No. 633,207. Patented Sept. 19, 1899.

C. W. MILES.

REFINING OR CRYSTALLIZING APPARATUS.

(Application filed Oct. 7, 1898.)

(No Model.)

3 Sheets—Sheet 1.

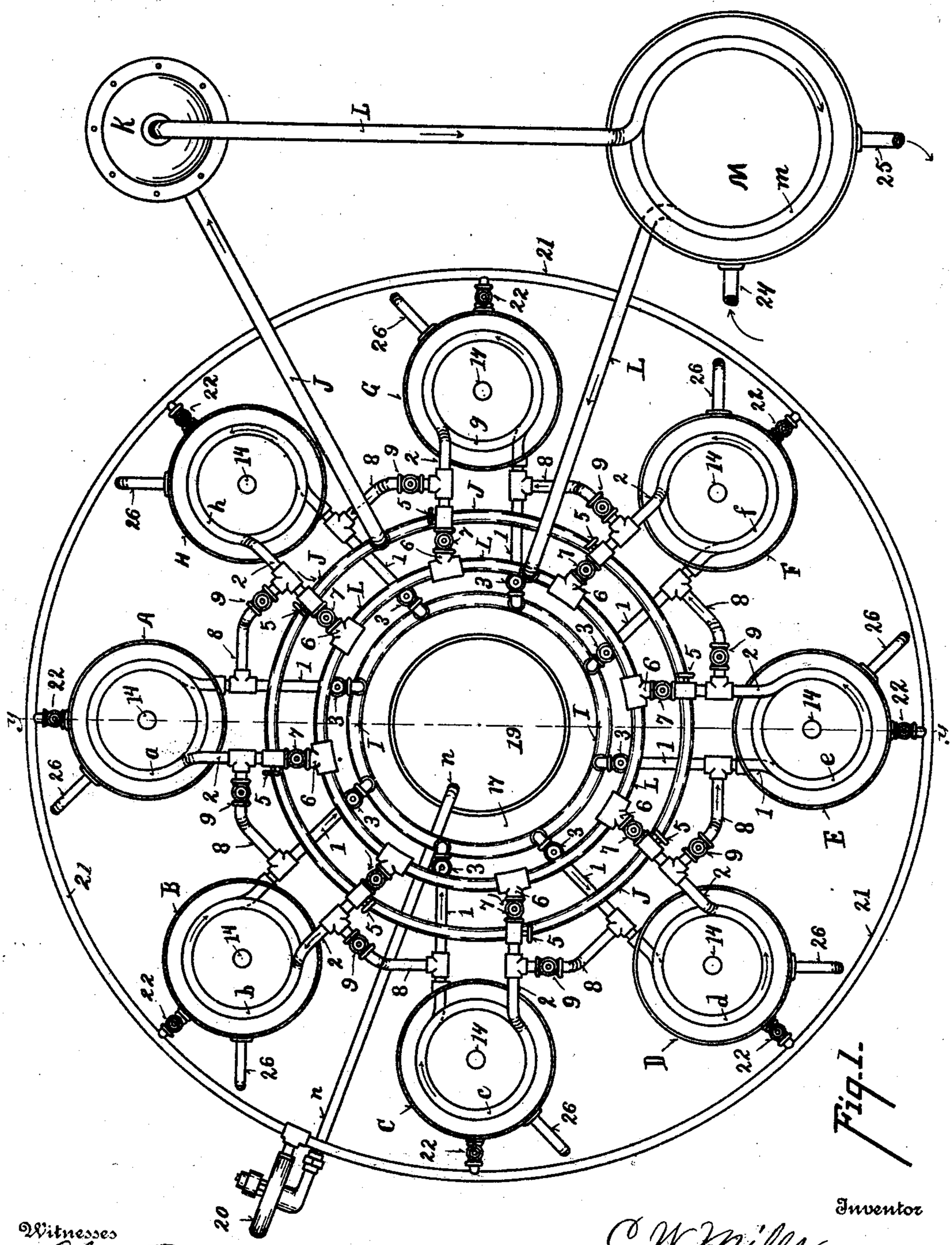

Fig. 1.

