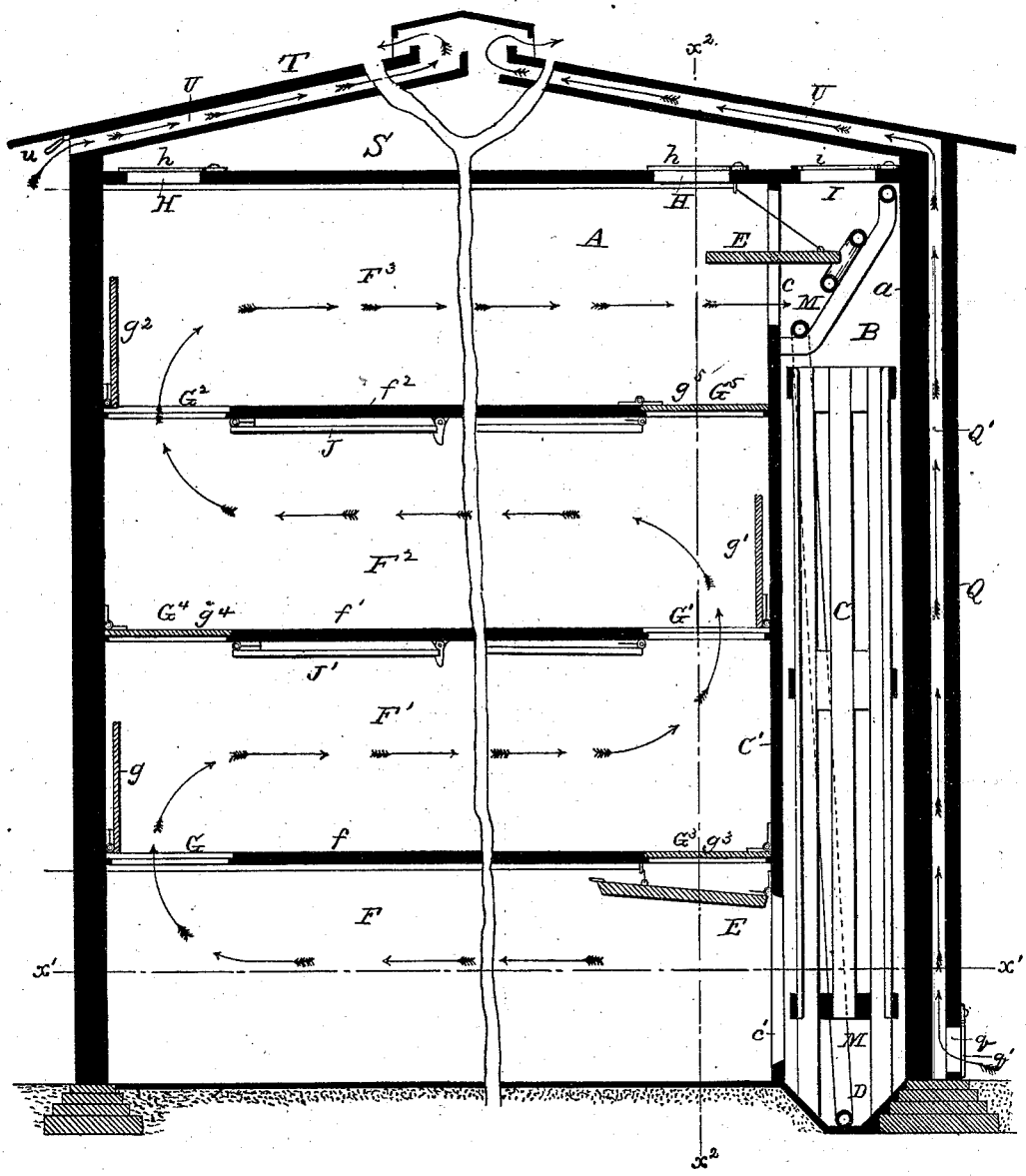
4 Sheets—Sheet 1.

DeW. C. SANFORD.

Refrigerating-House.

No. 217,552. **Patented July 15, 1879.**

FIG. 1.



