

June 21, 1932.

W. B. FLANDERS

1,864,127

GOVERNING MECHANISM

Filed Oct. 4, 1929

2 Sheets-Sheet 1

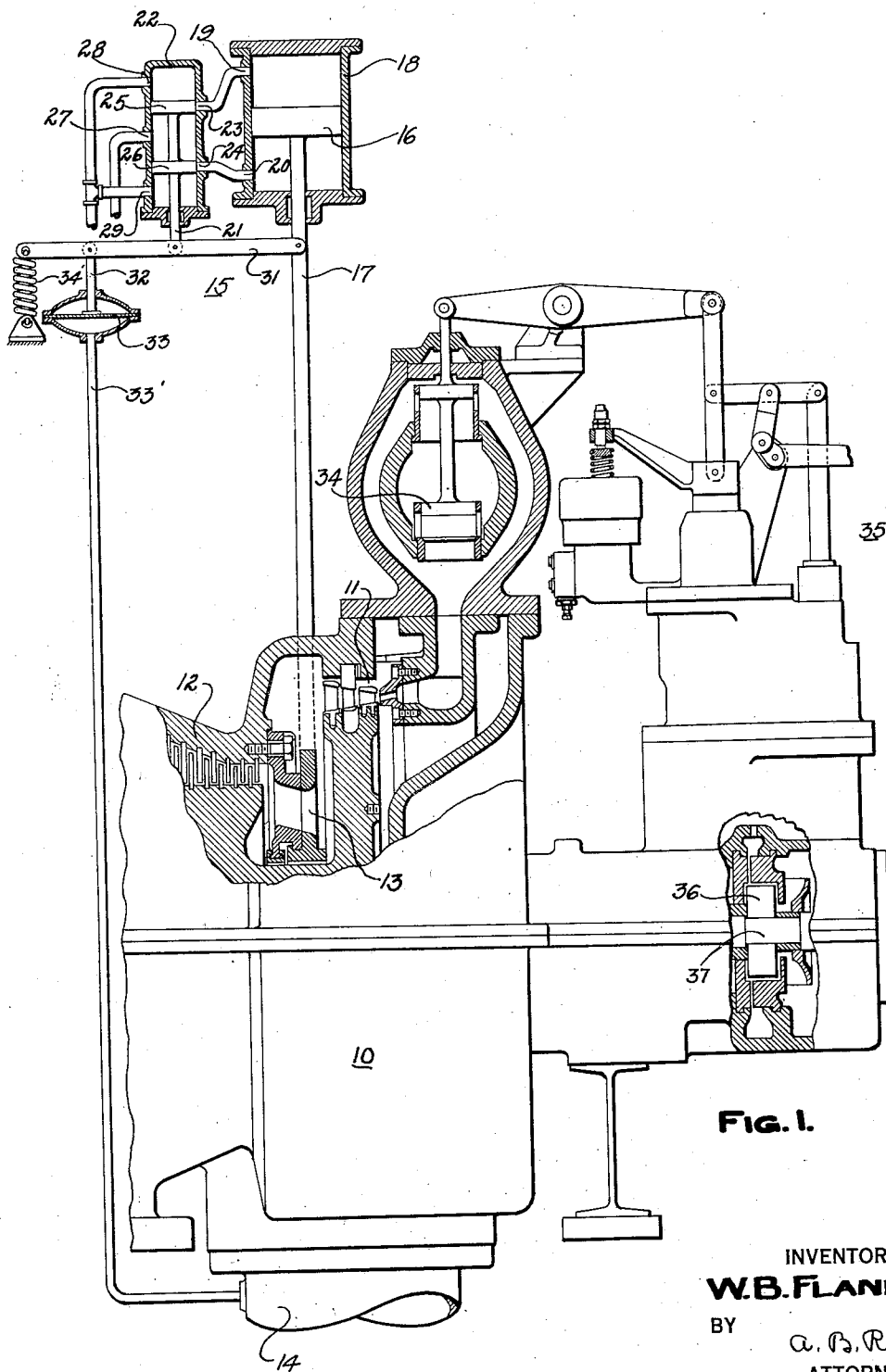


FIG. 1.

INVENTOR
W.B. FLANDERS
BY *A. B. Ruvins*
ATTORNEY

June 21, 1932.

