(No Model.)

J. B. WARING.

AIR COMPRESSOR.

No. 254,851. Patented Mar. 14, 1882.

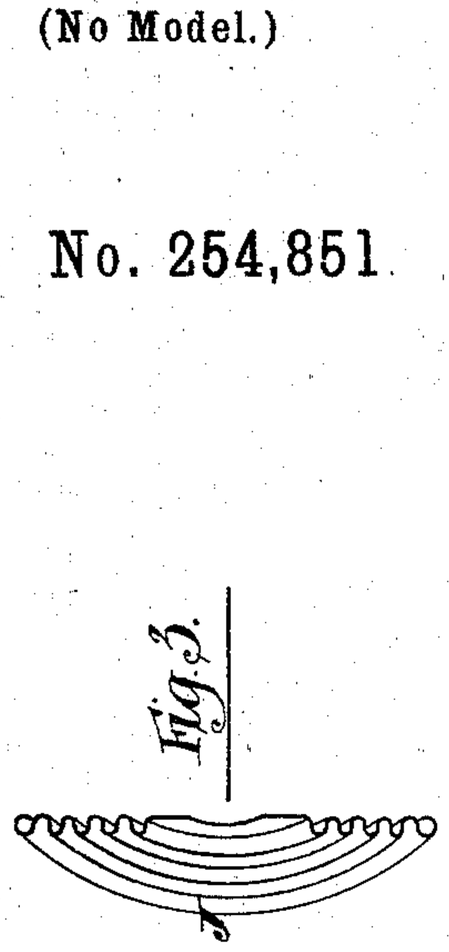

Fig. 3.

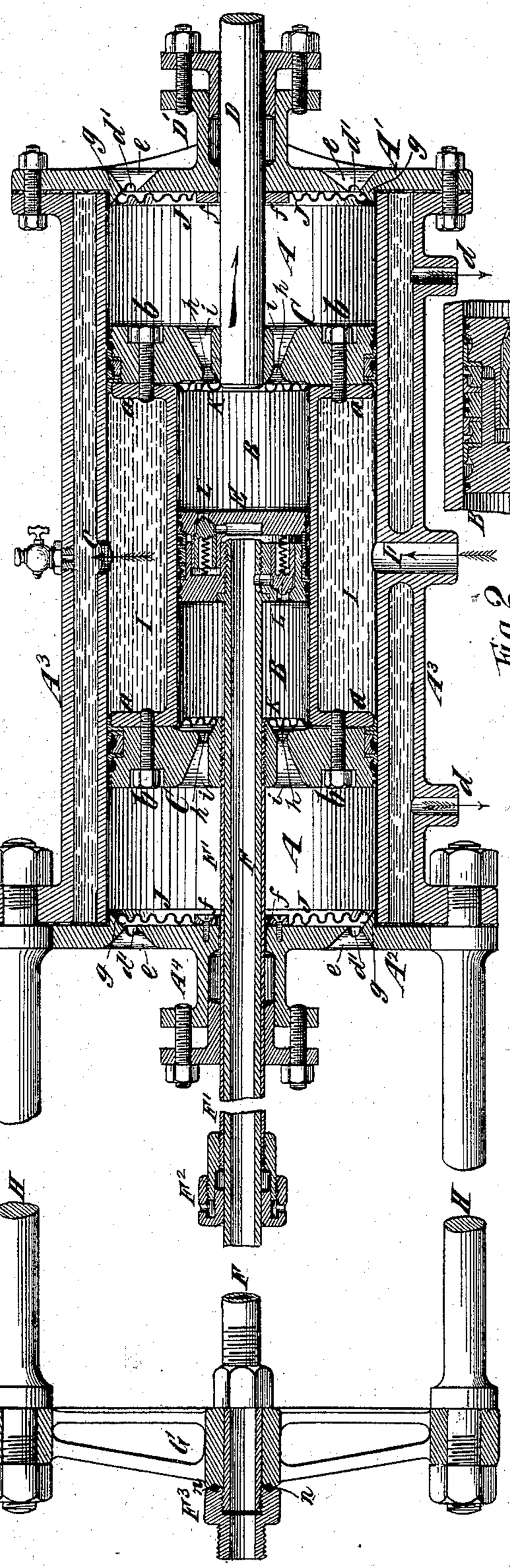

Fig. 1.