ATTEST:

Saml. S. Boyd
Paul Bakewell

INVENTOR:

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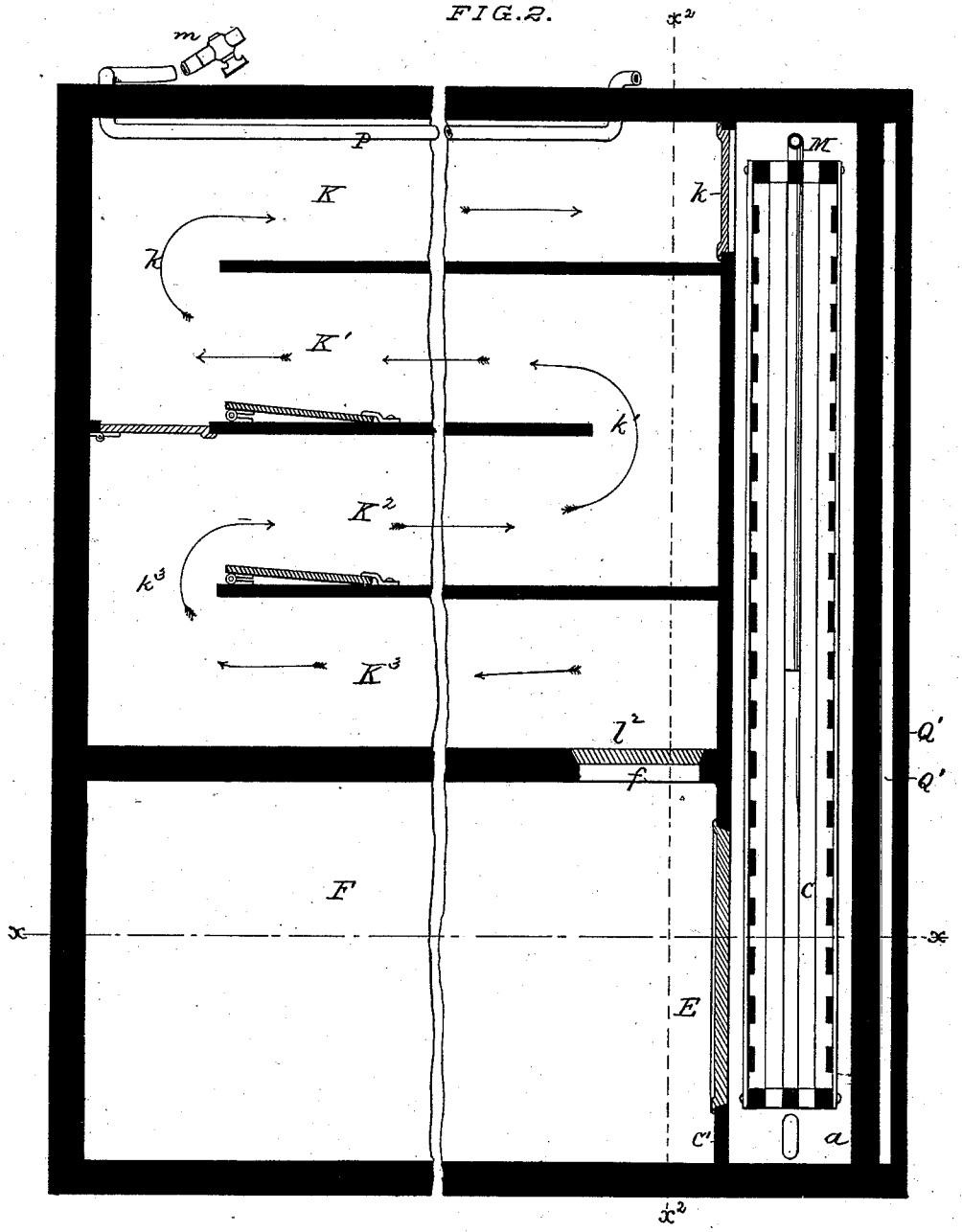
by Chas. D. Woody,
atty.

DeW. C. SANFORD.
Refrigerating-House.

No. 217,552. **Patented July 15, 1879.**

FIG. 2.



ATTEST:

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Paul Bakewell

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atty;

4 Sheets—Sheet 3.

DeW. C. SANFORD.

Refrigerating-House.

No. 217,552. Patented July 15, 1879.

