

Nov. 14, 1939.

A. F. MEYER

2,179,559

COMPOUND COMPENSATED GOVERNOR

Filed July 8, 1935

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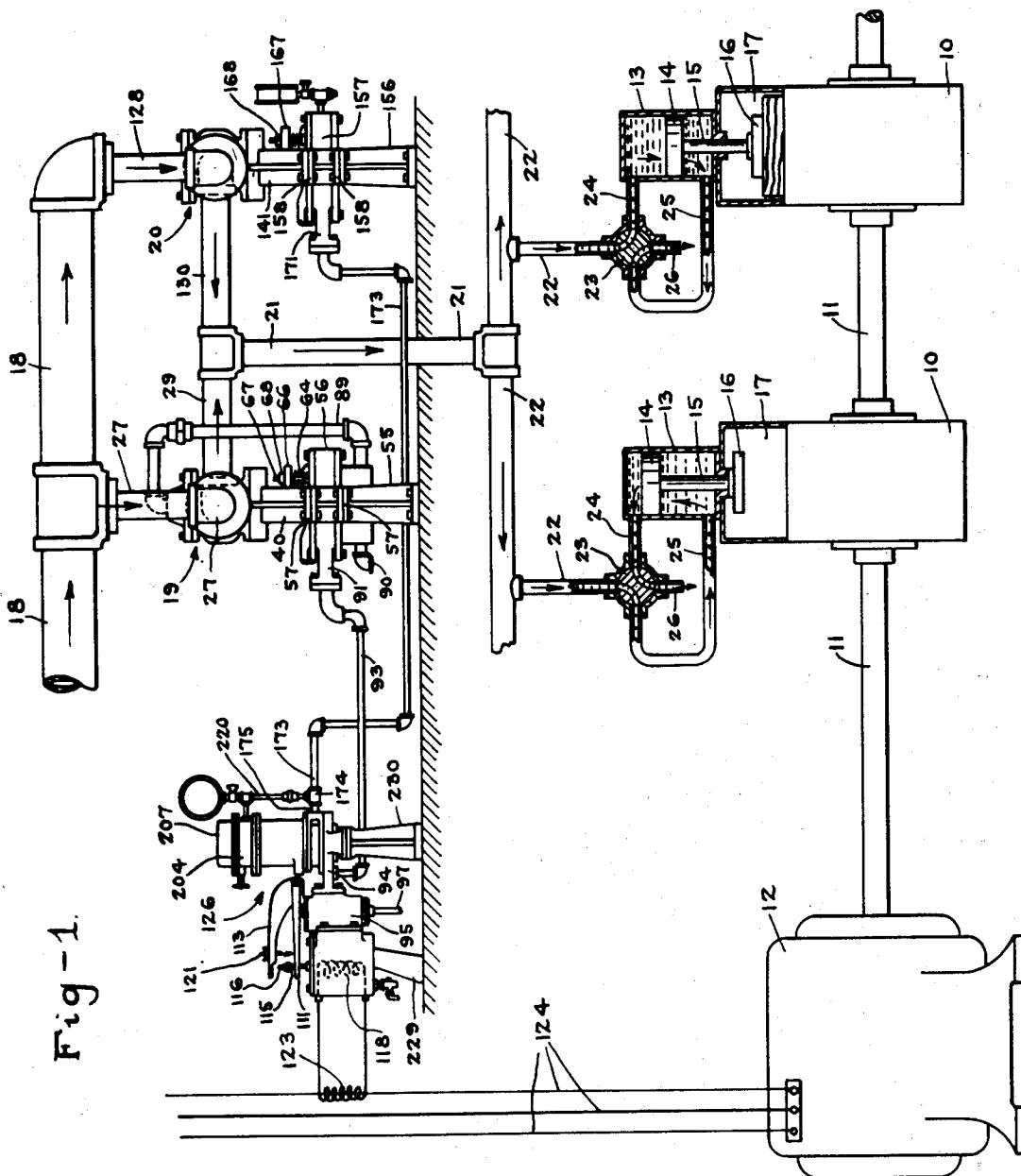


Fig-1.

