June 22, 1943. H. H. VANDERZEE 2,322,739

HYDRAULICALLY OPERATED APPARATUS

Filed Nov. 14, 1939 3 Sheets-Sheet 1

Fig. 1.

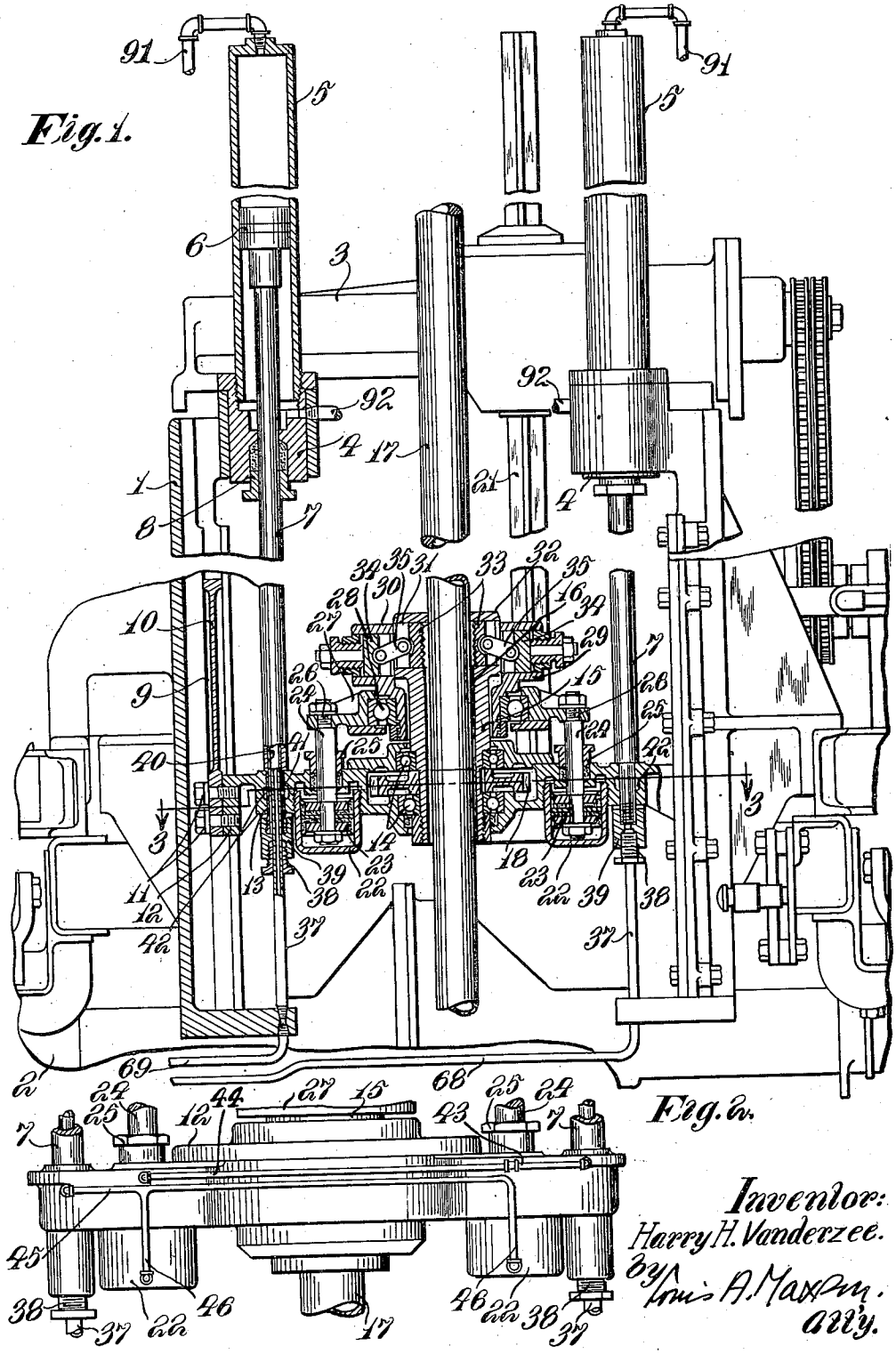

Fig. 2.

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HYDRAULICALLY OPERATED APPARATUS

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Fig. 3.

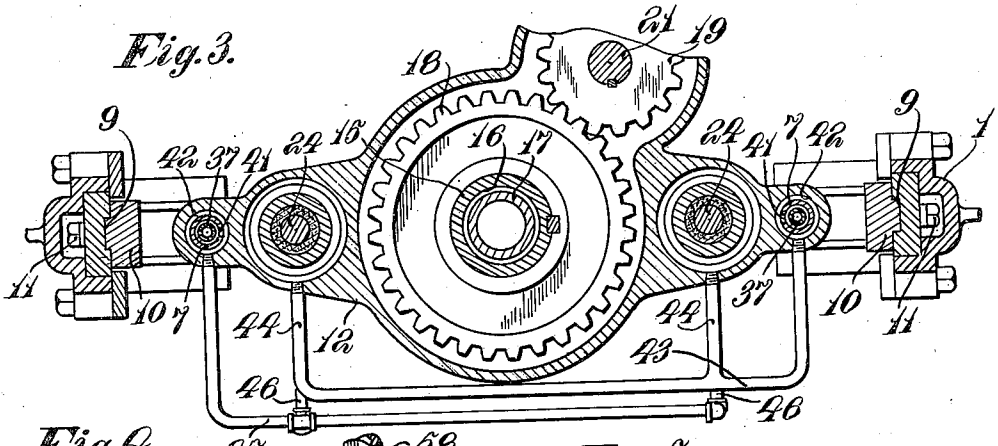

Fig. 4.

