

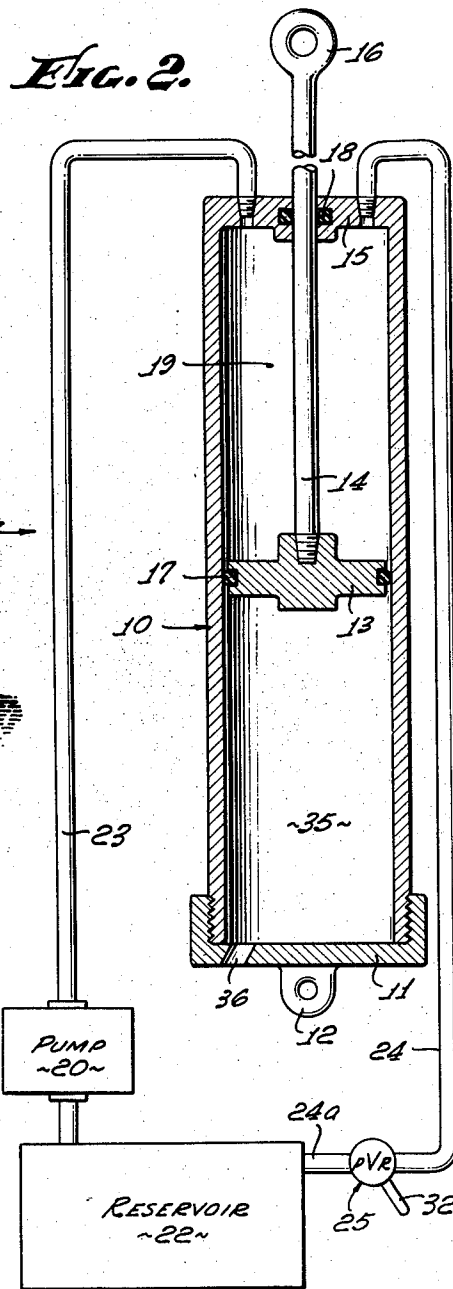
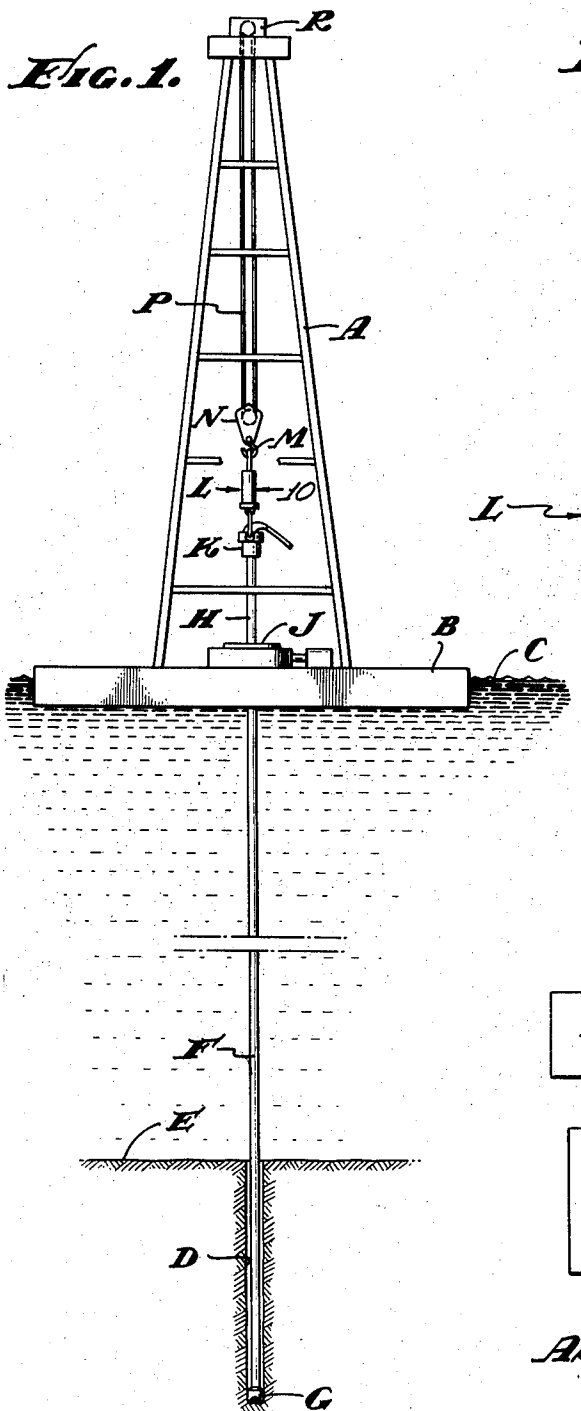
July 19, 1960

A. W. KAMMERER, JR.
HYDRAULIC WEIGHT COMPENSATING APPARATUS
FOR WELL BORE DEVICES

2,945,677

Filed Nov. 8, 1956

3 Sheets-Sheet 1



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Fig. 3.

