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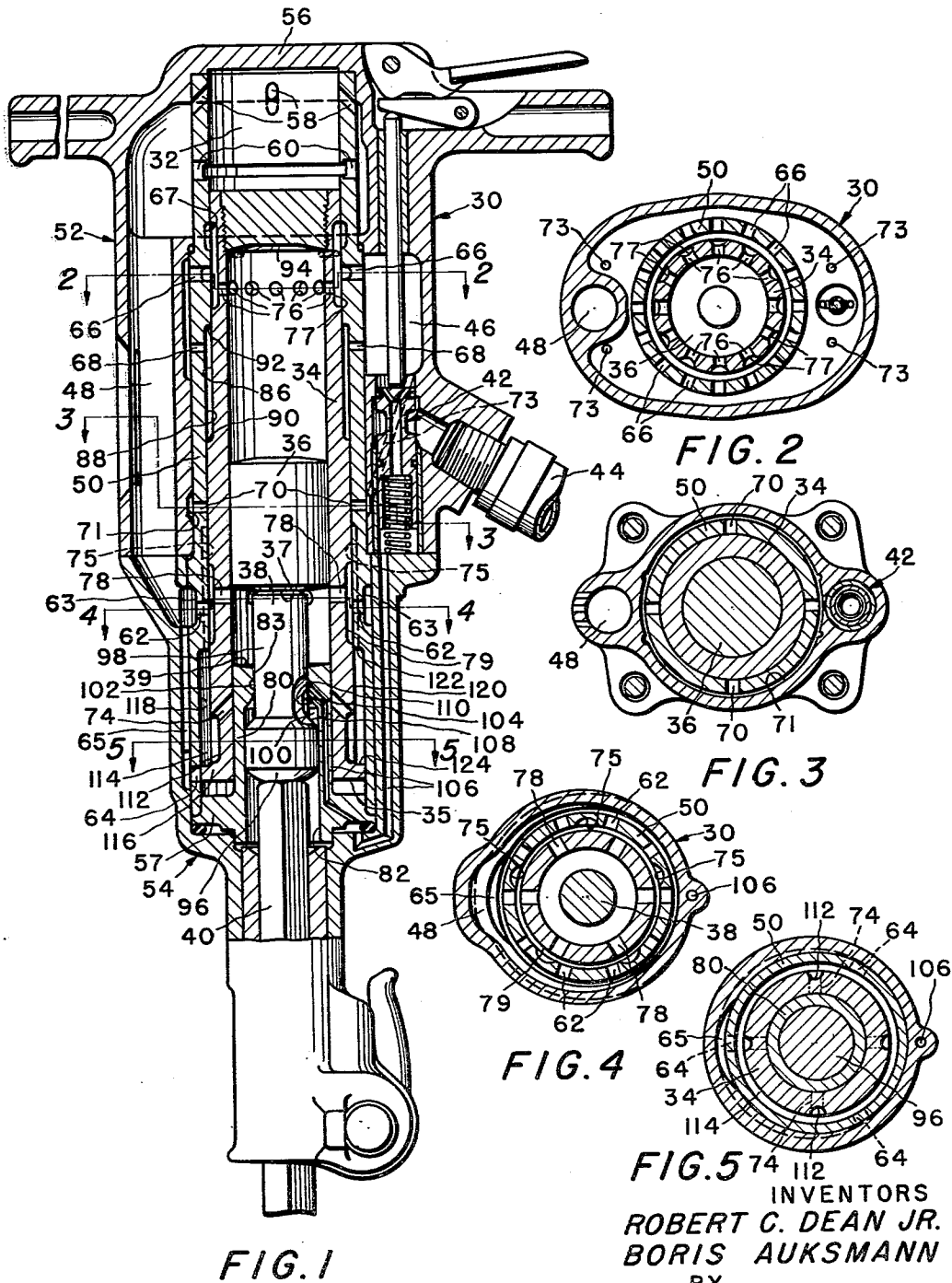
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3,060,894

