CF-105

UNDERCARRIAGE

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INTRODUCTION

The CF-105 has a tricycle undercarriage consisting of a forward retracting nose gear with dual wheels and main gears with tandem two-wheeled bogies, which retract inward and forward into the wings.

The undercarriage is retracted hydraulically by the aircraft utility system. Extension of the legs is by gravity, assisted by air loads once the initial lowering has commenced. The operation of the doors, however, is hydraulic both in opening and closing. In the event of failure of the normal extension of the gear, emergency air at 5000 p.s.i. is employed.

The nose gear is of the steerable type, operated from the pilot's rudder pedals and a shimmy damper system is incorporated for use when steering is not engaged.

Tubeless tires are used on all wheels.

The wheel brakes are normally operated by the utility hydraulic system, with emergency hydraulic operation supplied by an accumulator. An anti-skid system is provided in the normal braking circuit only.

1. MAIN UNDERCARRIAGE

1.1 Main Leg

The leg forging and drag strut are carried on a shaft mounted on bearings in the wing structure. This shaft is in two halves coupled together to facilitate leg removal; it carries the retraction jack attachment lug. The lower end of the drag strut is bolted to lugs on the main forging. A shackle held by a pip-pin at this point forms an engine hold-back and mooring point.

Another lug takes the ball-joint for the lower end of the telescopic side-stay, whose upper end is bolted to the wing structure. This stay contains the leg downlock, spring-closed, hydraulically released.

Adjacent to this lug is the leg uplock pin.

At the lower end of the leg forging is a sliding sleeve. Upon retraction, this sleeve is pulled up by an internal chain mechanism operated by the swinging movement of the leg. As it moves up, internal rollers in the sleeve run up helices in the leg forging and so rotate the sleeve. The object of this is to shorten the leg, without compressing the shock absorber, and to rotate the bogie beams, so that they assume the correct attitude for stowing in the wheel well.

The sleeve is fitted with internal splines which mate with splines on the leg forging when the sleeve is fully down, to prevent rotation of the sleeve in the leg-extended position. An internal spring lock keeps these splines engaged.

The liquid spring shock-absorber is carried within a sliding member running on bearings inside the leg forging, and can be removed, complete with this member, without removing the leg from the aircraft.

A scissor torque link extends from this sleeve to the lower end of the sliding member.

The bogie beam is attached to the lower end of the sliding member. The assembly includes two brake torque links and a recuperator for maintaining liquid spring pressure.

A telescopic spring tie extends from the leg forging to the forward end of the bogie beam and serves to ensure that the bogie beam is in the correct attitude for retraction, and to avoid bogie oscillation on landing.

Mechanical Operation:

Upon application of hydraulic pressure to retract the leg:-

(a) The downlock in the telescopic side-stay is released by its jack; this occurs before the retraction jack begins to fold the leg, because the load on the release jack is much less than that on the retraction jack - there is no sequence valve;

(b) The retraction jack now starts to swing the leg inboard.

(c) The first 15° of swing unlocks the shortening lock in the leg; this is done by the movement of the chain and sprocket assembly inside the leg, which then

(d) starts to shorten the leg;

(e) The first ½" of the shortening movement disengages the dogs which locate the rotating slide on the leg; the lower portion of the leg is now free to twist into stowing position;

(f) The next 8" of shortening twists the leg through 37½°; the telescopic spring tie meanwhile holds the front end of the bogie beam in a fixed position with relation to the leg during the retraction movement; this combined action locates the bogie beam and wheels in the correct attitude for stowing in the wheel well.

NOTES:

Shortening of the leg is accomplished without compressing the liquid spring shock absorber. However, an internal coil spring is compressed. This spring serves to take up any slack in the chain run during extension.

Extension of the main legs is by hydraulic release of the uplocks, opening a restricted run-around circuit to the retraction jack, and allowing the legs to fall by gravity.

1.2 Locks

The main gear downlock is spring closed and hydraulically released by a unit contained within the telescopic side-stay.

Inside the leg itself is another spring unit which locks the rotating-extending portion of the leg. Release of this lock is by the chain circuit which retracts and rotates the moveable portion of the leg.

Both these locks actuate microswitches wired to operate a signal light in the cockpit.

