No. 763,089. PATENTED JUNE 21, 1904.

W. E. CRANE, DEC'D.

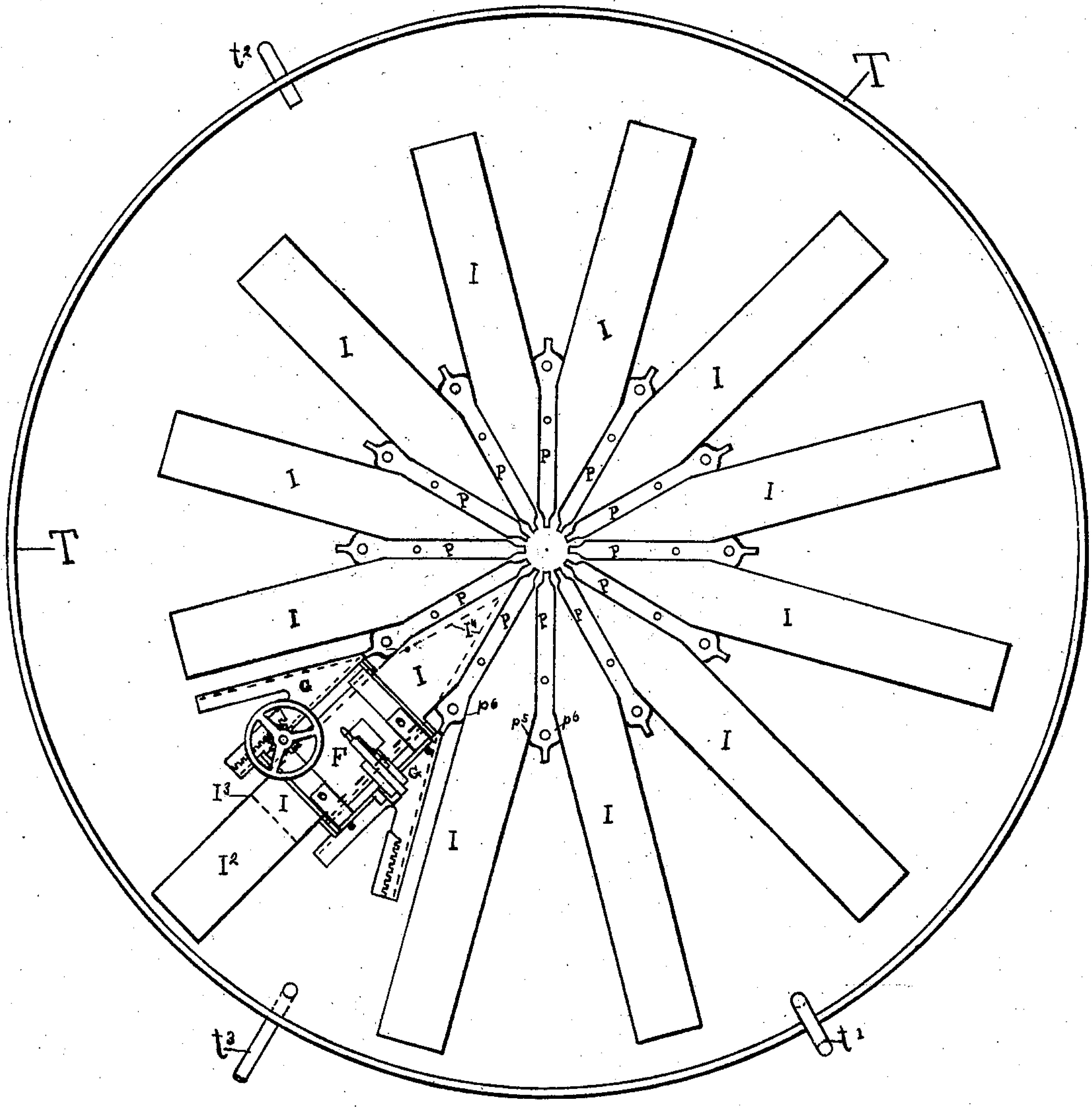
A. R. JOHNSON, ADMINISTRATOR.

APPARATUS FOR THE PRODUCTION OF ICE.

APPLICATION FILED SEPT. 18, 1899.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.



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Geo. W. Kittredge

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BY Walter E. Crane, ATTORNEY.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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NO MODEL. 3 SHEETS—SHEET 2.

Fig. 3.

