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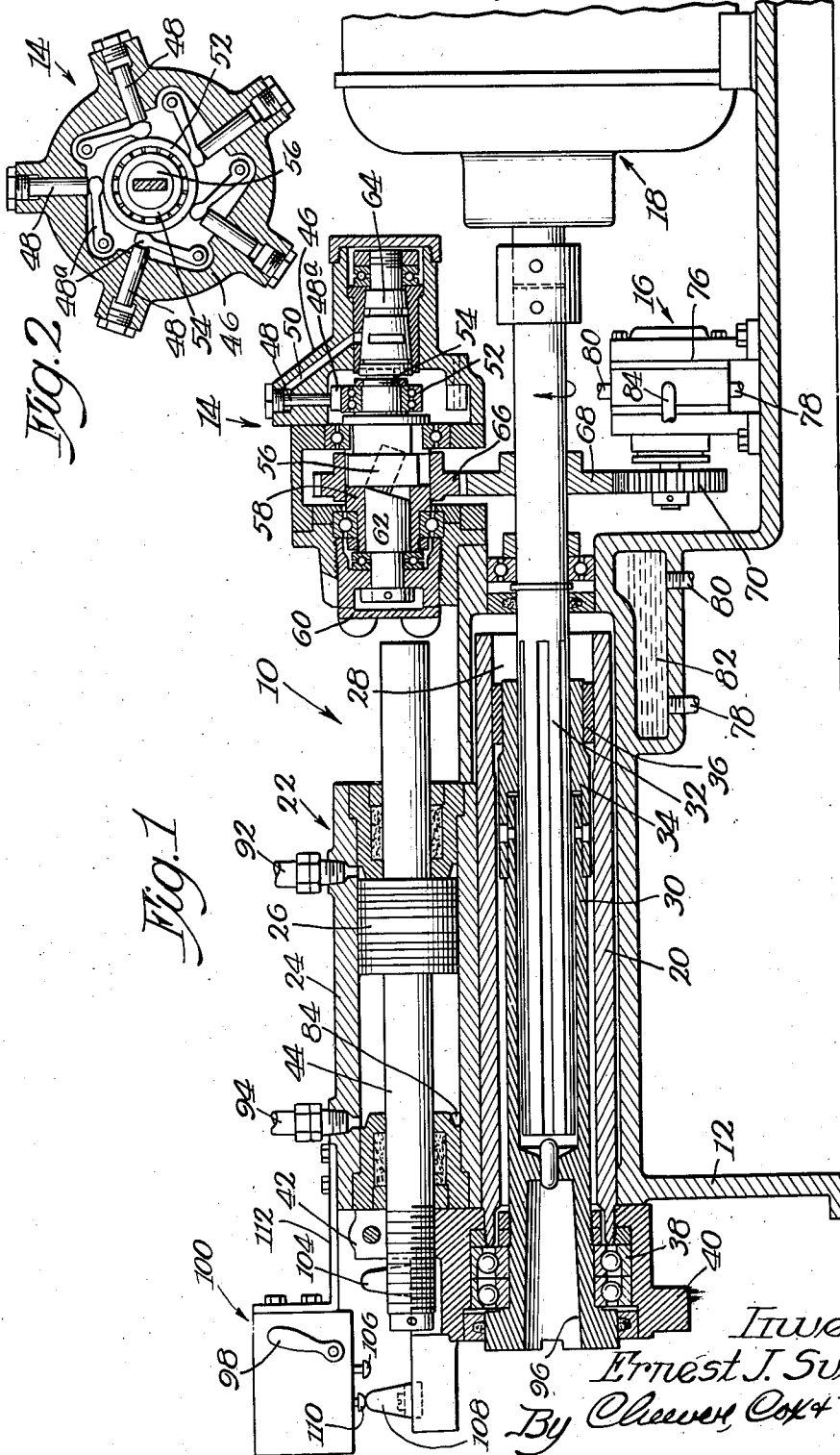
E. J. SVENSON

1,994,079

MATERIAL WORKING APPARATUS

Filed May 15, 1931

2 Sheets-Sheet 1



March 12, 1935.

