Aug. 4, 1931. A. L. DE LEEUW 1,816,829

HYDRAULIC UPRIGHT DRILL

Filed Dec. 4, 1926 4 Sheets-Sheet 1

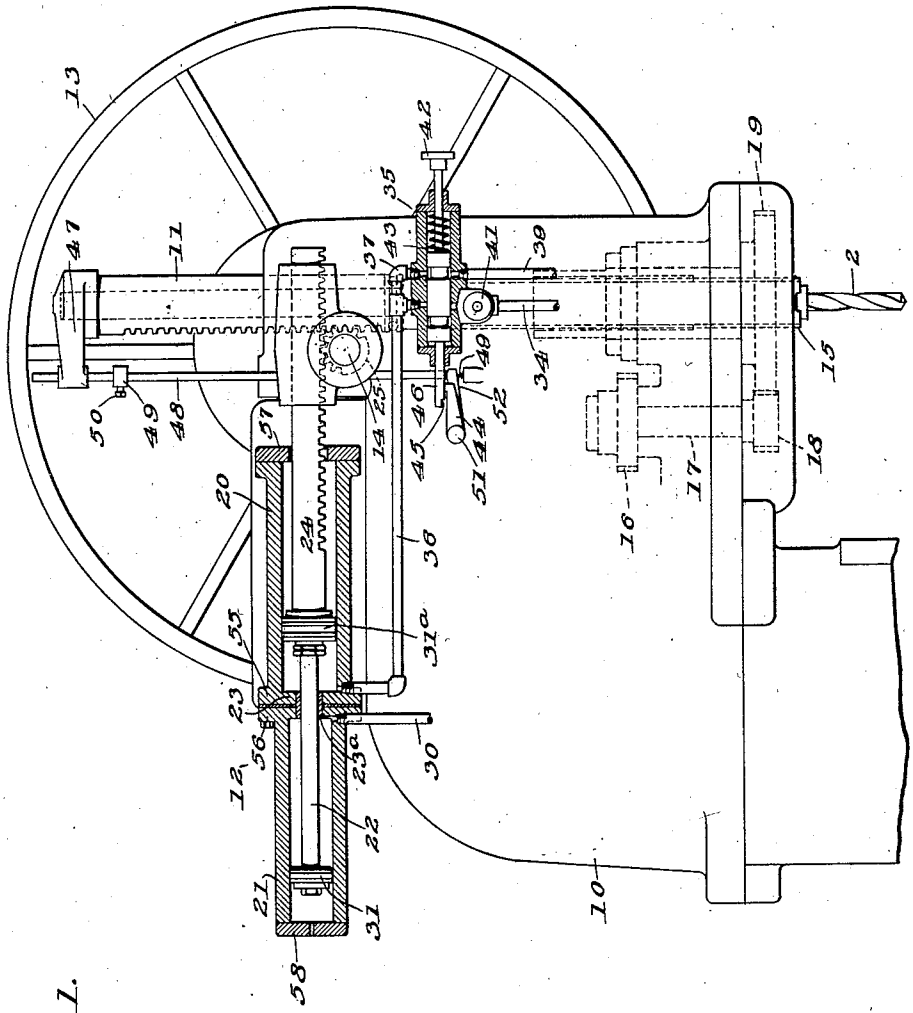

Fig 1.

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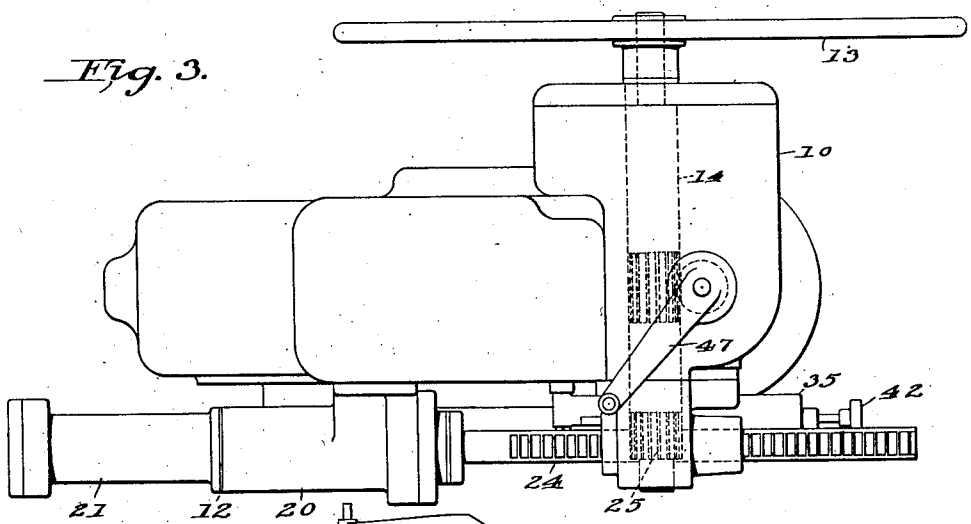
Fig. 3.