The gear uplock is a spring-loaded hook which catches a pin in the leg. Release of the hook is by hydraulic jack; the whole assembly is mounted in the wheel well.

1.3 Telescopic Tie

This is a spring compression strut, one end of which is pivoted to the leg outer casing. The other end pivots on an arm bolted to the forward end of the bogie beam.

One purpose of this strut is to ensure that the bogie beam assumes the correct attitude for stowing as soon as the aircraft is airborne.

Its other purpose is to avoid violent oscillation of the bogie beam upon landing. The geometry of the gear is arranged so that the rear wheel touches the ground first; at this time, the telescopic tie prevents the bogie beam from tilting and allowing the front wheel to hit the runway; instead, the bogie beam pivots around the end of the tie and causes the shock absorber to compress and bring the front wheel down lightly.

1.4 Liquid Spring Shock Absorber

This consists of an outer casing which telescopes into the leg, sliding on two plain bearings.

Inside this casing is a small-diameter oil cylinder. The upper end of this is attached by a transverse pip-pin to a block inside the leg. The lower end carries a circular head which bears on the inner wall of the casing.

Inside the oil cylinder is the liquid-spring piston and piston rod. The piston slides inside the cylinder. The lower end of the piston rod is bolted to the end of the casing and to the bogie beam pivot forging.

When the aircraft touches down, the piston rod and outer casing slide upwards into the leg, and the liquid spring piston moves up the oil cylinder, compressing the oil.

Static pressure in this unit is of the order of 30,000 psi; closing pressure 53,000 psi.

1.5 Recuperator

Mounted on the inboard side of the forward brake link is an air-charged, hydraulic recuperator. The brake link itself also serves as an air reservoir for the recuperator. Pipe lines with swivel joints lead recuperator oil through a surge valve to the liquid spring piston rod which is rifle-bored to form a passage through the piston to the interior of the liquid spring oil cylinder.

The surge valve is closed when the aircraft is on the ground, but is opened by a cam during the last 1" of leg extension, to provide direct communication between the interior of the liquid spring cylinder and the oil chamber of the recuperator. At this time, a flow of oil is possible in either direction, depending on whether temperature variations have left the liquid spring under or over-charged. In this way, the shock absorber is always correctly charged immediately before touch down.

If the liquid spring becomes overcharged during flight when the leg is retracted and the surge valve is closed, a restricted helical passage-way is provided to permit slow pressure equalization.

The recuperator is fitted with air and oil charging connections.

Recuperation pressure is of the order of 1500 psi.

1.6 Mooring

Mooring and engine hold-back lugs are provided on the leg casing.

1.7 Towing

Spring-retracted towing eyes are fitted inside the main bogie beam pivot.

1.8 Doors and Fairings

The wheel-well in each wing is closed in flight by:-

(a) A small door at the outboard end which is hinged to the wing and linked to the leg;
(b) A fairing attached to the leg by 9 springs and pins;
(c) A large door hinged at the inboard end to the wing and actuated by a hydraulic jack.

The operation of leg and door is timed by mechanically operated sequence valves.

1.9 Electrics

Microswitches:

(a) A microswitch in each wheel well is actuated by the final travel of the door "UP". Each switch gives an "UP" indication in the cockpit, and when all three (including the nose gear) are actuated, the red warning light in the undercarriage selector lever knob goes out.
(b) A microswitch at each gear downlock is actuated by the final travel of the downlock and shows "GEAR DOWN" in the cockpit.
(c) On each main gear scissors, a microswitch is actuated by the initial leg compression movement. These two switches in series unlock the undercarriage selectro solenoid, permitting "UP" selection as soon as the wheels are off the ground.

1.10 Brakes

In the dual disc hydraulic brakes, the two discs are keyed to the wheel and rotate between three sets of flat cylindrical brake linings, fitted in recesses in the brake housing. Hydraulic pressure is applied to the piston in the brake cylinder, which has the effect of squeezing the discs between the linings, producing the necessary braking effect. When pressure is released, a spring returns the piston to the "OFF" position, thus freeing the brake discs from the linings.

The brakes are actuated by pressure on the pilot's rudder pedals, which are connected by cables to the brake control valves, which in turn control the supply of fluid from the utility hydraulic system to the brakes at a maximum pressure of 2500 p.s.i.

