PART 2

CHAPTER 2—AUTO-PILOT

List of Contents

Illustrations

PART 2

CHAPTER 2 — AUTOPILOT

DESCRIPTION

General

1. The automatic flight control system is manually controlled from five units all of which are located on the centre console. The units are: the autopilot master switches, a dual autopilot controller, a dual auto-throttle controller and two cut-out buttons on the pilots' control columns.

1A. The installation consists of two identical but independent autopilots, which are separately monitored, together with associated automatic tailplane trim and auto-throttle control systems. When electrical power is established, the autopilots are in a standby state at all times and ready to take control of the associated master PCU when engaged. Only one of the autopilots can be engaged at any one time.

2. The following facilities are provided:

Short term damping in the roll, pitch and yaw axes.
Attitude monitoring.
Holding an altitude, airspeed or mach number existing at engagement.
Holding a preset heading.
Flying an omni-range course in conjunction with the navigational receiver.
Making a completely automatic approach.

Smooth engagement is ensured by automatic coordination of the autopilot demands with the control surface position. Each mode of operation, height and airspeed can be accurately adjusted about the engaged datum point.

3. The complete system accepts information from the following sources:

Commands from the autopilot controller.
Navigational data from the flight director.
Pitch and roll attitude information from the twin attitude system and heading information from the polar path compasses.
Height, airspeed and mach number from an air data sensor.
Stabilisation signals from a three axis rate control and dynamic vertical sensor.
Steering data from the radio navigational aids.

4. Control signals from the various sources are processed in the lateral or longitudinal channel computers to make them suitable to operate the various control surfaces. The computer gain parameters are modified by the flight configuration so as to provide larger control surface movements at lower speeds and heights and proportionally smaller movements as speeds and heights increase.

5. Automatic comparison monitoring, using independently derived signals, is provided and the system can be monitored visually on the navigational instruments and indicators. Automatic disengagement of the autopilot occurs if the differences recorded by the comparison monitor exceed predetermined values.

Steady State Attitude Control

6. Autostabilisation in all three axes is carried out by disturbance detectors and correctors. Rate gyroscopes measure the rate of disturbance and correction is made by adjustment of the control surfaces. A separate yaw damper system is also provided.

7. *Roll.* In level flight a zero bank angle is maintained within $\pm 1°$ in smooth air and $\pm 2°$ in moderate turbulence. Long and short period damping is provided and low level oscillations do not exceed 0·5° under steady state conditions. If a complete loss of thrust from the critical engine occurs, the initial transient is damped and heading will be held within $\pm 2°$ in smooth air.

8. *Pitch.* During steady flight in smooth air the existing angle between the true vertical and the aircraft longitudinal axis is maintained within $\pm 0{\cdot}5°$. If a complete loss of thrust from the critical engine occurs, the initial transient and pitch attitude are maintained within $\pm 0{\cdot}5°$ in smooth air.

9. *Heading.* The existing heading is maintained within $\pm 0{\cdot}5°$ during steady, level flight in smooth air and within $\pm 2°$ in moderate turbulence. If a complete loss of thrust from the critical engine occurs, the initial transient is damped and the heading error does not exceed $\pm 0{\cdot}5°$ in smooth air.

Manoeuvring Control

10. *Range Limits.* The autopilot provides the following range of roll attitude in manoeuvres.

In manual mode ...	$25° \pm 3°$
In LOC/VOR mode ...	$25° \pm 3°$
In heading mode preset heading selection ...	$25° \pm 3°$
In glideslope mode ...	$25° \pm 3°$ down to $7° \pm 2°$ progressively during auto-approach

11. *Preset Heading.* A preset heading is attained within $\pm 0{\cdot}5°$ after one overshoot not exceeding 2°.

12. *Pitch Control.* The pitch controller can change the pitch attitude reference to command a change of $\pm 14^\circ$ $\pm 3^\circ$ pitch attitude. There is a $\pm 17^\circ$ pitch monitor (reference to zero in pitch attitude) in the autopilot interlock line.

Yaw Dampers

13. Each autopilot has an integral yaw damping system which operates when the autopilot is engaged or can be engaged independently, separately or together. A third independent yaw damper (standby) may be engaged at any time. It is normally powered from No 4 busbar but can automatically draw a supply from Elrat, when operating, provided that it is switched ON. Before an autopilot can be engaged, its associated yaw damper must be selected on. The damper remains operative when the autopilot is disengaged by normal means.

14. Yaw damper No 1 operates the middle rudder surface.
Yaw damper No 2 operates the lower rudder surface.
The standby yaw damper operates the upper rudder surface.

15. Yaw damping reduces over-swing after an initial disturbance to 0·6 of the amplitude at high altitude and high speed and to 0·7 during approach and landing.

16. A triple yaw damper indicator comprising three meters, each providing an indication of surface activity due to the associated yaw damper, is on the 1st pilot's instrument panel. A pre-flight test facility is incorporated in the indicator unit.

Autotrim

17. The autotrim operates to relieve elevator loading when under autopilot control, by trimming the aircraft by means of the tailplane. When the autopilot is disengaged and the control reverts to manual, the elevator and tailplane are trimmed at the time of changeover.

Airspeed Control

18. *Auto-Throttle Control of Airspeed.* This system is used to maintain airspeed in the lower speed range (100 to 180 knots) whilst flying under auto-control or manually. Its primary use is the maintenance of a constant airspeed during coupled approaches; provision is made for the pilot to override the automatic control if necessary. Speed is maintained in smooth air to within ± 5 knots of the selected speed. It is impossible to engage the automatic throttle above 185 knots.

19. *Elevator Control of Airspeed.* The elevators are operated by the airspeed control system to maintain the speed to within ± 5 knots at speeds up to 400 knots in calm air. The airspeed can be adjusted manually $\pm 15\%$ about the datum engage speed by means of a datum control.

Altitude Control

20. In level flight barometric altitude is held within ± 10 feet at sea-level (± 41 feet at 40,000 feet). During turns up to 30° bank angle the altitude is held within ± 20 feet at sea-level ($+82$ feet at 40,000 feet) in smooth air.

Mach Control

21. In calm air the mach number is maintained within 0·015 M. Variation of $+15\%$ about the engaged mach number is possible; the follow-up adjustment is limited to 0·5% of engaged mach number per second. This does not prevent the pilot selecting certain datum changes.

