

GOVERNMENT POLYTECHNIC, SONEPUR
THEORY OF MACHINE

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Governor.

A governor is a device to regulate the mean speed of an engine, where there is variation in the load.

(*) Types of Governors

There are basically two types of governors.

(i) Centrifugal governor

(ii) Inertia governor.

(1) Centrifugal governor

In centrifugal governors, the centrifugal force is balanced by the controlling force. These type of governors used extensively.

The centrifugal governors further classified as follows.

(1) Pendulum type governor

(2) Loaded type - (a) Dead weight type

(b) Porter's governor

(c) Proell governor

(d) Spring loaded type

(e) Hartnell governor

(f) Hartung governor

(g) Wilson-Hartnell governor

(h) Pickering governor.

(2) Inertia governor

In inertia governor, the inertia force is balanced by the controlling force.

They are not used popularly.



(A) Terminology

(1) Height of governor (h)

It is the vertical distance from the center of the ball to a point on the spindle axis where the axes of upper arms intersect.

(2) Centrifugal force (Fc)

It is the radial outward force acting on the ball due to the rotational speed.

(3) Controlling force

An equal and opposite force of the ball centrifugal force is called the controlling force.

(4) Equilibrium speed

It is the speed of the governor at which the sleeve does not move upward or downward on the spindle.

(5) Radius of rotation

It is the horizontal distance between the centre of ball and the axis of rotation.

(6) Mean equilibrium speed

It is the average of the maximum and minimum speed of rotation.

(7) Sleeve lift

It is the vertical distance travelled by



the sleeve on the spindle due to change in equilibrium speed.

(*) Watt Governor

Main Parts of a watt governor:

(1) Pivot

This is the point where both the arms get connected at the end.

(2) Arms

This is provided with the specified weight balls at these endpoints.

(3) Balls

Balls attached to the arms are with some specified weight and this is used to lift the sleeve which is connected with the help of connecting rod and according to the speed of rotation, sleeve gets lifted.

(4) Sleeve

This is connected to the fuel supply when the balls rotate, sleeve gets lifted and with supply of fuel pipe gets opened and helps to flow the required amount to the engine.

→ In this process the torque & main function is carried out by the movement of sleeve which moves upwards and downwards with the help of rotating balls.

→ Sleeve get lifted when when the two balls attached to the arms rotate and the momentum of sleeve depends on what speed the balls rotate.

