No. 700,081. Patented May 13, 1902.

T. H. PHILLIPS.

IMPACT TOOL.

(Application filed Feb. 13, 1902.)

(No Model.) 5 Sheets—Sheet 1.

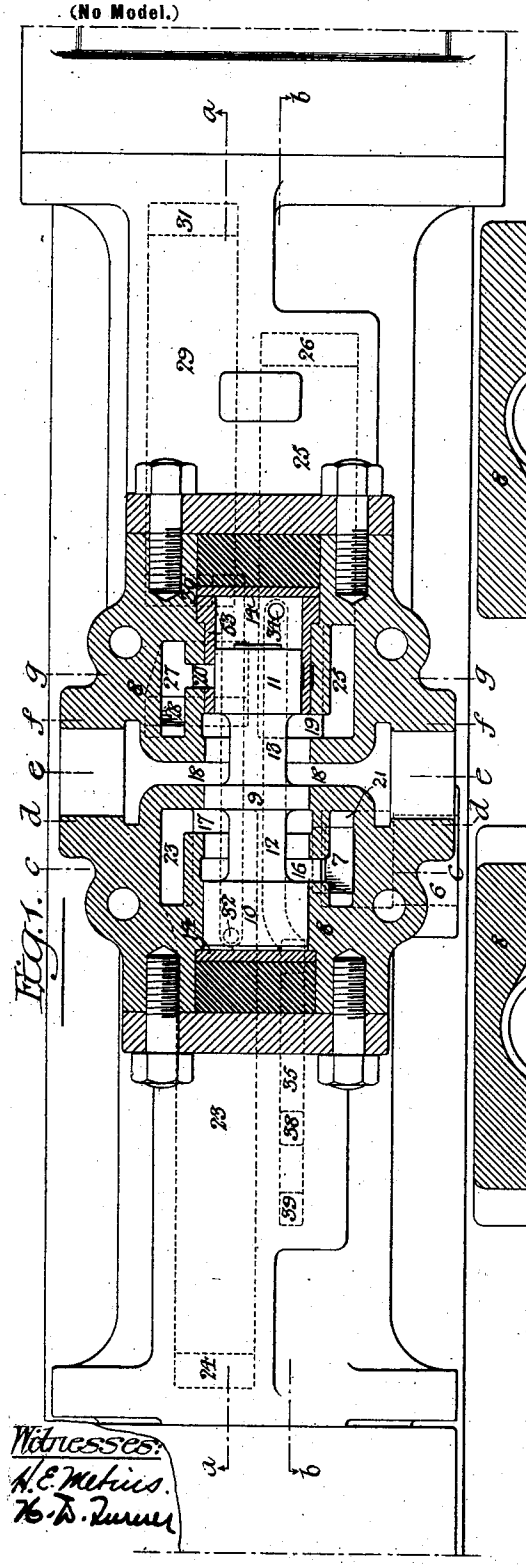


FIG. 1.

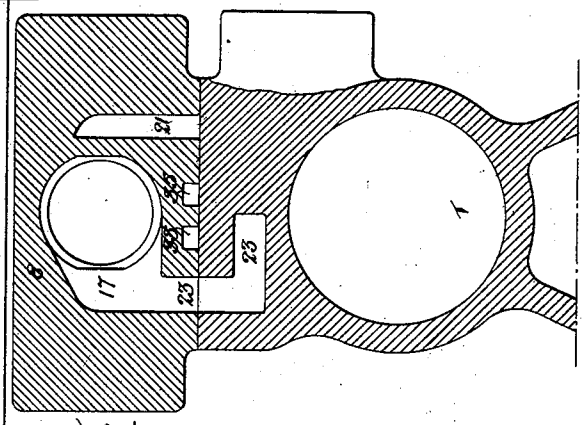


FIG. 5.

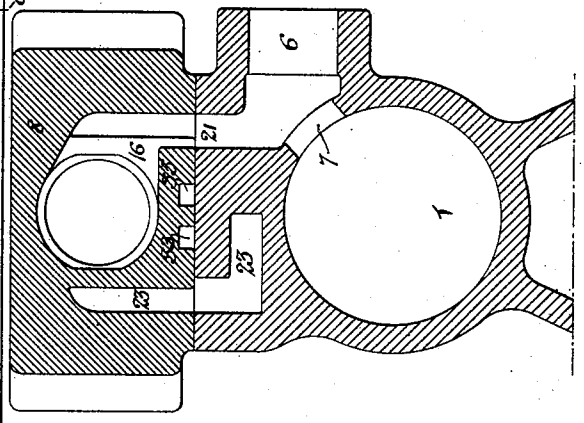


FIG. 4.

