Chapter 23

MOTOR GEAR ASSEMBLY, TYPE AFTS

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Introduction

1. The motor gear assembly, Type AFTS (Stores Ref. 5UD/4498) is used, in certain aircraft, to operate a system of shutters which governs the air flow to the carburettor. By use of a selector switch in the cockpit, hot, cold, or filtered air, as desired, is allowed to pass to the carburettor; the selector switch completes the circuit of the motor, which, through an associated gearbox, drives the shutter system to the particular position selected.

2. This chapter is primarily concerned with the electrical aspect of the air cleaner installation. To present a description of greater clarity, however, information is also given on such parts of the engine as are closely associated, in their operation, with the electrical components.

DESCRIPTION

3. The essential features of the installation, namely, a motor, gearbox, shutter system, and limit switch assembly, are described in this order, in the following paragraphs.

Motor

4. The split-field, series-wound motor is designed for 24-volt operation. Each of the two pole-pieces carries a field winding. One field when energized, causes the motor to rotate in an anti-clockwise, and the other in a clockwise direction. A circuit diagram appears at fig. 2.

5. A coil, connected in series with the armature, is wound on a rubber-shod metal core

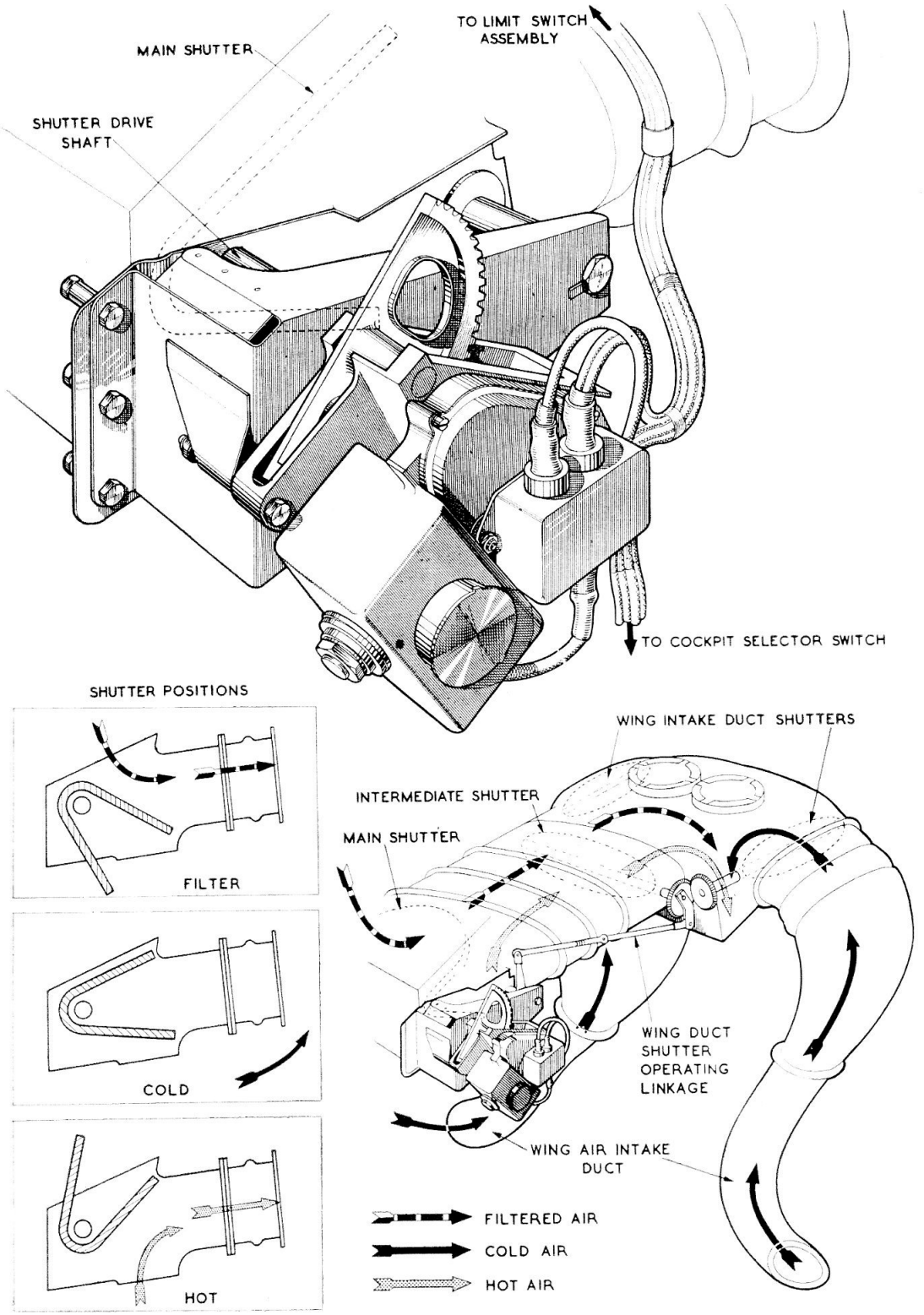


Fig. 1. Motor and gearbox (top), and air flow circuits (bottom)

which bears on the circumference of the armature, acting as a brake and preventing overrun or inching of the motor. When the motor circuit is completed, the coil is energized, lifting the brake clear of the armature which may then rotate unimpeded. The brake is contained in a metal pot integral with the moulded casing of the motor.

