

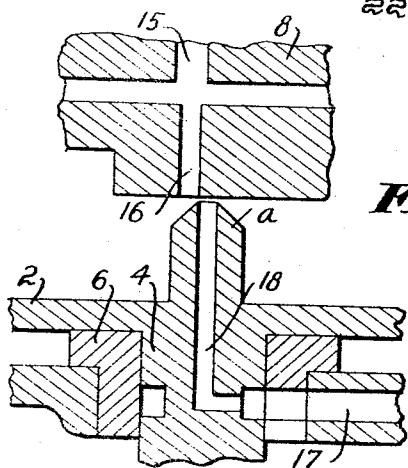
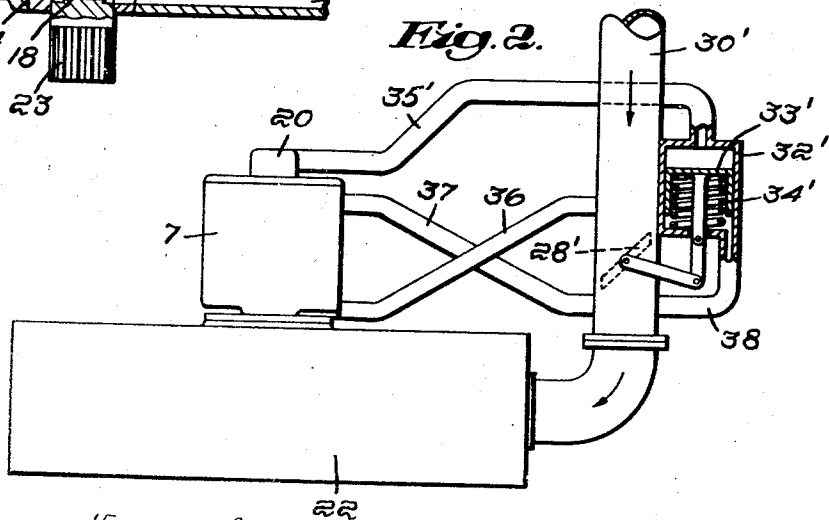
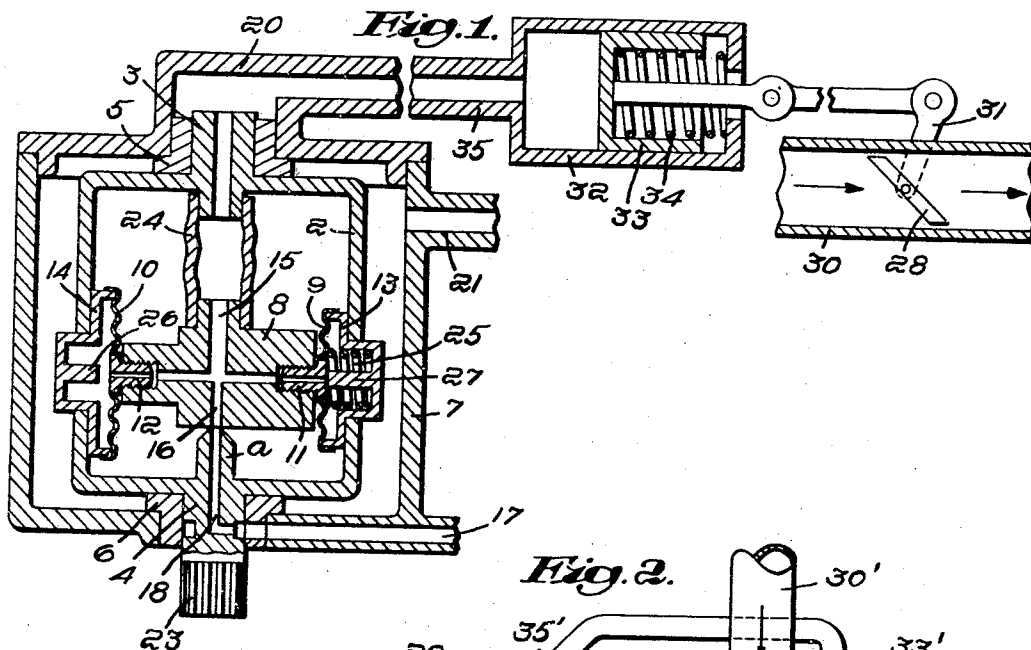
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SPEED GOVERNING MECHANISM

