

SECTION 10HYDRAULIC SERVICES1. Introduction

The hydraulic system is electrically controlled and operates the following services:-

- (a) Alighting Gear
- (b) Bomb Doors
- (c) Wheel Brakes
- (d) Nose-wheel Steering
- (e) A.A.P.P. Air Intake Scoop

Three engine driven Dowty hydraulic pumps fitted to Nos. 1, 2 and 3 engines feed the system with hydraulic fluid, and, an electro-hydraulic power pack is fitted to cater for emergency operation of the bomb doors, and to recharge the brake system when the main hydraulic pumps are not working. A compressed air system is installed to lower the undercarriage in an emergency.

2. Alighting Gear (Introduction)

The alighting gear comprises of two main wheel units which retract forwards and upward into the mainplanes, and a single nose wheel unit which retracts rearwards into the fuselage, aft of the crew's compartment. The units, operated by hydraulic jacks, are controlled by a push button selector switch on the pilots' centre instrument panel. The position indicator is fitted adjacent to the selector switch.

3. Selector Switch

This switch contains a mechanical locking device to prevent inadvertent selection of the undercarriage "UP" when the aircraft is on the ground. The lock is electrically released when the weight of the aircraft is relieved from the mainwheel units, by the action of two micro switches operated by the mainwheel shock absorber units.

For emergency raising of the undercarriage, the mechanical lock may be released by rotating the "UP" button through 60° thus allowing the "UP" button to be depressed.

IMPORTANT:- After the override has been operated the mechanical lock can only be reset to its original position by use of a Dowty service tool (Part No. S.T. 1157). Any other device such as hat pins, split pins and locking wire etc. will very definitely damage the lock mechanism to such an extent that the lock will become unreliable.

4. Emergency Lowering

The electrical supply to the alighting gear circuits is fed through the normally closed contacts of the micro switch adjacent to and operated by the emergency control valve lever on the starboard side of the fixed portion of the pilots console. Should emergency lowering become necessary, then pulling of the lever to the "EMERGENCY" position will operate the micro switch to isolate the normal alighting gear control circuit and energise relay 160 to maintain the nosewheel steering system. At the same time high pressure air is discharged into all jacks (doors and wheel units simultaneously) to lower the undercarriage.

## 5. Micro Switches

Twenty-three micro switches are employed in the alighting gear control and indicator circuits. All switches are of the DOMIC type C.1831Y series. It should be noted that operation implies depressed making contacts 2 - 3 and 5 - 6. When the plunger is released, the contacts changeover to make contacts 2 - 1 and 5 - 4. Micro switches are identified by code letters which can be found in A.P. 4505 Vol.1 Book 2. Sect. 6. Chapter 11.

## 6. Alighting Gear Operation 'UP' (Normal)

During take off, as soon as the aircraft becomes airborne, the undercarriage shock absorbers will extend. In the case of the main units, this action will operate micro switches P.S.A. and S.S.A. These switches will then enable the undercarriage selector safety lock to be released. The nosewheel shock absorber in extending will operate micro switch N.S.A. to isolate the nosewheel steering system. At this stage, operation of the "UP" selector will energise all undercarriage leg "UP" valves including the main legs' lock release valves. Taking the units separately, the starboard leg commences to retract forwards and upward. At the same time the bogie trim jack shortens thus placing the mainwheels in a stowage attitude. When the leg fully retracts, micro switches S.B.T. and S.U.4. are operated placing a 28V D.C. supply to energise the starboard door "UP" selector valves. As the starboard door closes micro switch S.D.4. is released to prepare for a down selection sequence. When the door fully closes micro switch S.D.4. operates to isolate the main door "DOWN" selector and also puts the indicator lights out. The leg and door "UP" selectors will have a permanent electrical selection maintained.

The retraction sequence for the port main undercarriage is similar to the starboard side.

The nose leg during retraction will operate in the following manner.

As was mentioned earlier in this paragraph, the nosewheel shock absorber extended to make micro switch N.S.A. thus isolating the nosewheel steering system. A centralising device ensures that the nose leg is correctly aligned for retraction and when the "UP" selector has been depressed, the nosewheel commences to retract rearwards and upwards. When the leg has fully retracted, micro switch N.U.4. is operated to changeover the 28V supply from the door "DOWN" selector to the door "UP" selector and the nosewheel doors commence to close. At the instant the doors fully close, micro switches N.D.4. are operated to put the nosewheel indicator light out. A permanent electrical selection is maintained on both leg and door selectors.