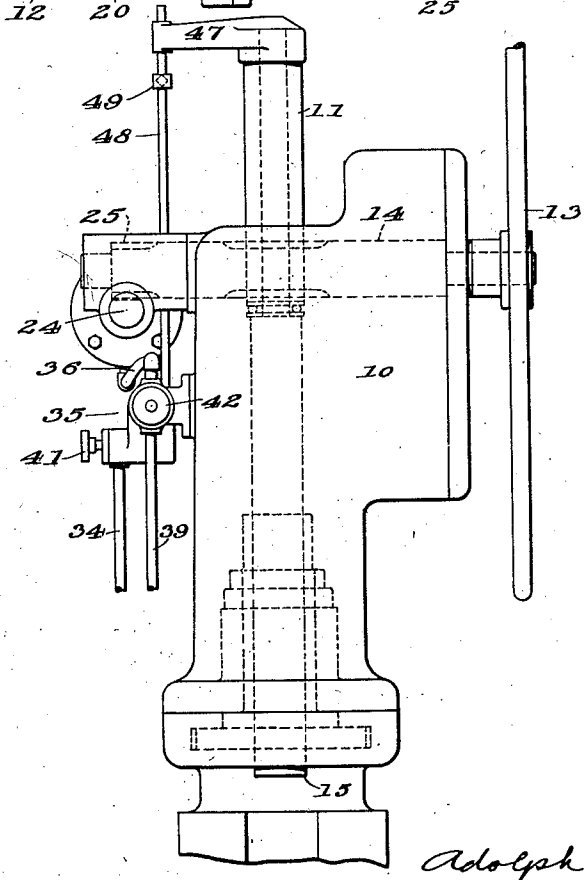


Fig. 2.

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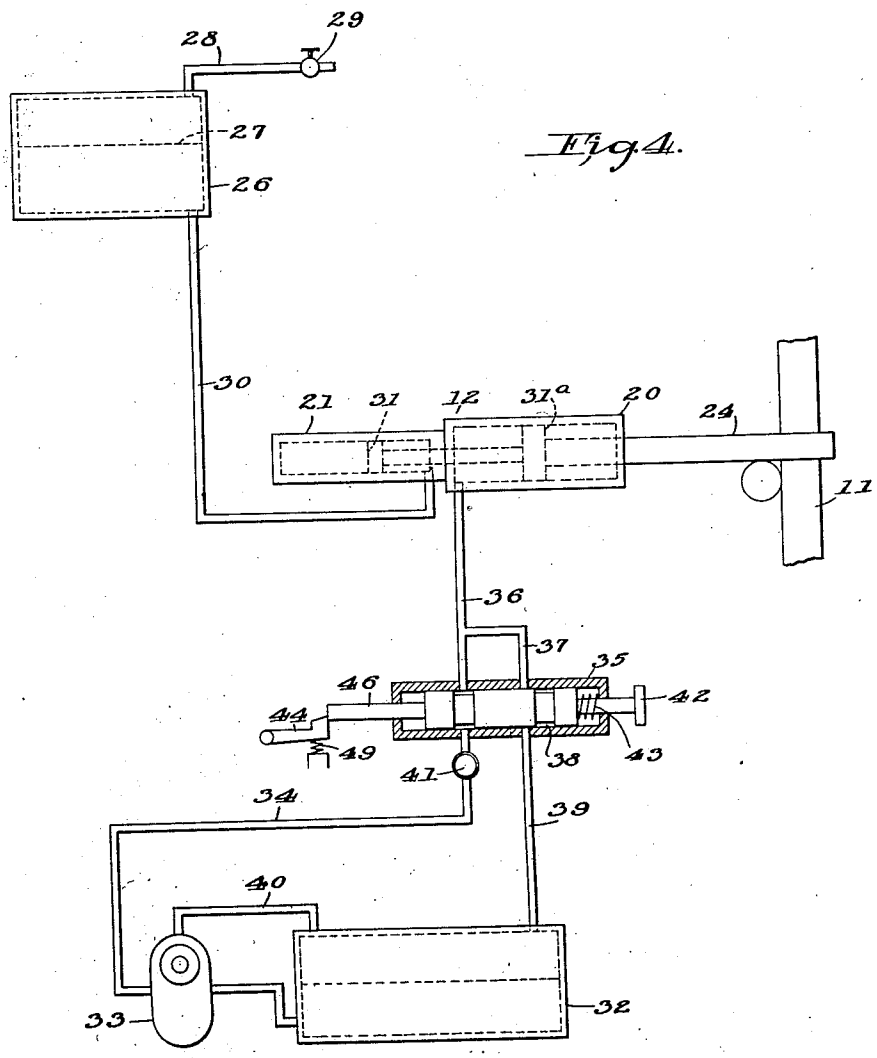