In case of failure of the utility hydraulic system and for use on the ground when the engines are not running, there is an emergency brake system which operates hydraulically from the utility accumulator at 1600-1700 p.s.i. The accumulator, when fully charged to 4000 p.s.i., would give a maximum of 40 operations immediately after engine shut-down. This number would be considerably reduced if the aircraft has been standing on the ground for some time.

The emergency system automatically takes over, without any additional action on the part of the pilot, in the event of hydraulic system failure.

An electrically controlled anti-skid system is incorporated in the brake system. It releases pressure when a skid is imminent, thus providing maximum braking effort without any change in brake pedal force by the pilot. The anti-skiding system is operative only with normal operation, not emergency.

The anti-spin braking circuit automatically applies the brakes during retraction of the landing gear.

2. NOSE UNDERCARRIAGE

2.1 Leg

The "Y" shaped leg forging pivots on two bearings carried in a frame in the front fuselage. An interchangeable tie-rod braces the two arms of the "Y". Near the upper end of the R.H. arm is the retraction jack attachment lug.

Just below the "Y" is the attachment arm for the folding drag-stay, the upper end of which is bolted to the fuselage structure. This stay contains the nose leg mechanical downlock and its hydraulic release jack.

The next item down the leg is the leg uplock pin, and, close to it, the nose-steering jack upper attachment lug.

Below this are the steering jack lower attachment lugs, the picketing lug, and the hinged fairing attachment brackets.

Still on the stationary portion of the leg is the boss holding the steering linkage.

Inside the lower end of the leg is the lower conical bearing carrying the steering and suspension head, and retained by dowels and circlips. On the outside of the leg are the stops limiting steering to 55°.

Attached to the steering head are the steering linkage and the upper end of the telescopic air strut. The lower end of this is bolted to the lower end of the suspension lever.

2.2 Drag Strut and Downlock

The nose gear downlock is spring closed and hydraulically released by a unit contained within the folding drag-strut.

An adjustment at the lower end of the drag-strut permits proper rigging of the leg after replacement.

The gear uplock is a spring-loaded hook which catches a pin in the leg. Release of the hook is by hydraulic jack; the whole assembly is mounted in the wheel well.

2.3 Ground Lock

Holes in the two halves of the drag strut permit the insertion of a safety bar when the nose leg is extended and locked.

2.4 Telescopic Air Strut

This strut extends from the steering head to the lower end of the suspension lever. It is inflated to a pressure of approximately 1000 psi and serves to ensure full extension of the shock absorber as soon as the nosewheels leave the ground. This is necessary for correct stowage of the gear in the wheel well, to permit closing of the nosewheel door.

2.5 Steering

The double-ended hydraulic jack mounted by 2 bolts on the nose-leg is attached to the nose steering linkage so that the reciprocating movement of the jack piston is converted to a rotary movement of the steering head and shock absorber.

The jack is operated by hydraulic pressure from the aircraft utility system, controlled by the steering valve mounted on the jack body. The valve is linked to the pilot's rudder pedals by cables, through a pulley box which is spring-loaded to maintain cable tension and to disconnect the cable drive when the gear is retracted.

Steering is possible when:-

(a) The nose gear microswitch is actuated by deflection of the shock absorber, i.e. when the weight of the aircraft is on the nose wheel; and
(b) When, at the same time, the pilot depresses the nose-steering selector button on the control column; this action opens a solenoid-controlled valve to admit pressure to the steering valve and so to the jack.

The jack then responds to rudder pedal movements, and a follow up mechanism, also cable-controlled, returns the control valve spool to neutral as soon as the nose wheels reach a position corresponding to the position of the rudder pedals.

In order to ensure synchronization of rudder pedal and nose wheel position before the steering is engaged, a hydraulic clutch is fitted inside the control valve. This clutch operates only when pressure is supplied to the control valve as noted in (a) and (b) above. At other times, the clutch is disengaged and allows free

movement of the rudder pedals and also free castoring of the nose wheels for towing.

Self-centring is hydraulic, aided by springs inside the jack.

