AIR PUBLICATION
116B-0603-1
Issued June 65

GROUP: RADIO
SUB-GROUP B: NAVIGATIONAL AIDS AND LANDING AIDS (AIR)

DECCA NAVIGATOR (AIR) FLIGHT LOGS

GENERAL AND TECHNICAL INFORMATION

BY COMMAND OF THE DEFENCE COUNCIL

(Ministry of Defence)

FOR USE IN THE
NAVAL SERVICE
ARMY SERVICE
ROYAL AIR FORCE

(Prepared by the Ministry of Aviation)

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LIST OF ASSOCIATED PUBLICATIONS

	A.P.
ARI.23076 Decca Navigator Mk. 1 (Air)	116*B*-0601-1 (*Formerly A.P.*2891*K*, *Vol.* 1)
Decca Navigator (Air) Special Test Equipment	116*B*-0602-1 (*Formerly A.P.*2891*KA*, *Vol.* 1)
Decca Navigator (Air) Mk. 8A	116*B*-0604-1

LAYOUT OF A.P.

Volume 1 General and Technical Information

Volume 2 General Order and Modifications

Volume 3 Equipment Schedules and Scales

Volume 4 Planned Servicing Schedules

Volume 5 Basic Servicing Schedules (*Not applicable*)

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PART 1

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Chapter 1

GENERAL INTRODUCTION

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Map presentation of Decca fix

1. The Decca Navigator (Air) flight log is a recorder/display system used in conjunction with a Decca Navigator airborne receiver equipment (e.g. Decca Navigator Mk. 1 (Air) or Decca Mk. 8A) to provide a direct pictorial display of immediate position and track made good on a specially-prepared navigational chart or charts. The primary function of this display system is to provide a continuous and immediate visual indication of the position fix, replacing the manual plotting procedure in which the readings from two phase-meters (Decometers) are referred to a navigational chart overprinted with the hyperbolic lattice laid down by the Decca ground chain (A.P.116B-0601-1 or A.P.116B-0604-1). The delay incurred in this process is avoided, with a consequent increase in accuracy of fixing.

2. The record of track made good permits instant assesement of any course corrections to hold the required track, avoiding the need to plot a series of fixes for this purpose. Secondary advantages of the flight log display are the availability of a permanent track record and the visual presentation of the area surrounding the immediate position fix. This last is of considerable importance in the event of a diversion from planned course, or the need for an emergency landing as the required change in course can be immediately related to the recorded track.

Principle of the display system

3. The basic flight log (fig. 1) comprises a two-co-ordinate plotter in which a chart or series of charts is moved vertically across the display area from one storage spool to a second in response to the phase rotation of one of the three receiver outputs and a recording pen is driven across the displayed chart in response to the phase rotation of a second receiver output. The lattice of two hyperbolic patterns related to the two receiver outputs is therefore presented on the flight log chart in orthogonal form. It will be apparent that, except for certain small areas where the two sets of hyperbolae cross at substantially 90°, a considerable degree of distortion will result from this hyperbolic/orthogonal translation.

4. To minimise this 'geographical' distortion, the output data from the receiver is processed in the coupling unit (Computer, navigational, 10AD/9456172—Part 2, Sect. 1, Chap. 3 or 10AD/9714277—Part 2, Sect. 2, Chap. 3). The processing involved varies according to the location of the specified chart area within the Decca lattice. In addition to this basic function, the computer provides scale changing and choice of chart orientation to permit, for example, the use of different scales for en-route and approach area charts and to ensure a heading-upwards display. The various functions of the computer with its associated control unit are described in the following paragraphs.

Alternative pattern configurations (fig. 2 to 7)

5. As shown in para. 3, the use of the basic Decca, Red, Green and Purple hyperbolic patterns, termed the Primary patterns in flight log operation, leads to considerable distortion in the charted information in most of the Decca coverage area. This is apparent by reference to fig. 2, which shows the general form of a four-station Decca chain lattice and figs. 3 and 4, which show respectively a small section of such lattice in hyperbolic and orthogonal (flight log) form. Fig. 2 gives an example of a typical position fix using co-ordinates Red I 16.50 and Green D 35.80. Also from fig. 2, it will be apparent that the intersection of co-ordinates Red I 1.50 and Green F 46.50 (to the right of the map area) will make an acute angle and this example is used in the illustration of the construction of the flight log patterns in fig. 3 and 4.

6. The main method for reducing chart distortion is the production of 'Secondary' pattern information within the computer. In a secondary pattern, the movement in one co-ordinate is the sum of the movements across two primary patterns and the movement in the second co-ordinate is the difference of the two primary movements. The method of generating secondary patterns may be followed by reference to fig. 1. If, for example, the Red forward and Green forward data are both routed via the pen pattern selection switching to the penhead servo, the pen will respond to the sum of the phase changes experienced as the aircraft moves through the red and green patterns (i.e. R + G). If the Red forward and Green reverse (−1) data are simultaneously routed via the chart pattern selection switching to the chart head servo, the chart movement will correspond to the difference between the two phase changes (R − G). The secondary patterns thus produced are shown for a typical Red/Green layout in fig. 5. It will be seen that the R + G and R − G patterns provide an angle of intersection approaching 90° over a large area where the primary pattern relationship is much less satisfactory. The effect of using such secondary patterns in the examples of fig. 3 and 4 is shown in fig. 6 and 7.

Note . . .

In fig. 5 primary patterns are shown in fine line and secondary patterns in thick line: R + G in continuous thick line and R − G in broken thick line.

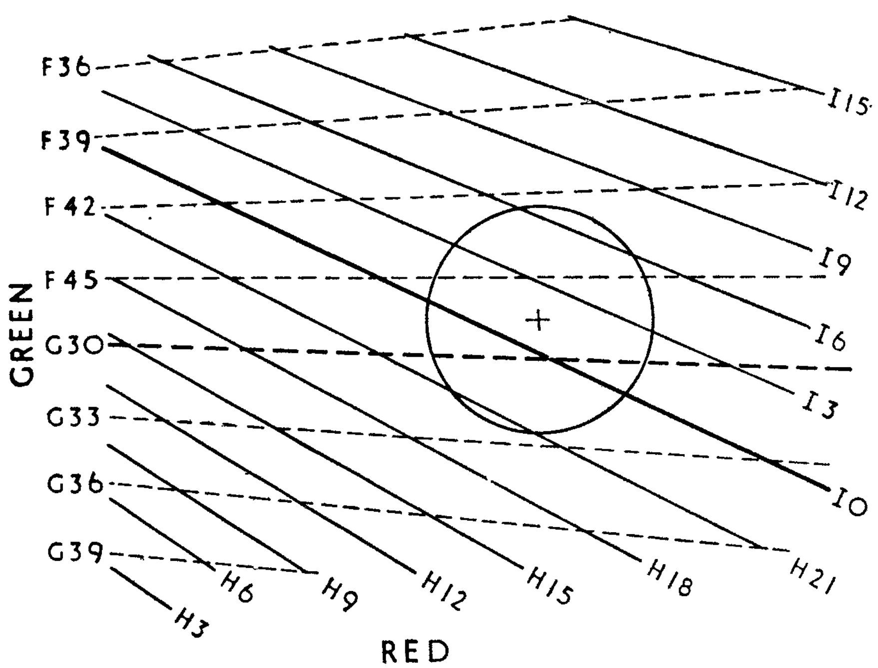

Fig. 3. Section of primary (Red : Green) hyperbolic chart with circular track centred on Green F 46.50, Red I 1.50

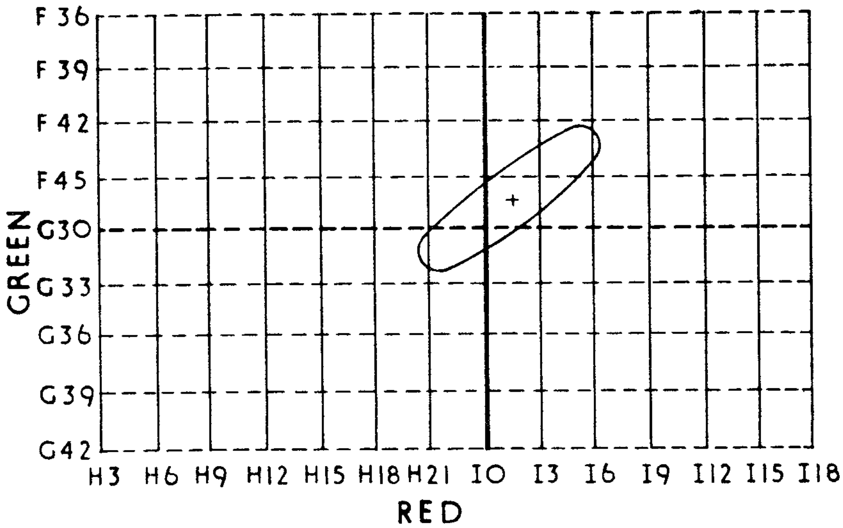

Fig. 4. Transportation of fig. 3 to orogonal flight log display

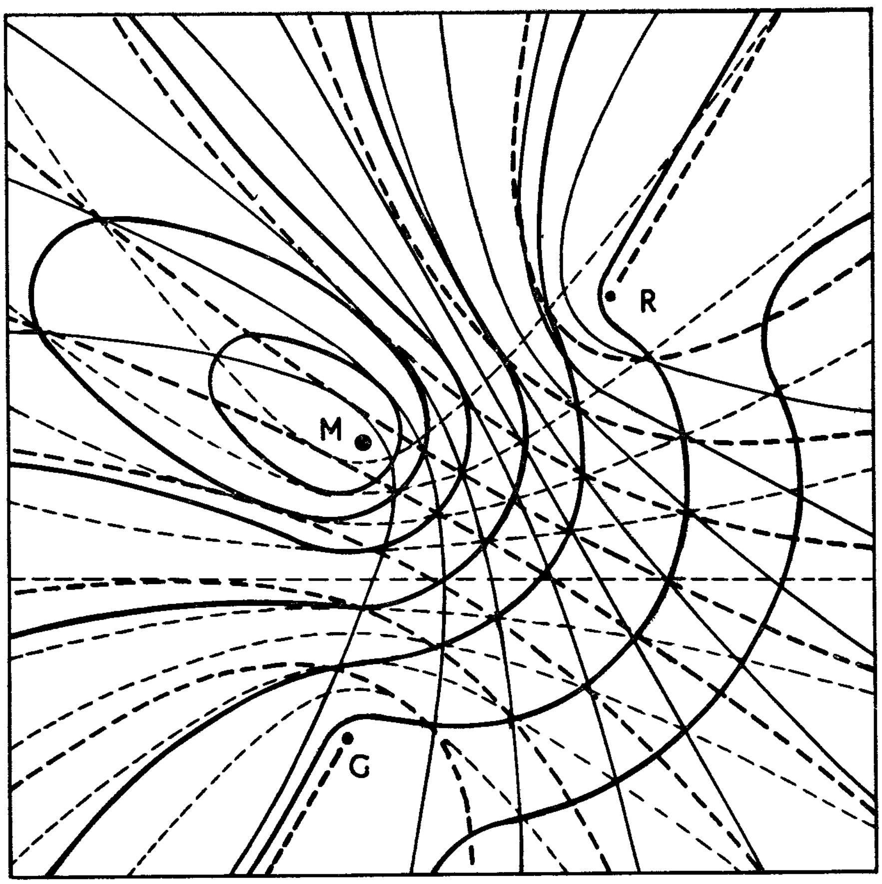

Fig. 5. Primary Red and Green patterns and sum and difference patterns derived therefrom

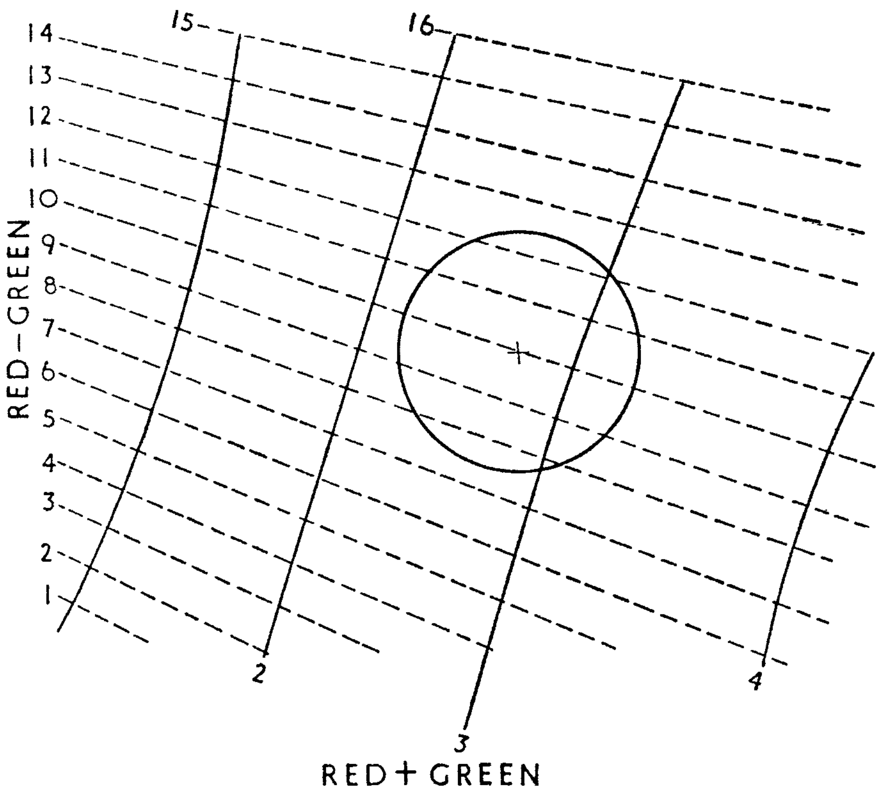

Fig. 6. Secondary (Red+Green with Red−Green) pattern for area shown in fig.

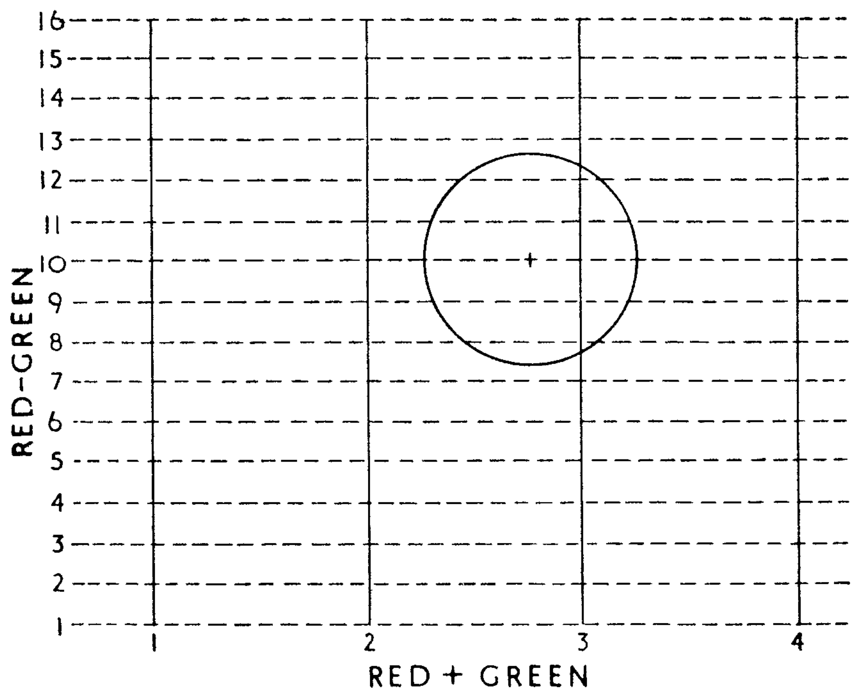

Fig. 7. Flight Log display for area of fig. 3 based on secondary patterns

7. By the use of the various possible secondary patterns based on R : G, R : P and G : P combinations or of one such secondary pattern in conjunction with a primary pattern, and by appropriate choice of scale for the two co-ordinates, chart distortion may be kept within reasonable bounds throughout the coverage area of a Decca chain. Further improvement can be made in some circumstances by combination of two patterns on other than a 1 : 1 basis. For example, the Red : Green sum and difference patterns can be combined on the basis of Red movement versus ½ Green movement or vice versa. These further derived patterns are termed 'skewed' patterns and they find particular use where it is desirable to compress a long en-route chart in the alon-track co-ordinate without degrading the across-track scale: controlled chart distortion is deliberately introduced in these circumstances.

Form of equipment

8. The two flight log display systems used with Decca Navigator airborne equipment are listed in Table 1 and 2. They are similar in general form, functions and method of control and differ mainly in physical characteristics. The S.B.A.C. form of equipment (Table 1) embodies a display designed in two parts, the base, permanently mounted in the aircraft and the cassette, carrying the roll of charts, which is removed from the base for loading of the charts. The computer set employs largely electro-mechanical switching. The A.T.R form of equipment (Table 2) has a display which, although it embodies a detachable cassette, is so arranged that the latter may be hinged forward and a pre-loaded chart roll inserted. The cassette is not intended to be removed for other than servicing or repair purposes. The compter set in this installation is based on electronic (solid-state) switching.

9. All the adjustments necessary to set up the computer for a specific chart are controlled by the Selector, which is inserted in the control box. This selecter takes the form of a turret switch into which are inserted cylindrical metal keys having groups of contact rings which mate with fixed contacts in the switch housing when the turret is turned to bring the selected key to the 12 o'clock position. Each key carries on its end an engraved letter code or letter/number code visible throught the front of the selector. The same code is printed on the edge of the corresponding chart. In practice, when a series of charts are made up for a specific flight, the appropriate keys are inserted in a selector in the correct sequence and that selector is issued to the operator together with the loaded cassette or chart roll and a recorder pen or pens. These three items are not normally retained on the aircraft.

TABLE 1

Flight Log Equipment for Decca Mk. 1 (Air) S.B.A.C.-type units: used on ARI.23102/1

Unit	Reference number	Dimensions (w)	(d)	(h)	Weight lb.	oz.
Computer, navigational Decca Type 9257	10AD/5826-99-945-6172	◀5·688	14·250	7·75	14	14
Control, navigational computer set Decca Type 9258	10L/5826-99-945-6173	5·813	4·625 (mounted)	5·438	2	11
Selector, navigational computer set Decca Type 839KK	10D/5826-99-945-6174	2·0	3·55	2·0		4 (not including keys)
Display head comprising:						
Base, recorder Decca Type 968	10D/5826-99-945-6175	12·875	4·75	5·00	8	11
Cassette, recorder Decca Type 969	10D/5826-99-945-6177	13·125	4·5	4·00		
Pen recorder	10AF/5826-99-945-6178	—	—	—		▶

Note . . .

Dimensions are given in order (w) width of face, (d) depth from front to back, (h) height. Overall dimensions are quoted. Weight of Selector depends upon keys fitted. The computer is designed for mounting on standard 12½ depth S.B.A.C. racking.
The Control mounts on standard S.B.A.C. mounting batten. The Recorder base mounts direct on an instrument panel or a suitable bracket or plate dependent upon the aircraft and location.

TABLE 2

Flight log equipment for Decca Mk. 8A or Decca Mk. 1 (Air)
A.T.R. type units: used on ARI.23121/1 and on composite S.B.A.C./A.T.R. installations (ARI.23102/2) with Decca Mk. 1 (Air)

Unit	Reference number	Dimensions (inches) (w)	(d)	(h)	Weight lb.	oz.
Computer, navigational Decca Type 9360	10AD/5826-99-971-4277	2·375	22·063	7·75	9	8
Control, computer Decca Type 941 including:	10L/5826-99-945-0477	5·745	6·000	(9·938 mounted) 2·994	2	4
Selector, navigational computer set Decca Type 839KK	10D5826-99-945-6174	2·0	3·55	2·0		4
Indicator, chart and map-position Decca Type 961	10Q/5826-99-971-4276	11·875	5·438	(not including keys) 2·625	6	0
Comprising:—				(2·984 mounted)		
Cassette, recorder	10U/5826-99-950-9947	—	—	—	—	
Base, recorder	10U/5826-99-950-9948	—	—	—	—	
Pen, recorder	10AF/5826-99-945-6178	—	—	—	—	

Note . . .

The computer is housed in a standard $\frac{1}{4}$ *ATR-long case. The control is designed for mounting in accordance with ARINC specification* 306 *on* 5·365 *in.* × 1·875 *in. centres. The display (indicator chart and map-position) mounts directly on instrument panel or airframe or on a suitable bracket or plate according to aircraft and location.*

TABLE 3

Flight log equipment for Decca Mk. 8A
ATR type units: used on ARI.23121/2

Unit	Reference number	Dimensions (inches) (w)	(d)	(h)	Weight lb.	oz.
Computer, navigational Decca Type 938	10AD/5826-99-945-0476	2·375	22·063	7·750	12	8
Control, computer Decca Type 941	10L/5826-99-945-0477	5·745	6·00	2·994	2	4
Cassette, recorder Decca Type 969	10D/5826-99-945-6177	13·125	4·5	4·00	8 (together with base)	11
Base, recorder Decca Type 968	10D/5826-99-945-6175	12·875	4·75	5·00		

Note . . .

The computer is housed in a standard $\frac{1}{4}$ *ATR-long case. The control is designed for mounting in accordance with ARINC specification* 306 *on* 5·365 *in.* × 1·875 *in centres. The display mounts directly on instrument panel or airframe or on a suitable bracket or plate according to aircraft and location.*

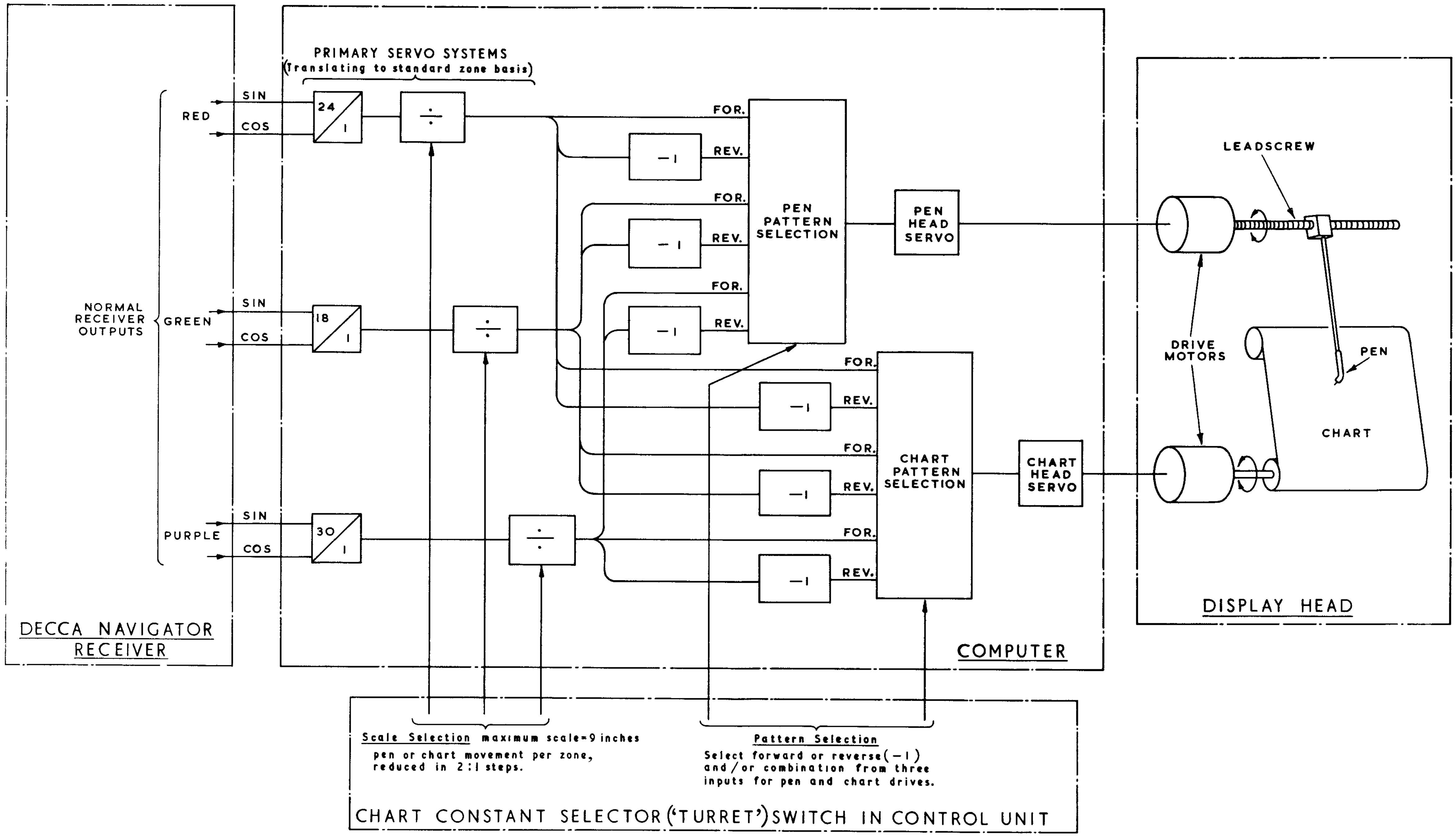

Fig. 1 Basic form of flight log display Fig. 1

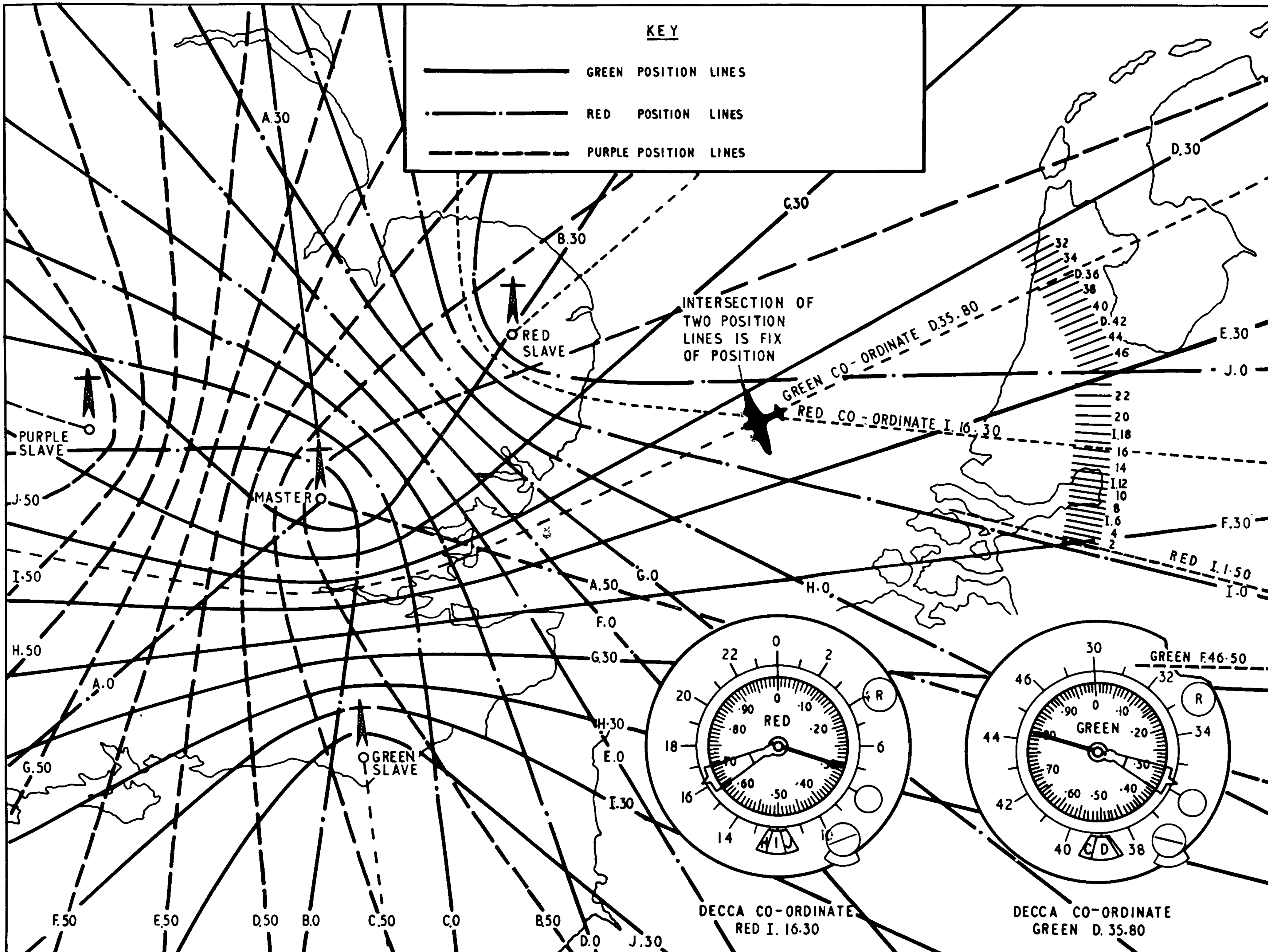

Fig. 2 Hyperbolic lattice of Decca chain Fig. 2

PART 2

TECHNICAL INFORMATION

SECTION 1

FLIGHT LOG DECCA TYPE 9257

Chapter 1

OUTLINE OF SYSTEM

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LIST OF ILLUSTRATIONS

General

1. The equipment described in this section forms the flight log (pictorial display) sub system of ARI.23102/1. In that installation it operates from the outputs of a Decca Navigator Mk. 1 (Air) receiver (A.P.116B-0601-1). The three basic elements of the flight log sub-system are

(1) The navigational computer; the Decca Type number 9257 is used for convenience to identify the sub-system in this volume (fig. 1).

(2) The computer set control unit (fig. 2).

(3) The display head, which comprises a base unit permanently installed in the aircraft and a removable cassette carrying the display charts (fig. 3).

The general form and function of these elements is described in this chapter. Chapter 2 gives the installation data, operation and ground test procedures. The computer and associated control unit are described in detail in Chap. 3 and the display head is described in Chap. 4.

Outline of computer operation (fig. 4)

2. The essential features of the computer are shown in simplified form in fig. 4. The analogue inputs to the computer are initially translated to digital form, and the resultant pulse trains separated in time: this facilitates both scale changing, which is effected primarily in the analogue digital conversion (para. 3 to 5) and the combination of inputs for secondary patterns (Sect. 1, Chap. 1, para. 6) as the time-multiplex pulse trains may be readily added or subtracted. A time-sharing switch system (the 'Cam unit') provides the appropriate gating periods for the various sequential operations. The essential cam unit contacts are shown in fig. 4 defined by the 'levels' occupied by each contact set on the unit (e.g. LEI, LE2). The complete time relationships of the cam gating periods are defined in Chap. 3: for the purpose of the following outline description, the presence of the gating contacts in certain of the circuits only, needs to be considered.

3. The input signals to the computer take the form of two varying d.c. voltages related to each of the three Decca patterns, Red, Green and Purple (A.P.116B-0601-1, Sect. 1, Chap. 1). Each

Fig. 1. Computer, Decca Type 9257

pair of voltages which have a maximum excursion of the order of ±15V, have approximately sine and cosine relationships to the phase angle between the Decca Master and Slave signals generating the appropriate position-line pattern and a 360° rotation of these inputs represents one lane in that pattern. The lane widths in the three patterns have the ratio 4 Red : 3 Green : 5 Purple measured on the respective baselines but in all three patterns the lanes are grouped into 'Zones' comprising 24 Red lanes, 18 Green lanes and 30 Purple lanes giving identical Zone widths in all three patterns. To simplify the operation of the computer, all three inputs are translated to a common digital standard in terms of impulses per Zone and all subsequent processing is effected on the signals in this form.

4. The computer input circuits comprise the three 'primary' servo systems: these are identical in mechanical design and differ only in the mechanical gear ratios required to standardize the impulses-per-Zone output. Referring to fig. 4, the Red primary servo system comprises M2 with the mechanically-linked sin-cos potentiometer elements and primary scaling (digitizing) switches and the associated relay switching circuits. The input signals (Red sine and cosine) are applied to the two sin-cos potentiometers which are connected in parallel. Each potentiometer is equipped with two wipers set at 180° and driven by M2 via appropriate gearing. Either set of wipers may be connected by means of relay RRT to the error relay RRA, which controls the forward/reverse routeing relay system, contacts of which control M2 and complete a zero-seeking servo loop. The input signals produce on the sin-cos potentiometers a potential diagram which rotates as the aircraft moves across the Red Decca pattern: this potential diagram performs one rotation per lane traversed. The servo system drives the potentiometer wipers to follow the null points in the potential diagram and simultaneously rotates the red primary digitizing switch wipers.

5. The digitizing switch comprises a stator with two 24-segment contact rings each scanned by two wipers at 180°; one pair of wipers are connected in the X circuits and another pair in the Y circuits, permitting separate selection of scales for X and Y drives. Scale selection is effected by connection of the 24 contact segments in groups to five

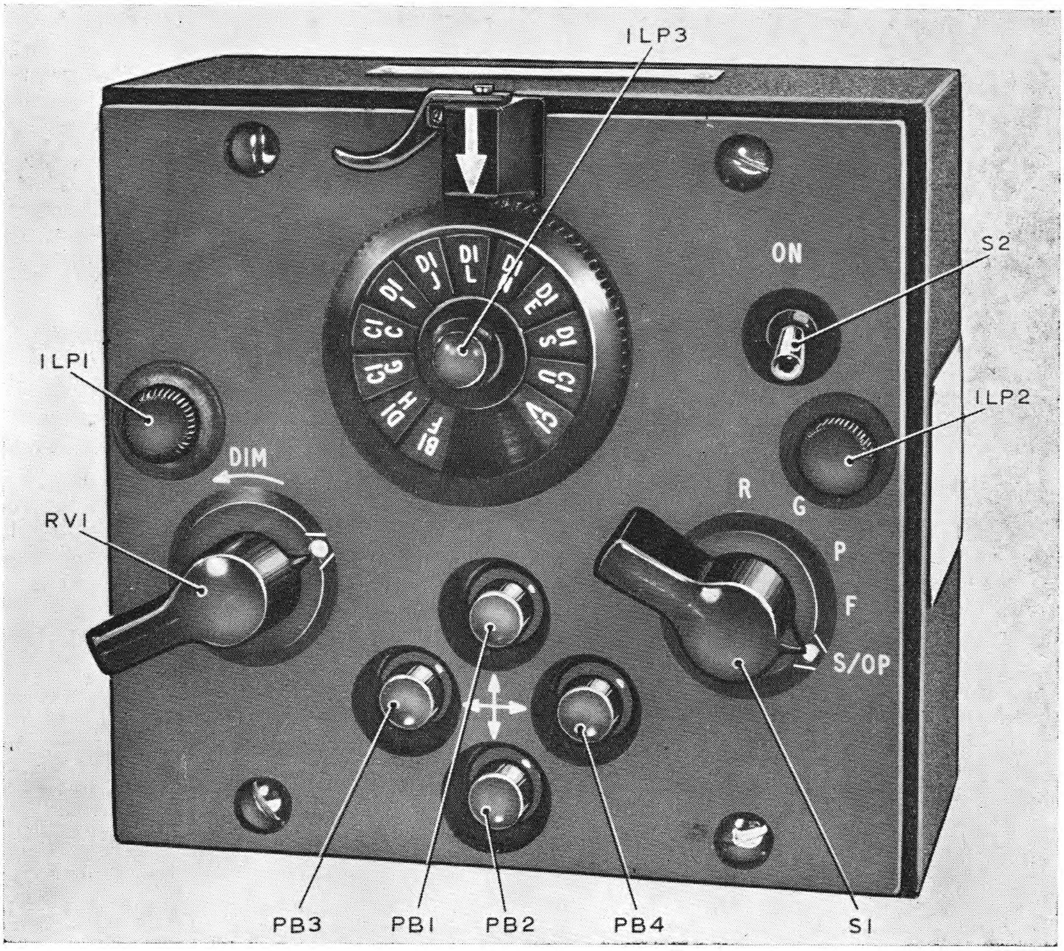


Fig. 2. Computer set control unit

separate contacts in the control unit turret switch: the corresponding wards on the turret switch key earth 1, 2, 3, 6 and 12 segments respectively, permitting selection of from 2 to 48 impulses per revolution of the scale switch wiper. The gear ratio between the basic sin-cos potentiometer shaft and this switch wiper is 54 : 75, giving a maximum scale capacity of 1600 impulses per Zone. As shown in fig. 4, a further 2 : 1 gear is included in the drive to the second sin-cos potentiometer wiper set. These wipers are normally connected via RRT: in this state the maximum scale is 800 impulses per Zone. This effectively doubles the permissible operating speed of the display system and establishes the normal maximum chart scale at 4·5 in. per Zone. RRT is energized by the presence of 'multiplier' wards on the turret switch key to obtain the 9 in. maximum scale when required.

6. The Green and Purple primary servo systems operate in the manner described in paras. 4 and 5 but the gear ratios between the basic sin-cos potentiometer shaft and the primary scales switch shaft are 54 : 100 for Green and 54 : 60 for Purple, providing in each instance $33\frac{1}{3}$ revolutions of the switch or 1600 impulses per Zone maximum as in the red servo system. The divide-by-two facility, using 2 : 1 gearing between the two sin-cos potentiometer shafts is identical with that of the Red servo system.

7. The digitized outputs from the three primary servo systems pass via further forward/reverse routeing contacts to the colour selection switching. In the normal state, the Red and Purple X and Y outputs are connected to the subsequent stores. If either combination Red : Green or Purple : Green is indicated by the key selected at the turret switch, the appropriate Green digitizing switch output is switched through to the appropriate stores in place of the Purple or the Red output respectively.

8. The stores comprise a series of capacitors, one connected in each of the eight control lines, two each X forward, X reverse, Y forward and Y reverse. The capacitors are normally charged from a 12V point on the d.c. supply. This charge is replenished once per cycle of the Cam switch operation and each capacitor is discharged when the digitizing switch connected to the capacitor passes over an earthed segment, so that the digital information is stored as a no charge condition (i.e. a negative pulse with respect to the 12V datum is obtained when the store is scanned by the associated cam switch contacts).

9. From the X and Y stores, the scaled and digitized information passes via reversal relays RXA, RXB and RYA, RYB, to the X and Y head servo systems. The purpose of these relays is to invert the sense of control over either head drive system when required. Conventionally, an increase in the Decca reading (a 'forward' movement) represents a movement to the right in the X co-ordinate or a movement upwards in the Y co-ordinate. If the orientation of the charted area is such that the higher lane numbers lie to the left or to the bottom of the flight log chart, the appropriate reversal relays are operated by inclusion of the X or Y reversal ward on the key associated with that chart. The head servo systems are virtually identical and the following description of the X system can be taken as representative for both.

10. The two X forward lines from RXA or RXB are routed via cam contacts LJ, LK to the single X servo positive (forward) Schmitt trigger and the two X reverse lines are similarly routed via further LJ, LK contacts to the X negative (reverse) Schmitt trigger. Levels J and K on the cam unit operate sequentially so that the output pulses from the two X stores will be added in the positive or negative servo circuits. The trigger circuits provide the input pulses to the positive and negative decade counters, each of which produces a 'staircase' d.c. output. At any moment, the required displayed head movement may be defined by the difference in the d.c. levels present on the two decades and the display head X motor drive is operated via forward/reverse routeing relays controlled by a comparator system connected to the two counter decades. This mode of operation is necessary to permit secondary pattern operation when one primary output may be fed into the positive circuit and the second output fed into the negative circuit. Further, it prevents 'hunting' when the aircraft follows a position line and alternate forward and reverse pulses may occur.

11. The impulse rate in the head servo system is determined by the speed of the cam unit (levels LJ, LK operate once per revolution). The display X drive will therefore perform one step every cam revolution if a difference count is registered, whereupon a balancing pulse is fed to the decade holding the lower count each time the comparator responds to a count difference. This impulse is gated by a further cam unit contact (LE) before the next LJ/LK gating period. Overspill of the counters is avoided in two ways. Firstly, and automatic reset-to-zero control is applied whenever the comparator shows a parity count. Secondly, if the impulse rate is such that either decade reaches a count of eight without this reset occurring, switching relays operate to inhibit the input servo systems and at the same time to increase the cam unit motor speed. In this way the display head drive rate is speeded up to restore the counter

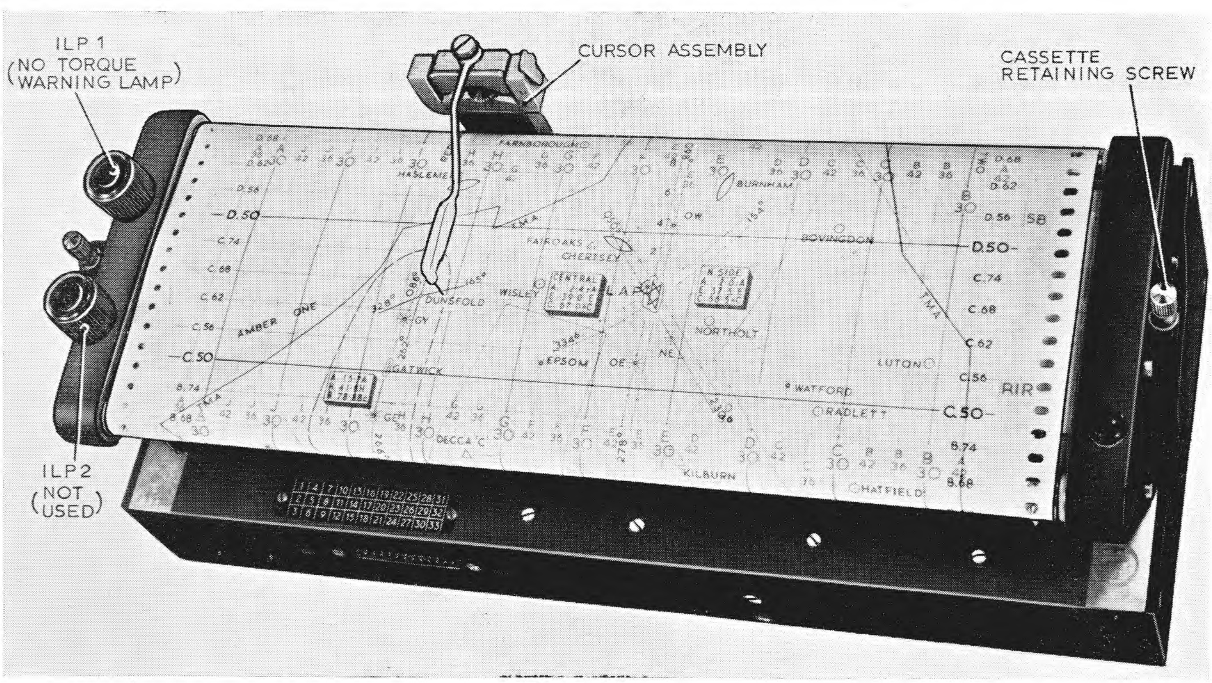


Fig. 3. Display head

balance and, as soon as this occurs, the input servo loops are restored: as the time taken for this operation is less than that represented by a one-half lane movement of the aircraft, the result is only a momentary lag in the displayed position while the primary servo systems step round to the current input conditions.

12. A further detail of the head servo systems is the presence of the 'divide-by-two' relays RXZ, RYZ in the two counter input circuits. As shown in para. 5, the 9 in. per Zone scale is obtained by operation of the 'multiplier' relay. The three multiplier relays RRT, RGT, RPT are all operated simultaneously and the 'divide-by-two' relays are included to permit the use of the multiplied or 9 in. maximum scale on one display co-ordinate only. If, for example, the multiply-by-two facility is required on the Y co-ordinate, the turret switch carries the Y multiplier ward only: this energizes the primary servo multiplier relays and at the same time causes the release of RXZ. This relay places an earth on the first stage outputs of the X decade counters and reduces them to a scale-of-five so that one voltage step is obtained per two input impulses. In this way the X drive is reduced from the 9 in. per Zone, maximum, mode to $4\frac{1}{2}$ in. per Zone, but the Y drive operates in the 9 in. per Zone mode.

Display head

13. The display head (fig. 3) comprises the base unit, which is a cockpit fitting, removed only for servicing or repair, and the cassette, which forms the display element. The electrical components and mechanical elements of the cursor (X) drive are housed in the base and the chart (Y) drive and reset motors and associated mechanical elements are housed in the cassette.

14. The display base takes the form of a shallow box casting with the cursor assembly carried by a lead screw and guide bar at the rear edge (the upper edge when the display is mounted vertically). The lead screw is driven by a gear train from the X drive M motor housed in the base casting: it is provided with spring-loaded buffers at each end which permit the cursor to run on to the un-threaded end of the leadscrew if overdriven and ensure that it is re-engaged when the drive is reversed. The cursor takes the form of a fine tubular stylus fed with ink by capillary effect from a small plastic reservoir.

15. Also housed in the base is a small transistor oscillator unit which provides the excitation voltage for the electroluminescent rear lighting of the displayed chart on the cassette. Capacitor-resistor filter networks for both X and Y drive motors and for the chart reset motor are mounted on a panel adjacent to the oscillator unit and all connections for the display are made via a 25-pole plug recessed in the front edge of the base casting.

16. The cassette is fixed to the base by two captive knurled-head screws which thread into a lug at each end of the base: precise location is ensured by two dowel pins on the rear of the cassette, which enter alignment holes in the face of the base casting, and all connections between base and cassette are automatically completed via a 25-pole plug, on the rear of the cassette, which mates with a socket on the base.

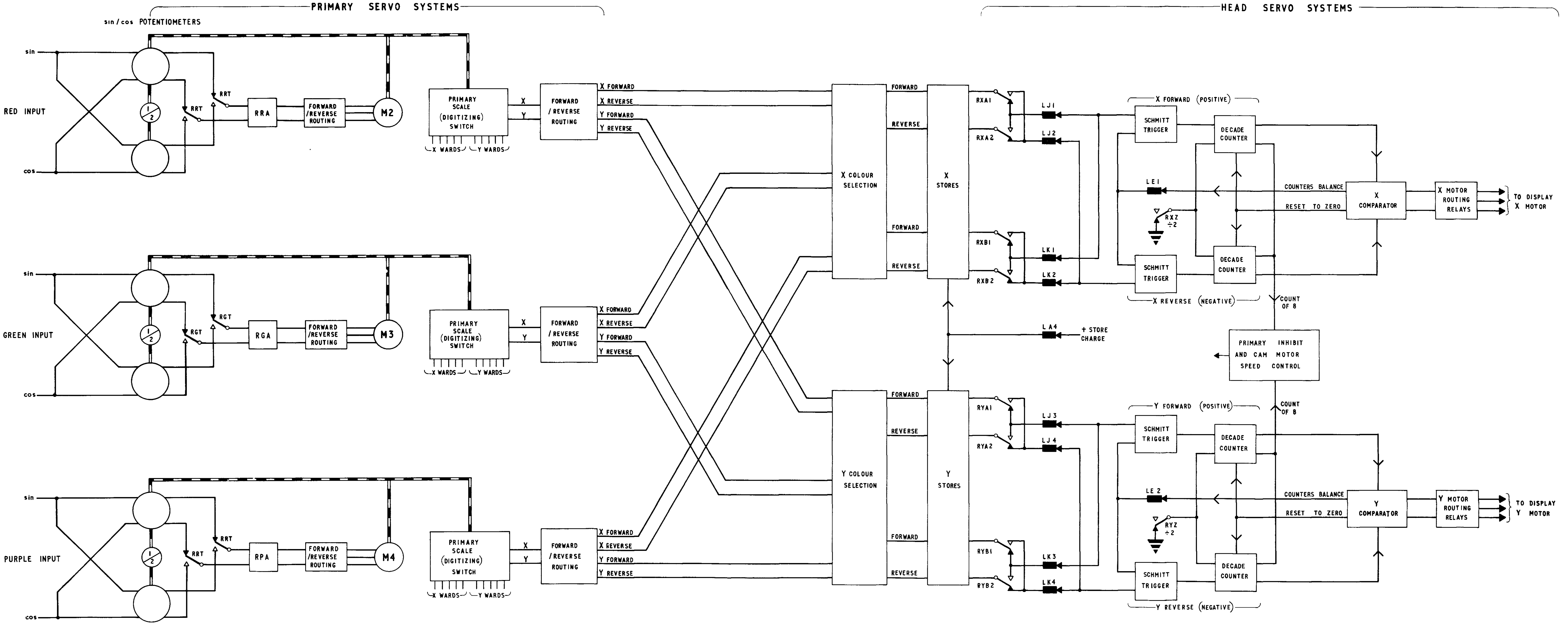
17. The cassette has a trough-shaped body housing the Y drive motor and the Y reset motor with its associated clutch assembly. The drive is taken via gears in the right-hand end casing to the sprocketed chart drive rollers which are located at the upper and lower edges of the body. The face of the cassette is an electroluminescent panel, which fits over the trough to form the display surface. The chart passes from a storage spool behind the upper edge of the cassette body, over the upper drive roller, across the display face, over the lower drive roller and on to the take-up spool behind the lower edge of the bodly. The spools are pre-loaded to maintain constant chart tension: the drive rollers are therefore required only to transfer the charts from storage to take-up spools or vice-versa.

