May 28, 1940. N. S. MADSEN 2,202,216

FEED CONTROLLING APPARATUS

Filed May 15, 1936 2 Sheets-Sheet 1

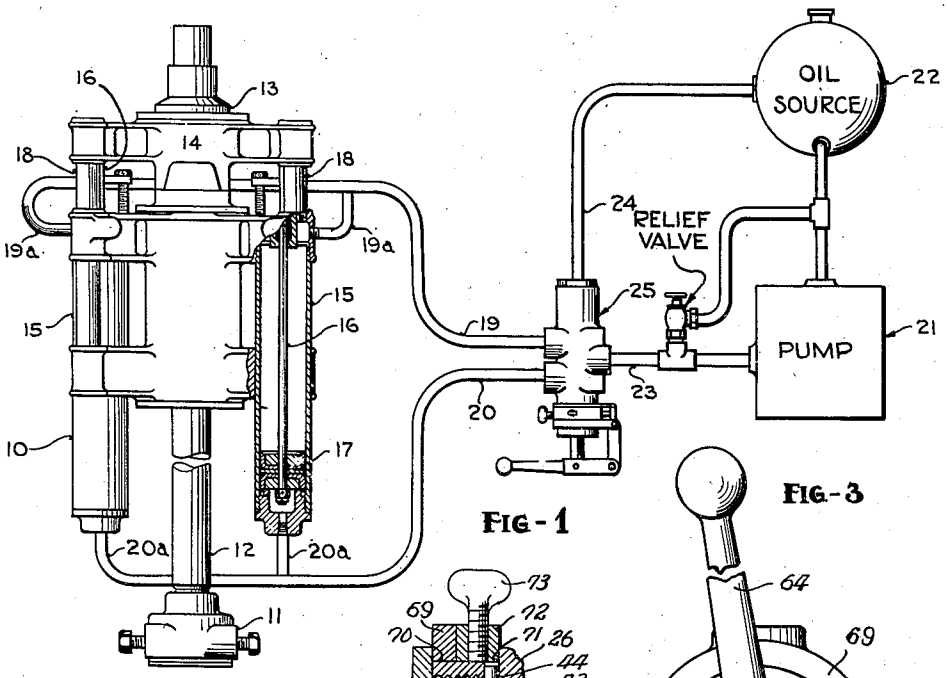

FIG. 1

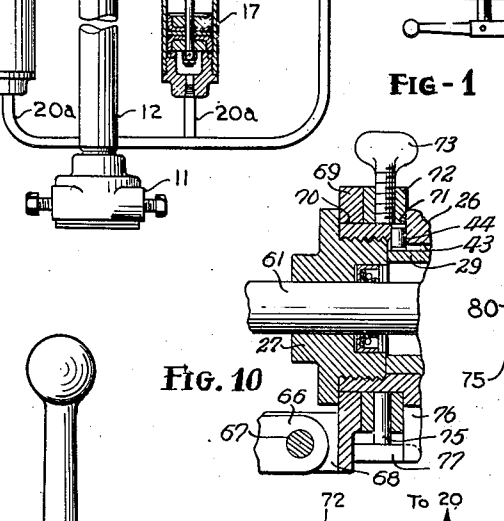

FIG. 10

