Nov. 23, 1965 J. R. YORK ETAL 3,218,935

CONCRETE FINISHING TOOL

Filed Nov. 23, 1962 2 Sheets-Sheet 1

FIG. 1

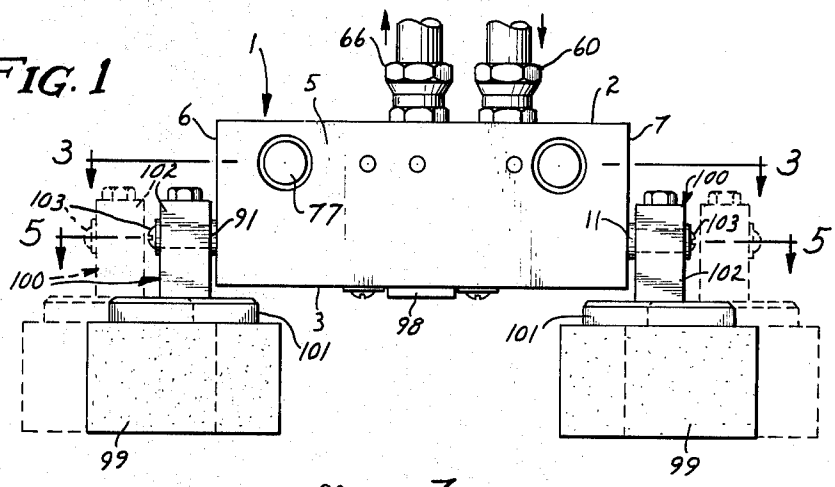
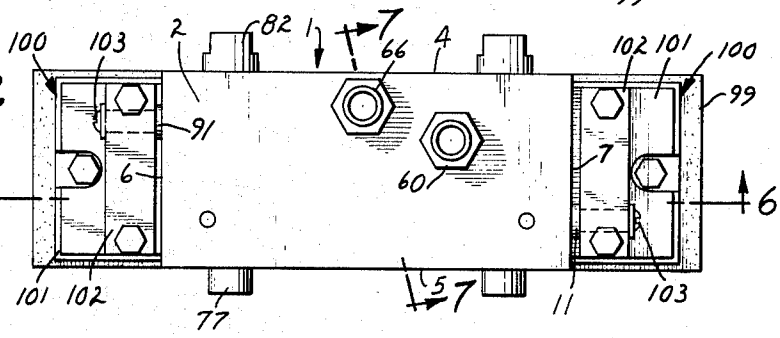