6. The armature is carried in two ball bearings, whilst a steel ball and disc at the commutator end of the armature shaft act as a thrust bearing. A screwed bush, normally locked by a dished washer, is provided for adjusting the disc.

7. The yoke casing and commutator end frame are formed as a single, plastic moulding, the driving end frame being of metal. The yoke, complete with pole-pieces and field coils, is a sliding fit in the yoke casing, and is secured by two studs and nuts.

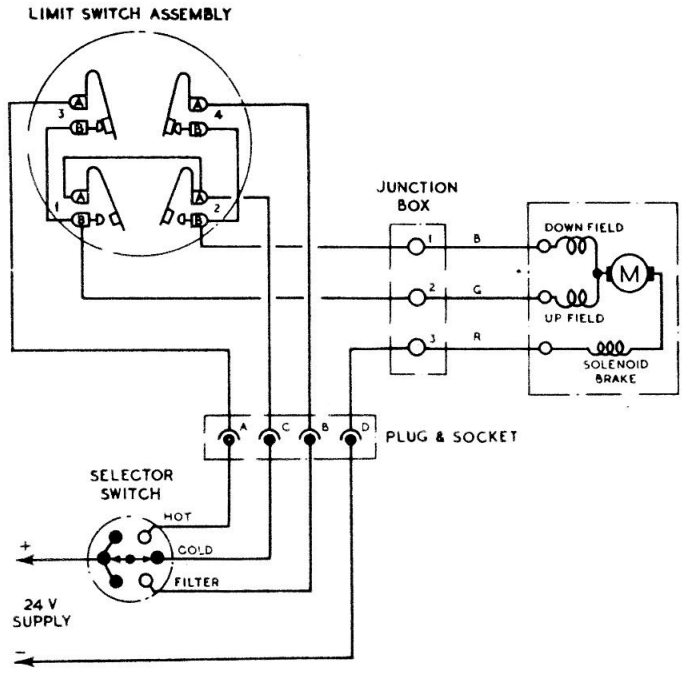


Fig. 2. Circuit diagram

8. Each brush is located in a holder secured to the end frame by grub screws, and is under the pressure of a spring housed in a brass brush cap. The motor and brake leads are brought out through a rubber grommet in the moulded yoke casing to the three terminals in a junction box (*fig.* 3).

Gearbox

9. The driving end of the armatute shaft has a worm drive machined upon it. This drive engages with a bakelised fabric worm wheel. On one side of the worm wheel is assembled a friction clutch, through which the gears are driven. A central nut, locked by a grub screw, affords adjustment for the clutch. The clutch is set to a predetermined torque, and will slip if this torque is exceeded This, in effect, disconnects the motor from the load and permits it to continue rotating without being damaged.

10. The gear ratio of the worm drive to the worm wheel is 84 : 1. A 14-tooth pinion is mounted on the hub that carries the worm wheel, the wheel and pinion being retained in position by a steel thrust washer which bears on the gearbox cover plate. The worm wheel pinion engages with an intermediate gear wheel, on the hub of which is mounted a further 14-tooth pinion driving a light alloy sector gear. The latter is secured to, snd drives a shaft that extends through the shutter box on top of the aircraft engine. The total gear reduction between the motor and the sector gear is 2,450 : 1.

