Chapter 3

POWER UNIT
(Completely Revised)

CONTENTS

ILLUSTRATIONS

1. This chapter gives a general description of the power unit, together with notes on the servicing of the fuel and oil systems and the adjustment of the engine controls. Instructions for the removal of the engine, oil and fuel tanks are given in Part 2, Sect.2, Chap.1 and 2, whilst the refuelling procedure, together with important notes on cartridge starting will be found in Part 2, Sect.1, Chap.2. For details of the servicing of the power unit and any of its components which are not covered here, reference should be made to AP 1500B, Vol.1 and Vol.6, Part 1 and, if necessary, to AP 103D-0101-16C for further details of the Plessey starter. For propeller data, refer to AP 102P-1200-16A.

ENGINE INSTALLATION

Description

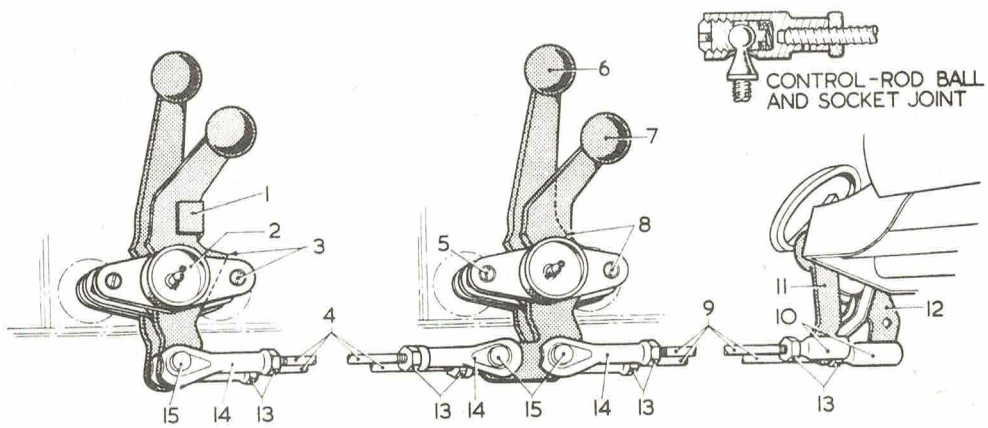
2. The Gipsy Major Mk.8 is an unsupercharged, air-cooled, inverted four-cylinder in line engine, having push-rod operated poppet valves. Fuel is supplied to the single Hobson A.I. 48 P.M. float-chamber carburettor, through a filter and duplicate D.H.A.C. diaphragm-type pumps. Two B.T.H. A.G. 4-10 magnetos provide dual ignition, the starboard magneto being fitted with an impulse starter. The engine-driven accessories comprise a Type 500 generator, and a Plessey B3X, Mk.1 vacuum pump. These, together with a Plessey S.7 Mk.2 cartridge starter, are mounted on the rear cover.

3. The engine mounting consists of two, triangulated, welded tubular steel structures, each of which is secured by bolts to the upper and lower longerons on the front fuselage. A diagonal bracing strut is connected between each structure and a pick-up fitting at the top of the firewall. The arrangement of the mounting is shown in Part 2, Sect.2, Chap.2.

4. Lubrication, on the dry sump principle, is by gear-type pumps through filters integral with the engine, the main pressure filter being of the Auto-Klean type.

5. A cooling system, consisting of an air scoop and a system of baffles, is employed to circulate the air round the finned cylinder barrels and heads. Interconnected carburettor air-intake heat control levers are provided on the starboard side of both cockpits and, when Mod.H.108 is incorporated, a spring is introduced into the shutter-operating cable to reduce control loading.

6. Conventional, interconnected throttle levers (fig.1) are mounted on quadrants, one on the port side of each cockpit. A mixture control lever is also fitted to each quadrant and is so arranged that movement of the throttle to the closed position, automatically moves the mixture control to RICH. A friction nut is incorporated on each quadrant.



1 MIXTURE AUTOMATIC CLOSING CATCH
2 FRICTION NUT
3 MIXTURE FORWARD STOP
4 INTERCONNECTING CONTROL RODS
5 CONTROL REAR STOP
6 FRONT COCKPIT THROTTLE CONTROL KNOB
7 FRONT COCKPIT MIXTURE CONTROL
8 THROTTLE FORWARD STOP
9 CONNECTING RODS TO ENGINE PICK-UP LEVERS
10 BALL ENDS
11 ENGINE MIXTURE PICK-UP LEVER
12 ENGINE THROTTLE PICK-UP LEVER
13 LOCK NUTS
14 FORK ENDS
15 CLEVIS PINS

CAUTION...
Clevis pins (item 15) attaching connecting rods to throttle and mixture control levers are to be fitted with heads inboard, toward centre-line of aircraft. (AIL 4/73 incorporated).

Fig.1 Engine controls

Note...

On aircraft pre-Mod.H206, the fork end of the throttle and mixture rod to control lever interconnections in the front cockpit are secured directly to the control levers. When Mod.H206 is embodied, however, the fork end is linked to the levers to provide a swivel joint and thus reduce the strain at the threaded ends of the rods.

SERVICING

Engine, Accessories and propeller

7. The servicing of the engine and engine-driven accessories is fully described in AP 1500B, Vol.1 and Vol.6, Part 1, and the appropriate manuals. The propeller requires periodical checks for looseness on its hub. To do this, rock the propeller on its shaft and, if necessary, adjust by the eight hub bolts which must be locked correctly after adjustment; refer to AP 102P-1200-16A, Part 1, Sect.1, Chap.1, App.1.