Fig 4.

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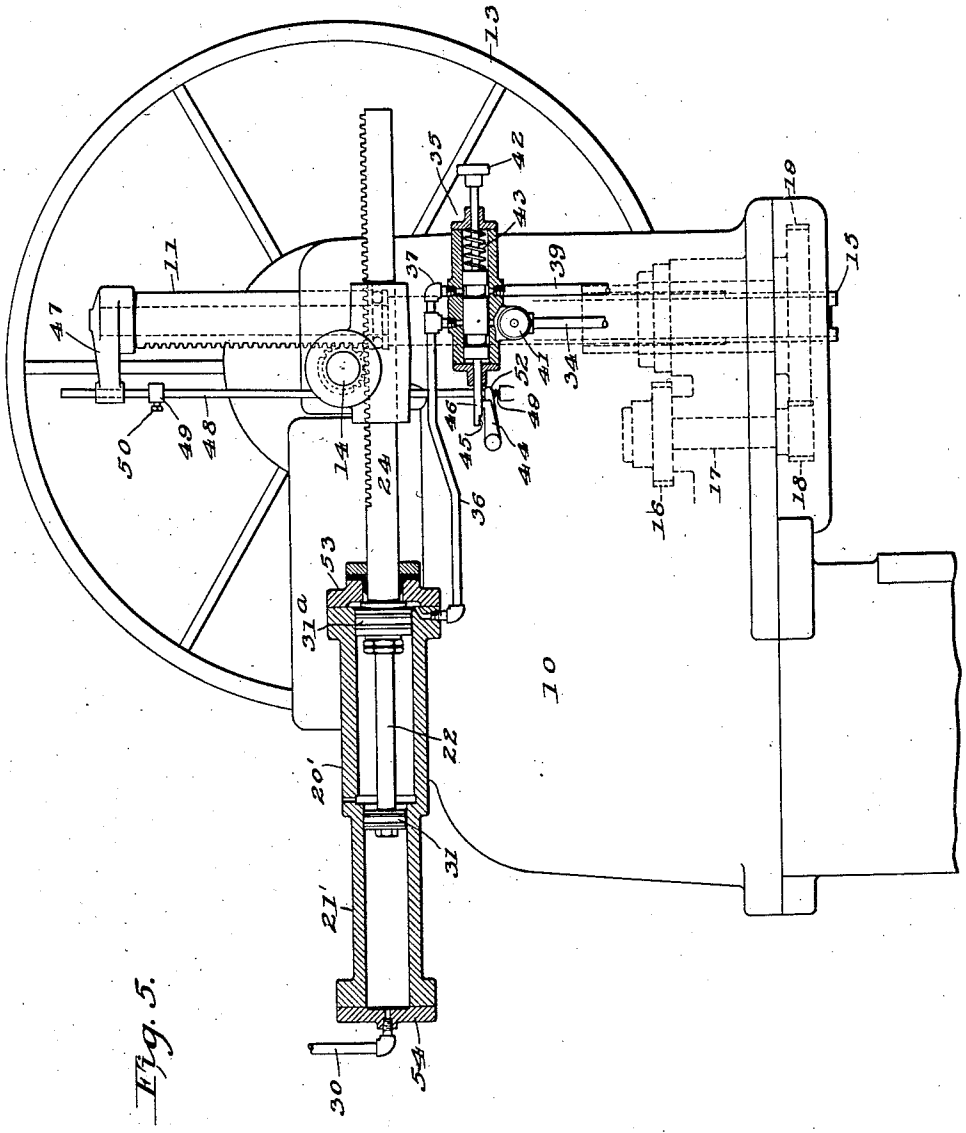