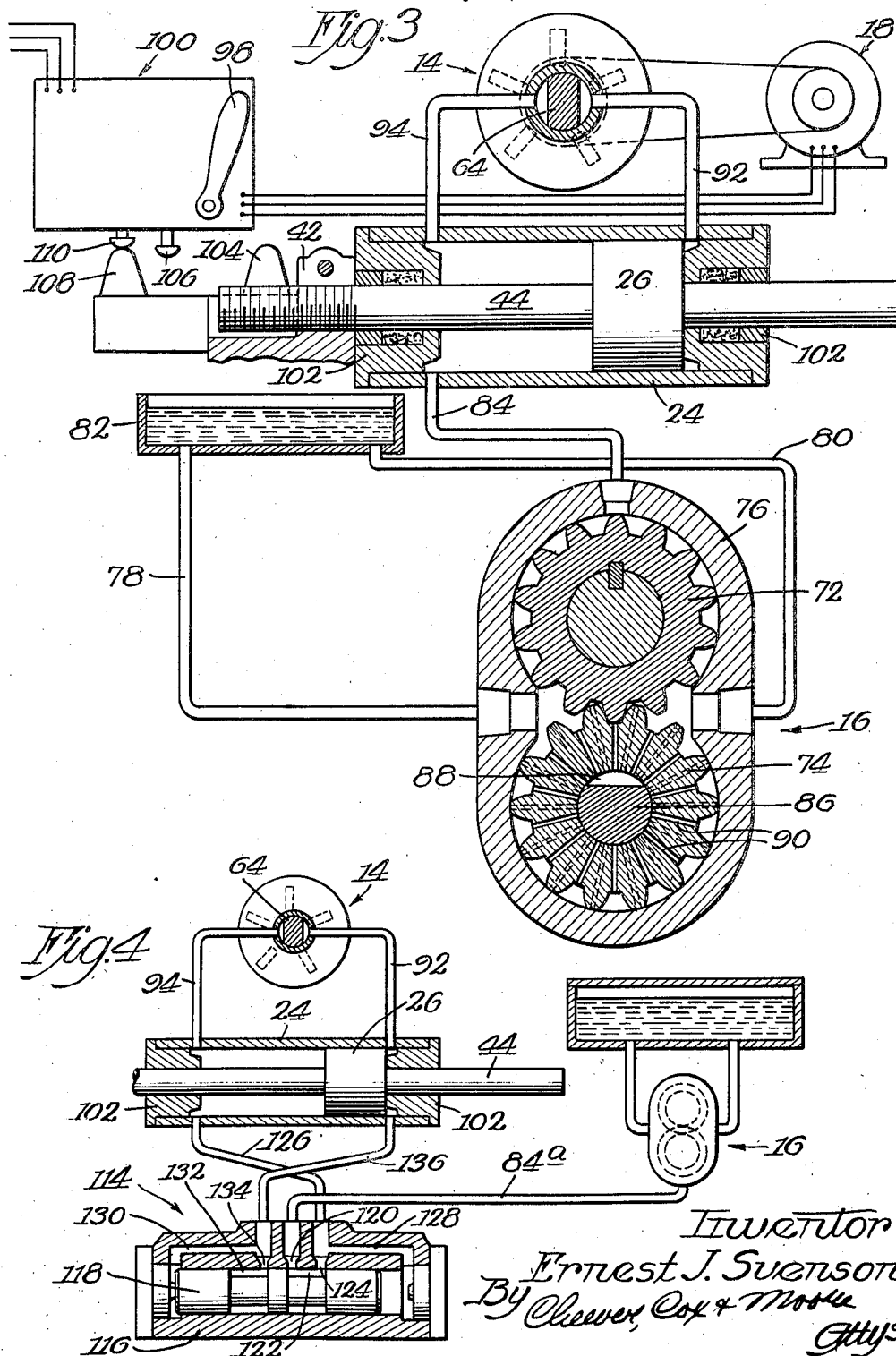
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

1,994,079

MATERIAL WORKING APPARATUS

Ernest J. Svenson, Rockford, Ill.

Application May 15, 1931, Serial No. 537,646

44 Claims. (Cl. 10—105)

My invention relates generally to material working apparatus, and particularly to hydraulically operated apparatus for reciprocating machine tools and the like.

5 It is one of the primary objects of my invention to provide an improved hydraulic actuator mechanism for shifting machine tools and the like, which are adapted to be rotated in reverse directions.

10 More specifically, my invention contemplates the provision of an improved hydraulically operable tool actuating mechanism in combination with a prime mover, such as an electric motor of the reversible type, which prime mover is coupled with a rotary tool driving device.

15 Another object of my invention is to provide a hydraulic actuator system, in which a reversible pumping mechanism is coupled with a hydraulic actuator through the agency of a substantially closed fluid circuit, whereby said actuator will be moved in a direction corresponding with the direction in which the pumping mechanism is being propelled.

25 A further object of my invention is to provide a hydraulic actuator system as above set forth, which is extremely accurate in controlling the shifting of a tool driving actuator in either direction, the accuracy being such as to enable tools, such as taps, to be expeditiously driven into and out of a work piece.

30 Still more specifically, my invention contemplates the provision of an apparatus having a rotary driving spindle adapted to accommodate tool elements, such as taps, a prime mover for imparting rotation to said spindle, and a reciprocable hydraulic actuator coupled with said spindle for imparting longitudinal movement thereto in timed relation with the rotary movement imparted by the prime mover during the entire period of reciprocation of the spindle.

35 It is a further object of my invention to provide a mechanism for reciprocating tool elements, such as taps and the like as above set forth, in which a reversible pumping mechanism is incorporated, whereby said pumping mechanism functions to drive the hydraulic actuator in either direction in timed relation with the rotation of the spindle.

40 Still another object of my invention is to provide, in combination with a reciprocable hydraulic actuator and pumping mechanism as above set forth, a low pressure high displacement pumping mechanism, which is also adapted to be driven in opposite directions.

55 The foregoing and numerous other objects and

advantages will be more apparent from the following detailed description when considered in connection with the accompanying drawings, wherein—

Figure 1 is a central sectional view of a tapping or material working apparatus which is representative of one embodiment of my invention;

Figure 2 is a transverse sectional view of the plunger pump shown in Figure 1;

Figure 3 is a semi-diagrammatic disclosure of the fluid and electrical circuits employed for controlling the functioning of the hydraulic actuator; and

Figure 4 is a modified circuit arrangement disclosing the manner in which an automatically reversible valve may be employed to direct low pressure fluid to either end of an actuator cylinder.

Referring now to the drawings more in detail, wherein like numerals have been employed to designate similar parts throughout the various figures, it will be seen that Figure 1, which is representative of one embodiment of my invention, constitutes a tapping unit designated generally by the numeral 10. This unit or apparatus includes a frame 12 which is adapted to be conveniently mounted upon any suitable base or support. One end of the frame 12 provides a support for driving and pumping mechanisms, namely, a variable displacement plunger pump 14, a charging pump or gear pump 16, and a prime mover or electric motor 18.