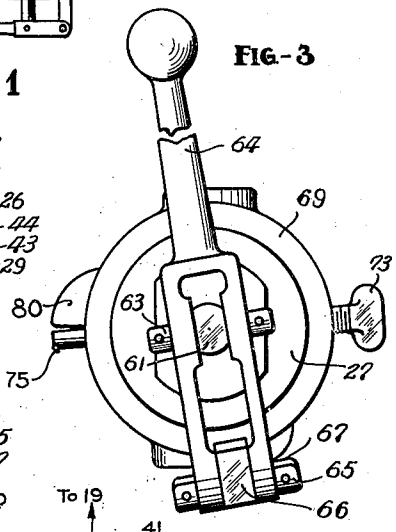

FIG. 3

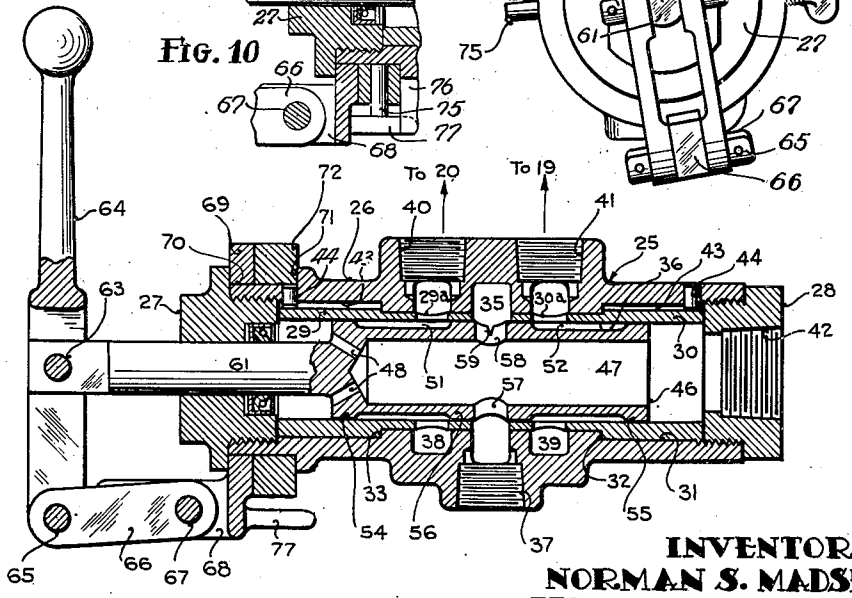

FIG. 2

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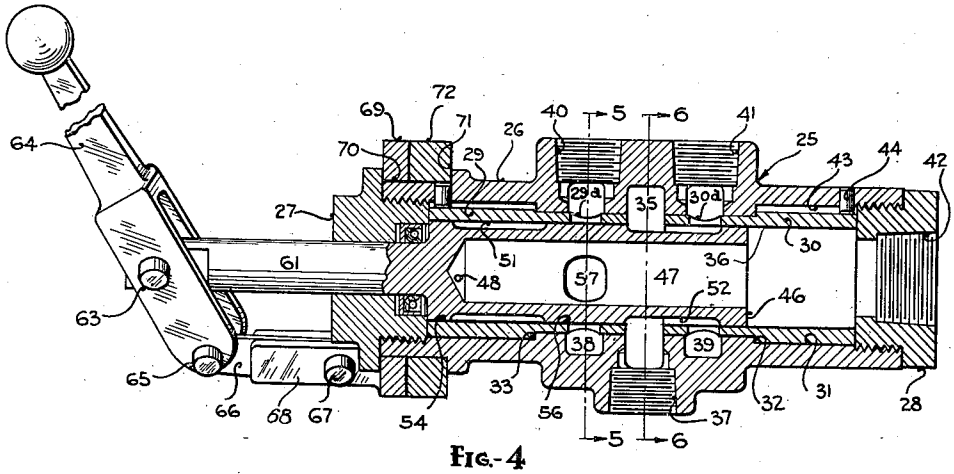


