Chapter Thirteen

Nose Wheel Steering Systems

A. Small Aircraft

Almost all airplanes with tricycle landing gear have some provisions for steering on the ground by controlling the nose wheel. Some of the smallest airplanes, however, have a castering nose wheel, and steering is done by independent use of the brakes. Other small airplanes have the nose wheel connected to the rudder pedals, some directly, and others that are steerable up through a specified angle, after which the steering disconnects and the gear is free to caster up to the limit of its travel.

B. Large Aircraft

Large aircraft are steered on the ground by directing hydraulic pressure into the cylinders of a dual shimmy damper, as shown in Figure 13-1. A control wheel operated by the pilot directs fluid under pressure into one or the other of the steering cylinders. Fluid from the opposite side of the piston in these cylinders is directed back to the system reservoir through a pressure relief valve that holds a constant pressure on the system to snub any shimmying. An accumulator in the line to the relief valve holds pressure on the system when the steering control valve is in its neutral position.

C. Shimmy Dampers

The geometry of the nose wheel makes it possible for it to shimmy, or oscillate back and forth, at certain speeds. Sometimes violently! To prevent this highly undesirable condition, almost all nose wheels are equipped with some form of hydraulic shimmy damper between the piston and cylinder of the nose wheel oleo strut. A typical shimmy damper is shown in Figure 13-2.

1. Piston Type

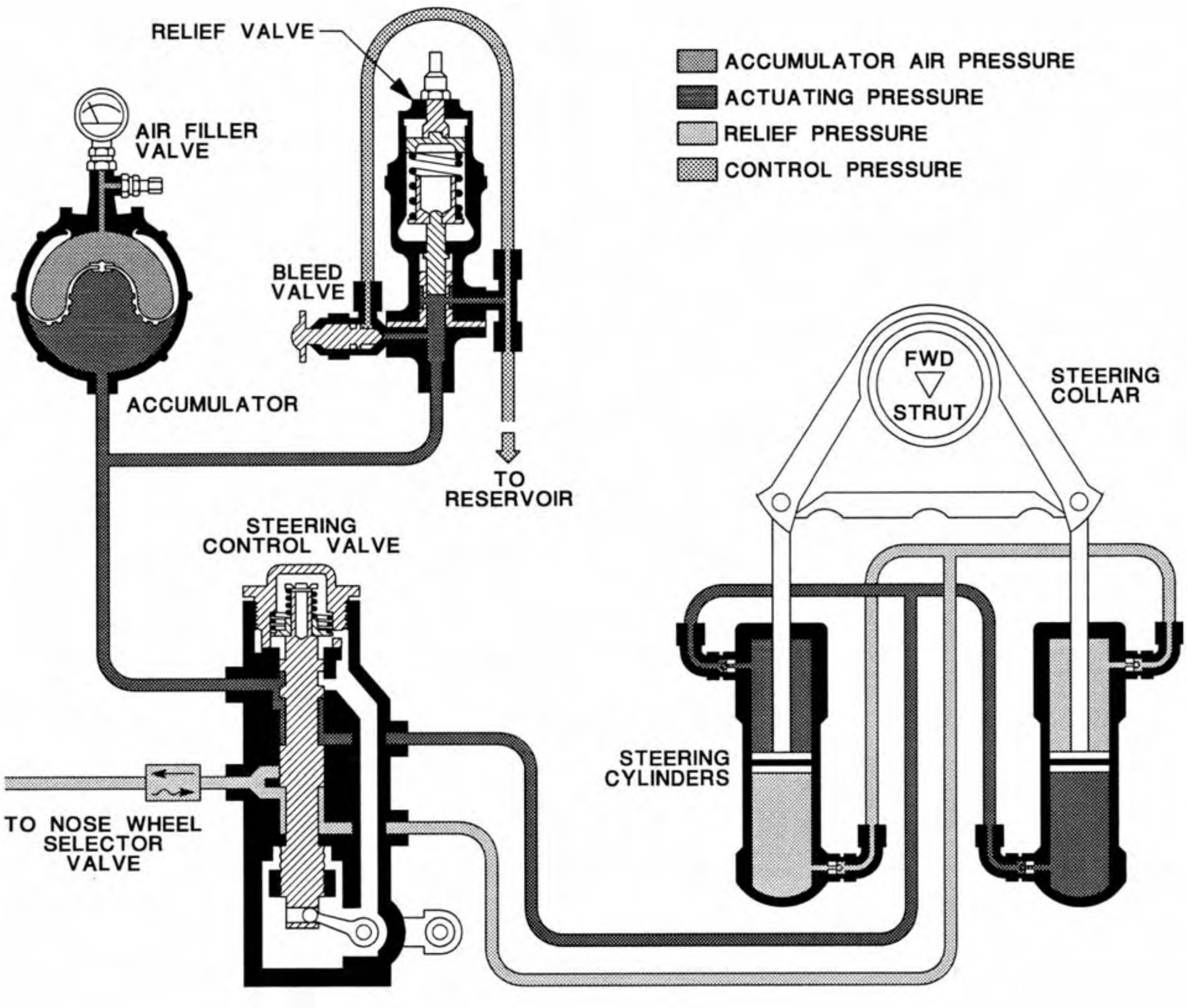
Shimmy dampers are normally small hydraulic cylinders with a controlled bleed of fluid between the two sides of the piston. The restricted flow prevents rapid movement of the piston, but has no effect on normal steering.

