June 12, 1956 H. THOMAS 2,749,938

LOAD AND SPEED GOVERNOR FOR INTERNAL COMBUSTION ENGINES

Filed Feb. 6, 1952 2 Sheets-Sheet 1

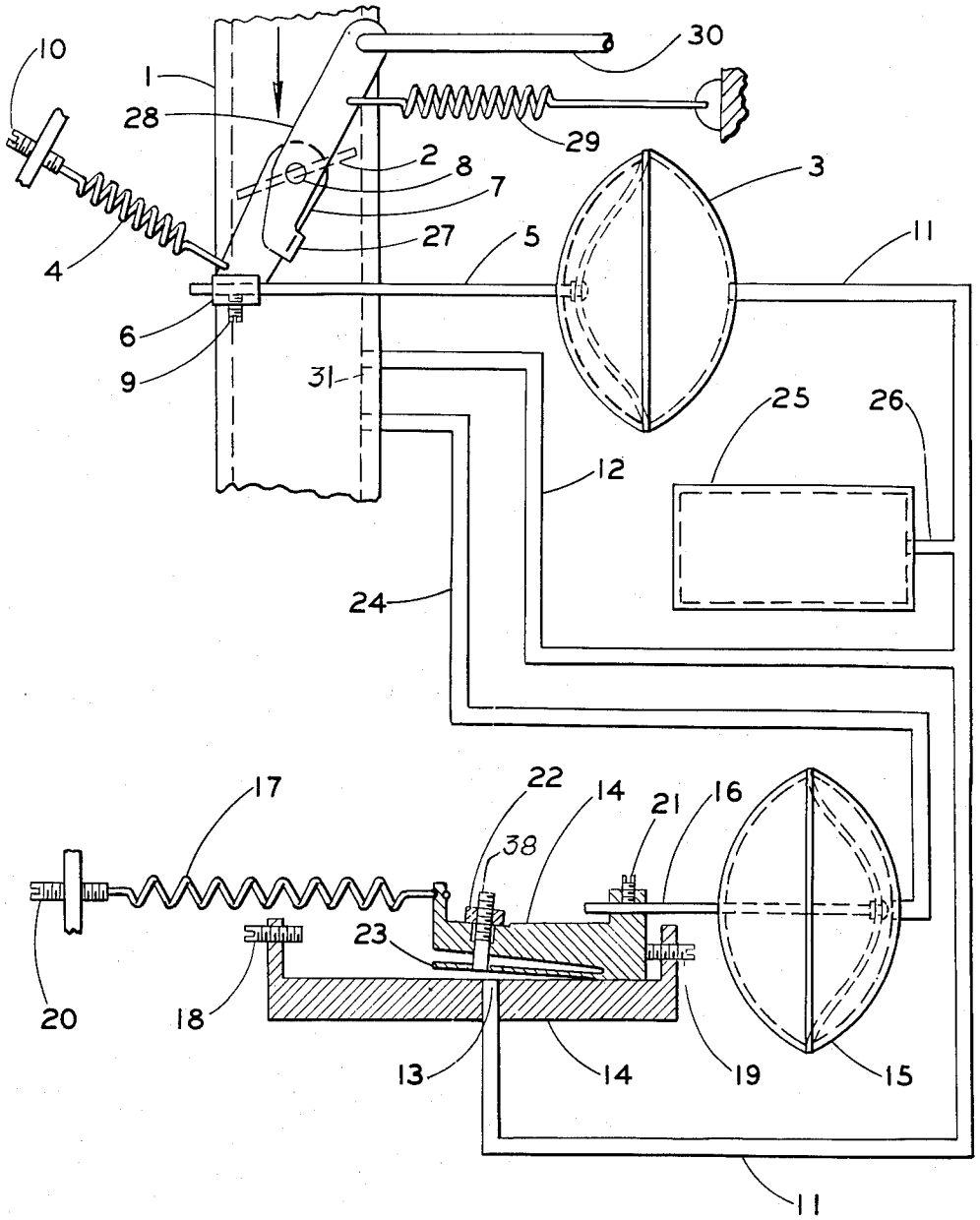


FIG. 1

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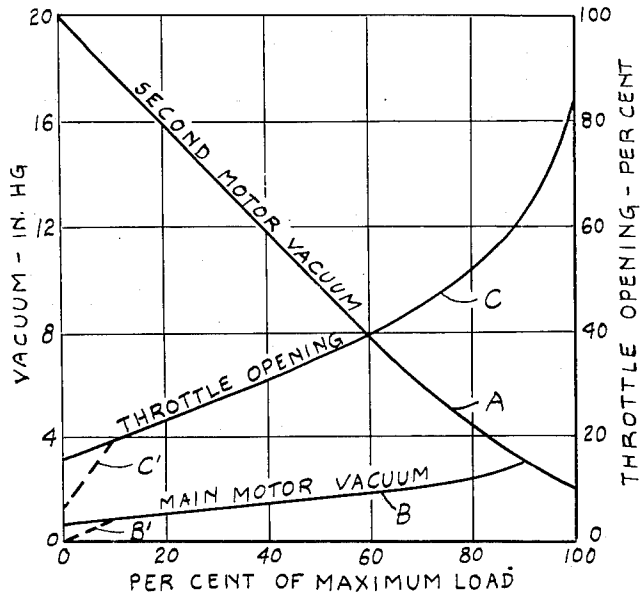


FIG. 2.

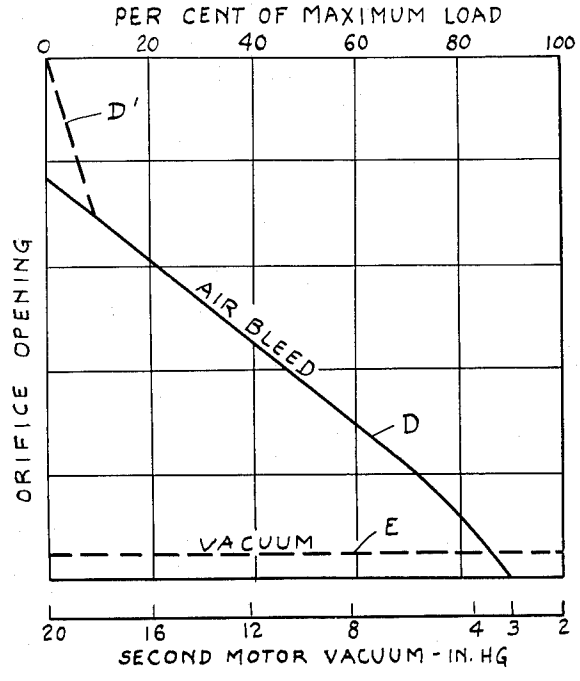


FIG. 3.

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2,749,938

LOAD AND SPEED GOVERNOR FOR INTERNAL COMBUSTION ENGINES

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4 Claims. (Cl. 137—483)

The present invention relates to an improvement in load and speed governors for internal combustion engines and specifically, the improvement consists of a novel apparatus for utilizing intake passage vacuum, the differential between atmospheric and intake passage pressure, to control engine speed under any load condition.

The present invention is of the full-vacuum-controlled type as opposed to the so-called centrifugal and velocity types. The essential novel features of the present invention include a combination of a main vacuum-actuated and resilient means having throttle-valve opening power and a second vacuum-actuated and resilient means controlling an air bleed valve which regulates the degree of vacuum supplied to the main vacuum-actuated means.

One of the advantages of the present invention is that it can be designed to meet a wider range of engine speed control requirements than is possible with prior devices. It can be designed, for example, to limit engine speed to a constant value under any load condition, which is the usual function of an engine governor. If desired, it may also be designed to act as a load-sensing governor permitting the engine to run at a predetermined low-speed under no-load conditions and causing engine speed to increase automatically as additional load is applied up to a predetermined high-speed at maximum load. As load decreases the governor then automatically reduces engine speed.

