H. C. BEHR.

PNEUMATIC PERCUSSIVE APPARATUS.

APPLICATION FILED JUNE 10, 1911.

1,026,555.

Patented May 14, 1912.

3 SHEETS—SHEET 1.

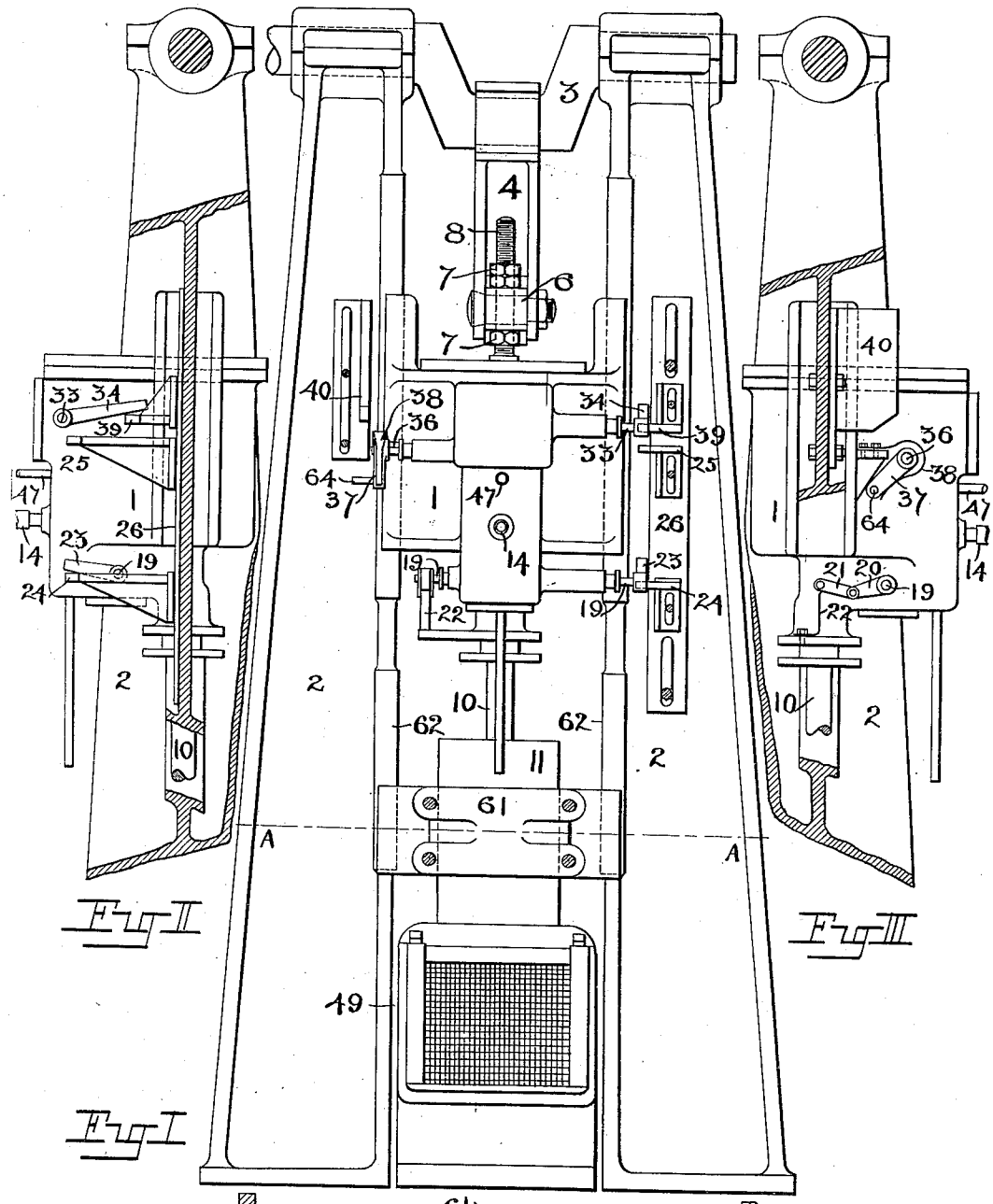

Fig II

Fig III

Fig I

Fig IV

