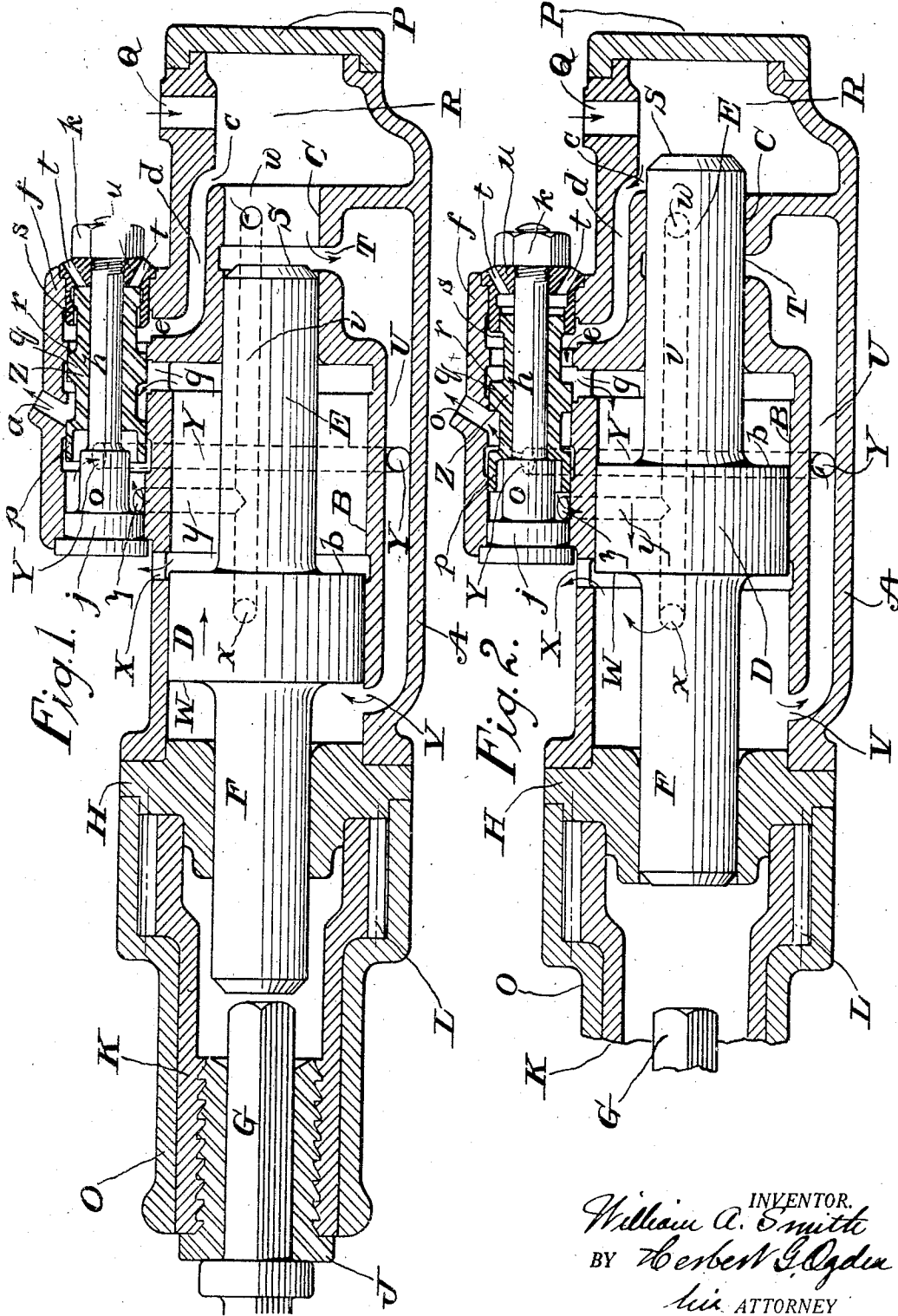


W. A. SMITH.
 FLUID ACTUATED RECIPROCATING MOTOR.
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FLUID-ACTUATED RECIPROCATING MOTOR.

