No. 743,920. PATENTED NOV. 10, 1903.

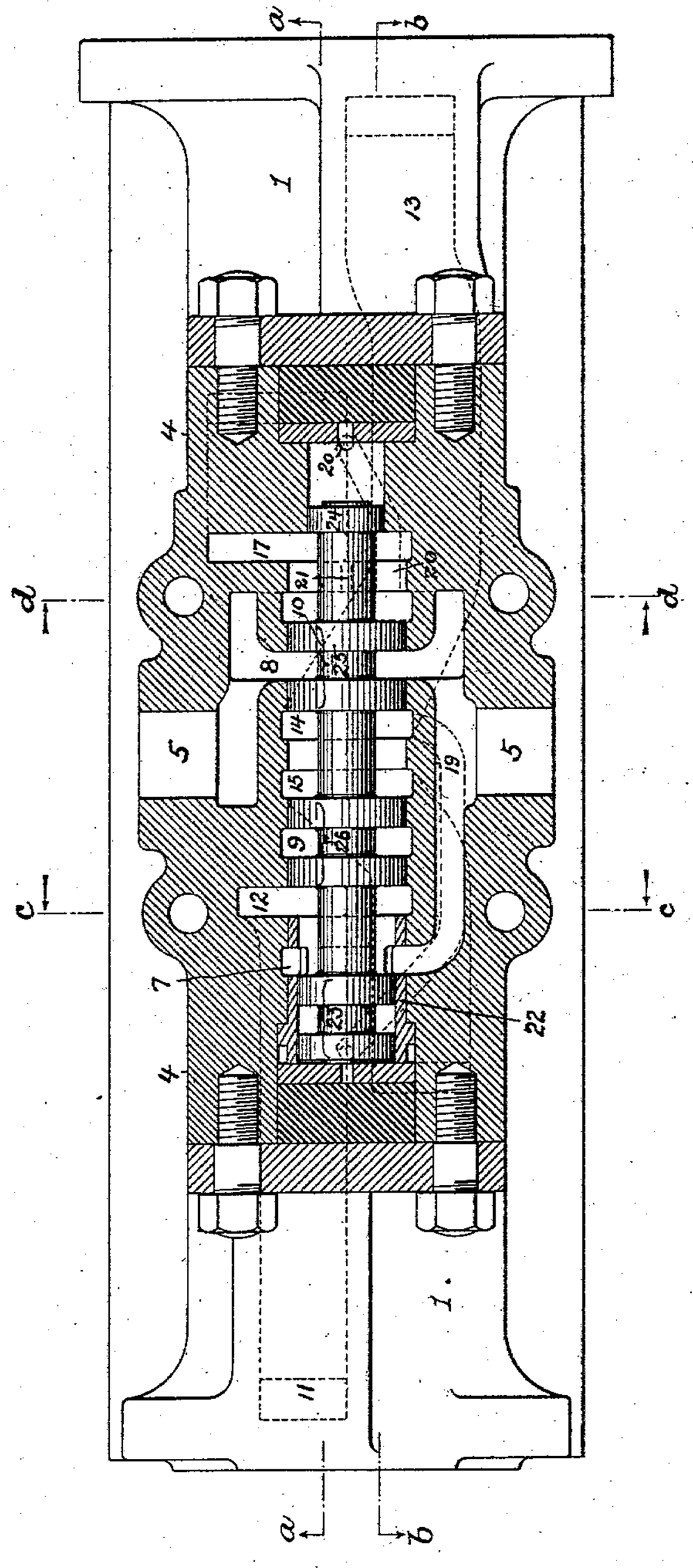
T. H. PHILLIPS.

IMPACT TOOL.

APPLICATION FILED SEPT. 2, 1902.

NO MODEL. 5 SHEETS—SHEET 1.

Fig. 1.