FIG. 2



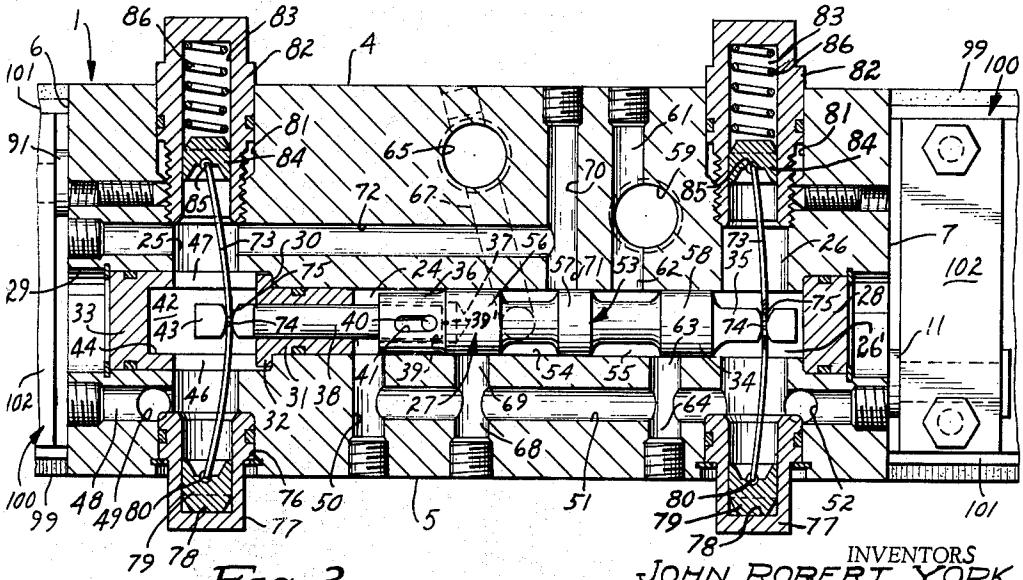


FIG. 3

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FIG. 4

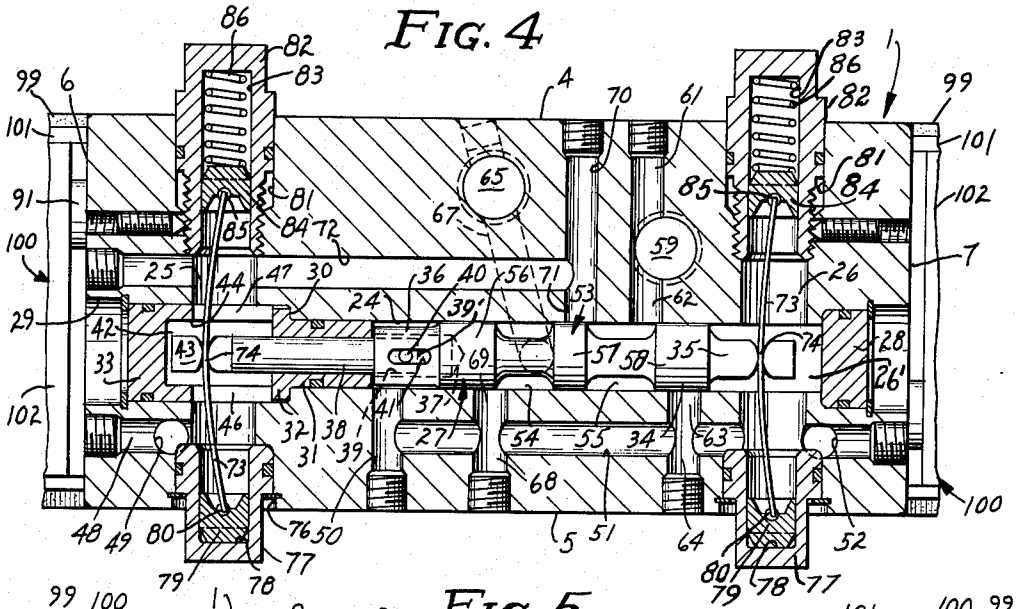


FIG. 5

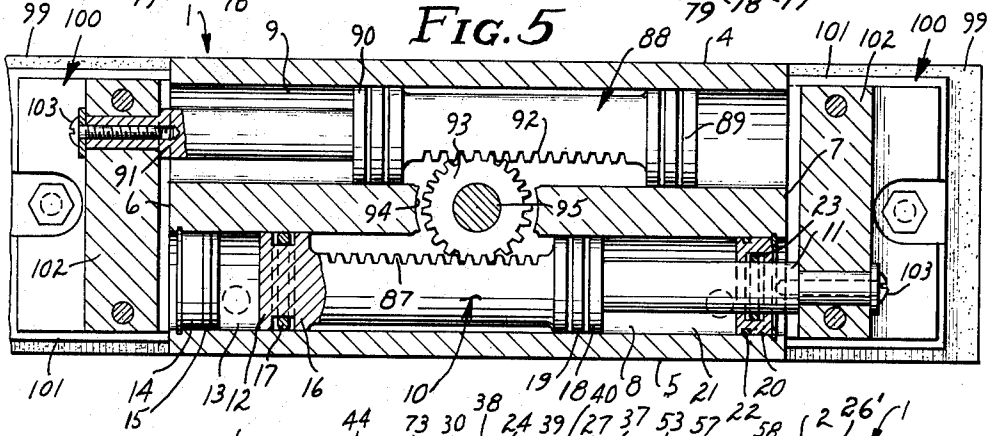


FIG. 6

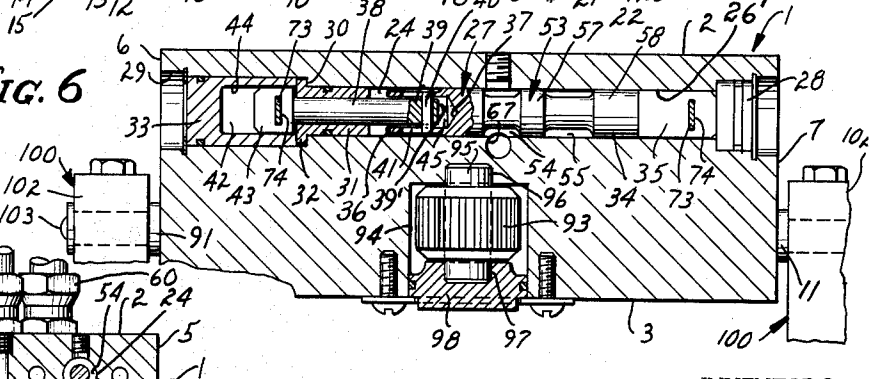
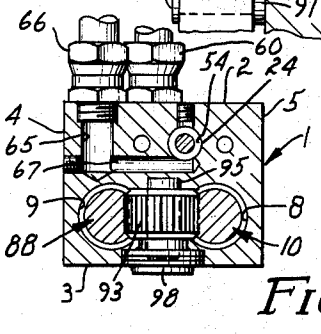


FIG. 7



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CONCRETE FINISHING TOOL

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1 Claim. (Cl. 91—318)

This invention relates generally to concrete finishing tools and equipment, and it further relates to a novel reciprocating fluid-operated motor for a concrete finishing tool.

It has generally been the practice in the finishing of concrete surfaces to use a finishing tool of the rotary type. However, rotary finishing tools have definite drawbacks and disadvantages including their tendency to throw broken stone chips and therefore present a safety hazard. In addition, rotary finishing tools do not produce a finished surface of a smoothness and quality which may be obtained by the use of a linear reciprocating finishing tool. As compared therewith, the present invention has for one of its important objects a provision of a concrete finishing tool which is free from the above-mentioned objections, and also possesses further advantages, as will be noted.

Another important object of this invention is the provision in a concrete finishing tool of the type having a pair of spaced finishing stones of a reciprocating fluid-operated motor adapted to impart linear reciprocating action to the finishing stones of the tool.

Another object of this invention is the provision of a reciprocating fluid-operated motor which includes novel control mechanism for controlling the reciprocating action of the motor whereby the recoprocating parts are biased toward one or the other of their extreme positions.

