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H. HORNSCHUCH

2,489,778

CONTROLLING DEVICE FOR PRIME MOVERS

Filed Nov. 30, 1946

3 Sheets-Sheet 1

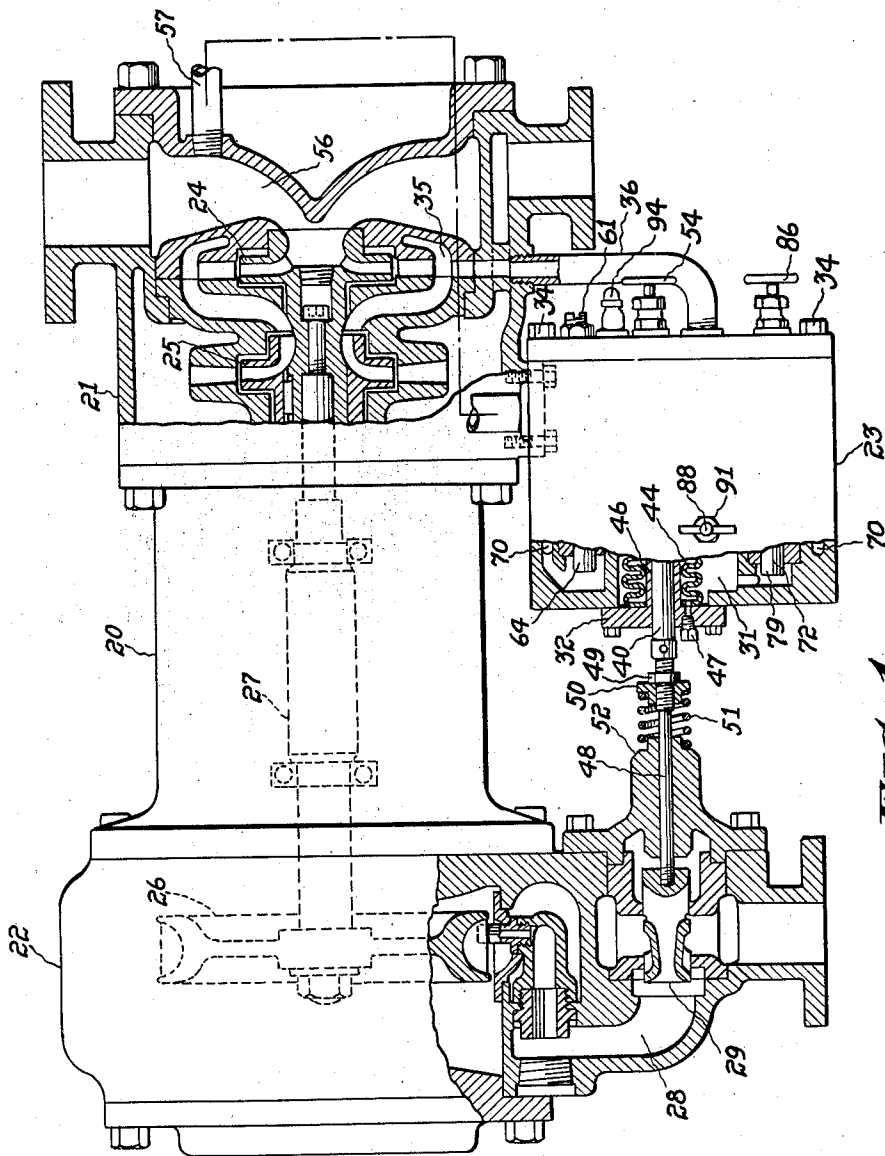


FIG. 1.