ROCK DRILL

Filed Feb. 29, 1960

3 Sheets-Sheet 1



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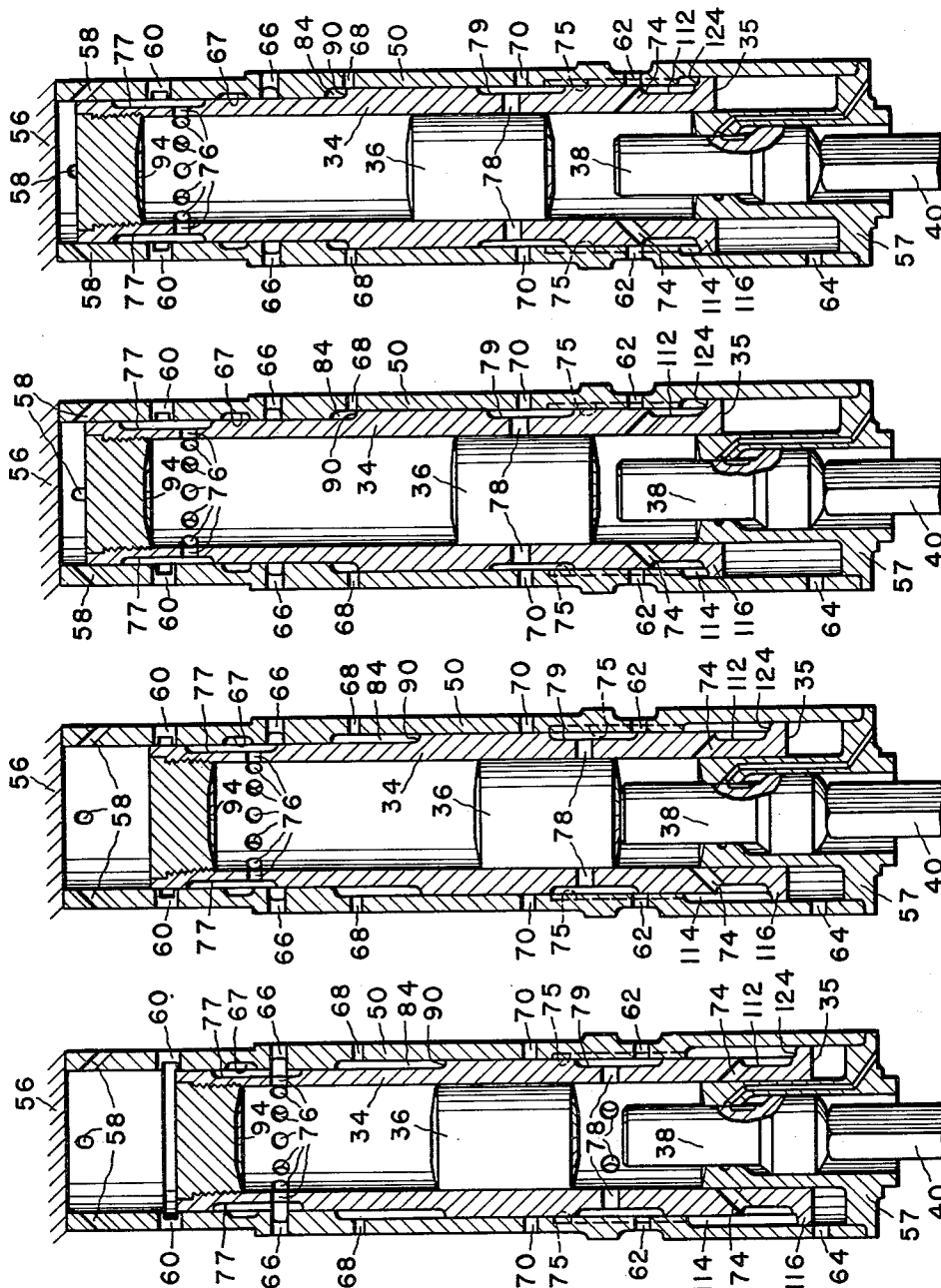


FIG. 9

FIG. 8

FIG. 7

FIG. 6

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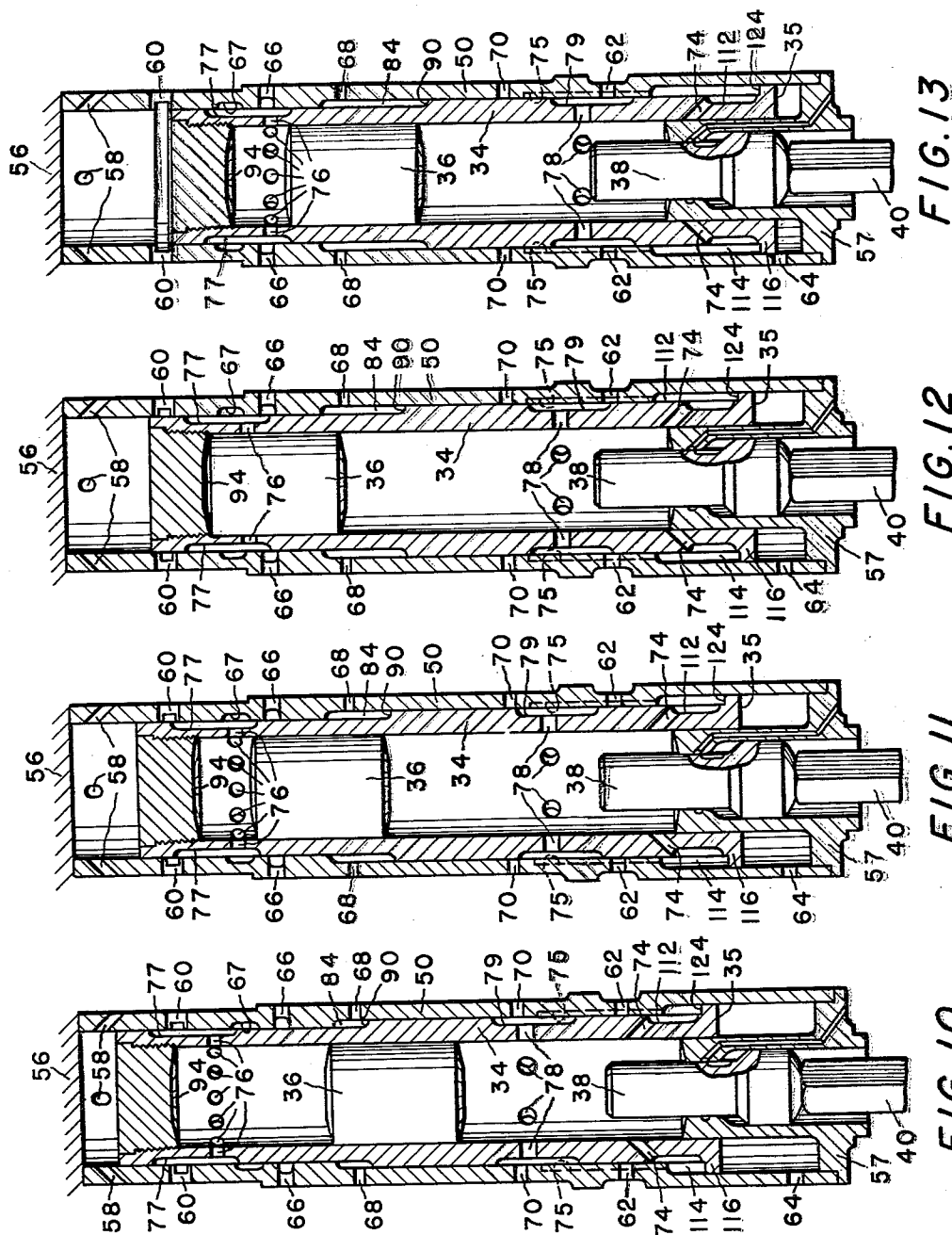
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3 Sheets-Sheet 3



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3,060,894 ROCK DRILL

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This invention relates to percussive type pneumatic tools, and more particularly to an improved type of paving breaker.

