July 14, 1931. J. S. MYERS 1,814,630

GOVERNOR

Filed July 15, 1925 4 Sheets-Sheet 1

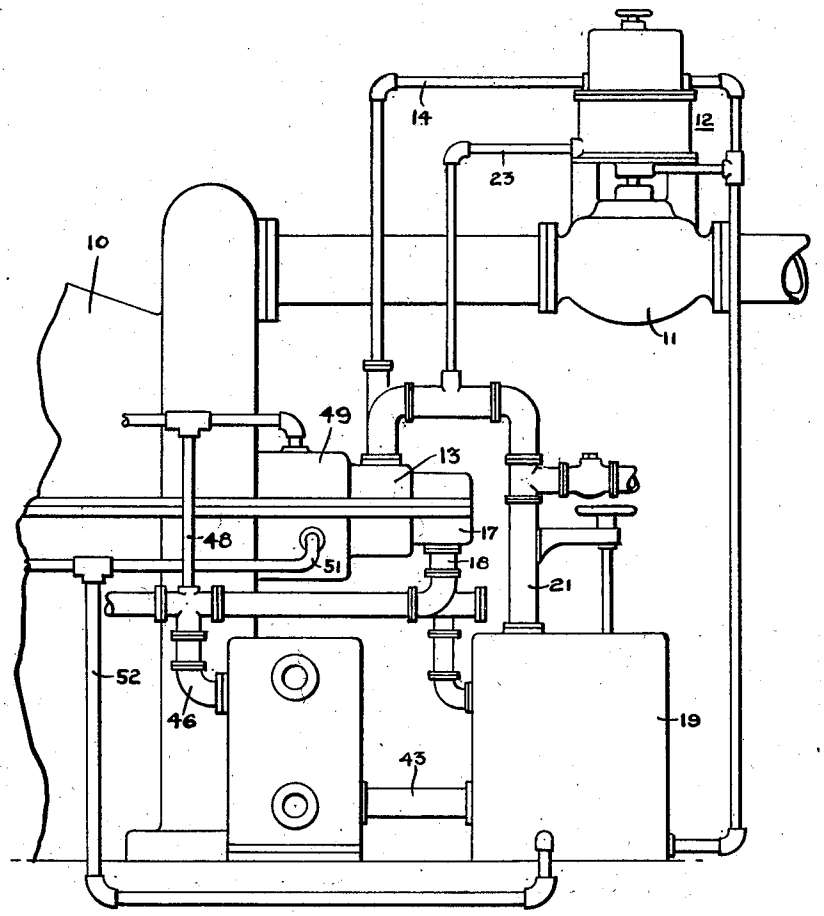


Fig. 1.

WITNESS

J. S. Myers
INVENTOR

BY

ATTORNEY

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GOVERNOR

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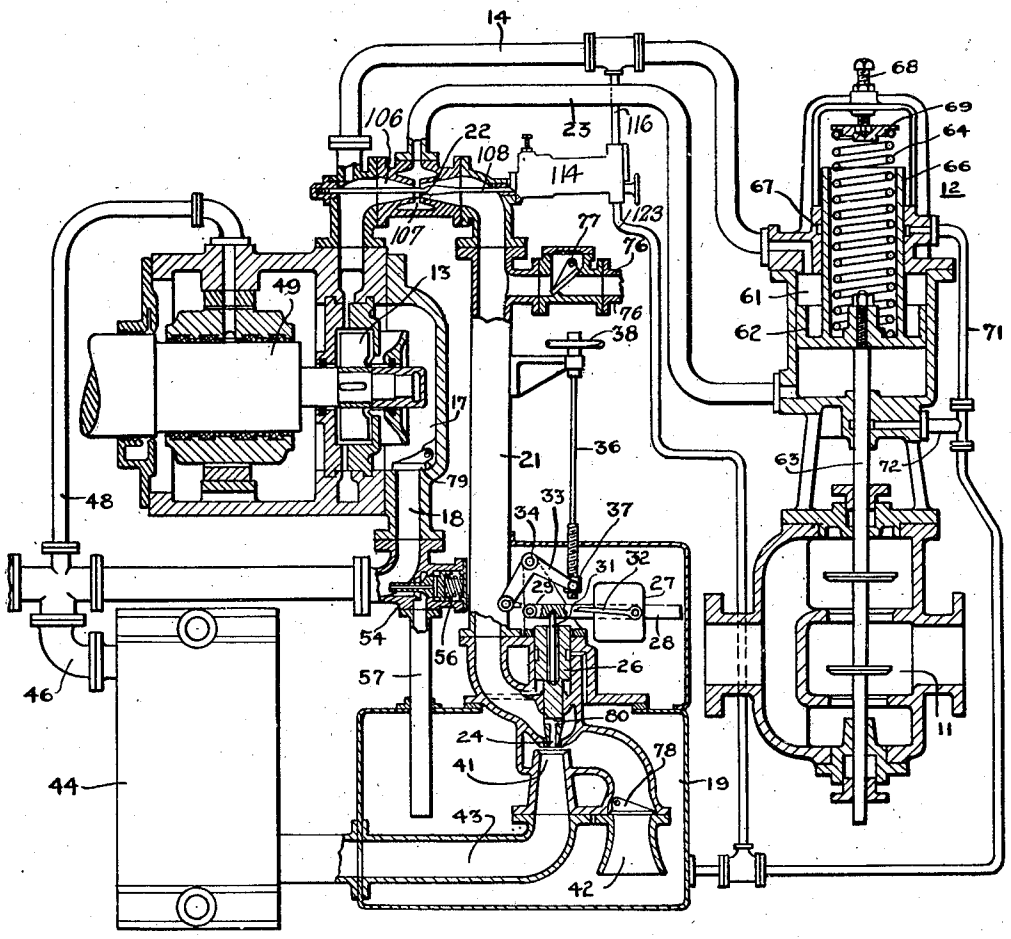