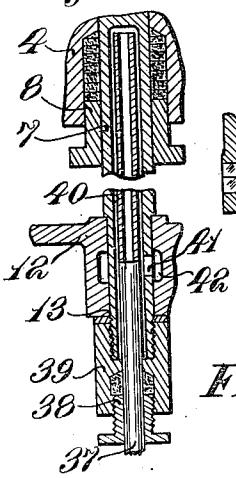

Fig. 5.

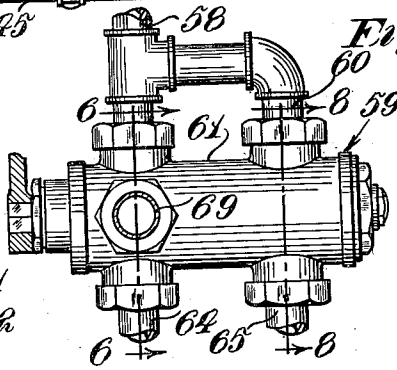

Fig. 7.

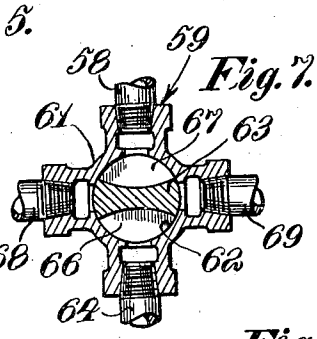

Fig. 6.

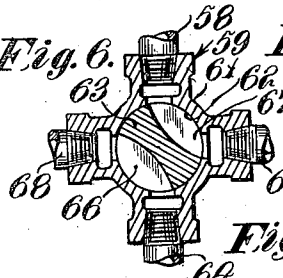

Fig. 8.

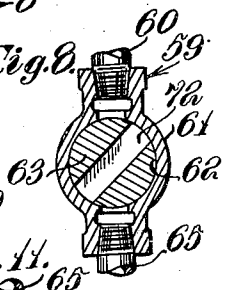

Fig. 9.

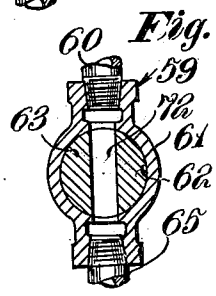

Fig. 10.

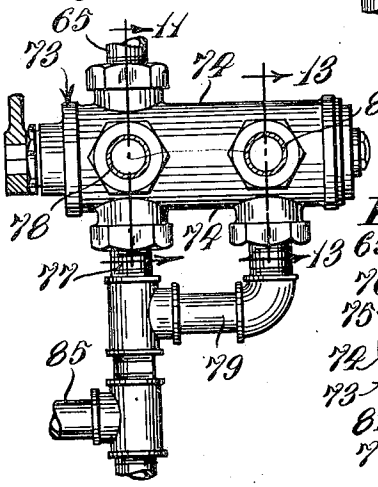

Fig. 11.

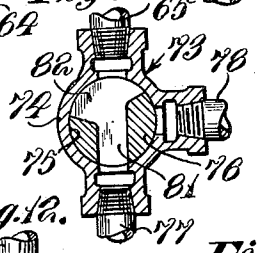

Fig. 13.

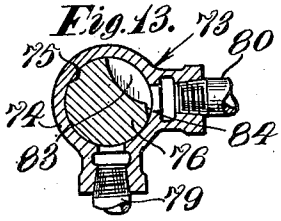

Fig. 12.

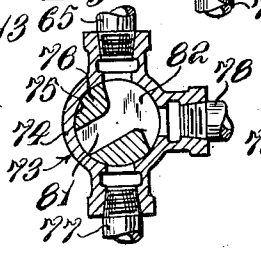

Fig. 14.

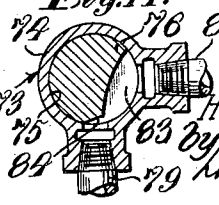

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Fig. 15.

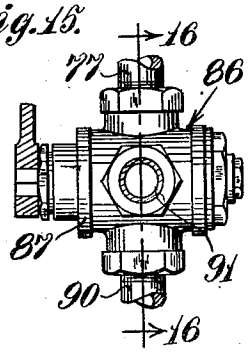


Fig. 16.

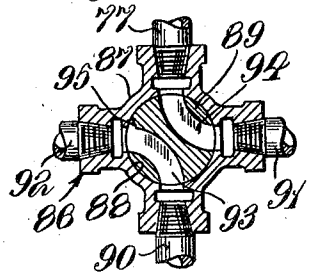


Fig. 17.

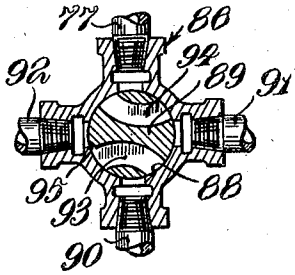


Fig. 18.