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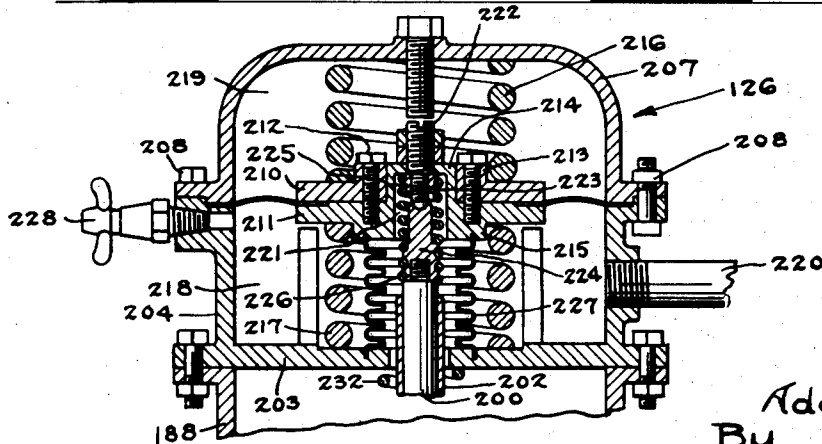
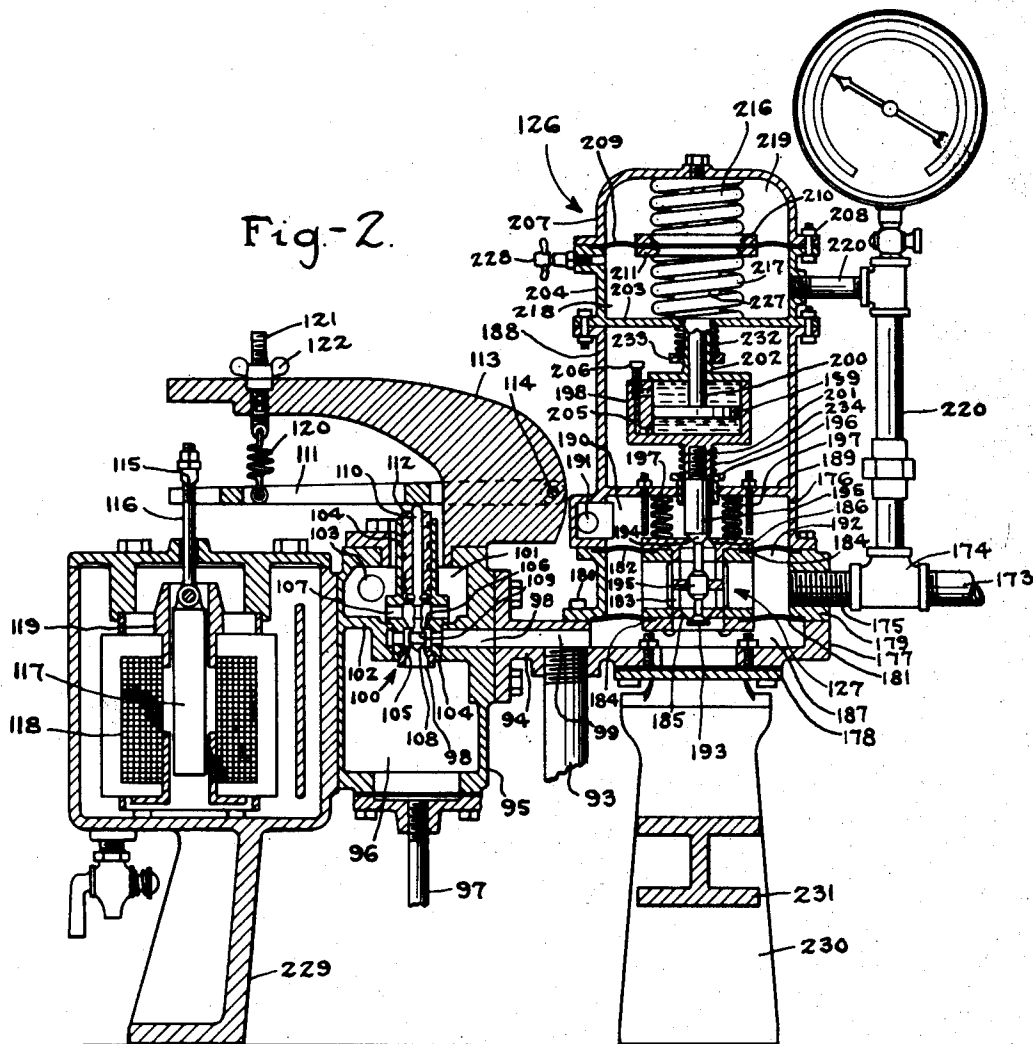
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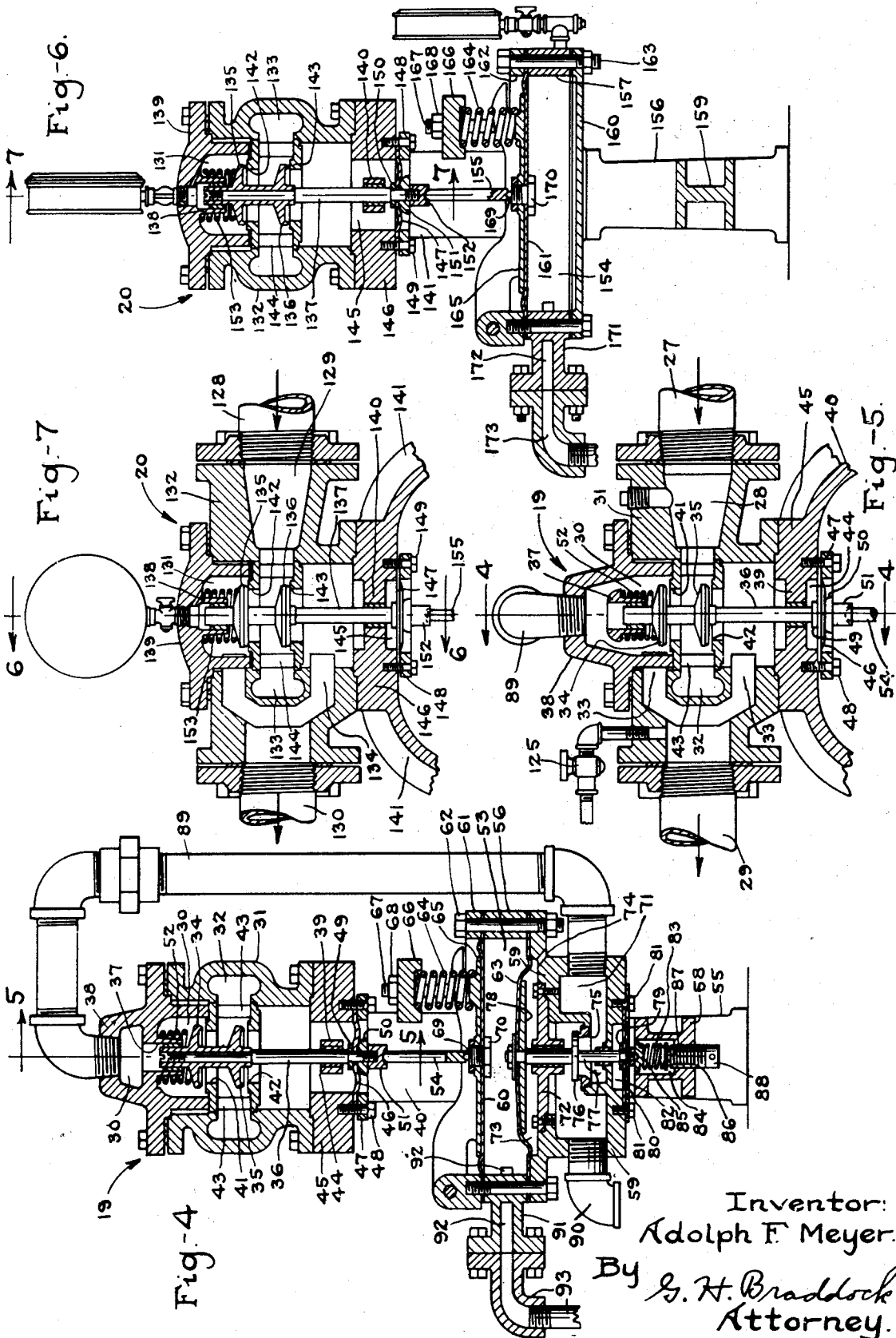
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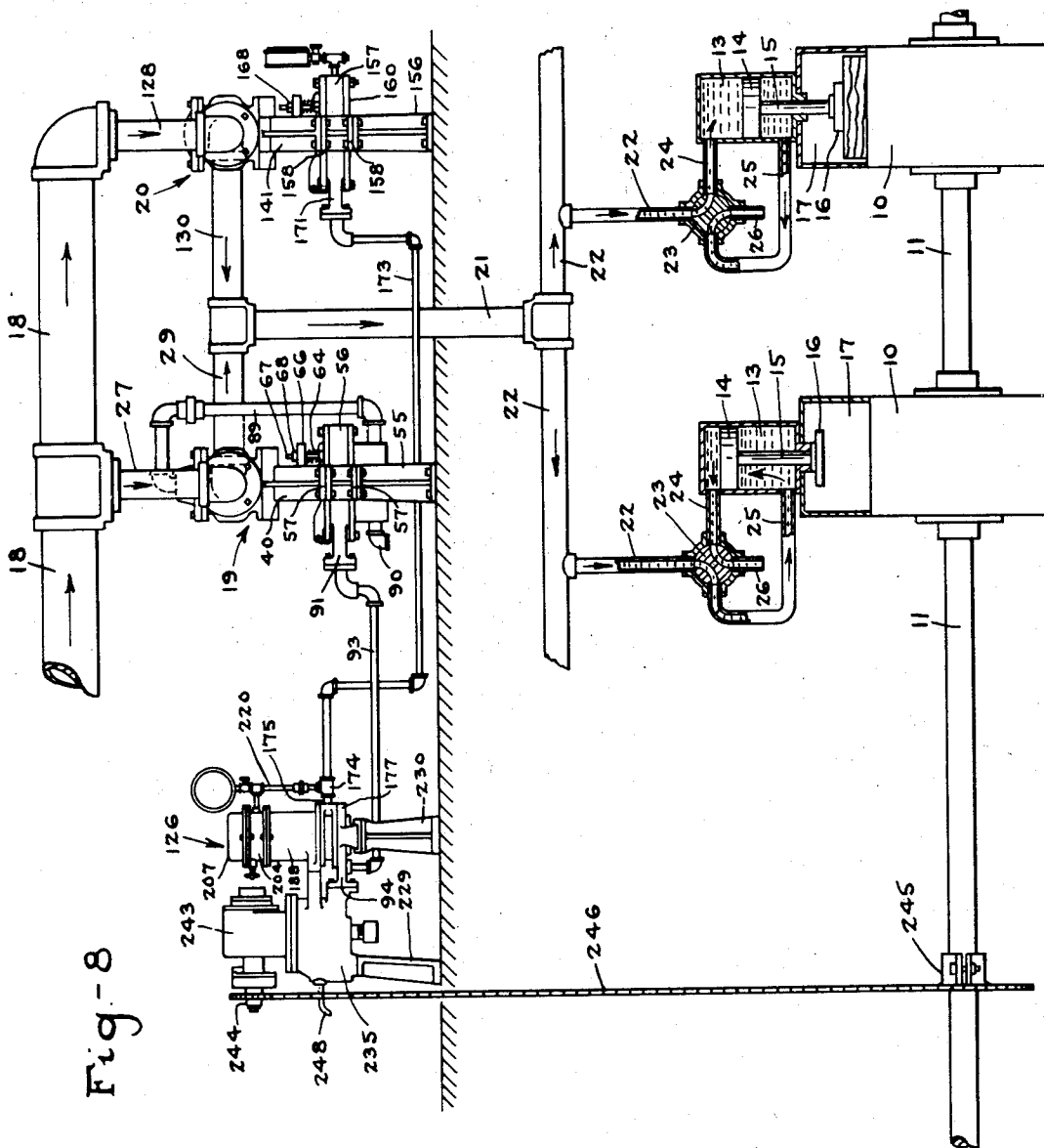
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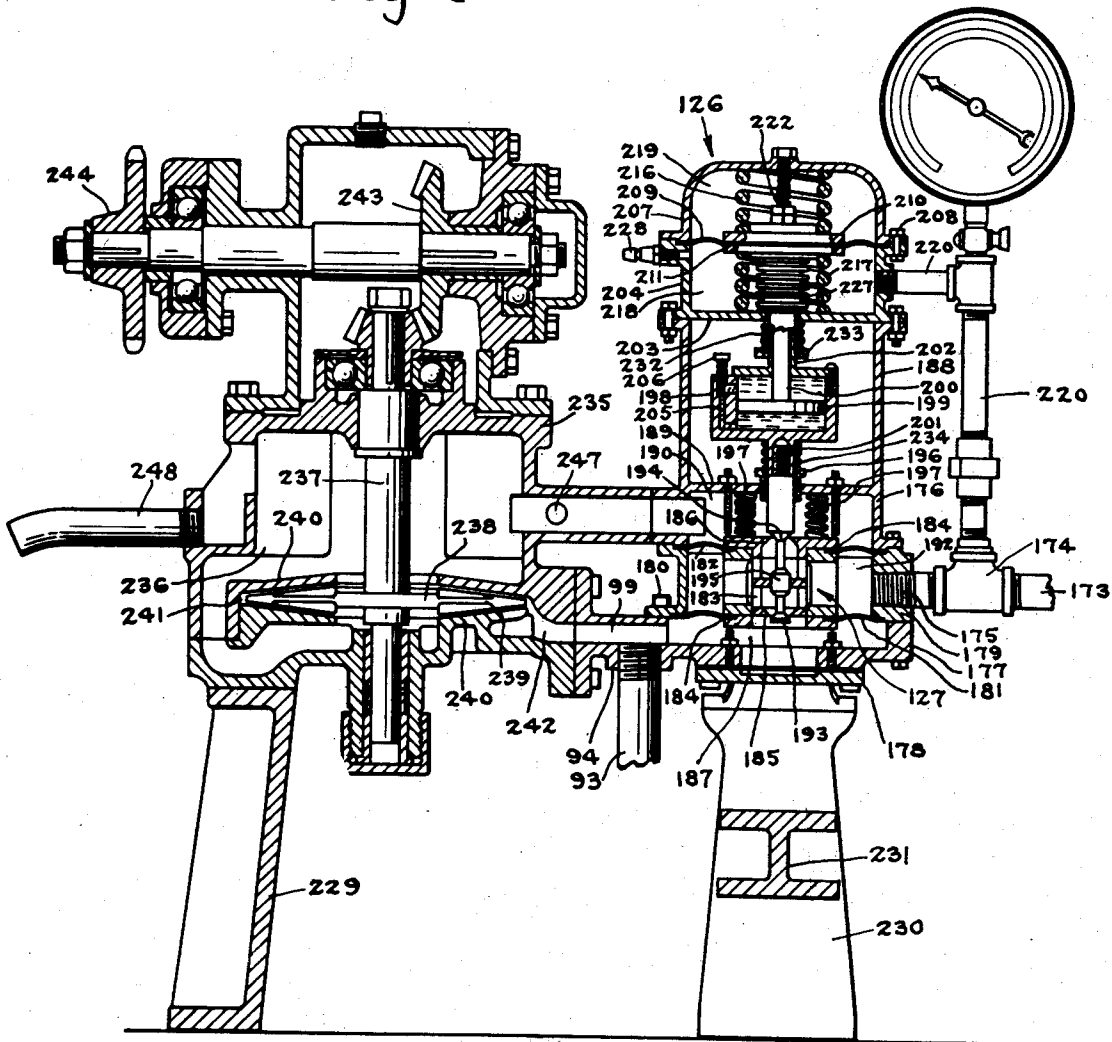
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Fig.-9



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UNITED STATES PATENT OFFICE

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COMPOUND COMPENSATED GOVERNOR

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Application July 8, 1935, Serial No. 30,414

24 Claims. (Cl. 83—75)

This invention relates to a compound compensated governor for the control of fluid flow and pressure and which is more particularly adapted for use as a means for the automatic maintenance of any desired load on and/or any desired speed of rotation of a driven member working under a friction load produced by fluid pressure.

The governor or regulator of the invention is capable of a wide variety of uses in which a sensitive and responsive automatic control of fluid pressure and flow is desired. As herein disclosed, the governor or regulator is applied to use in the wood-pulp making art in connection with well-known electric motor driven and hydraulic turbine driven grindstones used for the production of wood-pulp. In the present art, both electric motor driven and turbine driven grinders are employed. The grinders have a plurality of separate pockets into each of which wood blocks are placed and are pressed by hydraulic means against the faces of the grinders. When the blocks in a pocket are completely ground and when the pocket is pulled off for refilling with wood blocks, the normal friction load on a grinder is resultantly lessened and the current consumption decreases, and/or the grinder speeds up, unless special mechanism, of the nature as herein contemplated, for maintaining a desired load on, and/or a desired speed of, said grinder is utilized. The present compound compensated governor functions to increase the fluid flow and pressure with the least reduction in friction load and decrease the fluid flow and pressure with the least increase in friction load when the governor is employed in connection with electric motor driven grinders, and also functions to increase the fluid flow and pressure with the least increase in speed of rotation of the grinder and decrease the fluid flow and pressure with the least decrease in speed of rotation of the grinder when the governor is employed in connection with hydraulic turbine driven grinders. In each instance the governor or regulator constitutes a means for maintaining a desired load on a driven grinder.

