(Model.)

2 Sheets—Sheet 1.

F. M. McMILLAN.

APPARATUS FOR THE MANUFACTURE OF ICE AND FOR OTHER COOLING PURPOSES.

No. 246,406. Patented Aug. 30, 1881.

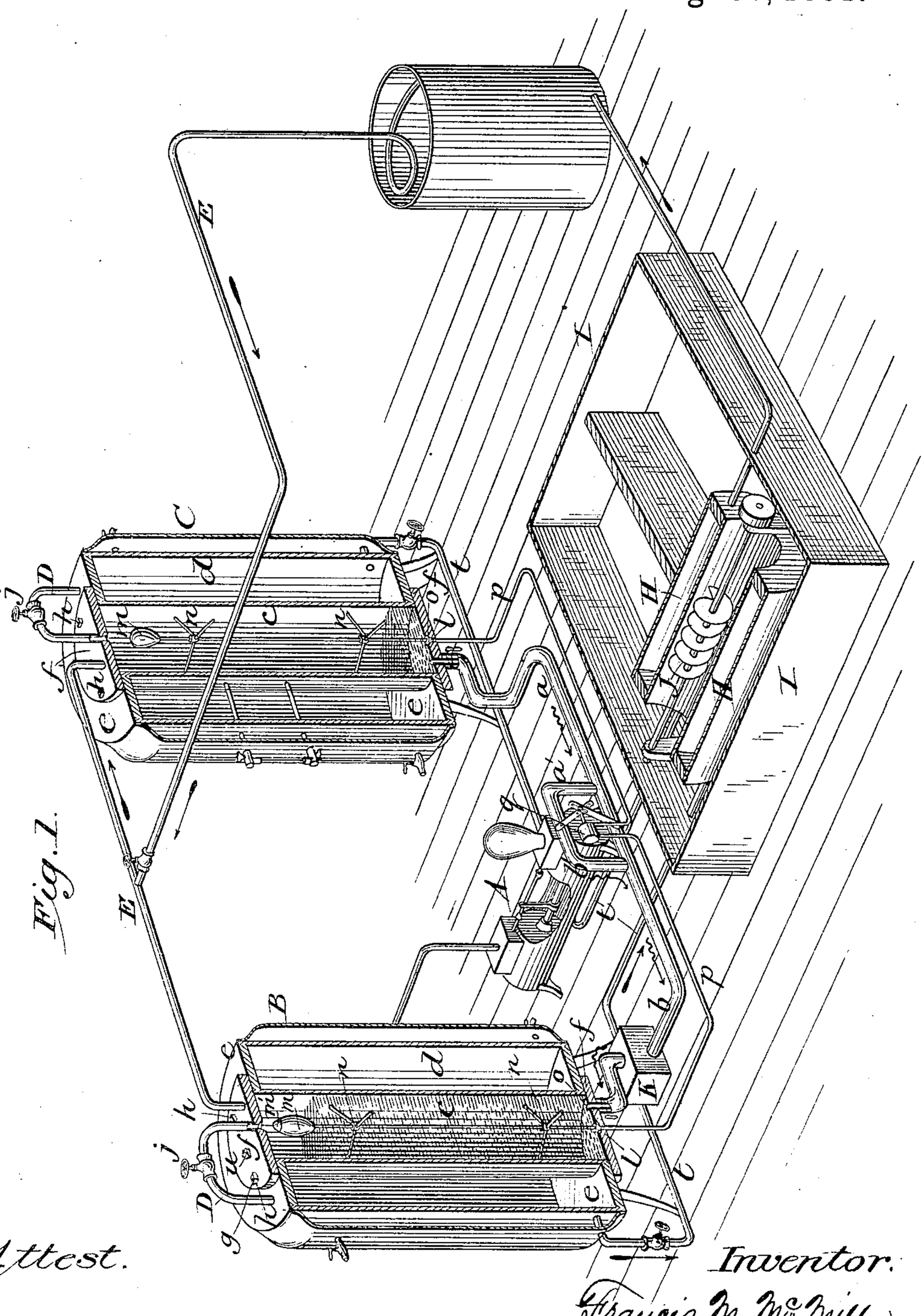

Fig. 1.

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Sidney P. Hollingsworth.
Walter S. Dodge.