Another object of this invention resides in the provision of a hydraulically powered reciprocating motor which is designed so as to be compact in construction and efficient in its operation.

Other objets of this invention reside in the provision of a concrete finishing tool which is safe in operation, which is designed so as to be portable, and which is strong and durable throughout long periods of continued use.

The above and still further objects and advantages of this invention will become apparent from a consideration of the following detailed specification, appended claims and attached drawings.

Referring to the drawings, wherein like reference characters indicate like ports or elements throughout the several views:

FIG. 1 is a view in side elevation of a finishing tool constructed in accordance with this invention, with alternative positions of some parts thereof being shown by dotted lines;

FIG. 2 is a view in top plan thereof;

FIG. 3 is a view in section taken on the line 3—3 of FIG. 1;

FIG. 4 is a view corresponding to FIG. 3, but showing alternative positions of some portions of the structure;

FIG. 5 is a view in section taken on the line 5—5 of FIG. 1, some portions being broken away;

FIG. 6 is a view in section taken on the line 6—6 of FIG. 2, some portions being broken away; and

FIG. 7 is a view in section taken on the line 7—7 of FIG. 2.

The novel concrete finishing tool as disclosed herein comprises a reciprocating fluid-operated motor, the latter of which includes a generally rectangular housing, represented generally by the reference numeral 1. The housing 1 is machined and bored in accordance with the design shown in the drawings and particularly described hereinafter. For ease of reference, the construction of

the housing 1 will be described with respect to a top portion 2, a bottom portion 3, side portions 4, 5, and end portions 6, 7.

