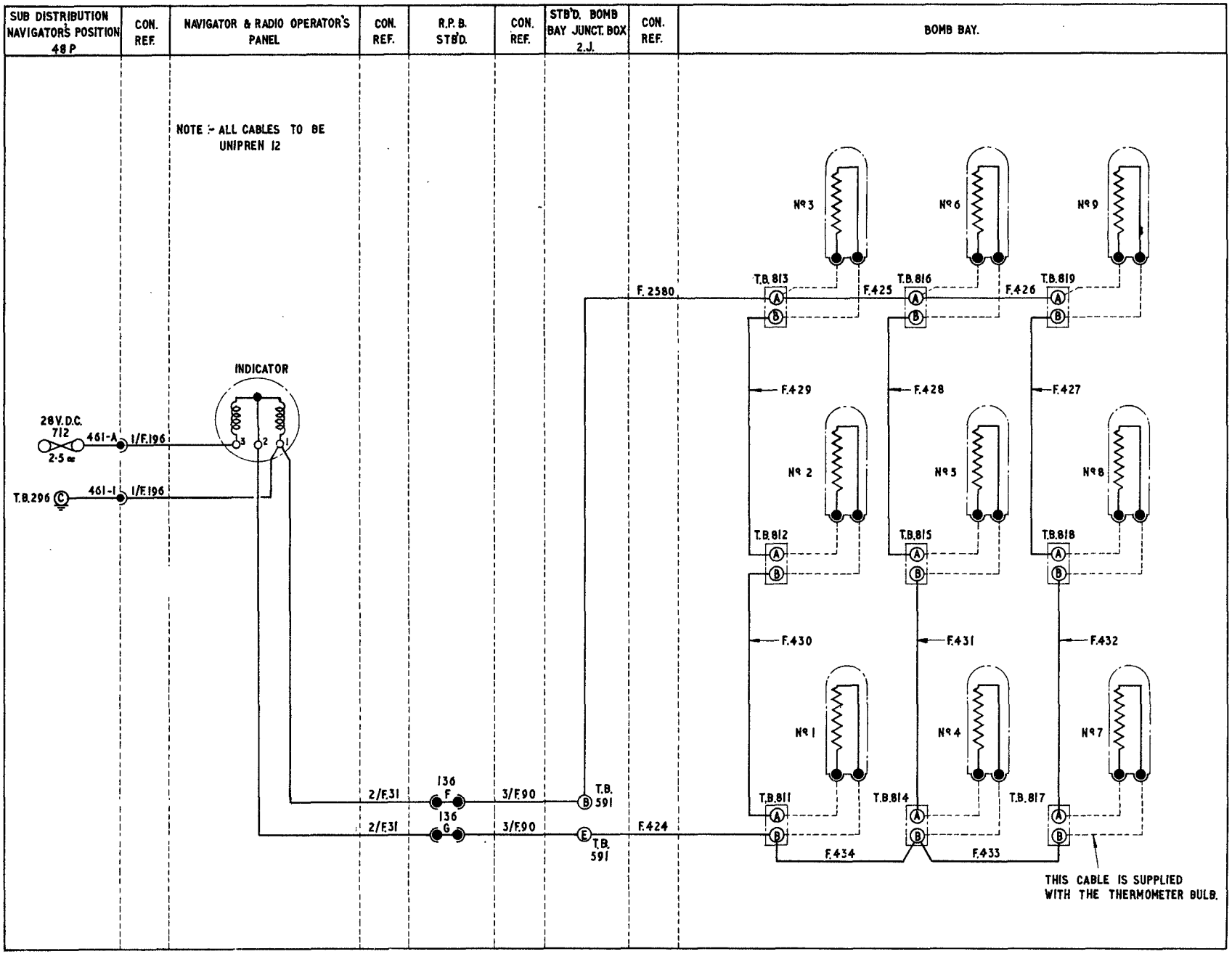

Fig.2 Bomb bay temperature indicator

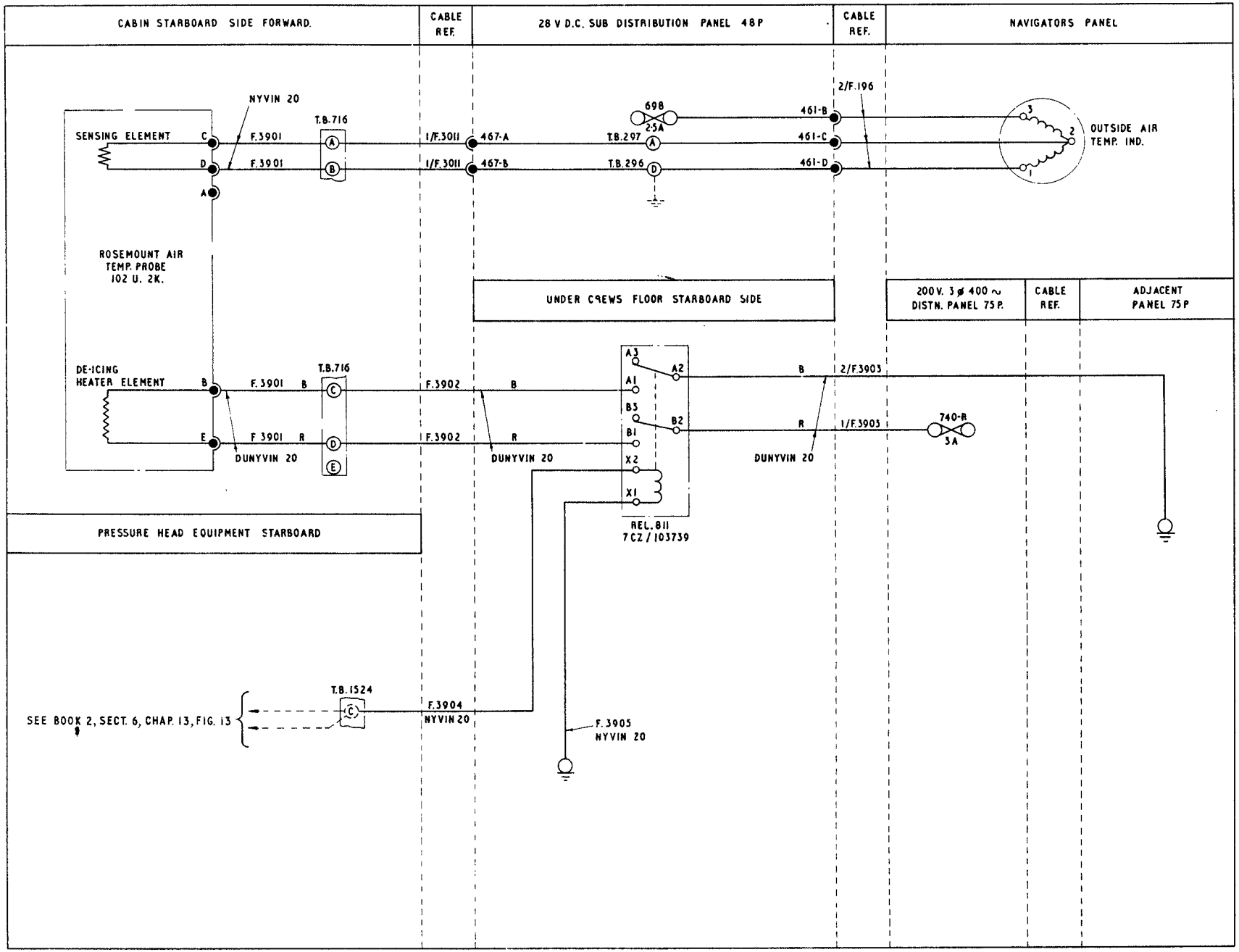

Fig. 3 Outside air temperature indicator

◄ Mod. 2020 embodied ►

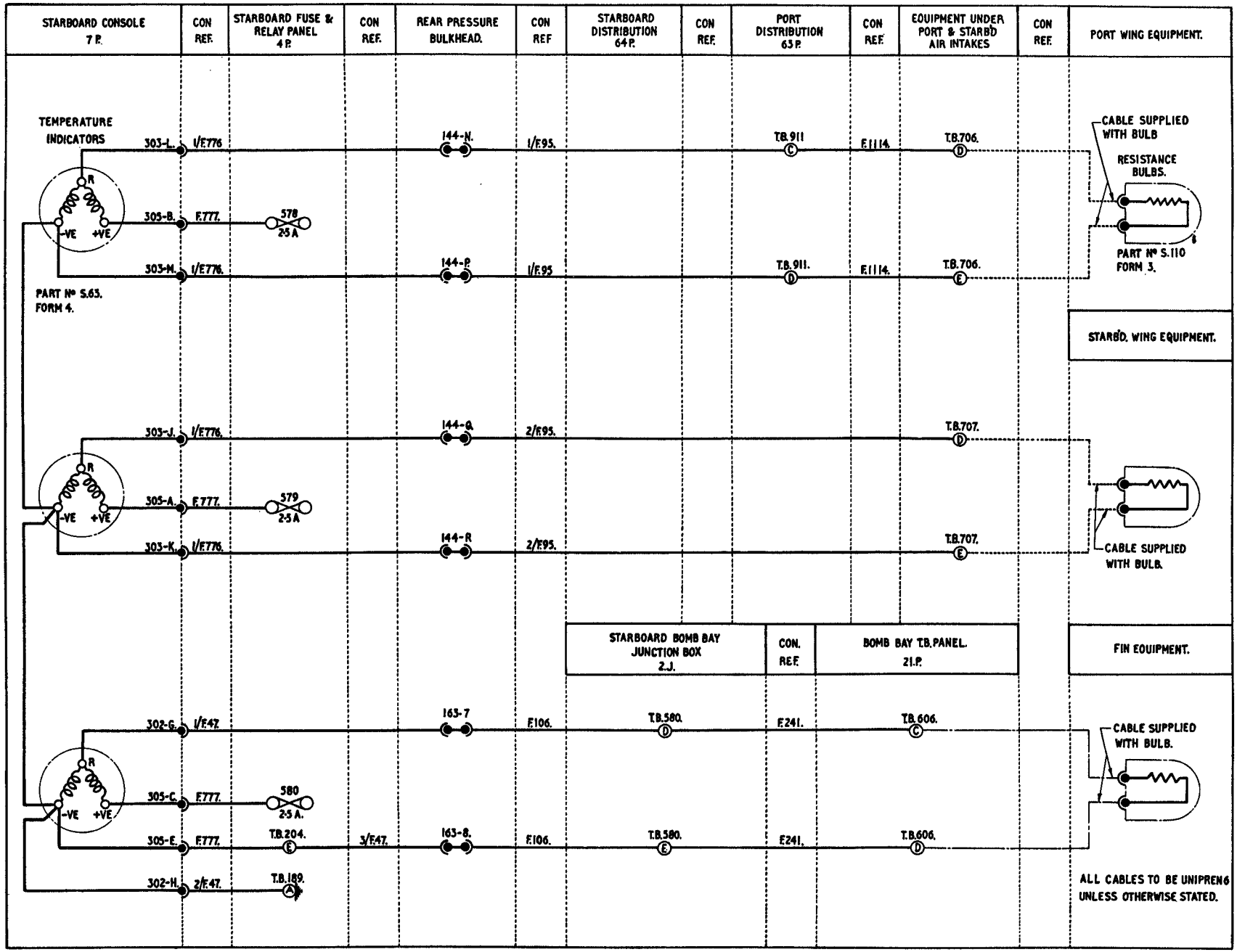

Fig.4 Anti-icing temperature indicator

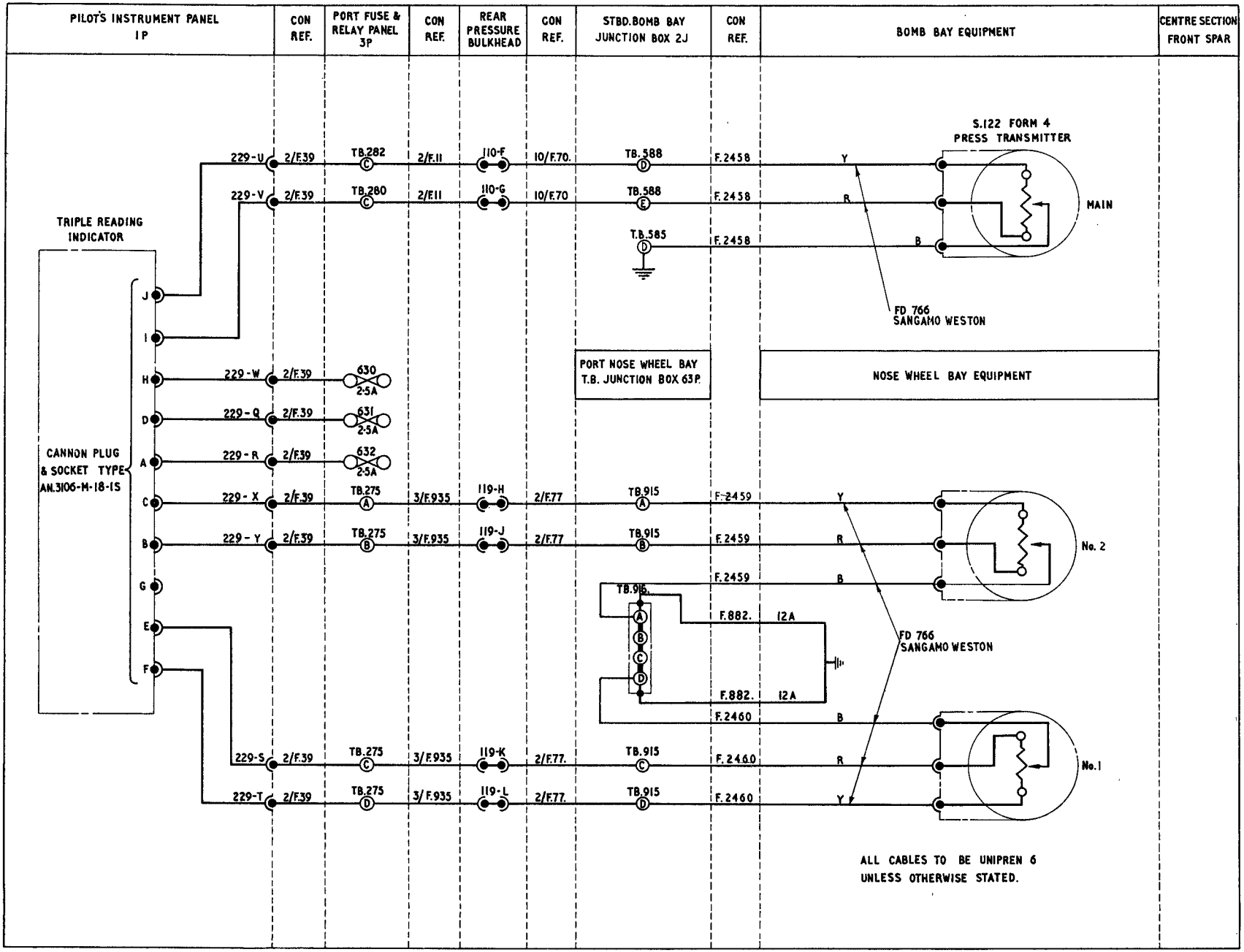

Fig.5 Hydraulic and brake pressure gauge

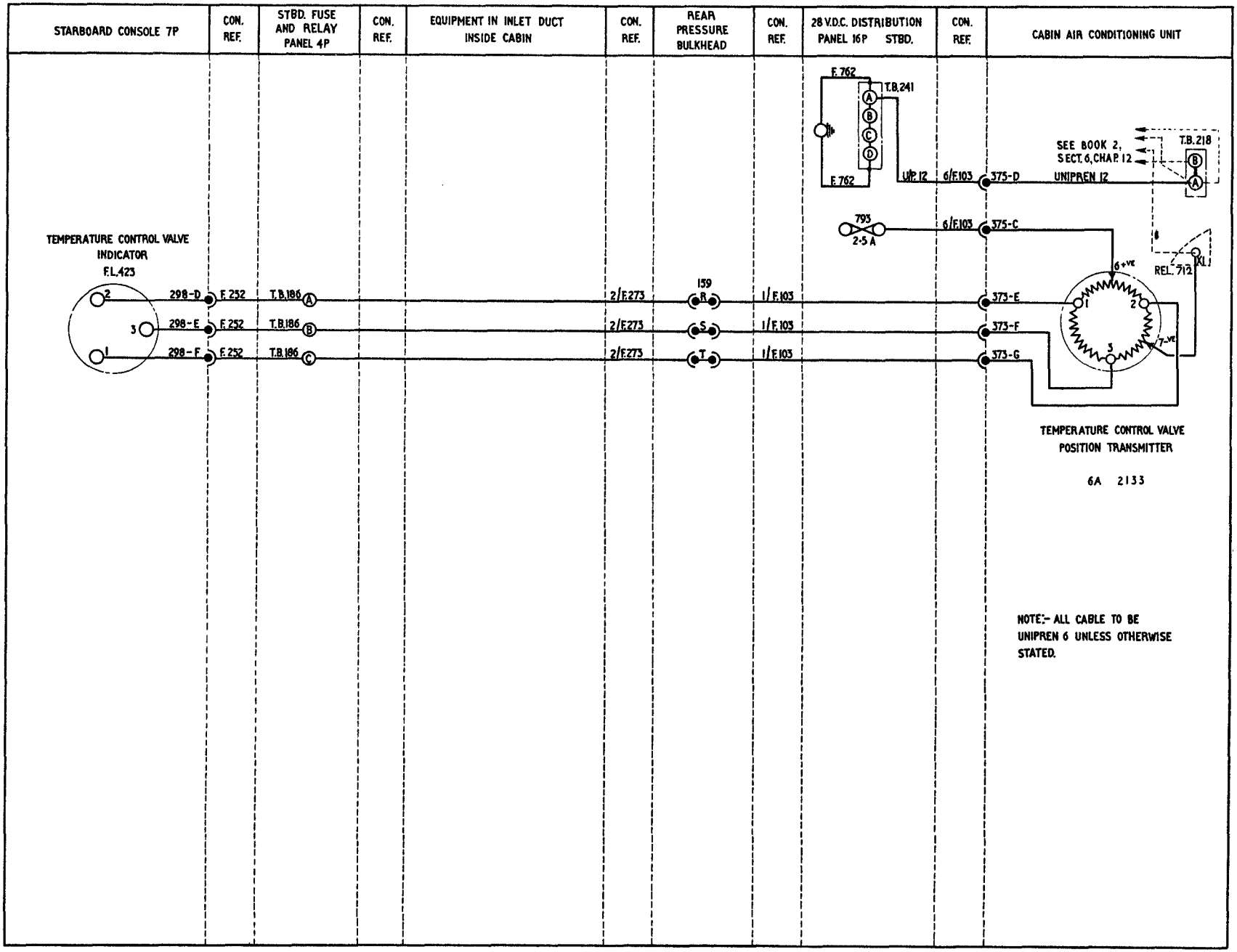

Fig. 6 Cabin temperature control valve indicator
◂Mod. 1969 embodied▸

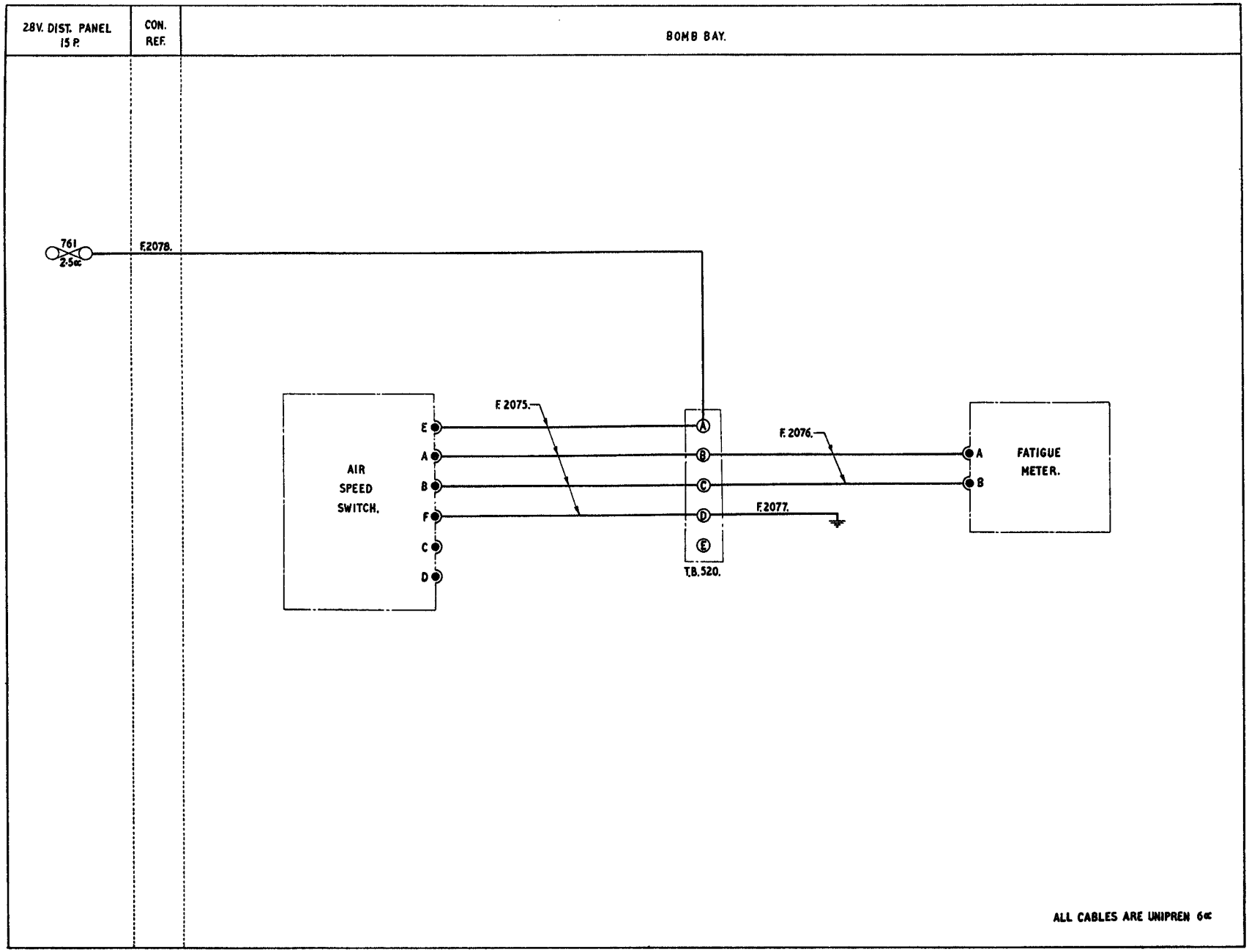

Fig.7 Fatigue meter

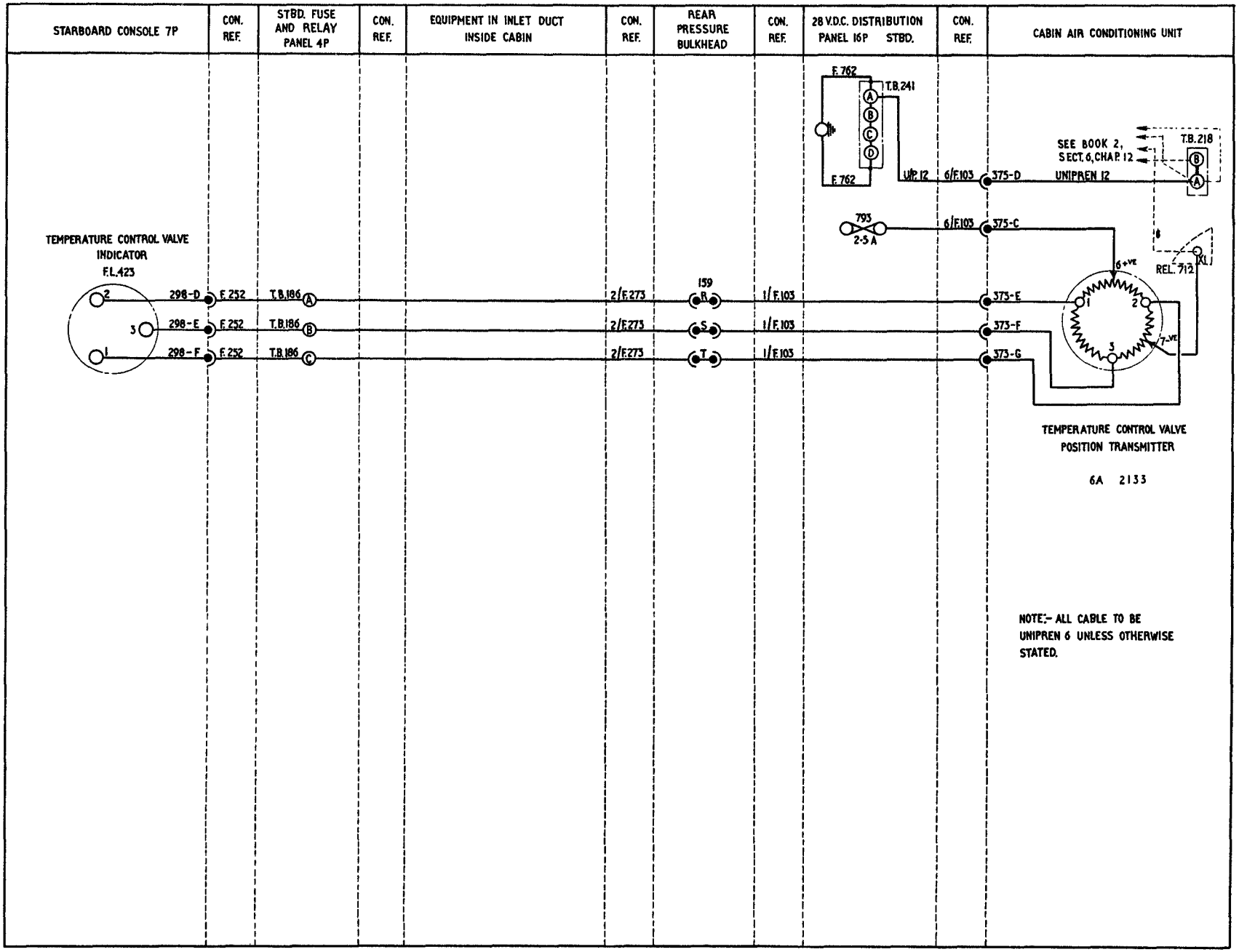

Fig. 6 Cabin temperature control valve indicator

<Mod. 1969 embodied>

RESTRICTED

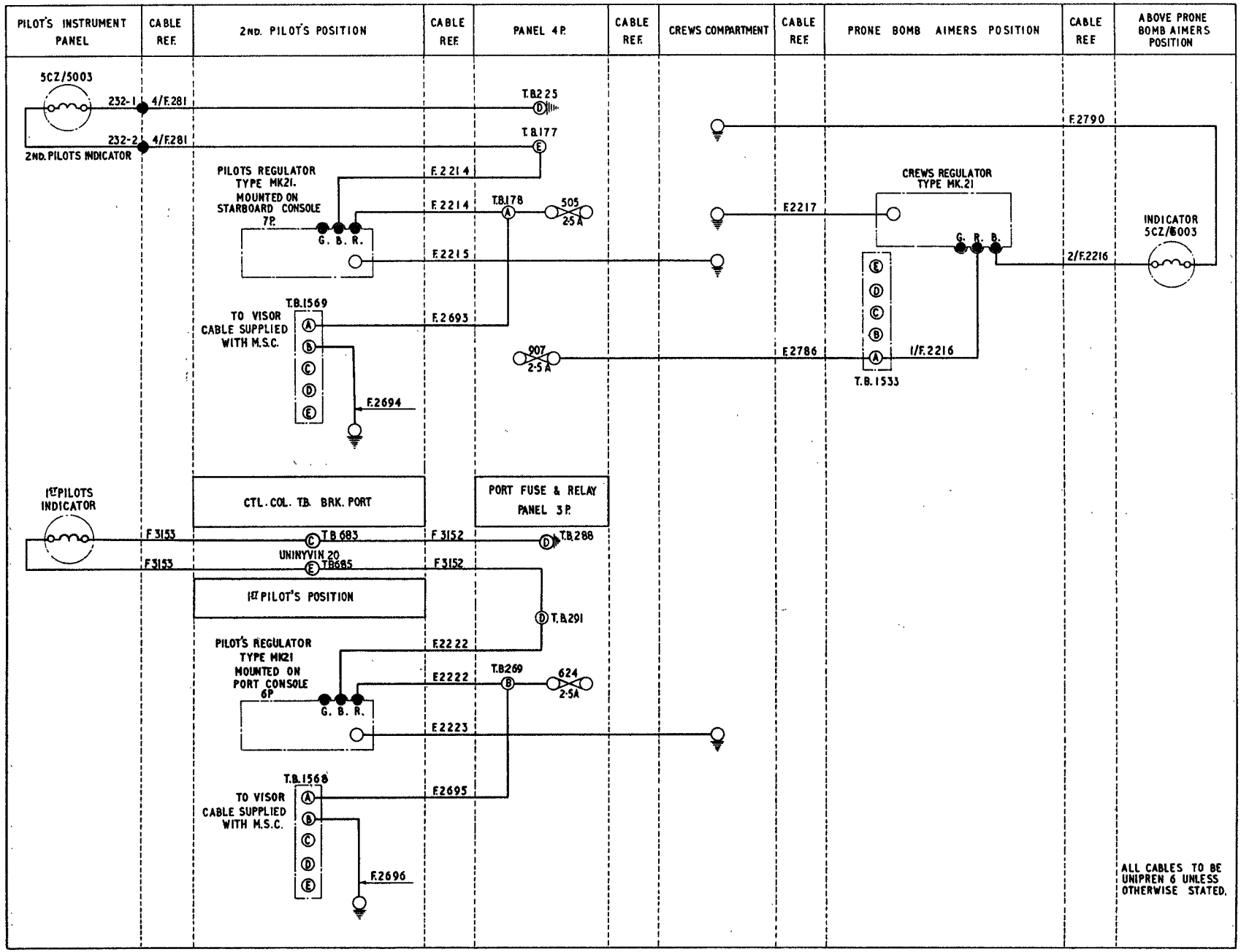

Fig. 8. Oxygen regulators, forward crew members

◂ Mods 908 and 1801 embodied ▸

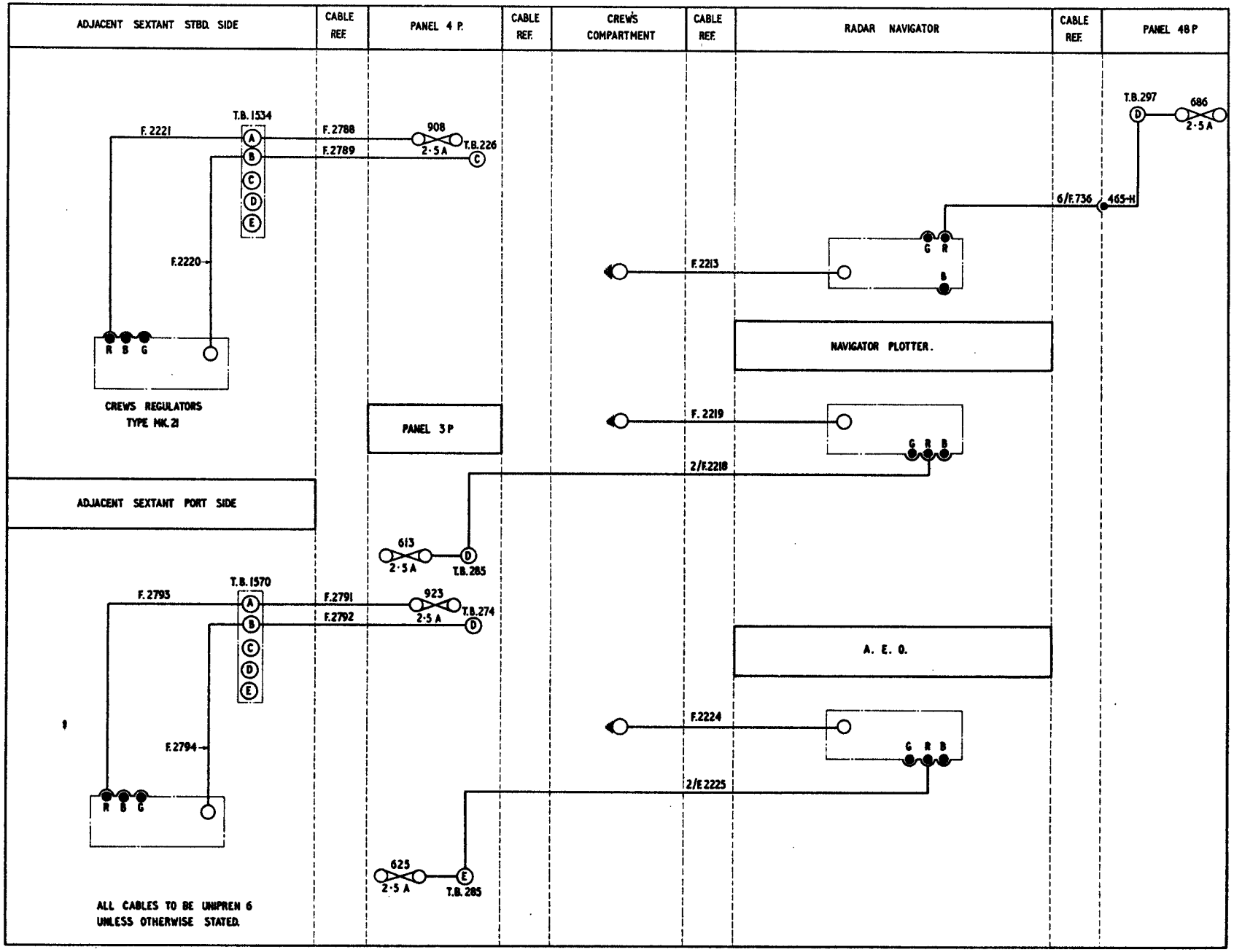

Fig. 9 Oxygen regulators, aft crew members.

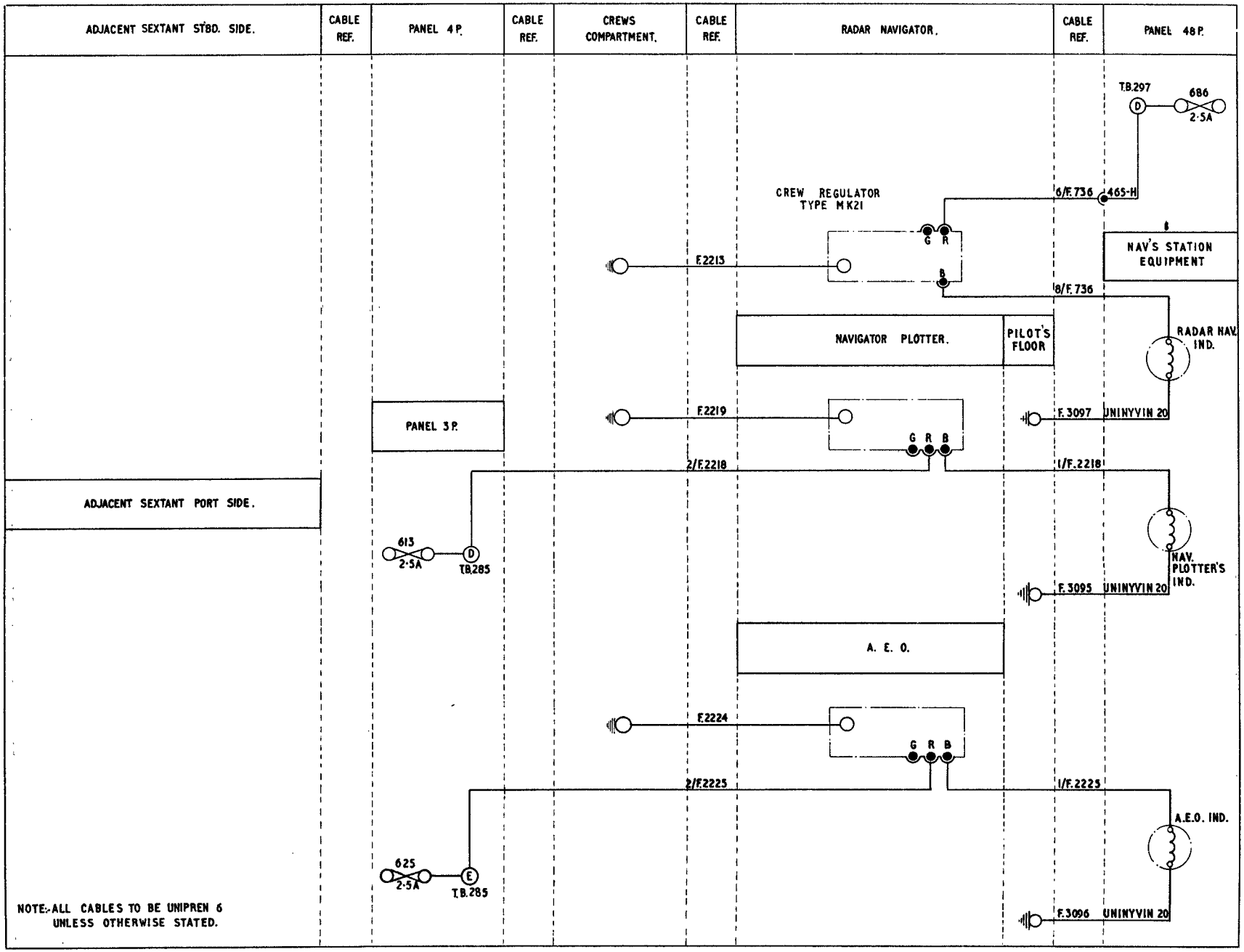

Fig. 10 Oxygen regulators, aft crew members (post mod. 748)

◀ *Mods. 1696 and 1801 embodied* ▶

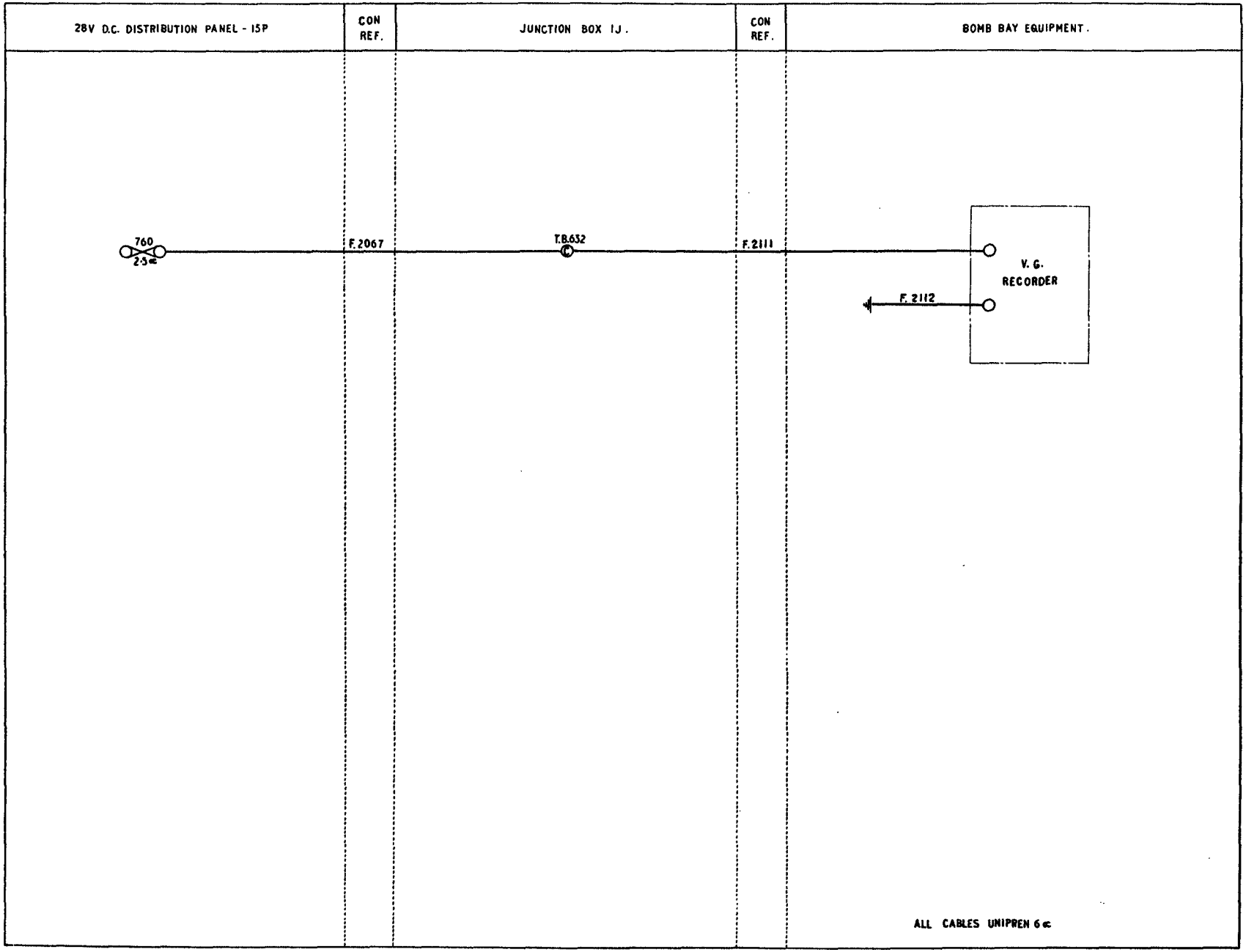

Fig.11 V.G. recorder

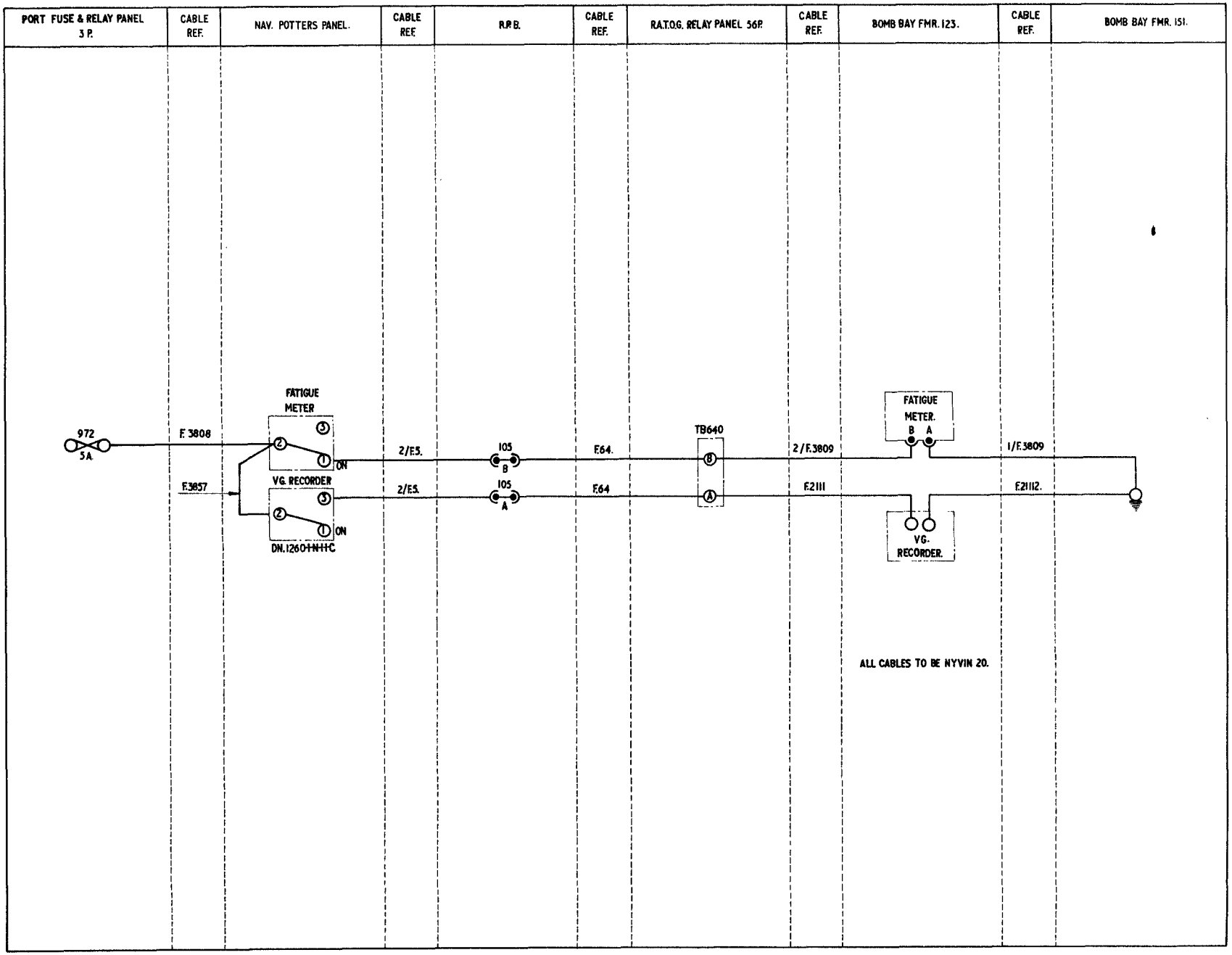

Fig. 12 2nd. fatigue meter and V.G. recorder(S.O.O.)

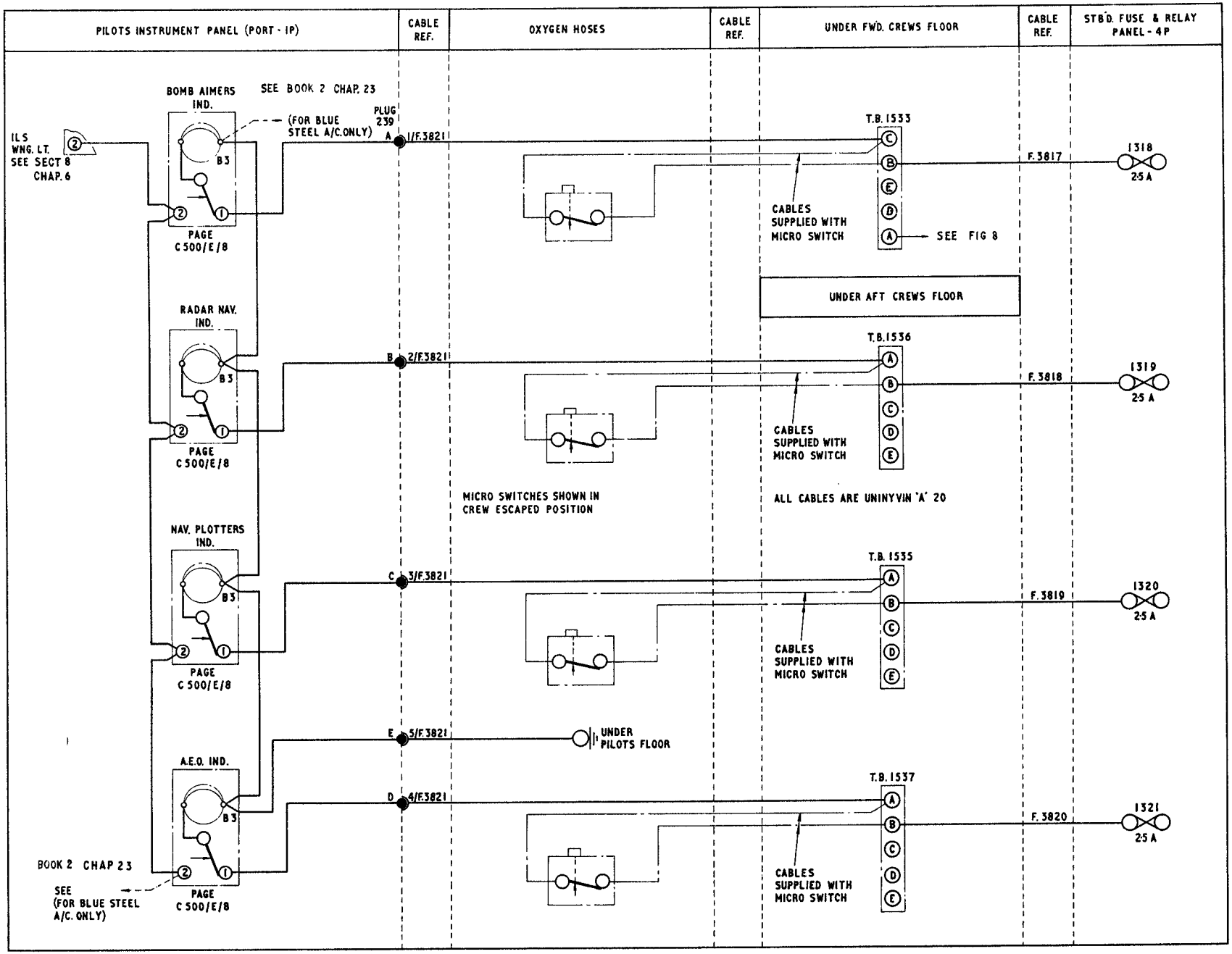

Fig. 13 Escape indication

Chapter 5

ARMAMENT INSTRUMENTS

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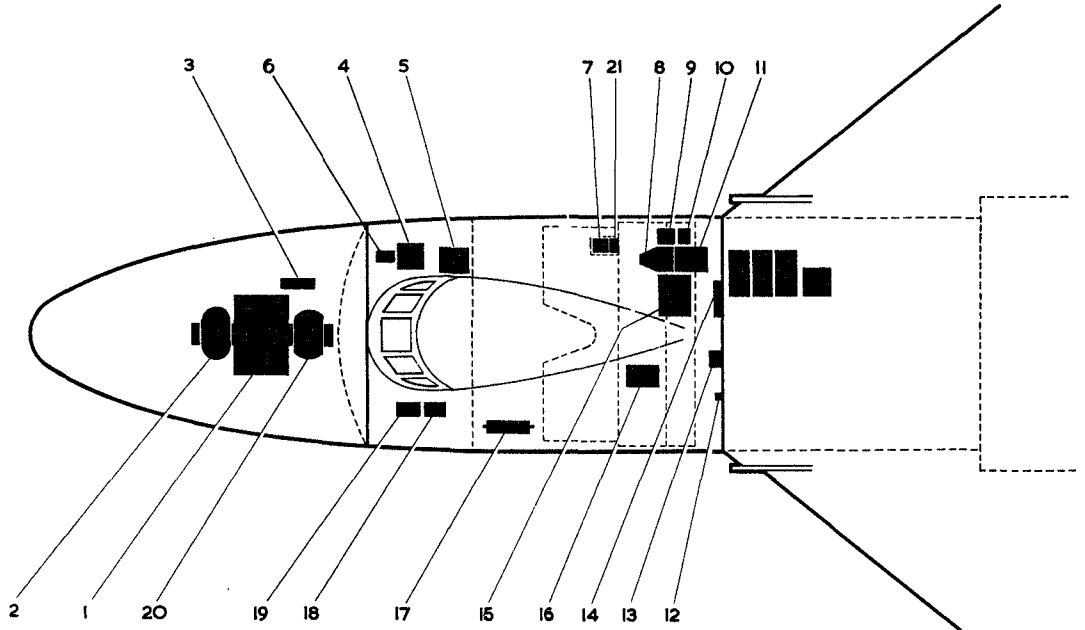
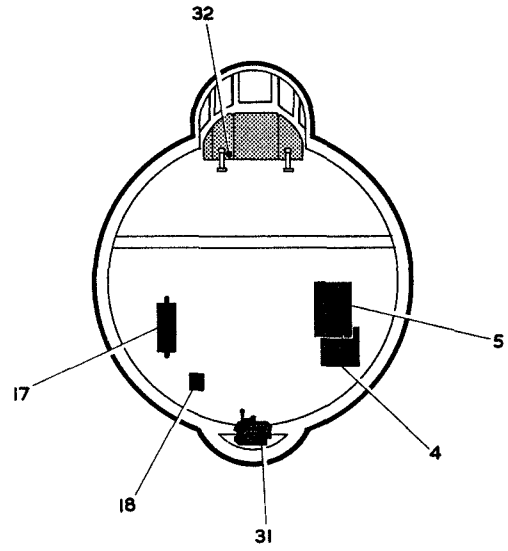
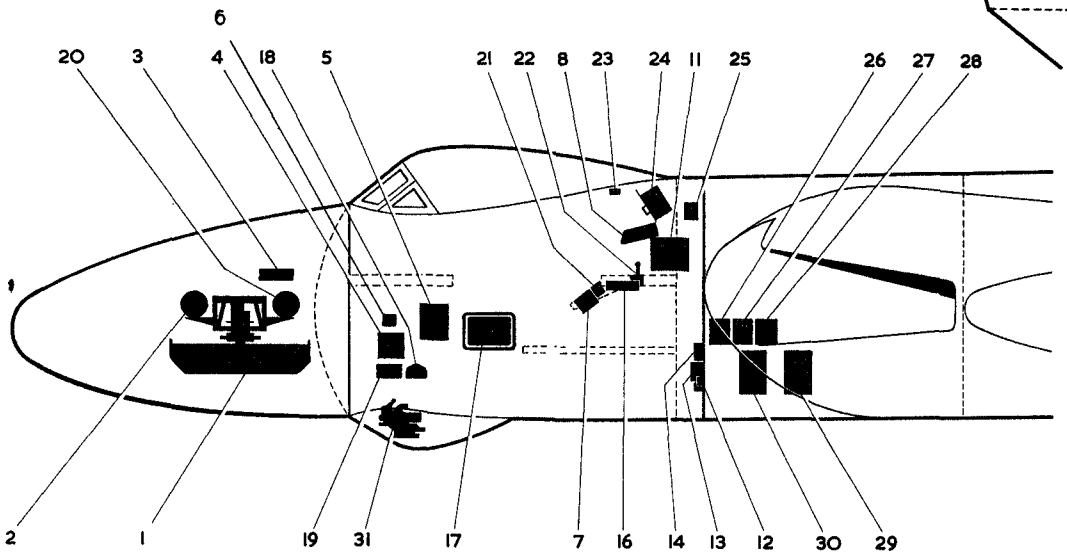






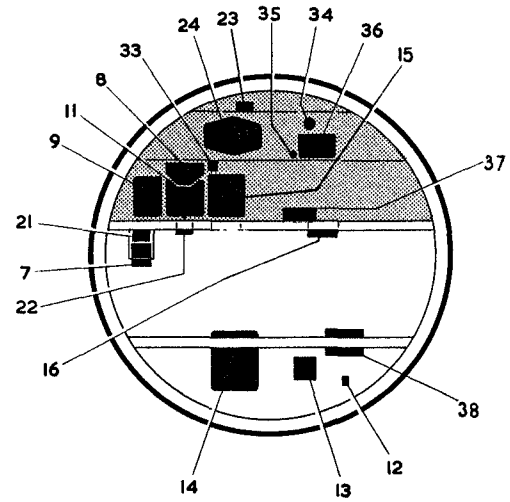


Fig. 1 Location of armament instruments

Mods. 1010 and 1031 included

Introduction

1. The instruments described in this chapter are those which form the Navigation and Bombing System Mk.1A and the T.4 bombsight installation. Information on the servicing and removal of these instruments is also provided.

KEY TO FIG.1

Location of armament instruments

1 *SCANNER UNIT TYPE 121A*
2 *AMPLIFIER*
3 *AMPLIDYNE*
4 *CALCULATOR TYPE 2, MK.2*
5 *CALCULATOR TYPE 3, Mk.2*
6 *GROUND SPEED RESOLVER*
7 *CONTROL UNIT TYPE 12580*
8 *CAMERA RX88*
9 *CONTROL UNIT TYPE 595*
10 *CONTROL UNIT TYPE 903*
11 *INDICATING UNIT TYPE 301*
12 *SUPPRESSOR TYPE G5*
13 *RESISTANCE UNIT MK.1*
14 *JUNCTION BOX TYPE 343, Mk.2*
15 *CONTROL UNIT TYPE 585 (modified)*
16 *CONTROL UNIT TYPE 12558*
17 *T.4 BOMBSIGHT COMPUTOR*
18 *T.4 BOMBSIGHT SIGHTING HEAD CONTROL PANEL*
19 *T.4 BOMBSIGHT GYRO CONTROL*
20 *MODULATOR TYPE 2*
21 *BOMBING SELECTOR SWITCH*
22 *CONTROL UNIT TYPE 626*
23 *VARIABLE AIRSPEED UNIT*
24 *NAVIGATION PANEL MK.1A*
25 *WIND UNIT*
26 *POWER UNIT TYPE 729*
27 *CALCULATOR AUTOMATIC 5A*
28 *WAVEFORM GENERATOR TYPE 68*
29 *CALCULATOR TYPE 1, Mk.1*
30 *POWER UNIT MK.1*
31 *T.4 BOMBSIGHT SIGHTING HEAD*
32 *BOMBING INDICATOR*
33 *WIND INDICATOR*
34 *FORWARD THROW INDICATOR*
35 *STEERING SIGNAL TEST JB*
36 *TRACK CONTROL UNIT*
37 *G.P.I. MK.6*
38 *BLUE STEEL JB*

2. Brief details of the a.c. and d.c. power supplies to the installations are given in this chapter but for more detailed information reference should be made to Book 2, Sect.6, Chap.7.

3. Fig.1 shows the location of the various units which comprise the two installations, whilst the two tables (Table 1 and Table 2) give a complete list ot the N.B.S. equipment, its location, and the necessary Type and Reference numbers. Further details concerning the individual units, that make up the N.B.S. and mentioned in this chapter, may be found in A.P.2894K, Vol.1 (2nd Edn.), Part 1, Sect.1and 2.

4. Although the N.B.S. functions as a complete system it has been found convenient in some instances to treat the radar service (H.2.S) and the computing instruments (N.B.C.) as separate installations. By so doing it is hoped to avoid confusion when dealing with power supplies and removal instructions.

DESCRIPTION AND OPERATION

N.B.S. MK.1A (A.R.I.5928)

5. The Navigation and Bombing System Mk.1A comprises a Navigation and Bombing Computor Mk.2A and a range finding radar H.2.S. Mk.9B and is designed for use in medium and long range aircraft operating beyond the range of ground based aids. The system can be operated to produce steering signals for the aircraft, the response to which may be manual or automatic. In the latter case the N.B.S. is linked with the autopilot Mk.10A or 10B.

Blue steel role

6. On aircraft adapted to the Blue Steel role the N.B.S. is used in conjunction with the inertial navigation system of the missile. Interconnection to the missile circuits is made via the Blue Steel junction box and the ground speed resolver. Circuit details are shown in fig. 4 and fully described in the appropriate publication.

Free fall role

6A. On aircraft designated 'free fall' the N.B.S. is used in conjunction with the Heading Reference System (H.R.S.) described in Chap.10. Interconnection to the H.R.S. is made via the Blue Steel junction box, the ground speed resolver and the G.P.I. Mk.6; these three items are common to the Blue Steel and Free fall aircraft.

Air cooling

7. To prevent loss of efficiency, due to overheating when in use, the units in the system are provided with a supply of cool air. The amplidyne unit and the H.2.S. scanner unit in the radome are supplied with cooling air from the cabin air conditioning system. The air is fed via a combined valve assembly mounted close to the pressure dome in the nose, Note that when Mod.812 is embodied the air supply to the amplidyne unit is deleted. The air conditioning system is described in Book 2, Sect.6, Chap.12 and in Book 1, Sect.3, Chap.8.

8. Those units installed on the starboard side of the nose wheel bay are cooled by air ducted from the starboard air intake. The ducting is arranged so that the cool air will flow up and around each unit. The N.B.S. power unit and calculator have special muffs fitted to further assist in distribution of air past the units.

Pressurisation

9. The H.2.S. scanner system is supplied with air at a controlled pressure of

15 p.s.i. The air is supplied from a storage cylinder located in the nose of the aircraft on the port side. The cylinder is charged at 1,800 p.s.i. which is subsequently reduced by valves and regulators to the required pressure. Two gauges are provided in the system, one at the charging point in the nose, the other on the nav. bomber's panel. Both gauges are described in Chapter 4.

10. The various units fitted at the starboard side of the nose wheel bay are similarly pressurised from a second storage bottle adjacent to the scanner air bottle. Pressure in these units is maintained at 2·5 p.s.i. by a differential pressure regulator. Two pressure gauges are provided, one at the charging point the other on the nav. bomber's panel. Both gauges are described in Chapter 4.

11. Two switches adjacent to the gauges on the nav. bomber's panel control the pressurisation of the units by means of electro-magnetic taps fitted in the pressure lines. The complete pressurisation system is dealt with in Book 2, Sect.6, Chapter 12, where the routing chart for the circuit will be found.

Navigation computing

12. Before the navigation computor can operate certain inputs from associated equipment are required. Inputs representing true air speed are fed to the system from the T.A.U. together with heading information from the compass system of the MFS. This information together with N/S and E/W components of wind velocity, which can be set in manually or semi-manually, is sufficient to enable the computor to function and display the aircraft's track and ground speed. The aircraft's ground displacement (N/S and E/W) from a starting point can also be calculated from the N/S and E/W components of ground velocity. Position numerators record the present position in terms of latitude and longitude.

13. Magnetic variation information is provided by the navigation computor for transmission to the compass system of the MFS via the Track Control Unit. Provision is also made for comparison of N/S and E/W components of ground speed with ground speed components from the G.P.I. These components are produced from ground speed measured by A.R.I.5951 and are instantaneously more accurate than those provided by the navigation computing of the N.B.S.

Ballistic computing

14. Ballistic information relevant to the type of bomb carried is contained on a short piece of 35 mm. film. Information from the film is fed into the Calculator Type 3, Mk.2, which is connected to the static line of the starboard pitot-static system. The equipment then operates to calculate the required track to the release point. Steering signals are fed to the M.F.S. via the bombing system selector switch and the M.F.S. selector switch. These signals are then displayed on the azimuth directors and can be interlocked with the Mk.10A or 10B autopilot through the Computor Unit (Navigational) of the M.F.S. Signals to open the bomb doors and release the bomb are also provided.

15. Immediately above the indicating unit Type 301 is a camera which photographs the P.P.I., at intervals of 8 seconds throughout the bombing run. The film is marked, automatically, at the moment of bomb release and will continue to photograph the P.P.I. until completion of the bombing run.

Power supplies

16. The units in the N.B.S. requiring a.c. supplies are fed from the screened side of distribution panel 11P.

17. All the a.c. supplies to the equipment originate from the main alternators and reach panel 11P via the No.1 frequency changer, the N.B.S. transformer and a local transformer.

18. D.C. is fed from two sources; 28-volt from the main 28-volt system and 112-volt from a transformer rectifier unit in the nose.

19. In the paragraphs that follow a brief description of the a.c. and d.c. supplies to the N.B.C. and H.2.S. equipment is given. For more detailed information, including a theoretical diagram of the screened supplies, reference should be made to Book 2, Sect.6, Chapter 7.

N.B.C. Mk.2A power supplies

20. Power for the N.B.C. equipment is supplied from plugs 421; 422 and 484 on panel 11P. The output from the three plugs is as follows:-

Plug 421: 115-volt, single phase, 1600 c/s, a.c. and 28-volt d.c. to the J.B. Type 343.

Plug 422: 115-volt, three phase, 400 c/s, a.c. to the J.B. Type 343.

The Type 343, Mk.2, junction box is mounted in the cabin on the rear pressure bulkhead and serves as the main junction box for the N.B.C. equipment.

21. The No.1 frequency changer is controlled by two control switches on panel 12P at the A.E.O.'s station. With the changer running, a 115-volt single phase, 1600 c/s, a.c. supply is available for distribution to the equipment. In the event of a failure, provision is made for switching the load to the No.2 frequency changer. Details will be found in Sect.6, Chap.4. Both frequency changers are mounted in the nosewheel bay.

22. The N.B.S. transformer provides three phase, 400 c/s, a.c. at 115-volts. and will function when either the N.B.S. control switch or the H.2.S. control switch is placed in the ON position. In the event of failure of the original supply to the transformer, provision is made for switching to an alternative source of supply. Details of the changeover circuit will be found in Sect.6, Chap.7. The transformer is fitted in the nosewheel bay adjacent to the frequency changers.

Control unit, Type 12558

23. Control unit, Type 12558, was introduced by Mod.1010 and provides the N.B.S. operator with double the offset range to that provided by control unit, Type 585. No further supplies are required for this new unit as a direct connection is made to the control unit, Type 585. The new unit is simply an extension to the existing control unit, Type 585.

24. Due to the addition of the new control unit, Type 12558, the existing control unit, Type 585, has been modified to suit. Further details may be found in A.P.2894K, Vol.1 (2nd Edn.), Part 2, Sect.1.

H.2.S. Mk.9B power supplies

25. With the exception of the 112-volt d.c., and the 200-volt a.c. supply to the amplidyne, all supplies to the H.2.S. equipment are fed from 11P. The actual H.2.S. supply cables pick up from the aircraft supplies in two ways; supplies to the control units direct from plugs 424, 426, 423 and 437 on 11P, and supplies to the scanner from T.B.s 783 and 784 in J.B. 4J, the radio supplies panel. A further T.B., number 785 in J.B. 4J, carries 112-vclt d.c. and 28-volt d.c. to the scanner. The various supplies may be listed as follows:-

11 P	plug 424:	115-volt, single-phase, 1600 c/s, a.c. and 28-volt d.c. to power unit Type 729.
	plug 426:	115-volt, three phase, 400 c/s, a.c. and 28-volt d.c. to control unit Type 903.
	plug 423:	115-volt, single-phase, 1600 c/s, a.c. and 28-volt d.c. to control unit Type 595.
	plug 437:	115-volt, single phase, 1600 c/s, a.c. to control unit, Type 12580.
JB 4J	TB.784:	115-volt, single-phase, 400 c/s, a.c. and 28-volt d.c. to scanner.
	TB.783:	115-volt, single-phase, 400 c/s, a.c. and 115-volt single-phase, 1600 c/s, a.c. to scanner.
	TB.785:	112-volt d.c. and 28-volt d.c. to scanner.
75P		200-volt, three phase, 400 c/s, to amplidyne motor.

26. Supplies to 11P are from the No.1 frequency changer and the N.B.S. transformer as described in para.20 and 21 and in greater detail in Sect.6, Chap.7. Supplies will be fed to the equipment when the H.2.S. switch is switched to ON and the scanner stabilisation switch is at any position other than OFF. With the switches in the positions stated, 200-volt a.c. supplies will be fed to the transformer-rectifier and the amplidyne motor, both in the nose of the aircraft. The transformer-rectifier will then produce a 112-volt d.c. output for use at the scanner, via T.B.785 in J.B.4J. A full description of the supplies, including normal and emergency operation, will be found in Chap.7, Sect.6, Book 2.

Control switches and indicators

27. Supplies to the N.B.S. are controlled by four switches. Two of these,the N.B.C. switch and the H.2.S. switch, are double-pole, centre off, two-way switches which are selected up for ON and down for EMERGENCY. The switches are mounted side by side on panel 12P at the nav. bomber's station.

28. The two other switches (scanner rotation and scanner stabilisation) are mounted on the radar panel. The scanner rotation switch is a single-pole ON-OFF switch whilst the scanner stabilisation switch is a 2 gang, rotary, four position switch. The four switch positions are OFF-EMERGENCY-STANDBY-ON.

29. Mounted immediately above the scanner rotation and stabilisation switches are two magnetic indicators, one for the N.B.C. and the other for H.2.S. With the control switches in the OFF position the indicators present a white indication. When the equipment is operating the indicators are energised to show black. Two indicator lamps and a switch marked N.B.C. BOMB GEAR ISOLATION are mounted on the bombing panel 9P at the starboard side of the crew's cabin. The

function and purpose of this switch will be found in Sect.6, Chap.19, together with a routing chart for the circuit. For further details of the supplies and control of the N.B.S. system reference should be made to Book 2, Sect.6, Chap.7

Mod.748

30. With the introduction of Mod.748 the scanner rotation and stabilisation switches are moved to the lower corner of the radar panel, port side. The two magnetic indicators, labelled N.B.C. and H.2.S. are now fitted at the bottom edge of the radar panel, between the indicating unit Type 301 and the navigation panel Mk.1A.

Mod.972 and Mod.1431

31. An additional switch is introduced into the system when Mod.972 is embodied. This switch, labelled N.B.C. D.C. EMERGENCY, is mounted on panel 12P and enables the d.c. supply to the N.B.C. to be switched on, independent of the a.c. supply. The switch is for emergency use only and circuit details will be found in Book 2, Sect.6, Chap.7, Mod.1431 introduces a guard over the Bombing Selector switch to prevent inadvertent operation.

Test sockets

32. Two Mk.4 test sockets are provided for checking the various supplies to the N.B.S. equipment. The first of these (595) is mounted on the starboard side of 11P, the other (594) is mounted in the nose section. Instructions for using both sockets will be found in para.48.

T.4 BOMBSIGHT

33. The T.4 bombsight, which is mounted centrally on the floor of the aircraft at the air bomber's prone position, is a visual impact bombsight which will compute and indicate continuously the point on the ground which will be struck if the bomb is released at any instant.

34. The sight has been designed to utilize the accurate drift and ground speed information provided by the A.R.I. 5951 equipment and to cover the operating ranges of modern aircraft.

35. The complete installation comprises the following items:-

(1) Computor

(2) Sighting head

(3) Amplifier

(4) Gyro control unit

(5) Sighting head control panel

(6) Flexible drives and gear boxes.

(7) Mounting bracket for sighting head.

36. All the above items are located at the prone air bomber's position as shown in fig.1. A brief description of the function of each of these items is provided in the following paragraphs. For more complete details reference should be made to A.P.1275D, Vol.1, Sect.7.

Computor

37. The basic function of the computor unit is to calculate, in terms of sighting angle and drift angle, the various continuously fed inputs of height, airspeed, drift, and ground speed, and to transmit these settings to the sighting head. A drift smoothing cut-out switch is mounted on the bomb aimers azimuth control panel.

Amplifier

38. The amplifier provides amplification for signals from the drift and ground speed synchro motors. The amplified signal is then fed to the servo motors to cause follow-up in their respective mechanisms.

Gyro control unit

39. This unit controls the electrical supplies to the Mk.8 gyro unit in the sighting head and the Mk.9 gyro unit in the computor unit.

Sighting head control panel

40. The sighting head panel controls the electrical supplies to the collimator lamp and the drift scale light in the sighting head.

Sighting head

41. The T.4 sighting head enables the air bomber to see a graticule in the form of a sword-shaped cross moving over the ground. Any point on the ground covered by the intersection of the cross represents the point of impact of a bomb released at that instant. In flight the apparent ground position of the graticule image is controlled by the computor through the rotation of two flexible shafts.

Power supplies

42. The following power supplies are provided to operate the sight:

115-volt, single phase, 1600 c/s, a.c. from fuse 333 (11P) to the amplifier.

115-volt, three phase, 400 c/s, a.c. from fuse 250R and 250B (24P) to the gyro control unit.

28-volt d.c. from fuse 666 (3P) to the computor.

28-volt d.c. from fuse 667 (3P) to cockpit lamp.

28-volt d.c. from fuse 668 (3P) to the gyro control unit.

28-volt d.c. from fuse 669 (3P) to the sighting head control panel.

A routing chart showing the above supplies plus the connections to A.R.I.5951 is provided in fig.5. Internal circuits of the components and their circuit operation will be found in A.P.1275D, Vol.1, Sect.7.

Air supply

43. The bombsight computor is fed with dry air at a pressure of 60 p.s.i. from an air storage bottle fitted at the starboard side of the aircraft, adjacent to the bombsight. The air is used for various purposes within the computor as explained in A.P.1275D, Vol.1, Sect.7. Details of the air bottle and its associated valves and gauges will be found in Book 1, Sect.3, Chap.7.

TRUE AIRSPEED UNIT

44. A True Airspeed Unit, Ref.No.6B/3013, is mounted below the starboard air intake. The unit is controlled by a control panel, .Ref.No.6B/3014, mounted on the radar panel, and provides inputs to an air mileage indicator and the variable airspeed unit. An air temperature bulb, Ref.No.6B/3125, works in conjunction with the T.A.U. and is mounted on the starboard underside of the aircraft at former 189·5.

45. The control panel is fed with a 115-volt, 3 phase, 400 c/s a.c. supply from fuses 248 R & B in panel 24P. A 28-volt d.c. supply is fed to the control panel from fuse 725 in panel 48P. Pitot and static supplies are fed to the unit from the starboard pitot-static system. A detailed description of the T.A.U. and its associated equipment will be found in A.P.1275B, Vol.1.

AIR SPEED PRESSURE SWITCH

46. Mounted at the starboard side of the bomb bay just aft of the front spar is a Type TP.5099 airspeed pressure switch. This switch, which is operated by the starboard pitot-static system, forms part of the release circuit for a special store and is designed so that the switch contacts will close when the speed of the aircraft exceeds 150 knots. A description of the switch will be found in Vol.1, of A.P.1275A.

SERVICING

N.B.S. MK.1A

47. All N.B.S. items of equipment should be checked for security of mounting and tightness of plug and socket connections. Before removing any item of equipment suspected of being defective, checks should be made for continuity and insulation on the associated cable assemblies. Complete instructions for servicing the system in the aircraft will be found in A.P.2894K, Vol.1 (2nd Edn.), Part 2, Sect.3.

NOTE...

Before carrying out ground tests provision must be made for cooling the scanner unit equipment. An external cooling rig is available for this purpose and is described in Book 1, Sect.3, Chap.8 of this publication.

Power supplies

48. The 115-volt, 3 phase, 400 c/s output from the N.B.S. transformer can be checked at test socket 595 on the starboard side of 11P. The transformer output is connected to pins A, B and C of the socket, via fuses 340-R and B and the earthed yellow phase. At pins D and E of the same plug the 1600 c/s output from the No.1 frequency changer can be tested.

49. Test socket 594 in the nose section enables the 115-volt, 1600 c/s, a.c. supply to equipment in the nose to be conveniently tested. The supply is fed via TB.785 to pins D and E of the socket.

50. As the test sockets are tapped across the actual supply leads to the equipment, tests may be made at the socket whenever the main power supplies are switched ON and the H.2.S. and N.B.C. switches are at ON or EMERGENCY. Servicing details for the N.B.S. power transformers, and the frequency changers, will be found in the servicing notes for Chapter 4 and 7, Sect.6, of this publication.

T.4 BOMBSIGHT

51. The units comprising the installation should be checked for security and tightness of plug and socket connections. The sighting head should also be examined for cleanliness and signs of damage.

52. Before removing any item suspected of being defective the fuses and power supplies to the various units should first be checked. Full details for servicing the bombsight in the aircraft will be found in A.P.1275D, Vol.1, Sect.7, Chap.7.

TRUE AIRSPEED UNIT

53. Full details for servicing the T.A.U. together with a fault finding table and the Standard Serviceabiiity Test, will be found in A.P.1275B, Vol.1.

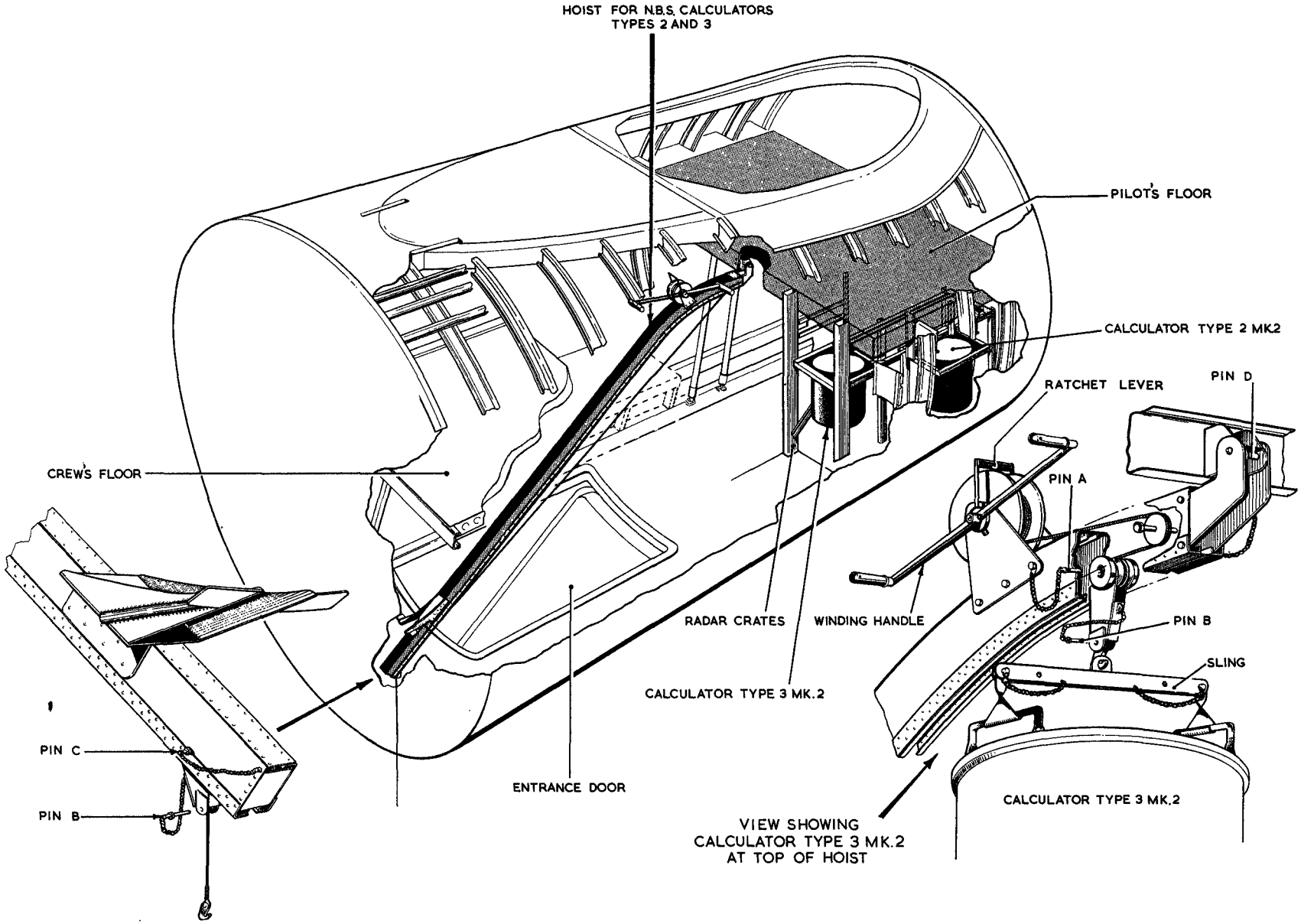


Fig. 2 Removal of N.B.C. calculators

REMOVAL AND INSTALLATION

N.B.S. MK.1A

54. The removal of the main items of N.B.S. equipment requires the use of special equipment which is designed to assist in the smooth and efficient progress of this operation. In the paragraphs that follow reference will be made to the equipment required, followed by detailed instructions for removing the item in question. The method of assembly is in all cases the reverse of that for removal. Before removing any pressurised item of equipment check that the pressurisation switches on the nav. bomber's panel are in the OFF position.

N.B.C. equipment

Directional indicator

55. This item is easily removed from the first pilot's instrument panel when the panel has been detached in accordance with the instructions given in Chapter 1.

Equipment under pilot's floor

56. The calculators, Type 2, Mk.2 and Type 3, Mk.2, are mounted at the starboard side of the aircraft under the second pilot's floor as shown in figs.1 and 2. The calculators slide into the radar crate and are locked in position by quick release "pip" pins.

57. An AVRO built hoist Ref.26DC/95083 is available and when fitted between the bottom fuselage and the pilot's floor, as shown in fig.2, provides a means of lifting the calculators into, or out of, the aircraft as required.

58. The method of removal for the calculator, Type 3, Mk.2, after disconnection of all services, is shown in fig.2. The sequence of operations, which is the same for both calculators is as follows.

Note that the ratchet lever must be used in conjunction with the winding handle when raising or lowering the units.

(1) Place hoist in position and secure to bracket under pilot's floor with pin D.

(2) Locate pin A through pulley of swinging link at top of hoist.

(3) Slide calculator, Type 3, Mk.2, out of crate and slide gently onto cabin floor.

(4) Attach sling (Ref.No.26DC/95094) to calculator.

(5) Lower the hoist hook by means of the winding handle and engage hook in sling.

(6) Raise calculator and engage pin B to secure hook to swinging link.

(7) Remove pin A and lower unit to foot of hoist.

(8) Locate pin C and remove pin B.

(9) Lower the unit onto a suitable trolley and remove sling.

(10) Repeat sequence of operations for calculator Type 2, Mk.2 and remove hoist.

Nav. bomber's equipment

59. The navigation panel Mk.1A, is secured to the radar panel by four screws. When the connector assemblies are uncoupled and the fastening nuts removed the unit can be withdrawn from the radar panel.

60. The control unit, Type 12558, is fitted inside the navigators table and is uncovered by a sliding panel in the table top. The unit can be lifted out when the securing nuts are unscrewed and the connectors removed.

61. Removal of other units at the nav. bombers station should present little difficulty and no special instructions are required.

Equipment in nose-wheel bay

62. The power unit Mk.1 and calculator, Type 1 are fitted to resilient mountings on two sliding trays in the radar crate and are held in position by quick release pip pins. A "safety raiser" or similar elevating trestle is required to effect the removal of these units. The trestle should be positioned under the nose wheel bay and the platform raised to a convenient level.

63. Two men are required on the platform and together should remove each unit in turn. When the connector assemblies are unscrewed and the pip pins pulled out, each unit should be withdrawn by the handles, together with its sliding tray, and lifted onto the platform. The platform should then be lowered to the ground and the units transferred to a suitable trolley.

H.2.S. equipment

Scanner unit

64. To permit the removal of the scanner unit the composite nose radome must first be removed in accordance with the instructions laid down in Book 1, Sect.3, Chap.1. The ground equipment required to remove the scanner unit comprises two trolleys for receiving and transporting the unit away from the aircraft. Each hoist is an assembly of parts listed in

Table 1 of Book 1, Sect.2, Chap.4; the trolleys Ref.No.4F/1787 and 4F/2202 respectively are fully described in A.P. 4552A.

65. Preparations for the removal of the scanner unit and positioning of the hoists require the use of a service ladder. The removal operation should be carried out by four men to the following instructions:-

(1) Prepare trolley Ref.No.4F/2202 to receive the scanner unit.

(2) Remove all aircraft connectors from the scanner unit and stow the disconnected leads.

(3) Disconnect the air pressure line and the air cooling ducts at the scanner unit.

(4) Attach hoists, one each side, to the hook-up points on the structure above the scanner units.

(5) Pull the hoist cables downward and attach each hook end to the support points on the scanner unit.

(6) Winch up the cables until taut.

(7) Remove the bolts securing the scanner unit.

(8) Position the receiving trolley below the scanner unit.

(9) Lower the scanner unit gently to disengage the dowel pins.

(10) Lower carefully into position on the trolley and bolt the unit to the cradle.

(11) Unhook the cables and remove the hoists.

(12) Attach trolley Ref.No.4F/1787 for transportation.

Amplidyne unit

66. The amplidyne unit in the nose is removed complete with its associated mounting. The mounting is secured to the structure by four bolts with distance tubes, and is free to pivot on two pins when the bolts are unscrewed. Note that the removal operation does not require the nose radome to be removed as in the case of the scanner unit. Access to the nose section is made from the porthole in the pressure dome.

67. With the bolts removed, and the cooling duct to the amplidyne disconnected, the mounting should be slid backwards, using the handle, and levered from the front end, until hanging vertically. The cables can then be disconnected and the unit, together with the mounting, lifted off at the pivot pins and brought away from the structure.

Navigator's equipment

68. The indicating unit Type 301 and the control units Type 585 and Type 595 are secured to the nav. bomber's radar panel by two knurled nuts in each case and held by retaining wires. To withdraw the units from the crate the connector assemblies should be removed, the knurled nuts slackened and the retaining wires released. The camera fitted to the indicating unit should be swivelled to one side on its hinges and eased upwards after releasing the screw on the right hand side.

69. The control unit Type 626 on the navigators table can be removed by uncoupling the connector from underneath the table and removing the four securing screws on the table top. The control unit Type 903 fitted behind the indicating unit can be removed by uncoupling the connectors and removing the three fixing screws.

Equipment in nose-wheel bay

70. The power unit, calculator and wave-form generator are fitted to a resilient mounting at the top of the radar crate and held by two knurled nuts in each case. A "safety raiser" is required for the removal operation and should be positioned under the nose wheel bay with the platform raised to a convenient height. The units can then be removed when the knurled nuts are slackened and the connectors uncoupled. When this has been carried out the units should be lifted onto the platform and the platform lowered to ground level. A suitable trolley should be made available for transporting the unit away from the aircraft.

TRUE AIRSPEED UNIT

71. The T.A.U. is mounted under the starboard engine air intake with the necessary connections facing inboard. Two round access panels are fitted side-by-side, flush with the aircraft skin, and provide facilities for removing the unit. Access to the electrical and pitot-static connections is gained from the inboard panel and the T.A.U. securing bolts are uncovered by the other panel. When the connections are removed the T.A.U. can be unbolted and lifted downwards from the aircraft.

T.4 BOMBSIGHT

Computor

72. The computor unit frame is secured to the aircraft structure by four saddle brackets, two at the top of the frame and two at the bottom. By unscrewing the

brackets, the computor unit complete with its mounting frame, can be withdrawn from the port radar crate. Before attempting to remove the unit the electrical, pitot-static and pneumatic services should be disconnected from the computor and fitted to the relevant stowages which are provided adjacent to the unit. Always ensure that the pneumatic air supply is turned off at the stop valve on the aft face of the pilots floor before disconnecting the air supply line from the computor.

Amplifier

73. The amplifier is easily removed from its mounting tray after disconnecting the plugs and sockets at the rear of the case. A stowage is provided for the disconnected leads.

Sighting head

74. No trouble should be experienced in removing the sighting head from its mounting bracket in the aircraft once the electrical services and the flexible drives have been disconnected. The flexible drives and electrical leads should be attached to the stowage provided.

Control panel

75. The control panel and other items are all easily removed from the aircraft and no special instructions are required.

TABLE 1

H.2.S MK.9B EQUIPMENT

Unit	Ref. No.	No. off	Location
Scanner unit, Type 121A	10B/19090	1	Nose radome
Amplifier A3703	10U/16761	1	
Modulator Type 2	10D/18638	1	
Transmitter receiver TR.3702	10D/18637	1	On scanner unit
Gyro unit Mk.6	6W/5	1	
Amplidyne unit	5UB/6431	1	Nose radome
Indicating unit Type 301	10QB/6493	1	Navs. station
Camera Type RX88	14A/4260	1	On indicating unit 301
Control unit Type 585	10LB/6366	1	Navs. station
Control unit Type 12558	10L/16493	1	Navs. station
Control unit Type 595	10LB/6376	1	Navs. station
Control unit Type 12580	10L/16495	1	Navs. station
Control unit Type 903	10L/16154	1	Behind type 595 c/u
Control unit Type 626	10L/16080	1	Navs. table
Power unit Type 729	10DB/8811	1	Nose-wheel bay
Calculator Type 5A	10D/20968	1	Nose-wheel bay
Waveform generator Type 68	10VB/6250	1	Nose-wheel bay

TABLE 2

N.B.C. MK.2A EQUIPMENT

Unit	Ref. No.	No. off	Location
Bombing indicator	9D/1372	1	1st Pilots instrument panel
Calculator Type 2, Mk.2	9D/1373	1	Under 2nd pilots floor
Calculator Type 3, Mk.2	9D/1146	1	
Navigation panel, Mk.1A	9D/1141	1	Navs. station
Wind unit	9D/756	1	
Indicator unit	9D/757	1	
Forward throw indicator	9D/1400	1	
Junction box Type 343, Mk.2	9D/1399	1	
* Junction box, Type 343, Mk.4	9D/2217	1	
Suppressor, Type G5	-	1	R.P.B. cabin
Resistance unit Mk.1	9D/12	1	Nose wheel bay
Calculator Type 1	9D/2	1	
Power unit Mk.1	9D/11	1	
Variable air speed unit	9D/11	1	Navs. station

* Mod.2034 (Free Fall aircraft only)

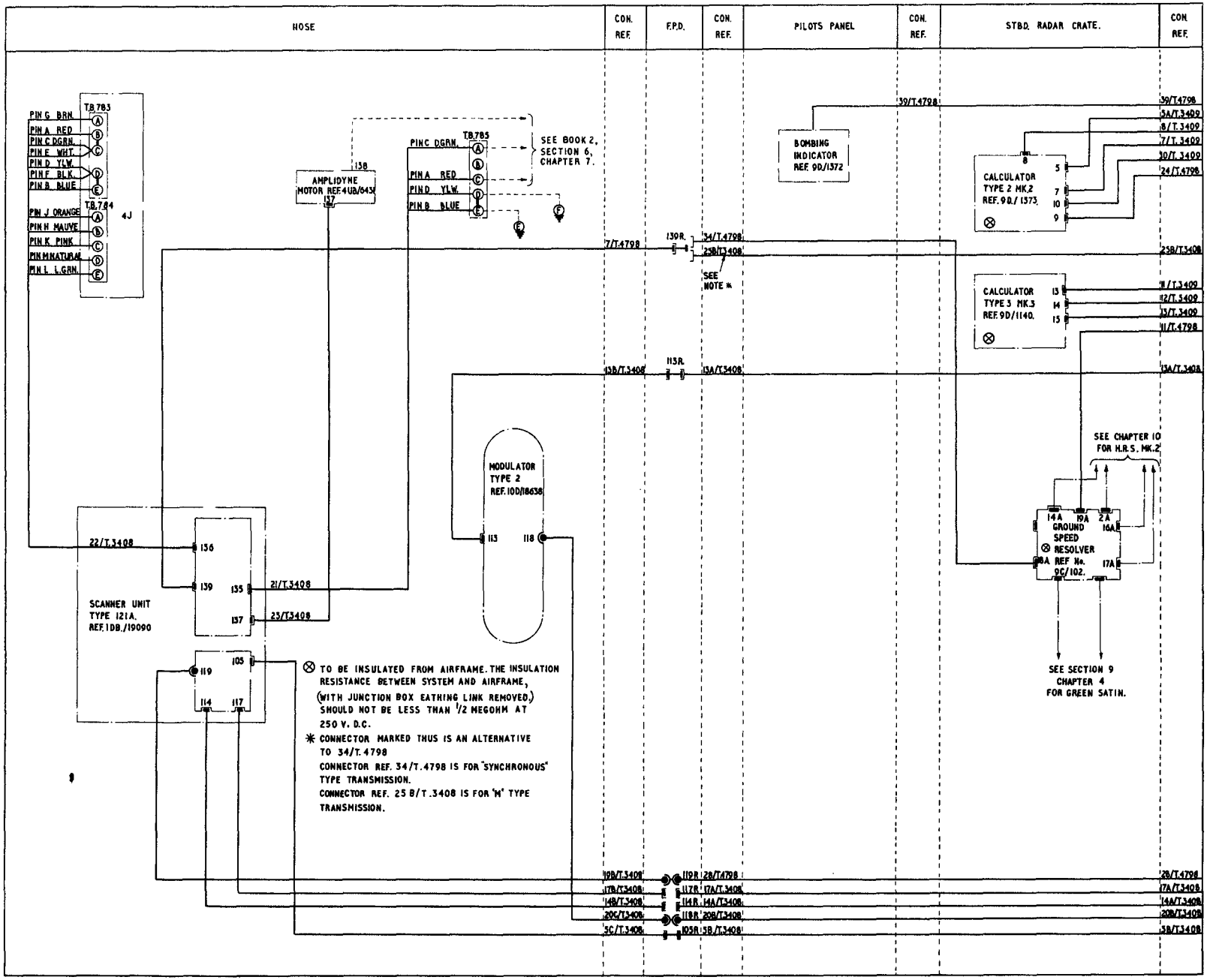
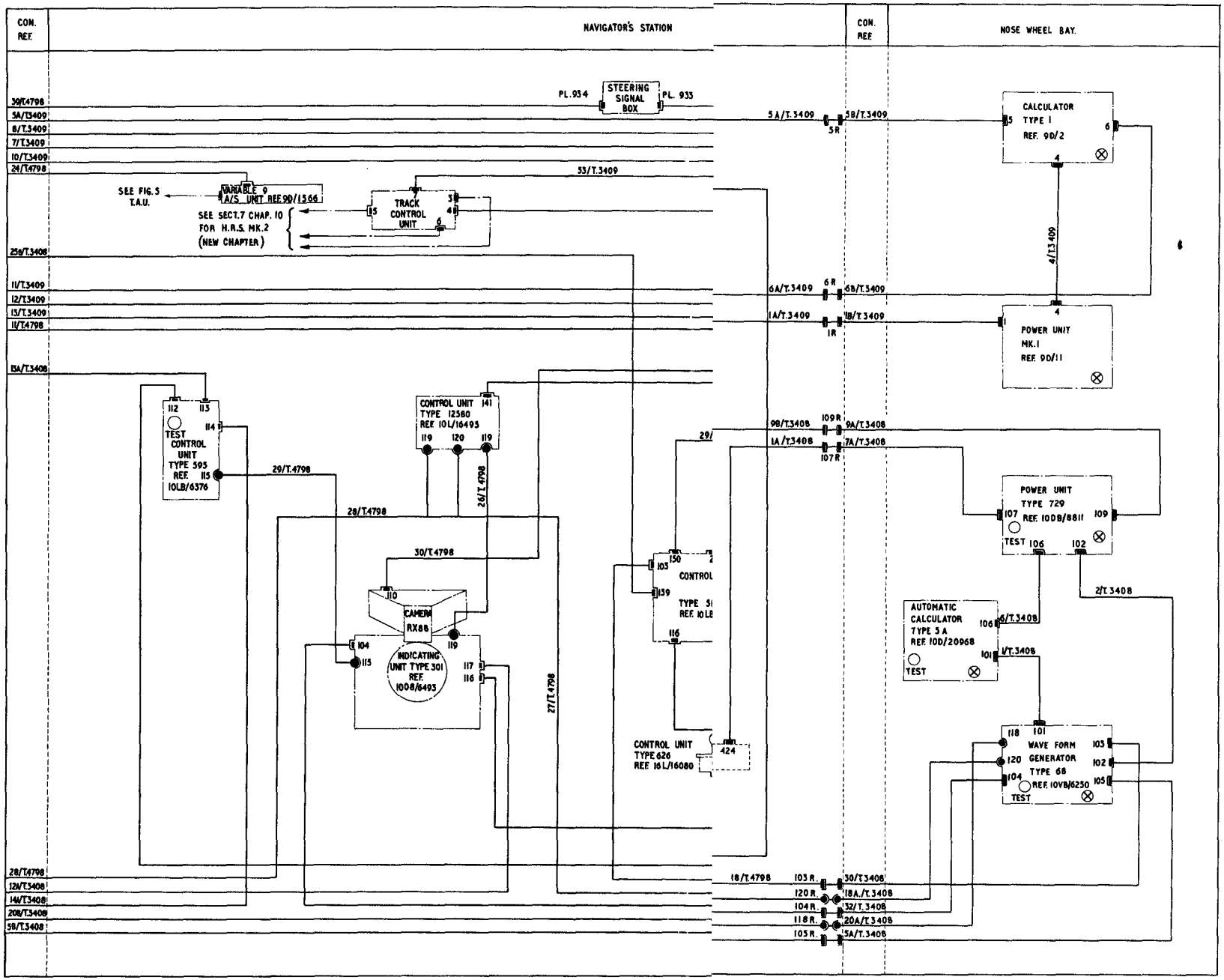
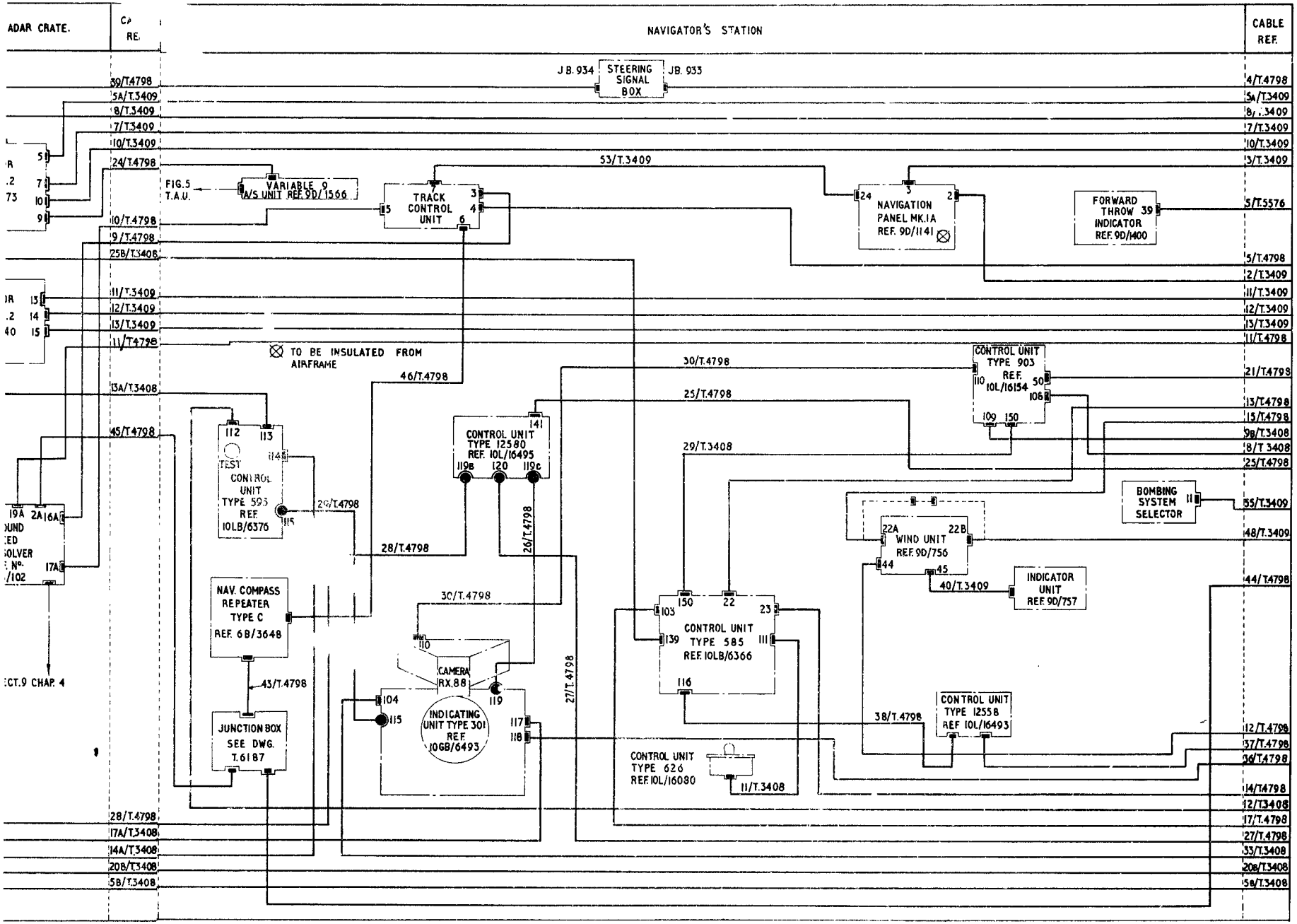


Fig.3 (1) N.B.S. installation (pre Mod.748)

◀ *Mods. 1455, 1522, 1716, 1720 and 1908* ▶


CON. REF.
NAVIGATOR'S STATION
CON. REF.
NOSE WHEEL BAY.
PL.934
STEERING SIGNAL BOX
PL. 933
39/T.4798
5A/T.3409
8/T.3409
7/T.3409
10/T.3409
24/T.4798
53/T.3409
SEE FIG.5 T.A.U.
VARIABLE D A/S UNIT REF.90/1566
SEE SECT.7 CHAP.10 FOR H.R.S. MK.2 (NEW CHAPTER)
TRACK CONTROL UNIT
259/T.3408
11/T.3409
12/T.3409
13/T.3409
11/T.4798
15A/T.3408
TEST CONTROL UNIT TYPE 595 REF. 10LB/6376
29/T.4798
28/T.4798
30/T.4798
26/T.4798
CONTROL UNIT TYPE 12580 REF. 10L/16495
CAMERA RX88
INDICATING UNIT TYPE 301 REF. 1008/6493
27/T.4798
CONTROL UNIT TYPE 626 REF. 16L/16080
424
5A/T.3409
5R
5B/T.3409
CALCULATOR TYPE 1 REF. 90/2
4/T.3409
6A/T.3409
6R
6B/T.3409
1A/T.3409
1R
1B/T.3409
POWER UNIT MK.1 REF. 90/11
98/T.3408
109R
9A/T.3408
1A/T.3408
107R
7A/T.3408
POWER UNIT TYPE 729 REF. 10DB/8811
TEST
2/T.3408
AUTOMATIC CALCULATOR TYPE 5A REF. 10D/20968
6/T.3408
V/T.3408
WAVE FORM GENERATOR TYPE 68 REF. 10VB/6250
18/T.4798
103R.
30/T.3408
120R.
18A/T.3408
104R.
32/T.3408
118R.
20A/T.3408
105R.
5A/T.3408
28/T.4798
12A/T.3408
14A/T.3408
20B/T.3408
58/T.3408



1) N.B.S. installation (post Mod.748)

1010, 1031, 1078, 1188, 1851, 1852 and 1888 ▶

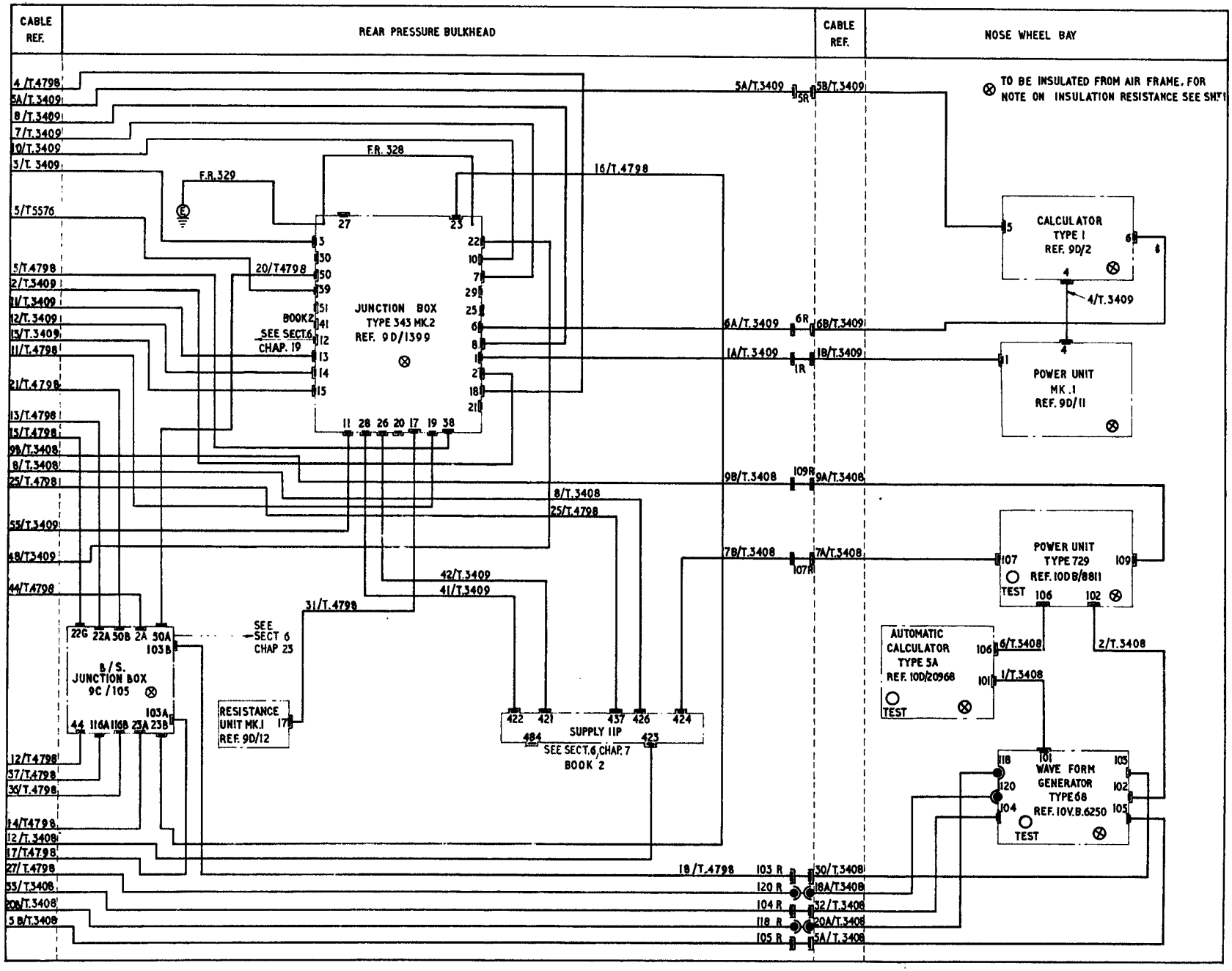


Fig.4 (2) N.B.S. installation (post Mod.748)

Mods. 1010, 1031, 1078, 1188, 1851, 1852 and 1888

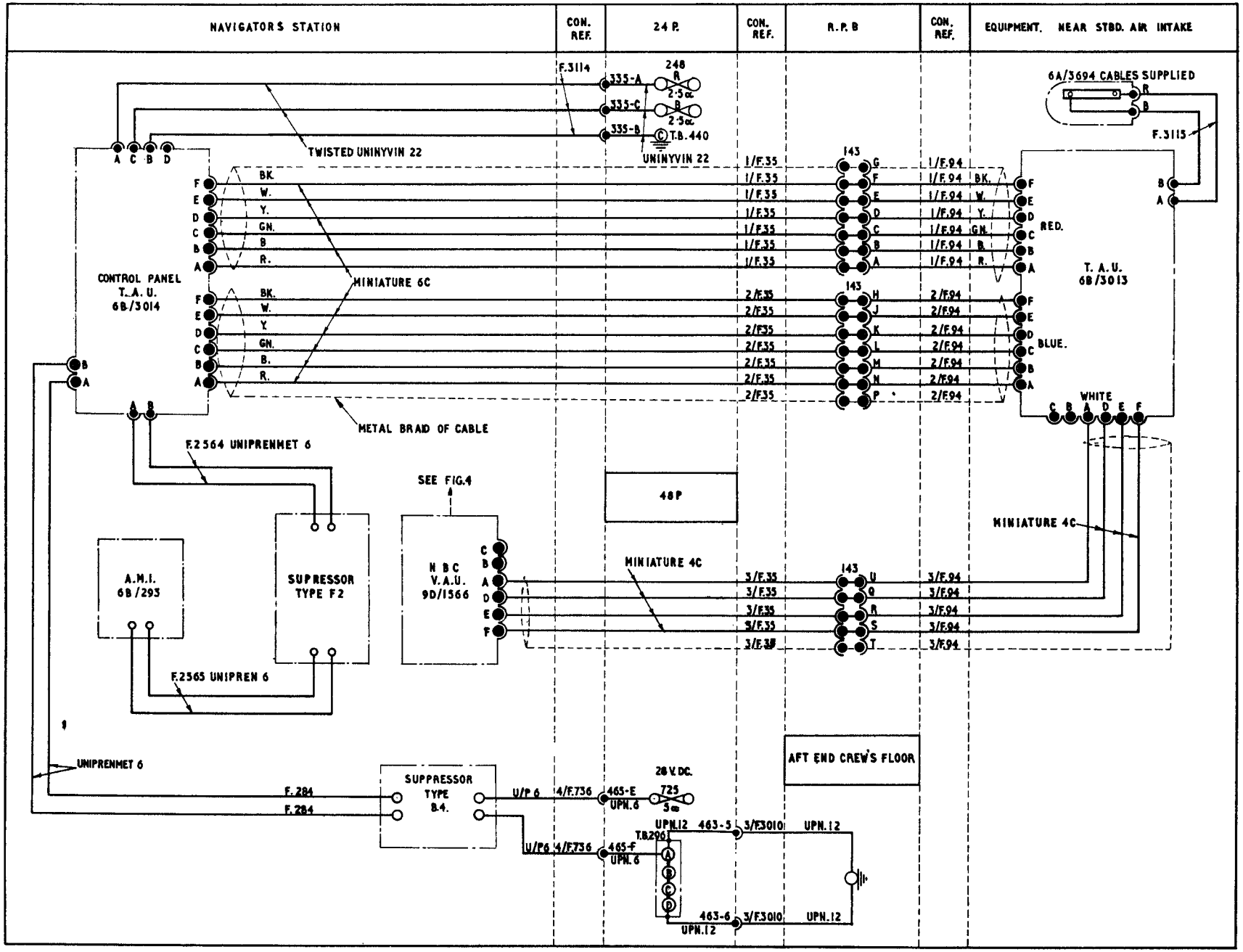


Fig.5 T.A.U. for use with N.B.C.

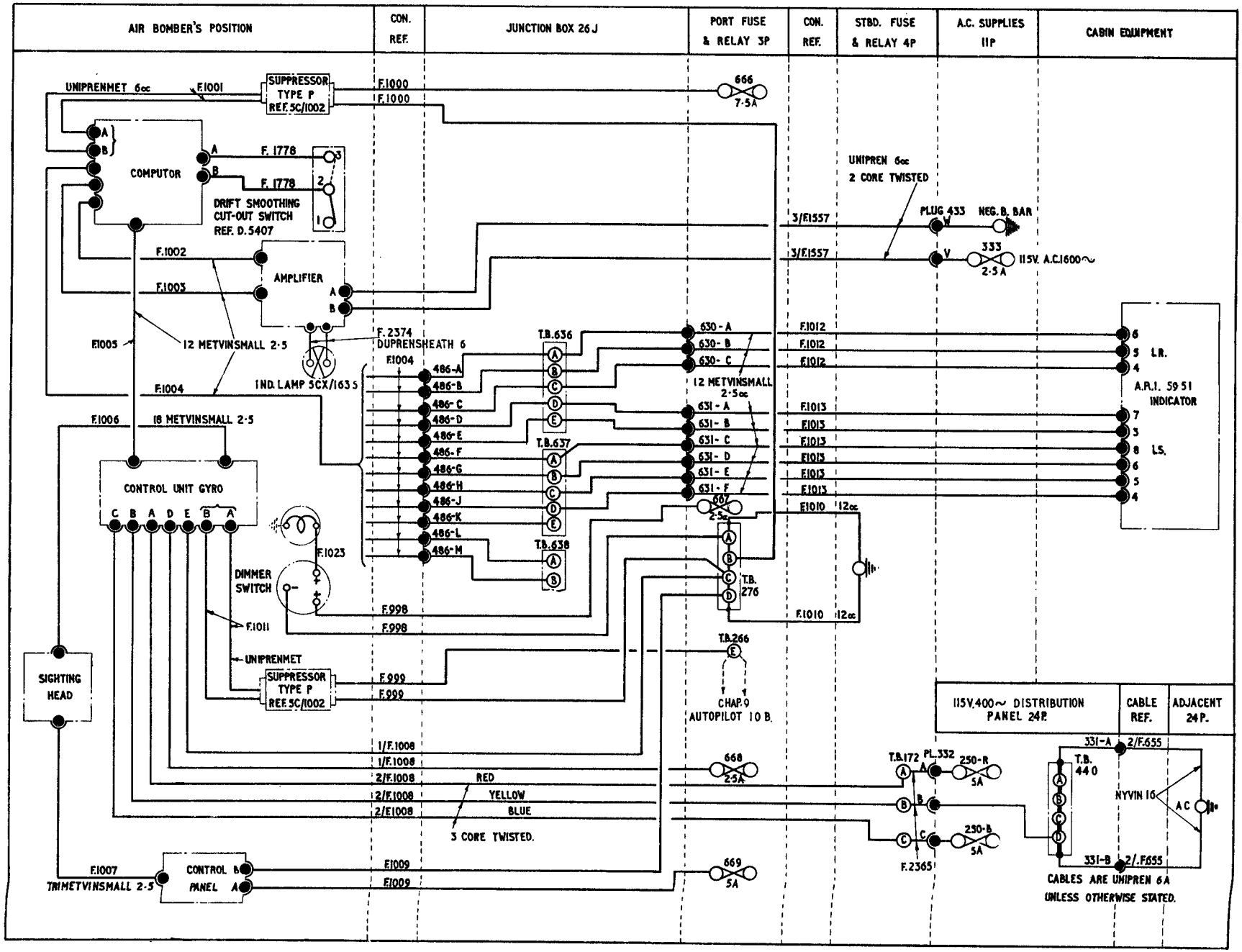


Fig. 6. T4 Bombsight.

◂ Mod. 1320 embodied ▸

Chapter 6

AUTOCONTROLS

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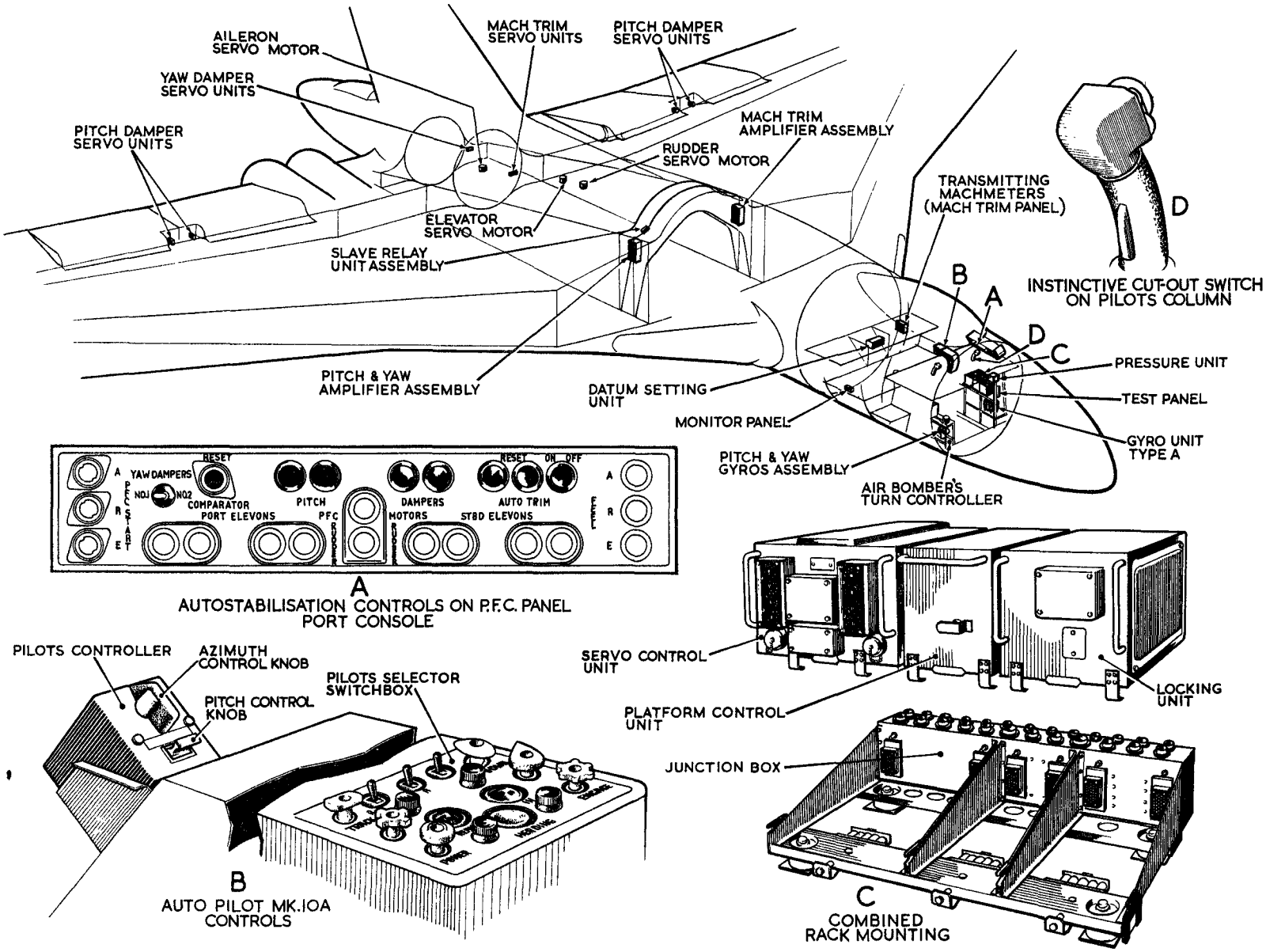

Fig. 1 Location of autocontrols

Introduction

1. This chapter contains descriptive and servicing information on the autopilot Mk.10A and the autostabilisation system. The various units comprising the systems are described, together with details of their location and the necessary power supplies. The autopilot Mk.10B, which is basically the same as the Mk.10A, incorporates an automatic landing facility, and is dealt with in Chap.9. As both autopilots are integrated with the aircraft flying and autostabilisation controls, certain cross-references to this chapter have been included in Chap.9. The flying controls are dealt with in Book 2, Sect.6, Chap.10 and also in Book 1, Sect.3, Chap.4. A complete description of the autopilot Mk.10A will be found in A.P. 1469EA, Vol.1, whilst the autostabilisation system is described in A.P.1469SA, Vol.1. Routing charts for both systems are provided at the end of the text.