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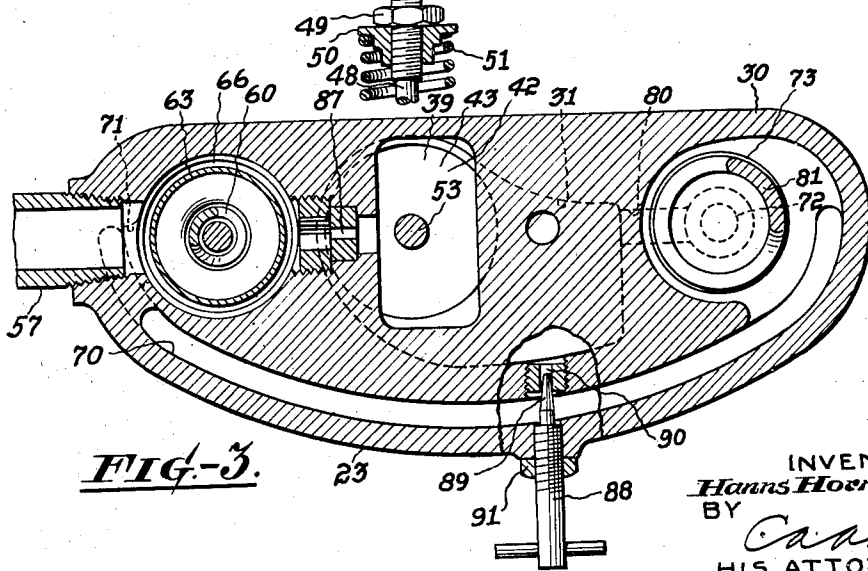
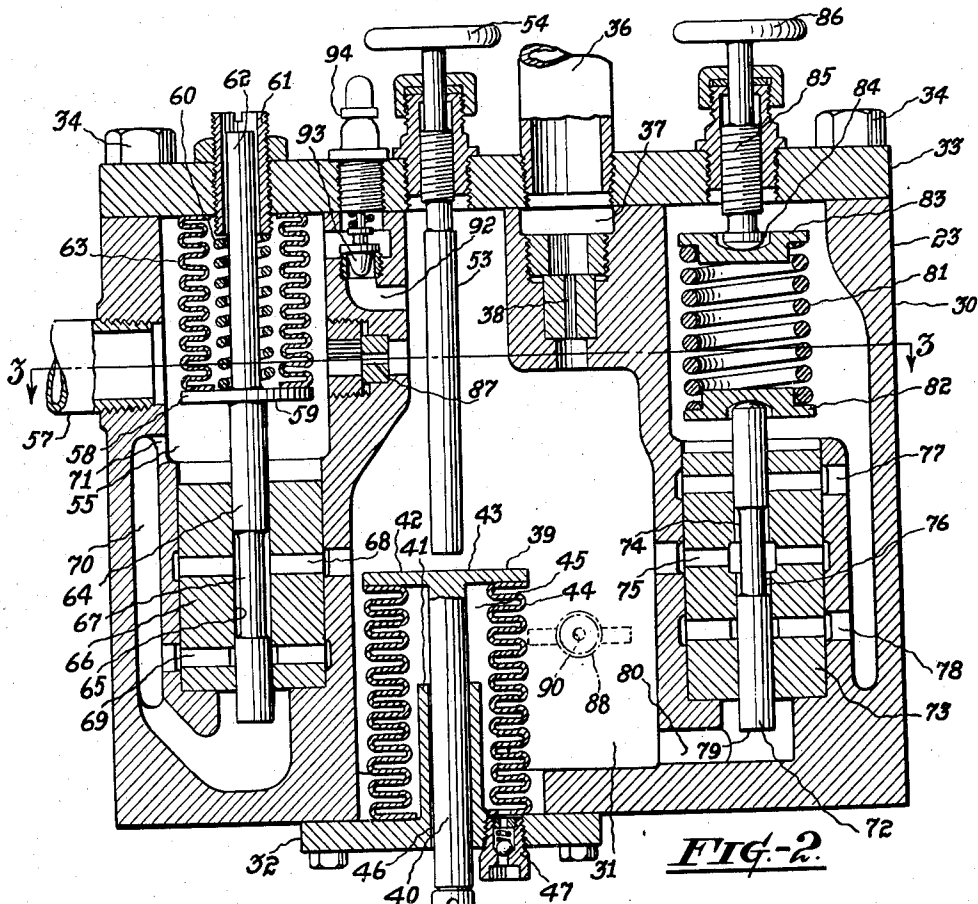
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CONTROLLING DEVICE FOR PRIME MOVERS

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3 Sheets-Sheet 2



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CONTROLLING DEVICE FOR PRIME MOVERS

