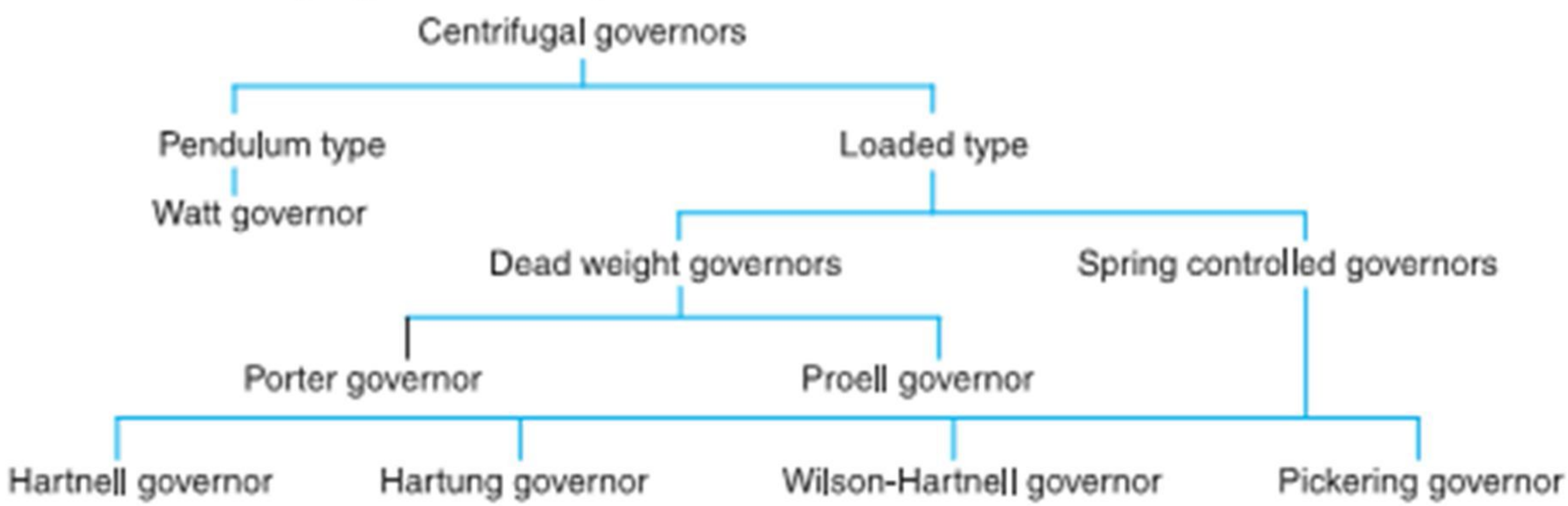
DynamicsofMechines

ThirdyearB.TechClass

Governers

- Mainlyoftwotypes:
  - Centrifugalgovernors
  - Inertiagovernors

The centrifugal governors, may further be classified as follows :



Centrifugal governor

The centrifugal governors are based on the balancing of centrifugal force on the rotating balls by an equal and opposite radial force, known as the ***controlling force****.It consists of two balls of equal mass, which are attached to the arms as shown in Fig. 18.1. These balls are known as ***governor balls or fly balls.***

