Nov. 15, 1949 J. C. CURTIS ET AL 2,488,270

PRESSURE FLUID MOTOR

Filed March 20, 1944 2 Sheets-Sheet 1

Fig. 1.

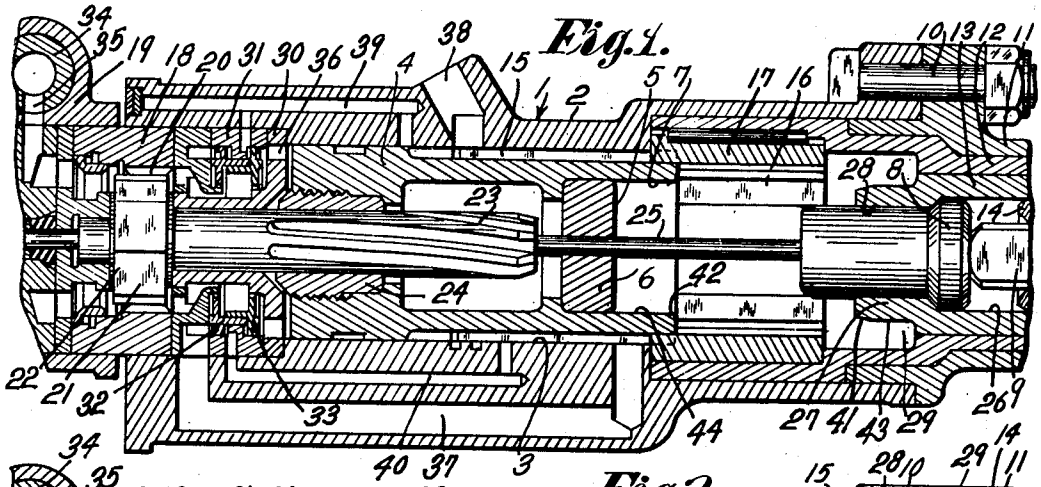

Fig. 2.

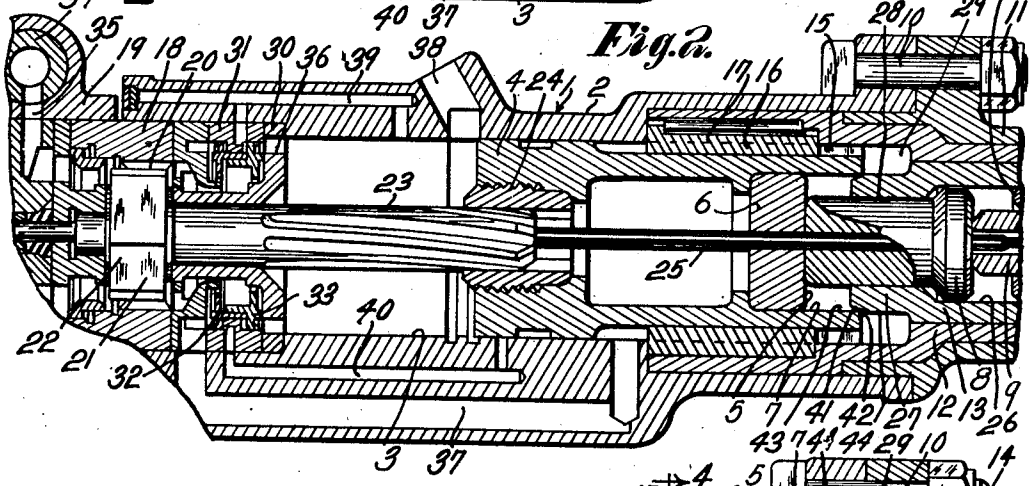

Fig. 3.

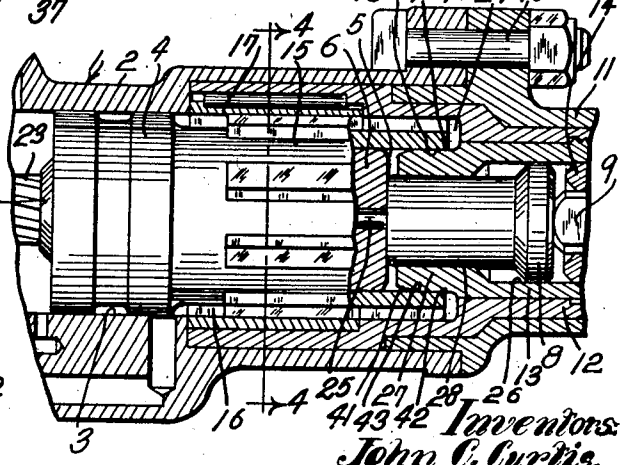

Fig. 4.