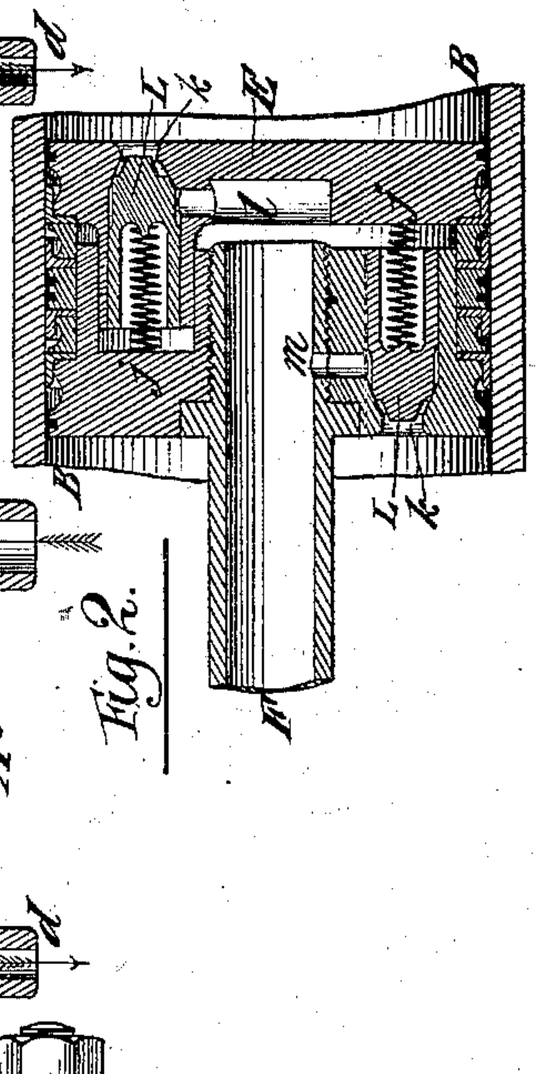

Fig. 2.

Witnesses:-

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UNITED STATES PATENT OFFICE.

JOHN B. WARING, OF NEW YORK, N. Y., ASSIGNOR OF ONE-HALF TO MILAN C. BULLOCK, OF CHICAGO, ILLINOIS.

AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 254,851, dated March 14, 1882.

Application filed May 21, 1881. (No model.)

To all whom it may concern:

Be it known that I, JOHN B. WARING, of the city and county of New York, in the State of New York, have invented certain new and useful Improvements in Air-Compressors and in Valves Therefor, and for other purposes, of which the following is a specification.

In air-compressors as usually constructed, in which the air is drawn into a cylinder by one stroke of the piston and expelled into the reservoir or receiver by the return-stroke of the piston, much difficulty is experienced in working a compressor smoothly and without shock, owing to the variable resistance offered to the piston during its stroke. The resistance at the beginning of the stroke, without considering that due to friction, is nothing, and the resistance gradually increases as the piston travels, and reaches its maximum at the end of the stroke. Another serious difficulty is the large amount of waste space or clearance in the valve ports and openings of the compressor-cylinder, which are filled with compressed air at each stroke, that expands during the return-stroke and partly fills the cylinder.

The object of my invention is to overcome these difficulties and to produce a compressor which shall be very compact and of comparatively light weight.

To this end my invention consists in the combination, in an air-compressor, of a stationary outer cylinder, a movable cylinder of smaller diameter arranged therein, piston-heads fitting said outer cylinder and movable with said inner cylinder, a stationary piston for said inner cylinder, and valves for admitting air to each end of said outer cylinder for passing air from said outer to said inner cylinder, and for discharging air from said inner cylinder, whereby the air, which is partially compressed in passing from the outer to the inner cylinder, is still further compressed in said inner cylinder. The outer cylinder is constructed with a water-jacket, as is usual in air-compressors, and the space between the outer and inner cylinders and between the movable piston-heads, is preferably filled with water, which serves to cool the inner and outer cylinders. The water used for cooling passes first into the space between the cylinders, and thence into and through the jacket of the outer cylinder. The discharge-valves for the inner cylinder are preferably arranged within the stationary piston of said inner cylinder, and the piston-rod to which said piston is attached may consist of a tube and serve as a discharge-pipe, through which the compressed air passes directly to the reservoir or receiver.

My invention further consists in a novel arrangement of valve and valve-openings for air-compressors and for other pumps or engines, and in various details of construction and combinations of parts, hereinafter to be described.

The accompanying drawings represents only the air-cylinders and appurtenances of a compressor, my invention being adapted for use with any suitable operating mechanism.

In the drawings, Figure 1 represents a longitudinal section of the compressor. Fig. 2 represents a longitudinal section of the fixed piston and a portion of the movable cylinder upon a larger scale, and Fig. 3 represents a perspective sectional view of one of my improved valves.

Similar letters of reference designate corresponding parts in the figures.