FIG.-4

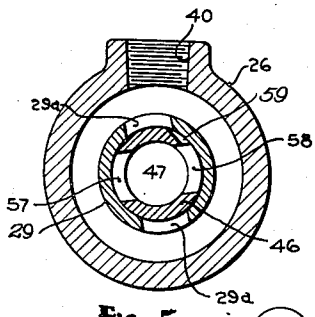


FIG.-5

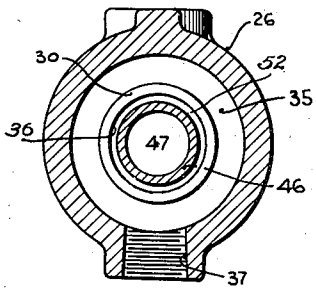


FIG.-6

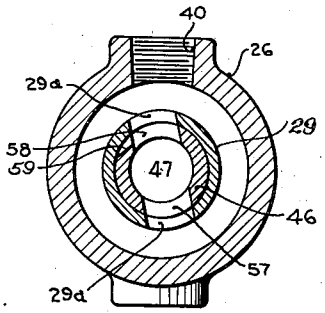


FIG.-7

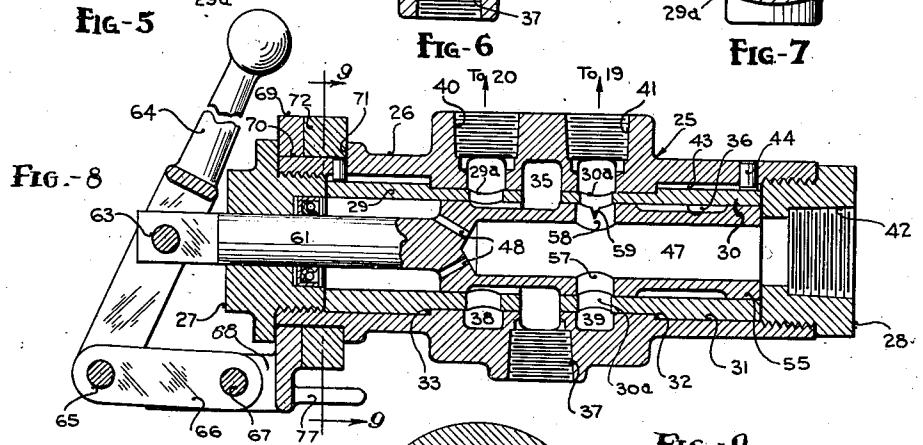


FIG.-8

FIG.-9

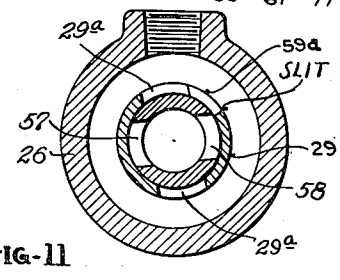
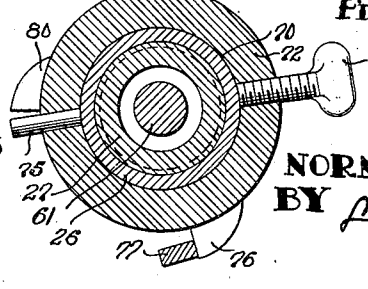


FIG.-11



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Patented May 28, 1940

2,202,216

UNITED STATES PATENT OFFICE

2,202,216

FEED CONTROLLING APPARATUS

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Application May 15, 1936, Serial No. 79,932

6 Claims. (Cl. 60—52)

My invention relates to controlling devices, from one aspect thereof, and, from another aspect, to drill feeding and controlling mechanisms. It is not limited, however, to drill feeding, and, in a broad aspect, is applicable to substantially any hydraulic feeding problem requiring alternate high speed motion and closely regulated feed.

In core drilling and similar operations it is important to be able to effect retraction of the feeding mechanism at a rapid rate, to initiate it instantly when desired, and to regulate forward feed with great nicety. To secure the first two desiderata mentioned and also to be able to resume immediately forward feed at precisely the same rate at which this had been taking place prior to interruption or reversal of feed has not, so far as I am advised, been possible prior to my invention.

In a drilling apparatus of widely recognized superiority, hydraulic feed and retraction have been provided for, and by the use of a four-way, rotary valve, it has been possible to change from feed to no-feed, and to retraction, quickly and at will; but where feed was interrupted or reverse was effected, an instantaneous readjustment to optimum feeding conditions was impossible. Again, with such an apparatus, when no-feed position of the valve was effected, the hydraulic pump was compelled to work against a considerable load, whereas it would have been desirable if possible (and it is possible with my invention) to allow the pump merely to circulate the feeding fluid substantially only against a friction head.

It is an object of my invention to provide an improved controlling device. It is another object of my invention to provide an improved controlling device for a reversible feeding mechanism. It is a further object of my invention to provide an improved controlling device for a reversible feeding mechanism in which provision is made for facile and certain return to optimum feeding conditions after feed has been cut off or reversed; and with respect to this object of my invention it is a further subordinate object to provide improved means whereby adjustment may be made so that a wide range of predetermination of minimum feeding speeds may be possible. It is still another object of my invention to provide an improved hydraulic feeding mechanism having improved controlling means so arranged that a single manually controllable operating element may, by generically different types of movement, selectively control feeding direction and feeding speed at the operator's will.