The housing 1 is bored to define generally adjacent its bottom portion 3 a pair of elongated generally parallel generally longitudinally extending cylindrical chambers which extend through the housing 1 between its opposite end portions 6, 7. One of these cylindrical chambers is represented by the reference 8, and the other thereof is represented by the reference numeral 9. An elongated fluid pressure responsive generally cylindrical piston, represented generally by the reference numeral 10, is received in the cylindrical chamber 8 for reciprocatory movements between an extended position, as partially shown by dotted lines in FIG. 1, and a retracted position, as shown by full lines in FIGS. 1 and 5. The extended and retracted positions of the piston 10 are the opposite extreme positions on opposite sides of a dead-center condition, not shown, of the piston 10. The outer end portion 11 of the piston 10 is disposed outwardly of the housing end portion 7, as shown particularly in FIG. 5, and the inner end portion 12 of the piston 10 is disposssd within the housing 1 and in spaced relationship to the housing end portion 6. The inner end portion 12 of the piston 10 defines with the cylindrical chamber 8 a pressure compartment 13, which is also defined by a cylindrical plug 14 secured in the end portion of the cylindrical chamber 8, as shown particularly in FIG. 5. The plug 14 is provided with an annular sealing O-ring 15. The inner end portion 12 of the piston 10 defines a cylindrical portion 16 having a compression ring 17, and a second cylindrical portion 18 is defined by the piston 10 in axially spaced relationship to the outer end portion 11. The second cylindrical portion 18 includes a compression ring 19, and the cylindrical portion 18, in cooperation with the cylindrical chamber 8 and an annular plug 20, define a second pressure compartment 21. The annular plug 20 defines an outer sealing O-ring 22 and an inner sealing O-ring 23. The pressure compartments 13, 21 associated with piston 10 are adapted upon the alternating supply of fluid under pressure thereto to hydraulically drive the piston 10 between its extended and retracted positions.

In order to reciprocate the piston 10 by the use of a pressurized fluid source, means referred to herein as fluid supply means is provided in accordance with this invention, said fluid supply means alternately supplying fluid under pressure to one or the other of the pressure compartments 13, 21 and at the same general time exhausting the fluid from the other of the pressure compartments 13, 21, as will be described more particularly hereinafter.

The fluid supply means comprises an elongated cylindrical chamber 24, sometimes referred to herein as a second or upper chamber. The upper chamber 24 is disposed above but in general parallelism with the cylindrical chambers 8, 9, the upper chamber 24 also being disposed adjacent the top portion 2 of the housing 1 and extending between the opposite end portions 6, 7 of the housing 1. The housing 1 further defines a pair of spaced generally parallel bores or cavities 25, 26, the transverse cavities 25, 26 extending between the housing side portions 4, 5 generally adjacent the housing top portion 2, and the transverse cavity 25 being disposed generally adjacent the housing end portion 6 and the transverse cavity 26 being disposed generally adjacent the housing end portion 7. It is noted that the opposite end portions of the upper chamber 24 open into and communicate with the transverse cavities 25, 26. The fluid supply means mentioned above further comprises an elongated valve spool, represented generally by the reference numeral 27, which is received in the upper chamber 24 for axially directed reciprocating movements with respect to the chamber 24 and the housing 1, one extreme position of

the valve spool 27 being shown in FIG. 3, and the other extreme position of the valve spool 27 being shown in FIG. 4. The end portion of the upper chamber 24 disposed adjacent the housing end portion 7 is enlarged to receive an O-ring equipped plug 28. The upper chamber 24 defines an enlarged section 29 adjacent the housing end portion 6, said enlarged chamber section 29 extending inwardly beyond the transverse cavity 25, as shown particularly in FIGS. 3 and 6. The inner extremity of the enlarged chamber section 29 defines an annular abutment surface 30 whereat there is disposed an annular O-ring equipped bearing bushing 31. The bearing bushing 31 has a radially outwardly extending flange 32 positioned against the abutment surface 30. An O-ring equipped end plug 33 is secured within the enlarged chamber section 29 and positioned with its inner end portion against the flange 32 of the bearing bushing 31, as shown particularly in FIGS. 3 and 4.

