CHAPTER 9

HYDRAULIC SYSTEM AND LANDING GEAR

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CHAPTER 9 HYDRAULICS, LANDING GEAR AND FLAPS

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CHAPTER 9

HYDRAULIC SYSTEM AND LANDING GEAR

General Description

The hydraulic power system includes a main and emergency system independently supplied with hydraulic fluid from the reservoir.

The main hydraulic system provides hydraulic power to operate the following:

- Landing gear
- Wheel brakes
- Nose wheel steering
- Flaps
- Spoilers
- Stall protection stick push.

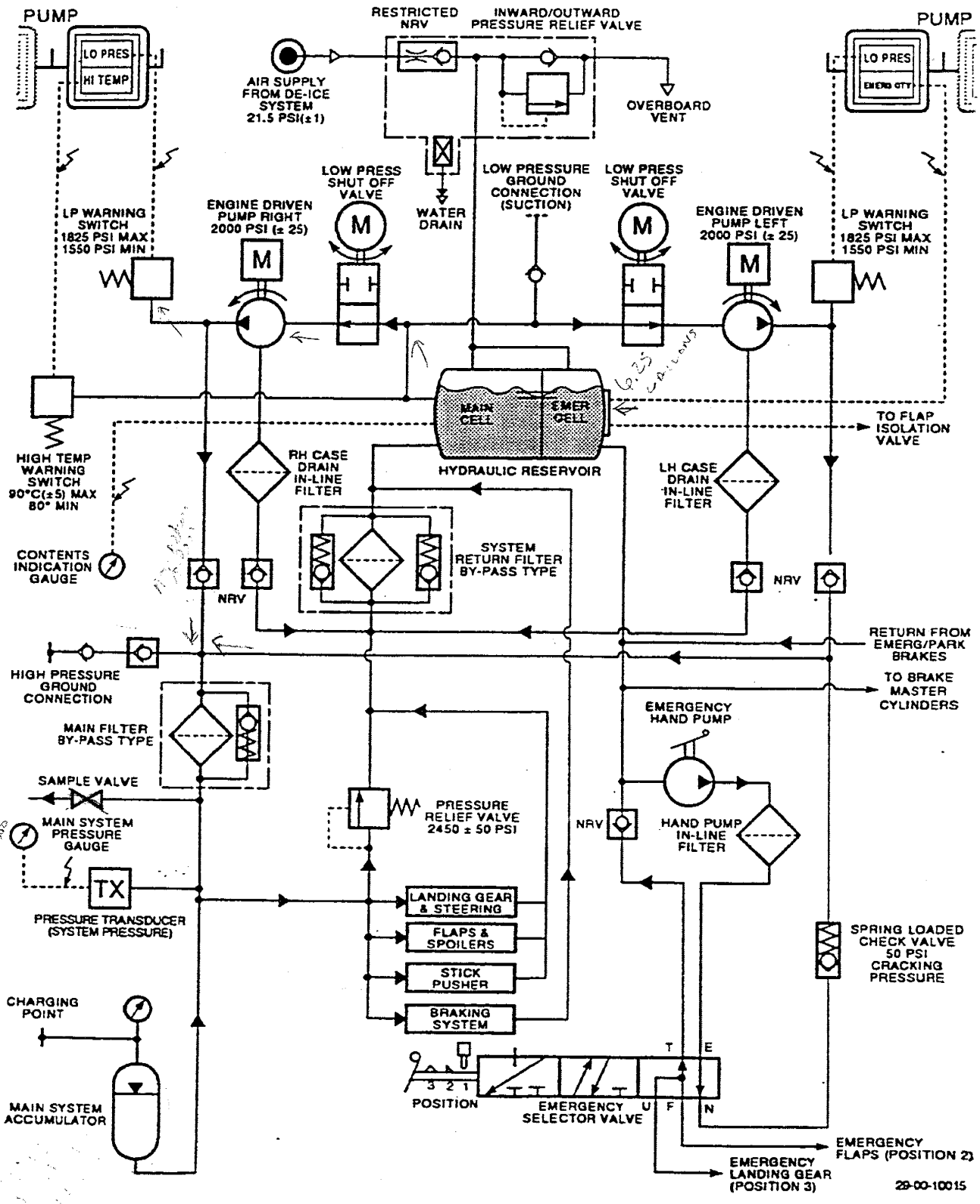
The emergency hydraulic system provides hydraulic power to operate the flaps and landing gear to the down position only.

1. Hydraulic Power Supply

A. Main Sub-System

The main sub-system is supplied with power from two engine driven pumps, one installed on each engine. The primary components in the normal system are:

- Reservoir
- Engine driven pumps
- Low pressure shut-off valve
- Low pressure warning switch
- Non return valves
- Ground test connections
- Filters
- Pressure indication
- Accumulator
- Pressure relief valve.



Hydraulic System

(1) Reservoir

Hydraulic fluid is stored in a reservoir installed in the hydraulic bay of the ventral pod. The reservoir contains both a main and an emergency cell interconnected at high level by a fluid transfer tube. Both cells are filled from the one filler cap installed in the main cell.

The reservoir is pressurized with engine bleed air, through a non-return valve, to 21.5 psi (±1psi). This will ensure an adequate supply of hydraulic fluid and prevent cavitation at the pump inlets.

An inward/outward pressure relief valve is installed to prevent negative differential pressure in the reservoir during aircraft descent. This pressure relief valve also regulates reservoir over pressure. The valve opens inwards at -1 psi and outwards at 26 psi (±1).

The contents of the main cell are shown on a contents indication gauge in the lower centre panel. A contents sight glass is installed on the emergency cell side of the reservoir, both cells are provided with a drain valve.

An overheat detector is installed in the main cell. If the temperature of the fluid reaches 90°C (±5°C) it will be indicated by:

- A CAP [HYD] (amber) caption
- A lower centre panel [HI TEMP] (amber) caption.

When the temperature of the fluid falls back to 80°C the switch will de-activate and the captions will go off.

(2) Engine Driven Pumps

Two engine driven pumps (one installed on each engine) provide hydraulic power for the main system. The outputs from each pump are mixed to give a single supply pressure of 2000 psi (± 25 psi). If a pump or engine fails to operate then the remaining serviceable pump is able to supply sufficient pressure to operate all the related systems.

(3) Low Pressure Shut-Off Valve

A hydraulic Low Pressure (LP) shut-off valve is installed in the supply pipe to each engine driven pump. The LP valve is electrically operated. Each LP valve is controlled by a two-position left or right LP VALVES switch installed in the HYDRAULICS section of the lower centre panel. A split caption is installed above each switch.

When the LP valve is in the normal open position there is no indication on the caption. Whilst the valve is in transit between open and shut, the caption will show black cross-hatch. When the valve is in the shut position the caption will show SHUT (white). If a failure occurs when the valve is in transit, between the open and shut positions, it will be indicated by:

- A CAP HYD (amber) caption
- A left or right (black cross-hatch) transit caption on the lower centre panel remaining on.

Each LP shut-off valve will also move to the shut position when the associated engine CONDITION lever is moved to the FEATHER position (this also closes the associated fuel LP valve).

Closing the hydraulic LP valve stops the supply of fluid to the hydraulic pump. It is not hazardous to run the hydraulic pump in the dry condition. Refer to the Abnormal Drills when the hydraulic LP valve is closed and the engine is running. The LP valve has a pressure relief facility to prevent pressure build-up in the LP supply line to the pump, which may occur due to a failure of the pressure line NRV.

(4) Low Pressure Warning Switch

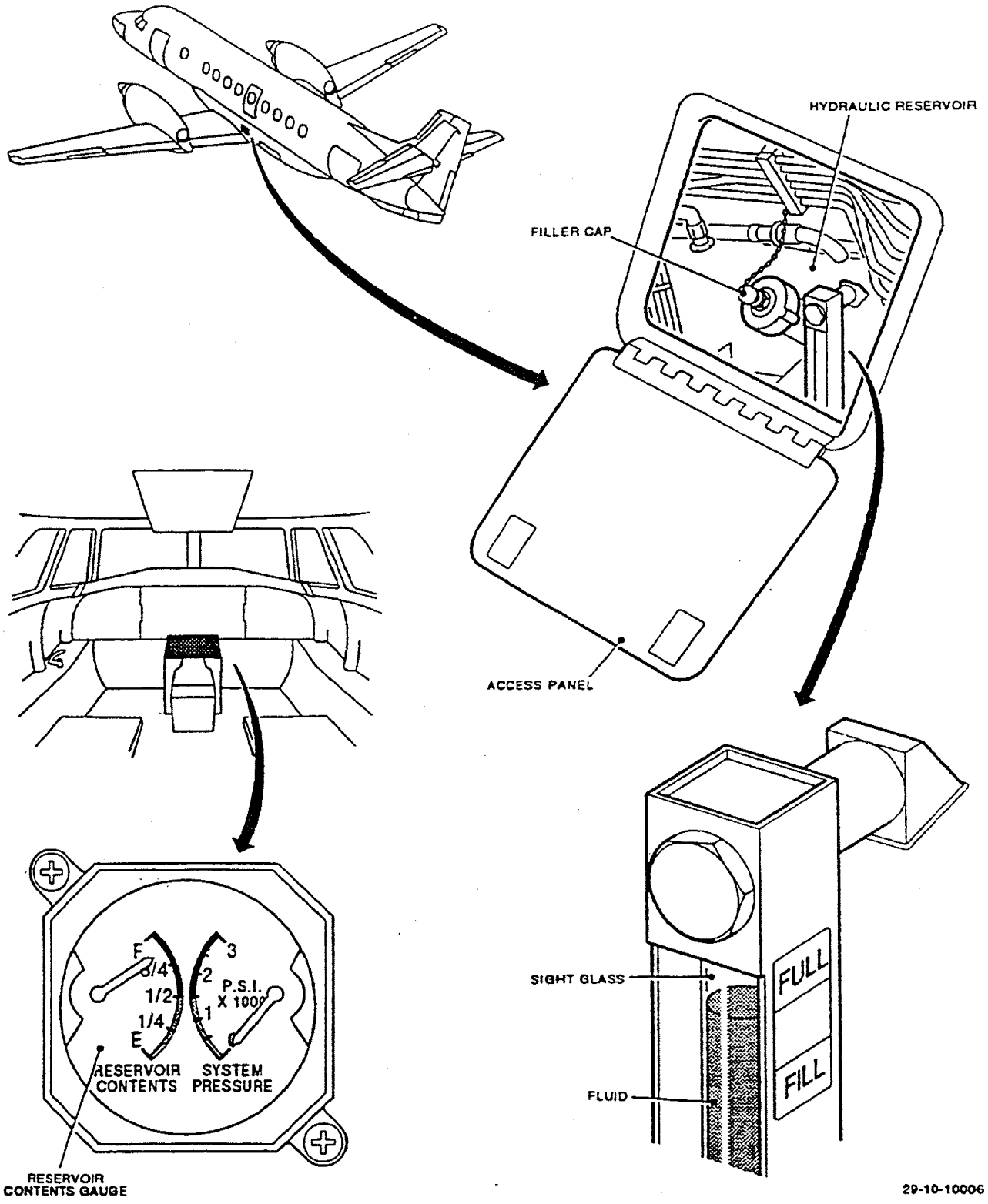
When the output pressure of the hydraulic pump decreases to 1550 psi the LP warning switch operates. The LP warning switch will cause the following indications:

- A CAP HYD (amber) caption
- A lower centre panel PUMP, LO PRES (amber) caption.

The caption goes off when the output pressure of the hydraulic pump rises above 1825 psi.

(5) Non-Return Valves

A non-return valve is installed in the supply pipe from each hydraulic pump. The non-return valve prevents hydraulic fluid flowing back into a non-operating pump.



Hydraulic Reservoir Indications

(6) Ground Test Connections

A LP ground test connection is installed downstream of the hydraulic pumps supply pipe connection. The ground test connections are used to attach a ground test rig to the aircraft, this allows maintenance checks without operating the hydraulic pumps.

(7) Filters

A main filter is installed downstream of the HP connection, and a system return filter is installed in the reservoir return line. A sampling valve is installed downstream of the main filter and is used to take samples of hydraulic fluid for contamination test.