An object of the invention is to provide a novel and improved apparatus of the present character for controlling fluid pressure.

A further object is to provide a novel and improved apparatus for the maintenance of a desired load on a driven member working under a friction load produced by fluid pressure.

A further object is to provide a novel and improved apparatus for the maintenance of a desired speed of rotation of a driven member

working under a friction load produced by fluid pressure.

And a further object is to provide a compound compensated governor of the nature as stated, wherein will be incorporated various improved features and characteristics of construction novel both as individual entities of the governor and in combination with each other.

With the above objects in view, as well as others which will appear as the specification proceeds, the invention comprises the construction, arrangement and combination of parts as now to be fully described and as hereinafter to be specifically claimed, it being understood that the disclosure herein is merely illustrative and intended in no way in a limiting sense, changes in details of construction and arrangement of parts being permissible so long as within the spirit of the invention and the scope of the claims which follow.

In the accompanying drawings forming a part of this specification,

Fig. 1 is a diagrammatic view of the compound compensated governor as when employed in connection with electric motor driven pulp grinders;

Fig. 2 is a vertical sectional view of the main pilot valve housing and associated parts, as well as of the compensator unit, of the governor of Fig. 1;

Fig. 3 is an enlarged fragmentary sectional view detailing features of the compensator unit;

Fig. 4 is a vertical sectional view, taken as on line 4—4 in Fig. 5, of the bleeder valve unit of the governor;

Fig. 5 is a fragmentary vertical sectional view, taken as on line 5—5 in Fig. 4, of said bleeder valve unit;

Fig. 6 is a vertical sectional view, taken as on line 6—6 in Fig. 7, of the compensated valve unit of the governor;

Fig. 7 is a fragmentary vertical sectional view, taken as on line 7—7 in Fig. 6, of said compensated valve unit;

Fig. 8 is a diagrammatic view of the compound compensated governor as when employed in connection with hydraulic turbine driven grinders; and

Fig. 9 is a vertical sectional view of the pump unit and the compensator unit of the governor of Fig. 8.

It is to be noted that in Figs. 1, 2, 4, 5, 6 and 7 there is disclosed a compound compensated governor for utilization with electric motor driven pulp grinders, and in Figs. 8, 9, 4, 5, 6 and 7 there is disclosed an equivalent governor for utilization

with hydraulic turbine driven grinders. The detail disclosure in Fig. 3 is common to both the compensator unit of Figs. 1 and 2 and the compensator unit of Figs. 8 and 9.

5 The novel and improved apparatus is, in the instance of each form of the invention, shown in connection with a driven member such as a grindstone. A plurality of these grindstones are usually mounted upon and rotated by a driven 10 shaft. An instrumentality is provided to press wood placed in pockets against the faces of the grindstones, and usually consists of a piston having a head movable in a cylinder. The opposite end of the piston is provided with a foot 15 by means of which the wood is pressed against the grindstone face. Not only may a plurality of grindstones be mounted upon a shaft, but each grindstone may be provided with more than one of these cylinder and piston devices for pressing the wood in the several pockets against the 20 grindstone. Each grindstone is operated under friction load induced by blocks of wood thus forcibly held against its peripheral surface.

25 It is common in the present art to employ a fluid under pressure not only for the purpose of forcibly pressing the wood blocks in the pockets against the grinders by means of pistons, but also to use this fluid pressure to remove the piston heads away from the grinders in order that the pockets may be refilled with blocks of wood. 30 It should be noted that the maintenance of the uniform electrical load on the electric motors in the form of the invention of Figs. 1 to 7, as well as the maintenance of the speed of rotation of the hydraulically driven turbine grinders in the form of the invention of Figs. 8, 9 and 3 to 7, is effected by the maintenance of a uniform friction 35 load on the grindstones. When a pocket is pulled off for refilling, it is obvious that in the instance of the form of the invention as in Figs. 1 to 7 the motor load would be lessened and hence the pressure must be increased upon the other pistons, and that in the instance of the form of the invention as in Figs. 8, 9 and 3 to 7, the grinder would tend to speed up due to lessened 40 load and hence the pressure must be increased upon the other pistons. A complication arises in that the amount of fluid, such as water, consumed in forcing the pistons in their normal 45 working movement to maintain objects engaged with the grinder is small, while the amount of water consumed upon abnormal movement of each piston from or to its object-maintaining position is relatively large. These two factors 50 make load control and grinder speed control difficult. In each of its forms the invention presents an apparatus which controls the fluid flow and pressure supplied to the pistons. In the instance of the apparatus of Figs. 1 to 7 the control of the fluid flow and pressure maintains constant the electric motor consumption, and in the instance of the apparatus of Figs. 8, 9 and 3 to 7 the control of the fluid flow and pressure maintains constant the speed of rotation of the grinders. 65

70 With respect to Figs. 1 to 7 of the drawings and the numerals of reference thereon, each grinder 10 is fast upon a shaft 11 driven by an electric motor 12. Each of a plurality of cylinders 13 is suitably mounted adjacent the peripheral surface of a grindstone 10 and bears therein a piston-head 14 mounted upon a rod 15. The opposite end of each rod 15 carries a foot 16 operating in a pocket 17 to press blocks of wood 75 against the surface of a grindstone so that the

wood will be ground into pulp. Several such grindstones may be mounted fast upon the same shaft and several such cylinders and connections may be operatively associated with each grindstone. 5

A pass is provided for supplying water under pressure from a suitable source to the wood-pressing cylinders 13. This pass consists of a supply pipe 18 connected to a suitable source of supply of water under pressure and having a 10 plurality of valve mechanisms, denoted generally at 19 and 20, respectively, interposed in the supply pass between the pipe 18 and a pipe 21 which forms a continuation of the pass. The valve mechanism 19 is included as a part of what may 15 be termed a bleeder valve unit, and the valve mechanism 20 is included as a part of what may be termed a compensated valve unit. The pipe 21 supplies the water under pressure in accordance with usual practice to each of the different cylinders 13. As shown in Fig. 1, passages 20 22 lead from the pipe 21. Each passage 22 is provided with a two-way valve 23 which is manually operable either to divert the water under pressure to one side of the corresponding piston-head while permitting escape of any water on 25 the other side of the head, or vice versa. In the position shown at the right in Fig. 1, the right valve 23 is turned to permit water under pressure through the corresponding passage 22 and 30 a port 24 to the upper face of the piston-head 14 by which means this piston-head is gradually forced downwardly to maintain the wood in engagement with the grindstone. This movement may be termed the normal movement. As the 35 piston-head 14 is forced downwardly by means of pressure admitted to the upper portion of the cylinder through the port 24, any water in the lower portion of the cylinder may escape through a port 25 by way of the two-way valve 23 to an exhaust 26. What may be called the abnormal 40 movement of the work-feeding instrumentality occurs when the valve 23 is manually turned half way as shown at the left in Fig. 1. In the position of the left valve 23, direct connection is had 45 between the port 24 of the cylinder and the exhaust 26 to permit the escape of water from the upper portion of the cylinder and to direct the water under pressure from the passage 22 to the port 25 by which means the corresponding 50 piston-head 14 is forced upwardly to permit refilling of the pocket with wood. This abnormal movement, being substantially unopposed, is relatively rapid and demands an increased amount of water.

55 Similar abnormal movement, although of less magnitude, occurs when a pocket has been refilled and the corresponding two-way valve 23 is then turned to the position shown at the right in Fig. 1, so as to move the piston-head 14 downwardly until the foot 16 again engages the blocks of wood. 60

During the normal operation of the apparatus; that is to say, during the operation while all of the piston-heads 14 are moving normally; all of the water which enters the pipe 21 under pressure from the pipe 18 passes through the valve mechanism 19 and none of the water at this time passes through the valve mechanism 20. The water enters the valve mechanism 19 70 through a pipe 27 leading from said pipe 18 and through a port 28 in said valve mechanism 19, and finds outlet to the pipe 21 through a pipe 29.

The valve mechanism 19 includes a pressure chamber 30 provided by a casting 31. The cast- 75

ing 31 is formed with a substantially annular waterway 32 communicating with the port 28 and opening inwardly into the pressure chamber 30. A double valve structure is provided to control the flow of water from the port 28 and the waterway 32 into passages 33 in the casting 31 which lead to the pipe 29. The governor or regulator is usually erected in upright position, and the valve 34 may be termed the upper valve and the valve 35 the lower valve of the double valve structure. These two valves are fixed to a stem 36 slidably mounted at its upper portion in a recessed boss 37 of a cap 38, and slidably mounted at its lower portion in a spider 39 of supporting arches 40. The stem 36 is thus adapted to have vertical reciprocating movement. An upper valve seat 41 and a lower valve seat 42 are provided by a cage 43 fitted within the annular portion of the casting 31 and the lower valve seat has a shoulder and recess mounting upon a lower portion of the casting.

The lower portion of the pressure chamber 30 has a continuation formed by a central recess 44 in an annular head 45 integrally provided by opposed arches 40. The bottom of the pressure chamber 30 is closed by a movable partition such as a diaphragm 46 of suitably flexible material, as, for example, rubber composition. The diaphragm 46 is held in water-tight position by a ring 47 and screws 48. The lower portion of the valve stem 36 is of reduced diameter and provides a downwardly presented shoulder. The reduced stem portion extends through the diaphragm 46 and receives a washer 49 between the diaphragm and shoulder and another washer 50 between the lower face of the diaphragm and a cap nut 51 threaded upon the lower end of the stem 36. When the nut 51 is turned home, the parts are so assembled that movement of the diaphragm 46 is communicated directly to the stem 36.

Means tending to force the double valve structure to seated position consists of a compression spring 52 which encircles the boss 37 and exerts downward force against the upper and lower valves 34 and 35. This downward force is aided by the grinding pressure communicated to the chamber recess 44 and to the diaphragm 46 so that the grinding pressure upon said diaphragm 46 also tends to seat the valves 34 and 35. This downward valve-seating force upon the valves 34 and 35 is opposed by another force consisting of water pressure in a pressure chamber 53 exerted through a post 54.