Witnesses
Harris Mathews.
M. Mayo Duvall

Inventor
Hans C. Behr
by Williams, Fisher
+ Witherspoon.
his attorneys

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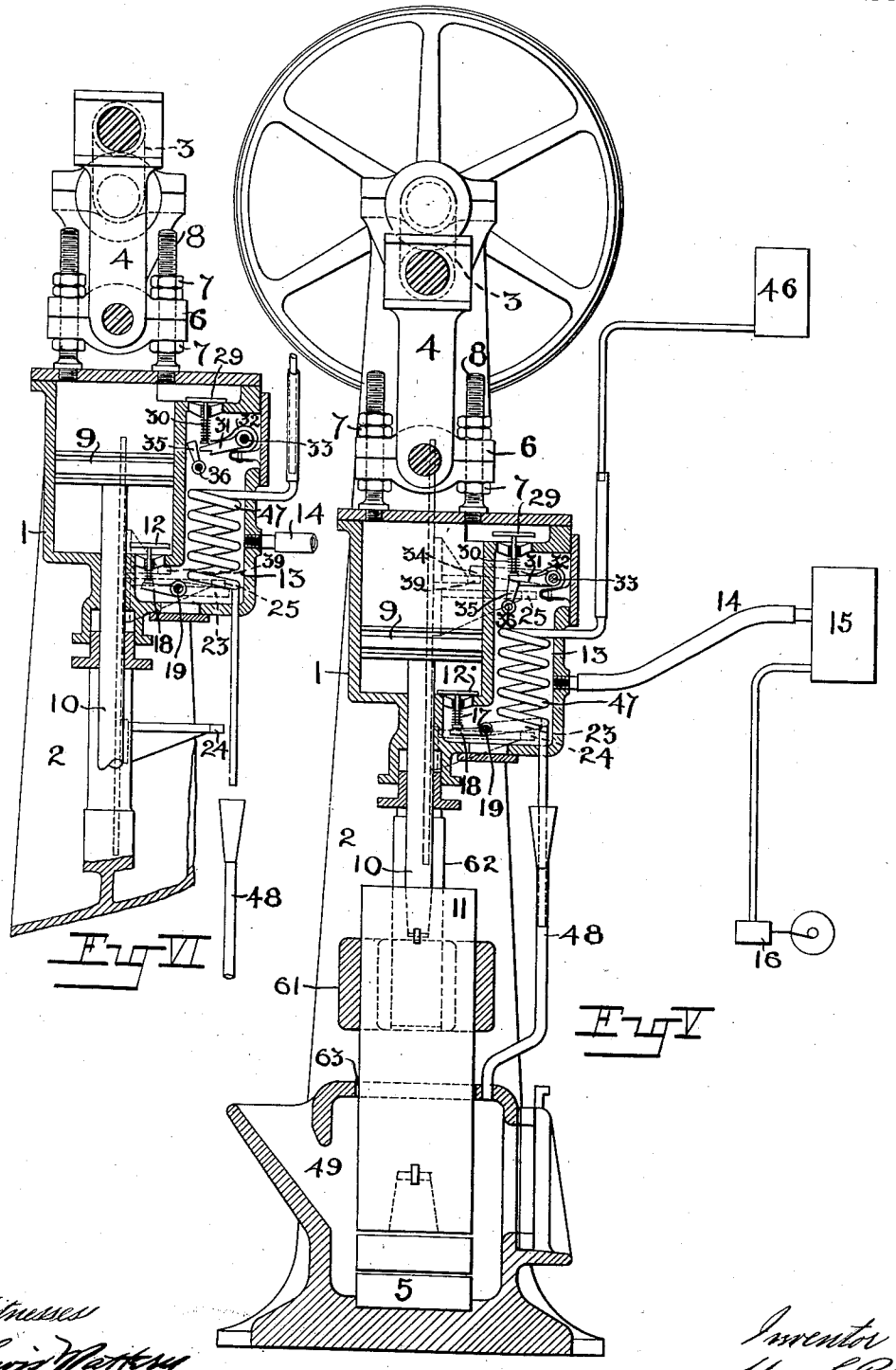

