Chapter 6 HYDRAULIC SYSTEMS

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DESCRIPTION

General information

1. Three independent systems operate the flying controls and services. These systems, and the components for which they provide pressure, are:-

(1) *Services system*
(two engine-driven pumps)

Alighting gear
Wheel brakes
Air brakes
Flaps
Nose-wheel centring
Autostabilizer actuators
Feel units
Canopy
Two-missile pack

(2) *No.1 controls system*
(one engine-driven pump)

Aileron p.f.c.u. (outboard)
Tail-plane p.f.c.u. (stbd. motor)
Rudder p.f.c.u. (forward piston)
Alighting gear emergency lowering
Braking-parachute doors

(3) *No.2 controls system*
(one engine-driven pump)

Aileron p.f.c.u. (inboard)
Tail-plane p.f.c.u. (port motor)
Rudder p.f.c.u. (aft piston)

2. All rigid pipes in the system are of stainless steel and have colour identification markers and direction-of-flow indicators.

Power supplies *(fig.1)*

3. Power for the three systems is supplied by four engine-driven pumps, mounted in pairs on the external wheel-case of each engine; the forward pumps jointly power the services system and the aft pumps the No.1 and No.2 controls systems respectively. The pumps are the two-stage type, the first stage consisting of a pair of meshing gears, and the second stage, seven pistons in radially-disposed cylinders, operated by an eccentric driving ring; when maximum line pressure is attained the pumps commence to off-load the fluid to the reservoirs via the by-pass circuit. Each pump embodies a magnetic filter element located in the by-pass chamber of the gear housing. To maintain the minimum pressure of 2700 lb/in^2 required when the two-missile pack a.c. generator motor is running, a pressure regulator and a non-return valve *(para.14)* are interposed between the services No.1 and No.2 pump delivery lines.

Hand pump

4. A hand pump, located behind access panel 75P, is provided for ground operation of the services system. The pump handle is detachable, and is stowed in the port wheel well. The pump handle attachment is accessible behind panel 79P.

Reservoirs *(fig.2)*

5. Four (three main and one auxiliary) reservoirs are in the fuselage:-

Services system; one reservoir, between frames 50 and 51, port.

No.1 controls system, two reservoirs (one auxiliary) between frames 48 and 49, and frames 50 and 51, port.

No.2 controls system, one reservoir, between frames 51 and 52, starboard.

6. The three main reservoirs are identical, each comprising a cylindrical metal body containing a bladder in which fluid is stored. A junction head, fitted to the base of each reservoir, is drilled and tapped to provide connections for delivery fluid to the pump, return fluid from the pump and system, reservoir fluid drain, and compressed air. Fluid is drawn through holes in a tube positioned centrally in the bladder, and passes, through a hollow bolt forming the suction connection to the pump. Return fluid from the pump or system enters the reservoir through a banjo connection and passes around the outside of the hollow bolt and through cross drillings in the junction head, to enter the bladder through a filter.

7. Protection against over-pressurizing is provided by a relief valve set to discharge at 34 ± 2 lb/in^2. The services reservoir relief valve also functions to relieve excess fluid when an emergency lowering of the alighting gear is made. The reservoir drain connection on the junction head is fitted with a pipe which is taken to the top of the reservoir, and blanked with a cone cap. The purpose of the auxiliary reservoir fitted between the No.1 controls main reservoir and the engine-driven pump is to increase the capacity

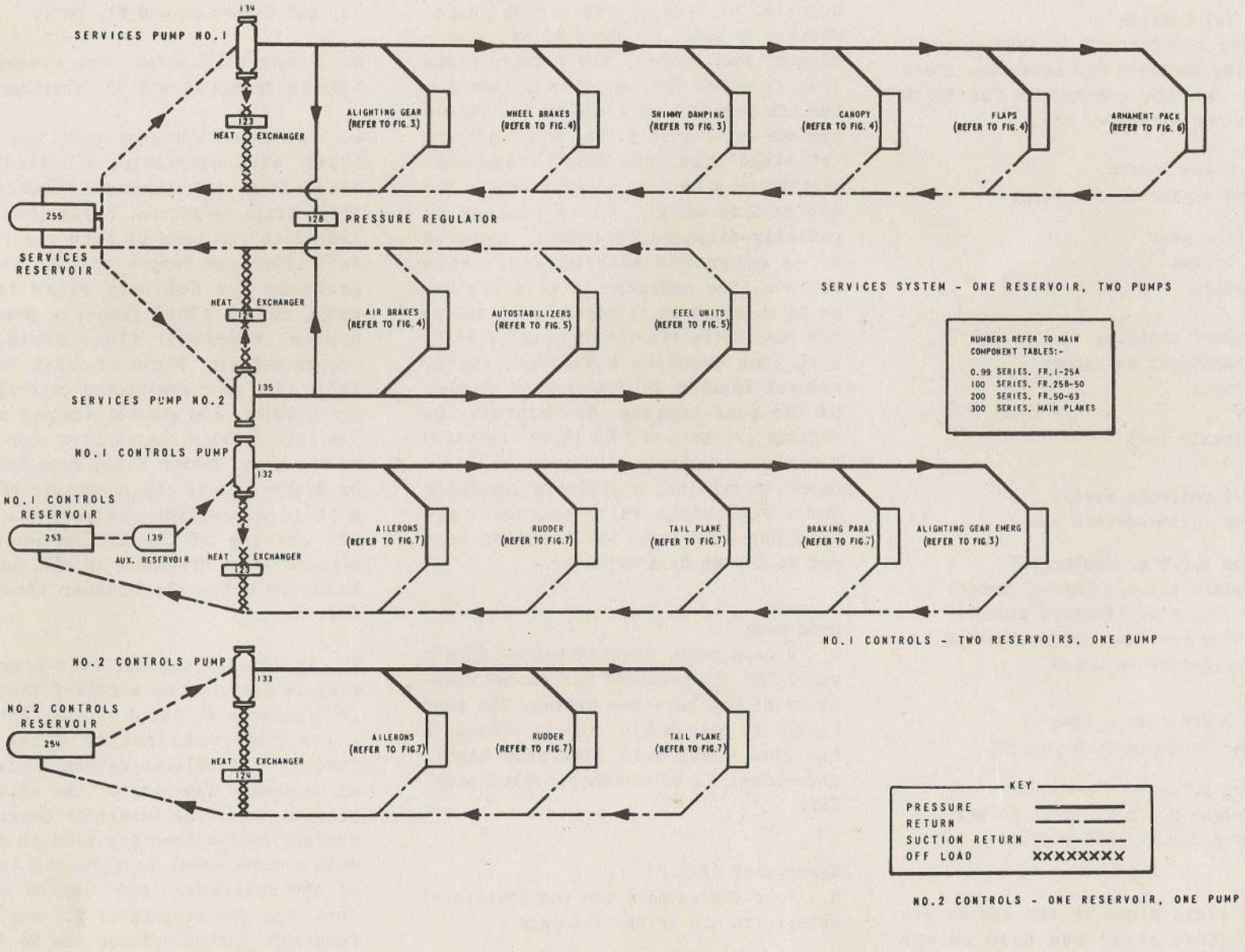


FIG.1. POWER SUPPLIES

of the system to provide for alighting gear emergency lowering. This reservoir is similar in construction to the main reservoirs, the junction head containing fluid and air connections.

Reservoir air supply

Main

8. The main reservoirs are supplied with air at 16-18 lb/in² from the engine compressors. A non-return valve in the system retains the pressure and isolates the reservoirs from the rest of the auxiliary air system. Air enters each reservoir at the junction head connection and passes into the space between the bladder and the cylinder walls. As the bladder becomes fully charged with fluid, it is expanded against the cylinder walls, and the surrounding air is expelled through a relief valve, set at 24 ± 2 lb/in²; post Mod.4061 the air expelled through the relief valve is vented overboard. As fluid is withdrawn by the pumps, the bladder collapses, and the fluid volume is replaced by air on the outside of the bladder. An air-charging and release valve, serving the reservoirs, is located behind access panel 63P.

Auxiliary

9. The auxiliary reservoir has an atmospheric head which allows ingress of air at atmospheric pressure and spillage of air (fluid in the case of bladder failure) at pressure in excess of normal main reservoir pressure. The reservoir bladder is thus maintained in a stable condition of inflation and its life correspondingly prolonged.

Heat exchangers *(fig.1)*

10. Off-load fluid from each pump is cooled by circulation through a heat exchanger in the pump by-pass line. The heat exchangers are connected to the main-plane integral fuel tanks delivery pipes, the fuel being the cooling medium. Each exchanger is divided into two heat-transfer compartments, respectively cooling by-pass fluid from a controls or services pump.

Off-load circuit *(fig.1)*

11. In each of the three systems, fluid is drawn from the associated reservoir, or reservoirs, by the pumps, which commence to off-load at about 2650 lb/in². When fully off-loaded at 3000 lb/in², delivery ceases and the fluid is returned to the reservoir via a heat exchanger, a non-return valve and a filter.

Relief valves

12. Relief valves safeguard the alighting-gear circuit in the event of a pressure rise in excess of 3600 lb/in². The valves are located as follows:-

(1) One pressure relief valve in each main and nose undercarriage up line.

(2) One thermal relief valve in No.1 controls pressure line to the emergency selector.

(3) One thermal relief valve embodied in the protection unit.

Pressure switches

13. A pressure switch, set to close at 1750 lb/in², is provided in the pressure line of both No.1 and No.2 controls systems. The switches are each in circuit with an associated power failure warning on the auxiliary warnings indicator panel. In the event of pressure failure of both systems, an additional warning on the standard warning system indicator unit, together with the attention lamp, becomes illuminated. The No.1 controls pressure switch is located in the front fuselage between frames 22 and 23 port side, and is accessible behind panel 26P; the No.2 controls pressure switch is fitted on the aft face of frame 55, rear fuselage starboard side, and is accessible behind panel 72S.

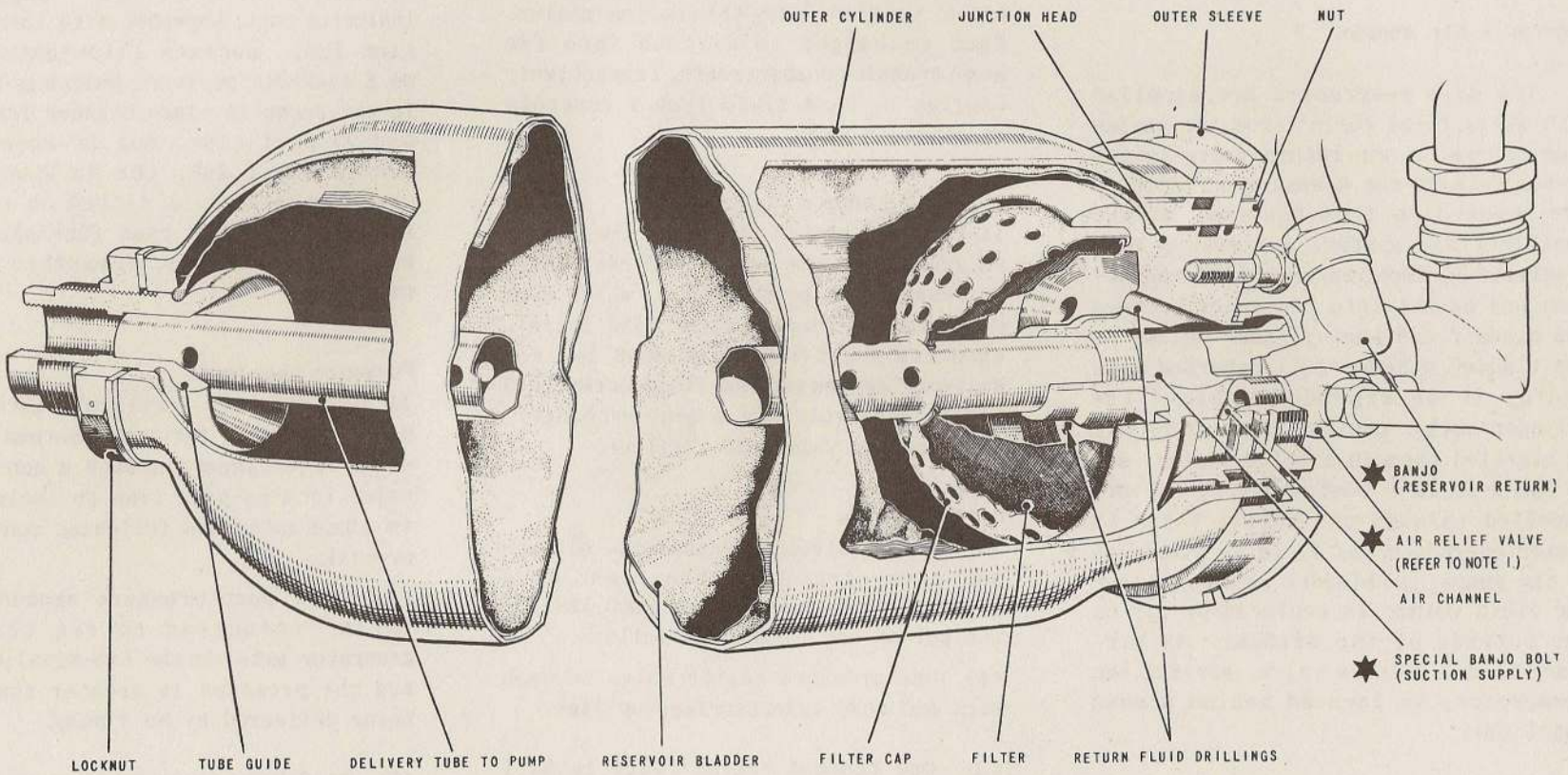
Pressure regulator

14. The pressure regulator, interposed between the two services systems pumps, works in conjunction with a non-return valve in a by-pass line to isolate the two pumps unless the following conditions prevail:-

(1) No.1 pump pressure exceeds 2700 lb/in² (required to run the a.c. generator motor in the two-missile pack) and the pressure is greater than that being delivered by No.2 pump.

(2) No.2 pump pressure is greater than that of No.1 pump.

(3) When condition (1) is current the pressure closes the non-return valve and displaces the spring-loaded piston in the regulator which opens a port and allows the pressure to augment that of No.2 pump. When condition (2) arises the pressure opens the non-return valve and assists No.1 pump.



NOTE 1...
ON AIRCRAFT WITH MOD. 4061 EMBODIED, THE AIR RELIEF VALVE IS REPOSITIONED AFT OF FRAME 50 ON THE STARBOARD SIDE OF THE FUSELAGE

NOTE 2...
★ ITEMS MARKED THUS ARE FITTED DURING ASSEMBLY OF THE RESERVOIR TO THE AIRCRAFT

FIG.2. FLUID RESERVOIR

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Protection unit

15. The protection unit ensures that, in a case of services pressure failure, the alighting gear can be lowered by using No.1 controls system pressure via the emergency selector. In normal conditions this pressure retains a piston in the lower position, allowing free flow of services pressure to the normal alighting-gear selector. When the emergency system is used the emergency selector redirects No.1 controls system pressure to the opposite side of the piston which moves up and closes a valve to isolate the services pressure line, and opens another valve to connect the normal selector, irrespective of its setting, to return. The services system is protected from pressure fluctuations by an integral non-return valve at the inlet connection, and a relief-valve which vents fluid to return if the normal working pressure is exceeded.

Accumulators – system location, access and nitrogen inflation pressures

(Table 3)

16. Eight accumulators in the controls and services systems hold, under nitrogen pressure, a reserve volume of fluid which minimizes fluctuations of pressure when heavy fluid demands are being made; they also provide power for a limited number of operations of the flying controls and certain components if hydraulic failure occurs. To extend this period for the flying controls, braking parachute and alighting gear emergency lowering, the accumulators serving them are provided with separate nitrogen bottles. An accumulator provided for the nose-wheel shimmy damper is charged with hydraulic fluid only. Table 3 gives a list of the accumulators, the components they serve, access and charging pressures.

Accumulator gauges

17. Miniature gauges, fitted in the fuselage skin, provide an indication of hydraulic pressure in the accumulators. With the exception of the feel unit damping accumulator the gauge dials are calibrated 0-4 and the readings must be multiplied by 1000 to give the true reading in pounds per square inch. The dial of the feel unit damping accumulator gauge is calibrated 0-2 and the reading must be multiplied by 100 to give the true reading. For details of gauge positions and types, refer to Tables 6, 7 and 8 and their associated illustrations.

SERVICES SYSTEM

Alighting gear

General information

18. A two-position lever-switch in the cockpit, controls operation of the alighting gear. Moving the lever to either of the two marked positions, UP or DOWN, energizes one of two solenoids integral with the alighting-gear selector which, according to the selection made, operates valves to direct fluid to the appropriate ends of the jacks, and opens the opposite lines to return. A pitot-operated pressure switch, connected into the alighting gear up electrical circuit, renders the up switch inoperative below an actual or simulated ◀ air speed of 165 ± 5 knots. ▶ For details of the electrical circuit, refer to Sect.6, Chap.5. Emergency lowering of the alighting gear is controlled by a handle, to port of the pilot's seat, connected by cable to an emergency selector *(Chap.11)*. A protection unit installed between the pumps and the selector unit ensures that, when the emergency lowering system *(para.24)* is used, all up lines in the alighting gear circuits are connected to return irrespective of the setting of the normal selector.

Main undercarriage (fig.3)

19. *UP selection.* – When an UP selection is made, the pumps deliver fluid to each undercarriage down-lock jack, to the undercarriage jack via the open sequence valve, and to the closed wheel-well door sequence valve; the latter valve ensures that the door retraction jack up line is vented to suction return, thus preventing door movement until the strut is retracted. The undercarriage down-lock (in the radius rod) is released hydraulically and the main jack functions to raise the undercarriage which, on its final movement, contacts the trip mechanism on the door sequence valve to open the valve. With the sequence valve open, fluid is directed to the door jack and to the door up-lock jack; the internal locking mechanism in the door jack is released and the jack operates to close the door. Finally, when the trip pin on the doors strikes the toggle lock in the master door-lock mechanism *(Chap.5)*, the up-latch jack retracts, operating the door latch hooks to lock the door.

