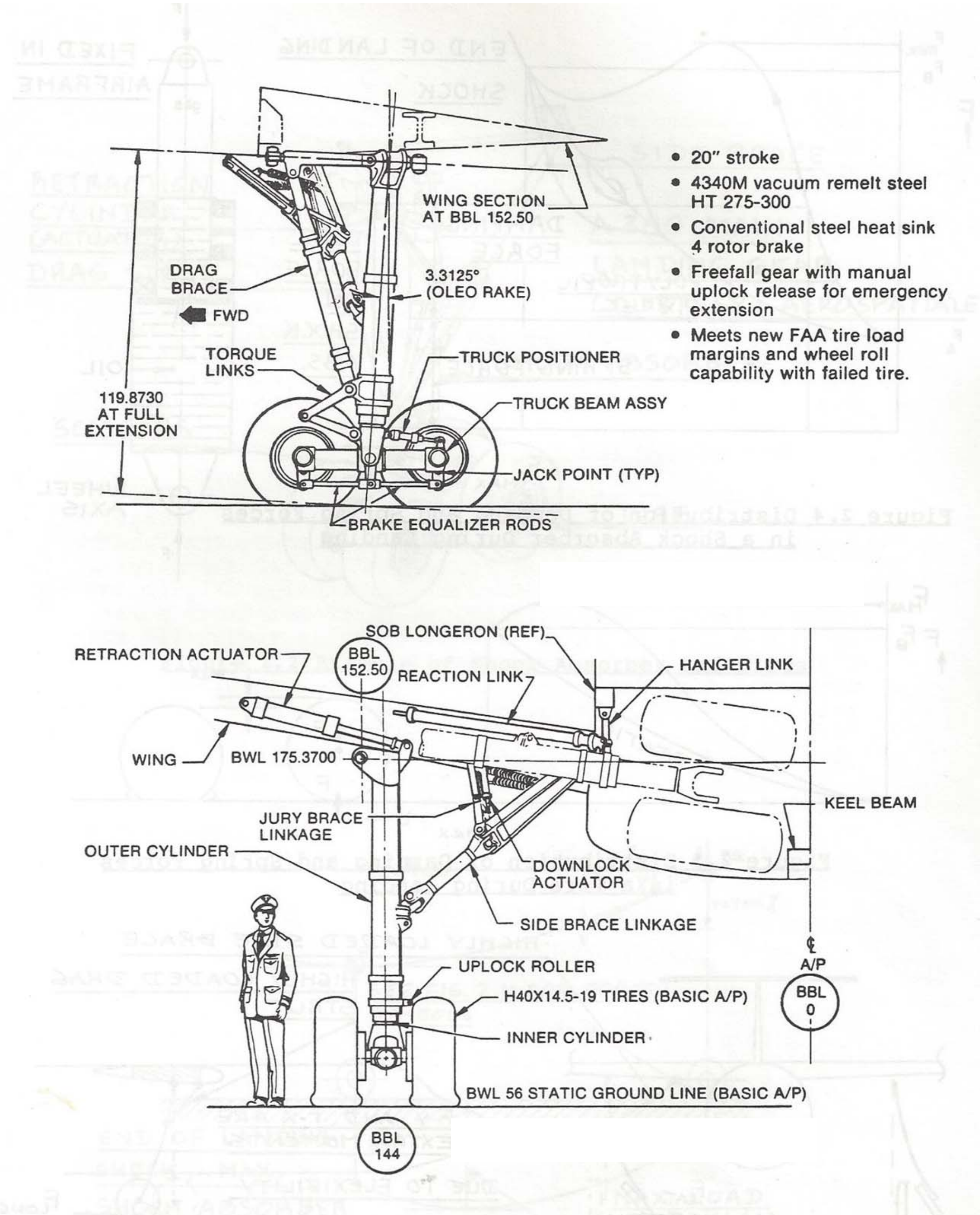
