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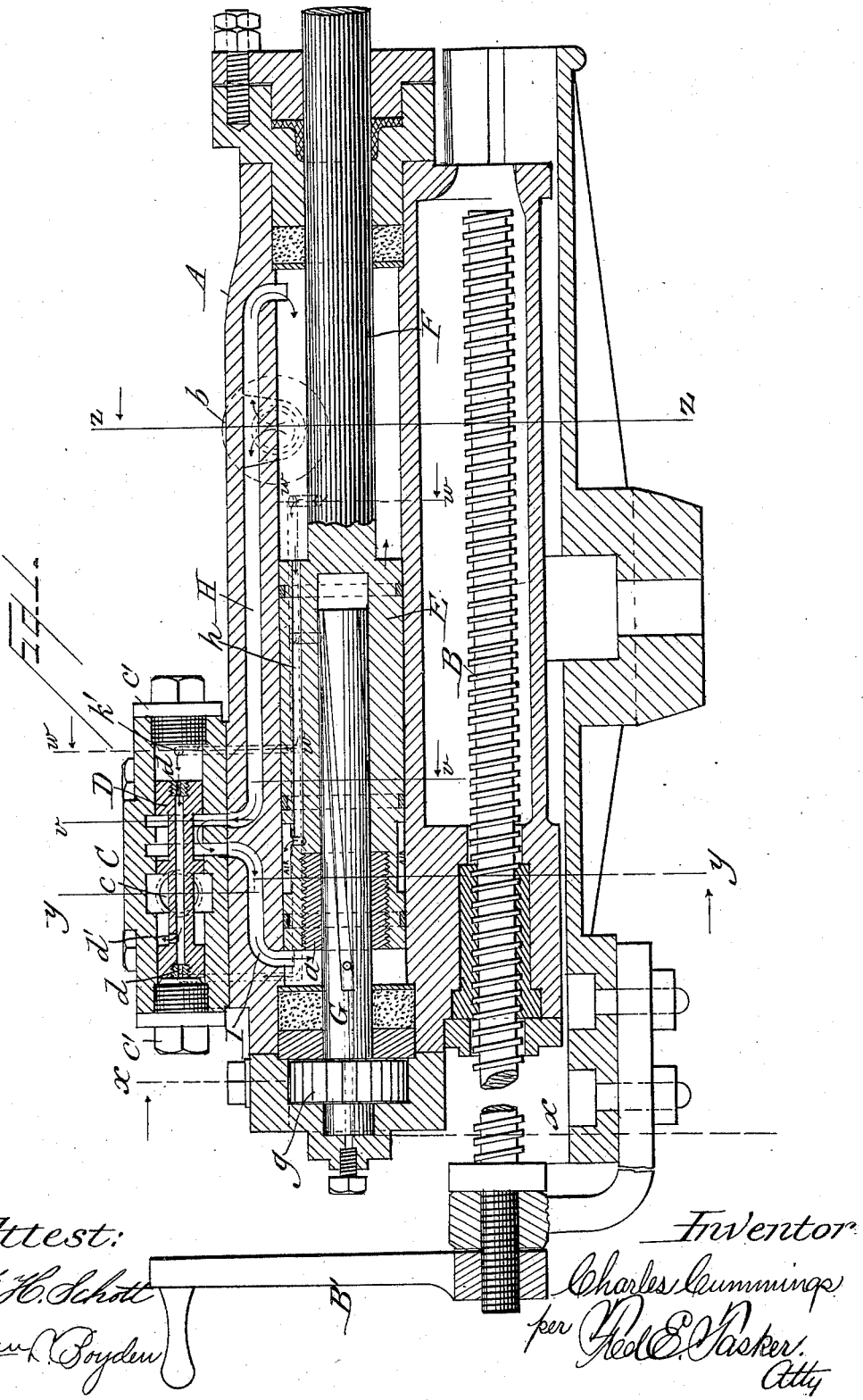
C. CUMMINGS.

ROCK DRILL.

No. 456,942. Patented Aug. 4, 1891.



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(No Model.) 4 Sheets—Sheet 2.