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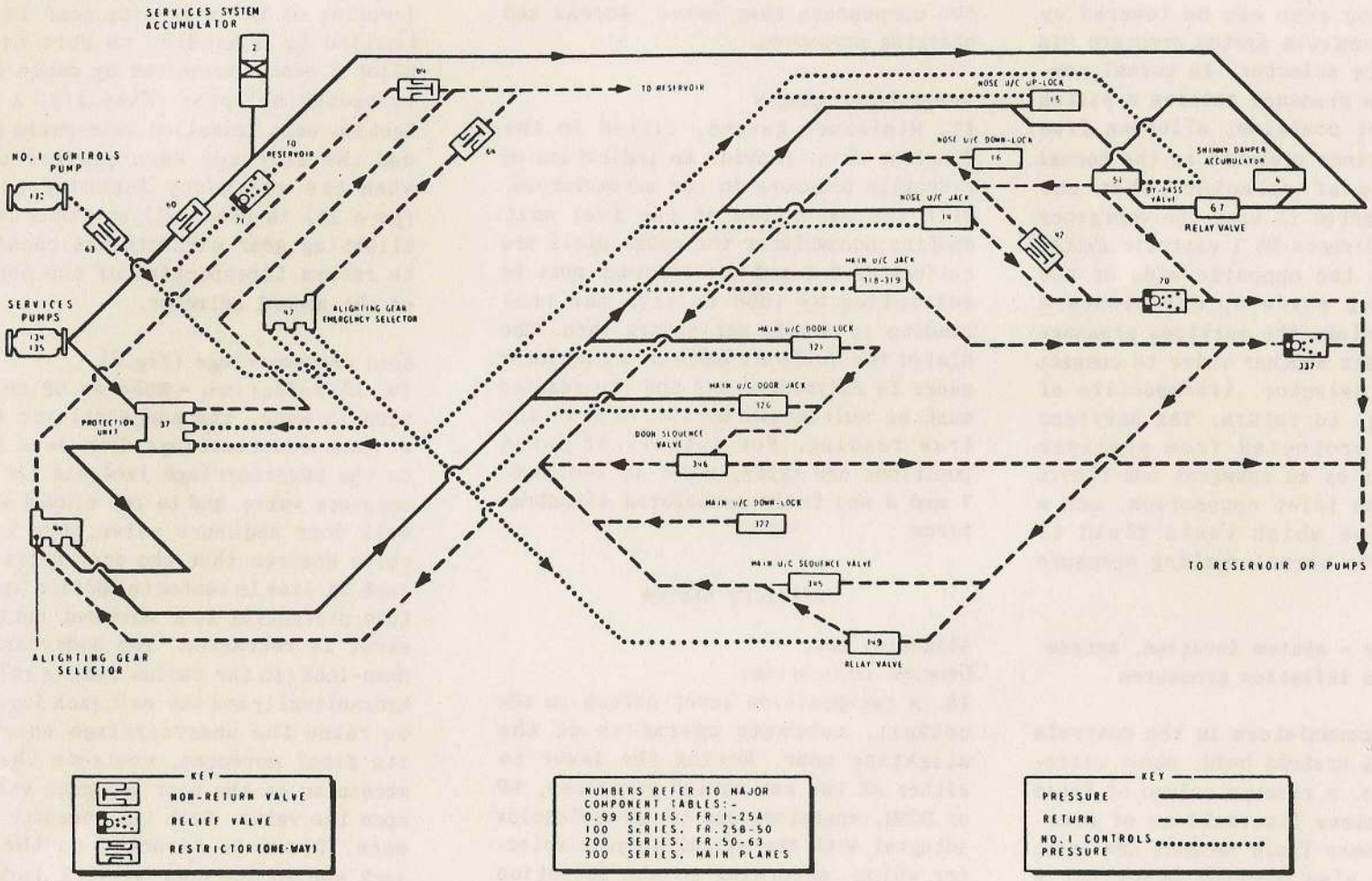

FIG.3. SERVICES AND NO.1 CONTROLS SYSTEMS - ALIGHTING GEAR

20. *DOWN selection.*- A DOWN selection causes pressure to be directed to the door up-lock jacks, door jacks, and undercarriage jacks. On each undercarriage, the door up-lock jack operates to disengage the door latching mechanism, then the door jack extends to open the door which, when fully open, is locked by an internal mechanism in the jack. The final opening of the door causes contact to be made with the trip mechanism of the undercarriage sequence valve which opens to permit fluid transfer between the undercarriage jack and the reservoir via the up line. The undercarriage jack then retracts to lower the undercarriage which, when fully down, is locked by the spring-loaded down-lock jack in the radius rod.

Nose undercarriage (fig.3)

21. *Shimmy damping.*- The nose undercarriage is equipped with a hydraulic shimmy damper and centring unit. The unit receives pressure from the nose undercarriage shimmy damper accumulator which, in turn, can be pressurized from the services system. The accumulator has a main and a secondary piston, the former being influenced by hydraulic pressure and the latter by the accumulator spring and by a mechanical connection with hydraulic pressure when alighting gear UP is selected. The shimmy damper is pressurized for castering and shimmy damping on touchdown, by the basic spring pressure of 60-70 lb/in^2 exerted by the accumulator spring.

22. *UP selection.*- When an UP selection is made, fluid is directed to the undercarriage down-lock jack, the by-pass valve and the undercarriage jack. The lock-jack extends to disengage the lock, and the undercarriage jack retracts to raise the undercarriage. The up line pressure to the by-pass valve operates the valve to cut off the services suction return line from one side of the nose undercarriage shimmy-damper accumulator main piston, and to connect services pressure in its place. The main piston is directly connected, on its opposite side, with services pressure but, the effective piston area on this side being the lesser of the two, the resultant differential force causes a movement of the main piston towards the secondary piston. Mechanical contact of the main piston extensions with the secondary piston increases the shimmy-damping pressure of 60-70 lb/in^2, exerted by the accumulator spring, to 685 lb/in^2, thus ensuring that the wheel is centred and locked. The undercarriage is finally locked in the up position by the locking plunger housed in the strut *(Chap.5)*.

23. *DOWN selection.*- When a DOWN selection is made, pressure fluid is directed to the by-pass valve and to the up-lock jack, and to the undercarriage jack via the shuttle valve. The by-pass valve functions to cut off services pressure from the valve to the nose undercarriage shimmy-damper accumulator, and to by-pass the supply line to services suction return. The direct services pressure to the accumulator then moves the main piston extensions out of contact with the secondary piston. The up-lock jack operates to disengage the locking mechanism, and the undercarriage jack extends to lower the undercarriage, which is finally locked mechanically. A one-way restrictor in the up-line, between the jack and the by-pass valve, limits the rate of return flow, to prevent the strut lowering too quickly; the pipeline upstream of the restrictor is protected by a 3600 lb/in^2 relief valve. For the operation of the undercarriage doors, linkage and mechanical locks, refer to Chap.5.

Emergency lowering (fig.3)

24. The emergency selector directs No.1 controls pressure to:-

(1) Close a valve in the protection unit to isolate services pressure from the normal selector.

(2) Open a valve in the protection unit to connect the normal selector input to return, so ensuring that all up circuits in the system are connected to return irrespective of the setting of the normal selector.

(3) Apply pressure to the by-pass valve to move the shuttle to the nose undercarriage down position.

(4) Simultaneously apply pressure to:-

(a) The emergency side of the relay valves.

(b) The emergency side of the shuttle valves on the main and nose undercarriage jacks.

(c) The emergency side of the shuttle valves on the main under-

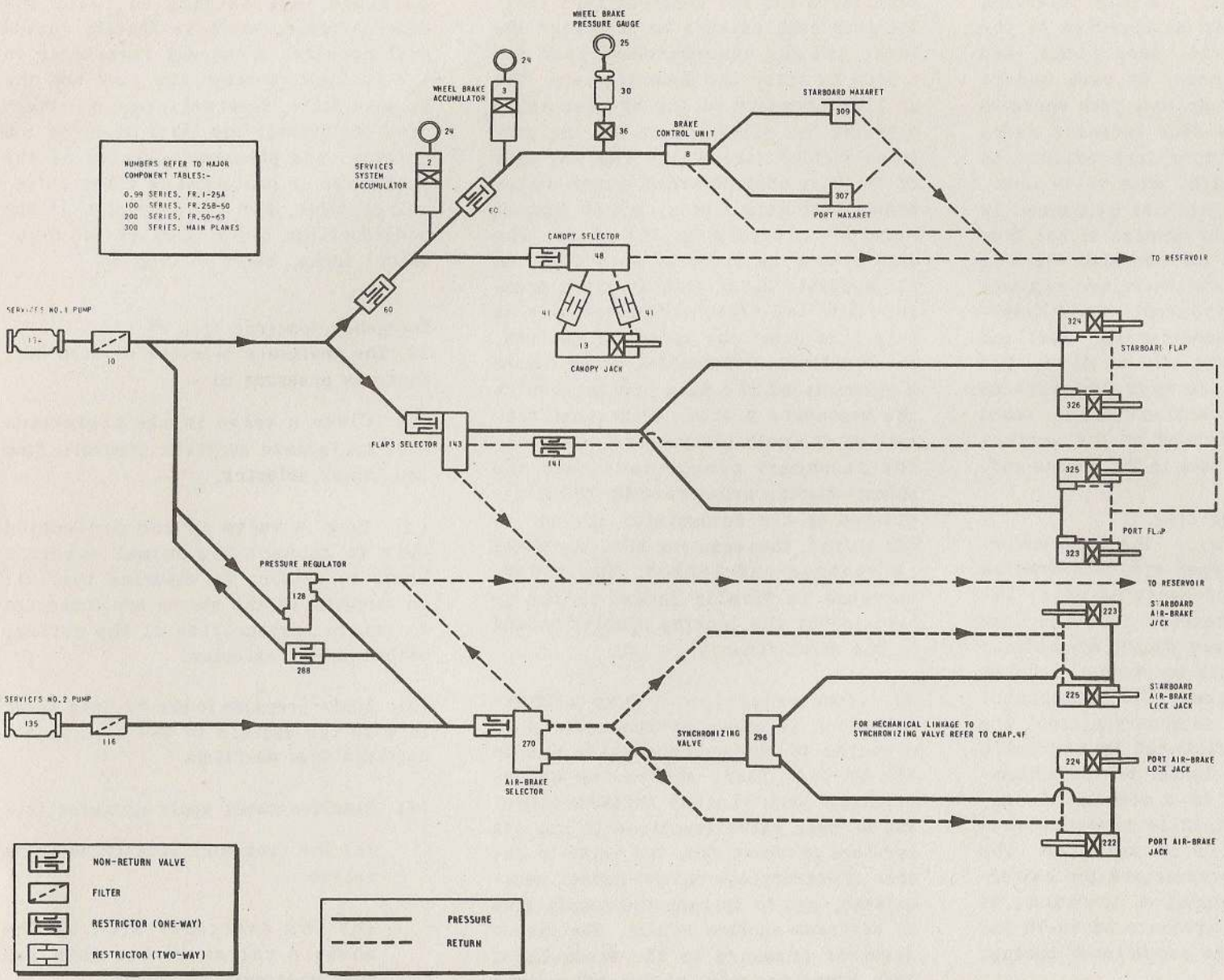

FIG. 4. SERVICES SYSTEM - FLAPS, WHEEL BRAKES, AIR BRAKES AND CANOPY

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carriage door jacks and door up-lock jacks, and the nose undercarriage up-lock jack.

The door up-lock jacks and the door jack shuttle valves of each main undercarriage are displaced, and the door unlocked and opened, by emergency pressure which also opens a port in the relay valve, allowing return fluid to by-pass the closed sequence valve. Fluid entering the undercarriage jack via the shuttle valve lowers the undercarriage. Return fluid is passed to the services system reservoir through the up line via the normal selector unit and the protection unit. In the nose undercarriage, emergency pressure operates the up-lock jack and the undercarriage jack after displacing the shuttle valves. Shimmy damping is effected normally by the pressure imparted by the nose undercarriage shimmy-damper accumulator spring.

Wheel brakes *(fig.4)*

25. The wheel brakes are applied by means of a lever on the control column handle, which tensions a cable connected to the brake control unit which transmits hydraulic pressure to the brakes up to 1500 lb/in^2. The pressure applied is proportional to the degree of displacement of the control lever and, for steering purposes, the rudder pedals to which the unit is connected by a lost motion linkage. Pressure is supplied from the wheel-brakes and services system accumulators; non-return valves in the line on the pump side of the accumulators isolate them to maintain a reserve of pressure. From the brake control unit, pressure is transmitted to each brake via a Maxaret anti-skid unit; when pressure is released, the fluid is connected to return through the open Maxaret return valve. A Maxaret unit is mounted on each undercarriage leg; should excessive deceleration occur and wheel locking be imminent, the units release brake pressure and allow the wheels to revolve; the cycle then recommences, ensuring that maximum tyre adhesion is maintained. An indicator registering brake pressure available, from 0 to 4000 lb/in^2, is mounted on the port instrument panel and is operated electrically by a pressure transmitter. Between the transmitter and the accumulator is a pressure relay valve, which seals off the system in the event of leakage or failure in the single line to the pressure transmitter. A relay valve isolates, in services system failure conditions, the services system accumulator from the shimmy damper by-pass valve to prevent leakage from the valve exhausting the accumulator.

Air brakes *(fig.4)*

General information

26. The air brakes take the form of two forward-opening doors fitted one on each side of the fuselage, just forward of the fin. They are each operated by a jack, through a selector unit, and controlled by a switch mounted on the No.2 engine throttle lever. The switch has three positions - IN, OUT, and centre off - and is spring-loaded to the centre off position. Operation of the switch energizes one of two solenoids in the electro-hydraulic selector unit, causing a slide valve to be displaced to connect the appropriate ends of the jacks to pump supply, and the opposite ends to return. A Mach pressure switch in the electrical circuit to the selector prevents the air brakes opening or, if they are already open, closes them at a predetermined Mach number. A mechanical linkage from each brake is connected to control levers on the synchronizing valve unit. When IN or OUT selections are made, the levers will move equally if the jacks are synchronized. If, however, one brake tends to lead, the action of the control lever will cause the relevant metering valve in the synchronizing valve unit to be throttled until synchronization is effected.

OUT selection

27. When air brakes OUT is selected, fluid from the services pumps is directed by the selector, via a synchronizing valve unit, to the lock jacks and the brake jacks. The locks disengage, and the brake jacks extend and pivot to open the brakes. Return fluid from the brake jacks and lock jacks is passed via the selector to the reservoir.

IN selection

28. When air brakes IN is selected, fluid from the pumps is directed by the selector to the brake jacks, which retract to close the brakes. When fully closed, the brakes are locked mechanically *(Chap.4F)*. Return fluid from the jacks passes through the synchronizing valve and the selector valve to the reservoir.

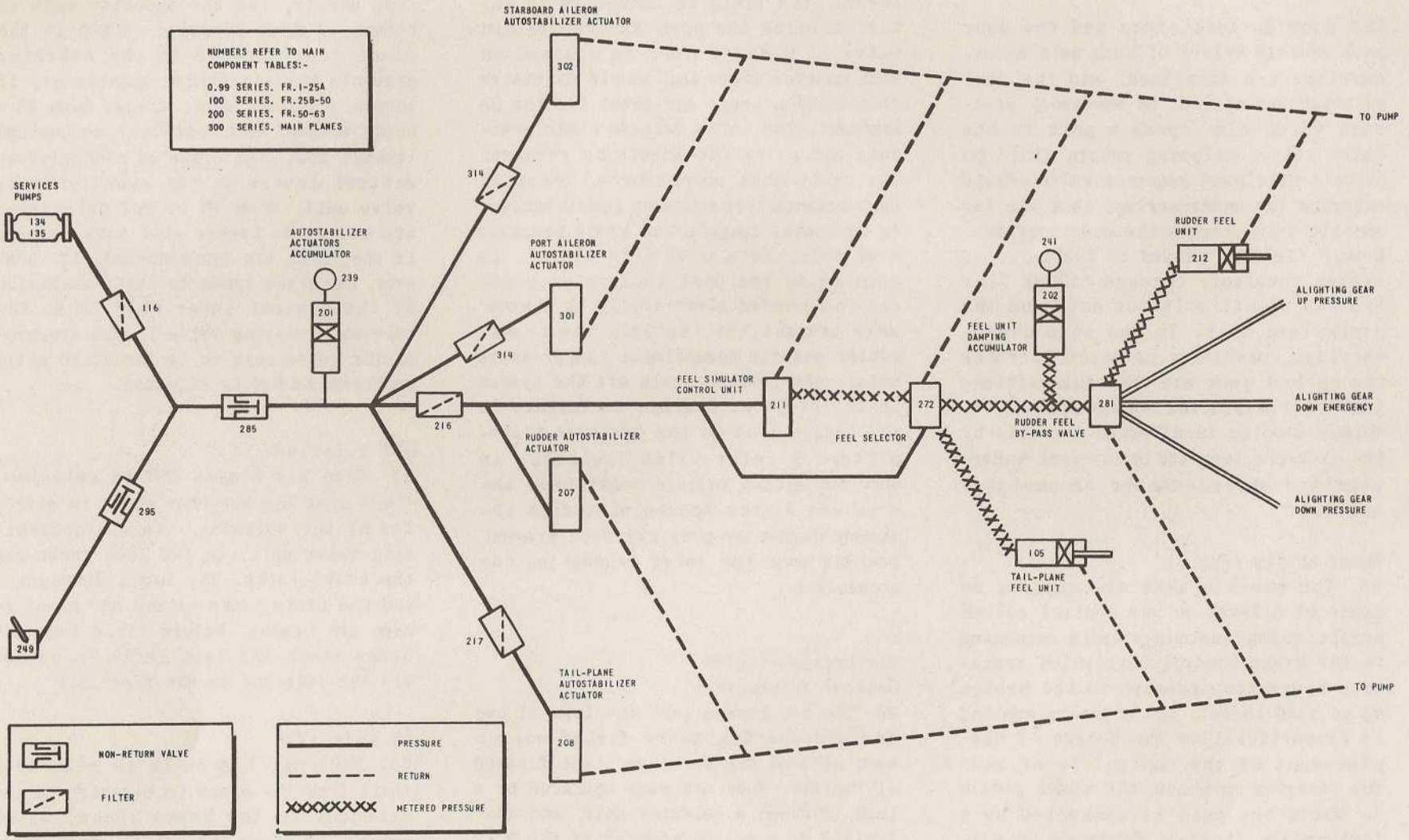

FIG. 5. SERVICES SYSTEM - AUTOSTABILIZERS AND FEEL UNITS

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Flaps *(fig.4)*

29. The two-position flap selector on the port instrument panel, is in circuit with an electro-hydraulic selector unit. Pressure fluid is supplied by the services pumps and directed by the selector to the up or down connections of the four jacks; return fluid is directed via the selector to the reservoir. To prevent abrupt trim changes, each jack has integral up and down restrictors, the former being assisted by a one-way restrictor downstream of the selector. Internal mechanical locks in each jack give positive locking in the up position, whilst a DOWN selection brings a hydraulic lock into operation to prevent an asymmetric flap condition arising on take-off or landing. A transmitter, linked to each flap, is in circuit with a twin-dial position indicator fitted on the port instrument panel. A switch, operated by pitot pressure, ensures that the flaps are automatically raised at air speeds above 250 knots.

Autostabilizer actuators *(fig.5)*

30. Operating pressure for the aileron, rudder and tail-plane autostabilizer actuators *(Chap.4C, 4D and 4E respectively)* is provided by the autostabilizer actuator accumulator (access panel 66S). Each actuator has a filter in its pressure line; a non-return valve, on the pump side of the accumulator, isolates accumulator pressure from all services except autostabilization and feel simulation.

Tail-plane and rudder feel system *(fig.5)*

31. A simulated-feel system provides artificial tail-plane and rudder feel, and prevents excessive control surface movement at high air speeds. Operating pressure is supplied by the autostabilizer actuator accumulator. The system is based on a feel simulator control unit *(A.P.4604Z, Sect.1, Chap.8)* and two hydraulic feel units. Interaction between the feel units, due to rapid operation of the controls, is absorbed by the feel unit damping accumulator. An electro-hydraulic feel selector is operated by a two-position switch in the cockpit and, when feel ON is selected, a slide in the selector operates to direct metered pressure from the feel simulator to the damping accumulator and the two feel units; when the switch is set to OFF, the slide in the selector moves to connect the feel units and the accumulator to return, so cancelling hydraulic feel. A by-pass valve, fitted between the selector and the rudder feel unit, is subjected to alighting gear up and down pressures on opposing sides. When alighting gear DOWN (normal or emergency) selection is made, the by-pass valve connects the rudder feel unit to return, so cancelling rudder hydraulic feel, which is re-introduced when alighting gear UP is selected.