Inventor.
Francis M. McMillan
by Dodge & Son,
Attys.

(Model.) 2 Sheets—Sheet 2.

F. M. McMILLAN.

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Fig. 3.

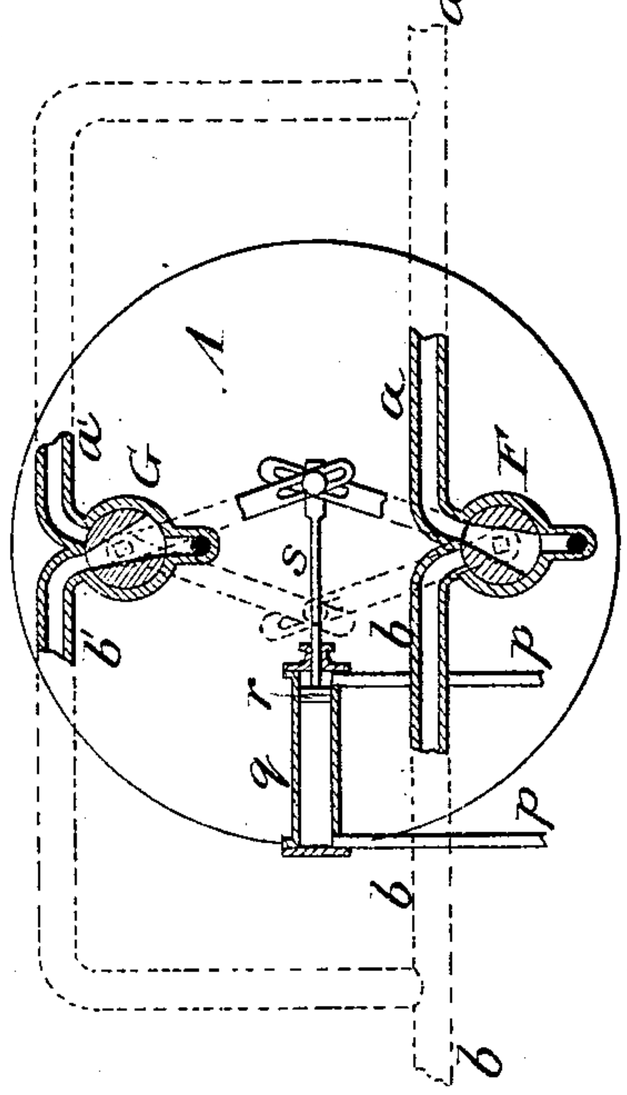
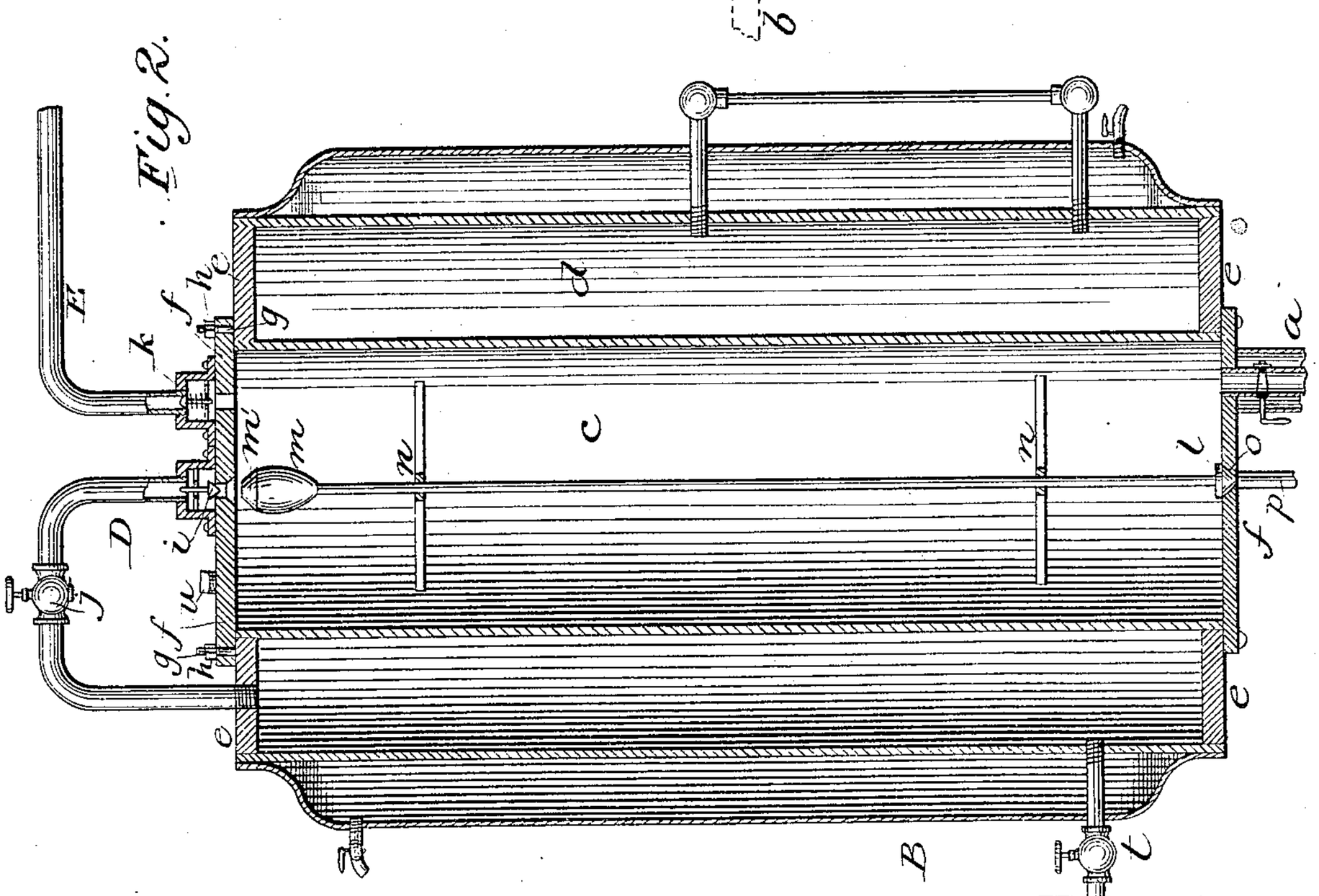


