

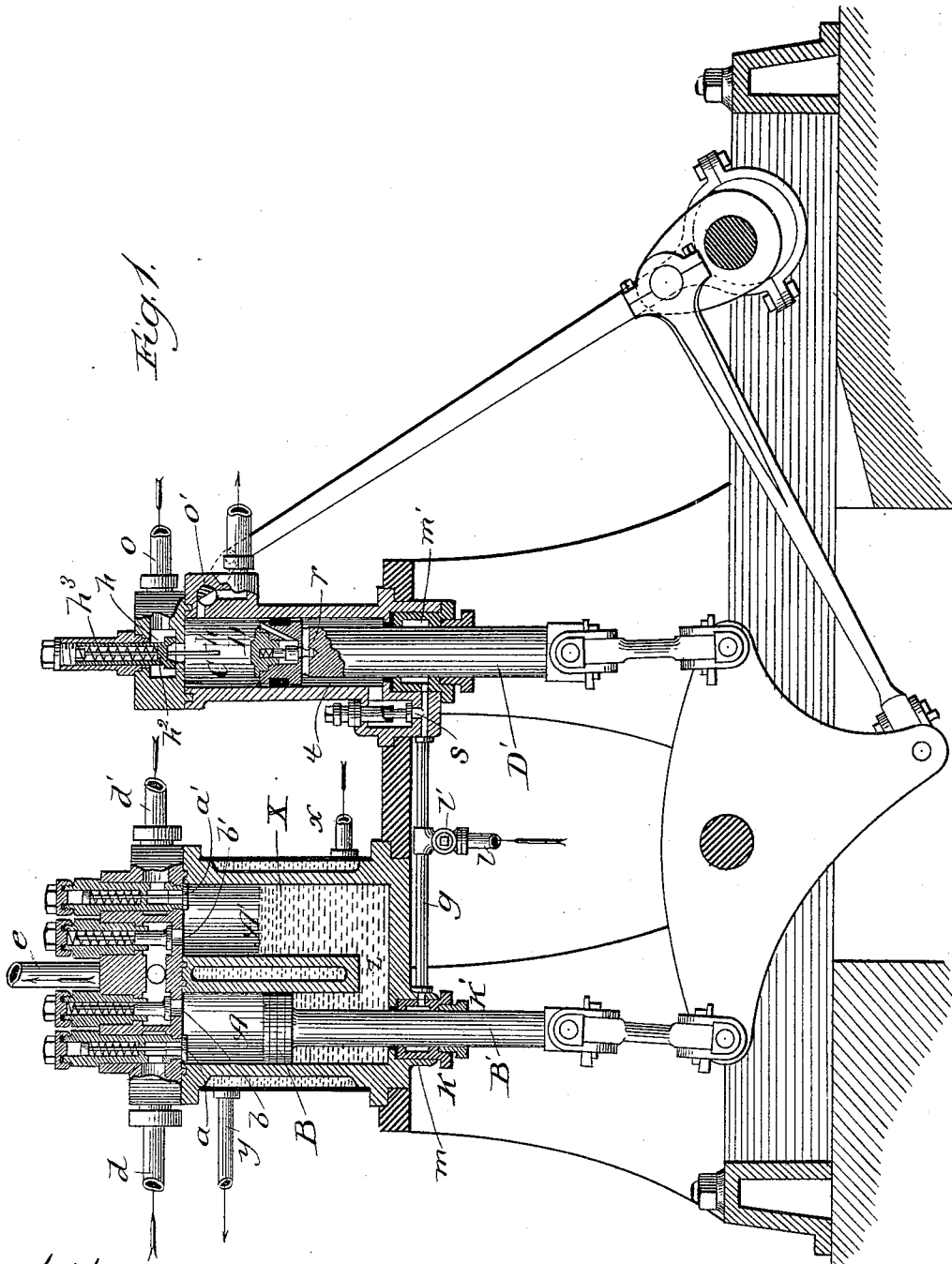
(No Model.)