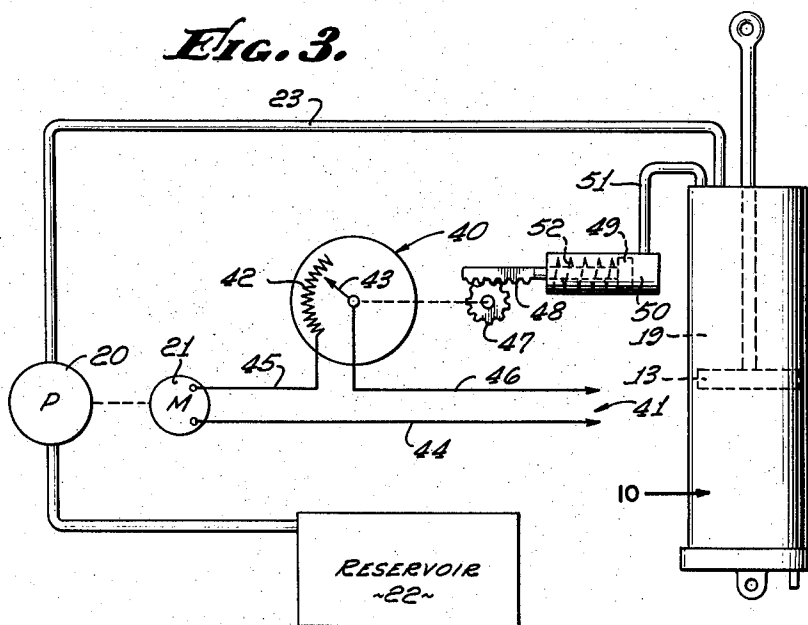
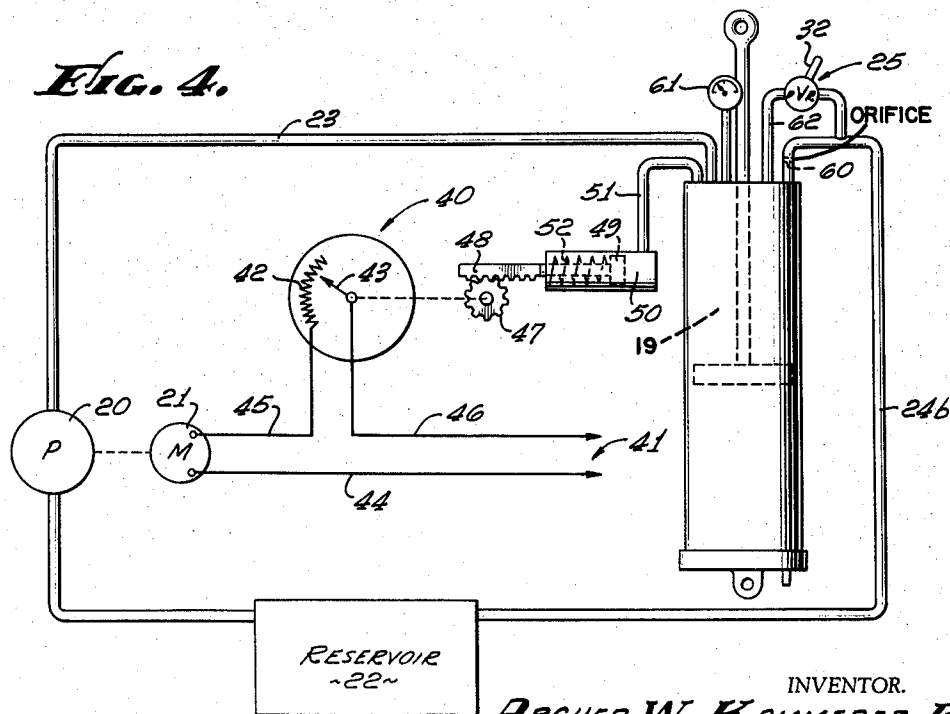


Fig. 4.



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FIG. 5.