Fig. 2.



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UNITED STATES PATENT OFFICE.

FRANCIS M. McMILLAN, OF WASHINGTON, DISTRICT OF COLUMBIA.

APPARATUS FOR THE MANUFACTURE OF ICE AND FOR OTHER COOLING PURPOSES.

SPECIFICATION forming part of Letters Patent No. 246,406, dated August 30, 1881.

Application filed July 15, 1881. (Model.)

To all whom it may concern:

Be it known that I, FRANCIS M. McMILLAN, of Washington, in the county of Washington, District of Columbia, have invented certain Improvements in Apparatus for the Manufacture of Ice and for other Cooling Purposes, of which the following is a specification.

My invention relates to the manufacture of ice and to cooling generally; and it consists, primarily, in a pump communicating with the internal chambers of two cylinders or vessels, each provided with a central chamber and an annular surrounding chamber, said pump being arranged to deliver a body of water or other liquid from one vessel to the other alternately in opposite directions, and provided with a reversing-gear controlled and operated by said liquid in such manner that when the liquid attains a given height in one chamber it shall cause the pump to be automatically reversed and the liquid to be pumped to the other chamber, suitable valves and pipes being provided for the admission of gas or other fluid into the central chambers, and for its delivery into the annular surrounding chambers when compressed by the rise of the water-column.

The invention further consists in a peculiar construction of the cylinders or vessels, in a novel arrangement of valves for controlling the reversing-gear of the pump, and in various other details hereinafter explained.

In the accompanying drawings, Figure 1 represents a perspective view of my apparatus, with the cylinders in section to show the internal construction and arrangement; Fig. 2, a vertical central section of one of the upright cylinders; Fig. 3, a detail view of the reversing-gear of the pump.