In drilling operations with tools of conventional design, it is commonly known that the vibrations of the tool, transmitted to the operator, are objectionable.

It is then the principal object, according to the present invention, to provide an improved percussive type pneumatic tool which more effectively matches the operator's ability to hold the tool and to provide one in which the vibrations of the tool transmitted to the operator are substantially reduced.

Another object of the present invention is to provide an improved percussive type pneumatic tool having a controlled impulse frequency which is substantially lower than with conventional tools of the same bore, stroke and piston weight.

Another object of the present invention is to provide an improved percussive type pneumatic tool which produces a higher impact force than is produced by conventional tools of this type, and, as a result, has a high breaking rate, compared to the commonly known percussive type tools.

A further object is to provide a percussively operated tool which utilizes its impact energy more effectively than is true of conventional tools of this type.

Still another object of the present invention is to provide an improved percussive type pneumatic tool having a highly simplified structure compared to that of the conventional type.

According to the invention, an improved percussive type pneumatic tool is provided in which the oscillating reaction forces on the tool casing, caused by the piston movement, are substantially reduced. This is achieved by the provision of a combination of a novel sleeve type cylinder and a piston, the piston actuated within the sleeve type cylinder and the sleeve type cylinder actuated within the casing of the tool. With this new arrangement and with the cooperation of the pressure fluid the movements of the piston and the sleeve type cylinder are coordinated to isolate the vibrations of the piston, and consequently, to reduce such vibrations being transmitted to the tool casing and to the operator of the tool.

In addition thereto, the sleeve type cylinder is constructed in such a way to function as a valve, cooperating with the casing of the tool and the piston, to distribute the pressure fluid in order to operate the tool. Furthermore, the sleeve type cylinder valve arrangement serves another purpose: that of adapting the frequency of the impulses produced by the tool to the operator's ability of holding the tool. In addition thereto the sleeve type cylinder valve arrangement is adapted such that the tool produces an impact, the force of which is independent of the frequency of the tool; in other words, the force of the impact is maintained constant regardless of any chosen frequency of the tool.

With the aforementioned arrangements an improved percussive type pneumatic tool has been provided in which: a controlled impulse frequency is achieved, the vibrations transmitted to the operator are reduced to a minimum, a high breaking rate is produced, and, the use of an air distributing valve, as used in the conventional

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type paving breakers, is eliminated by providing a multi-purpose free sleeve type cylinder valve in the tool. With this improved percussive type pneumatic tool the reactive force of the tool is matched to the operator's ability to hold the tool with ease.

These and other features of this invention will appear more fully from the following description made in connection with the accompanying drawings in which

FIGURE 1 shows a preferred embodiment of the paving breaker according to the present invention, partly in longitudinal section,

FIGS. 2, 3, 4 and 5 are cross sectional views of FIG. 1 taken along the lines 2-2, 3-3, 4-4 and 5-5, respectively, and looking in the direction of the arrows,

FIGS. 6, 7, 8, 9, 10, 11, 12 and 13 illustrate in steps the operation of the paving breaker, and show in longitudinal section, only those parts of the paving breaker in connection with their various positions relative to each other throughout a complete cycle of operation of the paving breaker.

Referring now more particularly to the drawings, the tool shown in FIGS. 1-5 is a preferred embodiment of the invention and includes an elongated casing 30 having a chamber 32 in which a sleeve 34, acting as a cylinder valve, is reciprocated. A reciprocable piston 36 is disposed in the sleeve 34 to strike an anvil block 38 which transmits the impacts to a steel 40 positioned through the forward end of the casing 30. A conventional type throttle valve 42 controls the supply of pressure fluid which is conducted from a source of supply (not shown) through a hose 44 into a reservoir 46 recessed in the casing 30. From the reservoir 46 the pressure fluid is conducted through various ports and passages in the casing 30 and in the cylinder valve 34 to reciprocate the cylinder valve 34 and the piston 36 whereafter the pressure fluid is discharged into an exhaust chamber 48.

The casing 30, comprising a backhead 52 and a front head 54, includes a sleeve 50 which is tightly held within the backhead 52 and the front head 54, the chamber 32 being defined by the interior of the sleeve 50 and bounded at one end by the rear end 56 of the backhead 52 and at the opposite end by a member 57 held together with the forward end of the sleeve 50 in the front head 54. The member 57, including a cylindrical portion 80 slidably extending into the forward end portion of the cylinder valve 34, is provided with a bore 82 to slidably receive the anvil block 38 extending into the interior of the cylinder valve 34.

The sleeve 50 (see FIGS. 1-5), is provided with exhaust ports 58, 60, 62 and 64, and inlet ports 66, 68 and 70, the exhaust ports to discharge fluid into the exhaust chamber 48 while the inlet ports are in communication with the pressure fluid reservoir 46. An annular groove 71 in the casing 30 (see FIGS. 1 and 3), is connected by means of a passage 73 with the pressure fluid reservoir 46 to conduct pressure fluid to the inlet ports 70. The exhaust ports 62 (see FIGS. 1 and 4), communicate with the exhaust chamber 48 through an undercut 63 in the sleeve 50, and, the exhaust ports 64 (see FIGS. 1 and 5), are in communication with the exhaust chamber 48 through a passage 65 in the casing 30.

The cylinder valve 34 (see FIGS. 1-5), reciprocable in the sleeve 50, is provided with inlet ports 74 (see FIG. 5), which conduct pressure fluid to the forward end portion of the interior of the cylinder valve 34. The ports 76 (see FIG. 2), and 78 (see FIG. 4), in the cylinder valve 34 are dual purpose ports and act as inlet or exhaust ports, depending upon the position of the cylinder valve 34 relative to the sleeve 50, to conduct fluid from or to the interior of the cylinder valve 34.

