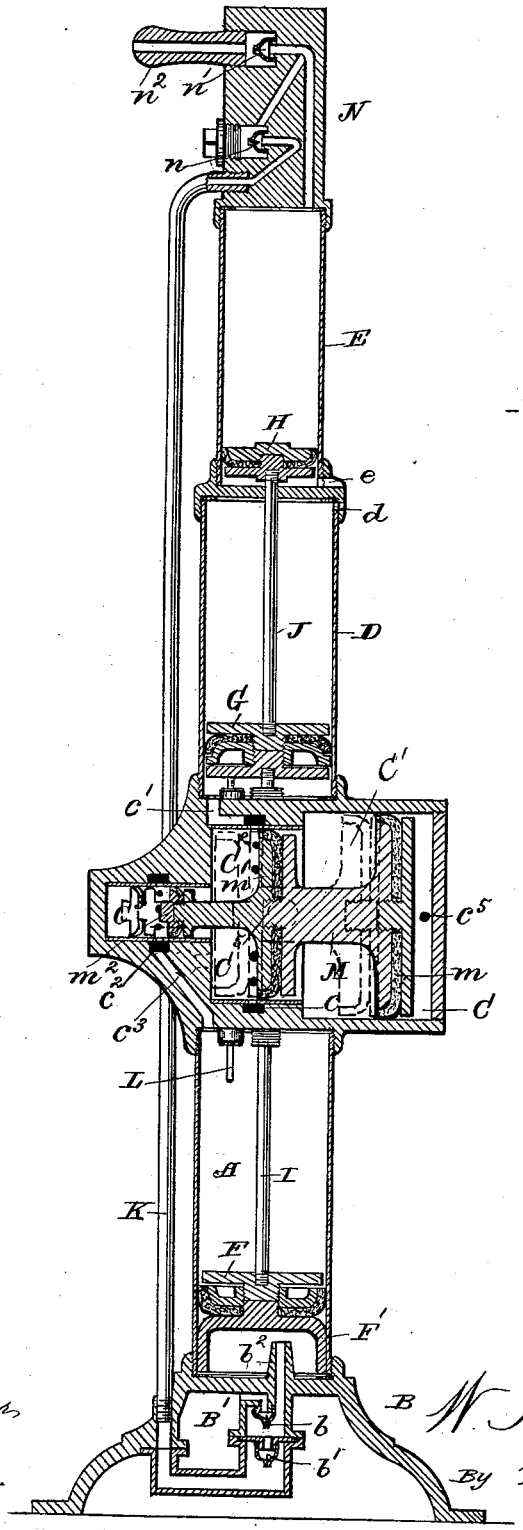
(No Model.)

3 Sheets—Sheet 1.

W. A. BABCOCK.

COMPOUND HYDRAULIC AIR COMPRESSOR.

No. 523,064. Patented July 17, 1894.



-FIG. I-

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(No Model.) 3 Sheets—Sheet 2.

