Sept. 26, 1933. O. BAUR ET AL 1,928,476

CENTRIFUGAL GOVERNOR FOR HIGH SPEED INTERNAL COMBUSTION ENGINES

Filed May 16, 1932 2 Sheets-Sheet, 1

Fig. 6

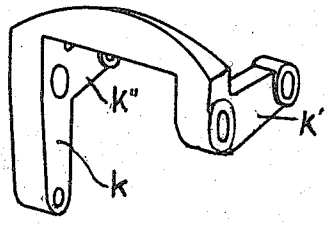


Fig. 1

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Fig. 2

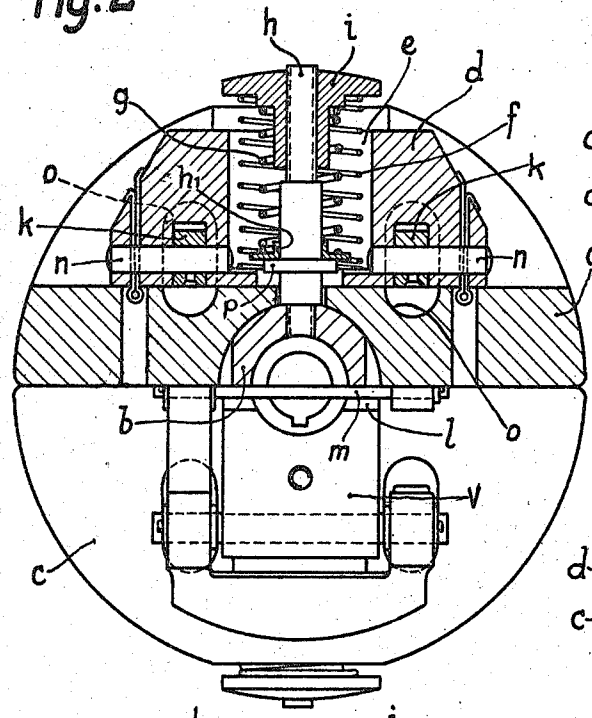
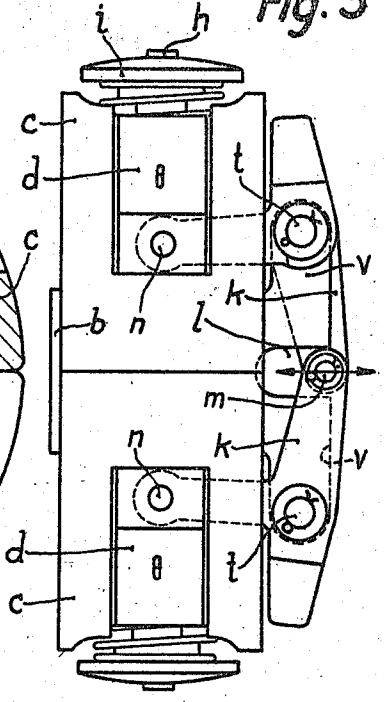