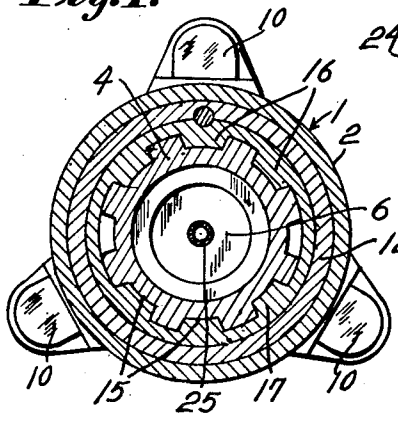

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Fig. 5.

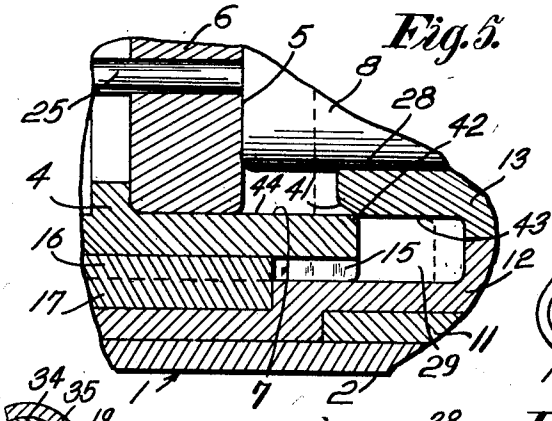


Fig. 8.

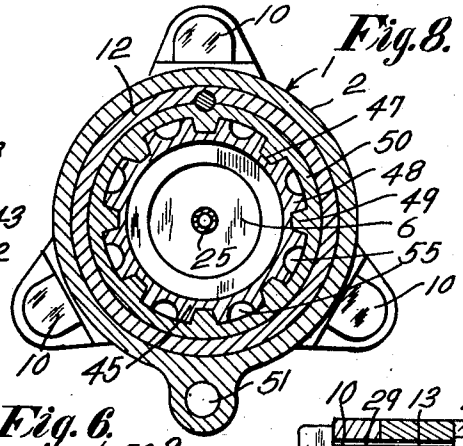


Fig. 6.