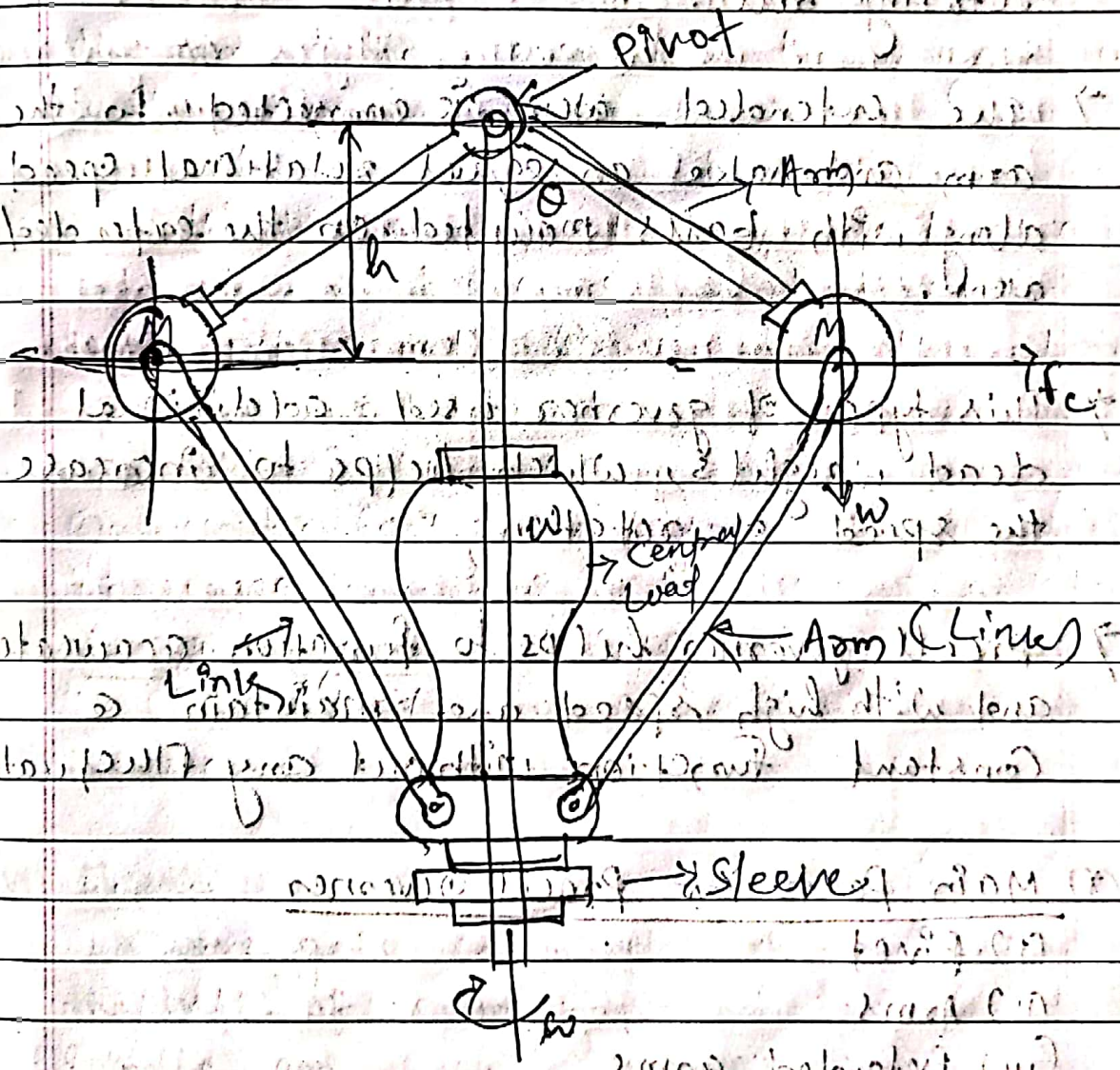
→ According to the sleeve lifted the supply of fuel to the engine depends.

→ When the balls rotate with high speed at a fixed center of pivot the arms get stretched and the help of connecting between the balls and the sleeve, it gets lifted.

→ In this, the fuel get supply to the engine from the storage tank above the sleeve. Quantity of fuel supply depends on the sleeve lifted.

→ when the sleeve moves in the upward direction the fuel pump connected to it supply the fuel according to the moment of sleeve

→ with the help of this process the fluctuations can be reduced and help to function in a smooth condition.



Proell Governor

- Proell Governor is a little different type of governor which is an updated form of simple centrifugal governor.
- Proell Governor is a type of governor which contain an additionally extended arms which is used to support the rotating ball.
- The extended arm is connected to the arm and make an equal rotational speed along with balls mounted on the extended arm.
- This type of governor used additional dead weights, which helps to increase the speed of rotation.
- Proell governor helps to function accurately and with high speed and maintain a constant function without any fluctuations.

(*) Main Parts of Proell Governor

- (i) Pivot
- (ii) Arms
- (iii) Extended arms
- (iv) Balls
- (v) Sleeve
- (vi) Fuel Pump.



(i) Pivot

This is the point at the top end which connects the arms.

(ii) Arms

This connected to the balls and makes rotating along with the balls.

(iii) Extended arms

These are the straight arms pivoted at the end of the arm and this is used to support the balls on it.

(iv) Balls

These balls are connected at the top of the extended arms and the balls have some specific weight according to the application and this helps to move the sleeve up and down direction.

(v) Connecting Rod

This is used to connect between the balls and the sleeve.

(vi) Sleeve

Sleeve gets connected with the balls with the help of connecting rod to slides on the spindle and which helps to flow the fuel from the fuel tank to engine.