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Setting the carburettor air-intake heat control

8. Before checking or adjusting the cable, ensure that the cable condition is satisfactory throughout its length, that there is no undue wear on the spindle bearings of the air inlet shutter, and that the shutter is secure on the spindle. To set the controls, move the shutter into the cold position and, with the cockpit control levers fully forward, adjust the cable to give the minimum amount of slack. Move the control lever to the hot position and check that the shutter has moved over its full range of travel. When Mod. H 108 is embodied, the spring (just forward of the firewall) should extend at least 0·15 in. during control lever movement from cold to hot.

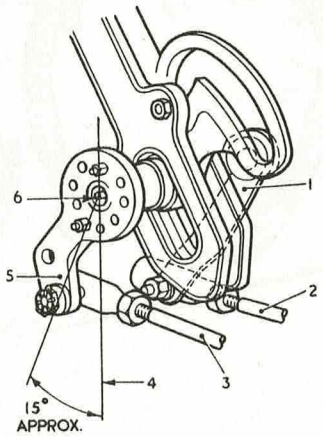
Setting the engine controls (fig. 1)

9. The engine controls should be checked for security and for full, free and correct travel after an engine change and periodically as stipulated in the Servicing Schedule, Volume 5. If the fully-open or fully-closed throttle positions are not attainable at the carburettor stops by means of the cockpit control, the most probable cause is excessive lost movement by cumulative backlash in the circuit. Therefore, before proceeding to adjust the cockpit engine controls, it should be ensured that the clevis pins do not need renewing, that the fork end and cockpit throttle lever eye holes are not unduly enlarged by wear and that the throttle and mixture control connecting rods are not bowed and have not become worn where they pass through the firewall guide tubes. When, after renewals if necessary, the foregoing checks prove satisfactory, the cockpit controls should be adjusted as outlined in the following paragraph.

Adjustment procedure (fig. 1)

10. To adjust the throttle and mixture controls, first ensure that the controls on the engine have been correctly adjusted and proceed as follows :-

(1) Disconnect the rear cockpit levers from those in the front cockpit.



1 ENGINE MIXTURE PICK-UP LEVER
2 CONNECTING ROD TO COCKPIT
3 CONNECTING ROD TO COCKPIT
4 C/L THROUGH PIVOT POINT (PARALLEL TO FIREWALL)
5 ENGINE THROTTLE PICK-UP LEVER
6 PIVOT POINT

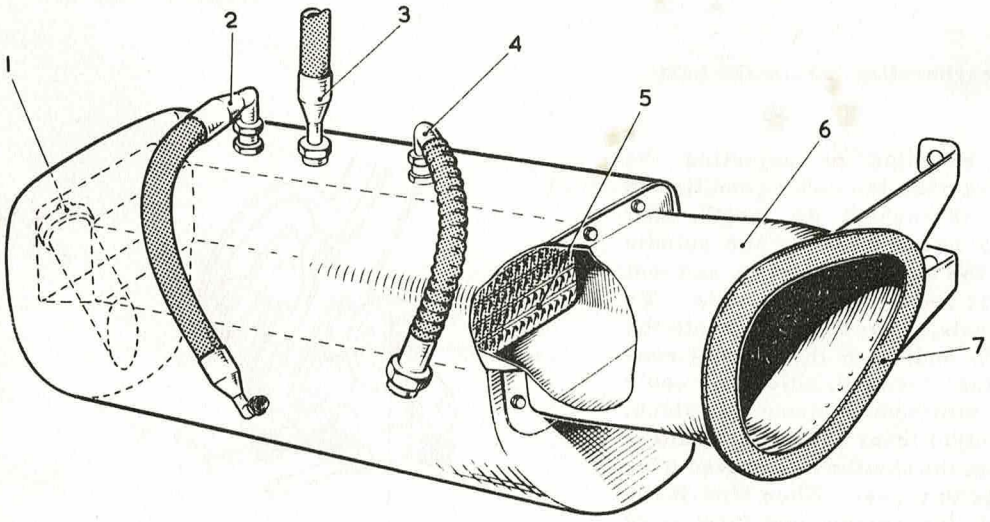
Fig.2. Throttle adjustment

(2) Move the throttle and mixture levers in the front cockpit fully back, and then just forward of the stops; tighten the friction nut.

(3) Locate the free end of the throttle pick-up lever on the port side of the engine, 15 deg. forward of a vertical line through the pivot point centre line (fig.2).

(4) Couple the connecting rods from the front cockpit, to the engine levers (refer to sub para. 9). Ensure that equal adjustment is available at both ends of the rods and that the ends are in safety, then tighten the locknuts.

(5) With the front cockpit mixture lever (7) in the RICH position, as above, ensure that it is synchronous with the altitude valve position in the carburettor, i.e. that the valve is fully



1 FILLER CAP
2 RETURN PIPE
3 VENT PIPE
4 DELIVERY PIPE
5 AIR COOLER
6 AIR SCOOP
7 FELT GASKET

Fig. 3. Oil tank

closed against its stop. Adjust, if necessary, by the cockpit connecting rod, ensuring that there is equal adjustment at each end of the rod and that the ends are in safety; lock with the locknuts.

(6) Set the rear cockpit throttle control approximately 0·1 in. forward and the mixture control fully back, i.e., to synchronize with the current position of the controls in the front cockpit, and tighten the friction nut to maintain this position.

(7) Reconnect the interconnecting rods (4), ensuring that there is approximately equal adjustment at the ends of each rod and that their ends are in safety. Lock with the lock nuts.