Shutter assemblies

11. Contained in the shutter box is a V-shaped shutter (*fig.* 1), which, according to its position, allows hot, or filtered air to pass to the carburettor of the engine. The shutter is mounted on the shutter drive shaft driven by the motor and gearbox.

12. Cold air from the carburettor is ducted from an air intake port in the leading edge of each main plane, and does not pass through the shutter box. When cold air is being fed to the carburettor, the shutter box is blanked off by an intermediate shutter (*fig.* 1) located some six inches forward of the V-shaped shutter, previously mentioned. All hot and filtered air is, thus, excluded from the carburettor.

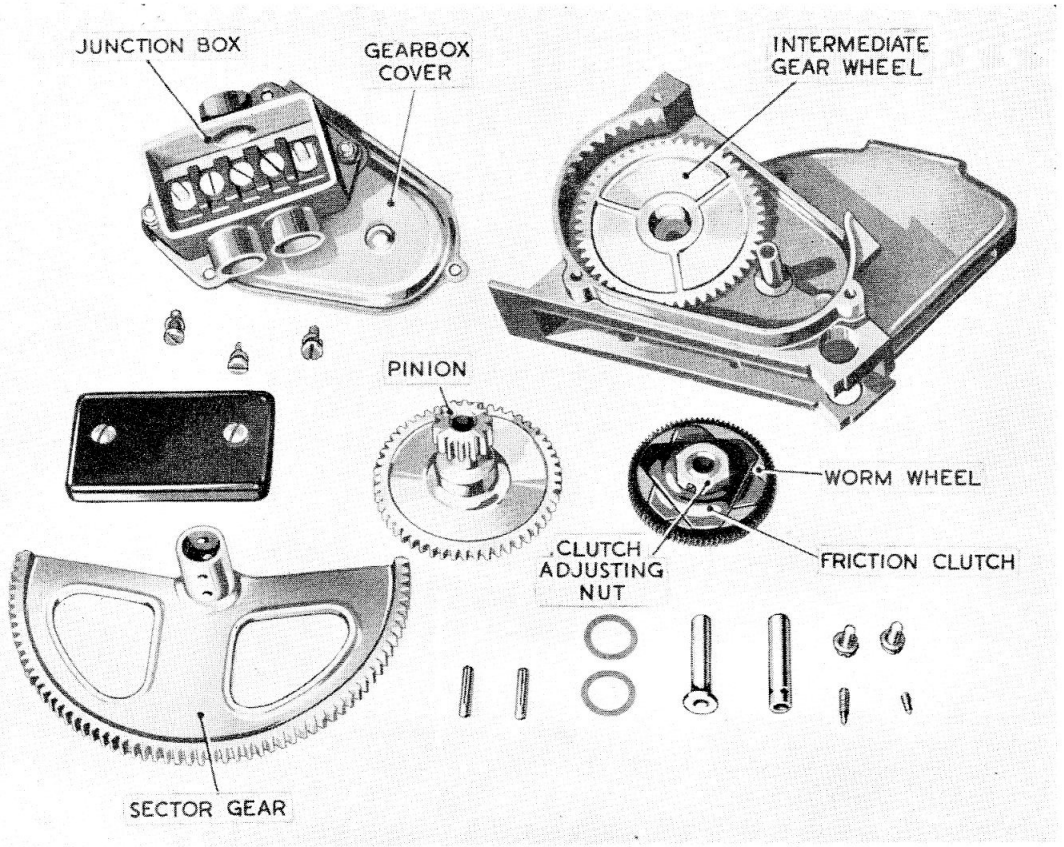


Fig. 3. Gearbox components

13. In each of the wing air intake ducts the air flow is controlled by a separate shutter ; these are operated, through a lever, connecting rod, link, and bevel gears, by the motor and gearbox.

Filtered air supply

14. Referring to fig. 1 (top inset) the V-shaped shutter is seen in the FILTER position. Air enters a louvres in the rear panel of the engine cowling, passing through filter trays into the duct head, thence to the carburettor. The hot air intake is sealed off by the upper arm of the shutter, and all cold air is excluded from the system by the wing intake duct shutters which are closed. Thus, filtered air only is fed to the carburettor.

Cold air supply

15. When a cold air supply to the carburettor is required, the motor may be operated to bring the shutter in the shutter box to a position where it blanks off both the hot and filtered air intakes (*fig.* 1—centre inset). Simultaneously, the motor actuates the connecting mechanism between the gearbox and wing intake shutters, thus opening the shutters and allowing cold air to pass to the carburettor.