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To all whom it may concern:

Be it known that I, WILLIAM A. SMITH, a citizen of the United States, residing at Easton, in the county of Northampton and State of Pennsylvania, have invented a certain new and useful Improvement in Fluid-Actuated Reciprocating Motors, of which the following is a specification.

This invention relates to fluid actuated reciprocating motors, but more particularly to a motor of that class applicable to a percussive tool of the hammer drill type in which the hammer is reciprocated by fluid pressure distributed to and exhausted from the pressure chambers by suitable means which may include a valve.

It is desirable to prolong the period of exhaust in a tool of this type and thus increase the efficiency while decreasing the power consumption of the tool and the primary object of the present invention is to secure quick acting and positive means for maintaining the exhaust open from the pressure chambers as long as conveniently practicable.

The particular tool I have selected for the application of this invention, is provided with a differential piston hammer formed with two forwardly acting pressure areas and a rearwardly acting pressure area, in this instance one of the forwardly acting pressure areas operating in a constant pressure chamber although the invention is not limited to such construction, and I have only selected this form of tool for the purpose of illustrating my invention.

I have also shown the invention in connection with a hammer having a main head and two reduced extensions or shanks extending therefrom on opposite sides, and I preferably form each extension or shank of the same length and of uniform diameter throughout so that the hammer is reversible in the tool, and either end may be used as the striking end for the drill steel. This reversible feature is sometimes an advantage in case one end of the hammer becomes chipped or broken, as the same hammer may be used in the tool without waiting to renew the entire hammer.

In order that the tool may be adapted to receive the hammer and operate with either extension or shank inserted rearwardly within the cylinder chambers, provision is made for such interchangeability, and the

ports and passages of the tool which are adapted to be controlled by one extension or shank, are equally adapted to be controlled by the other extension or shank. Likewise the valve operation I provide, functions in the same manner in either of the interchangeable positions of the hammer.

In the particular tool illustrated, the rear end of the hammer extension or shank which extends rearwardly into the cylinder chambers, constitutes a constant pressure forwardly acting pressure area, and fluid pressure is intermittently or alternately admitted to and exhausted from the forwardly acting and rearwardly acting pressure areas of the main head.

I prefer to permit the movements of the rearwardly extending hammer extension or shank to control the admission of fluid pressure to the forward end of the cylinder to act upon the rearwardly operating pressure area of the main head, for the return stroke of the hammer, but I have provided a valve mechanism for controlling and prolonging the admission of fluid to the forwardly acting pressure area of the main head, and for prolonging the period of exhaust from the intermittently supplied pressure areas.

One of the objects of the invention is to improve upon this valve mechanism which in this instance is shown as a differential valve controlled by the movements of the piston hammer in such manner that it moves quickly and positively with freedom of action and satisfactorily maintains the exhaust open for the maximum period with certainty and precision under operating conditions.

Further objects of the invention will hereinafter appear and to all of these ends the invention consists of the features of construction, combinations of elements and arrangements of parts substantially as herein described and claimed and shown in the accompanying drawings in which—

Figure 1 is a diagrammatic side elevation, partly in longitudinal section and partly broken away, of a tool embodying the invention, and

Fig. 2 is a similar view with the hammer in a different position in its travel.

In both figures only so much of the percussive tool is shown as will be necessary to an understanding of the invention and the valve mechanism and related ports and passages in the tool are brought as far as possible

sible into the same plane in the drawing for clearness of illustration.

The particular tool shown is adapted to be provided with means independent of the hammer itself for imparting rotation to the drill steel, but the rotating motor and its mechanism are omitted as forming no part of this invention.