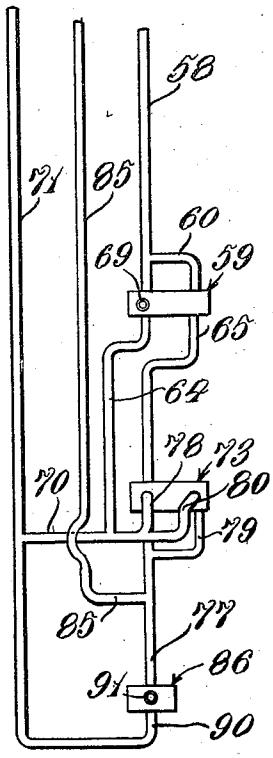
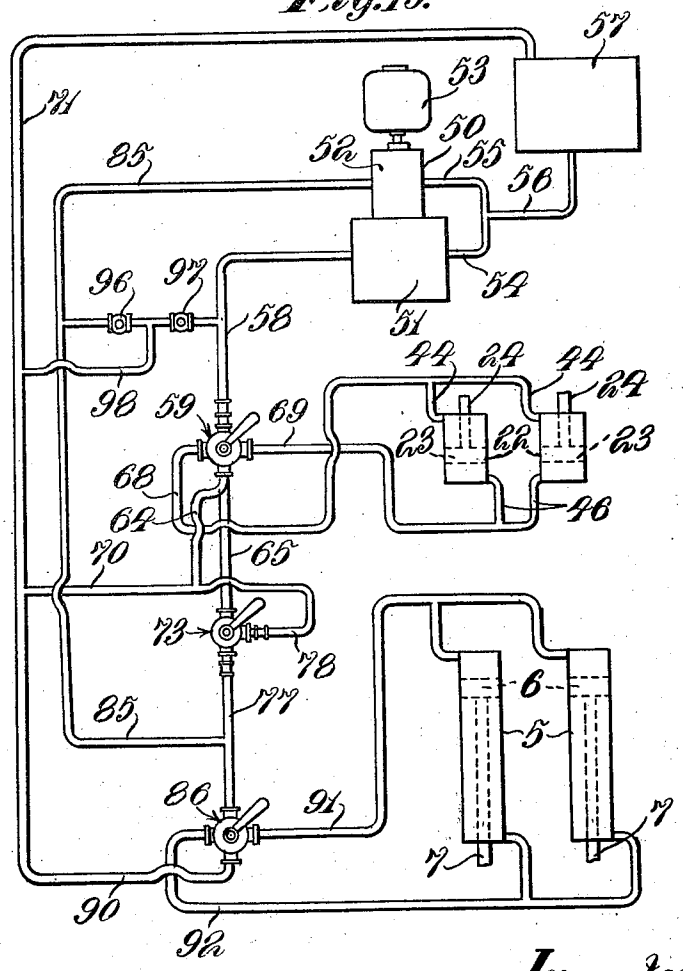


Fig. 19.



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Patented June 22, 1943 2,322,739

UNITED STATES PATENT OFFICE

2,322,739

HYDRAULICALLY OPERATED APPARATUS

Harry H. Vanderzee, Michigan City, Ind., assignor to Sullivan Machinery Company, a corporation of Massachusetts

Application November 14, 1939, Serial No. 304,384

15 Claims. (Cl. 60—97)

This invention relates to hydraulic pump systems, and more particularly to improvements in the controlling means for a rotary drilling apparatus of the type embodying hydraulically operated feeding means and hydraulic operating means for the drill chuck.

In drilling apparatus of the rotary core type, the drill bit is usually fed by hydraulic pressure toward and from the work. In the normal drilling operation, the drill bit is fed toward the work rather slowly and, as drilling progresses and the weight of the drill rods increases, a point is finally reached when no hydraulic feeding force is necessary, and beyond this point the weight of the drill rods, in excess of the pressure required to feed the drill bit to the work, must be removed from the bit, or an excessive feeding pressure on the bit will result. Ordinarily, when the weight of the drill rods becomes excessive, the excess weight is removed from the bit by hydraulic pressure. In other words, the feeding pressure applied to the drill bit is determined by the weight of the drill rods. The hydraulic pressure in the hydraulic system must be sufficient for lifting the weight of the drill rod line for a hole of a given depth. It is accordingly evident that the feeding pressure on the drill bit must be relatively high during starting of the drill hole, and as the length of the rod line increases, the feeding pressure must be reduced, and when the weight of the rod line becomes excessive, the hydraulic pressure in the feeding means must be sufficient to remove the excessive rod line weight from the drill bit. Also it is desirable to obtain a rapid feeding movement of the drill chuck when the latter is moved to a new rod line gripping position after the feed has moved its distance of travel. Also under certain conditions, it is required that the rod line be raised and lowered while being rotated, and here again a relatively rapid rate of chuck advance is necessary for the sake of efficiency.

An object of this invention is to provide an improved hydraulic pump system having improved controlling means. Another object is to provide an improved multiple pump system embodied in the hydraulic feeding means of a rotary core drill whereby the drill bit is fed and controlled in an improved manner. A further object is to provide improved hydraulic operating means for the drill chuck associated with the fluid system for the feeding means whereby the chuck may be controlled in an improved manner. Yet another object is to provide an improved multiple pump system for a rotary drilling apparatus wherein the volume of liquid supplied to the system may be varied in accordance with the demand. Yet another object is to provide a dual capacity pump arrangement embodying a pump unit of small capacity and a pump unit of large capacity, the pump of small capacity normally maintaining the required pressure in the fluid system when a small volume is required, and the pump of large capacity supplying a substantially greater volume of fluid to the system when rapid operation is desired, as for rapid drilling in soft formations, the utilization of the small capacity pump eliminating the excessive generation of heat in the fluid system which would occur if the large pump had to force large quantities of fluid through a loaded by-pass valve, when a small volume of fluid only is being used. Other objects and advantages of the invention will, however, hereinafter more fully appear.

In the accompanying drawings there is shown for purposes of illustration one form which the invention may assume in practice.

In these drawings:

Fig. 1 is a vertical sectional view, with parts in elevation, illustrating a portion of a drilling apparatus with which the invention is associated.

Fig. 2 is an enlarged fragmentary side elevational view of a portion of the drilling apparatus shown in Fig. 1.

Fig. 3 is an enlarged horizontal sectional view taken substantially on line 3—3 of Fig. 1.

Fig. 4 is an enlarged detail sectional view showing a portion of one of the fluid supply connections.

Fig. 5 is an enlarged side elevational view of one of the control valve mechanisms.

Fig. 6 is a cross sectional view taken on line 6—6 of Fig. 5.

Fig. 7 is a view similar to Fig. 6, showing the control valve in a different position.

Fig. 8 is a cross sectional view taken on line 8—8 of Fig. 5.

Fig. 9 is a view similar to Fig. 8, showing the control valve in a different position.

Fig. 10 is an enlarged side elevational view of the by-pass valve mechanism.

