(No Model.) 2 Sheets—Sheet 1.

E. W. R. VON BÜHLER.

PNEUMATIC TOOL.

No. 510,155. Patented Dec. 5, 1893.

Fig. 1

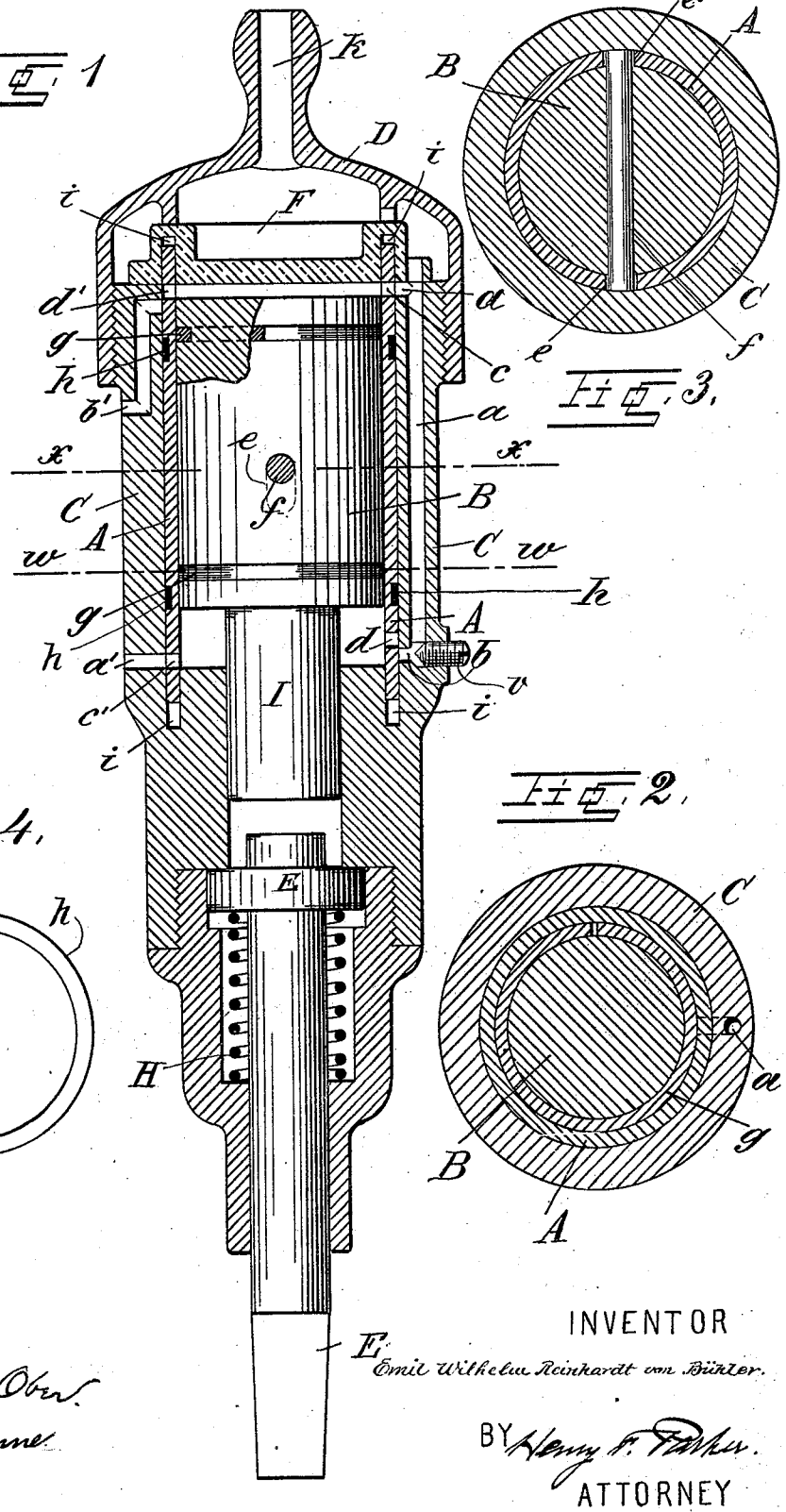

Fig. 3.

Fig. 4.

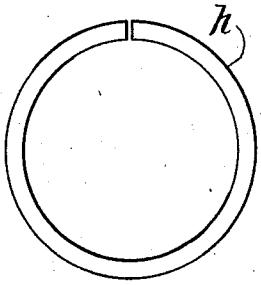

Fig. 2.

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(No Model.)

