Chapter 7

AIR DATA COMPUTER, TYPE B, Ref. No. 6A/5404 and TYPE C, Ref. No. 6A/8743

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GENERAL DESCRIPTION

INTRODUCTION

General

1. The air data computer, Type B, Ref. No. 6A/5404, forms part of the air data system, Mk. 1B (A.D.S.), and is housed in a computer mounting tray, Type A, Ref. No. 6A/5936, into which it is guided by means of two dowels on the mounting tray which locate on two bushes at the rear of the computer. The unit is secured by three screw clamps which engage on lugs on the front panel. The computer cover may be removed by unscrewing two captive nuts at the rear of the unit. The computer is approximately 17 in. in length (with handles), 6 in. in height, 13 in. in width and weighs 28 lb. No external controls are provided.

2. The incorporation of Mod. ADS/26, which provides improved Mach No. output accuracy, changes the Type B computer to Type C, Ref. No. 6A/8743, and Mod. ADS/138 introduces a unit label marked with the new identity. Type B and C computers are not directly interchangeable in service use. Except where indicated in the text, the information in this chapter is applicable to both types of computer.

Note . . .

This issue of the chapter covers computers with modifications ADS/7, 17, 24, 25, 26, 34, 52, 60, 63, 71, 80, 97, 103, 104, 130, 134, 138 *and* 143 *incorporated, but, where necessary, information on earlier models is included.*

System summary

3. The air data computer receives basic aerodynamic information, in the form of electrical signals, from the pitot-static (P-S) and static (S) transducers of the A.D.S. Mk.1B and temperature information from an external temperature probe. This basic information is then computed, before providing the following output signals — Mach number, true air speed (T.A.S.), vertical speed (rate of climb or dive) and height. Indicated air speed (I.A.S.), and a further height signal are derived within the pitot-static and static transducers respectively, but for convenience are routed directly through the computer, without modification, and appear as computer outputs. The outputs from the computer are fed to the display instruments of the system and also to other user equipments, the latter being designated OUE (A), OUE (B), and OUE (C) for the purposes of this chapter.

4. The pitot-static and static transducers are connected to the aircraft's pressure head and transform the relevant pressure variations into electrical signals by means of internal servo loops.

5. The external temperature probe consists of a temperature-sensitive resistance element which forms the variable resistance in one ratio arm of a bridge circuit, the remainder of which is located in the computer. Temperature information is only required for the computation of true air speed and the function of the temperature circuit is described in detail in the description of the T.A.S. channel (para. 71).

6. The design of the A.D.S. Mk.1B includes provision for the compensation of pressure errors by means of a voltage proportional to pressure error correction (P.E.C.), which is not applicable in the Mk.1B system. The components associated with P.E.C. are, however, physically present in the computer and are shown on the circuit diagrams, but are not connected electrically.

7. The relationship between the primary variables (P-S pressure, S Pressure and temperature) and the output quantities (Mach number T.A.S., vertical speed and height) can be expressed as mathematical formulae, as shown in Appendix 1 to this chapter. It is the function of the computer to constantly resolve the formulae as the primary variables change and to present the solutions in the form of electrical outputs. The mathematical process required is more conveniently achieved in logarithmic form and therefore, with one exception, the variables are converted to voltages proportional to the logarithm of the variable. For example, in simplified form Mach number is proportional to P-S pressure diveded by S pressure; this can more easily be computed by the subtraction of log S from log P-S to give a solution of log Mach number. Furthermore, if the signal voltages representing log P-S and log S are arranged to be of opposite phase, the computation process requires only the addition of these two voltages. Throughout the computation, therefore, most of the signal and intermediate voltages are arranged to be proportional to the logarithm of the quantity and to be of a particular voltage phase.

8. The required voltage phase is produced by applying two 20V, 400c/s supplies as excitation for the signal sources. One of these voltages is designated phase Y and is in phase with the reference supply and the other is designated phase X and is in anti-phase. Two further voltages at 9·5V (nominally 10V), 400c/s (phase Y and X) are used in the vertical speed channel. These four supplies together with a 6V, 400c/s supply for the temperature probe circuit are obtained from transformer T3 in the A.D.S. Mk.1B power supply unit.

9. With the exception of a logarithmic rate of change of height output to the height and rate of climb display, the solution of the formulae are transformed into natural quantities (i.e. Mach number, T.A.S., linear rate of change of height, etc.) before being fed from the computer.

Transducer outputs

10. Indicated air speed is obtained from synchro CX1 in the P-S transducer and is routed directly through the computer to a receiver synchro in the speed display. Similarly, height is obtained from synchro CX2 in the static transducer and fed directly through the computer to the two height displays. The transducer outputs used in computation are (a) log (P-S), phase Y from potentiometer RV3 in the P-S transducer, (b) log S, phase X from potentiometer RV3 in the S transducer and (c) corrected height from CX1 in the S transducer. The application of these outputs within the computer is described in detail in the channel descriptions.

Computer outputs

11. Mach number, T.A.S. and log $\frac{dh}{dt}$ outputs are fed from synchros G5/CX1, G7/CX1 and G4/TX1 respectively to the appropriate displays. Addition-three main computation channels.—Mach number, are fed from potentiometers G5/RV5 and G5/RV4 respectively to OUE (A), T.A.S. from potentiometers G7/RV5 and G7/RV4 to OUE (B) and OUE (C) respectively and linear $\frac{dh}{dt}$ from potentiometer G4/RV5 to OUE (C). The computer also controls operation of the transducer heater circuits by means of microswitch MSW1 in the height gearbox assembly G3. ◀MSW1 and the associated relays are removed post-mod. ADS/130▶

Computer summary

12. The computer can be considered as having three main computation channels,—Mach number, true air speed (T.A.S.) and vertical speed (rate of climb or dive), together with a further channel, height, which has a limited application in the Mk.1B system. Each main channel comprises two servo systems, in cascade, with the exception of the height channel, which is a single servo system. Each servo system consists of a servo amplifier and a gearbox assembly, the latter incorporating a gear train which controls the various servo-driven components providing the required outputs. Each servo system is mechanically separate and inter-connection with other servo systems and components is provided solely by electrical means. The height channel is removed post-mod. ADS/134.

Note . . .

For the purpose of this description the term servo system includes the relevant transistor amplifier, demodulator and magnetic amplifier (which comprise a complete servo amplifier), and the gearbox assembly. It should be noted, however, that the transistor amplifier, the magnetic amplifier, with its associated demodulator, and the gearbox assembly are, in fact, separate entities.

13. Identical transistor amplifiers and identical magnetic amplifiers are used throughout the computer, but the external connections vary slightly. The seven gearbox assemblies are similar in construction and the gear train is in most cases driven by an a.c. motor-tachogenerator, which also provides a velocity feedback signal. An exception is the rate of climb gearbox assembly where the a.c. motor section is used to drive the gear train, but the a.c. tachogenerator is disconnected and a simulated velocity feedback is derived from a d.c. tachogenerator. A number of computation cam units (CU) are incorporated in the various gear trains and these modify shaft output in accordance with prescribed laws. The components in each servo system vary, but include output and feedback precision potentiometers, sychros, d.c. tachogenerators and micro-switches. Further details are given in subsequent paragraphs.

Abbreviations

14. Although the indentities G1, G2, etc. apply strictly to the gearbox assemblies in the servo system they have also been used in this chapter to identify the servo system. It should be noted that SA1 which contains TA1 and MA1 is associated with servo system G2 and SA2, which contains TA2 and MA2 is associated with servo system G1. This identification accords with the physical identification on the equipment and with information published elsewhere. TA8 is associated with servo system G3.

15. The following abbreviations are used throughout this chapter:—

Servo system		Servo system identity
Log Mach number Mach number output	employed in Mach channel	G1 G5
Temperature (temperature transducer T.A.S. output	employed in T.A.S. channel	G6 G7
Rate of climb Vertical speed output	employed in vertical speed channel	G2 G4
Height	Employed in height channel	G3

SA1	Servo amplifier associated with G2
SA2	Servo amplifier associated with G1
SA3-SA7	Servo amplifiers associated with G3 to G7
TA1	Transistor amplifier associated with G2
TA2	Transistor amplifier associated with G1
TA3-TA7	Transistor amplifiers associated with G3 to G7
TA8	Transistor amplifier associated with G3
MA1	Magnetic amplifier associated with G2
MA2	Magnetic amplifier associated with G1
MA3-MA7	Magnetic amplifiers associated with G3 to G7
MTG	Motor-tachogenerator
D.C. TG	D.C. tachogenerator
AD5-B/AD2-A	Computer socket AD5 pin B, connected to computer plug AD2, pin A
TBD G2-20/19/TA2-B	Tagboard, G2, pin 20, strapped to pin 19, connected to transistor amplifier TA2, pin B
I.F.I.S.J.B.	Integrated flight instrument system junction box
MSW	Microswitch
CU	Cam unit (Computation cam)
OUE(A)	Other user equipment, destination (A)
OUE(B)	Other user equipment, destination (B)
OUE(C)	Other user equipment, destination (C)

General construction

16. The unit consists of a front panel (fig. 1), a main chassis comprising an upper deck (fig. 1), a lower deck (fig. 2), a hinged chassis (fig. 3) steady plate and side bracket assemblies. The upper deck houses seven gearbox assemblies (G1 to G7), three relays RLA, RLB and RLC (see height channel) and three reference transformers (T1, T2 and T3) (para. 19). The raised section at the rear of the unit houses transistor amplifiers TA4, TA5, TA6 and TA7, together with magnetic amplifiers MA4, MA5, MA6 and MA7. The lower deck houses the interconnection tagboards for the seven gearbox assemblies and provides apertures for the individual gearbox assembly tagboards (para. 22). The hinged chassis is attached to the raised rear section of the upper deck and is secured to the main chassis by means of three Dzus fasteners. This section houses transistor amplifiers TA1, TA2. TA3 and TA8, magnetic amplifiers MA1, MA2 and MA3 and potentiometers RV1 and RV2 (fig. 2). When opened, the hinged chassis provides access to the magnetic amplifier and transistor amplifier component panels (para. 23). Further details in regard to assembly are given under general electrical information. ◀TA3, TA8, MA3 and G3 are removed post-mod. ADS/134.▶

GENERAL ELECTRICAL INFORMATION

Plugs and sockets

17. The following plugs and sockets are mounted on the front panel (fig. 1):

25-way plugs	AD2 to I.F.I.S.J.B. AD7 to power supply unit
3-way socket	AD8 to temperature probe
12-way sockets	AD1 and to I.F.I.S.J.B. AD6
18-way socket	AD9 to I.F.I.S.J.B.
25-way sockets	AD3 (not in use) AD4 to test point AD5 to static transducer

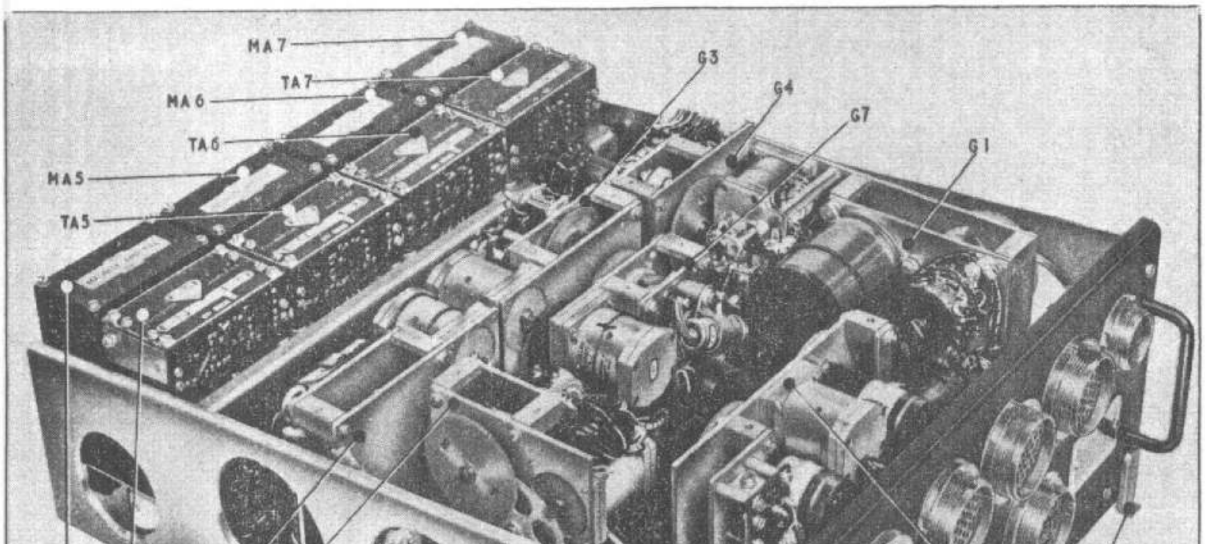


Fig. 1. Computer Type B—main chassis (upper deck) (pre-mod. ADS/134)

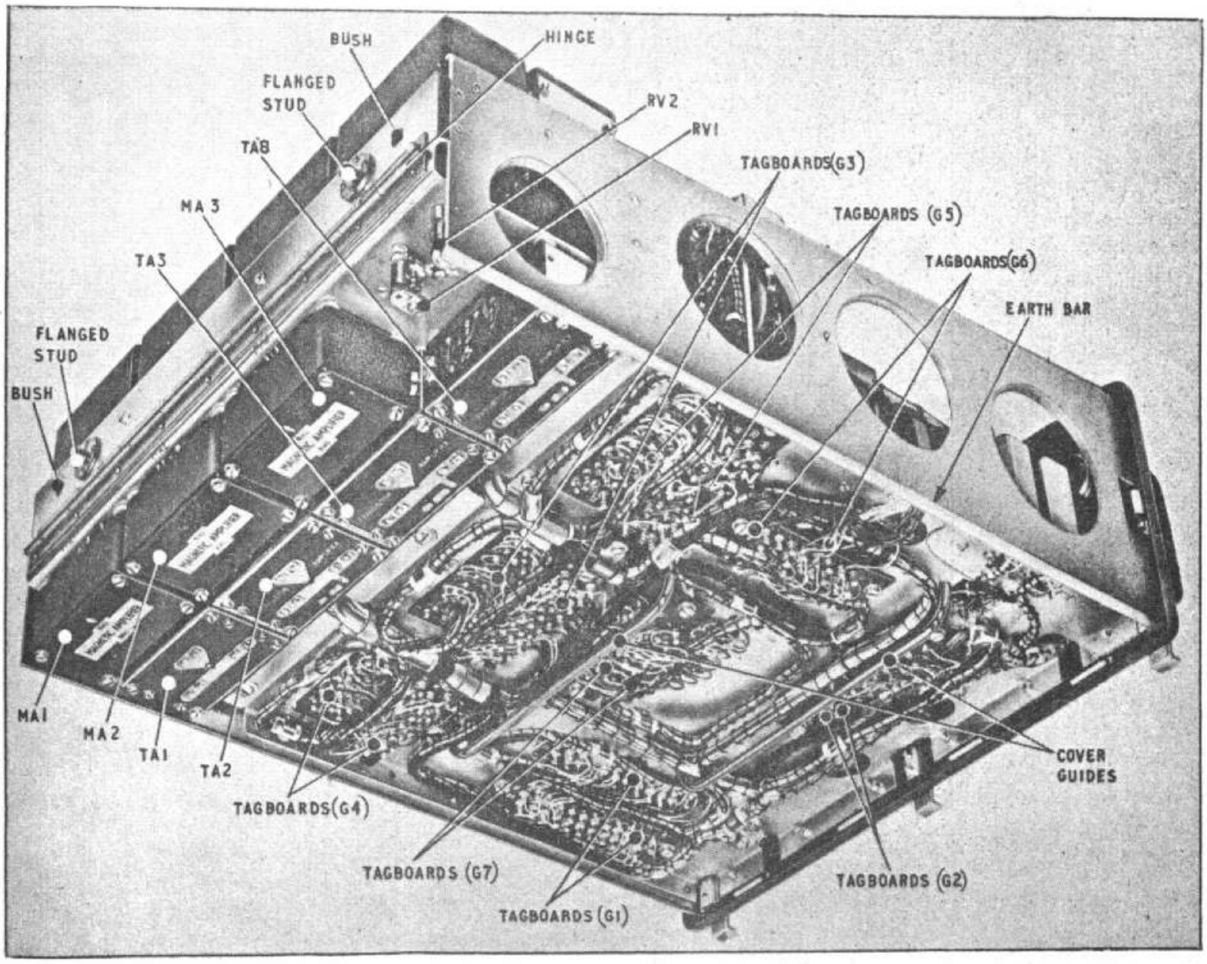


Fig. 2. Computer Type B—main chassis (lower deck) (pre-mod. ADS/134)

Power supplies

18. All power supplies except the 7·5V a.c. reference voltage are derived from the power supply unit ((P.S.U.) (A.P.4685, Vol. 1, Part 2, Sect. 3, Chap. 9). The primaries of the transformers in the P.S.U. are Scott-connected in order to provide a 50V excitation phase for the motor section of each A.D.S. motor-tachogenerator, this supply being 90 degrees in advance of the 25V reference supply. The unit requires a warm-up period of three minutes prior to operational use.

19. Transformers T1, T2 and T3 (fig. 1) supply the 7·5V a.c. reference voltage for the servo amplifier demodulator circuits, the primaries of the transformers being fed from the 25V reference phase obtained from the P.S.U. Individual secondary outputs are provided for each demodulator circuit, one of the secondaries also supplying the base voltage for the transistors associated with G2 (see vertical speed channel).