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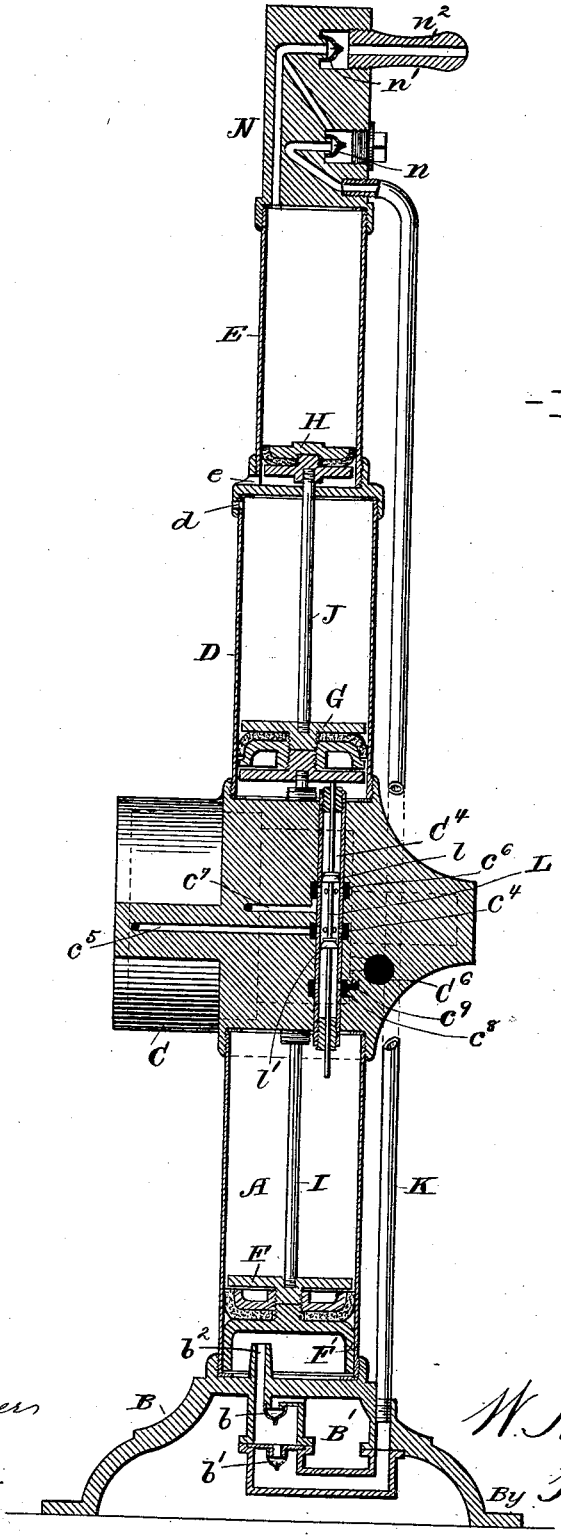

-FIG. II-

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(No Model.) 3 Sheets—Sheet 3.

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COMPOUND HYDRAULIC AIR COMPRESSOR.

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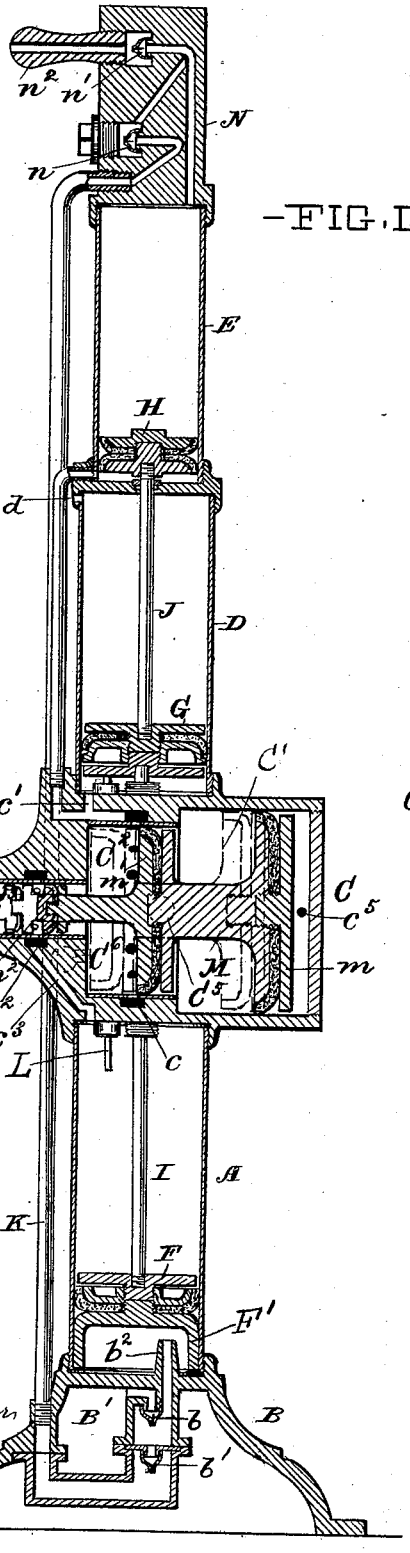
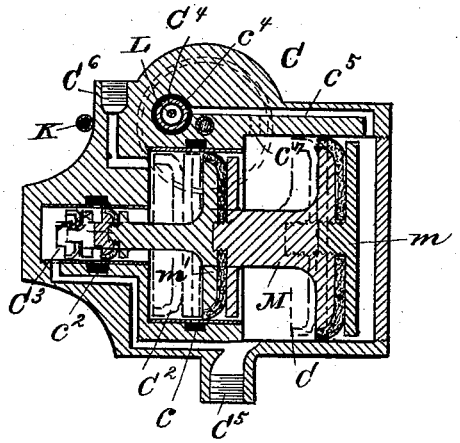
—FIG. III—



—FIG. IV—



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Inventor,
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UNITED STATES PATENT OFFICE.