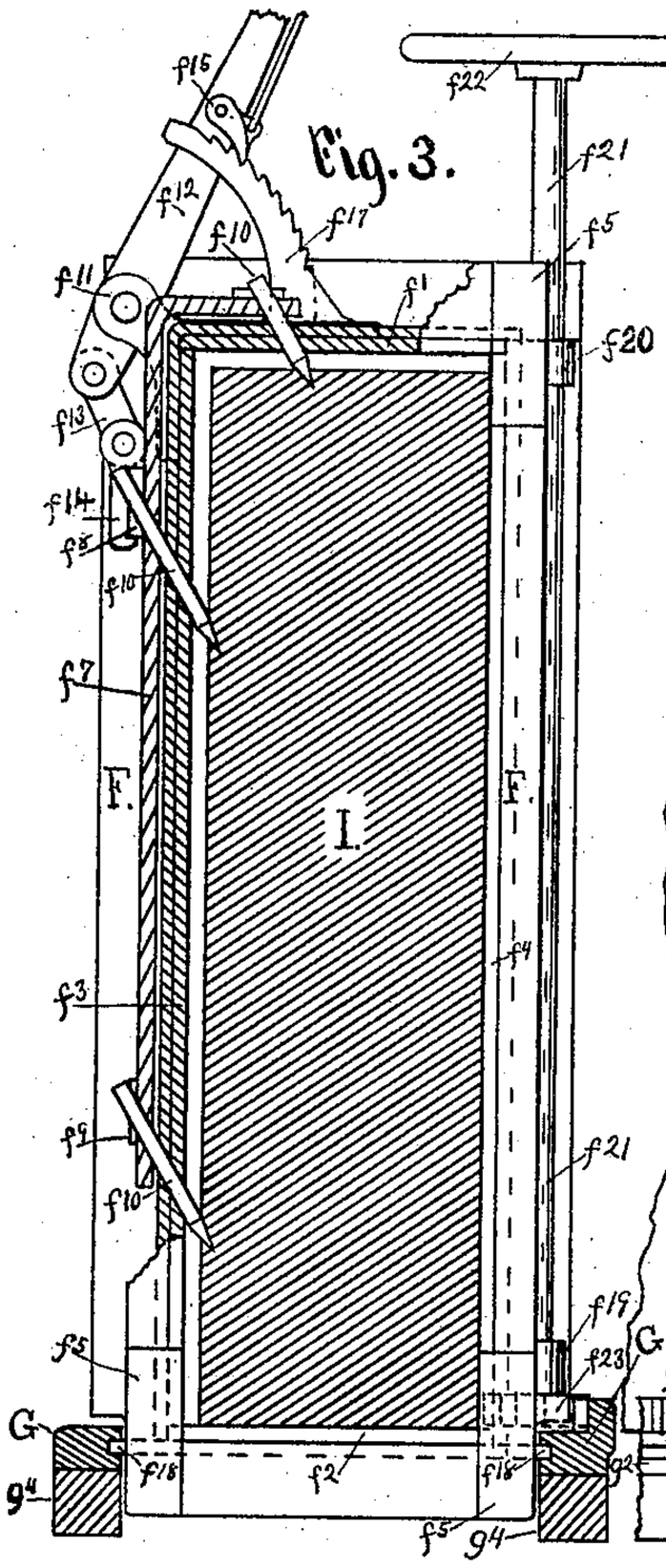


Fig. 2.

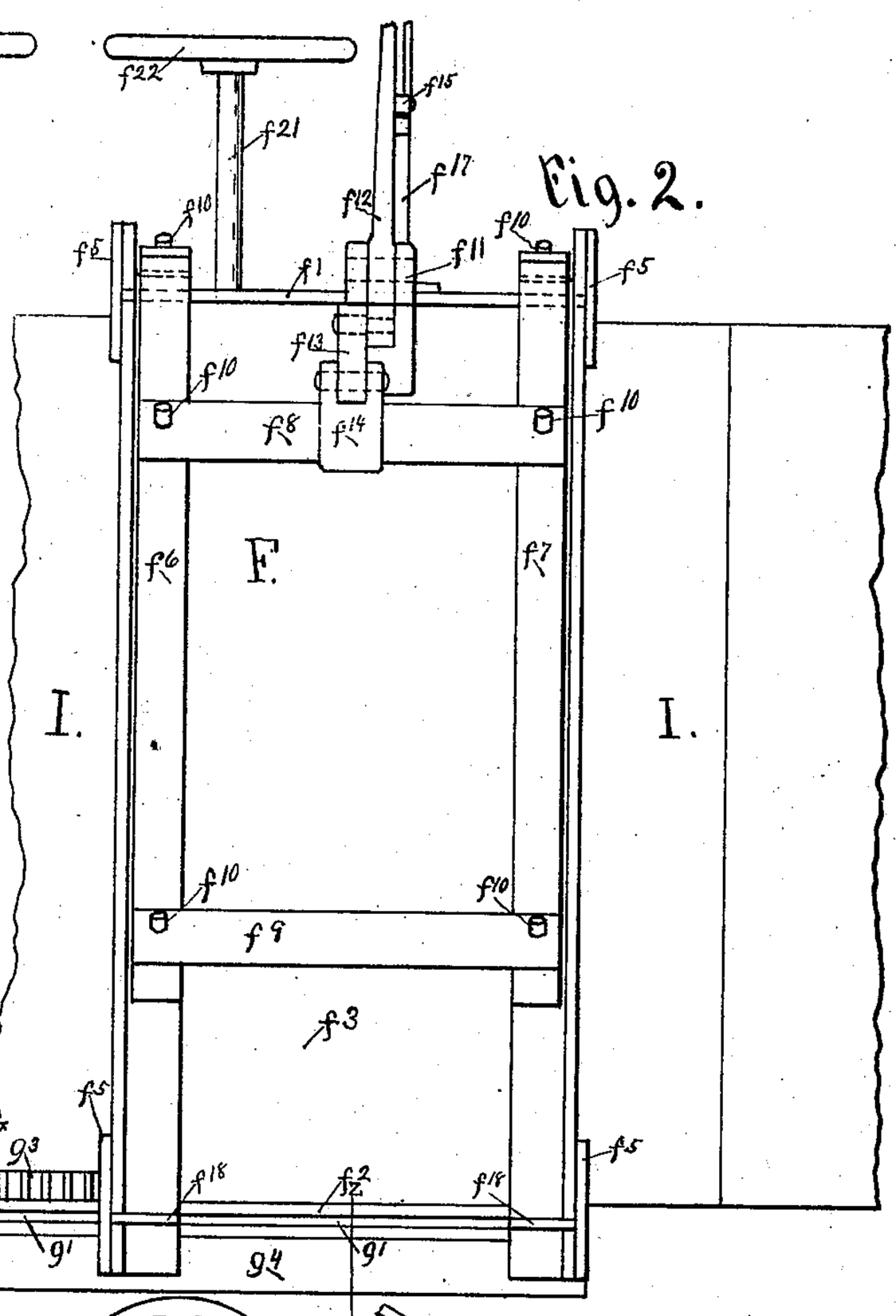


Fig. 5.