Earth system

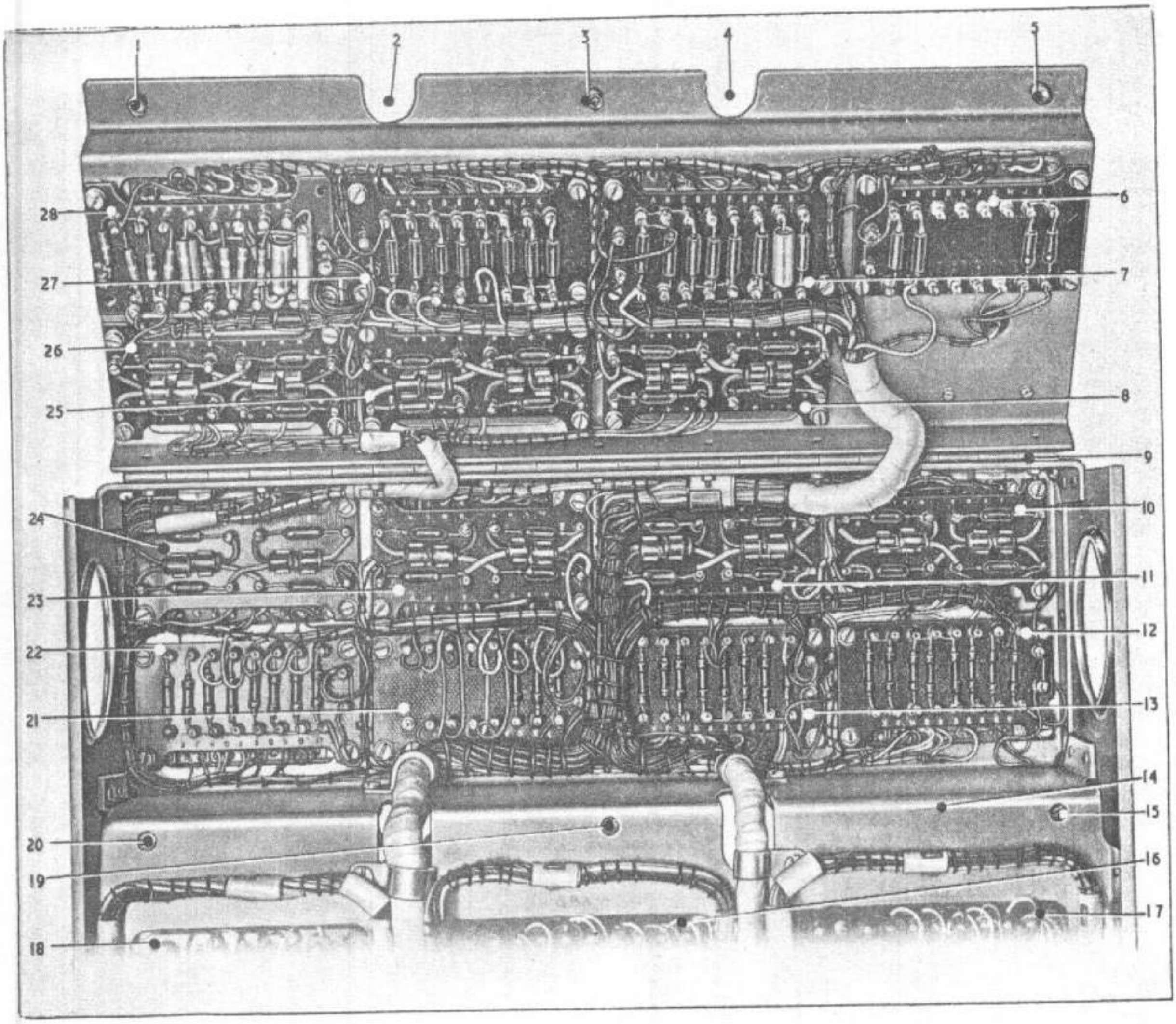
20. The A.D.S. has two primary earth lines, signal earth (Sig. E) and bias earth (Bias E). Both these lines are returned to a single earth-to-chassis point in the P.S.U. and Ref. 2 (25V) is also earthed at the same point. Bias earth provides the earth return system for magnetic amplifiers and motor tachogenerators; as implied, signal earth is the earth system for the signal voltages and is in all cases returned to pin b of each transistor amplifier (TA). In addition, each TA-b is interconnected in order to eliminate earth loops. Each TA-b is strapped to TA-c, which is connected to the Sig. E busbar (fig. 2), AD7-G, and thence to chassis earth in the P.S.U.

Cable-forms (fig. 2 and 3)

21. There are four main cable-forms, which are routed to and from the plugs and sockets on the front panel via two inlets to the main chassis (lower deck), and seven subsidiary cable-forms providing interconnections for each pair of tagboards, all being secured where necessary by clips and clamps. CF1 connects plugs AD2, AD7 and sockets AD1, AD3, AD4 and AD5 to the interconnection tagboards (secured directly to the chassis), the bases of relays RLA, RLB and RLC, the earth bar on the lower deck and (via a grommet) transformers T1, T2 and T3 on the main chassis (upper deck). CF2 provides interconnections between individual servo amplifiers. CF3 provides interconnections between the servo amplifiers, the gearbox assembly tagboards and (via a grommet) potentiometers RV1 and RV2. CF4 provides interconnections between all the plugs and sockets on the front panel. CF5 to CF11 inclusive are used for interconnections between each pair of tagboards. Tie bars are used to secure CF1 and CF4.

Tagboards (fig. 2)

22. Two tagboards, a gearbox assembly tagboard (e.g. TBD G1) and an interconnection tagboard (e.g. TBD G1 (INT)), are associated with each gearbox assembly and all tagboards as accessible on the main chassis (lower deck). Two screws



1 DZUS FASTENER
2 CABLE RECESS
3 DZUS FASTENER
4 CABLE RECESS
5 DZUS FASTENER
6 TA8 COMPONENT PANEL
7 TA3 COMPONENT PANEL
8 MA3 COMPONENT PANEL (DEMODULATOR)
9 HINGE
10 MA4 COMPONENT PANEL (DEMODULATOR)
11 MA5 COMPONENT PANEL (DEMODULATOR)
12 TA4 COMPONENT PANEL
13 TA5 COMPONENT PANEL
14 MAIN CHASSIS (LOWER DECK)
15 SPRING
16 TBD G3
17 TBD G5
18 TBD G4
19 SPRING
20 SPRING
21 TA6 COMPONENT PANEL
22 TA7 COMPONENT PANEL
23 MA6 COMPONENT PANEL (DEMODULATOR)
24 MA7 COMPONENT PANEL DEMODULATOR)
25 MA2 COMPONENT PANEL (DEMODULATOR)
26 MA1 COMPONENT PANEL (DEMODULATOR)
27 TA2 COMPONENT PANEL
28 TA1 COMPONENT PANEL

Fig. 3. Computer Type B—hinged chassis

secure the gearbox assembly tagboard to the gearbox assembly and two screws secure both tagboards to the main chassis.

Component panels

23. A component panel is associated with each magnetic amplifier (MA) and each transistor amplifier (TA) (fig. 3) making a total of 7 MA and 8 TA component panels. Each MA component panel supports the diodes and resistors which comprise the associated demodulator circuit, while the TA component panels support a variety of components not necessarily associated with their respective servo amplifiers. An additional component panel, located in the rate of climb gearbox assembly (G2), is discussed in the vertical speed channel, and a rectifier panel in the height gearbox assembly (G3) is discussed in the height channel. Components associated with a particular servo system are detailed in the description of the appropriate channel.

DETAILED DESCRIPTION

General

24. Certain features of the computer are common to all channels and these features are described first and then followed by a detailed description of each channel.

SERVO SYSTEM

25. The signal input to each servo amplifier of the computer has a phase sense which demands either the clockwise or counter-clockwise rotation of the servomotor and an appropriate direction of shaft movement in the relevant gear train. Rotation of the servomotor causes feedback signals to be produced from its tachogenerator and (in most cases) from feedback potentiometers driven by the gearbox, which stabilize the servo loop action and null the primary input signal. An additional feedback signal is fed from the output of the magnetic amplifier, via a T-network, to stabilize the gain of the servo amplifier, to improve low frequency response and to remove unwanted time lags from the servo loop. The servo loop action required to maintain this signal balance with varying primary input signals repositions the output signal components to produce a proportional change in output signal.

Servo amplifier

26. The servo amplifiers used throughout the computer consist of a transistor amplifier, a ring bridge demodulator and a magnetic amplifier.

27. The signal input to the servo amplifier is too weak to be applied directly to a power stage and is therefore amplified initially by the transistor amplifier. Since the signal is of alternating form, it is demodulated by the ring bridge demodulator to provide a d.c. input to the magnetic amplifier. The magnitude and polarity of this d.c. signal depends on the magnitude and phase of the alternating input to the transistor amplifier. The d.c. signal is applied to the control winding of the magnetic amplifier, which provides a suitable power output to energize the control winding of the servomotor. The overall gain of the servo amplifier is approximately 130,000.

Transistor amplifier

28. The transistor amplifiers are printed-circuit sub-assemblies secured to the appropriate chassis by four screws (TA1, TA2, TA3 and TA8 being attached to the hinged chassis and TA4, TA5, TA6 and TA7 to the raised rear section of the main chassis). Individual component panels are secured to the underside of each chassis by the same screws. A tag strip (labelled at the base of the plinth) is provided for each amplifier, and

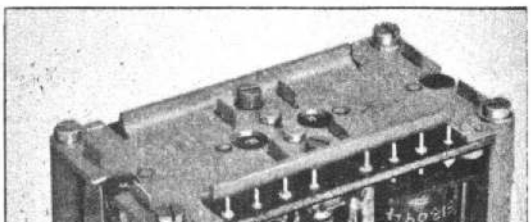


Fig. 4. Magnetic amplifier and typical demodulator panel

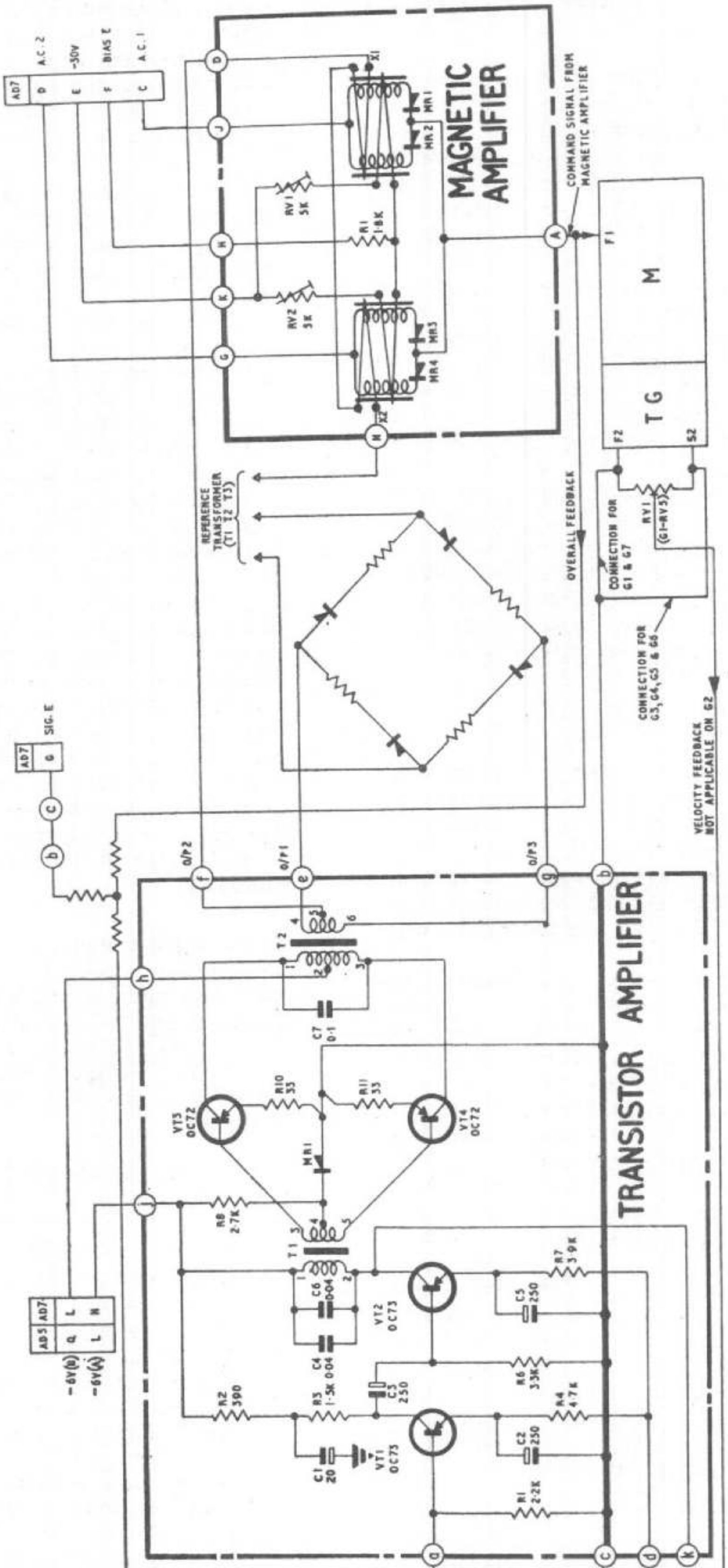


Fig. 5. Servo amplifier—circuit diagram

these are accessible under the hinged chassis. A tie rail is provided in each case for the associated cable-form.

29. The circuit (fig. 5) consists of an input stage, resistance-capacitance coupled to a driver stage, which is coupled by a phase-splitter transformer to a Class B push-pull output stage. Germanium PNP junction transistors are used throughout. The input impedance is 800 ohms, and the input signal is fed to the base of VT1 (OC73), which has +9V applied to the emitter and −6V(A) to the collector. VT1 is resistance-capacitance coupled, via R3, C3 and R6, to VT2 (OC73), which operates with the same emitter and collector voltages as VT1 and is biased by R7, decoupled by C5. The phase-splitter transformer T1 couples VT2 to the output stage, the primary being tuned by C4 and C6 to give maximum gain at 400 c/s. A germanium junction diode, MR1, provides temperature compensation for the bias voltage of the output stage, VT3 and VT4 (OC72's), bias for the emitters being derived from the currents through R10 and R11 respectively. The collectors are fed with −6V(B), via the centre tap of the primary T2, which is tuned by C7 for maximum gain at 400 c/s. T2 matches VT3 and VT4 into the output load.

Demodulator

30. In all cases, the demodulator components are mounted on a demodulator component panel (fig. 4), which is attached by four screws to the base of the associated magnetic amplifier and is accessible under the hinged chassis. Each demodulator comprises four 100 ohm resistors and four silicon diodes, the diodes being secured by clips.

31. The demodulator may be considered as a changeover switch arranged in such a manner that the phase reversal of the signal input will reverse the current flow in the control windings of the transductors, so reversing the phase of the amplifier output and in turn reversing the rotation of the servomotor. The demodulator thus functions as a phase-sensitive network in which the phase of the signal voltage is compared with the phase of the reference voltage. The demodulators use a 7·5V a.c. reference supply, the associated reference transformers T1, T2 and T3 (fig. 1) being located in the computer. The primaries of these transformers are fed from the 25V reference supply in the P.S.U. via AD7-A (Ref. 1) and AD7-B (Ref. 2) and separate secondaries provide the 7·5V reference voltage for each ring demodulator. In all cases, the reference voltage is always in excess of the signal in order to prevent the signal voltage switching the diodes.

Magnetic amplifier

32. Magnetic amplifiers MA4, MA5, MA6 and MA7 are each secured by four screws to the raised rear section of the main chassis (upper deck), and MA1, MA2 and MA3 are similarly secured to the hinged chassis (lower deck). The magnetic amplifier is capable of delivering 5 watts a.c. power to the control phase winding of the motor-tachogenerator. The input resistance is 74 ohms, the current gain at 4mA d.c. input is 20, and a maximum output of 120mA r.m.s. is available as a command signal to the motor tachogenerator, which is tuned to 400 c/s by capacitor C1 in parallel with the control winding.

33. The circuit of the magnetic amplifier (fig. 4) consists of two matched transductors, each with two silicon diode rectifiers, MR1-MR4, with R1 and two preset resistors RV1 and RV2 controlling the bias circuit. All components are suitably mounted on a metal chassis. Internal connections are made via tagboards, located at each side of the chassis and these are labelled on the chassis. The sub-assembly functions as a Class B magnetic amplifier connected in such a manner as to provide a load current which is the difference between the alternating currents flowing in the transductors. The transductors are fed from the opposite ends of an 85-0-85V, 400 c/s supply, and the phase of the load current is reversed when the direction of the control current (d.c.) reverses. The transductor operating points are set independently by means of the internal preset resistors, RV1 and RV2, the bias current being derived from the −30V d.c. supply. These bias control potentiometers are adjustable through two access holes in the top of the magnetic amplifier chassis. ◀Magnetic amplifiers post-mod. ADS/143 have a zener diode connected between pin K of the amplifier and pin b of the transductors. Its purpose is to maintain the bias on the magnetic amplifier constant over a wide range of fluctuation of the bias voltage supply. ▶

Servo amplifier inputs

34. The inputs to the servo amplifiers are summated at tag "a" on the transistor amplifier and are as shown for each servo system in fig. 13, 14, 19, 20, 26, 27 and 31. The input to the transistor amplifier is the algebraic sum of the following voltages:—

(1) Signal voltages, fed via the relative input resistor.

(2) Damping signal. An angular-velocity feedback signal is derived from RV1 (RV5 in the case of G1) which is connected across the output winding of the tachogenerator. In G2, the d.c. tachogenerator (d.c. TG1) output is modified by a chopper circuit to provide simulated a.c. velocity feedback (see vertical speed channel).

(3) Overall amplifier feedback. An overall amplifier feedback signal is developed from the servo amplifier output via the T-network between tag A output of the magnetic amplifier and tag "a" input to the transistor amplifier. This signal stabilizes the gain of the servo amplifier, improves the low frequency response, and removes unwanted time lags from the servo loop.

