Chapter 4
A.R.I. 5972
(Completely Revised)

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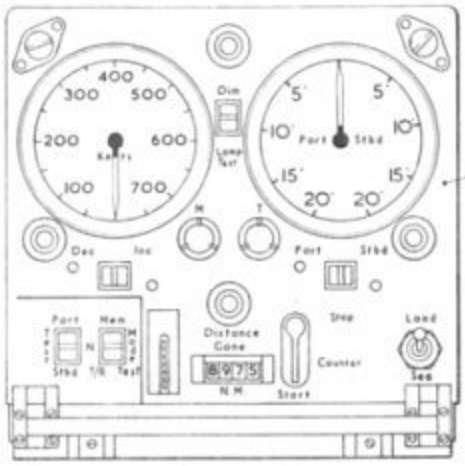
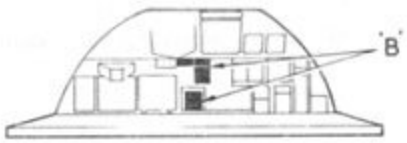
Introduction

1. The A.R.I.5972 introduced by Mod.2256 comprises a 'J' band lightweight navigational radar aid which can operate under all flight conditions to determine accurate navigational data.

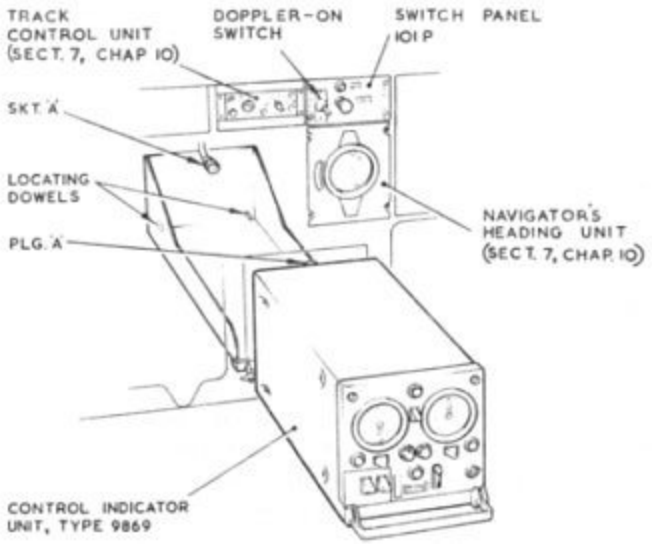
2. The A.R.I. utilizes the Doppler techniques to compute along and across heading velocity data, determines ground speed, drift angle and distance gone for display. This data is also routed to the aircraft Heading Reference System (H.R.S.) Mk.2 installation for further processing. (Sect.7, Chap.10).

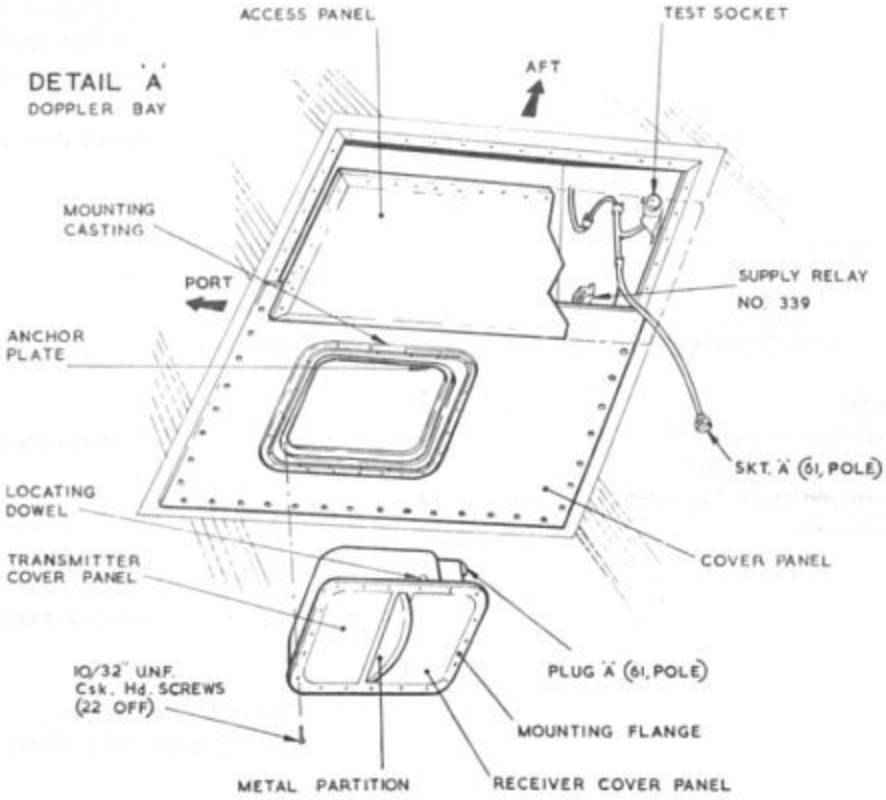
3. Descriptive, servicing and operating details for the A.R.I. are given in the Air Publication listed in Table 1. A location illustration of the major components is contained in fig.1. Equipment and Connector Tables and a Routing chart will be found at the end of the text.