2 Sheets—Sheet 2.

E. W. R. VON BÜHLER.

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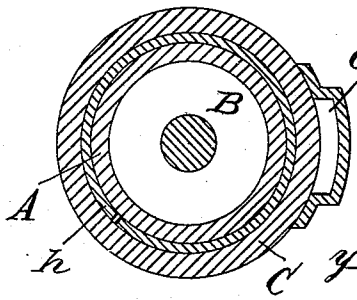

Fig. 7.

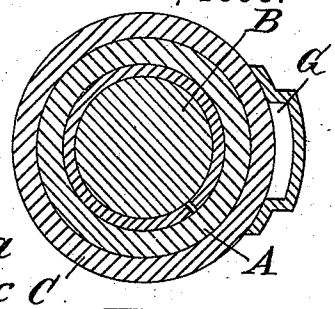

Fig. 6.

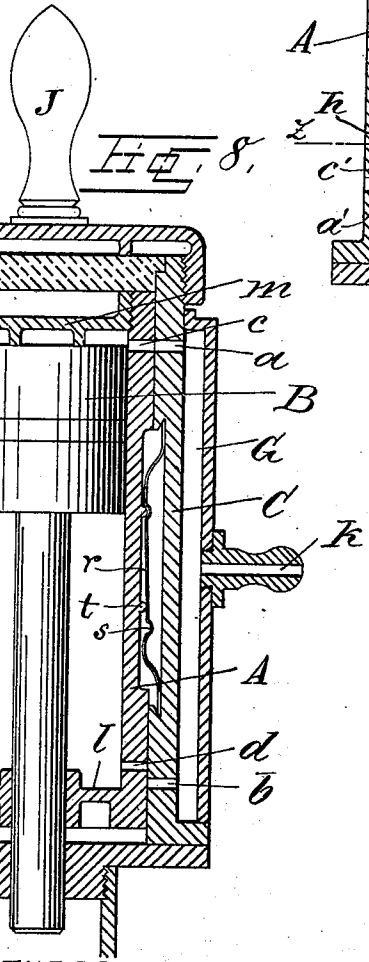

Fig. 8.

Fig. 5.

Fig. 9.

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UNITED STATES PATENT OFFICE.

EMIL WILHELM REINHARDT VON BÜHLER, OF BERLIN, GERMANY.

PNEUMATIC TOOL.

SPECIFICATION forming part of Letters Patent No. 510,155, dated December 5, 1893.

Application filed April 1, 1893. Serial No. 468,754. (No model.)

To all whom it may concern:

Be it known that I, EMIL WILHELM REINHARDT VON BÜHLER, a subject of the King of Würtemberg, residing at the city of Berlin, in the Kingdom of Prussia, Empire of Germany, have invented certain new and useful Improvements in Motors Adapted for Pneumatic Tools and other Purposes, of which the following is a specification.

My invention relates to pressure motors generally, but more especially to apparatus for operating reciprocating tools by compressed air or other fluid; the same being designed for commercial uses such as stone dressing, calking, riveting, dental plugging, &c., or rock drilling or other purposes.

The object of my invention is, in a pneumatic tool, to secure the necessary capacity of the induction and eduction ports or passages for conducting the motive fluid to and from the cylinder; and also to regulate the velocity of the piston for a given pressure.

The distribution of actuating fluid has in pneumatic tools heretofore invariably been accomplished through the agency of a transversely reciprocating valve within the piston or within the diametric limit of the cylinder, which valve has therefore been of restricted dimension and correspondingly restricted portage, and would not admit of speed regulation. Moreover, the wear and tear of the small sized valve heretofore used has been such as to render the durability of the machine imperfect.

To the ends above indicated the invention consists in a cylindric or annular distributing valve circumferentially interposed between the piston and the cylinder, and also in suitable means for actuating the said valve by the motion of the said piston; and in order to enable others skilled in the art to which my invention appertains to understand and use the same, I will proceed to describe the details of its construction, explain its operation and subsequently point out in the appended claims its novel characteristics.

Referring to the accompanying drawings in which similar letters of reference indicate corresponding parts throughout the several views, Figure 1, represents a longitudinal sectional elevation of a pneumatic tool constructed according to my invention; Fig. 2, a cross-section of Fig. 1, taken on the line w, w; Fig. 3, a cross-section of Fig. 1, taken on the line x, x; and Fig. 4, a detail view of one of the retarding springs employed on the annular valve in Fig. 1. Fig. 5, is a longitudinal sectional elevation showing a modified construction of my invention as applied to a pneumatic tool; Fig. 6, a cross-section of Fig. 5 taken on the line y, y; and Fig. 7, a cross-section of Fig. 5, taken on the line z, z. Fig. 8, is a partial longitudinal section showing a modification of the retarding spring applied to the valve; and Fig. 9, a detail view of the said retarding spring detached.