The upper portion of the frame 12 slidably receives a spindle supporting member or quill 20. Positioned immediately above the quill 20 is a hydraulic actuator 22 which includes a cylinder section 24 and a piston 26 which is reciprocable within said cylinder.

Positioned within a central opening 28 of the quill 20 is a rotatable work or tool supporting spindle 30. Rotation is imparted to this spindle by means of a splined drive shaft 32 which operates within a complementary splined sleeve 34. This sleeve 34 fits over and is coupled with the spindle 30, as clearly shown in Figure 1, and the portion of the sleeve extending away from the spindle is rotatable within a bushing 36. Thus it will be apparent that the bushing 36 provides a bearing for the inner extremity of the spindle 30.

The outer extremity of the spindle 30 is mounted within suitable anti-friction bearings 38, and these bearings are of the preloaded type which are adapted to take up end thrust as well as radial load. A head 40 is mounted upon the

outer end of the spindle 30 and the quill 20, and a split projection 42 of said head is clamped upon the left extremity of a piston rod 44 which is connected with the piston head 26. Thus it will be apparent that the prime mover or motor 18, which is coupled with the splined shaft 32, causes rotation of the tool supporting spindle 30, and longitudinal travel of the piston 26 causes a corresponding longitudinal travel of the spindle 30. The present invention does not relate to the specific structural features of the spindle, quill, etc., but more particularly relates to said structures in combination with means for controlling the actuation of these parts in timed relation with the actuation of the piston 26. Therefore, a detailed description of the machine elements is not essential to a clear understanding of the present invention. Obviously a variable speed motor may be employed to obtain the required variation in rotative speed of the spindle 30.

To effect the movement of the hydraulic actuator 22, I employ the pumps 14 and 16. The plunger pump 14 is preferably of the type disclosed in my other co-pending application, Serial No. 456,572, filed May 28, 1930. This pump includes a stationary support or casing 46 which supports a plurality of radially disposed reciprocable pistons 48. The outer ends of the chambers, in which these pistons are reciprocable, communicate with inclined radial passageways 50. Movement is imparted to the pistons 48 by means of an eccentrically adjustable driving ring 52, which is mounted on an anti-friction bearing 54, and this ring 52 engages pivoted fingers 48a. By having these fingers 48a, I am able to obtain absolute uniformity in the speed of travel of said pistons during each predetermined angular displacement of the driving ring 52. In other words, during each quarter revolution or angular displacement of the driving ring, each piston will be moved half of its total stroke regardless of the position of said driving ring. For a more detailed explanation of the functional characteristics of the pump 14, reference is made to my above mentioned co-pending application. It will suffice for the present application to state that with a pump of my improved design employed in the circuit about to be described, a tool may be propelled without the slightest degree of pulsation or stuttering.

Rotation or angular displacement is imparted to the driving ring 52 by means of a rotary driving member 56, which is adjustable laterally of and driven by a rotary driving sleeve 58. Accurate adjustment of the driving member 56 is obtained by manually manipulating a screw 60, which is connected with a longitudinally shiftable member 62, a portion of which angularly projects within the member 56. By moving the member 62 in and out, the degree of eccentricity of the driving ring may be conveniently varied. Coupled with the driving member 56 is a tapered rotary valve 64, which is provided with inlet and outlet ports adapted to successively register with the lower extremities of the passageways 50. An annular gear 66 which is mounted upon the driving sleeve 58 meshes with a companion driving gear 68 carried by the shaft 32. Thus the plunger pump 14 is driven in response to the actuation of the prime mover 18. The pump 14 is of the reversible type, that is, of the type which is adapted to be driven in either direction.

The driving gear 68 also meshes with a companion gear 70 connected with the gear pump 16.

This pump 16 includes a pair of meshing gears 72 and 74 mounted within a suitable housing 76. Opposite sides of the pump 16 are connected through pipe lines 78 and 80 with a fluid reservoir 82. A pipe line 84, Figure 3, connects the gear pump intermediate the intake and outlet ports thereof with one extremity of the cylinder 24. Thus, regardless of the direction in which the gear pump 16 operates, fluid under pressure will be directed through the pipe line 84 into the left end of the cylinder 24. The gear 74 of the pump 16 is provided with a central oscillatory valve 86, which is provided with a lateral port 88. The gear 74 is also provided with radial ports 90, which serve to relieve against the development of fluid pressure between the meshing teeth. Therefore, regardless of the direction of rotation of the gear 74, fluid trapped between the meshing teeth will always be delivered through the passageways 90 and the port 88 to the low pressure side of the gear pump.

From Figure 3 it will be apparent that the plunger pump 14 is connected to opposite ends of the cylinder 24 by suitable pipe lines 92 and 94 which extend between the valve 64 and said cylinder.