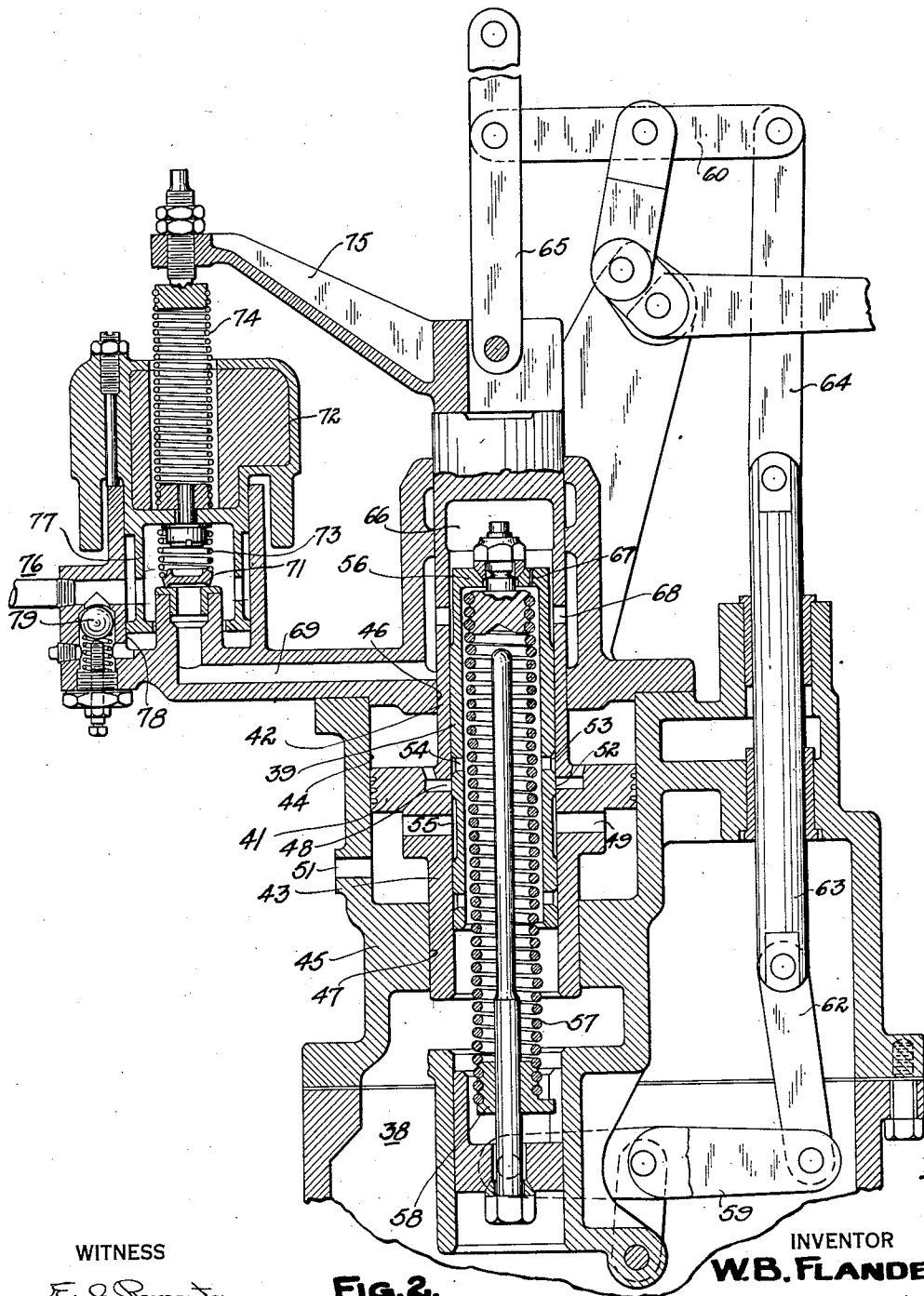
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2 Sheets-Sheet 2



WITNESS

E. Q. Remington

FIG. 2.

INVENTOR

W.B. FLANDERS

BY

O. B. Davis
ATTORNEY

UNITED STATES PATENT OFFICE

WARREN B. FLANDERS, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

GOVERNING MECHANISM

Application filed October 4, 1929. Serial No. 397,355.

My invention relates to a governing or regulating mechanism, more particularly to the speed governor of a prime mover, and it has for its object to provide apparatus of the character designated whereby improved regulation is obtained.