2.6 Shimmy Damping

When steering is not selected, the solenoid-controlled valve remains closed and system pressure is not applied to the nose-steering system. The steering valve, being spring-loaded, shifts to centre and forms a closed circuit consisting of the steering jack, two one-way restrictor valves, and the steering valve.

Any movement of the nose wheels from the trailing position results in fluid being forced out of one end of the jack, through the restricted path in one restrictor valve, through the centre steering valve, through the free-flow path in the other restrictor valve, and back into the opposite end of the jack. The self-centring springs in the jack itself also assist in the damping process.

2.7 Doors and Fairings

The nose-wheel well is enclosed in flight by:-

(a) The leg fairing which is hinged to the fuselage at its rear end and tied to the leg by two struts near its forward end.
(b) By a hydraulically operated door hinged to the R.H. side of the wheel well.

The operation of leg and door is timed by mechanically-operated sequencing valves.

2.8 Electrics

Microswitches:

(a) A microswitch in the nose-wheel well is actuated by the final travel of the door "UP". This gives an "UP" indication in the cockpit. Actuation of this switch plus the two main gear switches puts out the red warning light in the undercarriage selector lever knob.
(b) A microswitch in the gear downlock is actuated by the final travel of the downlock and shows "GEAR DOWN" in the cockpit.
(c) Compression of the nose shock absorber actuates a microswitch which completes the circuit to the nose-wheel steering solenoid selector valve.
(d) When the nose gear door is not up and locked, a microswitch breaks the armament circuit.

(e) An electrical receptacle on the leg accepts an electrical ground cable for 28V D.C. power, starter control, intercom and telescramble leads.

(f) Two sealed-beam lamps are fitted on the nose undercarriage. One is fitted on the steerable portion of the leg for taxiing purposes and the other, the landing light, on the fixed portion.

For landing, both lights are switched on, but for taxiing the taxiing light alone may be used.

A micro-switch ensures that the lights cannot be switched on with the nose gear retracted.

2.9 Liquid Spring Shock Absorber

This unit operates on the same principle as the main liquid spring (para. 1.4).

It is fitted, rod end uppermost, in a sleeve which is free to rotate inside the nose leg and which is connected to the steering mechanism.

The liquid spring is connected to this sleeve at the upper end only; the lower end being attached to the centre of the suspension lever.

The landing shock is passed from the wheels, through the suspension lever to the liquid spring. This cushions the shock and passes it into the rotating sleeve, which in turn passes it through the tapered lower bearing into the leg and aircraft structure.

2.10 Undercarriage Drawings

Main Undercarriage:

Dowty V1280	Installation Main Undercarriage
Dowty PS135	General Arrangement Main Undercarriage
Dowty XV1283-1 A/B	Main Undercarriage Assembly
Dowty V1283-9 A/B	Shock Absorber Assembly
Dowty Q1283-12 A/B	Recuperator Valve Assembly
Dowty V1283-6 A/B	Front Brake Link - Recuperator Assembly
Dowty SV1284-1 A/B	Sectional Arrangement of Side Stay
Goodyear PD 732	Wheel & Brake

Nose Undercarriage:

Jarry 1500	Nose Gear Assembly
Jarry L-184	Nose Landing Gear Control Drawing
Jarry L-148	Drag Strut Assembly
Dowty XT-3007	Shock Absorber Unit
Dowty XT-3105-1	Shock Absorber Assembly

1. MAIN UNDERCARRIAGE

1.1 Removal of Leg from Aircraft

Before removing the leg, the jury strut should be fitted over the telescopic tie, to secure the bogie-beam in position relative to the main leg.

Jack up the aircraft high enough to allow removal of the under-carriage.

The leg fairing and small pivot door can now be removed, followed by the hydraulic lines and electric cables on the leg and telescopic side-stay.

The main undercarriage jack is then disconnected from the drag strut, and the pin securing the lower end of the drag strut to the leg is removed.

The telescopic side stay can now be removed by removing the bolt at the top end and the ball end at the lower end. The leg is secured in the mobile dolly ready for removal from the wing.

Remove the bolts securing the coupling in the main pivot shaft, which permits withdrawal of the coupling. This allows the inner end of the shaft to be slid outboard sufficiently to withdraw it from its housing. The drag strut, which is integral with the inner shaft, may be removed. After removal of the locknut, the outer section of the shaft is free to slide out of its housing. This frees the leg from the wing and it can be removed on the mobile dolly.