A pressure chamber 84 of variable volume is formed

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between the outer wall 86 of a reduced diameter portion of the cylinder valve 34 and the inner wall 88 of an enlarged diameter portion of the sleeve 50, and bounded by the shoulders 90 and 92, acting as pressure surfaces, of the cylinder valve 34 and the sleeve 50, respectively. It is to be noted that, as the pressure chamber 84 is constantly in communication with the pressure fluid reservoir 46 through the inlet ports 68, pressure is constantly exerted on the shoulder 90 of the cylinder valve 34 to constantly urge the cylinder valve 34 forwardly. The cross sectional area of the inlet ports 68 is such that the pressure in the pressure chamber 84 is maintained constant, irrespective of the position of the cylinder valve 34 relative to the sleeve 50 and thus irrespective of the volume of the pressure chamber 84.

The bore of the sleeve 50 is enlarged at its forward end portion and is adapted to slidably receive the flange like foot 116 of the cylinder valve 34. An annular chamber 114 is formed between the inner wall 118 of the enlarged bore portion of the sleeve 50 and the outer wall 120 of the cylinder valve 34 bounded by the shoulder 122 of the sleeve 50 and the rear end surface 124 of the foot 116, the function of the annular chamber 114 to be explained hereinafter.

For a clear demonstration of the operation of the tool throughout one complete cycle of operation, the various positions of the piston 36 and the cylinder valve 34, relative to each other and relative to the sleeve 50, are illustrated in FIG. 1 and FIGS. 6-13, inclusive.

Starting with the impact stroke of the piston 36, as shown in FIG. 1, the cylinder valve 34 is in its normal extreme forward position, the foot 116 at the forward end of the cylinder valve 34 shutting off the exhaust ports 64 in the sleeve 50. The air forwardly of the foot 116 of the cylinder valve 34 is now trapped and the reason therefor being to cushion the forward movement of the cylinder valve 34 in case it is accidentally moved beyond the exhaust port 64. It is to be noted that in normal operation of the tool this cushioning effect does not occur, as will be understood from the description made hereinafter.

The impact on the anvil block 38 has been applied with full impact force by the piston 36 without cushioning of the forward movement of the piston 36 as the ports 78 in the cylinder valve 34 discharge the fluid forward of the piston 36 through an undercut 79 in the cylinder valve 34 and ports 62, the latter in the sleeve 50, into the exhaust chamber 48.

It is to be noted that the annular undercut 79 in the cylinder valve 34 is provided to permit the ports 78 in the cylinder valve 34 to communicate alternately with the exhaust ports 62 in the sleeve 50, and with the inlet ports 70 in the sleeve 50, during a predetermined range of forward or rearward movement of the cylinder valve 34 as will appear in fuller detail hereinafter.

At the rear end portion of the tool, pressure fluid from the reservoir 46 is supplied through the inlet ports 66 in the sleeve 50, and ports 76 in the cylinder valve 34 into the interior of the cylinder valve 34. The cylinder valve 34 is actuated rearwardly, and, rearward of the cylinder valve 34, the exhaust ports 58 and 60, both in the sleeve 50, are open to the exhaust chamber 48. The fluid rearwardly of the cylinder valve 34, after the cylinder valve 34 has moved beyond the exhaust valve 60, is then discharged through the vent ports or exhaust ports 58 to permit a further free rearward movement of the cylinder valve 34. The fluid rearward of the foot 116 of the cylinder valve 34 is exhausted through the grooves 75, undercut 79, ports 62, and exhaust chamber 48.

There are a number of longitudinal grooves 77 (see FIG. 2) in the rear end portion of the cylinder valve 34, and, as each port 76 is in communication with a groove 77, the grooves 77 are adapted to permit the ports 76 to communicate alternately with the inlet ports 66 in the sleeve 50 and with the exhaust ports 60 in the sleeve 50 during a

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predetermined range of rearward or forward movement of the cylinder valve 34, as will appear in fuller detail hereinafter.

It is to be noted that, although pressure fluid is also conducted through the inlet ports 68 in the sleeve 50 into the pressure chamber 84 the force on the greater area of the rear end surface 94 of the cylinder valve 34, relative to the area of the pressure surface on the shoulder 90, will overcome the force exerted on the shoulder 90 to move the cylinder valve 34 rearwardly.

Referring now to FIG. 6, the cylinder valve 34 has moved rearwardly, and the piston 36 is shown in a position after rebounding from the anvil block 38. The force of the pressure fluid rearward of the piston 36 in the cylinder valve 34 halts the rebound motion of the piston 36 and returns the piston to its original impact position as shown in FIG. 1. The cylinder valve 34 continues its rearward movement.

FIG. 7 shows the piston in its returned position on the anvil block 38 while the cylinder valve 34 has moved further rearwardly to a point where the cylinder valve 34 has almost shut off the inlet ports 66 and the exhaust ports 62, both in the sleeve 50. The rearward movement of the cylinder valve 34 has opened the inlet ports 74, positioned at the forward end portion of the cylinder valve 34, to the interior of the cylinder valve 34 forward of the piston 36.

FIG. 8 illustrates the positions of the piston 36 and the cylinder valve 34, both members moving rearwardly, the cylinder valve 34 approaching its normal extreme rearward position while the piston 36 has just moved out of its original position on the anvil block 38. The inlet ports 70 in the sleeve 50 have been opened by the cylinder valve 34 while moving from the position shown in FIG. 7 to the position shown in FIG. 8 to permit pressure fluid into the undercut 79 in the cylinder valve 34 from where it is conducted through a number of longitudinal grooves 75 in the sleeve 50 (see FIG. 4), the annular chamber 114 between the sleeve 50 and the cylinder valve 34, through a number of longitudinal grooves 112, and into the inlet ports 74 in the cylinder valve 34. The grooves 75 in the sleeve 50 (see FIG. 4) are positioned between the exhaust ports 62 in the sleeve 50, such, to communicate the inlet ports 74 in the cylinder valve 34 with the undercut 79 in the cylinder valve 34 to conduct pressure fluid from the inlet ports 70 in the sleeve 50 for starting the piston 36 on its rearward stroke.