(8) Loosen the friction nuts on each quadrant and check for synchronization and correct functioning of the automatic closing of the mixture control (1).

(9) For attachment of the engine levers, the connecting rods each have an adjustable ball-and-socket joint of the type illustrated on fig. 1. These joints require particular care during assembly and adjustment, in order to obtain efficient working without risk of binding or detachment. Before making or adjusting the joint, the spring should be checked for serviceability. To remove (or assemble) the ball-end fitting, the split pin must be removed from the adjusting plug, and the plug then unscrewed sufficiently to permit passage of the ball from (or into) its retaining cups. On assembly, or during adjustment, the adjustment plug must be screwed in until the ball is clamped tight, then unscrewed until the next split pin hose in the socket is in line with the slot in the adjustment plug. Under no circumstances should the plug be unscrewed more than one-quarter turn. Finally, lock the plug with a new split pin, and subsequently check that the threaded end of the connecting rod is in safety in the ball joint socket.

OIL SYSTEM

Description

11. The oil tank (fig.3) is located on the lower face of the firewall; it has a total capacity of two and half gallons comprising two gallons effective capacity and half a gallon air space. Either a pre-Mod, or Mod H81 oil tank may be installed; the pre-Mod H81 tank being bolted to brackets on the firewall, and the Mod H81 tank retained by straps. The oil is cooled by air scooped in on the port side of the cowling, entering the port side of the tank and venting out of the starboard side. At temperatures of -5° I.S.A. or below, a blanking plate can be fitted to increase the oil temperature. In use, the plate is fitted on the inner surface of the cowling, behind the air scoop, and attached by the four bolts which secure the scoop.

Operation

12. Oil is fed to the engine pressure pump and returned to the tank by dual scavenge pumps. The tank is vented through the crankcase breather-drain pipe which is open to atmosphere at the base of the firewall. An Auto-Klean pressure filter and a suction filter are incorporated.

SERVICING

13. Other than the removal of the oil tank, which is covered in Part 2, Sect.2, Chap.2, and the instructions given in A.P.1500B, Vol.1, and Vol.6, Part 1 regarding the oil system within the engine, the only general servicing operations are the inspection of the pipe lines and connections for possible leaks, particularly on the suction side of the pressure pump, the replenishing of the oil tank, as necessary, and the keeping clean of the cold air passage in the tank.

Draining

14. The oil should be drained whilst hot. The drain plug is fitted under the port side of the tank and is wire-locked to a tab.

FUEL SYSTEM (fig.4 and 5)

Description

15. Two flexible fuel tanks are installed (fig.4), one within each D-nose assembly. The tanks are enclosed by metal wing linings (3) riveted to stiffeners (11) on the lower skin of the tank bay. Each tank has a capacity of nine gallons and is provided with a filler cap (6) and a Smith's direct-reading, type F.G.1335 (Ref.No. 6A/2670) fuel contents gauge (7).

16. Venting, balanced from both tanks, is effected at a vent assembly (fig.4) through a small vertical tube projecting upwards from each tank through the main plane upper surface, where it is covered by a fairing. The lower end of the tube has a tapered seating and this is sealed by a ball valve in the inverted flying position. From inside each fairing a pipe runs rearwards and inboard (fig.5) through the main plane into the fuselage. The pipes combine, at a point just forward of the rearmost access panel, via two unions and a common pipe covered by a recessed fairing, this being on the fuselage under-surface. A hole in this pipe forms the vent to atmosphere. A small hole in each main plane vent fairing, ensures that syphoning action does not occur when attaining the inverted attitude, or any flying attitude that might result in the ball valve being open.

Note...

If the hole in the vent fairing is obstructed, due to icing or other causes, syphoning can commence at any time when the ball valve is not completely closed.

17. Priming is effected by a hand-priming lever on the fuel pumps and a carburettor flooder.

Fuel cock (fig.5)

18. The ON-OFF fuel cock (12) is remotely controlled by duplicate levers

(4 and 5) situated, one in each cockpit, on the centre of the floor. Fibre washers are interposed on each side of the control box member to ensure the taking up of any slackness in the lever mountings. The forward lever is connected to the fuel cock lever arm by a rod (13) with ball and socket end fittings, and is coupled to the rear cockpit lever (5) by a plain connecting rod retained by stiffnuts.

Operation (fig.5)

19. The supply pipes from the tanks are connected to a T-piece assembly (detail A) located in the fuselage, and non-return valves (3) are incorporated between the inboard ends of the supply pipes and the opposing screwed ends of the T-piece. The assembly is completed by a Vickers two-way fuel cock which is coupled to the third T-piece opening, facing forward.