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3 Sheets-Sheet 3

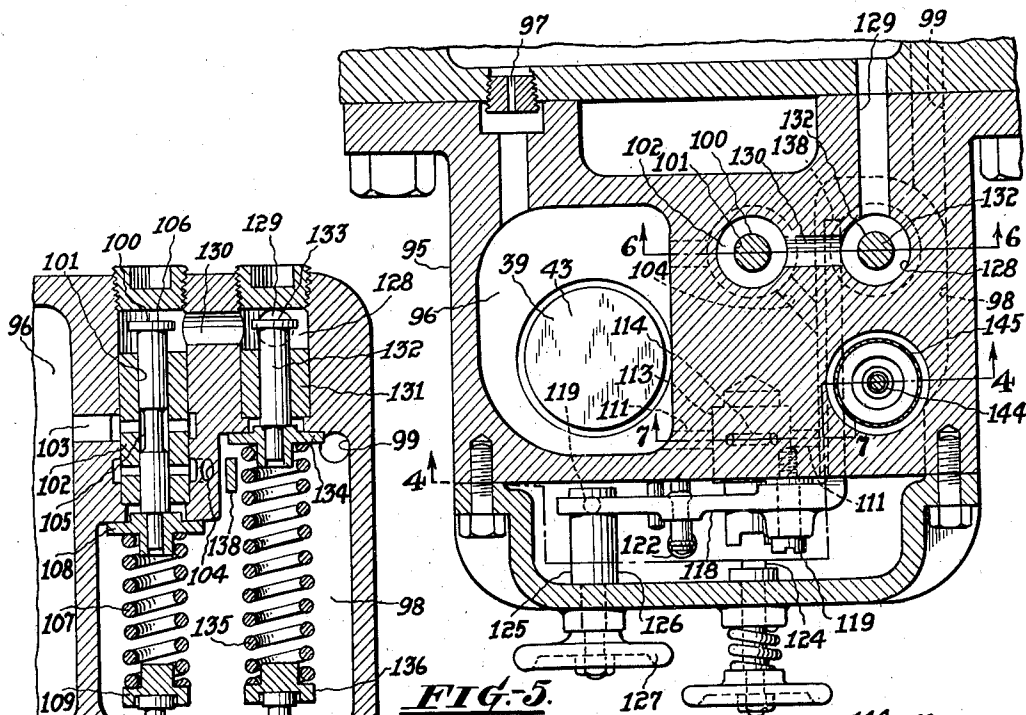


FIG. 5.

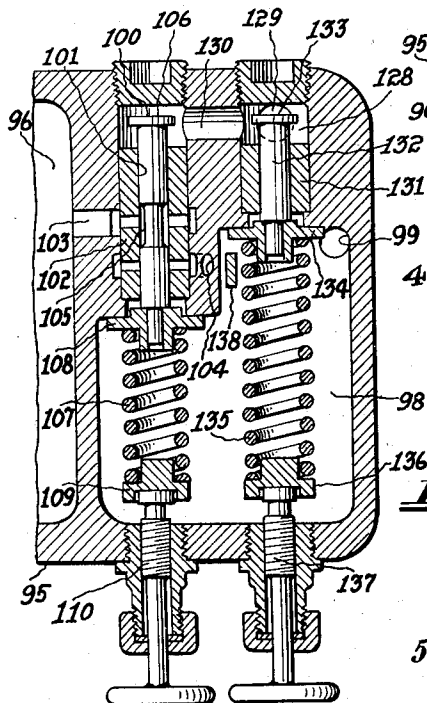


FIG. 6.

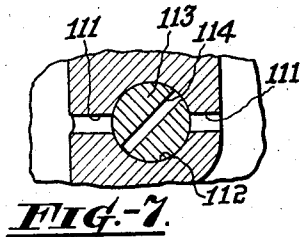


FIG. 7.

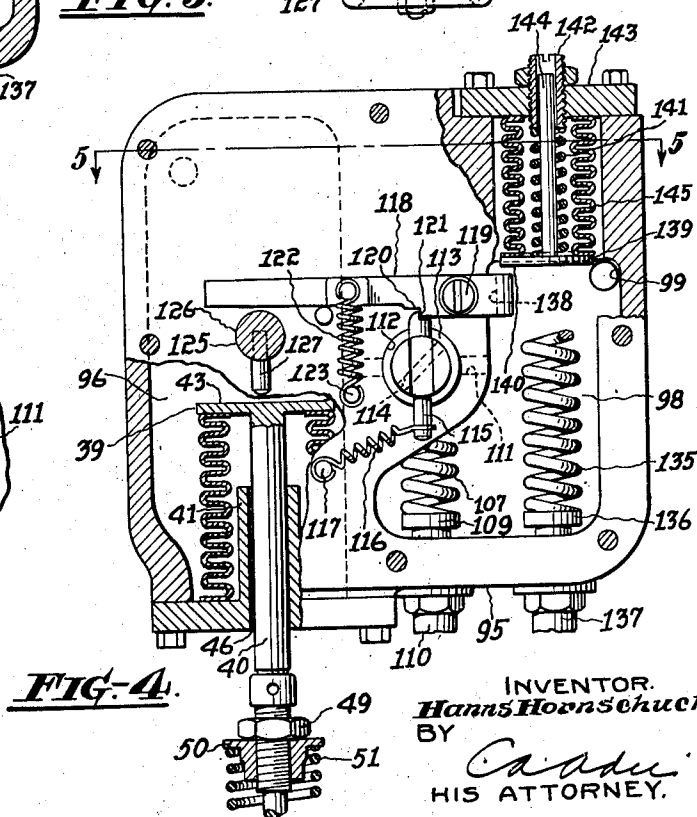


FIG. 4.