18. Two warning lamps are mounted on the left hand casing: only one of these is used in the present application: as a 'No-torque' warning, indicating failure of any of the computer inputs.

Control unit (fig. 2)

19. The control unit carries the turret switch, function switch, illumination dimmer and on/off switch together with four reset push-buttons. The turret switch carries the selector (Part 1, Chap. 1, para. 9), equipped with up to twelve keys, each of which carries wards in the shape of contact rings in several of a maximum of 38 possible positions. These wards earth contact wires in the switch body when the selector is turned to bring the key to the uppermost (12 o'clock) position and in so doing, they set up the appropriate scale, pattern selection and orientation conditions for the associated chart as described in para. 5 to para. 12.

20. The function switch has five positions, R, G, P, F and S/OP. The first three positions are used when it is necessary to set up the displayed position by Lane adjustment in terms of the individual patterns, red, green and purple. The F position permits fast resetting in the Y co-ordinate and is used in initial setting up or when changing charts. In the S/OP position, the display system is fully operational and slow reset facilities are available for fine adjustment. Resetting of the displayed position is effected by the four push-buttons, these are arranged in a diamond: operation of the upper button causes the chart to run downwards (i.e. equivalent of moving the plotted point up). In a similar manner, operation of the lower button causes an upwards chart movement and operation of the left and right-hand buttons cause movement of the cursor to left and to right respectively.



Computer Type 9257: functional block diagram

Fig.4

AIR DIAGRAM-MIN
116B-0603-MD4
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE NAVAL SERVICE/ROYAL AIR FORCE
ISSUE Prepared by the Ministry of Aviation

D.89386 470 10/66 A.(C)Ltd. Gp. 956/3

Chapter 2

INSTALLATION AND OPERATION

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Installation: General

1. The following information is based on the current standard aircraft installation ARI.23102/1: receiver Decca Mk. 1 Air with computer Decca Type 9257 and associated Type 968/969 display. The cable data are based on the use of a junction box through which the receiver and flight log systems are interconnected.

Units of equipment

2. The main items comprising the basic flight log installation are illustrated in Part 2, Sect. 1, Chap. 1 and listed (with reference numbers, overall dimensions and weights) in Part 1, Chap. 1.

Mounting and location of units

3. In general, a large degree of flexibility exists in the siting of the units subject only to the limitations noted in the following paragraphs.

Computer, navigational (Decca Type 9257: 10AD/9456172)

4. The unit is designed to be mounted on 6 inches of S.B.A.C. racking 12½ inches deep. The unit is secured by two threaded dowels and by a screw fastener at the front. The racking is secured through the anti-vibration mounts and will not permit the unit to be mounted in any attitude other than the horizontal. The unit is sited in the aircraft in a position which permits sufficient space for ventilation, flexing of mountings and removal of unit. All electrical connections are made through three 28-pole butt-connector plugs at the rear of the unit; PL1 — bottom plug, PL2 — middle plug, PL3 — top plug.

5. The normal racking includes A/V mounts with characteristics to BS, 2G100, Part 2, Grade B. If the rack is mounted in a suitably A/V mounted equipment tray, the A/V mounts on the Decca rack are removed. When the computer is mounted in a composite rack (i.e. together with the Decca receiver units), blown air cooling is provided via a plenum chamber beneath the racks. In installations where the computer is mounted in an individual rack air blowing is omitted or a specially designed plenum chamber is used.

Recorder, base and cassette (display head Decca Type 968/969, 10*D*/9456175 *and* 10*D*/9456177

6. The recorder (flight log display head) comprises the recorder base and the detachable cassette. The display head must be mounted so that it may comfortably be viewed and adjusted by the appropriate crew member(s) and so that the cassette may be easily attached to or removed from the base to facilitate chart roll changing or servicing. The mounting attitude is limited only by the requirement for gravity feed of ink through the capillary type pen. The display head is secured to a suitable flat surface by three 2BA screws. Anti-vibration mounts are not required. Electrical connections are made via one or other of two 25-pole plugs according to the cable routing on the specific aircraft fit: these plugs are connected in parallel, pole-to-pole. One plug is at the side of the base and the other is beneath the unit. The cassette is attached to the base by two 4BA knurled head screws, one at each end of the unit. Electrical connections are made via a 25-pole plug mating with a corresponding socket on the base.

Control, navigational computer set (Decca Type 9258*G*: 10*L*/9456173)

7. The computer control unit is designed for mounting on 5½ inches of S.B.A.C. mounting

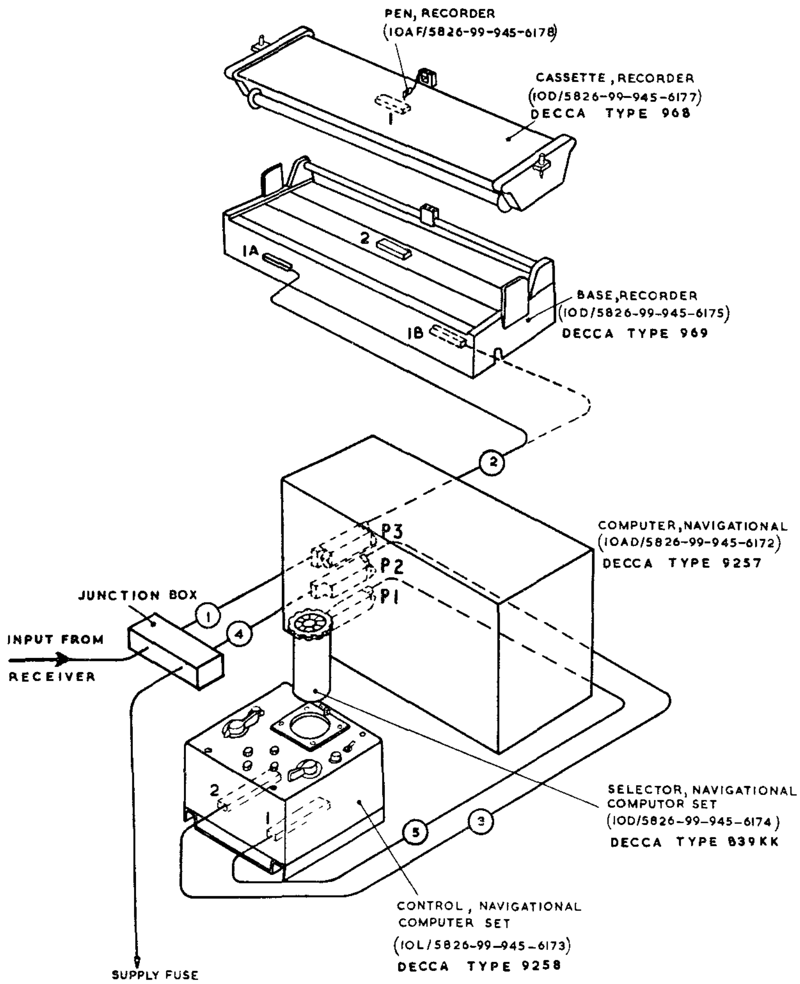

Fig. 1. Installation interconnection diagram
(*ERRATA*: *for DECCA TYPE* 968 *read DECCA TYPE* 969 *and for DECCA TYPE* 969 *read DECCA TYPE* 968)

channel and is secured by four captive 2BA screws through the front panel. The unit should be sited in the cockpit so that it can easily be viewed and operated by the pilot or navigator. Electrical connections are made at the rear of the unit via two 28-pole butt-connector plugs, PL1 — right hand plug, PL2 — left hand plug (viewed from front panel). Anti-vibration mounts are not required. The selector, 10D/9456174, is fitted in the control unit but is issued as a separate item.

Cabling

8. The basic interconnections of a complete receiver/flight log installation are shown in fig. 1. The aircraft installation normally takes the form of a set of individual point-to-point cable connectors. Fig. 1 indicates the standard layout of the basic installation wiring: the various conductor runs are identified as connectors 1 to 5 and are detailed in Tables 2 to 6.

Junction box wiring

9. A junction box or panel is required to link the flight log installation to the receiver installation and the aircraft d.c. supply. In Tables 1 and 5 are listed the junction box connections of the receiver outputs and the aircraft d.c. supply, required for the flight log installation.

10. The junction box referred to in the connector tables, may be a separate unit or spare terminals in an existing box or panel in the aircraft. To cover all these possibilities the junction box terminals have been arbitrarily numbered in sequence.

Operation

11. Operational procedure may be classified under four headings: —

(1) Ground checks

(2) Pre-flight setting-up procedure

(3) In-flight operation

(4) Chain and chart changing

The use of the flight log installation is described in Part 1, Chap. 1 of this Air Publication.

Ground checks

12. A thorough examination of the flight log installation should be made before power is applied to the equipment and before any functional checks are made. The following is a summary of the points to be checked: —

(1) Ensure that the threaded dowels and the screw fastener holding the computer are tightened sufficiently to prevent the unit moving or vibrating in its mounting rack.

(2) Check all mounting bolts for security.

(3) Examine all plug and socket connections for firm union and check that the cables are in good condition.

(4) Operate all controls to ensure that they function correctly and have not been damaged during installation.

(5) Check bondings between units and to airframe.

13. The functional ground checks on the flight log installation may be made either from received chain signals or from a signal generator 10S/9458648 (Decca Type 9351) or 10S/17777 (Decca Type 9209). In either instance the flight log installation is dependent upon the Decca receiver for its input signals. It is assumed therefore in the following checks that the Decca receiver is switched on, set up and serviceable. The ground check procedure provides a brief check on the serviceability of the flight log installation; the complete test procedure, which is also used for fault checking, is detailed in Part 3, Sect. 1, Chap. 1.

14. The following items of test equipment are required to carry out the ground check procedure:

(1) Selector, navigational computer set, 10D/9456174 (flight log turret Decca Type 839KK).

(2) Test keys: XID, XIE, XIF, XIG, XIH, XII, XIO.

(3) Flight log test chart Decca Type TC108B/969.

(4) Cassette, recorder, 10S/9456177 (Decca Type 969).

(5) Knob, cassette loading, 10AK/9456179 (Decca Type A328A).

The above items form part of the test kit, navigational computer, 10S/17921 (Decca Type 53-TY).

15. The chart roll is loaded into the display head cassette as follows:

(1) Lift pen.

(2) Unscrew the knurled captive screws, situated centrally in each end plate, and remove the cassette.

(3) Lock the loading knob on the shaft which is visible at one end of the cassette.

(4) Hold the cassette face downwards with the top spool nearest you, insert the tongue of the roll, marked TOP, into the slot of the nearer spool and, after guiding the first

thickness of chart onto the spool by hand, wind on the roll by means of the loading knob.

(5) When all but the last 12 inches of the roll is on, run the remainder over the face of the cassette and insert the tongue in the slot on the second spool. Turn the spool by hand so that the chart winds into the inside of the cassette.

(6) Wind back to the chart required, when it will be found that the paper will automatically assume the correct tension.

(7) Remove the loading knob and replace the cassette in the display head, tightening it securely with the knurled captive screws. Replace pen.

Note . . .

Do not overtighten the captive screws as this may result in stripped screw-thread in the base end plates.

16. The test keys are inserted in the flight log turret in the following manner:

(1) Rotate rear knurled locking ring anti-clockwise until the first key slot is visible.

(2) Insert first test key through the locating hole in the front plate.

(3) Rotate the locking ring sufficiently to lock the first key and expose the next slot, repeating until all test keys are inserted. Finally rotate the locking ring until its cut-away again aligns with that in the main barrel of the turret.

Insert turret into control unit by depressing stop catch and aligning the cut-away in the turret face with the key window at the top-dead-centre position; check that the locating stop catch locks in.

17. When checking the flight log installation from received Decca chain signals, the receiver should be set to ensure uninterrupted input to the computer. The ground check procedure is as follows: —

(1) Switch on flight log installation by setting on/off switch to ON; warning lamp on display head should commence flashing. Ensure that continuous illumination of this lamp occurs only in the S/OP position of the function switch.

(2) Ensure the panel illumination of the flight log control unit operates. Test mechanical dimmer of the display head warning lamp. Ensure that the intensity of the display head chart illumination is varied by the dimmer control on the computer control unit. Ensure that the turret switch lamp is illuminated.

Note . . .

Panel and display head chart illumination is of low intensity. If these tests are performed in full daylight, careful screening will be necessary to make the lighting visible.

(3) Set function switch to F and ensure (a) that the upper and lower reset pushbuttons, when depressed, produce fast chart reset in the appropriate directions and (b) that the left and right reset pushbottons, when depressed, provide slow pen reset in the correct directions. Set function switch to S/OP and check that all four reset pushbuttons, when depressed, provide slow reset in the correct directions.

(4) Select test key XID and set function switch to S/OP. Set display head pen to point of origin of test traces on test chart. Set function switch to R and depress the upper reset pushbutton. The pen should follow the 'XID' line on the test chart. Repeat this test, using the lower reset pushbutton, when pen will move in the opposite direction. Check that when the function switch is set to G or P, depressing the upper or lower reset pushbuttons produces no display head movement. Select test key XIE and repeat above test.

(5) Select test key XIF and XIG in turn and repeat test (4) with function switch set to G. Check that no display head movement results when depressing upper or lower reset pushbutton when the function switch is set to R or P.

(6) Select test keys XIH, XII and XIO in turn and repeat test (4) with function switch set to P. Check that no display head movement results when depressing the upper or lower reset pushbutton when the function switch is set to R or G.

18. The following procedure should be followed when testing the flight log installation from a Decca signal generator output: —

(1) Carry out the tests described in para. 17(1), (2) and (3).

(2) Set the Red decometer lane and fractional pointers to zero. Select test key XID and set function switch to S/OP. Set pen to point of origin of test traces on test chart. Set signal generator phase rotation motor to the speed setting indicated on the test chart and switch on. Ensure that the pen travels along the 'XID' line and that upon reaching the end point, the number of revolutions of the Red decometer fractional pointer coincides with the indications printed on the test chart. Repeat with signal generator phase control rotating in the opposite direction, driving the pen back to the point of origin.

Repeat these tests, using test keys XIE, XIF, XIG, XIH, XII, XIO in turn, when pen should follow the appropriate line.

(3) Carry out the tests described in para. 17(4), (5) and (6) for test keys XIE, XIG, XII only.

Pre-flight setting-up

19. It is assumed in the following procedure that the Decca receiver installation is switched on, set up for flight and checked for correct functioning. Note that the operation of the flight log controls has no effect on the decometers and operating the reset controls on the decometers has no effect on the flight log installation.

(1) Load the chart roll into the display head cassette and insert the turret, loaded with the appropriate keys, into the control unit.

(2) Switch on flight log installation by setting on/off switch to ON. Set function switch to F and check that the display head warning lamp commences to flash.

(3) Lift display head pen and use the upper or lower reset pushbutton to bring the required chart into view.

(4) Select control unit turret key appropriate to the chart in use.

(5) Check the decometer readings and determine the correct position in the Decca lattice printed on the flight log chart. Set display head pen approximately to this position. Set the function switch to S/OP, ensure that the warning lamp is now continuously lit, lower pen onto chart, and position the pen accurately on the correct position.

In-flight operation

20. The display head cassette must be loaded with a suitable flight log chart and the corresponding keys fitted to the control unit turret switch. During the flight every opportunity must be taken to check the flight log indication against the decometer readings.

21. If, during the flight, the pen position deviates from the correct position by one or more whole Decca lanes of any pattern, the lane slipping facility can be used for correction. The three lane slipping positions, R, G and P of the function switch enable this correction to be made individually in each pattern. With the function switch set to P, for example, a change of exactly one lane in the Purple pattern is made by holding down the upper or lower reset pushbutton (to add or subtract a lane respectively) until the flight log pen has traversed more than half a lane of that pattern. If the pushbutton is then released, the pen will continue moving until it has taken up its position exactly one Purple lane away from the original setting. If the pushbutton is released before half a lane has been traversed the pen and/or chart will return to its original position.

Chain and chart changing

22. Charts, which cover specific routes, are normally marked with 'change points' near the edges, and as soon as the pen reaches a change point the next chart should be selected. The key coding of the next chart is printed within a ring alongside the change point, together with a square symbol, within which a figure may be added, indicating the number of charts on the roll that have to be skipped (if any) before the new chart comes into view. The pen is set to the correct position on the new chart by reference to the decometer readings.

23. A change to a new Decca chain is necessarily accompanied by a chart change (para. 22). On a chart roll for a route involving a chain change, the change point at which the transfer to the next chain is marked with the decometer readings for that point in the new chain co-ordinates. A few minutes before the actual chain change, it is convenient to set the decometers to these figures. On reaching the change point, set the receiver to the new chain and change key and chart, checking the flight log indication against the decometers and resetting the pen position as necessary.

TABLE 1

Receiver outputs at junction box

Function	Junction Box
Red Vertical receiver output	1
Red Horizontal receiver output	2
Green Vertical receiver output	3
Green Horizontal receiver output	4
Purple Vertical receiver output	5
Purple Horizontal receiver output	6

TABLE 2

Connector 1: Computer to junction box

Computer PL3 28-pole socket	Function	Junction Box
5	Red Horizontal	2
6	Red Vertical	1
8	Earth	7
19	Green Horizontal	4
21	Green Vertical	3
27	Purple Horizontal	6
28	Purple Vertical	5

TABLE 3

Connector 2: Computer to display head

Computer PL3 28-pole socket	Function	Display Head PL1 25-pole socket
4	Chart illumination	4
8	Earth	8
9	28V +ve supply (via start relay)	9
12	X motor	12
13	X motor	13
14	X motor	14
15	Y motor	15
16	Y motor	16
17	Y motor	17
22	Fast reset downward	22
23	Fast reset upward	23
24	Warning light	24

TABLE 4

Connector 3: Computer to computer control unit

Computer PL2 28-pole socket	Function	Control Unit PL2 28-pole socket
1	Earth	1
2	Earth	2
3	Earth	3

TABLE 4—contd.

Computer PL2 28-pole socket	Function	Control unit PL2 28-pole socket
4	Chart illumination	4
5	24V stabilized supply	5
6	X (pen) reset	6
7	Lane set (not used)	7
8	+ve Lane slip	8
9	−ve Lane slip	9
10	Green lane slip selector	10
11	Purple lane slip selector	11
12	Y (chart) reset	12
13	Warning lamp release	13
14	28V +ve d.c. supply	14
15	Start line	15
16	28V +ve d.c. supply	16
17	Downward fast reset	17
18	Upward fast reset	18
19	28V +ve d.c. supply (via relay)	19
20	Ward 29	20
21	Ward 30	21
22	Ward 31	22
23	Ward 32	23
24	Ward 33	24
25	Ward 34	25
26	Ward 35	26
27	28V +ve d.c. supply	27
28	Ward 36	28

TABLE 5

Connector 4: Computer power input via junction box

Computer PL2 28-pole socket	Function	Junction box
1	Earth	7
2	Earth	7
3	Earth	7
14	28V + ve aircraft supply	17
16	28V +ve aircraft supply	17
27	28V +ve aircraft supply	17

TABLE 6

Connector 5: Computer to computer control unit

Computer PL1 28-pole socket	Function	Control unit PL1 28-pole socket
1	Ward 1	1
2	Ward 2	2
3	Ward 3	3
4	Ward 4	4
5	Ward 5	5
6	Ward 6	6
7	Ward 7	7
8	Ward 8	8
9	Ward 9	9
10	Ward 10	10
11	Ward 11	11
12	Ward 12	12
13	Ward 13	13
14	Ward 14	14
15	Ward 15	15
16	Ward 16	16
17	Ward 17	17
18	Ward 18	18
19	Ward 19	19
20	Ward 20	20
21	Ward 21	21
22	Ward 22	22
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24	Ward 24	24
25	Ward 25	25
26	Ward 26	26
27	Ward 27	27
28	Ward 28	28

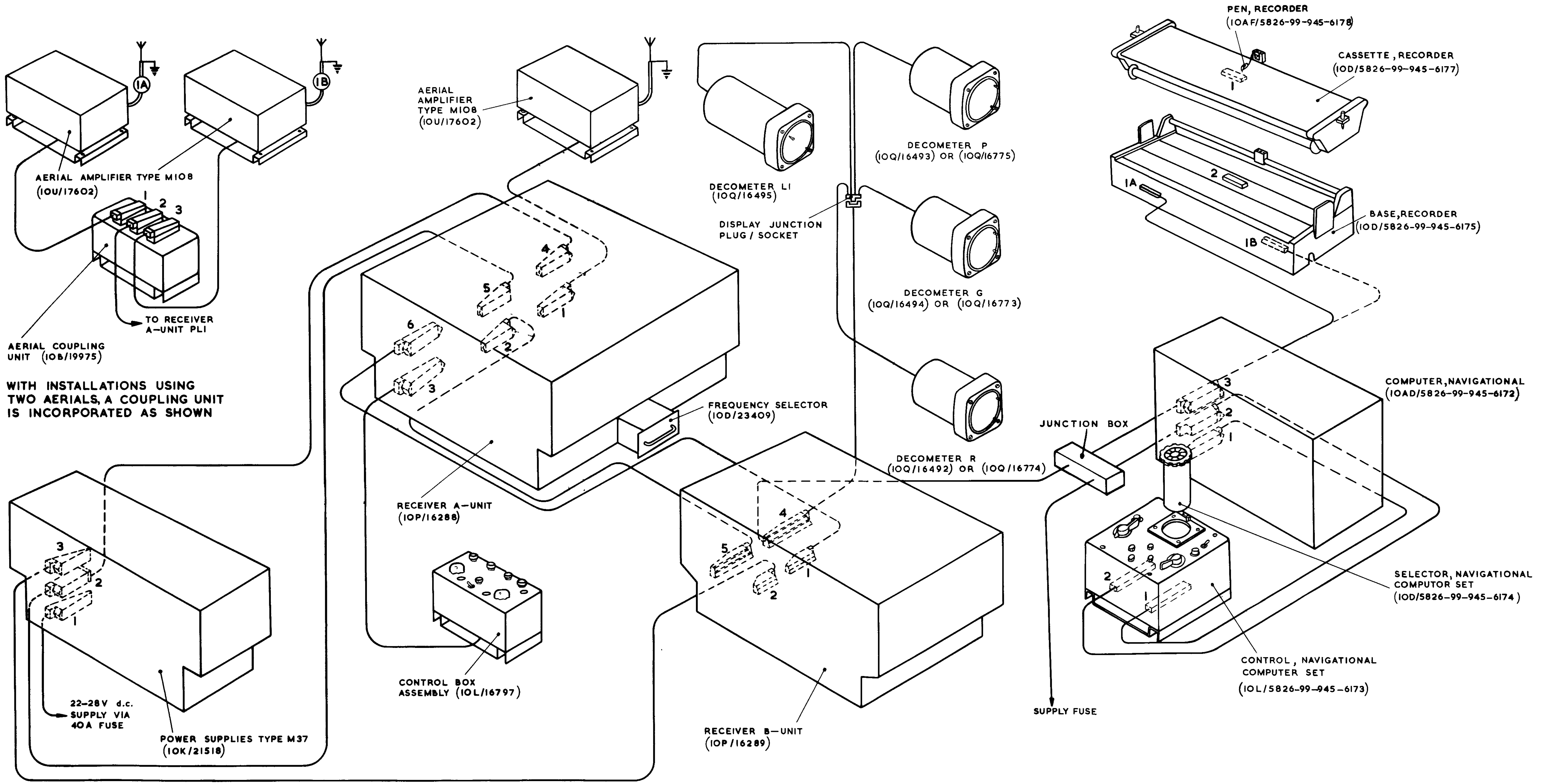

Fig. 2. Representative overall installation diagram Fig. 2.

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Chapter 3

COMPUTER, NAVIGATION, AND CONTROL UNIT

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COMPUTER

1. The following detailed description covers the complete processing of the applied signals that are required to provide appropriate drive switching for the display head motors for any selected pattern/scale combination and the functions of the ancillary circuits necessary to provide Lane slip, reset and alarm facilities. Where two or more similar sub-units exist (e.g. Red, Green and Purple primary servo units), only one is described in detail. Operation of the remaining sub-unit(s) is identical unless otherwise indicated. The circuit diagram is shown in figs. 4 and 5 which are divided broadly into the primary and head servo systems respectively.

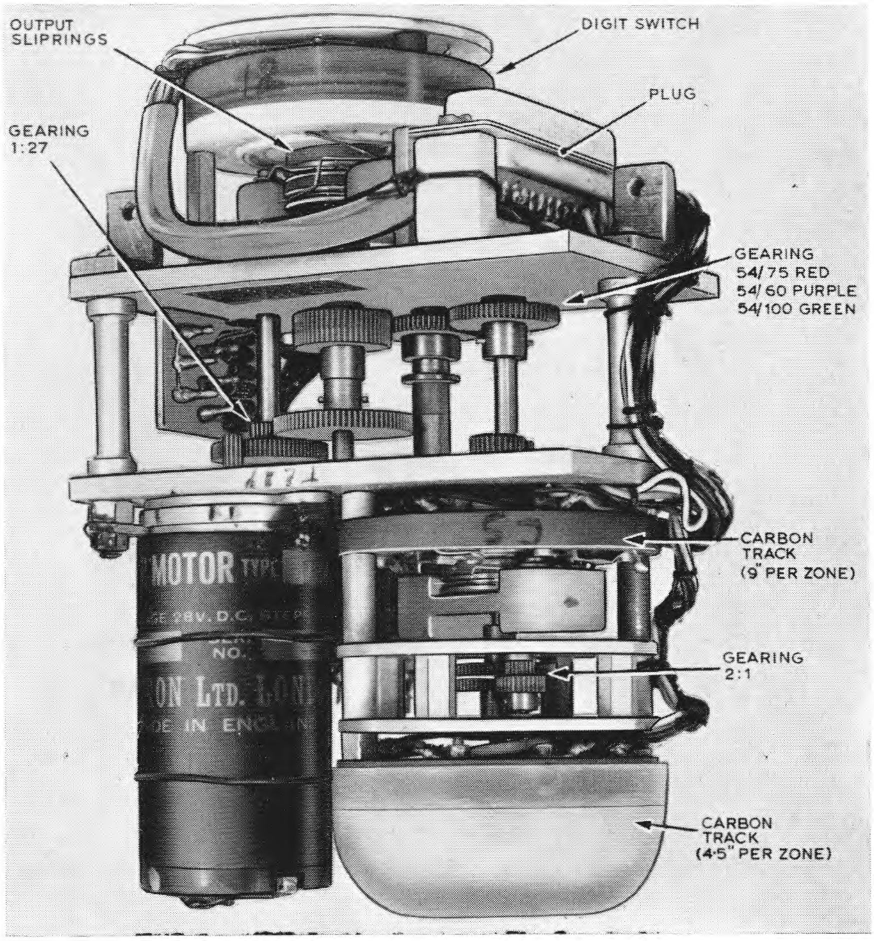

Fig. 1. Computer Type 9257: primary servo unit

2. As shown in Part 2, Sect. 1, Chap. 1, all the essential impulse generation and process sequencing is controlled by the cam unit. The operation of this unit is described in para. 24 and the closing periods for each set of cam level switches are shown in their correct time-relationship in the timing diagram at the top of fig. 4. Cross reference is made to this diagram in the following paragraphs where it may simplify the explanation of various sequenced operations.

Primary servo systems (fig. 4)

3. The three primary servo systems are identical in all but sin:cos potentiometer to digitizing switch gear ratios (Part 2, Sect. 1, Chap. 1, para. 6). The function of the Red primary servo system will be considered in detail.

4. Assuming that the system is initially in the zero error state (i.e. the sin: cos potentiometer wipers rest at the null points in the potential diagram generated on the potentiometer track by the signal inputs), any change in input data will produce an error voltage between the wipers. This voltage will cause the centre-stable moving contact of RRA to close to one or other of the fixed contacts, depending upon the polarity of the error voltage, which is determined by the sense of rotation of the input signals. This operation connects the coil of either RRD, the forward slave/hold relay or of RRH, the reverse slave/hold relay to cam contact LA1, so that the appropriate relay is energised when the contact closes.

5. Operation of the slave/hold relay in turn energises the associated routeing relays; assuming that RRD (forward) is operated, these relays are RRE, RRF, RRG. A self-hold circuit is established via RRJ1, MR4, RRD1 and cam contact LB1 so that RRD remains operated for both LA and LB cam periods (fig. 4). At the same time, closure of RRD1 provides a reverse bias impulse to RRA via C1, R1, forcing release of that relay.

6. Routeing relays RRE, RRF control the red servo motor, M2, connecting the three windings, defined by their terminal numbers 4/2, 4/5 and 4/6, to the pairs of cam unit switch contacts LC1, LD1; LG1, LH1 and LE1, LF1 respectively. One

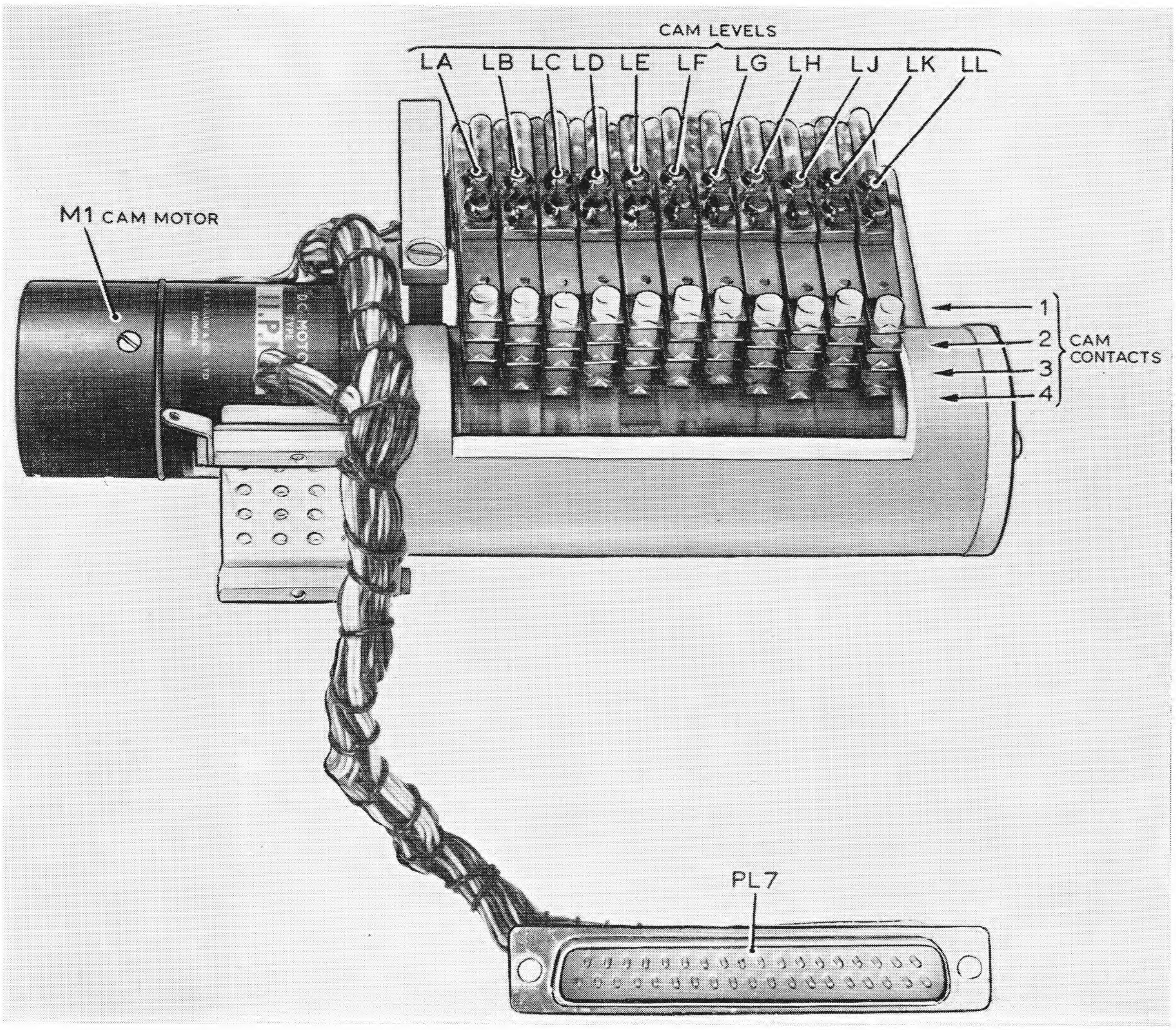

Fig. 2. Computer Type 9257: cam switch unit

of each pair of cam contacts is connected to the positive d.c. (28V nominal) supply and the remaining one is connected to earth (d.c. return). Reference to fig. 4 shows that at any moment one of each of two of these pairs of cam contacts is closed so that one of the motor windings is nominally disconnected from the supply. This winding will then be effectively at the star point potential of the windings (i.e. at approximately one-half the d.c. line voltage) and this potential is taken as the zero or reference potential in the following note on the motor control system. The d.c. line and earth conditions are defined as + and − respectively, referred to this zero condition.

7. The M motor will be energised for the duration of the cam level LA and LB dwell periods during which time RRD and therefore RRE, RRF remain energised. In that time, the sequenced operations of the six cam levels LC to LH during a 180° rotation of the cam unit cause one complete revolution of the M motor as shown in fig. 7. The quiescent motor condition (before level LA contacts close) is as shown at MOTOR ROTATION 0° at the bottom of fig. 7. Coil 4/2 is held at line voltage (+) via RRF/1, RRK/1 and R7. Coil 4/5 is held at earth potential (−) via RRJ/2, RRE/2, R5 and coil 4/6 is held at line potential (+) via RRF/2, RRK/2 and R7. When LA contacts close (LA START in fig. 7), LG and LF will be closed maintaining earth (−) on coil 4/5 and line voltage (+) on coil 4/6, but coil 4/2 is now at zero potential (LD open) and a 30° motor step results. As the dwell period of each cam switch is rather larger than the nominal 60°, LC will close before LG opens and

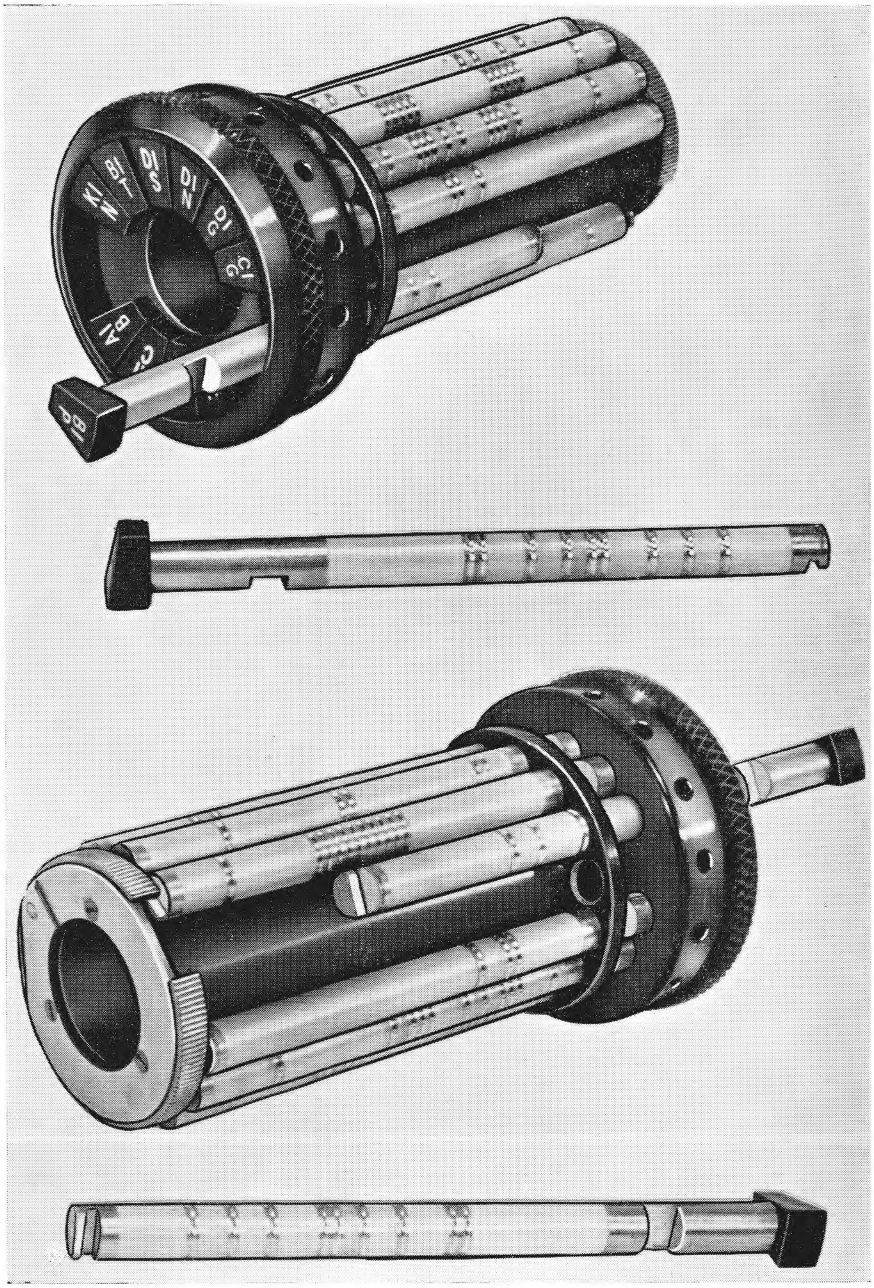

Fig. 3. Control unit switch turret

the coil 4/2 will be earthed just before coil 4/5 is de-energised. This overlap results in a further 30° step of the motor and a third 30° step occurs when LG opens. Subsequent operation of levels LH, LE, LD step the motor round in the same manner and at the completion of the LB hold period for RRD, the motor has been rotated by 12 successive 30° steps to the original (quiescent) position. It is then held in this position until RRD is again energised or RRH is energised by a reversal of the input error voltage.

8. In the course of this revolution, the motor drives the X-scale and Y-scale wipers over one stud each on the Red impulse (digitizing) switch. These wipers will be connected via the contacts of the third routeing relay, RRG1 and RRG2 (fig. 5), and the X and Y pattern selector relay contacts RGN1, RGQ1 (these relays are assumed to be de-energised for the purpose of this description) to the store capacitors C30 and C32. If either of the switch studs scanned by the wipers in this operation are earthed via PL4, PL1 and the selected turret switch key in the control box, C30 or C32 will be discharged through the earth return path so established, and the primary servo step will be stored as a zero-charge condition on the affected capacitor.

NOTE: CAM CONTACT OVERLAP (CROSS HATCHED) NOT SHOWN TO TIME SCALE

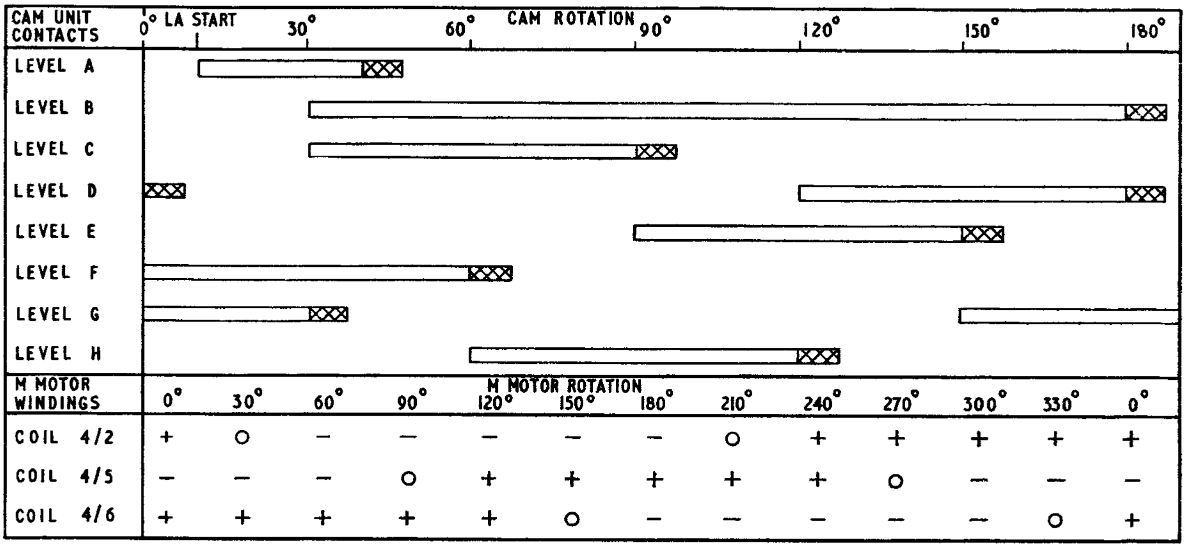

Fig. 7. Sequencing of primary servo M motor (in forward mode)

9. Operation of the primary servo on a reverse sense of input charge is similar but the reverse slave/hold relay RRH will be energised, energising in turn routeing relays RRJ, RRK and RRL. Motor stepping is effected in an identical manner but RRK reverses the connections to motor coils 4/2 and 4/6 to reverse the sense of rotation established and RRL connects the X and Y digitizing switch wipers to the 'reverse' store capacitors C31, C33. In this manner the correct sense of servo loop operation is maintained and the sense of the output impulses is maintained in the stores.

10. As stated in para. 3, the Green and Purple primary servo systems are identical in general operation. The various routeing relays and other elements have similar references to those described. The relay reference (Table 1) carry G or P as the first reference letter in place of R (e.g. RGA, RGD replace RRA, RRD).

Pattern and scale selection

11. The basic method of scale selection is simply that of earthing the required number of X and/or Y digitizing switch contacts on each primary servo unit to establish the number of impulses-per-zone fed to the head servo systems (para. 8 and Part 2, Sect. 1, Chap 1, para. 5). This method is slightly complicated in the Green scale selection circuits by the inclusion of RGN and RGQ (fig. 4), which permit automatic pattern selection switching. As will be seen from the circuit diagram, RGN will be energised via MR52-MR56 if any one or more of the Green X scale studs are earthed and RGQ will similarly be energised via MR42-MR46 if any Green Y scale is selected. In this way, the use of any Green input (defined by green X or Y wards on the selected turret switch key: Table 2) is made to set up the required pattern combination automatically within the computer as follows.

12. The stores and subsequent head servo routeing and sequencing systems are arranged to process any two inputs in both the X and the Y co-ordinates. To simplify switching and to avoid the need for additional turret switch key wards to define the pattern combinations (which are implicit in the X and Y wards present on the key), the Green X and Y primary servo outputs are permanently connected to the store capacitors C30/C31 (X) and C32/C33 (Y). In the absence of a Green input (i.e. no Green X or Y wards on the turret switch key), RGN and RGQ are de-energised and the Red primary servo outputs may be applied to these store capacitors as described in para. 8. In these circumstances, the Purple primary servo outputs will be applied to the store capacitors C34/C35 (X) and C36/C37 (Y). When the selected key carries, for example, a Green X ward or wards, RGN will be energised and contacts RGN1, RGN2 will transfer the Red X servo output lines to C34 and C35. In these circumstances either of the combinations Green/Red or Green/Purple may be employed on the X co-ordinate dependent upon whether Red or Purple X wards are present on the selected key (in no instance are all three colour wards for one co-ordinate present on a turret switch key for this flight log system). In a similar manner, selection of any Green Y scale energises RGQ, which transfers the Red Y outputs to store capacitors C36/37.

X and Y stores (fig. 5)

13. The 8 store capacitors C30 to C37 are connected via rectifiers MR110 to MR117 and a limiting resistor R31 to cam contact LA4. During cam unit period A they are connected to the 12V supply point (junction of R140 and C80, C81 in the power supply circuit) so that they are normally maintained charged to approximately 12V and are discharged during the subsequent cam unit B period to store a primary output pulse when this occurs (para. 8). This stored impulse is then cancelled during the subsequent A period when the capacitor recharges.

Reversal circuits

14. The sense (forward or reverse) of the primary outputs is retained by the use of separate forward and reverse stores as described in para. 9. In many instances, one or both head servo systems are required to operate in the reverse sense from normal (e.g. the X system may need to provide movement to the left for increasing lane reading). This requirement is peculiar to the chart in use and the turret switch key therefore has four wards allocated to reversal independently of the two X and two Y inputs. These wards, Nos. 31 to 34 in Table 2 control respectively RXA, RXB, RYA and RYB (fig. 5). Each relay transposes the connections between the associated pair of forward/reverse store capacitors and the head servo system.

Head servo input sequencing

15. The 8 store outputs are applied to the head servo outputs X forward, X reverse, Y forward and Y reverse via cam unit contacts LJ1 to 4 and LK1 to 4. These two levels operate consecutively (fig. 4) thus permitting combination of the two X or Y forward or reverse inputs at this point. The head servo input signals comprise an earth pulse obtained each time a discharged store capacitor is connected to the input line via the associated LJ or LK cam contact. As shown in fig. 4, these contacts operate during the latter part of the cam unit B period, thus this store sampling occurs after the primary servo has discharged the capacitor and before the subsequent recharge via level A (LA4) (fig. 5).

16. From the sequencing point (cam unit levels LJ, LK) the X and Y head servo systems are virtually identical and the following description of the X system is applicable also to the Y system apart from the relay and component references.

Trigger and counter system

17. The X forward and reverse impulses, routed via LJ1, LK1 and LJ2, LK2 respectively (fig. 5), are applied to the forward and reverse Schmitt trigger circuits VT1, VT2 and VT3, VT4. The trigger circuits produce one negative square-wave pulse of the order of 2mS duration each time a stored impulse is scanned by the LJ, LK contacts. These output pulses are fed to the X forward and reverse decade counters.