DESCRIPTION AND OPERATION

AUTOPILOT MK.10A

2. The Mk.10A autopilot is provided in the aircraft to relieve the human pilot of much of the physical and mental strain to which he is subjected when controlling high speed bomber aircraft during long flights. The autopilot improves the stability of the aircraft under difficult flying conditions. The system operates on the 'rate-rate' principle and will stabilise an aircraft in each of the pitch, roll and yaw axes.

3. In addition to the above functions the autopilot may be used by the human pilot to change an aircraft's heading or attitude, maintain a constant altitude or indicated airspeed, turn on to and maintain a pre-selected heading or make fully automatic approaches to an airfield equipped with I.L.S. During bombing runs the autopilot may also be used to manoeuvre the aircraft in response to signals from the N.B.S. Mk.1A or from a turn controller by the air bomber.

4. Bombing, heading and radio information is passed to the system via the Military Flight System (M.F.S.) with which the autopilot is integrated. Details of the M.F.S. will be found in Chap.7. For details of the N.B.S. reference should be made to Chapter 5 of this section.

5. As will be seen from fig.1 most of the autopilot units are mounted on a special rack mounting under the first pilot's floor. Other units are individually mounted nearby. The controller, selector and cut-out switches are installed at the pilot's station whilst the servo motors are mounted in the bomb bay and aft power compartment. Table 1 gives a complete list of the units together with their type and reference numbers.

Gyro unit

6. The gyro unit is mounted at the port side of the aircraft under the first pilot's floor and contains the three disturbance detecting rate gyros. Also mounted on the gyro platform is the pitch monitor and a mercury switch, both of which respond to displacement of the aircraft in the pitch axis. The mercury switch maintains the gyro platform level when the autopilot is switched on, but disengaged.

Servo control unit

7. The servo control unit contains the three servo control channel amplifiers (rudder, aileron and elevator) and the roll error cut-out amplifier. The unit is mounted in the special rack mounting below the first pilot's floor.

Platform control unit

8. This unit is mounted alongside the servo control unit in the special rack mounting under the first pilot's floor. The unit contains the pitch and bank platform amplifiers, the pitch integrator amplifier and the pitch datum unit.

Locking unit

9. The locking unit houses the signal amplifiers for control in azimuth (localiser, heading and bombing signals) and pitch (glide path signals) along with the amplifiers for the altitude and airspeed lock system. The unit is mounted alongside the platform control unit in the special rack.

NOTE . . .
Strong interference with the I.L.S. signal will be experienced if this unit is fitted without its associated gearing pad.

Rack mounting and junction box

10. The rack mounting which carries the locking unit, platform control unit and servo control unit is so constructed that the backplate is formed by a junction box. The junction box carries six Cannon plugs to which the three units connect. Twenty-five miniature Mk.4 connectors are provided on the junction box for connection to the other units of the autopilot system.

Pressure unit

11. The pressure unit is mounted just forward of, and slightly above, the special rack mounting under the first pilot's floor. The unit contains the altitude and airspeed detectors and their associated chaser motors. The unit is fed with a pressure and static supply from the starboard pitot-static system and provides signals for the airspeed and altitude locks.

Servomotors

12. The three servomotors which operate the control surfaces are mounted in the bomb bay and aft power compartment as

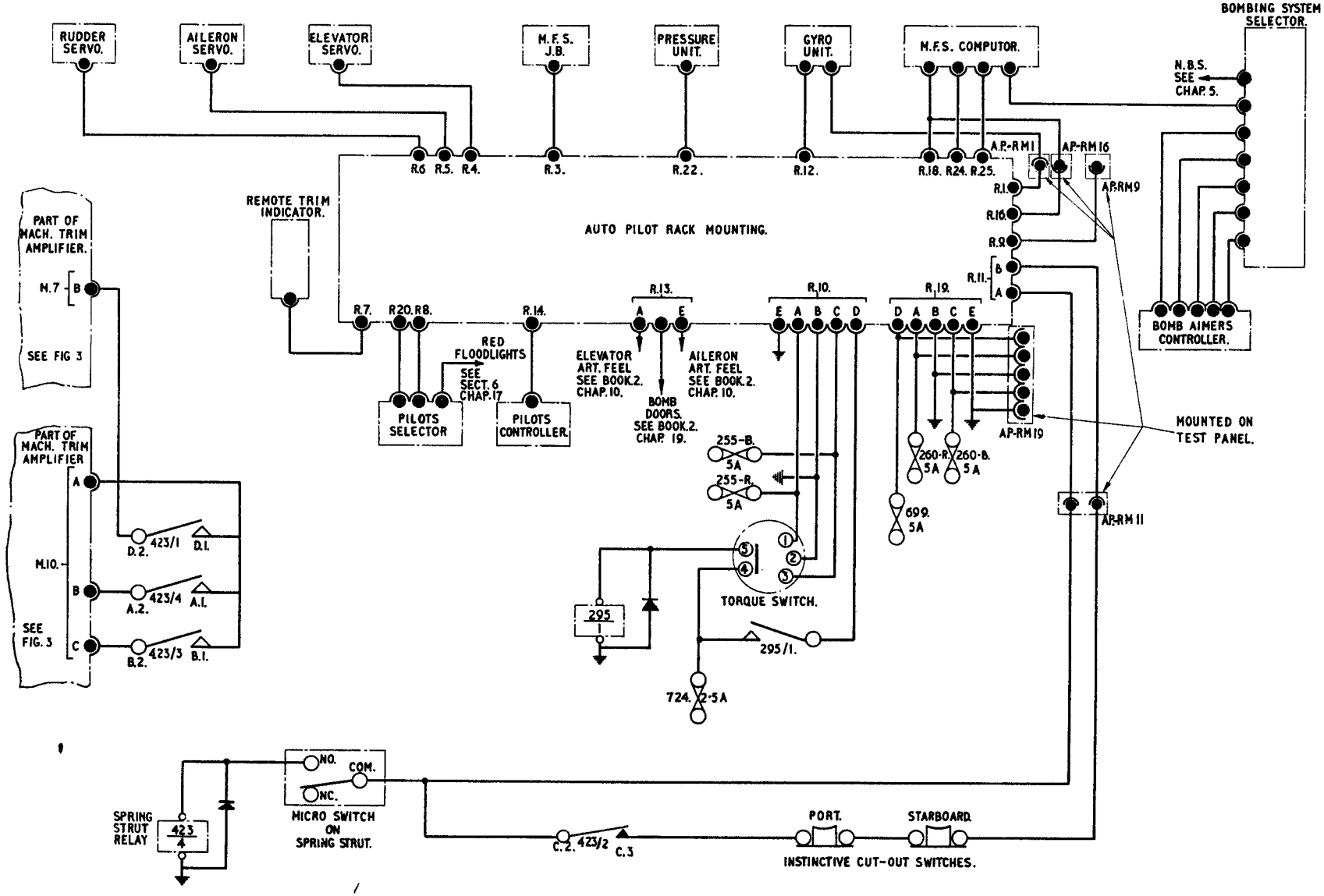

Fig. 2 Autopilot Mk. 10A

Test panel details added

shown in fig.1. The aileron servomotor, Type C, is mounted between the rear spar and the front fin support on the forward bulkhead of the aft power compartment. The rudder servomotor, Type C, is mounted on the port side of the bomb bay between stations 259.092A and 243.127A. The elevator servomotor, Type A, is on the port side of the bomb bay between stations 321.936A and 343.387A.

13. Each servomotor unit contains a three-phase motor, an a.c. tacho-generator, an electro-magnetic clutch, and a reduction gear train which terminates in an external output pinion. The electro-magnetic clutch enables the servomotor to be disengaged from the aircraft's control surfaces when necessary and is operated by a switch on the pilot's selector switch box. The reduction gearing is housed in the mountings on which the servomotors are installed.

Pilot's selector

14. The pilot's selector switch box is mounted on the retractable centre console as shown in fig.1. Mounted on the face of the box are the power supplies switch, the track and glide selector switches, the three control switches for the electro-magnetic clutches, the bomb, altitude and airspeed lock selector switches, and the engagement switch.

Pilot's controller

15. The pilot's controller is mounted at the forward end of the retractable centre console and takes the form of a knob which may be rotated clockwise or anti-clockwise to bank the aircraft up to 40 deg. starboard or port. The central position is located by a detent, but the knob is not spring-loaded and will remain at any desired setting until it is restored manually to the centre position.

Pitch control

16. Immediately below the control knob on the pilot's controller is a small spring-centred lever which is moved forward to make the aircraft dive and aft to make the aircraft climb. Slow and fast control rates are provided, the lever being spring-loaded at each half travel position to indicate the changeover from one rate to another.

Air bomber's controller

17. A second azimuth controller is provided in the system to enable the air bomber to control the aircraft when the visual bomb-sight is being used. The controller is mounted at the starboard side of the prone bomb aiming position and will operate only when VISUAL is selected on the bombing system selector switch.

Bombing system selector switch unit

18. The bombing system selector switch unit is mounted on a bracket which projects from the front face of the navigator's table at the nav. bomber's station. The unit consists of a two-position switch marked BLIND-VISUAL and a rotary switch marked N.B.C. GEARING. Depending upon the position of the two-position switch, signals are fed to the autopilot from either the bomb aimer's controller or the N.B.C.

Remote trim indicator

19. A remote trim indicator Type B is fitted on the first pilot's panel. This indicator, by means of a pointer moving within a miniature outline of the aircraft, indicates the pitch trim of the aircraft whenever the autopilot is in use.

Safety arrangements

20. In emergency conditions the autopilot may be immediately disengaged by means of the instinctive cut-out switches fitted on each pilot's column. In addition to these switches a roll error cut-out is embodied in the system to disengage the autopilot should a 'runaway' occur in the roll axis. The autopilot may also be disengaged by the action of a spring strut operating between the elevator servo motor and the control rods at former 321.936. The spring strut is pre-loaded to operate a micro switch when subjected to a load in excess of 78 lbs. in either direction. The micro switch controls a relay No.423, which is connected in the autopilot cutout circuit and the mach trim comparator circuits.

Spring strut operation

21. It will be seen from fig.2[1] that the spring strut micro switch is connected in series with the two instinctive cut-out switches and relay 423. When the micro switch is closed by action of the spring strut, relay 423 is energised to open relay contacts 423/2 and close relay contacts 423/1, 423/3 and 423/4. Opening relay contacts 423/2 will have the same result as pressing an instinctive cut out switch and the autopilot will be disengaged. The closing of relay contacts 423/1, 423/3 and 423/4 will permit spurious negative and positive G signals to be fed into the mach trim comparator circuits. This will result in the immediate locking of the mach trim servo and at the same time a misalignment signal will be presented on the mach trim indicator.

Power supplies

22. Supplies for the autopilot are fed to the junction box on the special rack mounting under the first pilot's floor. Distribution and interconnection is carried out within the junction box, the supplies being finally fed to the various units from the Cannon plugs and Mk.4 connectors. Two separate 115-volt, 3-phase, 400 c/s, a.c. supplies are fed to the junction box. The first of these is from fuses 260R and 260B in panel 25P and feeds direct to the junction box, plug R19, pins A, B, and C. The second supply is from fuses 255R and 255B in panel 24P. This supply also feeds direct to the junction box (plug R10, pins A, B and C) but has a torque switch connected across the three phase lines.

Torque switch

23. Mounted at the starboard side of the aircraft under the crew's floor and adjacent to panel 24P is a Type B1 torque switch. The switch is connected across the 115-volt, 3-phase supply to plug R10 in the rack mounting junction box and controls the d.c. supply to pin D of the same plug. The switch takes the form of a three-phase motor which operates to close the switch contacts whenever the a.c. supply to the motor is within the prescribed limits. A fault in the a.c. supply lines will cause the contacts to open and cut off the d.c. supply.

Operation of the torque switch

24. Providing the a.c. supply, to plug R10 and the torque switch, is within the prescribed limits, the torque switch motor will run and the switch contacts will close. Reference to fig.2 will show that a 28-volt d.c. supply from fuse 724 in panel 48P will then pass through the switch contacts to energise relay 295 which is fitted adjacent to the torque switch. With relay 295 energised, relay contacts 295/1 will close and allow a supply from fuse 724 to pass to pin D in plug R10. Should a fault develop in the a.c. supply, the switch will open, thus de-energising relay 295 and isolating the d.c. supply from the equipment. Complete details of the torque switch will be found in A.P.4343C, Vol.1, Sect.4, Chap.1. A description of the a.c. supplies to panels 24P and 25P will be found in Book 2, Sect.6, Chap.4.

D.C. supplies

25. In addition to the d.c. supply from fuse 724, fed via the torque switch, a second d.c. supply is fed direct to plug R19, pin D. This supply, together with all other supplies to the autopilot, will be found on the routing chart fig.3.

Test panel

26. A test panel, with five test sockets incorporated, is fitted on the forward member of the crate under the first pilot's floor. The panel enables the a.c. and d.c. supplies, connected to the autopilot via the rack mounting, to be monitored during servicing periods. The test sockets are labelled from top to bottom A.P.-RM.11, A.P.-RM.19, A.P.-SUPPLY TEST, A.P.-RM.16 and A.P.-RM.1.

Track and glide

27. When the aircraft is making an I.L.S. approach under autopilot control it has been found that the elevator angles demanded by the autopilot are in excess of those allowed by the spring strut authority. This is particularly so in rough weather and thereby constitutes an unacceptable nuisance.

28. To overcome this, provision has been made for the spring strut authority to be increased during an I.L.S. approach. This is achieved by reducing the artificial feel forces when the M.F.S. selector switch has been set to G.P., and the autopilot TRACK switch pulled ON. Further details of the artificial feel system will be found in Book 2, Sect.6, Chap.10 of this publication.

29. An indication that partial feel relief is operative is provided by the artificial feel magnetic indicator on the pilots' centre panel which changes from black to white. The elevator feel lamp however will not light. A failure in the elevator circuit when partial feel relief is operative will be indicated in the normal manner by the main warning system. To prevent the possibility of an out-of-trim release, or autopilot mal-function the maximum speed for selecting G.P. on the M.F.S. navigational selector switch is 180 knots I.A.S.

Aileron channel

30. The rate of roll in the event of autopilot mal-function at high altitudes is too great for the roll error cut-out. Consequently it has been necessary to restrict the aileron authority when the autopilot aileron channel is engaged. This is accomplished by moving the aileron A.F.U. stops to the high speed position when the aileron channel is engaged. This condition will be indicated by the artificial feel magnetic indicator changing from black to white. At the commencement of an I.L.S. approach, when G.P. is selected on the M.F.S. selector navigational switch and TRACK is selected on the autopilot, the aileron stops will move to allow 6° of aileron movement.

Bomb door compensation

31. Provision has been made in the autopilot, and in the aircraft wiring, for compensating elevator angle signals to be applied to the autopilot whenever the bomb doors are being opened. These signals will correct the aircraft's trim so that steady flight is maintained. As the required compensating elevator angle may vary with the operational role of the aircraft the elevator angle is adjustable. The E adjustment, which controls this setting is mounted below a perspex panel in the servo control unit. Further details will be found in A.P.1469EA, Vol.1.

Gearing pads

32. The servo control unit and the locking unit each have a gearing pad plugged into their front faces. These pads enable the parameters of the autopilot system to be made compatible with the aerodynamic characteristics of the aircraft. Further details are contained in Table 1.

NOTE . . .
Strong interference with the I.L.S. signal will be experienced if this unit is fitted without its associated gearing pad.

AUTOSTABILISATION AND MACH TRIM SYSTEMS

33. Under certain flight conditions it has been found that aircraft tend to oscillate about the yaw, roll and pitch axes. This tendency is particularly undesirable when an aircraft is being manoeuvred on to a target. The autostabilisation system is designed to combat this tendency by first detecting the oscillations and then suppressing them by suitable movement of the control surfaces.

34. The autostabilisation system embraces two separate systems, the yaw damper system, operating in the yaw axis, and the pitch damper system, operating in the pitch axis. In addition to being separate from each other, each system operates through a number of separately wired channels. The yaw damper system has two such channels and the pitch damper system has four. All channels pass through the datum setting unit under the navigators table which acts as a central servicing point. A similar type of system, which employs signals from modified machmeter assembly, is fitted to correct the inherent nose-down tendency of the aircraft when flying at speeds in excess of a certain mach number. This system is called Mach Trim and will be described in the later paragraphs of this chapter. A detailed description of all the systems will be found in A.P.1469SA, Vol.1. Table 2 gives a complete list of all the units employed in the autostabilisation system together with their individual part and reference numbers.

Yaw damper system

35. Each channel of this two channel system is completely separate from the other and consists of the following units:-

Rate gyro unit
Airspeed monitor unit
Datum setting unit
Amplifier unit
Slave relay unit
Servo unit

36. Yaw movement of the aircraft is detected by the rate gyro. The gyro produces a signal which is first passed to the airspeed monitor where it is modified and then passed on to the amplifier, via the datum setting unit. The output from the amplifier is fed to the slave relay unit, which passes the signal to the servo unit for subsequent operation of the control surfaces.

Control switches

37. The sequence of operations described in the previous paragraph will take place in only one of the two channels, depending upon the position of the pilot's selector switch. This switch is a 'centre-off', changeover type switch, marked OFF, YAW 1, YAW 2. The switch is mounted on the port console as shown in fig.1. Reference to fig.2 will show that the switch, which is fed with two separate 28-volt supplies from fuses 533 and 944, also acts as a master switch for the yaw damper system. Movement of the switch to the YAW 1 position will energise relay 297 from fuse 533 and at the same time pass a supply from fuse 944 to pin C.D.3 - C on the datum setting unit. This latter supply will complete the circuit for YAW channel 1 and the system will function. The energising of relay 297 will close relay contacts 297/1 and permit a 28-volt supply from fuse 943 to be fed to the magnetic reminder indicator. However, the indicator will not operate, due to feedback from the pitch and mach-trim systems. The feedback will be eliminated and the indicator will change to black when all three systems are switched on and functioning correctly. A similar sequence of operations will take place when the switch is moved to YAW 2. In this position, relay 297 is fed from fuse 944, and the datum setting unit, pin C.D.4 - C from fuse 533. Yaw channel 2 will thus be brought into operation.

Equipment location

38. The yaw gyro assembly is mounted under the second pilot's floor between formers 358 and 372. The unit is mounted at a small angle to the horizontal so as to pick up some component of rolling rate in addition to the yawing rate. The monitor assembly is mounted on a panel which carries the height switches and the speed and height monitoring units. This panel is fitted under the aft end of the crew's floor between formers 232 and 268.

39. The datum setting unit, through which all channels pass, is in the centre of the aircraft under the navigators' table, whilst at bomb arch 44.592, on the starboard side of the bomb bay, the pitch and yaw amplifier assembly is fitted. Adjacent to the amplifier assembly is the slave relay assembly. The yaw servo unit is mounted in the rudder control rod circuit at former 428 and forms an extensible link which operates through a differential lever linkage.

Power supplies

40. The location of the two d.c. supply fuses mentioned in para.36 is as follows:- fuse 944, panel 3P; fuse 533, panel 4P. The other a.c. and d.c. supplies are fed direct to the pitch and yaw amplifier assembly. These direct supplies ensure that the system is stable and ready for use when required. The system will not function however until the d.c. circuit through the yaw channel selector switch has been completed. The supplies are fed to the system via plug P.Y.7 and P.Y.8 on the pitch and yaw amplifier assembly. Each plug receives a 115-volt, 3-phase, 400 c/s a.c. supply on to pins A, B and C, and a 28-volt d.c. supply on to pin D. The supply sources and channels served are as follows:-

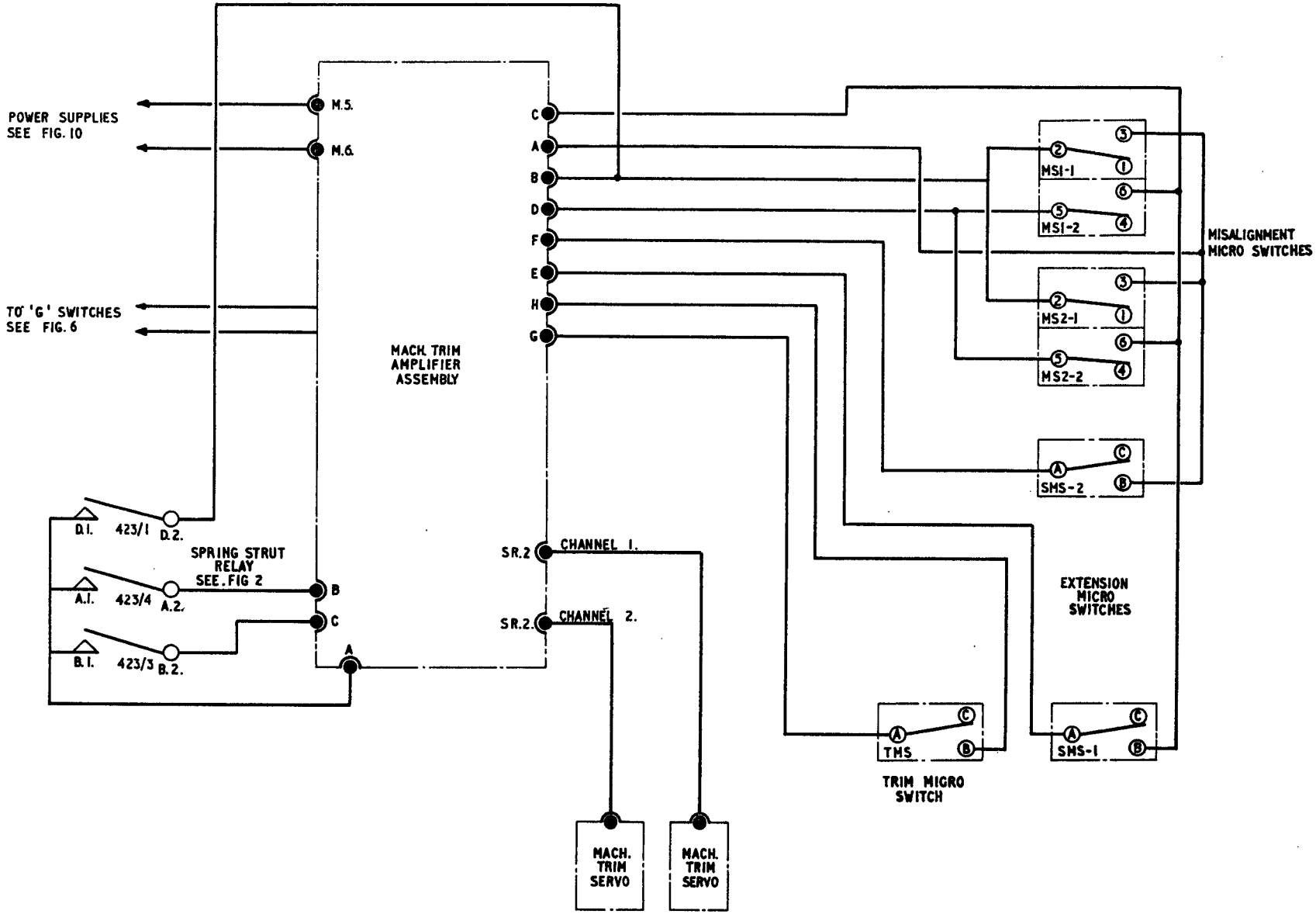

Fig. 3 Mach trim safety circuits

P.Y.7 115-volt, 3-phase, 400 c/s a.c. from fuses 314R and 314B in panel 28-P, 28-volt d.c. from fuse 821 in panel 19P. — Yaw channel 1

P.Y.8 115-volt, 3-phase, 400 c/s a.c. from fuses 313R and 313B in panel 28P, 28-volt d.c. from fuse 820 in panel 19P. — Yaw channel 2

Reference to para.46 will show that these supplies also serve pitch channels 3 and 4, distribution taking place within the amplifier assembly. For details of the 3 kVA transformer which provides the a.c. supplies, reference should be made to Sect.6, Chap.4. Details of the change-over circuit for use in the event of a transformer failure will be found in the same chapter.

Channel failure warning

41. Unlike the pitch damper and mach-trim systems, no failure indication is provided in the yaw damper system. Warning of a channel failure will be detected by the pilot from his experience of the aircraft's stability under normal operation of the system. If at any time he should suspect that the channel selected is faulty, he will immediately select the other channel by appropriate movement of the selector switch.

Pitch damper system

42. The pitch damper system is similar to the yaw damper system in many respects and much of the equipment is located adjacent to, or integrated with, the yaw damper units. The main difference is that the pitch damper system has four independent channels operating simultaneously, any three of which will, together, meet the design requirements of the system. A single channel failure will not cause noticeable deterioration in the system and it is possible for two channels to fail without serious effect on aircraft stability.

43. The detection, amplification and signal path for each channel follows the same sequence as that given for the yaw damper system in para.34, with only one exception, the monitoring stage. The pitch system monitoring depends upon height and powered monitors which modify the gyro signal as it passes first to the datum setting unit and then to the amplifier.

Equipment location

44. The pitch gyro assembly is mounted under the second pilot's floor adjacent to the yaw gyro assembly, while the datum setting unit, which, as previously stated, serves all channels from the three systems, is mounted under the navigator's table. The pitch amplifiers and comparator are mounted on the same assembly as the yaw amplifiers at bomb arch 44.592. Mounted adjacent to the amplifier is the slave relay assembly which carries the slave relays for both the pitch and yaw systems. The four servo units are fitted so as to form a mechanical feedback link on each of the power control units for the two inner pairs of elevons.

Control switches

45. Four push-pull type control switches are mounted on the port console as shown in fig.1. Each switch controls one channel and incorporates a warning lamp in the switch head. The system is switched on by moving the channel switches to the pulled-out position, thus completing the individual channel circuits from the datum setting unit. The system is prevented from operating in this condition by the height switches which act as a further control in the system and limit its functioning to altitudes above 20,000 feet. The height switches are mounted in the monitor assembly underneath the crew's floor between formers 232 and 238.

Power supplies

46. The four 28-volt supplies to the pitch warning lamps are fed from fuses 945, 946, 932 and 934 in panel 3P. Other d.c. and a.c. supplies are fed direct to each pitch channel via plugs P.Y.5, P.Y.6, P.Y.7 and P.Y.8 on the pitch and yaw amplifier assembly. Each plug serves a separate channel and is fed with 115-volt, 3-phase, 400 c/s, a.c. on to pins A, B and C, together with a 28-volt d.c. supply on to pin D. The plugs and their various supplies and services may be listed as follows:-

P.Y.5 115-volt, 3-phase, 400 c/s a.c. from fuses 288R and 288B in panel 27P, 28-volt d.c. from fuse 834 in panel 19P — Pitch channel 1

P.Y.6 115-volt, 3-phase, 400 c/s a.c. from fuses 287R and 287B in panel 27P, 28-volt d.c. from fuse 833 in panel 19P — Pitch channel 2

P.Y.7 115-volt, 3-phase, 400 c/s a.c. from fuses 314R and 314B in panel 28P, 28-volt d.c. from fuse 821 in panel 19P — Pitch channel 3

P.Y.8 115-volt, 3-phase, 400 c/s a.c. from fuses 313R and 313B in panel 29P, 28-volt d.c. from fuse 820 in panel 19P — Pitch channel 4

As in the case of the yaw damper system, these direct supplies ensure that the pitch system is stable and ready for use when required. It should be noted however that the system will not function until the d.c. control switches described in para.45 have been made.

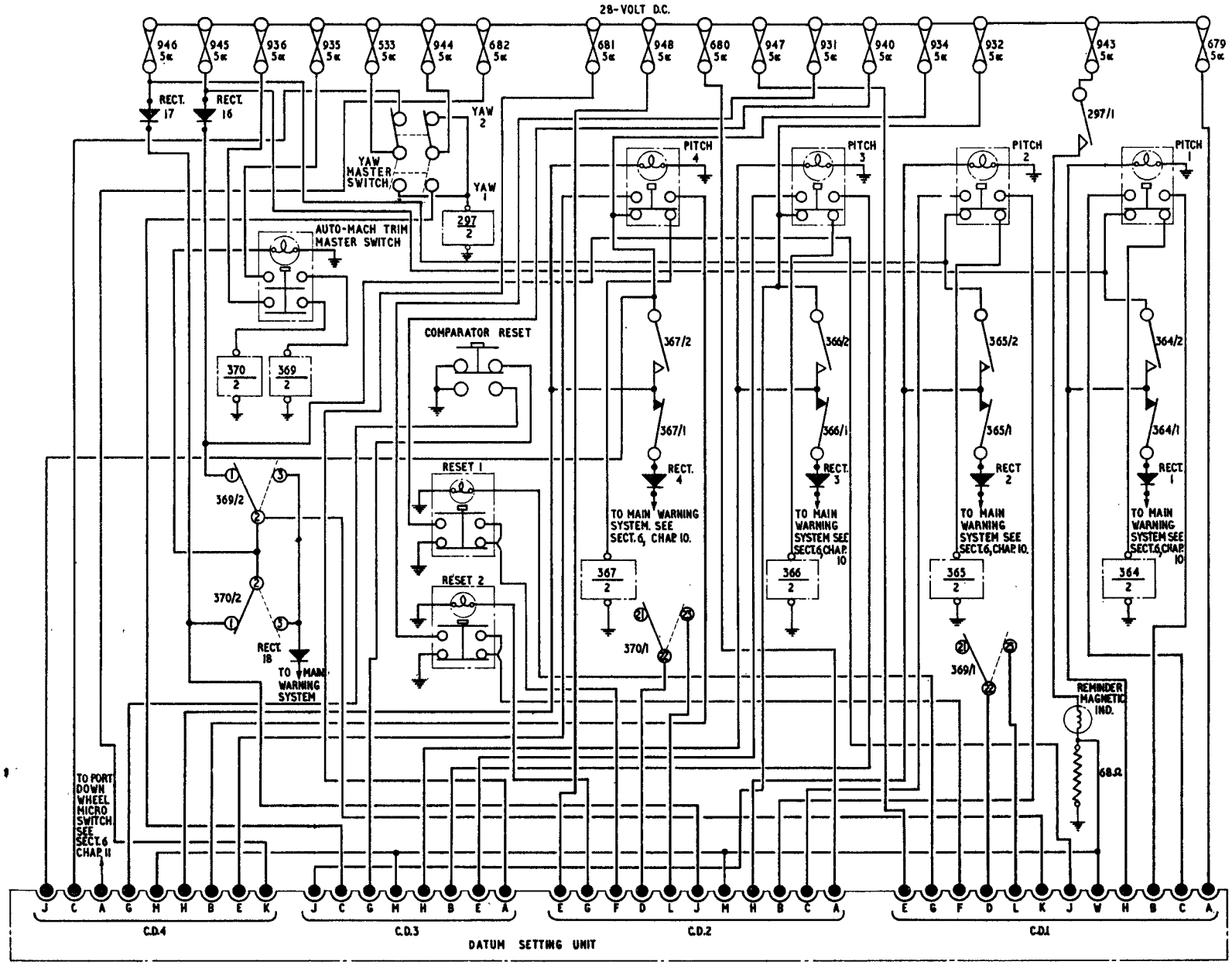

Fig. 4 Autostabilisation switching and indication

47. The a.c. supplies are fed from the starboard 3 kVA transformer which is described in Sect.6, Chap.4. In the event of a transformer failure, provision is made for switching the load to the other 3 kVA transformer. Details will be found in Sect.6, Chap.4.

Pitch servo heaters

48. The four pitch servo units are provided with internal heaters to prevent the units freezing during flight. The supply to the heaters is controlled by a relay in the pitch and yaw rack, supplies being fed to the heaters when the relays are de-energised. The relays are operated by the alighting gear circuit, as shown in Book 2, Sect.6, Chap.11. Whenever the aircraft is on the ground, a supply will be fed from fuse 619, panel 3P, via the port main wheel down-lock micro switch to energise the relays and disconnect the supplies to the heaters. Retraction of the alighting gear will break the supply, de-energise the relays and thus connect the supplies to the heaters.

Channel failure warning

49. Failure of any one of the four pitch channels will provide the pilot with two warning indications:-

(1) The main warning lamps on the pilots' centre instrument panel will light.

(2) The lamp in the head of the control switch for the channel affected will light.

The lamps are operated by the pitch comparator which compares the positions of all four servo feedbacks and indicates misalignment of any channel. Assuming that a failure has occurred in Pitch channel 1, reference to fig.4 will show that the misalignment signal is fed to the lamp in the head of the control switch for this channel, from pin CD1-H on the datum setting unit. At the same time the signal is fed, via the normally closed relay contacts 364/1, to the main warning system, thus providing an indication on the pilot's centre panel.

50. To ensure that the main warning system is clear and available for indication of further failures, the main warning lamps are switched off by pressing the illuminated head of the control switch for the channel that has failed. In the case of a pitch channel 1 failure this will isolate the faulty channel circuit and at the same time energise relay 364 from fuse 945, via the lower switch contacts. Relay contacts 364/2 will now close to complete the circuit from fuse 945 to the pitch warning lamp, thus providing a permanent reminder that the channel has failed. At the same time relay contacts 364/1 will open to isolate the main warning system.

51. Failure of a second channel will be indicated in a similar manner provided that the main warning system has been reset by depressing the illuminated channel switch. In the remote event of a third channel failure, all four channel lamps will be illuminated together. Before pressing the individual channel lamp, the system should first be proved faulty by pressing the comparator re-set push on the port console. Providing the system is functioning correctly the warning signal will be cancelled.

Mach trim system

52. It was stated in paragraph 34 that the mach trim system is fitted in the aircraft to correct the inherent nose-down tendency of the aircraft when flying at speeds in excess of a certain mach number. This is achieved by replacing the gyro signals of a system similar to those previously described, with signals from a unit sensitive to mach number.

53. The unit consists of two transmitting machmeters whose output is passed to the main amplifier units, via the datum setting unit. From here the amplifier output is fed, via slave relay units, to the servo units. These units are mounted on the power bay forward bulkhead and coupled into the elevon control rod circuit through a differential linkage.

Equipment location

54. The mach trim panel is mounted at the port side of the aircraft, under the crew's floor, between formers 218 and 232. The panel contains the transmitting machmeter unit and receives a pitot-static supply from both pitot-static systems. The datum setting unit is fitted amidships under the navigator's table as described in para.38 and 43. The mach trim amplifier assembly is mounted at bomb arch 44.592 on the port side of the bomb bay. This assembly also carries the slave relay units and the comparators. The two accelerometers incorporated in the system are mounted side by side on top of the amplifier assembly. Five micro switches are mounted on the mach trim servo assembly at the rear spar. These switches operate extension reminders and also provide a signal when misalignment occurs between the two servo units.

Power supplies

55. The d.c. supplies to the switch control circuits are all fed from panel 3P. Other d.c. and a.c. supplies are fed direct to each of the mach trim channels, via plugs M5 and M6 on the mach trim amplifier assembly. Each plug serves a separate channel and is fed with 115-volt, 3-phase, 400 c/s a.c. on to pins A, B and C, together with a 28-volt d.c. supply on to pin D. The supplies and services are as follows:-

M.5	115-volt, 3-phase, 400 c/s a.c. from fuse 301R and 301B in panel 28P, 28-volt d.c. from fuse 825 in 19P	Channel 1

M.6 115-volt, 3-phase, 400 c/s a.c. from fuses 273R and 273B in panel) Channel 2
27P, 28-volt d.c. from fuse 827 in panel 19P)

The 3 kVA transformer which provides the a.c. supplies is described in Sect.6, Chap.4, where details of the changeover circuit switching for the transformers will be found.

Control switches

56. Three switches, which have warning lamps fitted in their heads, are employed in the mach trim system. The switches are mounted in a row on the pilot's console as shown in fig.1. The most forward of the three switches is the master switch, which, when moved to the ON (pulled-out) position, completes the circuits for both channels of the system. Reference to fig.4 will show that with the switch in the OFF position, the lamp in the head of the switch will be lit by means of a supply from fuses 945 and 946 via terminals 1 and 2 of relays 369/2 and 370/2. Moving the switch to the ON position will energise relays 369 and 370, from fuses 935 and 936 respectively. Energising these relays will change-over the contacts of both relays to terminals 2 and 3, thus cutting off the supply to the lamp. At the same time relay contacts 369/1 and 370/1 will changeover to terminals 22 and 23 thereby completing the circuits for both mach trim channels. As in the case of the pitch dampers, the system is fitted with height switches to prevent the system being used below 20,000 feet. In addition to acting as an ON-OFF indicator the switch-head lamp has a second function which is described in para.57. The other two switches are spring-loaded out and pushed in to bring the servos back to their fully retracted position. The lamps fitted in these switches will light whenever the relevant channel servo is extended.

Failure warning indication

57. As stated in the previous paragraph, the amber lamp in the head of the master switch performs a dual function. In the first instance it acts as an ON-OFF indicator (para.56) and in the second instance as a servo misalignment indicator. Should misalignment occur in either servo this will be detected by the micro switches on the servo assembly and a signal will pass to relay contacts 369/2 and 370/2 via pin C.D.1-K on the datum setting unit. Reference to fig.4 will show that with the relay energised and the contacts in the changeover position (terminals 2 and 3) the signal will pass first to the main warning system and then to the lamp in the switch head. Following such an indication, the system may be re-set by depressing the channel re-set switches and then the comparator re-set switch. When a mach trim lock out has occurred due to excessive loading of the control system, the mach trim system must be switched off before re-setting and switching on again.

58. Runaway protection is provided by two accelerometers which, at predetermined increments of normal acceleration, prevent further movement of either servo in the direction of the applied 'g'. Provided that the comparator circuit gives no indication of misalignment between the two channels the servos will be re-energised when 'g' is reduced. If, however, misalignment is present when 'g' is applied, then the accelerometer relays will lock on. The system may be re-set by depressing the comparator re-set switch. This should not be attempted until the aircraft's speed has been reduced, the mach trim switched off and the servos re-set to their retracted position by means of the channel re-set switches. Provision has also been made for lock out of the mach trim system by the action of a spring strut fitted in the elevator control circuit. Details of the spring strut are given in para.20.

Magnetic indicator

59. In addition to the warning indications previously outlined for the pitch damper and mach trim systems, a magnetic indicator is fitted on the pilots' centre panel and is marked AUTO STABILISER. This indicator (previously mentioned in para.37) normally presents a white indication and will show black only when all stabilisation systems are switched ON and are functioning correctly. A failure in any channel of the pitch damper or mach trim systems will change the indication from black to white, and thus provide a permanent reminder to the pilots of a fault in one of the systems. The indicator will also show white if either of the mach trim servos is extended whilst the aircraft is flying at an altitude below that at which the height switches operate (20,000 ft).

SERVICING

60. As the instrument, electrical and mechanical components of the autocontrols system are so closely integrated, it is essential that complete co-operation be maintained between the various tradesmen concerned. Such co-operation will prevent wasteful duplication of ground tests and at the same time ensure that a high degree of serviceability is maintained in the systems.

AUTOPILOT MK.10A

61. The fixed components of the autopilot system require very little servicing apart from a periodical check, on the con-

nectors and cables for security, cleanliness and signs of damage. In the paragraphs that follow, instructions will be found for pre-flight ground functioning of the entire installation together with a detailed ground test procedure for setting-up the aileron and elevator artificial feel systems for autopilot control. These instructions should be read in conjunction with A.P.1469E, Vol.1, Sect.4 which contains detailed information on the initial installation and ground testing of the Mk.10A autopilot. A test socket is provided adjacent to the rack mounting which enables the supplies at plug R19 to be tested when necessary.

Functional ground check

62. These checks, which are performed without the use of test equipment, should be carried out daily, or at the periods laid down in A.P.4505B, Vol.4. Proceed as follows:-

(1) Remove fuse 612. (This is done to prevent unnecessary operation of the aileron A.F.U., since the unit would move to its high speed position upon engagement of the aileron channel).

(2) Ensure that the 200-volt a.c. and 28-volt d.c. ground supplies are available and connected.

(3) Ensure that the flying controls are free from obstruction.

(4) Switch on the 3 kVA transformers by means of the two switches on the secondary supplies control panel, 50P, at the A.E.O.'s station. Start up the powered flying controls. Switch on the mach trim, pitch and yaw systems.

(5) Check the flying controls for freedom and full range of movement.

(6) Pull up the retractable centre console, locate the pilot's selector and pull the POWER switch into the ON position. Allow 60 sec. ± 30 sec. to elapse then check the READY flag has appeared. This indicates that the autopilot may now be engaged.

(7) Switch the three channel switches to the IN position, then pull the ENGAGE switch on. Check that the READY flag has disappeared and that the IN flag is now showing. When the channel 'A' switch is selected the feel indicator on the centre panel should show white.

63. Select each channel switch to OUT, in turn, and check the following:-

(1) The READY flag should appear in addition to the IN flag.

(2) When the respective channel switch is disengaged the other two channel switches should remain firm.

(3) Upon re-engagement the READY flag should disappear.

64. With the autopilot fully engaged, carry out each of the following instructions, in turn:-

(1) Individually operate each pilot's instinctive cut-out switch.

(2) Apply a manual force in either direction to the elevator or rudder controls.

(3) Select all three channel switches to OUT.

(4) Select full bank on the pilot's controller in either direction.

Check that the result in each case is total disengagement of the three channels, together with disappearance of the IN flag, appearance of the READY flag, and release of the ENGAGE switch. Select all three channels to IN and re-engage the autopilot.

NOTE...

If the aircraft is not laterally level 'drift' will be present on the rudder controls when the autopilot is engaged. Rudder movement will be to starboard when the starboard wing is low, and vice versa.

65. Apply a steadily increasing force (26 lbs. approx.) in either direction to the elevator control. Ensure that all three channels disengage, the autostabiliser indicator on the pilots' centre panel turns white, and that the main warning lamps light.

66. Re-engage the autopilot and ensure that the autostabiliser magnetic indicator remains white and that the main warning system lamps are still lit. Re-set the mach trim system by switching the mach trim switch to OFF. Press the comparator re-set switch and then switch on the mach trim. Ensure that the autostabilisation indicator is now black and that the main warning lamps are out.

67. Displace the pilot's turn controller slightly to port. Check that the control columns move to port, accompanied by a slow movement of the rudder to port. Repeat for a turn to starboard, then return the controller to the detent position.

NOTE....

As a roll-error cut-out is fitted, the required results will only be obtained by slow movement of the turn controller. Harsh movement of the turn controller will probably result in total disengagement.

68. Select VISUAL on the bombing system selector. Repeat para.67 using the air bomber's turn controller. When completed, return the controller to the detent position.

69. Move the pitch control forward and check that the control columns move forward. Repeat for backward movement of the pitch control. Check that the control columns move aft.

NOTE . . .

A few degrees of movement is sufficient.

70. Push either control column forward. Check that the trim indicator shows NOSE HEAVY. Now pull the control column back and check that the indicator shows TAIL HEAVY. Disengage the autopilot, centralise the control columns, then re-engage The autopilot.

71. If the control columns tend to 'drift', align the heading monitor as follows:-

(1) Set the port and starboard compass isolation switches to ON. Allow two minutes for the twin compass system to warm up.

(2) Set M.F.S. selector switch to PORT, and both annunciator units to COMP.

(3) Adjust the synchronising knob of the port annunciator unit until all movement of control columns is stopped. Immediately movement stops, select channel switch A (on the pilots' selector) to OUT.

(4) Synchronise the port compass system.

(5) Set the M.F.S. selector switch to STARBOARD and channel switch A to IN.

(6) Adjust the synchronising knob of the starboard annunciator unit until control column movement stops. Immediately set channel switch A to OUT.

(7) Synchronise the starboard compass system.

72. With the autopilot fully engaged, select ALT on the ALT-IAS switch and pull on. Check the following results.

(1) When ALT-IAS switch is held in the ON position, no control column movement takes place.

(2) The pitch control is inoperative in both directions on slow rate.

(3) When the pitch control is moved to the full dive position, the ALT-IAS switch is released.

(4) When, after re-engagement of ALT-IAS switch, the pitch control is moved to the full-climb position, the ALT-IAS switch is again released.

(5) When the ALT-IAS switch is re-engaged and the elevator channel is switched out, the ALT-IAS switched is again released.

73. With the autopilot fully engaged turn the ALT-IAS switch to I.A.S. Pull the switch to ON then check the following:-

(1) The I.A.S. switch is held in the ON position and there is no movement of the controls.

(2) The pitch control is inoperative in both directions.

(3) The I.A.S. switch is released when the pitch control is moved to the full dive position.

(4) Re-engage the I.A.S. switch and then move the pitch control to the full climb position. The I.A.S. switch should again be released.

(5) Re-engage the I.A.S. switch then select the elevator channel out. The I.A.S. switch should be released. Refit fuse 612.

74. Ensure that the heading index on the M.F.S. beam compass coincides with the heading pointer, then with all channels engaged, switch out the aileron channel. Check that the artificial feel magnetic indicator on the pilot's centre panel turns black. Select G.P. on the M.F.S. selector switch, pull the autopilot TRACK switch to ON and check that the artificial feel magnetic indicator turns white. Switch off the TRACK switch and note that the feel indicator reverts to black.

75. Centralise the controls and pull the autopilot TRACK switch to on. Select G.P. on the M.F.S. selector switch and ensure that the TRACK switch does not switch off. Wait for 10 seconds then move the ailerons by rotating the beam compass heading index. Ensure that a full range of movement is available. Switch off the autopilot TRACK switch and after 10 secs. ensure that the aileron range is reduced by approximately 50 per cent.

76. Depress the aileron artificial feel warning test switch on panel 66P. Ensure that the main warning lamps on the pilots' panel and the artificial feel warning lamp light. Finally, switch off the autopilot and mach trim systems, also stop the P.F.C. motors using the individual stop switches, and switch off the two 3 kVA transformers and remove the ground supplies.

Ground test procedure
Artificial feel system

77. The initial setting-up procedure for the artificial feel system will be found in Book 2, Sect.6, Chap.10, of this publication. The following paragraphs contain the necessary instructions for setting up and testing the aileron and elevator feel

system on autopilot control. The following equipment is required for these tests.

(1) Pitot pressure simulator rig.

(2) Suitable ohmmeter.

(3) Two-foot rule.

Calibration of elevator servomotor authority

78. When the autopilot is used for auto-controlled I.L.S. approach, the authority of the elevator servo is increased by reducing the level of the artificial feel forces. The elevator feel warning circuit is biased correspondingly so that only the centre instrument panel "Feel" indicator gives indication of this change. The following test procedure checks the elevator servo authority in both normal and approach conditions.

(1) Remove fuse 612, in panel 3P, to prevent unnecessary operation of the aileron A.F.U.

(2) Disconnect the pitot piping from the elevator feel unit airspeed transmitter on the port side of the bomb bay and the associated pitot pipe from the elevator feel warning transmitter on the starboard side of the bomb bay. Connect a pitot pressure simulator rig to both transmitters simultaneously.

NOTE...
It is important to connect the rig to both transmitters simultaneously to prevent unbalancing the system.

(3) Ensure that the 200-volt a.c., and 28-volt d.c. ground supplies are connected.

(4) Switch ON the two 3 kVA transformers at panel 50P, A.E.O.'s station.

(5) Ensure that the flying controls are free from obstruction.

(6) Check that the autopilot is disengaged and then trim the elevator into line with the inboard fixed trailing edge.

(7) Engage the autopilot and then trim the elevators until the remote trim indicator indicates zero load (see note (a)). Pull the pitch control backward to the "slow rate" position until the autopilot is disengaged by the operation of the spring strut cut-out. Measure the maximum deflection of the elevators between "zero load" and "cut-out" (see note (b)).

NOTE...
(a) *It is important that when trimming the servomotor to zero load, the final movement of the pitch control must be in the same sense in which it is required to move the elevators in the tests which follow.*

NOTE...
(b) *When the autopilot is disengaged by the operation of the spring strut, the elevators will return to their trimmed position at high speed dictated by the recovery of the artificial feel unit. Care must, therefore, be taken when measuring the deflection of the elevators.*

(8) Slowly increase the airspeed in the pitot pressure rig and (by listening at the A.F.U. for the first operation of the actuator) note the speed at which the elevator A.F.U. cuts-in. Refer this speed to the elevator movements measured at sub para(7) above (i.e., record the servo authority at A.F.U. "cut-in" speed).

(9) Repeat the test in sub-para.(7) at simulated airspeeds of 120, 160 and 200 knots, taking care always to approach target-speed from below. Record the elevator movements and associated airspeeds.

(10) Decrease the airspeed to zero and repeat the tests in sub-para.(7) and (8) with the pitch control pushed forward to the "slow rate" position.

(11) Check, and set if necessary, the resistance values at potentiometers Nos.3 & 2 in Panel 83P to 200 ohms.

(12) Switch the M.F.S. selector to LOC and G.P. engage the autopilot and pull "ON" the TRACK switch. Repeat the test in sub-para.(7) to (10)at simulated airspeeds of 160, 180 and 200 knots.

NOTE...
Artificial feel failure warnings arising during these checks may be ignored. See para.80 for feel warning circuit balance checks.

(13) Check that all the readings obtained in the above tests lie between the appropriate curves in fig.4A. If they do not, proceed as in para.79.

79. If readings obtained from 78 (7) to 78 (10) do not lie within the appropriate tolerances the fault lies either in the spring strut breakout load or in the artificial feel system. To determine where the fault is located proceed as follows;-

(1) The spring strut breakout load may be checked with a spring balance. The load to operate the micro switch should be 80 lb. ± 2 lb.

(2) If (1) above shows no fault in the strut, then the control circuit should be checked for excessive friction. It is essential that the breakout force at the control column does not exceed 9 lb.

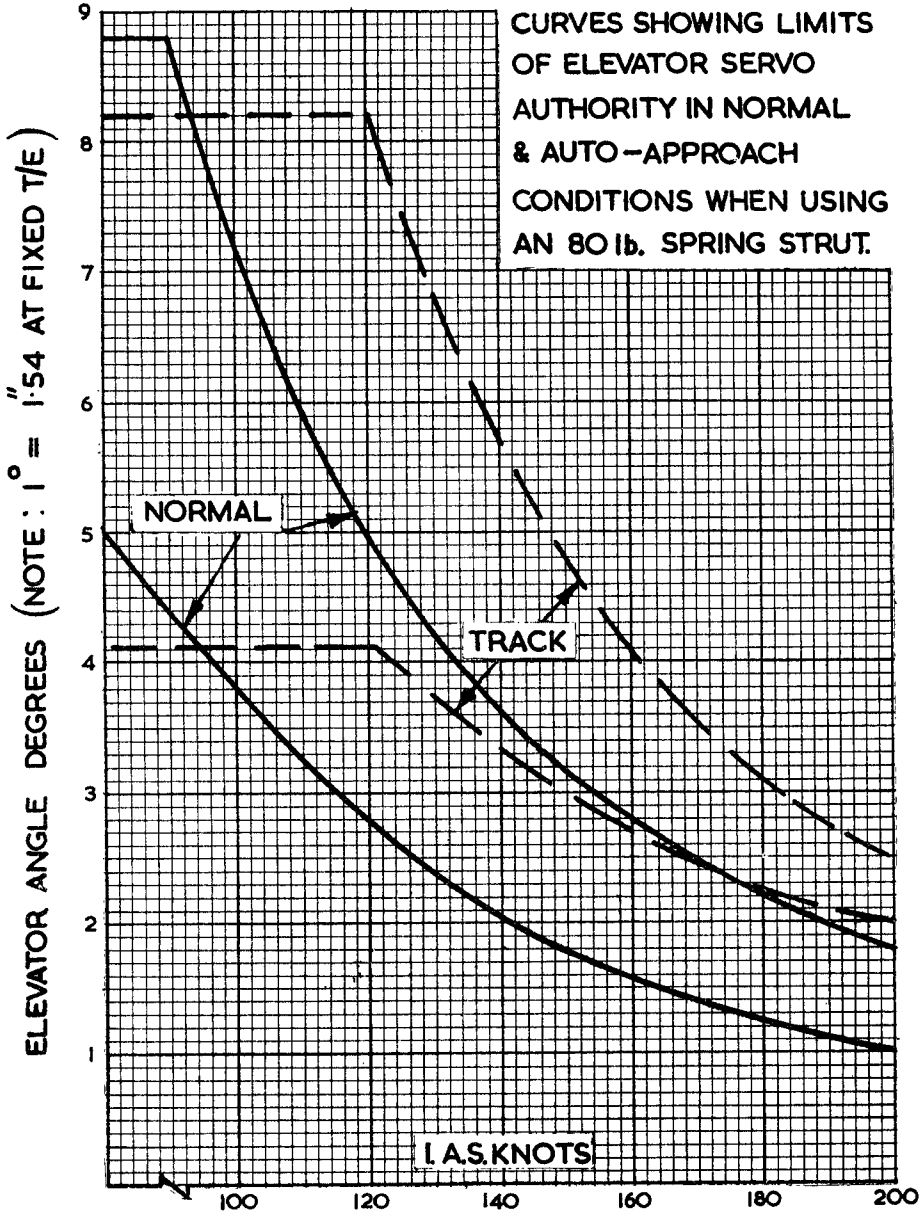

Fig. 4A Elevator control limits

(3) If the fault still persists, then the artificial feel system must be re-calibrated and appropriate remedial action taken (Book 1, Sect.3, Chap.4).

(4) With satisfactory results from tests 78 (7) to 78 (10) if the results from tests 78(12) do not lie within the appropriate range then the amount of artificial feel bias may be adjusted at potentiometer number 1 in panel 83P.

Elevator feel warning balance

80. The procedure for setting-up the elevator feel warning balance system is as follows:-

(1) Switch OUT the aileron channel and replace fuse 612 in panel 3P.

(2) Simulate an airspeed of 200 knots approx. at the elevator feel and warning transmitters, then adjust airspeed until the relay dial on the feel unit reads zero.

(3) Check that all feel failure indications are normal and test the failure warning circuit by depressing the elevator test button on panel 66P (bomb bay).

NOTE...
Setting up procedure for this circuit is given in Book 2, Sect.6, Chap.10, of this publication.

(4) Engage the autopilot and with M.F.S. selector at 'LOC and GP', pull ON the TRACK switch. It is possible that a feel failure indication will result.

(5) Whether a feel failure warning occurs or not, check the position of the elevator warning relay dial in panel 66P and adjust potentiometer No.2 in panel 83P until a zero reading is obtained at the relay.

(6) Check that feel failure warnings are cancelled with the exception of the centre instrument panel indicator which must remain white.

(7) Depress the TRACK switch OFF. The feel unit must reset to normal and the white indication revert to black in approx. 2 seconds.

(8) Disengage the autopilot, reduce to zero (at not more than 20 knots per second) the simulated airspeed at the feel system and disconnect the simulator. Reconnect and make good the aircraft A.S.I. piping circuit.

(9) Lock the adjustments on potentiometer 3 and 2 in panel 83P.

Aileron range check

81. Selection of aileron channel engaged causes the A.F.U. to restrict aileron angle to ± 5 deg; the aileron feel failure warning circuit is inhibited, but the reminder indicator on the centre instrument panel turns white to indicate the above conditions. During Auto-I.L.S. approach the permitted aileron angle is increased to ± 6 deg. with the same warning circuit conditions prevailing. The following procedure governs the setting-up and checking of these arrangements.

NOTE...
This interconnection implies that the A.F.U. is exercised each time the autopilot is engaged or disengaged. Up to this stage of the tests this effect has been prevented by removal of fuse 612, or by switching out the aileron channel, but from this point, the frequency of engage or disengage switching should be minimised to prevent needless wear and tear on the A.F.U. In any case a time of 10 seconds should be allowed to elapse between engagement and disengagement.

(1) With the autopilot disengaged check that the elevons are trimmed in line with the inboard fixed trailing edge.

(2) In panel 83P, check that the total resistance between relay 702 (terminal 2) and plug 892 terminal E) is set at 795 ohms. Reset if necessary at potentiometer No.1.

(3) With the aileron channel switched OUT, engage the autopilot and check that the feel indicator on the centre instrument panel shows black.

(4) Switch IN the aileron channel and ensure that:-

(a) The indicator shows white, but no main warning occurs.

(b) The aileron A.F.U. has moved to its high speed condition (i.e., stop clearance reduced to 0·4 in. approx.).

(5) Move the turn control a small amount clockwise and measure the maximum control surface movement. This should be between 4·5 deg. and 5 deg. (i.e. between 7 in. and 7·7 in. at the fixed trailing edge). If, these movements are not correct the feel system is at fault and reference should be made to Book 1, Sect.3, Chap.4 for remedial action. Re-centre the turn control.

NOTE...
If the turn control is held over for any length of time the autopilot may disengage via the roll error cut-out. Should this occur 10 seconds must be allowed before re-engagement takes place.

(6) With the M.F.S. Selector at 'LOC and GP', pull ON the TRACK switch. The A.F.U. stops should open out by approx. ·08 in.

(7) Move the compass setting knob a small amount clockwise and measure the resulting control surface movement. This should be between 6 deg. and 6·5 deg. (i.e. between 9·4 in. and 10·1 in. at the fixed trailing edge) and is adjustable at potentiometer No.1 in panel 83P.

(8) Repeat (7) above with anti-clockwise movement of the compass setting knob.

(9) Lock the adjustment on potentiometer No.1.

(10) Disengage the autopilot. Stop the P.F.C. motors using the individual stop switches. Switch off the two 3 kVA. transformers. Disconnect the ground supplies.

AUTOSTABILISATION AND MACH TRIM SYSTEMS

82. Apart from periodical checks of the wiring and connectors, little in the way of servicing is required in the installation. During the checks, all wiring and connectors should be examined for signs of damage and general security. The fixed components should also be examined for security and signs of damage.

83. Detailed instructions for servicing the autostabilisation systems will be found in A.P.1469SA, Vol.1, where instructions on the use of the No.1 test set Type 1170, Ref.No.6C/2113, will be found. No test equipment is required for functioning checks on the systems as built-in test facilities are provided in the datum setting unit. These facilities take the form of a number of switches which are fitted underneath the front flap of the datum setting unit. There are eleven switches in all: four of these, S1A, S2A, S3A and S4A, are used to override the altitude switches which would normally prevent operation of the systems at ground level. Of the other

seven switches, four are used for pitch damper tests, S1B, S2B, S3B and S4B, two others for mach trim tests, S5B and S6B, and the remaining one for yaw damper tests, S7B. For more thorough checks on the mach trim system it will be necessary to employ suitable test equipment in order to simulate conditions of altitude, airspeed and mach number. Instructions for connecting the equipment to the pitot-static system, together with the necessary calibration figures, will be found in A.P.1469SA, Vol.1.

Functional ground check

84. The checks that follow are to be carried out daily or at the periods laid down in A.P.4505B, Vol.4. No special equipment is required for the checks other than a magnet to operate the accelerometers, and the necessary ground power supplies. Proceed as follows:-

(1) Ensure that the 200-volt a.c., and 28-volt d.c. ground supplies are connected.

(2) Switch ON the two 3 kVA transformers at panel 50P, A.E.O.'s station.

(3) Ensure that the flying controls are free from obstruction.

85. Open the front flap of the datum setting unit and ensure that the test switches are set as follows:-

(1) The four pitch damper switches S1B, S2B, S3B, S4B are at the mid-position.

(2) The two mach trim switches S5B and S6B are at the mid-position.

(3) The yaw damper switch S7B is in the mid-position.

(4) The four altitude override switches S1A, S2A, S3A and S4A are set towards the aircraft floor.

86. Inspect the P.F.C. control panel on the port console to ensure that the following lamps are lit:-

(1) The warning lamps contained in the P.F.C. switches.

(2) The four warning lamps contained in the pitch damper switches.

(3) The warning lamp contained in the mach trim switch.

(4) The main warning lamps on the pilots' centre panel.

87. Switch on all the P.F.C. motors and check that all the P.F.C. warning lamps and main warning lamps go out. With the motors running, set the controls to neutral, then pull the four pitch damper switches to ON. Check that the pitch warning lamps go out.

NOTE ...
If any pitch damper warning lamp remains alight, operate the comparator re-set switch on the P.F.C. control panel.

88. Set the yaw damper switch to YAW 1 and pull ON the mach trim switch. Check that the following indications of correct functioning are given.

(1) Mach trim switch: warning lamp goes out.

(2) Mach trim re-set switches: warning lamps out.

(3) Magnetic indicator on pilot's centre panel: shows black.

NOTE ...
If any lamp remains alight, press the mach trim re-set switches for a period of not more than 15 sec.

Pitch damper checks

89. Using the pitch damper test switches, S1B, S2B, S3B and S4B, in the datum setting unit, carry out the following checks:-

(1) Operate switch S1B towards the floor of the aircraft. Ensure that No.3 elevon moves down and then returns to the neutral position.

(2) Return switch S1B to its original position. Ensure that No.3 elevon moves up, then returns to the neutral position.

(3) Repeat operations (1) and (2) with switches S2B, S3B and S4B. Ensure that Nos.4, 5 and 6 elevons respectively move in a similar manner.

NOTE ...
If, during the tests, a warning indication is given by any of the pitch damper switches, the comparator re-set switch should be operated.

Yaw damper checks

90. Using switch S7B, in the datum setting unit, carry out the following checks:-

(1) Operate switch S7B towards the floor of the aircraft. Ensure that the rudder moves to port and then returns to the neutral position. (The return period may take up to 15 secs.).

(2) Return switch S7B to its original position and ensure that the rudder moves to starboard and then returns to the neutral position.

(3) Set the yaw damper switch on the P.F.C. control panel to YAW 2 and repeat operations (1) and (2).

Mach trim checks

91. Using switches S5B and S6B in the

datum setting unit, carry out the following checks:-

(1) Operate switch S5B towards the floor of the aircraft and check that the following indications are given:-

(a) Mach trim No.1 re-set switch: warning lamp is lit.

(b) The elevons move up.

(c) Mach trim switch: warning lamp is lit.

(d) Main warning system: lamps are lit.

(e) Magnetic indicator on the pilot's centre panel: shows white.

(2) Return switch S5B to its original position immediately the main warning lamps light. Ensure that the indications given in 1(a) to (e) are cancelled, i.e., warning lamps out, magnetic indicator showing black and elevons at neutral.

(3) Repeat (1) and (2) using switch S6B.

92. Set the four altitude override switches S1A, S2A, S3A and S4A to their original position. When this is done, operate switches S1B, S2B, S3B, S4B, S5B and S6B, first towards the floor of the aircraft and then back to their original position. Ensure that the elevons remain at neutral.

93. Push the four pitch damper switches, the mach trim switch, and each of the P.F.C. switches to OFF, in turn. Check that the switch warning lamps light in each instance. Set the yaw damper switch to the mid-position. Switch off the two 3 kVA transformers and disconnect the power supplies.

Gyro rotation

94. Check the gyros of the pitch and yaw damper systems for correct rotation. Direction of rotation can be most readily detected when the gyros are just starting up, or in the final stage of running down. Direction of rotation should be anti-clockwise when viewed from the open end.

REMOVAL AND INSTALLATION

General

95. The components which form the autopilot and autostabilisation systems are readily accessible and no special removal instructions are required. Removal of the servo units will normally be carried out by the airframe tradesmen, providing that the electrical services to the unit have been previously disconnected. Before removing the servo unit the flying controls should be locked in the position described in Book 1, Sect.3, Chap.4 of this publication where full instructions for removing the units will be found.

◀ *WARNING...*

The bolts securing the micro switch bracket to the mach trim servo unit should be torque loaded to 16-20 lbs./in. whenever refitment of the micro switch bracket to the servo unit is made, otherwise severe distortion of the bracket leading to possible jamming of the servo unit action may be experienced. ▶

TABLE 1

Autopilot equipment

Equipment	Type	Ref.No.	No.off
Pilots' selector	A	6T/1623	1
Pilots' controller	A	6T/214	1
Bomb aimer's controller	A	6T/400	1
Gyro unit	B	6T/1648	1
Servo control unit	A	6T/1615	1
Platform control unit	A	6T/1616	1
Locking unit	A	6T/1617	1
Rack mounting	A	6T/1622	1
Junction box	A	6T/1621	1
Pressure unit	A	6T/1614	1
Pressure unit (post Mod.1160)	B	6T/1718	1
Pressure unit mounting	A	6T/402	1
Servo motor	A	6T/230	1
Servo motor	C	6T/307	2
Servo motor mounting	A	6T/232	3
Bombing system selector	A	6T/1613	1
Remote trim indicator	B	6T/1676	1
Gearing pad (servo control unit)	-	6T/1618	1
Sense pad (servo control unit)	-	6T/1620	1
Gearing pad (locking unit)	-	6T/1619	1

TABLE 2

Autostabilisation equipment

Equipment	Part No.	Ref.No.	No.off	
Amplifier unit	869	6S/241	4	)
Gyro unit	868	6S/240	4	)
Mounting	867	6S/239	1	) Pitch Gyro Assembly
Transformers	870	6S/319	4	) Part No.866
Amplifiers	871	6S/320	4	)
Amplifier unit	869	6S/241	2	)
Gyro unit	868	6S/240	2	)
Mounting	873	6S/243	1	) Yaw Gyro Assembly
Transformers	870	6S/319	2	) Part No.872
Amplifiers	871	6S/320	2	)
Pitch amplifier	890	6S/253	4	)
Pitch comparator	884	6S/252		)
Yaw amplifier	892	6S/254	2	) Pitch and Yaw Amplifier Assembly
Magnetic amplifier	893	6S/255		) Part No.1223
Mounting	1224	6S/251	1	)
Slave relay unit	899	6S/261	6	) Pitch and Yaw Slave Relay Assembly
Mounting	898	6S/260	1	) Part No.897
Pitch servomotor	894	6S/256	4	
Yaw servomotor	895	6S/257	1	
Mach trim servomotor	1350	6S/258	2	
Datum setting unit	1352	6S/270	1	
Powered monitor, Type A	1015	6S/273	2	)
Magnetic amplifier, Type 2	1016	6S/276	2	)
Static unit, Type B	1017	6S/277	2	) Monitor Panel
Altitude switch	880	6S/274	2	) Part No.1357
Yaw airspeed monitor	878	6S/275	2	)
Mounting	1358	6S/272	1	)
Transmitting machmeter unit	884	6S/249	2	
Junction box	1359	6S/248		
Mounting	882	6S/247	1	
Amplifier unit	1004	6S/264	2	)
Comparator	1355	6S/265	2	)
Auto-magnetic amplifier	1005	6S/267	2	) Mach trim Amplifier Assembly
Magnetic amplifier	1006	6S/268	2	) Part No.1353
Slave relay unit	1009	6S/269	2	)
Mounting	1354	6S/263	1	)

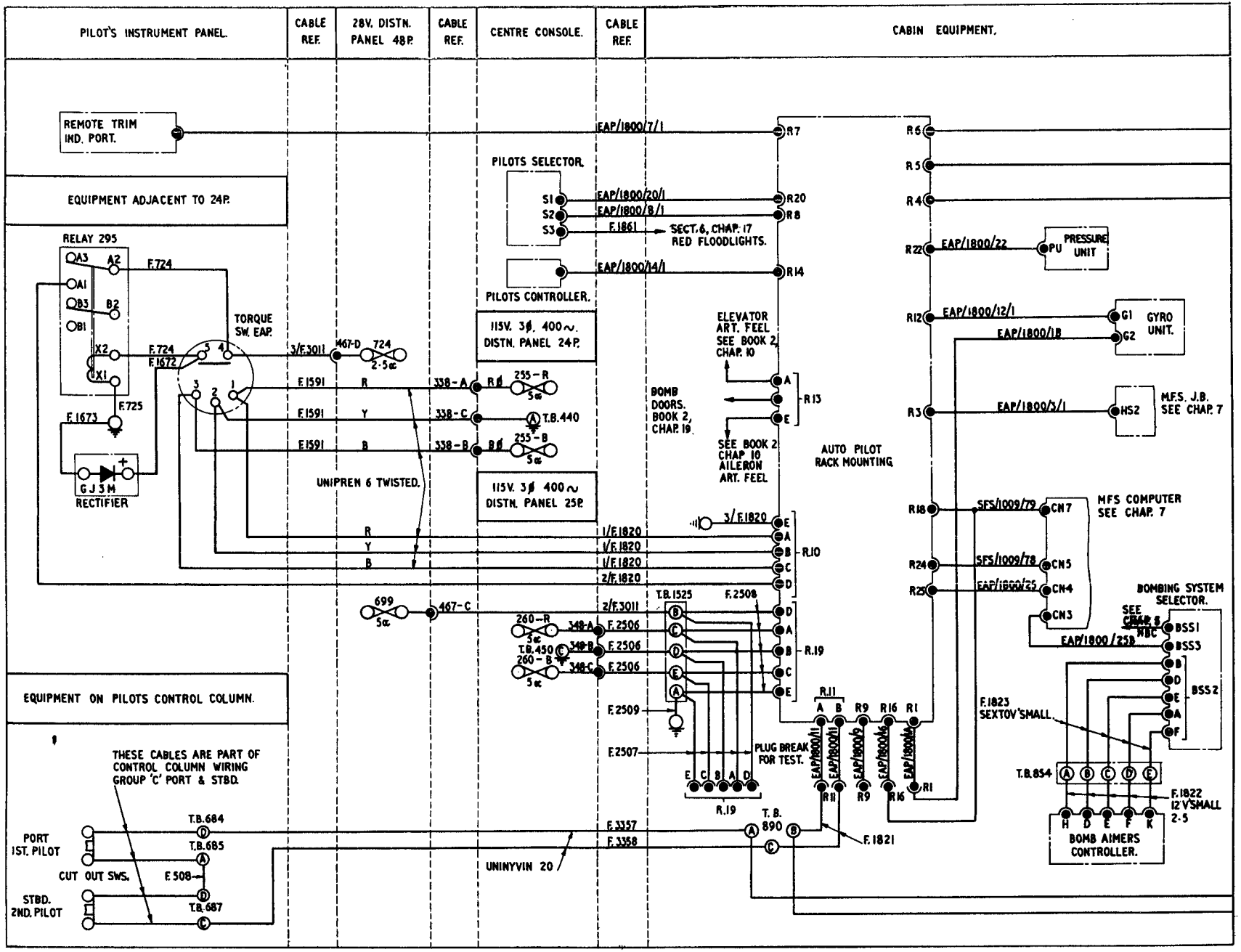

Fig. 5 (1) Autopilot Mk. 10A

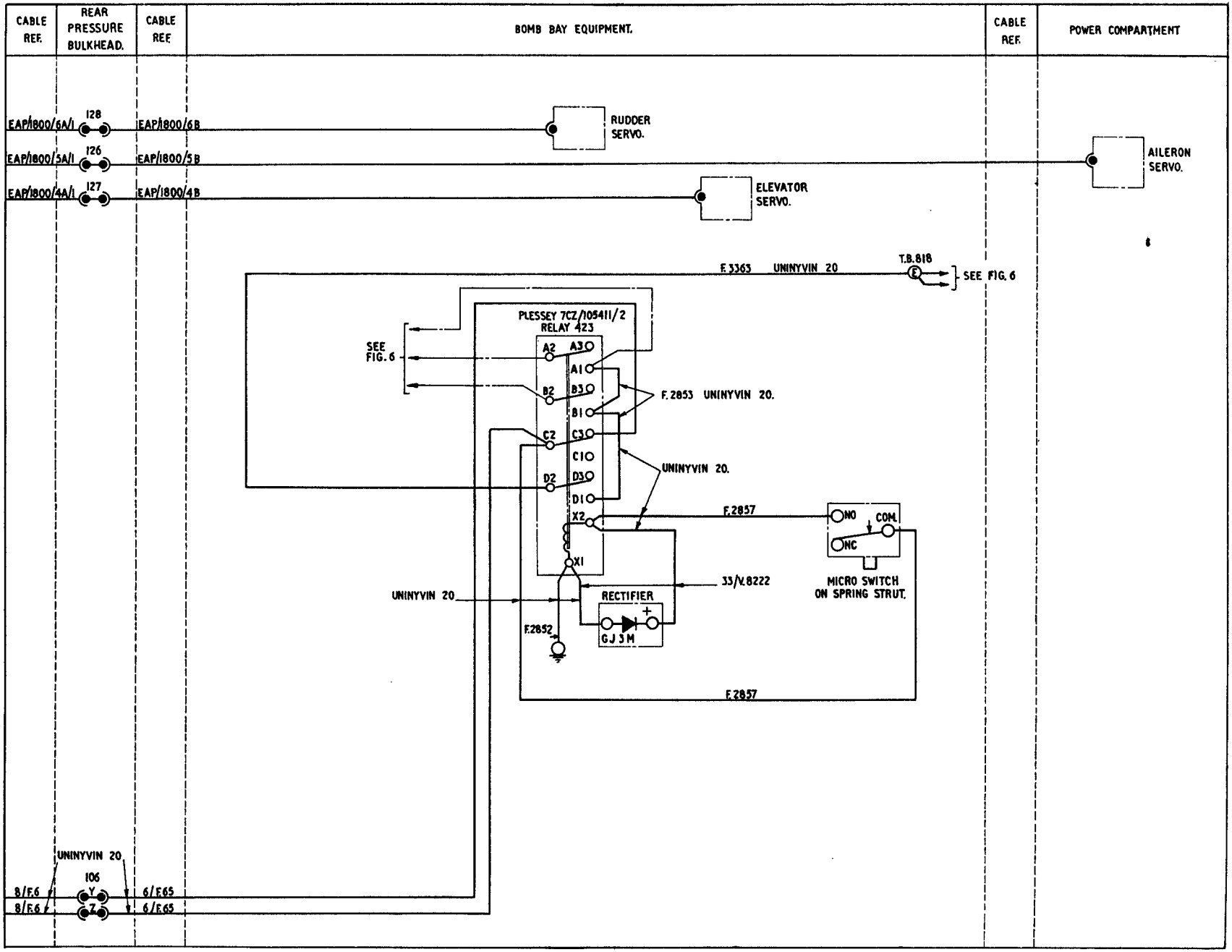

Fig. 5 (2) Autopilot Mk. 10A

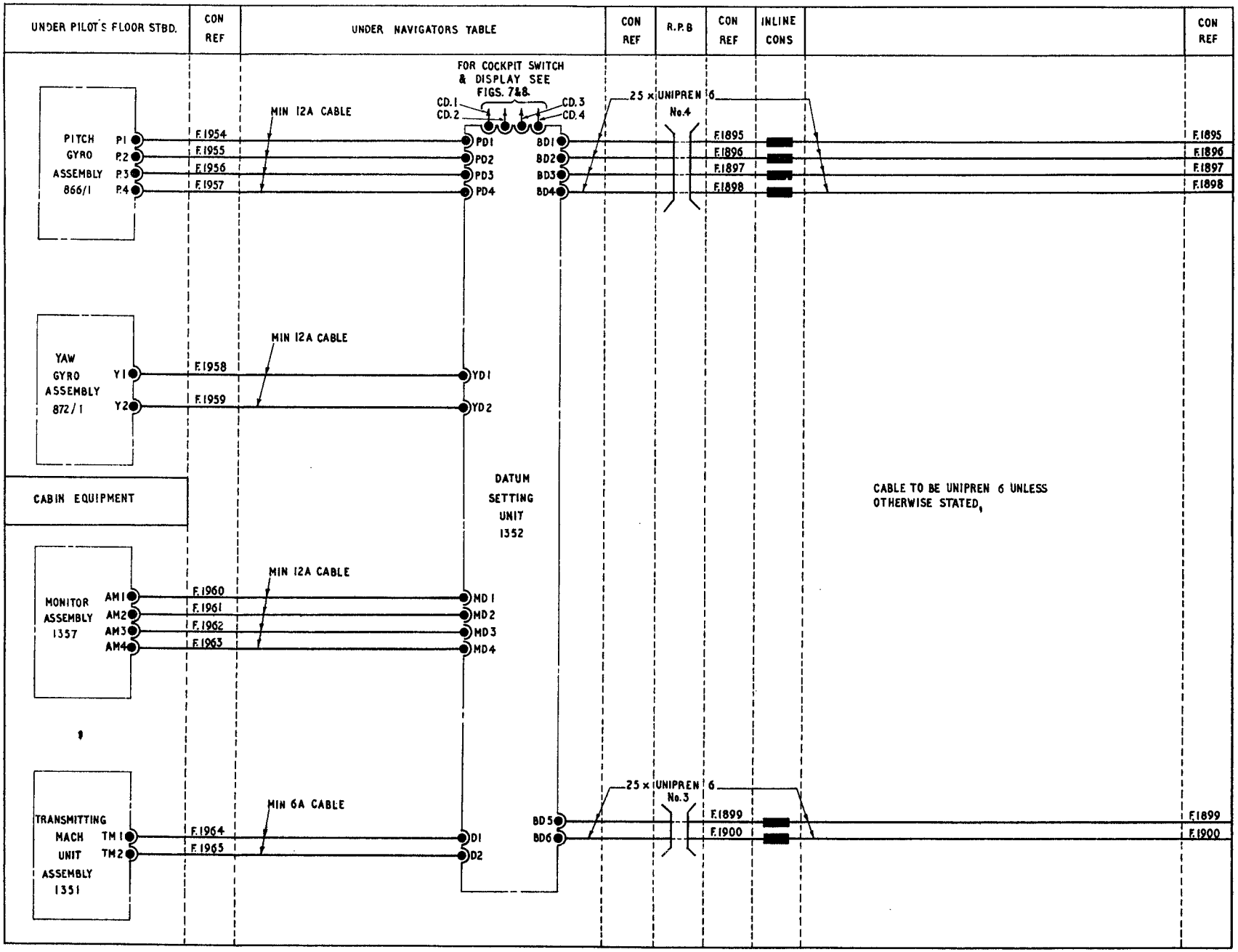

Fig. 6 (1) Autostabilisation systems

Minor correction

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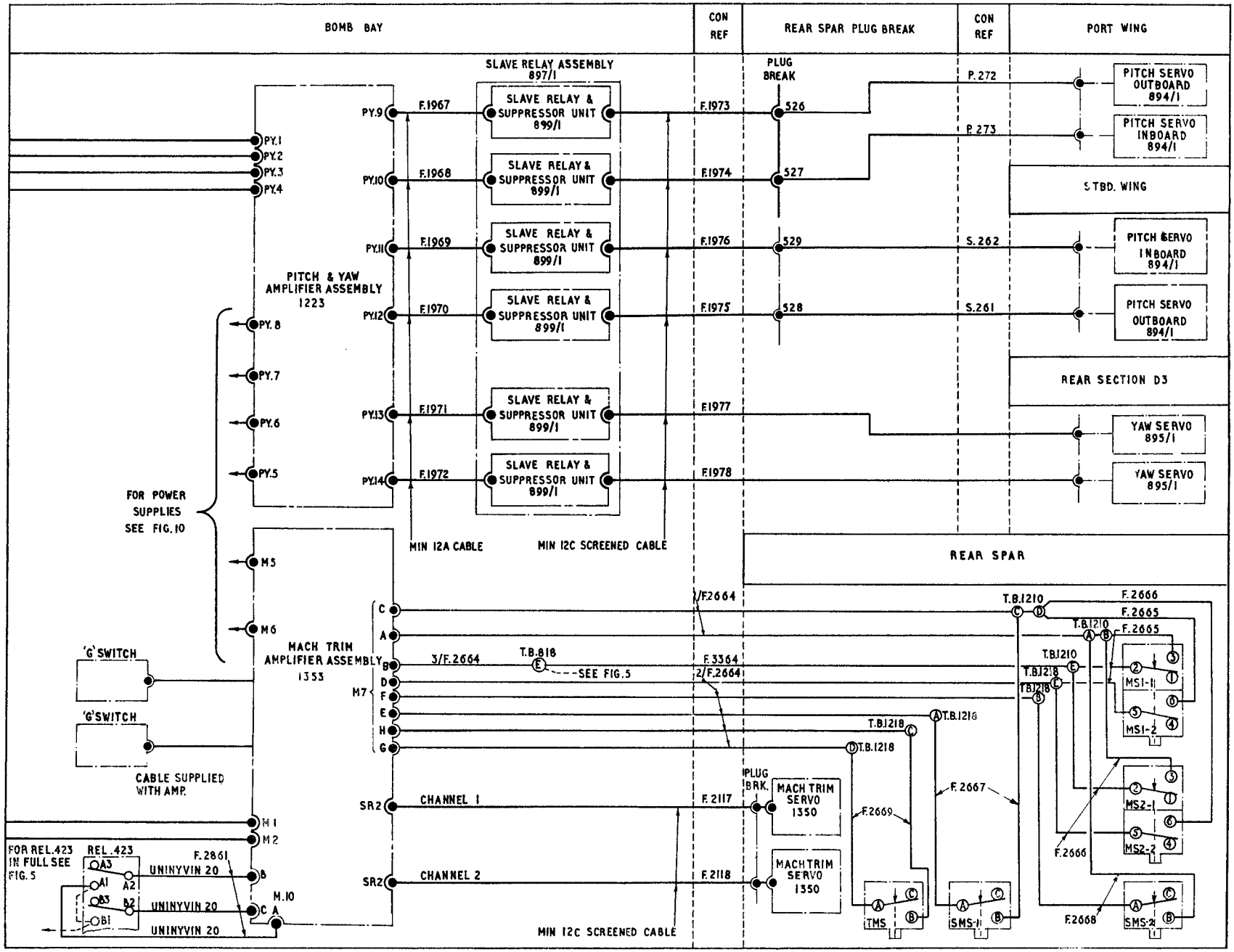

Fig. 6 (2) Autostabilisation systems

Minor correction

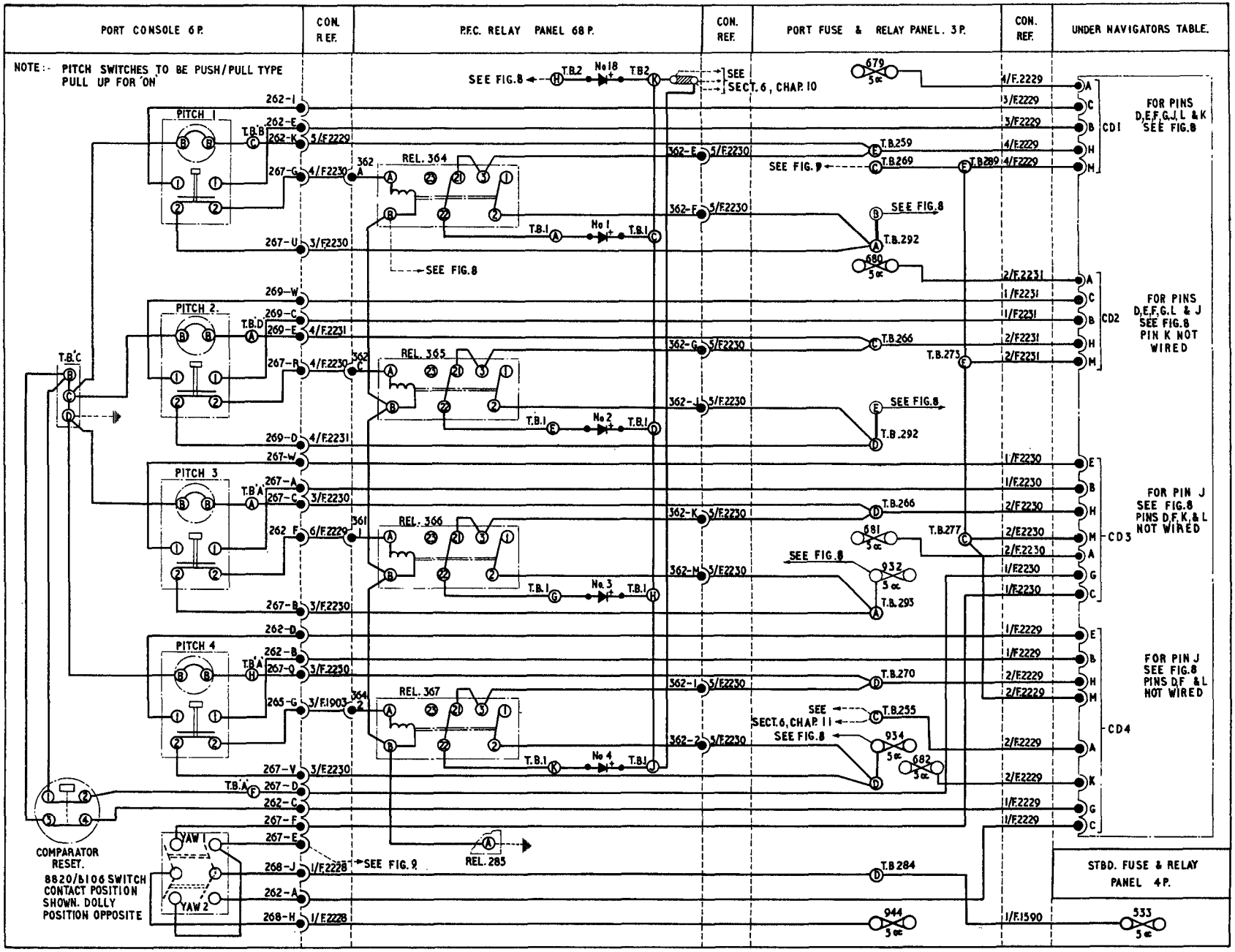

Fig. 7 Pitch yaw and comparator reset switching

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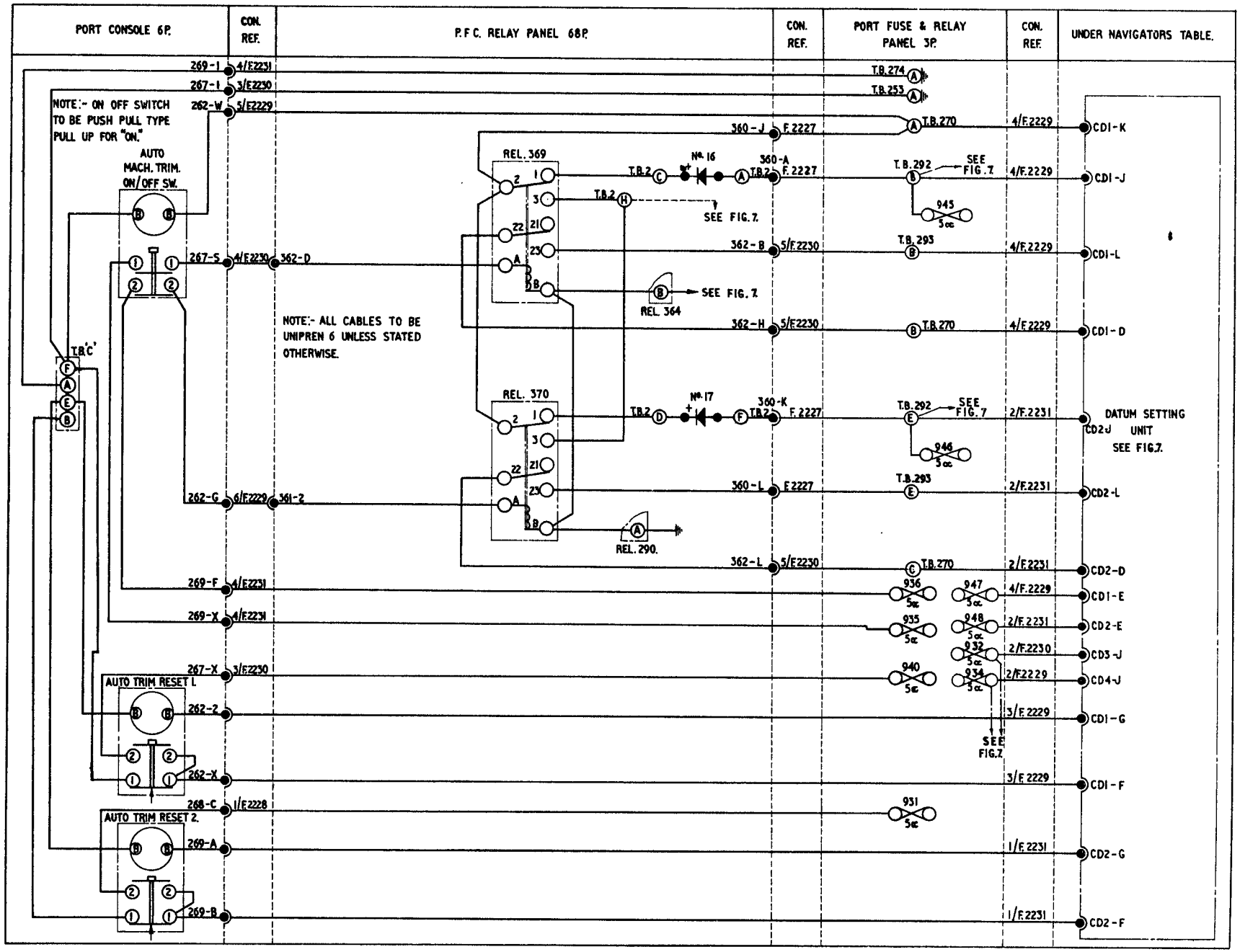

Fig.8 Mach trim switching

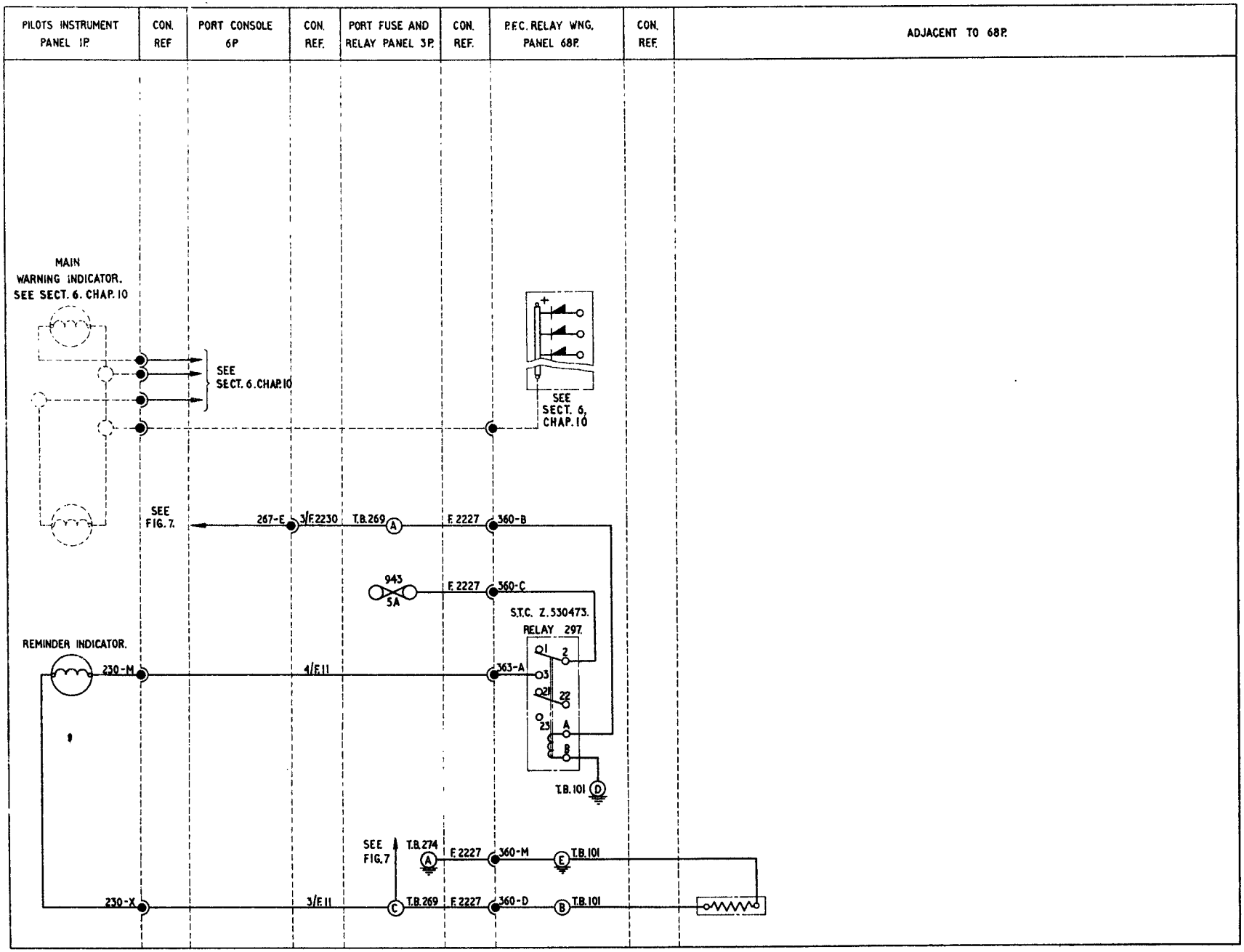

Fig.9 Autostabilisation indication

(◀ T.B. 273E 277C and 289E deleted ▶)

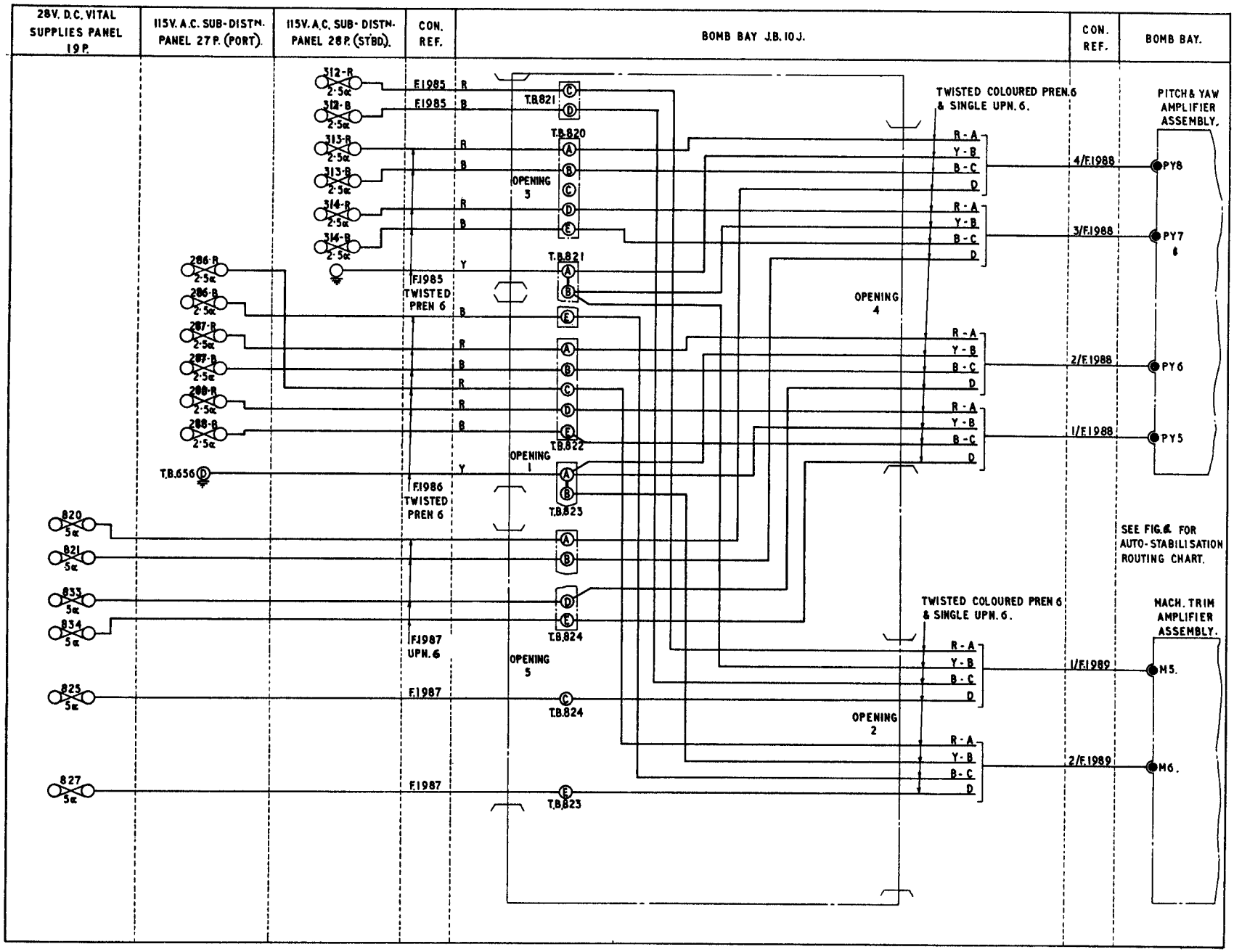

Fig. 10 Power supplies for autostabilisation

Chapter 7

MILITARY FLIGHT SYSTEM

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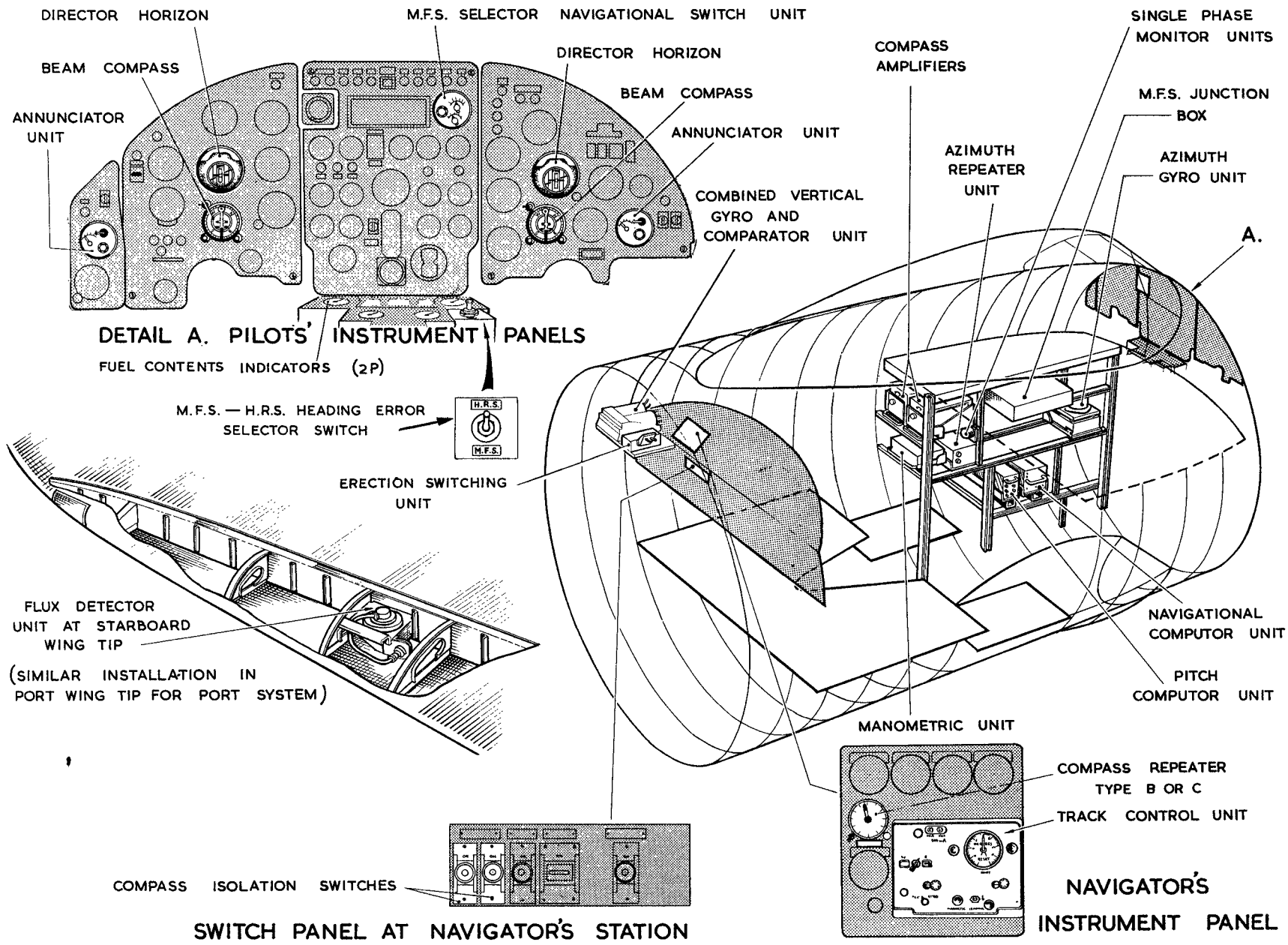


Fig. 1 Location of M.F.S. equipment

◄ Change to H.R.S. – M.F.S. heading switch ►

Introduction

1. The military flight system (M.F.S.) is a system of flight instrumentation designed to reduce pilot fatigue and provide increased safety and efficiency. In the M.F.S. several instrument facilities have been correlated to provide heading and attitude information, radio beam displacement and comprehensive flight director displays on two instruments, namely the director horizon and the beam compass.

2. A duplicate pair of instruments is provided for the 2nd pilot and the systems may therefore be referred to as the twin attitude and twin compass systems. The navigator may monitor the heading shown on the pilots' instruments via the navigator's compass repeater located on the Nav./plotter control panel.

3. The M.F.S. may be coupled with other equipment to provide complete instrument control of flight in all weather conditions and in all phases of manual, flight director, and fully automatic flight and landing operations. The installations associated with the M.F.S. to provide these facilities are the autopilot Mk.10A or 10B, the N.B.S. Mk.1A, A.R.I.18011, A.R.I.5951, H.R.S. Mk.2 (introduced by Mod.1908) and T.F.R. (introduced by Mod. 2057). The autopilot Mk.10A or 10B are dealt with in Chap.6 and 9 respectively, the N.B.S. in Chap.5, the H.R.S. in Chap. 10 and A.R.I.18011 in Sect.8 of this Book The A.R.I.5951 and T.F.R. may be found in Sect.9 of this Book.

4. This chapter contains an outline of the military flight system, its operation, equipment location, and necessary power supplies, together with the servicing and removal information. The instrument and associated equipment location may be found in fig.1 and the relevant routing chart contained in fig.2. Further details of the power supplies will be found in Sect.6, Chap.4 of this publication. A complete and detailed description of the M.F.S. is given in A.P.4686B, Vol.1, Book 1.

5. The requirements of the M.F.S. differ for Blue Steel and 'Free Fall' aircraft and therefore slight variants in some of the units that make up the M.F.S. Mk. 1B are in existance. Tables 1 and 2 show the different types of units in relation to the Blue Steel and 'Free Fall' aircraft installations.

DESCRIPTION AND OPERATION

6. Although the military flight system operates as a single combined unit, it does in fact consist of several separate systems. These systems, although separate, are closely related and form an integrated group. Basically the M.F.S. comprises an attitude system, a compass system and a flight director system. The compass and attitude systems are each split into two similar but completely independent systems, so as to form a port compass system and a starboard compass system, a port attitude system and a starboard attitude system. Consequently these systems are referred to as the twin compass system and the twin attitude system.

7. As previously stated the instrument display consists of a beam compass and director horizon for each pilot. The first pilot's instruments are operated by the port compass and attitude systems; the second pilot's instruments by the starboard compass and attitude systems. This arrangement gives maximum reliability and an accurate failure warning. The instruments may also be used to display radio beam displacement information as an additional function.

TWIN ATTITUDE SYSTEM

8. The twin attitude system consists of two identical distant-reading attitude indicating systems. The two systems are completely independent in all aspects including the power supplies which are described in para.4. As stated in the previous paragraph the systems are referred to as port and starboard, although the gyros are mounted on a combined assembly at the port side of the aircraft.

Director horizons

9. The port and starboard director horizons are mounted on the first and second pilot's instrument panels respectively, as shown in Fig.1. Seperate indications are given for pitch, roll and azimuth direction; pitch attitude by a pitch pointer, roll attitude by an horizon bar and azimuth direction by an azimuth director pointer.

10. The pitch pointer, in the form of a miniature aircraft, moves over a pitch scale which is capable of being moved up and down to provide a fixed datum in order that the aircraft may be easily maintained at a given pitch attitude. The only difference between the instruments fitted to 'Free Fall' and Blue Steel aircraft is the pitch scale calibration marks, which for 'Free Fall' aircraft are linear and Blue Steel aircraft are non-linear. Further information may be found in Table 1 and 2 and also A.P.4686B, Vol.1, Book 2, Sect.4, Chap.8A.

11. The horizon bar has a bank ring sight pointer which moves over a scale at the bottom of the instrument dial to in-

dicate precise angle of bank. The azimuth director pointer is used in conjunction with the bank ring-sight and indicates the heading error derived from the associated beam compass (Para.19).

Warning indication

12. Both director horizons normally indicate the same aircraft attitude. If this is not the case it may be assumed that one half of the twin attitude system is faulty. Warning flags will appear in the director horizons if the indications differ by more than 3.5 deg. in pitch and 5 deg. in roll. The warning flags are controlled by the comparator unit which is mounted on a common assembly with the gyros.

Combined vertical gyro and comparator unit

13. This combined assembly consists of two vertical gyros, a vertical gyro comparator unit and in addition an erection switching unit. These items are all fitted onto a mounting tray, Type F, which in turn is fitted onto a mounting tray, Type A, which is fitted behind the navigator's sloping panel as shown in fig.1.

Vertical gyro

14. The vertical gyro provides pitch and roll attitude information for the M.F.S. Mk.1B and uses, as a reference, a gyroscope spinning about a vertical axis. As the unit is a precision instrument all vital parts are housed in a hermetically sealed case, with only the test points and connectors easily accessible.

15. An individual transmission link is fitted between each gyro and it's corresponding director horizon. The secondary potentiometers of the starboard vertical gyro provide pitch information for the pitch computor unit (para.41) and roll information to the auto-pilot.

Comparator unit, Type B and C

16. The comparitor unit contains two magnetic amplifiers which compare the two pitch signals and the two roll signals of the twin attitude system, when the pitch or roll signals differ by a pre-determined amount, the attitude failure flags in the director horizons are operated. The Type B unit contains two pitch sloping networks having non-linear characteristics and the Type C contains two pitch sloping networks having linear characteristics.

Erection switching unit

17. The erection switching unit operates and controls the two vertical gyros, providing facilities for rapid run-up of the gyro wheels and automatic erection of the gimbols so that both instruments are fully operational in less than 30 seconds. Connection to the vertical gyros is made by two cableforms each terminating in a 12-pole Mk.4 socket.

TWIN COMPASS SYSTEM

18. The twin compass system consists of two identical, but independent compass systems. Separate power supplies are provided for each system as described in para.33. The systems are referred to as port and starboard and operate the first pilot's beam compass and second pilot's beam compass respectively.

Beam compasses

19. The two beam compasses, port and starboard, are mounted on the first and second pilot's instrument panels as shown in fig.1. Heading information is presented on each compass by a heading pointer which takes the form of a miniature aircraft and ring-sight moving over a normally fixed compass card. The card may be rotated to set any desired scale marking at the top of the dial. So doing will not affect the heading as the heading pointer will be moved at the same time and thus continue to indicate the same information. The card is rotated by pressing, and then turning, the setting knob at the bottom right corner of the instrument.

20. When the heading pointer or the heading index is displaced by the setting knob, a potentiometer wiper in the instrument picks off a voltage which represents the direction and magnitude of the displacement. This heading error signal, as it is called, is applied to the associated director horizon and in turn controls the movement of the azimuth director pointer (para.11).

Mod.2033

21. For aircraft designated 'Free Fall' an alternative heading error signal, derived from the H.R.S. (Chap.10), may be displayed by the azimuth director pointer via a selector switch labelled H.R.S. - M.F.S. The selector switch is mounted adjacent to the fuel contents panel 2P, as shown in fig.1 and circuit details are contained in fig.3.

Annunciator units

22. The port and starboard compass systems are each provided with an annunciator unit. These units are mounted on the first and second pilot's panels as shown in fig.1 and provide a means of synchronising the two compass systems. Synchronisation, or otherwise, is indicated by the position of two small arrow heads when viewed through a small circular window immediately above the synchronising knob. The presence of an arrow head in the window indicates that the systems are not synchronised. Synchronisation is achieved by rotating the synchronising knob in the direction shown by

the arrow head. When the arrow head disappears, and the shafts of both arrows are centrally placed over the fixed datum mark, the systems are synchronised.

23. Also fitted on each annunciator is a COMP/DG switch. When the switch is in the COMP position the system operates as a normal gyro - magnetic compass. Selecting D.G. on the switch converts the compass system to an unmonitored directional gyro system. Whenever the D.G. function is selected, a flag marked D.G. will appear in the face of the appropriate beam compass. Either or both halves of the twin compass system may be operated in this way.

M.F.S. selector navigational switch unit

24. This unit, which is mounted on the pilots' centre panel, is the primary control unit through which almost all the various functions of the M.F.S. may be selected. The unit carries two five-position selector switches and a two-position compass selector switch. The switch unit is shown in fig.1. Although many of the switch positions are connected only with the flight director system, certain positions affect the heading information displayed on the beam compasses.

25. When the upper five-position switch is set to LOC or LOC and GP, or is in the central unmarked position, the port and starboard beam compasses will show the magnetic heading of the aircraft, providing both systems are synchronised. If the switch is set to the REMOTE or BOMB positions the information presented on the beam compasses is controlled by the navigator, who, by means of the track control unit, can cause true track to be shown by both beam compasses.

Track control unit

26. This unit distributes heading information to other aircraft equipment and provides, among other things, the facility for presenting true track on the beam compasses and navigators' compass repeater. Magnetic variation information from the N.B.S. and drift information from A.R.I.5951 are fed to the unit along with magnetic heading information from the compass system. Three synchronous outputs of true heading are provided for the G.P.I. Mk.6, N.B.S. and the H.R.S. (Chap.10) when fitted.

Twin azimuth gyro unit

27. The twin compass system employs two magnetically monitored azimuth gyroscopes which act as a director reference. The hermetically sealed gyros are mounted side-by-side on a common mounting under the first pilot's floor. Magnetic monitoring is by two flux detector units which are fitted one in each wing tip. Pendulous elements within the detector units sense the earth's field and provide the monitoring signal for the gyros.

Compass amplifiers

28. Signals from the port and starboard detector units are fed to their respective amplifier units which are mounted side-by-side under the first pilot's floor as shown in fig.1. The resolver unit shaft in each amplifier drives five servos, which feed heading information to the track control unit for distribution to the beam compasses and other equipment.

Warning indication

29. A warning lamp is fitted at the lower left corner of each beam compass. The warning lamps will light whenever the beam compass indications differ by more than 5 deg. A comparison of the beam compass readings is made by two resolver synchros which are fitted one in each beam compass. A delay switch prevents a warning indication being given if the misalignment signal is of only short duration.

I.L.S. BEAM DEVIATION DISPLAY

30. Radio information from an I.L.S. equipped airfield may be displayed on the M.F.S. instruments by appropriate selection of the M.F.S. selector navigational switch unit. Provided that A.R.I.18011 is switched on and functioning correctly, localiser beam displacement signals will be presented when the upper switch is set to LOC. Localiser and glidepath deviation will be shown simultaneously when the switch is set to LOC and GP.

NOTE . . .

Strong interference with the I.L.S. signals may be experienced if the autopilot locking unit has no gearing pad fitted.

31. The two elements of radio beam information are displayed separately. Deviation from the localiser beam is indicated by the beam bar fitted in each beam compass. Glidepath deviation is shown by the glidepath pointer of each director horizon.

32. Presenting the information in this manner ensures that the localiser beam displacement is related to the aircraft magnetic heading and the glidepath displacement is related to the aircraft pitch attitude.

Indicator flags

33. An indication that the I.L.S. beams have been selected, and that everything is functioning correctly, is provided by two flags which appear in each director horizon. One flag, marked BEAM, indicates selection and correct functioning of the I.L.S. localiser beam information. The other flag, marked G.P., indicates selection and correct functioning of the glidepath information. Weak radio signals will be indicated by pulsating of the flags. A failure in the equipment will prevent the flags from coming into view.

FLIGHT DIRECTOR SYSTEM

34. Flight director information is presented on the director horizons in addition to the normal aircraft attitude information. By presenting these two distinct indications together the pilot can see not only the movement demanded by the director, but also the actual manoeuvre he is performing at that moment.

35. The normal aircraft attitude display is provided by the pitch pointer and the horizon bar which together indicate the existing attitude of the aircraft. Demand signals from the flight director system are indicated by the large centre dot of the pitch scale and the azimuth director pointer. When following an I.L.S. glidepath beam, pitch director demand signals are shown by the glidepath pointer.

M.F.S. selector navigational switch unit

36. Control of the signals displayed is by means of the M.F.S. selector navigational switch unit which was previously mentioned in para.15. The sub-paragraphs that follow give a brief description of the signal source and display for each switch position selected.

Upper switch (azimuth selector)

BOMB position

With the azimuth selector switched to BOMB, bombing steering signals are fed to the azimuth director pointer. The steering signals are fed from either the N.B.S. or the bomb aimer's turn controller, depending upon the position of the NBS/VISUAL switch on the bombing system selector. The azimuth demand signals may be complied with either manually or by engaging the autopilot and selecting BOMB on the autopilot selector switchbox. With the autopilot engaged the director horizons will provide a visual indication of the autopilot performance.

REMOTE position

With the selector in this position, variation and drift signals are fed into the compass system so that the beam compasses display true track. Consequently the azimuth director will be used to turn on to new tracks as selected by the pilot on his beam compass. The signal for the azimuth director is derived from a heading error potentiometer in the beam compass.

Central position

When the switch is in the central position, signals, proportional to the angular difference between a selected heading and the heading pointer, are fed from the heading error potentiometer, in the beam compass, to the azimuth director pointer.

LOC and LOC and GP positions

When the selector is set to either of these positions I.L.S. localiser deviation signals are made available from A.R.I.18011 for the M.F.S. and the autopilot. The I.L.S. signal is mixed with heading error signals before being displayed on the azimuth director pointers. The beam compass display when the selector is in this position is described in para.21.

Lower switch (pitch selector)

MACH position

This position is provided for selecting mach lock direction when a suitable source of mach error signals becomes available. Until this equipment is introduced the MACH position is inoperative.

HEIGHT position

Pitch director signals which enables the pilot to maintain a constant pressure height are displayed on the director horizons when HEIGHT is selected on the pitch selector. The signals are produced by the manometric unit and are fed, together with a signal from the pitch computor unit, to the pitch scale servo. If the aircraft departs from a selected height by more than a predetermined amount a limit switch will operate to disengage the height lock facility. The manometric unit, which is sensitive to altitude, is fed with a static supply from the starboard pitot-static system and is mounted with the other M.F.S. equipment under the first pilot's floor.