Fig. 5.

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UNITED STATES PATENT OFFICE

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HYDRAULIC UPRIGHT DRILL

Application filed December 4, 1926. Serial No. 152,681.

This invention concerns a machine tool and as specifically shown an upright drill although many of the objects and means disclosed herein are not limited to the specific type of machine tool shown.

In metal working machines various means have been developed for rotating the spindle carrying the working tool and for moving the tool into engagement with the stock to be machined and for moving the tool through its working stroke. Purely mechanical means for advancing the tool through its working stroke were subject to certain defects which it was sought to overcome. For example a positive feed such as a worm and nut engaging therewith would often result in broken parts in the event that too much resistance was met with.

With the development of fluid pressure means it was discovered that such means could be applied to machine tools for translating certain members in a very advantageous manner, thereby overcoming many of the objectionable features of a rigid, positive, purely mechanical means for transmitting power to the element to be moved.

A piston actuated by a hydraulic fluid could be connected up to translate a movable working element to give it a smooth steady travel and one which was as strong as desired but yet yielding to unusual resistance or a positive stop.

One of the many defects in the mechanical drives was the presence of back lash or play between the parts especially after the parts became worn. This was practically eliminated by the fluid pressure means and especially so by the use of differential pistons wherein a fluid acted continuously on the piston of smaller area tending to move it in one direction, and thereby taking up the play or back lash. By intermittently and selectively applying fluid to the opposite side of the piston it was caused to move against the opposing lesser pressure and to perform its machining operation. Both elastic fluids such as air and inelastic fluids such as oil have been used. Each of these have defects in certain cases. The oil may prove too rigid and positive while the air often proved too flexible resulting in uneven movement due to compression of the gas.

In the general utilization of fluid pressure in connection with a cylinder and piston for operating various devices such as the machine tool herein disclosed an objectionable feature also developed which was the loss of fluid through the piston rod packing. With the increasingly high pressures which are being used going up to 1,000 lbs. and even much higher, this defect has become more noticeable and is the source of much annoyance, loss of pressure and of fluid, and necessitating the expenditure of considerable time, labor and money. Even when low pressure is used the constant wear on packing soon results in leakage and requires frequent replacement or attention to the packing.

One of the main objects of this invention consists of a novel arrangement whereby this leakage is practically eliminated or if any leakage takes place the fluid passes directly into the system without any attention from the operator. This novel feature is arrived at by providing two pistons of unequal area arranged at opposite ends of the piston rod each piston being arranged in its corresponding cylinder with an intervening wall through which the rod passes. Reciprocation is obtained by admitting an hydraulic fluid to the chambers on opposite sides of the wall whereby any leakage from one cylinder necessarily passes into the other cylinder. The whole results in a very much simplified cylinder construction and one inexpensive to manufacture.

Another object of the present invention is to apply, in a machine tool such as the drill shown, a combination of two fluids, one elas-

tic and the other inelastic for causing the translation of the working spindle. On the working stroke the piston means disclosed for applying the power is actuated by an hydraulic fluid, the opposing fluid which acts constantly on the opposite piston face is more elastic and is made especially so by the insertion in the fluid line of a reservoir to provide for to-and-fro movement of the fluid.