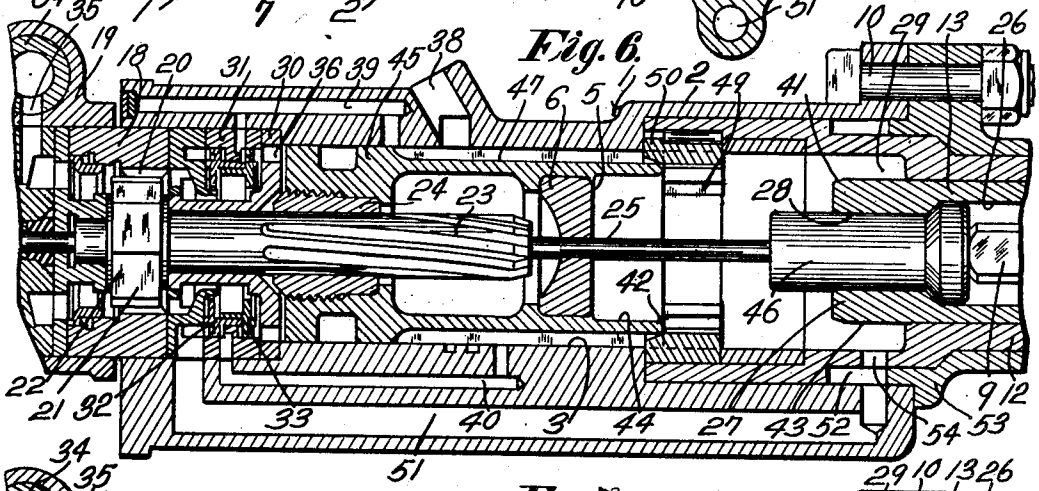
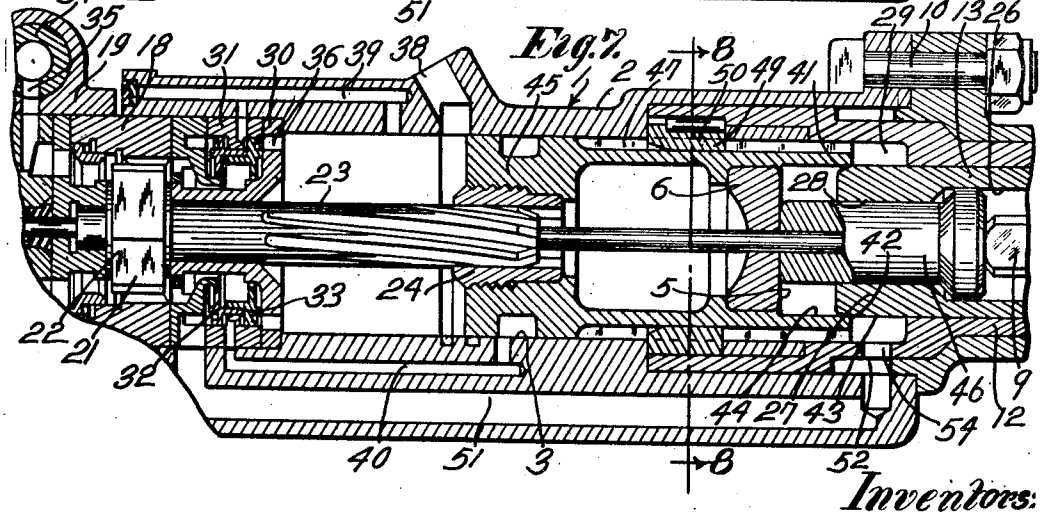


Fig. 7.



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UNITED STATES PATENT OFFICE

2,488,270

PRESSURE FLUID MOTOR

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Application March 20, 1944, Serial No. 527,259

10 Claims. (Cl. 121—32)

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This invention relates to pressure fluid motors and more particularly to improvements in pressure fluid motors of the reciprocating piston type especially designed for use in hammer rock drills.

The invention, from a broad aspect, may comprise, in a pressure fluid motor, a motor cylinder element containing a reciprocable piston element, and cushioning means associated with the cylinder and piston elements and embodying a fluid-receiving bore provided in an annular portion of one element which may receive a cylindrical portion on the other element, the surfaces of the bore and cylindrical portion moving into sealing contact only when the piston element moves a distance greater than its movement during normal operation of the motor. The surfaces of the bore of the annular portion and the exterior of the cylindrical portion are always substantially out of sealing contact during normal motor operation and thus wear of the surfaces, during normal motor operation, is substantially negligible. Since undue wear of the contacting surfaces of the cushion does not occur during normal motor operation, an extremely effective trapping of the fluid in the bore may be attained, resulting in an extremely effective cushioning action when the piston element exceeds its normal distance of movement. In a preferred embodiment of the invention, from this aspect thereof, the cushioning means associated with the cylinder and piston of the pressure fluid motor may comprise an axial fluid-receiving bore opening through the forward end of the motor piston and a cylindrical portion provided at the forward end of the cylinder which is received in the piston bore when the piston over-travels its normal distance of movement. More specifically, the cylindrical portion at the forward end of the cylinder may comprise a portion formed on a part of a chuck mechanism which supports a member against which the motor piston strikes during operation of the motor.

An object of the present invention is to provide an improved pressure fluid motor. Another object is to provide an improved pressure fluid motor of the reciprocating piston type, having improved cushioning means for the piston. A further object is to provide an improved pressure fluid motor of the reciprocating piston, hammer type especially designed for use in hammer rock drills. A still further object is to provide an improved cushioning means for the hammer piston whereby the effectiveness of the cushion is not materially decreased, due to wear of the sealing surfaces, even after a long period of operation. Yet another object is to provide an improved cushioning means wherein the sealing surfaces of the cushion do not substantially engage during normal operation of the motor so that leakage, due to wear of the sealing surfaces, is substantially eliminated. Still another object is to provide an improved cushion for the hammer piston of a hammer motor, wherein an element of the drill chuck mechanism constitutes a part of the cushion. These and other objects and advantages of the invention will, however, hereinafter more fully appear in the course of the following description.