Central position

No pitch director signals are displayed when the pitch selector is in the central position.

DATUM position

This position is not normally selected until the pilot, having decided to use the glidepath facility, and having previously selected LOC or LOC and GP, has established the aircraft on the centre line of the localiser beam. He will select DATUM immediately before beginning his descent. This will move the pitch scale to a point which represents the known approximate attitude of the aircraft when following a glidepath beam. This datum is preset to suit the particular aircraft type.

APPROACH position

The selector switch is spring-loaded to move back to this position immediately after release from the DATUM position. This action will then bring into circuit a drift unit which is contained in the pitch computor unit. The drift unit will ensure that the aircraft is maintained along the localiser beam centre line in the presence of cross winds. The switch will remain in the APPROACH position only when LOC and GP is selected on the azimuth selector.

Pitch flags

37. An indication that a pitch director function has been selected is provided by two flags marked 'P' which will appear one in the face of each director horizon. Like most other flags in the M.F.S. the pitch flags indicate correct functioning; not failure.

Beam compass sense knob

38. Each beam compass has radio coupled range marks set at the top and bottom of the scale. A sense knob fitted at the top left corner of the compass enables the pilot to select the range with which he desires radio coupling. The knob is engraved with an arrow which, by its position, indicates which range is coupled to the radio information. Both ranges, top and bottom, are radio coupled when the arrow points to port. With the arrow pointing upright, radio coupling is with the top range only, whilst with the arrow pointing down, radio coupling is with the bottom range only.

Compass system selector switch

39. In addition to the azimuth selector and the pitch selector, the selector navigational switch unit has a third switch mounted at the left. This two-position switch, marked 'COMP', is the compass system selector switch which enables the pilot to choose which compass system will provide heading signals for the autopilot and other associated equipment.

Computor unit (navigational)

40. This unit, which is mounted under the first pilot's floor as shown in fig.1, receives and controls signals selected by the selector navigational switch unit. Signals fed to the computor unit are from the I.L.S. equipment, the bombing selector switch and the heading error potentiometer in the beam compass. After passing through the selector navigational switch unit the signals are routed to the M.F.S. display and the Mk.10A or 10B autopilot. This unit also contains the necessary interlocks with the autopilot system.

Computor unit (pitch)

41. This unit is mounted on a common mounting with the computor unit (navigational), under the first pilot's floor. In addition to the pitch direction relay switching, the unit contains the pitch scale servo amplifiers, the pitch datum unit, the pitch datum amplifier and the drift unit.

POWER SUPPLIES

42. Reference has been made in earlier paragraphs to the twin compass system and the twin attitude system, and it was shown how each of these systems contains a port system and a starboard system. To maintain the independence of the systems, two separate sources of supply are provided, and these in turn are referred to as the port and starboard power supplies.

Port power supplies

43. The port attitude and compass systems are provided with a 115-volt, 3-phase, 400 c/s, a.c. supply from fuses 247-R and 247-B in panel 24P. The supply is fed direct to the port fuse and relay panel, 71P, for distribution and fusing, before passing to the M.F.S. junction box, which is mounted under the first pilot's floor with the other equipment.

44. A 28-volt d.c. supply is provided from fuse 941 in panel 3P. The supply is fed direct to the port fuse and relay panel, 71P, for fusing and distribution before passing to the M.F.S. junction box.

45. As the supplies are fed direct, the system would normally operate immediately power supplies were available. However, as the compass system must not be run except during flight or ground functioning checks, the a.c. supply to the compass system is controlled by a relay, No.179, mounted in panel 71P. The relay is controlled by a single-pole compass isolation switch on the navigator's panel. Moving the switch to ON will energise the relay by means of a 28-volt d.c. supply from fuse 942 in panel 3P. Energising the relay will complete the a.c. supply circuit to the compass system and the compass will run.

Starboard power supplies

46. Power supplies are provided for the starboard systems in a manner similar to that used for the port system. A 115-volt 3-phase, 400 c/s, a.c. supply is taken from fuses 261-R and 261-B in panel 25P, and is fed to the starboard fuse and relay box, 72P, for fusing and distribution before passing to the M.F.S. junction box.

47. A 28-volt d.c. supply is provided from fuse 890 in the starboard fuse and relay panel 4P. The supply is fed direct to panel 72P for fusing and distribution before passing to the M.F.S. junction box.

48. A second compass isolation switch and relay are provided to perform the same function as their counterparts in the port system. The d.c. supply to the switch is from fuse 891 in panel 4P.

Monitor units

49. A monitor unit is connected into each single-phase (red) supply to the comparator unit. Each monitor unit contains a small self-starting single-phase induction motor which operates a mechanically coupled switching device. Should either of the red phase supplies deviate from the limits necessary for efficient operation of the comparator, the switches will open and disconnect the supply. This action will ensure that the director horizon warning flags appear.

50. The fixed components of the system require very little servicing, apart from a periodical check on the connectors and cables for security, cleanliness and signs of damage. Pre-flight ground functioning of the system is described in the paragraphs that follow. More extensive checks upon the system, using the Test Set 273 T.E., are described in A.P.4686B, Vol.1.

Pre-flight functional ground check

51. These checks, which are performed without the aid of test equipment, should be carried out daily or at the periods laid down in A.P.4505B, Vol.4. Proceed as follows:-

(1) Ensure that the 200-volt, a.c. and 28-volt d.c. ground supplies are available and connected.

(2) Switch on the two 3 kVA transformers by means of the two switches on panel 50P at the A.E.O.'s station.

(3) Check that within two minutes the attitude pointers on both director horizons stop oscillating and settle into positions dependent upon the aircraft attitude. Check that both failure warning flags are out of view.

(4) Switch on the port and starboard compass isolation switches at the navigator's panel.

NOTE...
The twin compass system must NOT be run unduly whilst the aircraft is on the ground.

52. Wait at least one minute after switching on the compasses, then set both annunciator unit switches to COMP. Synchronise both compass systems by means of the synchronising knob and indicator on each annunciator unit.

53. Set the compass card of each beam compass so that N is at the top datum mark. Check that both heading pointers indicate approximately the same aircraft heading as the standby magnetic compass.

NOTE...
Some differences may be expected between the indicated headings if the aircraft is within a hangar or if some external magnetic influence is in the vicinity of the wing tips.

54. Set the COMP knob on the navigational selector switch unit to port and the upper five-position selector switch to the central position. Check that the lower five-position selector switch is also in the central position and remains so throughout the tests. Set the port annunciator switch to D.G. Check that the D.G. flag appears in the port beam compass face. Repeat for the starboard compass system.

55. Turn the port synchronising knob so that the port beam compass heading pointer and the port resolver dial rotate. The resolver dials are fitted in the front face of their respective compass amplifiers. Have an assistant check that the resolver dial follows the heading pointer and that the two indications agree at cardinal points. At the same time, check that the turn switch reset indicator (compass amplifier front face) spins while the resolver dial is turning, and stops spinning shortly after the resolver dial stops. Repeat these checks on the starboard system.

56. Turn the synchronising knob on the port annunciator unit until the port beam compass heading pointer is at least 20 deg. clockwise from the starboard heading pointer. Set both annunciator switches to COMP. Check that both D.G. flags have cleared and that both compass warning lamps light within 45 secs.

57. Rotate the port synchronising knob slowly so that the port heading pointer is gradually brought towards the same indication as the starboard heading pointer. Check that the warning lamps remain on until the difference between the two pointers is reduced to less than 3 deg.

58. Turn the port synchronising knob until the port heading pointer is at least 20 deg. anti-clockwise from the starboard heading pointer and then repeat para.47.

59. Turn the port synchronising knob until the difference between the heading pointer is sufficient to bring on the warning lamps. Check that the warning lamps go out when the port annunciator switch is set to D.G. Restore the switch to COMP and check that the lamps switch on again. Repeat the instructions given in this paragraph, on the starboard system.

60. Rotate, simultaneously, both annunciator unit synchronising knobs so that both heading pointers turn in a clockwise direction together. Check that the warning lamps go out while the pointers are rotating and come on again when the pointers stop. Repeat this check in a reverse direction by rotating both synchronising knobs anti-clockwise. Re-synchronise both compass systems.

61. Pull and turn the port beam compass setting knob until the heading index is set against the top datum. Push and turn the setting knob to set the heading pointer coincident with the heading index. Check that the azimuth director pointers of both director horizons are at zero.

62. Pull and turn the port beam compass

setting knob to rotate the heading index up to 20 deg. either side of the top compass datum. Check that both azimuth director pointers move freely over their full range of movement. Check that the azimuth director pointers move to starboard when the heading index is set to starboard and vice versa.

63. Set the COMP knob on the navigational selector switch unit to starboard and repeat para. 52 and 53 on the starboard system. Check that the BEAM and G.P, flags are not visible on either director horizon. Ensure that the radio beam displacement bars of both beam compasses are central in their scales.

64. Check that when the upper five-position selector switch on the navigational selector switch unit is in any position other than the LOC or G.P. position, rotation of the pitch scale setting knob on the port director horizon causes full range movement of the pitch director pointer. Check that this facility is cancelled by switchihg to LOC and G.P.

65. With the five-position switch set to LOC check that both director horizon BEAM flags pulse in and out of view. Select LOC and G.P. and note that both BEAM and G.P. flags pulsate.

NOTE...
The flags will not remain fixed in view unless the ILS equipment is switched ON and a I.L.S. radio signal is being received. The presence of I.L.S. radio signals will be indicated by deflection of the compass beam bars and/or the pitch director pointers.

66. Return the upper selector switch to the central position and check that the BEAM and G.P. flags go out of view. Switch off the compass isolation switches. Switch off the 3 kVA transformer and disconnect the power supplies.

Compass correction

67. The twin compass system should be checked and adjusted at suitable intervals to ensure that the system maintains a high degree of accuracy. Compass swinging should take place on a suitable compass base which has been previously surveyed for freedom from magnetic interference. The routine calibration procedure will be found in A.P.1275B, Vol.1, Sect.9, Chap.2. Instructions for adjusting the twin compass system will be found in A.P.4686B.

Sighting rods

68. A box, Ref. No. 26DC/95422, containing the necessary sighting rods is available as ground equipment. The box contains a front sighting rod, Ref.No. 26DC/95238, and a rear sighting rod, Ref.No. 26DC/95239 together with an extension piece, H.S.A.Part No. 1U/1651, which is used in conjunction with the front sighting rod. Brackets, having suitably screwed holes, are permanently fixed to the structure at bulkhead 75F and former 487.5, for receiving the front and rear sighting rods respectively.

69. The extension piece is provided to increase the effective length of the front rod, thus enabling it to be seen beyond the projection of rear fuselage. When fitting the front rod, the extension piece is first screwed into the attachment bracket and then the sighting rod screwed into the extension piece. When in use the rods, painted white, are sighted against the nose wheel oleo leg.

Mod. G.E.2078 S.O.O.

70. Mod.G.E.2078 introduces compass sighting rods complete with box, Part No. 1/U.2178, for use with certain Blue Steel aircraft not carrying the missile.

REMOVAL AND INSTALLATION

71. The major units of the system are all provided with rack mountings which enable the units to be removed and fitted with a minimum amount of trouble. The removal of those units mounted in the pilot's panels will present little difficulty once the panels have been removed in accordance with the instructions given in Chapter 1.

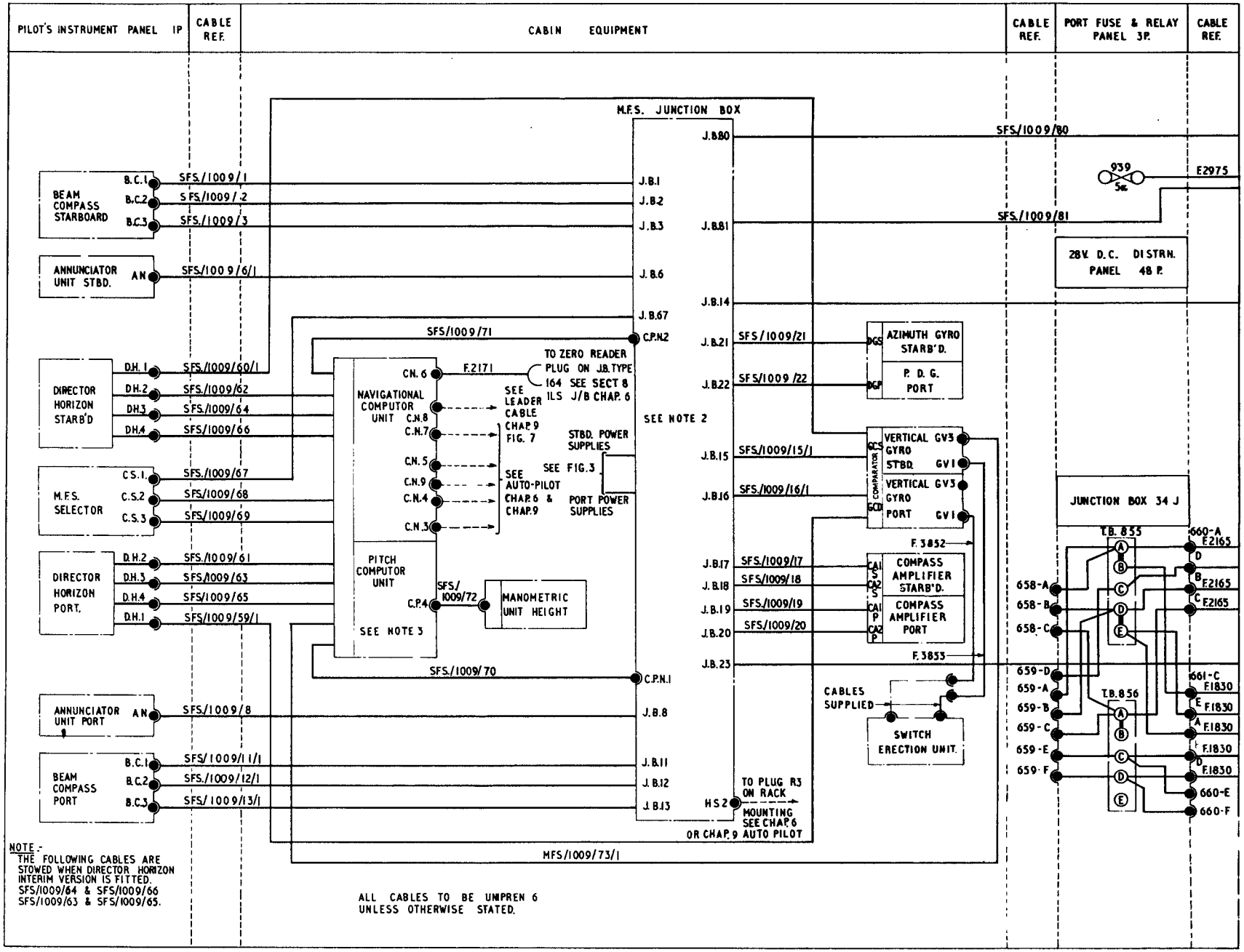
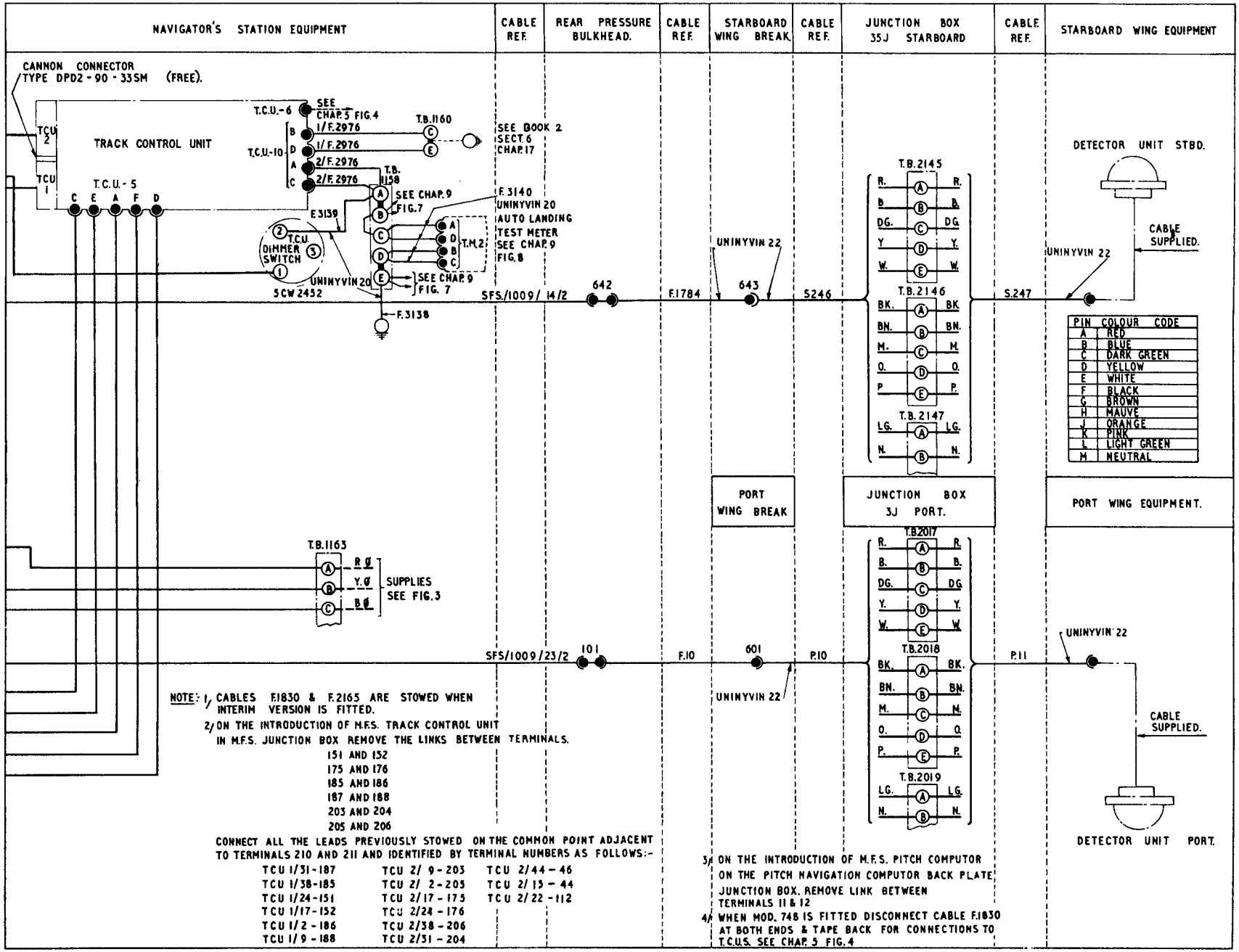


Fig. 2 (1) Military flight system.



NOTE: 1/ CABLES F.1830 & F.2165 ARE STOWED WHEN INTERIM VERSION IS FITTED.

2/ ON THE INTRODUCTION OF M.F.S. TRACK CONTROL UNIT IN M.F.S. JUNCTION BOX REMOVE THE LINKS BETWEEN TERMINALS.

151 AND 152
175 AND 176
185 AND 186
187 AND 188
203 AND 204
205 AND 206

CONNECT ALL THE LEADS PREVIOUSLY STOWED ON THE COMMON POINT ADJACENT TO TERMINALS 210 AND 211 AND IDENTIFIED BY TERMINAL NUMBERS AS FOLLOWS:-

TCU 1/31-187	TCU 2/ 9-203	TCU 2/44-46
TCU 1/38-185	TCU 2/ 2-205	TCU 2/15-44
TCU 1/24-151	TCU 2/17-175	TCU 2/22-112
TCU 1/17-152	TCU 2/28-176	
TCU 1/2-186	TCU 2/38-206	
TCU 1/9-188	TCU 2/31-204	

3/ ON THE INTRODUCTION OF M.F.S. PITCH COMPUTOR ON THE PITCH NAVIGATION COMPUTOR BACK PLATE JUNCTION BOX. REMOVE LINK BETWEEN TERMINALS 11 & 12

4/ WHEN MOD. 748 IS FITTED DISCONNECT CABLE F.1830 AT BOTH ENDS & TAPE BACK FOR CONNECTIONS TO T.C.U.S. SEE CHAP. 5 FIG. 4

Fig. 2 (2) Military flight system.
(◂ *Minor changes only* ▸)

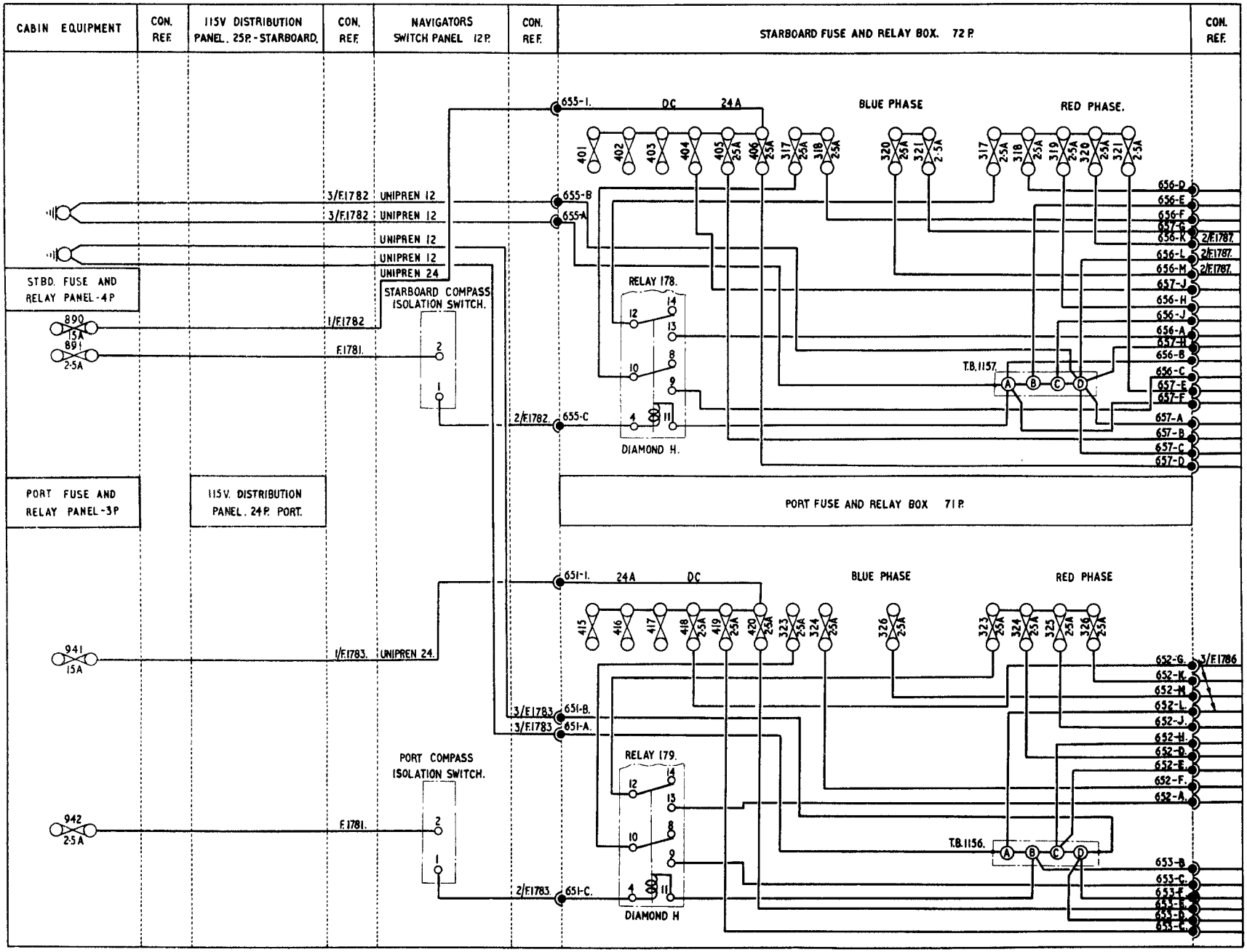


Fig. 3 (I) Power supplies for M.F.S.

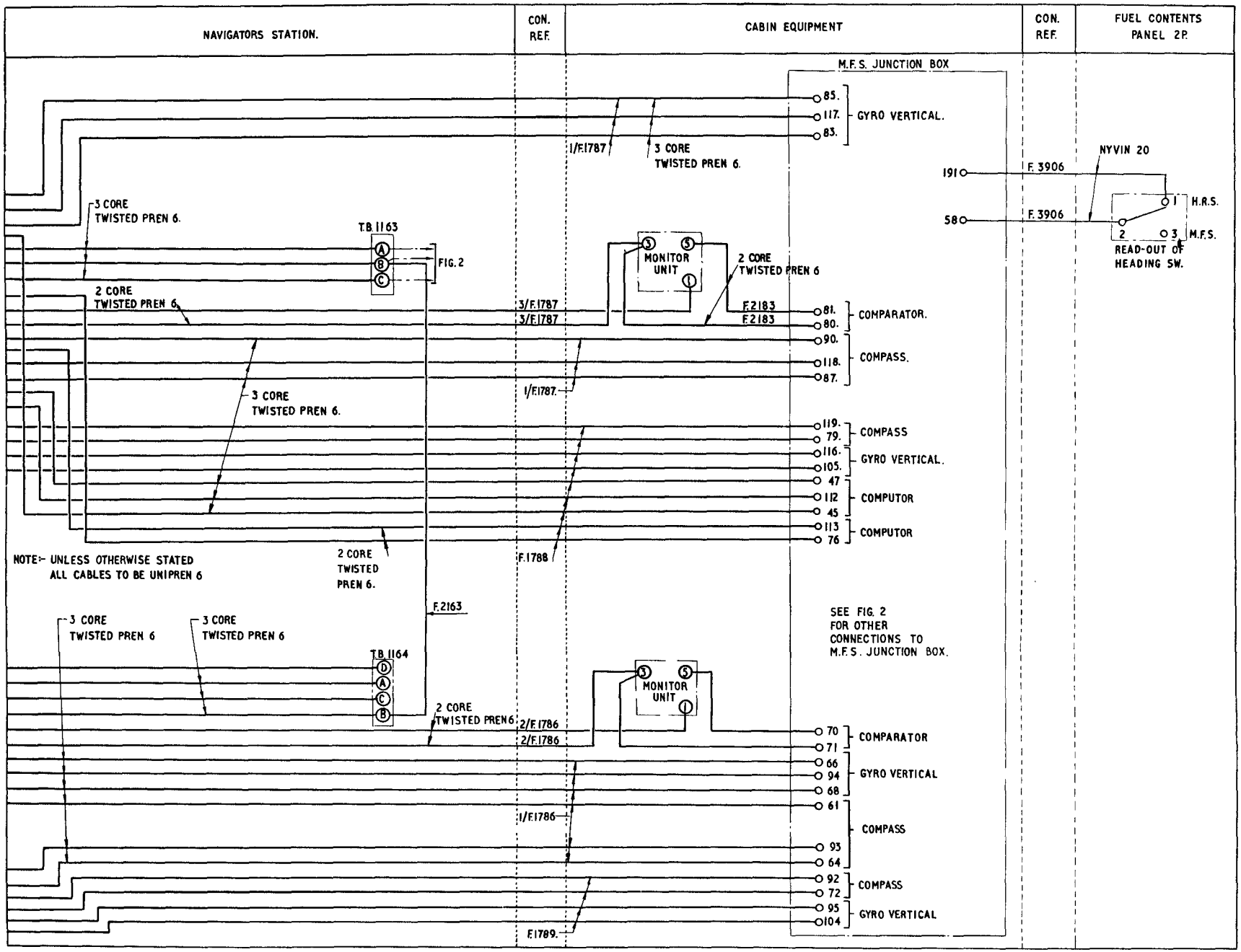


Fig. 3 (2) Power supplies for M.F.S.

Wiring change to H.R.S - M.F.S. heading switch

Chapter 8

TEST EQUIPMENT

ARTIFICIAL FEEL UNIT CALIBRATOR

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LEADING PARTICULARS

Type	1/U1390
Ref.No.	26DC/95217
DIMENSIONS	
Length (overall)	75 in.
Height	60 in.
Width	22.5 in.
Weight	210 lbs.
Supply voltage	28 volts d.c.

DESCRIPTION

Introduction

1. The calibrator 26DC/95217 is designed to facilitate bay servicing of the artificial feel units. It provides individual mountings for the different types of feel units, and enables them to be functionally tested throughout their normal working range. The control console which is the means of control during feel unit testing, can be removed from the calibrator and used for 'in situ' testing of the aircraft artificial feel failure warning systems.

2. This chapter contains a description of the calibrator and the servicing requirements. Test schedules for the respective types of artificial feel units in current use are included as an appendix. Information on the feel units and the associated electrical system is contained in Sect.3, Chap.4, and Sect.6, Chap.10 of this publication.

Construction

3. The calibrator framework is an accurately constructed box frame structure built from mild steel channel and angle sections. It consists of a top frame mounted by six main vertical supports on a rectangular base. Four lugs attached to the base side members enable the calibrator to be firmly anchored to the ground or floor, and adjustable bolt assemblies are fitted one to each lug for levelling purposes.

4. A stowage cupboard and a control console occupy the top portion of the framework. At the left hand position a support frame accommodates the cupboard, which is equipped with seven shelves for stowage of the loose equipment supplied with the calibrator. The control console is mounted at the right hand position on two angle brackets, and is secured by two knurled attachment bolts passing through the top frame. Below the console, a platform fitted with two hinged clamping bolts is provided for mounting a battery which can be used as an alternative power supply for operating the electrical system.

5. The lower section of the framework accommodates a balance arm and individual mountings for the four types of feel units. The balance arm pivots between the two centre supports of the framework, and is mounted by two ball bearings located in housings attached one to each support. Precision fitted relative to the balance arm, the feel unit mountings are arranged two each side of the structure (fig.1).

6. Two three-roller bearings, similar to those used in the aircraft flying control system, are attached to a swivel plate fitted at the left hand end of the structure. The bearings support an extension tube used when calibrating Mk.2 aileron feel units to transmit input rod movement to a dial gauge, which for this application is

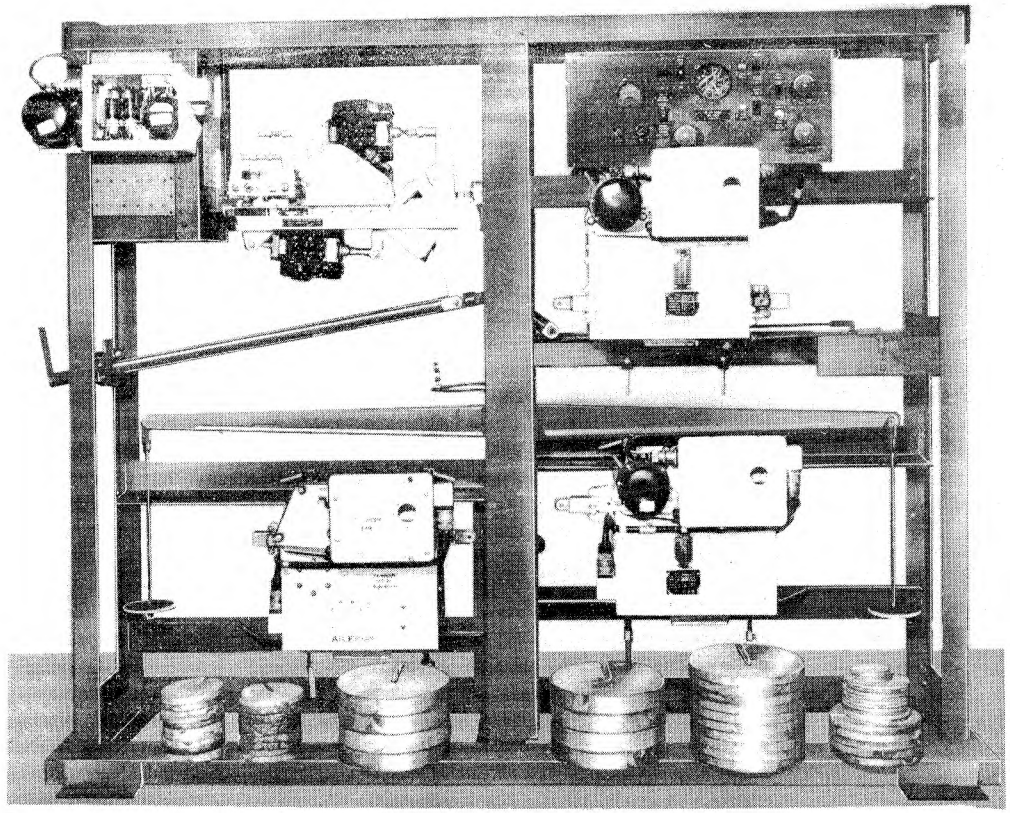

Fig.1 General view of calibrator

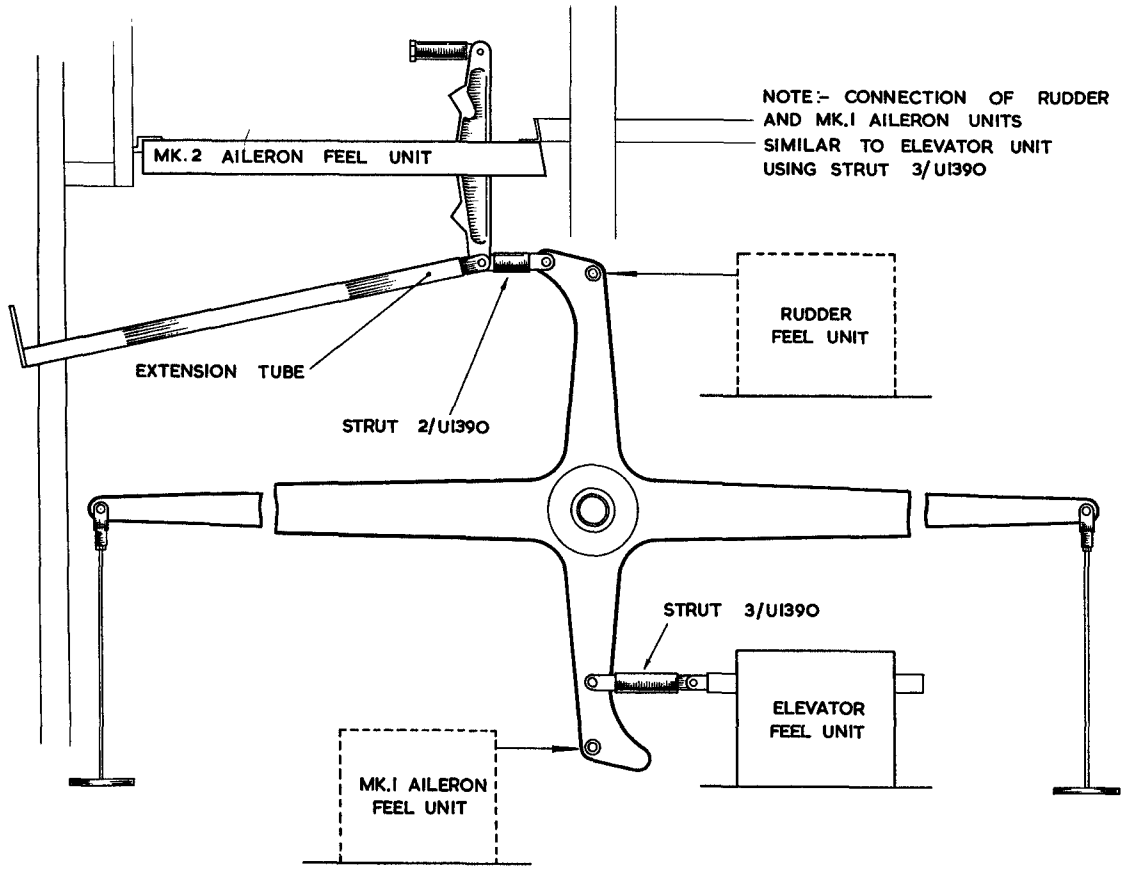

Fig.2 Arrangement and connection of feel units

mounted outside the calibrator structure. When not in use the extension tube is stowed within the framework by securing the inner end in a spring clip.

Feel unit mountings

7. The elevator, rudder and Mk.1 aileron feel unit mountings are similar, each consisting of two horizontal members bolted and dowelled to the centre and end supports at the rear of the calibrator. Each member is fitted with a locating plate and two spring loaded fasteners for location of the unit, and in addition, the lower members are provided with an extension plate to support the unit during installation. The Mk.2 aileron feel unit is mounted between the centre supports and the cupboard frame on two brackets and a vertical support plate. A separate attachment is provided for the associated electrical component unit, by anchor nuts fitted to the front and inner side members of the cupboard frame.

Balance arm

8. The balance arm is the medium through which loads are applied to the feel units. It consists of a main beam mounted by bosses on a central shaft which pivots in the bearings in the calibrator framework. Two vertical lugs welded one either side of the beam centre are each fitted with two ball bearings to provide alternative connecting points for the respective feel units. To link the feel units to the balance arm, two connecting struts are provided, the shorter, Item 2/U.1390 being used for Mk.2 aileron units, and Item 3/U.1390 for all other units (fig.2). The location of the bearings in the balance arm and the length of the connecting struts ensures that when a feel unit is installed and connected, the mechanical advantage appropriate to that unit will be obtained.

9. For applying push or pull loads to the feel units, weight carriers are attached, one to each end of the balance arm. Weights of ½, 1, 2, 5, 10 and 20 lb. are supplied, and when not in use are stowed on pegs fitted to the calibrator base.

Loose equipment

10. The loose equipment supplied with the calibrator comprises five extension cables, three flexible pneumatic pipes, a dial gauge and clamps for mounting the gauge. Four of the cables are identified to correspond to the markings of the plug connections on the console, and of these, one has a dual marking TRACK and GLIDE-AUTO PILOT. This cable serves two purposes and is connected to the console TRACK and GLIDE plug for elevator unit testing, and to the AUTO PILOT plug for Mk.2 aileron unit testing. The remaining cable is used for Mk.2 aileron units only, and has seven connecting sockets which are individually identified.

Control console

11. The control console is of light alloy angle and plate construction and contains the controls, indicators and components associated with the electrical and pneumatic systems. For carrying and mounting the console when used for testing the aircraft artificial feel failure warning system, two handles and four rubber foot pads are fitted.

12. The controls and indicators are mounted on the front panel as shown in fig.3. The system components are housed within the console and for access to them the front and rear panels are detachable. Six plugs and two stub pipes mounted on the left hand panel are suitably identified for connection of the extension cables and pneumatic pipes whereby the test systems are linked to the feel unit. Two terminals on the right hand panel are the connections for the electrical power supply.

Pneumatic system

13. The pneumatic system (fig.4) provides the air supplies to the feel units and failure warning system for simulating varying airspeeds. A small air bottle clamped to the console base plate, serves as the system reservoir, and a cycle type pump is provided for charging the bottle via a valve which protrudes through the console rear panel.

14. Two valves identified AIRSPEED INCREASE and AIRSPEED DECREASE respectively, control the airspeed, which is recorded on a 50-600 knot indicator. Air supplies are piped to the stub pipe connectors on the console end panel, one connector being directly supplied, the other via a FAULT SIMULATION valve. For feel unit testing, only the former connector is used, and is linked to the feel unit airspeed transmitter using the short flexible pipe. Both connectors are used for testing the failure warning system, and are connected to the aircraft warning panel and to the feel unit, using the long flexible pipes. In the latter application, the fault simulation valve is used to obtain an airspeed differential between the warning panel and the feel unit.

Electrical system

15. The electrical system provides the supplies for operating the feel units under conditions of variable feel, feel relief and auto-pilot control. The 28-volt d.c. input supply for the system is obtained from a suitable ground supply source or battery connected to the console terminals, and routed via the system components and controls to the group of plugs on the console end panel.

16. The elevator and rudder feel units are each connected to the system via the plugs identified SUPPLY, NORMAL/RELIEF and LIMIT SWITCHES, and for elevator units the TRACK and GLIDE plug

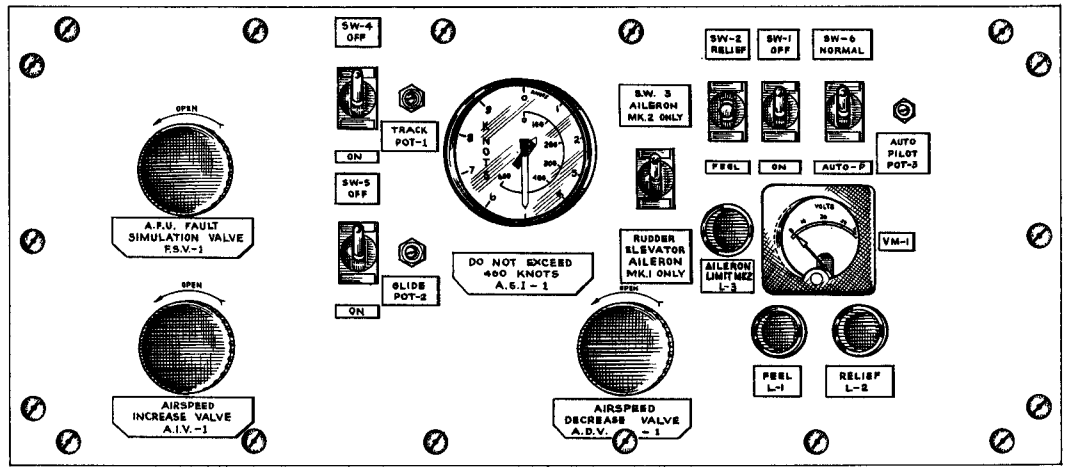

Fig.3 Control panel

Aileron limit warning lamp L3 introduced

is also used. As the aileron feel unit differs mechanically and in operation from the other units, an alternative supply route is provided, and connection to the system is made via the Mk.2 AILERON SUPPLY, NORMAL/RELIEF and AUTO-PILOT plugs.

17. The controls and indicators for the supply system consist of the following:-

(a) SW.1 a two position master switch labelled ON-OFF.

(b) A voltmeter to indicate input supply voltage.

(c) SW.2 a 3-position switch labelled FEEL-RELIEF, spring loaded to centre OFF from both positions. This switch is used in conjunction with the feel units to set conditions of variable feel or feel relief for elevator and rudder units, or variable and unrestricted movement for aileron units.

(d) SW.3 a two position switch labelled AILERON Mk.2 - ELEVATOR RUDDER MK.1 AILERON, used to set circuit conditions appropriate to the unit being calibrated.

(e) Two warning lamps, L1 green, L2 red, to provide indication of variable feel and feel relief conditions respectively.

(f) Red warning lamp L3 to indicate that the additional limit switch fitted to the aileron unit (Mod.1806) is operating.

NOTE . . .
Warning lamp L3 was introduced by G.E. Mod.1944 which also provides an additional power supply for testing feel units with Mod.1499 embodied.

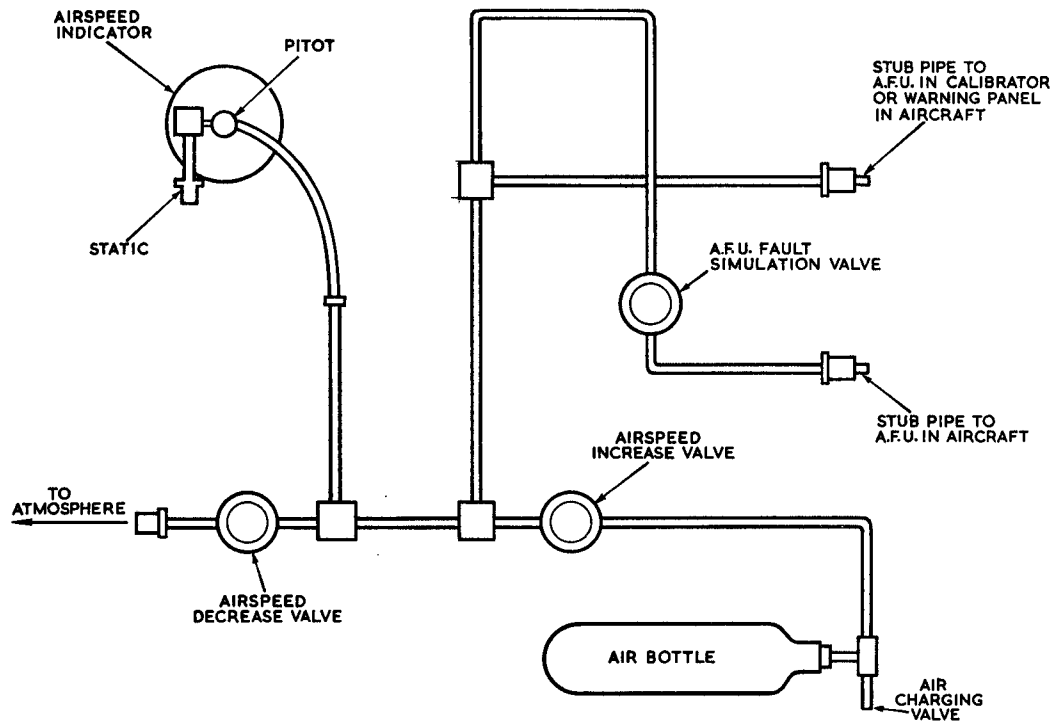

Fig.4 Pneumatic system

18. For elevator and rudder units, selection of switch SW.3 to the appropriate position will connect a supply to the feel unit electrical component unit and feel actuator via the SUPPLY plug. Selection of switch SW.2 to either position will supply the extend or retract field of the relief actuator, via the NORMAL/RELIEF plug. The feel unit will now move to the variable feel or feel relief position dependent on switch selection.

19. Selection of switch SW.3 to the MK.2 AILERON position prepares the circuit for connection of supplies to this type of feel unit. Subsequent selection of switch SW.2 to the FEEL position will supply the feel unit electrical component unit and the feel motor of the actuator, via the MK.2 AILERON SUPPLY plug. The feel unit will now move to the variable movement position. Selection of switch SW.2 to RELIEF will connect a supply to the relief motor of the actuator via the NORMAL/RELIEF plug, and the feel unit will move to the unrestricted movement position.

Auto pilot control

20. To check operation of the elevator and aileron feel units under auto pilot control conditions, two separate resistance circuits are included in the system. The elevator units, are connected via the TRACK and GLIDE plug, and circuit operation is controlled by two 2-position ON-OFF switches SW4 and SW5, labelled TRACK and GLIDE respectively. By

selecting switch SW.4 to ON, a 330 ohm resistor and a potentiometer are inserted in the circuit, causing the feel unit to move to a position of reduced feel. Switch SW.5 is provided for the Mk.1 elevator units only, and when selected ON will insert a second potentiometer into the circuit resulting in further feel reduction.

21. The aileron units are connected via the AUTO-PILOT plug and the circuit is controlled by a two-position switch SW.6 labelled NORMAL - AUTOPILOT. Selection of this switch to AUTOPILOT introduces two 330 ohm resistors and a potentiometer into the circuit causing movement of the feel unit to the high speed position.

OPERATION

Calibrator installation

22. The calibrator is a static rig and will normally be installed in a component servicing bay. It should be sited on a solid foundation, set level by means of the adjusting bolts provided in the base mounting lugs, and then firmly secured. The feel unit mounting members can be used as a reference for levelling purposes.

Failure warning system testing

23. The control console can be removed from the calibrator by releasing the knurled attachment screws, and used for simulating different airspeeds during checks on the associated failure warning systems as detailed in Book 2, Sect.6, Chap.10 of this publication. The connections to the aircraft warning panel 66P, and the feel unit, are clearly identified, and are made using the two long flexible pipes supplied with the calibrator.

Feel unit testing

24. In theory, for a given airspeed and for a given linear movement of the pilots control rods, the spring unit of the elevator and rudder feel units will be loaded to a degree dependent on the linear movement and on the mechanical advantage of the input lever. If therefore, the loading and corresponding linear movement are measured and plotted at suitable intervals throughout the normal speed range, a graph relating loading to input movement will fall within defined limits if the feel unit is serviceable but will fail to do so if the unit is unserviceable.

25. These measurements are obtained through the balance arm which is so designed that when linked to a feel unit, the balance arm ratio is identical to that which would be obtained if the feel unit were connected to the aircraft control system. With the feel unit connected to the balance arm, and with the balance arm unloaded, i.e. in a state of balance, there is no deflection of the feel unit input shaft which is centralised by its centring spring. In this balanced condition the dial gauge connected to the input shaft is set to zero. If a weight is now attached to the balance arm, the feel unit input shaft will move until the balance arm comes to rest, the extent of movement being recorded on the gauge. The weight on the balance arm multiplied by the factor of the mechanical advantage is the measure of the resistance offered by the spring unit for this balanced condition.

26. The aileron feel units differ from the other units in that they incorporate variable stops, the available movement between the stops varying with airspeed. In a similar manner, stop movement can be measured relative to airspeed. As no resistance exists between the stops other than the preload of the input shaft, the use of weights for loading is unnecessary, and hand pressure is applied to the balance arm to move the input shaft through the stop range and provide indication on the dial gauge.

Installing the feel units

27. To install the feel unit in the calibrator:-

(1) Position the feel unit on the appropriate mounting and firmly secure the spring loaded fasteners.

(2) For aileron units, secure the associated electrical component unit to the stowage cupboard frame using the bolts provided.

(3) Check that the balance arm pivots freely. Couple the feel unit shaft to the corresponding bearing on the balance arm as shown in fig,2 using the connecting struts as follows:-

(a) Strut 3/U1390 for elevator and rudder units.

(b) Strut 2/U1390 in conjunction with the extension tube for aileron units.

(4) Make the following electrical connections:-

(a) Elevator units

Pre. and Post Mod.1499

(i) Connect the NORMAL/ RELIEF, LIMIT SWITCH and SUPPLY cables to the corresponding plugs on the console, and to the 4-pin

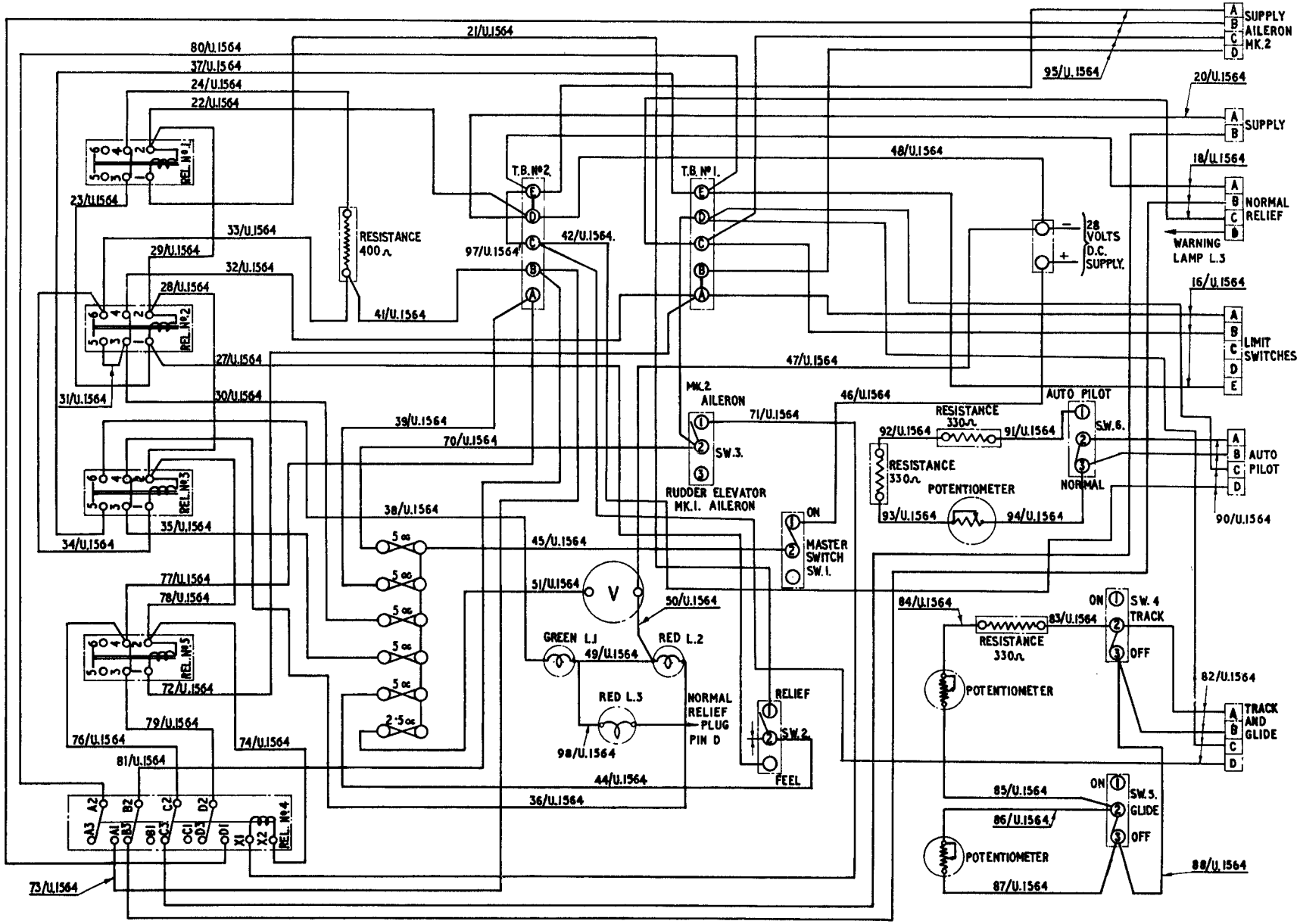

Fig. 5 Calibrator wiring diagram

◀ Mod. GE. 1944 embodied ▶

and 5-pin plugs on the feel unit and the 2-pin plug on the electrical component unit.

(ii) Connect the TRACK and GLIDE/AUTO PILOT cable to the TRACK and GLIDE plug on the console and to the 4-pin plug on the electrical component unit.

(b) Rudder unit

Pre. Mod.1499

(i) Connect as in sub.para. (4) (a) item (i).

(c) Rudder unit

Post Mod.1499

(i) Connect as in sub.para. (4) (a) items (i) and (ii).

(d) Aileron unit

(i) Connect cable assembly 32/U1390 to the Mk.2 AILERON SUPPLY and NORMAL/RELIEF plugs on the console, and to the feel unit and electrical component unit in accordance with the cable idents.

(ii) Connect the TRACK and GLIDE/AUTO PILOT cable to the AUTO PILOT plug on the console and to the 4-pin plug on the electrical component unit.

(5) Connect the short flexible pneumatic pipe to the appropriate connection on the console and to the pitot connection of the feel unit airspeed transmitter.

Precautions during test

28. The following precautions must be observed during tests:-

(1) When applying weights for loading or unloading the feel unit, the total weight must be either increased or decreased. On no account should a load be applied which involves taking off one weight to replace it by another. Weights must be lowered gently onto the carrier to avoid overcoming friction.

(2) When increasing airspeed, do so slowly to avoid the risk of damaging the airspeed indicator or the transmitter. During calibration, the airspeed must always be increasing, never decreasing. If a desired airspeed is passed, decrease to 50 knots below, and again increase airspeed to the setting required.

(3) A maximum airspeed of 460 knots must not be exceeded.

SERVICING

General

29. Servicing of the calibrator will normally be confined to the balance arm and the pneumatic and electrical system components in the control console. To ensure smooth operation, the balance arm bearings should be suitably protected from ingress of dirt etc., at all times when the calibrator is not in use, and lubricated when necessary using grease XG-295.

The system components should be checked periodically for condition and security of connections, and the airspeed transmitter subjected to serviceability checks as detailed in A.P.1275A, Vol.1, Sect.21. When operating the air control valves, any sudden surge of pressure is an indication that the valve is sticking. This condition could result in excess pressures being applied to the feel unit airspeed transmitter, and must be rectified immediately.

Electrical system proving

30. The electrical system can be proved using the following tests. A test lamp will be required, with a 28-volt d.c. supply connected to the console terminals.

Test lamp connections	Switch function	Indication
	Switches SW.1 and SW.2 OFF	
	Switch SW.3 to Mk.1	All lamps extinguished
	Master switch SW.1 ON	Voltmeter indication - 28 volts
		Red lamp L2 lit
AUTO-PILOT plug pins C-D		Test lamp lit
SUPPLY plug pins A-B		Test lamp lit
TRACK and GLIDE plug pins C-D		Test lamp lit
Connect temporary link between SUPPLY plug pin B and NORMAL/RELIEF plug pin D		Red lamp L3 lit
Remove temporary link		Lamp L3 extinguished
Connect temporary link between SUPPLY plug pin B and LIMIT SWITCH plug pin E	Switch SW.2 to FEEL	Lamp L2 extinguished
		Green indicator lamp L1 lit
Connect temporary link between LIMIT SWITCH plug pins A-B		
NORMAL/RELIEF plugs pins A-C		
Mk.2 AILERON SUPPLY plug pins A-C		Test lamps extinguished
	Switch SW.2 to RELIEF	Test lamps lit
Remove temporary links		
NORMAL/RELIEF plug pins A-B	Switch SW.2 to FEEL	Test lamp lit
	Switch SW.2 to RELIEF	Test lamp extinguished.
	Switch SW.3 to Mk.2 AILERON	Lamp L2 lit
		Lamp L1 extinguished.
	Switch SW.2 to FEEL	Lamp L2 extinguished.
		Lamp L1 lit
Mk.2 AILERON SUPPLY plug pins A-B		Test lamp lit
	Switch SW.2 to RELIEF	Test lamp extinguished
Connect temporary link between Mk.2 AILERON SUPPLY plug pins C-D		
NORMAL/RELIEF plug pins A-C		Test lamp lit
Remove temporary link		Test lamp extinguished

TABLE 1

SCHEDULE OF PARTS

Ref.No.	Part No.	Description	Qty.
26DC/95217	1/U1390	Calibrator, artificial feel unit	
	2/U1390	Strut, (c/w bearing SKF/1/132498)	1
	3/U1390	Strut, (c/w bearing SKF/1/132498)	1
	4/U1390	Housing, (c/w bearing BSS/BAM/⅝ in.)	1
	5/U1390	Housing, (c/w bearing BSS/BAM/⅝ in.)	1
	6/U1390	Weight 2 lb.	20
	7/U1390	Weight 10 lb.	10
	8/U1390	Weight 20 lb.	8
	29/U1390	Weight ½ lb.	2
	30/U1390	Weight 1 lb.	10
	31/U1390	Weight 5 lb.	5
	23/U1390	Tube extension	1
	1/R3460	Bearing base	2
	1/R4410	Roller, Glacier	6
	1/U1555	Lever assembly	1
	Skefko 1/132498	Bearing	4
	1/U1564	Console	1
	Smiths 148/AS/PC	Indicator, airspeed 50-600 knots	1
	Bryans 1517	Valve, control	3
5Q/1693		Voltmeter 0-40 volts	1
5H/74		Block, fuse, 6-way	1
5CZ/5214		Fuse 2.5 amp.	1
5CZ/5215		Fuse, 5 amp.	5
	Colvem 10W/Z271401	Potentiometer	3
5CW/6430		Switch	1
5CW/5823		Switch	3
5CW/5822		Switch	1
	Rotax D5401	Switch	1
5CW/6453		Relay	4
5CW/6098		Relay	1
6A/1200		Resistor, 400 ohms	1
	Welwyn Elec.AW3115	Resistor, 330 ohms	3
5H/87		Link, commoning	1

TABLE 1 - continued

Ref.No.	Part No.	Description	Qty.
	1/V5650	Block connector	2
	15/V5650	Socket	6
5CX/1635		Lamp, warning (green)	1
5CX/1069		Lamp, warning (red)	1
5L/9951273		Lamp, filament	2
	Belling Lee L1003/A	Terminal (black) type R	1
	Belling Lee L1003/A	Terminal (red) type R	1
	Graviner 127 AVE	Bottle, air	1
	Dunlop 4062	Valve assembly miniature	1
		Pump, cycle type (standard item)	1
		Loose equipment consisting of:-	
	20/U1390	Gauge dial c/w backplate No.37 (Baty model AL.17)	1
	25/U1390	Clamp, universal	1
	26/U1390	Clamp, 'G'	1
	27/U1390	Rod, holding	1
	10/U1390	Cable, assembly	1
	11/U1390	Cable, assembly	1
	13/U1390	Cable, assembly	1
	22/U1390	Cable, assembly	1
	32/U1390	Cable, assembly	1
	9/U1390	Pipe, flexible ¼ in. i.d. x 6 ft.	1
	24/U1390	Pipe, flexible ¼ in. i.d. x 15 ft.	1

APPENDIX 1

FEEL UNIT TESTING

LIST OF CONTENTS

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General

1. Prior to installation in the aircraft, each feel unit is accurately adjusted to provide the control characteristics appropriate to its particular system. To ensure that the required characteristics are maintained after bay servicing, it is necessary for the feel unit to be subjected to the function and calibration checks contained in the Schedule of Tests. These checks are made on the complete feel unit assembly comprising both the mechanical and the electrical component units. After testing, the feel unit must be retained and subsequently installed in the aircraft as a complete tested assembly. This is most important in respect to the aileron feel unit as the mechanical and electrical component units are mounted separately in the aircraft.

2. To service and test the feel units, the operator must be fully conversant with the mechanical and electrical operation of the system. This information is contained in Sect.3, Chap.4 and Sect.6, Chap.10 of this publication.

Feel unit adjustments

3. Due to the mechanical and electrical tolerances in the feel unit, adjustments are provided to enable the correct requirements to be obtained. In elevator and rudder feel units the cam can be moved in the slotted mounting holes in the fulcrum lever, and in the aileron feel unit the cam can be slightly rotated. Two electrical trimmers identified HIGH SPEED and LOW SPEED respectively, are provided to reset the balance of the Wheatstone bridge. The positions of the cam and trimmers are initially determined by first setting the trimmers to their appropriate mid positions and then applying a suitable load to the feel unit at each airspeed indicated on the appropriate calibration sheet. The resultant input shaft movement is plotted and must lie within the limit lines applicable to the airspeed. By altering the position of the cam and resetting the trimmers, the required setting can be obtained. In elevator and rudder feel units, movement of the cam toward the pivot will normally stiffen the feel, but care must be taken to ensure that the cam does not foul any other part of the unit. The low speed trimmer will have most effect at low speeds but it should be understood that any adjustment will alter the feel at all speeds. The sensitivity

trimmer should always be set to maximum increase.

4. The stroke of the main actuator is set by the component manufacturer to provide the operating range of the feel unit. The end fitting of the actuator is adjustable and may be moved to give a more correct setting during calibration. When setting the actuator in elevator and rudder units, the following points must be observed.

(1) It is primarily important that fouling does not occur. With the actuator in the fully extended or retracted positions, the fulcrum pivot must not touch the end of the slot in the slotted lever. With the cam set and the actuator fully retracted, the cam should not force the follow up ratiometer arm against its stops or against the side of the feel unit.

(2) When fully retracted, the actuator should give a pivot setting which is slightly nearer to the input shaft end of the slotted lever than that obtained when maximum airspeed is applied. The reason for this is that as the input shaft is moved, the fulcrum lever is strained so that the pivot setting deflects upward toward the spring unit. When this occurs, the Wheatstone bridge is unbalanced and the actuator further retracts to return the pivot to its original setting. There must therefore be sufficient actuator movement available to enable this resetting to occur at the maximum speed position.

5. No defined procedures can be specified for setting a feel unit, it is only by experience that the operator will learn how to make the desired corrections.

ELEVATOR AND RUDDER FEEL UNITS

6. The elevator and rudder feel units operate on the same basic principles and are therefore tested in a similar manner. The checks necessary and the requirements for the respective units are outlined in the following paragraphs, and apply to units of pre and post Mod.1499 standard.

Preparation for test

(1) With the feel unit installed in the calibrator as detailed in Chap.8 para.27, proceed as follows:-

(a) Using the clamps provided, mount the dial gauge to the free end of the feel unit input shaft so that the plunger contacts the unit end plate. Set the dial gauge to obtain equal movement in both directions and set to zero.

(b) Connect a 28 volt d.c. supply to the console terminals.

(c) Ensure that the three airspeed control valves are closed and charge the pneumatic system air bottle.

(d) Set the master switch SW.1 to ON.

(e) Set switch SW.3 to the RUDDER ELEVATOR and Mk.1 AILERON position.

(f) Set switch SW.2 to FEEL and check that the GREEN indicator lamp lights.

(g) Set switches SW.4 and SW.5 to OFF.

(h) Set switch SW.6 to NORMAL.

Cut-in and cut-out speeds

(2) To check the cut-in and cut-out speeds:-

(a) Open the airspeed INCREASE valve slowly until the main actuator commences to operate and note the indicated airspeed. This is the cut-in speed.

NOTE . . .
Operation of the main actuator can be heard as a medium pitched hum quite distinct from the high pitched operating noise of the relief actuator.

(b) Continue to increase airspeed slowly until the main actuator stops operating. This is the cut-out speed.

(c) Check that the cut-in and cut-out speeds are within the following limits.

	Cut-in	Cut-out
Elevator	90-100	445-465
Rudder	130-142	440-455

Symmetrical loading

(3) Check for symmetrical loading by selecting an airspeed and applying a suitable load to the feel unit, using first the R.H. and then the L.H. weight carrier. Movement of the input shaft in each direction should be the same.

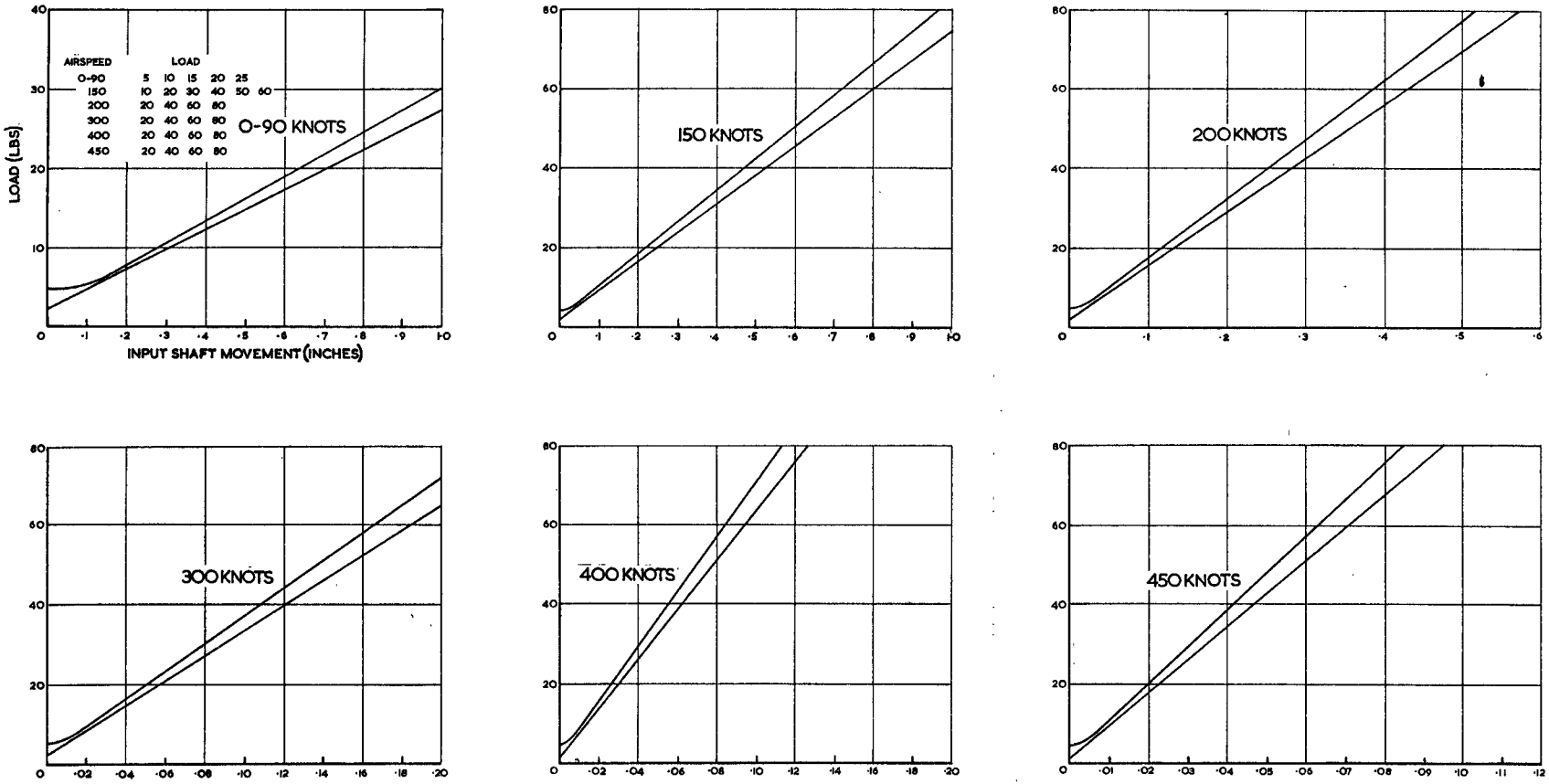


Fig. 1 Elevator A.F.U. Load/input shaft movement limits

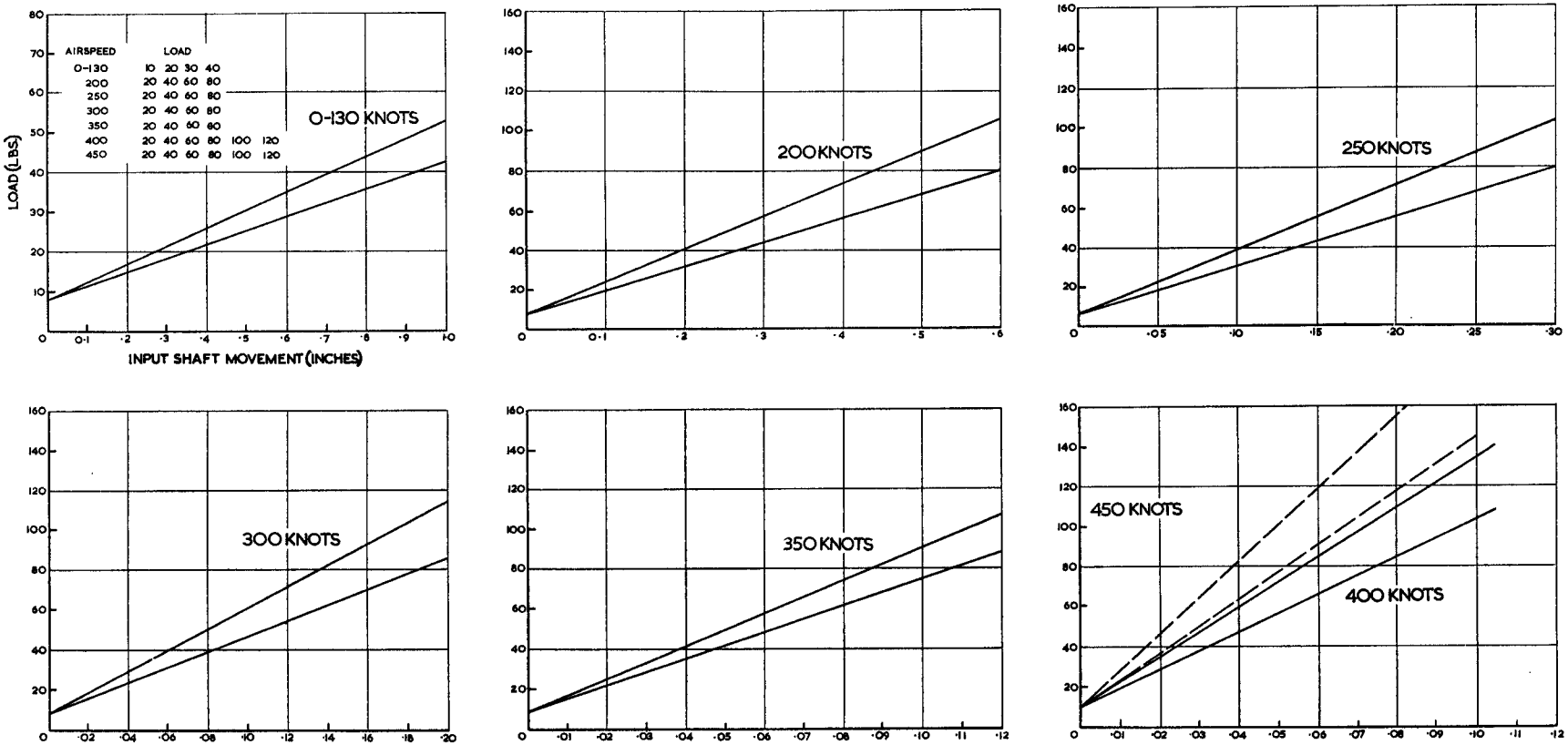


Fig. 2 Rudder A.F.U. Load/input shaft movement limits

Break out force

(4) To check break out force:

(a) Select zero airspeed.

(b) Load the weight carrier in small increments until the input shaft moves. Check that the applied weight is within the following limits:

Elevator	2 -	4 lb.
Rudder	8 -	10 lb.

Feel relief check

(5) To check function of the unit under feel relief conditions:-

(a) Select zero airspeed.

(b) Set switch SW.2 to RELIEF. Check that the RED indicator lamp lights and the relief actuator retracts to a slightly softer feel position i.e. to move the pivot nearer to the spring unit, before tripping the limit switch.

(c) Set switch SW.2 to FEEL. Check that the GREEN indicator lamp lights and the relief actuator extends to the normal low speed position.

(d) Set airspeed to 460 knots. Set switch SW.2 to RELIEF. Check that the RED indicator lamp lights and the relief actuator retracts to the feel relief position.

(e) Select switch SW.2 to FEEL and reduce airspeed to zero.

Calibration check

(6) The object of the calibration check is to determine the load/input shaft movement characteristics of the feel unit. The calibration sheets fig.1 elevator, and fig.2 rudder, show the upper and lower limits for input shaft movement at the various speed settings. To check calibration:-

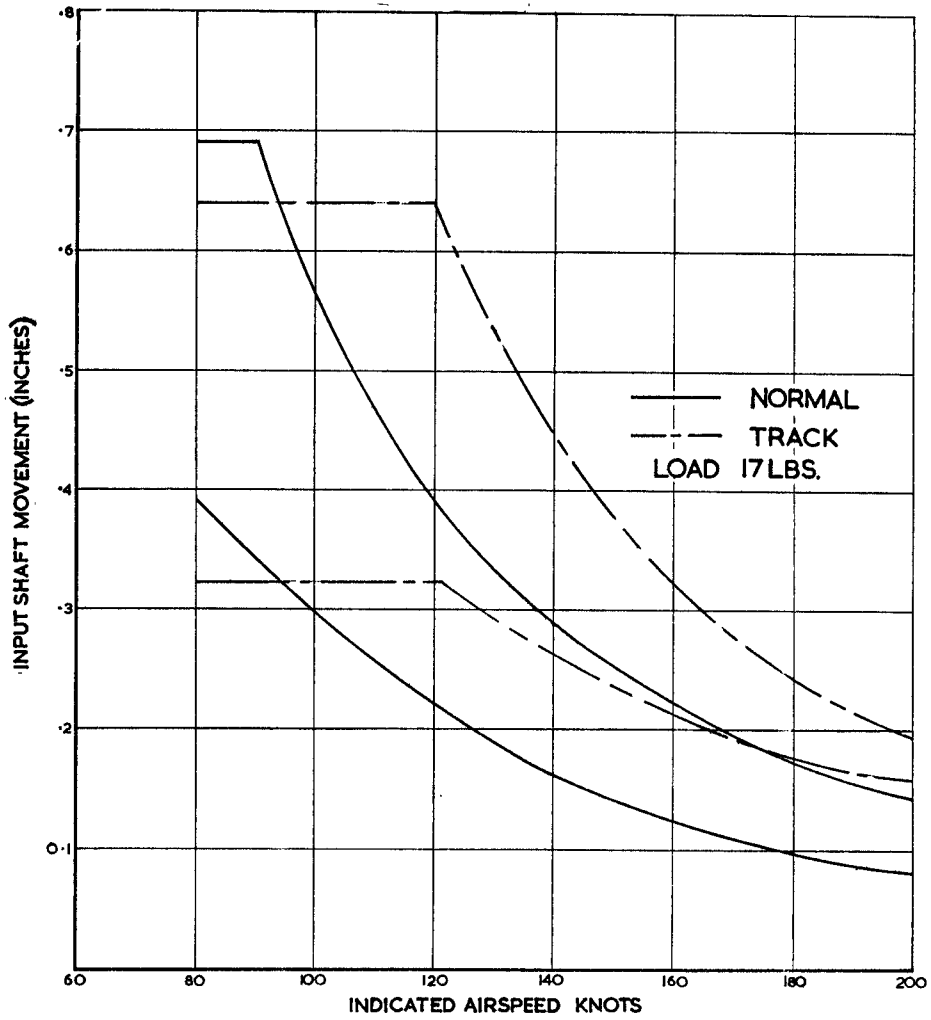


Fig.3 Elevator A.F.U. Auto-pilot (Track) calibration limits

(a) Set the dial gauge to zero.

(b) Select the lowest airspeed appropriate to the unit being tested.

(c) Apply PULL loads to the feel unit by loading the appropriate weight carrier in the stages specified on the calibration sheet. Plot input shaft movement for each load. When maximum load is reached, remove the load in the same increments as for loading and plot results. Repeat this procedure at each airspeed setting.

(d) Check that the graphs plotted for increasing and decreasing loads at each airspeed setting are within the limit lines shown on the calibration sheet.

(e) Repeat operations (b) to (d) using the opposite hand weight carrier to apply PUSH loads to the feel unit.

Friction check

(7) Friction of the feel unit is checked at the low (pre cut-in) and high (after cut-out) airspeed settings. A typical plot to determine friction of a rudder feel unit is shown in fig.5. To check friction:-

(a) Open the air increase valve to obtain the low speed setting i.e. 0.90 knots for elevator units, 0-130 knots for rudder units.

(b) Apply PULL loads to the feel unit by loading the appropriate weight carrier in increments of two lb. up to 28 lb. An initial load of 8 lb. should be applied to the rudder unit to overcome the break out force. Unload in the same increments as for loading, and plot load/input shaft movement for each increasing and decreasing load.

(c) Increase airspeed to the high speed setting of 460 knots.

(d) Apply PULL loads to the feel unit in two lb. increments up to 40 lb., unload by the same amounts and plot results.

(e) Repeat operations (a) to (d) using the opposite hand weight carrier to apply PUSH loads. Friction of the feel unit is equal to half the vertical distance between the increasing and decreasing load curves, and at the 0.1 in. (low speed) and 0.01 in. (high speed) input shaft movement positions must not exceed:

	Elevator	Rudder
Low Speed	½ lb.	1 lb.
High Speed	1 lb.	1¾ lb.

Auto-pilot (track) calibration (elevator only)

(8) During auto-pilot control on an I.L.S. approach, the elevator feel unit is given a degree of relief when TRACK is selected. The limits for this calibration shown in fig.3 apply only to elevator feel units with Mod.1073 embodied. To check track calibration:-

(a) Set the console controls as detailed in sub para.(1).

(b) Apply a load of 17 lb. to the balance arm.

(c) Increase airspeed from 80 to 200 knots in 10 knot increments and plot input shaft movement at each speed using calibration sheet fig.3. Check that the graph plotted is within the NORMAL limit lines.

(d) Reduce airspeed to zero.

(e) Set switch SW.4 to ON.

(f) Increase airspeed from 80 knots to 200 in 10 knot increments and plot input shaft movement. Check that the graph plotted is within the TRACK limit lines.

(g) Reduce airspeed to zero and set switch SW.4 to OFF.

(h) Apply the load in the opposite direction and repeat operations (c) to (f).

AILERON FEEL UNIT

7. The following paragraphs outline the checks necessary and specify the requirements for aileron feel units to pre and post Mod.1499 standard.

Preparation for test

(1) With the feel unit installed in the calibrator as detailed in Chap.8 para.27, proceed as follows:-

(a) Using the clamps provided, secure the dial gauge to the end structure of the calibrator so that the plunger contacts the striker arm of the extension tube. Set the dial gauge to obtain equal movement in each direction and set to zero.

(b) Connect a 28 volts d.c. supply to the console terminals.

(c) Ensure that the three airspeed control valves are closed and charge the pneumatic system air bottle.

(d) Set the master switch SW.1 to ON.

(e) Set switch SW.3 to the Mk.2 AILERON position.

(f) Set switch SW.2 to FEEL and check that the GREEN indicator lamp lights.

(g) Set switches SW.4 and SW.5 to OFF.

(h) Set switch SW.6 to NORMAL.

Cut-in and cut-out speeds

(2) To check the cut-in and cut-out speeds:-

(a) Open the air INCREASE valve slowly until the main actuator commences to operate and note the indicated airspeed. This is the cut-in speed and should be 148 to 155 Knots.

(b) Continue to increase airspeed slowly and note the airspeed at which the main actuator stops operating. This is the cut-out speed and should be 368 to 375 Knots

Break out force

(3) To check the break-out force:-

(a) Select zero airspeed.

(b) Load the weight carrier in small increments and check that the load required to move the input shaft is not more than 1½ lb.

Feel relief check

(4) To check function of the unit under feel relief conditions:-

(a) Set airspeed to 380 knots.

(b) Set switch SW.2 to RELIEF. Check that the RED indicator lamp lights, and the relief motor of the actuator operates to move the feel unit to the unrestricted movement position. Apply hand pressure to each end of the balance arm in turn, and check that the resultant movement of the input shaft in both directions is 0·975± 0·050 ins.

(c) Set switch SW.2 to FEEL and check that the actuator extends to the normal position for this airspeed.

(d) Set airspeed to zero.

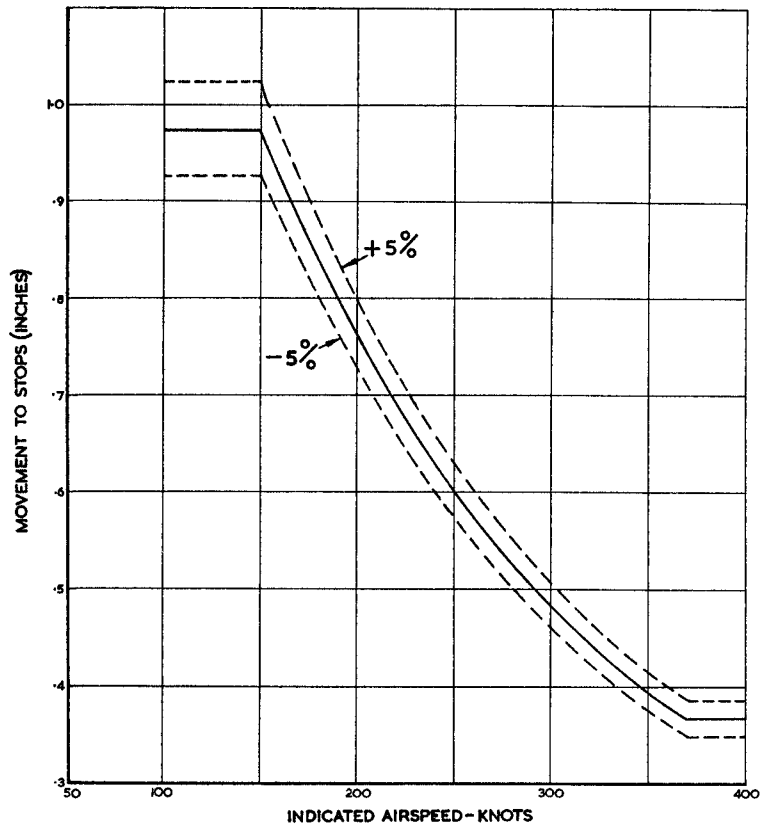


Fig.4 Aileron A.F.U. Airspeed/stop movement limits

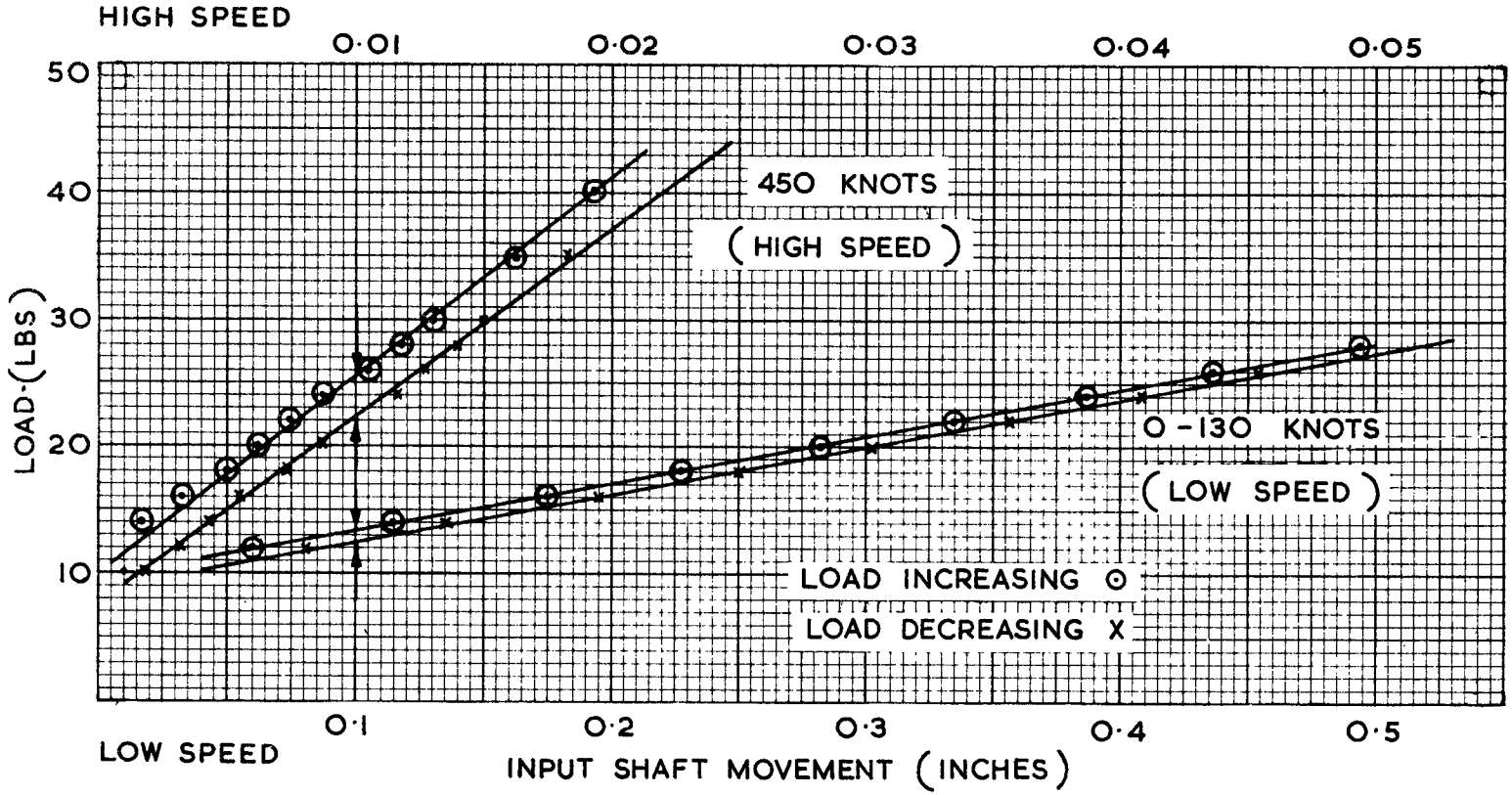
Calibration check

(5) The object of the calibration check is to determine the airspeed/available movement characteristics of the feel unit. The upper and lower limits of movement are shown on calibration sheet fig.4. To check calibration:-

(a) Set the dial gauge to zero.

(b) Set airspeed to 150 knots.

(c) Apply hand pressure to one



FRICTION IS EQUAL TO HALF THE VERTICAL DISTANCE BETWEEN THE LOAD INCREASING AND LOAD DECREASING CURVES, MEASURED AT THE 0.10 IN. (LOW SPEED) AND 0.01 IN. (HIGH SPEED) INPUT SHAFT MOVEMENT POSITIONS RESPECTIVELY.

IN THE EXAMPLE SHOWN FRICTION AT LOW SPEED - ½ LB.
AT HIGH SPEED - 1½ LB.

NOTE . . .

FRICTION OF THE ELEVATOR A.F.U. IS DETERMINED IN A SIMILAR MANNER AT THE APPROPRIATE LOW AND HIGH AIRSPEED SETTINGS.

Fig.5 Typical friction calibration - rudder A.F.U.

end of the balance arm to take up movement between the stops, and record the input shaft movement on calibration sheet fig.4. Repeat this procedure at 25 knot intervals throughout the normal speed range.

(d) Repeat operation (c), depressing the balance arm in the opposite direction. Check that the graphs plotted in both directions are within the limit lines shown on the calibration sheet.

Auto-pilot calibration

(6) When the auto-pilot aileron channel is engaged, the aileron authority is restricted by moving the feel unit stops toward the high speed position. To check auto-pilot calibration:-

(a) Select zero airspeed.

(b) Set switch SW.6 to the AUTO-PILOT position.

(c) Apply hand pressure to each end of the balance arm in turn, and check that movement of the input shaft in both directions is 0.425 ± 0.023 in. The auto-pilot potentiometer POT.3 may be adjusted to obtain this setting.

◀ **Actuator override limit switch setting**

(7) On feel units with Mod.1806 incorporated, check function of the actuator override micro switch as follows:-

(a) Set the controls as in sub. para.7 (1).

(b) Set airspeed to 400 knots.

(c) Set switch SW.6 to AUTO-PILOT and allow the actuator to run to full extent.

(d) Insert a plate strip 24 SWG. thick between the striker pin and the micro switch plunger, and check that the red warning lamp L3 illuminates.

(e) Remove the plate strip and check that lamp L3 extinguishes.

(f) Reduce airspeed to zero.

(g) Set switch SW.6 to NORMAL. ▶

Chapter 9

AUTOMATIC LANDING SYSTEM

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Introduction

1. This chapter contains descriptive and servicing information on the installations which enable the aircraft to land automatically at those airfields equipped with the necessary ground equipment.

2. The automatic landing system is formed by the combination and integration of four different installations. These installations are listed as follows:-

(1) Leader cable (A.R.I.23063) - used for azimuth (lateral) guidance.

(2) F.M. radio altimeter Mk.7B (A.R.I.23172) - used for pitch (height) guidance.

(3) Auto-throttle - used for controlling the speed of the aircraft during the automatic approach and landing phases.

(4) Autopilot Mk.10B - used to operate the control surfaces (i.e. elevons, rudder etc.) during the automatic approach and landing phase.

3. In this chapter, only the Leader cable, Auto-throttle and Autopilot Mk.10B installations are individually dealt with. The F.M. radio altimeter, however, is fully described in Sect.8, Chapter 7 of this book. The autopilot Mk.10B, as in the case of the autopilot Mk.10A, is integrated with the M.F.S. system. Full details of the M.F.S. system will be found in Section 7, Chapter 7 of this book.

4. A brief description of the implications in the artificial feel system is also included, together with details of the autolanding test meter. The artificial feel system is fully described in Sect.3, Chap. 4 and Sect.6, Chap.10 of this publication.

5. Illustrations which show the various components of the system are provided together with equipment tables and connector tables. The appropriate routing charts will be found at the end of the text.

6. The following mods. are incorporated:-

Mod.980 To make provision for the leader cable loop aerial, autolanding instruments and auto-throttle installation.

Mod.1204 To introduce the leader cable installation, autopilot Mk.10B, the auto-throttle installation and auto-landing instruments, to complete the auto-landing installation.

Mod.1232 To introduce a test point to simulate bomb doors open and opening positions.

Mod.1512 To introduce relay, Type 4190 GD in lieu of Type 4190 HD, in servo control unit. (complementary to Smiths Mod.AP/E. 156).

Mod.1545 To introduce pilots' control handle, Type AC.61320, in lieu of Type AC.14256, which contains an instinctive cut-out switch requiring a conscious action.

Mod.1581 To bring the autoland installation up to the interim release standard by allowing the autopilot Mk.10B to be used with the autoland facility disconnected, and also ensuring that all a.c. supplies for the autopilot Mk.10B are derived from the same source.

Mod.1856 This mod. supercedes mod. 1581 and permits full operation of the autopilot Mk.10B with the autoland facility to the C.A. release standard.

DESCRIPTION AND OPERATION

General

7. The following paragraphs contain a brief description of an automatic approach and landing, so that the reader can familiarise himself with the general functions of the various installations involved. Full details of the autolanding system will be found in A.P.1469 EB, Vol. 1, Book 1.

Automatic approach

8. In the automatic approach sequence, which is immediately prior to the automatic landing sequence, the autopilot is radio-coupled to the I.L.S. installation. Signals from this system enable the aircraft to fly along the correct line of approach to the runway (localiser signal) and also control the angle of descent (glidepath signal). In addition, at the commencement of an

automatic approach, the Automatic Throttle Control system (para.21), can be initiated by the pilot to provide precise control of airspeed throughout all phases of the automatic approach and subsequent automatic landing phases. Details of the I.L.S. installation will be found in Sect.8, Chap.6 of this book.

Automatic landing

9. The automatic landing sequence is divided into five phases, during which the aircraft is controlled by the following guidance signals to enable it to land automatically.

Phase 1 - Glide
Controlled in pitch and azimuth respectively by the I.L.S. glidepath and localiser signals.

Phase 2 - Leader cable
Controlled in pitch by I.L.S. glidepath signals and in azimuth by leader cable signals.

Phase 3 - Attitude
During this phase the aircraft maintains a constant attitude in pitch and is controlled in azimuth by leader cable signals.

Phase 4 - Flare
Controlled in pitch by the F.M. radio altimeter Mk.7 installation and in azimuth by leader cable signals.

Phase 5 - Land
Controlled in pitch by the radio altimeter and in azimuth by leader cable signals.

Each phase of the landing is shown on the phase ring of the combined autolanding phase and altitude indicator.

Phase 1 - Glide

10. The landing starts with the Glide phase, which is a standard automatic I.L.S. approach. Signals from the I.L.S. localiser (azimuth beam) and I.L.S. glidepath (pitch beams), are fed into the autopilot which locks the aircraft on to these received signals. The I.L.S. signals are connected in to the autopilot, via the M.F.S., when the LOC and GP position is selected at the M.F.S. selector navigational switch unit and the LOC position is selected at the LOC-L/CABLE switch on the autopilot control unit. Operating the LOC-L/CABLE switch causes the PRIME segment to appear on the autolanding phase/altitude indicator.

I.L.S. beam display

11. The two elements of the radio beam information are displayed separately. Deviation from the localiser beam is indicated by the beam bar fitted in each beam compass and glidepath deviation is shown by the glidepath pointer of each director horizon. Presenting the information in this manner ensures that the localiser beam displacement is related to the aircraft magnetic heading and the glidepath displacement is related to the aircraft pitch attitude. Further information on the I.L.S. beam display will be found in Sect.7, Chap.7 of this book.

12. The localiser and glidepath beams will bring the aircraft to the undershoot area of the runway at a height of approximately 320 feet. During the Glide phase, the aircraft speed is held constant by the auto-throttle installation.

Phase 2 - Leader cable

13. On completion of the Glide phase, the aircraft comes within the range of the magnetic leader cables. With the leader cable installation switched ON selection of the L/CABLE position at the LOC/L-CABLE switch, situated on the pilots selector switch box, disconnects the I.L.S. localiser signal and substitutes the leader cable signal (from A.R.I.23063), to the autopilot azimuth channel. With this more precise azimuth information, any lateral error from the runway centre-line can be reduced before touch-down.

14. Selecting the L/CABLE position at the LOC-L/CABLE switch, causes the indicator on the leader cable control unit to change from diagonal stripes to full white, and the L/CABLE segment of the phase ring to appear on the autolanding phase/altitude indicator. The beam bars in the M.F.S. beam compasses will display any deviation from the leader cable signal.

Phase 3 - Attitude

15. At an altitude of about 120 feet the I.L.S. glidepath signal becomes unusable for pitch guidance, therefore the signal is removed automatically from the autopilot elevator channel. It is too early, however, to guarantee a good guidance signal from the radio altimeter, because the aircraft is not yet over the level runway, and so, for a few seconds, the aircraft pitch attitude is held constant at an average value during the whole approach to this stage. During this phase of the landing the aircraft height is reduced to about 70 feet and the ATTITUDE segment of the phase ring appears on the autolanding phase/altitude indicator.

Phase 4 - Flare

16. At a height of about 70 feet the Flare begins. This is the manoeuvre which progressively reduces the aircraft rate of descent, from approximately 10 ft./sec. on the approach to 2 ft./sec. at touch-down.

17. With the A.R.I.23172 switched ON, signals from the radio altimeter installation are fed into the autopilot elevator channel.

The signals are fed in such a way that the aircraft rate of descent is proportional to its height, i.e., the lower the aircraft the more slowly it descends. During the Flare phase, the auto-throttle installation moves the throttles steadily back to the ground idling position and the FLARE segment of the phase ring appears on the autolanding phase/altitude indicator.

Phase 5 - Land

18. On completion of the Flare phase, the aircraft altitude is reduced to approximately 18 feet and the Land segment of the phase ring appears on the autolanding phase/altitude indicator. During the Land phase, the kick-off drift manoeuvre is carried out. If the aircraft has drifted laterally, due to cross winds etc., the autopilot automatically applies rudder movement in the appropriate direction to ensure that the aircraft not only touches down on the runway centre-line, but is also lined up with the runway. A few seconds after the LAND segment appears on the indicator, the aircraft touches-down on the runway.

NOTE . . .

The kicking-off drift manoeuvre, together with detailed information of the implications in the artificial feel system when operating during an automatic landing, will be found in Book 2, Sect.6, Chap.10 of this publication.

Manual ground run

19. After touch-down the pilot disengages the autopilot and auto-throttle installation, and brings the aircraft to a stop manually, using as guidance information, either the runway centre-line or the leader cable signals displayed on the M.F.S. beam compasses.

Disengagement

20. The autopilot can be disengaged at any stage of an automatic landing. After the LOC-L/CABLE switch has been pulled ON (para.10), the autopilot and auto-throttle installation disengage simultaneously by operating the autopilot cut-out switch.

Automatic throttle

21. During the whole of the approach (para.8 to 12), the airspeed is held constant by the automatic throttle installation which uses pitch attitude and airspeed as input data. The installation also closes the throttle automatically during the Flare (para.16), so that when the aircraft touches down the engines are running at flight idling speed.

22. The remainder of this chapter describes in detail the leader-cable, auto-throttle and the autopilot Mk.10B installations. The radio altimeter is fully described in Sect.8, Chap.7 of this book.

LEADER CABLE INSTALLATION
(A.R.I.23063)

23. The leader cable installation provides azimuth guidance information, of sufficient accuracy and of correct form, to enable the aircraft, when terminating an I.L.S. approach, to continue to make a satisfactory landing under automatic control.

24. The system is based on magnetic leader cable techniques. The ground installation supplies two low frequency alternating currents, of different frequencies and equal amplitudes, to two cables. These cables are situated one on either side of, and equidistant from, the runway centre-line.

25. The airborne equipment compares the relative field strengths from the two cables, with respect to a rotating loop aerial assembly mounted near the roll axis (centre-line) of the aircraft. The loop aerial assembly consists of a three-phase motor which rotates two crossed loops. The loops are tuned, one to each of the transmitted frequencies, and consequently induce a voltage into the respective loop aerial. These induced voltages are fed into the receiver unit via slip rings where they are amplified and converted into a d.c. voltage proportional to aircraft deviation from the runway centre-line. This information is then passed to the autopilot azimuth channel and the M.F.S. beam compasses.

26. The control unit incorporates an IN-FLIGHT TEST switch, a magnetic switch, a magnetic indicator and a displacement meter. These components allow the system to be checked before committing the aircraft to an I.L.S. approach and automatic landing.

27. A location diagram of the major components is provided at Fig.1. A routing chart is contained in fig.7 and a connector table will be found at the end of the text.

28. Descriptive and servicing details for the leader cable installation are contained in A.P.2534Q, Vol.1, which should be read in conjunction with the information contained in this chapter.

Unit location

29. The leader cable installation consists of five main units which are located as follows:-

Unit	Location
Aerial assembly, Type 16050	Under surface of the fwd. fuselage.
Receiver unit, Type 16048	Nose compartment.

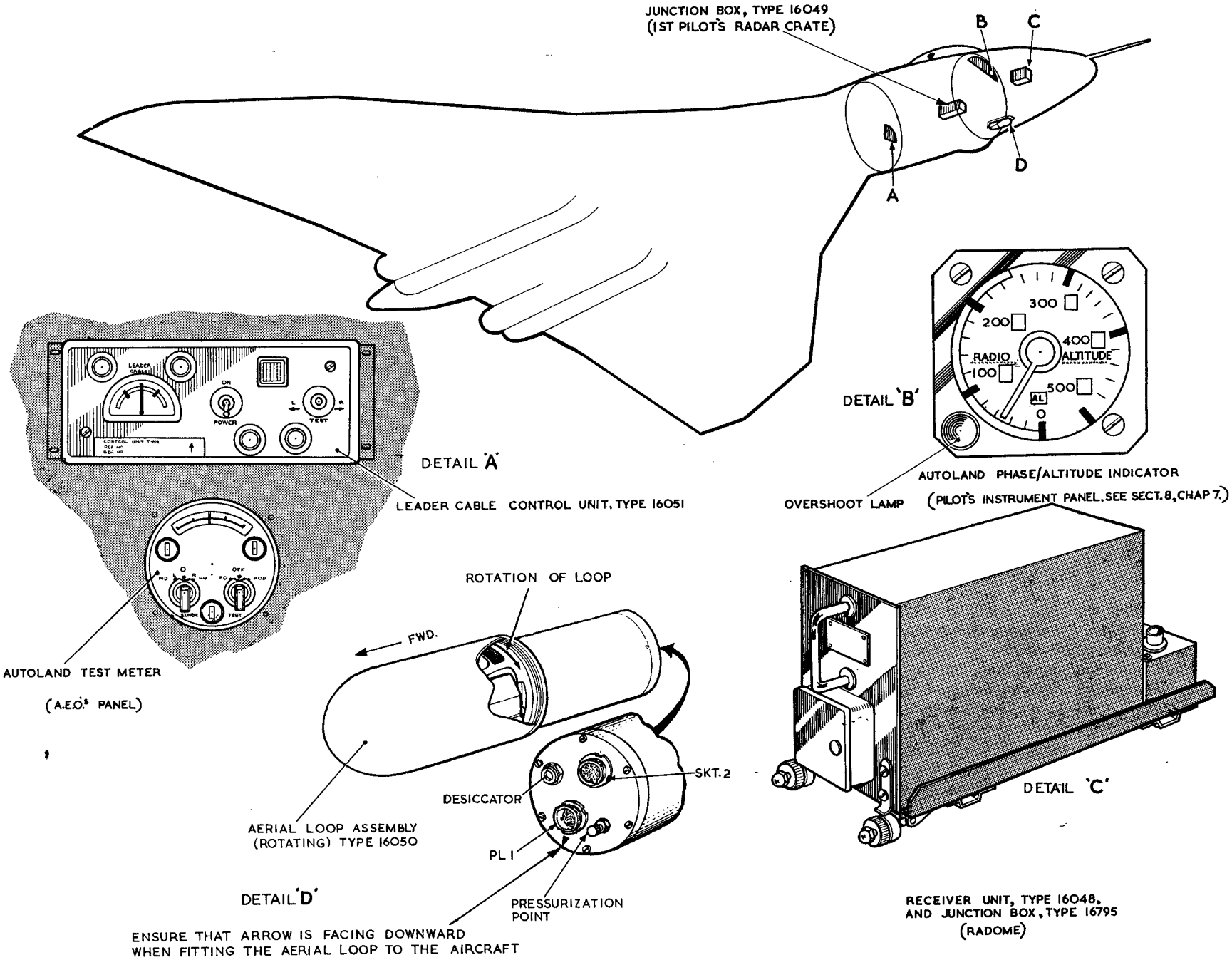


Fig. 1. Leader cable components.

◄Detail 'D' re-drawn►

Unit	Location
Junction box, Type 16795	Nose compartment.
Junction box, Type 16049	First pilot's radar crate (under pilot's floor).
Control unit Type 16051	A.E.O.'s panel.

Aerial assembly, Type 16050

30. The aerial assembly is contained in a pressure sealed alloy case which has a bullet shaped nylon nose section. The assembly consists of two loop aerials mounted at right-angles and a miniature 3-phase 400 c/s induction motor which rotates them at 1000 rev/min. A fixed loop aerial is placed around the rotating loops, and is used for injecting simulated leader cable ground signals into the rotating loops for checking the overall performance of the receiver, prior to committing the aircraft to an I.L.S. approach and automatic landing (para.26).

Receiver unit, Type 16048

31. The receiver, Type 16048, is a self-contained unit housed in a light-alloy case. Fitted inside the unit is a transformer and voltage regulator which provide the required L.T. and H.T. power supplies. The function of the receiver is to amplify the modulated signals from the aerials, convert them into a d.c. voltage that is proportional to the aircraft displacement from the runway centre-line, and then pass this information on to the autopilot azimuth channel and M.F.S. beam compasses.

32. The A.G.C. (automatic gain control) voltage developed in the receiver is used to operate a relay, the contacts of which remove the I.L.S. localiser signal and substitute the leader cable signal at the autopilot azimuth channel and M.F.S. beam compasses. The A.G.C. voltage is applied to the relay when the L/CABLE position is selected at the LOC-L/CABLE switch on the autopilot control unit. A test circuit is built into the receiver which enables a functional check to be carried out on the entire installation.

Junction box, Type 16795

33. The junction box, Type 16795, is an integral part of the receiver unit rack mounting. The receiver is connected into the junction box by means of a 32-pole plug and socket. Mounted on top of the junction box are two multipole sockets which connect the receiver to the aerial assembly and junction box, Type 16049, via the connecting cables.

Junction box, Type 16049

34. The junction box, Type 16049, is the main interconnecting unit for the various major components of the installation. Each component is connected to the junction box, via a multipole plug and socket, where interconnection and distribution is carried out, the signals and supplies being finally fed to the appropriate unit via the respective plug and socket. Mounted on top of the junction box is an EXT. LOAD (External Load) rotary switch which has five positions labelled 0, 1, 2, 3, 4. This switch selects various positions of a balancing circuit, which matches the receiver output impedance to the input impedance of the M.F.S. navigators computor unit. For Vulcan aircraft the switch is normally set at position 4. Located adjacent to the EXT.LOAD switch is a voltage selector which is used to select either 115-volt or 200-volt a.c. supplies.

Control unit, Type 16051

35. The control unit provides full remote control of the receiver and aerial assembly, together with facilities for checking the entire installation. The following components are situated on the front panel of the unit:-

POWER - ON switch
TEST switch
Centre-zero test meter
Magnetic indicator

The POWER - ON switch controls the supplies to the aerial assembly and receiver unit and is used to switch the installation 'on' or 'off'. The TEST switch is used in conjunction with the test meter and magnetic indicator to check the installation prior to an automatic landing.

Power supplies

36. The system is fed with two supplies, one of 200-volt, 3-phase, 400 c/s and one of 28-volt d.c. The 200-volt supply is connected from fuses 733 in panel 75P, via pins A, B and C of plug and socket 1PL1, to the junction box, Type 16049. The 28-volt d.c. supply is connected to the junction box from fuse 642 in panel 3P, via pin D of plug and socket 1PL1. Distribution and interconnection is carried out inside the junction box, the supplies being finally fed to the various units via the appropriate plugs and sockets.

AUTO-THROTTLE INSTALLATION

37. The auto-throttle installation, which is an integral part of the autopilot, Mk. 10B, provides facilities for controlling the aircraft speed automatically during an I.L.S. approach. The system is also used to progressively reduce the aircraft speed during the Flare phase of an automatic landing (para.16).

38. A location diagram of the major components is contained in fig.2 and a routing chart for the electrical circuit is contained in fig.8.

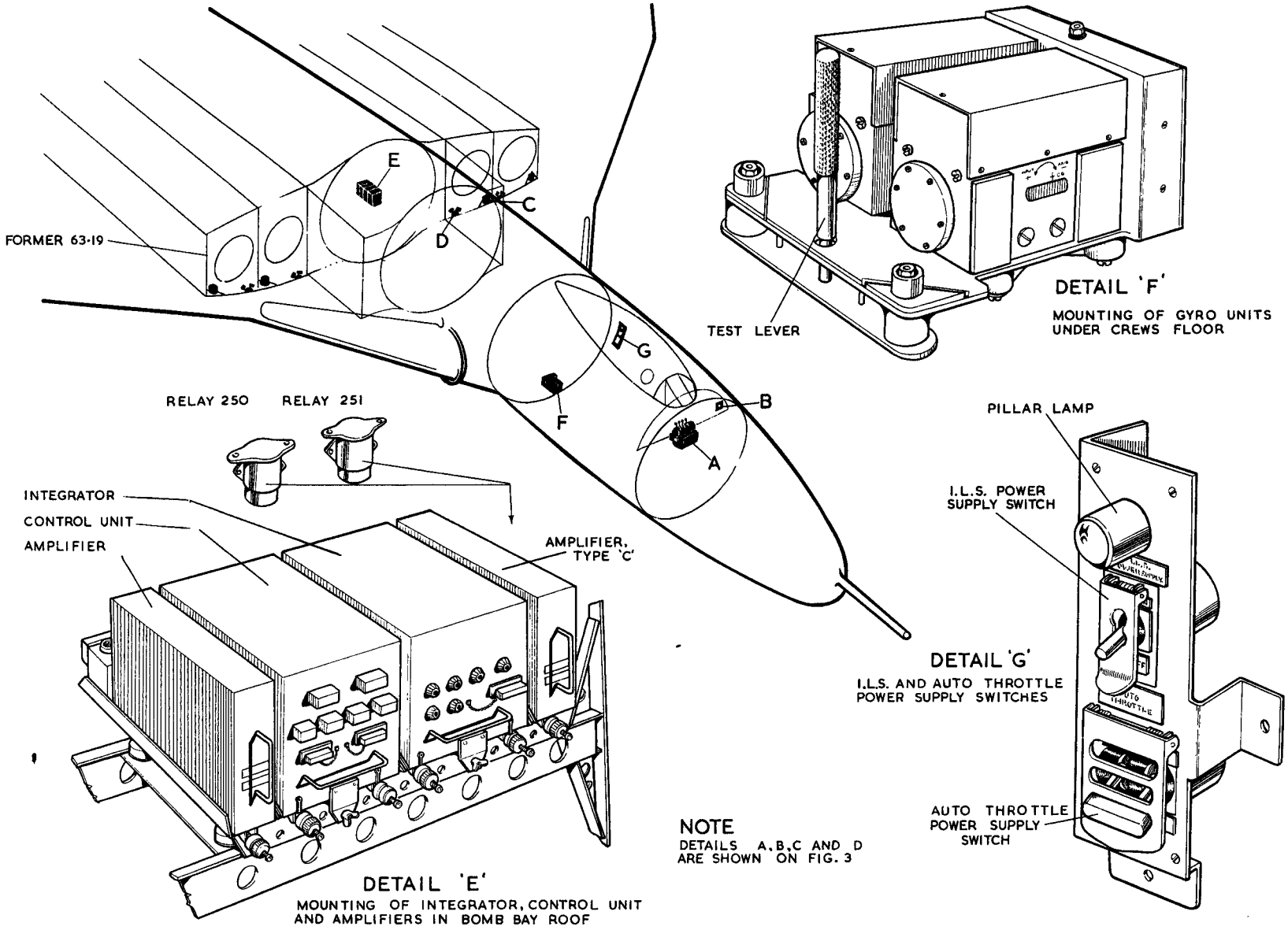


Fig. 2 Auto-Throttle components

39. Descriptive and servicing details for the auto-throttle installation will be found in A.P.1469 EB, Vol.1, Book 2, which should be read in conjunction with the information contained in this chapter.

General

40. The four engine throttles can be controlled automatically to maintain a given airspeed during an auto-approach and landing. A twin channel system is embodied, one channel operating the inboard and one the outboard, throttle levers. Control is effected by servo-motors which operate the throttles through mechanical linkages. Both channels are monitored by a comparator system which disconnects the throttles if there is a difference of more than 7 deg. between the movements of the inner and outer servo-motors.

NOTE . . .
Detailed information on the mechanical aspect of the system is contained in Book 1, Sect.4, Chap.1 of this publication.

41. Control of the throttles is achieved by a combination of airspeed error signals and pitch rate gyro signals, together with a long-term integrated airspeed error factor. Airspeed signals are fed from the port pitot-static system into the airspeed detector indicator.

42. The installation compares the relative speed of the aircraft to a selected speed (para.60) which is shown on the airspeed detector indicator (port instrument panel). Should the aircraft deviate from the selected speed, signals proportional to the deviation (error signals), will be produced in the airspeed detector indicator and/or the rate gyro units. These signals are amplified to drive the servo-motors which in turn control the throttles accordingly.

43. The system incorporates throttle limit switches, which actuate relays within the servo amplifier units, Type C, and are operated near the extremities of travel of the throttle levers (fig.4). If on receipt of the throttle demand signals, from the control unit, Type A, the throttle levers are driven to the upper or lower limits, relays within the servo amplifier units will be de-energised, via the limit switches, and cause a fixed 'drive off' signal to be injected into the servo amplifier, from the integrator unit, which in turn drives the throttle levers off the limit. If the throttle demand signal is constant a noticeable pulsating movement of the throttle levers will occur, indicating that the system has reached its operating limits.

44. The auto-throttle installation cannot be started up when the I.A.S. lock is engaged on the autopilot control unit. Similarly, the I.A.S. lock cannot be engaged when the auto-throttle system has been started up.

Unit location

45. The auto-throttle installation consists of twelve main units which are located as follows:-

Unit	Location
Airspeed detector indicator, Type A	First pilot's instrument panel (port).
Rate gyro units, Type A (2) Gyro unit mounting tray, Type A	Below navigators' floor.
Control unit, Type B	Bomb bay roof (fwd).
Integrator unit, Type B	Bomb bay roof (fwd).
Amplifier units, Type C (2)	Bomb bay roof (fwd).
Junction box, Type B	Bomb bay roof (fwd).
Servo motors, Type B (4)	One in each engine bay.

In addition to the above units, there are two comparator warning lamps mounted on the port outer instrument panel, an A/T SYSTEM ENGAGE switch fitted on the stbd. side of the throttle box and two system release switches mounted one on each of the outer throttle controls. For further details of the auto-throttle equipment, reference should be made to Table 2.

Airspeed detector indicator, Type A

46. The airspeed indicator is contained in a light alloy case. Mounted on the face of the unit are the following components:-

Veeder counter - The veeder counter, which receives information from the pitot static system, registers the aircraft speed. As the system is designed to operate within a range of 90 - 180 knots, the counter is covered by a bar when the aircraft speed is outside this range. The counter shows the actual aircraft speed until auto-throttle is engaged. When the auto-throttle has engaged the counter remains steady to indicate the datum airspeed (para.59 and 60).

Datum setting knob - The datum setting knob is located on the lower left hand corner of the instrument case. The knob enables the datum airspeed, indicated on the counter, to be adjusted by a small amount. To operate, the knob is 'pushed in' and turned.