DETAIL 'B'
NAVIGATOR'S CENTRE PANEL





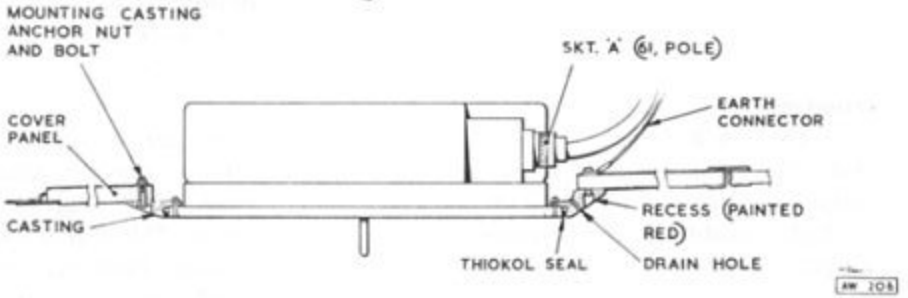


Fig.1 Component location A.R.I. 5972

◄Re-drawn in line with latest changes►

DESCRIPTION AND OPERATION

General

4. The A.R.I. is a compact installation comprising a transmitter-receiver and aerial unit, Type 9307, and a control indicator, Type 9869. The installation will operate between altitudes of 15 to 60 000 feet in all weather conditions and in limited pitch and roll configurations over land or sea. Use of the Doppler technique eliminates inaccuracies resulting from rough terrain. A built in facility permits manual correction of errors arising from increased refraction and scatter encountered over calm water.

5. The transmitting array projects three narrow beams of C.W. radiation towards the terrain in a Janus configuration. The beams, each contained in a hyperbolic envelope, are projected one forward and starboard (A), one forward and port (B) and one aft and port (C) (fig.2). Two spot frequencies are used for the beams. 13 325 MHz ± 2 MHz for beams 'A and B', and 13 314.3 MHz ± 2.3 MHz for beam 'C'.

6. The 3-channel receiver array detects reflections from the terrain and extracts the Doppler frequency shift components present in each beam. Frequency tracking is carried out for each C.W. beam centre spot frequency so that Doppler shift deviation can be accurately measured. Each Doppler shift frequency is directly proportional to the vector sum of velocities in the three directions, forward, sideways and aft. The equipment uses suitable combinations of two of the three detected shift frequencies to produce signals directly proportional to aircraft heading and drift velocities.

7. If there is a loss of signal in any channel, the system will be automatically switched to a 'memory' mode to freeze component velocity signals. Manual updating can be carried out once signal acquisition is made.

8. The following outputs from the aerial unit are routed to the control indicator:

(1) Along heading velocity

(2) Across heading velocity

(3) Across heading sense

(4) Memory mode

9. The control indicator resolves the Cartesean co-ordinates of along and across heading into Polar co-ordinates of ground speed and drift angle. Ground speed and drift angle together with a cumulative figure of distance gone are available for display and the following signals are routed to the H.R.S. and Military Flight System (M.F.S.) installations:-

(1) Three separately excited synchro transmissions of drift angle.