Fig. 2.

WITNESS

J. S. Myers
INVENTOR

BY D. C. Davis
ATTORNEY

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GOVERNOR

Filed July 15, 1925 4 Sheets-Sheet 3

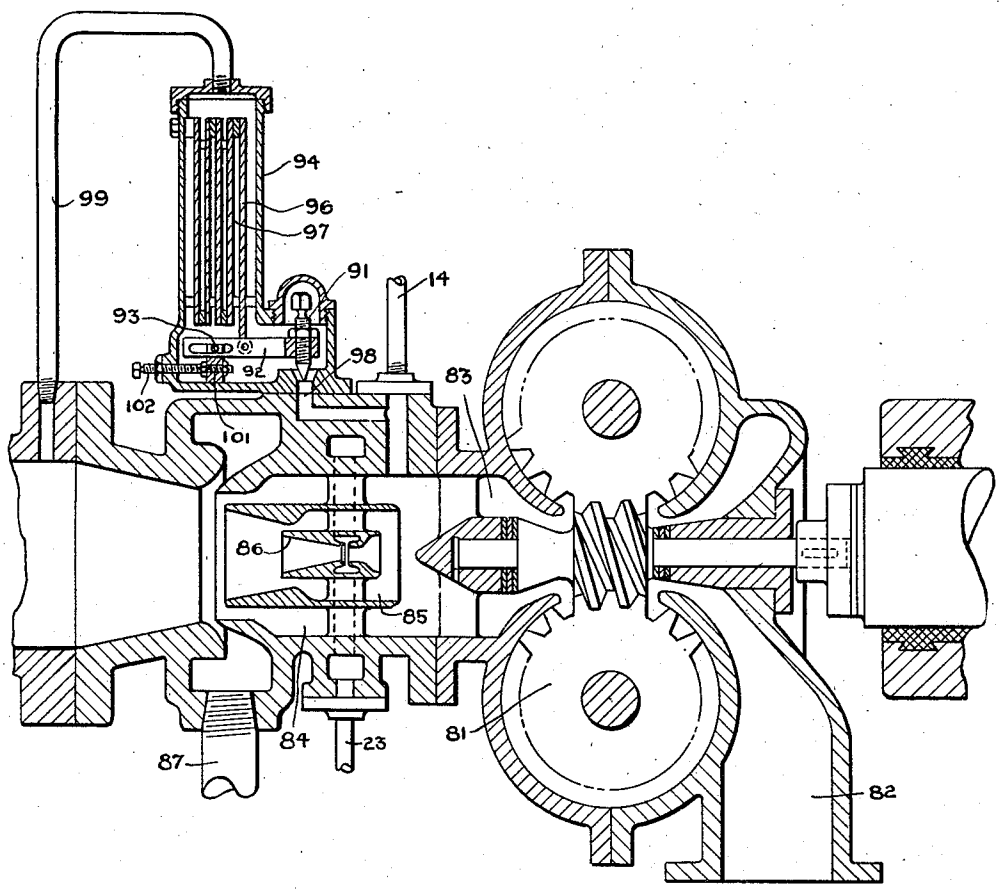


Fig. 3.