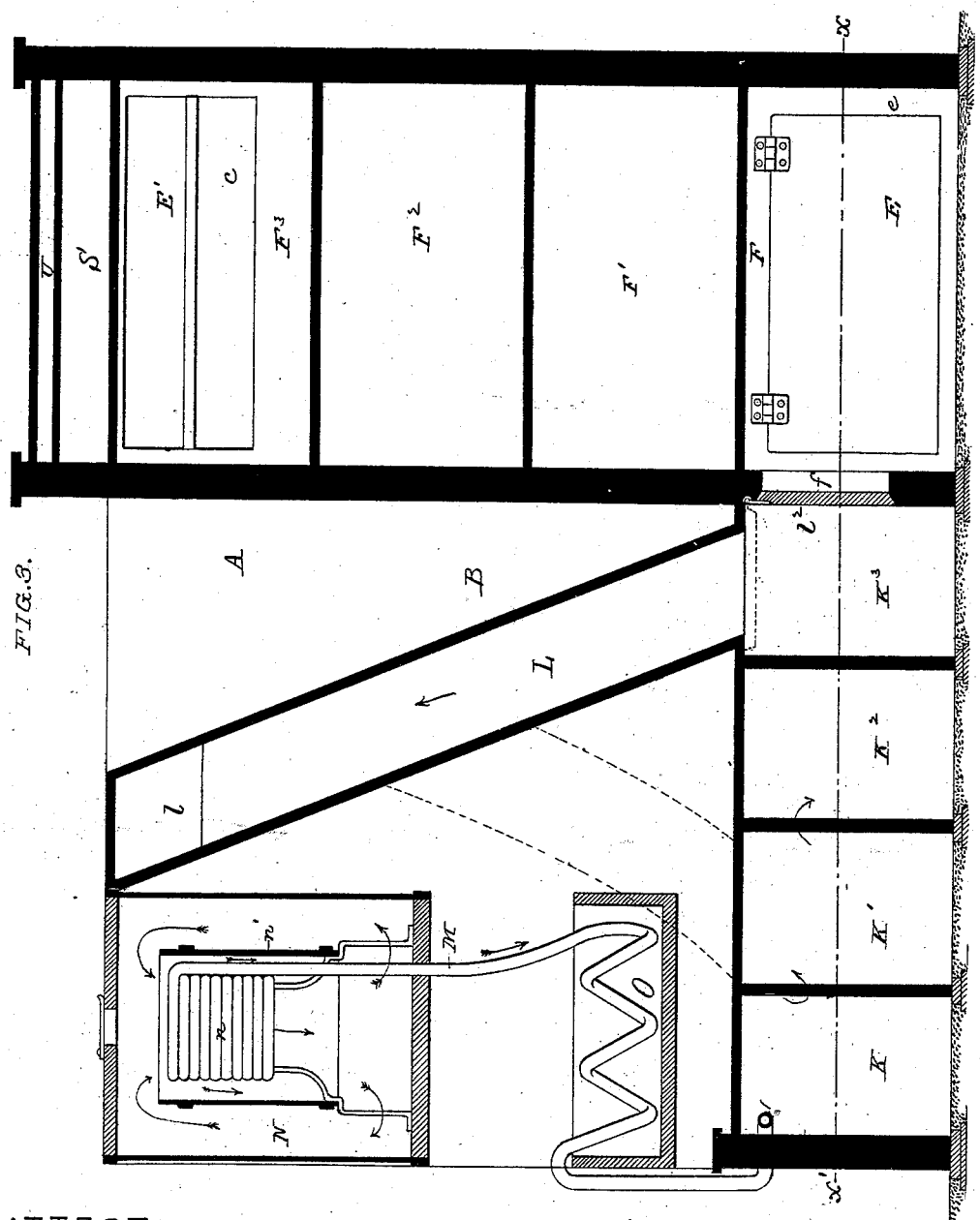

FIG. 3.

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DeW. C. SANFORD.
Refrigerating-House.

No. 217,552. Patented July 15, 1879.

FIG. 4.

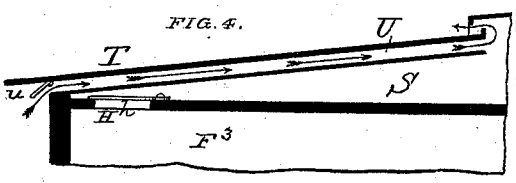

FIG. 5.

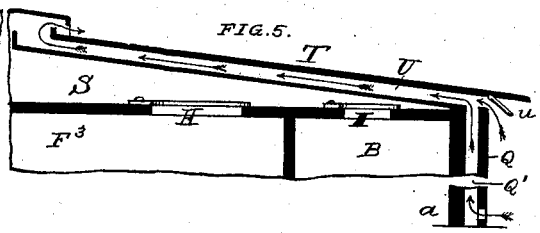

FIG. 6.

