N. A. CHRISTENSEN.

COMPOUND AIR COMPRESSOR.

APPLICATION FILED NOV. 11, 1902.

938,742.

Patented Nov. 2, 1909.

2 SHEETS—SHEET 1.

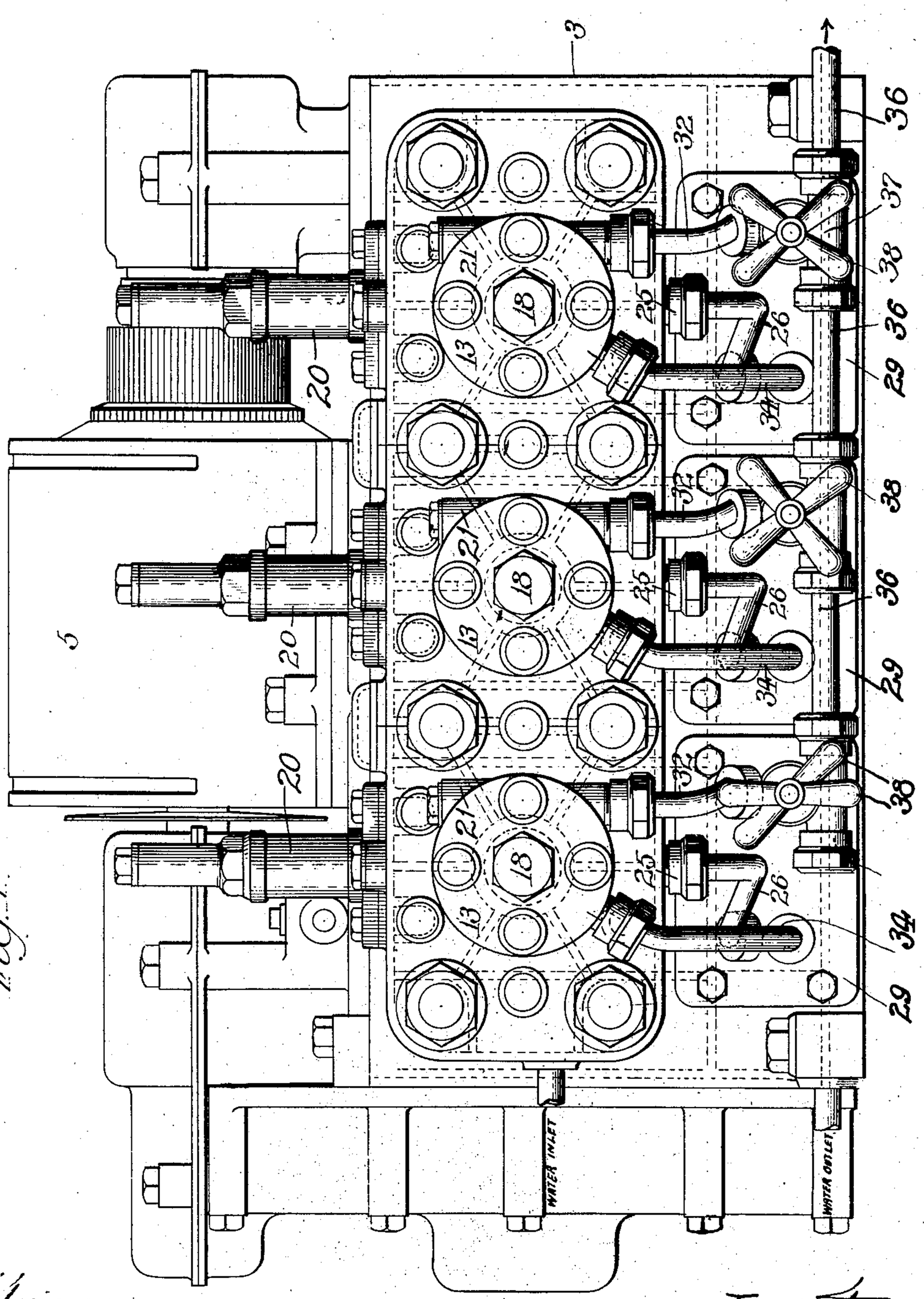


Fig. 1.

