No. 677,503. Patented July 2, 1901.

W. J. FRANCKE.

COMPRESSOR.

(Application filed Jan. 4, 1900.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

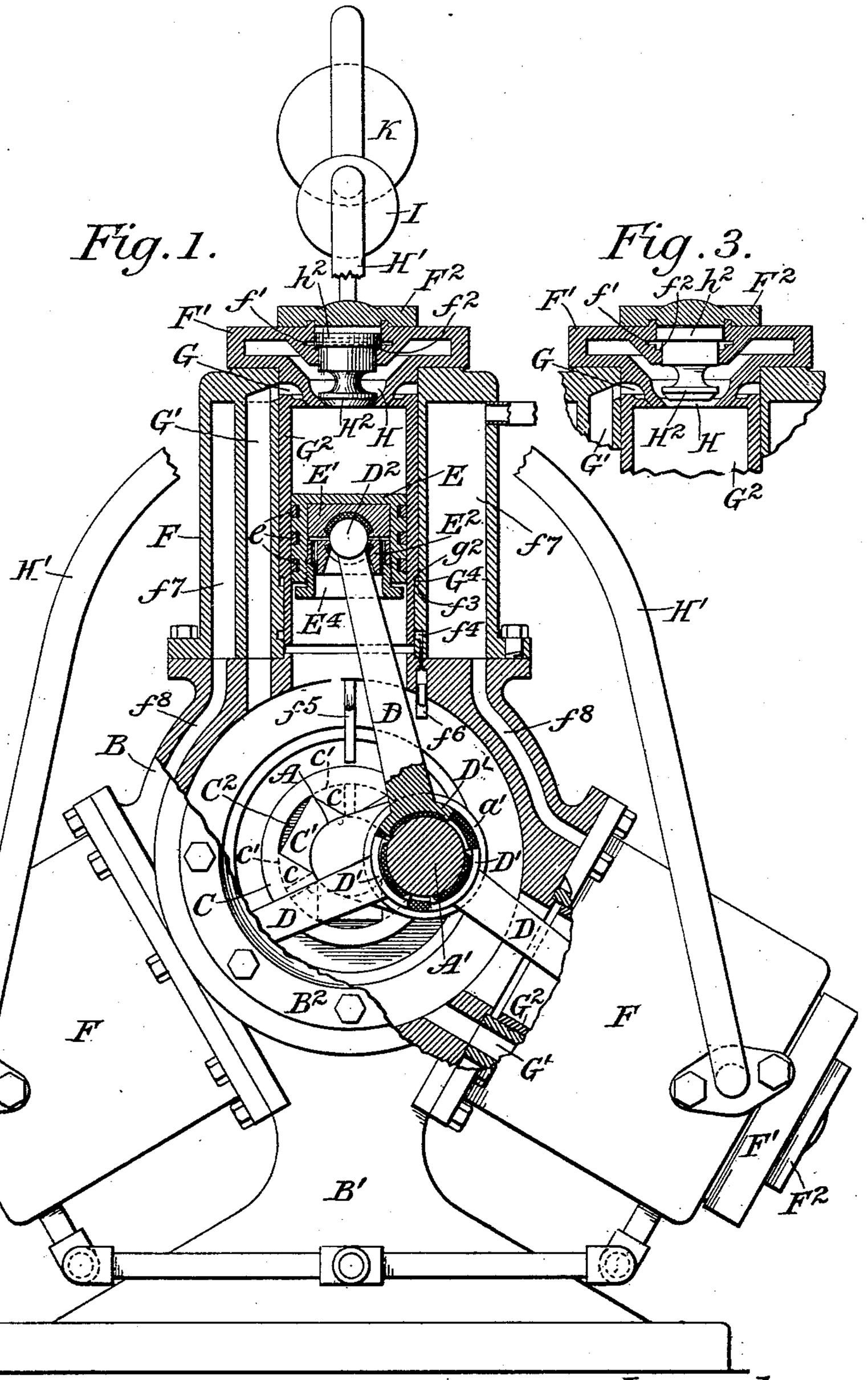

Fig. 3.

