3 Sheets—Sheet 1.

J. B. WARING.

Air-Compressors.

No. 217,965. Patented July 29, 1879.

FIG 1

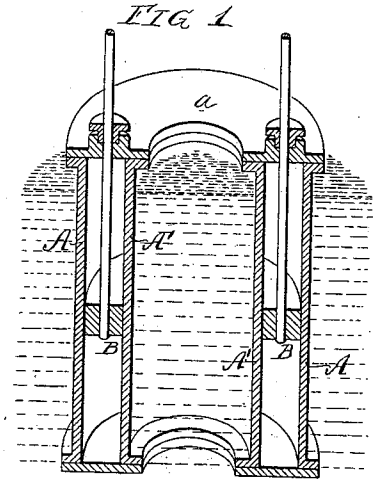
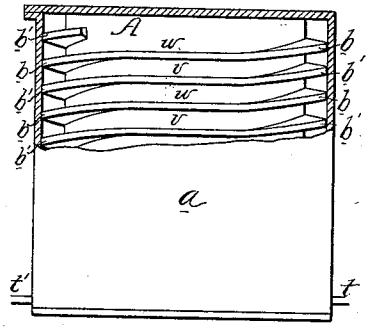


FIG. 2.



Witnesses
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Harry Smith

Inventor
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3 Sheets—Sheet 2.

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Fig. 3.

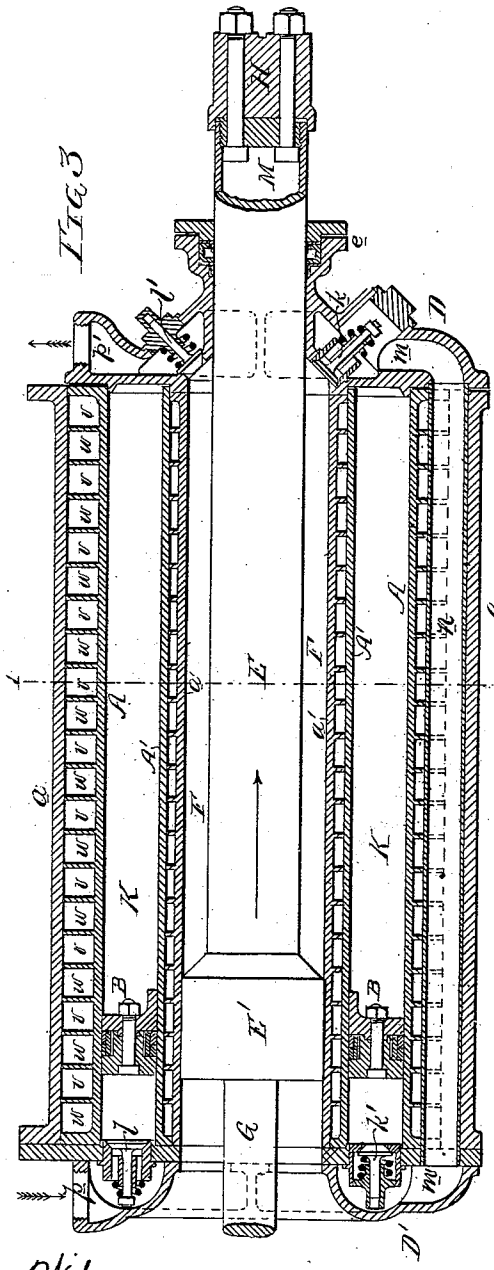


Fig. 4.

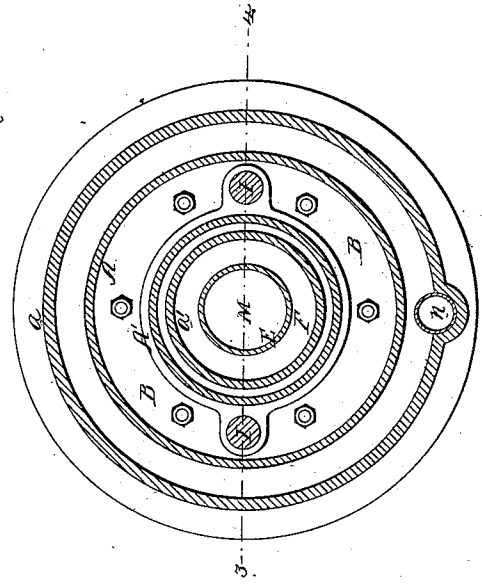
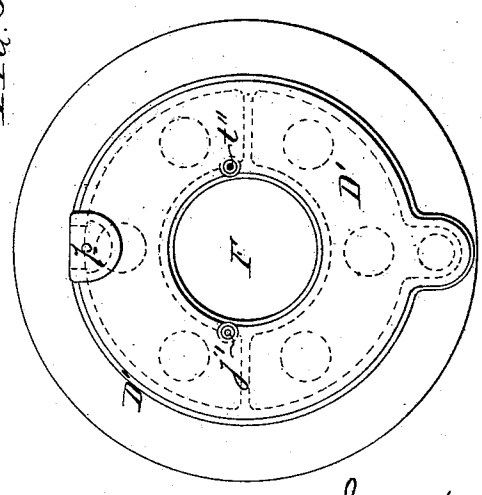


