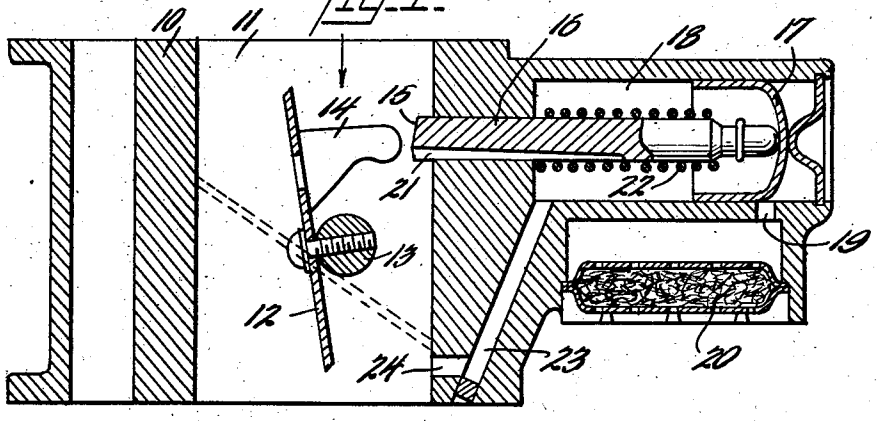
Sept. 24, 1946. R. C. DARNELL 2,408,161

SPEED GOVERNOR

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FIG. 1.



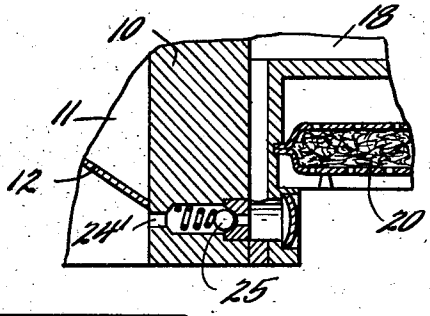


FIG. 2.

FIG. 3.

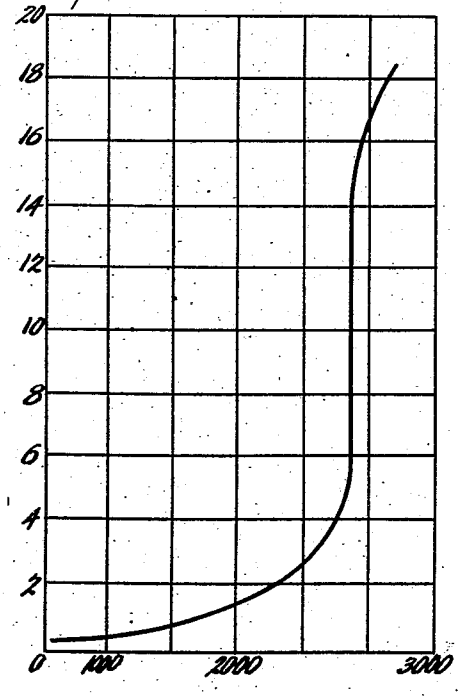
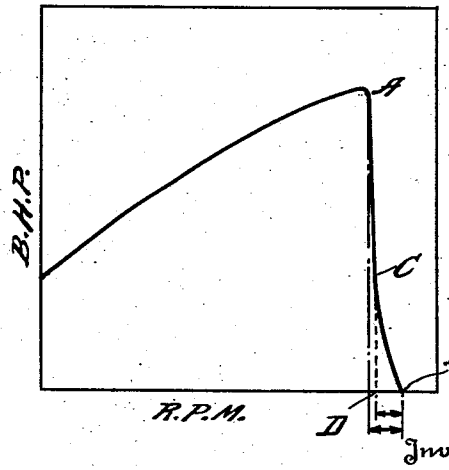


FIG. 4.



Inventor

Roy C. Darnell

By Watson, Cole, Grindle & Watson

Attorney

Sept. 24, 1946. R. C. DARNELL 2,408,161

SPEED GOVERNOR

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FIG. 5.