In the construction shown in Figs. 1 to 4 inclusive, C, represents the external cylinder forming the body of the tool within which the movable parts are concentrated as much as possible for the purpose of promoting convenient manipulation. E, is the tool holder or tool head which is movable in a cavity in the lower part of the cylindric body of the tool as indicated; the said holder or head being retracted at the intervals of the blows by a spiral spring H or other suitable or well known means. B, is the reciprocating piston, the downwardly projecting shank I of which abuts on the tool holder or head E, at each descending stroke. The cylinder is double acting, the motive fluid being supplied and exhausted at each end of the cylinder. In Fig. 1, the upper end of the cylinder is closed by a head F, which is retained in position by means of the screwed cap D, which also bears a nipple k, adapted for the attachment of a flexible supply tube. The cap D, being hollow, provides a conduit for the introduction of the motive fluid to the induction passages a, b, of the motor cylinder. a, b, are the induction ports at the respective ends of the cylinder; c, d, are the induction passages near the respective ends of the valve A; c', d' are the exhaust passages near the respective ends at the opposite side of the said valve A, and a', b', are the exhaust ports at the respective ends on the opposite side of the cylinder C. These several ports or passages are so arranged that when the valve A, is at the upper end of its stroke, as represented in the drawings, the induction ports a, c, coincide and establish admission above the piston B, while the exhaust ports b', d', are closed.

The induction ports *b*, *d*, at such upper position of the said valve A, are out of coincidence, while the exhaust ports *c'*, *a'*, coincide and establish the exhaust beneath the piston as seen. When the valve A, is at its lower extremity of stroke, the port connections are reversed, applying pressure beneath the piston B and exhausting it above. The valve A, is retarded against displacement at an improper time by the frictional engagement of the annular split rings *h*, on the cylinder C. Motion is imparted to the valve A, by means of the transverse pin *f* in the piston, projecting from the sides thereof, into longitudinal slots *e*, *e*, in the valve A. The slots *e*, are of such length that the reciprocation of the pin *f*, therein shall occur at a distance less than the full stroke of the piston. Thus the piston moves the valve during the latter part of its stroke, to reverse the distribution of pressure. The piston B, is provided with spring rings *g*, adapted to render it pressure tight within the cylindric valve A, and also to take up wear. *v*, represents an adjusting plug valve adapted to vary the capacity of the lower induction passage *b*, for the purpose of varying the velocity of the tool.

Referring now to Figs. 5 to 9 inclusive, the cylindric valve A, is closed at its ends. In this construction the transverse pin *f*, is dispensed with and the ends of the piston itself are permitted to abut or to act through an air cushion on the heads *m*, *l*, of the valve A to actuate it. The arrangement of the ports in Fig. 5, is substantially similar to that illustrated in Fig. 1, excepting that the inlet nipple *k*, is located upon the side of the cylinder C, in lieu of the end; the flexible tubing being thereby attached at the side and admitting the provision of a handle J at the extremity of the tool for manipulating it. In order to avoid the loss of momentum which would be involved by too abrupt concussion of the piston B, on the head *l*, of the valve in descending, an air cushion or other spring may be provided at *p*, which is designed to check the abutment of the parts A, B, and reserve the full force of the blow for the tool holder E. The air cushion at *p*, is obtained by locating the exhaust passage *c'* in the valve a little above the valve head *l*, so that the escape of air is checked or totally cut off, before the piston actually abuts on *l*. In lieu of such arrangement, a spiral ring may be obviously employed in interposition between the lower end of the piston B, and the head *l*.

In Fig. 8, the modification illustrated consists in the provision of a retarding spring *r*, situated in the cylinder C, having notches *s*, engaging with the corresponding projections *f*, on the valve A. The entrance of the projections *f*, into the notches *s*, of the spring serves to retain the valve at its respective extremities of stroke until forced out of such position by the abutment of the piston B, in the manner hereinbefore described.

