Part I—Description and Management of Systems

Chapter 13—Other Aircraft Controls

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Undercarriage System

1 Undercarriage—general

(*a*) The undercarriage mainwheel units are four-wheel, eight-tyred bogies and the nosewheel unit is twin-tyred. The nosewheel is steerable. When undercarriage retraction is selected, the bogies pivot, to be parallel to the main oleos.

(*b*) Hydraulic pressure operates the undercarriage doors, extension mechanism, bogie trimmers and down locks, through electrically controlled selector valves ; sequencing of the operation is controlled by micro-switches.

2 Undercarriage normal control and operation

(*a*) Undercarriage raising and lowering is controlled by the UP and DOWN buttons (B/14) on the engine instruments panel.

(*b*) When the weight of the aircraft is on its wheels, a safety device prevents the undercarriage from being raised. This device may be overridden, however, by rotating the flange of the UP button slowly and gently clockwise, through approximately 60°, at the same time exerting positive forward pressure. On subsequent DOWN selection, ensure that the safety-clip is inserted prior to landing.

WARNING. In spite of this safety device, the UP button must always be regarded as operative, as the protective devices may not function.

(*c*) Excessive force should not be used on the UP button when making a normal selection.

(*d*) If the UP button cannot be depressed normally, the emergency override facility may be used to raise the undercarriage in flight, on condition that the following requirements are met:

(i) Excessive force must not be used to depress the UP button after rotating the override flange.

(ii) No attempt must be made to return the override flange to its normal position once it has been moved.

(iii) The safety guard must be fitted on the UP selector button before landing.

(iv) Operation of the emergency override must be recorded in the F700.

(*e*) If, during pre-flight checks, it is found that the override has been operated, the aircraft must not be flown. No attempt must be made to reset the override when the electrical system is live.

(*f*) Under normal operating conditions, if all components of the undercarriage do not retract completely after an UP selection has been made, no further attempt must be made to raise the undercarriage. The undercarriage should be lowered by use of the normal system, or emergency system if necessary, and the aircraft landed as soon as possible.

(*g*) If all components of the undercarriage do not lock down after a normal DOWN selection when the hydraulic pressure is normal, operate the emergency override before re-cycling the undercarriage. Post-Mod. 1280 (re-positioning the bogie micro-switch), the undercarriage can be re-cycled normally.

3 Undercarriage position indicator

(*a*) The undercarriage position indicator (B/24) is on the pilot's centre panel and indicates as follows: —

All wheels locked up and doors closed	No lights
Wheels unlocked	Three red lights
Wheels locked down	Three green lights

(*b*) A flag indicator, marked U/C, is incorporated in the co-pilot's ASI and shows if the speed is reduced below 160 knots when the undercarriage is not locked down. The absence of the indicator must not be taken as proof that the undercarriage has locked down. When Mod. 1377 is embodied (two-needle type ASI) the indicator is deleted.

4 Nosewheel steering and centring

(*a*) *Nosewheel steering*

(i) Nosewheel steering is hydraulically operated and electrically controlled. The nosewheel can move through $47\frac{1}{4}°$ on either side of centre and movement is controlled by a pushbutton (A/2) on either pilot's control column handle and by movement of the rudder pedals.

(ii) With the steering pushbutton depressed, rudder pedal movement causes the nose to move in the appropriate direction ; the operation of a drum switch cuts off the electrical supply to the selector valve when the selected angle is achieved.

(iii) The circuit is isolated by a micro-switch when the nosewheel leaves the ground.

(*b*) *Nosewheel centring*

Nosewheel centring is hydraulically operated, the main delivery pressure passing through a pressure regulator valve direct to the centring jack. The centring system operates automatically when nosewheel steering is not in use, or when the nosewheel is off the ground.

(*c*) *Nosewheel steering override*

A nosewheel steering NORMAL—OVERRIDE switch, wire-locked at NORMAL, is located on the fuse panel behind the 1st pilot. If the micro switch referred to in (*a*)(iii) fails, setting the switch to OVERRIDE will energise the nosewheel circuit, which will function in the normal manner. If the switch is used on the ground, it must be set to NORMAL before the undercarriage is raised after take-off.