The cylinder valve 34 has closed the inlet ports 66 in the sleeve 50, and opened the exhaust ports 60 in the sleeve 50 to the ports 76 in the cylinder valve 34 through the grooves 77 in the cylinder valve 34 in order to exhaust the fluid rearward of the piston while the piston 36 is moved rearwardly. The inlet ports 70 are now fully in communication through the undercut 79, grooves 75, and chamber 114 with the inlet ports 74 to permit the pressure fluid to actuate the piston 36 rearwardly.

It is to be noted that the speed of the cylinder valve 34 is considerably decreased as the inlet ports 66 in the sleeve 50 are closed and the exhaust ports 60 are open so that no force is exerted on the rear end surface 94 of the cylinder valve 34 while a constant pressure has been exerted on the shoulder 90 of the pressure chamber 84 during the rearward movement of the cylinder valve 34.

Referring now to FIG. 9, the cylinder valve 34 has reached its normal extreme rearward position. It is to be noted that in case the cylinder valve 34 shuts off the vent ports or exhaust ports 58 in the sleeve 50, cushioning of the cylinder valve 34 is obtained to prevent the cylinder valve from striking the rear end 56 of the backhead 52, should the cylinder valve accidentally overtravel. This cushioning, however, does not occur in normal operation of the tool. As the piston 36 moves rearwardly the portion of the interior of the cylinder valve 34 rearward of the piston 36 is being exhausted through the

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ports 76 in the cylinder valve 34, grooves 77 in the cylinder valve 34, and exhaust ports 60 in the sleeve 50.

It is to be noted that the number of blows delivered by the piston, for a given time, in the tool of the present invention has been reduced, as compared to the number of blows delivered by the piston, for the same time, in conventional types of paving breakers. In order to achieve this the time of each cycle of the tool is lengthened substantially by two means. First, the piston 36 is delayed when in the forward position, held down by pressure fluid rearwardly of the piston, until the cylinder valve moves far enough to close the inlet ports 66 and open the exhaust ports 60. Secondly, the rearward stroke of the piston is made substantially slower than the forward or impact stroke of the piston by throttling the flow of pressure fluid through the inlet ports 70 which are considerably smaller than the supply ports 66. Accordingly, the cross sectional area of the inlet ports 70 in the sleeve 50 is made less than the cross sectional area of the inlet ports 66 in the sleeve 50, to permit less flow of pressure fluid for a given time through the inlet ports 70, relative to the flow of pressure fluid for the same time through the inlet ports 66.

The time of the cycle depends upon several factors, the principal ones being the cylinder valve mass, cylinder valve stroke, and area of the shoulder 90. The piston must be made to move harmoniously with the cylinder valve by proper location of the various closings and openings of ports 62, 70, 66 and 60 and by proper selection of the area of the ports 70. This will be explained in fuller detail hereinafter with respect to the forward stroke of the piston 36, to illustrate that the piston is moved rearwardly at a lower speed relative to the forward or impact stroke speed of the piston 36, in order to control the impulse frequency of the tool.

FIG. 10 shows the piston 36 on its rearward stroke after having opened the ports 78 in the cylinder valve 34 to permit pressure fluid from the inlet ports 70 in the sleeve 50 to flow through the ports 78 into the portion of the interior of the cylinder valve 34 forward of the piston 36 to drive the piston to its normal rearward position. The cylinder valve 34 has been moved forwardly from its normal extreme rearward position by the constant pressure of the pressure fluid exerted on the shoulder 90 of the pressure chamber 84. The cylinder valve 34 is also moved forwardly by the pressure fluid flowing through the inlet ports 70, undercut 79, ports 78, through the interior of the cylinder valve 34, ports 74, grooves 112, and chamber 114 to exert force on the rear end surface 124 of the foot 116. Pressure fluid flowing through the inlet ports 70 and undercut 79 also flows through the grooves 75 into the chamber 114.

It is to be noted that the exhaust ports 64 in the forward end portion of the sleeve 50 and forward of the forward end 35 of the cylinder valve foot 116 are constantly open to the exhaust chamber 48 through the passage 65 in the casing 30 (see FIG. 1), thus there being no restriction in either the forward or the rearward normal movement of the cylinder valve 34 at its forward end.

FIG. 11 shows the piston 36 moving further rearwardly while the cylinder valve 34 is moving forwardly, the inlet ports 70 in the sleeve 50 being shut off by the cylinder valve 34. Before reaching its normal extreme rearward position the piston 36 will shut off the ports 76 in the cylinder valve 34, thereby trapping fluid in the rear end portion of the interior of the cylinder valve 34 rearward of the piston 36, to cushion the piston's final portion of the rearward stroke to prevent the piston 36 from striking the rear end surface 94 of the cylinder valve 34. The inlet ports 66 are held closed by the cylinder valve 34.

FIG. 12 shows the piston 36 in its normal extreme rearward position, the ports 76 in the cylinder valve 34 being shut off by the piston to form a cushion for the piston on its final portion of its rearward stroke as explained in connection with FIG. 11. The cylinder valve 34 con-

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tinues moving forwardly. The inlet ports 70 in the sleeve 50 are now fully closed, and the exhaust ports 62 are being opened by the cylinder valve 34. The discharge of the fluid forward of the piston 36 can now take place when the piston 36 is moved forwardly.

FIG. 13 illustrates the position of the piston 36 and the cylinder valve 34 relative to each other and relative to the sleeve 50. The piston 36, having rebounded forwardly due to the cushioning of the piston in the rear of the cylinder valve 34, has opened the ports 76 in the cylinder valve 34 to permit the full charge of the pressure fluid to be conducted from the reservoir 46 through the inlet ports 66 in the sleeve 50, the grooves 77 in the cylinder valve 34, and the ports 76 in the cylinder valve 34, into the rear end portion of the interior of the cylinder valve 34 rearward of the piston 36 to drive the piston with a substantial force to strike the anvil block 38. The ports 78 are now in full communication through the undercut 79, exhaust ports 62, and undercut 63, see FIG. 1, with the exhaust 48 to discharge the fluid forward of the piston 36 during its entire impact stroke.