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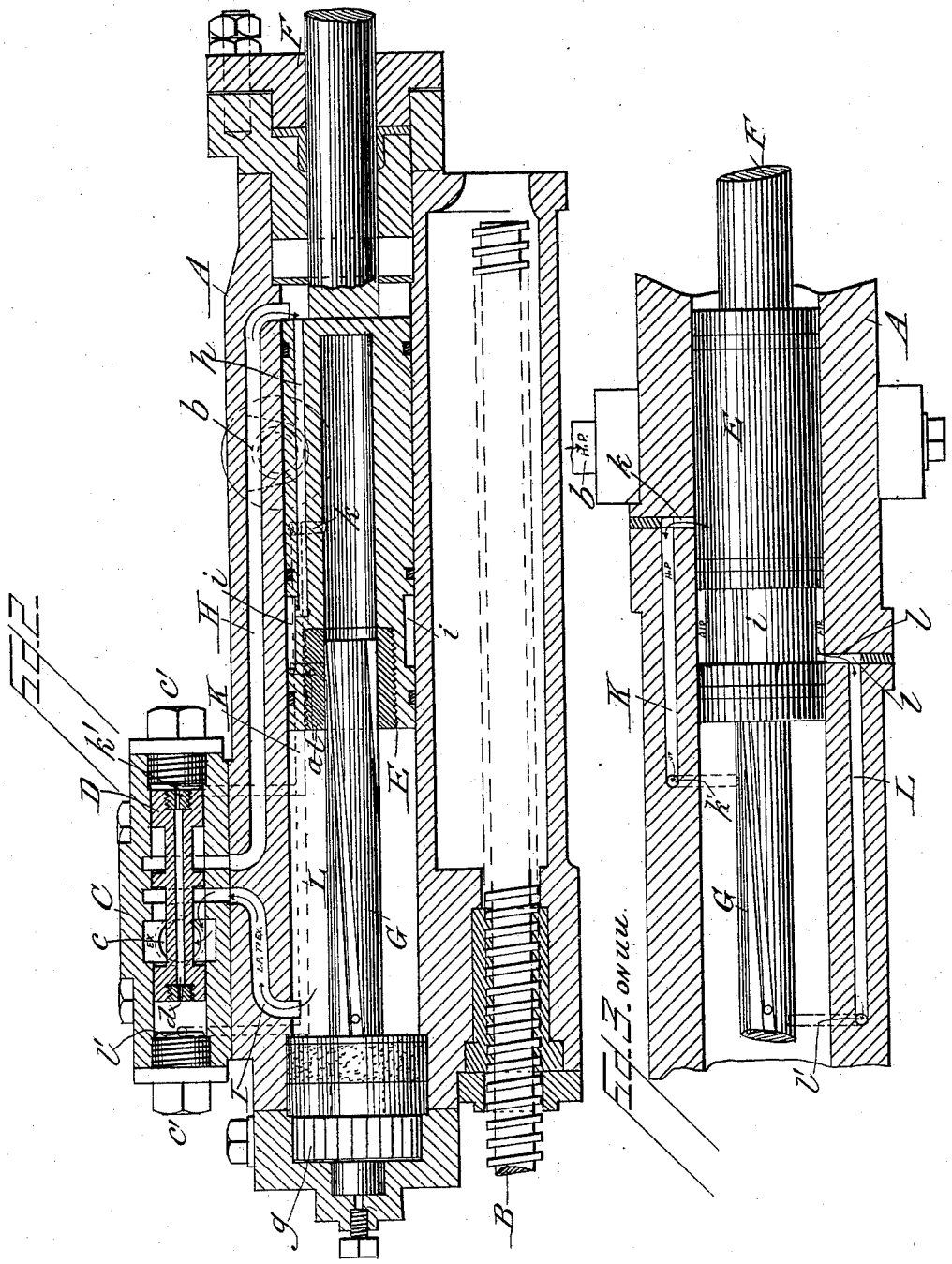

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C. CUMMINGS.