The present invention has an advantage in that by the use of two fluids the pressures of the two fluids need not be the same and can be adapted to the requirements and to what would be best under the operating conditions. A further object and advantage lies in the arrangement of the fluid pressure operating means relative to the working spindle. Heretofore the cylinder and piston means have been principally connected directly to the movable spindle. In an upright drill in which a rotatable spindle has a vertical translation the cylinder and piston were attached in a vertical manner directly to the upper end of the spindle, thereby placing a large amount of weight and strain on a somewhat suspended part of the drill and the weight of the hydraulic fluid at times resting on the piston interfering with manual operation of the spindle. Also with varying amounts of liquid resting on the piston at different points in the stroke the force exerted was not always the same. With the present device the cylinder and piston means are arranged horizontally with suitable connections therefrom for vertically moving the spindle. Thus many of the variations in force applied are eliminated and manual adjustment of the spindle is made easier.

The particular combination of manual means for translating the spindle with the fluid pressure means forms another object of this invention. Such combinations are broadly old but heretofore various means such as by-pass valves have been found necessary for rendering the fluid pressure entirely inoperative while manual movement was being undergone as e. g. quickly bringing the tool into engagement with the stock. With the fluid pressure means herein disclosed the fluid pressure acts constantly in one direction but is of such a flexible nature as to allow of manual movement in opposition thereto.

A still further object of the invention lies in the application of a particular type of slide valve which gives a more accurate and reliable control of the fluid.

The means for operating the control valve have been simplified and made more dependable thus resulting as a whole in a fluid pressure operated machine tool which is more flexible yet, accurate, strong and reliable in its operation.

Other objects and advantages will be in part indicated in the following description and in part rendered apparent therefrom in connection with the annexed drawings.

To enable others skilled in the art so fully to apprehend the underlying features hereof that they may embody the same in the various ways contemplated by this invention, drawings depicting a preferred typical construction have been annexed as a part of this disclosure and, in such drawings, like characters of reference denote corresponding parts throughout all the views, of which:—

Figure 1 is an elevational view of the upper portion of a vertical drill showing the fluid pressure operating means connected thereto. Fig. 2 is also an elevational view of the same drill looking from the front. Fig. 3 is a plan view thereof. Fig. 4 is a diagrammatic view showing the fluid pressure means and Fig. 5 is a view similar to Fig. 1 but showing a different type of fluid pressure cylinder for operating the drill.

The main features of the machine shown comprise a head 10 of a vertical drill having mounted therein the spindle 11 designed to receive a vertical motion from the fluid pressure means 12 and also from the hand wheel 13 both geared to the horizontally arranged shaft 14. The lower end of the spindle 15 is designed to accommodate a tool such as the drill 2 and receives a rotary motion from the gearing shown in dotted lines in Fig. 1. Such gearing comprises a spur-gear 16 fixed on the shaft 17 for driving through the gear 18 the gear 19 splined on the spindle portion 15. The means for giving the spindle a rotary motion is somewhat conventional and forms no part of this invention and any type of driving means desired could be used in place thereof.

Referring more particularly to the fluid pressure means for translating the spindle in a vertical direction, such means comprises a cylinder 20 arranged in tandem with the cylinder 21 with the pistons arranged in the respective cylinders and connected together by the piston rod 22 passing through the common wall or cylinder head 23 to be later described in more detail. Connected to the larger piston is the rack 24 engaging with the rack gear 25 mounted on and rigid with the shaft 14.

The shaft 14 has also mounted thereon at one end thereof the large wheel 13 for manual rotation of the shaft whereby the drill spindle may receive its vertical movement either manually or by the fluid pressure means shown.

The novel arrangement of the fluid pressure cylinders with respect to the remaining structure particularly the drill spindle is one of the main objects of this invention. By the arrangement shown the cylinders are independent from the spindle and in fact may be detached therefrom. The arrangement

shown has the advantage of relieving the spindle of the weight of the pistons and the fluid in contact therewith. The weight of the fluid in the construction shown has no influence on the spindle such as would be the case if the cylinders were arranged in a vertical manner over the spindle with the pistons directly attached to the spindle. It may be seen that in the latter case the weight of fluid on the pistons would vary for different points in the stroke and the force required to overcome such weight through the wheel 13, for example, might at certain points of the stroke be considerable.