From one aspect, my invention, in a preferred embodiment thereof, may comprise a casing having fluid supply conduit means leading thereto, fluid return conduit means leading therefrom, a plurailty of further passages adapted to serve selectively as fluid supply or return means, and valve means for controlling the selective connection of said passages with said conduit means and adjustable to vary the area of at least one connection previously established, together with manually operable controlling means having different movements for effecting the selection of connections and the area variation thereof at the will of the operator. Desirably, one of said movements may be reciprocatory and another rotary, but it will be understood that any forms of relative movement between valve and valve chamber porting in which relative movement in one direction varies the generic fluid flow and movement in a different direction effects a control of the rate of fluid flow lie within the scope of this aspect of my invention; and a construction in which said valve means may be in the form of a single valve reciprocable to effect modifications in the nature of the connections between the passages and conduits and rotatable to vary flow area, is very satisfactory. Preferably, means for providing an adjustable limit to area variation is provided and a very satisfactory form of construction involves a control of return flow while having fluid supply area unrestricted.

From another aspect, my invention comprises a reversible hydraulic feeding mechanism having improved controlling mechanism in which preferably a single manually operable controlling element may at the will of the operator, effect, by different types of manipulation thereof, selectively (*a*) control of direction of feed and of the existence of feed, and (*b*) control of the rate of feed. A preferred embodiment of this aspect of my invention employs a cylinder and piston type reversible hydraulic feed and, under the control of the controlling element mentioned, a valve capable both of reciprocatory and rotary movement. By the employment of appropriate stops, including an adjustable stop whose position controls the minimum rate of feed selectable by rotation of the valve, instantaneous return to a desired feed rate is possible, notwithstanding an intervening period of non-feed, or of retraction. By appropriate arrangements, different minimum feed rates for advance and retraction are possible, or a predetermined minimum forward feed

and interruption entirely of retraction may be made possible upon valve rotation, as by the use of a pin in fixed relation to the valve and traveling in a U-slot whose base is parallel to the valve axis and whose arms extend arcuately about the axial line of the valve and have independent means for limiting travel therein.

From still another aspect my invention comprises the provision of a pump, a reservoir, a reversible feed device, and a controlling valve mechanism movable at the operator's will to establish feeding movement in either direction, or to interrupt feed and connect pump discharge to the reservoir.

In the accompanying drawings, in which one form which my invention may assume in practice, together with a detail modification, has been shown for purposes of illustration:

Fig. 1 is a diagrammatic view, with some parts shown in section, showing the invention incorporated in a core drilling apparatus.

Fig. 2 is a central, longitudinal, vertical section through the controlling valve shown in Fig. 1.

Fig. 3 is a front end view of the controlling valve mechanism with parts in different positions from those of Fig. 2.

Fig. 4 is a view generally similar to Fig. 2 but showing the valve in position for restricted forward feed.

Figs. 5 and 6 are respectively transverse sections on the planes of the section lines 5—5 and 6—6 of Fig. 4.

Fig. 7 is a section similar to Fig. 5 showing the valve position prior to rotation to minimum speed position.

Fig. 8 is a view generally similar to Fig. 2 showing the valve in position to effect retraction.

Fig. 9 is a transverse section in the plane of line 9—9 of Fig. 8.

Fig. 10 is a detail sectional view showing the stop ring, stop pin and stop lugs, with the control handle in position with its stop lug against the stop pin.

Fig. 11 shows a modified mode of securing a predetermined minimum feed rate.

Referring first to Fig. 1, it may be noticed that 10 indicates a portion of a core drilling apparatus, of which 11 designates the chuck, 12 the drive rod, 13 the thrust bearing housing, 14 the crosshead, 15, 15 the feed cylinders, 16, 16 the feed piston rods, and 17 one of the feed pistons, while 18, 18 are the guide rods for the crosshead. Fluid conducting passages 19 and 20 have connection through branches 19*a*, 19*a* and 20*a*, 20*a* respectively with the upper and lower ends of the feed cylinders 15, 15. A hydraulic pump 21, power-driven, desirably, by any suitable means, draws fluid, preferably oil, from a sump, herein a tank 22, and delivers it at an appropriate pressure to a supply conduit 23. A return conduit 24 leads back to the tank 22, and a valve mechanism, generally designated 25, controls the connections of the passages 19 and 20 with the conduits 23 and 24.