Witnesses

D. Lewis Watkins

W. Mayo Dwall.

Inventor

Hans C. Behr

by Williamson, Fisher & Witherspoon

his Attorneys

H. C. BEHR.

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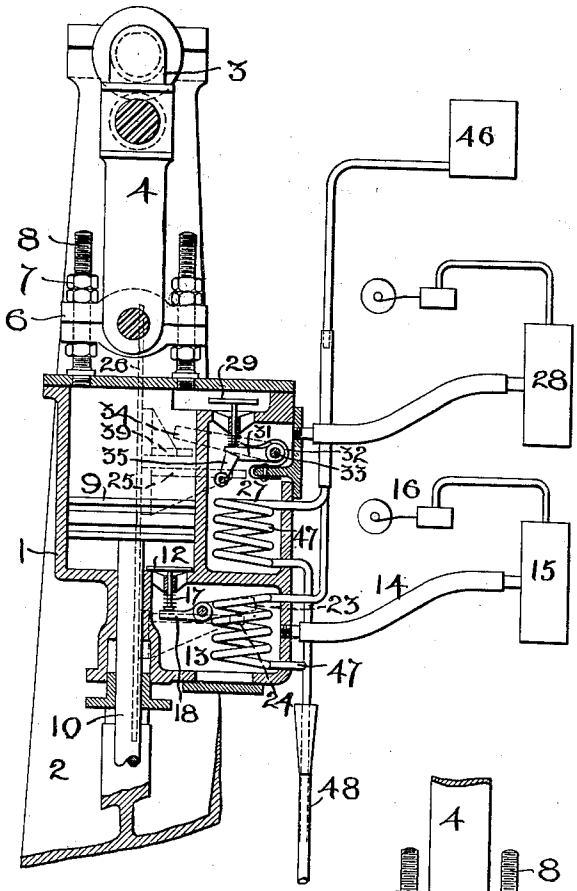