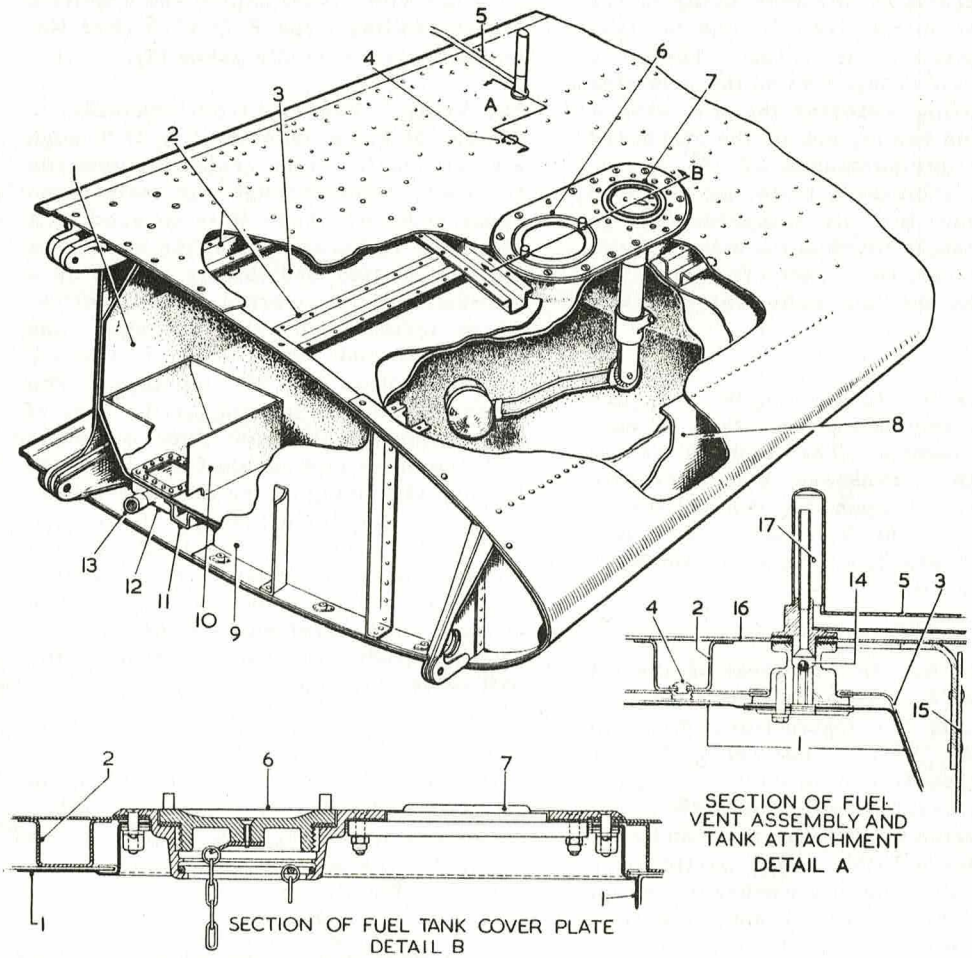


Fig.4. Fuel tank installation

On aircraft not embodying Mod.H.126, the non-return valves are attached to the T-piece at the inboard end of the supply pipes.

20. A single supply line is connected between the fuel cock and the filter (14). The four pipes, between the tanks and the filter, are rigid tubes of light alloy, coupled by union nuts. A flexible pipe carries the supply from the filter to the pumps which are operated, through levers, by cams integral with the camshaft. From the pumps, fuel is carried, through the pump filters and a flexible pipe, to a banjo fitting at the carburettor.

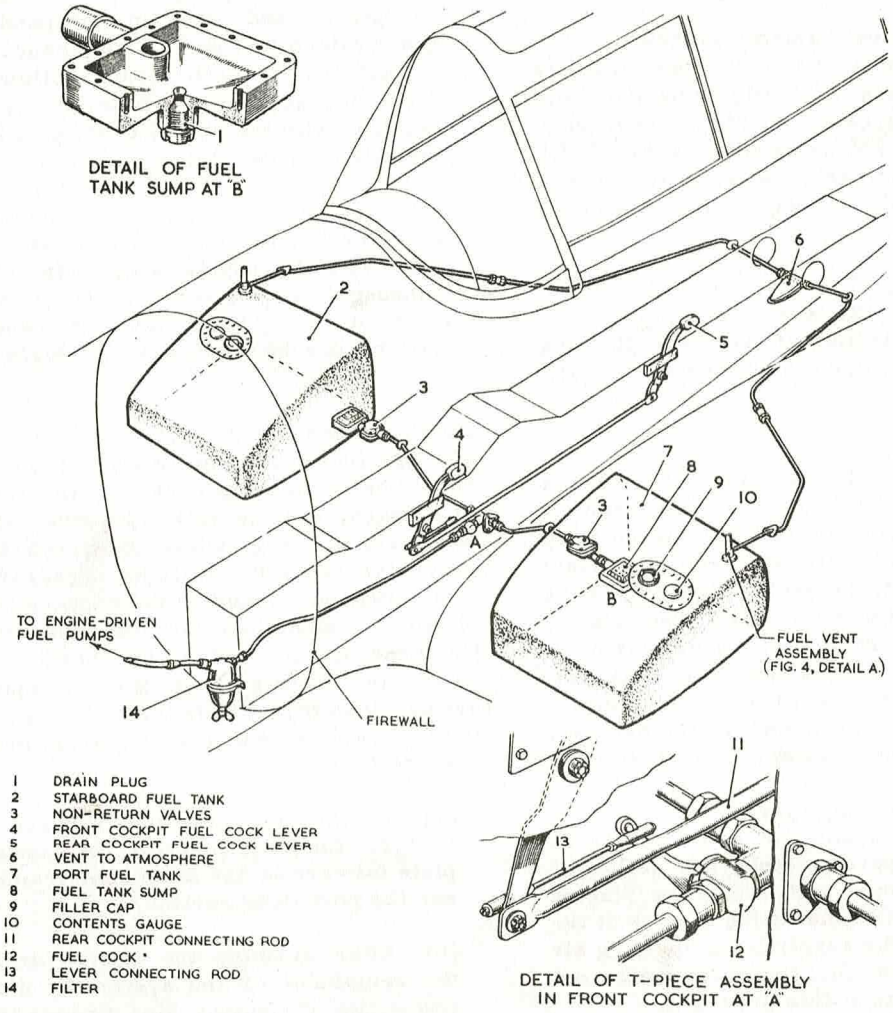


Fig.5. Fuel run

Note...