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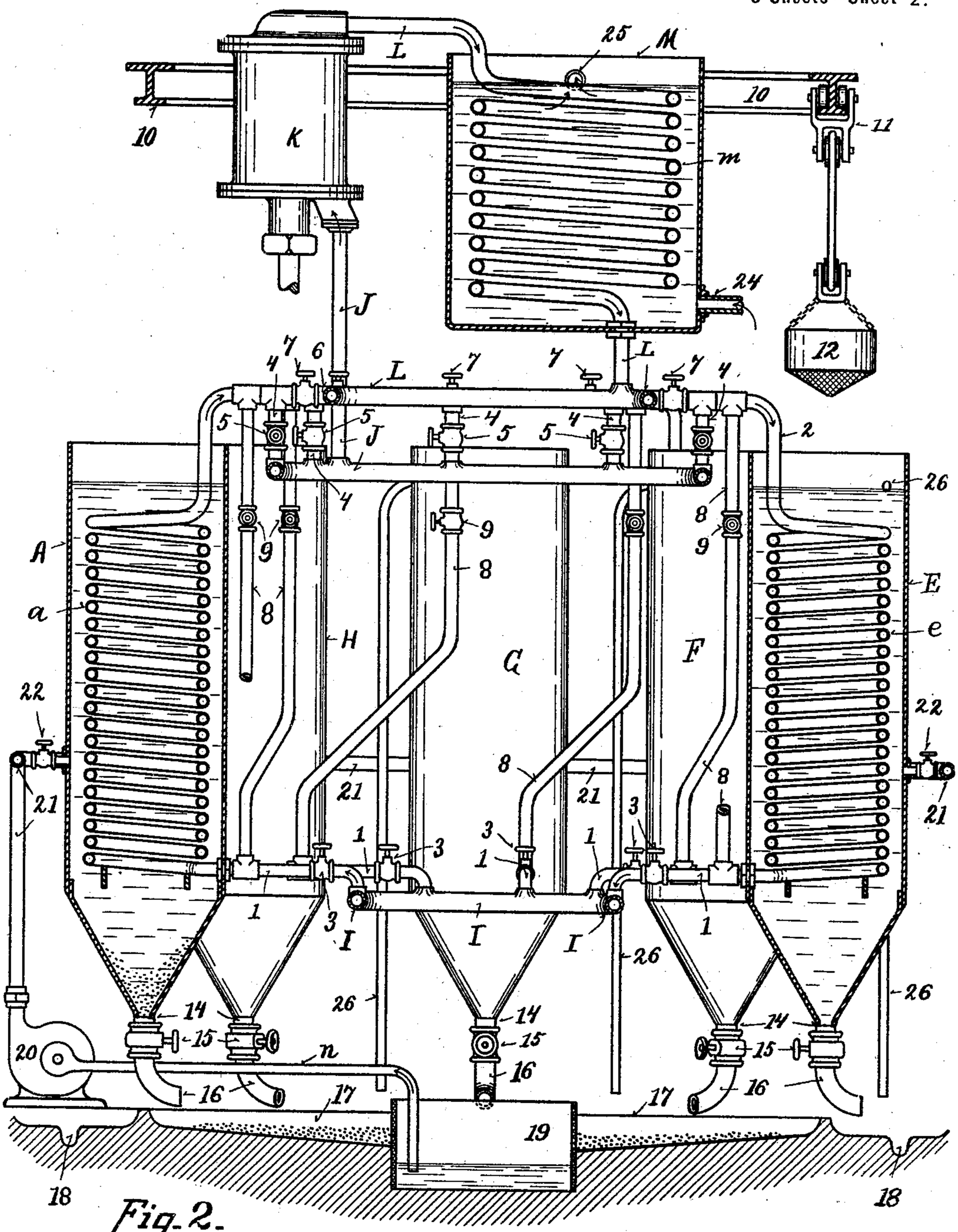

Fig. 2.

