Oct. 26, 1948. W. J. WHITEHEAD 2,452,088

GOVERNOR CONTROL FOR PRIME MOVERS

Filed April 19, 1943 2 Sheets-Sheet 1

Fig. 1

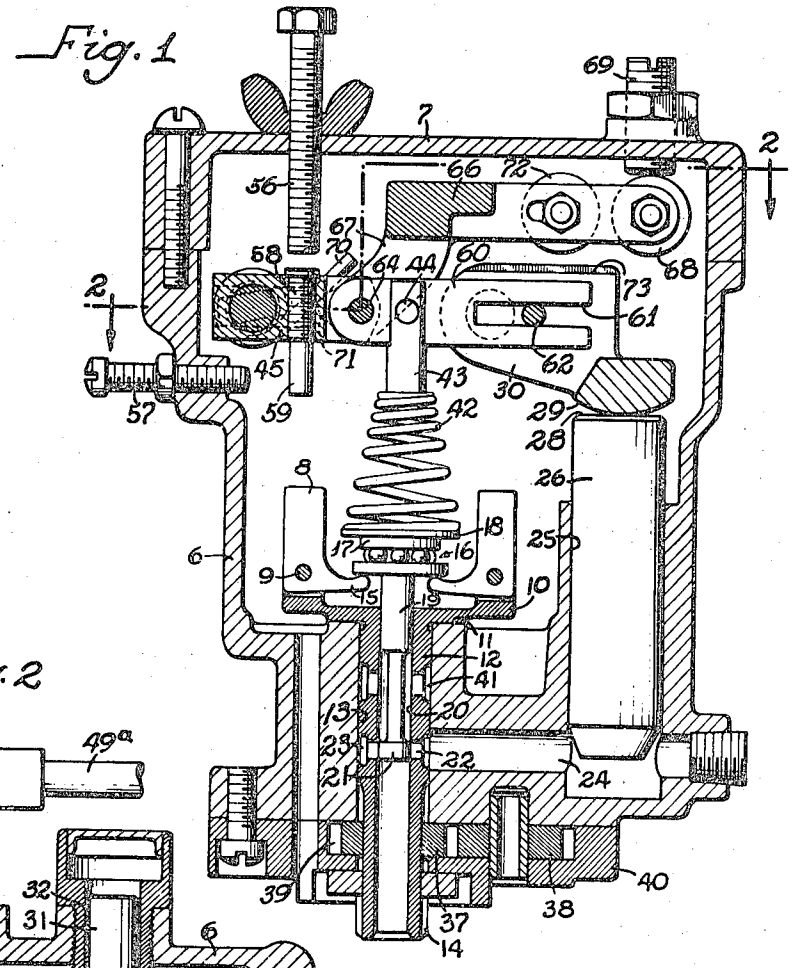
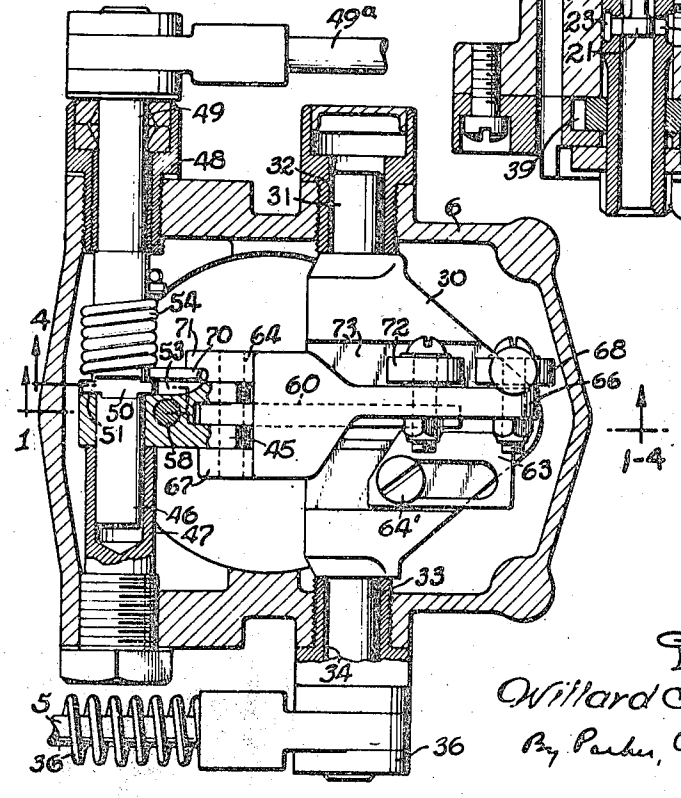