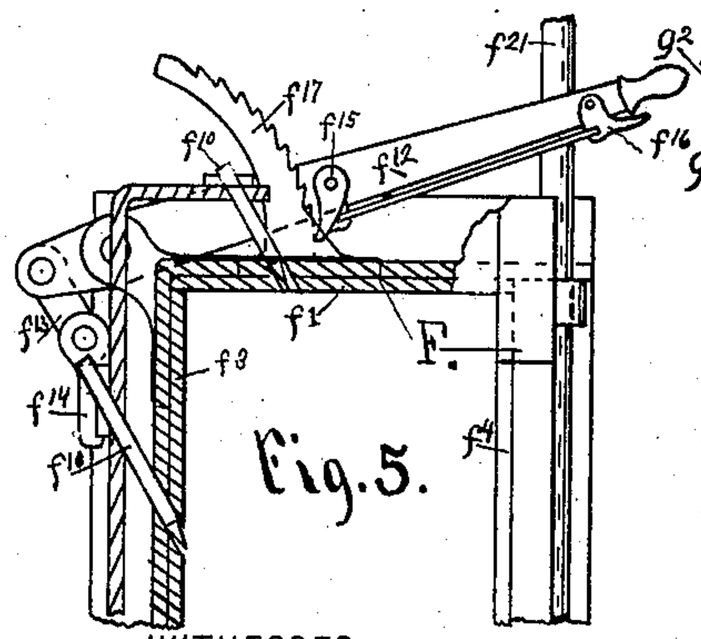
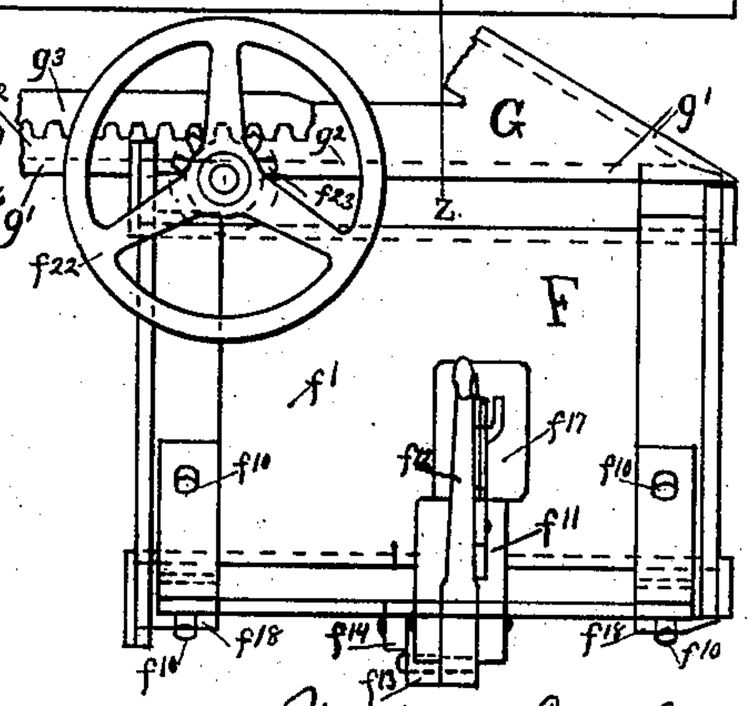


Fig. 4



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NO MODEL. 3 SHEETS—SHEET 3.

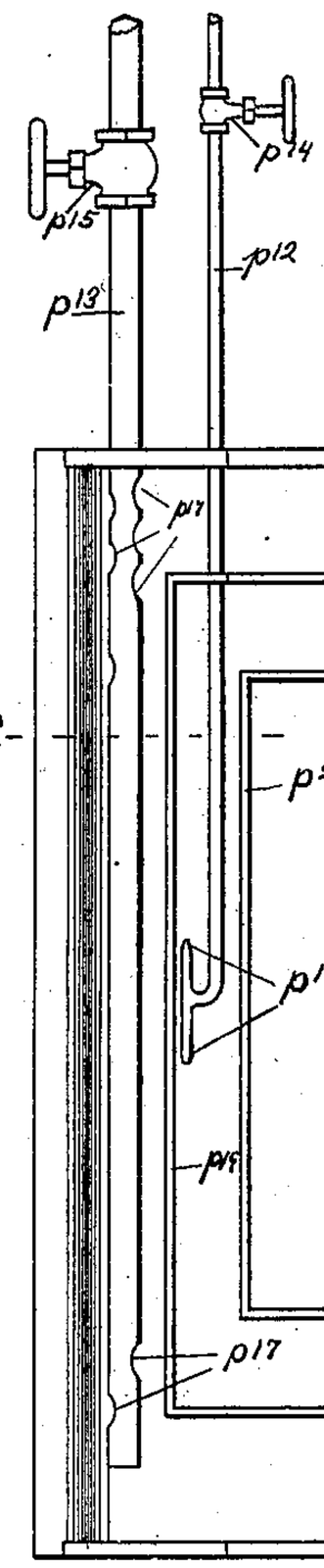

Fig. 8.

