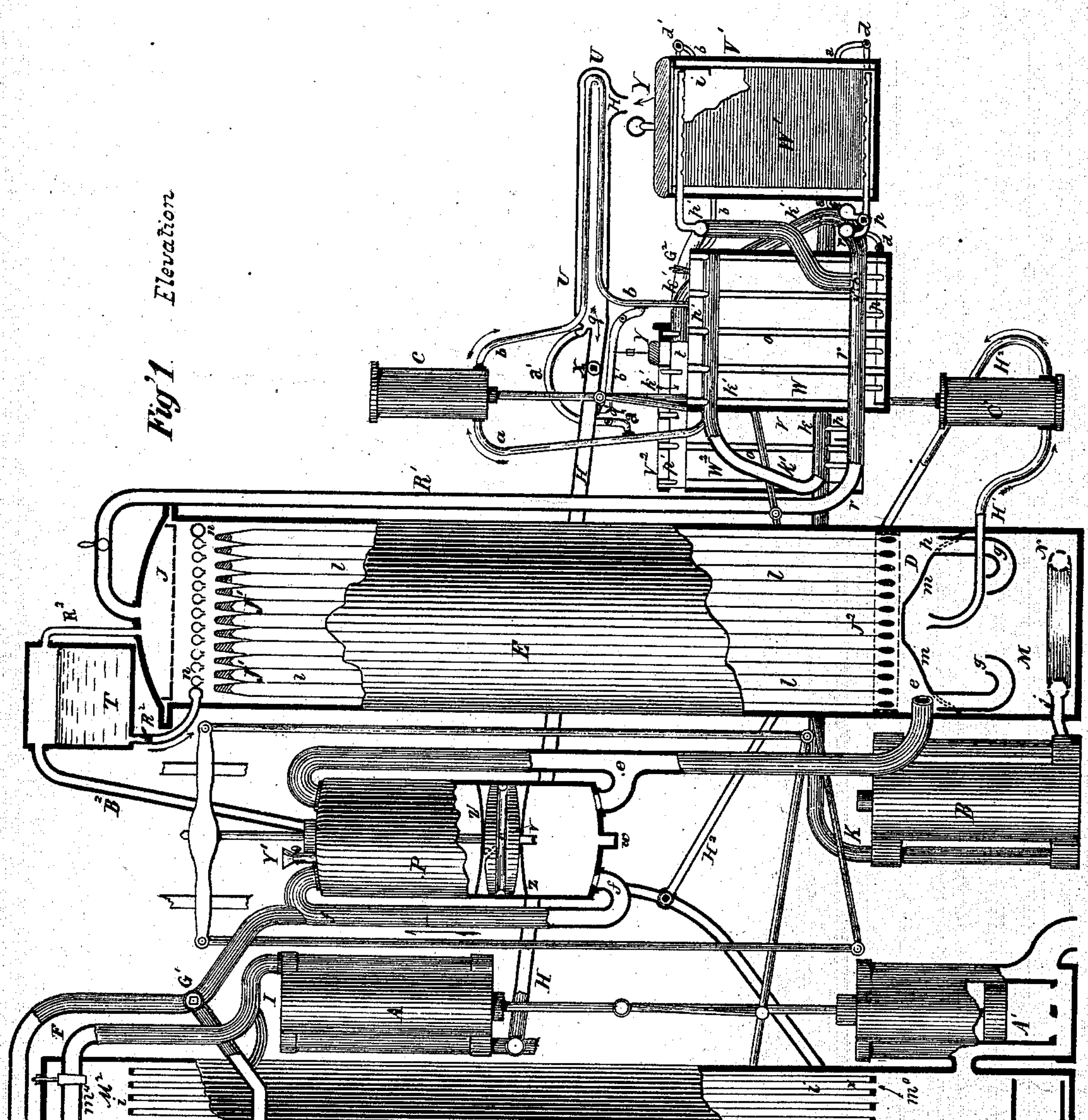
2 Sheets--Sheet 1.

A. C. TWINING.
Ice-Machines.

No. 146,621. Patented Jan. 20, 1874.



Witnesses
A. M. Catlin
James Hadley

Inventor
Alex C. Twining

2 Sheets--Sheet 2.

A. C. TWINING.

Ice-Machines.

No. 146,621. Patented Jan. 20, 1874.