Flag indicators - Two flag indicators show IN when the auto-throttle system

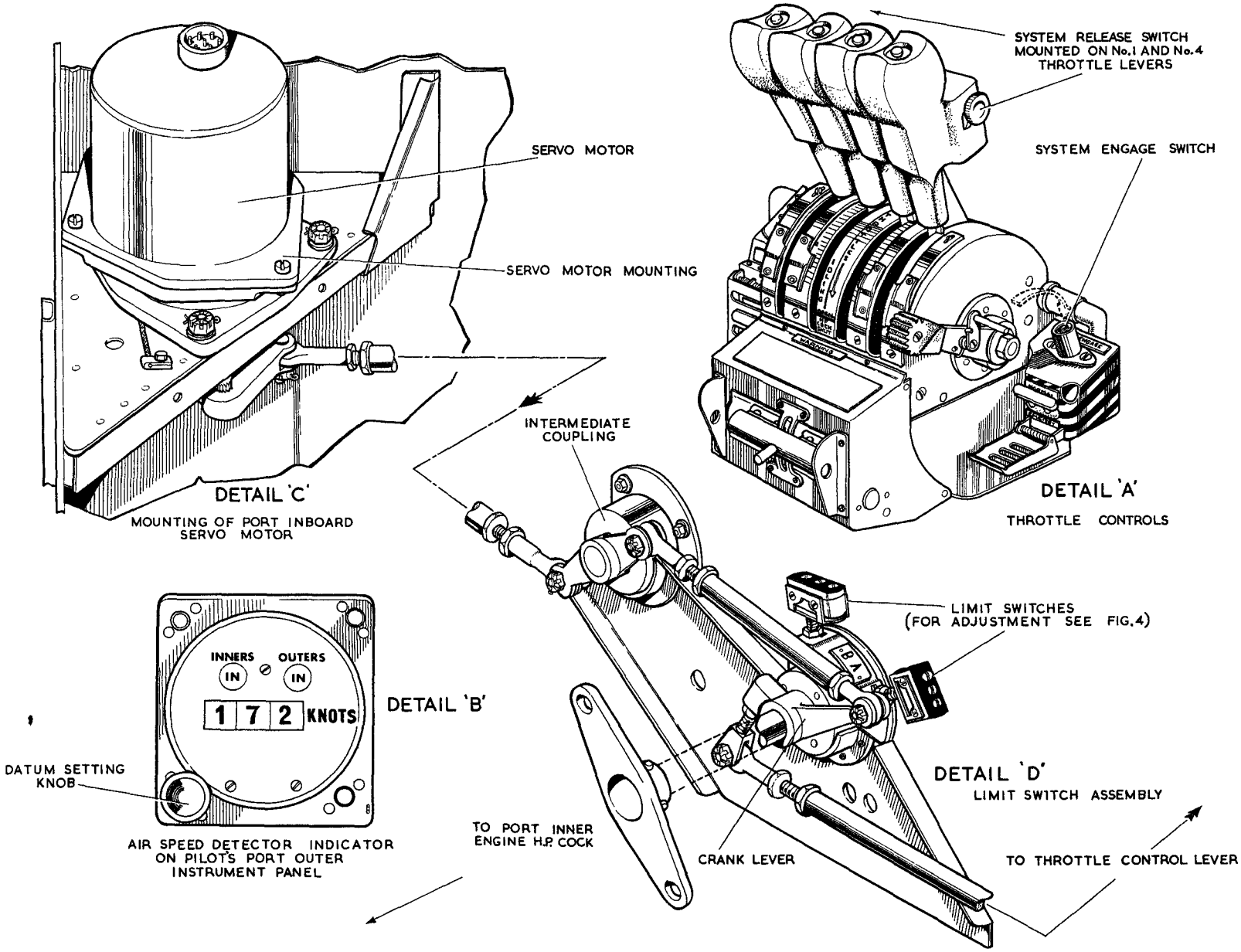


Fig.3 Servo control and indication

is engaged. One flag represents the inner throttles, and the other the outer throttles.

47. Fitted inside the instrument is a pitot static driven pick-off unit. This is an electro-mechanical device which converts deviation in pitot-static pressure (caused by deviation in airspeed), into a signal which varies in amplitude with respect to variations in airspeed. This signal (airspeed error signal) is connected to the control unit (para.49), and also appears at test socket 1196 (para.117).

Rate gyro units, Type A

48. The two rate gyros are contained in cast alloy cases and fitted side by side into a mounting tray, Type A, as shown in fig.2. A lever fitted to the rear of the mounting tray, enables the gyros to be tilted slightly in the pitch axis for testing purposes. The purpose of the gyros is to measure the rate of change of the aircraft pitch attitude, and to provide compensation signals to amend the throttle setting so that transient changes of airspeed are not created by changes of attitude. This error signal is fed to the appropriate servo amplifier via the control unit and integrator unit.

Control unit, Type B

49. The control unit is housed in a light alloy case which is mounted on the rack assembly containing the integrator and amplifier units. Signals from the pitot-static driven pick-off unit and the rate gyros are fed into the control unit where they are suitably shaped to produce the throttle demand signals. The control unit also operates in conjunction with the integrator unit in order to compare the signals received from both channels.

Integrator unit, Type B

50. The integrator unit, which is mounted on the rack assembly containing the control unit and amplifiers, is contained in a light alloy case. The signal from each channel is compared in the integrator unit. Should they differ, by an amount proportional to more than 7 deg. of servo-motor movement, the integrator operates relays which isolate the auto-throttle system. Similarly, if a fault develops in either one of the channels, the integrator isolates the unserviceable channel. Isolation of one or both channels illuminates the appropriate comparator warning lamp(s).

Comparator warning lamps

51. Located on the port outer instrument panel are two amber coloured warning lamps, one for the inboard and one for the outboard throttle control channels. The lamps, which are operated by the integrator unit, are illuminated under the following conditions:-

(1) On initial engagement of the auto-throttle system. Both lamps are illuminated for approximately 60 secs. and are then extinguished automatically.

(2) In the event of an a.c. power failure. Both lamps are illuminated and remain lit.

(3) On isolation of the auto-throttle system (para.50). Both lamps are illuminated if there is an error of more than 7 deg. between the movements of the inboard and outboard servo-motors.

(4) In the event of transient failures, i.e., lagging gyros etc. One or both lamps will be illuminated and remain lit.

(5) On failure of the d.c. supply to the system. One lamp is illuminated and remains lit.

Should the lamp(s) be illuminated as detailed in sub-para.(2) to (5), the electro-magnetic clutches on the throttle levers will become disengaged to isolate the auto-throttle control. The clutches remain disengaged until the lamp(s) are extinguished. This is achieved by depressing the SYSTEM ENGAGE switch. Should the lamp(s) still fail to extinguish, the system is considered unserviceable, and the POWER SUPPLY switch is operated to the OFF position.

Amplifier units, Type C

52. The two amplifier units each contain two separate amplifiers, i.e.,four amplifiers, one for each engine throttle, and each amplifier unit is mounted on either side of the integrator and control units, as shown in fig.2. Signals from either channel are fed into the appropriate amplifier, via the control unit and integrator, where they are amplified to operate the two port and two starboard throttle servo motors.

Servo-motors, Type B

53. The four servo-motors, Type B, are contained in cast alloy cases and are mounted one in each engine bay. Fitted to one end of each servo-motor spindle is a lever which is connected to a control rod. These control rods are part of the mechanical linkages which transfer servo-motor movement to the throttle levers, via the limit switch assemblies and the throttle connecting rods.

Limit switch assemblies

54. Each limit switch assembly consists of two micro-switches, a shouldered cam and a spindle. Pivoted on the spindle is a bell crank lever, with one end attached to the throttle connecting levers, and the other end to the servo-motor control rods. The micro-switches are secured to a

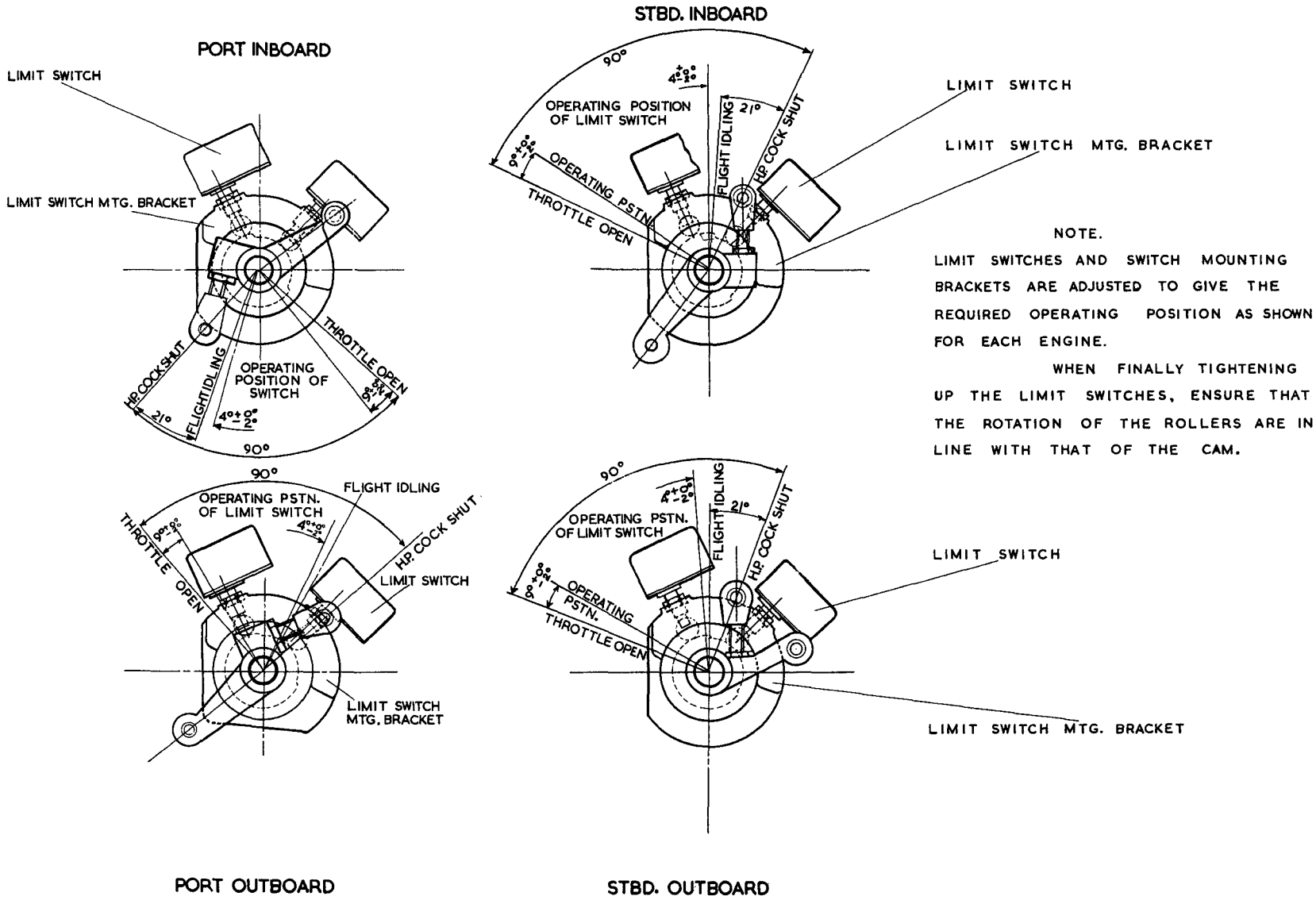


Fig. 4 Limit switch adjustments

bracket and are operated by the shouldered cam attached to the assembly spindle. The switches are operated to alter the supplies to the servo-motors when the throttles are at either extremity of the throttle gate (para.43). The switches can be adjusted as detailed in para.131 to give the required operating positions as shown in fig.4.

Junction box, Type B

55. The junction box, Type B, is an integral part of the rack mounting, Type A, which contains the control unit, integrator unit and the amplifiers. These units are connected into the junction box by means of multipole plugs, mounted on the rear of each unit, which 'mate' with the sockets fitted on the junction box face. The junction box is the main interconnecting unit for the installation which interconnects and distributes both the control signals and power supplies to the appropriate units, via the fourteen multipole plugs and sockets mounted on top of the box.

Supplies and control

56. Reference to fig.8 will show that the installation is fed with two supplies, one of 200-volt, 3-phase, 400 c/s and one of 28-volt d.c. The 200-volt a.c. supply is connected from fuses 196R, Y and B in panel 27P, via pins A, C and F of plug AT11, to the junction box, Type B. The 28-volt, d.c. supply is connected from fuses 545, 652, 672, 976 and 977 which are located in panel 3P. These supplies, which are used chiefly for switching purposes, are fed into the junction box for distribution to the appropriate units.

Power supply switch

57. Located on a small panel fitted at the A.E.O.'s station is a two pole ON-OFF switch. The switch, labelled AUTO. THR. POWER SUPPLY SW., connects a 28-volt d.c. supply from fuses 976 and 977, via pins F and L of plug 103 and pin A of plugs AT12 and AT15, to the junction box, Type B. The supplies are then fed, via the respective plugs and sockets, to energise the switching relays in the appropriate units. The contacts of these relays connect the supplies of 200-volt a.c. and 28-volt d.c. to the auto-throttle system in readiness for subsequent engagement.

System engage switch

58. Fitted on the stbd. side of the throttle box is a two-pole push switch, labelled A/T SYSTEM ENGAGE SWITCH. The switch is so positioned that it cannot be operated unless the throttle friction is released. With the datum airspeed selected and the power supply switch ON, depression of the A/T SYSTEM ENGAGE SWITCH connects a 28-volt d.c. supply from fuses 976 and 977 to energise the control relays in the various units. The energising of these relays connects the prepared supplies (para.57) to the auto-throttle system which becomes operative and maintains the speed of the aircraft at the datum airspeed shown on the airspeed detector veeder counter.

Datum airspeed

59. The datum airspeed is the pre-set speed at which the aircraft is required to fly when the auto-throttle system is engaged. Should the aircraft deviate from this speed, the auto-throttle installation applies throttle movement in the appropriate direction to maintain the speed of the aircraft at the datum airspeed.

60. The datum airspeed is selected by manually adjusting the throttles until the required speed is shown on the airspeed detector veeder counter. With the power supply switch ON, depression of the A/T SYSTEM ENGAGE SWITCH engages the auto-throttle system as detailed in para.58.

61. The reading on the veeder counter and A.S.I. should be identical. If, however, there is a discrepancy between the two readings, the veeder counter can be adjusted to read the same as the A.S.I. by operating the datum setting knob as detailed in para.46. Adjustment of the datum airspeed automatically adjusts the throttle accordingly (para.58).

System release switches

62. The throttles can be disengaged simultaneously, individually, or when autoland has been primed, in conjunction with the autopilot.

63. The throttles are released simultaneously by momentarily depressing either one of the system release switches, located one on each auto-throttle control lever. Depression of one of these switches connects a 28-volt supply, from fuse 545 or 652, to energise relay 250 or 251. With either of these relays energised, the hold-in circuits to the switching relays (para.57) will be broken and the supplies to the installation will be isolated. The pilot can then resume manual control of the throttles.

64. Each throttle can be released individually by depressing the appropriate re-light switch recessed into the top of each throttle lever. Depression of any one of these switches energises the respective re-light relay which isolates the supply to the appropriate throttle servo-motor. The supplies are isolated by the following relays:-

Throttle No.	Relay No.
1	185
2	186
3	187
4	188

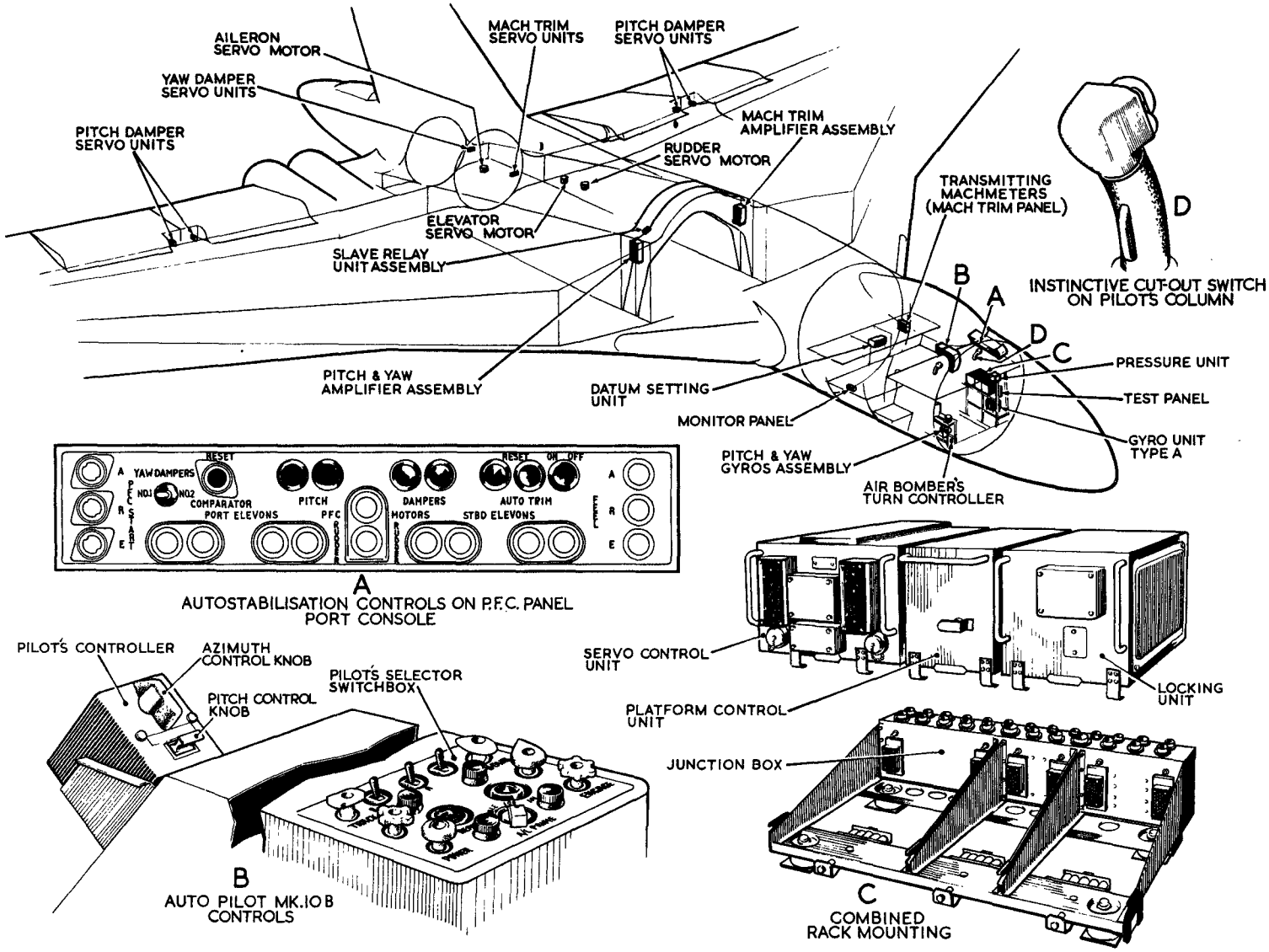


Fig. 5 Location of autocontrols.

Further details of the re-light relays are contained in Book 2, Sect.6, Chap.8, App.1, of this publication.

65. The throttles can be disengaged simultaneously with the disengagement of the autopilot (para.20). Operation of the autopilot cut-out switch disconnects the supplies to the switching relays in the appropriate units, which in turn disconnect the a.c. and d.c. supplies to the auto-throttle system. This action enables the pilot to take over manual control of the throttles.

Comparator warning lamps

66. The comparator warning lamps, which are illuminated under the conditions detailed in para.51, are supplied from the aircraft 28-volt d.c. system via fuse 672 in panel 3P.

AUTOPILOT MK.10B INSTALLATION

General

67. The autopilot Mk.10B is a development of the autopilot Mk.10A. The installation is designed to utilise I.L.S., Leader Cable and Radio Altimeter signals to provide an automatic landing facility, in addition to the facilities provided by the autopilot Mk.10A. The autopilot Mk.10B operates on the 'rate-rate' principle and provides 'long' and 'short' term stabilisation in the roll, pitch and yaw axes.

68. Short term stabilisation in the roll, pitch and yaw channels is provided by three 'rate-of-turn-signalling' gyroscopes. Long term stabilisation in the pitch and yaw channels is provided by two monitors of the 'signalling pendulum' type. Long term stabilisation in the roll axis is derived from the M.F.S. compass system.

69. The rate gyro and monitor signals are shaped and amplified to operate the electric servo-motors which in turn actuate the three aircraft control surfaces. The three rate gyros are mounted on a gyro platform which can be rotated in the pitch and roll axis to produce aircraft manoeuvres with respect to these axes.

70. The principle of 'aileron steering' is employed to control the aircraft in azimuth. In this method, the heading of the aircraft is controlled by the application of aileron only. The rudder is used solely to damp short period yaw instability, and, for the longer term, to suppress side slip.

Facilities

71. The autopilot Mk.10B provides twelve facilities as follows:-

(1) The short term stabilisation of the aircraft in the roll, pitch or yaw axis. Deviations from a desired flight path are automatically corrected, with a critically damped subsidence, to bring the aircraft back to the desired flight path.

(2) The long term maintenance of a desired aircraft attitude in yaw, roll and pitch.

(3) The manoeuvring of the aircraft in pitch and roll by the human pilot with the minimum of physical effort.

(4) To maintain the aircraft at any selected barometric height.

(5) To maintain the aircraft at any selected indicated airspeed.

(6) To maintain the aircraft on any desired magnetic heading.

(7) The automatic execution of co-ordinated turns.

(8) The complete compatability with the M.F.S. by which the autopilot may be monitored at all times.

(9) The control and stabilisation of the aircraft during bombing operations.

(10) The automatic subsidence on to, and consequent holding of, the localiser and glidepath beams of an I.L.S. system.

(11) To facilitate automatic landing of the aircraft under I.L.S. Leader cable and Radio altimeter control.

(12) To enable the altitude and airspeed locks to be used independently of each other.

It will readily be seen from the sub-para. above, that the facilities provided by the autopilot Mk.10B are similar to those provided by the autopilot Mk.10A with the exception of the long and short term system of stabilisation, and the automatic landing. As a detailed description of the autopilot Mk.10A is provided in Chap.6., this chapter will only contain information on those facilities which are not provided by the Autopilot Mk.10A.

72. The units comprising the autopilot Mk.10B are similar to those which comprise the Mk.10A autopilot. Reference to Table 3 will show that the items marked with an asterisk are fitted only in the Mk.10B installation. The unmarked items of Table 3 are fitted in both the Mk.10A and 10B systems. The marked items only are described in this chapter.

CONTROL AND UNIT LOCATION

73. Reference to fig.5 will show that most of the autopilot units are contained in the combined rack assembly located under the first pilot's floor. Other units are mounted individually nearby. The controller, selector and cut-out switches

are installed at the pilot's station, whilst the servo-motors are fitted in the bomb bay and aft power compartment. A circuit diagram is given in fig.6 and the relevant routing chart is contained in fig.9.

Pilot's selector, Type B

74. The pilot's selector switch box is mounted on the aft end of the retractable centre console 5P as shown in fig.5. In addition to the switches detailed in Chap.6, the selector fitted in the autopilot Mk.10B installation contains a two position switch labelled A/L PRIME. The two positions are annotated L/CABLE and LOC.

75. At the commencement of an I.L.S. approach (the Glide phase of an automatic landing), the switch is operated to the LOC position. This actuates the autopilot to lock the aircraft on to the I.L.S. localiser (azimuth) and glidepath (pitch) radio signals. These signals guide the aircraft during the whole of the Glide phase.

76. On completion of the Glide phase the switch is operated to the L/CABLE position. This action substitutes the leader cable signal in lieu of the localiser signal to the azimuth channel of the autopilot (para.107).

Locking unit, Type F

77. The locking unit is located on the combined rack assembly located under the pilots' floor. In addition to those components described in Chap.6, the locking unit contains a multi-contact ledex switch which is operated by signals from the Radio altimeter installation (Sect.8, Chap.7). The switch is used to initiate the various phases of an automatic landing. The amplifiers contained in the locking unit utilise both localiser and leader cable signals (azimuth), together with glidepath and radio altimeter signals (pitch), for guidance control during an I.L.S. approach and automatic landing.

Platform control unit, Type B

78. The platform control unit is mounted alongside the locking unit on the combined rack assembly. In addition to the functions detailed in Sect.7, Chap.6, the platform control unit, Type B, produces a signal which is used to operate the ledex switch (para.77), which in turn will isolate the pitch integrator unit during the Attitude phase of an automatic landing. This action renders the pilot's and bomber's controllers (Chap.6) inoperative.

Servo control unit, Type D

79. The servo control unit contains four high gain amplifiers, one each for the aileron, elevator and rudder channels, and one for the roll error cut-out circuit. When Mod.1512 is embodied, the servo-control unit embodies Smiths Mod.AP/E156.

Junction box, Type F

80. The junction box, Type F, is an integral part of the combined rack assembly which contains the platform control unit, the servo control unit and the locking unit. The junction box carries six Cannon plugs, to which the above three units connect, and 25 miniature Mk.4 connectors which serve to connect the three units to the other components comprising the installation. When fitted in the autopilot Mk.10B system, the interior of the junction box is re-wired to accommodate the three modified units.

Gyro unit, Type A or B

81. The gyro unit is mounted on the port side of the aircraft, under the first pilot's floor, and contains the three 'short term' disturbance detecting gyros. Also mounted on the platform is the 'long term' pitch monitor and a mercury switch, both of which respond to aircraft displacement in the pitch axis. The mercury switch is also used to keep the platform level when the autopilot is switched on but disconnected.

Servo-motors

82. The servo-motors, which are described in Chap.6, are mounted in the bomb bay and aft power compartment. Each servo-motor contains an integrally coupled a.c. tacho-generator which produces a signal, proportional in amplitude, to the rate of control surface application. The elevator and aileron servo-motors, Type A and C, are used in both the Mk.10A and Mk.10B installations, the rudder servo-motor, however, is changed from a Type C, to a Type B, in order to provide the increased rudder authority required to perform the kick-off-drift manoeuvre during the Flare phase of an automatic landing.

Autoland test meter

83. Located on the A.E.O's instrument panel is the autoland test meter (fig.1). The test meter, which is operated by the A.E.O. immediately prior to committing the aircraft to an automatic landing, is used to check the functioning of the kick-off-drift amplifier and the flare-out integrator sections of the locking unit.

84. The instrument consists of a 'centre zero' moving coil meter movement. Located on the front panel are two switches, one labelled TEST, the other labelled SENSE. Each switch has three positions which are annotated as follows:-

SENSE switch
- O - Off
- NDL - Nose down left
- NUR - Nose up right

TEST switch
- OFF - Off
- FO - Flare out
- KOD - Kick-off-drift

Operation

85. The functional checks detailed in para.83 are carried out by operating the SENSE and TEST switches as follows:-

(1) With the TEST switch set to FO

and the SENSE switch set to NU, the meter pointer should rise slowly to mid-scale on the right. When the SENSE switch is set to ND there should be no indication on the meter.

(2) With the TEST switch set to KOD and the SENSE switch set to ND, the meter pointer should initially rise to the left full-scale mark and then slowly drop back and remain at mid-scale. The check is repeated with the SENSE switch set to NU and the meter pointer should deflect fully to the right and then settle on the right mid-scale mark.

Satisfactory results from these checks ensure that the equipment is functioning correctly. Erratic behaviour of the meter pointer is indicative of equipment malfunction in the locking unit. It should be noted that when check (1) is carried out, the overshoot lamp on the combined autoland phase and altitude indicator (refer to Sect.8, Chap.7 of this book) will be lit, this is normal.

PRINCIPLE OF OPERATION

86. As previously mentioned in para.67, the autopilot provides long and short term stabilisation. The following para. contain a brief description of each term, together with information on the operation of the autoland sequence, and details of the bombing manoeuvres and the datum airspeed lock.

Short term stabilisation

87. Short term stabilisation in the roll, pitch and yaw axes is provided by a combination of the rate-gyro signals (para.81) and the tacho-generator signals (para.82), being added together and amplified to drive the servo-motors.

88. The gyro signal is shaped (para.90) and added to the tacho-generator signal, their algebraic sum being fed to the appropriate servo amplifier (para.79). In such a system it is arranged that the two signals are of opposite polarities and therefore tend to balance each other out. Consequently, when the two signals are added together, the resultant signal is proportional to the rate of change of aircraft attitude. The signal is amplified to drive the servo-motors which apply control surface movement at the same rate but in opposite direction to the aircraft change of attitude.

89. Should the aircraft deviate from the desired flight path the control surfaces are made to operate to bring the aircraft back on the original flight path. The control surface angle progressively diminishes as the aircraft error is corrected, and reduces to neutral when the recovery is complete.

Roll and pitch axes

90. In the roll and pitch axes the gyro signals are 'shaped' by having part of their signals passed through a passive differentiating network, the resultant derivative being added to the original signal. Shaping of the gyro signals provide enchanced short period damping.

91. In the yaw channel, the whole of the signal is passed through a differentiating amplifier and only the derivative is used to control the rudder.

Roll and yaw axes

92. Signals from the roll and yaw axes gyros are added algebraically and fed to the roll servo channel. In the event of a yaw disturbance, aileron control surface is applied, at a rate proportional to the aircraft rate of yaw, and the aircraft commences to roll. The roll gyro senses the roll and produces a signal proportional to this rate of roll.

93. The roll and yaw gyro signals are of opposite polarities and tend to cancel each other out. In consequence, the aileron angle commences to move progressively and comes to rest when the two signals are equal, i.e., no derivative. At this point, the bank angle of the aircraft is equal to the yaw disturbance and the control surface is neutral.

94. Side slip now occurs and the directional stability of the aircraft, aided to some extent by the action of the rudder channel, gives rise to a yawing movement which brings the aircraft back on to its original heading. This results in aileron surface movement which takes off the aircraft bank angle. As the aircraft commences to roll off the bank, the aileron angle is progressively reduced until the aircraft is re-established on its original heading, when the aileron angle is reduced to zero.

NOTE ...

Cross-feed is also used to maintain the aircraft wings level during the kick-off-drift manoeuvre carried out during the Flare phase of an automatic landing.

Long term stabilisation

95. Long term stabilisation is derived, in the pitch and yaw axes, from signalling pendulum type monitors, and in the roll axis, from the M.F.S. compass system. The monitors are described in Sect.7, Chap.6 and the M.F.S. compass system in Sect.7, Chap.7 of this book.

Pitch axis

96. The pitch axis monitor is mounted on the gyro unit platform (para.81), longitudinal to the aircraft line of flight. The monitor provides signals which are proportional in amplitude to the aircraft's pitch attitude relative to the plane of the earth over which the aircraft is flying. The signal is shaped (para.90), and fed to the elevator amplifier in the servo control unit, where it is amplified to drive the servo-motor. In this channel a rate of elevator movement is applied, which is

proportional to the rate of change of pitch attitude. This elevator movement acts to reduce the pitch deviation to zero, when the elevator angle is neutral.

Yaw axis

97. The yaw axis monitor, which is located under the second pilot's floor between formers 358 and 372, is mounted across the aircraft line of flight. The monitor provides signals, proportional in amplitude to the aircraft deviation from a plane which is vertical to the plane of the earth and longitudinal relative to the true track. This signal is fed unshaped to the rudder channel servo amplifier where it is amplified to drive the servo-motor. In this channel the rate of applied rudder is proportional to the rate of side slip and the rudder movement acts to reduce the side slip to zero.

Roll axis

98. Gradual deviation from the aircraft magnetic heading is detected by the M.F.S. compass monitor (Sect.7, Chap.7) which produces a signal proportional to the deviation. The signal is shaped and fed into the aileron channel servo amplifier where it is amplified to drive the servo-motor. The resultant aileron movement causes the aircraft to bank, and thereby turn it back on to its original heading.

Control of bombing manoeuvres

99. The aircraft can be guided along a pre-determined track for a bombing run, by signal, from either the bomb aimers controller or the N.B.C., operating through the autopilot. Bank angle and rate of turn are proportional to signal amplitude. Further details of the bombing manoeuvres are contained in Sect.7, Chap.6, of this book.

Bomb door compensation

100. Opening the bomb doors causes extra drag on the aircraft fuselage resulting in a nose-down pitch error. Provision has been made in the autopilot and aircraft wiring for compensating signals to be applied to the elevator servo channel, and also disconnection of the pitch monitor, which results in elevator movement. This movement corrects the aircraft trim so that steady flight is maintained. Compensation is not applied once the doors are fully open or whilst they are closing. A test socket labelled BOMB DOOR TEST, is fitted on the autopilot test panel (para.117) and is used to inject signals into the autopilot to simulate the opening and fully opened positions of the bomb doors during servicing periods.

Operation

101. As the bomb doors begin to open, a 28-volt d.c. supply appears on pin C of plug R13 of the autopilot junction box (fig.9). This supply, derived from fuse 480 via the bomb door (closed) micro switches (see Sect.6, Chap.19), is used to inhibit the compensation signals applied to the elevator channel. When the bomb doors are fully open, a 28-volt d.c. supply appears on pin B of plug R13. This supply, derived from fuse 481 via the bomb door (open) micro switches, is used to reset the system. Full details of the bomb door compensation are contained in A.P.1469EB, Vol.1, Book 1.

101A. On certain Free Fall aircraft (Mod.1173) the 28-volt d.c. supply on pin B of plug R13 is derived from fuse 486 (see fig.10 and Sect.6, Chap.19). For Blue Steel aircraft (Mod.748) a supply is not required for pin B and the associated cable is not connected as shown in fig.10.

Automatic landing

102. As previously stated the automatic landing is divided into five phases during which the autopilot receives signals from the I.L.S., radio altimeter and leader cable installations. The five phases of autoland are as follows:-

Phase 1	Glide
Phase 2	Leader cable
Phase 3	Attitude
Phase 4	Flare
Phase 5	Land

Each phase is shown on the phase ring of the combined autoland phase and altitude indicator, which is an integral part of the FM radio altimeter Mk.7 installation (Sect.8, Chap.7). During an automatic landing, the aircraft speed is controlled by the auto-throttle system.

Glide phase

103. With the autopilot engaged in 'track' and the M.F.S. set to 'localiser' the heading index of the beam compass system is set to the O.D.M. of the runway. The error between the aircraft's actual heading and the Q.D.M. is fed to the roll platform system, together with the localiser radio signal. The two signals are of opposite polarities and hence tend to balance. The resultant signal is amplified to drive the servo-motor which operates the aileron surfaces. To some extent the rudder surface is also operated due to cross-feed between the aileron and rudder channels. Operation of the ailerons in this manner ensures that the aircraft approaches the localiser beam centre line along a straight course and at a pre-determined angle of approach.

104. The localiser signal is received by the I.L.S. receiver (Sect.8, Chap.6) where it is amplified and then fed, via the navigators computor unit (Sect.7, Chap.7), to the aileron channel servo amplifier. The signal is also connected to the beam bars in the M.F.S. beam compasses which show a visual display when the aircraft enters the localiser beam.

105. For control along the glidepath, a signal, proportional to the aircraft displacement from the glidepath centre line, is used to control the pitch platform. Signals produced by the pitch platform are amplified to drive the servo-motor which operates the elevators accordingly. Thus the pitch attitude is held constant as the aircraft descends along the glidepath.

106. The signal used to control the pitch platform is obtained from the I.L.S. glidepath receiver (Sect.8, Chap.6), and is fed to the elevator servo amplifier via the navigators computor unit. The signal is also fed to the M.F.S. director horizon which shows a visual display when the aircraft enters the glidepath beam.

Leader cable phase

107. Operation of the PRIME switch (para.74) to the L/CABLE position immediately initiates the leader cable phase. However, the I.L.S. localiser signal will remain connected to the aileron channel until the leader cable signal is of sufficient amplitude to produce an A.G.C. voltage which in turn operates a ledex switch in the locking unit. Operation of this switch connects the leader cable signal to the aileron channel in lieu of the localiser signal. With this more precise azimuth information the ailerons will reduce any lateral error before the aircraft touches down on the runway.

108. The leader cable signal is produced in the leader cable receiver, where it is amplified and fed to the aileron servo channel via the navigator's computor unit. The signal is also fed to the M.F.S. beam compasses.

109. During the leader cable phase, pitch guidance is obtained from the I.L.S. glide path signals as detailed in para.105 and 106.

Attitude phase

110. The attitude phase is initiated automatically when the radio altimeter signal (Sect.8, Chap.7) reaches a pre-determined level. The signal operates a ledex switch in the locking unit which removes the glidepath signal from the elevator channel and substitutes the radio altimeter signal. However, the radio altimeter signal is not yet used as the aircraft is not yet over the level runway, so the rate of descent is held constant at a value averaged during the whole approach to this stage. During the attitude phase, the aircraft is controlled in azimuth by the leader cable signals as detailed in para.107.

Flare phase

111. The flare phase is initiated in the same manner as the attitude phase, i.e., by signals from the radio altimeter. The vertical guidance signal, which is proportional in amplitude to the aircraft height above ground, is developed in the radio altimeter receiver and fed, via plug R16 (fig.9) to the pitch control system. With this more precise pitch information, the elevators will act to reduce the rate-of-descent to approx. 2 ft./sec. Azimuth guidance is still controlled by the leader cable signals.

112. During the flare phase the throttles are moved steadily back to the ground idling position to ensure that when the aircraft touches down, the engines are running at flight idling speed. A signal is fed from the locking unit, via the ledex switch, to the amplifiers in the throttle system, where it is amplified to operate the servo motors which act to move the throttles back to the idling position.

Land phase

113. The land phase is initiated in the same manner as the two preceding phases. During this last phase, signals from the leader cable installation are fed to the rudder channel servo amplifier where they are amplified to drive the rudder servo-motor. Throughout the land phase the aircraft is controlled in pitch by signals from the radio altimeter (para.111).

Datum airspeed lock

114. The datum airspeed is the controlled speed at which the aircraft is required to fly during an automatic approach. The speed which is selected as detailed in para.59 is controlled by a combination of pitch attitude error and airspeed error signals. When the auto-throttle system is engaged, the hold-in supply to the ALT/IAS switch is isolated. Conversely, when the ALT/IAS switch is pulled to the ON position, the d.c. supplies to the auto-throttle system are isolated.

Safety arrangements

115. The safety arrangements for the autopilot Mk.10B are described in Sect.7, Chap.6. It should be noted, however, that with both the autopilot and auto-throttle systems engaged, operation of either the spring strut, or the pilot's cut-out switches, disengages both systems. As a requirement of Mod.1856, it is necessary, when the aircraft enters the attitude phase of an automatic landing, to bias the artificial feel system as described in para.119, and also override all safety devices. This action is controlled by relay 722 which is energised when attitude is signalled to the combined auto-land phase/altimeter indicator. With reference to fig.6 it will be seen that when relay 722 is energised contacts 722/1 and 6 open to isolate the aileron and rudder artificial feel from the autopilot and thereby alter the aileron and rudder feel bias as described in para.121 and 124 respectively. Contacts 722/3 open and contacts 722/2 close to isolate the spring strut cut-out as described in para. 123. Contacts 722/4 open, which in turn changes the artificial feel dolls-eye indication to that described in para. 125 (4). Contacts 722/5 close to provide a d.c. signal at test socket 1197 pin F. When Mod.1545 is embodied, the pilot's control columns, Type AC.14256, are replaced by control columns, Type AC.61320, which contain cut-out switches that require a conscious action to operate. The switches are fitted to prevent inadvertent cut-out of the autopilot.

Power supplies

116. Supplies for the autopilot are fed to the rack mounting junction box, the supplies being finally fed to the various units via the cannon plugs and Mk.4 connectors. A full description of the power supplies connected to plug 10 of the autopilot rack mounting, together with information concerning the operation of the torque switch, is contained in Chap.6 to which reference should be made. It should be noted, however, that the 115-

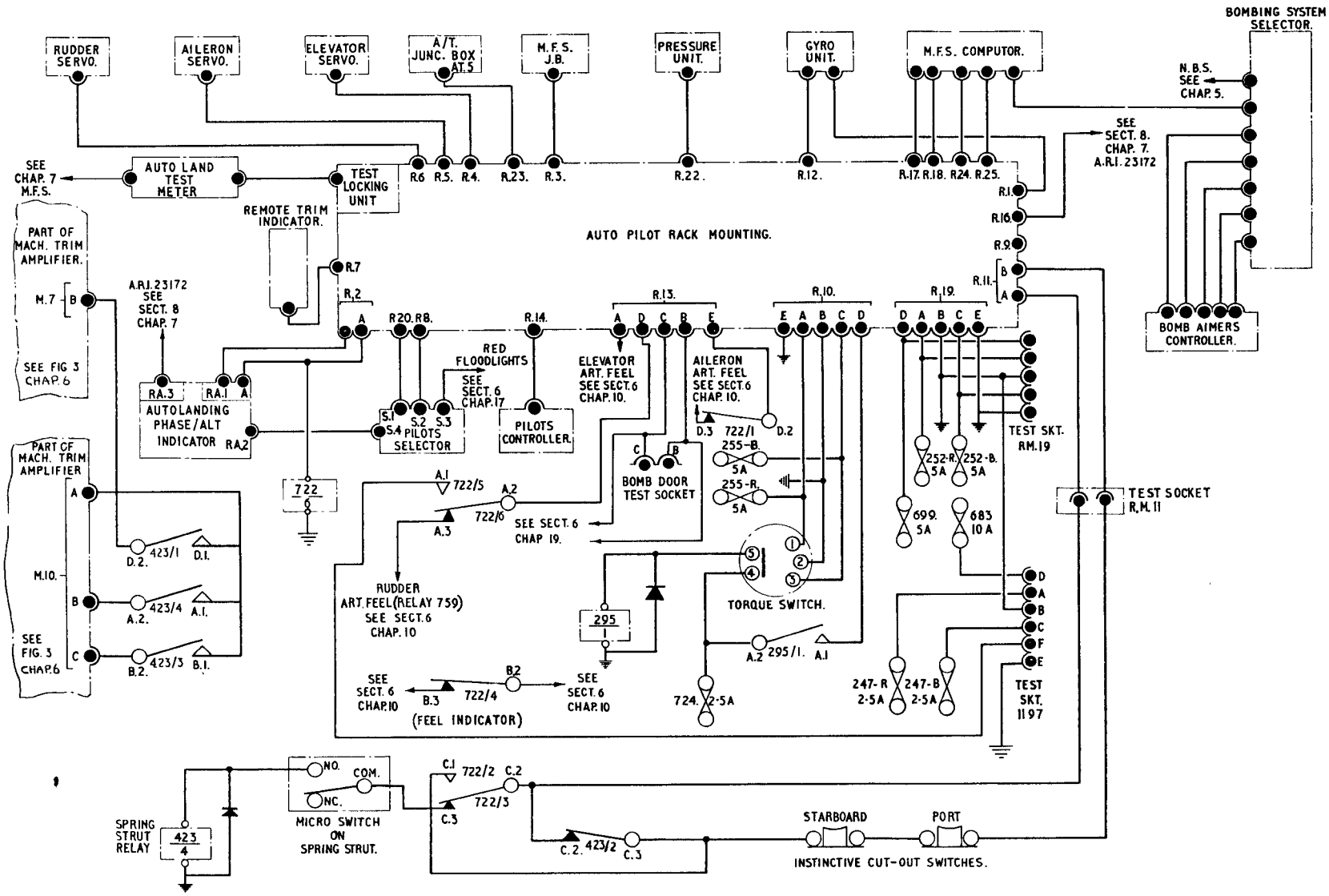


Fig. 6 Auto-pilot Mk.10B circuit diagram

◄ Mod. 2082 embodied ►

volt, a.c. supplies to plug 19 pins A and C of the rack mounting are now fed via fuses 252R and B (Mod.1581). All power supplies are shown on the routing chart, fig.9.

Test panel

117. A test panel, fitted with five test sockets, is located on the forward member of the crate situated under the first pilot's floor. The panel test sockets are labelled as follows:-

A.P.-RM11	-	Used to check the autopilot cut-out circuits.
A.P.-RM19	-	Used to check the a.c. and d.c. supplies connected to plug 19 on the autopilot rack mounting.
A.P. BOMB DOOR TEST	-	Described in para. 100.
1196 test socket	-	Used to connect simulated airspeed error signals when ground testing the autothrottle system (fig.8).
AUTOTHROTTLE TEST SUPPLY 1197	-	Used to connect a.c. and d.c. supplies to test equipment from a.c. fuses 247R and B and d.c. fuse 683 (fig.9).

ARTIFICIAL FEEL SYSTEM

118. The mechanical and electrical aspects of the artificial feel system are described in detail in Book 1, Sect.3, Chap.4 and Book 2, Sect.6, Chap.10 respectively. The following paragraphs contain information on the implications in the feel system when operating during an automatic landing.

General

119. In order to cover the performance and safety aspects of the Mk.10B autopilot in its autoland function, it is necessary to bias the artificial feel forces, in all three axes, at various stages in the automatic landing sequence. The following paragraphs outline the changes made to each of the aileron, elevator and rudder feel systems.

Aileron feel

120. In normal flight, with the aileron channel engaged, the available aileron angle is reduced to between 4.5 and 5 deg. This is achieved by running the feel actuator to the high speed (fully extended) position. Under I.L.S. approach conditions, the available aileron angle is increased to approximately 6.5 deg. This is achieved by biasing the feel system on selection of the LOC & GP position on the M.F.S. and engagement of TRACK on the autopilot.

121. On commencement of the attitude phase during an automatic landing, the full normal aileron range of 12.5 deg. is restored. This is achieved by retracting the actuator to the slow speed (fully retracted) position when attitude is signalled to the autoland phase indicator.

Elevator feel

122. In normal flight, with the elevator channel engaged, there are no changes made to the elevator feel system, i.e., full elevator angle is available. However, under I.L.S. approach conditions, the feel forces are reduced to give increased servo authority. Selection of the LOC & GP position on the M.F.S. and engagement of TRACK on the autopilot, causes the elevator feel actuator to extend by a fixed amount to give a partial feel relief.

123. At the start of the attitude phase the spring strut cut-out switch is bypassed allowing more than twice the normal elevator servo authority. This occurs when attitude is signalled to the autoland phase indicator.

Rudder feel

124. In order to provide autopilot runaway safety during normal flight, the rudder forces opposing the autopilot are increased by 50%. This opposition to the autopilot is applied when the rudder channel is engaged. On commencement of the attitude phase, normal feel is restored resulting in 50% increase in rudder authority. This increased authority is required to perform the kick-off-drift maneouvre during the flare phase of an automatic landing.

Warning indicator

125. The various functions of the autopilot system are shown by the artificial feel dolls-eye indicator, which is located on the pilots' centre instrument panel. The indicator has three positions BLACK/WHITE/I.L.S. and normal indication for the following functions is as follows:-

(1)	Autopilot all channels engaged	- BLACK
(2)	Rudder disengaged	- Immediate White
(3)	Aileron disengaged	- Black for 10 sec. then White
(4)	All disengaged	- I.L.S. for 10 sec. then Black
(5)	LOC.parameters engaged	- I.L.S. indicated
(6)	'Attitude' phase selected	- I.L.S. remains (no indication).

Failures in the system will normally show a white display, but certain exceptions are unavoidable, Table 4 contains these exceptions.

Precautions

126. Service personnel in particular are warned that a.c. and d.c. voltages in excess of 100 volts can be dangerous to the extent of causing personal injury, fatal or otherwise. It is essential that the utmost attention is given to servicing instructions where matters of safety are concerned and that maximum co-operation is maintained between tradesmen mutually concerned in servicing operations.

LEADER CABLE INSTALLATION (A.R.I.23063)

127. The setting up, operating and servicing instructions for the A.R.I.23063 and its components are contained in A.P.2534Q, Vol.1. The security of all components should be checked regularly. All connectors, plugs, sockets and terminal blocks should be examined for damage and ingress of dirt and moisture.

Aerial assembly, Type 16050

128. With a suitable pressure gauge, check that the internal pressure of the aerial assembly is 5 p.s.i. above atmospheric. Located on top of the unit is a schrader valve, which is provided to renew the pressure by means of a hand pump should the pressure fall below 20 p.s.i. The hand pump should incorporate a desiccator unit.

Functional check

129. The A.R.I.23063 is so designed, that it requires the minimum of testing. Hence the following functional check is all that is required to ensure satisfactory operation of the installation. The test should be carried out at those periods laid down in A.P.4505B, Vol.4. With ground supplies of 28-volt d.c. and 200-volt, 3-phase, 400 c/s connected to the aircraft system, proceed as follows:-

(1) Check that the EXT. LOAD switch located on the junction box, Type 16049, is set at position A.

(2) At the control unit, Type 16051, switch the POWER-ON switch to the ON position and check that the magnetic indicator shows diagonal stripes after a short delay (20-30 secs.).

(3) Operate the TEST switch alternately left (L) and right (R), checking that the meter pointer deflects left and right respectively within the white sectors of the meter dial and also that the magnetic indicator changes to full white.

NOTE...
If the meter readings appear unstable, or beat steadily when the TEST switch is held at either the left or right position, it is indicative of external interference and the test should be carried out as detailed in (4) below.

(4) Under interference conditions an electromagnetic shield, Ref. No.10AL/2289, is placed over the nylon cover of the loop aerial assembly. The test at (3) is repeated and the meter pointer should read left and right respectively within the green bands of the meter dial.

With satisfactory results from the above tests the POWER-ON switch is operated to the POWER position and the ground supplies are disconnected from the aircraft. It should be noted that the A.R.I.23063 is an integral part of the auto-landing system and the compatibility tests are contained in A.P.1469EB, Vol.1.

NOTE...
A test set, Type 12968, is available whereby the major components of the installation can be bench tested and aligned correctly. Full details of this test set and the methods of using it will be found in A.F.2534Q, Vol.1, Part 2.

AUTO-THROTTLE INSTALLATION

130. Detailed information on the setting up, operating and servicing instructions for the auto-throttle system are given in A.P.1469EB, Vol.1. All components should be checked at regular intervals for security of connections. Plugs, sockets, connectors and terminal blocks should be checked for ingress of dirt and moisture.

Limit switches

131. The limit switches are secured to brackets by means of two lock-nuts, one above and one below the bracket surface. These lock-nuts allow the position of the micro-switches to be raised or lowered for adjustment purposes. The brackets containing the micro-switches are bolted to each limit switch assembly by three bolts. The securing bolt holes in the brackets are slotted to allow the micro-switches to be adjusted horizontally as required. Thus, by the combination of the vertical and horizontal adjustments, the micro-switches can be set to operate within the limits shown in fig.4.

Functional checks

132. These checks, which are performed without the use of test equipment, should be carried out at those periods laid down in A.P.4505B, Vol.4. It should be noted that the aircraft engines should not be running during these checks. With ground supplies of 28-volt d.c. and 200-volt, 3-phase 400 c/s connected to the aircraft system, proceed as follows:-

(1) Switch ON the autopilot power supplies, the auto-stabilisation system, the powered flying controls and the M.F.S. Check that the veeder counter, on the airspeed detector indicator, is obscured by the warning bar and that the INNERS and OUTERS engage flags show black.

(2) At the airspeed detector indicator, rotate without depressing, the datum setting knob in either direction and check that this rotation does not affect the veeder counter reading. Depress and turn the knob, checking that for clockwise rotation the counter reading increases and vice-versa. Set the counter to read about 10 knots.

(3) Switch ON the auto-throttle power supplies (para.57). Move all throttle levers to mid-way between the flight idle and fully open positions and check that:-

(a) Throttle movement is free and unrestricted.

(b) Both comparator warning lamps extinguish between 30-90 secs. after switching 'ON' the supplies.

(c) The INNERS and OUTERS engage flags on the airspeed detector indicator still show black.

(d) The filaments of the comparator warning lamps are serviceable by operating the press-to-test facility. Replace unserviceable filaments.

If the check at (3) (a) is unsatisfactory, ensure that the throttle friction lever, located on the port side of the throttle box, is at the 'off' position.

(4) Depress the A/T SYSTEM ENGAGE switch and check:-

(a) That the INNERS and OUTERS flags show IN.

(b) That the throttle servo-clutches engage (by pressing on the throttle levers).

(5) Move each throttle in turn forward and backward about one inch checking that the throttle servo-clutches can be slipped at a reasonable pressure and that the throttles remain stationary at their new positions.

(6) Press either system release switch, located one on each outer throttle, and check that all throttles become free and that the INNERS and OUTERS flags show black.

(7) Re-engage the system as in (4) and check that each throttle servo-clutch can be disengaged by momentarily depressing the appropriate re-light button, and that the remaining throttles remain engaged.

133. Re-engage the auto-throttles, pull ON the autopilot POWER switch and engage the elevator channel. Check that it is not possible to engage the autopilot I.A.S. lock when auto-throttle is engaged. Disengage the throttles by depressing either system switch and engage the I.A.S. lock. Check that it is not possible to re-engage auto-throttle.

134. Release the I.A.S. lock and re-engage auto-throttle. At each rate gyro, apply a nose-up pitch movement, by operating the test lever fitted to the assembly gyro. Check that the throttles move forward, and that after the initial movement, return slowly back to their original positions.

135. At the airspeed detector indicator, depress and turn the datum setting knob to increase the datum airspeed by 5 knots, i.e., to 15 knots, and check that the throttles open. As soon as throttle movement is apparent, return the datum airspeed to its original value and check that throttle movement ceases. Repeat the test for a reduction in airspeed, checking that the throttles close.

136. Switch the M.F.S. to GP and switch OUT the elevator channel. Engage autopilot and select TRACK and GLIDE, also PRIME L/CABLE or LOC and engage auto-throttle then wait for 20 secs. Check that pressing either one of the autopilot instinctive cut-out switches, located one on each control column, disengages the autopilot, and also pressing either auto-throttle release switch disengages the auto-throttle. If the result of this check is satisfactory push OFF the autopilot POWER switch.

137. On completion of the tests switch off, in sequence, the autopilot, power supplies, the auto-stabilisation system, and M.F.S. Disconnect the ground supplies from the aircraft and check that the flying controls and throttle levers have freedom of movement in all directions.

AUTOPILOT MK.10B INSTALLATION

General

138. Servicing of the fixed components of the autopilot consists of servicing by replacement. If a unit is suspected of being faulty, it should be removed and a serviceable replacement fitted in the aircraft. The unserviceable unit should then be returned to an authorised depot for repair. At regular intervals a check should be made on the connectors and cables for security, cleanliness and signs of damage.

139. In the paragraphs that follow, instructions will be found for pre-flight ground functioning of the autopilot system.

The instructions should be read in conjunction with A.P.1469EB, Vol.1, which contains detailed information on the initial installation and ground testing of the Mk.10B autopilot.

Functional checks

140. These checks are performed without the use of test equipment and should be carried out at those periods laid down in A.P.4505B, Vol.4. With ground supplies of 28-volt d.c. and 200-volt a.c. connected to the aircraft, proceed as follows:-

(1) Ensure that the flying controls are free and unobstructed.

(2) Switch on the 3kVA transformers by operating the two switches located on the secondary supplies panel (50P) at the A.E.O's station.

(3) Switch on the powered flying controls (P.F.C's) checking that each control is free from obstruction and has full range of movement.

(4) Trim to neutral the control surface position indicator.

141. Switch 'on' the autostabilisation system and pull the POWER switch to the ON position. The READY flag should appear within 60 ± 30 secs. The appearance of the READY flag indicates that the autopilot may be engaged as follows:-

(1) Set the three channel switches to IN and pull ON the ENGAGE switch. Check that the READY flag disappears, the IN flag appears and the artificial feel indicator (panel 1P), should remain BLACK.

(2) Select, in turn, each channel switch to the OUT position and check that:-

(a) The READY flag appears in addition to the IN flag.

(b) The associated P.F.C. becomes free while the others remain steady.

(c) Upon re-engagement the READY flag disappears.

(d) When the R channel is switched OUT the artificial feel indicator appears WHITE.

(e) When the A channel is switched OUT the artificial feel indicator gives a BLACK indication for approx. 10 secs. before turning WHITE.

(f) When the A and R channels are switched OUT simultaneously the artificial feel indicator gives an I.L.S. indication for approx. 10 secs. before turning BLACK.

142. Select feel relief at either pilot's control column, and cancel the resulting main warning. With the autopilot fully engaged check that each of the following operations causes the IN flag to disappear, the READY flag to appear and all P.F.C's become free:-

(1) Operate either pilot's cut-out switch located on the control columns.

(2) Set all three channel switches to the OUT position.

(3) Rotate the turn control fully clockwise or anti-clockwise. Recentralise the turn control.

142A. If the autopilot is not disengaged by the roll error cut-out in test 142(3) above, the following procedure should be carried out:-

(1) With the autopilot disengaged and the turn control in the centre position move control stick (aileron sense) fully one way and hold.

(2) Engage autopilot and slowly transfer load onto the aileron servo.

(3) Move turn control fully in the opposite sense and the autopilot should disengage. Centralise the turn control.

143. Re-engage the autopilot and apply a steadily increasing manual load (approximately 26lb.) in either direction, on the control column. Check that all three channels disengage, the ASTAB. indicator (centre instrument panel) shows WHITE and the main warning lamps are alight. Push the mach trim switch to OFF, press the comparator reset switch, and then set the mach trim switch to ON. Check that the ASTAB. indicator shows BLACK and the main warning lamps are extinguished.

144. Engage the autopilot and rotate the pilots' turn controller slowly clockwise and check that the control column also rotates clockwise accompanied by slow right rudder movement. Rotate the turn control slowly counter-clockwise and check that the control column rotates counter-clockwise accompanied by slow left rudder movement. Return the controller to the detent position. Repeat the above test using the bomb aimer's turn controller with the VISUAL/BLIND switch (bombing selector) set to VISUAL and the BOMB switch pulled ON.

NOTE...

As a roll error cut-out facility is fitted in the system, the required results will only be obtained by 'slow' movement of the controller. Rapid movement may cause total disengagement.

145. Move the pitch control fully forward and then fully backward, checking that the control column moves forward and backward respectively. Pull the ALT. switch ON and move the pitch controller

to 'fast rate' forward and backward, check that in both cases the ALT. switch is released to the OFF position. Push either control column forward for approx. 2 sec. Check that the remote trim indicator pointer deflects towards the nose of the silhouette aircraft. Pull the control column back checking that the pointer deflects towards the tail of the aircraft.

146. On completion of the tests detailed in para.145, disengage the autopilot, re-trim the flying controls to neutral, and then re-engage the autopilot.

147. If the control columns tend to drift, the heading monitor on the M.F.S. requires to be aligned. This is achieved as follows:-

(1) Switch OUT the aileron (A) channel, then set the port and starboard compass isolation switches to NORMAL. Wait for approximately two minutes for the compass system to warm up and stabilise.

(2) Set the M.F.S. selector switch to PORT and both annunciator switches to COMPASS. Switch IN the A channel.

(3) Adjust the synchronizing knob on the port annunciator until the control columns stop moving. Immediately switch OUT the A channel.

(4) Synchronize the port compass system.

(5) Set the M.F.S. selector to STARBOARD and re-engage channel A.

(6) Repeat the test at (3) on the starboard annunciator until the control columns stop moving. Immediately switch OUT channel A.

(7) Set the compass isolation switches to ISOLATE.

148. Re-engage the A channel and align the heading pointer of the starboard beam compass by operating the heading index. Switch out channels A and R and reset the aileron and elevator artificial feel systems. Check that the artificial feel flag indicator shows BLACK. Select GP on the M.F.S. selector and pull ON the autopilot TRACK switch. Check that the artificial feel flag indicator shows I.L.S. (See Note).

NOTE...
This test may result in an indication of elevator feel failure, due to the inability of the elevator feel unit to respond to bias demand at zero airspeed. Therefore it may be necessary to carry out this test with 140 knots simulated airspeed on both A.S.I. systems.

149. Pull the ALT. switch to ON and then pull the GLIDE switch to ON, the ALT. switch should release to OFF. Push the GLIDE switch to OFF. Pull I.A.S. switch to ON and then pull the GLIDE switch to ON, the I.A.S. switch should release to OFF.

149A. Switch out the E channel. Pull back the column to approx. half travel and re-select the E channel. Pull ON the GLIDE switch and check that the column moves forward to its normal position. Switch out the E channel.

150. The following compatability tests between the Mk.10B autopilot and the Radio Altimeter Mk.7, Leader Cable and the Autoland test meter are as follows:-

WARNING...
During tests involving Radio Altimeter interlocks with the autopilot, personnel should keep clear of the underside of the aircraft.

(1) Depress the test switch on the Radio Altimeter control unit and check that a reading of approx. 60ft. appears on the combined Radio Altimeter/Phase indicator.

(2) Operate the test switch on the Leader Cable control unit to the left and right and check that the dolls-eye indicator turns white, and that the meter pointer reads left and right from the centre position respectively.

(3) Switch to FO on the Autoland test meter and check that the overshoot warning lamp on the combined Radio Altimeter/Phase indicator is lit.

(4) Set the Radio Altimeter to the high range. Pull on L/C PRIME switch and check that the following occurs:-

(a) The Radio Altimeter changes to the low range. (See Note).

(b) The PRIME sector and the A.L.flag of the phase indicator appear.

(c) Check that the Radio Altimeter test and Leader Cable receiver tests are inhibited.

(d) Switching to FO does not light the overshoot warning lamp.

(5) Push off GLIDE and check that the L/C PRIME switch releases and cannot be held on.

NOTE...
In para.150, sub para.(4) (a), when the Radio Altimeter switches to the low range, it is possible for the autopilot to run through the complete autoland cycle. If this occurs, switch off the Radio Altimeter to carry out the tests in sub para. (4) (b) (c) and (d) and sub para. (5). This will result in an aileron feel warning and main warning,

which should be removed when the M.F.S. selector is set vertical (para. 150A).

150A. Re-engage GLIDE and PRIME LOC. Check that all segments of the phase indicator appear. Select the E channel IN, and by pulling on the control column, check that the spring strut cut-out is inoperative. Check that the GP flag holds down and the beam flag pulses. Check that right rudder is applied if the M.F.S. Beam Compass heading index is displaced clockwise. Repeat for opposite sense. Set the M.F.S. selector vertical and wait 10 seconds. Disengage the autopilot.

150B. On completion of the functional checks switch off in turn, the autopilot power supplies, the auto-stabilisation system, the M.F.S. and powered flying controls. Disconnect the ground supplies to the aircraft and ensure that the flying controls have freedom of movement in all directions.

Ground test procedure
Artificial feel system

151. The initial setting up procedure for the artificial feel system will be found in Book 2, Sect.6, Chap.10, of this publication. The following paragraphs contain the necessary instructions for setting up and testing the aileron, elevator and rudder feel system on autopilot Mk.10B control. The following equipment is required for these tests.

(1) Pitot pressure simulator rig.

(2) Two-foot rule.

Calibration of elevator servomotor authority

152. When the autopilot is used for auto-controlled I.L.S. approach, the authority of the elevator servo is increased by reducing the level of the artificial feel forces. The elevator feel warning circuit is biased correspondingly so that only the centre instrument panel "Feel" indicator gives indication of this change. The following test procedure checks the elevator servo authority in both normal and approach conditions.

(1) Disconnect the pitot piping from the elevator feel unit airspeed transmitter on the port side of the bomb bay and the associated pitot pipe from the elevator feel warning transmitter on the starboard side of the bomb bay.

(2) Connect a pitot pressure simulator rig to both transmitters simultaneously.

NOTE...
It is important to connect the rig to both transmitters simultaneously to prevent unbalancing the system.

(3) Ensure that the 200-volt a.c., and 28-volt d.c. ground supplies are connected.

(4) Switch ON the two 3 kVA transformers at panel 50P, A.E.O.'s. station.

(5) Ensure that the flying controls are free from obstruction.

(6) Check that the autopilot is disengaged and then trim the elevator into line with the inboard fixed trailing edge.

(7) Engage the autopilot and then trim the elevators until the remote trim indicator indicates zero load (see note (a)). Pull the pitch control backward to the "slow rate" position until the autopilot is disengaged by the operation of the spring strut cut-out. Measure the maximum deflection of the elevators between "zero load" and "cut-out" (see note (b)).

NOTE...
(a) It is important that when trimming the servomotor to zero load, the final movement of the pitch control must be in the same sense in which it is required to move the elevators in the tests which follow.

NOTE...
(b) When the autopilot is disengaged by the operation of the spring strut, the elevators will return to their trimmed position at high speed dictated by the recovery of the artificial feel unit. Care must, therefore, be taken when measuring the deflection of the elevators.

(8) Slowly increase the airspeed in the pitot pressure rig and (by listening at the A.F.U. for the first operation of the actuator) note the speed at which the elevator A.F.U. cuts-in. Refer this speed to the elevator movements measured at sub para.(7) above (i.e., record the servo authority at A.F.U. "cut-in" speed).

(9) Repeat the test in sub-para.(7) at simulated airspeeds of 120, 160 and 200 knots, taking care always to approach target-speed from below. Record the elevator movements and associated airspeeds.

(10) Decrease the airspeed to zero and repeat the tests in sub-para.(7) and (8) with the pitch control pushed forward to the "slow rate" position.

(11) Set potentiometer No.3 in panel 83P to its mid-position.

(12) Switch the M.F.S. selector to LOC. and G.P. engage the autopilot and pull "ON" the TRACK switch. Check that the artificial feel indicator shows I.L.S. (See note (a) below). Repeat the tests in sub-

◀ para.(7) to (10) at simulated airspeeds of 160, 180 and 200 knots.

NOTE . . .
Artificial feel failure warnings arising during these checks may be ignored.

(a) This test may result in an indication of elevator feel unit failure due to the inability of the feel unit to respond to bias demand at zero airspeed, but correct function should be obtained with 140 knots simulated airspeed on the system.

(13) Check that all the readings obtained in the above tests lie between the appropriate curves shown in fig.4A, Sect.7, Chap.6 of this book. If they do not proceed as in para.153.

153. If readings obtained from sub para. 152(7) to 152(10) do not lie within the appropriate tolerances, the fault lies either in the spring strut breakout load or in the artificial feel system. To determine where the fault is located proceed as follows:-

(1) The spring strut breakout load may be checked with a spring balance. The load to operate the micro switch should be 80 lb. ± 2 lb.

(2) If (1) above shows no fault in the strut, then the control circuit should be checked for excessive friction. It is essential that the breakout force at the control column does not exceed 9 lb.

(3) If the fault still persists, then the artificial feel system must be recalibrated and appropriate remedial action taken (Book 1, Sect.3, Chap.4).

(4) With satisfactory results from tests in para.152(7) to 152(10), if the results from tests in para. 152(12) do not lie within the appropriate range then the amount of artificial feel bias may be adjusted at potentiometer No.3 in panel 38P.

(5) Lock the adjustment on potentiometer No.3 in panel 83P.

Calibration of aileron range

154. Selection of the aileron channel engaged causes the A.F.U. to restrict aileron angle to ± 5 deg. and the aileron feel failure warning circuit to be inhibited. During auto I.L.S. approach the permitted aileron angle is increased to ± 6 deg., and the warning circuit is re-installed at the start of the "attitude" phase. All restrictions are removed to allow full aileron range of ± 12.5 deg. The following procedure governs the setting-up and checking arrangements.

NOTE . . .
This interconnection implies that the A.F.U. is exercised each time the autopilot is engaged or disengaged. Up to this stage of the tests this effect has been prevented by selection of feel relief, or by switching out the aileron channel, but from this point, the frequency of engage or disengage switching should be minimised to prevent needless wear and tear on the A.F.U. In any case a time of 10 seconds should be allowed to elapse between disengement and engagement.

(1) With the autopilot disengaged check that the elevons are trimmed in line with the inboard fixed trailing edge.

(2) In panel 83P, set potentiometer No.1 to its mid-travel position.

(3) With the aileron and rudder channels switched OUT, engage the autopilot and check that the feel indicator on the centre instrument panel shows BLACK.

(4) Switch IN the aileron channel and ensure that:-

(a) The feel indicator shows WHITE, but no main warning occurs.

(b) The aileron A.F.U. has moved to its high speed condition (i.e., stop clearance reduced to 0.2 in. approx).

(5) Select the roll error cut-out switch on the test set to INHIBIT. Move the turn control a small amount clockwise and measure the maximum control surface movement. This should be 5 deg. – 0.5 deg. + 1.5 deg. (i.e. 7.75 in. – 0.75 in. + 2.25 in. at the fixed inboard trailing edge). If these movements are not correct the feel system is at fault and reference should be made to Book 1, Sect.3, Chap.4 for remedial action. Re-centre the turn control.

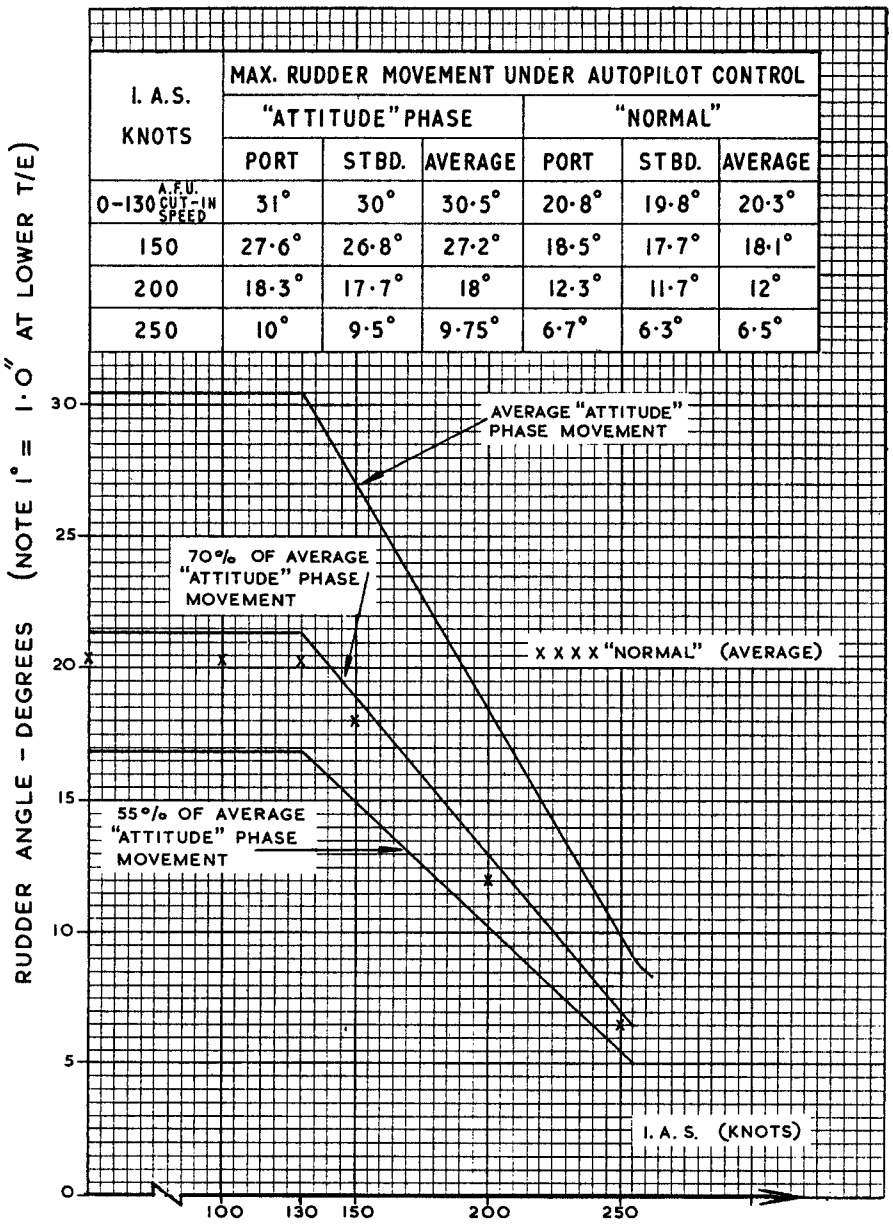
(6) With the M.F.S. selector at LOC. and G.P. pull ON the TRACK switch. The A.F.U. stops should open out by approximately 0.08 in.

(7) Move the compass setting knob a small amount clockwise and measure the resulting control surface movement. This should be 6 deg. – 0 deg. + 1.0 deg. (i.e., 9.4 in. – 0 in. + 1.5 in. at the fixed trailing edge) and is adjustable at potentiometer No.1 in panel 83P. Repeat with anti-clockwise movement of turn control.

(8) Lock potentiometer No.1.

(9) Run through landing sequence to ATTITUDE phase. Check that the aileron A.F.U. stops are fully open in order to allow full aileron range.

(10) Disengage the autopilot and set M.F.S. selector vertical. ▶



I. A.S. KNOTS	MAX. RUDDER MOVEMENT UNDER AUTOPILOT CONTROL					
	"ATTITUDE" PHASE			"NORMAL"		
	PORT	STBD.	AVERAGE	PORT	STBD.	AVERAGE
0-130 A.F.U. CUT-IN SPEED	31°	30°	30·5°	20·8°	19·8°	20·3°
150	27·6°	26·8°	27·2°	18·5°	17·7°	18·1°
200	18·3°	17·7°	18°	12·3°	11·7°	12°
250	10°	9·5°	9·75°	6·7°	6·3°	6·5°

Fig.6A Rudder control limits

Calibration of rudder servomotor authority

155. When the autopilot is engaged the rudder feel forces are increased to restrict the authority of the rudder servomotor. At the start of the ATTITUDE phase the feel forces are restored to normal to perform the 'kick-off-drift' manoeuvre. A time of 10 seconds should be allowed to elapse between disengagement and engagement of the autopilot. The procedure for authority calibration is similar to that used for the elevator circuit and is as follows:-

(1) Disconnect the pitot piping from the rudder feel unit airspeed transmitter on the port side of the bomb bay and the associated pitot pipe from the rudder feel warning transmitter on the starboard side of the bomb bay.

(2) Connect a pitot pressure simulator rig to both transmitters simultaneously.

(3) With autopilot disengaged, trim the rudder to neutral, set potentiometer No.2 in panel 83P to its mid-position. Switch IN the rudder and aileron channels.

(4) Engage the autopilot. Select LOC. and G.P. on the M.F.S. selector. Pull ON the TRACK switch. Run through landing sequence to ATTITUDE phase.

(5) Set S5 to L.C. Set radio injector switches to ON and NORMAL. Set radio injection to obtain full rudder deflection. Measure the deflection at the bottom trailing edge corner of the rudder.

(6) Record this movement in a table as shown in fig.6A against zero airspeed.

(7) Simulate on an airspeed of 150 knots and again check maximum

rudder deflection using the radio injection switch. Record the rudder movement.

(8) Repeat sub.para. (7) at speeds of 200 and 250 knots.

(9) Repeat tests (6), (7) and (8) above with the radio injection switch at REVERSE. Plot average 'attitude' phase movements on a graph as shown in fig.6A.

(10) Disengage the autopilot and reduce the simulated A.S.I. to 200 knots. Set the M.F.S. selector vertical.

(11) Engage the autopilot. Rotate the turn control and check rudder movement. This should be approximately 2/3 of that noted in test (8) above for the same A.S.I. (200 knots), when the aircraft is laterally level.

(12) Repeat tests (6), (7), (8) and (9) above and plot results on a graph as shown in fig.6A using the turn control in lieu of the radio injection switches.

NOTE . . .
Rudder movement to port and starboard should be plotted together with an average.

(13) Average rudder movement under normal autopilot control should always be between 55% and 70% of the "average" value in "attitude" phase. If not then further adjustment of potentiometer No.2 in panel 83P must be made and the above test repeated. Lock potentiometer No.2.

(14) Disengage the autopilot.

Bomb door compensation

156. To offset the nose down pitch error, due to the extra drag caused by the opening of the bomb doors whilst in flight, compensating signals are provided by the autopilot and fed to the elevator servo channel to provide automatic trims during the operation. The following tests check this function with the aircraft on the ground.

NOTE . . .
During this test procedure it is necessary to operate the bomb doors, therefore a hydraulic rig will be required. Ensure that the bomb doors are unobstructed and cleared for operation.

(1) At the servo control unit, remove the perspex panel from the bomb door compensation adjustments. Ensure that all settings are at zero.

(2) Engage the autopilot and check that the aircraft controls remain stationary. Pull the BOMB switch on the pilots' selector.

(3) Open the bomb doors and whilst the bomb doors are in motion, check that no control movement exists.

(4) Close the bomb doors.

(5) At the servo control unit set and lock the E adjustment at - 5.

(6) Open the bomb doors and check that a slow up elevator movement occurs whilst the bomb doors are in motion and that both movements cease when the bomb doors are fully open.

(7) Close the bomb doors and disengage the autopilot.

(8) Push OFF the autopilot power switch and disconnect all test equipment used making good all connections broken down for testing.

157. On completion of the calibration checks above switch "off" in turn the M.F.S. and powered flying controls. Disconnect the ground supplies and ensure that the flying controls have freedom of movement in all directions.

REMOVAL AND INSTALLATION

General

158. Access to the major components is straightforward, therefore no special instructions are required. Should it become necessary to remove or replace any component, all loose connectors should be secured to the adjacent aircraft structure to prevent damage.

LEADER CABLE INSTALLATION A.R.I.23063

159. The receiver, Type 16048, the junction box, Type 16795, and the aerial assembly, Type 16050, which are located in the radome, are accessible through the access hatch fitted in the forward bulkhead of the bomb aimer's compartment.

Aerial assembly, Type 16050

160. The aerial assembly is secured by a clamp fitted to the aircraft structure. To remove, disconnect the two connectors, loosen the clamp securing screws and lower the assembly from its mounting.

NOTE . . .
When fitting the aerial assembly to the clamp ensure that the black arrow is facing downward as shown in fig.1.

Receiver unit, Type 16048

161. The unit is secured in a mounting tray by locating dowels at the rear and two knurled locking nuts at the front. To remove, unscrew the two knurled nuts at the base of the unit, take hold of the transport handle and slide the unit off the tray. On replacement, ensure that the locating dowels engage correctly.

Junction box, Type 16795

162. The junction box, Type 16795, is an integral part of the receiver mounting tray, Type 16784. The tray is removed by removing the receiver, disconnecting the connectors located on top of the junction box and unscrewing the securing screws located in the base of the tray. The junction box can then be isolated from the tray by removing the securing nuts on the under surface of the tray.

Junction box, Type 16049

163. The junction box, Type 16049, is secured to the aircraft structure by four securing screws. To remove the unit, disconnect the six connectors and unscrew the securing screws.

Control unit, Type 16051

164. The control unit is secured to the A.E.O.'s panel by four securing screws. Removal of these screws will allow the unit to be pulled out of the panel face. Located on the rear of the unit is a multipole plug which is removed to isolate the unit from the aircraft.

AUTO-THROTTLE INSTALLATION

Airspeed detector indicator, Type A

165. To remove the airspeed detector indicator the port outer instrument panel has to be lowered from the support brackets by removing the three securing screws and the two tufnol distance pieces. Care should be taken to ensure that the weight of the panel is not taken on any of the cable connectors.

166. To remove the indicator disconnect the four connectors at the rear of the instrument and unscrew the three securing screws.

Comparator warning lamps

167. For ease of accessibility in removing one or both lampholders, first lower the port outer instrument panel. Unscrew the insulated cap at the rear of the lampholder, unsolder the connectors, release the retaining spring and withdraw the lampholder through the panel.

168. When replacing the instrument panel, ensure that the tufnol distance pieces are placed between the panel and support brackets, and that no cables have been trapped or damaged.

Junction box, Type B

169. The junction box, Type B, is an integral part of the rack mounting containing the control unit, integrator unit and amplifiers. To remove the junction box first withdraw the control unit, integrator and amplifiers. Disconnect the fourteen connectors located on top of the junction box and unscrew the securing screws at the rear of the rack assembly.

Control unit, Type B

170. The control unit is located in its tray by two locating dowels at the rear and two knurled locking nuts at the front. To remove, unscrew the knurled nuts at the front of the unit, take hold of the transport handle and slide the unit off the tray.

Integrator unit, Type B

171. The integrator unit is secured in its tray by two locating dowels at the rear and two knurled locking nuts at the front. The method of removal is as described in ◀ para.170. ▶

Amplifier units, Type C

172. Each amplifier is secured in its tray by dowels at the rear and a knurled locking nut at the front. The units are removed as detailed in ◀ para.170. ▶

173. When replacing either the control unit, integrator unit, or the amplifiers, care should be taken to ensure that the dowels at the rear of the units engage correctly in the locating holes recessed in the junction box face.

Rate gyro units, Type A

174. To remove one or both gyro units, the gyro unit mounting, Type A, has to be removed from the aircraft structure by disconnecting the two connectors at the rear of the mounting and unbolting the three securing bolts. To remove each gyro from the gyro mounting, unscrew the four securing screws, located on the under surface of the mounting, and unplug the gyro from the mounting junction box.

175. Care should be taken to ensure that the gyros are not knocked or jarred whilst being removed or installed in the aircraft.

Servo-motors, Type B

176. The four servo-motors are secured to mounting brackets which are then bolted to the aircraft structure. To remove the servo-motors, the control rods, which are bolted to the lever attached to each motor spindle, must be disconnected. This is achieved by withdrawing the split pin and removing the connecting nut and bolt.

177. To remove each servo-motor, uncouple the connector at the rear of the unit and remove the three securing bolts.

Limit switches

178. Each pair of limit switches, which are mounted on a bracket fitted to the forward bulkhead in each engine bay, are removed by disconnecting the connecting leads and unscrewing the locking nut located on the under surface of the bracket. The switches can then be withdrawn through the face of the bracket.

Power supply switch

179. Removal of the A/T POWER SUPPLY SWITCH is straightforward and

no special instructions are required. On removal, however, ensure that the supply leads are insulated and stowed.

AUTOPILOT MK.10B INSTALLATION

General

180. Removal of the components which comprise the autopilot Mk.10B, is straightforward, therefore no special instructions are required. Should any unit be removed, all loose connectors should be secured to the adjacent aircraft structure to prevent damage. The servo units will normally be removed by the airframe tradesmen providing that the electrical connectors to the units have been disconnected. Before removing the servo units, the flying controls should be locked in the positions detailed in Book 1, Sect.3, Chap.4 of this publication, where detailed instructions for removing the units will be found.

TABLE 1

Connectors for A.R.I.23063

A.V. Roe Item No.	Cable form	Connecting		
2/T4910	Min. cable 3C	A.E. loop	to	Pl.1018
8/T4910	Min. cable 6C	Pl.1018	to	J.B.16049
11/T4910	Min. cable 4C	J.B.16049	to	T.B.1158
12/T4910	Min. cable 6D	J.B.16049	to	M.F.S. computer
13/T4910	Min. cable 12D	J.B.16049	to	Control unit
14/T4910	Min. cable 4D	A.E. loop	to	J.B.16795
15/T4910	Min. cable 25C	J.B.16049	to	Pl.1019
16/T4910	Min. cable 25C	Pl.1019	to	J.B.16795
1/FR735	Uninyvin 20 3-core twisted	J.B.16049	to	75P fuses 733 R.Y.B.
2/FR735	Uninyvin 22	J.B.16049	to	3P fuse 642
3 /FR735	Uninyvin 22	J.B.16049	to	earth point

TABLE 2

Auto-throttle equipment

Equipment	Type	Ref. No.	No. off
Airspeed detector indicator	A	6T/1686	1
Rate gyro unit	A	6T/1687	2
Gyro unit mounting tray	A	6T/1698	1
Amplifier unit	C	6T/1951	2
Integrator unit	B	6T/1952	1
Control unit	B	6TB/2029	1
Gearing pad (Functionator)	J	6T/1730	2
Gearing pad (Pre-amp)	J	6T/1728	2
Gearing pad (Flare)	J	6T/1729	2
Gearing pad (Comparator)	M	6TB/2031	2
Junction box	B	6T/1953	1
Mounting	A	6T/1731	1
Servo motor	B	6TB/1984	4
Mounting	B	6T/1874	4

TABLE 3

Autopilot Mk.10B equipment

Equipment	Type	Ref. No.	No. off
* Pilot's selector	B	6T/1677	1
Pilot's controller	A	6T/214	1
Bomb aimer's controller	A	6T/400	1
Remote trim indicator	B	6T/1676	1
Gyro unit	A or B	6T/201 or 6T/1648	1
* Servo control unit	D	6T/1936	1
* Gearing pad No.1 (S.C.U.)	M	6TB/1955	1
* Gearing pad No.2 (S.C.U.)	M	6TB/1956	1
* Sense pad (S.C.U.)	J	6T/1841	1
* Platform control unit	B	6T/1680	1
◀ * Locking unit (Mods.2076 & 2150)	F(G & H)	6TB/1985 (6TB/2068 & 2295)	1 ▶
* Gearing pad No.1 (L.U.)	M	6TB/1986	1
* Gearing pad No.2 (L.U.)	M	6TB/1987	1
◀ * Junction box (Mod.2149)	F (H)	6TB/1988 (6TB/2294)	1 ▶
Rack mounting	A	6T/1622	1
Pressure unit	B	6T/1718	1
Mounting (Multiplex)	A	6T/402	1
Servomotor	A (Elevator)	6T/230	1
* Servomotor	B (Rudder)	6T/234	1
Servomotor	C (Aileron)	6T/307	1
Mounting (servomotor)	A	6T/232	3
* Autolanding phase and altitude indicator	A	6T/1829	1
* Autolanding test meter	A	6T/1684	1

NOTE...
*Items marked thus * are fitted only in the autopilot Mk.10B installation. Refer to para.72.*

TABLE 4

Artificial feel failure indications

Failure	Indication	Remarks
1. Rudder relay not engaged	Immediate white	Nil
2. Aileron relay not engaged	Immediate white	Nil
3. Elevator Loc relay fails to engage	Ind. remains black (should show ILS)	Nil
4. Attitude relay fails to engage	No indication	Nil
5. Elevator AFU failed (all cases)	Full normal warning	Nil
6. Rudder AFU failed (all cases)	Full normal warning	Nil
7. Aileron AFU failed (cruise and Autopilot engaged)	No warning prior to approach and attitude phases except on autopilot disengagement.	Nil
8. Aileron AFU fails (approach and attitude phase)	Full normal warning unless AFU fails to reset from 4½° cruise to 6½° approach configuration, in which case ILS remains after autopilot disengagement.	If AFU failure to reset is due to power supply loss then full normal warning is given.
9. Rudder relay fails to disengage (Attitude selected).	White after 10 secs.	Nil
10. Aileron relay fails to disengage (Attitude selected).	Immediate white	Nil
11. Elevator/loc relay fails to disengage.	Remains on ILS	Nil
12. Attitude relay fails to disengage on autopilot disengagement.	Immediate white, remaining	Nil

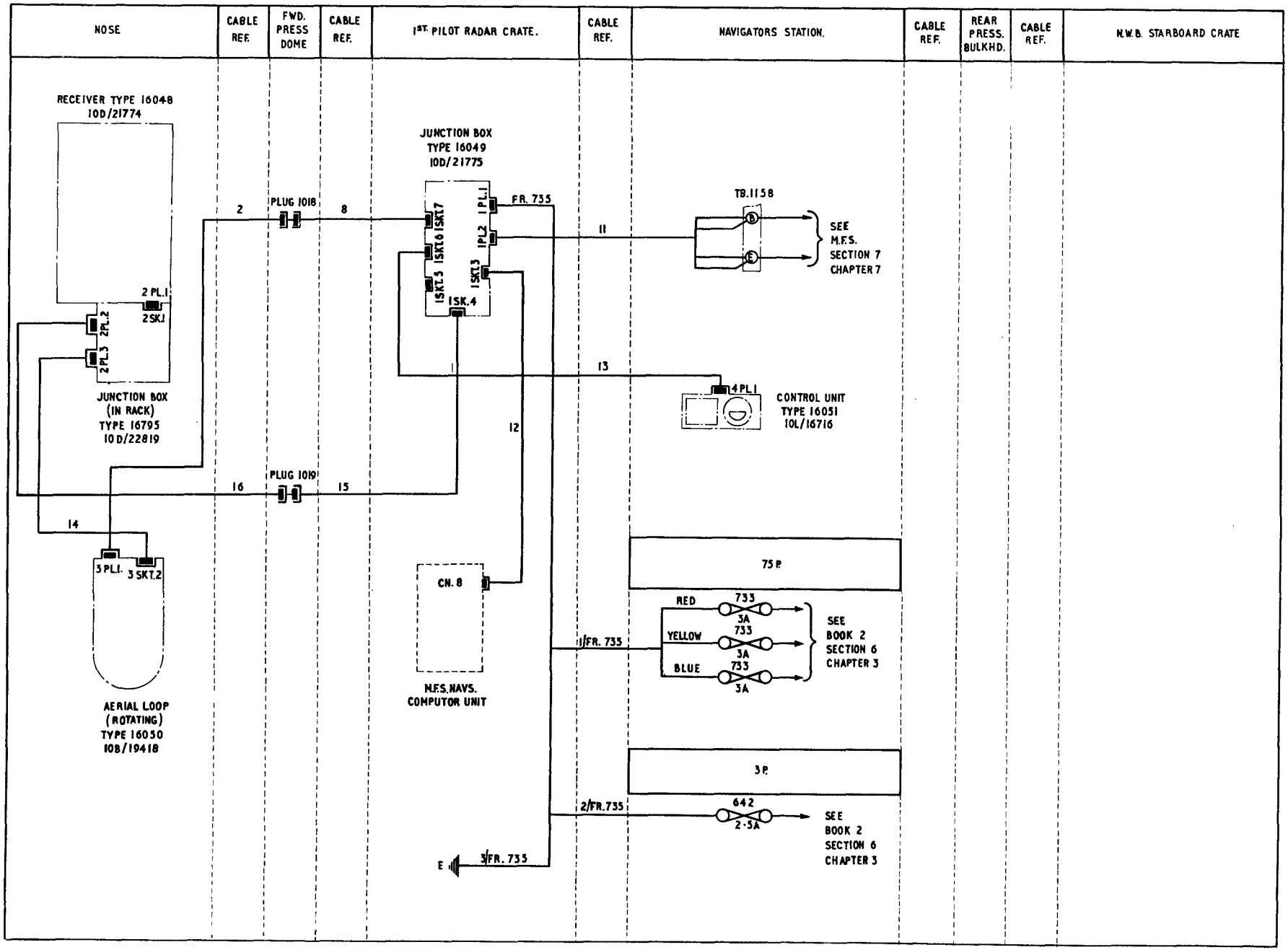


Fig. 7. A.R.I. 23063

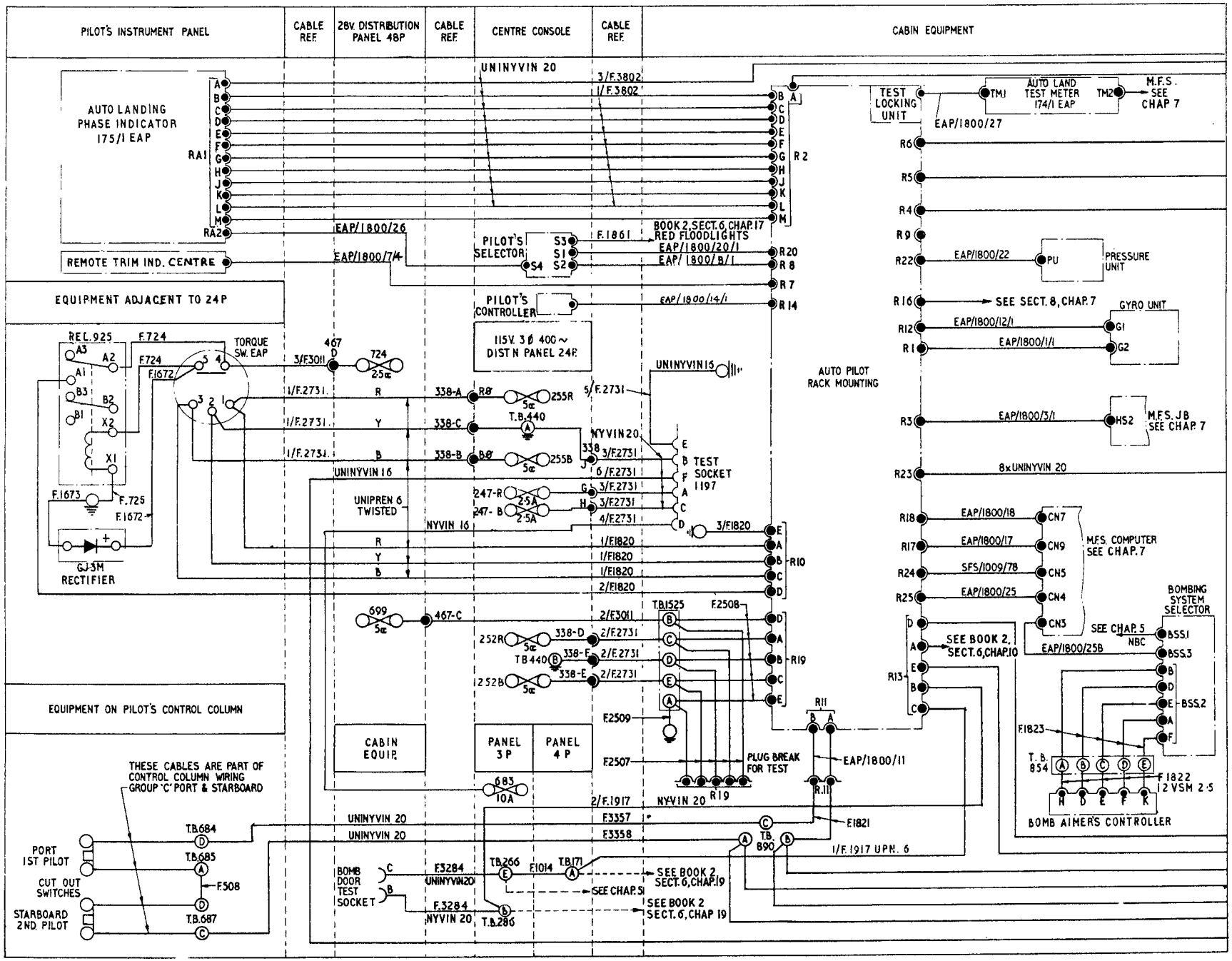


Fig. 9 (1) Auto – pilot Mk 10B (Pre. Mod. 748)

◄ Mod 2082 embodied ►

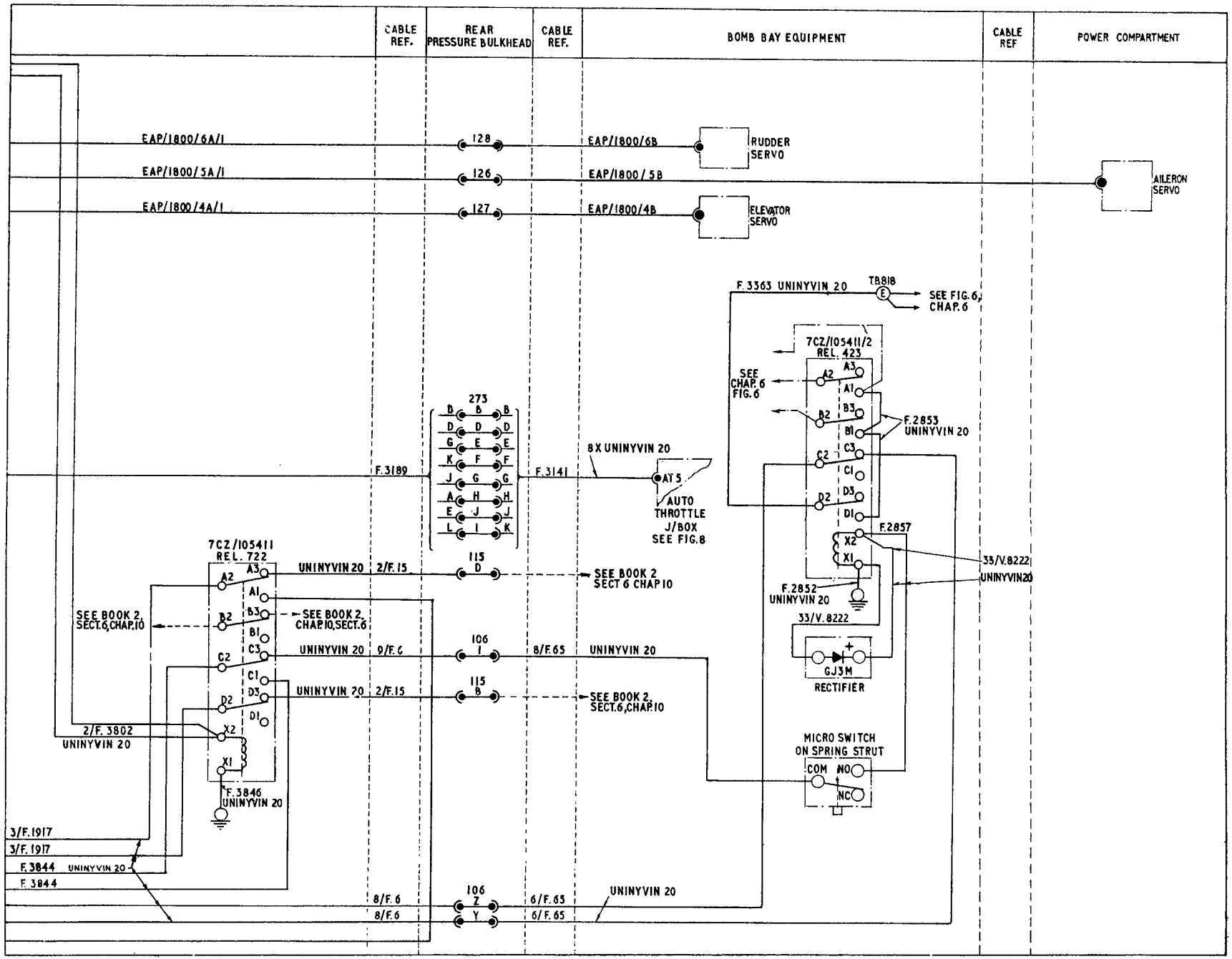


Fig.9 (2) Auto – pilot Mk 10B (Pre. Mod. 748)

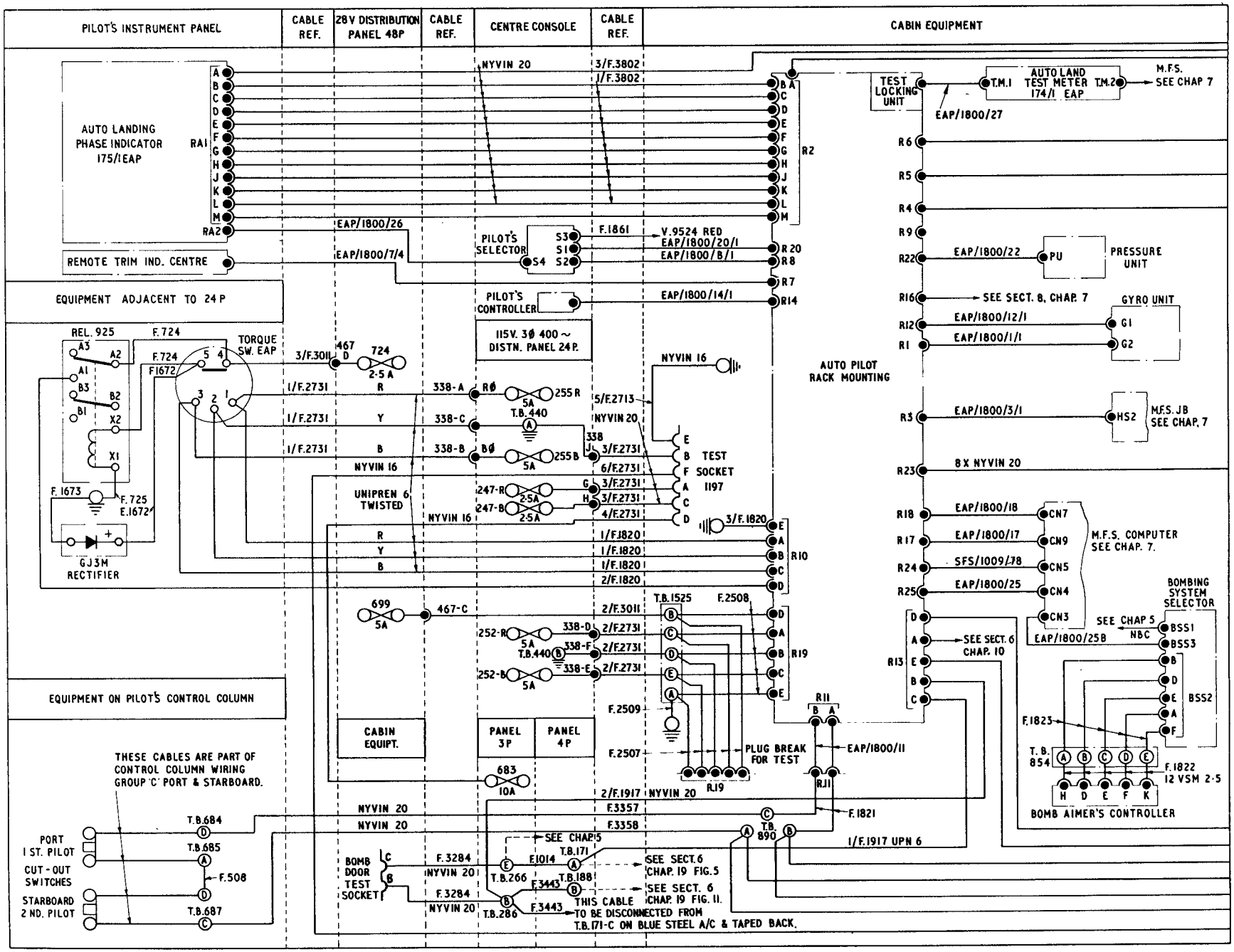


Fig 10 (1) Auto-pilot Mk 10B (post Mods 748 and 1173)

◄ Mod. 2082 embodied ►

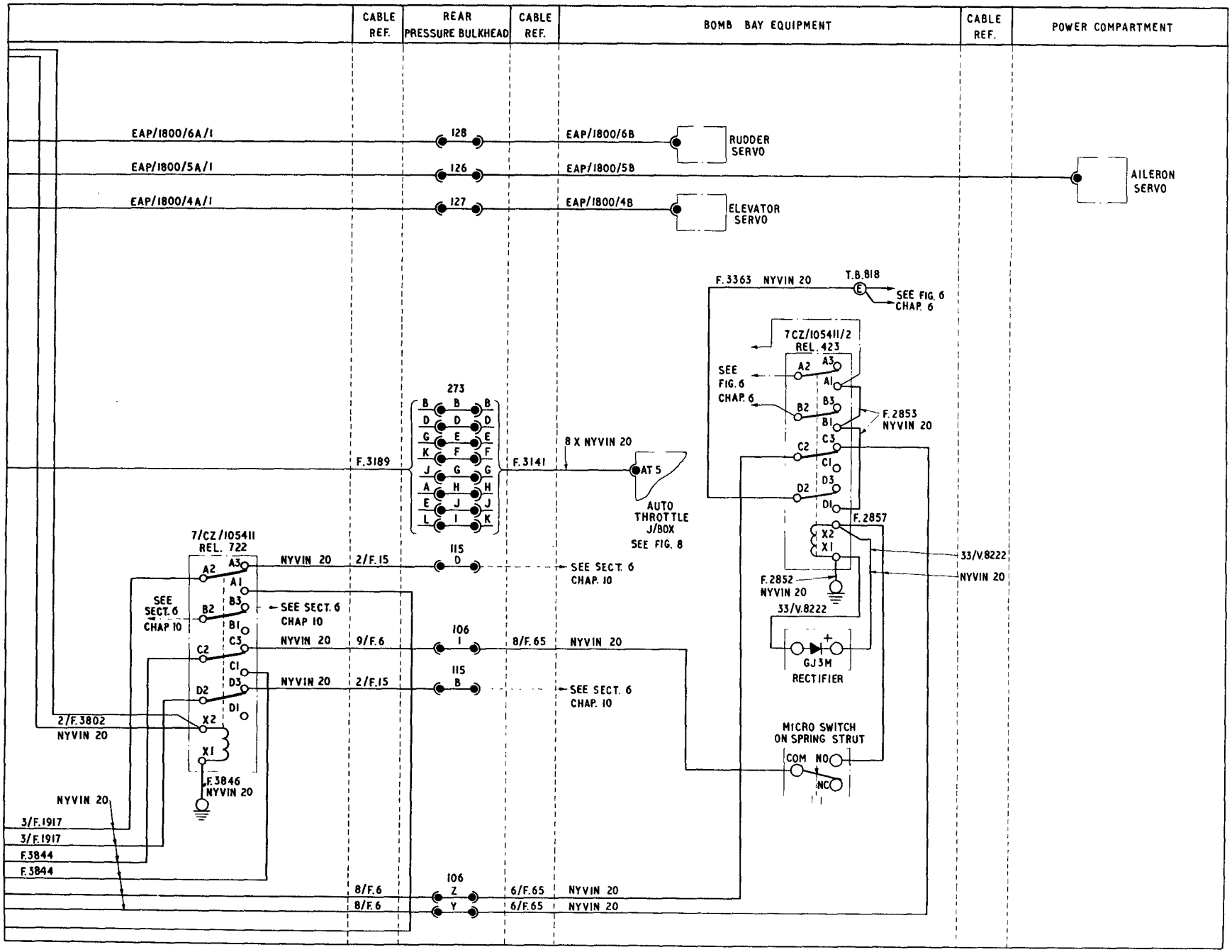


Fig. 10 (2) Auto-pilot Mk 10B (post Mods 748 and 1173)

Chapter 10

HEADING REFERENCE SYSTEM MK.2

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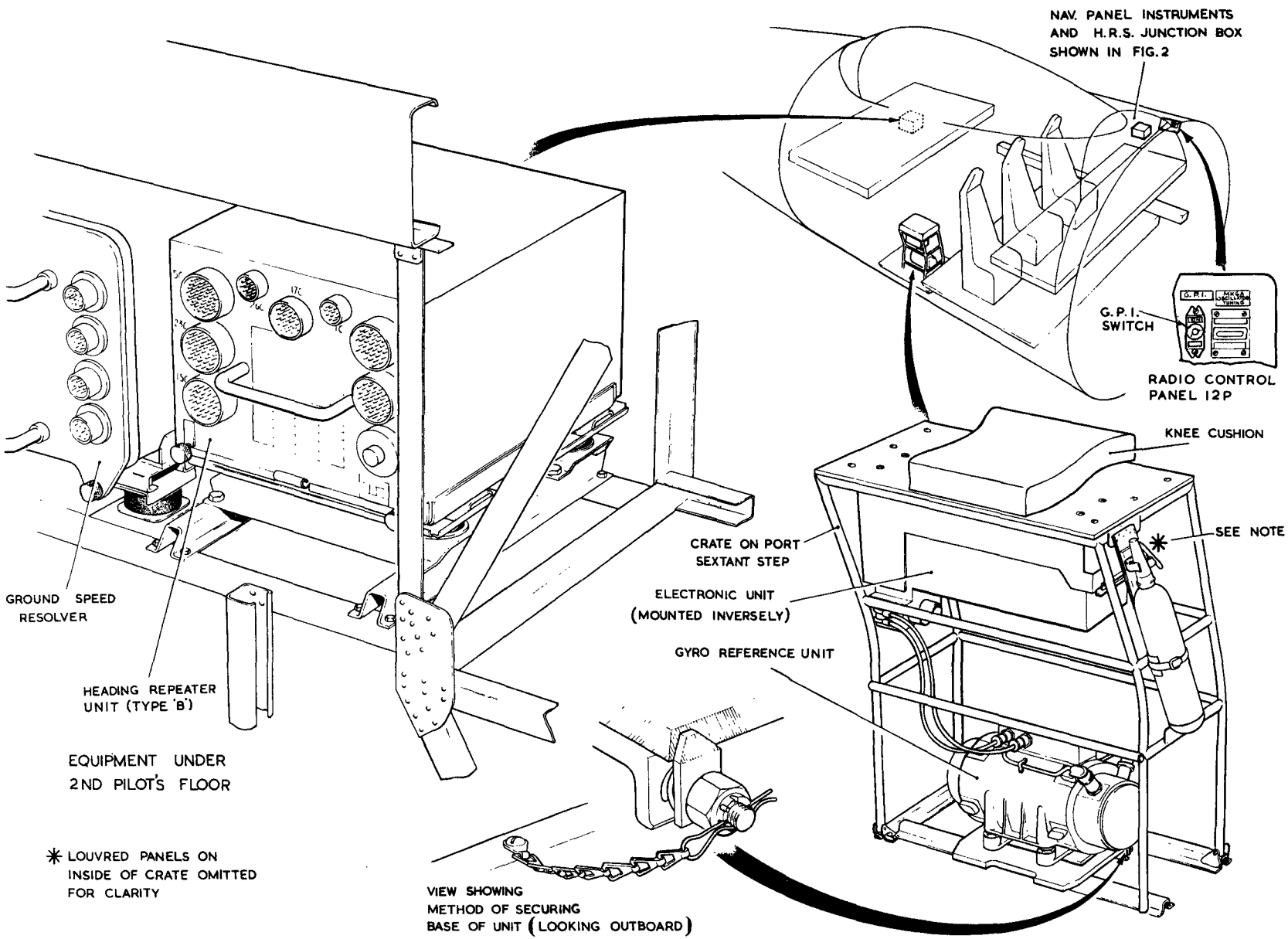


Fig. 1. H.R.S. equipment in cabin.

Introduction

1. The heading reference system (H.R.S. Mk.2) introduced by Mod.1908, is a flight navigation instrument system, installed in aircraft designated 'free fall' only, and designed to compute heading information and provide accurate heading referenced outputs for the navigator and associated systems in the aircraft. The H.R.S. Mk.2 is integrated with the N.B.S. (Chap.5), M.F.S. (Chap.7) and A.R.I. 5951 (Sect.9, Chap.4) installations so that it can receive suitable corrections which, when computed with a stable azimuth, produces a number of true north heading outputs.

2. The existing associated units concerned with the interconnection of the H.R.S. Mk.2 with the N.B.S., M.F.S and A.R.I.5951 installations are the ground position indicator (G.P.I. Mk.6), ground speed resolver (G.S.R.), Blue Steel junction box, track control unit (T.C.U.), optical link junction box and the ground speed selector unit (G.S.S.U.). A brief description of the role that each unit mentioned above performs whilst functioning in the H.R.S. mode is given later in the text. A block diagram of the whole integrated system is contained in fig.3.

3. Details of the aircraft a.c. and d.c. supplies to the H.R.S. Mk.2 installation are included in the text. Illustrations showing the location of the various units which comprise the installation are included in this chapter with a block diagram and routing charts. For more detailed information concerning the individual units of the H.R.S. Mk.2 system, reference should be made to A.P.1275B, Vol.1, Sect.20, Book 1 and Book 2. Modification 2112 embodies H.R.S. Mk.2 on seven aircraft which have had a blue steel capability. The aircraft serial numbers are recorded on the appropriate routing charts.

DESCRIPTION AND OPERATION

General

4. The H.R.S. Mk.2 consists of a master reference gyro (M.R.G. Mk.2), heading repeater unit (H.R.U.), heading reference system control unit (H.R.S.C.U.), navigator's compass repeater, Type B, (N.C.R.) and a junction box (H.R.S. J/B Mk.2).

5. The following paragraphs contain a brief description of the various functions of the H.R.S. Mk.2 units and also the role each associated unit mentioned in para.2 performs whilst operating in the H.R.S. mode.

M.R.G. Mk.2

6. In the M.R.G. Mk.2, comprising electronic unit (E.U.) Type A or B, and gyro reference unit (G.R.U.) Type A or B, the G.R.U. provides the E.U. with a stable azimuth reference. This reference, an inertia gyro heading, is repeated and corrected in the E.U. for the earth rate and gyro bias drift for transmission to the H.R.U. as a great circle heading.

7. The earth rate correction is derived in the H.R.U. from a continuous supply of latitude information from the G.P.I. Mk.6 and the gyro bias drift correction is supplied from the H.R.S.C.U. The G.P.I. Mk.6 also supplies the H.R.U. with two corrections; a continuous synchro transmission of meridian convergence and also, on command, fix monitored azimuth (F.M.A.) correction signals. The H.R.U. is supplied from the M.F.S. with a continuous input of true heading that is based upon magnetic heading corrected for magnetic variation.

H.R.U., Type B

8. The H.R.U., Ref.No.9CD/8, operates in a number of modes (selected at the H.R.S.C.U.) which control the computation of heading information and corrections which are used to generate eight synchro outputs of true north heading i.e., true heading with meridian convergence correction. In the H.R.S. Mk.2 installation, these synchro outputs are transmitted to the associated units as follows:-

(1) Two outputs for the heading servo in the ground speed resolver (G.S.R.).

(2) Two outputs for the heading/track display servo in the navigator's compass repeater, Type B.

(3) Single output for the calculator, Type 2 of the N.B.S. via the N.B.S. junction box, Type 343 Mk.4.

(4) Single output for the true north servo in the electronic unit (E.U.) of the M.R.G. Mk.2.

(5) Single output for the pilot readout.

(6) Single output for a transfer gyro.

H.R.S.C.U., Type B

9. The H.R.S.C.U., Ref.No.9CD/12, provides the requisite controls and indicators that select and monitor the various modes of the H.R.S. Mk.2 operation. The

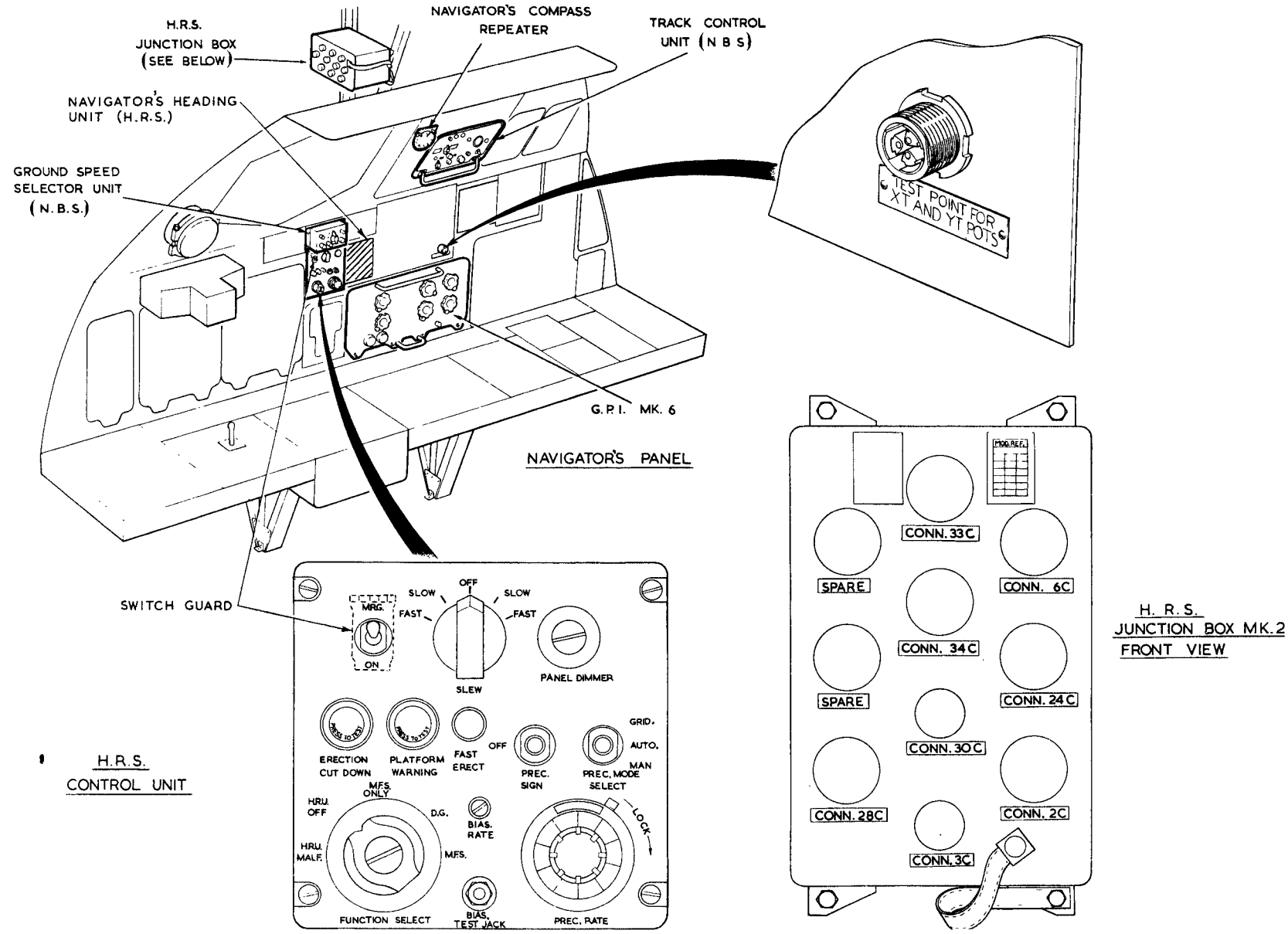


Fig. 2 H.R.S. equipment at navigator's station

control panel shown in fig.2 is contained in a light alloy case and the components, mounted to the inner face of the mounting panel, are enclosed by a box-shaped cover that is secured to the mounting (front) by four pillars and screws.