Referring to Fig. 4 a description of the fluid pressure system will be given. A tank 26 is shown as containing a liquid partially filling the tank to the level 27 and having in the upper portion of the tank an elastic fluid which is admitted through the pipe 28 having therein the valve 29. The reservoir is designed to be under constant pressure whereby the liquid therein acts through the pipe 30 on the piston 31 in cylinder 21. Such constant pressure may be maintained by the admission of an elastic fluid through the pipe 28 and would ordinarily comprise a connection to the air pressure line found in practically all plants. However, the fluid admitted may be steam or any other elastic fluid found convenient. If the valve 29 is left open the pressure in the reservoir will at all times remain practically constant. However, if such means is not available at all times the valve 29 may be closed and the fluctuations of the hydraulic fluid through the pipe 30 caused by the reciprocation of the piston 31 may be taken care of by the alternate compression and expansion of the elastic fluid in the upper portion of the reservoir. Means are provided for intermittently admitting hydraulic fluid to the larger cylinder to act against the piston 31^a therein in opposition to the pressure constantly maintained on the piston 31. This latter means comprises a sump 32 containing a suitable hydraulic fluid from which fluid is drawn by the pump 33 and forced through the line 34 through the valve 35 and pipe 36 to the cylinder 20. Or if the valve occupies a position to the left of that shown the fluid will exhaust from the cylinder 20 back through the pipe 36, connection 37, through the groove 38 in the valve and pipe 39 back to the sump 32. A relief and by-pass in provided for the pump 33 by a pipe 40. The rate of the flow of the liquid from the pump and thereby the speed of the larger piston may be regulated and very accurately controlled by means of the valve 41 having an adjustable opening placed at a convenient point in the line 34.

The position of the valve 35 is controlled by various means comprising a projecting handle 42 extending through one end of the valve casing and adapted to be grasped manually to move the valve to the right as shown in Fig. 1 against the tension of the spring 43 until the latch 44 engages in the notch 45 on the rod 46 extending from the left end of the valve. The valve is thus held in a position as shown in Fig. 4 until the latch 44 is released by the automatic means now to be described.

Such means comprises a laterally projecting arm 47 rigid with the upper end of the spindle, the outer end of which arm is provided with an eye for receiving the rod 48 which rod is mounted in suitable bearings on the frame and is adpated to receive a longitudinal movement. The rod 48 is normally maintained in its upper position by means of a spring 49 acting at the lower end thereof. The rod 48 has thereon an adjustable stop 49 adapted to be fastened in any desired position by means of the set screw 50.

The latch 44 is rigidly connected to a rotatable shaft 51 upon which shaft the lever 52 is also rigidly mounted. The spindle 11 in its downward movement causes the arm 48 to engage with the stop 49 which moves the lever 52 and therewith the latch 44 releasing the valve which under the tension of the spring 43 moves to the position shown in Fig. 1 whereby exhaust takes place from the cylinder 20 and the pressure in cylinder 21 acting upon the piston 31 causes the piston to move to the left retracting the spindle to its highest position.

In Fig. 5 is shown an arrangement similar to Fig. 1. In this form, however, the cylinders 20′ and 21′ have their outer ends closed by cylinder heads 53 and 54 respectively and the pressure fluids are admitted to act on the outer faces of the pistons. In this modification the operation is practically the same with the difference that the power stroke causes the pistons to move to the left whereas in the form shown in Fig. 1 the application of the fluid to the larger piston causes the pistons to move to the right. Hence in Fig. 5 the rack 24 is mounted underneath the main shaft 14 while in Fig. 1 it is mounted to engage with the opposite side thereof.

The construction shown in Fig. 1 has advantages which are one of the most important features of this invention. In hydraulic transmissions of this type it has been a constant source of difficulty to prevent leakage around the piston rods; such leakage resulting in inconvenience and loss of the hydraulic fluid as well as many other annoyances which would accompany the leakage of fluid around a production machine of this type. Since the hydraulic fluid used in transmissions of this type often reaches a very high pressure, such as 1,000 lbs. or even more, it can be understood that the packing around a piston rod in the ordinary construction must be extremely good and require frequent replacement and considerable attention.