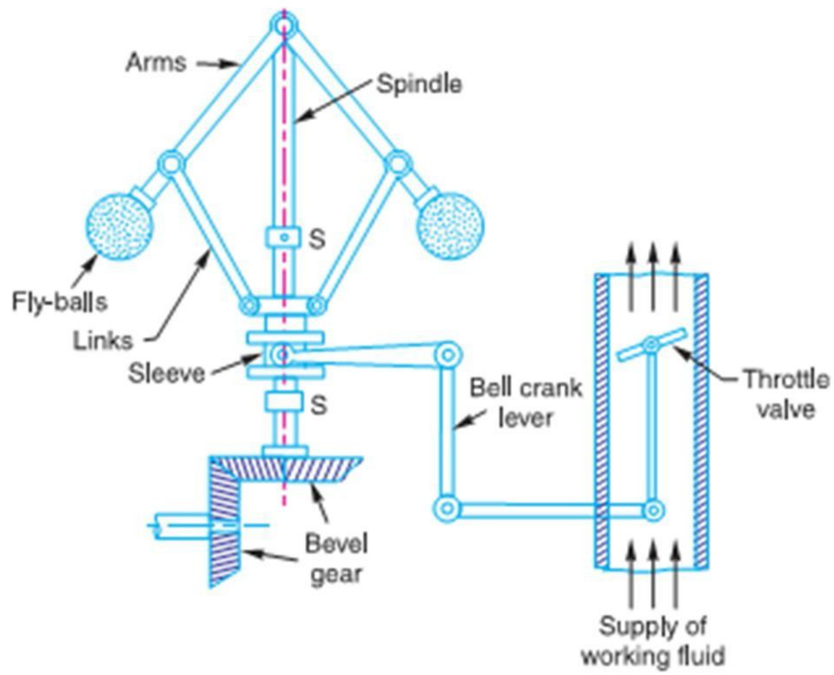


Fig. 18.1. Centrifugal governor.

Term used ingovernor

The following terms used in governors are important from the subject point of view ;

1. ***Height of a governor.*** It is the vertical distance from the centre of the ball to a point where the axes of the arms (or arms produced) intersect on the spindle axis. It is usually denoted by *h*.

2. ***Equilibrium speed.*** It is the speed at which the governor balls, arms etc., are in complete equilibrium and the sleeve does not tend to move upwards or downwards.

3. ***Mean equilibrium speed.*** It is the speed at the mean position of the balls or the sleeve.

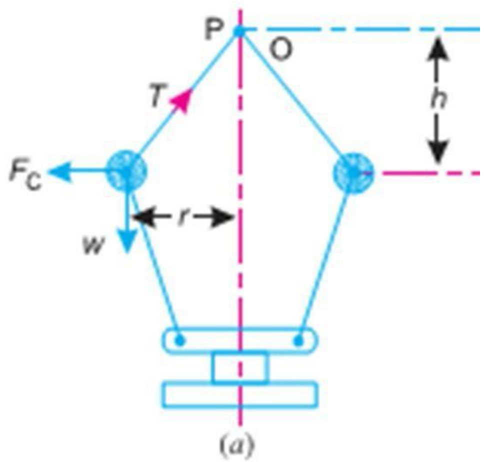
4. ***Maximum and minimum equilibrium speeds.*** The speeds at the maximum and minimum radius of rotation of the balls, without tending to move either way are known as maximum and minimum equilibrium speeds respectively.

Note : There can be many equilibrium speeds between the mean and the maximum and the mean and the minimum equilibrium speeds.

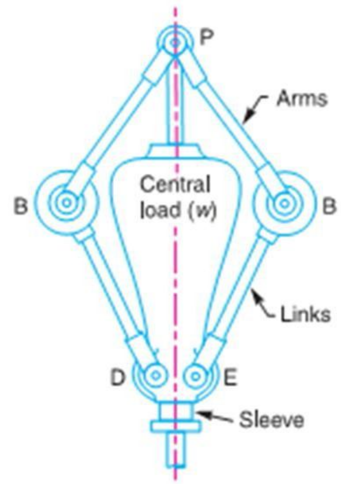
5. ***Sleeve lift.*** It is the vertical distance which the sleeve travels due to change in equilibrium speed.

Types of centrifugal governors

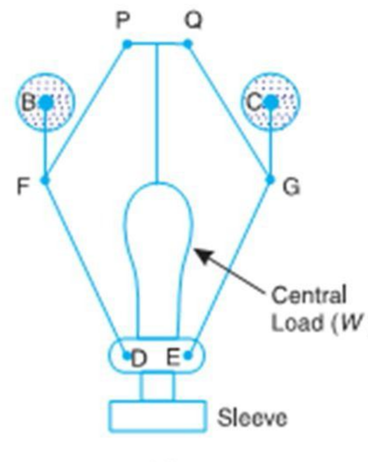
- Wattgovernor
- Portergovernor
- Proellgovernor