Different types of non-return valves are fitted according to the modification standard of the aircraft as follows :-

Mod. Standard	Valve	Ref. No.
Pre-H.124	SPE.1701	27F/2156
Post-H.124	SPE.1183	27F/2139
H.165	SPE.1747	27F/2207
H.199	SPE.1957	27F/2498

SERVICING

Positioning fuel contents gauges

21. In order to enable the fuel contents gauges to be read easily from the front cockpit, the gauge should be positioned so that a line running between the FULL and EMPTY markings is at an angle of approximately 45 deg. to the centreline of the aircraft.

Draining (fig.5)

22. A sump (8) with drain plug (1) is fitted at the bottom of each tank, the plug projecting through the lower skin of the wing.

Filter (fig.5)

23. The filter (14) is of the shallow sump type A.G.S. 1015 or A.S. 3220, and is mounted on the forward face of the firewall. Periodically, the hand-nut should be unscrewed, the casing cleaned and the filter washed with gasoline. The jointing washer, against which the filter casing is held in place by a stirrup and hand-nut, should also be examined and renewed if necessary. On reassembly, the hand-nut must be locked with soft-iron locking wire.

Testing the fuel system

24. The fuel system is tested for leaks by putting approximately one gallon of kerosine in each tank and, after placing the fuel cock ON and fitting a blank at the filter end of the supply line, applying air at $\frac{3}{4}$ lb. per sq. in.; the system must not show any leaks at this pressure.

25. The fuel flow may be tested by one of three methods :-

(1) With three gallons of fuel in each tank and using a suction type of test rig, a flow of twenty-six gallons per hour, free of aeration, should be obtained with a depression, measured at the inlet to the engine pumps, not exceeding 2 in. Hg.

(2) Alternatively, with three gallons of fuel in each tank, with the fuel pipe from the engine pumps directed into a receptacle and with an independent gravity-feed fuel system rig connected directly to the carburettor, a flow of forty-five gallons per hour should be obtained with the engine running at full throttle (2,000-2,100 r.p.m.).

(3) Alternatively, where no equipment is available, fill both tanks to capacity and, with the engine pump inlet disconnected and directed into a receptacle, a gravity flow of twenty gallons per hour should be obtained.

Fuel cock and non-return valves

26. The fuel cock, pipe lines and unions should be examined periodically for leaks or damage, and the cock operating linkwork and moving joints inspected for excessive wear; lubricate as necessary. The slotted nut securing the cock handle should be examined for looseness and tightened up, if needed, to retain the handle in a firm position; fibre washers are provided to facilitate this. To remove the fuel cock and non-return valves, proceed as follows :-

(1) Remove the wing fillets (Part 2, Sect.2, Chap.1), control box cover plate forward of the main spar frame, and the port floor section.

(2) After draining the tanks, drain the remainder of the system by disconnecting the supply pipe fittings inboard of the non-return valves, and the supply pipe forward of the fuel cock,

draining at these points.

(3) Disconnect the supply pipes to the cock at the inboard ends and remove the non-return valves from the tank sumps.

(4) Remove the control rod, fitted between the forward cockpit control lever and the fuel cock lever arm, without disturbing its length.

Note...

If a new assembly is to be fitted, adjust the rod so that the fuel cock is fully OFF with the cockpit levers in the OFF position.

(5) Disconnect the three stiffnuts, washers and bolts, which secure the T-piece assembly to the control box, and remove the assembly complete with fuel cock.

PLESSEY S TYPE STARTING SYSTEM

Introduction

27. The Plessey S type starting system consists of a mechanically-operated multiple breech directly connected to a single stroke, piston type starter. An exhaust tube, fitted to the starter, directs the exhaust gases overboard. A full description of the system is given in AP 103D-0101-16C.

DESCRIPTION

Breech (Fig.6)

28. The breech comprises front and rear beam assemblies abutting guide plates located, one at each end, on three tie rods. A barrel assembly is located in the guide plates and retained by a release lever. A stop plate on the release lever engages with a lug on the firing unit (para.31). A breech nose, secured by a lock nut, is located in the front assembly. A pulley cover is secured by a ring nut to cover plate attached to the rear beam.

29. The barrel assembly comprises six barrels, a spindle and an index wheel. The bore of each barrel is tapered at the end nearest the index wheel and a grid inserted in the opposite end.

30. The rear beam houses a firing unit and a drive shaft assembly. The drive shaft assembly comprises a flanged shaft with a half moon boss and a gear. An index pin is rivetted to the flange. The shaft is driven through a ratchet wheel and spring-

loaded pawl by a cable-operated pulley. A clock type main spring is housed, and anchored at one end, in the pulley; the other end is located on an anchor pin in the rear beam. A stop pin on the pulley engages with a stop plate located between the pulley and the cover plate. Movement of the stop plate is restricted by the spring anchor pin. A spring-loaded pawl, retained by a bolt in the side of the rear beam, engages with a notch in the periphery of the drive shaft flange. A spring-loaded pawl in the guide plate mating face of the rear beam engages with notches provided on the release lever. A similar pawl is provided in the guide plate mating face of the front beam.