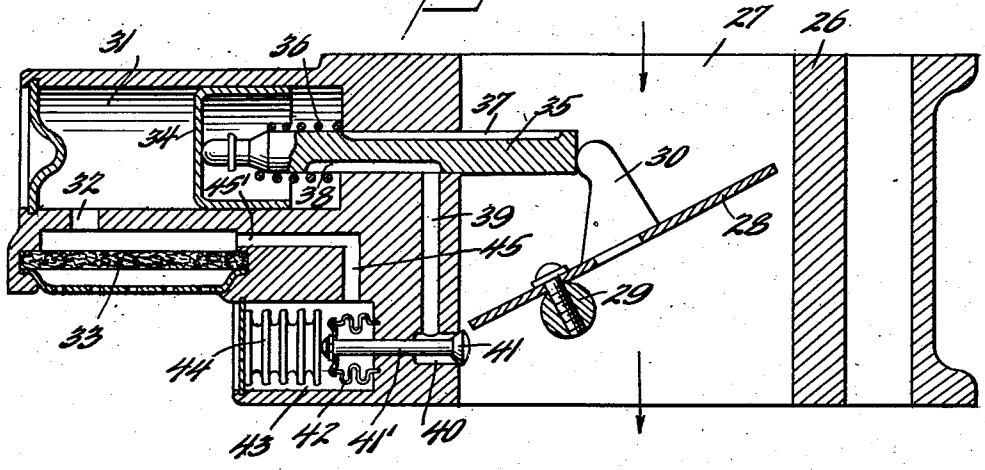


FIG. 6.

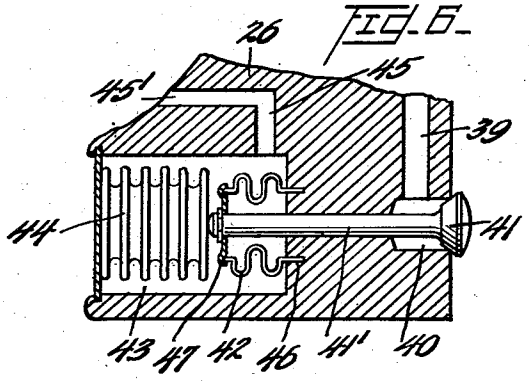


FIG. 7.

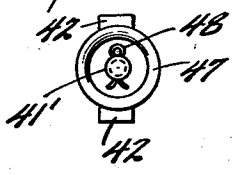
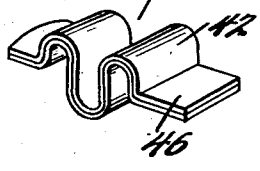


FIG. 8.



Inventor

Rex C. Darnell

By Watson, Cole, Grindle & Watson

Attorney

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UNITED STATES PATENT OFFICE

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SPEED GOVERNOR

Rex C. Darnell, Ann Arbor, Mich., assignor to King-Seeley Corporation, Ann Arbor, Mich., a corporation of Michigan

Application June 9, 1944, Serial No. 539,493

16 Claims. (Cl. 137—153)

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This invention relates to speed governors for internal combustion engines, and more particularly to governors of the "velocity" or "mixture-flow" type. Such governors consist essentially of a valve or throttle plate mounted on a rotatable shaft extending transversely of the intake manifold of the engine to be governed, said shaft being off the center line of the manifold passage, whereby the forces exerted on the throttle plate by the passage of fuel mixture through the manifold tend to move the plate from open towards closed position, said forces having varying values as the plate changes position. A reactance device in the form of a spring or combination of springs, connected to the throttle plate spindle or shaft through a suitable linkage, is employed to produce a balanced condition of the plate, in all positions, at governed speed, the positions of the throttle plate, and hence the amount of fuel mixture passing to the engine, being dependent upon the load imposed upon the engine.