WITNESS

J.S. Myers
INVENTOR

BY D.C. Davis

ATTORNEY

July 4, 1931. J. S. MYERS 1,814,630

GOVERNOR

Filed July 15, 1925 4 Sheets-Sheet 4

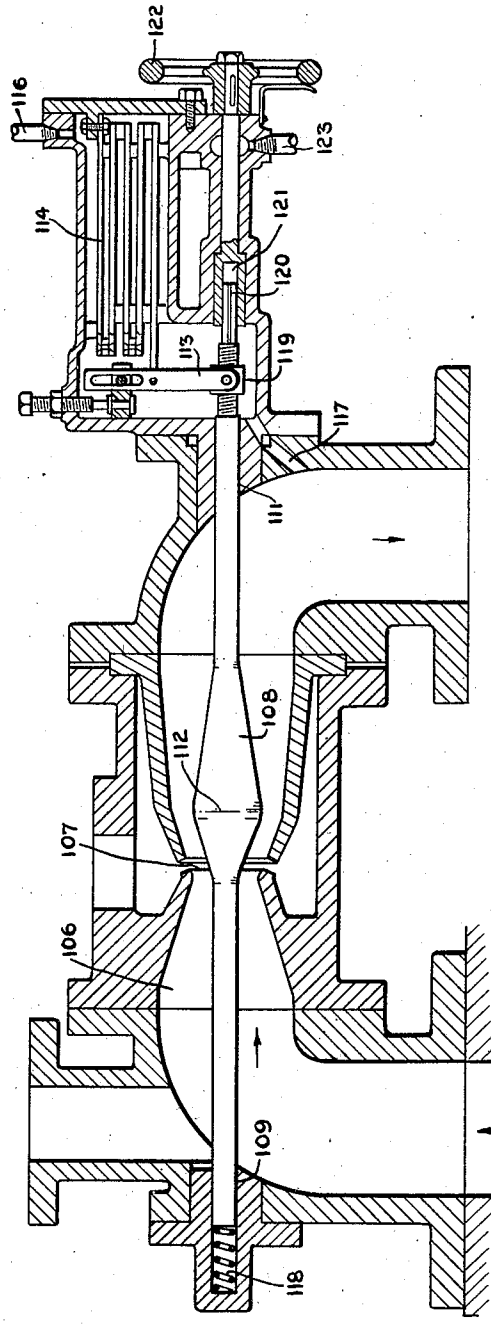


Fig. 4.

WITNESS

O. B. Wakefield

J. S. Myers
INVENTOR

BY D. C. Davis

ATTORNEY

Patented July 14, 1931 1,814,630

UNITED STATES PATENT OFFICE

JOHN S. MYERS, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

GOVERNOR

Application filed July 15, 1925. Serial No. 43,811.

My invention relates to fluid pressure operated governing systems for a prime mover and has for its object the provision of apparatus of the character designated which shall be extremely sensitive to variations in speed of the prime mover and which shall effect a positive control of said speed.

A further object of my invention is to provide means associated with a governor operated by variable fluid pressure developed by a pump, for obtaining further and wider variations in pressure varying with the velocity of the fluid under pressure delivered by the pump.

These and other objects are obtained by apparatus made in accordance with my invention and illustrated in the accompanying drawings wherein:

Fig. 1 is a view in elevation of an elastic fluid turbine having my improved governing apparatus applied thereto; Fig. 2 is a sectional view of the pump and governing apparatus shown in Fig. 1; Fig. 3 is a view similar to Fig. 2 but showing a modified form of my invention employing a different kind of pump from that shown in Fig. 1; and Fig. 4 is a sectional view of a form of viscosity compensating mechanism adapted to be employed with my invention.

It has heretofore been proposed to govern a prime mover by variable fluid pressure operated governing apparatus, the variable fluid pressure being developed by a pump driven by the prime mover. An example of such apparatus may be found in my Patent No. 1,533,888, issued April 14, 1925, and assigned to the Westinghouse Electric and Manufacturing Company. In the apparatus described in the aforesaid patent, governing movements are effected by fluid pressure developed by a centrifugal pump driven by the prime mover and varying as the square of the speed thereof. While such apparatus has proved to be eminently successful in operation, I have found that by the addition of a simple apparatus to the system, a far wider variation in pressure may be secured than the variation in pressure developed by the pump alone and, as a result, the governing apparatus is simplified and made more sensitive to variations in speed.

In accordance with my invention I may employ either a centrifugal pump, as shown in my patent aforesaid, or I may employ a pump having purely a volume displacement characteristic, said volume displacement varying with the speed, such, for example, as a gear pump, and interpose a suitable valve or orifice in the path of the fluid discharged from the pump, whereby it may be caused to develop a pressure varying with the speed of the prime mover. With whatever type of pump employed, the major portion of the fluid is discharged through a converging-diverging passage which, as is well known, has the characteristic of varying the pressure of the fluid passing through the converged portion thereof inversely to the velocity of said fluid. Thus, as the speed of the prime mover increases, the pressure developed by the pump increases and the volume of fluid pumped increases, increasing the velocity of fluid flowing through the converging-diverging passage.

As the velocity of the fluid flowing through the converging-diverging passage increases, its pressure decreases at the converged portion. Upon decreases in pressure developed by the pump, the volume of fluid pumped decreases, the velocity of fluid flowing through the converging-diverging passage decreases, and the pressure at the converged portion of the passage increases. I therefore provide a governing apparatus which utilizes both of the beforementioned variable pressures; employing the pressure which increases with a speed increase on one side of an operating piston, and the pressure which decreases with a speed increase on the opposite side of an operating piston. In the resulting apparatus, the effective change of pressure for a given change in speed is much greater than any heretofore known to me and the apparatus is therefore more sensitive and more effective in providing close regulation of the machine governed.