Radio Coupling Modes

22. *LOC and VOR Modes.* Control in these modes is achieved by selecting a VOR radial or LOC course on the course deviation indicator. When on course, deviations are continually corrected. Turning the turn control in these modes causes the autopilot to disengage the mode. Failure of a VOR or LOC signal causes the VOR/LOC flag to show in the course deviation indicator. (Flight director system.)

23. *Glideslope Auto-Mode.* Lateral control is as in LOC mode. On selection of glideslope auto-mode the glideslope arm light comes on. On interception of the glidepath the aircraft turns onto the path and engages down the glideslope. The glideslope engage light comes on and the ARM light goes out. During the arming phase the IAS, or ALT locks may be used but they disconnect automatically when the glideslope is engaged. ▶◀ Failure of a glideslope signal will not cause disengagement of the mode.

24. *Doppler.* This facility is not yet coupled.

Power Supplies

25. Power supplies to the autopilots are 115/200 volt, 3-phase AC and 28 volt DC, controlled by the two master switches on the centre console. Power for No 1 autopilot is taken from panels J and U under the control of the left-hand master switch; power for No 2 autopilot is taken from panels K and Z under the control of the right-hand master switch. The switches can be operated independently or a nuisance bar can be operated to switch off both switches together.

26. *Controls and Indicators — Autopilot.* (See **Table 1**).

Table 1. Controls and Indicators — Auto-pilot

Item	*Location*	*Marking/Description*
Auto-pilot master switches (2)	Centre console	AUTO-PILOT/MASTER ON-OFF
Auto-pilot switches	Auto-pilot dual controller on centre console	Auto-pilot engage switches (2) AP-1. AP-2. Damper engage switches (2) DAMPER-1/DAMPER-2 Height engagement switch ALT. Airspeed engagement switch IAS Mach number engagement switch MACH Doppler engagement switch DOPP (Not operational)
Auto-pilot mode rotary selector switch	Auto-pilot dual controller on centre console	HEADING/MAN/LOC. VOR/GS AUTO/GS MAN/FLARE (Flare setting is inoperative)
Datum adjustment control	Auto-pilot dual controller on centre console	DATUM ADJUST-DEC/INC.
Turn control	Auto-pilot dual controller on centre console	TURN
Pitch controls (2)	Auto-pilot dual controller on centre console	DOWN/UP
Cut-out buttons (2)	(1) Left handgrip of 1st pilot's control column (1) Right handgrip of co-pilot's control column	1st pilot's cut-out button Co-pilot's cut-out button
◀ Standby yaw damper	Centre console	STANDBY YAW DAMPER — ON/OFF ▶
Triple yaw damper indicator	1st pilot's panel	STANDBY/No. 1/No. 2
Three-axis trim indicators	(1) Left side of centre sill panel (No. 1 auto-pilot) (1) Right side of centre sill panel (No. 2 auto-pilot)	Three axis trim indicator RUD/AIL/EL.
Auto pilot failure warning lights (2)	(1) Left side of centre sill panel (1) Right side of centre sill panel	Auto-pilot OFF. Red. (Press-to-test or to cancel)
Glideslope armed lights (2)	(1) Left side of centre sill panel (1) Right side of centre sill panel	GS ARM. Blue. (Press-to-test)
Glideslope engaged indicator lights (2)	(1) Left side of centre sill panel (1) Right side of centre sill panel	GS ENG. Amber. (Press-to-test)
Pitch trim indicator	Pilots' centre panel	TAIL TRIM NOSE-UP 0° to minus 14° NOSE-DOWN 0° to plus 3°

—Continued overleaf

Table 1. Controls and Indicators — Auto-pilot — *continued*

Item	*Location*	*Marking / Description*
Tail trim overrun lights (2)	Engineer's panel	(1) SYSTEM A. Red (1) SYSTEM B. Red
Tail trim overrun button-type switches (2)	Engineer's panel	(1) SYSTEM A. PUSH TO REARM (1) SYSTEM B. PUSH TO REARM
Auto-throttle dual controller	Centre console	Isolation switches (4) THROTTLES/ON Speed setting control SET KNOTS Engage switch No. 1/ENGAGE/No. 2 Power supply switch POWER ON Set speed indicator
Auto-throttle warning lights (2)	(1) 1st pilot's panel (1) Co-pilot's panel	AUTO-THROTTLE WARNING. Amber
Course deviation indicator (2)	(1) 1st pilot's panel (1) Co-pilot's panel	Flight director system. Provides a pictorial representation of aircraft displacement with reference to omni-range radial or localiser with glideslope deviation superimposed. Omni-range radial selection is made by turning the COURSE setting knob, which rotates the beam deviation needle with respect to aircraft heading and drives a numerical counter on the face of the instrument, to give the selected radial or QDM. Knob HDG controls the position of the arrowhead cursor on the compass dial for selection of desired heading.
Auto-trim warning lights (2)	Pilots' centre panel	AUTO TRIM ERROR: A/P No. 1: A/P No. 2. Amber (press-to-test)

OPERATION

General

27. The auto-pilots operate the control surfaces through torque motors attached to the power control units (PCU's). Torque limiters fitted to the torque motors of the elevator and rudder PCU's cause an auto-pilot disconnect if the control surface loads become excessive. If the auto-pilot is overridden manually the torque limiters again cause the disengagement. Before an auto-pilot can be engaged, its associated yaw damper must be selected on. The damper remains operative when the auto-pilot is disengaged by normal means.

28. The auto-pilots control the inboard units of the ailerons and elevators and the middle and lower rudder, i.e. No. 1 auto-pilot—right inner aileron, right inner elevator, and middle rudder. No. 2 auto-pilot—left inner aileron, left inner elevator and lower rudder. One PCU in each control axis is under auto-pilot control, the remaining PCU's acting as slaves. Engagement of an auto-pilot locks a spring strut in the pilot's control run thereby transmitting movements from the master PCU back to the pilot's control and feel simulator, and to the slave PCU.

NOTE: Provided that the power supplies are established the auto-pilots are in a standby state at all times; the act of engagement allows an auto-pilot to take control of its master PCU's.

Auto-stabilisation

29. Two separate systems of auto-stabilisation are employed, one provides stabilisation in yaw only

(i.e. yaw damper) and supplements the manual control of the pilot. The other provides stabilisation in roll, pitch and yaw. Auto-stabilisation is carried out by disturbance detectors and correctors. Rate gyroscopes are used to measure the rate of disturbance and correction is applied through the control surfaces.