(4) Position feedback. In all cases, except G2, a position feedback signal, which completes the servo loop, is derived from a suitable potentiometer in the gear train. Where necessary, the feedback potentiometer is controlled by a computation cam (para. 46). Associated preset potentiometers provide a means of setting-up the appropriate feedback voltage.

(5) Bias voltages. Bias voltages are applied to the summation points of G1 and G7 for reasons related to the resolution of associated formulae (see Appendix 1).

Servo follow-up system

Motor-tachogenerator

35. The motor-tachogenerator consists of a 2-phase, 2-pole squirrel cage motor with a 4-pole induction tachogenerator mounted on the same shaft, the motor being designed for 400 c/s operation. The excitation section of the motor is energized by the 50V supply, and the control winding is fed with the power-amplified command signal from the output of the magnetic amplifier, this voltage being in quadrature with the excitation voltage. The resultant rotating field causes the motor to rotate at a speed proportional to the amplitude of the command signal voltage ,which may either lead or lag the excitation voltage by 90 degrees, this factor deciding the direction of rotation. The motor spindle is connected by a pinion to the gear train. Electrical connections made to the motor-tachogenerator are made via a terminal block.

36. The tachogenerator provides a sinusoidal voltage of constant frequency, but with an amplitude proportional to the angular velocity of the shaft. The generator has two stator windings—excitation and output—the excitation winding being fed with 8V a.c. The output from the generator is known as velocity feedback and is fed to the input of the servo amplifier via an input resistor. A preset potentiometer RV1 (RV5 in G1) is connected across the generator output winding to enable the maximum velocity feedback signal to be varied between zero and 2·75V r.m.s. If the signal is inadequate, any disturbance will cause the servo to oscillate or hunt, whereas if the signal is too large the servo will be overdamped and sluggish. The preset potentiometer is adjusted during setting-up to provide a satisfactory measure of velocity feedback

37 Each motor-tachogenerator drives a gear train which incorporates the appropriate synchros, potentiometers, etc., which provide the outputs required for further computation or display. These outputs are discussed under the appropriate channels.

D.C. tachogenerator

38. In the rate of climb gearbox assembly (G2), the motor portion of the motor-tachogenerator is used to drive, via the gear train, two d.c. tachogenerators and the a.c. tachogenerator is not connected. Each d.c. tachogenerator provides a voltage output of 4V per 1000 rev/min into a 5K load and has a maximum speed of 3000 rev/min. The magnetic field for each d.c. tachogenerator is provided by a stationary permanent magnet and a low-inertia armature is secured to the non-magnetic driving shaft. The armature consists of a rigid, light-weight structure and the armature coils are connected to a three-segment commutator. An aluminium alloy housing encloses the unit and is provided with two output terminals.

39. The output voltage from the first d.c. tachogenerator (d.c. TG1) is fed, via a chopper circuit, to provide a simulated a.c. velocity feedback signal to SA1. It is also fed via a tendency, chopper and shaping circuit as an output to the next computation stage.

40. The second d.c. tachogenerator (d.c. TG2) is not used in the A.D.S.Mk.1B.

MECHANICAL COMPONENTS

General (fig. 36)

41. In each of the servo system gear trains, suitable bearings are provided for the various gear spindles and, unless otherwise specified, aluminium alloy is the material used for gears and stainless steel for pinions and spindles. All bearings are flanged ball bearings and are a press fit in their housings on the motor (or bearing) and component (or gear) plates. Split clamps are provided to facilitate the removal of gears or components, and dog clamps are provided on the component (or gear) plates for the synchros, d.c. tachogenerators and servo-driven potentiometers to enable these components to be adjusted during setting-up. In each case, axis 1 in the gear train is the drive from the associated motor.

42. Individual servo systems and their components are discussed under the heading of the associated channel. A number of mechanical items are common to most servo systems and these are discussed in the following paragraphs.

Slip clutch (pre-mod. ADS/34)

43. With the exception of G2, a slip clutch (overload clutch) is included in each gear train to protect the gears in the event of overload. The clutch consists of a three-legged dished spring and a free gear, mounted on a boss staked to an intermediate gear spindle. The spring is staked at its mid-point to the boss, in a plane at right angles to the axis, and the gear is free to rotate on the boss. On assembly the gear may be clamped against the spring by means of a washer staked to the boss and adjusted with shims so that rotation of the spindle, boss and spring is transmitted to the gear on normal loads. At a load some fifty per cent above the normal load for the motor, the clutch will slip, the motor will still drive, but the gear will not be driven.

◀ Ball lift clutch (post-mod. ADS/34)

44. On equipments post-mod. ADS/34, the slip clutch described in para. 43 is replaced by a ball lift clutch (fig. 6). Overload protection is afforded as previously with the added advantage that this type of clutch will not seize up under any operational condition. The clutch assembly consists of a flanged hub, gear, lift plate, spring and five steel balls. The gear is a bearing fit on the split lower spigot of the hub and is retained by the thrust plate which is staked to the hub. Equidistant drillings in the hub flange accommodate the steel balls which are also retained in corresponding indentations on the upper surface of the gear. The lower surface of the lift plate bears upon the steel balls by pressure exerted by the spring. A thrust washer and spring adjusting clamp complete the assembly, the clamp being set to exert the correct load pressure on the spring before being tightened round the upper spigot. The complete assembly is mounted upon a spindle in the relevant gear train and is secured by a split clamp. The gear train drive is transmitted to the spindle via the gear, steel balls, and hub. When the preset clutch loading is exceeded, the steel balls ride out of the gear indentations, the spring is compressed, and the gear rotates relative to the hub. ▶

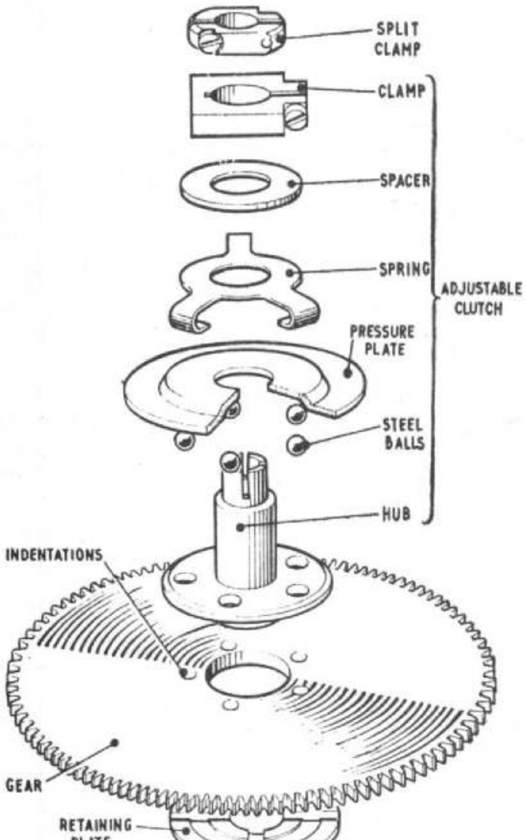


Fig. 6. Ball lift clutch

Split gear

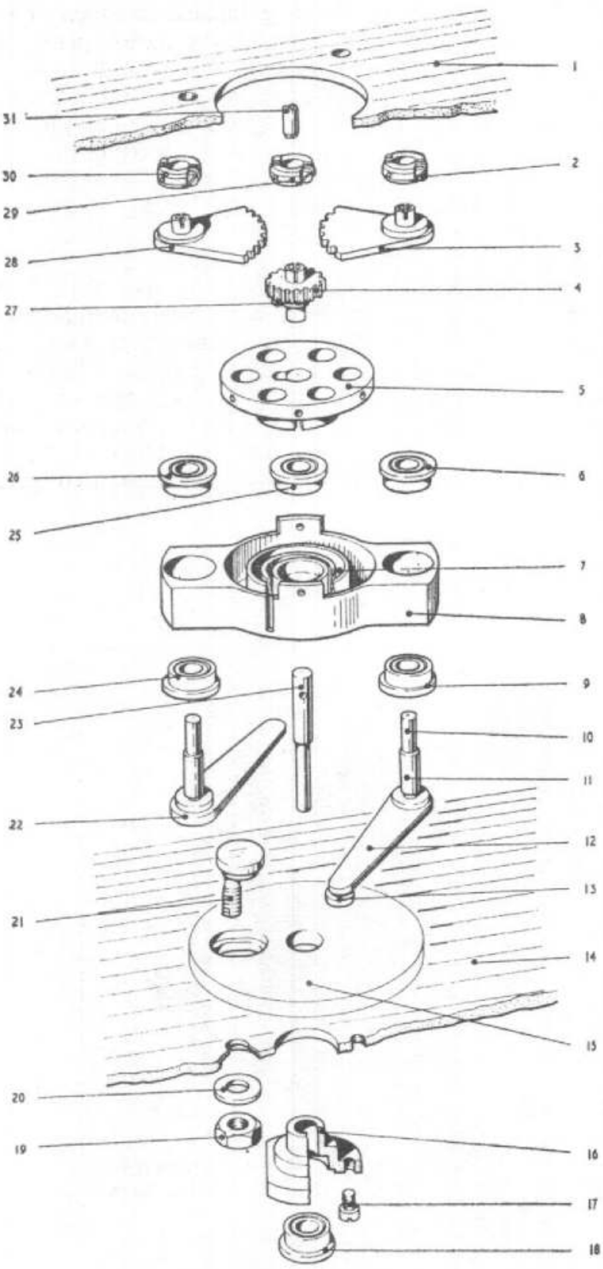
45. A split gear is a combination of two gears mounted coaxially, with abutting wheel faces, one gear being staked to a boss and the other free to rotate on the boss. The relative rotary position of the two gears is controlled by two coiled springs, each accommodated in a pair of slots in the gears. The pairs of slots are diametrically opposite and one end of each spring is attached to each gear; with minimum tension on the springs the teeth of the two gears do not coincide. When meshed, the teeth of the two wheels of the split gear are forced more nearly into coincidence, increasing the tension on the springs and rotating the free gear slightly relative to the fixed gear. Thus both sides of the meshing teeth are in contact and backlash is reduced to a minimum.

Computation cam (fig. 7)

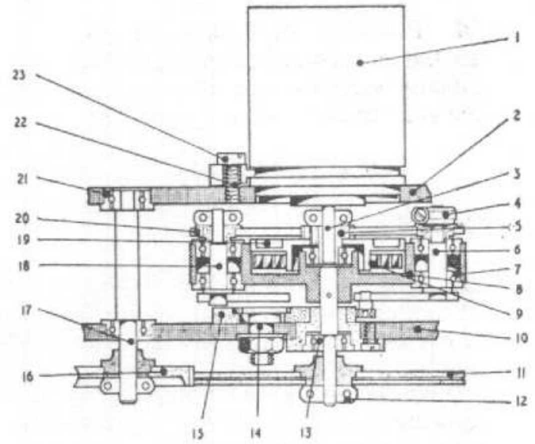
46. A computation cam is fundamentally a mechanical differential, the cam being designed to modify or correct the angular rotation of a spindle to a new function. Each cam unit is identified by a number (e.g. CU9, CU11), no number being given where a cam unit is fitted but not in use. It should be noted that two cam units numbered CU1A appear in the system; these two cams are identical (see height channel).

47. The cam unit comprises a fixed cam (15) and a cam follower (13) attached to a roller arm (12). The roller arm is pivoted in a spring housing (8) which is pinned to the input spindle (23). The outer end of a spiral spring (7) contained in the housing engages in a slot in the housing and its inner end in a slot in an inner housing (5). A pinion (4) on a short spindle is located in the inner housing by means of a key (27), and the upper end of this spindle is clamped to the output spindle (31). Rotation of the input spindle (23) will therefore be transmitted via the housing, spring, inner housing and pinion spindle to the output spindle (31).

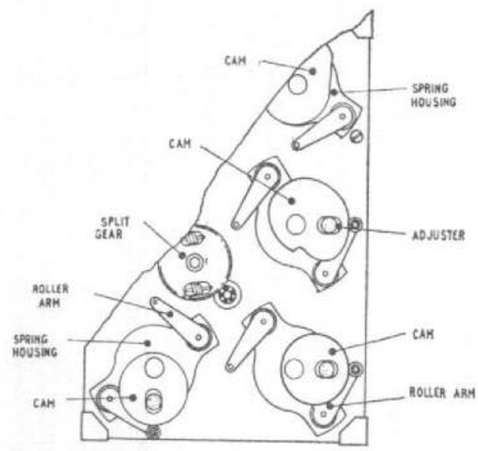
48. When a torque is applied to the input spindle (23) the spring housing is rotated carrying the cam follower round the cam. The drive is also transmitted through the spiral spring to the pinion (4). The pinion engages a sector (3) clamped to the upper end of the roller arm spindle (10) and, if the spindle is not free to rotate, a positive drive from the housing to the pinion will result. Follower movement is controlled by the shape of the cam; as the follower moves inwards or outwards the roller arm spindle will be rotated and the sector will drive the pinion relative to the spring housing. An angular movement of the pinion and output spindle is therefore added to or subtracted from the input spindle through the spring housing. The spring is sufficiently strong to keep the follower in contact with the periphery of the cam at all times. A dummy roller arm (22), which does not engage the cam, is mounted in the opposite end of the spring housing, complete with spindle and sector (28), as a counterbalance.



CAM UNIT - EXPLODED VIEW FIG.7A



CAM UNIT FIG.7B



TYPICAL CAM SHAPES FIG.7C

1 POTENTIOMETER
2 GEAR OR COMPONENT PLATE
3 SPINDLE
4 SPLIT CLAMP
5 GEAR AND PIN
6 ROLLER ARM AND BEARING
7 FLANGED BALL BEARING
8 SPINDLE AND SPRING HOUSING
9 SPRING
10 MOTOR PLATE
11 SPLIT GEAR
12 SPLIT CLAMP
13 FLANGED BALL BEARING
14 ADJUSTER
15 CAM
16 GEAR
17 SPINDLE
18 ROLLER ARM AND SPINDLE
19 INNER SPRING HOUSING
20 GEAR SEGMENT
21 FLANGED BALL BEARING
22 POTENTIOMETER CLAMP
23 6BA SCREW

Fig. 7. Computation cam

Gear stop

49. A gear stop is provided in G4 ond is arranged to engage with a motor plate stop at the extreme limits of the gear train travel. These extreme limits are well beyond the normal operating limits of the gear train.

Dummy synchro

50. Provision has been made in G3, G4 and G5 for the inclusion of additional synchros. Substitute dummy synchros are at present incorporated in the gear train for loading purposes.

MACH NUMBER CHANNEL

General

51. The Mach number channel of the computer comprises two servo systems in cascade, the log Mach number servo system, G1, and the Mach number output servo system, G5. Each servo system contains a servo amplifier (SA2 and SA5 respectively) and a gearbox assembly (G1 and G5 respectively) together with a number of servo-driven signal potentiometers and, in gearbox assembly G5, an output synchro.

Assembly (fig. 8 to 12)

52. The gear train for G1 (fig. 32A) is accommodated mainly between a motor plate and a gear plate, to which is attached a potentiometer mounting plate carrying RV10. The gear and motor plate house servo-driven potentiometers RV6, RV7, RV8, RV9 and RV11, the motor-tachogenerator and the associated gear system. The gear train consists of nine axes, the individual gears being located between the gear and motor plates, below the motor plate, or between the gear plate and the potentiometer mounting plate . Split gears are introduced on axes 5, 6, 7 and 8, and a slip clutch is provided on axis 3. ◀RV7/8 and the associated cam unit are removed post-mod. ADS/104 and a panel holding R7 is mounted in place of RV7.▶

53. The gear train for G5 (fig. 32B), which consists of eight axes, is accommodated between a motor plate and a component plate, certain parts of the gear train being located below the motor plate. The motor and component plates house synchro CX1, a dummy synchro, servo-driven potentiometers RV3, RV4 and RV5, the motor-tachogenerator and the associated gear system.