2. Steer Dampers

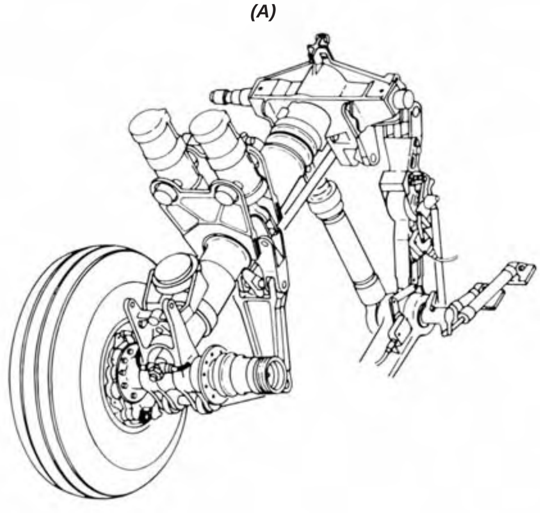
In many cases, the steering actuators serve as the steering dampers, since they are constantly charged with hydraulic fluid under pressure. As the nose wheel attempts to vibrate or shimmy, these cylinders prevent movement of the nose gear. This type of system is used on large aircraft, with a piston type shimmy dampener used on small aircraft.

3. Nose Wheel Steering-Shimmy Dampers

Some steering mechanisms are engaged-disengaged as the nose gear retracts and extends on the retractable type gear. One method used is illustrated in Figure 13-3. The steering bellcrank is connected to the steering rods, and through the rod to the rudder pedals. When the gear is extended, the steering bellcrank engages the steering arm which is attached to the upper part of the strut. Moving the steering arm will turn the nose wheel strut and the nose wheel for steering. As the nose gear retracts the steering bellcrank disengages from the bushing on the steering arm and steering action is disengaged. The strut roller and bracket alignment guide (see items 12 and 14 of Figure 13-3) centers the strut for retraction.



SCHEMATIC DIAGRAM OF THE CONTROL SYSTEM
(A)



STEERING CYLINDERS LOCATED ON THE NOSE-WHEEL SHOCK STRUT
(B)

Figure 13-1 Nosewheel steering system for a large aircraft.

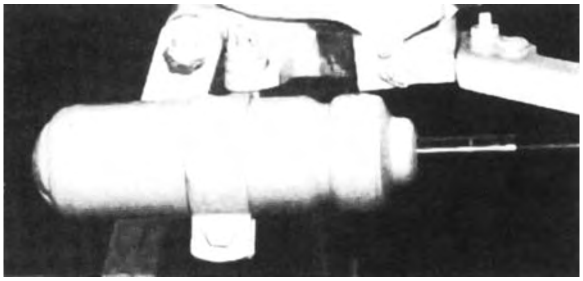


Figure 13-2 A shimmy damper snubs the rapid oscillations of a nosewheel, yet it allows the wheel to be turned by the steering system.