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SPEED GOVERNING MECHANISM

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5 Claims. (Cl. 264-14)

1

This invention relates to speed responsive apparatus or, in other words, to those mechanisms which make some adjustment, measurement, or other operation, automatically in response to changes in the speed of a body. The invention will be herein disclosed as embodied in a self-governing valve for controlling the speed of prime movers, such as internal combustion engines.

It is the chief object of the invention to improve self governing valves with a view of simplifying the construction of mechanisms of this type and eliminating many of the troubles commonly caused by friction, lost motion, and the like while providing a high degree of responsiveness. The invention also aims to provide an apparatus of the general character above indicated which shall be exceptionally flexible in its application to governing mechanisms for engines, or for other purposes, and in which the conditions of speed-responsiveness are readily adapted to the varying requirements of different installations.

The nature of the invention will be readily understood from the following description when read in connection with the accompanying drawings, and the novel features will be particularly pointed out in the appended claims.

In the drawing,

Fig. 1 is a vertical, sectional view, somewhat diagrammatic in character, illustrating a governor mechanism for a prime mover; and

Fig. 2 is a side elevation, with some parts in section, illustrating a modification of the arrangement shown in Fig. 1, and

Fig. 3 is a fragmentary, sectional view on a larger scale of parts of the rotor and the nozzle cooperating therewith.

Referring first to Fig. 1, the construction there shown comprises a rectangular frame 2 provided with upper and lower journal members 3 and 4, respectively, mounted in upper and lower bearing bushings 5 and 6. These bushings are fixed in the top and bottom end pieces, respectively, of a substantially closed casing 7 and they support the frame for rotation about the common axis of said journals. An inertia body 8, of generally cylindrical form, is connected to said frame by means of right and left flexible diaphragms 9 and 10 to which the opposite ends of said body are fastened by means of hollow screws 11 and 12, respectively. The outer margins of these diaphragms are soldered to the peripheral surfaces of two heads 13 and 14, respectively, each of which has a pressed fit with holes in the opposite upright legs of the frame 2.

The inertia body 8 is cross-drilled to provide

2

an air chamber 15 which is connected by two horizontal ducts with the holes through the two screws 11 and 12, above mentioned, and, consequently, with the air bodies confined in the chambers behind the respective diaphragms 9 and 10. This construction also provides a duct 16 leading vertically from the chamber 15 to the lower surface of the body 8.

Air under pressure is conducted into the stationary casing 7 through a duct 17 drilled horizontally in the bottom of said casing and the inner end of this duct registers with a hole through the bushing 6 and with the lower horizontal end portion of another duct 18 formed in the journal member 4 and in a nozzle extension *a* of this member. The duct 18 opens into an annular groove in the outer surface of said journal member which is constantly in communication with the inner end of the duct 17. Consequently, the air flowing through the latter duct is discharged through the nozzle *a*, and if the duct 16 is in communication with it, this air then flows upwardly into the chamber 15 and there divides, some flowing laterally from the lower end of this chamber into the two air chambers behind the diaphragms 9 and 10, while most of it flows upwardly through the bore of the journal member 3 to an outlet 20. Air which may be discharged from the nozzle *a* into the chamber in the casing 7 escapes through the nipple 21 into the surrounding air or into any other point of discharge to which the apparatus may be connected.

In the particular construction shown the casing 7 forms the head of a governor for an internal combustion engine indicated at 22 in Fig. 2. In order to revolve the governor frame member 2, the lower journal piece 4 for this member is splined, as shown at 23, for convenient attachment to the delivery end of some suitable set of connections running to the crank shaft of the engine so that the frame 2 will be revolved about a vertical axis at crank shaft speed, or in some definite ratio to that speed.