(8) Pressure Indication

A pressure transducer is installed downstream of the sampling valve. The output signal from the pressure transducer is transmitted to a system pressure gauge installed in the lower centre panel and indicates the system pressure. This dual indicator also shows the contents of the main cell in the hydraulic reservoir. The indicator shows these ranges:

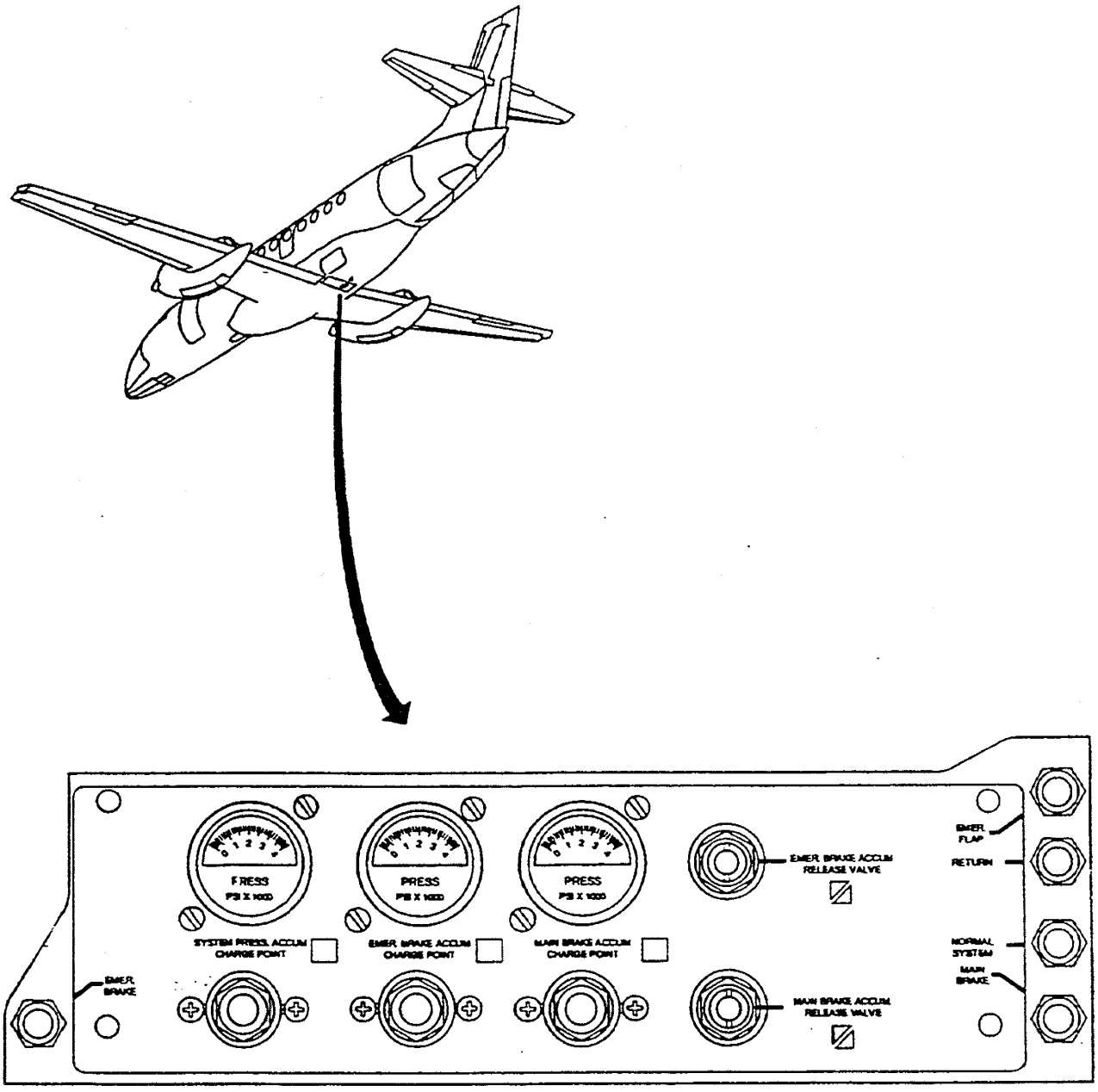
HYDRAULIC CONTENTS:	An amber band between 0 and 1/2.
	A green band between 1/2 and full.
HYDRAULIC PRESSURE:	An amber band between 0 and 1550 psi.
	A green band between 1550 psi and 2450 psi.
	A red line at 2450 psi.
	A red band between 2450 psi and 3000 psi

(9) Accumulator

A main system accumulator, pre-charged to 450 psi, with dry air or nitrogen, stores hydraulic fluid at a pressure of 2000 psi. Main accumulator pressure is indicated on a gauge adjacent to the accumulator charging point, installed in the hydraulic bay and cannot be read during flight.

(10) Pressure Relief Valve

If the system pressure rises to 2450 psi (±50) a Pressure Relief Valve (PRV) opens. When the PRV opens the hydraulic fluid goes back to the normal cell of the reservoir. When the system pressure falls below 2450 psi the PRV closes automatically.



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Accumulator Charge Panel

B. Emergency System

The emergency hydraulic system will supply hydraulic power to lower the landing gear and flaps. The primary components in the emergency system are:

- Handpump
- Emergency selector
- Emergency cell indications.

(1) Handpump

Hydraulic fluid from the emergency cell of the reservoir is sent to an emergency handpump. The emergency handpump is installed under the flight deck floor between the pilots seats. The handpump handle is installed on the left side of the co-pilots seat.

Access to the handpump is through a hatch in the floor. The handle is inserted into the handpump and operated to provide pressure to the selected system.

WARNING: TO AVOID THE LOSS OF HYDRAULIC FLUID THROUGH AN UNDIAGNOSED LEAK IN THE NORMAL SYSTEM THE HANDPUMP MUST NOT BE USED IN FLIGHT WITH THE EMERGENCY SELECTOR SET TO NORMAL.

(2) Emergency selector

The emergency handpump is connected to an emergency hydraulic selector valve installed under the flight deck floor between both pilots seats. The selector valve has three positions NORMAL, FLAPS DOWN, and GEAR DOWN.

With the selector valve in the NORMAL position hydraulic fluid can be pumped into the main hydraulic power generation system. This hydraulic fluid is used for maintenance checks and to increase hydraulic pressure in the wheel brake system before engine start.

In the FLAP DOWN and GEAR DOWN positions the hydraulic fluid can only be pumped into the flap or landing gear emergency systems.

The selector valve must only be moved away from NORMAL when called for in the aircraft drills. In flight, once FLAP DOWN or GEAR DOWN has been selected, the selector cannot be returned to the NORMAL position. The selector may move between FLAP DOWN or GEAR DOWN as required. However, a low level sensor in the reservoir emergency cell will, when activated, signal the flap isolation valve to close. This will allow only GEAR DOWN to be selected and operated.

(3) Emergency Cell Indications

A fluid low level sensor is installed in the reservoir emergency cell and activates when the fluid level in the cell is 135% of that required to lower the landing gear using the handpump.

To ensure that the remaining emergency fluid is only used to lower the landing gear, and not the flaps, a flap isolation valve will move to the shut position. The flap isolation valve is located in the hydraulic bay.

The fluid low level sensor will give the following indications:

- A CAP HYD (amber) caption
- A lower centre panel caption.

A contents sight gauge is installed on the emergency cell side of the reservoir, this gauge cannot be read in flight.

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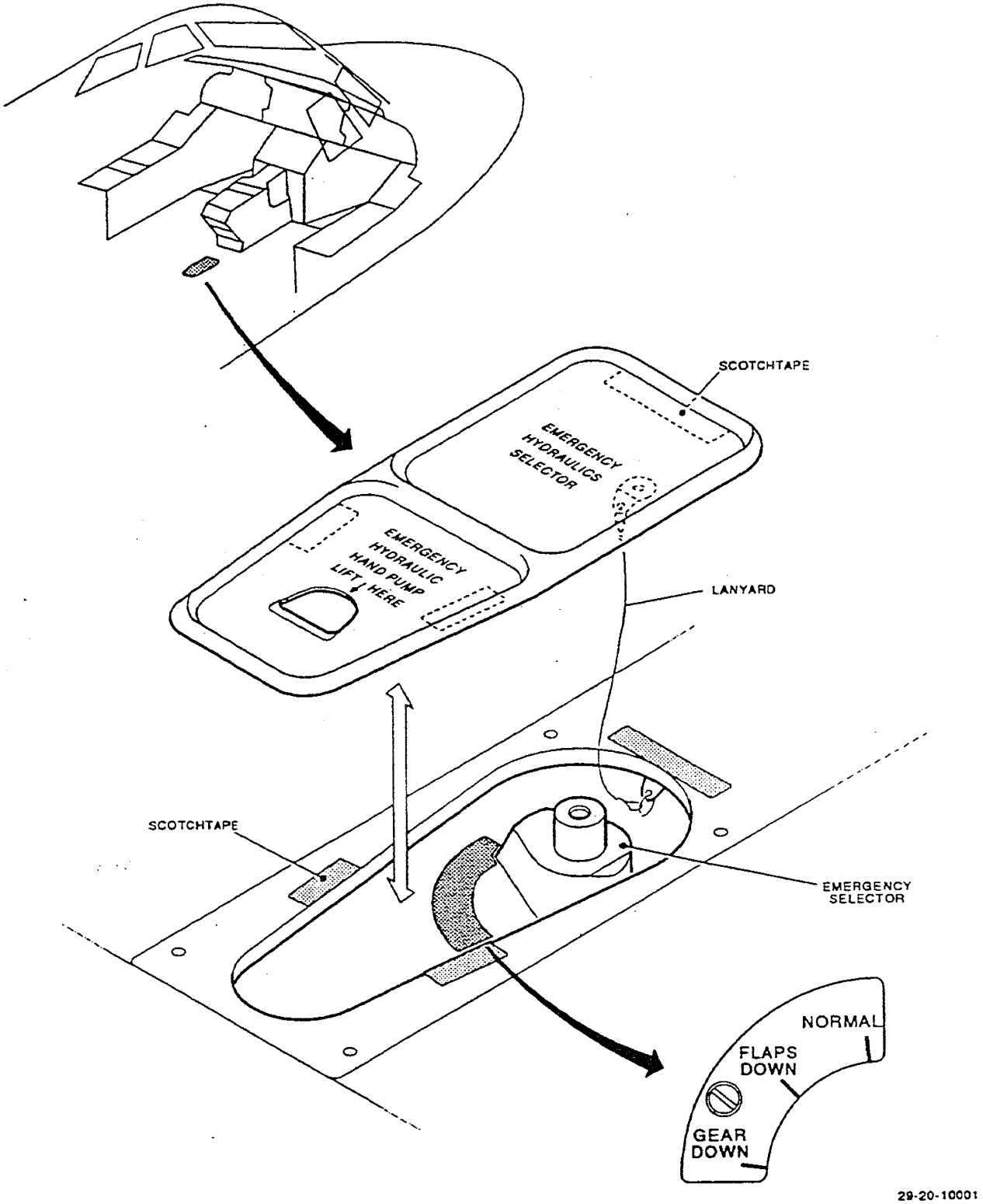


Emergency Hydraulic System

2. Landing Gear

A. General

The aircraft has a tricycle landing gear with two wheels on each leg. Each landing gear retracts forward; the nose gear into the front fuselage and the main gears into the underside of the engine nacelles. All landing gear doors are mechanically operated by landing gear movement. The retraction, lowering and locking are all achieved by hydro-mechanical means.

B. Main Landing Gear

The main landing gear retracts forward, raised and lowered by a hydraulic actuator. The actuator is supplied with 2000 psi pressure from the hydraulic power generation system. The downside of the actuator is equipped with normal and emergency hydraulic supply connections whilst the upside is only equipped for normal hydraulic operation.

The main gear legs are held in the retracted or extended position by 2000 psi hydraulic pressure and secondary mechanical up and down locks which are hydraulically released.