The object of my invention is to simplify and cheapen the apparatus required for the manufacture of ice, and especially to do away with the costly compressing apparatus hitherto generally employed. To this end I employ a pump of ordinary and simple construction, and interpose between it and the gas or fluid to be compressed a body of water, glycerine, or other suitable liquid, whereby the extremely careful fitting and packing of the pump is rendered unnecessary; and in order to render the action of the apparatus constant, I employ two vessels or chambers, pumping the liquid from one to produce a vacuum or partial vacuum therein, to cause the gas to enter, and into the other to compress the gas supplied thereto. In this way one or the other vessel is constantly receiving a supply of gas, while at the same time the gas or other fluid is being compressed in its companion. The vessels are, for convenience and economy of space, formed with a central chamber to contain the water or liquid column, and within which the gas or other fluid is compressed, and with an annular chamber surrounding the first, and serving as a reservoir to contain the gas or fluid when compressed and forced from the central chamber. The compression of the gas and fluid generates a high degree of heat, both in the fluid compressed and in the liquid employed in the compression; and to remedy difficulties which might arise from this source, both the vessels and the pipes connecting the same with the pump are, by preference, water-jacketed, and in some cases a coil may be located in the water-space, or in the chamber from which the jacketing of the pipes is supplied with water, through which coil a cooling agent may be forced to lower the temperature of the water. The gas or other fluid, which, in practice, is compressed to liquefaction, is conducted from the annular chambers or reservoirs to the cooler or refrigerator located in the freezing-tank, where it expands again and takes the form of a gas, whence it is again delivered to the upright cylinders, compressed, and so used continuously. The cooler or refrigerator consists merely of a double-walled cylinder, the annular chamber of which is supplied with the liquefied gas or fluid. The brine or liquid of the freezing-tank flows through the open center of the cooler and along its exterior, and is thus brought in contact with a large cooling-surface and rapidly cooled.

Referring now to the drawings, A represents a steam-pump, which may be of any ordinary construction, the Blake or the Knowles pump being admirably adapted for the purpose, and B C two upright vessels or cylinders communicating with the pump by means of pipes *a* and *b*. As shown more clearly in Fig. 2, the vessels or cylinders consist each of two cylinders, *c* and *d*, arranged concentrically one within the other, the annular space between the two being closed by collars or heads *e*, to which

the cylinders *c* and *d* are, by preference, welded at their ends. The inner cylinder or the central chamber of the vessels is closed at its ends by heads or cap-plates *f*, perforated or notched to receive bolts *g* projecting from the collars *e*, and provided with nuts *h*, as shown. Instead of this construction, it may be advisable in some cases to form the heads of cast-iron, providing them with annular grooves to receive the ends of the cylinders *c d*, which, being seated in the grooves, would be closely united to the heads by filling the grooves with molten tin or solder; or the grooves might be supplied with tin, the head then heated, and the cylinders pressed into the grooves, thereby insuring a perfect closing of all crevices in the joints; or, instead of employing molten metal, a gasket of lead or of pure rubber may be seated in the grooves, and ends of the cylinders bedded in the same by tightening the nuts of the longitudinal tie-rods, which will in any case be used with the cast-iron heads, to tie them firmly together and to maintain a perfect joint at all points.

In practice I propose to employ ordinary wrought-iron pipe in the construction of my cylinders, which, being found in all sizes in the market, forms at once a very cheap and convenient stock for the purpose.

As shown in Figs. 1 and 2, the central chamber and the annular surrounding chamber in each cylinder communicate by means of a pipe, D, provided with a valve, *i*, opening upwardly from the inner chamber, and with a globe or like valve, *j*, by which communication between the two chambers may be effectually closed. A gas-supply pipe, E, also communicates with the inner chamber of each vessel or cylinder, entering through the top or cap plates, *f*, and being furnished with a downwardly-opening valve, *k*, at the top of each chamber or vessel. At the lower ends of the vessels or cylinders the pipes *a* and *b*, communicating with the pump A, open into the central chambers of the respective vessels, as shown. The inner chamber of each vessel is also provided at its lower end with an upwardly-opening valve, *l*, provided with a stem or rod extending to the upper part of the chamber, and provided at its upper end with a float, *m*, the stem being carried and steadied in guides *n*, as shown.

From the openings *o*, closed by the valves *l*, pipes *p* extend to a small cylinder, *q*, and enter the same on opposite sides of a piston, *r*, mounted therein, and connected by its rod *s* with the reversing-gear of the pump A. This reversing-gear may be of any convenient or usual construction, that shown in the drawings being well adapted to the purpose for which it is intended.