18. The decade counters (fig. 6) are proprietary sealed units. Fundamentally a 4-binary counter giving a count of 16, they embody feedback from VT7 to VT4 and VT6 so that at the count of 8, stages 2 and 3 (VT3, 4 and VT5, 6) are reset to the 1:0 state. The output is taken from the four stages, via graded resistors, to produce a scale of ten 'staircase waveform' with steps of the order of 1V increments, which appears on the brown output lead (A2). VT9, coupled to the fourth binary stage, provides an output pulse at the count of 8 as an overspill warning. This output appears on the blue lead (A1). Reset to zero is effected by breaking the d.c. return to the orange lead (A8) and a divide-by-two facility is established by earthing the yellow line (A4): this suppresses the output of the first binary so that the output rises in 2V steps for each 2 input impulses. This facility is brought into operation by de-energising RXZ (para. 27).

Comparator (fig. 5)

19. The X comparator system comprises VT6, 8, 10, 12, RXF and VT7, 9, 11, 13, RXJ. The two relays RXF RXJ control forward/ reverse switching of the display head motor system (para. 20) and are controlled as follows: VT6, VT8 and VT7, VT9 are 2-stage d.c. amplifiers controlling VT10 and VT11 respectively. These two transistors are cross-coupled emitter to base so that only when the inputs applied to VT6 and VT7 are unbalanced will one or other transistor conduct. Assuming a net forward count is registered by the X decade counters 1 and 2, applying a higher 'staircase' voltage to VT6 than to VT7, VT10 will conduct, automatically back-biasing VT11, but causing VT12 to conduct and thus energising RXF. This will initiate forward rotation of the X motor and at the same time it will connect the reset lines of both X counters to the 12V line to prevent resetting during the head servo operating cycle. As no feedback loop exists over the head drive system, the counter unbalance must be cancelled once the drive cycle has been initiated to prevent continuous drive operation. This is effected via RXH, which is energised via RXF2 and cam unit contact LA2, and self- holds via RXH1 and cam unit LB2. Contacts RXH2 connect the X reverse Schmitt trigger via MR121, C42 to cam unit contact LE4 so that a balancing earth impulse is applied to the X reverse counter system upon the LE period immediately succeeding the LA period when RXH is energised.

X drive control relays

20. The X motor drive system is similar to that of the primary servo M motors (para. 7); the three motor coils are connected in the appropriate sequence to either +28V or earth via cam contacts LC2, LD2, LE2, LF2, LG2, LH2. These connections are established via RXG (energised in parallel with RXH: para. 19) and RXM, which is energised in parallel with RXG, RXH via

MR154. These relays are self-held via RXH1 for the level B period and a complete M motor switching cycle therefore performed as described in para. 7. A safeguard against hunting of the head drive is provided by the delayed release interlock system comprising R90, C60, VT40 and RXQ. The relay is energised via VT40 in parallel with the head routing relays RXH, RXG, RXM and contacts RXQ1 break the reverse drive switching circuit LA2, RXJ2. C60 delays decay of VT40 control voltage after release of the routeing relays so that the reverse routeing circuit is prevented from operating immediately after the forward routeing cycle has been completed. Hunting of the display is thereby minimised when the aircraft follows a Decca position line and random 'left-right' impulses may occur in the servo input.

21. The reverse mode of operation for the X head system is similar to that described in para. 20. If the X reverse count exceeds the forward count, RXJ will be energised and the head routeing relays RXK, RXL will be energised together with RXM. Relay contacts RXK1, RXK2 reverse two head drive motor outputs to reverse the sense of rotation as described for the primary M motor switching in para. 9. The delayed release interlock embodies R92, C61, VT41 and RXN and the balancing impulse is applied to the forward trigger/counter system via RXL2.

Counter reset and overspill operation

22. The reset lines (A8) of the X forward and reverse counters are held at +12V via either RXF1 or RXJ1 as long as unbalance exists between the counters. When the balance state is attained, the relay releases and the reset lines are returned to +12V via VT5. During the next closing period of cam contact LL1, VT5 is cut off and the reset lines are effectively earthed via the emitter resistor R51, resetting the four binary stages of each counter to the 0.1 state.

23. The overspill indication is obtained from the fourth binary stage via VT9 (fig. 6). At the count of 8, a negative pulse is obtained on the A1 (blue) lead of each counter. These leads are connected via rectifiers (e.g. MR130, MR127 in the X counter system) to the Schmitt trigger circuit VT36, VT37 (fig. 5). An overspill pulse on any counter A1 output line produces a change of state in this circuit, causing VT38 to conduct and energise RCJ. Contacts RCJ1 break the +28V supply to the slave-hold relays RRD, RRH, RGD, RGH and RPD, RPH (fig. 4) and thereby inhibit operation of the primary servo systems. Contacts RCJ2 place an earth on the base of VT53 in the cam motor control circuit (para. 24) producing the continuous fullspeed state.

Cam motor control circuit (fig. 4)

24. The cam unit drive motor is controlled via the transistor VT51 in series with the 24V stabilized supply to the motor The quiescent base potential is set by the operating conditions of the preceding amplifier VT53, VT52 to permit a relatively low emitter current and the motor speed in this condition is low. The base of VT53 is coupled to the contacts of all six primary servo slave/hold relays via rectifiers (e.g. via MR5, MR8 to RRD2 and RRH2 in the Red primary servo circuit) so that an earth pulse of the duration of the A + B cam level period is applied to the base each time a step occurs on any of the three primary servo systems. A relatively long time-constant R-C circuit R144, C82 in VT53 base circuit prevents rapid decay between pulses; the positive base potential will therefore assume a mean value proportional to the overall rate of input servo impulsing, reducing as the servo impulses rate increases. This change in VT53 operating state progressively increases the emitter current of VT51 and produces an increasing cam motor speed. Relay contacts RXS2 and RYS2 are included in VT53 base circuit to earth the transistor base and establish maximum cam motor speed during slow reset in the L/R and U/D directions and contacts RCJ2 perform the same function in the event of counter overspill (para. 23).

Lane slip facilities

25. The lane slip facility is provided to permit readjustment of the displayed information in whole-lane steps in any one pattern. This process is controlled by the upper and lower reset push-buttons on the control unit when the function switch is set to the R, G and P positions for Red, Green and Purple lane-slip respectively (para. 38). In the R lane-slip condition, the upper reset button switch PB1 (fig. 5) is connected, via MR93, and relays contacts RCF1 and RCD1, to the coil of the Red forward slave/hold relay RRD (fig. 4). Depressing the reset button places an earth on this line, energising RRD and establishing continuous forward operation of the Red primary servo system at a rate determined by the maximum cam unit speed. If the reset button is released when the servo sin: cos potentiometer inputs have completed more than one-half a revolution (or less than one and one-half revolution), the primary system will continue to run to the zero-error-state, establishing a one lane change in so doing. In a similar manner, any change in multiples of one Lane may be made by depressing the reset button until the primary servo system has rotated to within less than one-half lane of the required position.

26. The reverse Lane-slip operation, to reduce the displayed whole-Lane reading, is effected by depressing the lower (down) reset button PB2.

This operation energises the Red reverse slave/hold relay RRH via MR94, and relay contacts RCF2, RCD2. Green Purple Lane slip are effected in a similar manner but relays RCD and RCF are energised via the function switch G and P positions respectively to transfer the reset button circuits to the Green slave/hold relays RGD, RGH or the Purple slave/hold relays RPD, RPH.

Multiplier circuits

27. The normal state of operation of the computer is with the 4·5 in. per Zone primary sin: cos potentiometer wipers in circuit (Part 2, Section 2, Chap. 1, para. 5). When the maximum scale of 9 in. per zone is required on either the X or Y co-ordinate, the appropriate multiplier ward is included on the turret switch key. The presence of either ward (35 or 36, fig. 5) provides an earth return for the coil of RCY. Contacts RCY2 complete the operating circuit for all three primary multiplier relays RRT, RGT and RPT thus transferring the Red, Green and Purple error relays to the 9 in. per Zone sin: cos potentiometer wipers. Contacts RCY1 simultaneously break the earth return for the X and Y head servo multiplier relays RXZ (para. 18) and RYZ.

28. Assuming the X ward (No. 35 in Table 2), is used, the X head servo multiplier relay will remain energised via MR204 and the X ward. In these circumstances the input scales to both X and Y head servo systems will be doubled but the Y counters will be switched to the divide-by-five state by RYZ1. In this way the X head servo system operates in the 9 in. per Zone mode but the Y head impulsing rate is halved to retain the 4·5 in. per Zone maximum Y scale. In a similar manner, presence of the Y multiplier ward No. 36 completes the Y head servo multiplier RYZ energised and the X scale only is reduced by divide-by-two switching of the X counters via RXZ1. Presence of both wards results in both RXZ, RYZ remaining energised and the 9 in. per zone scale is obtained on both co-ordinates.

29. When the divide-by-two facility is employed as described in para. 27, 28, two input pulses are required to effect the counter balancing (para. 19) each time the comparator produces a display head step. This is effected by switching cam unit contact LH4 into the X or Y balancing system via RXZ2 or RYZ2 respectively. Two consecutive balancing impulses are therefore applied during each half-rotation of the cam unit.

Reset facilities (fig. 5)

30. Slow X reset facilities are provided at both the F (Fast reset) and S/OP (Slow reset/operational) settings of the control unit function switch (paras. 39, 40). Left and right reset is effected by operating the left-hand and right-hand reset buttons (PB3, PB4) respectively. Depressing the left-hand button applies an earth to the X reset line; depressing the right-hand button applies the 28V supply to this line. The reset line is connected to the coils of RXR, RXS and the return for these coils is made to a potential divider R32, R33 across the 28V supply. Operation of the left-hand button energises both relays via R32 but operation of the right-hand button energises only RXS via R33: due to the presence of MR120, which is reverse-biased in this state, energising of RXR is prevented.

31. In the right-hand slow reset state contacts RXS1 energise the head servo relays RXG, RXH, RXM causing continuous X motor forward stepping, and contacts RXS2 (fig. 4) set up the maximum cam-speed state (para. 24), thus ensuring maximum stepping rate of the X drive. In the left-hand slow reset state, the same conditions are set up but contacts RXR1, RXR2 (fig. 5) reverse two of the X display head motor lines to produce reverse movement of the cursor.

32. The operation of the Y slow reset system, using the upper and lower reset buttons (PB1, PB2) is identical to that described in para. 30, 31. RYS performs the motor switching and cam speed adjustment in both instances and RYR performs the Y motor reversal when the lower button is operated. These facilities are available only at the S/OP position of the control box function switch. In the F position, the upper and lower reset buttons are connected through the computer to control and Y reset motors in the display head (Part 2, Sect. 1, Chap. 4).

Power supply (fig. 5)

33. The +28V (nominal) d.c. supply is applied to the computer at PL2, poles 14, 16 and 27. It passes through the 7A fuse link FS1 to the start relay RCH, which is controlled by the ON switch S2 of the control unit. Contacts RCH1 switch the supply through to both computer and control box. To supply certain circuits (e.g. the display head lighting) which can tolerate a lower variation in voltage than the remainder of the equipment, a simple voltage stabilizer is included. This comprises a series regulating transistor VT50, the base-voltage of which is stabilized by the cascaded Zener diodes MR190, MR191. This circuit provides a constant output voltage of approximately 24V, which is reduced to 12V for some circuits through R140, which also forms a filter in conjunction with C80, C81.

Alarm circuit

34. A flashing warning light is provided on the display head to indicate when the equipment is not set to the normal S/OP state. The flashing **is**

effected by inclusion of a simple thermal break switch in series with the +28V line to the warning lamp. The shunt heater element of the switch is connected between the switched (lamp) side of the contacts and earth in all positions of the control box function switch except S/OP, when the earth return is broken.

CONTROL UNIT

35. The control unit, the circuit of which is shown in the upper part of fig. 5, carries all operating controls for the computer and display system. The majority of the control functions are defined in the preceding description of the computer. As shown in fig. 5, the controls comprise the turret switch (paras. 36, 37), the flight log system ON switch, S2, display lighting control, RV1, function switch, S1, and the four reset push-buttons, PB1 to PB4. The front panel comprises a translucent plate, edge lit by two recessed lamps ILP1, ILP2, and having a black opaque outer surface. Control markings are engraved through this surface to the illuminated layer as are also two arcs, one under the skirt of each of the rotary controls to indicate control position via a small index hole in the skirt of the control knob. The turret switch centre shaft houses a third illumination lamp, ILP3, which is hooded to direct the light upwards on to the face of the selected key.

Turret switch

36. The turret switch comprises two parts:—

(1) The main, fixed, switch assembly mounted in the control unit, and

(2) The detachable turret (fig. 3), which carries up to 12 cylindrical 'keys', each providing earthing contacts ('wards') in a selected group of 38 possible locations along its length.

In principle, the switch is simple: the main assembly is fitted with 38 gold alloy contact wires carefully aligned on a tagboard inside the top face of the assembly, so that they can coincide with the 38 key contact locations when the turret is inserted. Turning the turret to bring any required key into the operate (12 o-clock) position completes an earth connection between the contact wires and an earth point, in the shape of a spring contact made to the body of the key, via the wards present on the selected key. This operation completes the necessary control operations in the computer to set up the required operating conditions, as described in para. 8 to 27.

37. The keys (fig. 3) are inserted through holes in the front face of the turret and are retained by a captive, gapped, rotatable collar at the rear of the turret, which engages with a groove milled in the end of each key. The collar is turned to bring the gap opposite the required key position, the key is inserted and the collar then turned to lock the key in place. When the turret is loaded, the gap occupies a position in the blank arc of the turret, opposite the longitudinal key way which permits insertion of the turret in the keyed switch aperture. The front face of the key is fitted with a moulded head carrying the three-letter code identifying the ward combination. This code is that printed on all flight log charts that are based on the pattern/scale conditions that will be set up by the key, so that the turret switch has only to be turned to bring the key coded to agree with the chart in use opposite the index mark to establish the correct operating conditions. The wards are shown on fig. 4 and the ward functions are listed in Table 2.

Function switch and reset push buttons

38. In the first three positions of the function switch, S1, the up and down reset switches PB1, PB2 are connected to the + (forward) and − (reverse) Lane slip circuits via S1A and S1C. The PB2 N.O. contact is earthed via S1B (this operation also applies an earth connection via R4 to the alarm lamp circuit (para. 35). In the R position of S1, no other essential circuit is completed. In the G and P positions, S1E applies +28V to the Green and Purple Lane slip routeing relays respectively via PL2 pole 10 and PL2 pole 11.

39. The fourth position of S1: or fast reset connects PB1 and PB2 to control the display head Y reset motors. S1E routes the +28V supply to PB1 and S1A connects PB1 to the up reset motor line via PL2, pole 18. S1B maintains the earth connection to PB2 (and therefore to the alarm lamp circuit, para. 38) and S1C connects PB2 to the down reset motor line via PL2, pole 17. The slow left-right reset facility is established in this position by S1D, which applies the +28V supply via R1 to PB4 N.O. contact and S1F, which connects PB3 and PB4 to the L/R reset line.

40. In the fifth position of S1: S/OP (slow reset/operate), the L/R reset condition remains as described in para. 39 and similar conditions are set up in the up/down slow reset circuit via S1A, S1B, S1C, R2 and R3. The alarm lamp circuit is now connected to +28V via R4 and R2. The limiting resistor R4 ensures that, when PB2 is operated, the voltage drop across R2 does not produce sufficient current in the alarm circuit thermal switch heater to trip this switch.

TABLE I

Computer Type 9257: Relay coding and functions

Relay	Function
RRA/1	Red error voltage
RRD/2	Red forward slave/hold
RRE/2	Red and reverse inhibit motor forward routeing
RRF/2	Red motor forward routeing
RRG/2	Red X and Y output forward routeing
RRH/2	Red reverse slave/hold
RRJ/2	Red and forward inhibit motor reverse routeing
RRK/2	Red motor reverse routeing
RRL/2	Red X and Y output reverse routeing
RRT/2	Red sin-cos output switching (Multiplier)
RGA/1	Green sin-cos error voltage
RGD/2	Green forward slave/hold
RGE/2	Green and reverse inhibit motor forward routeing
RGF/2	Green motor forward routeing
RGG/2	Green X and Y output forward routeing
RGH/2	Green reverse slave/hold
RGJ/2	Green and forward inhibit motor reverse routeing
RGK/2	Green motor reverse routeing
RGL/2	Green X and Y output reverse routeing
RGN/2	X output colour selection
RGQ/2	Y output colour selection
RGT/2	Green sin-cos output switching (Multiplier)
RPA/1	Purple sin-cos error voltage
RPD/2	Purple forward slave/hold
RPE/2	Purple and reverse inhibit motor forward routeing
RPF/2	Purple motor forward routeing
RPH/2	Purple reverse slave/hold
RPJ/2	Purple and forward inhibit motor reverse routeing
RPK/2	Purple motor reverse routeing
RPL/2	Purple X and Y output reverse routeing
RPT/2	Purple sin: cos output switching (Multiplier)
RXA/2	X reversal 1
RXB/2	X reversal 2
RXF/2	X reversal 2
RXG/2	X display head motor forward routeing
RXH/2	Hold and opposite counter balancing
RXJ/2	X reverse pulse comparator
RXK/2	X display head motor reverse routeing
RXL/2	Hold and opposite counter balancing
RXM/1	X display head motor routeing
RXN/1	X display head motor forward delay
RXQ/1	X display head motor reverse delay
RXR/2	X display head reset
RXS/2	X display head reset
RXZ/2	X multiplier

TABLE 1—contd.

Relay	Function
RYA/2	Reversal 1
RYB/2	Y reversal 2
RYF/2	Y forward pulse comparator
RYG/2	Y display head motor forward routeing
RYH/2	Hold and opposite counter balancing
RYJ/2	Y reverse pulse comparator
RYK/2	Y display head motor reverse routeing
RYL/2	Hold and opposite counter balancing
RYM/1	Y display head motor routeing
RYN/1	Y display head motor forward delay
RYQ/1	Y display head motor reverse delay
RYR/2	Y display head slow reset
RYS/2	Y display head slow reset
RYZ/2	Y multiplier
RCD/2	Green Lane slip selector
RCE/2	Green Lane slip selector
RCF/2	Purple Lane slip selector
RCG/2	Purple Lane slip selector
RCH/2	Start
RCJ/2	Primary inhibition
RCY/2	Multiplier

TABLE 2

Turret switch key ward functions

Ward number	Control unit PL.	Control unit pole	Computer PL.	Computer pole	Key Ward function
1	1	1	1	1	Red Y scale: 12 stud
2	1	2	1	2	,, ,, 6 ,,
3	1	3	1	3	,, ,, 3 ,,
4	1	4	1	4	,, ,, 2 ,,
5	1	5	1	5	,, ,, 1 ,,
6	1	6	1	6	Red X scale: 12 stud
7	1	7	1	7	,, ,, 6 ,,
8	1	8	1	8	,, ,, 3 ,,
9	1	9	1	9	,, ,, 2 ,,
10	1	10	1	10	,, ,, 1 ,,
11	1	11	1	11	Green Y scale: 12 stud
12	1	12	1	12	,, ,, 6 ,,
13	1	13	1	13	,, ,, 3 ,,
14	1	14	1	14	,, ,, 2 ,,
15	1	15	1	15	,, ,, 1 ,,

Ward number	Control unit PL.	Control unit pole	Computer PL.	Computer pole	Key Ward function
16	1	16	1	16	Green X scale: 12 stud
17	1	17	1	17	,, ,, 6 ,,
18	1	18	1	18	,, ,, 3 ,,
19	1	19	1	19	,, ,, 2 ,,
20	1	20	1	20	,, ,, 1 ,,
21	1	21	1	21	Purple Y scale: 12 stud
22	1	22	1	22	,, ,, 6 ,,
23	1	23	1	23	,, ,, 3 ,,
24	1	24	1	24	,, ,, 2 ,,
25	1	25	1	25	,, ,, 1 ,,
26	1	26	1	26	Purple X scale: 12 stud
27	1	27	1	27	,, ,, 6 ,,
28	1	28	1	28	,, ,, 3 ,,
29	2	20	2	20	,, ,, 2 ,,
30	2	21	2	21	,, ,, 1 ,,
31	2	22	2	22	X reversal 1 (RXA)
32	2	23	2	23	,, ,, 2 (RXB)
33	2	24	2	24	Y reversal 1 (RYA)
34	2	25	2	25	,, ,, 2 (RYB)
35	2	26	2	26	X multiplier
36	2	28	2	28	Y multiplier
37	—	—	—	—	Not connected
38	—	—	—	—	Not connected

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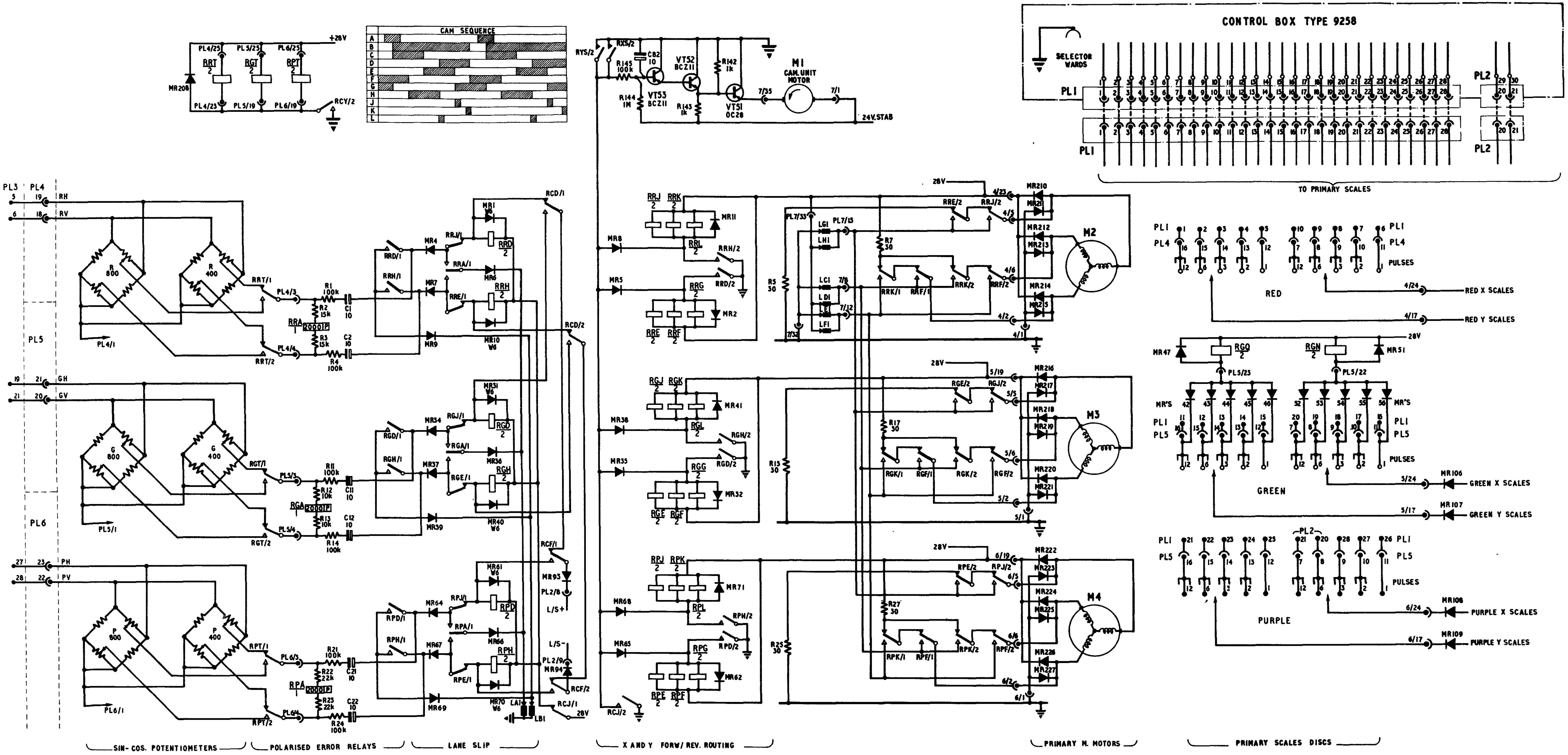


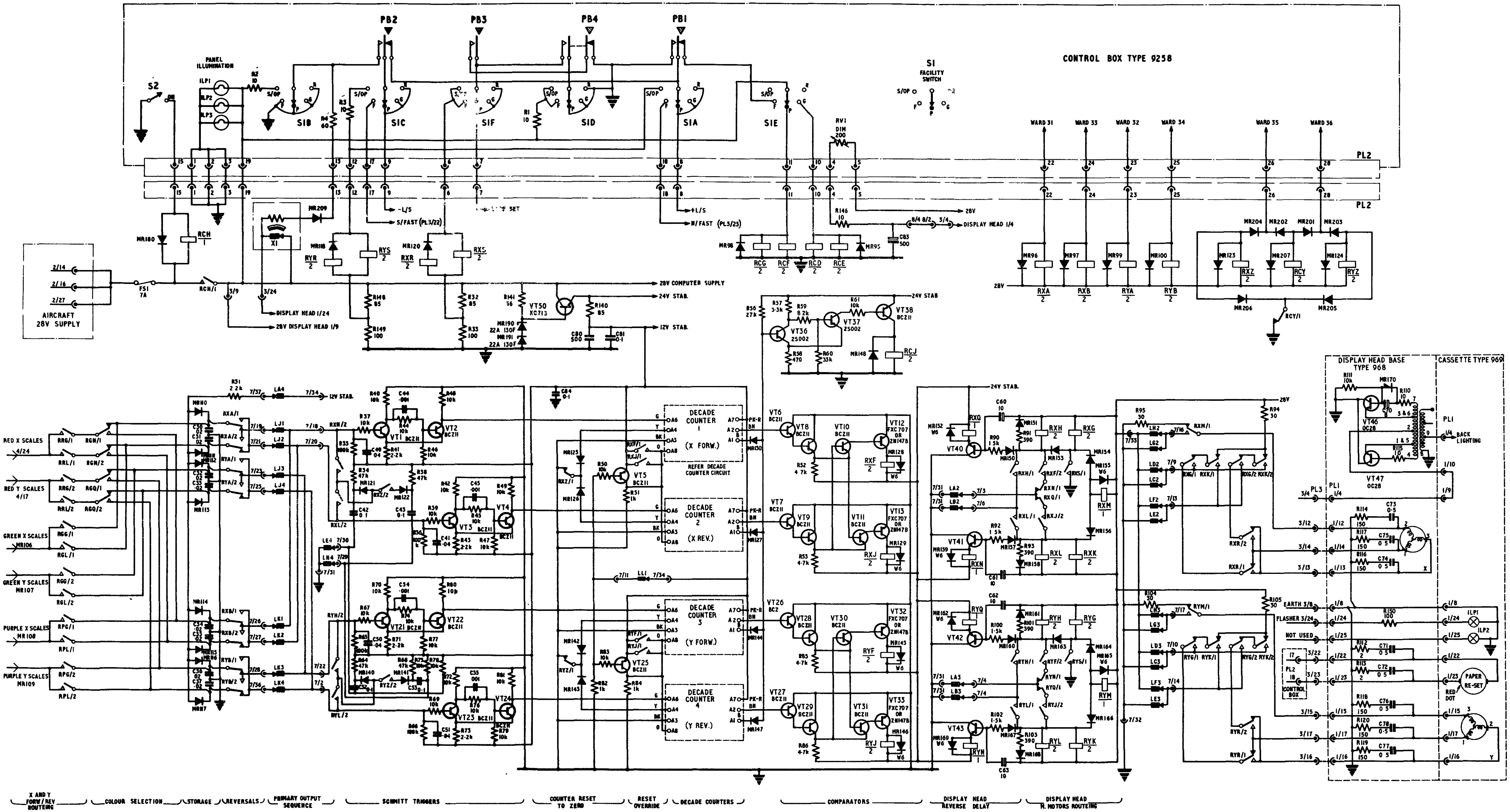
AIR DIAGRAM
116B-0603-MD1

BY COMMAND OF THE DEFENCE COUNCIL
FOR USE IN THE
ROYAL AIR FORCE

D 89356 171390 SW 10/66

Decca navigator (air) flight logs; computer Type 9257; primary servo system: circuit

Fig. 4

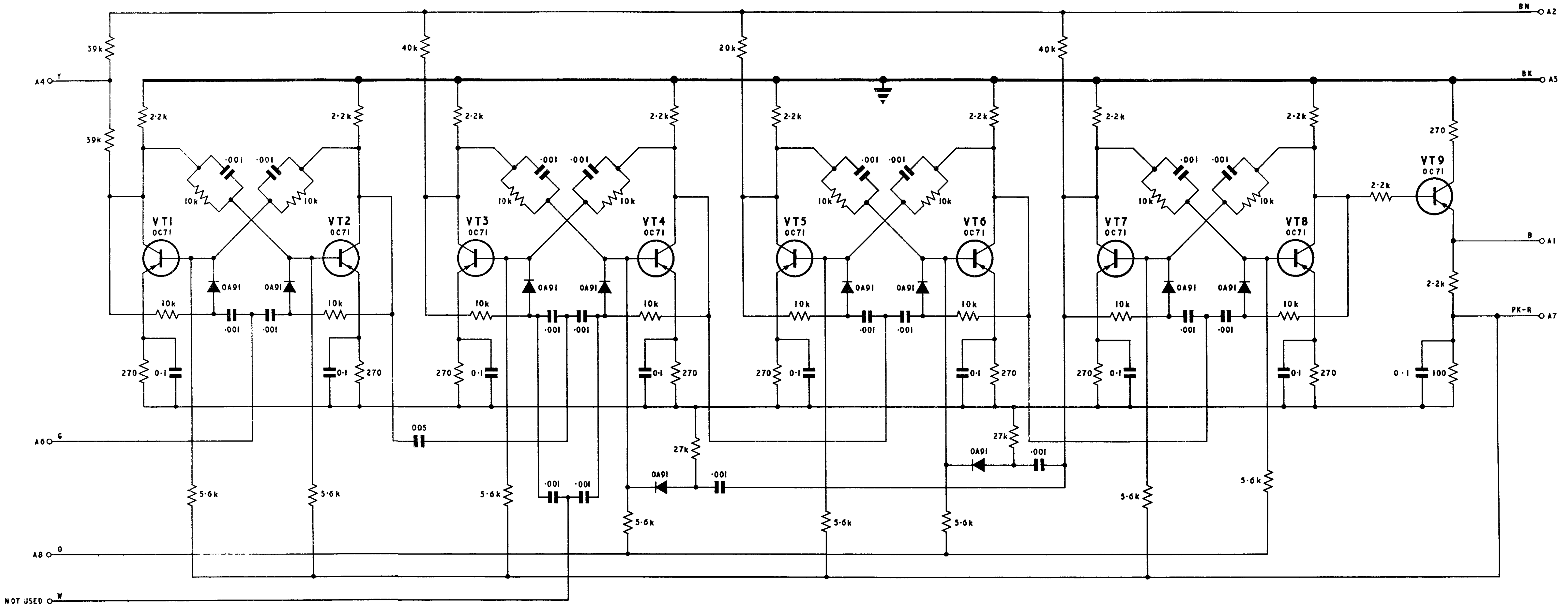


AIR DIAGRAM
116B-0603-MD2
ISSUE 1.

D 89356 171390 SW 10/66

Decca navigator (air) flight logs;
computer Type 9257; head servo systems, control unit and display head: circuit

Fig. 5



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ISSUE 1

D 89356 171390 SW 10 66

Decca navigator (air) flight logs; computer Type 9257; decade counter: circuit

Fig. 6

Chapter 4

DISPLAY, DECCA TYPE 968/969

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LIST OF ILLUSTRATIONS

General

1. The flight log display (Decca Type 968/969) used with the computer, navigational Decca Type 9257, comprises two main sub-assemblies:

(1) Display base (base recorder): fig. 1, 2.

(2) Display (cassette, recorder): fig. 3, 4.

A general view of the assembled display, with chart and cursor pen fitted is shown in Part 2, Sect. 1, Chap. 1, fig. 3. In normal service use, the base (less pen) is permanently installed in the aircraft and the cassette loaded with charts assembled in appropriate sequence for the flight plan is issued to the aircrew prior to the flight together with the recorder pens and a switch turret loaded with a set of keys in sequence corresponding to the charts (Part. 2, Sect. 1, Chap. 3, para. 37). Due to this practice, the two main elements of the display are treated as separate items for both stores and maintenance and repair purposes.

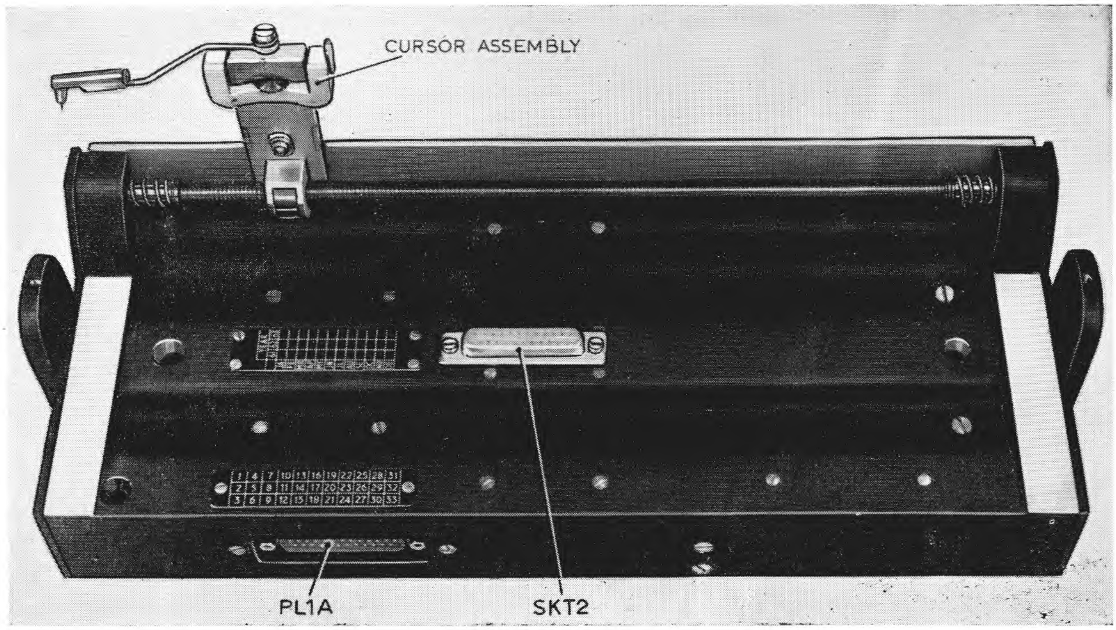


Fig. 1. Base recorder 10D/5826-99-945-6175 (Decca Type 968): Top

Display base (fig. 1, 2, 5)

2. The display base takes the form of a rectangular hollow casting with raised lugs at the rear carrying the leadscrew and cursor guide rail and two side members tapped to accommodate the cassette retaining screws (fig. 1). The leadscrew drive mechanism, filter networks and the a.c. source for cassette lighting are housed in the underside of the casting (fig. 2). These components are normally protected by a cover plate, not shown in fig. 2. In use, the cassette rests on the two machined faces on the upper surface of the base. Precise location is ensured by two dowel pins on the rear of the cassette, which enter corresponding holes in the base and the cassette is retained by two captive screws at the extreme ends of the cassette (Part 2, Sect. 1, Chap. 1, fig. 3). All electrical connections between base and cassette are automatically completed by PL1 on the cassette, entering SKT2 on the base when the cassette is fitted.

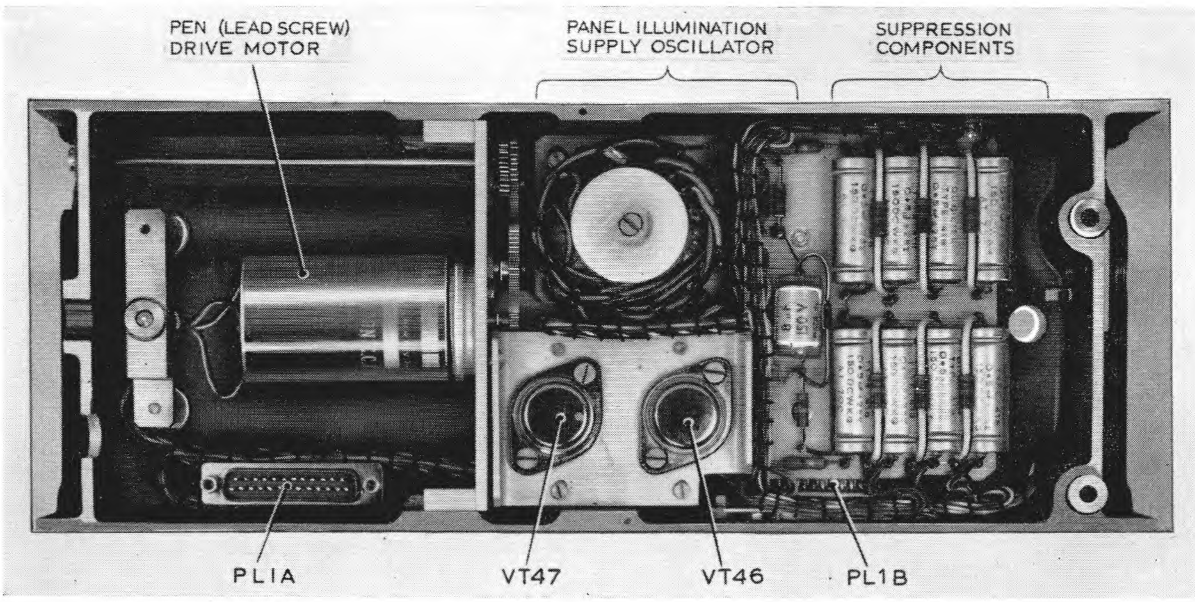


Fig. 2. Base, recorder 10D/5826-99-945-6175 (Decca Type 968): Underside

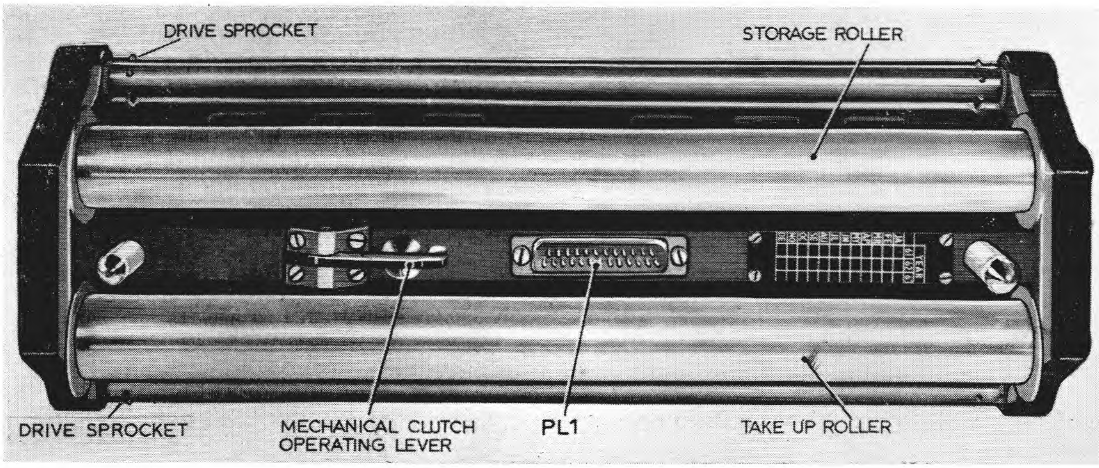


Fig. 3. Cassette, recorder 10D/5826-99-945-6177 (Decca Type 969): Underside

3. The X drive M motor is mounted longtitudinally under the base and drives the lead-screw via primary reduction gears mounted on a train plate towards the centre of the base casting. The leadscrew drives the cursor assembly via a split nut, which can be seen in fig. 1, and the cursor assembly slides on the vertical guide rail at the rear of the base; the edges of the guide rail are chamfered to retain the cursor. The lead screw is relieved at each end to prevent locking up of the drive if the cursor over-runs and a thrust washer and light spring are fitted over the relieved length to ensure that the split nut re-engages on the thread when the drive is subsequently reversed. As described in Part 2, Sect. 1, Chap. 2, para. 30, 31, the X drive motor is also employed for resetting of the cursor position and no separate reset facility is employed. The cursor pen assembly fits on a spring-loaded screw on the top cursor member as shown in fig. 1. It may be rotated sideways on this screw to permit removal of the cassette and may also be lifted slightly to clear the chart surface when a recorded track is not required.

4. The electronic elements fitted in the base comprise the cassette illumination oscillator VT46, VT47 with its associated components and the filter networks for both the X and Y drive motors and for the Y fast reset motor. The oscillator (fig. 5) is a conventional push-pull transistor d.c. converter circuit providing a square wave output at approximately 400 c/s. R111, C70, MR170 provide a forward starting bias and the switching frequency is determined primarily by the characteristics of the transformer T1. The d.c. supply for VT46, VT47 is obtained from the stabilized 24V line in the computer (Part 2, Sect. 1, Chap. 3, para. 33) via RV1 in the control unit: at the maximum setting of RV1 (24V applied), the 400 c/s output from T1 is of the order of 240V peak, falling as RV1 is rotated counter-clockwise.

5. Series capacitor-resistor filters, C71, R112, C72, R113 and C76, R118 to C78, R120, are connected between each motor control line and the common earth line to suppress switching transients and to avoid unwanted impulses being induced in adjacent conductors. All connections are made to the display base via the 25-pole plugs PL1A or PL1B. These two plugs are wired in parallel and are arranged so that alternative rear or side connection may be made to the base to suit installation requirements.

Cassette (fig. 4, 5)

6. The display cassette is shown installed and with a flight log chart in position in Part 2, Sect. 1, Chap. 1, fig. 3. Fig. 4 of this chapter shows the cassette viewed from the front with the illuminated chart display panel unfixed and turned back to expose the internal assembly. The cassette body houses the Y drive motor and the Y fast reset motor with its associated gearing and clutch operating solenoid. The gear drives to the upper and lower sprocketed rollers (seen in fig. 3) are housed in the right-hand side section of the cassette together with the clutch mechanism. The left-hand section carries two warning indicator lamps, ILP1, ILP2. Only the former is used in current Decca Navigator applications of the display head, the lower lamp, ILP2, is provided for use when the display is associated with a Doppler radar installation, when it provides a doppler system alarm.

7. The display face, over which the chart passes, is an electroluminescent panel. Connection to the

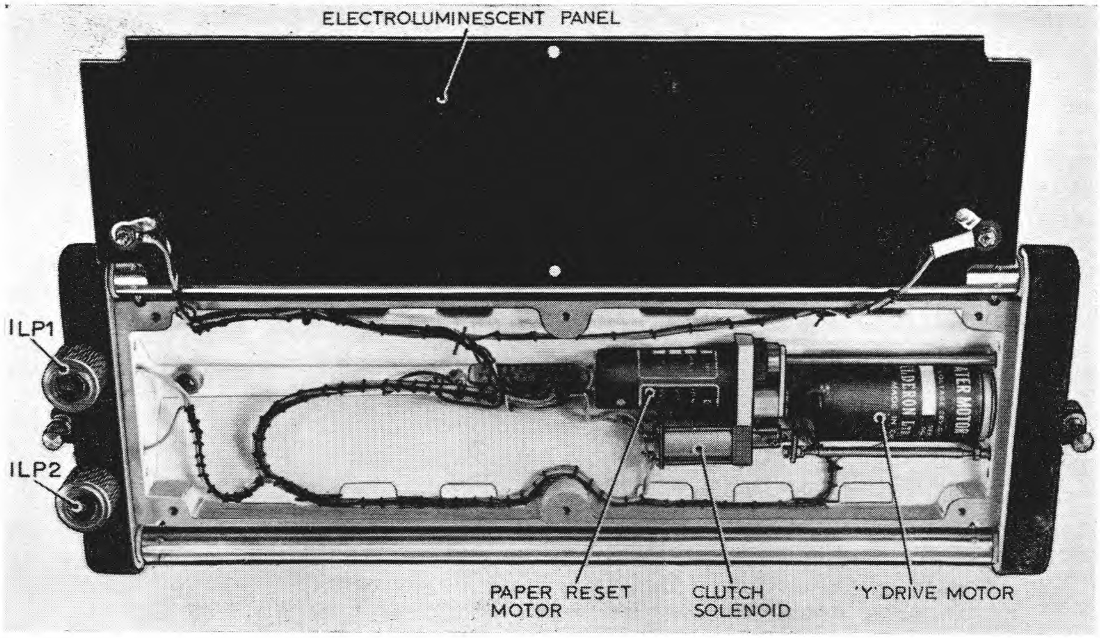


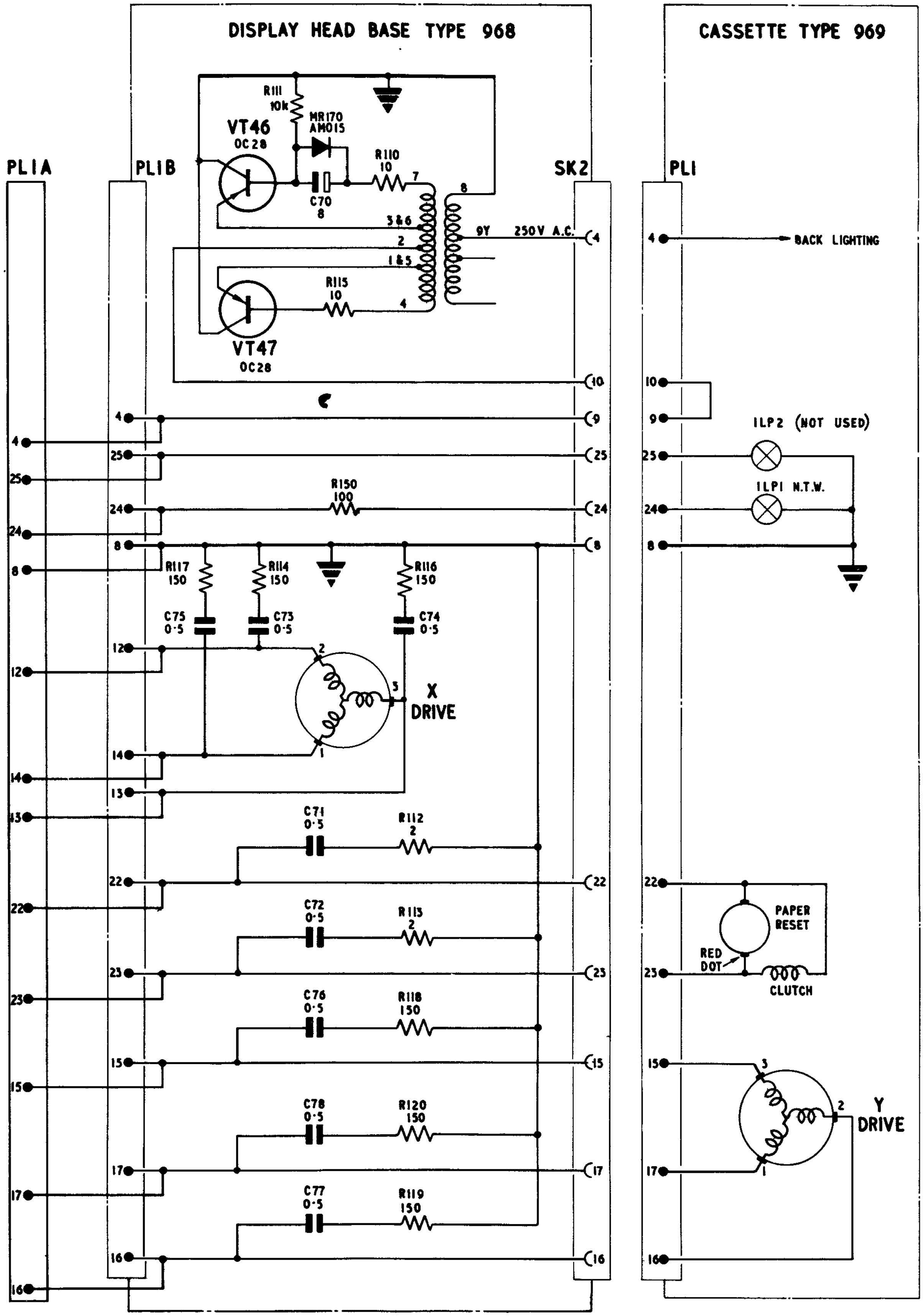
Fig. 4. Cassette, recorder 10D/5826-99-945-6177 (Decca Type 969): Top, with lighting panel lifted

two electrodes is made via terminal points on the rear of the panel at both ends, as shown in fig. 3, and excitation is provided for the panel by the 400 c/s d.c. converter unit embodied in the display base (para. 4). The panel provides even overall illuminations of the complete displayed chart area, measuring approximately 10 in. by 4·5 in.

