

**PART 1**  
**CHAPTER 5—POWERED FLYING CONTROLS AND TRIMMERS**

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**CONTROLS AND INDICATORS**

1. Details of the controls and indicators for the

F Mk 3 and F Mk 6 are listed in Table 1, and for the T Mk 5 in Table 2. They are illustrated in Fig 1 and Fig 2 respectively.

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Table 1 — Controls and Indicators — F Mk 3 and F Mk 6

<i>Item No</i>	<i>Item</i>	<i>Markings</i>	<i>Remarks</i>
1	Control column	—	—
2	Rudder bar	—	—
3	Aileron/tailplane trim	—	4-way, dual ganged switch, spring-loaded to the central, off, position
4	Rudder trim	RUDDER TRIM	Twin, ganged, 3-position switches, spring-loaded to central position
5	Trim indication	TRIM INDICATOR — RUD/TAIL/ AIL/AIR BRAKE	—
6	Feel selector	FEEL — ON/OFF	Guarded to ON
7	Power control failure warnings	HYD 1/HYD 2 (AWP) HYD (SWP)	— —
8	Rudder bar adjustment	PULL TO ADJUST RUDDER BAR	—

Table 2 — Controls and Indicators — T Mk 5

<i>Item No</i>	<i>Item</i>	<i>Markings</i>	<i>Remarks</i>
1	Control columns	—	—
2	Rudder bars	—	—
3	Aileron/tailplane trim (2)	—	4-way dual ganged switches, spring-loaded to the central, off, position. Not illustrated
4	Rudder trim (2)	RUDDER TRIM	Twin, ganged, 3-position switches spring-loaded to the central, off, position
5	Trim indication	TRIM INDICATOR — RUD/TAIL/ AIL/AIR BRAKE	—
6	Feel selector	FEEL UNIT — ON/OFF	Guarded to ON
7	Power control failure warnings	HYD 1/HYD 2 (AWP) HYD (SWP)	— —
8	Rudder bar adjustment (2)	RUDDER BAR ADJUST	a. Pupil b. Instructor