Watt



Porter



Proell

Types of centrifugal governors

- Hartnellgovernor
- Hartunggovernor
- WillsonHartnellgovernor

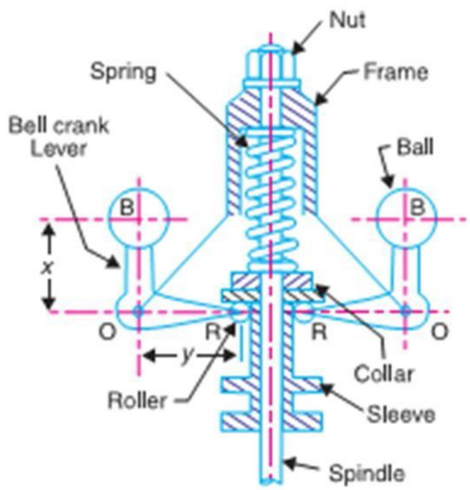
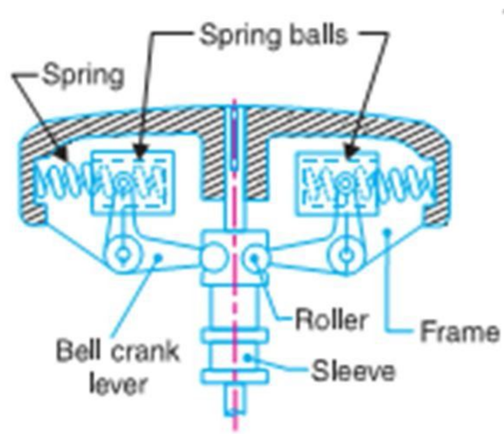
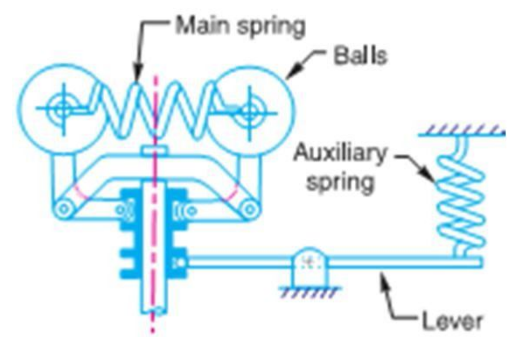


Fig. 18.18. Hartnell governor.





Wilson-Hartnell governor.

Sensitiveness of a governor

. the sensitiveness is defined as the ***ratio of the difference between the maximum and minimum equilibrium speeds to the mean equilibrium speed.***

Let N_1 = Minimum equilibrium speed,

N_2 = Maximum equilibrium speed, and

N = Mean equilibrium speed = $\frac{N_1 + N_2}{2}$.

∴ Sensitiveness of the governor

$$= \frac{N_2 - N_1}{N} = \frac{2(N_2 - N_1)}{N_1 + N_2}$$

$$= \frac{2(\omega_2 - \omega_1)}{\omega_1 + \omega_2} \quad \text{. . . (In terms of angular speeds)}$$

Stability of governors

A governor is said to be ***stable*** when for every speed within the working range there is a definite configuration *i.e.* there is only one radius of rotation of the governor balls at which the governor is in equilibrium. For a stable governor, if the equilibrium speed increases, the radius of governor balls must also increase.

Note: A governor is said to be unstable, if the radius of rotation decreases as the speed increases.

Isochronous Governors

A governor is said to be ***isochronous*** when the equilibrium speed is constant (*i.e.* range of speed is zero) for all radii of rotation of the balls within the working range, neglecting friction. The isochronism is the stage of infinite sensitivity.

Hunting of agovernor

A governor is said to be *hunt* if the speed of the engine fluctuates continuously above and below the mean speed. This is caused by a too sensitive governor which changes the fuel supply by a large amount when a small change in the speed of rotation takes place. For example, when the load on the engine increases, the engine speed decreases and, if the governor is very sensitive, the governor sleeve immediately falls to its lowest position. This will result in the opening of the control valve wide which will supply the fuel to the engine in excess of its requirement so that the engine speed rapidly increases again and the governor sleeve rises to its highest position. Due to this movement of the sleeve, the control valve will cut off the fuel supply to the engine and thus the engine speed begins to fall once again. This cycle is repeated indefinitely.