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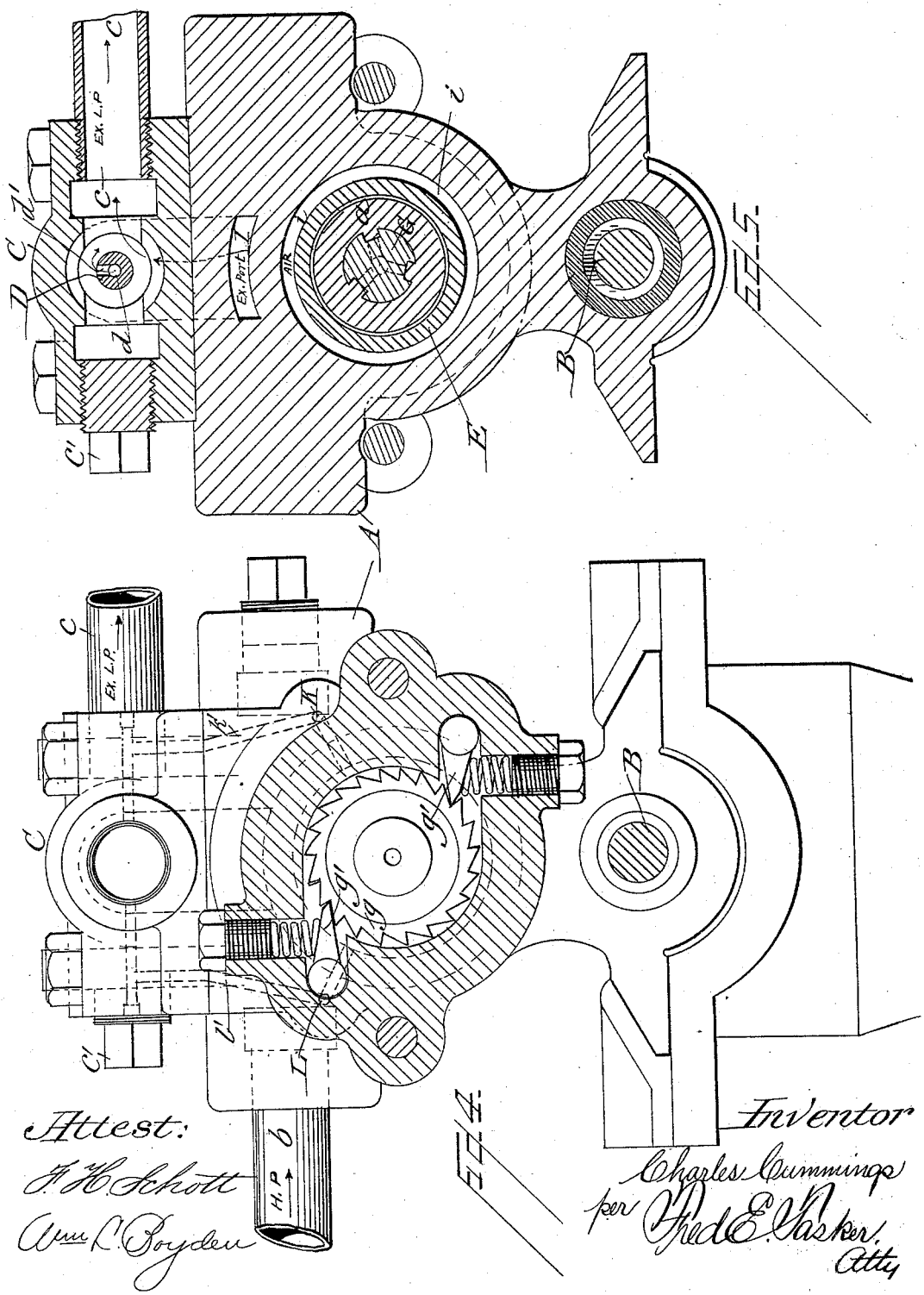

(No Model.) 4 Sheets—Sheet 4.

C. CUMMINGS.

ROCK DRILL.