Another object is to provide fluid pressure governing apparatus wherein the governing range, or effective speed change from one extreme of load to the other, may be reduced to any desired degree, or entirely eliminated or even reversed.

A more specific object is to provide fluid pressure governing apparatus comprising a mechanism which has a governing range and which acts promptly upon change in speed, in order to provide stability, and a mechanism which adjusts the setting of the first mechanism to restore or approximately restore the original speed.

A further object is to provide a governor for an extraction turbine which will maintain the speed thereof substantially constant and independent of the extraction demand.

In accordance with my invention, I employ, in connection with a prime mover, a fluid pressure governor of any suitable type which provides an admission valve opening varying inversely with the speed. This governor acts promptly upon a change in speed and provides stability.

To such governor I add a mechanism including means for imposing a second fluid pressure on the pressure-responsive element of the governor, and I vary this second pressure in accordance with the position of a part of the governor which controls the admission valve. This second pressure is so varied to change the speed setting upon movement of said part, that at each position of the admission valve the setting provides the speed which it is desired to maintain. The action of the means varying the second fluid pressure is retarded in order to prevent overtravel or hunting of the governor.

In accordance with another aspect of my invention, I provide an isochronous governor, such as specified above, for the admission valve of an extraction turbine. The admission valve of an extraction turbine must con-

trol the admission to the high pressure section not only to maintain the load on the turbine but also to provide the quantity of partially expanded motive fluid to be extracted from the turbine. In the governors heretofore in use, changes in the position of the admission valve could be effected only by changes in speed. Consequently, the speed of the prime mover varied over a wide range in order to effect the proper operation of the admission valve. By providing an isochronous governor for the admission valve, the admission valve is moved until the correct position is obtained, and the speed of the prime mover is always restored to its designed operating speed.

The above and other objects are effected by my invention, as will be apparent from the following description and claims taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a side elevation, with parts in section, of a steam turbine having my novel form of governor applied thereto; and,

Fig. 2 is a sectional view of my novel governing mechanism.

Referring now to the drawings more in detail, I show, in Fig. 1, a steam turbine 10 having a high pressure section 11 and a low pressure section 12. An interstage valve, such as a grid valve 13, controls the flow of partially expanded fluid to the low pressure section 12, and an extraction conduit 14 communicates with the interior of the turbine casing between the high pressure section and the interstage valve 13. By controlling the amount of motive fluid permitted to flow to the low pressure section or held back therefrom to supply the extraction conduit 14, the interstage valve 13 controls the distribution of fluid between the low pressure section 12 and the conduit 14.

The interstage valve 13 is controlled by a regulating mechanism indicated generally by the numeral 15. This mechanism includes a piston 16 connected to the interstage valve, and adapted to move the same in opening direction upon downward movement and in closing direction upon upward movement. The piston 16 is disposed in a cylinder 18 hav-

ing ports 19 and 20 at the upper and lower ends thereof. A pilot valve 21 is disposed in a pilot valve casing 22, the latter having ports 23 and 24 communicating with the ports 19 and 20 of the cylinder 18, respectively, and adapted to be normally covered by piston portions 25 and 26 formed on the pilot valve 21. The pilot valve casing 22 is further provided with an inlet port 27, through which fluid pressure is admitted for operating the piston 16, and with discharge ports 28 and 29 through which motive fluid is discharged from the opposite side of the piston 16.

A floating lever 31 is connected at one end to the piston rod 17, to the pilot valve 21 intermediate its ends, and by means of a link 32 to a diaphragm 33 at a point near the other end thereof. The diaphragm 33 is subjected on its lower side to the pressure in the conduit 14 communicated thereto through a conduit 33'. A spring 34', connected to the end of the lever 31 biases the end downwardly in opposition to the fluid pressure acting on the diaphragm 33.

The operation of this mechanism will be readily understood by those skilled in the art. Upon an increase in extraction pressure in the conduit 14, the diaphragm 33 moves the left hand end of the lever 31 upwardly, the right hand end being held stationary by the piston rod 17, and the pilot valve being moved upwardly thereby. The ports 23 and 24 are thus placed in communication with the inlet port 27 and the discharge port 29, respectively, thereby effecting downward movement of the piston 16. The downward movement of the piston rod 17 moves the right hand end of the lever 31 downwardly and restores the pilot valve to cut-off position, moving the interstage valve 13 in opening direction an amount corresponding to the increase in extraction pressure. The increased opening of the interstage valve 13 thereupon passes a greater amount of partially expanded steam to the low pressure section 12, and maintains the extraction pressure in the conduit 14 within predetermined limits.