(2) M-drive transmission of distance travelled.

(3) A d.c. tracking/memory mode control signal.

Transmitter-receiver and aerial unit, Type 9307

10. This unit, which houses the transmitter receiver, frequency trackers and aerial arrays, is mounted in a casting (H.S.A. Pt.No. F12943/1 and 2) fitted to the Doppler bay cover panel on the underside of the port wing as shown in fig.1, detail A. The unit measures 15.75 inches square by 4.75 inches deep and has a mounting flange around its periphery. Two locating dowels on the flange mate with corresponding holes in the mounting casting. The unit is secured to the casting by 22-10/32 UNF countersunk screws (Pt No. SS4910/05D) while the casting is secured to the Doppler bay cover panel by 16 bolts (Pt No. AS1248/9C). The bolt recesses in the casting are painted red to obviate inadvertant removal of the casting and subsequent misalignment of the aerials. Drain holes in the casting prevent accumulation of moisture from around the unit.

11. The aerial arrays, fitted in a recess on the lower face of the unit, consist of two slotted waveguide aerials, one the transmitter aerial (port), and one the receiver aerial (stbd). The two aerials are mounted side by side separated by a metal partition, to minimise inter-action between the two aerials. Each aerial is protected by a fibre glass panel screwed to the unit mounting flange.

12. The transmitter-receiver assemblies, mainly comprise solid state and integrated circuits constructed in modular form for ease of servicing and improved reliability. In addition, frequency tracking and analogue computing circuits are fitted. Electrical connections to the unit are made via a 61-pole plug mounted on the frame assembly (fig.1, detail A).

13. Forced air cooling is provided by an integral thermostatically controlled blower motor, and ventilation holes around the unit top cover.