Witnesses:
H. E. Mathias.
H. D. Turner

Inventor:
Thomas H. Phillips;
by His Attorneys;
Howson & Howson

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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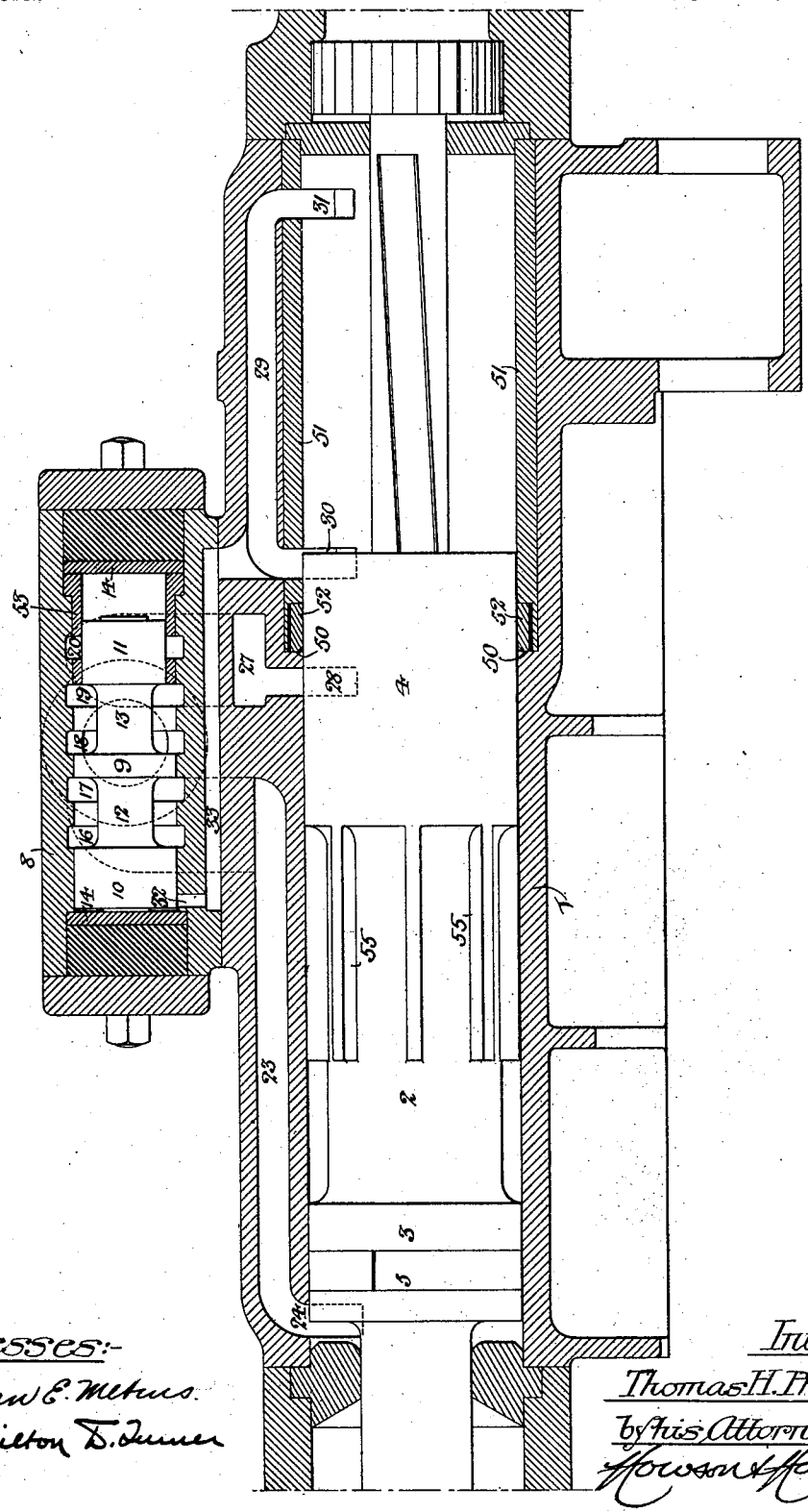


Fig. 2.

Witnesses:-
Herman E. Metcalf.
Hamilton D. Turner

Inventor
Thomas H. Phillips,
by his Attorneys;
Howson & Howson

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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T. H. PHILLIPS.

IMPACT TOOL.

(Application filed Feb. 13, 1902.)

(No Model.) 5 Sheets—Sheet 3.