In all velocity type governors, there is a certain variation between full load speed and no load speed, which variation must be permitted in order to secure proper functioning of the governor, as is well understood in the art. This increase in no load speed as compared with full load speed is preferably less than 10% of the governed speed, and is known as "the regulation" of the governor. Theoretically, the rate of increase in governed speed between full load and no load conditions is uniform, and if plotted in terms of R. P. M. versus brake-horsepower, would give a straight line "loading curve" or "load-speed curve." However, in practice, this desirable result has been achieved only in part.

In a velocity type governor, the forces acting upon the throttle plate, due to the passage of fuel mixture through the intake conduit have been considered as two-fold, namely, impingement of the fuel mixture upon the differential exposed areas of the throttle plate, and the difference in fluid pressure upstream and downstream of the throttle plate. As is well known, the pressure upstream of the throttle plate is substantially atmospheric when the carburetor throttle valve is in open position, as is the case when the engine is being operated under control of the governor. The pressure below or downstream of the governor valve, at governed speed, changes with the load, varying from a value in the neighborhood of 2" of Hg at full load to perhaps 20" of Hg at no load. In the higher vacuum ranges, say above 17" of Hg, the forces acting upon the governor valve to move it towards closed position change but very little with an increase in speed, and for this reason the loading curve or loading characteristic of such governors has, in the past, departed considerably from the desired straight line curve under conditions of light load or no load, resulting in a considerable increase of speed under such light load or no load conditions. This undesirable increase in speed has, heretofore, been tolerated as essential to produce the necessary force to close the valve.

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The general object of the present invention is the provision of an improved speed governor of the velocity or mixture flow type, in which the force necessary for proper governor valve closure under no load conditions is produced without resorting to engine speed increase, whereby a better loading characteristic or load-speed curve is obtained.

A further object is the provision of a governor of the type described in which, when the governor valve approaches closed position due to reduction in load, a force in addition to those normally acting upon the governor valve is employed for urging the latter toward closed position.

Another object is the provision of a governor of the type described in which special means, subject to the engine vacuum below the governor valve are employed to move the valve toward closed position.

Another object is the provision of an improved governor according to the last stated object, in which the special valve closing means are actuated only when the engine vacuum exceeds a predetermined value.

A further object is the provision of a governor of the type described in which the anti-steal piston usually associated with such governors is caused to be actuated as the governor valve approaches closed position, to urge the valve in a closing direction.

Another object is the provision of a modified form of the invention in which means operable upon a predetermined decrease in external atmospheric pressure are employed for urging the governor valve toward closed position, such modification being especially adapted for use at high altitudes, as in the case of aircraft.

A further object is the provision of a governor such as described in the last stated object, in which the conventional anti-steal piston is actuated at no load and upon a predetermined decrease in atmospheric pressure, to urge the governor valve in a closing direction.

A further object is the provision, in a governor according to the last stated object, in which means

are provided for compensating said valve closing means for changes in temperature.

Other and further objects, features, and advantages will be noted from the description which follows, taken in connection with the accompanying drawings in which

Figure 1 is a sectional view of a governor constructed in accordance with the present invention, on a plane including the axis of the fuel mixture passage and normal to the throttle valve shaft;

Figure 2 is a fragmentary sectional view, similar to Figure 1, illustrating a modification of the device of Figure 1;

Figure 3 is a curve illustrating the change in engine vacuum (below the governor valve) with wide open carburetor throttle valve, plotted against engine speed;

Figure 4 is a curve showing engine speed, in R. P. M., plotted against load in brake-horsepower, the substantially vertical portion of the curve being hereinafter referred to as the loading curve, and showing speed variation between full load and no load conditions;

Figure 5 is a sectional view, similar to Figure 1, illustrating a modification of the present invention especially adapted for high altitude operation;

Figure 6 is a fragmentary sectional view showing a portion of Figure 5 on an enlarged scale;

Figure 7 is a detailed view showing the bi-metallic temperature compensating device of Figure 6 in end elevation; and

Figure 8 is a detail view, in perspective, of one of the bi-metallic springs of the temperature compensating device of Figure 6.