Another advantage of the present invention is its ability to act as a load governor. Properly designed and adjusted it can limit the output of the engine to any predetermined fraction of maximum output. This is desirable in cases where longer engine life is important.

Moreover, the use of this load-governing feature permits the use of higher compression ratios with regular fuel since it prevents the engine from accepting loads great enough to cause destructive detonation or pressures. The greater fuel economy obtained with higher compression ratios is well known.

Further and incidental objects and advantages of the present invention will appear in the following description, reference being had to the accompanying drawings.

Fig. 1 shows an embodiment of one form of the present invention.

Fig. 2 is a graph showing the relationship between load, main and second motor vacuums, and throttle valve opening.

Fig. 3 is a graph showing the characteristics of the air bleed valve required to obtain the main motor vacuum shown in Fig. 2.

Referring again to Fig. 1, an intake passage 1 of an internal combustion engine is shown with a throttle valve 2 controlling the flow of motivating fluid therethrough into the engine, the direction of flow being indicated by the arrow. The throttle valve position is controlled by the main vacuum motor 3 and main spring 4. The main vacuum motor 3, which is of the simple diaphragm type, is operatively connected to the throttle valve 2 by means of rod 5, trunnion 6, throttle lever 7, and shaft 8. The

rod 5 slides in a trunnion 6 and a set screw 9 is provided to obtain in the proper relationship between throttle valve and vacuum motor travel. When supplied with certain values of vacuum, the main vacuum motor 3 will tend to open throttle valve 2. This throttle valve opening force is opposed by main spring 4 variably throughout the range of throttle valve travel so that for every value of vacuum supplied to the main vacuum motor 3 there is a corresponding throttle valve position where the two opposing forces are balanced. Main spring 4 which is shown connected to lever 7, is capable of returning throttle valve to the closed, or engine idling, position when main vacuum motor is not being supplied with vacuum. A manual adjustment screw 10 is provided to vary the counterbalancing effect of main spring 4. Decreasing the counterbalancing effect thereof permits the engine to run at higher speed and increasing the counterbalancing effect lowers engine speed. The main vacuum motor 3 is supplied with vacuum obtained from the intake passage orifice 31 on the engine side of throttle valve 2 and conducted therefrom through conduits 11 and 12. The atmospheric port 13 leading into the conduit 11 allows atmosphere to bleed through the conduit system and into intake passage 1, thus reducing the vacuum supplied to the main vacuum motor 3. The amount of air entering the atmospheric port 13 is controlled by the regulating valve 14. The position of the regulating valve 14 is in turn controlled by the combination of a second vacuum motor 15, connected to regulating valve 14 by rod 16, and second spring 17, also connected to regulating valve 14. The second vacuum motor when supplied with vacuum tends to move regulating valve in a direction which permits air to enter the atmospheric port 13—the greater the degree of vacuum the greater the freedom of air flow through the port. Second spring 17, shown connected to regulating valve 14, opposes the force of the second vacuum motor 15 variably throughout the range of valve travel so that for every value of vacuum supplied to the second vacuum motor there is a corresponding regulating valve position where the two opposing forces are balanced. The second spring 17 is capable of returning the regulating valve 14 to its normal, or maximum restricting, position against manual adjustable stop screw 18.

Adjustable stop screw 18 may also be termed the load-governing adjustment as the position thereof determines the percentage of maximum load that the engine will accept. For instance, if stop means 18 is set so that the regulating valve is permitted to move to the atmospheric port shut-off position, main vacuum motor 3 is enabled, by virtue of an increased value of vacuum supply, to motivate throttle valve 2 to the substantially maximum-load position at any predetermined governed speed. If adjustable stop means 18 is set to limit regulating valve travel to permit a certain amount of air bleed through atmospheric port 13, the throttle opening power of the main vacuum motor will thereby be lessened with a resultant decrease in the maximum load that the engine can accept at the governed speed.