A designates a stationary cylinder, which is provided with suitable heads, A′ A^2, and with a surrounding water-jacket, A^3. The cylinder A may be attached to any suitable bed-plate or support, and may be arranged horizontally, as here shown, or vertically.

B designates a smaller cylinder, arranged within the outer cylinder, A, and of much less length than the latter. The diameter of the cylinder B, as here represented, is about half that of the cylinder A, and its area is consequently one-fourth; but the relative proportion of the two cylinders may be varied to suit circumstances. The cylinder B is constructed with a flange, *a*, at each end. And C designates piston-heads, which are rigidly attached one to each end of the cylinder by means of bolts *b*, inserted through the heads and the flanges *a*, or in any other suitable manner, and which are movable with said inner cylinder. The piston-heads C are provided with suitable packing, so as to work air-tight in the outer cylinder, A, and the inner cylinder and piston-heads

constitute in fact a single piston, which is adapted to be reciprocated in the outer cylinder, A, by power applied to the piston-rod D, which works through a suitable stuffing-box, D′, in the head A′.

E designates a piston fitted to the inner cylinder, B, and provided with suitable packing. This piston is fixed to the end of a piston-rod, F, which passes through a stuffing-box, A^4, in the head A^2 and is rigidly secured at its outer end in a cross-head, G, which may be permanently connected with the cylinder A by rods H, or other means.

The piston-rod F may be and preferably is composed of a tube or pipe for a purpose hereinafter described. It will be observed that by its rigid connection with the cross-head G the piston E always occupies the same position relatively to the outer cylinder, A, and both are stationary.

Inasmuch as the inner cylinder, B, is used as a compression-cylinder, it, as well as the outer cylinder, should be provided with means to prevent its heating, and to effect this I fill the annular space I between the inner and outer cylinders and between the two piston-heads C with water, as clearly shown in Fig. 1. The water in the space I not only cools the inner cylinder, but as the inner cylinder and its attached pistons reciprocate the water comes in contact with the inner surface of the outer cylinder and cools the latter. The space I and the jacket A^3 may each have independent inlets and outlets for water; but I prefer to supply the water first to the space I, and thence to the jacket A^3, as illustrated in the present example of my invention.

I′ designates a water-inlet leading through the jacket A^3 and to the space I; and, after circulating around the inner cylinder, B, the water passes through a hole or aperture, *c*, into the jacket A^3, from whence it passes out through the discharge-apertures *d*.

The valves which are employed for admitting air to the outer cylinder, A, for controlling the passage of air from the outer cylinder, A, to the inner cylinder, B, and for discharge-valves to the said inner cylinder, may be of any desirable construction; but I preferably employ valves of the kinds here represented.

Referring first to the inlet-valves for the outer cylinder, A, *d′* designates an annular groove or channel, which is made in each of the heads A′ A^2, and which communicates by means of numerous holes or apertures, *e*, with the atmosphere.

J designates a valve, consisting of a circular disk of thin sheet metal, constructed with annular corrugations to give it sufficient flexibility, and having a central hole or aperture to slip over the piston-rod. One of these disks is secured to the inner side of each of the heads A′ A^2, as a valve-seat, by means of a collar or flange, *f*, and its outer rounded or turned-over edge just overlaps the annular groove or channel *d′*, the inside of the head being provided with a conical or tapered seat, *g*, therefor, composed of a flange or lip having an inclined or tapered inner edge. This form of valve is very desirable, inasmuch as a single valve takes the place of a number of the small valves heretofore used, thus lessening the cost of construction, and because the valves are so light that when running at a high speed there is little or no shock from their closing. It will likewise be observed that the piston-heads C work up close to the valves, and that there are no waste spaces to fill with compressed air at each stroke and lessen the efficiency of the compressor by subsequent expansion.

The valves controlling the passage of air from the outer cylinder are substantially the same as those just described.

Each piston-head C is constructed with an annular groove or channel, *h*, in its inner side, which communicates with the outer cylinder by holes or apertures *i*.

The valves K are made of corrugated metal, similar to the valves J, just described, and differ only from them in that they are secured at the outer edge by being clamped between the flanges *a* of the cylinder B and the piston-heads C, instead of being clamped around the central opening, like the valves J. Though the valves J and K are only here shown in connection with an air-compressor, they, or similar valves, are suitable for pumps of various kinds.