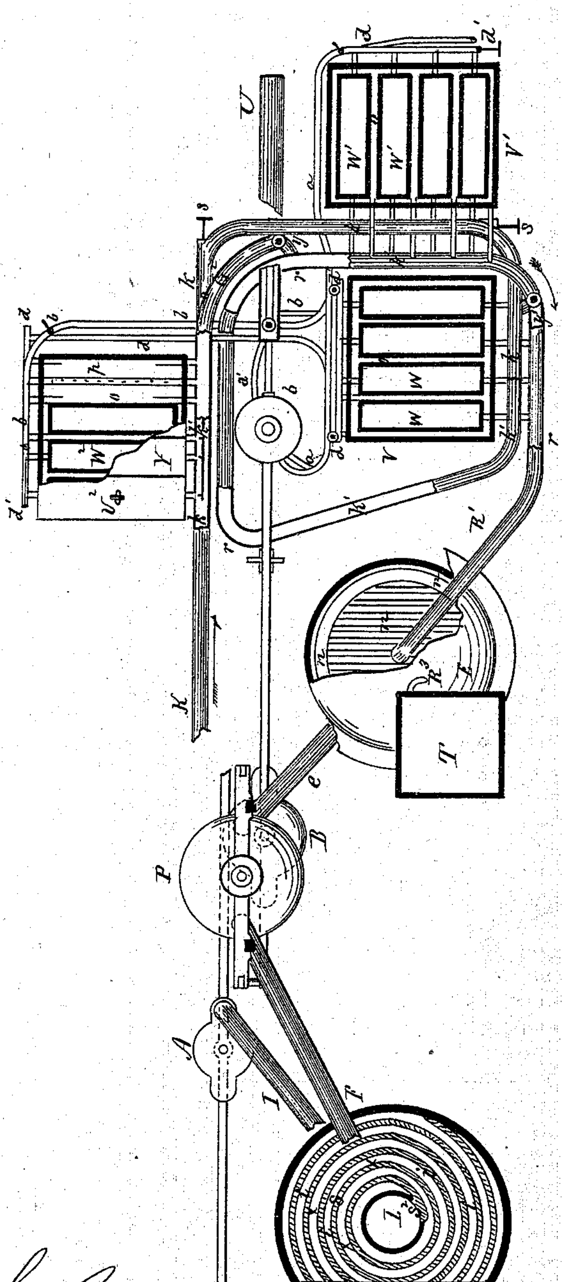


fig. 2 Ground Plan

Witnesses

J. M. Catlin

James Hadley

Inventor

Alexr C. Twining

AM. PHOTO-LITHOGRAPHIC CO.N.Y. (OSBORNE'S PROCESS)

UNITED STATES PATENT OFFICE.

ALEXANDER C. TWINING, OF NEW HAVEN, CONNECTICUT.

IMPROVEMENT IN ICE-MACHINES.

Specification forming part of Letters Patent No. **146,621**, dated January 20, 1874; application filed June 6, 1872.

To all whom it may concern:

Be it known that I, ALEXANDER CATLIN TWINING, of the city and county of New Haven and State of Connecticut, have invented a new and Improved Ice-Machine; and I hereby declare that the following is a full and exact description of my said improvement and invention, to wit:

The machine will produce the cold by the evaporation and recondensation of a volatile liquid, insoluble or but sparingly soluble in water, during mixture or contact of the same with salt-water, or other solution or medium, which last is cooled by contact with the first during the evaporation. Then the salt-water or medium so cooled, is made to circulate around receptacles or water-chambers containing water to be frozen, and is to be returned to the cooling-vessel to be cooled anew, all essentially, in this respect, as explained in an application for a patent heretofore made by me, and also as further explained herein. The foregoing word "medium" is and will be herein used exclusively to signify the liquid or solution, of whatever description, that is cooled in an evaporating vessel or process, and circulated as above described. But my improvement herein consists in the particular way, means, or parts for the operation and freezing effect thus generally above referred to.

Figure 1 is a view of the parts in elevation, and Fig. 2 is a ground plan of the same.

The cooling-vessel or refrigerator, in which the evaporation of the volatile liquid goes on, is E. The evaporation is effected by a double-action pump, P, which draws or receives vapor out of E, through the inlet-pipe and valves *e e*, and forces the vapor out through the exit-pipe and valves *f f*. Compression of the vapor, received as above, goes on alternately above and below the piston of the pump; and in order to prevent, as effectively as possible, any escape of the compressed vapor between the piston and the inner surface of the pump, and also to reduce friction between the same parts to the least possible, a channel, space, or spaces, *c*, all around the piston, is made to contain oil, glycerine, water, brine, or other liquid or solution for packing or lubrication, which liquid will fill any minute space or leak between the piston and the surface specified. But, because this liquid will in part escape or be forced into the chamber of the pump beneath the piston, the lower pump-head is made hollowing downward, and a small cylindric chamber, *w*, is provided in the middle to receive this escaped liquid flowing or delivered down into it. To make the flow or delivery the more complete and speedy, the flexible metallic or other plate *z* is fixed at its middle to the piston and beneath it, and has a less or a reversed curvature, compared with the interior surface of the pump-head which it comes upon, so that the rim of *z* will close first upon the exterior circle or part of the head, and then progressively close from the exterior to the middle, and force the liquid into *w*. The plunger *v* projects down from the middle of the piston, and fits snugly into the receptacle *w*, and so, in the latter part of the piston's descent, drives back the contained liquid into the groove *c* through the perforation which leads along the middle of *v*, as shown. If there should be an excess of liquid it escapes to the upper surface of the piston through a conduit or channel, shown by the dotted lines near and above *c*. This upper conduit should or may conduct to the rim or edge of the piston's upper surface, where a small depression may run around, and contain liquid of this same description and use. Regurgitation from *c* is prevented beneath by a small stop-valve in the conduit through *v*, and the same is prevented from above into *c*, if desired, by a stop-valve in the above-described conduit, leading upward; but it may be prudent, and it will be easily practicable, to make both these valves yielding to any force much greater than the compressive force of the vapor, so that an excess of liquid, if any, accumulated above the piston may be driven back by the gradual closing of the plate *z'* above the piston upon the upper hollowing surfaces of the latter. For it will be observed that, while *z* or *z'*, whether above or below, closes from rim to center upon the pump-head, they close from center to rim upon the piston's surfaces. As this lubrication liquid may waste a little through the inlet and outlet valves, a cup and cock, Y^1, should be provided to introduce a supply, as needed, into the upper chamber of the pump.