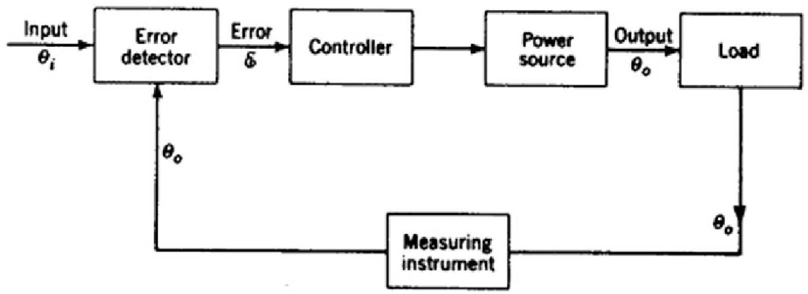


Figure 17-7 Block diagram of a closed-loop system.

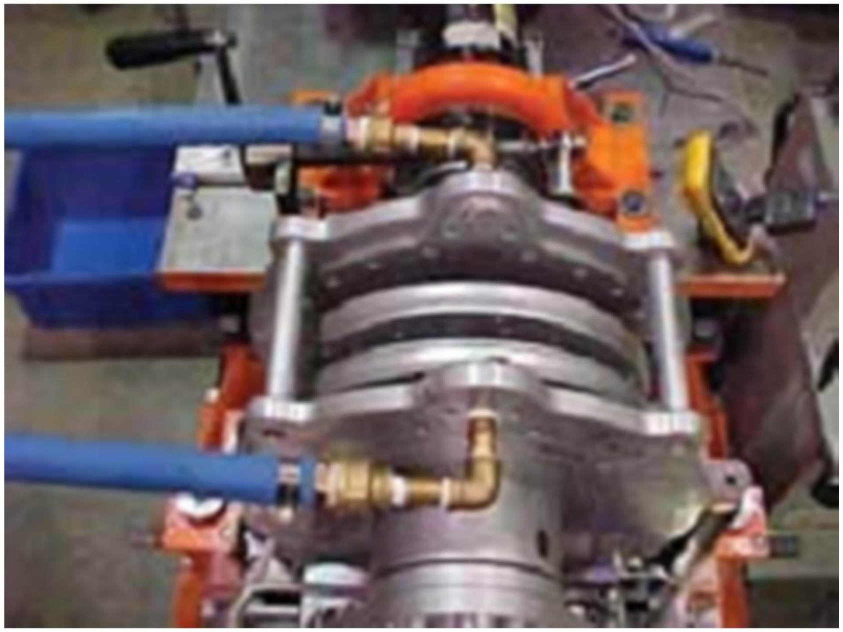
Dynamometers,types&classification

A dynamometer is a brake but in addition it has a device to measure the frictional resistance. Knowing the frictional resistance, we may obtain the torque transmitted and hence the power of the engine.

Following are the two types of dynamometers, used for measuring the brake power of an engine.

1. Absorption dynamometers, and 2. Transmission dynamometers.

In the *absorption dynamometers*, the entire energy or power produced by the engine is absorbed by the friction resistances of the brake and is transformed into heat, during the process of measurement. But in the *transmission dynamometers*, the energy is not wasted in friction but is used for doing work. The energy or power produced by the engine is transmitted through the dynamometer to some other machines where the power developed is suitably measured.