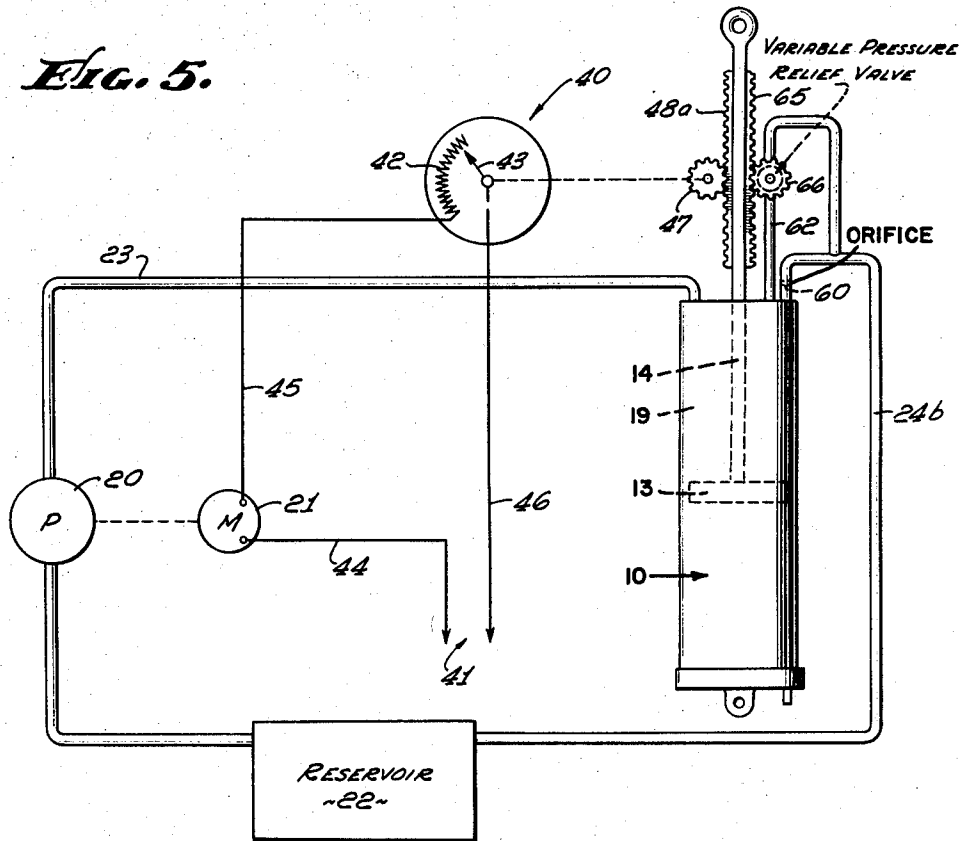
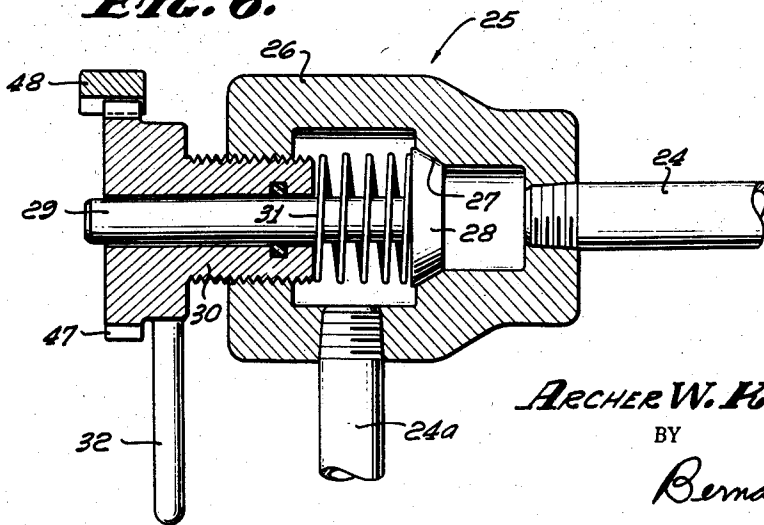


FIG. 6.



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HYDRAULIC WEIGHT COMPENSATING APPARATUS FOR WELL BORE DEVICES

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14 Claims. (Cl. 255—19)

The present invention relates to apparatus for controlling the stress in a running-in string, such as drill pipe, drill casing and tubing disposed in a well bore.

An object of the present invention is to provide telescopic hydraulic compensating apparatus for maintaining the stress in a running-in string substantially at a predetermined value by maintaining the fluid pressure in the apparatus substantially constant, despite telescopic movement of such apparatus, which changes its effective volume.

Another object of the invention is to provide hydraulic compensating apparatus for maintaining the stress in a running-in string substantially at a predetermined value, in which the stress imposed by the apparatus on the running-in string can be readily changed by changing the fluid pressure in the apparatus.

A further object of the invention is to provide telescopic hydraulic compensating apparatus for maintaining the stress in a running-in string substantially at a predetermined value, in which the fluid pressure in the apparatus is maintained substantially constant by automatically varying the speed of the pump supplying the fluid to the apparatus.

An additional object of the invention is to provide telescopic hydraulic compensating apparatus for maintaining the stress in a running-in string at a predetermined value, in which the fluid pressure in the apparatus is maintained substantially constant at the predetermined value in response to relative telescopic movement between parts of the apparatus.