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CONTROLLING DEVICE FOR PRIME MOVERS

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11 Claims. (Cl. 103—35)

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This invention relates to centrifugal pumps, and more particularly to a controlling device for prime movers serving to drive centrifugal pumps.

One object of the invention is to prevent the operation of a centrifugal pump under unfavorable pressure conditions, as when the suction pressure is below a predetermined minimum value or when the pump is insufficiently primed or improperly vented.

A more specific object is to effect the automatic cutting off of the power medium to the prime mover whenever any of the aforesaid conditions prevails.

Further objects will be in part obvious and in part pointed out hereinafter.

In the drawings accompanying this specification and in which similar reference numerals refer to similar parts,

Figure 1 is a longitudinal elevation, partly broken away, of a centrifugal pump and its prime mover equipped with a controlling device constructed in accordance with the practice of the invention,

Figure 2 is an elevation, partly in section, of one form of the invention,

Figure 3 is a transverse view taken through Figure 2 on the line 3—3,

Figure 4 is a side elevation, partly broken away, of a modified form of the invention taken through Figure 5 on the line 4—4,

Figure 5 is a transverse view taken through Figure 4 on the line 5—5, and

Figures 6 and 7 are elevations, in section, taken through Figure 5 on the lines 6—6 and 7—7, respectively.

Referring to the drawings and at first more particularly to Figure 1, 20 designates a pumping apparatus comprising a centrifugal pump 21, a prime mover 22 and a controlling device 23 constructed in accordance with the practice of the invention and shown secured to the casing of the pump.

The pump 21 is shown as having first and second stage impellers 24 and 25, respectively, and the prime mover 22 is shown, for the purpose of illustration, as being a turbine the wheel 26 of which is connected, by suitable shafting 27, to the impellers 24 and 25. The turbine has the usual ports and passages 28 for conveying power medium to the wheel 26, and the flow of power medium is controlled by a reciprocatory valve 29 which is actuated by the controlling device 23 for valving the power medium to the turbine.

In the form shown in Figures 2 and 3 the con-

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trolling device comprises a casing 30 having a chamber 31 closed at its lower end by a detachable cover 32 and at its upper end by a plate 33 overlying the casing and secured thereto by bolts 34. The chamber 31 is in constant communication with the discharge side of the pump 21, in the present instance with the discharge passage 35 for the impeller 24, through a conduit 36, a recess 37 in the casing 30, and an orifice 38 opening into the chamber.

The pressure of the fluid within the chamber 31 actuates the valve 29 and is transmitted thereto by an actuator 39 in the chamber. In a preferred form, the actuator 39 comprises a rod 40 that extends slidably through the cover 32 and through a cylindrical extension 41, on the inner side of the cover, and has a head 42 the end surface of which constitutes a pressure area 43 which is subjected to the pressure in the chamber 31.

In order to cushion the movement of the actuator 39 for opening the valve 29 a bellows 44, in fluid tight engagement with the head 42 and the cover 32, is disposed about the rod 40 and the extension 41 to form a cushioning chamber 45, and the clearance 46 between the rod 40 and the extension 41 is of such area that the air will flow therethrough from the chamber 45 at a sufficiently slow rate to cushion the downward stroke of the actuator and thereby assure the gradual opening of the valve 29. The return movement of the actuator and the valve takes place comparatively quickly, the cover 32 being provided with a check valve mechanism 47 of the ball type which operates in a well known way to admit air into the chamber 45.

The rod 40 extends exteriorly of the cover 32 and its lower end engages a stem 48 threadedly connected to the valve 29. The opposite end portion of the rod 48 carries a nut 49 which acts as an abutment for a seat 50 engaging an end of a spring 51 the opposite end of which seats against a boss 52 on the turbine serving as a guide for the rod 48.

As will be apparent, the force of the spring 51 may be conveniently varied by means of the nut 49 and, in practice, the spring 51 is so adjusted that the valve 29 will be opened slightly to cause operation of the turbine at idling speed whenever a pressure of the value of suction pressure exists in the chamber 31. Such opening movement of the valve 29 may, if desired, be effected manually by means of a rod 53 that depends from the plate 33 wherewith it is in threaded engagement. The rod 53 is normally so posi-

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tioned that its lower end is spaced from the head 42 of the actuator and at its opposite end is a hand-wheel 54 whereby the rod may be rotated for endwise adjustment thereof.