**DESCRIPTION OF THE SYSTEM**

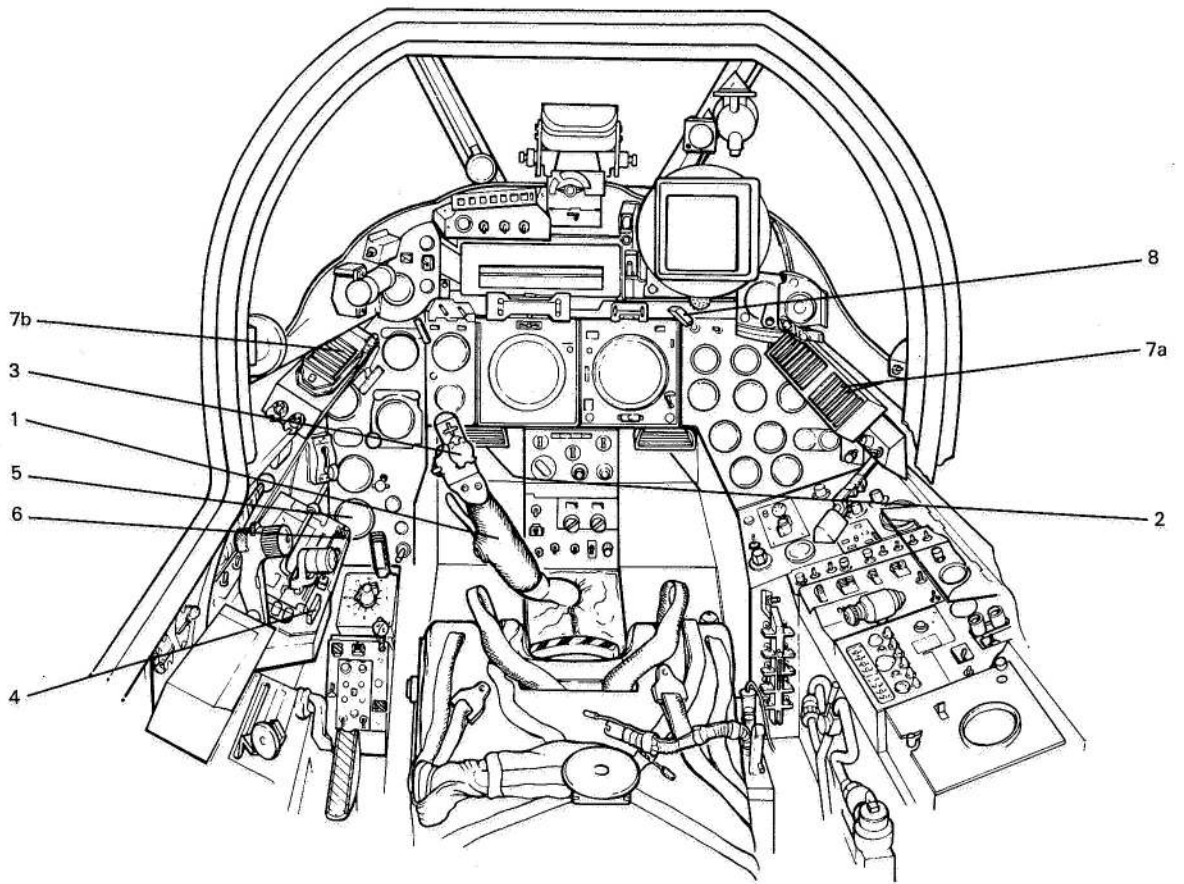
**General**

2. The ailerons, tailplane and rudder systems are fully power-operated flying controls. Each system is connected to two separate Controls hydraulic systems driven by hydraulic pumps on No 1 and No 2 engines. This gives mutual protection to the Controls systems in case one engine is shut down or if one hydraulic system fails, but there is no manual reversion to mechanical flying controls if both systems should fail. The ailerons and rudder are moved by jack-type powered flying control units (PFCU) and the tailplane by a twin screw-jack PFCU. The PFCU are mech-

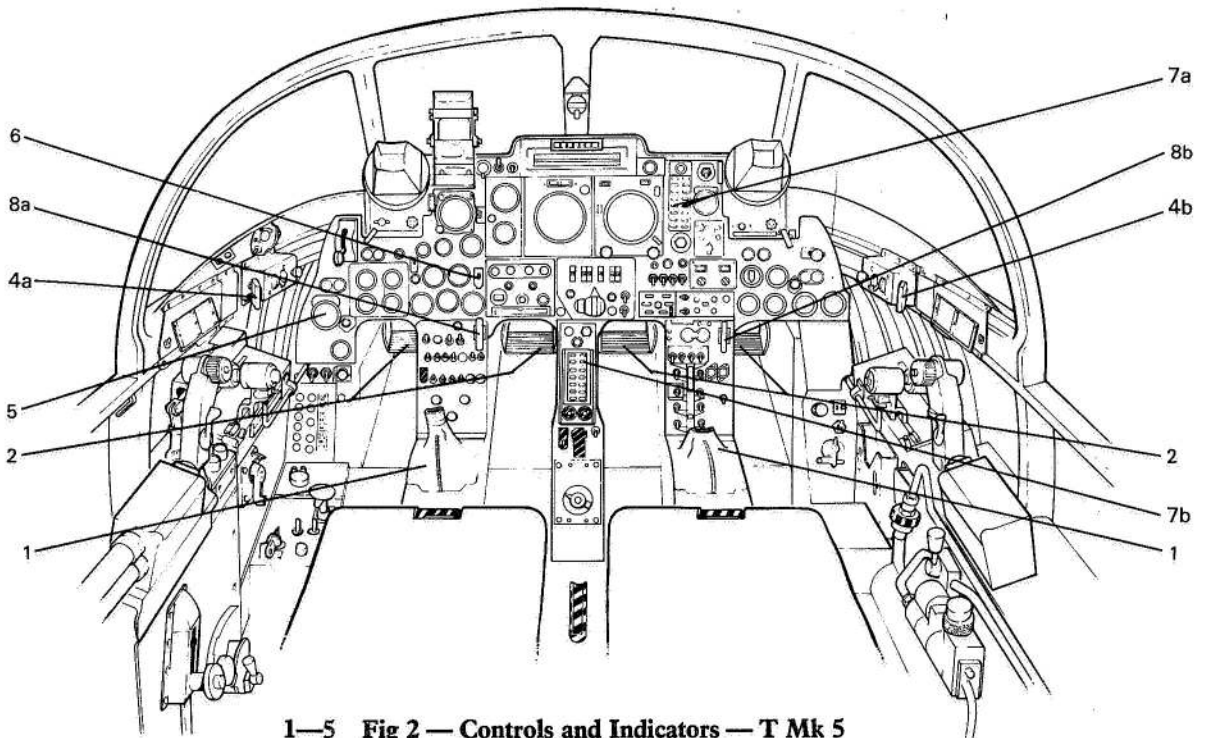
anically actuated from conventional pistol grip control column(s) and rudder bar(s). Artificial feel is provided in each circuit. Trimming is effected by electrically-operated actuators which, by moving the control runs, displace the PFCU and adjust the cockpit controls to a new neutral position.