Fig. 3



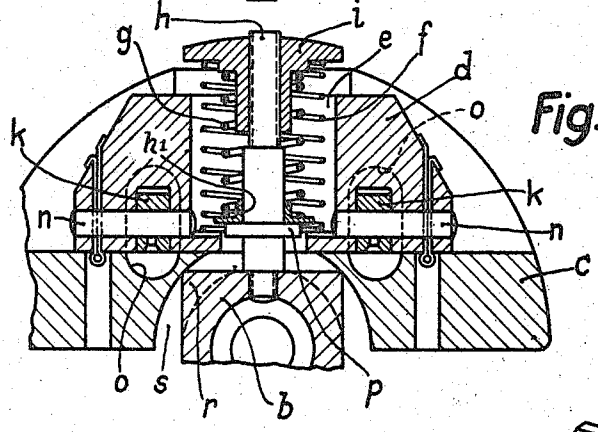


Fig. 7

Fig. 4

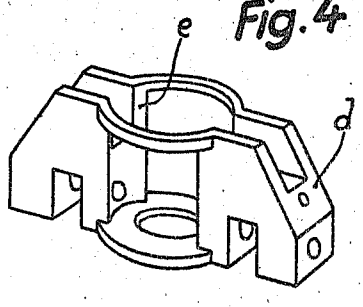
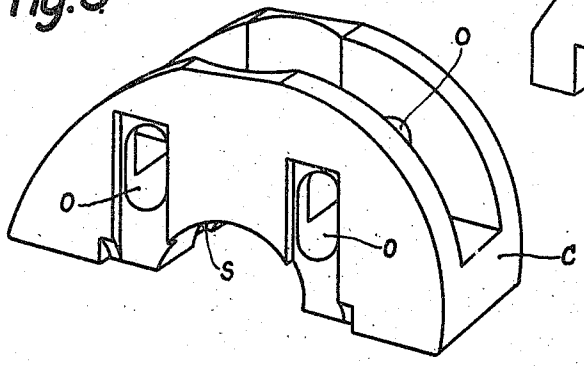


Fig. 5



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CENTRIFUGAL GOVERNOR FOR HIGH SPEED INTERNAL COMBUSTION ENGINES

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Application May 16, 1932, Serial No. 611,716, and in Germany May 27, 1931

11 Claims. (Cl. 264—17)

This invention relates to a centrifugal governor for high speed internal combustion engines adapted to work under conditions of varying load and speed, more especially for Diesel engines for vehicles, which prevents the engine dropping below a minimum speed and also prevents a maximum speed being exceeded, but is inoperative for an intermediate range of speeds. This invention relates particularly to a definite type of these governors, in which each individual centrifugal mass is divided into a plurality of parts so arranged as to act together like a single coherent weight as long as the engine is running idle, but with one part held inoperative against further outward movement, for example, by a stop, when the minimum speed is exceeded, so that only the other part of the centrifugal mass can continue to fly out.

A centrifugal pendulum governor of this kind is already known in which the pendulum oscillating on an arc flies out against the action of helical springs. These springs are, in this case, arranged laterally to the axis of the governor in planes perpendicular to the axis of rotation of the governor, so that due to the centrifugal force they bend transversely to their axes. Such flexure of the springs has the drawback that they are tensioned to an additional extent in an undesirable manner whereby the degree of sensitiveness of the governor is unfavourably effected. The higher the speed of the engine rises, the more perceptible does this drawback become. A further drawback of this known governor is that the pivot points of the oscillating pendulum are subjected to a varying strain, because of change in position of the centers of gravity of the masses as they oscillate and change in the lever lengths on which the governor springs act on those masses. Further, it should be added that the arrangement of the governor springs outside the oscillating pendulum takes up much room.

These defects which affect the serviceability and excellence of a governor are removed by the present invention. This is attained according to the present invention by divided centrifugal weights for controlling several ranges of speed, so arranged as to fly out perpendicularly to the axis of the governor against suitable forces adapted to return them, preferably helical springs, which also act perpendicularly to the governor axis. Further advantages obtained by the invention are described in connection with the following specification.

It should be further mentioned that centrifugal governors having centrifugal bodies with a perpendicular throw are already known. In that case, however, each centrifugal mass, in contradistinction to the present invention, consists of one part only, so that this known type of governor is not suitable for high speeds, especially for great differences between the speeds when running idle and the maximum speed, such as frequently occur in modern high speed vehicle motors.

The new governor, which is particularly suitable for fuel spraying pumps, is shown in two examples of construction in the drawings, in which:—

Figure 1 shows the first form of construction of the centrifugal governor in vertical median section, and a portion of fuel pump with which the governor may be used for control of the pump in respect to the quantity of fuel delivered.

Figure 2 is a partial vertical cross sectional view of the governor on the line x—y—z of Figure 1, looking from left to right as indicated by the arrows.