Duplicated microswitches on the dragstay and a single microswitch on the uplock hook (operated by strikers) indicate the gear position. Each main gear leg is fitted with a weight-on-wheels microswitch, operated by the movement of the torque links.

C. Nose Landing Gear

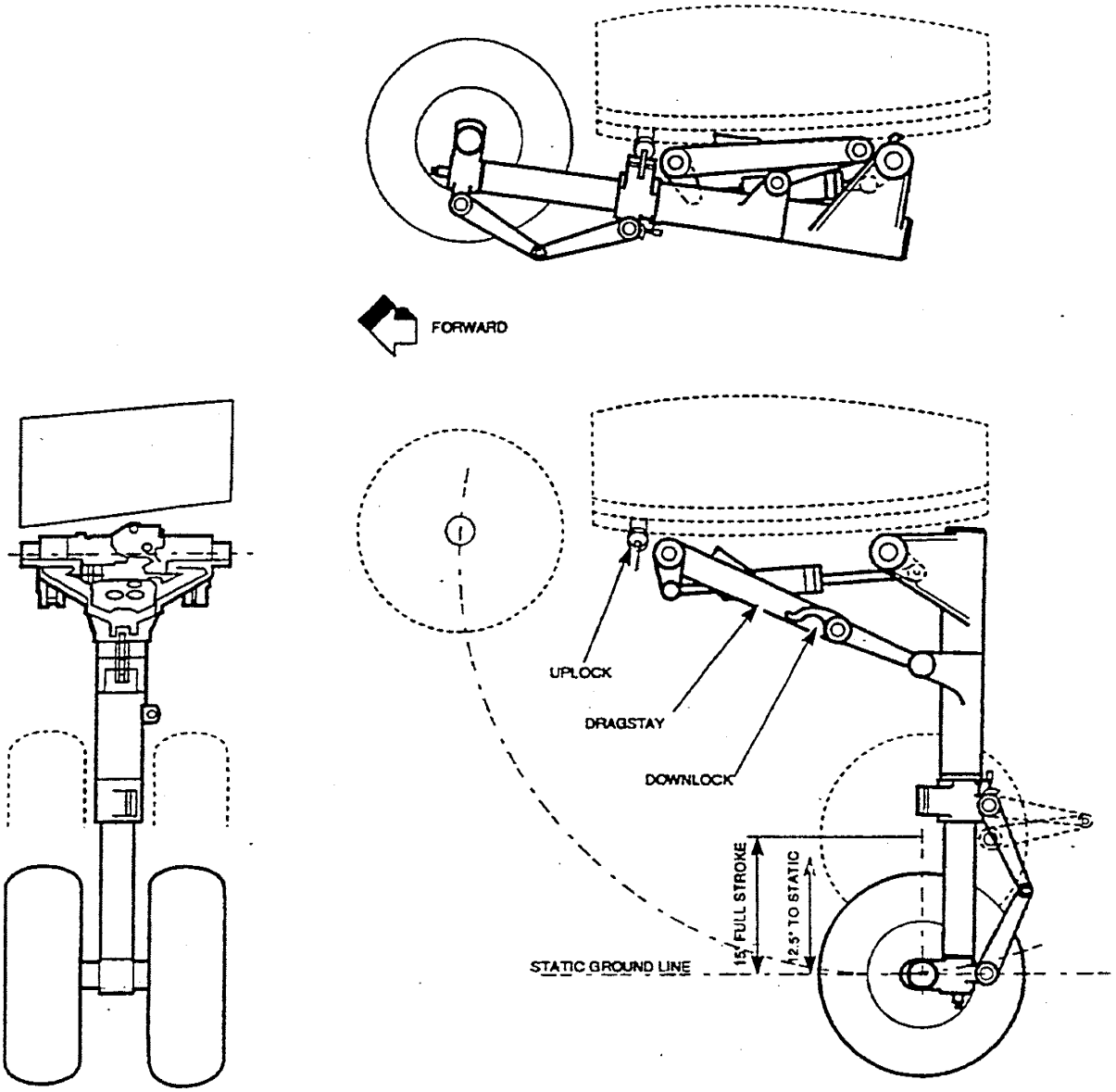
The nose gear retracts forward, raised and lowered by a hydraulic actuator. The actuator is supplied with 2000 psi hydraulic pressure from the hydraulic power generation system. The downside of the actuator is equipped with both normal and emergency supply connections. The upside of the actuator is equipped for normal hydraulic operation only.

The nose gear leg is held in the retracted and extended positions by 2000 psi hydraulic pressure and has mechanical secondary up and down locks which are hydraulically released. When the nose gear retracts forward a linkage draws the shock absorber up through the main casing, shortening the nose gear by nine inches.

Microswitches on the downlock and uplock hooks are operated by the lock pins on the landing gear casing to indicate the position of the nose gear.

The nose landing gear is fitted with a weight-on-wheels microswitch and operated by the movement of the torque links.

The taxi and two landing lamps are mounted on the front of the main casing.



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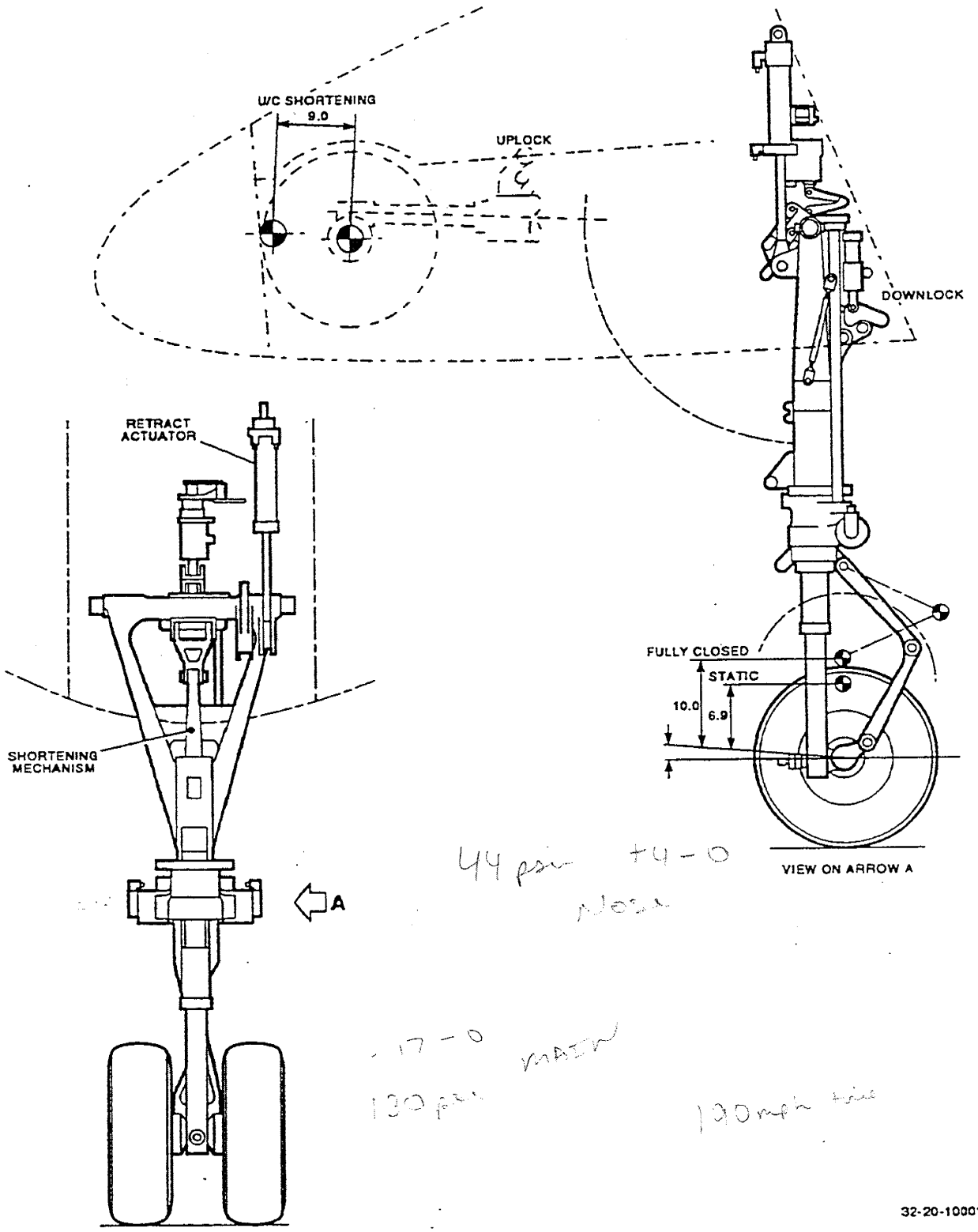
Main Landing Gear



Nose Landing Gear

D. Landing Gear Operation (Normal)

Retracting and lowering of the landing gear is controlled by an electro-hydraulic selector valve installed in the hydraulic bay. The selector valve solenoids are electrically operated and signalled by the landing gear selector lever located on the top right-hand side of the centre instrument panel. Movement of the solenoid valve sends pressurised fluid into the up or down side of the landing gear system and connects the opposite side of the actuators to the reservoir for return.

Movement of the selector lever to UP will direct system fluid to:

- Release the mechanical downlocks
- The retraction side of the actuators.

When the gear is fully retracted, hydraulic pressure is continuously applied to the retraction side of the actuators and up-locks to maintain the gear in the retracted position.

Movement of the selector lever to DOWN will direct system fluid to:

- Release the uplocks
- The down side of the actuators.

The main gears extend until the folding drag stays have fully extended and are locked by the spring loaded downlocks. The nose gear extends until the downlock pin engages in a spring biased downlock and rests against stops on the downlock assembly.

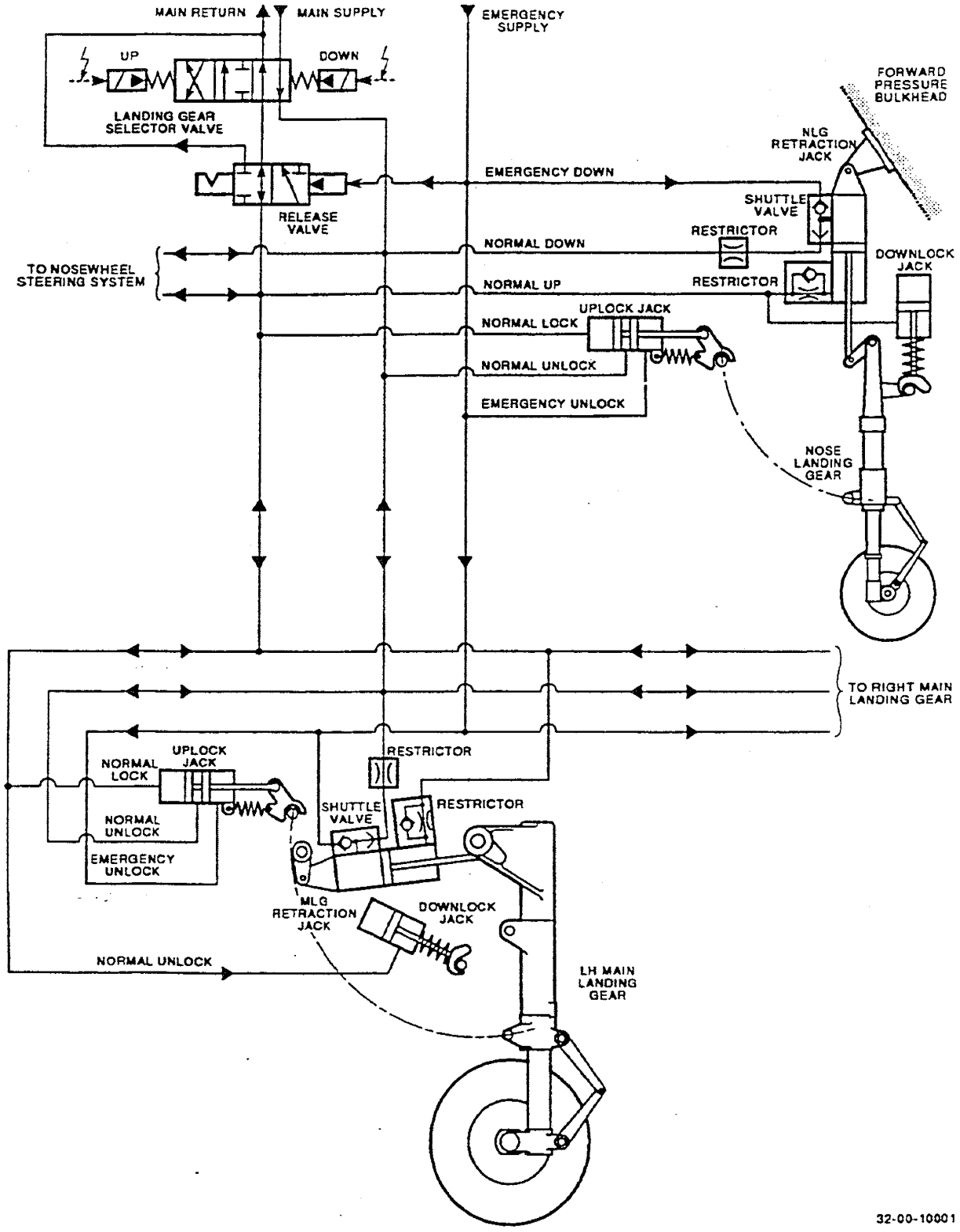
Hydraulic pressure is continuously applied to the down side of the actuators to keep the gear in the extended position.