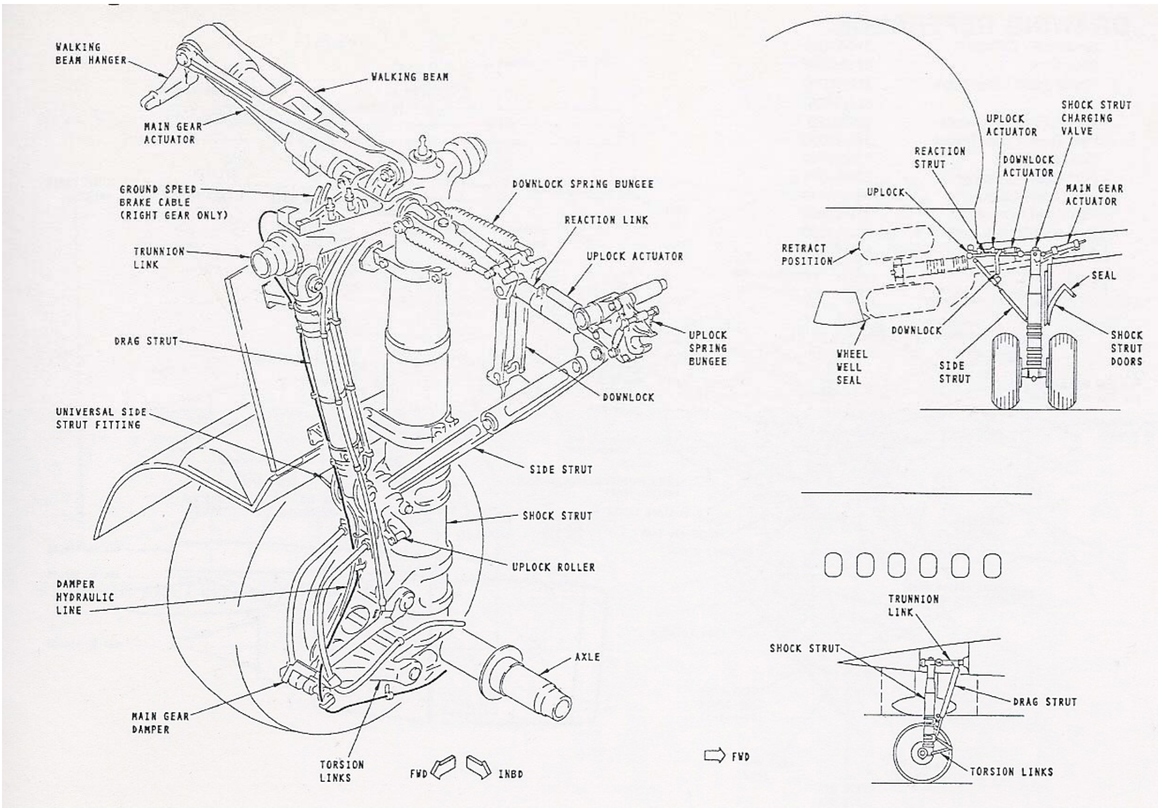
11.6 Gear-Retraction Geometry