Fig VII

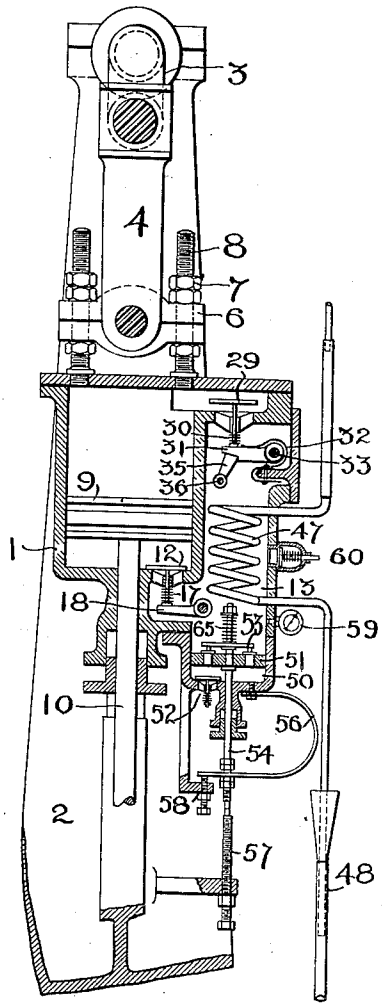

Fig VIII

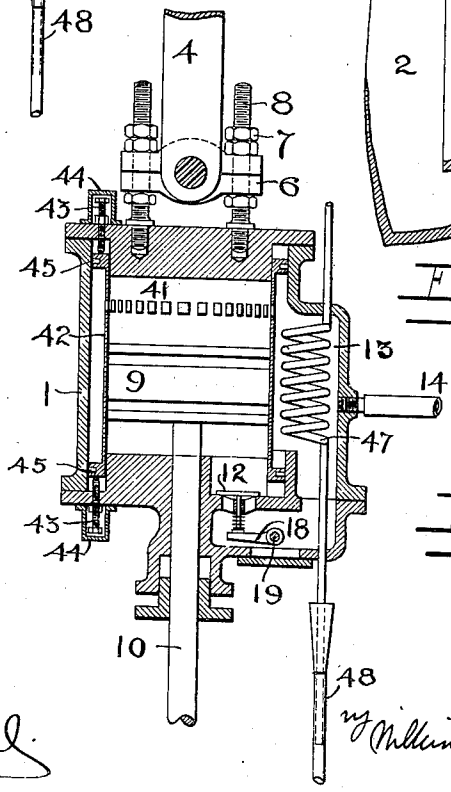

Fig IX

Witnesses
Theodore Watson
M. May Darrall.

Inventor
Hans C. Behr,
by Williamson, Fisher & Watkinson,
his Attorneys.

UNITED STATES PATENT OFFICE.

HANS CHARLES BEHR, OF JOHANNESBURG, TRANSVAAL.

PNEUMATIC PERCUSSIVE APPARATUS.

1,026,555. Specification of Letters Patent. Patented May 14, 1912.

Application filed June 10, 1911. Serial No. 632,459.

To all whom it may concern:

Be it known that I, HANS CHARLES BEHR, consulting mechanical engineer, a citizen of the United States of America, residing at Consolidated Goldfield's Building, Johannesburg, Transvaal, have invented certain new and useful Improvements in Pneumatic Percussive Apparatus, of which the following is a specification.

The present invention relates to pneumatic percussive apparatus comprising a positively reciprocated cylinder and a percussive member provided with a piston working therein and adapted to be reciprocated by means of an air cushion or air cushions inclosed between it and the cylinder end or ends.

The principal object of the invention is to construct a percussive apparatus capable of working at high speed and of imparting an unretarded stroke of high velocity, and so constructed as to reduce to a minimum the waste of energy due to the repeated compression and expansion of the air.

Other objects will appear from the description hereunder.

Pneumatic stamps have heretofore been put into operation, but they have all involved greater or less objections in that they were not capable of giving sufficient velocity to the stamp at the instant of the blow with a maximum of efficiency, or they were not capable of producing an unretarded stroke. Steam stamps of course, have been employed, but they are objectionable on account of the high cost of fuel and for other reasons.

Figure I of the accompanying drawings is a front elevation of an ore stamp embodying the invention; Figs. II and III are partial side elevations seen from opposite directions, the frame being shown as broken away; Fig. IV is a plan on line A—A of Fig. I; Fig. V is a vertical section showing the parts after striking the blow and when the cylinder is at the forward or lower end of its stroke; Fig. VI is a similar partial section illustrating the completion of the return stroke; and Figs. VII–IX are similar sections showing modified constructions.

The cylinder 1 is mounted on the frame 2 to be reciprocated by the crank 3 and connecting rod 4. For the purpose of adjusting the apparatus toward or from the die 5, the connecting rod may be attached to the top of the cylinder by a cross head 6 secured by nuts 7 to the upright screw studs 8.

Within the cylinder 1 is a piston 9 from which projects a piston rod 10 carrying the stamp head 11. The end of the cylinder from which the piston rod 10 projects will be called the front end and the opposite end the rear end. The movement of the apparatus by which the stamp head is urged toward the die will be referred to as the forward stroke and the reverse movement as the return stroke.

An opening controlled by a valve 12 affords communication between the front end of the cylinder and a reservoir of air. This reservoir may be the external atmosphere; but as the stamp illustrated is intended to work with an artificially dense atmosphere, the reservoir shown consists of a chamber 13 annexed to the cylinder 1, a flexible connecting pipe 14 and a receiver 15. The receiver is fed by a small compressor 16 the function of which, after it has produced the required working pressure, is simply to make up leakage.