The operation of the invention consists as follows: The piston B, being at its upper extremity of stroke the valve A is also raised, and the induction ports *a*, *c*, open above the piston; the exhaust ports *d'*, *b'* being closed. The induction ports *b*, *d*, are closed and the exhaust ports *a'*, *c'*, open beneath the piston. The piston then descends delivering a sharp blow upon the tool before the valve A, which is carried with it has closed at *a*, *c*. With the termination of the descending stroke of the piston B, the downward stroke of the valve A, is also completed, reversing the distribution of pressure, driving the piston upward. In Fig. 5, before the piston B or any connected part thereof has come into contact with the valve A, to move it, the interposed air cushion at *p*, serves to start the valve A on its downward stroke so that the latter will have terminated its movement before or at the time the piston B actually abuts thereon, if at all. The only abrupt concussion arresting or tending to arrest the descending movement of the piston B, thereby occurs at its impact on the tool holder or head E, concentrating the full effective force of momentum upon the tool. In apparatus used heretofore for distributing motive pressure to the reciprocating piston of a pneumatic tool, in which the distributing valve has been located diametrically within the piston or cylinder head, various difficulties have presented themselves, based particularly upon the fact that the area of the conduits for the supply of compressed air depended upon the diameter of the piston or that of the cylindric body of the tool, and that it was not admissible to have the same exceed the one-fortieth part of the area of such piston, while the distributing valve being of a very limited dimension and stroke, it has moreover been necessary to give the same cross sections to the admission and the discharge ports, which in other respects is undesirable and unsuitable. The small distance traveled by the slide valve, on the other hand, determined the cross sections of the supply and discharge ports, which had to be made not to exceed one-fifth of the travel of said slide valve, in order to prevent leakage along the valve seat from the supply ports to the discharge ports. Consequently the efficiency of tools operated by compressed air was exceedingly limited, and could not be increased as circumstances and the particular uses to which the tool had to be put might require. The efficiency of the tool soon suffered from the fact that owing to the short distance between the admission and discharge ports as well as between the ports above and below the piston, wearing of the slide valve occurred quickly causing back pressure. Moreover the piston which in practice moves at the rate of about six thousand down strokes per minute could not be regulated by varying the admission capacity of the ports owing to their concentrated arrangement and inaccessible position.

By means of my invention I acquire larger

bearing surfaces for the valve, and corresponding durability and strength of the same to resist wear and tear, and I also acquire access to the ports for regulating the relative capacity thereof, and the velocity of the piston according to the requirements of the work.

The normal areas of the induction and discharge ports may be as much as desired according to my present construction, and the area of the lower induction port *b*, for retracting the piston may be varied by means of the screw plug *v*, indicated. According to the regulation of the port *b*, the velocity of the piston or intervals occupied during retraction between its blows upon the tool head may be increased or decreased at will. The greatest rapidity of movement is acquired by making the areas of the admission ports above and below the piston equal.

The service of the piston in overcoming the slight inertia of the annular valve A, toward the termination of each stroke secures not only a more regular performance of the apparatus, but correspondingly increases its efficiency.

It will be obvious in reference to Fig. 5, that the transmission of motion from the piston B to the valve A, may be effected through air cushions at the up-stroke as well as at the down-stroke, in the manner described, and it is to be observed moreover that air cushions are or may be formed above and beneath the valve A, between the same and the respective ends of the cylinder C, in the construction shown in Fig. 5, or in the spaces *i*, in the construction shown in Fig. 1.

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

1. In a motor, the combination with a cylinder and a reciprocating piston therein, of a cylindric distributing valve circumferentially interposed and longitudinally movable between the piston and the cylinder, and means for actuating the said valve comprising a pin or rod extending from the valve through an opening in the piston, substantially as described.

2. The combination in a motor, with a cylinder and a reciprocating piston therein, of a longitudinally movable cylindrical distributing valve circumferentially interposed between said piston and said cylinder, induction and eduction ports in the cylinder, and corresponding induction and eduction ports in the valve, the same being located so as to operate in the manner described, and means for varying the area of the lower induction port.

3. In a motor, the combination with a cylinder and a reciprocating piston therein, of a longitudinally movable cylindrical distributing valve circumferentially interposed between the said piston and the said cylinder, and a spring interposed between said valve and said cylinder, and means for interlocking the said spring with the valve and adapted to retard the valve against premature displacement by the friction of the piston thereon, substantially as described.

4. In a pneumatic tool the combination with a tool holder, a pressure cylinder, and a reciprocating piston therein, of a reciprocating annular valve interposed between the piston and the cylinder, and a removable head provided at one end of the cylinder containing passages therein for the conduction of the motive fluid, substantially as described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

EMIL WILHELM REINHARDT VON BÜHLER.

Witnesses:

CHR. FRISCH,

A. R. DUNNE.