The valve spool 27 comprises a primary spool section 34 the outer end portion 35 of which is disposed within the transverse cavity 26, and the inner end portion 36 of the primary spool section 34 defines an axially opening end bore 37. The valve spool 27 further comprises a secondary spool section 38 the generally intermediate portion of which is received within the bearing bushing 31 for sliding reciprocatory movements with respect thereto. The inner end portion 39 of the secondary spool section 38 is loosely telescopingly received within the end bore 37 of the inner end portion 36 of the primary spool section 34, and a cross pin 40 secured in the inner end portion 39 of the secondary spool section 38 has its opposite end portions disposed within a pair of aligned elongated longitudinally extending slots 41 defined in the inner end portion 36 of the primary spool section 34 whereby to connect the inner end portions 36, 39 of the spool sections 34, 38 together for limited relative axially directed movement with respect to one another.

It is noted that the valve spool 27 defines with the upper chamber 24 and the housing 1 a pair of axially spaced pressure cells adapted upon the supply of fluid thereto to actuate the reciprocatory movements of the valve spool 27. One of the pressure cells, represented by the reference numeral 42, is located generally at the outer end portion 43 of the secondary spool section 38 and is defined by an axially inwardly opening bore 44 formed in the end plug 33, as shown particularly in FIGS. 3, 4, and 6. The other pressure cell, represented by the reference numeral 45 is located generally at the inner end portion 39 of the secondary spool section 38 and is defined by the end bore 37 of the primary spool section 34 and the end surface of the inner end portion 39 of the secondary spool section 38, as shown particularly in FIG. 6. It is noted that the generally tubular portion of the end plug 33 defines opposed and generally diametrically aligned axially extending slots 46, 47, so as to connect the pressure cell 42 with the transverse cavity 25, as shown particularly in FIGS. 3 and 4. It may be further noted that a third pressure cell 26' is provided adjacent the plug 28 in the end portion 7 of the housing 1, the purpose of the cell 26' becoming apparent hereinafter.

In accordance with this invention, the pressure cells 42, 45 and 26' are connected by fluid passages to corresponding pressure compartments 13, 21 of the piston 10. Referring to FIGS. 3 and 4, such fluid passage for the pressure cell 42 and the pressure compartment 13 comprises the slot 46 of the end plug 33, the adjacent bore of the transverse cavity 25, a bore 48 extending in from the housing end portion 6, and a bore 49 extending inwardly from the housing top portion 2 and connecting the bore 48 with the pressure compartment 13. Both of the bores 48, 49 are provided with suitable sealing plugs. The passage extending between the pressure cell 45 and the pressure compartment 21 comprises a lateral bore 50 which extends from the housing side portion 5 into the upper chamber 24, a longitudinal bore 51 extending inwardly from the housing end portion 7, and a bore 52 extending inwardly from the housing top portion 2 into the pressure compartment 21. The longitudinal bore 51 also communicates with the pressure cell 26' by means of the transverse cavity 26. The lateral bore 50, the longitudinal bore 51, and the bore 52 are all provided with suitable sealing plugs.

In order to switch the alternating supply and exhaust of fluid to and from the pressure cells 42, 45 and 26' and hence the pressure compartments 13, 21, a valve, represented generally by the reference numeral 53, is partially defined by the valve spool 27 and the upper chamber 24. The valve 53 comprises a pair of axially spaced annular channels 54, 55 defined intermediate a plurality of cylindrical portions 56, 57, and 58, as shown particularly in FIGS. 3, 5 and 6. The annular channels 54, 55 are located with respect to the valve spool 27 in correspondence with the positions of a plurality of valve ports to be described hereinafter, and in correspondence with the amount of limited relative axially movement between the primary spool section 34 and the secondary spool section 38. The annular channel 54 of the spool valve 53 is referred to herein as an exhaust channel, and the annular channel 55 is referred to herein as an intake channel. A fluid inlet passage 59 extends inwardly from the housing top portion 2 and is provided with a coupling 60 for connection to a suitable fluid conduit. A plug-equipped fluid inlet bore 61 extends inwardly from the housing side portion 4 and connects the fluid inlet passage 59 with the valve intake channel 55, the fluid inlet bore 61 defining an inlet port 62. An outlet port 63 for the valve intake channel 55 is defined by a plug-equipped lateral bore 64 which extends inwardly from the housing side portion 5 and connects with the longitudinal bore 51. A fluid outlet passage 65 extends inwardly from the housing top portion 2 and is provided with a coupling 66 for connection to a suitable fluid conduit. The fluid outlet passage 65 is connected by means of a cross over channel 67 to the valve exhaust channel 54, as shown particularly in FIG. 7. In order to provide a fluid flow circuit between the valve exhaust channel 54 and the pressure cells 42, 45 and 26', a plug-equipped lateral bore 68, having a valve port 69, extends inwardly from the housing side portion 5 and connects with the longitudinal bore 51, as shown particularly in FIGS. 3 and 4. Also, a plug-equipped lateral bore 70, having a valve port 71, extends inwardly from the housing side portion 4, and a plug-equipped longitudinal bore 72 connects the lateral bore 70 with the transverse cavity 25 and through the slot 47 with the pressure cell 42.