In order to facilitate an understanding of the invention, reference is made to the embodiments thereof shown in the accompanying drawings, and detailed descriptive language is employed. It will nevertheless be understood that no limitation of the invention is thereby intended and that various changes and alterations are contemplated such as would ordinarily occur to one skilled in the art to which the invention relates.

Referring now to Figure 4, the straight line ACD denotes a theoretically correct loading curve in which there is a slight, constant increase of speed with reduction in load. In practice, the actual loading curve ACB follows the line ACD as far as the point C, which corresponds roughly to an engine vacuum, below the governor valve, of 17" of Hg. From this point onward, as the load is reduced, and due to the previously mentioned fact that the forces exerted upon the unbalanced governor valve by the mixture flow change but little with increasing speed in the higher vacuum ranges, the loading curve ACB departs at an increasing rate from the line ACD, the actual departure at no load varying from 200 R. P. M., in the case of well designed governors, to very much larger values in less carefully designed governors. The reason for this departure may be more readily appreciated by consideration of Figure 3 which illustrates the values of engine vacuum below the governor valve, plotted against R. P. M. It will be seen that when the governor valve is wide open (i. e., the engine is running at below governed speed), the engine vacuum increases very slowly with increase in engine speed. As the engine approaches governed speed and the governor valve begins to close, the increase in vacuum with increase in R. P. M. occurs at a much higher rate, the curve becoming nearly vertical. Thus, for a relatively slight increase in speed, at engine vacuums representing substantial loads on the engine, the forces acting on the throttle valve increase at a relatively high rate, thus increasing the forces acting on the governor valve accordingly and effecting proper governing action. On the contrary, as the governor valve approaches closed position and the engine vacuum increases further, the curve swings away from the vertical, indicating that such further increase in vacuum is achieved only through an undesirable increase in engine speed.

In order to overcome the described deficiencies in the velocity type governors heretofore used, the present invention employs an additive force, derived from the engine vacuum below the governor valve, which force comes into play as the governor valve approaches closed position (i. e. in the higher vacuum range) which force, when added to those caused by mixture flow past the governor valve, serves to move the latter to closed position, thus eliminating the undesirable speed increase above noted.

Referring now to Figure 1, the embodiment there illustrated comprises a governor body **10** enclosing a fuel mixture conduit **11**. The governor body is intended to be inserted in the intake manifold between the carburetor and the engine, and with the conduit **11** aligned with said manifold passage, the direction of flow of fuel mixture being indicated by the arrows in Figure 1. The governor valve consists of a throttle plate **12** secured upon a shaft **13** extending transversely through the fuel conduit. It will be noted that the shaft **13** is mounted eccentrically with respect to the fuel conduit, and the throttle plate **12** is mounted eccentrically with respect to the shaft **13**, whereby the upstream portion of the throttle plate is considerably larger in area than the downstream portion. The shaft **13** is connected through suitable linkage to a spring balancing mechanism, which linkage and spring balancing mechanism are not shown for the reason that they are conventional and well understood in the art.

The throttle plate **12** is provided with a projecting arm **14**, for cooperation with the end **15** of the piston rod **16** of the conventional anti-steal piston **17** mounted in the cylinder **18** formed in the governor body. The piston **17** is subjected on its outer face to atmospheric pressure through the vent **19** and filter **20**, and on its inner face to the manifold vacuum above the governor valve through the groove **21** formed in the piston rod **16**. The piston is normally maintained in its outward position by a light spring **22**. The groove **21** may be suitably contoured both transversely and longitudinally, to produce a variable controlled air bleed depending upon the position of rod **16**.