L (see Fig. 2) designates valves through which air is discharged from the cylinder B, and which are contained in the piston E and kept closed by means of springs *j*, as shown most clearly in Fig. 2. These valves open in opposite directions and control the passage of air through ports or passages in opposite sides of the piston. From the right hand of the piston air passes through valve-openings *k*, thence to a cavity, *l*, in the piston, and out through the hollow piston-rod F to the air reservoir or receiver. From the left hand of the piston the air passes through valve-openings *k*, and thence through apertures or ports *m* to the hollow piston-rod F. To prevent any compressed air from leaking through the opening in the piston-head C around the rod F, I surround said rod by a pipe or tube, F′, which is rigidly secured in the piston-head, and is provided at its outer end with a stuffing-box, F^2, and in order to prevent any leakage from the cylinder B to the atmosphere I place an annular packing, *n*, between the cross-head G and a nut, F^3, which aids in securing the piston-rod F in the said cross-head.

Though the compressor is here shown as at about the middle of its stroke, and not in operation, the valves all being closed, its operation can be readily understood. If we suppose, for instance, that motion be imparted to the movable inner cylinder, B, and the piston-heads C in a direction toward the right hand of the drawings, as indicated by the arrow on the piston-rod, the inlet-valve J at the left-

hand end of the outer stationary cylinder will be opened, drawing in a fresh supply of air, while the valve K in the right-hand piston-head C will be opened and the supply of air in the right-hand end of the outer cylinder, A, forced through said valve into the right-hand end of the inner cylinder. At the same time the air which has been forced into the left-hand end of the inner cylinder by the last preceding stroke is forced through the valves in the stationary piston, and out through the hollow piston-rod F.

It will be observed that instead of the resistance upon the movable inner cylinder and piston-heads being nothing at the beginning of the stroke, as in common air-compressors, the resistance is equal to the pressure of partially-compressed air contained in the movable inner cylinder upon one side of the stationary piston B.

By my invention I produce an air-compressor of very simple and compact construction and light weight, and one which may be advantageously used for compressing air to heavy pressures.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination, in an air-compressor, of a stationary outer cylinder, a movable inner cylinder, piston-heads fitting said outer cylinder and movable with said inner cylinder, a stationary piston fitting said inner cylinder, and the several valves, substantially as described, for admitting air to each end of the outer cylinder for controlling the passage of air from the outer to the inner cylinder and for the discharge of air from the inner cylinder, substantially as and for the purpose specified.

2. The combination, in an air-compressor, of a stationary outer cylinder, a movable inner cylinder, piston-heads fitting said outer cylinder and movable with said inner cylinder, a stationary piston fitting said inner cylinder, inlet-valves for the outer cylinder, valves controlling the passage of air from the outer to the inner cylinder, discharge-valves for the inner cylinder arranged in the stationary piston, and a hollow piston-rod, to which said piston is attached, and which serves as a discharge-pipe, substantially as and for the purpose specified.

3. The combination, in an air-compressor, of a stationary outer cylinder, a movable inner cylinder and piston-heads, valves for the proper operation of said cylinders, a stationary piston fitting said inner cylinder, a piston-rod therefor, and a tube surrounding said piston-rod secured in one of the movable piston-heads and provided outside the cylinders with a stuffing-box which works upon said piston-rod, substantially as and for the purpose specified.

4. The combination, in an air-compressor, of a stationary outer cylinder, an inner movable cylinder, piston-heads movable with said inner cylinder and fitting said outer cylinder, valves for the proper operation of the cylinders and pistons, a water-inlet passage leading to the annular space between the outer and inner cylinders and between the movable piston-heads, and a water-outlet from said space, substantially as and for the purpose specified.

5. The combination, in an air-compressor, of a stationary outer cylinder constructed with a surrounding jacket, a movable inner cylinder and piston-heads, a stationary piston fitting said inner cylinder, valves for the proper operation of said cylinders and pistons, a water-inlet passage leading to the annular space between the inner and outer cylinders and between the movable piston-heads, a port or aperture leading from said annular space to the jacket surrounding the outer cylinder, and a water outlet or outlets from said jacket, substantially as and for the purpose specified.

6. The combination, with a valve opening or openings in a valve-seat, of a valve composed of a circular disk of corrugated spring metal having a central opening and means for securing it in place at one edge, substantially as specified.

7. The combination, with a valve-seat having in it an annular groove or channel and openings communicating therewith, of a valve composed of a circular disk of corrugated spring metal secured to the seat near its center and overlapping said annular groove or channel, substantially as specified.

8. The combination, with a valve-seat in which is an opening or openings, and which is constructed with a projecting annular lip or flange having an inclined inner surface forming a conical or taper seat, of a valve composed of a circular disk of corrugated spring metal overlapping said opening or openings and bearing against the taper or conical seat, substantially as specified.

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Witnesses:
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