H. C. BEHR.

PNEUMATIC PERCUSSIVE MACHINE.

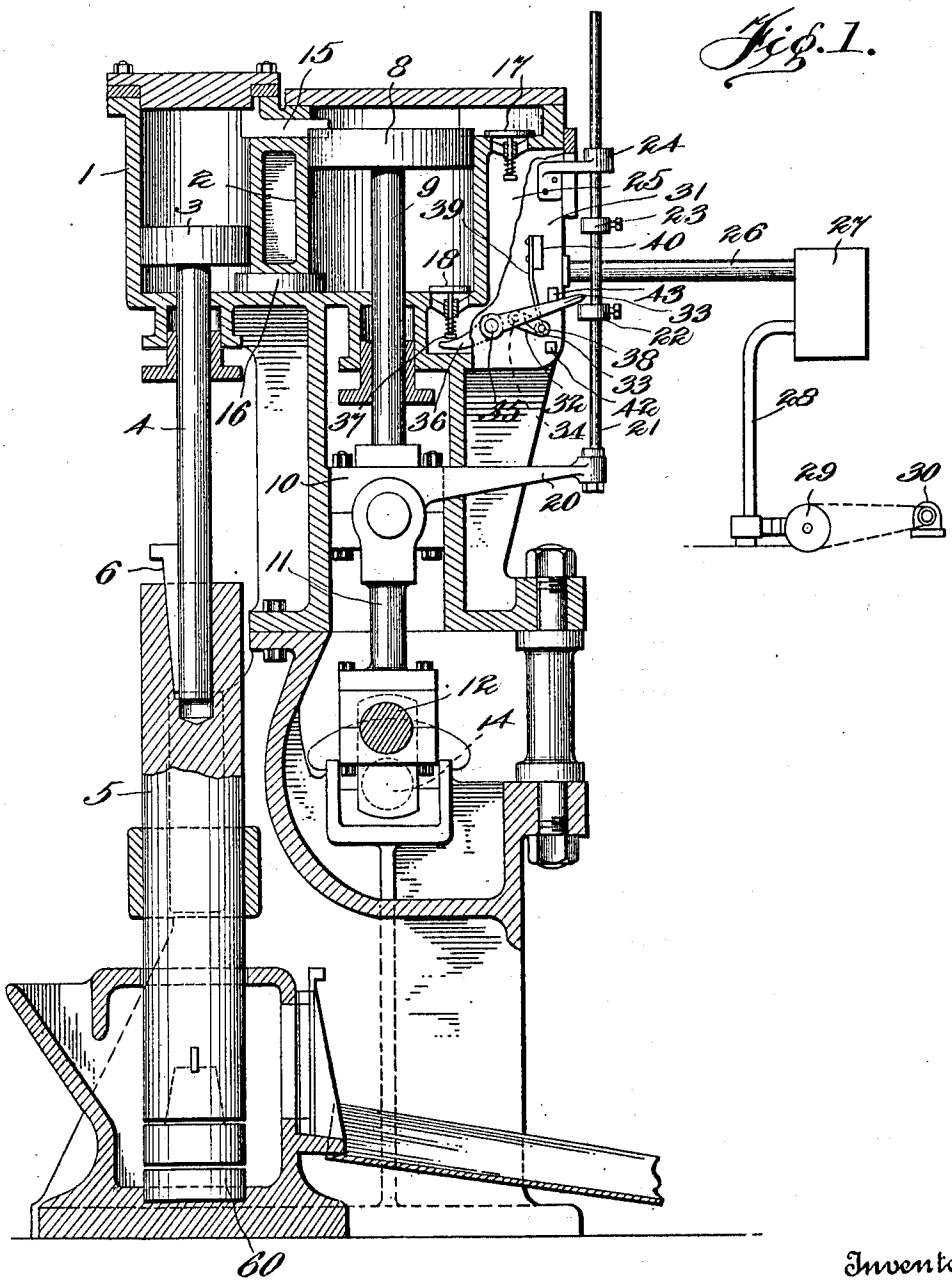
APPLICATION FILED NOV. 14, 1911.