In the operation of the unit 10, a tool such as a tap (not shown) may be inserted within the tapered opening 96 at the outer end of the spindle 20, Figure 1, and by manipulating a handle 98 of a conventional magnetic reversing switch noted generally by the numeral 100, the electric motor 18 will be motivated in a given direction, as, for example, in the direction indicated by the arrow in Figure 1. This will cause the actuation of the plunger pump 14 so as to direct fluid under high pressure through the pipe line 92 and into the right end of the cylinder 24. Fluid from the opposite end of the cylinder 24 will, during the advancement of the piston 26 to the left, be directed to the charging or intake side of the pump 14. Fluid supplied through the pipe line 84 from the gear pump 16 will serve to take care of any losses due to the leakage of fluid in the packing 102 of the actuator cylinder 24. By employing a pump such as the pump 14, no leakage of fluid is experienced within the pump itself, and the only loss which could possibly take place would be the leakage at either end of the actuator cylinder. As the tap or other tool (not shown) completes its cutting action upon a work piece, a dog 104 adjustably supported upon the head 40 engages a button 106 of the magnetic reversing switch 100, thereby causing the reversal of rotation of the prime mover or motor 18. The pump 14 is also actuated in a reverse direction, thereby causing fluid to be delivered under high pressure through the pipe line 94 into the left end of the cylinder 24. As the actuator reaches its starting position, a dog 108 engages a switch button 110, thereby causing the motor 18 to be deprived of its electrical energy. Obviously, conventional switches of the magnetic type may be employed for controlling the reversal and stopping of the motor 18, and hence I have not entered into a detailed description of the functional characteristics of the switch mechanism 100. It will suffice to say that said mechanism may be supported in a fixed position upon the tapping unit, as, for example, by means of a suitable bracket 112, Figure 1. Obviously any suitable switch mechanism of conventional design may be employed to control the functioning of the prime mover.

In Figure 4 I have disclosed a modified circuit

arrangement, the only difference in this circuit being that I provide a valve mechanism 114 which connects with the gear pump through a pipe line 84a which corresponds to the pipe line 84 just described. The valve mechanism 114 includes a cylinder 116 and a valve member 118 reciprocally mounted therein. When the valve member occupies the position shown in Figure 4, fluid from the pipe line 84a passes through a port 120 in the casing 116, an annular port 122 in the valve member 118 and then out through a port 124 into a pipe line 126, which connects with the left end of the cylinder 24. The valve member 118 is shifted in response to fluid pressure on the high pressure side of the actuator piston 26. Thus in the position shown the high pressure side is to the left of the piston 26, and this fluid pressure is transmitted from the pipe line 126 into a passageway 128, which communicates with the right end of the valve casing 116. This pressure is sufficient to urge the valve member to the left as shown in Figure 4. As soon as the plunger pump 14 is driven in a reverse direction, the right side of the piston 26 will be subjected to high pressure, and thus a passageway 130 which communicates with the left end of the valve casing 116 will serve to direct high pressure fluid against the left end of the valve member 118. Shifting the valve member to the right will cause fluid from the gear pump 16 to be directed from the port 120 through an annular port 132 into a port 134, which communicates with a pipe line 136 connected with the right end of the cylinder 24. In this manner the low pressure fluid supply is always connected to the low pressure side of the actuator cylinder 24 so as to take care of any leakage in the packing of said cylinder. I prefer, however, to employ the more simple arrangement described in connection with Figures 1 to 3 inclusive, wherein low pressure fluid from the gear pump 16 is continuously supplied to one end of the actuator cylinder 24. Supplying fluid to one end of the cylinder is sufficient to take care of any slight leakage in the packing and maintains perfect operating conditions in the hydraulic circuit, and at the same time eliminates the necessity of employing the automatic reversing valve 114.

From the foregoing it will be apparent that my invention contemplates the provision of a very simple and efficiently operable material working or tapping apparatus. Obviously the invention is not limited to a tapping mechanism but is capable of application in any instance where accurately timed relationship between the longitudinal movement of a hydraulically driven work holder and the rotation of said work holder is required in opposite directions. Attention is directed to the fact that by employing a circuit as above described, and particularly the circuit shown in Figure 3, I am able to compensate for variations which may occur at the moment the spindle is reversed. As the motor is subjected to a reversal, the tendency for the actuator piston to be advanced slightly by the momentum thereof, is counteracted by the presence of the fluid pressure which is continuously maintained at the left end of the cylinder 24, Figure 3. By this arrangement the operating relationship between the mechanism, namely, the prime mover for rotating the tap and the hydraulic actuator for moving it longitudinally, is maintained so that, when the tap is reversed in the work piece, threads previously cut will not be impaired. Obviously the tap will reverse itself within the

work piece, and the only power required to act upon the spindle is the power to rotate it in its bearing and the power to move the hydraulic actuator. It will also be appreciated that, by employing the above described circuits, a high pressure pump adapted to be driven in opposite directions may be very effectively employed, and also that a charging or low pressure pump adapted to be driven in opposite directions, may be used to great advantage.

Attention is directed to the fact that the valve member 86 of the gear pump 16 may be adjusted to provide the required fluid pressure in the pipe 84. It should also be understood that the pressure of the fluid in the gear pump 16 at the point where the pipe 84 connects therewith, is substantially equal to the fluid pressure normally obtained in the discharge chamber of the pump, namely, one of the oppositely disposed chambers which connects with the pipes 78 and 80.

It will also be noted that my invention contemplates a material working apparatus in which the rate of longitudinal movement of the tool holder may be accurately controlled by adjusting the displacement of the plunger pump 14. Thus, for example, if the described machine is used for tapping purposes, I am able to cause the tap to move longitudinally at a rate corresponding to a preselected lead by simply adjusting the screw 60, which will correspondingly vary the displacement of the feed pump 14. Thus I am able to accurately control the longitudinal travel of the tap supported by the spindle 30 in accordance with the lead of the tap or any speed proportional to the lead of the tap.

Obviously my invention is not limited for use in connection with tapping machines, but is capable of application in various types of apparatus, such as grinding, boring, milling, and other material working machines.

Having thus described my invention, what I claim as new and desired to secure by Letters Patent is:

1. In material working apparatus, a shiftable machine element, a hydraulic actuator for imparting movement thereto in opposite directions, said actuator including a piston within a cylinder, a fluid propelling mechanism adapted to be driven in opposite directions for imparting reciprocation to said actuator, a reversible prime mover connected with said fluid propelling mechanism, and means automatically operable when the actuator reaches the limit of its stroke in a given direction, to cause the prime mover to experience movement in a reverse direction, whereby to automatically reverse said fluid propelling mechanism.