The conventional functioning of the anti-steal piston is well understood in the art and will not be described, except to point out that, ordinarily, the piston rod **16** is in physical engagement with the projecting arm **14** of the throttle plate **12** only when the latter is at or near full open position and the carburetor throttle is partly closed, thus introducing the engine vacuum to the space between the two throttle-plates. During the intermediate portion of the travel of the throttle plate **12**, the piston rod **16** is normally retracted as shown in Figure 1 and, except for the present invention, the same would be true as the throttle plate approached closed position. However, in accordance with the present invention, the anti-steal piston is made use of during the latter por-

tion of the throttle plate travel toward closed position, for exerting the additive force heretofore mentioned.

To effect the above stated purpose, the inner end of the cylinder 18 is connected with the fuel mixture conduit 11 through passages 23 and 24, the latter opening into the conduit 11 at a point below the valve shaft 13 and so disposed as to lie below the downstream edge of the throttle plate 12 when the latter is at or near closed position. Thus, when the engine is under load and the throttle plate 12 is substantially open, the vacuum below the plate is substantially equal to that above the plate, and the vacuum communicated to the cylinder 18 through the passages 24 and 23 is so largely reduced by air entering through the groove 21 as to be insufficient to overcome the force of spring 22. Accordingly, the governor operates in a normal manner, without hindrance from the piston rod 16.

However, as the load decreases and the throttle plate 12 aproaches closed position the vacuum below the plate increases and, at the same time, the passage 24 is, in effect, transferred from the upstream to the downstream side of the throttle plate and is subjected to the relatively high vacuum existing below the latter under such conditions. The vacuum thus communicated to the cylinder 18 is only partially reduced by the air entering through groove 21, and is sufficient to overcome the force of the spring 22 and to cause the piston 17 and the piston rod 16 to move inwardly (to the left in Figure 1), thus causing the end 15 of the piston rod to impinge upon the arm 14 of the throttle plate with a force urging the latter in the closing direction. In this way, the forces normally acting upon the throttle plate to close it are augmented sufficiently so that the undesirable speed increase represented by the lower portion of the curve ACB of Figure 4 is avoided.

Figure 2 illustrates a modification in which valving means are provided in order that the cylinder 18 shall not be subjected to the engine vacuum until the latter exceeds a predetermined value. In this way, the piston rod 16 is prevented from coming into contact with the throttle plate arm 14 during the intermediate portion of the throttle plate travel, i. e., under normal load conditions. In order to effect this purpose, the passage 24', which otherwise corresponds to the passage 24 of Figure 1, is provided with a spring pressed ball check valve 25, which is adapted to open only when the vacuum below the throttle plate exceeds a predetermined value, say 17" of Hg. The arrangements of both Figure 1 and Figure 2 will serve functionally to meet the requirements as set forth above. However, it is believed that the arrangement of Figure 1, under certain operating conditions, might be more difficult to calibrate than that of Figure 2, which latter may therefore possess advantages in certain circumstances.

Referring now to Figures 5 to 8 inclusive, there is illustrated a modification of the invention which is especially adapted for use with engines operating at high altitudes. It has been recognized that the speed of an engine controlled by a velocity governor changes as the engine operates in different altitudes. Thus, both the full load and no load speeds of an engine so governed increase with altitude. In the past, no particular importance has been attached to this phenomenon, it being considered, particularly insofar as full load speed is concerned, actually to be an advantage since such increase in speed automatically compensated, to a degree, the loss of engine power incident to the reduction in air density and atmospheric pressure.

Under present day conditions, however, in which the engine speeds have become higher and the manifold pressures and resultant fuel velocities change but slightly with speed, the reduction in atmospheric pressure and density with altitude reduces the forces acting on the governor valve to such an extent as to materially reduce the closing effort on the valve, and thus increases the no load speed to a harmful extent. For example, it is known that an engine equipped with a velocity type governor set for a no load speed at sea level of 3000 R. P. M. to 3200 R. P. M. will, at high altitudes, reach a no load speed as high as 4000 to 4500 R. P. M., a speed in the order of 30% higher than that at which the manufacturer intended the engine to operate. By means of the present invention, in the form now to be described, this tendency is overcome so that the no load speed of an engine remains substantially constant regardless of the altitude at which it is operating. At the same time, since an increase in full load speed at high altitudes has some advantages, it is desirable that the correction shall be confined to the no load end of the curve.