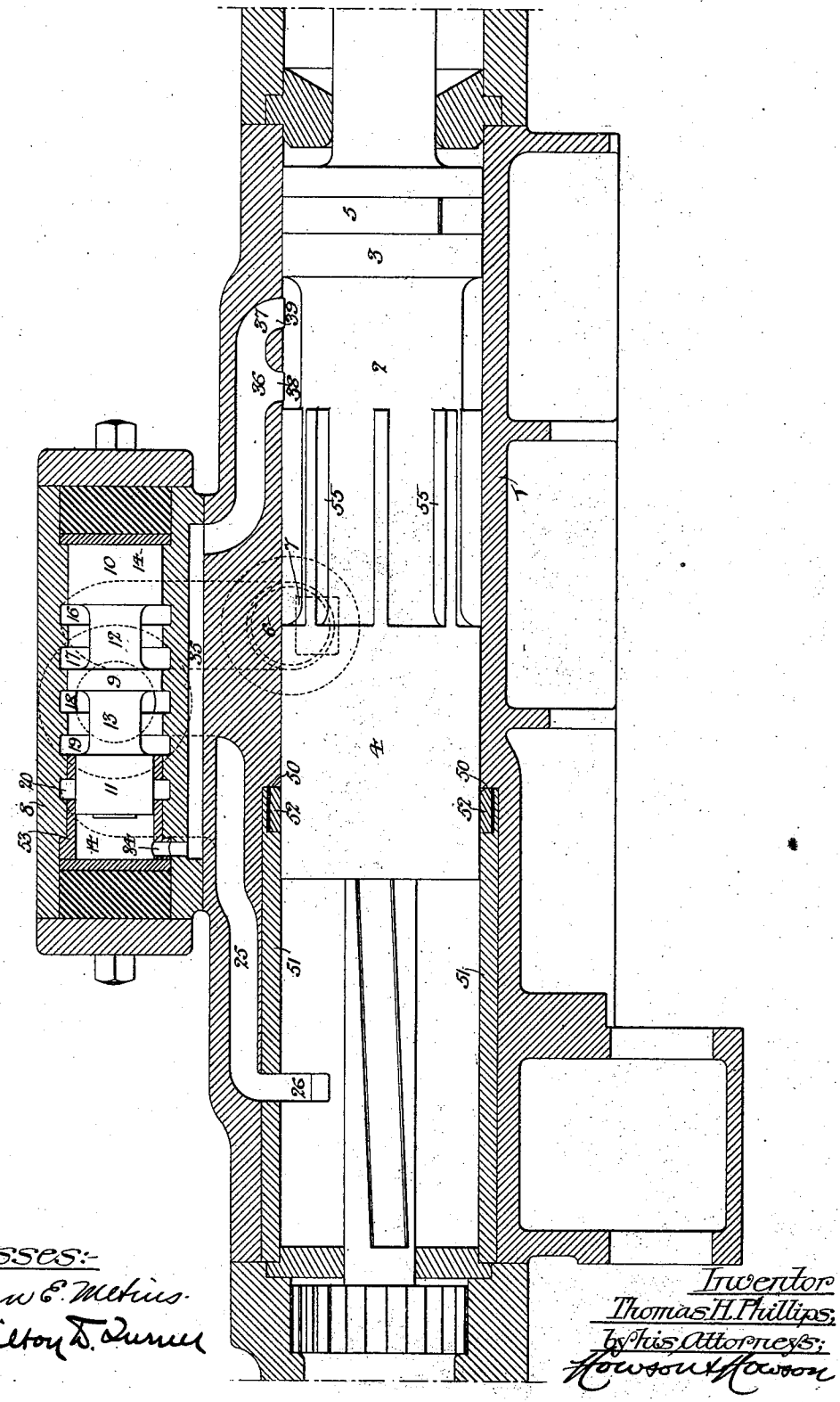


FIG. 3.

Witnesses:-
Herman E. Mekins.
Hamilton D. Turner

Inventor
Thomas H. Phillips,
by his Attorneys;
Howson & Howson

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 700,081. Patented May 13, 1902.

T. H. PHILLIPS.

IMPACT TOOL.

(Application filed Feb. 13, 1902.)

(No Model.) 5 Sheets—Sheet 4.

Fig. 8.

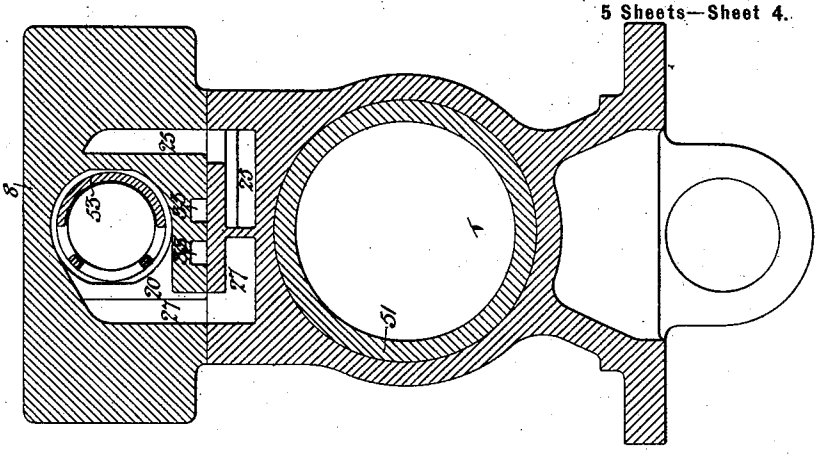


Fig. 7.