Referring now to the drawings for a better understanding of my invention I show in Fig. 1 at 10 an elastic fluid turbine having

an admission valve 11 controlled by my improved fluid pressure governing apparatus at 12. Fluid pressure for operating the governing apparatus 12 is developed by a pump 13, driven directly from the turbine shaft and delivering relatively high pressure fluid to the governing apparatus at 12 through a conduit 14. The inlet of the pump 13 is indicated at 17 and fluid passing to the inlet enters through a conduit 18. While a portion of the fluid under pressure developed by the pump 13 is piped directly from the discharge side of the pump to the governing apparatus at 12, the major portion of the fluid under pressure developed thereby is delivered to a fluid reservoir 19 through a conduit 21 in a manner to be more fully described later.

Referring now to Fig. 2 it may be seen that fluid discharged by the pump 13 into the conduit 21 passes through a converging-diverging passage or Venturi nozzle 22. The fluid passing the converged portion of the passage 22 has its velocity increased beyond the velocity of the fluid discharged by the pump, and the pressure thereat is consequently less than that either at the entrance or at the discharge side of the passage. Upon an increase in speed of the turbine 10, the pressure developed by the pump 13 increases as well as the volume of fluid passing through the conduit 21. The volume passing through the conduit 21 increasing, effects an increase in velocity at the converged portion of the passage 22 and the pressure thereat decreases. In my improved apparatus, therefore, the pressure delivered by the pump 13 and piped to the governing apparatus 12 through the conduit 14 increases upon increases in speed and decreases upon decreases in speed. At the same time, the pressure of the fluid in the converged portion of the passage 22 decreases upon increases in speed and increases upon decreases in speed. I accordingly provide a conduit 23 communicating with the converged portion of the passage 22 and leading to the governing apparatus 12 for operation thereof in a manner to be more particularly described later.

In order to provide a dependable rate of change in pressure in the converged portion of the passage 22 per unit of change in speed of the prime mover governed, it is desirable that the pressure at the discharge side of the passage 22 be maintained substantially constant. I have accordingly provided at the lower end of the conduit 21, within the reservoir 19, a relief valve 24 designed to keep said pressure substantially constant. The relief valve 24 has connected thereto a piston member 26 subjected, on its under side, to the pressure within the conduit 21 tending to force it upwardly and to force the valve 24 in an opening direction. Opposing the pressure acting against the piston member 26 is a weight 27 carried by a lever 28. The lever 28 is pivoted at 29 and bears upon the piston member 26 through a stem 31 abutting the lever 28 at a point between the weight 27 and the pivot 29. Should the pressure within the conduit 21 and at the discharge side of the passage 22 increase, the piston 26 is forced upwardly and the valve 24 opened wider, relieving the increased pressure. Should the pressure within the conduit 21 tend to decrease, the weight 27 causes the piston 26 to move the valve 24 in a closing direction, restricting the flow of fluid through the valve 24 and permitting the pressure within the conduit to build up. In order that the pressure within the conduit 21 may be regulated, I provide means for shifting the weight 27 along the lever 28 in the form of a rod 32 coupled to a bell crank lever 33 which is pivoted at 34 and which is operated through a stem 36, by a screw and nut connection 37. Upon rotating the stem 36, the bell crank lever arm connected thereto is raised or lowered and the weight 27 is moved inwardly or outwardly along the lever 28, varying the force exerted upon the piston 26 by the weight 27. The stem 36 may be rotated by any suitable means such, for example, as a hand wheel 38 which affords a ready means for moving the weight 27 along the lever 28 remotely from the weight 27, or by any other means known to the art. Inasmuch as variations in pressure in the conduit 21 vary the pressure at the converged portion of the passage 22, shifting the position of the weight 27 effects a variation in the speed of the turbine 10.

Fluid flowing through the conduit 21 is utilized to operate an ejector 41 having an inlet 42 and a discharge conduit 43. Fluid discharged through the conduit 43 preferably passes through an oil cooler 44 and from thence to a conduit 46. It will be apparent that the pressure developed by the ejector 41 and passing through the conduit 46 is below that of the pressure developed by the pump 13 and is such as to be desirable to employ in the lubrication of bearings. I accordingly show a conduit 48 leading from the conduit 46 to a bearing 49. After passing through the bearing 49 fluid is drained away therefrom through a conduit 51 and a branch conduit 52 back to the reservoir 19 (see Fig. 1). A portion of the fluid under pressure developed by the ejector 41 is conveyed to the inlet 17 of the pump 13 through the conduit 18 which is connected to the conduit 46. Inasmuch as the pressure developed by the pump is the pressure delivered thereto at its inlet side plus the pressure due to its speed, it is highly desirable that a constant pressure be provided at the inlet side of a pump employed for developing governing pressure in order that said pressure may truly be a function of the speed of the prime mover. I accordingly provide a by-pass valve 54 in the

conduit 46 which prevents a building up of pressure in the conduit 18 beyond a predetermined pressure. The by-pass valve 54 is biased towards its seat by a spring 56 of the desired tension. Should the pressure within the conduit 46 rise above the pressure determined by the load on the spring 56, the valve 54 is opened and fluid is by-passed thereby through a conduit 57 back to the reservoir 19.