1.2 Breakdown of Main Undercarriage into Components

The following have already been removed during the removal of the leg:

(a) Drag Strut
(b) Telescopic Side Stay.

Other units are removed as follows:

(c) Wheels
1. Remove locking pin from axle nut.
2. Remove nut and washer.
3. Slide wheel off axle.

(d) Brakes
1. Disconnect hydraulic line from brake housing.

2. Disconnect brake link from back plate.
3. Slide brake unit off axle together with spacer.

(e) Liquid Spring

1. Release air and fluid pressure, remove piping and surge valve from leg.
2. Remove bogie beam, telescopic tie and scissors from leg.
3. Removing locking tube from lower locking nut.
4. Remove lower locking nut from liquid spring.
5. Remove lower bearing from curvic coupling.
6. Remove dust cap and with extractor, withdraw pip pin securing liquid spring in the leg.
7. Withdraw liquid spring, complete with outer casing.
8. Remove liquid spring from casing.

1.3 Servicing

(a) Liquid Spring and Recuperator

Full servicing instructions are given on the instruction plate attached to the recuperator. See Fig. 1.

To charge the unit with fluid, the leg should be partially retracted, in order to open the surge valve connecting the recuperator and liquid spring. A hand pressure gun is used, fluid specification, DOWCAN 200.

It is not anticipated that the system will require air bleeding in normal service, but if it should be necessary, the liquid spring would have to be removed to gain access to the air bleed screw.

(b) Leg Shortening Mechanism

The initial setting is obtained by means of an adjustable stop on the airframe structure. This stop is in contact with the mounting for the upper sprocket of the chain mechanism, and governs the linear movement of the lower section of the leg during retraction.

No further adjustment will be necessary in normal service, as the chain is pre-stretched and will not elongate during the life of the undercarriage.

(c) Rigging Adjustment

The undercarriage is inclined inward 7.86" from the pivot shaft measured at the ground. This inclination is obtained by adjustment on the screw thread at the lower end of the telescopic side stay.

(d) Wheels and Brakes

Pending.

(e) Lubrication

50 hr. - Lubricate all grease nipples with grease gun and MIL-G-3278 grease. Grease nipples are MS 15000 series. Both press type and threaded types are used.
Pack wheel bearings with grease to spec. MIL-L-3545.

2. NOSE UNDERCARRIAGE

2.1 Removal of Leg from Aircraft

Jack up the aircraft so that the nose wheels are clear of the ground.

The nose leg fairing can be removed, together with the hydraulic lines, electric cables and the steering control cables from the nose wheel steering system.

The nose gear jack should then be disconnected from the leg and secured so that it will not foul the leg on removal.

Disconnect the folding drag strut by disconnect it at the lower end.

The dolly can then be secured to the leg so that the weight will be supported when the pivot pins are removed.

Remove the hydraulic swivel joint at each pivot point, and the pivot pins can then be removed, freeing the leg from the aircraft.

2.2 Breakdown of Nose Undercarriage into Components

Components are removed as follows:

(a) Telescopic Air Strut

Release the air pressure from the strut and disconnect upper and lower attachments.

(b) Wheels

1. Remove cotter pin and unscrew axle-nut.
2. Withdraw wheel off axle.

(This may require an extractor, owing to the wheel being splined to axle.) On assembly take up adjustment until free rotation without appreciable end play is obtained.

(c) Liquid Spring

1. Release air pressure and remove telescopic air strut.
2. Disconnect suspension lever from lower end of liquid spring.
3. Remove shaft securing suspension lever and lower steering link to steering head on rotating sleeve.
4. Remove suspension lever and steering link.
5. Remove circlips and retaining pins securing rotating sleeve in leg.
6. Withdraw sleeve downward.
7. Remove bolt securing rod end of liquid spring to sleeve.
8. Slide liquid spring from sleeve.

(d) Nose Wheel Steering Mechanism

Pending.

2.3 Servicing

(a) Liquid Spring

Charging: Jack the nose of the aircraft until all weight is off the leg. Determine the correct pressure for ambient temperature from the temperature/pressure chart. Connect a pressure gun to the inflation valve until correct pressure is shown on the gauge. Fluid Spec:- DOWNCAN 200.