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(No Model.) 3 Sheets—Sheet 3.

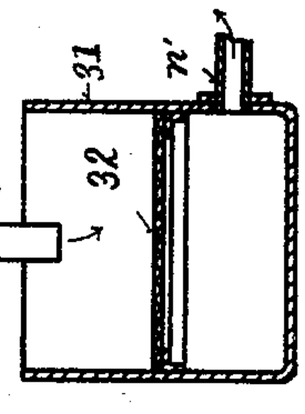

Fig. 4.

Fig. 3.

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UNITED STATES PATENT OFFICE.

CASPER W. MILES, OF CINCINNATI, OHIO.

REFINING OR CRYSTALLIZING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 633,207, dated September 19, 1899.

Application filed October 7, 1898. Serial No. 692,896. (No model.)

To all whom it may concern:

Be it known that I, CASPER W. MILES, a citizen of the United States of America, and a resident of Cincinnati, county of Hamilton, and State of Ohio, have invented certain new and useful Improvements in Refining or Crystallizing Apparatus, of which the following is a specification.

My invention relates to apparatus for refining or crystallizing soluble crystalline and other chemical compounds.

One of its objects is to provide improved mechanism for continuously carrying on the process by means of artificial refrigeration.

Another object is to provide improved means for removing the accumulated ice from the refrigerating-coils and employing it to condense the refrigerant.

Another object is to provide means for connecting the several refrigerator-coils in multiple tandem or parallel series and control the circulation of the refrigerant therein to get the most economical results in refrigeration.

Another object is to provide an improved condenser system having connecting-pipes and valves so arranged that the several refrigerating tanks and coils can be converted to condenser tanks and coils and back to refrigerating tanks and coils again.

My invention further consists in certain details and arrangements, which will be more fully set forth in the description of the accompanying drawings, in which—

Figure 1 is a diagram, in top plan, of my improved apparatus with the overhead track and bucket omitted. Fig. 2 is a central vertical section on line *y y*, Fig. 1, showing the circulating-pump located between tanks A and H instead of as in Fig. 1 and also showing the primary condenser in central vertical section. Fig. 3 is a view similar to Fig. 1, showing a modification.

Referring to Figs. 1 and 2, A B C D E F G H represent a series of tanks arranged in a circle. *a b c d e f g h* are coils of pipe located in said tanks, said tanks and coils being adapted to serve alternately as refrigerating and condenser tanks and coils. 1 2 represent the terminals of said coils, terminals 1 being all connected with a reservoir or pipe I, from which the liquefied gas is expanded into the coils when used as refrigerator-coils and into which the liquefied gas from the coils serving as condensers is discharged to take the place of that being expanded in the refrigerator-coils.

3 represents expansion-valves located in each of the terminals 1.

Each of the terminals 2 is connected by means of a branch pipe 4 with pipe J, which conveys the exhausted or expanded gas from the refrigerating-coils to the inlet of the compressor K. 5 represents a controlling-valve in each of the branch pipes 4. Each of the terminals 2 is also connected by a branch pipe 6 with pipe L from the outlet of the compressor, from which the compressed gas is conducted through the primary condenser-coil *m* in tank M to such of the coils *a b c d e f g h* as may be temporarily used as secondary condenser-coils. 7 represents controlling-valves in each of said branch pipes 6.

8 represents by-pass pipes connecting each of the terminals 2 with the terminal 1 of the next succeeding coil, 9 representing a controlling-valve in each of said pipes 8.

