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इंतज़ार हुआ ख़त्म
The function of a governor is to regulate the mean speed of an engine, when there are variations in the load e.g. when the load on an engine increases, its speed decreases, therefore it becomes necessary to increase the supply of working fluid.

On the other hand, when the load on the engine decreases, its speed increases and thus less working fluid is required. The governor automatically controls the supply of working fluid to the engine with the varying load conditions and keeps the mean speed within certain limits.
Governor

Centrifugal Governor

Work on change in speed

Inertia

Work on rate of change in speed

Sensitivity pp
Governor
Governor
Governor
Governor
Governor
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.

The balls and the sleeve rises when the spindle speed increases, and falls when the speed decreases.
When the load on the engine increases, the engine and the governor speed decreases. This results in the decrease of centrifugal force on the balls. Hence the balls move inwards and the sleeve moves downwards.

The downward movement of the sleeve operates a throttle valve at the other end of the bell crank lever to increase the supply of working fluid and thus the engine speed is increased.

When the load on the engine decreases, the engine and the governor speed increases, which results in the increase of centrifugal force on the balls. Thus the balls move outwards and the sleeve rises upwards.

This upward movement of the sleeve reduces the supply of the working fluid and hence the speed is decreased.
The centrifugal governors, may further be classified as follows:

- **Centrifugal governors**
  - **Pendulum type**
    - Watt governor
  - **Loaded type**
    - Dead weight governors
      - Porter governor
      - Hartnell governor
      - Hartung governor
    - Spring controlled governors
      - Proell governor
      - Wilson-Hartnell governor
      - Pickering governor
It is basically a conical pendulum with links attached to a sleeve of negligible mass.

Let

- \( m \) = Mass of the ball in kg,
- \( w \) = Weight of the ball in newtons = mg,
- \( T \) = Tension in the arm in newtons,
- \( \omega \) = Angular velocity of the arm and ball about the spindle axis in rad/s,
- \( r \) = Radius of the path of rotation of the ball i.e. horizontal distance from the center of the ball to the spindle axis in meters,
- \( F_C \) = Centrifugal force acting on the ball in newtons = \( m\omega^2r \), and
- \( h \) = Height of the governor in meters.
Taking moments about point O, we have:

\[ F_C \times h = w \times r = \frac{m.g.r}{m.\omega^2.r.h} = m.g.r \quad \text{or} \quad h = \frac{g}{\omega^2} \]

When \( g \) is expressed in m/s² and \( \omega \) in rad/s, then \( h \) is in metres. If \( N \) is the speed in r.p.m., then

\[ \omega = \frac{2\pi N}{60} \]

\[ h = \frac{9.81}{(2\pi N/60)^2} = \frac{895}{N^2} \text{ metres} \quad \ldots (\because g = 9.81 \text{ m/s}^2) \]

Note: We see from the above expression that the height of a governor \( h \), is inversely proportional to \( N^2 \). Therefore at high speeds, the value of \( h \) is small. At such speeds, the change in the value of \( h \) corresponding to a small change in speed is insufficient to enable a governor of this type to operate the mechanism to give the necessary change in the fuel supply. This governor may only work satisfactorily at relatively low speeds i.e. from 60 to 80 rpm.
Given that

\[ m = \text{mass of the ball of the governor,} \]
\[ \omega = \text{angular velocity of the governor and} \]
\[ g = \text{accelerate due to gravity} \]

The height of Watt’s governor is given by

\[ h = \frac{g}{\omega^2} \]

(a) \( \frac{g}{2\omega^2} \)  (b) \( \frac{g}{\omega^2} \)  (c) \( \frac{\sqrt{2g}}{\omega^2} \)  (d) \( \frac{2g}{\omega^2} \)
The change in governor height for a Watt governor when speed varies from 100 r.p.m to 101 r.p.m will be nearly

(a) 1.8 mm  (b) 2.6 mm  (c) 3.4 mm  (d) 4.2 mm

\[ h = \frac{8g\tau}{N^2} \]

\[ h_1 = \frac{8g\tau}{(100)^2} \]

\[ h_2 = \frac{8g\tau}{(101)^2} \]

\[ h_1 - h_2 = 8g\tau \left( \frac{1}{(100)^2} - \frac{1}{(101)^2} \right) \times 10^3 \]
✓ The Porter governor is a modification of a Watt’s governor, with central load attached to the sleeve.

✓ The load moves up and down the central spindle.