Witnesses:-

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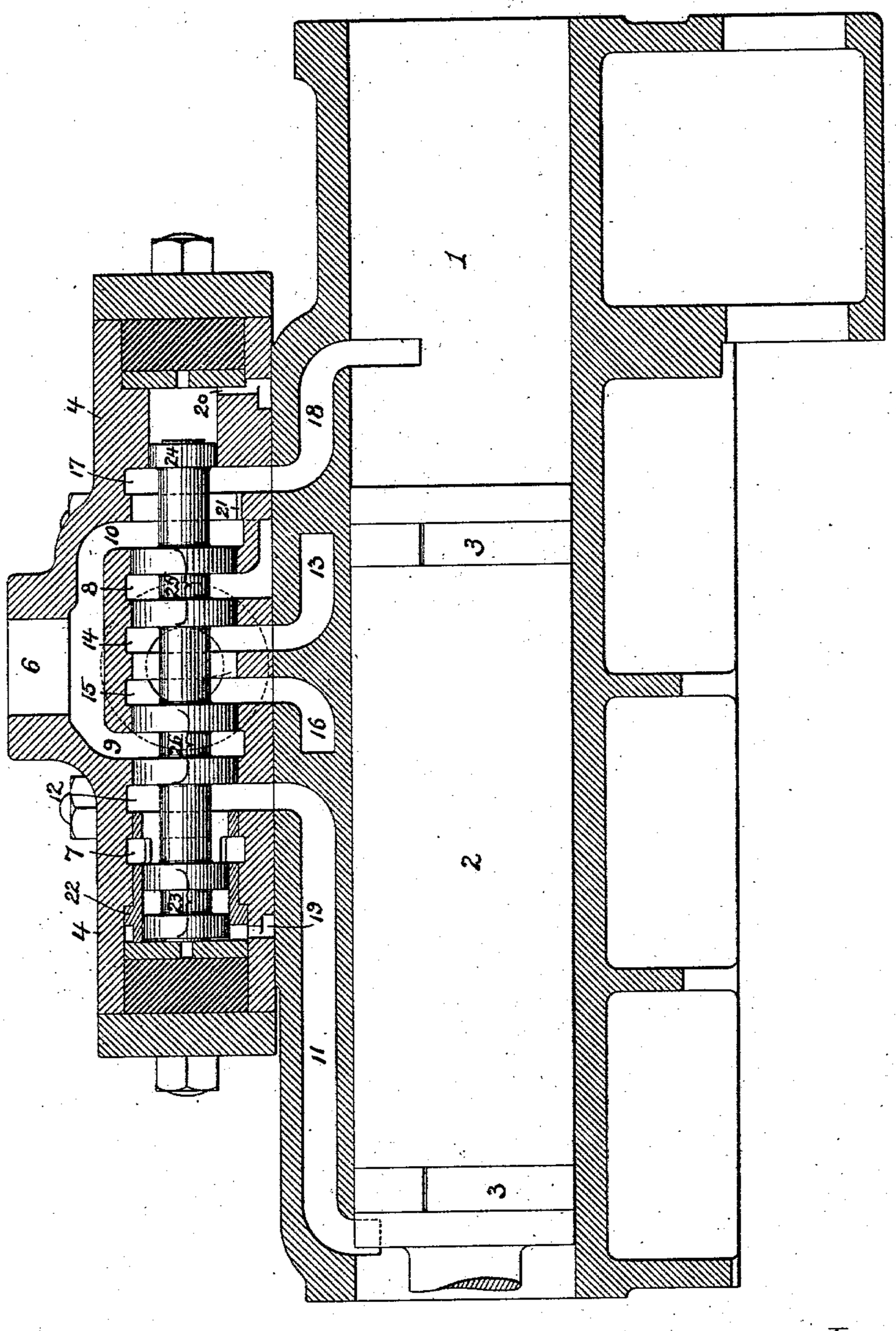
NO MODEL. 5 SHEETS—SHEET 2.

Fig. 2



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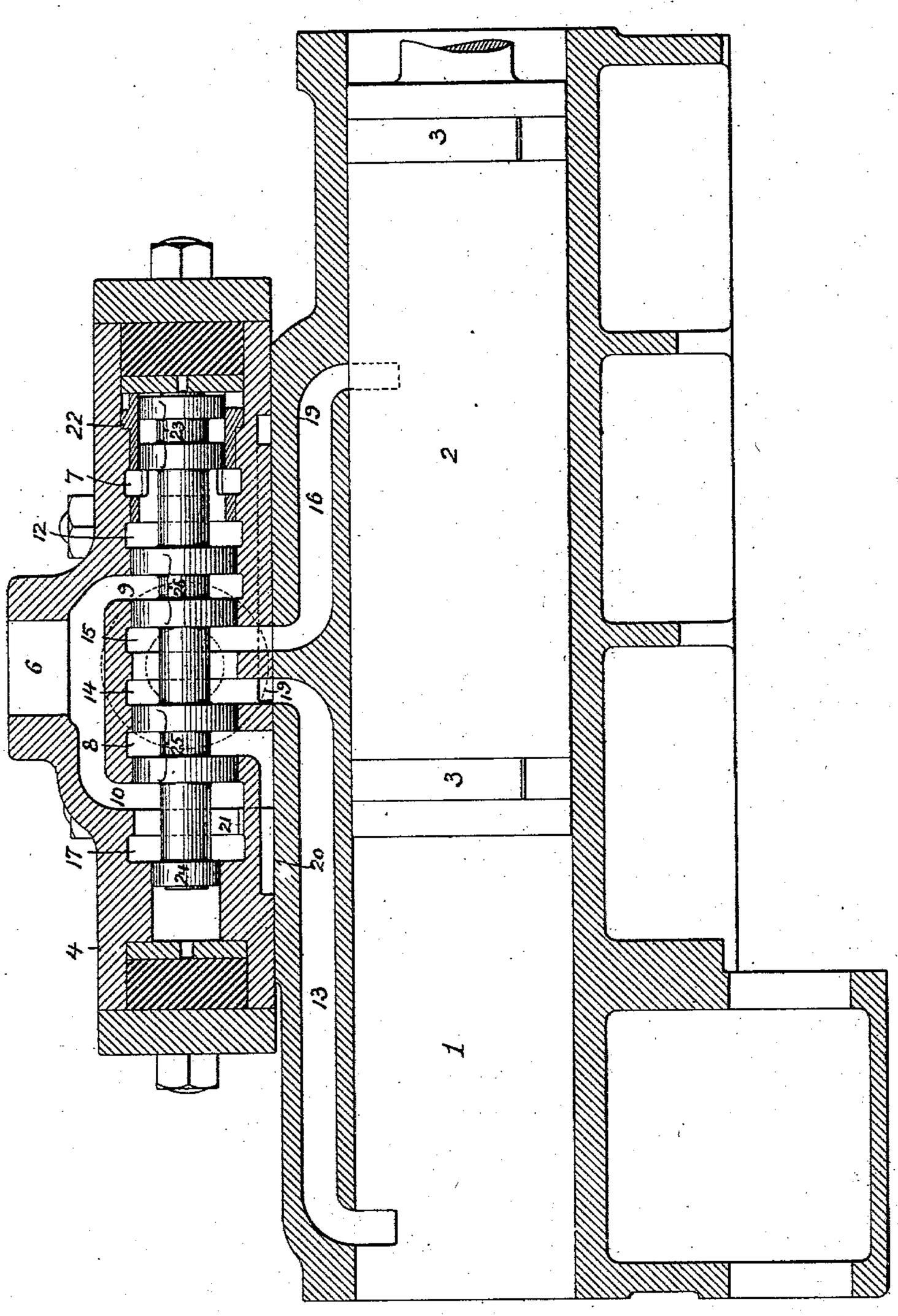
NO MODEL. 5 SHEETS—SHEET 3.