## 7. Alighting Gear Operation "DOWN" (Normal)

Depressing the "DOWN" selector, results in relay 161 de-energising which causes all door "DOWN" selectors being energised via three rectifiers. Taking the units separately, the starboard main door commences to open and releases micro switch S.D.4. causing a red light indication on the indicator. When the door is fully opened, micro switch S.D.4. is operated to energise the main leg "DOWN" selector and the main leg commences to lower. In lowering the bogie trim jack extends and releases micro switch S.B.T. and S.U.4. to prepare the system for future "UP" selection sequence.

When the main leg finally lowers a mechanical lock takes place which braces the undercarriage structure for landing. On landing, the weight of the aircraft is transmitted through the shock absorber causing it to shorten and in doing so operates micro switches S.S.A. and P.S.A. to

7. Alighting Gear Operation "DOWN" (Normal) - continued

de-energise the undercarriage selector safety lock thus preventing an "UP" selection.

The lowering sequence for the port main undercarriage is similar to the starboard side. The nose leg during lowering will operate in the following manner.

When the "DOWN" selector is depressed, the nose door will commence to open and in opening releases micro switch N.D.4. thus causing a red light indication on the indicator. When the port and starboard nose-wheel doors are fully opened micro switches S.N.D. †, and P.N.D. †, are operated to energise the nose leg "DOWN" selector and the leg commences to lower. When the leg has fully lowered a geometric lock takes place which braces the undercarriage structure for landing. On landing the weight of the aircraft causes the nose leg shock absorber to shorten and micro switch N.S.A. to be released thus allowing the nose wheel steering system to be operated when required.

8. Alighting Gear Operation Down (Emergency)

Emergency lowering is sufficiently described in paragraph 4 of this section. The procedure for resetting the alighting gear system after such an operation is largely an airframe trade responsibility, the only electrical operation being checks for correct undercarriage control and indication during the subsequent retraction tests.

9. Alighting Gear Indication

Indication of the position of the main and nosewheel units is given by a position indicator type "D" fitted to the pilots' central instrument panel. The position of the wheel units is given by red or green lights as follows:-

1. Three green lights - all wheels locked down.
2. Three red lights - all wheels unlocked.
3. No lights - all wheels locked up.

The indicator is fitted with a day/night screen, and a duplicate set of green lights. The alternative green lights may be operated by a switch on the face of the indicator unit. An airspeed indicator warning device is used to provide visual indication to the second pilot should the aircraft speed fall below 160 knots I.A.S. with the alighting gear retracted. The indicator takes the form of a flag labelled "Undercarriage". This flag when operated 'blinks' through an aperture at the upper face of the instrument.

10. Nose Wheel Steering (Introduction)

The design of the main wheel bogies makes it necessary for a system of power assisted ground steering of the nosewheel, it is achieved by a double acting jack which rotates the nosewheel through  $47\frac{1}{2}^{\circ}$  maximum.

11. Drum Switch

The steering is controlled by a drum switch located on the aft face of the rear pressure bulkhead. The switch is attached to a bracket which permits both the switch body and spindle to be rotated.

The body of the drum switch is connected by a suitable rod to the rudder push-pull control rods and the spindle is moved by a follow up rod connected to the nosewheel.

## 12. Nosewheel Steering Operation

Movement of the rudder pedals in either direction from the control axis will cause the drum switch body to rotate and connect with the spindle contact, thus energising the appropriate steering solenoid, this action causes hydraulic pressure to be applied to one side of the double acting jack. Rotation of the nosewheel will then cause the drum switch spindle to rotate via the follow up mechanism and eventually the spindle breaks contact with the drum. The 28V D.C. supply to the system is supplied via two push buttons situated one on each pilots control column.

## 13. A.A.P.P. Air Intake Scoop

This system has been sufficiently described in Section 5, Part 1.