Referring now to Figure 5, the governor body 26, fuel conduit 27, throttle plate 28, shaft 29, and throttle plate arm 30 correspond exactly to those illustrated in Figure 1 and described in connection therewith. The body 26 is likewise provided with a cylinder 31 corresponding to cylinder 18 of Figure 1, which cylinder communicates at its outer end with the external atmosphere through vent 32 and filter 33. A piston 34 is slidably mounted within the cylinder 31 and is provided with a piston rod 35 adapted to make contact under certain conditions with the throttle plate arm 30. The piston 34 is normally maintained in its outer position by a spring 36.

The piston rod 35 is formed with a groove 37 providing communication between the inner end of the cylinder 30 and the fuel conduit upstream of the governor valve. The piston rod is also formed with a second groove 38, which, when the piston is in its inward position, as illustrated in Figure 5, provides communication between the cylinder 31 and the passage 39 formed in the governor body. The passage 39 communicates at its lower end with a passage 40 opening into the fuel conduit 27 at a point downstream of the valve shaft 29 and so disposed as to be downstream of the lower edge of the governor valve plate 28 when the latter is at or near closed position.

The open end of the passage 40 is maintained normally closed by means of a valve 41 having a stem 41', which valve is normally held in closed position by a resilient device 42, the latter being housed in a recess 43 formed in the governor body. A sealed, gas-filled, expansible cartridge 44 is likewise housed within the recess 43, one end of said cartridge being in engagement with the outer end of stem 41' of the valve 41. It is intended that the cartridge 44 be filled, in unstressed condition, with a gas such as air, at normal sea level atmospheric pressure. The recess 43 is open to the atmosphere by means of passages 45, 45'.

As previously explained, the vacuum existing between the engine and the governor valve is of a rather high order, extending up to as high as 18 to 20" of Hg. at high speeds under no load. It is proposed to employ this force to create an addi-

tive closing effort on the throttle valve under no load conditions when operating at high altitudes, which efforts, however, shall be removed at normal levels. Thus, when operating at normal levels under a no load condition when the engine vacuum will be of the order of 20'' of Hg, the tendency of the valve 41 to open in response to such engine vacuum will be resisted by the spring 42, and the engine vacuum is thus prevented from being communicated to the cylinder 31. However, at relatively high altitudes, the entrapped air in the cartridge 44, being at a pressure higher than that existing in recess 43, will tend in conjunction with the high vacuum on the head of valve 41 to expand the cartridge 44, overcoming the force of the spring 42 and opening the valve 41. The engine vacuum is thus communicated to the passage 39, groove 38, and cylinder 31. The force thus exerted upon the piston 34 is communicated through the piston rod 35 to the throttle plate 30 and becomes the above mentioned additive force for urging the throttle plate 28 to closed position.

If, however, while operating under the above described conditions, an additional load is thrown on the engine, the engine speed will decrease somewhat, reducing the forces normally acting on the throttle valve, and the spring reactance will partially open the latter, forcing the piston rod 35 outwardly and interrupting communication between the groove 38 and passage 39. The cylinder 31 is thus cut off from the engine vacuum below the governor valve, and the additive closing force thus removed from the latter, thus permitting the engine to run in a normal manner, even though the lower edge of the throttle plate is still above the valve 41. As greater load is imposed on the engine, and the governor valve opens wider, the lower edge of the throttle plate 28 gradually passes below the valve 41, transferring the latter to the upstream side of the throttle valve and enabling the spring 42 to retract the valve 41 on to its seat. The combination of the interruption of communication between groove 38 and passage 39, and the transfer of the valve 41 from the downstream to the upstream side of the throttle plate, enables the governor to operate at high altitudes, in the heavier load positions of the throttle plate in the same manner as at low altitudes.