Fig. 5.



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3 Sheets—Sheet 3.

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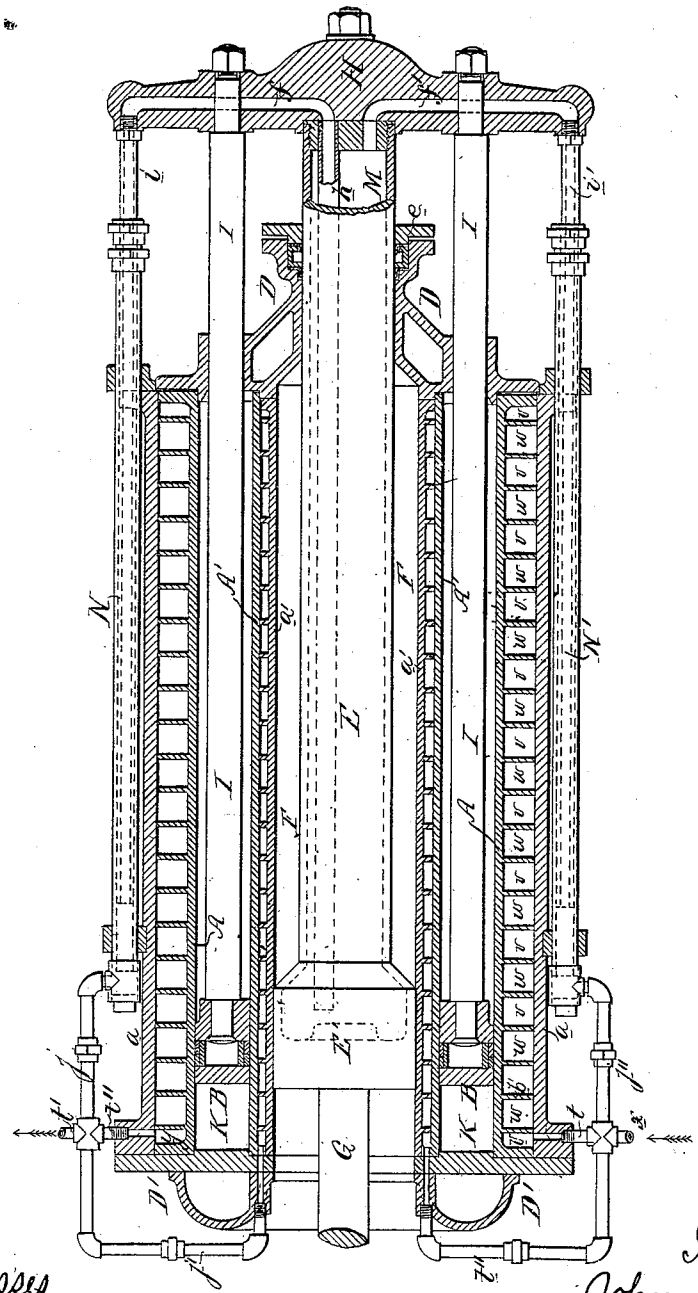
FIG. 6.



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UNITED STATES PATENT OFFICE.

JOHN B. WARING, OF NEW YORK, N. Y., ASSIGNOR OF A PART OF HIS RIGHT TO CHARLES L. CHASE AND FRANCIS WINTERS, JR., OF SAME PLACE.

IMPROVEMENT IN AIR-COMPRESSORS.

Specification forming part of Letters Patent No. **217,965**, dated July 29, 1879; application filed January 2, 1879.