8. The roll of chart is carried between storage and take-up spools at the rear of the cassette (fig. 3). The roll is loaded onto the upper, storage, spool (the lower spool when viewed from the rear in fig. 3). To facilitate loading, a special loading knob is provided with the cassette. This item, knob, cassette loading, (Decca Type A328A) 10AK/9456179, fits on the keyed end of the storage spool through a cut-out in one end plate of the cassette and is held in place by a captive knurled-head screw. An over-riding mechanical clutch is fitted to the chart drive mechanism released by a spring-loaded lever at the rear of the cassette (fig. 3), so that the drive is freed when the cassette is removed from the base and the chart may be fitted without resistance over the drive rollers.

9. The chart paper is loaded on the storage spool from the underside (viewed from the rear, as in fig. 3) so that the printed surface is inwards and the path of the paper is then over the adjacent sprocket drive roller, over the face of the display area, over the second sprocket roller, and on to the take up-spool, again entering under the spool as viewed from the rear. The chart rolls are fitted with tapered leader and tail ends for insertion into slots in the storage and take-up spools and paper tension is maintained by a pre-loaded spring tensioning device built into each spool.

10. The circuit of the cassette (fig. 5) is very simple. The Y drive motor, used also for slow Y resetting, is connected via PL1, poles 15, 17, 16, the associated suppression components being fitted in the display base. The d.c. fast reset motor, in parallel with the reset clutch solenoid, is connected via PL1, poles 22, 23 again with suppression components in the display base. The 400 c/s supply to the electroluminescent panel is provided via PL1, pole 4, the earth return for this supply being via pole 8, and a link between PL1, poles 9 and 10 is provided to break the d.c. supply to the lighting d.c. converter when the cassette is withdrawn. This feature prevents damage occurring due to operation of the converter in a no-load condition. The warning lamp ILP1 is connected between PL1, pole 24 and pole 8.



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Display Decca Type 968/969 : circuit Fig. 5

SECTION 2

FLIGHT LOG DECCA TYPE 9360

Chapter 1

OUTLINE OF SYSTEM

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LIST OF ILLUSTRATIONS

General

1. The equipment described in this section forms the flight log (pictorial display) sub system of ARI.23121/1 and ARI.23102/2. In these installations it operates from the outputs of the Decca Navigator Mk. 8A receiver (A.P.116B-0604-1) and the Decca Navigator Mk. 1 (Air) receiver (A.P.116B-0601-1) respectively. The three basic elements of the flight log sub-system are:

(1) The navigational computer (fig. 1). The Decca type number of the computer, Type 9360, is used for convenience to identify the complete sub-system in this volume.

(2) The computer set control unit (fig. 2).

(3) The display head, which comprises a base unit permanently installed in the aircraft and a hinged removable cassette carrying the display charts (fig. 3).

The general form and function of these elements is described in this chapter. Chapter 2 gives the installation data, operation and ground test procedures. The computer and associated control units are described in detail in Chap. 3 and the display head is described in Chap. 4.

Outline of computer operation (fig. 4)

2. The essential features of the computer are shown in simplified form in fig. 4. The analogue inputs to the computer are initially translated to digital form, and the resultant pulse trains separated in time: this facilitates the combination of inputs for secondary patterns (Part 1, Chap. 1, para. 6) as the time-multiplex pulse trains may be readily added or subtracted. An oscillator timing circuit provides the four time-separated pulse trains, which enable sequential operation of the computer. The time relationships of these four pulse trains is shown in fig. 4 and defined in Chap. 3.

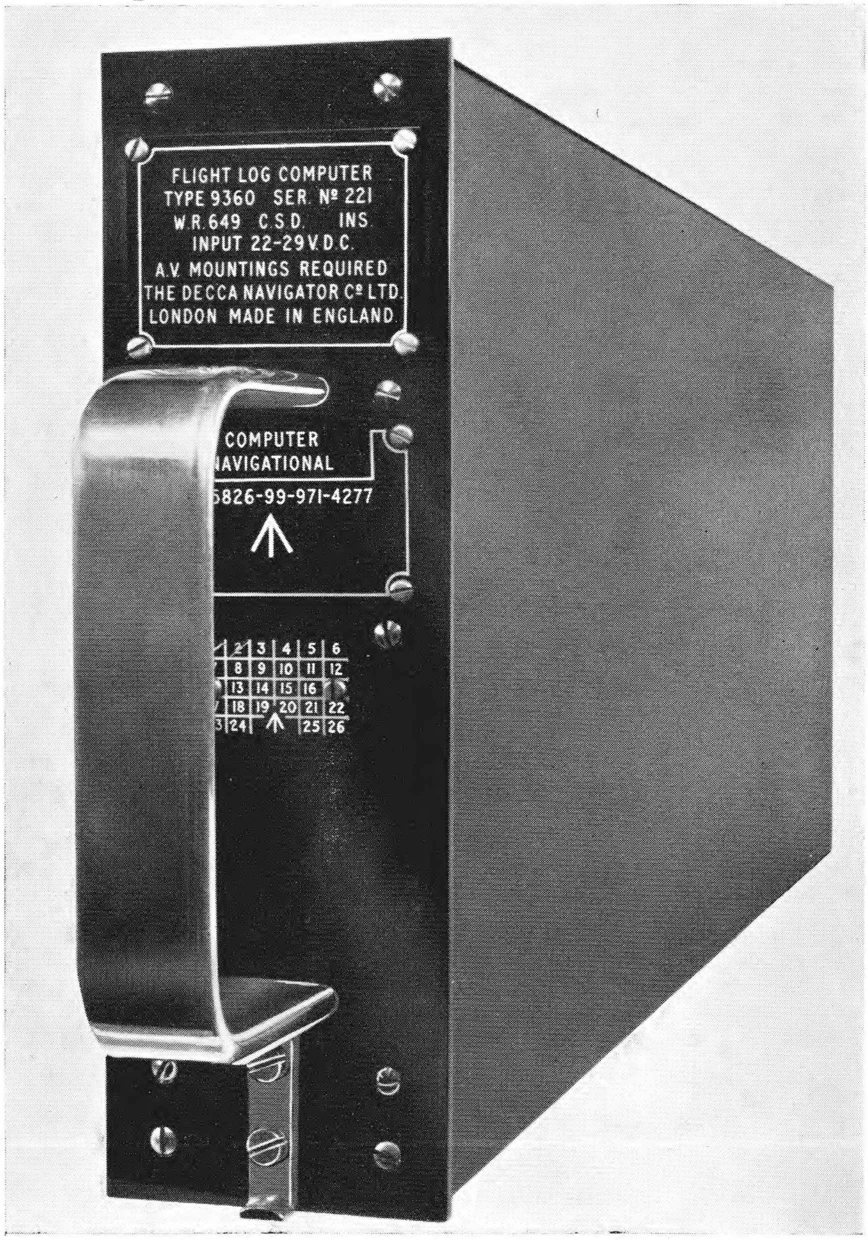

Fig. 1. Computer, Decca Type 9360

3. The input signals to the computer take the form of three sets of two varying d.c. voltages, each pair related to one of the three Decca patterns, Red, Green and Purple (A.P.116B-0601-1, Sect. 1, Chap. 1 and A.P.116B-0604-1, Sect. 1, Chap. 1). Each pair of voltages, which have a maximum excursion of the order of ± 15 volts, have approximately sine and cosine relationships to the phase angle between the Decca Master and Slave signals generating the appropriate position-line pattern and a 360° rotation of these inputs represents a lane in that pattern. The lane widths in the three patterns have the ratio: 4 Red : 3 Green : 5 Purple, measured on the respective base lines; the lanes are further grouped into 'Zones', comprising 24 Red lanes, 18 Green lanes and 30 Purple lanes respectively giving identical zone widths in all three patterns. To simplify the operation of the computer, all three inputs are translated to a common digital standard in terms of impulses per zone and all subsequent processing is effected on the signals in this form.

4. The computer input circuits comprise the three 'primary' servo systems: these are identical in electronic and mechanical design and differ only in the mechanical gear ratios required to standardise the impulses-per-zone output. The Red primary servo system comprises the Red primary servo unit and the Red primary servo circuit. The

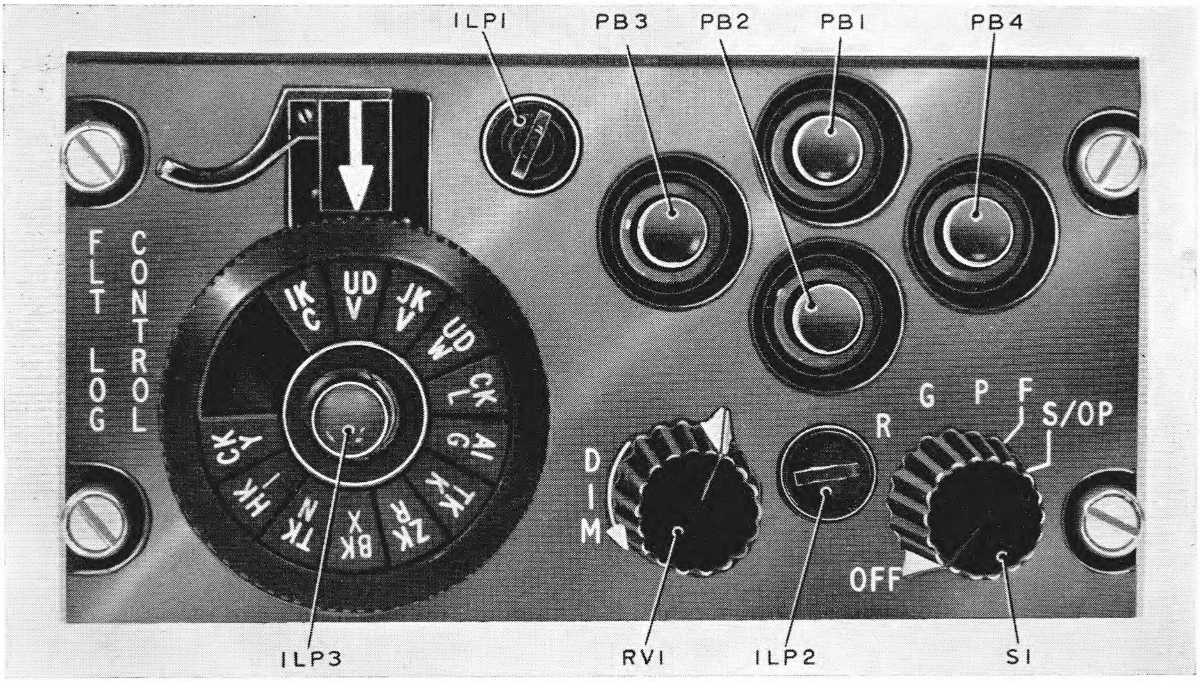

Fig. 2. Computer set control unit

primary servo unit comprises a M-motor driving two sin-cos potentiometer elements; the primary servo circuit comprises the electronic circuits completing the primary servo loop, and the primary scale selection circuits. The input signals (Red sine and cosine) are applied to the two sin-cos potentiometers which are connected in parallel. Each potentiometer is equipped with two wipers set at 180° and driven by the M-motor via appropriate gearing. The input signals produce on the sin-cos potentiometers a potential diagram which rotates as the aircraft moves accross the Red Decca

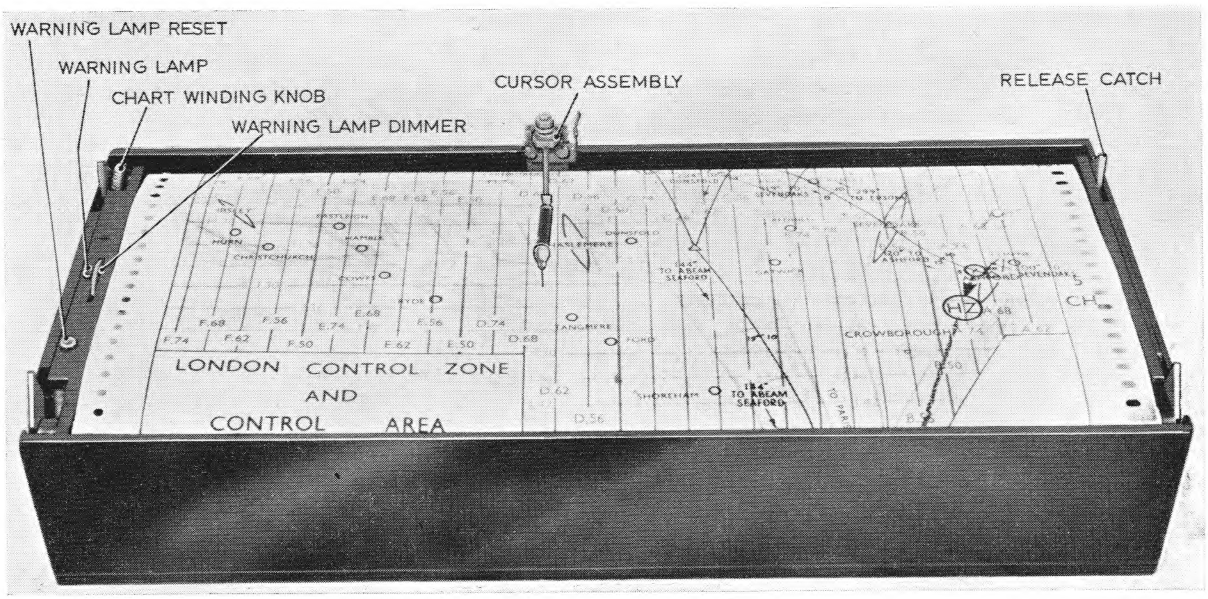

Fig. 3. Display head

pattern; this potential diagram performs one rotation per lane traversed. The track wipers pick up an error voltage which is dependent upon their position in the potential diagram. This error voltage is applied to an input comparator circuit, which routes the appropriate oscillator pulse train (para. 2) to one of two monostable circuits, depending upon the direction of the rotating potential diagram. The forward and reverse monostable circuits act as gated pulse generators. Each monostable circuit will, according to the pulse information received, apply its own pulses to a common reversible binary system. Each set of three pulses in one direction produces three different output states. These output state changes, applied via d.c. amplifiers, drive the M-motor over one complete revolution. The M-motor drives the potentiometer wipers to follow the null points in the potential diagram, thus closing the primary servo loop.

5. The outputs from the primary servo circuit are taken from the monostable circuits. The output pulses from these circuits are applied to the chart scale selection circuit. The circuit comprises five reversible binary counters, with a natural count of $2^5=32$, corrected by means of feedback to a count of 24. The five counter outputs, which contribute respectively 12, 6, 3, 2, 1 counts to each total count of 24, are connected each to separate X and Y gates. These gates are controlled by separate control unit key wards. This arrangement permits separate selection of X and Y scales ranging from $\frac{1}{24}$ to maximum scale. The gear ratios between the basic sin-cos potentiometer shaft and the M-motor is 24 : 800. Taking into account that a group of three pulses is required for one M-motor revolution and that 24 revolutions of the sin-cos potentiometer wipers constitute the traversing of one Red Decca zone, a maximum scale capacity of 2400 impulses per zone is obtained; this represents 9 inches movement of chart or cursor. As shown in fig. 4, a further 2 : 1 gear is included in the drive to the second sin-cos potentiometer wiper set. When this wiper set is used a maximum scale capacity of 2400/2; i.e. 1200 impulses per zone, is obtained. This effectively doubles the permissible operating speed of the display system and establishes the maximum chart scale at 4·5 inches per zone. Relay RL in the Red primary servo unit enables the input to the Red primary servo circuit to be switched between the two sets of wipers. Normally the 4·5 inches maximum scale is in use; the presence of 'multiplier' wards on the turret switch key energizes relay RL selecting the 9 inches maximum scale.

6. The Green and Purple primary servo systems operate in the manner described in paras. 4 and 5, but the gear ratios between the basic sin-cos potentiometer shaft and the M-motor are18 : 800 for Green and 30 : 800 for Purple, providing in each instance 2400 impulses per zone maximum, equivalent to a maximum chart scale of 9 inches per zone, as for the Red servo system. The divide-by-two facility, using 2 : 1 gearing between the two sin-cos potentiometer shafts is identical with that of the Red primary servo system.

7. Incorporated in each primary servo system is the lane slipping circuit. This facility (not shown on fig. 4) permits the quick resetting of the display position by one or more whole Decca lanes in either direction for any of the three patterns. It is operated from the control unit and it is achieved by blocking normal operation of the input comparator circuit and applying the appropriate oscillator timing pulses directly to either the forward or reverse monostable circuit as required, thus simulating forward or reverse servo operation. When lane slipping control is removed, the primary servo system will take up the correct fractional lane position but the display will be displaced by one or more whole lanes from its original position.

8. The digitized, time-separated outputs from the three primary servo systems, comprising forward and reverse X and Y impulse trains, pass to the summation circuit. In the normal state, the Red and Purple X and Y outputs are connected to the subsequent reversal circuits as Outputs I and II. If however a Green X or Y scale ward is used in the selected turret switch key, then the appropriate Green primary servo system output will replace the Red output as Output I and Red or Purple will form Output II for the appropriate X or Y circuit according to the further scale wards that are present on the key.

9. From the summation circuit the digitized information is passed to the Output I and II reversal circuits. The outputs of these circuits are combined and thus comprise single forward and reverse X and Y impulse trains, which are applied to the X and Y head servo systems. The purpose of reversal is to invert the sense of control over either head drive system when required. Conventionally, an increase in the Decca reading (a 'forward' movement) represents a movement to the right in the X co-ordinate or a movement upwards in the Y co-ordinate. If the orientation of the charted area is such that the higher lane numbers lie to the left or to the bottom of the flight log chart, the appropriate reversal circuits are operated by inclusion of the X or Y reversal ward on the key associated with that chart.

10. The X and Y, forward and reverse outputs from the reversal circuit are applied to identical X and Y head servo circuits. After amplification, the incoming pulses pass to separate three-stage, bi-stable counting circuits with a natural count of $2^3=8$, which produce 'staircase' d.c. outputs. At any moment, the required display head X or Y movement may be defined by the difference between the d.c. output levels present on the X or Y bi-stable counting circuits. The difference in output level is detected by a comparator circuit, which accordingly routes oscillator timing pulses to one of the two inputs of the appropriate display head M-motor drive circuit. This circuit comprises two monostable circuits, a common bi-stable system and a set of three power amplifiers; this arrangement is identical to that used in the primary servo system to drive the primary servo unit M-motor. Delay circuits are used to prevent hunting, when the aircraft follows a position line and alternate forward and reverse pulses may occur or when the use of secondary patterns cause rapidly following reversal. The delay circuits are controlled by the head servo circuits and prevent unnecessary reversal by introducing a short delay when required.

11. The impulse rate in the head servo system is determined by the timing oscillator frequency (the recurrence rate of the head servo timing pulses is one quarter of the oscillator frequency). The display head M-motor drive circuit will therefore receive one pulse each time a head servo timing pulse occurs if a difference count is registered, whereupon a balancing pulse is fed to the bi-stable counting circuit holding the lower count each time the comparator circuit responds to a count difference. This impulse is obtained from the operated monostable circuit in the display head M-motor drive circuit when it reverts to the stable state. Overspill of the counters is avoided in two ways. First, an automatic reset-to-zero control is applied by head servo timing pulses, whenever the comparator shows a parity count. Secondly, if the impulse rate is such that either counting circuit reaches a count of four without this reset occurring an inhibit circuit operates to inhibit the primary servo systems. As soon as the counter balance is restored, the input servo loops are restored: as the time taken for this operation is less than that represented by a one-half lane movement of the aircraft, the result is only a momentary lag in the displayed position while the primary servo systems step round to the current input positions.

12. A further detail of the head servo systems is the presence of the 'divide-by-two' circuit in the two counter input circuits. As shown in para. 5, the 9 inches per zone scale is obtained by operation of the 'multiplier' relay. The three multiplier relays (for the Red, Green and Purple primary servo units) are operated simultaneously and the 'divide-by-two' circuits are included to permit the use of the multiplied or 9 inches maximum scale on one display co-ordinate only. If, for example, the multiply-by-two facility is required on the Y co-ordinate, the turret switch carries the Y multiplier ward only: this energizes the primary servo unit multiplier relays and at the same time causes the operation of the X divide-by-two circuit. This circuit places an earth on the first stage output of the X counters and changes them to a half-scale (count of four) mode so that one voltage step is obtained per two input pulses. In this way the X drive is reduced from the 9 inches per zone, maximum mode, to 4·5 inches per zone, but the Y drive operates in the 9 inches per zone mode.

13. A reset circuit (not shown on fig. 4), operated from the control unit, provides slow reset for the display head, using the servo drive, by inhibiting the normal head servo operation and applying oscillator pulses direct to one of the two monostable circuits in the appropriate X or Y display head M-motor drive circuits. During slow resetting, the head servo input bi-stable counting circuits are prevented from counting and thus 'overspilling' by maintained application of reset-to zero oscillator timing pulses.

Display head

14. The display head (fig. 3) comprise the case and the cassette. The case, which houses the electrical components and mechanical elements of the curser (X) drive, is a cockpit fitting and is removed only for servicing or repair purposes. The cassette houses the chart (Y) drive and reset motors with their associated electrical components and mechanical elements. The cassette forms the display element and, although detachable, it is normally hinged forward to permit insertion of a pre-loaded chart spool. It is not intended to be removed for other than servicing or repair purposes.

15. The case takes the form of a shallow box with the cursor assembly carried by the guide rail at the rear edge (the upper edge when the display is mounted vertically). The cursor assembly is driven over the guide rail, via a steel cable, by the X drive M-motor: a slipping clutch is incorporated, both to prevent undue strain on the drive cable when the cursor is overrun and to permit manual movement of the cursor assembly. The track is recorded on the chart by a small ink-filled capsule pen attached to the cursor assembly. Electrical connections to the display head are made via a 15-pole socket, contained within the case, and so positioned as to permit rear or end entry of the input cable.

16. The cassette is fixed to the case by four catches. Upon release of both upper or both lower catches, the catches will move slightly outwards under the pressure exerted by a spring mounted in the case and it may then be hinged forward for acess to the chart spools. The cassette can be removed from the case by lifting the free end to the perpendicular position and releasing both remaining catches. All electrical connections between case and cassette are automatically completed via a 10-pole plug engaging a socket mounted on the underside of the cassette.

17. The cassette contains the chart drive assembly, which incorporates the Y drive M-motor and the d.c. motor which is used for fast reset. When the cassette is lifted away from the case, a release cam disengages the chart drive gearing to free the chart spool and permit easy operation of the chart winding knob. A solenoid performs this gear release electro-mechanically when the fast reset motor is used. The chart passes from one spool in the base of the cassette, over a roller at the top edge o the display area, over a second roller and on to the second (take-up) spool. The upper roller is driven and has sprocket teeth engaging the chart perforations. Chart tension is maintained by applying the drive to the spools at a slightly faster rate than to the sprocket roller via a system of ratchets and a clutch housed inside each spool assembly. The gears driving the sprocket roller and spools are housed beneath cover plates at each end of the cassette.

18. Also housed in the cassette is a small transistor oscillator unit providing the excitation supply for the electroluminescent rear lighting of the displayed chart on the cassette. A warning lamp, together with its associated reset pushbutton and brightness control, is mounted on the left hand end casing of the cassette: this is used as a 'Supply on' indicator.

Control unit (fig. 2)

19. The control unit accommodates all the operating controls for the computer and display head; these are: turret switch, function switch, display head back lighting intensity control (DIM) and four reset pushbuttons. The DIM control provides variable intensity chart lighting and an 'off' position. Illumination of the controls is provided by two lamps fitted on the front panel; these may be controlled from the aircraft instrument lighting dimmer.

20. The turret switch carries the selector (Part 1, Chap. 1, para. 9), equipped with up to twelve keys, each of which carries wards in the shape of contact rings in several of a maximum of 38 possible positions. These wards earth contact wires in the switch body when the selector is turned to bring the key to the uppermost (12 o'clock) position and in so doing they set up the appropriate scale, pattern selection and orientation conditions for the associated chart as described in para. 5 to para. 12.

21. The function switch has six positions: OFF, R, G, P, F, and S/OP. In the first position the computer and display head are disconnected from the power supply. The next three positions are used when it is necessary to set up the displayed position by lane re-adjustment in terms of the individual patterns, Red, Green and Purple (para. 7). The F position permits fast resetting in the Y co-ordinate and slow reset in the X co-ordinate and is used in initial setting-up or when changing charts. In the S/OP position, the display system is fully operational and X and Y slow reset facilities are available for fine adjustment.

22. Resetting of the display position is effected by the four reset pushbuttons, these are arranged in a diamond: operation of the upper button causes the chart to run downwards (i.e. equivalent of moving the plotted point up). In a similar manner, operation of the lower button causes an upwards chart movement and operation of the left-hand and right-hand buttons causes movement of the cursor to left and right respectively.

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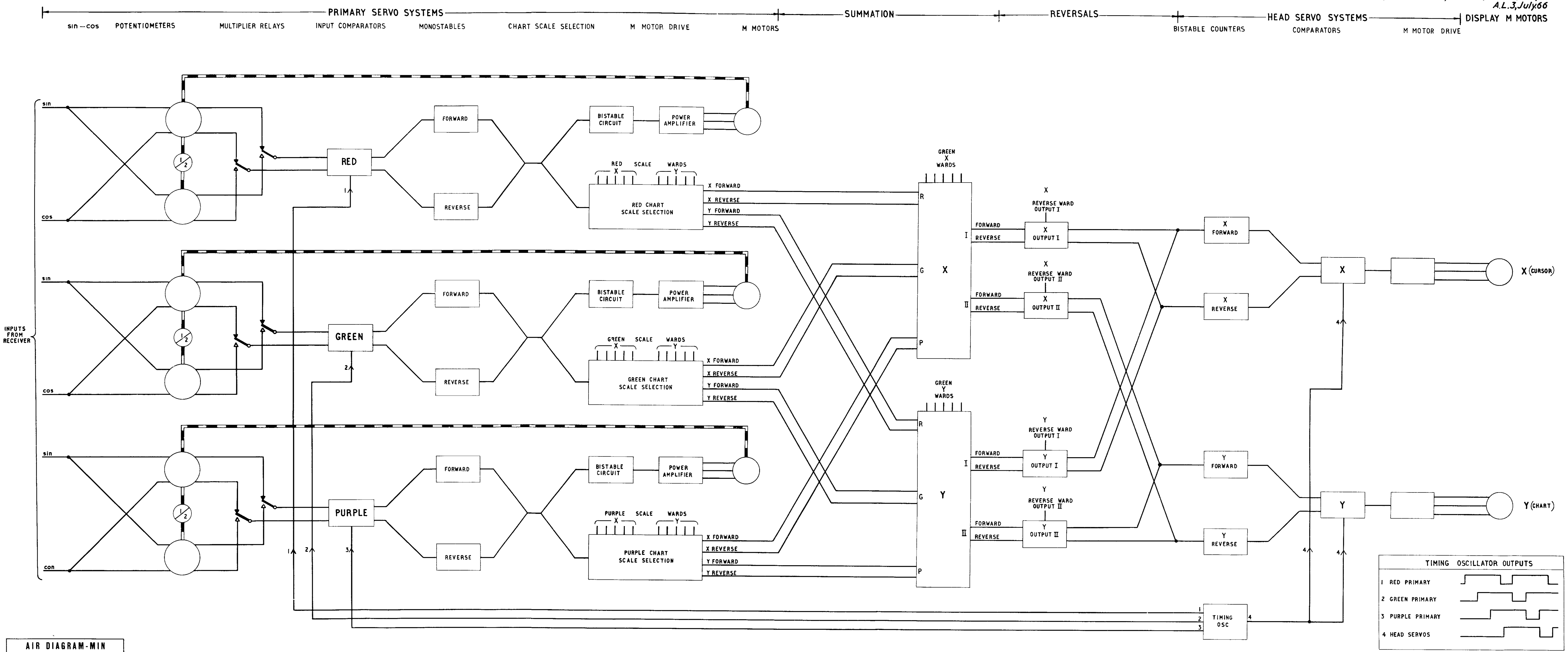

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116B-0603-MD20
BY COMMAND OF THE DEFENCE COUNCIL FOR USE IN THE NAVAL SERVICE/ROYAL AIR FORCE
ISSUE 1 Prepared by the Ministry of Aviation

Computer Type 9360 :functional block diagram

Fig. 4

D.89386 470 10/66 A (C)Ltd Gp. 956-3

Chapter 2

INSTALLATION AND OPERATION

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Installation: general

1. The following information is based on the current standard aircraft installation, ARI.23102/2 (receiver Mk. 1 (Air) with computer Decca Type 9360) and ARI.23121 (receiver Decca Mk. 8A with computer Decca Type 9360). The cable data are therefore based on the use of a junction box through which the receiver and flight log systems are interconnected.

Units of equipment

2. The main items comprising the basic flight log installations are illustrated in Part 2, Sect. 2, Chap. 1 and are listed (with reference numbers, overall dimensions and weights) in Part 1, Chap. 1.

Mounting and location of units

3. In general, a large degree of flexibility exists in the siting of the units subject only to the limitations noted in the following paragraphs.

Computer, navigational (Decca Type 9360)

4. The unit is designed to be accommodated in ½ A.T.R. (long) racking, and is located by a spring-loaded dowel pin. It is held in position by a locking device at the front. The racking is secured through the anti-vibration mounts and will not permit the unit to be mounted in any attitude other than the horizontal. The unit is sited in the aircraft in a position which permits sufficient space for ventilation, flexing of mountings and removal of unit. All electrical connections are made through two 32-pole plugs at the rear of the unit, PL1 — lower plug, PL2 — upper plug.

5. The normal racking includes A/V mounts with characteristics to BS, 2G100, Part 2, Grade B, but in certain helicopter installations where the air-frame resonances fall within a band of approximately 4-18 c/s the standard mount is inadequate. In these circumstances only, the use of Vibrashock Type 7002 (6 lbs.) A/V mounting is recommended. If the rack is mounted on a suitably A/V mounted equipment tray, the A/V mounts on the Decca rack are removed.

Indicator, chart and map, position (Decca Type 961)

6. The display head is mounted to permit easy viewing and access for adjustment by the appropriate crew member(s) and so that the cassette may readily be opened or removed (by operation of the release catches at the corners of the unit) to facilitate chart changing or servicing. The mounting attitude is limited only by the requirement for gravity feed of ink through the capillary-type pen. The display head is secured to its mounting plate by three captive nuts inside the base. Electrical connections are made via a 15-pole plug, which is recessed in the rear of the base. Anti-vibration mounts are not required.

Control, computer (Decca Type 941)

7. The computer control unit is designed for mounting in accordance with ARINC specification No. 306. The unit is located by indexed dowel pins in conjunction with a socket mounting plate and secured by four Dzus fasteners on the front panel: these fasteners normally mate with Dzus strips Type P3½ mounted at the side of the cavity. The unit is sited in the cockpit so that it can be viewed and operated by the pilot or navigator. Electrical connections are made at the rear of the unit via two 37-pole plugs, PL1 — lower plug, PL2 — upper plug. The plugs are identical but are not electrically interchangeable so a mounting plate assembly is used to ensure that the sockets are mated with the correct plugs. Anti-vibration mounts are not required.

Cabling

8. The complete interconnections for the flight log installation are shown in Fig. 1. In conformity with standard practice for ATR units these take the form of a complex wiring harness as distinct from a set of individual cables: the various conductor runs are identified as connectors 1 to 6 and are detailed in Tables 2 to 7. When more than one run terminates in one plug or socket connection, data on that connector will be found in the first table referring to the particular plug/socket termination.

Junction box wiring

9. A junction box or panel, having a minimum of 17 terminals is required to terminate the two main wiring harnesses:

(1) linking receiver, receiver control unit and decometers, and

(2) linking computer, computer control unit and display head and the incoming d.c. supplies.

In Table 1 are listed the junction box connections to the receiver outputs and aircraft supplies.

10. The junction box referred to in the connector tables is generally a 2 × 10-way Vickerstrip. Terminals numbers A1 to A10 and B1 to B10 are therefore used, as applicable to that form of connector. Terminal A1 is linked to B1 and terminal A2 is linked to B2. If no external cockpit lighting dimmer is provided then terminal A3 is linked to B1. Where the computer control unit lighting is controlled by an external cockpit lighting dimmer, this dimmer is connected to the junction box terminal A3 (using equipment wire to DEF12 Type 2, 14/·0076).

Terminals A6, A7, A8 and A10 may be used to anchor the several earth wires in the cable harness. These terminals are then connected to the airframe at a common earthing point near the junction box.

Operation

11. Operational procedures may be classified under four headings: —

(1) Ground checks.

(2) Pre-flight setting-up procedure.

(3) In-flight operation.

(4) Chain and chart changing.

The operational functions of the flight log installation are outlined in Part 1, Chap. 1 of this Air Publication.

Ground checks

12. A thorough examination of the flight log installation should be made before power is applied to the equipment and before any functional tests are made. The following is a summary of the points to be checked: —

(1) Ensure that the locking device holding the computer is tightened sufficiently to prevent the unit moving or vibrating in its mounting rack.

(2) Check all mounting bolts for security.

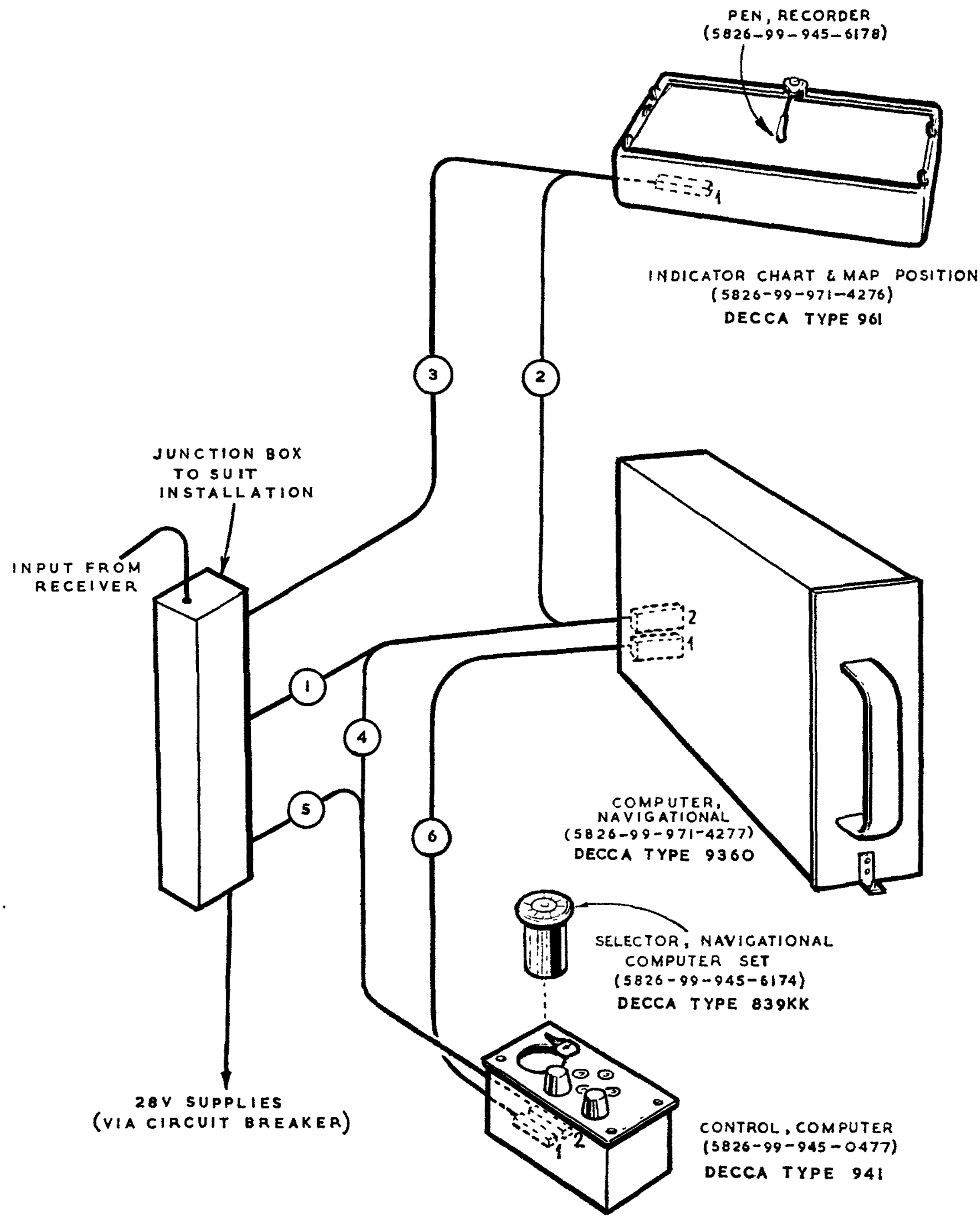

Fig. 1. Installation interconnection diagram

(3) Examine all plug and socket connections for firm union and check that the cables are in good condition.

(4) Operate all controls to ensure that they function smoothly and have not been damaged during installation.

(5) Check bondings between units and to airframe.

13. The functional ground checks on the flight log installation may be made either on received chain signals or on signals provided by a signal generator 10S/9458648 (Decca Type 9351) 10S/17777 (Decca Type 9209) or 10S/17783 (Decca Type 870). The signal generator should be coupled to the receiver installation and set at a suitable level (on a chain frequency not locally receivable) as described for receiver ground testing in the appropriate Air Publication. In practice it is convenient to perform the flight log test immediately following such receiver testing. In either method the flight log installation is dependent upon the Decca receiver for its input signals. It is assumed therefore in the following checks that the Decca receiver is switched on, set up and serviceable. The ground check procedure provides a brief check on the serviceability of the flight log installation: the complete first line test procedure is detailed in Part 3, Sect. 2, Chap. 1.

14. The following items of test equipment are required to carry out the ground check procedure:

(1) Flight log turret switch (selector, navigational computer set 10D/9456174) loaded with test keys XIA, XIB, XIC.

(2) Test chart 105/9558081 Decca Type 9161-CB.

15. The chart spool is loaded into the display head cassette as follows:

(1) Swivel display head pen to one side. Release both lower catches. Cassette will automatically swing upwards by about half an inch. Lift free end of cassette until it is perpendicular to base. (If required the cassette can now be completely disengaged from the base by releasing the two top catches and lifting clear).

(2) Pull back hinge plate on right-hand side of chart spool location. Insert loaded spool, ensuring that peg locates correctly in spool end. Close hinge plate.

(3) Pull approximately 12 inches of chart from loaded spool, lower cassette back into base and depress until lower catches engage.

(4) Release top catches. Cassette will swing upwards by about half and inch. Lift free end of cassette until it is perpedicular to base.

(5) Feed chart over free roller and sprocket roller and insert T-shaped end into slot of take-up spool. (The term 'take-up" is used for convenience in describing the loading procedure. In use, either spool can be defined as the take-up spool, depending upon the direction of flight).

(6) By turning the knurled winding knob in anti-clockwise direction, wind and guide approximately $1\frac{1}{2}$ turns of chart onto take-up spool. Check that chart perforations engage correctly in sprocket roller teeth and that chart is taut after the operation has been completed.

16. The test keys are inserted in the turret switch in the following manner: —

(1) Rotate rear knurled locking ring anti-clockwise until the first key slot is visible.

(2) Insert test key XIA through the locating hole in the front plate.

(3) Rotate the locking ring sufficiently to lock the first key and expose the next slot, repeating until all three test keys are inserted. Finally rotate the locking ring until its cut-away again aligns with that in the main barrel of the turret switch.

Insert turret switch into control unit, depressing stop catch and aligning the cut-away in the turret switch face with the key window at the top-dead-centre position; check that locating stop catch locks in when the turret is in position.

17. When testing the flight log installation from received Decca chain signals, the receiver should be set to ensure an uninterrupted input to the computer (i.e. in the normal operating state). The ground check procedure is as follows: —

(1) Switch on flight log installation by setting function switch of computer control unit to any position other than OFF. Note that the 'on' lamp on the display head is illuminated in all positions of the function switch other than OFF.

(2) Check the panel illumination of the flight log control unit. If this is connected to an external dimmer, ensure that this control functions correctly. Test mechanical dimmer of the display head 'on' lamp. Check that the intensity of the display head chart illumination is varied by the dimmer control on the computer control unit. Ensure that the turret switch lamp is illuminated.

Note . . .

Panel and display head chart illumination is of low intensity. If these tests are performed in full daylight, screening may be necessary to make the lighting visible.

(3) Set function switch to F and ensure that the upper and lower reset pushbuttons, when depressed, produce fast chart reset in the appropriate directions. Ensure that left and right reset pushbuttons provide slow pen reset in the appropriate directions. Set function switch to S/OP and check that all four pushbu.tons, when depressed, provide slow reset in the correct directions.

(4) Select test key XIA and set function switch to S/OP. Set display head pen to point A on test chart using the reset buttons to position chart and pen. Set function switch to R and depress the upper reset pushbuttons. Ensure that the pen follows the 'XIA' line on the test chart and that when the pushbutton is released, the pen comes to rest at a line intersection. This will be a multiple of 0·375 inch in both horizontal and vertical axes from point A on the test chart. Repeat this test using the lower reset pushbuttons when pen will move in the opposite direction. Check that when the function switch is set to G or P, depressing the upper or lower reset pushbuttons produces no display head movement.

(5) Select test key XIB and repeat test (4) with function switch set to G. Distance traversed by the pen will be multiples of 0·5 inch, measured along horizontal and vertical axes from point A. Check that no display head movement results when depressing upper or lower reset pushbuttons when the function switch is set to R or P.

(6) Select test key XIC and repeat test (4) with function switch set the P. Pen travel will be in multiples of 0·3 inch measured along horizontal and vertical axes from point A. Check that no display head movement results from depressing upper or lower reset pushbuttons when function switch is set to R or G.

18. The following procedure should be followed when testing the flight log installation on a Decca signal generator output:—

(1) Perform operations (1) to (3) inclusive, as described in para. 17.

(2) Operations (4) to (6) inclusive, should be modified as follows: —

Set the Red decometer lane and fractional pointers to zero. Select test key XIA and set function switch to S/OP. Set pen to point A on test chart. Set signal generator phase rotation motor to a suitable speed and switch on. Ensure that the pen travels along the 'XIA' line and that the number of revolutions of the Red decometer fractional pointer coincides with the indications printed on the test chart. Repeat with signal generator phase control rotating in the opposite direction, driving the pen back to point A.

Repeat for Green and Purple, using test keys XIB and XIC, pen should follow the appropriate line in each instance.

Preflight setting-up procedure

19. It is assumed in the following procedure that the Decca receiver installation is switched on, set up for flight and checked for correct functioning. Note that the operation of the flight log controls has no effect on the decometers and operating the reset controls on the decometers has no effect on the flight log installation.

(1) Insert chart spool in display head cassette and load turret switch into control unit. The display head cassette must be loaded with a suitable flight log chart and the corresponding keys fitted to the control unit turret switch.

(2) Switch on flight log installation by setting the function switch to F and ensure that the display head 'on' lamp lights up.

(3) Lift display head pen and use the upper or lower reset pushbutton to bring the required chart into view.

(4) Select control unit turret key appropriate to the chart in use.

(5) Note the decometer readings and determine the correct position in the Decca lattices printed on the flight log chart. Set the display head pen approximately to this position. Set the function switch to S/OP, lower pen onto chart, and position the pen accurately on the correct position.

In-flight operation

20. During the flight periodic checks should be made of the flight log indication against the Decometer readings. Deviation can be due to either a fault occuring in the flight log equipment or loss of lanes resulting from, for example, temporary loss of signal in very high noise conditions or sudden and abnormal change in aircraft direction or attitude.

21. If, during the flight, the pen position deviates from the correct position by one or more whole Decca lanes in any pattern as indicated above, the lane slipping facility can be used for correction. The three lane slipping positions, R, G and P of the function switch enable this correction to be made individually in each pattern. With the function switch set to P, for example, a change of exactly one lane in the Purple pattern is made by holding down the upper or lower reset pushbutton (to add or subtract a lane respectively) until the flight log pen has traversed more than half a lane of that pattern. If the pushbutton is then released, the pen will continue moving until it has taken up its position exactly one Purple lane away from the original setting. If the pushbutton is released before half a lane has been traversed the pen or chart will return to its original position.

Chain and chart changing

22. Charts, which cover specific routes, are normally marked with 'change points' near the edges, and as soon as the pen reaches a change point the next chart should be selected. The key coding for the next chart is printed within a ring alongside the change point, together with a square symbol within which is shown, for convenience in chart changing, a figure indicating the number of charts on the roll that have to be skipped (if any) before the new chart comes into view. The pen is set to the correct position on the new chart by reference to the decometer readings.

23. A change to a new Decca chain is necessarily accompanied by a chart change (para. 22). On a chart roll for a route involving a chain change, the change point at which the transfer to the new chain is made is marked with the decometer readings for that point in the new chain co-ordinates. Immediately before the actual chain change, it is convenient to set the decometers to these figures. At the change point the receiver is set to the new chain and the turret can then be turned to select the new key and the appropriate chart brought into position by means of the fast and slow reset facilities. Flight log indication is then checked against the decometers, adjusting the pen position as necesary.