Fig. 11 is a cross sectional view taken on line 11—11 of Fig. 10.

Fig. 12 is a view similar to Fig. 11, showing the by-pass valve in a different position.

Fig. 13 is a cross sectional view taken on line 13—13 of Fig. 10.

Fig. 14 is a view similar to Fig. 13, showing the by-pass valve in a different position.

Fig. 15 is an enlarged side elevational view of the feed control valve mechanism.

Fig. 16 is a cross sectional view taken on line 16—16 of Fig. 15.

Fig. 17 is a view similar to Fig. 16, showing the feed control valve in a different position.

Figs. 18 and 19 are diagrammatic views illustrating the hydraulic fluid system.

In this illustrative embodiment of the invention the improved hydraulic fluid system is shown embodied in a rotary drilling apparatus of the heavy duty, oil well drill type generally similar to that disclosed in the patent to H. C. Johansen, No. 2,114,305, patented April 19, 1938, although it will be evident that various features of the invention may be incorporated in drilling apparatus of various other types.

The rotary drilling apparatus illustrated herein comprises a vertical frame structure 1 mounted on a suitable base 2 and supporting a transverse upper frame 3. Secured within heads 4 mounted within the upper portion of the frame structure are vertical hydraulic feed cylinders 5, 5 arranged in parallel relation at the opposite sides of the frame structure and containing reciprocable feed pistons 6 having piston rods 7 extending downwardly through stuffing boxes 8 arranged within the cylinder heads 4. Formed along the opposite sides of the frame sections 1 beneath the feed cylinders are vertical guideways 9 having mounted therein, for vertical reciprocatory movement, sliding guide shoes 10. The lower portions of these sliding guide shoes are secured, as by screws 11, to a transverse frame 12, the frame 12, together with the sliding guide shoes, forming a sliding crosshead structure vertically reciprocable along the guideways with respect to the frame structure 1. As illustrated, the lower ends of the piston rods 7 are secured at 13 within the transverse crosshead frame 12, so that when hydraulic pressure is supplied to the feed cylinders the feed pistons are reciprocated therein, moving vertically therewith the sliding crosshead structure. Journaled in ball bearings 14, within the transverse crosshead frame 12, is a rotary drive sleeve 15 having a central opening 16 through which a drill rod 17 of the drilling apparatus is adapted to extend. Keyed to the drive sleeve 15 and arranged between the ball bearings 14 is a spur gear 18 meshing with and driven by a spur gear 19 (see Fig. 3) likewise journaled within the transverse crosshead. The gear 19 is keyed to a vertical drive shaft 21, the latter having telescopic relation with a driving element arranged within the transverse upper frame 3, in the manner fully described in the above mentioned Johansen patent, so that irrespective of the position of the sliding crosshead structure along its guideways the drive sleeve 15 may be rotated.

Carried by the drive sleeve 15 is a hydraulically operated chuck mechanism comprising vertical cylinders 22 carried by the transverse crosshead frame 12 and containing vertically reciprocable pistons 23 having their piston rods 24 extending upwardly through stuffing boxes 25 carried by the transverse crosshead frame 12. The upper ends of the piston rode 24 are secured at 26 to a transverse frame 27, the latter supporting a ball bearing 28 in which is journaled the cylindrical hub 29 of a rotatable chuck casing 30. Guided within guideways 31 formed within a cylindric enlargement 32 of the drive sleeve 15 are chuck jaws 33 adapted to grip the drill rod. Mounted in the chuck casing are blocks 34 connected by pivoted links 35 to the chuck jaws so that when hydraulic pressure is supplied to the lower ends of the cylinders 22 the pistons 23 are moved upwardly, moving therewith the chuck casing, and, through the toggle links, moving the chuck jaws into gripping relation with the drill rod, thereby connecting the drill rod to the drive sleeve for rotation therewith.

Now referring to the means for supplying liquid under pressure to the chuck jaw operating cylinders 22, it will be noted that vertical pipes 37 are secured within the lower portion of the frame portion 1, and these pipes extend upwardly through stuffing boxes 38 carried within members 39 which constitute the securing elements for securing the lower ends of the piston rods 7 to the sliding crosshead frame 12. The pipes 37 extend upwardly within the bores 40 in the piston rods 7, these piston rod bores being of slightly larger diameter than the diameter of the pipes, so that the liquid flowing through the pipes is discharged through the upper ends of the pipes into the piston rod bores. The piston rod bores communicate at their lower ends through ports 41 with annular chambers 42 formed in the sliding crosshead frame 12. As shown most clearly in Fig. 3, the annular chamber 42, at the right hand side of the transverse frame 12, is connected through a pipe 43 and branch pipes 44 to the upper ends of the bores of the cylinders 22 at the upper sides of the pistons 23, while the annular chamber 42, at the left hand side of the frame 12, is connected through a pipe 45 and branch pipes 46 to the lower ends of the bores of the cylinders 22 at the lower sides of the pistons 23. When hydraulic pressure is supplied to the right hand supply pipe 37, shown in Fig. 1, liquid under pressure flows to the right hand annular chamber 42 and thence through the pipes 43 and 44 to the upper ends of the cylinders 22, the pressure acting on the upper surface of the pistons 23 to move the latter downwardly into the position shown in Fig. 1, thereby to release the chuck jaws from the drill rod. When hydraulic pressure is supplied to the left hand supply pipe 37, liquid under pressure flows to the left hand chamber 42 and thence through the pipes 45 and 46 to the lower ends of the cylinders 22, the pressure acting on the lower surfaces of the pistons 23 to move the latter upwardly to connect the chuck jaws with the drill rod. It is accordingly evident that irrespective of the adjusted position of the sliding crosshead structure within its vertical guideways relative to the frame structure 1, hydraulic pressure may be supplied to the hydraulic chuck operating cylinders 22 through the supply pipes 37 telescopically arranged within the tubular feed piston rods 7. As the structure of the drilling apparatus is fully described in the above mentioned Johansen patent, further description thereof is herein unnecessary.