4. Shimmy Dampers

The torque links hold the nose wheel in alignment and must be kept in such a condition that there is a minimum of side or end play in the connecting rods and bolts. The shimmy damper is a hydraulic snubbing unit which reduces the tendency of the wheel to oscillate from side to side.

Shimmy dampers are usually constructed in one of two general designs, piston type and vane type. Both might be modified to provide

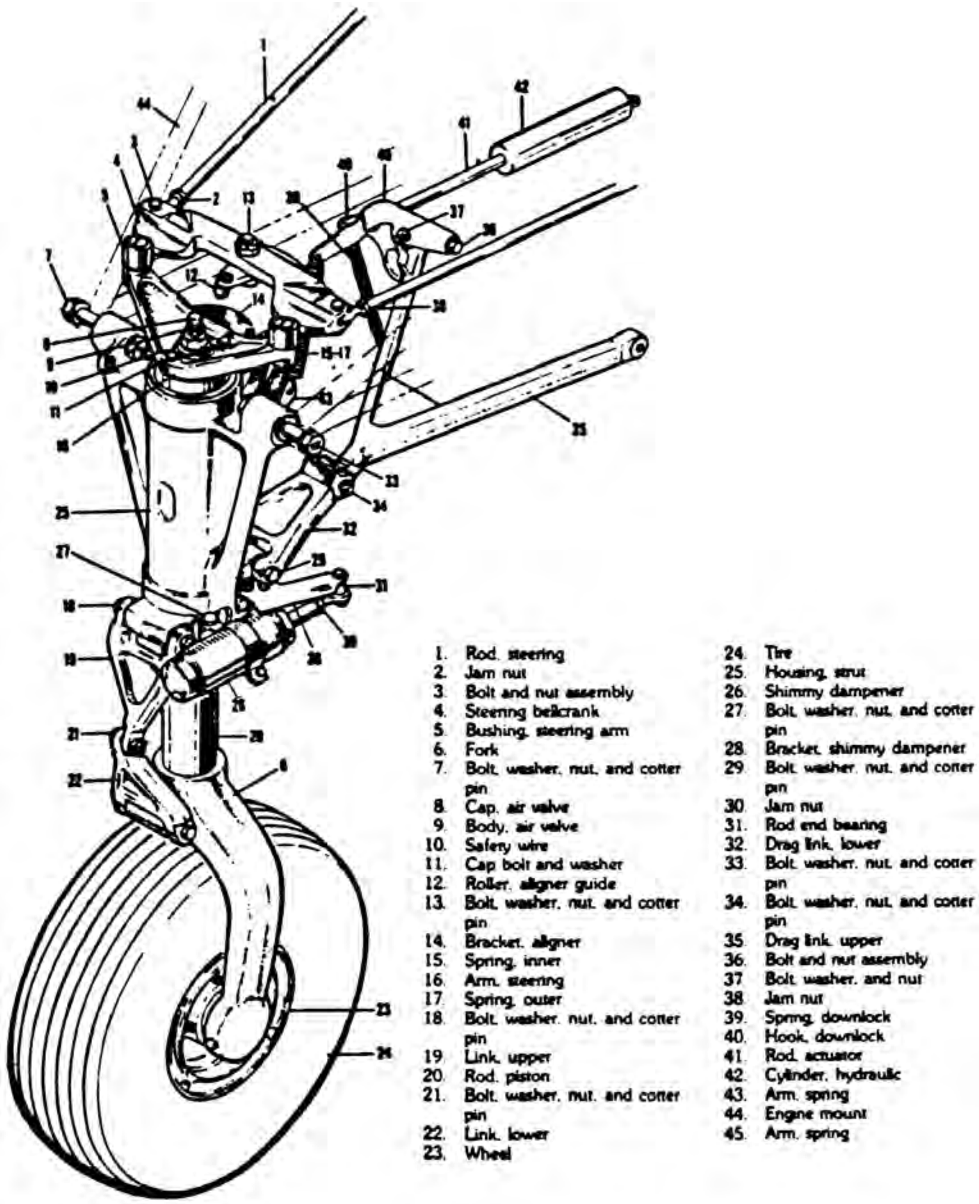


Figure 13-3 Nose gear for light airplane showing the steering mechanism.