Yaw Dampers

30. In this mode of operation the power control unit is primarily under the control of the pilot. The yaw damping signals are not fed back to the rudder pedals and therefore do not interfere with the pilot's control of the aircraft.

Attitude Hold

31. Correction of long term disturbances about the pitch and roll axis is effected by a vertical gyro which is the main reference for the automatic flight control system.

Trim Indication

32. Trim condition is indicated by a three axis indicator which consists of three separate meter movements which, prior to engagement of the auto-pilot, are connected one across each torque motor input. With the auto-pilot disengaged the indicators should read zero, due to the action of the synchroniser circuits (see para. 46 et seq.). After engagement the indicators are connected to the feel lever position transmitters and indicate any out-of-trim condition of the associated axis.

Lateral Accelerations

33. Lateral accelerations i.e. slip or skid during turns are detected by the dynamic vertical sensor which produces correcting signals in the rudder channel.

Aileron to Rudder Cross-feed (ARC)

34. To improve low speed performance in some flight conditions a signal proportional to aileron demand is cross-fed to the rudder channel. (See paragraph 81 below.)

Auto-trim

35. The purpose of auto-trimming is to maintain constant elevator authority by removing any load from the control column and reducing unnecessary drag by streamlining the elevators with the tailplane. It also ensures that the aircraft is in trim when reverting to manual control. A sensor on the elevator control run adjacent to the feel unit detects displacement, i.e. effective force, and the auto-pilot trims when the sensor output exceeds a certain "threshold". Thus the tailplane moves until the elevator deflection returns almost to zero. A delay of 5 seconds is introduced into the system to cater for over-activity under turbulent conditions.

NOTE: Operation of the aircraft trimming system associated with the auto-pilot in use causes the auto-pilot to disengage.

36. The trim variation is shown on the TAIL TRIM indicator on the pilots' centre instrument panel.

37. Auto-trim can be overriden manually, if necessary, and this will cause the auto-pilot to disengage. A time-delay in the system prevents aggravating any tendency for an auto-pilot to run away within normal pilot-reaction time.

38. No. 1 auto-pilot auto-trim operates through hydraulic System B. No. 2 auto-pilot auto-trim operates through hydraulic System A. The elevator trim is monitored by the AUTO-TRIM ERROR warning lights, one for each auto-pilot.

Auto-throttle

39. Two identical auto-throttle systems, capable of maintaining a pre-set airspeed within the range 100 to 180 knots, are provided. Only one system can be used at a time and each can be engaged independently of the auto-pilot and can be used with either auto-pilot.

◀39A. It is important to note that each auto-throttle is an integrated part of its associated auto-pilot system, i.e. No. 1 auto-throttle utilises the No. 1 VG, the longitudinal amplifier and computer, air data sensor and associated comparison monitoring for No. 1 auto-pilot system. Similarly No. 2 auto-throttle utilises the associated No. 2 auto-pilot system components. It is therefore desirable to use the auto-throttle appropriate to the auto-pilot in use, otherwise the auto-throttle remains engaged after fault disengagement of that auto-pilot; conversely the auto-throttle could be under the control of a faulty system without any facility for automatic disengagement. ▶

40. Auto-throttle is normally used during pattern-holding or landing approaches. A pre-set airspeed is maintained by varying engine thrust by automatic adjustment of the throttle levers. Actual airspeed is sensed in the air data sensor and compared with the desired airspeed set on the auto-throttle dual controller. The resultant signal is processed in an amplifier and provides power for the throttle actuators.

41. The throttle actuators drive the four throttle levers and control the engine thrust in accordance with the required speed dialled on the speed indicator on the auto-throttle dual controller. Engagement is only possible between the control range of 100 to 180 knots. To avoid violent throttle movement upon engagement the speed indicator should indicate with-

in 10 knots of the actual speed. Incremental adjustment of airspeed can be made at any time by adjusting the speed indicator.

42. The AUTO-THROTTLE WARNING light comes on when the speed indicator differs from the actual IAS by more than a small margin. This margin varies between 4 and 10 knots.

43. If an engine or its associated control run malfunctions, the throttle actuator can be declutched from it by setting the appropriate THROTTLES isolation switch off; the actuators can also be overridden manually by the throttle levers, the force required to overcome the friction clutches in the system being greater than for normal throttle operation.

44. If the control signals are such as to drive the throttle levers against their stops, the four clutches are automatically de-energised until the demand is reversed.

45. Disengagement of the auto-throttle system is by means of the ENGAGE switch, the instinctive cut-out buttons, the throttle POWER switch or the auto-pilot master switches.

NOTE: Auto-throttle must not be engaged if IAS lock is selected, as this causes an unstable situation.

SYNCHRONISATION AND LOCK FACILITIES

General

46. Smooth engagement of the auto-pilot, within its normal manoeuvring range and regardless of the existing aircraft attitude, is assured by the use of follow-up synchronising circuits. One circuit in each channel follows the control surface movement so that the auto-pilot control circuits are in corresponding states ready for engagement when required.

Elevator Channel Synchroniser

47. The synchroniser input is derived from the output stage of the control servo loops, and the synchroniser output is fed to the loop via the command limiter. When the auto-pilot is engaged the reference winding of the synchroniser motor is isolated and the motor stops, holding the position angle in the associated synchro. The synchro output provides a reference for the engaged pitch attitude, which it therefore maintains.

Aileron Channel Synchroniser

48. Two synchronisers are provided in the aileron channel, one of which is essentially similar to that in the elevator channel. The second synchroniser is provided to roll the aircraft out from any roll attitude other than wings-level when the auto-pilot is engaged.

Rudder Channel Synchroniser

49. Two synchronisers are employed, one in a similar manner to that in the elevator channel in that it will cancel any demand on the rudder torque-motor prior to auto-pilot engagement, thereby eliminating the possibility of a stop demand at the instant of engagement. The second synchroniser is primarily to isolate the rudder position signal when the yaw damper is engaged.

Air Data System

50. The basic pressure measurements of static and pitot-static systems are converted into electrical reference signals by the air data sensor. Synchro outputs are provided for height, airspeed and mach number and potentiometers for airspeed gain adjustment. The synchro outputs provide the reference for holding height, airspeed or mach number while the potentiometers provide the control for adjustment of the gain parameters of the computers. The sensor also provides switching at airspeeds of less than 185 knots to allow aileron to rudder cross-feed to be increased.

Synchro Outputs

51. Two synchros are used in each of the height, airspeed and mach number circuits; the second is used for comparison purpose.