Yet another object of the invention is to provide telescopic hydraulic compensating apparatus for maintaining the stress in a running-in string substantially at a predetermined value, in which the fluid pressure in the apparatus is maintained substantially constant by automatically varying the speed of the pump supplying the fluid to the apparatus, in response to relative telescopic movement between parts of the apparatus.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of several forms in which it may be embodied. Such forms are shown in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a diagrammatic view illustrating an application of the invention to an oil well drilling rig mounted on a floating barge;

Fig. 2 is a diagrammatic view, partly in section, of one form of weight compensating apparatus forming part of the equipment disclosed in Fig. 1;

Fig. 3 is a view similar to Fig. 2 of another embodiment of the invention;

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Fig. 4 is a view similar to Fig. 2 of still a further embodiment of the invention;

Fig. 5 is a view similar to Fig. 2 of yet another form of the invention;

Fig. 6 is a longitudinal section through a variable check or pressure relief valve used in the specific systems disclosed in Figs. 2, 4 and 5.

As disclosed in Fig. 1, a drilling derrick A is mounted on a barge B floating in a body of water C, such as an ocean, to enable a well bore D to be drilled commencing at the bottom or floor E of the ocean to the desired depth. The barge B is suitably anchored against lateral displacement, in order to hold a drill string F, such as drill pipe or drill casing, centered over the hole or well bore D being produced, a drill bit G being attached to the lower end of the tubular drill string F in the usual manner.

The upper or kelly portion H of the drill string F passes through and is slidably splined to the usual rotary table J, which is rotated by a suitable drive mechanism (not shown). The upper end of the kelly H is attached to a swivel K, which is, in turn, connected to the lower portion of the weight compensating apparatus L, which can assume any of the forms disclosed in Figs. 2, 3, 4 and 5. The upper portion of the weight compensating apparatus L is connected to the hook M of a traveling block N suspended by means of suitable lines P from the crown block R at the upper end of the derrick A fixed to the drilling barge B. The lines P are operated by the usual drawworks (not shown), by means of which the drill string F and the apparatus connected thereto is suspended from the crown block R.

One form of weight compensating apparatus is disclosed in Figs. 2 and 6. As shown, a cylinder 10 has a lower cylinder head 11 provided with a suitable eye or bail 12 for connection to the upper end of the swivel K. A piston 13 is reciprocally mounted in the cylinder, having a piston rod 14 extending slidably through an upper cylinder head 15, the rod having a suitable eye or bail 16 for attachment to the hook M of the traveling block N. Leakage of fluid between the cylinder 10 and piston 13 is prevented by a suitable seal ring 17 on the piston slidably and sealingly engaging the inner wall of the cylinder. Leakage of fluid between the piston rod 14 and cylinder head 15 is prevented by a suitable rod packing 18 on the upper cylinder head slidably and sealingly engaging the piston rod.

A certain desired portion of the weight of the drill string F is carried through a liquid medium filling the cylinder space 19 between the piston 13 and the upper cylinder head 15. The weight imposed by the drill string F and swivel K on the cylinder 10 is transferred through the liquid medium to the piston 13, and from the latter through the piston rod 14 to the traveling block N, the lines P, and the crown block R. The piston 13 and piston rod 14 are telescopically disposed within the cylinder 10 so that by maintaining the proper pressure in the liquid within the cylinder space 19, an upwardly directed force is exerted on the upper cylinder head 15, the cylinder 10 and the drill string F therebelow, supporting any desired portion of the weight of the drill string.

It is possible to increase the pressure of the liquid in the cylinder space 19 to such an extent as to support the entire weight of the drill string F, in which event there will be no drilling weight on the drill bit G. By reducing the pressure of the liquid to the desired value, the weight on the drill bit will be the difference between the buoyant weight of the drill string F and the upward force exerted by the liquid in the cylinder over the area of the upper cylinder head 15. Thus, assuming the cylinder to have an internal cross-sectional area of about one hundred square inches, a pressure of 800 p.s.i. in the liquid will mean that an upward supporting force is being

imposed on the entire drill string F of about 80,000 lbs. If the drill string itself weighs about 90,000 lbs., then the net drilling weight forcing the drill bit G against the bottom of the hole will be 10,000 lbs.

The liquid pressure in the cylinder space 19 is maintained by a pump 20, which may be of the centrifugal type rotated by a suitable prime mover 21, such as an electric motor. The pump draws the liquid, which may be oil, from a suitable reservoir 22, and discharges it through an inlet line 23 into the upper portion 19 of the cylinder, to which the inlet line is connected. The liquid can exit from the cylinder space 19 through a suitable outlet or return line 24 connected at any convenient point to the cylinder, as at the upper cylinder head, and to the reservoir 22. At least parts of the inlet line 23 and part of the outlet or return line 24 are made flexible, to permit vertical travel of the weight compensator L as it is raised or lowered by means of the traveling block N and the drawworks.