Upon a decrease in extraction pressure, the mechanism 15 operates in the reverse direction, as will be readily understood, to effect movement of the interstage valve in closing direction, thereby holding back additional steam from the low pressure section to supply the conduit 14.

The turbine 10 is further provided with an admission valve 34, controlled and actuated by a fluid pressure governor indicated generally by the reference numeral 35. The governor 35 is of the fluid pressure type and is controlled by fluid pressure developed by an impeller 36 mounted directly upon the turbine shaft 37. Any suitable fluid, preferably lubricating oil, may be used as the medium of fluid pressure. Referring to Fig. 2, showing the governor in section, the fluid

pressure developed by the impeller 36 and varying as the square of the speed of the turbine, is communicated through a passage 38 to the lower side of a hollow pilot valve 39.

The pilot valve 39 is disposed within the hollow cylindrical interior of an operating piston 41 having an upper tubular extension 42 and a lower tubular extension 43. The piston 41 operates in a cylinder 44, provided in the governor casing 45, and the tubular extensions 42 and 43 operate in cylindrical bores 46 and 47, respectively. The piston 41 is provided with an annular row of ports 48, opening into the cylindrical interior thereof and communicating with the upper end of the cylinder 44. The piston is also provided with an annular row of ports 49, providing communication between the interior of the piston and the lower end of the cylinder 44, the latter having a discharge opening 51.

The pilot valve 39 is provided with a piston portion 52 adapted to normally cover the ports 48. Immediately above the piston portion 52 is a recess 53 and an annular row of ports 54 providing communication between the recess 53 and the interior of the pilot valve. The pilot valve is further provided with an elongated recess 55 adapted to provide communication between the ports 48 and 49 upon upward movement of the pilot valve from the position in which the piston portion 52 covers the ports 48.

The pilot valve is formed with a closed upper end 56, which is connected to the upper end of a tension spring 57 disposed within the hollow interior of the pilot valve. The lower end of the spring 57 is connected to a spring-holding member 58, which is connected to the extension 42 of the piston 41, by means of levers 59 and 60 and links 62 to 65. The lever arm ratios of the levers 59 and 60 are so proportioned that upon movement of the operating piston, the spring-holding member 58 is moved a proportional but lesser amount, this movement being for the purpose of effecting greater movement of the operating piston 41 for a given deflection of the spring 57, as is fully explained in Patent No. 1,533,767, issued April 14, 1925, to H. F. Schmidt.

The parts of the governor so far described constitute a known fluid pressure governor of the type providing an opening of the admission valve varying inversely with the speed, which latter varies within the limits of a governing range, and the operation thereof is as follows:

Upon an increase in speed of the prime mover, the fluid pressure developed by the impeller 36 increases, and the force thereof on the pilot valve 39 moves the same upwardly, effecting increased deflection of the spring 57. The ports 48 and 49 are placed in communication by the recess 55. The fluid pressure acting on the lower end of the extension 43

moves the piston 41 upwardly, this being permitted by the flow of fluid from the upper end of the cylinder 44 to the lower end through the ports 48 and 49 until the ports 48 are again covered by the piston portion 52. The upward movement of the piston 41 effects closing movement of the valve 34 to restrict the admission of motive fluid, as is apparent from Fig. 1.

Upon a decrease in speed and consequent decrease in fluid pressure, the decreased deflection of the spring 57 moves the pilot valve 39 downwardly. Fluid pressure now flows through the ports 54, the recess 53 and the ports 48 to the upper end of the cylinder 44 to move the piston 41 downwardly until further admission to the ports 48 is cut off by the piston portion 52. The downward movement of the piston effects increased opening of the admission valve 34.

With the above described governor, and without the additional mechanism herein-after described, there is a range of speed variation, and a different speed within the range is required for each position of the admission valve. Therefore, a permanent change in speed is required to change the position of the admission valve, by which I mean that the turbine must operate at a changed speed as long as a changed position of the admission valve is to be maintained. In order to restore the desired operating speed after a change in valve-opening, I provide the following additional mechanism.