## 14. Bomb Doors (Introduction)

The operation of the bomb doors is controlled by a number of electrically operated selector valves in the hydraulic system. These valves operate the bomb door jacks. For normal operation, two electrically operated valves are employed which operate from the main hydraulic system. For emergency operation, and for ground use, a third selector valve is used. This selector is fed from an emergency hydraulic power pack. Electrical interlocking ensures that the normal selectors are electrically and hydraulically isolated during operations from the emergency power pack.

The forward and rear ends of the bomb bay are equipped with inflatable seals to assist in the prevention of heat losses from the bomb bay when the bomb doors are closed. The seals are operated by the aircraft pneumatic system, the seals being operated by electrically operated unimatic valves. The circuit is arranged so that the seals are inflated when the bomb doors are closed, and rapidly deflated on the selection of bomb door "Open". This is affected by the bomb door micro switch circuit. A description of main circuit components is given in the following paragraphs.

## 15. Micro Switches

Twelve micro switches, Dowty type C.1831 Y are employed for bomb door position indicator, jettison relay and to connect supplies to the inflatable seals. Four of these switches function to show doors closed and are common to the normal and special stores circuits. They are installed at the inner hinge on the port and starboard bomb doors, two forward and two aft.

Four other switches function at the doors open position in the normal stores circuit.

## 16. Bomb Door Selector Switches.

The bomb doors are controlled by three switches mounted on panel 6P (first pilot's console) namely:-

- (1) Normal bomb door control switch,  
A.3 position rotary selector switch labelled  
OPEN - AUTO - CLOSED.
- (2) Emergency bomb door control switch.  
A double pole change-over switch labelled  
OPEN - NORMAL - CLOSED
- (3) Emergency bomb jettison switch.  
A ~~single~~ <sup>double</sup> pole 3 position switch spring loaded to  
the centre position and labelled JETTISON - OVERRIDE.

NOTE:- Terminal 2 of the JETTISON-OVERRIDE switch is connected to earth. This prevents inadvertent operation of the jettison circuits by a stray positive supply.

#### 17. Indicator.

One magnetic indicator is employed to show the position of the bomb doors and is situated on the pilots panel 1P. With the doors closed the indicator energised 'BLACK' via the respective micro switches from fuse 480. As the doors commence to open the micro switches will also open and will de-energise the indicator to show 'WHITE'.

#### 18. Circuit Operation

The circuit is shown with all bomb door selector switches in the NORMAL position. In this condition the bomb door indicator is energised from fuse 480 via the closed contacts of the bomb door closed micro switches. The solenoids of the bomb doors closed valves are energised by a 28 volt D.C. supply from fuse 602 via the de-energised contacts of relay 162, the de-energised contacts of relay 155 and the de-energised contacts of relay 257. The return to earth for the valve being taken through the de-energised contacts of relay 257.

The bomb doors pneumatic seal valves are energised by a 28 volt D.C. supply from fuse 602, via the de-energised contacts of relay 162, the de-energised contacts of relay 257, and the port and starboard forward bomb doors micro switches.

When the bomb door normal selector switch is placed to the "OPEN" position, the following circuit action will take place:-

- (1) A 28 volt D.C. supply from fuse 602 will be fed via the selector switch to energise relay 162.
- (2) The energising of relay 162 will disconnect the supply to the bomb doors close valve solenoid. Also, the supply to the pneumatic seal valve solenoids will be interrupted, causing the seals to deflate.
- (3) The energising of relay 162 also connects a supply from fuse 602 to the bomb doors open valve solenoid via the de-energised contacts of relay 257. The bomb doors will thus commence to open.

As soon as the doors commence to open the indicator on 1P will be de-energised, thus giving a WHITE indication showing doors open. A permanent electrical selection maintains the doors in the open position.

When the selector switch is placed to "CLOSE", relay 162 will de-energise thus causing its contacts to revert to their original positions. This action will cause the bomb doors open valve solenoids to be de-energised. The CLOSE valve solenoids will now energise and the bomb doors will close. As the doors reach the fully closed position, the bomb doors closed micro-switches will revert to their normal position, thus connecting a supply to the doors seal valves and the seals will be inflated. At the same time, the indicator on 1P will be energised to show "CLOSED" (BLACK).

#### 19. Automatic Selection.

With the bomb doors selector switch in the "AUTO" position, the bomb doors can be opened automatically with a pulse from the N.B.S. installation. This pulse will be fed via the selector switch to energise relay 162. The bomb doors will now open as described in the previous paragraph.