10. An electroluminescent panel is secured to the front face of the mounting panel by five screws and, in addition to the various apertures required for the control knobs, the panel is also engraved with the respective control function. These engravings and certain switch surrounds become illuminated with a white light when the H.R.S. is energised from the aircraft 115-volt, 400 c/s power supply A panel dimmer control is also provided and is situated on the panel as shown in fig.2.

11. The control functions of the H.R.S. C.U. are to:-

(1) Switch the M.R.G. Mk.2 power supplies.

(2) Energise the H.R.U. and select mode of operation.

(3) Energise and provide manual operation of the slew control in the H.R.U.

(4) Energise and provide manual operation of the precession control in the H.R.U.

(5) Energise the demand fast erection relay in the electronic unit (E.U.) of the M.R.G. Mk.2.

(6) Provide a manual control of the bias drift correction signal to the M.R.G. Mk.2 integrator servo loop for gyro drift compensation.

The H.R.S.C.U. provides the following indications:-

(1) Erection cut back operation of the M.R.G. Mk.2.

(2) Heading output error relative to M.F.S. output that is above a pre-set level in the H.R.U.

12. The H.R.U. operational modes are effected by a 5-position 'FUNCTION SELECT' switch on the H.R.S.C.U. There are two normal modes of operation, D.G. and M.F.S. and one reversionary mode M.F.S. ONLY.

(1) In the D.G. (Directional Gyro) mode there is no closed loop monitoring of heading output in the H.R.U. There is also provision enabling periodic updating of heading using the F.M.A. technique.

(2) In the M.F.S. mode the heading output is continuously monitored by the M.F.S.

(3) In the M.F.S. ONLY mode, the H.R.U. is disconnected from the M.R.G. Mk.2 and the heading output is slaved to the M.F.S. output of magnetic heading plus variation.

H.R.S. Mk.2 junction box

13. The H.R.S. Mk.2 junction box (H.R.S. J/B Mk.2), Ref.No.9CD/9, is used for interconnecting the various units of the H.R.S., and to provide plugs for connection to the associated systems in the aircraft. A pictorial view of the junction box is shown in fig.2.

14. The only operational part of the junction box is a relay (RLA) which is energised from the heading reference unit ON signal. When the relay is energised, the M.F.S. heading synchro is excited from the H.R.U., through the T.C.U. (M.F.S.) via pins A and C of plug 28C on the junction box. When the relay RLA is not energised the M.F.S. heading synchro is excited from the same supply that is being fed to the G.S.R. via pins G and H of plugs 3C and 2C.

Navigator's heading unit

15. The navigator's heading unit, Ref. No.9CD/26, introduced by Mod.2033 and located on the navigator's panel (fig.2), contains servo mechanisms, gearing and synchros for adding heading corrections to the best available heading. Further information may be found in A.P.1275B, Vol.1, Sect.20, Book 1.

16. Mod.2033 also introduces a facility whereby the H.R.S. heading error signal may be monitored on the pilots' Director Horizon instrument via a selector switch mounted adjacent to the starboard side of the fuel contents panel 2P. The switch which is labelled H.R.S. - M.F.S., enables the pilot to select either the normal M.F.S. heading error signal, derived from the associated beam compass, or the H.R.S. error signal, derived from the H.R.S. pilot readout signal from the H.R.U., for display on the Director Horizon instrument. Further information may be found in Sect.7, Chap.7, (M.F.S.) of this Book.

Navigator's compass repeater, Type B

17. The navigator's compass repeater, Type B, Ref.No.6B/3647 is located next to the T.C.U. as shown in fig.2. The instrument provides an indication of the following three sources of compass information.

(1) M.F.S. aircraft heading or track

(2) G.S.R. aircraft track

(3) H.R.S. Mk.2 aircraft heading

The track or heading is displayed by a 360 deg. four digit reversible counter and by a pointer moving over a fixed compass dial.

18. The pointer and counter are controlled by a servo loop and the synchro associated with the compass information source is selected via a 3-position switch

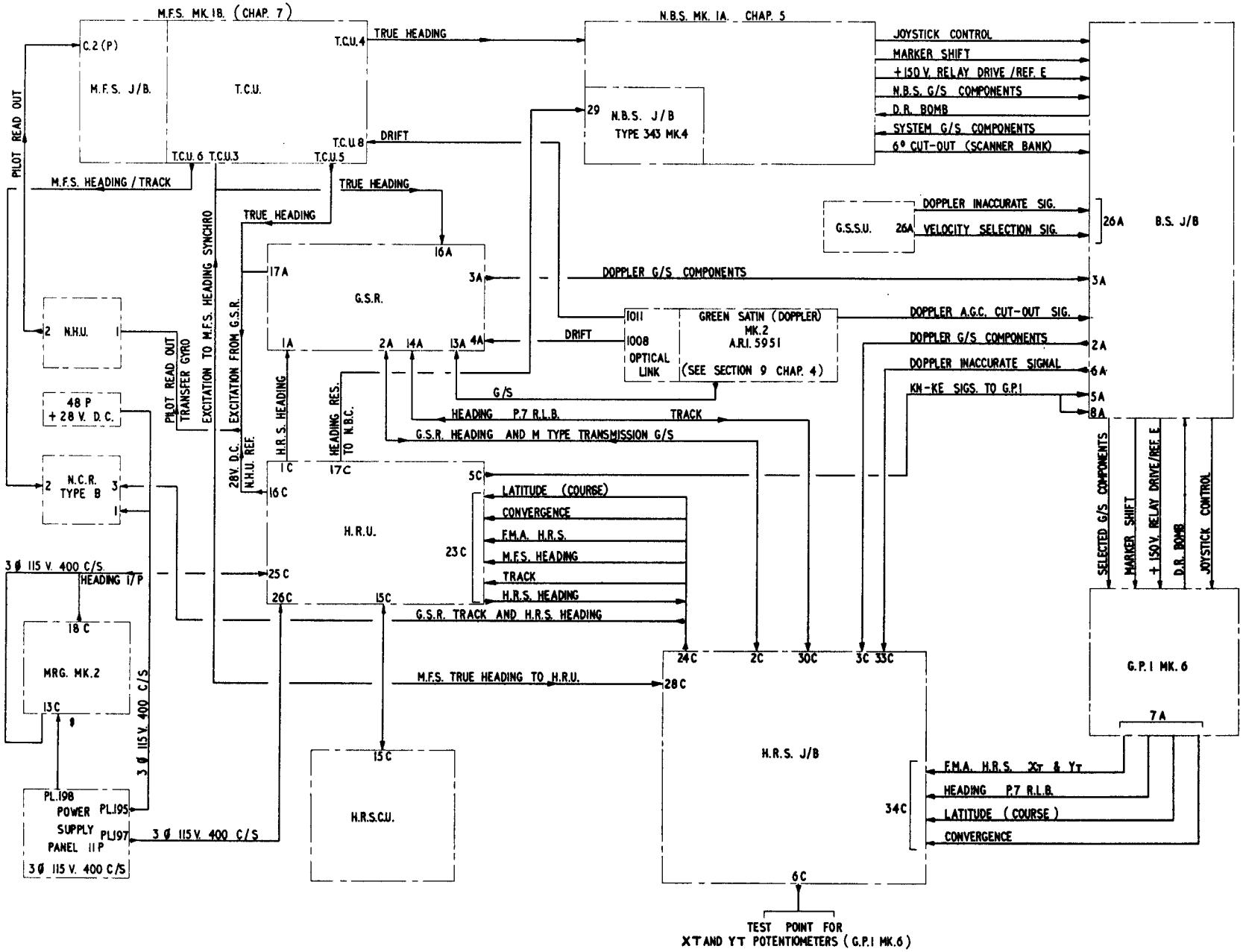


Fig. 3 Block diagram of H.R.S. Mk.2 and associated systems

situated at the bottom left hand corner of the instrument. A knob at the bottom right hand corner of the instrument controls an index which can be set against any desired heading on the compass card for reference purposes. Further information may be found in A.P.4686B, Vol.1, Book 2, Sect.4.

Associated units

19. The following existing items are normally associated with the N.B.S., M.F.S. and Green Satin installations but also perform certain functions when the aircraft heading is derived from the H.R.S. Mk.2. A brief outline of these functions are given in the following paragraphs.

G.S.R.

20. The principle function of the G.S.R., Ref.No.9C/102, is to resolve the Green Satin A.R.I.5951 (doppler) derived ground speed into easterly and northerly components. Drift information is supplied to the G.S.R. by Green Satin, whilst heading information is obtained from the H.R.S. Mk.2 or the M.F.S. The addition of drift and heading information within the unit provides track angle. Using the track angle and ground speed along track information, the unit provides outputs of aircraft ground speed in northerly and easterly components. The G.S.R. is fully described in S.D.4766C, Vol.1, Book 4, Sect.2, Chap.1.

B.S. junction box

21. This unit, Ref.No.9C/105, facilitates the interconnection of the H.R.S. Mk.2, N.B.S. and M.F.S. installations. The unit houses 37 relays and has 32 plug or socket connections. Further information may be found in S.D.4766C, Vol.1, Book 4, Sect.2, Chap.5.

G.P.I. Mk.6

22. The G.P.I. Mk.6, Ref.No.9C/101, performs two main tasks related to the H.R.S. Mk.2 operation:-

(1) Processes the North/South and and East/West resolved components of doppler derived ground speed from the G.S.R. into continuous computation of latitude and longitude information.

(2) Carries out a periodic comparison process in conjunction with N.B.S. by which dead reckoning navigational errors in the aircraft equipment may be corrected. This is called a Fix procedure and involves a process called the F.M.A. technique.

Further information on the G.P.I. Mk.6 may be found in S.D.4766C, Vol.1, Book 4, Sect.2, Chap.1.

Optical link junction box

23. This unit, Ref.No.26DC/10112, provides a 'T' junction which facilitates the routing of drift from Green Satin to the T.C.U. in the M.F.S. and to the G.S.R. Further details will be found in Sect.9, Chap.4 of this Book.

Ground speed selector unit

24. The ground speed selector unit, Ref.No.9C/172, is located above the H.R.S. control unit as shown in fig.2. The purpose of the unit is to provide those functions which were previously performed by the inertia navigation control unit for Blue Steel aircraft. These functions are also required for 'free fall' aircraft carrying the H.R.S. installation in order to fully integrate the H.R.S. with the existing N.B.S., M.F.S. and Green Satin installations. These functions are as follows:-

(1) Manual selection of the Green Satin or N.B.C. derived ground speed components.

(2) Indication of automatic change-over of ground speed selection to the G.P.I. Mk.6 in the event of Green Satin inaccuracy.

(3) Control of the Coarse/Fine sequence of the G.P.I. Mk.6 Latitude servo.

Power supplies

25. With reference to fig.5 it will be seen that the H.R.S. is supplied with 115-volt, 3-phase 400 c/s a.c. from the N.B.S. transformer via fuses 352R.B., 354R.B. and 355R.B. (one phase connected to earth) in panel 11P, and also 28-volt d.c. via fuses 716 and 722 in panel 48P. The a.c. supplies from fuses 352 and 354 are connected directly to the N.C.R., Type B, and H.R.U. respectively, whilst the a.c. supply from fuse 355R.B., is connected to the E.U. in the M.R.G. Mk.2 via the contacts of relay 321 in panel 11P.

26. When the switch labelled M.R.G. on the H.R.S.C.U. panel (fig.2) is switched to ON, a 28-volt d.c. supply (derived from fuse 716) energises relay 321 and thus connects the 115-volt, 3-phase a.c. supply and the same 28-volt d.c. supply to the E.U. via the now closed contacts of relay 321. Fuse 722 supplies 28-volt d.c. to the N.C.R., Type B, for energising relays within the N.C.R., Type B, which in turn selects the required source of heading information, via a 3-position switch (para. 17), for display on the dial of the instrument.

Power supplies G.P.I. Mk.6

27. With reference to fig.6 it will be seen that the G.P.I. Mk.6 receives its 115-volt, 3-phase 400 c/s a.c. supply, from fuses 341 R.B (one phase connected to earth) in panel 11P, via relay contacts of relay 540. The relay 540 is energised by a 28-volt d.c. supply from fuse 708 in panel 48P via a switch mounted on the radio control panel 12P shown in fig.1.

Test socket

28. The test socket shown in fig.2 is used to monitor output voltages associated with the XT and YT potentiometers (located in the G.P.I. Mk.6) which are related to the functioning of the F.M.A. technique carried out by the G.P.I. Mk.6 in association with the N.B.S. Mk.1A.

SERVICING

General

29. All H.R.S. items of equipment should be checked for security of mounting and tightness of plug and socket connections. Before removing any item of equipment suspected of being defective, checks should be made for continuity and insulation on the associated cable assemblies. Complete instructions for servicing the items of equipment comprising the H.R.S. will be found in A.P.1275B, Vol.1, Sect. 20, Book 2.

Functional checks

30. It is envisaged that some functional checks will be required in the future to prove the serviceability of the H.R.S. in the aircraft. The required information is not yet available and will be included in due course.

REMOVAL AND INSTALLATION

General

31. Access to the major units of the H.R.S. is straightforward and they may be easily removed or fitted with little or no difficulty. The only exception to this is the M.R.G. Mk.2 which as stated earlier comprises the G.R.U. and E.U. (mounted inversely) and are both fitted under the port sextant step as shown in fig.1. Therefore detailed instructions for the removal and installation of these particular items have been included in the following paragraphs.

M.R.G. Mk.2

G.R.U. Type A or B

32. To remove the G.R.U. from the port sextant step the following procedure should be adopted:-

(1) Remove louvred panels from around the port sextant step to gain access to the G.R.U. and E.U. (See fig.1).

(2) Disconnect the two cable assemblies that are connected between the G.R.U. and the E.U. by removing the plugs from the sockets on the G.R.U.

(3) Disconnect the earth strap from the G.R.U. at the aft end of the unit.

(4) Release two locking plates (one shown in fig.1) used to secure the base plate of the G.R.U. in position.

(5) Slide the G.R.U. complete with base plate towards the crew's entrance door and then lift clear.

CAUTION...
The G.R.U. is an extremely delicate instrument and must be handled with great care.

E.U. Type A or B

33. To remove the E.U. from the port sextant step, the following procedure should be adopted:-

(1) Remove louvred panels from around the port sextant step, also remove knee cushion fitted to the top of the step to allow access to six securing screws to be removed later.

(2) Disconnect the two cable assemblies that are connected between the G.R.U. and the E.U. by removing the plugs from the sockets on the G.R.U.

(3) Disconnect the two cable assemblies which are connected to sockets labelled 13C and 18C on the E.U. and stow carefully to the adjacent aircraft structure.

(4) Remove the six securing screws mentioned in sub.para. (1), which secure the top plate to the port sextant step structure, and lift off the plate complete with E.U. and anti-vibration mounting tray.

(5) Separate the E.U. and anti-vibration mounting tray from the top plate by removing the four securing screws.

(6) When it is required to separate the E.U. from the anti-vibration mounting tray, reference should be made to A.P.1275B, Vol.1, Sect.20, Book 2 where instructions for separating and re-assembling the two items are given in detail.

H.R.S. Mk.2 junction box

34. To remove the junction box, access must first be gained by lowering the navigator's sloping panel. Disconnect all plugs and sockets and stow cable assemblies to the adjacent aircraft structure to prevent damage. The junction box may then be removed by releasing four securing bolts (fig.2).

H.R.U. Type B

35. To remove this unit from its anti-vibration mounting tray, first disconnect all cable assemblies and stow them carefully to the adjacent aircraft structure to prevent damage. Unscrew two knurled locking screws and swing down so that the retainer collars disengage from the front panel catch of the H.R.U. Depress the retainer clip and slide the unit forward and lift clear of the mounting tray.

36. The H.R.U. is mounted and positioned on the mounting by placing the H.R.U. in the tray with its rear angled downwards so that the spring-loaded pins locate into their mating holes in the H.R.U. rear plate. With this engagement achieved, the H.R.U. is pushed rearwards against the action of the pins and lowered at the front so that the front panel engages with the retainer clip. Each locking screw is then swung upwards and operated so that the retainer collar engages with the clamps on to the front panel catch of the H.R.U.

H.R.S.C.U. Type B

37. To remove the control unit from the navigator's panel, release four quick release fasteners, situated at each corner of the front panel, and slide the unit forward. Disconnect the cable assembly from the rear of the unit and stow the cable carefully to the adjacent aircraft structure to prevent damage.

TABLE 1

Unit location

Unit	Type and Ref.No.	Location
G.R.U.	Type A or B* Ref.Nos. 6G/39 or 6G/40	Port Sextant step
E.U.	Type A or B* Ref.Nos. 6G/41 or 6G/42	Port Sextant step
H.R.U.	Type B Ref.No. 9CD/8	Under 2nd. Pilot's floor
H.R.S.C.U.	Type B Ref.No. 9CD/12	Navigator's panel
N.H.U.	Ref.No. 9CD/26	Navigator's panel
H.R.S. J/B Mk.2	Ref.No. 9CD/9	Behind Navigator's sloping panel
Navigator's compass repeater	Type B Ref.No. 6B/3647	See Sect.7, Chap.7 (M.F.S.)
G.S.S.U.	Ref.No. 9C/172	Above H.R.S.C.U. Navigator's panel
G.S.R.	Ref.No. 9C/102	See Sect.7, Chap.5 (N.B.S.)
B.S. J/B	Ref.No. 9C/105	See Sect.7, Chap.5 (N.B.S.)
G.P.I. Mk.6	Ref.No. 9C/101	See Sect.7, Chap.5 (N.B.S.)
Optical link J/B	Ref.No. 26DC/10112	See Sect.9, Chap.4 (Green Satin Mk.2)

* Type 'A' is of American Manufacture
Type 'B' is of British Manufacture
These units are identical in construction and operation and may be substituted directly.

TABLE 2

Connectors for H.R.S. Mk.2

H.S.A. Part No.	Cable form	Connection
2/T6351	Rists Ref.No.54/2002/1 20-cores	H.R.U. plug 25C to E.U. plug 13C
	Rists Ref.No.54/502/1 5-cores	H.R.U. plug 25C to E.U. plug 18C
	Miniature 6C 5-cores	E.U. plug 13C to plug 198 panel 11P
3/T6351	Uninyvin 20 7-cores	H.R.U. plug 26C to plug 197 panel 11P
4/T6351	Uninyvin 20 5-cores	N.C.R. plug 1 to plug 195 panel 11P
5/T6351	Rists Ref.No.54/1202/6 12-cores	H.R.S. J/B socket 30C to G.S.R. plug 14A
6/T6351	Rists Ref.No.54/2102/1 27-cores	H.R.U. plug 15C to H.R.S.C.U. plug 15C
7/T6351	Rists Ref.No.54/302/13 6-cores	H.R.U. plug 1C to G.S.R. plug 1A
8/T6351	Rists Ref.No.54/302/13 3-cores	H.R.S. J/B socket 28C to G.S.R. socket 16A
	Uninyvin 20 6-cores	H.R.S. J/B socket 28C to T.C.U. plug 3
9/T6351	Rists Ref.No.54/502/1 5-cores	N.C.R. plug 2 to T.C.U. plug 6
10/T6351	Miniature 25C	H.R.S. J/B plug 33C to B.S. J/B socket 6A
11/T6351	Rists Ref.No.54/1202/6 12-cores	H.R.S. J/B plug 3C to B.S. J/B plug 2A
12/T6351	Rists Ref.No.54/2502/4 25-cores	H.R.S. J/B socket 34C to G.P.I. Mk.6 plug 7A
13/T6351	Rists Ref.No.54/302/13	H.R.U. plug 5C to B.S. J/B plug 8A
	Rists Ref.No.54/302/15 3-cores	H.R.U. plug 5C to B.S. J/B socket 5A
14/T6351	Rists Ref.No.54/1202/6 12-cores	H.R.S. J/B socket 2C to G.S.R. plug 2A
15/T6351	Rists Ref.No.54/2102/1 21-cores	H.R.U. plug 23C to N.C.R. plug 3
	Rists Ref.No.54/1002/1 10-cores	H.R.U. plug 23C to H.R.S. J/B socket 24C
	Rists Ref.No.54/302/13 3-cores	N.C.R. plug 3 to H.R.S. J/B socket 24C
16/T6351	Rists Ref.No.54/902 9-cores	H.R.U. plug 17C to N.B.S. J/B socket 29
19/T6351	Miniature 3C	H.R.S. J/B plug 6C to A.E.O. Monitoring test socket
18/T6286	Rists Ref.No.54/502 5-cores	H.R.U. plug 16C to G.S.R. socket 17A
	Rists Ref.No.54/502 5-cores	H.R.U. plug 16C to T.C.U. plug 5
	Rists Ref.No.54/802/4 8-cores	H.R.U. plug 16C to N.H.U. plug 1
19/T6286	Rists Ref.No.54/602/4 6-cores	N.H.U. socket 2 to M.F.S. J/B plug C2P
2/T5142	Miniature 18J	G.P.I. Mk.6 plug 24A to B.S. J/B socket 24A
3/T5142	Miniature 25C	G.P.I. Mk.6 socket 20A to B.S. J/B plug 20A
4/T5142	Miniature 12C	G.P.I. Mk.6 plug 25A to B.S. J/B socket 25A
8/T5142	Miniature 25X	G.P.I. Mk.6 plug 21A to B.S. J/B socket 21A
22/T5203	Miniature 12C	G.S.R. plug 3A to B.S. J/B socket 3A
24/T5203	Miniature 25C	G.S.S.U. plug to B.S. J/B socket 26A

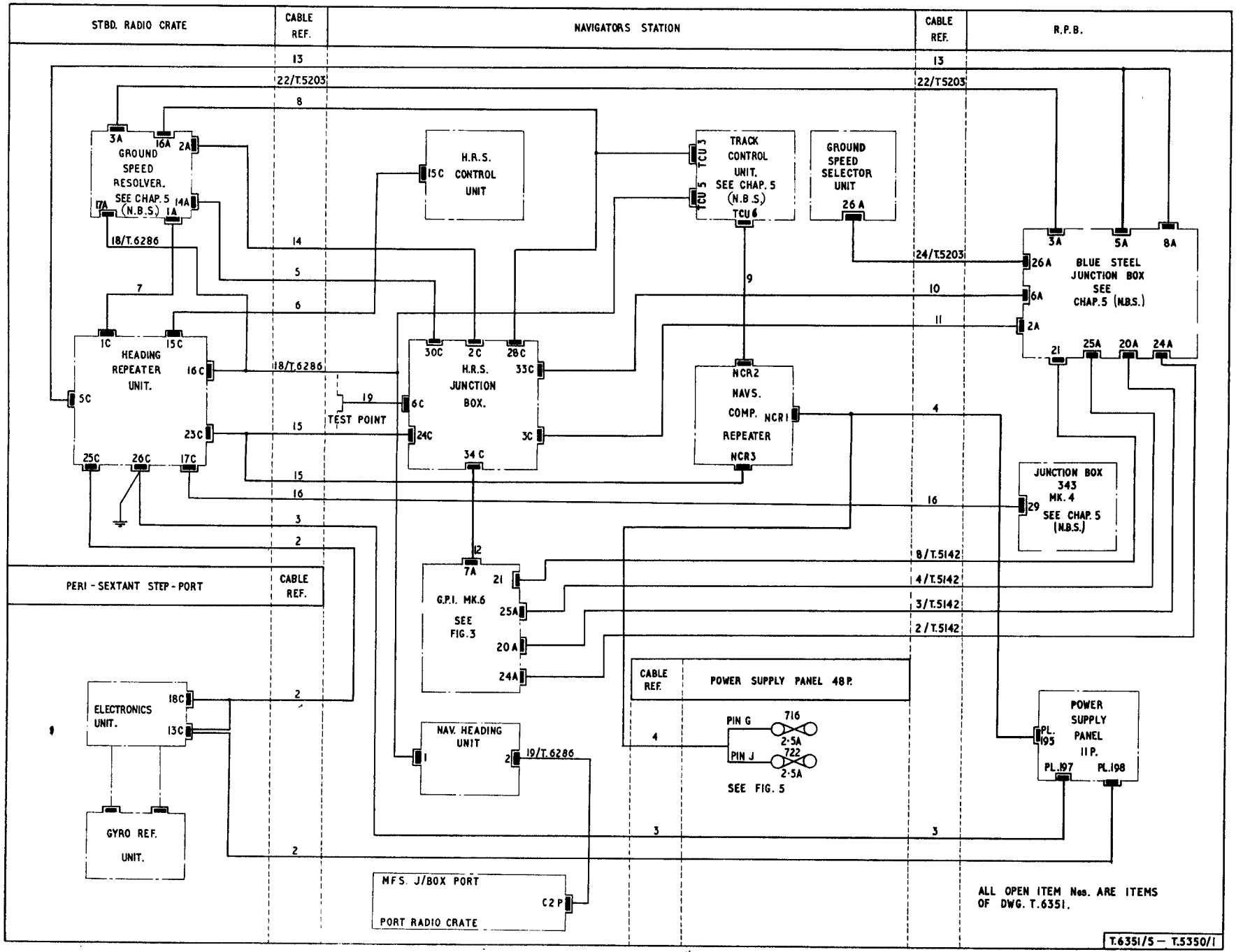


Fig.4 H.R.S. Mk.2

(additional information)

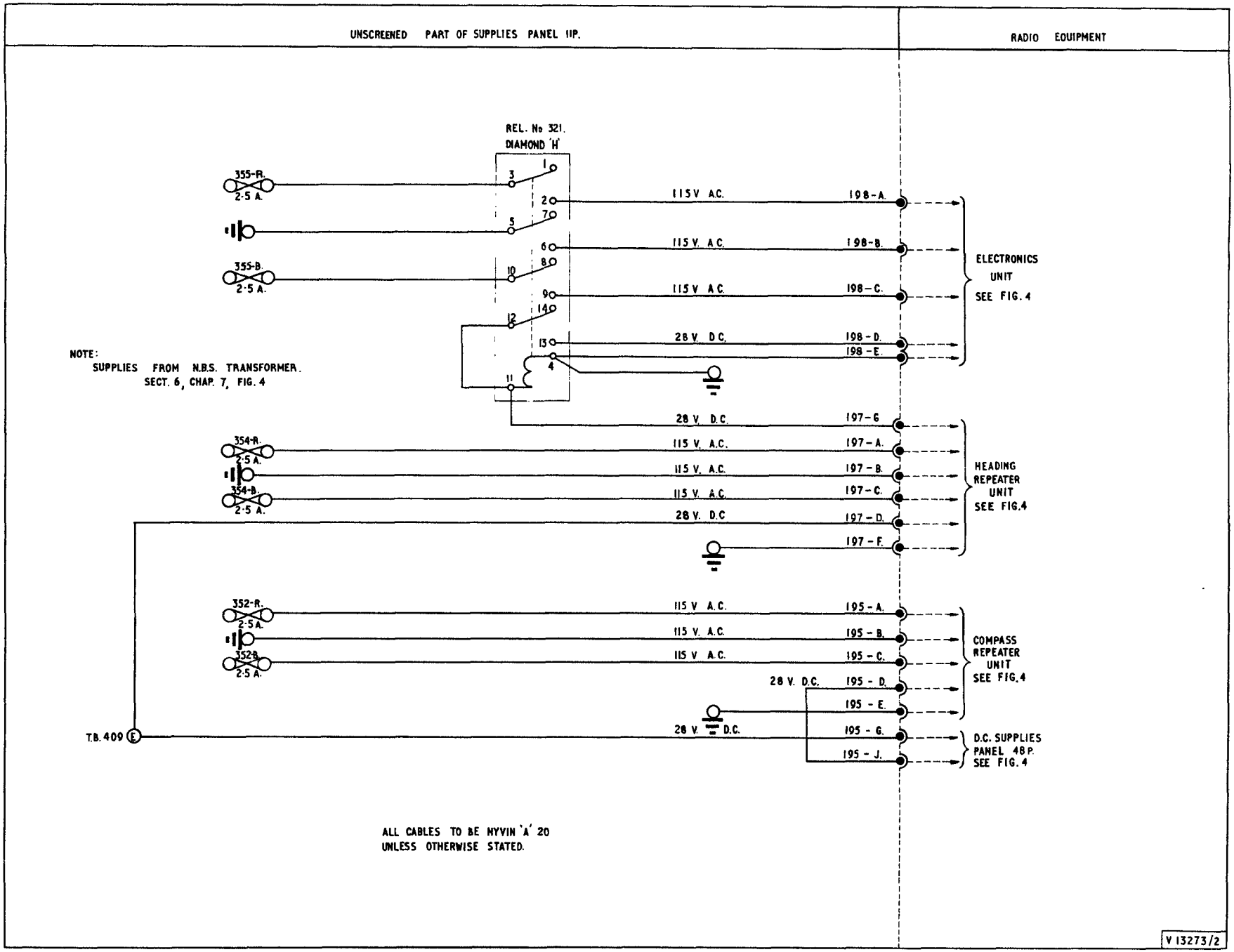


Fig.5 H.R.S. Mk.2 supplies
◀ *(additional information)* ▶

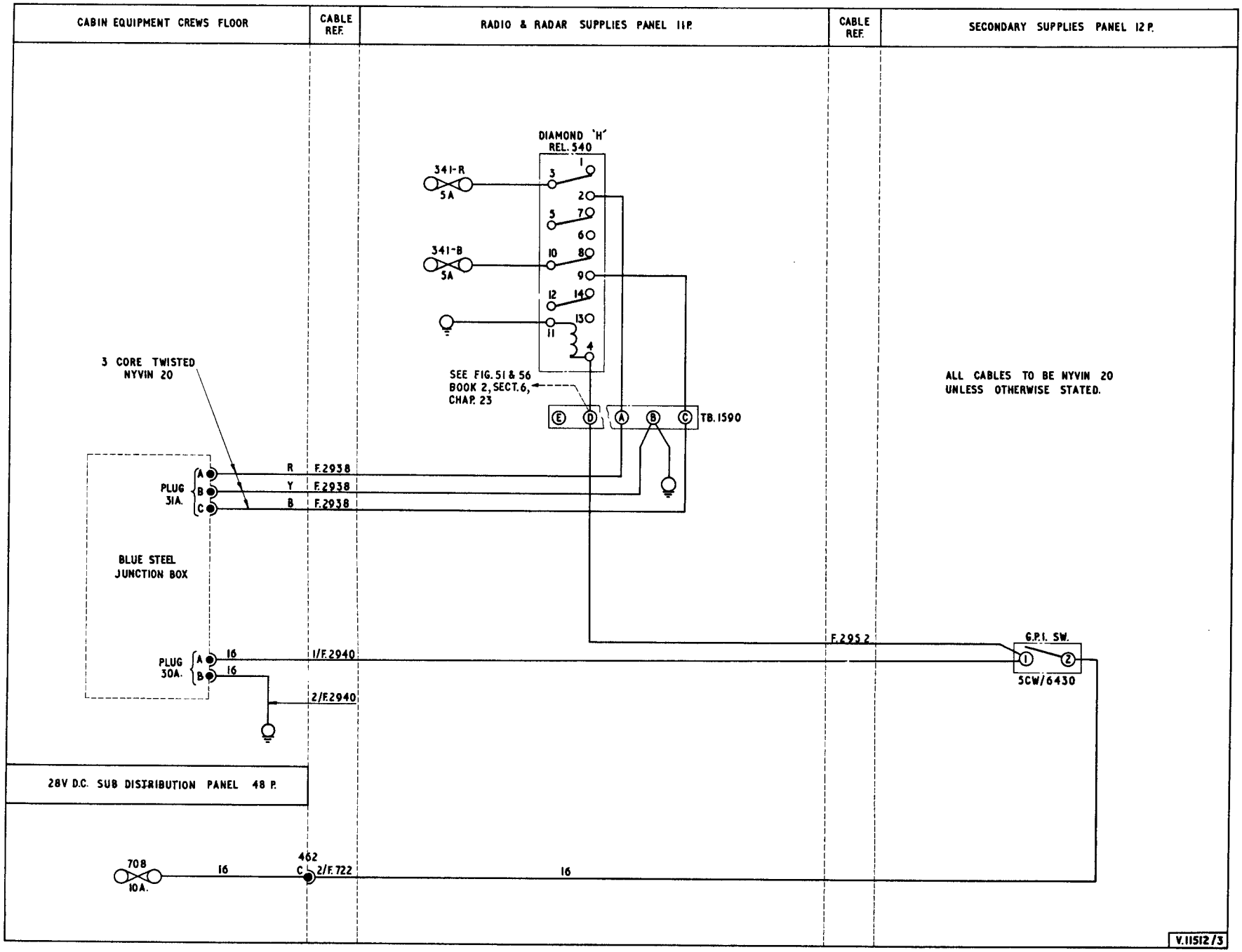


Fig.6 G.P.I. Mk.6 power supplies

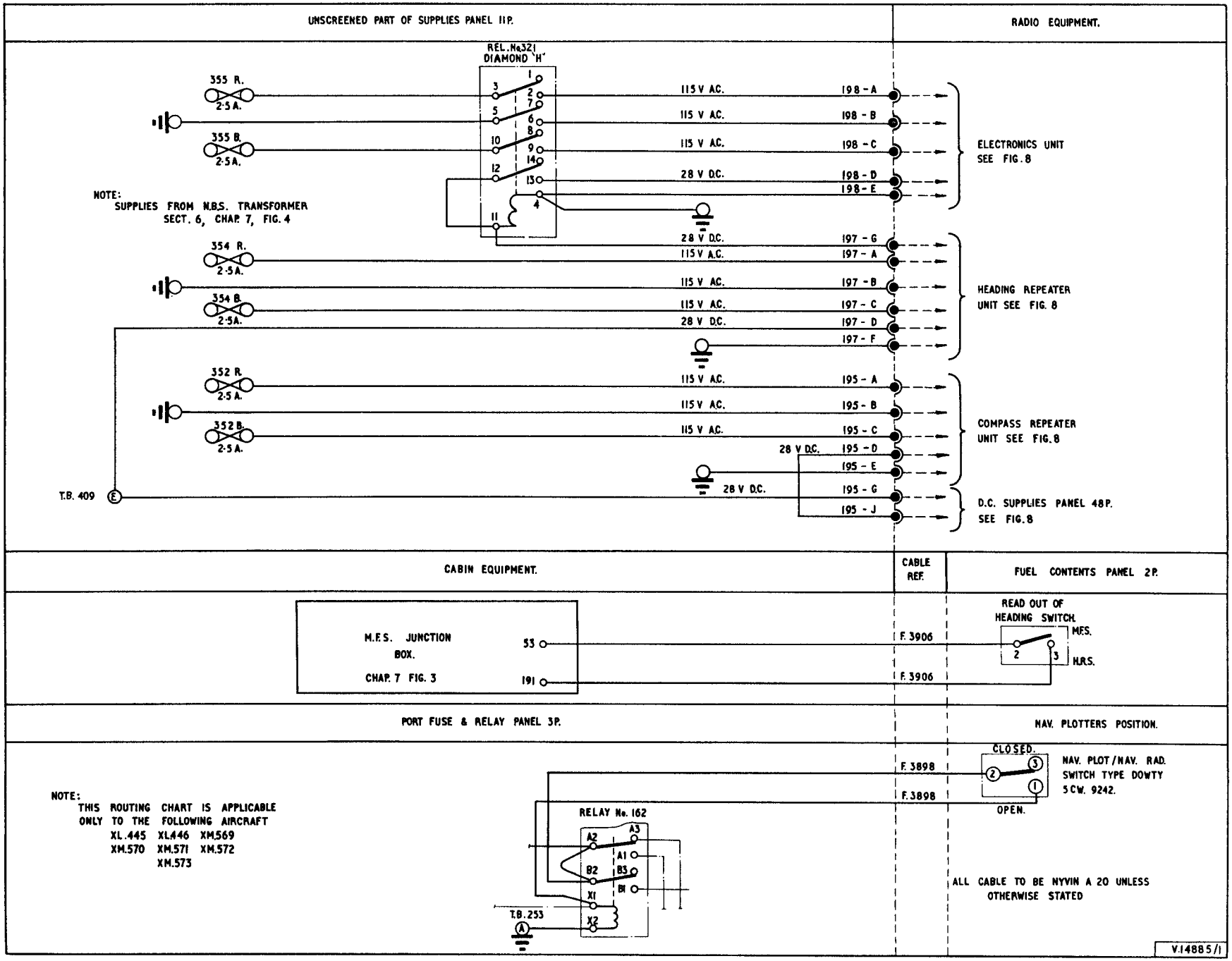
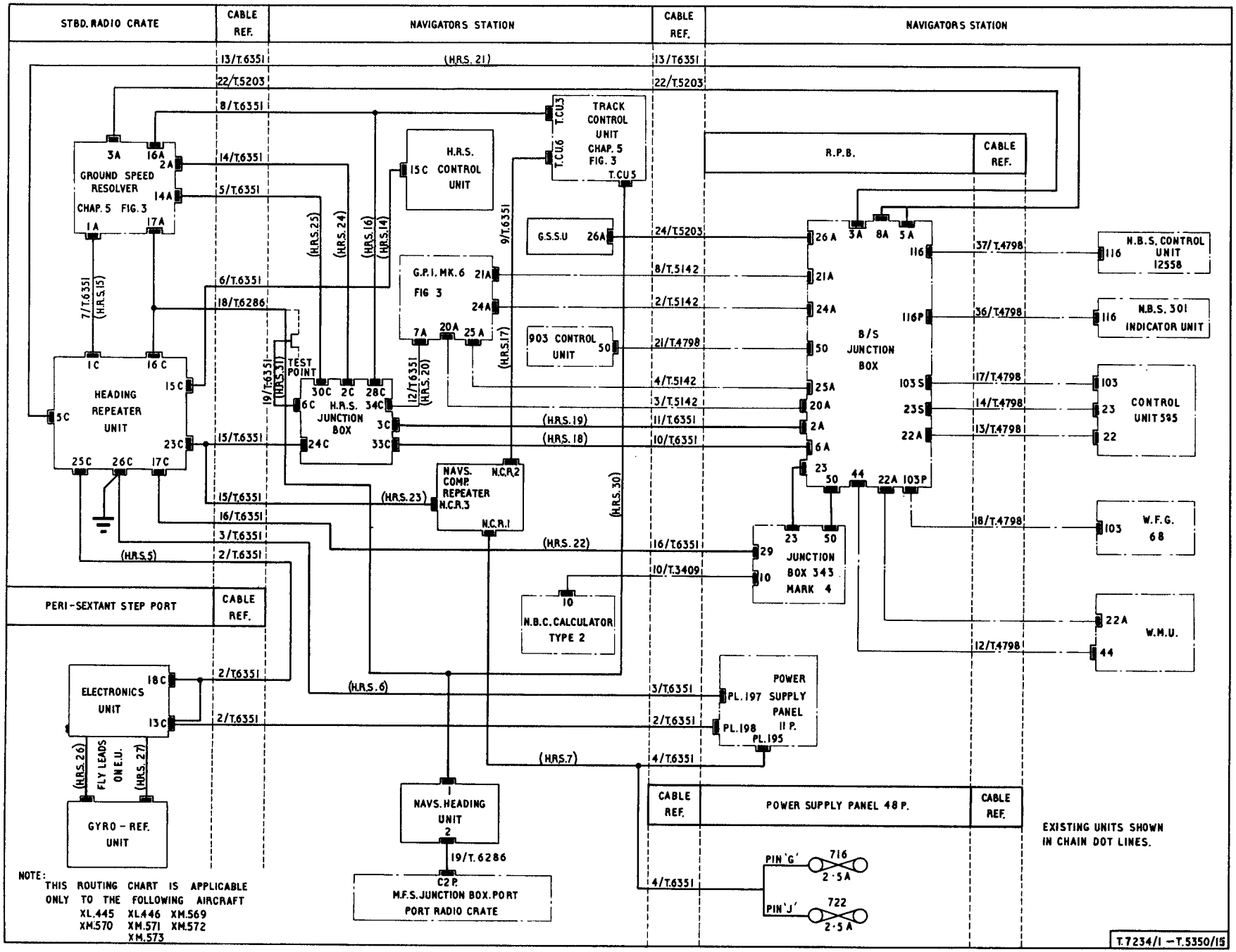


Fig.7 H.R.S. Mk.2 power supplies - post Mod.2112



NOTE:
THIS ROUTING CHART IS APPLICABLE ONLY TO THE FOLLOWING AIRCRAFT
XL.445 XL.446 XM.569
XM.570 XM.571 XM.572
XM.573

462716 625 11/67 H.S.A.1354

Fig.8 H.R.S. Mk.2 - post Mod.2112

Chapter 11

F95 CAMERA INSTALLATION

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Introduction

1. The camera installation, introduced by Mod.2072 (Part A and B), is used for low level bomb scoring. Mod.2072, Part A, provides the fixed fittings namely the control unit mounting bracket, associated blanking plate and aircraft wiring. Mod. 2072 Part B provides the F95 Mk.9 camera, camera frame assembly and control unit, Type 551.

2. The F95 Mk.9 camera is fitted to the camera frame and the whole assembly is mounted over the prone bomb aimer's window. The camera is remotely controlled by the navigator/bomber via the control unit, Type 551.

3. When Mod.2072 Part B is not embodied a blanking plate with dummy sockets are used to facilitate the stowage of the two connectors normally associated with the control unit.

4. A location diagram of the major units is contained in fig.1 and a routing chart will be found at the end of the text. Descriptive, servicing and operating details of the F95 Mk.9 camera and associated control unit, Type 551, may be found in A.P.1355C, Vol.1.

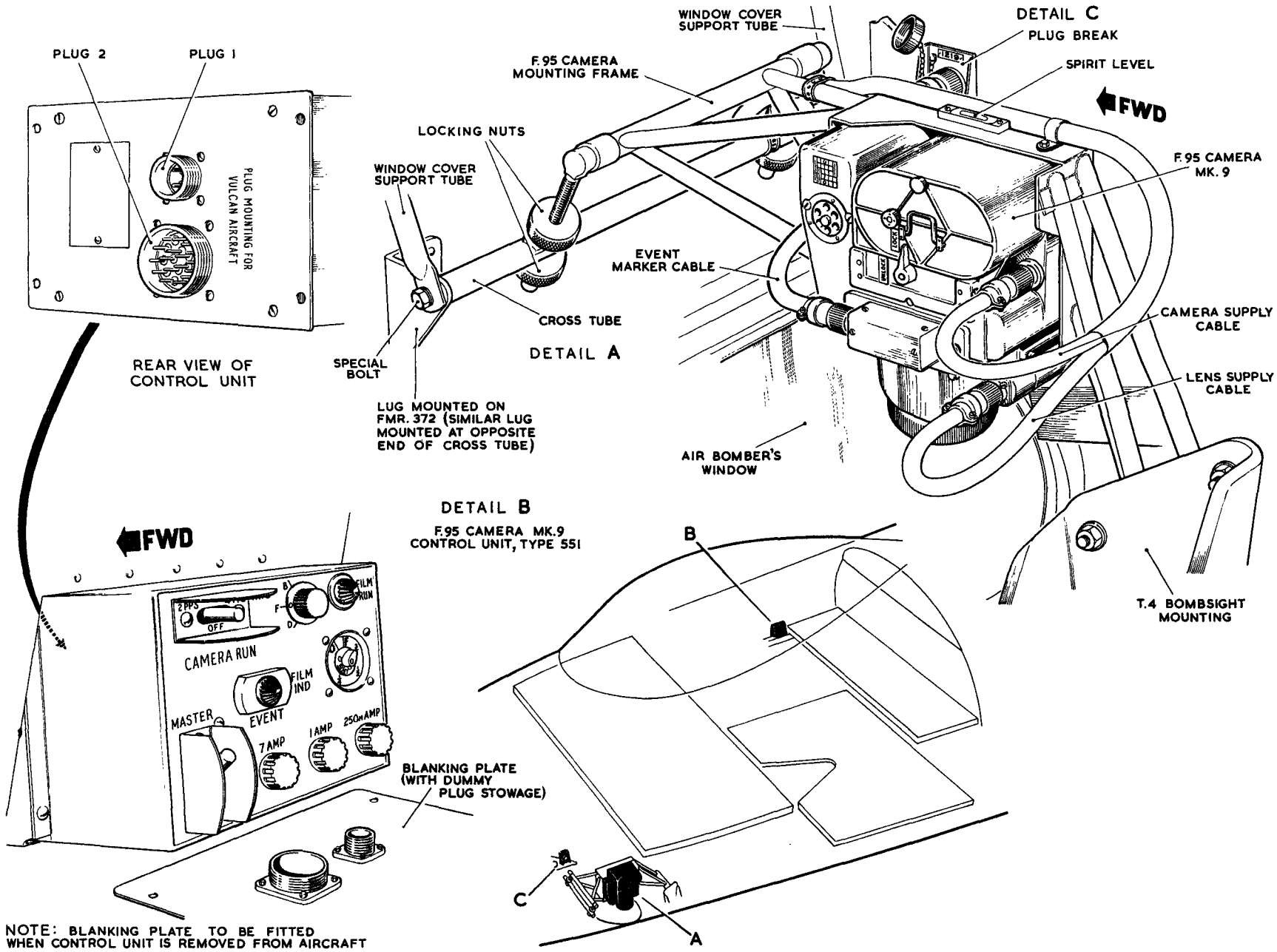

Fig. 1. F.95. camera installation.

DESCRIPTION AND OPERATION

General

5. The following paragraphs contain a brief description of the various functions of the camera installation. The installation comprises the following:-

Item	Ref. No.
F95 Mk.9 Camera	14A/6538
Camera mounting frame H.S.A. Part No.Z.11673	-
Control unit, Type 551	14A/6632

Camera installation

6. The camera mounting frame, complete with F95 Mk.9 camera, is fitted over the prone bomb aimer's window by utilizing the existing T4 bomb sight mounting spigot (aft. fixture) and two existing lug fittings, mounted on former 372, which are also used to secure the existing window cover support tubes (fwd. fixture) as shown in fig.1.

7. The camera supply, lens supply and event marker supply are all fed to the camera from the control unit, Type 551, via plug break 1219 and three connectors. The plug break 1219, positioned at the prone bomb aimer's station as shown in fig.1, has a protective cap attached to the body of the plug by a small chain. The protective cap is screwed on to the plug face when the camera is not fitted to the aircraft. Pin to pin wiring of the three camera cable connectors, plug break 1219 and control unit connectors PL1 and PL2 is contained in fig.2.

Control unit, Type 551

8. The control unit, mounted at the navigator/bomber station, provides full remote control and indication of the F95 Mk.9 camera. The following controls and indicators are fitted to the front panel:-

(1) Master Switch — Used for switching the aircraft 28-volt d.c. supply to the camera installation.

(2) Camera Run — This is a 3-position toggle switch, anotated 2PPS-OFF-4PPS used to select a film speed of 2 pictures per second (PPS) or 4 P.P.S.

(3) Iris — This is a 3-position rotary switch, anotated B, F and D, used for selecting the position of the iris (aperture setting) relative to the local lighting conditions.

(4) Film Ind. — The indicator is an electro - mechanical device which provides indication of the amount of film remaining unexposed in the camera magazine.

(5) Film Run — This indicator illuminates intermittently when the film winding mechanism is being wound over.

(6) Event — This indicator illuminates to indicate that the event marker on the camera has operated when initiated by the aircraft bomb release switch.

9. As previously mentioned when Mod. 2072 Part B is not embodied in the aircraft, a blanking plate, Part No. 5/Z11672, is fitted in place of the control unit, using the existing fixing holes. The two cable connectors PL1 and PL2, normally connected to the control unit, are stowed by connecting them to the two dummy sockets fitted to the blanking plate as shown in fig.1.

Power supplies

10. The camera installation is connected to the aircraft 28-volt d.c. supply from fuse 1315 in panel 4P via PL2 pin N on the control unit. A 28-volt d.c. supply pulse, derived from the bomb release switch on bombing panel 9P, is used to initiate the event marker on the F95 Mk.9 camera. The pulse is connected to the control unit via a diode, TB 675 (B) and PL1 pin A as shown in fig.2. Further information concerning the bomb release switch may be found in A.P.101B-1902-1B, Sect.6, Chap.21.

SERVICING

General

11. All items of equipment should be checked for security of mounting and tightness of plug and socket connections. Before removing any items of equipment suspected of being defective, checks should be made for continuity and insulation resistance on the associated cable assemblies. Complete instructions for servicing the items of equipment comprising the F95 Mk.9 camera installation will be found in A.P.1355C, Vol.1.

Supplies

12. With connector PL2 disconnected from the camera control unit, check that there is a 28-volt d.c. supply between pins N and R of connector PL2.

REMOVAL AND INSTALLATION

Camera assembly

13. The F95 Mk.9 camera, associated cableform and camera frame is assembled to form the camera mounting structure assembly, as shown in fig.1 prior to fitment to the aircraft. When fitting the camera mounting structure to the aircraft the following procedure should be adopted:-

(1) At the prone bomb aimer's station, check to see if the T4 bomb sight is fitted.

(a) If the T4 bomb sight is fitted, remove the bomb sight from the aircraft and return to the stores.

(b) If the T4 bomb sight is not fitted, fold up the window cover and stow in the vertical position.

(2) Remove and return to stores the existing split pins, washers and solid pins from the two lug fittings, on former 372, used to secure the window cover struts.

(3) Position the camera mounting structure with the short stub on the T4 bomb sight spigot and the cross member located between the two lug fittings on former 372 as shown in fig.1.

(4) Secure the cross member and window cover struts to the two lugs on former 372 using two special bolts and associated washers as shown in fig.1.

(5) Connect the camera cable connector to plug break 1219 positioned as shown in fig.1.

(6) Level up the camera structure, with the aid of the spirit level fitted to the top face of the frame, using the four knurled locking nuts to alter the height through the crosstube as shown in fig.1.

Control unit, Type 551

14. The control unit replaces the blanking plate, fitted when Mod.2072 Part A is embodied. The following procedure should be adopted:-

(1) Remove the four 2BA screws used to fix the blanking plate to the mounting bracket and retain the screws for further use.

(2) Disconnect the aircraft cable connectors from the dummy sockets fitted to the back of the blanking plate. Return the blanking plate to the stores.

(3) Connect the appropriate aircraft connectors to PL1 and PL2 at the rear of the control unit and secure the control unit to the mounting bracket using the four 2BA screws retained in sub. para. (1).

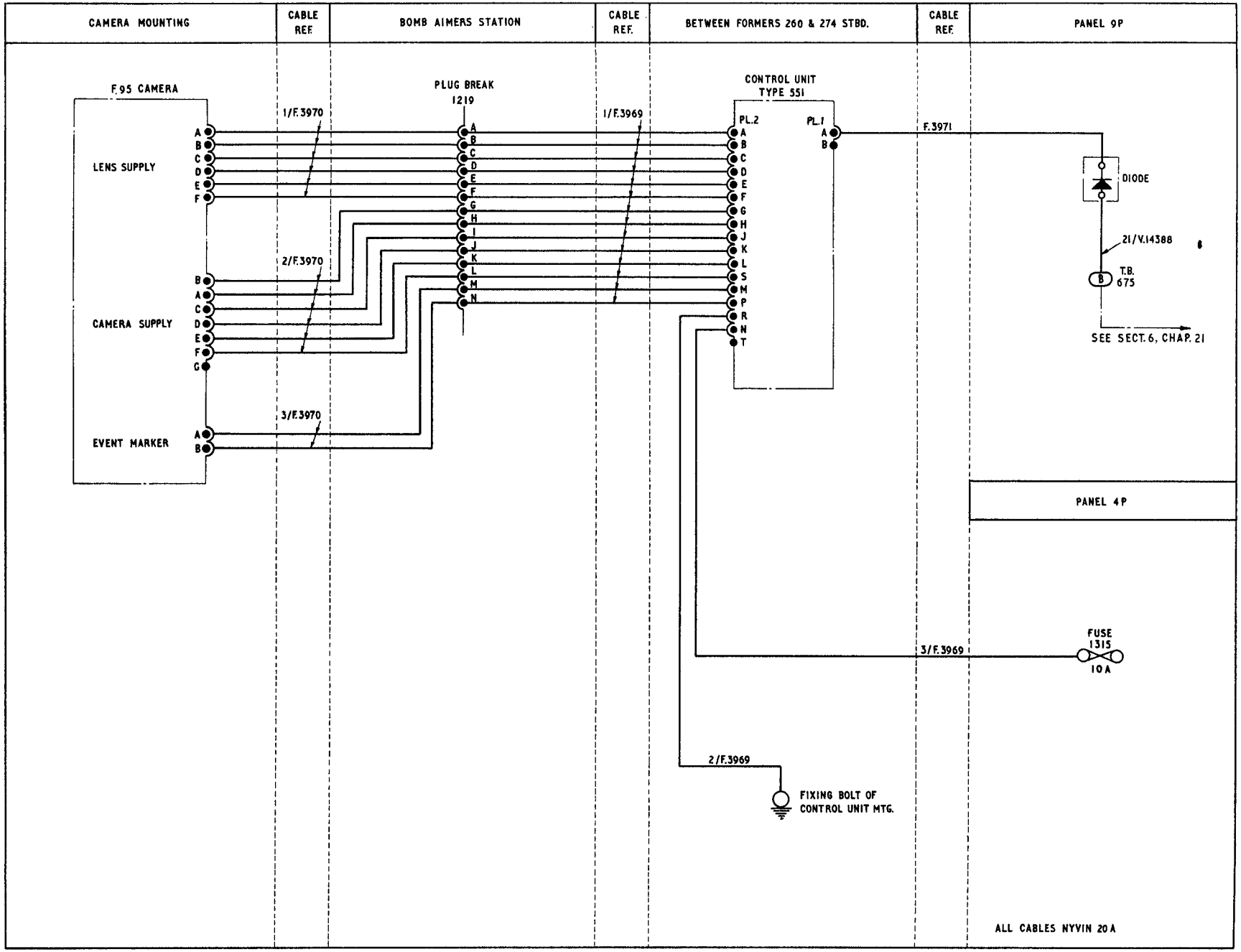

Fig. 2 F95 camera

SECTION 8

WIRELESS INSTALLATIONS

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1.	A.R.I.18089	Intercommunication system and Audio warning
2.	A.R.I.5874	H.F. Installation
3.	A.R.I.18064	V.H.F. Installation (Mod.2007 deletes)
4.	A.R.I.18124/2	U.H.F. Installation (R/T2)
5.	A.R.I.23023	A.D.F. Installation
6.	A.R.I.18011	I.L.S. Installation
◀ 7.	A.R.I. 23172	Mk.7B F.M. radio altimeter ▶
8.	A.R.I.18090	Mk.6A radio altimeter
9.	A.R.I.23143/1	V.H.F./U.H.F. Installation (R/T1) Mod.2007 introduces

Chapter 1

A.R.I. 18089 AND AUDIO WARNING

(Completely revised)

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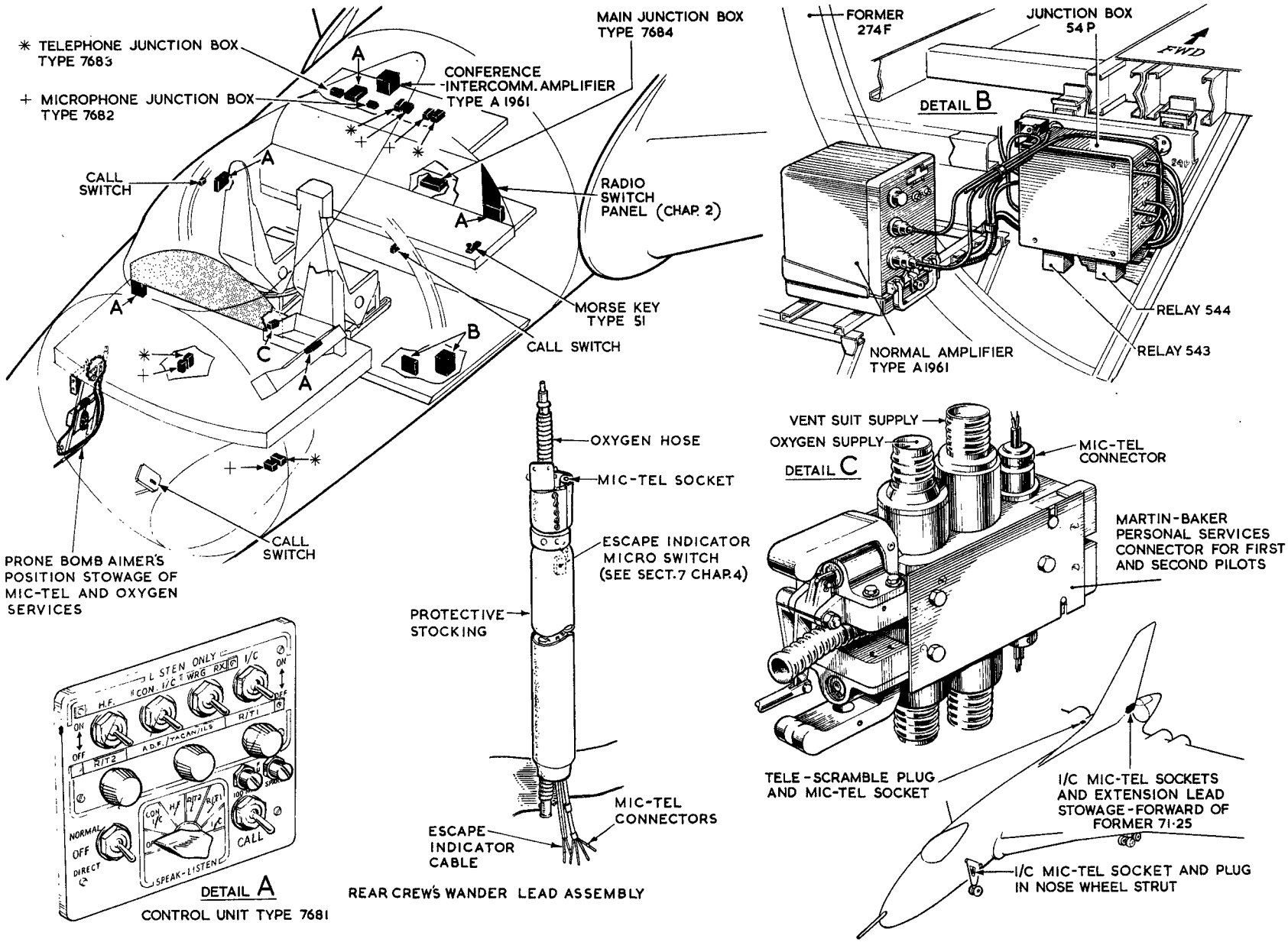


Fig. 1 Location of components A.R.I. 18089

(◄ Mods. 1801, 1696 and 2007 embodied ►)

Introduction

1. This chapter deals with the installation and general functioning of the intercommunication system (A.R.I.18089) as fitted to the Vulcan Mk.2 aircraft. A location illustration of the major components is provided in fig.1, and routing charts for the complete installation will be found at the end of the text. The system is operated from the 28-volt d.c. supplies which are described in Book 2, Sect.6, Chap.6.

2. Descriptive and servicing details for A.R.I.18089 are given in A.P.2876E, Vol.1, the reader is advised to consult this A.P. in conjunction with the information contained in this chapter.

3. With this amendment, information on the following modifications is included:-

Mod.1801	To introduce seperate mic-tel sockets in lieu of existing combined multi-service connectors for the rear crew members.
Mod.1696	To introduce swivel seats for rear crew members and reposition connection points for rear crew oxygen, air vent suit and mic-tel services.
Mod.1900	To introduce a low level high speed warning indication for the first and second pilot.
Mod.2007	To introduce a combined V.H.F./U.H.F. transmitter-receiver system in lieu of existing V.H.F. installation.

DESCRIPTION AND OPERATION

General

4. The A.R.I.18089 is a service-selecting and intercomm. system which fulfils three distinct but correlated functions as follows:-

(1) To provide a channel for the distribution of normal i/c.

(2) To provide a means of selecting all available transmitter and receiver services namely:-

A.R.I.18107/13
A.R.I.5874
A.R.I. 23143/1
A.R.I. 18124/2
A.R.I.23023
A.R.I.18011
A.R.I.18105
Conference i/c.

(3) To provide a means of mixing two or more receiver services, without one adversely affecting the other.

In addition to the foregoing, external i/c facilities are available (1) as an aid to the ground crew during servicing, and (2) as a means of alerting the crew for tele-scramble operations. Also switches are provided, one each for the A.E.O. and 2nd. pilot, for selecting an input to the normal i/c system for monitor or alarm, from A.R.I.18105. The installation is divided into two systems, viz. normal i/c and conference i/c, each having its own amplifier Type A1961.

Controls and supplies

5. The main control switches for the installation are fitted to a small panel located on the main panel at the A.E.O.'s station as shown on fig.1. The switches controlling the intercomm. system are as follows:-

Normal-Emergency-Off
External I/C - Off
Conference I/C - Off
Press-to-Transmit - Off

The 28-volt d.c. supply to the system is fed via fuses 526, 605, 636, 690 and 918, which are located in panel 3P, 4P and 48P.

NORMAL I/C INSTALLATION

Components

6. The normal i/c installation comprises the following major components:-

Item	No.Fitted
Amplifier, Type A.1961	1
Control units, Type 7681	5
Main junction box, Type 7684	1
Sub-junction boxes	
Microphone junction box, Type 7682	5
Telephone junction box, Type 7683	5
Junction box 54P	1
Multi-service connectors	2
Press-to-transmit switches	3
Press-to-call switches	3
Mic-tel socket, Type 359	2
Mic-tel plugs, Type 3570 (including tele-scramble)	3

Amplifier, Type A.1961

7. The intercomm. amplifier, Type A.1961, is fitted to an anti-vibration mounted tray, located under the crew's floor port side. The unit is a three-stage audio-frequency amplifier operating from the aircraft 28-volt d.c. supply. A rotary transformer is incorporated within the unit to give an H.T. supply of 260 volts. The L.T. supply is a stabilised

19 volts, voltage stabilisation being effected by a carbon pile regulator. Two fuses, one for L.T. and H.T. are provided access to these being on the front panel of the amplifier. Descriptive and servicing information for the amplifier, Type A.1961, will be found in A.P.2876E, Vol.1.

Control units, Type 7681

8. Control units, Type 7681, are provided, one at each crew station, namely:-

1st. pilot
2nd. pilot
A.E.O.
Nav. plotter
Nav. bomber

These units provide selection to three transmitter-receiver services, two i/c and three receiver services (A,D.F., TACAN and I.L.S.). Also included is a call switch, which superimposes the caller's signal on any other service, when operated. The first and second pilot have a further service which provides a warning tone to indicate a critical airspeed when flying at low level, further information is given later in the text. Selection of transmitter-receiver services is provided by a speak-listen switch, controlling the appropriate mic-tel circuits. R/T1 and R/T2 volume controls are provided to give a suitable signal level. A third volume control, labelled A.D.F./TACAN /I.L.S., is operated in conjunction with a switch similarly labelled on the port console. The mixing of signals from the receiver services is effected by the volume controls and four listen-only toggle switches. To prevent re-radiation of signals between the services, an anti-cross-talk network is employed, and an amplifier, integral with each unit, restores the signals to the normal level.

9. A 28-volt d.c. supply to the control units is obtained from the aircraft busbars via the following fuses:-

690 in 48P - 1st. pilot, Nav. plotter, Nav. bomber.

526 in 4P - 2nd. pilot, A.E.O.

A three-position switch, labelled NORMAL-OFF-DIRECT, controls the supply and connects the user's telephone to the amplifier in the NORMAL position. In the event of amplifier failure, the DIRECT position is selected; this cuts off the d.c. supply and connects the user's telephone direct to the incoming signal. It should be noted that no mixing facilities are available when the DIRECT position is selected.

Main junction box, Type 7684

10. This unit is located below the navigator's table and provides the central distribution point for the i/c system and its associated wireless services. Mounted on the top face of the unit are two control relays, designated NE/4 and 0/2. Alongside the relays are thirteen multi-pin plugs and sockets, which form the main connections to the system. These plugs and sockets are equipped with a key and slot locating device, thus rendering crossovers impossible.

Sub-junction boxes

11. Two junction boxes, one Type 7682, and one Type 7683, are fitted at each station equipped with a control unit, Type 7681. Each sub-junction box is equipped with three multi-pin plugs for inter-circuit connection, and a multi-pin socket for connection to the associated control unit. The junction box, Type 7682, carries the main microphone services; the junction box, Type 7683, carries the main telephone services. Internal connections are made by soldered spills on a tagboard, the spills are arranged according to the wireless services required. A jumper connection diagram (fig.2) shows the key and spill connections for each sub-junction box.

Junction box 54P

12. This unit (fig.1) is fitted below the crew's floor on the port side of the aircraft and contains relays No.543, 544 and terminal blocks 1074 to 1083 inclusive, for the interconnection of the i/c system and associated wireless services. A wiring diagram of the box is contained in fig.3.

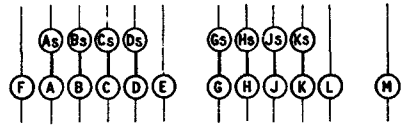
Multi-service connectors

13. Two multi-service connectors are provided for the first and second pilot and provide oxygen, air suit vent and mic-tel connections on the one plug and socket assembly. Descriptive and servicing information for the connectors will be found in A.P.4288B, Vol.1.

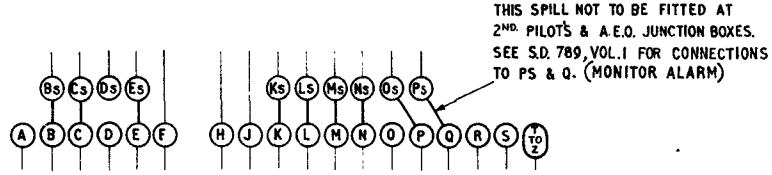
Rear crew service connectors

13A. The rear crew members have separate connectors for the air vent suit, oxygen and mic-tel services. The air suit and oxygen supply points are fully described in Vol.1, Book 1, Sect.3, Chap.8 and 11 respectively of this publication. The mic-tel interconnections are made via a normal jack plug and socket and mic-tel leads (strapped to the oxygen wander leads as shown in fig.1) sufficient in length to allow unrestricted access to the port and starboard perisextant stations. The prone bomb aimer's position is equipped with its own oxygen/mic-tel wander lead and stowage position. The port and starboard perisextant stations and prone bomb aimer's station are each provided with a call switch. The rear crew on leaving the aircraft uncouple the oxygen/mic-tel wander leads from their flying helmets and re-connect the oxygen connectors to special stowage brackets situated on the roof directly above the rear crew seating positions.

SWITCH POSITION CODE NUMBER	WHETHER POSITION ROTARY MIC-TEL SWITCH OR TELS ONLY SWITCH	SERVICE	MICROPHONE CIRCUIT IDENT. FROM CONTROL UNIT INSIDE J.B. 7682	MICROPHONE CIRCUIT. PRECEDING COLUMN TO CONNECT WITH PAIR BELOW	TRANSMITTER/RECVR. OUTLET 6-WAY MICS. TEL. & PTOT ON J.B. 7684 AS PRECEDING COLUMN	IDENT. LETTERS OF PRESS TO TRANS CIRCUIT FROM C/U INSIDE J.B. 7683.	MATING LETTERS IN J.B. 7683 FOR PRESS TO TRANS CIRCUIT.	IDENT. LETTERS OF TELEPHONE + CIRCUIT FROM C/U INSIDE J.B. 7683.	MATING LETTERS IN J.B. 7683 FOR TELEPHONE + CIRCUIT.
1	MIC / TEL	OFF	——	——	——	——	——	——	——
2	MIC / TEL	CON I/C ARI. 18089.	Bs & Hs	B & H	PL 2 B			Ls	L
3	MIC / TEL	HF ARI 5874	Js & Cs	J & C	PL 3 C	Cs	C	Ms	M
4	MIC / TEL	R/T 2 ARI 18124/2	Ks & Ds	K & D	PL 4 D	Bs	B	Ns	N
5	MIC / TEL	R/T 1 ARI 23143/1	Gs & As	G & A	PL 1 A	Es	E	Ks	K
6	MIC / TEL	I/C ARI. 18089	E & L	E & L	PL 7 K	——	——	J	J
7	TELS ONLY.	AIRBORNE WING ARI 18105	——	——	——	——	——	Ps	Q
8	TELS ONLY.	ADF. ARI 23023 ILS. ARI 18011	——	——	——	——	——	Os	P



SPILL CONNECTIONS FOR JUNCTION BOX TYPE 7682.



SPILL CONNECTIONS FOR JUNCTION BOX TYPE 7683.

Fig.2 Jumper connection diagram

Press-to-transmit facilities

14. Three press-to-transmit switches are provided, one on the 1st and 2nd pilots' control columns and one on the R/T panel at the A.E.O.'s station.

External intercomm. points

15. External intercomm. points for use during ground servicing periods and towing operations are provided by a mic-tel plug, Type 3570, fitted on the lower part of the nose wheel unit, and a ground i/c panel fitted in the starboard side of the tail section. The ground i/c panel contains a mic-tel plug, Type 3570, and a mic-tel socket, Type 359; an extension lead for the socket is stowed inside a satchel on the panel. Access to the panel is provided by a small hinged panel on the aircraft skin. Additional external i/c points are introduced by Mod.984 and the tele-scramble installation (see appropriate paragraphs).

Mod.984

16. When Mod.984 is embodied, a mic-tel socket, Type 359, is fitted on the lower part of the nose-wheel unit adjacent to the existing mic-tel plug, Type 3570. The socket is introduced to provide the servicing crew chief with i/c facilities during towing operations.

Normal operation

17. Reference to fig.6 and A.P.2876E, will show that the i/c system is ready for use when the normal-emergency-off switch is selected to NORMAL. A supply will be fed from fuse 636, via junction box 54P and plug 1 pin A of the amplifier, Type A.1961, to energise relay P2 which is located inside the amplifier. The earth return for relay P2 is connected via plug 2 pin E of the amplifier, junction box 54P, plug K pin E and socket J pin C of the main junction box, then through terminals 4-5 of the normal-emergency-off switch to earth. With relay P2 energised, its contacts will close and connect the supply to the rotary transformer and voltage regulator in the amplifier.

18. At the same time, relay NE/4 inside the main junction box will be energised by a supply fed from fuse 918 via junction box 54P and plug H pin A of the main junction box. The earth return for

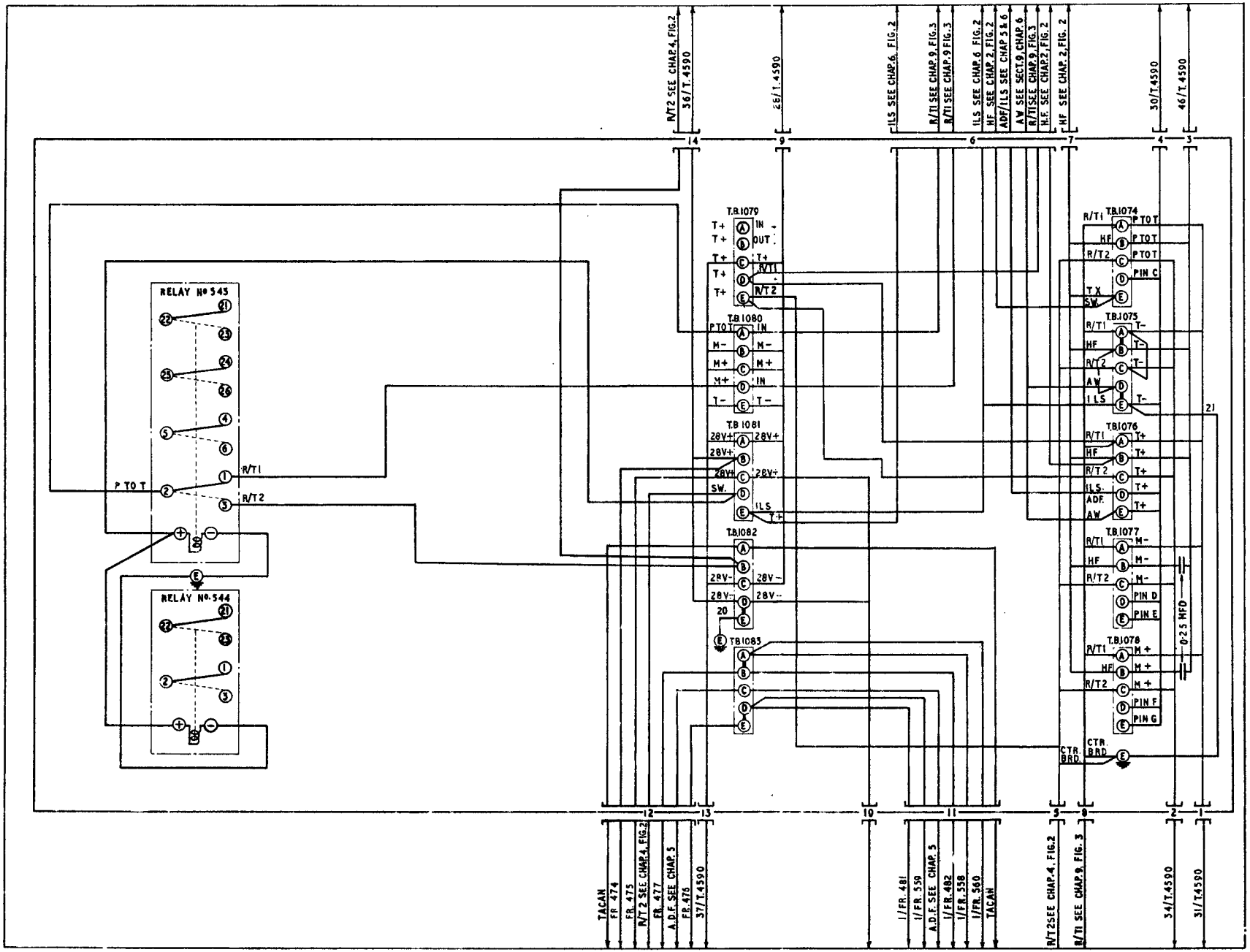


Fig.3 Internal wiring J.B 54 P

(◄Mod. 2007 embodied►)

relay NE/4 is connected via socket J pin D of the junction box and terminals 1-2 of the normal-emergency-off switch to earth. The contacts of relay NE/4 will close to connect the amplifier to the mic-tel circuits via plugs K-N and sockets F-M of the main junction box.

19. The amplifiers in the control units are supplied from fuses 526 and 690, via junction box 54P, plug B pin C of each junction box, Type 7683 (J.B. TEL), plug B pin Q of each control unit and the normal-off-direct switch. The crew members' telephones are connected into the amplifiers via the normal-off-direct switch and plug B pin R of the control units. The microphones are connected to the speak-listen switch from plug A, pins F and M, then out through pins F and L to the junction boxes Type 7682 (J.B. MIC.). Thus with the normal-off-direct switches selected to NORMAL and the speak-listen switch selected to I/C, inter-comm. facilities are available at all crew stations.

Emergency operation

20. Should a failure of the normal amplifier occur, the normal-emergency-off switch must be selected to EMERGENCY. Relay NE/4 in the main junction box will be de-energised; the mic-tel circuits will now utilize the audio stages of the R/T1 transmitter receiver (PTR 175) as an emergency amplifier (R/T1 switched ON).

Press-to-call switch

21. When any call switch on control units, Type 7681, is depressed, relay 0/2 in the main junction box will be energised, and a call telephone channel will then be available and will be super-imposed on any service selected on the control units, until the call switch is released.

CONFERENCE I/C INSTALLATION

22. Conference intercomm. provides an additional i/c channel for use between crew members when isolation from the normal i/c channel is desired. For this purpose an additional amplifier, Type A.1961 is provided and is fitted behind the navigator's panel. Supply to the amplifier is fed from fuse 605 and is remotely controlled by a single-pole switch on the front of the panel at the A.E.O.'s station. Selection to the conference i/c channel is made from the speak-listen and listen-only switches on the control units, Type 7681.

Circuit operation

23. Reference to fig.6 will show that the supply to the conference i/c amplifier, Type A.1961, is obtained from fuse 605. When the i/c conference switch is closed, the supply will be made through the coil of relay P2 inside the amplifier to earth. The relay will then be energised to complete the supply to the rotary transformer and regulator. Connection of the mic-tel circuits to the amplifier is made via pins A, B (earth), C and D of plug B in the main junction box. The telephone circuit is connected from plug B via pin L of socket M to the junction boxes, Type 7683; the microphone circuit is connected via pins B and H of plug N to the junction boxes Type 7682.

R/T1 Selection

24. Should the first pilot require R/T1 facilities, the following sequence of switching and circuit operation will take place. With the control unit, Type C.1607/4, situated at the A.E.O's position, switched on and the required channel selected. On the pilot's i/c control unit, Type 7681, select R/T1 on the speak-listen switch, rotate the R/T1 volume on the listen only panel and place the normal-off-direct switch in the NORMAL position. The R/T1 reception will now be available to the pilot and also to the crew via the crew members i/c control units.

Receiver

25. Reception of the incoming signals will be heard by the first pilot, and by any other crew member (para.8) via the following circuit. From the R/T1 set via the main junction box (pin A plug K to pin K socket M), junction box, Type 7683, (pin K plug C) spill connection K, to the control unit (pin K plug B) and with the switch in the NORMAL position, to the headset telephone.

Press-to-transmit

26. Closing of the press-to-transmit switch provides an earth via pin A plug B through the speak-listen switch to pin E plug B on the control unit; this closes the transmit relay K901 in the R/T1 transmitter-receiver.

Transmit

27. From the headset microphone a M.C.W. is transmitted, as follows:-

Mic. pos. routing

(1) From the microphone to the control unit (pin F plug A, through speak listen switch to pin A plug A) via spill connection A, junction box, Type 7682, (pin A plug C) and main junction box, (pin A plug N, pin D plug A) to the R/T1 set.

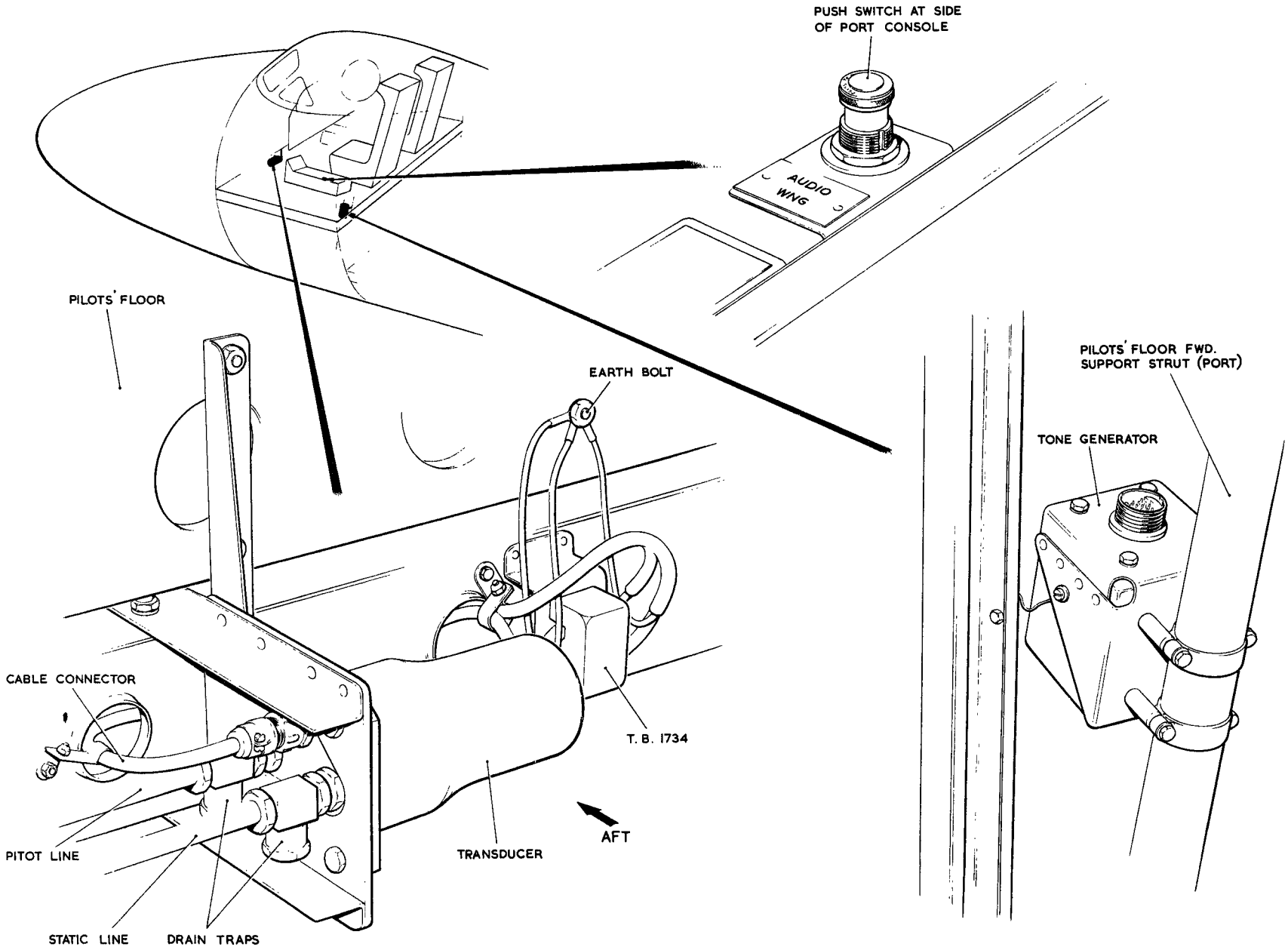


Fig. 4 Audio warning equipment

Mic. neg. routing

(2) From the microphone to the control unit (pin M plug A, through speak listen switch to pin G plug A) via spill connection G, junction box, Type 7682, (pin G plug C) and main junction box (pin G plug N, pin C plug A) to the R/T1 set.

TELE-SCRAMBLE INSTALLATION

General

28. Tele-scramble instructions to the crew are fed into the I/C via a mic-tel plug, Type 3570. This plug, together with a mic-tel socket Type 359, for ground servicing, is mounted on a panel on the starboard side of the power compartment. The panel, which is fitted with a spring-loaded cover, is positioned with the connectors facing aft for quick disconnection during rapid take-off (see Book 2, Chap.6, fig.4A). It should be noted that the tele-scramble channel provides one-way communication only, i.e., from ground control to the aircraft. Thus the aircraft crew members have no talk-back facility. A further mic-tel socket, Type 359, for ground servicing is included in the installation and is located in the bomb bay on the starboard aft face of bomb arch 201.367.

Control switching

29. Each crew member will be connected to the tele-scramble channel when he is on normal I/C selection, i.e. with the normal-off-direct switch selected to NORMAL and the speak-listen switch selected to I/C on his control unit.

Channel routing

30. Reference to fig.6 will show that the tele-scramble channel is connected into the intercomm. system as follows:-

Mic. pos.

(1) From the tele-scramble plug, via T.B.1726 terminal C (1726-C), 1055-C, 1096-D, 381-C, plug 171-C, T.B.372-D, the external intercomm. switch terminals 1-2 and T.B.373-D, to pin D plug F of the main junction box.

Mic. neg.

(2) From the tele-scramble plug, via T.B.1726 terminal D (1726-D), 1055-D, 1096-E, 381-D, plug 171-D, T.B.372-E, the external intercomm. switch, terminals 1-2 and T.B.373-E, to pin C plug F of the main junction box.

From the main junction box the channel will be connected via plug M to the junction boxes Type 7683, thence to the control units Type 7681 through to the headsets. Thus with the external i/c switch selected to ON and NORMAL i/c selected at the control units, each crew member can monitor the tele-scramble channel.

SERVICING

It is essential therefore that the utmost attention be given to servicing instructions, where matters of safety are concerned. It is essential that there is maximum co-operation between trades mutually concerned in servicing operations.

Precautions

34. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100 volts can be dangerous under certain conditions to the extent of causing personal injury, fatal or otherwise and/or damage to the equipment.

AIRSPEED AUDIO WARNING

General

31. The high airspeed audio warning system has been introduced by Mod.1900 and its purpose is to give an audio warning to the first and second pilots when the aircraft airspeed has reached a critical value during low level flight. The main items of equipment comprise a tranducer, Ref.No. 6A/9467, and a tone generator, Ref.No. 6A/9466. A push-to-test switch is fitted on the pilots console 6P. A location diagram and a routing chart are contained in fig.4 and 5 respectively.

Installation

32. The transducer and tone generator are mounted under the pilots' floor as shown in fig.4. The transducer is connected to the pitot-static pressure system and when the airspeed of the aircraft reaches 370 to 380 knots the transducer switches the tone generator on, the output tone being directly connected to the first and second pilots' headsets via T.B.1043 and T.B.1044 respectively. When the push-to-test switch on console 6P is depressed the earth return to the transducer is broken and the tone generator in turn is switched on, thus injecting the warning tone into the first and second pilots' headsets.

Power supplies

33. The system is operated from the aircraft 28-volt d.c. supply via fuse 719 in distribution panel 48P.

General

35. The servicing of the system consists of regular testing of the circuits and components at the periods stated in A.P. 4505B, Vol.4. All components should be frequently checked for security, and plugs sockets, terminal blocks, multi-service

connectors and strain cords should be examined for damage and ingress of dirt and moisture.

Power supplies

36. All ground i/c testing must be carried out with a ground electrical power supply trolley, supplying the normal aircraft d.c. system with 28 volts. The aircraft batteries must not be used.

Functional tests

Controls

37. At the A.E.O.'s station the control switches should be selected as follows:-

Normal-emergency switch	to NORMAL
External i/c switch	to ON
R/T1 control unit	to T/R

A functional test on the system can then be carried out by two men (man A and man B) in the following manner. At the R/T1 control unit at the A.E.O.'s position, man A selects the appropriate preset channel. At the second pilot's station, man B selects on the i/c control unit, Type 7681, the normal-off-direct switch to NORMAL.

Normal i/c

38. When men A and B, in the first and second pilot's stations respectively connect their headsets to the personal equipment connectors, transmission and reception of speech will be available with the normal-off-direct switch at NORMAL, and the speak-listen switch on control units Type 7681, at I/C.

Listen only

39. With the settings of the switches controlled by man A remaining in the normal i/c position (para.38), man B selects the speak-listen switch to OFF and listen-only switch to I/C; transmission of speech by man A is now received by man B. The procedure is then reversed.

Conference i/c

40. With the speak-listen switch, and listen-only switch selected to CON. I/C. repeat tests in para.38 and 39.

Call switch

41. With man A remaining on normal i/c (para.38), man B selects the speak-listen and listen-only switches to OFF. Man A then depresses his call switch and transmission of speech will be received by man B. The procedure is then reversed.

Control unit amplifier failure

42. To simulate a control unit amplifier failure, man A remaining on normal i/c (para.38), man B will select the normal-off-direct switch to DIRECT and the speak-listen switch to I/C. Transmission and reception of speech will now be available, but no mixing facilities.

Normal amplifier failure

43. To simulate a normal amplifier failure, at the air electronics officer's station, select the normal-emergency-off switch to EMERGENCY. At the control units, Type 7681, select the normal-off-direct switch to NORMAL, the speak-listen switch to R/T1 and rotate the R/T1 volume control clockwise for the duration of the test only (LISTEN ONLY panel). Transmission and reception of speech between first and second pilot's stations will now be available.

Sequence of testing

44. Tests as carried out in para.38 to 43 inclusive, between first and second pilot's stations, should be repeated from these two stations to all other crew stations fitted with control unit, Type 7681.

Isolated crew stations

45. The following isolated crew stations have no control unit, Type 7681, only a call switch and in the case of the prone bomb aimer a mic-tel lead and A.S.V. and oxygen supplies and stowage is provided.

Port perisextant
Prone bomb aimer
Starboard perisextant

On any control unit, Type 7681, man A will select the speak-listen and listen-only switches to OFF, the normal-off-direct switch to NORMAL. Man B, on depressing his call switch, is now able to transmit speech. Each isolated crew station is to be tested in this manner.

External i/c

46. With normal i/c selected (para.38), transmission and reception of speech is available between all crew stations fitted with control unit, Type 7681, and each external plug and socket.

Tele-scramble installation

47. When normal i/c is selected (para.38) and the external i/c switch is selected to ON, reception of speech from the tele-scramble socket is available at all crew stations fitted with control units Type 7681.

Audio warning system

48. Whenever the installation is suspect, or if any part of the pitot-static system has been disturbed, a sense and

leak test should be carried out in accordance with A.P.3158, Vol.2, Leaflet B.42. To test the audio warning system apply pressure to the pitot system and check that the tone generator is switched on giving a warning note on the first and second pilots' headsets at 375 to 380 knots I.A.S.

Completion of tests

49. On completion of the above tests, switch all services to OFF and remove the ground power supplies.

REMOVAL AND INSTALLATION

General

50. Access to the majority of components is straightforward. When it is necessary to remove or replace any components, secure all loose connectors to the adjacent aircraft structure.

Amplifiers, Type A.1961

51. Each amplifier, Type A.1961, is fitted to an anti-vibration equipment rack. Disconnect socket SK1, plugs PL1 and PL2, from the front panel, and unscrew the knurled nut at the amplifier base, then slide the unit out by means of the transport handle. On replacing the unit, ensure that the locating dowels engage properly at the rear of the rack.

Control units, Type 7681

52. These control units are located on panels or brackets; remove the retaining screws, withdraw the unit and disconnect the plugs.

Junction boxes, Type 7682, 7683 and 7684

53. These junction boxes are located on panels or airframe brackets. Disconnect the plugs and sockets from the units and remove the retaining screws.

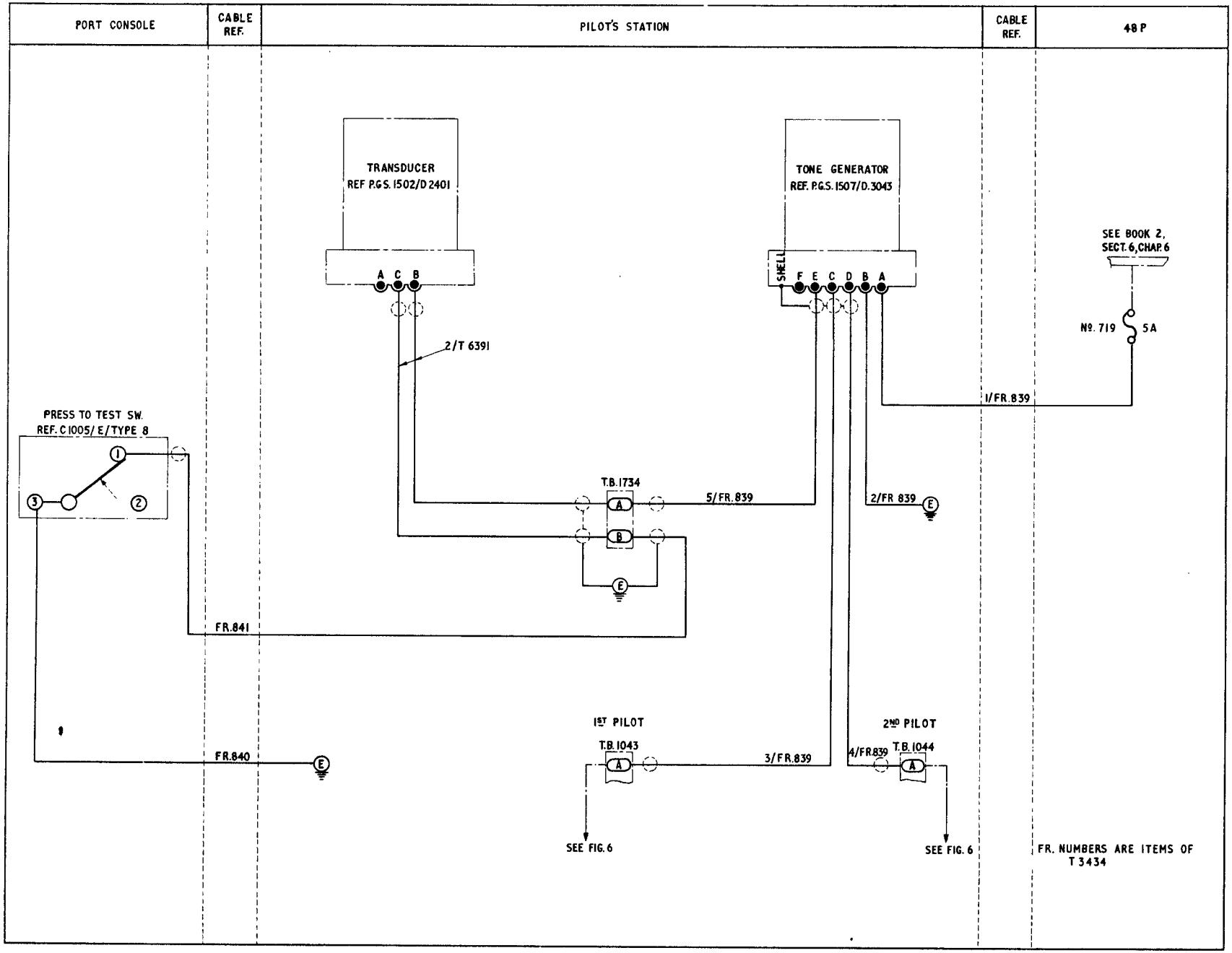
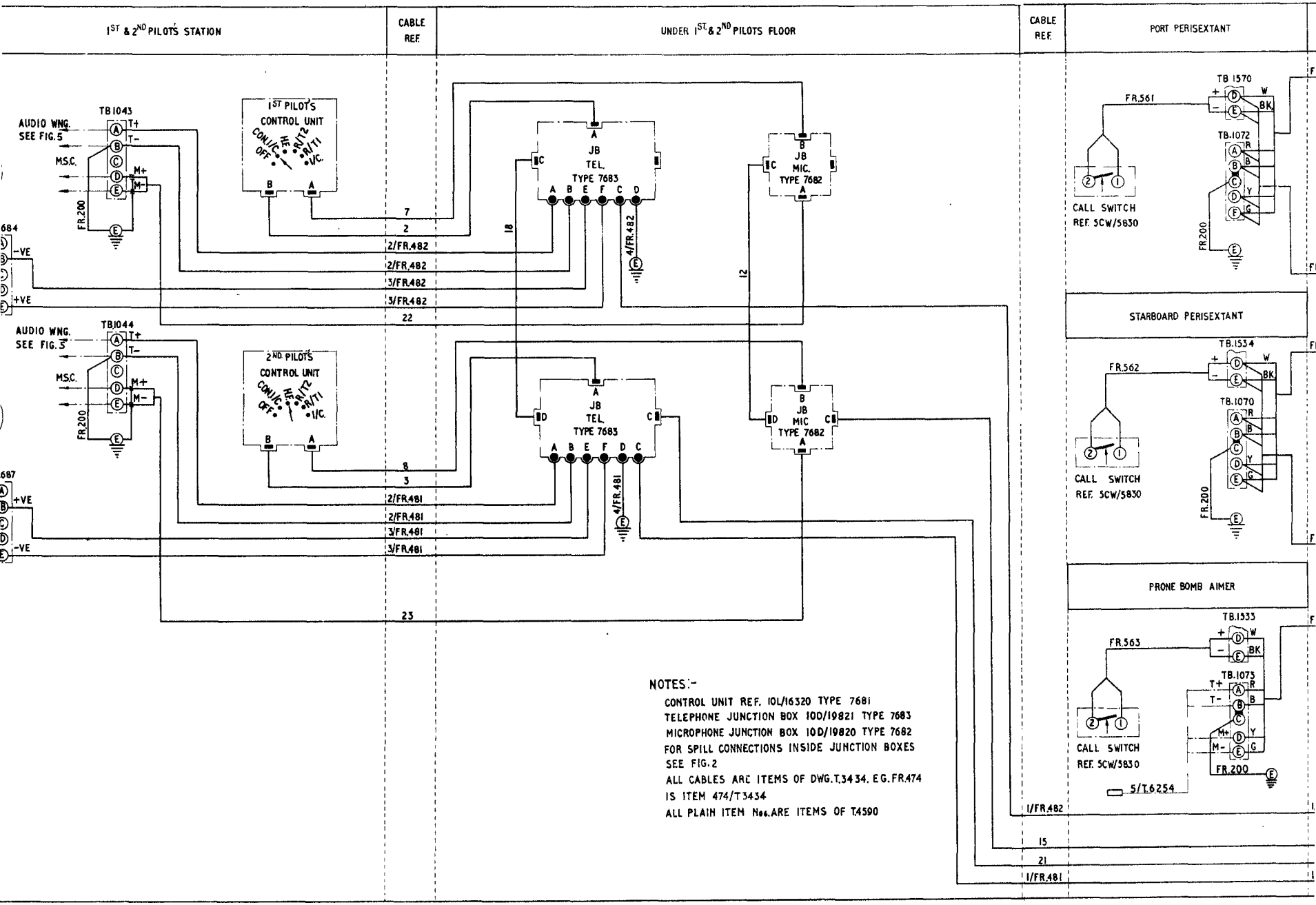


Fig. 5 Airspeed audio warning

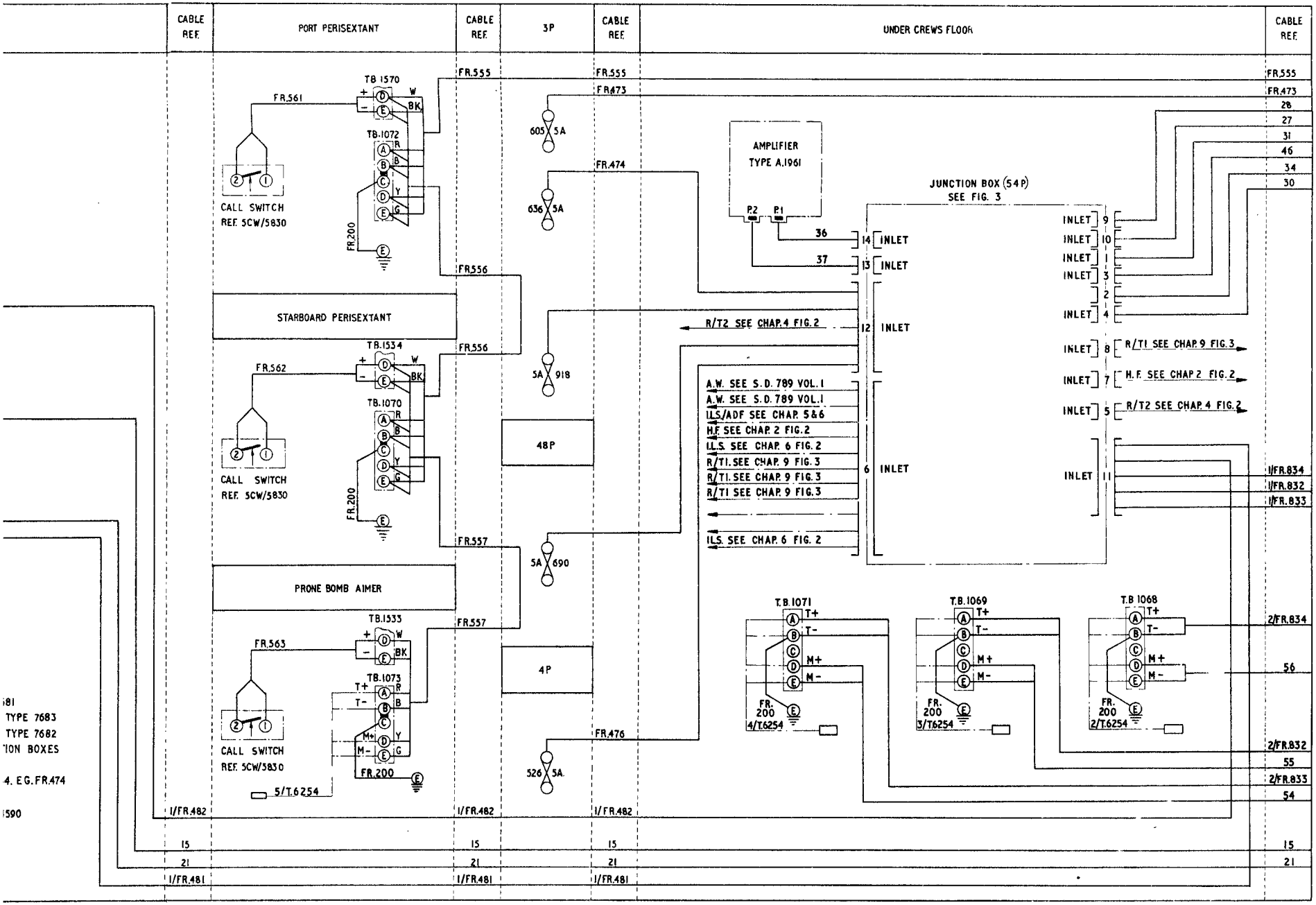


NOTES:-

CONTROL UNIT REF. 101/16320 TYPE 7681
TELEPHONE JUNCTION BOX 100/19821 TYPE 7683
MICROPHONE JUNCTION BOX 100/19820 TYPE 7682
FOR SPILL CONNECTIONS INSIDE JUNCTION BOXES SEE FIG.2
ALL CABLES ARE ITEMS OF DWG.T.3434. E.G. FR.474 IS ITEM 474/T3434
ALL PLAIN ITEM Nos. ARE ITEMS OF T.4590

Fig.6 (1) A.R.I.18089 with conference i/c

Mods.1801, 1696, 1900 and 2007 embodied



.6 (1) A.R.I.18089 with conference i/c

Mods.1801,1696,1900 and 2007 embodied ▶

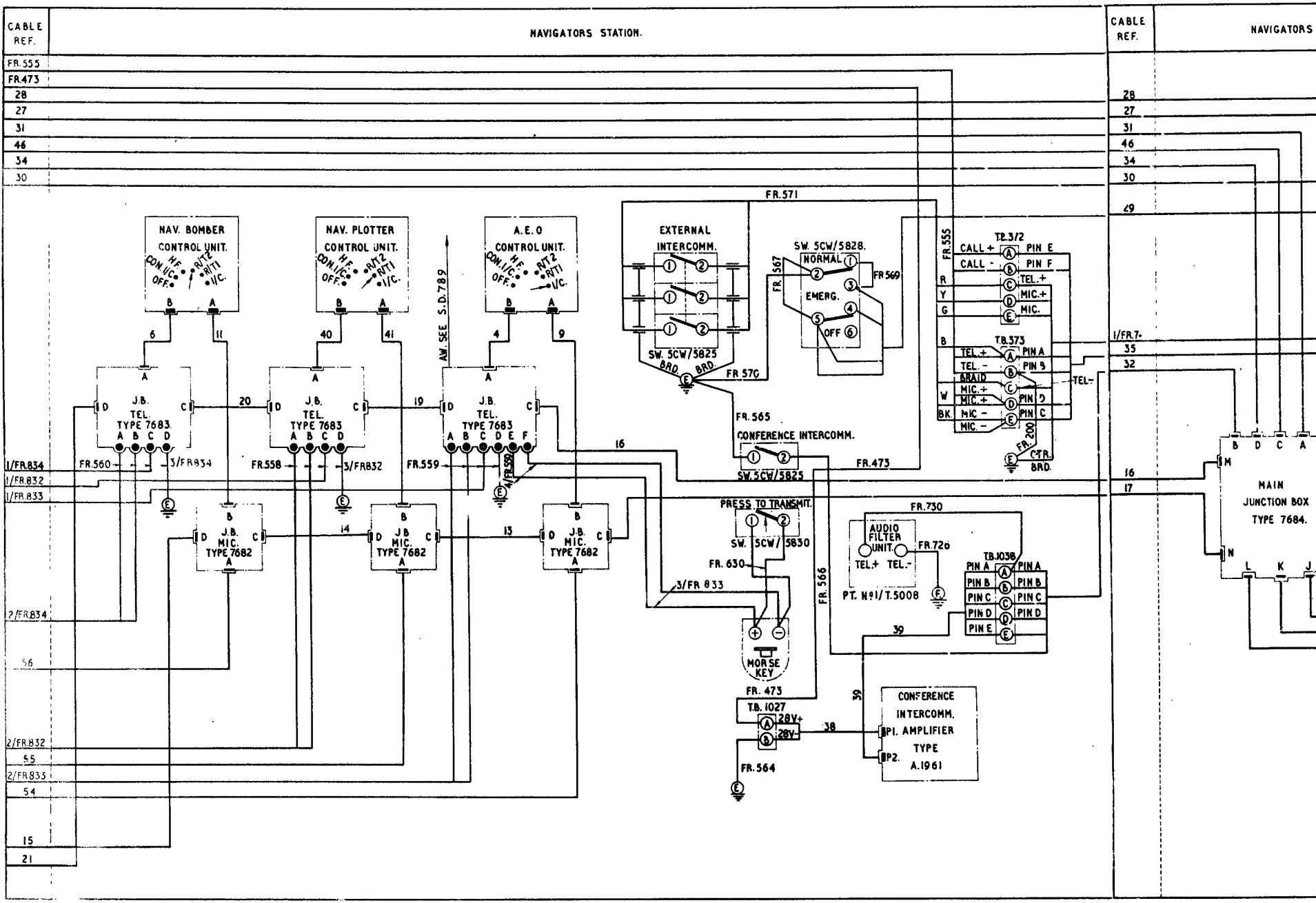


Fig.6 (2) A.R.I.18089 with conference i/c

Mods.1801,1696,1900 and 2007 embodied

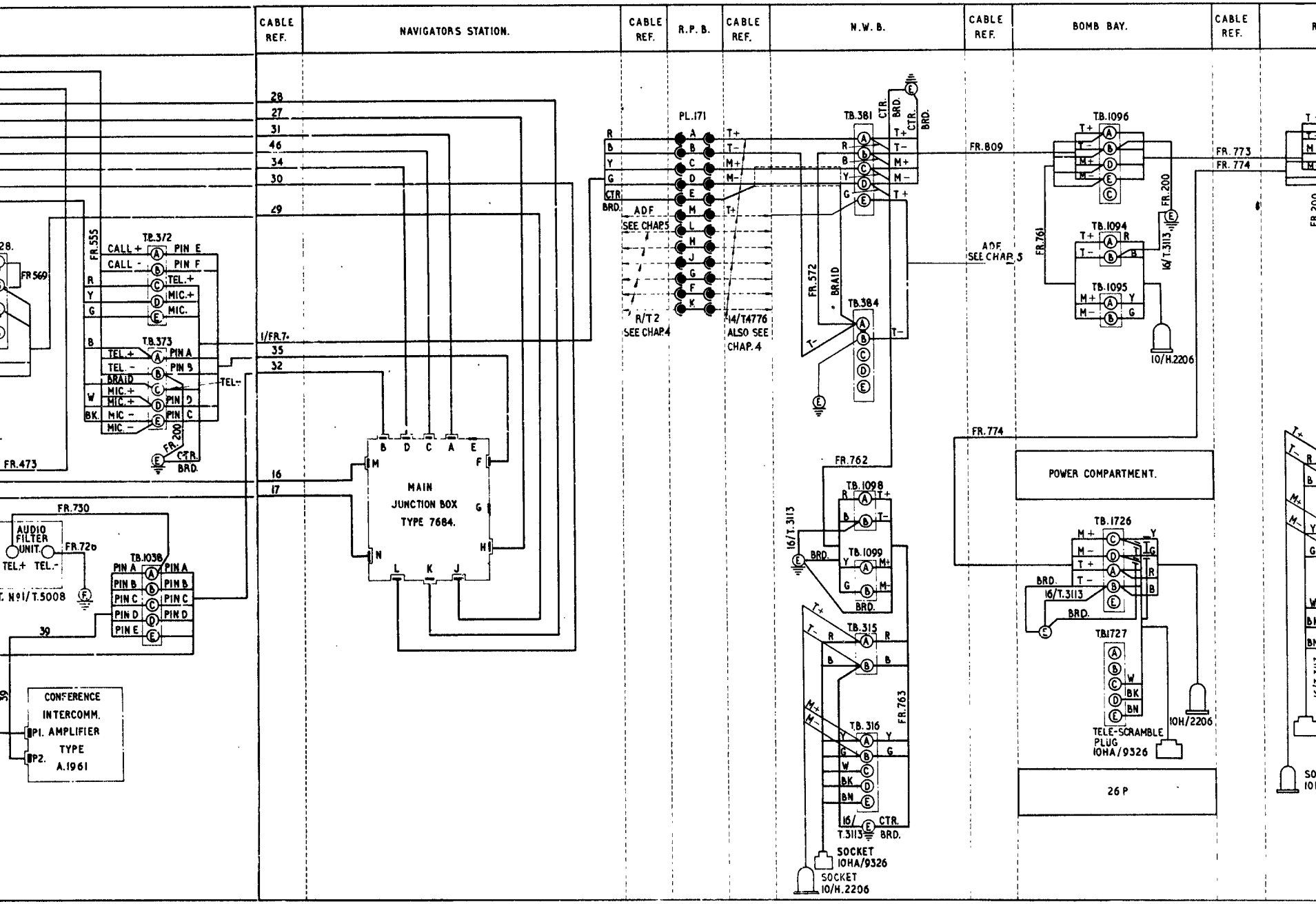


Fig.6 (2) A.R.I.18089 with conference i/c

Mods.1801, 1696, 1900 and 2007 embodied

Chapter 2

A.R.I.5874

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Introduction

1. This chapter deals with the installation and general functioning of the H.F. communication installation. The location of major components will be found in fig.1; a connector table and routing chart are provided at the end of the text. Descriptive and servicing details for the A.R.I.5874 are given in A.P.2535E, Vol.1, which should be read in conjunction with the information contained in this chapter. The associated 28-volt d.c. power supplies are dealt with fully in Book 2, Sect.6, Chap.6 of this publication.

DESCRIPTION AND OPERATION

BRIEF DESCRIPTION

2. The basic equipment of A.R.I.5874 includes a 24-channel crystal-controlled transmitter and receiver, operating in the H.F. band 2.8 Mc/s. to 18.1 Mc/s. Operation may be on C.W., M.C.W., or R.T. with a transmitter carrier output of approx. 100 watts. The complete installation forms a general purpose airborne H.F. communications system, and is used in conjunction with a suppressed aerial system.

POWER SUPPLIES

3. Two single pole switches labelled, H.F. SUPPLY-OFF and H.F. OUTPUT LOW-HIGH, are located on the A.E.O's switch panel, and a morse key, Type F, is secured to the table at the A.E.O's position. A d.c. supply via fuse 700 in panel 48P through the H.F. supply switch energises relay 334. With relay contacts A1-A2 closed, a d.c. supply is fed via C.B.52 in panel 15P, to the power and radio unit, Type 4192, and a voltage regulator, Type 228. The 28-volt d.c. input to the power and radio unit, provides H.T. for the transmitter unit. The receiver unit incorporates its own rotary transformer which supplies 220-volts H.T. for the receiver circuits. For certain L.T. circuits a stabilised supply of 19-volts d.c. is required; this is provided by the carbon pile voltage regulator.

INTER-UNIT CONNECTION

4. Connection between the units is made by engaging the plugs and sockets at the rear of individual units with the respective sockets and plugs on the ends of the cables located in the back-plates of the mounting racks. Each back-plate has two locating spigots which align the units to the back-plates. To improve the mating of multi-pin plugs, sockets and co-axial sockets a certain amount of "float" has been allowed for in design.

CONTROLS AND UNIT LOCATION

5. The A.R.I.5874 is controlled from a remote control unit, Type 4189, located on the port side of the navigator's panel. The remainder of the equipment is located on a shelf below the navigator's table, fitted with anti-vibration trays containing the following units:-

Power and radio unit,	Type 4192
Transmitter,	Type T.4188
Control unit,	Type 4190
Receiver,	Type R.4187
Junction box,	Type 4191
Voltage regulator,	Type 228

Remote control unit, Type 4189

6. All the units of the A.R.I. are operated from the remote control unit; no local controls facilities are available. The unit provides the following controls and indications:-

(1) Power supply switching

(2) Selection of type of transmission

(3) Selection of frequency with fine tuning and lamp indications

(4) R.F. gain control

(5) Aerial excitation meter

(6) Dimmer switch for dial light of the frequency selector switches

Power and radio unit, Type 4192

7. The chassis of the unit carries the following main units:-

Rotary transformer
Amplifying unit
Transformer

The unit provides H.T. power for the transmitter circuits, the power outputs being 300-volt and 600-volt respectively. Air cooling is obtained by a fan, mounted on the rotary transformer shaft, drawing air through an air filter unit.

Transmitter, Type T.4188

8. The transmitter, Type T.4188, consists mainly of three tuned amplifiers, a mechanical drive unit, which includes the tuning motor and a motor for air-cooling the P.A. stage. All the components are mounted on a cast aluminium chassis. The frequency range of the transmitter is provided in two bands namely:-

Band 1 - 2.8 to 7.0 Mc/s.
Band 2 - 7.0 to 18.1 Mc/s.

Referring to the front panel of the transmitter (fig.1), a TUNE key is provided to facilitate the checking of the valve currents with the aid of the meter switch. The changeover from automatic to manual control is made possible by using the AUTO/MAN switch. In the manual condition, the transmitter coils can be rotated, by means of the TRANS/TUNE knob, to enable a mechanical check to be made during inspection of the equipment. The transmitter H.T. is not available in this condition.