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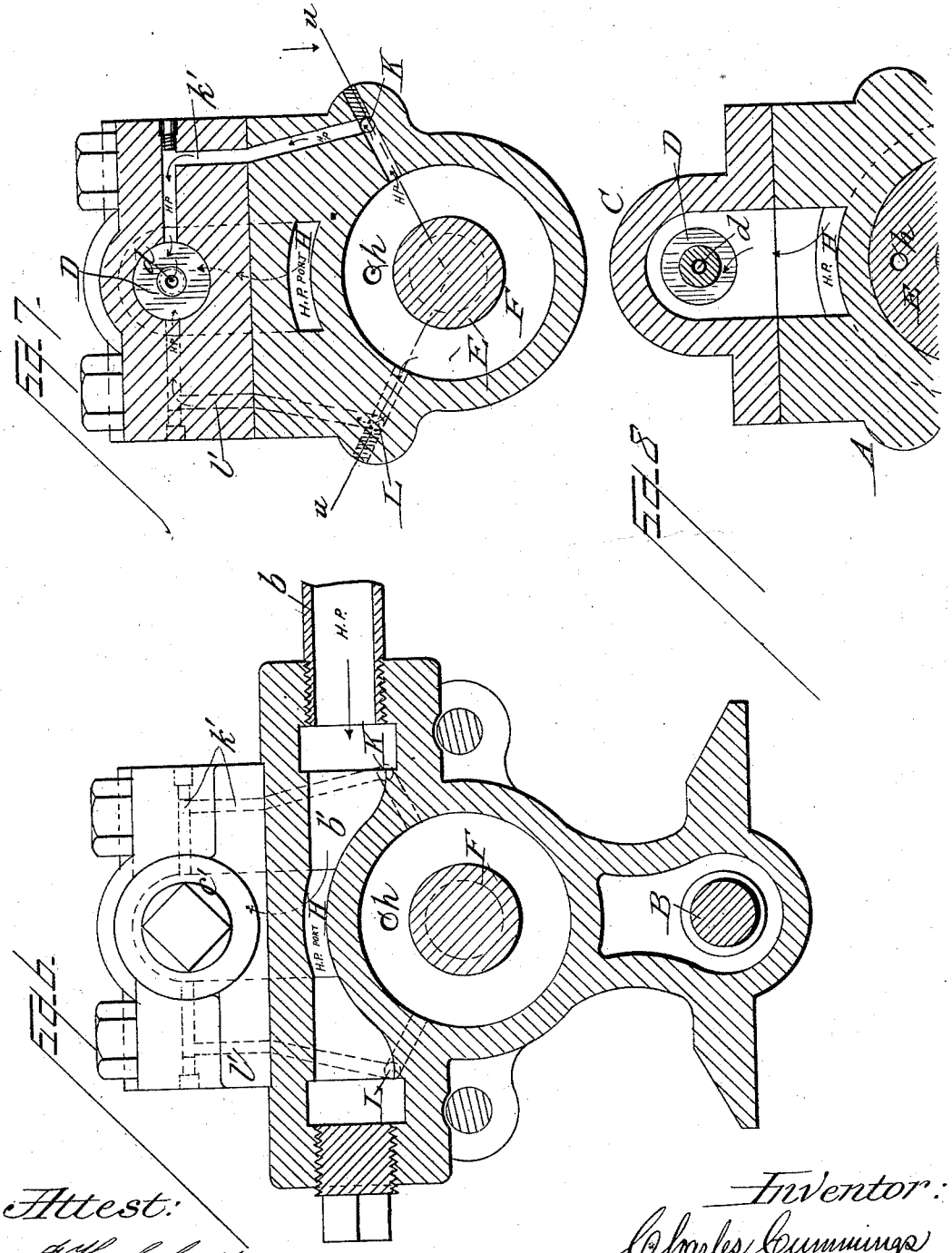

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Atty

UNITED STATES PATENT OFFICE.

CHARLES CUMMINGS, OF OAKLAND, CALIFORNIA.

ROCK-DRILL.

SPECIFICATION forming part of Letters Patent No. 456,942, dated August 4, 1891.

Application filed June 12, 1890. Renewed May 18, 1891. Serial No. 393,075. (No model.)

To all whom it may concern:

Be it known that I, CHARLES CUMMINGS, a citizen of the United States, residing at Oakland, in the county of Alameda and State of California, have invented certain new and useful Improvements in Rock-Drills; 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 an improvement in rock-drills which are intended to be driven by means of compressed air, the object of the invention being to so construct and arrange the mechanical parts of a rock-drill that my improved machinery for transmitting power by means of compressed air may be employed to actuate the said drill, said power-transmitting machinery to which I have thus alluded being a novel and improved means for increasing the efficiency of mechanism of this character, it being covered in my other pending application for Letters Patent for improvements in apparatus for transmitting power by means of compressed air, filed June 12, 1890, Serial No. 355,228, and involving the principle or method wherein are employed two unequal air-pressures, both above the normal atmospheric pressure, and maintaining a constant and fixed ratio to each other, these two pressures being adapted to operate upon the piston in the driven machine, which in this instance is the rock-drill, in such a manner as to produce the ordinary action in such mechanism; and the invention therefore consists in the construction, arrangement, and combination of parts, substantially as will be hereinafter more fully described and claimed.

In the accompanying drawings, illustrating my invention, Figure 1 is a longitudinal section of my improved drilling-machine, showing the piston near one end of its stroke. Fig. 2 is a similar longitudinal section, certain of the parts being removed and showing the piston near the other end of its stroke. Fig. 3 is a horizontal sectional plan on the line *u u* of Fig. 7. Fig. 4 is a sectional end elevation on the line *x x* of Fig. 1. Fig. 5 is a cross-section on the line *y y* of Fig. 1. Fig. 6 is a cross-section on the line *z z* of Fig. 1. Fig. 7 is a cross-section on the line *w w* of Fig. 1. Fig. 8 is a cross-section on the line *v v* of Fig. 1.

Similar letters of reference designate corresponding parts throughout all the different figures of the drawings.