The construction shown in Fig. 1 obviates many of these objections. The fluids it may be seen are applied on the opposite sides of the cylinder head 23. The fluid acts constantly in the cylinder 21. Therefore when liquid is admitted into the cylinder 20, since the pressures on the opposite side of the wall 23 are balanced or nearly so very little leakage, if any, will occur through the packing 23ª around the piston rod. Then when the pressure is relieved from the cylinder 20 if any leakage occurs from the cylinder 21 around the piston rod 22 such liquid will pass into the main cylinder and through the pipe 36 into the pump system and be collected therein. Ordinarily the fluid admitted to the larger cylinder 20 would probably be of a higher pressure than that in cylinder 21, hence any leakage during the power stroke would tend to replenish the supply of hydraulic fluid in the upper reservoir.

Thus with the construction shown the packing around the piston rod 22 need not be so strong nor require the attention such as would be the case if the piston rod passed out exteriorly of the cylinder.

The construction of the cylinders shown in Fig. 1 and the means of assembling is very much simplified and inexpensive to manufacture and comprises merely two cylindrical members having the flanged ends 55 and 56 adapted to be bolted together to form the common cylinder head 23 having the packing 23ª therein. The outer ends of the cylinders are provided with cover-plates 57 and 58 to keep out dust.

A brief description of the operation is as follows:

Assuming the spindle to be in its upper position with the valve in the position shown in Fig. 1 the operator grasps the wheel 13 rotating it to bring the tool into engagement with the work. This rotation must take place against the pressure in the cylinder 21 acting on the smaller piston therein. However, since this piston is relatively small and the fluid acting thereagainst can be of any desired pressure the force required to bring this spindle down need be only small. The means shown has the advantage that any time that the wheel 13 is released the spindle will automatically return to its upper position out of the way of the operator.

After the tool has been brought into engagement with the work the operator then may continue if he desires to force the tool on through its working stroke. However, ordinarily the operator now throws in the hydraulic feed which is accomplished by grasping the handle 42 and moving the valve to the position shown in Fig. 4. The spindle receives the positive feed until the end of the working stroke when the arm 48 engages the stop 49 tripping the latch mechanism 44 and allowing the valve to assume the position shown in Fig. 1 whereby the fluid exhausts from the large cylinder 20 and the pressure acting against the smaller piston 31 causes the spindle to move to its uppermost position.

It may be seen that the arrangement described provides a very efficient and a novel combination of hydraulic and manual means for translating the drill spindle. The reservoir 26 with its fluid connections to the smaller piston provides a very flexible and reliable means for automatically returning the spindle to its upper position but one which can be easily overcome when desired by the application of manual power to the wheel 13.

The automatic control means comprises but few parts and is necessarily accurate and reliable in its operation. The slide valve shown provides an exceedingly dependable valve means for controlling the fluid and one which is relatively free from leaks.

Without further analysis, the foregoing will so fully reveal the gist of this invention that others can, by applying current knowledge, readily adapt it for various utilizations by retaining one or more of the features that, from the standpoint of the prior art, fairly constitute essential characteristics of either the generic or specific aspects of this invention and, therefor, such adaptations should be, and are intended to be, comprehended within the meaning and range of equivalency of the following claims:—

Having thus revealed this invention, I claim as new and desire to secure the following combinations and elements, or equivalents thereof, by Letters Patent of the United States:—

1. In a machine tool, a rotatable spindle; piston means for translating said spindle; pressure fluid means connected to act constantly on said piston means to urge it in one direction; a second fluid pressure means for moving said piston means in the opposite direction; and control means for the latter comprising a slide valve, a projection from one end thereof for moving said valve manually whereby the second fluid pressure means moves said piston means against the pressure of said first fluid pressure means, elastic means for resisting the manual movement of said valve, a projection extending from the opposite end of said valve, latch mechanism for engaging said projection to lock it in the manually moved position; and means operated by the spindle for releasing said latch mechanism whereby the valve is moved to allow the exhaust of the second fluid pressure means thereby permitting the first fluid pressure means to operate said piston means.

2. Fluid pressure operating means comprising two pistons of differential area; a cylinder for each piston, said cylinders being

arranged in tandem; a wall therebetween; a piston rod connecting said pistons extending through said wall; means for applying a hydraulic fluid under constant pressure to the space between said wall and the small piston to move said piston in one direction; a system for furnishing hydraulic fluid under pressure; means for alternately admitting fluid therefrom into the space between said wall and the larger piston to move said pistons in an opposite direction and said last named being alternatively operative to open it to exhaust to said system whereby movement in the first direction is permitted and whereby losses of hydraulic fluid from leakage through said wall are substantially eliminated.