E. Landing Gear Operation (Emergency)

The landing gear may be lowered in an emergency by setting the emergency selector valve to GEAR DOWN and using the emergency hand pump. The selector valve is located under the floor between both pilots seats. Once the emergency selector valve has been activated it cannot be reset and the gear cannot be raised again in flight.

A release valve is located in the main hydraulic bay. After emergency lowering of the gear, the release valve operation will be shown by a pop-out indicator on the valve. This valve must be manually reset after landing.

Selection and operation of the landing gear emergency lowering system must be commenced in sufficient time to ensure the gear is down and locked before the final approach to land.



Landing Gear Operation

F. Landing Gear Selector Lever

The landing gear selector lever is protected from an inadvertent UP selection, on the ground, by a solenoid operated locking pin. The locking pin is electrically connected through the left main gear weight-on-wheels switch. This holds the selector lever in the DOWN position when the wheels are on the ground.

After take-off, when the main gear wheels are off the ground, the solenoid is energised, withdrawing the locking pin and allowing UP selection of the landing gear. An override is provided, on the selector lever panel, which will release the locking pin if required. If the selector lever will not move to the UP position after take-off the override should only be operated if it is essential for flight safety.

G. Indication And Warning

(1) Position Indication

Landing gear position is indicated by dual filament captions on the landing gear selector panel. Each gear position is identified by one green and one red caption. The captions and legends are:

- NOSE (green) and NOSE (red) for the nose gear
- LEFT (green) and LEFT (red) for the left main landing gear
- RIGHT (green) and RIGHT (red) for the right main landing gear.

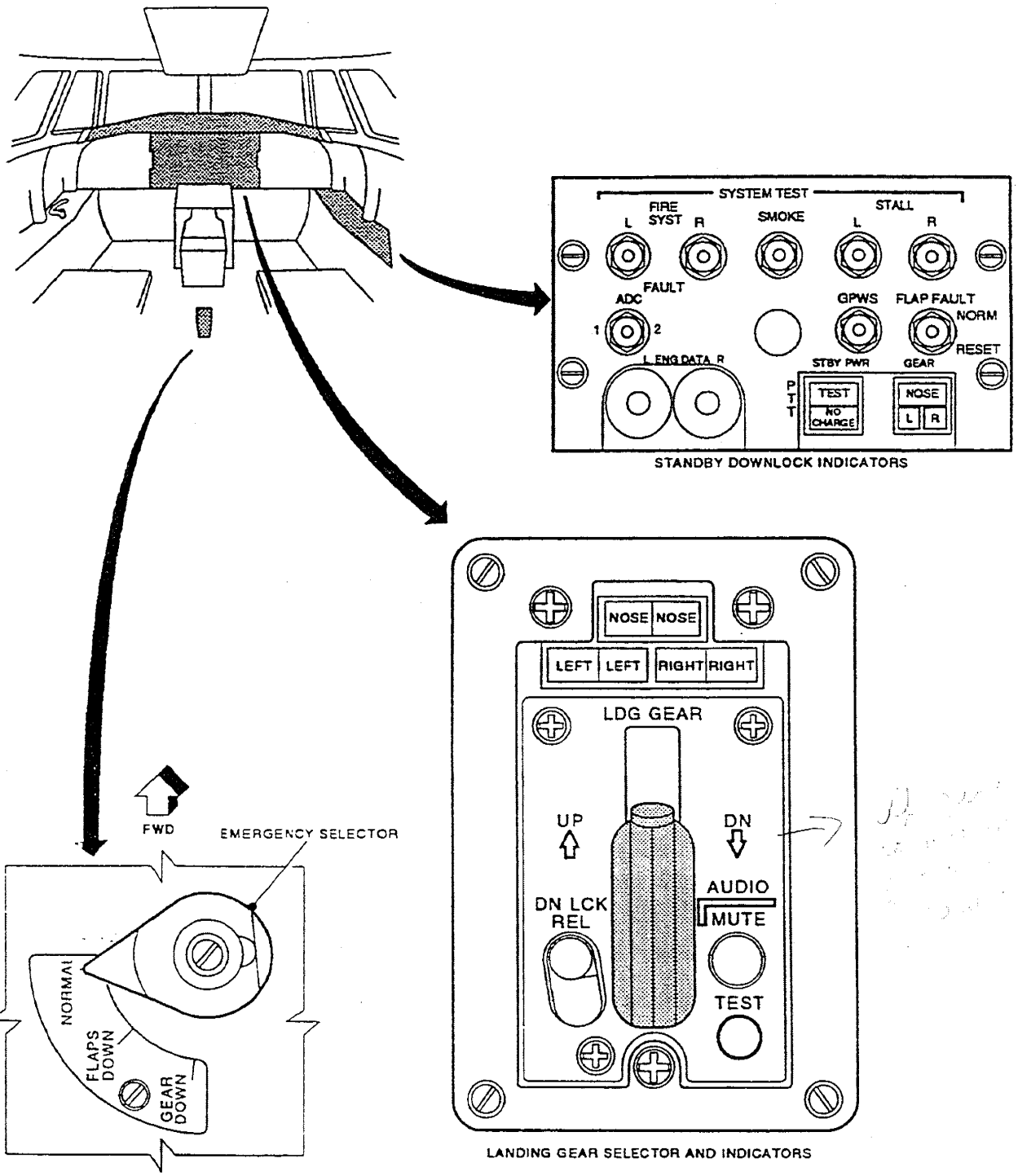
The captions are illuminated by independent isolated microswitches on the uplocks and downlocks of each of the landing gears. If a green caption is lit it means that the relevant gear is down and locked, when a red caption is lit it means the gear is unlocked or in transit. When both captions are out it indicates that the associated gear is up and locked.

A reversionary standby downlock caption is provided on the right side console for each of the three gears. The captions are signalled by an independent downlock microswitch for each gear.

A red light is installed in the handle of the landing gear selector lever. This indicator light will come on if:

- Any landing gear is not locked up 15 seconds after an UP selection
- Any landing gear is not locked down 15 seconds after a DOWN selection.

The light will remain on until all three gears are locked in the selected position.



STANDBY DOWNLOCK INDICATORS

LANDING GEAR SELECTOR AND INDICATORS

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Landing Gear Selection and Indication

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(2) Audio Warning

An audio warning is heard if the landing gear has not been extended and locked down and either of the following conditions exist:

- 15° flap or 25° flap has been selected
- Either POWER lever is retarded to the flight idle position and the speed is below ~~145~~ 143 Kts.

A MUTE button on the landing gear selector panel allows the audio warning to be cancelled but only if it is caused by power lever position. An audio warning cannot be cancelled when it is caused by flap position and when the gear is not locked down. When activated the audio mute select button light will come on.

Movement of the POWER lever to forward of flight idle will extinguish the button light and reset the audio warning system.

(3) Lighting And Dimming

The brightness of the landing gear position captions, the MUTE button and the red light on the selector lever handle can all be adjusted with a DIM CONTROL on the roof panel. The control is identified (RIGHT) MAIN PANEL. Brightness of the standby downlock captions (located on the right side console) is adjusted by the CONSOLES control.

H. Power Supplies

The 28V dc right essential busbar supplies power, through the DIM CONTROL, to the following:

- The normal landing gear selection and position captions
- The mute caption
- The red light in the landing gear selector lever handle.

The 28V dc emergency busbar supplies power to the:

- Standby indicators on the system test panel
- Horn mute buttons
- Landing gear selector.

I. Landing Gear Doors

Whilst in the fully retracted position the three landing gears are totally enclosed by the mechanical linkage doors. The forward doors are also in the closed position when the landing gear is locked down, but can be opened on the ground to gain access to the wheel bays.

J. Limiting Speeds

The maximum airspeeds for retracting and extending the landing gear is as follows:

- Maximum permitted airspeed for extension of the landing gear with 0° flap .....= 170 kt IAS

- Maximum permitted airspeed for extension of the landing gear with 9° flap .....= 200 kt IAS

- Maximum permitted airspeed for flight with the landing gear extended.....= 170 kt IAS

- Maximum permitted airspeed for flight with the landing gear extended and 9° flaps .....= 200 kt IAS

- Maximum permitted airspeed for retraction of the landing gear .....= 160 kt IAS

- Maximum permissible airspeed for extending, retracting and flight with flaps down:

9°.....200 kt IAS
15°.....160 kt IAS
25°.....140 kt IAS

3. Wheel Brakes

A. General

The brake system consists of:

- 4 main wheel brakes
- A normal brake control system
- An anti-skid control system
- An emergency brake control system.

The system includes hydraulic pressure indication and warning.

NOTE: Care must be taken not to operate the PITCH DISC - PULL control, when it is intended to operate the parking brake.

B. Main Wheel Brakes

The aircraft has four hydraulically operated brakes, one in each main wheel unit. The brakes are interchangeable left and right on both main landing gears.