To all whom it may concern:

Be it known that I, JOHN B. WARING, of the city, county, and State of New York, have invented a new and useful Improvement in Air-Compressors, of which the following is a specification.

My invention relates to an improvement in air-compressing engines which are mainly used in connection with ice-making and refrigerating apparatus; and the main object of my invention is to so construct the compressing-cylinder that the air therein may be exposed to extended and effective cooling-surfaces.

The sectional perspective diagram, Figure 1, Sheet 1, of the accompanying drawings will serve as a medium for a general explanation of the main feature and object of my invention.

In this view A and A′ are an inner and outer cylinder, which, when connected together by their covers, constitute what is known among engineers as an "annular cylinder," its piston B having two piston-rods, passing through stuffing-boxes in one of the covers and connected to the driving-engine.

There are suitable valves (illustrations of which it has not been deemed necessary to show in this diagram) for admitting air to and permitting it to escape from the annular space between the two cylinders.

The exterior of the outer cylinder and inner surface of the inner cylinder are exposed to the cooling influences of running water, so as to counteract the heat generated by the compressing of air in the annular space between the two cylinders. In other words, the compressed air in the said space is exposed to two cooling-surfaces instead of one, as in ordinary air-compressing cylinders.

In carrying out this main feature of my invention, however, I prefer to place a jacket round the outer cylinder and a jacket within the inner cylinder, and to cause cold water to circulate within the jackets, so that both cylinders may be constantly exposed to the cooling influences of water in motion; and in order that the cooling effect of the water may be enhanced, I cause it to traverse circuitous passages between each cylinder and jacket, preferring the spiral passages shown in the diagram, Fig. 2, Sheet 1, which represents an exterior view, with part of the jacket removed, to show a portion of the outer cylinder with spiral ribs cast on the same.

There are two distinct spiral ribs, *b b′*, arranged like the threads of a double-threaded screw, so that when the jacket *a* is fitted snugly to these ribs there will be two distinct spiral passages, *v* and *w*.

A stream of water entering the jacket at *t* will first traverse one spiral passage—say the passage *v*—to the top of the jacket, and then where the thread *b′* is cut away will enter the channel *w*, and, after traversing the latter, will escape at the outlet *t′*.

Figs. 3, 4, and 5, Sheet 2, and Fig. 6, Sheet 3, represent my invention in a more complete condition, Fig. 3 being a vertical section of the annular air-compressing cylinder; Fig. 4, a section on the line 1 2; Fig. 5, a bottom view; and Fig. 6, a vertical section on the line 3 4, Fig. 4.

In these views the outer cylinder, A, is provided with a jacket, *a*, the space between the latter and the cylinder being separated into two spiral passages by spiral ribs *b b′*, in the manner described above.

In like manner the inner cylinder, A′, is furnished with a jacket, *a′*, between which two similar spiral passages are formed.

D D′ are the two cylinder-covers, the former having a central stuffing-box, *e*, for a tubular rod, E, provided with a piston, E′, which is adapted to the secondary compressing-chamber F, contained within the jacket *a′* of the inner cylinder. This piston and piston-rod, as well as the annular piston B, are reciprocated through the medium of a rod, G, which may be a continuation of the piston-rod of the driving-engine, or may be operated from the crank of any driving-shaft.

The outer end of the tubular rod E is connected to a cross-head, H, to which are also secured the outer ends of the two piston-rods I I′ of the annular piston B of the first compressing-chamber, K.

In the cross-head H are passages *f f′*, the first communicating in one direction with a pipe, *h*, which terminates near the end of the

chamber M in the tubular rod E, and in the other direction with a tube, *i*, which passes into a fixed pipe, N, through a stuffing-box, the opposite end of the said fixed pipe communicating through a tube, *j*, with the outlet-pipe *t'*, which communicates through a tube, *t''*, with the spiral passage *y* of the outer cylinder, and through a tube, *j'*, with one of the spiral passages of the inner cylinder.

The passage *f'* in the cross-head forms a direct communication between the chamber M of the tubular rod E and the tube *i'*, which is arranged to slide in the fixed pipe N', the latter communicating through a tube, *j''*, with the inlet-pipe *x*, which communicates through a branch, *t*, with the spiral passage *v*, between the outer cylinder and its jacket *a*, and through a tube, *t''*, with one of the spiral passages between the inner cylinder and its jacket *a'*.