Source: Boeing

Fig. 11.6.1 Boeing 757 Main Landing Gear

A typical retraction mechanism for a large subsonic airliner is shown in Fig. 11.6.1. The main landing gear (MLG) for the 767 is similar. A single hydraulic actuator is attached to a lug which protrudes from the top of the MLG strut. This arrangement imposes large transverse loads on the trunnion, lug, and actuator attachment to the wing structure.



Source: Boeing

Fig. 11.6.2 Boeing 737 Main Landing Gear

A mechanism that is more compact and imposes smaller loads on the actuator attachment point is known as the "walking beam". This is used on the Boeing 737, 747, and other types.

The mechanism is illustrated schematically in Fig. 11.6.3. When the actuator pushes on the lower lug, the upper lug forces the horizontal beam to "walk" to the left. This arrangement is compact and reduces loads on the actuator attachment to the wing structure (on the left in the schematic), trunnion, and on the lugs. The actuator has to apply approximately half the force, but twice the displacement of the piston.

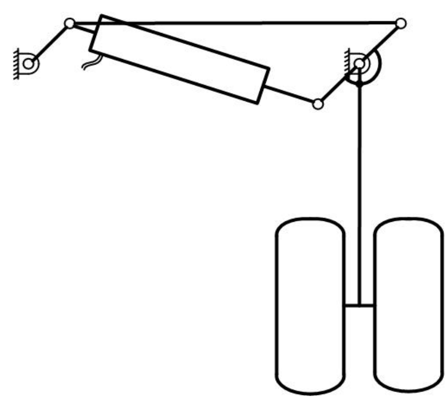


Fig. 11.6.3 Walking Beam Schematic

For a high-wing airplane, the landing gear is usually attached to the fuselage, and some ingenuity has to be used to prevent unsightly (and higher drag) blisters on the outer mold line of the fuselage.

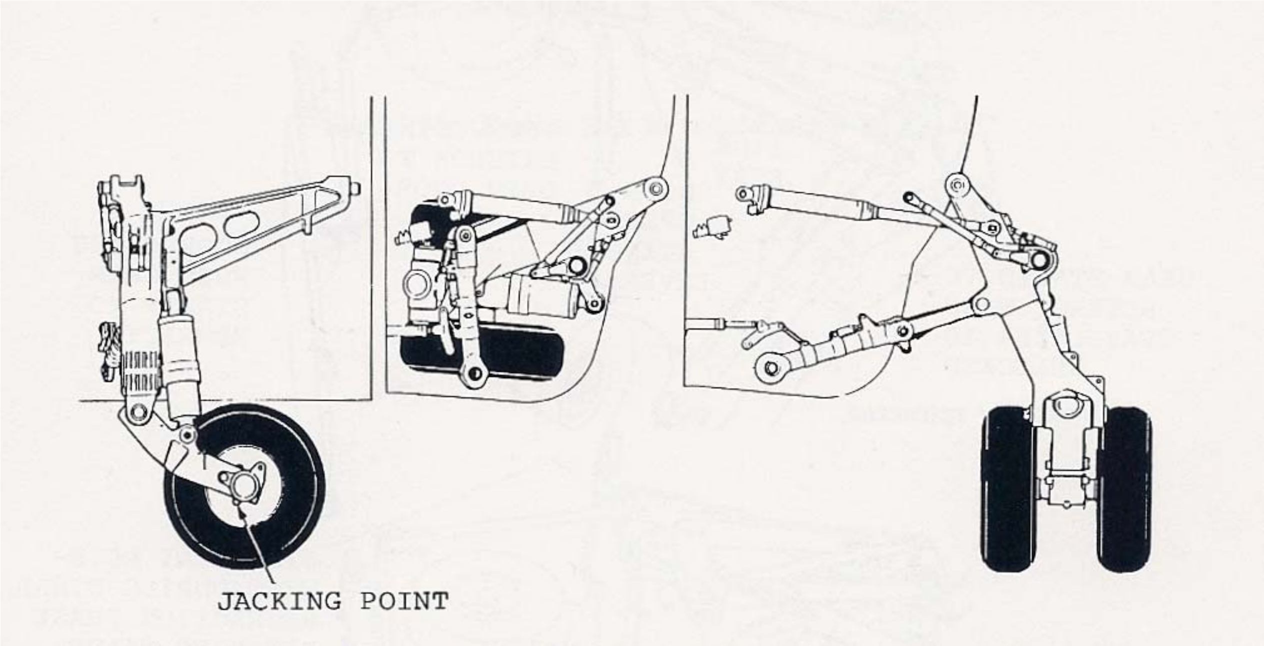


Fig. 11.6.3 BAe 146 Main Landing Gear

One such arrangement is on the BAe 146 regional jet. Four engines are on the wing, and a high wing was used to permit the fuselage to be closer to the ground. This permits easier passenger and baggage loading and unloading.