Fig. 3.



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NO MODEL. 5 SHEETS—SHEET 4.

Fig. 5

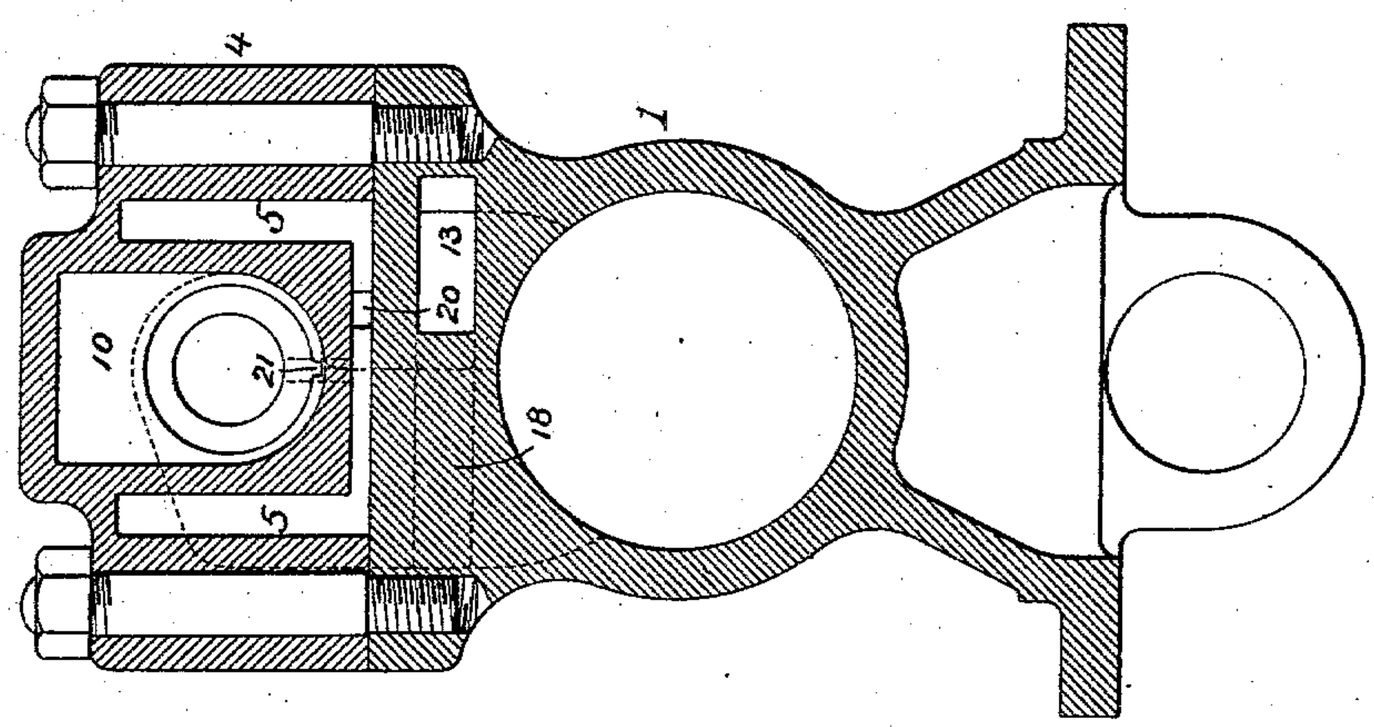
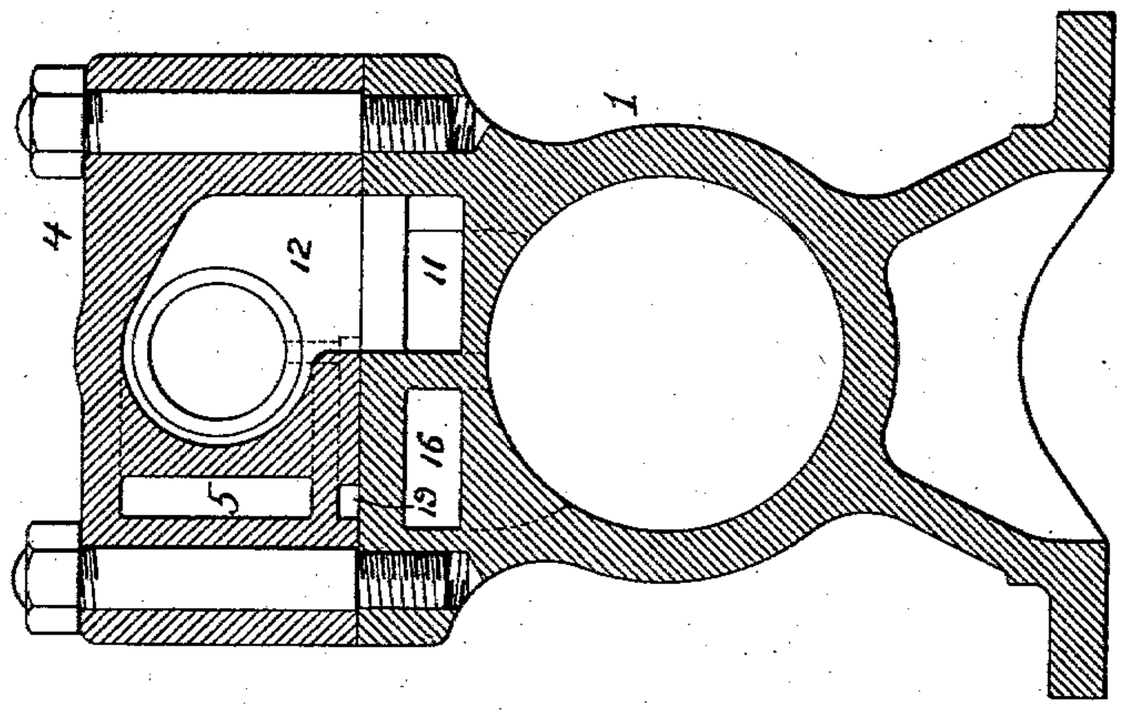