1,048,275.

Patented Dec. 24, 1912.

3 SHEETS—SHEET 1.

Fig. 1.



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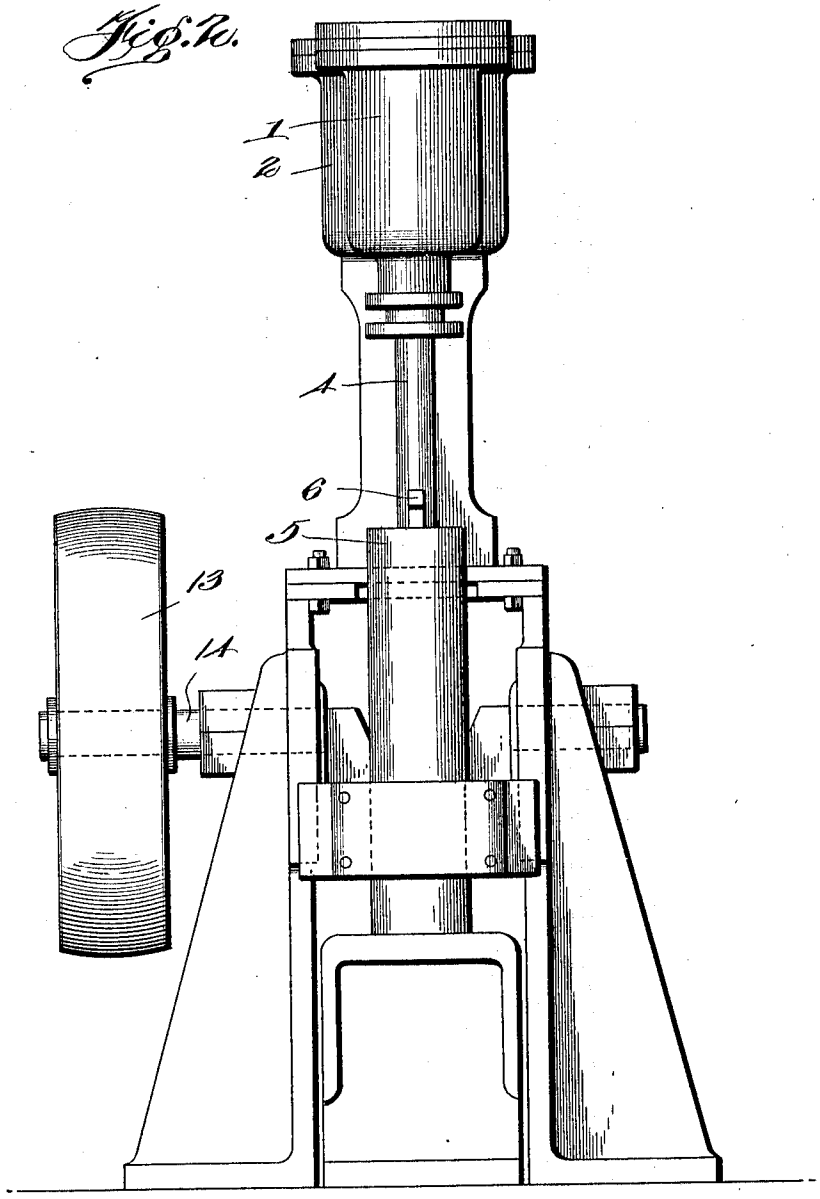
3 SHEETS—SHEET 2.

Fig. 2.