Fig. 2



INVENTOR
Willard J. Whitehead
By Parker, Carlson, Pitzner & Hubbard
ATTORNEYS

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Fig. 3

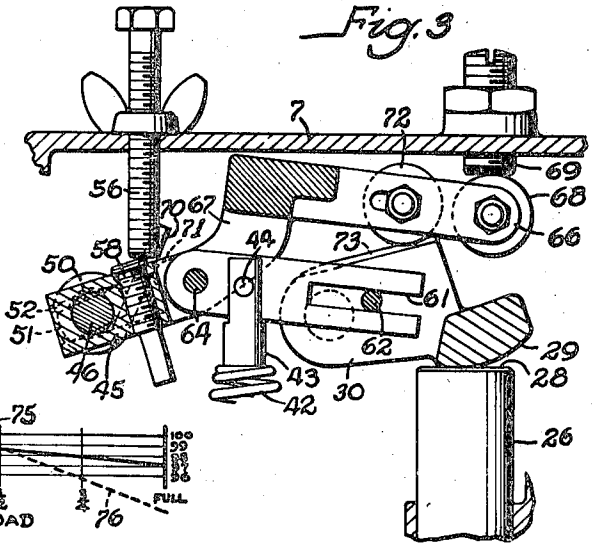


Fig. 6

Fig. 7

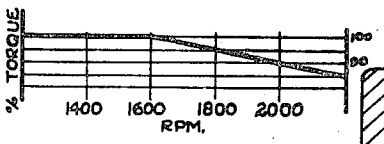


Fig. 4

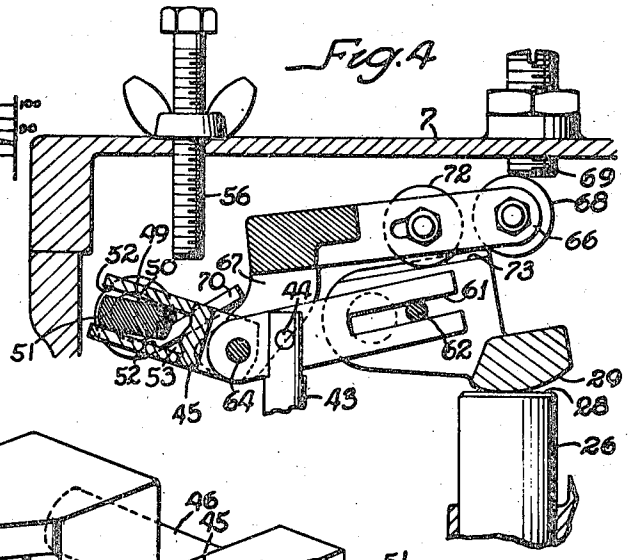
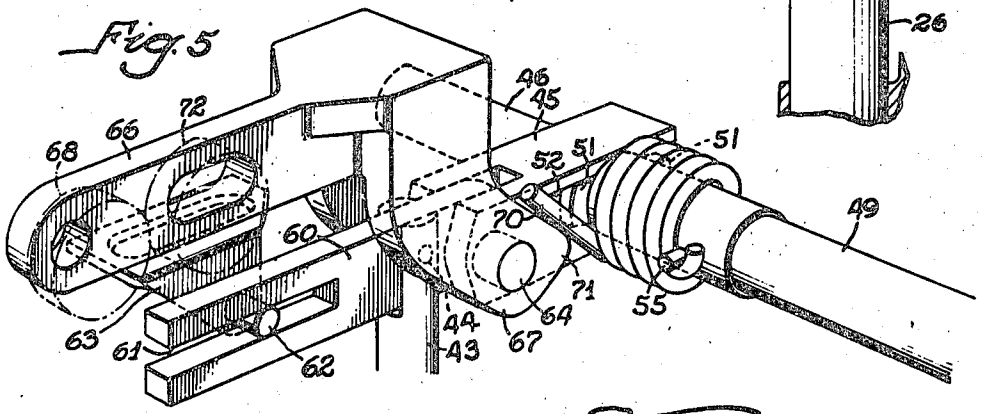