The pressure in the cylinder space 19 is maintained at a constant value by a variable check or pressure relief valve 25 connected in the outlet or return line 24. This valve can assume any desired form, one of which is illustrated in Fig. 6. The return line 24 leading from the cylinder 10 is connected to a valve body 26 having a valve seat 27 therein that is engageable by a companion valve head 28. The valve head is connected to a valve stem 29 slidable longitudinally in a spring seat 30 adjustably threaded in the body. A helical compression spring 31 encompasses the valve stem 29, bearing upon the valve head 28 and upon the spring seat 30, and constantly urging the valve head toward an engaged position with its companion seat 27. The closing force exerted by the spring 31 on the valve head 28 will determine the pressure which is maintained in the return line 24 and within the cylinder space 19. When such pressure is exceeded, the valve head 28 moves off its seat to bleed the excess liquid and pressure around the valve head 28, and out through a discharge line 24a that is connected to the reservoir 22.

By changing the force exerted by the spring 31, the pressure maintained in the return line 24 and cylinder 10 can be varied. One mode of changing such pressure is to connect a handle 32 to the spring seat 30 to facilitate turning of the latter and its axial feeding in a direction inwardly or outwardly of the valve body 26, to correspondingly increase or decrease the spring force.

Assuming, by way of example, that it is desired to provide a pressure of 800 p.s.i. in the cylinder space 19, the spring seat 30 will be turned to provide the required compressive force on the spring so that the valve head 28 will move away from its companion seat 27 when there is any tendency for the pressure in the cylinder and return line 24 to exceed 800 p.s.i. If a greater amount of drilling weight on the drill bit G is desired, then it is only necessary to reduce the spring tension so that the pressure maintained in the cylinder space 19 is correspondingly reduced, the liquid supplied by the pump 20 to the cylinder 10 passing out around the partially opened check valve 25, through the discharge line 24a, to the reservoir 22. Any tendency for the pressure in the cylinder to increase is accompanied by a greater shifting of the valve head 28 away from its seat 27, so as to release or bleed off a greater amount of fluid through the discharge line 24a back into the reservoir 22. Any tendency for the pressure to decrease is accompanied by a return movement of the valve head 28 toward the valve seat 27, to throttle or diminish the flow through the return line 24, and thereby maintain the pressure in the cylinder space 19 constant.

During the performance of the drilling operation, the pump 20 is constantly supplying liquid to the cylinder space 19 through the inlet line 23, the liquid flowing from the cylinder through the outlet line 24 and the check valve 25 back to the reservoir 22. As the drill bit G makes hole, the drill string F will lower, carrying the cylinder

10 downwardly along the piston 13. Despite such lowering action, the hydraulic pressure of the liquid in the cylinder space 19 above the piston 13 is maintained at the predetermined value, depending upon the adjustment of the check valve 25, insuring the maintenance of the desired net drilling weight on the bit G. Before the upper cylinder head 15 can contact the piston 13, the traveling block N and the piston 13 connected thereto will be lowered, to shift the piston away from the upper cylinder head 15 by a substantial distance, the amount of weight supported by the piston 13 and the drawworks through the liquid medium still remaining at the desired value established by the adjustment of the variable check valve 25. As the cylinder 10 lowers along the piston rod 14, the operator at the top of the hole is given visual indication of the footage being made by the drill bit G.

The apparatus L can be used in connection with the drilling of the well bore D, or in connection with the use of a milling tool in the well bore for drilling away objects therewithin or sections or lengths of casing. The hydraulic apparatus L will insure the maintenance of a steady drilling weight on the milling tool. Again, the apparatus can be used to maintain a predetermined stress or tension in any running-in string disposed in a well bore, such as a string of tubing connected to another tool in the well bore that might be anchored to the well casing. The fluid pressure in the cylinder space 19 will be selected to exert an upward force on the cylinder 10 which is greater than the weight of the tubing or other running-in string by an amount corresponding to the stress desired in the tubing string.

The apparatus L finds particular application in connection with drilling barges B, although it can be used in connection with drilling operations on dry land. The drilling barge B may be anchored against lateral movement by suitable means, but the action of the waves causes it to partake of vertical movement. Obviously, elevation of the barge and of the rig mechanism mounted thereon would cause an upward pull to be taken on the drill string F, which would decrease the drilling weight of the bit G against the bottom of the hole D. In fact, the drilling bit might even be raised above the bottom of the hole. Then again, a lowering movement of the barge B would effect the imposition of a greater weight on the drill bit than is desired. It might even result in the collapsing or bending of the entire drill string F. The present invention automatically compensates for the upward and downward movements of the drill barge B and the rig mounted thereon, maintaining a constant drilling weight on the drill bit G.