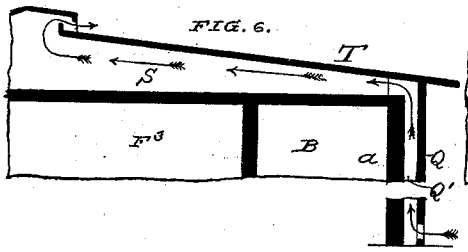

FIG. 7.

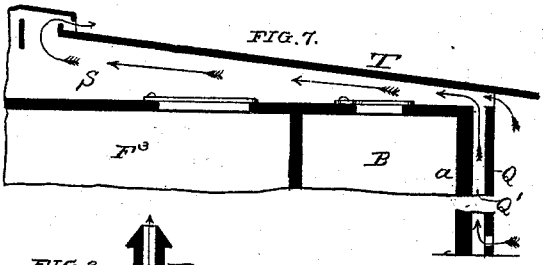

FIG. 8.

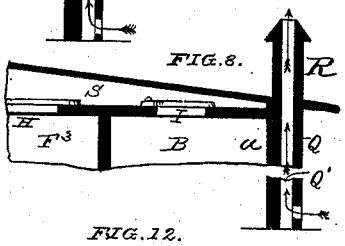

FIG. 9.

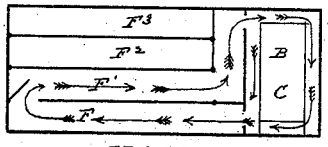

FIG. 10.

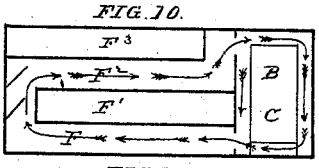

FIG. 11.

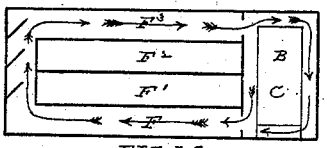

FIG. 12.

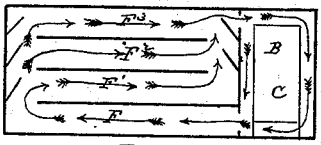

FIG. 13.

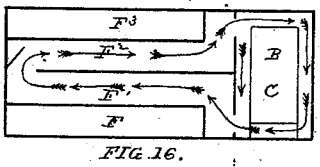

FIG. 14.

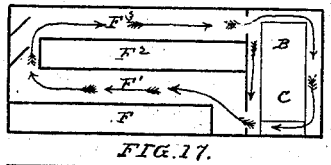

FIG. 15.

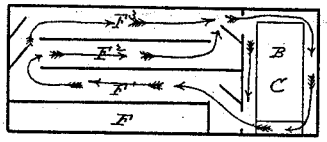

FIG. 16.

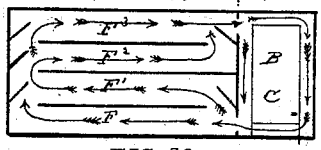

FIG. 17.

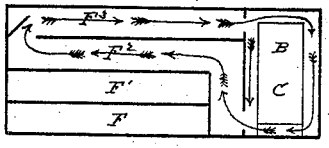

FIG. 18.

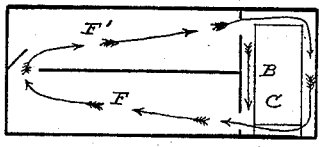

FIG. 19.

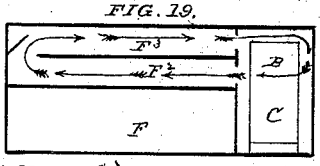

FIG. 20.

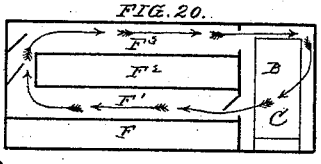

FIG. 21.

ATTEST:

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Paul Bakewell

INVENTOR:

D. W. C. Sanford.
by Chas. D. Moody
atty.

UNITED STATES PATENT OFFICE.

DE WITT C. SANFORD, OF ST. LOUIS, MISSOURI, ASSIGNOR OF ONE-HALF HIS RIGHT TO ELIZABETH H. SANFORD, OF SAME PLACE.

IMPROVEMENT IN REFRIGERATING-HOUSES.

Specification forming part of Letters Patent No. **217,552**, dated July 15, 1879; application filed January 4, 1878.