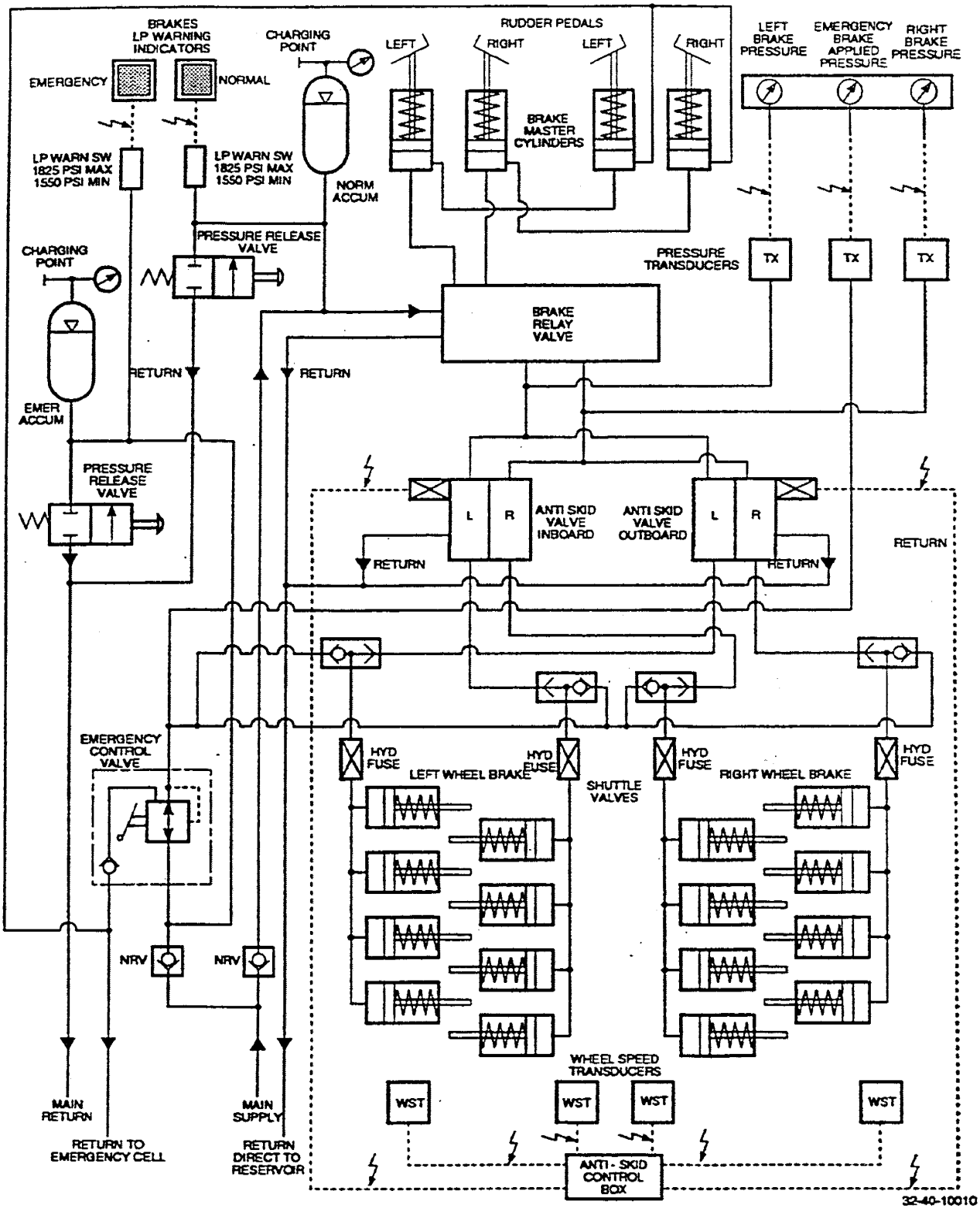
C. Normal Brake Control System

The normal brake control system is operated by depressing the pilots or co-pilots left and right brake pedals, each of which operates a master cylinder and a brake relay valve. The pilots left and right master cylinders connect directly to the brake relay valve and operate in series with the related co-pilots master cylinders. The co-pilots left and right master cylinders are supplied with hydraulic fluid from the return line of an emergency control valve in the normal brake control system.

The normal brake control system receives hydraulic power from the hydraulic power generation system. An accumulator, pre-charged with nitrogen, is supplied with hydraulic pressure at 2,000 psi and provides stored pressure for a limited number of brake applications if the hydraulic power generation system fails.

Two dual anti-skid valves are in the normal brake control system and are controlled by the anti-skid system. Skid protection is only available with the normal brake system. The normal brake control system may be used with the anti-skid system disarmed.

A hydraulic fuse, in each brake supply line, will prevent excessive loss of hydraulic fluid in the event of a pipe rupture on the landing gear.



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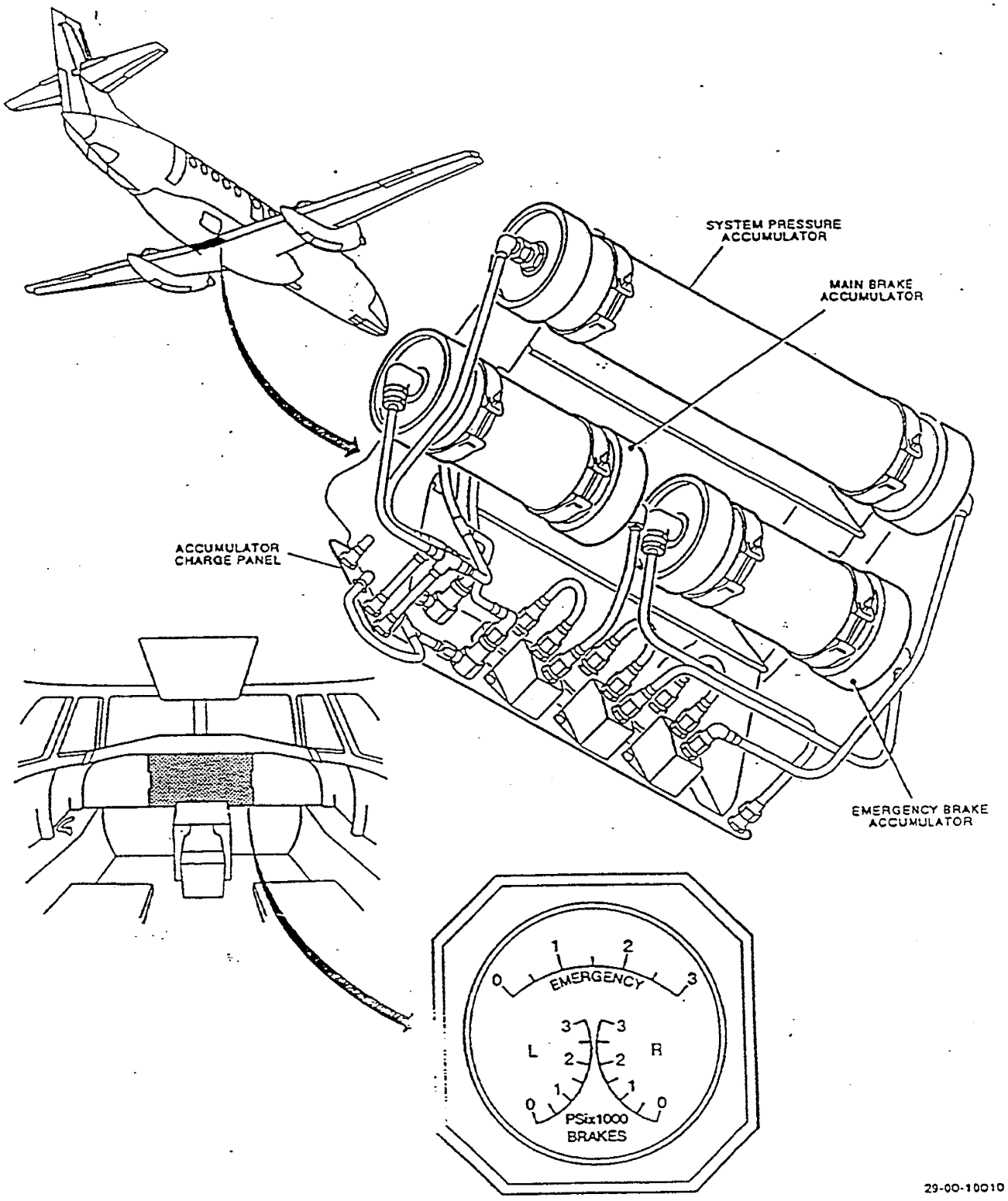

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Accumulators

D. Anti-Skid Control System

An electronic anti-skid control system is installed in the normal brake system. It controls both brake pressure and wheel speed to prevent damage to the tyres and achieve maximum braking efficiency.

(1) Operation

The system monitors individual main wheel speeds. System control logic responds to rapid deceleration of any wheel by providing a correction signal to the appropriate anti-skid control valve. The applied brake pressure will be reduced until the wheel speed has increased.

The anti-skid system has two independently operating systems, one for the inboard and one for the outboard wheels. Each system has an anti-skid valve.

Electrical power for the anti-skid system is from the 28 V dc emergency busbar, controlled through the landing gear uplock microswitches (to prevent system power applications when the landing gear is retracted) and the ANTI-SKID ON/OFF SWITCH. The ANTI-SKID ON/OFF switch is installed on the lower centre panel and provides the pilot with a means to arm and disarm the system.

A touchdown protection system prevents the brakes being applied before landing with the gear selected down. An electrical signal through the weight-on-wheels switches causes a brake release command to be generated in flight and for three seconds after the wheels are on the ground.

A spin-up override (of the touchdown protection system) will allow normal braking to take place, regardless of the weight-on-wheels switch position as long as the average wheel speed for each pair is more than 50 Kts.

To prevent a locked wheel situation the speed of the wheels is continuously monitored and compared. If one wheel speed drops to 40% below that of its paired wheel, a full brake pressure release signal is generated. The signal will give a full brake pressure release of the slow wheel and is maintained whilst this threshold is exceeded or until a speed of 20 Kts on the locked wheel is achieved.

E. Emergency Brake Control System

An emergency brake control system is available if the normal brake control system fails. Hydraulic power is provided by the hydraulic power generation system through an emergency brake control valve. This valve is operated by a cable from the PARK BRAKE handle located on the left side of the centre console.

An emergency brake accumulator pre-charged with nitrogen is supplied with hydraulic pressure at 2,000 psi. This provides stored pressure for a limited number of brake applications using the PARK BRAKE handle, if the hydraulic power generation and normal brake systems fail.

Only straight line braking is available with the emergency system and anti-skid protection is not provided. When the PARK BRAKE is used in an emergency it requires gradual applications of the brakes, this is achieved by slowly pulling on the ratchet retained handle. When used for parking the ratchet will retain the handle in the on position.

A microswitch operated by the PARK BRAKE handle sends an input to the take-off configuration warning system. The maximum hydraulic pressure applied to the brakes when using the PARK BRAKE is 1400 ±50 psi.

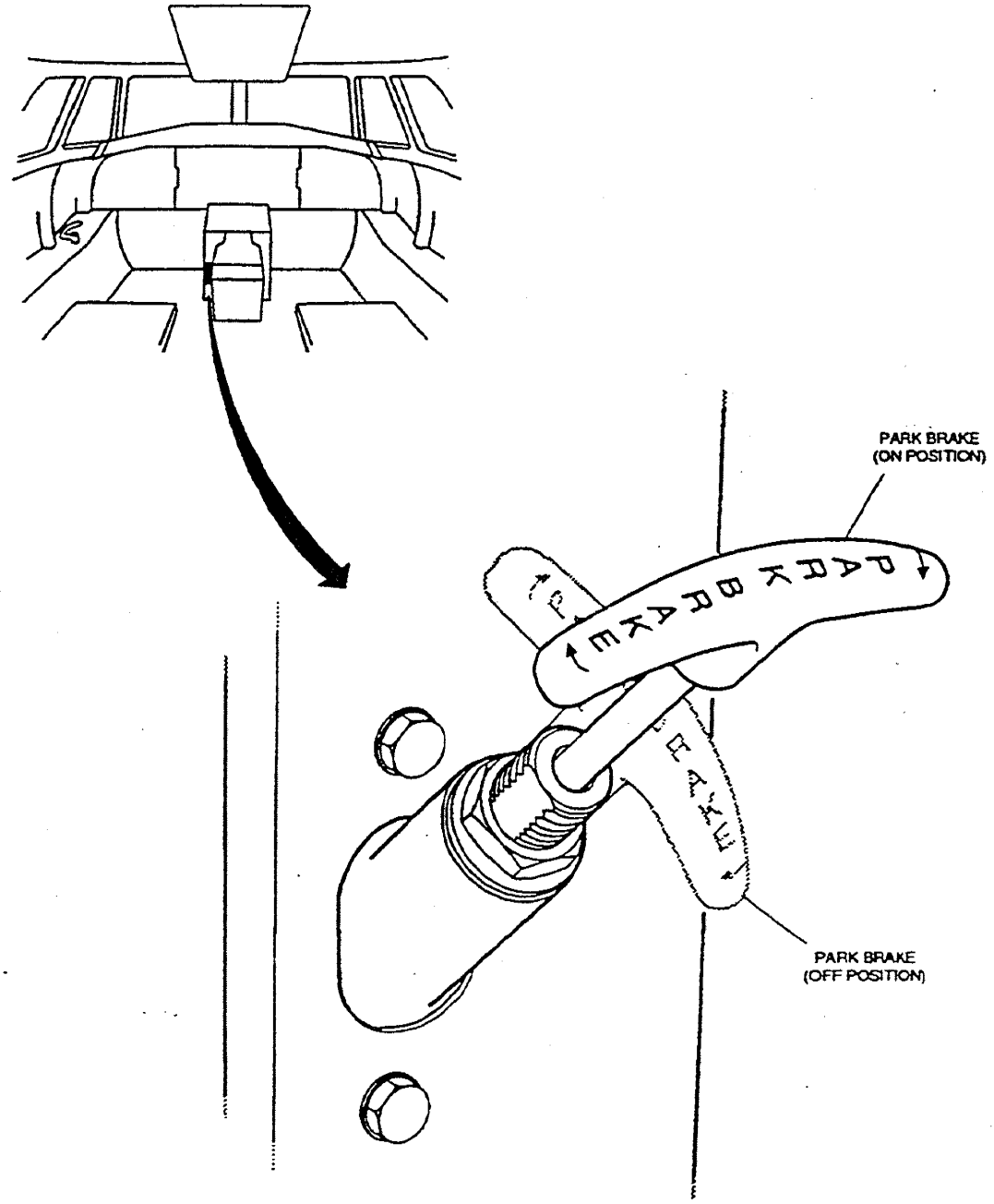
F. Pressure Indications

A triple hydraulic brake pressure gauge on the lower centre instrument panel indicates the Left and Right applied brake pressures for the normal brake control system, and the applied brake pressure of the EMERGENCY brake control system.