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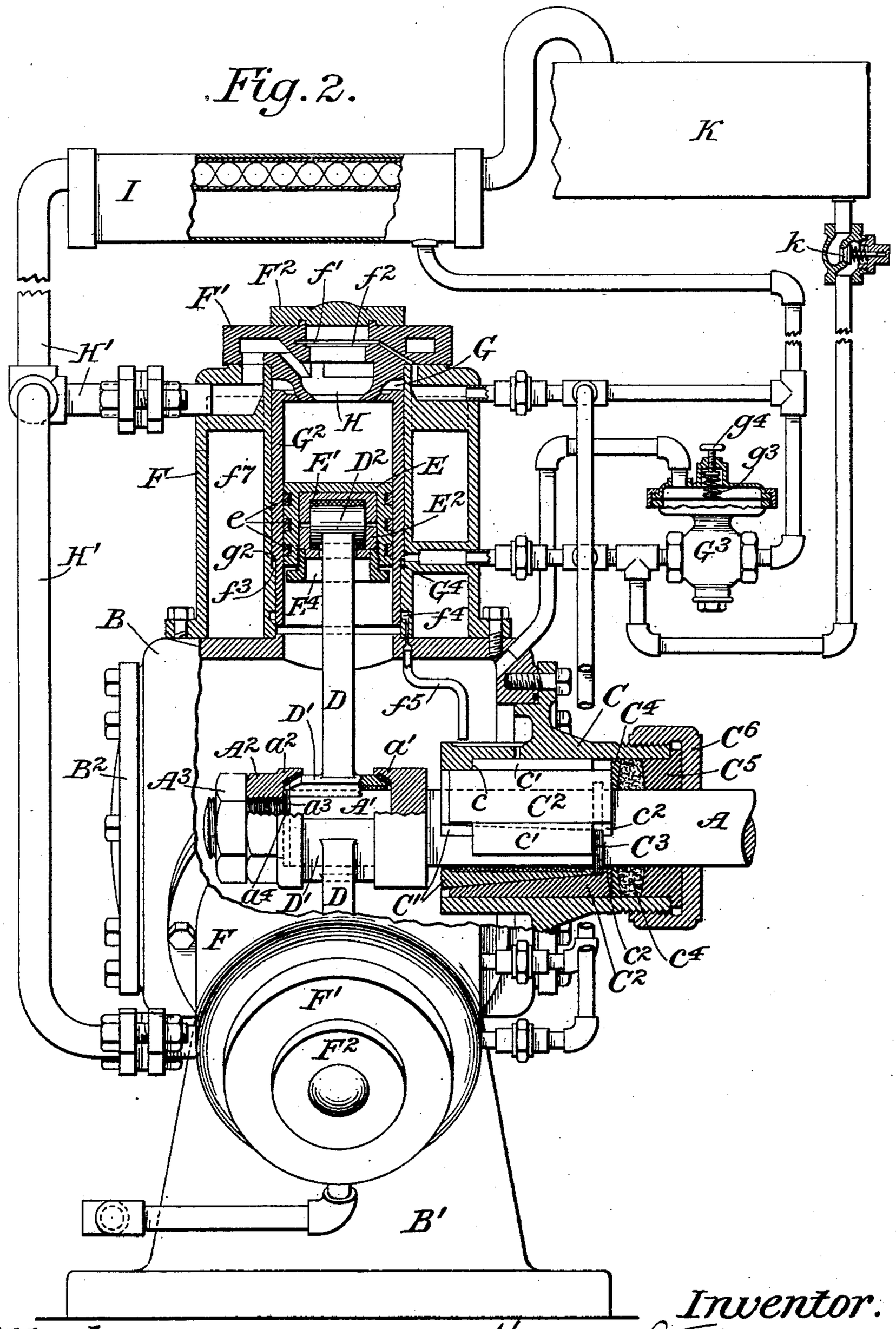
Fig. 2.



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UNITED STATES PATENT OFFICE.

WILLIAM J. FRANCKE, OF NEW BRUNSWICK, NEW JERSEY, ASSIGNOR TO THE BRUNSWICK REFRIGERATING COMPANY, OF SAME PLACE.

COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 677,503, dated July 2, 1901.

Application filed January 4, 1900. Serial No. 324. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM J. FRANCKE, a citizen of the United States, residing in New Brunswick, county of Middlesex, State of New Jersey, have invented certain new and useful Improvements in Compressors, of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof.

This invention relates to compressors for air and gases, such as are commonly employed in the arts; and it has for its general object to improve the construction of such compressors, so that they may be run at higher speed and shall have greater capacity and so that they shall be noiseless in operation.

The invention is more particularly concerned with the construction, arrangement, and operation of the suction and discharge valves, the object being to secure a large area of opening with a small lift and rapid opening and closing at the ends of the piston-stroke, whereby the efficiency of the compressor is increased.

It is further concerned particularly with the lubrication of the various working parts of the compressor, the circulation of the lubricant, and the relation of the lubricant to the operation of the valve, the objects being to provide for distribution of the lubricant under proper pressure at different points and to cushion the valves in their movement. Attention has also been given to the bearings in order to facilitate taking up wear and to prevent the escape of gas without producing undue friction on the working parts.