Assuming the barge to rise, the piston 13 will be elevated in the cylinder 10. However, the pressure of the fluid in the cylinder space 19 is not elevated since the excess pressure effects a fuller opening of the check valve 25, the valve head 28 moving further away from its seat 27, so that the liquid displaced by the piston 13 from the cylinder 10 is exhausted in a rapid manner through the return line 24 and the check valve 25 to the reservoir 22, resulting in the maintenance of a constant pressure in the cylinder space 19 despite the elevation of the piston 13 in the cylinder. On the other hand, assuming that the barge and the drilling rig lower on the water, then the piston 13 will be moved downwardly in the cylinder 10, the increased volume in the cylinder, by virtue of the movement of the piston away from the upper cylinder head 15, still not resulting in a decrease in the pressure in the cylinder space 19, since the check valve 25 will merely close to a greater extent and the centrifugal pump 20 will rapidly supply the additional liquid needed in the cylinder to compensate for the increase in cylinder volume. Actually, the pump 20 is always delivering an excess of liquid to the cylinder 10, such excess of liquid passing through the check valve 25 back to the reservoir 22. As the piston 13 moves down in the cylinder 10, the capacity of the pump is such as to very rapidly provide the addi-

tional liquid necessary for the maintenance of the pressure in the cylinder at the desired constant value, thereby maintaining the drilling weight on the drill bit G at a constant value.

Thus, it is apparent that despite the up and down movements of the drilling barge B and the drill rig, the drilling weight on the bit is not affected. Such movements are automatically compensated for in the weight control apparatus L.

The cylinder space 35 below the piston 13 may contain air at atmospheric pressure. However, to insure against the presence of any dead bodies of liquid in such cylinder space, a suitable drain hole 36 may be provided through the lower cylinder head 11, which allows any liquid that might leak past the piston 13 to drain out of the cylinder.

In the form of invention disclosed in Fig. 3, a weight compensating or stress compensating apparatus is provided in which the pressure of the liquid in the cylinder space 19 above the piston 13 is maintained at a substantially constant value, despite telescopic movement between the piston and cylinder, by controlling the speed of the centrifugal pump 20. As disclosed herein, the centrifugal pump 20 draws the liquid from the reservoir and discharges it through the inlet line 23 into the cylinder space 19. The pump is rotated by a suitable prime mover 21, such as a D.C. shunt motor. There is no return line provided from the cylinder 10 to the reservoir 22, reliance being had upon slippage in the centrifugal pump in the event no further liquid is being forced into the cylinder. If the liquid pressure in the cylinder space 19 tends to increase as the result of an elevation of the drilling barge B, which will shift the piston 13 upwardly in the cylinder 10, such increase in pressure is caused to reduce the speed of the motor 21 and of the pump 20. Reduction of the speed of the latter will be accompanied by the reduction of the pressure in the inlet line 23 and in the cylinder 10. On the other hand, in the event the barge B descends, to move the piston 13 downwardly in the cylinder 10, the speed of the motor 21 is increased to rotate the centrifugal pump 20 faster and build up the pressure in the inlet line 23 and the cylinder space 19 to the desired value.

As disclosed in Fig. 3, the motor speed is changed by changing its field current. Thus, a field rheostat 40 is provided connected across a suitable source of power 41, the field rheostat having a resistance 42 over which an arm 43 is movable. One end of the field coils is connected to one line 44 of the source of power 41, the other side of the field coils being connected by the lead 45 to an end of the resistance 42. The resistance 42 is contacted by the pivoted arm 43 that is connected to the other line 46 of the power source.

The field resistance is varied by arcuately moving the contact arm 43 over the resistance 42. Thus, a pinion 47 is connected to the arm 43 to rotate the latter, this pinion meshing with a rack 48 secured to a piston 49 reciprocable within a cylinder 50, the high pressure end of the cylinder being connected through a suitable line 51 to the upper portion of the weight compensating cylinder 10. A spring 52 encircles the piston 49, bearing at one end on the cylinder 50 and at its other end upon the piston 49, tending to urge the latter in a direction counter to the pressure of the liquid in the cylinder 50. As the pressure in the weight compensating cylinder 10 and the control cylinder 50 increases, the piston 49 is shifted to the left, as seen in the drawings, to rotate the pinion 47 counter-clockwise and cause a corresponding counter-clockwise movement of the rheostat arm 43 over the resistance 42, decreasing the resistance and increasing the field current, which will result in a decrease in the speed of the motor 21 and of the pump 20. On the other hand, as the pressure in the weight compensating cylinder 10 decreases, the spring 52 will shift the piston 49 and rack 48 to the right, as seen in Fig. 3, rotating the pinion 47 and the rheostat arm 43 in a clockwise direction, to increase the field resistance, which will result in an increase in the

speed of the motor 21 and of the pump 20. Thus, as the fluid pressure in the weight compensating cylinder 10 increases, as, for example, the result of the barge B and rig rising in the water C, the speed of the motor 21 and the pump 20 are decreased, to lower the pressure in the cylinder 10 back to its initial desired value. Conversely, should the pressure in the weight compensating cylinder 10 tend to decrease, as a result of lowering of the barge B and the rig on the water, then the speed of the motor 21 and of the pump 20 will be increased, to bring the pressure in the cylinder space 19 back to its initial value.