WILLIAM A. BABCOCK, OF CLEVELAND, OHIO, ASSIGNOR TO THE BISHOP & BABCOCK COMPANY, OF SAME PLACE.

COMPOUND HYDRAULIC AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 523,064, dated July 17, 1894.

Application filed April 26, 1893. Serial No. 471,869. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM A. BABCOCK, a citizen of the United States, and a resident of Cleveland, county of Cuyahoga, and State of Ohio, have invented certain new and useful Improvements in Compound Hydraulic Air-Compressors, of which the following is a specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle, so as to distinguish it from other inventions.

The annexed drawings and the following description set forth in detail, one mechanical form embodying the invention; such detail construction being but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawings—Figure I represents a vertical section of my improved compound hydraulic air compressor, the section being taken through the axes of the cylinders and through the axis of the main controlling valve chamber; Fig. II, a vertical section of the compressor, the section being taken through the axes of the cylinders and through the axis of the primary valve chamber; Fig. III, a vertical section,—similar to Fig. I,—and illustrating the compressor as having water applied to the under side of the smaller air compressing piston, and Fig. IV, a horizontal section taken through the axis of the main controlling valve chamber.

An air and water cylinder, A, is mounted upon a base, B, and has a valve casing, C, secured upon its upper end. Another air and water cylinder, D, is mounted upon this valve casing, and an air cylinder, E, of smaller diameter than the two lower cylinders, is mounted upon the top of said second air and water cylinder D. Pistons, F, G and H, reciprocate respectively in the three cylinders A, D and E, and are connected together by piston rods, I and J, so as to all move in unison,—said piston rods passing through suitably packed boxes at the ends of the cylinders. An air valve chamber, B′, is formed at the lower end of the first air and water cylinder A, and said valve chamber has an air inlet valve, *b*, and an air outlet valve, *b′*, and is continued, from the air outlet valve, by a channel, K, passing upward parallel with the three cylinders.

The upper or outer end of the second air and water cylinder D, has an air inlet and outlet, *d*, rendering said cylinder non-compressing or idle, as far as concerns air compression within it, and the lower or inner end of the air cylinder E, in the form shown in Figs. I and II, has an air inlet and outlet, *e*.

A valve casing, N, is secured upon the upper or outer end of the air cylinder E, and said casing has an air inlet valve, *n*, which admits air from the air channel K, into the upper end of the air cylinder E. The valve case has, furthermore, an air outlet valve, *n′*, which opens to a nipple, n^2, to which a pipe or other suitable connection may be attached, for conveying the compressed air to the desired destination.

The bottom of the lower air and water cylinder A, has an upright nipple, b^2, projecting around the air inlet and outlet, so that any small quantity of water, which may leak past the air and water piston in this cylinder, may collect in the bottom of the cylinder without danger of its entering the air passages. The under side or air side of the air and water piston F, is formed cup-shaped, as indicated at F′, so as to extend around the upright nipple b^2, when the piston is at the extreme of its compressing stroke; and the cup-shaped packing of said piston is turned upward, so as to allow accumulated water to be forced upward, past the piston, while,—as much as possible,—preventing the actuating water from leaking downward, past the piston.

The valve casing has a main controlling valve chamber consisting of a piston chamber, C′, a chamber, C^2, of smaller diameter than said piston chamber, and a chamber, C^3, of still smaller diameter. Said chambers are arranged axially, in the order named, and have their adjoining ends opening, one into the other. The middle chamber C^2, has an annular port channel, *c*, surrounding it, which channel communicates with the interior of the chamber through an annular port formed by an annular series of holes or by an annular slot, and with the inner end of the second air and water cylinder D, through a channel, *c′*. The smaller chamber C^3, has an annular

port channel, c^2, surrounding it, which channel communicates with the interior of the chamber through an annular port formed by an annular series of holes or by an annular slot, and with the inner end of the first air and water cylinder A, through a channel, c^3.