It should be observed that the inertia body 8 is compelled to revolve with its supporting frame 2, but that it is constrained against movement in any other direction except at right angles to the axis of rotation of said frame and in line with the common axis of the two screws 11 and 12. A flexible tube 24 provides an air tight connection between the body 8 and the downwardly extending end portion of the journal member 3, this connection being of such a nature as not to offer any substantial resistance to the lateral movements of the said body.

When the governor is at rest the inertia body is pushed toward the left by the biasing spring 25 until the screw 12 abuts against the stop 26. The duct 16 then is offset toward the left from the duct 18 in the nozzle *a*, the parts then being in the relationship shown in Fig. 3. But when the governor is started up, the centrifugal force created in the inertia body will tend to shift said body toward the right because its center of gravity is at the right of the axis of rotation of the frame 2. As the centrifugal force increases, it soon overcomes the action of the spring, the body 8 begins to move to the right, and it may continue in this direction until arrested by the contact of the screw 11 with the stop 27. At this time the ducts 16 and 18 will be in alignment with each other, as shown in Fig. 1, so that the air pressure transmitted through the ducts 17 and 18 to the chamber 15 then equals the applied fluid pressure.

During this operation a pressure has been created in the chamber behind the diaphragm 9 equal to that in the chamber 15, and it acts on the body 8 in a direction to oppose the shifting movement of the latter under the influence of centrifugal force. In practice the parts are so designed and the pressure of the spring 25 is so selected that in normal operation the shifting movement of the inertia body does not proceed far enough for it to be arrested by the stop 27, but it is stopped when the fluid pressure in the right-hand counter-balancing unit, including the diaphragm 9, is built up to such a value that this force, plus the spring force, equals the centrifugal force in the body 8. This, of course, disregards for the moment the action of the other fluid pressure unit including the diaphragm 10. Thus there is a direct correspondence between the pressure generated in the right-hand unit 9 and the speed at which the governor is driven. If the spring tension is increased, then the speed at which the balancing pressure becomes effective likewise will be increased.

The fluid pressure in the chamber 15 can be transmitted to any suitable type of pressure-responsive apparatus, as for adjusting a throttle valve or otherwise controlling the operation of the particular unit with which the governor is used. In the case of a prime mover, such as an internal combustion engine, the throttle valve, indicated diagrammatically at 28 in Fig. 1, may be mounted in the fuel supply pipe 30 and supported on a shaft to which an arm 31 is connected. The throttle operator here shown consists of a cylinder 32 with a piston 33 working in it and mechanical connections running from it to the arm 31, the piston being backed up by a spring 34. Pipe connections 35 conduct fluid pressure from the governor outlet nipple 20 to the cylinder.

In such an arrangement the fluid pressure required to operate the throttle valve is large for a closed throttle and is small for an open throttle. Also, as will be evident from the foregoing, the pressure in the chamber 15 of the governor is high for high speeds and low for low speeds. Consequently, with the governor controlling the application of pressure to the piston 33, the relationship desired for maintaining a substantially constant engine speed is here provided. At normal speeds the pressure in the chamber 15 is transmitted to the piston 33, holding it in such a position as to maintain the throttle at, say, a 45° inclination, or at some other angle which will give the required speed, a suitable adjustment for this purpose being readily obtainable in

the usual mechanical connections. If, now, the engine speed should drop, the inertia body will move toward the left, thus partly cutting off the flow of air from the nozzle *a* into the chamber 15 and, consequently, reducing the pressure in the cylinder 32. This permits the spring 34 to open the throttle valve further, thereby speeding up the engine. Upon a reversal of these conditions the pressure will build up in the chamber 15 and in the cylinder 32, thus forcing the piston 33 back and closing the throttle somewhat.

In a governor so organized, the speed will drop off with a sudden increase in load, as is, in fact, usually true in conventional governors. But by reducing the effective area of the diaphragm 9 to a smaller value, the sensitivity of the governor can be increased because the control pressure then will change more rapidly with changes in speed. This expedient, however, cannot be carried too far for the reason that when the governor becomes too sensitive, the engine goes through a relatively long period of transient oscillatory operation after a sudden increase in load, the speed falling and rising alternately until these conditions finally are damped out.