Fig 4



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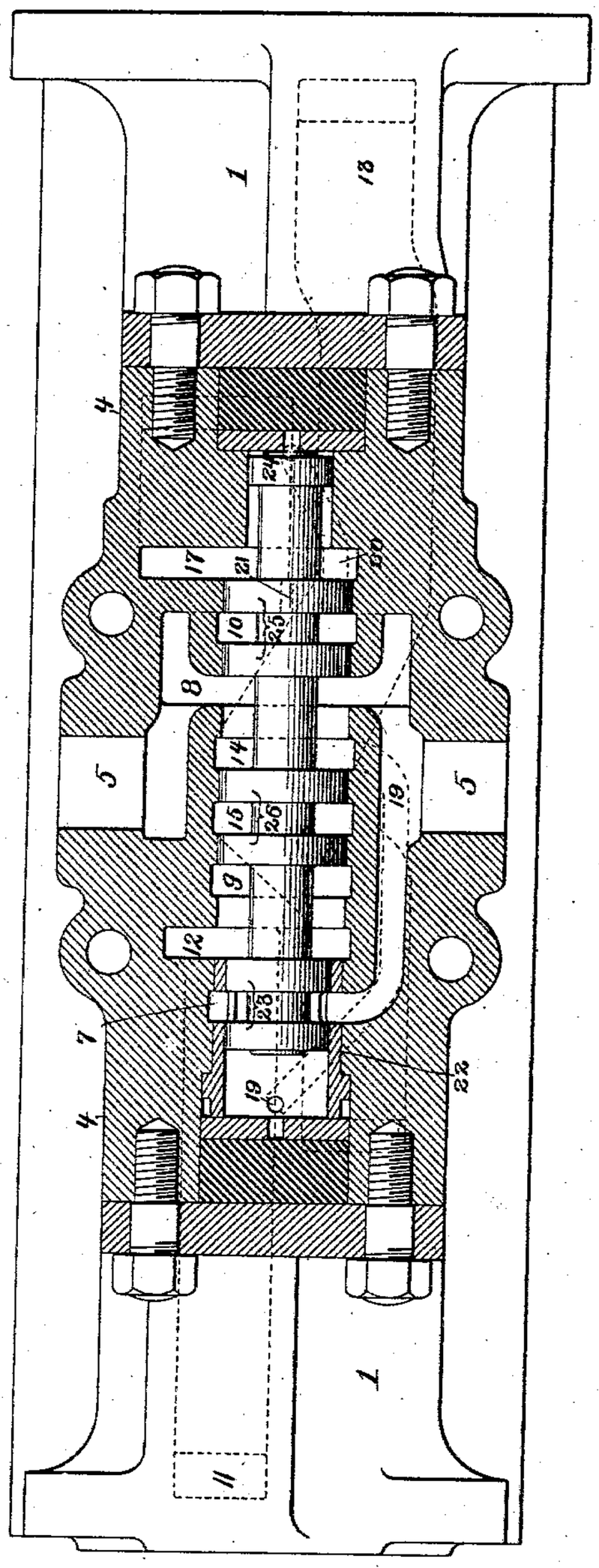
NO MODEL. 5 SHEETS—SHEET 5.

