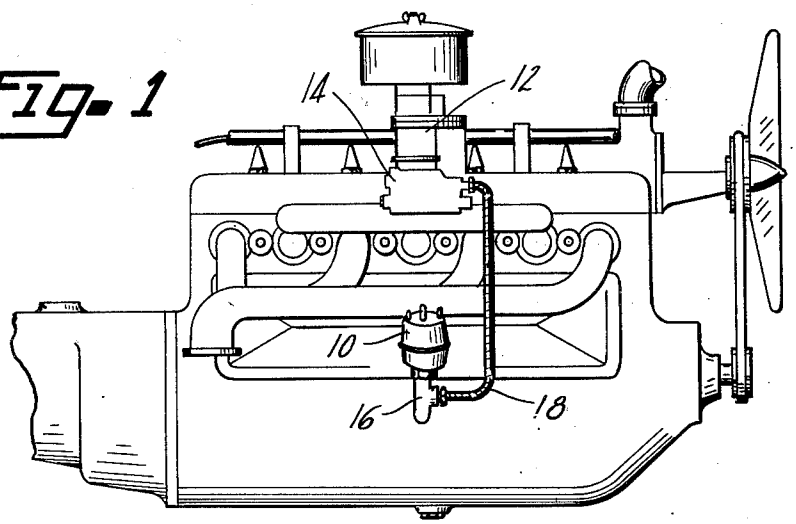
Oct. 14, 1952 R. W. SLOANE ET AL 2,613,657