The EMERGENCY brake pressure indication is powered from the 28V dc emergency busbar. The normal brake pressure indications are powered by the left essential busbar.

G. Warnings

Indications of low normal and low emergency brake accumulator pressures are provided on the lower centre instrument panel next to the triple brake pressure gauge. The BRAKES LO PRES indications are LO MAIN and LO EMERG captions, they are operated by low pressure switches and come on when the related accumulator pressure falls to 1550 psi (minimum). The captions will go off when the pressure rises above 1825 psi (maximum).



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Parking Emergency Brake-Operation

The anti-skid system is continuously monitored. If a failure is detected a CAP [A-SKID] (amber) caption will come on. The caption will come on whenever a failure is detected in the inboard or outboard systems and can be annunciated by any of the following failures:

- Gear handle down and system power off
- Open or short circuit in the anti-skid electrical system
- An electrical failure in the anti-skid control box system
- A wheel lock-up in excess of three seconds.

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4. Nose Wheel Steering

A. General

The aircraft has a hydraulically powered rack and pinion nose-wheel steering system. The system is controlled from the flight compartment by a steering handle installed on the left side console.

B. Operation

Movement of the nose-wheels is provided by a hydraulic, double-acting, steering selector valve. This selector valve is, in turn, controlled by a cable connected to the steering handle. The steering selector valve is located in the nose gear bay installed between the steering controls and the steering feed-back mechanism.

The teeth of the rack and pinion engage throughout the hydraulic steering range. The rack and pinion ensures that if castoring takes place beyond the hydraulic steering range, correct re-engagement will take place when re-entering the hydraulic steering range.

The nose-wheel can be steered 43 deg left or right of centre by the pilot. Castoring is limited to 100 deg left or right of centre by mechanical stops.

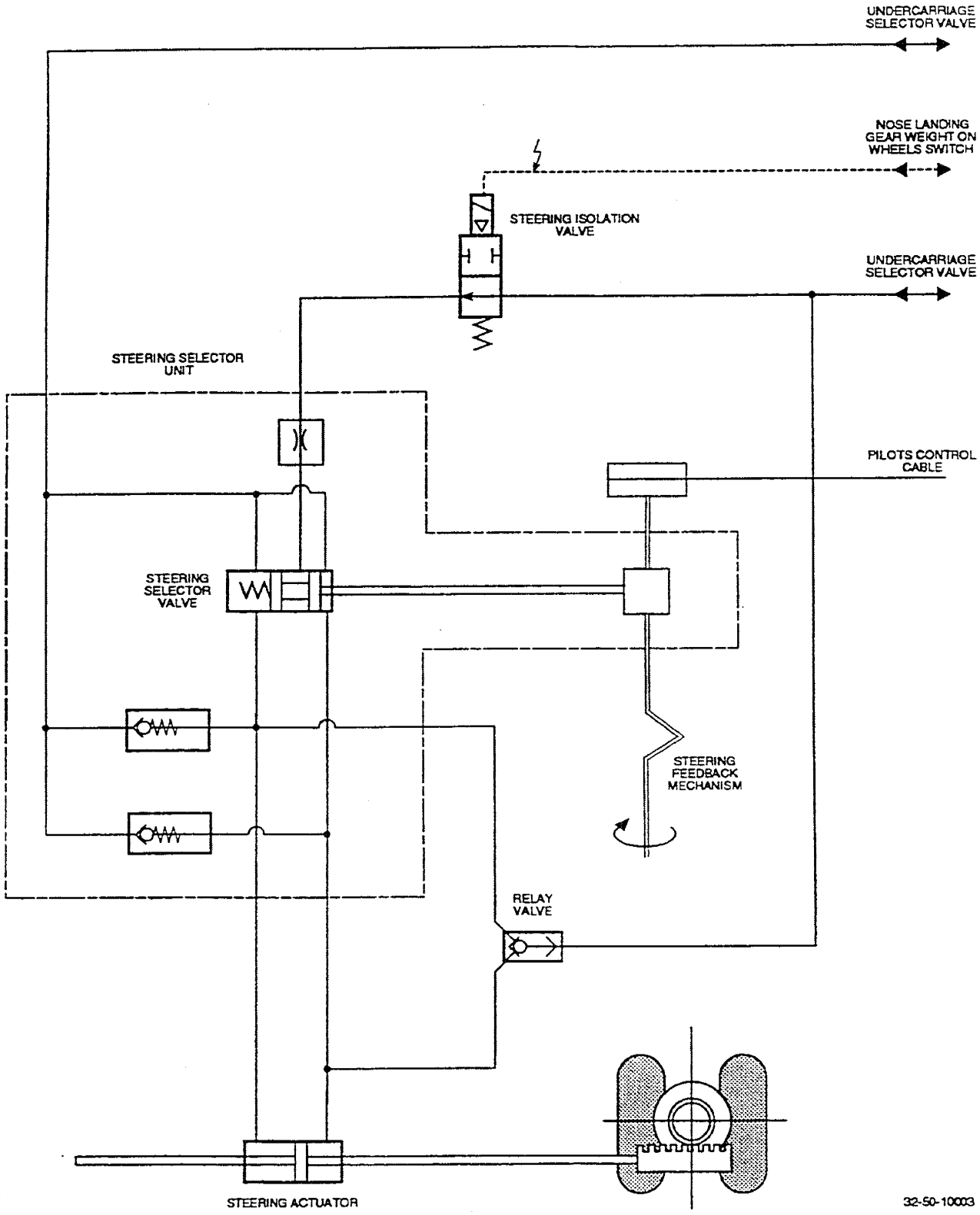
A steering feedback mechanism ensures that movement of the wheels to the steered position returns the selector valve to the central position and maintains the steering actuator in the selected position. This is achieved by linking the steering tube of the nose leg to the output shaft of the selector valve.

The steering actuator has centering pistons. During landing gear retraction hydraulic pressure is supplied to both sides of the steering actuator, this centres the nose-wheel before it enters the nose-gear bay. The nose-wheels are held in the centred position whilst the landing gear is retracted.

The hydraulic pressure for nose-wheel steering is taken from the landing gear down line through a steering isolation valve. The steering isolation valve is a solenoid operated valve that is normally open. The valve is electrically operated by the nose landing gear weight-on-wheels switches, this allows the flow of hydraulic fluid from the landing gear down line when the nose wheel is on the ground.

A load (torque) limiting device at the nose wheel handle shaft limits the pilots input to the system. The device "breaks-out" at a load approximately twice that required to steer the aircraft. If the device is overridden sufficient torque is still available to give full steering demand.

Nose wheel steering is not available if the landing gear has been lowered using the emergency hand pump.



Nosewheel Steering System

5. Wing Flap System

A. General

The wing flap system has a:

- Flap operation system
- Flap position control system
- Flap position indicators and warning system.

Hydraulic power at 2,000 psi is supplied by the main power generation system. Each wing has double slotted flaps hinged to the rear wing spar.

B. Flap Operation System

Hydraulic actuators connected between the wing rear spar, flap hinge arm and inboard flap hinge bracket operate the flaps.

The normal flap positions are:

- Take-Off - 0° (Retracted), 9° and 15°
- Landing - 15° and 25°
- Cruise - 0°.

The take-off and approach flap positions are controlled by the flap position control system and the retracted and landing flap positions are controlled by the full stroke of the actuator. The flaps being held in the retracted and landing position by 2,000 psi hydraulic pressure.

C. Flap Position Control System

The flap position control system has:

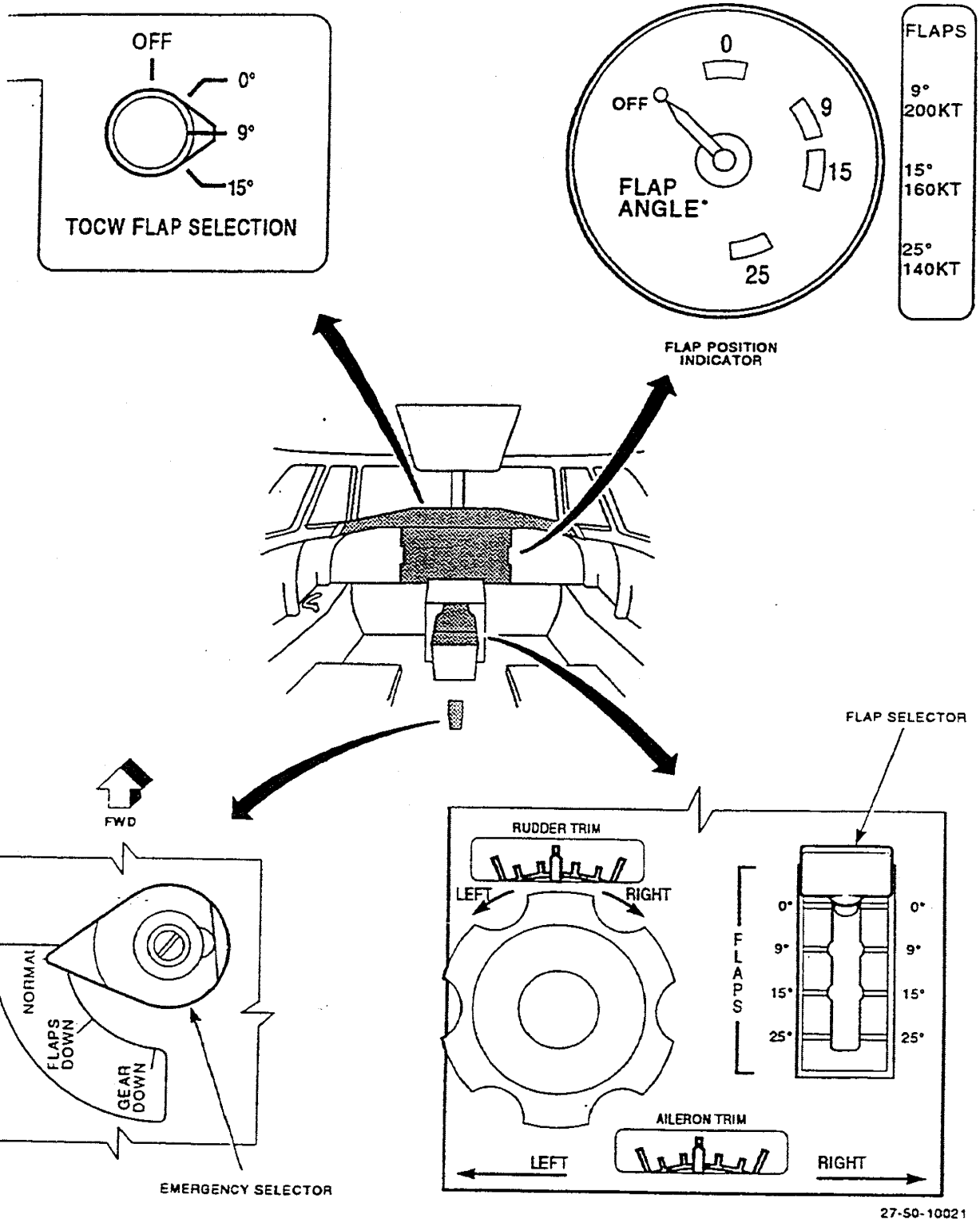
- A flap selector lever
- Hydraulic Flap Control Unit (HFCU)
- Flap position transducers
- An Electronic Flap Control Unit (EFCU).