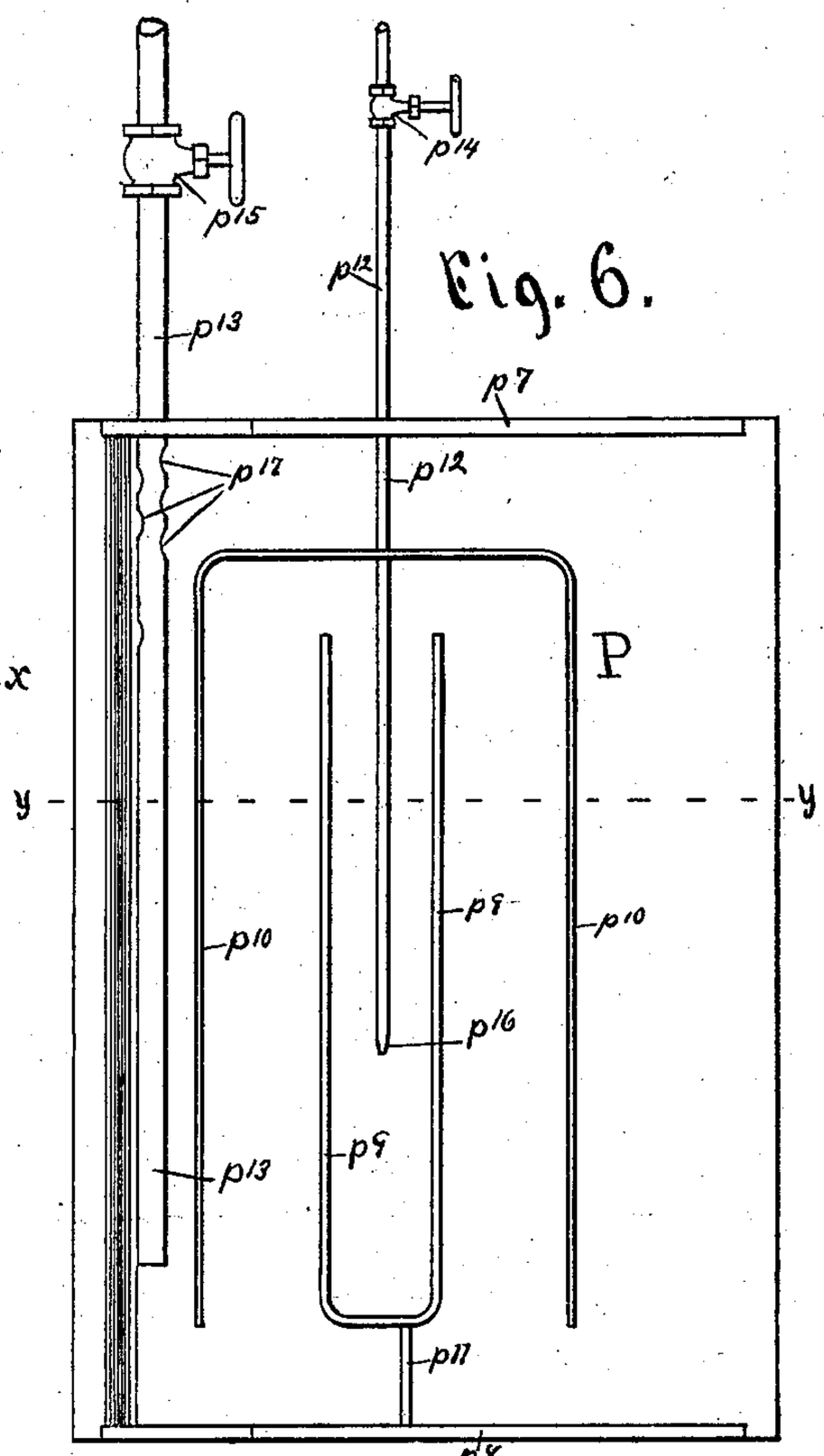

Fig. 6.

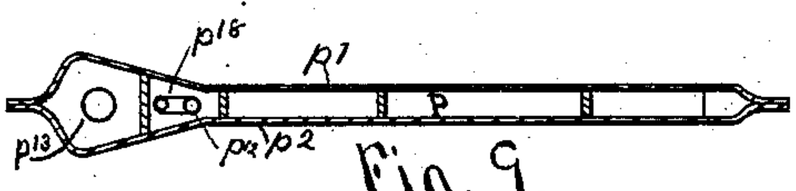

Fig. 9.

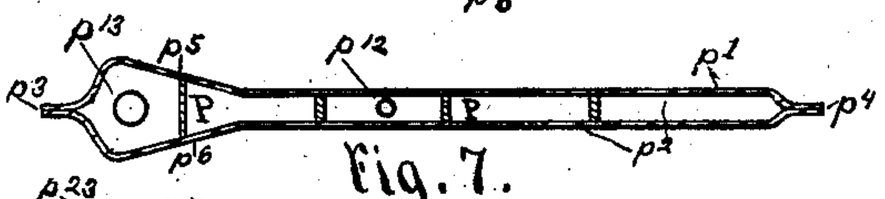

Fig. 7.

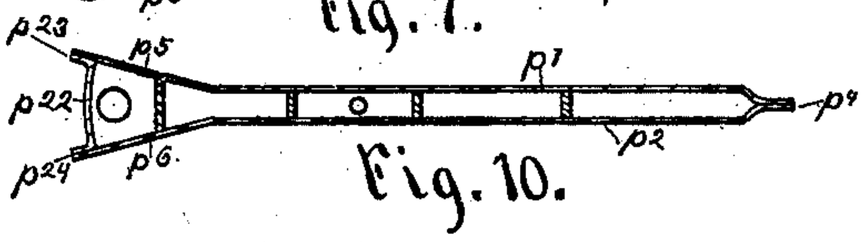

Fig. 10.

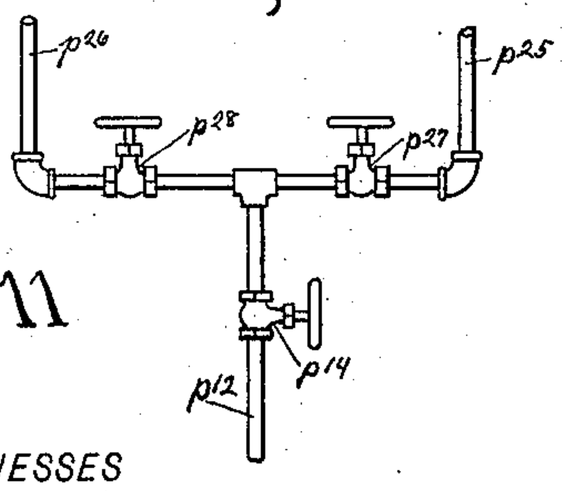

Fig. 11

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No. 763,089. Patented June 21, 1904.

UNITED STATES PATENT OFFICE.