The water pressure in the pressure chamber 53 is controlled by the electricity supplied to the electric motor 12 which drives the shaft 11 carrying the grindstones 10. Said electric motor 12 is preferably of the constant-speed type and its power consumption is dependent upon the friction load upon the grinders.

Supporting legs 55 rest upon the floor and carry a relatively thick ring 56 which has lugs 57 extending outwardly therefrom and arranged in spaced apart pairs. The lower lug of each pair is securely bolted to a leg 55 and the upper lug of each pair is similarly secured to a supporting arch 40. As disclosed, the legs 55 are joined by a reinforcing member 58. The lower opening of the ring 56 is closed by a plate or member 59 bolted to the under face of the ring. A diaphragm 60, similar to the diaphragm 46, closes the upper opening of the ring 56 and is held to the ring by means of an annulus 61 and bolts 62. The bolts 62 also attach a diaphragm 63 be-

tween the lower surface of the ring 56 and the plate 59. The diaphragm 63 is for a purpose to be made clear. The ring 56 and the diaphragms 60 and 63 define the pressure chamber 53. Compression springs 64 are mounted to exert a force tending to push the diaphragm 60 downwardly. The springs 64 are held between bosses on a cap or hinged disc 65 upon the diaphragm 60 and a bar 66 adjustably mounted upon posts 67 extending upwardly through the bar 66. Said bar 66 is held down by adjusting nuts 68 upon the upper ends of the posts 67 which are carried by the ring 56.

The above mentioned post 54 is mounted between the nut 51 on the stem 36 and the cap 65 on the diaphragm 60. The upper end of said post 54 is seated within a socket provided in the lower end of said nut 51 and the lower end of the post is provided with a socket for the reception of a ball 69 formed upon the upper end of a headed screw 70 the shank of which screw extends through the diaphragm 60 and its cap 65. The post 54 communicates the pressure in the chamber 53 to the valve stem 36.

The plate or member 59 is an integral part of a casting providing a chamber 71 beneath the pressure chamber 53. Said plate or member 59 and a removable member 72 thereon separate the chamber 71 from a concavity 73 between the diaphragm 63 and said plate or member 59 and member 72. The concavity 73 is open to the atmosphere as at 74. A bleeder valve dividing the chamber 71 consists of a suitable valve seat 75 and a valve member 76. The valve member 76 is fixed upon a vertical stem 77 guided for vertical reciprocating movement in the member 72 and in the lower wall of the casting providing the chamber 71. The upper end portion of the stem 77 is reduced to provide a shoulder holding a disc 78 against the lower face of the diaphragm 63. Said reduced upper end portion of said stem 77 passes through said disc 78 and through said diaphragm 63, and a nut upon the stem holds a washer against the upper face of the diaphragm. Thus is the stem secured to said diaphragm 63. The lower end portion of said stem 77 is also reduced to provide a shoulder holding a smaller disc 79 against a diaphragm 80 or other suitable flexible member secured to the lower surface of the casting providing the chamber 71, as at 81, about a concavity 82 in said lower surface of the casting and surrounding the stem 77. Said reduced lower end portion of said stem 77 passes through said smaller disc 79 and through said diaphragm or equivalent member 80, and a nut upon the stem holds a washer against the lower face of this last mentioned diaphragm or member. Thus is the stem 77 secured to the diaphragm or member 80. A compression spring 83 is mounted within a vertical guideway 84 in the reinforcing member 58 between an upper cap 85 and a lower cap 86 in said guideway. The upper cap 85 has a socket in which the lower reduced end of the stem 77 seats, and the lower cap 86 has a socket in which is seated a ball 87 carried by a screw 88 mounted in the reinforcing member 58 below the guideway 84 for vertical adjustment. Pressure of water in the pressure chamber 53 acts against the diaphragm 63 to normally hold the valve member 76 of the bleeder valve to its seat 75 against the action of the compression spring 83, and said compression spring, adjustable by means of the screw 88, supports the load placed on the diaphragm 63 and the disc 78 by the pressure

in the chamber 53. A pipe connection 89 leads from the pressure chamber 30 and enters the chamber 71 at one side of the bleeder valve, and an outlet 90 leads from said chamber 71 at the opposite side of said bleeder valve to atmosphere.

The pressure chamber 53 is filled with water under pressure during the operation of the governor, and said chamber 53 has communication with any source of relatively constant water pressure. As shown, the ring 56 is formed with an integral neck 91 through which a port 92 extends. The neck 91 is suitably attached to a pipe connection 93 which leads from a neck 94 suitably secured to a main pilot valve housing 95. The pilot valve housing 95 includes a chamber 96 with inlet 97 from said sources of relatively constant water pressure, which source could be the annular waterway 32. A passageway 98 leads from the chamber 96 to a port 99 through the neck 94, and said passageway 98 is controlled by a main pilot valve 100. The main pilot valve housing 95 includes a second chamber 101 separated from the chamber 96 by a partition 102 which includes the passageway 98 and an overflow outlet 103 to atmosphere leads from the chamber 101.

During the normal operation of the governor, a small flow of water is continuous through the inlet 97, the chamber 96, the main pilot valve 100, the chamber 101 and from the outlet 103 to atmosphere. Said main pilot valve 100 includes a valve cage 104 in the partition 102 providing a lower valve seat 105 and an upper valve seat 106. Flow from the chamber 96 through the passageway 98 to the port 99 past the valve seat 105, and from said chamber through said passageway 98 and passageways 107 to the chamber 101 past the valve seat 106, is controlled by a double acting valve member including a lower conical valve surface 108 for engaging the valve seat 105 and an upper conical valve surface 109 for engaging the valve seat 106. The several recesses around the main pilot valve or double acting valve member are for the purpose of baffling the waters swirling around the stem, denoted 110, which integrally supports said double acting valve member, and also to prevent dirt from being carried up along said stem, to thus prevent friction from dirt.

The double acting valve member including the conical valve surfaces 108 and 109 is electrically actuated. The stem 110 carrying said double acting valve member is held up against a lever 111 by the pressure of inlet water from the chamber 96. The lever 111 and said stem 110 are desirably unattached. A suitable guide 112 for the stem 110 is conveniently carried by the valve cage 104. Said stem 110 engages an intermediate portion of said lever 111 and an end of the lever is pivoted upon a bracket 113, as at 114. The bracket 113 is carried by the housing 95. The end portion of said lever 111 opposite its pivotal support is engaged by a knife edge 115 adjustably carried upon a threaded link 116 pivotally connected to a plunger 117 slidably borne within an electro-magnet 118 by means of a sleeve 119. The electro-magnet is desirably supported within a cooling oil-chamber. The weight of the plunger 117 and the pull exerted by the electro-magnet, due to the current flowing to the electric motor 12, tends to seat the valve surface 108 and to unseat the valve surface 109. Working against these mentioned forces is a tension spring 120 adjustably suspended by a threaded pin 121 and its wing nut 122 from the bracket 113.

Neither the lower conical valve surface 108 nor the upper conical valve surface 109 of the double acting valve member need ever be in position to entirely close passage from the chamber 96 to both the port 99 and the chamber 101. The outflow from the chamber 96 to the pressure chamber 53 and to the chamber 101 and through the outlet 103 is obviously controlled by said double acting valve member, and this mentioned valve member is in turn actuated through the medium of the water pressure in said chamber 96 and the electro-magnet 118 energizable by the current flowing to the electric motor 12 which drives the grinder shaft.

The opening of the valve mechanism 19 of the bleeder valve unit, and therefore the fluid flow and pressure in the pipe 21, are dependent first upon the pressure against the diaphragm 46, and second upon the amount of water momentarily contained in the pressure chamber 53.

A current transformer 123 is connected into one or more phases of current carrying wires 124 leading to the electric motor 12 which drives the shaft 11. By means of the transformer 123 a small and relatively constant percentage of the current flowing to the motor 12 is conveyed from the secondary side of the transformer to the electro-magnet coil. The plunger 117 exerts a pull on the lever 111 tending to close the valve 105—108 and to open the valve 106—109 in proportion to the current flowing to the motor 12. The greater the load on the motor, the greater will be the current flowing, and hence, the greater the pull exerted by the coil to close the valve 105—108 and to open the valve 106—109.

The pounds pressure exerted by the water from the chamber 96 against the double acting main pilot valve plus the pull of the tension spring 120 balances the pull of the magnet 118 and the weight of the plunger 117. An increase in pull of the electro-magnet accompanying an increase in load on the electric motor 12, and therefore an increased flow of electric current to said motor, causes the valve 105—108 to move toward closed position and the valve 106—109 to move toward open position, thus enlarging the outlet from the port 99 and the passageway 98 to the chamber 101 and reducing the inlet from the chamber 96 to the passageway 98 and allowing the pressure in the chamber 53 to drop. A drop in the pressure in said chamber 53, which pressure opposes the action of the compression springs 64, results in a downward movement of the diaphragm 60 effecting closing action of the valves 34 and 35 and a resultant reduction in fluid pressure in the pipe 21, friction load upon the grindstones and load upon the electric motor 12, and, therefore, a reduction in pull of the magnet 118 and a return to substantially normal load. When one of the pockets is pulled off for refilling or put on for movement of the corresponding foot 16 toward grinding position, the resultant above mentioned abnormal movement causes an abnormal demand for fluid flow and there is, as a result, a drop in fluid pressure in the pipe 21 and in the pressure chamber 30. The drop in fluid pressure in said chamber 30 reduces the pressure on the diaphragm 46 which cooperates with the compression spring 52. The opposing water pressure in the chamber 53 immediately causes the diaphragm 60 to move upwardly to thus effect opening action of the valves 34 and 35 providing passage for increased flow to the pipe 21 during the abnormal movement of the piston-head 14 which was the cause of the drop in pressure.

A drop in fluid pressure in the chamber 30 obviously causes an instantaneous drop in pressure in the pipe 21 and consequent reduction in load on the electric motor 12. This drop in load results in reduced pull by the electro-magnet 118 and hence an opening action of the valve 105—108 and a closing action of the valve 106—109 of the main pilot valve. The evident result is an increase in the pressure in the chamber 53 with further opening of the valves 34 and 35 to bring the load on the electric motor back toward normal.