In order to eliminate this condition, while still making the governor sufficiently sensitive, the second fluid pressure unit, including the diaphragm 10, has been provided. As shown, it is made slightly larger than the diaphragm 9, but the hole through the screw 12 is made considerably smaller than that through the screw 11 of the right-hand unit so that it will not respond as rapidly to changes in fluid pressure in the chamber 15, as does the latter unit. Assuming, for example, that the control pressure in the governor at normal speed is, say, four pounds per square inch, and a heavy load is suddenly applied to the engine, the governor immediately begins to slow down with the reduction in speed of the engine. Simultaneously the inertia body 8 moves toward the left, thus reducing the pressure in the chamber 15 to a value corresponding to the reduced centrifugal force. This same reduction in pressure occurs in the cylinder 32 of the throttle operator, and the throttle valve is opened somewhat. In the meantime air has been flowing slowly through the screw 12 into the chamber 15, so that after a short period of time, say two or three seconds, the pressures acting on the two diaphragms 9 and 10, will be equalized. By that time the speed has been re-balanced or reset to the desired value.

Thus by making the diaphragm areas exactly equal, it is possible to have the speed restored to the desired value and the prime-mover now runs at the same speed but under different load conditions, even after the application of a heavy load; or by making the area of the diaphragm 10 larger than that of 9, it is possible to re-balance the fluid forces so as to over-compensate for the reduction in speed and thus to produce a higher speed at heavy loads than at reduced loads. This, however, is a factor which can be predetermined in accordance with the expected operating conditions and the degree of compensation desired for changes in load. The second diaphragm or fluid pressure unit acting on the inertia body, with its action lagging behind that of the right-hand pressure unit, performs a valuable function in reducing the rate at which the governor will respond to sudden changes in load by a value sufficient to prevent the transient oscillations in speed which otherwise are likely to occur. This adds to the stability of the device.

5

Recapitulating, three important functions are present in the operation:

1. During a steady-state condition the nozzle *a* is throttled in accordance with the position of body 8, the centrifugal force of body 8 being balanced wholly by spring 25 since the pressures within the first and second pressure units are equal, resulting in equal and opposite forces upon body 8. (It is assumed that areas of diaphragms 9 and 10 are equal in accordance with column 4, lines 54 and 55, supra.)

2. Upon change of speed of the prime mover, the centrifugal force of body 8 varies, as does the spring force in reaction thereto. However, upon throttling movement of body 8, the pressure within chamber 15 changes and the pressure within the first pressure unit changes simultaneously therewith, since the passage 11 offers but little resistance to pneumatic flow the volume capacity of the first pressure unit charges (or discharges) quickly, the time constant being very small. It will be noted that the throttling range is directly determined by this pressure, and accordingly the first pressure unit may also be termed a proportioning means, there being a one-to-one correspondence between speed of the prime mover and the pressure within the first pressure unit and chamber 15. In other words, if this proportioning means or first pressure unit were not present the throttling action would be off-on, or infinitely sensitive. As is well known in amplifier theory, infinitely sensitive systems are wholly unstable. Hence, the first pressure unit may be thought of as a stabilizing means, or anti-hunting means.

3. With a change in pressure in unit 15 in accordance with the above events, the second pressure unit becomes operative, the volume capacity of the second pressure unit charging, or discharging, as a function of time. The pressure within the second pressure unit approaches the new pressure within chamber 15 and the first pressure unit exponentially, changing by $1/e$ of its value in a time (the time constant) uniquely dependent upon the size of restriction 12 and the volume of the second pressure unit. (It is to be particularly noted that the operating fluid medium must be compressible, a well known fact but mentioned to distinguish compressed air operation from incompressible fluid operated devices.) A force in the direction of the centrifugal force thus is brought to bear upon body 8 and after the passage of several time-constant units of time, the force developed by the second pressure unit cancels that due to the first pressure unit and the throttle remains in its new position, being balanced by the spring. The second unit is thus a reset unit.