10 represents a circular overhead track on which travels a truck 11, suspended from which is a bucket 12 with a perforated bottom. This bucket is adapted to be lowered into the refrigerating-tanks and to screen out the loose finely-divided ice floating on the top of the solution and to drain the same, after which the ice is dumped into one of the tanks being used as a condenser.

14 represent outlet-pipes located at the bottom of each of the tanks A B C, &c., and provided with valves 15 and elbows 16, which can be turned so as to discharge the solution and crystals from the refrigerating-tanks into the circular basin 17 or so as to discharge the contents of the condenser-tanks into the drain 18. From the basin 17 the solution drains off into the well 19, from which it is drawn through pipe *n* and forced by pump 20 through pipe 21 into one of the refrigerating-tanks. 22 represents valves directing the solution to the desired tank.

The mode of operation is as follows: Two or more of the tanks—say B C, Fig. 1—are selected to act as secondary condenser-tanks, and three or more—say D E F G H—are selected to act as refrigerator-tanks. The com-

pressor is started and valve 3 of tank D opened, permitting gas from pipe I to expand into coil *d*, from which it is preferably passed through pipe 8 to coil *e*, and thence in like manner to coils *f g h*, and from thence through branch 4 to pipe J and to the compressor, from which the gas, after being compressed, passes through outlet-pipe L, through the primary condenser M, which is supplied with cooling-water entering through pipe 24 and escaping through pipe 25, whereby the bulk of the heat is removed. The compressed gas then passes along pipe L and through branch pipes 6 to the coils *b c*, which are supplied with cooling-water and ice from the refrigerating-tanks, the gas being liquefied therein and gravitating to the reservoir or pipe I. One tank—say A—may be out of use for repair or having been emptied is ready to receive a supply of the solution and to be connected in as a refrigerating-tank. After the tanks D E F G H have been refrigerated for a sufficient length of time a thick coating of ice forms on the coils, which is heaviest on the first coil *d*. When this coating becomes sufficiently heavy, the loose ice is carefully removed from the top of the solution in tank D and deposited in tank C. Then the valve 15 is opened and elbow 16 turned to discharge the solution and crystals into basin 17, where the crystals remain, and the solution drains into the well 19, from whence it may be pumped through pipe 21 into any one of the tanks from E to A. Valve 15 is now closed and valve 3 of coil *d* closed until valve 9 between *d* and *e* has been closed and valve 3 of coil *e* opened, making tank E the first of the series of refrigerating-tanks. Valves 7 and 3 of coil *d* are now opened, letting in the warm gas from pipe L, thereby melting the ice from coil *d*. Valves 3 and 7 of coil *b* are now closed and the condensing-water from tank B discharged through valve 15 into drain 18, thereby getting tank B ready to receive a fresh supply of solution. The condenser-tanks C D are supplied with surface ice from the refrigerating-tanks from time to time by means of bucket 12, the surplus condenser-water overflowing from the condenser-tanks through overflow-pipes 26 into drain 18. Fresh solution is supplied from time to time through pump 20 to compensate for the ice removed. In this manner each tank in succession becomes alternately a refrigerating and a condenser tank, and there being a comparatively large number of refrigerating-tanks, each successively of slightly-higher temperature, enables me to obtain very low temperatures in the first tanks of the series with ultimate economy, since the gas enters the compressor at a comparatively high temperature after having passed successively through the series of refrigerating-tanks, and by long continued refrigerative action the great bulk of each charge of solution is congealed at each operation and comparatively little requires to be transferred to another tank by the pump.

In treating certain solutions it becomes important to regulate the temperature in the successive refrigerating-tanks to separate two or more substances from each other, as well as from the solvent, which can be done by connecting said tanks or coils, or part of them, in parallel series—that is, by opening valves 3 and 5 of each temporary refrigerating-coil and closing valves 7 and 9 of the same—the circulation being thus controlled and changed at will to obtain the desired temperature.