Referring to the drawings, the cylinder 10 A of any usual or suitable construction, is formed with a differential bore of two diameters including the larger forward bore B and the smaller rearward bore C. The piston hammer reciprocating in the 15 cylinder A is provided with a main enlarged head D having hammer extensions in the form of reduced shanks E and F extending therefrom in opposite directions. These shanks E and F are preferably each of the 20 same length and of the same uniform diameter throughout so that the hammer is reversible or interchangeable in the tool and either shank may be inserted in the smaller bore C of the cylinder and the other shank 25 used for striking the drill steel as desired.

The forward hammer extension or shank E or F as the case may be, is guided as shown in the bushing H, and the drill steel G is inserted in a suitable chuck J engaging 30 a rotating sleeve K having gear teeth L adapted to be engaged and actuated by any suitable independent rotating motor (not shown). A front head O incloses the sleeve K and the rear end of the cylinder is closed 35 by the usual back head P.

Operating fluid under pressure is admitted to the tool through the inlet Q and the chamber R forms a constant pressure 40 chamber, so that the pressure is constantly exerted on the forwardly acting pressure area S at the rear end of the rearward hammer extension or shank E. A piston controlled supply port T in the smaller cylinder bore C communicates with a main fluid pas- 45 sage U leading to the front end of the cylinder and communicating with the front end of the larger bore B through port V which not only admits fluid to the rearwardly acting pressure area W of the main head D 50 but serves the added function of acting as an auxiliary exhaust port on the forward stroke of the piston, as will hereinafter appear, since the fluid in front of the main piston head D may exhaust through the 55 main exhaust port X, until said port X is covered, and also through the port V, passage U and auxiliary cross passage Y around the controlling valve Z in the position shown in Fig. 2, and as indicated by 60 the arrows, to atmosphere through auxiliary atmospheric port a in the valve casing. This auxiliary exhaust continues after the main exhaust port X is closed and until the valve is thrown to the position indicated in 65 Fig. 1.

The admission and exhaust to and from the forwardly acting pressure area b of the main head D, is controlled by the valve Z and as shown, a constantly open supply 70 port c is provided in the chamber R, communicating with a main fluid passage d which opens through port e into the valve chamber in the valve casing f conveniently provided on the side of the cylinder A. 75 Motive fluid pressure is admitted from the valve chamber past valve Z through admission port g to the larger cylinder bore B behind the main head D when the valve is in the position shown in Fig. 2, and admis- 80 sion is cut off by the valve when in the position shown in Fig. 1, in which case the port g acts as an auxiliary exhaust port permitting the fluid to exhaust from the pressure area b of the main head D, around 85 valve Z and out through port a, while the main exhaust port X is open, and continuing after the main exhaust port is covered by the piston head until the valve Z is thrown to the position indicated in Fig. 2.

The controlling valve Z is preferably 90 formed with differential pressure surfaces, one or more of which are constantly subjected to the main fluid pressure, and another of which is intermittently subjected to said pressure. As shown in this instance, the 95 valve Z is of the spool type sliding on the stem h conveniently formed as a bolt with a flanged head j and a threaded end adapted to receive a nut or other fastening device k. The bolt is provided with a throat o form- 100 ing a stop for the valve Z which, as shown, is formed with an enlarged recessed head p extending over the throat o and abutting against the shoulder formed by said throat 105 in the position of the valve shown in Fig. 2. The recessed valve head p constitutes the intermittent pressure area of the valve and an enlarged portion q forming a shoulder r constitutes one of the constant pressure 110 areas. Another constant pressure area may be formed by the shoulder s, although this second shoulder may be omitted if desired. The rear end of the valve Z is vented to atmosphere through the ports t, preferably 115 provided in a flanged plug u fitting the end of the valve chamber, and held in position by the nut k on the shank h of the valve bolt.

In order to admit fluid pressure to and exhaust pressure from the recessed differ- 120 ential pressure area in the head p of the valve, for moving the valve backward and forward in the valve chamber, an auxiliary fluid passage v in the cylinder wall leads from the port w located at the rear of the smaller 125 cylinder bore C rearward of the supply port T, to a port x in the larger cylinder bore, adapted to be covered and uncovered by the main head D in its travel, and a branch auxiliary passage y leads from the passage 130

to a port z opening into the valve casing in front of the valve head p .