Fig. 6.



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No. 743,920. Patented November 10, 1903.

UNITED STATES PATENT OFFICE.

THOMAS H. PHILLIPS, OF ST. DAVIDS, PENNSYLVANIA.

IMPACT-TOOL.

SPECIFICATION forming part of Letters Patent No. 743,920, dated November 10, 1903.

Application filed September 2, 1902. Serial No. 121,837. (No model)

To all whom it may concern:

Be it known that I, THOMAS H. PHILLIPS, a citizen of the United States, residing in St. Davids, Delaware county, Pennsylvania, have invented certain Improvements in Impact-Tools, of which the following is a specification.

My invention relates to that class of impact-tools, such as rock-drills, which are actuated by steam, air, or other elastic fluid under pressure, one object of my invention being to so construct such a tool that the admission of motive fluid to the rear end of the cylinder for the purpose of cushioning the piston on the rearward stroke will be effected when the piston reaches a predetermined point in such stroke without any previous movement of the valve, so that this operation cannot be defeated or delayed by any failure of the valve to move or to move promptly.

A further object of the invention is to construct the valve, valve-chest, and passages therein so that the valve will move more quickly in one direction than in the other and will be subjected to such pressure when in either of its extreme positions as to prevent accidental displacement of it from either of these extreme positions.

Other objects of the invention are to provide for an uncushioned blow and for a variable stroke of piston—that is to say, a long stroke, a short stroke, and a stroke anywhere intermediate between these two extremes.

These objects I attain in the manner hereinafter set forth, reference being had to the accompanying drawings, in which—

Figure 1 is a view showing in sectional plan the valve-chest of my improved impact-tool and in plan the cylinder of the tool and the valve contained in the valve-chest. Fig. 2 is a vertical section of the tool on the line *a a*, Fig. 1. Fig. 3 is a similar section on the line *b b*, Fig. 1. Fig. 4 is a transverse section on the line *c c*, Fig. 1. Fig. 5 is a transverse section on the line *d d*, Fig. 1; and Fig. 6 is a view similar to Fig. 1, but illustrating the valve in its opposite extreme position in the chest.

Although my invention is applicable to impact-tools operated by any motive fluid under pressure, I will for the purpose of convenience in this specification allude to the tool as a rock-drill operated by steam.

In the drawings I have shown simply the cylinder and valve-chest structure, the piston, and the valve, omitting the heads of the cylinder and all other appurtenances not necessary for the proper understanding of my invention.

1 represents the cylinder, and 2 the piston contained therein, the latter being a solid piston with packing-rings 3 3 near each end, although it may, if desired, be centrally recessed to reduce its weight; but in that case the central recess will perform no other function, my present tool being distinct from that class of tools in which the central chamber of the piston is always in communication either with the steam-supply or with the exhaust, the admission of steam to and its exhaust from the cylinder and the ends of the valve-chest in the present instance being effected only through the medium of the valve-chest and its contained valve.

The valve-chest is represented at 4 and is suitably mounted upon the cylinder, said valve-chest having a steam-chamber 5 with opposite openings, either of which may be connected to the supply-pipe, the other being suitably plugged, thus permitting the tool to receive steam from a pipe either on the right-hand side or on the left-hand side of the same, as may be found most convenient in practice. On the top or back of the valve-chest is another opening 6, which constitutes the exhaust-opening and is intended to receive a pipe for conveying the exhaust to any desired point, or it may discharge the exhaust directly therefrom, if desired, when compressed air is the motive fluid employed.

The steam-chamber 5 is continuously in communication with two chambers 7 and 8, which communicate with the bore of the valve-chest, and the exhaust-opening is continuously in communication with two chambers 9 and 10, likewise communicating with the bore of the valve-chest.

Leading to the front end of the cylinder is a passage 11, which communicates with a chamber 12 in the valve-chest, and from the rear end of the cylinder extends a passage 13, which communicates with a chamber 14 of the valve-chest. Another chamber 15 of the valve-chest communicates, through a passage 16, with a port in the cylinder, whose position

is determined by that point in the rearward travel of the piston at which it is desired to admit steam to the rear end of the cylinder for cushioning the rear stroke of the piston. Another chamber 17 in the valve-chest communicates, through a passage 18, with a port in the cylinder located at that point where in the rearward stroke of the piston it is desired to cut off the exhaust from the rear end of the cylinder and to permit the exhaust from the rear end of the cylinder on the forward stroke.