TABLE 1

Junction box connections

Function	Junction box
Red horizontal receiver output	B6
Red vertical receiver output	B5
Green horizontal receiver output	B8
Green vertical receiver output	B7
Purple horizontal receiver output	B10
Purple vertical receiver output	B9
Earth	A6, 7, 8, 10
28V +ve aircraft supply	A1 – B1

TABLE 2

Connector 1: Computer to junction box

Type of cable: (a) 6 × Equipment wire, DEF12, Type 2, 14/·0076

(b) 5 × Equipment wire, DEF12, Type 2, 23/·0076

Computer PL2 32-pole socket Cannon DPA32-33S/3	Function	Wire type (see above)	Junction Box
1	28V +ve supply	(b)	B1
2	28V +ve supply	(b)	B1
3	earth	(b)	A6, 7, 8, 10
4	earth	(b)	A6, 7, 8, 10
9	28V +ve switched	(b)	B4
18	Red vertical	(a)	B5
19	Red horizontal	(a)	B6
20	Green vertical	(a)	B7
21	Green horizontal	(a)	B8
22	Purple vertical	(a)	B9
23	Purple horizontal	(a)	B10

TABLE 3

Connector 2: Computer to display head

Type of cable: 7 × Equipment wire, DEF12, Type 2, 14/·0076

Computer PL2	Function	Display head 15-pole socket Cannon DA-15S
12	X motor	2
13	X motor	3
14	X motor	4
15	Y motor	5
16	Y motor	6
17	Y motor	7
24	'on' lamp	8

TABLE 4

Connector 3: Display head to junction box

Type of cable: 7 × Equipment wire, DEF12, Type 2, 14/·0076

Display head 15-pole socket	Function	Junction box
1	earth	A6, 7, 8, 10
10	fast reset downward	A4
11	fast reset upward	A5
12	chart illumination	A9
13	28V +ve switched	B4
14	X motor centre-tap (earth)	A6
15	Y motor centre-tap (earth)	A7

TABLE 5

Connector 4: Computer to computer control unit

Type of cable: 14 × Equipment wire, DEF12, Type 2, 14/·0076

Computer PL2	Function	Computer control unit PL2 37-pole socket Cannon DC-37S
5	28V +ve switched	5
6	X reset	6
7	Lane set (not used)	7
8	Start relay	8
10	Ward 33	10
11	Ward 34	11
25	+ lane slip	25
26	−lane slip	26
27	Green lane slip selector	27
28	Purple lane slip selector	28
29	Y slow reset	29
30	Ward 35	30
31	Ward 36	31
32	Not used	32

TABLE 6

Connector 5: Computer control unit to junction box

Type of cable: (a) 7 × Equipment wire, DEF12, Type 2, 14/·0076
(b) 1 × Equipment wire, DEF12, Type 2, 23/·0076

Computer control unit PL2	Function	Wire type (see above)	Junction Box
3	earth (not used)	(a)	A6, 7, 8, 10
4	chart lighting dimmer	(a)	A9
9	28V +ve switched	(b)	B4
12	earth	(a)	A6, 7, 8, 10
13	earth	(a)	A6, 7, 8, 10
22	fast reset downward	(a)	A4
23	fast reset upward	(a)	A5
24	panel illumination	(a)	A3

TABLE 7

Connector 6: Computer to computer control unit

Type of cable: 32 × Equipment wire, DEF12, Type 2, 14/·0076

Computer PL1 32-pole socket Cannon DPA-32-33S/3	Function	Computer control unit PL1 37-pole socket Cannon DC-37S
1	Ward 1	1
2	Ward 2	2
3	Ward 3	3
4	Ward 4	4
5	Ward 5	5
6	Ward 6	6
7	Ward 7	7
8	Ward 8	8
9	Ward 9	9
10	Ward 10	10

TABLE 7—Cont.

Computer PL1 32-pole socket Cannon DPA-32-33S/3	Function	Computer control unit PL1 37-pole socket Cannon DC-37S
11	Ward 11	11
12	Ward 12	12
13	Ward 13	13
14	Ward 14	14
15	Ward 15	15
16	Ward 16	16
17	Ward 17	17
18	Ward 18	18
19	Ward 19	19
20	Ward 20	20
21	Ward 21	21
22	Ward 22	22
23	Ward 23	23
24	Ward 24	24
25	Ward 25	25
26	Ward 26	26
27	Ward 27	27
28	Ward 28	28
29	Ward 29	29
30	Ward 30	30
31	Ward 31	31
32	Ward 32	32

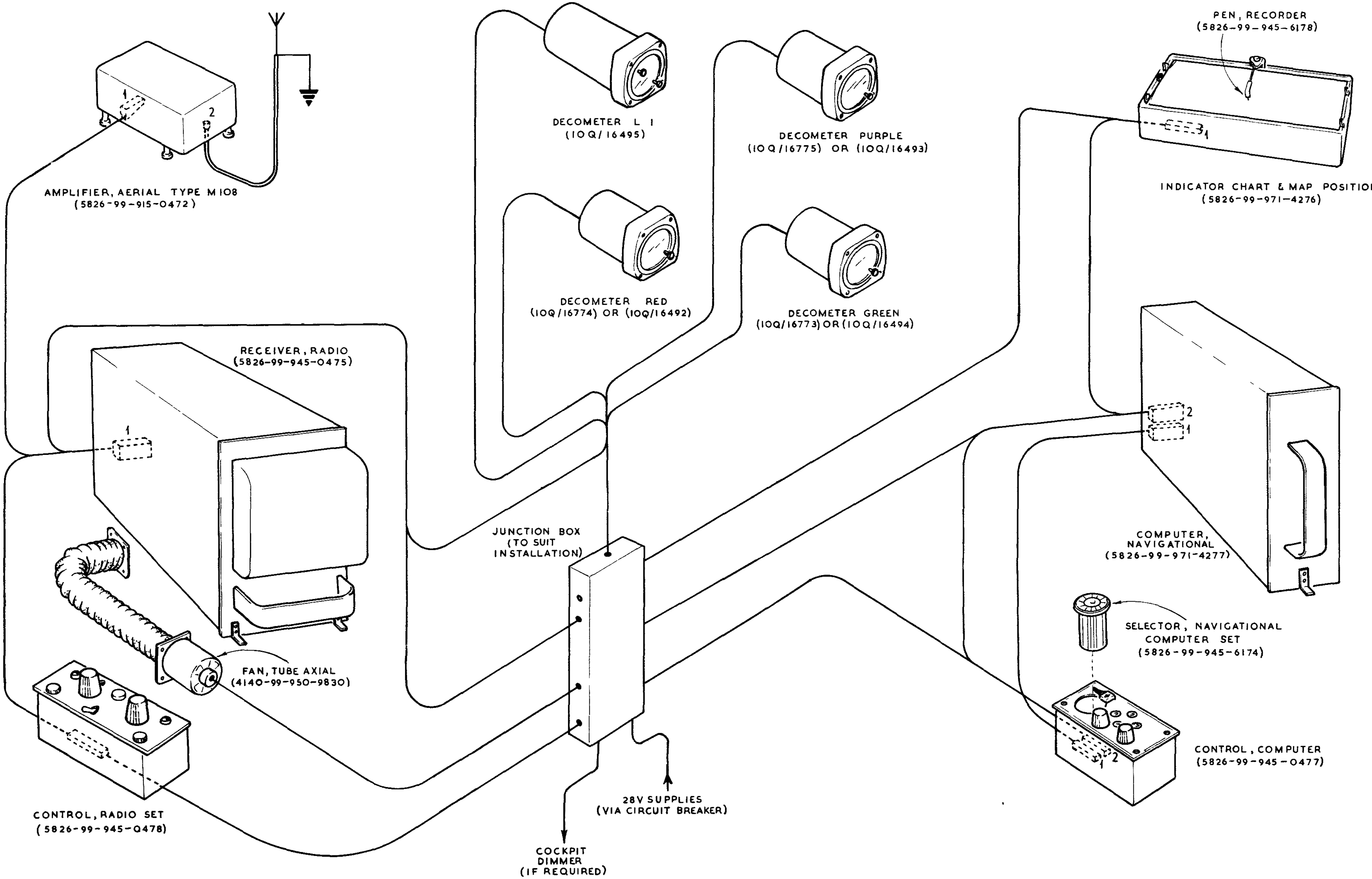

Fig. 2. Representative overall installation diagram Fig. 2.

Chapter 3

FLIGHT LOG DECCA TYPE 9360
COMPUTER, NAVIGATION AND CONTROL UNIT

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COMPUTER

1. The following description covers the processing of the applied Decca signals that is effected in the computer to provide the appropriate display head drive for any selected pattern/scale combination and the functions of the additional circuits, e.g. lane slip and reset facilities. The complete computer is shown in outline schematic form in figs. 2 and 3 which also show the division of the unit into circuit boards and sub units. When two or more similar sub-units exist, for example, Red, Green and Purple primary servo units, only one is described in detail. Operation of the remaining sub-unit(s) is identical, unless otherwise indicated.

2. The description is sub-divided in accordance with the physical break-down of the computer into separate sub-units (fig. 15). As shown in Part 2, Sect. 2, Chap. 1 the sequencing of the computing process is controlled by an oscillator. The operation of this circuit is described in para. 31 and 33 and the time sequence of the four main pulse trains is shown in fig. 1.

Primary servo units (fig. 4 and 5)

3. The computer input circuits consist of three primary servo units, Red, Green and Purple; each comprising an M-motor driving, through a reduction gear train, two sin-cos potentiometer elements. The units are identical in all but the mechanical gear ratios used (Part 2, Sect. 2, Chap. 1, para. 5 and 6), so that a Decca zone in each of the three patterns can be represented by the same distance on the display head charts, although the input data (one rotation per lane) are related to different fractions of a Zone.

4. The basic mechanical gear ratios between the M-motor and the sin-cos potentiometer element, permit a maximum chart scale of 9 inches per zone. In all three units an additional 2:1 gearing is included in the drive to the second sin-cos potentiometer element, producing a halved maximum scale of 4·5 inches per zone, which however doubles the computer maximum speed capability to 1,000 knots (along the baseline). A relay in each primary servo unit enables the input to the primary servo circuit to be switched between the two sin-cos potentiometer elements. All three relays are operated from a control circuit on the Purple primary servo unit (para. 53 to 57).

5. Each potentiometer element consists of two wipers, set at 180° separation, sweeping over a specially shaped carbon resistance element tapped at four 90° intervals. The two resistance tracks (4·5 in. and 9 in. per zone) are connected in parallel; two adjacent taps on each track are grounded and the sine and cosine receiver outputs are connected to the remaining two taps to produce a potential diagram, which rotates as the aircraft traverses the Decca pattern. This potential diagram has a null position represented by two equipotential points 180° apart: when the wipers rest in this position, no voltage appears between them but with any displacement of the wipers an error voltage is developed. The polarity of this voltage is determined by the flight direction and the magnitude is controlled by the displacement of the wipers from the null position. This voltage is applied via the primary servo circuit to operate the M-motor, rotating the wiper set so as to reduce the error voltage until the null position is attained.

Primary servo boards (fig. 4 and 5)

6. The Red, Green and Purple primary servo boards are identical and interchangeable. Each board comprises the primary servo and chart scale selection circuit for the appropriate pattern input. The primary servo circuit is sub-divided into: the input comparator circuit, the monostable and bi-stable circuits and the M-motor d.c. amplifiers. The Red circuit is described in the following paragraphs.

Primary servo circuit

7. The error voltage from the sin-cos potentiometer element is applied between the bases of VT24 and VT27 of the input comparator circuit. This circuit consists of two long-tailed pairs VT24, VT25 and VT27, VT26. The emitter followers VT24 and VT27 match the impedance of the carbon track to the transistor circuit. The base of VT25 is cross-coupled with the emitters of VT26 and VT27; similarly the base of VT26 is cross-coupled with the emitters of VT24 and VT25. With the wipers resting in the null position, the potential between them is zero, although both wipers may be negative or positive relative to ground. To accommodate this swing in mean voltage plus the error voltage, which may result in a total excursion above or below earth potential of up to ± 12V, the circuit is operated from a power supply isolated from the earth line.

8. The operation of the comparator circuit depends upon the two cross-coupling lines; the potentials closely follow the base potentials of VT24 and VT27. In the 'no error' voltage input condition, the potentials on both lines are equal; VT24 and VT27 conduct equally and VT25 and VT26 are cut off, which applies reverse bias to MR32 and MR33. Therefore the oscillator timing pulses applied to the junction C31, C32 cannot pass through the gates R47-R49, MR32 and R50-52, MR33. When an error voltage appears at the input, either VT25 or VT26 will conduct, reducing the reverse bias across the associated diode and permitting timing pulses to pass either through C31, MR32 or through C32, MR33. The comparator circuit thus converts the track error voltage into a pulse train which, depending upon the direction of rotation of the track potential diagram, is applied via one of the gates to one of two monostable circuits.

9. The two identical monostable circuits VT23, VT22 and VT16, VT17, act as gated pulse generators. The following description is based on the reverse monostable circuit VT16, VT17. In the quiescent condition, VT16 conducts and VT17 is cut off. When a pulse from the comparator circuit is applied via C12 then VT16 is cut off and VT17 conducts. This state will persist until the time constant circuit R20, C13 has discharged sufficiently to allow VT16 to conduct again. When this happens, a positive pulse from the collector of VT16 is applied via C10 and MR18 to the junction of C15, C16 (the input to the binary counter VT18, VT19).

10. Two gates are connected to the collector of VT17:—

(1) R29, MR25, C18, which controls the carry pulse to the binary system.

(2) R30, MR21, C25, which controls the binary system feedback.

Both gates are open during the period while VT16 is cut off and VT17 is conducting. The positive collector potential of VT17 is applied via R29 to the anode of MR25, the cathode of which is held at a positive potential through R36, and it is also applied via R30 to MR21, the cathode of which is held at a positive potential by the base-emitter junction of VT19.

11. The reversible binary system, comprising the two diode-gated binary counters VT18, VT19 and VT20, VT21, has a natural count of four, reduced by corrective feedback to a count of three. Each series of three pulses, applied in one direction, causes three different output states in sequence, the circuit reverts to the first state on the fourth pulse, i.e. the first of the next series of three pulses. The corrective feedback is obtained as follows.

12. Assuming VT18 conductive and VT19 cut off; a positive pulse applied to the junction C15, C16 reverses the circuit state. The resulting positive-going pulse from the collector of VT19 passes through C18, MR25, part of an open gate, to the junction C22, C21, the input to the binary counter VT20, VT21. Assuming this circuit to be in the condition VT21 conductive, VT20 cut off, the incoming pulse will cause VT21 to cut off and VT20 to conduct. This results in a positive-going pulse from the collector of VT20, which is applied, via C25, MR21, part of an open gate, to the base of VT19, causing this transistor to cut off again and VT18 to conduct. This feedback pulse from the collector of VT20 causes the bi-stable circuit to change state without the application of an external pulse.

13. The primary servo unit M-motor is operated by a set of three d.c. amplifiers VT10/VT11, VT12/VT13, VT14/VT15. The M-motor rotates in steps of 120° when its three coils are energized sequentially. The direction of rotation depends upon the sequence of operation of the d.c. amplifiers and this in turn is determined by the binary system. Amplifier VT10/VT11 is connected via diode gate MR19, MR29 to the collectors of VT18 and VT21, amplifier VT12/VT13 is connected to the collector of VT19 and amplifier VT14/VT15 is connected to the collector of VT20.

14. A motor coil is energized when the second transistor of the appropriate amplifier is conducting and thus the first transistor is cut off: this requires a positive (or minimum negative) base potential on the first transistor. This condition occurs in amplifier VT12/VT13 when VT19 conducts, similarly in amplifier VT14/VT15 when VT20 conducts. The diode gate input to VT10 permits this condition to occur in amplifier VT10/VT11 only when both VT18 and VT21 conduct; when one or both of these transistors are cut off, the negative collector potential will cause VT10 to conduct.

15. The three sequential states of the binary system, with input pulses from the reverse monostable circuit VT16/VT17, are: —

(1) VT19, VT21 cut off; VT18, VT20 conducting; and thus VT15 conducts.

(2) VT18, VT20 cut off; VT19, VT21 conducting; and thus VT13 conducts.

(3) VT19, VT20 cut off; VT18, VT21 conducting; and thus VT11 conducts.

This sequence causes the M-motor to drive the track wipers towards the null position. If the polarity of the error voltage is reversed (i.e. the rotation is forward), then the input pulses to the binary system are routed from the forward monostable circuit, the binary count is reversed and the M-motor is driven in the opposite direction.

Chart scale selection circuit

16. The chart scale selection circuit is controlled by control unit key wards and selects and routes the primary servo circuit output pulses to obtain the required chart scales. The circuit comprises five reversible binary counters, VT30/VT31 to VT38/VT39, together with their associated output gates. The pulse inputs are derived from the monostable circuits of the primary servo circuit. The collectors of VT16 and VT22 are connected via the diodes MR16 and MR30 to the junction C42, C43, the input to the first binary counter VT30/VT31.

17. Input pulses in the forward direction progress the binary count of the circuit as shown in Table 1. In this mode, output pulses are obtained from the collectors of VT30, VT32, VT34, VT36, VT38 and VT39; the carry pulses are derived from the collectors of VT31, VT33, VT35, VT37. The reverse progressive count is shown in Table 2. In this mode, output pulses are obtained from the collectors of VT31, VT33, VT35, VT37, VT38, VT39; and the carry pulses are derived from the collectors of VT30, VT32, VT34, VT36.

18. Two control lines are needed to govern the direction of the binary count as the input pulses are uni-directional. The forward control line applies the collector potential of VT23 of the forward monostable circuit to the forward 'carry' gates MR64, MR68, MR72, MR76 and the forward output gates MR44, MR48, MR52, MR56. Similarly the reverse control line applies the collector potential of VT17 of the reverse monostable circuit to the reverse carry and output gates. Both control lines are normally negative but acquire a positive potential when their associated monostable circuit operates. For example in the first binary counter; in the forward counting direction, the negative potential of the reverse control line, via R73, reverse-biases MR62, so that carry pulses can only come from the collector of VT31, similarly MR45 is reverse-biased, via R79, ensuring that output pulses can only come from VT30.

19. The chart scales of the computer Type 9360 are designed to match those of computer Type 9257, to enable the use of identical charts. The chart scale ratios of the computer Type 9257 are obtained by selecting and, when required, combining groups of 1, 2, 3, 6 or 12 pulses out of a 24 pulse cycle (Part 2, Sect. 1, Chap. 1). To match these ratios in the computer Type 9360, the natural count of $2^5 = 32$ of the chart scale selection circuit is corrected to 24.

20. In the chart scale selection binary system, this correction is obtained by feedback applied from the fifth to the fourth binary counter. In the forward counting direction, shown in Table 1, when state 15 is reached, input pulse 16 causes VT36 to cut off and VT37 to conduct and thus VT39 to cut off and VT38 to conduct. The positive-going pulse from the collector of VT38 is applied ,via MR77, to the base of VT37 which is cut off again, causing VT36 to conduct. This feedback loop reduces the binary count to the required 24. In the reverse counting direction, the feedback pulse is derived from the collector of VT39 and applied, via MR82, to the base of VT36.

21. Every train of twenty-four input pulses produces (as shown in Tables 1 and 2) 12, 6, 3, 1 and 2 output pulses from the first to the fifth binary counter respectively. The output gate of each binary counter divides the output into X and Y pulses. The following X and Y scale selection gates are controlled by control unit key wards. If a gate is not selected the X or Y output from the associated binary counter is blocked, e.g. selection of ward 1 opens the Y gate of the first binary counter and allows 12 out of every 24 input pulses to pass to the Y output, thus producing a $12/24 = \frac{1}{2}$ maximum Y output from the Red primary servo board.

22. The gating circuit of the binary counter VT30/VT31 is representative of the first four binary counters. The twelve pulses from this binary counter in the forward counting mode are applied from the collector of VT30 via C39 and the open gate MR44, C47 to the junction MR43, MR46. In the reverse counting mode the pulses are routed from the collector of VT31 via the open gate MR45, C47 to the same junction. The Y half-scale selection gate comprises MR43, C38, R69, R70. If ward 1 (Y12) is not selected (i.e. not grounded), MR43 is reverse-biased and the output pulses are blocked. If ward 1 is selected, then both cathode and anode of MR43 will be at ground potential and the pulses are allowed to pass to the Y output line. The identical X half-scale gate, comprises MR46, C48, R85, R84 and is controlled by ward 6. Selection of wards 1 and 6 produces one X and one Y pulse for each output pulse from the binary counter VT30/VT31. The collectors of VT32/VT33 are similarly connected to the Y6-X6 gates (MR47, MR50); the collectors of VT34/VT35 to the Y3-X3 gates (MR51, MR54); the collectors of VT36/VT37 to the Y1-X1 gates (MR55, MR58). Since pulses from VT38/VT39 are combined for the 2/24th scale selection, forward and reverse gates are not required so the collectors of VT38, VT39 are connected directly to the Y2-X2 gates (MR59, MR60).

23. The output pulses from the X and Y scale selection gates have no directional characteristics, so directional routeing is provided by common X and Y output gates. The Y output from the scale selection gates is connected to the junction of C93, C94. In the forward counting mode, diode MR83 cathode is positive and the anode is held positive via the forward control line. The pulses pass therefore via C93 and MR83 to the Y forward output line. No pulses can pass through MR84, which is reverse-biased by the reverse control line. In the reverse counting mode, the pulses will pass through C94 and MR84 to the Y reverse output; MR83 is now reverse-biased and blocks the Y forward output. The X output from the scale selection gates is similarly routed by diodes MR85, MR86.

Lane slipping circuit

24. The lane slipping facility enables quick resetting when the chart position presented on the display head disagrees with the correct position by one or more whole lanes. The control unit is linked to the lane slipping circuits by two selector and two control lines. The Green and Purple selector lines are applied to a common diode network MR68-71, mounted on the ancillary board (fig. 6). This network provides the Red, Green and Purple selector output lines, which control the individual operating circuits on the primary servo boards. The lane slipping direction is governed by the forward and reverse control lines, which are applied direct to all three operating circuits. In the lane slipping positions of the function switch, the control lines are normally open circuit but carry a negative potential when selected by the appropriate reset pushbutton.

25. The diode network on the ancillary board operates as follows: when the control unit function switch is set to P, a +28V potential is applied via MR71 and MR70 to the Purple and Red selector output lines. When the function switch is in the G position, a +28V potential is applied via MR68 and MR69 to the Green and Red selector output lines. When the function switch is set to R, all three selector output lines are open circuit.

26. The Red selector output line is connected to the base of VT29. When the Red lane slipping facility is selected, this line is open circuit, VT29 conducts and VT28 is cut off. The collector of VT29 applies, via PL/SKT 3, poles 21 and 18, a positive potential to the cathode of MR42. The forward and reverse control lines are connected, via MR41 and MR40 respectively and via R62, to the anode of MR42. If the 'upwards' and 'downwards' reset pushbuttons are not depressed, MR42 is unbiased and the Red oscillator timing pulses can pass through, maintaining normal servo operation. If either the upwards or downwards reset pushbutton is depressed, MR42 will be reverse-biased by the appropriate control line applying a negative potential to the anode, and normal servo operation will be stopped.

27. Depressing the upwards reset pushbutton applies a negative potential via MR39 to the junction of R57, R59, thus removing the reverse bias from MR37 by removing the positive potential from its cathode. The oscillator timing pulses can now pass via C35, MR37, C36 to the forward monostable circuit VT22/VT23, causing forward primary servo operation. Depressing the downward reset pushbutton removes the reverse bias from MR34 and routes the oscillator timing pulses to the reverse monostable circuit VT16/VT17 via C35, MR34 and C34, causing reverse primary servo operation.

28. In the G or P lane slipping positions of the function switch the Red selector output line applies +28V to the base of VT29, causing cut off. The negative collector potential of VT29 causes VT28 to conduct; it is also applied via R60 to the cathode of MR42. Whether the upwards or downwards reset pushbuttons are depressed or not, i.e. anode of MR42 negative or positive, the oscillator timing pulses will pass through MR42 and normal servo operation is not impeded. At the same time, the positive collector potential of VT28 is applied via PL/SKT 3, poles 20 and 19 to the anodes of MR35, MR36. This positive potential prevents oscillator timing pulses from passing these diodes, even if the upwards or downwards reset pushbuttons are depressed.

29. The Red selector output line, when selected, is open circuit. The Green and Purple selector output lines however carry a +28V potential when selected. Therefore in order to ensure identical operation of all three circuits, the connections to the collectors of VT228, VT229 (Green) and VT428, VT429 (Purple) are reversed. This transposition is made by changing the external interconnections to the circuit boards; at the Red board, pole 18 is linked to pole 21 and pole 19 to pole 30; at both Green and Purple boards, pole 18 is linked to pole 20 and pole 19 to pole 21.

Ancillary board (fig. 6 and 7)

30. The ancillary board comprises two separate sections. The timing section (fig. 6) provides the four time-separated pulse outputs which allow sequential operation of the Red, Green, Purple and head servo circuits. This section also contains the ancillary circuits which provide head servo delay and primary servo inhibit, when required. The second section (fig. 7) comprises the summation and reversal circuits, which combine the three primary servo board outputs and provide reversal of these outputs, when required. The lane slip selector diode network, described in para. 25, is also mounted on the ancillary board.

Oscillator and timing circuit

31. The uni-junction transistor VT1001 operates as a relaxation oscillator at a frequency of approximately 240 c/s. Its output in the form of negative-going, sawtooth pulses, is applied to the inverter circuit VT1002. The positive-going pulse output from this circuit is applied to the junction of C1005, C1006, the input to the two-stage bi-stable system VT1003/VT1004, VT1005/VT1006. The collectors of the four transistors in this binary sysetm are linked by diodes to combine their outputs in pairs. The combination VT1004, MR1013 and VT1005, MR1014 provides Red timing pulses; VT1003, MR1011 and VT1006, MR1018 provide Green timing pulses; VT1004, MR1012 and VT1006, MR1019 provide Purple timing pulses; VT1003 and VT1005 provide head servo timing pulses.

32. If the binary count is regarded as a continuous process, then it can be seen that the Red timing line will be positive in output states 3, 4, 1, which follow each other in direct sequence (fig. 1). The red computer circuits are operated by the leading edge of the positive pulse, which occurs at the start of state 3. The Green, Purple and head servo leading edges appear respectively at the start of states 4, 1, 2. Therefore the timing sequence becomes: Red, Green, Purple, head servo.

33. The head servo timing pulses are carried on six separate lines to prevent interference between X and Y, forward and reverse head servo operation and X and Y slow reset. The X and Y display head slow reset lines (PL11, poles E and R) have permanently forward-biased diode gates, which allow unrestricted passage of the oscillator timing pulses. The remaining four head servo timing lines are subject to control by the delay circuit (para. 34 to 37).

Head servo delay circuit

34. The head servo delay system introduces a short time lag (50 to 250 milliseconds) when pulses of opposite direction are applied in rapid sequence to the head servo circuits, in order to prevent unnecessary reversal of the display head M-motors. The delay system comprises four identical circuits VT1010/VT1012, VT1007/VT1009, VT1016/VT1018, VT1013/VT1015, which control the reverse and forward, X and Y head servo timing lines respectively. These circuits are controlled by the forward and reverse, X and Y delay control lines (para. 46 and 47), which normally carry a positive potential, but when pulses are applied to a head servo circuit the corresponding line attains a negative potential.

35. The Y delay circuits operate as follows: in the quiescent condition of the Y head servo circuit, the positive potential of the Y forward delay control line applied to the base of VT1018 causes this transistor to cut off and thus VT1016 is also cut off. The positive emitter potential of VT1016, via R1004, reverse-biases MR1007 and MR1002 and blocks oscillator timing pulses from the Y reverse head servo timing line. The identical delay circuit VT1013/VT1015, operated by the positive Y reverse delay control line, blocks the Y forward head servo timing line.

36. When input pulses are applied in the forward direction to the Y head servo circuit, the Y forward delay control line attains a negative potential and VT1018 starts to conduct. The resultant positive collector potential is applied via MR1067 to C1014 and via MR1027 to the base of VT1016. This transistor however remains cut off as the emitter is connected, via R1050, to the still-positive Y reverse delay control line. The negative potential of the Y forward delay control line, via R1043 and R1003, applies forward bias to MR1008 and MR1003, thereby allowing oscillator pulses to pass to the Y forward head servo timing line.

37. If the forward pulses to the Y head servo circuit are replaced suddenly by pulses in the reverse direction, then the Y reverse delay control line will assume a negative potential, while the Y forward delay control line reverts to a positive potential. The base of VT1015 becomes negative, causing this transistor to conduct. The positive

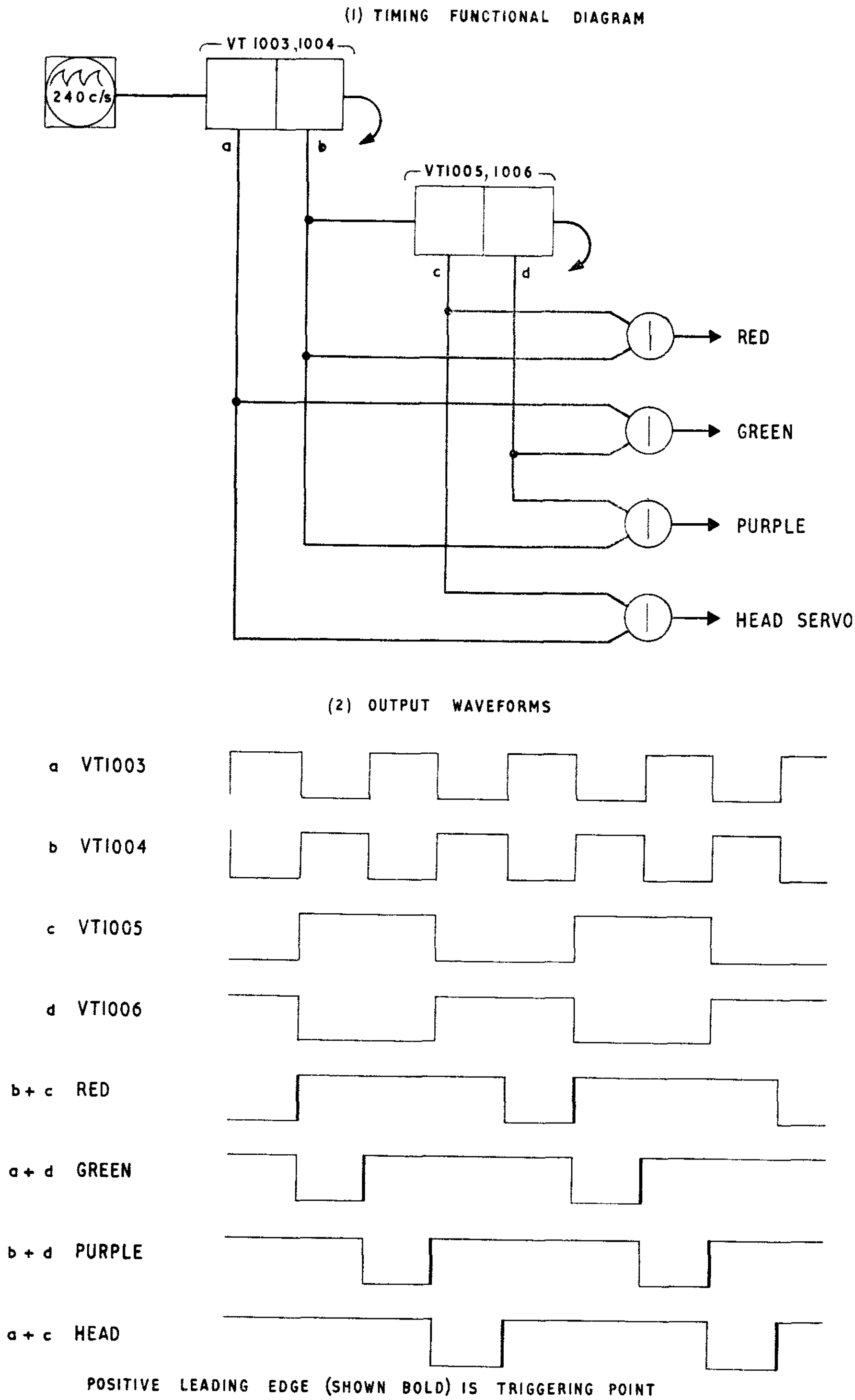


Fig. 1. Computer Type 9360: sequence of oscillator timing pulses

collector potential charges C1013 and cuts off VT1013, the emitter of which is connected to the positive Y forward delay control line. This positive potential also causes VT1018 to cut off and reverse-biases MR1008 and MR1003, blocking the Y forward head servo timing line. VT1016 remains conductive as the base will stay positive until C1014 is discharged and the resultant positive emitter potential maintains the reverse bias on MR1007 and MR1002, blocking the Y reverse head servo timing line. This reverse bias is removed when C1014 is discharged and VT1016 cuts off, and oscillator pulses can then pass to the Y reverse head servo timing line. A subsequent change from the reverse to the forward direction will be delayed by the charge on C1013.

Primary servo inhibit circuit

38. The primary servo circuits are inhibited when the head servo binary systems are unable to accept more input pulses (para. 52). In this condition the X and Y head inhibit line carries a positive potential, which is applied via MR1015, MR1016, MR1017 and R1006, R1008, R1010 to block oscillator pulses from the Red, Green and Purple timing lines stopping primary servo operation.

Summation circuit

39. The summation circuit consists of identical X and Y sections. The Y section operates as follows: the Green and Purple Y primary servo board outputs are routed directly to the Y output I and Y output II reversal circuits. The Red Y primary servo board output is routed via the auto-selector circuit VT1019. If no Green Y scale wards are selected, VT1019 is cut off and MR1028 and MR 1030 are reverse-biased. In this condition the Red primary servo board output passes through the unbiased diodes MR1029 and MR1031 to the junctions of C1023, C1024 and C1025, C1026, which form the input to the Y output I reversal circuit. The Green Y primary servo board output, in this condition, carries no pulses and the Red Y primary servo board output is the effective Y output I.

40. If one or more Green Y scale wards are selected, the negative ward potential applied via one or more of the diodes MR1036-MR1040 causes VT1019 to conduct, forward biasing-MR1028 and MR1030. The negative ward potential also reverse-biases MR1029 and MR1031. The Red Y primary servo board output will then pass through MR1028 and MR1030 to the junctions of C1027, C1028 and C1029, C1030, which form the input to the Y output II reversal circuit. The Red and Purple primary servo board outputs share therefore the Y output II reversal circuit when Green Y scale wards are selected. If both patterns are used to drive the Y axis, individual reversal is impossible. Normally however only one pattern, Red or Purple, would be used.

Reversal circuit

41. The reversal circuit comprises four identical sections: VT1021-VT1024, operating respectively on the Y and X, Output I and II pulse inputs. The outputs of the four reversal sections are combined to form Y and X, forward and reverse outputs. The Y output 1 circuit VT1021, controlled by reversal ward 32 (PL11, pole 17), is described.

42. If ward 32 is not selected, VT1021 is cut off. Its negative collector potential reverse-biases MR 1046 and MR1048, as their cathodes are connected to the +20V supply via R1071 and R1072. The Y output I forward input is therefore routed, via the unbiased MR1047, to the Y forward output (PL11, pole 14). The Y output I reverse input is routed, via the unbiased MR1049, to the Y reverse output (PL11, pole 13).

43. If ward 32 is selected, VT1021 conducts and its positive collector potential will remove the reverse bias from MR1046 and MR1048. The negative ward potential will, via R1073 and R1074, reverse-bias MR1047 and MR1049. The Y output I forward input is therefore routed, via MR1046, to the Y reverse output. The Y output I reverse input is routed, via MR1048, to the Y forward output.

Head servo board (fig. 8 and 9)

44. The X and Y head servo boards are identical and interchangeable. Each board contains the servo circuits required to convert the ancillary board outputs into the appropriate display head movement. In addition the boards carry the slow reset and multiplier circuits. The Y head servo board is described.

Head servo circuit

45. The Y forward and reverse inputs are applied, via the amplifiers VT826/VT827 and VT801/VT802, to forward and reverse binary systems, VT828-VT833 and VT803-VT808 respectively. Each binary system has an uncorrected maximum count of $2^3 = 8$. The three forward collectors of each binary system are connected via weighting resistors in the ratio 4:2:1 to a common output line. This arrangement enables the outputs to be expressed in staircase waveforms, each step indicating one input pulse.

46. The staircase waveform outputs of the two binary systems are applied to a comparator circuit. This six-stage circuit, symmetrically arranged in two sections, is similar to the primary servo comparator circuit (para. 7 and 8). The last stage in each section, VT836 and VT839, provides the reversal in polarity necessary to operate the head servo delay circuits on the ancillary board (para. 34 to 37).

47. When the output potential of one binary system is dominant, either VT835 or VT840 conducts. Assuming VT835 conductive, VT836 also conducts. Its negative collector potential is applied to the reverse delay control line (PL9, pole 18). Similarly if VT840 conducts, then VT839 will conduct and the forward delay control line (PL9, pole 20) assumes a negative potential. These two delay control lines are normally at a positive potential. The head servo delay circuits on the ancillary board react to a positive potential on a delay control line by barring oscillator timing pulses from the appropriate delay timing line, a negative potential allows pulses to appear on the delay timing line (para. 34 to 37). The difference count of the binary systems is thus converted into a pulse train which, depending upon the direction of the difference count, is applied to one of two monostable circuits.

48. The two monostable circuits, VT811/VT812 and VT818/VT817, together with the common bi-stable systems VT813/VT814, VT/816/VT815 and the three d.c. amplifiers VT819/VT820, VT821/VT822, VT823/VT824, form the display head M-motor drive circuit, which is identical to the primary servo M-motor drive circuit (para. 9 to 15).

49. The outputs of the binary systems must be balanced, after the difference count has been registered by the monostable circuits, to prevent overrun of the display head M-motor. This balancing pulse is applied from the operated monostable circuit to the opposite binary system. This is achieved by connecting the collector of VT812 in the reverse monostable circuit, via C856, MR850 to the second binary counter VT830/VT831, or via C855, MR846 to the first binary counter VT828/VT829 of the forward binary system. An identical connection exists between the forward monostable circuit VT818/VT819 and the reverse binary system.

50. To retain the full counting capacity, both binary systems are reset to the zero count condition when their outputs are balanced. These "reset to zero" pulses are derived from the operated monostable circuit upon return to its stable state and applied via MR826 or MR832, C868 to MR856. Head reset timing pulses are used as an additional resetting method, because both binary systems may count simultaneously when the computer is switched on, preventing operation of the monostable circuits. These pulses (PL9, pole 7) are applied via C867 to MR858.

51. The application of the reset pulses is controlled by the comparator circuit to prevent reset when a difference count exists. The collectors of VT836 and VT839 are connected via MR857, MR860 and R919 to the junction MR856, MR858. This junction is at positive potential via R918, R919 in the equal count condition when both VT836 and VT839 are cut off. Reset pulses can thus flow through MR858 and MR856. When a difference count exists, either VT836 or VT839 conducts and the negative collector potential blocks the reset pulses. The pulses passing through MR856 are applied, via C821 and the pulse amplifier VT810/VT809 to the second and third binary counter of both binary systems, via MR804, MR807, MR849, MR854.

52. Overloading of the binary systems is prevented by connecting the collectors of VT807 and VT832, via MR810 and MR852, to gates on the ancillary board (para. 38). When a binary system reaches the count of four, a positive-going pulse from VT807 or VT832 will cause these gates to block the primary servo timing lines causing the inhibition of the primary servo circuits.

Multiplier circuit

53. The computer provides chart scales in two ranges, up to 4·5 inches and up to 9 inches per zone maximum, these ranges can be selected independently for the X and Y co-ordinates. The selection is controlled by one X and one Y control unit ward, 35 and 36 respectively. The required switching, in two separate parts of the computer circuit, is carried out by the multiplier circuit which comprises the main control circuit and the X and Y head servo multiplier circuits.

54. The main control circuit, operated by the control unit wards, is mounted on the Purple primary servo unit and carries out two functions. It controls the operation of the Red, Green and Purple relays, RL2, RL202, RL402, mounted on the appropriate primary servo units. These relays switch the input to the primary servo circuits between the two sin-cos potentiometer elements of each primary servo unit. One sin-cos potentiometer element provides an output convertible into 1200 pulses per zone, equivalent to 4·5 inches per zone chart movement, the other sin-cos potentiometer element provides an output of 2400 pulses per zone, equivalent to 9 inches per zone chart movement. The main control circuit also provides the operating commands for the identical X and Y multiplier circuits on the head servo boards.

55. The X and Y multiplier circuits, VT625 and VT825, when neither ward 35 nor ward 36 are selected, apply a negative potential to the junction of the two output resistors of the first stage of their associated head servo input binary systems, which produces a halved output. The circuit in this condition also prevents the balancing of these first binary counters, and routes the balancing pulses to the second binary counter of each binary system. To prevent interference with the dividing function, no reset pulses are applied to the first stage of the head servo input binary systems.

56. The main control circuit operates as follows: when no multiplier wards are selected, the junction MR1253, MR1254 is at +28V potential and therefore relay RL2 and the parallel-connected relays RL202, RL402 are not operated; this selects the "4·5 inches per zone" sin-cos potentiometer elements to provide the computer inputs. The same positive potential, via MR1251 and R1251, causes VT1251 to conduct. Its negative collector potential is applied, via MR1257 and MR1258, to the X and Y head servo multiplier circuits. Taking the Y multiplier circuit as representative: the applied negative potential cuts off VT825. Its positive collector potential restores the output of the first stage of both input binary systems and allows balancing pulses to be applied to this counter. The applied negative potential also applies reverse bias to MR812 and MR850 preventing the balancing of the second binary counter. Thus, if no multiplier wards are selected, the chart scale range up to 4·5 inches per zone is selected on both axes; this provides a maximum speed capability of 1000 knots along the pattern baselines.

57. If one or both multiplier wards are selected then the junction MR1253, MR1254 is at a negative potential via one or both of these diodes and the primary servo unit relays are operated. This selects the "9 inches per zone" sin-cos potentiometer elements. Transistor VT1251 is cut off, but the selected multiplier ward(s) provides a negative potential via MR1255 and/or MR1256 to the X and/or Y multiplier circuit. Taking the Y multiplier circuit as representative: if no negative potential is applied, VT825 conducts. Its negative collector potential is applied via MR809 and MR843, to the junction R805, R806 and R891, R892, blocking the staircase output of the first stage of both input binary systems. The same negative potential also, via R828 and R895, reverse-biases MR811 and MR846, preventing the balancing of the first binary counters. A positive potential is applied, via R833 and R829, R896, to the anodes of MR812 and MR850; this allows balancing of the second stage of both binary systems. Thus if one or both multiplier wards are selected, the chart scale range up to 9 inches per zone is available on the selected axis or axes; if one axis is not selected, the automatic operation of the multiplier circuit will provide the 4·5 inches per zone range on that axis. The use of the "9 inches per zone" sin-cos potentiometer elements limits the speed capability to 500 knots along the pattern baselines.

Slow resetting circuit

58. Slow display head resetting is obtained by blocking the normal computor input to the appropriate X and Y head servo M-motor drive circuit and substituting "head reset timing" pulses in the required direction. This switching is carried out by identical X and Y circuits, which are controlled by "slow reset" lines from the control unit. These two lines are connected via the function switch to the appropriate pairs of reset pushbuttons. The Y slow reset line is operative only in the S/OP position of the function switch, the X slow reset line in both the F and S/OP positions. The Y circuit VT842 operates as follows:

59. The Y slow reset line is normally open circuit. In this condition, VT842 conducts and its positive collector potential maintains normal servo operation by forward-biasing MR833 and MR827 via R878, R874, R869, which permits operation of the monostable circuits by delay timing pulses. Simultaneously, head reset timing pulses are barred from the M-motor drive circuit by reverse-biasing MR836 and MR834 via R879 and R878, MR835, R875. Normal resetting of both head servo input binary systems is safeguarded by applying the positive collector potential of VT842, via R878, R922 to the cathode of MR856.

60. The Y slow reset line assumes a negative potential if the upwards reset pushbutton is depressed while the function switch is in the S/OP position. In this condition, normal head servo operation is prevented by blocking the delay timing pulses from the monostable circuits, as the negative control line potential reverse-biases MR833 and MR827. Forward drive of the display head Y M-motor is obtained by applying the negative control line potential to forward-bias MR834; this allows head reset timing pulses to operate the forward monostable circuit. Continuous resetting of both input binary systems is made possible by applying the same negative potential to the cathode of MR856. Transistor VT842 remains conductive and its collector potential, via R879, reverse-biases MR836, thus preventing head reset from operating the reverse monostable circuit.

61. The Y slow reset line assumes a positive potential, if the downwards reset pushbutton is depressed while the function switch is in the S/OP position. In this condition VT842 is cut off and the negative collector potential reverse-biases MR827, MR833, stopping normal head servo operation; it also forward-biases MR836, allowing head reset timing pulses to operate the reverse monostable circuit. Continuous resetting of both binary systems is made possible by forward-biasing MR856. The positive control line potential reverse-biases MR834, which prevents head reset timing pulses from operating the forward monostable circuit.

Power unit board (fig. 10)

62. On this board is mounted the whole of the power supply circuit, with the exception of the power transistor VT1210, which together with its heat sink forms a separate sub-unit. The power supply circuit is designed to operate from a nominal 28V d.c. input and provides four outputs:

(1) A 28V d.c. supply to the display head; this powers the oscillator providing the (a.c.) "Panelume" back lighting supply.

(2) A 28V d.c. supply to the control unit.

(3) A 20V stabilized d.c. supply to all computer circuits, with the exception of those listed in (4) below.

(4) Three 20V isolated ("floating") d.c. supplies to the Red, Green and Purple input comparator circuits. These supplies are subject to a degree of stabilisation.

63. When the control unit function switch is turned from the OFF position, relay RL1 is operated, via the start line (PL12, pole 5). The two parallel-connected contacts of this relay route the 28V d.c. supply, fused at 4A (FS1) to the control unit via PL12, pole 2, and to the display head via PL12, pole 4, and to the voltage regulator circuit.

64. The voltage regulator circuit provides the 20V stabilized d.c. power supply. The input supply is applied to a series stabilizer embodying a power transistor VT1210. The output voltage is monitored at the junction of the reference (Zener) diode MR1217 and R1203. The voltage across MR1217 is held constant at approximately 20V and variations in output voltage thus appear across R1203 and are applied to the amplifier VT1211/VT1212, which controls VT1210 base potential, to maintain the output voltage constant at 20V within $\pm 0 \cdot 5$V with variation in both input voltage and load current. C1211 is connected across the controlled output to suppress oscillation of the circuit. A 2A H.R.C. fuse (FS2) in series with VT1210 protects the transistor against overload. The output from the stabilizer circuit provides the d.c. supply, via PL12, pole 6, to all computer circuits, excepting the primary servo comparator circuits, and also provides the input to the d.c./d.c. converter circuit which generates the comparator supplies.

65. The d.c./d.c. converter circuit employs a conventional transformer/multivibrator oscillator using resistor coupling, emitter to base, between the junction VT1214, VT1213. Diodes MR1212 and MR1213 are included to the back e.m.f. of the transformer winding developing excess reverse voltage on the bases. The three transformer secondary outputs are individually rectified and smoothed to provide the 20V (nominal) d.c. supplies to the Red, Green and Purple comparator circuits. As the input to the converter is stabilized, a degree of stabilization is effected over these outputs but they are load-conscious and not as closely controlled as the 20V input line.

CONTROL UNIT (figs. 12, 13 and 14)

66. The control unit, the circuit of which is shown in fig. 12 carries all operating controls for the computer and display system. The majority of the control functions are defined in the preceding description of the computer. As shown in fig. 13 and 14, the controls comprise the turret switch (para. 67 and 68), the function switch S1, the display lighting control RV1 and the four display head reset pushbuttons PB1 to PB4. The front panel comprises a translucent plate, edge lit by two recessed lamps ILP1, ILP2, and has a black opaque outer surface. Control markings are engraved through this surface to the illuminated layer. The turret switch centre shaft houses a third illumination lamp ILP3, which is hooded to direct the light upwards onto the face of the selected key.

Turret switch

67. The turret switch comprises two parts:

(1) The main fixed switch-assembly, mounted in the control unit.