Valve 12 is held to its seat by a light spring 17 and is free to open when the reservoir pressure slightly exceeds that within the front end of the cylinder. For lifting the valve positively there is provided a wiper 18 secured to a spindle 19, both ends of which pass out of chamber 13 through stuffing boxes. At one end of spindle 19 is secured one link 20 of a toggle the other arm 21 of which is pivoted to a stiff spring 22; said device operating in the well known manner to retain the wiper 18 either in its lowered position shown in Fig. V, or in its raised position shown in Fig. VI, while permitting it to be forcibly moved from one such position to the other. At the other end of the spindle 19 is the tappet arm 23 and in the path thereof are the stops 24 and 25. Stops 24 and 25 are adjustably secured upon a plate 26 which itself is adjustably fixed to frame 2.

The functions of valve 12 will appear from the following description of the operation. During the return stroke of cylinder 1, tappet arm 23 comes into contact with stop 25 and lifts wiper 18. During the succeeding forward stroke therefore valve 12 is held open and by affording free communication between the front end of the cylinder and the reservoir, permits the piston 9, piston rod 10, and head 11 to move forward freely and strike an unretarded blow. The forward stroke of the piston 9 is completed and the blow struck before the cylinder 1 comes to the end of its forward travel; immedi-

ately upon which stop 24 forces up tappet arm 23 and permits valve 12 to close thereby imprisoning a body of air in the front of the cylinder, through which the latter acts on the piston to retract the same. During the return stroke the piston 9 will usually acquire sufficient momentum to cause it to over-run the cylinder, and thereby lower the pressure of the air body in the front end of the cylinder. Valve 12 will thereupon open automatically and admit air from the reservoir at substantially the same pressure as that in the front end of the cylinder, thus avoiding loss of energy due to inrush of air under great difference of pressure and also preventing undesirable retardation of the piston on its return stroke.

The rear end of the cylinder is, similarly to the front end, put into communication with a reservoir of air. This may be the external atmosphere, or the chamber 13, pipe 14 and receiver 15, or as shown in Fig. VII, a separate chamber 27 and receiver 28 containing air at a different pressure from that in receiver 15. Such communication may in the case of a stamp or hammer which is required to fall solely by gravity, be entirely free. For working at high speed however, said communication is controlled by a valve device which, as shown in Figs. V–VIII, comprises a valve 29 retained to its seat by a light spring 30 and adapted to open by a slight preponderance of pressure in the reservoir over that in the rear end of the cylinder. A wiper 31 for lifting the valve is pressed down by a spring 32 and rigidly mounted upon a spindle 33 which carries the external tappet arm 34. A latch 35 for holding the wiper 31 in its raised position is rigidly mounted upon spindle 36 together with the external tappet arm 37 (Fig. III), against which bears a spring 38 tending to force the latch 35 under the wiper 31. An adjustable stop 39 (Figs. I and II) is fixed to the plate 26 in the path of tappet arm 34; and an adjustable cam plate 40 (Figs. I and III) in the path of pin 64 extending from tappet arm 37. During the return stroke of the cylinder contact of pin 64 with cam plate 40 throws out the latch 35 and permits wiper 31 to drop and valve 29 to close. A body of air is thus entrapped in the rear end of the cylinder, which both cushions the return stroke of the piston and also enables the cylinder to propel the same on its next forward stroke. During the forward stroke, so long as the cylinder presses upon said air body to maintain its pressure, valve 29 remains closed. If however the piston gains on the cylinder so as to cause the pressure at the rear end of the cylinder to fall below that acting on the underside of valve 29, the latter will open and admit air to follow up the piston. In any case said valve is opened just before the termination of the forward stroke owing to tappet arm 34 coming into contact with stop 39. As soon as wiper 31 is lifted, the latch 35, urged by the spring 38, falls under it and locks the valve 29 open. Whenever the cylinder 1 is adjusted to or from the die 5 (by means of the adjustable cross head 6), the stops 24, 25 and 39, and cam plate 40 are correspondingly shifted on the frame 2 without changing their relative position; plate 26 enabling stops 24, 25 and 39 to be shifted together. Again, the individual adjustability of said stops and said cam plate enables their relative positions to be changed to adjust the apparatus for different conditions of working, such as changes in the weight of the percussive parts, or in the rate of working.