Fig. 5



INVENTOR
Willard J. Whitehead
By Parker, Carlson, Pitzner & Hubbard
ATTORNEYS

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GOVERNOR CONTROL FOR PRIME MOVERS

Willard J. Whitehead, Rockford, Ill., assignor to Woodward Governor Company, Rockford, Ill., a corporation of Illinois

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7 Claims. (Cl. 264—4)

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The invention relates to the speed control of prime movers, and the general object is to provide a novel mechanism for automatically limiting the supply of energy to the prime mover in response to abnormal loading thereof.

Another object is to provide a novel load limit control which operates by changing the speed droop characteristic of the governor.

The invention also resides in the novel character of the mechanism employed to effect the speed droop change.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which

Figure 1 is a vertical sectional view of a governor embodying the novel features of the present invention, the section being taken along the line 1—1 of Fig. 2.

Fig. 2 is a section taken along the line 2—2 of Fig. 1.

Figs. 3 and 4 are fragmentary views similar to Fig. 1 illustrating different positions of the parts, Fig. 4 being a section taken along the line 4—4 of Fig. 2.

Fig. 5 is a fragmentary perspective view.

Fig. 6 is a graph of the speed droop characteristic of the governor.

Fig. 7 is a curve showing the speed-torque relationship of a prime mover controlled by the governor.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail the preferred embodiment. It is to be understood, however, that I do not intend to limit the invention by such disclosure but aim to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

The governor shown for purposes of illustration is intended to detect changes in the speed of a prime mover (not shown) and to correct for such changes by positioning a speed regulating member such as a rod 5 controlling the supply of energy or fuel to the prime mover.

In the form shown, all of the operating parts of the governor are housed in a casing 6 usually mounted on the prime mover and closed at its upper open end by a cover 7. While various types of speed sensitive devices may be employed, the changes in the prime mover speed are detected herein by upstanding weights or flyballs 8 pivoted on horizontal pins 9 on a head 10 which rests on a ledge 11 of the casing. The head is fast on the

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upper end of a sleeve 12 journaled in a vertical bore 13 with its lower splined end 14 projecting from the casing bottom for connection with a suitable shaft driven by the prime mover.

Arms 15 on the flyballs bear upwardly against the lower race ring of a ball thrust bearing 16 having an upper ring 17 which abuts against a shoulder 18 on a rod 19. The latter is slidable in a bore 20 of the sleeve 12 and carries an enlargement or land 21 at its lower end cooperating with sleeve ports 22 which have a diameter substantially the same as the length of the land. The valve thus formed controls the flow of pressure fluid or oil through a groove 23 around the sleeve and a passage 24 leading to the lower end of a vertical cylinder 25 on the side of the casing opposite the valve structure.

A piston 26 reciprocates in this cylinder and cooperates therewith to form a servo motor for variably positioning the throttle rod 5 or other device by which the speed of the prime mover is regulated. Herein, the upper end 28 of the servo piston bears against a curved surface 29 on the free end of a bifurcated crank 30 having a trunnion 31 projecting laterally from one side of its other end and journaled in a bearing 32 on the casing 6. Projecting from the other side of the crank is a shaft 33 which is journaled in a bearing 34 and carries on its outer end a crank 35 connected to the throttle rod 5. A spring 36 urges the rod in the fuel decreasing direction in opposition to the hydraulic forces.

Pressure fluid is supplied by a pump comprising gears 37 and 38 disposed in a recess 39 in a plate 40 clamped against the casing bottom, the gear 37 being splined on the drive sleeve 12. Oil supplied under pressure by the pump is delivered through a passage (not shown) to an annular passage 41 formed in the sleeve 12 above the groove 23. The pump inlet may communicate with the oil supply line of the engine. When an excessive pressure develops, fluid is by-passed from the pump outlet to the inlet in a well known manner.