In the modification shown in Fig. 3 the tanks A′ B′ C′ D′, &c., and coils *a′ b′ c′ d′ e′ f′* are arranged in parallel rows, with the supply and discharge pipes located between them. I′ represents the reservoir-pipe and J′ the pipe to the compressor. Terminals 1′ are provided with expansion-valves 3′ and terminals 2′ with branches 4′, 6′, and 8′ and valves 5′, 7′, and 9′. M′ *m′* represent the primary condenser and L′ the pipe from the compressor. 30 represents pipes leading from each of the valves 15 to a well or screening-receptacle 31, in which the crystals are separated and drained on a screen-partition 32 and the solution returned by pump 20′ to the refrigerating-tanks through pipes 33, controlled by valves 34. 35 represents a loop line of pipe connecting the several tanks together and provided with controlling-valves 36 37. This pipe taps the tanks about midway between their top and bottom, and its object is to enable the operator to transfer either the solution from one refrigerating-tank to the other or fresh water from one condenser-tank to the other, thereby permitting the fresh warm solution to be first introduced into the last of the series of refrigerating-tanks, where it is first cooled and then transferred by pipe 35 to the other refrigerating-tanks as desired. In the case of the condenser-tanks all the ice is supplied to one condenser-tank, and the water due to the melting thereof is allowed to flow through the other condenser-tanks and then waste through one of the pipes 38, which are provided with valves 39 for this purpose. The operation, with the exception of the foregoing changes, is substantially the same as that of Figs. 1 and 2.

I have not shown the insulation employed on the several tanks and pipes, as it may be variously arranged and adapted thereto to prevent undue loss by radiation.

I claim—

1. In combination with a gas-compressor a crystallizing apparatus comprising a series of refrigerating tanks and coils; a series of condenser tanks and coils, refrigerant supply and discharge pipes leading to and from the same, and a series of valve-controlled branch-pipe connections, whereby said tanks can be converted from refrigerating to condensing tanks or vice versa as desired, substantially as specified.

2. In a crystallizing apparatus, the combination of a series of refrigerating tanks and coils, and a series of condenser tanks and coils, means for supplying compressed gas thereto, and discharge-pipes leading therefrom, a series of branch-pipe connections between the same, and means for controlling said several pipe connections, whereby said several refrigerating and condenser tanks can be converted one for the other, and can be connected either in tandem or parallel series, as desired, substantially as specified.

3. In combination with a gas-compressor, a liquefied-gas reservoir, a discharge-pipe leading to the compressor, and a return-pipe leading from the compressor, a series of crystallizing-tanks, a series of coils located therein and each provided with valve-controlled branches connecting them respectively with the reservoir, the discharge and the return-pipe, and a series of valve-controlled branch pipes connecting each of said coils with the succeeding one in the series, substantially as and for the purpose specified.

4. In a crystallizing apparatus in combination with a gas-compressor, a liquefied-gas reservoir, a discharge-pipe to the compressor and a return-pipe therefrom, a series of crystallizing-tanks, a series of coils located therein, and each connected by valve-controlled branch pipes respectively with the reservoir, the discharge, and the return-pipe, means for drawing off the solution and crystals into a separating and draining compartment, and means substantially as shown for returning the solution to any one of the crystallizing-tanks to be further acted upon, substantially as specified.

5. In a crystallizing apparatus in combination with a series of crystallizing-tanks adapted to serve alternately as refrigerator and condenser tanks, means substantially as shown for drawing off the crystals and solution, and separating said solution, a pump and valve controlled pipe whereby the separated solution can be returned to any one of the crystallizing-tanks, and a valve-controlled pipe connecting all of said crystallizing-tanks together whereby said solution can be transferred from one of said tanks to any one of the others substantially as specified.

6. In a crystallizing apparatus a gas-compressor, a liquefied-gas reservoir, a discharge or exhaust pipe leading to the compressor, a return-pipe from the compressor containing compressed gas, a series of crystallizing-tanks, a series of coils located therein and each connected by means of valve-controlled branch pipes with said reservoir, said discharge-pipe, and said return-pipe respectively, and a primary condenser interposed in said return-pipe between the compressor and crystallizing-tanks, substantially as specified.