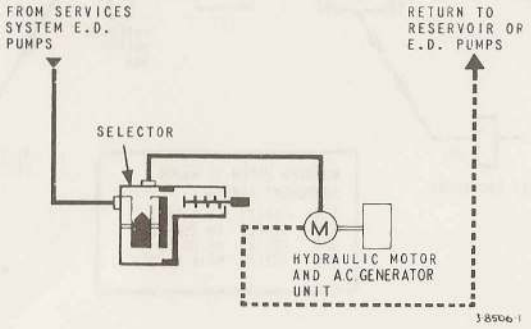

Fig.6. Services system - two-missile pack

Canopy *(fig.4)*

32. The canopy is opened and closed by a jack which is in circuit with the services system accumulator and is controlled through an electro-hydraulic selector by either of two switches. The location of the switches and a description of the mechanical locks will be found in Chapter 1A. Both switches have three positions - OPEN, CLOSE, and centre off - and are spring-loaded to the latter position. An OPEN selection of either switch operates the selector to direct pressure fluid through a two-way restrictor to the jack, which extends to open the canopy; return fluid passes through a two-way restrictor and the selector to the reservoir. Movement of the canopy may be arrested at any point between the closed and fully-open position by releasing the spring-loaded switch: the selector thereupon returns to neutral, locking the canopy hydraulically in the selected position. The canopy is closed by making the appropriate selection with either switch. An indicator on the auxiliary warnings panel is illuminated when the canopy is not closed and locked, and a warning buzzer sounds whilst the canopy is moving.

Two-missile pack *(fig.6)*

33. The two-missile pack electrical supply is provided by an a.c. generator driven by a hydraulic motor, both of

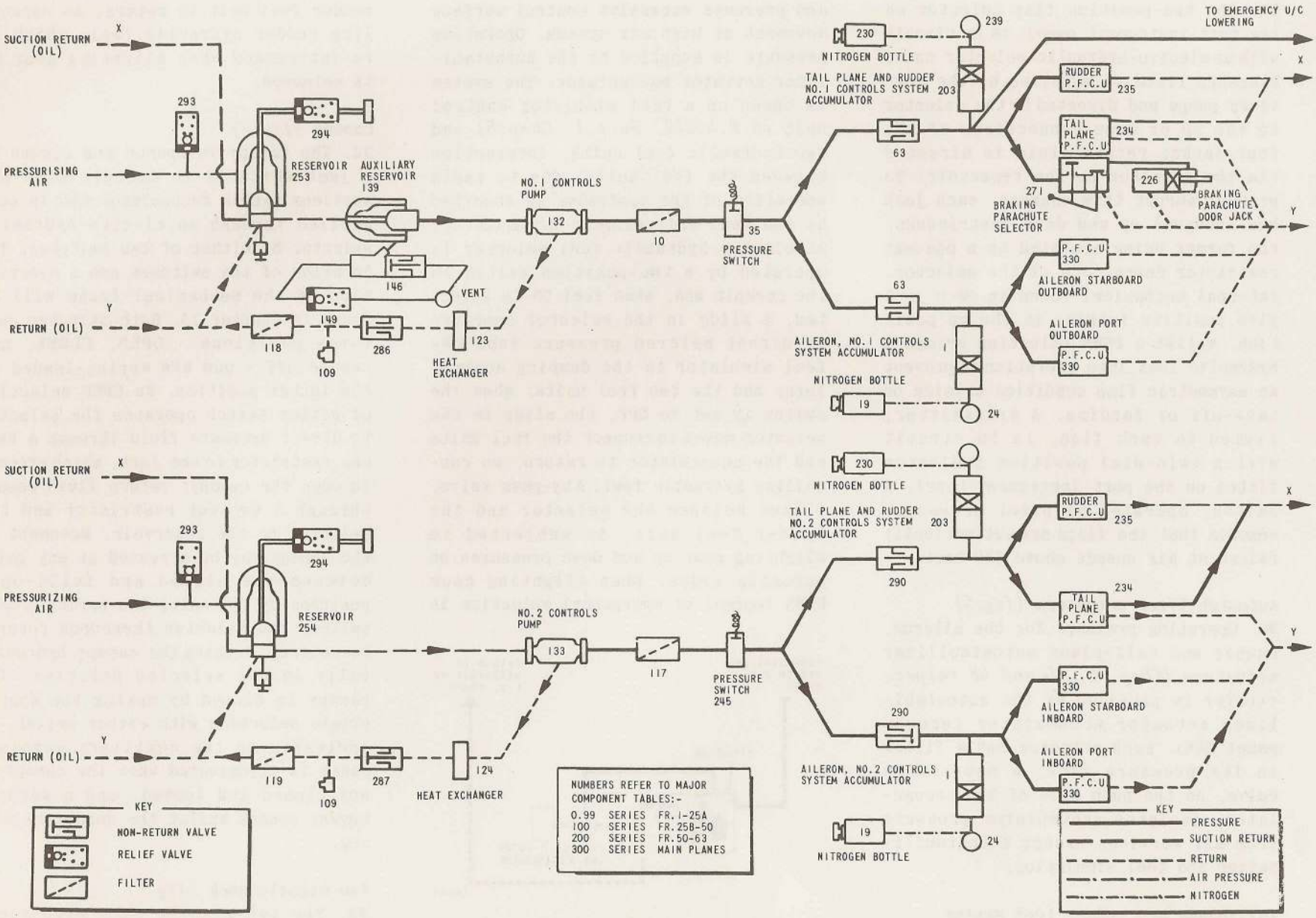

FIG. 7. NO.1 AND NO.2 CONTROLS SYSTEMS

◄ MINOR ALTERATIONS ►

which are installed in the pack. The motor is connected through a control valve and self-sealing couplings to the services system, and controlled by a solenoid-operated selector valve in circuit with the G.W. ARM switch/indicator in the cockpit.

Pressure gauge *(fig.1)*

34. A pressure gauge, operated by a pressure transmitter and indicating services system line pressure, is fitted above the standard warning panel. Selection of any service which has a heavy fluid demand will cause the gauge to fall rapidly and then gradually recuperate. In hydraulic pressure failure the gauge pointer falls to, and remains in, the red sector; electrical failure causes it to fall to the white sector.

CONTROLS SYSTEMS

Ailerons *(fig.7)*

35. Each aileron is moved by two p.f.c.u., power for the outboard control unit being supplied by No.1 controls system and for the inboard unit by No.2 controls system; effective aileron control is obtainable from either system should the other fail. Power for high rates of operation and for emergency use is augmented by the ailerons, No.1 and No.2 controls systems accumulators. The accumulator charging connections for both systems are situated behind access panel 27P. The control units are described in Chap.4C and A.P.105D-0405-16AC.

Tail plane *(fig.7)*

36. The tail plane is moved by a p.f.c.u. which comprises a pair of screwjacks powered by two hydraulic motors; an associated valve mechanism controls the direction of rotation *(Chap.4E)*. Fluid for the port motor is supplied by the No.2 controls system, and that for the starboard motor by the No.1 controls system. The tail plane and rudder, No.1 and No.2 controls systems accumulators assist the normal power supplies for high rates of operation and emergency use. Charging connections for the accumulators are accessible behind access panels 72S and 76P.

Rudder *(fig.7)*

37. The rudder is operated by a dual-piston p.f.c.u. *(Chap.4D)*. Fluid is supplied to the forward and aft pistons by No.1 and No.2 controls systems respectively, each system employing its associated relay valve on the p.f.c.u. Both valves are directly operated by the pilot's controls through the common input linkage. The accumulators described in para.36 also serve both rudder circuits.

Braking parachute doors *(fig.7)*

38. The braking parachute is streamed by pulling a control handle in the cockpit *(Chap.13)*. The handle is connected, through a cable-and-pulley system, to the lever of the parachute selector which directs fluid from the No.1 controls system to the parachute doors jack. The jack is connected by cables to the doors *(Chap.13)* in such a manner that retraction causes the compartment doors to open. When the selector is positioned normally, both sides of the jack piston are connected to return, permitting the jack ram to be reset manually.

Alighting gear emergency lowering

39. No.1 controls system is used for alighting gear emergency lowering. The emergency system is described in para.24.

SERVICING

WARNING

The relevant safety precautions detailed on the LETHAL WARNING marker card must always be observed before entering the cockpit or performing any operations upon the aircraft.

Note...

1. If, at any time, it is necessary to remove ten or more pipes from the controls systems, the scavenging instructions (para.71-77) must be carried out in full.

2. Bonding is to be restored to its previous state following breakdown of systems.

3. A.G.S.2111 outer sleeves must be fitted in such a manner that, when fully tightened, a flat of the sleeve is opposite any point of foul to enable clearance to be maintained.

4. Whenever servicing trolleys are being used to operate hydraulic systems, air pressure at 16-18 lb/in^2 must be applied to the associated reservoirs.

5. To operate the feel selector when required, the services system must be pressurized to a minimum of 1000 lb/in².

General information

40. Scrupulous cleanliness is essential during all servicing operations on hydraulic mechanisms. The presence of a foreign body, however minute, in a component may not only shorten the life of the equipment, but may result in serious failure. Benches, tools, test rigs, and fluid containers must, therefore, be kept spotlessly clean. All pipe ends and unions exposed during servicing operations must be blanked immediately to prevent the ingress of foreign matter. Hydraulic fluid has a deleterious effect on paint, rubber, cable insulation, etc., and care must be taken to avoid spilling it on such materials.

Tools and equipment

41. For tools and equipment used in servicing, and removal and assembly operations, refer to Table 5.

Techniques

Torque-loading of pipe connections

42. The torque-loading figures given in Table 1 are for stainless steel pipes fitted with steel or aluminium A.G.S. flared end-fittings. All torque-loading figures are applicable after initial finger tightening. During finger-tightening, care must be taken to ensure that the flare is in correct alignment with, and held firmly against, the cone of its mating coupling. Lubricate union threads with clean system fluid. The angular movements given in the Table correspond approximately with the specified torque loading applicable and may be used where couplings are inaccessible for the use of torque spanners.

Note...

If the sealing faces of the flared end of the pipe and its mating coupling do not seat fully after finger tightening they must be dismantled and rectified, or new parts fitted. After assembly all connections must be inspected with the system pressurized.

Screwed connections

43. Spanner torque must not be transmitted, inadvertently or otherwise, to the mating fitting or the assembly of a screwed connection: reaction in the form of a spanner held on the mating coupling must be provided during slackening or tightening.

Bonded seals – fitting

Note...

1. It is mandatory to use bonded seals which are pre-packed with their corresponding P.T.F.E. locating rings.

2. Mod.4649 introduces GD3294 series high temperature bonded seals and P.T.F.E. locating rings in lieu of A.G.S.4670 series to components in Zone 3.

44. When assembling connections incorporating bonded seals, GD3294 or A.G.S. 4670 wet assembly is to be employed, i.e. the threads and contact faces of the unions, seals and P.T.F.E. locating rings are to be wetted with the system fluid. The torque loadings given in Table 2 are to be applied in both single and double configurations and whether or not a P.T.F.E. locating ring is fitted. When Mod.4601 is embodied, all GD3294 and A.G.S.4670 series bonded seal connections in the No.1 and 2 engine and jet pipe bays are wrapped with Fluorcarbon rubber tape. When renewing bonded seals it is essential that this wrapping is maintained.

P.T.F.E. hoses – fitting and handling

45. If P.T.F.E. hoses are incorrectly fitted, mishandled, or subjected to strains, they will inevitably fail. To avoid failures the following precautions must be observed:-

(1) Hoses removed during servicing operations must be stored in a manner that allows them to retain the shape they take up in the aircraft.

(2) When installing a hose, secure the nuts at each end finger-tight only to allow the hose to adopt a natural lie without any twisting. Complete the installation by holding each end of the hose in turn, firmly by hand, to avoid twisting, and tighten the adjacent union nut.

(3) Spanners must not be applied to the hexagonal sections of the hose sleeve or ferrule. Use hand pressure only to avoid twisting.

(4) Ensure that hoses are not kinked or distorted by overtightening clips or bending through a small radius.

(5) The following pressures must not be exceeded when pressure-testing individual P.T.F.E. hoses:-

Suction and return low-pressure hoses	500 lb/in²
High-pressure hoses	4500 lb/in²

Servicing trolley connection

46. When connecting a servicing trolley to the services system connections at access panel 45P the following technique must be used to avoid damage to the services suction hose:-

(1) Disconnect the services suction hose at the servicing connection.

(2) Depress the hose lower elbow with the left hand and whilst so doing guide the free end of the hose with the right hand to a position below, and slightly inboard of, the servicing connection, and adjacent to the forward face of frame 31.

(3) With the hose retained in this position connect the servicing trolley hose.

(4) Removal is the reverse of the above procedure.

▶ *Services No.2 pump suction hose* ◀

47. Services No.2 pump suction hose must be fitted in accordance with the following instructions:-

(1) Check that the services No.2 pressure hose elbow-connection at frame 48 is set parallel to the fuselage skin.

(2) Check that the suction hose banjo connection on the pump is angled approximately 5 deg inboard from vertical.

(3) Connect the suction hose to the T-piece at frame 47.

(4) Hold the suction hose so that the bottom portion curves slightly outboard with the elbow pointing into the corner formed by frame 48 and the fuselage skin, and outboard of the services-pressure rigid pipe on the face of frame 48. With the hose held in this position connect it to the banjo connection at the pump. This procedure will ensure adequate clearance between the hose and the reheat fuel pipe.

(5) Check that the services No.2 pressure and the by-pass hoses are outboard of the suction hose.

(6) Lock all connections and fill and bleed the system *(para.53-55)*.

Accumulators

General information

48. Accumulator pressures listed in Table 3 are based on the assumption that the temperature of the nitrogen inside the accumulator is the same as that of the external air. Therefore, checks must not be made after flight or engine runs until sufficient time has elapsed for the nitrogen to cool. A table of accumulator pressures is displayed on a data plate attached to the inner surface of each main undercarriage door.

Checking nitrogen pressure

49. To check the nitrogen pressure:-

(1) Release the hydraulic pressure in the accumulators as follows:-

(a) Operate the aileron and tail-plane controls, at a rate not exceeding one stroke between limit stops in five seconds, until control surface movement ceases.

(b) Apply light fingertip pressure to deflect the control column aft and switch feel ON and OFF; slight pulsations will be felt on the control column with each switch movement. Continue switching until the pulsations cease.

(c) Ensure that feel is selected OFF. *(Refer to Note (5) after para.39)*.

(d) Alternately apply and release the wheel brakes until the brake pressure gauge in the cockpit registers zero.

(2) Fit an inflation adapter and pressure gauge to the accumulator being checked.

(3) With the air release valve on the adapter closed, and the inflation point blanking cap tight, turn the pressure gauge until a reading is obtained. Refer to Table 3 for the correct pressure relative to the surrounding air temperature of the accumulator being checked.

(4) If the reading is in excess of that given in the table, residual hydraulic pressure is indicated and must be released. If the reading is appreciably less than that specified, inspect the accumulator for any defect causing loss.

Note...

With maximum hydraulic pressure in the systems the tail plane and rudder, No.1 and No.2 controls systems accumulators may, when cold, indicate 2700 lb/in² system pressure caused by the piston abutting the end-fitting. This is a design feature and correct system pressure will be indicated as the temperature of the nitrogen rises.

(5) The accumulator is charged by removing the blanking cap and connecting the nitrogen rig line to the supply point on the inflation adapter.

Note...

When discharging, or after charging accumulators with nitrogen, an oil

mist may be released from the charging valve; this is normal and does not necessarily mean that fluid is leaking past the accumulator piston. All accumulators are purposely charged with a small volume of hydraulic fluid on the nitrogen side of the piston (60 to 70 cc for medium-sized accumulators) to provide lubrication for the piston seals. If an excessive amount of oil is emitted this should, of course, be investigated. On no account must oil be removed from or introduced into the nitrogen side of the accumulator unless instructed by the accumulator manufacturers.

Charging the nose undercarriage shimmy-damper accumulator

50. The accumulator is mounted behind the nose-undercarriage pivot pin at the port side, and its remote bleed screw and the charging point are on the nose undercarriage starboard beam and the shock-absorber strut respectively.

To charge the accumulator:-

(1) Remove the blanking cap from the charging point and fit an adapter.

(2) Connect a lubricating gun and adapter to the charging point.

(3) Centralize the wheel, and add oil OM-15 at a pressure not exceeding 300 lb/in^2, until the mark on the accumulator plunger rises above the pointer on the accumulator casing.

(4) Open the bleed screw and bleed off fluid until the plunger marking is level with the pointer.

(5) Disconnect the charging equipment, replace the blanking cap and wire-lock both cap and bleed screw.

Capacity checks

51. The accumulator capacity checks are given in the paragraphs detailing functioning tests of the various systems. As the same accumulators serve both the rudder and tail-plane systems, the capacity checks given for the tail plane cover both systems.

Reservoir draining

52. To drain a services or controls system reservoir:-

(1) Operate the associated system to discharge pressure.

(2) Connect an overflow pipe *(Table 5)* to the reservoir drain (No. 1 controls and services system, access panel 69P: No. 2 controls system access panel 66S). Place a receptacle to collect the fluid.

(3) Apply air pressure of 16-18 lb/in^2 at the air charging valve, access panel 63P.

PRIMING AND BLEEDING

General information

53. The instructions in the following paragraphs, if followed systematically, will result in a complete system relatively free from air. If a part of the system is subsequently broken down and reconnected, discretion will be necessary in determining the extent of bleeding required, but, in general, the instructions dealing with the section where breakdown has occurred, and subsequent instructions relating to the affected service, should be carried out.

In cases where only part of the system is being primed or bled, certain obvious additions to the sequence of operations given may be necessary for preparation, and to restore the system to normal after completion. As the flying controls are operated by two independent systems, it is recommended that the reservoir, pump, and pressure lines of one system be completely bled before commencing to bleed the other system. Before commencing priming and bleeding operations, all accumulators must be fully charged with nitrogen *(para. 49)*. Bleed points must not be re-tightened until a continuous flow of clear fluid is obtained. Hydraulic servicing trolleys should be connected to the ground connections of the appropriate system Sect. 2, Chap. 4, Table 3.

Services system

Filling and bleeding the reservoir

54. Fill and bleed the reservoir, using fluid OM-15 and a hydraulic fluid dispenser.

Note...

Only one hydraulic servicing trolley may be used when lowering the alighting gear.

(1) With the external electrical supply connected, select:-

Alighting gear	DOWN
Flaps	UP
Air brakes *(refer to note after (4))*	IN
Canopy	OPEN

(2) Release pressure from the system accumulators by alternately applying

and releasing the wheel brakes, and by alternately selecting feel ON and OFF.

(3) Remove the blanking cap from the services reservoir filling self-sealing half-coupling (access panel 63P), and connect the bayonet-type half-coupling of the dispenser. Fit an overflow pipe at the reservoir drain. Vent the air-release valve to atmosphere. Fill until clear fluid flows from the relief valve overflow pipe. Any air in the reservoir will be bled off before clear fluid commences to flow.

(4) Check the nitrogen pressure in the wheel brakes, autostabilizer actuator and feel unit damping accumulators *(para.48 and 49)*.

Note...

1. If any work has been done or is in progress on the air brakes or synchronizing mechanism, which necessitates subsequent adjustment of these components, then the jacks must not be moved unless the following precautions are observed.

(a) Disconnect the synchronizing mechanism from the doors by removing the pins connecting the linkage to each door bracket.

(b) Disconnect the jack ram from each door. Secure the doors open so that movement of the jack rams will not foul the doors.

(c) Support the jacks in such a manner that the jack rams can extend and retract without obstruction and without distortion of the swivel couplings.

(d) Insert, from above, a setting pin through the synchronizing unit shaft. It is important that the setting pin is used only when the synchronizing mechanism is disconnected from the doors.

(e) To satisfy (1), select air brakes IN, and move the jack rams by using the aircraft hand pump only.

2. After bleeding a jack it is necessary to exercise the jack a number of times and then repeat the bleeding.

Priming and bleeding the engine-driven pumps and hand pump

55. To prime the pumps:-

(1) Maintain pressure in the reservoir with the filling rig, and bleed at the services No.1 and No.2 ground servicing trolley connections on the aircraft or at the engine-driven pump bleed connections.

(2) Bleed at the pressure connection of the aircraft hand pump, assisting the flow, if necessary, by slowly operating the hand pump.

Bleeding the pressure lines

56. To bleed the pressure lines:-

(1) Jack and trestle the aircraft with all wheels clear of the ground *(Sect.2, Chap.4)*.