An important feature of this invention resides in the control means which is coupled with the valve 53 and includes yielding means urging the piston 10 toward one or the other of its extreme positions and out of its dead-center condition in unity with the direction of piston movement regulated by the valve 53. The above-mentioned yielding means comprises a pair of elongated leaf springs 73 one each received in a different one of the transverse cavities 25, 26 and connected, as at 74, intermediate its opposite end portions for limited pivotal movements with respect to the corresponding adjacent end portion of the valve spool 27. The outer end portions 35, 43 of the primary and secondary spool sections 34, 38 define transverse slots 75 adapted to receive the intermediate portions of the leaf springs 73, as shown particularly in FIGS. 3, 4 and 6. It is noted that the leaf springs 73 are disposed within the transverse cavities 25, 26 with their longitudinal axes extending generally transversely of the longitudinal axis of the valve spool 27.

Further description of the leaf spring 73 will be limited to one thereof and its associated mechanism and structure. Referring to the transverse cavity 25, one end portion thereof defines an enlarged cavity section 76 which receives an O-ring equipped retainer capsule 77 removably secured within the housing 1. The retainer

capsule 77 defines an inwardly opening cylindrical recess 78 in which is slidingly received a recessed cup 79 adapted to receive the end portion 80 of the leaf spring 73. The recessed cup 79 abuts against the inner end surface of the cylindrical capsule recess 78, as shown particularly in FIGS. 3 and 4.

The opposed end portion of the transverse cavity 25 defines an enlarged section 81 and a screw-threaded portion which are adapted to receive a threaded retainer capsule 82. The retainer capsule 82 is screw-threaded within the transverse cavity 25 and is also provided with a sealing O-ring. The retainer capsule 82 defines an inwardly opening cylindrical recess 83 adapted to receive a recessed cup 84 for engagement with the adjacent end portion 85 of the leaf spring 73. As shown particularly in FIGS. 3 and 4, a coiled compression spring 86 is interposed between the recessed cup 84 of the retainer capsule 82 and the end surface of the cylindrical recess 83. With this arrangement, it will be appreciated that the leaf spring 73 is disposed within the transverse cavity 25 and so arranged so as to permit transversely directed flexing movements of the greater intermediate portion of the spring 73 in the general direction of the axis of the valve spool 27 and also to permit limited movements of the end portion 85 of the leaf spring 73 in a direction generally longitudinally of the spring 73. Further, with this arrangement, the coil spring 86 for each of the leaf springs 73 will bias opposite end portions 80, 85 of the leaf springs 73 toward one another thereby causing leaf springs 73 to alternately assume the opposite flexed positions shown in FIGS. 3 and 4. This biasing action of the leaf springs 73 will bias the valve spool sections 34, 38 out of their dead-center condition and into one or the other of the positions shown in FIGS. 3 and 4 whereby to cooperate with the spool valve 53 so as to bias the piston 10 toward one or the other of its extreme positions and out of its dead-center condition.