(1) Flap Selector Lever

The flap selector lever is installed on the centre console. To move the flaps, the lever tab must be lifted (against a spring) and the lever moved through the quadrant. When the lever is moved from the 9 to 15 degree position an additional lifting force is required. The position of the flap selector lever provides electrical inputs to the EFCU.

(2) Hydraulic Flap Control Unit (HFCU)

The HFCU contains the solenoid valves and control valves for normal and emergency operations of the flap system.



Flap Selection and Indication

(3) Electronic Flap Control Unit (EFCU)

Operation of the extend and retract solenoid control valves is signalled by the EFCU which receives inputs from the flap selector valve and dual feedback signals from the flap position transducers. The EFCU continuously energises the flap selector lever switch and position transducers. The EFCU receives feedback signals to monitor for asymmetry/failure and control the operation of the HFCU and flap positions.

(4) Flap Position Transducers

Flap position transducers, mounted on the flap support hinges, are connected to the flap hinge arms. Each transducer contains two potentiometers which provide outputs for:

- Flap position control and asymmetry detection (one for each potentiometer)
- Flap position indicator (right hand unit)
- Flight data recorder (left hand unit).

D. Indication And Warning

(1) Indication

Flap position is indicated on a gauge mounted on the centre instrument panel. The indication for the gauge comes from the right flap position transducer. In the event of an indication failure, the flap position can be identified from painted lines on the flaps, these lines are visible from the passenger cabin.

(2) Warning System

Warning of an electrical flap system fault or of an asymmetry condition is provided by CAP [FLAP FAULT] (amber) and [FLAP ASYM] (amber) captions.

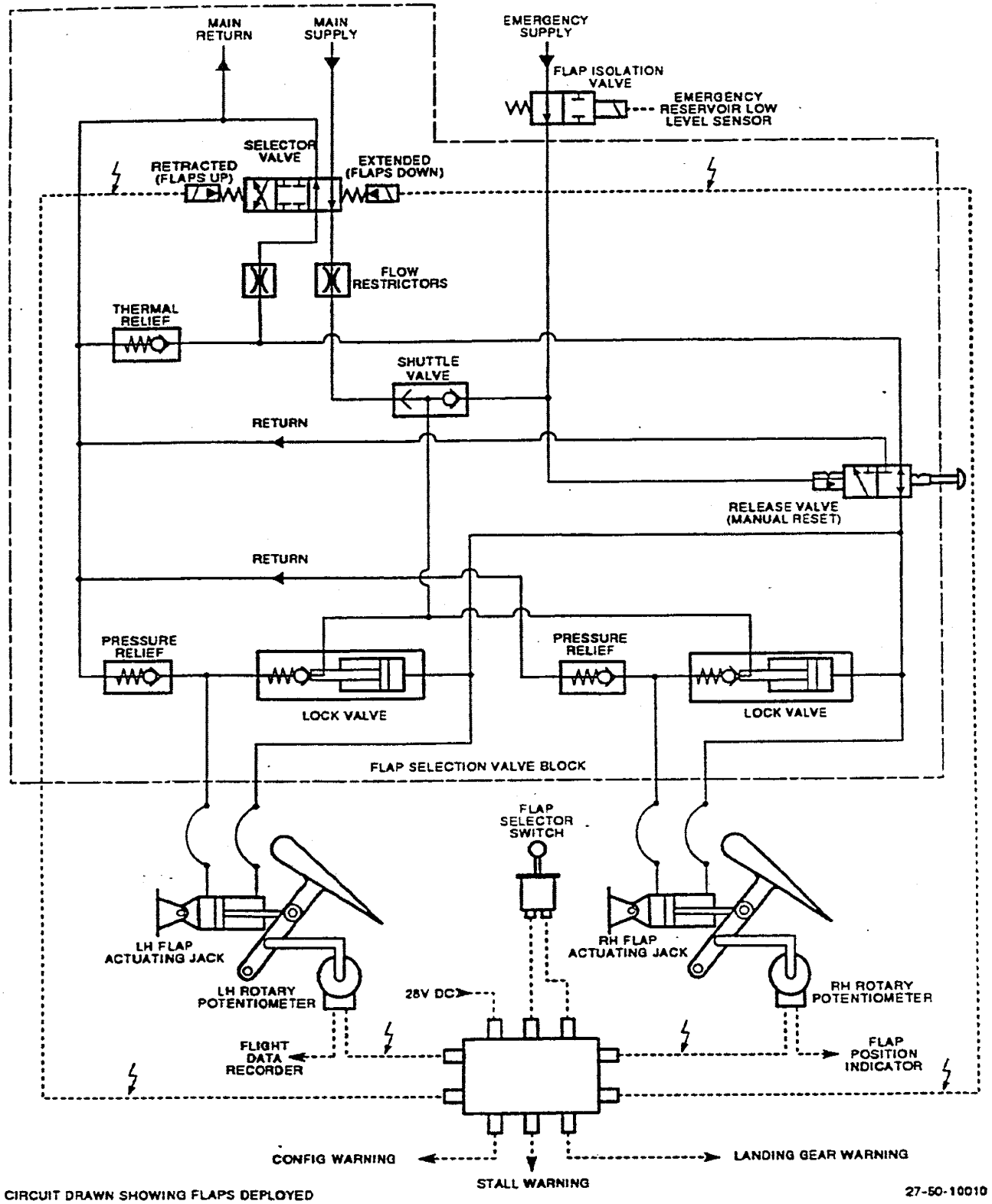
(3) Take-Off Configuration Warning System (TOCWS)

A Flap Take-Off Switch (FTOS) is located on the coaming panel. The FTOS ensures the TOCWS flap input signal agrees with the flap selector lever setting.

The FTOS must be set to the selected take-off flap setting prior to take-off. A take-off configuration warning will be generated if the FTOS is set to OFF or a difference between the FTOS setting and the flap selector lever setting exists.

The FTOS can be set either before or after the flaps have been set for take-off.

After each take-off the FTOS automatically resets to the OFF position. This ensures a positive selection of the FTOS prior to each take-off.



Flap Actuating System

E. System Operation (Hydraulic)

(1) General

The flap position is commanded by the operation of the flap selector lever. The actual and commanded positions are compared by the EFCU which signals the HFCU. The HFCU controls the flow of hydraulic pressure to drive the flap actuators. Actual flap position is indicated to the pilot.

(2) Operating Modes

The system has four operating modes:

- Static
- Extending
- Retracting
- Emergency extending.

(a) Static Mode

The static mode is when flap movement is not required and the flap is in the commanded position.

With the commanded and actual flap positions within 0.5° the EFCU signals static mode and both solenoid valves on the HFCU are de-energised. Actuator lock valves prevent uncommanded retraction of the flaps even if the hydraulic pressure is lost. At retracted and 25° uncommanded movement is further prevented by continuously energising the extend or retract solenoid valve.

The flap is therefore held in the retracted and 25° position by hydraulic pressure at 2,000 psi and at 9° and 15° by hydraulic lock.

(b) Extend Mode

When commanded to extend, the EFCU energises the extend solenoid valve on the HFCU, and the flap extends. When the commanded and actual values are within 0.5° of each other the static mode is signalled by the EFCU.

(c) Retract Mode

When commanded to retract, the EFCU energises the retract solenoid valve on the HFCU and the flap retracts. When the commanded and actual values are within 0.5° of each other the static mode is signalled by the EFCU.

(d) Emergency Extend Mode

Following a failure of the the flap selector valve, hydraulic or electrical system, extension of the flaps can be achieved using the emergency hydraulic handpump.

Operation of the handpump with the emergency selector in the FLAP DOWN position supplies pressure to the extend chamber of both actuating jacks, via a shuttle valve in the HFCU. Emergency supply pressure also moves a release valve which allows the return flow of hydraulic fluid from the actuating jacks to by-pass the flap selector valve.

Lock valves prevent flap retraction when the desired position is reached.

A solenoid operated flap isolation valve, installed in the flap emergency supply line, maintains the integrity of the emergency hydraulic supply system in the event of a flap actuator supply pipe disconnect or rupture.

The emergency release valve remains in the by-pass condition until it is manually reset. A by-pass condition is indicated by a pop-out indicator on the valve.

CAUTION IT IS NOT POSSIBLE TO REVERT TO NORMAL FLAP OPERATION IN FLIGHT, ONCE THE EMERGENCY FLAPS HAVE BEEN SELECTED AND OPERATED. IT IS NOT POSSIBLE TO RETRACT THE FLAPS BY EMERGENCY HANDPUMP OPERATION.

Using the emergency flap extension the flap should not be extended beyond the 15° setting. This can normally be attained by eight full strokes of the emergency handpump and care should be taken to monitor the flap position indicator to ensure that the desired angle of flap is not exceeded.

(e) Flap Failure

Flap symmetry is maintained by an interconnecting torque shaft. Failure of the torque shaft may cause a flap asymmetry condition to develop, this can also occur when there is either a mechanical or hydraulic failure in the flap operating system. When an asymmetry of 6° occurs the flap asymmetry system detects the error and interrupts the electrical signal to the hydraulic selector valve. The solenoid valves return to the static mode thus locking the flap actuators to prevent further movement, the indication is a CAP [FLAP ASYM] (amber) caption.

Protection against a disconnect or rupture of the actuator extend line is provided by a solenoid operated flap-isolation valve. This valve is energised by the emergency hydraulic reservoir low contents sensor. The valve is installed in the emergency supply line to the flaps and when energised, prevents further extension of the flaps and loss of fluid from the emergency system. This ensures an adequate supply of fluid is available for emergency lowering of the landing gear.

If it is necessary to lower both the landing gear and flaps using the emergency system; the landing gear should be lowered first. This avoids reliance on the flap isolation valve if the contents of the emergency system are lost.

To prevent jamming of a lock valve in the HFCU, pressure relief valves (also in the HFCU) relieve at 3,500 psi (± 350). This limits the load on the aircraft structure at landing flap setting when retract is selected.

(3) System Operation (Electrical)

The function of the EFCU in the flap position control has been described in the System Operation (Hydraulic).

(a) EFCU Flap Position Outputs

The EFCU provides four flap achieved position outputs and a take-off selected output (which is disabled when flaps are asymmetric) for use by other aircraft systems.

The flap positions achieved outputs are used by the Stall Warning System and Take-Off Configuration and Warning System.