Means are provided for preventing the operation of the pump under unfavorable conditions as, for example, when the suction pressure falls below normal, or if the pump is inadvertently cut off from the source of liquid supply, or is unprimed or improperly vented. To this end the casing 30 is provided with a chamber 55 that communicates with the inlet opening 56 of the pump 21 through a conduit 57 and contains a reciprocating piston 58 having an actuating surface 59 subjected to the pressure in said chamber. Such pressure is yieldingly opposed by a spring 60 interposed between the piston 58 and a tubular spring seat 61 threaded into the plate 33 for varying the force of the spring 60.

An extension 62 carried by the piston 58 retains the spring 60 in position and extends loosely through the spring seat 61. These parts are encircled by a bellows 63 interposed between the piston 58 and the plate 33, and the interior of the bellows 63 is in communication with the atmosphere through the spring seat 61.

On the opposite side of the piston 58 is a stem that serves as a valve 64 for communicating the chamber 31 with the chamber 55 whenever the pressure of the fluid acting against the surface 59 falls below the force exerted by the spring 60. The valve 64 is slidable in a bore 65 of a bushing 66 at the lower end of the chamber 55 and has an external annular groove 67 to afford communication between passages 68 and 69 leading, respectively, from relatively spaced points along the length of the bore 65 to the chamber 31 and a channel 70 communicating with the chamber 55, through a port 71, and with the lower end of the bore 65 to subject the adjacent end of the valve 64 to suction pressure.

In order to assure a substantially constant pressure in the chamber 31 the controlling device is provided with a valve 72 that serves to valve fluid from the chamber 31 to the channel 70 whenever the pressure in the chamber 31 exceeds a certain predetermined maximum value. The valve 72 is reciprocable in a bushing 73 and has an external annular groove 74 to afford communication between a passage 75, leading from the chamber 31 to the bore 76 containing the valve, and passages 77 and 78 leading from the bore 76 to the channel 70 and located, respectively, above and below the passage 75.

The lower end of the valve 72 constitutes a pressure surface 79 and is subjected to the pressure of the fluid delivered thereto from the chamber 31 by a passage 80. Such pressure is opposed by a spring 81 acting against a spring seat 82 on the other end of the valve 72. The opposite end of the spring 81 engages a spring seat 83 which has a depression 84 for the accommodation of an end of a screw 85 in the plate 33 and having a hand-wheel 86 whereby the screw may be rotated for varying the force of the spring 81.

Preferably, the chamber 31 is communicated with the chamber 55 through an orifice 87 to maintain the pressure in the chamber 31 at a value proportionate to that of the fluid delivered to the orifice 38, and the pressure in the chamber 31 may, if desired, be controlled manually by means of a needle valve 88 the valve portion 89 of which controls the flow area of a passage 90 leading from the chamber 31 to the channel 70.

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The needle valve 88 is supported by the outer wall of the casing 30 and is held fixedly by a lock nut 91.

In order to further assure against an excessive pressure within the chamber 31 the casing is provided with a relief passage 92 that leads from said chamber to the chamber 55 and is controlled by a spring-pressed relief valve 93 the casing portion 94 of which is supported by the plate 33.

In practice, and at the beginning of an operating period, all the chambers and passages within the controlling device will be filled with fluid entering them from the suction side of the pump. The valves 64 and 72 will then be held in their lowermost positions by their springs 60 and 81 and the chamber 31 will be in communication with the channel 70 through the passages controlled by the valves 64 and 72, and when the chamber 55 is filled the fluid acting against the surface 59 will elevate the valve 64 to cut-off communication between the passages 68 and 69. The fluid then in the chamber 31 and acting against the pressure area 43 will open the valve 29 in the degree required to cause the turbine wheel 26 to operate at idling speed.

Thereafter, as the pressure of the fluid delivered to the chamber 31 by the orifice 38 increases the actuator 39 will be further depressed thereby to open the valve 29 to wider limits. This pressure, acting against the pressure surface 79, will also hold the valve 72 in position to cut-off communication between the channel 70 and the chamber 31, and whenever it exceeds the predetermined maximum value intended to maintain in the chamber 31 it will shift the valve 72 upwardly to establish communication between the passages 75 and 77. Fluid will then flow from the chamber 31 into the channel 70 until the pressure within the chamber 31 is again reduced to normal and the spring 81 will then restore the valve 72 to its non-valving position.

In the event that the pressure of the fluid acting against the actuating surface 59 falls below the force exerted by the spring 60, as when the suction pressure at the pump falls below normal or the pump loses its prime, the spring 60 will depress the valve 64 and thereby place the passages 68 and 69 in communication with each other through the annular groove 67. Fluid then flows from the chamber 31 through these passages into the channel 70 and the pressure within the chamber 31 will thereby be reduced to a value permitting the spring 81 to quickly shift the valve 29 to the position for cutting off the fluid supply to the turbine.