GOVERNOR

Filed March 25, 1947 2 SHEETS--SHEET 1

Fig. 1



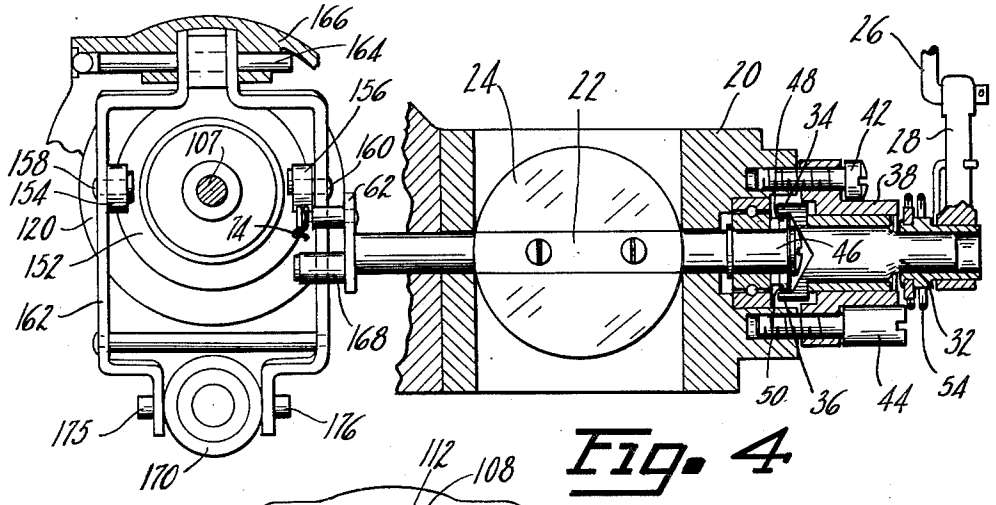


Fig. 4

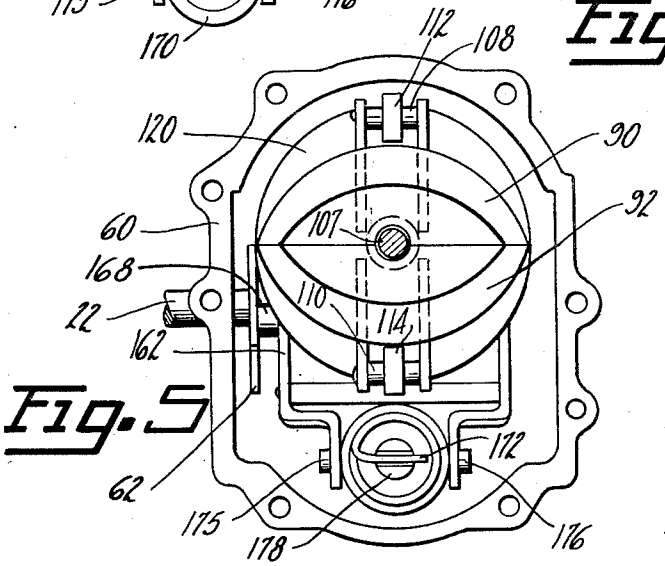


Fig. 5

INVENTORS
G. C. FRICKE
M. J. THOMAS
R. W. SLOANE
BY- M. A. Hobbs
ATTORNEY

Oct. 14, 1952 R. W. SLOANE ET AL 2,613,657

GOVERNOR

Filed March 25, 1947 2 SHEETS—SHEET 2

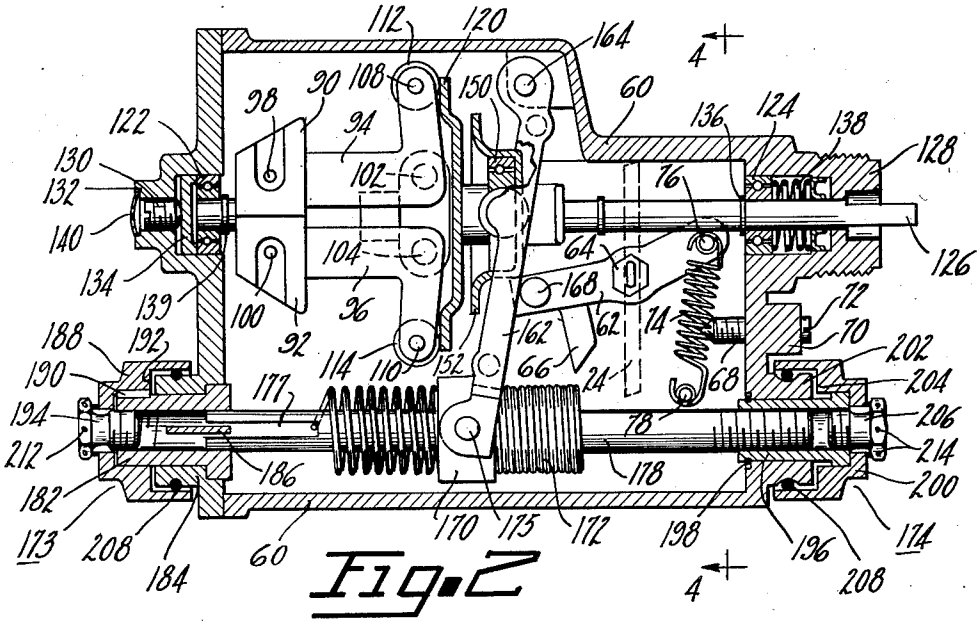


Fig. 2

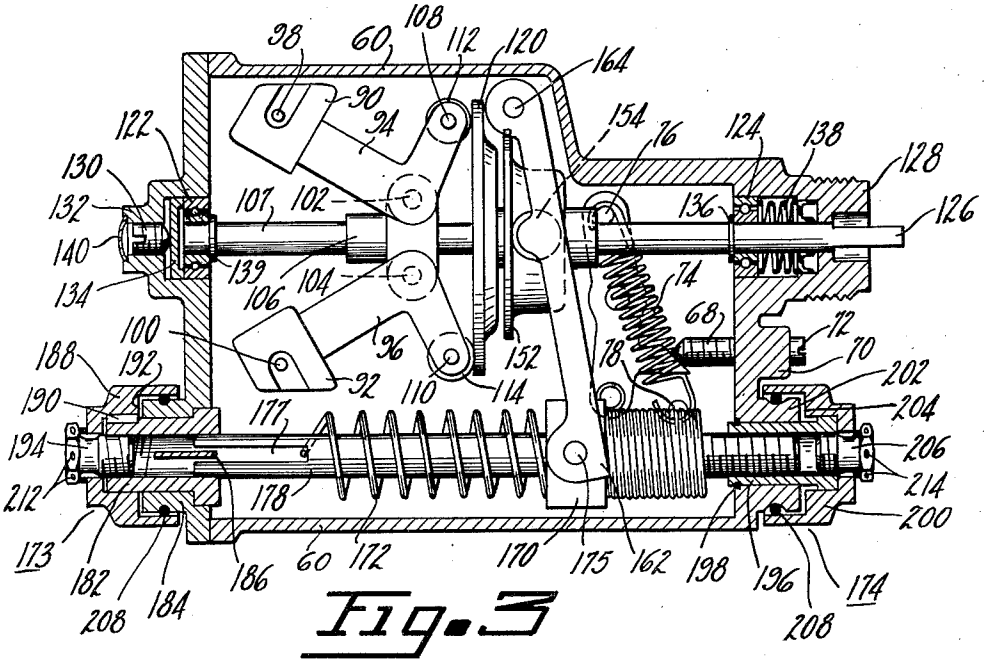


Fig. 3

INVENTORS
G. C. FRICKE
M. J. THOMAS
R. W. SLOANE
BY- M. A. Hobbs
ATTORNEY

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GOVERNOR

Robert W. Sloane, Detroit, Michael J. Thomas, Birmingham, and Guy C. Fricke, Pleasantridge, Mich., assignors to Bendix Aviation Corporation, South Bend, Ind., a corporation of Delaware

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28 Claims. (Cl. 123—108)

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The present invention relates to governors for internal combustion engines, especially for automotive vehicles and the like and more particularly to governors of the centrifugal type for regulating the speed of said engines by controlling the air flow in the induction passage.

One of the principal objects of the present invention is to provide a relatively simple, long wearing mechanical governor of high sensitivity for internal combustion engines, which can be easily mounted or installed on the engine and thereafter readily serviced as a unit.

Another object of the present invention is to provide a governor for regulating the speed of an internal combustion engine wherein all forces involved in the operation of the governor are applied on the center line of the rotating and moving parts when the engine is being operated below the governed speed.

Another object of the invention is to provide an internal combustion engine governor of the mechanical type wherein the governor mechanism remains essentially standard irrespective of engine or carburetor size.

A further object is to provide a centrifugal governor for an internal combustion engine which operates at a speed substantially less than that of the engine so that excessive stresses upon the governor elements and connections therefor may be avoided.

Another object of the invention is to provide a governor for the aforementioned engines which can be readily and accurately adjusted over a wide range to any desired maximum speed while the engine is running, without removing a single part from the governor or engine during the adjustment.

Still another object is to provide a compact, tamper-proof governor for an internal combustion engine in which all the mechanically operable elements are fully sealed against dirt, water or other foreign materials which would interfere with the operation thereof.

In order to obtain the foregoing objects and other objects which will be apparent from the following description, the present invention includes generally a yieldable means adapted to apply a variable torque to the throttle shaft for overbalancing the effect of air flow tending to close the throttle valve, centrifugal weights adapted to rotate about a shaft at a velocity proportional to engine speed for urging the throttle valve toward the closed position when a predetermined engine speed has been reached, a yieldable means for adjusting the speed at which the

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centrifugal weights become effective to urge the throttle valve toward the closed position, and a pivotal arm between said centrifugal weights and said yieldable means for increasing the force exerted by said yieldable means in opposition to the force of the centrifugal weights tending to close said throttle valve.

From the detailed description which follows, modifications and additions to the present invention will be apparent to those skilled in the art. It is to be understood that although only the preferred embodiment of the invention is disclosed in detail, many variations employing the combination of elements forming the present governor are possible, and we contemplate the use of any such variations in structure, arrangement and mode of operation that properly fall within the scope of the appended claims.