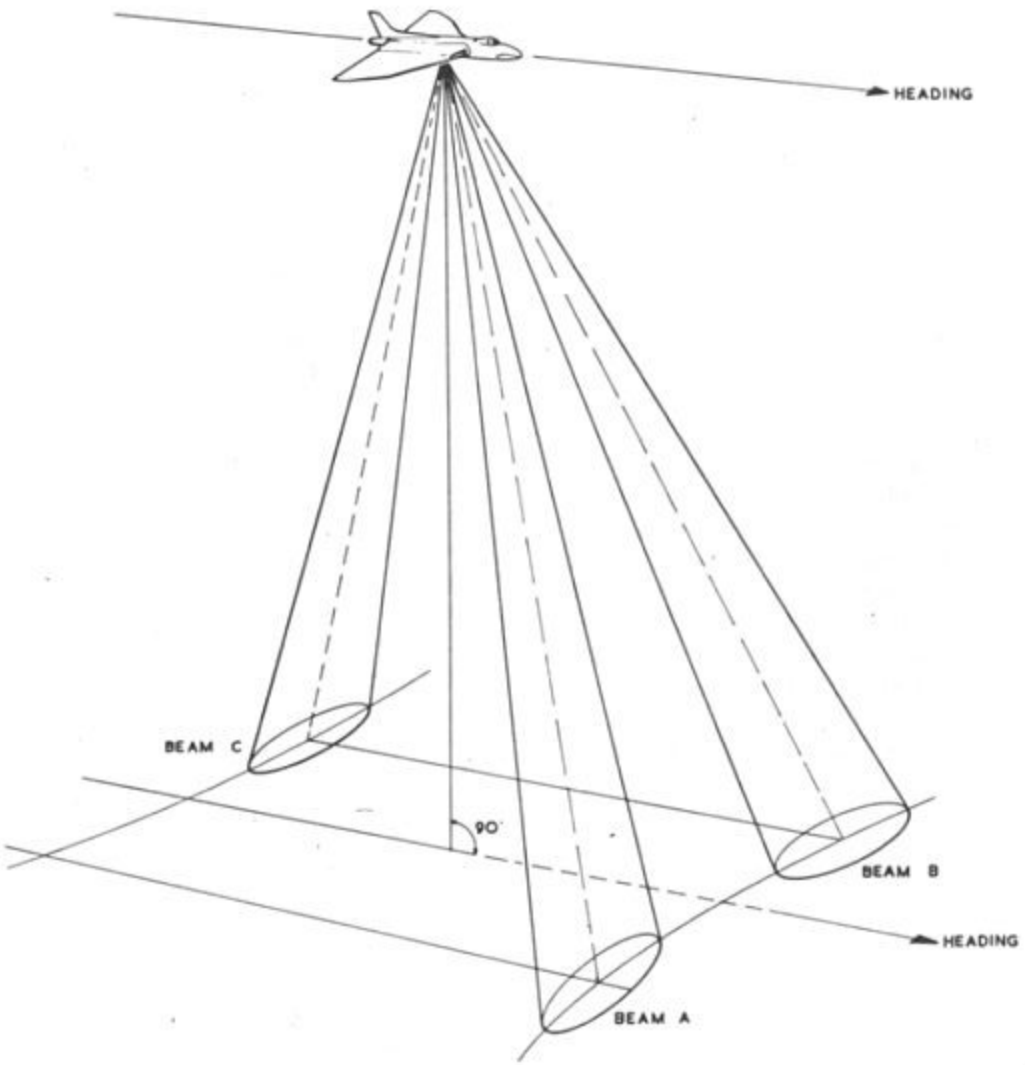


Fig.2 Beam Pattern (Janus configuration)

Control indicator, Type 9869

14. The control indicator unit, located at the navigator's station (fig.1, detail B) is fitted to a mounting tray supported on four anti-vibration mountings. The tray back plate has two locating dowels which engage with corresponding holes at the rear of the unit. Two wing nuts at the front of the tray secure the unit in position. Electrical connections are made via a 41-pole plug, identified PLG A, located at the rear of the unit.

15. The unit basically comprises a frame assembly which carries five sub-assemblies. These sub-assemblies form the necessary computing and display circuits for processing the signals received from the transmitter-receiver and aerial unit.

16. The front face of the unit is fitted with the following indicators and controls:

(1) A groundspeed indicator calibrated between 100 and 700 kts. In increments of 5 kts. The indicator dial has two white markers one at 414 to 430 kts and one at 688 to 706 kts.

(2) A drift angle indicator with centre zero and limits of 20 deg. to port and 20 deg. to starboard. The dial is calibrated in 5 deg. divisions sub-divided at 0.5 deg. intervals. The indicator dial has two white markers at the port and starboard 7.5 deg. position.

NOTE . . .
The white markers are used to define tolerance limits for test indications.

(3) A distance gone mechanical counter which can register between 0 and 999.9 nautical miles.

(4) A tracking indicator lamp, identified T, which lights when the equipment is operating on Doppler signals.

(5) A memory indicator lamp, identified M, which lights when the equipment reverts to the 'memory' mode.

(6) A three-position, inching switch, spring loaded to the centre off position, labelled DEC.–INC. which is operated to increase or decrease the indicated groundspeed during prolonged operation in the 'memory' mode.

(7) A three-position, inching switch, spring loaded to the centre off position, labelled PORT–STBD which is used during prolonged 'memory' mode operation to introduce port or starboard drift.

(8) A three-position, MODE switch, spring loaded to the centre off position, labelled MEM–T/R TEST, which is used to inject test signals to check the memory, transmitter, and receiver circuits.

(9) A three-position, TEST switch, spring loaded to the centre off position, labelled PORT–STBD, which selects unit internal test voltages.

(10) A change-over LAND–SEA switch which selects indicator scaling.

(11) A three position switch, spring loaded to the centre off position, labelled LAMP TEST–DIM.

(12) A COUNTER switch labelled STOP–START. The switch is used to disconnect the drive to the distance gone counters.

(13) A counter thumbwheel which is used to reset the distance gone counter to zero nautical miles.

The unit is fitted with four panel lamps which are used to illuminate the various indicators.