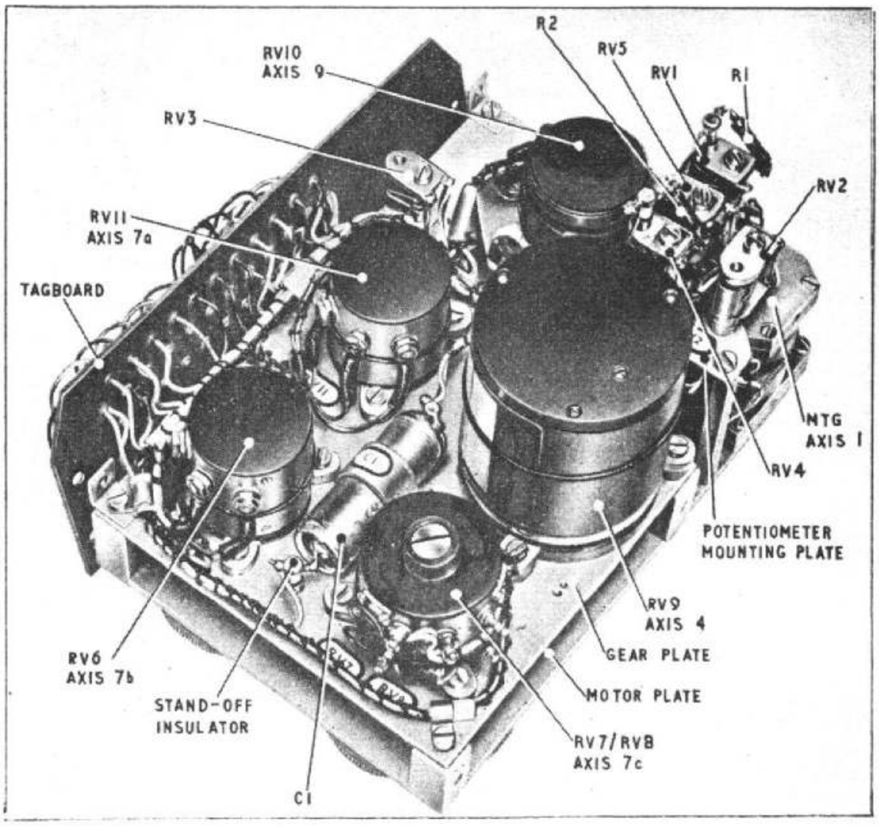


Fig. 8. Log Mach number gearbox assembly (G1)—view A (pre-mod. ADS/104)

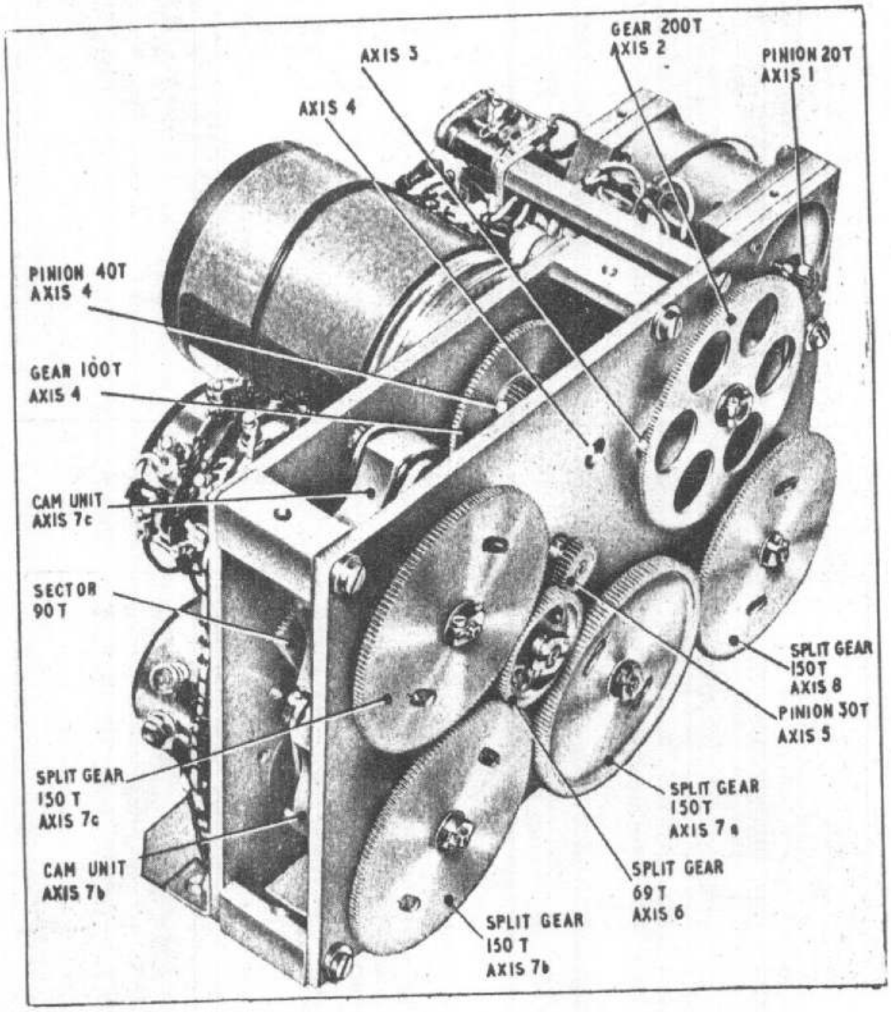


Fig. 9. Log Mach number gearbox assembly (G1)—view B (pre-mod. ADS/104)

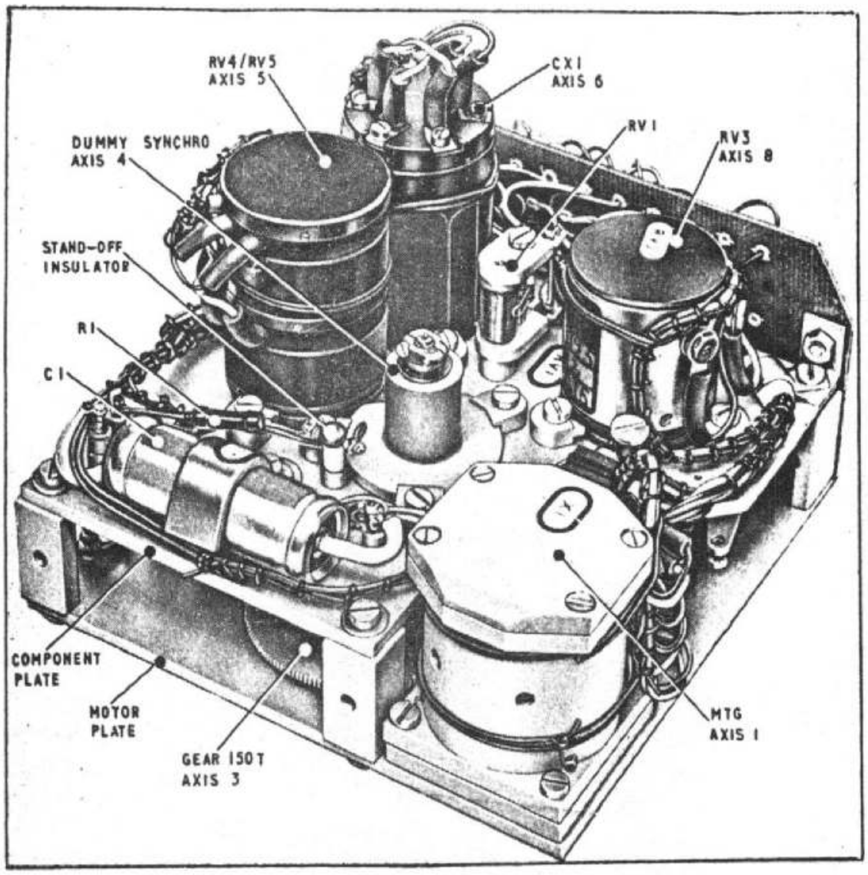


Fig. 10. Mach number output gearbox assembly (G5)—view A

Fig. 11. Mach number output gearbox assembly (G5)—view B

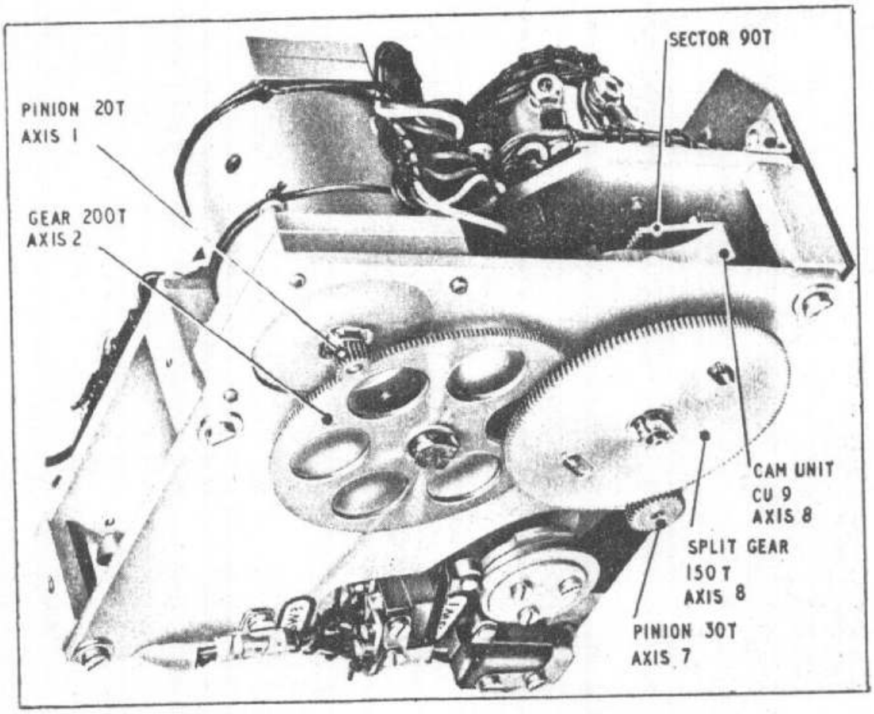


Fig. 12. Mach number output gearbox assembly—view C

◀Modification ADS/26 changes the type of potentiometer used for RV3 and also changes its value from 1K to 2K. The replacement potentiometer provides better resolution resulting in greater accuracy of the Mach No. output. Computers with this modification embodied are classified as Type C and are not interchangeable with Type B models in service use.▶ MSW1 and MSW3 are secured to the motor plate, and MSW2 to the component plate. Split gears are introduced on axes 4, 5, 6 and 8, and a slip clutch is provided at axis 3.

Circuit description

Servo system G1 (fig. 13 and 32C)

54. The primary inputs to the Mach number channel from which the channel outputs are computed are (a) log P-S (V1), fed from the P-S transducer via R12 and (b) log S (V2), fed from the S transducer via R11. These voltages are applied to the summation point at the input of transistor amplifier TA2 together with the following:—

(1) A constant bias voltage (V3) of approximately 15V from preset potentiometer RV1, via R8. V3 is provided to ensure that the nett voltage at the summation point of G1 does not change in sign over the whole range of speed and height. It is introduced to eliminate the need for centre-tapped potentiometers.

(2) A position feedback voltage ($V_{F/B}$) from servo-driven potentiometer RV9 via R9.

(3) A velocity feedback voltage (V_{VEL}) from the tachogenerator via preset potentiometer RV5 and R10.

(4) An overall amplifier feedback signal ($V_{O'ALL}$) from magnetic amplifier MA2 applied via T-network R61, R62, R63.

55. At the summation point, the signal voltages are algebraically added and the resultant signal applied to the transistor amplifier, the output from which is demodulated by the ring bridge demodulator and applied in d.c. form to the control winding of the magnetic amplifier. After power amplification in the magnetic amplifier, the resultant command signal (V_{COM}) is fed to the control winding of the motor-tachogenerator, the reference winding of the motor being energized with 50V, 400 c/s from the power supply unit.

56. With no signal input to the transistor amplifier, i.e. with the primary input balanced by the feedback and bias voltages, the servo system will be quiescent and there will be no movement of the motor. If now there is a change in primary input and consequently an error signal applied to the

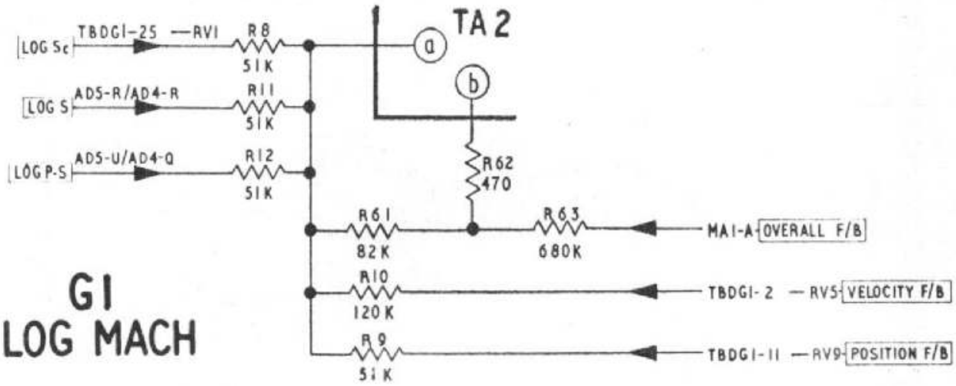


Fig. 13. Inputs to TA2

transistor amplifier, there will be a command signal from the magnetic amplifier and the motor will be driven in a direction dependent upon the phase of the error signal.

57. In turning, the motor will drive the wiper of feedback potentiometer RV9 and, through cam units in the gearbox, the wipers of the output potentiometers RV6, RV7, RV8, RV10 and RV11. The motor will continue to turn until the position feedback voltage from RV9 balances the input and the error signal is nulled. The change in output from the output potentiometer will then be proportional to the change in primary input. Since the motor also drives the tachogenerator a feedback signal proportional to the velocity of the motion will be applied to damp the servo system. ◀RV7/8 are removed post-mod. ADS/104 and resistor R7 is fitted in place of RV7.▶

58. The following outputs are produced from servo system G1:—

(1) Log Mach number (V4) from RV10.

(2) $\frac{1}{2}$ log $(1+0{\cdot}2KM^2)$ (V7) from RV11.

(3) Log P.E. (V5) from RV8—not applied.

(4) Pressure error correction (P.E.C.) from RV6—not applied.

(5) RV7—not used.

59. V4 is fed to the input of SA5 via R33 for further Mach number computation and also to the T.A.S. channel. V7 is fed via MSW1 in G5 to the T.A.S. channel.

60. In addition to the output potentiometers, gearbox assembly G1 contains preset potentiometers RV1 to RV5 inclusive. RV1 is used to set up the bias voltage (V3). RV2 and RV3 are used to adjust the 9·5V (X) supply voltage across output potentiometers RV6 and RV8 respectively and RV4 is used to adjust the 20V (Y) supply voltage across output potentiometer RV11. RV5 enables the proportion of tachogenerator voltage fed back to the amplifier to be adjusted to give correct damping of the system.

Servo system G5 (fig. 14 and 32C)

61. The primary input to servo system G5 is log Mach number (V4) from servo system G1. This voltage is applied via R33 to the summation point of TA5 together with the following inputs:—

(1) A position feedback voltage ($V_{F/B}$) from servo-driven potentiometer RV3, via R36. This potentiometer is fed with 20V (Y) and controlled by the gear train via cam unit CU9, which adjusts the feedback so that the servo system output is a function of Mach number and not log Mach number.

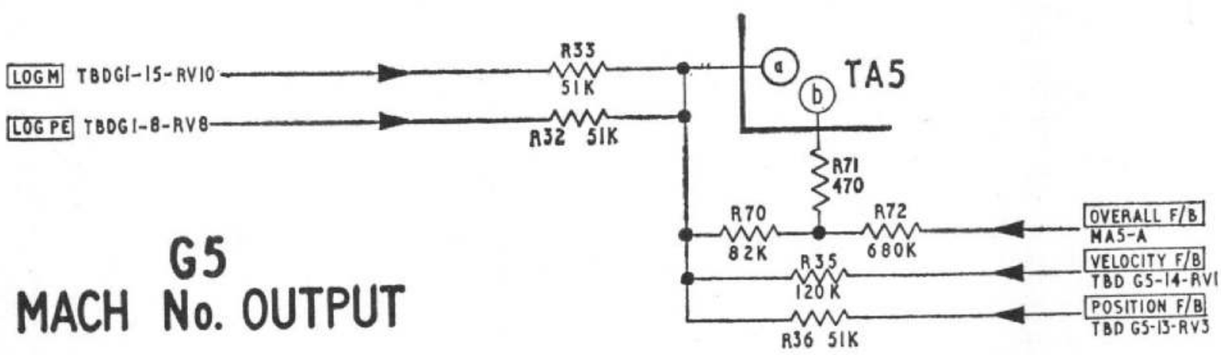


Fig. 14. Inputs to TA5

(2) A velocity feedback voltage (V_{VEL}) from the tachogenerator via a preset potentiometer RV1 and R35.

(3) An overall amplifier feedback voltage ($V_{O'ALL}$) from MA5 via T-network R70, R71, R72.

62. These voltages are added algebraically at the summation point of TA5 and the subsequent servo action is similar to that of servo system G1 (para. 55-57).

63. The following outputs are produced from servo system G5:—

(1) Mach number from synchro CX1.

(2) Mach number (V9) from RV4.

(3) Reciprocal Mach number (V8) from RV5.

64. Synchro CX1 is coupled to a receiver synchro in the speed display to control the Mach number tape. V8 and V9 are both fed to OUE(A) and it should be noted that the potentiometers RV4 and RV5 are supplied from the external equipment.

65. In addition to the signal outputs, the gearbox assembly controls the operation of three micro-switches MSW1, MSW2 and MSW3. MSW1 closes at speeds above Mach 0·2 and connects V7 from servo system G1 to servo system G7 in the T.A.S. channel. MSW2 closes at speeds below Mach 0·25 and controls an external supply to an undercarriage warning lamp on the aircraft centralized warning panel. MSW3 is not used.

TRUE AIR SPEED (T.A.S.) CHANNEL

General

66. The T.A.S. channel of the computer comprises two servo systems in cascade, the temperature servo system G6 and the T.A.S. output servo system G7. Each servo system contains a servo amplifier (SA6 and SA7 respectively) and a gearbox assembly (G6 and G7 respectively) together with a number of servo-driven potentiometers and, in gearbox assembly G7, an output synchro.