Bleeding: If air is present in the liquid spring it will be necessary to remove and invert the unit, so that the bleed screw will be uppermost on the cylinder when bleeding is carried out.

To bleed, pressurize the liquid spring, open thebleed screw and charge until air-free fluid is obtained at the bleed aperture. Close the bleed screw whilst pressure is maintained.

(b) Rigging of Nose Leg

The nose leg is inclined $3^{\circ}36'$ rearward, and this angle is obtained by adjustment of the screwed lower eye end of the folding drag strut.

(c) Wheels and Tires

Pending.

(d) Lubrication

50 hr. - Lubricate all grease nipples with grease gun and MIL-G-3278 grease. The Grease Nipples are MS 15000 series. Both press type and threaded types are used. Pack wheel bearings with grease to spec. MIL-L-3545.

3. MAINTENANCE SCHEDULE

3.1 Between Flights

Check tires visually.
Check telescopic air strut pressure on nose gear.

3.2 Daily

Check tires and wheels for condition, pressure and creep.
Check liquid spring units for leaks and correct extension (on main gear check oil content and air pressure indicators).
Check brakes for leaks, overheating and wear.
Check wheel wells and legs for cleanliness and signs of fouling.
Check door operating mechanism for damage.
Check emergency air pressure.

3.3 25 Hours

Check struts, ties, stays and their attachments for leaks, corrosion and damage.
Check hydraulics jacks, valves and lines for leaks, security and damage.
Check brake clearances.
Check brake control valves for security, damage and leaks.
Check brake accumulator air pressure.
Check steering unit for security, damage, cables for fraying.

3.4 50 Hours

Carry out retraction check.
Remove wheels; check wheels, brakes, bearings, axles and dust excluders for wear, cracks and general condition. Lubricate and replace.
Check nose wheel steering operation and castering action of nose wheels.
Check brake operation, including anti-skid, anti-spin and emergency systems.
Check all pivot bearings and pins for wear.
Lubricate according to lubrication chart.

3.5 100 Hours

Carry out emergency extension of undercarriage (emergency air).

SERVICING OF LIQUID SPRING/COMPENSATOR SYSTEM

WHENEVER THE LANDING GEAR IS UNLOADED THIS RECUPERATOR AUTOMATICALLY COMPENSATES FOR THE EFFECTS OF TEMPERATURE CHANGE UPON THE LIQUID SPRING. RECHARGING IS REQUIRED ONLY AFTER LEAKAGE OR DISMANTLING.

NOTE:- THE OIL CONTENT INDICATOR IS AT THE AIR END OF THE COMPENSATOR, AND THE AIR PRESSURE INDICATOR IS AT THE OIL END.

TO CHECK THE OIL CONTENT:- COMPARE TEMPERATURE READING AT INDICATOR WITH AIR TEMPERATURE AT LATEST LANDING IF GEAR IS STILL LOADED, OR WITH AMBIENT TEMPERATURE IF GEAR IS UNLOADED. ADJUST OIL CONTENT TO CORRECT ANY DISCREPANCY GREATER THAN 20°F.

TO CHECK THE AIR PRESSURE:- THE SYSTEM IS BASED ON A NOMINAL PRESSURE OF 1500 P.S.I. A MINIMUM AIR PRESSURE, ESSENTIAL FOR SATISFACTORY STOWAGE OF THE GEAR, IS INDICATED BY THE EXTREMITY OF THE CRANKED POINTER RESTING ON THE CYLINDER. THIS SHOUID BE CHECKED BEFORE EACH FLIGHT.

FOR ACCURATE SETTING OF THE AIR PRESSURE, WHICH SHOULD ALSO FOLLOW ANY ADJUSTMENT OF THE OIL CONTENT, ALLOWANCE MUST BE MADE FOR AMBIENT TEMPERATURE (AND TEMPERATURE OF LATEST LANDING IF GEAR IS STILL LOADED). FOR DETAILS SEE RELEVANT SERVICING MANUAL.

INSTRUCTION PLATE

Dowty Equipment of Canada Limited

FIGURE 1