The bleeder valve 75—76 functions as a load actuated relief valve to supplement the action of the valve mechanism 19 which is a load actuated pressure-regulating valve. As before mentioned, the valve mechanism 19, or pressure-regulating valve, controls the supply of water pressure in accordance with the load requirements. The bleeder valve 75—76 acts as a relief valve by providing an outlet from the chamber 30 to reduce the grinding pressure in cases of emergency when the pressure-regulating valve mechanism 19 is not able to reduce the grinding pressure to the desired amount. When the load requirements demand a reduction in grinding pressure so that the pressure in the chamber 53 is reduced to a certain point where the pressure on the diaphragm 63 and the disc 78 is no longer sufficient to overcome the action of the compression spring 83, the bleeder valve is permitted or caused to open to provide an outlet from the chamber 30 which, as an obvious consequence, lowers the grinding pressure.

A hand-operated bleeder valve 125 is provided on the casting 31 so as to permit bleeding off the proper and desired amount of grinding-pressure water from the chamber 30 when the valve mechanism 19 has become leaky and before the valves in said chamber 30 are refinished.

Under normal conditions, the valve mechanism 19, together with the remainder of the bleeder valve unit, alone regulates the grinding pressure in accordance with load demands, in the manner as hereinbefore appearing. The compensated valve unit, and its valve mechanism 20, does not come into operation until the load on the electric motor 12 has dropped slightly below normal. When this happens, the pull of the electro-magnet 118 lessens and permits a compensator unit, denoted 126, including a double acting pilot valve, indicated 127, to increase capacity for flow of water to said compensated valve unit. With increase of motor load from below normal to normal, the capacity for flow of water to the compensated valve unit as well as to the bleeder valve unit, proportionally decreases. When the valve mechanism 20 does operate, water enters this mentioned mechanism through a pipe 128 leading from the pipe 18 and through a port 129 in said valve mechanism 20, and finds outlet to the pipe 21 through a pipe 130.

The valve mechanism 20 includes a pressure chamber 131 provided by a casting 132. The casting 132 is formed with a substantially annular waterway 133 communicating with the port 129 and opening inwardly into the pressure chamber 131. A double valve structure is provided to control the flow of water from the port 129 and the waterway 133 into passages 134 in the casting 132 which lead to the pipe 130. Upper and lower valves of the double valve structure are represented 135 and 136, respectively. Said valves are fixed to a stem 137 slidably mounted at its upper portion in a recessed boss 138 of a cap 139, and

slidably mounted at its lower portion in a spider 140 of supporting arches 141. The stem 137 is thus adapted for vertical reciprocating movement. An upper valve seat 142 and a lower valve seat 143 are provided by a cage 144 fitted within the annular portion of the casting 132 and the lower valve seat has a shoulder and recess mounting upon a lower portion of the casting.

The lower portion of the pressure chamber 131 has a continuation formed by a central recess 145 in an annular head 146 integrally provided by the opposed supporting arches 141. The bottom of the pressure chamber 131 is closed by a movable partition or diaphragm 147 of flexible material. The diaphragm 147 is held in watertight position by a ring 148 and screws 149. The lower portion of the valve stem 137 is of reduced diameter and provides a downwardly presented shoulder. The reduced stem portion extends through the diaphragm and receives a washer 150 between the diaphragm and shoulder and another washer 151 between the lower face of the diaphragm and a cap nut 152 threaded upon the lower end of the stem 137. When the nut 152 is turned home, the parts are so assembled that movement of the diaphragm 147 is communicated directly to the stem 137.

Means tending to force the double valve structure to seated position consists of a compression spring 153 which encircles the boss 138 and exerts downward force against the upper and lower valves 135 and 136. This downward force is aided by the grinding pressure communicated to the chamber recess 145 and to the diaphragm 147 so that the grinding pressure upon this diaphragm 147 also tends to seat the valves 135 and 136. The downward valve-seating force upon the valves 135 and 136 is opposed by another force consisting of water pressure in a pressure chamber 154 exerted through a post 155.

The water pressure in the pressure chamber 154 is controlled by the electricity supplied to the electric motor 12, and the compensator unit 126 and its pilot valve 127 cooperate with the main pilot valve 100 in the accomplishment of the control.

Supporting legs 156 rest upon the floor and carry a relatively thick ring 157 which has lugs 158 extending outwardly and arranged in spaced apart pairs. The lower lug of each pair is securely bolted to a leg 156 and the upper lug of each pair is similarly secured to a supporting arch 141. The legs 156 are joined by a reinforcing member 159. The lower opening of the ring 157 is closed by a plate 160 bolted to the under face of the ring. A diaphragm 161 closes the upper opening of the ring 157 and is held to the ring by an annulus 162 and bolts 163. The bolts 163 also attach the plate 160 to the ring 157. Compression springs 164 are mounted to exert a force tending to push the diaphragm 161 downwardly. The springs 164 are held between bosses on a cap or hinged disc 165 upon the diaphragm 161 and a bar 166 adjustably mounted upon posts 167 extending upwardly through the bar 166. The bar 166 is held down by adjusting nuts 168 upon the posts 167 carried by the ring 157.

The post 155 is mounted between the nut 152 on the stem 137 and the cap 165 on the diaphragm 161. The upper end of the post 155 is seated within a socket provided in the lower end of the nut 152 and the lower end of the post is provided with a socket for the reception of a ball 169 formed upon the upper end of a headed screw 170 the shank of which screw extends through the

diaphragm 161 and its cap 165. The post 155 communicates the pressure in the chamber 154 to the valve stem 137.

The pressure chamber 154 is filled with water under pressure received from the compensator unit 126. The ring 157 is formed with an integral neck 171 through which a port 172 extends. The neck 171 is suitably attached to a pipe connection 173 which leads from a fitting 174. The fitting 174 is also attached to a short pipe 175 suitably secured in a wall of a housing 176 for the pilot valve 127 of the compensator unit 126 in communicating relation with said pilot valve 127.

The pilot valve housing 176 includes a bottom wall 177 which may be integral with the neck 94, and said wall 177 has a removable cover plate 178 secured thereto in water-tight fashion. A flange on the wall 177 conveniently carries an annular member 179 which is bolted down as at 180. A specially constructed metal diaphragm 181 is soldered to the lower portion of the annular member 179, and a second specially constructed metal diaphragm 182 is soldered to the upper portion of said annular member. The diaphragms 181 and 182 are in spaced apart, parallel relation, and the short pipe 175 is arranged in the annular member 179 between these mentioned diaphragms. The central portions of the diaphragms 181 and 182 are cut away and conveniently support a valve cage 183 of the pilot valve 127, said valve cage including flanges which are bolted to each other and are clamped as at 184 to inner marginal portions of the diaphragms about their cut-away portions. The valve cage 183 provides a lower valve seat 185 and an upper valve seat 186. The diaphragm 181 is in spaced relation to the bottom wall 177 to define a chamber 187 in communication with the port 99 and directly below the valve cage 183. A shell 188 of the pilot valve housing 176 includes a partition 189 providing a chamber 190 between said partition and the diaphragm 182, and an overflow outlet 191 to atmosphere leads from the chamber 190.

During the normal operation of the governor or regulator, a small flow of water continues from the port 99 through the chamber 187, the pilot valve 127, the chamber 190 and from the outlet 191 to atmosphere, as well as through the main pilot valve 100, the chamber 101 and from the outlet 103, the flow supply of course emanating from the inlet 97 and the chamber 96, as before set forth. The flow from the chamber 187 past the valve seat 185 to the space 192 between the diaphragms 181 and 182 and in communication with the short pipe 175, and from said space 192 past the valve seat 186 to the chamber 190, is controlled by a double acting valve member including a lower conical valve surface 193 for engaging the valve seat 185 and an upper conical valve surface 194 for engaging the valve seat 186. A portion of a stem 195 integrally carrying the just mentioned double acting valve member is situated between the conical valve surfaces 193 and 194 and is suitably guided by the valve cage 183. The valve cage 183 is a structure which rigidly attaches the central portions of the diaphragms 181 and 182 to each other so that said diaphragms and valve cage, including the valve seats 185 and 186, are adapted to swing to and fro, upwardly and downwardly as disclosed, as a unit when acted upon as presently to be described. A portion of the valve stem 195 above the conical valve surface 194 extends upwardly through the partition 189 and passes through a bushing 196 threaded in said partition. The stem

195 is in spaced relation to the bushing. Compression springs 197 in the chamber 190 and between the partition 189 and the valve cage 183 act against the double diaphragm structure in opposition to pressure of water in the chamber 187.

The shell 188 provides a compartment or space of the compensator unit above the partition 189 which houses a dash pot composed of a closed cylinder 198 and a piston 199 with connecting rod 200. The closed cylinder 198 has an integral neck 201 on its lower side which is threaded upon a reduced portion of the valve stem 195. The neck 201 is of size to pass freely through the bushing 196. Said closed cylinder 198 also has an integral neck 202 on its upper side which extends upwardly freely through an opening in the base 203 of an annular member 204. The base 203 constitutes the upper wall of the shell 188. The piston rod 200 extends upwardly through the neck 202 to position above the upper end of said neck, and this mentioned neck and said piston rod are adapted to have relative longitudinal sliding movement. The closed cylinder 198 of the dash pot is filled with oil of desired viscosity, and includes a by-pass 205 about the piston 199 which is adjustable by means of a screw 206 to permit desired rate of by-pass flow of oil in said closed cylinder from one side to the other of said piston, depending upon the condition prevailing at some particular time, as will be made clear.

A cap member 207 of the housing 176 is fastened down upon the annular member 204, as at 208, and the outer marginal portion of a diaphragm 209 is removably clamped between said cap member 207 and said annular member 204. The central portion of the diaphragm 209 is cut away and conveniently carries a bracket member including an upper disc 210 and a lower disc 211 which are detachably secured together, as at 212, and clamp the bracket member upon the inner marginal portion of the diaphragm 209 about its cut-away portion. Said diaphragm is removable from the bracket member and from the members 207 and 204 for convenience in making replacements. The upper disc 210 includes an upwardly extending annular flange 213 which provides an opening into which a boss 214 of the lower disc fits. Said lower disc itself includes a downwardly extending annular flange 215. A compression spring 216 is arranged between the upper wall of the cap member 207 and the upper disc 210, being fitted about the annular flange 213, and a compression spring 217 is arranged between the base 203 and the lower disc 211, being fitted about the annular flange 215. The diaphragm 209 with its bracket member consisting of the discs 210 and 211 constitutes a division between a closed chamber 218 defined by the annular member 204, its base 203 and the diaphragm with bracket member, and a chamber 219 defined by the cap member 207 and said diaphragm with bracket member. The chamber 219 is desirably open to the atmosphere. A pipe connection 220 leads from the fitting 174 and communicates with the chamber 218 defined by the annular member 204. The compression springs 216 and 217 are evidently in opposed relation.