Referring particularly to FIG. 5, it will be noted that the piston 10 defines an intermediate rack portion 87 located between the cylindrical piston portion 16 and the second cylindrical piston portion 18. An elongated member 88, which is similar in construction to the piston 10, is received in the cylindrical chamber 9 of the housing 1 for reciprocating movements between an extended position shown by dotted lines in FIG. 1 and a retracted position shown by full lines in FIGS. 1, 2 and 5. The inner end portion of the elongated member 88 defines an O-ring equipped cylindrical portion 89 which is always disposed within the housing 1, and the elongated member 88 also defines a generally intermediately located O-ring equipped second cylindrical portion 90, as shown particularly in FIG. 5. It is noted that the outer end portion 91 of the elongated member 88 extends outwardly of the housing 1. The elongated member 88 also defines a rack portion 92 located between the cylindrical portion 89 and the second cylindrical portion 90 thereof, and a gear wheel 93 is journalled within the housing 1 for engagement of its teeth with the teeth of both of the rack portions 87, 92, as shown in FIG. 5. With this arrangement, mechanical coupling means is provided for imparting reciprocating movements to the elongated member 88 in a direction opposite to and in response to the reciprocating movements of the elongated piston 10 whereby the piston 10 and the elongated member 88 will both be in their extended and retracted positions at the same general time. The gear wheel 93 is located within a generally cylindrical chamber 94 defined adjacent the housing bottom portion 3, and the gear wheel 93 is provided with opposed spindle portions 95, one of which is journalled in a recess 96 defined in the housing 1 and the other of which spindle portion 95 is journalled within a recess 97 defined by an O-ring equipped bearing insert 98. The bearing insert 98 is secured within the cylindrical chamber 94 of the housing 1 by suitable fasteners, as shown particularly in FIG. 6.

The finishing tool disclosed by this invention further comprises a pair of finishing stones 99 one of which is removably secured to the outer end portion 11 of the piston 10 and the other of which is removably secured to the outer end portion 91 of the elongated member 88. Each of the finishing stones 99 is removably secured to a mounting bracket 100. The mounting racket 100 defines a plate portion 101 and a shoulder portion 102, the latter of which is provided with a cross bore adapted to receive the outer end portion of the corresponding piston 10 or elongated member 88. The outer end portions of the piston 10 and elongated member 88 are secured to the shoulder portions 102 of the mounting brackets 100 by means of suitable cap screws 103, as shown particularly in FIGS. 1 and 5.

Having specifically described the present invention, the operation thereof will be readily understood by reference to FIGS. 3 and 4. As illustrated in FIG. 3, when fluid under pressure is connected to the fluid inlet passage 59, the fluid passes into and out of the intake valve channel 55, through the lateral bore 64 and into the longitudinal bore 51. At this time, fluid in the longitudinal bore 51 is conveyed through the bore 52 into the second pressure compartment 21 so as to move the piston 10, and hence the elongated member 88, toward its retracted position shown by full lines in FIG. 5. Also, fluid is conveyed from the longitudinal bore 51 through the cavity 26 and into the pressure cell 26' at the same time fluid is being conveyed from the longitudinal bore 51 through the lateral bore 50 and around the inner end portion 39 of the secondary spool section 38 and into the pressure cell 45. At this point it should be noted that by applying pressure to surfaces of equal areas on the opposite ends of the primary spool section 34, fluid pressure on the spool section 34 is neutralized or counterbalanced and only the pressure applied to the end surface 39' of the secondary spool section 38 in the pressure cell 45 exerts a driving force or is effective to move the secondary spool section 38 and carry the spool section 34 with it because of the connection between the pin 40 and the slots 41. Whereupon, the fluid pressure within the pressure cell 45 hydraulically drives the secondary spool section 38 in an axially outer direction and the cross pin 40 then engages the outer ends of the elongated slots 41 of the inner end portion 36 of the primary spool section 34 so as to pull the primary spool section 34 with the secondary spool section 38. Such movement of the primary spool section 34 causes the outlet port 63 of the spool valve 53 to be closed so as to stop the flow of fluid into the pressure cell 45; however, at the same time, the port 69 of the exhaust valve channel 54 opens so as to exhaust the fluid through the exhaust channel 54 into the crossover channel 67 and out the fluid outlet passage 65.