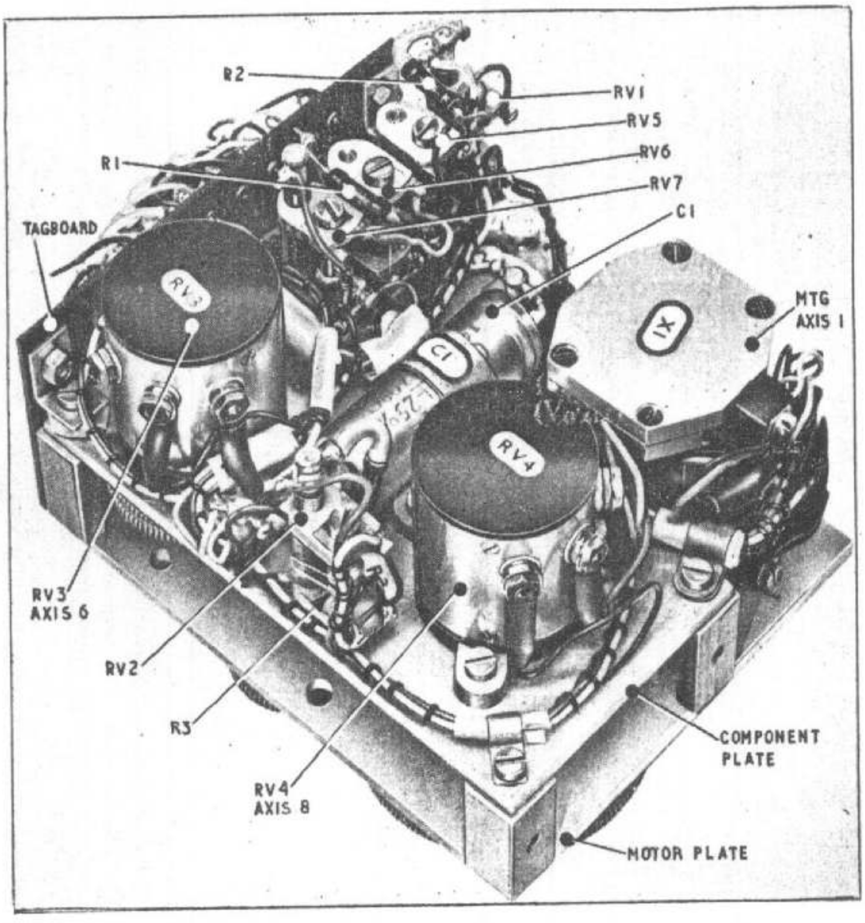


Fig. 15. Temperature gearbox assembly (G6)—view A

Assembly (fig. 15 to 18)

67. The gear train for G6 (fig. 33A) is accommodated between a motor plate and a component plate, certain parts of the gear train being located below the motor plate. The motor and component plates house potentiometers RV3 and RV4, the motor-tachogenerator and the associated gear system. The gear train consists of seven axes, numbered 1 to 4 and 6 to 8 respectively, axis 5 having no application. Split gears are introduced on axes 6 and 8, and a slip clutch is provided on axis 4.

68. The gear train for G7 (fig. 33B) is accommodated mainly between a motor plate and a component plate, to which is attached a mounted component plate carrying RV4, RV5 and RV6. The component and motor plates house synchro CX1, the motor-tachogenerator and the associated gear system. The gear train consists of ten axes, the individual gears being located between component and motor plates, below the motor plate, or between the component plate and the mounted component plate. Split gears are introduced on axes 5, 6 and 9 and a slip clutch is provided at axis 4.

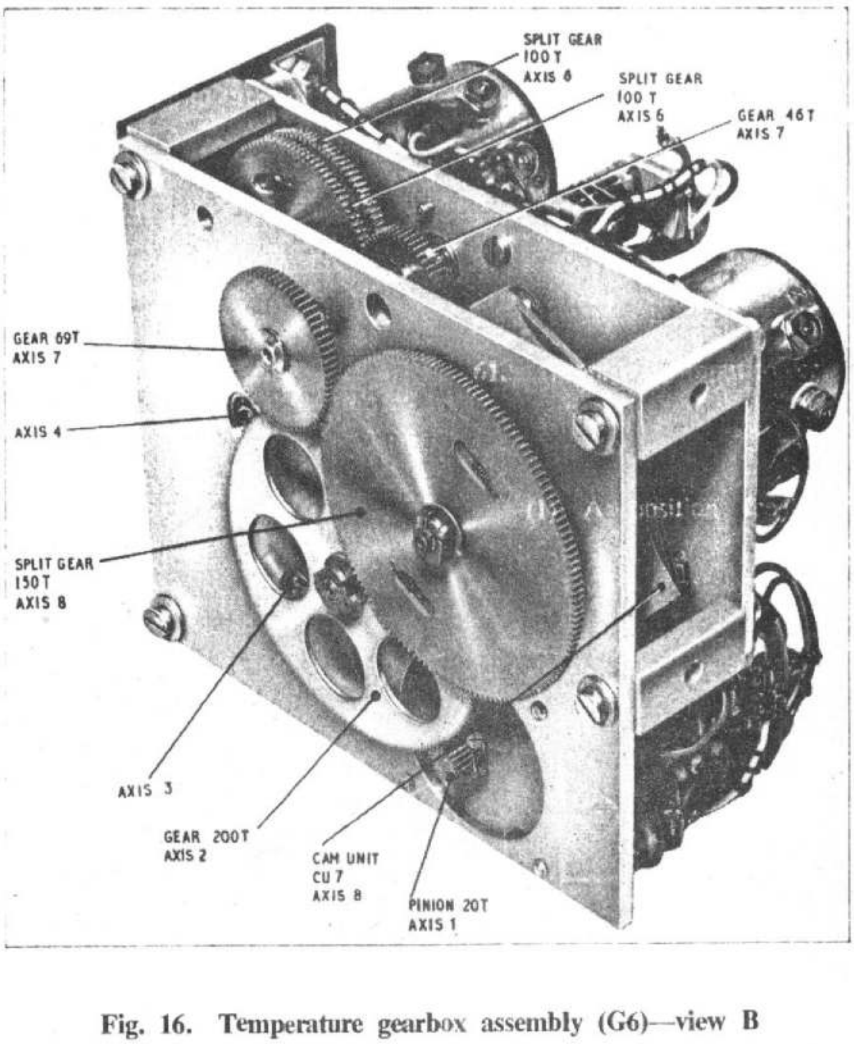


Fig. 16. Temperature gearbox assembly (G6)—view B

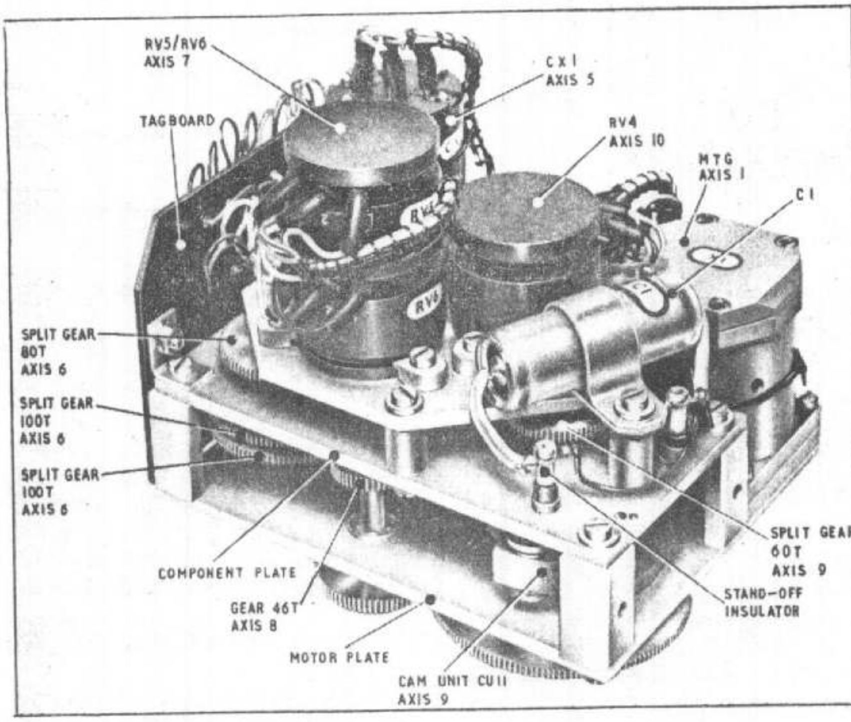


Fig. 17. T.A.S. output gearbox assembly (G7)—view A

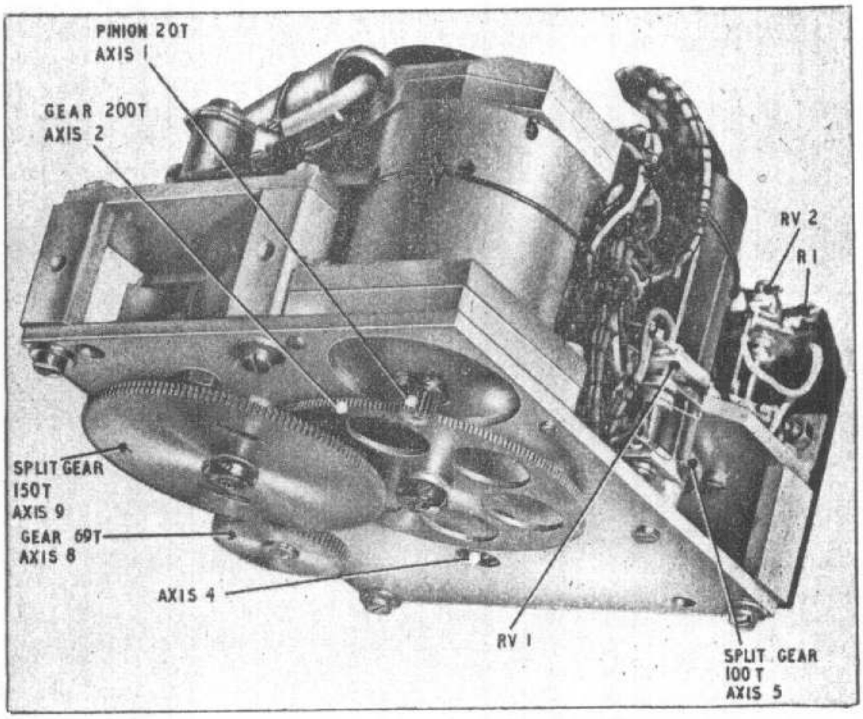


Fig. 18. T.A.S. output gearbox assembly (G7)—view B

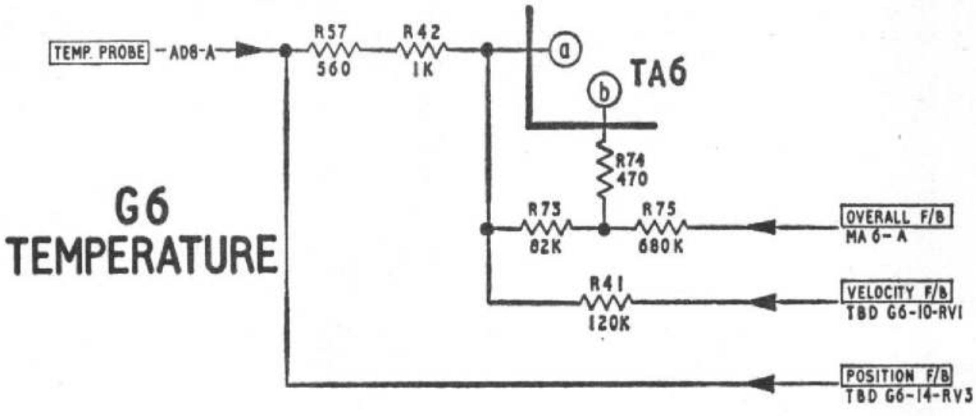


Fig. 19. Inputs to TA6

Circuit description

Servo system G6 (fig. 19 and 33C)

69. The primary input to the T.A.S. channel is indicated temperature T_1 from the external temperature probe, which has a range from −70 degrees C to +150 degrees C. This signal is applied via R57 and R42 to the summation point of transistor amplifier TA6 together with the following voltages:—

(1) A position feedback voltage ($V_{F/B}$) from servo-driven potentiometers RV3, via R57 and R42. RV3, with preset potentiometer RV7, and the temperature probe make up two arms of a bridge network, which is described in detail in para. 71.

(2) A velocity feedback voltage (V_{VEL}) from the tachogenerator via preset potentiometer RV1 and R41.

(3) An overall amplifier feedback signal ($V_{O'ALL}$) from MA6 applied via T-network R73, R74 and R75.

70. These voltages are added algebraically at the summation point to TA6 and the subsequent servo action is similar to that described in para. 55-57.

71. The bridge network consists of the external temperature probe (which is a temperature-sensitive resistor) and RV5 in one ratio arm, and RV6, RV7 and the servo-driven potentiometer RV3 in the other ratio arm. A 6V supply is applied to the network via R1 and R2 and the bridge is balanced during setting-up by means of RV5, RV6 and RV7, the appropriate temperature being simulated by means of a dummy resistance in place of the probe. In flight, any change in temperature will vary the resistance of the temperature probe and unbalance the bridge. This will produce an input signal to TA6 (fed via the input resistors R57, R42) and G6 will drive until RV3 re-balances the bridge and thus nulls the input to TA6.

72. The output from G6 is provided by the servo-driven potentiometer RV4, computation cam CU7 converting this output to a voltage proportional to $\frac{1}{2}$ log T_1, which is fed via the input resistor R49 to the summation point of SA7. Preset potentiometer RV2 is used to adjust the 20V (X) supply voltage across RV4.

Servo system G7 (fig. 20 and 33C)

73. The primary inputs to servo system G7, applied to the summation point of TA7, are (a) log Mach number (V4) from servo system G1, via R47 (b) $\frac{1}{2}$ log $(1 + 0{\cdot}2KM^2)$ (V7) from servo system G5, via R48, and (c) $\frac{1}{2}$ log T_1 (V10) from servo system G6, via R49, together with the following inputs:—

(1) A constant bias voltage (V11) of approximately 17V from preset potentiometer RV2, via R51. This voltage represents a constant term and is required for the solution of the T.A.S. equation (Appendix 1).

(2) A position feedback voltage ($V_{F/B}$) from servo-driven potentiometer RV4, via R52.

(3) A velocity feedback voltage (V_{VEL}) from the tachogenerator, via preset potentiometer RV1 and R50.

(4) An overall amplifier feedback signal ($V_{O'ALL}$) from MA7 applied via T-network R76, R77, R78.

74. These voltages are added algebraically at the summation point of TA7 and the subsequent servo action is similar to that described in para. 55-57.

75. The following outputs are produced from servo system G7:—

(1) T.A.S. from synchro CX1.

(2) T.A.S. (V12) from RV5.

(3) T.A.S. (V13) from RV6.

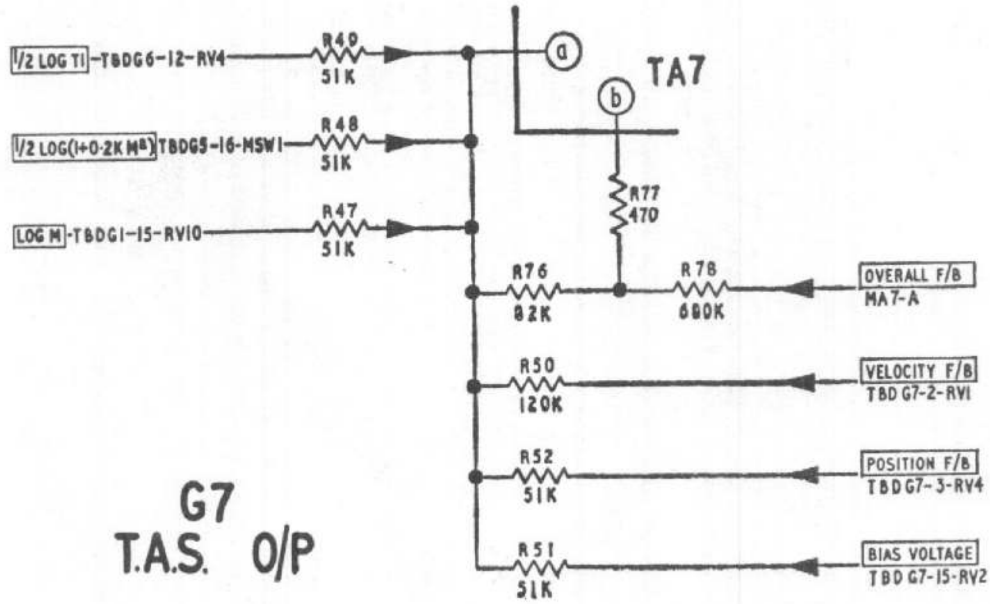


Fig. 20. Inputs to TA7

76. Synchro CX1 is coupled to a receiver synchro in the height and T.A.S. display to control the T.A.S. display. V12 is fed to OUE (B) and V13 to OUE (C); it should be noted that the potentiometers RV5 and RV6 are supplied from external equipment.

VERTICAL SPEED (RATE OF CLIMB OR DIVE) CHANNEL

Introduction (fig. 34C)

77. During normal flight, an aircraft is subjected to small changes of height, sometimes at a fairly high rate, this condition being normal and not requiring any control movement to stabilize the aircraft. The A.D.S. is sensitive to these changes and the vertical speed channel incorporates a tendency, chopper and shaping circuit which damps this sensitivity.

D.C. tachogenerators

78. A basic requirement in the vertical speed channel is that for zero rate of climb or dive, the output for display or other purposes shall be zero. An a.c. tachogenerator may, at zero velocity, present a residual voltage to the amplifier which cannot be filtered and may vary both in magnitude and phase. For this reason a d.c. tachogenerator, d.c. TG1, is used in the rate of climb servo system (G2) of the vertical speed channel; a second d.c. tachogenerator (d.c. TG2) has no application at present.

Chopper circuits

79. Owing to the difficulty of drift stabilization with d.c. amplifiers, a.c. servo amplifiers are used in the vertical speed channel and it is thus necessary to convert the d.c. output from d.c. TG1 (V14) into (a) an a.c. velocity feedback signal (V14a) applied to the input of SA1 and (b) a shaped rate of change of height a.c. signal (V14b) which provides the input to SA4. Two transistorized chopper circuits are used to convert the d.c. signal (V14) to square-wave a.c. signals (V14a and V14b), the amplitude and phase of which correspond to the amplitude and polarity of the d.c. input.

80. The transistor has 7·5V, 400c/s reference applied to the base and is effectively turned on (i.e. bottomed) by the negative half cycles and turned off on the positive half cycles of the switching waveform. Thus, on negative half cycles the transistor acts as a closed switch with the collector-emitter voltage approaching zero at the a.c. input capacitor, C2. On positive half cycles, the switch is open and the input potential appears on C2, the effect of the rectifier being such as to speed up the switching time by allowing the base to go no more than approximately 0·5V positive. With a positive potential at the d.c. tachogenerator (which delivers approximately 213mV per thousand feet rate of climb or dive) a positive output waveform will be produced; a negative potential producing a negative waveform.