The governing apparatus 12 embodies an operating cylinder 61 having disposed therein a piston 62 connected directly to the admission valve 11 through a stem 63. The piston 62 is biased downwardly, in a direction for closing the valve 11, by a spring 64. On the upper side of the piston 62 is a stem portion 66 of relatively large diameter which makes an approximately fluid-tight fit with the upper cover 67 of the cylinder 61. The purpose of the upper stem portion 66 of the piston 62 is to limit the area of the upper side of said piston and make it less than the area of the under side. Fluid under pressure developed by the pump 13 is delivered through the conduit 14 to the upper side of the piston 62 and, in addition to the force exerted by the spring 64, tends to force the piston downwardly and to force the valve 11 in a closing direction. Fluid under a pressure varying inversely with the velocity of the fluid flowing through the passage 22 is conveyed through the conduit 23 to the lower side of the piston 62 and acts upon the greater area of said piston, tending to force it upwardly against the force of the higher pressure acting on the upper side of said piston plus the force exerted by the spring 64. The initial deflection of the spring 64 may be varied by means of an adjusting screw 68 extending through the upper part of the governor and connected to an abutment 69 bearing against the spring 64. Fluid leaking past the stem portion 66 of the piston 62 is free to pass to the reservoir 19 through a drain conduit 71. Fluid leaking by the stem 63 in the lower part of the cylinder 61 passes through a conduit 72 to the conduit 71 and thence to the fluid reservoir 19.

The operation of the apparatus so far described is as follows: Assume that the turbine 10 is running under normal load and at normal speed. The fluid under pressure developed by the pump 13 is conveyed to the upper side, or the side of lesser area, of the piston 62 and, in addition to the force of the spring 64, tends to force the piston downwardly. At the same time, fluid under a lesser pressure flowing through the converged portion of the passage 22 is conveyed to the lower side of the piston 62 through the conduit 23 and bearing against the greater area of said piston tends to force the piston upwardly. Under the conditions assumed, under normal load and running at normal speed, the opposing forces acting on the piston 62 are equal and the piston 62 remains stationary. Assume now that there is an increase in speed of the turbine 10, increasing the fluid pressure developed by the pump 13 as well as increasing the volume of fluid flowing through the passage 22. The pressure in the converged portion of the passage 22 and acting against the lower side of the piston 62 decreases while the pressure developed by the pump increases in proportion to the square of its speed. The piston 62 is therefore promptly moved downwardly, imparting a closing movement to the admission valve 11. The piston 62 continues to move downwardly until the load on the spring 64 has decreased sufficiently so that the lesser pressure acting against the lower side of the piston can balance the force exerted by the greater pressure plus the force exerted by the spring 64 against the upper side of the piston or side of lesser area.

Assume now that there is a decrease in the speed of the turbine 10. The pressure developed by the pump 13 decreases as well as the volume delivered thereby. With a decrease in pressure and a decrease in volume, the pressure within the conduit 14 decreases and the pressure within the conduit 23 increases. With a decreased pressure acting on the upper side of the piston 62 and an increased pressure acting against the lower side thereof, the piston is caused to move upwardly, imparting an opening movement to the admission valve 11.

Inasmuch as the force of the spring 64 is exerted to move the piston 62 in a direction for closing the admission valve 11, it will be obvious that upon a failure of governing fluid pressure, the admission valve 11 will be closed. This will also occur upon shutting down the turbine 10. In order to start the turbine after being idle, it is necessary to introduce fluid under pressure into the system from an outside source. I accordingly show at 76 a conduit adapted for connection with fluid under pressure from some outside source, not shown, and connected to the conduit 21. A check valve 77 is provided in the conduit 76 which prevents a back flow of fluid from the conduit 21 when the pump 13 is in operation and developing fluid pressure. I further provide a check valve 78 within the ejector intake 42 which prevents an outflow of fluid from the conduit 21 when fluid is being admitted from an outside source. A similar check valve 79 is provided at the inlet of the pump 13 to prevent an escape of fluid from the pump when fluid is being admitted to the system through the conduit 76. When pressure is being admitted to the conduit 76, therefore, it is free to build up pressure quickly within the conduit 21 and the conduits 23 and 14. As the pressures within the conduits 23 and 14 are, under the circumstances described, equal, the pressure within the conduit 23 acting against the

greater area of the piston 62 forces said piston upwardly and opens the admission valve 11, permitting the turbine 10 to be started. In order that the bearings may be lubricated when starting the turbine and introducing fluid under pressure from an outside source, I provide a passage 80 in the relief valve 24 which permits a restricted flow of fluid into the conduit 43 and from thence to the bearings in a manner already described.