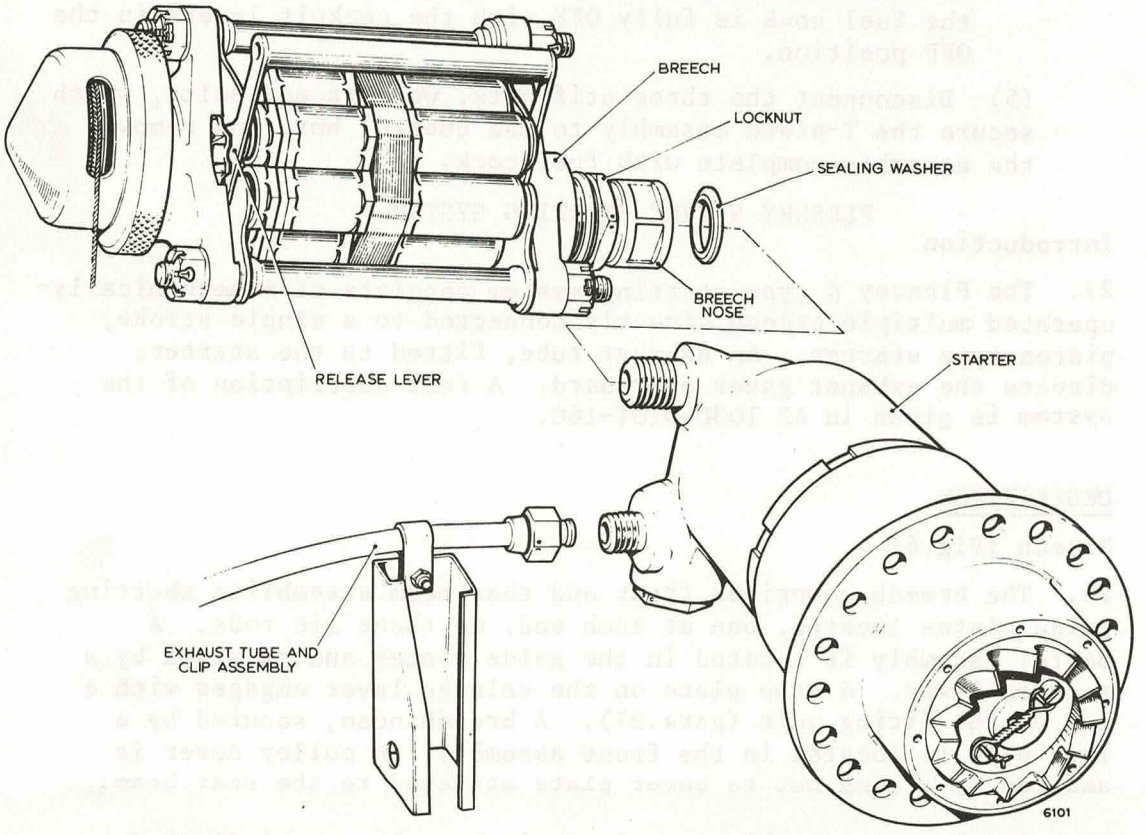


Fig.6 Type S7 Mk.2 starter and SA breech

31. The firing unit comprises a double profiled firing cam and gear, located in the shank of a profiled sealing pad, and a spring-loaded hammer, retained in the sealing pad shank by a cup and locking ring. Lugs on the hammer extend through slots provided in the sealing pad shank to engage on one profile of the cam. The sealing pad, which

engages with the remaining cam profile, is provided with an external lug mating with the stop plate on the release lever. The cam is rotated by the gear on the drive shaft.

Starter (Fig.6)

32. The starter comprises a housing and cylinder screwed together to house a spring-loaded piston coupled through helically splined shafts with a dog type clutch jaw. Two threaded air holes, one of which is blanked off with a screw, are drilled in the housing to vent the underside of the piston. A flange on the housing is drilled to facilitate attachment of the starter to the engine.

33. The clutch jaw, sliding in a thrust race and centralised by the end cap assembly, is located in the housing. A shoulder is provided on the jaw which bears against the thrust race during operation. An externally splined drive shaft engages in the clutch jaw and is retained by a special slotted retaining screw. A torsion spring maintains the backlash between the drive shaft and clutch jaw. The helical splines of the drive shaft engage with the internal/external splined shaft fitted to the piston. The external splines of the splined shaft engage with internal splines in the housing. A clutch jaw bolt, extending through the splined shaft, retains the piston in position against a main spring located between the piston and housing. Spring-loaded plungers in the clutch jaw bolt head bear on the drive shaft bore.

34. A combustion chamber, screwed on to the neck of the cylinder, includes integral externally threaded inlet and outlet ports and houses an exhaust valve, exhaust valve housing and safety disc holder. Spring-loaded balls housed in a transverse drilling of the exhaust valve locate in an annular groove in the valve housing to retain the valve in the 'open' position during operation.

35. A headed exhaust valve rod housed in the clutch jaw bolt bore extends through the piston crown and is screwed into the exhaust valve. Two springs, one each side of the rod head, actuate the exhaust valve during operation.

OPERATION

Breech (Fig.7)

36. With the breech just loaded, initial movement of the pulley cable rotates the pulley in the clockwise direction, when viewed on

the pulley cover, to engage the pawl in the ratchet wheel. This rotates the drive shaft (detail 1, fig.7) to engage the index pin in the slot in the index wheel and rotate the barrell assembly. At the same time, the firing unit is rotated until the lug on the sealing pad abuts the end of the stop plate on the release lever (detail 2, Fig.7). Rotation of the pulley also loads the main spring.