Now referring to the improved hydraulic fluid system, it will be noted that a liquid pump 50 is provided, this pump being of the dual capacity type and preferably having a small capacity side and a large capacity side. This pump may consist of two distinct pumping units coupled together, one pump unit preferably having a substantially larger capacity than the other. The feature, hereinafter more fully explained, of the provision of means enabling supply from two sources in parallel when needed, but with power consumption and heat production minimized, is a feature of basic importance. The pump 50 herein comprises a large capacity unit 51 and a small ca-

pacity unit 52, these pump units being driven by a motor 53. The intake sides of the pump units 51 and 52 are connected through branch conduits 54 and 55 to a conduit 56 leading to a liquid supply tank 57. The discharge side of the large pump unit 51 is connected by a conduit 58 to a five-way valve mechanism generally designated 59. A branch conduit 60 leads from the conduit 58 also to the valve mechanism 59 (see Fig. 5).

The valve mechanisms illustrated and now to be described are to be understood as but illustrative of the means which can be utilized to accomplish the desired functions.

The valve mechanism 59, as shown in Figs. 5 to 9 inclusive, comprises a valve casing 61 having a bore 62 containing a rotary control valve 63, the latter having a suitable manual operating handle. The conduits 58 and 60 communicate with the valve bore at longitudinally spaced points, while communicating with the valve bore at points diametrically opposite from the conduits 58 and 60, respectively, are conduits 64 and 65. The valve 63 is cut away at the opposite sides of a diametric plane to provide passages 66 and 67. Communicating at diametrically opposite points with the valve bore, midway between the conduits 58 and 64, are conduits 68 and 69 respectively leading, through the connections described with respect to Fig. 1, to the upper and lower ends of the chuck operating cylinders 22. The conduit 64 is connected to a return conduit 70, in turn communicating with a liquid discharge conduit 71 leading back to the tank 57. Traversing the valve body is a passage 72 adapted to connect the conduits 60 and 65. When the valve 63 is in the position shown in Fig. 7, the supply conduit 58 and the exhaust conduit 64 are cut off from the conduits 68 and 69 leading to the chuck operating cylinders 22, and, as shown in Fig. 9, the conduit 60 is connected by the passage 72 in the valve with the conduit 65, so that liquid under pressure is conducted through the conduit 65 to a by-pass valve mechanism generally designated 73. When the valve 63 is in the position shown in Fig. 6, the supply conduit 58 is connected to the lower ends of the chuck operating cylinders 22 through the conduit 69, while the upper ends of the chuck operating cylinders are connected to exhaust through the conduit 64. When the position of the valve 63 is reversed, the upper ends of the chuck operating cylinders are connected to the liquid supply while the lower ends of the cylinders are connected to exhaust. Whenever by-passing occurs through the passage 72 in the valve, the supply of fluid to the chuck operating cylinders 22 is always cut off.

The by-pass valve mechanism 73 comprises, as shown in Figs. 10 to 14 inclusive, a casing 74 having a bore 75 containing a rotary valve 76, the latter having a suitable manual operating handle. The conduit 65 communicates with the valve bore, as shown in Fig. 11, and a conduit 77 communicates with the valve bore at a diametrically opposite point. Communicating with the valve bore at a point in the same plane with and midway between the conduits 65 and 77 is a conduit 78 communicating with the return conduit 70. The conduit 77 has a branch conduit 79 communicating with the valve bore at a point spaced longitudinally from the conduits 65 and 77, and the conduit 78 has a branch conduit 80 communicating with the valve bore in the same transverse planes as the conduit 79 (Fig. 13). The valve 76 has a passage 81 provided with a widened mouth 82 for connecting the conduit 65 either with the conduit 77 or the conduit 78. Also traversing the valve body is a passage 83 having a narrow bleeding or metering slot 84 for connecting the conduit 79 to the exhaust conduit 80 whereby the by-passing of fluid past the valve 76 may be closely regulated. A conduit 85 connects the discharge side of the small pump unit 52 with the conduit 77. The conduit 77 leads to a valve mechanism, generally designated 86, for controlling the flow of liquid under pressure to the feed cylinders.

The feed control valve mechanism 86 as shown in Figs. 15, 16 and 17 comprises a casing 87 having a bore 88 containing a rotary valve 89, the latter having a suitable manual operating handle. The conduit 77 communicates with the valve bore, and communicating with the valve bore, at a diametrically opposite point, is a conduit 90, the latter being connected to the return conduit 71 leading back to the tank. Also communicating with the valve bore in the same transverse plane with and located midway between the conduits 77 and 90 are conduits 91 and 92 leading respectively to the upper and lower ends of the feed cylinders 5. The valve body is traversed by passages 93 and 94, and in the different positions of the valve the passage 93 is adapted to connect the conduit 92 with either the supply conduit 77 or the exhaust conduit 90, and the passage 94 is adapted to connect the conduit 91 either with the conduit 77 or 90, so that when liquid under pressure is supplied to one of the conduits 91, 92 the other conduit is always connected to exhaust. Communicating with the passage 93 is a bleeding or metering slot 95 whereby the flow of liquid under pressure from the bottoms of the feed cylinders may be closely regulated, thereby to enable regulation of the rate of forward feed. When the valve 89 is in the position shown in Fig. 17, the supply of liquid under pressure through the conduits 91 and 92 to the opposite ends of the feed cylinders is completely cut off, but the connection 92 from beneath the feed pistons has a restricted connection through the slot 95, the passage 93 and a lateral enlargement of the mouth of the passage with which the exhaust conduit 90 connects, with the exhaust conduit 90, so that during drilling under the weight of the rod line the rate of feed can be controlled by finely regulating the escape of liquid from beneath the fluid pistons. The supply conduits 58 and 85 respectively leading from the discharge sides of the large and small pump units are connected through relief valves 96 and 97 with a conduit 98 leading to the discharge conduit 71 so that when the pressure in the supply conduits becomes excessive the relief valves open automatically to relieve the pressure in the system. The relief valves 96 and 97 may be set at any appropriate pressures suitable to the particular conditions encountered, but preferably the relief valve 97 for the large pump unit is set at a relatively lower pressure than the pressure setting of the relief valve 96 for the small pump unit. This difference in pressure settings of the relief valves is desirable since at times, in a drilling apparatus of the character disclosed herein, a relatively high pressure must be available to effect certain auxiliary drill operating functions. However, such differences in the pressure settings of the relief valves do not come into effect in the structure embodying the present invention, and, therefore, the pressure settings are of no particular importance herein. In this instance, the feeding pressure is determined by