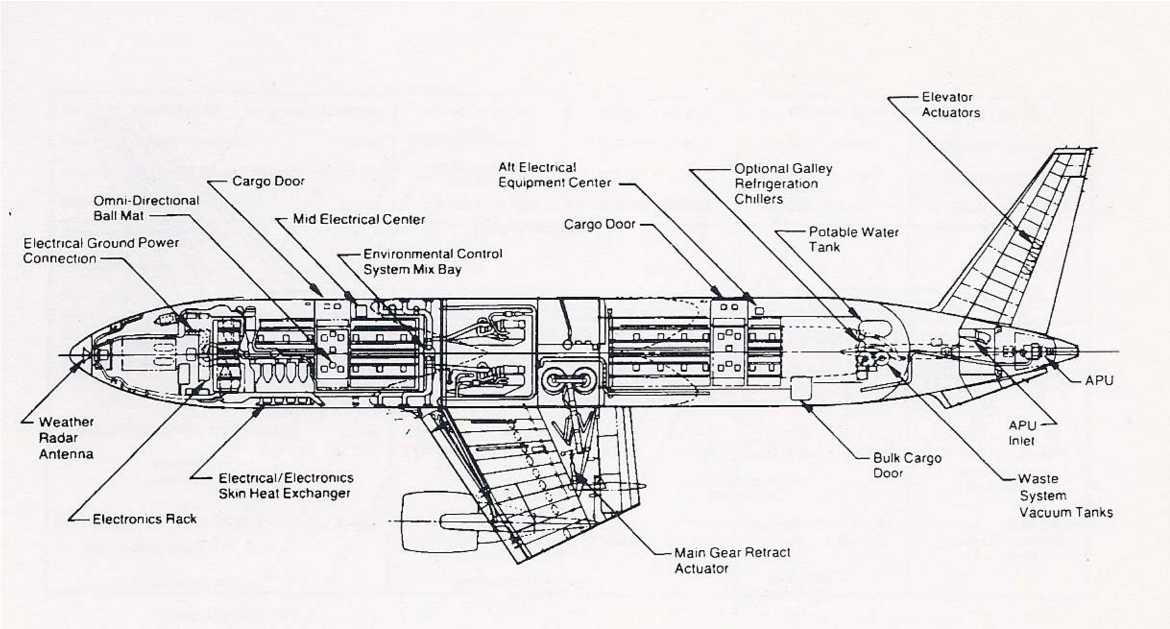
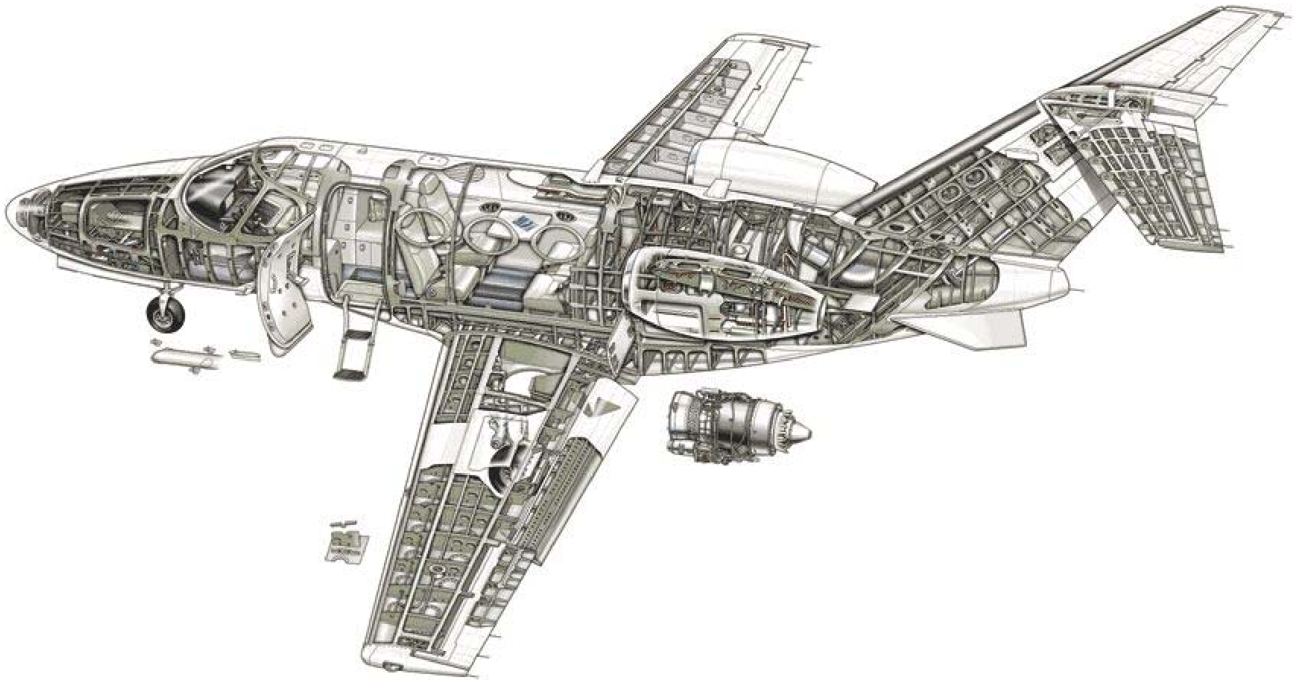