A denotes the cylinder of the drilling-machine; B, the feed-screw having the operating crank-handle B′; C, a valve-chamber on the side of cylinder A; E, the piston within the cylinder A, having piston-rod F, which is adapted to have the drill connected thereto; G, a rod which carries at its outer end the ratchet-wheel *g*, which is engaged by the spring-pawls *g′ g′*, said rod G entering a central longitudinal socket in the piston E and being provided on its surface with spiral grooves that are engaged by tongues on the nut *a*, which is screwed into the end of the piston, the said grooves and tongues being indicated in Fig. 5, and all of these parts being so arranged and related that on the downstroke of the piston the ratchet will be fed forward, while on the return or upstroke of the piston the ratchet will stand still, but the engagement of the nut with the spirally-grooved rod G will serve to partially rotate the drill.

In the machine which I have above alluded to at the outset, and which is used for transmitting motion to actuate my present improved drill, two unequal air-pressures are created, which bear a constant and fixed ratio to each other, the ratio being maintained constant by suitable means, one of the air-pressures being, for example, one hundred pounds to the square inch and the other air-pressure being, for example, two hundred pounds to the square inch, and the air at the lower of the two pressures is termed low-pressure air and at the higher of the two pressures high-pressure air. In said air-compressing apparatus there are two pipes or conduits leading from the compressor to the driven element, such as the rock-drill, which pipes or conduits contain the unequal pressures of air just mentioned. A cross-pipe connects these two pipes at a certain point and is provided with a hand-valve; also, there is what I term an "air-governor," which is an important feature of the combination. It has two important functions: first, to keep the geometrical ratio of the two unequal air-pressures con-

stant; second, to regulate the speed of the compressor in proportion to the work to be done by the driven machine.

In charging up the apparatus the operator will first open the valve which admits atmospheric-pressure air into the compressor, and he will also open the valve in the cross-pipe just mentioned, which valve, as we have seen, is a hand-valve and is non-automatic. Then the compressor will be set to work and air will be drawn from the atmosphere into the compressing-cylinders, compressed therein, and sent through the pipes of the system. The compressed air in the entire system will of course be now at the same pressure, and the like degree of pressure will therefore be indicated upon both gages, that belonging to the high-pressure pipe and that belonging to the low-pressure pipe. The operation of compressing will be continued until both gages register, say, one hundred pounds. Then the operator will close the hand-valve in the cross-pipe. This will separate the system of low-pressure pipes from the system of high-pressure pipes, leaving the pressure in the former system fixed permanently at one hundred pounds. The operation of the compressor will now continue until the air in the high-pressure pipes has attained a pressure of, say, two hundred pounds, when the inlet-valve will be closed by hand, preventing the admission of any more air into the compressor, and a valve will be opened by hand to allow air at a pressure of one hundred pounds to be delivered to the compressor-cylinder. We have now our closed system, wherein the air circulates between the compressor and the drill, the air in one part of the apparatus being at one hundred pounds pressure and the air in the other part being at two hundred pounds pressure, there being thus two unequal pressures of air both above atmospheric pressure, the ratio of the pressures being as two to one, which ratio is kept constant by means of the air-governor, and this governor is found in actual practice to do its work so perfectly that hardly any fluctuation of the ratio is perceptible upon the gages or indicators with which the apparatus is preferably provided.

I am aware of patents showing machinery for transmitting power by means of compressed air, wherein are pipes leading from a compressor to a driven engine, said pipes being connected at a certain point by a cross-pipe, wherein is a weighted automatic valve, said apparatus thus employing two unequal pressures of air, which are kept at a constant difference by means of the weighted valve. The construction and operation of my compressing apparatus, however, is entirely distinct and radically different from that shown and described in the patent alluded to. I may say that there are three substantial differences between my apparatus and the other. One is the use of the hand-valve in the pipe, connecting the low and high pressure pipes of the apparatus, in the place of the weighted automatic valve, which is not adapted to be worked by hand. Another is an automatic governor, which maintains the two pressures in the circuit at a constant ratio, and a third is a novel construction in the air-compressor. The mere substitution of a hand-valve for the heavily-weighted automatic valve of the other apparatus, though a slight change, yet plainly enables an entirely different manner of operating the apparatus for charging it with the two pressures. Furthermore, my automatic air-governor is plainly something more than an equivalent of the weighted valve when in action as a regulator, for the reason that my governor maintains a constant geometrical ratio between the two unequal air-pressures, while the weighted valve maintains only a constant difference between air-pressures. My governor so coacts with the other elements of the combination in the apparatus in which it is found that the result is not only regulation of power according to the demand of the duty done by the drill or other worker, but also constant maintenance of a ratio of the pressures, notwithstanding the changes of power imparted to the motor, compressor, and worker, and thereby a constant maintenance of all the utilities of that variance by ratio instead of by difference, which I accomplish and maintain in my apparatus.