3 Sheets—Sheet 1.

F. WINDHAUSEN.
COMPRESSING APPARATUS.

No. 460,696.

Patented Oct. 6, 1891.



Witnesses:
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Inventor:
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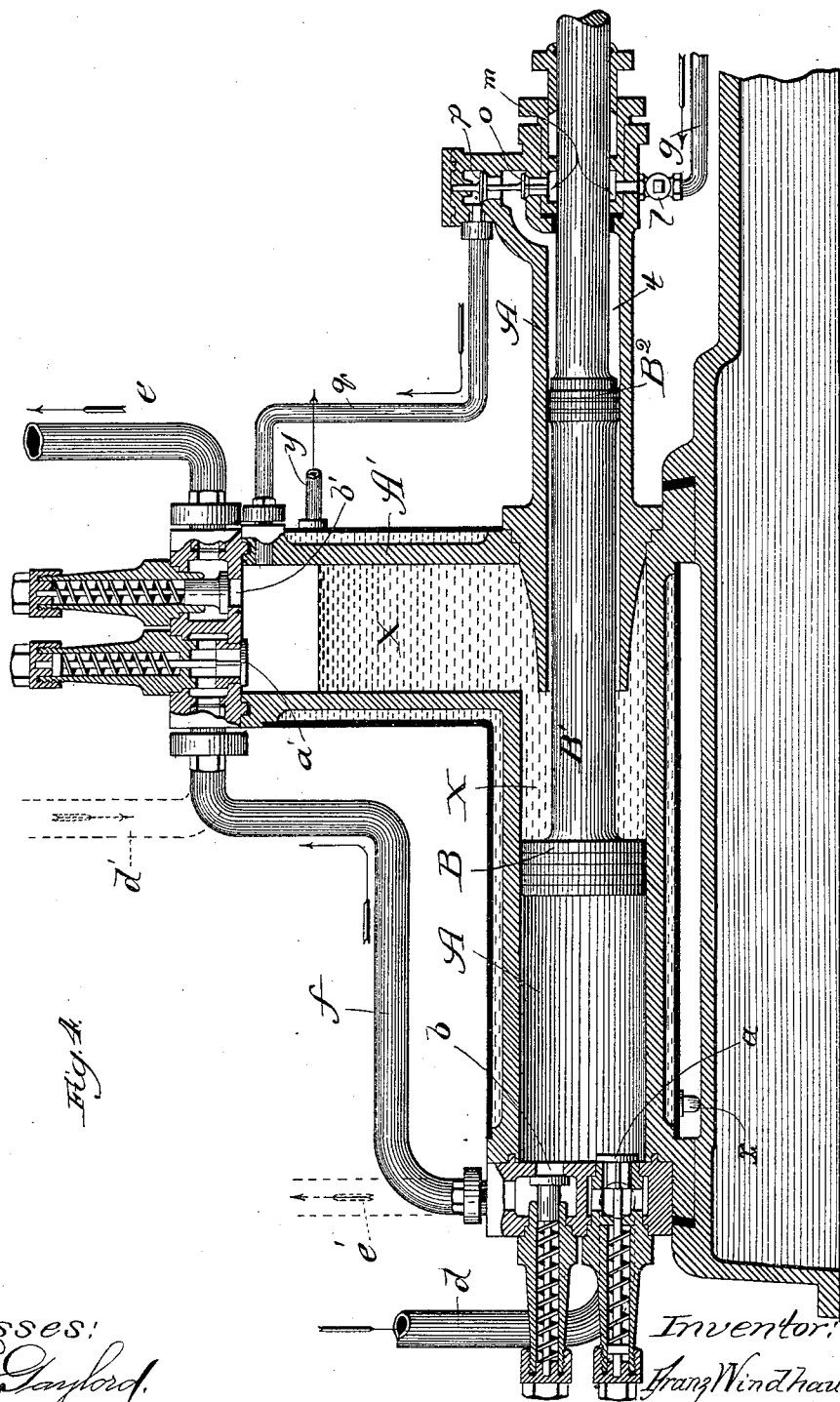
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UNITED STATES PATENT OFFICE.