Test facilities

17. The control indicator unit is provided with built-in self-check and test facilities which enable the transmitter, receiver and aerial circuits to be tested in the air or on the ground. The tests described in the following paras. are carried out using the unit front panel controls and indicators. Further details of all tests are contained in A.P.114E-1600-16, Cover 1.

18. With the MODE switch operated to T/R TEST, a functional test of the transmitter-receiver and aerial circuits is carried out. The test function checks the electronic circuits by injecting a known frequency into the receiver i.f. stages to provide groundspeed and drift angle indications of 697 kts and 0 deg. drift respectively. When the MODE switch is set to MEM., the equipment reverts to the 'memory' mode, freezing the indicated ground-speed and drift indications. This facility checks the 'memory' mode circuits for correct operation.

19. The TEST switch enables the operator to manually select an internal d.c. test voltage (port or starboard) to give a fixed indication of 421 kts ground-speed with 7.5 deg. drift angle.

20. When the LAMP TEST–DIM switch is operated to LAMP TEST, a d.c. supply is connected to the memory (M) and tracking (T) indicator lamps to check their serviceability. To dim the front panel lamps, the switch is operated from the normal centre position to DIM.

Test socket

21. A 19-pole test socket labelled DOPPLER TEST, located in the Doppler bay (fig.1), provides facilities for ground testing of the installation. The socket is provided with a dust cap which must be fitted to the socket when not in use.

Switch panel 101P

22. Panel 101P located at the Nav's/A.E.O's position (fig.1) is secured to the console by four quick-release fasteners. The panel houses the DOPPLER–ON power supply switch.

Supplies

23. The equipment is provided with 115-volt, 400 Hz single phase a.c. from fuse 234R at the 200/115 volt sub-distribution panel 28P (Sect.6, Chap.7). In addition auxiliary 28-volt d.c. and 115-volt a.c. reference supplies are derived from the H.R.S. (Sect.7, Chap.10) and M.F.S., (Sect.7, Chap.7).

24. The 115-volt, 400 Hz single phase a.c. fed from fuse 234R is controlled by relay No.339 located in the compartment aft of the port main wheel bay and the DOPPLER–ON switch on panel 101P (fig.1).

Circuit operation

25. With the DOPPLER switch operated to ON, a 28-volt d.c. supply from fuse 726 at the sub-distribution panel 48P is routed via the DOPPLER switch contacts 1-2 to the coil of relay No.339 (fig.3). Relay 339 energizes and contacts L1-A close to connect the 115-volt a.c. from fuse 234R to the transmitter-receiver and aerial unit. For further details of the supply switching reference should be made to Sect.6, Chap.7.

26. During equipment operation, the control indicator generates low voltages a.c. and d.c. supplies for internal computing circuits.

SERVICING

Precautions

27. 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. The precautions detailed in A.P.3158, Vol.2, Leaflet H12 are to be taken when working with such voltages. 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

28. Setting up operating and servicing instructions for the A.R.I. are contained in the Air Publication listed in Table 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.

Test facilities

29. The control indicator unit is provided with built-in self check and test facilities. For information of these tests reference should be made to paras.17 - 20 of this chapter and the Air Publication listed in Table 1.

Test set

30. The DOPPLER TEST socket (Para.21) is provisionally fitted for use in conjunction with a test set (not yet in service) for ground testing purposes. Further details of the test set procedures will be issued at a later date, when details are available.

REMOVAL AND INSTALLATION

General

31. Detailed instructions for removing and refitting the transmitter-receiver and aerial unit are given in the following paragraphs. Access to the remaining components in the installation is straightforward and therefore special removal and installation procedures are not given. Reference should be made to fig.1 before attempting to remove any item of equipment from the aircraft.

32. The following points should be observed when removing or refitting any item of equipment used in the installation.

(1) Ensure that the appropriate 115-volt a.c. supply (Sect.6, Chap.3) and 28-volt d.c. supply

(Sect.6, Chap.7) are switched off, fuses removed and dummy fuses fitted.

(2) Take care not to pull or tug cable harnesses when removing equipment.

(3) Always insulate and stow disconnected cables. Before reconnecting cables, check the routing chart for corresponding cable and terminal numbers.