Hot air supply

16. Air, which has been heated in passing between the engine cylinders, enters at the bottom of the shutter box when the shutter is moved to the position shown in fig. 1 (bottom inset). As illustrated, the filtered air intake is blocked. The wing intake shutters are also closed, sealing off the cold air supply.

Limit switches

17. On the side of the duct head opposite to the motor and gearbox is a limit switch-assembly (*fig.* 4 *and* 6). This comprises a moulded casing and cover, inside which are mounted four limit switches. The switches are connected in the motor circuit, as shown in fig. 2 ; the direction of rotation of the

motor, and the time for which it is in operation, are determined by the opening and closing of these switches.

18. The shutter drive shaft, driven by the sector gear, extends through, and protrudes from the opposite side of the shutter box. On the end of the shaft remote from the gear-box a cam is mounted. According to its position, the cam bears on, and closes certain limit switches, leaving others open, as detailed in Table 1.

TABLE 1

Limit switch settings

Shutter position	Limit switch position	Limit switch numbers
HOT	OPEN	1 & 3
	CLOSED	2 & 4
COLD	OPEN	1 & 2
	CLOSED	3 & 4
FILTER	OPEN	2 & 4
	CLOSED	1 & 3

Override switch

19. An override switch—not shown in the wiring diagram—is incorporated in the motor circuit. Its purpose is to ensure that filtered air only is fed to the carburettor when the aircraft is on or near the ground. The switch is located in the starboard wheel bay. When the undercarriage is lowered the switch completes the FILTER circuit of the motor, which moves the shutter to the appropriate position. Only when the undercarriage is retracted, and the override switch becomes inoperative, does the selector switch again become effective, making it possible to move the shutter to any of its three positions.

INSTALLATION

20. Before installing the motor and gearbox in an aircraft, it is essential that the shutter in the shutter box be placed in the COLD position, i.e., as shown in fig. 5. This illustration shows also the correct relationship between the sector gear and spur wheel in the motor gearbox. The spur wheel must mesh at the mid-point of the sector gear's periphery. The motor should not be operated electrically until it is coupled to the shutter drive.

Shutter box and duct head controls

21. The selector switch in the cockpit should be set at COLD, and the override switch (*para.* 19) in the starboard wheel bay fully depressed throughout the following operations.

(1) Referring to fig. 5, check that lever A and connecting rod B of the duct head controls are set in line.

(2) Rotate lever D in the direction of the arrow to the full extent of its travel.

(3) With the controls set in accordance with the two preceding sub-paragraphs, adjust connecting rod C and couple it to lever D.

Limit switches

22. The controls must be set according to the instructions in para. 21 before making the following adjustments to the limit switches.

(1) Connect a suitable electrical power supply to the circuit, and remove the cover of the limit switch assembly.

(2) Set the selector switch in the cockpit to FILTER, and after a full movement of the shutters is obtained, i.e., when the motor clutch is slipping, carefully adjust limit switch 4 so that its move-