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Harold G. Barrett.
Louis B. Erwin

Inventor:
Niels Anton Christensen.
By Rector & Hibben
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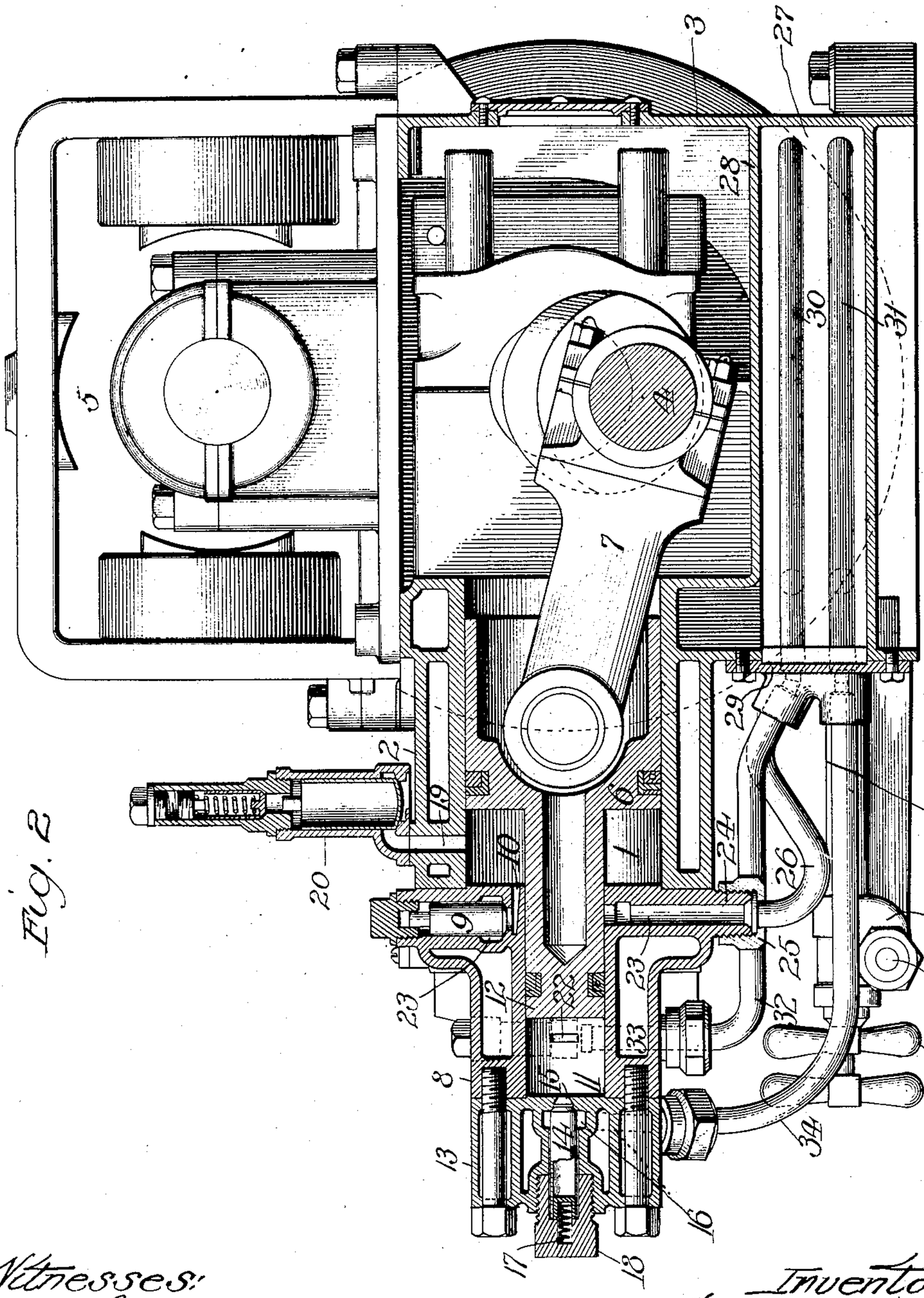


Fig. 2

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# UNITED STATES PATENT OFFICE.

NIELS ANTON CHRISTENSEN, OF MILWAUKEE, WISCONSIN.

## COMPOUND AIR-COMPRESSOR.

938,742. Specification of Letters Patent. Patented Nov. 2, 1909.

Application filed November 11, 1902. Serial No. 130,894.

*To all whom it may concern:*

Be it known that I, NIELS ANTON CHRISTENSEN, residing at Milwaukee, Milwaukee county, Wisconsin, have invented certain new and useful Improvements in Compound Air-Compressors, of which the following is a specification.