**Ailerons**

3. Each aileron is moved by two PFCU. The out-board PFCU are powered by the No 1 Controls system and the inboard by the No 2 Controls system. If the hydraulic supply fails to one PFCU, the aileron is moved by the other PFCU, resulting in a slight reduction in the maximum operating rate.



1-5 Fig 1 — Controls and Indicators — F Mk 3 and F Mk 6



1-5 Fig 2 — Controls and Indicators — T Mk 5

4. Aileron movement is limited to approximately half travel ( $\pm 10^\circ$ ) whenever the undercarriage is up. A restrictor in the control run in the left wing engages with the undercarriage wheel well door as it closes.

#### Rudder

5. The rudder PFCU incorporates twin piston assemblies in tandem. The forward piston is operated by the No 1 Controls system and the rear by the No 2 Controls system. Failure of one Controls system does not affect the rate of operation.

#### Tailplane

6. The slab tailplane is moved by a twin screw-jack PFCU powered by two independent, reversible hydraulic motors through a common gearbox. The right hydraulic motor is supplied by the No 1 Controls system and the left from the No 2 Controls system. Failure of the hydraulic supply to one of the motors reduces the rate of tailplane operation; for this reason manoeuvre is limited to 2g following such a failure.

#### Aileron Feel System

7. Artificial feel in the aileron system is provided by a torsion bar connecting the control column to the control run. Feel force is directly proportional to control column movement and does not vary with speed and altitude.

#### Tailplane and Rudder Feel

8. Artificial feel in the rudder and tailplane control systems is provided primarily by hydraulic feel units, supplied by the *Services* hydraulic system, in each control run. Hydraulic feel may be cancelled by selecting the FEEL (FEEL UNIT, T Mk 5) switch to OFF, but the switch is normally left guarded to ON. Spring feel is also provided to supplement the hydraulic feel and to act as a standby system in the event of hydraulic feel failure.

9. *Operation.* When the control column or rudder bar is moved, a piston in the feel unit is displaced against hydraulic pressure. Relaxing the force on the control allows the piston to move the control column or rudder bar back to its trimmed position.

10. *Hydraulic Feel Units.* The hydraulic feel units give a linear increase in feel force with control movement and an increasing feel force with increase in pitot/static differential pressure through the action of a feel simulator control unit which meters hydraulic pressure to the feel unit pistons. If the pitot/static differential pressure is increased by increasing air-speed, the feel simulator control unit increases the pressure at the pistons until the speed reaches 0.9M, above which speed feel is maintained at a constant

value for a given altitude. However, differences in static pressure continue to affect feel force at speeds greater than 0.9M.

11. *Accumulators.* There are two accumulators in the hydraulic feel system:

- a. A small accumulator acts as a damper between the rudder and tailplane units during rapid operation of the controls and also prevents reaction on the feel simulator valve which would otherwise cause the flight instruments to fluctuate.
- b. A large accumulator prevents changes in feel occurring when the general services are being operated. It also provides continued operation of the feel system for a limited period after *Services* system failure.

12. *Rudder Loading.* To reduce the foot load on the rudder bar in the landing configuration, hydraulic feel to the rudder is disengaged when the undercarriage is selected DOWN and is restored when an UP selection is made.

#### Trimmers

13. The flying controls are trimmed by an electric motor in each system. In the tailplane and rudder systems the motors are connected to the hydraulic feel units and in the aileron system to the torsion bar. Operation of the appropriate motor displaces the feel unit or aileron torsion bar which in turn displaces the control column or rudder bar to a new neutral position.