During the impact stroke of the piston 36, the cylinder valve 34 continues its forward travel reaching its normal extreme forward position at substantially the same time as the impact of the piston 36 is delivered on the anvil block 38. After the impact of the piston on the anvil block, the cycle of operations of the piston 36 and the cylinder valve 34 are repeated as specified hereinbefore, starting with the positions of the piston 36 and the cylinder valve 34 as shown in FIG. 1.

As specified hereinbefore, cushioning means has been provided to prevent the piston 36 and the cylinder valve 34 to strike each other or to strike the backhead or the front head of the tool. In this respect it is to be noted that cushioning means has also been provided to prevent the piston 36 from striking the retaining member 57 disposed in the front head 54 of the tool.

In case the forward end (not shown) of the steel 40 encounters a soft spot in the material to be broken, the steel 40 and the anvil block 38, after being struck by the piston 36, will move forwardly beyond their normal operational positions as shown in FIG. 1. In this case the piston 36 will also be moved forwardly beyond its normal striking position relative to the anvil block 38 and relative to the cylinder valve 34, shutting off the ports 78 in the cylinder valve 34. As the cylinder valve 34 is in its normal extreme forward position the ports 74 in the cylinder valve 34 are closed by the retaining member 57. With this arrangement the fluid in the space between the forward end 37 of the piston 36 and the rear end 39 of the retaining member 57 is trapped, thereby cushioning the piston's forward movement and to prevent the piston 36 from striking the rear end 39 of the retaining member 57 or even the anvil block 38 as this has moved out of reach with respect to the piston 36.

It is also to be noted that provisions have been made to prevent the shoulder 108 of the forward end portion 96 of the anvil block 38 to contact the shoulder 110 of the retaining member 57. As shown in FIG. 1 the retaining member 57 has two bores, 82 and 83, the bore 83 being of smaller diameter than that of the bore 82. The anvil block 38 comprises two portions, 96 and 98, the portion 98 being of smaller diameter than that of the portion 96 and adapted to slidably fit the bore 83, and the portion 96 adapted to slidably fit the bore 82. A chamber 100 is formed between the greater diameter portion 96 of the anvil block 38 and the smaller bore portion 83 of the retaining member 57. A passage 106, drilled partly in the casing 30 and partly in the retaining member 57, serves to conduct pressure fluid from the air valve 42 to the chamber 100. The rear end portion of the retaining member 57 is provided with an annular groove 102, and forward thereof, the anvil block 38 is provided with a number of longitudinal grooves 104. When the anvil block 38 is in its operational posi-

tion, as shown in FIG. 1, there is no communication between the chamber 100 and the passage 106, but, whenever the anvil block is moved rearwardly, relative to the retaining member 57, the grooves 104 in the anvil block portion 98 will be opened to the annular groove 102 in the retaining member 57 and pressure fluid from the passage 106 will be admitted into the chamber 100 to form a cushioning means to prevent the shoulder 108 of the anvil block 38 from contacting the shoulder 110 of the retaining member 57.

It is pointed out that this anvil cushioning action is provided to automatically position the entire tool relative to the steel 40, thereby keeping the shoulder 108 of the anvil block 38 away from the shoulder 110 of the retaining member 57. This placement allows the anvil block to move slightly during the upward rebound of the steel from the work after piston impact. This motion occurs during the interaction of the steel through the anvil block with the piston which is held down during this period by pressure fluid rearwardly of the piston. The rebound of the steel is stopped largely by the pressure fluid rearwardly of the piston holding the piston on the anvil block after the impact stroke, and not by the cushion between the shoulder 108 of the anvil block and the shoulder 110 of the retaining member 57.

The main feature of the tool, that of preventing the vibrations caused by the reaction forces of the piston to be transferred to the casing 30, is achieved in the pressure chamber 84. Referring to the explanation given in connection with FIGS. 9, 11 and 12, respectively, the cushioning of the cylinder valve 34, the cushioning of the piston 36, and the inlet of the pressure fluid through the ports 76 to force the piston 36 downwardly, the sudden shocks, caused at the time of cushioning of the piston and at the time of the pressure fluid inlet at the start of the impact stroke of the piston, will be transmitted to the cylinder valve and will urge the cylinder valve 34 rearwardly. However, as the cylinder valve 34 is constantly urged forwardly by the constant pressure of pressure fluid in the pressure chamber 84 exerting a constant force on the shoulder 90 of the cylinder valve 34, the aforementioned shocks will be transmitted from the cylinder valve 34, i.e., the shoulder 90, to the pressure fluid in the pressure chamber 84 to be substantially absorbed by the pressure fluid. In this manner there will be practically no recoil of the tool at the time of cushioning and at the start of the impact stroke of the piston 36 or vibration at any other instance during the operation of the tool.

It is also to be noted that, as the area of the rear end 39 of the retaining member 57, see FIG. 1, is made equal to the area of the rear end 122 of the chamber 114, and, as the pressure in the chamber 114 and the pressure in the space forward of the piston 36 is always equal, the forces on the rear end 39 and on the rear end 122 cancel out each other. With this arrangement then, there will be no vibration at the front head 54 of the tool.

It is to be understood that the invention is not to be restricted to the details set forth since these may be modified within the scope of the appended claims without departing from the scope and spirit of the invention.

We claim:

1. A fluid actuated percussive type tool including a casing having a bore, a first fluid pressure actuated element reciprocable in said casing bore, a second pressure fluid actuated element reciprocable within the first element, a working implement extending into the casing and actuated by the second said element, means controlled by movement of said elements for controlling the supply and exhaust of pressure fluid to actuate said elements, and means providing an elastic force relationship between the casing and said first element to apply constant oppositely directed elastic forces on said first element and said casing to prevent the transmission of vibration from

said first element to the casing when said elements reciprocate.