Manometric Locks

52. The manometric locks of altitude, airspeed and mach number are affected through the elevators from signals derived from the air data sensor. Operation of any one of the three engage switches (ALT, IAS, MACH) will lock the aircraft on to the altitude, airspeed, or mach number existing at the time. When a manometric lock facility is selected, the pitch control wheels are rendered ineffective. It is only possible to make one selection at a time, previous selection being automatically rejected when another selection is made.

53. The three modes all employ the DATUM ADJUST-DEC/INC knob for limited alterations of the engaged datum. The DATUM ADJUST knob has "click stops" which allow equal adjustment in any particular condition.

Auto-pilot Engagement

54. An auto-pilot is engaged by pressing the relevant switch on the dual controller; the switches are held in the ON setting magnetically and unless all the interlocks are satisfied for the mode of operation the switch will not hold ON. An interlock prevents an auto-pilot from being engaged unless its associated yaw damper is engaged. Instinctive cut-out buttons on the pilot's control wheels are used to disconnect the auto-pilot manually.

55. The autopilot relays are energised by the 115/200 volt AC supply; a 28 volt DC aircraft supply normally operates the failure warning light, but failure of the normal 28 volt DC supply results in the warning light circuit being automatically transferred to the autopilot internal 28 volt DC supply (unfiltered). Under this alternative supply, the warning light changes its role and operates as an indicator; it provides a steady red light when the autopilot is engaged and is extinguished in the event of autopilot failure.

56. Indications given by the autopilot failure warning light are:

Flashing light ...	Automatic disengagement of the autopilot
Steady light ...	Failure of the normal 28 volt DC supply
Steady light followed by light going out ...	Autopilot failure subsequent to failure of warning light power supply

Autopilot Disengagement

57. Any autopilot facility can be disconnected by returning the appropriate engage switch to OFF. The autopilot is normally disengaged by operation of the pilots' cut-out buttons (this action, however, does not disconnect any engaged damper), the master switches (which also disengage dampers), or by manually overpowering the autopilot system.

58. If the autopilot is disengaged by use of the engagement switches, the autopilot failure warning light continues to flash and must be extinguished by use of the pilots' cut-out button before re-engegement can take place.

AUTOPILOT MODES

General

59. The mode selector switch allows the selection of various modes of autopilot operation. It is spring-loaded to the MAN setting and held at all other settings by a holding coil.

60. The mode settings are:

Heading mode
Manual mode
LOC/VOR mode
Glideslope (Auto) mode
Glideslope (Manual) mode
Flare (not functioning).

Manual Mode

61. In manual mode the autopilot manoeuvres the aircraft into any desired pitch and roll attitude in response to commands set by the pilots. Two controls located on the dual controller are used, a double pitch wheel and a turn control knob. Both controls provide attitude command signals. The turn control is connected so that larger movement of the turn control produces steeper bank angles in the turn. When in the manual mode the heading is held to that existing at the time of engagement (clutched heading), the datum being derived from the compass system. During turns the heading datum is temporarily disengaged until the turn control is returned to its centre detent position; the heading then held is maintained.

62. The 'clutched heading' is 'unclutched' when:

a. The autopilot is off.

b. The mode selector on the compass controller is set to SYN.

c. The TURN knob is out of its detent.

d. The SET knob on the compass controller is moved from centre, or

e. Any other mode is selected.

Items b and d allow for compass synchronisation without the aircraft following rotation of the compass coupler.

Heading Mode

63. In this mode, the selector switch is held at HEADING by the holding coil.

64. To turn on to a particular heading, set the heading cursor, on the course deviation indicator, by means of the HDG knob, to the desired heading. Operation of the mode selector switch to HEADING then causes the autopilot to steer to and maintain the selected heading.

65. Longitudinal control in this mode is as in the manual mode.

LOC/VOR Mode

66. In this mode, the selector switch is held at LOC/VOR by the holding coil.

67. When LOC/VOR is selected, and a ▶◀ VOR signal is present, the aircraft automatically captures and tracks the beam. Heading information is obtained from the associated course deviation indicator after use of the COURSE knob to position the course cursor to the required QDM or VOR radial.

68. To fly a ▶◀ VOR radial, after setting the required bearing on the course deviation indicator, operate the mode selector switch to LOC/VOR, when the aircraft will be manoeuvred to assume a ◀45° intercept with respect to the bearing. After▶

the aircraft closes on the beam centre and completes the capture, the beam is tracked accurately and corrections to heading for drift are automatically made.

68A. To intercept an ILS localiser beam, set the required QDM on the CDI. When the localiser beam is approached and the L-C flag on the CDI is clear, select LOC/VOR on the mode selector switch. Initially nothing will happen and the aircraft may be turned using the heading control knob on the CDI to attack the localiser beam at an angle less than 80°. As the aircraft closes on the beam, the localiser signals are automatically switched to control the autopilot, turning the aircraft on to the beam and allowing for drift. Indication that this has occurred is given by failure of the aircraft to respond to inputs from the heading selector.

69. Operation of the turn control causes the mode to be disengaged. Failure of VOR or localiser signals causes the L-C flag to show in the course deviation indicator, the aircraft holding the heading existing at the time of the failure; the autopilot will not disengage.

70. The 'hold in' of the LOC/VOR switch is released by selecting a non-radio mode ie MAN or HEADING.

71. Longitudinal control in this mode is as in the manual mode.

Glideslope Auto Mode

72. Lateral control in this mode is as for LOC/VOR mode.

73. In this mode (GS AUTO) the selector switch only holds in if the VOR receiver is tuned to a localiser frequency, the glideslope signal is present and the glideslope has *not* been intercepted prior to the selection of GS AUTO.

74. The facility is selected prior to reaching the glide path and capture and tracking occurs automatically. On initial interception of the glideslope beam, with a large off-beam error signal, the glideslope circuits are armed and the GS ARM blue light comes on.

75. When at a small and specified displacement from the glideslope beam centre the following automatically occurs:

a. The glideslope signal is fed to the autopilot.

b. All manometric lock facilities are disconnected.

c. Pitch control wheels are rendered inoperative.

d. The GS ARM blue light goes out and the GS ENG amber light comes on.

e. Attenuation circuits in the air data sensor reduces the sensitivity of both the localiser and glideslope as the aircraft descends, reducing localiser signals to 50% and the glideslope signal to 25% after a height reduction of 1800 feet.

f. Integration to the glideslope commences.