As the valve casing forms the central portion of the entire compressor, from and toward which the pistons reciprocate, when the compressor is in action, and in view of the fact that the compressor may be constructed horizontal, having its base upon one end of the valve casing, as well as vertical, the terms "in-stroke" and "out-stroke," and "inner" and "outer," are employed as referring to the relations of the parts to the valve casing.

A primary valve chamber, C^4, is formed in the valve casing, parallel to the piston rod bearing in the same, and has its ends within the ends of the two air and water cylinders. The primary valve chamber has an annular port channel, c^4, which communicates with the outer end of the valve piston chamber C', through a channel, c^5; an annular port channel, c^6, at one side of said other port channel c^4, and communicating through a channel, c^7, with the inner end of the piston chamber C', and through the latter with the inlet C^5 for the actuating fluid; and a port channel, c^8, which communicates with the outer end of the middle chamber C^2, through a channel, c^9, and through said chamber with the outlet C^6 for the actuating fluid. The port channel c^4, is a distributing port to the outer end of the valve piston chamber, and the port channels c^6 and c^8 are, respectively an inlet port and an outlet port for the primary valve chamber.

A primary valve, L, slides in the primary valve chamber, and has the ends of its stem projecting out through stuffing boxes in the ends of the valve chamber, into the two air and water cylinders, so as to be alternately shifted by the pistons therein striking the ends of the valve stem. The valve has two pistons, l and l', one of which, l, is permanently to one side of the inlet port, and the other one, l', shifts to the opposite sides of the distributing port, so that said port may alternately be connected to the inlet port and to the outlet port.

A main controlling valve, M, slides in the main controlling valve chamber, and has a large actuating piston, m, in the piston chamber, a smaller valve piston, m', in the chamber C^2, and a still smaller piston, m^2, in the smaller chamber C^3. The actuating piston is reciprocated by the action of the actuating fluid, and the valve pistons shift to both sides of the annular ports.

In describing the action of the compressor, the parts will be assumed to be in the relative positions illustrated in the drawings, when the actuating water is admitted through the inlet,—the inlet having been suitably connected to a water service pipe or other source of water under pressure, and the outlet having been connected to a suitable waste pipe or other means for receiving or conveying the waste water. The position of the primary valve in Fig. II, connects the outer end of the piston chamber of the main controlling valve with the water inlet, which enters the inner end of said piston chamber, as seen in Fig. IV, and thereby communicates with channel c^7, causing the actuating water to shift said valve from the position illustrated in full lines in Figs. I, III and IV, to the position illustrated in dotted lines in said figures. The inlet water, which had heretofore passed through the smaller valve chamber, the port channel around the latter, and the channel from said port channel, into the first air and water cylinder, depressing the three pistons, will now flow through the middle valve chamber, the annular port channel around the same, and the channel from said port channel, into the second air and water cylinder, raising the pistons. When the primary valve is again shifted by the ascent of the pistons, the main controlling valve will again be shifted back to the position illustrated in full lines in the drawings, and the operation will thus be repeated as long as the inlet water is admitted. The shifting of the main valve, caused by the primary valve alternately connecting the outer end of the actuating piston chamber to the inlet and to the waste, shifts the main controlling valve, and when one air and water cylinder is connected to the inlet, by means of said valve, the other cylinder will be connected to the the outlet, and vice versa. As the pistons are reciprocated, the air and water piston in the first cylinder A, will draw in air at its in-stroke, and will expel air at its out-stroke. The air compressed by the piston in the first air and water cylinder will pass up through the vertical connecting channel, K, into the upper end of the third and smaller air cylinder E; the piston in the same drawing the air into the cylinder,—being on its in-stroke. When the pistons have finished the above-mentioned stroke, the water valves will be shifted, and water will be exhausted from the inner portion of the air and water cylinder A, and will be admitted into the inner portion of the second air and water cylinder D, forcing the piston in said cylinder outward, expelling air from the outer portion of said cylinder, and causing the air compressing piston H, in the air cylinder to further compress the compressed air contained in the said air cylinder.