Figure 3 is a partial side elevational view of the governor according to Figure 1.

Figures 4 and 5 show in perspective views the two parts of the centrifugal body serving for governing the speeds, but with these parts of a somewhat different construction from that of the corresponding parts of Fig. 1.

Figure 6 is a perspective view of a bell-crank lever, two of which form operating parts of the governor mechanism.

Figure 7 is a partial vertical cross sectional view of the governor, similar to the upper half portion of Fig. 2 but with certain parts modified to positively guide the centrifugal bodies. As compared with the first example in Figures 1 and 2, the centrifugal bodies are positively guided on the governor hub.

a is a conical shaft end of a fuel spraying pump, of the general type described in the co-pending application of one of the present joint applicants, Ottmar Baur, Serial No. 421,513, filed January 17, 1930. Upon this end of the pump shaft the governor hub b is secured. On the periphery of the governor hub two centrifugal bodies of general segment shape in side contour, as shown in Figs. 2 and 5, are mounted so as to be capable of flying out radially of the hub. The two centrifugal bodies each consist of two parts, namely, a heavy part c and a light part d formed for the nesting of the part d in the part c with sufficient clearance to enable the part d to move in the radially outward direction with respect to the part c as shown in Fig. 3. The light part is guided in a cut-away portion c',

Fig. 5, of the heavy part lying transverse to the governor axis and has a cylindrical recess *e* lying perpendicular to the governor axis. In this latter recess two governor springs *f* and *g* are arranged, which are inserted over a bolt *h* fixed in the governor body, on the outwardly directed end of which bolt a screwable spring-plate *i* is provided by means of which the tension of both governor springs can be simultaneously adjusted. *f* is the governor spring for idle running; it has a weak tension and its tension corresponds to the desired speed when running idle. The end of this governor spring directed towards the axis of the governor bears on the bottom of the light centrifugal body part *d*. When the governor is quite at rest, the governor spring *f* presses both the light as well as the heavy part of the centrifugal body against the body of the governor.

The spring *g* is substantially more strongly tensioned than the spring *f*, and is so arranged with respect to the lighter inner centrifugal body part *d* that it resists the centrifugal force of that body part *d* over the whole normal working range of speeds, as will later more fully appear. The end of the spring *g* facing the governor body rests on an abutment consisting of an apertured plate *h'* displaceable on the bolt *h* and pressed by the governor spring *g* against a collar *p* on the bolt. The governor body or hub *b* has two radial arms *v* to which bellcrank levers *k* are pivotally connected by bolts *t* lying transverse to the governor axis. Each bellcrank lever is connected, through its arm directed towards the governor axis, to the adjusting bolt *m* lying transversely to that axis, so that as the bell-crank levers are operated, as hereinafter described, the adjusting bolt *m* moved to and fro in a longitudinal slot *l* in the governor body, as indicated by the double arrows on Fig. 1. It will be understood, of course, that there is a sufficient play of the bolt *m* through the apertures in the adjacent ends of the lever arms to permit the swinging of those lever arms and the to-and-fro movement of the bolt.

The arm of each of the two bellcrank levers remote from the governor axis is forked as shown at *k'* and *k''* in Fig. 6 and pivoted by bolts *n* to the light inner centrifugal body part *d*, the forked arm parts passing through the outer heavy centrifugal body part. The slots *o* provided for this purpose in the heavy centrifugal body part are of such size that the forked arm parts do not come in contact with the heavy part *c* on the flying out of the centrifugal body part.

The adjusting bolt *m* is connected with the governor sleeve C by a slide D which is axially guided in the bushing D' fastened on the radial arms *v* of the governor hub by means of screw bolts or the like. To the sleeve C is pivoted a two-armed lever E by means of a pivot block F. This lever oscillates on an axis H journaled in bearings (not shown) in the side walls of the governor casing J, and its upper arm is connected, through rod K, with the fuel-feed-control rod L of the pump.