2. The fluid actuated percussive tool claimed in claim 1 in which said first element is in the form of a sleeve and said second element is in the form of a piston, and in which the last said means includes a variable volume air chamber defined between the casing and the sleeve and in constant communication with a source of air under pressure.

3. The fluid actuated percussive tool claimed in claim 1 in which said means includes a pressure fluid containing chamber and oppositely directed pressure surfaces on said casing and said first element constantly exposed to fluid pressure in said chamber when said tool operates.

4. A fluid actuated percussive type tool including a casing having a head and a bore, a first pressure fluid actuated element slidably reciprocable in said casing bore, a second pressure fluid actuated element slidably reciprocable within the first said element, a working implement having an end extending into the tool to be actuated by the second said element, means controlled by movement of said first and second elements to deliver pressure fluid to actuate said first and second elements, and means to constantly resiliently urge said first element in the direction of said working implement when said tool is operating.

5. A fluid actuated percussive type tool including a casing having a bore therein, a supply of pressure fluid to operate said tool, a fluid actuated sleeve reciprocable in said bore, a fluid actuated piston reciprocable within said sleeve, an impact transmitting member having an end extending into the forward end of said sleeve to be actuated by said piston member, fluid distributing means connected to said supply of pressure fluid and controlled by movement of said sleeve and said piston for distributing fluid to the end portions of the interior of said sleeve to reciprocate said piston and said sleeve, and means to constantly resiliently urge said sleeve in the direction of said working implement when said tool is operating.

6. The tool claimed in claim 5 in which there is provided a pressure surface on the sleeve constantly exposed to fluid pressure to constantly urge said sleeve forwardly, and said fluid distributing means is operable to constantly conduct pressure fluid from said supply of pressure fluid to said pressure surface during operation of said tool.

7. A pressure fluid actuated percussive type tool comprising a casing and a reciprocable piston therein, an impact transmitting member positioned in the forward end portion of said casing to be actuated by said piston, said impact transmitting member having an enlargement at its forward end portion, a retaining member positioned in the forward end portion of said casing having a bore to slidably receive the enlargement of said impact transmitting member, said retaining member having an inward projection, an annular chamber being formed between the forward end of said inward projection and the rearward end of said enlargement of said impact transmitting member, a fluid supply passage in the retainer open to said bore, and a groove in the impact transmitting member positioned to communicate said chamber and passage whenever the impact transmitting member is moved rearwardly of its normal operative position.

8. A pressure fluid actuated percussive type tool including a casing having a first bore, a slidably reciprocable sleeve in said first bore having a second bore, a slidably reciprocable piston in said second bore, a working implement extending through the forward end of said casing to be actuated by said piston, fluid supply and exhaust ports in said casing and said sleeve cooperating with each other by movement of said sleeve and said piston for the distribution of pressure fluid to said bores to actuate said sleeve and said piston, and means constantly urging said sleeve in one direction to constantly cushion the movement of said sleeve when moved in the other direction.

9. The tool claimed in claim 8 in which said means includes a chamber of variable volume formed between

a portion of said first bore and an opposing portion of the outer periphery of said sleeve and bounded by opposing pressure surfaces on said casing and said sleeve, said chamber being in constant communication with the supply of pressure fluid to said ports.

10. A pressure fluid actuated percussive type tool including a casing having a closed rear end and a first bore, a slidably reciprocable sleeve in said first bore having a closed rear end and a second bore, a slidably reciprocable piston in said second bore, fluid supply and exhaust ports in said casing and said sleeve cooperating with each other by movement of said sleeve and said piston for distribution of pressure fluid to and from said bores to actuate said piston and said sleeve, a retaining member provided with a third bore positioned in the forward end portion of said casing having one end portion closing the forward end of said first bore and said second bore, the other end portion of said retaining member extending into the forward end portion of said sleeve and provided with a shoulder projecting into said third bore, a working implement extending into said third bore of said retaining member, an impact transmitting member having a shouldered portion disposed within said third bore positioned to be actuated by said piston and to transmit such actuation to said working implement, cushioning means between said shoulder in said third bore and said shouldered portion of said impact transmitting member to prevent said impact transmitting member to strike said retaining member, cushioning means between the rear ends of said piston and said sleeve to prevent said piston to strike said sleeve, cushioning means between the forward end of said sleeve and said one end of said member to prevent said sleeve to strike said member, cushioning means between the rear ends of said casing and said sleeve to prevent said sleeve to strike said casing, and a second cushioning means between said casing and said sleeve to constantly urge said sleeve to move in one direction only.

11. In a fluid actuated percussive type tool, a casing having a forward end portion and a rear end portion, a sleeve valve disposed for reciprocable movement within said casing, a piston disposed for reciprocation in said sleeve, an anvil disposed at the forward end portion of the casing and positioned to be intermittently struck by said piston, inlet passage means in said sleeve alternately passing pressure fluid into the forward and rear end portions of said sleeve to reciprocate said piston toward and away from said anvil, first exhaust passage means in continuous communication with the forward end portion of the sleeve to receive fluid in advance of the piston movement in a direction toward said anvil until after said piston strikes said anvil and out of communication with the forward end of the sleeve after the piston strikes the anvil, and second exhaust passage means in communication with the rear end portion of said sleeve to receive fluid in advance of the piston movement in a direction away from said anvil until said piston approaches the end of its rearward travel and out of communication with the rear end portion of said sleeve for the remaining rearward travel of the piston to provide a pressure build-up in advance of the piston to retard the rearward movement of the piston.