5 Undercarriage emergency air system

(*a*) The emergency air supply for the main and nosewheel lowering is contained in two separate bottles in the nosewheel bay. The two controlling valves are mechanically linked and are operated by a single EMERGENCY AIR—U/C handle (B/26) on the right of the throttle quadrant. BC Mod. 56 provides a guard for the handle. handle.

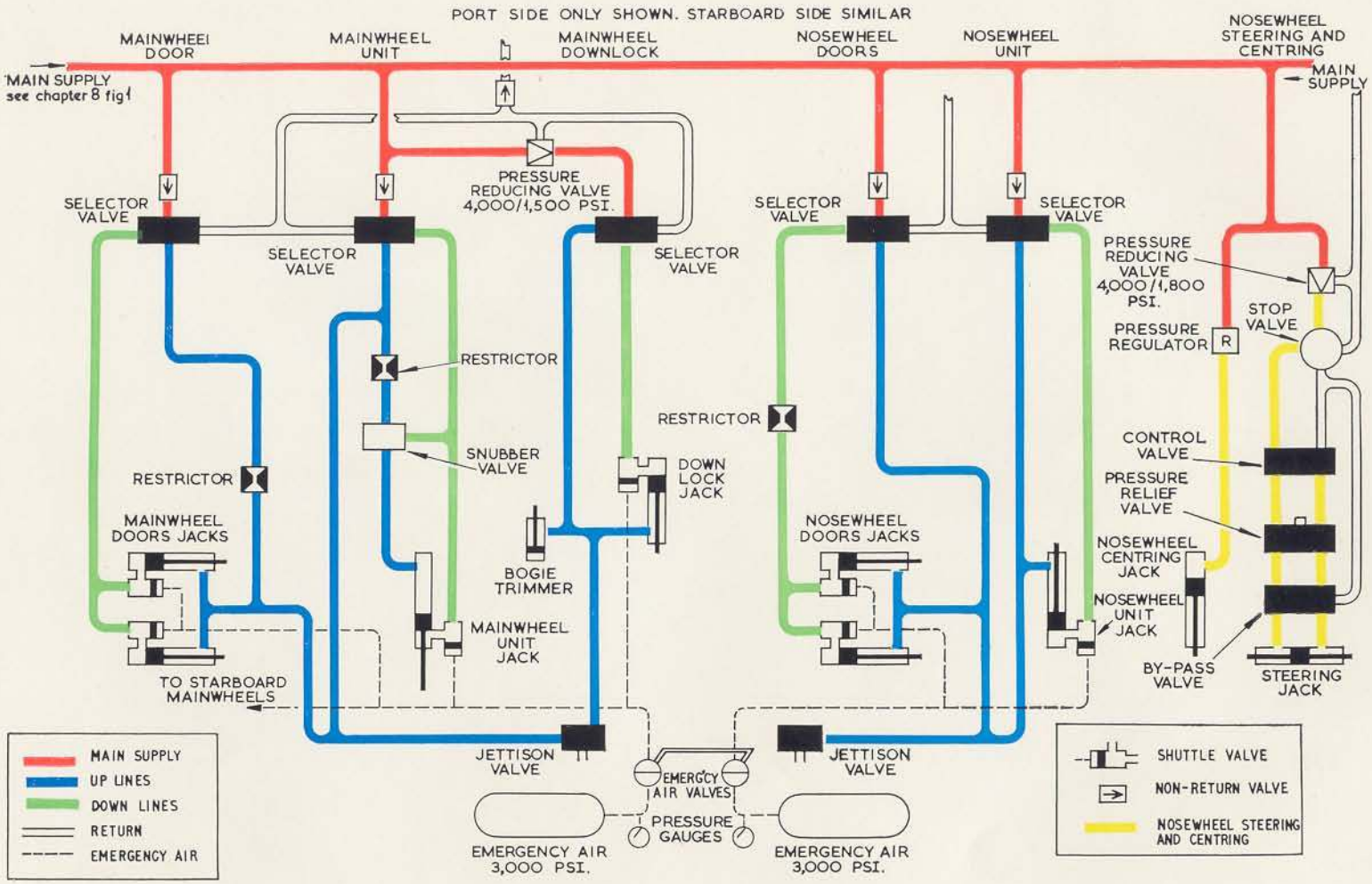

Fig 1 Undercarriage Hydraulic System

(*b*) When the handle is pulled to its full extent, air from the bottles passes to shuttle valves and jettison valves, expelling hydraulic fluid from the lines and allowing air to pass to the jacks. The undercarriage will then lower, regardless of the position of the normal selector. It is, however, recommended that normal DOWN selection be made first, so that any residual hydraulic pressure may be used to assist in lowering the undercarriage.