The upper part of the connecting rod 200 on the piston 199 is attached to the lower disc 211 of the bracket member on the diaphragm 209 by a flexible joint. As disclosed, said disc 211 and its boss 214 are provided with a concavity 221, and a screw 222 in the boss includes a down-

wardly extending reduced threaded portion 223 in said concavity. The lower end of the reduced threaded portion 223 engages a socket in the upper end of a nut 224 upon a reduced threaded portion of the connecting rod 200. The reduced threaded portion 223 itself carries a nut 225. A coil spring 226 lies freely within the concavity 221 and extends below said concavity in surrounding relation to the nuts 224 and 225. The spring 226 is in tension. Its lower and upper portions are situated in grooves of the lower and upper nuts 224 and 225, respectively, as shown more clearly in Fig. 3, to hold the two parts of the flexible joint rigidly together and at the same time permit sidewise movement which may be necessary due to deflection of the diaphragm 209. A rigid connection of the rod 200 with the bracket member consisting of the discs 210 and 211 would cause undesirable friction. A flexible skirt 227 surrounds the opening through the base 203 receiving the neck 202 and also surrounds the flexible joint to protect it from water in the chamber 218. A hand-operated valve 228 is for leading air from the chamber 218 should this become necessary.

A coil spring 232 between the base 203 and a nut 233 threaded on the upper neck 202 of the closed cylinder 198 cooperates with a coil spring 234 between the bushing 196 and the lower surface of said closed cylinder to normally retain the closed cylinder and the double acting valve member carried thereby at definite and predetermined position or elevation.

It might be here remarked that stops are provided for all of the diaphragms in the apparatus to prevent over-travel.

The cooling oil chamber for the electro-magnet 118 and parts associated with said electro-magnet and chamber are supported from the floor by a leg 229. Supporting legs 230 for the compensator unit are integral with the bottom wall 177 of the housing 176. The legs 230 are joined by a reinforcement member 231.

When a pocket is pulled off for refilling or put on for movement toward grinding position, the drop in fluid pressure in the pipe 21 will obviously cause a drop in the pressure of water in the chamber 131, as well as in the chamber 30 as before set forth, because of relief of pressure in the pipe 130 leading to said pipe 21. Drop in fluid pressure in said chamber 131 reduces the pressure on the diaphragm 147 which cooperates with the compression spring 153. The opposing water pressure in the chamber 154, due to pressure of water from the chamber 96 by way of the passage 98, the port 99, the chamber 187, the chamber 192 and the pipe 173, immediately causes the diaphragm 161 to move upwardly to thus open the valves 135 and 136 providing for flow through the compensated valve unit to the pipe 21 during the abnormal movement of the piston-head 14 which was the cause of the drop in pressure, as hereinbefore set forth.

It will be evident that drop in electric motor load, causing opening action of the valve 105—108 and closing action of the valve 106—109 of the main pilot valve 100, accomplishes increase in pressure in the chamber 187, and that rise in electric motor load, causing closing action of said valve 105—108 and opening action of said valve 106—109, accomplishes decrease in pressure in said chamber 187.

Neither the lower conical valve surface 193 nor the upper conical valve surface 194 is ever in position to entirely close passage past either valve

seat 185 or 186, except perhaps momentarily. With increase and decrease of pressure in the chamber 187 the double diaphragm structure including the specially constructed diaphragms 181 and 182 is actuated. That is, in the disclosure as made, said diaphragms are swung upwardly as a unit with increase in pressure of water in the chamber 187 against the action of the compression springs 197, and are swung downwardly as a unit by said compression springs with decrease in pressure in said chamber. When said diaphragms 181 and 182 are swung upwardly, the valve 186—194 is actuated toward closed position to decrease the size of the passage from the chamber 192 to the chamber 190 having the outlet 191 and the valve 185—193 is actuated toward open position to increase the size of the inlet from the chamber 187 to said chamber 192, and when said diaphragms 181 and 182 are swung downwardly, said valve 186—194 is actuated toward open position to increase the size of said passage from said chamber 192 to said chamber 190 and said valve 185—193 is actuated toward closed position to decrease the size of said inlet from said chamber 187 to the chamber 192.

Upon opening movement of the valve 185—193 and closing movement of the valve 186—194, because of increase in water pressure in the chamber 187 due to drop in electric motor load as and for the reasons stated, with obvious resultant and proportionate increase of pressure of water in the chamber 192, the increased pressure is directly communicated from said chamber 192 through the pipe connection 173 to the chamber 154 of the compensated valve unit. The increased pressure in said chamber 154 results in further and considerable opening of the valves 135 and 136 to quickly bring the load on the electric motor back to normal. As said load comes back to normal, the pressure in the chambers 187, 192 and 154 also comes back to normal, as will be obvious.

The amount of increase in grinding pressure which can be secured through direct action, or, stated differently, through the effect of changes in the original actuating pressure transmitted through the pipe connection 93 to the pressure chamber 53 of the bleeder valve unit, is limited, because if too large changes are made, hunting and surging will result. When pockets are pulled off or put on again, there is a greatly increased demand for water to move the pistons of the grinder cylinders down, while, at the same time, increased pressure is required to compensate for the lesser number of pockets in use. Such a radical change in conditions is very efficiently and rapidly made through the action of the pilot valve 127 and the compensated valve unit functioning through the medium of the compensator unit 126. By the arrangement as illustrated and described, a relatively small change in original actuating pressure acting on the lower diaphragm 181 of the double diaphragm structure will cause a relatively high increase in the inlet opening of the pilot valve 127 to the chamber 192 and a corresponding reduction in the outlet opening of said pilot valve from said chamber 192 to the chamber 190 having the outlet 191, thereby greatly increasing the pressure transmitted through the pipe connection 173 to the pressure chamber 154 of the compensated valve unit. This increased pressure, in turn, will produce a large increase in the opening of the valves 135 and 136 of said compensated valve unit so as to supply a very large volume of water for moving the pistons 14

down, while, at the same time, maintaining the desired pressure necessary for substantially uniform load in the instance of the form of the invention now being described, and for substantially uniform speed in the instance of the form of the invention as in Figs. 8, 9 and 3 to 7.

When the pilot valve 127 moves to increase the pressure transmitted through the pipe connection 173 to the chamber 154 of the compensated valve unit, the pressure in the chamber 218 of the compensator unit is also increased through the pipe connection 220. The increase in pressure acting under the diaphragm 209 results in rapid upward movement of the dash pot connecting rod 200. When the piston 199 is thus suddenly pulled upward due to increased pressure in the chamber 218, the closed cylinder 198 of said dash pot is carried along to lift the valves 193 and 194, to thus move the valve 193 toward its closed position and the valve 194 toward its open position. Or, stated differently, the action upon the valves 193 and 194 caused by upward movement of the diaphragm 209, and with it the piston 199, the closed cylinder 198 and said valves 193 and 194, is opposed to the action of an increase in the original actuating pressure on the lower diaphragm 181 which tends to open the valve 193 and close the valve 194. When the closed cylinder 198 is moved upward, the load is taken off the lower centering spring 234 and the upper centering spring 232 is compressed. Immediately, however, these springs 232 and 234 endeavor to restore the normal position of said closed cylinder 198. The oil, being under pressure, tends to flow through the by-pass 205, permitting the pilot valve 127 to return to its normal position. By proper design of all of the parts concerned and proper adjustment of the by-pass by some such means as the screw 206, the rate of restoration of equilibrium is controlled to meet the requirements of each individual situation in the pulp mill.

The compression springs 197 oppose the pressure in the chamber 187 against the diaphragm 181. The pilot valve 127 is not entirely balanced in that the pressure on the underside changes somewhat. This pressure, however, is very small because the projected area of the lower end of said pilot valve 127 is very small. To compensate for the unbalance, the upper diaphragm 182 may desirably be made a trifle larger than the lower diaphragm 181, so that when the pressure in the chamber 192 increases, the double valve structure including the diaphragms 181 and 182 will be raised slightly to compensate for the raising of the valve structure including the valves 193 and 194 through increased actuating pressure in the chamber 187 acting on the projecting area of the valve 193.

The wing nut 122 is for controllably adjusting the tension of the spring 120 which opposes the pull of the electro-magnet 118. As disclosed, the pull of said electro-magnet is proportional to the load on the electric motor 12 in amperes. Where watt control is desired, it is imposed in the form of a master regulator (not shown) which automatically adjusts the tension of the electro-magnet spring.

The disclosure as in Figs. 8, 9 and 3 to 7 is in all respects like the disclosure of Figs. 1 to 7 already described, except as hereinafter set forth. The functioning of the compound compensating governor, as well as the construction of said governor may be identical whether actuated in response to load condition of the electric motor 12 as in Figs. 1 to 7, or in response to speed of rota-

tion condition of the driven shaft 11 as in Figs. 8, 9 and 3 to 7.

In Figs. 8 and 9 the neck 94 is secured to a pump housing 235 providing a water reservoir 236. An impeller in the lower portion of the reservoir has a shaft 237 rotatably mounted in the housing 235. The shaft 237 fixedly carries a disc 238 having radially projecting vanes 239. An annular way, within which the disc 238 with vanes 239 rotates, is provided by portions 240 cast integral with the housing 235. A peripheral end portion of said annular way is provided with an annular portion 241 which communicates with a port 242 in the housing 235 and leading to the port 99 through the neck 94. The function of the impeller is to create pressure. Suitable gearing, denoted generally at 243, functions to rotate the impeller shaft 237 upon rotation of a sprocket 244 conveniently attached in driving relation to said gearing 243.

The shaft 11 which carries the grinders 10 of Fig. 8 is driven by an hydraulic turbine (not shown), and rotates the sprocket 244 by means of a sprocket 245 fixed upon said shaft 11 and a chain 246 riding said sprockets 244 and 245.

The pressure water for operating the apparatus is supplied to the reservoir 236 through an inlet 247 to said reservoir, and an overflow outlet 248 leads from the reservoir. The water supplied through the inlet 247 merely maintains a certain depth of water over the impeller of the pump unit and said impeller acts to produce water pressure in the pipe connection 93 and the chamber 187 in proportion to grinder speed. Outflow from the chamber 190 of Fig. 9 is to the reservoir 236.

During normal operation of the apparatus, a small flow of water is continuous through the inlet 247, the reservoir 236 and out of the port 242 to the several operative parts of said apparatus, as before set forth. Rotation of the shaft 11 at uniform rate of speed drives the impeller uniformly to set up a definite and predetermined pressure in said port 242 for communication to said operative parts. Abnormal operation of the apparatus, which reduces the load on the grinders 10, has tendency toward permitting the shaft 11 to be driven at increased speed by the hydraulic turbine. Increased speed of said shaft 11 in turn causes the pump impeller to be rotated, through the instrumentality of the sprocket and chain drive, at increased speed and to build up pressure in the port 242 proportionate to the increased speed of said impeller. As the speed of the shaft 11 comes back to normal, the pressure in said port 242 obviously also comes back to normal.