The fully-motivated, or least restricting, position of the regulating valve 14 is governed by manually-adjustable stop screw 19. A manual adjustment screw 20 is provided to vary the counterbalancing influence of the second spring 17 on the second vacuum motor 15. Increasing the counterbalancing influence permits engine speed to increase and decreasing the counterbalancing effect results in lower governed speeds. Another manual adjustment set screw 21 is also provided to obtain the desired relationship between the position of the motivating member of second vacuum motor 15 and regualting valve 14.

The regulating valve shown is of the adjustable-rate type, i. e., the degree of atmospheric port opening relative

to regulating valve travel may be varied by changing the angle of flexible restricting member **23** by means of the adjustable nut **22** on the screw **38** connected to the restricting member **23**. This adjustment enables the present invention to act as a load-sensing, speed governor. At a given rate of valve opening, as determined by the other adjustments previously described, the maximum speed of the engine may be held constant under any load condition. Increasing the rate of valve opening by the adjustment means **22** will permit the engine to run at a predetermined low speed under no-load conditions and cause engine speed to increase automatically as additional load is applied, up to any predetermined maximum load speed. When the load decreases, the governor then automatically reduces engine speed. The regulating valve **14** may also be designed to permit engine to run at a predetermined constant speed from maximum load to any predetermined minimum load and automatically reduce engine speed to a predetermined low point below this predetermined minimum load. This may be done by varying the shape of the restricting member **23** in the high-vacuum range of regulating valve travel to permit a sharply reduced restriction of air flow through atmospheric port **13**.

The second vacuum motor is supplied with vacuum obtained from the intake passage **1** at a point on the engine side of throttle valve **2** and conducted therefrom through conduit **24**. To eliminate the possibility of engine speed variation, or hunting, a surge chamber **25** may be connected to the vacuum supply system for the main vacuum motor **3** through a passage **26**. It is important for the correct functioning of the present invention that the second vacuum motor be more sensitive to intake passage vacuum variation than the main vacuum motor. This can be achieved by the proper design of surge chambers or restrictions in the vacuum supply conduits.

To provide positive manual control over the maximum opening of the throttle valve **2**, a movable stop **27** on lever **28**, which rotates freely on shaft **8** is provided. This stop is designed and located to limit the travel of the throttle lever **7** in the throttle valve opening direction. A third spring **29** operatively connected to lever **28** capable of overruling any throttle opening force of the main vacuum motor **3** causes stop **27** to move throttle lever **7** and consequently throttle valve **2** to the closed, or engine idling, position. To permit throttle valve opening, sufficient manual force must be applied through rod **30**, which is operatively connected to lever **28**, to overcome the counterbalancing force of the third spring **29**, the degree of throttle valve opening permitted being determined by the amount of manual force applied.

Assuming that the governor is designed and adjusted for constant speed operation at 3000 R. P. M. with the load to be governed at 90 per cent of maximum full throttle load, the operation would be as follows:

After starting the engine and manually moving stop **27** to permit full governor control of the throttle valve **2**, the high no-load vacuum of approximately 20 in. Hg in the intake passage will actuate the main, or throttle, servo-motor **3** and consequently the throttle valve **2**, so that engine speed increases to the governed speed. This high no-load vacuum is modified by the regulating valve **14** controlled by the second vacuum motor **15** which allows sufficient air bleed into the supply conduit **11** so that the effective vacuum reaching the main servo-motor **3** is considerably reduced in value.

The relationship between the main and second motor vacuums, throttle valve position, and per cent of maximum full throttle load at 3000 R. P. M. engine speed is shown by curves A, B, and C of Fig. 2. Curve A shows second motor, or intake passage, vacuum vs. per cent of maximum full throttle load. It can be seen that the second motor vacuum is inversely proportional to engine load. Also, within narrow limits, curve A is representative of the second motor vacuum at any governed speed above or below 3000 R. P. M.