Other features of the invention will be referred to hereinafter. It will be understood that while the several features of the invention hereinafter referred to have been devised with especial reference to their use in compressors nevertheless some of such features are capable of use in other machines or forms of apparatus and that it is not intended to restrict the invention as to such features to the particular type of machine or apparatus in which they are herein described as embodied.

In the accompanying drawings, in which for purposes of explanation the invention is illustrated, Figure 1 is a view, partly in elevation and partly in vertical section, on a plane transverse to the axis of the shaft of a compressor which embodies the invention. Fig. 2 is a view of the same, partly in elevation and partly in vertical section, on a plane at right angles to the plane of section of Fig. 1. Fig. 3 is a detail view of the discharge-valve, showing the same open.

The compressor illustrated in the drawings is represented as having three cylinders arranged about a common crank-shaft A and secured to the crank-casing B, which forms a part of the base B′ of the compressor. It will be understood, however, that the compressor may have a greater or smaller number of cylinders. The several pistons are connected to the common crank-pin A′ by pitmen D in any suitable manner.

Each piston E is preferably formed, as shown, as an ordinary hollow trunk-piston with packing-rings *e*. In the inner end of each hollow piston is placed a thrust-block E′, formed to receive about half of the diameter of the cylindrical head D^2 of the corresponding pitman. A two-part bearing-block E^2, embracing somewhat less than half of the diameter of the head D^2, is placed within the hollow piston outside of the head D^2 and is held against the same by a threaded ring E^4, which engages the end of the hollow piston. To take up wear between the head of the pitman and its bearing in the piston, it is simply necessary to advance the threaded ring slightly.

The outer end of each cylinder F is covered by a head F′, in which are formed the concentric suction and discharge valve ports. By forming these valve-ports concentrically it is possible to give them relatively large areas, so that the lift of each valve shall be proportionately small. The annular suction-port G is connected by a passage G′ with the crank-casing, which the gas or air enters at any convenient point from its source of supply. The end of a sleeve G^2 within the cylinder forms a valve to close the suction-port, said sleeve forming a longitudinally-movable lining for the cylinder and within which the piston moves, said sleeve being moved to a limited extent by the friction of the piston or by the pressure of the suction-gas, or by both.

It will be evident that at the instant the piston commences its suction-stroke the sleeve will move with it by friction or, being released, will move under the pressure of the suction gas or air, if it be under pressure, to open the suction-valve, and that at the instant the piston commences its compression-stroke the sleeve will be moved with the piston by friction to close the suction-valve. The central discharge-port H is connected by suitable passages with the common discharge-pipe H′ and is closed by a valve H^2. The valve is lifted by the pressure of the gas or air during the compression-stroke of the piston and falls again to its seat by gravity or the action of a spring the instant that the piston commences its suction-stroke.

The lubricating-oil, which is introduced into the circulating system at any convenient point, collects in the bottom of the crank-casing, enters the lower cylinders through the suction-passages G′, and is forced with the gas into the discharge-pipe and through an oil-separator I. From the latter the oil passes through suitable passages under the discharge-pressure of the gas or air to an annular channel or chamber f', formed in the head F′ around the enlarged upper portion h^2 of the discharge-valve H^2. The valve has a snug fit within the bore of the head F′, and slightly below the oil-chamber f' is formed a shoulder f^2, the location of the shoulder f^2 being such that when the valve rests on its seat a space is left between the shoulder f^2 and the shoulder formed by the enlarged upper part h^2 of the valve. This very narrow space is filled with oil under discharge-pressure, and the very small quantity of oil therein serves to cushion the valve as it returns to its seat and must escape around the valve before the latter actually rests upon its seat. The valve thus cushioned is absolutely noiseless in operation. The oil which escapes in the manner described serves also to lubricate the valve. Oil from the separator also passes through a suitable pressure-reducing valve (indicated at G^3) to an annular oil channel or chamber G^4, which is formed between a shoulder g^2 and a shoulder f^3 on the cylinder F. This oil channel or chamber G^4 is filled with oil under approximately suction-pressure, (through the action of the pressure-reducer G^3,) which cushions the cylinder-sleeve G^2 as it reaches the limit of its movement to open and shut the valve, since it must escape between the sleeve and the cylinder. The pressure-reducer may be of any ordinary construction; but by preference the chamber on the upper side of its diaphragm is connected by a suitable pipe with the suction side of the compressor, so that the pressures on opposite sides of the diaphragm shall be nearly balanced, and a spring g^3 is applied to the upper side of the diaphragm with an adjusting-screw g^4, so that the action of the pressure-reducer may be controlled and regulated. By such means the pressure on the oil in the chamber G^4 is permitted to be a little greater than the suction-pressure and balances to some extent the weight of the cylinder-sleeve, so that the suction-port is thereby closed more quickly when the piston commences its compression-stroke. It is also possible by so regulating the pressure to regulate also the lift of the suction-valve, as well as the volume of the oil-cushion. The oil which escapes around the sleeve passes into a channel f^4 in the cylinder-wall, from which it is distributed through suitable conduits f^5 and f^6 to the main bearing and the crank-pin. From the bearing and crank-pin and other parts it drips into the crank-casing and is again caused to circulate in the manner already described. The reducing-valve g^3, moreover, acts as a check-valve when the suction-valve is open, forcing the oil in the cushion G^4 through said tubes or conduits f^5 f^6 to the main and crank-pin bearings.