The function of my governor is not to maintain a uniform speed under all circumstances, as is the case with ordinary steam-engine governors, but it is designed to automatically vary the speed of the compressor to suit the work done by a driven machine. Thus suppose one rock-drill requires a certain number of revolutions of the steam-engine per minute to actuate the compressor sufficiently to transmit the required power to drive said drill. Obviously two of these drills will require twice as many revolutions of the actuating-engine to drive it. The air-governor automatically varies the steam-supply, and thus controls the speed of the engine, and consequently the speed of the compressor, so that only so much air is compressed as is required for use and there is no waste of energy. I have thus stated somewhat fully the operation and results of my improved compressing apparatus covered by the application above alluded to, in order that the employment of the novelties of my system to the actuation of a rock-drill may be clearly and accurately understood. We will suppose, therefore, that the drilling-machine which I am describing is supplied with low-pressure air having a pressure of one hundred pounds to the square inch, and also with high-pressure air having a pressure of two hundred pounds to the square inch, this air being in two separate conduits.

b designates the high-pressure conduit, which delivers air at the higher of the two unequal pressures to the cylinder, said conduit entering the side wall of the cylinder at some suitable point, as shown in Figs. 1, 2, 3,

and 6, while *c* designates the low-pressure or exhaust pipe, which is connected to the valve-chamber C at some suitable point, as shown in Figs. 1, 4, and 5, said pipe *c* containing air at the lower of the two pressures—that is to say, the exhaust-pressure of the air used by the drill—which in this example is supposed to be one hundred pounds to the square inch.

By referring to Fig. 6 it will be seen that air enters through the high-pressure pipe *b* into the cross-passage *b'*, and thence into the high-pressure port H, formed in the barrel of the cylinder, said port H having communication at one end with the valve-casing C and at the other end with the bore of the cylinder, as will be seen by observing the direction of the arrows in Fig. 1. Therefore the air on the right-hand end of the piston, as it appears in Fig. 1, which in actual practice is the lower end of the piston, is always high-pressure air.

By observing the piston E it will be noted that the two ends thereof are of unequal area. The right-hand or lower end where the piston-rod F starts from the piston is an annular surface, all the central portion of the piston end being occupied by the rod F, so that the air can only act against the annular or rim space of the piston surrounding the rod F. The left-hand or upper end of the piston, however, exposes its entire area to the action of the air, for although the rod G enters a longitudinal recess in the piston, yet said rod is rifled or spirally grooved in such a manner that the air can get through between the joints, and hence the air is allowed to act upon the entire surface of that end of the piston. This inequality of areas permits me to use high-pressure air on both ends of the piston to give the impulse thereto, for when the high-pressure air is acting upon the right-hand or lower end of the piston, although the area of this end is less than that of the other end, yet, since low-pressure air will at this time be upon the other end the high-pressure air will overbalance the low-pressure air and the piston will move toward the back end of the cylinder, and when high-pressure air is upon the left-hand end of the piston-rod to impel the latter it will be able to do so, since the area of that end of the piston is so much greater than the area of the other end of the piston, although the other end of the piston is likewise in contact with high-pressure air. In the wall of cylinder A is likewise a low-pressure port I, which enters the end of the cylinder-bore opposite where the high-pressure port H enters and which enters the valve-chamber C at a point near the port H. The port I is clearly seen in Figs. 1 and 2 and also in Fig. 5.

The valve-chest C contains the piston-valve D, which may be of any suitable and ordinary construction. Said valve D is adapted to connect or disconnect the ports I and H. The valve D is provided with a longitudinal passage *d*, extending from end to end.

c' c' denote the heads of the valve-chamber. The longitudinal passage *d* has a side opening *d'*, through which air can pass in the direction of the arrow, as shown in Fig. 1, from the interior of passage *d* sidewise into the interior of the valve-chamber occupied by the low-pressure air. The purpose of the passage *d* is to prevent violent concussion between the end of the piston-valve D and the head of the valve-chamber when the valve is shifted. When the valve shifts, the air between the end thereof and the head of the valve-chest will be compressed sufficiently to form a cushion for the movement, since the said air will enter but slowly into the small opening at the end of the passage *d*, after which it escapes through port *d'* into the exhaust.

In the wall of cylinder A is a long port K, (see Fig. 3,) one end of which enters the cylinder-bore at *k*, while the other end enters the valve-casing C at *k'* near one of the casing-heads *c'*. L denotes another long port, which enters the cylinder-bore at *l*, and also the other end of the valve-casing C at *l'* near the other casing-head *c'*.