In the construction shown in Fig. IX, the piston 9 takes the place of the separate valve 29, by coöperating with the ports 41 affording communication between the rear end of the cylinder and the chamber 13, which ports it covers during its return stroke and re-opens during its forward stroke. The point of the stroke at which such closing and opening occurs may be made adjustable. According to Fig. IX this is effected by forming the ports 41 in a sleeve 42 which is adjustable axially of the cylinder by means of set screws 43. Said set screws are inclosed by fluid tight covers 44 and the sleeve is made fluid tight in the cylinder by packing 45. The recurrent flow of the working fluid into chamber 13 affords a convenient method of disposing of the heat produced by its repeated compression within the cylinder. To this end cooling water is applied to said chamber 13, either by spraying it externally, or as shown, by passing cooling water from a source 46 through a pipe coil 47 fitted within said chamber. The water withdrawn from the coil 47 may be conducted by pipe 48 into the mortar box 49.

A modified apparatus which embodies the compressor within itself is shown in Fig. VIII. A compressor cylinder 50 in communication with chamber 13 is furnished with a compressor piston 51. Air may pass from the atmosphere through the inwardly opening non-return valve 52 and from the space beneath piston 51 into chamber 13 through the non-return valve 53 controlled by spring 65. A piston rod 54 projects through a stuffing box 55—not shown in Fig. VIII—and is fitted with a spring 56 tending to force it outwardly, such motion being limited by an adjustable stop 58 on the cylinder. On the frame 2 is carried an adjustable stationary stop 57. As the main cylinder 1 travels forward, rod 54 strikes stop 57 and causes displacement of the compressor piston 51 relatively to its cylinder 50, whereby air is drawn in through valve 52. On the return of the main cylinder, piston 51 is retracted by its spring 56 and air is forced

into chamber 13 through valve 53. The inward travel of piston 51 is controlled by stop 58 and its outward travel by stop 57; whereby both the extent of the travel of said piston and the volume of the clearance space remaining under it at the end of its outward stroke, may be adjusted. Thus for a predetermined working pressure in chamber 13, the amount of air delivered by the compressor may be regulated to equal that lost by leakage; the clearance space below the compressor piston 51 being so adjusted that the terminal pressure produced therein upon the completion of the outward stroke of piston 51 is insufficient to lift valve 53 so long as said predetermined pressure is maintained. Upon the pressure in chamber 13 falling owing to increased leakage, the pressure beneath piston 53 will overcome that in chamber 13 plus the resistance of the valve spring 65 and will lift valve 53 and replenish chamber 13. A gage 59 indicates the pressure within chamber 13 and a blow-off valve 60 disposes of any surplus air.

For guiding the stamp head 11, there is provided a slider 61 adjustably clamped thereto and sliding upon guides 62. The latter are spaced clear of the opening 63 of the mortar box so that lubricant from them falls clear of said opening. As the shoe and die wear down, the slider 61 is loosened from the head 11 and shifted higher up the same; while rotation of the head to insure even wear is similarly effected from time to time after it has been loosened from the slider 61.