76. This sequence locks in, and the lock can only be released by setting the mode selector to LOC/VOR. The sequence also occurs when GS MAN is selected whenever the glideslope is intercepted. GS AUTO selection will not hold in once the sequence has commenced, ie when the aircraft is on the glideslope GS AUTO cannot be selected.

77. Failure of the glideslope signals will not cause disengagement of the mode.

Glideslope Manual Mode

78. In this mode (GS MAN), the selector switch always holds in provided that LOC frequency is selected.

79. This setting is for use when the aircraft is on the glideslope and is selected when the course deviation indicator glideslope bar is about to reach beam centre. The mode is available when automatic glideslope capture is not practical.

80. Selection of GS MAN causes the sequence of events in para 75 for GS AUTO to commence immediately.

81. During this phase of the approach the demand to the ailerons is also crossfed to the rudders.

Note: As the glideslope is immediately accepted in this mode, care must be taken to ensure that the aircraft is on the glideslope prior to selection. If selected when the glideslope displacement is large, the aircraft will manoeuvre to capture the glideslope.

82. Failure of the glideslope signals will not cause disengagement of the mode.

Interlock Circuits

83. The 115-volt DC supply for the autopilot engage circuits is taken from the power junction box and fed through engage interlocks to the autopilot engage relays and engage switch hold-on coil.

84. Each of the three power interlock relays closes when a 115-volt, 400 Hz supply is fed to the relevant phase winding in the junction box.

85. The vertical gyro interlock is a thermally-operated switch which closes 60 seconds after the gyro supply is switched on; this enables the gyro to reach operating speed. Failure of the power supply to the vertical gyro results in the interlock opening.

86. Glideslope interlocks are open whenever a glideslope signal of usable strength is not being received by the radio receiver.

87. Two interlocks in the autopilot dual controller prevent engagement if the TURN control is not in the detent and the mode selector not in the MAN position. On autopilot engagement, the TURN control and mode selector can be used without causing disengagement.

88. Localiser interlocks are open when a localiser signal of usable strength is not being received by the radio receiver. The interlocks are shorted out until the glideslope is armed or engaged.

89. The slow over pitch attitude interlocks are open when the comparison vertical gyro pitch signals reach a set value.

90. The IAS error between the air data sensor and the comparison air data sensor causes the ADS pitot-static interlocks to open. When the aircraft speed is below 100 knots the interlocks are shorted out.

91. A height error between the air data sensor and the comparison air data sensor causes the ADS static interlocks to open.

92. The manometric error interlock opens if the lock error signal from the air data sensor exceeds the pre-determined amount.

93. The pitch logic interlock opens if a hard-over elevator channel monitoring circuit operates.

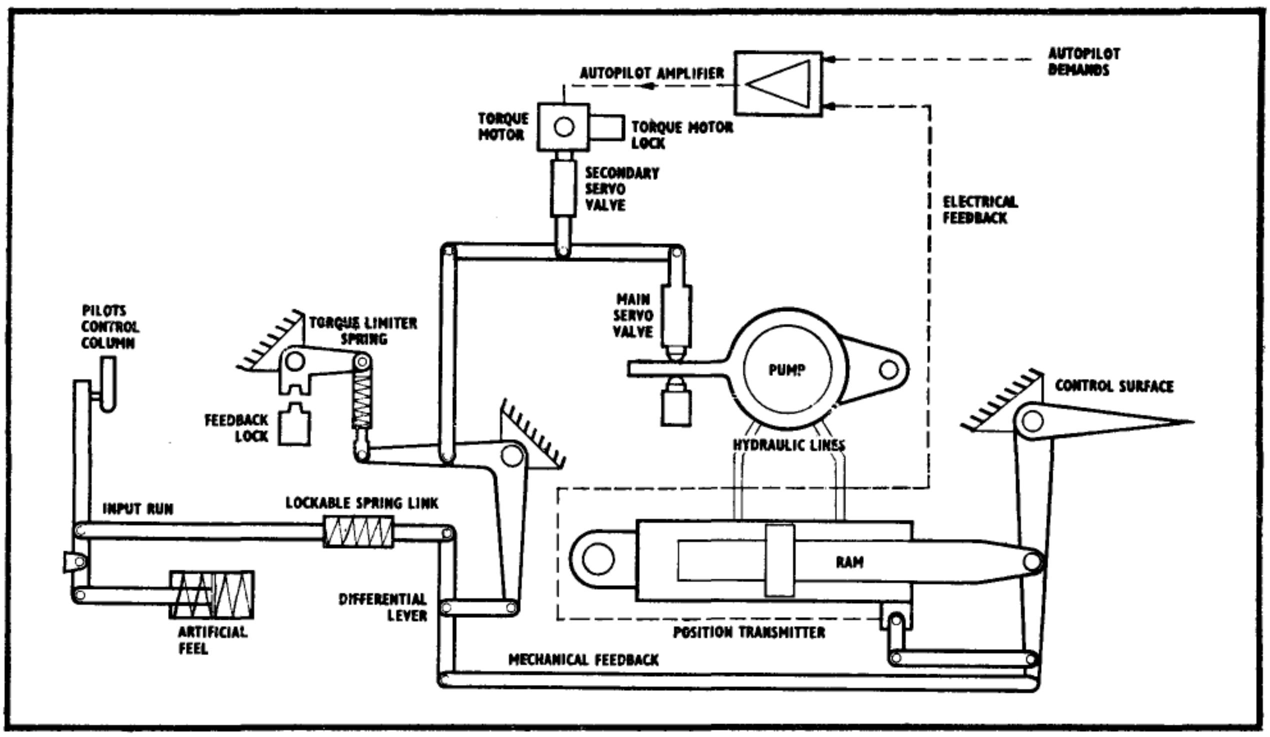
94. The roll logic interlock opens if the hard-over aileron channel monitoring circuit operates.