2. In material working apparatus, a shiftable machine element, a hydraulic actuator for imparting movement thereto in opposite directions, said actuator including a piston within a cylinder, a fluid propelling mechanism adapted to be driven in opposite directions for imparting reciprocation to said actuator, a reversible prime mover connected with said fluid propelling mechanism, and means automatically operable when the actuator reaches the limit of its stroke in a given direction, to cause the prime mover to experience movement in a reverse direction, whereby to automatically reverse said fluid propelling mechanism, and low pressure fluid propelling mechanism connected with said hydraulic actuator.

3. In material working apparatus, a shiftable machine element, a hydraulic actuator for imparting movement thereto in opposite directions, said actuator including a piston within a cylinder,

der, a fluid propelling mechanism adapted to be driven in opposite directions for imparting reciprocation to said actuator, a reversible prime mover connected with said fluid propelling mechanism, and means automatically operable when the actuator reaches the limit of its stroke in a given direction, to cause the prime mover to experience movement in a reverse direction, whereby to automatically reverse said fluid propelling mechanism, and a low pressure fluid propelling mechanism connected with said hydraulic actuator and driven from said prime mover.

4. In material working apparatus, a shiftable machine element, a hydraulic actuator for imparting movement thereto in opposite directions, said actuator including a piston within a cylinder, a fluid propelling mechanism adapted to be driven in opposite directions for imparting reciprocation to said actuator, a reversible prime mover connected with said fluid propelling mechanism, and means including a shiftable control element for automatically controlling the reversing of said prime mover.

5. In material working apparatus, a shiftable machine element, a hydraulic actuator for shifting said element, said actuator including a piston within a cylinder, a fluid propelling mechanism adapted to be driven in opposite directions for imparting reciprocation to said actuator, said fluid propelling mechanism and hydraulic actuator being connected within a closed circuit, whereby to effect uniform speed in opposite directions to said actuator, and means controlled in accordance with the movement of the machine element for governing the direction of operation of said fluid propelling mechanism.

6. In material working apparatus, a shiftable machine element, a hydraulic actuator for shifting said element in opposite directions, said actuator including a piston within a cylinder, a fluid propelling mechanism adapted to be driven in opposite directions for imparting reciprocation to said actuator, said fluid propelling mechanism and hydraulic actuator being connected within a closed circuit, whereby to effect uniform speed in opposite directions to said actuator, a reversible prime mover connected with said propelling mechanism, and means operable in response to the movement of said machine element for controlling the direction of operation of said reversible prime mover.

7. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, fluid propelling means for delivering fluid under pressure at a substantially uniform rate to said actuator in opposite directions, a rotary machine element connected with and adapted to be axially shifted by said actuator, and a prime mover for rotating said machine element, the axial travel of said rotary machine element, in response to the influence of said fluid propelling means, being proportional to the speed of the prime mover.

8. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a plunger pump hydraulically connected with said actuator within a closed circuit and adapted to impart movement thereto in either direction, said plunger pump being adapted to displace the same volume of fluid under increased pressure as it receives for charging purposes under a low pressure, an element driven by said hydraulic actuator, and means for driving the plunger pump in either direction.

9. In a hydraulic actuator system for moving supporting members and the like, a hydraulic actuator including a piston within a cylinder, a plunger pump for imparting movement to said actuator in either direction, the fluid from the high pressure side of said plunger pump serving to urge said actuator in a given direction, and the fluid from the discharge side of said actuator being sufficient to charge said plunger pump, whereby to present a closed hydraulic circuit which includes said actuator and said plunger pump, and means for driving said plunger pump in either direction.

10. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a plunger pump for imparting feeding movement to said actuator in either direction, the fluid from the high pressure side of said plunger pump serving to urge said actuator in a given direction, and the fluid from the discharge side of said actuator being sufficient to charge said plunger pump, whereby to present a closed hydraulic circuit which includes said actuator and said plunger pump means for driving said plunger pump in either direction, and a low pressure pumping mechanism connected with said hydraulic actuator.

11. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a plunger pump for imparting feeding movement to said actuator in either direction, the fluid from the high pressure side of said plunger pump serving to urge said actuator in a given direction and the fluid from the discharge side of said actuator being sufficient to charge said plunger pump, whereby to present a closed hydraulic circuit which includes said actuator and said plunger pump, means for driving said plunger pump in either direction, and means for automatically effecting the reversal of said plunger pump when the actuator has been shifted a predetermined distance.

12. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a plunger pump for imparting feeding movement to said actuator in either direction, the fluid from the high pressure side of said plunger pump serving to urge said actuator in a given direction and the fluid from the discharge side of said actuator being sufficient to charge said plunger pump, whereby to present a closed hydraulic circuit which includes said actuator and said plunger pump, and a reversible prime mover coupled with said plunger pump.

13. In a hydraulic actuator system for moving supporting members and the like, a hydraulic actuator including a piston within a cylinder, a high pressure fluid propelling means for propelling said actuator in either direction at a feeding rate, said propelling means being adapted to operate in forward and reverse directions to impart reciprocation at a uniform rate to said actuator, and a low pressure fluid propelling means connected with said hydraulic actuator, said low pressure fluid propelling means being adapted to be driven in a reverse direction without affecting the delivery of fluid thereby to said hydraulic actuator.

14. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, fluid propelling means for supplying fluid under relatively high pressure to either side of said piston, a supporting element adapted to be reciprocated by

said hydraulic actuator, means for effecting the reversal of said fluid propelling mechanism when the actuator reaches a predetermined position during the advancement thereof within its cylinder, whereby to deliver fluid under high pressure in a reverse direction to said cylinder, and a low pressure fluid propelling mechanism hydraulically connected with the discharge side of said actuator, whereby to facilitate the reversal thereof upon the reversal of said high pressure fluid propelling mechanism.

15. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, fluid propelling means for propelling said actuator, means for driving said fluid propelling means, a gear pump having oppositely disposed intake and discharge ports, and a second discharge port positioned intermediate the first mentioned ports, whereby to effect the continuous discharge of fluid from the gear pump regardless of the direction in which it may be driven.

16. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, fluid propelling means for propelling said actuator, means for driving said fluid propelling means, pumping means having oppositely disposed intake and discharge ports, a second discharge port positioned intermediate the first mentioned ports, whereby to effect the continuous discharge of fluid from the pumping means regardless of the direction in which it may be driven, and means connecting the intermediate port of said gear pump with the cylinder of said hydraulic actuator.

17. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, fluid propelling means for propelling said actuator, means for driving said fluid propelling means, a gear pump having oppositely disposed intake and discharge ports, a second discharge port positioned intermediate the first mentioned ports, whereby to effect the continuous discharges of fluid from the gear pump regardless of the direction in which it may be driven, a valve mechanism shiftable in response to pressure conditions within the actuator cylinder, and means connecting said valve mechanism with the intermediate port of said gear pump.

18. In material working apparatus, a shiftable machine element, a hydraulic actuator for imparting movement thereto, said actuator including a piston within a cylinder, a fluid propelling mechanism for imparting reciprocation to said actuator, said mechanism being adapted to operate in opposite directions, a reversible electric motor coupled with said fluid propelling mechanism, and means including an electric control mechanism for automatically effecting the reversal of the motor when the actuator reaches a predetermined position.

19. In material working apparatus for moving machine parts and the like, a frame, a spindle for receiving cutting tools such as taps, said spindle being rotatable and longitudinally shiftable within said frame, a prime mover for rotating said spindle, a hydraulic actuator including a cylinder and a piston therein, said actuator being coupled with said spindle to impart longitudinal movement thereto, pumping means connected in series with said cylinder, said pumping means adapted to be driven in either direction for imparting movement in opposite directions to said spindle, and means connecting said pumping

means with said prime mover, whereby, when said prime mover is driven in one direction, the spindle will be rotated and shifted longitudinally at a uniform rate, and when said prime mover is driven in the opposite direction a corresponding reverse movement will be experienced by said spindle.

20. In material working apparatus for moving machine parts and the like, a frame, a spindle for receiving cutting tools such as taps, said spindle being rotatable and longitudinally shiftable within said frame, a prime mover for rotating said spindle, a hydraulic actuator including a cylinder and a piston therein, said actuator being coupled with said spindle to impart longitudinal movement thereto, pumping means connected in series with said cylinder, said pumping means adapted to be driven in either direction for imparting movement in opposite directions to said spindle, means connecting said pumping means with said prime mover, whereby, when said prime mover is driven in one direction, the spindle will be rotated and shifted longitudinally at a uniform rate, and when said prime mover is driven in the opposite direction a corresponding reverse movement will be experienced by said spindle, and a low pressure pumping mechanism hydraulically coupled with said actuator and driven from said prime mover.

21. In material working apparatus, a support, a spindle operatively associated therewith for receiving a rotary cutting tool, a prime mover for rotating said spindle, a hydraulic actuator including a relatively reciprocable piston and cylinder construction for causing relative movement in opposite directions between said spindle and support, a feed pump connected in series with said cylinder, said feed pump being adapted to be driven in either direction for imparting relative movement in opposite directions to the spindle and support, and means connecting said feed pump with said prime mover, whereby when said prime mover is driven in one direction, the relative movement between the spindle and support will take place at a uniform rate in a given direction, and when said prime mover is driven in the opposite direction, a corresponding relative reverse movement will be experienced by the spindle and support.

22. In material working apparatus, a support, a spindle operatively associated therewith for receiving a rotary cutting tool, a prime mover for rotating said spindle, a hydraulic actuator including a relatively reciprocable piston and cylinder construction for causing relative movement in opposite directions between said spindle and support, a feed pump connected within a closed circuit with said cylinder, said feed pump being adapted to be driven in either direction for imparting relative movement in opposite directions to the spindle and support, and means connecting said feed pump with said prime mover, whereby when said prime mover is driven in one direction, the relative movement between the spindle and support will take place at a uniform rate in a given direction, and when said prime mover is driven in the opposite direction, a corresponding relative reverse movement will be experienced by the spindle and support.

23. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston and cylinder construction, fluid propelling means hydraulically connected in a closed circuit with said actuator for delivering fluid under pressure at a substantially uniform

rate thereto in opposite directions, a rotary machine element connected with and adapted to be axially shifted by said actuator, and a prime mover for rotating said machine element, the axial travel of the rotary machine element in response to the influence of said fluid propelling means being proportional to the speed of the prime mover.

24. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston and cylinder construction, fluid propelling means for delivering fluid under pressure at a substantially uniform rate to said actuator in opposite directions, ducts connecting said actuator with the opposite sides of said fluid propelling means, said ducts being adapted to maintain the fluid body therein intact regardless of the load experienced by said actuator, a rotary machine element connected with and adapted to be axially shifted by said actuator, and a prime mover for rotating said machine element, the axial travel of the rotary machine element, in response to the influence of said fluid propelling means, being proportional to the speed of the prime mover.