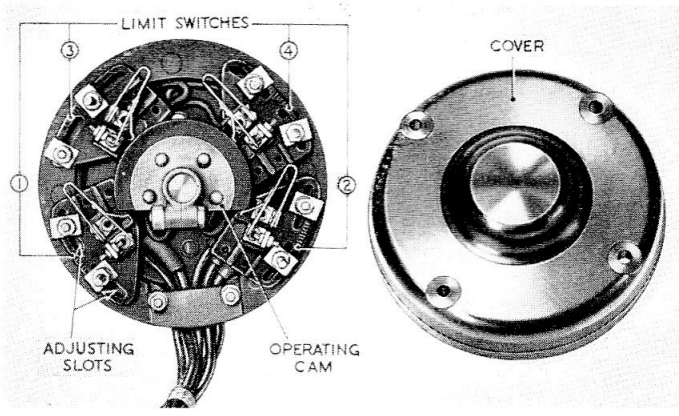
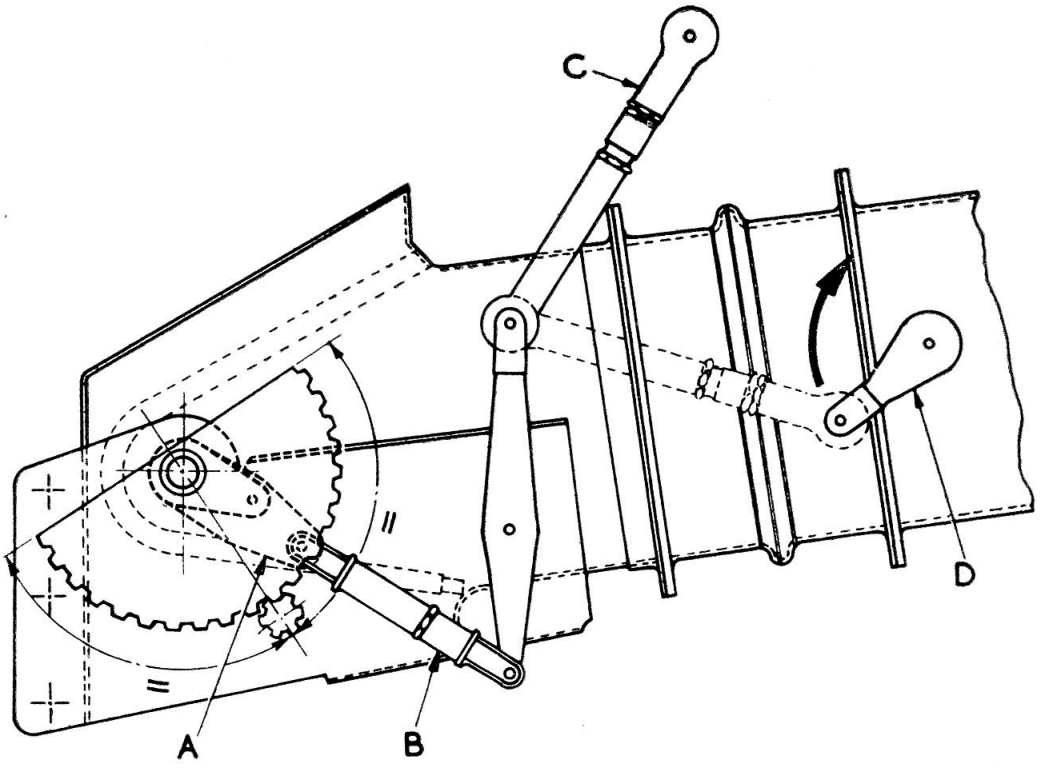
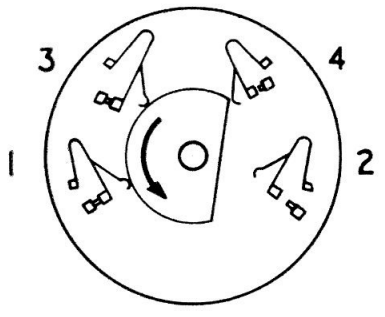


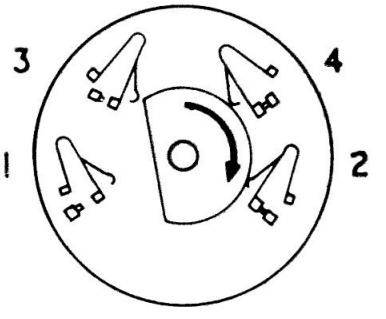
Fig. 4. Limit switch assembly details



SHUTTER BOX AND DUCT HEAD
CONTROLS SHOWN IN COLD POSITION



SWITCH SHOWN WITH SHUTTERS
IN FILTER POSITION



SWITCH SHOWN WITH SHUTTERS
IN HOT POSITION

Fig. 5. Installation drawing

ment is just sufficient to break the circuit and stop the motor. The position will be approximately as shown in fig. 5.

(3) Set the selector switch in the cockpit to HOT, and, when the clutch slips, adjust limit switch 3 so that the motor circuit is broken. The position of the switch will be approximately as shown in fig. 5.