In a chamber, *m*, formed in the cover D is a valve, *k*, opening inward to the secondary compressing-chamber F, the said chamber communicating through a pipe, *n*, with a chamber, *m'*, in the cover D', and this latter chamber having a valve, *k'*, opening outward from the first compressing-chamber, K.

In the same cover D' is a chamber, *p*, having a valve, *l*, which opens inward to the first compression-chamber, K, and in the cover D is a valve, *l'*, opening into a discharge-chamber, *p'*.

On moving the cross-head and its adjuncts in the direction of the arrow, Fig. 3, the valve *l* will open, and by the time the piston has reached the limit of its movement in this direction the chamber K will have received a full supply of air at the atmospheric pressure.

On reversing the movement of the cross-head the air will be compressed by the annular piston B in the first compressing-chamber, K, and will be forced into the valve-chamber *m'*, through the pipe *n* into the chamber *m*, and thence into the second compressing-chamber, F.

On again moving the cross-head in the direction of the arrow the air will be still further compressed in the secondary compression-chamber F by the piston E', and this highly-compressed air will be finally forced by the said piston into the chamber *p'*, and thence to its destination. Thus, during one movement of the cross-head a volume of air is receiving its first pressure in one chamber, and during the reverse movement the air is receiving its second pressure in the second chamber. In the meantime water admitted at *x*, Fig. 6, takes its course through the tubes *t*, *j''*, and *t''*.

Tracing the course of the first volume of water, which enters the spiral passage between the outer cylinder and its jacket, it will traverse this passage and then return through the other spiral passage, *w*, and will finally escape at the outlet *t'*.

The second volume of water, passing through the tube *t''* enters one of the spiral passages between the inner cylinder and its jacket, and, after traversing the whole length of the same, returns through the other spiral passage, and finally escapes through the tube *j'* to the outlet *t'*.

The third volume of water passes through the tube *j''* into the fixed pipe N', thence through the tube *i'* and through the passage *f'* in the cross-head into the chamber M of the tubular rod E, from which chamber it passes through the pipe *h*, through the passage *f* of the cross-head, through the tube *i* and fixed pipe N, and finally through the tube *j* to the outlet *t'*.

It will thus be seen that the air, as it is received in and is being forced from the first compressing-chamber, K, is exposed to two opposite cooling-surfaces, one surface being cooled by the constant flow of water through the spiral passages of the outer cylinder, and the other surface being cooled by the flow in contact with it of the water through the spiral passages of the inner cylinder.

The cooling influence of the water, however, is not solely through the medium of the cylinders, in contact with which the water flows, for the spiral ribs themselves exert a cooling influence on the air, as the water flowing in intimate contact with these ribs cools the same, and being good conductors, the cooling of the ribs is felt by the cylindrical casing, and is imparted by the latter.

The volume of air, as it is admitted to and is being forced from the second compressing-chamber, F, is also cooled by opposite cooling-surfaces—namely, that of the jacket of the inner cylinder and that of the surface of the hollow piston E'.

In some cases the secondary compressing-chamber F and its piston E' may be dispensed with, and the spiral passages may be restricted to the outer cylinder; but I prefer to make compressing-cylinders of the larger class in the manner described, and illustrated in Sheets 2 and 3 of the drawings.

I claim as my invention—

1. An air-compressor in which an inner and outer cylinder, both exposed to cooling influences, are combined with a reciprocating annular piston adapted to the compressing-chamber between the two cylinders, all substantially as set forth.

2. The combination, in an air-compressor, of an inner and outer cylinder, each provided with a jacket, the spaces between each cylinder and its jacket being in communication with a supply of water under pressure, and having suitable outlets, substantially as described.

3. The combination of an annular compressing-cylinder and its annular piston B, and the central compression-chamber, F, and piston E' with the system of inlet and outlet passages and automatic valves herein described, whereby the air, after being compressed in the annular cylinder, is conveyed to the central cylinder, to be there further compressed, all substantially as set forth.

4. The combination of the compressing-

chamber F, the piston E′, and tubular piston-rod E with tubes and passages by which water is introduced into and permitted to flow from the interior of the said piston, substantially as specified.

5. The combination of the compressing-chamber F, its piston, and tubular piston-rod with the cross-head H and its passages, the pipes *i i′*, and fixed pipes N N′, the latter communicating with an inlet-tube, and the former with an outlet-tube, all substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

J. B. WARING.

Witnesses:
WM. J. COOPER,
HARRY SMITH.