In the form of invention disclosed in Fig. 4, the same pressure control arrangement is provided as is used in Fig. 3, except that a return line 24b is provided from the cylinder space 19 to the reservoir 22, the motor driven pump 20 providing a steady supply of liquid to the cylinder 10. The return line 24b has a choke orifice 60 therein, which will throttle the flow of fluid in the return line 24b and cause a back pressure of the desired value to be built up in the cylinder space 19. In the event that such pressure were to increase or decrease, the motor speed control mechanism 40 to 51 would automatically function to either decrease the speed of the pump 20, in the event of an increase in pressure, or to increase the speed of the pump 20, in the event of a decrease in pressure. At all times, the actual pressure in the cylinder 10 can be observed on a suitable pressure gauge 61 connected to the cylinder 10.

If desired, a pressure relief or variable check valve 25 can be connected between the cylinder 10 and the return line 24b. Thus, a branch line 62 is connected to the upper cylinder head 15 and to the return line 24b on the discharge side of the choke orifice 60. A manually controlled variable check valve 25 is located in this branch line 62, this check valve being of the same general type as disclosed in Fig. 6. It is set to provide a desired pressure which is to be maintained in the cylinder space 19, depending upon the net drilling weight to be imposed on the drill bit G, or depending upon the stress to be maintained in some other running-in string F disposed in the well bore. In the event such pressure is exceeded, the check valve 25 will open to bleed the excess fluid from the cylinder space 19 around the choke 60 to the return line 24b.

Normally, the choke orifice 60 may be sufficient to insure the maintenance of the proper pressure in the cylinder space 19, but in the event there is a sudden surge of pressure in the cylinder space 19, as might result from a sudden elevation of the barge B, the pressure relief valve 25 will open to as wide an extent as is necessary to bleed the excess liquid from the cylinder space 19, around the choke 60 to the return line 24b, and back to the reservoir 22.

Thus, the system disclosed in Fig. 4 maintains the pressure in the cylinder space 19 at the desired value by use of the choke orifice 60, which insures the maintenance of the back pressure in the cylinder space, by controlling the speed of the motor 21 and pump 20, and by bleeding off any excess fluid from the cylinder space 19 through the variable check valve 25.

In the embodiment of the invention disclosed in Fig. 5, the same general control action is obtained as in the system illustrated in Fig. 4. However, the variable check valve 25 and the field resistance are controlled mechanically, depending upon the relative telescoped position between the piston 13 and piston rod 14, on the one hand, and the cylinder 10, on the other hand. Thus, the piston rod 14 may have a rack 48a formed thereon meshing with a gear 47 connected to the resistance arm 43 of the rheostat 40 that swings over the resistance 42, the gear and rheostat being suitably supported from the weight control cylinder 10. Another or the same rack 65 meshes with a pinion 66 that is formed on the adjustable spring seat 30 threaded in the valve body 26, the valve body also being suitably supported by the drilling weight

control cylinder 10. The variable check valve 25 is connected in a branch line 62 around the choke orifice 60, in the same manner as disclosed in Fig. 4.

As the pressure in the cylinder space 19 tends to increase, for example, as a result of elevation of the barge B and the rig, the piston 13 and rod 14 will move upwardly, causing the rack 48a to rotate the pinion 47 and arm 43 counter-clockwise, in order to decrease the field resistance and thereby reduce the speed of the motor 21 and the pump 20, to lower the rate of liquid flow to the cylinder 10. At the same time, the rack 65 rotates the gear 66 to rotate the spring seat 30, and decrease the compression of the spring 31, thereby allowing the valve head 28 to shift away from its seat 27 at lower pressures or to a wider open position. Thus, a much faster response is secured to prevent any substantial increase in the pressure of the liquid in the cylinder space 19, by decreasing the speed of the motor 21 and pump 20, and also by decreasing the pressure setting of the relief valve 25.

On the other hand, should the pressure in the cylinder space 19 decrease, as, for example, caused by the lowering of the barge B and rig on the water, then the racks 48a, 62 will shift downwardly relative to the cylinder 10 to increase the field resistance of the motor 21, resulting in an increase in the speed of the latter and of the pump 20 connected thereto, while at the same time the spring seat 30 is adjusted to increase the force of the spring 31, which will tend to close the valve head 28 against the seat 27, imposing a greater resistance to the bleeding of liquid from the cylinder space 19 to the return line 24b, and insuring a greater and faster filling of the cylinder 10 with liquid and its maintenance of such liquid at the desired pressure, so as to maintain the drilling weight on the bit G at the desired value.