A holding circuit for relay 162 maintains the bomb doors in the "OPEN" position. At the conclusion of bombing operations, the bomb doors are closed by placing the selector switch to the "CLOSE" position.

## 20. Emergency Jettison.

The bomb load may be jettisoned in the event of an emergency by the use of the jettison override switch. NOTE:- The override selection is only fully effective before the bomb doors are fully open.

When the emergency jettison switch is held momentarily to the jettison position relay 155 will be energised and the following circuit action will take place:-

- (1) Closure of relay 155 will cause a holding circuit for itself. *& Relay 163*
- (2) Closure of relay 155 will connect a supply to the coil of a time delay unit.
- (3) Closure of relay ~~155~~ <sup>163</sup> will place a 28 volt D.C. supply to the bomb doors open valve solenoids.
- (4) Closure of relay 155 will connect a supply to the bomb doors open micro-switches in preparation for the jettison action.

When the bomb doors reach the fully open position, the doors open micro-switches will operate to energise the jettison relays. NOTE: The stores will be jettisoned "safe" due to the operation of contacts on relay ~~155~~ <sup>163</sup>.

After a pre-determined interval, during which the stores will be jettisoned, a positive supply will be fed from the time delay switch (terminal 5) to positively block and thus de-energise relay 155. This action causes relay ~~155~~ <sup>163</sup> contacts to revert to their normal position, and the bomb doors will return to the closed position.

## 21. Jettison Override

If after jettison selection, the pilot changes his mind, and decides that jettison action is not required, the action can be stopped by holding the jettison override switch to the override position. This action positively blocks relay 155. Thus, if the override selection is made before the bomb doors are fully open, then no bombs will be jettisoned and the doors will return to the closed position. Wherebomb jettison is already taking place, selection of "OVERRIDE" will stop the jettison sequence and return the doors to the closed position.

## 22. Emergency Switch

In the event of a failure in the main hydraulic system, the bomb doors can be operated by the use of an emergency hydraulic power pack. This unit is dealt with under a separate heading, but circuit operation for emergency bomb doors selection is contained in the following paragraph. When the bomb doors emergency switch is placed to "OPEN", the following circuit action will occur:-

- (1) The bomb doors emergency valve solenoid will be energised with a supply from fuse 638, via the contacts of the control switch and the de-energised contacts of relay 254.
- (2) Relay 257 will be energised with a supply from fuse 638 via the control switch to isolate the normal bomb doors selector valves.
- (3) Relay 259 will be energised with a supply from fuse 638 and causes the 200 volt A.C. 3 phase induction motor driving the emergency hydraulic power pack to start.

/At the instant.....

At the instant the motor commences to run a 28 volt D.C. supply is taken to initiate a time delay switch which is connected to the control side of a hydraulic relief valve solenoid. Two seconds later contacts inside the time delay switch operate to de-energise the relief valve solenoid, and full pump effort is applied to the bomb door jacks. As soon as the jacks have moved to the full extent of their travel pressure will be built up in the hydraulic pipe line, thus causing a pressure switch to close its contacts. This action energised relay 255 breaking the supply to relay 259, thus closing down the power pack motor.

When the emergency bomb doors switch is placed to the "CLOSE" position, the circuit operation is similar to that contained in the preceding paragraphs for "OPEN" selection, except that the supply from fuse 638 is directed to the emergency valve close solenoid.