In the drawings:

Figure 1 is a side elevation of an internal combustion engine on which the present governor is mounted;

Figure 2 is a cross section taken through the housing of the governor showing the several elements comprising the governor in elevation in the relative positions they occupy when the engine is inoperative and the throttle valve is in the wide open position;

Figure 3 is a view of a governor similar to that shown in Figure 2 wherein the elements are shown in the position they occupy when the engine is being throttled to prevent further increases in speed;

Figure 4 is a section taken through a carburetor throttle body and through the governor on the line 4—4 of Figure 2; and

Figure 5 is an end view of the governor after the cover at the end of the housing thereof has been removed, showing the elements in non-operative position.

Referring to Figure 1 of the drawings in which a side elevation of a conventional internal combustion engine is shown, numeral 10 designates a spark distributor, 12 a conventional carburetor and 14 the present governor mounted on the side of carburetor 12 adjacent the throttle valve and connected to the drive 16 of the distributor 10 by a flexible cable 18. Although in this embodiment of the invention, the governor is shown driven by the engine through the distributor, it may be driven from some other power take-off and through any other suitable power transmission means.

The carburetor 12 on which the present governor is mounted is of the single barrel downdraft

type and is provided with a throttle body 20 in which the throttle shaft 22 of throttle valve 24 is centrally located in respect to the induction passage therethrough. The throttle mechanism, which is clearly shown in Figure 4, is actuated manually by an accelerating pedal or the like (not shown) through a rod 26, a lever 28 and a one-way connection including a partly hollow shaft 32 on which throttle lever 28 is rigidly mounted, a pair of oppositely disposed lugs 34 and 36 mounted on the inner end of said shaft and a housing 38 therefor secured to the throttle body 20 by screws 42 and 44. A sleeve 46 is rigidly secured to the end of throttle shaft 22 and is provided with a pair of oppositely disposed lugs 48 and 50 which cooperate with lugs 34 and 36 of shaft 32 to form the one-way connection between the throttle valve 24 and the throttle control mechanism. A torsion spring 54 mounted on shaft 32 and anchored at one end to housing 38 and secured at the other end to throttle lever 28 urges the throttle mechanism in the direction to close the throttle valve when the accelerating pedal or equivalent lever is released by the operator. In the operation of this manual control mechanism, the operator in pressing on the accelerating lever rotates shaft 32 and lugs 34 and 36 in the direction to withdraw said lugs from lugs 48 and 50 of the throttle shaft, thus permitting the throttle shaft and valve to move in the opening direction. A spring incorporated in the governor, hereinafter fully described, constantly urges the throttle valve in the opening direction, though this spring is somewhat weaker than spring 54 so that said latter spring can close the throttle valve when the accelerating lever is released. It is thus seen that by this arrangement the operator cannot positively open the throttle valve at any time nor prevent the governor, which is connected to the end of throttle shaft 22 opposite the manual actuating mechanism, from closing the throttle valve when the predetermined maximum speed is reached. In addition to the elements mentioned hereinabove, the carburetor includes a main fuel discharge jet for delivering fuel from a fuel bowl or other suitable source to the induction passage on the air intake side of throttle valve 24. Other elements normally included in a conventional carburetor, such as power enrichment jet and accelerating pump, are also included, though they are not shown or described since they are not directly related to the present invention.

In Figure 2 of the drawings, the throttle valve 24 of carburetor 12 is shown in broken lines mounted on throttle valve shaft 22, one end of which extends through housing 60 of the governor and is adapted to be actuated by the centrifugal speed control mechanism of said governor through lever 62 mounted on the end of said shaft and secured in place by nut 64. Lever 62 is provided with lug 66 which in cooperation with adjustable stop screw 68 limits the throttle closing movement of said lever, said stop screw being threadedly received in a hole in boss 70 and provided with slot 72 for use in making adjustments. The aforementioned stop mechanism is preferably adjusted so that the throttle valve will not reach the fully closed position.

Throttle valve 24 is constantly urged toward wide open position and caused to follow the one-way manual throttle control means by a coiled torque spring 74 connected at one end to one arm of lever 62 by pin 76 and anchored at the other end to housing 60 by pin 78. Spring 74 is provided primarily for the purpose of balancing the effect of air flow in the induction passage tending to close the throttle valve during the operation of the engine irrespective of the position of said throttle valve. Sufficient additional torque must be provided by spring 74 to move the throttle valve in the opening direction when the operator actuates the accelerating lever during the time the speed governing mechanism is in its inoperative position. When the throttle valve is in the nearly wide open position, the air flow produces a small amount of torque tending to open the throttle valve, but as the throttle valve moves toward the closed position, this opening torque of the air flow readily diminishes to zero and the closing torque increases progressively to a maximum at a point of about 35° from the vertical position. From this point on, the closing torque of the air flow on the throttle valve decreases at approximately the same rate as it increased to said point. The anchored end of spring 74 is so located in respect to the end of lever 62 that as the air flow torque increases, the spring force tending to open the throttle valve increases proportionally until the point at approximately 35° from vertical is reached; after this point, as the air flow torque decreases with further throttle closing, the force of spring 74 likewise decreases proportionally inasmuch as the spring passes from a position substantially tangent to the arc of lever 62 to a position nearly diametrical to said arc.

The centrifugal mechanism of the governor is clearly shown in Figures 2 and 3 of the drawing and includes centrifugal weights 90 and 92 which are mounted on the long arms of bell crank levers 94 and 96 and are secured thereto by pins 98 and 100 inserted in holes through said weights and levers. In order to make the unit as compact as possible, the weights are provided with a peripheral curvature of a radius substantially equal to the radius of the arc produced by the outer edge of said weights when they are in their fully extended position as shown in Figure 3. The outside faces of the weights are such that they are parallel with the axis of rotation when the weights are fully extended. The weights are preferably made of some relatively heavy metal so that their size will be consistent with compactness and efficiency of operation.