My invention relates to air compressors of that type known as compound compressors wherein the air is compressed in two or more stages, and the object of my invention is to provide a simple, efficient and reliable compressor of this character whose features of advantage and utility will be readily understood and appreciated from the description hereinafter given.

While my invention is herein shown embodied in a two stage compressor, yet it will be understood that it may be embodied in a compressor having an increased number of stages of air compression by adding a third or fourth cylinder and so on, when high pressures, say 1500 to 2000 pounds per square inch, are required, but instead of thus increasing the number of cylinders of a single, unitary machine, I prefer to duplicate the machine and operate it in a manner hereinafter explained and better understood after a description of the two stage compressor illustrated in the drawings.

In the accompanying drawings Figure 1 is a front elevation of the entire machine, including the compressors and the electric motor which drives them, and Fig. 2 a sectional elevation taken centrally through one of the series of cylinders.

In the present instance I have illustrated a series of three independent sets of compressors actuated by a single crank shaft which is itself operated by a single electric motor, but, as is obvious, my invention is embodied in each set of compressors and a single set thereof may be used.

So far as is concerned the series of three low pressure cylinders, herein shown, actuated by the single crank shaft and the electric motor, as well as the suction valves, these parts are the same as corresponding parts shown in my prior patent No. 663,862, issued to me on December 18, 1900, for a high pressure fluid compressor, which as shown was, however, a single stage compressor.

The cylinders 1 are formed in a forward extension 2 of a casing 3 which incloses the crank shaft 4. This shaft is, in the present instance, driven by an electric motor 5 by means of suitable gearing, my machine being by preference a combined motor and compressor of the type shown and described in my prior patent No. 635,280 issued to me on October 17, 1899, for a combined pump and motor and being driven in the same manner as shown in said patent.

Each cylinder has a single acting piston 6 which is operatively connected to the crank shaft by means of a connecting rod 7.

To the front end of the cylinders is secured a casing 8 which constitutes a combined valve head and high pressure cylinder inasmuch as it contains the discharge valves 9 governing the discharge ports 10 leading from the low pressure cylinders 1 and also contains the high pressure cylinders 11.

Each high pressure cylinder has a piston 12 which is a tubular, integral extension of the low pressure piston 6. Owing to this described arrangement of the high and low pressure cylinders and their pistons, the necessity of a stuffing box for the high pressure piston is obviated and the simple but efficient arrangement shown is rendered possible.

To the forward end of the high pressure cylinders is secured a head 13 containing three discharge valves 14 (one for each cylinder) for governing the discharge port 15 leading to the discharge passage 16. Each discharge valve comprises a seamless, steel cylinder normally seated by a light spring 17 interposed between its outer end and a hollow screw plug 18 screwing into the head 13. This construction of discharge valve is not herein claimed.

The low pressure cylinders, by preference, have their suction ports 19 arranged a slight distance from the forward end thereof and have the suction and safety valve device 20 such as described and claimed in my said prior patent No. 663,862.

The suction valve of each high pressure cylinder may be of ordinary construction or similar to suction valve device 20 and the same is arranged in a slight extension 21 on the casing 8, as best seen in Fig. 1. This valve governs a suction port 22, Fig. 2, which is arranged in advance of the compression end of the cylinder, in the same manner and for the same reasons as suction port 19.

Each discharge valve 9 governs a dis-

charge port 10 leading from its low pressure cylinder and communicating with a discharge passage 23, extending around the high pressure cylinder. This discharge passage, as shown, terminates in a screw threaded nozzle 24, which by means of the union 25 is coupled to the curved pipe or gooseneck 26.

The discharge of the low pressure cylinder is connected by means of the pipe 26, with an intercooler which for the sake of compactness and general utility is arranged in a cooling chamber 27 formed at the lower portion of the crank casing by means of a false bottom 28 constituting the bottom proper of the crank chamber. Cold water is circulated through this cooling chamber and the circulation may be a part of that through the various heads and jackets of the cylinders.

The forward side of the cooling chamber is provided, in the present instance, with three openings directly below the cylinders, one opening for each cylinder. Each opening is closed by a removable plate 29 bolted to the front of the cooling chamber casing and provided with transverse openings for inlet and outlet pipes to be described.