✓ This additional downward force increases the speed of revolution required to enable the balls to rise to any predetermined level.
Let

\( m \) = Mass of each ball in kg,
\( w \) = Weight of each ball in newtons = \( mg \),
\( M \) = Mass of the central load in kg,
\( W \) = Weight of the central load in newtons = \( Mg \),
\( r \) = Radius of rotation in meters,
\( h \) = Height of governor in meters,
\( N \) = Speed of the balls in rpm,
\( \omega \) = Angular speed of the balls in rad/s = \( \frac{2 \pi N}{60} \) rad/s,
\( F_C \) = Centrifugal force acting on the ball in newtons = \( m\omega^2r \),
\( T_1 \) = Force in the arm in newtons,
\( T_2 \) = Force in the link in newtons,
\( \alpha \) = Angle of inclination of the arm (or upper link) to the vertical
\( \beta \) = Angle of inclination of the link (or lower link) to the vertical.
Taking moments about the point \( I \),

\[
F_C \times BM = w \times IM + \frac{W}{2} \times ID
\]

\[
= m \cdot g \times IM + \frac{M \cdot g}{2} \times ID
\]

\[
\therefore F_C = m \cdot g \times \frac{IM}{BM} + \frac{M \cdot g}{2} \left( \frac{IM}{BM} + \frac{MD}{BM} \right)
\]

\[
= m \cdot g \times \frac{IM}{BM} + \frac{M \cdot g}{2} \left( \frac{IM}{BM} + \frac{MD}{BM} \right)
\]

\[
= m \cdot g \tan \alpha + \frac{M \cdot g}{2} (\tan \alpha + \tan \beta)
\]
Dividing throughout by \( \tan \alpha \),

\[
\frac{F_C}{\tan \alpha} = m.g + \frac{M \cdot g}{2} \left(1 + \frac{\tan \beta}{\tan \alpha}\right) = m.g + \frac{M \cdot g}{2} (1 + q)
\]

\[
\therefore q = \frac{\tan \beta}{\tan \alpha}
\]

We know that \( F_C = m.\omega^2.r \), and \( \tan \alpha = \frac{r}{h} \)

\[
\therefore m.\omega^2.r \times \frac{h}{r} = m.g + \frac{M \cdot g}{2} (1 + q)
\]

\[
h = \frac{m.g + \frac{M \cdot g}{2} (1 + q)}{m} \times \frac{1}{\omega^2} = \frac{m + \frac{M}{2} (1 + q)}{m} \times \frac{g}{\omega^2}
\]

\[
\text{... (Same as before)}
\]

When \( \tan \alpha = \tan \beta \) or \( q = 1 \), then

\[
h = \frac{m + M}{m} \times \frac{g}{\omega^2}
\]
Which one of the following equation is valid with reference to the given figure?

(a) \( \omega^2 = \left( \frac{W}{W} \right) \left( \frac{g}{h} \right) \)

(b) \( \omega^2 = \left( \frac{W + w}{w} \right) \left( \frac{g}{h} \right)^{\frac{1}{2}} \)

(c) \( \omega^2 = \left( \frac{w}{W + w} \right) \left( \frac{h}{g} \right)^{\frac{1}{2}} \)

(d) \( \omega^2 = \left( \frac{W + w}{w} \right) \left( \frac{g}{h} \right) \)
Centrifugal governors are preferred to the inertia type governors because an inertia governor
(A) has less controlling force
(B) is highly sensitive and more prone to hunting
(C) poses problems in the balancing of inertia forces
(D) has high initial and maintenance cost
Which one of the following is a gravity controlled type governor?

(A) Hartnell governor
(B) Hartung governor
(C) Watt governor
(D) Pickering governor

SSC - JE 2008
Hartnell governor could be classified under the head of:

(A) inertia type governors
(B) pendulum type governors
(C) centrifugal type governors
(D) dead weight type-governors

SSC - JE 2009
Governor is used in automobile to:

(A) decrease the variation of speed
(B) control \( \delta N / \delta t \)
(C) control / \( \delta N \)
(D) All the above

SSC - JE 2009
The height ‘h’ and angular speed to ‘w’ for the Watt governor and Porter governor are related by the identity:

(A) $h \propto \omega$
(B) $h \propto 1/\omega$
(C) $h \propto \omega^2$
(D) $h \propto 1/\omega^2$

(SSC - JE 2010)
The stiffness of the spring in a hartnell governor is equal to, where

\( S_1 = \) Spring force exerted on the sleeve at maximum radius of rotation.

\( S_2 = \) Spring force exerted on the sleeve at minimum radius of rotation.

(A) \( \frac{2(S_1-S_2)}{h} \)  
(B) \( \frac{(S_1-S_2)}{2h} \)  
(C) \( \frac{S_1-S_2}{h} \)  
(D) \( \frac{S_1-S_2}{h} \)
In a Hartnell governor, 800 N force is exerted on the sleeve at minimum radius and 1200 N force is exerted at maximum radius. If sleeve lift is 20 mm, the value of spring stiffness (s) is -

(A) 10N/mn  
(B) 20 N/mn  
(C) 16 N/mn  
(D) 18 N/mm
The angular speed of a watt governor, when its height is 20 cm, will be equal to -

(A) 20 rad/sec
(B) 10 rad/sec
(C) 6 rad/sec
(D) 7 rad/sec
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