3. A fluid pressure operating means comprising a cylinder; a larger cylinder in tandem therewith; a wall between said cylinders; a piston in each cylinder; a piston rod extending through said wall connecting said pistons; means connected to one of said pistons for taking off power; means for admitting a pressure fluid to act constantly in the space between said smaller piston and said wall; and means for alternately admitting hydraulic fluid from a pressure system to the space between said larger piston and the wall and exhausting said fluid back into said system whereby the pistons are operated in one direction by admission of fluid from said system and in the opposite direction by the first named pressure fluid when said exhaust back into said system is open and fluid leakage through said wall around the piston rod is led to and retained in the system.

4. Hydraulic operating means for machine tools comprising two pistons of differential area; a cylinder for each piston arranged in tandem, and having a common cylinder head; a piston rod connecting said pistons and extending through said cylinder head; a reservoir for hydraulic fluid; fluid connections therefrom in constant communication with the space between said cylinder head and the piston of smaller area; means for placing the reservoir in constant communication with an elastic fluid under pressure; a closed system for intermittently furnishing hydraulic fluid to the space between said cylinder head and the piston of larger area whereby the pistons are operated in one direction by admission of hydraulic fluid from said system and in the opposite direction by fluid from said reservoir when fluid is permitted to exhaust to said system and whereby losses from leakage through said wall around the piston rod are eliminated.

5. In a machine tool, a rotary spindle; and hydraulic means for translating said spindle comprising two pistons of unequal area, a cylinder for each piston said cylinders being arranged in tandem and having a common cylinder head, a piston rod connecting said pistons and extending through said cylinder head, means operatively connecting one of said pistons to said spindle, a source of hydraulic fluid under pressure in constant communication with the space between said cylinder head and the smaller piston, a closed hydraulic system adapted to alternately admit and exhaust hydraulic fluid from the space between said cylinder head and the larger piston whereby the pistons are caused to move in one direction when hydraulic fluid is admitted from said closed hydraulic system and to move in the opposite direction under pressure of fluid from said constantly communicating source when the exhaust to said closed hydraulic system is open, and whereby losses of hydraulic fluid from leakage around said piston through said wall are eliminated.

6. Fluid pressure operating means comprising a first cylinder and a second cylinder arranged in tandem having a common end wall; pistons in each of said cylinders connected by a piston rod passing through said wall; a first source of fluid pressure in constant communication with the space in said first cylinder between its piston and said wall; a second source of fluid pressure having means for alternately admitting and exhausting hydraulic fluid to the space in said second cylinder between its piston and said wall, said hydraulic fluid being under greater pressure than the fluid from said first source whereby said admission of hydraulic fluid causes movement of the pistons in one direction and said exhaust permits the fluid from said first source acting in said first named space to move the pistons in the opposite direction, and the arrangement also serving thereby to eliminate any losses of fluid through said wall around said piston rod.

7. A drilling machine combining a frame; a drill spindle arranged for vertical translation thereon; power cylinder and piston means horizontally arranged on said frame and operatively connected to said spindle for translating it; means connecting a source of fluid under pressure to said piston means constantly tending to move said piston means in a direction to retract said spindle; manually operative means to feed said spindle against the force of said fluid pressure means; and means for intermittently admitting a hydraulic fluid to act on said piston means to feed said spindle downward in opposition to said first mentioned fluid means, said first mentioned fluid means being operative to retract said spindle and retain it in such retracted position when said hydraulic fluid for feeding is open to exhaust.

8. A machine tool combining a frame; a spindle mounted for vertical translation thereon; cylinder and differential piston means on said frame arranged with their axis substantially horizontal; connections there-

from to said spindle for translating the latter; fluid pressure means connected to act constantly on the piston of smaller area tending to raise said spindle; manually operable means for lowering said spindle against the force of said fluid pressure means; and hydraulic means for electively supplying hydraulic fluid to act on the piston of larger area in a direction to intermittently feed said spindle against the force of said fluid pressure means tending to retract said spindle.

In witness whereof, I have hereunto subscribed my name.

ADOLPH L. DE LEEUW.