12. In a fluid actuated percussive type tool, a casing having a forward end portion and a rear end portion, a sleeve valve disposed for reciprocable movement within said casing, said sleeve being closed at opposite ends to provide a chamber, a piston disposed for reciprocation in said chamber of said sleeve, an anvil disposed at the forward end portion of the casing and positioned to be intermittently struck by said piston, inlet passage means in said sleeve for alternately passing pressure fluid into the forward and rear end portions of said chamber to reciprocate said piston toward and away from said anvil, a first exhaust passage means in the forward end portion of the sleeve for exhausting fluid from the forward end portion of the chamber during movement of the piston

in a direction toward said anvil, said piston and said sleeve being operatively associated with each other to close said first exhaust passage means after said piston strikes the anvil, and a second exhaust passage means in the rear end portion of the sleeve for exhausting fluid from the rear end portion of the chamber during movement of the piston in a direction away from said anvil, said piston being operatively associated with said sleeve to close said second exhaust passage means before the piston reaches the end of its rearward travel to trap fluid in the rear end portion of the chamber so that rearward movement of the piston is retarded.

13. The apparatus of claim 12 wherein said casing is provided with pressure fluid passage means communicating with a source of pressure fluid and said sleeve is operatively associated with said casing and said piston to communicate said casing fluid passage means with the inlet passage means in said sleeve to provide for flow of pressure fluid to the forward end of said chamber upon a predetermined time interval after the piston has struck the anvil.

14. In a fluid actuated percussive type tool, a casing having a forward end portion and a rear end portion, a sleeve valve disposed for reciprocal movement within said casing, said sleeve being closed at opposite ends to provide a chamber, a piston disposed to reciprocate within said chamber of said sleeve, an anvil disposed at the forward end of the casing and positioned to be intermittently struck by said piston, means for reciprocating said sleeve, said sleeve having first fluid inlet means and first fluid exhaust means at the forward end thereof, and second fluid inlet means and second fluid exhaust means at the rear end thereof, pressure fluid inlet means in said casing communicating with a source of pressure fluid to receive fluid therefrom, said sleeve being cooperatively associated with said casing to provide for alternately communicating said first and second fluid inlet means with the pressure fluid inlet means in said casing to alternately pass pressure fluid into the forward and rear end portions of the chamber to reciprocate said piston toward and away from said anvil, said piston and said sleeve being cooperatively associated to maintain said first fluid exhaust means open during forward travel of said piston toward said anvil and to close said first exhaust means after the piston strikes the anvil, said piston and sleeve being cooperatively associated with each other to maintain said second fluid exhaust means open during part of the rearward travel of the piston away from the anvil and to close said second fluid exhaust means during the remaining rearward travel of the piston to cause pressure build-up in advance of the piston between the piston and closed rear end of the sleeve and retard rearward travel of the piston, said sleeve casing and piston being cooperatively associated with each other to communicate the first fluid inlet means with the pressure fluid inlet means in said casing to provide for flow of pressure fluid into said forward end portion of the chamber of the sleeve after a predetermined time interval after the piston strikes the anvil.

15. The apparatus of claim 14 wherein said means for reciprocating said sleeve valve comprises a plurality of spaced opposed pressure surfaces in said sleeve alternately communicating with the pressure fluid inlet means in said casing to cause reciprocation of said sleeve

16. In a fluid actuated percussive type tool, a casing having a forward end portion and a rear end portion, a sleeve valve disposed for reciprocal movement within said casing, said sleeve being closed at the opposite ends to provide a chamber, a piston disposed to reciprocate within said sleeve, an anvil disposed at the forward end of the casing and positioned to be intermittently struck by said piston, a sleeve having inlet and outlet passage means adjacent the forward and rear end portions thereof, pressure fluid inlet passages and pressure fluid exhaust passages in said casing, said sleeve having opposed pressure

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faces alternately communicating with said pressure fluid inlet passages to thereby reciprocate said sleeve, said inlet passage means in the rear end portion of the sleeve being in communication with the pressure fluid inlet passages in said casing as the sleeve reciprocates to provide for flow of pressure fluid into said chamber of the sleeve to move the piston in a direction toward said anvil to strike the latter when the sleeve is in its rearward position of travel, said sleeve cooperating with said casing to prevent communication of the inlet passage means in the forward end portion of the sleeve with the pressure fluid inlet passages in the casing during the forward movement of the sleeve and provide communication between the inlet passage means in the sleeve with the said pressure fluid inlet passages in the casing to pass pressure fluid into the forward portion of the chamber in the sleeve to drive the piston in a direction away from said anvil after the sleeve has moved a predetermined distance in its rearward travel, said piston sleeve and casing being cooperatively associated with each other to communicate said outlet passage means in the forward end of said sleeve with the pressure fluid exhaust passages in the casing during forward travel of said piston and sleeve to prevent a pressure build-up in advance of the piston, and closing said outlet passage means after the piston strikes the anvil, said piston, sleeve, and casing being cooperatively associated with each other to communicate the outlet passage means in the rear end of said sleeve with the outlet passage means in the casing during part of the rearward travel of said piston and sleeve and closing said outlet passage means for the remaining rearward travel of the piston to cause a pressure build-up in advance of the piston to thereby retard the rearward movement of the piston.

17. In a fluid actuated percussive type tool, the combination comprising: a casing having forward and rear end portions and a hollow chamber located between said end portions; a free piston slidably mounted in said chamber for reciprocation; an anvil mounted in the forward end portion of said casing to be struck at the end of the

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forward stroke of said piston; means for admitting pneumatic pressure into said chamber alternately on the opposite ends of said piston for reciprocating it in said chamber; a member slidably and reciprocally mounted in said chamber adjacent the rear end portion of said casing and operative, when reciprocated, to vary the volume of the space located between said member and said piston; and means operative to pneumatically move said member forwardly in said chamber during the forward stroke of said piston.

18. The tool of claim 17 including means for constantly applying pneumatic pressure to said member to bias it forwardly in said chamber during both the forward and rearward strokes of said piston.

19. The tool of claim 17 wherein: said member includes valve means for alternately admitting pneumatic pressure into said chamber on the opposite ends of said piston and being operative to control the distribution of pneumatic pressure in a manner to cause the rearward stroke of said piston to be substantially slower than its forward stroke.

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