the position of the by-pass valve means and not by the relief valve settings. Of course, when both pump units are discharging to the feed cylinders 5, 5, the maximum pressure available is the setting pressure of the relief valve 97 for the large pump unit, as both pump units may by-pass through this relief valve.

From the foregoing it will be evident that the liquid discharged from the large pump unit 51 may be conducted, under the control of the valve 63, to the operating cylinders 22 of the chuck so that the full volume may be utilized to apply or release the chuck jaws. When the supply of liquid under pressure to the chuck operating cylinders 22 is cut off, as shown in Fig. 7, the liquid flowing in the conduit 58 is by-passed through conduit 60, passage 72 in the valve and conduit 65 to the by-pass valve mechanism 73. When the valve 76 is in the position shown in Fig. 12, the liquid is by-passed through conduit 78 to the return conduit leading back to the tank. When the by-pass valve 76 is in the position shown in Fig. 11, liquid under pressure may flow from conduit 65 through the passage 81 in the valve to the conduit 77 leading to the feed control valve mechanism 86. Liquid under pressure is continuously supplied from one (herein the small) pump unit through conduit 85 to the conduit 77, and when the valves 63 and 76 are in the positions shown in Figs. 9 and 11 pressure is supplied from the large pump unit to the conduit 77, so that the total available supply of pressure fluid is that delivered by the pump units combined. When the feed control valve 89 is in the position shown in Fig. 16, liquid under pressure may flow from conduit 77 through the valve passage 94 to the conduit 91 leading to the tops of the feed cylinders 5, and the bottoms of the feed cylinders are at that time connected to exhaust through conduit 92, passage 93 in the valve and conduit 90 leading to the liquid return conduit 71. When the valve 89 is rotated to a position so that passage 93 connects conduits 77 and 92, and passage 94 connects conduits 90 and 91, pressure fluid is supplied to the bottoms of feed cylinders 5 and vented from the tops of feed cylinders 5. When the liquid supply from the large pump unit is connected to the return conduit, liquid under pressure may continue to be supplied from the small pump unit through conduit 85 to the feed cylinders. The large volume discharge from both pump units is utilized when a rapid rate of feed is desired, while the small volume discharge from the small pump unit is used in slow feed during normal drilling; and during the slow feeding operation the discharge side of the large pump unit is connected back to the tank through the return valve mechanism. The presence of the small capacity pump eliminates the excessive generation of heat from the fluid system which occurs when a large volume of liquid is forced through a loaded by-pass valve for any substantial length of time. When the valve 76 is in the position shown in Figs. 12 and 14 the discharges from both the large and small pump units are conducted through the return conduit 70 back to the tank. When the valve 76 is in the position shown in Figs. 11 and 13, liquid under pressure may be conducted through conduits 58, 65 and 77 to the feed control valve 86, so that the feed pistons may be fed upwardly or downwardly as desired under the control of the valve 89 at a relatively rapid rate. When the valve 76 is in its by-passing position shown in Figs. 12 and 14, the wide mouth 82 of the passage 81 permits a limited amount of adjustment of the valve, thereby to permit bleeding of the output from the small pump unit by means of the metering slot 84 to whatever pressure is required. The rate and direction of feed may then be determined by the position of the feed control valve 89. When the weight of the drill rods is in excess to the pressure required to feed the drill bit to the work both pump units may be by-passed, and the rate of feed is at that time regulated by metering the flow of liquid from the lower ends of the feed cylinders beneath the feed pistons by means of the metering slot in the four-way valve as heretofore explained. Further, when varying or cavernous formations are encountered by the drill bit, the "under feed" method of feeding the drill bit may be employed, and at that time the small pump unit may supply liquid under pressure to the upper ends of the feed cylinders above the feed pistons, and the rate of feed may be controlled, as by regulating the amount of liquid by-passed.

As a result of this invention, it will be noted that an improved controlling means is provided in the hydraulic fluid system of a rotary drilling apparatus whereby the feeding means may be controlled in an improved manner. It will further be evident that by the provision of the improved controlling means for the hydraulic feeding means, the feeding pressure on the drill bit may be controlled through a relatively wide range. It will also be noted that an improved hydraulic controlling means for the drill chuck is associated with the fluid system for the feeding means whereby the chuck may be controlled in an improved manner. It will also be evident that by the provision of the improved multiple pump system the volume of the liquid supplied to the system may be varied in accordance with the demand. Other uses and advantages of the invention will be clearly apparent to those skilled in the art.