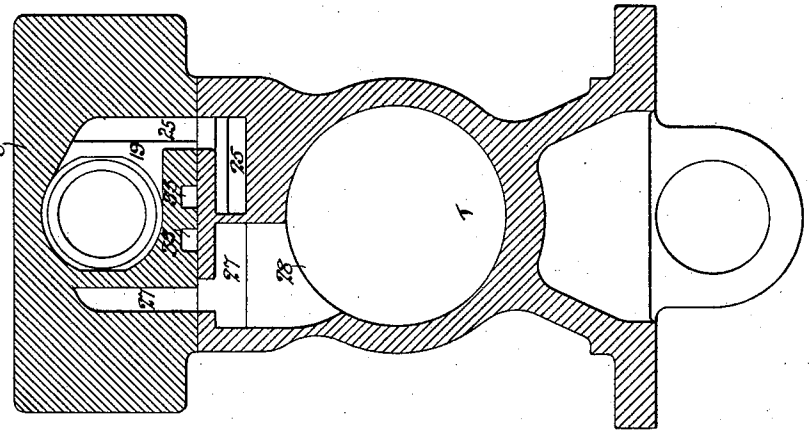
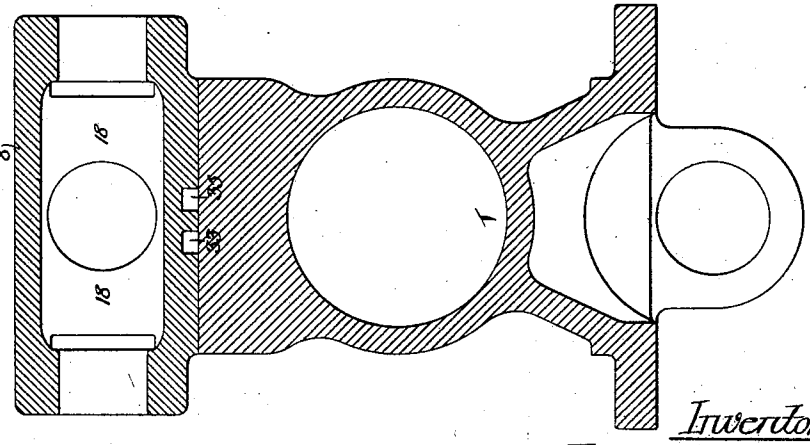


Fig. 6.



Witnesses:-
Herman E. Metius
Hamilton D. Turner

Inventor:
Thomas H. Phillips;
by his Attorneys;
Howson & Howson

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 700,081. Patented May 13, 1902.

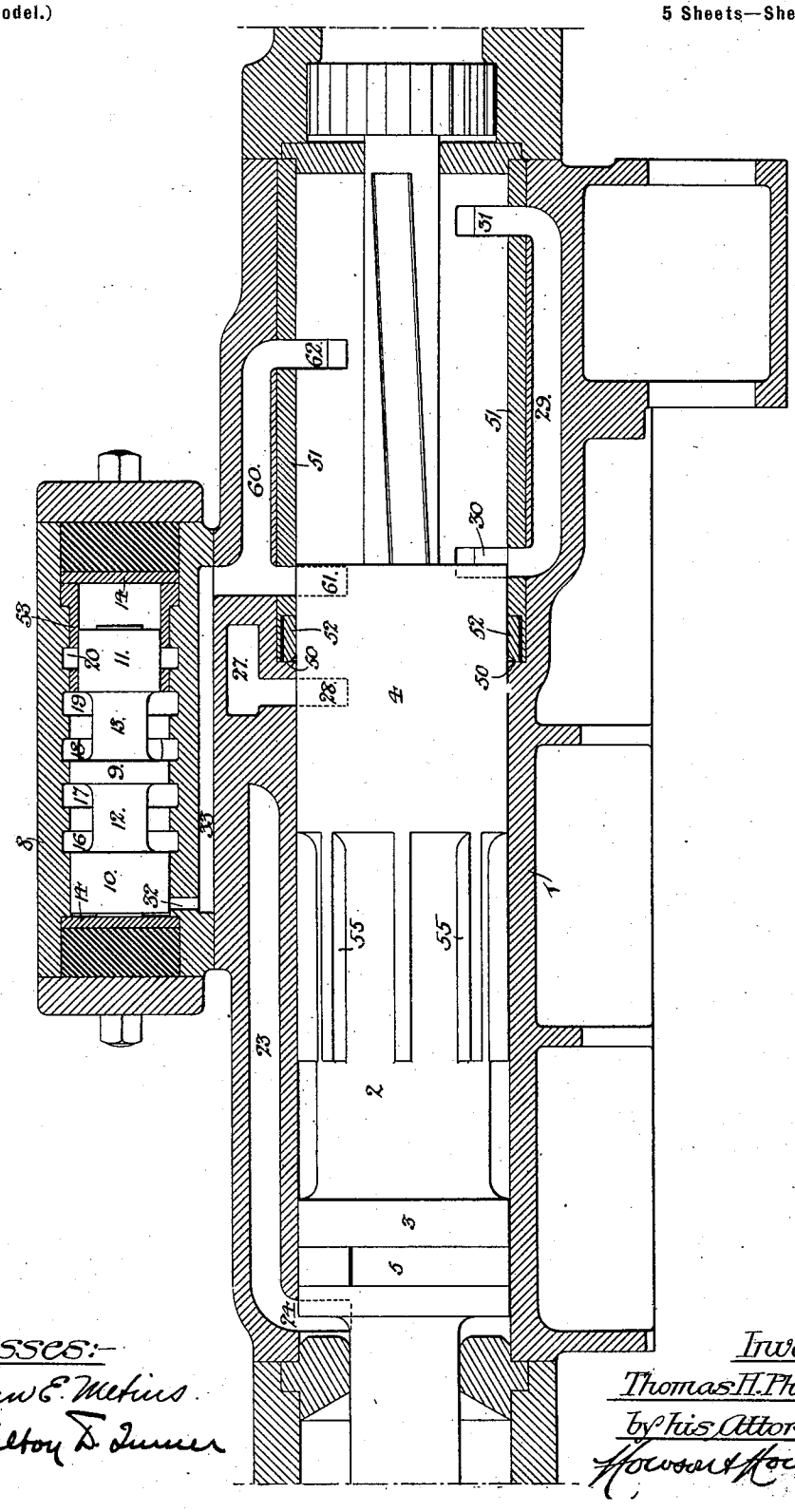
T. H. PHILLIPS.