This method of packing a piston by a lubricating or other liquid, constantly supplied, may apply as well to the piston of the power-cylinder of the engine by which the pump P is worked as to that of the pump itself. The lower space or chamber M of the refrigerator is chiefly occupied by the medium, which must not hold the volatile liquid employed more than sparingly, at least, in solution. When the volatile liquid employed for evaporation is butyline, butyl, or any of the hydrocarbons lighter than the medium employed, the former will float and occupy the space *m*, whence it may be drawn off through the pipe H^1. Above all this there rests a grating, J^2, and in the higher spaces of E there rests another grating, J^1, composed of bars parallel to the bars of J^2, and vertically above the middle line of the spaces between the latter. Sheets or cloths *l* are extended between these lower and upper bars, and these cloths or sheets may be parted at top either way, so that each shall be fastened above to two contiguous bars, and a triangular trough be formed at top of each sheet; or these troughs may be separate and distinct parts, made of thin metal, or of canvas, or parchment, or of any suitable material, and in any suitable shape, and the cloths or sheets may be attached to them in any suitable way. The material of these troughs is either porous or else it is perforated by minute holes, so that a liquid discharged into the troughs will readily flow through both sides, and flood or saturate and run down both sides of each of the cloths or sheets. Immediately above J^1 is the hollow ring *n*, with cross-pipes parallel to the afore-described bars, and each pipe enters endwise either way into the ring, and receives the volatile liquid through it, and discharges the same liquid down through a fine slit along its bottom and a nipple running along each side of the slit and projecting down, as shown by the drawing. This slit in each instance runs along parallel to and vertically above the bottom line or angle of the trough formed by the cloths or sheets underneath. Again, there is a colander, J, immediately above *n*, spreading across the interior of E, and formed with holes in rows, each row being vertically above the middle of a pipe, *n*, and as many rows as pipes. These holes discharge the medium, equably distributed, down upon the pipes *n*, and the same runs down both sides of the pipes and the nipples, and falls, mixed equably and intimately with the volatile liquid, into the troughs, and the two liquids flow together down the cloths or sheets in films or minute drops, commingled or superimposed one upon another. For the colander there may be substituted any vessel, coil, or assemblage of pipes or parts full of orifices, so numerous, minute, and disposed in rows or otherwise, as to deliver the medium in fine drops, jets, or spray equably upon the ring and pipes *n*, or grating J^1, or the upper extremities or parts of the cloth or sheets; and the like substitution may be made for the ring and pipes *n*, relatively to the distribution of the volatile liquid, provided that the substitute or substitutes shall be so constructed and situated as to secure the equable intermixture of the volatile liquid with the mass of the medium, and also the equable distribution of the intermixture in the troughs, or upon the bars, or upper part of the cloths or sheets; but, because neither the intermixture nor the distribution can be absolutely equable, it is best that the volatile liquid should be present in excess. It is very easily understood that the drops or films of volatile liquid, being made cold by evaporation, as described, must impart cold to the medium with which they are in commixture or contact. The medium greatly exceeds in mass the volatile liquid, and it falls down, in union with any of the latter remaining unevaporated, upon the diaphragm D. This sinks on all sides so as to form a gutter, *h*, entirely around, and conduct the cold medium and residue of the volatile liquid to the pipes *g*, which pierce the diaphragm and open into the gutter. Through these pipes the mixed liquids runs down into M, and the lighter of the two rises to *m*, as above described.