Levers 94 and 96 each consist of two parallel members, as shown in Figure 5, pivotally mounted on pins 102 and 104 of bracket 106, said bracket being rigidly secured in a fixed position on rotatable shaft 107. These two parallel members are rigidly held in a fixed position relative to one another by the pins at each end of the bell crank. Inserted between the short arms of each bell crank and journaled on pins 108 and 110 are rollers 112 and 114 which are adapted to engage the face of disc 120 and to force said disc to the right as shown in Figures 2 and 3, as the centrifugal weights swing outwardly while rotating about shaft 107. In the present embodiment, an angle between the two arms of the bell cranks is preferably less than 90° as for example about 85°.

Shaft 107 is journaled near each end in antifriction bearings 122 and 124 and is driven by flexible cable 18 secured to the flat side extension 126 on the right hand end, as shown in the drawings. A threaded boss 128 is provided to receive one end of the casing of the flexible cable. In order that shaft 107 and the elements mounted thereon may be accurately adjusted in respect

to the throttle control mechanism, an adjustment means is provided to move shaft 107 axially and consists of a set screw 130 threadedly received in a boss 132 in the housing at the left hand end of said shaft and adapted to engage a cup-shaped member 134 which bears against bearing 122. The bearing 124 near the right hand end of said shaft is urged to the left against a retaining ring stop 136 by a coil spring 138 reacting between said bearing and the inner side of boss 128. Bearing 122, together with shaft 107, is constantly urged to the left by spring 138 to hold the bearing against member 134, the force of said spring being transmitted to said bearing through the shaft, and a retaining stop 139. It is thus seen that the position of cup-shaped member 134 as adjusted by screw 130 determines the exact axial position of shaft 107 and the elements mounted on said shaft. A seal 140 closes the opening in boss 132 to prevent the infiltration of dirt and water into the governor housing and to prevent unauthorized tampering with the adjustment mechanism.

As disc 120 moves axially on shaft 107 under the influence of the centrifugal weights, antifriction bearing 150 and cup-shaped disc 152 move therewith, and the right hand face of disc 152 bears against rollers 154 and 156 journaled on pins 158 and 160 seated in the side arms of yoke 162 clearly shown in Figure 4. Yoke 162 is pivoted at one end on rod 164 which is rigidly held by bracket 166 formed integrally with housing 60. Yoke 162 engages a roller 168 mounted on one end of lever 62 and transmits the movement of the centrifugal mechanism to the throttle control mechanism. Inserted between the two side arms of yoke 162 opposite the pivoted end is a pivoted nut 170 threaded to receive the convolutions of the main governor spring 172 and to move said spring as yoke 162 is moved by the centrifugal weights when they become operative and to be moved by said spring as said weights are returned to their normal inoperative position.

In order to adjust the governor to operate at various maximum speeds over a wide range, primary and secondary adjustment mechanisms 173 and 174 are included to vary both the rate and tension of the main governor spring 172. Referring to Figures 2 and 3, the main governor spring is threaded into nut 170 which is held against rotation by pins 175 and 176 journaled in the side arms of yoke 162. The left hand end of spring 172 is anchored in slot 177 of adjustment rod 178 while the right hand end of said spring remains free. The spring convolutions to the right of nut 170 are ineffective and perform no function in the governing operation, but are nevertheless readily available for use at lower governed speeds after they have been screwed through the nut to become active and thereby decrease the spring rate.

Rod 178 is supported at one end in bushing 182, which is rotatably received in a boss 184 and held against independent rotation with said rod by key 186 inserted in slot 177. A cap 188 slips over the outer end of bushing 182 and is prevented from independent rotation by key 190, engaged in a longitudinal slot in bushing 182, though the cap is adapted to move freely in the axial direction. An inner shoulder 192 of the cap and the outer end of boss 184 are serrated so that when cap 188 is fully seated over boss 184, it is prevented from rotating by the two interlocking serrated portions, said cap being held in its seated position by screw 194 threadedly received in bushing 182. It is thus seen that by loosening screw 194, cap 188 can be lifted sufficiently to disengage the serrated portions, and thus permit rotation of the cap which results in rotation of bushing 182, rod 178 and spring 172. The rotation of said spring into or out of nut 170 increases or decreases the number of active coils and consequently increases or decreases the rate of the spring, the active coils being those between the left side of nut 170 and the right end of slot 177.

The other end of rod 178 is threadedly received in bushing 196 which is adapted to rotate but which is held against longitudinal movement by retainer 198 and tension of spring 172. A cap 200 similar to cap 188 seats over bushing 196 and when seated is prevented from rotating by serrations on the outer end of boss 202 and on shoulder 204. A screw 206 threadedly received in the outer end of bushing 196 holds cap 200 in its seated position and thus prevents rotation of said cap. A sealing ring 208 is interposed between each cap and the respective boss to prevent dust or water from entering the housing around the adjustment mechanism.