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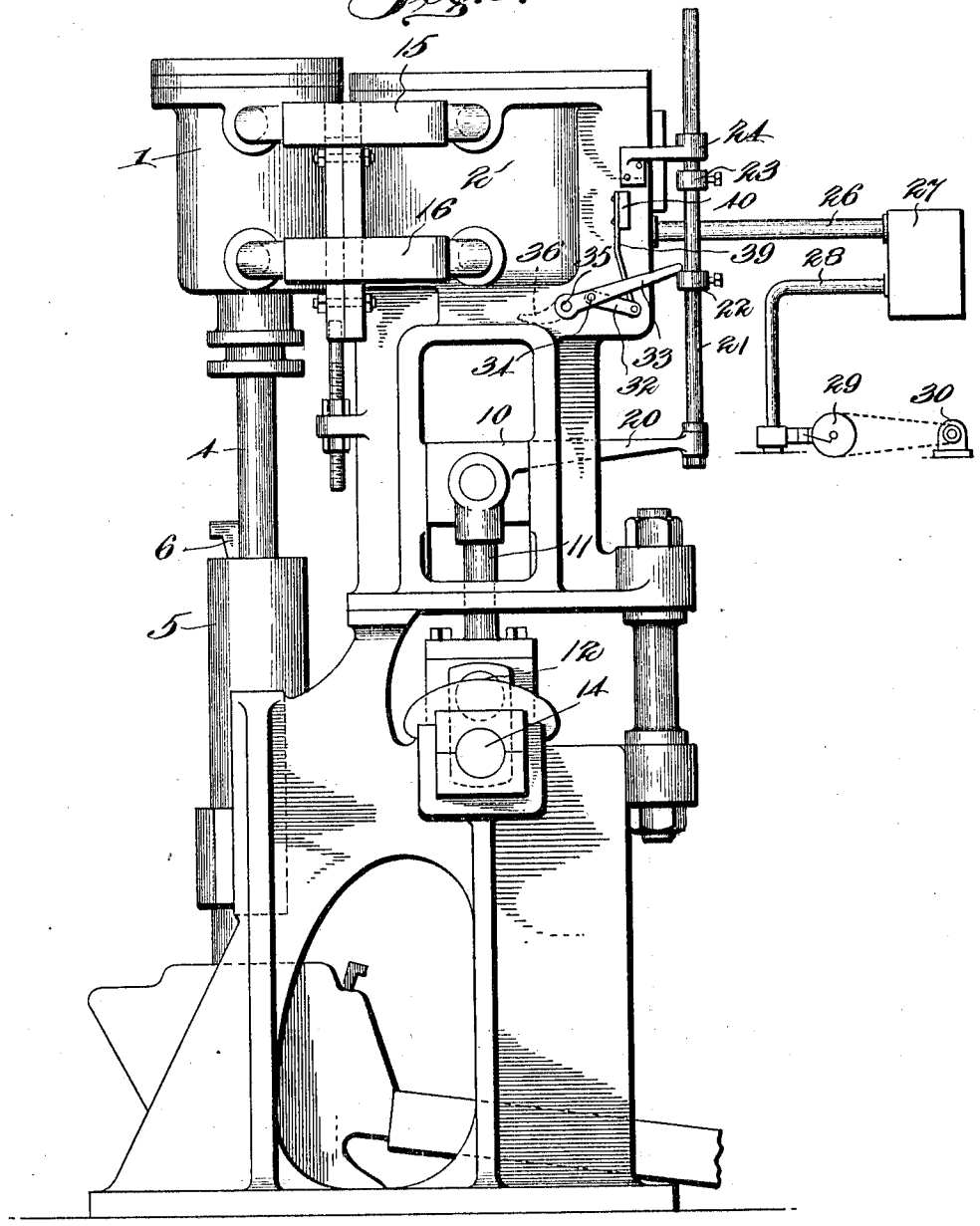
3 SHEETS—SHEET 3.

Fig. 3.



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UNITED STATES PATENT OFFICE.

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PNEUMATIC PERCUSSIVE MACHINE.

1,048,275. Specification of Letters Patent. Patented Dec. 24, 1912.