WALTER ELIPHALET CRANE, OF MINNEAPOLIS, MINNESOTA; A. ROLAND JOHNSON ADMINISTRATOR OF SAID CRANE, DECEASED.

APPARATUS FOR THE PRODUCTION OF ICE.

SPECIFICATION forming part of Letters Patent No. 763,089, dated June 21, 1904.

Application filed September 18, 1899. Serial No. 730,911. (No model.)

To all whom it may concern:

Be it known that I, WALTER ELIPHALET CRANE, a citizen of the United States, residing at Minneapolis, in the county of Hennepin and State of Minnesota, have invented certain new and useful Improvements in Apparatus for the Production of Ice, of which the following is a specification.

My invention relates to the production of ice in merchantable cakes or commercial form by "artificial means," so called, by repeatedly freezing successive thin additional layers to the so-called "formative end" of the cake being formed.

Generally stated, this invention has for its object to provide an improved apparatus for carrying out a novel process or method, which will incidentally appear in the following description, but which is the subject-matter of a separate application, filed as a division of this original application and bearing Serial No. 738,293, filed November 27, 1899, entitled "Method of producing ice."

It is a known fact that the resistance of ice to the passage of heat increases about in proportion to the square of its thickness or the distance through which the heat is to be conducted. It therefore follows that ice five and one-half inches thick, for example, would offer about four hundred and eighty-four times as much resistance to the passage of heat as ice one-fourth of an inch in thickness and one hundred and twenty-one times as much as ice one-half an inch in thickness. Again, a layer of ice one-fourth of an inch in thickness may be easily frozen in two minutes, while it requires to freeze to the center of a can of ice eleven inches thick or to freeze progressively five and one-half inches, for example, sixty hours in ordinary practice. Hence it is of course desirable for the sake of economy in time, cost, and space to limit to a minimum the distance through which heat must be conducted in the progressive formation of the ice cakes. My improved apparatus, hereinafter described, has been designed to especially accomplish this result.

In accordance with the desired ends above indicated several of the more specific objects of my invention may be briefly stated, as follows:

First. To provide a practical and efficient means for freezing on successive additional layers at the formative end of the cake. This object I accomplish by the provision, in connection with freezing-plates, of means for successively lowering and raising the temperature of said plates below and above the freezing-point and means for intermittently moving the progressively-formed cakes of ice away from the freezing-plates by short steps of movement immediately after the last frozen layer of the cake is thawed loose from the said freezing-plates.

Second. To form a series of ice-molds with the freezing-plates so disposed as to obtain the maximum efficiency with the resulting minimum of waste by radiation of heat, to so construct and arrange such freezing-plates that the impurities of the water will not be caged or caught in the freezing process, with the result that the ice is left pure, and to effect an economy in space occupied by the series of molds. These objects I accomplish by the provision of wedge-shaped molds formed between divergently and vertically disposed freezing-plates that are common to adjacent molds. These wedge-shaped molds are placed in a water tank or receptacle below the water-level thereof, and to secure the best results the bottom of the freezing-plates should be terminated some distance above the bottom of said tank and the upper end below the water-level, so as to permit the free circulation of the water and the escape of the impurities.

Third. To provide a form of freezing-plate in which the freezing will be slightly more rapid at the central or intermediate portion thereof, so that the impurities in the water will be forced outward and ejected from the region wherein the freezing of the water is taking place. This I accomplish by forming the hollow freezing plate or member with ingress and egress passages and with expansion chambers or compartments that progressively increase in capacity from the point of ingress to the point of egress.

Fourth. To provide an apparatus for the manufacture of ice in which the operation is very rapid, with the result that a large quantity of ice per day may be turned out or produced from a comparatively small and inexpensive plant, thereby making possible the production of ice at a comparatively low cost.

Other minor objects and features of my invention will appear in the detailed description of the apparatus.

The invention consists of the novel devices and combinations of devices heretofore noted and to be hereinafter noted, and to be particularly set forth in the claims.

The invention is illustrated in the accompanying drawings, wherein, like characters indicating like parts throughout the several views—

Figure 1 is a plan view of the circular freezing-tank, showing the series of twelve freezing-plates, also the twelve cakes of ice being formed, and one of the controlling-frames with its guides. Fig. 2 is a side elevation of one of the controlling-frames with a portion of a cake of ice inclosed therein. Fig. 3 is an end elevation, partly in section, of the so-called "controlling-frame" or "ice-controlling" frame shown in Fig. 2, showing the means for securing the cake of ice in the frame. Fig. 4 is a plan view of the controlling-frame, showing also a portion of one of the guides which support it in position in the tank. Fig. 5 is a view similar to Fig. 3 of a portion of the controlling-frame, showing the securing device in a released position. Fig. 6 is a vertical elevation of one of the hollow freezing-plates with the front side of the same removed to show the arrangement of the pipes and partitions of the interior. Fig. 7 is a sectional view of a freezing-plate on line $y\ y$ of Fig. 6. Fig. 8 is an elevation similar to Fig. 6 of a freezing-plate, showing the partitions and inlet-pipe in a modified form. Fig. 9 is a sectional view of a freezing-plate on line $x\ x$ of Fig. 8. Fig. 10 is a section view of a freezing-plate, showing a modified form of constructing the outer shell of the plate. Fig. 11 is a view of the inlet or outlet pipes (which may be similar) for the freezing-plates, showing the valves for the alternate admission or exit of the freezing or thawing agents.