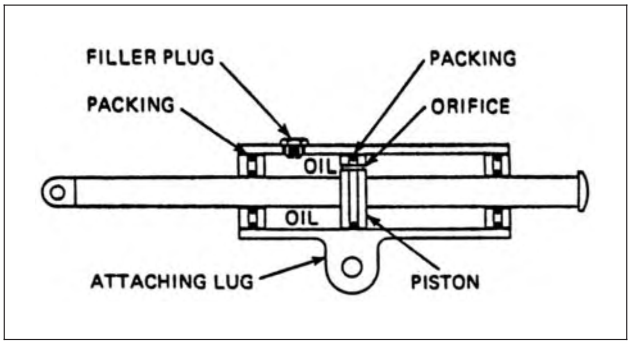


Figure 13-4 Drawing of a shimmy damper.

power steering as well as shimmy damper action. A piston type shimmy damper is simply a hydraulic cylinder containing a piston rod and piston filled with hydraulic fluid. Figure 13-4 illustrates the typical piston type damper. There is an orifice in the piston which restricts the speed of the piston moving in the cylinder. The piston rod is connected to a stationary structure. Any movement of the nose gear will cause the piston to move inside the cylinder. If the movement is slow there will be little resistance from the shimmy damper as the fluid can flow through the orifice to transfer from one chamber to the other. However, if the movement is rapid, there is a strong

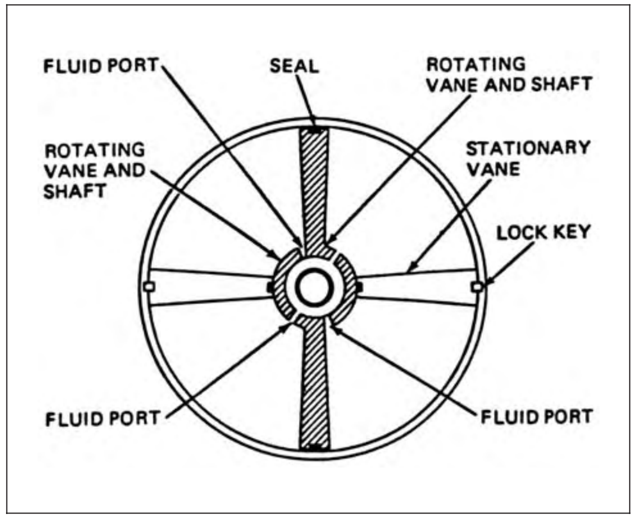


Figure 13-5a Principle of a vane-type shimmy damper.

resistance because of the time required for the fluid to flow through the orifice. This action dampens rapid oscillations.

5. Vane-Type Shimmy Dampers

Vane-type shimmy dampers (Figure 13-5) are designed with a set of moving vanes and a set of stationary vanes as shown. The moving vanes are mounted on a shaft which extends