Fig. 11.6.4 Boeing 767 Underfloor Plan

For commercial airplanes with a low wing and moderate sweep, the MLG bogie fits just behind the wing box when retracted, as illustrated in Fig. 11.6.4.

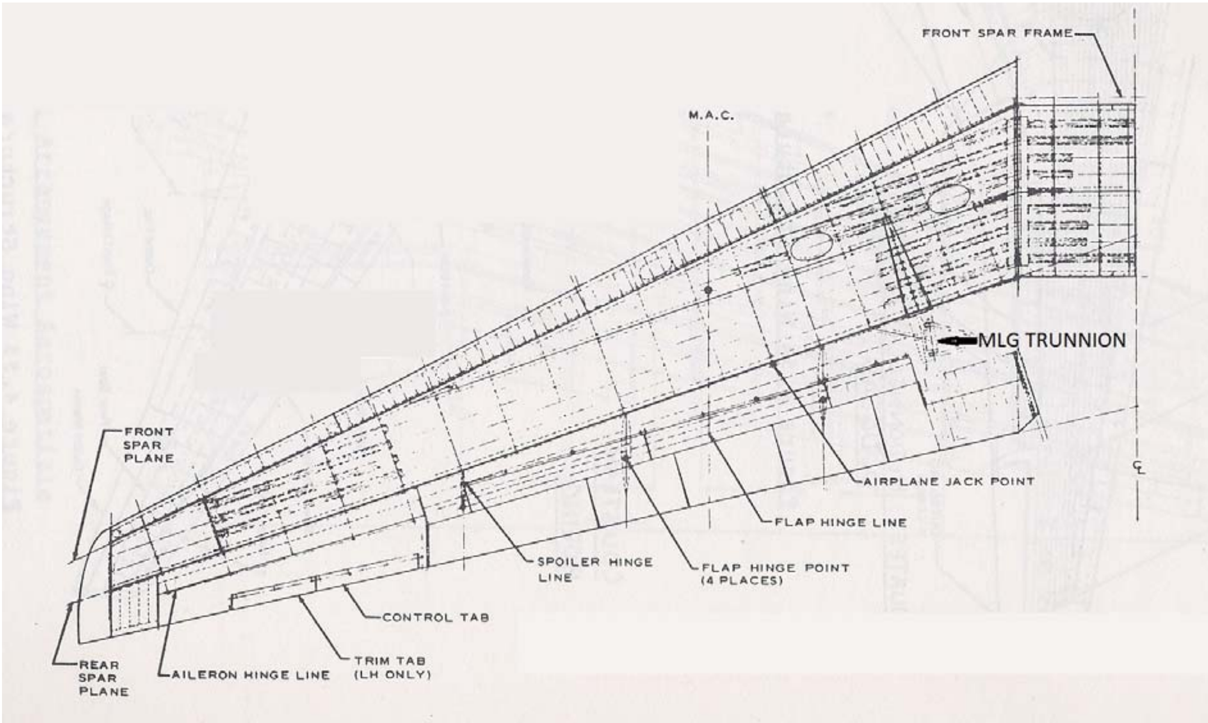


Source: Flight International

Fig 11.6.5 Cessna Citation Mustang

If there is little or no sweep, then the MLG will have to fit between the front and rear wing spar, as illustrated in Fig. 11.6.5. This takes up valuable space that could otherwise be taken up by fuel.

For commercial aircraft with moderately swept low wings, the MLG trunnion is usually attached to the wing and fuselage structure using a structural layout similar to that shown in the annotation to Section 11.2, Fig 11.2.1, or in Fig. 11.6.4 above. The