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The present application is a continuation-in-part of our copending application Serial No. 493,240, filed July 2, 1943, now Patent No. 2,461,530.

In the accompanying drawings there are shown for purposes of illustration two forms which the invention may assume in practice.

In these drawings:

Fig. 1 is a view in longitudinal vertical section through a pressure fluid motor constructed in accordance with an illustrative embodiment of the invention.

Fig. 2 is a sectional view similar to Fig. 1, showing the moving parts in a different position assumed during normal running of the motor.

Fig. 3 is a fragmentary sectional view taken on the plane of Fig. 2, showing the motor piston in a forward cushioned position.

Fig. 4 is a cross sectional view taken substantially on line 4—4 of Fig. 3.

Fig. 5 is an enlarged detail sectional view taken on the plane of Fig. 2, showing the piston in its forward position during normal running of the motor.

Fig. 6 is a sectional view similar to Fig. 1, showing a modified form of the invention.

Fig. 7 is a view similar to Fig. 6, showing the moving parts in a different position assumed during normal running of the motor.

Fig. 8 is a cross sectional view taken substantially on line 8—8 of Fig. 7.

In both illustrative embodiments of the invention the improved pressure fluid motor is shown incorporated in a hammer rock drill of the stoper type, although it will be evident that features of the invention may be embodied in pneumatic hammer tools of other types. The hammer rock drill may be of the same general design as that disclosed in our copending application Serial No. 475,782, filed February 13, 1943, now Patent No. 2,461,527.

The pressure fluid motor of the illustrative embodiment shown in Figs. 1 to 5 inclusive, is the

same as that disclosed in our said Patent No. 2,461,530. The pressure fluid motor is generally designated 1 and includes a motor cylinder 2 having a bore 3 containing a reciprocatory hammer piston 4. The hammer piston has an impact surface 5 formed on an impact member 6 fixed within a bore 7 formed centrally within the forward portion of the piston. This piston impact surface is adapted to strike against a tappet or striking block 8 which transmits the blows of the piston to the shank of a conventional drill steel 9. Attached as by bolts 10 to the forward end of the motor cylinder is a chuck housing 11 within which a driver sleeve 12 is journaled. Secured to the driver sleeve 12 for rotation therewith is a chuck sleeve 13 in turn having secured therein a chuck member or bushing 14 for receiving and supporting the drill steel shank. The drill steel shank is mounted in the chuck member 14 for free reciprocation, but is connected to the chuck member so that when the chuck member is rotated with the driver sleeve 12 and the chuck sleeve 13, the drill steel is rotated therewith, in a well known manner.

Formed externally on the hammer piston 4 are straight flutes or grooves 15 which cooperate with straight keys or splines 16 on a chuck nut 17 keyed within the driver sleeve 12 so that the rotary motion of the hammer piston may be transmitted to the driver sleeve and thence to the drill steel. Arranged within a rear head member 18, held in position with the rear end of the cylinder by a rear head block 19, is a ratchet ring 20 engaged by usual spring-pressed pawls 21 carried by a pawl carrier 22. The pawl carrier is integrally secured to a spirally grooved rifle bar 23 which extends forwardly into the rear end of the cylinder bore and engages a rifle nut 24 secured within the hammer piston. As the hammer piston moves forwardly to effect its working stroke, i. e. to strike a blow on the tappet 8, the pawls of the carrier slip over the ratchet teeth, thereby permitting unimpeded piston movement. Upon rearward movement of the hammer piston, the pawls engage the ratchet teeth to hold the rifle bar against rotation so that, due to the spiral groove interlocking connection, a rotary motion is imparted to the piston, and this rotary motion is transmitted to the drill steel through the chuck. As is usual in rock drills of the type disclosed, cleansing fluid may be conducted to the drill steel bore to effect cleansing of the drill hole, and a tube 25 provided for this purpose extends axially from the rear head block into the motor cylinder and through the hammer piston and tappet into the drill steel bore. In distinction from other constructions, the tube is a close sliding fit for the openings in the impact member 6 and the tappet 8 so that leakage of pressure fluid along the tube past the striking block and tappet is substantially prevented.