7. In a crystallizing apparatus a gas-compressor, a liquefied-gas reservoir, a discharge-pipe leading to the compressor, a return-pipe from the compressor, a series of crystallizing-tanks provided with means for drawing off the crystals and solution at the bottom thereof, a series of coils located in said tanks and each provided with valve-controlled branch pipes connecting said coils respectively with the gas-reservoir, the discharge-pipe, and the return-pipe, whereby each of said tanks and coils is adapted to be alternately employed as a refrigerator and condenser, substantially as specified.

8. In a crystallizing apparatus in combination with a series of crystallizing-tanks adapted to serve alternately as refrigerator and condenser tanks, means substantially as shown for drawing off the solution and crystals and separating said solution, and a pump and valve controlled pipe whereby the separated solution can be returned to any one of the crystallizing-tanks, substantially as specified.

9. In a crystallizing apparatus a gas-compressor, a liquified-gas reservoir, a series of crystallizing-tanks, a series of coils located therein, each connected at one end to said reservoir and provided with a regulating-valve, each coil also being connected at the opposite end by means of valve-controlled branch pipes respectively with the inlet and outlet pipes of said compressor, a series of valve-controlled branch pipes connecting each of said coils with the opposite end of the next succeeding coil, and a primary condenser interposed in the outlet-pipe of the compressor between the compressor and crystallizing-tanks, substantially as specified.

10. In a crystallizing apparatus in combination with a gas-compressor and a liquefied-gas reservoir a series of crystallizing-tanks, a series of coils located therein, each of said coils being connected respectively by means of valve-controlled branch pipes with said reservoir, and with the inlet and outlet of said compressor, a series of valve-controlled branch pipes connecting each of said coils with the next succeeding coil, a primary condenser interposed in the outlet-pipe of the compressor between the compressor and crystallizing-tanks, means substantially as shown for drawing off the crystals and solution and separating the solution, a pump and pipe connections therefrom to the several crystallizing-tanks whereby said solution can be returned to any one of said tanks, substantially as specified.

11. In a crystallizing apparatus a gas-compressor, a liquefied-gas reservoir, a discharge-pipe to said compressor and a return-pipe therefrom, a series of crystallizing-tanks a series of coils located therein, each of said coils being connected respectively with the said reservoir, and with the discharge, and return-pipes, a series of valve-controlled branch pipes connecting each of said coils with the succeeding coil of the series, and a primary condenser interposed in the return-pipe between the compressor and said crystallizing-tanks, substantially as specified.

12. In a crystallizing apparatus a gas-com-

pressor, a liquefied-gas reservoir, a discharge-pipe to said compressor and a return-pipe therefrom, a series of crystallizing-tanks a series of coils located therein, each of said coils being connected respectively with said reservoir, said discharge, and said return-pipe, a series of valve-controlled branch pipes connecting each of said coils with the succeeding coil of the series, and means for removing the detached ice from the solution in said crystallizing-tanks, substantially as specified.

13. In a crystallizing apparatus a gas-compressor, a liquefied-gas reservoir, a discharge-pipe to said compressor and a return-pipe therefrom, a series of crystallizing-tanks, a series of coils located therein, each of said coils being connected respectively with said reservoir, said discharge, and said return-pipe, a series of valve-controlled branch pipes connecting each of said coils with the succeeding coil of the series, and a valve-controlled pipe connection between said several crystallizing-tanks, whereby the solution can be transferred from one of said tanks to any other one of said tanks, substantially as specified.

Signed by me at Cincinnati, Ohio, this 5th day of October, 1898.

CASPER W. MILES.

Witnesses:
OLIVER B. KAISER,
WM. C. PEIRCE.