The inventor claims:

1. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; means for constantly conducting the fluid supplied by said pump to said cylinder means back to said source of fluid; and check valve means in said conducting means for maintaining the pressure in said cylinder means substantially constant.

2. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; and means responsive to relative movement of said piston means in said cylinder means for varying the speed of said pump.

3. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; and means responsive to the pressure of the fluid in said cylinder means for varying the speed of said pump.

4. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove

and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; means for conducting the fluid supplied by said pump to said cylinder means back to said source of fluid; check valve means in said conducting means for maintaining the pressure in said cylinder means substantially constant; and means responsive to relative movement of said piston means in said cylinder means for adjusting said check valve means to vary its opening pressure.

5. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; means for conducting the fluid supplied by said pump to said cylinder means back to said source of fluid; check valve means in said conducting means for maintaining the pressure in said cylinder means substantially constant; means responsive to relative movement of said piston means in said cylinder means for adjusting said check valve means to vary its opening pressure; and means responsive to relative movement of said piston means in said cylinder means for varying the speed of said pump.

6. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; means responsive to the fluid pressure in said cylinder means for maintaining such pressure substantially constant; and means responsive to relative movement of said piston means in said cylinder means for adjusting said fluid pressure responsive means.

7. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; means for conducting the fluid supplied by said pump to said cylinder means back to said source of fluid; a choke orifice in said conducting means through which the fluid can flow; and check valve means connected in said conducting means around said choke orifice through which fluid can flow and by-pass said choke orifice.

8. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; means for conducting the fluid supplied by said pump to said cylinder means back to said source of fluid; a choke orifice in said conducting means through which the fluid can flow; check valve means connected in said conducting means around said choke orifice through which fluid can flow

and by-pass said choke orifice; and means responsive to the pressure of the fluid in said cylinder means for varying the speed of said pump.

9. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; means for conducting the fluid supplied by said pump to said cylinder means back to said source of fluid; a choke orifice in said conducting means through which the fluid can flow; check valve means connected in said conducting means around said choke orifice through which fluid can flow and by-pass said choke orifice; means responsive to the pressure of fluid in said cylinder means for varying the speed of said pump; and means responsive to relative movement of said piston means in said cylinder means for adjusting said check valve means to vary its opening pressure.

10. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; an electric motor for rotating said pump; and means responsive to relative movement of said piston means in said cylinder means to reduce the speed of said motor and pump as the piston means and cylinder means tend to extend with respect to one another and to increase the speed of said motor and pump as the piston means and cylinder means tend to contract with respect to one another.

11. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; an electric motor for rotating said pump; and means responsive to the pressure of the fluid in said cylinder means to reduce the speed of said motor and pump as said fluid pressure in said cylinder means tends to increase and to increase the speed of said motor and pump as said fluid pressure in said cylinder means tends to decrease.

12. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; means for conducting the fluid supplied by said pump to said cylinder means back to said source of fluid; check valve means in said conducting means for maintaining the pressure in said cylinder means substantially constant; means responsive to relative movement of said piston means in said cylinder means for adjusting said check valve means to various opening pressure; an electric motor for ro-

tating said pump; and means responsive to relative movement of said piston means in said cylinder means to reduce the speed of said motor and pump as the piston means and cylinder means tend to extend with respect to one another and to increase the speed of said motor and pump as the piston means and cylinder means tend to contract with respect to one another.

13. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; means for conducting the fluid supplied by said pump through said cylinder means back to said source of fluid; a choke orifice in said conducting means through which the fluid can flow; check valve means connected in said conducting means around said choke orifice through which fluid can flow and by-pass said choke orifice; an electric motor for rotating said pump; and means responsive to the pressure of the fluid in said cylinder means to reduce the speed of said motor and pump as said fluid pressure in said cylinder means tends to increase and to increase the speed of said motor and pump as said fluid pressure in said cylinder means tends to decrease.

14. An apparatus having cylinder means and piston means slidable therein and adapted to be disposed between and connected to a suspension device thereabove and a running-in string therebelow to maintain a predetermined stress in the running-in string; a source of fluid; a pump connected to said source and cylinder means for forcing fluid under pressure into said cylinder means, whereby the stress on one of said means is transmitted through the fluid to the other of said means; means for conducting the fluid supplied by said pump through said cylinder means back to said source of fluid; a choke orifice in said conducting means through which the fluid can flow; check valve means connected in said conducting means around said choke orifice through which fluid can flow and by-pass said choke orifice; an electric motor for rotating said pump; means responsive to the pressure of the fluid in said cylinder means to reduce the speed of said motor and pump as said fluid pressure in said cylinder means tends to increase and to increase the speed of said motor and pump as said fluid pressure in said cylinder means tends to decrease; and means responsive to relative movement of said piston means in said cylinder means for adjusting said check valve means to various opening pressures.

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