The tendency of the flyballs to lift the pilot valve rod 19 is counteracted in the present instance by a resilient means in the form of a frusto-conical coiled compression spring 42 acting between the abutment 18 and a rod 43 the upper end of which straddles a lever 60 and is pivotally connected intermediate the ends of the lever by a pin 44. One end of the lever projects into the bifurcation of the crank 30 and is formed with a slot 61 that receives a pivot pin 62. For a purpose to appear later, the latter is mounted on a slide 63 (Fig. 2) which, by loosening of a

screw 64' may be shifted along the crank to change the position of the pin 62 relative to the crank axis and thereby vary the motion-transmitting ratio of the lever. The opposite end of the lever projects into the bifurcated end of a crank 45 and is pivotally connected thereto by a pin 64. This crank is fast on a rockshaft 46 journaled in a plug 47 which is screwed into the side of the casing and is disposed parallel to the throttle shaft 33.

By adjusting the angular position of the crank 45, the lever 60 will be swung about its pivot 62 thereby varying the stress of the spring 42 and therefore the speed setting of the governor. Such adjustment is effected by turning a rockshaft 49 journaled in a plug 48 and projecting through the casing 6 for connection of its outer end with a suitable linkage 49a extending to a desired point of control and having means (not shown) for maintaining each selected position of adjustment. In the present instance, this connection is made yieldable so as to allow a small degree of relative movement of the lever 45 independently of the shaft 49. A head 51 on the inner end of this shaft is formed with flattened sides 50 spaced closer together than the walls 52 of a groove 53 formed on the side of the crank 45. The limited angular slack in lost motion connection thus provided is normally taken up by a torsion spring 54 encircling the adjusting shaft 49 and anchored at 55 thereto. To limit the range of speed adjustment of the governor, adjustable stop screws 56 and 57 thread through the cover 7 and the casing wall and are engageable with the head of a screw 58 in the lever 45 to determine the lower limit of the speed range (see Fig. 3) or with the lower end 59 of the screw to determine the upper speed limit.

In the present instance, a speed droop characteristic is imparted to the governor by communicating the motions of the servo piston 26 to the speeder spring 42. This is accomplished through the lever 60 above described which, for any given speed setting, will fulcrum on the pin 64 as the servo piston moves up or down. In response to upward motion of the piston to increase the fuel supply and correct for a drop in engine speed, the rod 43 will be raised decreasing the spring stress and correspondingly decreasing the effective speed setting of the governor. Similarly, on lowering of the servo piston by the spring 36 as permitted by a rise in engine speed detected by the governor, the lever 60 will compress the spring 42 and increase the speed setting. As a result of these increases and decreases in the speeder spring stress with changes in servo position, the prime mover speed maintained by the governor for any adjustment of the shaft 49 will decrease or droop as the load on the engine increases. Such speed droop may be a linear function as shown by the line 75 (Fig. 6). The amount of such droop may be increased or decreased by adjusting the pin 62 away from or toward the axis of the crank 30.

The present invention contemplates the incorporation of means in the governor above described for limiting the amount of fuel that may be delivered to the prime mover when the torque demands at a given speed are exceeded. Herein, this means operates in conjunction with the speed droop mechanism to effect a rather sharp increase in the amount of speed droop in response to speed-increasing or upward movement of the servo piston beyond a predetermined point which varies with the manually selected speed setting of the governor.

In the embodiment illustrated, this speed droop changing means comprises a secondary lever 66 which is inactive under normal load conditions but which is brought into play when the piston 26 rises above a predetermined point for a given engine speed. This lever then operates with a greater motion-transmitting ratio than the lever 60 to similarly change the speeder spring stress and thus increase the amount of the speed droop. In order that the load at which the lever 66 becomes effective will vary automatically with the governor speed setting, the depending end 67 of the lever, which is generally L-shaped, is pivotally supported on the speed adjusting lever 45, being for this purpose supported pivotally by the pin 64 and straddling the lever 45. The opposite end of the lever carries a roller 68 which normally bears against the downwardly facing end of a stop 69 in the form of a screw threading through the cover 7 so as to be adjustable vertically. Such normal engagement is maintained by the torsion spring 54 which at one end is formed with an arm 70 bearing downwardly against a lug 71 on the lever 66 and exerting a force that acts eccentrically of the pivot 64 to force the roller against the stop. Spaced a short distance from the roller 68 and adjustable along the lever 66 is a roller 72 whose lower side is positioned for engagement with a surface 73 on the top of the crank 30.