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To all whom it may concern:

Be it known that I, HANS CHARLES BEHR, a citizen of the United States, residing at Johannesburg, in the Colony of Transvaal, South Africa, have invented certain new and useful Improvements in Pneumatic Percussive Machines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a pneumatic stamping or percussive machine capable of general use, but especially adapted for ore stamps, and has for its object the production of a device of this nature that may be operated at a high speed, and will deliver powerful blows at high velocities without substantial losses of energy in compressing the air.

It has been heretofore proposed to allow compressed air in front of the piston to flow into the atmosphere, to avoid cushioning the blow, but in such cases the work done in compression is lost. By my invention, on the other hand, I never permit air to be compressed to any substantial extent by the forward or blow movement of the stamp piston, so neither a cushioning action nor a loss of compression energy due to such movement is experienced. Further by my invention the energy expended in compressing that portion of air which is utilized to drive the stamp piston forward or downward as seen in Figure 1, is recovered upon the subsequent expansion of this said air, and the same remarks apply to that portion of the air which is compressed in order to force the said stamp piston backward or upward, all as will appear more fully below.

With the above and other objects in view my invention consists in the novel details of construction and combinations of parts more fully hereinafter disclosed and particularly pointed out in the claims.

Referring to the accompanying drawings forming a part of this specification in which like numerals designate like parts in all the views:—Fig. 1 is a vertical sectional view of an ore stamp made in accordance with my invention; Fig. 2 is an end elevational view of the parts shown in Fig. 1; and, Fig. 3 is a side elevational view of said parts.

1 represents the stamp cylinder and 2 the actuating cylinder preferably rigid therewith. Operating in the stamp cylinder is the piston 3, provided with the piston rod 4 adjustably attached to the stamp head 5, as by means of the wedge 6; and operating in the actuating cylinder is the piston 8, provided with the piston rod 9 rigid with the cross head 10, suitably connected to the connecting rod 11, operated by the crank 12 rotated by the power pulley 13 mounted on the shaft 14. Channels 15 and 16 are provided between the cylinders 1 and 2, and the cylinder 2 is further provided with the spring pressed valves 17 and 18 preferably located one at each end as shown. The cross head 10 is provided with an arm 20, carrying a rod 21, on which are adjustably mounted the tappets 22 and 23, and said rod is reciprocated in the guide 24 secured to the cylinder 2 as will be clear from the drawings.

25 represents an air chamber or space within the casing 31 adjacent the cylinder 2, and connected by the pipe 26 with the compressed air reservoir 27 which is in communication through the pipe 28 with the compressor 29 driven by the motor 30.

Mounted on the outer walls 31 of the air chamber 25, are the toggle levers 32 and 33 which may be connected as at 34. The lever 33 is carried on the outer end of the rocking stud or shaft 35, which passes through the casing 31 and into the chamber 25. Mounted in the space 25 on the rock shaft 35 is the lifting toe or lever 36 adapted to contact with the valve stem 37 of the valve 18. The lever 32 may be also pivoted as at 38 to the spring 39, secured at its other end as at 40 to the casing 31. The lever 33 in addition extends, as shown, beyond the casing and is moved in opposite directions to rock the shaft 35 by the reciprocations of the tappets 22 and 23. The rocking of said shaft 35 causes the lever 36 to lift the valve 18, and as the spring 39 presses the pivot 38 toward said rock shaft, its action is to force the pivot 34 of the toggle either up or down, as seen in Fig. 1, and therefore past a line join-

ing the said pivot 38 and rock shaft, so that said lever will be held in its last position by the tension of said spring until it is forced out of the same by a tappet 22 or 23 as the case may be. The movement of the lever 33 in either direction is limited by the stops 42 and 43 projecting from the casing 31.