In the adjustment of the main governor spring 172 to establish some desired maximum engine speed, the spring rate as well as spring tension is changed. Throughout the normal operating governor range the spring rate and spring tension are made with the primary adjustment 173 by loosening screw 194 enough to disengage interlocking serrations, and then turning cap 188, bushing 182 and rod 178, thus increasing or decreasing the number of spring convolutions between the anchored end of said spring and nut 170, and consequently increasing or decreasing the spring rate. For each revolution of the spring, the tension is changed by an amount equal to the diameter of the wire. Since this change in tension would not be correctly coordinated with the change in spring rate, the tension of the spring is also changed by the rotation of the threaded end of rod 178 in the internally threaded bushing 196. As rod 178 is rotated, it screws into or out of internally threaded bushing 196, thus moving said rod axially to the right or left and consequently moving the slot in which one end of spring 172 is anchored to the right or left. Each revolution of the rod would change the spring tension by an amount equivalent to the pitch of the thread on rod 178. It may be further seen that for each revolution of said rod and spring by using primary adjustment 173, the tension of the spring would be changed by an amount equivalent to the diameter of the wire minus the pitch of the thread on said rod. In some instances where the maximum speed setting has been moved to a point near the maximum or minimum limit of the governor range the setting obtained by the primary adjustment mechanism may not be as accurate as desired. To make the desired correction, the secondary adjustment mechanism 174 is used. This adjustment is made by turning cap 200 and bushing 196 to move rod 178 axially either to the left or right and consequently move the point at which spring 172 is anchored. This results in a change in spring tension without causing a change in spring rate. For example, for each coil of a main governor spring (made of .055 inch wire) added to the left hand section of said spring by the primary adjustment, the anchor point in slot 176 is shifted .020 of an inch to the left by the threaded end of rod 178 in bushing 196 to obtain

the proper tension and flexibility of the spring for any desired setting throughout the normal governing range, though as previously pointed out, some adjustment by the secondary adjustment mechanism may be necessary when settings near the limits of said range are being made. It is thus seen that in the present governor, as the rate of the main governor spring is decreased, the tension of said spring is also decreased though at a rate less than that effected by the addition of spring convolutions.

In either the primary or secondary adjustment, the respective cap is released from the serrations between the shoulder and boss when the screw in the center of the cap is loosened. The cap is then rotated in the direction required to make the desired change in spring tension or spring rate. After the adjustment has been made, the cap is reseated to interlock the serrations, and the cap screw is tightened to secure said cap in its newly adjusted position. In order to prevent unauthorized tampering with the adjustment mechanism after the setting has been made and the cap screws retightened, a sealing wire is threaded through holes **212** and **214** of cap screws **194** and **206** respectively and secured to the housing at some fixed point, thus preventing loosening of said screws and caps without definite telltale evidence of that fact.

In the operation of the present governor while the engine is running at a speed less than the predetermined governed speed, the centrifugal weights are rotated by the engine through flexible cable **18** and shaft **107** and are held in their non-operative position as shown in Figure 2 by the force exerted by the main governor spring **172** through yoke **162**, and discs **152** and **120** on the short arms of bell cranks **94** and **96**. With the yoke in the position shown in Figure 2, the throttle valve can move to wide open position without roller **168** engaging the side arm of said yoke. The throttle valve is constantly urged to its wide open position by torque spring **74** urging lever **62** in a clockwise direction. When the accelerating pedal is depressed, throttle valve lever **28** moves shaft **32** in a clockwise direction and lugs **34** and **36** tend to move away from lugs **48** and **50** on the throttle valve shaft **22**. The throttle valve, however, under the force of spring **74** moves in the opening direction along with the movement of the throttle valve lever. By this arrangement, the operator is unable to positively open the throttle valve though his control of the throttle valve is unhampered so long as the speed of the engine is less than the governed speed. When the accelerating pedal is released by the operator, spring **54**, acting on throttle valve lever **28**, moves the throttle valve to closed position since the force of spring **54** is greater than the force of spring **74** tending to open the throttle valve. Except when the throttle valve is in substantially wide open position, the air flow in the induction passage urges the throttle valve closed with varying degrees of force, depending upon the position of said valve. The torque spring **74** overbalances the force of the air flow tending to close the throttle valve with a force of such value that the difference between these two forces results in a substantially constant force applied longitudinally to the governor mechanism. Thus, the entire governor mechanism, in closing the throttle valve, operates on a constant opposing force tending to open the throttle valve.

When the velocity of the engine reaches the

desired maximum speed as determined by the governor setting, the centrifugal weights which have been rotating with shaft **107** at the lower speeds in the position shown in Figure 2 move outwardly to the position shown in Figure 3, or to some intermediate point depending on engine load, thus causing the short arms of bell crank **94** and **96** to force discs **120** and **152** to the right on shaft **107**, engaging rollers **154** and **156** of yoke **162**. As the yoke moves toward the right in opposition to the main governor spring, it engages roller **168** of lever **62** and rotates said lever in a counterclockwise direction to urge the throttle valve in the closing direction and thus reduce the speed of the engine, or prevent overspeeding thereof. Since the one-way connection is provided between lugs on shaft **32** and those on the throttle valve shaft, the operator is unable to prevent the throttling action of the governor. Should the governor completely close the throttle valve, the valve is prevented from sticking by stop **66** contacting screw **68** as shown in Figure 3. When the engine speed has decreased to a rate somewhat below the predetermined maximum speed, the centrifugal force in weights **90** and **92** is no longer able to overcome the force of the main governor spring and the weights are rapidly moved to their original position, as shown in Figure 2. The operator can again regulate the engine speed without interference from the governor.

It is contemplated that other arrangements of elements comprising the present invention than those shown in the accompanying drawings may be provided without departing from the scope of the present invention. Further, the present invention is applicable not only to engines equipped with carburetors, but also to steam engines, and engines wherein the fuel is supplied by solid injection. Other modifications of the present governor as well as other uses therefor will occur to those skilled in the art.

We claim:

1. In a speed responsive governor for controlling a valve, the combination of an element adapted to be operatively connected to the valve, yieldable means connected to said element for urging said element in the valve opening direction, a rotatable shaft, a plurality of centrifugal weights, levers pivoted on said shaft for supporting said weights, a member adapted to be moved by said levers, and a lever pivoted at one end and spring loaded at the other end for yieldably opposing the movement of said member by said weight levers, said spring loaded lever being operatively connected to said element to urge said element in the valve closing direction.