(4) If any item of equipment is removed and refitted or replaced, carry out the functional tests detailed in para. 17 - 20 to ensure system serviceability.

Transmitter-receiver and aerial unit

33.

WARNING . . .

The sixteen bolts, housed within a recess painted red (para.10) which secure the mounting frame casting to the aircraft should not be disturbed during removal of the transmitter-receiver and aerial unit. Failure to observe this warning will result in misalignment of the aerial.

To remove the transmitter-receiver and aerial unit, refer to fig.1 and proceed as follows:-

(1) Locate and remove the glass fibre access panel aft of the unit mounting panel. The glass fibre panel is secured by 44 screws.

(2) Disconnect 61-pole socket 'A' from the unit and stow.

(3) Identify the 22 screws (para.10) which secure the unit mounting flange to the mounting frame casting. Slacken off all 22 screws to break the Thiokol seal between the unit mounting flange and the mounting frame casting. With the aid of another tradesman support the underside of the unit and remove the 22 screws. Lower the unit onto a suitable transporting trolley taking care not to damage the unit and aerial cover panels.

(4) Remove all traces of Thiokol sealing compound from the unit mounting flange and unit mounting frame casting.

To fit a serviceable unit, reverse the removal procedure given in (1) to (4) inclusive, observing the following details:-

(1) Prior to installing the unit in the mounting casting, the perimeter edge and inboard face of the unit flange are to be lightly coated with Silicone grease XG 315 D.T.D.897 (Ref.No. 34B/9100519).

(2) To ensure correct orientation of the unit the two locating dowels on the unit mounting flange must locate with the corresponding holes in the mounting frame casting.

(3) After the unit is secured apply Thiokol sealing compound in the gap between the unit mounting flange and mounting casting taking care not to obstruct drainage holes and ducts in the casting. Trim off surplus Thiokol.

Blanking plate

34. When the transmitter-receiver and aerial unit, is not fitted to the aircraft, a blanking plate is fitted to the mounting frame casting. Further information dealing with the fitting of the blanking plate will be found in A.P.101B-1902-1A, Sect.3, Chap.1.

Mounting frame casting

35.

NOTE . . .

The mounting frame casting must not be removed during first line servicing.

The casting is only removed when there has been structural damage to the aircraft within the vicinity of the transmitter-receiver and aerial unit. In this instance the casting must be re-aligned with the fore and aft axis of the aircraft using an Optical alignment jig, H.S.A. Pt No.1/U2233, in accordance with current servicing procedures.

TABLE 1

A.R.I. 5972 equipment

Equipment	Type	Ref. No.	Location	A.P. Ref.
Transmitter-receiver and aerial assembly	9307 RA17	5841-99-112-4924	Compartment aft of port main wheel bay	114E-1600-16
Control indicator	9869	5841-99-112-4930	Navigators panel	
Power supply relay No.339	D6301	-	Compartment aft of port main wheel bay	–
DOPPLER-ON switch	5CW5825	I/S 3321	Navigator's switch panel 101P	–

TABLE 2

Connectors for A.R.I. 5972

H.S.A. Part No.	Cableform	Connecting
2/T7824	Duminyvin 22 2 core Minyvin 22 8 core	Control indicator unit socket A to plug break 176
	Minyvinmetsheath 22 4 core Minyvin 22 3 core	Control indicator unit socket A to Groundspeed resolver plug 13A
	Minyvinmetsheath 22 3 core	

TABLE 2 (Cont'd)

Connectors for A.R.I. 5972

H.S.A. Part No.	Cableform	Connecting
2/T7824	Minyvin 22 6 core	Control indicator unit socket A to Groundspeed resolver plug 4A
	Minyvin 22 5 core	Control indicator unit socket A to track control unit plug 8
	Minyvin 22 5 core	Control indicator unit socket A to Navigators heading unit
3/T7824	Dufepsil 22 2 core	
	Fepsil 22 8 core	Aerial unit socket A to Doppler test socket
	Fepsilmetsheath 22 4 core	
	Minyvin 22 7 core	Aerial unit socket A to R.P.B. plug 176
	Minyvinmetsheath 22 5 core	
	Minyvin 20 1 core	Aerial unit socket A to relay 339
	Minyvin 20 1 core	Aerial unit socket A to doppler bay aircraft earth