(iv) Fuel Pump.

This is used to supply the fuel from the fuel tank to the engine when the sleeve moves upward direction and stops when the sleeve reaches the bottom endpoint.

Working of Proell Governor

The working of Proell governor is of the same as the other types of governor but the ~~construction~~ construction is little different when the extended arm rotate along with the balls mounted on it the sleeve gets moved in an upward direction due to the connection between the arm and the sleeve and the moment of sleeve helps to flow the fuel from the fuel tank to engine.

Hartnell Governor

- Hartnell Governor is same as watt Governor which is used to supply a required quantity of fuel to the engine to reduce fluctuations.
- But Hartnell Governor consists of few different parts for accurate working and is high speed.
- This type of Governor consists of a spring which helps to apply an additional force on the sleeve.
- There is a lever called a bell crank lever for support the rotation of the balls and connected to the frame of the governor.
- When these balls used to rotate along with the lever to lift the sleeve according to the speed of balls rotation.
- This governor is provided with an additional nut placed above the frame, this is used to adjust the spring force.

Main parts of a Hartnell Governor

(i) Nut
This is provided on the top of the frames which used to adjust the force on the sleeve.

(ii) Frame
This is provided with a spring inside which protects and support it and the frame is connected to the bell crank lever which it rotate along the lever.

(iii) Spring
This is used to apply the pressure on the sleeve ~~when~~ whenever required and this helps to push the sleeve downwards when it raised more than the required.

(iv) Balls
These are placed on the bell crank lever which is done with some specific weight.

(v) Bell crank lever
This is used to rotate along with the balls provided on it and it is connected to the frame to rotate it.

(vi) Collar: This is provided on the top of the sleeve to support the spring on it.

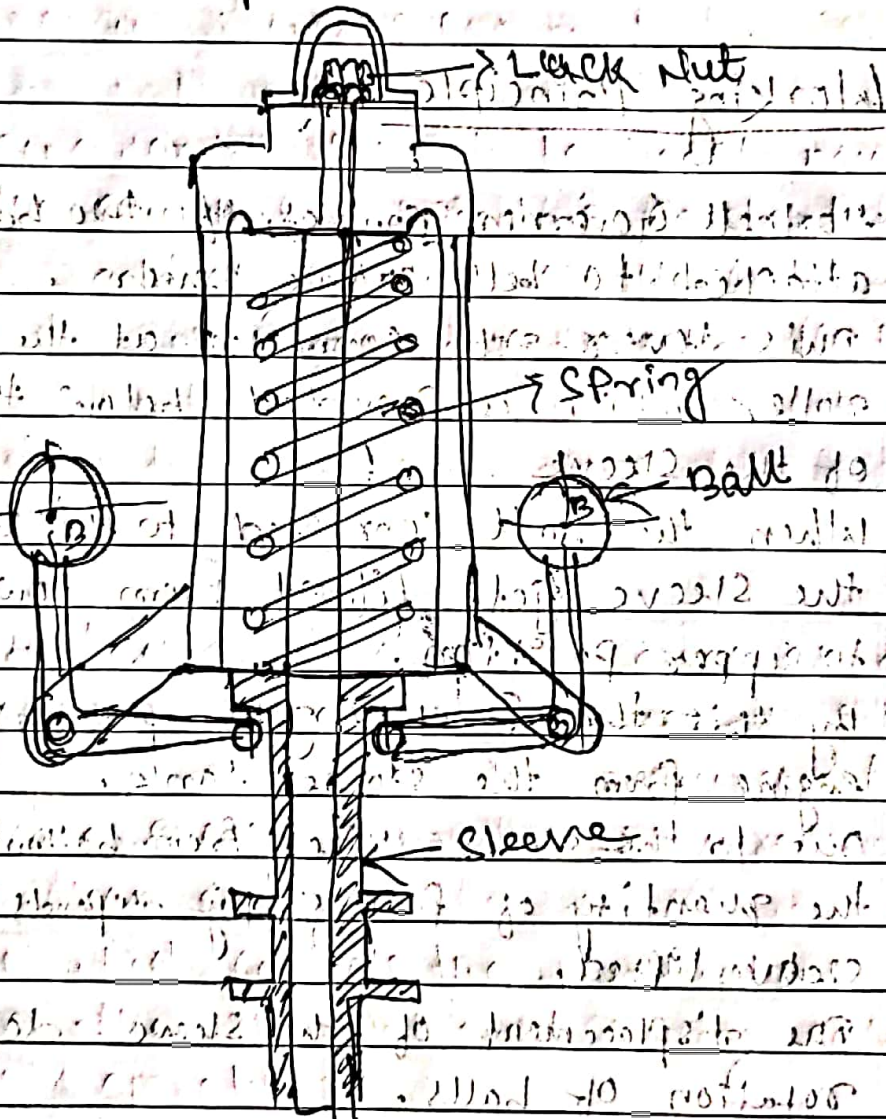
(vii) Sleeves: This is used to move in an upward and downward direction according to the rotation of the bell crank lever attached to it.