The manner in which the volatile liquid is supplied to the hollow ring *n*, and the medium to the colander J, out of which, respectively, these liquids flow, as above described, will next be explained. In the mass M there is immersed a hollow ring, N, perforated with numerous holes, and out of this proceeds the pipe *j*, which conducts to the exhaust of the cold-medium pump B. This is shown double acting, and discharges through K into the freezing-cisterns V V^1 V^2, &c., hereafter described, in which the cold medium circulates around the water-chambers W W^1 W^2, &c., and whence the pumping-force sends it through *r* R^1 into the colander J; but the volatile liquid is collected in the receptacle T, whence it flows through the regulation-cock and the pipe R^2 into the ring *n*. The pressure above the liquid in T is kept equable with that in E by the communicating-pipe R^3. As fast as liquid is discharged through R^2, it is resupplied from the condenser or restorer R through B^2, and from *m* through H^1 and the pump C^1, which last draws volatile liquid from *m*, and discharges into B^2 through H^2, and thence into T. If the volatile liquid is heavier than the medium—as in case bisulphide of carbon is used—the ring N must occupy the upper part of the mass M, and the pipe H conduct out of the lower part.

The condenser R may be constructed in the ordinary manner of pipes for cold water flowing within them, to condense compressed vapor surrounding the pipes, or vice versa, in a tight vessel; or the same may be of any other suitable construction. The condensed vapor will be forced out of the bottom of R by the superior pressure in the latter vessel, through B^2 and its regulating-cock into T, as above.

For simplicity of construction and a greater effectiveness of performance, I have invented the form and arrangement of condenser shown in the drawing. In the middle of the tight and strong cylindric or other vessel R, a small cylinder or acute cone, L, may conveniently pass from the top far down to the bottom; and it may also receive either the water-pipe I, as shown by dotted lines at G, or the vapor-pipe F, as shown by the dotted lines and two-way cock at m^3. Also, on one side it has a vertical narrow slit, S^2, or series of openings into a channel between thin metallic sheets, soldered or tightly attached on the sides of the slit or series, and extending from the bottom of the central cylinder or cone nearly to its top, or as high as the under part of the space or compartment D^1 in the drawing. Both sheets together are then to be wound spirally around and around, but kept at an even and small distance apart by interposed strips or knobs between the sheets. In this way a spiral space, i, will be formed, as shown in the ground plan, while at the same time another spiral space, x, will be formed, exterior to or between the first. Both spaces are shown in the drawing, where the entire metallic coil, so formed with the spiral spaces, is denoted by S. The spiral space i is much narrower than x, and is designed to receive, through f F, the vapor from E, compressed into it by the pump P. But the spiral space x is meant to receive the circulating cold water from the cold-water pump A, through its discharge-pipe I. While i receives the vapor through L and S^2, the cooling or condensing water may come from I through a slit, S^1, in the shell of the restorer, as hereafter fully explained. The vapor, circulating spirally toward the circumference, falls condensed into the compartment m^1, into which i opens; but the water from S^1, circulating toward the center, descends into m^1, into which x opens. Or, by admitting the vapor from F' into S^1, as shown, and continuing the water-pipe into L, and thence into x, instead of i, by a proper and obvious construction or attachment of the metallic sheets, the above respective directions of the vapor circulation and the water circulation may be interchanged. In either case, the spaces i and x must, for this variety of operation, be closed at top completely, instead of only partially, as in the drawing, and also must be closed at bottom, except the limited entrances provided for i into m^1 and for x into M^1. Ordinarily, however, the spaces i and x may open into the upper chamber of R more advantageously than into L, (thence to F and I by the slits S^1 S^2,) as above described. For this purpose, and in order to isolate completely those spaces from one another, the diaphragm D^1 divides the upper space of R, above S, into two distinct compartments, m^2 and M^2, and the diaphragm D^2 in like manner divides the space below S into two compartments, m^1 and M^1. Of these compartments, m^1 and m^2 are open to i at the upper and lower openings or boundaries of that space, while, in like manner, M^1 and M^2 are open to x. Thus, the drawing shows i stopped from any opening into M^1, and M^2 and x stopped likewise from any communication with m^1 and m^2. Accordingly, the mode of operating (externally to L and without its use) is the following: Water drawn, as through H, from any source of supply into the cold-water pump A is received into M^2 through I and the cock m^4, passes down through x into M^1, cooling the metallic sheets on its way, and condensing the compressed vapor in i. This vapor, received from f F into m^2, pervades the space i and falls down, when condensed to a liquid, into m^1, whence it flows through B^2, as above. It should be observed that an equivalent construction for this same mode of operation would be to form and dispose the above metallic sheets into concentric cylinders, (with the spaces i and x between the sheets, relatively, as before described) increasing in diameter from the interior to the exterior of R, and closed from communication with the chambers on either side of D^1 and D^2 in like manner, as already explained; but the coil has the advantage of avoiding the long vertical solderings or joints of the cylinders, and, besides, the edges can be loosened, and the sheets uncoiled for cleaning from time to time with great facility. The chamber D^1 G around L illustrates yet another variation. Let, for example, the cock m^4 close I to M^2, and open it to that chamber. Into the same chamber x will also open by one at least of its coils, but is supposed in this, as in a former case, to be closed completely from M^2 as well as from m^2. Equally, also, is it supposed to be closed from M^1 as well as from m^1, except at one or two of the external coils, as at m^o. By this a water circulation is secured from the middle outward. There is shown also a slit, S^1, in the external shell of R, with which i communicates. This is covered by the box or half-cylinder L', into which the pipe F enters, being closed by the cock G' and diverted from m^2 to L'; then by closing i everywhere above and below, except a single coil, as M^o, opening into m^1, the gas may be made to expand spirally from exterior parts to central parts. Obviously, as before stated and described, the same would be true of the cooling water if x were connected with L', but closed everywhere above and below, except at some coil or two next to L and underneath; but, in what manner soever circulated, the water thrown in by A is discharged by the waste-pump A' after its cooling office is performed. This pump is exactly alike in shape and dimensions to A, and to work oppositely, either in manner substantially as shown by an attachment to one and the same reciprocating shaft, or in any other manner by which the effect shall be secured, that both pumps A and A' are at every instant equal and antagonistic to each other in the amounts of water received and discharged. This will prevent any possible rupture of the coils S by unequal hydraulic pressure. But, yet another essential to equalize pressures between the compressed vapor and the cooling water—in other words, between the two spaces i and x, or the chambers m^1 and M^1—is the office of the equalizer. This last consists of the smooth-bore cylinder C^2 and its free but snuglyfitting piston c^2. It is obvious that by this provision the pressure in m^1 or in i will always be propagated to the water in M^1, and vice versa. No matter, therefore, in respect to this, how thin the metal sheets of S may be, since a change of form cannot ensue in virtue of the interior pressures, whether by collapse or enlargement. However, there are other modes for the same cautionary prevention, of which the foregoing is simply a type or equivalent. Also, it is obvious that this above-described construction by coiled metallic sheets, or by concentric cylinders furnished with an equalizer, is just as applicable to the absorber or to the exchanger (so called) of an ammonia or Carrè ice-machine as to the above. In those uses the space x for the cooling water would be relatively less than in the drawing. In the first named of those uses, the space i being duly enlarged, would serve for the absorption, water and ammoniacal gas being emptied by an ammonia-pump forcing into the retort or boiler.