95. The relevant torque motor limit interlock opens if the elevator or rudder torque motor reaches its travel limit.

96. The manual trim select interlocks open if the elevator manual trim lever is moved from the detent.

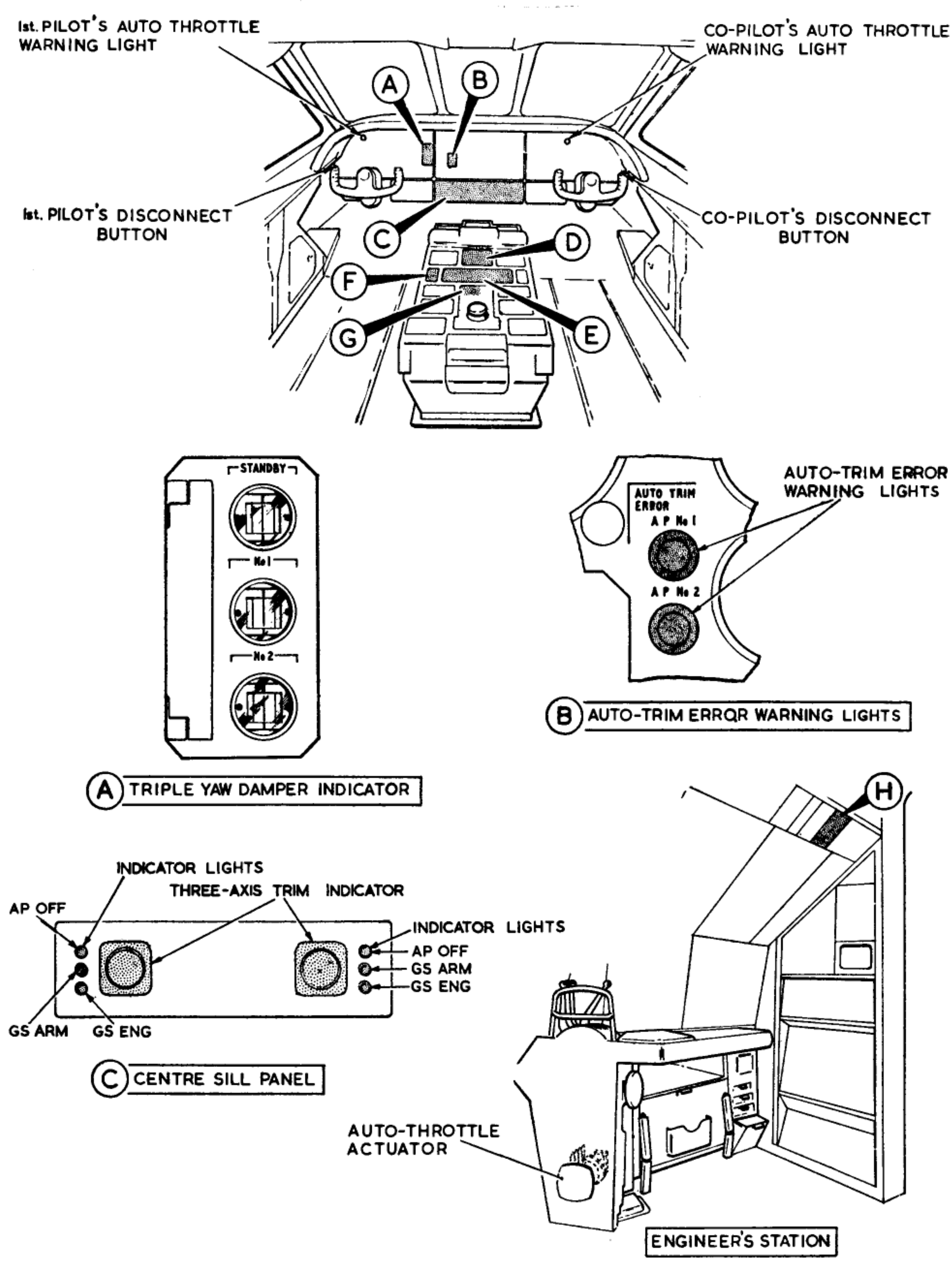
97. The auto-trim pressure switches open if hydraulic pressure is not applied to the auto-trim system. This may be due to hydraulic system failure, logic pressure sensor switching or elevator over-travel.

98. The torque motor lock solenoid interlocks are open until the relative lock solenoid is energised.



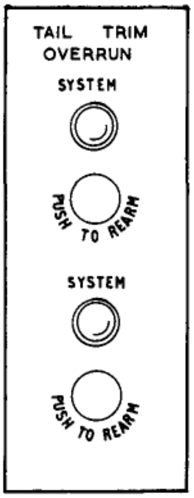
VC10/13A

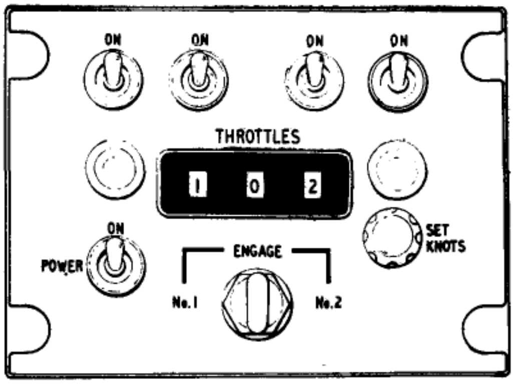
2—2 Fig 1 Control Surface Coupling



VC10/14A

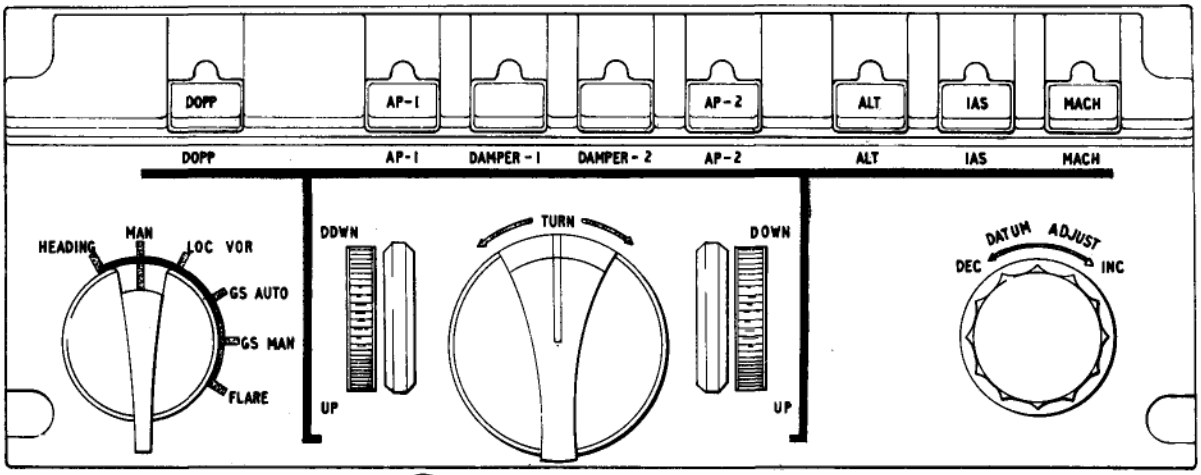
2—2 Fig 2 Equipment on Flight Deck (1)