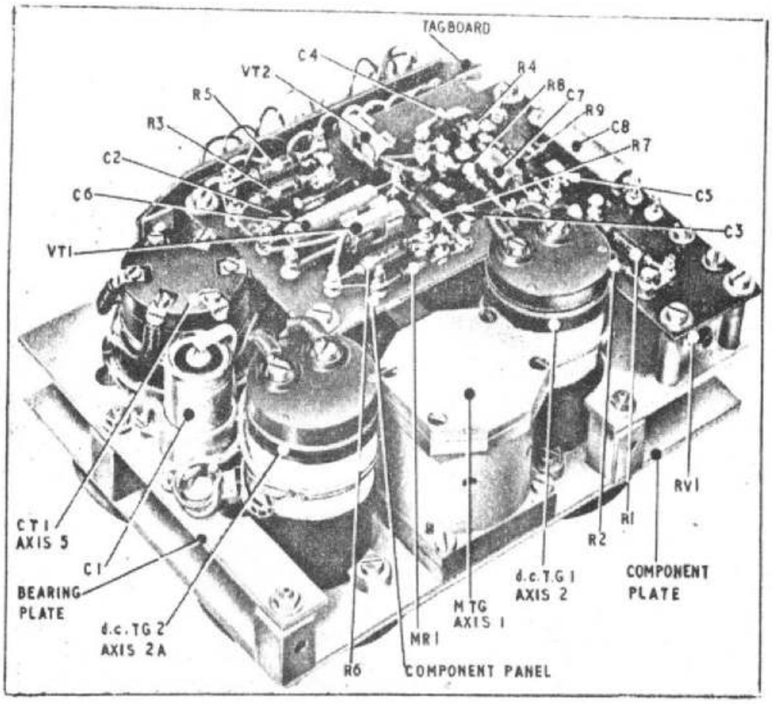


Fig. 21. Rate of climb gearbox assembly (G2)—view A

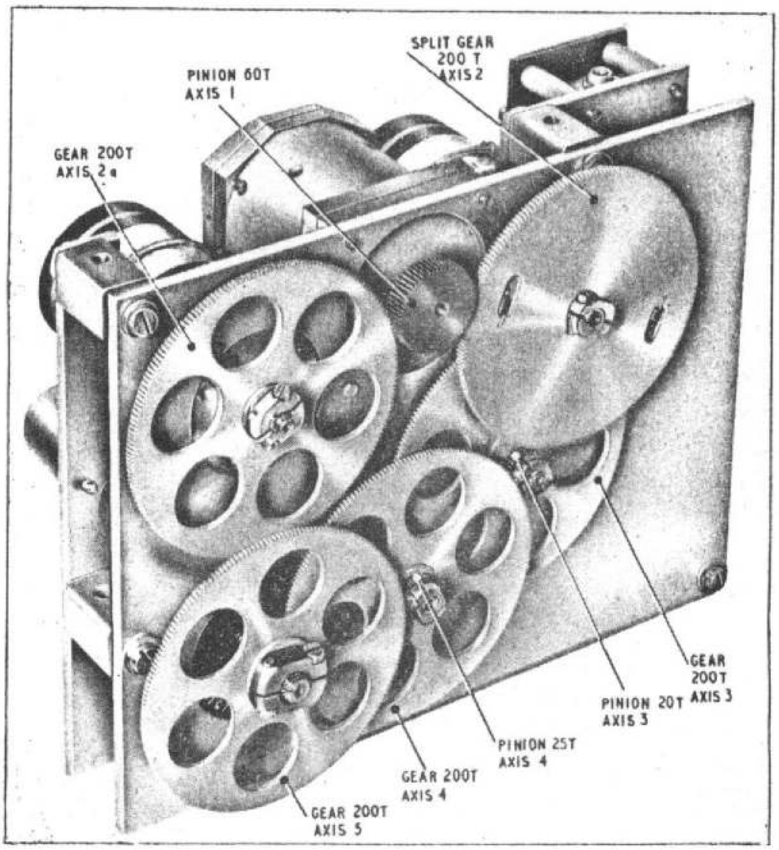


Fig. 22. Rate of climb gearbox assembly (G2)—view B (pre-mod. ADS/80)

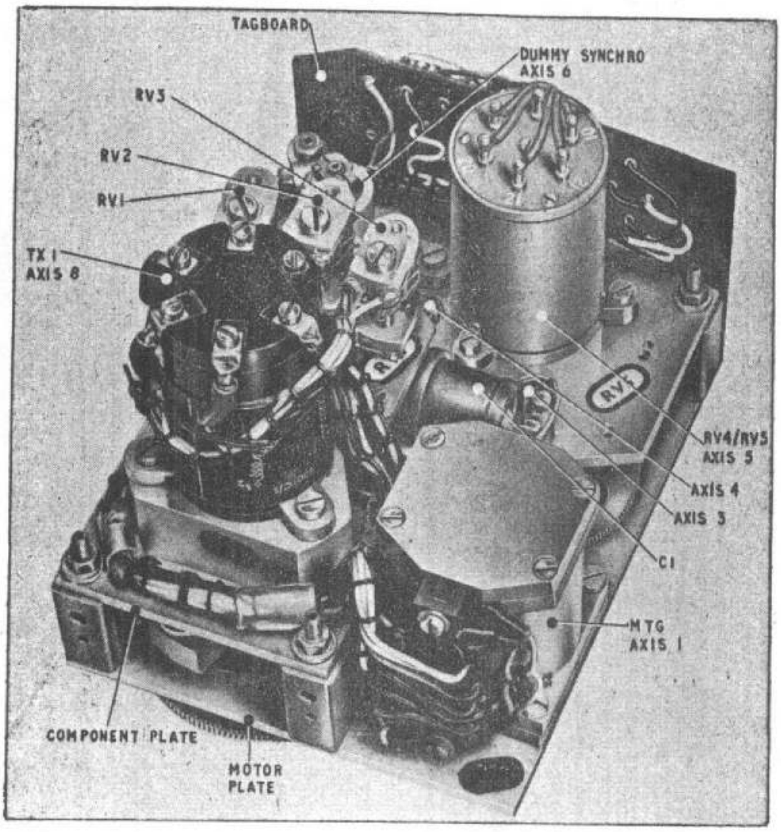


Fig. 23. Vertical speed output gearbox assembly (G4)—view A

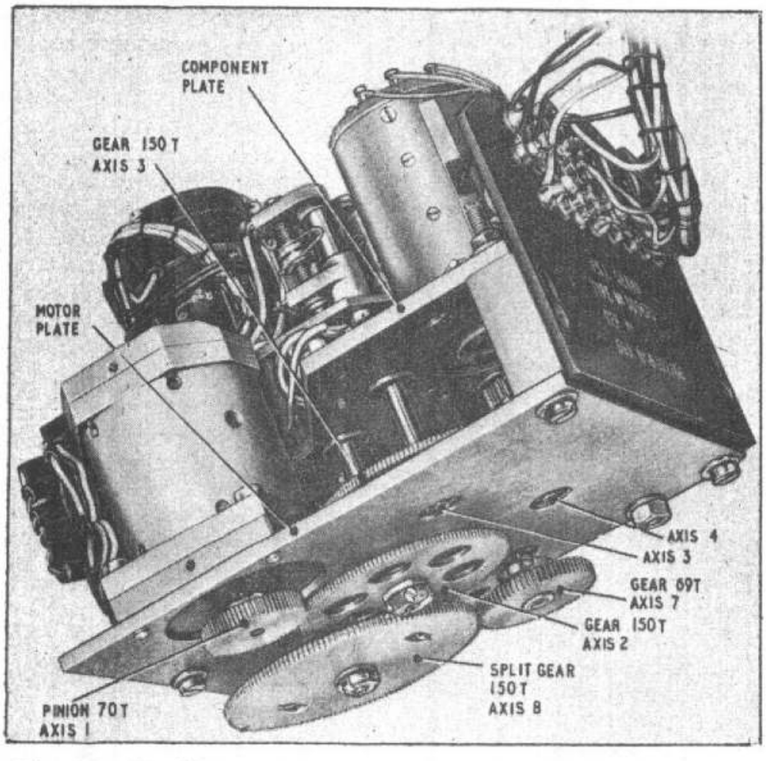


Fig. 24. Vertical speed output gearbox assembly (G4)—view B (pre-mod. ADS/97)

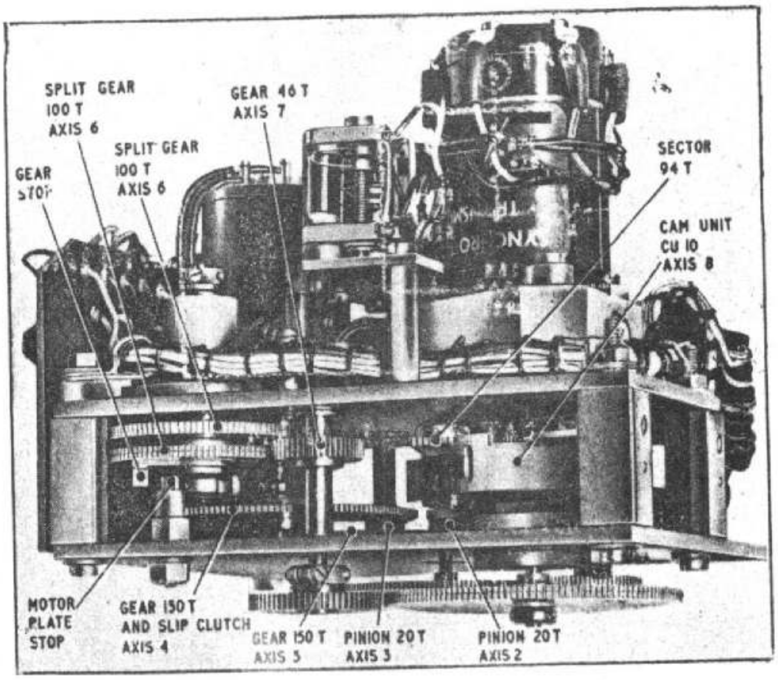


Fig. 25. Vertical speed output gearbox assembly (G4)—view C

Tendency, chopper and shaping circuit (output V14b)

81. The output from d.c. TG1 is also fed to a tendency, chopper and shaping circuit, the chopper section of which is basically similar to that already described. The signal V14 (producing V14b) is damped by the capacitive network C2, C3, C4 and C5, which initially offers a high impedance to V14 due to the capacitors charging, but permits a small tendency signal to pass. As the capacitors continue to charge, the circuit impedance falls, the output rises and a sustained rate of change will thus produce a strong tendency signal to which the rate of climb display will respond. With changes of an oscillitory nature, the capacitors alternately charge and discharge and the tendency signal remains negligible. The tendency signal is fed via a chopper circuit (VT1) to an emitter follower (VT2) which incorporates a shaping circuit and a means of adjusting the level of the tendency signal in readiness for application to the input of SA4.

General

82. The vertical speed channel of the computer comprises two servo systems in cascade, the rate of climb servo system G2 and the vertical speed output servo system G4. Each servo system contains a servo amplifier (SA1 and SA4 respectively) and a gearbox assembly (G2 and G4 respectively), together with two d.c. tachogenerators and an input synchro in G2, and two servo-driven potentiometers and an output synchro in G4.

Assembly (fig. 21 to 25)

83. The gear train for G2 (fig. 34A) has six axes, numbered 1, 2, 2A, 3, 4 and 5, and is mounted on the underside of a component plate. A motor-tachogenerator and two d.c. tachogenerators are mounted on the reverse side of the same plate and a synchro CT1 is mounted on a bearing plate above the component plate. A split gear is provided on axis 2 of the gear train. A component panel mounted above the bearing plate carries the subsidiary electrical components. ◀Mod. ADS/80 transfers the split gear to axis 5 and introduces a single gear at axis 2.▶

84. The gear train for G4 (fig. 34B), which consists of eight axes is accommodated between a motor plate and a component plate, certain parts of the gear train being located below the motor plate. The motor and component plates house servo-driven potentiometers RV4 and RV5, a dummy synchro, the motor-tachogenerator, synchro TX1 and the associated gear system. Split gears are introduced on axes 5, 6 and 8, a slip clutch is provided on axis 4, and a gear stop (para. 49) at axis 6. ◀The split clamps on axes 2 and 5 are removed and the gears pinned to their shafts post-mod. ADS/97.▶

Circuit description

Servo system G2 (fig. 26 and 34C)

85. The primary input to the vertical speed channel from which the channel outputs are computed is a height signal fed directly from synchro

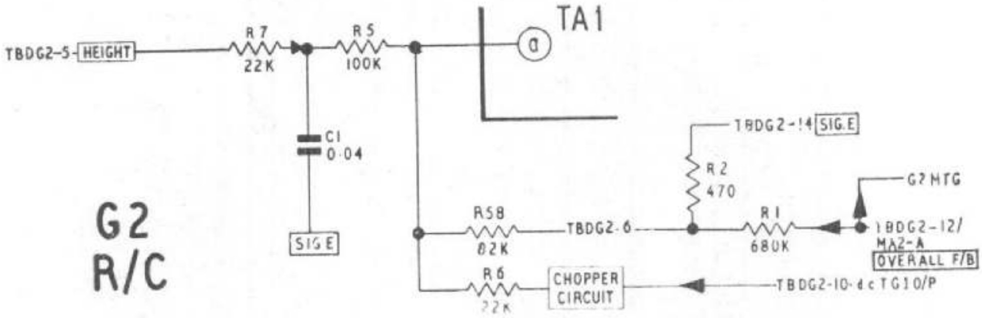


Fig. 26. Inputs to TA1

CX1 in the S transducer to synchro CT1 in servo system G2. The output from CT1 rotor is applied (circuit A), via R7 (decoupled by C1) and input resistor R5, to the summation point at the input of transistor amplifier TA1 together with the following voltages:—

(1) A simulated a.c. velocity feedback voltage (V14a) from d.c. TG1, via a chopper circuit and R6 (circuit A) (para. 79 and 80).

(2) An overall amplifier feedback signal ($V_{O'ALL}$) from MA1 applied via T-network R1, R2 (in G2) and R58 (in SA1).

86. These voltages are added algebraically at the summation point to TA1 and the subsequent servo action is similar to that described in para. 55-57.

87. The output from G2, a shaped rate of change of height signal (V14b), is fed from the tendency, chopper and shaping circuit (para. 81) and preset potentiometer RV1 to the input of SA4.

Servo system G4 (fig. 27 and 34C)

88. The primary input to servo system G4 is the shaped rate of change of height signal (V14b) which is applied via R25 to the summation point of TA4 together with the following voltages:—

◀(1) A position feedback voltage ($V_{F/B}$) from servo-driven potentiometer RV4 via R27. This potentiometer is fed with 9·5V(X) and 9·5V(Y), pre-set potentiometers RV3 and RV2 being used to set up these supplies, one phase operating for rate of climb and the other phase for rate of dive.▶

(2) A velocity feedback voltage (V_{VEL}) from the tachogenerator via preset potentiometer RV1 and R26.

(3) An overall amplifier feedback signal ($V_{O'ALL}$) from MA4 via T-network R67, R68, R69.

89. These voltages are added algebraically at the summation point of TA4 and the subsequent servo action is similar to that described in para. 55-57.

90. The following outputs are produced from servo system G4:—

(1) Logarithmic rate of change of height from synchro TX1.

(2) Linear rate of change of height (V16) from RV5.