While there is in this application specifically described one form which the invention may assume in practice, it will be understood that this form of the same is shown for purposes of illustration and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In a hydraulically operated apparatus, hydraulically operable means for selectively gripping and releasing a tool, hydraulically operable means for selectively feeding and retracting a tool when it is gripped by said first mentioned hydraulically operable means, a relatively large capacity pumping unit, a relatively small capacity pumping unit, a valve means for selectively rendering one of said pumping units operable to supply fluid to said first mentioned hydraulically operable means to effect gripping of a tool or to trap fluid in said first mentioned hydraulically operable means to maintain tool gripping while rendering the discharge of said pumping unit available for other purposes, means for selectively rendering one or both of said pumping units operable to supply fluid to said second mentioned hydraulically operable means, a return line, and means operable to connect the discharge from one or both of said pumping units freely to said return line when the same are not supplying fluid to said second mentioned hydraulically operable means.

2. In a hydraulically operated apparatus, hydraulically operable means for selectively gripping and releasing a tool, hydraulically operable means for selectively feeding and retracting a tool when it is gripped by said first mentioned hydraulically operable means, a relatively large capacity pumping unit, a relatively small capacity pumping unit, valve means for selectively rendering said first mentioned pumping unit operable to supply fluid to said first mentioned hydraulically operable means to effect gripping of a tool or to trap fluid in said first mentioned hydraulically operable means to maintain tool gripping while rendering the discharge of said first mentioned pumping unit available for other purposes, means for selectively rendering one or both of said pumping units operable to supply fluid to said second mentioned hydraulically operable means, a return line, and means operable to connect the discharge from one or both of said pumping units freely to said return line when the same are not supplying fluid to said second mentioned hydraulically operable means.

3. In a hydraulically operated apparatus, hydraulically operable means for selectively gripping and releasing a tool, hydraulically operable means for selectively feeding and retracting a tool when it is gripped by said first mentioned hydraulically operable means, a relatively large capacity pumping unit, a relatively small capacity pumping unit, valve means for selectively rendering one of said pumping units operable to supply fluid to said first mentioned hydraulically operable means to effect gripping of a tool or to trap fluid in said first mentioned hydraulically operable means to maintain tool gripping while rendering the discharge of said pumping unit available for other purposes, means for selectively rendering the second or both of said pumping units operable to supply fluid to said second mentioned hydraulically operable means, a return line, and means operable to connect the discharge from one or both of said pumping units freely to said return line when the same are not supplying fluid to said second mentioned hydraulically operable means.

4. In a hydraulically operated apparatus, hydraulically operable means for selectively gripping and releasing a tool, hydraulically operable means for selectively feeding and retracting a tool when it is gripped by said first mentioned hydraulically operable means, a relatively large capacity pumping unit, a relatively small capacity pumping unit, valve means for selectively rendering said first mentioned pumping unit operable to supply fluid to said first mentioned hydraulically operable means to effect gripping of a tool or to trap fluid in said first mentioned hydraulically operable means to maintain tool gripping while rendering the discharge of said first mentioned pumping unit available for other purposes, means for selectively rendering the second or both of said pumping units operable to supply fluid to said second mentioned hydraulically operable means, a return line, and means operable to connect the discharge from one or both of said pumping units freely to said return line when the same are not supplying fluid to said second mentioned hydraulically operable means.

5. In a hydraulically operated apparatus, hydraulically operable means for selectively gripping and releasing a tool, hydraulically operable means for selectively feeding and retracting a tool when it is gripped by said first mentioned hydraulically operable means, a relatively large capacity pumping unit, a relatively small capacity pumping unit, valve means for selectively rendering one of said pumping units operable to supply fluid to said first mentioned hydraulically operable means to effect gripping of a tool or to trap fluid in said first mentioned hydraulically operable means to maintain tool gripping while rendering the discharge of said pumping unit available for other purposes, means for selectively rendering one or both of said pumping units operable to supply fluid to said second mentioned hydraulically operable means, a return line, and means operable to connect the discharge from one or both of said pumping units freely to said return line when the same are not supplying fluid to said second mentioned hydraulically operable means, said latter means embodying metering slot means whereby the discharge from one of said pumping units may be closely regulated.

6. In a hydraulically operated apparatus, hydraulically operable means for selectively gripping and releasing a tool, hydraulically operable means for selectively feeding and retracting a tool when it is gripped by said first mentioned hydraulically operable means, a relatively large capacity pumping unit, a relatively small capacity pumping unit, valve means for selectively rendering said first mentioned pumping unit operable to supply fluid to said first mentioned hydraulically operable means to effect gripping of a tool or to trap fluid in said first mentioned hydraulically operable means to maintain tool gripping while rendering the discharge of said first mentioned pumping unit available for other purposes, means for selectively rendering one or both of said pumping units operable to supply fluid to said second mentioned hydraulically operable means, a return line, and means operable to connect the discharge from one or both of said pumping units freely to said return line when the same are not supplying fluid to said second mentioned hydraulically operable means, said latter means embodying metering slot means whereby the discharge from the small pumping unit may be closely regulated.

7. In combination, a hydraulically operable device including an element subjectable to working pressure on its opposite sides, a pump of small capacity, a pump of larger capacity, a valve casing providing a bore having a connection with said pump of larger capacity, and at opposite sides of said first mentioned connection connections to the opposite sides of said element of said hydraulically operable device, said valve casing bore also having a second connection with said larger capacity pump, means providing a connection for said bore with said smaller capacity pump, and a valve movable in said casing and having means formed thereon toward one end thereof for connecting said first connection selectively with the opposite sides of said element of said hydraulically operable device and means formed adjacent the other end thereof for establishing or interrupting communication between said second connection and said means providing a connection with said smaller capacity pump, said valve movable to interrupt said communication when in a position to supply fluid to said hydraulically operable device.