(4) Release the override switch in the star-

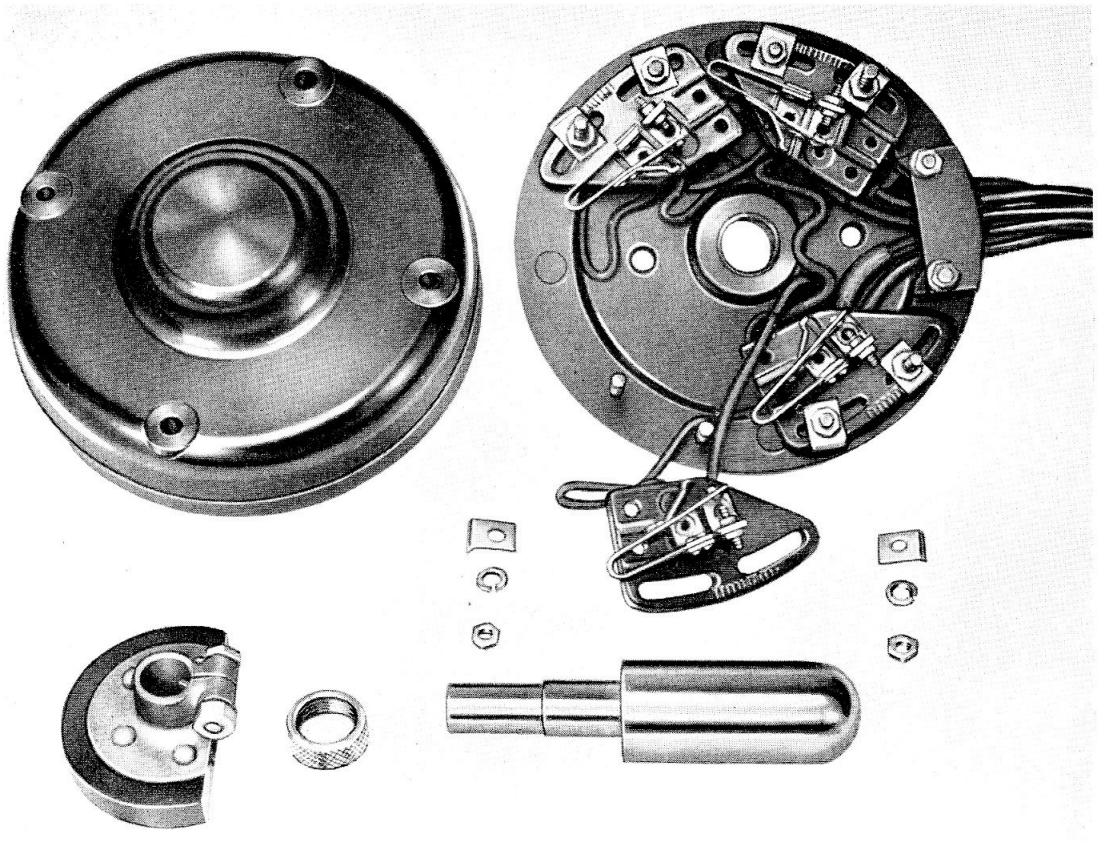


Fig. 6. Limit switch assembly partly dismantled

board wheel bay, and the motor will then move the shutters to the FILTER position. The selector switch in the cockpit should also be set to this position.

OPERATION

23. To simplify explanation, the limit switches in fig. 4 are numbered 1, 2, 3, and 4. As the motor has split-field series winding, it may be rotated in a clockwise or anti-clockwise direction, according to which field is selected.

24. If the shutter is in the central, i.e., the COLD position, the cam will be located as shown in fig. 4. Limit switches 3 and 4 will be closed, whilst 1 and 2 will be open. Assuming that the selector switch is moved to the FILTER position, the following sequence of operations occurs. A circuit is completed through pin B (plug and socket), limit switch 4, and the DOWN field of the motor. The motor rotates the shaft which moves the shutter downwards. The cam, being fixed to the shaft, moves also, in an anti-clockwise direction (with reference to fig. 4). Eventually, the cam opens limit switch 4 and breaks the motor circuit. Simultaneously, limit switch 1 is closed.

25. The shutter is now in the FILTER position, and at the limit of its downward travel. If the selector switch is moved to COLD or HOT, the UP field of the motor will be energized, with a consequent upward movement of the shutter to the new position. When the desired position is reached, the circuit will be broken by the cam acting on the limit switches.

SERVICING

Motor

26. The installation normally requires very little servicing. The motor bearings are

packed with grease by the manufacturers, and should not need lubricating during their service life. If bearing faults do occur, the motor will have to be dismantled this work should be done by a Maintenance Unit.

General

27. Periodically the gearbox components should be examined for faults. If necessary, grease XG-275 (Stores Ref. 34B/9105058) may be lightly applied to the gear surfaces. All cables, particularly those passing over the top of the duct head, should be examined for wear. The security of the junction box connections and of those in the plug and socket should also be checked.