All the foregoing description has special reference to the operation and devices for producing the cold required; but what follows will have reference mainly to applying the cold medium, when and in whatever way refrigerated, and chiefly to applying it for the purpose of manufacturing ice. For this I provide any required number of tight freezing-cisterns, V V^1 V^2, &c., having re-entering water-chambers W W^1 W^2, &c., separated from one another, and from the cisterns by the surrounding channels o, through which the medium circulates. Of these cisterns, the first of the series, for the time being, is always considered to be the one which first receives the refrigerated medium from the refrigerating vessel or apparatus. For example, from E, as above described, the drawing shows a provision for pumping this medium by B through K into a pipe, k, traversing near and parallel to the lower front angle or edge of V^2, which, at this point of the description, is taken as the first cistern in the series. The flow is checked when near or opposite the far corner of V^2, and its course there diverted by a stop-valve worked by the rod and handle s. The small lateral pipes p receive it, each one alike, as nearly as may be, and discharge it upward through a series of small orifices directly beneath the middle and along the extent of the water-chambers W^2, thus causing the refrigerated medium to impinge equably and symmetrically upon the under surfaces of those chambers. From beneath the chambers it flows laterally into the vertical narrow receptacles o, and rises through them in a slow and even current. These rectangles or channels are surmounted or closed by pipes p' exactly or sufficiently similar to the foregoing p, and similarly perforated with orifices, which let in the medium from beneath, and conduct it to an external pipe, k', that extends parallel to k along and opposite to the upper front angle or edge of the cistern. Water filling the water-chambers of V^2 will thus have been refrigerated or frozen by the circulating medium, which last, on the other hand, will have become less cold and less refrigerating. It does not, however, pass immediately back to E to be refrigerated anew, but the pipe k' turns down or branches to the two-way cock y, which can close it, but which, in the position now or first considered, opens the way for it into a supply-pipe in front of the cistern V^1, exactly corresponding in situation, structure, dimensions, and office, relatively to that cistern, with k and its lateral distributing-pipe p, above described. And, for this reason, this supply-pipe is marked for that and every cistern by the same letter, k, as well as its valve and handle by s, and its lateral or distributing-pipes are marked p. Also, universally, the upper receiving-pipes and discharge-pipes, like the foregoing, are marked, respectively, p^1 and k^1, because they correspond with the like parts of V^2 in construction and office. Also, the channels o surrounding the water-chambers W^1 convey a circulation, and perform a refrigerating or freezing of the water in those chambers precisely corresponding to the like already described for V^2 and W^2, only less in degree. The drawing shows the second cistern, V^1, of the series, having its lateral receiving-pipes p conducting into o, and thence into k^1, which last, as described for the like preceding, turns down by its branch to the two-way cock y^1, opposite the rear end of the cistern V, next following. This, again, opens into the pipe k which runs near and parallel to the front bottom angle or edge of V, and has, like the others, its distributing-pipes p. The refrigerating medium, accordingly, circulates beneath and between the water-chamber, W, and refrigerates or freezes the water filling those chambers, precisely as before in V^1 and V^2, but less in rapidity of operation. The same medium then passes up by o, and along the distributing-pipes p^1, into the discharge-pipe of V, which, like those preceding, turns down and conducts the refrigerating medium into the lower pipes and the circulating channels of the next freezing-cistern, if such there is, and so on to the next cistern, and through the entire series of connecting cisterns, however numerous or however limited in number. But the last discharge-pipe of the series, for the time being shown as k' of the cistern V in the drawing, debouches into the discharge-pipe R^1 of the entire assemblage of cisterns, either directly or, as in the particular arrangement shown by the drawing, into pipes conducting to it, as hereafter described. The force of the circulation-pump B, propagated through the series and into R^1, throws the returned medium into the colander J at top of E, as before described. Now, when the water-chambers of the first cistern V^2 have become frozen up, that cistern must be shut off and detached from further operation, and V^1 must take its place as first in the series for the time being. To effect this detachment, turn the handle *s* properly, and the connected central rod, which is shown with its projecting arms, will revolve, at their extremities, certain covers that fit the curve of the bore of *k* and shut off from that frozen-up cistern V^2, the entrances of the pipes *p*. By the same movement a disk (not shown) at the extremity of *k* next to *s*, but which had performed as the stop-valve before referred to, will simultaneously revolve open and afford the refrigerating medium a passage past V^2 onto the front bottom pipe *k* of the next cistern V^1, thence into V^1 and through the channels *o* around the chambers W^1 and to the discharge-pipe *k'* of that cistern, thence turning down to the cock *y'*, which opens to the next succeeding cistern, and so on through the last of the series and to the pipe R^1, as hereinabove described.