Under conditions of normal operation of the apparatus of Figs. 8, 9 and 3 to 7, the valve mechanism 19, together with the remainder of the bleeder valve unit, alone regulates the grinding pressure in accordance with the speed demands of the shaft 11, the water under pressure in the chamber 53 being supplied by the pump impeller through the ports 242 and 99 and the pipe connection 93. The compensated valve unit and its valve mechanism 20 comes into operation and functions in the manner as before described upon increase of speed of rotation of said shaft 11 slightly above normal. When this happens, the impeller speeds up and permits the compensator unit 126 with double acting pilot valve 127 to increase capacity for flow of water to the compensated valve unit as before set forth. With decrease of speed of the shaft 11 back to normal, the capacity for flow of water to the compensated

valve unit, as well as to the bleeder valve unit, proportionately decreases.

Both normally and when a pocket is pulled off for refilling or put on for movement toward grinding position, the apparatus of Figs. 8, 9 and 3 to 7 operates in the manner as recited in connection with the disclosure of Figs. 1 to 7, except that the increase and decrease of pressure in the port 242, communicated to the operative parts of the apparatus, is caused by increase and decrease in speed of rotation of the shaft 11 and in turn controls the speed of rotation of said shaft by regulating the load on the grinders, and that the bleeder valve 75-76 functions in the present instance as a speed actuated relief valve to supplement the action of the valve mechanism 19. In the instance of Figs. 8, 9 and 3 to 7 the valve mechanisms 19 and 20 are, more properly, speed actuated pressure-regulating valves. Said bleeder valve 75-76 acts in the manner as before described when the speed requirements demand a reduction in grinding pressure.

Whereas in Fig. 2 the outflow from the chamber 190 is through the outlet 191 directly from said chamber, the similar outflow from the equivalent chamber 190 in Fig. 9 is to the water reservoir 236. Overflow from said reservoir is through the outlet 248.

In the instance of each form of the invention, the original actuating fluid pressure enters the governor mechanism through the port 99. It travels directly through the pipe 93 to the chamber 53 of the bleeder valve unit and it also supplies the pilot valve 127 of the compensator unit 126. Said pilot valve 127 steps the original actuating pressure down to a lower pressure which passes through the pipe connection 173 to the chamber 154 of the compensated valve unit. The discharge being to the atmosphere, the outlet pressure from the pilot valve 127 is constant, so that said mentioned pilot valve is substantially balanced under all conditions. Normally, the regulated pressure is about half way between the inlet pressure and the outlet pressure so that both sides of the pilot valve 127 are open substantially equal amounts.

The supply pressure to the main pilot valve 100 of Figs. 1 and 2 being constant and the discharge being to atmosphere so that the outlet pressure is constant, this pilot valve is also substantially balanced under all conditions.

The pilot valves 100 and 127 are double-acting in that the same motion increases the inlet opening and reduces the outlet opening, and vice versa, and said pilot valves are balanced from the view point of the regulated pressures produced. By using sharp-edged seats, the pilot valves are also substantially balanced against changes in the flow of water. Each pilot valve acts to throttle the flow.

The entire apparatus is made as frictionless as possible. There is very little travel between any of the points, and thus inertia and momentum effects are avoided and rapid and precise action is secured.

The two valve units, which include the valve mechanisms 19 and 20, respectively, cooperate to control the load on the electric motor 12 in the instance of the form of the invention as disclosed in Figs. 1 to 7, and to control the speed of rotation of the grinders 10 and the shaft 11 in the instance of the form of the invention as disclosed in Figs. 8, 9 and 3 to 7. The valve mechanism 19 of the bleeder valve unit is continually in operation and provides the normal control while all

pockets are grinding. The valve mechanism 20 of the compensated valve unit is normally closed for the reason that if said valve mechanism 20 were permitted to operate normally, it would set up hunting and surging because of its high sensitiveness. Were the valve mechanism 20 permitted to be operative at times except when pockets are taken off or put on, small changes in load in the instance of the invention of Figs. 1 to 7, and small changes in speed in the instance of the invention of Figs. 8, 9 and 3 to 7, would produce such large action in said valve mechanism of the compensated valve unit as to result in over-travel and consequent hunting and surging.

The original actuating pressure operating in the instance of either form of the invention through the instrumentality of the bleeder valve unit constitutes a simple functional type of governor in that the position of the valve mechanism 19 is directly proportional to the load or speed, as the case may be. The original actuating pressure operating through the instrumentality of the compensator unit 126 and the compensated valve unit constitutes what is practically a relay type of apparatus in that said original actuating pressure will continue to increase grinding pressure so long as the original actuating force remains above the normal for which the governor is set. From the practical view point, substantially no change; that is, a change so small as to be negligible; is required in the position of the double valve structure including the diaphragms 181 and 182 of the pilot valve 127 to produce an almost unlimited increase in grinding pressure and thereby to effect a return of load or speed, as the case may be, to normal. A high grinding pressure necessitates a high pressure in the chamber 154 of the compensated valve unit. When the pressure in said chamber 154 is high, the pressure in the chamber 218 of the compensator unit 126 is also high, the upper spring 216 above the diaphragm 209 is considerably compressed, and the piston 199 is raised to a high position in the closed cylinder 198, but the pilot valve itself is always returned eventually to its normal position by the centering springs 232 and 234.

What is claimed is:

1. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, said pass including a plurality of fluid conveyors in parallel, a continuously open valve for controlling one of said fluid conveyors, a valve normally restricting another of said fluid conveyors and adapted to be moved toward open condition of said other conveyor to increase flow of fluid under pressure with decrease of friction load upon the driven member, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, means responsive to fluid-pressure regulated by said entity for actuating said continuously open valve toward wider open and nearer closed conditions of the fluid conveyor controlled by the continuously open valve to alter the pressure under which fluid is supplied for producing said friction load, a device actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, and means responsive to fluid-pressure controlled by

said device for actuating said valve normally restricting said other conveyor between open and restricted conditions of this last mentioned conveyor.

2. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, a valve movable to alter the pressure under which said fluid is supplied, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a device actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, means responsive to fluid-pressure controlled by said device for accomplishing movement of said valve, and complementary means responsive to flow of fluid through said pass for altering the pressure under which fluid is supplied for producing said friction load.

3. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, said pass including a plurality of fluid conveyors in parallel, a continuously open valve for controlling one of said fluid conveyors, a valve normally restricting another of said fluid conveyors and adapted to be moved toward open condition of said other conveyor upon decrease of friction load upon the driven member to a predetermined extent to increase flow of fluid under pressure and the friction load upon said driven member, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, cooperating mechanisms including means responsive to flow of fluid through said pass and means responsive to fluid-pressure regulated by said entity for actuating said continuously open valve toward wider open and nearer closed conditions of the fluid conveyor controlled by the continuously open valve to alter the pressure under which fluid is supplied for producing said friction load, a device actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, and cooperating mechanisms including means responsive to flow of fluid through said pass and means responsive to fluid-pressure regulated by said entity and controlled by said device for actuating said valve normally restricting said other conveyor toward open condition of the other conveyor upon decrease of the friction load upon said driven member to said mentioned predetermined extent.

4. In an apparatus of the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, said pass including a plurality of fluid conveyors in parallel, a continuously open valve for controlling one of said fluid conveyors, elastic means straining to move said continuously open valve in one direction, a valve normally restricting another of said fluid conveyors and adapted to be moved toward open condition of said other

conveyor upon decrease of friction load upon the driven member to a predetermined extent to increase flow of fluid under pressure and the friction load upon said driven member, elastic means holding said last mentioned valve in the restricted condition of said other conveyor, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, means responsive to fluid-pressure regulated by said entity for actuating said continuously open valve in direction counter to the direction said first mentioned elastic means strains to move said valve, a device actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, and means responsive to fluid-pressure controlled by said device for actuating said valve normally restricting said other conveyor toward open condition of this mentioned conveyor upon decrease of the friction load on said driven member to said mentioned predetermined extent.

5. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, said pass including a plurality of fluid conveyors in parallel, a continuously open valve for controlling one of said fluid conveyors, a valve normally restricting another of said fluid conveyors and adapted to be moved toward open condition of said other conveyor with decrease of friction load on the driven member, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a device actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, means responsive to fluid-pressure regulated by said entity for manipulating said continuously open valve, and means responsive to fluid-pressure regulated by said entity and controlled by said device for moving said valve normally restricting said other conveyor toward open condition of this last mentioned conveyor upon decrease of friction load upon said driven member to a predetermined extent.

6. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, said pass including a plurality of fluid conveyors in parallel, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a device actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, means responsive to fluid-pressure regulated by said entity for controlling the passage of fluid through one of said conveyors, and means responsive to fluid-pressure regulated by said entity and controlled by said device for controlling the passage of fluid through another of said conveyors.

7. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, an instrumentality having movement forcibly maintaining objects in

engagement with said driven member and abnormal movement upon travel of the objects to and from maintaining position, a pass including a conveyor thereof for continuously supplying a fluid under pressure to said instrumentality and a different conveyor thereof for supplying additional fluid under pressure to the instrumentality during abnormal movement thereof, a continuously open valve for controlling said conveyor, a flow-restricting valve for controlling said different conveyor, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a device actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, means continuously responsive to fluid-pressure regulated by said entity for manipulating the continuously open valve toward wider open and nearer closed positions, and means responsive to fluid-pressure regulated by said entity and controlled by said device for moving the flow-restricting valve toward open position at the commencement of abnormal movement of said instrumentality and for controlling the extent of opening of said flow-restricting valve during said abnormal movement.

8. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass for supplying fluid under pressure for producing a friction load upon said driven member, a source of fluid-pressure supply, valve means actuated by fluid-pressure from said source and movable to alter the passage of fluid through said pass, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, and a device actuated by fluid-pressure regulated by said entity and continuously alterably controlling fluid-pressure operable upon said valve means.

9. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass for supplying fluid under pressure for producing a friction load upon said driven member, a source of fluid-pressure supply, valve means movable to alter the passage of fluid through said pass, a chamber with movable element actuable by fluid-pressure from said source for manipulating said valve means, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, and a compensating unit actuated by fluid-pressure regulated by said entity and controlling fluid-pressure in said chamber, said compensating unit comprising a double diaphragm structure including spaced apart diaphragms movable as a unit and providing a second chamber between the diaphragms in communication with the first mentioned chamber, one of said diaphragms having an inlet opening to said second chamber for receiving fluid under pressure from said entity and another of said diaphragms having an outlet opening from said second chamber, a valve member with valves for controlling said inlet and outlet openings, respectively, said valve member being normally positioned to allow passage of fluid under pressure through both said inlet and outlet openings, flexible means urging said double diaphragm structure in direction counter to the action of fluid-pressure regulated by said entity, said inlet open-

ing being adapted to increase in size and said outlet opening being adapted to decrease in size with rise of fluid-pressure regulated by said entity and operable upon said double diaphragm structure, and vice versa, means responsive to relatively rapid rise of fluid-pressure regulated by said entity and imparted to said chambers for actuating said valve member to decrease said inlet opening and increase said outlet opening, and mechanism for returning said valve member to normal position after rapid rise of fluid-pressure imparted to said chambers.

10. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass for supplying fluid under pressure for producing a friction load upon said driven member, a source of fluid-pressure supply, valve means movable to alter the passage of fluid through said pass, a chamber with movable element actuable by fluid-pressure from said source for manipulating said valve means, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, and a compensating unit actuated by fluid-pressure regulated by said entity and controlling fluid-pressure in said chamber, said compensating unit comprising a double diaphragm structure including spaced apart diaphragms movable as a unit and providing a second chamber between the diaphragms in communication with the first mentioned chamber, one of said diaphragms having an inlet opening to said second chamber for receiving fluid under pressure from said entity and another of said diaphragms having an outlet opening from said second chamber, a valve member with valves for controlling said inlet and outlet openings, respectively, said valve member being normally positioned to allow passage of fluid under pressure through both said inlet and outlet openings, flexible means urging said double diaphragm structure in direction counter to the action of fluid-pressure regulated by said entity, said inlet opening being adapted to increase in size and said outlet opening being adapted to decrease in size with rise of fluid-pressure regulated by said entity and operable upon said double diaphragm structure, and vice versa, a dash-pot having the casing thereof connected to said valve member, a third chamber with which said chamber and second chamber communicate, a diaphragm actuated in one direction by fluid-pressure in said third chamber, flexible means for actuating said diaphragm in opposite direction, the piston of said dash-pot being connected to said last mentioned diaphragm whereby rapid rise of fluid-pressure regulated by said entity and imparted to said chambers will actuate said valve member through the instrumentality of the casing and piston of the dash-pot and their connections movable as a unit to decrease the size of said inlet opening and increase the size of said outlet opening, and mechanism for returning said valve member to normal position after rapid rise of fluid-pressure imparted to said chambers, said mechanism being constituted as flexible means for moving the casing and piston of said dash-pot relatively to each other.

11. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a conveyor adapted to continuously supply fluid under pressure for

producing a friction load upon said driven member, a valve for altering the passage of fluid through said conveyor, said conveyor including a fluid receiving chamber at the inlet side of said valve, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, means responsive to fluid-pressure regulated by said entity for actuating said valve to wider open and nearer closed conditions, an outlet to atmosphere from said chamber, a relief valve normally maintained in the closed condition of said outlet by fluid-pressure regulated by said entity, and means for permitting said relief valve to be moved to an open condition of said outlet upon decrease of fluid-pressure regulated by said entity to a predetermined extent.

12. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, a valve movable to alter the pressure under which said fluid is supplied, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a valve structure for continuously alterably controlling fluid-pressure regulated by said entity, and means responsive to fluid-pressure regulated by said entity and controlled by said valve structure for accomplishing movement of said valve.

13. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid-pressure, a pass including a plurality of fluid conveyors, one of said fluid conveyors being adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, a valve normally restricting another of said fluid conveyors and adapted to be moved toward open condition of said other conveyor upon decrease of friction load upon the driven member to a predetermined extent to increase flow of fluid under pressure and the friction load upon said driven member, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a compensating valve structure actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, and means responsive to fluid-pressure regulated by said entity and controlled by said compensating valve structure for actuating said valve toward open condition of said other conveyor upon decrease of the friction load upon said driven member to said mentioned predetermined extent.

14. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid-pressure, a pass adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, said pass including a plurality of fluid conveyors in parallel, a continuously open valve for controlling one of said fluid conveyors, a valve normally closing another of said fluid conveyors and adapted to be moved to an open condition of said other conveyor upon decrease of friction load upon the driven member to a predetermined

extent to increase flow of fluid under pressure and the friction load upon said driven member, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, means responsive to fluid-pressure regulated by said entity for actuating said continuously open valve toward wider open and nearer closed conditions of the fluid conveyor controlled by the continuously open valve to alter the pressure under which fluid is supplied for producing said friction load, a compensating valve structure actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, and means responsive to fluid-pressure regulated by said entity and controlled by said compensating valve structure for actuating said valve normally closing said other conveyor to the open condition of this conveyor upon decrease of the friction load on said driven member to said mentioned predetermined extent.

15. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid-pressure, a pass adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, a valve movable to alter the pressure under which said fluid is supplied, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a compensating valve structure actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, means responsive to fluid-pressure controlled by said compensating valve structure for accomplishing movement of said valve, and complementary means responsive to flow of fluid through said pass for altering the pressure under which fluid is supplied for producing said friction load.

16. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass including a plurality of fluid conveyors, one of said fluid conveyors being adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, a valve normally restricting another of said fluid conveyors and adapted to be moved toward open condition of said other conveyor to increase flow of fluid under pressure with decrease of friction load upon said driven member, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a compensating valve structure actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, and cooperating mechanisms including means responsive to flow of fluid through said pass and means responsive to fluid-pressure controlled by said compensating valve structure for actuating said valve toward open and restricted conditions of said other conveyor.

17. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass including a plurality of fluid conveyors, one of said fluid conveyors being adapted to continuously supply fluid under pressure for producing a friction load upon said

driven member, a valve normally restricting another of said fluid conveyors and adapted to be moved toward open condition of said other conveyor to increase flow of fluid under pressure and the friction load upon said driven member, elastic means for holding said valve in the restricted condition of said other conveyor, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a compensating valve structure actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, and means responsive to fluid-pressure controlled by said compensating valve structure for actuating said valve toward open condition of said other conveyor against the action of said elastic means.

18. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, an instrumentality having normal movement forcibly maintaining objects in engagement with said driven member and abnormal movement upon travel of the objects to and from maintaining position, a pass adapted to continuously supply fluid under pressure to said instrumentality for producing a friction load upon said driven member, said pass including a plurality of fluid conveyors in parallel, a continuously open valve for controlling one of said fluid conveyors, a valve normally restricting another of said fluid conveyors and adapted to be moved toward open condition of said other conveyor upon abnormal movement of said instrumentality decreasing friction upon the driven member, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, means responsive to fluid-pressure regulated by said entity for actuating said continuously open valve toward wider open and nearer closed conditions of the fluid conveyor controlled by the continuously open valve to alter the pressure under which fluid is supplied for producing said friction load, a compensating valve structure actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, and means responsive to fluid-pressure regulated by said entity and controlled by said compensating valve structure for actuating said valve normally restricting said other conveyor toward open condition of this last mentioned conveyor upon abnormal movement of said instrumentality.

19. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid-pressure, a pass adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, said pass including a plurality of fluid conveyors in parallel, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a compensating valve structure actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, means responsive to fluid-pressure regulated by said entity for controlling the passage of fluid through one of said conveyors, and means responsive to fluid-pressure regulated by said entity and controlled by said compensating valve structure for

controlling the passage of fluid through another of said conveyors.

20. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid-pressure, an instrumentality having movement forcibly maintaining objects in engagement with said driven member and abnormal movement upon travel of the objects to and from maintaining position, a pass including a plurality of fluid conveyors, one of said fluid conveyors being for continuously supplying fluid under pressure to said instrumentality and another of said conveyors being for supplying additional fluid under pressure to the instrumentality during abnormal movement thereof, a continuously open valve for controlling said first mentioned conveyor, a flow-restricting valve for controlling said other conveyor, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a compensating valve structure actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, means continuously responsive to fluid-pressure regulated by said entity for manipulating the continuously open valve toward wider open and nearer closed positions, and means responsive to fluid-pressure regulated by said entity and controlled by said compensating valve structure for moving the flow-restricting valve toward open position at the commencement of abnormal movement of said instrumentality and for controlling the extent of opening of said flow-restricting valve during said abnormal movement.

21. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid-pressure, a pass for supplying fluid under pressure for producing a friction load upon said driven member, a source of fluid-pressure supply, valve means actuated by fluid-pressure from said source and movable to alter the passage of fluid through said pass, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, and a compensating valve structure actuated by fluid-pressure regulated by said entity and continuously alterably controlling fluid-pressure operable upon said valve means.

22. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass including a plurality of fluid conveyors, one of said fluid conveyors being adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, a valve normally closing another of said fluid conveyors and adapted to be moved to an open condition of said other fluid conveyor to increase flow of fluid under pressure and the friction load upon said driven member, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a device actuated by fluid pressure regulated by said entity for controlling said last mentioned fluid-pressure, and means responsive to fluid-pressure regulated by said entity and controlled by said device for actuating said valve to open and closed conditions of said other conveyor.

23. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load produced by fluid pressure, a pass including a plurality of fluid conveyors, one of said fluid conveyors being adapted to continuously supply fluid under pressure for producing a friction load upon said driven member, a valve normally restricting another conveyor of said pass and adapted to be moved toward open condition of said other conveyor to increase flow of fluid under pressure and the friction load upon said driven member, elastic means for holding said valve in the restricted condition of said other conveyor, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a device actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, and means responsive to fluid-pressure controlled by said device for actuating said valve toward open condition of said other conveyor against the action of said elastic means.
24. In an apparatus for the maintenance of a substantially uniform operating condition of a driven member working under a friction load

produced by fluid pressure, an instrumentality having movement forcibly maintaining objects in engagement with said driven member and abnormal movement upon travel of the objects to and from maintaining position, a pass including a plurality of fluid conveyors, one of said fluid conveyors being adapted to continuously supply fluid under pressure to said instrumentality and another of said conveyors being adapted to supply additional fluid under pressure to the instrumentality during abnormal movement thereof, a source of fluid-pressure supply, an entity for regulating fluid-pressure from said source responsive in its operation to the magnitude of the friction load upon said driven member, a device actuated by fluid-pressure regulated by said entity for controlling said last mentioned fluid-pressure, means continuously responsive to fluid-pressure regulated by said entity for controlling the passage of fluid through said conveyor, and means responsive to fluid-pressure regulated by said entity and controlled by said device and operative during abnormal movement of said instrumentality for controlling the passage of fluid through said other conveyor.

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