The tappet 8 is mounted for reciprocatory movement in a bore 26 in the chuck sleeve 13, and the chuck sleeve has a reduced rearwardly projecting portion 27 having a bore 28 which receives the reduced body portion of the tappet in the manner shown. The tappet projects rearwardly from the rear end of the chuck sleeve into a position to be struck by the hammer piston. Surrounding the rearward reduced portion 27 of the chuck sleeve within the driver sleeve 12 is an annular chamber or space 29 into which the forward annular portion of the hammer piston is

adapted to enter during its reciprocation as will later be made apparent.

The rear end of the cylinder bore is closed by a rear head plate 30, and arranged between this head plate and the rear head member 18 is a valve chest 31 having a valve chamber containing a pair of cooperating relatively movable fluid distributing valves 32 and 33. Carried by the rear head block 19 is a throttle valve 34 which may control the flow of pressure fluid through a supply passage 35 to the valve chamber internally of the valves. Leading from the opposite ends of the valve chamber are fluid supply passages 36 and 37 for conducting pressure fluid, under the control of the valves, to the opposite ends of the cylinder bore to effect reciprocation of the hammer piston. The piston controlled cylinder exhaust is indicated at 38. The pressure fluid may flow, in the manner fully described in the said Patent No. 2,461,527 above referred to, to the annular chamber or space 29 at the forward end of the hammer piston from the front end of the cylinder bore through certain of the piston flutes to assist in returning the hammer piston after it delivers its impact blow to the tappet 8. When the piston has moved rearwardly to bring the flutes thereon into communication with the exhaust passage 38, the fluid in the front end of the cylinder is exhausted to atmosphere. Throwing passages 39 and 40, controlled by the piston, connect the cylinder bore with the valve chamber so that the distributing valves may be thrown automatically into their different operating positions as the hammer piston reciprocates. This valve structure and the fluid supply and throwing passages are described in the said Patent No. 2,461,527 above mentioned.

The cylindrical exterior of the rearward portion of the chuck sleeve projection 27 is tapered at 41, as shown most clearly in Fig. 5, and the front edge of the piston surrounding the bore 7 therein is chamfered or rounded off at 42 so that during normal operation of the motor, the forward end of the hammer piston and the chuck sleeve projection never come into substantial contact, or if contact should occur, it would be relatively slight (see Fig. 2). Thus very little wear of the surfaces at 43 and 44 occurs during normal operation of the motor. Pressure fluid flowing from the cylinder bore through the piston flutes to the annular chamber or space 29 also enters the piston bore 7 at the rear of the chuck sleeve projection so that some cushioning of the piston movement takes place, although comparatively little resistance to the forward movement of the piston is present at that time. Should the hammer piston be driven forwardly into a more advanced forward position, for instance, in the event the drill steel strikes a pocket in the material being drilled, the tappet is driven forwardly into the chuck sleeve bore, as shown in Fig. 3, and the surfaces 43 and 44 (Fig. 5) move into contact, thereby providing a seal and trapping the fluid in the piston bore to provide a substantial cushion for the piston, thus preventing contact of the forward end of the piston with the chuck parts. Since during normal operation of the motor little wear of the surfaces 43 and 44 occurs, a relatively fluid tight seal is provided to prevent substantial fluid leakage from the cushion. Of course, there is no substantial loss of the cushion, both because of the maintained surface contact between the impact surface 5 and the rear end of the tappet 8, and because the close fits around the tube 25 would prevent

serious leakage in the short times available, in any event. If the motor is run with the drill steel 9 removed, the tappet may move into contact with the inner end of the chuck bushing, and the forward end of the hammer motor piston may move forwardly almost into contact with the inner end of the chuck sleeve at its extremes of forward movement, and under these circumstances, the close fits around the tube 25 will safely maintain the necessary cushion pressure against escape.