Working Principle

- Hornell Governor consists of two balls which are attached to bell crank lever.
- This lever get connected at the point of the roller which is provided below the top corner of the sleeve.
- When the ball connected to the lever rotates the sleeve gets lifted from lower position to upper position.
- By this, the fuel gets up supply to the engine from the storage tank.
- Due to the sleeve rises from bottom end point the quantity of fuel supply depends on the sleeve lifted.
- The displacement of the sleeve depends on the rotation of balls.
- In this governor the spring provided inside the frame applies an opposite force on the sleeve when it gets lifted from the bottom position.

→ In this type of governor we can apply the required amount of force with the help of spring and can adjust with the nut provided on the top of the frame.

→ The amount of fuel supplied to the engine depends on the sleeve position when the sleeve get raised then fuel is supplied to the engine with the help of fuel pump from the fuel tank.



In this governor the sleeve position is controlled by the force applied on the sleeve. When the sleeve moves up, the fuel pump is operated and fuel is supplied to the engine.

(*) Sensitivity of Governor

Consider two governors 'P' and 'Q' running at the same speed. When the speed increases or decreases by a particular amount, the lift of the sleeve of governor 'P' is greater than the lift of the sleeve of governor 'Q'. It is then said that the governor 'P' is more sensitive than governor 'Q'.

Sensitivity of

Sensitivity of a Governor

Let N_1 and N_2 be the speeds at which the lift of the sleeve is h for two governors.

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

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

$$N = \frac{N_1 + N_2}{2}$$

where N_1 is the minimum equilibrium speed and N_2 is the maximum equilibrium speed.

N_2 = max^m equilibrium speed

N_1 = min^m equilibrium speed

$$N = \frac{N_1 + N_2}{2}$$



(*) Stability of Governor

A governor is said to be stable, when for every speed within the working range, there is a definite configuration of the governor balls at which the governor is in equilibrium. If there is only one radius of rotation of the governor balls at which the governor is in equilibrium, it is said to be stable.

(*) Isochronous Governor

A governor is said to be isochronous when the equilibrium speed is constant for all the radii of rotation of the balls within the working range neglecting friction.

(*) Flywheel

Flywheel is a device that serves as a reservoir to store energy when the supply of energy is more than the requirement, and release energy when the requirement is more than supply.

A flywheel controls the fluctuations of speed of the prime mover during each cycle of operation.

Fly wheel

Governor

(i) It decrease the variation of speed of prime mover

(i) It regulate the speed of prime mover from cycle to cycle

(ii) It decreases the fluctuations of speed due to difference in output and input

(ii) It decreases the fluctuation of speed by adjusting the output of the prime mover

(iii) A fly wheel controls $\frac{dn}{dt}$

(iii) A governor controls $\frac{dn}{dt}$

(iv) It stores energy and gives up when required

(iv) It regulate the speed by regulating the quantity of working medium of the prime mover

(v) It has no control over the quality of the working medium

(v) It takes care of the quality of the working medium

(vi) It is not an essential part of every prime mover

(vi) It is an essential part of every prime mover