It is important to note that the axial movement of the secondary spool section 38 upon the introduction of pressurized fluid into the pressure cell 45 causes the leaf springs 73 to be moved from their flexed condition shown in FIG. 3 toward and beyond a dead-center condition thereof, not shown. Further movement of the leaf springs 73 in such direction will of course cause the springs 73 to immediately flex to their positions shown in FIG. 4 because of the bias imparted to the leaf springs 73 by the coiled compression springs 86. This operation of the leaf springs 73 controls the shuttle action of the valve 53 so as to prevent a condition of the valve 53 equivalent to a dead-center equilibrium condition of the piston 10.

Referring to FIG. 4, when the valve channels 54, 55 are moved from their positions shown in FIG. 3 to their positions shown in FIG. 4, fluid is exhausted from the pressure cells 45, 26' and the pressure compartment 21 through the exhaust valve channel 54, and at the same general time, fluid under pressure is introduced from the inlet port 62 through the valve intake channel 55, through the valve port 71, through the longitudinal bore 72, through the slot 47 in the end plug 33 and into the pressure cell 42. The pressurized fluid also travels through

the pressure cell **42**, through the elongated slot **46** in the end plug **33**, through the bore **49** and into the pressure compartment **13** so as to hydraulically drive the piston **10**, and hence the elongated member **88**, toward its extended position shown by dotted lines in FIG. 1. The pressurized fluid in the pressure cell **42** also hydraulically drives the secondary spool section **38** in its reverse direction toward the primary spool section **34**, and then through the medium of the slip connection of the cross pin **40**, the spool valve **53** of the primary spool section **34** is returned to its position shown in FIG. 3. At this time, the fluid in the pressure compartment **13** and the pressure cell **42** and in the associated passages is exhausted through the longitudinal bore **72**, the lateral bore **70**, into the exhaust valve channel **54** and out through the cross-over channel **67** and into the fluid outlet passage **65**.

It is important to note the function of the leaf springs **73**, which is to urge the reciprocating motor mechanism out of a state of equilibrium or dead-center condition, and also to insure that the valve **53** and its associated mechanism is in one or the other of its alternative conditions so as to be sure that the motor will start reciprocating when fluid pressure is applied.

This invention has been thoroughly tested and found to be completely satisfactory for the accomplishment of the above objects; and while I have shown and described above a preferred embodiment thereof in which the principles of the present invention have been incorporated, I wish it to be specifically understood that the same may be modified without departure from the scope and spirit of the appended claims.

What we claim is:

A reciprocating fluid operated motor, said motor comprising:

(a) a housing which defines an elongated cylindrical chamber,

(b) an elongated fluid pressure responsive piston received in said cylindrical chamber for reciprocating movements between extended and retracted positions at opposite extremes from a dead-center condition, said piston defining with said chamber axially spaced pressure compartments adapted upon the alternating supply of fluid to said pressure compartments to hydraulically drive said piston between its extended and retracted positions,

(c) fluid supply means for alternately supplying fluid under pressure to one or the other of said pressure compartments and at the same general time exhausting the fluid from the other pressure compartment, said means comprising:

(1) an elongated second chamber defined in said housing,

(2) an elongated valve spool received in said second chamber for axially directed reciprocating movements with respect thereto, said valve spool comprising a primary spool section and a secondary spool section disposed in generally coaxial end-to-end relationship with respect to said primary spool section, said spool sections having their inner end portions connected together for limited relative axially directed movement therebetween,

(3) said valve spool defining with said second chamber axially spaced pressure cells adapted upon the supply of fluid thereto to actuate the reciprocating movements of said valve spool, one of said pressure cells being defined generally at the inner end of the secondary spool section of said valve spool and the other of said pressure cells being defined generally at the outer end of said secondary spool section,

(4) said pressure cells being connected by fluid passages to corresponding pressure compartments of said piston, and

(5) a valve defined by said valve spool and said second chamber and adapted upon reciprocation of said valve spool to switch the alternating supply and exhaust of fluid to and from said pressure cells and said pressure compartments,

(d) control means coupled with the valve of said fluid supply means and including snap-action yielding means urging said valve spool toward one or the other of the extreme positions and out of its dead-center condition.

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