inboard end of the kick spar is attached to a reinforced fuselage frame, and thus carries some of the landing gear loads directly into the fuselage structure. A notable exception is the structural arrangement of the DC-9, in which the trunnion is cantilevered off the rear wing spar and covers, as illustrated in Fig. 11.6.5. Landing gear loads have to be carried through the wing structure (mostly the rear wing spar) into the fuselage.



Source: McDonnell Douglas

Fig. 11.6.5 DC-9 Wing

The nose landing gear (NLG) should retract forward whenever possible, so that if the actuator fails, there is reasonable chance that the slipstream will push the gear into the lowered and

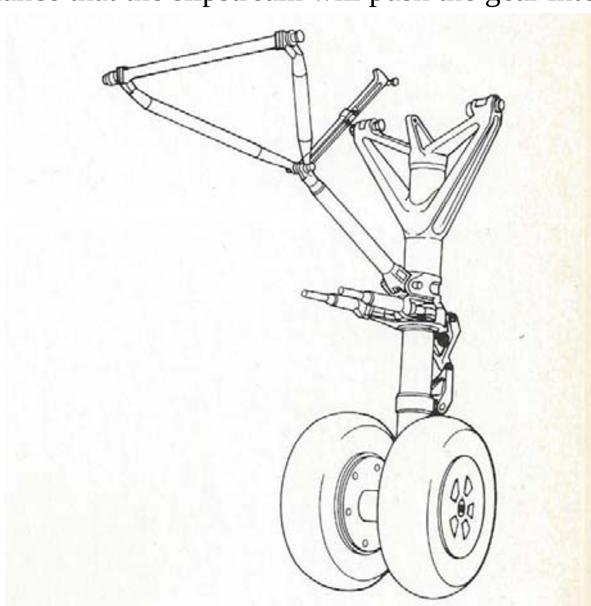
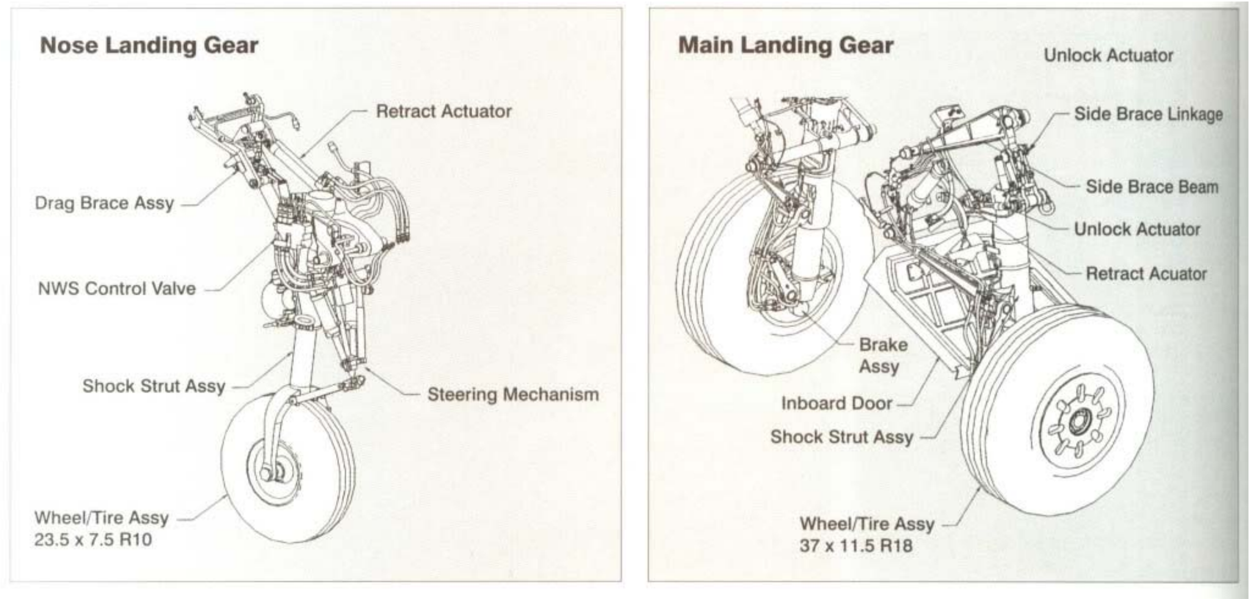