(2) The detachable turret (identical with that shown in fig. 3 in Part 2, Sect. 1, Chap. 3), which carries up to twelve cylindrical "keys", each providing earthing contacts ("wards") in a selected group of 38 possible locations along its length.

In principle the switch is simple: the main assembly is fitted with 38 gold alloy contact wires carefully aligned on a tagboard inside the top face of the assembly, so that they coincide with the 38 key contact locations when the turret is inserted. Turning the turret to bring any required key into the operational (12 o'clock) position completes an earth connection between the contact wires and an earth point, in the shape of a spring contact made to the body of the key, via the wards present on the selected key. This operation completes the necessary control operation in the computer to set up the required operating conditions, as described.

68. The keys (fig. 3 of Part 2, Sect. 1, Chap. 3) are inserted through holes in the front face of the turret and are retained by a captive, gapped, rotatable collar at the rear of the turret, which engages with a groove milled in the end of each key. The collar is turned to bring the gap opposite the required key position, the key is inserted and the collar then turned to lock the key in place. When the turret is loaded, the gap occupies a position in the blank arc of the turret, opposite the longitudinal key way which permits the insertion of the turret in the keyed switch aperture. The front face of the key is fitted with a moulded head carrying the three-letter code identifying the ward combination. The code is that printed on all flight log charts that are based on the pattern/scale conditions that will be set up by the key, so that the turret switch has only to be turned to bring the key coded to agree with the chart in use opposite the index marks to establish the correct operating conditions. The ward functions are listed in Table 3, and connections are shown in fig. 13.

Function switch and reset pushbuttons

69. In the OFF position of the function switch S1, the switch S1A removes the earth connection from the start line PL2, pole 10. This prevents operation of the start relay on the power unit board and isolates the computer from its 28V d.c. supply. In the two following, unmarked, positions of the function switch, the same connections as described for the R position (para. 70) are established: these two positions are used in alternative applications of the control unit.

70. In the R, G and P positions of the function switch, the upwards and downwards reset pushbuttons PB1, PB2 are connected, via S1B and S1D, to the forward (+) and reverse (−) lane slip control lines, PL2, poles 25 and 26. The normally open contact of PB2 is grounded via S1C, similarly the normally open contact of PB4 is grounded via S1E. In the G and P positions, switch S1F applies +28V to the Green and Purple lane slip selector lines respectively via PL2, poles 27 and 28.

71. In the F (fast reset) position of the function switch, the reset pushbuttons PB1 and PB2 are connected to control the display head Y reset motor. Switch S1F routes the +28V supply to PB1 and S1B connects PB1 to the upwards reset motor line, PL2, pole 23. Switch S1C maintains the earth connection to PB2, and S1D connects PB2 to the downwards reset motor line, PL2, pole 22. The slow left-right reset facility is established in this switch position by S1E, which applies the +28V supply to the normally open contact of PB4, and S1G which connects PB3 and PB4 to the L/R reset line.

72. In the S/OP (slow reset/operate) position of the function switch, the left-right reset condition remains as described in para. 71, and similar conditions are set up in the upwards/downwards slow reset circuit, via S1B and S1D connecting PB1 and PB2 respectively to the U/D slow reset line, PL2, pole 29. Resistor R1 prevents a short circuit occurring if both buttons are depressed simultaneously in this switch position. Switch S1C routes the +28V supply to PB2. The "lane set" connections made by S1G in the first two operation positions are not used with this computer.

TABLE 1

Forward count of chart scale selection binary system

Pulse	State	BINARY COUNTERS					Output pulse
		VT30 VT31	VT32 VT33	VT34 VT35	VT36 VT37	VT38 VT39	
0	0	01	01	01	01	01	VT39
1	1	10	01	01	01	01	VT30
2	2	01	10	01	01	01	VT32
3	3	10	10	01	01	01	VT30
4	4	01	01	10	01	01	VT34
5	5	10	01	10	01	01	VT30
6	6	01	10	10	01	01	VT32
7	7	10	10	10	01	01	VT30
8	8	01	01	01	10	01	VT36
9	9	10	01	01	10	01	VT30
10	10	01	10	01	10	01	VT32
11	11	10	10	01	10	01	VT30
12	12	01	01	10	10	01	VT34
13	13	10	01	10	10	01	VT30
14	14	01	10	10	10	01	VT32
15	15	10	10	10	10	01	VT30
16	16a	01	01	01	01	10	VT38
	16b	01	01	01	10	10	No output pulse
17	17	10	01	01	10	10	VT30
18	18	01	10	01	10	10	VT32
19	19	10	10	01	10	10	VT30
20	20	01	01	10	10	10	VT34
21	21	10	01	10	10	10	VT30
22	22	01	10	10	10	10	VT32
23	23	10	10	10	10	10	VT30
24	0	01	01	01	01	01	VT39

TABLE 2

Reverse count of chart scale selection binary system

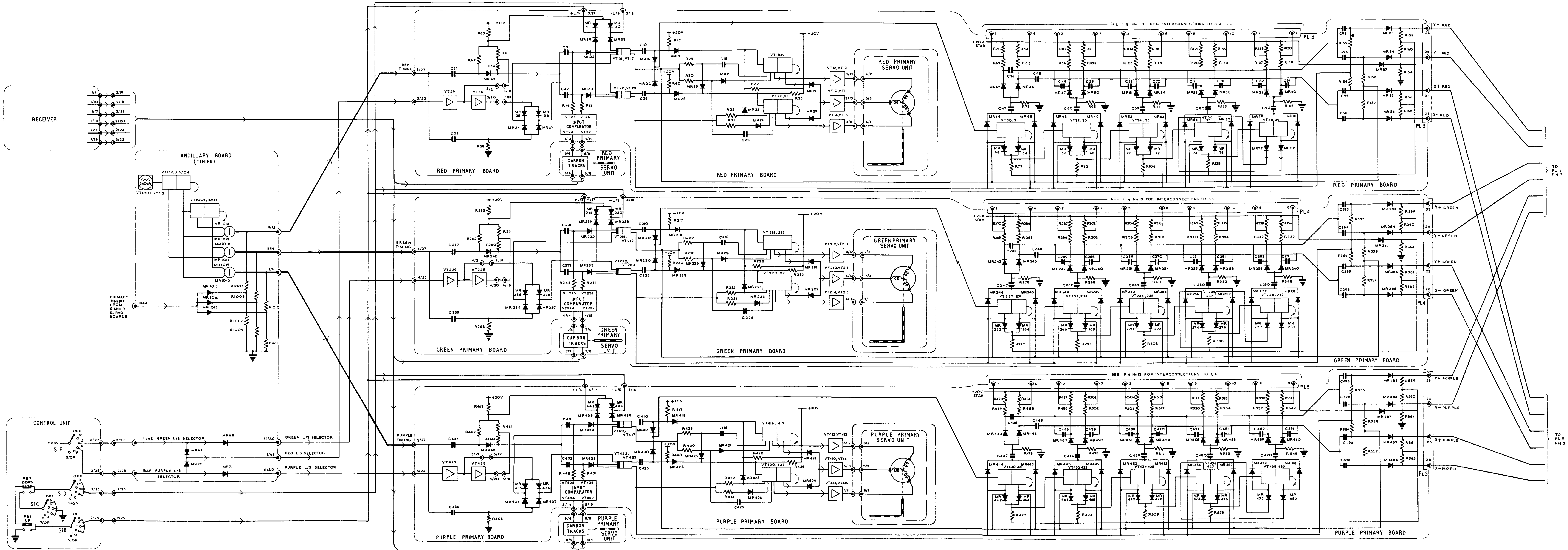
Pulse	State	BINARY COUNTERS					Output pulse
		VT30 VT31	VT32 VT33	VT34 VT35	VT36 VT37	VT38 VT39	
0	23	10	10	10	10	10	VT38
1	22	01	10	10	10	10	VT31
2	21	10	01	10	10	10	VT33
3	20	01	01	10	10	10	VT31
4	19	10	10	01	10	10	VT35
5	18	01	10	01	10	10	VT31
6	17	10	01	01	10	10	VT33
7	16	01	01	01	10	10	VT31
8	15	10	10	10	01	10	VT37
9	14	01	10	10	01	10	VT31
10	13	10	01	10	01	10	VT33
11	12	01	01	10	01	10	VT31
12	11	10	10	01	01	10	VT35
13	10	01	10	01	01	10	VT31
14	9	10	01	01	01	10	VT33
15	8	01	01	01	01	10	VT31
16	7a	10	10	10	10	01	VT39
	7b	10	10	10	01	01	No output pulse
17	6	01	10	10	01	01	VT31
18	5	10	01	10	01	01	VT33
19	4	01	01	10	01	01	VT31
20	3	10	10	01	01	01	VT35
21	2	01	10	01	01	01	VT31
22	1	10	01	01	01	01	VT33
23	0	01	01	01	01	01	VT31
24	23	10	10	10	10	10	VT38

TABLE 3

Turret switch key ward functions

Ward number	Control unit PL.	Control unit pole	Computer PL.	Computer pole	Key ward function
1	1	1	1	1	Red Y scale: 12 pulse
2	1	2	1	2	" " " 6 "
3	1	3	1	3	" " " 3 "
4	1	4	1	4	" " " 2 "
5	1	5	1	5	" " " 1 "
6	1	6	1	6	Red X scale: 12 pulse
7	1	7	1	7	" " " 6 "
8	1	8	1	8	" " " 3 "
9	1	9	1	9	" " " 2 "
10	1	10	1	10	" " " 1 "
11	1	11	1	11	Green Y scale: 12 pulse
12	1	12	1	12	" " " 6 "
13	1	13	1	13	" " " 3 "
14	1	14	1	14	" " " 2 "
15	1	15	1	15	" " " 1 "
16	1	16	1	16	Green X scale: 12 pulse
17	1	17	1	17	" " " 6 "
18	1	18	1	18	" " " 3 "
19	1	19	1	19	" " " 2 "
20	1	20	1	20	" " " 1 "
21	1	21	1	21	Purple Y scale: 12 pulse
22	1	22	1	22	" " " 6 "
23	1	23	1	23	" " " 3 "
24	1	24	1	24	" " " 2 "
25	1	25	1	25	" " " 1 "
26	1	26	1	26	Purple X scale: 12 pulse
27	1	27	1	27	" " " 6 "
28	1	28	1	28	" " " 3 "
29	1	29	1	29	" " " 2 "
30	1	30	1	30	" " " 1 "
31	1	31	1	31	X reversal ward R/G (O/P I)
32	1	32	1	32	Y " " R/G (O/P I)
33	2	10	2	10	X " " R/P (O/P II)
34	2	11	2	11	Y " " R/P (O/P II)
35	2	30	2	30	X multiplier ward
36	2	31	2	31	Y " "
37	–	—	–	—	Not connected
38	–	—	–	—	" "

6651 89675 1/67 200 W.A.S



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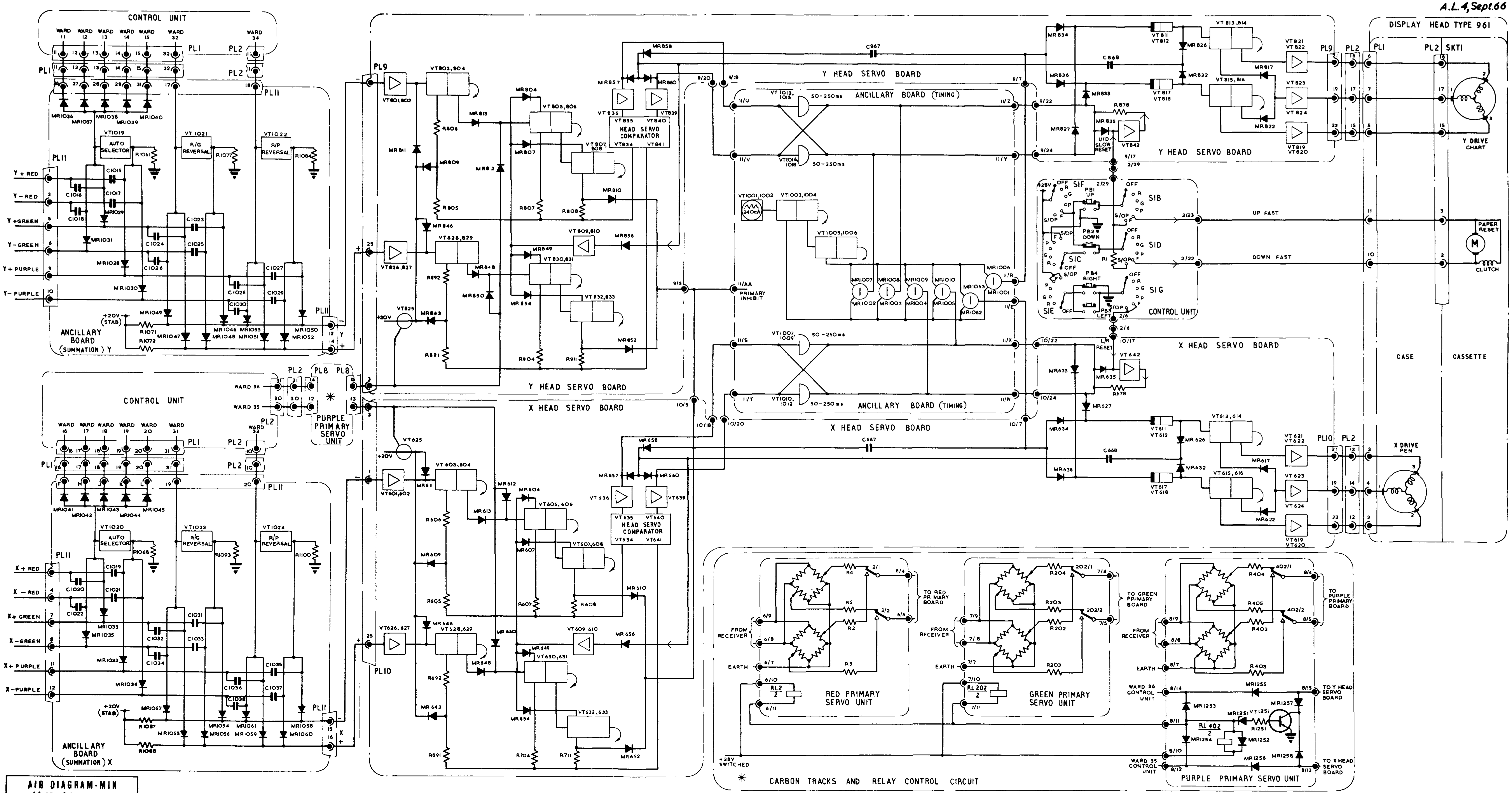
Computer Type 9360 primary systems: functional diagram

Fig. 2



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Computer Type 9360 summation and head servo systems: functional diagram

Fig.3

NOTES

COMPONENTS IN GREEN PRIMARY SERVO UNIT HAVE 200 ADDED TO CIRCUIT REFERENCES AND IN PURPLE PRIMARY SERVO UNIT HAVE 400 ADDED AS SHOWN IN TABLE BELOW WHICH ALSO GIVES VARIATION IN VALUES

COMPONENT IN RED SERVO	EQUIVALENT COMPONENT IN GREEN SERVO	PURPLE SERVO
PL6	PL7	PL8
SKT6	SKT 7	SKT8
RL2	RL202	RL402
R2 10k	R202 8 2k	R402 15k
R3 10k	R203 8 2k	R403 15k
R4 15k	R204 12k	R404 22k
R5 15k	R205 12k	R405 22k
R6 ∞	R206 ∞	R406 220k
R7 68k	R207 100k	R407 56k

∞ DENOTES NO RESISTOR FITTED

NOTES:-

1. GREEN PRIMARY BOARD PL/SKT 4 HAS PIN 18 EXTERNALLY CONNECTED TO PIN 20 AND PIN 19 EXTERNALLY CONNECTED TO PIN 21, REST OF CIRCUIT IDENTICAL TO RED PRIMARY BOARD. TO OBTAIN CIRCUIT REFERENCE NUMBERS ADD 200
2. PURPLE PRIMARY BOARD PL/SKT 5 HAS PIN 18 EXTERNALLY CONNECTED TO PIN 20 AND PIN 19 EXTERNALLY CONNECTED TO PIN 21, REST OF CIRCUIT IDENTICAL TO RED PRIMARY BOARD. TO OBTAIN CIRCUIT REFERENCE NUMBERS ADD 400

Computer Type 9360 red primary board: circuit diagram (Sheet 1)

Fig. 4

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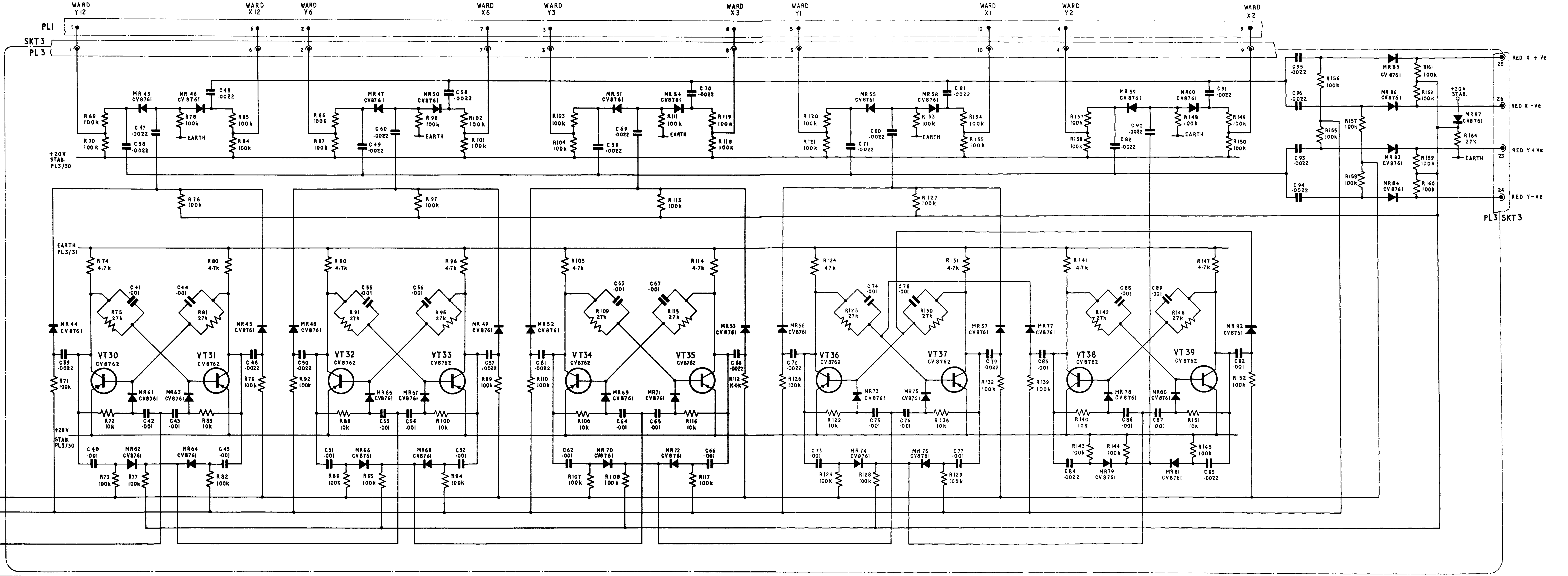

Computer Type 9360 red primary servo board: circuit diagram (Sheet 2)

Fig. 5

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116B-0603-MD10

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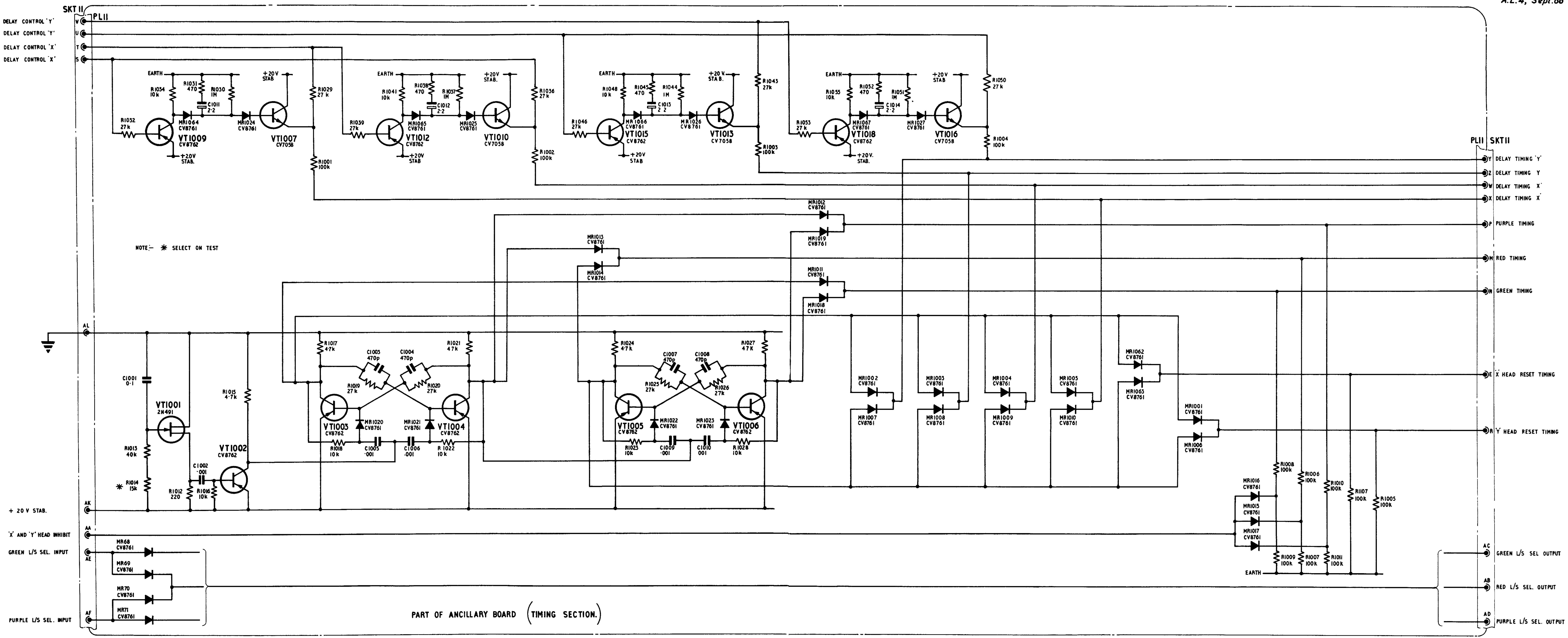

Computer Type 9360 ancillary board timing section: circuit diagram.

Fig. 6

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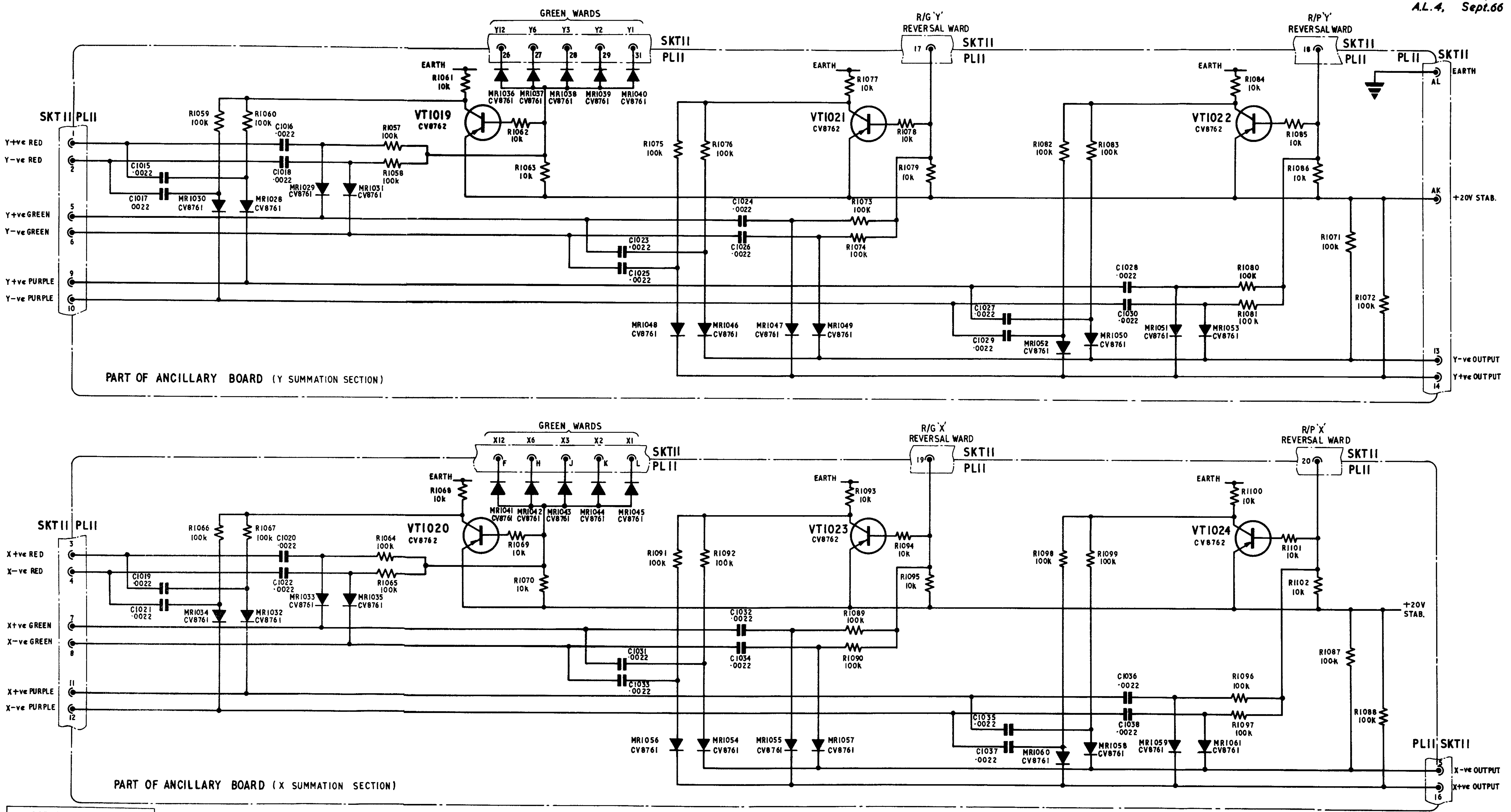

Computer Type 9360 ancillary board summation section: circuit diagram

Fig.7

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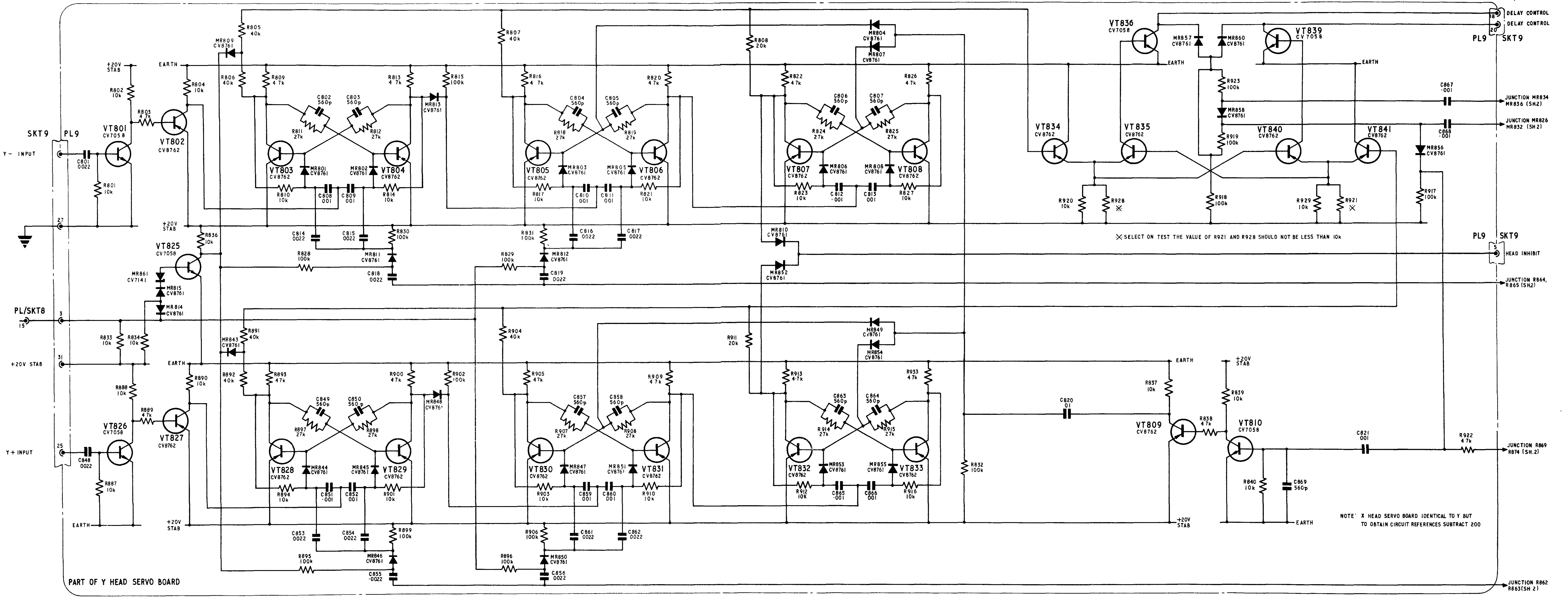

Computer Type 9360 Y head servo board: circuit diagram (Sheet 1)

Fig. 8

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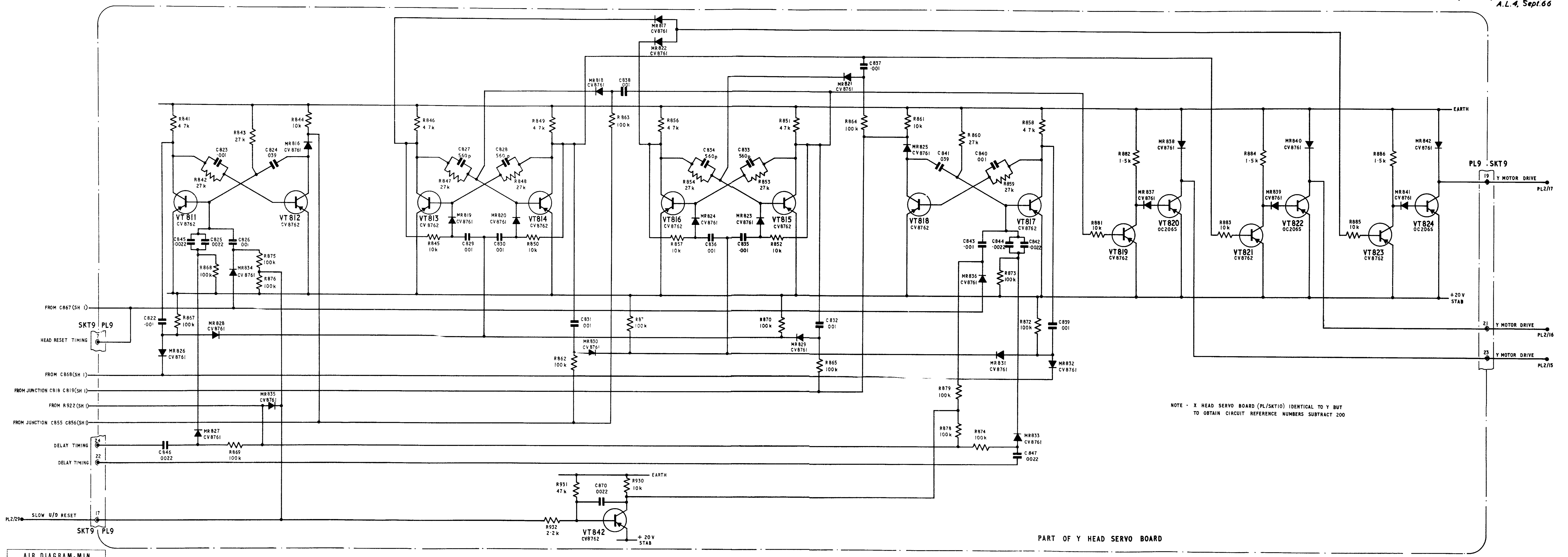

Computer Type 9360 Y head servo board : circuit diagram (Sheet 2)

Fig. 9

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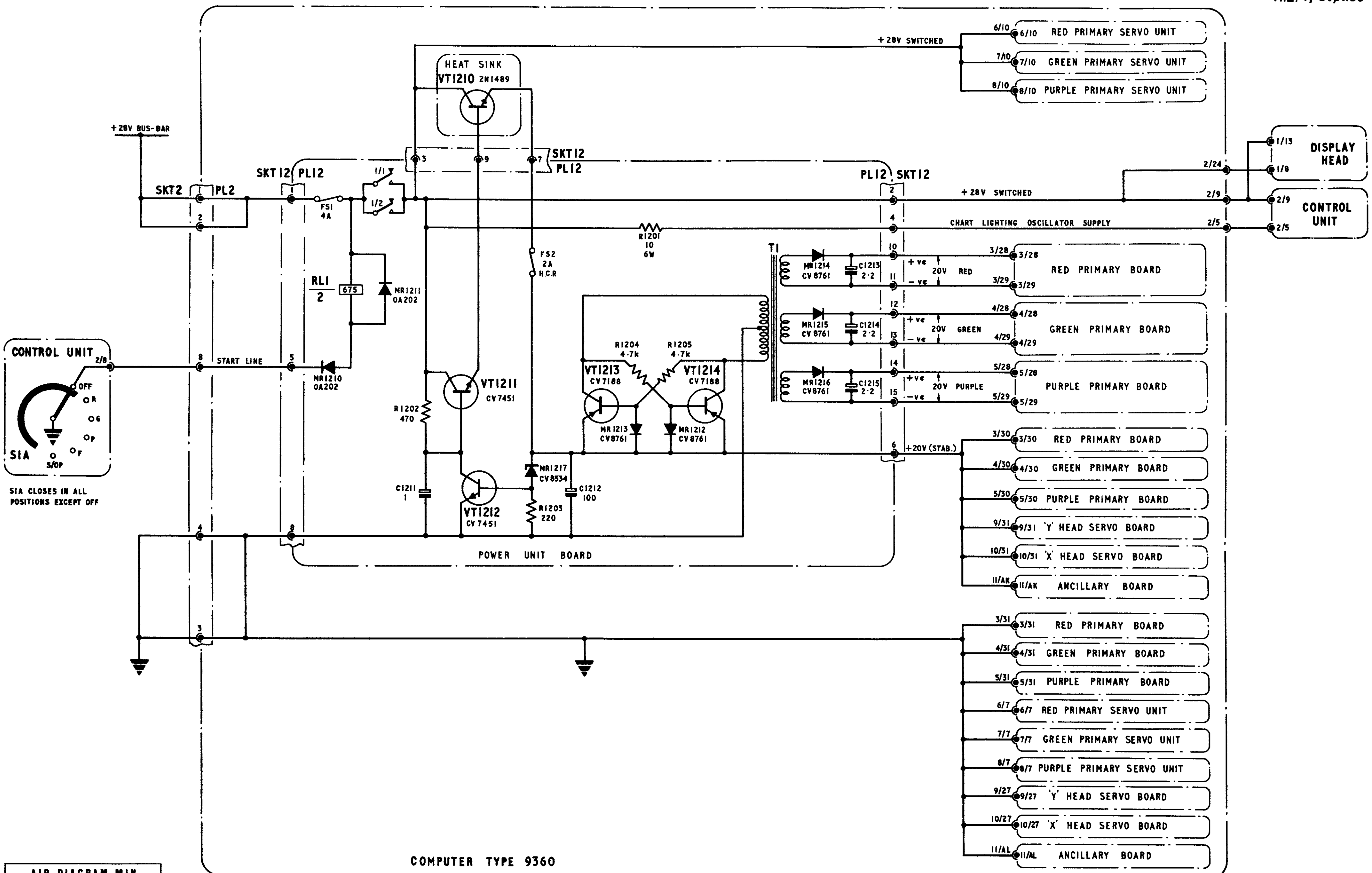

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Computer Type 9360 power unit board and power distribution : circuit diagram

Fig.10

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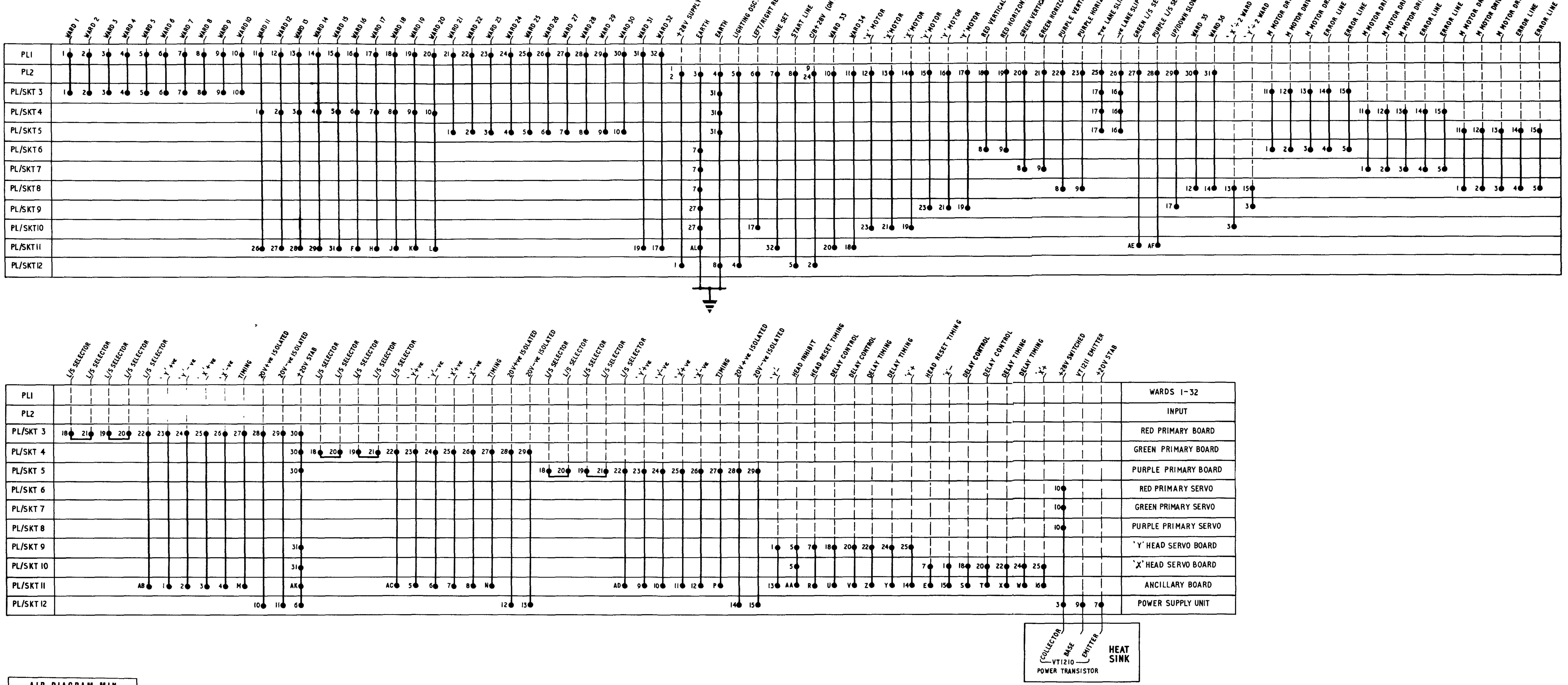

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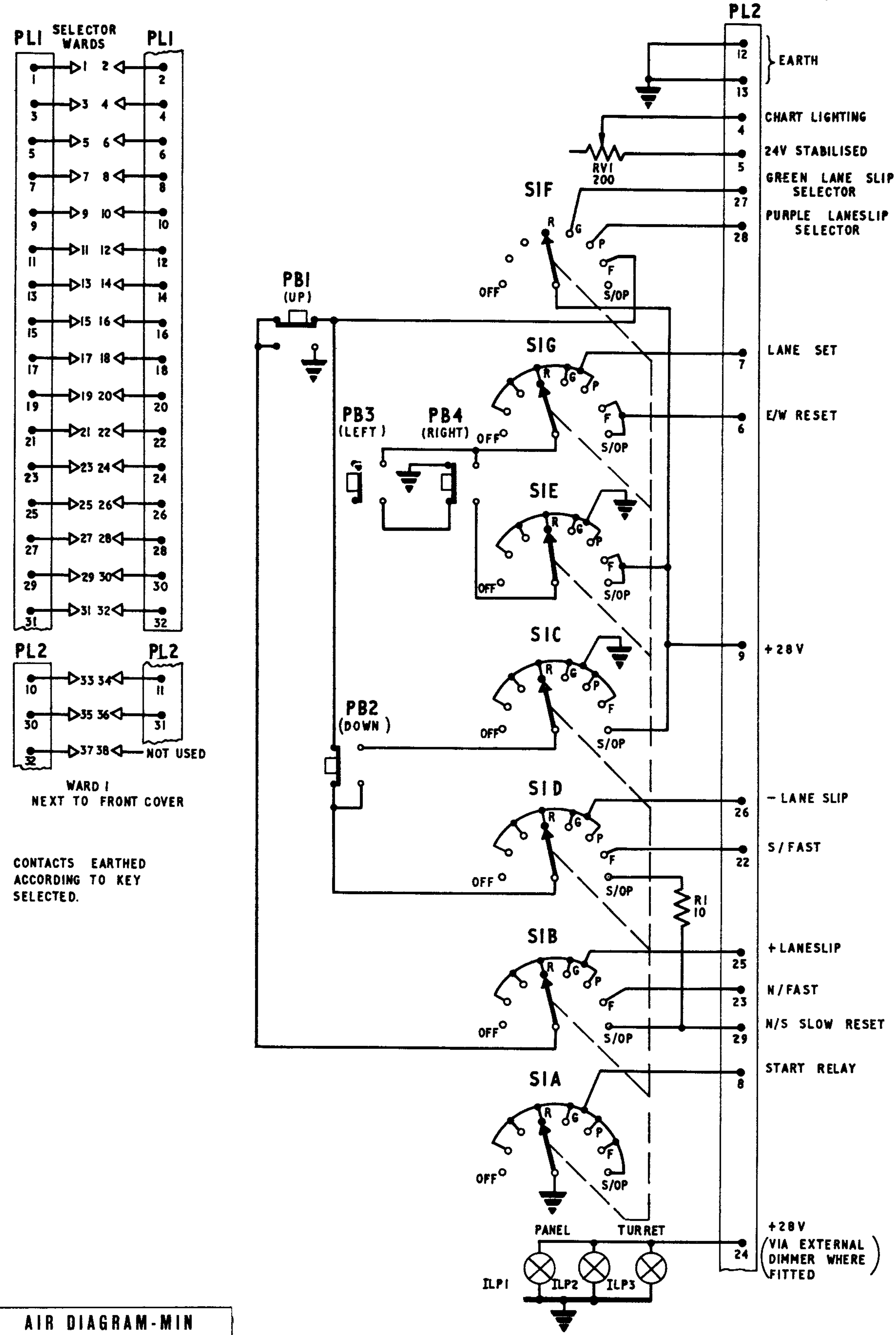
Computer Type 9360 plug interconnections: frame wiring

Fig. 11



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Control unit Type 941: circuit

Fig. 12

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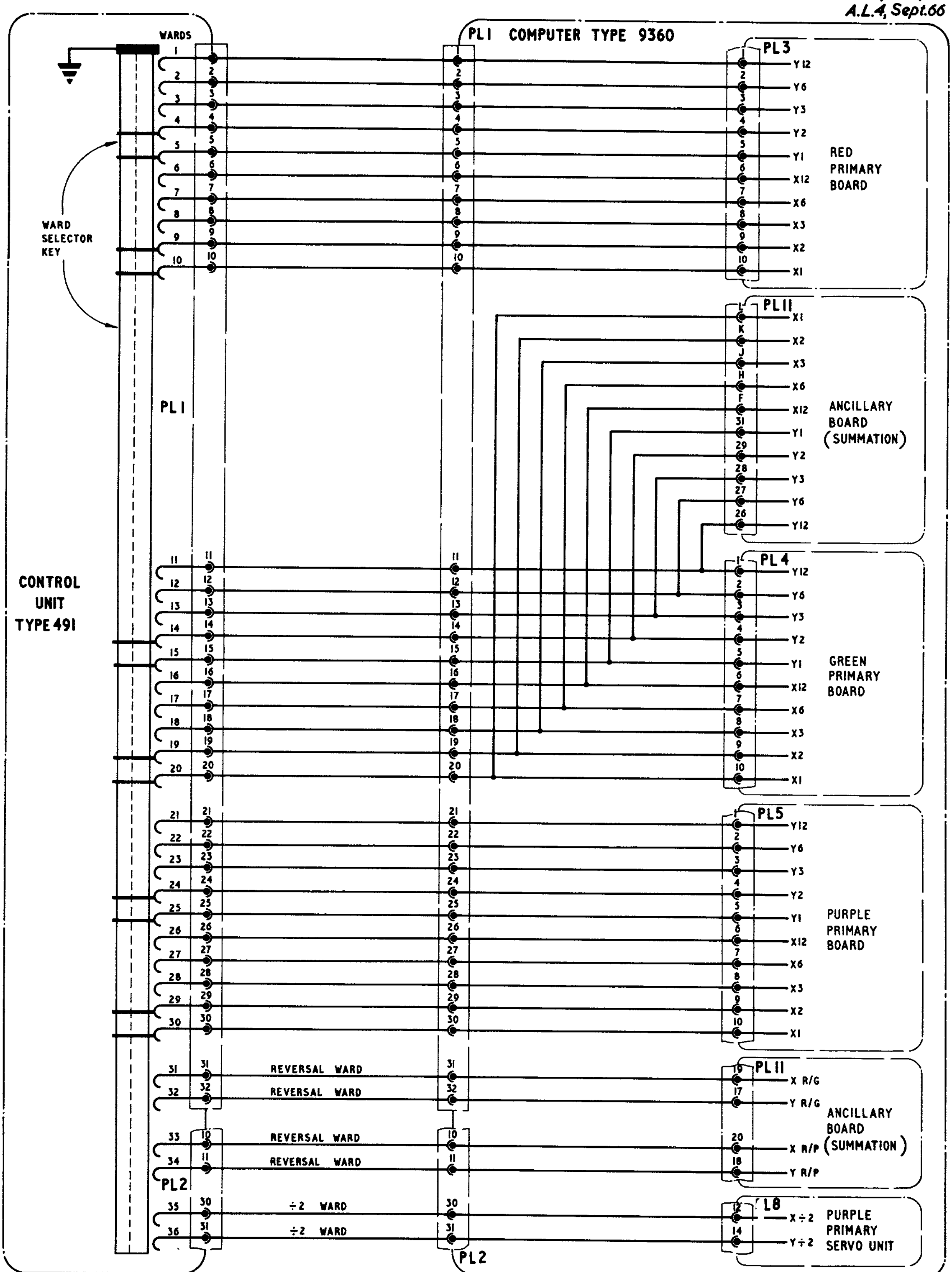