Fig. 2 may be noted for an understanding of the valve mechanism 25. This may be noted herein to include a body or casing element 26, provided with heads 27 and 28 and with bushings 29 and 30 arranged within the bore 31 of the casing. Each bushing has a shoulder 32 co-operating with a shoulder 33 on the inner wall of the casing and clamped against that shoulder when the adjacent head is brought into place. The casing is annularly internally grooved about midway between its ends, as at 35, and the adjacent ends of the bushings 29, 30 are spaced apart so that the groove 35 is in free communication with the cylindrical chamber 36 which extends from end to end of the body within the bores of the bushings. A connection 37 is provided in the body for the supply conduit 23 which opens into the groove 35 so that the latter becomes an annular supply chamber.

Annular grooves 38 and 39, equally spaced from the groove 35 and at opposite sides of the latter, communicate through suitable openings 40 and 41 respectively with the fluid conducting passages 20 and 19; and the bushings 29 and 30 are each provided with diametrically opposite passages, the passages in bushing 29 designated 29*a* and those in bushing 30 designated 30*a*, so that the grooves 38 and 39 each communicate with the cylindrical chamber 36. The head 28 has an opening 42 therethrough with which the return conduit 24 communicates. The bushings are held against rotation relative to the casing by longitudinal peripheral grooves 43 and stop pins 44.

Within the chamber 36 there is reciprocably and rotatably mounted a valve element 46. This valve element is hollow, having a chamber 47 formed therein extending nearly throughout its length; and passages 48 connect the chamber 47 with the space at the end of the valve remote from the head 28. The periphery of the valve is grooved at opposite sides of the central longitudinal zone of said valve, so that annular grooves 51 and 52 completely surround the exterior of the valve, and each of these grooves is of sufficient length to be capable of connecting the annular supply groove 35 with one of the pairs of fluid conducting passages 29*a* or 30*a*. The body of the valve 46 has a collar or spool-like portion 54 at one end, a similar portion 55 at the other end and a wider spool-like portion 56 adjacent its middle. The valve is traversed at about the longitudinal center thereof and midway between the ends of the spool-like portion 56 by a pair of diametrically opposite passages 57 and 58, each of an arcuate width approximately equal to the arcuate width of the ports 29*a*, 29*a* and 30*a*, 30*a*. The port 58 has in communication with it an auxiliary port 59 which is in the form of a V-like notch diminishing in depth circumferentially of the valve towards its extremity remote from its point of communication with the port 58 and also diminishing in width towards said point.

The valve 46 has a reduced stem 61 which passes through the head 27 and is pivotally connected as at 63 to an operating handle or lever 64. The lower end of the lever 64 is pivotally connected at 65 to a link 66 whose other end is pivotally connected at 67 to pairs of projecting arms 68 secured to a rotating ring 69 turning upon a cylindrical surface 70, near the end of the body 26. Between the ring 69 and a shoulder 71 formed on the body 26, there is adjustably rotatably mounted a stop ring 72, also journaled on the cylindrical surface 70, and having a set screw 73, by means of which its position may be fixed. The stop ring carries a stop pin 75, whose position can obviously be adjusted by rotating the stop ring. A stop 76 is arranged on the body 26 for engagement by a lug 77 mounted on the ring 69, when full open position of the valve is desired; and the lug 77 is adapted to co-operate with the pin 75 in minimum feed position of the valve. A third stop lug 80 is provided on the body 26 to limit rotation of the valve beyond a totally closed position.

It will be appreciated that the handle 64, when pressed laterally, will rotate about the axis of the stem 61 and turn the valve 46 with it and

also turn the ring 69 with it. When the handle 64 is either pushed or pulled, it will effect longitudinal movement of the valve 46: when pushed, moving the ports 57, 58 opposite the ports 30a, and when pulled, moving the ports 57, 58 opposite the ports 29a. Accordingly, pushing the outer head of the lever 64 towards the casing 26 will establish connections for drill retraction, while opposite longitudinal movement of said valve will create connections for forward feed.