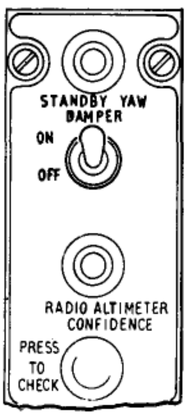


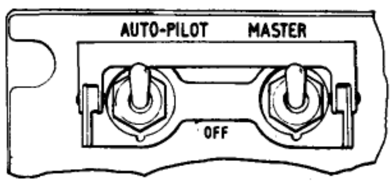
(D) AUTO-THROTTLE CONTROLLER

(H) TAIL TRIM OVERRUN



(E) AUTO-PILOT CONTROLLER





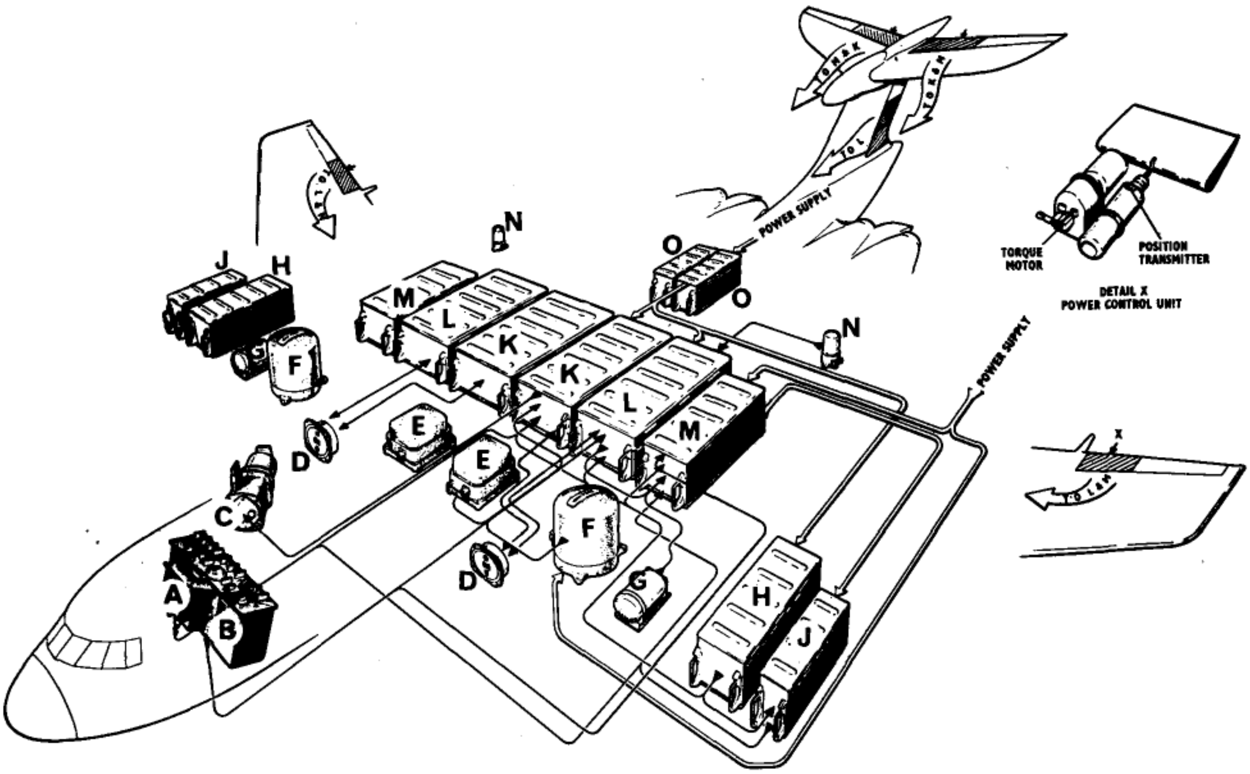
(G) AUTO-PILOT MASTER SWITCHES
LEFT RIGHT

(F) STANDBY YAW DAMPER SWITCH

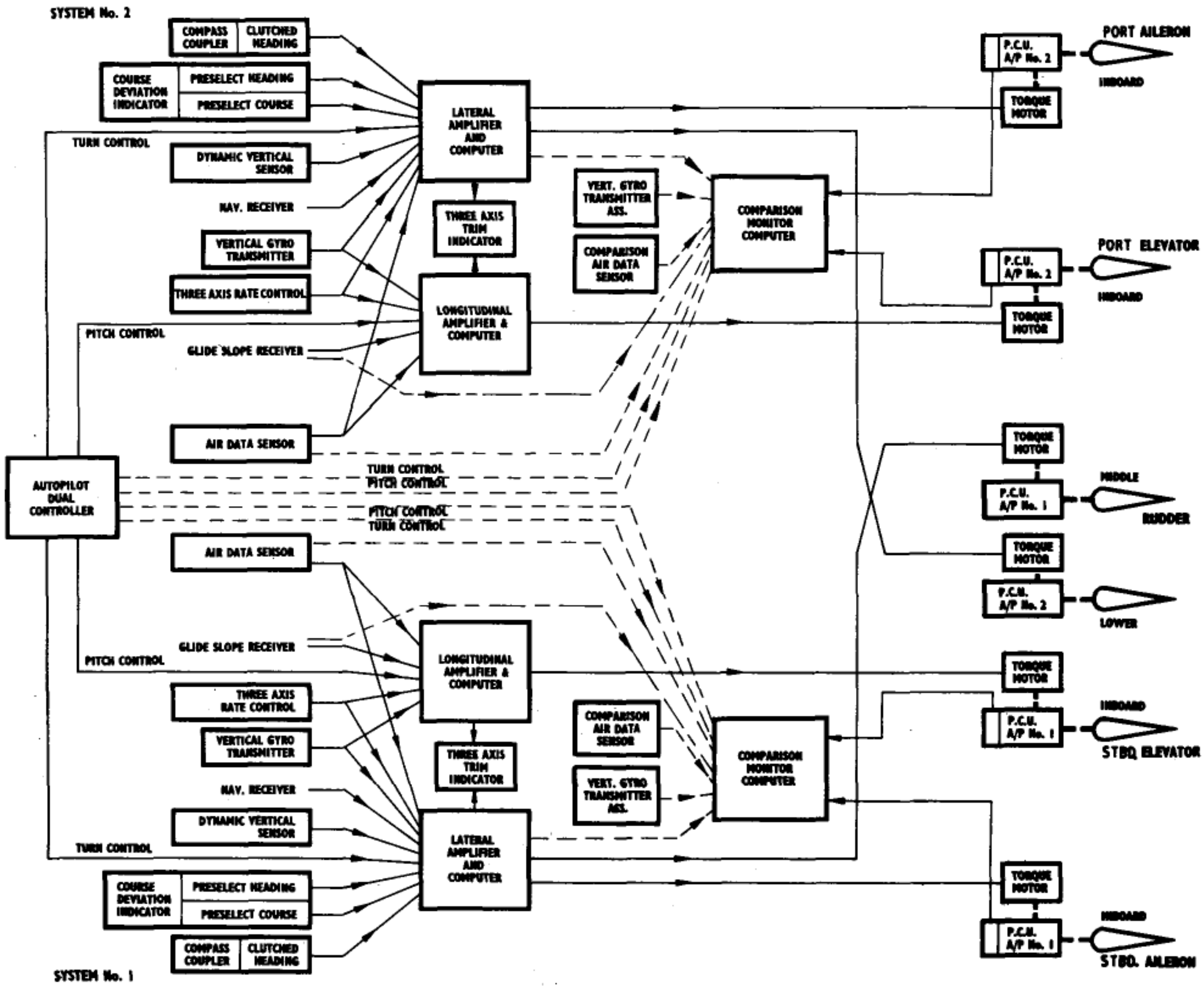
2.2 Fig. 3. Equipment on Flight Deck (2)