IMPACT TOOL.

(Application filed Feb. 13, 1902.)

(No Model.) 5 Sheets—Sheet 5.

Fig. 9.



Witnesses:-
Herman E. Metius.
Hamilton D. Sumner

Inventor:-
Thomas H. Phillips,
by his Attorneys;
Howson & Howson

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

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

IMPACT-TOOL.

SPECIFICATION forming part of Letters Patent No. 700,081, dated May 13, 1902.

Application filed February 13, 1902. Serial No. 93,891. (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 is an improvement upon the impact-tool shown in my previous patent, No. 662,815, dated November 27, 1900.

One of the objects of my present invention is to insure the positive reversal of the valve at a fixed point in the backward movement of the piston in the cylinder and at all times to have either one end or the other of the cylinder open to the exhaust, while the opposite end of the cylinder contains motive fluid under pressure.

A further object of the invention is to prevent leakage past the rear head of the piston due to wear of that portion of the cylinder in which said rear head of the piston operates, and also to facilitate repairs rendered necessary by such wear.

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

Figure 1 is a view, partly in plan and partly in sectional plan, through the valve-chest of sufficient of an impact-tool to illustrate my present invention. Fig. 2 is a longitudinal section on the line *a a*, Fig. 1. Fig. 3 is a longitudinal 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. Fig. 6 is a transverse section on the line *e e*, Fig. 1. Fig. 7 is a transverse section on the line *f f*, Fig. 1. Fig. 8 is a transverse section on the line *g g*, Fig. 1; and Fig. 9 is a longitudinal section illustrating a special construction adopted in some cases.

Like reference characters indicate corresponding parts in the different views, and so far as possible I have used characters similar to those in the drawings of my previous patent, above referred to, to indicate corresponding parts of the tool.

The tool is adapted to be actuated by any motive fluid under pressure; but for purposes of convenience I will assume it to be a steam-actuated tool.

In the machine of my former patent the valve was moved in each direction by full-pressure steam acting on one end of the valve against pressure of expanded steam acting on the opposite end of the valve, and the admission of steam to the front end of the cylinder and rear end of the valve-chest was cut off by the piston sufficiently ahead of the admission of steam to the rear end of the cylinder and front end of the valve-chest to cause expansion in said front end of the cylinder and in the rear end of the valve-chest sufficient to permit of the movement of the valve.

In what is known as a "tight hole"—that is to say, one wherein the retractive power of the piston is barely sufficient to overcome the resistance in the hole and the weight to be lifted—the piston would sometimes not acquire sufficient momentum to carry it back far enough after the admission of steam to the front end of the cylinder had been cut off by the piston to cause expansion in the front end of the cylinder and rear end of the valve-chest sufficient to permit movement of the valve, and under these conditions steam would be admitted to the rear end of the cylinder through the passage in the cylinder not controlled by the valve, and as the valve had not yet been moved there was no exhaust from the front end of the cylinder and the piston would come to a standstill. In order to prevent the existence of such conditions in the present tool, I supply the front end of the cylinder, through the valve-chest, with steam taken directly from the steam-inlet—that is to say, without first passing through the cylinder—and I employ a valve having ends of different area, so that the valve can be moved backwardly by full pressure of steam acting upon its larger forward end, opposed by the full pressure of steam acting upon the smaller rear end, whereby full pressure of steam can be maintained in the front end of the cylinder for effecting backward movement of the piston until the position of the valve has been reversed. In an impact-tool such as a rock-drill there are neither guides nor cross-heads for keeping the piston in line with the cylinder, and one of the principal difficulties in maintaining the efficiency of a rock-drill is due to this cause, for, owing to the scraping action of the piston-rings carried by the rear head of the piston, as well as of the rear head itself, the bore of the cylinder at the rear

end, for a distance somewhat greater than the length of the stroke, begins to enlarge from the time the drill commences to work, and this results in leakage of steam from the central steam-chamber of the piston over the rings or between their joints and thence past the rear head of the piston and into the rear end of the cylinder, with consequent loss of steam when said rear end of the cylinder is open to the exhaust. In that class of tools in which the central chamber of the piston is an exhaust-chamber there is leakage in the reverse direction. Because of the wear, moreover, the cylinders must be frequently renewed, thus involving delay and expense. In order to overcome this objection, I provide the rear end of the cylinder with a removable bushing and mount upon the rear head of the piston a continuous packing-ring in which said rear head of the piston fits snugly, but which has no longitudinal movement in the cylinder, being confined between a shoulder in the latter and the forward end of the bushing, but being so constructed as to have a limited amount of lateral play, so that it can be carried by the piston-head from side to side as said piston plays laterally in the cylinder, a steam-tight joint being formed between a face of this ring and an opposed face of the cylinder or bushing and this joint being constantly maintained by the steam-pressure upon the ring, so as to prevent leakage of steam past the joint.