It will, of course, be appreciated that in order to obtain a gradual transfer of forces it may be necessary to provide progressive areas of registration between the groove 38 and the passage 39 and also progressive areas of communication between the fuel conduit 27 and the groove 37 so as to eliminate sudden changes of force and produce, instead, a gradual transfer at such a rate as will bring about a proper functioning of the device as a whole. This may be accomplished by suitably contouring the grooves 37 and 38 by empirical methods.

The foregoing description has not taken into account the effect of the variation in temperature upon the cartridge 44. It will be appreciated that if the cartridge is sealed at a normal outdoor temperature of say 70° F., as its temperature rises due to engine heat, the enclosed entrapped air will rise in pressure and the force acting to open the valve 41 will be thus increased. In order to offset this factor, the springs 42 are formed of bi-metallic strips of serpentine configuration, although other bimetal arrangements would be familiar to those schooled in the art, secured in the governor body at their inner ends (46, Figure 6) and connected at their outer ends by a grooved washer 47 which also serves to connect them to the valve stem 45, the washer 47 being retained on the valve stem 41' by means of a clip 48. The springs 42 are so constructed that they tend to expand upon an increase in temperature, and are so calibrated as to exactly offsets the tendency of the cartridge 44 to expand upon a like increase in temperature.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. In a speed governor for internal combustion engines, a governor body enclosing a fuel mixture conduit, an unbalanced throttle plate pivoted in said conduit and having the larger of its unbalanced areas disposed upstream of its pivot axis, means including a pressure responsive element for urging said throttle plate toward closed position, and means for subjecting said element to the engine vacuum when said throttle plate is near its closed position.

2. In a speed governor for internal combustion engines, a governor body enclosing a fuel mixture conduit, an unbalanced throttle plate pivoted in said conduit and having the larger of its unbalanced areas disposed upstream of its pivot axis, means including a pressure responsive element for urging said throttle plate toward closed position, and means for subjecting said element to the engine vacuum when said throttle plate is near its closed position, said last means comprising a passage extending from said element to a point in said fuel mixture conduit downstream from said throttle plate.

3. In a speed governor for internal combustion engines, a governor body enclosing a fuel mixture conduit, an unbalanced throttle plate pivoted in said conduit and having the larger of its unbalanced areas disposed upstream of its pivot axis, means including a pressure responsive element for urging said throttle plate toward closed position, and means for subjecting said element to the engine vacuum when said throttle plate is near its closed position, said last means comprising a passage extending from said element to a point in said fuel mixture conduit, said last point being located below the downstream edge of said throttle plate when the latter is near its closed position.

4. In a speed governor for internal combustion engines, a governor body enclosing a fuel mixture conduit, an unbalanced throttle plate pivoted in said conduit and having the larger of its unbalanced areas disposed upstream of its pivot axis, means including a pressure responsive element for urging said throttle plate toward closed position, and means for subjecting said element to the engine vacuum when said throttle plate is near its closed position, said last means comprising a passage extending from said element to a point in said fuel mixture conduit downstream from said throttle plate, and valve means in said passage adapted to open when the engine vacuum exceeds a predetermined value.

5. In a speed governor for internal combustion engines, a governor body enclosing a fuel mixture conduit, an unbalanced throttle plate pivoted in said conduit and having the larger of its unbalanced areas disposed upstream of its pivot axis, means including a pressure responsive element for urging said throttle plate toward closed position, and means for subjecting said element to the engine vacuum when said throttle plate is near its closed position, said last means com-

prising a passage extending from said element to a point in said fuel mixture conduit downstream from said throttle plate, valve means in said passage, and spring means for maintaining said valve in closed position during normal operation under load.