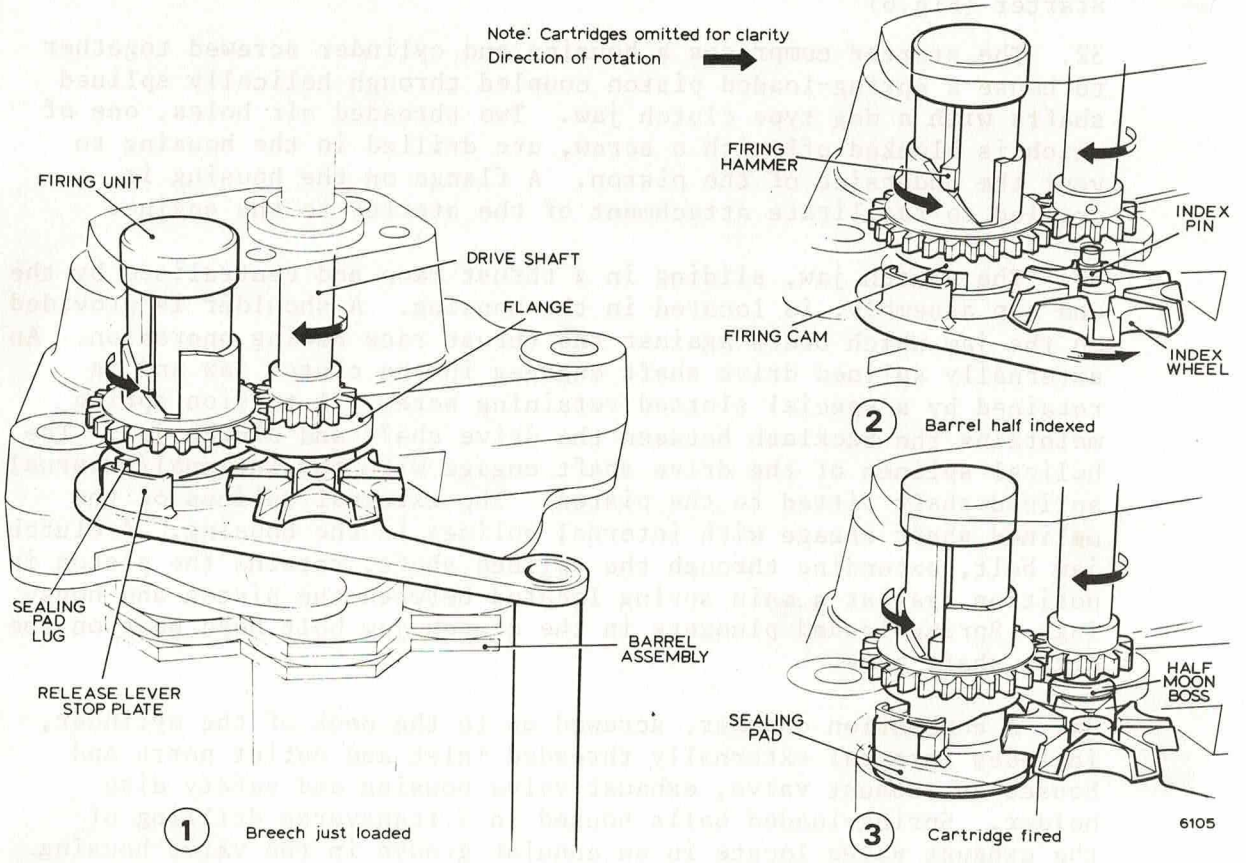


Fig.7 Indexing and firing mechanism

37. Movement of the pulley then indexes the barrel assembly one sixth of a turn to bring the next barrel in line with the firing unit and simultaneously rotates the firing cam relative to the sealing pad and firing hammer. When the indexing movement is complete the half moon boss on the drive shaft locates in the

crescent in the index wheel to lock the barrel, and the firing cam pushes the sealing pad into the barrel.

38. Further movement of the pulley, and hence the firing cam, lifts the hammer, compressing the firing unit spring, until the lugs on the hammer disengage and the hammer returns under spring pressure to fire the cartridge (detail 3, Fig.7). At this stage the pulley stop abuts its stop plate to prevent further movement and the catch pawl engages with the drive shaft flange to prevent it moving when the cable is released.

39. On releasing the cable the ratchet wheel disengages from its pawl and the pulley is returned to its original position by the main spring, leaving the sealing pad in the barrel, the index wheel locked and the lug on the sealing pad abutting the end of the release lever stop pad.

40. As the sealing pad is now in a different relative position to the firing cam than it was when the breech was just loaded (Details 1 and 3, Fig.7) the firing cam is retaining the sealing pad in the barrel. Initial movement of the cable will now rotate the firing cam to release the sealing pad before the index pin engages in the index wheel, after which the sequence is as previously described.

41. On opening the release lever, the stop plate on the lever rotates the sealing pad back from the position shown in detail 3, Fig.7 to that shown in detail 1. As the firing cam remains stationary the relative movement releases the sealing pad from the cylinder.

42. When the cartridge is fired, the expansion of the head against the taper in the barrel forces the cartridge back against the sealing pad. Simultaneously, the pressure of the gas generated reacts on the barrel grid to move the barrel assembly towards the breech nose to effect a gas seal.

Starter (Fig.8)

43. The gas from the breech forces the piston and splined shaft down the cylinder through the housing, imparting a rotary movement through the splines to the drive shaft. On initial movement of the piston the drive shaft pushes the clutch jaw forward to engage with

the teeth on the engine drive (detail 1, Fig.8). During this operation the torsion spring in the clutch jaw ensures that the engine and starter teeth are fully engaged before engine resistance is felt. Further forward movement of the clutch jaw is prevented by the jaw shoulder abutting thrust race, then rotary movement only is imparted for the remainder of the stroke.