(*c*) Selection of emergency air also isolates the normal selector solenoids, so that the undercarriage cannot again be retracted once the emergency selector has been operated. Nosewheel steering, however, is still available, provided that hydraulic pressure is normal.

6 Undercarriage emergency operation

(*a*) If, after normal DOWN selection, three green lights are not obtained, first check the main hydraulic pressure. If this is normal, check the bulb changeover, the indicator fuse and the selector fuse.

(*b*) If hydraulic pressure is low, or if no electrical fault can be found, the undercarriage must be lowered by emergency air, after first re-selecting DOWN on the normal control. If practicable, operation of the emergency air should be left until the aircraft is over the terminal airfield so that lowering may be visually monitored by experts and if any part of the aircraft falls away it can be recovered and examined.

(c) An exception to this rule is the case where *one* unit indicates locked up, when a mechanical failure is possible and emergency air may not release this unit. If the locked-up unit is the nosewheel, emergency air may be used immediately but, if a mainwheel is involved, consideration must be given to ordering the rear crew members to abandon the aircraft before emergency air is selected.

(*d*) If, after using emergency air, loud bangs and heavy vibration occur, it may be that the undercarriage structure has been damaged. The indication of three greens may be suspect under these conditions.

(*e*) If the undercarriage is successfully lowered using the emergency air system, a certain amount of hydraulic fluid will be lost from the hydraulic system. The aircraft should be stopped as soon as possible after clearing the runway and the engines should be shut down.

Wheelbrakes

7 Wheelbrakes—general

(*a*) Each main undercarriage wheel has a maxaret brake unit. These are designed to help the pilot, when using maximum braking, not to lock the wheels. The units can only come into operation if the wheels are rotating.

(*b*) The brake units are hydraulically operated, the main system pressure being reduced to 2,500 PSI at the brakes.

Two accumulators, charged to 4,000 PSI provide a reserve of pressure for brake operation. These accumulators can be recharged by the hydraulic power pack (see Chapter 8). A failure of one accumulator does not prevent the other from supplying pressure to both sets of wheels. A drop in air pressure in one or both accumulators would be disguised as long as the main hydraulic pressure remains normal.

(*c*) The pressure at the brakes is shown on two dual pressure gauges in the nosewheel bay and the pressure at the hydraulic accumulators is shown on the triple pressure gauge (B/7) on the engine instruments panel. The accumulator air pressure gauges and charging points are also in the nosewheel bay, together with two manually operated pressure release valves, for releasing any residual hydraulic pressure in the accumulators.

(*d*) A parking brake is provided, which operates through a bowden cable to open simultaneously all the hydraulic valves in the brakes control valve.

8 Wheelbrakes operation

(*a*) Brake selection is controlled by toe-buttons on the rudder pedals. The pressure delivered to the brakes is proportional to the force applied to the toe-buttons ; when this pressure is released, the relay in the brakes control valve closes and the fluid from the brakes is returned to the reservoir.

(*b*) The aircraft must be firmly on the ground before the brakes are applied, as the maxaret units do not operate until the wheels are rotating. As a safeguard against locking the wheels during a bounce the maxaret units do not cut out until 4 seconds have elapsed. On dry runway surfaces the maxaret units will normally prevent the wheels locking if excessive brake pressure is applied but, unless the shortest possible stopping distance is required, more gentle use of the brakes is recommended. On wet, flooded or icy surfaces drastic reduction of braking efficiency must be expected. Continuous application of brake pressure during a slip or skid can lead to wheel locking and the scuffing and possible bursting of tyres, particularly during the landing run. Under these conditions it is recommended that light intermittent braking action is commenced as soon as the nosewheel is firmly on the ground. If slip or skid or difficulty in keeping straight is experienced, release the brakes momentarily. The pressure may be increased and held continuously as soon as there is no tendency to slip or skid.