Control unit, Type 4190

9. The control unit, Type 4190, is fitted only to aircraft with suppressed aerial systems. This is the control and drive unit of the transmitter, together with the pre-set potentiometers for setting up

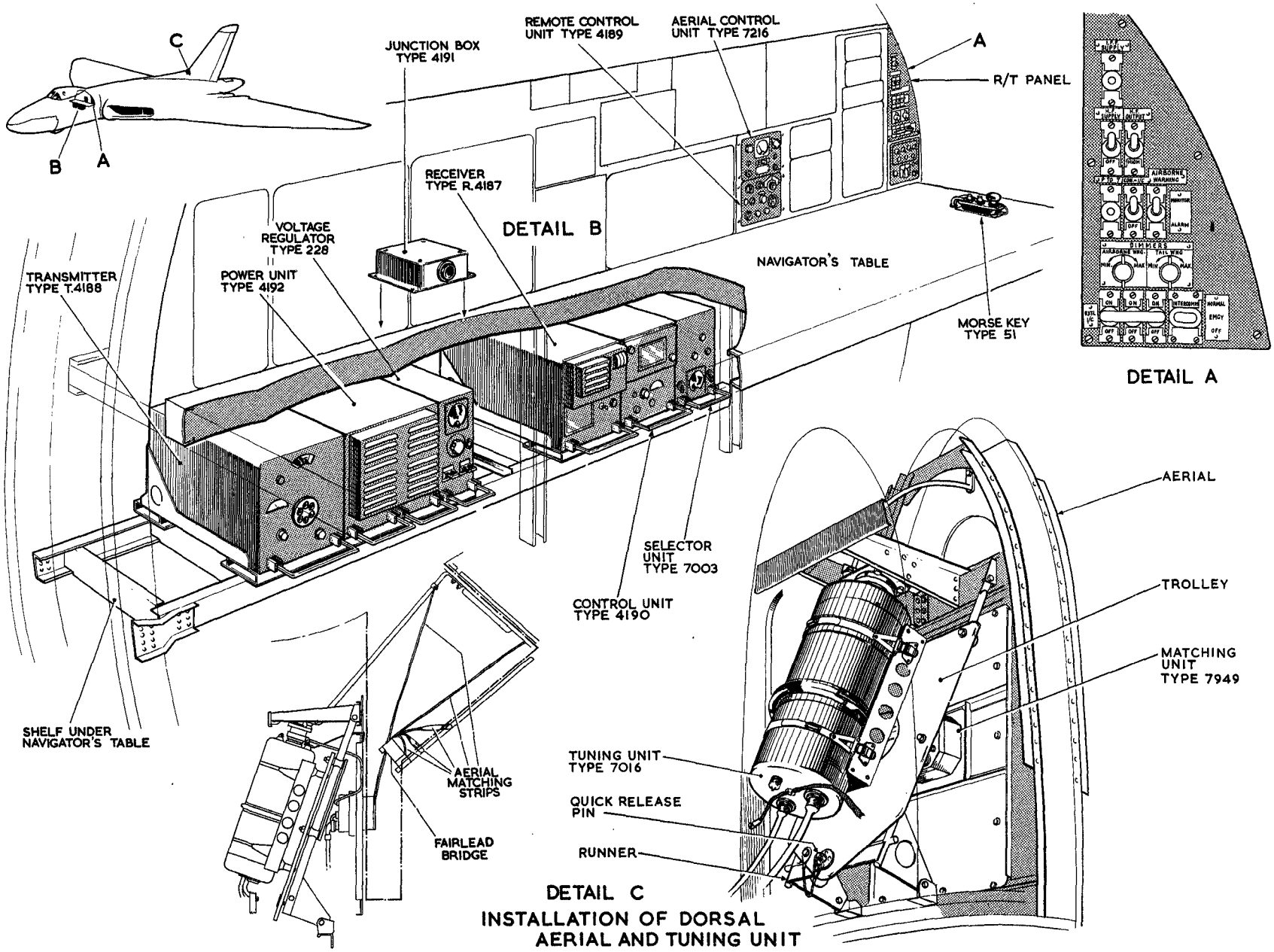

Fig. 1 Component location

Morse key type 51 was type F

the channels. The unit is fitted with 24 crystals and an aperiodic crystal oscillator which determines the transmitter frequency. The crystals are heated in thermostatically controlled enclosures, the heaters of which do not allow the temperature to fall below 10 deg.C.

Receiver, Type R.4187

10. Receiver, Type R.4187, is virtually a self-contained unit in the installation since it incorporates its own power unit, operating from the aircraft 28-volt d.c. system, and all those circuits necessary for the reception of signals from the aerial input. The receiver tuning range is divided into three frequency bands with the following coverage:-

Band 1 - 2.8 to 5.2 Mc/s.
Band 2 - 5.2 to 9.7 Mc/s.
Band 3 - 9.7 to 18.1 Mc/s.

The main chassis, assembly Type 4211, carries the following main units:-

Amplifying unit, Type 4207
Amplifying unit, Type 4208
Power unit
Crystal oven
24 crystal units
Selector unit

Junction box, Type 4191

11. The junction box, Type 4191, connects the remote control unit to the receiver and transmitter circuits, and is equipped with one multi-pole socket and two multi-pole plugs.

Voltage regulator, Type 228

12. From an input voltage of 28-volts d.c. the voltage regulator output is stabilised at 19-volts d.c. On the front panel of the unit are mounted a voltmeter and the following controls and switches:-

ADJUST VOLTS	A manual control of the volts potentiometers which is calibrated with an arbitrary scale and can be locked after adjustments.
CHECK	A press-release switch for the output level tests
SET	A press-release switch for the output level adjustments
LIGHT	A push-pull switch controlling the illumination of the voltmeter

SUPPRESSED AERIAL SYSTEM, TYPE 9502

13. The suppressed aerial system, Type 9502, is fitted to the aircraft for the A.R.I.5874 installation. This takes the form of a notched excitation aerial fitted in the lower part of the dorsal fin. The notch is cut to provide a cavity in the aircraft structure which is tunable to resonance through a frequency range of 2.8 Mc/s. to 18.1 Mc/s. The aircraft structure, when connected via the impedance matching unit to the transmitter receiver, functions as a dual purpose aerial element. Tuning of the system is effected automatically or manually, automatically in conjunction with selection on the T.R. control unit, and manually in the event of failure of the automatic system.

Aerial component location

14. Referring to fig.1, it will be seen that the suppressed aerial system consists of the four major components:-

Aerial control unit	Type 7216
Selector unit	Type 7003
Aerial tuning unit	Type 7016
Impedance matching unit	Type 7949

Aerial control unit, Type 7216

15. The control unit, Type 7216, has three main functions:-

(1) To enable the operator to take direct control of the frequency range selection and timing

(2) To provide setting up facilities for the aerial system on pre-set frequencies

(3) To give a measure of fine tuning after the system has been automatically set up on a frequency channel

The controls and indicators located on the front panel of the unit are as follows:-

Selection of automatic and manual tuning
Selection of the appropriate frequency range with coarse or fine tuning
Limit indicator lamp which lights when the timing motor reaches either end of its travel
Tuning meter for R.F. output or servo check
Servo check switch
Safe warning lamp which lights in conjunction with a pressure switch in the aerial tuning unit

Selector unit, Type 7003

16. The selector unit, Type 7003, contains the master elements for all servo

channel selection and tuning systems. The following pre-setting controls and indications are provided on the front panel:-

Selected channel indicator, this operates in conjunction with the remote control unit, Type 4189
Selection of tune, operate and test conditions effecting the transmitter power output, with lamp indication of tune conditions
Frequency range setting and capacitor tuning
R.F. output and servo check meter
Servo check switch

Aerial tuning unit, Type 7016

17. The aerial tuning unit, Type 7016, consists mainly of an electro-mechanical drive unit, driving a three section variable capacitor in association with a fixed capacitor. Since the unit is outside the pressure section, it is contained in a cannister which is pressurized to 20 lb. per sq.in. Two pressure switches are fitted, one operates the SAFE lamp on the control unit, Type 7216; the SAFE lamp is extinguished if the pressure in the cannister falls below 16 lb. per sq.in. R.F. breakdown is prevented by the second pressure switch, which automatically switches the transmitter to the low power condition should the pressure fall below 14 lb. per sq.in.

Impedance matching unit, Type 7949

18. The impedance matching unit, Type 7949, provides the means of varying the inductive value in the tuned circuit. It is designed to maintain a reasonable match between the input impedance of the aircraft excitation system and the output impedance of the transmitter at all frequencies within the band.

SERVICING

Precautions

19. Servicing personnel in particular are warned that a.c. or d.c. voltages in excess of 100-volts can be dangerous, to the extent of causing personal injury, fatal or otherwise. It is essential that the closest attention be given to servicing instructions where matters of safety are concerned, and also that maximum co-operation be maintained between trades concerned in servicing operations.

Installation

20. Setting up, operating and servicing instructions for the installation and its components, including the suppressed aerial system, are contained in A.P.2535E, Vol.1. The security of all components should be checked regularly in addition to minor and major servicing. All plugs, sockets, terminal block connectors, personnel equipment connectors and strain cords should be examined for damage and ingress of dirt and moisture.

Power supplies

21. In conjunction with the servicing of the system as laid down in A.P.4505B, Vol.4, periodic checks should be made with a suitable test voltmeter to check that the d.c. output at T.B.400-A is 28-volts. At T.B.398-B, test that the output from the voltage regulator is 19-volts. Both T.B.'s are located on the port rear supporting leg of the navigator's table.

REMOVAL AND ASSEMBLY

Units below navigator's table

22. The following units are located below the navigator's table and are mounted on standard S.B.A.C. racking:-

Power and radio unit	Type 4192
Transmitter	Type T.4188
Control unit	Type 4190
Receiver	Type R.4187
Selector unit	Type 7003
Junction box	Type 4191
Voltage regulator	Type 228

The units are removed by releasing the knurled screws securing the handles, and withdrawing the units from the racks. On replacement, care should be taken to ensure that the locating dowels engage properly in order to align the plugs and sockets at the rear of the units with those on the racks.

A.E.O's panel

23. The following units are mounted on the panel:-

Remote control unit	Type 4189
Aerial control unit	Type 7216

The units are withdrawn from the panel by removing the securing screws and then disconnecting the associated cables.

Aerial tuning unit, Type 7016

24. Access to the tuning unit is obtained through an access panel at the aft end of the bomb bay roof. The removal procedure is as follows:-

(1) Disconnect the plug 15AB and socket 15AC, and the two bonding strips at the base of the unit. The bonding strip securing nuts should be replaced in order to prevent the weight of the end cover being taken by the pins of the connectors

(2) Disconnect the two bonding strips from the aft terminal at the top of the unit

(3) Remove the securing nut at the base of the carriage, and allow the unit to slide onto the stops

(4) Break the locking wire of the four quick release clamps, which secure the unit to the carriage

(5) Holding the unit firmly with one hand, unfasten the quick release clamps and remove the unit

When replacing the unit care should be taken to slide it into the carriage so that the aerial coupling at the top of the unit engages; the four quick release clamps should then be wirelocked.

Matching unit, Type 7949

25. With a servicing ladder giraffe, Type D4, remove the dielectric cover at the base of the dorsal fin, disconnect the five copper braid aerial matching strips from the airframe, slacken off the insulated clamp on the fairlead bridge and slide the aerial matching strips through. As in para.24, remove the aerial tuning unit and trolley frame. Disconnect the three plugs to the matching unit, remove the strengthened panel containing the matching unit by releasing the twelve attachment screws. Then carefully lower the panel through the bomb bay roof access panel, drawing with it the aerial matching strips. Next remove the four attachment bolts on the matching unit and withdraw the unit from the strengthened panel. It should be noted that all nuts, bolts, screws and washers, should be replaced loosely in their appropriate holes to prevent loss.

TABLE 1

CONNECTORS FOR A.R.I.5874

A.V.Roe Item No.	Cable form	Connecting between
1/T4053	Equip. wire (6145-100168 - 10 off; 6145-100179 - 10 off; 6145-100229 - 3 off; 6145-100249 - 1 off)	Power and radio unit (3D) to transmitter (2D)
2/T4053	Uniradio 70	Control unit, Type 4190 (1B) to transmitter (2B)
3/T4053	Miniature cable 25C	Control unit, Type 4190 (1AF) to selector unit, Type 7003 (13AF)
4/T4053	Miniature cable 25C	Control unit, Type 4190 (1AE) to junction box,Type 4191 (12AE)
5/T4053	Miniature cable 25C	Receiver, Type R.4187 (4AD) to junction box, Type 4191 (12AD)
6/T4053	Equip. wire (6145-100249 - 1 off; 6145-100179 - 2 off)	Receiver, Type R.4187 (4N) to power and radio unit (3N)
7/T4053	Equip. wire (6145-100179 - 17 off; 6145-100229 - 3 off)	Control unit, Type 4190 (1A) to power and radio unit (3A)
8/T4053	Unipren 12 - 3 off	Receiver, Type R.4187 (4M) to power supply T.B.398
9/T4053	Uniradio 70	Control unit, Type 4190 (1L) to receiver, Type R.4187 (4L)
10/T4053	Uniradio 65	Power and radio unit (3E) to transmitter (2E)
11/T4053	Uniradio 65	Control unit, Type 4190 (1AG) to b/head break plug 490
12/T4053	Miniature cable 25C	Selector unit, Type 7003 (13AB) to b/head break plug 489
15/T4053	Unipren 4-18 off; Unipren 6-2 off	Power and radio unit (3P) to power supply, T.B.400 and 398
16/T4053	Unipren 4-14 off; Unipren 12-1 off	Volt regulator to power supply, T.B.400 and 398
17/T4053	Uniradio 65	Control unit, Type 4190 (1C) to transmitter (2C)
2/T4324	Miniature cable 18C	Aerial selector unit, (13AA) to aerial control, Type 7261 (14AA)
3/T4324	Miniature cable 25C	Junction box, Type 4191 (12AH) to remote control unit,Type 4189 (11AH)
4/T4324	Uniradio 65	B/head break plug 490 to matching unit, Type 7949 (16AG)
5/T4324	Miniature cable 25C	Aerial tuning unit, Type 7016 (15AB) to b/head breaks plug 489
6/T4324	Miniature cable 12C	Matching unit, Type 7949 (16AC) to aerial tuning unit, Type 7016 (15AG)
7/T4324	Unipren 4	T.X. shorting plug (3J)
8/T4324	Miniature cable 6D	Power and radio unit (3F) to 54 i/c junction box (Inlet 7)

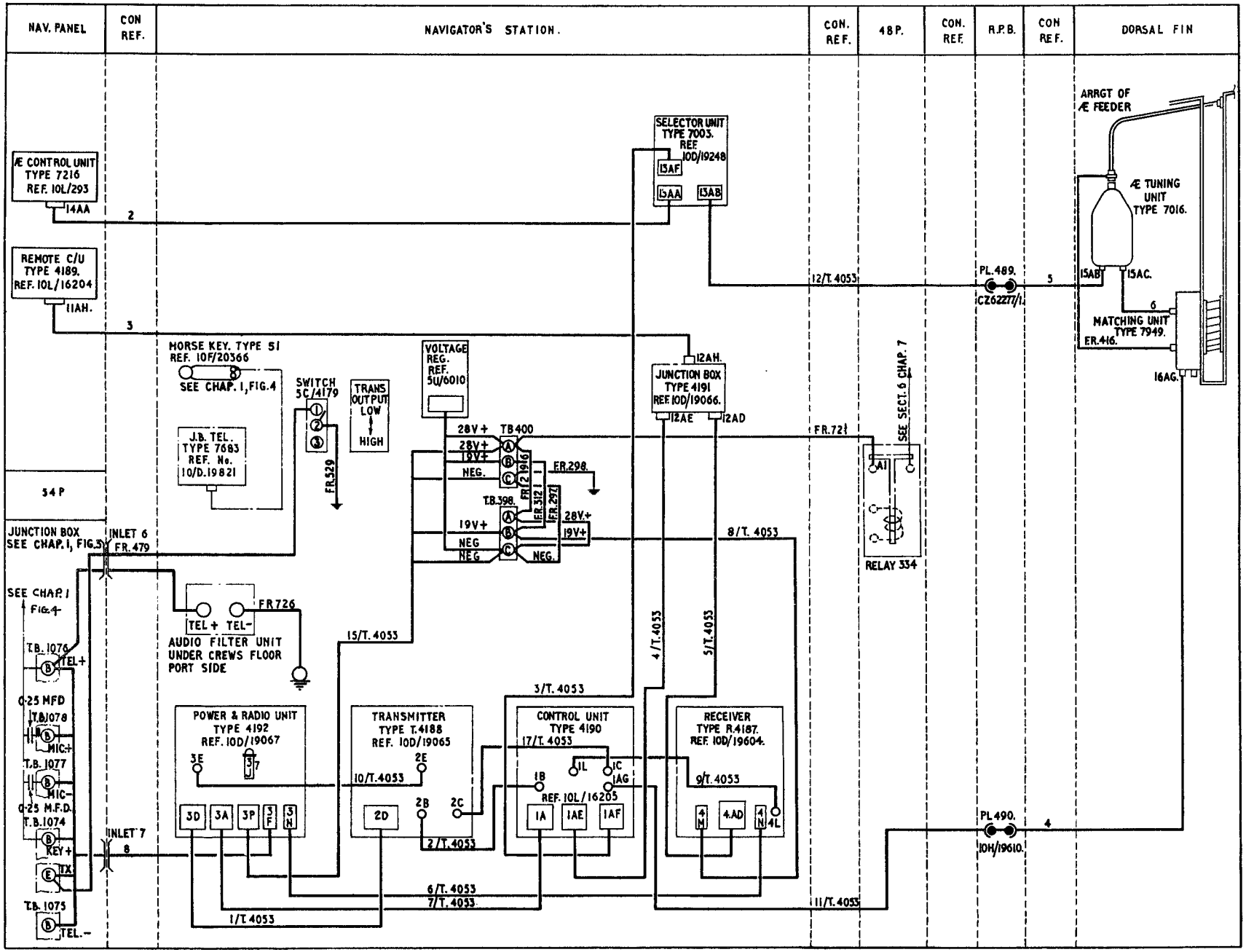

Fig. 2. A.R.I. 5874.

(◀ *Mod 939, 961 and 1779 embodied* ▶)

Chapter 3

A.R.I.18064

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Introduction

1. This chapter deals with the installation and general functioning of the A.R.I.18064 which incorporates a simulated bombing tone for tactical training in Vulcan aircraft. The A.R.I.18064 is an airborne V.H.F. installation consisting of two transmitter-receivers (1985 and 1986), operating on C.W. and M.C.W. on ten spot crystal-controlled frequencies, covering a range band of 100 Mc/s to 156 Mc/s with its associated control unit, voltage regulators, relays, external trimmer resistances and aerial. A location illustration of the major components is provided in fig.1, routing charts and a connector table will be found at the end of the text.

2. Descriptive and servicing details for the A.R.I.18064 are given in A.P.2528P, Vol.1, which should be read in conjunction with the information contained in this chapter.

CONTROL AND UNIT LOCATION

3. The installation is controlled from a control unit, Avro Part No.1/T4488, fitted on the first pilot's console. The No.1 transmitter-receiver, Type 1985, is located below and to the rear of the navigator's table, and the following associated units are fitted below the crew's floor in the V.H.F. crate on the starboard side:-

Transmitter-receiver No.2	Type 1986
Voltage regulator (2)	Type 60
Relay	Type 125
Relay	Type 102A
Trimmer resistances	Type 3
Mic-tel. sockets (2)	Type 359

An aerial 140-L.R.U.-67C is fitted to the aircraft, above No.2 tank bay. The simulated bombing tone control panel is attached to panel 9P in the navigator bomber's position. A plug and relay box, Avro Part No.1/T4607, is located below the crew's floor on the port side

Transmitter-receiver units, 1985 and 1986

4. Each of the transmitter-receiver units are similar in design and appearance, the difference being basically in the values of the R.F. inductors and trimmer capacitors and in the crystal frequency used. The selection of any one channel within the frequency range of the particular T.R. unit is by means of an automatic channel-change mechanism, manually controlled by a rotary switch in the control unit. The frequency range covered by the two transmitter-receivers is as follows:-

T.R.1985 100 Mc/s. to 125 Mc/s.
T.R.1986 124.5 Mc/s. to 156 Mc/s.

Control unit, 1/T4488

5. The control unit, 1/T4488, consists of a control unit, Type 9116, with the volume control removed and a suitable blanking plate fitted. The unit carries two rotary switches, No.1 and No.2, for channel selection, a set selector switch, labelled SET 1 - SET 2, and a dimmer switch for dial illumination. The No.1 and No.2 rotary switches carry the channel letters A to J, and K to T respectively. Volume controls for the V.H.F. sets are provided on the associated intercomm. control units, Type 7681, at each crew position.

Voltage regulator, Type 60

6. The voltage regulator, Type 60, has been adjusted from its nominal output of 19 volts d.c., with its associated external trimmer resistance set to a mid-position, to give an output of 24 volts on a 7 amp. load.

Relay units, Type 125 and 102A

7. The two relays Type 125 and 102A, are the aerial and wiring change-over switch units, which operate in conjunction with the set selector switch in the control unit.

Aerial 140 - L.R.U. - 67C

8. The vent sleeve aerial, 140-L.R.U. - 67C, is of shark fin design, with a short rod projecting horizontally at the rear of the blade; it is mounted on the aircraft top skin (fig.1).

POWER SUPPLIES

9. With the set selector switch selected to No.2 on the control unit, relays 125 and 102A are energised from fuse 608 in panel 3P. The selection of any channel on the control unit energises relay 5/1 in the V.H.F. sets via fuse 695 for set No.1 (T.R.1985) and fuse 696 for set No.2 (T.R.1986). The simulated bombing tone relays 647 and 648 are energised from fuses 546 and 545 respectively in panel 4P. Reference should be made to Book 2, Sect.6, Chap.6 for a full description of the 28-volt d.c. power supplies.

SIMULATED BOMBING TONE

10. Incorporated into the audio stages of the V.H.F. system is a controlled tone network for simulated bombing. The system is operated from panel 9P at the navigator's bomb station. When the bomb firing switches in the prone bomb aimer's station and the bomb aimer's panel 9P, are depressed, the tone circuit is cancelled.

Circuit operation

11. With the V.H.F. system switched ON, a simulated bombing tone is transmitted in the following manner (refer to fig.2). The change-over switch labelled SIM. BOMB is selected to V.H.F. and the start switch momentarily depressed, a 28-volt d.c. supply from fuse 555 will be fed through the sim. bomb and start switches to the energising coil of relay 648 via a 680 ohm resistor, and earthed via relay contacts 647/1. The relay 648 is held in by its own contacts 648/1 and the lamp will now light.

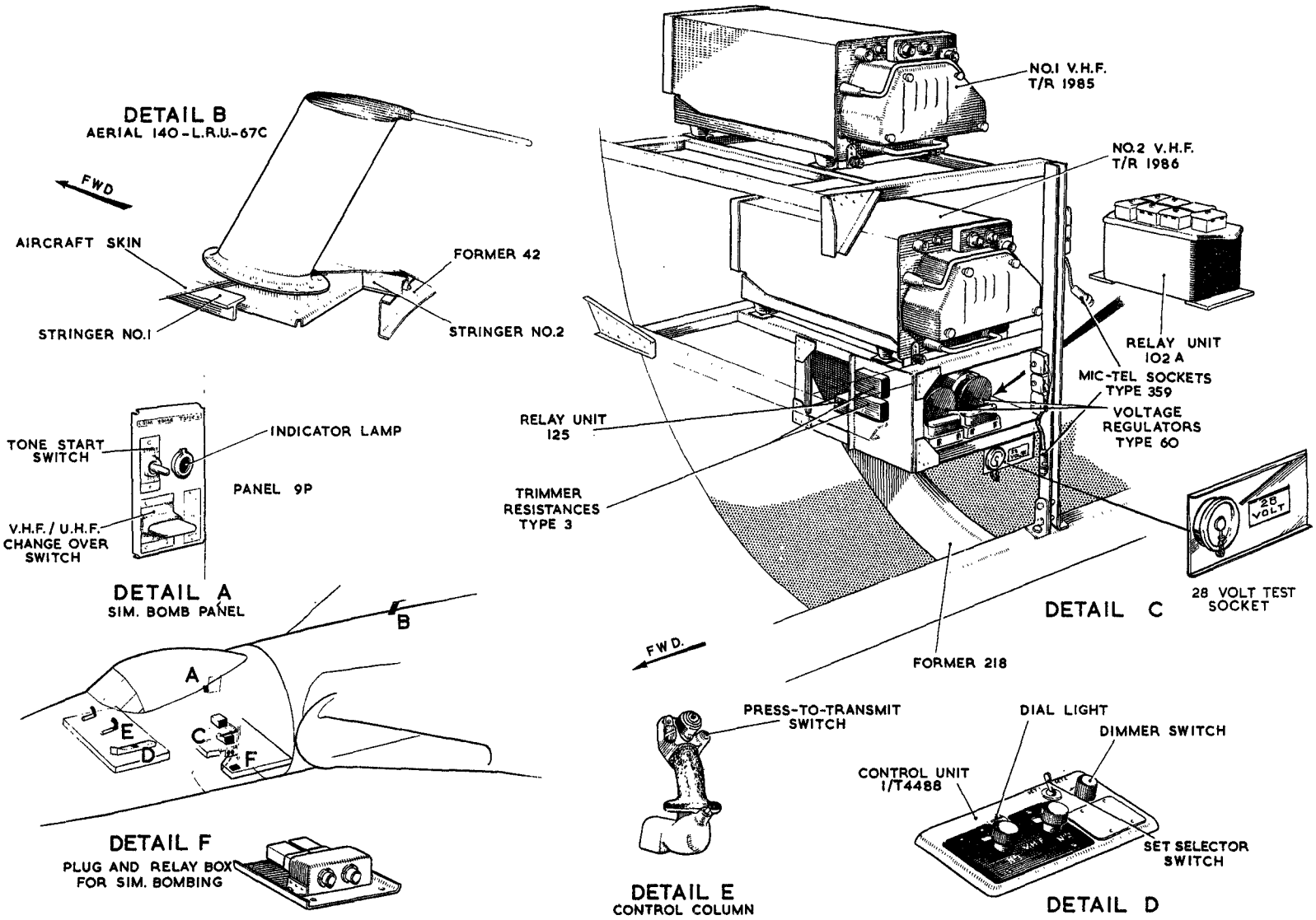

Fig. 1 Component location

◀ Test socket panel added on detail C ▶

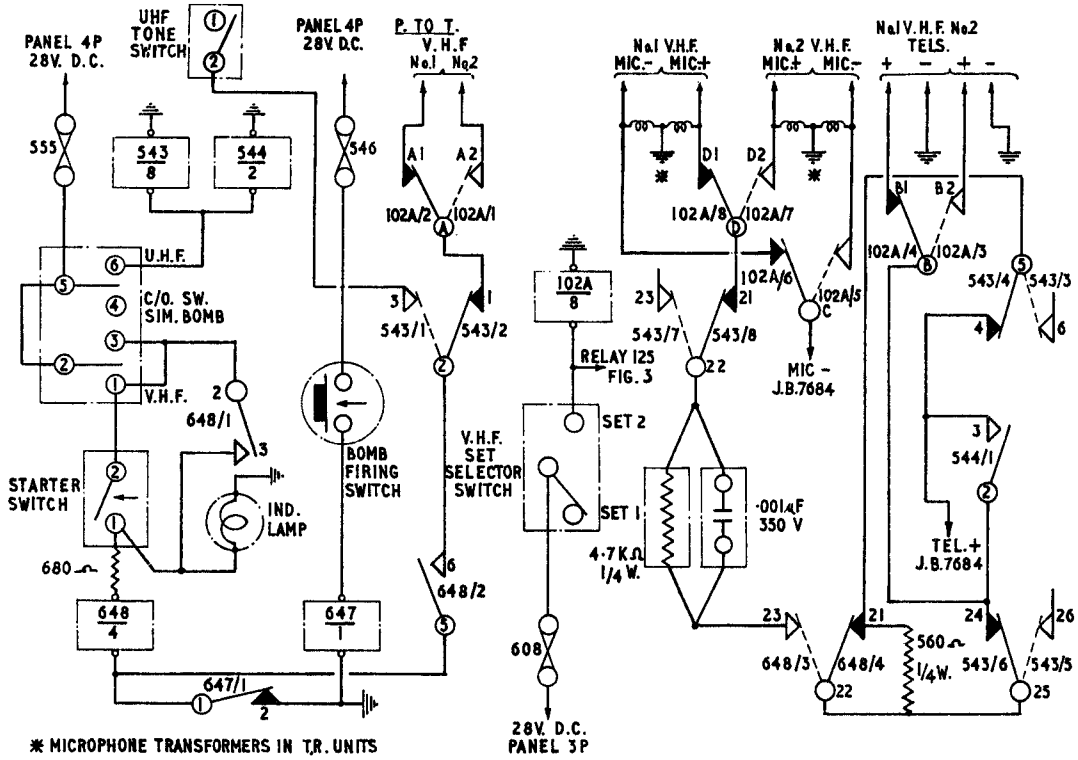

Fig.2 - Simulated bombing tone

12. The 1000 c/s simulated bombing tone is generated in the following way. A 4,700 ohm resistor and a .001 microfarad capacitor connected in parallel, are connected between the input (mic +) and output (tel +) of the V.H.F. audio amplifier via relay contacts 102A/8, 543/8 and 648/3, 543/6 and 102A/4. The values of the resistance and capacitance network determines the frequency at which positive feedback occurs. The 1000 c/s tone is injected into the crews intercomm. system via a 560 ohm resistor and relay contacts 543/4.

13. The tone is automatically transmitted by completing the earth return of the press-to-transmit relay 3/2 in the V.H.F. set, via normally closed contacts 102A/2, 543/2 and 647/1 and the now closed contacts 648/2.

14. On depressing the bomb firing switch in the prone bomb aimer's position or the bomb aimer's switch on panel 9P, the tone is cancelled by energising relay 647 from fuse 546 in panel 4P. Relay contacts 647/1 open, to break the earth to the coil of relay 648, and the indicator lamp goes out.

SERVICING

Precautions

15. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100 volts can be dangerous, to the extent of causing personal injury, fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned. It is essential that maximum co-operation be employed between trades mutually concerned in servicing operations.

Installation

16. The setting up, operating and servicing instructions for the A.R.I.18064 installation and its components are contained in A.P.2528P, Vol.1. The security of all components should be checked regularly. All connectors, plugs, sockets, terminal blocks, mic-tel sockets and strain cords should be examined for damage and ingress of dirt and moisture.

Power supplies

17. In conjunction with the servicing of the system as laid down in A.P.4505B, Vol.4, and using a ground supply, the following periodic checks should be carried out. With a suitable test meter, check that the d.c. output from each voltage regulator is 24 volts, when each V.H.F. set is on TRANSMIT. Voltage adjustment is controlled from a remote trimmer resistor, Type 3. Disconnect the supply socket 874, from plug 874 in

the plug and relay box, 1/T4607 With the appropriate switches selected to on, a 28-volt d.c. supply will now be available at pins B and C in the supply socket 874. A 28-volt test socket connected to fuse 695 and fitted just below the voltage regulators, Type 60, is used for supplying the test-set, Type 740, when testing the V.H.F. equipment in situ.

Voltage regulator, Type 60

18. Before the installation of the voltage regulator, Type 60, for the V.H.F. installation, it is necessary to re-set the ballast resistor to raise the output from its initial 19 volts to 24 volts for a 7 amp. load. The remote trimmer resistor, Type 3, is to be set to mid-point during this operation. Mod.688 must be painted on the regulator adjacent to the label, after this adjustment has been made. Using the revised values, carry out normal voltage regulator checks in accordance with A.P.4343B, Vol.1, Chap.22.

TABLE 1

CONNECTORS FOR A.R.I.18064

A.V.Roe Item No.	Cableform	Connecting between
2/T4775	Miniature 6D	T.R. unit 1985 to T.B.'s 1047, 1048, 1049
3/T4775	Miniature 6D	T.R. unit 1986 to T.B.'s 1050, 1051, 1052
7/T4775	Uniradio 67	R.P.B. plug 179 to V.H.F. aerial
8/T4775	Miniature 12A	T.R. unit 1985 to control unit plug No.3
9/T4775	Miniature 12A	T.R. unit 1986 to control unit plug No.2
10/T4775	Unipren 12 - 2 off	T.R. unit 1985 to T.B.1046
11/T4775	Unipren 12 - 2 off	T.R. unit 1986 to T.B.1046
12/T4775	Uniradio 67	T.R. unit 1985 to aerial relay unit 125 No.1
13/T4775	Uniradio 67	T.R. unit 1986 to aerial relay unit 125 No.2
14/T4775	Uniradio 67	Aerial relay unit 125 to R.P.B. plug 179

REMOVAL AND INSTALLATION

General

19. Access to the components is straightforward, but the following points should be observed. When it is necessary to remove or replace any components, secure all loose connectors to the adjacent aircraft structure to prevent damage.

Transmitter-receiver units

20. On both transmitter-receiver units, disconnect the four sockets and unscrew the two knurled nuts at the base of the T.R. unit, take hold of the transport handle and slide the unit off its anti-vibration mounting tray. On replacing the unit, ensure that the locating dowels engage properly at the rear of the tray.

Voltage regulators, Type 60

21. The two voltage regulators, Type 60, are mounted side by side below No.2 V.H.F. set. Ensure before disconnecting, that the channel selector switches on the pilot's control unit are in the OFF position. Remove the terminal block cover, disconnect the three cables and unscrew the four retaining nuts and bolts.

Relay units, Type 125 and 102A

22. These units are mounted behind the voltage regulators, Type 60. Remove either No.2 V.H.F. set or the voltage regulators, Type 60. For relay unit 125, disconnect the leads in the terminal block, unscrew the three aerial connectors, and then remove the four securing nuts and bolts. For relay 102A, disconnect the leads in the seven terminal blocks, and then remove the four securing nuts and bolts.

Trimmer resistances, Type 3

23. The two trimmer resistances (mounted on a plate adjacent to the voltage regulators) can be removed, by releasing the cover, disconnecting the two leads, and then removing the two securing screws.

Control unit

24. On the pilot's control unit, 1/T4488,

remove the 4 retaining screws and withdraw the unit from the port console panel. Sufficient cable length has been allowed to enable the plug to be disconnected.

Aerial 140 - L.R.U. - 67C

25. The aerial feeder lead is located just forward and above the front spar, and should not be difficult to disconnect. In order to gain access to the aerial, a servicing ladder giraffe, Type D4, may be used. Remove the ten counter-sunk securing bolts at the base of the aerial and lift off the aerial. On replacing, ensure that there is good bonded surface between the base of the aerial and the aircraft structure.

Plug and relay box

26. The plug and relay box, 1/T4607, (mounted on an anti-vibration plate), can be removed, by disconnecting the plug and socket connectors, and then removing the 2 securing nuts and bolts.

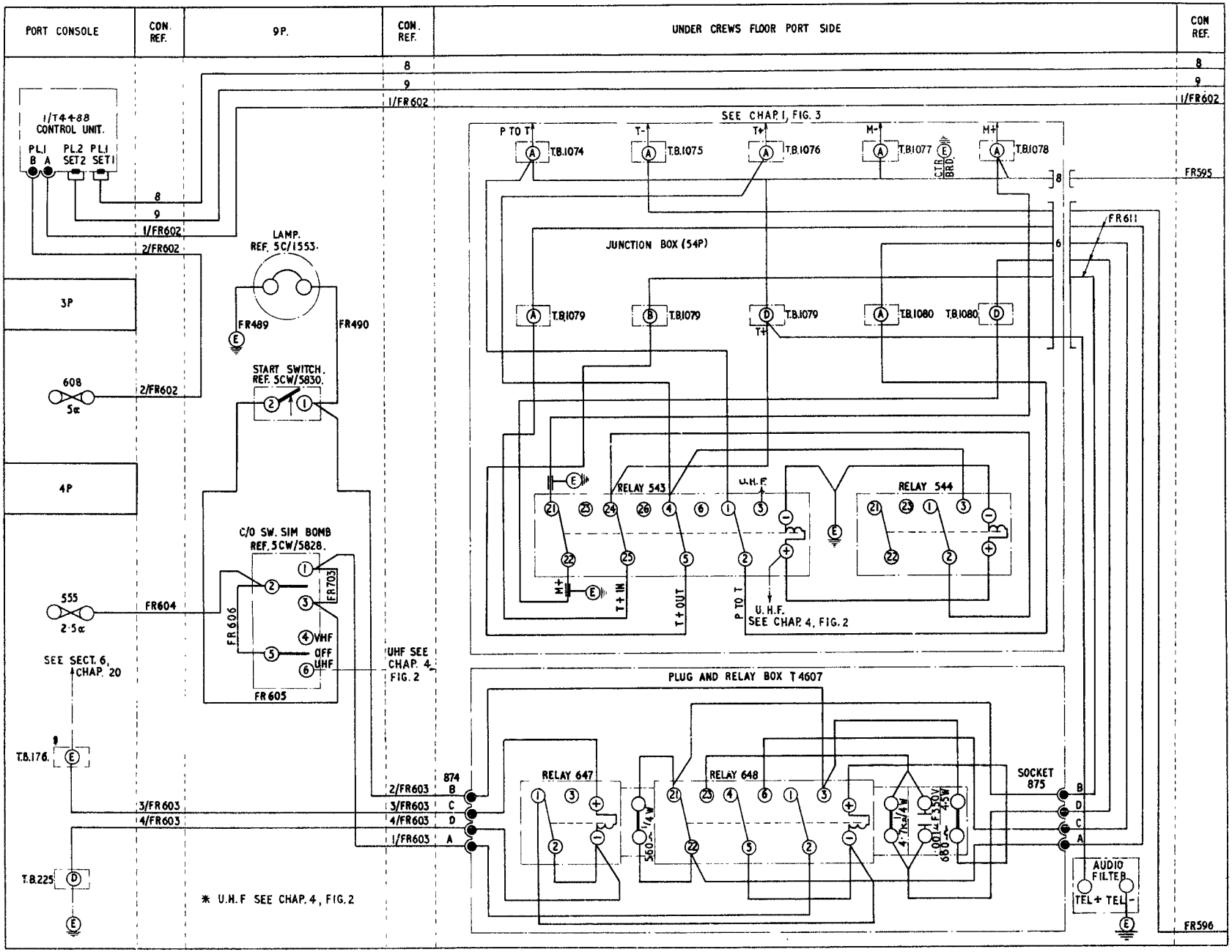

Fig. 3 (1). A.R.I. 18064
(◀ Mod 1427 and 939 embodied ▶)

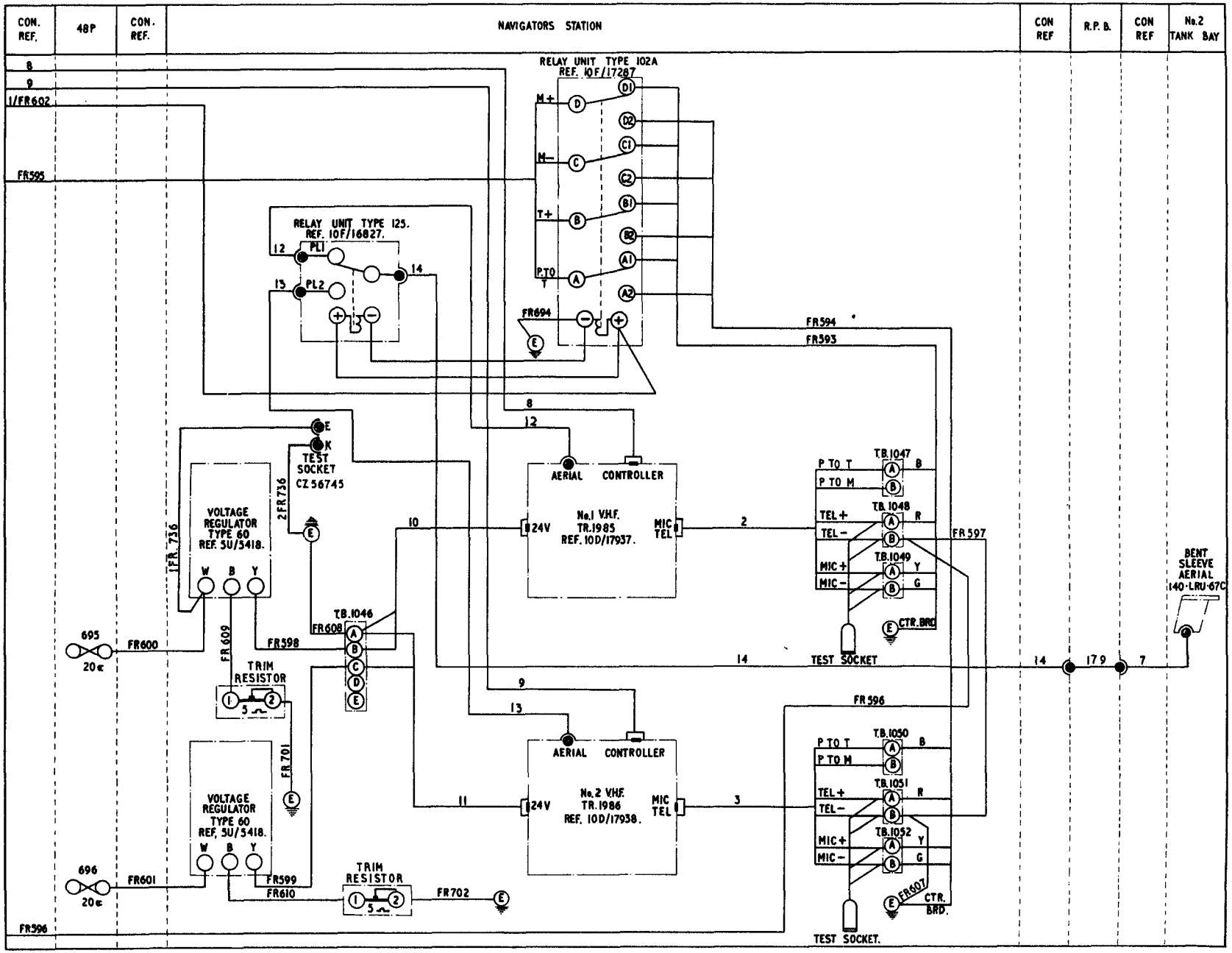

Fig. 3 (2) A.R.I. 18064
(◀ Test socket added ▶)

Chapter 4

A.R.I. 18124/2

(Completely revised)

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Introduction

1. This chapter deals with the installation and general functioning of the A.R.I.18124/2 (a.c. version) which incorporates a simulated bombing tone for tactical training on Vulcan aircraft. The A.R.I.18124/2 is an airborne U.H.F. installation, designated R/T2, consisting of a multi-channel transmitter-receiver, operating on a crystal-controlled frequency range of 225.0 Mc/s. to 399.9 Mc/s. with facilities available to radiate M.C.W. for emergency or direction finding purposes. A location illustration of the major components is provided in fig.1, routing charts and a connector table will be found at the end of the text.

2. Descriptive and servicing details for the A.R.I.18124/2 are given in A.P.2531J, Vol.1; the reader is advised to consult this A.P. in conjunction with the information contained in this chapter and chapter 9.

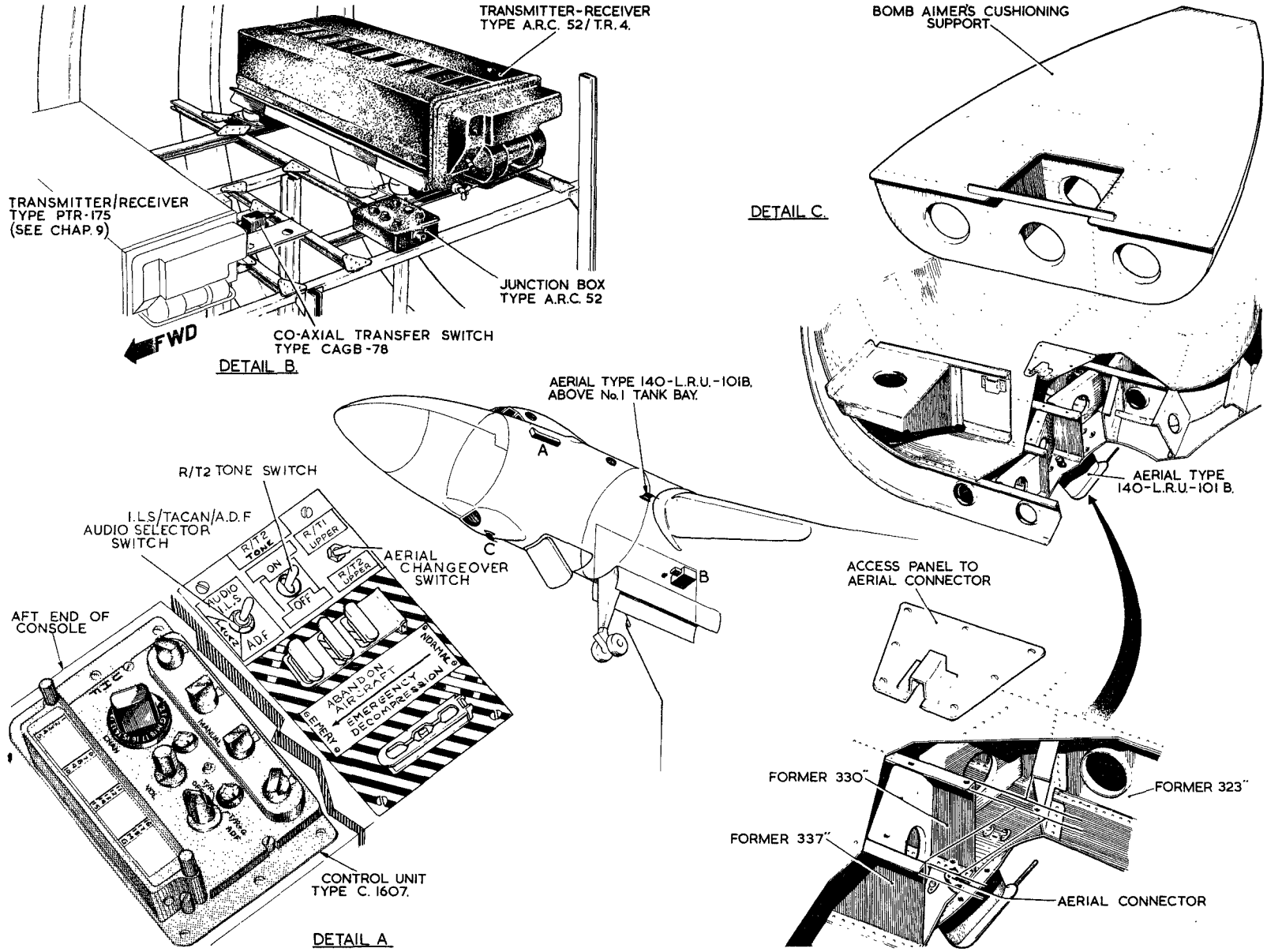

Fig. 1 Component location A.R.I. 18124/2

(◄ *Mod. 2007 embodied* ►)

DESCRIPTION AND OPERATION

CONTROLS AND UNIT LOCATION

3. The installation is remotely controlled from a control unit, Type C1607, in conjunction with an aerial changeover switch and a tone switch. These controls are located on the port console, the following associated units are fitted on a shelf on the starboard side of the nose-wheel bay:-

Transmitter-receiver	Type ARC52/TR4
Junction box	Type AN/ARC52
Aerial transfer switch	Type CAGB-78

Two U.H.F. aerials, Type 140-L.R.U-101B are located as follows:-

No.1 aerial - below the bomb aimer's blister.

No.2 aerial - above No.1 tank bay

Both aerials are shared with the R/T1 installation (Chap.9) and are fitted externally on the aircraft skin.

Transmitter-receiver, Type ARC52/TR4

4. The transmitter-receiver unit comprises a front panel and a main chassis, the unit being mounted on an anti-vibration tray. The front panel contains:-

Pressure air valve (Schrader)
External dual air blower
Multi-pole plug
Aerial plug

The main chassis has all the sub-assemblies mounted on it and the whole assembly is enclosed in a double walled aluminium case (pressurised to 18 p.s.i.g.) which functions as a heat exchanger between the outside air and the air inside the case. Air forced between the walls by the dual blower, dissipates the heat absorbed by the inner wall and is exhausted out through the vents on the top of the outer case. The T.R. unit has sufficient crystals fitted in the unit to provide 1,750 frequency channels spaced at 100 kc/s apart. A pre-determined guard frequency is constantly monitored, by a fixed tuned receiver (fitted in the unit), operating on a frequency range of 238 Mc/s. to 248 Mc/s. An M.C.W. tone of 1,000 c/s. (approx.) is transmitted, (when the tone switch is depressed) from a tone generator incorporated in the modulator unit for emergency or direction finding purposes. The tone generator is also employed in providing a simulated bombing tone.

Control unit, Type C.1607

5. The control unit, Type C.1607, provides remote control of the installation by operation of the following switches, mounted on the front panel. The function switch has four positions:-

OFF	In this position the power relay K1101 remains de-energised.
T.R.	In this position the power relay K1101 is energised and makes the installation ready for use.
T.R.+G	The guard receiver is now available in addition to the T.R.
A.D.F.	The T.R. is switched to A.D.F. with the appropriate airborne equipment.

The volume controller (VOL) is used to adjust the level of the audio signal in the telephones. The channel selector switch (CHAN) is a 20-position rotary switch, labelled 1 to 18 inclusive, G and M. Each numeral position has a pre-set frequency, which on selection, selects the frequency automatically. In position G, and the function switch selected to T.R., the guard receiver output is cut-off, and the main receiver can now receive or transmit at this guard frequency. In position M, the selection of automatic frequency is cut off and allows manual control to take place. Selection of any one of the 1,750 channels can be obtained by rotating the manual control switches to the required frequency, which then actuates the automatic tuning mechanism. Frequency adjustments for pre-selected channels are made by releasing a small panel at the bottom of the control unit front panel, which has an ivorine tablet on which the frequencies selected may be marked. Two lamps are arranged to provide diffused illumination of the controls.

Junction box, Type ARC/52

6. The junction box, Type ARC/52, is the main distribution point for the R/T2 system. The junction box is equipped with seven multi-pole sockets, which provide the following facilities:-

(1) Connects the microphone input and audio output circuits from the T.R. unit to the i/c system

(2) Links the control unit to the T.R. unit

(3) Connects the power supplies to the T.R. unit

(4) Connects the tone output and panel light to the appropriate control and dimmer switches

Aerial transfer switch, Type CAGB-78

7. The aerial transfer switch is operated by a 28-volt d.c. supply and is only energised when the aerial selector switch on the port console 6P is set to

R/T2 UPPER. With the aerial selector switch set to R/T2 UPPER the U.H.F. upper aerial is connected to the transmitter-receiver belonging to this installation (R/T2) and the U.H.F. lower aerial is connected to the transmitter-receiver, Type PTR.175, (R/T1 chap.9). With the aerial selector switch set to R/T1 UPPER the aerial transfer switch is de-energised and the switch contacts transfer the upper aerial to the R/T1 transmitter-receiver and the lower aerial to the R/T2 transmitter-receiver.

Aerial, Type 140 - L.U.R. - 101B

8. The aerial, Type 140 - L.R.U. - 101B is of shark fin design, with a short rod projecting horizontally at the rear of the blade.

POWER SUPPLIES

9. When the function switch, on control unit, Type C1607 (located on the port console) is rotated from the OFF position to either T.R., T.R. + G or A.D.F., a power relay K1101, in the power unit is energised by a 28-volt d.c. vital supply from fuse 822 in panel 19P. With relay K1101 energised, a 200-volt 400 cycle a.c. supply is fed from fuses 230 (R.Y.B.) in panel 28P to the T.R. unit. When the aerial change-over switch (located on the port console) is selected to R/T1 upper a 28-volt d.c. supply from fuse 933 in panel 3P energises the aerial transfer switch, Type CAGB-78 and thus connects the lower aerial to this installation (R/T2). The upper aerial will be automatically connected to this installation (R/T2) and the lower aerial connected to the R/T1 installation (chap.9) when the aerial transfer switch is un-energised. When the console red flood dimmer (located on the port side, below the cockpit rail) is operated, a 28-volt d.c. supply from fuse 629 in panel 3P, is fed to the lamp which illuminates the dials and switches on control unit, Type C.1607. Power supplies for the radio installation are fully described in Book 2, Sect.6, Chap.6 and 7 of this publication.

SIMULATED BOMBING TONE

10. As previously mentioned (para.4) the tone generator in the U.H.F. R/T2 set is used for simulated bombing. The system is operated from panel 9P at the navigator's bomb station. When the bomb firing switch at the prone bomb aimer's station or the bomb aimer's panel 9P are depressed, the tone circuit is cancelled.

Circuit operation

11. With the R/T2 system switched to ON and with reference to fig.2 in Sect.8, Chap.9, a simulated bombing tone is transmitted in the following manner. The change-over switch labelled SIM BOMB, is selected to R/T2 and the start switch momentarily depressed. A 28-volt d.c. supply from fuse 555 in panel 4P, will be fed through the sim bomb and start switches to the energising coils of relays 543 and 544 to earth, also to the energising coil of relay 648 via a 680 ohm resistor, and earth via relay contacts 647/1. The relay 648 is held in by its own relay contacts 648/1 and the indicator lamp will now light.

12. The earth return to relay K904 in the U.H.F. set is normally earthed via a tone switch situated on the port console 6P. When relay K904 is energised in this way, thereby switching on the tone generator, the press-to-transmit relay K901 is also energised and thus transmit the R/T2 tone signal automatically.

13. For simulated bombing purposes the earth return for relay K904 is completed via terminal 2 of the tone switch, and relay contacts 543/1, 648/2 and 647/1. The tone will therefore be automatically transmitted when R/T2 is selected on the simulated bombing change-over switch and the start switch operated. The side tone to the crew's intercomm. system is routed via the normal R/T2 set J.B. Type AN/ARC.52.

14. On depressing the bomb firing switch in the prone bomb aimer's position or the bomb aimer's switch, on panel 9P, the tone is cancelled by energising relay 647 from fuse 546 in panel 4P. Relay contacts 647/1 open, to break the earth to the coil of relay 648, and the indicator lamp goes out. Relays 543 and 544 remain energised, until the change-over switch sim bomb is selected to OFF.

Mod.1534 (Blue Steel aircraft)

14A. The above sim.bomb tone circuit operation changes slightly when Mod.1534 is embodied and the modified circuit operation is described in Sect.8, Chap.9 of this Book.

SERVICING

Precautions

15. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100-volts can be dangerous, to the extent of causing personal injury, fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned. It is essential that maximum co-operation be maintained between trades mutually concerned in servicing operations.

General

16. The setting up, operating and servicing instructions for the installation and its components are contained in A.P.2531J, Vol.1. The security of all components should be checked regularly. All connectors, plugs, sockets and terminal blocks should be examined for damage and ingress of dirt and moisture.

Power supplies

17. In conjunction with the servicing of the system as laid down in A.P.4505B, Vol.4, and using a ground supply, the following periodic checks should be carried out. With a suitable test meter, check that the d.c. output is 28 volts at T.B. 1060-A and that the a.c. output is 200-volt 400 c/s, at T.B.1054-A.B. and C.

REMOVAL AND INSTALLATION

General

18. Access to the components is straightforward, but the following points should be observed. When it is necessary to remove or replace any components, secure all loose connectors to the adjacent aircraft structure to prevent damage.

Transmitter-receiver unit

19. On the front panel of the unit disconnect the two connector sockets, unscrew the two knurled nuts at the base of the unit, take hold of the transport handle and slide the unit off its anti-vibration mounting tray.

Junction box, Type ARC/52

20. Disconnect the five connector plugs from the sockets attached to the lid of the unit. The lid of the unit can now be removed by releasing the three securing screws. The remainder of the unit may be removed after taking out the four securing screws.

Aerial transfer switch, Type CAGB-78

21. For ease of accessibility, remove amplifier unit, Type 16089 (see Chap. 7 for removal instructions). On the aerial transfer switch, disconnect the four aerial plugs, remove the securing screws and nuts and lift off.

Control unit, Type C.1607

22. On the control unit, Type C.1607, release the four quick release fasteners, raise and withdraw the unit from the console panel. Sufficient cable length has been allowed to enable the plug to be disconnected.

Aerials 140 - L.R.U. - 101B

23. The lower aerial feeder can be disconnected by removing the prone bomb aimer's cushions, and unscrewing the four floor securing bolts. Lift and remove the floor panel, release the seven quick release fasteners on the U.H.F. aerial access panel, and disconnect the feeder lead. The aerial fitted to the external surface of the bomb bay blister, can now be removed by unscrewing the ten counter-sunk securing bolts at the aerial base. Access to the upper aerial (on top of No.1 tank bay) is gained by the use of a servicing ladder Giraffe, Type D4. Remove the ten counter-sunk securing bolts at the base of the aerial, lift the aerial and disconnect the feeder lead.

TABLE 1

CONNECTORS FOR A.R.I.18124/2

H.S.A. Part No.	Cableform	Connection
2/T4776	Equip. wire 14/.0076	R.P.B. plug 942 to control unit, Type C.1607
3/T4776	Equip. wire 14/.0076	R.P.B. plug 942 to junction box, Type ARC/52
13/T4776	Unitersil 14 Unitersil 22 Unitersilmet 22	T.R. unit to junction box, Type ARC/52
15/T4776	Uniradio 73	T.R. unit to aerial relay, Type CAGB-78
16/T4776	Uniradio 73	Aerial No.2 to aerial relay, Type CAGB-78
17/T4776	Uniradio 73	R.P.B. plug 931 to aerial relay, Type CAGB-78
8/T4776	Uniradio 67	R.P.B. plug 931 to aerial No.1
9/T4776	Miniature 2P Miniature 3D	Junction box, Type ARC52 to T.B.'s 1054, 1060
10/T4776	Miniature 6D	Junction box, Type ARC52 to T.B.1062

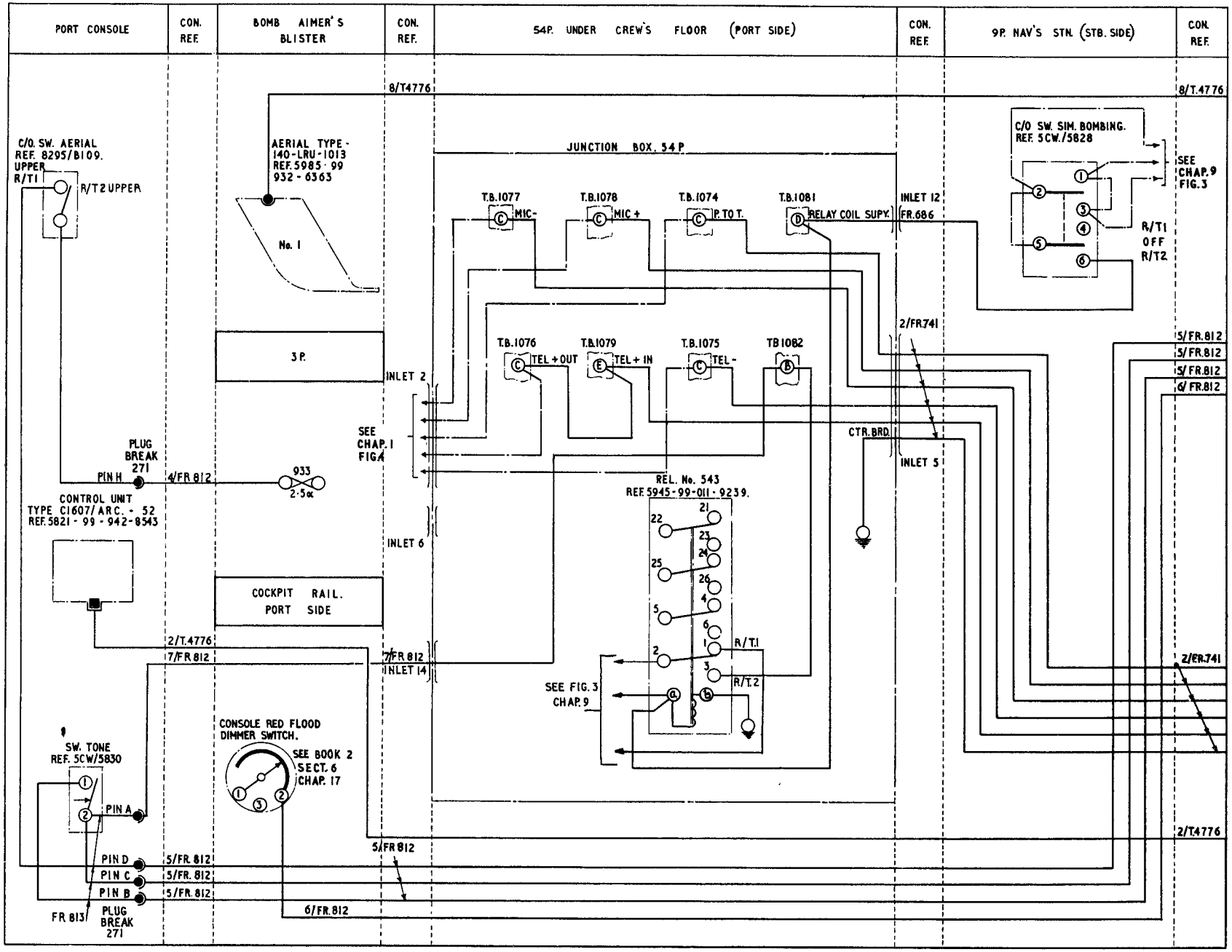

Fig. 2 (1) A.R.I. 18124/2 (R/T2)

(◄Mod. 2007 embodied►)

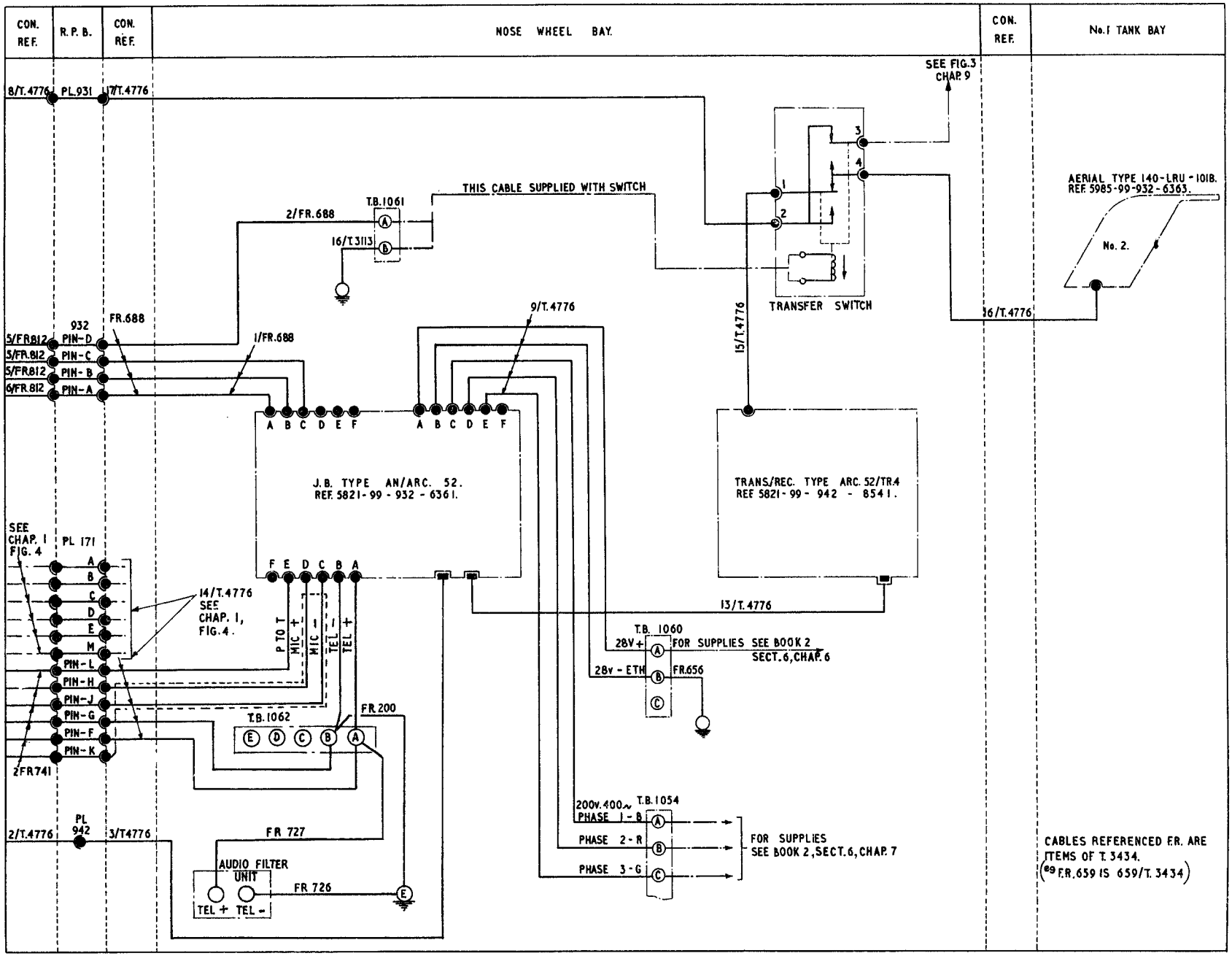

Fig. 2 (2) A.R.I. 18124/2 (R/T2)
(◄ Mods. 1779 and 2007 embodied ►)

Chapter 5

A.R.I.23023

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Introduction

1. The chapter deals with the A.R.I. 23023, which is an airborne automatic direction finding installation. The installation provides the following facilities:-

(1) Automatic relative bearing indication from the source of radio signals.

(2) Aerial relative bearing determination by null signal method, the loop aerial being remotely controlled.

(3) Aerial reception of modulated or unmodulated radio signals, either by loop or sense aerial.

(4) Radio range reception.

2. A location illustration of the major components is provided in fig.1. A routing chart and a connector table will be found at the end of the text.

3. Descriptive and servicing details for the A.R.I.23023 are given in A.P.2883 KD, Vol.1.

CONTROLS AND UNIT LOCATION

4. The installation is controlled from the navigator plotter's station from a control unit, Type 1274. Other controls fitted on the navigator's panel consist of a loop controller, Type 1342, a bearing and tuning indicator, Type 1630, and a shorting plug. In addition a second bearing and tuning indicator is provided on the second pilot's panel. A change-over switch for A.D.F./TACAN/I.L.S. is located on the port console, and a single-pole switch on the R/T panel at the A.E.O's station controls the 28-volt d.c. supply to the system.

5. The bulk of the equipment is mounted above the fuselage tank bay and consists of the following units:-

Receiver	Type A.D.7092D
Aerial transformer	Type 1343
Power factor transformer	Type 1571
Voltage regulator	Type 1555A
Junction box	Type 1629

The receiver is fitted on an anti-vibration mounting tray, and connections to the units are made at the rear by plugs and sockets.

6. Two aerials are utilised in the system. A loop aerial, Type 1324A, is mounted at the forward end of the bomb bay roof, and a "towel rail" sense aerial, Type F.402/L5/54, is mounted on the port nose wheel door.

7. The sense aerial is connected to a sense amplifier, Type 1628, which is located on the port side of the nose wheel bay adjacent to panel 73P.

Receiver, Type A.D.7092D

8. The receiver is a complete unit, fitted in a light alloy case. A small rotary transformer is fitted to the rear of the receiver case for H.T. supply. Motors for driving the tuning condensers and control switches are mounted on the front of the unit, and are accessible by removing the covers on the front panel.

Aerial transformer, Type 1343

9. The aerial transformer unit is secured to the back-plate of the receiver and serves to match the impedance of the co-axial aerial cable to the input circuits of the receiver.

Control unit, Type 1274

10. The unit permits full remote control of the receiver and incorporates an illuminated tuning scale calibrated in frequency. The following controls are provided:-

System switch
Frequency range switch
R.T./C.W. selecting switch
Tuning control
Gain control
Light switch

Two spare dial lamps are included on the unit.

Bearing and tuning indicator, Type 1630

11. The indicator contains two separate movements providing both relative bearing and tuning indication. The relative bearing indicator is operated by the transmitting element in the loop and has a direct current (Desynn) movement. The tuning indicator is a 500 micro-amp F.S.D. moving coil meter. In addition to its function as a tuning indicator, it also provides an indication of the strength of the received signal.

Power factor transformer, Type 1571

12. This unit is installed to improve the power factor of the load on the a.c. supply to the receiver.

Loop controller, Type 1342

13. The unit provides for the remote rotation of the loop when using the aural D.F. facility.

Sense amplifier, Type 1628

14. The amplifier is required when the loop aerial, Type 1324A, is installed, in order to transform the sense aerial impedance to match that of the receiver aerial cable.

Loop aerial, Type 1324A

15. The loop aerial is an iron core recessed unit, contained in a shallow tray. The loop shaft is supported in suitable bearings, on a chassis beneath the loop baseplate, electrical connections to the loop being made by means of slip rings and silver faced brushes in holders attached to the chassis. A two-phase a.c. motor drives the loop through a suitable reduction gear train.

Voltage regulator, Type 1555A

16. The voltage regulator is connected in series with the aircraft 28-volt d.c. supply, to provide a stabilized 19-volt d.c. output for the receiver circuits.

Junction box, Type 1629

17. The junction box, serves to form a connection point between the sense amplifier, loop aerial and the receiver installation.

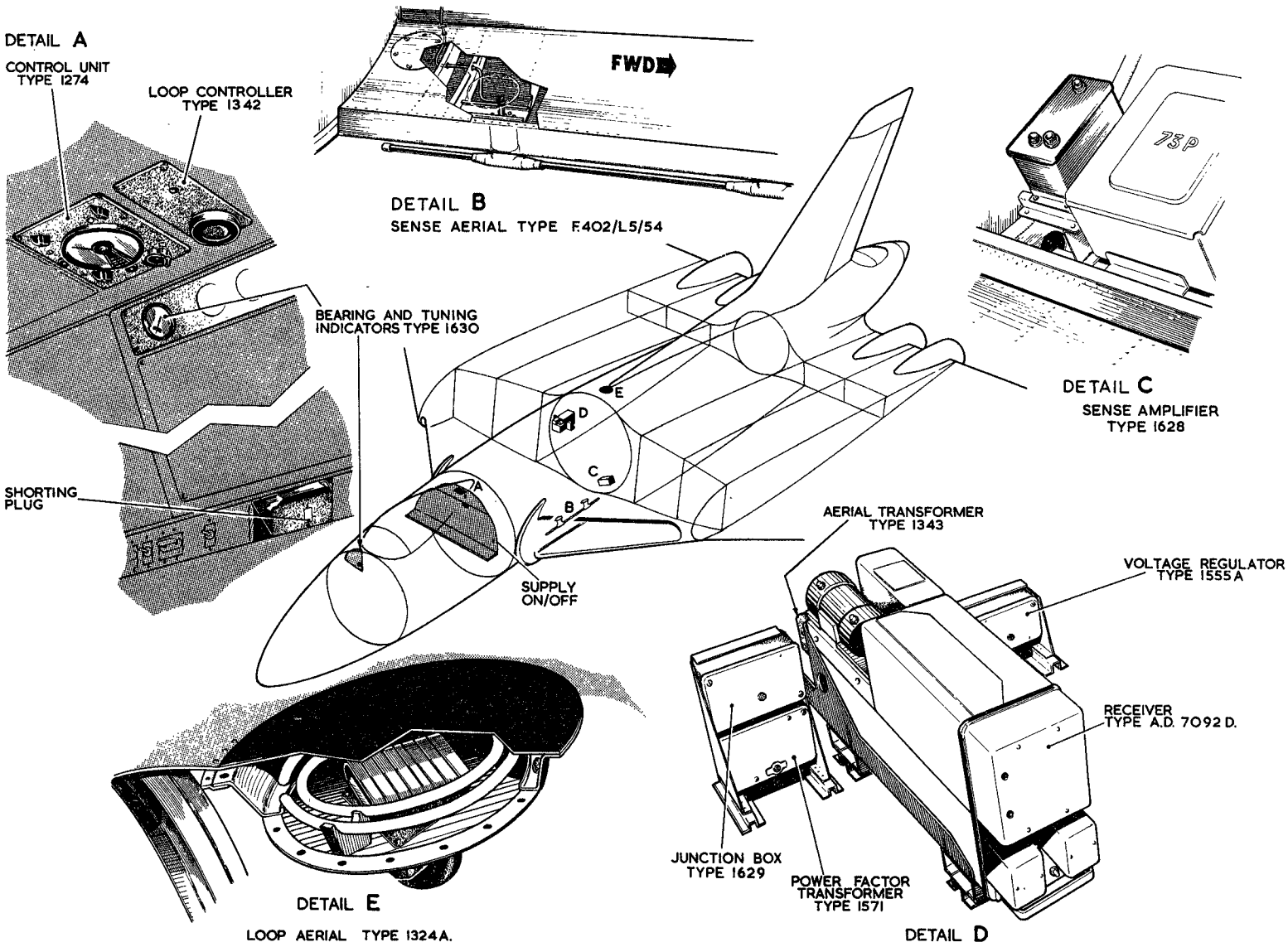

Fig.1 Component location

◀ Detail B and C redrawn ▶

Sense aerial, Type F402/L5/54

18. The sense aerial is an omni directional type and is used initially for the reception of a broadcast station prior to actual direction finding via the loop aerial and the associated A.D.F. equipment.

Shorting plug

19. The shorting plug (refer to fig.2) which is attached to a panel in the navigator's plotters position, is only removed when a voice range filter unit, Type 1275, is fitted.

Power supplies

20. A 28-volt d.c. supply is fed from fuse 670 in panel 3P, to the voltage regulator, Type 1555A via the A.D.F. supply switch. A 115-volt 400 c/s a.c. supply is fed from fuse 251-R in panel 24P, to the power factor transformer, Type 1571. A routing chart of the supplies is contained in Book 2, Sect.6, Chap.7.

SERVICING

Precautions

21. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100-volt can be dangerous, to the extent of causing personal injury, fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned. It is essential that maximum co-operation be employed between trades mutually concerned in servicing operations.

Installation

22. The setting up, operating and servicing instructions for the A.R.I.23023 and its components are contained in A.P. 2883KD, Vol.1.

23. The security of all components should be checked regularly. All connectors, plugs, sockets and terminal blocks should be examined for damage and ingress of dirt and moisture.

Power supplies

24. In conjunction with the servicing of the system as laid down in A.P.4505B, Vol.4, and using a ground power electrical servicing trolley, the following periodic checks should be carried out. With a suitable test meter check that the a.c. supply at T.B.1005-A is 115-volt 400 c/s and that the d.c. supply is 28-volt at T.B.1005-D.

Voltage regulator

25. On the front panel of the voltage regulator, at the check voltage socket, connect a suitable test meter. The voltage reading should be 19.2 -volt, with the receiver switched on. Voltage adjustment is effected by a trimmer on the front panel labelled INCREASE VOLTAGE. Switch supply off and on and re-check voltage; re-adjust the control if necessary.

REMOVAL AND INSTALLATION

General

26. Access to the components is straightforward, but the following points should be observed. When it is necessary to remove or replace any components secure all loose connectors to the adjacent aircraft structure to prevent damage.

Bearing and tuning indicators

27. The second pilot's indicator is removed by disconnecting the connector, supporting the instrument from under the panel and then removing the four counter-sunk screws. The navigator plotter's indicator is removed by lowering the panel, disconnecting the connector and then removing the four counter-sunk screws.

Control unit

28. Remove the four securing screws,

withdraw unit from panel and then disconnect the connector.

Loop controller

29. Remove the two securing screws, withdraw unit from panel and then disconnect the connector.

Equipment above No.2 tank

30. To remove the receiver, disconnect the six connectors at the rear of the unit, unscrew the knurled nut, securing the handle to the tray, and then slide the unit off its anti-vibration mounting. The power factor transformer, junction box and voltage regulator are removed by disconnecting their connectors and removing the securing screws.

Loop aerial

31. Disconnect the four connectors and then unscrew the twelve bolts securing the mounting plate to the aircraft structure.

Sense amplifier

32. Disconnect the three connectors and then unscrew the four securing bolts and lift the unit off its anti-vibration mounting.

Sense aerial

33. The whole aerial assembly or just the aerial rod may be removed as required. To remove the aerial rod only, release the protective covering from around the two aerial masts. Slacken off the two collet locknuts at each mast in order to release the grip on the aerial rod, by sliding off the protective plastic cap at one end of the rod, the rod can be withdrawn from both aerial masts.

34. To remove the complete aerial assembly from the aircraft, the access panel on the inner skin of the port nose wheel door must first be removed, by removing six securing screws. With the panel removed access to the aerial lead-in connector can be made and then disconnected. After releasing the protective covering around the two aerial masts, both masts can be removed from the outer aircraft skin by releasing six securing bolts from the mast flanges.

TABLE 1

CONNECTORS FOR A.R.I.23023

A.V.Roe Item No.	Cableform	Connecting between	
1/T4096		A.D.F. loop	to R.P.B. plug 177
2/T4096		A.D.F. loop	to R.P.B. plug 130
3/T4096		A.D.F. loop	to junction box
4/T4096	Uniradio 70 - 2 off	A.D.F. loop	to A.D.F. receiver
5/T4096		A.D.F. receiver	to i/c. tels. T.B.381
6/T4096		A.D.F. receiver	to junction box
10/T4096		A.D.F. receiver	to R.P.B. plug 129
11/T4096		A.D.F. receiver	to voltage regulator
12/T4096		A.D.F. receiver	to P.F. transformer
15/T4096		R.P.B. plug 177	to T.B.'s 1000, 1001
21/T4096	Equip. wire 25 (23 x .0076)	P.F. transformer	to T.B. 1005
22/T4096	Equip. wire 25 (23 x .0076)	Voltage regulator	to T.B. 1005
2/T4276		Indicator (Nav.)	to T.B.'s 1000, 1001
3/T4276		Indicator (2nd pilot)	to T.B.'s 1000, 1001
4/T4276		Loop controller	to R.R.B. plug 130
5/T4276		Receiver controller	to R.P.B. plug 129
6/T4276		R.P.B. plug 112	to shorting plug
7/T4276		A.D.F. receiver	to R.P.B. plug 112
8/T4276		A.D.F. receiver	to sense amplifier
9/T4276		Junction box	to sense amplifier
10/T4276		Sense aerial	to sense amplifier

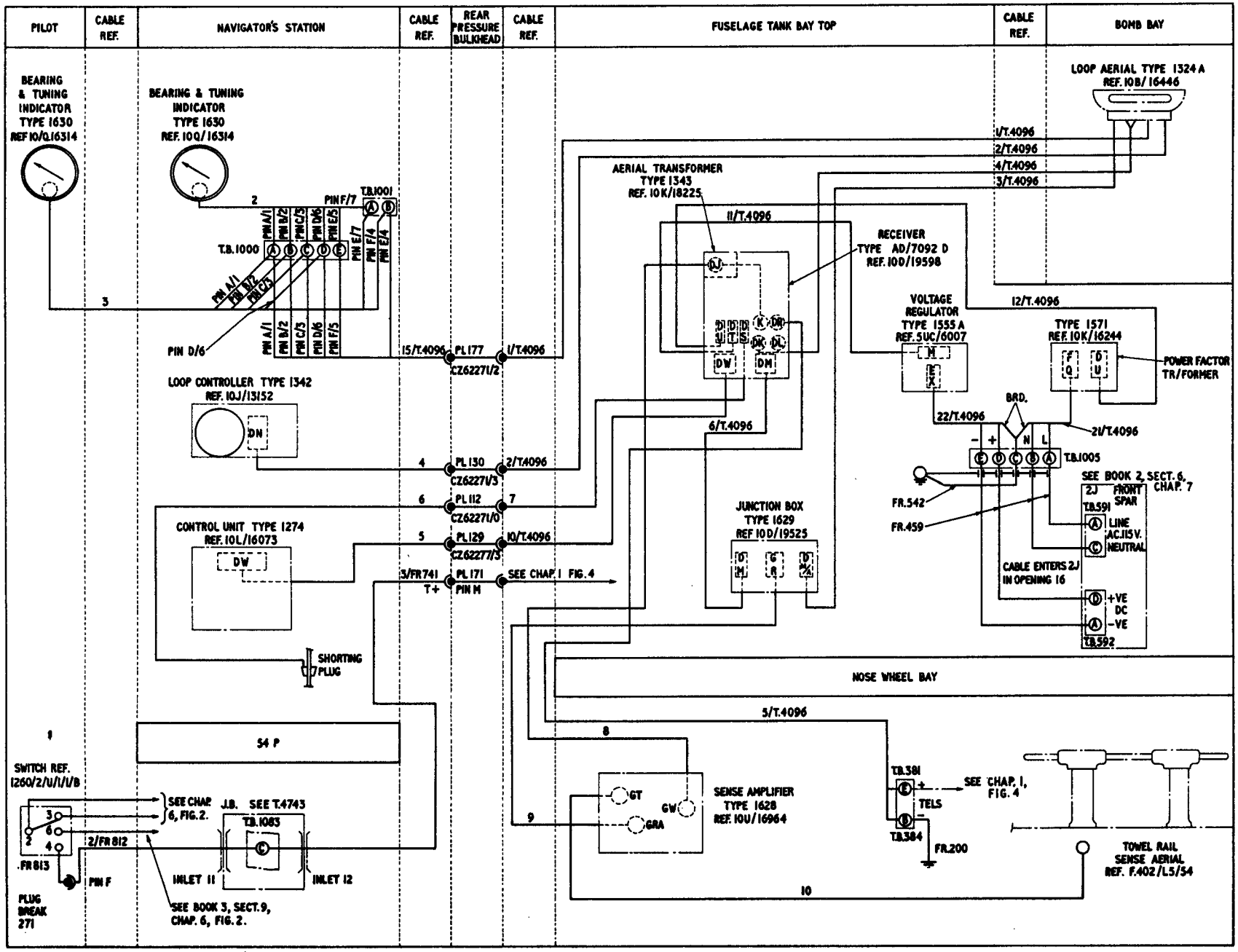

Fig. 2 A.R.I. 23023

(Mod 908. 1155 and 1631 embodied)

Chapter 6

A.R.I.18011

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Introduction

1. This chapter deals with the A.R.I. 18011, which is an airborne instrument landing system (I.L.S.) operating in conjunction with ground transmitters. This installation provides the pilot with indications of his aircraft's position relative to the runway touch-down point, when descending to low altitude in bad visibility.

2. The signals received by the localizer and glide path receiver units, are fed via a junction box, Type 164, to the navigator's computor unit (Book 3, Sect.7, Chap.5 of this publication). Signals so received will be displayed on the beam compass and director horizon instruments, which are also used in conjunction with the military flight system (Book 3, Sect.7, Chap.7 of this publication. A location illustration of the major components is provided in fig.1. A routing chart and a connector table will be found at the end of the text.

3. Descriptive and servicing details for the A.R.I.18011, are given in A.P. 2534E, Vol.1, and the military flight system in A.P.4686B, Vol.1. Both should be read in conjunction with the information contained in this chapter.

CONTROLS AND UNIT LOCATION

4. The system is operated from a control unit, Type 705, located on the port side of the cabin between formers 260 and 274. The pilot's control switches are positioned on the port console and consist of a single-pole supply switch and an A.D.F./TACAN/I.L.S. changeover switch. Two red marker warning lamps are provided on the pilots' instrument panels, and the audio signal level is controlled by the A.D.F./TACAN/I.L.S. volume control on each I/C control unit, Type 7681. The junction box, Type 164, for the system is mounted below the first pilot's floor, and the following units are located below the crew's floor, port side:-

Localizer/marker receiver	Type R.1964
Glide path receiver	Type R.1965
Voltage regulator	Type 60
Junction box	Type 157

The suppressed marker aerial, Type 237, is located below the No.2 tank bay (starboard side). On the port wing tip is the localizer/aerial, Type 239, and on the starboard wing tip is the glide path aerial, Type 238.

Control unit, Type 705

5. The control unit, Type 705, consists of the following components:-

Red indicator lamp
12-position rotary switch with a dial lettered A to L inclusive.

The localizer/marker and glide path receiver oscillator circuits.

When the I.L.S. supply switch is selected to the ON position, the indicator lamp is illuminated, indicating that the localizer/marker and glide path receivers, are switched on. The selection of any one letter on the rotary switch brings into circuit two pre-selected frequency crystals, one for each of the localizer and glide path receivers. The marker receiver is a fixed tuned receiver and is not affected by the operation of the rotary switch.

Localizer/marker receiver, Type R.1964

6. The unit consists of a front panel and main chassis. Contained on the front panel, are two aerial plugs, H.T. fuse, spare fuse holder, and the following pre-set controls, which are located behind sliding access covers:-

Marker gain
Speech volume
Marker volume
Set zero
Deflection sensitivity

Contained in the front panel is a Vokes air filter, through which air is drawn by a fan attached to the rotary transformer spindle.

7. The main chassis consists of the following units:-

L.F. unit	Type 4
Receiver unit	Type 117
Receiver unit	Type 118
Power unit	Type 797

The L.F. unit carries the tone and audio stages of the localizer receiver, Type 117, and the marker receiver, Type 118. The localizer receiver operates on any one of the twelve pre-selected spot frequencies available (spaced at 100 kc/s apart) in a range band of 108.1 Mc/s to 111.9 Mc/s. The marker receiver is fixed tuned at 75 Mc/s. On reception of the ground marker beacon signals as the aircraft passes over each marker beacon, the receiver transmits a keyed coding in the form of a flashing light, to the marker warning lamps at the first and second pilots' stations. The power unit, Type 797, provides the H.T. output of 200 volts for the localizer/marker receiver, the L.F. unit, and the oscillator circuits in the control unit Type 705.

Glide path receiver, Type R.1965

8. The unit consists of a front panel and main chassis. Contained on the front panel is an aerial input plug, H.T. fuse, spare fuse holder and the following pre-set controls, which are located behind a sliding access cover:-

Set zero
Deflection sensitivity

Contained in the front panel is a Vokes air filter, through which air is drawn by a fan attached to the rotary transformer spindle.

9. The main chassis consists of the following units:-

L.F. unit	Type 5
Receiver unit	Type 119
R.F. unit	Type 74
Power unit	Type 797

The L.F. unit, Type 5, carries the tone output and the main A.G.C. circuits of the glide path receiver. The glide path receiver, Type 119, operates on a range band of 329.3 Mc/s to 335 Mc/s, on twelve pre-selected spot frequencies, of the twenty frequencies available, spaced at 300 kc/s apart. The R.F. unit, Type 74, is the frequency multiplier for the glide path first local oscillator. The power unit, Type 797, provides the H.T. output of 200 volts to the glide path receiver, L.F. unit and the R.F. unit.

Voltage regulator, Type 60

10. The voltage regulator, Type 60, consists of a carbon pile assembly, con-

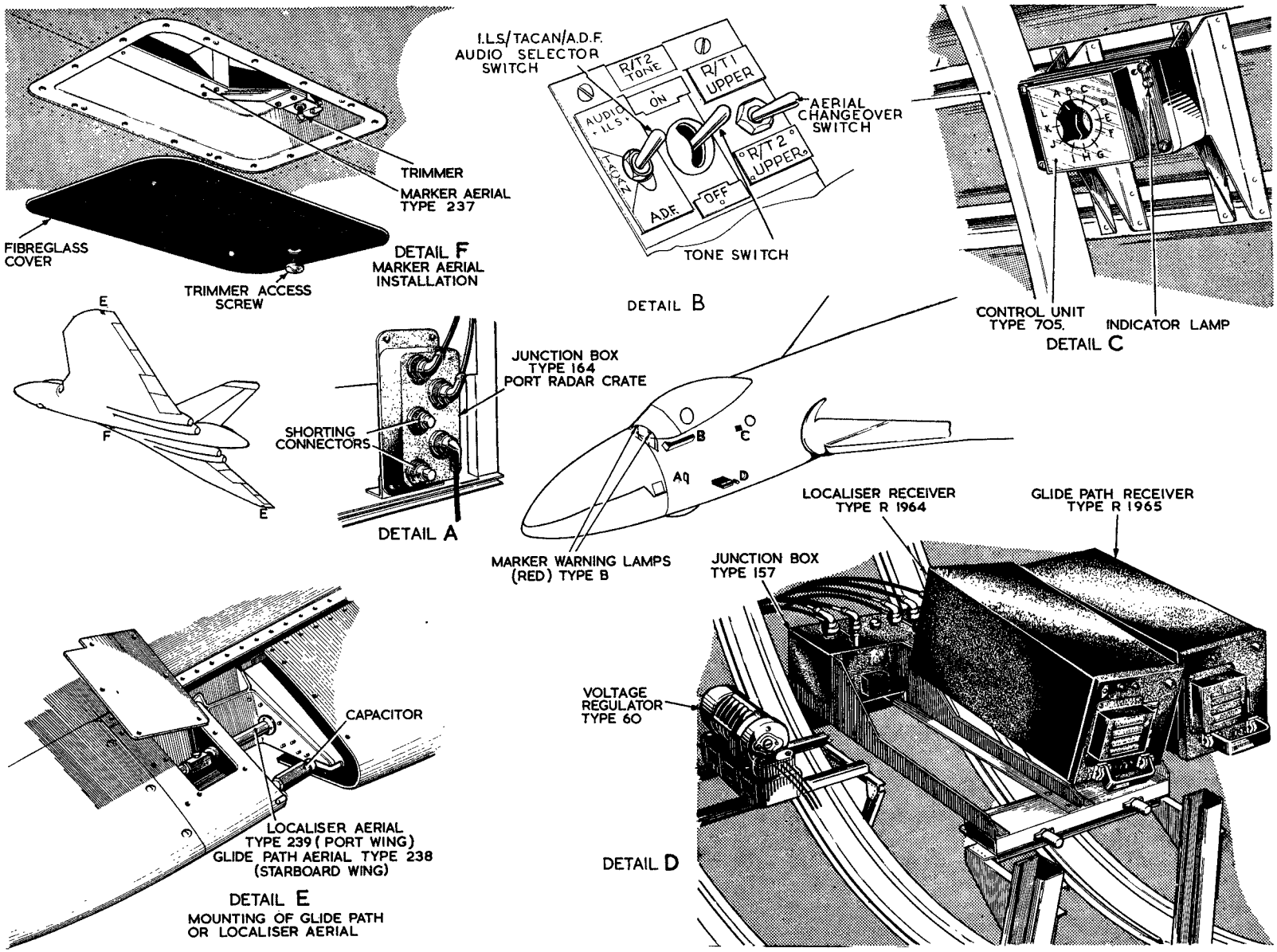

Fig.1 Component location

◀ *Detail B altered* ▶

nected in series with the normal aircraft supply of 28-volt d.c. to provide a stabilized output of 19-volt d.c.

Junction box, Type 157

11. The combined junction box, Type 157, provides for connections to both receivers, when mounted together side-by-side. The front panel consists of two 20-way sockets and two 2-way plugs. The selector panel above each 20-way socket provides for the introduction of compensating resistors into the indicator and flag output circuits. Four locating dowels project from the front panel (two to each receiver) to ensure correct alignment and to prevent inter-changing of the receiver units. The top panel face of the junction box accommodates the aircraft connector assemblies.

Junction box, Type 164

12. The junction box, Type 164, is the distribution point for the marker lamp, localizer and glide path signals. The junction box contains five plugs, of which only three are used; the remaining two have shorting connectors fitted.

Aerial, Type 237

13. The suppressed marker aerial, Type 237, is fitted into a recess below No.2 tank bay starboard side. The aerial which is horizontally polarized, has its field of reception vertically downwards and consists of a silvered metal strip, contained in a shallow dish, with one end of the silvered strip connected to the dish, and the other end of the strip connected, via a loading capacitance, to the other side of the dish. A trimmer forms part of the loading capacitance, which allows each individual aircraft to be tuned to resonate at 75 Mc/s. Access to the trimmer can be gained by the removal of a plug in the outer cover of the aerial.

Aerials, Type 238 and 239

14. The localizer aerial, Type 239, and the glide path aerial, Type 238, are built into the port and starboard wings. The localizer aerial is tuned to resonate at a frequency of 108.1 Mc/s to 111.9 Mc/s, and the glide path aerial to resonate at 329 Mc/s to 335 Mc/s. Although termed aerials, they are in fact devices for tuning notches or apertures in the aircraft skin to resolve the current flow induced in the skin by ground transmissions.

Power supplies

15. The switch labelled, I.L.S. SUPPLY ON-OFF, located on the first pilot's console, feeds a 28-volt d.c. supply, from fuse 676 in panel 3P, to the following units:-

Voltage regulator	Type 60
Junction box	Type 157

The voltage regulator, is connected in series with the 28-volt d.c. supply to give a stabilized output of 19-volt d.c., for the valve heater circuits in the receiver units, the marker warning lamps and the indicator lamp in the control unit Type 705. The junction box distributes the 28-volt d.c. supply to the rotary transformers in the receiver units.

SERVICING

Precautions

16. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100 volts can be dangerous, to the extent of causing personal injury, fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned. It is essential that maximum co-operation be employed between trades mutually concerned in servicing operations.

Installation

17. The setting up, operating and servicing instructions for the A.R.I.18011 and its components are contained in A.P.2534E, Vol.1, the military flight system in A.P. 4686B, Vol.1, and the voltage regulator, in A.P.4343B, Vol.1. The security of all components should be checked regularly. All connectors, plugs, sockets and terminal blocks should be examined for damage and ingress of dirt and moisture.

Power supplies

18. In conjunction with the servicing of the system as laid down in A.P.4505B, Vol.4, and using a ground electrical servicing trolley, the following periodic checks should be carried out. With a suitable test meter, check that the d.c. output is 28-volt at T.B.396-A, and that the d.c. output from the voltage regulator is 19-volt $\pm$ 0.5 volt at T.B. 396-C.

REMOVAL AND INSTALLATION

General

19. Access to the components is straightforward, but the following point should be observed. When it is necessary to remove or replace any components, secure all loose connectors to the adjacent aircraft structure to prevent damage.

Control unit, Type 705

20. Take hold of the unit, release the four captive securing bolts, allow the unit to drop forward and then disconnect the two sockets and the plug.

Receivers, Type R.1964 and 1965

21. Disconnect the aerial feeder connectors from the front panels of the receivers and unscrew the knurled nut at the base of each receiver. Take hold of the transport handles and slide the units off their mounting trays.

Junction box, Type 157

22. To remove the combined junction box, Type 157, first remove the two receivers and disconnect the seven connectors. Unscrew the six securing screws on the front panel which attach the junction box to the mounting tray and lift the box clear.

Junction box, Type 164

23. Disconnect the three connectors, take hold of the junction box, and remove the four securing bolts.

Voltage regulator, Type 60

24. Remove the terminal block cover, disconnect the three leads and then remove the four securing nuts and bolts.

Aerial, Type 237

25. Remove the fibre glass panel, by releasing the fourteen counter-sunk screws holding the dish container to the aircraft structure. Take hold of the dish shaped container and lower it. The aerial feeder connector can now be disconnected. On replacing, ensure that there is a good bonded surface between the dish shaped container and the aircraft structure.

Aerials, Type 238 and 239

26. Removal of both types of aerials is similar. Remove the wing tip fibre glass panel. Disconnect the aerial feeder connector. Carefully unscrew the inner aerial lock nut and withdraw the aerial plug through the aerial diaphragm and the aerial diaphragm support plate. Then remove the aerial diaphragm securing bolts. On replacing the aerial, the reverse procedure is carried out. The following check must be made during the fitting of the aerial plug. The aerial plug is supplied with three shim washers, which are to be placed as required, between the plug and the aerial diaphragm support. This is to ensure that, when the aerial plug is secured, there is a clearance of 0.010 to 0.030 of an inch between the insulation of the plug and the face of the connector on the aerial.

TABLE 1

CONNECTORS FOR A.R.I.18011

A.V.Roe Item No.	Cable form	Connecting between	
2/T4272	Miniature cable 2C	J.B.164	to T.B.596
3/T4272	Miniature cable 12C	J.B.164	to J.B.157 (12 P7)
8/T4272	Shorting socket 2 off	J.B.164 indicators	
9/T4272	Uniradio 67	R.P.B. plug 508	to S.R.14
10/T4272	Uniradio 67	R.P.B. plug 175	to S.R.14
11/T4272	Uniradio 67	R.P.B. plug 187	to S.R.15
12/T4272	Miniature cable 2C	J.B.157 (12 P3)	to 54P i/c J.B. inlet 6
13/T3406	Miniature cable 4R	J.B.157 (12 P1)	to supply (T.B.396)
14/T3406	Miniature cable 4R	J.B.157 (12 P8)	to supply (T.B.396)
16/T3406	Uniradio 67	R.P.B. plug 175	to marker aerial
20/T3406	Miniature cable 6C	J.B.157 (12 P5)	to control unit
21/T3406	Uniradio 43	J.B.157 (12 J2)	to control unit
22/T3406	Uniradio 43	J.B.157 (12 P6)	to control unit

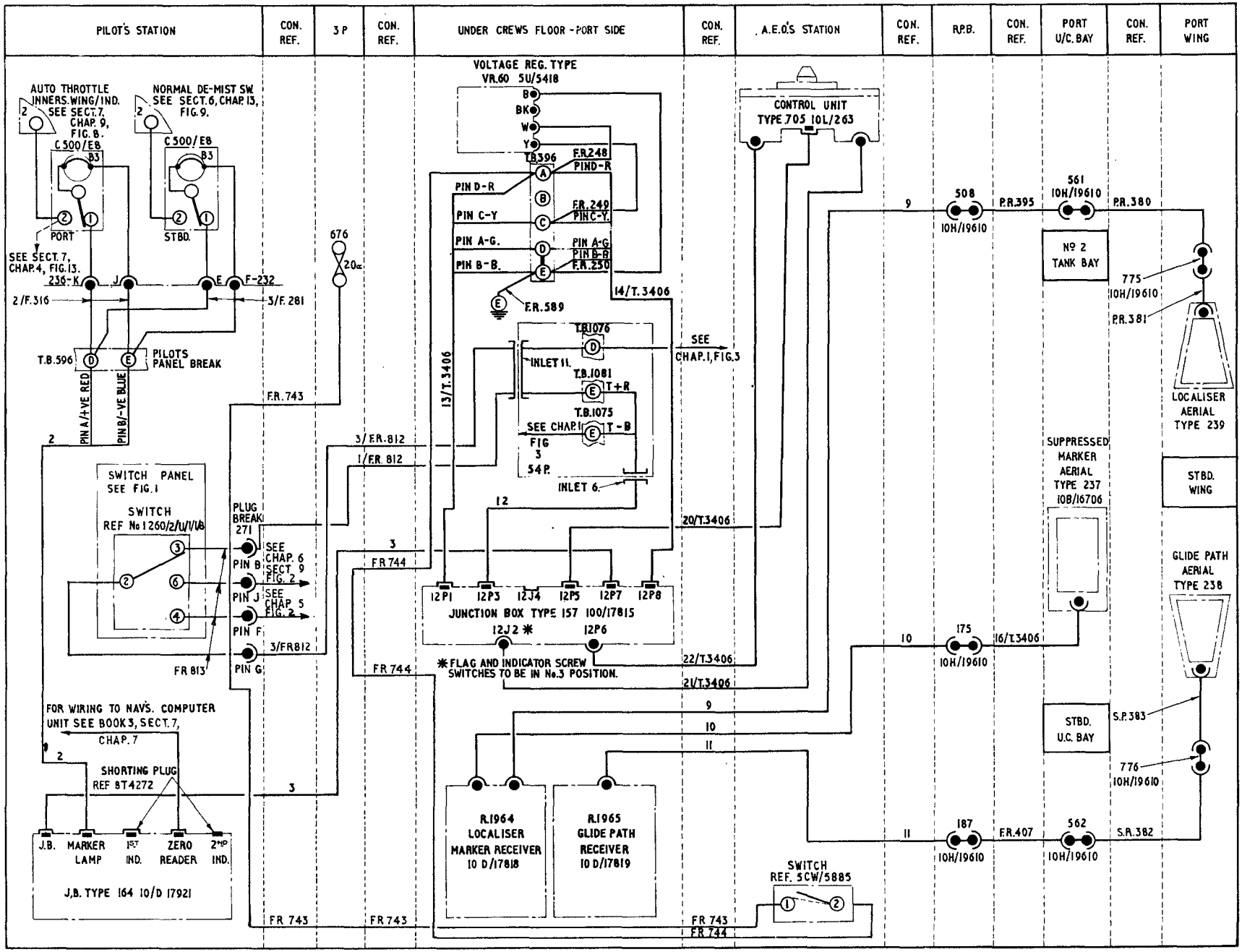

Fig. 2 A.R.I. 18011

(◀ Mods. 1696 and 1856 embodied ▶)

Chapter 7

F.M. RADIO ALTIMETER MK.7B
A.R.I.23172

(Completely revised)

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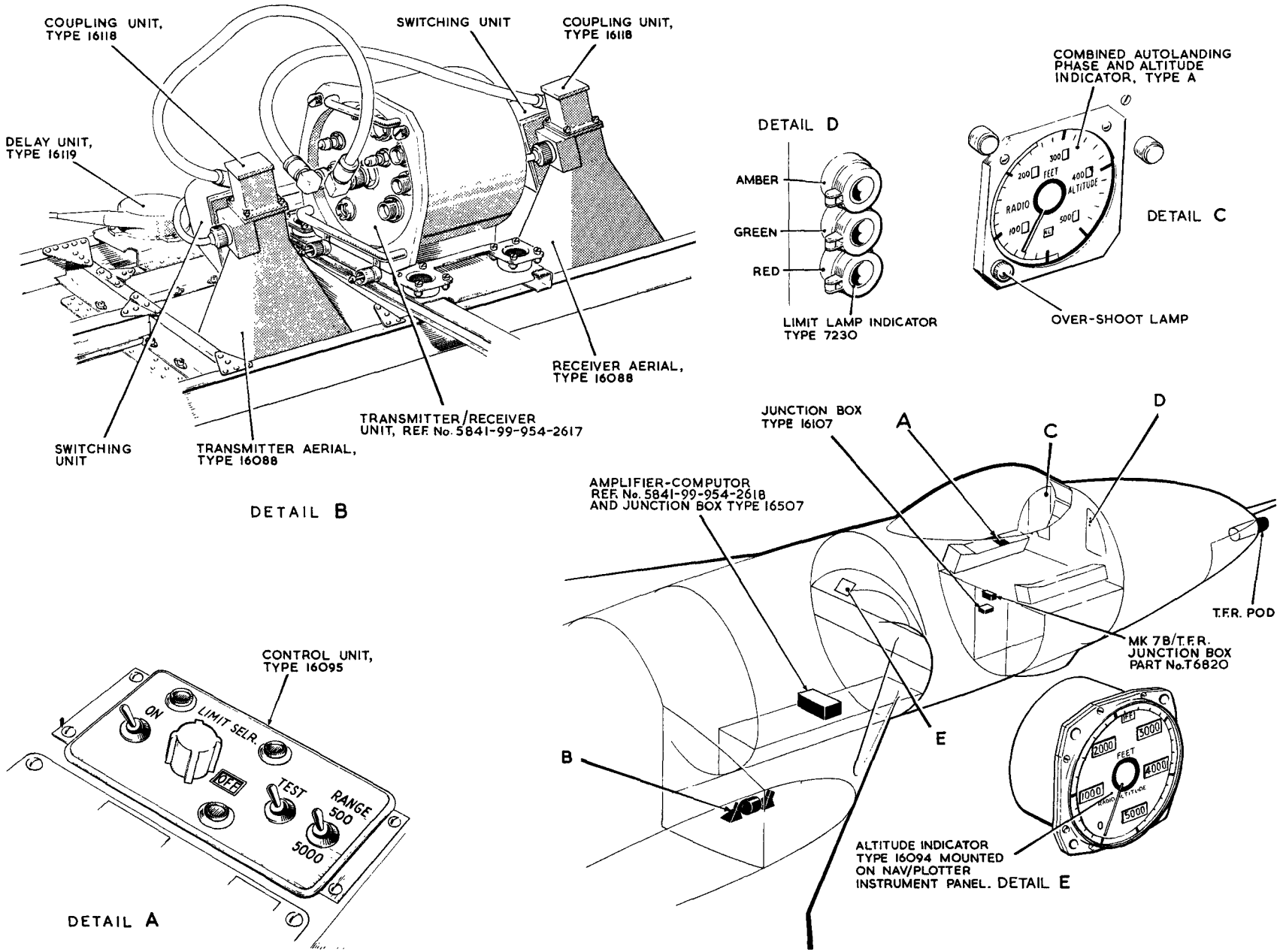

Fig. 1. Component location.

Mod 2117 embodied

Introduction

1. This chapter deals with the installation and general functioning of A.R.I. 23172, introduced by Mod.2117, which is an improved version of A.R.I.23061 originally dealt with previously in this chapter. The installation, which is an integral part of both the aircraft autolanding system and the T.F.R. (terrain following radar) system, consists of a low level radio altimeter which provides low level height and guidance information to enable the aircraft to land automatically at the airfields equipped with the necessary ground equipment. The installation also provides low level height information for use with the T.F.R. system to enable the aircraft to fly at low level over varying terrain.

2. The altimeter becomes operative when the aircraft has descended to a height of 120 feet during an automatic landing. At this height, signals from the altimeter operate a relay, the contacts of which disconnect the I.L.S. glidepath signal from the autopilot elevator channel. Continuing the descent, when a height of 70 feet has been reached the altimeter feeds information into the elevator channel which reduces the aircraft rate of descent from 10 ft/sec on the I.L.S. approach, to 2 ft/sec at touch down.

3. A location diagram for the major components is provided at Fig.1. A routing chart and connector table will be found at the end of the text.

4. Detailed information on the automatic landing system and T.F.R. system will be found in Sect.7, Chap.9 and Sect.9, Chap.7 of this book respectively. Descriptive and servicing details of the A.R.I.23172 will be found in A.P.116B-0203-1. These publications should be read in conjunction with the information contained in this chapter.

DESCRIPTION AND OPERATION

General

5. The installation consists of a transmitter/receiver unit housed in a pressurized cast alloy case which is mounted adjacent to two 'horn' aerials fitted in the lower part of the starboard air intake. The altimeter can operate on two ranges, one of 5,000 feet and one of 500 feet, both of which are selected at the control unit. The control unit also provides facilities for selecting fixed heights at which to fly within the range of 50-5,000 feet. Deviation from the selected height is shown by 'high' - 'on' - 'low' lamp indicators located on the pilot's instrument panel. A test facility is incorporated in the system whereby the pilot can check the installation before committing the aircraft to an automatic landing.

Principle of operation

6. The system is based on the asdic technique. The radio altimeter Mk.7B operates within the frequency band of 4,200 to 4,400 Mc/s, and is frequency modulated at 300 c/s.

7. A signal is transmitted from the aircraft to the ground and is reflected by the ground back to the aircraft receiver. Part of the transmitted signal is fed directly into the receiver, as a reference signal, where it is mixed with the reflected signal. Due to the time taken for the reflected signal to travel to the ground and back to the receiver, a frequency difference will exist between the reflected signal and the reference signal. Consequently when the two signals are mixed together, a 'beat note' is produced, the frequency of which is proportional to aircraft height, i.e., the higher the aircraft the higher the beat note frequency.

8. The beat note signal is fed from the receiver into an amplifier where it is amplified and converted into a d.c. voltage that is proportional to the aircraft height. This information is then fed to the combined autolanding phase/altitude indicator and the autopilot elevation channel. With this information the autopilot will in conjunction with the autothrottle, reduce the aircraft rate of descent, from 10 feet/second on the approach, to 2 feet/second at touch down.

Unit location

9. The installation consists of eleven main units, which are located as shown in Table 1, and described in the paragraphs that follow.

Transmitter/receiver aerials, Type 16088

10. The aerial assembly consists of two rectangular aerial horns, one for the transmitter and one for the receiver. Mounted on top of the horns are the coupling units which contain the waveguide - to - coaxial matching circuits which are required to couple the aerials to the transmitter and receiver connecting cables. Fitted on the side of the horns are the switch units. These units contain the electro-mechanical actuators which insert probes into the horns to connect the 'in-flight' test delay unit across the aerial system.

Delay unit, Type 16119

11. The delay unit comprises a known length of coaxial cable wound round a coil former. Each end of the cable is connected to the probe in each aerial horn. Depressing the TEST switch at the control unit operates the electro-mechanical

actuators which insert the probes into the horns and connects the delay cable across the aerial assembly. The delay cable simulates a height of 60 feet, which is shown on the autolanding phase/altitude indicator.

Transmitter/receiver unit

12. The transmitter receiver unit is a self-contained unit housed within a pressure sealed cast alloy case. The transmitter contains a power unit, R.F. generator, waveguide cavity and a modulation motor. The modulation motor is driven from a special stable 300 c/s oscillator, and rotates a double-vane butterfly paddle assembly inside the waveguide cavity. The action of the paddle assembly, frequency modulates the transmitter carrier mechanically at 300 c/s, and thereby causes a deviation of 100 Mc/s (low range 500 ft.) or 10 Mc/s (high range 5,000 ft.) about the carrier frequency. The receiver contains a balanced mixer and a pre-amp. which mixes the reflected and directly fed signals from the transmitter and amplifies the beat note thereby produced. The receiver is fed with the necessary power supplies from the transmitter power unit.

Amplifier-computor unit

13. The amplifier-computor unit is a self contained unit housed in a light alloy case. The amplifier-computor, which is completely transistorised except for the power unit, consist of the following sub-units:-

Power unit
Amplifier unit
Height counter unit
Limit light counter unit
Computor unit

The power unit, which is supplied from the aircraft 200-volt system, provides the necessary stabilised power supplies for the amplifier and counter units. The amplifier unit contains a six stage amplifier with a push-pull output. Both counter units incorporate triggering circuits, multivibrator and a push-pull (counting) full wave rectifier output stage.

14. Signals from the receiver pre-amp are fed into the amplifier unit where they are amplified and coupled into the triggering circuits of the counter units. The triggering circuits operate in conjunction with the multivibrators to produce a square-wave signal which is rectified at the output stage to a d.c. voltage. As the signal from the receiver pre-amp is proportional to aircraft height, so it follows that the d.c. voltage produced in each counter unit is also proportional to aircraft height.

15. The output from the height counter unit is fed, via junction boxes, Type 16507 and 16107, to the autopilot elevator channel, autolanding phase/altitude indicator and the altitude indicator, Type 16094, on the plotter's instrument panel. With this information the autopilot will progressively reduce the rate of descent of the aircraft and the pilot and plotter can monitor this change on the appropriate indicator.

16. The output from the limit light counter unit is fed to the electrical indicator, Type 7230, via the junction box and the LIMIT SELR (limit selector) switch on the control unit. Selecting a height at the LIMIT SELR switch inserts a load across the output from the limit light counter unit. The value of this load is such that the voltage applied to the indicator, Type 7230, is proportional to the selected height.

Junction box, Type 16507

17. The junction box is an integral part of the amplifier-computor unit rack mounting. Two sockets and one plug are mounted on the junction box which connect the amplifier-computor unit to the appropriate units in the installation.

Junction box, Type 16107

18. The junction box. Type 16107, is the main interconnecting unit for the various major components of the installation. Each component is connected to the junction box, via a multi-pole plug and socket, where interconnection and distribution is carried out, the signals being finally fed to the appropriate component via the respective plug and socket.

Mk.7B/T.F.R. junction box

18A. The Mk.7B/T.F.R. junction box, Part No.T6820, is used to connect the height information, derived from the Amplifier-computor unit, to the T.F.R. installation. The unit houses two relays one of which is energised via the T.F.R. control unit and the other energised by the 'change range' signal which is only available when the RANGE switch on the Mk.7B radio altimeter is set to 5,000 ft. (see fig.1). The junction box is dealt with more fully in Sect.9, Chap.7 of this book.

Combined autolanding phase and altitude indicator, Type A

19. The indicator is a completely sealed unit housed in a cast alloy case. The indicator performes four functions and indicates the following:-

(a) The altitudes measured by the radio altimeter in either of two ranges, 0-500 feet or 0-5000 feet.

(b) That the automatic landing circuits of the autopilot Mk.10B have been primed.

(c) The particular phase of the landing (from the leader cable phase onwards) in which the aircraft is flying.

(d) An "overshoot" lamp to give warning of a malfunction in the system, and that the aircraft must overshoot and make a new approach.

20. The altitude indicator consists of a milliammeter movement geared to a pointer which may be rotated through 320 deg. over a dial calibrated 0-500 feet. When used on the 0-5000 feet range an additional zero appears in an aperture in the dial beside each 100 feet calibration mark. When the A/L PRIME switch is pulled on to either of its two positions, a fluorescent yellow flag marked AL appears in an aperture on the dial of the indicator (see fig.1).

21. The phase indicator is a fluorescent yellow band driven counter-clockwise in an annular aperture round the edge of the dial between the 250 feet and zero feet calibration marks. The end of the band, when stationary, indicates the altitude of the aircraft with respect to the start of the next phase. For Vulcan Mk.2 aircraft these phases start at the following altitudes:-

Attitude phase starts at	-	120 feet
Flare phase starts at	-	70 feet
Land phase starts at	-	17.5 feet

Located on the lower left hand corner of the instrument bezel is the red "overshoot" warning lamp and when lit is indicative of a malfunction in either the autopilot or the leader cable systems. A full description of the phase/altitude indicator will be found in A.P.1469EB, Vol.1, Book 2.

NOTE...
The 'overshoot' lamp will be lit when the autoland test meter switch is set to F.O. (Sect.7, Chap.9 of this book refers).

Altitude indicator, Type 16094
21A. The altitude indicator, Type 16094, is fitted to the plotter's instrument panel and displays the same height information to that shown by the pilots' combined autolanding phase/altitude indicator. The indicator is a completely sealed unit housed in a cast alloy case and is similar in appearance to the pilots' instrument. The altitude indicator, Type 16094, is fully described in A.P.116B-0203-1.

Electrical indicator, Type 7230
22. Three electrical indicator lamps are mounted adjacent to the autolanding phase/altitude indicator. These lamps indicate the height of the aircraft relative to the height selected at the control unit (para.5). The lamps, which are coloured amber, green and red, provide the following indications:-

Amber	Above height (more than 5%)
Green	On height (within 5%)
Red	Below height (more than 5%)

All three lamps incorporate a press-to-test facility.

23. The three lamps are normally fitted to a panel and the assembly is supplied as an indicator, Type 7230. On Vulcan aircraft, however, the mounting is not used and the lamps are fitted directly to the pilots' instrument panel.

Control unit, Type 16095
24. The control unit provides full remote control of the transmitter/receiver and amplifier unit, together with facilities for carrying out a functional check on the entire installation. The following switches are mounted on the front panel of the unit:-

ON - OFF switch
LIMIT SELR. switch
TEST switch
RANGE switch

The ON-OFF switch controls the power supplies to the installation. The LIMIT SELR. (limit selector) switch selects heights at which to fly, the selected height being shown in the 'window' adjacent to the switch. The RANGE switch selects the range the equipment is required to operate on. The TEST switch is used to check the system prior to an automatic landing, (Sect.7, Chap.9).

Power supplies
25. The installation is fed with two supplies, one of 200-volt, 3-phase 400 c/s and one of 28-volt d.c. The 200-volt supply is connected from fuses 282R and B, in panel 27P to terminals A and C respectively of T.B.1088. The supply is then fed, via the respective plug, to the transmitter/receiver and amplifier units. The 28-volt d.c. supply for these units is connected from fuses 656 and 657 in panel 3P, via plug 170, to terminals A and B of T.B.1089. The supply is then fed via the appropriate plug to the respective unit. The control unit is also supplied from the 28-volt d.c. system via fuses 658 and 659 in panel 3P.

SERVICING

Precautions
26. Servicing personnel in particular are warned that a.c. or d.c. voltage in excess of 100 volts can be dangerous, to the extent of causing personal injury, fatal or otherwise. It is essential that the closest attention is given to servicing instructions where safety matters are concerned. It is also essential that maximum co-operation is employed between trades mutually concerned in servicing operations.

Installation
27. The setting up, operating and

servicing instructions for the A.R.I.23172 and its components will be found in A.P.116B-0203-1. The security of all components should be checked regularly. All connectors, plugs, sockets and terminal blocks should be examined for damage and ingress of dirt and moisture.

Transmitter/receiver unit

28. With a suitable pressure gauge check that the internal pressure of the unit is 5 p.s.i. above atmospheric. A schrader valve is provided to renew the pressure by means of a hand pump, which should incorporate a desiccator unit.

Test set, Type 13430

29. A test set is available whereby a complete check can be carried out on the installation. Full details of this test set and the methods of using it will be found in A.P.2533J, Vol.1.

Functional ground check

30. The following ground check should be carried out at those periods laid down in A.P.4505B, Vol.4. With supplies of 200 volt, 3 phase, 400 c/s and 28 volt d.c. connected to the aircraft proceed as follows:-

(1) At the control unit switch ON the installation and allow a few minutes for the equipment to warm-up and stabilise. Select the 500 feet range at the RANGE switch and the 50 feet position at the LIMIT SELR. switch. The autolanding phase/altitude indicator and the altitude indicator on the plotter's instrument panel should read slightly below zero.