It will be observed that when the surface 73 is disposed below the roller 72 as shown in Fig. 1, the lever 66 will be ineffectual and the speed droop characteristic of the governor will be determined by the motion transmitting ratio of the lever 60. However, when the torque demand increases to an abnormal degree, the servo piston 26 will carry the surface 73 above the point of contact with the roller 72, the lever 66 then fulcruming about the point of engagement with the stop 69 and raising the pivot 64. This motion takes place against the action of the torsion spring 54 and is permitted by virtue of the lost angular motion provided between the crank 45 and the speed adjusting shaft 49. This upward motion of the pin 64 is transmitted to the speeder spring through the intermediary of the lever 60 fulcruming about the pin 62. As a result, the upward motion of the piston 26 is communicated to the speeder spring at a greater ratio by the lever 66 than by the lever 60, and the resulting decrease in the speeder spring stress effects an abrupt change and consequent limitation in the permissible upward movement of the servo piston.

Operation

When the governor has attained equilibrium under normal load conditions, the parts will be positioned as shown in Fig. 1, and the throttle rod 5 will be disposed in a position corresponding to the prime mover speed selected by the prevailing position of the adjusting rockshaft 49.

First, assume that the load on the engine increases, resulting in a decrease in speed. In response to this, the flyballs 8 move inwardly dropping the pilot valve land 21 below the ports 22 so as to admit pressure fluid beneath the servo piston. This raises the latter against the action of the spring 36 and through the crank 30, rocks the throttle rod shaft 33 and crank 35 to increase the throttle opening. In this motion, the lever 60 pivots about the then fixed fulcrum 64 to decrease the stress of the speeder spring 42 and reestablish equilibrium at a lower engine speed.

The reverse action takes place when the engine speed decreases below the selected value. In response to this, the land 21 is raised permitting oil to drain from the cylinder 25 lowering the piston 26 and decreasing the fuel supply until the accompanying downward movement of the speed droop lever 60 has increased the speeder spring stress to establish equilibrium under the new load. During such operation under normal load conditions, the crank 30 will move up and down idly without contacting the roller 72, and the position of the lever 66 will remain unchanged except when the speed setting of the governor is changed by manual adjustment of the rockshaft 48.

When an abnormal load is encountered, the engine speed will fall appreciably below the selected value, and the piston 26 will, as the governor attempts to compensate for this decrease, move so far that the surface 73 will contact the roller 72 and raise the latter. When this occurs, the lever 66, fulcruming about the point of contact between the roller 68 and the stop 69, will raise the pivot 64 and thus produce a substantially greater rise in the position of the pivot 44 for a given servo movement than the movement normally produced by the main speed droop lever 60. Consequently, the stress in the speeder spring 42 is decreased abruptly, and the effective speed setting of the governor correspondingly reduced by this changed speed droop characteristic to such an extent as to limit the upward movement of the servo piston. In this way, the fuel supply and therefore the torque delivered by the prime mover are restricted.

The speed droop characteristics of the governor above described are shown in Fig. 6, the line 75 representing the speed load curve for a governor similar to the one herein described but without the torque limiting feature, and the line 76, representing the modified droop which results from the action of the auxiliary droop lever adjusted so as to limit torque at the upper end of the prime mover speed range. With these droop characteristics, the governor would control the prime mover to limit the torque output as shown in Fig. 7. In this example, the torque is limited to 100 per cent between speeds from 1200 to 1600 R. P. M. From 1600 to 2200 R. P. M. the limit torque is reduced progressively to 85 per cent.

These characteristics may, of course, be varied in many ways by adjustment of the screw 69 or by shifting the roller 72 along the lever which varies the slope of the secondary droop line 76, or by changing the mechanical advantage of the primary droop lever 60 which changes the normal amount of droop. As a result, the governor may be adapted to meet widely varying conditions and give substantially any torque limiting curve desired, provided that the curve has a characteristic which descends as the speed increases.

It will be observed that since the position of the auxiliary speed droop lever 66 varies with the setting of the arm 45, the extent of fuel increasing movement of the servo piston that is required before the roller 72 is engaged and the limiting action is initiated is determined by the prevailing speed setting of the governor. At the low speed settings as shown in Fig. 3, the roller may be disposed beyond the range of movement of the servo so that no limiting action will take place. For high speed settings, however, the engagement takes place in response to a shorter

servo movement thereby producing the declining speed-torque characteristic shown in Fig. 7.