As the area of the air compressing piston H, and the cross sectional area of the air compressing cylinder E, are smaller than the area of the air and water piston G, which drives said air compressing piston, it is obvious that the air which has been drawn and forced into the air compressing cylinder, and which has already received a degree of compression proportionate to the actuating water pressure, will receive an increased degree of compression, by the same water pressure, correspond-

ing to the relative proportions of the areas of the water actuated piston G, and the air compressing piston H.

When the air compressor is first put in operation, and is connected to a suitable receptacle for compressed air, the greater portion of the air compressed by the lower air and water piston, will pass directly into the receptacle; but, when the air pressure in said receptacle equals the pressure created by said lower cylinder, the air compressed in said cylinder cannot pass directly to the receptacle, but only the air which is additionally compressed, under greater pressure, by the upper air compressing piston.

The surplus amount of air which cannot be accommodated within the air compressing cylinder, when drawn and forced into the latter during the in-stroke or down-stroke of the piston therein, may be suitably provided for by a properly adjusted leak or vent in the air pipe between the two cylinders.

Although the cup-shaped packing of the air and water piston F, is turned upward, and is spread against the inner sides of the cylinder by the pressure of the actuating water, a certain amount of leakage cannot be avoided, and the construction of the packing, the under side of the piston, and the air outlet in the bottom of the cylinder is such, that it will admit of the accumulated leakage water being forced back, past the piston. The accumulated water will be prevented from passing ing into the outlet pipe by the nipple forming the end of said pipe, and when a quantity of water has accumulated in the bottom of the cylinder, the pressure of the compressed air in the bottom of the cylinder will force the accumulated water upward, around the edge of the cup-shaped under side and past the upturned packing of the piston, at that moment when the inner or upper portion of the lower air and water cylinder is opened to the waste, but before the piston has started upon its upward stroke,—the friction of the pistons and piston rods, respectively in the cylinders and packings, retarding the reversal of the stroke for a moment, when this forcing out of the leakage water takes place.

The inner or lower end of the air compressing cylinder E, may be suitably connected,—as disclosed in Fig. III,—to the valve mechanism, so that water pressure may be also applied to the piston of said air compressing cylinder, and I do not deem it necessary to more specifically describe such form or its operation, as it simply involves duplication of the water connection for cylinder D, extended and applied to cylinder E, and the action of said form is otherwise similar to that above described.

Other modes of applying the principle of my invention may be employed for the mode herein explained. Change may therefore be made as regards the mechanism thus disclosed, provided the principles of construction set forth respectively in the following claims are employed.

I therefore particularly point out and distinctly claim as my invention—

1. In a hydraulic air compressor, the combination of two co-operating air and water cylinders having air inlets and outlets, an air compressing cylinder of a smaller diameter than the air and water cylinders and connected to co-operate with the latter, and an air channel connecting the air outlet of an air and water cylinder with the air inlet of said smaller air compressing cylinder, substantially as set forth.

2. In a hydraulic air compressor, the combination of an air-compressing air and water cylinder, a non-compressing air and water cylinder, and an air compressing air cylinder of smaller diameter than said cylinders, connected pistons in said cylinders, and an air channel between the air compressing portion of the compressing air and water cylinder and of the air cylinder, substantially as set forth.

3. In a hydraulic air compressor, the combination of an air and water cylinder having valved air inlet and outlet at its outer end and water inlet and outlet at its inner end, an air and water cylinder arranged in axial alignment with said other cylinder and having air inlet and outlet at its outer end and water inlet and outlet at its inner end, valve mechanism controlling the water inlets and outlets, an air cylinder of smaller diameter than the two cylinders and arranged in axial alignment with the same and having valved air inlet and outlet at its outer end, connected pistons in the cylinders, and an air channel connecting the air outlet of the first air and water cylinder to the air inlet of the air cylinder, substantially as set forth.

4. In a hydraulic air compressor, the combination with a vertical air and water cylinder having an upright nipple formed at the air outlet in the bottom of the cylinder, of a piston in said cylinder, having water at its upper side and air at its under side and formed with an upwardly turned cup-packing and with a cup-shaped under side, substantially as set forth.

In testimony that I claim the foregoing to be my invention I have hereunto set my hand this 24th day of April, A. D. 1893.

W. A. BABCOCK.

Witnesses:
WM. SECHER,
J. C. TURNER.