(2) At the electrical indicator, Type 7230, check the lamps for serviceability by operating the press-to-test facility. Replace any unserviceable filaments.

(3) At the control unit depress the TEST switch. A reading of approximately 60 ft. should appear on the autolanding phase/altitude indicator and the altitude indicator on the plotter's instrument panel. The amber lamp of the electrical indicator should also be illuminated.

(4) Select the 100 ft. position on the LIMIT SELR. switch. At the electrical indicator note that the amber lamp is extinguished and the red lamp is illuminated.

(5) Return the LIMIT SELR. switch to the OFF position. The red lamp on the electrical indicator should extinguish.

(6) Select the 5,000 ft. range and check that the additional zeros appear on the autolanding phase/altitude indicator and the altitude indicator on the plotter's instrument panel. Depress the TEST switch and both the above indicators should read 60 ft. (not 600 ft.).

On completion ot the above checks, the TEST switch and the ON-OFF switch should be operated to the OFF position and the ground supplies disconnected from the aircraft.

REMOVAL AND INSTALLATION

General

31. Access to the major components is straightforward so no special instructions are required. Should it become necessary to remove or replace any component, all loose connectors should be secured to the adjacent aircraft structure to prevent damage.

Transmitter/receiver aerials, Type 16088

32. Removal of both aerials is similar. The aerials are removed by unscrewing the twelve counter-sunk screws. This allows the aerial cone to drop down. Care should be taken when lowering the aerials to ensure that the weight of the aerials is not taken on the co-axial cable. The aerials can then be removed by disconnecting the co-axial cable.

Transmitter/receiver unit

33. The transmitter/receiver unit is secured in an anti-vibration tray by dowels at the rear and two knurled locking nuts at the front. To remove the unit disconnect the six connectors and remove the two knurled nuts at the base of the unit. Take hold of the two transport handles and slide the unit off its tray.

Delay unit, Type 16119

34. The delay unit is secured by three screws to a shelf located adjacent to the transmitter aerial. The unit is removed by disconnecting the two connectors and unscrewing the three securing screws.

Amplifier-computor unit

35. The amplifier-computor unit is secured in a tray by dowels at the rear and two knurled locking nuts at the front. To remove the amplifier-computor, unscrew the two knurled nuts at the base of the unit and, using the transport handle, slide the unit off its tray. On replacement, care should be taken to ensure that the locating dowels engage properly in order to align the plug at the rear of the unit with the socket on the tray.

Junction box, Type 16107

36. The junction box, Type 16107, is secured to the aircraft structure by four counter-sunk screws. To remove, disconnect the seven connectors and unscrew the four securing screws.

Control unit, Type 16095

37. The control unit is secured to the port console by four screws. Removal of these screws will allow the unit to be lifted up from the console. Located at the rear of the unit are two connectors which, when disconnected, enable the complete unit to be removed from the aircraft.

Combined autolanding phase and altitude indicator

38. To remove the autolanding phase/altitude indicator, the first pilots port outer instrument panel has to be lowered from the support brackets, by removing the three securing screws and the two tufnol distance pieces. Care should be taken to ensure that the weight of the panel is not taken on any of the cable connectors.

39. To remove the indicator disconnect the three connectors at the rear of the instrument and unscrew the securing screws.

Altitude indicator, Type 16094

39A. To remove this instrument from the plotter's instrument panel, access to the rear of the plotter's panel must first be gained by carrying out the instructions given in Sect.7, Chap.1 of this book. The instrument may then be removed from the panel by disconnecting the connector at the rear of the instrument and removing four securing screws.

Indicator lamps

40. To gain access to one or more indicator lampholders, first remove the autolanding phase/altitude indicator. Unscrew the insulated cap at the rear of the lampholder, unsolder the connectors, release the retaining spring, and withdraw the lampholder through the panel.

41. When replacing the instrument panel, ensure that the tufnol distance pieces are placed between the panel and support brackets, and that no cables have been damaged or trapped.

TABLE 1

Unit location

Unit	Type and Ref.No.	Location
Transmitter and receiver aerials	Type 16088 Ref.No.10B/19424	Starboard air intake
Delay unit	Type 16119 Ref.No.10D/22305	Starboard air intake
Transmitter/receiver unit	Ref.No.5841-99-954-2617	Starboard air intake
Amplifier-computor unit	Ref.No.5841-99-954-2618	Nose wheel bay (starboard crate)
Junction box	Type 16507 Ref.No.10D/22437	Nose wheel bay (starboard crate)
Junction box	Type 16107 Ref.No.10D/21788	First pilot's radar crate
Autolanding phase/altitude indicator	Type A Ref.No.6T/1829	Pilots' instrument panel (port)
Electrical indicator	Type 7230 Ref.No.10Q/89	Pilots' instrument panel (stbd.)
Control unit	Type 16095 Ref.No.10L/16720	Port console
Altitude indicator	Type 16094 Ref.No.10Q/16459	Plotter's instrument panel

TABLE 2

Connectors for A.R.I.23172

H.S.A. Part No.	Cable form	Connecting
18/T.4909	Min. electric 6C	J.B.16107 to Indicator, Type 7230
3/T.4909	Min. electric 12C	J.B.16107 to Control Unit
4/T.4909	Min. electric 4C	J.B.16107 to PL.1016
5/T.4909	Min. electric 4C	PL.1016 to T.R. Unit
8/T.4909	Uniradio 43	T.R. Unit to J.B.16507
9/T.4909	Unipren 4	T.R. Unit to T.R. Aerials
4/T.6195	Min. electric 6C	J.B.16107 to Autolanding Phase/ altitude indicator
11/T.4909	Min. electric 6C	T.B. to T.R. Unit
12/T.4909	Min. electric 12C	J.B.16107 to Autopilot
13/T.4909	Min. electric 4C	J.B.16507 to T.B.'s
14/T.4909	Uninyvin 22	Fuses 656 & 657 to PL.170
15/T.4909	Uninyvin 22	PL.170 to T.B.1089
17/T.4909	Min. electric 18C	PL.1017 to J.B.16507
21/T.4909	Min.electric 18C	P.L.1017 to Mk.7B/T.F.R. J/B P.L.1
22/T.4909	Min.electric 18C	Mk.7B/T.F.R. J/B SK.3 to J/B16107 P.L.2A
1/FR.733	Uninyvin 22	Control unit, Type 16095, to 3P Fuses 658 and 659
2/FR.733	Uninyvin 22	Control unit, Type 16095, to earth connection
3/T.6195	Min.electric 6C	J.B.16107 to altitude indicator, Type 16094

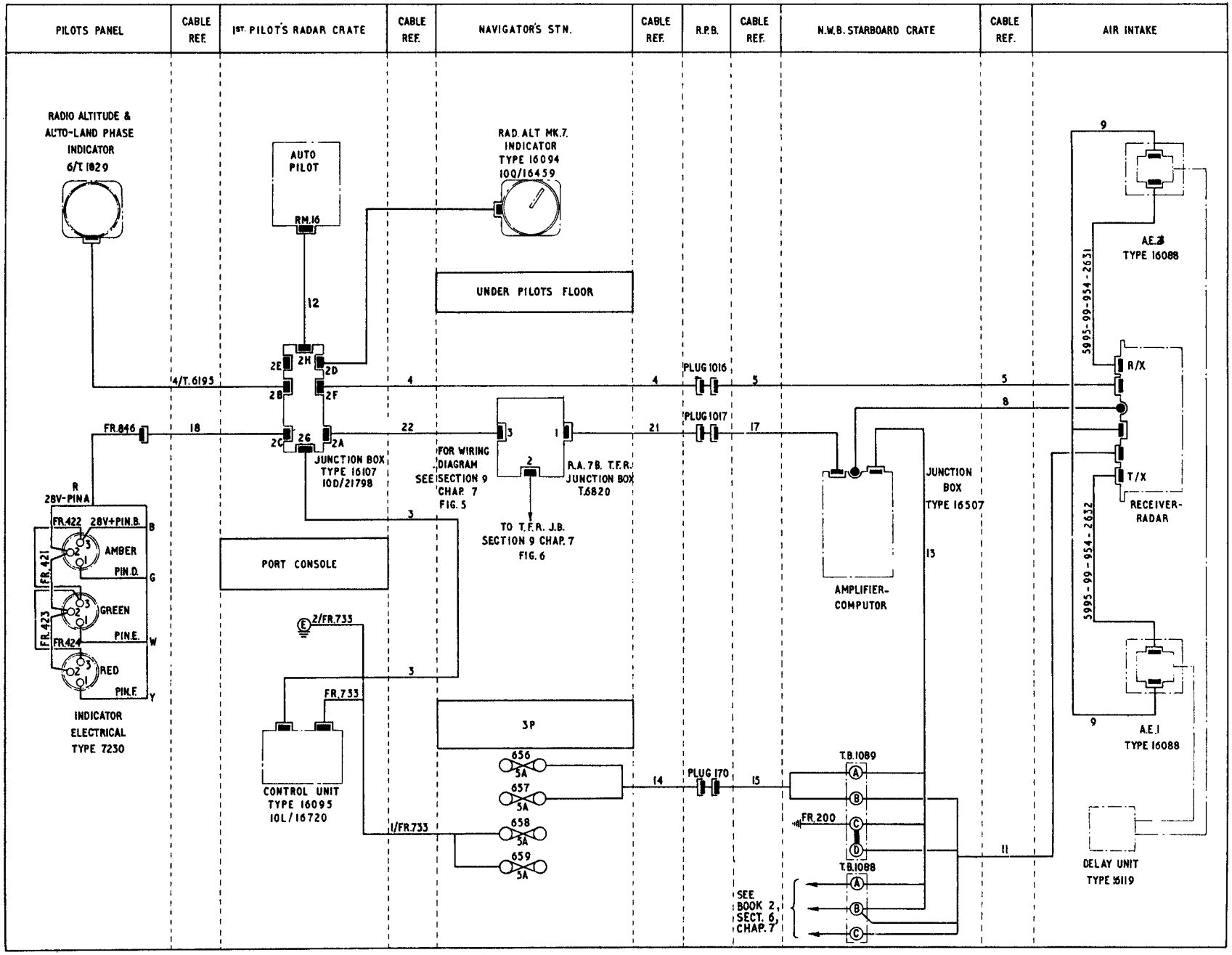

Fig. 2 A.R.I. 23172

Chapter 8

A.R.I.18090

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Introduction

1. This chapter deals with the A.R.I.18090, which is an airborne radio altimeter Mk.6A. The installation employs a pulse radar technique in a frequency range of 1600 Mc/s, to 1660 Mc/s, to measure the height of the aircraft above the terrain immediately beneath, through a range of 500 to 50,000 feet. A location diagram of the major components is provided in fig.1. A connector table is contained in the text and a routing chart will be found at the end of the chapter.

2. Descriptive and servicing details of the A.R.I.18090 are given in A.P.2533G, which should be read in conjunction with the information contained in this chapter.

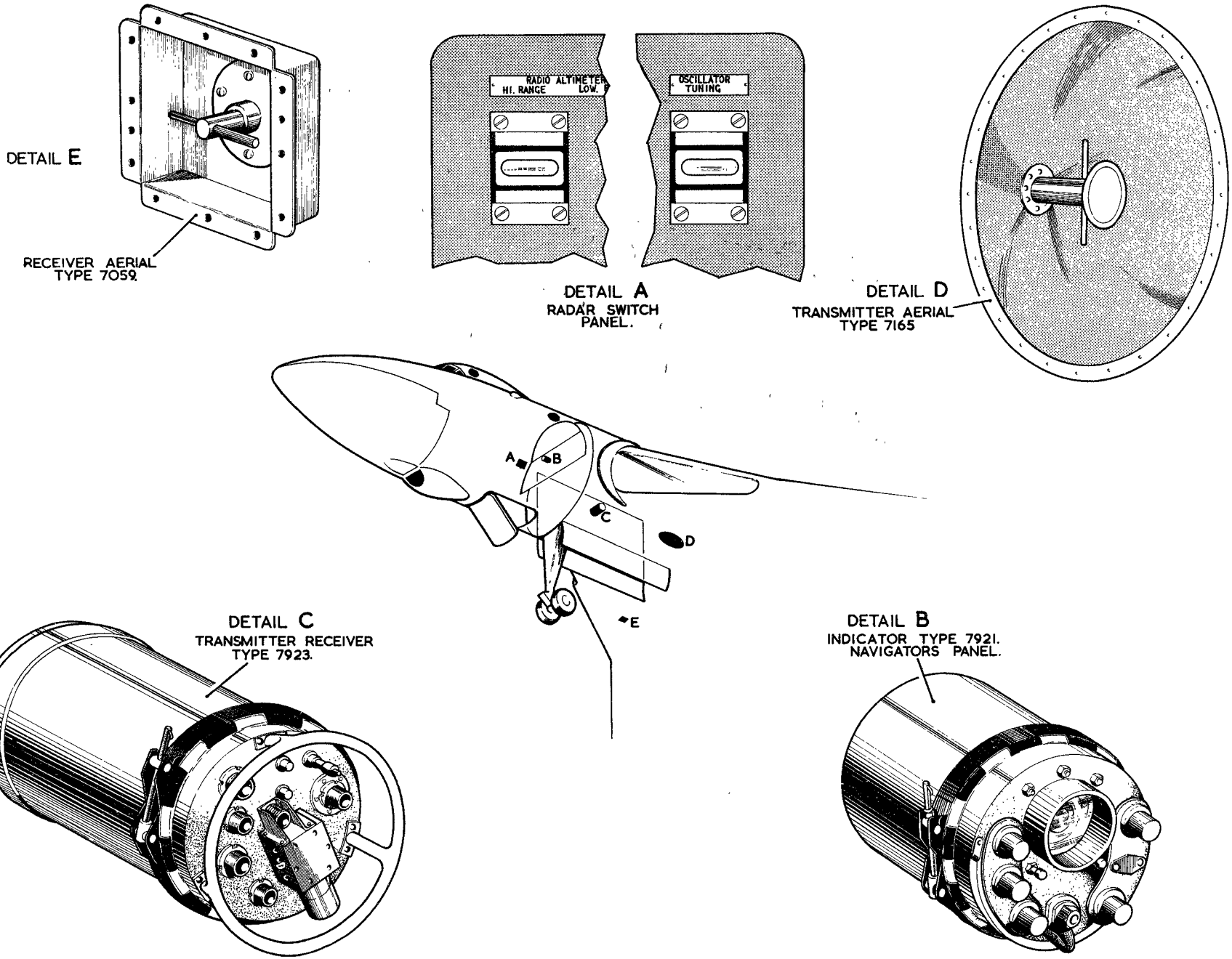

Fig. 1 Component location

DESCRIPTION AND OPERATION

CONTROL AND UNIT LOCATION

3. The power supply control switch labelled RADIO ALTIMETER HI. RANGE and the switch labelled OSCILLATOR TUNING are contained in the radio switch panel (between formers 246 and 260) at the navigator bomber's position, starboard side. The indicating unit, C.R.T. Type 7921, is contained in the navigator bomber's main panel. The transmitter-receiver, Type 7923, mounted on an anti-vibration tray, is located in the nose wheel bay radio crate on the starboard side. Below the engine air intake in the port wing is the transmitting aerial, Type 7165, and in a similar position in the starboard wing is the receiving aerial, Type 7059.

Transmitter-receiver, Type 7923

4. The T.R. unit consists of a front panel and a main chassis enclosed in a pressurised container. The front panel contains the following:-

Sockets (3)
Aerial plugs (2)
Schrader valves (2)
Desiccator
Mechanical drive unit

The mechanical drive unit, which contains a d.c. motor coupled to an oscillator tuning unit, is controlled by a three-position, double-pole toggle switch, spring loaded to centre off.

5. The main chassis contains the T.R. and its components, and is fed with both 28-volt d.c. and 115-volt, 1600 c/s. a.c. supplies. The 28-volt d.c. supply operates the power relay and the two blower motors (internal and external) for cooling purposes. The 115-volt, 1600 c/s., a.c. supply is fed to the power unit to provide the E.H.T., H.T. and L.T. voltages.

Indicator unit, Type 7921

6. The indicator unit consists of a front panel with the main chassis enclosed in a pressurised container. The front panel incorporates a cathode-ray tube and the following controls:-

Range switch
Gain switch
Circle size switch
Brilliance switch
Pre-set trimmers (2)
Schrader valves (2)
Desiccator

Of the two concentric scales printed on the face of the cathode ray tube, the outer scale is used for indication in the 0-5,000 ft. range and the inner scale in the 0-50,000 ft. range. Both scales are graduated from 0 to 5.

Power supplies

7. The 28-volt d.c. supply is fed from fuse 719 in panel 48P, to the high range altimeter switch terminal 2 and linked to the oscillator tuning switch terminal 5. The 115-volt 1600 c/s., a.c. supply is fed from fuse 332 to the high range altimeter switch terminal 4. Power supplies for the installation are shown in the routing chart for unscreened radio supplies contained in Book 2, Sect.6, Chap.7 of this publication.

SERVICING

Precautions

8. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100 volts can be dangerous, to the extent of causing personal injury, fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned, and that maximum co-operation be maintained between trades mutually concerned in servicing operations.

Installation

9. The setting up, operating and servicing instructions for the A.R.I.18090 and its components are contained in A.P.2533G. The security of all components should be checked regularly. All connectors, plugs, sockets and terminal blocks should be examined for damage and ingress of dirt and moisture.

Transmitter-receiver and indicator units

10. Check the colour of each desiccator visible through the perspex window. If the desiccant colour is pink, unscrew the container and re-new with re-activated desiccant. Check with a suitable gauge, that the air pressure inside each container is 5 lb. per sq. in. above atmosphere. This pressure may be renewed if necessary, by means of a hand pump incorporating a desiccator unit, through a Schrader valve mounted on the front of the units.

Power supplies

11. In conjunction with the servicing of the system as laid down in A.P.4505B, Vol.4, and using a ground supply trolley, the following periodic checks should be carried out. Check with a suitable test meter, that the d.c. output is 28-volts at T.B. 676-D, T.B.1205D, and that the a.c. output is 115-volt, 1600 c/s at T.B. 676-A.

REMOVAL AND ASSEMBLY

General

12. Access to the components is straightforward, but the following points should be observed. When it is necessary to remove or replace any components, secure all loose connectors to the adjacent aircraft structure to prevent damage.

Transmitter-receiver

13. On the front panel disconnect the six connectors, unscrew the two knurled screws, take hold of the transport handle and slide the unit off its mounting tray.

Indicator unit

14. On the front panel disconnect the two connectors, unscrew the two knurled screws, take hold of the unit and slide it off its anti-vibration mounting tray. On replacing the unit, ensure that the locating dowels engage properly, at the rear of the mounting tray.

Aerials, Type 7059 and 7165

15. For removal and assembly of these aerials see Chap.7 of this section.

TABLE 1

CONNECTORS FOR A.R.I.18090

A.V.Roe Item No.	Cableform	Connecting Between	
2/T 4326	12 Metvinsmall 2.5	T.R. unit	to R.P.B. plug 201
3/T 4326	12 Metvinsmall 2.5	Indicator unit	to R.P.B. plug 201
4/T 4326	Uniradio 70	T.R. unit	to R.P.B. plug 183
5/T 4326	Uniradio 70	Indicator unit	to R.P.B. plug 183
6/T 4326	Uniradio 65	T.R. unit T.X.	to port aerial
8/T 4326	Unipren 6 2 off	T.R. unit	to T.B. 1205
9/T 4326	Miniature 4c	T.R. unit	to T.B. 676
17/T 3407	Uniradio 65	T.R. unit R.X.	to starboard aerial

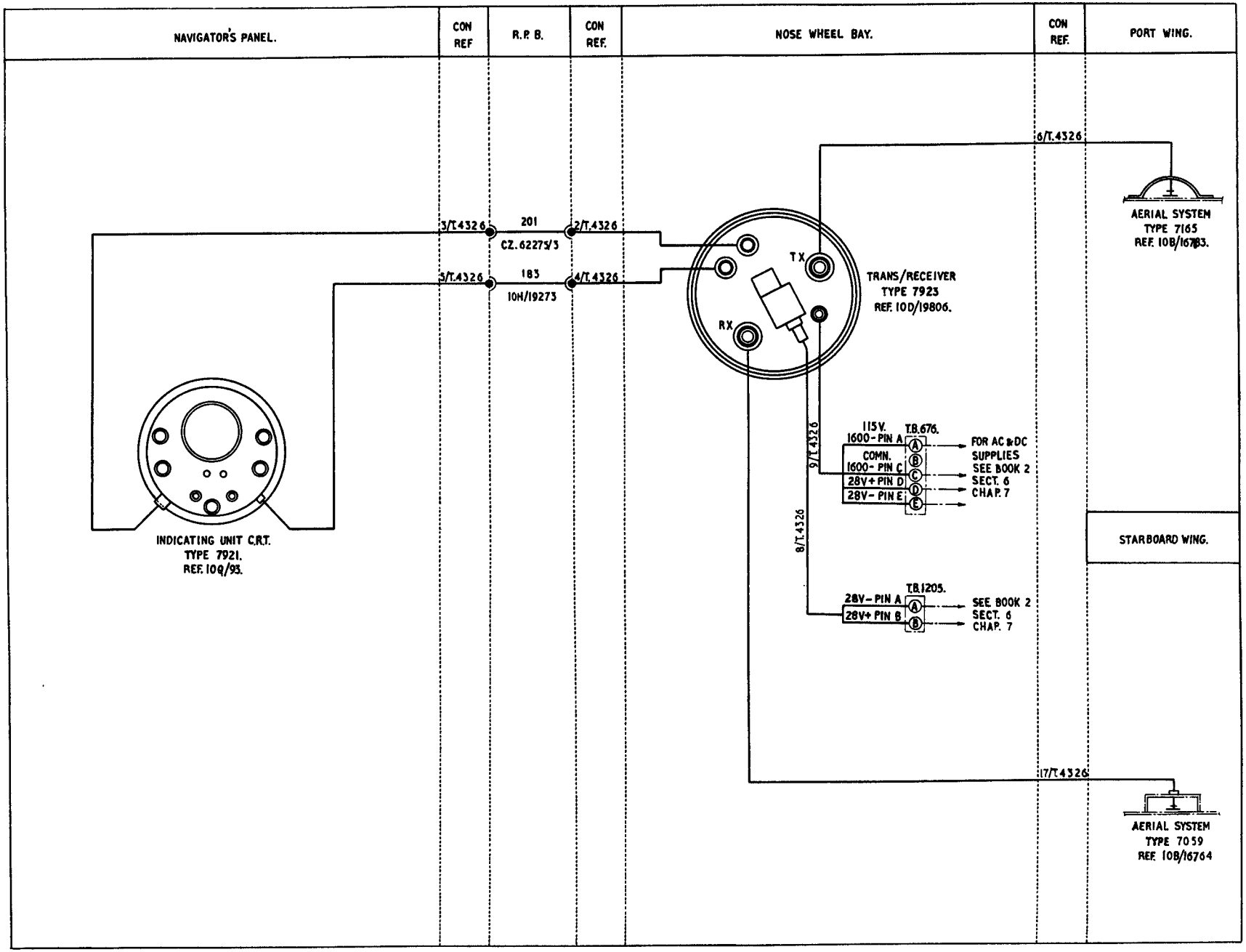

Fig. 2 A.R.I.18090

Chapter 9

A.R.I.23143/1

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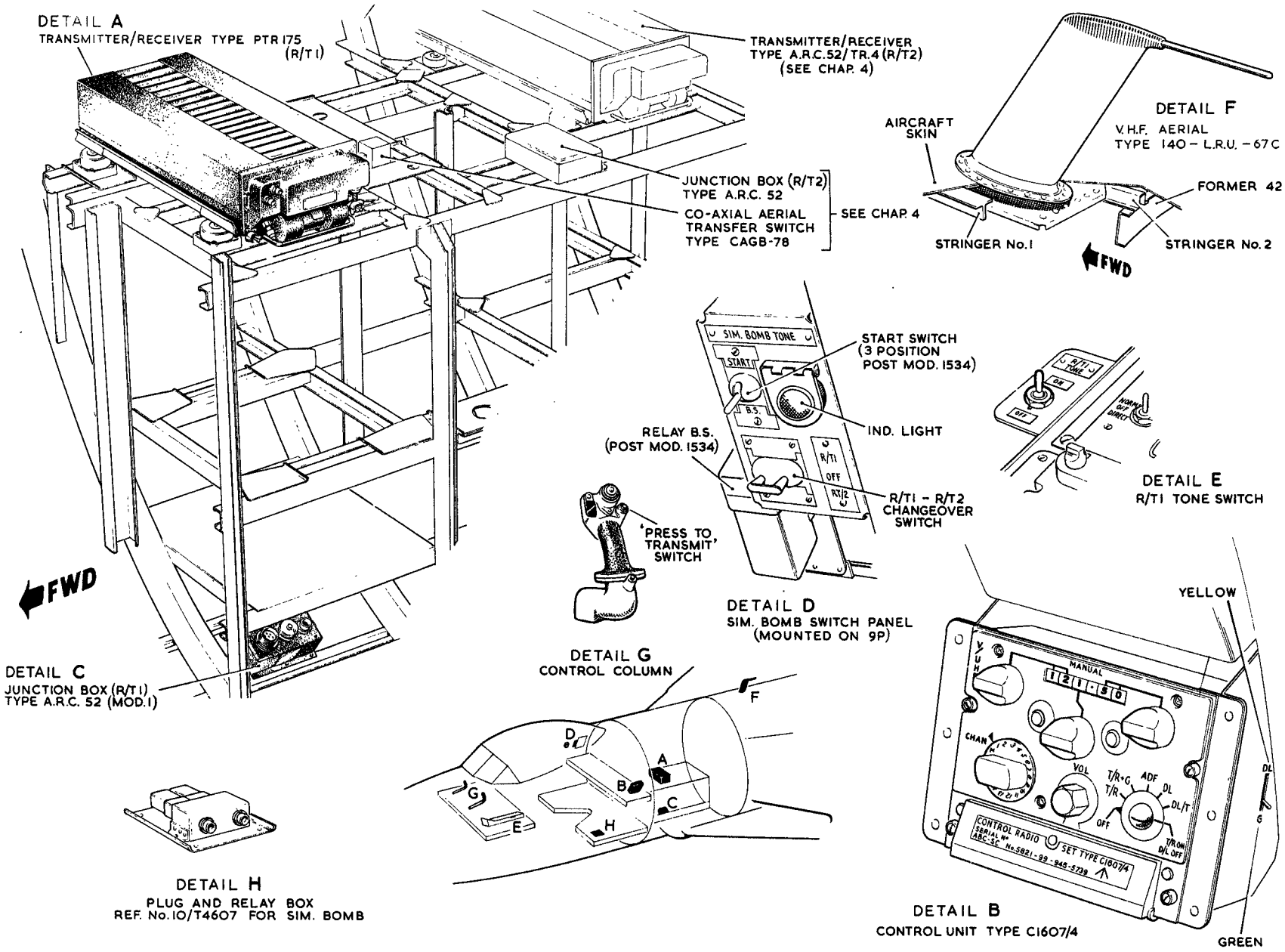

Fig. 1. Component location.

Introduction

1. This chapter deals with A.R.I. 23143/1 (d.c. version) which is a combined multi-channel V.H.F./U.H.F. transmitter-receiver installation and has been introduced by Mod.2007 to replace the V.H.F. installation A.R.I.18064. This new installation is a derivative of the existing U.H.F. system A.R.I.18124/2 which is dealt with in Sect.8, Chap.4 of this Book.

2. The transmitter-receiver may be set to operate on any of the 3500 frequency channels in the 225.0 Mc/s to 399.95 Mc/s U.H.F. range, and 420 frequency channels in the 115.0 Mc/s to 135.95 Mc/s V.H.F. range. In addition to R/T transmission and reception, facilities are available for M.C.W. transmission, simulated bombing tone and direction finding purposes.

3. A location illustration of the major components is provided in fig.1, routing charts and a connector table will be found at the end of the text. Descriptive and servicing details for the A.R.I.23143/1 are given in A.P.2531J, Vol.1 and the reader is advised to consult this A.P. in conjunction with the information contained in this chapter and also Sect.8, Chap.4 of this Book.

DESCRIPTION AND OPERATION

General

4. The installation is remotely controlled from a control unit, Type C1607/4, in conjunction with an aerial change-over switch and tone switch. The control unit is mounted at the A.E.O's position as shown in fig.1 and the aerial and tone switches are located on the pilot's port console. The existing U.H.F. aerials (upper and lower) belonging to A.R.I. 18124/2 are shared with this installation as described later, and also the existing V.H.F. aerial which originally belonged to A.R.I.18064 is now connected to the V.H.F. section of this installation.

5. The associated transmitter-receiver, Type PTR 175, and the junction box, Type AN/ARC52, are both located in the nose wheel bay as shown in fig.1. It should be noted that the junction box, Type AN/ARC52, used in this installation, has Mod.1 embodied and therefore should not be confused with a similar junction box, with the same reference number, used in the A.R.I.18124/2 installation.

6. The aircraft designation for both the A.R.I.18124/2 and A.R.I.23143/1 is R/T2 and R/T1 respectively and these references will be used from time to time throughout the following text. Routing charts and the various associated labels in the aircraft carry these references.

V.H.F. aerial, Type 140-L.R.U.-67C

7. The V.H.F. aerial, Type 140-L.R.U. -67C, originally used for the A.R.I.18064 installation has been retained and is now connected directly to the transmitter-receiver (R/T1) V.H.F. aerial socket. The vent sleeve aerial is of shark fin design with a short rod projecting horizontally at the rear of the blade. The aerial is mounted on the top of the aircraft fuselage above No.2 fuel tank bay as shown in fig.1

U.H.F. aerials

8. The two U.H.F. aerials (upper and lower) used in A.R.I.18124/2 (R/T2) are shared with this installation (R/T1). The aerial change-over switch and aerial relay, which are part of A.R.I.18124/2, operate in the following way. When the upper U.H.F. aerial is selected for operation with R/T2, via the aerial change-over switch on the pilot's port console, the lower U.H.F. aerial is automatically connected to the U.H.F. aerial socket of the transmitter-receiver R/T1.

9. When the upper U.H.F. aerial is selected for operation with the R/T1 installation, the lower U.H.F. aerial is automatically connected to the transmitter-receiver R/T2. Further information concerning the U.H.F. aerials may be found in Sect.8, Chap.4 of this Book.

Transmitter-receiver, Type PTR 175

10. The transmitter-receiver unit comprises a front panel and a main chassis, the unit being mounted on an anti-vibration tray. The front panel contains.

Pressure air valve (Schrader)

External combined dynamotor/ airblower

Multi-pole plug

U.H.F. aerial socket

V.H.F. aerial socket

The main chassis, which has various sub-assemblies fitted to it, is enclosed in a double walled aluminium case (pressurised to 18 p.s.i.g.) which functions as a heat exchanger between the outside air and the air inside the case. Air forced between the walls by the blower fitted at both ends of the dynamotor shaft, dissipates the heat absorbed by the inner wall and is exhausted out through vents on the top of the outer case.

11. The transmitter-receiver unit has sufficient crystals fitted in the unit to provide 420 channels at 50 kc/s spacing in the V.H.F. range and 3,500 channels at 50 kc/s spacing in the U.H.F. range. A facility for presetting 18 channels is provided, and also a guard receiver which

is permanently tuned to monitor the U.H.F. distress frequency band of 238.0 Mc/s to 248.0 Mc/s.

12. A M.C.W. tone of approx. 1,000 c/s is automatically transmitted when the pilot's tone switch is operated and may be used for emergency or direction finding purposes. The tone generator is also employed in providing a simulated bombing tone as described later.

Control unit, Type C.1607/4

13. The control unit, Type C.1607/4, provides remote control of the installation by operation of various switches, mounted on the front panel. The function switch has seven positions, four of which are used for normal operation. The remaining three positions are not applicable to the Vulcan aircraft installation. The switch positions are as follows:-

(1) OFF. The power supplies are switched off.

(2) T/R. The power supply is switched on and the equipment is automatically set for receiving purposes. When it is required to transmit, the push-to-transmit switch must be operated.

(3) T/R + G. The guard receiver is switched on, while normal transmit-receive facilities on the selected channel are retained.

(4) A.D.F. The transmitter-receiver is switched to A.D.F. with the appropriate airborne equipment, and includes facilities to permit normal transmission and reception when the A.D.F. position is in use.

(5) DL. These last three positions are for use
(6) DL/T. with special data link equipment not fitted
(7) T/R ON DL OFF. to Vulcan aircraft.

14. The volume control (VOL) permits the level of the audio signal to be set to the required level. The channel selector switch (CHAN) is a 20-position rotary switch labelled 1 to 18 inclusive, and a further two positions labelled G and M. Each numeral position indicates a preset frequency, which on selection selects the frequency automatically.

15. With the channel selector switch switched to G and the function switch selected to T/R, the guard receiver output is cut off and the main receiver can now receive or transmit at this guard frequency.

16. With the channel selector switch switched to M, the preset frequency selection becomes inoperative and the required frequency is then obtained by manual adjustment of three manual frequency selector switches. The manual frequency selection switches permit one of the 3,500 (U.H.F.) and 420 (V.H.F.) channels to be selected. Figures indicating the selected frequency appear in a small window above the manual control knobs as shown in fig.1.

17. Frequency adjustments for pre-selected channels are made by first pulling down a small hinged panel cover to expose the pre-set frequency switch actuator. Actual setting up is done by means of switch actuators mounted on a drum, there being one bank of actuators for each channel. A special pre-setting tool, normally stowed in the cover panel when not in use, is used to slide the actuators to the required position. The actuators operate certain switches when the drum is revolved via the movement of the channel selector switch. Two lamps are arranged to provide diffused illumination of the main panel controls.

NOTE...
The Type C.1607/4, control unit has a two-position switch visible through the case on the right hand side as shown in fig.1. In this installation this switch should remain in the green G (guard) position.

Junction box, Type ARC/52

18. The junction box, Type ARC/52, is the main distribution point for the R/TI installation and its location in the nose wheel bay is shown in fig.1. The junction box is equipped with five multi-pole sockets which provide the following facilities:-

(1) Connects the microphone input and output audio circuits from the transmitter-receiver to the aircraft intercommunication system.

(2) Links the control unit to the transmitter-receiver unit.

(3) Connects the aircraft d.c. power supply to the transmitter-receiver unit.

(4) Connects the tone control circuit and control unit lights to the appropriate control and dimmer switches.

Power supplies

19. When the function switch, on the control unit, Type C.1607/4, is rotated from the OFF position to either T.R., T.R. + G or A.D.F., a power relay in the transmitter-receiver power unit is energised by a 28-volt d.c. supply from fuse 1379 in panel 16P. This same supply is used to energise an internal combined dynamotor/blower which in turn provides the transmitter-receiver with the necessary a.c. supplies.

20. When the console red flood dimmer, mounted on panel 70P, is operated a 28-volt d.c. supply from fuse 677 in panel 3P, is fed to the lamps which illuminate the dials and switches on the control unit, Type C.1607/4. Power supplies for

Introduction

1. This chapter deals with A.R.I. 23143/1 (d.c. version) which is a combined multi-channel V.H.F./U.H.F. transmitter-receiver installation and has been introduced by Mod.2007 to replace the V.H.F. installation A.R.I.18064. This new installation is a derivative of the existing U.H.F. system A.R.I.18124/2 which is dealt with in Sect.8, Chap.4 of this Book.

2. The transmitter-receiver may be set to operate on any of the 3500 frequency channels in the 225.0 Mc/s to 399.95 Mc/s U.H.F. range, and 420 frequency channels in the 115.0 Mc/s to 135.95 Mc/s V.H.F. range. In addition to R/T transmission and reception, facilities are available for M.C.W. transmission, simulated bombing tone and direction finding purposes.

3. A location illustration of the major components is provided in fig.1, routing charts and a connector table will be found at the end of the text. Descriptive and servicing details for the A.R.I.23143/1 are given in A.P.2531J, Vol.1 and the reader is advised to consult this A.P. in conjunction with the information contained in this chapter and also Sect.8, Chap.4 of this Book.

DESCRIPTION AND OPERATION

General

4. The installation is remotely controlled from a control unit, Type C1607/4, in conjunction with an aerial change-over switch and tone switch. The control unit is mounted at the A.E.O's position as shown in fig.1 and the aerial and tone switches are located on the pilot's port console. The existing U.H.F. aerials (upper and lower) belonging to A.R.I. 18124/2 are shared with this installation as described later, and also the existing V.H.F. aerial which originally belonged to A.R.I.18064 is now connected to the V.H.F. section of this installation.

5. The associated transmitter-receiver, Type PTR 175, and the junction box, Type AN/ARC52, are both located in the nose wheel bay as shown in fig.1. It should be noted that the junction box, Type AN/ARC52, used in this installation, has Mod.1 embodied and therefore should not be confused with a similar junction box, with the same reference number, used in the A.R.I.18124/2 installation.

6. The aircraft designation for both the A.R.I.18124/2 and A.R.I.23143/1 is R/T2 and R/T1 respectively and these references will be used from time to time throughout the following text. Routing charts and the various associated labels in the aircraft carry these references.

V.H.F. aerial, Type 140-L.R.U.-67C

7. The V.H.F. aerial, Type 140-L.R.U. -67C, originally used for the A.R.I.18064 installation has been retained and is now connected directly to the transmitter-receiver (R/T1) V.H.F. aerial socket. The vent sleeve aerial is of shark fin design with a short rod projecting horizontally at the rear of the blade. The aerial is mounted on the top of the aircraft fuselage above No.2 fuel tank bay as shown in fig.1

U.H.F. aerials

8. The two U.H.F. aerials (upper and lower) used in A.R.I.18124/2 (R/T2) are shared with this installation (R/T1). The aerial change-over switch and aerial relay, which are part of A.R.I.18124/2, operate in the following way. When the upper U.H.F. aerial is selected for operation with R/T2, via the aerial change-over switch on the pilot's port console, the lower U.H.F. aerial is automatically connected to the U.H.F. aerial socket of the transmitter-receiver R/T1.

9. When the upper U.H.F. aerial is selected for operation with the R/T1 installation, the lower U.H.F. aerial is automatically connected to the transmitter-receiver R/T2. Further information concerning the U.H.F. aerials may be found in Sect.8, Chap.4 of this Book.

Transmitter-receiver, Type PTR 175

10. The transmitter-receiver unit comprises a front panel and a main chassis, the unit being mounted on an anti-vibration tray. The front panel contains.

Pressure air valve (Schrader)

External combined dynamotor/ airblower

Multi-pole plug

U.H.F. aerial socket

V.H.F. aerial socket

The main chassis, which has various sub-assemblies fitted to it, is enclosed in a double walled aluminium case (pressurised to 18 p.s.i.g.) which functions as a heat exchanger between the outside air and the air inside the case. Air forced between the walls by the blower fitted at both ends of the dynamotor shaft, dissipates the heat absorbed by the inner wall and is exhausted out through vents on the top of the outer case.

11. The transmitter-receiver unit has sufficient crystals fitted in the unit to provide 420 channels at 50 kc/s spacing in the V.H.F. range and 3,500 channels at 50 kc/s spacing in the U.H.F. range. A facility for presetting 18 channels is provided, and also a guard receiver which

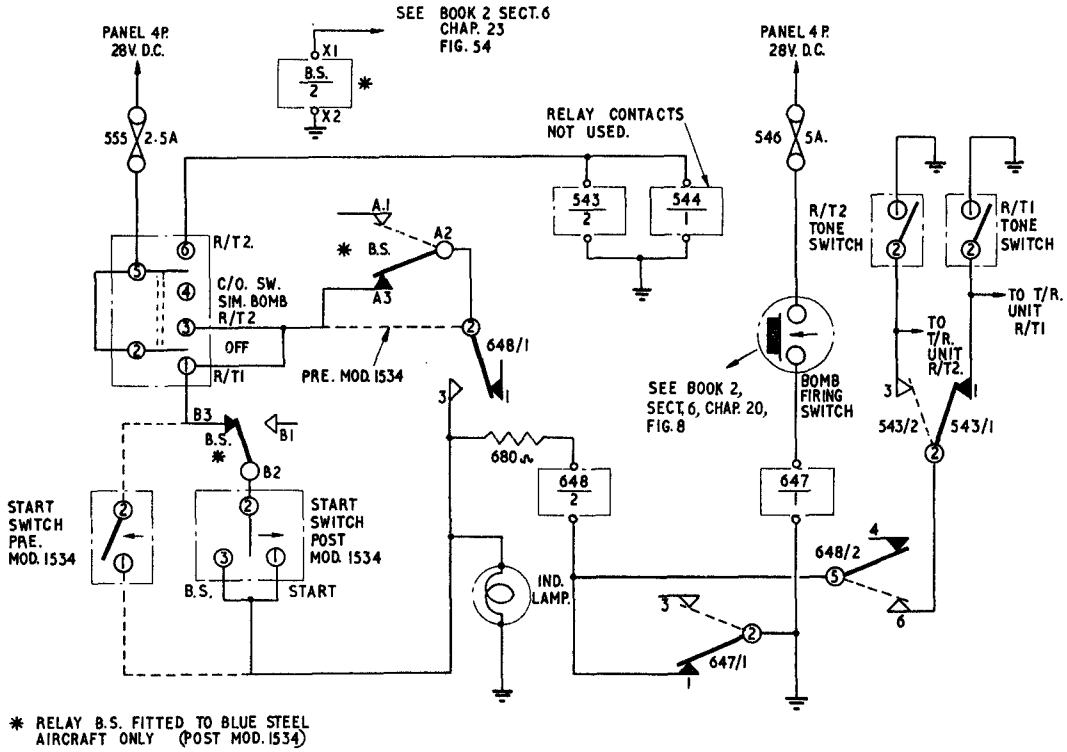

Fig.2 Simulated bombing tone

the radio installation are fully described in Book 2, Sect.6, Chap.7 of this publication.

SIMULATED BOMBING TONE

21. The simulated bombing tone system is operated from panel 9P at the navigator's bomb station. When the system is primed, a 1,000 c/s tone is transmitted, via the R/T1 or R/T2 (Chap.4) installations, until the bomb firing switches at the prone bomb aimer's station or the navigator's bomb aimer's are depressed, thus cancelling the tone circuit.

Circuit operation

22. With the R/T1 installation switched on, a simulated bombing tone is transmitted in the following manner (refer to fig.2). When the change-over switch labelled SIM.BOMB is selected to R/T1 and the start switch momentarily depressed, a 28-volt d.c. supply from fuse 555 in panel 4P will be fed through the sim.bomb and start switches to the energising coil of relay 648 via a 680 ohm resistor, and earthed via relay contacts 647/1. The relay 648 is held in by its own contacts 648/1 and the indicator lamp will now light.

23. The earth return to tone relay K904 in the transmitter-receiver, Type PTR175, (R/T1) is normally earthed via a tone switch situated on the port console 6P as shown in fig.1. When relay K904 is energised in this way thereby switching on the tone generator, the press-to-transmit relay K901 is also energised and thus transmits the tone automatically.

24. For simulated bombing purposes the earth return for K904 is completed via terminal 2 of the pilot's R/T1 tone switch and relay contacts 543/1, 648/2 and 647/1. The tone will therefore be automatically transmitted when R/T1 is selected on the simulated bombing changeover switch and the start switch operated. The side tone to the crew's intercomm. system is routed via R/T1 junction box, Type ARC/52.

25. On depressing the bomb firing switch in the prone bomb aimer's position or the bomb aimer's switch, on panel 9P, the tone is cancelled by energising relay 647 via fuse 546 (panel 4P) and the bomb firing switches. Relay contacts 647/1 open and therefore de-energise relay 648, opening contacts 648/2 and thus removing the earth connection from the tone switch (R/T1) terminal 2. The indicator lamp is also extinguished by the opening of relay contacts 648/1.

Mod.1534 (Blue steel aircraft)

26. Mod.1534 provides an extra relay (B.S.) and also changes the existing start switch to that of a different type, labelled START/B.S., which has a change-over

centre "off" action and spring return in one direction only. The additional relay contacts are wired in series with the start switch such that when the relay remains in the de-energised position the associated contacts are normally closed and the sim. bomb priming and cancelling circuit functions normally, as described in para.22 and 25 respectively, when the start switch is momentarily pressed towards the START position. With relay B.S. de-energised but the start switch placed in the B.S. position, the priming and cancelling of the sim. bomb tone circuit operation is now as described in the following paragraph.

26A. With reference to fig.2 the sim. bomb tone is primed by energising relay 648 via terminals 2 and 3 of the start switch, the main sim. bomb change-over switch set to R/T1 and fuse 555. The associated contacts 648/1 of relay 648 close which in turn energises the tone relay K904 is the R/T1 transmitter-receiver and the tone is thus transmitted. The tone is cancelled when either relay B.S. is energised by Blue Steel requirements, i.e. 28-volt d.c. supply isolated from relay 648 via opening of B.S. relay contacts, or when the bomb firing switches are depressed, i.e. relay 647 energises and the associated contacts 647/1 open to remove earth return on relay 648. With relay 648 de-energised the R/T1 tone relay K904 is also de-energised and the tone is not transmitted. The tone is again transmitted when the bomb firing switches are released providing that the B.S. relay remains de-energised. A routine chart is contained in fig.4.

27. When the simulated bombing tone is required to be transmitted by the R/T2 installation (Chap.4) the R/T2 tone relay K904 is earthed via contacts 543/2. Relay 543 is energised when the sim. bomb change-over switch is selected to R/T2. The earth return via contacts 543/2 operates the R/T2 transmitter-receiver in a similar way to that given for the R/T1 installation. Further information concerning this aspect is given in Sect.8, Chap.4 of this Book.

SERVICING

Precautions

28. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100 volts can be dangerous to the extent of causing personal injury, fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned. It is essential that maximum co-operation be maintained between trades mutually concerned in servicing operations.

General

29. The setting up, operating and servicing instructions for the installation and its components are contained in A.P.2531J, Vol.1. The security of all components should be checked regularly. All connectors, plugs, sockets and terminal blocks should be examined for damage and ingress of dirt and moisture.

REMOVAL AND INSTALLATION

General

30. Access to the components is straightforward, but the following points should be observed. When it is necessary to remove or replace any components, secure all loose connectors to the adjacent aircraft structure, to prevent damage.

Transmitter-receiver, Type PTR 175

31. On the front panel of the unit disconnect the V.H.F. and U.H.F. aerial connections and the multipole plug, unscrew the two knurled nuts at the base of the unit, take hold of the transport handle and slide the unit off its anti-vibration mounting tray.

Junction box, Type ARC/52

32. Disconnect the five connector plugs from the sockets attached to the lid of the unit. The lid of the unit can now be removed by releasing the three securing screws. The remaining part of the unit may be removed from the aircraft structure by releasing a further four securing screws.

Control unit, Type C.1607/4

33. On the control unit, Type C.1607/4, release the four quick release fasteners, and withdraw the unit. Sufficient cable length has been allowed to enable the connector plug to be disconnected.

Aerial Type 140-L.R.U.-67C

34. The aerial feeder lead is located forward and above the front spar, and should be disconnected. In order to gain access to the aerial, a servicing ladder Giraffe, Type D4, may be used. Remove the ten countersunk securing bolts at the base of the aerial and lift off the aerial. On replacing ensure that there is a good bonding surface between the base of the aerial and the aircraft structure.

Plug and relay box

35. The plug and relay box, Ref.No. 10/T4607, (Mounted on an anti-vibration plate) can be removed by disconnecting the plug and socket connectors, and then removing two securing nuts and bolts.

TABLE 1

Unit location

Unit	Type	Location
Transmitter-receiver	PTR 175	Nose wheel bay (starboard crate)
Control unit	C.1607/4	A.E.O.'s position
Junction box (Mod.1)	ARC/52	Nose wheel bay (starboard crate)
V.H.F. aerial	140-L.R.U.-67C	Aircraft fuselage (above No.2 fuel tank)

TABLE 2

Connectors for A.R.I.23143/1

H.S.A. Part No.	Cableform	Connecting
2/T6206	Uniradio 67	T/R, Type PTR 175 U.H.F. aerial socket to aerial transfer switch
3/T6206	3a-30 cores **	R.P.B. plug 1198 to control unit, Type C.1607/4
5/T6206	Uniradio 67	T/R, Type PTR 175 V.H.F. aerial socket to V.H.F. aerial
7/T6206	Min. 6D	R.P.B. plug 1199 to I/C junction box 54P

TABLE 2 Cont'd

Connectors for A.R.I.23143/1

H.S.A. Part No.	Cableform	Connecting
11/T6206	Min.6D	Junction box, Type ARC/52 to R.P.B. plug 1199
12/T6206	Min.4A	Junction box, Type ARC/52 to R.P.B. plug 1200
13/T6206	3a-30 cores **	Junction box, Type ARC/52 to R.P.B. plug 1198
14/T6206	39 cores *	Junction box, Type ARC/52 to T/R, Type PTR 175 (pin-to-pin connection)
1/FR.848	UNINYVIN 14	Junction box, Type ARC/52 to aircraft earth connection
2/FR.848	UNINYVIN 14	Junction box, Type ARC/52 to fuse 1379 panel 16P
1/FR.864	UNINYVIN 20	P.P.B. plug 1200 R/T1 tone switch on console 6P
2/FR.864	UNINYVIN 20	R.P.B. plug to T.B.1665

NOTE...

This cableform is made up of 39 cable cores using four types of cables as follows:-

(1) Equipment wire Type 3 - 70/.0076 White (8a) - 2 cores

(2) Equipment wire Type 2 - 14/.0076 Black (8b) - 33 cores

(3) Equipment wire Type 2S - 14/.0076 individually screened - 2 cores Black (8c)

(4) Ristscable 103/202/GY common screen (8d) - 2 cores

TABLE 2 Cont'd

Connectors for A.R.I.23143/1

** NOTE...

These two cableforms are each made up of 30 cable cores using equipment wire, Type 2 (3a 14/.0076 white), for each core. As these two particular cableforms do not have corresponding pin-to-pin connections at each end of the cable, the following pin-to-pin connection chart has been provided:-

Cableform 3/T6206 30 - Cores

Control unit, C1607/4 Socket Pin End 'A'		R.P.B. SKT. 1198 Socket Pin End 'B'
A	to	D
T	to	J
S	to	R
R	to	Z
P	to	f
N	to	m
M	to	s
L	to	r
K	to	p
J	to	n
H	to	g
F	to	a
E	to	S
D	to	K
C	to	E
B	to	A
V	to	C
U	to	B
d	to	H
c	to	P
b	to	X
a	to	l
Z	to	k
Y	to	j
X	to	h
W	to	b
g	to	F
f	to	G
h	to	T
i	to	L

Pins N,M,W,V,d,c, at end 'B' not used

Cableform 13/T6206 30 - Cores

R.P.B. Plug 1198 Plug Pin End 'B'		Junction Box, ARC/52 Plug Pin End 'A'
D	to	A
J	to	T
R	to	S
Z	to	R
f	to	P
m	to	N
s	to	M
r	to	L
p	to	K
n	to	J
g	to	H
a	to	F
S	to	E
K	to	D
E	to	C
A	to	B
C	to	V
B	to	U
H	to	d
P	to	c
X	to	b
l	to	a
k	to	Z
j	to	Y
h	to	X
b	to	W
F	to	g
G	to	f
T	to	h
L	to	i

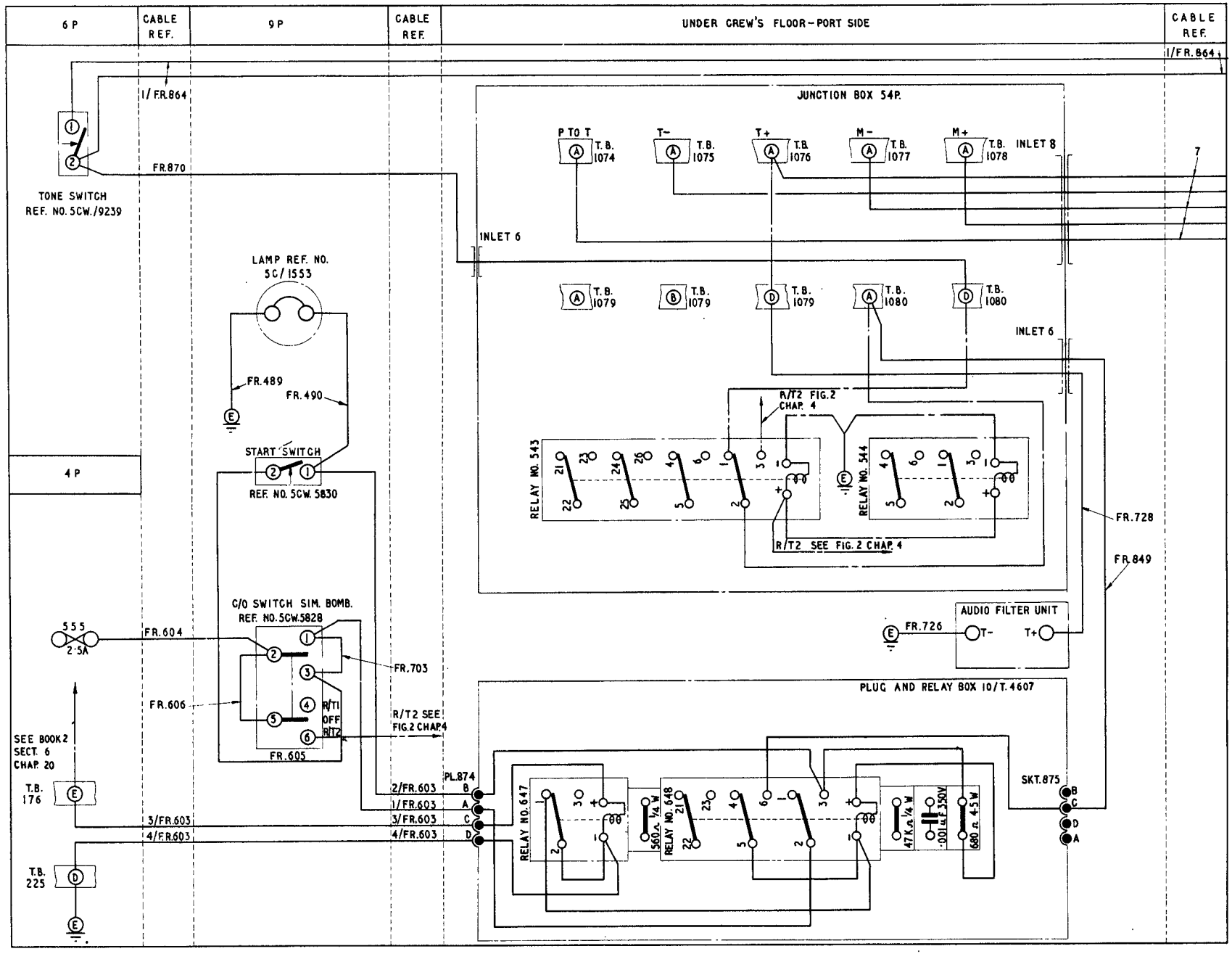

Fig. 3 (1) A.R.I. 23143/1 (R/T1)

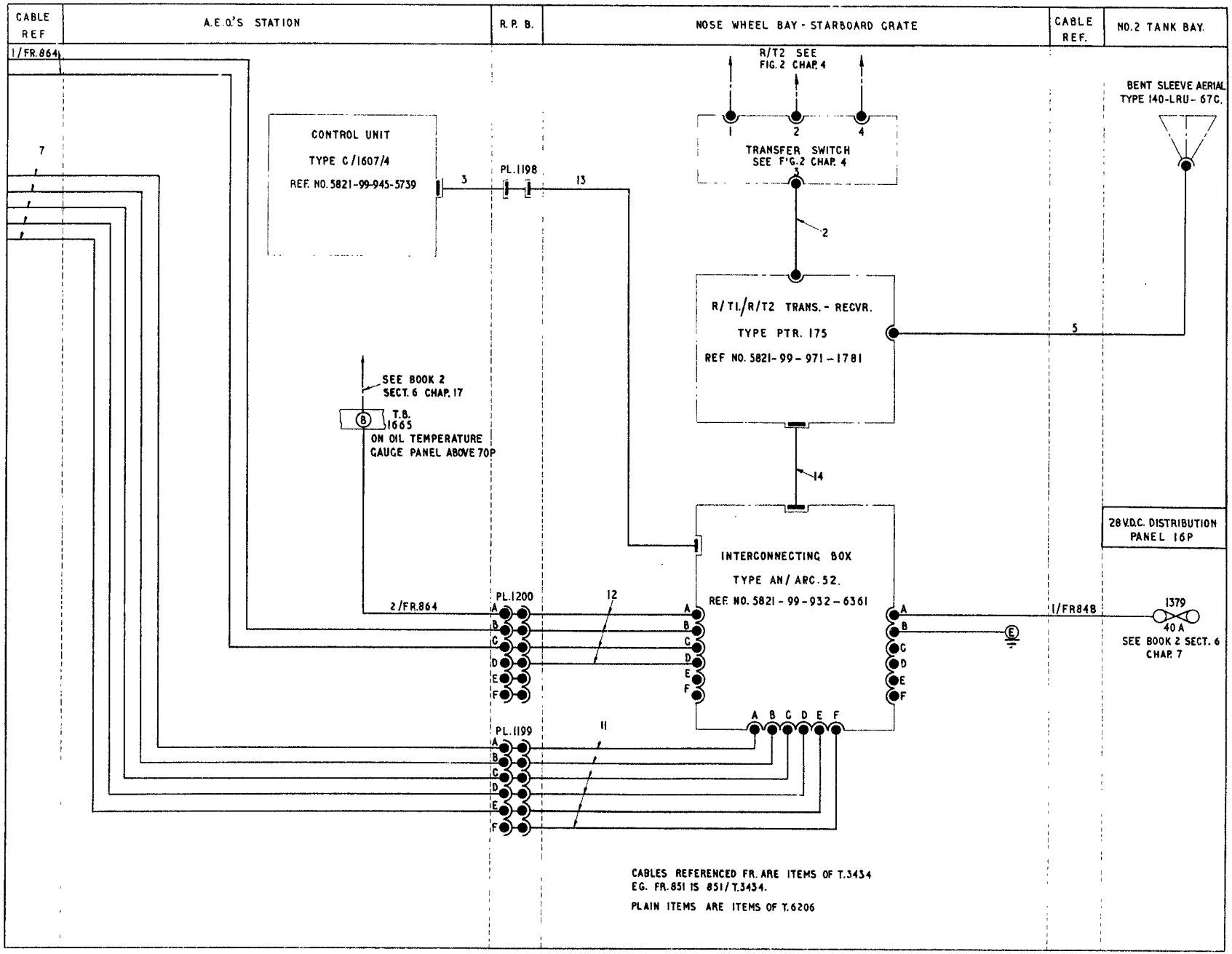

Fig. 3 (2) A.R.I. 23143/1 (R/T1)

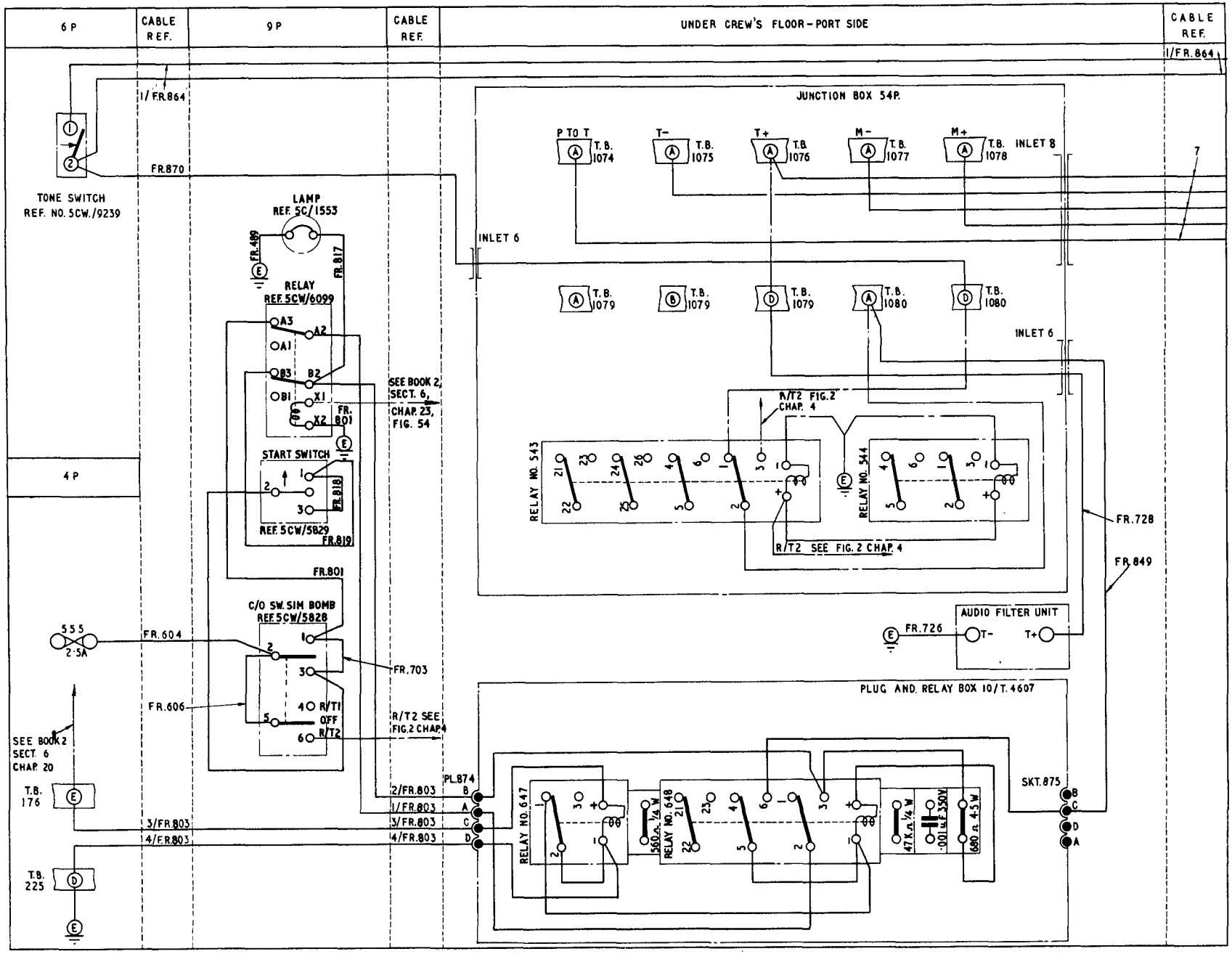

Fig. 4 (1) A.R.I. 23143/1 (post Mod. 1534)

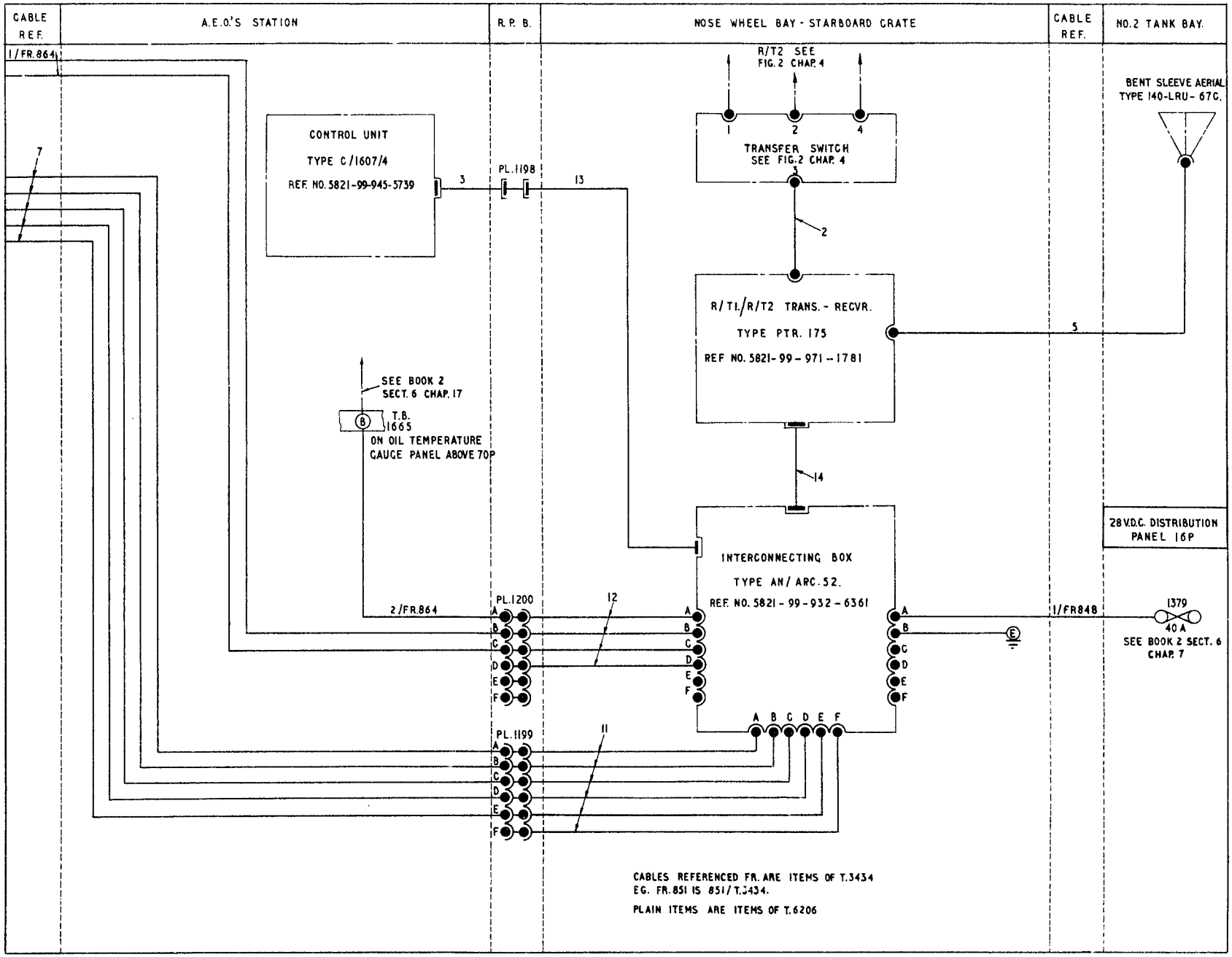

Fig. 4 (2) A.R.I. 23143/1 (post Mod. 1534)

SECTION 9

RADAR INSTALLATIONS

LIST OF CHAPTERS

1.	A.R.I.5816	Gee Mk.3 installation (Mod.1631 deletes)
2.	A.R.I.5848	I.F.F. Mk.10 installation
3.	A.R.I.5919	Tail warning installation
4.	A.R.I.5951	Green satin Mk.2 installation
5.	A.R.I.5924	Rebecca Mk.10 installation (Mod.1707 deletes)
6.	A.R.I.18107/13	Tacan installation (Mod.1631 introduces)
7.	A.R.I.5959	T.F.R. installation
◀ 8.	A.R.I.5952	Tail warning installation Mk.2 ▶

Chapter 1

A.R.I.5816

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Introduction

1. This chapter deals with the GEE Mk.3 installation which is a radio navigational aid, to enable an aircraft to find its position in the area served by the Gee ground system. The ground system conconsists of chains of fixed ground radio transmitters which radiate the position fixing signals.

2. The installation fitted to the aircraft (A.R.I.5816) receives and displays the signals from the ground chain, and provides information which the navigator plotter can interpret on special charts.

3. A location diagram of the major components is provided in fig.1. A connector table is contained at the end of the text and a routing chart will be found at the end of the chapter.

4. Descriptive and servicing details of the A.R.I.5816 are given in A.P. 2557M, Vol.1, which should be read in conjunction with the information contained in this chapter.

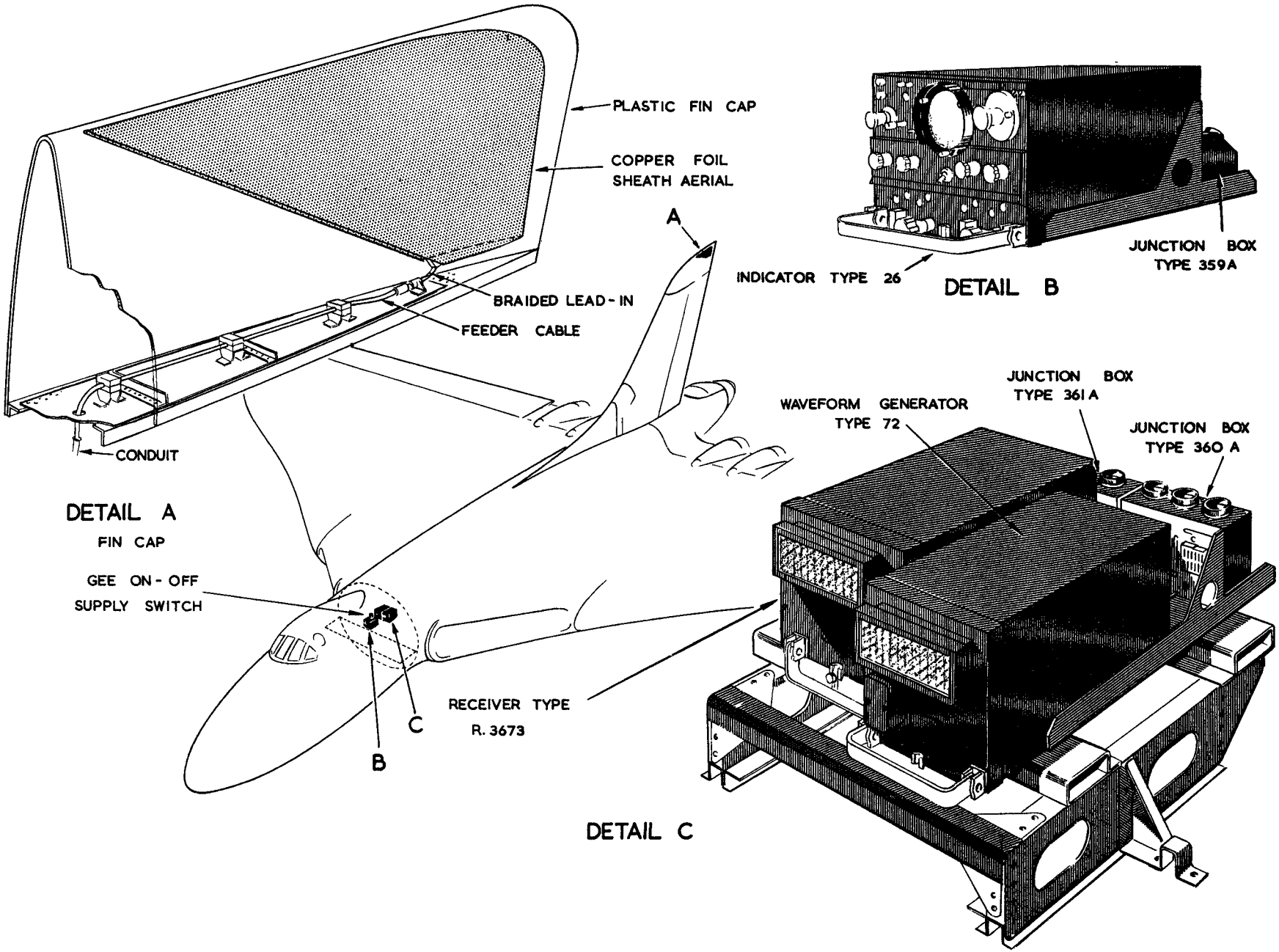

Fig. 1 Component location

DESCRIPTION AND OPERATION

Component details

5. The Gee Mk.3 installation is under the control of the navigator plotter and consists of the following major components:-

Receiver	Type R3673
Waveform generator	Type 72
Indicator C.R.T.	Type 26
Suppressed fin aerial	supplied with fin
Junction box	Type 359A
Junction box	Type 360A
Junction box	Type 361A
On/off switch	Ref.No.5CW5827

All controls used in normal operation of the installation are carried on the indicator unit.

Equipment on navigators' top shelf

6. The receiver unit, Type R3673, and waveform generator, Type 72, are located on the navigators' top shelf. Both units are mounted side by side on standard S.B.A.C. resilient racking.

7. The junction boxes, Type 361A, for the receiver unit and Type 360A, for the waveform generator, are secured to the rear framework of the rack and the units locate into the junction boxes through dowels which project from the unit back plates. A spring-loaded clamp on the front member of each mounting rack holds the unit in position on the rack, and also holds the unit's carrying handle.

8. The connections between the receiver and the waveform generator units and their respective junction boxes are made via Jones - type plugs and sockets. The inter-connections between the junction boxes are carried out through connectors terminating in Mk.4 miniature sockets.

Indicator, Type 26

9. The indicator unit, Type 26, is installed in a single type standard S.B.A.C. mounting rack, with junction box, Type 359A, attached to the rear framework of the rack. The indicator unit is located in the navigator plotter's front panel.

Aerial system

10. The aerial for the A.R.I.5816 is built into the cap at the extreme aft tip of the fin. It consists of a copper foil sheath secured to the inside contour of the preformed insulated fin cap, two copper braid leads being attached to each side of the aerial to form a suitable lead in.

Power supplies

11. The power supplies to the installation are controlled by a double-pole switch labelled GEE, located on the navigators' panel. The 28-volt d.c. supply from fuse 718 in panel 48P, is fed via terminals 2-1 of the Gee switch to the installation. From terminal 1 also, the supply is fed via a suppressor, Type 5CY1002, to a blower motor installed behind the navigators' panel to provide cooling air for the equipment, (Book 2, Sect.6, Chap.7). The 115-volt, 400 c/s. a.c. supply is fed from fuse 233R in panel 28P.

SERVICING

Precautions

12. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100-volt can be dangerous to the extent of causing personal injury, fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned, and that maximum co-operation be maintained between trades mutually concerned in servicing operations.

Installation

13. The setting up, operating and servicing instructions for the A.R.I.5816 and its components are contained in A.P.2557M. The security of all components should be checked regularly. All connectors, plugs, sockets and terminal blocks should be examined for damage and ingress of dirt and moisture.

Power supplies

14. Using a ground supply trolley, check with a suitable test meter that the d.c. input is 28-volts at pins C (pos.) and D (neg.) of the input socket to J.B.360A, and that the a.c. input is 115-volt at pins A and B at the same socket.

REMOVAL AND ASSEMBLY

General

15. Access to the components is straightforward, but the following points should be observed. When it is necessary to remove or replace any components, secure all loose connectors to the adjacent aircraft structure to prevent damage.

Equipment on navigators' top shelf

16. Release the securing screws holding the top half of the navigators' port side panel and lower to the extent of its strain cords. Access is now available to remove the receiver and waveform generator, by releasing the knurled screw on

the front panel of each unit, and then sliding the unit off its mounting tray. On replacing, ensure that the locating dowels on the rear panel are properly engaged.

Indicator, Type 26

17. The indicator unit, which is located on the navigator's front panel, is easily removed by releasing the knurled screw and then sliding the unit off its mounting tray.

TABLE 1

Connectors for A.R.I.5816

A.V.Roe Item No.	Cable form	Connecting between
6/T3411	Uniradio 43	R.P.B. plug 199 to aerial break
7/T3411	Uniradio 43	Aerial break to aerial
2/T4779	Miniature 18J	Indicator (yellow) to waveform generator (yellow)
3/T4779	Miniature 25C	Indicator (red) to receiver (red)
4/T4779	Uniradio 43	Receiver to R.P.B. plug 199
5/T4779	Miniature 4A	Waveform generator to supply plug 436
6/T4779	Miniature 18J	Waveform (blue) to receiver (blue)

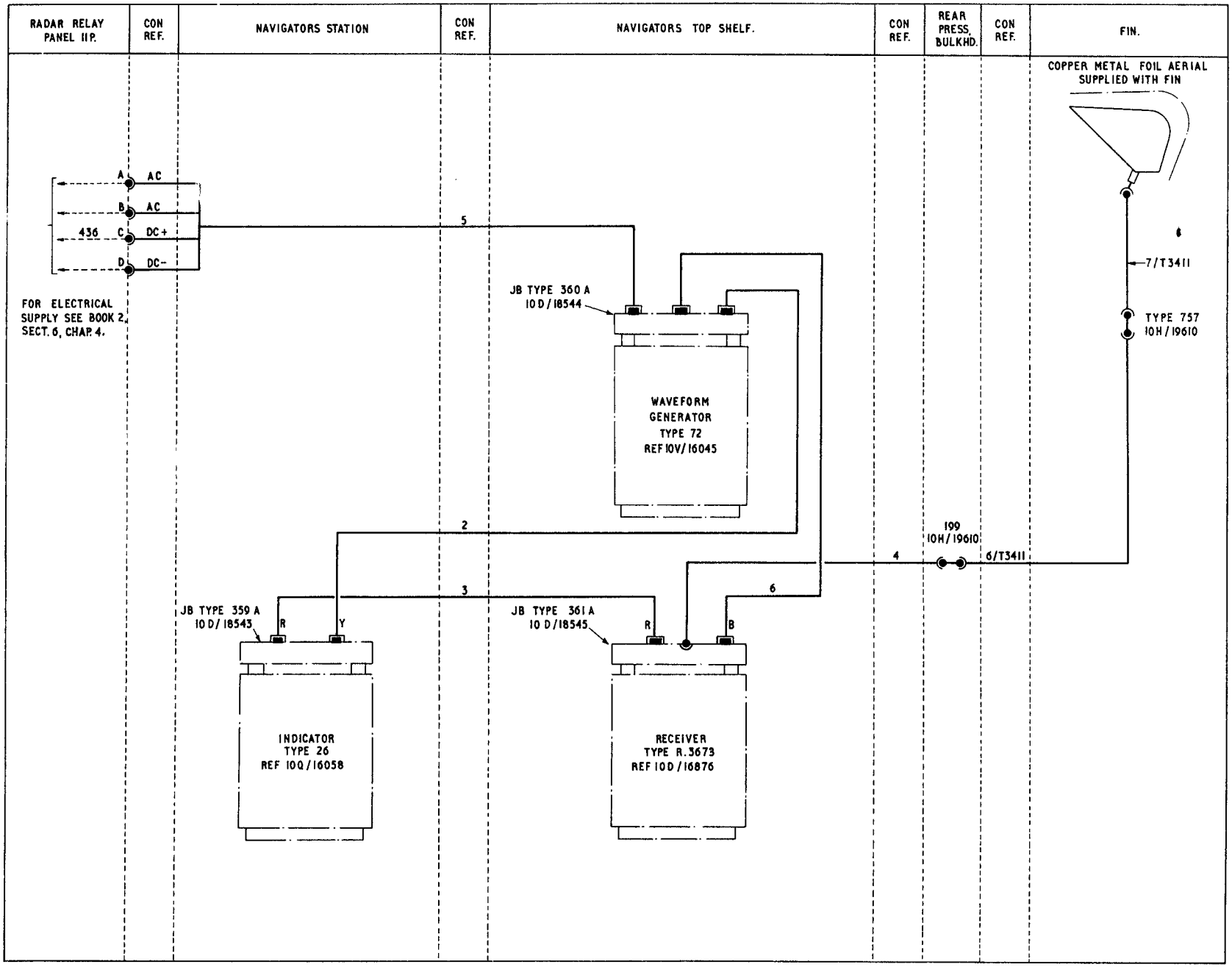

Fig. 2 A.R.I. 5816

Chapter 2

A.R.I. 5848

(Completely revised)

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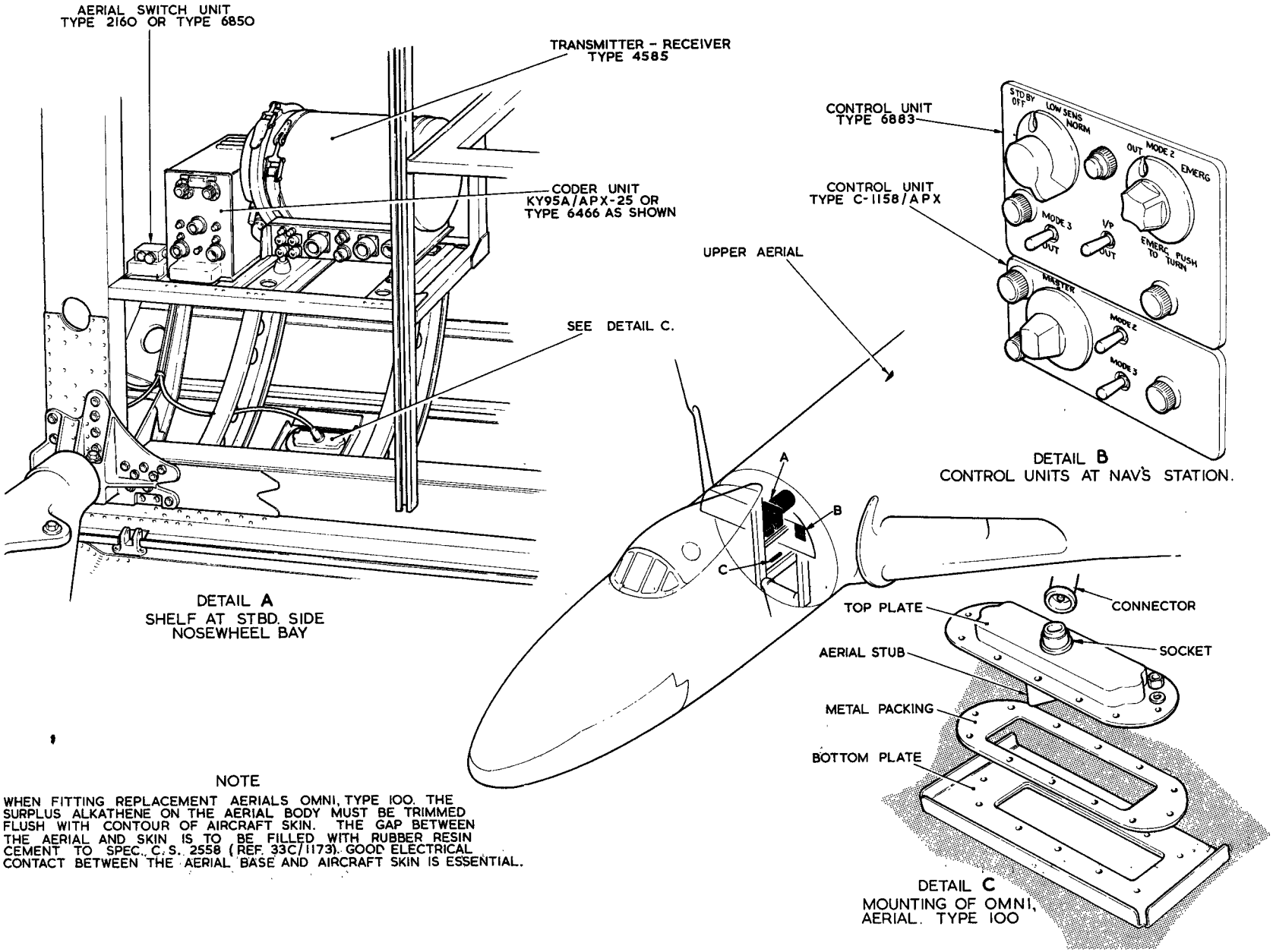
Introduction

1. This chapter provides descriptive and servicing information on the A.R.I. 5848. A location diagram of the main units is provided together with a routing chart of the installation.

DESCRIPTION AND OPERATION

General

2. A.R.I.5848 is a secondary radar system which provides automatic identification as friendly when the aircraft is properly challenged by suitably equipped ground or airborne radars.



NOTE

WHEN FITTING REPLACEMENT AERIALS OMNI, TYPE 100. THE SURPLUS ALKATHENE ON THE AERIAL BODY MUST BE TRIMMED FLUSH WITH CONTOUR OF AIRCRAFT SKIN. THE GAP BETWEEN THE AERIAL AND SKIN IS TO BE FILLED WITH RUBBER RESIN CEMENT TO SPEC. C.S. 2558 (REF. 33C/1173). GOOD ELECTRICAL CONTACT BETWEEN THE AERIAL BASE AND AIRCRAFT SKIN IS ESSENTIAL.

Fig. 1. Component location.

3. The equipment provides two separate channels for identification of specific friendly aircraft among many friendlies. A coded reply, independent of the mode of interrogation, is provided as an emergency signal and indicates that the aircraft is in distress.

Main units

4. The main units of the installation are shown in Fig.1 and described briefly in the paragraphs that follow. For more detailed information reference should be made to A.P.2887N, Vol.1.

T.R. Unit, Type 4585

5. The T.R. unit, Type 4585, is a pressurised airborne transponder designed as a direct replacement for American transponders RT82/APX-6 and RT279/APX-6. The pressurised casing is charged from a Schrader valve on the front face of the unit and an internal blower is provided for cooling purposes. The unit has suitable plugs and sockets to mate with the existing aircraft cables and is mounted at the starboard side of the nosewheel bay.

Coder unit, Type KY-95A/APX-25

6. This unit works in conjunction with, and is mounted adjacent to, the T.R. unit in the nosewheel bay.

Control units

7. Two control units are used in the installation, a Type C1158/APX for use with the T.R. unit and a Type C1128/APX25 for use with the coder unit. Both units are mounted at the A.E.O.'s station as shown in Fig.1.

Aerial switch unit, Type 2160 or 6850

8. The switch unit is mounted adjacent to the T.R. unit in the nosewheel bay and when in use switches the T.R. unit alternatively to the upper and lower aerials.

Aerial test switch

9. This 3-position switch is mounted in the nosewheel bay adjacent to the aerial switch unit. The switch is labelled AERIAL POSITION - UPPER, LOWER, FLIGHT. The switch allows the T.R. unit to be permanently connected to either the upper or lower aerials for test purposes. The switch must be locked in the FLIGHT position for normal operation.

Aerial system

10. The aerial system consists of two omni Type 100 aerials fitted, one to the upper surface, and one to the lower surface of the fuselage. The upper aerial is located on the bomb bay roof forward of the A.D.F. loop aerial. The lower aerial is located on the undersurface of the fuselage at the starboard side of the nosewheel bay.

Power supplies

11. Power supplies to the installation are controlled by a single pole switch at the A.E.O's station. The switch is labelled I.F.F. SUPPLY and when switched to the ON position allows a 28-volt d.c. supply from fuse 693 in 48P to energise relays 337 and 723. When energised relay 337 allows a 28-volt d.c. supply and a 115-volt single phase a.c. supply to pass to the T.R. unit. Relay 723 when energised allows a 115-volt, 3 phase a.c. supply to pass to the blower motor in the T.R. unit. Further details of the power supplies will be found in Book 2, Sect.6, Chap.7.

SERVICING

Precautions

12. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100 volts can be dangerous to the extent of causing personal injury fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned and that maximum co-operation be maintained between trades mutually concerned in servicing operations.

Installation

13. The setting up, operating and servicing instructions for A.R.I.5848 will be found in A.P.2887N, Vol.1. The connectors, plugs, sockets and terminal blocks should be examined for damage and ingress of dirt and moisture and the security of all components should be checked regularly. The aerial test switch should be checked to ensure that it is locked in the FLIGHT position.

Pressure check

14. At each inspection check that the case pressure of the T.R. unit is not less than 3 lbs.per sq. in. If necessary the pressure should be raised to 4 or 5 lbs.per sq. in. using a pressurising pump Ref.No.4G/5435. On completion ensure that the cap of the Schrader valve is screwed back in position.

Power supplies

15. The supplies to the installation can be checked with a suitable test meter at the disconnected sockets from the two plugs marked POWER and FAN on the T.R. unit. Further details will be found in Book 2, Sect.6, Chap.7 together with the appropriate routing chart.

REMOVAL AND ASSEMBLY

General

16. Removal of the main units is relatively straight forward and no special instructions are required.

TABLE 1

Connectors for A.R.I.5848

A.M. Ref. No.	A.V.Roe Item No.	Cable form	Connecting between
10HA/15962	-	Uniradio 4 or 67	Aerial switch unit and upper aerial
10HA/15963	-	Uniradio 4 or 67	Aerial switch unit and lower aerial
-	2/T4633	Miniature 12A	Plug 1034 and control unit
-	3/T4633	Miniature 12A	Plug 1034 and coder unit
-	4/T3403	Uniradio 67	Aerial switch unit and T.R. unit
-	7/T3403	Miniature 12F	Coder unit and T.R. unit
-	8/T3403	Uninyvin 20	Aerial switch unit and aerial test switch

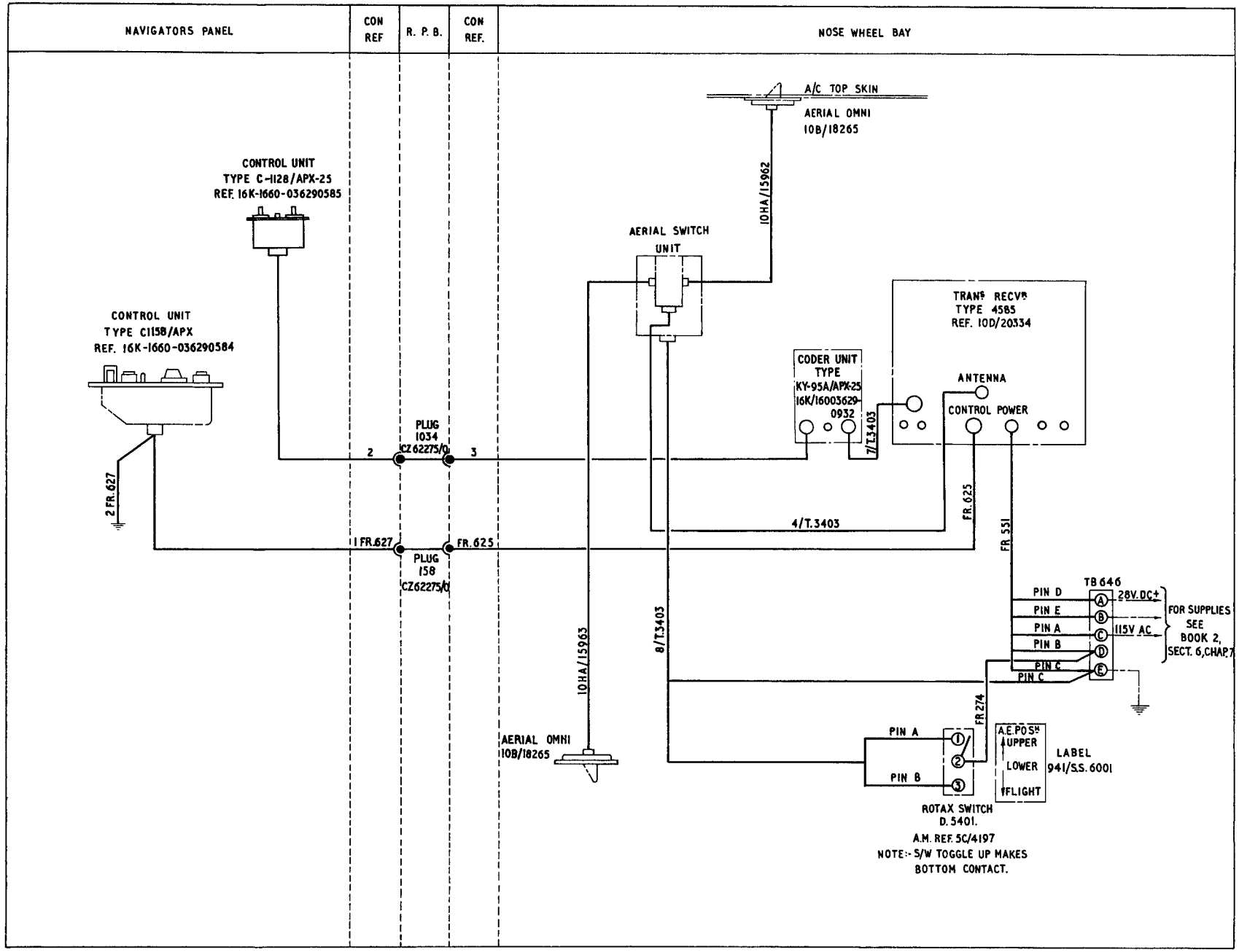


Fig. 2 A.R.I. 5848

Chapter 3

A.R.I. 5919

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Introduction

1. This chapter deals with the A.R.I. 5919, which is a X-band search radar system operating in conjunction with A.R.I.18105. The A.R.I.5919 consists of a tail-mounted radar unit and an indicator unit in the A.E.O's front panel. The indicator unit combines the functions of indicator and control unit.

2. When airborne the A.R.I.5919 will normally be maintained in a stand-by condition (not transmitting) due to the A.R.I.18105 being installed. When required A.R.I.5919 can be switched to transmit in order to find the exact range and bearing of the attacking aircraft.

3. Descriptive, servicing and operating details of the A.R.I.5919 are given in A.P.2891J, which should be read in conjunction with the information contained in this chapter.

4. A location diagram of the major components is provided in fig.1. A connector table is contained in the text and a routing chart will be found at the end of the chapter.

5. The cooling system for this A.R.I. is fully described in Book 1, Sect.3, Chap.16 of this publication.

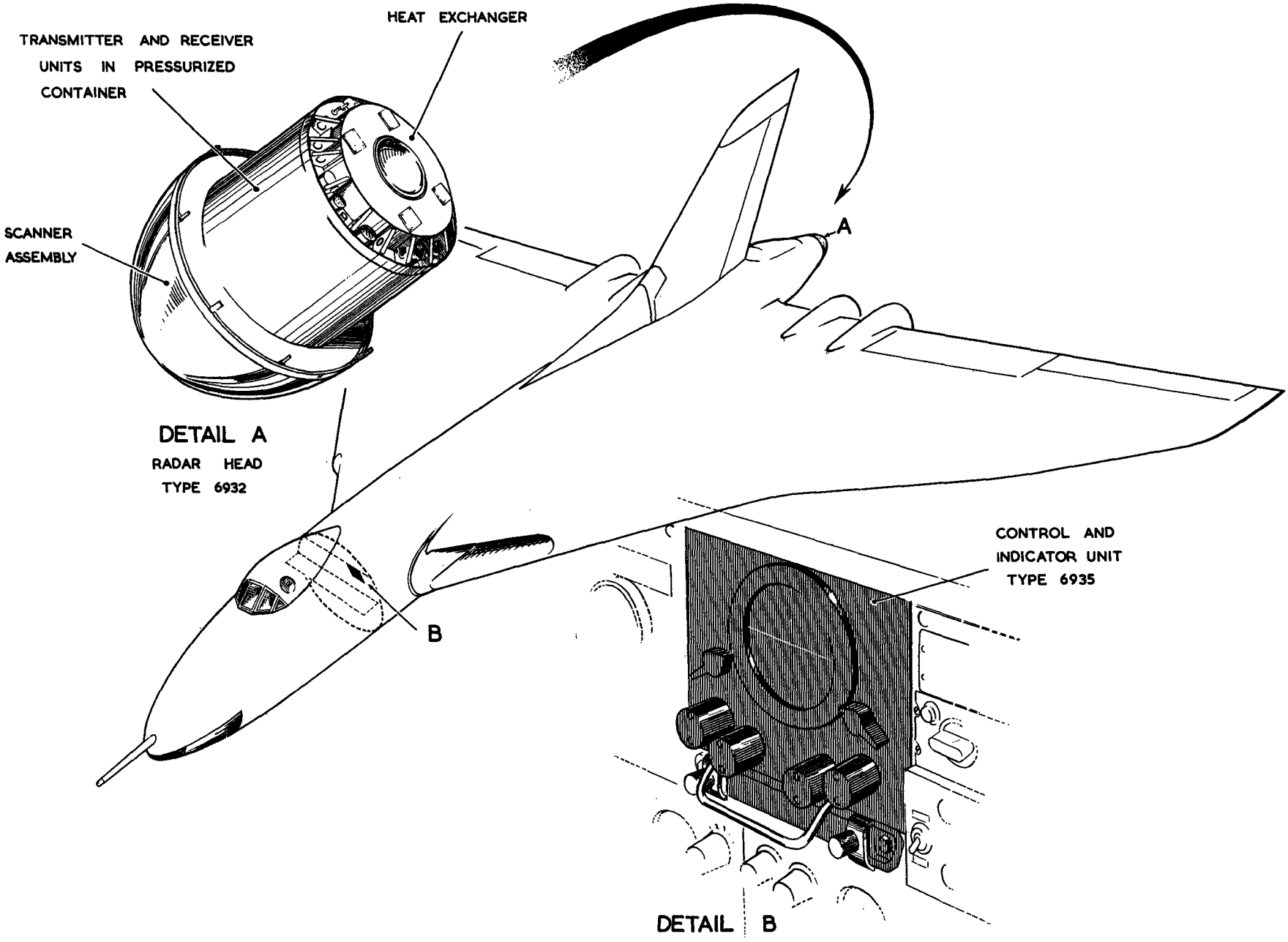

Fig. 1 Component location

DESCRIPTION AND OPERATION

Components

6. The installation consists of the following components:-

Indicator unit	Type 6935
Radar head	Type 6932

Indicator unit, Type 6935

7. The indicator unit, Type 6935, is installed on an anti-vibration tray on the navigator's panel at the A.E.O's station as in fig.1. This unit combines the functions of indicator and control unit for the installation. A rotary switch provides for the selection of warm up, stand-by or transmit condition of the circuits in the radar head. A C.R.T. display provides location and distance indication in three time base ranges as follows:-

0 to 5 N.M.
5 to 10 N.M.
8 to 18 N.M.

Diffused lighting of the dials on the front is provided by a twin ganged dimmer switch located on the A.E.O's radio switch panel.

Radar Head, Type 6932

8. The radar head, Type 6932, is installed at the extreme end of the rear fuselage structure, the radome of the scanner forming the tail cone of the fuselage. The head consists of a pressurised cylindrical canister in which is mounted the scanner assembly, together with the transmitting and receiving units.

9. Pressurization of the canister is provided by air bottles mounted adjacent to the radar head. The pressure first inflates the radome sealing ring and seals the unit, and then pressurises the remainder of the unit via a differential valve. The canister is cooled through the medium of a heat exchanger, which is supplied with a flow of ram air regulated by a thermostatically-controlled electrically-actuated valve. The mechanical aspect of the pressurization and cooling system is described in Book 1, Sect.3, Chap.16, and the electrical circuit for the cooling system in Book 2, Sect.6, Chap.22 of this publication.

Power supplies

10. The 28-volt d.c. and 200-volt, 3-phase, 400 c/s. a.c. supplies required for the installation are fed from the following fuses:-

(1) 28 volt d.c.

Service	Fuse	Rating	Location
Indicator dial lighting	(548	5A	3P
	(655	5A	4P
Cooling circuit and relay 630	706	7·5A	48P

(2) 200-volt, 3-phase, 400 c/s. a.c.

Service	Fuse	Rating	Location
Radar head circuits	103-R	10A	60P
	103-B	10A	60P
	103-Y	10A	60P

SERVICING

Precautions

11. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100 volts can be dangerous to the extent of causing personal injury, fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned and that maximum co-operation be maintained between trades mutually concerned in servicing operations.

Installation

12. The setting-up, operating and servicing instructions for the A.R.I.5919 and its components are contained in A.P. 2891J. The security of all components should be checked regularly. All connectors, plugs, sockets and terminal blocks should be examined for damage and ingress of dirt and moisture.

Pressurization system

13. In conjunction with the servicing of the system as laid down in A.P.4505B, Vol.4, the following periodic check should be carried out on the radar head. With a suitable pressure gauge, check at the schrader valve marked TEST, that the pressure of the radar head is 20lb.per.sq.in.

Power supplies

14. Using a ground power supply trolley check with a suitable test meter at the disconnected radar head supply socket, that the a.c. output is 200-volt at pins A to J and the d.c. output is 28-volt at pins K and M.

REMOVAL AND ASSEMBLY

General

15. Access to the components is straightforward, but the following points should be observed. When it is necessary to remove or replace any components, secure all loose connectors to the adjacent aircraft structure to prevent damage.

Indicator unit, Type 6935

16. To remove the indicator unit, Type 6935, release the two knurled screws on the front panel and slide the unit out of its anti-vibration mounted box.

Radar head, Type 6932

17. The radar head incorporating the radar unit, heat exchanger, mounting ring and radome is removed and installed as a complete unit. Ensure that all electrical power supplies are switched off, then proceed as follows:-

(1) Close the line valve on the pressure reducing panel, to shut off the air supply to the radar head.

(2) Disconnect the air hose where it connects to the radar head.

(3) Disconnect the head from the temperature sensing unit.

(4) Disconnect the four electrical connectors from the unit.

(5) Disconnect the four quick release clamps, which attach the cooling air manifolds to the adaptor fitted to the cooling air ports of the heat exchanger.

(6) Remove the screws indicated by arrows stencilled on the radome.

(7) Fit the lifting attachment Ref.No. 10S/17399.

(8) Attach suitable hoisting equipment to the slinging link on the arm of the lifting attachment. It should be noted that the link should be fitted in the third hole from the end of the arm.

(9) Slightly tension the hoist, then release the four fasteners securing the radar head to the fuselage.

(10) Lower the radar head and secure it to the attachment ring, Ref. No.10S/17398, which is fitted to the servicing trolley, Ref.No. 10S/17400. It should be noted that for field use, this trolley, is mounted on trolley, Type E, Ref. No. 4F/1924.

TABLE 1

Connectors for A.R.I.5919

A.V.Roe Item No.	Cable form	Connecting between
3/T4511	Miniature 6E	R.P.B. plug 189 and plug break 916
4/T4511	Miniature 25C	R.P.B. plug 881 and plug break 915
5/T4511	Miniature 6E	Plug break 916 and radar head
6/T4511	Miniature 25C	Plug break 915 and radar head

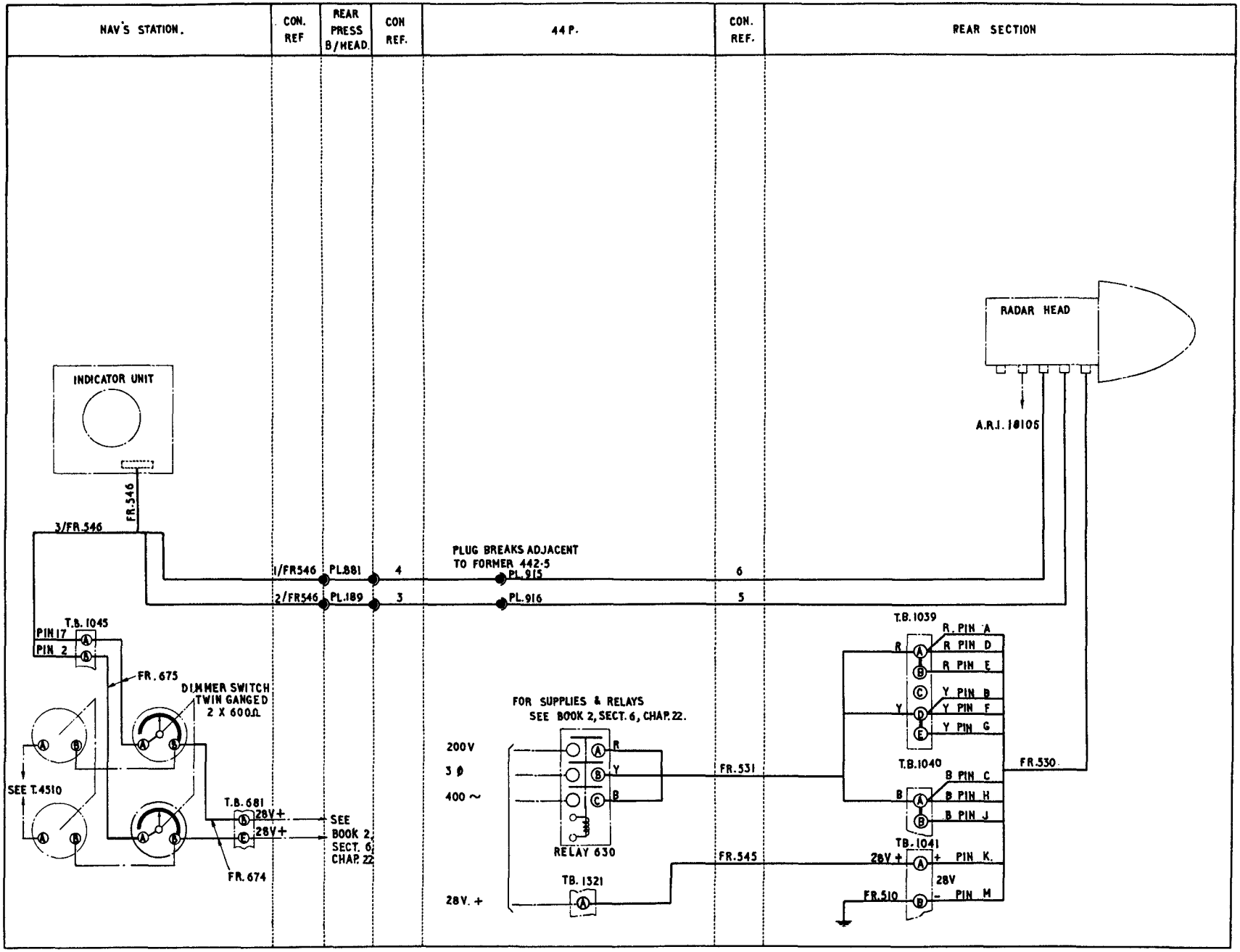

Fig. 2 A.R.I. 5919

Chapter 4

A.R.I.5951

(Completely revised)

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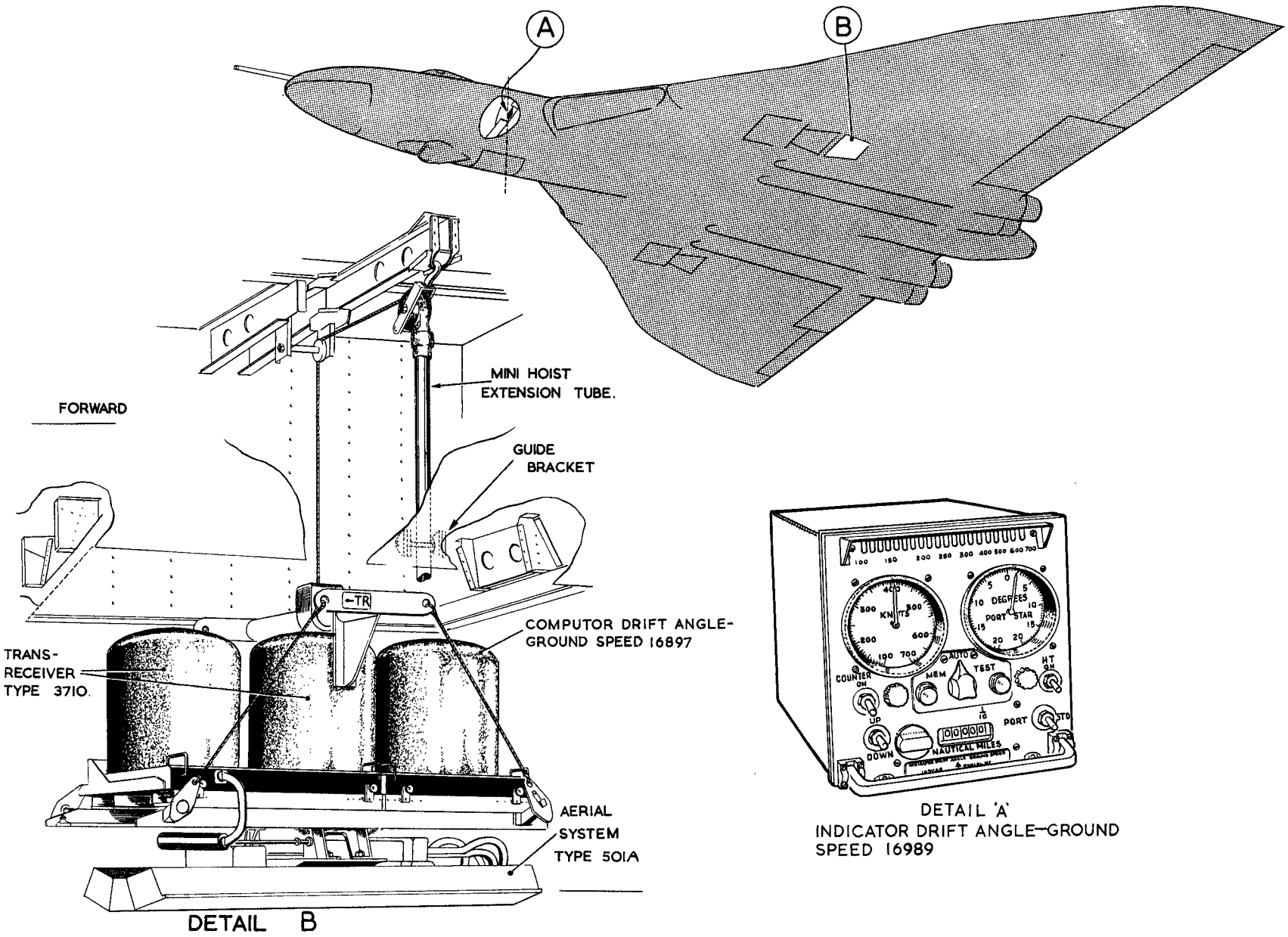

Fig. 1 Component location

Introduction

1. This chapter deals with the Green Satin (A.R.I.5951) installation, introduced by Mod.1777, which is an improved version of A.R.I.5851 originally dealt with in this chapter. The installation determines accurate ground speed and angle of drift information for connection to either the H.R.S. Mk.2 installation (Free Fall aircraft) or the Blue Steel inertia navigation installation (Blue Steel aircraft).

2. Descriptive and servicing details of the A.R.I.5951 are given in A.P.2890R, Vol.1. The associated aircraft systems, Blue Steel inertia navigation and the H.R.S. Mk.2, are described in Sect.6, Chap.23 and Sect.7, Chap.10 of this publication respectively and should be read in conjunction with the information contained in this chapter.

3. A location diagram of the major components is provided in fig.1 and the associated routing charts appear at the end of the chapter. A connector table is also included and may be found at the end of the text.

DESCRIPTION AND OPERATION

General

4. The installation is controlled by the navigator/plotter and produces information within the following ranges:-

Ground speed	- 100-700 knots
Drift angle	- 0-20 deg. port and starboard
Operating height	- 400-60,000 ft.

Component details

5. The installation consists of the following basic equipment:-

Transmitter - receiver unit, Type TR.3710
Computor, drift angle - ground speed, Type 16897
Indicator, drift angle - ground speed, Type 16989
Aerial system, Type 501A

Transmitter - receiver, Type TR.3710

6. This unit consists of two circular containers mounted on a light alloy casting and pressurised to 5 p.s.i.g. The assembly is fitted to a mounting tray installed in a compartment aft of the port main wheel bay as shown in fig.1. One container houses the magnetron transmitter, its associated circuits and a section of the receiving circuit. The other container houses the H.T. and E.H.T. power supply circuits for the transmitter - receiver.

Computor, drift angle - ground speed, Type 16897

7. This unit consists of one circular container mounted on a separate casting but fitted alongside the transmitter - receiver on the same mounting tray and pressurised to 5 p.s.i.g. The unit receives the I.F. signal from the transmitter - receiver, Type TR.3710, amplifier, detects and filters it to abstract the Doppler frequencies which are continuously measured. From these frequencies ground speed, distance flown and drift angle are computed.

Indicator, drift angle - ground speed, Type 16989

8. The indicator is mounted at the navigator's station and provides the following displays:-

(1) A circular dial and pointer showing ground speed in knots and calibrated from 100 to 700.

(2) A circular dial and pointer showing the drift angle calibrated in degrees 20-0-20 port and starboard.

(3) A five digit cyclometer type counter showing distance flown and calibrated in nautical miles.

(4) Twenty neon indicators, positioned side by side at the top of the front panel, are used to show the approximate aircraft speed. Relative to the aircraft speed certain neons are illuminated and compared to a scale which appears below the neons. The scale is calibrated in knots 100 to 700 as shown in fig.1 and indicates the approximate ground speed only.

9. A memory lamp (Amber) and lock lamp (Green) and an associated 3-position switch labelled MEM/AUTO/TEST are mounted on the front panel. For normal operation (AUTO) the green lamp is illuminated and the amber lamp remains off when there is a good signal in the system and all circuits are locked on.

10. When the signal-to-noise ratio falls below a predetermined level, the green lamp is extinguished and the amber lamp is illuminated to indicate the loss of signal and also that the equipment has switched over to memory operation. The return signal is indicated by the amber lamp flashing for a brief period at approximately 1 c/s. When the circuits lock on again the amber lamp is extinguished and the green lamp is illuminated.

11. If the amber lamp continues to flash this indicates that the circuits need

to be inched on to the correct speed and drift, as indicated by the neons, by operating the speed and drift inching switches. The inching switches, comprising two separate 2-position, centre bias off toggle switches, are mounted horizontally (DRIFT PORT-STBD.) and vertically (SPEED UP-DOWN) on the front panel as shown in fig.1.

Aerial system, Type 501A

12. The aerial system consists of four slotted arrays lying parallel to each other in a directional horn assembly. The axis of the aerials is horizontal and they are coupled to the transmitter - receiver unit by a wave guide system. The horn assembly is mounted immediately beneath the transmitter - receiver and computor, drift angle - ground speed unit as shown in fig.1.

Track control unit

13. This unit is part of the M.F.S. which is dealt with in Sect.7, Chap.7 of this publication. The Track Control unit distributes heading information to other aircraft equipment and provides, as one of its functions, the facility for presenting true track on the beam compasses and navigators' compass repeater.

14. The drift information from this installation, magnetic variation from the N.B.S. and magnetic heading information from the M.F.S. compass are all fed to the Track Control unit. Three synchronous outputs of true heading are provided for the G.P.I. Mk.6, N.B.S. and H.R.S. Mk.2 systems.

Ground speed resolver

15. The principle function of the ground speed resolver (G.S.R.) Ref.No.9C/102, is to resolve the ground speed, derived from this installation, into northerly and easterly components. Drift information, also from this installation, together with heading information derived from either the H.R.S. Mk.2 or the M.F.S. is connected to the G.S.R.

16. The addition of drift and heading information within the G.S.R. unit provides track angle. Using the track angle and ground speed along track information, the unit provides outputs of aircraft ground speed in northerly and easterly components. Further information may be found in Sect.6, Chap.23 (Blue Steel) and Sect.7, Chap.10 (Free Fall) of this publication.

Optical link junction box

17. This unit, Ref.No.26DC/10112, provides a 'T' junction which facilitates the routing of drift information from the installation A.R.I.5951 to both the Track Control unit (para.14) and the G.S.R. (para.15).

Test point

18. Two test sockets are provided for testing purposes and are used in conjunction with performance testers 4332 and 4333. Both sockets are connected to the transmitter - receiver. One is a co-axial socket (test point LH) and carries the I.F. test signal; the other is a 12-pole socket (test point LJ) and carries power supplies, crystal current and other services.

Shorting plug

19. A shorting plug affixed to test socket LJ, by a short length of chain, must always be inserted in that socket during normal operation of the equipment. Pins D, E, F and M of the shorting plug are connected together to complete the earth return for all crystal currents.

Power supplies

20. The installation requires two 115-volt, 3-phase, 400 c/s supplies, a normal supply and a special supply (pulse). Both supplies are separately fused and are derived from the secondary windings of a 1 kVA static transformer housed in the Green Satin bay.

21. The power supplies are controlled by a single-pole switch labelled GREEN SATIN, located on the navigators' panel. On pre.Mod.748 aircraft the switch is mounted on a small panel (101P) at the centre of the navigators' panel; post Mod. the switch is similarly positioned, but on the main panel itself.