In the modified form of the invention shown in Figures 4 to 7 inclusive, the casing 95 has a control pressure chamber 96 into which discharge pressure is introduced through an orifice 97 and a low pressure chamber 98 that communicates with the suction side of the pump 21 through a passage 99. The pressure within the chamber 96 is normally maintained substantially constant by a valve 100 which controls communication between the chambers 96 and 98. The valve 100 is reciprocable in a bore 101 of a bushing 102 to control passages 103 and 104 spaced along the length of the bushing and, respectively, lead to the chamber 96 and the chamber 98. Communication is afforded between the passages 103 and 104 by an external annular groove 105 in the valve.

One end of the valve 100 constitutes an actuating surface 106 subjected to pressure from the discharge side of the pump 21, say from the dis-

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charge passage 35, and this pressure is opposed by a spring 107 that seats against a plate 108 on the end of the valve and against a plate 109 resting upon an adjusting screw 110 in the wall of the casing 95.

Means are provided for effecting a quick reduction of the pressure in the chamber 96 whenever it becomes excessively high or when the suction pressure falls to a predetermined value. To this end the casing has a discharge passage 111 that leads from the chamber 96 to the chamber 98 and is bisected by a valve chamber 112 containing a valve 113 for controlling said passage. The valve 113 is of the rotary type. It has a passage 114 for registry with the branches of the passage 111 and carries a pin 115 having an end connected to a tension spring 116 anchored to a pin 117 in the casing.

The valve 113 is held in position to blank off the passage 111 by holder 118, of L-shape, pivotally mounted on a screw 119 supported by the casing. The holder has a shoulder 120 for engagement with a notch 121 in the pin 115 and is held in engagement therewith by a spring 122 connected to the holder and to a pin 123 in the casing 95. The spring 122 exerts a pull on the holder 118 for maintaining it in engagement with the pin 115, and the valve 113 may be manually rotated, to effect such engagement, by means of a spring-pressed rod 124 adapted for interlocking engagement with the valve and operable from the exterior of the casing 95.

In the wall of the casing is a manually operable rotary trip member 125 comprising a rod 126 having a hand-wheel 127, for rotating it, carrying a radially extending pin 19 for tilting the holder out of engagement with the pin 115.

To the end that the holder 118 will be rocked out of engagement with the pin 115 to release the valve 113 whenever the pressure of the fluid delivered to the orifice 97 exceeds a certain predetermined maximum, the casing is provided with a chamber 128 and a passage 129 to convey fluid from the discharge side of the pump to the chamber 128, whence fluid also flows to the surface 106 of the valve 100 through a passage 130. At one end of the chamber 128 is a guide bushing 131 for a plunger 132 having a pressure surface 133 at an end thereof subjected to the fluid in the chamber 128. On the opposite end of the plunger 132 is a plate 134 that engages an end of a spring 135 which seats against a plate 136 resting upon an adjusting screw 137 in the wall of the casing 95. The plate 134 overlies an arm 138 of the holder 118, in spaced relation therewith, and seats against the roof of the chamber 98.

Means are provided to also tilt the holder 118 out of engagement with the valve 113 in response to a predetermined minimum suction pressure for relieving the pressure in the chamber 96. To this end, a piston 139 is arranged in the chamber 98 to overlie the arm 138, and the underside of the piston 139 serves as a pressure surface 140 which is subjected to the pressure in the chamber 98 for holding the piston out of engagement with the arm 138. A spring 141 seats against the other side of the piston 139 and against a tubular spring seat 142 threaded, for endwise adjustment, into a plate 143 covering the chamber 98. A rod 144 on the piston 139 acting as a guide for the spring 141 extends loosely through the spring seat 142, and a corrugated bellows 145 interposed between the piston 139 and the cover 143 is in constant com-

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munication with the atmosphere through the spring seat 142.

In the operation of the device, assuming the chambers thereof to be filled with fluid at suction pressure and communication between the chambers 96 and 98 to be cut-off by the valve 113 in the manner shown in Figure 4 of the drawings. This pressure in the chamber 96 will open the valve 29 slightly and cause the turbine to operate at idling speed. The piston 139 will then be held out of contact with the holder 118 by the fluid in the chamber 98 and the plunger 132 will be held thus by the spring 135. The pressure of the fluid thereafter delivered to the chamber 96, by the orifice 97, will further depress the actuator 39 and open the valve 29 gradually to the limiting position determined by the spring 51.