In the operation of the tool, the piston hammer, in starting on its forward stroke, first uncovers the valve controlling port w at the rear of the smaller cylinder bore C , before it uncovers the supply port T , and at the same time the main head D covers the valve controlling port x in the larger cylinder bore B , so that motive fluid pressure is admitted through auxiliary passage v and branch passage y to the valve chamber and throws the valve Z rearwardly against the constant pressure on the differential diameters r and z .

The air passes from passage y through port z and thence through cross passage Y into the main passage U and to the forward end W of the main head D . The main fluid pressure also passes through supply port T , when uncovered, and through main passage U to the forward end of the main head D . When the piston starts on its rearward stroke, it shuts off the supply port T before covering the valve controlling port w .

As the valve Z moves over from the position shown in Fig. 2 to that shown in Fig. 1, it opens the port g from the rearward end of the main head D , to exhaust through the auxiliary atmospheric port a , and the piston has also opened the main exhaust port X .

As the piston moves rearwardly on its return stroke, the main head D first shuts off the main exhaust port X , but the port g is left open to exhaust through atmospheric port a to relieve the pressure at the rear of the head D . Then the inlet through supply port T is shut off and the inlet through the valve controlling port w is covered, and the valve controlling port x is uncovered by the main head D , thus relieving the pressure in front of the valve head p through port z , branch passage y , auxiliary passage v and port x , when exhaust port X is uncovered which permits the valve Z to move from the position shown in Fig. 1 to that shown in Fig. 2, and the cycle is repeated.

I claim—

1. In a fluid actuated reciprocating motor, the combination of a cylinder, a piston therein, a main passage controlled by the piston for intermittently supplying fluid pressure in front of the piston, main exhaust means for exhausting the cylinder from both ends of the piston, a second main passage for intermittently supplying fluid pressure behind the piston, a differential valve having larger and smaller pressure areas for controlling said second main passage and for controlling auxiliary exhaust means from both ends of the cylinder, said valve being actuated in one direction by constant pressure on its smaller area, and in the other direction by intermittent pressure on

its larger area, a combined auxiliary supply and exhaust passage controlled by the piston for supplying pressure to, and exhausting pressure from, the larger area of said valve, and an additional auxiliary supply and exhaust passage permitting the pressure supplied to said larger area of the valve to pass to the front end of the cylinder and also affording an auxiliary exhaust for the front end of the cylinder.

2. In a fluid actuated reciprocating motor, the combination of a cylinder, a differential piston therein, a constant pressure chamber for constantly maintaining fluid pressure on one of the forwardly acting pressure areas of said piston, a main passage controlled by the piston for intermittently supplying fluid pressure to the cylinder for the rearwardly acting pressure area of said piston, a differential valve subjected to constant pressure on one pressure area controlling the intermittent supply of fluid pressure to the cylinder for the other forwardly acting pressure area of said piston, means for exhausting the said intermittently supplied portions of the cylinder, said valve controlling an auxiliary exhaust from each of said intermittently supplied cylinder portions, the auxiliary exhausting means including a combined auxiliary supply and exhaust passage connecting the said main supply passage with the valve chamber, and means for intermittently supplying main fluid pressure to the other pressure area of said valve including additional auxiliary supply and exhaust passages adapted to connect the valve chamber with the constant pressure chamber at the rear of the cylinder and with the cylinder in front of the rearwardly acting pressure area of the piston, whereby pressure admitted to the valve chamber through said additional auxiliary passages may pass to the front end of the cylinder through said combined auxiliary supply and exhaust passage in one position of the valve.