44. During the stroke the exhaust valve is retained on its seat in the combustion chamber by the gas pressure and holds the exhaust valve rod stationary. The clutch jaw bolt slides along the bore of the drive shaft and as the piston reaches the end of its stroke the coil spring on the valve rod is compressed between the underside of rod head and the end of the piston. Continued movement of the piston lifts the exhaust valve off its seat which releases the gas pressure, and permits the spring to snap the valve completely clear of its seating to allow the spring-loaded balls to engage in the exhaust valve housing groove (detail 2, Fig.8). In this way rapid opening of the valve is achieved, to prevent gas erosion of the valve face and seat, and the valve is held open during the return stroke of the piston.

45. The gas pressure, now released, is discharged to atmosphere through the exhaust port. Should the gas pressure exceed the safe limit before the exhaust valve opens, the safety disc will rupture and the gas will be released through the safety disc holder and exhaust port.

46. When the gas pressure has been exhausted, the piston returns under the action of the main spring pressure. The spring-loaded plungers in the clutch jaw bolt head create sufficient frictional drag to reduce piston speed and prevent damage to the components during this return stroke. Before the piston reaches the end of its return stroke the exhaust valve rod return spring is compressed between the head end of the clutch jaw bolt bore and the crown of the exhaust valve rod head (detail 3, Fig.8). Continued movement of the piston overcomes the spring-loaded balls engaged in the exhaust valve housing groove and snaps the exhaust valve closed.

SERVICING

General

47. In-situ servicing procedures and relevant safety precautions are contained under the heading of cartridge starting in Pt.2, Sect.1, Chap.3 Bay servicing procedures, together with comprehensive descriptive information are given in AP 103D-0101-16C.

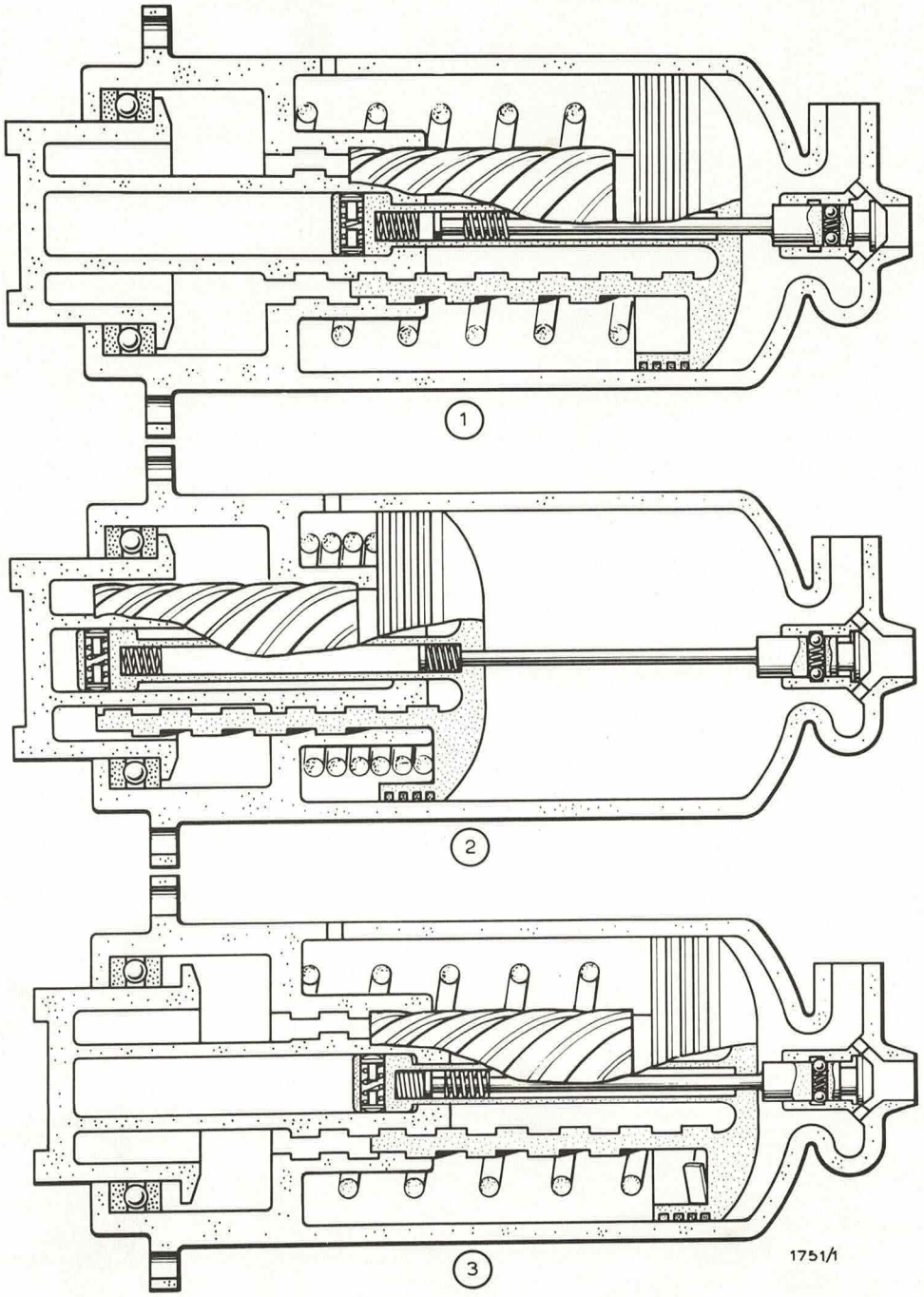


Fig.8 Operation of starter