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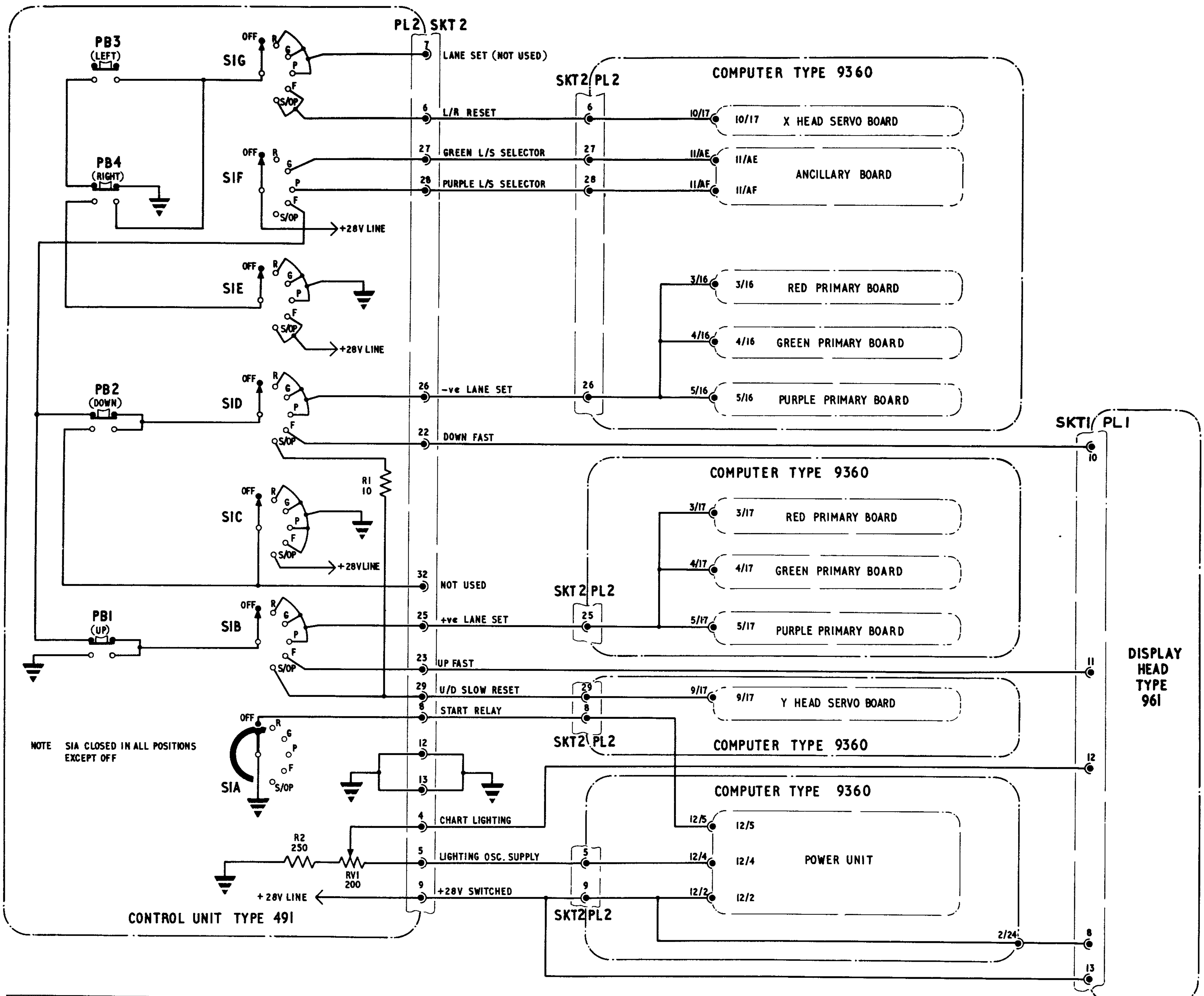
Control unit Type 941 key wards and connections

Fig 13



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Control unit Type 491 function switch and reset buttons

Fig. 14

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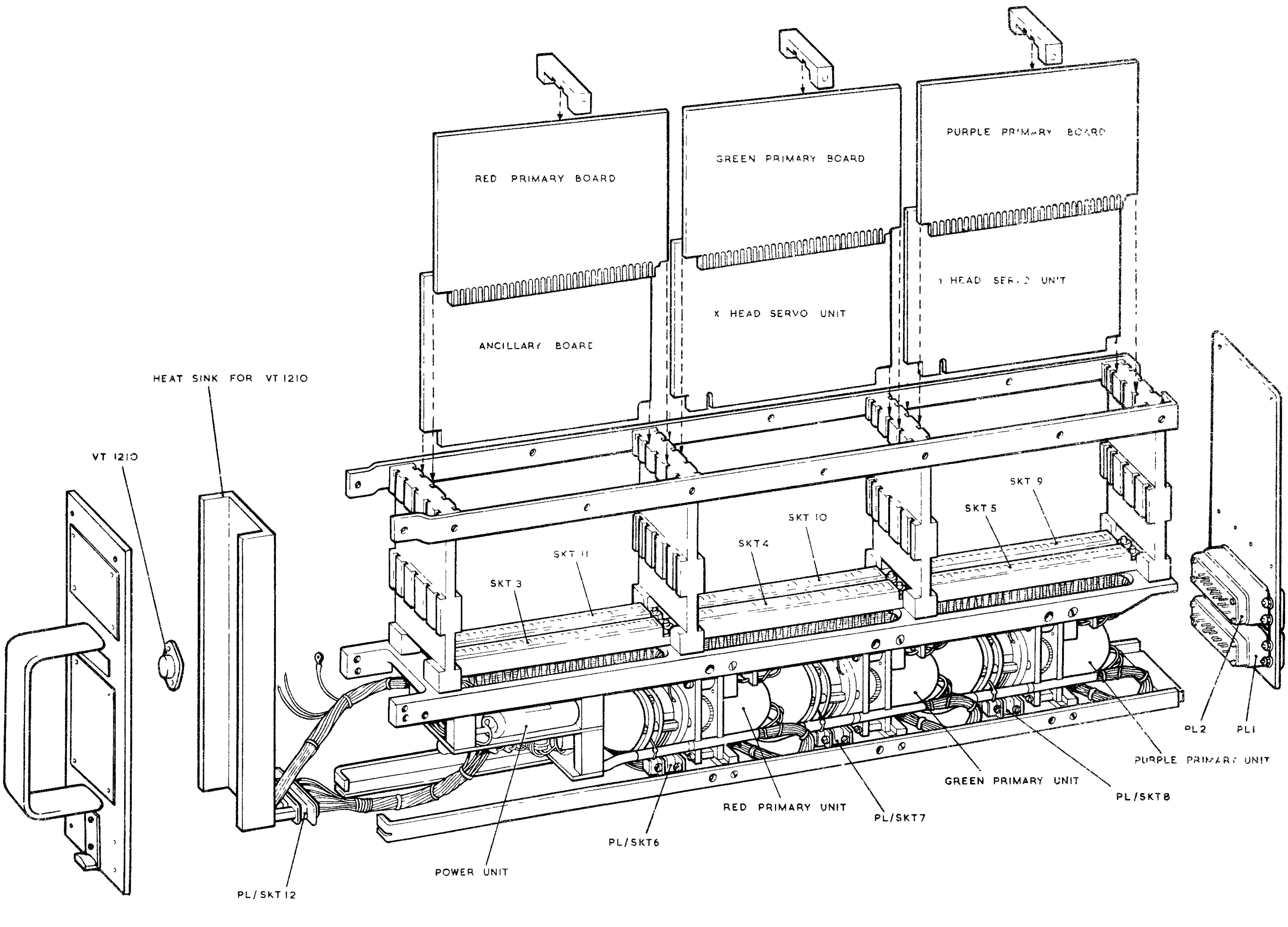

Fig.15 Computer Type 9360 : sub-unit location Fig.15

89675-171835-12/66.P.P.Ltd.950-2.

Chapter 4

DISPLAY, DECCA TYPE 961

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LIST OF ILLUSTRATIONS

General

1. The flight log display (Decca Type 961), used with the computer, navigational, Decca Type 9360, comprises two main sub-assemblies:

(1) the display base (base, recorder): fig. 1 and 2.

(2) the display cassette (cassette, recorder): fig. 1 and 3.

A general view of the assembled display, with chart and cursor pen fitted, is shown in Part 2, Sect. 2, Chap. 1, fig. 3. In normal service use, the base (less capsule pen) and cassette are permanently installed in the aircraft, and the removable cassette storage spool, loaded with charts assembled in appropriate sequence for the flight plan, is issued to the flight crew prior to the flight, together with a number of recorder pens and a control unit switch turret, loaded with a set of keys in sequence corresponding to the charts (Part 2, Sect. 2, Chap. 3, para. 67 and 68).

Display base (figs. 1, 2 and 4)

2. The base contains the X (pen) drive system, comprising the cursor drive and pen carrier assemblies and the pen M-motor suppression network. The base takes the form of a rectangular, aluminium box with stiffening plates riveted to all four sides. A rigid surface, essential for accurate mechanical drive, is provided by a base plate inside the base unit, screwed to the bottom. Three, floating 2BA bushes are provided for fixing the display to a suitable mounting plate in the aircraft.

3. Diodes connected between each of the three M-motor operating lines and earth and the 28V supply respectively, suppress switching transients and prevent unwanted impulses being induced in adjacent conductors. These six diodes, MR12 to MR17, are mounted on a small tagboard fixed to the base plate adjacent to the cursor drive assembly. An alternative suppression consisting of one diode in each M-motor line and a 20 ohms resistor in series with the M-motor centre tap replaces the six diode configuration in later model display units. All electrical connections to the display are made via the 15-pole plug PL1, which is positioned on the base plate to permit left-side cable entry. The electrical connections between base and cassette are automatically completed by

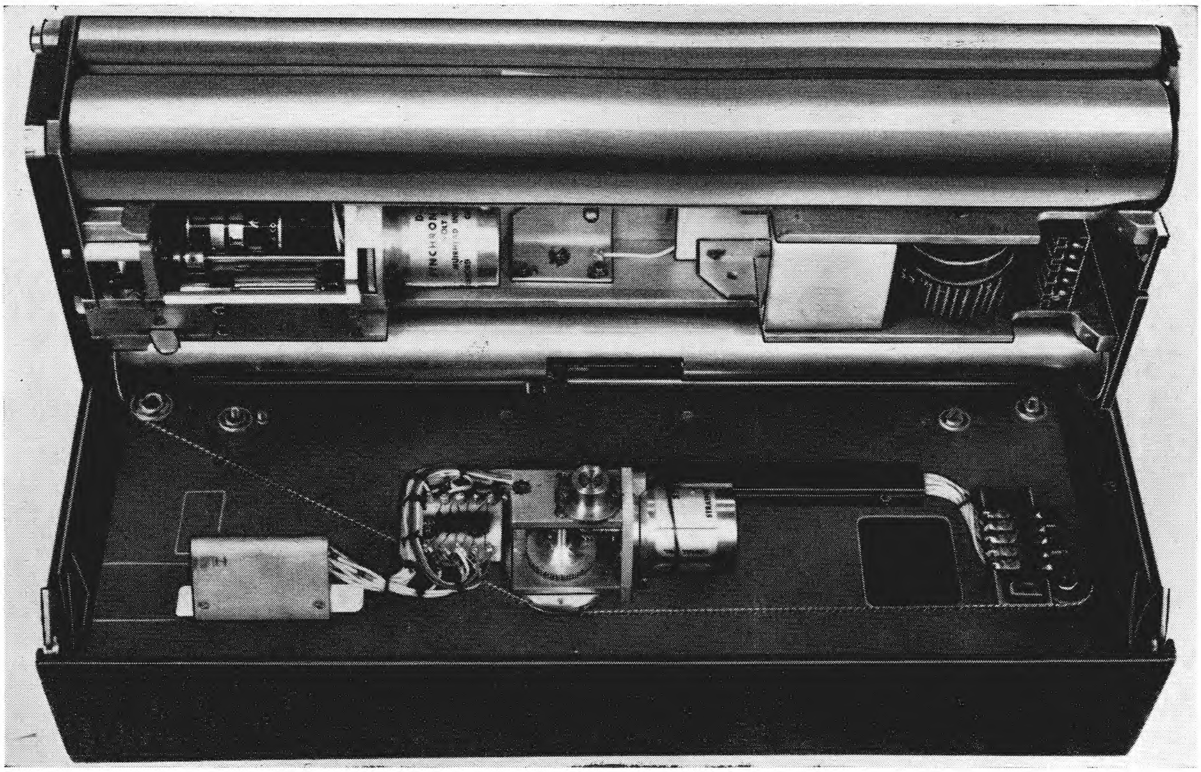

Fig. 1. Indicator, chart and map 10Q/5826-99-971-4276 (Decca Type 961): Overall view, with cassette raised

the 10-pole plug PL2, on the base; PL2 enters SKT1 on the cassette, when this is fitted.

4. The cassette fits into the base and is held in position by four small dowel pins, at the four corners of the cassette, engaging four retaining catches on the base unit. A push-out spring, mounted on top of the cursor drive assembly, exerts an upwards pressure on the cassette when the catches are engaged and provides a slight upward movement when either the top or bottom catches are released, facilitating tilting outwards of the cassette for loading or complete withdrawal if all four catches are released.

5. The cursor drive assembly consists of the X-drive M-motor mounted longtitudinally on the base plate, which rotates a wire drive drum via a reduction gear train. The pen carrier assembly comprises basically a cadmium-plated, brass block with two parallel boxes through its width. Two cursor guides, fixed between the sides of the base unit, run parallel along the entire width of the rear of the base unit; the upper guide, for additional rigidity, is secured at two points to the rear of the base unit. The upper bore in the pen carrier block extends into two brass end pieces and is a slide fit over the upper cursor guide; the lower bore slides over the lower cursor guide.

6. The drive from the cursor drive assembly to the pen carrier assembly is transmitted via a continuous loop of Ormalised, stainless steel cable, running over the drive drum and over one large and two small pulley wheels. One small pulley wheel is positioned below each end of the lower cursor guide so that the drive cable is routed underneath and along the length of the cursor guides. The pen carrier assembly is fixed to the drive cable. The pen carrier moves 9 inches along the cursor guides for every 2048/3 M-motor revolutions. A slipping clutch, included between wire drum and reduction gears, enables the pen carrier to be moved manually; no electrical fast reset is therefore provided for the pen drive. This arrangement also prevents undue strain on the drive cable when the pen carrier is driven to the limits of the cursor guides. Access to the clutch in gained via a small inspection cover fitted in the bottom of the case.

7. The pen mechanism assembly is screwed on to the top of the pen carrier. The track is recorded on the chart by a small ink-filled capsule pen, which is a push-fit on the end of an arm attached to the pen mechanism assembly. A toggle, when pressed inwards, raises this arm so that the pen is lifted clear of the chart when a recorded track is not required. The pen may be moved clear of cassette by raising and swivelling the pen arm through 90°. The reduction gear train, the plug PL1 and the wiring to plug PL2 are protected by covers against accidental damage.

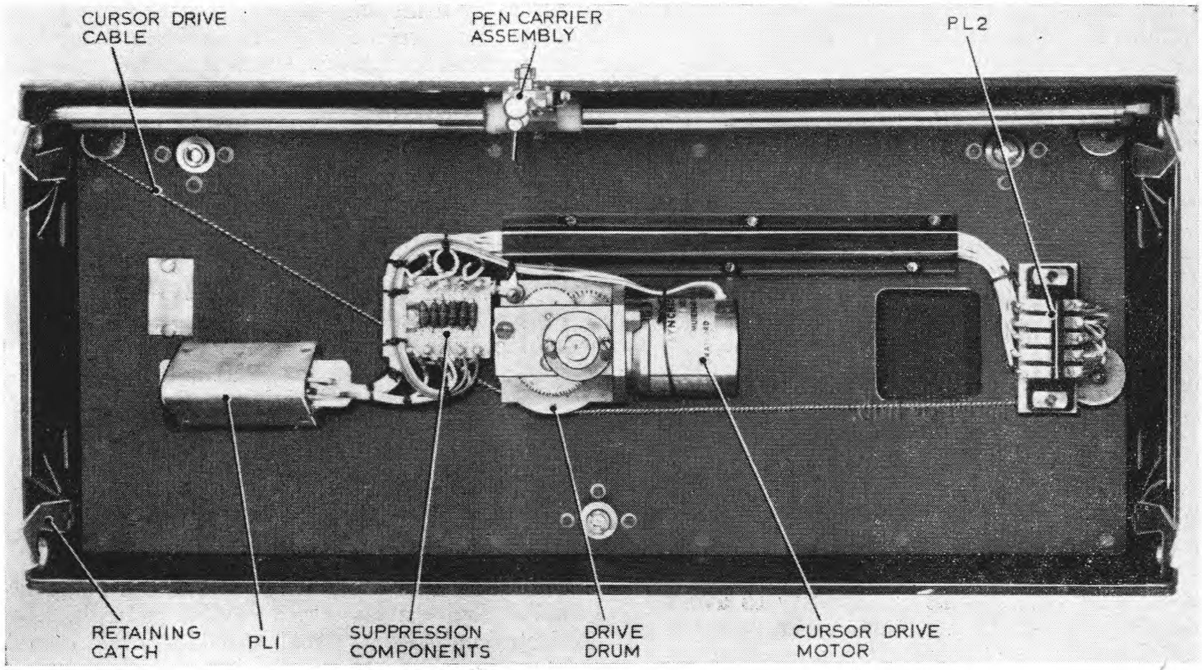

Fig. 2. Base, recorder 10U/5826-99-950-9948 (Decca Type 961): Overall view

Display cassette (fig. 1 and 3)

8. The cassette contains the Y (chart) drive system. In addition it accommodates the chart M-motor suppression network, the chart fast reset circuit and the power supply circuit for the chart back lighting system. The cassette consists of two rectangular, L-shaped, castings, connected at each end by a steel side plate.

9. The cassette, which is removable from the base, carries up to 20ft. of chart on two spools. One spool is removable and is loaded with the charts. The chart roll base has a leader with a

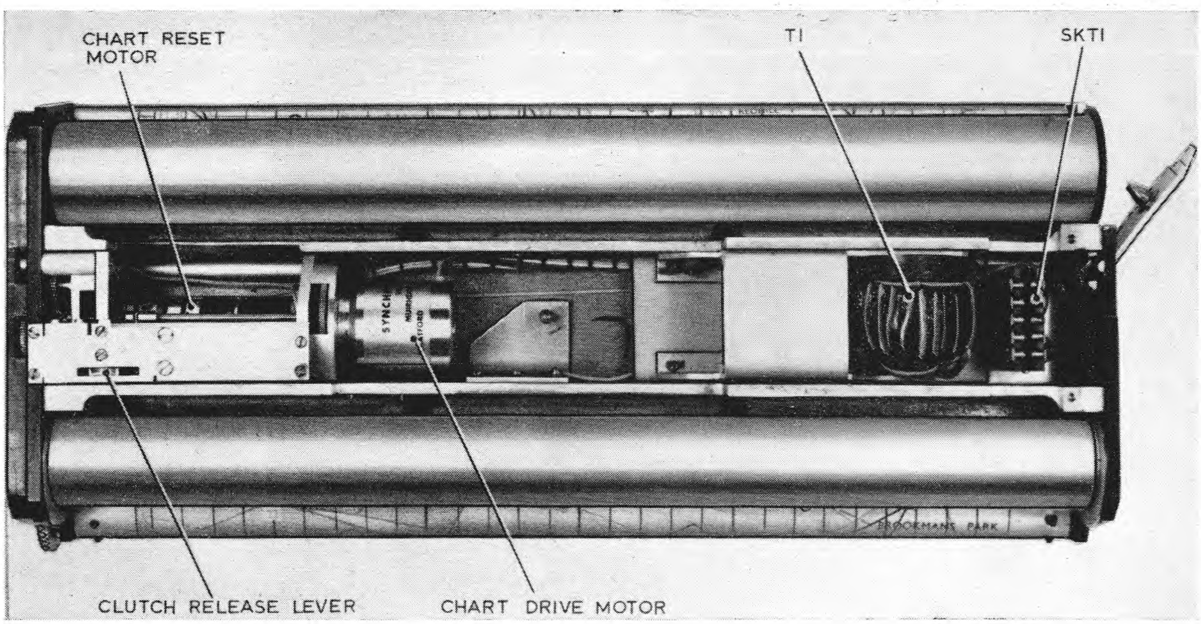

Fig. 3. Cassette, recorder, 10U5826-99-950-9947 (Decca Type 961): Underside view

a T-shaped end tab which fits a slot in the fixed take-up spool. The removeable spool is accommodated under the lower edge of the cassette and is driven at one end by a faceplate fitted with an off-centre drive pin; a hinged plate with a centre pin retains the other end of the spool.

10. The chart passes from the loaded spool over two rollers at the upper and lower edges of the cassette face and on to the fixed take-up spool. The roller at the upper edge of the cassette has sprocket teeth at each end which engage the perforations in the chart. Tension is maintained by driving the spools slightly faster than the sprocket roller by a system of ratchets via clutches housed inside the take-up spool assembly and in the driving hub of the storage spool. These clutches consist of a broad spring of several turns fixed to the driving shaft and transmitting the drive by friction to the inside of the spool or hub.

11. The chart is driven normally by a M-motor and, during fast rest, by a separate d.c. motor. The chart moves 9 inches for every 2048/3 revolutions of the M-motor. When the fast reset motor is used, a solenoid is energized which disengages the M-motor gear train. This is necessary to avoid overloading the fast reset motor. When power is cut off from the reset motor, it continues to act as a generator, holding the solenoid energized until the speed of rotation of the gear train is low enough to permit engagement of the M-motor, without causing damage to the gear teeth. This arrangement is operated by transistor circuit VT3. When the cassette is lifted away from the base unit, a release lever disengages the chart drive gearing, to facilitate easy operation of the knurled chart winding thumb-wheel, located at the top left hand corner of the cassette.

12. The Y-drive M-motor, reset motor with solenoid, and their associated gearing are mounted in the left-hand section of the trough between the two cassette castings. The gear drives to the upper sprocketed roller, the lower roller and two chart spools are mounted on the left side plate and protected by a moulded plastic cover. The left side plate also carries the ON/OFF indicator lamp with its mechanical dimmer and a lamp reset pressure switch, which is not used with the present computer. This switch, however, is still in circuit and it breaks the earth connection to the indicator lamp when depressed.

13. The chart passes over a display face, consisting of a perspex panel with a raised central longtitudinal strip, which provides the pen with a firm writing surface; by providing a single line contact with the chart, this construction minimizes frictional loading on the chart and its associated drive system. Back lighting of the chart is provided by an electroluminescent panel underneath the display face. Connection to this lighting panel is made via terminal points on the rear at both ends. Excitation is provided by a d.c./a.c. converter circuit which is mounted in the right-hand section of the cassette trough together with the suppression network for the chart M-motor and the fast reset transistor circuit. The electroluminescent panel provides even overall illumination of the display area which measures approximately 10 inches by 4·5 inches.

14. The chart illumination circuit comprises a d.c./a.c. converter consisting of two transistors VT1, VT2, and a toroidal transformer T1 arranged as a push-pull 400 c/s square wave generator. The d.c. supply for the circuit is obtained from the 28V line in the computer, via the dimmer control RV1, in the control unit, at the maximum setting of RV1, the 400 c/s output is of the order of 240V peak, falling as RV1 is rotated counterclockwise.

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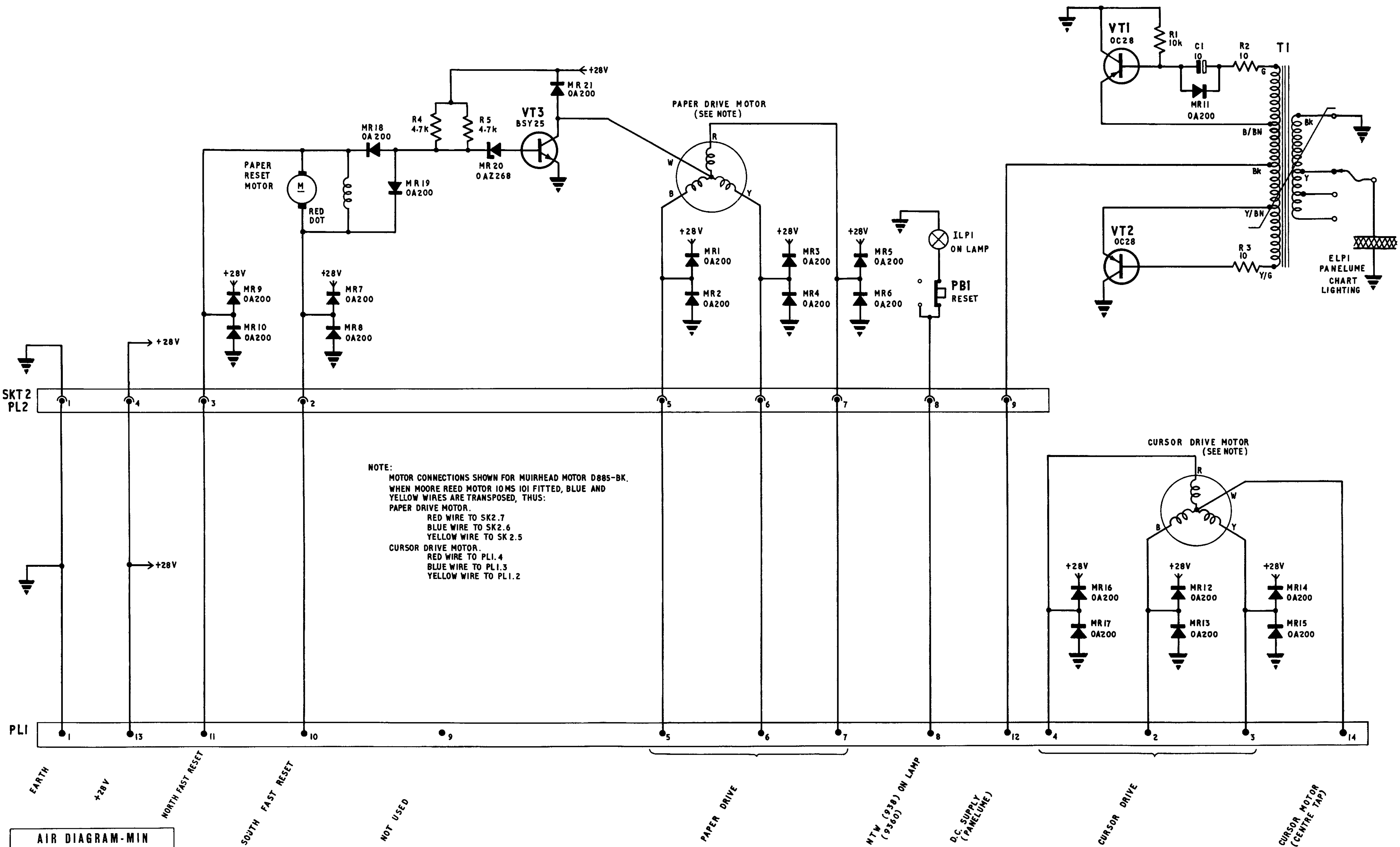

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Display Decca, Type 961 : circuit

Fig. 4

PART 3

FAULT DIAGNOSIS

SECTION 1

FLIGHT LOG DECCA TYPE 9257

Chapter 1

FIRST LINE FAULT ACTION

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General information

1. The first line ground check and fault location procedure comprises a mechanical inspection of the installation, which is followed, upon satisfactory completion, by a functional test routine based on the use of a Decca signal generator coupled to the receiver system to provide simulated operating conditions. If the equipment passes satisfactorily through all the checks detailed in this routine (para. 7) it may be assumed serviceable. Table 1 lists faults that may be experienced at each stage of the check procedure and the rectification actions in order of probability.

2. In Table 1, reference is made to the installation wiring in terms of the connectors defined in Part 2, Sect. 1, Chap. 2, Tables 2 to 6 inclusive. The affected conductors and plug or socket connections in each instance may be readily identified from these tables. Table 2 lists the wards selected in the control unit turret switch by the used test keys, together with their connections to plug PL1 and PL2 of the computer.

Mechanical inspection

3. A thorough examination of the flight log installation should be made before power is applied to the equipment and before any functional checks are carried out. The following is a summary of the points to be checked:—

(1) Inspect plugs and sockets, both on the computer rack and on removeable units for security and damage.

(2) Inspect all mounting bolts for security.

(3) With computer mounted, ensure that the two threaded dowels and the screw fastener are tightened sufficiently to prevent the unit moving or vibrating in its rack.

(4) Ensure that the rack is free to move on the anti-vibration mounts and is not restricted by cable connections and other obstructions.

(5) Ensure that the bonding of all units to the airframe is less than 0·05 ohm.

(6) Operate all controls to ensure that they function smoothly and that they are not damaged.

Ground checks

4. It is convenient, when checking the performance of the aircraft installation, to regard the complete Decca Navigator installation in two separate parts, namely the receiver system and the flight log installation. As the flight log installation is dependent upon the receiver for its input signals, it is assumed that the receiver installation has been checked and found serviceable before the flight log installation is checked.

5. The ground check procedure on the flight log installation requires the receiver to derive its input from a Decca signal generator 10S/9458648 (Decca Type 9351), 10S 17777 (Decca Type 9209) or 10S/17783 (Decca Type 870). It is assumed in the ground check procedure that the signal generator is connected to the receiver installation and switched on (refer to the appropriate Air Publication).

Test equipment

6. The following items of test equipment are required to carry out the ground check procedure; these are all included in the test kit, navigational computer, 10S/17921 (Decca Type 53-TY):—

(1) Selector, navigational computer set, 10D/9456174 (flight log turret Decca Type 839KK).

(2) Test keys: XID, XIE, XIF, XIG, XIH, XII, XIJ, XIK, XIL, XIM, XIN, XIO, XIP, XIQ, XIR, XIS.

(3) Flight log test chart Decca Type TC108B/969.

(4) Cassette, recorder, 10S/9456177 (Decca Type 969).

(5) Knob, cassette loading, 10AK/9456179 (Decca Type A328A).

Check procedure

7. The check procedure is as follows:—

(1) Load the test chart into the display head cassette as described in Part 2, Sect 1, Chap. 2, para. 15. Insert the test keys into the turret switch and fit this into the computer control unit as described in Part 2, Sect. 1, Chap. 2, para. 16.

(2) Carry out the checks described in Part 2, Sect. 1, Chap. 2, para. 17(1), (2) and (3).

(3) Position display head pen on point of origin of test traces on test chart. Set Red decometer lane and fractional pointers to zero. Select test key XID in computer control unit switch turret. Set signal generator motor control to medium speed forward (clockwise rotation of phase control) and switch on motor. Count off 24 lanes on Red decometer. Switch off signal generator motor and check that the display head pen has travelled to the 'XID' point marked on the test chart. Reverse direction of signal generator phase rotation and switch on motor. Count off 24 lanes on Red decometer. Switch off motor and check that the display head pen has returned to the point of origin on the test chart.

(4) Repeat check (3) with test keys XIE, XIF, XIG, XIH and XII selected in turn. Check in each instance that a signal generator phase rotation of 24 Red lanes produces the display head movement indicated on the test chart.

(5) Set signal generator motor control to slow speed (approximately 2 revs/min). Repeat check (3) with test keys XIJ, XIK, XIL, XIM, XIN, XIO, XIP, and XIQ selected in turn. Check in each instance that a signal generator phase rotation of 12 Red lanes produces the display head movement indicated on the test chart.

(6) Repeat check (3) with test key XIR selected. Check that signal generator phase rotation produces no display head movement.

(7) Repeat check (3) with test key XIS selected. Check that a signal generator phase rotation of 6 Red lanes produces the display head movement indicated on the test chart.

(8) Set control unit function switch to R. Select test key XID. Check that depressing the upper and lower reset pushbuttons produces a display head movement to the left and to the right respectively. Check that depressing the upper and lower reset pushbuttons when the function switch is in the G or P position, produces no display head movement.

(9) Repeat check (8) with test key XIF selected and check that Green lane slip facility functions correctly.

(10) Repeat check (8) with test key XIR selected and check that Purple lane slip facility functions correctly.

TABLE 1

Fault check Table

Note— *References in 'Operation' column apply to the checks described in para. 7.*

Operation	Fault indication	Action
Para. 7(2)	Warning lamp fails to operate correctly.	(1) Check 28V supply at junction box (terminal 17) (2) Check connector 2 (computer PL3, pole 24). (3) Check connector 3 (computer PL2, pole 13). (4) Replace display head. (5) Replace computer. (6) Replace control unit.
	Control unit panel illumination fails to operate.	(1) Check connector 3 (computer PL2, poles 1, 2, 3, 19). (2) Replace control unit. (3) Replace computer.
	Display head chart illumination fails to operate.	(1) Check connector 2 (computer PL3, pole 4). (2) Check connector 3 (computer PL2, pole 4). (3) Replace display head. (4) Replace control unit. (5) Replace computer.
	No fast chart reset.	(1) Check connector 2 (computer PL3, poles 22, 23). (2) Check connector 3 (computer PL2, poles 17, 18). (3) Replace display head. (4) Replace control unit. (5) Replace computer.
	No slow chart reset.	Set control unit function switch to R. Select test key XIE. Depressing upper and lower reset buttons should produce appropriate chart movements. Set control function switch to G and P respectively and use of upper and lower push-buttons should produce no chart movement.
	(1) If check with key XIE is satisfactory.	(1) Check connector 3 (computer PL2, pole 12). (2) Replace computer. (3) Replace control unit.
	(2) If check with key XIE is unsatisfactory.	(1) Check connector 2 (computer PL3, poles 15, 16, 17). (2) Replace computer. (3) Replace display head.
	No slow pen reset.	Follow procedure in para. 7(8).
	(1) If check 7(8) is satisfactory.	(1) Check connector 3 (computer PL2, pole 6). (2) Replace computer. (3) Replace control unit.
	(2) If check 7(8) is unsatisfactory.	(1) Check connector 2 (computer PL3, poles 12, 13, 14). (2) Replace computer. (3) Replace display head.

TABLE 1—contd.

Operation	Fault indication	Action
Para. 7(3) Key XID	No or inaccurate pen movement.	Follow procedure in para. 7(8).
	(1) If check 7(8) is satisfactory.	(1) Check Red receiver output connections at junction box, terminals 1, 2. (2) Check connector 1 (computer PL3, poles 5, 6). (3) Replace computer.
	(2) If check 7(8) is unsatisfactory.	(1) Check connector 5 (computer PL1, poles, 6, 7, 8, 9, 10). (2) Check connector 3 (computer PL2, pole 22). (3) Replace computer. (4) Replace control unit.
Para. 7(4) Key XIE	No or inaccurate chart movement.	(1) Check connector 5 (computer PL1, poles 1, 2, 3, 4, 5). (2) Check connector 3 (computer PL2, pole 23). (3) Replace computer. (4) Replace control unit.
Key XIF	No or inaccurate pen movement.	Follow procedure in para. 7(9).
	(1) If check 7(9) is satisfactory.	(1) Check green receiver output connections to junction box, terminals 3, 4. (2) Check connector 1 (computer PL3, poles 19, 21). (3) Replace computer.
	(2) If check 7(9) is unsatisfactory.	(1) Check connector 5 (computer PL1, poles 16, 17, 18, 19, 20). (2) Replace computer. (3) Replace control unit.
Key XIG	No or inaccurate chart movement.	(1) Check connector 5 (computer PL1, poles 11, 12, 13, 14, 15). (2) Replace computer. (3) Replace control unit.
Key XIH	No or inaccurate pen movement.	Follow procedure in para. 7(10).
	(1) If check 7(10) is satisfactory.	(1) Check Purple receiver output connections at junction box, terminals 5, 6). (2) Check connector 1 (computer PL3, poles 27, 28). (3) Replace computer.
	(2) If check 7(10) is unsatisfactory.	(1) Check connector 5 (computer PL1, poles 26, 27, 28). (2) Check connector 3 (computer PL2, poles 20, 21, 24). (3) Replace computer. (4) Replace control unit.
Key XII	No or inaccurate chart movement.	(1) Check connector 5 (computer PL1, poles 21, 22, 23, 24, 25). (2) Check connector 3 (computer PL2, pole 25). (3) Replace computer. (4) Replace control unit.

TABLE 1—contd.

Operation	Fault indication	Action
Para. 7(5) Key XIJ	No or inaccurate display head movement.	(1) Check connector 3 (computer PL2, pole 28). (2) Replace computer. (3) Replace control unit.
Key XIK	No or inaccurate display head movement.	(1) Check connector 3 (computer PL2, pole 26). (2) Replace computer. (3) Replace control unit.
Keys XIL, XIM, XIN, XIO, XIP, XIQ	No or inaccurate display head movement.	(1) Replace computer. (2) Replace control unit.
Para. 7(6) Key XIR	Display head movement.	(1) Replace computer. (2) Replace control unit.
Para. 7(7) Key XIS	No or inaccurate display head movement.	(1) Replace computer. (2) Replace control unit.
Para. 7(8)	No or inaccurate pen movement.	(1) Check connector 3 (computer PL2, poles 8, 9, 10, 11). (2) Replace computer. (3) Replace control unit.
Paras. 7(9) Paras. 7(10)	No or inaccurate pen movement.	(1) Replace computer. (2) Replace control unit.

TABLE 2

Test key wards

Test key	Wards selected	Computer connections
XID	6, 7, 8, 9, 10, 31	6, 7, 8, 9, 10, on PL1; 22 on PL2
XIE	1, 2, 3, 4, 5, 32	1, 2, 3, 4, 5, on PL1; 23, on PL2
XIF	16, 17, 18, 19, 20, 31	16, 17, 18, 19, 20 on PL1; 22 on PL2
XIG	11, 12, 13, 14, 15, 32	11, 12, 13, 14, 15, on PL1; 23 on PL2
XIH	26, 27, 28, 29, 30, 33	26, 27, 28, on PL1; 20, 21, 24, on PL2
XII	21, 22, 23, 24, 25, 34	21, 22, 23, 24, 25, on PL1; 25 on PL2
XIJ	1, 6, 11, 16, 31, 32, 34, 36	1, 6, 11, 16, on PL1; 22, 23, 25, 28, on PL2
XIK	2, 7, 12, 17, 31, 32, 33, 35, 36	2, 7, 12, 17 on PL1; 22, 23, 24, 26, 28, on PL2
XIL	3, 8, 13, 18, 32, 33, 34, 35, 36	3, 8, 13, 18, on PL1; 23, 24, 25, 26, 28, on PL2
XIM	4, 9, 14, 19, 31, 33, 34, 35, 36	4, 9, 14, 19, on PL1; 22, 24, 25, 26, 28, on PL2
XIN	21, 26, 35	21, 26, on PL1; 26 on PL2
XIO	22, 27, 35, 36	22, 27 on PL1; 26, 28 on PL2
XIP	23, 28, 35, 36	23, 28 on PL1; 26, 28 on PL2
XIQ	24, 29, 35, 36	24 on PL1; 20, 26, 28 on PL2
XIR	1-20 incl., 33-36 incl.	1-20 incl. on PL1; 24, 25, 26, 28 on PL2
XIS	1-10 incl., 21-30 incl., 35, 36	1-10 incl., 21-28 incl. on PL1, 20, 21, 26, 28 on PL2.

Chapter 2

SECOND LINE FAULT ACTION

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GENERAL INFORMATION

1. The procedure detailed in this chapter is directed to the diagnosis and, where possible, repair of faults in the units of the flight log installation. Faulty operation of a unit may become apparent during a ground check or during operation in flight. In the latter case the following details should be obtained:—

(1) Nature of fault or reported failure.

(2) Duration of failure(s), if intermittent.

(3) Performance of Decca receiver installation.

2. Reference to any available information on the nature of the operational failure will assist in the quick location of the fault. Where such information indicates that the fault is of an intermittent nature, a prolonged run of the affected unit or units may be necessary to enable the fault to be repeated. In some instances, failure may not recur until the equipment has stabilized at full operating temperature.

3. When no fault condition can be found in the unit, despite an operational defect report, a decision on the serviceability of the unit must be made on the following considerations:—

(1) The adequacy and reliability of the initial defect report.

(2) The nature of the reported failure.

(3) The likelihood of a cable fault in the installation.

(4) The possibility of a d.c. supply failure.

(5) The possibility of the receiver installation being at fault.

TEST EQUIPMENT

4. The following items of test equipment are required to carry out the functional checks on the units of the flight log installation:—

(1) Test bench rig 10S/9558076 (Decca Type 53-TC), complete with cable assemblies 10HS/9711917 (Decca Type 53-TD), 10HS/9711915 (Decca Type 53-TE), 10HS/9711916 (Decca Type 53-TF), 10HS/9711914 (Decca Type 53-TG), 10HB/9711911 (Decca Type 53-TH).

Note . . .

The test bench rig should be connected to a power supply with an output voltage, variable on load, between 22 to 31 volts d.c., with an output resistance not exceeding 5 ohms at 3 amps and a ripple content not exceeding 2 volts peak-to-peak.

(2) The following units of the flight log installation should be available for use in the test bench rig as required: —

Computer, navigational (Decca Type S9257/C/9) 10AD/9456172.

Control navigational computer set (computer control unit Decca Type 9258G) 10L/9456173.

Base recorder (display head base Decca Type 968) 10D/9456175.

(3) Test kit, navigational computer (Decca Type 53-TY) 10S/17921 from which the following items are required: —

Cassette, recorder (display head cassette Decca Type 969) 10S/9456177.

Test chart (Decca Type TC108A/969) 10AF/9702057.

Knob, cassette loading (Decca Type A328A) 10AK/9456179.

Selector, navigational computer set (turret switch Decca Type 839KK), 10D/9456174.

Set of test keys, comprising the following types: —

XID (10AR/9701860), XIE (10AR/9701861),

XIF (10AR/9701862), XIG (10AR/9701863),

XIH (10AR/9701864), XII (10AR/9701859),

XIJ (10AR/9701858), XIK (10AR/9701857),

XIL (10AR/9701856), XIM (10AR/9701855),

XIN (10AR/9701854), XIO (10AR/9701853),

XIP (10AR/9701852), XIQ (10AR/9701851),

XIR (10AR/9701850), XIS (10AR/9701849),

XIT (Ref. No. NIV), XIU (Ref. No. NIV).

Pen recording (capsule pen Decca Type A806D) 10AF/9456178.

(4) Sine/cosine generator, mains driven (Decca Type 9005) 10S/9456089.

(5) Indicator, electrical, Red (decometer Type 274B or Z) 10Q/16492 or 10Q/16774, to monitor sine/cosine generator output.

(6) Multimeter CT498, 5QP/17447 or test set multimeter No. 1, 6625-99-105-7049.

PROCEDURE

5. The second line check and fault location procedure comprises a mechanical inspection of the affected unit, followed upon satisfactory completion, by a functional test routine. If the unit passes satisfactorily through these checks it may be assumed serviceable (paras. 2 and 3).

6. Unless a unit has a self-evident fault, it should be subjected to the complete test procedure. Where a particular check produces unsatisfactory results the fault finding tables (Tables 1 and 2) should be consulted for the most likely cause. To derive the greatest benefit from these tables the sequence of the test procedure should be strictly followed. A complete check of the unit should be made when the fault has been rectified.

7. Most faults in the unit will necessitate the replacement of a faulty sub-assembly. Servicing procedure should however include the overall cleaning of the unit, specifically the cleaning of plug and socket contacts, and lubrication of moving parts. These routine servicing measures are detailed for each main unit under the appropriate main headings.

Computer

8. The second line servicing of the flight log computer is restricted to the routine servicing (outlined in para. 9) and the replacement of certain sub-assemblies found faulty after mechanical and or functional inspection (paras. 10 to 17 inclusive). The replaceable sub-assemblies are: the Red, Green and Purple primary servo units, and the cam unit.

9. The following routine servicing procedure should be carried out: — Examine and clean computer where necessary, paying particular attention to internal and external plugs and sockets. Examine and clean all three primary servo units; lubricate all gears lightly with oil OM13, 34D/9100570, ensuring that no oil gets onto carbon tracks. Examine and clean cam unit; lubricate motor gears lightly with oil OM13, 34D/9100570.

Mechanical inspection

10. A thorough examination of the flight log computer should be made before power is applied and before any functional tests are made. Check:

(1) General assembly conforms to the current modification state.

(2) Piece parts, plating, etc. show no signs of damage, rust or corrosion.

(3) All components and cable forms are secure, show no signs of overheating or damage and are not likely to touch moving parts or the tie rod assemblies.

(4) All wiring is free from damage to insulation and not too close to resistors.

(5) Connection loops on printed circuit boards are low enough to avoid damage when unit is cased.

(6) Components and tracks are secure on both sides of the printed circuit boards and are not squashed.

(7) All soldered connections are neat and mechanically sound.

(8) The decade assemblies are securely housed and not cracked.

(9) All fixing screws are correctly seated and secured with varnish.

(10) Sub-assembly interconnecting plugs and sockets are securely mated.

(11) External plugs are clean, undamaged and all pins free to move individually.

(12) All applicable modifications have been incorporated and are recorded on the modification labels.

(13) Engraved figures and letters are legible.

Functional tests

11. The following functional tests should be carried out to ensure correct functioning of the computer. All checks are performed with the computer placed in the test bench rig, and the cover of the unit removed for visual checking when necessary. Unless stated otherwise, all checks should be performed with a power supply of 28V d.c. and with the sine/cosine generator output set to full torque; the ambient temperature should not exceed 55°C.

12. Load the test chart into the display head cassette, as described in Part 2, Sect. 1, Chap. 2, para. 15. Insert the test keys into the turret switch and fit turret into the computer control unit, as described in Part 2, Sect. 1, Chap. 2, para. 16. The turret should be loaded initially with test keys XID to XIM inclusive, XIT, XIU. For the pattern and scale tests (para. 17) the turret should be re-loaded with test keys XIN to XIS inclusive. Switch on computer by setting the on/off switch to ON; warning lamp on display head cassette should commence flashing. Ensure that the warning lamp lights steadily only when the function switch is set to the S/OP position.

13. Carry out the following tests on the cam unit:—

(1) Set control unit function switch to R. Select test key XID. Ensure that depressing the upper and lower reset pushbuttons produces a display head movement of 2·7 – 3·2 inches per 15 seconds to the left and to the right respectively. Check that the cam speed rises to a maximum in approximately 4 seconds when a pushbutton is depressed and returns to the minimum speed within 6 seconds after the pushbutton is released. Ensure also that the cam contacts do not spark excessively.

(2) Repeat test (1) with keys XIF and XIH selected, setting the function switch to the Green and Purple lane slipping positions respectively.

14. Test primary servo unit operation as follows:—

(1) Switch on sine/cosine generator and set output to $\frac{1}{3}$ TORQUE and select slowest speed on motor drive (position 3 on stepped speed control). Switch on sine/cosine generator motor and ensure that the primary servo units rotate smoothly in both directions, using motor REVERSE switch. Ensure that the movement takes place in single steps and that no excessive overthrow of the wipers occurs.

(2) Set sine/cosine generator output to FULL TORQUE and select medium speed on motor drive (position 1 on stepped speed control). Repeat test (1).

(3) Ensure that the X and Y primary output wipers take up a position between the contacts on the stud switch when the primary servo units are at rest.

(4) Select key XIT. Select high speed on motor drive (position 1 on stepped speed control). Switch on sine/cosine generator and using variable speed control gradually increase speed of signal generator phase rotation until primary servo units run at maximum speed. Ensure that the primary servo units inhibit intermittently in this condition. Reverse direction of sine/cosine generator motor drive and repeat test.

(5) Select key XIU and repeat check (4).