In the event that the suction pressure falls below the predetermined minimum force exerted by the spring 141, said spring will thrust the piston 139 downwardly against the arm 138 of the holder and disconnect it from the valve 113. The spring 116 will then rotate the valve and place the passage 114 in registry with the passage 111. Fluid will then flow from the chamber 96 into the chamber 98 to reduce the pressure acting against the actuator 39, and the spring 51 will shift the valve 29 to cut-off the flow of power medium to the turbine.

When normal suction pressure is again restored in the chamber 98 it will move the piston 139 out of the path of the arm 138 and the valve 113 is then rotated to its closed position, by means of the spring-pressed rod 124, and the spring 122 will rock the holder 118 into locking engagement with the pin 115.

During the normal operation of the pump the plunger 132 remains inactive but when the pressure acting against the surface 133 exceeds that exerted by the spring 135 it will shift the plunger and cause the plate 134 to tilt the holder 118 out of engagement with the valve. The latter will then assume the open position for reducing the pressure in the chamber 96 and enable the spring 51 to quickly close the valve 29 for cutting off the flow of power medium to the turbine.

Normally, the pressure of the fluid in the chamber 96 is maintained substantially constant by action of the valve 100. This valve is subjected to the same fluid as the plunger 132, its spring 107 being adjusted, however, to yield to a different pressure. Thus, whenever the pressure in the chamber 128 exceeds the force of the spring 107 the valve 100 will be moved downwardly to establish communication between the passages 103 and 104. The pressure in the chamber 96 will thereby be reduced to the normal value and the spring 107 will then again return the valve 100 to its closed position.

I claim:

1. In a controlling device for a prime mover having a power medium controlling member, a pump driven by the prime mover, a casing having a chamber into which said pump delivers a portion of the fluid pumped thereby, means acting responsively to the pressure in the chamber for actuating the controlling member in one direction, resilient means for actuating the controlling member in the opposite direction, and means subjected to the pump suction pressure and acting in response to a predetermined minimum pump suction pressure for effecting a reduction of the pressure in the chamber below the value required to operate the controlling member.

2. In a controlling device for a prime mover having a power medium controlling member, a pump driven by the prime mover, a casing having a chamber into which said pump delivers a portion of the fluid pumped thereby, means in the chamber acting responsively to the pressure therein for actuating the controlling member in one direction, resilient means for actuating the controlling member in the opposite direction, and means constantly subjected to the pump suction pressure and acting in response to a predetermined minimum value thereof for effecting a reduction of the pressure in the chamber below the value required to operate the controlling member.

3. In a controlling device for a prime mover having a power medium controlling member, a pump driven by the prime mover, a casing having a chamber into which said pump constantly delivers a portion of the fluid pumped thereby, means acting responsively to the pressure in the chamber for operating the controlling member, valve means acting in response to a predetermined high pressure in the chamber to valve fluid therefrom for maintaining a constant pressure in the chamber, and other valve means acting responsively to the pump suction pressure to valve fluid from the chamber for lowering the pressure therein below the value required to operate the controlling member whenever the suction pressure falls below a predetermined minimum value.

4. In a controlling device for a prime mover having a power medium controlling member, a pump driven by the prime mover, a casing having a chamber into which said pump constantly delivers a portion of the liquid pumped thereby, a piston subjected to the pressure in the chamber for moving the controlling member in a direction to supply power medium to the prime mover, yieldable means constantly tending to move the controlling member in a direction to cut-off the flow of power medium to the prime mover, valve means operating in response to the pressure in the chamber to normally maintain a constant pressure therein, and other valve means acting responsively to the pump suction pressure to effect a reduction in the pressure within the chamber to a value below the force exerted by the yieldable means whenever the suction pressure reaches a predetermined minimum value.

5. In a controlling device for a prime mover having a power medium controlling member, a pump driven by the prime mover, a casing having a chamber into which the pump constantly delivers a portion of the fluid pumped thereby, a reciprocating piston actuated by the pressure in the chamber for moving the controlling member in a direction to supply power medium to the prime mover, yieldable means constantly tending to move the controlling member in a direction to reduce the supply of power medium to the prime mover, means for damping the movement of the piston, and means acting in response to a predetermined minimum pump suction pressure for effecting a reduction in the pressure within the chamber below the force exerted by the yieldable means.