The freezing-plate P, Figs. 1, 6, and 7, is a hollow rectangular plate of a length fully as great as the length of the cake of ice it is desired to make, and its outer shell or exterior is constructed, preferably, of two thin sheets of metal p' and p^2, bent, as shown, so as to be riveted together at the two vertical edges of the plate p^3 and p^4, and also of two end pieces p^7 and p^8 at the top and bottom of the plate and through which the side plates p' and p^2 are also riveted together. At such a distance radially outward upon the plate P (see Fig. 1) as will make the divergence between the surfaces of two adjacent plates equal to the thickness of the cake of ice it is desired to make, as eleven inches thick, the plates p' and p^2 are bent outward at an angle one-half as great as the angle between adjoining plates that this portion p^5 and p^6 of the plate may lie approximately parallel with the sides of the cake of ice I. The width of this slanting portion p^5 and p^6 of the plate P is made about equal to the necessary movement of the cake outward to produce the desired separation of the cake I from the freezing-plates P. The shaping of the plates thus is to insure the side surfaces of the cake being made smooth. The end pieces p^7 and p^8 of the plate P are so shaped as to conform to the shape of the opening between the side plates p' and p^2, Fig. 7, and the riveting together of these four parts to constitute the exterior of the plate is to be so done as to make the plate perfectly gas-tight.

Secured in any desired manner, as by screws or rivets, to the interior of one or both of the plates p' and p^2 are partitions p^9 and p^{10}, bent U-shaped, and also partition p^{11}. These partitions are of the same width as the end pieces p^7 and p^8 and are intended to make approximately tight joints with the side plates in order to effectually direct the movement or flow of the refrigerific element.

Projecting down through the top end piece p^7 of the plate P are the inlet-pipe p^{12} and the larger outlet-pipe p^{13}, which are provided with suitable stop-valves p^{14} and p^{15}, and these pipes are made perfectly tight where they pass through the top end piece p^7.

One object of the partitions p^9 and p^{10} is to partially confine the ammonia or other refrigerific agent used as it first expands at the entering-nozzle p^{16} by means of the partition p^9. Then let it flow into the larger space at both sides of partition p^9 and nearly inclosed by the partition p^{10}, then into the still larger space outside of that inclosed by partition p^{10}, thus not allowing the expansion to take place wholly at one spot and providing also for a nearly uniform circulation within all parts of the plate P. With the above arrangement of the partitions within the plate there will still be somewhat greater expansion of the refrigerific element in the vicinity of the center of the plate than toward the edges thereof, and this is desired to a certain degree in order that the freezing of the "additional layers" may be first completed at the center and then progress rapidly outward, that the impurities will be discharged rather than imprisoned and frozen in. The outlet-pipe p^{13} receives and conducts away from the plate P the fully-expanded ammonia-gas or other refrigerific element and has holes or perforations p^{17} for the reception of the gas, as well as the opening at the lower end of the pipe.

In Fig. 8 is shown a modified form of construction of the partitions within the plate P, in which the refrigerific element is admitted to the plate through a double nozzle p^{18} into

the gradually-expanding compartments inclosed by the E-shaped partitions p^{19} and p^{20}. The partitions p^{21} are designed to divert a portion of the refrigerant to the extreme central right-hand portion of the plate.

In Fig. 10 is shown a modified form of construction of the plate P from that shown in Fig. 7, in which the side plates p' and p^2 terminate at the edge of the slanting portion p^5 and p^6, and instead of their being bent so as to be secured together, as at p^3, they are connected by a separate piece flanged at both edges p^{22}, through which they are riveted or otherwise secured to the side pieces at p^{23} and p^{24}. The advantage of this form over that shown in Fig. 7 lies chiefly in the ease and convenience of construction.

Fig. 1 shows twelve of these freezing-plates P placed on suitable supports and arranged equidistantly spaced in a circle about a common center and concentric with the circular tank T, in which they are placed. This tank T is of sufficient depth to have the plates P set up from the bottom upon the timbers g^4, Figs. 2 and 3, which also support the guides G, as will hereinafter be explained, and in addition is deep enough to allow of the complete submerging of the plates P without overflowing the tank. With the freezing-plates thus raised from the bottom of the tank T the cakes of ice I will be formed entirely above the sediment in the water which accumulates in the bottom portion of the tank. The tank T is provided with a supply-pipe t', through which water, preferably cooled nearly to the freezing-point, is admitted and kept at the proper level in the tank. The tank is also provided with an overflow-pipe t^2, which leaves the tank at the distance from the top where it is desired to maintain the surface of the water. The tank is also supplied with one or more discharge-pipes t^3, leaving the tank at the bottom, by means of which the settlings may be drained off from the bottom of the tank or by which the tank may be entirely emptied for the purpose of washing it out or to obtain access to any of the ordinarily submerged parts. Located opposite each opening between the freezing-plates where the cakes of ice are formed are twelve controlling-frames, (only one of which is shown in Fig. 1,) by means of which the cakes of ice are held in proper position with reference to the freezing-plates and are moved radially to separate the cakes from the plates after each successive freezing operation. This controlling-frame has an opening through it in a radial direction of sufficient height and width to freely admit through it a cake of ice as large as may be frozen by the freezing-plates. This controlling-frame F is composed of top plate f', bottom plate f^2, and side plates f^3 f^4, which are properly secured to the inner side of two end frames, composed, preferably, of side and end strips of angle-iron. These angle-iron frames are secured together at the corners by small plates f^5. The controlling-frame F is provided with a securing-frame composed of the bent bars f^6 and f^7, connected together by the bars f^8 and f^9, and in these are securely fixed the spikes f^{10}. A support f^{11} is secured to the top of the controlling-frame, and in this is fulcrumed a lever f^{12}, which is connected by link f^{13} to a casting f^{14}, secured firmly to cross-bar f^8 of the securing-frame. The lever f^{12} is provided with a pawl f^{15}, connected in the usual manner with handle-piece f^{16}, and to the top of the frame F is securely fastened a sector f^{17}, provided with notches for engagement with the pawl f^{15}. The lever f^{12} extends above the floor (not shown) of the tank T, and by means of it the operator may easily secure the cake of ice within the frame F by placing the lever in the position shown in Fig. 3 or release the cake of ice by placing the lever in the position shown in Fig. 5, which shows the securing-spikes withdrawn from the cake of ice. In operation the frame F is released from the cake of ice immediately after the two additional layers have been frozen fast to the cake, is then moved a short distance toward the center of the tank, and is then again secured to the cake of ice. The cake of ice is then thawed loose from the freezing-plates I by first cutting off the refrigerific fluid and then letting a relatively warm gas or fluid for a short interval of time circulate through the said so-called "freezing-plates." The cake of ice is then, by means of the frame F, moved the proper short distance away from the freezing-plates. The movement of the cake of ice separates it from the freezing-plates sufficiently for the formation of the successive additional layers of ice. The frame F is provided with projections f^{18}, extending outward from the sides at the bottom in position and adapted to project into grooves g' in the sides of the guides G, Figs. 1, 2, and 3. The guides G are made double—that is, a right and a left guide together in the form of a V—and are firmly secured to the top of timbers g^4, which are placed in the bottom of the tank for the support of the guides G and the freezing-plates. The guide g^2 for the left side of the frame F has formed integral therewith a raised portion provided with the vertical teeth or rack g^3, and the frame F is provided with bearings f^{19} and f^{20}, in which is mounted an upright shaft f^{21}, having secured to it a hand-wheel f^{22} and pinion f^{23} in position and adapted to engage with the rack g^3, and by means of these the frame F is moved by the operator after each freezing operation, as beforementioned. The securing-spikes f^{10} pass through the holes in the frame F, and therein act as guides for the movement of the securing-frame when moved by the lever f^{12}. For the sake of greater clearness the guides G and timber g^4 in Fig. 3 are both