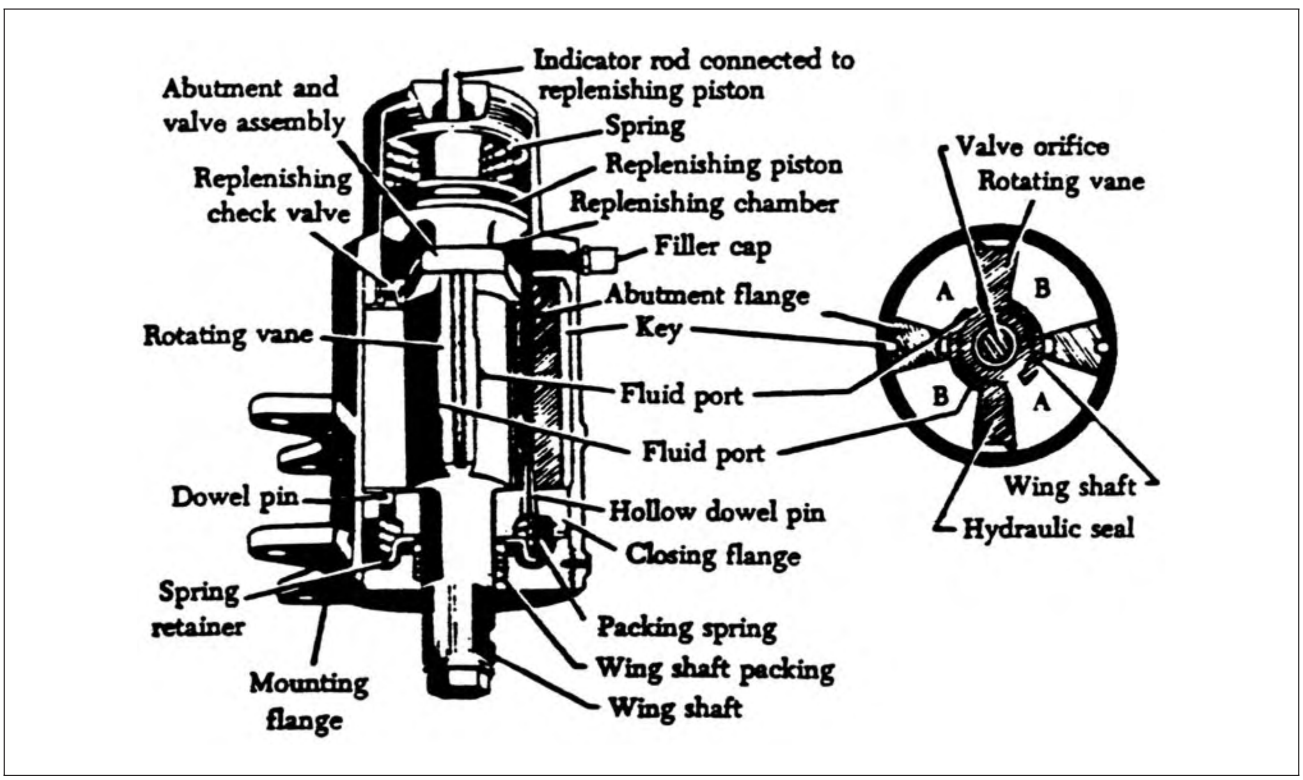


Figure 13-5b Typical vane-type shimmy damper.