FRANZ WINDHAUSEN, OF BERLIN, GERMANY.

COMPRESSING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 460,696, dated October 6, 1891.

Application filed January 8, 1889. Serial No. 295,798. (No model.)

To all whom it may concern:

Be it known that I, FRANZ WINDHAUSEN, a subject of the Emperor of Germany, residing at Berlin, in the Kingdom of Prussia and Empire of Germany, have invented a new and useful Improvement in Gas-Compressing Apparatus for Ice and Cooling Machines, of which the following is a specification.

My invention relates, particularly, to an apparatus for use in connection with machines for producing cold, and known in the art as "ice, refrigerating, or cooling machines," and for more especial use with such machines as employ a gas liquefiable under mechanical compression and the expansion of which produces the cold in taking up heat from a surrounding body. Carbonic-acid gas is the cold-producing medium, for the control of which my improved compression apparatus is more particularly intended. Hence and for the sake of convenience the following description is confined to carbonic acid as the cold-producing medium, though it is to be understood that I do not limit myself to the same, as other gases having similar properties may be employed with my improved machine.

My present invention affords an improvement upon the apparatus for compressing gas for which Letters Patent of the United States No. 405,289 were granted me on the 18th day of June, 1889, whereby the force-pump therein shown and described shall be supplanted by the compressor hereinafter set forth, and the means for regulating and controlling the supply of the refrigerating medium from the condenser to the refrigerator or vaporizer shall be supplanted by an expansion-chamber into which the cold-producing medium in liquid form enters as required, and therein becomes cooled by vaporization and partial expansion, and is thence forced into the refrigerator.

The principal objects of my present improvements are to provide means whereby contact of the gas with the piston and stuffing-box packing shall be prevented, to provide means for economizing in the motive power of the machine, to provide means whereby the machine may be replenished with the cold-producing medium (carbonic acid) from an extraneous generator, and to provide means

whereby the gas from the refrigerator may be compressed in two successive operations and forced into the condenser.

In the accompanying drawings, Figure 1 represents in sectional elevation my improved compressor communicating with an expansion-cylinder, both being shown as connected with a well-known form of actuating mechanism. Figs. 2, 3, and 4 show similar views of modified constructions of my improved compressor.

The compression-pump is formed of two chambers or cylinders A and A', communicating through a channel z. The cylinder A is accurately bored and contains a piston B, provided with a piston-rod B', which extends below the cylinder through a double stuffing-box K K'. In the heads of the cylinders A and A' are provided, respectively, suction-valves a and a' and discharge-valves b and b'. Into the space adjacent to the suction-valves suction-pipes d and d' enter, and a discharge-pipe e communicates with the space adjacent to the discharge-valves b and b' and common to both of the latter. Within the cylinder A, between the piston and the stuffing-box of the piston-rod, and also within the chamber A', is a pressure-fluid X, which serves, incidentally, as a lubricant, and upon the upper surface of which, in the cylinder A', the carbonic-acid vapors are drawn by suction from the refrigerator and compressed, while compression and suction of the vapor in the cylinder A takes place on the outer or upper side of the piston B.

The quantity of pressure-fluid should be sufficient to fill the chamber A' to the valves a' and b' when the piston B is at the end of its downstroke in the cylinder A. Between the double packing K K' of the piston-rod B' is a space m, which receives any of the pressure-fluid that may escape through the packing K, and from which it flows through a pipe g into a space m' of the stuffing-box of a cylindrical expansion-chamber C, Fig. 1, whence it is conducted in the manner hereinafter described into the circuit of the machine.