As stated at the beginning of this specification, the governor is adapted to operate, under conditions of varying load and speed, to prevent the engine dropping below a minimum speed and rising above a maximum speed. This, of course, means that the variations in load and the variations in speed between the minimum and maximum require some means operating independently of the governor to voluntarily vary the fuel supply to the engine in accordance with the varying load or the desired change in speed within the limits set by the governor. For example, when running the engine idle it is necessary to voluntarily increase the fuel supply preparatory to imposing a load on the engine, or when running the motor vehicle at twenty miles an hour and it is desired to increase the speed to forty. Any suitable means for such voluntary variation of the amount of the fuel feed may be employed. One such means is shown in Fig. 1, comprising an eccentric disc G on the axis H of the lever E, and a lever M on the shaft H which can be actuated voluntarily by hand or foot operating mechanism (not shown). It is evident that when the shaft H is turned by the lever M, and with it the eccentric disc G, the lever E is shifted bodily on the block F as a pivot, and thereby the fuel-feed-control member L is actuated independently of the governor. The structure C, F, G, H, M and E, is old and well known as a means for voluntarily varying a fuel charge feed to an internal combustion engine, as shown, for example, in the patent to Noack No. 1,257,918, February 26, 1918.

The governor described works as follows:—

If the engine is running idle, then both weight parts *c*, *d* fly out radially together, they act in this case like a single coherent weight on the weak spring *f*, which is designed for the desired speed when running idle. By this means the controlling member of the spraying pump is so adjusted, through the bellcrank levers *k* and the adjusting bolt *m*, that the engine cylinders are supplied only with the quantity of fuel necessary for maintaining the idle running.

If the idle running speed tends to increase, for example, through the decrease of the internal resistance as the engine heats up, the outward movement of the light centrifugal part *d* exerts an outward pivoting movement on the connected arms *k'*, *k''* of each bell-crank lever, with resulting axially inward pivoting movement of the opposite arm of each lever and corresponding movement, to the right in Fig. 1, of the adjusting bolt *m*, and consequent following movement of the governor sleeve C, so that the governor correspondingly reduces the supply of fuel.

Before load is placed on the motor when running light, the quantity of fuel injected must be increased by voluntary operation of the lever M mounted on the axis H of the eccentric disc G. Thereby the position of the two-armed lever E is changed, so that it moves the rod K and with it simultaneously the fuel-feed-controlling member L of the injection pump B. This results in such an increase in the speed of the motor that the two heavy fly weights *c* come against the stay bolt collar *p*, and thus become inoperative. The governor remains in this position over a large range of working speeds. It is to be noted that when the weight *c* moves radially outward into engagement with the collar *p* on the bolt *h* that the lighter weight *d* thereafter engages against the under side of the spring plate *h'*. Therefore, only when the speed, and thus the centrifugal force, of the light governor weight *d*, which is now alone operative, is sufficiently high to overcome also the tension of the spring *g*, do the light governor weights fly out radially against the action of the springs *g* on a further rise of the speed, so that the bellcrank levers *k* are further turned and thus the adjusting bolt *m* further displaced. By this means the quantity of fuel conveyed by the pump is limited to such

an extent that the engine even when under a small load does not exceed a certain maximum speed.

Further various ways are shown, in which the governor can be adapted in a simple manner to correct the constant tendency to increase the maximum speed of engines more and more, without thereby raising the lowest speed when running idle. One way is to keep the weight of the centrifugal body part *d*, which is alone operative in the maximum speed range, correspondingly small. This can readily be done by extensively cutting this part away, as is shown for example in Fig. 4. Or, this part can also be made of light metal.

If the governor is used for four-stroke cycle engines, it is preferably arranged for the purpose stated on the driving shaft of the fuel pump. The governor then need only be calculated on half the highest permissible speed of the engine since the pump shaft runs at half speed.