Referring now to Fig. 3 I show a modified form of my invention employing a gear pump which has the characteristic of displacing a variable volume of fluid in accordance with the speed of the prime mover instead of a variable volume and pressure. However, by providing an orifice adapted to pass a constant quantity of fluid at all times, the pressure on the discharge side of the pump will vary directly with the speed. In the drawing a pump is shown at 81, such as illustrated and described in my copending application Patent No. 1,654,048, issued December 27, 1927, on an application which was copending herewith, and assigned to the Westinghouse Electric and Manufacturing Company, and has an intake 82 and a discharge conduit 83. Inserted within the discharge conduit 83 is a converging-diverging nozzle which, when used in connection with a gear pump, I prefer shall be of the compound variety comprising an outer converging-diverging nozzle 84 and one or more inner converging-diverging nozzles, illustrated as two, 85 and 86. The purpose of compounding the converging-diverging passage is to secure a wider variation in pressure per unit of change in the velocity of the fluid passing therethrough than can be obtained with a single orifice. The orifices or converged portions of the nozzles 84, 85 and 86 afford sufficient resistance to the flow of fluid delivered by the pump 81 to cause it to develop at its discharge side a pressure varying with the speed. The conduit 14 leading to the governor 12 and conveying the higher pressure is connected directly to the delivery passage 83, while the conduit 23 conveying the lower pressure is connected to the throat or converged portion of the inner nozzle 86.

Connected to the throat of the nozzle 84 is a conduit 87 which may be connected to the reservoir 19 (Fig. 2), whereby a greater quantity of fluid may be entrained from the reservoir and discharged at a lower pressure for use in the turbine bearings.

When starting the turbine 10, the fluid, usually lubricating oil, pumped by the pump 81 is liable to be cooler than when the turbine has been run for a considerable time, having a greater viscosity, and the resistance to flow through the nozzles 84, 85 and 86 will therefore be greater. With a greater resistance to flow through the nozzles, the pressure at the discharge side of the pump for a given speed is higher than it is after the oil has reached a uniform temperature and viscosity. I accordingly provide means responsive to the temperature of the fluid and consequently responsive to its viscosity for by-passing a part of the fluid delivered to the conduit 83 and maintaining the fluid pressure delivered to the conduit 14 a true function of the speed of the turbine. The apparatus comprises an adjustable valve member 91 carried by a lever 92 which is pivoted at 93. The lever 92 is controlled by a thermostat 94 which is comprised of a series of alternating strips of metal 96 and 97, for example, brass and steel, having different coefficients of expansion. A passage 98 leads from the discharge conduit 83 to the valve member 91 and fluid passing by said valve member 91 flows around the members 96 and 97 and out at the top of the thermostat 94 through a conduit 99 into the discharge side of the converging-diverging passage. The members 96 and 97 are so arranged that as the temperature of the fluid decreases, the valve 91 is raised, permitting a freer flow of fluid thereby and lowering the pressure in the conduit 83.

Upon an increase in temperature of the fluid, the lever 92 is lowered and the valve 91 is moved in a closing direction, restricting the flow of fluid by the valve 91. In order that the rate of opening of the valve 91 per unit of change in temperature of the fluid may be varied, I provide a movable support 101 for the pivot 93 and provide an adjusting screw 102 for moving said pivot longitudinally of the lever 92. Should the pivot 93 be moved inwardly of the thermostat 94 it is apparent that the rate of opening of the valve 91 will be greater. Should the pivot 93 be moved outwardly of the thermostat 94 the rate of opening of the valve 91 will be lessened.

The operation of this modification of my invention is as follows: Fluid from the fluid reservoir 19 supplied to the inlet of the pump 81 is pumped therethrough in a volume directly proportional to the speed of the turbine into the discharge conduit 83. The resistance to flow within the discharge conduit causes pressure to build up at the delivery side of the pump varying directly with the speed of the turbine. At the same time, the thermostat 94 operates through the valve 91 and compensates for any changes in viscosity of the fluid and renders the pressure within the conduit 14 a true function of the speed of the pump 81. The major portion of the fluid delivered by the pump 81 passes through the nozzles 84, 85 and 86, having its pressure reduced in the throat portions thereof, said pressure varying inversely to the speed of the prime mover. The conduit 23, leading to the governor 12, as shown in Fig. 2, connects directly with the converged portion of the nozzle 86 and serves to aid in the

operation of the governor 12 in a manner already described.