3. In a fluid actuated reciprocating motor, the combination of a cylinder having a differential bore, a differential piston therein having a main head and at least one reduced shank, a chamber for constantly maintaining fluid pressure on the rear end of said reduced shank, a main fluid supply passage controlled by said reduced shank and leading to the front end of the cylinder for intermittently supplying fluid pressure in front of said main head, a valve chamber, a differential controlling valve therein, a main fluid supply passage leading to said valve chamber whereby the smaller area of said valve is constantly subjected to the main fluid pressure, a port controlled by said valve for intermittently supplying fluid pressure behind the said main piston head and adapted to act as an auxiliary exhaust port, main exhaust means overrun by the

piston head in its travel by exhausting both ends of the cylinder, an auxiliary atmospheric port for the valve chamber, auxiliary passages controlled by the reduced shank of the piston for intermittently supplying the main fluid pressure to the valve chamber in front of the larger pressure area of said valve, said passages communicating with the forward end of the cylinder through a port controlled by the piston head, and an auxiliary passage controlled by the valve for placing the valve chamber and said first named auxiliary passages in communication with the main fluid supply passage leading to the front end of the cylinder.

4. In a fluid actuated reciprocating motor, the combination of a cylinder having a differential bore, a differential piston therein having a main head and at least one reduced shank, a chamber for constantly maintaining fluid pressure on the rear end of said reduced shank, a main fluid supply passage leading to the front end of the cylinder and controlled by said reduced shank for intermittently supplying fluid pressure in front of said main head, said main passage also being adapted to act as an auxiliary exhaust passage, a valve chamber, a differential controlling valve therein, a main fluid supply passage leading to said chamber whereby the smaller area of the valve is constantly subject to the main fluid pressure, a port controlled by said valve for intermittently supplying fluid pressure behind the said main head, said port also being adapted to act as an auxiliary exhaust port, main exhaust means overrun by the piston in its travel for exhausting pressure from in front of and behind the main head, an auxiliary atmospheric port for the valve chamber, auxiliary passages controlled by the piston for connecting the constant pressure chamber of the cylinder with the valve chamber in front of the larger pressure area of the valve and for connecting the said portion of the valve chamber with the front end of the cylinder in front of the main head, and an auxiliary passage controlled by the valve for connecting the said portion of the valve chamber with the main fluid supply passage leading to the front end of the cylinder.

5. In a fluid actuated reciprocating motor, the combination of a cylinder having a differential bore and a differential piston operating therein, means for constantly main-

taining fluid pressure on one of the forwardly driving pressure areas of said piston, a main fluid passage controlled by the piston for intermittently supplying motive fluid to the rearwardly driving pressure area, and a differential valve constantly subjected on its smaller pressure area to motive fluid pressure for controlling the intermittent supply of motive fluid to the other forwardly driving pressure area of the piston and for controlling auxiliary exhaust passages from said intermittently supplied pressure areas of the piston, said valve being intermittently subjected to motive fluid pressure on its larger pressure area, said auxiliary exhaust passages including means for admitting motive fluid around the valve to the rearwardly driving pressure area of the piston in addition to the motive fluid supplied through the said main piston controlled fluid passage when the valve is in one position.

6. In a fluid actuated reciprocating motor, the combination of a cylinder having a differential bore and a differential piston operating therein, means for constantly maintaining fluid pressure on one of the forwardly driving pressure areas of said piston, a main fluid passage controlled by the piston for intermittently supplying motive fluid to the rearwardly driving pressure area, and a differential valve constantly subjected on its smaller pressure area to motive fluid pressure for controlling the intermittent supply of motive fluid to the other forwardly driving pressure area of the piston and for controlling auxiliary exhaust passages from said intermittently supplied pressure areas of the piston, said valve being intermittently subjected to motive fluid pressure on its larger pressure area, said auxiliary exhaust passages including means for admitting motive fluid around the valve to the rearwardly driving pressure area of the piston in addition to the motive fluid supplied through the said main piston controlled fluid passage when the valve is in one position, and also including means for exhausting pressure from the larger pressure area of the valve to the cylinder in front of the main head when the valve is in another position.

In testimony whereof I have hereunto set my hand.

WILLIAM A. SMITH.