#### Rudder Bar Adjustment

14. *F Mk 3 and F Mk 6.* When the PULL TO ADJUST RUDDER BAR handle is pulled out, a toothed plunger is withdrawn from the rudder bar rack allowing the rudder bar to move aft under the action of a compression spring or to be pushed forward against the spring pressure. When the desired leg reach position is attained, releasing the handle allows the toothed plunger to re-engage the rack.

15. *T Mk 5.* The rudder bars at each station in the T Mk 5 are adjusted independently by pulling out the RUDDER BAR ADJUST handles and then turning the handles anti-clockwise to shorten leg reach and vice versa. After adjustment, turning the handles to the vertical position and pushing them in locks the adjustment gear.

## MANAGEMENT OF THE SYSTEM

#### Pre-Flight Checks

16. *Failure Warnings.* Check the HYD 1 and HYD 2 captions on the AWP and the HYD caption on the SWP are on before starting, the HYD and HYD 1

warnings go out after starting No 1 engine, and the HYD 2 warning goes out after starting No 2. Re-check the warnings are all out before take-off.

17. *Rudder Trim.* On the first sortie of the day, test the rudder trim for a live circuit by disconnecting the ganging bar and operating each of the two rudder trim switches separately. If any movement of the rudder trim actuator occurs, the aircraft is not to be flown. Test the rudder trim over its full range by operating both switches together and then set neutral trim. Replace the ganging bar. On subsequent sorties test the rudder trim for correct operation.

18. *Tailplane and Aileron Trim.* On the first sortie of the day, test the tailplane and aileron trims for a live circuit by raising the ganging bar and operating each switch separately. If any movement of either tailplane or aileron trim occurs, the aircraft is not to be flown. Replace the ganging bar and check it is locked by attempting to lift it. Test the aileron and tailplane trims over their full range and then set the ailerons to neutral and the tailplane to TO. On subsequent sorties test the tailplane and aileron trim for correct operation.

19. *Controls Checks.* Adjust the rudder bars. After starting No 1 engine and before take-off, make full and free movement control checks ensuring that the appropriate failure warning captions do not come on. If an excessive movement of the tailplane control is made, it is possible to 'bottom' the control valve in the PFCU. This is made apparent by an increase in feel force; no mechanical damage should occur.

#### **In Flight**

20. Make routine periodic checks of the AWP to ensure the HYD 1 and HYD 2 captions are out during flight.

21. *Limitations.* The limitations on the use of ailerons are to be found in Part 2, Chapter 1 (**Rolling Manoeuvres**).

#### **After Landing**

22. Follow the **Checks After Landing and Shut-down Checks** in FRC.

### **MALFUNCTION OF THE SYSTEMS**

#### **General**

23. The drills for power controls, trim and feel systems failures are to be found in FRC.

#### **Double Controls Systems Failure**

24. After double Controls systems failure the HYD warning on the SWP comes on together with the attention-getters, in addition to the HYD 1 and HYD 2 warnings on the AWP. The accumulators in the systems provide for limited operation for a short period before the controls freeze solid. If the failure is caused by a double flame-out, the accumulator supply may be supplemented by the Controls systems hydraulic pumps if the speed is kept at 250 knots or above to give a sufficient engine windmilling speed.

25. The most probable cause of a double Controls systems warning, other than a double flame-out, is aeration of the system followed by pump cavitation after negative-g flight. A period of straight and level flight is likely to allow the restoration of hydraulic power. The drill in the FRC recommends engagement of the autopilot for the following reasons:

- a. The autopilot detects deviations from the flight path quickly and compensates economically whilst accumulator pressure is available.
- b. When the controls eventually freeze it is essential that the aircraft is in stabilised flight. Having the autopilot engaged ensures that the aircraft remains straight and level long enough for the pressure to recover after aeration. This has been known to take up to eight minutes.

#### **Trim Malfunctions**

26. If the aileron trim fails or runs away, the control forces can be held even if the system has failed at the extreme end of its authority. Prolonged flight in this condition is tiring and there is reduced aileron control against the trim. Land as soon as practicable.

27. After tailplane trim runaway, switch OFF the autopilot master switch.

28. If the rudder or tailplane trim runs away or fails to function, control forces are reduced by switching OFF the FEEL (FEEL UNIT, T Mk 5) switch. If the tailplane trim seizes in a nose-down position, switch OFF the feel system for the approach and landing.

**WARNING:** When flying with the feel system switched off, the control forces are light and care must be taken not to exceed the airframe limitations. Speed is to be limited to 400 knots.

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