(2) Maintain reservoir pressure with the ground filling rig, and slowly operate the aircraft hand pump. Bleed in turn at the pressure connections of the following components:-

Air-brakes selector
Autostabilizer actuator accumulator
Tail-plane autostabilizer
Feel simulator
Rudder autostabilizer
Services No.1 and No.2 engine-driven pumps (or servicing trolley connections)
Flaps selector
Alighting-gear selector
Canopy selector
Two-missile pack selector (when fitted)
Services system accumulator
Wheel-brakes accumulator
Aileron autostabilizers
Feel selector
Pressure gauge transmitter

Bleeding the service lines

57. To bleed the service lines:-

(1) *Air brakes*

(a) Disconnect the air-brake jacks from the doors *(Chap.4F)*, and select air brakes OUT. Ensure that the synchronizing unit is centralized and maintaining pressure in the reservoir with the ground filling rig, operate the aircraft hand pump slowly and bleed in turn at the bleed screw at the jack out line connections, and at the out line connections of the air brake door-lock jacks.

(b) Select air brakes IN, and repeat the bleeding operations at the in line bleed screws.

(2) *Flaps*

(a) Disconnect the jacks from the flaps *(Chap.4F)*, and select flaps DOWN. Maintain reservoir pressure

with the ground filling rig, operate the aircraft hand pump slowly, and bleed in turn at the jack end of the swivel-coupling connections to the port and starboard, inboard and outboard jack down lines.

(b) Select flaps UP, and repeat the bleeding operations at the up line connections.

(3) *Alighting-gear emergency*

(a) Bleed No. 1 controls system *(para. 60-63)*.

(b) With the undercarriage down and with the emergency selector in the normal position, maintain pressure in No. 1 controls reservoir with the ground filling rig. Operate the hand pump on the No. 1 controls servicing trolley slowly, and bleed at the second connection from the indicator-rod end of the protection unit.

(c) Select alighting-gear emergency DOWN and, maintaining reservoir pressure with the ground filling rig, operate the hand pump on the servicing trolley slowly, and bleed in turn at the emergency connections of the following components:-

Protection unit (connection adjacent to indicator rod)

Nose undercarriage jack shuttle valve

Nose undercarriage up-lock jack shuttle valve

Main undercarriage door jack shuttle valves

Main undercarriage door-lock jack shuttle valves

Main undercarriage jack shuttle valves

Main undercarriage relay valves

Shimmy damper by-pass valve

Rudder feel by-pass valve

(d) Reset the emergency system *(para. 83)*.

(e) Pressurize No. 1 controls system, using the servicing trolley, until the protection unit indicator rod is fully extended.

(4) *Main and nose undercarriages*

(a) Ensure that the protection unit is in the normal position with the indicator rod fully extended. With the selector and alighting gear in the DOWN position, maintain pressure in the services reservoir with the ground filling rig. Operate the aircraft hand pump slowly and bleed in turn at the normal down connection of the following components:-

Nose undercarriage up-lock jack at the down and emergency pipe connections aft of frame 14

Nose undercarriage jack shuttle valve

Main undercarriage door jack shuttle valves

Main undercarriage door-lock jack shuttle valves

Main undercarriage jack shuttle valves

Shimmy damper by-pass valve

Rudder feel by-pass valve

(b) With the aircraft fully jacked and trestled, apply pitot pressure equivalent to 165 ± 5 knots.

▶◀

(c) Select alighting gear UP, and depress and secure the plungers of the sequence valves operated by the main undercarriage legs when in the up position. Maintain pressure in the reservoir with the ground filling rig, operate the aircraft hand pump slowly, and bleed in turn at the following components:-

Nose undercarriage down-lock jack

Nose undercarriage jack (up connection)

Main undercarriage jacks (up connections)

Main undercarriage door jacks (up connections), or nearest accessible connections in up lines

Main undercarriage door-lock jacks (up connections)

Main undercarriage down-lock jacks

Rudder feel by-pass valve (up connection)

Shimmy damper by-pass valve (up connections)

Nose undercarriage shimmy damper accumulator (two side connections)

(d) Release the undercarriage door sequence valve plungers.

(5) *Canopy*

(a) Maintaining reservoir pressure with the ground filling rig, select canopy OPEN, operate the aircraft hand pump slowly, and bleed at the open connection to the jack (or the nearest accessible connection).

(b) Select canopy CLOSED and repeat, using the opposite jack connection.

(6) *Two-missile pack*

Remove the panel giving access to the a.c. generator. Maintain reservoir pressure with the ground filling rig, and bleed at the return connection on the a.c. generator.

(7) *Shimmy damper and centring circuit*

(a) With the nose undercarriage in the down position, connect a priming rig to the filling point on the starboard side of the nose undercarriage leg. Prime and bleed at the shimmy damper and centring jack uppermost bleed screws at each end of the jack, and at the bleed nipple aft of the nose-wheel pivot on the starboard nose-wheel beam.

(b) Centralize the nose wheel, and operate the aircraft hand pump slowly to over-fill the accumulator, but do not allow the pressure to exceed 300 lb/in². Slacken the accumulator bleed nipple, and bleed until the level indicators on the top of the accumulator are in line.

(8) *Wheel brakes*

(a) Maintain reservoir pressure with the ground filling rig, and set the parking brake ON. Operate the aircraft hand pump slowly, and bleed in turn at the bleed nipples on the port and starboard main undercarriage brake assemblies.

(b) Maintain reservoir pressure and bleed at the return connection on the brake differential unit or the nearest accessible connection in the return line, and at the port and starboard Maxaret units.

(9) *Feel system*

(a) With the aircraft fully jacked and trestled, and with pitot pressure equivalent to 165 ± 5 knots ▶ applied, maintain reservoir pressure with the ground filling rig. ◀ Select alighting gear UP, and operate the aircraft hand pump to increase the system pressure to 300 lb/in² ; the alighting gear should partially retract. Select feel ON, operate the aircraft hand pump slowly, and bleed in turn at the pressure connection of the feel unit damping accumulator, and at the bleed nipples of the rudder and tail-plane feel units.

(b) Stop pumping with the hand pump, and bleed in turn at the return connections of the following components whilst still maintaining pressure in the reservoir:–

Tail-plane and rudder feel units

Feel selector

Feel simulator

Rudder feel by-pass valve

(10) *Autostabilizers*

Maintain reservoir pressure with the ground filling rig, and bleed at the return connections of the port and starboard aileron and the tail-plane and rudder autostabilizers.

(11) *Wheel brakes accumulator gauge relay*

Fit a clamp between the two grooves at the base of the relay and, maintaining reservoir pressure with the ground filling rig, bleed at the pressure transmitter connection. Remove the clamp from the relay.

Note...

To avoid distorting the cylinder, care must be taken not to overtighten the clamp.

Bleeding the return lines

58. The following operations involve the functioning of the aircraft services to expel air from the return lines. Before the operations are commenced, reference must be made to the services system functioning tests *(para.78-91)*. After completing the instructions given in para.54-57 bleed the services system return lines:-

(1) With the aircraft fully jacked and trestled, and with pitot pressure equivalent to 165 ± 5 knots ▶ ◀

▶ ◀ applied, connect an external air supply of 16-18 lb/in² to the services reservoir.

(2) Using the aircraft hand pump, function each of the services at least three times in each direction; air in the return lines will be returned to the reservoir, and should be bled off as instructed in para. 54. This operation may result in excess fluid being discharged from the reservoir overflow during the actual movement of the service.

(3) When each service has been functioned and all air bled from the reservoir, refill and bleed the reservoir as instructed in para. 54.

(4) With a servicing trolley connected to each services ground pressure connection and an external air supply of 16-18 lb/in² applied to the reservoir, start the servicing trolleys and run for approximately one minute without operating any of the services. Stop the trolleys.

(5) Discharge the accumulators as instructed in para. 54. Release air pressure and re-bleed the reservoir using the ground filling rig.

(6) Apply reservoir air pressure, start one servicing trolley, and operate the following services at least three times, in turn:-

Alighting gear

Air brakes

Flaps

Canopy

(7) Stop the trolley, discharge the accumulators, release the reservoir air pressure, and re-bleed the reservoir, using the ground filling rig.

(8) Repeat (6) and (7) until no further air can be bled from the reservoir.

(9) Disconnect the ground servicing trolleys from the ground pressure connections, and reconnect the services engine-driven pumps into the system.

(10) Maintaining reservoir hydraulic pressure with the ground filling rig bleed at the pump bleed connections or the nearest accessible connections.

Bleeding the autostabilizer actuators after renewal or malfunction

59. Minute quantities of air in the autostabilizer actuators can result in an oscillatory malfunction at the rate of approximately 1 c/s. This can be corrected by, repeating twice, the operations detailed in para. 67 (5), (6), (7) and (8) and then carrying out operation (13). In the renewal case, the autostabilizer actuator should be bled on the aircraft, in addition to bench servicing, as a precautionary measure.

Controls systems

Filling and bleeding the reservoirs

60. Fill and bleed the reservoirs using fluid OM-15 and a fluid dispenser.

(1) Release the hydraulic pressure in the ailerons, No. 1 and No. 2 controls systems and tail plane and rudder, No. 1 and No. 2 controls systems accumulators by operating the tail plane and aileron controls. The rate of operation must not exceed one stroke between stops in 5 sec.

(2) In the No. 1 controls system, ensure that the alighting gear emergency lowering control is set to normal, and the brake parachute door jack normal, i.e. PULL TO STREAM control handle in, and parachute compartment doors closed.

(3) Remove the blanking caps from the self-sealing half-couplings of No. 1 and No. 2 controls reservoir filling connections, and fit an overflow pipe to each drain. Connect the bayonet-type half-couplings of the dispenser to each connection in turn, and fill until clear fluid flows from the overflow pipes. The filling connections for No. 1 and No. 2 controls systems reservoirs are located beneath access panels 63P and 60S, respectively.

(4) Check the nitrogen inflation pressure in the ailerons, No. 1 and No. 2 controls systems and autostabilizer actuator accumulators *(Table 3)*.

Priming and bleeding the engine-driven pumps

61. Maintain pressure in the controls reservoir of the system to be bled and bleed at the servicing trolley connection.

Bleeding the pressure lines

62. To bleed the pressure lines:-

(1) Maintain pressure in the reservoir of the system to be bled, using the ground filling rig, and slowly operate the hand pump on the servicing trolley

connected to the system. On No. 1 controls system, bleed in turn at the pressure connections of the following components:-

Pressure switch

Ailerons, No. 1 controls system accumulator

Aileron p.f.c.u. (outboard)

Emergency alighting gear selector

Tail plane and rudder, No. 1 controls system accumulator

Tail-plane p.f.c.u. (starboard motor)

Braking parachute selector

Rudder p.f.c.u. (No. 1 controls connection)

(2) Similarly, for No. 2 controls system maintaining reservoir pressure with the ground filling rig connected to No. 2 controls reservoir, slowly operate the hand pump of the servicing trolley connected to the system, and bleed at the pressure connections of the following components:-

Ailerons, No. 2 controls system accumulator

Aileron p.f.c.u. (inboard)

Pressure switch

Rudder p.f.c.u. (No. 2 controls connection)

Tail plane and rudder, No. 2 controls system accumulator

Tail-plane p.f.c.u. (port motor)

Bleeding the return lines

63. The following operations involve the functioning of the aircraft controls to expel air from the return lines, Before the operations are commenced, reference must be made to the controls system functioning tests *(Chap. 4C, 4D, and 4E)* and para. 92-102 of this chapter. To bleed the return lines:-

(1) Connect an external air supply of 16-18 lb/in^2 to the reservoir of the system to be bled, and start the servicing trolley connected to the system.

(2) For No. 1 controls system, operate the following controls over full stroke several times:-

Ailerons

Tail plane

Rudder

Braking parachute

Do not operate emergency alighting gear selector.

(3) Stop the servicing trolley and exhaust accumulator pressure by operating the aileron and tail-plane controls. Rate of operation is not to exceed one stroke between stops in 5 sec.

(4) Release the reservoir air pressure and bleed the reservoir, using the ground filling rig.

(5) Repeat (1) to (4) until no further air can be bled from the reservoir.

(6) For No. 2 controls system, repeat (1) to (5) using the appropriate reservoir and ground servicing trolley connections, with the exception of the operation of the braking parachute in (2).

(7) Disconnect the servicing trolleys, and reconnect No. 1 and No. 2 controls system engine-driven pumps.

(8) Maintaining hydraulic pressure in the appropriate reservoir, using the ground filling rig, bleed at the pump bleed connections or the nearest accessible connections.

Bleeding after replacement of the pressure filters

64. After periodical removal and replacement of the pressure filter elements, the filters and adjacent pipelines are to be filled and bled by the following method. During these operations the reservoirs are to be maintained in a topped-up condition.

(1) Fill and bleed the services and controls systems reservoirs *(para. 54 and 60)*.

(2) Connect servicing trolleys with the pipelines primed and bled, to services No. 1 and No. 1 controls ground test connections.

(3) To fill and bleed services No. 1 pressure filter:-

(a) Slacken the union of the protection unit non-return valve (access panel 26P) and operate the hand pump of the servicing trolley slowly until air-free fluid flows from the slackened union.

(b) Repeat (a) using the aircraft hand pump. When clear fluid flows, tighten the union and cease pumping. Wire-lock the union.

(4) To fill and bleed No.1 controls pressure filter:-

(a) Slacken the union on the upstream side of the tail-plane starboard motor non-return valve (access panel 26P) and operate the servicing trolley hand pump slowly until clear fluid flows from the union. Tighten the union and cease pumping.

(b) Slacken the union at No.1 controls pressure switch (access panel 26P) and operate the servicing trolley hand pump slowly until air-free fluid flows from the union. Tighten the union and cease pumping.

(c) Wire-lock the non-return valve and pressure switch unions.

(5) To fill and bleed services No.2 pressure filter:-

(a) Disconnect the servicing trolley from services No.1 ground test connection and replace the self-sealing coupling on the trolley pipeline with a stud coupling. Connect the pipeline to services No.2 ground test connection.

(b) Slacken the union at the top of services No.2 pressure filter (access panel 58S) and operate the hand pump of the servicing trolley slowly until clear fluid flows from the union. Tighten the union, cease pumping and wire-lock the union.

(c) Detach the servicing trolley and replace the stud coupling with the self-sealing coupling. Bleed the pipeline and attach it to services No.1 ground test connection.

(6) To fill and bleed No.2 controls pressure filter:-

(a) Connect a servicing trolley to No.2 controls ground test connection.

(b) Slacken the union on the top of No.2 controls pressure filter (access panel 60S) and operate the servicing trolley hand pump slowly until clear fluid flows from the union. Tighten the union and cease pumping. Wire-lock the union.

(7) With a servicing trolley connected to services No.1 ground test connection function the flaps several times using the trolley hand pump. Replenish the services reservoir and repeat the functioning and replenishing until the fluid flowing from the reservoir overflow pipe is clear and free from air.

(8) Function the air brakes several times using the trolley hand pump. Replenish the services reservoir and repeat the functioning and replenishing until the fluid flowing from the reservoir overflow pipe is clear and free from air.

(9) Repeat (7) and (8) with the servicing trolley connected to services No.2 ground test connection.

(10) With servicing trolleys connected to No.1 and No.2 controls ground test connections, function the tail plane, using the trolley hand pump on each system in turn. Replenish No.1 and No.2 controls reservoirs and continue functioning and replenishing until clear fluid flows from each reservoir overflow pipe.

(11) Finally, repeat (7) to (10) and ensure that the reservoir fluid is free from air. Replenish the reservoirs, disconnect the servicing trolleys and replace the access panels.

Bleeding systems of laid-up aircraft

At commencement of lay-up

65. If an aircraft is to be laid up for a period exceeding seven days, and the systems are to be made unserviceable by the nature of the lay-up, the nitrogen pressure must be discharged from all accumulators in the services and controls systems at the commencement of the lay-up *(para.54 and 60)*.

During any seven concurrent days of a lay-up

66. If the instructions in para.65 have not been carried out the following operation must be carried out within any seven concurrent days from the start of the lay-up:-

Exercise all accumulators in the services and controls systems by moving the accumulator pistons up and down the bores by fully hydraulically charging and discharging each accumulator for a minimum of three times.

Servicing trolleys will be required for the controls systems.

This procedure will dispense with the need to carry out the instructions in para. 67.

Before first engine run following lay-up

67. If an aircraft has been laid up for a period in excess of ten days without exercising the accumulators the following operations must be carried out before the first engine run:-

Note...

The accumulator pressures should be noted before and after carrying out the following operations and any deviation from normal investigated (refer to Table 3 for correct pressures).

(1) Connect servicing trolleys to the No.1 and No.2 controls systems.

(2) Fill and bleed the reservoirs *(para.54 and 60)*.

(3) Maintain pressure with the hand pump and bleed at the services No.2 engine driven pump and the hand pump until a flow of clear oil is obtained.

(4) Bleed the wheel brake assemblies and Maxaret units *(para.57(8))*.

(5) Using the aircraft system hand pump, maintain the system pressure at 2000 lb/in^2. Apply pitot pressure of 300 knots. Connect an autopilot test set to the test connections in the main equipment bay.

(6) Select YAW on the test set and allow the autostabilizer actuator to stroke and centralize before releasing the switch. After releasing the switch, allow the actuator to stroke and centralize in the opposite sense, and then repeat the operations until the autostabilizer actuator accumulator is exhausted.

(7) Repeat (5) and (6) with the test set switched to the ROLL channel.

(8) Repeat (5) and (6) with the test set switched to the PITCH channel.

(9) Pressurize the hydraulic system to 2000 lb/in^2 and apply pitot pressure of 300 knots. Select feel ON and OFF repeatedly until the autostabilizer actuator accumulator is exhausted. Do not discharge the wheel brakes accumulator.

(10) Repeat (2) and (3).

(11) Repeat (5), (6), (7), (8) and (9).

(12) Repeat (2) and (3).

(13) Discharge the wheel brakes accumulator by repeated application of the brakes.

(14) Repeat (2) and (3).

(15) Operate all the flying controls a minimum of three times over their full range of movement.

(16) Fill and bleed the controls reservoirs *(para. 60)*.

(17) If necessary repeat (15) and (16) until a flow of clear oil is obtained.

During first engine run following lay-up

68. To ensure that the systems are free from air, as many units as possible must be exercised during the first engine run after a lay-up. In particular, the controls systems must be operated to produce large oil flows. After the engine run is completed the reservoirs must be topped up *(para.54 and 60)*.

Bleeding jacks before installation

69. Before installing a jack into the aircraft system, the following procedure must be adopted to assist in the subsequent bleeding of the system:-

(1) Set up the jack on a test bench and, using a hand-pump rig, fill the jack with fluid by connecting the pipe unions to each jack connection in turn. The connections to the jack should be made whilst slowly pumping so that air in the connecting pipelines is expelled; the union should be tightened only when clear fluid is flowing freely from the joint.

(2) Stroke the jack over its full travel three times, (e.g. extend-close-extend) with the relief connection uppermost and slackened to allow the escape of trapped air.

(3) When all air is finally expelled disconnect the jack from the hand-pump

rig, and fit pressure blanks pending the fitment of the jack into the aircraft system.

(4) Before installing the jack, the pressure and service lines and the reservoir should be bled as described in the foregoing paragraphs.

(5) After installing the jack, but before connecting the jack to the mechanism, select the opposite position and, maintaining pressure in the reservoir with the ground filling rig, operate the aircraft hand pump slowly and bleed at the selected connection until clear fluid is flowing. Do not stroke the jack.

(6) Tighten the connection with clear fluid flowing, and stroke the jack to its opposite position.

(7) Reverse the selection and bleed in a similar manner at the opposite connection. Do not stroke the jack until bleeding is completed and the connection finally tightened.