Fig. 11.6.6 DC-10 Nose Landing Gear

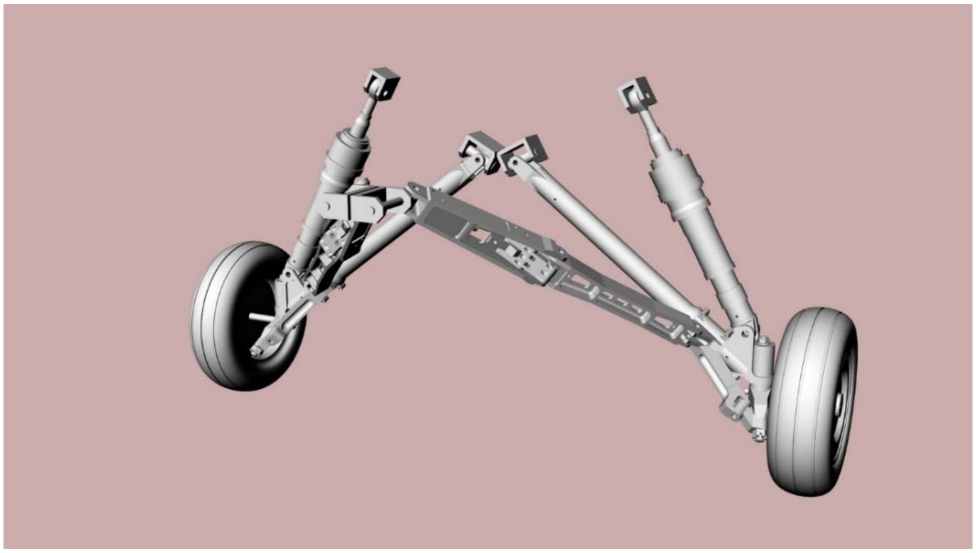
locked position. The mechanism shown in Fig. 11.6.6 is similar to the schematic of Raymer Fig. 11.14 (b). Retraction is actuated by pulling on the break in the drag brace.



Source: http://cs.finescale.com

Fig. 11.6.7 F-22 Landing Gear

For military airplanes there is somewhat more diversity in MLG retraction mechanisms, although the F-22 uses a conventional strut with drag and side brace. The trunnion axis is longitudinal, as illustrated in Fig. 11.6.7.



Source: f16model.blogspot.com

Fig. 11.6.8 F-16 Main Landing Gear CAD Model

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The F-16 is a single-engine fighter, and the fuselage is narrower than that of the F-22. For the MLG to have the required stance, the oleo strut must be angled outboard of the fuselage, as illustrated in Fig. 11.6.8.