2. In a governor for an engine having an induction passage with a throttle valve therein urged toward closed position by air flow in said passage, the combination of an element adapted to be operatively connected to the valve, a yieldable means for overbalancing the effect of said air flow on the valve, a shaft adapted to be rotated in accordance with engine speed, a plurality of centrifugal weights driven by said shaft, levers pivoted on said shaft for supporting said weights, a member mounted on said shaft adapted to be moved by said levers, and a lever pivoted at one end and spring loaded at the other end for yieldably opposing the movement of said member by said weight levers, said spring loaded lever being operatively connected to said element to urge said element in the valve closing direction.

3. In a governor for an engine having an induction passage with a throttle valve therein urged toward closed position by air flow in said passage, the combination of an element adapted to be operatively connected to the valve, a yieldable means for overbalancing the effect of said air flow on the valve a substantially constant amount between closed and wide open throttle, a shaft adapted to be rotated in accordance with engine speed, a plurality of centrifugal weights driven by said shaft, bell cranks mounted on said shaft for supporting said weights, a disc mounted on said shaft adapted to be moved axially by said bell cranks, and a lever pivoted at one end and spring loaded at the other end for yieldably opposing the axial movement of said disc by said bell cranks, said spring loaded lever being operatively connected to said element to urge said element in the valve closing direction.

4. In a governor for an engine having an induction passage with a throttle valve therein urged toward closed position by air flow in said passage, the combination of an element adapted to be operatively connected to the valve, a yieldable means for overbalancing the effect of said air flow on the valve a substantially constant amount between closed and wide open throttle, a stop means for limiting the closing movement of said throttle valve, a shaft adapted to be rotated in accordance with engine speed, a plurality of centrifugal weights driven by said shaft, bell cranks mounted on said shaft for supporting said weights, a disc mounted on said shaft adapted to be moved by said bell cranks, and a lever pivoted at one end and spring loaded at the other end for yieldably opposing the movement of said disc by said bell cranks, said lever being operatively connected to said element to urge said element in the valve closing direction.

5. In a governor for an engine having an induction passage with a throttle valve therein urged toward closed position by air flow in said passage, the combination of an element adapted to be operatively connected to the valve, a yieldable means for overbalancing the effect of said air flow on the valve a substantially constant amount between closed and wide open throttle, a drive shaft adapted to be rotated in accordance with engine speed, a plurality of centrifugal weights driven by said drive shaft, bell cranks mounted on said shaft for supporting said weights, a disc mounted on said shaft adapted to be moved axially by said bell cranks, and a lever pivoted at one end and spring loaded at the other end for yieldably opposing the axial movement of said disc by said bell cranks, said lever being operatively connected to said element to urge said element in the valve closing direction.

6. In a governor for an engine having an induction passage with a throttle valve therein urged toward closed position by air flow in said passage, the combination of an element adapted to be operatively connected to the valve, a yieldable means for overbalancing the effect of said air flow on the valve a substantially constant amount between closed and wide open throttle, a drive shaft adapted to be rotated at a fraction of engine speed, a plurality of centrifugal weights driven by said drive shaft, bell cranks mounted on said shaft for supporting said weights, a disc mounted on said shaft adapted to be moved axially by said bell cranks, a bifurcated lever pivoted at one end and adapted to be moved by the force of the centrifugal weights to move said element in the valve closing direction, and an adjustable yieldable means for opposing the force developed by the rotation of said weights.

7. In a speed responsive governor for controlling a valve, the combination of an element adapted to be operatively connected to the valve, yieldable means connected to said element for urging said element in the valve opening direction, a rotatable shaft, a plurality of centrifugal weights driven by said shaft, levers pivoted on said shaft for supporting said weights, a member adapted to be moved by said levers, a bifurcated lever pivoted at one end and adapted to be moved with said member by the force of the centrifugal weights to move said element in the valve closing direction, a nut pivotally mounted on the free end of said bifurcated lever, and a coil spring anchored at one end and threaded through said nut to provide a resilient force for opposing the movement effected by said weights.

8. In a governor for an engine having an induction passage with a throttle valve therein urged toward closed position by air flow in said passage, the combination of an element adapted to be operatively connected to the valve, a yieldable means for overbalancing the effect of said air flow on the valve a substantially constant amount between closed and wide open throttle, a shaft adapted to be rotated at a fraction of engine speed, a plurality of centrifugal weights driven by said shaft, bell cranks mounted on said shaft for supporting said weights, a disc adapted to be moved axially by said bell cranks, a bifurcated lever pivoted at one end and adapted to be moved with said disc by the force of the centrifugal weights to move said element in the valve closing direction, a nut pivotally mounted on the free end of said bifurcated lever, and a coil spring anchored at one end and threaded through said nut to provide a resilient force for opposing the movement effected by said weights.

9. In a governor for an engine having an induction passage with a throttle valve therein urged toward closed position by air flow in said passage, the combination of an element adapted to be operatively connected to the valve, a yieldable means for overbalancing the effect of said air flow on the valve a susbtantially constant amount between closed and wide open throttle, a stop means for limiting the closing movement of said throttle valve, a shaft adapted to be rotated in accordance with engine speed, a plurality of centrifugal weights driven by said shaft, levers pivoted on said shaft for supporting said weights, a bifurcated lever pivoted at one end and adapted to be moved by the force of the centrifugal weights to move said element in the valve closing direction, a nut pivotally mounted on the free end of said bifurcated lever, and a coil spring anchored at one end and threaded through said nut to provide a resilient force for opposing the movement effected by said weights.