Where a centrifugal pump is employed with my invention, difficulties due to varying viscosity of the fluid employed are not so evident as where a gear pump is employed. Conditions may arise, however, where the varying viscosity of the fluid passing through the converging-diverging passage employed in the system will render erratic the pressure of fluid in the throat portion of passage. I accordingly show in Figs. 2 and 4 further apparatus designed to compensate for variations in the viscosity of the fluid, which may be used with equal effectiveness with a gear pump or a centrifugal pump. In these figures of the drawings, a converging-diverging nozzle 106 is shown having a converged or throat portion 107. Within the nozzle member 106 and extending longitudinally thereof I provide an adjusting member 108, said member being carried in suitable guides 109 and 111 located at opposite ends of the nozzle 106. The adjusting member 108 is provided, intermediate its ends and adjacent the throat 107, with an enlarged portion 112 substantially conforming in contour to the throat passage 107. One end of the compensating member 108 is connected to a lever 113 which is operated by a thermostat 114 in the same manner as already explained for the thermostat 94. Fluid from the discharge side of the pump with which the nozzle 106 is associated is conveyed to the thermostat 114 through conduits 14 and 116 and passes outwardly thereof through a passage 117. The opposite end of the compensating member 108 is provided with a spring 118 for biasing it inwardly of the nozzle member 106 and taking up slack in the thermostatic connections. In order to change the initial adjustment of the compensating member 108 it may be connected to the lever 113 by a screw and nut connection 119 and have the associated end of the member 108 squared as shown at 120 to fit a socket 121 having a stem extending outwardly of the thermostat 114 and operable by means of a hand wheel 122. By rotating the hand wheel 122 the member 108 is turned in the screw and nut connection 119 and the enlarged portion 112 is moved inwardly or outwardly, as the case may be, of the throat portion 107. At 123 I show a drain conduit for carrying away leakage by the adjusting mechanism.

The operation of this modification of my invention will be apparent. Fluid enters and passes through the nozzle member 106 in the direction shown by the arrows. When the fluid is relatively cool, the thermostat 114 is so connected that the enlarged portion 112 of the compensating member 108 is moved away from the throat portion 107, permitting a freer flow of fluid therethrough. As the temperature of the fluid increases, the thermostat 114 operates to move the enlarged portion 112 toward the throat portion 107, restricting the flow of fluid therethrough.

From the foregoing it will be apparent that I have provided an improved governing apparatus extremely sensitive in operation and capable of effecting close control of the prime mover governed.

While I have shown my invention in but two forms, it will be obvious to those skilled in the art that it is not so limited, but is susceptible of various other changes and modifications, without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or as are specifically set forth in the appended claims.

What I claim is:

1. The combination with a prime mover, of a pump driven thereby for developing a fluid pressure varying with the speed thereof, a fluid reservoir, a discharge conduit leading from the pump to the fluid reservoir, a converging-diverging passage within the discharge conduit, a biased relief valve for maintaining a substantially constant pressure at the discharge side of the converging-diverging passage, an ejector operated by fluid pressure passing the relief valve for supplying fluid under pressure to the inlet side of the pump, means for maintaining the pressure supplied to the inlet side of the pump substantially constant, a fluid pressure operated governor including a biased element movable in response to variations in fluid pressure, means for subjecting one side of said element to the pressure delivered by the pump, and means for subjecting the other side of said element to the variable pressure in the converged portion of the passage.

2. In a fluid pressure operated governing apparatus for controlling the speed of a prime mover having a pump driven thereby for developing a fluid pressure varying as a function of only the speed thereof, the combination of an operating piston having a side of lesser and of greater area, a spring for biasing the piston in the direction of its side of greater area, conduit means leading from the pump discharge to the side of lesser area, a converging-diverging passage provided in said conduit and other conduit means leading from the converged portion of the passage to the side of greater area.

3. The combination with a prime mover having an admission valve, of a pump driven by the prime mover for developing fluid pressure varying with the speed thereof, a discharge conduit for the fluid under pressure developed by the pump and having a converging-diverging passage therein, a differential piston for controlling the admission valve, a spring for biasing the differ-

ential piston in a direction for closing the admission valve and in the direction of the side of greater area of said piston, conduit means leading from the pump discharge to the side of lesser area of the differential piston, and other conduit means leading from the converged portion of the passage to the side of greater area.

4. The combination with a prime mover having an admission valve, of a pump driven by the prime mover for developing fluid pressure varying with the speed thereof, a discharge conduit for the fluid under pressure developed by the pump, said conduit having a converging-diverging passage provided therein, a fluid pressure operated governor for controlling the admission valve and actuated by the resultant force exerted by the pressure of fluid developed by the pump opposed by force exerted by the pressure of fluid in the converged portion of the passage, a valve member for modifying the rate of flow through the passage, and means responsive to the temperature interposed in the path of the fluid discharged from the pump for actuating the valve member.