As shown more clearly in Fig. 3, the pipes *a b* are each branched or divided at a point near the pump, forming the double connection *a a'* and *b b'* for each pipe with said pump, one branch of each communicating with the supply and the other with the delivery port of the pump, as indicated.

Between the supply-port and the pipes *a b*, and between the delivery-port and the branch pipes *a' b'*, I interpose a two-way valve or cock, (represented by the letters F and G, respectively.) The valve F has its ports so arranged that when its plug is turned to one position it shall open communication between pipe *a* and the pump, at the same time closing communication with pipe *b*, and when turned to its other position it shall open communication between pump A and pipe *b*, closing communication with pipe *a*. The valve G operates in precisely the same manner to simultaneously open communication between the pump and one branch and close communication with the other branch, the valves being so arranged in relation to each other that communication shall be established with pipe *a* and branch *b'* simultaneously and cut off with pipe *b* and branch *a'*, or vice versa. Each of the valves is provided with an operating arm or lever connected with the rod *s* of piston *r*, by which the valves are actuated and controlled. Under this arrangement the rise of water in the inner chamber causes the elevation of the float *m* and the consequent opening of the valve *l*. Water or other liquid is thus admitted through the pipe *p* to the cylinder *q*, where it acts upon the piston *r*, and through its movement reverses the pump.

As stated, gas or other suitable fluid is admitted to the inner chambers of the vessels B C through a pipe, E, and after being compressed enters the surrounding annular chambers, whence it is conveyed through pipes *t* to the cooler or refrigerator H, which, as shown in Fig. 1, consists of two concentric pipes or cylinders having the annular space between them closed at the ends in the same manner as in the vessels B and C. The central chamber or the inner cylinder is, however, left open at the ends, in order that the brine or liquid in which the cooler is immersed may flow freely through the same from end to end, and thus be brought in contact with an extensive surface and rapidly cooled, both the inside and outside surfaces being thus made to assist in cooling the brine or liquid. The cooler H is immersed in the brine or liquid of the freezing-tank I; and to insure a proper circulation and uniform refrigeration of said liquid a spiral vane, J, or a wheel with inclined blades, may be arranged within the open passage of the cooler and rotated in any convenient manner, thereby causing the liquid to travel slowly and continuously in one direction through the tank. The liquefied gas or fluid from the reservoirs of vessels B C enters the annular chamber of the cooler H, where it expands and resumes the form of a gas, taking up the heat contained in the brine or liquid in so doing, and thereby rapidly lowering the temperature thereof, after which the gas passes to the pipe E, to be again delivered to the compressing-chambers of the vessels B C. The gas, as it comes from the cooler, is still at a low temperature, and in order to utilize this cold the pipe E may be

provided with a coil and said coil arranged in the supply-tank from which the water to be frozen is taken, thus lessening the work of the cooler by lowering the temperature of the water before supplying it to the freezing-cans.

In order that the water or other liquid employed in the upright chambers or vessels may not enter the annular surrounding-chambers, the floats *m* may be each furnished with a valve-plug, *m'*, which shall close against a valve-seat at the mouth of the pipe D as the float rises to open the valve *l;* or the valve *i* may be provided with a second plug, which shall be forced to its seat against the mouth of pipe D through the rise of the liquid to close said pipe and prevent the liquid from passing from one chamber or cylinder to the other.

As shown in Fig. 1, the pipes *a b* are jacketed, and the intervening space between the pipes and their jackets is supplied with water, which may be taken from a tank, I, through which it may be made to circulate by reason of the difference in temperature of the water entering and leaving the tank, or in any other convenient manner. Instead of this arrangement, a continuous flow of water may be kept up through the jacketing from an ordinary service-main. These remarks apply also to the jacketing of the vessels or cylinders B and C.

When no means of cooling the water in the jacketing of the cylinders is provided, and there is not a constant flow of water through the same, the feed-water for the boiler of the steam-pump may be taken from said jacketing, and, being at a comparatively high temperature, may be used with considerable saving of fuel required for heating.