(*c*) The parking brake is applied by turning and pulling the lever (A/44) on the left of the throttle quadrant.

9 Brakes accumulator charging

(*a*) If it is necessary to recharge the accumulators in flight, or on the ground when the engines are not running, this may be done by the hydraulic power pack (see Chapter 8).

(*b*) To charge the accumulators, either of the START—STOP switches, on the port console (C/30) or in the nosewheel bay, should be set to START. This action opens the shut-off valve and admits fluid to the accumulator circuit. A pressure switch will operate to cut off the supply when the pressure reaches 4,000 PSI, or the supply may be stopped at any time by setting the control switch to STOP.

Airbrakes and Brake Parachute

10 Airbrakes—general

(*a*) Slot-type airbrakes are contained in the mainplane, above and below the engine air intakes. They are electrically controlled by two motors, using 112-volt DC: the port motor is supplied by the battery bus-bar and the starboard motor by the No. 3 generator bus-bar.

(*b*) The airbrakes have three extended positions:

MEDIUM DRAG	35°
HIGH DRAG (undercarriage up) . .	55°
HIGH DRAG (undercarriage down) . .	80°

The airbrakes must not be operated on the ground when the bomb-door access panels are open.

11 Airbrakes control and operation

(*a*) The airbrakes are operated and controlled by the ganged switches (A/41) marked IN—MEDIUM DRAG—HIGH DRAG at the rear face of the throttle quadrant ; the button in the centre of the switch must be pressed in before the switch can be moved to HIGH DRAG.

(*b*) Two electric motors operate the airbrakes during extension from IN to HIGH DRAG and during retraction from HIGH DRAG to MEDIUM DRAG. Should one motor fail in this range of movement the remaining motor will operate the airbrakes at reduced speed. During retraction from MEDIUM DRAG to IN only one motor normally operates. Should the operative motor in this range fail, the AIR BRAKE CHANGEOVER switch (A/39) marked NORMAL—EMERGY, on the starboard side of the throttle quadrant should be moved to the EMERGY position to bring into use the serviceable motor and complete retraction.

(*c*) *Airbrakes indicator*

An AIRBRAKES magnetic indicator (A/19) on the top left-hand corner of the engine instruments panel indicates black when the airbrakes are fully retracted and white when they are not fully retracted.

12 Brake parachute—general

(*a*) A brake parachute is installed in the tail cone, aft of the rudder, to provide additional braking during the landing run.

(*b*) Operation of the parachute is electrically controlled by a split two-pole JET'N-STR'M PARA switch (A/14) on the 1st pilots' instrument panel. When the switch is returned from STR'M PARA to JET'N the parachute is jettisoned. A magnetic indicator adjacent to the external intercomm point, visible when a small access panel on the starboard side of the rear fuselage is raised, shows black when the parachute door is locked and all switches and relays in the circuit are at their correct setting ready for the stream operation.

(*c*) Should an unselected stream occur, the action of the door opening without electrical selection will cause a supply to be fed to the jettison release unit, and the parachute will be jettisoned automatically.

13 Use of the brake parachute

(*a*) The normal maximum cross-wind component for using the brake parachute is 20 knots. In higher cross-winds, a swing is liable to develop and, in such cases, if the parachute is used it should be jettisoned at the first sign of a swing.

(*b*) As soon as the mainwheels are on the runway and the speed is below 135 knots, select STR'M and place the nosewheel on the ground before the parachute develops. This should take about 5 seconds. The braking effect is very high at speeds above 70 knots.

(*c*) If the parachute fails to stream, and it is decided to overshoot, the parachute must be jettisoned immediately.

(*d*) The parachute should normally be jettisoned when at taxying speed and before the aircraft is stopped, but it can be jettisoned safely at any time during the landing run. If it is necessary to turn off the runway before jettisoning the parachute, it must be jettisoned before the aircraft is tail to wind.