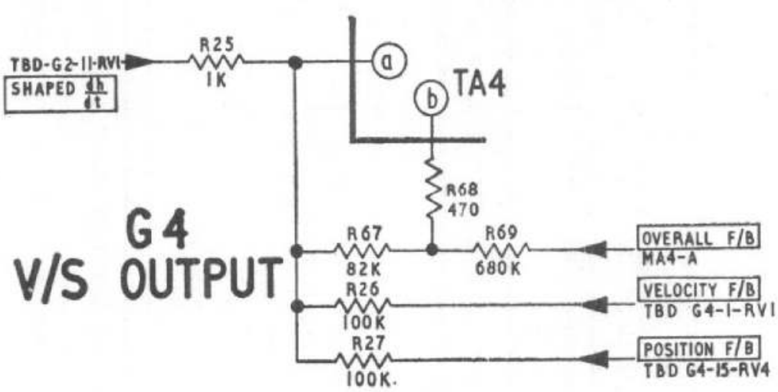


Fig. 27. Inputs to TA4

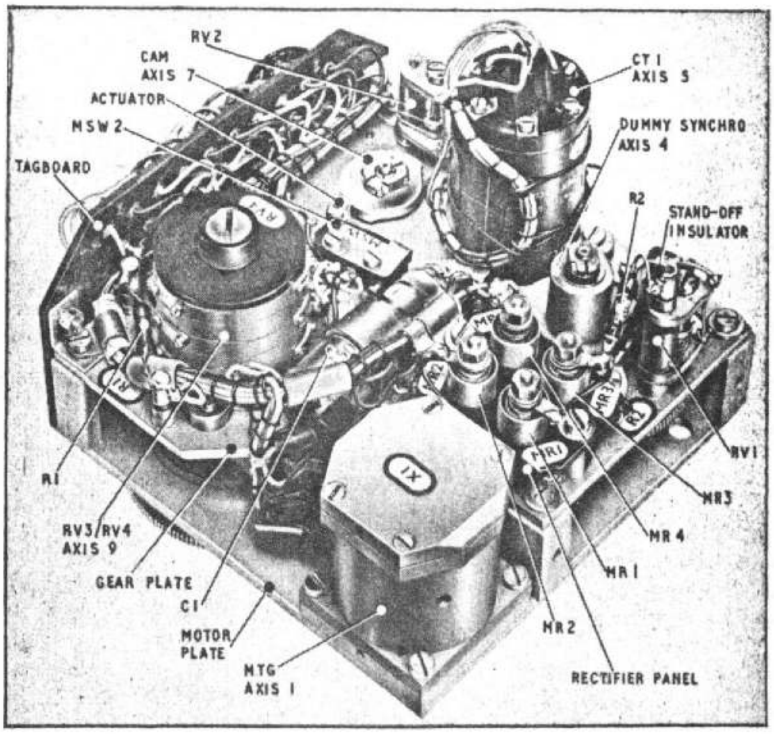


Fig. 28. Height gearbox assembly (G3)—view A (pre-mod. ADS/103)

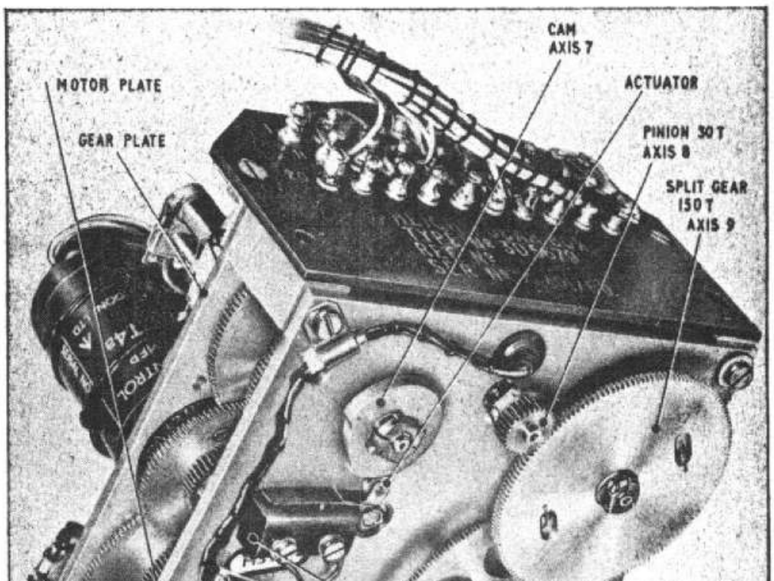


Fig. 29. Height gearbox assembly (G3)—view B (pre-mod. ADS/130)

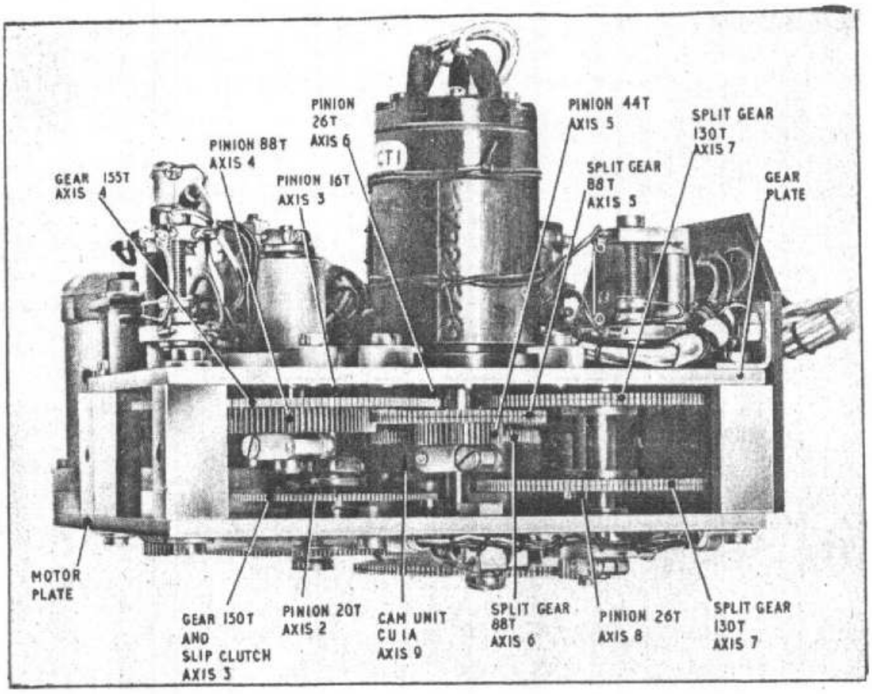


Fig. 30. Height gearbox assembly (G3)—view C (pre-mod. ADS/97)

91. Synchro TX1 is linked to a receiver synchro in the height and rate of climb display to control the rate of climb display. TX1 is controlled by cam unit CU10, which converts the output signal into logarithmic form to match the logarithmic scale of the display. V16 is fed to OUE (C) and it should be noted that potentiometer RV5 is supplied from external equipment.

HEIGHT CHANNEL

Introduction

92. The main purpose of the height channel is to apply height discrimination to a pressure error (P.E.) voltage, derived from the Mach number channel, and to develop a pressure error correction (P.E.C.) voltage for application to the summation point of the static transducer servo amplifier. ◀The height channel is removed post-mod. ADS/134.▶

93. P.E.C. is not applicable in the A.D.S. Mk.1B, and P.E. and P.E.C. are disconnected throughout the system. Use is made of G2, however, to provide height control, via MSW1, for the transducer heater circuits. The following description is complete but the salient features of G3 in relation to the height control of micro-switches are detailed in para. 99. ◀MSW1 and RLB are removed post-mod. ADS/130.▶

General

94. The height channel of the computer comprises the height servo system G3, which contains a servo amplifier, a gearbox assembly, an additional transistor amplifier TA8, two servo-driven potentiometers and an input synchro.

Assembly (fig. 28 to 30)

95. The gear train for G3 (fig. 35A), which consists of nine axes, is accommodated between a motor plate and a gear plate, certain parts of the gear train being located above the gear plate. The gear and motor plates house synchro CT1, a dummy synchro, servo-driven potentiometers RV3 and RV4, the motor-tachogenerator and the associated gear system. Split gears are introduced on axes 5, 6, 7 and 9, and a slip clutch is provided on axis 3. ◀RV4 is removed post-mod. ADS/103.▶

Circuit description (fig. 31 and 35B)

96. Synchro CT1 in G3 is fed with a height signal from synchro CX1 in the static transducer. The output signal from CT1 rotor is fed via the de-energized contact of RLA, R82 (decoupled by C3) and R18 to the summation point of SA3, G3 then driving CT1 to the null signal. The ganged potentiometers RV4/RV3 (pre-mod. ADS/103, see para 95), controlled by cam unit CU1A, are also driven by G3. The input to TA8 consists of log S (phase Y) (V2y) from the static transducer via R23, and signal equal to log S but of opposite phase (phase X) (V2x) from RV3 via R24. Whilst CX1 in the S transducer and CT1 in G3 are in step, voltages V2x and V2y remain equal and opposite, thus cancelling each other, and the output from TA8 is zero.

Alignment circuit

97. If CX1 and CT1 become out of step, a potential difference appears between V2x and V2y which results in an output from TA8. Part of this output is fed via a full-wave rectifier (MR1 to MR4) and R2 and is used to energize relay RLA, which disconnects CT1 rotor output from SA3 and replaces it with the output from TA8, which is also fed via R82 (decoupled by C3) and R18. G3 is then driven by the combined outputs of TA8 and SA3 and this condition continues until V2x and V2y cancel each other at the input to TA8. This occurs when CX1 and CT1 are synchronized, whereupon the output of TA8 falls to zero, RLA becomes de-energized, and the output from CT1 rotor is fed to SA3 for normal operation.

98. Preset potentiometer RV2, with R1, is used for setting-up the 20V (X) supply associated with RV3.

Transducer heater circuit control

99. Microswitch MSW1 (fig. 35B) is closed at heights at and above 10,500 ft. and, in conjunction with the bi-metal switches in the transducers, connects the −30V supply to relays RLB and RLC. Relay contacts RLB1 and RLC1 complete the 115V supply circuit to the transducer heater elements; it should be noted that the phase in the heater circuit is phase A/C since the circuit interconnects with 115V A phase and the 115V C phase. A second microswitch MSW2 is not used. ◀MSW1 and RLB are removed post-mod. ADS/130.▶

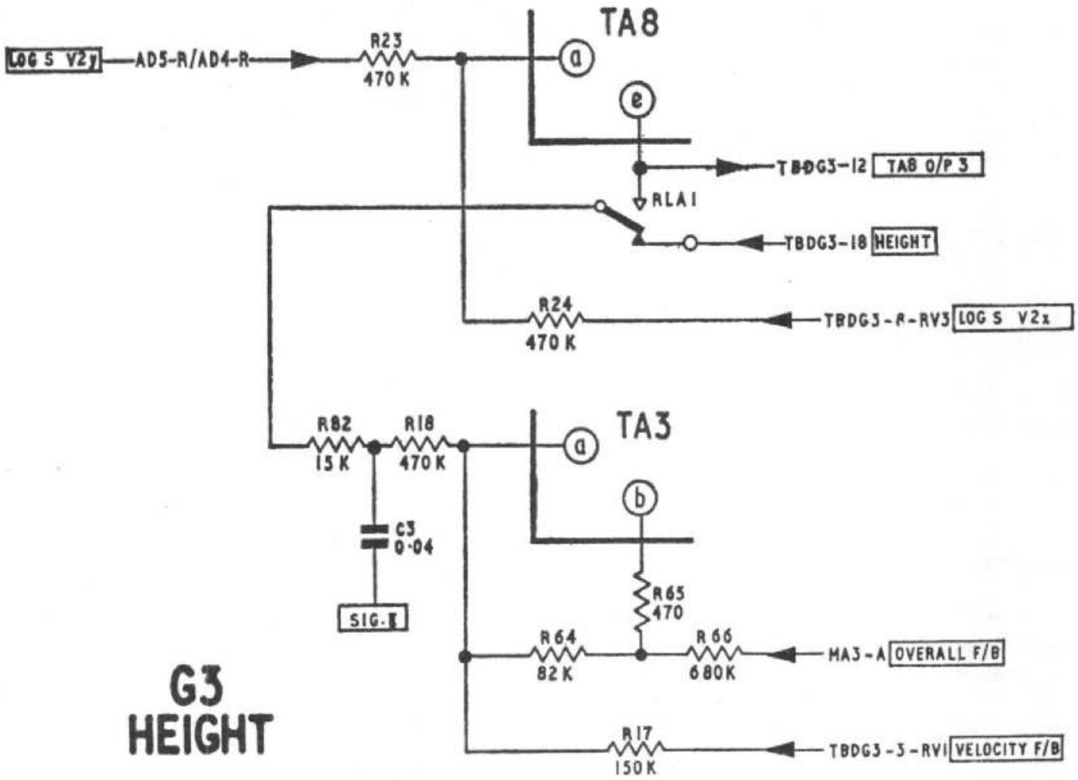


Fig. 31. Inputs to TA3 and TA8

TABLE 1

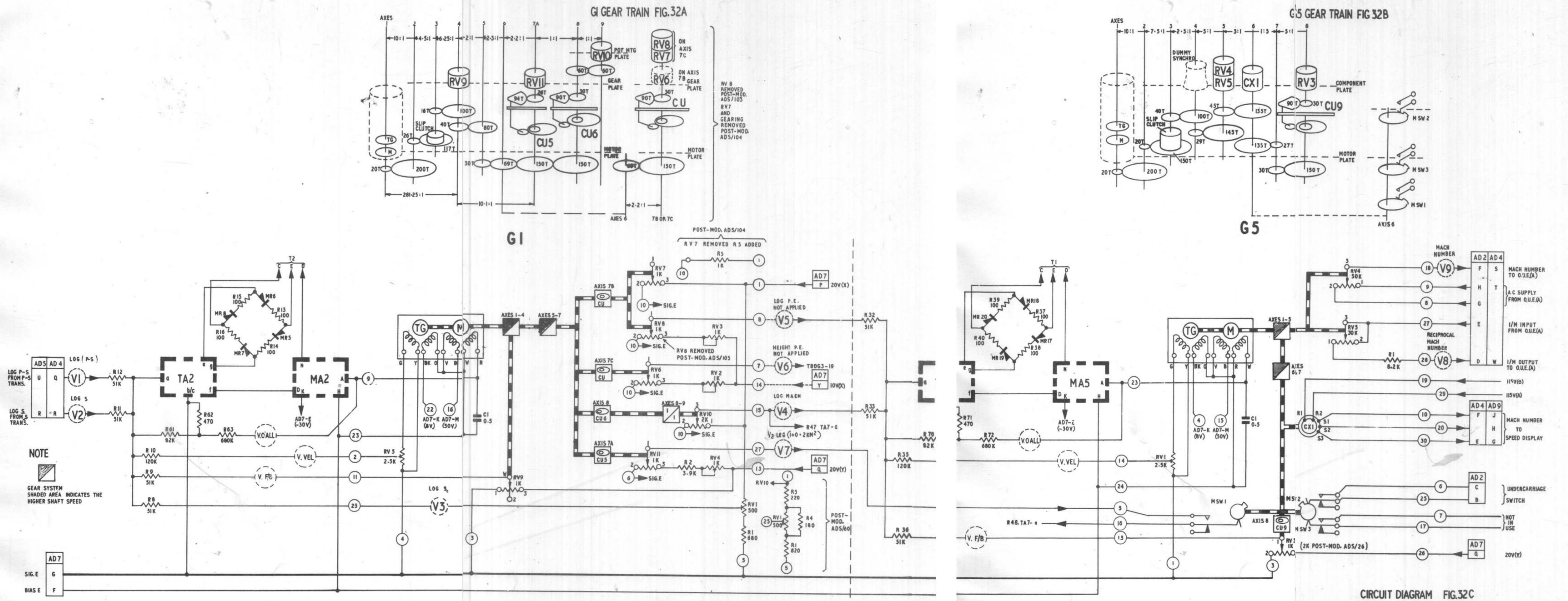
Computer channels

Channels	Gearbox assembly	Output Signal from Computer	Destination
	G1 Log Mach number Elliott Part No. 3D 5685/6		
Mach number	G5 Mach number output Elliott Part No. 3D 5635/7	Synchro (CX1) Potentiometers (RV4, RV5) Microswitch (MSW2)	Display O.U.E. (A) Undercarriage
	G6 Temperature Elliott Part No. 3D5045/9		
True Air Speed (T.A.S.)	G7 T.A.S. output Elliott Part No. 3D5674/7	Synchro (CX1) Potentiometers (RV5, RV6)	Display O.U.E. (B) and (C)
	G2 Rate of climb Elliott Part No. 3D6328/4		
Vertical speed	G4 Vertical speed output Elliott Part No. 3D5673/7	Synchro (TX1) a Potentiometer (RV5)	Display O.U.E. (C)
Height	G3 Height Elliott Part No. 3D5679/5 (Removed post-mod. ADS/134)	Potentiometer (RV4) (pre-mod. ADS/103) Microswitch (MSW1) (pre-mod. ADS/130)	S transducer Transducers

TABLE 2

Variables and outputs

Variable	Source	Destination
Log P-S	P-S transducer	Mach number channel
Log S	S transducer	Mach number channel Height channel
Temperature T_1	Temperature probe	T.A.S. channel
Height	S transducer	Vertical speed channel Height channel
Height (from S transducer, via computer)	Height and rate of climb display	Synchro (CX2)
	Height and T.A.S. display	Synchro (CX2)
I.A.S. (from P-S transducer via computer)	Speed display	Synchro (CX1)
T.A.S.	Height and T.A.S. display	Synchro (G7/CX1)
	OUE (B)	Potentiometer (G7/RV5)
	OUE (C)	Potentiometer (G7/RV6)
Mach number	Speed display	Synchro G5/CX1)
	OUE (A)	Potentiometer (G5/RV4)
Reciprocal Mach number	OUE (A)	Potentiometer (G5/RV5)
Rate of change of height (logarithmic)	Height and rate of climb display	Synchro (G4/TX1)
Rate of change of height (linear)	OUE (C)	Potentiometer (G4/RV5)

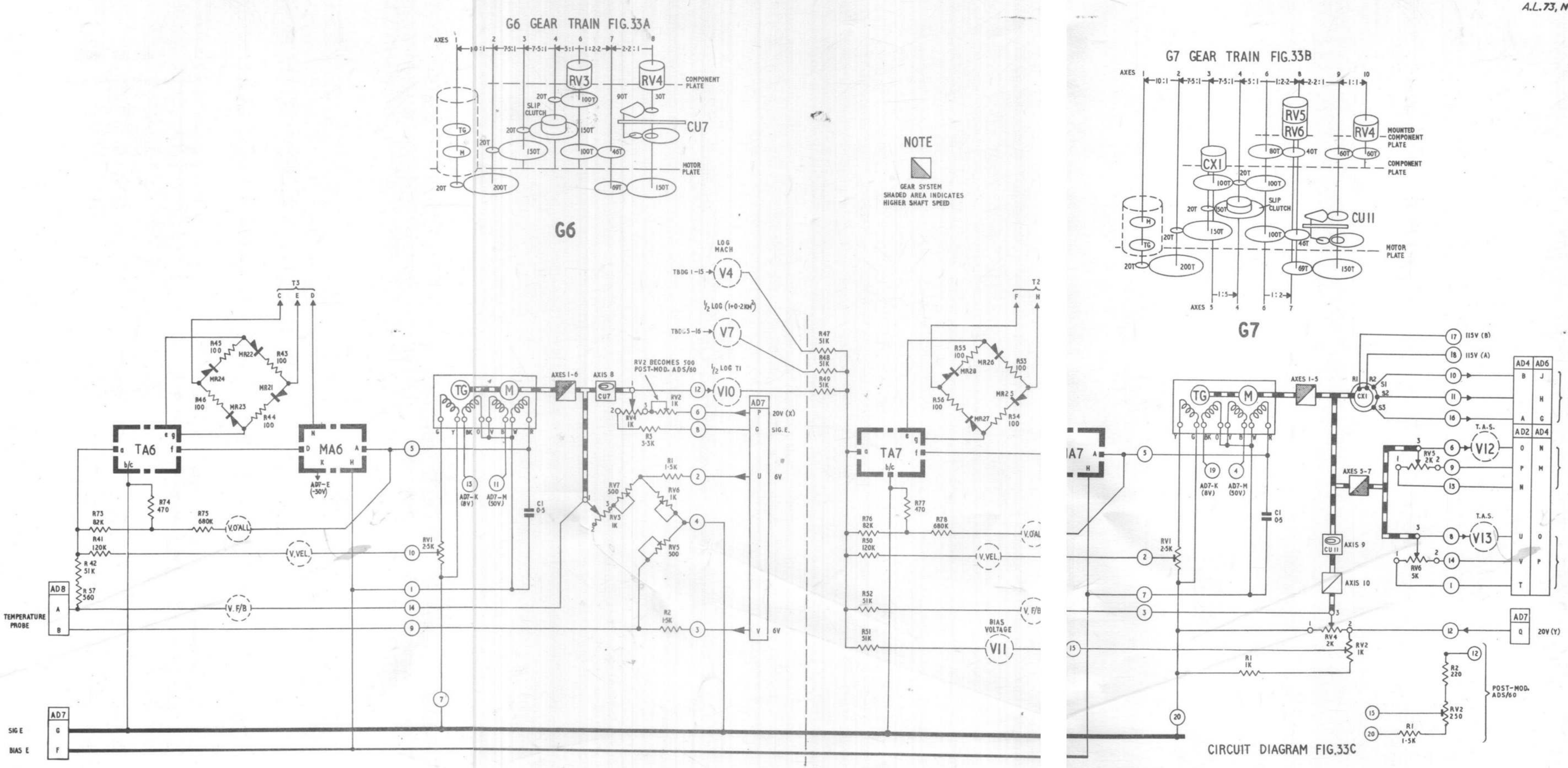


AIR DIAGRAM
6320AH/MIN
ISSUE 2 — PREPARED BY MINISTRY OF AVIATION FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

D.1349. 373879. S.W.Ltd. 11/64

A.D.S. MK.1B - MACH NUMBER CHANNEL, G1 AND G5

FIG. 32



CIRCUIT DIAGRAM FIG.33C

AIR DIAGRAM
6320AJ / MIN
ISSUE 2 — PREPARED BY MINISTRY OF AVIATION FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