5. The combination with a prime mover having an admission valve, of a pump driven by the prime mover for developing fluid pressure varying with the speed thereof, a discharge conduit for the fluid under pressure developed by the pump, said conduit having a converging-diverging passage provided therein, a fluid pressure operated governor for controlling the admission valve and actuated by the resultant of force exerted by pressure of fluid developed by the pump opposed by force exerted by the pressure of fluid in the converged portion of the passage, temperature responsive means disposed within the path of the fluid under pressure developed by the pump, and means actuated by said temperature responsive means for varying the area of the converged portion of the passage.

6. The combination of a prime mover having an admission valve, a pump driven by the prime mover for developing fluid pressure varying with the speed thereof, a discharge conduit for the fluid under pressure developed by the pump, said conduit having a converging-diverging passage provided therein, a fluid pressure operated governor for controlling the admission valve and actuated by the resultant of force exerted by pressure of fluid developed by the pump opposed by force exerted by pressure of fluid in the converged portion of the passage, temperature responsive means disposed within the path of the fluid under pressure developed by the pump, a diverging-converging member disposed within the converging-diverging passage, and an operative connection between the temperature responsive means and the diverging-converging member.

7. The combination of a prime mover having an admission valve, a pump driven by the prime mover for developing fluid pressure varying with the speed thereof, a discharge conduit for the fluid under pressure developed by the pump, said conduit having a converging-diverging passage provided therein, a governor for controlling the admission valve and operated by the differential of forces exerted by fluid pressure developed by the pump opposed by pressure of fluid in the converged portion of the passage, temperature responsive means disposed within the path of the fluid under pressure developed by the pump, a diverging-converging member disposed within the converging-diverging passage, an operative connection between the temperature responsive means and the diverging-converging member, and manually operable means for regulating the action of the means responsive to temperature.

8. The combination of a prime mover having an admission valve, a pump driven by the prime mover for developing fluid pressure varying with the speed thereof, a discharge conduit for the pump having a converging-diverging passage, a fluid pressure operated governor having an element actuated by the differential of forces exerted by pressure of fluid developed by the pump opposed by pressure of fluid in the converged portion of the passage, a relief valve for controlling the pressure at the discharge side of the passage, a lever bearing upon the relief valve, a sliding weight provided on the lever for varying the force exerted thereby, and means remote from the weight for varying the position thereof on the lever.

9. The combination with a prime mover having an admission valve, of a speed governing mechanism for controlling the speed of the prime mover comprising a piston connected to and directly actuating the admission valve, a spring biasing the piston and admission valve in valve-closing direction, a pump driven by the prime mover and providing a fluid pressure varying substantially only as the square of the speed of the prime mover, conduit means for conveying said fluid pressure to said piston, said fluid pressure biasing the piston in valve-closing direction, a converging-diverging passage therein communicating with said pump, and means for applying the fluid pressure obtaining at the throat of said converging-diverging passage to the piston in valve-opening direction; the variations in the last-mentioned fluid pressure cooperating with the variations in the first-mentioned fluid pressure to provide increased variation in deflection of the spring upon variation in speed.

10. In a governor for governing the speed of a prime mover having an admission valve, the combination of means developing a fluid

pressure varying as the square of the speed of the prime mover, means providing a second fluid pressure varying inversely with the speed of the prime mover, valve operating mechanism for the admission valve including a pressure responsive element and a spring biasing the element, said mechanism operating upon change in spring deflection to provide a valve movement proportional to the change in spring deflection, means for applying the first fluid pressure to the pressure responsive element in valve closing direction, and means for applying the second fluid pressure to said element in opposition to the first fluid pressure so that the variations in the second fluid pressure assist the variations in the first fluid pressure to provide increased spring deflection and consequent increased valve movement.

11. In a governor for governing the speed of a prime mover having an admission valve, the combination of means for developing fluid pressure varying as a function of the speed of the prime mover, means responsive to said fluid pressure for providing a second fluid pressure varying inversely with the first fluid pressure, valve operating mechanism for the admission valve including a pressure responsive element and a spring biasing the element, said mechanism operating upon change in spring deflection to provide a valve movement proportional to the change in spring deflection, means for applying the first fluid pressure to the pressure responsive element in valve closing direction, and means for applying the second fluid pressure to said element in opposition to the first fluid pressure so that the variations in the second fluid pressure assist the variations in the first fluid pressure to provide increased spring deflection and consequent increased valve movement.

12. In a regulating mechanism for providing a regulation in response to a variable governing force, the combination of a movable element subjected to the governing force, a spring acting on said element, the deflection of said spring being changed upon change in the governing force, means for applying a third force to said element, and means for providing, upon variation in the governing force, a variation in the third force which assists said variation in governing force to provide a change in deflection of said spring which is greater in proportion to the total spring deflection than the change in governing force is to the total governing force, and means controlled by said element for providing the regulation.

In testimony whereof, I have hereunto subscribed my name this eighth day of July, 1925.

JOHN S. MYERS.