#### 23. Emergency Hydraulic Power Pack

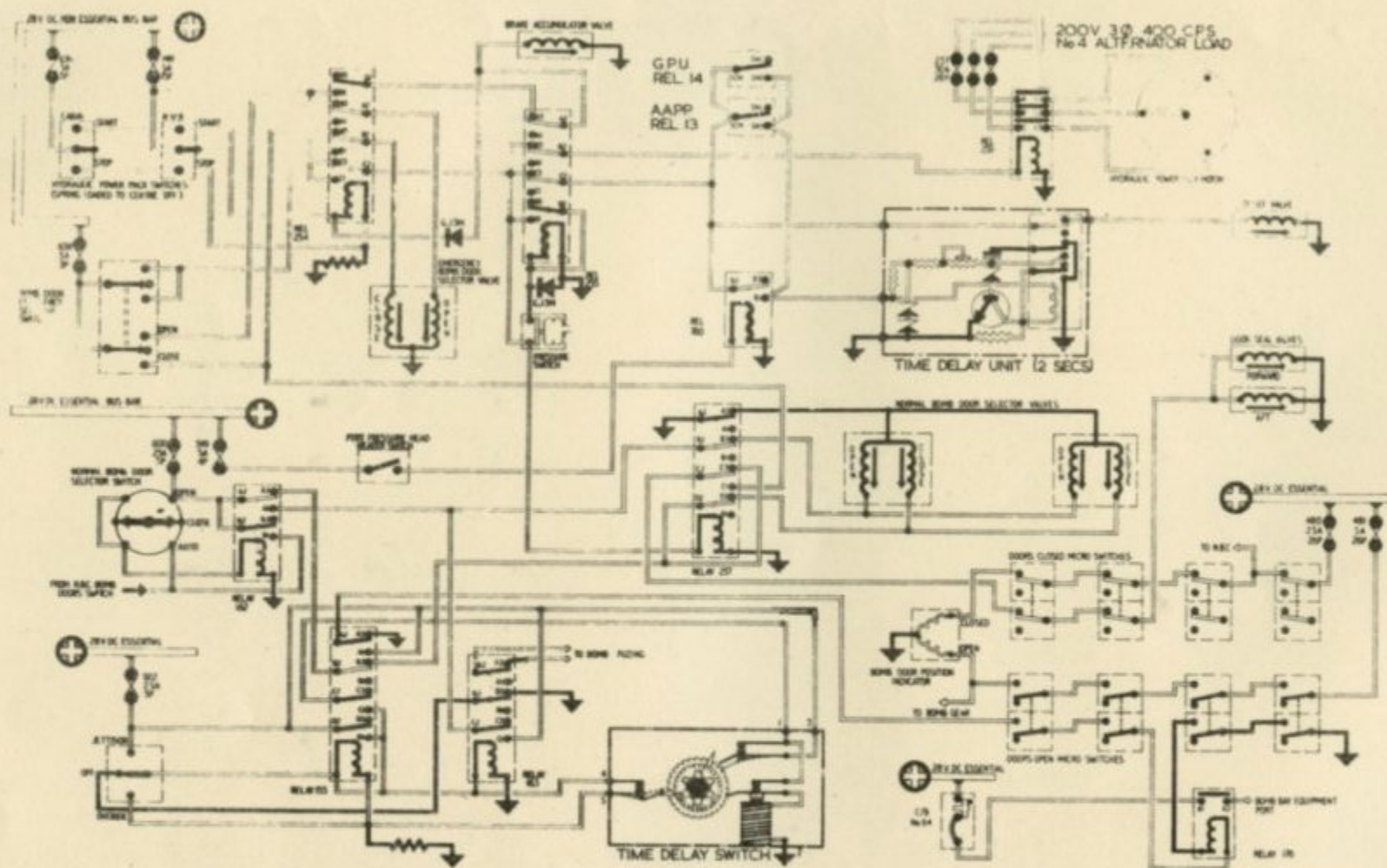
Emergency hydraulic power pack, driven by a 200 volt 3 phase 400 cycles induction motor is installed on the starboard side of the bomb bay. The unit consists of a high pressure radial pump built in to a cylindrical casing, to which the electric motor and the filter assembly are mounted. The operating pressure is 4,000 lbs. per square inch which is regulated by a pressure switch incorporated in the electrical circuit to the motor. Since the starting torque of an induction motor is poor, the motor must start up "off load". To achieve this a relief valve connected between the pressure and return lines of the hydraulic circuits opens during initial starting to enable the pump output to idle.

#### 24. Controls

The emergency hydraulic power pack is provided for emergency bomb doors operation, and can also be used on the ground for re-charging the brake accumulators. The power pack is switched on from one of three positions, namely:-

- (1) By operation of the "EMERGENCY" bomb doors selector switch on the port console 6P.
- (2) The emergency hydraulic power pack "STOP-START" switch on ~~the~~ 1P port console 6P.
- (3) The emergency hydraulic power pack "STOP-START" switch adjacent to 16p in the nosewheel bay.





BOMB DOOR & EMERGENCY HYDRAULIC POWER PACK CIRCUIT

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