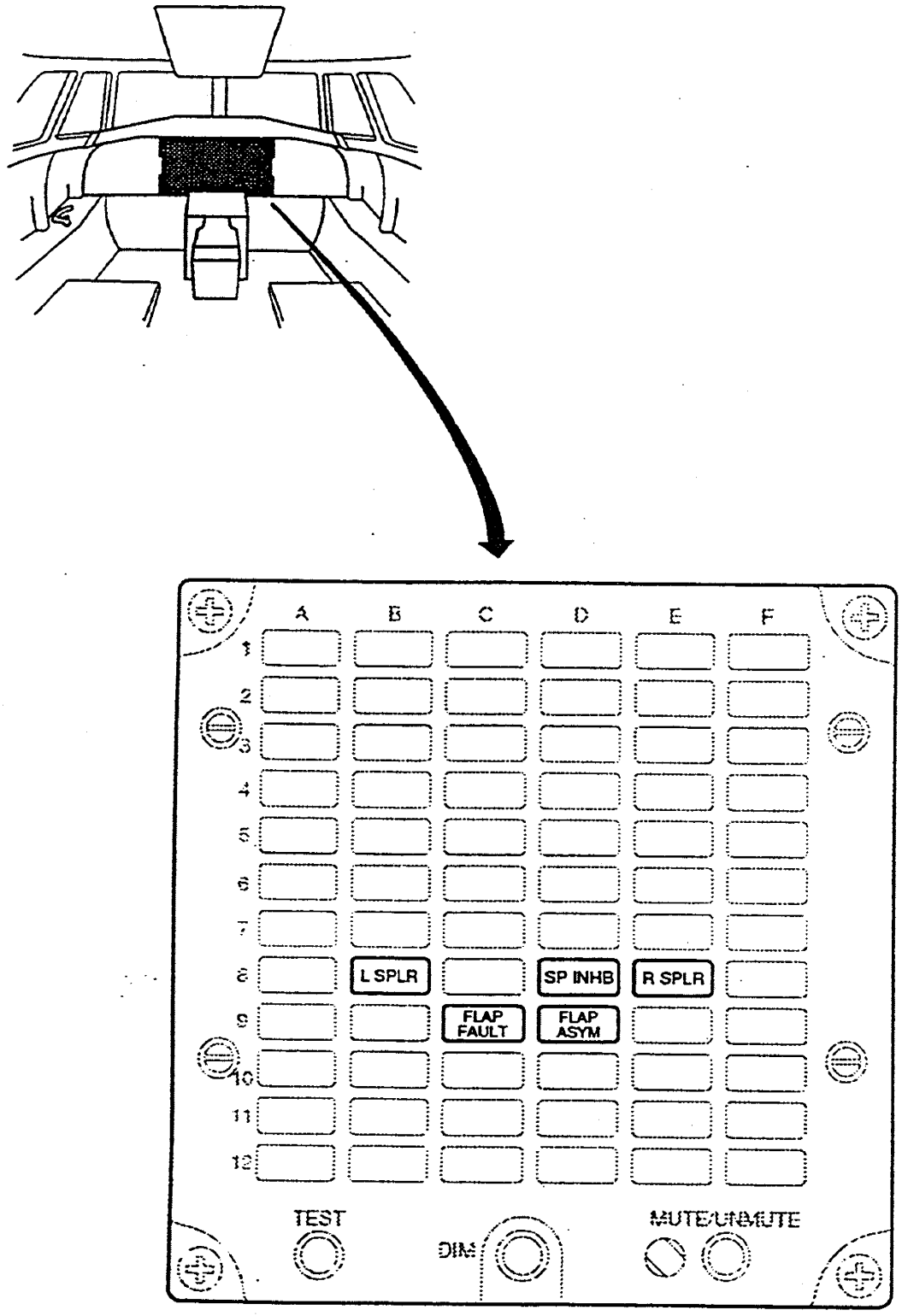
The approach and landing achieved outputs are used by the Landing Gear Position Warning System. The take-off outputs are used by the Take-Off Configuration Warning System.

(4) System Test

The EFCU has an internal test facility initiated by the flap fault test switch. The fault test switch is installed on the maintenance test panel on the flight deck.

Continuous internal fault monitoring also tests the flap system. Any detected failure results in the disabling of the solenoid outputs so that a fail freeze condition is maintained. Detection of asymmetry will be indicated by a CAP [FLAP ASYM] (amber) caption. Any other faults will make the CAP [FLAP FAULT] (amber) caption come on.

An EFCU reset switch enables the EFCU circuit to be reset without pulling the FLAP CTRL circuit breaker. On activation, the 28V supply to the EFCU is removed to reset the system. If a fault is still present, the CAP [FLAP FAULT] (amber) caption will return. The FLAP FAULT reset switch is installed on the system test panel on the right console.



CAP-Flap and Spoiler System Indications

6. Ground Spoilers

A. General

A spoiler is fitted on the upper trailing edge of each wing, between the fuselage and the engine. The function of the spoilers, which can only be deployed when the aircraft is on the ground, is to reduce (dump) wing lift. The spoilers are electrically controlled and hydraulically operated.

B. System Operation

The spoiler system has two modes of operation, deploy and retract. The system operates in the retract mode during all ground and flight phases, with the exception of the landing roll, during which the system operates in the deploy mode.

The spoilers are armed when the SPOILERS switch is set to ARM and the right power lever has been moved forward to give take-off power.

Deployment occurs when the system has been armed and the following conditions are met:

- One main landing gear weight-on wheels switch is in the ground position
- Both power levers in ground range.

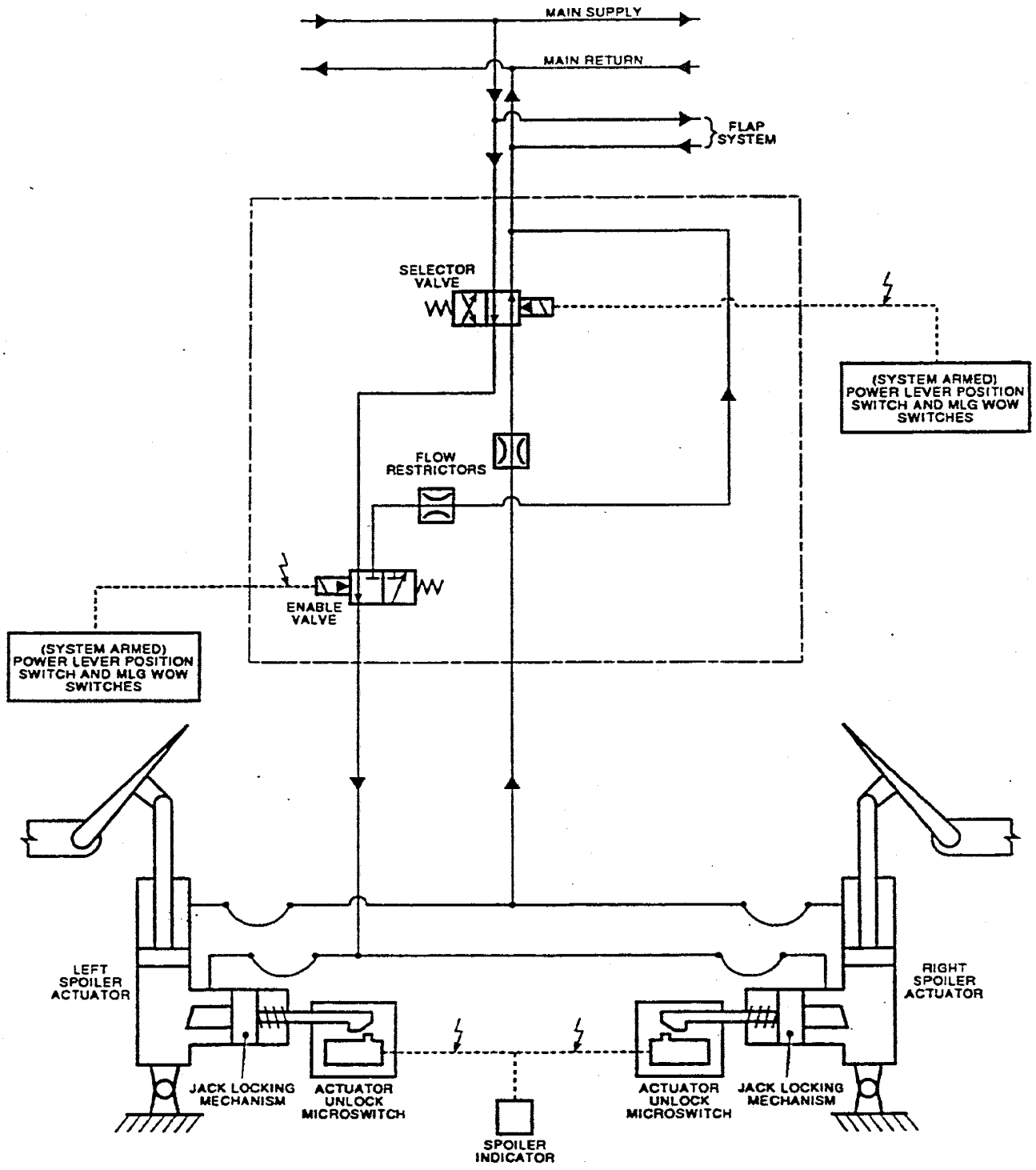
Spoiler retraction on the ground, after the landing run is achieved by setting the SPOILERS switch to OFF or by advancing either power lever for a go-around.

(1) Retract Mode

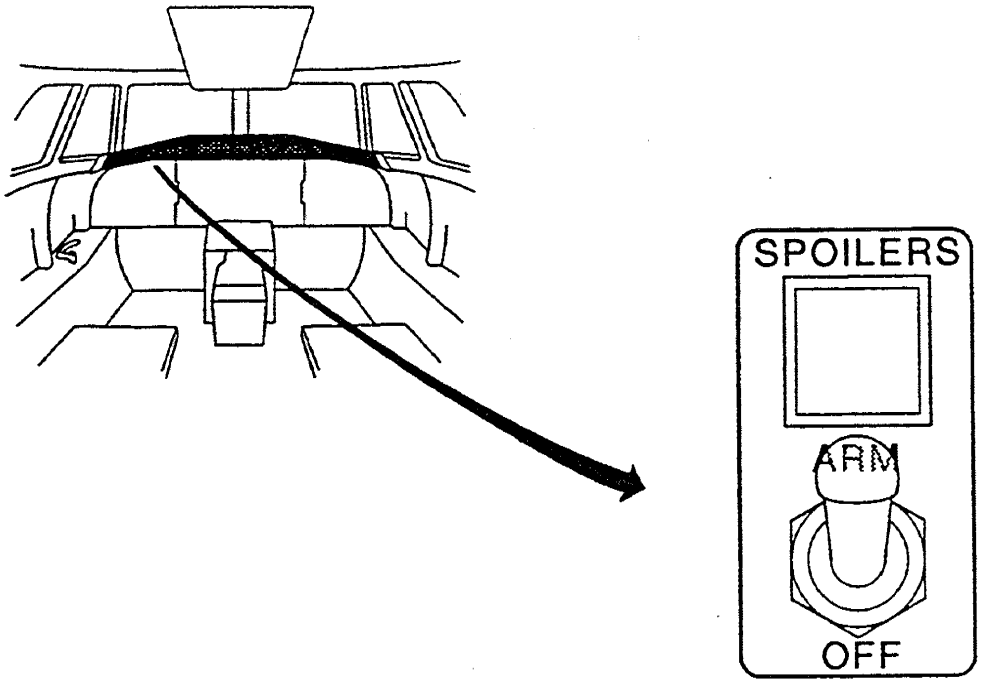
In the retract mode the selector and enable solenoid valves are de-energized. Under 2,000 psi hydraulic pressure the actuators retract together and the spoilers are positioned flush with the wing surface. When fully retracted the spoilers are held in position by 2,000 psi hydraulic pressure and a secondary lock pin.

(2) Deploy Mode

When the spoilers are deployed the selector and enable solenoid valves are energized by the control circuits. 2,000 psi hydraulic fluid is supplied to the actuators to release the lock pin and deploy both spoilers together to a 70 deg angle. The spoilers are held in the deploy position by 2,000 psi hydraulic pressure. The lock pin is held out by the hydraulic pressure and provides indication that the actuators are deployed.



Spoiler Hydraulic System-Schematic



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Ground Spoiler Control Switch

C. System Control

Operation of the spoiler surfaces is controlled electrically by the ARM switch located on the coaming, micro-switches located on the power lever quadrants and weight-on-wheels oleo switches. All three must be in the correct position for the spoilers to deploy.

(1) Operation

The control switch must be set to ARM prior to the take-off roll. It is interlocked with the take-off configuration warning system which provides an aural warning and a CAP CONFIG (red) caption if the switch is not set to ARM. In addition when the control switch is set to OFF a CAP SP INHB (white) caption comes on.The system is only armed when the right power lever is advanced for take-off.

The control switch remains at ARM throughout the flight and is only set to OFF during taxi or maintenance.

After landing the spoilers are retracted by moving one of the power levers forward of flight idle or selecting the SPOILERS control switch to OFF.

D. Indication

Both spoiler actuators are fitted with downlock micro-switches which give indication of spoiler positions.

When the spoilers are retracted there are no flight deck captions. When the spoilers are deployed a green cross-hatch caption comes on. The caption is adjacent to the ARM switch on the coaming. If either spoiler fails to deploy, the green annunciator will not come on.

If either spoiler deploys with both power levers not in the ground range a CAP [L SPLR] and [R SPLR] (amber) caption will come on.

A spoiler-unlocked warning control relay, which builds a one second time delay into the [L SPLR] and [R SPLR] caption, prevents spurious warning during touch and go operations.