To the inner side of each plate 29 are fixed two separate cooling tubes or coils 30 and 31, which communicate with the transverse openings therein. The coil 30 coöperates directly with the low pressure cylinder and the coil 31 with the high pressure cylinder in a manner to be explained.

Continuing the description of the operation, the compressed air discharged from the low pressure cylinder passes through the pipe 26, which is connected to the plate 29, and enters the tube or coil 30, with the result that the compressed air is cooled by its passage through such coil. This compressed air, after traversing coil 30, is conducted by the pipe 32 (which is connected to the plate 29) to the suction passage 33 and thence to the high pressure cylinder 11 through the suction port 22.

The discharge from the high pressure cylinder passes through port 15, passage 16 and through the high pressure discharge pipe 34 which is secured at its rear end to the plate 29 and communicates with the coil 31. The high pressure compressed air traverses the coil 31 and is discharged therefrom through a pipe 35, also connected to the plate.

The machine herein shown is a two stage compressor and the pressure is now ready to be conducted to a reservoir or place of use, but if further compression is desired, the discharge through pipe 35 would be led to the suction of a third cylinder preferably in alinement with the cylinders described or to the first suction of a machine the duplicate of the present one. In the present instance, the discharge of the high pressure through pipe 35 communicates with a manifold 36, such communication being governed by a cut out valve device 37 of suitable construction and operated by the handles 38. By blanking either end of the manifold, that is closing it by a cap, the air pressure can be led from either side of the machine to a place of use or to a storage reservoir.

Each cylinder has its own cooling coil, closing plate 29 and cut out valve and connections, so that the cylinders are, in fact, independent, with the result that any one or more of them may be cut out of compressing operation by holding the proper suction valve or valves open and closing the proper cut out valve or valves. This may be done without stopping the working of the pistons.

As hereinafter suggested, if it is desired to further compress the air, a duplicate machine may be employed, arranged to be operated from or in unison with the first machine, and proper air connections be made, so that the air is compressed in the low pressure cylinder of the first machine, then in the second stage cylinder arranged immediately in tandem therewith, after having been cooled in the base, thence from this second cylinder transferred to another intercooler and to a third cylinder in the other compressing set, thence to another cooler and to the fourth cylinder, thence to an after cooler or reservoir as may be desired.

The water jacketing system in this compressor is so arranged that both the cylinders and valve heads are completely circulated inside, and the cooling chamber for the tubes or coils is by preference a part of the same circulating system. As herein shown these tubes are surrounded by cold water but it is obvious that the reverse arrangement might be adopted, that is, the air may be on the outside of the cooling tubes and the water inside the same, but for mechanical reasons it is the easier to have the air inside the tubes.

I claim:

1. A compound compressor comprising a low pressure cylinder, a combined high pressure cylinder and valve head secured to the low pressure cylinder, said cylinders being arranged in axial alinement with each other and of different diameter, a single piston structure having differential piston heads each of uniform diameter to fit the two cylinders, suction and discharge valves, of which the discharge valve of the low pressure cylinder is located in said valve head and of which the suction valve of the high pressure cylinder is located in such cylinder, a valve head forming the outer end of the high pressure cylinder and containing the discharge valve thereof, and connections between said cylinders and valves.

2. A compound compressor comprising a low pressure cylinder, a combined high pressure cylinder and valve head secured to the low pressure cylinder, said cylinders being arranged in axial alinement and having piston heads traveling therein, and suction and discharge valves for said cylinders, the discharge valve and delivery passage of the low pressure cylinder being arranged in said valve head said piston heads being valveless and imperforate.

3. A compound compressor comprising a low pressure cylinder, a combined high pressure cylinder and valve head secured to the low pressure cylinder with said cylinders in axial alinement, piston heads for said cylinders, which heads are integral but of differential diameters, said valve head containing the discharge port of the low pressure cylinder, a discharge valve therefor and a suction port for the high pressure cylinder and a suction valve therefor said piston heads being valveless and imperforate.

4. A compound compressor comprising a low pressure cylinder, a combined high pressure cylinder and valve head secured to the low pressure cylinder with said cylinders in axial alinement, piston heads for said cylinders, which heads are integral but of differential diameters said valve head containing a valve governed discharge port for the low pressure cylinder and a valve governed suction port for the high pressure cylinder, and a valve head secured to the high pressure cylinder and containing a valve governed discharge port said piston heads being valveless and imperforate.

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