10. In a speed responsive governor for controlling a valve, the combination of an element adapted to be operatively connected to the valve, yieldable means connected to said element for urging said element in the valve opening direction, a rotatable shaft, a plurality of centrifugal weights driven by said shaft, levers pivoted on said shaft for supporting said weights, a member adapted to be moved by said levers, a bifurcated lever pivoted at one end and adapted to be moved with said member by the force of the centrifugal weights to move said element in the valve closing direction, a nut pivotally mount-

ed on the free end of said bifurcated lever, a coil spring anchored at one end and threaded through said nut to provide a resilient force for opposing the movement effected by said weights, and a primary adjustment means for simultaneously changing the rate and tension of said spring including a means for changing the number of spring convolutions by turning said spring through said nut and also including a means for simultaneously changing the anchor point relative to said nut to modify the change in tension of said spring effected by the change in number of effective spring convolutions.

11. In a governor for an engine having an induction passage with a throttle valve therein urged toward closed position by air flow in said passage, the combination of an element adapted to be operatively connected to the valve, a yieldable means for overbalancing the effect of said air flow on the valve a substantially constant amount between closed and wide open throttle, a shaft adapted to be rotated at a fraction of engine speed, a plurality of centrifugal weights driven by said shaft, bell cranks mounted on said shaft for supporting said weights, a disc adapted to be moved axially by said bell cranks, a bifurcated lever pivoted at one end and adapted to be moved with said disc by the force of the centrifugal weights to move said element in the valve closing direction, a nut pivotally mounted on the free end of said bifurcated lever, a coil spring anchored at one end and threaded through said nut to provide a resilient force for opposing the movement effected by said weights, and a primary adjustment means for simultaneously changing the rate and tension of said spring including a means for changing the number of spring convolutions by turning said spring through said nut and also including a means for simultaneously changing the anchor point relative to said nut to modify the change in tension of said spring effected by the change in number of effective spring convolutions.

12. In a governor for an engine having an induction passage with a throttle valve therein urged toward closed position by air flow in said passage, the combination of an element adapted to be operatively connected to the valve, a yieldable means for overbalancing the effect of said air flow on the valve a substantially constant amount between closed and wide open throttle, a stop means for limiting the closing movement of said throttle valve, a shaft adapted to be rotated in accordance with engine speed, a plurality of centrifugal weights driven by said shaft, levers pivoted on said shaft for supporting said weights, a bifurcated lever pivoted at one end and adapted to be moved by the force of the centrifugal weights to move said element in the valve closing direction, a nut pivotally mounted on the free end of said bifurcated lever, a coil spring anchored at one end and threaded through said nut to provide a resilient force for opposing the movement effected by said weights, and a primary adjustment means for simultaneously changing the rate and tension of said spring including a means for changing the number of spring convolutions by turning said spring through said nut and also including a means for simultaneously changing the anchor point relative to said nut to modify the change in tension of said spring effected by the change in number of effective spring convolutions.

13. In a speed responsive governor for controlling a valve, the combination of an element adapted to be operatively connected to the valve, yieldable means connected to said element for urging said element in the valve opening direction, a shaft adapted to be rotated in accordance with engine speed, a plurality of centrifugal weights driven by said shaft, levers pivoted on said shaft for supporting said weights, a member adapted to be moved by said levers, a bifurcated lever pivoted at one end and adapted to be moved with said member by the force of the centrifugal weights to move said element in the valve closing direction, a nut pivotally mounted on the free end of said bifurcated lever, a coil spring anchored at one end and threaded through said nut to provide a resilient force for opposing the movement effected by said weights, and a primary adjustment means for simultaneously changing the rate and tension of said spring including a means for changing the number of spring convolutions by turning said spring through said nut and also including a nut and screw for changing the anchor point of the spring relative to said first mentioned nut to modify the change in tension of said spring effected by the change in number of effective spring convolutions.

14. In a governor for an engine having an induction passage with a throttle valve therein urged toward closed position by air flow in said passage, the combination of an element adapted to be operatively connected to the valve, a yieldable means for overbalancing the effect of said air flow on the valve a substantially constant amount between closed and wide open throttle, a shaft adapted to be rotated at a fraction of engine speed, a plurality of centrifugal weights driven by said shaft, bell cranks mounted on said shaft for supporting said weights, a disc adapted to be moved axially by said bell cranks, a bifurcated lever pivoted at one end and adapted to be moved with said disc by the force of the centrifugal weights to move said element in the valve closing direction, a nut pivotally mounted on the free end of said bifurcated lever, a coil spring anchored at one end and threaded through said nut to provide a resilient force for opposing the movement effected by said weights, and a primary adjustment means for simultaneously changing the rate and tension of said spring including a means for changing the number of spring convolutions by turning said spring through said nut and also including a nut and screw for changing the anchor point of the spring relative to said first mentioned nut to modify the change in tension of said spring effected by the change in number of effective spring convolutions.

15. In a governor for an engine having an induction passage with a throttle valve therein urged toward closed position by air flow in said passage, the combination of an element adapted to be operatively connected to the valve, a yieldable means for overbalancing the effect of said air flow on the valve a substantially constant amount between closed and wide open throttle, a stop means for limiting the closing movement of said throttle valve, a shaft adapted to be rotated in accordance with engine speed, a plurality of centrifugal weights driven by said shaft, levers pivoted on said shaft for supporting said weights, a bifurcated lever pivoted at one end and adapted to be moved by the force of the centrifugal weights to move said element in the valve closing direction, a nut pivotally mounted on the free end of said bifurcated lever, a coil spring anchored at

one end and threaded through said nut to provide a resilient force for opposing the movement effected by said weights, and a primary adjustment means for simultaneously changing the rate and tension of said spring including a means for changing the number of spring convolutions by turning said spring through said nut and also including a nut and screw for changing the anchor point of the spring relative to said first mentioned nut to modify to a lesser degree the change in tension of said spring effected by the change in number of effective spring convolutions.

16. In a governor for an engine, a member adapted to be actuated by a speed responsive means, a nut mounted on said member, and a coiled governor spring of substantially constant diameter throughout the effective portion thereof anchored at one end and threaded through said nut whereby the number of effective coils of said spring can be adjusted by turning the spring in said nut.