[redacted]

A THROTTLE DUAL CONTROLLER
B AUTO-PILOT DUAL CONTROLLER
C THROTTLE DUAL ACTUATOR
D THREE-AXIS TRIM INDICATOR
E THREE-AXIS RATE TRANSMITTER
F VERTICAL GYRO TRANSMITTER
G VERTICAL GYRO TRANSMITTER ASSEMBLY
H AIR DATA SENSOR
J COMPARISON AIR DATA SENSOR
K LONGITUDINAL AMPLIFIER AND COMPUTER
L LATERAL AMPLIFIER AND COMPUTER
M COMPARISON MONITOR COMPUTER
N DYNAMIC VERTICAL SENSOR
O POWER JUNCTION BOX

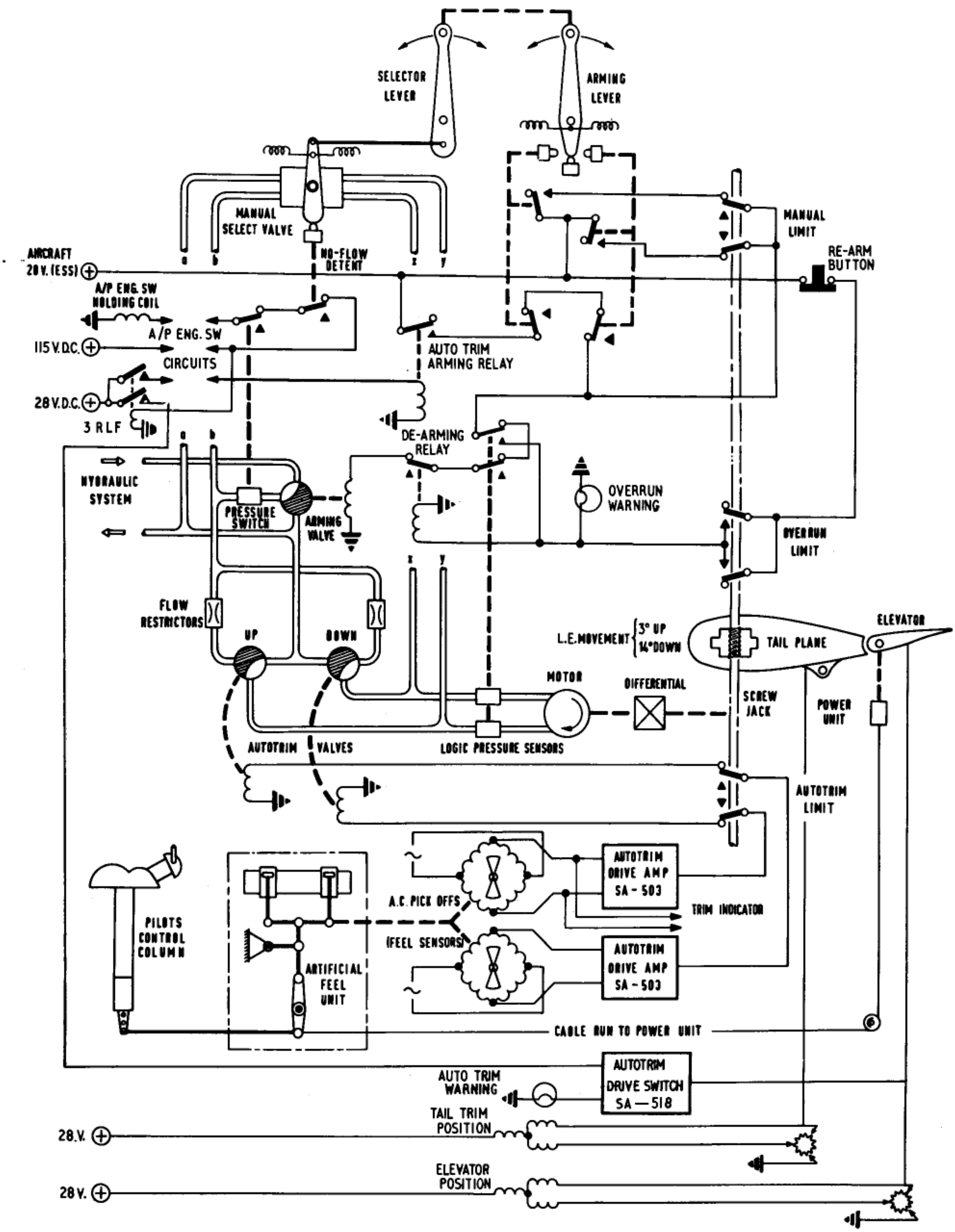


2.2 Fig. 4. Auto-pilot Control—Block Diagram



VC10/17B

2–2 Fig 5 Autopilot Block Diagram
◀ *Illustration Updated* ▶



VC10/18A

2–2 Fig 6 **Autotrim Electro Mechanical Diagram**