(8) Select and stroke the jack to the required position for attachment to the mechanism.

Filters - tail-plane p.f.c.u.

70. Servicing of the filters *(A.F.105D-0405-16AC)* in the tail-plane p.f.c.u. is required only if any of the following conditions arise:-

(1) Sluggishness of control response to application of normal hydraulic pressure.

(2) Noisy operation of the p.f.c.u.

(3) Contamination of either controls systems.

(4) After major breakdown of either controls systems.

After refitting the filters carry out functioning tests, using both controls systems, and bleed the systems if necessary.

Scavenging No. 1 and No. 2 controls systems

71. The following instructions cover the whole of the No. 1 and No. 2 controls systems. Where contamination is suspected in a particular section of either system it will be obvious which pipe or pipes should be disconnected to scavenge the affected area. If any doubt exists regarding the cleanliness of a system the whole of the scavenging instructions must be carried out.

Note...

1. If the highest standard of cleanliness is not observed throughout the scavenging sequence, the whole operation may be rendered abortive; and the system left in a worse condition than before scavenging took place.

2. When a system or part of a system has been scavenged the appropriate bleeding instructions and functioning tests must be carried out.

No. 1 controls

Pressure pipelines

72. To scavenge the pressure pipelines:-

(1) Uncouple the flexible pressure pipe at the No. 1 controls pump and connect it to a scavenging rig *(Table 5)*.

(2) Disconnect the following pipes and fit extra lengths of pipes and blanking caps:-

(a) Pressure connection of the pressure switch (aft face of frame 22, access panel 26P).

(b) Single connection at the protection unit supplied by the alighting gear emergency selector (aft face of frame 23, port).

(c) The pressure side of the thermal relief valve, alighting gear emergency pressure supply (between frames 23-25, port).

(d) Pressure connection at the ailerons, No. 1 controls system accumulator (fwd. face of frame 23, port).

(e) Pressure connection at the tail plane and rudder, No. 1 controls system accumulator (fwd. face of frame 56, port).

(f) Pressure connection at starboard tail-plane motor (access panel 93P).

(g) Pressure side of braking parachute door jack (frames 57-59 stbd.).

(h) Flexible pipe at forward pressure connection on rudder p.f.c.u. (access panel 86S).

(j) Flexible pipe at pressure connection to port outboard aileron p.f.c.u. (access panel 132B).

(k) Flexible pipe at pressure connection to starboard outboard aileron p.f.c.u. (access panel 132B).

(l) Flexible pipe at port undercarriage jack shuttle-valve emergency connection (port undercarriage bay).

(m) Emergency connection at port undercarriage door jack shuttle-valve (port undercarriage bay).

(n) Emergency connection at relay valve (port undercarriage bay).

(o) Emergency connection at port undercarriage door-lock jack shuttle-valve (port undercarriage bay).

(p) Flexible pipe at starboard undercarriage jack shuttle-valve emergency connection (starboard undercarriage bay).

(q) Emergency connection at starboard undercarriage door jack shuttle-valve (starboard undercarriage bay).

(r) Emergency connection at relay valve (starboard undercarriage bay).

(s) Emergency connection at starboard undercarriage door lock-jack shuttle-valve (starboard undercarriage bay).

(t) Emergency connection at nose undercarriage jack shuttle-valve (frames 13-14 stbd.).

(u) Emergency connection at nose undercarriage up-lock jack shuttle-valve (frames 13-14 stbd.).

(v) Emergency connection at by-pass valve (frames 15-16, port).

(w) Emergency connection at feel by-pass valve (fwd. face, frame 57 stbd.).

(3) Disconnect the pipes at the pressure filter and connect them together using extra pipes and connectors (aft face, frame 23, port).

(4) Disconnect the emergency pipes at the 180 deg banjo bolt on the protection unit and connect them together using extra pipe and connectors (aft face, frame 23, port).

(5) Check that the alighting gear emergency selector is in the unoperated position.

(6) Set the braking-parachute selector to the stream position.

(7) Remove the blank from each pipe in turn in the sequence given in (2) (a) to (k) inclusive and, using the scavenging rig, thoroughly flush out each pipe run. Refit the blanks immediately after each operation.

(8) Operate the alighting gear emergency selector to the emergency position; remove the blank from each pipe in turn in the sequence given in (2) (l) to (w) inclusive and, using the scavenging rig, thoroughly flush out each pipe run. Refit the blanks immediately after each operation.

(9) From each pipe in turn, remove the extra pipe or blank and restore the system to normal.

(10) Reset the alighting gear emergency selector to normal *(Chap.11)*.

Return pipelines

73. To scavenge the return pipelines:-

(1) Disconnect the return pipe at No.1 controls reservoir and connect the pipe to the scavenging rig.

(2) Disconnect the following pipes at their respective connections and fit extra lengths of pipe and blanking caps:-

(a) The return connection at the starboard tail-plane p.f.c.u. (access panel 93P).

(b) The return connection at the braking-parachute door selector.

(c) The return connection of the braking parachute door-jack (access panel 78S).

(d) The flexible pipe at the by-pass return from the engine-driven pump.

(e) The reservoir oil filling line at bayonet coupling (access panel 63P).

(f) The return connection of the thermal relief valve, alighting gear emergency pressure supply (frames 23-25, port).

(g) The flexible pipe at the return connection of the port outboard aileron p.f.c.u. (access panel 132B).

(h) The flexible pipe at the return connection of the starboard outboard aileron p.f.c.u. (access panel 132B).

(3) Disconnect the pipes at the non-return valve in the No.1 controls by-pass return line from the heat-exchanger, and connect the pipes together. Use an extra pipe and couplings (frame 39, port).

(4) Disconnect the three pipes at the No.1 controls by-pass filter and connect them together using extra pipes and couplings (frame 42, port).

(5) Remove the blank from each pipe in turn in the sequence given in (2) (a) to (f) inclusive and, using the scavenging rig, thoroughly flush out each pipe run. Refit the blanks immediately after each operation.

(6) From each pipe in turn, remove the extra pipe or blank and restore the system to normal.

Suction pipe lines

74. To scavenge the suction pipelines:-

(1) Disconnect the suction pipe at No.1 controls reservoir and connect it to the scavenging rig (frames 50-51, port).

(2) By-pass the auxiliary reservoir by disconnecting the pipes and connecting them together with extra pipes and couplings (frames 48-49, port).

(3) Disconnect the following pipes and fit extra lengths of pipe and blanking caps:-

(a) The valve return connection at the starboard tail-plane motor (access panel 93P).

(b) The flexible pipe at the return connection of the rudder p.f.c.u. (access panel 86S).

(c) The flexible pipe to the engine-driven pump.

(4) Remove the blank from each pipe in turn in the sequence given in (3) (a) to (c) and, using the scavenging rig, thoroughly flush out each pipe run. Refit the blanks immediately after each operation.

(5) From each pipe in turn, remove the extra pipe or blank and restore the system to normal.

No.2 controls

Pressure pipe lines

75. To scavenge the pressure pipelines:-

(1) Uncouple the flexible pressure pipe at the No.2 controls pump and connect it to the scavenging rig.

(2) Disconnect the following pipes and fit extra lengths of pipe and blanking caps:-

(a) Pressure connection of the pressure switch (aft face, frame 55, access panel 72S).

(b) Pressure connection at the tail plane and rudder, No.2 controls system accumulator (frames 55-56, stbd.).

(c) Pressure connection at port tail-plane p.f.c.u. (access panel 93P).

(d) Flexible pipe at aft pressure connection on rudder p.f.c.u. (access panel 86S).

(e) Pressure connection at the ailerons, No.2 controls system accumulator (frames 22-23, port).

(f) Flexible pipe at pressure connection to starboard inboard aileron p.f.c.u. (access panel 132A).

(g) Flexible pipe at pressure connection to port inboard aileron p.f.c.u. (access panel 132A).

(3) Disconnect the pipes at the pressure filter and connect them together using extra pipes and connectors (fwd, face of frame 49, stbd.).

(4) Remove the blanks from each pipe

in turn in the sequence given in (2) (a) to (g) and, using the scavenging rig, thoroughly flush out each pipe run. Refit the blanks immediately after each operation.

(5) From each pipe in turn, remove the extra pipe or blank and restore the system to normal.

Return pipelines

76. To scavenge the return pipelines:-

(1) Disconnect the return pipe at No.2 controls reservoir and connect the pipe to the scavenging rig.

(2) Disconnect the following pipes at their respective connections and fit extra lengths of pipe and blanking caps:-

(a) The return connection at the port tail-plane p.f.c.u. (access panel 93P).

(b) The reservoir oil filling line at the bayonet coupling (access panel 60S).

(c) The flexible pipe at the by-pass return from the engine-driven pump.

(d) The flexible pipe at the return connection of the starboard inboard aileron p.f.c.u. (access panel 132A).

(e) The flexible pipe at the return connection of the port inboard aileron p.f.c.u. (access panel 132A).

(3) Disconnect the pipes at the non-return valve in the No.2 controls by-pass return line from the heat-exchanger, and connect the pipes together. Use an extra pipe and couplings (frames 46-47, port).

(4) Disconnect the three pipes at the No.2 controls by-pass filter and connect them together using extra pipes and couplings (forward face, frame 47, stbd.).

(5) Remove the blank from each pipe in turn in the sequence given in (2) (a) to (e) and, using the scavenging rig, thoroughly flush out each pipe run. Refit the blanks immediately after each operation.

(6) From each pipe in turn, remove the extra pipe or blank and restore the system to normal.

Suction pipelines

77. To scavenge the suction pipelines:-

(1) Disconnect the suction pipe at No.2 controls reservoir, and connect it to the scavenging rig.

(2) Disconnect the following pipes and fit extra lengths of pipe and blanking caps:-

(a) The valve return connection at the port tail-plane p.f.c.u. (access panel 93P).

(b) The flexible pipe at the return connection of the rudder p.f.c.u. (access panel 86S).

(c) The flexible pipe to the engine-driven pump.

(3) Remove the blank from each pipe in turn in the sequence given in (2) (a) to (c) and, using the scavenging rig, thoroughly flush out each pipe run. Refit the blanks immediately after each operation.

(4) From each pipe in turn, remove the extra pipe or blank and restore the system to normal.

FUNCTIONING TESTS

Precautions

78. Under certain conditions it is possible for the alighting gear selector to be selected DOWN electrically and UP hydraulically, with the ensuing danger of initial hydraulic pressure causing the unlocking of one, or more, of the down locks. To prevent these conditions arising the following procedure must be adopted before lowering the aircraft off jacks:-

(1) D.C. power ON.

(2) Alighting gear selected DOWN.

(3) Apply 2000 lb/in^2 minimum, services hydraulic pressure.

(4) Ensure alighting gear locks engage and position indicator shows three green lights.

(5) Fit alighting gear ground locks.

Alighting gear ground locks must be

fitted at all times during servicing unless functioning checks are being carried out.

Services system

Preparation

79. To prepare the aircraft for functioning tests:-

(1) Jack and trestle the aircraft with the wheels clear of the ground *(Sect.2, Chap.4).*

(2) Replenish the fluid in the reservoirs *(para.54 and 60)* and connect an external air supply of 16-18 lb/in^2 to the reservoir air release valve (access panel 63P).

(3) When carrying out alighting gear retraction or flap functioning tests with pitot pressure applied, the flying controls must be set to neutral and feel OFF must be selected to obviate feel unit reaction; therefore:-

(a) Connect servicing trolleys, one to each controls system ground connection coupling.

(b) Start both trolleys and set the flying controls to netural; do not lock the controls. Stop the trolleys.

(c) Select feel OFF. *(Refer to Note (5) after para.39.)*

Alighting gear

Note . . .

1. During functioning tests of the alighting gear or air brakes, it is essential that the upper engine hatch is fitted.

2. When lowering the alighting gear during functioning tests, do not use power from more than one servicing trolley.

3. If the nose wheel is castered to the extent that the auto-disconnect operates it must be centralized manually, to re-engage the mechanism, before any further retractions are carried out.

80. *Nose-wheel centring.-* To fulfil this test:-

(1) Build up the services system pressure to 3000 lb/in^2 to charge the services system accumulator. Stop the trolley.

(2) With the alighting gear in the down position, pivot the nose wheel over one way. Select alighting gear UP and, using the hand pump, commence to retract the alighting gear, the nose wheel should centre during the initial stages of retraction. Repeat the operation, pivoting the nose wheel in the opposite direction.

Note . . .

1. For this test the nose wheel must not be castered more than 30 deg in either direction to avoid automatic disconnection from the centring device. Should this occur inadvertently then the nose wheel must be centred to re-engage before any attempt at retraction is made.

2. The services system accumulator must be hydraulically charged for each repetition of this test.

◀ *3. If the nose wheel fork is found to be off-centre in the wheel bay or clearance of less than 0.1 in. exists between the axle and the ballast weights or airframe structure, the cause must be investigated. Should adjustment of the shimmy damper be required, it must not exceed the limits laid down in A.P.104C-1204-16C, para.18(11).* ▶

81. *Operation and correct locking.-* With the servicing trolley running and with the pitot pressure in excess of 165 ± 5 knots applied, retract and lower the alighting gear five times, checking the following:-

(1) That the main undercarriage door-locks and the nose undercarriage up-lock engage in the up position.

(2) That the main and nose undercarriage down-locks engage in the down position.

(3) That the mechanical lock indicator on the underside of each main undercarriage door jack is indicating full engagement of the jack internal lock in the down position. (The lock is engaged when the tab and the scribed lines are aligned.)

(4) That the alighting gear position indicators in the cockpit give correct indications. These are:-

No lights	Locked UP
Red light(s)	Associated undercarriage not locked
Three green lights	Locked DOWN

82. *Rates of operations.-* To fulfil this test:-

With a servicing trolley connected to one of the services system ground connections, and with pitot pressure in excess of 150 ± 5 knots applied, raise and lower the alighting gear and check the rates of operation *(Table 4).*

83. *Emergency retraction.–* To fulfil this test:-

(1) Connect a servicing trolley to the services No.1 ground connection couplings.

(2) Connect a pitot pressure rig to the pressure head. Apply pressure progressively and check that the alighting gear up switch is inoperative below a rig A.S.I. reading of 165 ± 5 knots.

(3) Start the servicing trolley and, with a pitot pressure rig A.S.I. reading of less than 165 knots (the pressure switch operates at 165 ± 5 knots), select emergency UP on the selector, by turning the knob of the selector lever clockwise and then selecting UP in the normal manner. Check that the emergency override functions correctly. Reset the emergency up-lock by using a resetting tool to depress the spring-loaded plunger in the shaft of the selector-lever and turning the knob of the lever counter-clockwise as far as it will go.

84. *Emergency lowering.–* To fulfil this test:-

(1) Start the servicing trolley connected to the services system and select air brakes OUT and flaps DOWN.

(2) Retract the alighting gear, stop the trolley and release pitot pressure. Do not select alighting gear DOWN until the emergency lowering tests have been completed.

(3) Connect a servicing trolley to No.1 controls system ground connection and start the trolley.

(4) Using a spring balance, operate the emergency lowering handle in the cockpit and check that the force required does not exceed 8-45 lb. Check that the alighting gear is lowered and locked correctly. Stop the trolley and select alighting gear DOWN using normal selector.

(5) Reset the emergency selector lever and the control handle in the cockpit to the unoperated position *(Chap.11).* The emergency selector is behind access panel 26P.

(6) Check that the visual indicator rod on the protection unit has returned to its normal position, i.e. that the rod is visible (the protection unit should be reset automatically by pressure from the tail plane and rudder, No.1 controls system accumulator).

(7) Start the servicing trolley connected to the services system and build up pressure to 3000 lb/in^2 to reset the alighting-gear shuttle valves to normal.

(8) Disconnect the external air supply from the reservoir air-release valve and release the reservoir air pressure. Remove the blanking cone from the reservoir drain (access panel 69P) and fit a suitable length of pipe to the drain.

(9) Reconnect the external air supply and, using air pressure, remove a full half-gallon of fluid from the services reservoir. Release the air pressure, and refit the blanking cone to the drain.

(10) Start the servicing trolley connected to the services system and select flaps UP and air brakes IN.

(11) Release pressure from all services accumulators, and refill the services system reservoir *(para.54).*

(12) Release pressure from the ailerons and tail-plane accumulators and refill the No.1 controls reservoir *(para.60).* Reconnect the external air supply to the reservoir air-release valve, and pressurize to 16-18 lb/in^2.

(13) With the servicing trolley connected to the services system, retract and lower the alighting gear twice.

(14) Repeat operation (13) with a trolley connected to the other services connection.

Note . . .

1. It is important that, after any emergency lowering of the alighting gear, (5) to (14) are carried out; (13) and (14) at least twice.

2. Should the strand of tell-tale wire on the emergency handle in the cockpit be found broken, i.e. the handle partially moved, then (5) to (7) inclusive must be carried out.

3. Using the emergency system, the time taken to lower the alighting gear must agree with time given in Table 4.

Flaps

85. To test the functioning of the flaps:-

(1) With servicing trolleys connected to both services system ground connections, start the trolleys and lower and raise the flaps. Check the flap position indicators, and the flap jack mechanical locks. Check that the operating times agree with those shown in Table 4.

(2) With the flaps in the down position, apply pitot pressure equivalent to 250 knots air speed; the flaps should return to the up position regardless of the DOWN selection.

(3) Release pitot pressure; the flaps should revert to the down position.

(4) Repeat the tests using one servicing trolley only.

Air brakes

86. Adjustment, synchronizing checks, and functioning tests of the air brakes are described in Chap.4F.

Wheel brakes

87. To fulfil this test:-

(1) Attach an inflation adapter and pressure gauge to the test connection in each brake pipeline at the main undercarriage.

(2) With the rudder pedals in neutral, release the parking brake, and check the gauge readings; these should not be greater than the air pressure in the reservoirs.

(3) With the rudder pedals in neutral, apply the brakes. Check that the gauge reading at each test point is $1500 \pm \frac{150}{50}$ lb/in^2. Adjust on the brake lever adjusting screw to obtain the correct pressure reading ensuring that the adjusting screw prevents excessive load on the brake cable. Check the parking brake catch for correct operation after any adjustment. The brake lever adjusting screw is located between the parking brake catch and the brake lever and is locked by a 'clicker' spring. *(Refer to fig.7A for location).*

(4) Apply half port rudder. Check that the pressure at the starboard test point falls to zero or to the air pressure in the reservoirs, and that the port remains at $1500 \pm \frac{150}{50}$ lb/in^2.

(5) Apply half starboard rudder. Check that the pressure at the port test point falls to zero or to the air pressure in the reservoirs, and that the starboard remains at $1500 \pm \frac{150}{50}$ lb/in^2.

(6) With wheel brakes OFF and rudder pedals in neutral, check that the gauge readings do not exceed the air pressure in the reservoirs. Spin the wheels and, allowing for the retarding effect of the Maxaret unit, check that the brakes are not binding.

Note...

With the rudder pedals in neutral, any difference between the two gauge readings must not exceed:-

(a) 100 lb/in^2 for all pressures between 0 and 1000 lb/in^2.

(b) 150 lb/in^2 for all pressures between 1000 and 1500 lb/in^2.