6. In a speed governor for internal combustion engines, a governor body enclosing a fuel mixture conduit, an unbalanced throttle plate pivoted in said conduit and having the larger of its unbalanced areas disposed upstream of its pivot axis, means including a pressure responsive element for urging said throttle plate toward closed position, and means for subjecting said element to the engine vacuum when said throttle plate is near its closed position, said last means comprising a passage extending from said element to a point in said fuel mixture conduit downstream from said throttle plate, valve means in said passage, spring means for maintaining said valve in closed position during normal operation under load, and means for opening said valve against the pressure of said spring when the barometric pressure of the surrounding atmosphere becomes substantially less than normal sea-level barometric pressure.

7. The combination defined in claim 6, said valve opening means comprising a sealed, gas-filled expansible cartridge, one wall of said cartridge operatively engaging said valve.

8. The combination defined in claim 6, said valve opening means comprising a sealed, gas-filled expansible cartridge, one wall of said cartridge operatively engaging said valve, and said spring being of temperature-compensating construction to counterbalance the effect of a temperature increase on said cartridge.

9. The combination defined in claim 6, said valve opening means comprising a sealed, gas-filled expansible cartridge, one wall of said cartridge operatively engaging said valve, and said spring being of serpentine, bimetallic construction to counterbalance the effect of a temperature increase on said cartridge.

10. In a speed governor for internal combustion engines, a governor body enclosing a fuel mixture conduit, an unbalanced throttle plate pivoted in said conduit and having the larger of its unbalanced areas disposed upstream of its pivot axis, means including a pressure responsive element for urging said throttle plate toward closed position, and means for subjecting said element to the engine vacuum when said throttle plate is near its closed position, said throttle plate having a projecting arm, and said pressure responsive element comprising a cylinder associated with said governor body, a piston in said cylinder and subjected to atmospheric pressure on its outer end, and spring means for urging said piston toward its outward position, said piston having a rod extending through and closely fitting a bore in said governor body and

projecting into said conduit and adapted to engage said throttle plate arm.

11. The combination defined in claim 10, said piston rod being formed to provide a communicating passage between said cylinder and said conduit.

12. The combination defined in claim 10, said piston rod being formed to provide a communicating passage between said cylinder and said conduit, the cross-sectional area of said passage varying along its length, whereby the area of the opening between said rod and said body varies with movements of said piston.

13. In a speed governor for internal combustion engines, a governor body enclosing a fuel mixture conduit, an unbalanced throttle plate pivoted in said conduit and having the larger of its unbalanced areas disposed upstream of its pivot axis, said throttle plate having a projecting arm, a cylinder associated with said governor body, a piston in said cylinder subjected to atmospheric pressure on its outer end, said piston having an extension projecting into said conduit and adapted to engage said throttle plate arm, said extension being formed to provide a communicating passage between said cylinder and said conduit and a second passage extending from said cylinder into said governor body, spring means for urging said piston toward its outward position, a passage opening into said conduit at a point downstream from said throttle plate and extending in said valve body to a point adjacent said piston extension, whereby said last passage and said second passage intercommunicate when said piston is in an inward position, a valve in said last mentioned passage, spring means for maintaining said valve normally closed, and means for opening said valve against the pressure of said spring when the barometric pressure of the surrounding atmosphere becomes substantially less than normal sea-level barometric pressure.

14. The combination defined in claim 13, said valve opening means comprising a sealed, gas-filled expansible cartridge, one wall of said cartridge operatively engaging said valve.

15. The combination defined in claim 13, said valve opening means comprising a sealed, gas-filled expansible cartridge, one wall of said cartridge operatively engaging said valve, and said spring being of temperature-compensating construction to counterbalance the effect of a temperature increase on said cartridge.

16. The combination defined in claim 13, said valve opening means comprising a sealed, gas-filled expansible cartridge, one wall of said cartridge operatively engaging said valve, and said spring being of serpentine, bimetallic construction to counterbalance the effect of a temperature increase on said cartridge.

REX C. DARNELL.