The piston E is provided with the longitudinal passage *h*, extending inward from the right-hand end of the piston and communicating with the annular recess *i*, formed in the piston. The points *k* and *l* where the ports K and L enter the cylinder-bore are not exactly in line with each other, but are located as indicated in Fig. 3, so that when the cylinder is at the right-hand end of its stroke the piston will cover the port K, while the annular recess *i* is opposite the port L and in communication therewith; and in the reciprocations of the piston it will be observed that the port K only becomes uncovered, so as to be in communication with the interior of the cylinder-bore when the end of the piston passes it, while the port L is in communication with the interior of the cylinder-bore through the annular recess *i* and the longitudinal passage *h* whenever the said annular recess is opposite the point *l*, as is shown in Fig. 3.

I will now proceed to describe the operation of the air in producing the reciprocations of the piston. When the piston is at the right-hand end of its stroke, as shown in Figs. 2 and 3, then the valve D will be at the right-hand position, as indicated in Fig. 2, in which position the ports I and H are cut off from each other, said port I being filled with low-pressure air, which air likewise fills the space at the left-hand end of the piston, and also a portion of the space within the valve-chamber C, there being obviously a communication between the low-pressure pipe and that portion of the cylinder-bore at the left of the piston. The port H is filled with high-pressure air, which is acting upon the right-hand end of the piston. Hence the longitudinal passage *h*, the annular recess *i*, and the port L are full of high-pressure air, and hence the air acting upon the left-hand end

of the valve D is high-pressure air. Port K is now closed, as the piston covers it. This being the condition of the parts and of the air, it is evident that the pressure on the right-hand end of the piston is greater than the pressure of the low-pressure air on the left-hand end of the piston, and hence the piston will begin its reciprocation and move to the other limit of its stroke. On its way the end of the piston will uncover the opening of the port K, which will admit high-pressure air into said port and conduct it to the right-hand end of the piston-valve D, thus shifting said valve so as to place the ports I and H into communication with each other, and therefore causing high-pressure air to be introduced into the port I, so as to enter the left-hand end of the cylinder-bore and act upon the left-hand end of the piston. This will cause the pressure on the left-hand end of the piston—it having the greater area—to overbalance the pressure on the right-hand end of the piston, and therefore the said piston will reciprocate to the right, or in a downward direction, the reverse of the former reciprocation, until, as it nears the limit of its stroke, it closes the port K and brings its recess *i* into communication with the port L, whereby high-pressure air is carried to the left-hand end of the piston-valve, and the valve is again shifted, so as to separate the ports I and H and allow the pressure on the right-hand end of the piston to overbalance the pressure on the left-hand end, the air on this latter end of the piston now being permitted to exhaust into the low pressure, and this reciprocation of the piston in each direction will take place continuously in the manner I have just described.

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

1. A drilling-machine adapted to be operated by compressed air, in combination with two pipes or conduits containing air at two unequal pressures, both above normal atmospheric pressure, said air circulating in a closed system through the pipes, the compressing device and the drilling-machine and the two pressures maintaining a fixed ratio to each other.

2. In a compressed-air drilling-machine operated by two unequal pressures of air, both above normal atmospheric pressure, a piston operated by said pressures, which maintain a fixed geometrical ratio to each other, and two pipes or conduits containing the air at the two unequal pressures, the said air circulating in a system closed against the external atmosphere through the pipes, the drilling-machine, and the means for compressing.

3. In a drilling-machine, the combination of the piston impelled in each direction by the action of the higher of the two air-pressures, and two pipes or conduits, one containing air at a certain lower pressure and the other air at a certain higher pressure, the two pressures maintaining a fixed geometrical ratio to each other, both being above normal atmospheric pressure, and said air circulating in a closed system through the conduits, the compressing device, and the drilling-machine.

4. In a compressed-air drilling-machine operated by two unequal pressures of air, both above normal atmospheric pressure, a piston having high-pressure air constantly on one end thereof and high-pressure and low-pressure air alternately on the other end thereof, the impelling air on each end being always the high-pressure air.

5. In a compressed-air drilling-machine operated by two unequal pressures of air, both above normal atmospheric pressure, a piston having unequal areas on each end and having high-pressure air constantly on one end thereof and high-pressure and low-pressure air alternately on the other end thereof, the impelling air on each end being always the high-pressure air.

6. In a compressed-air drilling-machine operated by two unequal pressures of air, both above normal atmospheric pressure, the combination of the cylinder, a piston therein having unequal areas on its ends and having high-pressure air constantly on one end thereof and high-pressure and low-pressure air alternately on the other end thereof, the impelling air at each end being always the high-pressure air, and a suitable valve device for controlling the admission of high-pressure air into that end of the piston where the high-pressure and low-pressure air alternate.