The mode of operation of the illustrative embodiment of the invention which has been described will easily be understood. While the valve mechanism 25 is shown in one position in Fig. 1 and in another position in Fig. 2, it will be understood that it may assume any convenient position, but will preferably be arranged with its body 26 horizontal and with the handle 64 nearly upright and towards the operator as he stands in the bst position to control the work to be done.

The position of Fig. 2 represents the "off" position, with no feed, either forward or reverse. The fluid discharged by the pump 21 simply flows through conduit 23, connection 37, groove 35, ports 57, 58, chamber 47, chamber 36, connection 42, and pipe 24 back to the tank 22. This is a great advantage in that the load on the pump is much reduced, and wear and danger of leakage minimized. In this position of valve 46 fluid is entrapped in the passages 19, 20, etc., and in the cylinders 15, 15 and the parts are held against movement.

Fig. 1 shows the feed pistons 17 in bottom position. Let us therefore assume that the operator will desire to raise the pistons and the parts which they support. To do this he will need to supply fluid beneath the pistons 17 and permit fluid above them to escape. Accordingly, the operator will press the handle element 64 backward, and that will move the valve 46 backand the groove 51 on the valve will connect annular groove 35 with ports 29a and so with groove 38 and connection 40 and passages 20, 20a and 20a. Fluid will then be delivered to the lower ends of the cylinders 15 and act therein to raise the pistons 17. Simultaneously ports 57 and 58 in the valve come opposite the ports 30a, 30a in the sleeve 30 and accordingly fluid may be displaced from the portions of the cylinder bores above the pistons 17, 17 and may flow through connections 19a, 19a, 19 and 41, annular groove 39, ports 30a, 30a in the sleeve 30, ports 57, 58 in the valve 46, through the chamber 47 within the valve, through the part of space 36 to the right of the valve, through connection 42, and through conduit 24 back to the tank 22. The rate of raising may require no retardation, but if any is desired, the handle 64 may be turned clockwise (looking at the mechanism from the left hand end thereof in Fig. 2), and this rotary movement will diminish the degree of communication of port 57 with the lower port 30a, and of port 58 with the upper port 30a. If desired this communication can be wholly interrupted, even the supplemental port 59 moving out of communication with upper port 30a, or complete interruption of communication may be avoided, by adjustment of ring 72 as will later be described. The rate of feeding movement may be controlled by imposing a retarding effect upon it, with the connections described, but obviously a reversal of connections of the valve mechanism with the lines 23 and 24 would provide control by throttling flow of fluid to the cylinders. When the pistons 17 reach the desired upper point of travel the handle 64 may be moved outwardly to bring the valve 46 again to the position of Fig. 2. It will be noted that this will connect fluid delivery line 23 with fluid return line 24 whether or not the handle 64 be rotated again to its original substantially upright position.

And now let it be assumed that a controlled forward (herein downward) feed is desired. When the lug 77 on the ring 69, which rotates with the valve as above explained, contacts with the stop 76 and the valve 46 is moved either inwardly or outwardly, it establishes full open connections between ports 57, 58 and ports 30a, 30a or ports 29a, 29a. When the valve 46 is rotated until lug 77 engages stop 80 on the casing 26, no open passage between the interior of the valve and either groove 39 or 38 will remain. If however, ring 72 be adjusted so that pin 75 is not quite so far around (clockwise) as lug 80, then notch 59 may serve to provide a connection of small flow area between one or the other of the grooves 38 or 39 (through upper port 29a or 30a) and the interior of valve 46. Because of the double taper, so-to-speak, of notch 59, a well regulated flow control will be possible, anything from virtually a port of a cross section no larger than a pin hole to a cross sectional area equal a port perhaps ¼'' square, though the maximum area of port 59 is of course capable of being made large or small as desired. When the fluid flow through the valve mechanism 25 is restricted, a portion of the fluid supplied by the pump is by-passed from the supply conduit 23 through the relief valve and by-pass line shown in Fig. 1, back to the supply tank. Of course as soon as port 58 begins to connect with one or the other of ports 29a or 30a more rapid increase in area may be made. Let us assume that ring 72 is adjusted so that rotation of handle 64 clockwise will be stopped by engagement of lug 77 with pin 75 when port 59 is covered for one-half its length by sleeve 29 when valve 46 is drawn forward and rotated as far as pin 75 will permit. The operator may obviously effect a restricted predetermined rate of forward feed merely by drawing handle 64 towards him and rotating it until pin 75 stops lug 77. If the setting of ring 72 is made just what is desired, the operator can change his chuck's engagement with the rod line, or momentarily retract before continuing feed, or in general interrupt and renew feeding, and go at once back to the same desired feeding rate.