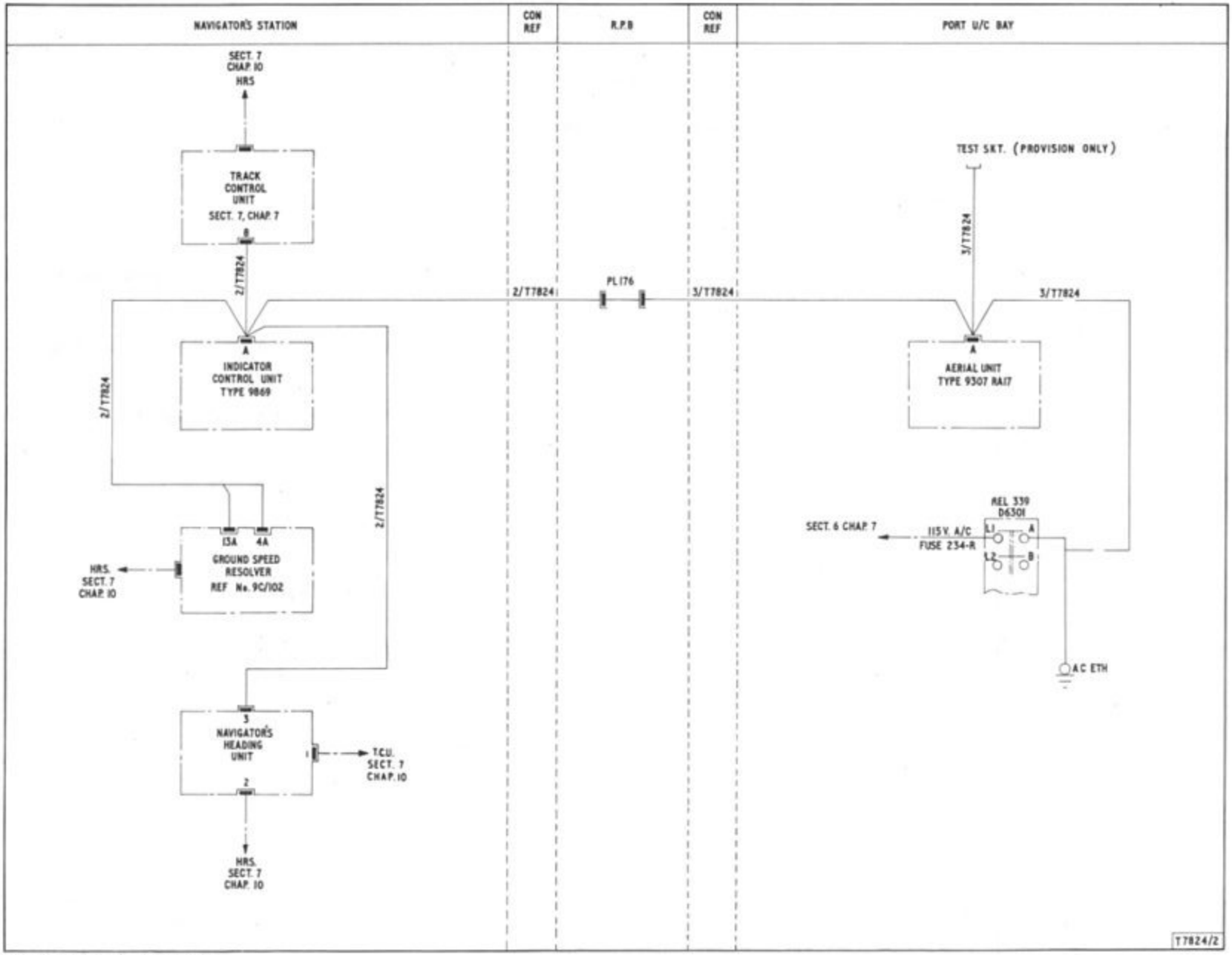


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Fig. 2 A.R.I. 5972

Cross Ref. to T.C.U. added