The expansion-chamber C supplants the regulating-valve and regulating apparatus shown in my said former application, and referred to therein, respectively, by the letters

L and M. Liquid carbonic acid flows from the condenser (not shown) through a pipe *o* with a pressure of about sixty atmospheres, and enters through a valve *h*, of tubular form, the cylinder C, wherein it presses against the piston D during about one-tenth to two-tenths of its back-stroke, after which the valve *h* automatically closes. During the back or down stroke of the piston D a portion of the liquid carbonic acid within the chamber C (from one-fifth to one-third) evaporates and expands nearly to the pressure within the refrigerator, (twenty to twenty-five atmospheres,) and is then, being correspondingly cooled, by the opposite stroke of the piston discharged through a slide-valve *o'*, Fig. 1, regulated by an eccentric on the fly-wheel of the machine, into the refrigerator.

The timely opening of the inlet-valve *h* is effected by the piston D striking a stem *h'*, extending from a piston-head *h²* in the tubular valve *h* into the cylinder C and capable of reciprocating therein, a spring *h³*, confined in the valve against the head *h²*, producing a tendency in the latter to close upon its seat afforded by the head of the valve through which the stem *h'* extends. The extent of projection of the stem *h'* into the cylinder C (about one-tenth to two-tenths of the stroke of the piston) corresponds with the depth to which the cylinder should be filled with the liquid carbonic acid. By its forward or upward stroke the piston D pushes back the rod or stem *h'*, and thereby, shortly before attaining the end of its stroke, opens the valve *h* by eventually forcing the stem against the head at the upper or outer end of the tubular valve *h*. During the return stroke of the piston D and the simultaneous influx of liquid carbonic acid from the condenser the valve *h* remains open until the head *h²* on the rod *h'* impinges against the valve *h*, thereby closing it and shutting off the supply. From the time of shutting off the supply, as described, and until the piston D completes its return stroke a portion of the liquid carbonic acid contained in the cylinder evaporates, owing to its latent heat, and the resultant vapors expand to a pressure nearly equaling that in the refrigerator, into which the mixture of liquid and gaseous carbonic acid thus cooled to a low temperature is discharged by the upward or forward stroke of the piston through the slide-valve *o'*. Any of the carbonic acid which may have escaped around the packing of the piston D enters the space *t* around the piston-rod D', and is reconducted by the downstroke of the piston into the cylinder between the piston and valve *h* through a valve *r*, provided in the piston. The same valve *r* serves also for the passage of any of the pressure-fluid X which may find its way into the space *m'* from the chamber *m* of the stuffing-box of the compression-cylinder A, it being conducted through the valve *r* by way of the suction-pipe *s* and the space *t*. Pressure-fluid, and also carbonic-acid gas produced in an ex-

traneous generator, may be introduced by the action of the compressor into the circuit of the machine through a pipe *l* and valve *l'*.

The actuating mechanism with which the pistons B and D are connected and thus connected together presents no features of novelty, being the same as that used with other compressors, and may be varied at pleasure without affecting my improvement.

If it be desired to compress the gas introduced from the refrigerator into the compressor in two successively-performed operations, the suction-valve *a'* is placed in the position of the discharge-valve *b'* and, vice versa, the discharge-pipe *e*, leading to the condenser, closed, and the suction-pipe *d'* connected with the condenser, (not shown,) when, the machine being in operation, the gaseous carbonic acid is drawn through the pipe *d* from the refrigerator (not shown) and discharged by the upward stroke, Fig. 1, of the piston B, through the valves *b* and *a'*, into the cylinder A' over the pressure-fluid X therein, and subsequently, by the return stroke of the piston and the consequent compression of the pressure-fluid in the chamber A', through the valve *b'* and the pipe *d'*, into the condenser.