Curve B shows the vacuum supplied to the main, or throttle, vacuum motor vs. per cent of maximum throttle load. It will be noted that, whereas the second motor vacuum decreases as the load increases, the opposite is true of the main motor vacuum. This effect is achieved by the action and design of the regulating valve and servo-motor combination **14—15** which allows a large amount of air to bleed into the main motor vacuum supply system **11—12** when the intake passage vacuum is high and a rapidly decreasing amount of air bleed as the intake passage vacuum decreases.

Curve C shows the throttle valve opening required at various loads to maintain a constant speed of 3000 R. P. M.

Curve D shows the size of the air bleed opening **13**, as controlled by the second vacuum motor **15**, in relationship to the percentage of maximum full throttle load and also second motor, or intake passage, actuating vacuum. Curve E shows the size of the main motor vacuum supply orifice **31** relative to the air bleed opening **13**.

At 3000 R. P. M., no load, therefore, the engine intake passage vacuum would be 20 in. Hg and the vacuum supplied to the main vacuum motor **3** would be 0.8 in. Hg. This latter value is sufficient to open the throttle valve **2** the required 16 per cent for this speed and load condition. As load is imposed on the engine, the intake passage vacuum decreases and consequently the vacuum supplied to the main vacuum motor **3** increases in the correct proportion to open the throttle valve **2** sufficiently to maintain the governed speed. At 90 per cent load, air bleed is completely shut off as shown by curve D, and intake passage vacuum is delivered unmodified to the main throttle motor **3** to obtain the required 61 per cent throttle opening and so maintain the governed speed. A load greater than 90 per cent of maximum full throttle load could not be handled by the engine since the actuating vacuum beyond this point decreases in value, as shown by curve A.

As load is taken off the engine, the intake passage vacuum increases, resulting in a decrease of throttle motor actuating vacuum and consequently a decrease in throttle opening.

If operating conditions are such that the engine runs under no-load conditions for a considerable part of the time, it may be desirable from an economy standpoint to utilize the load-sensing ability of the present governor so that engine speed is reduced from the governed speed down to a low idling speed whenever engine load decreases below some predetermined value such as 10 per cent of maximum load. This effect is accomplished by changing the characteristic of the regulating valve **14** to permit an abrupt increase in air bleed at and above 18 in. Hg intake passage vacuum as shown by curve D'. This results in a reduction of the main motor vacuum to substantially zero as shown by curve B' and consequently a sharp decrease in throttle valve opening as shown by curve C'.

What I claim is as follows:

1. A governor for an internal combustion engine comprising a suction intake passage, a throttle valve movable in said passage to control the flow of a motivating fluid therethrough, a first servo-motor means operatively connected to said throttle valve for moving said valve between open and closed positions, a first fluid conduit connecting said first servo-motor means and said intake passage downstream of said throttle valve, a fluid bleed opening in said first conduit for varying the effective pressure acting upon said first servo-motor means, a valve controlling said fluid bleed opening, a second servo-motor means operatively connected to said bleed opening control valve to move said control valve between open and closed positions, a second fluid conduit connecting said second servo-motor means and said intake passage downstream of said throttle valve, said second servo-motor means thus being actuated by the pressure of the motivating fluid downstream of said throttle valve to move said bleed opening

control valve toward its open position when said pressure decreases, thereby causing said first servo-motor means to move said throttle valve toward its closed position.

2. The governor set forth in claim 1 wherein the first servo-motor means includes a first resilient means tending to move the throttle valve toward its closed position.

3. The governor set forth in claim 2 wherein the second servo-motor means includes a second resilient means tending to move said bleed opening control valve towards its closed position.

4. The governor set forth in claim 3 including a movable member in said bleed opening control valve whereby the rate of valve opening relative to valve travel may be varied, and an adjustment means whereby the position of said movable member may be varied.

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