The operation of my invention is as follows:—Power being applied to the pulley 13, the shaft 14 turns the crank 12 which reciprocates the connecting rod 11, and the piston 8. As the piston 8 rises to the position shown in Fig. 1, the valve 17 being closed, air is compressed above the piston 3 and the same is forced downwardly into the position shown. On the previous down stroke of the piston 8, however, the tappet 23 had contacted with the lever 33, which had caused the rock shaft 35 to be turned and the lever 36 to be lifted. The valve 18 accordingly had been lifted from its seat, whereupon the tension of the spring 39 had acted to hold the lever 36 in its raised position. It therefore follows that as the piston 3 is forced downward in the manner and by the operation above, the air below said piston passes out of the cylinder 1 through the channel 16 and past the valve 18 into the space 25. It therefore results from this that the said piston 3 in its downward stroke is only opposed by the pressure of the air in the chamber 25. The energy of compression of said air due to said downward or forward stroke of the piston 3 will be negligible, but whatever it may be, it is recovered on the subsequent expansion of said air in the closed system so that no real loss of motive energy occurs as will appear below. In fact, so small is the energy involved in forcing the air out of the lower end of the cylinder 1, that the chamber 25 can be open to the atmosphere and the reservoir 27 dispensed with without changing the principle of my invention. Since the piston 3 is not required to compress air trapped in the cylinder 2 on its downward stroke as just explained, and since it descends not only under the influence of gravity but also under the action of the compressed air on its upper surface, it is evident that its velocity will be an accelerated one. So great is the acceleration found in practice in ordinary pistons that the air above said pistons at one point of their downward strokes, is found to be so rarefied as to have a pressure less than that of the air below said pistons, and therefore ordinary pistons working under the above conditions usually have their blow strokes cushioned, and especially when a high pressure of air is employed beneath them. In the operation of my invention on the other hand the valve 17 prevents any cushioning action on the blow stroke as will now appear. As soon as the above accelerated movement of the piston 3 causes the air above the same to become so rarefied that said air has a pressure at which a cushioning action is about to occur, then the valve 17 lifts and additional air is admitted from the reservoir 25, or from the atmosphere as the case may be, to prevent the pressure above said piston from falling below a predetermined point. Accordingly it will be seen that my invention is capable of delivering an unretarded stroke of very high velocity, and therefore it is clear that my invention is capable of imparting a blow to the die 60 of great suddenness and power. Just before the piston 8 completes its upward stroke the tappet 22 contacts with the lever 33, moves it into the position shown in Fig. 1, and causes the lever 36 to descend, which permits the valve 18 to close. It will thus be seen so far as has now been disclosed that the air below the pistons 3 and 8 during the descent of the piston 3 is in approximate equilibrium with the pressure of the outer air or with that in the reservoir 27, so that as stated above, no energy is lost in useless compressions of this particular portion of air; or by reason of inrushes of other air to equalize abnormally different pressures. Further as the piston 8 descends from the position shown in Fig. 1, the valve 18 being closed, the said piston compresses that portion of the air below the piston 3, and causes the latter to rise. In the meantime the energy that was previously expended in compressing that portion of the air above the piston 8 is now recovered during the expansion of said air back to its previous condition. In the same way when the piston 8 rises, the air that was compressed in raising the piston 3, expands back to its previous condition and thereupon saves to the system the energy that was expended in its compression. In other words, it will now be clear that since, theoretically, no air need leave the system, there need be no energy losses due to wasteful compressions of the air utilized. Such wastes as do occur in practice are very small, and are easily supplied by the compressor 29, which need not be of large dimensions. It will now be clear that all of the energy expended in compressing air to move the stamp piston may be recovered on the subsequent expansions of said air, and that no unnecessary compressions of air, and therefore no cushion of the blow is experienced. In other words, if at any time the air in the chamber 25 should be at a higher pressure than the air above the piston 8, then the valve 17 will lift and the equilibrium will be restored. On the other hand should the stamp piston 3 on its return stroke gather so much momentum as to rarefy the air passing through the channel 16 to a point at which its pressure is less than that in the chamber 25, then the valve 18

will lift, and the equilibrium again restored. In such cases should any energy be expended by the piston 3 in compressing the air above it, such energy will be utilized when the piston 8 rises to further compress said air to force said piston 3 downward. It will thus be seen that in all cases, my apparatus will be capable of delivering powerful uncushioned blows at high velocities without incurring any substantial losses of energy in useless compressions or expansions of the air 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 is:—