shown in section, as at line *z z*, Figs. 2 and 4. The tank T is made of sufficient diameter to allow of the extension of the cakes of ice I to such a distance radially from the frame F as will admit of a block of ice of a desired width, (as twenty-two inches,) I^2, being sawed off or otherwise severed from the continuous cake being formed by any suitable means, (not shown,) approximately where shown by the dotted line I^3. As one after another of the cakes of ice attain the proper length they are severed by the operator and the separated cakes removed by any suitable means from the tank.

Fig. 11 represents an arrangement of the admission-pipe p^{12}, which is provided above the stop-valve p^{14} with a T and opposite branch pipes p^{25} and p^{26}, each having an admission or regulating valve p^{27} p^{28}. One pipe, as p^{25}, connects with the supply of liquid ammonia or other refrigerific element, and the other pipe, p^{26}, connects with a thawing agent, as heated expanded ammonia-gas or other fluid or gas having a temperature above the freezing-point. The arrangement of the exit-pipes may be exactly the same as to branches and valves as those for admission. During the continuance of the freezing operation the valve p^{14} is open, the valve p^{27} partially open or regulated to admit the proper amount of refrigerific element, and the valve p^{28} closed to shut out the thawing agent, while the valves of the exit-pipe are in a similar position. At the time of completion of the freezing operation the valve p^{27} is closed and the valve p^{28} opened and regulated to allow the admission of a proper amount of the thawing agent, and the valves of the exit-pipes are similarly reversed to deliver the warmer or thawing agent instead of the expanded refrigerific element to its appropriate receptacle.

If deemed desirable, the twelve inlet-pipes for the whole series of freezing-plates may be joined together and combined to form the pipe p^{12}, that they may be manipulated simultaneously and as one. The exit-pipes may also be joined and operated as a unit. As a matter of convenience it may be deemed desirable to connect the inlet and outlet pipes, respectively, into two or three groups for the series, that the attention of the operator may be given to the manipulation of the controlling-frames more promptly after the thawing loose of the freezing-plates.

The series of ice-controlling frames F may be said to alternate with the series of freezing-plates, as they occupy intervening radial positions with reference to the freezing-plates. The freezing-plates being arranged equidistantly disposed in a circle from the center of which they radiate, they are therefore uniformly divergent one from another. The cake of ice as it is formed from between the diverging freezing-plates is wedge-shaped, and this wedge-shaped end of the progressively-formed cake may be said to be the "formative" end of the cake. In virtue of the fact that the freezing-plates which form the wedge-shaped molds are vertically disposed and are set slightly above the bottom of the tank and below the level of the water, thus leaving the mold open at its top and bottom, permits the natural circulation of the water due to convection, and hence in "freezing on the additional layers" the impurities of the water are free to settle or to float from the freezing zone up to the very last stage of these comparatively short operations. Those impurities which settle may be drawn off from the bottom of the tank from time to time and an additional supply of fresh water substituted for the water wasted by this operation. Likewise those impurities which float may be skimmed from the surface of the water within the tank, and it will be understood that the water in the tank will be kept at such a level that it will fully cover or submerge the freezing-plates.

It will of course be understood that the apparatus above described is capable of a large range of modification in construction within the scope of my invention. I do not, of course, limit myself to any definite number of freezing-plates in the series or circle or to the circular or radial arrangement thereof, as the number might be greater or less than shown in the drawings, and the said freezing-plates might be differently disposed, although there are advantages in the circular or radial disposition of the said plates. Also, so far as the broad idea of my invention is concerned, the so-called "adjusting-frames" for moving the cake of ice progressively might be very considerably modified.

The timbers g^4, which support the freezing-plates and the guides in the tank, are cut down for the guides, the portion which supports the freezing-plates being of substantially the same height as the top of guide G, as shown at the left side in Fig. 3. This brings the bottom end of the freezing-plates on a level with the lower edge of the cake of ice formed thereby.

It will be further understood that many modifications of the construction above described may be made within the scope of my invention.

What I claim, and desire to secure by Letters Patent of the United States, is as follows:

1. In an apparatus for the production of ice in cakes, the combination with a tank adapted to contain the water to be frozen, of a series of separated, vertical, radiating, substantially flat freezing-plates, fixedly sustained below the water-level of the said tank, and forming the water into V-shaped portions between the adjacent plates of the series; a like series of ingress and egress pipes connecting the said plates respectively with the refrigerific element; and an auxiliary series of pipes in position and adapted to enable substitute connec-

tion to be made at will, of the said plates with a thawing element.