Without altering the principal of operation of my improved compressor, as shown in Fig. 1 and described in connection therewith, it may be disposed as shown in Fig. 2, wherein it comprises two cylinders, one A within the other A', and provided with a piston B and rod B'. The two cylinders communicate through openings *n* near the base of the cylinder A, through which the pressure-fluid in the two cylinders moves up in the one and down in the other simultaneously with the movements of the piston. The suction and the compression of the gas from the refrigerator are accomplished as by the arrangements shown in Fig. 1—namely, over the pressure-fluid in the cylinder A', whence the compressed gas is discharged through the pipe *e* into the condenser. The stuffing-box involves the construction shown in Fig. 1, and any of the pressure-fluid X which enters the chamber *m* passes through the pipe *g* into the expansion-cylinder. The cylinders of the compressor may also be arranged at right angles to each other, as shown in Fig. 3. By this arrangement the pressure-fluid is confined in the vertical cylinder A' between the piston B and piston-rod B' of the horizontal cylinder A. The gas is drawn from the refrigerator first into the cylinder A, wherein it is compressed and discharged through the valve *b* and a pipe *f* into the cylinder A' upon the pressure-fluid. There, by the back-stroke of the piston, the gas, thus having been partially compressed, is discharged through a valve *c* and the pipe *e* into the condenser.

Any of the pressure-fluid which has escaped into the space *m* of the stuffing-box may be returned to the compressor by means of a suitable pump operated by the actuating

mechanism of the machine, or, as hereinbefore described, into the expansion-cylinder, if employed, when it may also be disposed in horizontal position.

5 As shown in Fig. 4, the cylinders A and A' are arranged as in Fig. 3; but they are provided with similar heads containing similar suction-valves *a* and *a'* and discharge-valves *b* and *b'*, whereby the carbonic-acid vapors
10 may be drawn and compressed in the two successive operations, as hereinbefore described, or separately into the cylinder A' upon the pressure-fluid X therein and into the cylinder A from the refrigerator, (not shown,) respectively, through the pipes *d'* and *d* and
15 discharged through the pipes *e* and *e'* (shown in dotted lines) into the condenser. (Not shown.) If the gas is to be compressed by the two successive operations referred to and forced into
20 the condenser through the medium of the pressure-fluid, the two pipes *e'* and *d'* are omitted and supplanted by the connecting-pipe *f*, affording communication of the chamber of the discharge-valve *b* of the cylinder
25 A with the chamber of the suction-valve *a'* of the cylinder A'.

For returning any of the pressure-fluid which may escape a cylinder A², of smaller diameter than either of the other cylinders,
30 may be concentrically extended from one end of the horizontal cylinder A. In this cylinder A² is a piston B² on the piston-rod B' of the piston B for the cylinder A. Pressure-fluid which escapes from between the pistons
35 B and B² first enters the space between the piston B² and the stuffing-box, and is then by the back-stroke of the piston B² forced through a valve into the cylinder A', as shown, and any pressure-fluid which escapes from the
40 space *m* of the stuffing-box is reconducted

through the suction-pipe *o* into the space *t* behind the piston B², and thence through the valve *p* and the pipe *q* into the cylinder A'.

For the purpose of reducing the heat of compression the compressor in the various
45 forms thus shown and described should be surrounded by a water-jacket into which water enters through a pipe *x* and from which it escapes through a pipe *y*.

What I claim as new, and desire to secure 50 by Letters Patent, is—

1. In a machine for producing cold by the expansion of a gas liquefiable under mechanical compression, the combination, with a compressor having a chamber A, provided with a
55 piston, a chamber A', communicating with the chamber A and containing a pressure-fluid X, confined between the piston and the stuffing-box of the piston-rod, of an expansion-cylinder C, having a piston provided with a
60 valve *r*, a space *t* around the piston-rod, a valve *s*, and a space *m'* within the stuffing-box of the piston-rod and communicating with a space *m* in the stuffing-box of the compressor, substantially as and for the purpose set forth. 65

2. In a machine for producing cold by the expansion of a gas liquefiable under mechanical compression, the combination, with the compressor and an expansion-chamber C, of
70 a pipe *g*, affording communication between the compressor and expansion-chamber at their stuffing-boxes, and a branch pipe *l*, provided with a check-valve *l'*, through which to draw carbonic-acid gas from an extraneous
75 source into the machine, substantially as described.

FRANZ WINDHAUSEN.

In presence of—

B. ROI,

CARL WINDHAUSEN.