7. In a rock-drilling machine operated by two unequal pressures of air, both above normal atmospheric pressure, the combination of a cylinder having a high-pressure and a low-pressure port therein, a piston having high-pressure air constantly on one end thereof and high-pressure and low-pressure air alternately on the other end thereof, the impelling air at each end being always the high-pressure air, and the valve device for regulating the inflow of air to that end of the cylinder where the high-pressure and low-pressure air alternate.

8. In a rock-drilling machine operated by two unequal pressures of air, both above normal atmospheric pressure, the combination of the cylinder having a high-pressure and a low-pressure port therein, a piston having unequal areas on each end and having high-pressure air constantly on one end and high-pressure and low-pressure air alternately on the other end, said piston having a longitudinal passage, and an annular recess and the valve-casing and valve therein, together with two ports leading from the cylinder-bore to said casing and entering the same at opposite ends.

9. In a rock-drilling machine operated by two unequal pressures of air, both above normal atmospheric pressure, the combination of the cylinder having a high-pressure port and

a low-pressure port, a piston in said cylinder having unequal areas on its ends and having high-pressure air constantly on one end thereof and high-pressure and low-pressure air alternately on the other end thereof, the impelling air being always high-pressure air, said piston having a longitudinal passage opening into the cylinder-bore and an annular recess with which said passage communicates, the valve-casing and the valve therein, and the two ports leading from the bore of the cylinder to the opposite ends of the valve-casing.

10. In a rock-drilling machine, the combination of the cylinder having high-pressure and low-pressure ports, a high-pressure inlet-pipe entering said cylinder, a piston within the cylinder having high-pressure air constantly on one end thereof and high-pressure and low-pressure air alternately on the other end thereof, said piston having a longitudinal passage and an annular recess, the valve-chamber and valve therein, the exhaust or low-pressure pipe entering said valve-chamber, and the two ports leading from the bore of the cylinder to the opposite ends of the valve-casing.

11. In a rock-drilling machine operated by two unequal pressures of air, both above normal atmospheric pressure, the combination of a cylinder having high-pressure and low-pressure ports, a piston within said cylinder having unequal areas on each end and having high-pressure air constantly on one end and high-pressure and low-pressure air alternately on the other end, the valve-chamber and the valve device therein for controlling the admission of high-pressure air to that end of the piston where the high-pressure and low-pressure air act alternately, said piston having a longitudinal passage, substantially as described.

12. In a rock-drilling machine operated by two unequal pressures of air, both above normal atmospheric pressure, the combination of the cylinder having the ports therein, the piston, the ports leading from the cylinder-bore to the valve-chamber, the valve-chamber and the valve within said chamber, said valve having a longitudinal passage and a side outlet.

13. In a rock-drilling machine designed for operation by means of two unequal pressures of air, both above normal atmospheric pressure, the combination of the cylinder having the ports therein leading into the cylinder-bore near opposite ends, the inlet-pipe for admitting high-pressure air to the cylinder, the piston within the cylinder having a longitudinal passage and an annular recess, the valve-casing, the valve therein, the two ports leading from the cylinder-bore and entering said casing near opposite ends thereof, one of said ports being adapted to communicate with the annular recess of the piston at certain times and the other port being adapted to be uncovered by the end of the piston at certain times, substantially as described.

14. In a rock-drilling machine operated by two unequal pressures of air, the combination of the cylinder having two ports entering the bore thereof near opposite ends, the valve and its casing, the two ports leading from the cylinder-bore to the valve-casing, and the piston with its longitudinal passage and annular recess, together with the piston-rod and the rifled rod entering the longitudinal recess in the piston, the opposite ends of said piston being of unequal areas, and the high-pressure air acting constantly on one end of the piston while the high-pressure and low-pressure air act alternately on the other end of the piston.

15. In a rock-drilling machine, the combination of the cylinder, the feed-screw and its handle, the valve-chamber and its valve, the piston and its piston-rod, together with the rifled rod entering the piston and carrying at its other end a ratchet, the ends of said piston being of unequal areas, and high-pressure air acting constantly on the end of less area, and high-pressure and low-pressure air acting alternately upon the end of greater area, together with the several ports and passages.

16. In a rock-drilling machine, the combination of the cylinder, the piston having its ends of unequal areas, the valve-chamber and its valve, the high-pressure air-inlet entering the cylinder and the low-pressure air-inlet connected to the valve-chamber, high-pressure air acting constantly upon the piston end of less area and high-pressure and low-pressure air acting alternately upon the piston end of greater area, the impelling air being always the high-pressure air, together with suitable ports and passages, all arranged to accomplish the results substantially as described.

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

CHARLES CUMMINGS.

Witnesses:

WM. L. BOYDEN,

GEO. L. CLARK.