The forward end of the bore of the valve-chest communicates, through a passage 19, with the chamber 14 of said chest and with the rear end of the cylinder through the passage 13, and the rear end of the valve-chest bore is in constant communication, through a passage 20, with the steam-chamber 5 of the chest.

The chamber 17 of the valve-chest is in communication with the exhaust-chamber 10 of the same through a small passage 21, this latter passage consisting simply of a slot formed in that portion of the valve-chest bore which intervenes between the passages 10 and 17, as shown in Figs. 2, 3, and 5.

The valve-chest has a differential bore, the diameter of said bore being greatest in the central portion of the chest, somewhat less at one end, and still less at the other end, and in order to permit the boring of the chest and the insertion and removal of the valve the reduction in diameter at the larger end of said bore is effected by means of a bushing 22, inserted therein and properly ported to communicate with the chamber 7 and passage 19 of the valve-chest. The valve has an end piston 23, an opposite end piston 24, and two intermediate pistons 25 and 26, the pistons 23, 25, and 26 being grooved for the purpose of reducing the weight of the valve, although they may be solid, if desired, the grooves having no operative function.

Supposing that the parts are in the position shown in Figs. 1 and 2—that is to say, with both piston and valve at the forward extremes of their movement—the operation of the tool is as follows: Steam is being admitted to the forward end of the cylinder through the chambers 7 and 12 and passage 11 and is being exhausted from the rear end of the cylinder through the passage 18 and chambers 17 and 10, the chamber 12 being cut off from communication with the exhaust-chamber 9 by the piston 26 and the chambers 14 and 15 being in communication with each other between the pistons 25 and 26. The piston 2 consequently moves rearward in the cylinder, the first effect of this action being to cut off the exhaust from the rear end of the cylinder when the piston closes the cylinder end of the passage 18, the initial stage of compression in the rear end of the cylinder then beginning. The piston continues to move rearwardly under these conditions until the forward end of the piston uncovers the cylinder end of the passage 16, whereupon steam from the forward end of the cylinder passes through said passage 16, through the valve-chest between the pistons 25 and 26, and through the passage 13 to the rear end of the cylinder, so as to provide the desired cushion for preventing the piston 2 on its rearward movement from striking the rear head of the cylinder. Up to the time that the passage 16 was uncovered by the piston 2 the valve was held in its forward position by the pressure of live steam exerted against the rear face of the piston 24, this pressure being opposed only by the pressure exerted upon the forward face of the piston 26 less the pressure exerted upon the rear face of the piston 23, the forward face of the latter having been relieved from pressure by the exhaust of the steam therefrom through the passages 19 13, the rear end of the cylinder, and the passage 18, the compression in the rear end of the cylinder after the rear end of the piston passes the passage 18 not being sufficient to change these conditions. As soon, however, as the passage 16 is uncovered by the piston 2 live steam enters the forward end of the valve-chest through the passage 19, and the pressure conditions are now reversed, full pressure being now exerted upon the forward faces of the pistons 23 and 26 and resisted only by the pressure upon the rear faces of the pistons 23 and 24. The area of the forward faces thus exposed to pressure being considerably in excess of the area of the rear faces upon which pressure is exerted, the valve is quickly moved rearward in the chest to the position shown in Fig. 6. The forward end of the cylinder is now open to the exhaust through the passage 11 and chambers 12 and 9, while steam still continues to be admitted to the rear end of the cylinder through the passage 13 and chambers 14 and 8. Hence the conditions are now such as to cause the piston to travel forwardly. The passage 16 is cut off from the exhaust by the piston 26 of the valve; but steam is still admitted to the front end of the valve-chest through the passage 19 in order to maintain the valve in the rearward position against the pressure of steam exerted upon the smaller piston of the valve. As the piston 2 travels forwardly in the cylinder the rear end of the same uncovers the passage 18, whereupon steam from the rear portion of the cylinder gains access to the chamber 17 of the valve-chest, and the forward pressure of steam upon the rear face of the piston 24 of the valve is now reinforced by pressure against the rear face of the piston 25 less the pressure exerted against the forward face of the piston 24, and as the pressure upon the forward face of the piston 23 of the valve is less than the combined pressures upon the pistons 24 and 25 the valve is again moved to its forward position, as shown in Figs. 1 and 2, the forward face of the valve being then relieved from pressure by reason of the exhaust of the steam therefrom through the passages 19, 13, and 18.

By the use of a solid piston 2 of the char-

acter specified the construction of the same is simplified and its cost lessened and a longer bearing-surface and wearing effect is provided than in a piston having a central annular groove, the lessening of wear adding to the period of usefulness of both piston and cylinder.

It will be evident that although the steam for effecting the cushioning of the piston on the back stroke passes through the valve-chest and between pistons of the valve the preliminary flow of steam to the rear end of the cylinder is controlled by the movement of the piston in the cylinder and not by movement of the valve. Hence sticking of the valve in its chest or a sluggish movement of the valve due to any cause cannot delay the cushioning action upon the piston 2 and permit injury to the rear head of the cylinder. As soon as the valve is moved, however, the open communication between the two ends of the cylinder is cut off by piston 26 of the valve, so that there can be no waste of steam through the same from the rear end of the cylinder when the forward end of the cylinder is open to the exhaust.

