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EXPERIMENTAL INVESTIGATION ON PROELL GOVERNOR TO INCREASE MINIMUMSPEED

Daravath Srinu[1] ,GiriBabu Surarapu[2] and Maloth Nageswara Rao[3]
[1,2,3]Assistant Professor in ME , TKRCET, HYDERABAD, TELANGANA, INDIA

Abstract-The function of the governor is to maintain the mean speed of the engine with in specified limits whenever there is a variation of the load. The objective of our investigation is modifying the Proell Governor (dead weight type) to increase minimum speed limit. Inour study we extend lower arm and fly ball position of the proell governor to the downside from the intersection of link and arm, and then we derive the equation for governor speed. We fabricated the model of governor and observed effect of the extension of lower link and fly ball weight on minimum speed of the governor. This analysis carried out by extension of lower links of the governor and position of fly balls.

Index Terms-Extension of lower links, position of fly balls, minimum speed of the governor, central sleeve load.

I. INTRODUCTION

A Governor, or speed limiter is a device used to measure andregulates the fuel supply to the engine with respect to the engine load variations, when a load on the engine increases sleeve move downwards and due to attached bell crank lever to the supply valve, the fuel supply will decreases and vice-versa. This can regulate the fuel supply to the engine automatically. A classic example is the centrifugal governor, Also known as the watt. [1] Centrifugal governors were used to regulate the distance and pressure between millstones in windmills since the 17th century. Early stem engines employed a purely reciprocating motion, and were used for pumping water an application that could tolerate variations in the working speed. It was not until the Scottish engineer James Watt introduced the rotative steam engine, for driving factory machinery, that a constant operating speed became necessary. Between years 1775 and 1800, Watt, in partnership with industrialist Mathew Bolton, produced some 500 rotati-vebeam engines. At the heart of these engines was Watt self designed " conical pendulum" governor: a set of revolving steel balls attached to a vertical spindle by links and arms, where the controlling force consists of the weight of the balls. Building on Watt design was American engineer Willard Gibbs who in 1872 theoretically analyzed Watt's conical pendulum governor from a mathematical energy balance perspective. During his graduate school years at Yale University, Gibbs observed that the operation of the device in practice was beset with the disadvantages of sluggishness and a tendency to overcorrect for the changes in speed it was supposed to control. The objective our investigation to increase the minimum speed of the ProellGovernor by extending lower arm to the down side from the intersection of upper and lower arm position and fly ball position, and noted that how the minimum speed will changes in different positions of fly ball weight.

II. MODIFICATION OF PROELL GOVERNOR

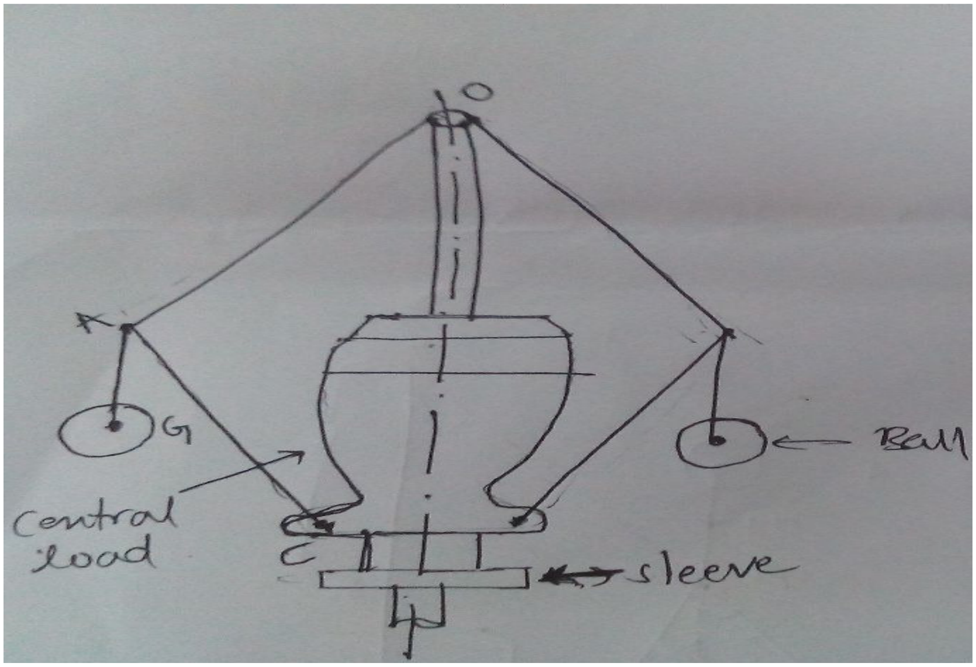

Fig. 2.1: Modification of Proell Governor

It consists of a pair of two balls which are attached to the spindle with the help of links and arms .the upper links are pinned at 'A' and lower arms are fitted to the sleeve.

Which is similar to the Proell governor, but it differs from Proell Governor in the arrangement of fly balls .the fly balls are carried on the extension of lower arm to the downside from the intersection of upper links and lower arms, instead of at junction of upper and lower arms. The action of this Governor is similar to Proell governor.