A chamber 66 is formed in the tubular extension 42 above the closed end 56 of the pilot valve. An orifice 67 is formed in the closed end 56, through which a restricted flow of fluid under pressure is admitted to the chamber 66. The chamber communicates, through openings 68 in the extension 42 and a passage 69, with a pressure-relief valve 71, which controls the pressure in the chamber 66.

The relief valve 71 is loaded by a weighted member 72, a compression spring 73 being interposed between the weighted member and the relief valve. A tension spring 74 is connected at its lower end to the weighted member 72, for taking a variable portion of the weight thereof, and at its upper end to a bracket 75 carried by the extension 42.

A dash pot 76, formed by a piston 77 carried by the weighted member 72 and a cylinder 78 in which the piston 77 is disposed, retards downward movement of the weighted member 72. A check valve 79 permits flow of liquid from the upper side of the piston to the lower side thereof, and thus upward movement of the weighted member 72 is but slightly retarded.

The operation of the governing mechanism as a whole is as follows:

Upon a decrease in load, the speed of the turbine increases and the governor operates in the manner above described to effect a de-

creased opening of the admission valve 34. The upward movement of the piston extension 42 elongates the spring 74, which takes a greater portion of the weight of the weighted member 72 and raises the same a small amount. The upward movement of the weighted member is slightly retarded by the dashpot 76. The upward movement of the weighted member 72 reduces the compression of the spring 73, and the decreased bias on the relief valve 71 results in reduced pressure in the chamber 66.

The decrease in pressure in the chamber 66 effects a relatively small additional deflection of the spring 57 and further decrease in the opening of the admission valve 34, this operation continuing at a slightly retarded rate until the speed of the turbine has been reduced to the original or normal operating speed.

Upon increase in load, a decreased deflection of the spring 57 results from decrease in speed and consequent decrease in fluid pressure. An opening movement of the admission valve 34 is effected as above described, and the downward movement of the operating piston 41 effects decreased deflection of the spring 74. The weighted member 72 moves downwardly, the rate of movement being substantially retarded by the dashpot 76. The compression of the spring 73 is slowly increased, and the valve 71 effects a slowly increasing pressure in the chamber 66.

The latter pressure effects still further decrease in the deflection of the spring 57 and further opening movement of the admission valve 34 until the speed is again slowly raised to the normal operating speed.

It will thus be seen that while a temporary change in speed is required to effect movement of the admission valve, the speed is restored upon completion of such movement. There is no permanent change in speed.

To operate as an isochronous governor as above described, that is, to return the prime mover to the same speed at all loads, a scale of the spring 74 is chosen which will, for a given movement of the operating piston 41, effect a change in the force of the fluid pressure in the chamber 66 acting on the pilot valve 39, which provides a deflection of the spring 57 corresponding to said given movement of the operating piston. This is, as there is to be no permanent change in the fluid pressure developed by the impeller 36 and acting upwardly on the pilot valve 39, the deflection of the spring 57 required to effect correct movement of the admission valve 34 to carry the load must be provided by a change in fluid pressure in the chamber 66.

Such a scale of the spring 74 eliminates a permanent governing range. However, by making it of lighter scale, the governing range would not be eliminated but merely reduced, while by making it of greater scale a

negative governing range would result, that is, the speed would increase with increase in load.

By providing a lighter scale of the spring 74, the change in pressure in the chamber 66 is not sufficient to provide the required movement of the admission valve upon a change in load, and a permanent change in speed is required, though the change is less than that which would be required in the absence of the pressure in the chamber 66.

By making the scale of the spring 74 greater than that required for isochronous operation, the change in pressure in the chamber 66 is greater than is required to effect necessary movement of the admission valve. Upon increase in load, a temporary decrease in speed takes place, but the speed then increases to more than the original speed.

It will be seen that the mechanism for varying the pressure in the chamber 66 constitutes a means for varying the speed setting. For a given pressure, the governor operates within a given range, which is the initial operation upon a change in load and momentary change in speed. However, upon movement of the operating piston after such change in speed, the pressure in the chamber 66 varies to change the speed setting so that the normal operating speed will correspond to whatever the load on the turbine may be and to the admission valve opening required to carry that load.

A change in demand for partially expanded motive fluid operates the mechanism 15 as above described. Operation of the mechanism 15 to supply an increased demand reduces the amount of motive fluid delivered to the low pressure section 12, resulting in decrease in power developed by that section. The speed temporarily decreases, and the governing mechanism operates to increase the fluid admission until the normal speed is restored in the same manner as if an increase in load had occurred. Likewise, upon decreased demand and resultant increase in the power developed by the section 12, the speed temporarily increases, and the governing mechanism operates to decrease the fluid admission until the normal speed is restored, in the same manner as if a decrease in load had occurred.