Fig. 11 shows a modification. Obviously the equivalent of notch 59 may be formed in sleeve 29 (or in both sleeves), as for example a notch or saw slot as at 59a in Fig. 11. The shape of port 58 would then be regular in outline.

The mechanism specifically described obviously possesses great advantages in practical use. Full speed feed in either direction is possible. Any desired predeterminedly limited feed in either direction is possible. Full speed feed in one direction and predeterminedly limited feed in the other is possible. Motion to off position is possible with the simplest possible (rectilinear) movement from any one position. Automatic by-passing takes place whenever off position is taken. The predetermined minimum speeds may be easily and quickly adjusted. Any speed between the predetermined minimum and maximum can be secured by mere rotation of the valve. Engagement of the ends of the valve with the heads of the casing automatically locate the

valve in optimum flow position. The best feeding speed can be immediately resumed after temporary interruptions of feed. The device is simple, certain in operation and rugged, and provides a facility of operation much needed with hydraulically fed devices.

While there is in this application specifically illustrated and described one form, together with a minor modification, which the invention may assume in practice, it will be understood that the showing provided is for purposes of illustration and that the invention may be further modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

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

1. A hydraulic control device for controlling the flow of a liquid between a hydraulic feed cylinder, a liquid reservoir, and a pump which has an intake connected with the liquid reservoir and a discharge for liquid under pressure connectible to the feed cylinder, said control device comprising a ported valve casing having a bore, a control valve mounted in said bore for movement relative to said ported casing and adapted to be moved oppositely from a neutral position in a direction within one plane to connect the pump discharge selectively to the opposite ends of the feed cylinder and to connect the ends of the feed cylinder not connected to the pump discharge to a return flow connection, said valve being adapted while stationary as regards its first mentioned movements to be moved in a direction within a plane making an angle with said first mentioned plane and being operative, purely by the latter movement thereof, in either of the opposite working positions of the valve assumed as a result of its first mentioned movements, to control the amount of liquid flowing between said valve casing and the feed cylinder, said valve also being adapted to provide a direct connection between the pump discharge and the liquid supply when said valve is moved to its neutral position, said valve having fluid conducting means formed therein cooperating to provide said direct connection when said valve is in its neutral position, and which same fluid conducting means establishes a flow connection for an end of the feed cylinder when said valve is appropriately moved from its neutral position in the manner first above mentioned, and a control means for said valve operable at will by an operator and by means of which the valve is movable either to control the amount, or the direction, of liquid flow relative to the feed cylinder.

2. A hydraulic control device as claimed in claim 1, characterized in that said valve is adapted to control the connection of said pump discharge to the feed cylinder and to said liquid supply by longitudinal movement thereof and to control the amount of liquid flowing through the connections to the feed cylinder by a rotary movement thereof.