25. In material working apparatus, a shiftable machine element, a hydraulic actuator for imparting movement thereto in opposite directions, a fluid propelling mechanism adapted to be driven in opposite directions for imparting movement to said actuator, a reversible prime mover connected with said fluid propelling mechanism, means automatically operable, when the actuator completes a predetermined movement in a given direction, to cause the prime mover to experience movement in a reverse direction, whereby to automatically reverse said fluid propelling mechanism, a low pressure fluid propelling mechanism connected with said hydraulic actuator, and means for varying the volumetric delivery of fluid from said low pressure fluid propelling mechanism in accordance with the requirements of the actuator.

26. In material working apparatus, a shiftable machine element, a hydraulic actuator for shifting said element, a fluid propelling mechanism adapted to be driven in opposite directions for imparting reciprocation to said actuator, said fluid propelling mechanism and hydraulic actuator being connected within a closed circuit, whereby to effect uniform speed in opposite directions to said actuator, means operable in accordance with the movement of the machine element for controlling the direction of operation of said fluid propelling mechanism, and pumping means adapted to propel said actuator at another rate.

27. An actuator unit including a support, a spindle rotatable within said support, a hydraulic actuator for imparting translation to said spindle, driving means for rotating said spindle in opposite directions, pumping means adapted to be driven in opposite directions for imparting reciprocation to said actuator, said pumping means being operatively connected with said driving means, valve means for controlling the delivery of fluid from said pumping means to said actuator, control means for automatically controlling the reversal of said driving means, and a frame structure for carrying all of the aforementioned elements as a self-contained unit.

28. An actuator unit including a support, a spindle rotatable within said support, a hydraulic actuator for imparting translation to said spindle, driving means for rotating said spindle in

opposite directions, pumping means adapted to be driven in opposite directions for imparting reciprocation to said actuator, a second pumping means for propelling said actuator at a rapid rate, valve means for selectively controlling the functioning of said pumping means, control means for automatically governing the reversal of said driving means, and a frame structure for supporting all of said elements as a self-contained unit.

29. An actuator unit including a support, a spindle rotatable within said support, a hydraulic actuator for imparting translation to said spindle, said actuator including a piston and spindle construction positioned laterally of and in substantial parallelism with the axis of said spindle, driving means for rotating said spindle in opposite directions, pumping means adapted to be driven in opposite directions for imparting reciprocation to said actuator, said pumping means being operatively connected with said driving means, valve means for controlling the delivery of fluid from said pumping means to said actuator, control means for automatically controlling the reversal of said driving means, and a frame structure for carrying all of the aforementioned elements as a self-contained unit.

30. In material working apparatus, a shiftable machine supporting member, a hydraulic actuator for shifting said member, fluid pumping means adapted to be driven in opposite directions for imparting reciprocation to said actuator, said pumping means and actuator being hydraulically coupled in a manner to effect uniform speed in opposite directions to said actuator, and means automatically controlled in timed relation with the movement of the supporting member for governing the direction of operation of said pumping means.

31. In material working apparatus, a shiftable supporting member, a hydraulic actuator for shifting said member, a plunger pump connected with said actuator and adapted to impart uniform movement thereto in either direction, said plunger pump being adapted to displace substantially the same volume of fluid under increased pressure as it receives fluid for charging purposes under a lower pressure, means for driving said plunger pump in either direction, and means for automatically controlling the operative functioning of said pump.

32. In a hydraulic actuator system for moving supporting members and the like, a hydraulic actuator, reversible pumping means hydraulically coupled therewith, a supporting member adapted to be reciprocated by said hydraulic actuator, a rotary supporting element for carrying a cutting tool, a prime mover for rotating said tool supporting element, driving means between said pumping means and said rotary tool supporting element, whereby to effect synchronous actuation of said tool supporting element and said pumping means, means for effecting the reversal of said pumping means when the actuator reaches a predetermined position, and means for selectively governing the proportional synchronism between the pumping means and the tool supporting element.

33. In material working apparatus, a shiftable supporting member, a hydraulic actuator for imparting movement thereto in opposite directions, a reversible fluid transmitting mechanism for imparting movement to said actuator in opposite directions, a reversible prime mover connected with said fluid transmitting mechanism, means

automatically operable, when the actuator completes a predetermined movement, to cause the prime mover to experience movement in a reverse direction, whereby to automatically reverse

5 said fluid transmitting mechanism, a low pressure fluid transmitting mechanism connected with said hydraulic actuator, and valve means for controlling the direction of the low pressure fluid to said actuator.

10 34. In material working apparatus, a shiftable supporting member, a hydraulic actuator for imparting movement thereto in opposite directions, a fluid pressure generating mechanism adapted to be driven in opposite directions for governing the movement of said actuator, a reversible prime mover connected with said fluid pressure generating mechanism, means automatically operable when the actuator completes a predetermined movement to cause the prime mover to experience movement in a reverse direction, whereby to automatically reverse said fluid pressure generating mechanism, a low pressure fluid transmitting mechanism connected with said hydraulic actuator, and a determinative for controlling the direction of flow of low pressure fluid to said actuator.

35. In a hydraulic actuator system for moving supporting members and the like, a hydraulic actuator, reversible fluid transmitting means hydraulically coupled therewith, a supporting member adapted to be reciprocated by said hydraulic actuator, a rotary supporting element for carrying a cutting tool, a prime mover for rotating said tool supporting element, driving means between said fluid transmitting means and said rotary tool supporting element, whereby to effect synchronous actuation of said tool supporting element and said fluid transmitting means, and means including a shiftable element operable automatically when the actuator reaches a predetermined position to cause the reversal of said fluid transmitting means.