For the purpose of rendering the action of the compressor automatic, so that it will run without a load whenever the pressure in the receiver reaches a predetermined degree, the receiver (indicated at K) is connected to the oil channel or chamber G^4 through a check-valve k, which is set to open when the pressure in the receiver reaches the predetermined degree, so that the pressure in the receiver shall then act against the under side of the suction-valve or cylinder-sleeve G^2 and hold the valve against its seat, thus shutting off the supply of gas or air to the compressor and permitting the latter to run idle until such time as the pressure in the receiver falls again below the predetermined degree and the suction-valve is again permitted to open. The connection from the receiver to the oil channel or chamber is preferably effected at the lowest point of the receiver, so that any oil therein shall be returned to the circulating-piston and at a point in the oil conductor or passage between the pressure-reducer G^3 and the oil channel or chamber.

In addition to the advantages in operation already described it will be evident that by the removal of the head F′ and the supplemental cap F^2 the valves are made easily accessible for inspection and repair. The cylinders may be provided with water-jackets f^7, as usual, and the water-jackets of the several cylinders may be connected by channels f^8, formed in the crank-casing, for the circulation of the water from one to another.

It will be obvious that various changes in details of construction and arrangement may be made without departing from the spirit of the invention and that some of the features of improvement are capable of use in other kinds of machines or apparatus than that shown and described herein, wherefore the invention is not to be limited to the precise construction and arrangement shown and de-

scribed nor to the application of the several features together to a machine of the character referred to.

I claim as my invention—

1. The combination with the piston, and its cylinder having an annular valve-port in its head, of an open-ended sleeve surrounding the said piston and in frictional contact therewith for operation thereby to open and close said valve-port; correspondingly-opposed annular shoulders being formed on the cylinder and sleeve between their ends and between which is formed a closed cushion-chamber, and a fluid-supply for said chamber; substantially as described.

2. The combination in a compressor with the piston, its cylinder, an annular suction-valve port and a discharge-valve port in the cylinder-head, and a discharge-valve, of an open-ended sleeve-valve surrounding the piston and operated by the friction thereof, to control the suction-port, a closed annular cushioning-chamber between the adjacent walls of said sleeve and cylinder to cushion the return movement of the sleeve, and an oil-separator, a pipe connecting the separator with the discharge side of the cylinder-head, and an oil-pipe leading from said separator to the said cushioning-chamber; substantially as described.

3. The combination in a compressor with the piston, its cylinder, an annular suction-valve port and a discharge-valve port in the cylinder-head, and a discharge-valve, of an open-ended sleeve-valve surrounding the piston and operated by the friction thereof to control the suction-port, a closed annular cushioning-chamber between the adjacent walls of the said sleeve and cylinder to cushion the return movement of the sleeve, an oil-separator, a pipe connecting the separator with the discharge side of the cylinder-head, an oil-pipe leading from the separator to the cushioning-chamber, and a reducing-valve in said oil-pipe and having controlling means whereby the pressure exerted in the cushioning-chamber on the sleeve-valve may be increased beyond the suction-pressure under which the machine is operated and thereby to close the suction sleeve-valve, substantially as described.

4. In a compressor, the combination with the cylinder, the piston, the crank-shaft to which said piston is connected, an annular suction-valve port and a discharge-valve port at the outer end of the cylinder, a discharge-valve, an open-ended sleeve-valve surrounding the piston, a closed annular cushioning-chamber for said sleeve between it and the cylinder, an annular oil-passage in the cylinder near its inner end and covered by the said sleeve and pipes or passages leading from said annular oil-passage to the bearing of the crank-shaft and crank-pin, of an oil-separator connected with the discharge side of the cylinder, a pipe leading from the oil-separator to the said cushioning-chamber and a fluid-pressure regulator in said pipe; substantially as described.