3. A hydraulic control device for controlling the flow of a liquid between a hydraulic feed cylinder, a liquid reservoir, and a pump which has an intake connected with the liquid reservoir and a discharge for liquid under pressure connectible to the feed cylinder, said control device comprising a ported valve casing having a bore, a control valve mounted in said bore for movement relative to said ported casing and adapted to be moved oppositely from a neutral position in a direction within one plane to connect the pump discharge selectively to the opposite ends of the feed cylinder and to connect the ends of the feed cylinder not connected to the pump discharge to a return flow connection, said valve being adapted while stationary as regards its first mentioned movements to be moved in a direction within a plane making an angle with said first mentioned plane and being operative, purely by the latter movement thereof, in either of the opposite working positions of the valve assumed as a result of its first mentioned movement, to control the amount of liquid flowing between said valve casing and the feed cylinder, said valve casing bore having a lateral fluid supply connection, an end connection with the point of discharge, and a pair of connections with the opposite ends of the feed cylinder, each of said last mentioned connections communicating with said valve casing bore through ports extending less than completely around said bore, said valve being hollow, having annular peripheral grooves at the opposite sides of its longitudinal center selectively operative to connect the opposite ends of said feed cylinder to the supply connection and being traversed by a port of relatively small arcuate extent adjacent its longitudinal center selectively operative to provide a discharge from the opposite ends of the feed cylinder, said port in said valve being adapted to be moved by a longitudinal movement of said valve into communication with said lateral fluid supply connection or into communication with either of said connections to the feed cylinder, and a control means for said valve operable at will by an operator and by means of which the valve is movable either to control the amount, or the direction, of liquid flow relative to the feed cylinder.

4. A hydraulic control device for controlling the flow of a liquid between a hydraulic feed cylinder, a liquid reservoir, and a pump which has an intake connected with the liquid reservoir and a discharge for liquid under pressure connectible to the feed cylinder, said control device comprising a ported valve casing having a bore, a control valve mounted in said bore for movement relative to said ported casing and adapted to be moved oppositely from a neutral position in a direction within one plane to connect the pump discharge selectively to the opposite ends of the feed cylinder and to connect the ends of the feed cylinder not connected to the pump discharge to a return flow connection, said valve being adapted while stationary as regards its first mentioned movements to be moved in a direction within a plane making an angle with said first mentioned plane and being operative, purely by the latter movement thereof, in either of the opposite working positions of the valve assumed as a result of its first mentioned movement, to control the amount of liquid flowing between said valve casing and the feed cylinder, said valve casing bore having a lateral fluid supply connection, an end connection with the point of discharge, and a pair of connections with the opposite ends of the feed cylinder, said valve being hollow, having annular peripheral grooves at the opposite sides of its longitudinal center and being traversed by a port of relatively small arcuate extent adjacent its longitudinal center, said port in said valve being adapted to be moved by a longitudinal movement of said valve into communication with either of said connections to the feed cylinder, said valve being adapted to be rotated to interrupt communication of said port with the connections with said feed cylinder,

and said valve having a supplementary relatively restricted port communicating with said valve port whereby selectively a passage of small or larger flow area may be provided, by rotary movement of said valve, between an end of the feed cylinder and the hollow interior of said valve, and a control means for said valve operable at will by an operator and by means of which the valve is movable either to control the amount, or the direction, of liquid flow relative to the feed cylinder.

5. A hydraulic control device for controlling the flow of a liquid between a hydraulic feed cylinder, a liquid reservoir, and a pump which has an intake connected with the liquid reservoir and a discharge for liquid under pressure connectible to the feed cylinder, said control device comprising a ported valve casing having a bore, a control valve mounted in said bore for longitudinal and rotary movements relative to said ported casing and adapted to be moved oppositely from a neutral position in a longitudinal direction to connect the pump discharge selectively to the opposite ends of the feed cylinder and to connect the ends of the feed cylinder not connected to the pump discharge to a return flow connection, said valve being adapted while stationary as regards its longitudinal movements to be rotated and being operative, purely by the rotary movement thereof, in either of the opposite working positions of the valve assumed as a result of its longitudinal movements, to control the amount of liquid flowing between said valve casing and the feed cylinder, a control means for said valve operable at will by an operator and by means of which the valve is movable at any time either to control the amount, or the direction, of liquid flow relative to the feed cylinder, and means for limiting the rotation of said valve, said limiting means including two cooperable stops, one for positioning said valve for full flow establishment and the other adjustable to stop said valve in positions corresponding to different desired feed rates less than maximum.

6. A hydraulic control device as claimed in claim 5, characterized in that the second one of said stops of claim 5 is provided on a rotatable abutment-carrying stop ring carried by said valve casing, and means is provided for securing said ring in various relative positions on said casing for varying the limit of valve rotation.

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