When the water-chambers W^1 of this last-described cistern, V^1, have become frozen up, V^1 must, in turn, be detached from the series. This will be done by turning its handle *s* and the connected covers and terminal disk exactly as above described for V^2 and its pipes. By this manipulation V will have become, instead of V^1, the first operative cistern of the series. Meanwhile the ice-blocks of V^2 will have been loosened and removed, in manner, it may be, as hereafter described, and its chambers W^2 refilled with fresh water. Accordingly, this V^2 is now in preparation to be reconnected with the series of operative cisterns; but it will evidently, when so connected, be the last of that series considered respectively to the refrigerating performance. But this renewed connection cannot be made by opening the discharge-pipe of the preceding cistern V into the supply-pipe *k* of V^2, as in ordinary cases, because the latter pipe is already performing in the cold-medium circuit to supply V^2 and the series beyond. Therefore, let *k* of this and of every cistern be supplemented with a second pipe, *r*, in front of and parallel to them, respectively, and communicating with any desired branch of *k'* through *y* or *y'*, &c., which cocks can open the way from *r* to *k'*, and simultaneously shut off *k'* from *k*. All the distributing-pipes *p* are continued into this supplementary pipe, which may thus be made the supply-pipe, when *k* is shut off, and every cistern of the entire number is supplemented in this manner, as shown, and marked by *r* in the drawing, because every one will become frozen up and detached in turn. Also, every supplementary pipe is supplied with a handle, S, and a central rod, working covers for shutting the entrances of *p*, and a terminal disk for a stop-valve, in like manner as explained for the pipes *k*. The arrangement of these stops and valves is such that *r* of either cistern has its entrances *p* open, when the terminal stop-valve is closed, and vice versa. Therefore, the discharged medium from V, entering by the supplementary pipe *r*, circulates along the chambers of V^2 till discharged anew by *k'* of that last cistern to the cock *y* of the next cistern V^1; but, since that cistern V^1 is now in course of discharging its ice, and of refilling with fresh water, its communications *p* are to be kept closed, so that both *k* and *r* are shut off, for the time being, from V^1, although each, by itself, through its open stop-valves, conducts its own free current past that detached cistern —that is to say, the supply-pipe *k* conducts onward past the frozen cistern the cold current coming from K, and through the supply-pipe of V^2, but the supplementary pipe *r* conducts similarly the less cold current coming through *y* from the discharge-pipe *k'* of V^2, as described. In short, the mode of adjustment for the entire series at any and every stage of the operation is easily to be understood, as follows: Beginning at and with the detached cistern, let it be noticed that its supply-pipe *k*, and with it every like supply-pipe back to K, is closed or cut off from the cisterns; but, consequently, each one is open to the supply-pipe next following itself in the current's direction, and open, as well, each one to the supply-pipe next preceding itself all the way up to K, and including the supply-pipe itself, which joins or opens into K; but every supply-pipe, other than those last named, is open at once, and only to its own cistern and to the discharge-pipe *k'* of the cistern preceding it. Again, the supplementary pipe of every cistern, except the detached cistern, is in the opposite condition to that of the supply-pipe of the same cistern, in respect to being closed or open to the cistern.