In connection with the operation of my invention it should be pointed out that if neither of the valves 12 and 29 were employed, as the cross head 6 reaches its lowest position, air would first be compressed in the rear portion of the cylinder 1, while as the front portion of said cylinder moved forward, air in front of the piston 9 would be expanded. But, as the piston 9 gained velocity, it would compress the air in the front portion of the cylinder 1 and thereupon lose most of the velocity gained. It would, therefore, result from this action that the blow delivered by the stamp would be greatly lessened. Again, if we suppose the valve 12 to be permanently closed, then as the cross head 6 approaches its extreme position shown in Fig. 5, air which was first compressed will now be expanded in the rear of the cylinder 1, and the piston 9 driven forward as in the first case, but in this last case, with the valve 12 closed, air will be highly compressed in the front end of the cylinder 1 between said piston and said valve 12; and since the intensity of the blow will depend entirely upon the velocity imparted to the piston, it will be clear at once in this case that the force of said blow will be greatly lessened. On the other hand, if the valve 12 is held open, and the valve 29 closed, as is done in this invention, while the cross head 6 is reaching the position shown in Fig. 5, then air will be at first compressed and then expanded in the rear portion of the cylinder 1, which will drive the unretarded piston 9 forward with a maximum velocity owing to the fact that air can freely escape past the valve 12, and a maximum blow will be therefore delivered by the hammer. Further, in this last case, should the forward movement of the piston 9 compress the air in front of said piston more highly than is the air in the rear of said piston, then the valve 29 will lift and allow an equilibrium of pressure to take place. It results from this construction that by the mechanism disclosed, I provide a rotating means which is capable, of delivering sudden and powerful blows at a high efficiency which would not be possible were a rigid connection employed.

It is obvious that those skilled in the art may vary the details of construction and the arrangement of parts without departing from the spirit of my invention, and therefore I do not wish to be limited to the above disclosure except as may be required by the claims.

What I claim and desire to secure by Letters Patent is:—

1. The combination of a cylinder, a piston working therein, means for causing a relative reciprocation between said cylinder and piston, a piston rod projecting from the front end of the cylinder, a valve for the front end of the cylinder controlling communication between the same and a reservoir of air, and automatic means causing said valve to be open during the forward stroke of the piston and closed during the rearward stroke of the same.

2. The combination of a cylinder, means for reciprocating the same, a piston working therein, a piston rod projecting from the front end of the cylinder, a valve for the front end of the cylinder controlling communication between the same and a reservoir of air, and automatic means causing said valve to be open during the forward stroke of the cylinder and closed during the rearward stroke of the same.

3. The combination of a cylinder, means for reciprocating the same, a piston working therein, a piston rod projecting from the front end of the cylinder, a valve for the front end of the cylinder controlling communication between the same and a reservoir of air, said valve being free to open upon the reservoir pressure exceeding that in the front end of the cylinder and tending to close when the reservoir pressure is less than that in the front end of the cylinder, and automatic mechanism adapted to open and close said valve.

4. The combination of a cylinder, means for reciprocating the same, a piston work-

ing therein, a piston rod projecting from the front end of the cylinder, a valve for the front end of the cylinder controlling communication between the same and a reservoir of air, means causing said valve to be open during the forward stroke of the cylinder and closed during the rearward stroke of the same, and automatic means controlling communication between the rear end of the cylinder and a reservoir of air, and adapted to open such communication while the cylinder is effecting its forward stroke and to close the same before the termination of the return stroke.

5. The combination of a cylinder, means for reciprocating the same, a piston working therein, a piston rod projecting from the front end of the cylinder, a valve for the front end of the cylinder controlling communication between the same and a reservoir of air, means causing said valve to be open during the forward stroke of the cylinder and closed during the rearward stroke of the same, a valve controlling communication between the rear end of the cylinder and a reservoir of air, said latter valve being free to open when the reservoir pressure exceeds that in the rear end of the cylinder, automatic means for opening said latter valve during the forward stroke of the cylinder and for closing the same before the termination of the return stroke.

6. The combination of a cylinder, means for reciprocating the same, a piston working therein, a chamber communicating with the cylinder, automatic valve means controlling communication between said chamber and the cylinder and cooling means for said chamber.

7. The combination of a cylinder, means for reciprocating the same, a piston working therein, a chamber communicating with the cylinder, automatic valve means controlling communication between said chamber and the cylinder, a pipe coil within the chamber, and means for flowing cooling liquid through said coil.

8. In combination, a cylinder, means for reciprocating the same, a piston working in the cylinder, means providing a storage of high pressure fluid, and automatic valve means controlling communication between both ends of the cylinder and said storage means.

In testimony whereof I affix my signature in the presence of two witnesses.

HANS CHARLES BEHR.

Witnesses:

E. N. GUNSAULUS,

C. B. HENDERSON.