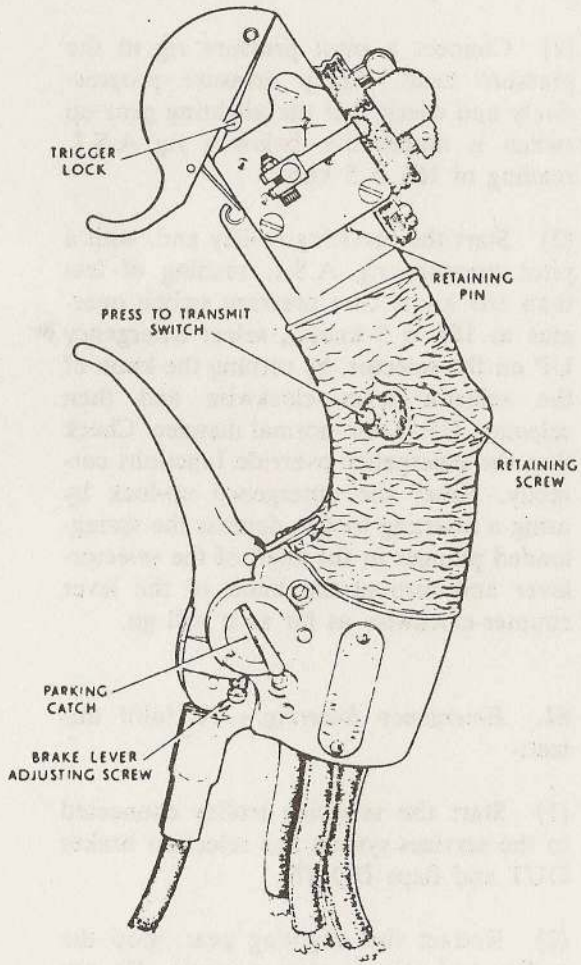

Fig.7A. Control handle and brake lever

(7) Remove the inflation adapters, and refit the blanks to the test points.

Maxaret units

87A. To fulfil this test:-

(1) Remove the main wheels *(Chap.5)*.

(2) Test each Maxaret unit in turn, by spinning the Maxaret wheel in the direction of arrow and ensure that the brakes come ON. Stop the wheel abruptly and ensure that the brakes come OFF.

(3) Refit the main wheels *(Chap.5)*.

Accumulator capacity test

88. Fully charge the wheel brakes accumulator using the hand pump, and discharge the services system accumulator by selecting canopy OPEN and CLOSED repeatedly. With the rudder pedals in neutral, apply and release the brakes at a rate not to exceed one operation in 5 seconds and with the brakes in the OFF position for 3 sec between each application. A minimum of 10 cycles should be obtained before the accumulator pressure is discharged.

Canopy

89. To test the functioning of the canopy system:-

(1) Connect a servicing trolley to the services No.1 ground connections.

Note...

1. During the following tests, check that the canopy mechanical locks and the warning indicator function correctly and that the audible warning sounds during canopy movement.

2. Ensure that the I.F.F. aerial connector flexes rearwards as the canopy closes and does not foul any structure.

(2) Open and close the canopy twice, using the cockpit controls.

(3) Repeat (2) using the external controls.

(4) Stop the servicing trolley and open and close the canopy by means of the services system accumulator.

(5) Open the canopy, and with both control switches in the neutral position, check that it remains open, i.e. observe it for creep.

Pressure gauge

90. To check for correct functioning of the services system pressure gauge in the cockpit:-

(1) Connect electrical and hydraulic ground servicing trolleys.

(2) With the instrument master switch

OFF check that the pressure gauge pointer is in the white sector of the dial.

(3) With the instrument master switch ON and no pressure in the services system check that the pressure gauge pointer is in the red sector of the dial.

(4) With the servicing trolley running and instrument master switch ON, check that a pressure of approximately 3000 lb/in² is indicated on the gauge.

(5) Operate air brakes or alighting gear (if the aircraft is on jacks) and check that the gauge pointer falls rapidly, and then gradually rises to approximately 3000 lb/in² when air brakes or alighting gear come to rest.

(6) Repeat (5) three times.

(7) Stop the servicing trolley and release pressure in the services system *(para.54)*. Check that the gauge pointer drops to the red sector on the dial.

(8) Switch the instrument master switch OFF and check that the gauge pointer falls to the white sector on the dial.

(9) Remove the servicing trolleys and return the system to normal.

Services operating times

91. The services operating times are shown in Table 4. The times quoted are for ground test conditions and do not correspond to operating times in conditions of flight.

(1) *Internal locks*
In the case of alighting gear and flaps, both of which have internal locks, it may be found that the times have been exceeded when locking is completed. The time for internal locking after jack movement has ceased must not exceed 3 sec.

(2) *Flap asymmetry*
Flap asymmetry, port to starboard, must not exceed ½ sec.

No. 1 and No. 2 controls systems

Rudder

92. The following functioning tests of the rudder must always be carried out after a replacement rudder control unit has been fitted, subsequent to the rigging instructions *(Chap.4D)* being effected.

93. *Pressure test.*–

(1) Select feel OFF. The services system must be pressurized to a minimum of 1000 lb/in² to ensure that the feel selector operates.

(2) Set the rudder to neutral and remove the pin connecting the control unit input lever to the control system. Do not disturb the setting of the turnbarrel adjuster.

(3) Start the hydraulic servicing trolley connected to No.1 controls system. Move the control unit input lever to apply port rudder until the control unit is fully extended. Keeping the relay valve open, check for leakage of the control unit and the hydraulic connections.

(4) Repeat (3) with the control unit fully retracted and the rudder to starboard.

(5) Repeat (3) and (4) with the trolley connected to No.2 controls system.

(6) Stop the trolley. Reconnect the control unit input lever to the turnbarrel adjuster.

94. *Operational test.*–

(1) Select feel OFF. The services system must be pressurized to a minimum of 1000 lb/in² to ensure that the feel selector operates.

(2) Start the servicing trolley connected to a controls system.

(3) Displace the rudder pedals and check the control unit functioning and rudder sense.

(4) Operate the rudder pedals at the rate of 2 strokes per second for 6 seconds.

(5) Repeat (3) and (4) with the servicing trolley connected to the other controls system.

Tail plane

95. The following functioning tests of the tail plane must always be carried out after a replacement tail-plane control unit has been fitted, subsequent to the rigging instructions *(Chap.4E)* being effected.

96. *Operational test.*–

(1) Select feel OFF. The services

system must be pressurized to a minimum of 1000 lb/in^2 to ensure that the feel selector operates.

(2) Release all pressure from the tail plane and rudder, No. 1 controls system accumulator.

(3) Start the servicing trolley connected to No. 2 controls system.

(4) Move the control column, and check the motor functioning and tail-plane sense.

(5) Operate the control column at the rate of 1½ strokes per second for 3 seconds.

(6) Repeat the test with the tail plane and rudder, No. 2 controls accumulator exhausted and the servicing trolley connected to No. 1 controls system.

97. *Accumulator capacity test.*–

(1) Select feel OFF. The services system must be pressurized to a minimum of 1000 lb/in^2 to ensure that the feel selector operates.

(2) Release all pressure from the tail plane and rudder, No. 1 controls system accumulator.

(3) With the servicing trolley connected to No. 2 controls system, start the trolley and, with the control column stationary, allow the system to build up to maximum pressure. Stop the trolley.

(4) Operate the control column to extremes (rate not to exceed 1 stroke between stops in 5 seconds). There should be a minimum of 3½ strokes before the accumulator pressure is exhausted.

(5) Repeat (2), (3) and (4) with tail plane and rudder, No. 2 controls system accumulator exhausted, and the servicing trolley connected to No. 1 controls system.

(6) If the requirements of this test fail to be met refer to para. 103.

98. *Motor test.*– If contamination of system fluid is found or suspected, the following check must be carried out after ensuring that the tail plane and rudder, No. 1 and No. 2 controls systems accumulators are fully charged:–

(1) With an operator stationed at each tail-plane trailing edge, move the control column, tail-plane sense, at a rate of approximately one stroke per 2 seconds until the accumulators are discharged.

(2) Whilst carrying out (1) check the quietness and smoothness of tail-plane movement by ear and touch. The normal low-level gear noise is acceptable. A succession of harsh metallic knocks accompanied by tail-plane vibration indicates motor failure and must be investigated.

Ailerons

99. The following functioning tests of the ailerons must always be carried out after a replacement aileron control unit has been fitted, subsequent to the rigging instructions *(Chap. 4C)* being effected.

100. *Pressure test.*– Before installation the p. f. c. u. must be checked for external leakage as described in A.P. 105D-0405-16AC.

101. *Operational test.*–

(1) Release ailerons, No. 1 and No. 2 controls system accumulators and line pressure from the controls systems by operating the control column until all pressure is exhausted.

(2) Connect a servicing trolley to No. 2 controls system. Start the trolley.

(3) Check the ailerons for control unit functioning and aileron sense when the control column handle is displaced. Operate the control column at the rate of 2 strokes per second for 6 seconds.

(4) Repeat (3) with ailerons, No. 2 controls system accumulator and line pressure exhausted and with a servicing trolley connected to No. 1 controls system.

102. *Accumulator capacity test.*–

(1) With no accumulator or line pressure in No. 1 controls system, connect a servicing trolley to No. 2 controls system.

(2) Start the trolley, and with the control column handle at neutral, build up maximum pressure. Stop the trolley.

(3) Operate the control column; there should be a minimum of 5 full strokes before the accumulator pressure is exhausted.

(4) Repeat (1) to (3) with no accumulator or line pressure in the No.2 controls system, and with the servicing trolley connected to No.1 controls system.

(5) If the requirements of this test fail to be met refer to para.103.

P.f.c.u. leakage check

103. To check the p.f.c.u. for excessive leakage:-

(1) Connect a ground servicing trolley to the No.1 controls hydraulic system and pressurize the system to 3000 lb/in^2.

(2) Centralize the control column and rudder bar.

(3) Stop the servicing trolley.

(4) Ensure no movement of the controls for a period of 60 seconds.

(5) Operate the control column, tail plane sense, at a rate of one full stroke in 5 seconds. Check that two full strokes are obtained before the accumulator is exhausted.

(6) Repeat (5) operating the control column aileron sense. Check that 3½ strokes are obtained.

(7) Repeat (1)-(6) with servicing trolley connected to No.2 controls hydraulic system.

(8) If the correct number of strokes is not achieved, check the return leakage of the p.f.c.u. in the affected system, the values of which must not exceed:-

Aileron	300 cc per minute
Rudder	200 cc per minute
Tail plane	600 cc per minute

(9) If the return leakages are within these values, the source of the leakage must be found by checking non-return valves, selectors, etc., in the affected system.

Tests after fitting a replacement controls system engine-driven pump

104. The following tests are to be carried out, during engine runs before flight, after a replacement controls system pump has been fitted:-

(1) Run No.2 engine at 98 per cent rev/min. Check that the tail plane and rudder, No.2 controls system accumulator is hydraulically charged and that feel is selected OFF before carrying out (2) and (3).

(2) Operate the control column (tail-plane sense) over its full travel at a rate of 1 stroke per second for a minimum of 45 seconds.

(3) Check that the system functions correctly.

(4) Run No.1 engine at 98 per cent rev/min with No.2 engine idling (55 per cent rev/min). Check that the tail plane and rudder, No.1 controls system accumulator is hydraulically charged and that feel is selected OFF before carrying out (5).

(5) Repeat (2) and (3).

Braking parachute release mechanism

105.

(1) Remove the braking parachute *(Chap. 13)* if fitted.

(2) Connect a servicing trolley to No.1 controls system. Start the trolley.

(3) Using a spring balance, operate the parachute control handle in the cockpit, and check that the force required is between 35 and 45 lb, and that the parachute doors and operating mechanism function correctly.

(4) Return the control handle and doors to the unoperated condition *(Chap.13)*.

(5) Repeat (1) to (4) twice and stop the servicing trolley.

(6) Exhaust the pressure from No.1 controls system by operating the control column at a rate not exceeding 1 stroke between stops in 5 seconds.

REMOVAL AND ASSEMBLY

Note...

Bonding is to be restored to its previous state following breakdown of systems.

General information

106. The recommended method of removal of certain system components from the aircraft is given in the following paragraphs. Installation of a component is normally the reverse of the removal procedure; any special assembly notes are given at the end of the paragraph concerned. After assembly of a component,

the relevant priming, bleeding and functioning tests, given in the previous paragraphs, must be completed.

Note...
The undercarriage selector valve located behind panel 26P, is connected by a socket connector. To prevent intermittent connection the socket is to be hand tight and wire-locked to the hydraulic pipe union situated above the socket.

Reservoirs
Services and No.1 controls systems
107. The reservoirs of these systems are protected on the inner side by a heat shield, to the lower horizontal portion of which the reservoir bases are secured. Connections to the heads and bases of the reservoirs are accessible with access panels 69P and 71P removed. The removal instructions given below apply equally to either reservoir. To remove a services or No.1 controls system reservoir:-

(1) Remove access panels 63P, 69P, and 71P.

(2) Release the air pressure from the reservoirs at the release valve (63P).

(3) Unscrew and remove the ¼ in. B.S.P. cone cap from the drain connection of the reservoir to be removed and, with a two-gallon container beneath the drain, fit a suitable pipe extension.

Note...
To retain the fluid in a usable condition the container should be totally enclosed except for an air vent, the pipe extension being connected to the inlet by a short length of rubber tubing.

(4) With an external air supply of 16-18 lb/in^2 connected to the charging valve (access panel 63P), drain the reservoir into the container. Release the air pressure, remove the drainpipe extension and replace the cone cap.

(5) Disconnect the electrical cables from each of the j.p.t. amplifiers above the reservoirs, remove the two 2 B.A. bolts securing each amplifier tray and remove the amplifiers from the aircraft.

(6) On both reservoirs unscrew and remove the 3/8 in. B.S.P. banjo bolt securing the fluid relief valve and uncouple the first pipe union downstream of the valve. Remove the valve and pipe assemblies and fit blanks to the exposed pipe ends.

(7) Remove the two 2 B.A. bolts securing the drainpipe bracket to the frame of access panel 69P.

(8) From the base of the appropriate reservoir (71P) disconnect the following pipelines:-

Suction (services)	7/8 in. B.S.P. banjo assembly
Return (No.1 controls)	¾ in. B.S.P. banjo assembly
Return	½ in. B.S.P. banjo assembly
Pressure (air)	¼ in. B.S.P. pipe union
Drain	¼ in. B.S.P. pipe union

(9) Unscrew and remove the air release pipe from the base of the reservoir.

(10) Remove the two ¼ in. B.S.P. shouldered bolts securing the reservoir base to the heat shield.

(11) Remove the two 2 B.A. bolts securing the collar, fitted around the reservoir neck, to the aircraft structure.

(12) Raise the reservoir and remove it from the aircraft through access panel 69P.

Note.
When assembling a reservoir to the aircraft, the bonded seals, removed in the dismantling operations, must be renewed, and all nuts and connections must be wire-locked (Table 2).

No.2 controls system
108. Connections to the head and base of this reservoir are accessible with panels 64S and 66S removed. Removal of the reservoir from the aircraft necessitates the prior removal of No.1 engine intermediate and reheat jet pipes *(Sect. 4, Chap.1)*; access is then gained by removal of a panel, secured by quick-release fasteners, in the heat shield protecting the reservoir. To remove the reservoir:-

(1) Remove access panels 64S and 66S.

(2) Refer to para.107 and perform operations (2) to (4) and (6) to (11) for this reservoir.

(3) Within the fuselage, unfasten the quick-release fasteners securing the removable panel in the heat shield protecting the reservoir, and remove the panel.

(4) Remove the reservoir through the access aperture.

Note...

When assembling the reservoir, the bonded seals, removed in the dismantling operations, must be renewed and all nuts and connections must be wire-locked (Table 2).

Auxiliary

Removal

109. To remove the auxiliary reservoir:-

(1) Remove the No.1 engine jet pipes *(Sect.4, Chap.1)*.

(2) Drain the No.1 controls main reservoir *(para.52)*.

(3) Slacken the union of the inlet pipe at the base of the auxiliary reservoir and empty the reservoir.

(4) Disconnect the banjo connections at the inlet and outlet pipes, and the atmospheric head connection at the base of the reservoir.

(5) Unscrew and remove the slotnut and washer securing the reservoir to the top support plate.

(6) Remove the five 2 B.A. bolts from the flanged half-plate and remove it from the top support plate.

(7) Remove the three 2 B.A. bolts securing the base of the reservoir to the bottom support plate.

(8) Remove the reservoir from the aircraft. Fit blanks to all pipe ends and reservoir connections.

Installation

110. Installation of the reservoir is the reverse of removal. After installation the main and auxiliary reservoirs must be filled and bled as detailed in para. 60 (when fitting the flanged half-plate the longer bolt is fitted at the rear outboard position).

Reservoir bladder

Removal

111. To remove a reservoir bladder:-

(1) Remove the reservoir from the aircraft *(refer to para.107, 108 or 109 as appropriate)*.

(2) Remove the banjo bolt, banjo and washers from the junction head, and the outer slotnut from the stackpipe guide (the latter operation is not required on main reservoirs).

(3) Fit the reservoir in a clamping cradle, and unscrew the outer sleeve.

(4) Remove the reservoir from the cradle and remove the outer sleeve from the cylinder.

(5) Remove the slotnut (main reservoirs, locknut) and lockwasher from the stackpipe guide.

(6) Remove the junction head, bladder, stackpipe and guide from the cylinder.

(7) Unscrew and remove the retaining nut and sealing bush from the junction head.

(8) Separate the bladder from the junction head and remove the junction head, spring cap (main reservoirs, and filter) and stackpipe.

(9) Separate the bladder from the stackpipe guide.

Installation

112. To install a new bladder into a reservoir:-

(1) Fit new sealing rings to the junction head and sealing bush.

(2) Insert the stackpipe guide into the small orifice of the bladder.

(3) Insert the stackpipe through the large orifice of the bladder and into the stackpipe guide.

(4) Assemble the spring cap (main reservoirs, filter) to the junction head, and fit the assembly to the stackpipe.

(5) Carefully pull the larger orifice of the bladder over the junction head and check that the bladder rim fits snugly in the groove in the junction head.

(6) Fit the sealing bush over the junction head and screw on the retaining nut. Torque load to 350 lb in.

(7) Carefully insert the assembly into the cylinder, ensuring that the grooves in the stackpipe guide are positioned at 90 deg to the flats on the cylinder. Guide the stackpipe-guide through the small orifice of the cylinder. If the stackpipe guide is in its correct position the lockwasher will fit over the guide and engage freely with the

flats on the cylinder. If the washer does not so engage remove the whole assembly from the cylinder, rotate the required amount and re-insert. This procedure must be repeated as necessary until the lockwasher falls freely into position. On no account must the stackpipe guide be rotated in the cylinder or the bladder twisted to obtain the correct position.

Note. . .

Force must not be used on the junction head to locate the stackpipe guide in the cylinder, as this may damage the spring cap.

(8) Fit the slotnut on the stackpipe guide and torque load to 50-60 lb in.

(9) Fit the outer sleeve on the cylinder, but do not tighten.

(10) Position and secure the reservoir in a clamping cradle, ensuring that the pegs locate in the junction head.

(11) Using a soft-lead pencil, draw a creep mark on the cylinder and the cradle.

(12) Fully tighten the outer sleeve, using a maximum torque loading of 250 lb in. Check for any signs of creeping. If creeping has taken place the assembly must be dismantled to enable (7) and subsequent operations to be carried out again.

(13) When (12) has been successfully completed, remove the reservoir from the cradle; wire-lock the outer sleeve to the retaining nut, and the stackpipe guide slotnut to the cylinder.

Note. . .

Screw threads are to be lubricated with grease ZX-24.

Testing

113. After assembly, test the reservoir as follows:-

◀ (1) Apply air pressure, not exceeding 5 lb/in^2, simultaneously to both sides of the bladder and check for leaks. ▶

(2) Fill the bladder with hydraulic fluid and maintain a maximum hydraulic pressure of 56 lb/in^2 absolute. No leakage is permissible.

Note. . .

The period of time between the assembling of the reservoir, and fitting it in the aircraft system must be kept to a minimum. If the reservoir is not to be installed in the aircraft immediately following assembly it must be stored with the bladder filled with hydraulic fluid and all connections blanked off.