In order that the outer heavy centrifugal body part *c* may not become obliquely positioned during the working of the governor and thus become canted to one side, whereby the reliability of the governor is affected as is well known, the part *c* may be positively guided so that an exact parallel guidance of the centrifugal body part is ensured. In Fig. 7 a construction suitable for this purpose is shown by way of example. The part *c* is provided with an annular recess *s* in which a correspondingly shaped rib *r* on the periphery of the governor body *b* engages and keeps the part *c* always in an exactly rectilinear radial path.

We declare, that what we claim is:

1. A speed regulator for internal combustion engines comprising a rotating member driven by the engine, a divided centrifugal mass comprising two distinct fly weights assembled together to form the centrifugal mass, means supporting said centrifugal mass on said rotating member in a manner causing said member to revolve said mass while permitting movement of said fly weights radially of said member, spring means yieldingly resisting outward radial movement of each of said fly weights, means positively limiting the outer radial movement of one of said fly weights while permitting continued outer radial movement of the other of said fly weights against the resistance of said spring means, and means responsive to the radial movement of said centrifugal mass as a whole and to the independent radial movement of said other fly weight to vary the speed of the engine.

2. A speed regulator for internal combustion engines comprising a rotating member driven by the engine, a divided centrifugal mass comprising two distinct fly weights assembled together as inner and outer fly weights with respect to their axis of revolution, means supporting said fly weights in their assembled relation on said rotating member in a manner causing said member to revolve said fly weights while permitting movement thereof radially of said member, spring means yieldingly restraining said fly weights to engaging relation as a coherent mass and yieldingly resisting their outward radial movements, means positively limiting the outward radial movement of the inner fly weight while permitting continued outward radial movement of the outer fly weight against the resistance of said spring means, and means responsive to the radial movement of the two fly weights together as a coherent means and to the independent radial movement of the outer fly weight to adjustably control the speed of the engine, said means being arranged to operate in response to radial movement of the two fly weights together to control the minimum engine speed and in response to the independent radial movement of the outer fly weight to control the maximum engine speed.

3. A speed regulator as defined in claim 2 having additional spring means operative only on said outer fly weight to yieldingly resist its said independent outward radial movement beyond the limit of the radial movement of the two fly weights together as a coherent mass.

4. A speed regulator for high speed internal combustion engines adapted to work under conditions of variable load and speed, comprising a rotating member, a divided centrifugal mass comprising a heavy body forming one part and a light body forming another part of said centrifugal mass, means supporting said centrifugal mass on said rotating member in a manner causing said member to revolve said mass while permitting radial movement of said mass outwardly of said member, resilient means resisting the radial travel of said centrifugal mass, a stop limiting the radial travel of said heavy body but permitting continued radial movement of said light body and means responsive to the radial movement of said centrifugal mass as a whole and to the independent movement of said light body to influence the speed of the engine.

5. A speed regulator for high speed internal combustion engines adapted to work under conditions of variable load and speed, comprising a rotating member, a divided centrifugal mass comprising a heavy body having a recess therein and a light body accommodated in the recess in said heavy body, means supporting said centrifugal mass on said rotating member in a manner causing said member to revolve said mass while permitting radial movement of said mass outwardly of said member, resilient means resisting the radial travel of said centrifugal mass, a stop limiting the radial travel of said heavy body but permitting continued radial movement of said light body, and means responsive to the radial movement of said centrifugal mass as a whole and to the independent movement of said light body to influence the speed of the engine.

6. A speed regulator for high speed internal combustion engines adapted to work under conditions of variable load and speed, comprising a rotating member, a divided centrifugal mass comprising a heavy body forming one part of said centrifugal mass and a light body forming the other part of the centrifugal mass, means supporting said centrifugal mass on said rotating member in a manner causing said member to revolve said means while permitting movement of said mass radially of said member, resilient means resisting the radial travel of said centrifugal mass, means to positively guide said centrifugal mass in a rectilinear radial path, a stop limiting the radial movement of said heavy body but permitting continued radial movement of said light body, and means responsive to the radial movement of said centrifugal mass as a whole and to the independent movement of said light body to influence the speed of the engine.