By a "continuous" packing-ring is meant one which is not split or formed in separable segments, since the separation of such segments would permit leakage of steam, and therefore defeat the purpose for which my ring is used.

The cylinder 1 is of the usual construction and receives the reciprocating piston, which has a central groove or chamber 2 and front and rear heads 3 and 4, the front head having one or more packing-rings 5, but the rear head being without packing-rings. The rear end of the cylinder is bored out to a greater diameter than the front end, so as to form a shoulder 50 at the junction of the two bores, and to this enlarged rear bore of the cylinder is fitted a bushing 51, countersunk at the front end, and between the base of this countersunk portion of the bushing and the shoulder 50 is longitudinally confined a packing-ring 52, which fits snugly to the rear head 4 of the piston, but is less in external diameter than the internal diameter of the countersunk portion of the bushing, so that it has a slight amount of lateral play therein, and hence is carried by the rear head of the piston in any of the lateral movements of said head permitted by the wear of said bushing.

The front end of the packing-ring 52 is preferably beveled in order to facilitate the entrace of the rear head of the piston into the same and so that the pressure of steam upon the forward end of said ring may have a constant tendency to press the rear face of the same against the base of the countersunk portion of the bushing 51, and thereby maintain at all times at that point a steam-tight joint to prevent the leakage of steam between the ring and the bushing, the snug fit of the ring to the rear head of the piston being relied upon to prevent leakage of steam between the two at all times when the rear end of the cylinder is open to the exhaust.

The central grooved portion 2 of the piston has ribs 55, which serve to support the ring 52 when the rear head 4 of the piston passes rearwardly beyond the same, there being no leakage of steam past the rear head at such time because the rear end of the cylinder then contains steam under full pressure.

When the bushing 51 becomes so worn as to be unserviceable, it can be readily removed and a new bushing inserted in its place, thereby saving much of the delay and expense usually involved in the replacing of the entire cylinder when the same becomes worn.

By adapting the ring 52 to a countersink in the forward end of the bushing I prevent such clamping of the ring between the bushing and the shoulder 50 as would interfere with the lateral movement of the ring; but the countersink may be discarded if by careful adjustment of the bushing in the cylinder the same result is attained.

The steam-inlet passage 6 terminates in the cylinder in a port 7, which is always in communication with the central groove or chamber 2 of the piston, so that steam under full pressure is constantly maintained in this chamber when the tool is in operation.

Above or at one side of the cylinder 1 is the valve-chest 8, to which is adapted a valve having a central flange 9, opposite heads 10 and 11, and two chambers or grooves 12 and 13, the opposite ends of the valve-chest having buffer-plates 14, backed by rubber or other springs, as usual. The chamber or groove 12 intervenes between the central flange 9 of the valve and the forward head 10, and the chamber or groove 13 intervenes between said central piston 9 and the rear head 11. The rear head 11 of the valve is of somewhat less diameter than the intermediate piston 9 and the forward head 10; but instead of constructing the steam-chest with a reduced bore at the rear end to suit the smaller diameter of the head of the valve working therein I use a reducing-bushing 53, because of greater ease in construction and accuracy of alinement for the snug fit required for the valve.

Communicating with the chamber within the valve-chest are five ports 16, 17, 18, 19, and 20. The port 16 constitutes one termination of a passage 21; but said passage instead of communicating with the interior of the cylinder, as in the machine of my previous patent, now communicates directly with the steam-inlet passage 6. Hence steam can enter the valve-chest through the passage 21 without first entering the cylinder, steam under pressure being therefore always main-

tained within said passage 21, which is not controlled in any way by the movement of the piston. The port 17 constitutes the rear termination of a passage 23, which extends to the front end of the cylinder and terminates therein in a port 24. The port 18 is the exhaust-port and communicates with an exhaust-passage leading to both sides of the valve-chest, as before. The port 19 constitutes the forward termination of a passage 25, which has its rear termination at a port 26 in the cylinder or rather in the bushing 51 thereof, and the port 20 constitutes the valve-chest termination of a passage 27, which has its other termination at a port 28 in the cylinder.

A passage 29 has both its forward and rear ports 30 and 31 in the cylinder-bushing 51, and near the front end of the valve-chest is a port 32, which communicates through a passage 33 with said passage 29, while near the rear end of the valve-chest is a port 34, which communicates with a passage 35, the latter having two branches 36 and 37, which terminate, respectively, in ports 38 and 39 in the bore of the cylinder, the port 39 being some distance in advance of the port 38.