TABLE 1

Torque loading of stainless steel pipe assemblies

Outside diameter of pipe (in.)	Torque (lb in.) ± 10%	Angular movement
3/16	40	2 spanner flats
1/4	100	
3/8	135	
1/2	175	1½ spanner flats
5/8	196	
3/4	230	
7/8	280	
1	330	
1 1/4	455	
1 1/2	780	

TABLE 2

Torque loading of bonded seals

Sect./Ref.No.	A.G.S.4670 Suffix letter	Size (B.S.P.)	Torque required (lb in.)
28F/1302016	A	1/8 in.	100 ± 5
28F/1302017	B	1/4 in.	170 ± 10
28F/1302023	BB	19 T.P.I., 0.6 in. o.d.	260 ± 12
28F/1302018	C	3/8 in.	360 ± 15
28F/1302065	CC	14 T.P.I., 0.75 in. o.d.	475 ± 20
28F/1302019	D	1/2 in.	615 ± 25
28F/1302020	E	5/8 in.	660 ± 30
28F/1302021	F and over	3/4 in.	700 ± 35

Note...

The torque loadings in Table 2 do not apply to the 1/2 in. B.S.P. adapter and banjo bolts on Marston Excelsior heat exchangers, Type D.237A and Type D.2718-2A nor to 1/2 in. B.S.P. light alloy adapters, Pt.No.9952.1 on the flap selector fitted between frames 42 and 43, port. (The Table 2 figures do apply to 1/2 in. B.S.P. steel adapters, Pt.No.1.071.U.00.DB. where fitted). The torque loadings to be applied are:-

Adapters and banjo bolts, Marston Excelsior heat exchangers — *375 ± 25 lb in.*

Light alloy adapters, Pt.No.9952-1 — *600 lb in. max.*

TABLE 3

Accumulators - system location, access and nitrogen inflation pressures

COMPONENT	ACCUMULATOR TITLE	SYSTEM	ACCESS PANEL	PRESSURE LIMITS	PRESSURE lb/in² RELATED TO AMBIENT TEMPERATURE					
					−26°C (−14.8°F)	−10°C (14°F)	0°C (32°F)	15°C (59°F)	30°C (86°F)	50°C (122°F)
Wheel brakes	Wheel brakes (refer to fig.4, item 3)	SERVICES	27S	+50 − 0	1455	1550	1610	1700	1790	1905
Wheel brakes Canopy Nose-wheel centring	Services system (refer to fig.4, item 2)	SERVICES	27S	+50 − 0	1285	1370	1420	1500	1580	1680
Shimmy damping	Nose undercarriage shimmy damper (refer to fig.3, item 4)	SERVICES	Nose-wheel leg	−	Charged with oil OM-15 only					
Autostabilizers Feel units Feel selector Feel simulator	Autostabilizer actuator (refer to fig.5, item 201)	SERVICES	66S	+50 − 0	1285	1370	1420	1500	1580	1680
Feel unit damping	Feel unit damping (refer to fig.5, item 202)	SERVICES	76S	+ 0 − 5	100	105	110	115	122	130
Aileron p.f.c.u. (outboard)	Ailerons, No.1 controls system (refer to fig.7, item 1)	NO.1 CONTROLS	27P	+50 − 0	1285	1370	1420	1500	1580	1680
Tail-plane p.f.c.u. (stbd. motor) Rudder p.f.c.u. (forward piston) Brake parachute doors Alighting gear emergency lowering	Tail plane and rudder, No.1 controls system (refer to fig.7, item 203)	NO.1 CONTROLS	76P	+50 − 0	1285	1370	1420	1500	1580	1680
Aileron p.f.c.u. (inboard)	Ailerons, No.2 controls system (refer to fig.7, item 1)	NO.2 CONTROLS	27P	+50 − 0	1285	1370	1420	1500	1580	1680
Tail plane p.f.c.u. (port motor) Rudder p.f.c.u. (aft piston)	Tail plane and rudder, No.2 controls system (refer to fig.7, item 203)	NO.2 CONTROLS	72S	+50 − 0	1285	1370	1420	1500	1580	1680

TABLE 4

Services operating times in seconds

Service	One pump 3750 rev/min		Two pumps 3750 rev/min	
	Up, in or close	Down, out or open	Up, in or close	Down, out or open
Alighting gear	7.5 max.	16.0 max.	1.7 min. 4.0 max.	-
Alighting gear emergency	-	21.0 max.	-	-
Flaps	2.5 min. 3.5 max.	3.0 min. 4.0 max.	2.5 min. 3.5 max.	3.0 min. 4.0 max.
Air brakes - 50 deg travel	No.1 services pump 5.0 max.	7.5 max.	3.5 max.	4.0 max.
	No.2 services pump 4.5 max.	6.0 max.	-	-
Canopy	3.0 min. 5.0 max.	3.0 min. 5.0 max.	3.0 min. 5.0 max.	3.0 min. 5.0 max.

TABLE 5
Tools and equipment

Ref.No.	Description	Application/remarks
26DK/95171	Spanner, box	Micronic filters
26DK/95072	Spanner, reservoir	Outer sleeve tensioning
26DK/95175	Spanner, special-to-type	Hydraulic fluid reservoir
26DK/95176	Spanner, socket, special	
26DK/95177	Cradle, clamping	
26DK/95316	Spanner, special-to-type	Sequence valve
27VA/3303 or 27VA/5258	Clamp, bleed	Pressure relay valve ACM18798
27Q/14103	Adapter	Use with 1B/4467
6C/2038	Set, test, Mk.13 autopilot	
26DK/95575	Spanner, key	
26DK/95782	Spanner, banjo bolt	Auxiliary reservoir
26DK/95131	Pin, setting	Airbrake synchronization
27Q/34904	Pin, setting	Resetting U/C selector button
26DK/	Rig, scavenging	Scavenging systems
1L/233	Wrench, crowfoot, 5/16 in. B.S.F. x ¼ in. S.D.	Torque loading hydraulic pipe unions
1L/234	Wrench, crowfoot, 3/8 in. B.S.F. x 3/8 in. S.D.	
1L/332	Adapter, 3/8 in. S.S. x ½ in. S.P.	
37J/3432	Extractor, magnetic element	Hydraulic pumps
26DK/95191	Dispenser, hydraulic fluid, Juniper	Priming hydraulic fluid reservoirs
26DK/95039	Adapter	
1B/4467	Gun, lubricating	Charging shimmy damper accumulator
26DK/95368	Pipe, overflow	Hydraulic system
26DK/95862	Drain, overflow	Reservoirs
26DK/95220	Adapter, nose-wheel shimmy damper	Accumulator charging
26DK/95304	Adapter, nitrogen charging	Accumulators
26DK/95781	Rig, setting	Hydraulic pump connections
4F/3603	Trolley, Mk.3	Hydraulic servicing
4FE/3761 or 4FE/4527 or 4FE/5147 or 4FE/3786 or 4FE/4258	Trolley	Electrical servicing
4G/3029	Gauge, pressure 0-3500 lb/in^2	Wheel brake servicing
4G/3026	Gauge, pressure 0-600 lb/in^2	
4G/6246	Adapter, inflation	
6C/3131	Sets, test, pitot static Mk.5	Tests after lay-up
6C/973	Adapter, Mk.9 pitot static system	

TABLE 6

Major components - frames 1-25A

Item No.	Component	Type or Part No.	Qty.	A.P. Reference A.P.	Sect.	Chap.	App.
	Accumulators						
1	Ailerons, No.1 and No.2 controls systems	Dowty Rotol 8785	2	T	8	7	
2	Services system	Dowty Rotol 8603		T	8	6	
3	Wheel brakes	Dowty Rotol 8603		T	8	6	
4	Nose undercarriage shimmy damper	Dowty Rotol 8794	1	T	8	9	
	Control unit						
8	Brakes pre / post Mod.2150	Dunlop AC12734 / AC60692		S	7 / 7	2 / 2	3
	Filters						
10	Pressure No.1 controls and services No.1	Palmer Aero D10612	2	1803			
	Jacks						
13	Canopy	Electro Hydraulics 6149/1		F	9	4	
14	Nose undercarriage	Dowty Rotol 1.01003.001		U	11	5	
15	Nose undercarriage up-lock (pre Mod.2122)	Dowty Rotol 1.01190.001		U	11	21	1
	Nose undercarriage up-lock (post Mod.2122)	Dowty Rotol 1.01190.002	1	U	11	21	1
16	Nose undercarriage down-lock (pre / post Mod.2122)	Dowty Rotol 1.01118.001		U	11	21	3
		Dowty Rotol 1.01118.002		U	11	21	3
17	Shimmy damper	Dowty Rotol 4561		T	5	3	
	Nitrogen bottles						
19	Ailerons No.1 and No.2 controls systems accumulators	Dowty Rotol 8786	2	T	8	11	
	Pressure gauges						
24	Accumulators (4000 lb)	Appleby and Ireland AI-440-EE or EW	2	112G-0400-1		4-2	
25	Brakes (4000 lb)	Sangamo Weston S-149-1-126 (6A/6098)					
26	Services system	Appleby and Ireland AI-756		1275A	16	29	
	Pressure transmitters						
30	Brakes	Sangamo Weston S122-4-55	1	112G-0400-1			
31	Services system gauge (pre Mod.4653)	Appleby and Ireland AI-757	1				
	(post Mod.4653)	Appleby and Ireland AI-757E					
	Pressure and protection						
35	Pressure switch, No.1 controls	Thermal Controls TP298		1275A	11		
36	Pressure relay valve, services pressure	Dunlop ACM 18798		105B-0715-1			
37	Protection unit	Dowty Rotol H5059 pre Mod.4057		1803T	13		
		Dowty Rotol 1.02508.001 post Mod.4057		1803U	9		

continued...

TABLE 6 Major components - frames 1-25A - *continued*

Item No.	Component	Type or Part No.	Qty.	A.P. Reference A.P.	Sect.	Chap.	App.
	Restrictors						
41	Canopy two-way	1.00379.001	2		U 9	32	
42	Nose undercarriage one-way	H5053	1		T 13	56	2
	Selectors	Dowty Rotol					
46	Alighting gear	1.00181.004			U 8	24	
47	Alighting gear emergency ▶ ◀	▶ ◀	1	1803	T 11	12	
		EF3.73.8521			U 7	4	
48	Canopy	1.00135.002			U 7		
50	Two-missile pack	Dowty Rotol C1012 Mk.1 or 6372 Mk.1			T 14	3	1
51	By-pass, nose-wheel centring	8521			T 13	54	
	Valves						
	Inflation						
56	Accumulator charging	High Pressure Components A58	4	4303Z	4	6	1
57	Shimmy damping		1				
	Non-return						
60	Services pressure ¼ in. B.S.P.	H2011	2		T 13	60	
62	Dual, No.1 controls pressure	Dowty Rotol 1.01068.001	1		U 9	28	
63	Controls No.1 pressure and services return	Dowty Rotol H2012	2		T 13	62	1
64	Services return, post Mod.2355	H2012	1		T 13	62	1
	Relay						
67	Services pressure	Electro-Hydraulics 6960			F 8	15	
	Relief			1803			
70	Nose undercarriage up line	H5055	1		T 13	4	4
71	Thermal, undercarriage emergency	▶ ◀			U 9	27	
		1.01067.002					
	Shuttle	Dowty Rotol					
75	Nose undercarriage jack	8423			T 13	52	
76	Nose undercarriage up-lock jack	8423			T 13	52	

continued...

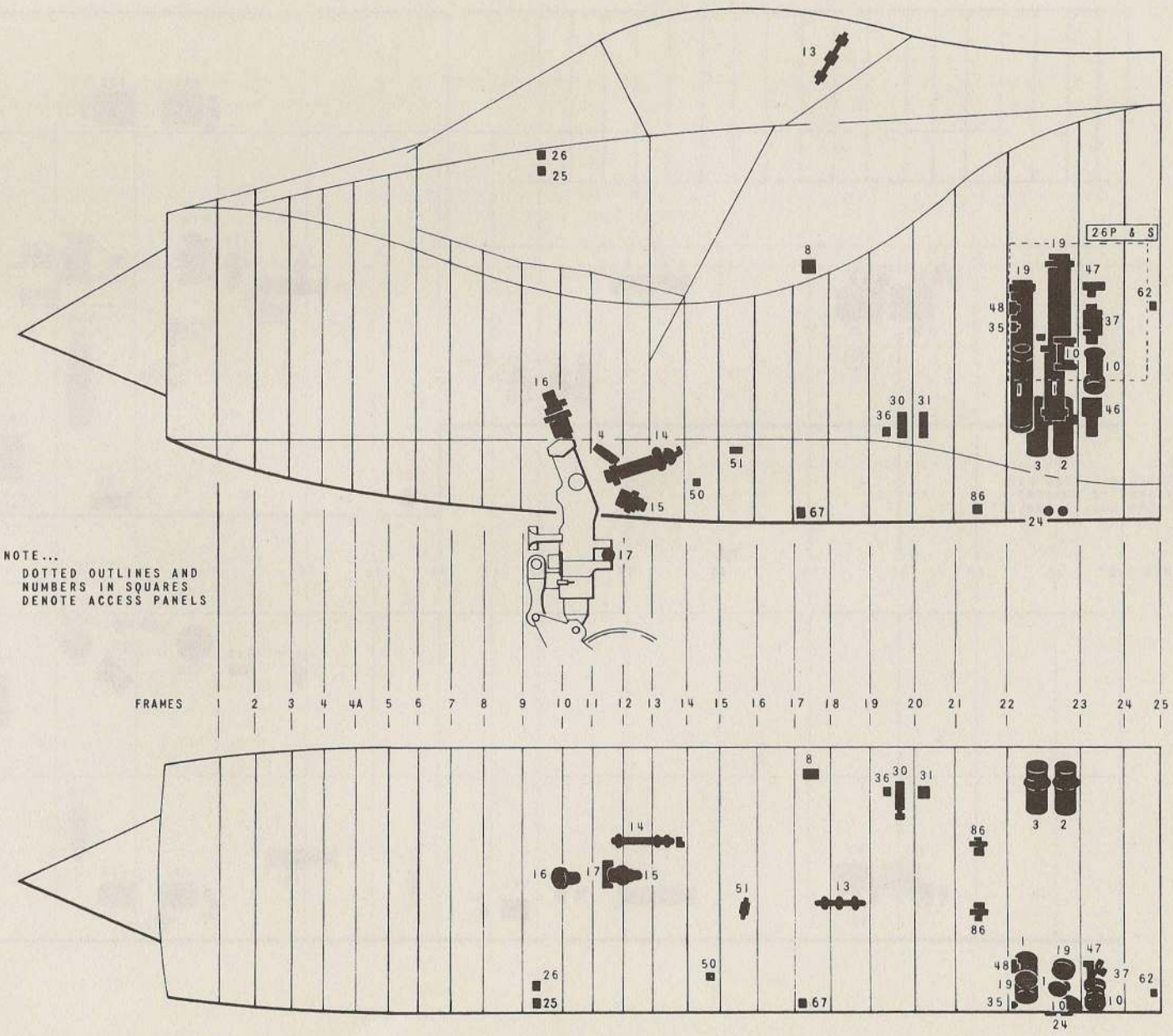

FIG.8. LOCATION OF MAJOR COMPONENTS – FRAMES 1-25A

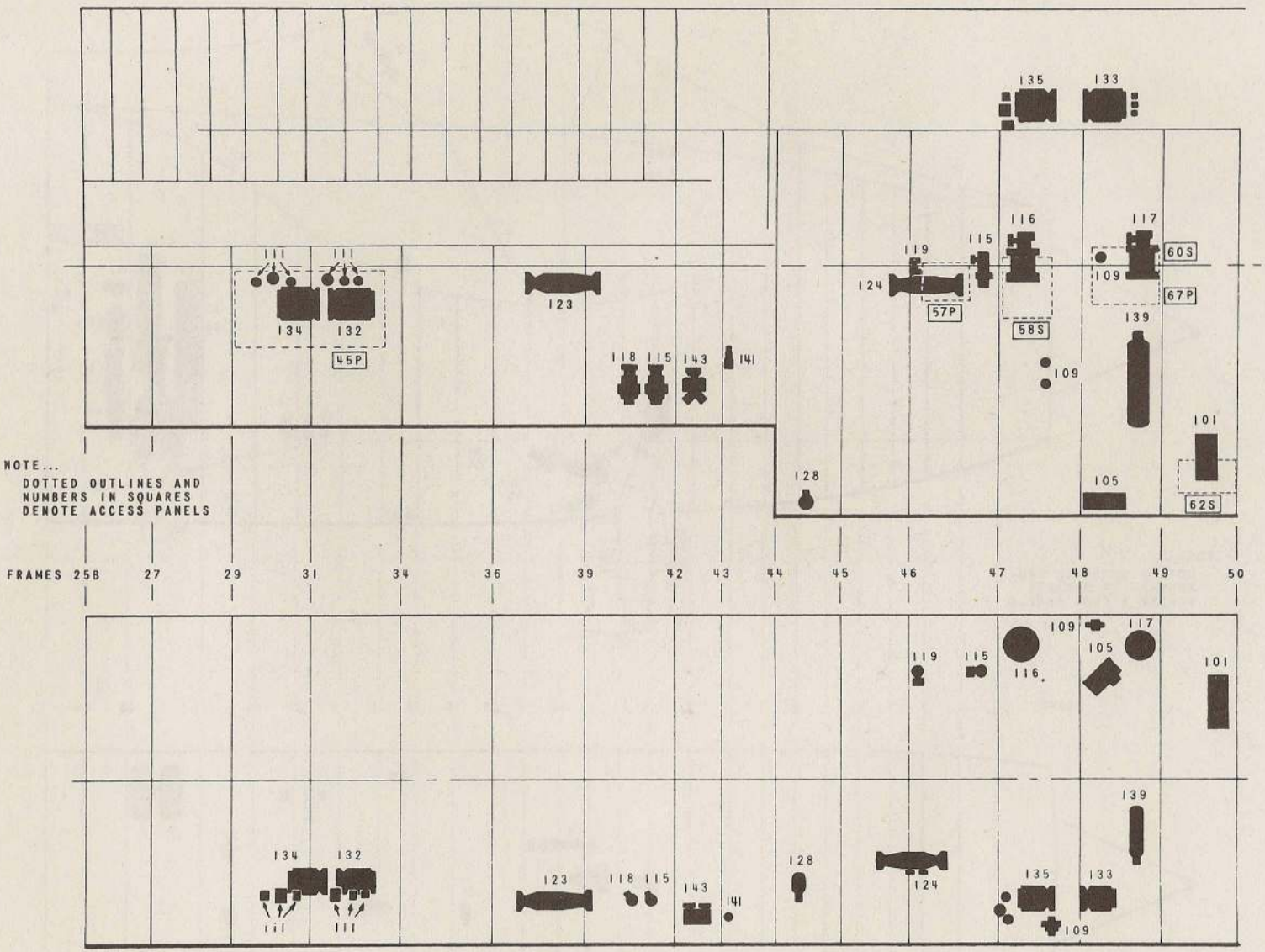

FIG. 9. LOCATION OF MAJOR COMPONENTS - FRAMES 25B - 50

3-8509-1

TABLE 6 Major components - frames 1-25A - *continued*

Item No.	Component	Type or Part No.	A.P. Reference Qty.	A.P.	Sect.	Chap.	App.
	Swivel couplings						
80	Nose undercarriage UP	Dowty Rotol C8521Y	1		11	28	
81	Nose undercarriage DOWN	Dowty Rotol C8520Y			11	28	
82	Nose undercarriage EMERGENCY	Dowty Rotol C8478Y-Mk.A	1	1803D	11	28	
83	Shimmy damping	12086YA01			11	30	
84	Shimmy damping	1.0152.001		1803U	12	26	
	Couplings						
86	Armament pack c/w blanking caps	King Aircraft C17320/8	2				
		King Aircraft C17321/8	2				
	Flexible pipe						
88	Shimmy damping bleed pre, Mod.4643	Palmer Aero FP304/982	1				
	Shimmy damping bleed post, Mod.4643	Palmer Aero 813502872	1				

TABLE 7

Major components - frames 25B-50

Item No.	Component	Type or Part No.	A.P.Reference Qty.	A.P.	Sect.	Chap.	App.
	Control units						
105	Feel unit, tail plane (pre Mod.4747)	EB2.45.3291	1				
	Feel unit, tail plane (post Mod.4747)	EB2.45.3327	1				
	Couplings						
109	Ground servicing oil, and air release ¼ in. B.S.P.	Lockheed Avery AVA 551B	3				
110	Ground servicing air, ½ in. B.S.P.						
111	Ground servicing at hydraulic pumps		12				
	Filters						
115	Services return pre, post, Mod.2439	Palmer Aero D10601 L.H., D10603 L.H.	1				
116	Services pressure	Palmer Aero D10612					

continued...