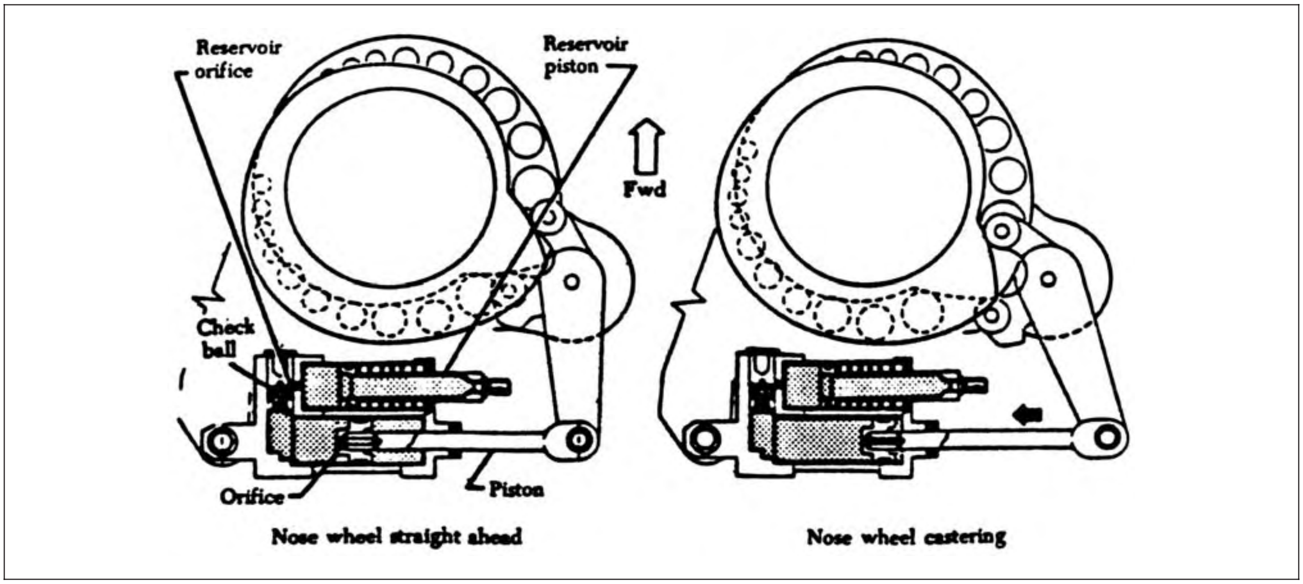


Figure 13-6a Shimmy damper operational schematic.

outside the housing. When the shaft is turned, the chambers between the vanes change in size, forcing the fluid through the orifices from one chamber to another, this will provide a dampening effect to any rapid movement. The body is normally mounted on a stationary part of the nose gear and the shaft to a turning point.

Shimmy dampers do not require extensive maintenance but should be checked regularly to check for leakage and effective operation. Some dampers have a fluid reservoir attached and must be checked periodically, with fluid added when required.

6. Piston-Type Shimmy Dampers

Figure 13-6 is a typical shimmy damper with reservoir. This piston type shimmy damper consist of a spring-loaded reservoir piston to maintain the confined fluid under constant pressure. A ball-check permits the flow of fluid from the reservoir to the operating cylinder to make up for any fluid loss. A red indicator line on the reservoir piston indicates fluid level in the reservoir. When the red mark is not visible, the reservoir must be serviced.

This same feature, a pressurized reservoir and a fluid level indicator can also be provided on a vane type shimmy damper. (See Figure 13-6a). Consult the manufacturers service manual for each specific installation service and maintenance requirements.

7. Power Steering Systems

There are many different designs and configurations to provide powered nose wheel steering. These systems range from all electric actuated system as used on the Gates Learjet, a small business jet, to the largest hydraulic powered system using the latest electronic controls, as is the case on the Boeing 747, and 767 airliners. Since these systems are both complex and specific in their operation they will not be described here. The systems described will contain many of those features, but will serve to represent a typical system instead of any one particular aircraft.

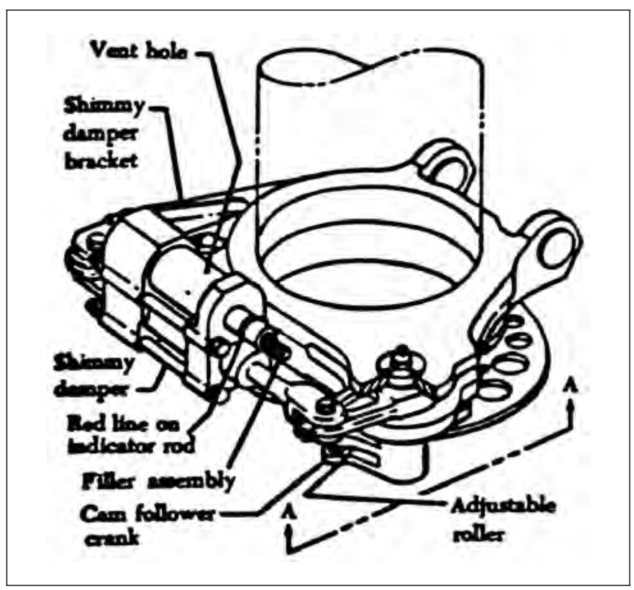


Figure 13-6b