Levered Suspension

Resilience to Both Drag and Vertical Loads Ensures Efficient Operation of the Shock Absorber: An Interesting Undercarriage Development Explained and Reviewed

By R. H. Bound, F.R.Ae.S., A.M.I.Ae.E.

The design of aircraft undercarriages has been the study of specialist firms for a number of years, in parallel with the work of other specialist concerns manufacturing such units as engines, airscrews, gun-turrets and other major components.

The design of retracting undercarriages involves such problems as adequate energy absorption, good taxiing characteristics, reliable retracting mechanism and locking gear, and the provision of emergency methods of lowering in the event of failure of the normal system.

Analysis of the telescopic compression leg, which has been in popular use for many years, reveals certain deficiencies which are inherent in the system. In particular, it is impossible so to position the leg that all combinations of vertical load and side loads induced by drift landings, and drag loads due to braking, shall give a resultant loading which is truly axial in the shock absorber. Consequently, the telescopic strut is subjected to bending. This results in deflection with concurrent binding, thus preventing the shock absorber from functioning smoothly.

Problems of dissipating the kinetic energy of vertical descent in landing, together with the provision of a resilient carriage for taxiing over surfaces of varying degrees of roughness, have been attacked in a wide diversity of designs and combinations in shock-absorbing media. These range from the early undercarriages using axles sprung by rubber cord to the modern telescopic shock-absorber units.

Levered Suspension Principle

The shock absorber is the mechanical centre of the undercarriage, and the working efficiency of this unit is of primary importance. Unfortunately, due to the complicated nature of undercarriage loadings, the optimum performance of the shock absorber is difficult to realise, but levered suspension has provided a practical solution to the problem and established:

a. Smoothly-working undercarriage which is resilient to both drag and vertical loads.

Figs. 1, 2 and 3 illustrate the principle of levered suspension. Fig. 1 shows an undercarriage for a modern bomber. Fig. 2 is a sideways-retracting levered suspension undercarriage for fighter. Fig. 3 illustrates a levered suspension nose wheel used on one of our latest fighters. This unit employs a tension-type shock absorber.

The arrangement consists essentially of pin-jointing the working parts of the undercarriage so that the shock absorber is pin-jointed to a beam or lever which also carries the wheel, a principle from which this type of landing gear has derived the title “Levered Suspension.” The legs in this case, as distinct from the telescopic compression legs illustrated in Fig. 4, are purely structural members to which are attached the swinging arms which form the mounting for the landing wheel. The shock absorbers are attached to these swinging arms and to the legs through a medium of pin joints, movement of the wheel being controlled by the shock absorber.

Under the action of vertical loads the wheels swing about the pivot bearing, thus compressing the shock absorber; drag loads (which also have a moment about the pivot bearing) result in the same movement, so utilising the energy-absorption characteristics of the undercarriage for loads whether they arise from landing impact or from drag due to taxiing over rough surfaces.

It will be noted that, in the case of the telescopic compression leg, the shock absorber has nominally the same linear travel as the wheel. With levered suspension this movement of the piston is reduced by an amount corresponding to the leverage ratio, and this results in a smaller and more compact shock absorber.

The undercarriage must be of a robust construction and provide means for absorbing the shock of landing. In the case of the telescopic leg the shock absorber is integral with the structure, a combination which is not entirely satisfactory as the bending moments, which are inherent with the cantilever-leg undercarriage, can adversely affect the resilient properties of the undercarriage. Levered suspension ensures that the shock absorber is relieved of bending forces which interfere with the working efficiency of the unit.

Hydraulic Shock Absorbers

A few aircraft still rely on rubber for their suspension, usually in conjunction with a friction device to damp rebound action. The efficient ground performance of the wide diversity of aircraft types has, for a number of years, resulted in the fairly general use of a unit consisting of a combination of oil and an energy-storing device. In this arrangement the oil serves the purpose of dissipating the kinetic energy of landing, springing being provided by steel springs, or air.