7. A speed regulator for high speed internal combustion engines adapted to work under conditions of variable load and speed, comprising a rotating member, a divided centrifugal mass comprising a heavy body forming one part of

said centrifugal mass having a guiding recess therein, a light body forming the other part of the centrifugal mass, means supporting said centrifugal mass on said rotating member in a manner causing said member to revolve said mass while permitting movement of said mass radially of said member, a guide rib on said rotating member engaging the recess in said heavy body to maintain said centrifugal mass in a rectilinear path, resilient means resisting the radial travel of said centrifugal mass, a stop limiting the radial outward movement of said heavy body but permitting continued radial movement of said light body, and means responsive to the radial movement of said centrifugal mass as a whole and to the independent movement of said light body to influence the speed of the engine.

8. A speed regulator for high speed internal combustion engines adapted to work under conditions of variable load and speed, comprising a rotating member secured to the shaft of the fuel spraying pump of the engine, a centrifugal mass comprising a heavy body forming one part of said centrifugal mass and a light body forming the other part of the centrifugal mass, means supporting said centrifugal mass on said rotating member in a manner causing said member to revolve said mass while permitting movement of said mass radially of said member, resilient means resisting the radial travel of said centrifugal mass, a stop limiting the radial outward movement of said heavy body but permitting continued radial movement of said light body, and means responsive to the radial movement of said centrifugal mass as a whole and to the independent movement of said light body to influence the speed of the engine.

9. A speed regulator for high speed heavy oil engines adapted to operate under conditions of variable load and speed comprising a base member secured to the shaft of the fuel spraying pump of the engine, a divided centrifugal mass comprising a heavy body forming one part of said centrifugal mass and a light body forming the other part of said centrifugal mass, means supporting said mass from said base member in a manner causing said shaft to revolve said mass while permitting movement of said mass radially of said base member, a spring acting on both said bodies to resist their outward radial movement and another spring acting in like manner on said light body independently of said heavy body, a stop to limit travel of said heavy body but permitting continued radial movement of said light body, and means responsive to the radial movement of said centrifugal mass as a whole and to the independent movement of said light body to influence the speed of the engine.

10. A speed regulator for high speed heavy oil engines adapted to operate under conditions of variable load and speed comprising a base member secured to the shaft of the fuel spraying pump of the engine, a divided centrifugal mass comprising a heavy body forming one part of said centrifugal mass, and a light body forming the other part of said centrifugal mass, means supporting said mass on said base member in a manner causing said shaft to revolve said mass while permitting movement of said mass radially of said base member, a spring acting on both said bodies to resist their outward radial movement, and another spring arranged concentrically with said first-mentioned spring acting in like manner on said light body independently of said heavy body, a stop to limit the radial travel of said heavy body but permitting continued radial movement of said light body, and means responsive to the radial movement of said centrifugal mass as a whole and to the independent movement of said light body to influence the speed of the engine.

11. A speed regulator for high speed heavy oil engines adapted to operate under conditions of variable load and speed comprising a base member secured to the shaft of the fuel spraying pump of the engine, a divided centrifugal mass comprising a heavy body forming one part of said centrifugal mass and a light body forming the other part of said centrifugal mass, means supporting said mass on said base member in a manner causing said shaft to revolve said mass while permitting movement of said mass radially of said base member, said supporting means comprising a bolt secured to said base member and passing through said centrifugal mass, a spring arranged about said bolt and acting on both said bodies to yieldingly resist their outward radial movement, a stop on said bolt to limit the outward radial movement of said heavy body but permitting continued radial movement of said light body, a spring arranged concentrically within said first-mentioned spring bearing upon said light body independently of said heavy body and means responsive to the radial movement of said centrifugal mass as a whole and to the independent movement of said light body to influence the speed of the engine.

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