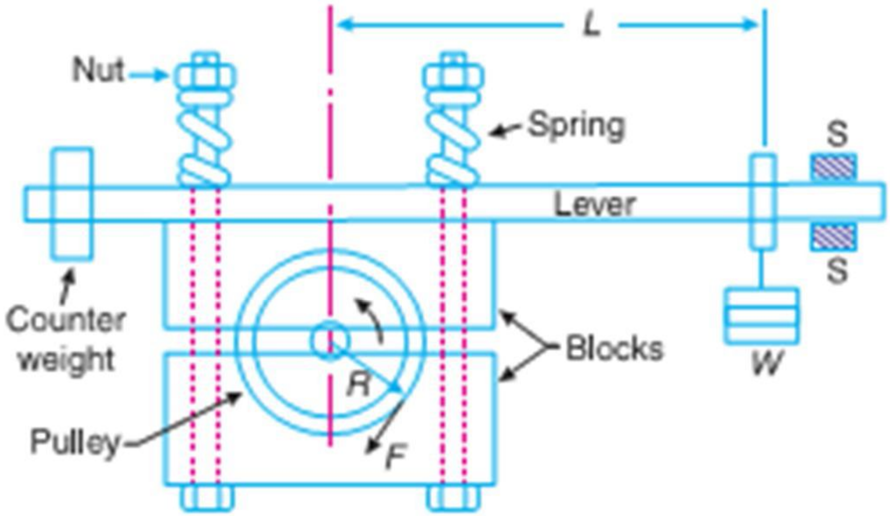


Classification of Absorption Dynamometers

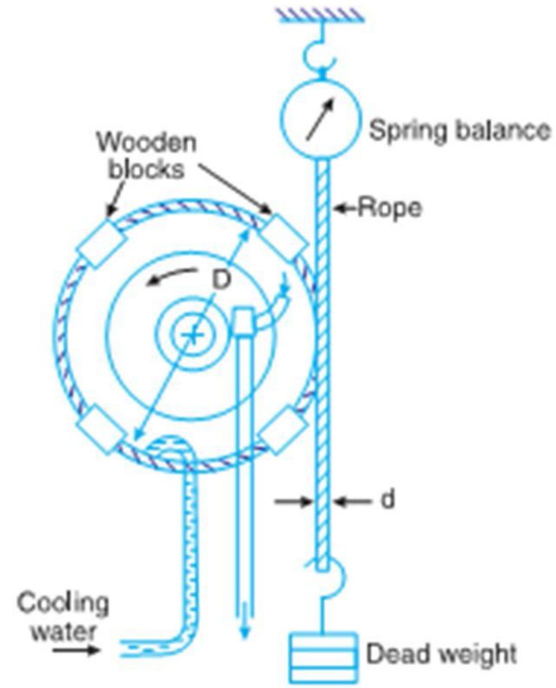
The following two types of absorption dynamometers are important from the subject point of view:

1. Prony brake dynamometer, and 2. Rope brake dynamometer.

Absorptiondynamometer



Prony braketype



RopeBraketype

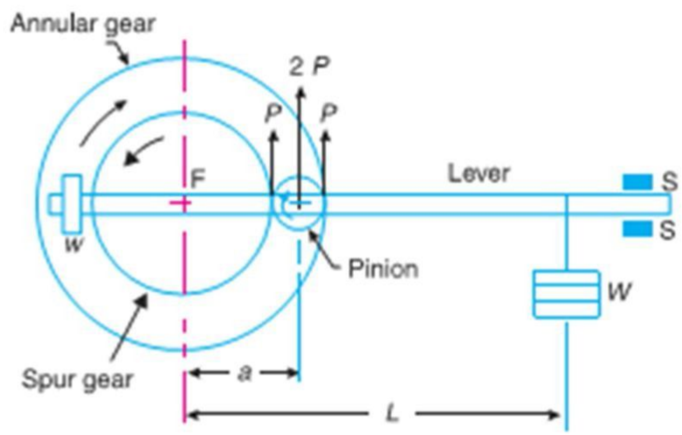
Transmissiontypedynamometer

Classification of Transmission Dynamometers

The following types of transmission dynamometers are important from the subject point of view:

1. Epicyclic-train dynamometer, 2. Belt transmission dynamometer, and 3. Torsion dynamometer.

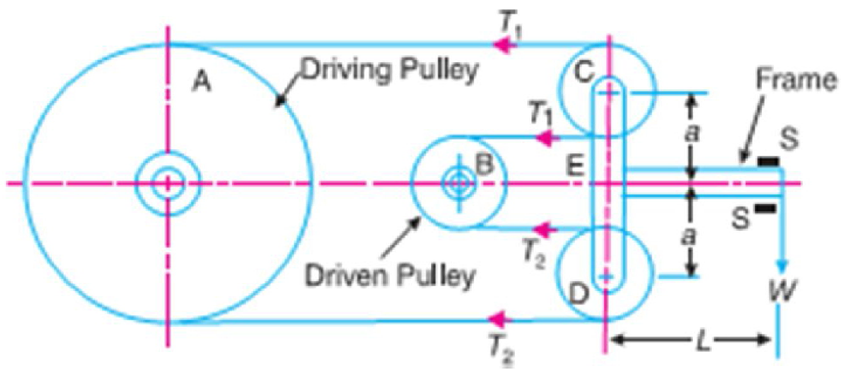
Epicyclic-train Dynamometer



Transmissiondynamometers

Belt Transmission Dynamometer-Froude or Throneycroft Transmission Dynamometer

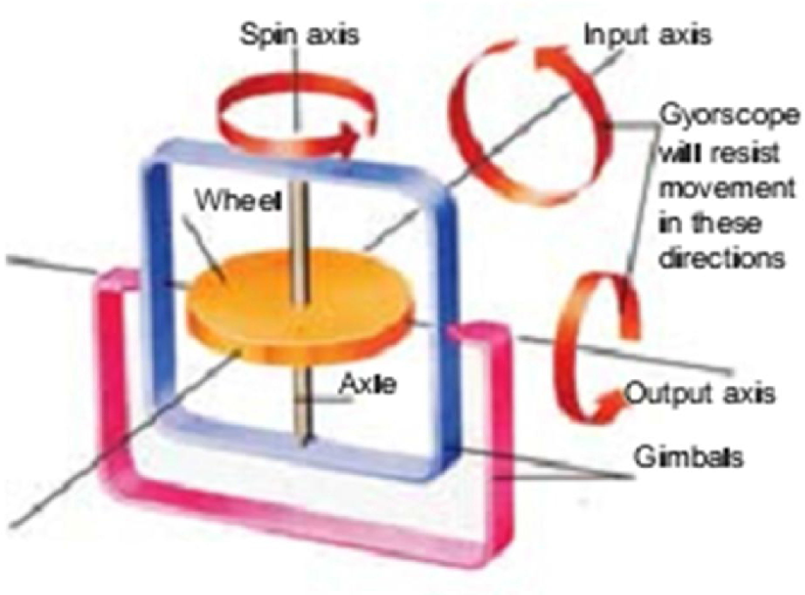
When the belt is transmitting power from one pulley to another, the tangential effort on the driven pulley is equal to the difference between the tensions in the tight and slack sides of the belt. A belt dynamometer is introduced to measure directly the difference between the tensions of the belt, while it is running.



Torsion Dynamometer

A torsion dynamometer is used for measuring large powers particularly the power transmitted along the propeller shaft of a turbine or motor vessel. A little consideration will show that when the power is being transmitted, then the driving end of the shaft twists through a small angle relative to the driven end of the shaft. The amount of twist depends upon many factors such as torque acting on the shaft (T), length of the shaft (l), diameter of the shaft (D) and modulus of rigidity (C) of the material of the shaft. We know that the torsion equation is

Gyroscope


Spin axis
Input axis
Gyorscope will resist movement in these directions
Wheel
Axle
Output axis
Gimbals

Gyroscopic couple

Consider a disc spinning with an angular velocity ω rad/s about the axis of spin OX, in anticlockwise direction when seen from the front, as shown in Fig. 14.2 (*a*). Since the plane in which the disc is rotating is parallel to the plane YOZ, therefore it is called ***plane of spinning***. The plane XOZ is a horizontal plane and the axis of spin rotates in a plane parallel to the horizontal plane about an axis OY. In other words, the axis of spin is said to be rotating or processing about an axis OY. In other words, the axis of spin is said to be rotating or processing about an axis OY (which is perpendicular to both the axes OX and OZ) at an angular velocity ω_P rap/s. This horizontal plane XOZ is called ***plane of precession*** and OY is the ***axis of precession.***

Let I = Mass moment of inertia of the disc about OX, and

ω = Angular velocity of the disc.

∴ Angular momentum of the disc

$$= I.\omega$$

Since the angular momentum is a vector quantity, therefore it may be represented by the vector $\vec{ox}$, as shown in Fig. 14.2 (*b*). The axis of spin OX is also rotating anticlockwise when seen from the top about the axis OY. Let the axis OX is turned in the plane XOZ through a small angle $\delta\theta$ radians to the position OX', in time δt seconds. Assuming the angular velocity ω to be constant, the angular momentum will now be represented by vector ox'.