In starting the apparatus the pump is first caused to exhaust the air from the interior thereof, the valves being then open. Gas is then admitted to the inner chamber of one cylinder to replace the air taken therefrom, and water or other liquid is next supplied to the inner chamber of the other vessel through an opening closed by a valve or a screw-plug, *u*, until the float *m* rises and lifts the valve *l* from its seat, the opening through which water was supplied being promptly closed. The rising of the float and opening of valve *l* cause the valves of the pump to be reversed and the liquid to be pumped to the cylinder containing the supply of gas, as above explained, compressing the same, the cylinder from which the liquid is pumped at the same time receiving a supply of gas, as explained, and so on continuously. Cans or vessels containing the water or liquid to be frozen are immersed in the brine or liquid of the freezing-tank in the usual manner.

It is apparent that the details of the apparatus may be considerably varied or modified without departing from the spirit of my invention—as, for instance, by substituting any other well-known form of reversing-valves for those shown, by employing a rotary instead of a reciprocating pump, and in various other respects which will readily suggest themselves to the practical mechanic.

For the purpose of more effectually cooling the liquid as it is pumped from one vessel or chamber to the other, said liquid may be caused to pass through a series of tubes surrounded by a cooling medium or agent at a point between the pump and the liquid column.

In speaking of the reversing-gear of the pump it is, of course, meant valves or gear for reversing the direction of the liquid-current.

Having thus described my invention, what I claim is—

1. The herein-described apparatus for the manufacture of ice and other cooling purposes, consisting of the vessels B C, each having an inner and an outer chamber, communicating by pipes D, provided with upwardly-opening valves, a pump, A, communicating with the inner chambers of the vessels and arranged to pump from one to the other alternately in opposite directions, a gas-supply, E, opening into the inner chambers and provided with downwardly-opening valves, and a cooler communicating with the outer chambers and with the gas-supply pipe, substantially as shown.

2. In an apparatus for the manufacture of ice and other cooling purposes, the combination of a pump provided with reversing-valves, a vessel communicating with the pump and with a reservoir, and a float located within the vessel and adapted to open a valve when the liquid attains a given height therein, whereby the liquid is permitted to escape and to operate the reversing-valves of the pump.

3. The combination, in an ice or cooling apparatus, of a pump provided with reversing-valves, a vessel communicating with the pump and connected with a reservoir by a pipe containing an upwardly-opening valve, a gas-supply pipe opening into the upper end of the vessel and provided with a downwardly-opening valve, and an upwardly-opening valve at the lower end of the vessel connected with a float at the upper end thereof, whereby the rise of liquid in the vessel is caused to raise the valve at the lower end of the vessel and permit a portion of the liquid to escape and operate the reversing-valves of the pump, substantially as and for the purpose set forth.

4. In an ice or cooling apparatus, a pump provided with reversing-valves and arranged to deliver water or other liquid into a chamber to compress gas therein, a cylinder communicating with said chamber and arranged to receive liquid therefrom, and a piston located in said cylinder and connected with the reversing-valves of the pump, whereby the liquid entering the cylinder is caused to reverse said valves.

5. In an ice or cooling apparatus, the combination of a pump provided with reversing-valves, a piston mounted in a cylinder and connected with said reversing-valves, a vessel communicating with the pump, and a float-valve adapted to open communication between the vessel and cylinder when the fluid attains

a given height, for the purpose of reversing the pump.

6. The herein-described vessel for use in the manufacture of ice, &c., consisting of the concentric cylinders, closed at their ends and communicating by a pipe, as shown and described, and provided with a water-jacket, whereby the compressed gas is confined between two liquid bodies, and thus relieved of its heat.

7. The vessel for use in the manufacture of ice, &c., consisting of two concentric cylinders, placed one within the other and closed at their ends, whereby the liquid of one chamber is caused to cool the gas of the adjoining chamber.

8. In combination with a gas vessel or chamber and a pump adapted to force liquid into the chamber for compressing gas, a pipe connecting the vessel and the pump and provided with a water-jacket, whereby the water is cooled before entering said chamber.

9. In combination with a pump provided with reversing-valves, a float-valve arranged within the receiving-chamber, supplied by the pump, and adapted to control the reversing-valves.

10. In combination with a compressing or liquid chamber, a reservoir, a pipe connecting the liquid-chamber and the reservoir, and a valve actuated by the liquid to close the connecting-pipe.

FRANCIS M. McMILLAN.

Witnesses:

WILLIAM W. DODGE,

WALTER S. DODGE.