36. In a hydraulic actuator system for moving supporting members and the like, a hydraulic actuator, reversible fluid transmitting means hydraulically coupled therewith, a supporting member adapted to be reciprocated by said hydraulic actuator, a rotary supporting element for carrying a cutting tool, a prime mover for rotating said tool supporting element, driving means between said fluid transmitting means and said rotary tool supporting element, whereby to effect synchronous actuation of said tool supporting element and said fluid transmitting means, means including a shiftable element operable automatically when the actuator reaches a predetermined position to cause the reversal of said fluid transmitting means, and another pumping means adapted for automatic coupling with said actuator.

37. In a hydraulic actuator system for moving supporting members and the like, a hydraulic actuator, fluid transmitting means hydraulically coupled therewith, conduits connecting said fluid transmitting means in a closed circuit with said actuator, a supporting member adapted to be reciprocated by said hydraulic actuator, a rotary supporting element for carrying a cutting tool, a prime mover for rotating said tool supporting element, driving means between said fluid transmitting means and said rotary tool supporting element, whereby to effect synchronous actuation of said tool supporting element and said fluid transmitting means, and means including a shiftable element operable automatically when

the actuator reaches a predetermined position to cause the reversal of said fluid transmitting means.

38. In material working apparatus, a shiftable machine element, a hydraulic actuator for imparting movement thereto in opposite directions, said actuator including a piston within a cylinder, a fluid propelling mechanism adapted to be driven in opposite directions for imparting reciprocation to said actuator, a reversible prime mover connected with said fluid propelling mechanism, and means controlled by and operated in response to the movement of said actuator for imparting reverse movement to said prime mover in a manner to synchronize the speed of travel of the actuator with the variable rotative speed of said prime mover during said reversal.

39. In material working apparatus, a shiftable machine element, a hydraulic actuator for imparting movement thereto in opposite directions, said actuator including a piston within a cylinder, a fluid propelling mechanism adapted to be driven in opposite directions for imparting reciprocation to said actuator, a reversible prime mover connected with said fluid propelling mechanism, means controlled by and operated in response to the movement of said actuator for imparting reverse movement to said prime mover in a manner to synchronize the speed of travel of the actuator with the variable rotative speed of said prime mover during said reversal, and low pressure fluid propelling mechanism connected with said hydraulic actuator.

40. In material working apparatus, a shiftable machine element, a hydraulic actuator for imparting movement thereto in opposite directions, said actuator including a piston within a cylinder, a fluid propelling mechanism adapted to be driven in opposite directions for imparting reciprocation to said actuator, a reversible prime mover connected with said fluid propelling mechanism, and means including a shiftable control element for automatically controlling the reversing of said prime mover, said control means being operated in response to the movement of said actuator to cause a reverse movement of said prime mover in a manner to synchronize the speed of the actuator with the variable rotative speed of said prime mover during said reversal.

41. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a plunger pump hydraulically connected with said actuator within a closed circuit and adapted to impart movement thereto in either direction, said plunger pump being adapted to displace the same volume of fluid under increased pressure as it receives for charging purposes under a lower pressure, an element driven by said hydraulic actuator, means for driving the plunger pump in either direction, a prime mover for said plunger pump, and control means operated in response to the movement of said actuator for governing the reversal of said prime mover in a manner to synchronize the speed of the actuator with the variable rotative speed of said prime mover during the reversal thereof.

42. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston within a cylinder, a plunger pump for imparting feeding movement to said actuator in either direction, the fluid from the high pressure side of said plunger pump serving to urge said actuator in a given direction, and the fluid from the discharge side of said actuator

being sufficient to charge said plunger pump, whereby to present a closed hydraulic circuit which includes said actuator and said plunger pump, means for driving said plunger pump in either direction, and valve means for controlling the flow of fluid toward and away from said actuator, said valve means being adapted for hydraulic coupling with a source of fluid supply independent of said plunger pump.

43. In a hydraulic actuator system for moving supporting members and the like, a hydraulic actuator including a piston within a cylinder, a high pressure fluid propelling means for propelling said actuator in either direction at a feeding rate, said propelling means being adapted to operate in forward and reverse directions to impart reciprocation at a uniform rate to said actuator, a low pressure fluid propelling means connected with said hydraulic actuator, said low pressure fluid propelling means being adapted to be driven in a reverse direction without affecting the delivery of fluid thereby to said hydraulic actuator, a reversible prime mover for said high pressure fluid propelling means, and control means operated in response to the movement of said actuator for governing the reversal of said prime mover in a manner to synchronize

the speed of the actuator with the variable rotative speed of the prime mover during said reversal.

44. In a hydraulic actuator system for moving machine parts and the like, a hydraulic actuator including a piston and cylinder construction, fluid propelling means for delivering fluid under pressure at a substantially uniform rate to said actuator in opposite directions, ducts connecting said actuator with the opposite sides of said fluid propelling means, said ducts being adapted to maintain the fluid body therein intact regardless of the load experienced by said actuator, a rotary machine element connected with and adapted to be axially shifted by said actuator, a reversible prime mover for rotating said machine element, the axial travel of the rotary machine element, in response to the influence of said fluid propelling means, being proportional to the speed of the prime mover, and control means operated in response to the movement of said actuator for governing the reversal of said prime mover in a manner to synchronize the axial travel of the rotary propelling means with the variable rotative speed of said prime mover during the reversal thereof.

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