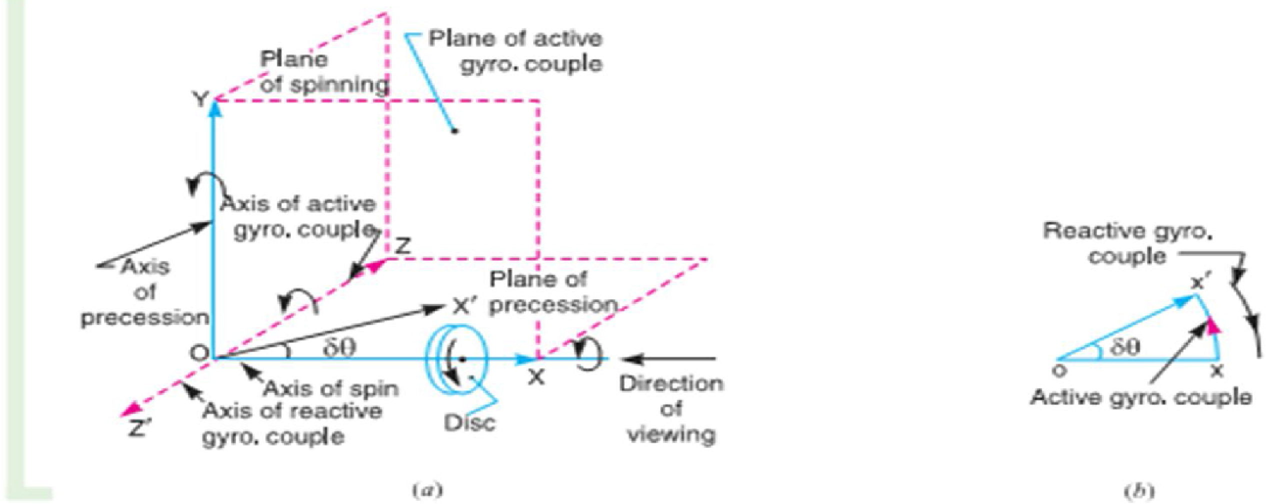
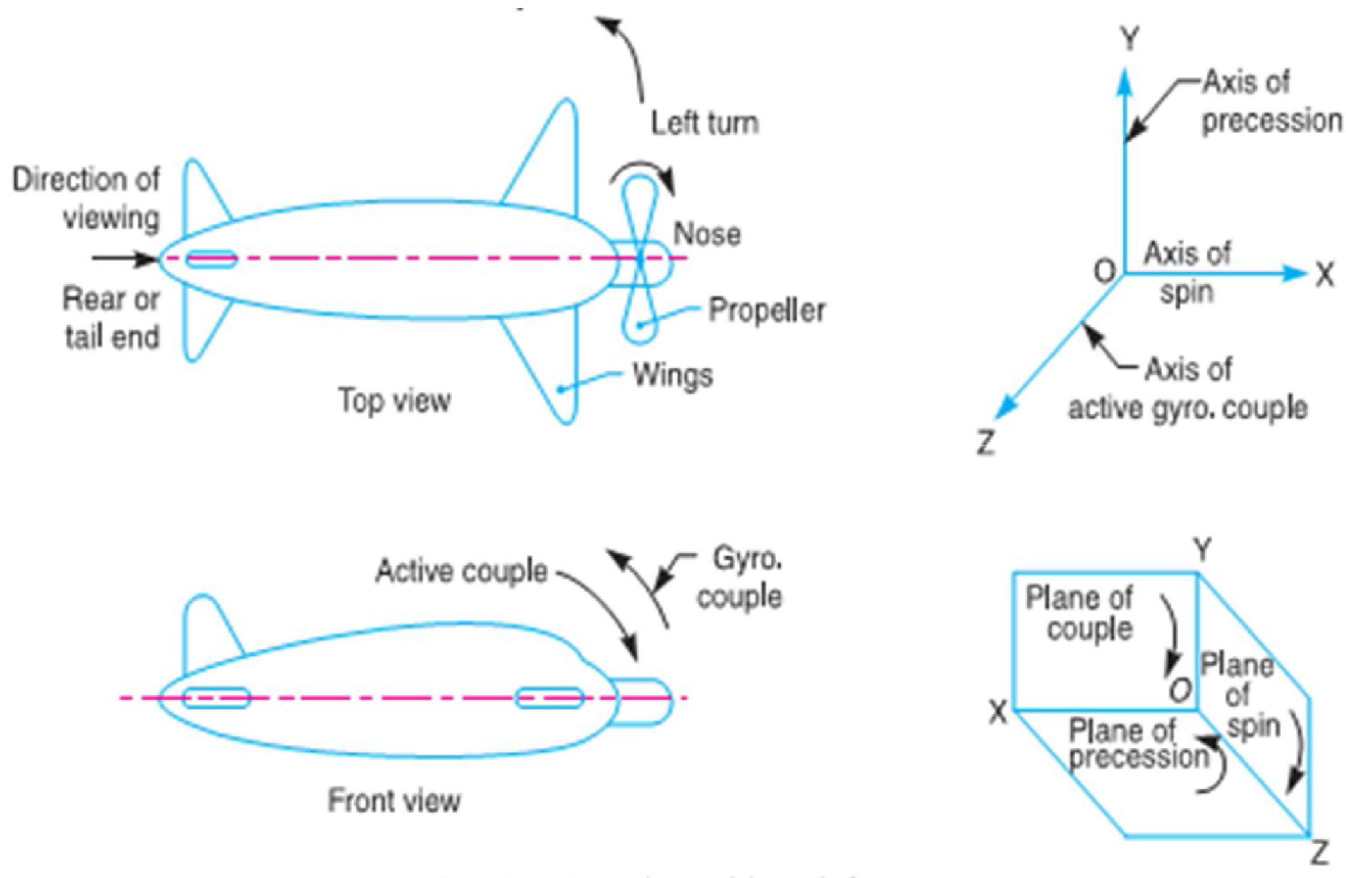
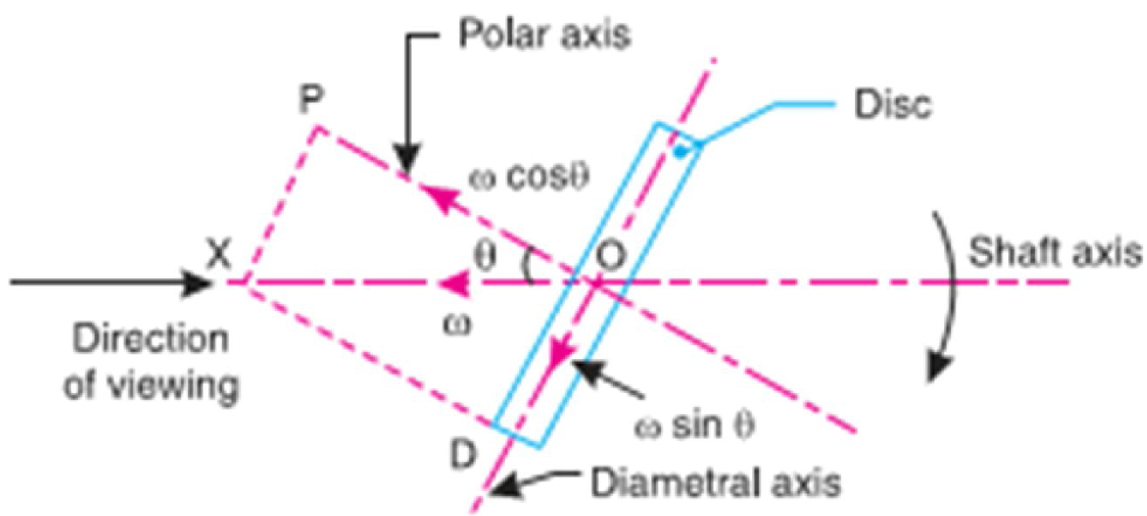


Fig. 14.2. Gyroscopic couple.

Effectofgyroscopiccoupleinanairplane



Effect of gyroscopic couple



Effect of gyroscopic couple on a disc fixed rigidly at a certain angle to a rotating shaft.