WARNING. Personnel must keep well clear when the parachute-compartment door is tested, since it opens with considerable force.

(*e*) *Power supplies*

The brake parachute operation uses 28-volts DC.

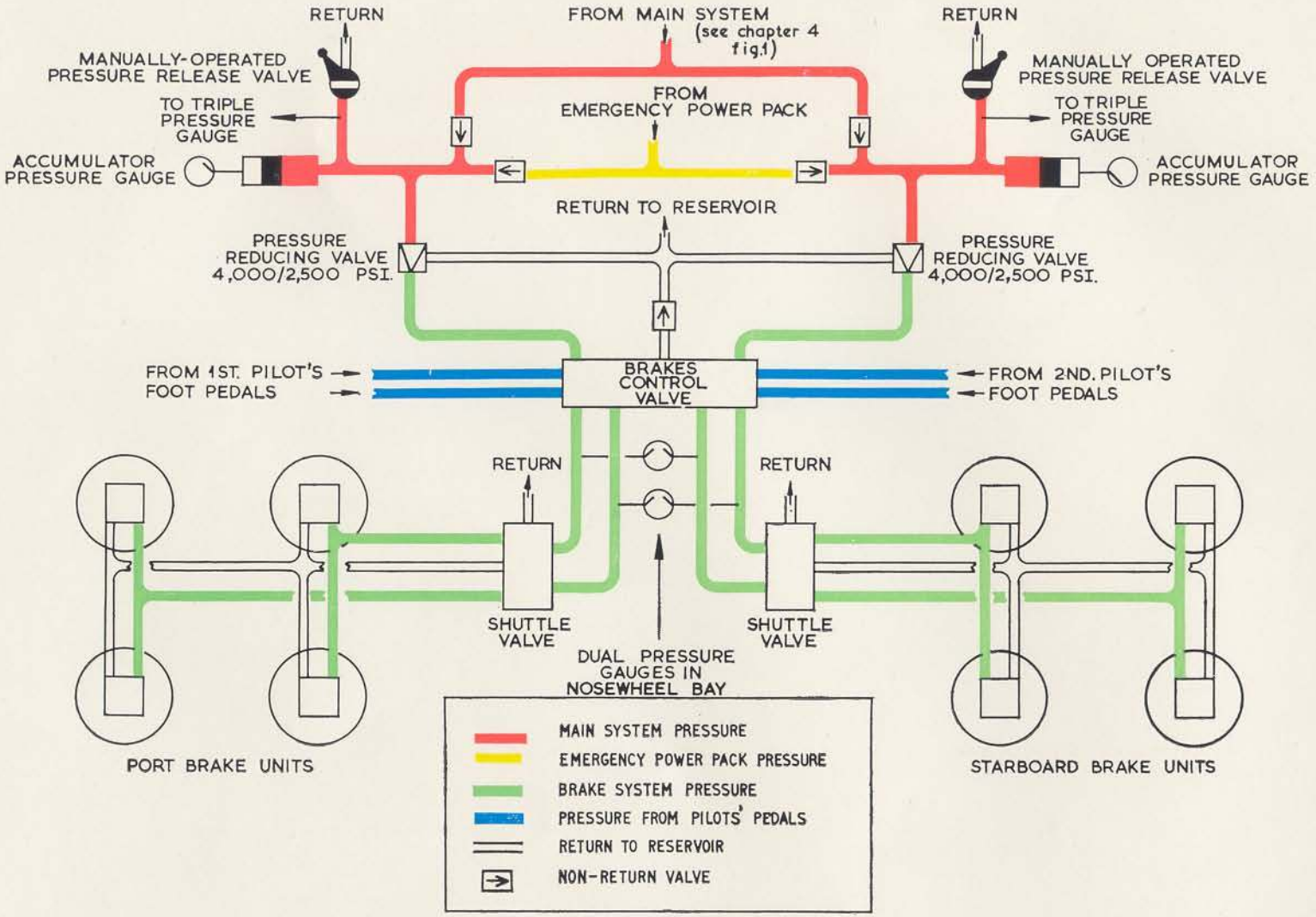

Fig 2 Brakes System