In the illustrative embodiment shown in Figs. 6 to 8 inclusive, the pressure fluid motor is generally the same as that above described but is somewhat modified in certain details as will now be made apparent. The cylinder bore contains a reciprocable hammer piston 45 similar to the piston 4, which similarly delivers impact blows through a tappet 46 to the shank of the drill steel 9. The piston has formed externally thereon a series of relatively narrow longitudinal grooves 47 arranged between relatively wide keys 48, and these keys engage the keys 49 on a chuck nut 50 similar to the chuck nut 17 above described. A supply passage 51 corresponding to the passage 37 of the first embodiment, extends along the cylinder and opens at its forward end within an annular space 52 formed within the front end of the cylinder rearwardly of a chuck housing 53. Passages 54 in the rotatable driver sleeve 12 connect the space 52 with the annular chamber or space 29 at the forward side of the hammer piston. The piston keys 48 have formed externally thereon longitudinal grooves 55 for conducting pressure fluid from the annular space 29 longitudinally of the piston to the exhaust passage 38. Thus in this form of the invention, the flow of pressure fluid to the front end of the cylinder to the annular space 29 at the front side of the piston is direct instead of through the cylinder and past the piston. The cushion structure associated with the piston is the same as that of the other form. It is accordingly evident that the supply of pressure fluid to the annular space 29 is through the supply passage 51, and exhaust from the space 29 occurs through the grooves 55 on the piston and exhaust passage 38. Otherwise, both structurally and functionally, this modified embodiment is similar to the other embodiment.

In both embodiments of the invention, the hammer piston may have a cylindric projection, and means may be provided at the front end of the cylinder providing a bore which may receive the piston projection, and the cushion may be provided between the forward end of the piston projection and the forward wall of the bore.

As a result of this invention, an improved pressure fluid motor is provided having novel cushioning means for the motor piston. The improved motor structure embodying the novel cushioning arrangement disclosed affords an improved and extremely effective cushioning of the motor piston. Wear of the sealing surfaces of the cushion is substantially eliminated during normal motor operation, due to the novel arrangement of parts so that when the sealing surfaces come into substantial contact a very effective trapping of the cushioning fluid is possible. Other advantages of the invention will be clearly apparent to those skilled in the art.

While there are in this application specifically described two forms which the invention may assume in practice, it will be understood that these forms of the same are shown for purposes of illustration and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What we claim as new and desire to secure by Letters Patent is:

1. In a pressure fluid motor, a cylinder, a piston reciprocable in said cylinder and having an axial bore opening through its forward end and a striking face within said bore and spaced rearwardly from the forward end of the piston, said piston also having a forwardly facing area outside of said bore, means at the front end of said cylinder providing a cylindrical portion receivable in said piston bore with its exterior surface spaced inwardly from the walls of said cylinder, a tappet sealingly guided by said cylindrical portion and normally engageable by said striking face in a forward position of the piston, said piston bore and said cylindrical portion having surfaces adapted to have substantially sealing contact only when said piston moves forwardly a distance greater than its movement during normal operation of the motor, said surfaces being substantially always out of sealing contact during normal motor operation, and fluid distribution means including means for supplying pressure fluid to the forward end of said cylinder to subject said forwardly facing area of said piston outside of said bore to live pressure and also to subject said striking face to live pressure when said surfaces are not in engagement, said surfaces when in sealing contact trapping fluid in said piston bore to provide a cushion for said piston.

2. In a pressure fluid motor, a cylinder, a percussive piston reciprocable in said cylinder having a forward annular portion providing a central bore at the inner end of which a striking face is provided, means at the front end of said cylinder cooperating with said piston and providing an annular space for receiving said annular portion of said piston and having a cylindrical portion receivable in said piston bore, said piston bore and said cylindrical portion having surfaces adapted to have substantial sealing contact only when said piston moves forwardly a distance greater than its movement during normal operation of the motor, said surfaces being always substantially out of sealing contact during normal motor operation, a blow receiving element sealingly guided by said cylindrical portion and engageable by said striking face, and fluid distribution means including means for supplying pressure fluid through said annular space to said piston bore and including fluid passage means in continuous communication with the space ahead of the forward annular portion of said piston, the fluid in said annular space acting on the forward end of said piston to effect rearward piston movement, and said surfaces when in sealing contact trapping fluid in said piston bore to provide a cushion for said piston.