2.1 FROM INSTANTANEOUS CENTER METHOD

In this method, equilibrium of the forces acting on the link AC is considered. The instantaneous centre 'I'lies at the point of intersection of AC produced and a line through C perpendicular to the spindle axis, as shown in figure.2.2

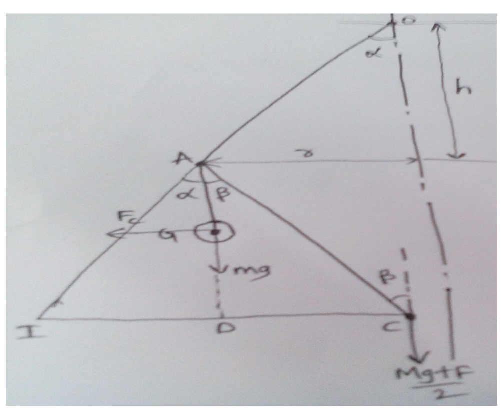

Fig. 2.2: Instantaneous Centre Method

Now taking moments about 'I'

$F_c \times GD = m\times g\times ID + (Mg/2)\times IC$ Where $F_c = m\,\omega^2 r$, w=mg and , $\omega = 2\Pi N/60$,

GD=AD-AG

$F_c \times (AD-AG) = m\times g\times ID + (Mg/2)\times IC$

$F_{c} = \frac{m\times g\times ID + Mg/2\times IC}{AD-AG}$

By simplify above equation we can get

$N^2 = \frac{AD}{AD-AG}\left(\frac{m+M}{m}\times\frac{895}{h}\right)$

As sown in fig. 2.1. Here AC- length of the arm (cm), AB = r = Radius of rotation (cm), OB = h = Height of the governor (cm), $30^0 = \alpha$ = Angle of inclination,AG-Length of extension of lower arm,

AE = 10 cm = 100mm,AG = 6 cm = 60 mm, Height of the governor WKT h1= AB* cosα = 200* $\cos 30^0$ = 17.3 cm = 0.1732 m

For minimum speed (N_1)

$N_1^2 = \frac{AD}{AD-AG}\left(\frac{m+M}{m}\times\frac{895}{h1}\right)$

$N_1^2 = \frac{0.1732}{0.107}\left(\frac{4+20}{4}\times\frac{895}{0.1732}\right)$

N_1=224 r.p.m

For maximum speed (N_2)

Assume sleeve to be lift 20mm

$h_2 = h_1 - 0.02 = 0.1732-0.02 = 0.1532$ m

$N_2^2 = \frac{AD}{AD-AG}\left(\frac{m+M}{m}\times\frac{895}{h2}\right)$

N_2= 238 r.p.m.

The range of speed of the governor is $N=N_2-N_1=238-224=14$r.p.m.

2.2 Ina Proell Governor

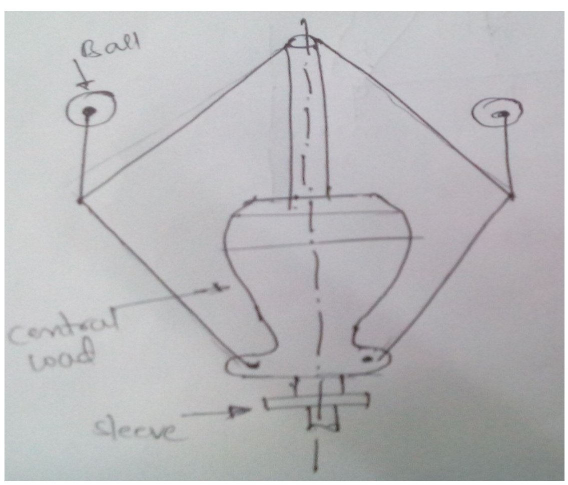

Fig. 2.3: ProellGovernor

As sown in fig. 2.1. Here AC- length of the arm (cm), AB = r = Radius of rotation (cm), OB = h = Height of the governor (cm), 30^0= α = Angle of inclination, AG-Length of extension of lower arm,

AE = 10 cm = 100 mm, AG = 6 cm = 60 mm, Height of the governor WKT h1= AB* cosα = 200* $\cos 30^0$ = 17.3 cm = 0.1732 m

Minimum speed:

We know that

$N_1^2=\frac{AD}{\mathrm{AD+AG}}\left(\frac{m+M}{m}\times\frac{895}{h1}\right)$

$N_1^2 = \frac{0.1732}{0.223}\left(\frac{4+20}{4}\times\frac{895}{0.1732}\right)$

N_1 = 155 rpm

Assume sleeve to be lift 20 mm,

Maximum speed:

Now h2 = h1-20 mm = 01732-0.02 = 0.153 m

$N_2^2 = \frac{AD}{\mathrm{AD+AG}}\left(\frac{m+M}{m}\times\frac{895}{h2}\right)$,

$N_2^2 = \frac{0.1732}{0.223}\left(\frac{4+20}{4}\times\frac{895}{0.1532}\right)$

N_2 = 164 rpm

III. RESULTS AND DISCUSSIONS

i. The small modification of Proell Governor will give better results in operating speed limits.We have been fabricated this governor in our laboratory and observed working of this governor.
ii. The modification of Proell Governor will may replace the Hartnelsgovernorssome extent
iii. In generally To maintain 224 r.p.m minimum speed by proell governor it needs more than 30 Kg ofcentral sleeve load. bust by small modification of Proell Governor it needs only 20 Kg of central sleeve load with same arm lengths and fly balls.

IV. FUTURE SCOPE

i. Analysis of Stress concentration on various elements of the governor which minimizes the failures.
ii. Analysis on different materials for sleeve, spindle and arms.
iii. Vibration analysis will give better results in accuracy.
iv. Study on various factors (i.e. stability, sensitivity, and hunting) of the governors.

V. CONCLUSIONS

i. Modification of Proell Governor gives better results when compare with porter and Proell Governor.
ii. To study the effect of extension of lower arm on variation in minimum speed of the governor
iii. To maintain 224 r.p.m minimum speed by proell governor it needs more than 30 Kg of central sleeve load. bust by small modification of Proell Governor it needs only 20 Kg of central sleeve load with same arm lengths and fly balls.

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