Circuit operation

22. A 28-volt d.c. supply from fuse 726 in panel 48P is connected to the energising coil of relay 339 via terminals 1 and 2 of the Green Satin control switch. With relay 339 energised a 200-volt, 3-phase, 400 c/s a.c. supply is connected to the primary windings of a 1 kVA transformer via fuses 234 R, Y and B in panel 28P and the closed contacts of relay 339.

23. The transformer secondary output of 115-volt, 3-phase, 400 c/s a.c. supply is connected to the Green Satin normal supply circuit via fuses 370R, Y and B and terminal B of T.B.2045 and to the special supply (pulse) circuit via fuses 369R, Y and B and terminal A of T.B. 2045. For further details see Sect.6, Chap. 7 of this publication.

SERVICING

Precautions

24. Servicing personnel in particular are warned that a.c. and d.c. voltage in excess of 100-volts can be dangerous to the extent of causing personal injury, fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned, and that maximum co-operation

be maintained between trades mutually concerned in servicing operations.

Installation

25. The setting up, operating and servicing instructions for the A.R.I.5951 are contained in A.P.2890R, Vol.1. The security of all components should be checked regularly. All connectors, plugs, sockets and terminal blocks should be examined for damage and ingress of dirt and moisture.

Aerial alignment

26. Aerial alignment is carried out at those periods recommended in Vol.4 of this publication. The method of aerial alignment using an alignment jig, Ref.No. 10AF/604, is given in the following paragraph.

27. The following equipment is required:-

Watts datum compass
Aerial alignment jig
Compass datum posts

Proceed as follows:-

(1) Insert the aerial alignment jig into the sockets provided on the aircraft.

(2) Insert and adjust sighting rods to the vertical axis.

(3) Insert aircraft sighting rods and adjust to the vertical axis.

(4) Set up the Watts datum compass a convenient distance away and adjust the aerial bay sockets until an 'in line' condition is achieved (allowing for the off set distance between the Green Satin bay and centre line of the aircraft).

Further details on aerial alignment may be found in A.P.2890R, Vol.1, Part 2, Chap.1.

Zeroing Aerial system

28. To ensure that zero drift information is accurate the associated drift synchro a.c. output voltage must be at a minimum, measured at PL.4 on the drift synchro gearbox, when the aerial array is aligned with the aircraft fore and aft master datum (derived in para.27). Full details for adjusting the drift synchro is given in A.P.2890R, Vol.4.

REMOVAL AND INSTALLATION

General

29. Access to the components is straightforward, but the following points should be observed. When it is necessary to remove or replace any components, secure all loose connectors to the adjacent aircraft structure to prevent damage.

Indicator, drift angle - ground speed, Type 16989

30. To remove this unit from the navigator's panel release the two knurled screws on the front of the panel and slide the unit from its mounting tray.

Equipment in port wing

31. The Transmitter-receiver unit, Computor, drift-angle unit and Aerial system are all mounted on a tray which is removable as a complete unit as shown in fig.1.

32. To remove the complete unit from the aircraft the following procedure should be adopted:-

(1) Obtain the following items:-

Ref.No.	Item
4GC/5703	Minihoist 5 cwt.
4GC/5452	Extension tube (84 in.)
4GC/5743	Handle (9 in.)
4GC/5736	Top sheath hook
4GC/5433	Ball end
26DC/95093	Green satin sling
26DC/95095	Trolley, Type U1238

(2) Disconnect all connectors from the equipment.

(3) Attach the sling, by the four hooks provided, to the mushroom pins at the corners of the tray.

(4) Position the minihoist inside the compartment by threading it upwards through the guide bracket on the outboard wall, and securing the hook of the top sheath to the U link fastened to the structure immediately above the bracket as shown in fig.1.

(5) Thread the ball end of the hoisting cable through the pulley in the centre of the compartment roof and attach it to the sling.

(6) Take up the slack in the hoisting cable, ensuring that the attachments to the tray are secure and that the steadying members of the sling fit properly to the centre canister.

(7) Remove the four bolts securing the tray to the aircraft structure.

(8) Hoist the tray to disengage the attachment lugs from those of the structure and lower the complete unit on to the trolley.

To install the complete unit into the Green satin compartment reverse the procedure given above.

TABLE 1

Connectors for A.R.I.5951

H.S.A. Part No.	Cableform	Connecting
3B/T.3412	Tripren 18	U/C plug break to T.R. unit plug L.M.
4B/T.3412	Equipment wire	U/C plug break to T.R. unit plug LN/A.
9/T.3412	Uniradio 70	T.R. unit plug LG to Computor unit plug LG.
10/T.3412	Equipment wire	Aerial plug LB/B to Computor unit plug LB/B
11A/T.3412	Uniradio 70	T.R. unit plug LH to test point.
12A/T.3412	Equipment wire	T.R. unit plug LJ to test point
2/T.4275	Equipment wire and uniradio 70	T.R. unit plug LA to Computor unit plug LA and plug break 930
2/T.4882	Min.12C	G.S.R. plug 4A to R.P.B. plug 176
3/T.4882	Min.12C	R.P.B. plug 176 to Optical link J/B plug 1008
7/T.4882	Min.6C	G.S.R. plug 13A to R.P.B. plug 157.
8/T.4882	Min.6C	T.C.U. plug 8 to R.P.B. plug 100
9/T.4882	Min.6C	Optical link J/B plug 1011 to R.P.B. plug 100
11/T.4882	Min.6C	U/C plug break 780 to wing break plug 777

TABLE 1 (continued)

H.S.A. Part No.	Cableform	Connecting
12/T.4882	Min.6C	Wing break plug 777 to R.P.B. plug 157
13/T.4882	Min.6C	U/C break plug 780 to Computor unit plug LD
14/T.4882	Min.18C	Optical link J/B plug 1009 to wing break plug 778
15/T.4882	Min.18C	U/C break plug 782 to wing break plug 778
16/T.4882	Min.18C	Computor unit plug LV/A to U/C break plug 782
17/T.4882	Equipment wire	U/C break plug 781 to Computor unit plug LC
18/T.4882	Equipment wire	U/C break plug 781 to wing break plug 779
19/T.4882	Equipment wire	Wing break plug 779 to R.P.B. plug 191
20/T.4882	Equipment wire	R.P.B. plug 191 to Indicator plug LC

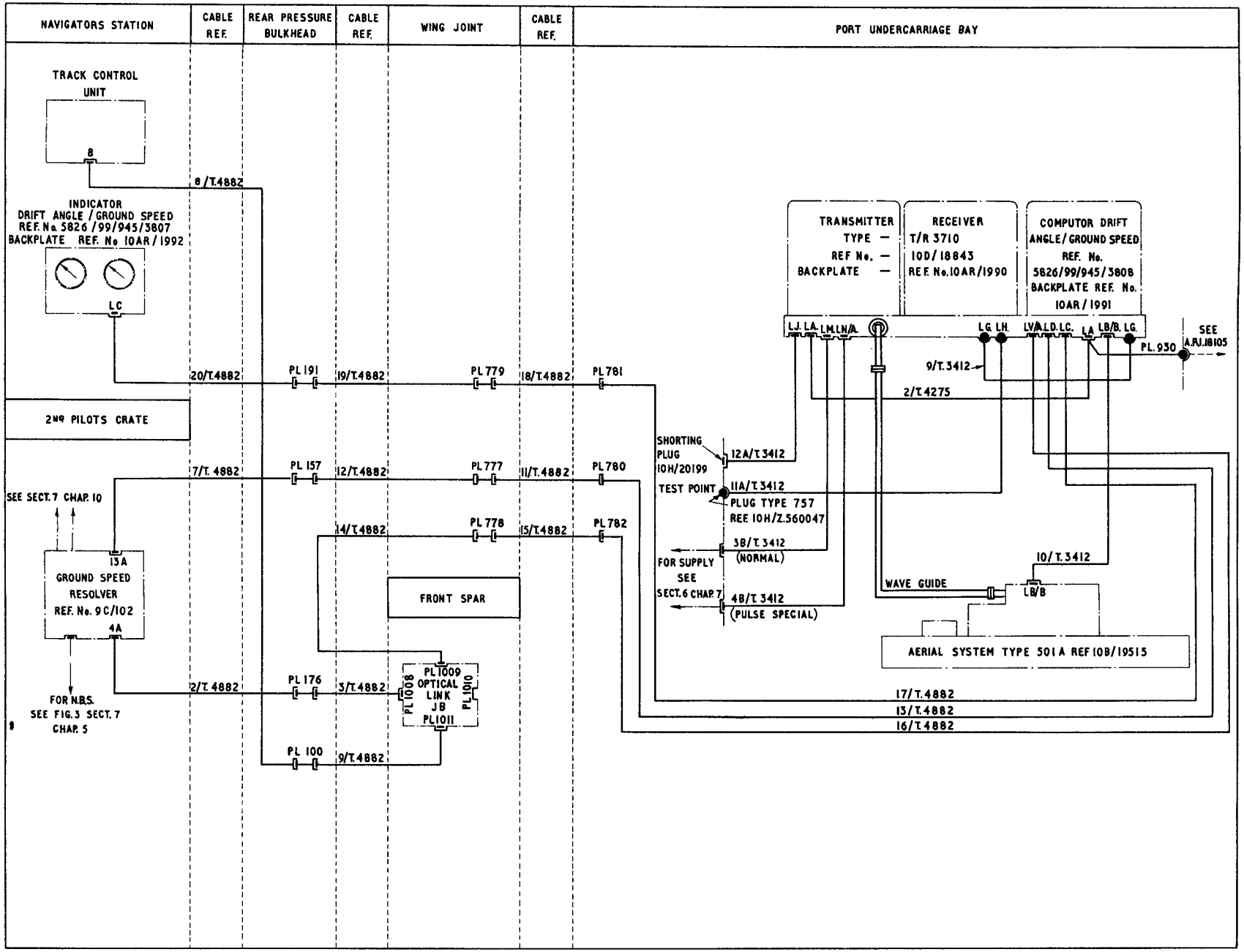

Fig. 2 A.R.I. 5951 (pre Mod. 748)

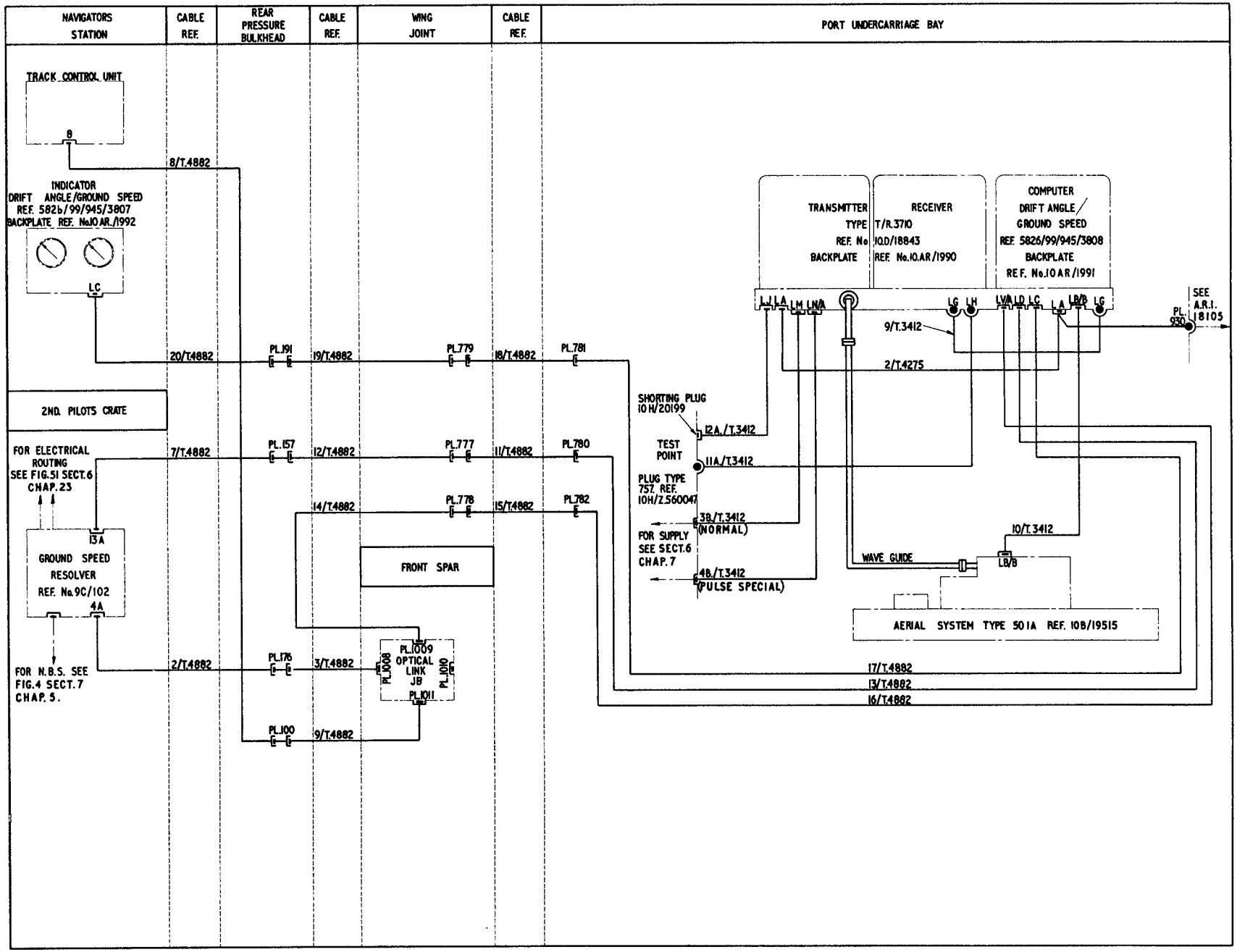

Fig.3 A.R.I. 5951 (post Mod 748)

Chapter 5

A.R.I. 5924

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Introduction

1. This chanter provides descriptive and servicing information on the A.R.I. 5924. A location diagram of the main units is provided, together with a routing chart of the installation.

DESCRIPTION AND OPERATION

2. The A.R.I.5924 installation radiates interrogation pulses and receives reply and identification pulses from the A.R.I. 5922 fitted in tanker aircraft. The information is displayed continuously on the on the cathode ray tube screen of an indicator unit. The trace provides range, heading, and identification information at distances up to a maximum of 100 nautical miles and a minimum of 400 yds.

Main units

3. The main units of the installation are shown in fig.1 and described briefly in the paragraphs that follow. For more detailed information reference should be made to A.P.2914 AN, Vol.1.

T.R.unit, Type 6649

4. The T.R. unit is mounted below the second pilots' floor as shown in fig.1.

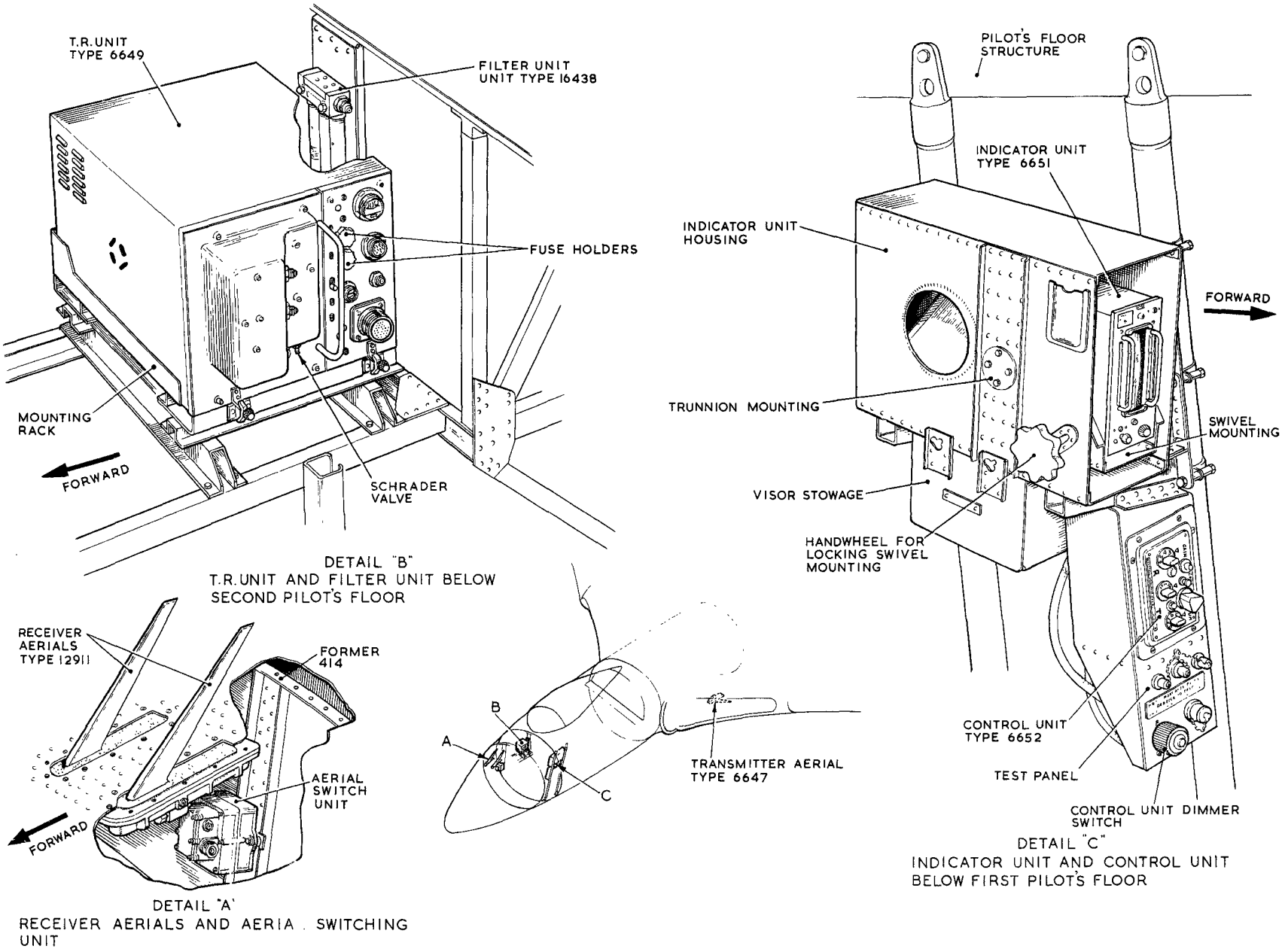

Fig.1 Location of components

A receiver unit, transmitter unit, I.F. amplifying unit, video amplifier, sweep generator and power unit are housed in the unit and are readily detachable for servicing purposes. Corona discharge is prevented by housing the transmitter unit in a pressurised compartment which is charged from a valve on the front face of the unit. An internal blower is provided for cooling purposes.

5. The unit operates on a frequency band of 420-460 Mc/s and employs motor driven tuning to select any of the eight channels in the receiver and transmitter. Interconnection to other units is made by plugs and sockets on the front face of the unit.

Indicator unit, Type 6651

6. The indicator unit, Ref.No.10Q/16438, is secured to a swivel mounting on the port side of the aircraft, adjacent to the I.L.S. junction box. The unit houses a cathode ray tube and its associated power unit and has focus and brilliancy controls mounted on its front face. The trace is "read-off" against range scales which are presented on an edge-lit graticule. Graticule illumination is controlled by a knob on the control unit.

Control unit, Type 6652

7. The control unit, Ref.No.10L/16497, is mounted vertically on a panel at the port side of the aircraft, immediately below the indicator unit. The unit provides remote control of the installation and has the following controls mounted on its front face:-

Transmitter channel switch
Receiver channel switch
Function switch
Manual code key
Receiver gain control
Graticule illumination control

The two latter controls, receiver gain and graticule illumination, are used in conjunction with the indicator unit.

Aerial switch unit, Type 16498

8. This unit is mounted in the nose of the aircraft on the forward face of former 414. When in use, the unit switches the receiver alternately to the port and starboard receiver aerials.

Aerials

9. Three aerials are used with the complete installation, one is the transmitter aerial, the other two are receiver aerials.

Transmitter aerial

10. The Type 6647 transmitter aerial is of modified shark fin design and is mounted on the underside of the aircraft centre section, as shown in fig.1.

Receiver aerials

11. The two Type 12911 receiver aerials are of modified shark fin design and are mounted side by side on top of the aircraft nose structure, as shown in fig.1.

Filter unit, Type 16438

12. This unit, Ref.No.10P/16256, is mounted adjacent to the T.R.unit, under the second pilots' floor. The unit works in conjunction with a similar unit in the A.R.I.18124/2 to prevent interference between the two installations. This second filter unit is brought into the A.R.I.18124/2 installation by Mod.1009, which introduces A.R.I.5924 into the aircraft.

Power supplies and control

13. The T.R. unit is fed with a 115-volt, single-phase, 400 c/s a.c. supply, from fuse 739R in panel 75P. A second 115-volt, single-phase 400 c/s a.c. supply is fed from fuse 739B to a test panel which forms part of the mounting for the control unit. Two 28-volt d.c. supplies, for the operation of small motors and relays, are fed to the T.R. unit from fuses 664 and 1166, the former in panel 3P, the latter in panel 4P. A third d.c. supply is fed from fuse 653, in panel 3P, to the control unit for panel lighting. The a.c. supply to the T.R. unit is controlled by the function switch on the control unit.

SERVICING

Precautions

14. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100-volts can be dangerous to the extent of causing personal injury, fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned, and that maximum co-operation be maintained between trades mutually concerned in servicing operations.

Installation

15. Detailed instructions for setting

up, operating and servicing the installation will be found in A.P.2914AN, Vol.1. All components should be checked at regular intervals for security of attachment. Cables and connections should be examined for signs of damage and a check made to ensure that all plugs and sockets are correctly mated. Reference should be made to the appropriate routing chart before re-connecting any cables which may have been disconnected for servicing or removal of equipment.

Pressure check

16. At each inspection check the case pressure of the transmitter. It should not be less than 3 lbs. per sq. in. If below this figure the pressure should be raised to 4 or 5 lbs. per sq. in. using a pressurising pump Ref.No.4G/5435. On completion ensure that the cap of the Schrader valve is screwed back in position.

Test panel

17. The test panel forms part of the mounting for the control unit and carries three aerial adaptors and a test socket for the 115-volt, 400 c/s a.c. supply. The adaptors are labelled TX AERIAL, PORT RX AERIAL, STARBOARD RX AERIAL and are used in conjunction with the test equipment described in A.P.2914 AN.

REMOVAL AND ASSEMBLY

Cabin equipment

18. The main units fitted in the cabin are all readily accessible and no special removal instructions are required.

Aerials

19. A servicing ladder Type D4 will be required to reach the aerials. Once the aerial securing screws have been removed the aerials may be lifted from the aircraft skin to disconnect the feeder cables.

Aerial switch unit

20. This unit is mounted immediately behind the receiver aerials inside the nose of the aircraft. Access to the unit is gained by opening the port hole in the front pressure bulkhead. Three screws secure the unit to brackets fixed on former 414.

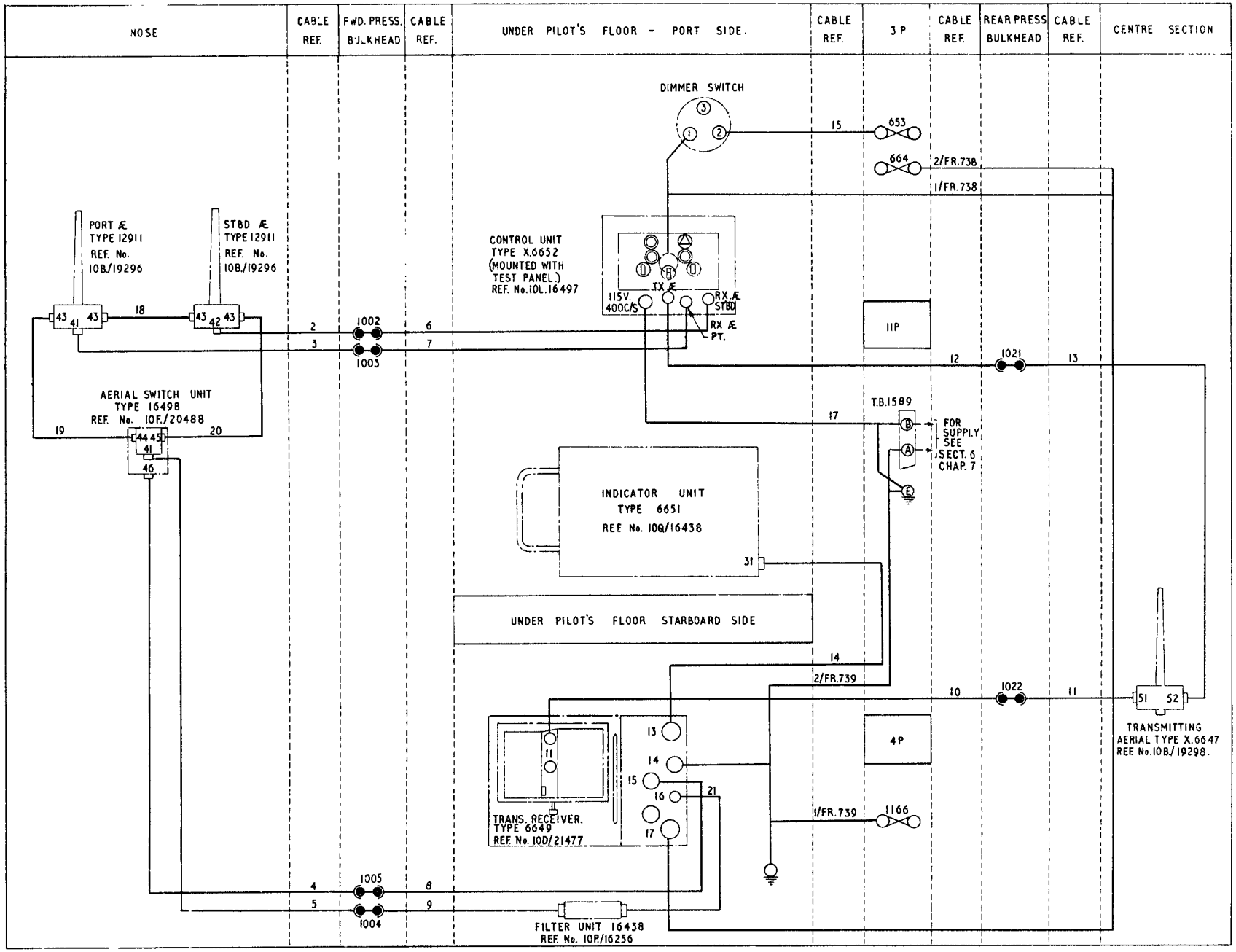

Fig.2 A.R.I. 5924

Chapter 6

A.R.I.18107/13

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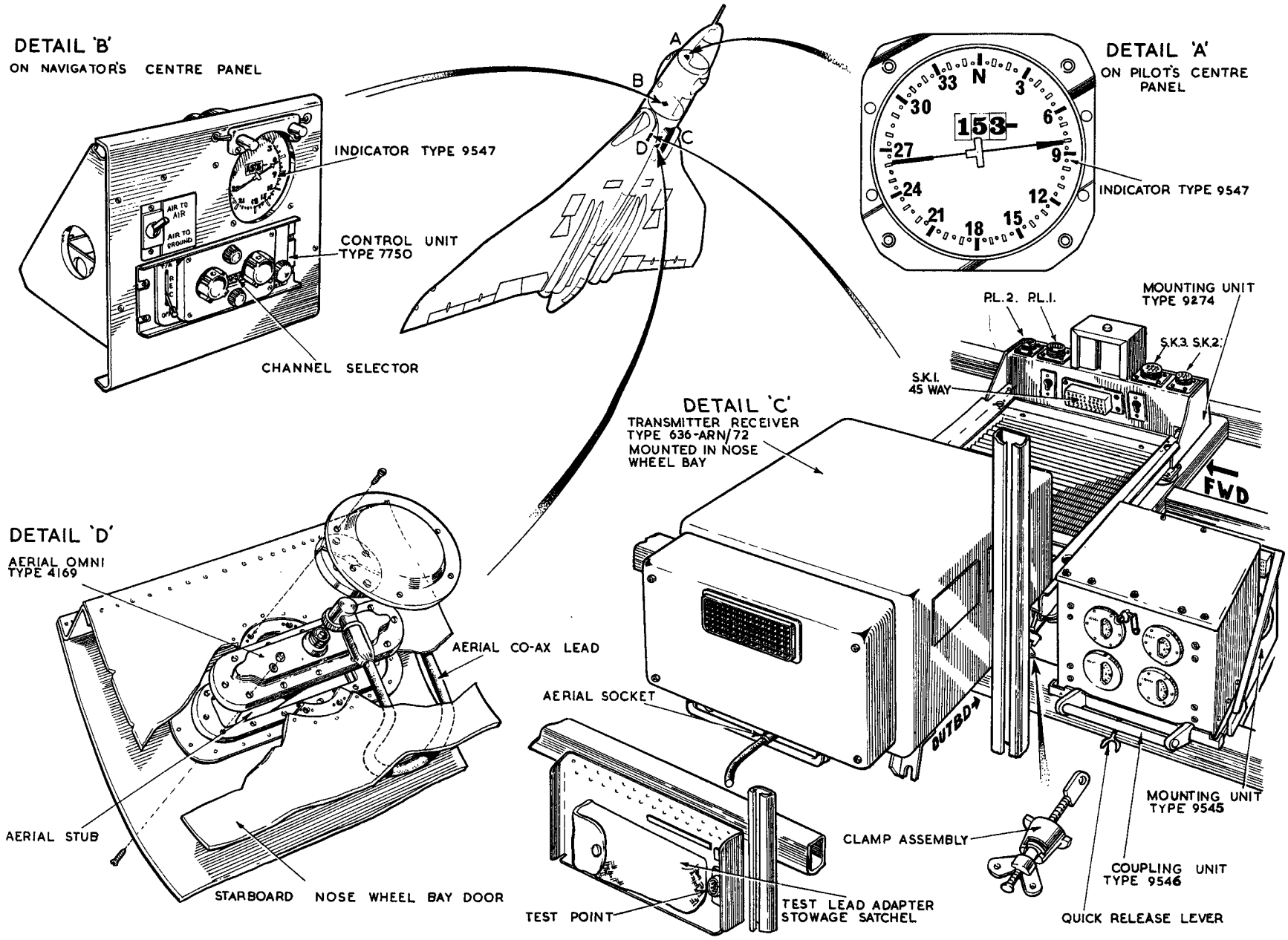

Fig.1 Location of equipment

Introduction

1. This chapter deals with the TACAN navigational system installation A.R.I. 18107/13 introduced by Mod.1631, which supersedes the A.R.I.5816 GEE navigational system. The TACAN system provides distance and bearing information that will indicate the position of the aircraft relative to a surface beacon to which the equipment has been tuned. A facility for interrogating tanker aircraft is also provided.

2. The distance and bearing information is presented continuously to both the pilot and navigator by an indicator, Type 9547. A control unit, Type 7750, is positioned below the navigator's indicator, Type 9547, thus enabling the navigator to control the entire system.

3. The transmitter-receiver, Type R.T.636-ARN/72, and coupling unit, Type 9546, are both fitted in the nose wheel bay, and the aerial omni, Type 4169, is fitted to the starboard nose wheel bay door. A location diagram of the equipment is contained in Fig.1 and a routing chart in Fig.2. Full descriptive and servicing information on the complete system can be found in A.P.2534N, Vol.1.

4. Any one of 126 crystal-controlled channels in the 962 to 1214 Mc/s band can be selected by the navigator via control unit, Type 7750. Each channel comprises two frequencies 63 Mc/s apart, one for air-to-ground interrogation and the other for ground-to-air responses.

5. A morse-code recognition signal is transmitted by the surface beacon every 37·5 seconds, and can be heard on the crew's headsets via their respective intercomm. control panels, thus confirming the identity of the selected beacon. The signal level is controlled by a volume control fitted to the navigator's control unit, Type 7750.

DESCRIPTION AND OPERATION

Equipment details

6. The TACAN installation as stated previously is under the control of the navigator and consists of the following equipment:-

Indicator (2)	Type 9547
Control unit	Type 7750
Coupling unit	Type 9546
Transmitter-receiver	Type R.T.636-ARN/72
Aerial omni	Type 4169
Transmitter-receiver mounting unit	Type 9274
Coupling unit mounting unit	Type 9545

The location of the above equipment in the aircraft can be seen in Fig.1. A full description of the individual units is contained in A.P.2534N, Vol.1 and should be read in conjunction with the following paragraphs.

Indicator, Type 9547

7. Two indicators are utilized in the system and are positioned on the pilot's and navigator's centre panel respectively. The bearing pointer has a continuous 360 deg. travel. The bearing of the selected beacon from the aircraft is shown by the arrow head of the pointer and the bearing of the aircraft from the selected beacon is indicated by the tail of the pointer.

8. The distance of the aircraft from the selected beacon is shown in a window in the dial of the indicator. The right hand digit shows the 'unit' nautical miles and the next to the left digit shows the 'tens' nautical miles. When the aircraft is over 100 nautical miles from the selected beacon a 'one' appears to the left of the 'tens' digit.

9. When the system is not locked to the beacon transponding signal, the distance digits are partially masked by a flag across the distance window, the flag has a horizontal white line painted on it to improve visibility. When the aircraft is outside the range of the beacon, the bearing pointer will be revolving round the bearing scale, also the distance numbers will be rotating rapidly behind the masking horizontal white line.

Control unit, Type 7750

10. This unit provides the main control for the complete system and is fitted to the navigator's centre panel below the indicator, Type 9547. The following controls are situated on the front of the control unit:-

(1) Two channel selector rotary switches, a 10 way and 13 way, enable the navigator to select any channel from 1 to 126. The number of the selected channel

appears in an illuminated window positioned between the two switch knobs. The left hand switch when operated will show numbers 0 to 12 and the right hand switch will show numbers 0 to 9.

(2) A three-position switch which is marked OFF, REC. and T/R is used to energise the system in the two modes of either receive only or transmit and receive for distance measurements.

(3) A control marked VOL. is used for adjusting the surface beacon identity tone to the required level. Note that all crew members can monitor the signal via the aircraft intercomm. system.

Coupling unit, Type 9546

11. This unit is located in the nose wheel bay and provides the servo links for operating the pilot's and navigator's indicators, Type 9547 (para.7). The unit is secured via rear fitting dowels to a horizontal mounting unit, Type 9545, which is fitted to the aircraft structure by four anti-vibration mountings. A spring-loaded quick release device at the front of the mounting unit enables the coupling unit to be easily released. Four dials on the front panel provide similar information to that displayed by the pilot's and navigator's indicators.

Mounting unit, Type 9545

12. The spring loaded quick release device is operated by a lever situated underneath the mounting unit. When the lever is pulled outwards and then to the right the coupling unit is freed from the grip of four heavy gauge springs which hold the four plugs and sockets in their mating position.

Transmitter-receiver, Type RT.636-ARN/72

13. The transmitter-receiver is positioned next to the coupling unit in the nose wheel bay, and is fitted into a mounting unit, Type 9274. The transmitter-receiver is secured to the mounting unit by means of two spring-loaded spigots at the rear, and two screw clamps at the front. The mounting unit is installed as an integral part of the aircraft and uses four anti-vibration mountings to cushion movement.

Mounting unit, Type 9274

14. A housing across the rear of the mounting unit contains plugs and sockets and serves as a junction box for ingoing and outgoing supplies for the transmitter-receiver. In addition to the plugs and sockets the housing contains four power control relays and a filter circuit for suppressing unwanted pick-up in the control and power supply cables respecively. Details of the plugs and sockets mounted on the housing are as follows:-

(1) Plug (PL.1) is a 19 way connector and is used for carrying 'distance' information between the coupling unit, Type 9546, and the mounting unit.

(2) Socket (SK.3) is a 19 way connector and is used for carrying 'bearing' information between the coupling unit, Type 9546, and the mounting unit.

(3) Socket (SK.2) is a 10 way connector and is used for inter-connecting the control unit, Type 7750, to the mounting unit.

(4) Plug (PL.2) is a 7 way connector and carries the aircraft supplies to the mounting unit.

(5) Socket (SK.1) is a 45 way socket, which mates with a 45 way plug fitted to the rear end of the transmitter-receiver chassis. The 45 way plug and socket is used to connect all the ingoing and outgoing supplies from the transmitter-receiver to the mounting unit housing.

Aerial omni, Type 4169

15. The aerial is a small metal blade in the shape of a shark fin approximately 3 inches high from its base. It is mounted through the aircraft skin from the inside and positioned on the starboard side of the nose wheel bay door. The aerial is connected to the transmitter-receiver unit via a coaxial cable link and plug. The coaxial aerial socket is fitted to the front panel of the transmitter-receiver unit.

Air to air and air to ground switch

16. This switch is mounted on a panel together with indicator, Type 9547, and control unit, Type 7750, on the Navigator's centre panel. The switch is used for changing over from normal TACAN operation to that of tanker aircraft interrogation and response. Further information on this mode of operation will be available in due course.

Power supplies

17. The power supplies for the TACAN installation are controlled by a switch labelled OFF/REC./T/R. positioned on the control unit, Type 7750, which is located on the navigator's centre panel. The switch operates relays, via a 28-volt d.c. supply from fuse 872 in distribution panel 16P, which in turn connects a 115-volt, 400 c/s supply to the transmitter-receiver unit from fuses 301R, 301B, 302R and 302B in distribution panel 28P. A 28-volt d.c. supply from fuse 975 in panel 3P is used to change the normal

TACAN mode of operation to that of tanker aircraft interrogation via the air-to-air and air-to-ground switch. The control panel illumination lamps are fed from a 28-volt d.c. supply via fuse 974 in distribution panel 3P.

SERVICING

Precautions

18. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100 volts can be dangerous to the extent of causing personal injury, fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned, and that maximum co-operation be maintained between trades mutually concerned in servicing operations.

Installation

19. The setting up, operating and servicing instructions for the TACAN installation can be found in A.P.2534N, Vol.1. A test plug is fitted below the transmitter-receiver unit in the nose wheel bay and provides a 115-volt, 400 c/s supply for the TACAN performance tester Type 10166. A satchel fitted adjacent to the test plug contains the test lead adapter for use with the performance tester.

REMOVAL AND INSTALLATION

General

20. Access to all the individual units that make up the complete installation is straightforward, but the following points should be observed. When it is necessary to remove or replace a unit, secure all loose connectors to the adjacent aircraft structure to prevent damage.

Equipment in the nose wheel bay

21. When replacing the transmitter-receiver unit into its mounting unit, ensure that the two spring loaded spigots at the rear are located correctly and that the 45 way plug and socket has mated properly. Ensure also that the front screw clamps are tight and secure.

22. When replacing the coupling unit into its mounting unit, ensure that the locating dowels are correctly aligned and the four plugs mated. A spring loaded locking device is employed at the front of the unit, ensure that the locking device has operated and that the coupling unit is properly secured.

Navigator's equipment

23. The navigator's indicator and control unit together with the air-to-air/air-to-ground switch are all mounted on a panel fitted to the navigator's centre panel. The panel can be withdrawn by first removing four securing screws from the front of the panel.

Pilot's indicator

24. The pilot's indicator mounted on the pilot's centre panel is easily removed after the centre panel has been removed in accordance with the instructions given in Sect.7, Chap.1 of this publication.

TABLE 1

Connectors for A.R.I.18107/13

Avro Ref.No.	Cable form	Connecting between
2/T5808	Miniature 12C	Indicator No.1 Type 9547 to R.P.B. plug 173.
3/T5808	Miniature 12C	Indicator No.2 Type 9547 to R.P.B. plug 172
4/T5808	Miniature 12C	R.P.B. plug 173 to coupling unit (PL3)
5/T5808	Miniature 12C	R.P.B. plug 172 to coupling unit (PL1)
6/T5808	Uninyvin 20 10 cores	R.P.B. plug 178 to T.R. unit (SK2)
7/T5808	Uninyvin 20 4 cores	T.R. unit (PL2) to panel 64P
8/T5808	Miniature 18H	T.R. unit (PL1) to coupling unit (PL2)
9/T5808)	Miniature 18H	T.R. unit (SK3) to coupling unit (PL4)
)	Twisted uninyvin 20	Panel 64P to coupling unit (PL4)
10/T5808	Uniradio 67	Aerial to T.R.unit aerial socket
11/T5808	Uninyvinmetsheath 20	Test point socket to panel 64P
12/T5808	Miniature 3a	Test point socket to test equipment (stowed in satchel)
814/T3434	Uninyvin 20	Fuse 975 in 3P to air to air switch pin 3
811/T3434	Uninyvin 20	See Table 2

TABLE 2

Cable form 811/T3434

Avro Ref.No.	Cable form	Connecting between
1/FR811	Uninyvin 20 10 cores	Control unit plug pins A - K to R.P.B. plug 178 pins A - K (connected pin to pin) *
2/FR811	Uninyvin 20	Control unit plug pin K to air to air switch pin 2 *
3/FR811	Uninyvin 20	Control unit plug pin M to fuse 974 in panel 3P
4/FR811	Uninyvinmetsheath 20	Control unit plug pin N to panel 54P entry 12
5/FR811	Uninyvin 20	Air to air switch pin 1 to R.P.B. plug 178 pin M

* Note Pin K on control unit plug is common to pin K on R.P.B. plug 178 and air to air switch pin 2.

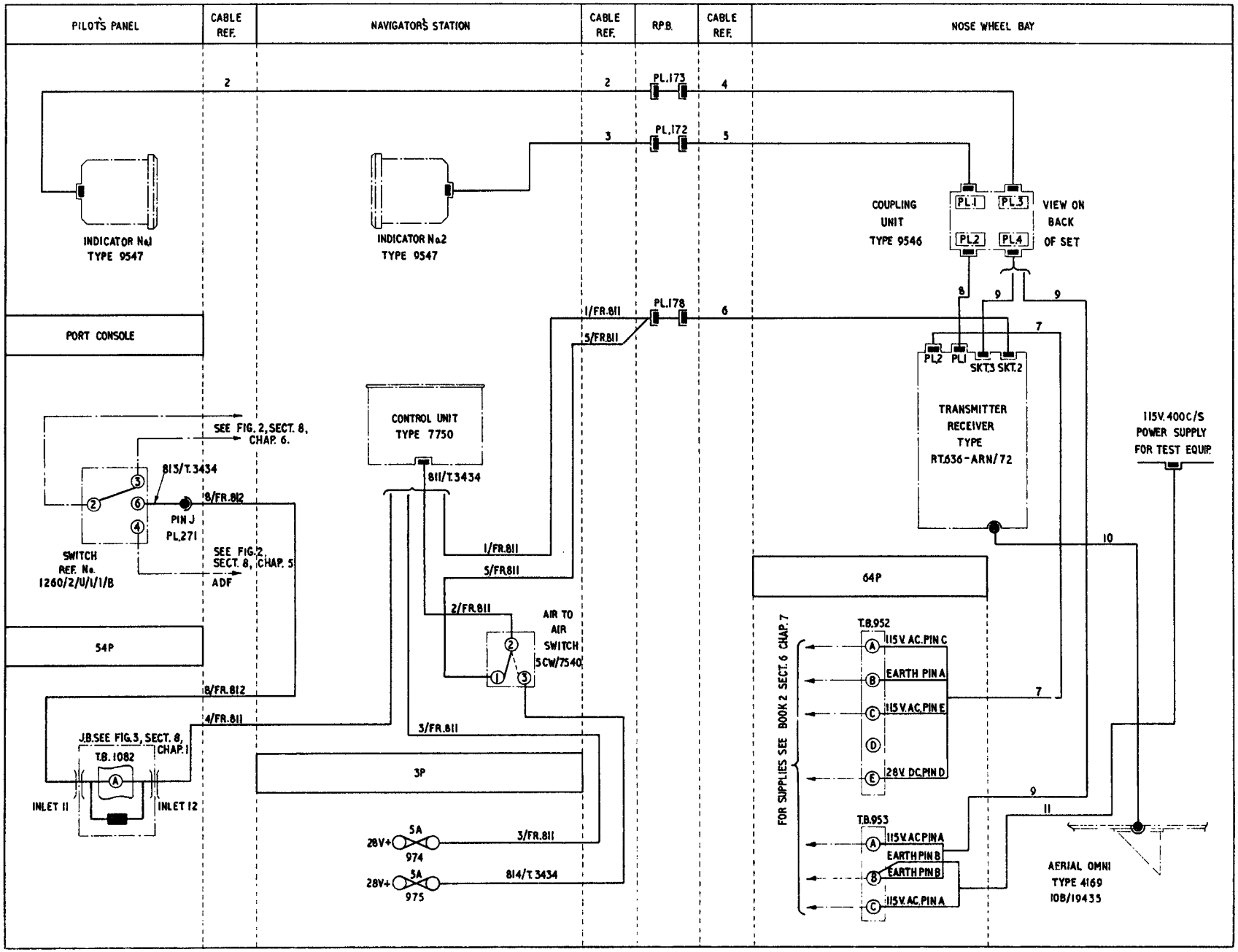

Fig.2 A.R.I. 18107/13

Chapter 7

A.R.I. 5959

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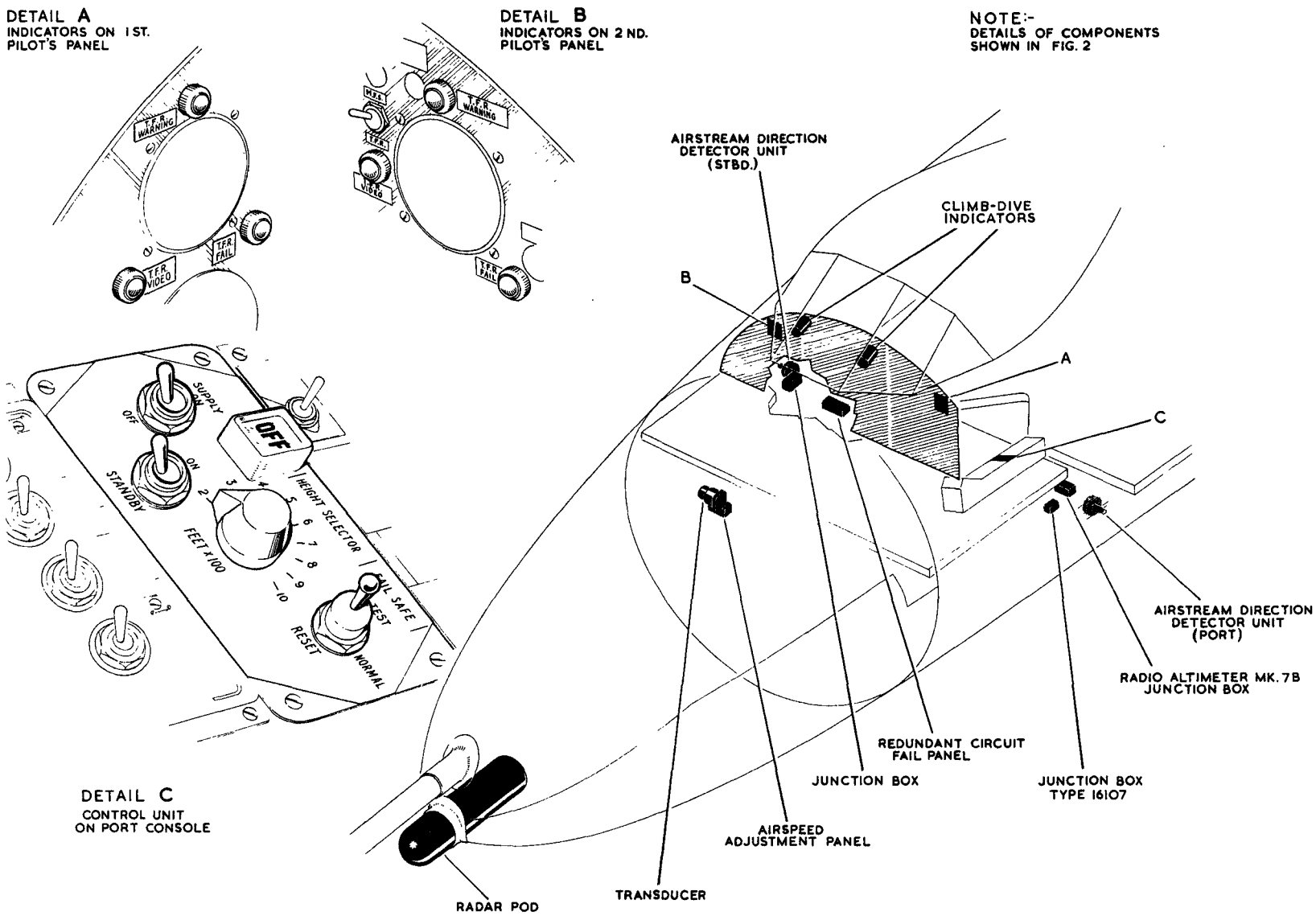


Fig. 1. Location of components A.R.I. 5959.

Introduction

1. This chapter deals with the installation and general functioning of A.R.I. 5959 which is a terrain following radar (T.F.R.) introduced by Mod.2057. The system consists of a elevation-monopulse fixed beam radar and computor (forward looking radar) working in conjunction with a F.M. Mk.7B radio altimeter, and is used to assist the pilot during low level flight.

2. The F.M. Mk.7B radio altimeter (A.R.I.23172) is dealt with in Sect.8, Chap.7 of this book and more detailed information appears in A.P.116B-0203-1. A location diagram for the T.F.R. components is given in fig.1 and a more detailed description of the major units is contained in fig.2. The associated aircraft routing charts and connector table will be found at the end of the text.

3. The forward looking radar and associated computor is housed within a cylindrical container (radar pod) and fitted to the nose of the aircraft as shown in fig.1. Further information on the radar pod will be found in A.P.114N-0101-1, which should be read in conjunction with the information contained in this chapter.

DESCRIPTION AND OPERATION

General

4. The forward looking radar system utilises a 'on-boresight' Ku-band monopulse radar technique and has the ability to detect and respond to individual objects within a continually moving field approximately 0.1 mile deep located at a selected distance forward of the flight path depending on altitude, speed, flight characteristics of the vulcan aircraft and F.M. Mk.7B radio altimeter height information input to the computor.

5. The forward looking radar measures the range of objects immediately forward of the flight path and the F.M. Mk.7B radio altimeter provides accurate height information of the aircraft relative to the terrain immediately below the aircraft flight path.

6. These two sources of information range (R) and height (H) are compared, in the computor, with a reference range (r) and a reference height (h). The reference (r) is already programmed into the computor to suit the flying characteristics of the Vulcan aircraft and the reference (h) is set into the computor via the height selector switch on the T.F.R. control unit.

7. When either (H) or (R) becomes more or less than references (h) or (r), due to changes in the terrain, a pitch-down or pitch-up signal is generated respectively and shown on either the head up display (CLIMB-DIVE indicator) or head down display (M.F.S. director horizon). The pilot, according to the display, alters the attitude of the aircraft in pitch to null the climb or dive indication and thereby causes the aircraft to follow the rise and fall of a changing terrain at a pre-determined height above the ground. This technique is shown in fig.1A.

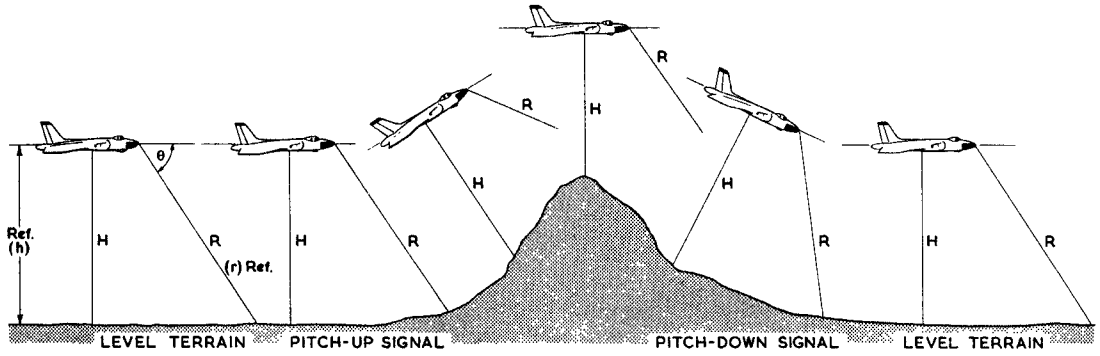
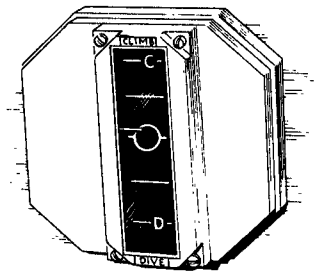


Fig.1A T.F.R. mode of operation

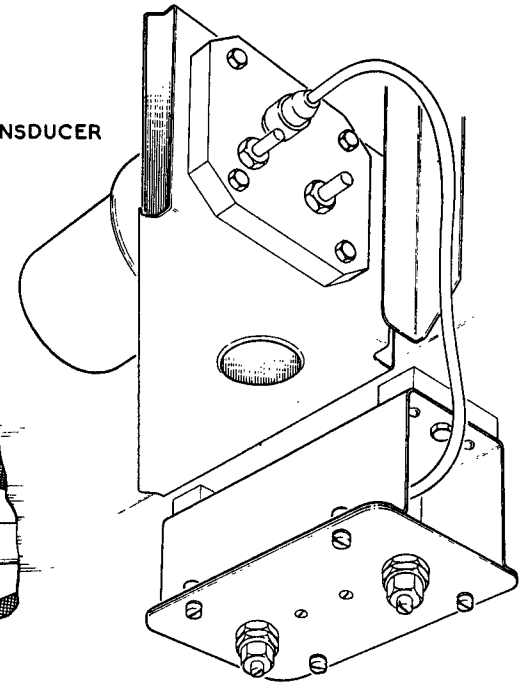
Radar pod

8. The radar pod, Ref.No.AN/APN/170, is fitted to the nose of the aircraft as shown in fig.1. The radar pod is air cooled in flight by two scooped inlet openings located underneath the radar pod radome. Provision has been made for fitting a special adaptor to the radar pod to provide forced air cooling when testing the system on the ground. Further details concerned with the fitting and securing of the pod to the aircraft and also the fitting of the special adaptor may be found in A.P.101B-1902-1A, Sect.3, Chap.1. When the pod is not fitted to the aircraft a special blanking cap is fitted to the nose.

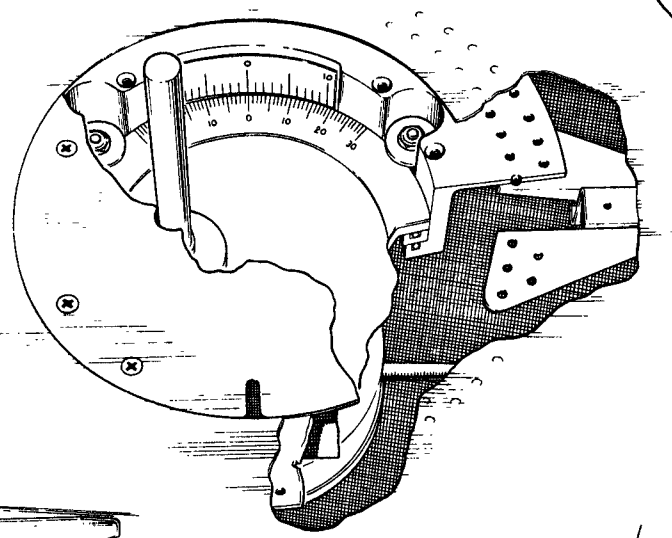


CLIMB - DIVE INDICATOR

A. S. I. TRANSDUCER

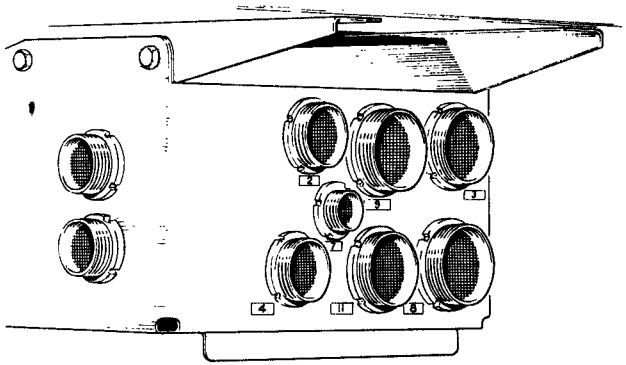


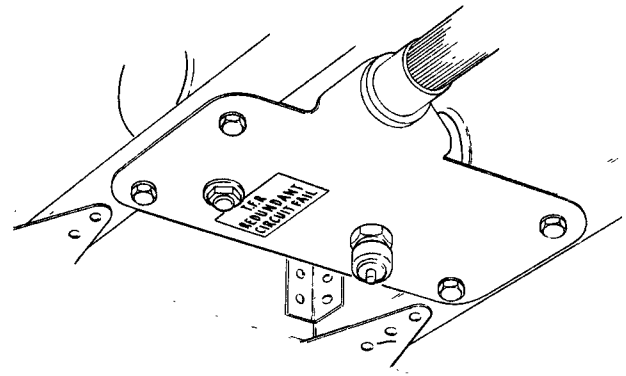
AIRSPEED ADJUSTMENT PANEL



AIRSTREAM DIRECTION
DETECTOR UNIT

T.F.R. JUNCTION BOX





REDUNDANT CIRCUIT FAIL PANEL
AND ANGLE OF ATTACK TRIMMER

Fig. 2. Component details.

Associated equipment

9. The associated equipment in addition to the radar pod and the Mk.7B radio altimeter installation is listed in Table 1. Further items comprising first and second pilots' T.F.R. indicators, fitted to the first and second pilots' panels, and a change-over switch labelled T.F.R. - M.F.S., fitted to the second pilot's panel, are shown in fig.1. The equipment listed in Table 1 together with the indicators and change-over switch are dealt with more fully in the following paragraphs.

Control unit, Part No.T6654

10. The control unit is located on the port console as shown in fig.1. The following controls are fitted to the front panel of the unit:-

(1) Supply ON-OFF toggle switch

(2) STANDBY - ON toggle switch

(3) FAIL SAFE - TEST 3-position toggle switch

(4) Height selector, 9-position 2-pole rotary switch

11. The ON-OFF and STANDBY-ON switches are used to switch the aircraft a.c. and d.c. supplies to the T.F.R. pod. The 3-position magnetic indicator shows OFF when a.c. and d.c. supplies are not connected to the radar pod, shows STANDBY when the supply switch is set to ON and the STANDBY/ON switch set to STANDBY. When both the supply ON-OFF switch and the STANDBY/ON switch are set to ON the indicator gives a blank indication thereby indicating that the a.c. and d.c. supplies are connected to the radar pod. A circuit description is given in para.42.

12. The aircraft reference height signal (para.6) is set into the pod computor via the height selector switch. The switch provides a range in height between 200 and 1,000 ft. in nine steps, 100 ft. each step. With reference to fig.4 it will be seen that the height selector switch comprises a 2-pole, 9-position rotary switch.

13. Both a.c. and d.c. height reference signals are provided by the control unit and are derived from the 2-pole, 9-position rotary switch in association with two voltage divider resistance networks common to each switch pole.

14. Stabilised a.c. and d.c. height reference supplies are connected to the two resistance networks in the control unit from the pod computor via the main junction box, Part No. T6658, and the control unit connector pins K and J (a.c. ref.) and pins C and M (d.c. ref.)

15. The a.c. reference and d.c. reference resistance networks comprise eight 400 ohm fixed resistors connected in series and also between each adjacent switch contact of the 9-position rotary switch to form two separate stepped voltage divider circuits.

16. As the height selector switch is rotated to each of its 9-positions an a.c. and d.c. voltage progressively increases in amplitude as the selected height, indicated by the switch knob pointer, increases. These a.c. and d.c. voltages appear on the switch sliders and are connected to the pod computor via the main junction box and the control unit connector, pin H (a.c. ref.) and pin P (d.c. ref.)

17. These a.c. and d.c. reference voltages are used to vary the angle of the video return signal to the aircraft flight datum. Further information on this aspect may be found in A.P.114N-0101-1.

18. The T.F.R. system may be checked for correct functioning and 'fail safe' operation by the test switch labelled TEST/NORMAL/RESET. When the switch is set to TEST the red indicators labelled T.F.R. FAIL, on the first and second pilots' panels, are illuminated. When the test switch is set to RESET the red indicators are extinguished and the green indicators labelled T.F.R. VIDEO, also on the pilots' panels, are illuminated. The test switch is placed in the NORMAL position for normal T.F.R. operation.

19. The 28-volt d.c. supplies which illuminate the FAIL and VIDEO indicators, when operating the test switch, are derived from the pod and are present when the system is either functioning incorrectly (Fail indicator) or correctly (Video indicator). The purpose of the test switch is to produce an error signal and thereby ensure that the 'fail safe' and warning circuits in the pod are functioning correctly. The error signal is derived from two resistors (1.78K ohm and 7.5 ohm) mounted in the control unit and connected to the test switch as shown in fig.4. The test circuit is connected to the T.F.R. pod via the control unit connector pins A,B,D and E, and the main junction box. Further information may be found in A.P.114N-0101-1.

Mk.7B/T.F.R. junction box, Part No.T6820

20. The junction box, which is located in the aircraft as shown in fig.1, is used to connect height information from the Mk.7B radio altimeter installation to the T.F.R. radar pod. Two relays (Relay 1 and Relay 2) are housed within the junction box and are connected to form the circuit shown in fig.5.

21. Height signals are only supplied to the T.F.R. pod computor when the Mk.7B radio altimeter is operating in the high range (5,000 ft.). To ensure this Relay 1 is first energised from the aircraft 28-volt d.c. supply from fuse 1312 in fuse panel 4P, via the STANDBY-ON switch, on the

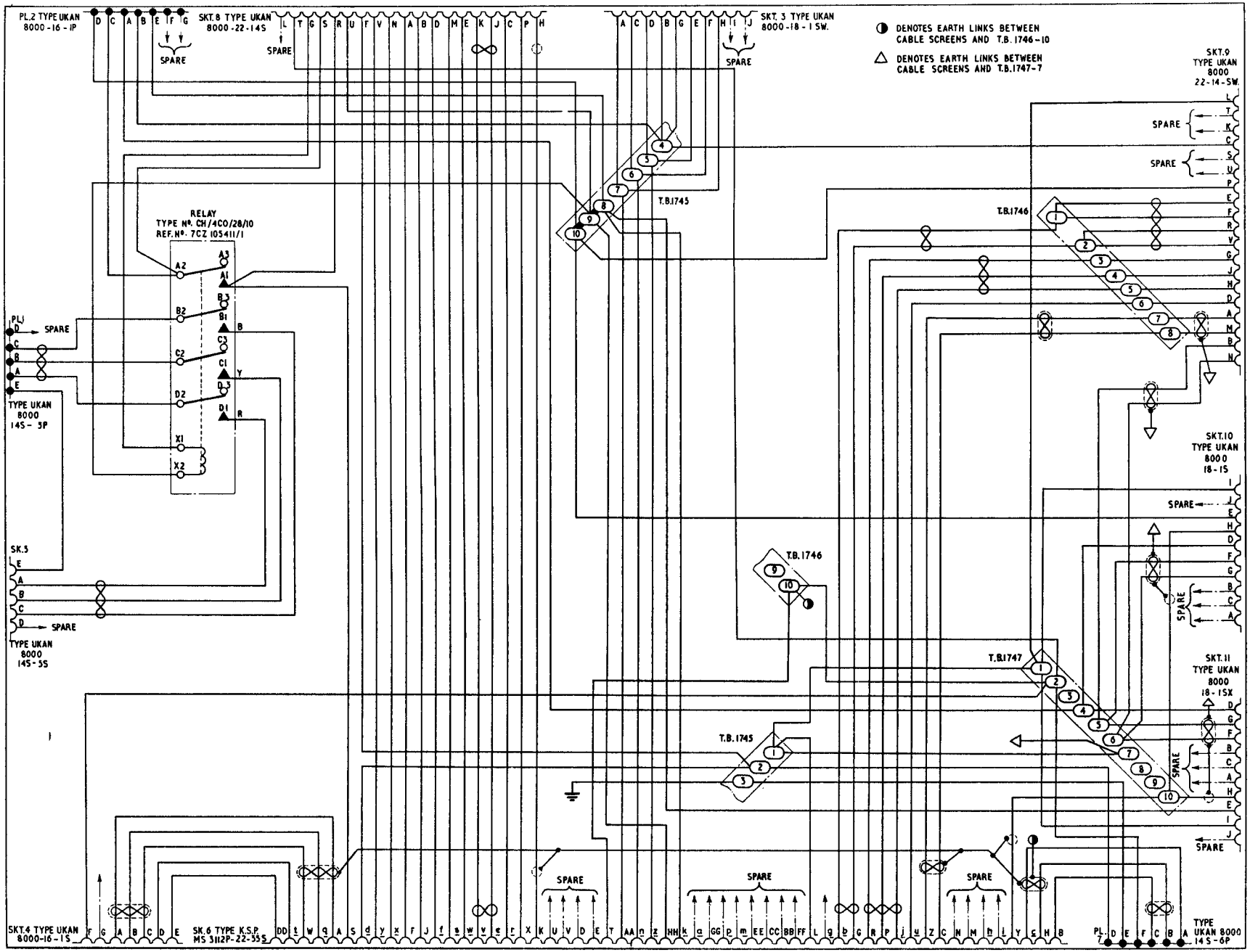


Fig. 3 Internal wiring A.R.I. 5959 J/B

T.F.R. control unit, switched to ON. The contacts of Relay 1 subsequently close to connect a 'range change' signal, already existing on plug 1 pin C of the junction box when HIGH RANGE (5,000 ft.) is selected on the Mk.7B radio altimeter control unit, on to the coil of relay 2 and relay 2 is energised (see fig.5). The 'range change' signal is also used to bring up the extra noughts on the pilots' and navigators height indicators.

22. The contacts of Relay 2 close and connects the height and flag signals, already existing on plug 1 (pins L, K and S) and socket 3 (pins L, K and S), on to socket 2 pins A, B and C respectively. The height signal, also used to control the pilots' and navigators Mk.7B height indicator pointers, and flag signal, also used to remove the OFF indication on the Mk.7B height indicators when the installation is operating correctly, are connected to the radar pod computor via socket 2 of the Mk.7B/T.F.R. junction box and plug 7 and socket 6 of the main junction box. Further information may be found in A.P.114N-0101-1.

23. If the change range switch on the Mk.7B radio altimeter control unit is inadvertently switched to low range (500 ft.) whilst flying the aircraft on T.F.R. the 'range change' signal is removed from the Mk.7B/T.F.R. Junction box plug 1 pin C and Relay 2 becomes de-energised. The height and flag signals are subsequently disconnected from the radar pod and the 'fail safe' circuits in the pod computor become operational. The pilots' red T.F.R. FAIL indicators become illuminated and also a climb command is displayed on the pilots' head-up or head-down indicators.

T.F.R. junction box, Part No.T6658

24. The junction box is located as shown in fig.1 and provides the main interconnection between the T.F.R. pod, T.F.R. control unit, indicators, aircraft power supplies and the Mk.7B radio altimeter installation. The junction box houses one relay which is used to connect the aircraft a.c. and d.c. supplies to the T.F.R. pod. The internal wiring of the junction box is contained in fig.3 and the circuit operation of the relay is dealt with in para.42.

Indicators

25. Three indicators are utilised to show the serviceability of the T.F.R. system and are mounted on the first pilot's panel as shown in fig.1. A further three indicators mounted on the second pilot's panel duplicate the information presented by the first pilots indicators. Each indicator has a press-to-test facility for checking the serviceability of the lamp and has a special 28-volt d.c. supply from fuse 1317 in panel 4P for this purpose.

26. The indicators coloured Red, Green and Amber are labelled T.F.R. FAIL, T.F.R. VIDEO and T.F.R. WARNING respectively. The FAIL indicator is illuminated when the system is unserviceable, the VIDEO indicator is illuminated when the system is working correctly and the amber WARNING indicator displays a flashing signal when the pitch rate error signal exceeds a climb command of one degree per second.

Redundant circuit fail panel, Part No.T6662

27. The panel is located under the pilots' floor as shown in fig.1 and houses a two gang potentiometer. The potentiometers are connected to the port and starboard airstream direction detectors and are used to trim out tolerance errors that may exist between the port and starboard detector units.

28. The panel (pre-Mod.2139) also houses an amber indicator (Redundant circuit fail indication) which is illuminated whenever a failure occurs in one of the systems' redundant channels. When Mod. 2139 is embodied the amber indicator is removed from the panel and repositioned on the navigators panel below the navigators Mk.7B height indicator.

Airspeed detector transducer

29. The transducer, Ref.No.D3457, is fitted under the pilots' floor and is connected to the starboard pitot-static system. A signal proportional to the aircraft airspeed is derived from the transducer and connected to the T.F.R. pod via the airspeed trimming panel potentiometers and socket 9 and 6 of the main junction box as shown in fig.6. Further details may be found in A.P.114N-0101-1.

Airspeed trimming panel, Part No.T6787

30. The panel is fitted adjacent to the transducer (para.29) and is used to trim out tolerance errors in the associated transducer potentiometer when the initial setting up is being done and also subsequent setting up procedures in the event of a replacement transducer being fitted. The panel comprises two potentiometers connected in series with fixed resistors to form the circuit contained in fig.6.

Airstream direction detectors

31. The detector, Ref.No.6A/6456, consisting of a probe to which is attached at one end a potentiometer. Two of these units are installed one on each side of the aircraft as shown in fig.1. The probe projects into the airstream being horizontally installed on the side of the aircraft.

32. The probe is a stainless steel cylinder approximately 4 in. long and 0.5 in. in diameter. It is divided into two passages that have slots facing the relative airstream. Slots in the probe

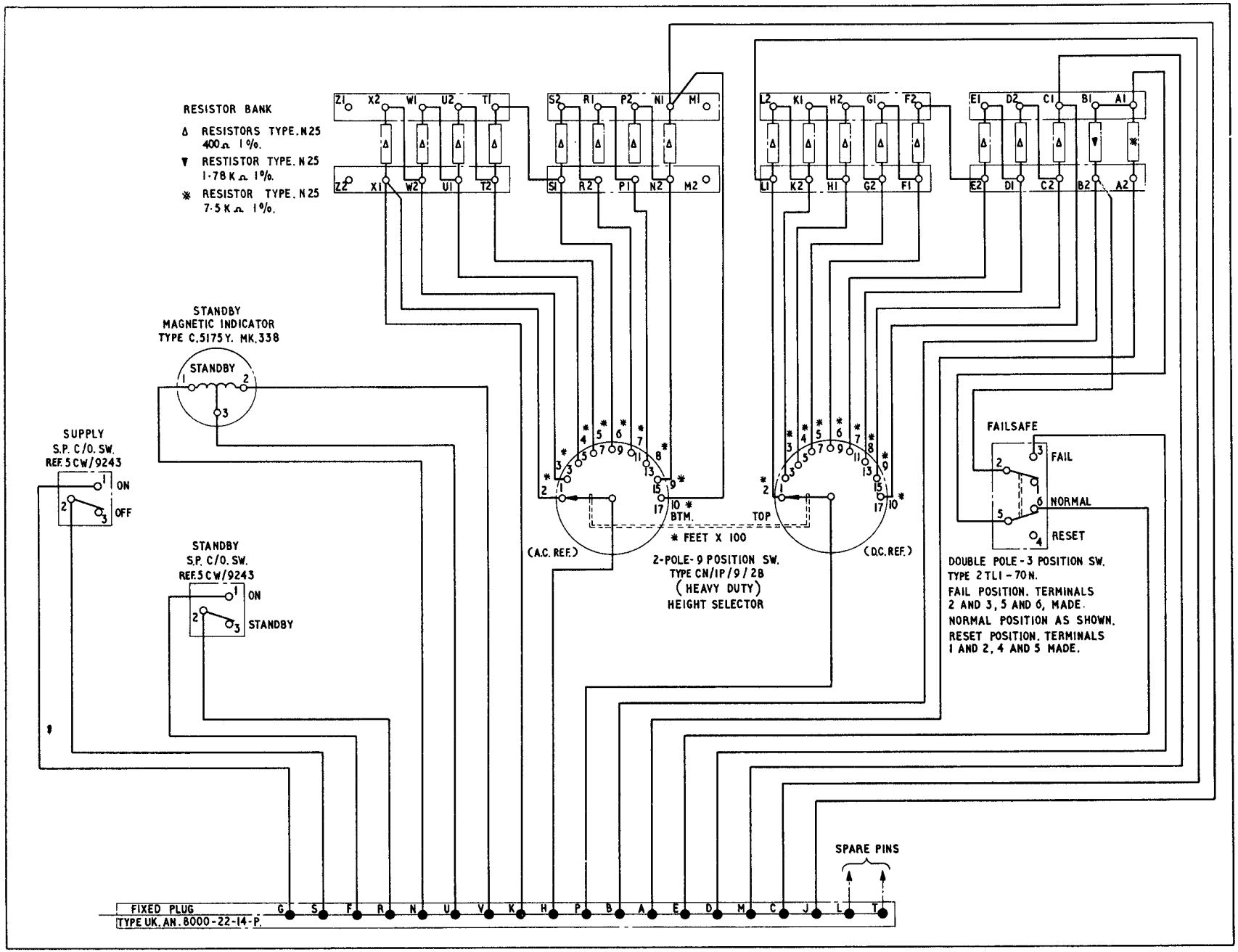


Fig. 4 Internal wiring A.R.I. 5959 control unit

transmit the air pressure through separate passages, past a filter system, into the two sides of a paddle chamber. This paddle is attached directly to the base of the probe within the housing.

33. Under a condition of steady airflow the pressure differential between the two sides of the paddle is zero. Whenever a change of airflow direction occurs, the paddle and the probe turns around automatically until the pressure differential is again zero. As the probe rotates to follow the airflow it alters the output of two potentiometers. However, only one of these potentiometers is used on the Vulcan installation.

34. The output signals from the port and starboard detectors are connected to the T.F.R. pod computor via sockets 9, 10, and 11 of the main junction box and a two gang potentiometer (para.27). Further information may be found in A.P.114N-0101-1.

35. A thermostatically controlled 70-watt 28-volt d.c. heater element, fitted within the probe, provides de-icing of the probe. The port and starboard probe heaters are switched on at the same time as the pitot-static probe heaters via a control switch situated on the starboard console 7P. (See Sect.6, Chap.13 of this publication).

36. A 28-volt d.c. supply from fuse 519 in panel 4P energises relay 815, also in panel 4P, via the pitot-static heater control switch (para.35) and T.B.1524(A). The contacts of relay 815 subsequently close to connect a 28-volt d.c. supply, from fuse 908 in panel 4P, to the port and starboard probe heater elements via plug 2 and sockets 10 and 11 of the main junction box.

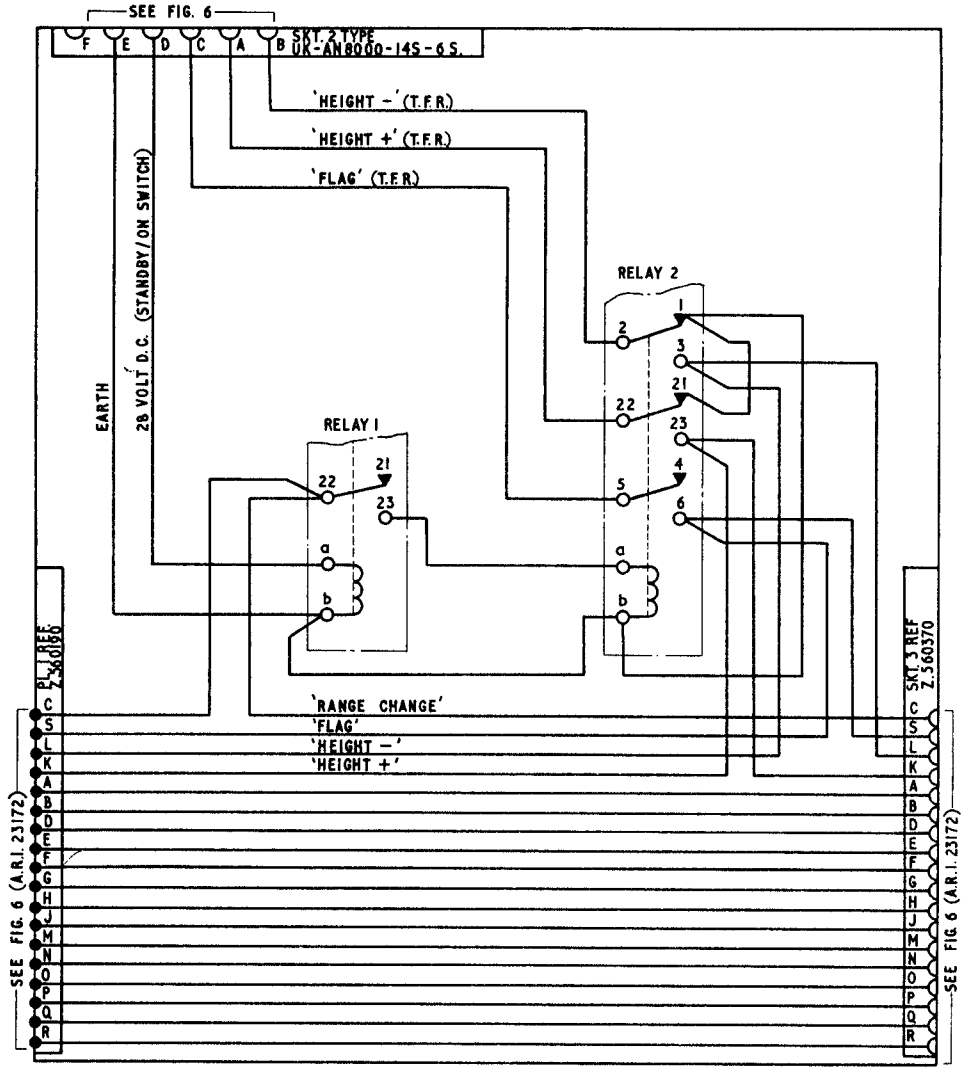


Fig.5 Internal wiring Mk.7B/T.F.R. J/B

Head-up indicators

37. The climb-dive indicators, Ref.No. 6A/10471, are fitted on top of the pilots coaming, as shown in fig.1. The indicator, shown in more detail in fig.2, shows the pitch command signal in the form of a pointer moving vertically across a pitch scale. As the pointer moves in response to the changes in the terrain the pilot alters the attitude of the aircraft in pitch to counteract the pointer movement thus nulling the indication. This technique allows the pilot to keep the

aircraft at a set height above the terrain whilst following the rise and fall of the terrain.

38. The port and starboard CLIMB-DIVE indicators are illuminated and controlled in brightness via two existing dimmer controls also used to control the illumination of the port and starboard E2B standby compasses. A 28-volt d.c. supply is fed to the port CLIMB-DIVE indicator via T.B.1743, T.B.1748, the associated dimmer control and fuse 916 in panel 3P, and the starboard CLIMB-DIVE indicator via T.B.1744, T.B.1748, the associated dimmer control and fuse 881 in panel 4P (See Sect.6, Chap.17 of this publication).

Head-down indicators

39. The pitch command signal may also be monitored on the M.F.S. first and second pilot's director horizon by operation of a change-over switch labelled T.F.R. - M.F.S. located on the second pilot's panel as shown in fig.1. The pilot will alter the aircraft in pitch in order to null the pitch indication shown by the glide path pointer on the director horizon and thus keep the aircraft at a set height whilst following the rise and fall of the terrain.

T.F.R. - M.F.S. switch

40. The T.F.R. - M.F.S. switch, when operated to the T.F.R. position, energises a relay housed in the M.F.S. pitch computor, Type B, via connector CP3 pins A and B (fig.7). The closed contacts of this relay connects the pitch demand signal, supplied from the T.F.R. pod via socket 6 and socket 4 of the main junction box (fig.3), to the glide-path pointer movement of the port and starboard director horizon instruments, via connector CP5 pins A and B and connector CP2 pins 2 and 20 of the pitch computor. Further information is available in A.P.4686B, Vol.1, Book 2, Sect.4, Chap.12A. The M.F.S. system is also dealt with in Sect.7, Chap.7 of this book.

Vertical reference

41. The vertical reference signal, which is derived from the M.F.S. port vertical gyro, provides continuous information on the pitch attitude of the aircraft relative to a stable vertical axis. The signal is connected to the T.F.R. pod via socket 4 pins A, B and C and socket 6 pins A, (q) and W of the main junction box (fig.3). Further information on the vertical gyro may be obtained in Sect.7, Chap.7 of this book and a more detailed description in A.P.4686B, Vol.1, Book 2, Sect.4, Chap.24A.

Supplies

42. When the supply ON-OFF switch on the control unit is set to ON (fig.4) a 28-volt d.c. supply, from fuse 1312 in fuse panel 4P, is connected to the coil of the internal relay, housed within the main junction box (fig.3), via plug 2 pin C and socket 8 pin S of the main junction box, control unit connector pin S (fig.4), supply switch terminals 2 and 1, control unit connector pin G and socket 8 pin G of the main junction box.

43. With the internal relay in the main junction box energised the relay contacts close to connect the aircraft 200-volt, 3-phase, 400 c/s supply, from fuses 739 R.Y.B. in fuse panel 75P, to the T.F.R. pod via plug 1 pins A, B and C, the relay contacts and socket 5 pins A, B and C of the main junction box. A 28-volt d.c. supply from fuse 1312 is also connected to both the T.F.R. pod, via socket 6 pin S, and terminal 2 of the STANDBY-ON switch via socket 8 pin R and control unit connector pin R.

44. The T.F.R. system is now in the standby condition and primed ready for operation. A 28-volt d.c. supply from the T.F.R. pod is connected to terminal 1 of the magnetic indicator, situated on the control unit, via socket 6 pin (x) and socket 8 pin N of the main junction box. The earth connection to the magnetic indicator is routed via T.B.1745 pin 9 and socket 8 pin U of the main junction box, control unit connector pin U and terminal 3 of the magnetic indicator. The indicator is energised and displays STANDBY.

45. When the STANDBY-ON switch on the control unit is switched to the ON position a 28-volt d.c. supply, from fuse 1312, on terminal 2 of the standby switch (para.43) is connected to both the T.F.R. pod and Relay 1 in the Mk.7B/T.F.R. junction box (para.21) via terminal 1 of the standby switch, control unit connector pin F, socket 8 pin F and T.B.1745 terminal 2 of the main junction box.

46. The 28-volt supply at this junction is now connected to the T.F.R. pod via pocket 6 pin (d) of the main junction box and also to Relay 1, in the Mk.7B/T.F.R. junction box, via plug 7 pin D of the main junction box and socket 2 pin D of the Mk.7B/T.F.R. junction box. A wiring diagram of the Mk.7B/T.F.R. junction box is contained in fig.5 and a circuit description is given in para.21.

47. No immediate operation of the T.F.R. is available when the system is switched to ON due to a time delay circuit incorporated in the T.F.R. pod. After this time delay the system becomes operational and R.F. power is transmitted. At the same time the 28-volt d.c. supply, from the T.F.R. pod, on the magnetic indicator terminal 1 (para.44) is removed and a 28-volt d.c. supply, from the T.F.R. pod is connected to terminal 2 of the magnetic indicator via socket 6 pin (y), socket 8 pin V of the main junction box and control unit connector pin V. The indicator is energised to show a blank indication.

48. With no a.c. or d.c. supplies connected to the T.F.R. pod, the magnetic indicator displays OFF.

SERVICING

General

49. All T.F.R. items of equipment should be checked for security of mounting and tightness of plug and socket connections. Before removing any items of equipment suspected of being defective, checks should be made for continuity and insulation on the associated cable assemblies. Fully comprehensive setting up, operating and servicing instructions for the T.F.R. may be found in A.P.114N-0101-1.

Ground cooling adaptor

50. The adaptor, Part No.Z11693, provides cooling air for the T.F.R. pod when testing the complete system on the ground. The adaptor is mounted over the pod radome and injects forced cooling air into the two existing pod airscoops. Further information is available in A.P. 101B-1902-1A, Sect.3, Chap.1.

Test set

51. A special test set, Part No.TA. 23067, is available for checking the aircraft T.F.R. installation when the T.F.R. pod is removed from the aircraft. The test set is connected to the aircraft via a test lead and the T.F.R. pod connector plug.

52. The test set provides the necessary checks and supplies as follows:-

(1) Connects on appropriate signal to the airstream direction detectors (A.D.D.) and A.S.I. transducer trimming potentiometers for accurate adjustment and setting.

(2) Measures the output of the A.D.D. and A.S.I. transducer potentiometers.

(3) Checks the continuity and functioning of the associated Mk.7B/T.F.R. junction box circuit, M.F.S. pitch computor and vertical gyro pitch potentiometer.

(4) Checks for correct functioning of circuits associated with the height selector, FAIL indication and RESET via simulated T.F.R. pod signals.

(5) Checks all the associated T.F.R. cable forms for continuity and insulation.

53. A test procedure using the test set may be found in A.P.114N-0101-1. The Mk.7B radio altimeter installation may also require testing and details of these tests may be found in Sect.8, Chap.7 of this publication.

REMOVAL AND INSTALLATION

General

54. Access to the major units of the T.F.R. is straightforward and they may be easily removed or fitted with little or no difficulty, therefore no special instructions are required. The only exception to this is the T.F.R. pod and the airstream direction detector unit. Detailed instructions for removing or fitting the T.F.R. pod to the aircraft together with a special alignment technique is given in A.P.101B-1902-1A, Sect.3, Chap.1. Instructions for removing the airstream direction detector (A.D.D.) are given in the following paragraph.

Airstream direction detector

55. When it is necessary to replace the A.D.D., port or starboard, it is extremely important that the new unit should be fitted to the aircraft in exactly the same position originally occupied by the defective unit. With reference to fig,2 the following procedure should be carried out as follows:-

(1) Disconnect the associated A.D.D. cable from either the main junction box socket 10 (starboard unit) or the port plug break (port unit).

(2) Remove the small circular panel from around the probe, accessible from outside the aircraft, by removing eight screws and lifting off.

(3) Carefully take note of the vernier setting (see fig.2) and then remove four self lock nuts and spacers used to clamp the unit into position. Withdraw the unit, complete with cable and socket, carefully away from the aircraft skin.

(4) To fit the new unit reverse the procedure given in sub-panel (1), (2) and (3) ensuring that the unit is positioned and clamped correctly to that noted, in sub-para.(3).

WARNING...

These instruments are extremely delicate and great care must be exercised when handling or servicing on the aircraft.

Cable connectors

56. Should any unit be removed from the aircraft, all loose connectors should be secured to the adjacent aircraft structure to prevent damage.

Blanking cap

57. When the T.F.R. pod is not being carried by the aircraft a blanking cap is fitted to cover the T.F.R. pod cut-out on the radome. Further information concerning the fitting of the blanking cap is available in A.P.101B-1902-1A, Sect.3, Chap.1.

TABLE 1

A.R.I.5959 equipment

Equipment	H.S.A. Part No.	Ref. No.	No. off.
T.F.R. pod		Type AN/APN/170	1
Control unit	T6654	-	1
Airstream direction detector, Type RL 50	-	6A/6456	2
Redundant circuit fail panel	T6662	-	1
Climb-dive indicator	-	6A/10471	2
T.F.R. junction box	T6658	-	1
Mk.7B/T.F.R. junction box	T6820	-	1
Airspeed transducer	-	Type D.3457	1
Airspeed adjustment panel	T6787	-	1

TABLE 2

Connectors for A.R.I.5959

H.S.A. Part No.	Cableform	Connecting
7/T6653	Uninyvin 20 17-cores	T.F.R. control unit to T.F.R. J/B socket 8 pin to pin
8/T6653	Min 2C	T.F.R. J/B plug 7 to Mk.7B/T.F.R. J/B socket 2 pin to pin
9/T6653	Uninyvin 20 20-cores Trinyvin 20 3-cores Uninyvin twisted 4-cores Min 3C 3-cores Min 2C 4-cores Uninyvin met 20 2-cores	T.F.R. junction box socket 6 to plug break 1216 pin to pin
10/T6653	Trinyvin 20 3-cores Uninyvin 20 2-cores Min.2C 2-cores Uninyvin met 20 1-core	T.F.R. junction box socket 11 to A.D.D. probe port plug break pin to pin
FR861	Trinyvin 20 3-cores Uninyvin 20 1-core	T.F.R. junction box socket 5 to plug break 1215. (Trinyvin-pin to pin, Uninyvin core pin E to pin D)
FR862	Uninyvin 20 7-cores	Circuit fail panel (A.D.D. trimming and fail indicator) to plug break

TABLE 2

Connectors for A.R.I.5959

H.S.A. Part No.	Cableform	Connecting
7/T6653	Uninyvin 20 17-cores	T.F.R. control unit to T.F.R. J/B socket 8 pin to pin
8/T6653	Min 2C	T.F.R. J/B plug 7 to Mk.7B/T.F.R. J/B socket 2 pin to pin
9/T6653	Uninyvin 20 20-cores Trinyvin 20 3-cores Uninyvin twisted 4-cores Min 3C 3-cores Min 2C 4-cores Uninyvin met 20 2-cores	T.F.R. junction box socket 6 to plug break 1216 pin to pin
10/T6653	Trinyvin 20 3-cores Uninyvin 20 2-cores Min.2C 2-cores Uninyvin met 20 1-core	T.F.R. junction box socket 11 to A.D.D. probe port plug break pin to pin
FR861	Trinyvin 20 3-cores Uninyvin 20 1-core	T.F.R. junction box socket 5 to plug break 1215. (Trinyvin-pin to pin, Uninyvin core pin E to pin D)
FR862	Uninyvin 20 7-cores	Circuit fail panel (A.D.D. trimming and fail indicator) to plug break

TABLE 2 (Cont'd)

Connectors for A.R.I.5959

H.S.A. Part No.	Cableform	Connecting
FR882	Uninyvin 20 3-cores Min.2C 4-cores	T.F.R. junction box socket 9 to circuit fail panel plug break
	Trinyvin 20 3-cores	T.F.R. junction box socket 9 to airspeed trimming panel T.B.1753
	Uninyvin 20 Twisted 2-cores	T.F.R. junction box socket 9 to T.B.1743
	Uninyvin 20 Twisted 2-cores	T.F.R. junction box socket 9 to T.B.1744
FR883	Trinyvin 20 3-cores	T.F.R. pod plug to plug break 1215 (pin M to pin A, pin h to pin B and pin i to pin C)
	Uninyvin 20	T.F.R. pod plug to plug break 1215 (pin N to pin D)
	Uninyvin 20 20-cores Trinyvin 20 3-cores Uninyvin 20 Twisted 4-cores Uninyvinmet 20 2-cores Min.2C 4-cores Min.3C 3-cores	T.F.R. pod plug to plug break 1216 pin to pin

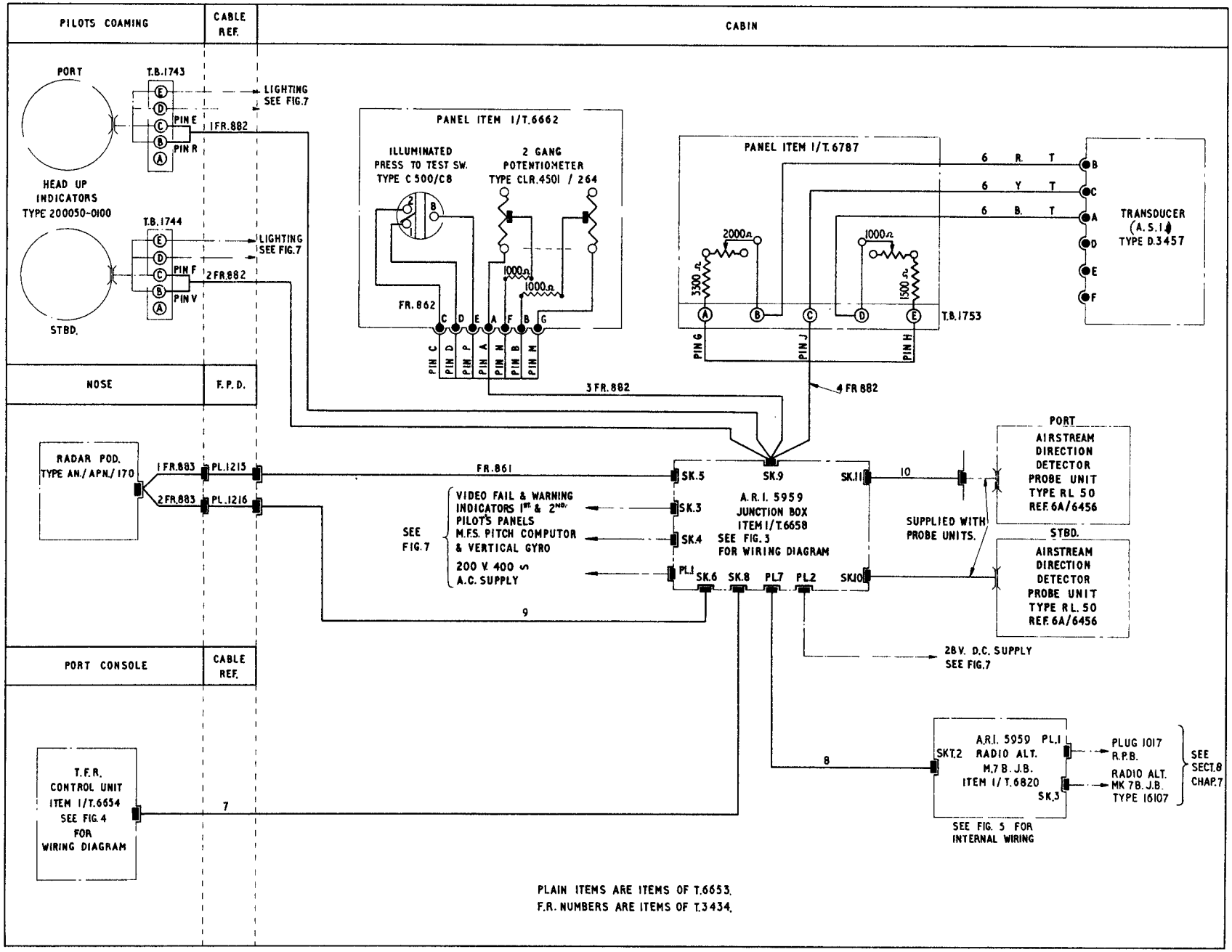


Fig. 6 A.R.I. 5959

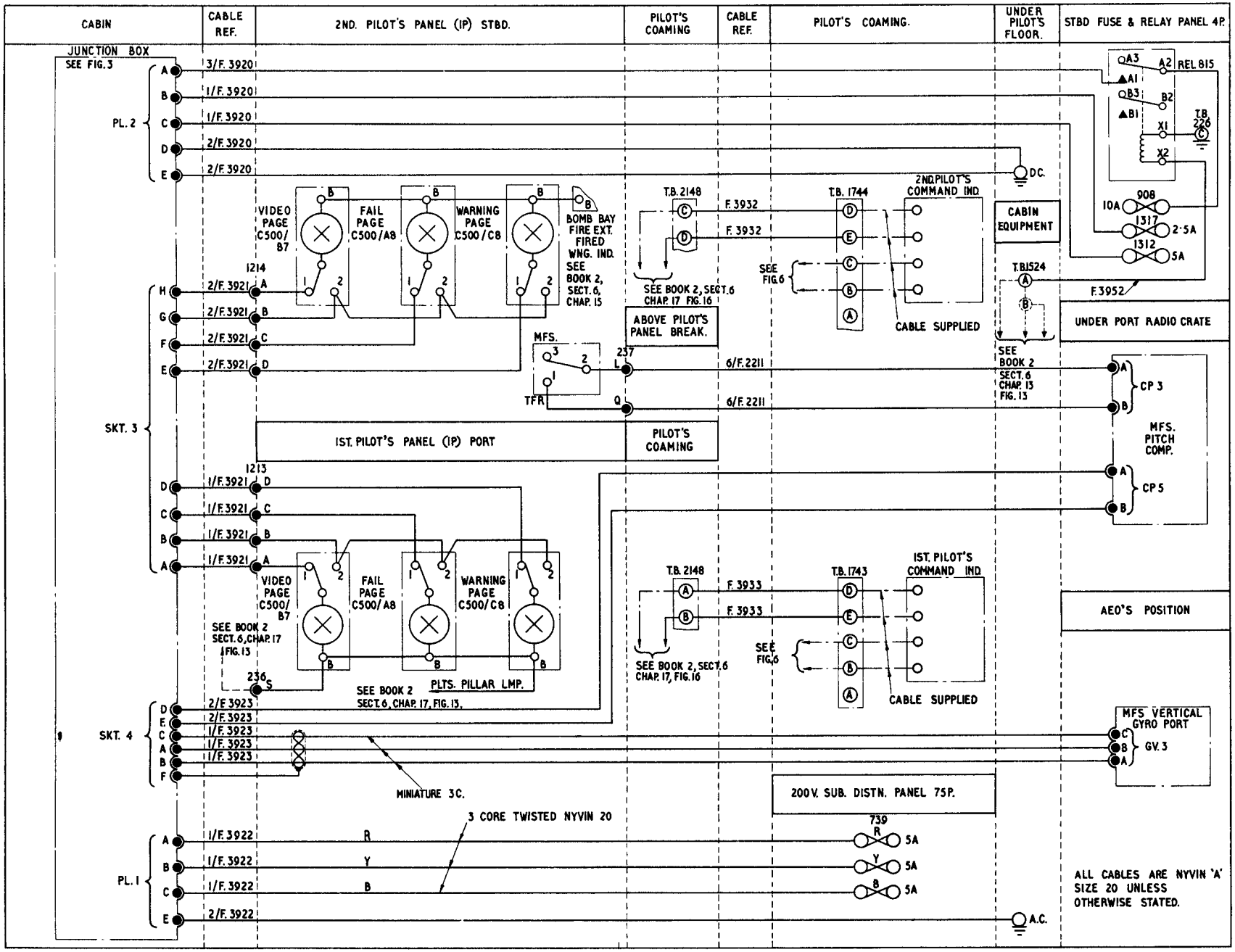


Fig. 7 A.R.I. 5959 power supplies

Chapter 8

A.R.I.5952

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Introduction

1. A.R.I.5952, introduced by Mod.2017, is an X-band search radar system operating in conjunction with A.R.I.18105. The system which is a further development of A.R.I.5919 consists of a tail-mounted radar unit, scanner alignment unit and an indicator, azimuth range unit mounted at the navigator's station. The indicator combines the functions of indicator and control unit.

2. When airborne the A.R.I.5952 will normally be maintained in a stand-by condition (not transmitting) for most of the time. This is due to the operation of other E.C.M. equipment including A.R.I. 18105. When required A.R.I.5952 can be switched to transmit in order to find the exact range and bearing of the attacking aircraft.

3. The display on the indicator shows the position of an attacking aircraft relative to the aircraft and may be suitably stabilised to offset errors caused by the roll and pitch variations of the aircraft during flight. The vertical reference signal, used to stabilise the display scan with respect to ground, is derived from the standby horizon gyro Mk.5A mounted on the first pilot's panel.

4. A location diagram of the major units is contained in fig.1 and a routing chart and connector table may be found at the end of the text. Descriptive, servicing and operating details of the A.R.I. 5952 will be found in A.P.114M-0100-1A. The cooling system for this installation may be found in A.P.101B-1902-1A, Sect.3, Chap.16 of this publication.

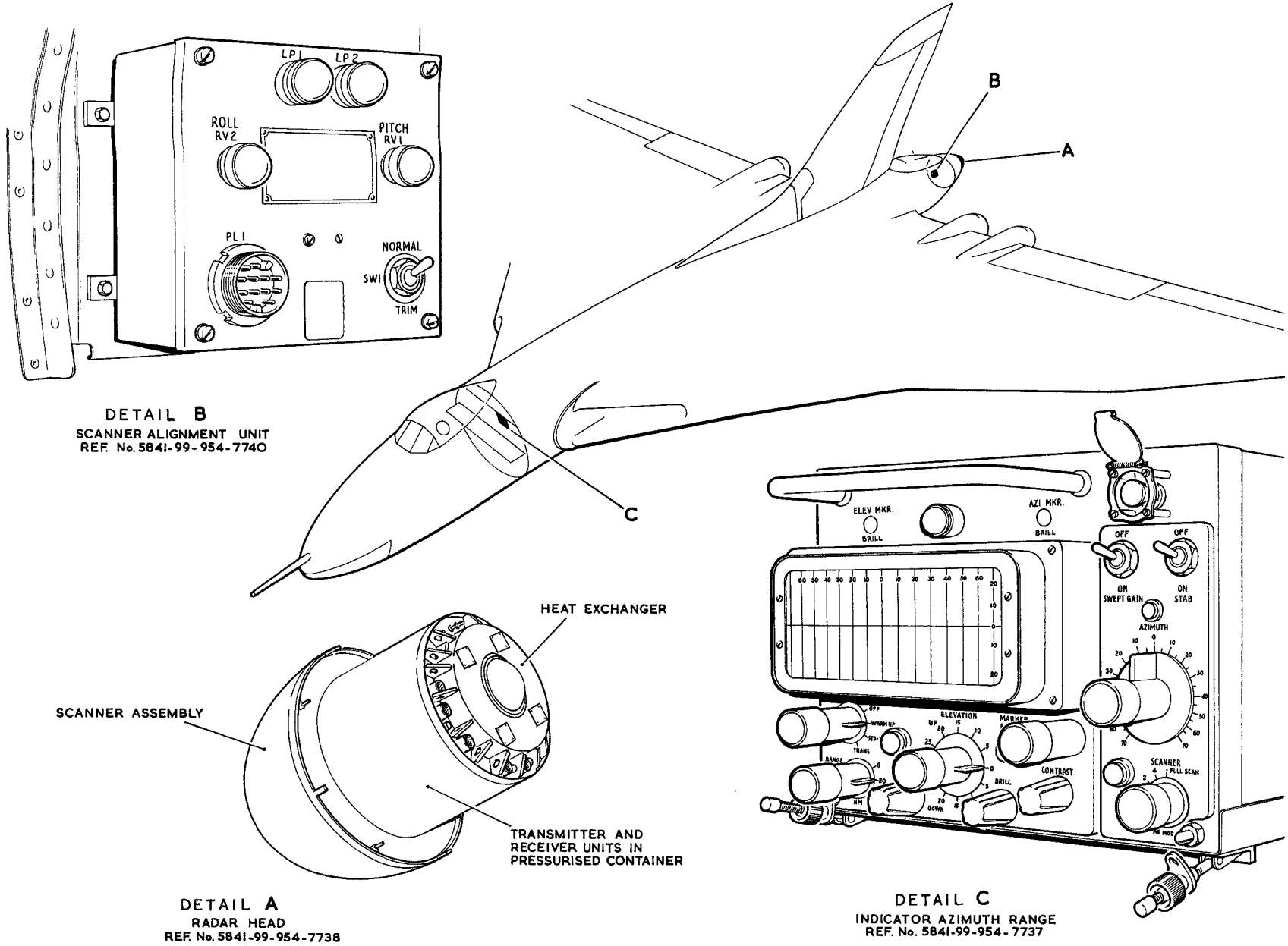

Fig. 1. Location of A.R.I. 5952 equipment.

DESCRIPTION AND OPERATION

General

5. The following paragraphs contain a brief description of the various functions of the A.R.I.5952 units previously mentioned in para.1. The reference numbers for these items are contained in fig.1. The system is under the control of the A.E.O. and consists of the following major components:-

Radar head	1
Indicator, azimuth-range	1
Scanner alignment unit	1

Radar head

6. The radar head is mounted at the extreme end of the rear fuselage structure, the radome covering the scanner forming the tail cone of the fuselage as shown in the attached drawing. The head consists of a pressurized cylindrical canister in which is mounted the scanner assembly, together with the transmitting and receiving units.

7. Pressurization of the canister is provided by air bottles mounted adjacent to the radar head. The pressure first inflates the radome sealing ring and seals the unit, and then pressurizes the remainder of the unit via a differential valve. The set is automatically switched off if the pressure falls below 13·5 p.s.i.a.

8. The canister is cooled through the medium of a heat exchanger, which is supplied with a flow of ram air regulated by a thermostatically-controlled electrically-actuated valve. The mechanical aspect of the pressurization and cooling system for the A.R.I.5952 will appear in A.P. 101B-1902-1A, Sect.3, Chap.16 and the electrical circuit for the cooling system will appear in A.P.101B-1902-1B, Sect.6, Chap.22.

Indicator, Azimuth range

9. The indicator is installed on an anti-vibration tray on the navigator's panel at the A.E.O's station as shown in fig.1. The unit contains all operational controls and a display C.R.T. A rotary switch provides for the selection of warm up, stand-by or transmit condition of the circuits in the radar head. The C.R.T. display provides location and distance indication via calibrated azimuth and elevation markers using two time base speeds to give the following ranges:-

0 - 6 N.M.
0 - 20 N.M.

Diffused lighting of the various dials on the front panel is controlled in brightness by a twin gang dimmer switch located on the A.E.O's radio switch panel.

10. The indicator unit has forced air cooling. The rear panel contains a heat exchanger section and a blower which exhausts air from the unit. An indicator lamp on the front panel will be illuminated when the radar head pressure is greater than 17·5 p.s.i.a. and will be extinguished for lower pressures.

Scanner alignment unit

11. This unit provides adjustment to correcting for the residual error in the alignment of the radar head to the vertical reference. The roll and pitch adjustments are effected by two potentiometers in association with two indicator lamps. The unit is mounted in the rear fuselage as shown in fig.1.

Vertical reference

12. The vertical reference is derived from the standby horizon gyro Mk.5A, fitted to the first pilot's panel, for the stabilisation of the C.R.T. scan in pitch and roll axes. A stabilised supply is connected to the pitch and roll potentiometers belonging to the horizon gyro. Signals representing the attitude of the aircraft in pitch and roll are picked off via the potentiometer sliders and used to stabilise the C.R.T. scan pattern on the control unit. The Mk.5A horizon gyro is dealt with in Sect.7, Chap.2 of this book.

Power supplies

13. The 28-volt d.c. and 200-volt, 3-phase, 400 c/s a.c. supplies required for the installation are fed from the following fuses:-

(1) 28-volt d.c.

Service	Fuse	Rating	Location
Indicator dial	548	5A	3P
Lighting	655	5A	4P
Cooling circuit and relay 630	706	7·5A	48P

(2) 200-volt, 3-phase, 400 c/s. a.c.

Service	Fuse	Rating	Location
Radar head circuits	103R	10A	60P
	103B	10A	60P
	103Y	10A	60P

Further information on the associated supplies is contained in A.P.101B-1902-1B, Sect.6, Chap.22.

SERVICING

Precautions

14. Servicing personnel in particular are warned that a.c. and d.c. voltages in excess of 100 volts can be dangerous to the extent of causing personnel injury, fatal or otherwise. It is essential that the utmost attention be given to servicing instructions where matters of safety are concerned and that maximum co-operation be maintained between trades actually concerned in servicing operations.

Installation

15. The setting up, operating and servicing instructions for the A.R.I.5952 and its components are contained in A.P.114M-0100-1A. The security of all components should be checked regularly. All connectors, plugs, sockets and terminal blocks should be examined for damage and ingress of dirt and moisture.

Pressurization system

16. In conjunction with the servicing of the system as laid down in Vol.4 of this publication, the following periodic check should be carried out on the radar head. With a suitable pressure gauge, check at the TEST valve on the heat exchanger that the pressure of the radar head is 20 p.s.i.a. The inflatable seals are maintained at 3 p.s.i.a. above the radar head pressure and therefore a pressure of 23 p.s.i.a. should be indicated when the pressure gauge is connected to the DEFLATE SEALS valve located on the heat exchanger.

Power supplies

17. Using a ground power supply trolley, Ref.No.4G/4221, check with a suitable test meter, at the disconnected radar head supply plug PLA, that the a.c. supply is 200-volts at pins A to J and the d.c. supply is 28-volts at pins K and M.

REMOVAL AND INSTALLATION

General

18. Access to the components is straightforward, but the following points should be observed. Where it is necessary to remove or replace any components, secure all loose connectors to the adjacent aircraft structure to prevent damage.

Indicator, Azimuth range

19. To remove the indicator unit release the two knurled screws on the front panel and slide the unit forward and out of its antivibration tray.

Scanner alignment unit

20. The unit may be removed from the inside of the aircraft tail section by disconnecting the socket connector (PL1) and removing four bolts.

Radar head

21. The radar head incorporating the radar unit, heat exchanger, mounting ring and radome is removed and installed as a complete unit. The following items of equipment are required.

Item	Ref.No.
Minihoist 5 cwt.	4GC/5703
Handle (9 in.)	4GC/5743
Extension tube (36 in.)	4GC/5443
Hook, cable end	4GC/5429
Servicing Giraffe, Type AA, Mk.2	4G/5461
Jib	4G/5708
Platforms, Mk.2	4G/5628
Sling assemblies	10S/17399
Road transportation trolley	4F/1924
Trolley, radar servicing	10S/17400
Ring assembly	10S/17398

22. Ensure that all electrical power supplies are switched off, then proceed as follows:-

(1) Close the line valve on the pressure reducing panel, to shut off the air supply to the radar head.

(2) Disconnect the air hose from the radar head.

(3) Disconnect the cable connector (plug H) from the temperature sensing unit fitted to the heat exchanger air port.

(4) Disconnect the five cable connectors marked A, B, C, E and J from the radar head.

(5) Disconnect the four quick release clamps, which attach the cooling air manifolds to the adaptor fitted to the cooling air ports of the heat exchanger.

(6) Remove the screws indicated by arrows stencilled on the radome.

(7) Fit the sling assemblies, Ref.No. 10S/17399.

(8) Attach the minihoist equipment to the slinging link on the arm of the lifting attachment. It should be

noted that the link should be fitted to the third hole from the end of the arm.

(9) Slightly tension the hoist, then release the four fasteners securing the radar head to the fuselage.

(10) Lower the radar head assembly and secure it to the ring assembly, Ref.No.10S/17398, which is fitted to the servicing trolley, Ref.No. 10S/17400. It should be noted that for field use, the servicing trolley is mounted on the transportation trolley, Ref.No.4F/1924.

To install the radar head to the aircraft reverse the above procedure.

TABLE 1

Connectors for A.R.I.5952

H.S.A.Part No.	Cableform	Connecting
2/T.6451	Equipment wire, Type 2, 25-cores	R.P.B. plug 881 to plug 915
3/T.6451	Equipment wire, Type 2, 12-cores	R.P.B. plug 189 to plug 916
4/T.6451	Equipment wire, Type 2, 25-cores	Plug 915 to radar head plug C
5/T.6451	Equipment wire, Type 2, 12-cores	Plug 916 to radar head plug B
6/T.6451	Equipment wire, Type 2, 18-cores	R.P.B. plug 881 to Indicator control unit
	Equipment wire, Type 2, (screened 3-core twisted)	R.P.B. plug 881 to plug break 235
	Equipment wire, Type 2, 12-cores	R.P.B. plug 189 to Indicator control unit
	Uninyvin 20,1-core	T.B.1735A to Indicator control unit
	Uninyvin 20,2-cores	T.B.1045 A and B to Indicator control unit
7/T.6451	Miniature 12C	Radar head plug J to Scanner alignment unit
FR510	Unipren 6	T.B.1041B to earth
FR531	Unipren 6, 3-core twisted	Relay 630 to T.B.1039A and D and T.B.1040A
FR545	Unipren 6	T.B.1041A to T.B.1321A
FR674	Unipren 6, 2-cores	T.B.681 to dimmer switches
FR675	Unipren 6, 2-cores	T.B.1045 to dimmer switches
FR853	Uninyvin 20, 12-cores	Radar head plug A to T.B.1039, 1040 and 1041
FR854	Uninyvin 20	T.B.1039C to earth

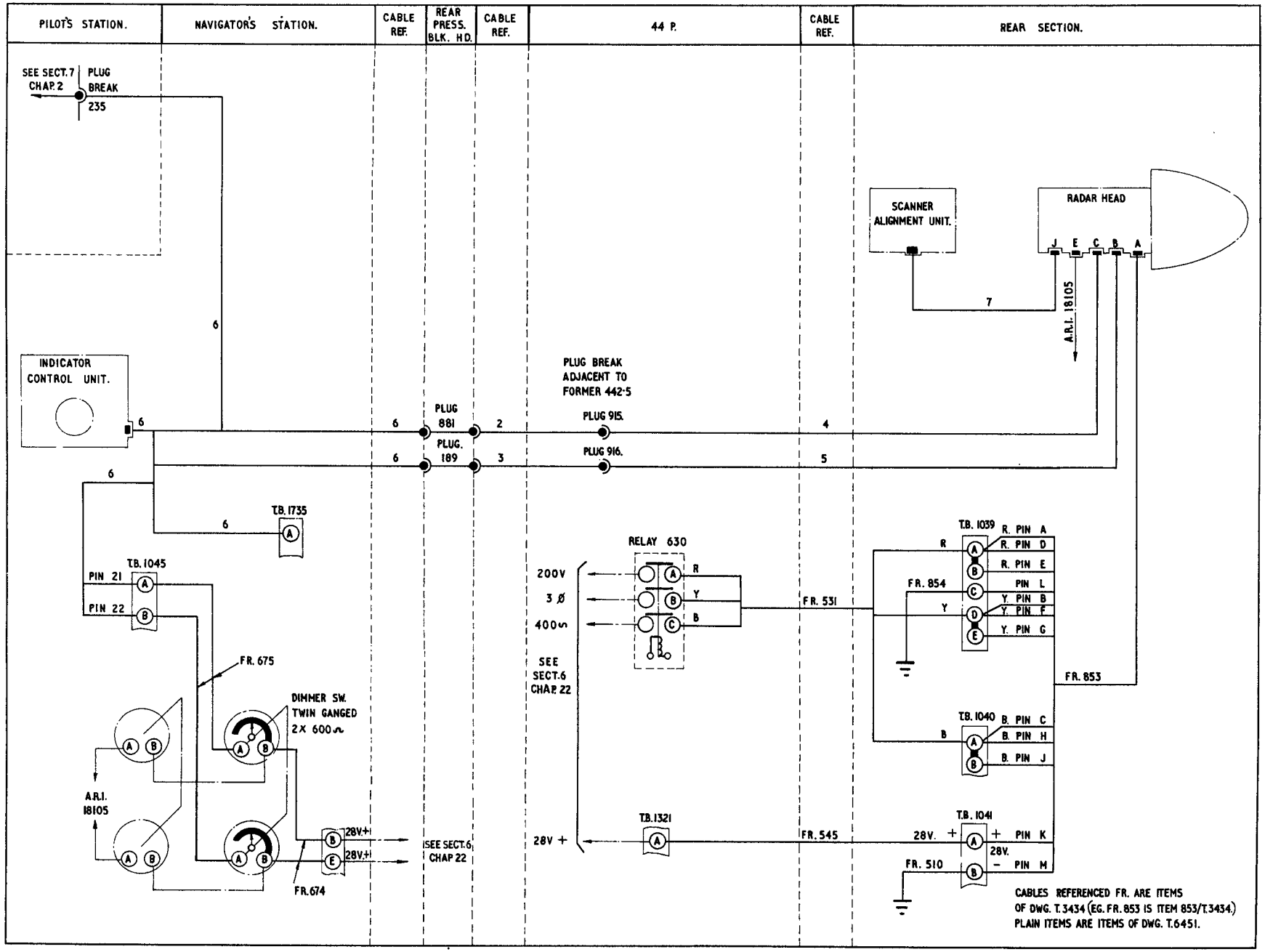

Fig. 2 A.R.I. 5952

89960 625 3.67 H.S.A.1354