The operation of the tool is as follows: Supposing that both the piston and valve are at the forward termination of the stroke, as shown in Figs. 2 and 3, the groove 12 of the valve connects the ports 16 and 17, and the groove 13 of the valve connects the ports 18 and 19. Hence there is a free inlet of steam to the forward end of the cylinder while the rear end of the cylinder is open to the exhaust. The forward end of the valve-chest is also open to the exhaust through the passages 33 and 29. The rear end of the cylinder and the passage 25 and the rear end of the valve-chest are open to the live-steam pressure through the passage 35, which receives steam from the central chamber 2 of the piston. Hence the valve is firmly retained in the forward position shown. As the piston moves rearward its front head closes the rear port 38 and at the same time opens the forward port 39. Hence full-pressure steam from the front end of the cylinder enters the rear end of the valve-chest, so as to retain the valve in its forward position in said chest. Simultaneously with or, if desired, either before or after this action the rear head of the piston uncovers the port 28, and thereby permits access of steam to the passage 27; but as the port 20 of this passage is covered by the rear head 11 of the valve this has no effect in changing the position of said valve. Rearward movement of the piston continues until its rear head uncovers the port 30, thereby admitting steam through the passage 29 to the rear end of the cylinder, so as to act as a cushion and prevent contact of the rear head of the piston with the rear head of the cylinder. At the same time steam is admitted to the forward end of the valve-chest through the passage 33, and as the forward head of the valve is of greater area than the rear head the preponderance of pressure exerted upon said forward head will force the valve rearwardly in the valve-chest, so that the forward groove 12 of the valve will connect the ports 17 and 18 and open the forward end of the cylinder and rear end of the valve-chest to the exhaust, the groove 13 of the valve connecting the ports 19 and 20 and opening the passage 25 to the steam from the cylinder through the passage 27. The port 26 of the passage 25 was covered by the rear head of the piston before the opening of the port 30. Hence steam for cushioning the rearward movement of the piston and for beginning the forward movement of the same is derived from the passage 29 until said port 26 is uncovered by the rear head of the piston in its forward movement, steam being then admitted to the rear end of the cylinder through passage 25 until the rear head of the piston in its forward stroke closes the port 28, and thus cuts off the further flow of steam from the passage 2 of the piston into the passage 27. At the same time or subsequently, if desired, the port 39 is coverved and the port 38 is uncovered by the forward head of the piston, and full-pressure steam is thus admitted to the rear end of the valve-chest; but as the area of the rear head 11 of the valve is less than that of the forward head 10 the valve will not be moved forwardly until the steam in the rear end of the cylinder and front end of the valve-chest has expanded sufficiently to reduce the pressure against the forward head of the valve to such an extent as to permit forward movement of said valve by the full pressure of steam exerted upon the smaller rear head 11 and the additional pressure due to the fact that the central piston 9 of the valve presents a greater area to the steam in communication with the rear end of the cylinder through the passage 25 than is presented by the rear head 11 of the valve. The combined forces tending to move the valve forward will not, however, start the valve and cause it to finish its movement until the piston has completed its forward stroke and the blow has been delivered, after which the operations above described will be repeated.

With larger machines having a longer stroke and used for drilling deep holes in which the bit is more apt to bind I prefer to employ the construction shown in Fig. 9. In this case I use an independent passage 60, with two branch ports 61 and 62, opening into the cylinder for leading steam from the chamber 2 of the piston and from the rear end of the cylinder to the front end of the valve-chest in the same manner as steam is conveyed from said chamber 2 and the front end of the cylinder to the rear end of the valve-chest. The port 62 is covered and the port 61 is uncovered by the piston on its rearward movement, and steam is admitted to the front end of the valve-chest somewhat in advance of the uncovering of port 30 and the admission of

steam to the rear end of the cylinder. Hence if the piston should stop before the port 30 was uncovered steam would be admitted through the valve-chest to the rear end of the cylinder through port 28, passages 27 and 25, and port 26, and the piston would be again driven forward.

In some cases the admission of steam to the rear end of the cylinder may be effected entirely by means of the passage 29, controlled by the piston, the passage 27 and the port 28 of the same being dispensed with, or the passage 29, with its ports 30 and 31, might be dispensed with and reliance placed on passage 25. In such case the port 26 would have to be placed at the rear end of cylinder in the location now occupied by the port 31 for both inlet and exhaust. The construction shown, however, is preferred.

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

1. The combination, in an impact-tool, of the cylinder, the piston having a steam-supplying groove, the valve-chest, the valve having heads of different area, a steam-inlet uncontrolled by the piston for admitting steam to the forward end of the cylinder through the medium of the valve, and a steam-inlet controlled by the piston for admitting steam to the rear end of the cylinder, substantially as specified.

2. The combination, in an impact-tool, of the cylinder, the piston having a steam-supplying groove, the valve-chest, the valve having heads of different area, a steam-inlet uncontrolled by the piston for admitting steam to the forward end of the cylinder through the medium of the valve, and a steam-inlet controlled by the piston for admitting steam to the rear end of the cylinder through the medium of the valve, substantially as specified.

3. The combination, in an impact-tool, of the cylinder, the piston having a steam-supplying groove, the valve-chest, the valve having heads of different area, a steam-inlet uncontrolled by the piston for admitting steam to the forward end of the cylinder through the medium of the valve, a steam-inlet controlled by the piston for admitting steam to the rear end of the cylinder independently of the valve, and a steam-inlet controlled by the piston for admitting steam to the rear end of the cylinder through the medium of the valve, substantially as specified.

4. The combination in an impact-tool, of the cylinder, the piston having a steam-supplying groove, the valve-chest, the valve having heads of different area, and ports and passages whereby the rearward movement of the valve is effected by full-pressure steam acting upon its larger forward head against full-pressure steam acting upon the smaller rear head, and forward movement of the valve is effected by full-pressure steam acting upon said smaller rear head against expanded steam acting upon the larger forward head, substantially as specified.