3. In a pressure fluid motor, a cylinder, a hammer piston reciprocable in said cylinder and having a forward annular portion providing an axial bore opening through the forward end of said piston, means at the front end of said cylinder providing a cylindrical portion projecting rearwardly into said cylinder and having its exterior surface spaced inwardly from the cylinder walls to provide an annular space surrounding said cylindrical portion, said cylindrical portion being receivable in said piston bore and the forward annular portion of said piston being receiv-

able in said annular space, the surface of said piston bore being adapted to fit over the exterior surface of said cylindrical portion, and said surfaces being in substantial sealing contact only when said piston moves forwardly a distance greater than its movement during normal operation of the motor and has said annular piston portion within said annular space, means for supplying pressure fluid through said annular space to said piston bore including a fluid supply connection opening into said space and at all times in free communication with the foremost end of the latter, said surfaces when in sealing contact trapping the fluid in said piston bore to provide a cushion for said piston.

4. In a percussive tool, the combination comprising a motor cylinder, a hammer piston element reciprocable in said cylinder, a chuck mechanism having a sleeve element, one of said piston and sleeve elements having a bore and said other element having a cylindrical projection adapted to enter said bore, said bore and said projection having surfaces adapted to move into substantial sealing contact only when said piston element moves forwardly a distance greater than its movement during normal operation of the tool, said surfaces being substantially always out of sealing contact during normal tool operation, means for supplying fluid to said bore, said surfaces when in sealing contact trapping the fluid in said bore to provide a cushion for said piston element, and means for providing a further protection against forward overtravel of said piston including an uncounterbalanced, forwardly facing area on the piston and means for continuously subjecting it to live pressure when the piston is in extreme forward position.

5. In a percussive tool, the combination comprising a motor cylinder, a hammer piston reciprocable in said cylinder and having a front axial bore having a striking face at its inner end, a chuck mechanism having a cylindrical sleeve portion projecting rearwardly into said cylinder to provide an annular chamber surrounding said sleeve portion, said cylindrical projection being receivable in said piston bore and the forward portion of said piston being receivable in said annular chamber, a bounding surface of said piston bore being adapted to fit over the cylindrical peripheral surface of said projection, said surfaces being always substantially out of contact during normal tool operation and being in substantial sealing contact only when the piston moves forwardly a distance greater than its movement during normal operation of the tool, means for receiving from said striking face the impact of said piston and for transmitting it to a tool, slidably guided in substantially fluid-tight relation in said projection, and means for supplying fluid through said annular chamber to said piston bore, said surfaces when in sealing contact trapping the fluid in the piston bore to provide a cushion for the piston.

6. In a pressure fluid motor, a cylinder having a bore, a piston reciprocable in said cylinder bore and having an axial bore extending into its forward end forming a forward piston portion of annular cross section, means at the forward end of said cylinder providing a cylindrical portion projecting rearwardly into said cylinder bore in concentric relation therewith with its exterior surface spaced inwardly from the walls of said cylinder bore to provide an annular chamber, said cylindrical portion adapted to be received within said piston bore with the surface of said piston bore

sealingly fitting over the exterior surface of said cylindrical portion, said surfaces moving into substantial sealing contact only when said piston moves forwardly a distance greater than its movement during normal operation of the motor and has its annular forward portion within said annular chamber, means for receiving the impact of the piston sealingly reciprocable in said cylindrical portion, and means for suplying pressure fluid to said annular chamber and said piston bore, said surfaces when in sealing contact trapping the fluid in said piston bore rearwardly of said cylindrical portion to provide a cushion for said piston.

7. In a fluid operated percussive tool, a cylinder having a bore, a hammer piston reciprocable in said cylinder bore and having an axial chamber opening through its forward end forming a forward piston portion of annular cross section, said piston having an impact surface at the bottom of said axial chamber, means at the forward end of said cylinder providing a hollow cylindrical portion projecting rearwardly into said cylinder bore in concentric relation therewith with its exterior surface spaced inwardly from the walls of said cylinder bore to provide an annular chamber, said cylindrical portion having an axial bore therethrough and receiving a reciprocable impact element which has a fluid-tight sliding fit within said cylindrical portion and projects rearwardly from said cylindrical portion into a position to be struck by said piston impact surface, said cylindrical portion adapted to enter the piston chamber with the surface of the piston chamber fitting over the exterior surface of said cylindrical portion, said surfaces being in substantial sealing contact only when said piston moves forwardly a distance greater than its movement during normal operation of the tool and has its annular forward portion within said annular chamber, and means for supplying pressure fluid to said piston chamber, said surfaces when in sealing contact trapping the fluid in said piston chamber rearwardly of said cylindrical portion to provide a cushion for said piston.