15. Test the display head reset facility as follows:—

(1) Set control unit function switch to F. Ensure that upper and lower reset pushbuttons, when depressed, produce a fast chart movement in the appropriate directions.

(2) Keep function switch in the F position. Select key XID in the control unit turret. Rotate sine/cosine phase control to give a

slow pen movement to the left. Depress right-hand reset pushbutton and ensure that the pen immediately moves to the right at a rate of approximately 3 inches per 15 seconds; the pen should resume its former direction and speed of travel upon release of the push-button.

(3) Repeat test (2) with the sine/cosine phase control dial rotating in the opposite direction, when depressing the left-hand reset pushbutton should cause a pen movement to the left.

(4) Set the function switch to S/OP and repeat tests (2) and (3).

(5) Keep the function switch in the S/OP position. Select key XIE in the control unit turret. Rotate the sine/cosine generator phase control to give a slow downward chart movement. Depress the lower reset pushbutton and ensure that the chart immediately moves upwards at a rate of approximately 3 inches per 15 seconds; the chart should resume its former direction and speed of travel upon release of the reset pushbutton.

(6) Repeat test (5) with the sine/cosine phase control rotating in the opposite direction, when depressing the upper reset pushbutton should cause a downward chart movement.

16. Test the lane slipping facility as follows:—

(1) Set the function switch to R. Select key XID. Rotate the sine/cosine phase control to give a slow pen movement to the left. Ensure that when the lower reset pushbutton is depressed the pen direction reverses after a delay of approximately one second.

(2) Repeat test (1) with reversed direction of signal rotation, when depressing the upper reset pushbutton should cause a reversal of pen direction after a delay of approximately one second.

(3) Ensure that depressing the upper and lower reset pushbuttons, when the function switch is in the G or P position, produces no display head movement.

(4) Repeat tests (1), (2) and (3) with the test key XIF selected and ensure that the Green lane slipping facility functions correctly.

(5) Repeat tests (1), (2) and (3) with the test key XIH selected and ensure that the Purple lane slipping facility functions correctly.

17. Carry out the following pattern and scale tests:—

(1) Position the display head pen on the point of origin of the test traces on the test chart. Set the lane and fractional pointers of the monitoring Red decometer to zero. Select the test key XID. Set the sine/cosine generator motor control to medium speed forward (position 2 of the stepped speed control), i.e. clockwise rotation of the sine/cosine generator phase control. Switch on the motor and count off 24 lanes on the Red decometer. Switch off the motor and check that the display head pen has travelled to the XID point marked on the chart. Reverse the direction of the sine/cosine generator phase rotation. Switch on the motor and count off 24 lanes on the Red decometer. Switch off the motor and check that the pen has returned to the point of origin on the chart. A tolerance of 0·015 inch is permitted in the indicated display head position.

(2) Repeat test (1) with test keys XIE, XIF, XIG, XIH, XII selected in turn. Ensure that a sine/cosine generator phase rotation of 24 Red lanes with the key XIE selected, 18 Red lanes with the keys XIF, XIG selected and 30 Red lanes with the keys XIH, XII selected, each produce the display head movement indicated on the test chart for the appropriate key.

(3) Set the sine/cosine generator motor control to slow speed (position 3 on the stepped speed control). Repeat test (1) with the keys XIJ to XIS inclusive selected in turn. Ensure that a sine/cosine generator phase rotation of 16 Red lanes with the keys XIJ, XIK selected, 24 Red lanes with the key XIL selected, 30 Red lanes with the key XIM selected, 20 Red lanes with the keys XIN, XIO, XIP selected, 40 Red lanes with the key XIQ selected, 16 Red lanes with the key XIR selected, 6 Red lanes with the key XIS selected, each produce the display head movement indicated on the test chart for the appropriate key. A tolerance of 0·030 inch is permitted in the indicated display head position, excepting the tests carried out with keys XIN, XIO, XIP, XIQ for which a tolerance of 0·015 inch is acceptable.

Control unit

18. The second line servicing of the flight log control unit is restricted to the replacement of the panel illumination bulbs. The following routine servicing procedure should be carried out: examine and clean the control unit where necessary, paying particular attention to the plugs. Clean, examine and check for distortion the turret switch ward wires.

Mechanical inspection

19. A thorough examination of the flight log control unit should be made before the power is applied and before any functional tests are made. Check:—

(1) General assembly conforms to the current modification state.

(2) Piece parts, plating, etc. show no signs of damage, rust or corrosion.

(3) All components are secure and show no signs of overheating or damage.

(4) All wiring is free from damage to insulation and all soldered connections are neat and mechanically sound.

(5) All fixing screws are correctly seated and secured with varnish.

(6) All switches and pushbuttons move freely and locate positively.

(7) Function switch and dimmer control rotate to the prescribed limits and the knobs are firmly located.

(8) Gold alloy contact wires (turret switch wards) are parallel and equally spaced.

(9) Turret rotates easily through 360° and locates positively at each key position when release lever is depressed.

(10) Turret and panel illumination lamps are correctly seated.

(11) External plugs are clean, undamaged and all pins free to move individually.

(12) All applicable modifications have been incorporated and are recorded on the modification label.

(13) Engraved figures and letters are legible.

Functional tests

20. The following functional tests should be carried out to ensure the correct functioning of the control unit. The turret switch may be funtionally tested by carrying out the test described in para. 21 which is a static test to be made with the control unit out of the bench rig and requires the use of a testmeter (see para. 4). Alternatively the turret switch can be tested by carrying out the pattern and scale tests described in para. 17. The remainder of the functional tests for the control unit, paras. 22, 23, 24, are made with the control unit in the bench rig.

21. Check the turret switch as follows:—

(1) Load the turret switch with the test keys XIJ, XIR and XIS.

(2) Select key XIJ. Check that continuity exists between ground and control unit PL1, poles 1, 6, 11, 16; PL2, poles 22, 23, 25, 28. Check that no continuity exists between ground and control unit PL1, poles 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 15, 17, to 28 inclusive, PL2, poles 20, 21, 24, 26.

(3) Select the key XIR. Check that continuity exists between ground and control unit PL1, poles 1 to 20 inclusive; PL2, poles 24, 25, 26, 28. Check that no continuity exists between ground and control unit PL1, poles 21 to 28 inclusive; PL2, poles 20 to 23 inclusive.

(4) Select the key XIS. Check that continuity exists between ground and control unit PL1, poles 1 to 10 inclusive, 21 to 28 inclusive; PL2, poles 20, 21, 26, 28. Check that no continuity exists between ground and control unit PL1, poles 11 to 20 inclusive; PL2, poles 22 to 25 inclusive.

22. Test the on/off switch, the function switch and the reset pushbuttons as follows:—

(1) Ensure that the computer is switched on by setting the on/off switch to the ON position.

(2) Set the function switch to F and ensure that the upper and lower reset pushbuttons, when depressed, produce fast chart reset in the appropriate directions. Ensure that the left and right reset pushbuttons provide slow pen reset in the appropriate directions. Set the function switch to S/OP and ensure that all four reset pushbuttons, when depressed, provide slow reset in the correct directions.

(3) Select the test key XID and set the function switch to S/OP. Set the display head pen to the point of origin of the test traces on the test chart. Set the function switch to R and depress the upper reset pushbutton. Ensure that the pen follows the XID line on the test chart. Repeat this test using the lower reset pushbutton when the pen should move in the opposite direction. Ensure that when the function switch is set to G or P, depressing the upper or lower reset pushbutton produces no display head movement.

(4) Select test key XIF and repeat test (3) with the function switch set to G. Ensure that no display head movement results when depressing the upper or lower reset pushbutton when the function switch is set to R or P.

(5) Select test key XIH and repeat test (3) with the funtion switch set to P. Ensure that no display head movement results when depressing the upper or lower reset pushbutton when the function switch is set to R or G.

23. Ensure that when the display head backlighting dimmer control is in the fully anti-clockwise position the chart is not illuminated and that as the control is turned clockwise, the lighting comes on and increases to full intensity.

24. Ensure that the two panel illumination lamps and the turret switch lamp are functioning.

> **Note . . .**
>
> *Panel and display head chart illumination are of low intensity. If these tests are carried out in full daylight, careful screening will be necessary to make the lighting visible.*

Display head

25. The second line servicing of the flight log display head is restricted to the routine servicing, outlined in para. 26, and the replacement of certain sub-assemblies and components found faulty after mechanical and/or functional inspection (para. 27 to 32 inclusive). The replacement sub-assemblies and components are: — the cassette, the base, the pen mechanism assembly and the indicator lamp.

26. The following routine servicing procedure should be carried out: —

(1) Remove, examine and clean the pen mechanism assembly.

(2) Remove the cassette, examine and clean where necessary.

(3) Remove, examine and clean the perspex cover and the electroluminescent panel (Panelume); clean the recess.

(4) Examine, clean and lubricate lightly the motor gearing and solenoid actuating mechanism, using oil OM13, 34D/9100570.

> **Note . . .**
>
> *Phosphor-bronze bushes require no lubrication.*

(5) Refit the electroluminescent panel and the perspex cover.

(6) From the warning lamp end of the cassette: remove the lamp housings, the bulbs, the circlip and the cassette securing screw, the end cover.

(7) Examine and clean the gears, the lamp supply, the lamp housing recesses and the lamp housings.

(8) Lubricate lightly all gears and bushes, using oil OM13, 34D/9100570.

(9) Refit the cover, the securing screw with circlip, the bulbs and lamp housings.

(10) From the opposite end of the cassette: remove the circlip and the cassette securing screw, the rubber bung from the lamp housing recess hole, the end cover.

(11) Examine and clean the gears, the lamp housing recess, the lamp supply. Lubricate lightly all gears and bushes, using oil OM13, 34D/9100570.

(12) Refit the cover, the securing screw with the circlip, the rubber bung.

(13) Examine and clean the base unit.

(14) Remove the base plate and the pen gear end cover. Examine, clean and lubricate lightly all gears and bushes, using oil OM13, 34D/9100570.

(15) Refit the cover and the base plate.

(16) Clean and examine the plug and socket contacts.

(17) Refit the cassette to the base.

(18) Refit the pen mechanism assembly.

Mechanical inspection

27. A thorough examination of the flight log display head should be made before power is applied and before any functional tests are made. Check: —

(1) General assembly conforms to the current modificaton state.

(2) Piece parts, plating, etc. show no signs of damage, rust or corrosion.

(3) All components are secure and show no sign of overheating or damage.

(4) All wiring is free from damage to insulation and all soldered joints are neat and mechanically sound.

(5) All fixing screws are correctly seated an secured with varnish.

(6) Gears show no signs of excessive wear, are clean and run freely.

(7) All moving parts are lubricated.

(8) The interconnecting plug and socket are clean, free from damage and able to engage fully.

(9) External plug is clean, undamaged and free to move to some small extent.

(10) The lever releasing the drive to the chart drive M-motor operates correctly.

(11) The friction clutches in the chart spools operate correctly.

(12) Warning lamp mechanical dimmer and switch operate correcly.

(13) The electroluminescent panel is free from damage and no starring has occured around the fixing holes.

(14) Cassette retaining screws are captive, i.e. circlips are present and correctly fitted.

(15) Cassette retaining screw holes on display head base have undamaged threads and are not badly worn.

(16) The chart winding knob operates correctly.

(17) All applicable modifications have been incorporated and are recorded on the modification labels.

(18) Engraved figures and letters are legible.

Functional tests

28. The following functional tests should be carried out to ensure the correct functioning of the display head. All tests are made with the display head in the bench rig.

29. Test the pen and chart M motor servo drives by setting the function switch on the computer control unit to S/OP and verify that the four reset pushbuttons, when depressed, produce slow display head reset movement in the appropriate directions. Each pushbutton should be kept depressed for at least one minute. Ensure also that the leadscrew does not jam when the pen carriage is run off the leadscrew at either end.

30. Test the fast chart reset motor by setting the function switch to F and ensuring that the upper and lower reset pushbuttons, when depressed, produce fast chart movement in the appropriate directions.

31. Ensure that warning lamp lights steadily when the function switch is in the S/OP position.

32. Ensure that the display head backlighting is off when the dimmer control on the computer control unit is in the fully anti-clockwise position and that lighting comes on and increases to full intensity when control is turned clockwise. Ensure that the electroluminescent panel provides even overall illumination of the display area.

TABLE 1

Fault check table, flight log computer

Para.	Test Subject	Fault indication	Fault location
12.	Switching on computer.	Display head warning lamp does not light.	7A computer fuse.
13.	Cam unit operation.	(1) Excessive contact sparking.	Cam unit.
		(2) No maximum cam speed.	Cam unit.
		(3) No display head movement on one or both axes.	Cam unit.
		(4) No display head movement when key XID is selected.	(1) Red primary servo unit. (2) Cam unit.
		(5) No display head movement when key XIF is selected.	(1) Green primary servo unit. (2) Cam unit.
		(6) No display head movement when key XIH is selected.	(1) Purple primary servo unit.
14.	Primary servo unit operation.	Uneven primary servo unit operation.	Appropriate primary servo unit(s).
15.	Display head reset facility.	No slow reset.	Cam unit.

Para.	Test Subject	Fault indication	Fault location
16.	Lane slipping facility.	No lane slipping movement or movement fails on specific pattern.	(1) Cam unit. (2) Appropriate primary servo unit(s).
17.	Pattern and scale tests.	No or incorrect movement. (1) Keys XID, XIE.	(1) Cam unit. (2) Red primary servo unit.
		(2) Keys XIF, XIG	(1) Cam unit. (2) Green primary servo unit.
		(3) Keys XIH, XII, XIN, XIO, XIP, XIQ.	(1) Cam unit. (2) Purple primary servo unit.
		(4) Keys XIJ, XIK, XIL, XIM, XIR.	(1) Cam unit. (2) Red primary servo unit. (3) Green primary servo unit.
		(5) Key XIS.	(1) Cam unit. (2) Red primary servo unit. (3) Purple primary servo unit.

TABLE 2

Fault check table, flight log display head

Para.	Test Subject	Fault indication	Fault location
29.	X and Y servo drives.	(1) No pen movement or pen carriage jams. (2) No chart movement.	Base unit. Cassette.
30.	Fast chart reset.	No or slow movement.	Cassette.
31.	Warning lamp.	Not illuminated.	Bulb.
32.	Cassette back lighting.	No, insufficient or uneven illumination.	(1) Base unit. (2) Cassette.

Note . . .

Replace the pen mechanism assembly if toggle fails to raise pen or if assembly is found unserviceable in any other aspect.

SECTION 2

FLIGHT LOG DECCA TYPE 9360

Chapter 1

FIRST LINE FAULT ACTION

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General information

1. The first line ground check and fault location procedure comprises a mechanical inspection of the installation, which is followed, upon satisfactory completion, by a functional test routine based on the use of a Decca signal generator to provide simulated operating conditions. If the equipment passes satisfactorily through all the checks detailed in this routine (para. 7) it may be assumed serviceable. Table 1 lists the faults that can be experienced at each stage of the check procedure and the possible fault locations in order of probability.

2. In Table 1 reference is made to the installation wiring in terms of the connectors defined in Part 2, Sect 2, Chap, 2, Tables 2 to 7 inclusive. The affected conductors and plug or socket connections in each instance may be readily identified from these tables. Table 2 lists the wards selected in the control unit turret switch by the used test keys, together with their connections to plug PL1 and PL2 of the computer.

Mechanical inspection

3. A thorough examination of the flight log installation should be made before power is applied to the equipment and before any functional checks are carried out. The following is a summary of the points to be checked:—

(1) Inspect plugs and sockets, both on the computer rack and on removable units, for security or damage.

(2) Inspect all mounting bolts for security.

(3) With computer mounted, ensure that the locking device is tightened sufficiently to prevent the unit moving or vibrating in its rack.

(4) Ensure that the rack is free to move on the anti-vibration mounts and is not restricted by cable connections and other obstructions.

(5) Ensure that the bonding of all units to the airframe is less than 0·05 ohm.

(6) Operate all controls to ensure that they function smoothly and that they are not damaged.

Ground checks

4. It is convenient, when checking the performance of the aircraft installation, to regard the complete Decca Navigator installation as two separate parts, namely the receiver system and the flight log display system. As the flight log installation is dependent upon the receiver for its input signals, it is assumed that the receiver installation has been checked and found serviceable before the flight log installation is checked.

5. The ground check procedure on the flight log installation requires the receiver to derive its input from a Decca signal generator 10S/9458648 (Decca

Type 9351), 10S/17777 (Decca Type 9209) or 10S/17783 (Decca Type 870). It is assumed in the ground check procedure that the signal generator is connected to the receiver installation and is switched on. (Refer to to the appropriate Air Pubications: A.P.116B-0601-1 for the Mk. 1 receiver or A.P.116B-0604-1 for the Mk. 8A receiver).

Test equipment

6. The following items of test equipment are required to carry out the ground check procedure:

(1) Flight log turret switch (selector, navigational computer set) 10D/9456174 (Decca Type 839KK), loaded with test keys XID, XIE, XIF, XIG, XIH, XII, XIJ, XIK, XIL, XIM, XIN, XIO, XIP, XIQ, XIR, XIS.

(2) Flight log test chart Decca Type TC108 on spool (free roller tube) Decca Type A9161/49.

These are included in the test kit, navigational computer Type 9293B (10S/9546868), which is a standard item of first line test gear for both ARI. 23102/2 and ARI.23121/1.

7. The check procedure is as follows: —

(1) Load the test chart TC108 into the display head cassette as described in Part 2, Sect. 2, Chap. 2, para. 15. Insert the test keys into the turret switch and fit this into the computer control unit as described in Part 2, Sect. 2, Chap. 2, para. 16.

(2) Carry out the ground test checks described in Part 2, Sect. 2, Chap. 2, para. 17(1) to (3) inclusive.

(3) Position display head pen on point A (origin of test traces) on test chart. Set Red decometer lane and fractional pointers to zero. Select test key XID in computer control unit switch turret. Set signal generator motor control to medium speed forward (clockwise rotation of phase control) and switch on motor. Count off 24 lanes on Red decometer. Switch off signal generator motor and check that the display head pen has travelled to the 'XID' point marked on the test chart. Reverse direction of signal generator phase rotation and switch on motor. Count off 24 lanes on Red decometer. Switch off motor and check that the display head pen has returned to the point of origin on the test chart.

(4) Repeat check (3) with test keys XIE, XIF, XIG, XIH and XII selected in turn. Check in each instance that a signal generator phase rotation of 24 Red lanes produces the display head movement indicated on the test chart.

(5) Set signal generator motor control to slow speed (approximately 2 revs./min.). Repeat check (3) with test keys XIJ, XIK, XIL, XIM, XIN, XIO, XIP and XIQ selected in turn. Check in each instance that a signal generator phase rotation of 12 Red lanes produces the display head movement indicated on the test chart.

(6) Repeat check (3) with test key XIR selected. Check that a signal generator phase rotation produces no display head movement.

(7) Repeat check (3) with test key XIS selected. Check that a signal generator phase rotation of 6 Red lanes produces the display head movement indicated on the test chart.

(8) Set control unit function switch to R. Select test key XID. Check that depressing upper and lower reset pushbuttons produces a display head movement to the left and to the right respectively. Check that depressing upper and lower reset pushbuttons when the function switch is in the G or P position, produces no display head movement.

(9) Repeat check (8) with test key XIF selected and check that Green lane slip facility functions correctly.

(10) Repeat check (8) with test key XIH selected and check that Purple lane slip facility functions correctly.

TABLE 1

Fault check Table

Note—*References in 'Operation' column only apply to the checks described in para. 7.*

Operation	Fault indication	Action
Para. 7(2)	'on' lamp fails to light.	(1) Check 28V supply at junction box (terminals A1, B1). (2) Check connector 1 (computer PL2, poles 1, 2, 3, 4) (3) Check connector 4 (computer PL2, pole 8). (4) Check connector 2 (computer PL2, pole 24). (5) Replace display head. (6) Replace computer. (7) Replace control unit.

TABLE 1—contd.

Operation	Fault indication	Action
	Control unit panel illumination fails to operate	
	(1) If receiver control unit panel illumination fails to operate	(1) Check dimmer supply (junction box terminal A3).
	(2) If receiver control unit panel illumination operates.	(1) Check connector 5 (control unit PL2, pole 24). (2) Replace control unit.
	Display head chart illumination fails to operate	(1) Check connector 3 (display head PL1, pole 12). (2) Check connector 5 (control unit PL2, poles 4, 9). (3) Check connector 1 (computer PL2, pole 9). (4) Replace display head. (5) Replace control unit. (6) Replace computer.
	No fast chart reset	(1) Check connector 3 (display head PL1, poles 10, 11). (2) Check connector 5 (control unit PL2, poles 22, 23). (3) Replace display head. (4) Replace control unit.
	No slow chart reset	Set control function switch to R. Select test key XIE. Depressing upper and lower reset buttons should produce appropriate chart movement. Set control function switch to G and P respectively and use of upper and lower pushbuttons should produce no chart movement.
	(1) If check with key XIE selected is satisfactory.	(1) Check connector 4 (computer PL2, pole 29). (2) Replace computer. (3) Replace control unit.
	(2) If check with key XIE selected, is unsatisfactory	(1) Replace computer. (2) Replace display head.
	No slow pen reset	Follow procedure in para. 7(8).
	(1) If check 7(8) is satisfactory	(1) Check connector 4 (computer PL2, pole 6). (2) Replace computer. (3) Replace control unit.
	(2) If check 7(8) is unsatisfactory.	(1) Replace computer. (2) Replace display head.
Para. 7(3) Key XID	No or inaccurate pen movement	Follow procedure in para. 7(8).
	(1) If check 7(8) satisfactory	(1) Check Red receiver output connections at junction box terminals B6, B5. (2) Check connector 1 (computer PL2, poles 18, 19). (3) Replace computer.
	(2) If check 7(8) unsatisfactory	(1) Check connector 6 (computer PL1, poles 6, 7, 8, 9, 10, 31). (2) Replace computer. (3) Replace control unit.
Para. 7(4) Key XIE	No or inaccurate chart movement	(1) Check connector 6 (computer PL1, poles 1, 2, 3, 4, 5, 32). (2) Replace computer. (3) Replace control unit.

TABLE 1—contd.

Operation	Fault indication	Action
Key XIF	No or inaccurate pen movement	Follow procedure in para. 7(9).
	(1) If check 7(9) satisfactory	(1) Check Green receiver output connections to junction box terminals B7, B8. (2) Check connector 1 (computer PL2, poles 20, 21). (3) Replace computer.
	(2) If check 7(9) unsatisfactory	(1) Check connector 6 (computer PL1, poles 16, 17, 18, 19, 20). (2) Replace computer. (3) Replace control unit.
Key XIG	No or inaccurate chart movement	(1) Check connector 6 (computer PL1, poles 11, 12, 13, 14, 15). (2) Replace computer. (3) Replace control unit.
Key XIH	No or inaccurate pen movement	Follow procedure in para. 7(10).
	(1) If check 7(10) satisfactory	(1) Check Purple receiver output connections at junction box terminals B9, B10. (2) Check connector 1 (computer PL2, poles 22, 23). (3) Replace computer.
	(2) If check 7(10) unsatisfactory	(1) Check connector 6 (computer PL1, poles, 26, 27, 28, 29, 30). (2) Check connector 4 (computer PL2, pole 10). (3) Replace computer. (4) Replace control unit.
Key XII	No or inaccurate chart movement	(1) Check connector 6 (computer PL1, poles 21, 22, 23, 24, 25). (2) Check connector 4 (computer PL2, pole 11). (3) Replace computer. (4) Replace control unit.
Para. 7(5) Key XIJ	No or inaccurate display head movement	(1) Check connector 4 (computer PL2, pole 31). (2) Replace computer. (3) Replace control unit.
Key XIK	No or inaccurate display head movement	(1) Check connector 4 (computer PL2, pole 30).
Keys XIL, XIM, XIN, XIO, XIP, XIQ	No or inaccurate display head movement	(1) Replace computer. (2) Replace control unit.
Para. 7(6) Key XIR	Display head movement obtained	(1) Replace computer. (2) Replace control unit.
Para. 7(7) Key XIS	No or inaccurate display head movement	(1) Replace computer. (2) Replace control unit.
Para. 7(8)	No or inaccurate pen movement	(1) Check connector 4 (computer PL2, poles 25, 26, 27, 28). (2) Replace computer. (3) Replace control unit.
Para. 7(9) Para. 7(10)	No or inaccurate pen movement	(1) Replace computer. (2) Replace control unit.

TABLE 2

Test key wards

Test key	Wards selected	Computer connections
XID	6, 7, 8, 9, 10, 31	6, 7, 8, 9, 10, 31 on PL1
XIE	1, 2, 3, 4, 5, 32	1, 2, 3, 4, 5, 32 on PL1
XIF	16, 17, 18, 19, 20, 31	16, 17, 18, 19, 20, 31 on PL1
XIG	11, 12, 13, 14, 15, 32	11, 12, 13, 14, 15, 32 on PL1
XIH	26, 27, 28, 29, 30, 33	26, 27, 28, 29, 30 on PL1; 10 on PL2
XII	21, 22, 23, 24, 25, 34	21, 22, 23, 24, 25 on PL1; 11 on PL2
XIJ	1, 6, 11, 16, 31, 32, 34, 36	1, 6, 11, 16, 31, 32 on PL1; 11, 31 on PL2
XIK	2, 7, 12, 17, 31, 32, 33, 35, 36	2, 7, 12, 17, 31, 32 on PL1; 10, 30, 31 on PL2
XIL	3, 8, 13, 18, 32, 33, 34, 35, 36	3, 8, 13, 18, 32 on PL1; 10, 11, 30, 31 on PL2
XIM	4, 9, 14, 19, 31, 33, 34, 35, 36	4, 9, 14, 19, 31 on PL1; 10, 11, 30, 31 on PL2
XIN	21, 26, 35	21, 26 on PL1; 30 on PL2
XIO	22, 27, 35, 36	22, 27 on PL1; 30, 31 on PL2
XIP	23, 28, 35, 36	23, 28 on PL1; 30, 31 on PL2
XIQ	24, 29, 35, 36	24, 29 on PL1; 30, 31 on PL2
XIR	1-20 incl., 33-36 incl.	1-20 incl. on PL1; 10, 11, 30, 31 on PL2
XIS	1-10 incl., 21-30 incl., 35, 36	1-10 incl. ,21-30 incl. on PL1; 30, 31 on PL2

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Chapter 2

SECOND LINE FAULT ACTION

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GENERAL INFORMATION

1. The procedure detailed in this chapter is directed to the diagnosis and, where possible, repair of faults in the units of the flight log installation. Faulty operation of a unit may become apparent during a ground check or during operation in flight. In the latter case, the following details should be obtained: —

(1) Nature of fault or reported failure.

(2) Duration of failure(s), if intermittent.

(3) Performance of Decca receiver installation.

2. Reference to any available information on the nature of the operational failure will assist in quick location of the fault. Where such information indicates that the fault is of an intermittent nature, a prolonged run of the affected unit or units may be necessary to enable the fault to be repeated. In some instances, failure may not recur until the equipment has stabilized at full operating temperature.

3. When no fault condition can be found in the unit, despite an operational defect report, a decision on the serviceability of the unit must be made on the following considerations: —

(1) The adequacy and reliability of the initial defect report.

(2) The nature of the reported failure.

(3) The likelihood of a cable fault in the installation.

(4) The probability of a d.c. supply failure.

(5) The possibility of the receiver installation being at fault.

TEST EQUIPMENT

4. The following items of test equipment are required to carry out the functional checks on the units of the flight log installation: —

(1) Test bench rig (Decca Type 9293-D) 10S/9515764, complete with cable harness Decca Type 9293-H (10HS/9515971).

Note . . .

The test bench rig should be connected to a power supply with an output voltage, variable on load, between 22 to 31 volts d.c., with an output resistance not exceeding 5 ohms at 3 amps and a ripple content not exceeding 2 volts peak-to-peak.

(2) The following units of the flight log installation should be available for use in the test bench rig as required: —

Computer, navigational (Decca Type 9360) 10L/9714277

Control, computer (computer control unit Decca Type 941) 10L/9450477

Indicator, chart and map position (display head Decca Type 961) 10Q/9714276

(3) Test kit, navigational computer (Decca Type 9293-B) 10S/9546868, from which the following items are required: —

Test chart with spool (Decca Type 9161-CA) 10S/9515986

Selector navigational computer set (turret switch Decca Type 839KK) 10D/9456174.

Set of test keys, comprising the following types: —

XID (10AR/9701860), XIE (10AR/9701861),

XIF (10AR/9701862), XIG (10AR/9701863),

XIH (10AR/9701864), XII (10AR/9701859),

XIJ (10AR/9701858), XIK (10AR/9701857),

XIL (10AR/9701856), XIM (10AR/9701855),

XIN (10AR/9701854), XIO (10AR/9701853),

XIP (10AR/9701852), XIQ (10AR/9701851),

XIR (10AR/9701850), XIS (10AR/9701849),

Pen recording (capsule pen Decca Type A806D) 10AF/9456178.

(4) Sine/Cosine generator (mains driven) (Decca Type 9005) 10S/9546089.

(5) Indicator, electrical, Red (decometer Decca Type 274B, Z or ZS) 10Q/16492, 10Q/16774 or 10AS/9533417, to monitor sine/cosine generator output.

(6) M counter (Decca Type 9497) 10Q/9515775

(7) Multimeter CT498 5QP/17447 or test set multimeter No. 1, 6625-99-105-7049.

(8) Oscilloscope CT436, 10S/9138618

(9) Adapter lead (Decca Type 9293-G) 10HB/0515973.

PROCEDURE

5. The second line check and fault location procedure comprises a mechanical inspection of the affected unit, followed, upon satisfactory completion, by a funtional test routine. If the unit passes satisfactorily through these checks it may be assumed serviceable (paras. 2 and 3).

6. Unless a unit has a self-evident fault, it should be subjected to the complete test procedure. Where a particular check produces unsatisfactory results the fault finding tables (Tables 2 and 3) should be consulted for the most likely cause. To derive the greatest benefit from these tables the sequence of the test procedure should be strictly followed. A complete check of the unit should be made when the fault has been rectified.

7. Most faults in the units will necessitate the replacement of a faulty sub-assembly. Servicing procedure should however include the overall cleaning of the unit, specifically the cleaning of plug and socket contacts, and lubrication of moving parts. These routine servicing measures are detailed for each main unit under the appropriate main headings.

Computer

8. The second line servicing of the flight log computer is restricted to the routine servicing (outlined in the following para. 9) and the replacement of certain sub-assemblies found faulty after mechanical and/or functional inspection (paras. 10 to 17 inclusive). The replaceable sub-assemblies are: the Red, Green and Purple primary servo units; the Red, Green and Purple primary servo circuit boards; the ancillary circuit board; the X and Y head servo circuit boards; the power unit board.

9. The following routine servicing procedure should be carried out: Examine and clean computer where necessary, paying particular attention to internal and external plugs and socket. Examine and clean all three primary servo units; lubricate all gears lightly with oil OM13, 34D/9100570, ensuring that no oil gets onto the carbon tracks.

Mechanical inspection

10. A thorough examination of the flight log computer should be made before power is applied and before any functional tests are made: check:

(1) General assembly conforms to the current modification state.

(2) Piece parts, plating, etc. show no signs of damage, rust or corrosion.

(3) All components are secure and show no signs of overheating or damage.

(4) Gear teeth of primary servo units show no signs of excessive wear.

(5) All wiring is free from damage to insulation.

(6) Circuit boards have an unbroken coating of epoxy resin.

(7) Adequate clearance exists between adjacent boards and cover and adjacent connections.

(8) Securing blocks are in position at top of circuit boards.

(9) Sub-assembly interconnecting plugs and sockets are securely mated.

(10) All soldered connections are neat and mechanically sound.

(11) All fixing screws are correctly seated and secured with varnish.

(12) External sockets are clean, undamaged and free to move vertically to some small extent.

(13) All applicable modifications have been incorporated and are recorded on the modification label.

(14) Engraved figures and letters are legible.

Functional tests

11. The following functional tests should be carried out to ensure correct functioning of the computer. All checks are performed with the computer placed in the test bench rig, and the cover of the unit removed for visual checking when necessary. Unless stated otherwise, all checks should be performed with a power supply of 28 volts d.c. and at an ambient temperature not exceeding 55°C.

12. Load the test chart into the display head cassette, as described in Part 2, Sect. 2, Chap. 2, para. 15. Insert the test keys into the turret switch and the turret into the computer control unit as described in Part 2, Sect. 2, Chap. 2, para. 16. Switch on computer by setting function switch on computer control unit to any position other than OFF.

13. Test the power supply circuit as follows:—

(1) Measure the stabilized output voltage (pole 6 of PL/SKT 12) to be between 19·5 to 21 volts with a power supply input of 28 volts d.c.

(2) Check that the stabilized output voltage does not fall below 19 volts d.c. when the power supply input is varied between 22 and 30 volts d.c.

(3) Check that the noise level on the stabilized output supply does not exceed 200 millivolts (peak-to-peak).

(4) Repeat tests (1), (2) and (3) after the power supply circuit has been made to operate on an input of 31 volts d.c. for 5 minutes.

14. Test primary servo unit operation as follows:

(1) Switch on sine/cosine generator and set output to $\frac{1}{3}$ TORQUE and select lowest speed on motor drive (position 3 on stepped speed control). Switch on sine-cosine generator motor and ensure that the primary servo units rotate smoothly in both directions, using motor REVERSE switch.

(2) Check that the backlash upon reversal of direction does not exceed 0·06 on sine/cosine potentiometer scale.

(3) Repeat tests (1) and (2) with sine/cosine generator output set to FULL TORQUE and check that the mechanical backlash in this condition does not exceed 0·015 on the sine/cosine potentiometer scale.

(4) Ensure that clockwise rotation of sine/cosine potentiometer control results in clockwise rotation of primary servo unit carbon tracks.

(5) Verify that primary servo unit M motors rotate at doubled speed when either or both wards 35 and 36 are selected (test keys XIJ, XIN, XIO).

15. Test the display head reset facility as follows:—

(1) Set control unit function switch to F. Ensure that upper and lower reset pushbuttons, when depressed, produce a fast chart movement in the appropriate directions.

(2) Keep function switch in the F position. Select key XID in the control unit turret. Rotate sine-cosine potentiometer control to give a slow pen movement to the left. Depress right hand reset pushbutton and ensure that the pen immediately moves to the right at a rate of approximately 3 inches per 15 seconds: the pen should resume the former direction and speed of travel upon release of the pushbutton.

(3) Repeat check (2) with the sine/cosine potentiometer control rotating in the opposite direction, when depressing the left hand reset pushbutton should cause a pen movement to the left.

(4) Set the function switch to S/OP and repeat tests (2) and (3).

(5) Keep the function switch in the STOP position. Select key XIE in the control unit turret. Rotate the sine/cosine potentiometer control to give a slow downward chart movement. Depress the lower reset pushbuttons and ensure that the chart immediately moves upward at a rate of approximately 3 inches per 15 seconds; the chart should resume the former direction and speed of travel upon release of the reset pushbutton.

(6) Repeat test (5) with the sine/cosine potentiometer control rotating in the opposite direction, when depressing the upper reset pushbutton should cause a downward chart movement.

16. Test the lane slipping facility as follows:—

(1) Set the function switch to R. Select key XID. Rotate the sine/cosine potentiometer control to give a slow pen movement to the left. Ensure that when the lower reset pushbutton is depressed the pen direction reverses after a slight delay. If this delay is not visually perceptible, check with the oscilloscope that a momentary change in level (positive-going 25-250 milliseconds) occurs on the head inhibit line (PL/SKT 9, pole 5).

(2) Repeat test (1) with reversed direction of signal rotation, when depressing the upper reset pushbutton should cause a reversal of pen direction after a slight delay.

(3) Ensure that depressing the upper and lower reset pushbuttons, when the function switch is in the G or P position, produces no display head movement.

(4) Repeat tests (1), (2) and (3) with the test key XIF selected, and ensure that the Green lane slipping facility functions correctly.

(5) Repeat tests (1), (2) and (3) with the test key XIH selected and ensure that the Purple lane slipping facility functions correctly.

17. Carry out the following pattern and scale tests:—

(1) Position the display head pen on the point of origin of the test traces on the test chart. Set the lane and fractional pointers of the monitoring Red decometer to zero. Select the test key XID. Set the sine/cosine potentiometer motor control to medium speed forward (position 2 of the stepped speed control), i.e. clockwise rotation of the sine/cosine generator phase control. Switch on the motor and count off 24 lanes on the Red decometer. Switch off the motor and check that the display head pen has travelled to the 'XID' point marked on the test chart. Reverse the direction of the sine/cosine generator phase rotation. Switch on the motor and count off 24 lanes on the Red decometer. Switch off the motor and check that the pen has returned to the point of origin on the test chart. A tolerance of 0·015 inch is permitted in the indicated display head positions.

(2) Repeat test (1) with the test keys XIE, XIF, XIG, XIH, XII selected in turn. Ensure that a sine/cosine generator phase rotation of 24 Red lanes with the key XIE selected, 18 Red lanes with the keys XIF, XIG selected and 30 Red lanes with the keys XIH, XII selected, each produce the display head movement indicated on the test chart for the appropriate key.

(3) Set the sine/cosine generator motor control to slow speed (position 3 on the stepped speed control). Repeat test (1) with the keys XIJ, XIK, XIL, XIM, XIN, XIO, XIP, XIQ, XIR, XIS selected in turn. Ensure that a sine/cosine generator phase rotation of 16 Red lanes with the keys XIJ, XIK selected, 24 Red lanes with the key XIL selected, 30 Red lanes with the key XIM selected, 20 Red lanes with the keys XIN, XIO, XIP selected, 40 Red lanes with the key XIQ selected, 16 Red lanes with the key XIR selected, 6 Red lanes with the key XIS selected, each produce the display head movement indicated on the test chart for the appropriate key. A tolerance of 0·030 inch is permitted in the indicated display head positions, excepting the tests carried out with keys XIN, XIO, XIP, XIQ for which a tolerance of 0·015 inch is acceptable.

Note . . .

The pattern and scale tests may be carried out, using the M counter in place of the display head, in which case Table 1 should be consulted for the correct counter reading.

Control unit

18. The second line servicing of the flight log control unit is restricted to the replacement of the panel illumination bulbs. The following routine servicing procedure should be carried out: — Examine and clean the control unit where necessary, paying particular attention to the plugs. Clean, examine and check for distortion the turret switch ward wires.

Mechanical inspection

19. A thorough examination of the flight log control unit should be made before power is applied and before any functional tests are made.

Check: —

(1) General assembly conforms to the current modification state.

(2) Piece parts, plating, etc. show no signs of damage, rust or corrosion.

(3) All components are secure and show no signs of overheating or damage.

(4) All wiring is free from damage to insulation and all soldered connections are neat and mechanically sound.

(5) All fixing screws are correctly seated and secured with varnish.

(6) All switches and pushbuttons move freely and locate positively.

(7) Function switch and dimmer control rotate to the prescribed limits and knobs are firmly located.

(8) Gold alloy contact wires (turret switch wards) are parallel and equally spaced.

(9) Turret rotates easily through 360° and locates positively at each key position when the release lever is depressed.

(10) Turret and panel illumination lamps are correctly seated.

(11) External plugs are clean, undamaged and free to move vertically to some small extent.

(12) All applicable modifications have been incorporated and are recorded on the modification label.

(13) Engraved figures and letters are legible.

Functional tests

20. The following functional tests should be carried out to ensure the correct functioning of the control unit. The first test (para. 21) is a static test to be made with the control unit out of the bench rig. The remainder of the tests are made with the control unit in the bench rig.

21. Check the turret switch as follows:—

(1) Load the control unit turret with the test keys XIJ, XIR and XIS.

(2) Select the key XIJ. Check that continuity exists between ground and control unit PL1, poles 1, 6, 11, 16, 31, 32; PL2, poles 11, 31. Check no continuity exists between ground and control unit PL1, poles 2, 3, 4, 5, 7, 8, 9, 10, 12, 13, 14, 15, 17 to 30 inclusive; PL2, poles 10, 30.

(3) Select the key XIR. Check that continuity exists between ground and control unit PL1 poles 1 to 20 inclusive; PL2, poles 10, 11, 30 and 31. Check no continuity exists between ground and control unit PL1, poles 21 to 32 inclusive.

(4) Select the key XIS. Check that continuity exists between ground and control unit PL1, poles 1 to 10 inclusive, 21 to 30 inclusive; PL2, poles 30, 31. Check no continuity exists between ground and control unit PL1, poles 11 to 20 inclusive, 31, 32; PL2, poles 10, 11.

22. Test the function switch and the reset pushbuttons as follows: —

(1) Ensure that the computer is switched on, by setting the function switch to any position other than OFF.

(2) Set the function switch to F and ensure that the upper and lower reset pushbuttons, when depressed, produce fast chart reset in the appropriate directions. Ensure that the left and right reset pushbuttons provide slow pen reset in the appropriate directions. Set the function switch to S/OP and ensure that all four pushbuttons, when depressed, provide slow reset in the correct directions.

(3) Select the test key XID and set the function switch to S/OP. Set the display head pen to the point of origin of the test traces on the test chart. Set the function switch to R and depress the upper reset pushbutton. Ensure that the pen follows the XID line on the test chart. Repeat this test using the lower reset pushbutton, when the pen should move in the opposite direction. Ensure that when the function switch is set to G or P, depressing the upper or lower reset pushbuttons produces no display head movement.

(4) Select test key XIF and repeat test (3) with the function switch set to G. Ensure that no display head movement results when depressing the upper or lower reset pushbuttons when the function switch is set to R or P.

(5) Select the test key XIH and repeat test (3) with the function switch set to P. Verify that no display head movement results from depressing the upper or lower reset pushbuttons when the function switch is set to R or G.

23. Ensure that when the display head back lighting dimmer control is in the fully anti-clockwise position the chart is not illuminated and that as the control is turned clockwise, the lighting comes on and increases to full intensity.

24. Ensure that the two panel illumination lamps and the turret switch lamp are operational.

Note ...

Panel and display head chart illumination are of low intensity. If these tests are carried out in full daylight, careful screening will be necessary to make the lighting visible.

Display head

25. The second line servicing of the flight log display head is restricted to the routine servicing, outlined in para. 26, and the replacement of certain sub-assemblies and components found faulty after mechanical and/or functional inspection (paras. 27 to 32 inclusive). The replaceable sub-assemblies and components are: the cassette, the base, the pen carrier assembly and the indicator lamp.

26. The following routine servicing procedure should be carried out: —

(1) Remove the cassette, examine and clean where necessary.

(2) Check the motor gearing and solenoid actuating mechanism.

(3) Lubricate the gears and bearings, using oil OM13, 34D/9100570.

(4) Remove the end cover, check the gearing and lubricate where necessary.

(5) Clean the perspex cover.

(6) Examine and clean the base, lubricate where necessary.

(7) Clean and examine plug and socket contacts.

Mechanical inspection

27. A thorough examination of the flight log display head should be made before power is applied and before any functional tests are made.

Check: —

(1) General assembly conforms to the current modification state.

(2) Piece parts, plating, etc. show no signs of damage, rust or corrosion.

(3) All components are secure and show no signs of overheating or damage.

(4) All wiring is free from damage to insulation, all soldered joints neat and mechanically sound, and wiring protection covers in position.

(5) All fixing screws are correctly seated and secured with varnish.

(6) Gears show no signs of excessive wear, are clean and run freely.

(7) All moving parts are lubricated.

(8) The interconnecting plug and socket are clean and free from damage.

(9) External plug is clean, undamaged and free to move to some small extent.

(10) The pen carriage can be moved manually along the entire length of the cursor guide.

(11) The lever on the pen mechanism assembly lowers and raises the pen arm.

(12) The four catches on the base engage the cassette correctly and the cassette moves slightly upward upon release of two of the four catches, under pressure from the push-out spring in the base.

(13) The drive cable in the base is correctly routed and sufficiently tight.

(14) The knurled chart winding knob operates correctly.

(15) All applicable modifications have been incorporated and are recorded on the modification label.

(16) Engraved figures and letters are legible.

Functional tests

28. The following functional tests should be carried out to ensure the correct functioning of the display head. All tests are made with the display head in the bench rig.

29. Test the pen and chart M motor servo drives by setting the function switch on the computer control unit to S/OP and verify that the four reset pushbuttons, when depressed, produce slow display head reset movement in the appropriate directions.

30. Test the fast chart reset motor by setting the function switch to F and ensure that the upper and lower reset pushbuttons, when depressed, produce fast chart movement in the appropriate directions.

31. Test the 'on' lamp to be illuminated in any position other than OFF of the function switch.

32. Ensure that the display head back lighting is off when the dimmer control on the computer control unit is in the fully anti-clockwise position and that the lighting comes on and increases to full intensity when the control is turned clockwise. Verify that the electroluminescent panel provides even overall illumination of the display area.

TABLE 1

M counter readings for computer pattern and scale checks

Operation	M counter reading X	Y	Tolerance in reading
Para. 17(1)			
XID	1200W	—	1
Para. 17(2)			
XIE	—	1200N	1
XIF	1200W	—	2
XIG	—	1200N	2
XIH	1200W	—	1
XII	—	1200N	1
Para. 17(3)			
XIJ	133W	1867N	3
XIK	933W	133N	3
XIL	100E	700N	3
XIM	583W	83S	3
XIN	800E	400S	1
XIO	400E	400S	1
XIP	200E	200S	1
XIQ	267E	267S	1
XIR	533E	533S	3
XIS	2160E	2160S	2

TABLE 2

Fault check table, flight log computer

Test Para.	Subject	Fault indication	Fault location
12.	Switching on computer	Cassette on/off lamp does not light	(1) Computer 4A fuse (F1) (2) Power unit board
13.	Power supply circuit	No or incorrect output voltage, excessive noise level	(1) Computer 2A fuse (F2) (2) Power unit board
14.	Primary servo operation	No or incorrect servo operation	(1) Appropriate primary servo board (2) Appropriate primary servo unit
15.	Display head reset facility	No or incorrect slow reset	(1) Ancillary board (2) X or Y head servo board as appropriate

TABLE 2—continued

Para. Test	Subject	Fault indication		Fault location
16.	Lane slipping facility	No or incorrect lane slip		
			Key XID	(1) Red primary servo board (2) Anciliary board
			Key XIF	(1) Green primary servo board (2) Ancillary board
			Key XIH	(1) Purple primary servo board (2) Ancillary board
		No head inhibit upon reversal		X or Y head servo board as appropriate
17.	Pattern and scale tests	One pattern only serviceable		(1) Appropriate primary servo board (2) Ancillary board
		Two or more patterns not serviceable		(1) X or Y head servo board as appropriate (2) Ancillary board
		The patterns not serviceable, have keys with common wards		Check wards earthed at flight log control unit

TABLE 3

Fault check table, flight log display head

Test Para.	Subject	Fault indication	Fault location
29.	X and Y servo drives	(1) No pen movement or pen carriage jams	Base unit
		(2) No chart movement	Cassette
30.	Fast chart reset	No or slow movement	Cassette
31.	ON lamp	Not illuminated	Bulb
32.	Cassette back lighting	No, insufficient or uneven illumination	(1) Base unit (2) Cassette

Note . . .

Replace the pen mechanism assembly if toggle fails to raise pen or if assembly is found unserviceable in any other aspect.

Printed for Her Majesty's Stationery O
270711/D 545546 200 10/67 Gp.483