An important feature of this invention resides in utilizing the pressure drop across the throttle valve of an engine as the source of fluid pressure required for the operation of the governor. This pressure drop varies with the degree of valve opening, the larger that opening the lower the pressure drop, and vice versa. But by properly designing the valve operator and making a suitable selection of the strength of the operating spring to suit the amount of pressure drop available in a given installation, this source of pressure can be utilized successfully, thus making it unnecessary to pipe to an independent source of pressure.

Fig. 2 illustrates an arrangement operating in accordance with this unique idea. Here the inlet duct 17 for the governor and the outlet 21

6

for the exhaust air are connected by tubes 36 and 37, respectively, to the high pressure and low pressure points on the intake pipe 30' at opposite sides of the throttle valve 20'. The fluid pressure connection 35' from the outlet 20 to the cylinder 32' is the same as in Fig. 1, but the cylinder space below the piston is connected by a tube 38 to the intake pipe 30' at the low pressure side of the throttle valve. Thus the throttle operating piston and the governor both operate on the fluid pressure drop across the throttle valve. This materially simplifies the installation.

It will be evident from the foregoing that the invention provides an exceptionally simple and sturdy governor mechanism in which errors due to friction in the speed responsive parts are substantially eliminated. The nature of the construction is such as to make it extremely reliable and to facilitate installation in any of a great variety of ways suited to the requirements of individual situations.

While I have herein shown and described a preferred embodiment of my invention, it will be evident that the invention may be embodied in other forms within the spirit and scope thereof. Having thus described my invention, what I desire to claim as new is:

1. An isosynchronous governor for a prime mover having a throttle valve actuated by fluid pressure operable means and characterized by affording a fluid source and sink by virtue of an inherent pressure drop comprising; fluid conduits connecting the source and sink and defining a fluid path; an inertia member interposed in the fluid path in valving relationship therewith to supply pressure to the fluid pressure operable means actuated by the prime mover and responsive to the speed thereof by developing a centrifugal force; a spring responsive to the centrifugal force indicative of the isosynchronous condition and reactive to the centrifugal force to substantially fully balance the inertia member during steady state running conditions of the prime mover; a first pressure unit operatively connected in the fluid path on the fluid pressure operable means side thereof and to the inertia member fashioned to exert a force upon the inertia member in sense of the spring force; and a second fluid pressure unit operatively connected to the fluid path on the fluid pressure operable means side thereof through an orifice limiting the build-up or decay of pressure therein and fashioned to exert a force upon the inertia member in sense opposite the spring force.

2. The combination with an engine equipped with a throttle valve for controlling its speed, of an automatic governor driven by said engine, and means controlled by said governor for utilizing the fluid pressure drop across said valve to operate the valve itself in governing the speed of the engine.

3. The combination with an engine equipped with a throttle valve for controlling its speed, of an automatic governor driven by said engine, and fluid pressure operated means controlled by said governor for utilizing the fluid pressure drop across said valve to adjust the valve itself in response to changes in the engine speed.

4. The combination with an engine equipped with a throttle valve for controlling its speed, of an automatic governor driven by said engine, fluid pressure actuating means for said valve, connections between said valve and said governor for applying the fluid pressure drop across

7

said valve to said governor, the governor including centrifugally controlled valve means for regulating the application of said fluid pressure drop to said actuating means for the valve to adjust it in response to changes in the engine speed.

5. An automatic governor for an isosynchronous prime mover having a valve characterized by an inherent pressure drop, comprising pressure proportioning means responsive to an error in speed of the prime mover, valve actuating means responsive to the pressure proportioning means, and delay pressure means acting in opposition to the first named means to reset the isosynchronous condition, wherein the means are energized by the inherent pressure drop.

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8

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,189,697	Kasley	July 4, 1916
1,311,850	Huff	June 30, 1931
2,137,689	Karelitz	Nov. 22, 1938
2,155,247	Warner	Apr. 18, 1939