2. In an apparatus for the production of ice in cakes, the combination with a tank containing the water to be frozen, of a series of separated, radially-disposed, hollow freezing-plates, each having substantially parallel principal surfaces, and fixedly secured in vertical position submerged in the said water; ingress and egress passages connecting each of said plates primarily with a refrigerific element, and secondarily with a thawing element; and means substantially as described for sustaining and advancing V-shaped cakes of ice from the said plates.

3. In an apparatus for the production of ice in cakes, the combination with a tank containing the water to be frozen, of a series of radially-disposed, separated, vertical, hollow freezing-plates, fixedly submerged in the said water; ingress and egress refrigerific communication with each of said plates; substitute thawing-element communication with each of said plates; a series of radial guides alternating with said freezing-plates; and a like series of sustaining and controlling frames mounted in the said guides, and adapted to alternately hold and advance the cakes of ice progressively formed by the said freezing-plates.

4. In an apparatus for the production of ice in cakes, the combination with a tank adapted to contain the water to be frozen, of a circular series of separated, vertical, hollow freezing-plates fixedly sustained beneath the working water-level of said tank; ingress-passages from the source of supply of a refrigerific element to the central portion of each of said freezing-plates; return-passages from the outer portion of each of said plates; substitute circulatory passages from each of said plates to a source of supply of a thawing medium; and means substantially as described, for sustaining and intermittently advancing the cakes of ice progressively formed in the divergent openings between the adjacent plates of the series.

5. In an apparatus for the production of ice in cakes, the combination with a tank containing the water to be frozen, of a series of radially-disposed, separated, vertical, hollow freezing-plates, fixedly submerged in the said water; ingress and egress refrigerific communication with each of said plates; and substitute ingress and egress thawing-element communication with each of said plates, the said communications being in position and adapted for greater refrigerific activity in the central portion of the plates.

6. In an apparatus for the production of ice in cakes, the combination with a tank containing the water to be frozen, of a radiating series of separated, vertical, substantially flat freezing-plates submerged in the said water, forming it into V-shaped portions between the adjacent plates of the series and allowing free communication between the said V-shaped portions of water and the water in the exterior and top and bottom portions of the tank, and limited communication with the water in the center of the same; ingress-passages from a source of supply of a refrigerific element to the central portion of each of said freezing-plates; return-passages from the outer portion of each of said plates; and the same being all arranged in suitable operative positions with reference to V-shaped blocks of ice supported with their diverging faces in juxtaposition to the principal surfaces of said plates, that the freezing from said plates to said blocks of ice shall be first completed in the central portion, expelling impurities toward and past the edges of the cakes of ice being formed.

7. In an apparatus for the production of ice in cakes, the combination with a tank containing the water to be frozen, of a radiating series of separated, vertical, substantially flat freezing-plates submerged in the said water; ingress and egress refrigerific communication with each of said plates; substitute circulatory thawing-element communication with each of said plates, the same being in suitable operative relation and position to a like series of blocks of ice having V-shaped inner ends, supported with their diverging faces in juxtaposition to the principal surfaces of said plates; and minor inclined surfaces of the said plates, each substantially parallel with the mating surface of the adjacent plate, and contiguous to the parallel sides of the inclosed block of ice.

8. In an apparatus for the production of ice in cakes, the combination with a tank containing the water to be frozen, of a series of stationary separated, vertical, diverging freezing plates or members of rectangular hollow form, radially disposed to form a series of wedge-shaped molds or openings, the said plates being common to the center of the tank and forming vertical walls of adjacent molds, in which cakes of ice are progressively formed.

9. In an apparatus for the production of ice in cakes, the combination with a tank containing the water to be frozen, of a horizontally-disposed series of independent, stationary, submerged freezing-plates radiating from a common center of said tank, to form intervening molds for the water to be frozen while the same is in free communication with the water in the tank.

10. In an apparatus for the production of ice in cakes, the combination with a tank or receptacle for the water, of a series of freezing-plates radiating from a common center within said tank and forming a series of wedge-shaped molds, having vertical walls, and an alternating series of radially-movable ice-supporting frames, substantially as described.

11. A hollow freezing plate or member having ingress and egress passages and expansion-

compartments progressively increasing in capacity from the point of ingress to the point of egress.

12. A hollow freezing plate or member having an ingress-passage opening into the intermediate portion of the same, and an egress-passage opening from the marginal or outer portion of the same, and having interior expansion-compartments intermediate of said passages increasing in holding capacity from the former to the latter, substantially as described.

13. In an apparatus for the production of ice in cakes, the combination with freezing plates or members constructed with a central admission and successively larger compartments to their outlet, providing greater refrigerific activity at their center and intermediate portions, of circulating connections thereto for alternately admitting to said plates a refrigerific and a thawing medium.

14. In a hollow freezing-plate, the combination with the side and end plates thereof, of a U-shaped central partition; an inlet-pipe projecting into the space within said partition; an inclosing U-shaped partition about the open end of said partition; and an outlet-pipe communicating with the space outside of said inclosing partition, to provide duplex expanding circulatory passages for the refrigerific element.

15. In a hollow freezing-plate, the combination with an inlet-pipe opening at or near the central portion of the plate, of duplex expanding compartments extending from the central portion to the exterior portion of said plate, and an outlet-pipe in connection with said exterior portion, substantially as described.

16. In an apparatus for the production of ice in cakes, the combination with a guide provided with a parallel rack, of an ice-controlling frame mounted thereon; a wheel and pinion engaging with said rack; ice-supporting sides at right angles with each other in said frame; a series of spikes adapted to sustain a cake of ice against said supporting sides; and a lever for projecting and withdrawing said spikes at will.

WALTER ELIPHALET CRANE.

Witnesses:

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O. F. GUSTAFSON.