8. In combination, reversible hydraulically operated means, a hydraulically operated mechanism, a plurality of pumps of different discharge volumes for supplying fluid to said hydraulically operated means and to said mechanism, a return line to said pumps, and controlling means for

said means and said mechanism for controlling fluid flow relative to them from said pumps including means providing three valve receiving bores, three valves movable in said bores respectively, one in each of said bores, fluid supply conduits leading from said pumps, one fluid supply conduit having passages leading to two of said bores and another having communication with the third of said bores, passage means for connecting said last mentioned bore with one of the others, the valve in the third mentioned bore being movable therein to control said mechanism and the connection of the third mentioned bore with the one of the others to which said passage means leads from said third mentioned bore, the valve in the bore to which said last mentioned passage means leads controlling communication between that bore and said third mentioned bore and communication between each of said supply conduits and the return line to said pumps, and the valve in the other of said bores controlling said hydraulically operated means.

9. In combination, a hydraulically operable device including an element subjectable to working pressure on its opposite sides, a pump of small capacity, a pump of larger capacity, a valve casing providing a bore having a connection with said pump of larger capacity, and at opposite sides of said first mentioned connection connections to the opposite sides of said element of said hydraulically operable device, said valve casing bore also having a second connection with said larger capacity pump, means providing a connection for said bore with said smaller capacity pump, and a valve movable in said casing and having means formed thereon toward one end thereof for connecting said first connection selectively with the opposite sides of said element of said hydraulically operable device and means formed adjacent the other end thereof for establishing or interrupting communication between said second connection and said means providing a connection with said smaller capacity pump, said valve movable to interrupt said communication when in a position to supply fluid to said hydraulically operable device.

10. In a hydraulically operated apparatus, a pump having a small discharge capacity, a pump having a larger discharge capacity, means providing valve-receiving bores, valves movably arranged in said bores respectively, a passage connecting the pump of large discharge capacity with one of said bores, a second passage connecting the pump of small discharge capacity with the other bore, a third passage connecting said bores whereby the liquid flowing from the large capacity pump from said one of said bores flows through said third passage to said other bore, the liquid flowing past the valve in said one of said bores to said third passage, and a fourth passage communicating with said second passage, and said valve in said other bore controlling the flow of liquid from said third passage to said fourth passage.

11. In a hydraulically operated apparatus, a pump having a small discharge capacity, a pump having a larger discharge capacity, means providing valve receiving bores, valves movably arranged in said bores respectively, a passage connecting the pump of large discharge capacity with one of said bores, a second passage connecting the pump of small discharge capacity with the other bore, a third passage connecting said bores whereby the liquid flowing from the large capacity pump from said one of said bores flows through said third passage to said other bore, the liquid flowing past the valve in said one of said bores to said third passage, a fourth passage communicating with said second passage, and said valve in said other bore controlling the flow of liquid from said third passage to said fourth passage, and the liquid from the smaller discharge capacity pump flowing directly from the second passage to said fourth passage independently of control of the valve in said other bore.

12. In a hydraulically operated apparatus, a pump having a small discharge capacity, a pump having a larger discharge capacity, means providing valve receiving bores, valves movably arranged in said bores respectively, a passage connecting the pump of large discharge capacity with one of said bores, a second passage connecting the pump of small discharge capacity with the other bore, a third passage connecting said bores whereby the liquid flowing from the large capacity pump from said one of said bores flows through said third passage to said other bore, the liquid flowing past the valve in said one of said bores to said third passage, a fourth passage communicating with said second passage, and said valve in said other bore controlling the flow of liquid from said third passage to said fourth passage, and the liquid from the smaller discharge capacity pump flowing directly from the second passage to said fourth passage independently of control of the valve in said other bore, and a discharge line communicating with said other bore and the valve in said other bore controlling the connection of said second passage with said discharge line.

13. In a hydraulically operated apparatus, a pump having a small discharge capacity, a pump having a larger discharge capacity, means providing valve receiving bores, valves movably arranged in said bores respectively, a passage connecting the pump of large discharge capacity with one of said bores, a second passage connecting the pump of small discharge capacity with the other bore, a third passage connecting said bores whereby the liquid flowing from the large capacity pump from said one of said bores flows through said third passage to said other bore, the liquid flowing past the valve in said one of said bores to said third passage, a fourth passage communicating with said second passage, and said valve in said other bore controlling the flow of liquid from said third passage to said fourth passage, and the liquid from the smaller discharge capacity pump flowing directly from the second passage to said fourth passage independently of control of the valve in said other bore, and a discharge line communicating with said other bore and the valve in said other bore controlling the connection of said second passage with said discharge line, said valve in said other bore also controlling the connection of said third passage with said discharge line.

14. In a hydraulically operated apparatus, a pump of small discharge capacity, a pump of large discharge capacity, means providing valve-receiving bores, valves arranged in said bores respectively, a passage connecting the pump of large discharge capacity with one of said bores, a second passage connecting the pump of small discharge capacity with said other bore, a third passage connecting said bores whereby the liquid from the large capacity discharge flows from said one bore to said other bore through said third passage past the valve in said one bore, a discharge line connected to said other bore, said

valve in said other bore controlling the connection of said third passage with said second passage and with said discharge line, and a fourth passage communicating with said one bore and controlled by the valve in said one bore.

15. In a hydraulically operated apparatus, a pump of small discharge capacity, a pump of large discharge capacity, means providing valve-receiving bores, valves arranged in said bores respectively, a passage connecting the pump of large discharge capacity with one of said bores, a second passage connecting the pump of small discharge capacity with said other bore, a third passage connecting said bores whereby the liquid from the large capacity discharge flows from said one bore to said other bore through said third passage past the valve in said one bore, a discharge line connected to said other bore, said valve in said other bore controlling the connection of said third passage with said second passage and with said discharge line, and a fourth passage communicating with said one bore and controlled by the valve in said one bore, said valve in said other bore also controlling the connection of said second passage with said discharge line.

HARRY H. VANDERZEE.

CERTIFICATE OF CORRECTION.

Patent No. 2,322,739. June 22, 1943.

HARRY H. VANDERZEE.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 68, for "rode" read --rods--; page 4, second column, line 60, before "valve" strike out "a"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 23rd day of November, A. D. 1943.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)