6. In a controlling device for a prime mover having a power medium controlling member, a pump driven by the prime mover, a casing having a chamber into which the pump constantly delivers a portion of the fluid pumped thereby, means subjected to the pressure in the chamber for moving the controlling member in a direction for supplying power medium to the prime mover, yieldable means for moving the controlling mem-

ber in the opposite direction, means for damping the movement of the first said means, a spring-pressed valve actuated by a predetermined maximum pressure in the chamber for valving fluid from the chamber to normally maintain a constant pressure in said chamber, and a spring-pressed valve acting responsively to the suction pressure at the pump to valve fluid from the chamber for reducing the pressure therein below the force exerted by the yieldable means whenever the suction pressure reaches a predetermined minimum value.

7. In a controlling device for a prime mover having a power medium controlling member, a pump driven by the prime mover, a casing having a chamber into which the pump constantly delivers a portion of the fluid pumped thereby, means acting responsively to the pressure in the chamber for operating the controlling member, a discharge passage in the casing for the chamber, a valve for controlling the passage, a holder for normally maintaining the valve in position to close the passage, means constantly tending to move the valve into position for opening the passage, and means acting responsively to a predetermined minimum pump suction pressure for actuating the holder to release the valve and thereby enable the second mentioned means to move the valve into position for opening the passage.

8. In a controlling device for a prime mover having a power medium controlling member, a pump driven by the prime mover, a casing having a chamber into which the pump constantly delivers a portion of the fluid pumped thereby, an actuator for the controlling member actuated by the pressure in the chamber for supplying power medium to the prime mover, a spring for moving the actuator to reduce the supply of power medium to the prime mover, a discharge passage for the chamber, a valve for controlling the discharge passage normally positioned to preclude the flow of fluid from the chamber through the passage, means for causing the valve to assume a position for opening the passage for effecting a reduction of the pressure in the chamber below the force exerted by the spring whenever the pump suction pressure reaches a predetermined minimum value, and means for causing the valve to assume a position for opening the passage whenever the pressure of the fluid discharged by the pump exceeds a certain predetermined value.

9. In a controlling device for a prime mover having a power medium controlling member, a pump driven by the prime mover, a casing having a chamber into which the pump constantly delivers a portion of the fluid pumped thereby, means subjected to the pressure in the chamber for moving the controlling member in a direction to supply power medium to the prime mover, a spring for moving the controlling member in the opposite direction, a discharge passage in the casing for the chamber, a valve for controlling the passage, a holder for normally maintaining the valve in position to close the passage, means constantly tending to move the valve into position to open the passage, means acting responsively to a predetermined minimum pump suction pressure for actuating the holder to release the valve and thereby enable the second mentioned means to move the valve into position for opening the passage to reduce the pressure in the chamber below the force exerted by the spring, and means acting in response to a predetermined maximum pressure of the fluid supplied to the

chamber for actuating the holder to release the valve and thereby enable the second mentioned means to move the valve into position for opening the passage to reduce the pressure in the chamber below the force exerted by the spring.

10. In a controlling device for a prime mover having a power medium controlling member, a pump driven by the prime mover, a casing having a chamber into which the pump constantly delivers a portion of the fluid pumped thereby, an actuator for the controlling member actuated by the pressure in the chamber for supplying power medium to the prime mover, a spring for moving the actuator to reduce such supply of power medium, means acting in response to the pressure of fluid discharged by the pump for normally maintaining a constant pressure in the chamber, a discharge passage in the casing for the chamber, a spring-pressed valve for controlling the passage normally positioned to preclude the flow of fluid from the chamber through the passage, means for causing the valve to assume a position for opening the passage to effect a reduction of the pressure in the chamber below the force exerted by the spring whenever the pump suction pressure reaches a predetermined minimum value, and means for causing the valve to assume a position for opening the passage whenever the pressure of the fluid discharged by the pump exceeds a certain predetermined maximum value.

11. In a controlling device for a prime mover having a power medium controlling member, a pump driven by the prime mover, a casing having a chamber into which the pump constantly delivers a portion of the fluid pumped thereby, an actuator for the controlling member actuated by

the pressure in the chamber for supplying power medium to the prime mover, a spring to move the actuator for reducing the supply of power medium to the prime mover, a discharge passage for the chamber, a rotary valve to control the passage, a spring constantly tending to position the valve for opening the passage, a holder pivotally mounted in the casing to engage the valve for holding said valve in position to close the passage, a spring-pressed piston constantly subjected to pump suction pressure and acting at a predetermined minimum value thereof to disengage the holder from the valve and thereby enable the spring to move the valve into position for opening the passage to effect a reduction of the pressure in the chamber below the force exerted by the first mentioned spring, and a spring-pressed piston constantly subjected to pump discharge pressure and acting at a predetermined maximum value thereof to disengage the holder from the valve and thereby enable the spring to move the valve into position for opening the passage to effect a reduction of the pressure in the chamber below the force exerted by the first mentioned spring.

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