5. The combination, in a compressor with a cylinder having a valve-seat, a bore to receive and support the valve and provided with an annular shoulder, of a valve having a snug fit in said bore and having a shoulder forming with the first-named shoulder, a cushioning-chamber, and an oil-circulating system including the suction and discharge passages and having a pipe or passage connecting it with the cushioning-chamber, substantially as described.

6. In a compressor, the combination with the cylinder, the piston, the crank-shaft to which said piston is connected, an annular suction-valve port and a discharge-valve port at the outer end of the cylinder, a discharge-valve, an annular cushioning-chamber between the stem of said valve and its casing and comprising opposed shoulders on the two above the inner working face of the valve, an open-ended sleeve-valve in said cylinder, a closed annular cushioning-chamber for said sleeve between it and the cylinder and comprising opposed annular shoulders, an annular oil-passage in the cylinder near its inner end and covered by the inner end of the sleeve-valve, and pipes or passages leading from said oil-passage to the crank-pin and bearing, of an oil-separator connected with the discharge side of the cylinder, an oil-pipe leading from the oil-separator to the cushioning-chamber of the sleeve-valve and provided with a pressure-reducing valve, and a pipe leading from the said oil-pipe to the cushioning-chamber of the discharge-valve; substantially as described.

7. The combination with the cylinder, its piston, and the annular suction-valve port, of a sleeve-valve surrounding the piston and controlling said suction-valve port; the cylinder and sleeve-valve being provided between their ends with opposed shoulders forming a cushioning-chamber for said sleeve in its return movement, of an oil-separator connected with the discharge side of the cylinder, an oil-pipe leading from the separator to the said cushioning-chamber and provided with a pressure-regulating valve, a receiver connected with the oil-separator to receive the purified compressed air or gas, a pipe leading from the bottom of the receiver to the said oil-pipe and provided with a check-valve; substantially as described.

8. In a compressor, the combination with a discharge-valve and a closed cushioning-chamber between it and its casing, and independent of the compression-cylinder, of a pipe or passage having connection with the discharge side of the compressor to supply oil to said cushioning-chamber, under pressure of the discharge and resist the return of the valve to its seat; substantially as described.

9. In a compressor, the combination of a discharge-valve and a closed cushioning-chamber between it and its casing and inde-

pendent of the compressor-cylinder, with an oil-circulating system including the suction and discharge passages of the compressor and having a pipe or passage connecting it with the said cushioning-chamber to supply it with oil under pressure and cushion the return of the valve to its seat; substantially as described.

10. The combination, in a compressor, with the discharge-valve and a closed cushioning-chamber between it and its casing, and independent of the compression-cylinder, of an oil-separator connected with the discharge-passage of the compressor and also connected with said cushioning-chamber to supply the same with oil to resist the return of the valve to its seat; substantially as described.

11. In a compressor, the combination of a discharge-valve having an enlargement on its stem, a casing or guide therefor forming a cushioning-chamber between itself and the enlargement on the valve-stem, and an oil-separator connected with the discharge-passage of the compressor and with said chamber; substantially as described.

12. In a compressor, the combination of an oil-circulating system including the suction and discharge passages of the compressor, cushioning-chambers for said valves connected with said oil system and a pressure-reducer included in said system between the discharge and the suction side of the compressor, and independent of the gas-discharge pipe.

13. In a compressor, the combination of a suction-valve having a liquid cushion, an oil-circulating system including the suction and discharge passages and connected with said liquid cushion, and a pressure-reducer included in said system between the discharge and said liquid cushion and independent of the gas-discharge pipe.

14. In a compressor, the combination of an oil-circulating system including the suction and discharge passages of the compressor, cushioning-chambers for said valves connected with said oil system, an oil-separator included in said system, and a pressure-reducer between the oil-separator and the suction side of the compressor and independent of the gas-discharge pipe.

15. In a compressor, the combination with a suction-valve having a cushioning-chamber, an oil-circulating system including the suction and discharge passages and connected with the said cushioning-chamber, an oil-separator, a pressure-reducer included in said system, a compressed-air receiver, and a pipe leading from the receiver to the oil-pipe between its pressure-reducer and the cushioning-chamber and provided with a check-valve, substantially as described.

This specification signed and witnessed this 30th day of December, A. D. 1899.

WILLIAM J. FRANCKE.

In presence of—

ANTHONY N. JESBERA,

W. B. GREELEY.