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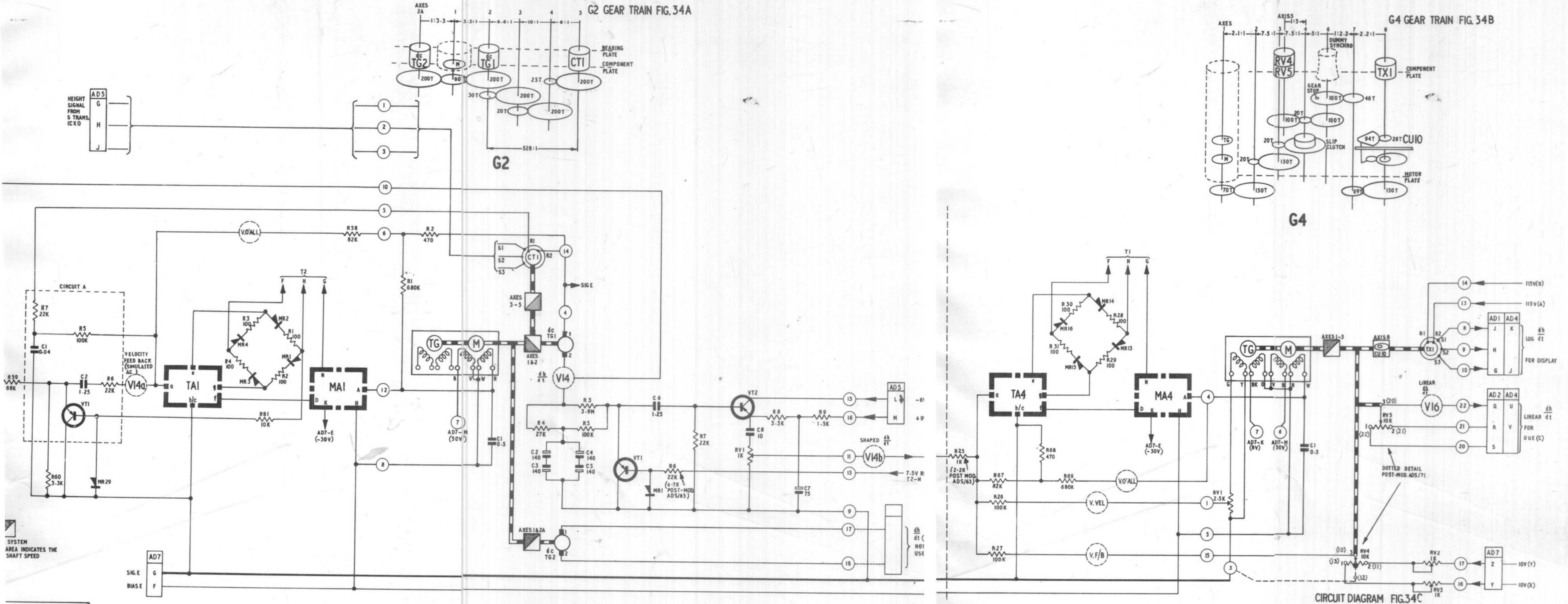
A.D.S. MK.1B - T.A.S. CHANNEL, G6 AND G7

RESTRICTED

FIG. 33



AIR DIAGRAM
6320AK/MIN

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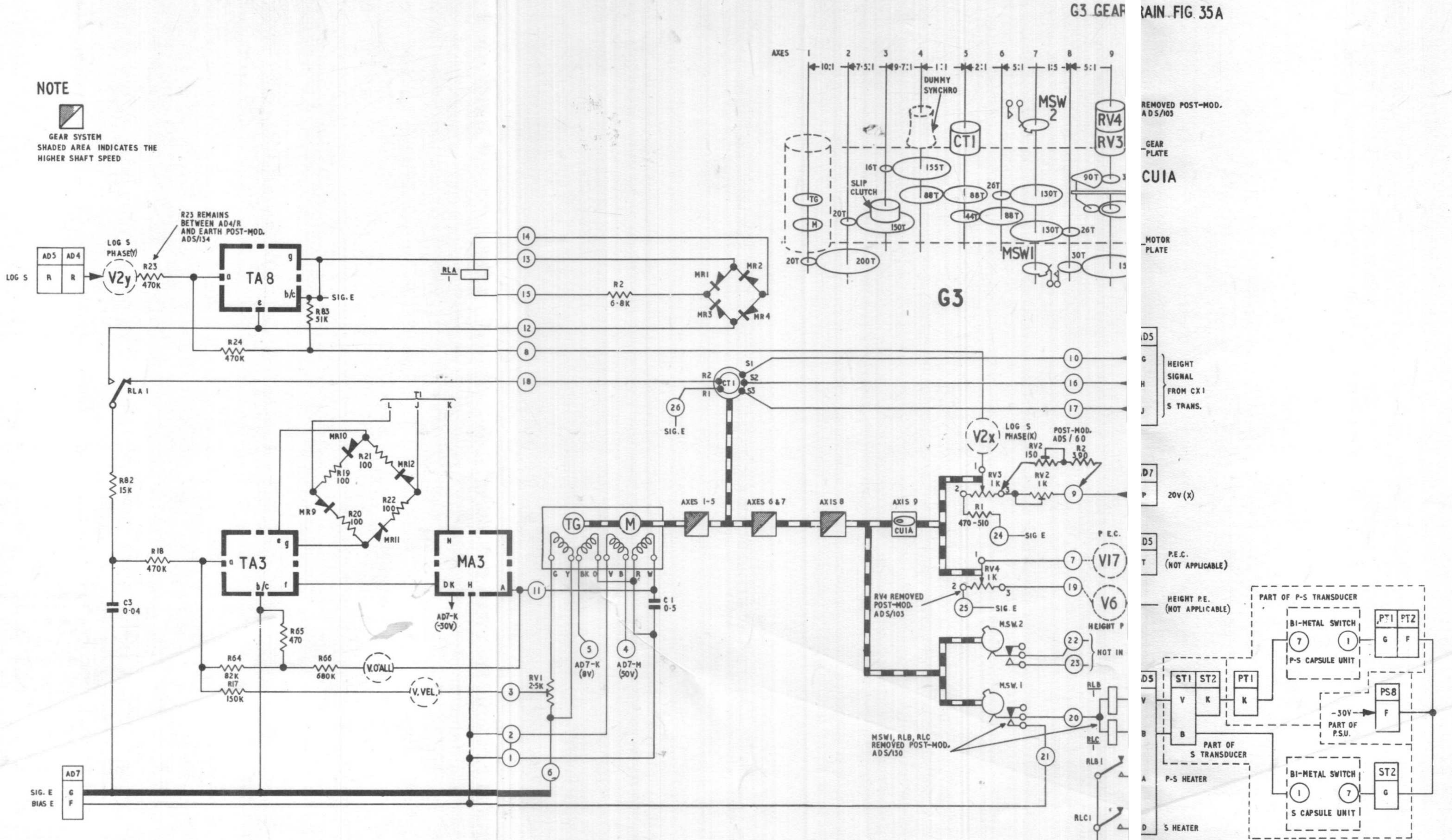
D.1349. 573679. S.W.Ltd. 11/64.

A.D.S. MK.IB - VERTICAL SPEED (RATE OF CLIMB OR DIVE) CHANNEL, G2 AND G4

RESTRICTED

FIG.34



AIR DIAGRAM
6320 AY /MIN
ISSUE 2 PREPARED BY MINISTRY OF AVIATION FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

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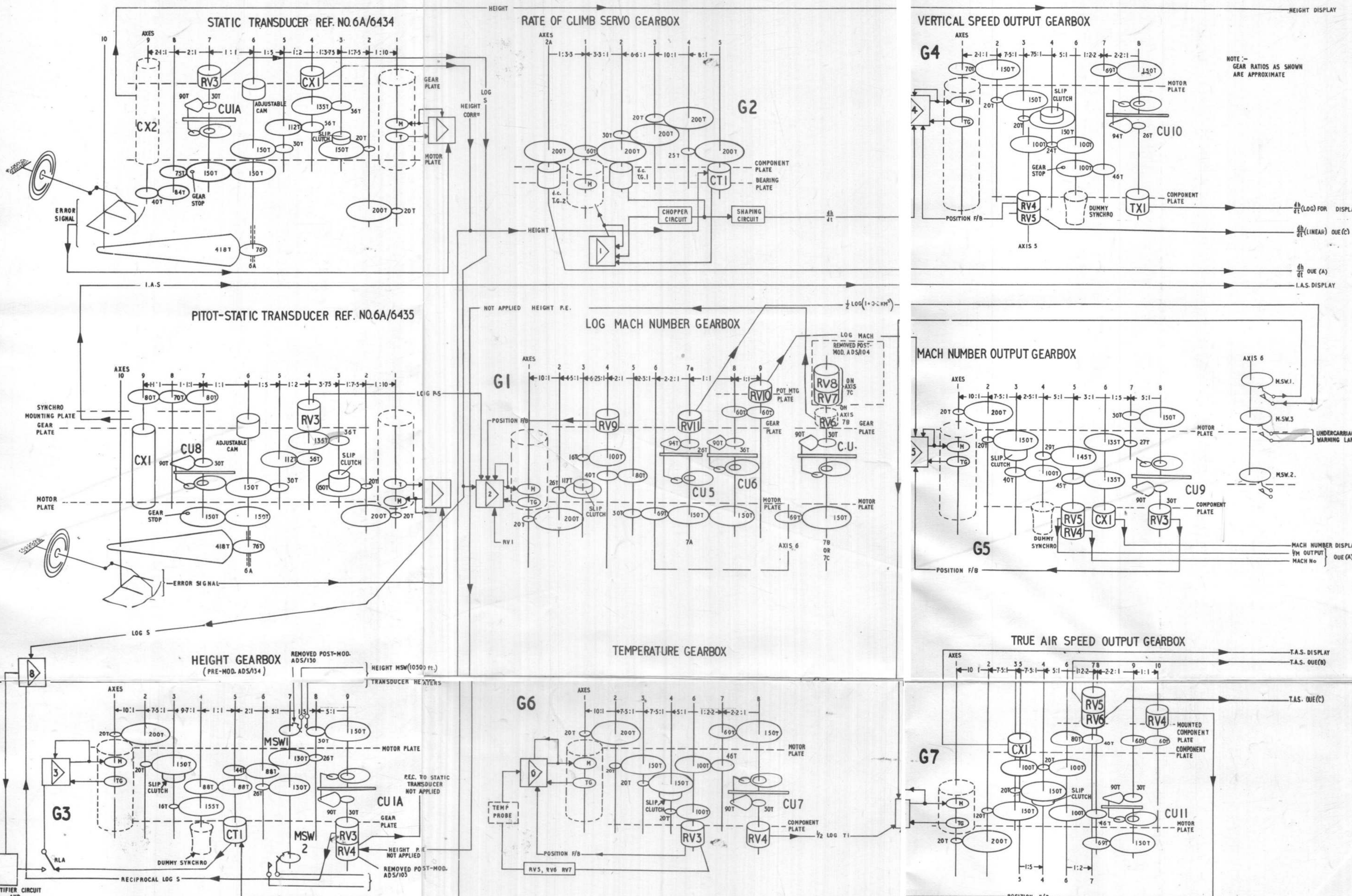
A.D.S. MK.1B-Height channel, G3 (Pre-mod. A.D.S./134)

FIG. 35

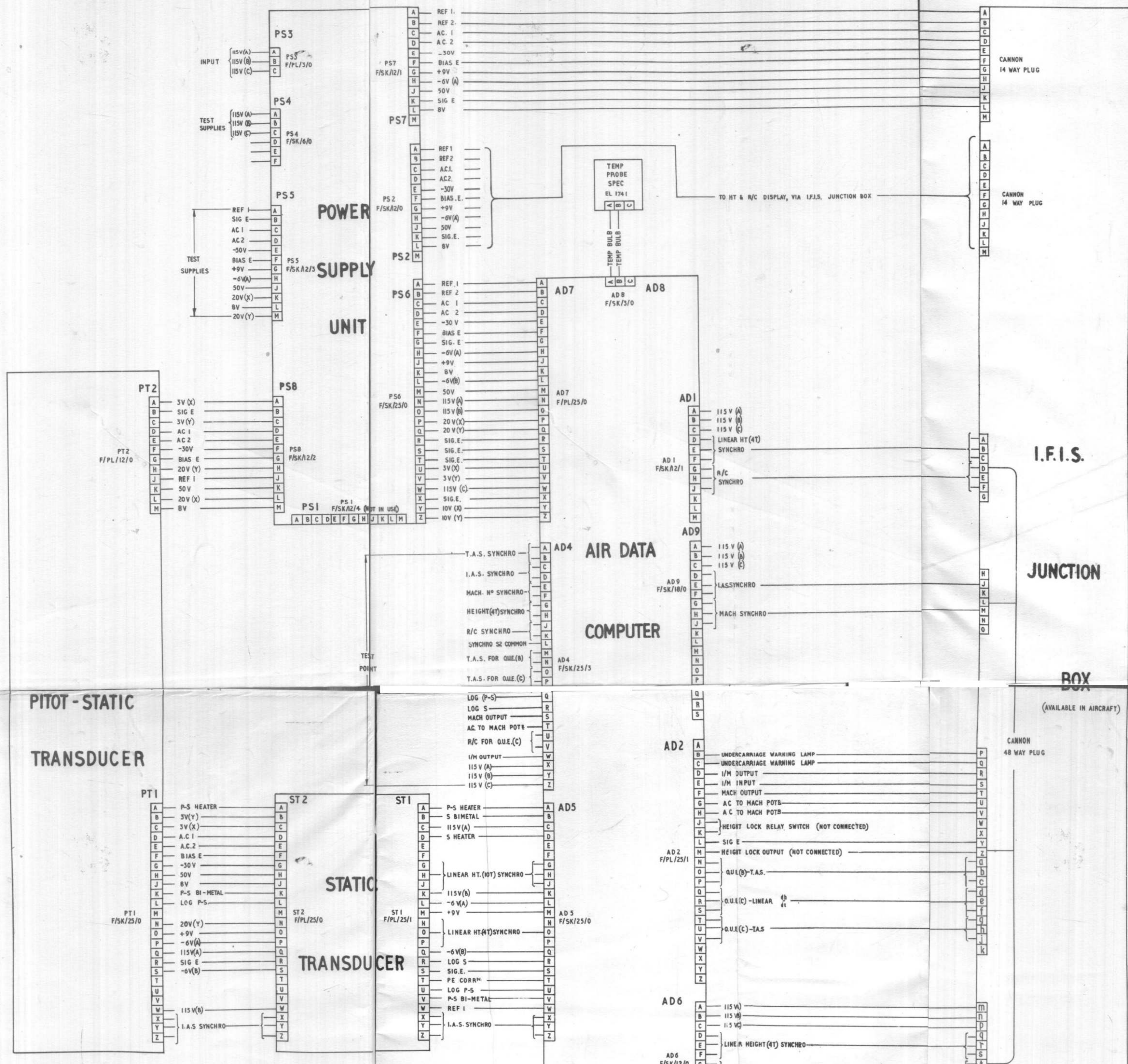


AIR DIAGRAM
6320AT / MIN
ISSUE 2 PREPARED BY MINISTRY OF AVIATION FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

D.1349. 375879. S.W.Ltd. 11/64.

A.D.S. Mk. I.B. GEAR SYSTEM AND ELECTRICAL INTERCONNECTIONS (TRANSDUCERS AND COMPUTER)

RESTRICTED



AIR DIAGRAM	
6320AR/ MIN	
ISSUE 2	PREPARED BY THE MINISTRY OF AVIATION FOR PROMULGATION BY AIR MINISTRY ADMIRALTY

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A.D.S. MK IB – INTERCONNECTION DIAGRAM

RESTRICTED

FIG.37


J-1712