One object of using a larger piston on one end of the valve than on the other end is to provide on the forward stroke of the piston 2 for a movement of the valve in the chest which will be slower than the movement of the valve in the opposite direction, so that the valve will not be shifted to admit steam to the forward end of the cylinder until the blow has been struck, thereby obtaining an uncushioned blow and utilizing all of the energy stored up in the moving piston. Another object of this construction is that when the valve is in its proper position in the chest, with full pressure exerted upon its end pistons 23 and 24 and the piston 2 making its forward movement in the cylinder, there shall be a preponderance of pressure upon the piston 23 of the valve, so as to hold the valve in that position until the piston 2 uncovers the port connecting with the passage 18, thus preventing any premature movement of the valve.

The difference in area between the middle pistons of the valve and the larger end piston should be less than the area of the smaller end piston of the valve, so that when the larger end of the valve-chest is open to the atmosphere there will be a preponderance of pressure on the opposite or small end of the valve to hold it in position and prevent accidental displacement.

The valve is a balanced piston-valve. Consequently the wear upon it and upon the steam-chest is slight and the renewals of these parts which are required will be infrequent.

It is obvious that the cylinder end of the exhaust-passage 18 can be located in any desired relation to the rear end of the cylinder, depending upon the point in the forward travel of the piston at which it is desired to admit steam to the valve-chest for the purpose of shifting the valve, and in like manner the cylinder end of the passage 16 can bear any desired relation to the front end of the cylinder, depending upon the point in the rearward stroke of the piston at which it is desired to admit steam to the rear end of the cylinder for cushioning purposes.

It will be noted that if the rearward movement of the piston 2 was arrested as soon as the forward end of said piston uncovered the cylinder end of the passage 16 steam would be admitted to the rear end of the cylinder, the valve would be moved, opening the front end of the cylinder to the exhaust, and the piston would be forced in a forward direction. In like manner if the forward movement of the piston 2 was arrested as soon as the rear end of said piston had uncovered the cylinder end of the passage 18 the valve would be moved, opening the rear end of the cylinder to the exhaust and admitting steam to the front end of the cylinder to cause the return of the piston. Between these two points, therefore, would be the limits of the shortest stroke. A short light stroke is particularly advantageous in starting a hole or in crossing seams in the rock, which vary in hardness from the inclosing strata. The extent to which the piston is permitted to move forwardly in the cylinder after uncovering the passage 18 and before delivering the blow is dependent upon the adjustment of the cylinder upon its supports, and the greater this length of stroke the greater will be the rearward movement of the piston after uncovering the passage 16, because of the greater momentum acquired by it at the time it uncovers said passage.

The purpose of the passage 21 between the chambers 17 and 10 of the valve-chest is to provide against the possibility of any premature movement of the valve in the valve-chest on the forward stroke of the piston due to any leakage of steam around the piston and thence through the passage 18 to the chamber 17, such leaking steam being prevented from accumulating in the chamber 17 by reason of the open communication between said chamber and the exhaust-chamber 10, which is provided by said passage 21. This passage 21 is of such area that while it will permit the escape of steam which might otherwise accumulate in chamber 17 from wear between the piston and cylinder it will have little or no effect upon the full pressure exerted upon the piston 25 of the valve after the piston 2 has uncovered the cylinder end of the passage 18. After the rear end of the piston covers the exhaust-port 18 on the return stroke the compression of vapor remaining in the rear end of the cylinder begins and continues until the front end of the piston uncovers the port 16 and permits a flow of steam under pressure into the rear end of the cylinder to form a cushion, this preliminary compression assisting in bringing the piston to a state of rest and assisting

by reaction in starting the piston upon the return or forward stroke.

Although in the drawings herewith I have shown the valve to be so arranged with respect to the cylinder that the larger end piston of the valve is nearest the front end of the cylinder and the movement of the valve is such that it follows in the same direction the movement of the piston in the cylinder and although this is the preferable construction, there are certain types of rock-drills in which the movement of the valve is in a direction opposite to that of the movement of the piston in the cylinder, and it will be evident that my invention is equally applicable to structures of that type.

Having thus described my invention, I claim and desire to secure by Letters Patent—

1. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve, and passages extending from the rear end of the cylinder to the valve-chest and from the valve-chest to a point some distance from the front end of the cylinder, whereby, when the piston, in its rearward movement, uncovers said forward passage, steam will be permitted to pass directly from the front end of the cylinder to the rear end of the same, independently of any movement of the valve, substantially as specified.

2. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve, passages serving to convey steam from the forward end of the cylinder to the rear end of the same without movement of the valve after the piston has partially completed its rearward stroke, and an exhaust-passage from the rear end of the cylinder which is covered by the rear end of the piston before the steam-conveying passage is uncovered by the forward end of the same, substantially as specified.

3. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve, and passages whereby steam is conveyed from the forward end of the cylinder to the rear end of the same without movement of the valve after the piston has partially completed its rearward stroke, the valve being constructed to cut off this communication when it has moved so as to open the forward end of the cylinder to the exhaust, substantially as specified.

4. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve, and passages whereby steam is conveyed from the forward end of the cylinder to the rear end of the same without movement of the valve after the piston has partially completed its rearward stroke, the valve being constructed to cut off this communication when it has moved so as to open the forward end of the cylinder to the exhaust, and being so combined with the motive-fluid inlet as to open the rear end of the cylinder to the motive fluid simultaneously with such closing of communication between the front and rear ends of the cylinder, substantially as specified.

5. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve having at one end a piston of greater diameter than the piston at the other end, passages whereby a continuous pressure of motive fluid is exerted upon the smaller piston of the valve and passages whereby the cylinder-piston, at a certain point in the rearward stroke, opens communication between the forward end of the cylinder and the larger end of the valve-chest so as to permit flow of motive fluid from one to the other, substantially as specified.

6. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve having at opposite ends pistons of different diameters, passages for admitting constant pressure of motive fluid to the smaller piston, passages whereby communication is established between the front and rear ends of the cylinder without movement of the valve when the cylinder-piston reaches a certain point in its rearward stroke, and a communication between said passages and the larger end of the valve-chamber, substantially as specified.

7. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve having at opposite ends pistons of different diameters, intermediate pistons of greater diameter than the larger end piston, and passages whereby movement of the valve in one direction is effected by pressure exerted upon the larger end piston of the valve and the adjacent intermediate piston, while movement of the valve in the other direction is effected by pressure exerted upon the smaller end piston of the valve and the adjacent intermediate piston, substantially as specified.

8. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve having end pistons of different diameters and intermediate pistons of larger diameter than the larger end piston, passages whereby movement of the valve in one direction is effected by pressure upon the smaller end piston and upon the adjacent intermediate piston, a permanently-open exhaust-chamber, a valve-controlled exhaust-passage leading to the cylinder and a permanent leakage-passage between said valve-controlled exhaust-passage and the permanently-open exhaust-passage, substantially as specified.

9. The within-described valve for an impact-tool, said valve having a small piston at one end, a larger piston at the other end, and two intermediate and still larger pistons, substantially as specified.

10. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve having opposite end pistons and intermediate pistons but having no communication between its opposite ends, steam inlet and exhaust passages communicating with the valve-chest at an intermediate point whereby the flow of

steam to and from the cylinder is controlled by said intermediate pistons, and passages whereby full pressure is constantly exerted on one end of the valve, and the opposite end of the valve is opened alternately to full pressure and exhaust, substantially as specified.

11. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve having opposite end pistons one of which is larger in diameter than the other and intermediate pistons of still larger diameter but having no communication between its opposite ends, steam inlet and exhaust passages communicating with the valve-chest at an intermediate point whereby the flow of steam to and from the cylinder is controlled by said intermediate pistons, and passages whereby full pressure is constantly exerted upon the small end of the valve, and its larger end is alternately opened to full pressure and to the exhaust, substantially as specified.

12. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve having no communication between its opposite ends but having end pistons one of which is larger in diameter than the other, and intermediate pistons of still larger diameter, and passages so disposed in respect to the pistons of the valve that the piston of small diameter is subjected to constant pressure, and full-pressure steam is admitted to the opposite end of the valve-chest to move the valve against this pressure on the piston of small diameter, and also while the valve is being moved in the opposite direction, substantially as specified.

13. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve, a passage leading to one end of the valve-chest and serving to admit motive fluid under full pressure to the valve-chest and exhaust it therefrom, and other passages coöperating therewith, whereby motive fluid to cause movement of the valve is derived from the forward end of the cylinder, and motive fluid to hold the valve in position is derived from the rear end of the cylinder, substantially as specified.

14. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve, passages whereby motive fluid is permitted to pass from the forward end to the rear end of the cylinder without movement of the valve, and an independent passage serving to convey motive fluid under pressure to the valve-chest to assist in the movement of the valve, substantially as specified.

15. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve, passages whereby motive fluid is permitted to pass from the forward end to the rear end of the cylinder without movement of the valve, and an independent passage serving to exhaust motive fluid from the rear end of the cylinder, said passage also serving to convey motive fluid under pressure to the valve-chest to assist in the movement of the valve, substantially as specified.

16. The combination in an impact-tool, of a cylinder, a piston, a valve-chest, a valve, a piston-controlled passage serving to convey motive fluid from the cylinder to the valve-chest to move the valve, and a leakage-opening leading from said passage to the exhaust, whereby motive fluid leaking around the piston is prevented from accumulating in the passage, substantially as specified.

17. The combination in an impact-tool, of a cylinder, an unchambered piston therein, a valve-chest, a valve, and passages whereby motive fluid is permitted to pass from the forward to the rear end of the cylinder without movement of the valve when the piston reaches a predetermined point in its rearward stroke, substantially as specified.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS H. PHILLIPS.

Witnesses:
FLORENCE HILLMAN,
F. E. BECHTOLD.