5. The combination in an impact-tool, of the cylinder, the piston having a steam-supplying groove, the valve-chest, the valve having heads of different area, ports and passages whereby said valve controls admission of steam to the front end of the cylinder and exhaust of steam from both ends of the cylinder, and other ports and passages whereby the rearward movement of the valve is effected by full-pressure steam acting upon its larger forward head against full-pressure steam acting upon the smaller rear head, and forward movement of the valve is effected by full-pressure steam acting upon said smaller rear head against expanded steam acting upon the larger forward head, substantially as specified.

6. The combination in an impact-tool, of the cylinder, the piston having a steam-supplying groove, the valve-chest, the valve having heads of different area, ports and passages whereby said valve controls admission of steam to and exhaust of steam from each end of the cylinder, and other ports and passages whereby the rearward movement of the valve is effected by full-pressure steam acting upon its larger forward head against full-pressure steam acting upon the smaller rear head, and forward movement of the valve is effected by full-pressure steam acting upon said smaller rear head against expanded steam acting upon the larger forward head, substantially as specified.

7. The combination in an impact-tool, of the cylinder, the piston having a steam-supplying groove, the valve-chest, the valve having central piston and forward and rear heads, said rear head being of less diameter than the central piston and forward head, and ports and passages whereby rearward movement of the valve is effected by live-steam pressure acting upon the forward head in opposition to live-steam pressure acting upon the rear head, and forward movement of the valve is effected by live-steam pressure acting upon the rear head assisted by expanded pressure in the chamber between the central piston and rear head, and opposed by expanded pressure acting upon the forward head, substantially as specified.

8. The combination in an impact-tool, of the cylinder, the piston having a steam-supplying groove, the valve-chest, the valve having central piston and forward and rear heads said rear head being of less diameter than the central piston and forward head, ports and passages whereby said valve controls admission of steam to the forward end of the cylinder, and exhaust of steam from both ends of the cylinder, and other ports and passages whereby rearward movement of the valve is effected by live-steam pressure acting upon the forward head in opposition to live-steam pressure acting upon the rear head, and forward movement of the valve is effected by live-steam pressure acting upon the rear head assisted by expanded pressure in the cham-

ber between the central piston and rear head, and opposed by expanded pressure acting upon the forward head, substantially as specified.

9. The combination in an impact-tool, of the cylinder, the piston having a steam-supplying groove, the valve-chest, the valve having central piston and forward and rear heads said rear head being of less diameter than the central piston and forward head, ports and passages whereby said valve controls the admission of steam to and exhaust of steam from each end of the cylinder, and other ports and passages whereby rearward movement of the valve is effected by live-steam pressure acting upon the forward head in opposition to live-steam pressure acting upon the rear head, and forward movement of the valve is effected by live-steam pressure acting upon the rear head assisted by expanded pressure in the chamber between the central piston and rear head, and opposed by expanded pressure acting upon the forward head, substantially as specified.

10. The combination in an impact-tool, of the cylinder, the piston having a steam-supplying groove, the valve-chest, the valve having a forward head of greater area than the rear head, ports and passages whereby said valve controls admission of steam to and exhaust of steam from both ends of the cylinder, a steam-inlet to the rear end of the cylinder controlled by the piston independently of the valve, and ports and passages whereby on the rearward movement of the piston steam under full pressure is conveyed to the forward end of the valve-chest from the cylinder, before the uncovering of said direct steam-passage, and on the forward movement of the piston, steam under full pressure is maintained in the rear end of the valve-chest, after the cutting off of the inlet of steam to the rear end of the cylinder, substantially as specified.

11. The combination of the cylinder and piston of an impact-tool, with a packing-ring fitting snugly upon said piston but free to move laterally with the same in the cylinder, said ring having a face bearing against a corresponding face in the cylinder, substantially as specified.

12. The combination of the cylinder and piston of an impact-tool, with a packing-ring fitting snugly upon said piston but free to move laterally with the same in the cylinder, said ring having a face bearing against a corresponding face in the cylinder and having its opposite face beveled, substantially as specified.

13. The combination in an impact-tool, of the cylinder having an enlarged rear bore, a bushing fitted to said enlarged bore, a piston working within said bushing and having fitted to it a packing-ring which is free to play laterally to a limited extent within the cylinder and occupies a chamber between a shoulder in the cylinder and the bushing, substantially as specified.

14. The combination in an impact-tool, of the cylinder having an enlarged rear bore, a bushing fitted to said enlarged bore and having a countersunk forward end, a piston working within said bushing, and a packing-ring fitted to said piston and having a slight lateral play in the countersunk bore of the bushing, substantially as specified.

15. The combination in an impact-tool, of the cylinder, the piston having a rear head and a groove in advance of the same, a packing-ring fitting upon said rear head of the piston and free to move laterally with the same in the cylinder, but confined longitudinally between shoulders in said cylinder, and ribs on the grooved portion of the piston for supporting said ring when the piston-head leaves the same, 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:
F. E BECHTOLD,
JOS. H. KLEIN.