The complete operation or performance will be the following: The newly-refrigerated current from E into *k* is cut off from, and so avoids, in passing, all the cisterns as far as to the one next following (in the current's direction) the detached cistern. It enters this first cistern, for the time being, of the operative series through the pipes *p*, and the circulation goes on progressively in that and the following cisterns around the water-chambers, and out through the respective discharge-pipes *k'* and into the next following supply-pipes *k*, in manner as before described. This progression continues through the supply-pipes up to R^1, or into and through the cistern whose supplementary pipe *r* (see V in the drawing) opens directly into or joins R^1; but, thence, the pipes *r* take up the supply, for the discharge-pipe *k'* of this last cistern conducts the current into the supplementary pipe of the next cistern, or that one (see V^2 in the drawing) whose supply-pipe *k* joins K immediately. This supplementary pipe *r* now takes the office of the supply-pipe; and the same is true of every supplementary pipe, into which the discharge-pipes successively open through *y y'*, &c., all the way to the cistern preceding the detached cistern, that being the last of the operative series for the time being. Beyond this last, in the current's direction, the supplementary pipes are shut off from the cisterns, but are open, one to another, all the way to R^1, through which, finally, the current or medium is returned to the evaporating or refrigerating vessel.

Another method of construction wherewith to accomplish the same purposes in an equally effective manner, would be to make the discharge-pipes k continuous from cistern to cistern, with a cock between each two continuous cisterns. Of these cocks only the one between the detached cistern and the cistern next preceding, or the last of the operating series, will be open. Being thus open, it will admit the discharge from the last cistern of the series to pass through k' of the detached cistern and flow into the supplementary pipe of the next cistern, or the first of the series, through the branch which would unite with y, as above described. The drawing shows this discharge-pipe continued (in the elevation) from V^2 to V^1, and furnished between the two with a cock, G^2. The cocks y, &c., would perform, as before, between r, k, and k'; but, by a varied or equivalent construction to the foregoing, an added function would be performed relative to and between r and k. This function would be to interrupt the continuity of r, and to divert the cold medium coming through it into k at and by the cock y of the first cistern of the series. To make this construction clear, let each supply-pipe, after traversing its own cistern's length, be permanently interrupted at its far extremity, instead of temporarily by a stop-valve; and let the handle S and its appurtenances be dispensed with, both in these and the supplementary pipes. Also, let the supplementary pipes r be continuous as one pipe, and form a prolongation of K in front of the whole series of cisterns, without direct connection with either of them, but only with cocks y y', &c., and with the supply-pipes at and through them. To operate this arrangement, let y of the first cistern of the operating series be so set as to interrupt r, but to open it to k in the part between y and K, and admit the cold medium from K to the cistern by that inlet, and let the same position or adjustment of that cock close the connected branch of k' to k, and open it to r on the side opposite to that of the inlet just above mentioned. The cold medium through r being interrupted at and by y, will turn into k and the distributing-pipes p of the first cistern of the series. It will circulate upward along the water-chambers, and through the discharge-pipe of that cistern to the supply-pipe of the second cistern of the series, and so on successively until it will have passed around and back to the detached cistern, and through its discharge-pipe and its branch down into r on the other side, or in advance of the interruption by y, and will find a free way to R^1 and the refrigerator.

It is hardly necessary to add that a substitute for the continuous pipe r, in the last-described arrangement, might be had in the use of two flexible tubes, one of the two to couple on and connect K with y of the first cistern of the operating series, and the other to couple upon and similarly connect R^1 with the branch of the discharge-pipe of the last of the series.

It remains to explain the manner and means in and by which the ice-cakes are detached from the disconnected cistern. First, they must be loosened from the water-chambers. This may be done by making the current—or a partial current—of the cooling water of the condenser or restorer circulate in the channels o beneath and around the chambers. For this, let each of the series of cisterns be furnished behind, both at top and bottom, with the two interrupted horizontal pipes d and d'. Of these the lower, d, is for an inlet of the circulating water, and the upper, d', is an outlet for its egress. The pipes p and p' are continued through and into this outlet and inlet, in like manner as before described for the front pipes k and k'. Let the water-pipe H be closed, or partially closed, by the cock X; and suppose V^1 to be the detached cistern from which the ice is to be removed. Attach the flexible tube a' to the water-pipe on the side from which the water is flowing, (see q,) and also to the conduit a leading to and joining the inlet-pipe of V^1. (See d.) Attach, also, a second flexible tube, b', to H on the side of X in the direction of the water's flow or current, (see q.) and also by the intervention of b to the exit-pipe d' of V^1. The operation will be that the water-current in H will be diverted into V^1 and its circulating channels, either wholly or partially, according to the degree of interruption afforded by the position of X. The warmth of the circulating waters will loosen the cakes in W^1, so that they may be withdrawn; but the small percentage of ice thawed will not be mainly a loss, because the cooling of the water of condensation will reduce the pressure in R, and, by so much, relieve the working pump.