1. In a percussive apparatus the combination of a cylinder; a piston working therein having an accelerated movement adapted to rarefy the air above said piston; a reciprocating means attached to said piston adapted to deliver a blow; means for delivering compressed air above said piston to cause a relative movement between said piston and cylinder; and additional means for providing additional air above said piston to prevent the pressure above said piston being reduced to a predetermined point, substantially as described.

2. In a percussive apparatus the combination of a cylinder; a reciprocating piston working therein; a reciprocating means attached to said piston; means for delivering compressed air to said piston at different times to cause relative movements between said piston and cylinder; additional means to provide additional air above said piston; and means comprising an automatic valve mechanism to permit reëxpansions of said compressed air, substantially as described.

3. In a percussive apparatus the combination of a cylinder; a reciprocating piston working therein; a reciprocating stamp head attached to said piston; means for delivering compressed air to said piston to cause relative movement between said piston and cylinder; a valve on one side of said piston adapted to close on the upward stroke of the same; and means for holding said valve open substantially throughout the blow stroke of said piston, substantially as described.

4. In a percussive apparatus the combination of a cylinder; a piston working therein; a reciprocating stamp head attached to said piston; means comprising a second piston for compressing air to reciprocate said first mentioned piston in said cylinder; a valve controlling the flow of air on the lower side of said first piston; and means for holding said valve open substantially throughout the blow stroke of said first mentioned piston, substantially as described.

5. In a percussive apparatus the combination of a cylinder; a piston therein; a reciprocating member fixed to said piston and having a stamp head; a second cylinder; a second piston in said second cylinder adapted to alternately compress air to raise and lower said first piston; and means permitting the alternate reëxpansions of said air in a closed circuit wholly within said apparatus, substantially as described.

6. In a percussive apparatus the combination of a cylinder; a piston therein; a stamp head fixed to said piston; a second cylinder; a second piston in said second cylinder adapted to alternately compress air to raise and lower said first piston; additional means for providing additional air above said first piston; and means comprising a plurality of valves for controlling the reëxpansions of said compressed air, substantially as described.

7. In a percussive apparatus the combination of a cylinder; a piston therein; a stamp head fixed to said piston; a second cylinder; said apparatus being provided with passages between said cylinders; a second piston in said second cylinder; a valve on each side of said second piston; means for operating said second piston; and connections between said operating means and one of said valves adapted to hold said latter valve open substantially throughout one of the strokes of said piston, substantially as described.

8. In a percussive apparatus the combination of a cylinder; a piston therein; a stamp head fixed to said piston; a second cylinder; said apparatus being provided with passages between said cylinders; a second piston in said second cylinder; a spring controlled valve on each side of said second piston; means for operating said second piston; and connections comprising tappets and a lever between said operating means and one of said valves adapted to hold said last named valve open substantially throughout one of the strokes of said piston in said cylinders to be returned to the system, substantially as described.

9. In a percussive apparatus the combination of a cylinder; a reciprocating piston working therein; a reciprocating means attached to said piston; means for compressing air to raise said piston; means to admit air above said piston after it has partially completed its movements in an opposite direction; a valved outlet associated with said compressing means; and means to open said outlet and permit the expansion of said compressed air substantially throughout the time said piston is moving in said opposite direction, substantially as described.

10. In a percussive apparatus the combination of a cylinder; a reciprocating piston therein; a stamp head associated to said piston; means to deliver compressed air at different times to both sides of said piston; means to deliver additional air to one side of said piston after its stroke in one direction has been partially completed; and means to permit the reëxpansions of said compressed air, substantially as described.

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

HANS CHARLES BEHR.

Witnesses:
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N. CURTIS LAMMOND.