17. In a governor for an engine, a pivoted lever adapted to be rotated by a means responsive to variations in engine speed, an internally threaded nut mounted on said lever, a coiled governor spring of substantially constant diameter anchored at one end and threaded through said nut, and an adjustment means for changing the rate and tension of said spring including a means for changing the number of effective spring convolutions by turning said spring through said nut.

18. In a governor for an engine, a member adapted to be actuated by a means responsive to variations in engine speed to control the speed of the engine, an internally threaded nut mounted on said member, a coiled governor spring of substantially constant diameter anchored at one end and threaded through said nut, and an adjustment means for changing the rate and tension of said spring including a means for changing the number of effective spring convolutions by relative rotation of said nut and spring and also including means for adjusting the anchor point and said nut relative to one another to modify the change in tension of said spring effected by the change in number of effective convolutions.

19. In a governor for an engine, a lever pivoted at one end and adapted to be actuated by a means responsive to variations in engine speed to control the speed of the engine, an internally threaded nut pivotally mounted on the free end of said lever, a coiled governor spring anchored at one end and threaded through said nut, and an adjustment means for changing the rate and tension of said spring including a means for changing the number of effective spring convolutions by turning said spring through said nut and also including a means for simultaneously changing the anchor point relative to said nut to modify the change in tension of said spring effected by the change in number of effective convolutions.

20. In a governor for an engine, a member adapted to be actuated by a speed responsive means, a governor spring of substantially constant diameter operatively connected to said member for controlling the movement thereof, a rotatable rod threadedly received in a support and forming an anchor for one end of said spring, and an internally threaded nut adapted to receive said spring and to form an anchor for one end of the effective portion thereof, whereby the rate and tension of said spring can be adjusted by relative rotation of said rod and nut.

21. In a governor for an engine, a member adapted to be actuated by a speed responsive means, a nut mounted on said member, a rotatable rod threadedly received in a support, and a governor spring anchored at one end to said rod and threaded through said nut whereby the rate and tension of said spring can be adjusted by the rotation of said rod.

22. In a governor for an engine, a lever pivoted at one end and adapted to be rotated by a means responsive to variations in engine speed to control the speed of the engine, an internally threaded nut mounted on the free end of said lever, an axially movable rod extending through the hole in said nut and threadedly received at one end in a normally fixed support, and a coiled governor spring anchored at one end to said rod and threaded through said nut, whereby the rate and tension of said spring are adjusted by the rotation of said rod and spring.

23. In a governor for an engine, a lever adapted to be actuated by a speed responsive means, a nut mounted on said lever, a rotatable rod extending through the hole in said nut, a support means for threadedly receiving one end of said rod and for adjusting said rod longitudinally, and a coiled governor spring anchored at one end to said rod and threaded through said nut.

24. In a speed responsive governor for controlling a valve, the combination of an element adapted to be operatively connected to said valve, a plurality of centrifugal weights driven in accordance with engine speed, a member actuated by said weights for controlling said valve and adapted to engage said element, a nut mounted on said member, and a coiled governor spring of substantially constant diameter anchored at one end and threaded through said nut whereby the number of effective coils of said spring can be adjusted by turning the spring in said nut.

25. In a speed responsive governor for an engine having an induction passage with an air valve therein, the combination of an element adapted to be operatively connected to said valve, a plurality of centrifugal weights driven in accordance with engine speed, a member actuated by said weights for actuating said element, a governor spring operatively connected to said member for controlling the movement thereof, a rotatable rod threadedly received in a support and forming an anchor for one end of said spring, and an internally threaded nut adapted to receive said spring to form an anchor for the other end thereof, whereby the rate and tension of said spring can be adjusted by relative rotation of said rod and nut.

26. In a speed responsive governor for an engine having an induction passage with an air valve therein, the combination of an element adapted to be operatively connected to said valve, a yieldable means for overbalancing the air flow urging said valve toward closed position, a shaft adapted to be rotated in accordance with engine speed, a plurality of centrifugal weights mounted on and driven by said shaft, levers pivoted on said shaft for supporting said weights, a lever actuated by said weights for actuating said element, an internally threaded nut mounted on the free end of said lever, an axially movable rod extending through the hole in said nut and threadedly received at one end in a normally fixed support, and a coiled governor spring anchored at one end to said rod and threaded through said nut whereby the rate and tension of said spring are adjusted by the rotation of said rod and spring.

27. In a speed responsive governor for an en-

gine having an induction passage with an air valve therein, the combination of an element adapted to be operatively connected to said valve, a plurality of centrifugal weights driven in accordance with engine speed, a member actuated by said weights for actuating said element, a governor spring of substantially constant diameter operatively connected to said member for controlling the movement thereof, a nut adapted to threadedly receive said spring and to form an anchor for one end of the effective portion thereof, a means for anchoring the other end of said spring portion, and an adjustment means adapted to move said nut and spring anchoring means relative to one another.

28. In a governor for an engine, a movable member adapted to be actuated by a speed responsive means, a normally fixed supporting member, a nut mounted on one of said members, and a coiled governor spring of substantially constant diameter throughout its effective length secured to the other of said members and threaded through said nut, whereby the number of effective coils of said spring can be varied by relative rotation of said spring and nut.

ROBERT W. SLOANE.
MICHAEL J. THOMAS.
GUY C. FRICKE.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
964,651	Kirk	July 19, 1910
973,641	Dysart	Oct. 25, 1910
1,480,309	Short et al.	Jan. 8, 1924
1,653,687	Wilshusen	Dec. 27, 1927
2,299,824	Kalin	Oct. 27, 1942
2,349,145	Darnell	May 16, 1944
2,369,426	Benjamin	Feb. 13, 1945
2,378,558	Kalin	June 19, 1945

FOREIGN PATENTS

Number	Country	Date
110,078	Germany	Apr. 18, 1900
138,823	Germany	Mar. 6, 1903