In the above there is, however, this disadvantage, that the medium in the cistern will become mixed or incorporated with the circulating water, and be wasted, unless previously drawn off by an imperfect and laborious operation. Therefore I provide the separate circulation or medium pump C, whose outlet-pipe a conducts the circulated liquid into the particular part or segment of the inlet-pipe desired, which part is isolated for the time from every external pipe, except a, by turning the attached stop-cocks properly. Also, the inlet-pipe b conducts the same liquid (or "medium," since it is the same liquid or solution as that in E, and interchangeable with it) out from the proper segment of the exit-pipe d', which is isolated for the time and purpose, and corresponds with the like of the inlet-pipe, as above described. The pipe a or else the pipe b is so much prolonged or enlarged, in some part of it, as to hold a sufficient quantity of the medium to be circulated by C; and to keep this medium from being cooled down, the prolonged or enlarged part of it is surrounded by a swell, U, of H, so as to be enveloped in the fresh, and comparatively warm, water of condensation flowing into and through H.

For convenience in attaching *a* and *b* to their respective segments, the inlet and exit pipes *d* and *d'* may be constructed in isolated segments, like the separate supply and discharge pipes in front, before described. Then *a* may run along the inlet-pipes, parallel to them, and be connected by a stem and a cock with each segment, to be opened or shut off at pleasure. Next, it may turn and be connected similarly with the outlet-pipes or segments, and go on to *b*, and discharge into the latter. Of course, an interruption-cock must be provided in *a b*, to cut off communication between these inlet and exit branches. This system will correspond closely with the afore-described prolongation of K into the single and continuous supplementary pipe *r*, having interrupted or variable connections with *k*, through *y y'*, &c., and finally debouching into R^1. Every water-chamber, during refrigeration, is isolated on top from the external atmosphere by a wooden or other non-conducting cover, Y, fitting closely. In order to conveniently withdraw the cake after loosening as above, there is projected down from the cover a metallic or other tenacious and serrated or corrugated strip, *t*, attached one to each opposite narrow side of the cover. These strips are hooked or serrated deeply enough to hold the cake securely when frozen into its mass, as they will be at top. Then the cover and its attached cake will be lifted together, and the latter be easily detached by a blow; or the stock of the central lifting-ring of Y may be channeled or cut as a screw and turned out from the cake after withdrawal from the water-chamber. Immediately after being delivered of the ice, all the water-chambers will be refilled with water cooled previously, if practicable, and to the lowest temperature allowed by the cooling means at command.

What I claim in the above, and desire to secure by Letters Patent, is the following:

1. The combination, in a refrigerating or evaporating vessel, of the colander J or its equivalent, and the ring and pipes *n*, or their equivalent, with the sheets or cloths and an evaporating pump or apparatus, substantially as and for the purpose described.

2. In union with an evaporating pump or apparatus, the combination of salt water, or other equivalent medium, with a volatile or easily-evaporated liquid, not soluble, or but sparingly soluble, in that medium, and with trough-like spaces beneath to receive and to diffuse those liquids commingled upon both surfaces of the sheets, substantially as and for the purpose described.

3. In or with an evaporating vessel or refrigerator, the combination of the diaphragm D, the pipes *g'*, the discharge-pipe H^1, and a discharging-pump, substantially as described.

4. For condensing or restoring to its liquid condition the vapor of a volatile liquid, the vessel R, made with isolated spaces contained by thin metallic sheets, one of the spaces or series of spaces being closed or shut off from the condensing water, but open to the entrance of the vapor to be condensed, while the remaining space or series of spaces is closed or shut off from the vapor, but open to the admission of the cooling water, combined with a cold-water pump, or equivalent apparatus, and an equalizer, substantially as described; specially, in the same general combination, the construction described, by or with coiled or spiral sheets and spaces.

5. The combination, in a series of freezing-cisterns having water-chambers contained or bounded by circulation channels with the supply-pipes and discharge-pipes, or their equivalents, for equable distribution and circulation of a refrigerating medium, and with supplementary pipes or the continuous supplementary pipe described, or the flexible tubes equivalent to the latter pipe, and also with a pump or apparatus for circulation of the medium, or any combination substantially the same, and for the same purpose, as described.

6. The general system or combination for loosening the ice-cakes—that is to say, of inlet and outlet pipes and a pump circulating water or a medium of higher than freezing temperature—in the channels of cisterns having water-chambers contained or bounded by those channels, or any substantially the same, as and for the purpose described.

7. The means described, or any substantially the same, for drawing out the ice-blocks from the chambers—that is to say, a hooked or serrated strap or strips, bolt, or screw to be frozen upon or within the mass of ice and attached to a ring, handle, or cover above the chamber, which can be lifted to draw out the block.

8. The force-pump *w* for returning the escaped packing or lubricating liquid, in combination with the groove or space *c* upon or around the body or surface of the piston of a pump or working-cylinder, or any substantially the same, as and for the purpose described.

New Haven, May 31, 1872.

ALEXR. C. TWINING.

Witnesses:

J. M. CATLIN,

JAMES HADLEY.