It will thus be seen that I have provided governing mechanism for an extraction turbine which provides no permanent change in speed upon variation in amount of fluid extracted.

While I have shown my invention in but one form, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are im-

posed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. In a speed governing mechanism for a prime mover, the combination of means providing a fluid pressure varying as a function of the speed of the prime mover, pressure-responsive means subjected to said fluid pressure, a fluid pressure relay mechanism controlled by said pressure-responsive means and including an operating piston, means providing a second fluid pressure varying as a function of the position of the operating piston, and means for applying said second fluid pressure to the pressure-responsive means in that direction in which the variations in fluid pressure increase the action of the pressure-responsive means.

2. In a speed governing mechanism for a prime mover, the combination of means providing a fluid pressure varying as a function of the speed of the prime mover, pressure-responsive means subjected to said fluid pressure, a fluid pressure relay mechanism controlled by said pressure-responsive means and including an operating piston, means providing a second fluid pressure varying with the position of the operating piston, means for applying said second fluid pressure to the pressure-responsive means, and means for retarding the speed of operation of the means providing the second fluid pressure.

3. In a speed governing mechanism for a prime mover, the combination of means providing a fluid pressure varying as a function of the speed of the prime mover, pressure-responsive means subjected to said fluid pressure, a fluid pressure relay mechanism controlled by said pressure-responsive means and including an operating piston, means providing a second fluid pressure varying as a function of the position of the operating piston, said last-mentioned means decreasing said second fluid pressure upon movement of the operating piston in consequence of speed increase and increasing said pressure upon movement of the operating piston in consequence of speed decrease, and means for applying said second fluid pressure to the pressure-responsive means in opposition to the first-mentioned fluid pressure.

4. The combination with a prime mover having an admission valve, of governing mechanism therefor comprising means providing a fluid pressure varying substantially as the square of the speed of the prime mover, a pressure-responsive element subjected to said pressure and controlling said admission valve, means for providing a second fluid pressure and for increasing the same upon increase in opening of the admission valve and decreasing the same upon decrease in valve opening, and means for applying said second fluid pressure to the pressure-responsive ele-

ment in opposition to the first-mentioned fluid pressure.

5. The combination with a prime mover having an admission valve, of a governing mechanism therefor comprising means providing a fluid pressure varying as a function of the speed of the prime mover, a fluid pressure relay including a piston for operating said admission valve and a pilot valve subjected in one direction to said fluid pressure, means providing a second fluid pressure, and means for increasing said second fluid pressure upon movement of the operating piston in valve-opening direction and decreasing said second fluid pressure upon movement in valve-closing direction, said pilot valve being subjected to the second fluid pressure in opposition to the first-mentioned fluid pressure.

6. In a governing mechanism for a prime mover having an admission valve, the combination of a fluid pressure relay for the admission valve having a controlling element, means biasing said element with a fluid pressure varying as a function of the speed of the prime mover, means providing an enclosed space, means providing a restricted flow of fluid into said space, a pressure-relief valve controlling the escape of fluid from said space and imposing a pressure on the fluid therein, a spring interposed between the pressure-relief valve and a part movable with the operating piston for varying the pressure imposed on the fluid in said space in accordance with the position of the operating piston, and means for imposing the fluid pressure obtaining in said space on said controlling element in that direction in which the variations in fluid pressure increase the movement of the controlling element.

7. The combination with a prime mover having an admission valve, of governing mechanism therefor comprising means for developing a fluid pressure varying as the square of the speed of the prime mover, a pressure-responsive element subjected to said fluid pressure, a fluid pressure relay mechanism controlled by said pressure-responsive element and actuating said admission valve, means providing an enclosed space, means providing a restricted flow of fluid into said enclosed space from said variable fluid pressure, means controlling the escape of fluid from said space and imposing a back pressure thereon, said back pressure increasing upon increase in opening of said admission valve and decreasing upon decrease in opening thereof, and means for imposing the pressure in said enclosed space to the pressure-responsive element in opposition to the first-mentioned fluid pressure.

In testimony whereof, I have hereunto subscribed my name this 17th day of September, 1929.

WARREN B. FLANDERS.