I claim as my invention:

1. A governor having in combination, rotary flyballs, means resiliently opposing said flyballs, an element manually movable to adjust the stress on said flyballs by said means whereby to vary the speed setting of the governor, a speed-regulating member variably positioned in accordance with speed changes detected by said governor, a lever pivotally supported by said element and actuated by said member to adjust said stress with changes in the position of the member, and a second lever pivotally supported by said element and normally disconnected from said member but movable with the latter within a portion of the range of movement of the member, said second lever operating with a greater motion-transmitting ratio than said first lever to adjust said stress.

2. A governor having, in combination, a movable speed adjusting element, a lever fulcrumed on said element, resilient means variably stressed by movement of said lever, selectively settable adjusting means having a resiliently yieldable lost motion connection with said element, a speed sensitive device influenced by said resilient means, a speed regulating member movable in response to speed changes detected by said device and pivotally connected to said lever, and means operable after a predetermined fuel-increasing movement of said member to produce yielding of said connection and shifting of the fulcrum of said lever in a direction to increase the effective speed droop of the governor.

3. A governor for a prime mover having, in combination, a regulating member movable back and forth, means operable to control the positioning of said member in response to detected speed changes, a resilient element selectively adjustable to vary the setting of the governor, means for transmitting the motion of said member to said element continuously to vary the stressing thereof and impart speed droop to the governor, an auxiliary motion-transmitting means operating with a greater ratio than said first motion-transmitting means to vary the stress of said element and increase the speed droop of the governor, and means providing a lost motion connection between said regulating member and said auxiliary means operable to render the auxiliary means active when the member moves beyond a predetermined position in the fuel-increasing direction.

4. A governor for a prime mover having, in combination, a regulating member movable back and forth, means operable to control the positioning of said member in response to detected speed changes, an element selectively movable to impart speed droop to said governor, means providing a motion-transmitting connection between said member and said element, and an auxiliary motion-transmitting means between said element and said member operating with a greater ratio than said first mentioned motion-transmitting means, said last mentioned motion-transmitting means having a lost-motion connection with said regulating member for maintaining the auxiliary motion-transmitting means ineffectual in one portion of the range of movement of said regulating member.

5. The combination of a member adapted for connection to the speed regulator of a prime mover and movable back and forth through a range between high and low torque positions,

a governor adapted to be driven by the prime mover and operable to position said member within said range in accordance with detected speed changes, a device movable back and forth to change the speed setting of said governor, and mechanism connecting said member and said device for transmitting the motion of the member to said device to impart speed droop to said governor, said mechanism including an auxiliary device normally inactive throughout the low torque portion of said range and actuated by said member only in the high torque portion of the range to increase the ratio of motion transmission from said member to said adjusting device and thereby increase said speed droop.

6. The combination of a member adapted for connection to the speed regulator of a prime mover and movable back and forth through a range between high and low torque positions, a governor adapted to be driven by the prime mover and operable to position said member within said range in accordance with detected speed changes, said governor including flyweights, mechanism actuated by said member and operable to vary the loading of said flyweights progressively with changes in the position of said member whereby to impart speed droop to said governor, and an auxiliary mechanism maintained inactive in the low torque portion of said range and actuated by said member in the high torque portion of said range to vary the amount of loading of said flyweights for a given movement of said member and thus increase the speed droop of said governor.

7. The combination of a member adapted for connection to the speed regulator of a prime mover and movable back and forth through a range between high and low torque positions, a governor adapted to be driven by the prime mover and operable to position said member within said range in accordance with detected speed changes, said governor including flyweights, mechanism actuated by said member and operable to vary the loading of said flyweights progressively with changes in the position of said member whereby to impart speed droop to said governor, an auxiliary mechanism maintained inactive in the low torque portion of said range and actuated by said member in the high torque portion of said range to vary the amount of loading of said flyweights for a given movement of said member and thus increase the speed droop of said governor, and means selectively adjustable to vary the point in the movements of said member at which said auxiliary mechanism is rendered active and inactive.

WILLARD J. WHITEHEAD.

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