TABLE 7 Major components – frames 25B-50 – *continued*

Item No.	Component		Type or Part No.	Qty.	A.P. Reference			
					A.P.	Sect.	Chap.	App.
117	No.2 controls pressure	2439	Palmer Aero D10612	1				
118	No.1 controls return pre Mod.		D10602 R.H.					
	post Mod.		D10604 R.H.					
119	No.2 controls return pre Mod.		D10602 R.H.					
	post Mod.		D10604 R.H.					
	Pressure gauges							
122	Accumulator (4000 lb)		Appleby and Ireland AI-44D-EE	2	112G-0400-1	4-2		
	Heat exchangers							
123	Services and No.1 controls		Marston Excelsior D237-4A					
124	Services and No.2 controls		D2718-2A					
	Pressure regulators							
128	Services pressure		Dowty Rotol 11651-Y-AO2		1803D	9	110	2
	Pumps							
132	No.1 controls	engine driven	Integral Type ▶ ◀ 220 Mk.63 37J/6119691 ▶ ◀		1803J	2	10	
133	No.2 controls							
134	Services No.1							
135	Services No.2							
	Reservoirs							
139	No.1 controls, auxiliary		EF3.73.2183	1				
	Restrictor							
141	Flaps		Dowty Rotol 1.01339.001		1803 U	9	46	
	Selectors							
143	Flaps		1.00182.004		U	8		
	Valves							
	Non-return							
146	Atmospheric head, auxiliary reservoir		Dowty Rotol H2015		T	13		
	Relief							
149	Atmospheric head, auxiliary reservoir		Dowty Rotol 1.01344.001 included in EF3.73.2627		U	9	39	
	Vents							
152	Auxiliary reservoir, atmospheric head		EF2.73.2625					

TABLE 8

Major components – frames 50-63

Item No.	Component	Type or Part No.	Qty.	A.P. Reference			
				A.P.	Sect.	Chap.	App.
	Accumulators						
201	Autostabilizer actuators	Dowty Rotol 8603	1	1803 T	8	6	
202	Feel unit damping	Dowty Rotol A1032	1	1803 T	8	10	3
203	Tail plane and rudder No.1 and No.2 controls systems	Dowty Rotol A1019	2	1803 T	8	8	1
	Autostabilizers						
207	Rudder	Type 214 Mk.3 6T/613	1	4685	4	3	
208	Tail plane	Type 214 Mk.1 6T/614	1	4685	4	3	
	Control units						
211	Feel simulator tail-plane and rudder	Type 205 Mk.2	1	4604 Z	1	8	
212	Feel unit, rudder	EB2.45.3259 (pre Mod.4778) EB2.45.3333 (post Mod.4778)	1	4604 Z	1	8	
	Filters						
216	Services pressure feel system	Palmer Aero D10630	1				
217	Services pressure T/P autostabilizer	Palmer Aero D10630	1				
	Jacks						
222	Air brake port	Dowty Rotol J5061	1	1803 T	15	40	
223	Air brake stbd.	Dowty Rotol J5061	1	1803 T	15	40	
224	Air brake lock jack, port	Dowty Rotol 5168	1	105B-0907-16C			
225	Air brake lock jack, stbd.	Dowty Rotol 5168	1	105B-0907-16C			
226	Brake parachute	▶ Dowty Rotol 1,03034,002 ◀	1	1803 T 105B-0952-16C	15	38	
	Nitrogen bottles						
230	Tail plane and rudder No.1 and No.2 controls systems	Dowty Rotol 8607	2	1803 T	8	12	
	P.f.c.u.						
234	Tail plane	Hobson Type 455 T and S	1	105D-0405-16AC	1	5	
235	Rudder	Hobson Type 337 Mk.3	1	105D-0405-16AC	3	1	
	Pressure gauges						
239	Tail plane and rudder No.1 and No.2 controls systems accumulators	Appleby and Ireland AI-440-EE or EW-4000 lb	2				
240	Autostabilizer actuators accumulator	Appleby and Ireland AI-441-E or EW-200 lb	1	112G-0400-1		4-2	
241	Feel unit damping accumulator	Appleby and Ireland AI-441-E or EW-200 lb	1	112G-0400-1		4-2	
	Pressure switches						
245	Controls No.2, T/P motor	Thermal controls TP298	1	1275	11		

continued...

TABLE 8 Major components - frames 50-63 - *continued*

Item No.	Component	Type or Part No.		Qty.	A.P. Reference			
					A.P.	Sect.	Chap.	App.
	Pumps							
249	Hydraulic, hand	EB3.73.125						
	Reservoirs							
253	No.1 controls	▶ ◀						
254	No.2 controls	▶ ◀						
255	Services	EB2.73.8893						
	Swivel couplings							
260	Rudder feel unit, pressure	Dowty Rotol	C8477Y	1	1803	D 11	26	
261	Air brake stbd. IN		C8361Y				25	
262	Air brake port IN							
263	Air brake stbd. OUT		C8360Y				25	
264	Air brake port OUT							
	Selectors							
270	Air brake		1.00132.004			D 8	53	2
271	Braking parachute		1.02835.001			T 11	11	
272	Feel units		1.00133.004			D 8	54	2
	Valves							
276	Inflation	High Pressure Components A58		4	4303Z	4	6	1
277	Accumulator charging							
	By-pass							
281	Rudder feel			1	1803		54	
			1.02601.001	1				
	Non-return							
285	Services pressure ¼ in. B.S.P.		H2011	2			60	
286	No.1 controls return ½ in. B.S.P.			1		T 13		
287	No.2 controls return ½ in. B.S.P.			1			61	
288	Services pressure ½ in. B.S.P.		H2014	1				
289	Services return ½ in. B.S.P.			2				
290	No.2 controls pressure 3/8 in. B.S.P.	Dowty Rotol	H2012	2			62	1
291	Air supply from engines		H2015	1				
	Relief							
293	Air supply to reservoirs			3		T 13	49	
			1.01344.001	3		U 9	39	
294	Hydraulic, from reservoirs		5056	1		T 13	58	
	Synchronizing							
296	Air brakes		8361	1		T 12	10	

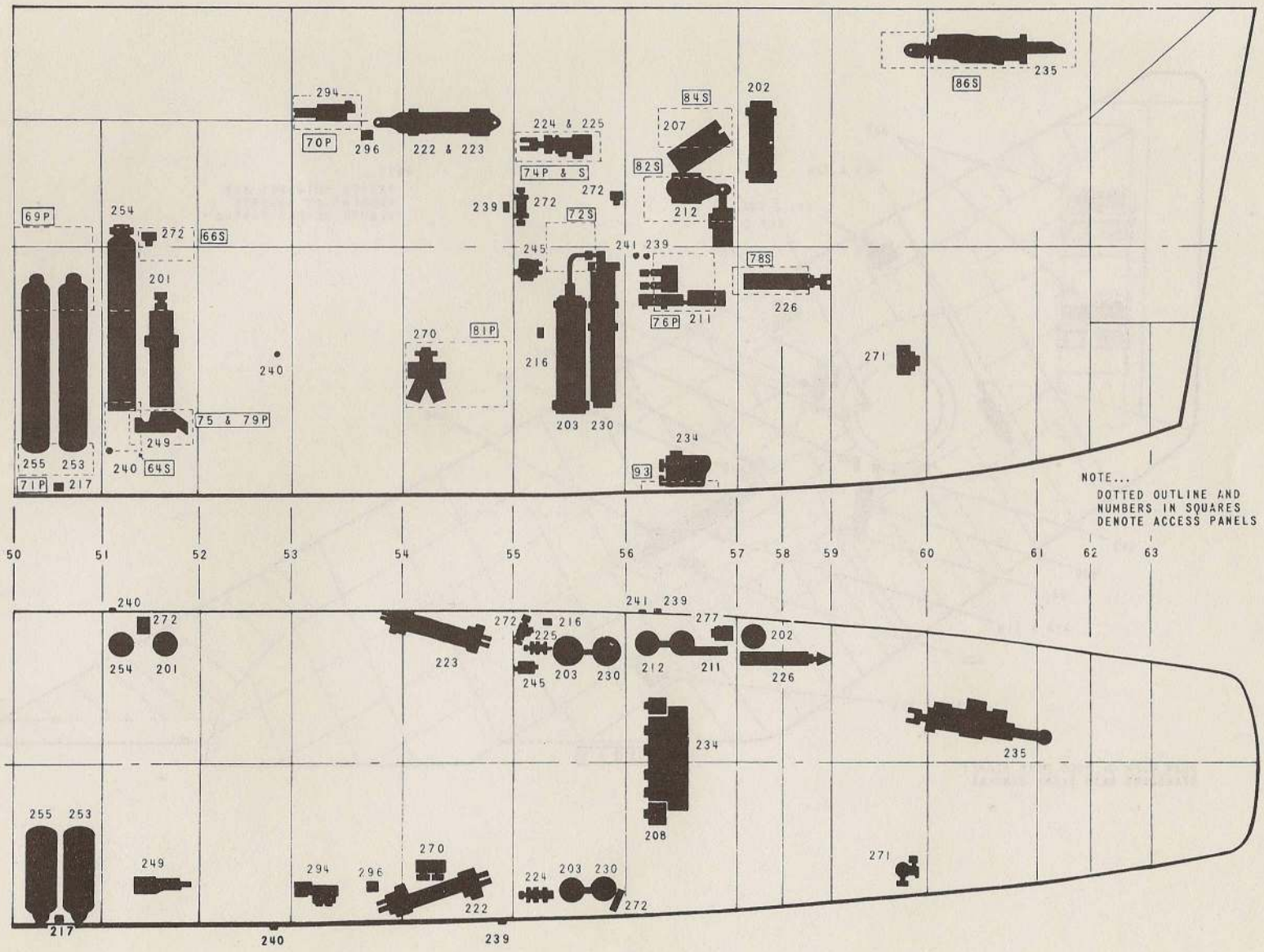

FIG.10. LOCATION OF MAJOR COMPONENTS — FRAMES 50-63

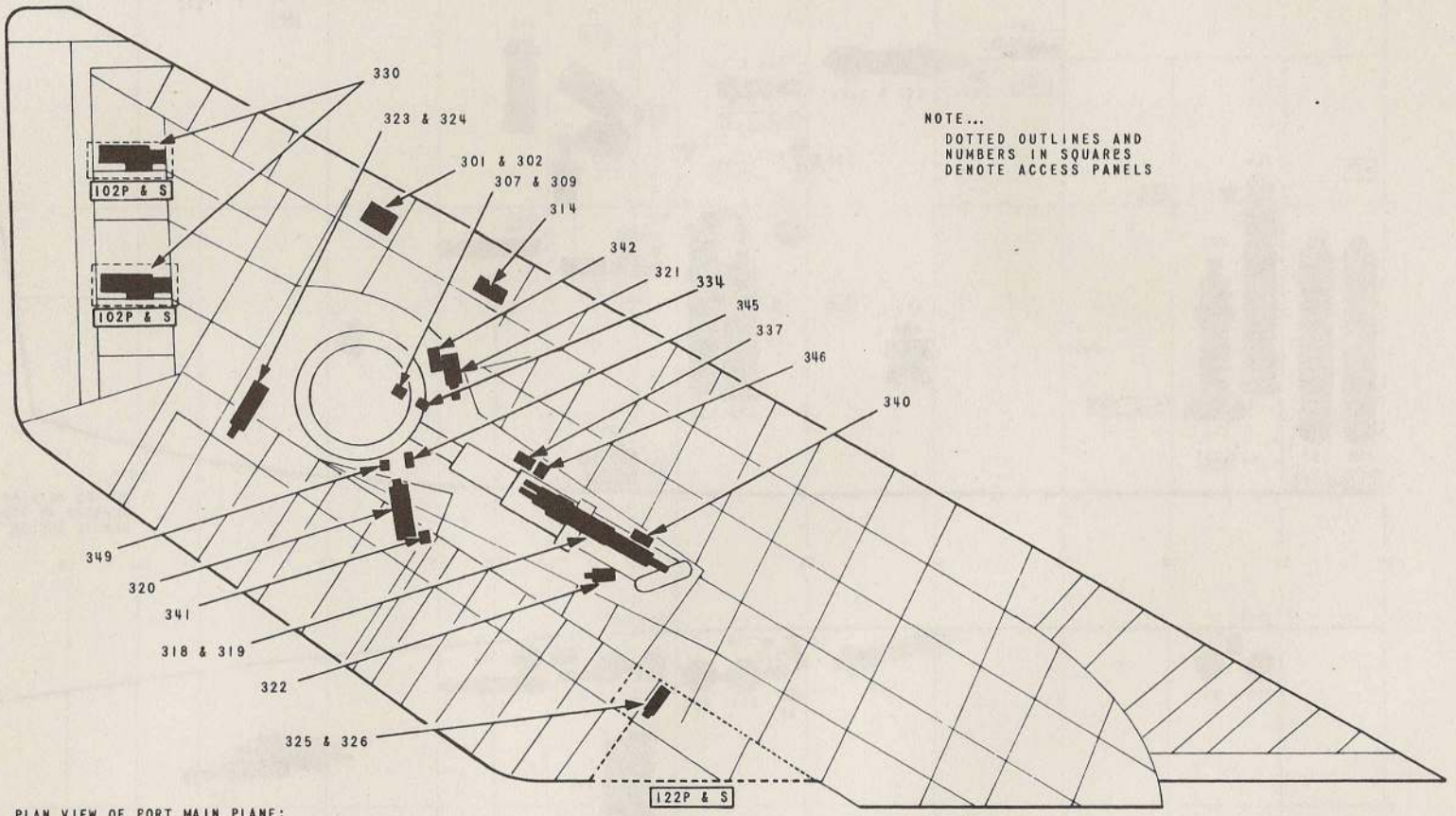

FIG.11. LOCATION OF MAJOR COMPONENTS – MAIN PLANES

3-8511-1

◀ ITEM 334 ADDED ▶

TABLE 9

Major components – main planes

Item No.	Component	Type or Part No.	Qty.	A.P. Reference			
				A.P.	Sect.	Chap.	App.
	Autostabilizers						
301	Aileron – port	Type 214 Mk. 2 Ref. No. 6T/601	1	4685	4	3	
302	Aileron – stbd.	Type 214 Mk. 4 Ref. No. 6T/617	1	4685	4	3	
	Brakes						
306	Port wheel	Refer to Leading Particulars	1	2337	3		
307	Maxaret unit, port	Refer to Leading Particulars	1	1803S	8		
308	Starboard wheel	Refer to Leading Particulars	1	2337	3		
309	Maxaret unit, stbd.	Refer to Leading Particulars	1	1803S	8		
	Filters						
313	Refer to item 345						
314	Aileron autostabilizer P and S	Palmer Aero D10630	1 each				
	Jacks						
318	Main undercarriage – port	1.01085.011		1803	U 11	24	
319	Main undercarriage – stbd.	1.01085.012	1	1803	U 11	24	
320	Main undercarriage – door, P and S	5373	1	105B-0907-16C	T 15	41	
321	Main undercarriage – door lock, P and S	104266001	1	105B-0907-16C			
322	Main undercarriage – down-lock, P and S	Dowty Rotol J5026	1	105B-0907-16C	T 15	33	1
323	Flap – outboard, port	1.00698.006		1803	U 11	30	
324	Flap – outboard, stbd.	1.00698.005		1803	U 11	30	
325	Flap – inboard, port	1.00698.005	1	1803	U 11	30	
326	Flap – inboard, stbd.	1.00698.006		1803	U 11	30	
	P.f.c.u.						
330	Aileron, P and S	Lucas Type 203 Mk. 4	2 each	105D-0405-16AC		2	1
	Valves						
	Inflation						
334	Wheel-brake pressure, P and S	High Pressure Components A58	1 each	4303Z	4	6	1
	Relief						
337	Undercarriage up, P and S	Dowty Rotol H5055	1 each	1803T	13	4	4

continued...

TABLE 9 **Major components - main planes** - *continued*

Item No.	Component	Type or Part No.	Qty.	A.P. Reference A.P.	Sect.	Chap.	App.
	Shuttle						
340	Undercarriage: jack, P and S.	Dowty Rotol H8420		T	13	51	
341	Undercarriage: door jack, P and S	Dowty Rotol 8423		T	13	52	
342	Undercarriage: door-lock jack, P and S	Dowty Rotol 8423					
	Sequence						
345	Main undercarriage c/w filter 8198 P and S	1.00321.001		U	10	6	
346	Undercarriage doors, P and S	1.00322.002	1 each	U	10	5	2
	Relay						
349	Main undercarriage P and S	Electro Hydraulics 6960		F	8	15	
	Swivel couplings						
352	Undercarriage door jack: UP, P and S	C8779Y Mk.A					
353	Undercarriage door jack: DOWN, P and S	C8784Y Mk.A		D	11	28	
354	Undercarriage door jack: EMERGENCY, P and S	C8784Y Mk.A		1803			
355	Flap: O/B jack: UP, port	1.01002.001	1			25	
356	Flap: O/B jack: UP, starboard	1.01002.002	1			25	1
357	Flap: O/B jack: DOWN, P and S.	1.01001.001	1 each			24	2
358	Flap: I/B jack: UP, port	Dowty Rotol 1.00699.005				25	3
359	Flap: I/B jack: UP, starboard	Dowty Rotol 1.00699.006		U	12	25	3
360	Flap: I/B jack: DOWN, port	1.01000.005	1			24	4
361	Flap: I/B jack: DOWN, starboard	1.01000.006				24	4
362	Wheel brakes: port	1.00632.003					
363	Wheel brakes: starboard	1.00632.004					

continued...

TABLE 9 Major components - main planes - *continued*

Item No.	Component	Type or Part No.	A.P.Reference Qty.	A.P.	Sect.	Chap.	App.
	Flexible pipes						
370	jack, UP, P and S (pre Mod.4643)	FP406/369					
	(post Mod.4643)	813502881					
371	jack, DOWN, P and S (pre Mod.4643)	FP406/981					
	(post Mod.4643)	◀ Palmer Aero 813502892	1 each ▶				
372	Undercarriage jack, EMERGENCY, P and S (pre Mod.4643)	FP404/980					
	(post Mod.4643)	813502891					
373	down-lock jack, P and S (pre Mod.4643)	FP404/1032					
	(post Mod.4643)	813502895					
374	Maxaret return P and S (pre Mod.4643)	FP303/362					
	(post Mod.4643)	813502853					
375	Maxaret return P and S (pre Mod.4643)	FP304/361					
	(post Mod.4643)	813502852					
376	Wheel-brake pressure, P and S (pre Mod.4643)	Palmer FP304/367	1 each				
	(post Mod.4643)	Aero 813502854					
377	Aileron jacks I/B and O/B return, P and S						
	(pre Mod.4643)	FP408/384					
	(post Mod.4643)	813502887					
378	Aileron jacks I/B and O/B, pressure P and S						
	(pre Mod.4643)	FP406/383					
	(post Mod.4643)	813502886