8. In a fluid operated percussive tool, a cylinder having a bore, a hammer piston reciprocable in said cylinder bore and having an axial chamber opening through its forward end forming a forward piston portion of annular cross section, said piston having an impact surface at the bottom of said axial chamber, a chuck mechanism at the forward end of said cylinder bore having a hollow sleeve portion projecting rearwardly into said cylinder bore in concentric relation therewith with its exterior surface spaced inwardly from the walls of said cylinder bore to provide an annular chamber, said sleeve portion having a reciprocable impact element guided therein and which has a fluid-tight sliding fit with the inner walls of the sleeve portion and projects rearwardly from said sleeve portion into a position to be struck by said piston impact surface, said sleeve portion adapted to enter the piston bore with the surface of said piston bore fitting over the exterior surface of said sleeve portion, said surfaces being in substantial sealing contact only when said piston moves forwardly a distance greater than its movement during normal operation of the tool and has its forward annular portion within said annular chamber, and means for supplying fluid to said piston bore, said surfaces when in sealing contact trapping the fluid in said piston chamber rearwardly of said sleeve portion to provide a cushion for said piston.

9. In a fluid operated percussive tool, a cylinder having a bore, a hammer piston reciprocable in said cylinder bore and having an axial chamber opening through its forward end forming a forward piston portion of annular cross section, said piston having an impact surface at the bottom of said axial chamber and a forwardly facing surface to the outside of said chamber, means at the forward end of said cylinder providing a hollow cylindrical portion projecting rearwardly into said cylinder bore in concentric relation therewith with its exterior surface spaced inwardly from the walls of said cylinder bore to provide an annular chamber, said cylindrical portion having an axial bore therethrough and receiving a reciprocable impact element which has a fluid-tight sliding fit within said cylindrical portion and projects rearwardly from said cylindrical portion into a position to be struck by said piston impact surface, said cylindrical portion adapted to enter the piston chamber with the surface of the piston chamber fitting over the exterior surface of said cylindrical portion, said surfaces being in substantial sealing contact only when said piston moves forwardly a distance greater than its movement during normal operation of the tool and has its annular forward portion within said annular chamber, means for supplying pressure fluid to said piston chamber, said surfaces when in sealing contact trapping the fluid in said piston chamber rearwardly of said cylindrical portion to provide a cushion for said piston, and means for subjecting the forwardly facing surface of said piston to the outside of said chamber to live pressure when said piston is in its extreme forward position.

10. In a fluid operated percussive tool, a cylinder having a bore, a hammer piston reciprocable in said cylinder bore and having an axial chamber opening through its forward end forming a forward piston portion of annular cross section, said piston having an impact surface at the bottom of said axial chamber, a chuck mechanism at the forward end of said cylinder bore having a hollow sleeve portion projecting rearwardly into

said cylinder bore in concentric relation therewith with its exterior surface spaced inwardly from the walls of said cylinder bore to provide an annular chamber, said sleeve portion having a reciprocable impact element guided therein and which has a fluid-tight sliding fit with the inner walls of the sleeve portion and projects rearwardly from said sleeve portion into a position to be struck by said piston impact surface, said sleeve portion adapted to enter the piston bore with the surface of said piston bore fitting over the exterior surface of said sleeve portion, said surfaces being in substantial sealing contact only when said piston moves forwardly a distance greater than its movement during normal operation of the tool and has its forward annular portion within said annular chamber, and means for supplying fluid to said annular chamber and to said piston bore including fluid conducting means in constant free communication at its forward end with said annular chamber, said surfaces when in sealing contact trapping the fluid in said piston chamber rearwardly of said sleeve portion to provide a cushion for said piston.

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