To all whom it may concern:

Be it known that I, DE WITT C. SANFORD, of St. Louis, Missouri, have invented new and useful Improvements in Refrigerating-Houses, of which the following is a full, clear, and exact description, reference being had to the annexed drawings, making part of this specification, in which—

Figure 1 is a longitudinal vertical section of a refrigerating-house embodying my invention, taken on the line *x x* of Fig. 2; Fig. 2, a horizontal section of the same, taken on the line x^1 x^1 of Fig. 1; Fig. 3, a transverse vertical section taken on the line x^2 x^2 of Figs. 1 and 2; Figs. 4, 5, 6, 7, and 8, details, being vertical sections, showing the roof and sun-protecting wall and various modifications of the flues therewith connected; and Figs. 9 to 21, inclusive, vertical longitudinal sections of the building, (the roof not being shown,) illustrating different modes of passing the refrigerating-currents through the building.

Similar letters refer to similar parts.

The present invention is applicable to meat-curing, packing, and preserving establishments; to breweries, beer-caves, wine-vaults, vessels, railway-cars, hospitals, houses, stores, cellars, saloons; to portable refrigerators, such as for hotels, stores, saloons, and houses; and to other buildings, structures, places, and purposes where refrigeration, desiccation, or ventilation is desired.

The distinguishing feature of the invention is employing refrigerating air-currents in a horizontal direction.

The invention further relates to the means for directing and controlling the refrigerating-currents.

It also has reference to the mode and means for utilizing the drip-water.

It further has reference to the construction of the outer walls and roof of the building.

The construction employed in carrying out the invention consists, mainly, of an apartment wherein air is cooled, and a series of refrigerating-apartments, through which the air, after being cooled, travels to and fro in a horizontal direction, the air leaving the air-cooling apartment at the lower level thereof, and, after traversing the refrigerating-apartment, passing into the air-cooling apartment again at the upper level thereof, and the current being due to the difference in weight of the colder air in the air-cooling apartment and the warmer air in the refrigerating-apartments.

The refrigerating-apartments may be arranged side by side and upon the same level; or they may be one above the other, and the air, after passing through them, may be discharged into the open air, and fresh air may constantly be taken into the air-cooling apartment, in place of using the same air over and over. In all cases, however, the refrigerating-apartments themselves constitute the flues for the air-current, and the latter is caused to move horizontally through them, saving when the series of refrigerating-apartments are arranged one above another, and in such case the current is partly in a vertical direction—viz., in passing from a lower story to an upper one.

Referring to the annexed drawings, A represents a building embodying the invention. B represents the apartment wherein the air to be used in the refrigerating-apartments is cooled and dried. For this purpose any suitable cooling agent, system, or apparatus may be employed. I preferably use ice, placing it in a crib, C.

The ice should be arranged to expose as much surface as is practicable to the air, so as to cool the requisite quantity of air as speedily as possible. To this end the upright and cross slats of the crib should be spaced apart the farthest practicable distance, and at the same time sufficient space must be left between the crib and the walls of the apartment and around the ice for abundant air to freely pass.

I prefer constructing the crib so that its top, sides, and bottom are exposed to the air; but it may extend to the floor and against the walls of the apartment, providing a space or flue is left open through which the air can descend in contact with the ice.

The crib may be movable or a fixture, and it should be made so that the ice can be introduced either at its sides or top.

To obtain the best results, the body of ice

should extend as high as the lower edge of the upper opening, *c*.

D represents a reservoir, arranged beneath the ice, to catch the drip-water and hold it for use, as hereinafter described.

C′ represents the partition-wall between the air-cooling chamber and the refrigerating-apartments. There are openings, *c* and *c′*, respectively, at the top and bottom of this wall. Through the lower one, *c′*, the air passes from the chamber B into the refrigerating-apartments, and through the upper one, *c*, it returns from the refrigerating-apartments into the chamber B. These openings are fitted, respectively, with doors or valves E E′, by moving or closing which the circulation of the air through the entire refrigerator can be regulated or stopped at will.

F F^1 F^2 F^3 represent a series of four refrigerating-apartments, corresponding to a four-storied house, being separated by close floors or shelves $f f^1 f^2$, extending horizontally across the length and breadth of their respective apartments, excepting that an opening, G G^1 G^2, is left at the ends or sides alternately farthest from and next to the air-cooling chamber B. These openings are for the passage of air from one horizontal apartment or story to the next one above it. By this arrangement the refrigerating-apartments become a series of horizontal flues, which, with the openings connecting them, form a continuous circuitous flue, (of uniform cross-section, or nearly so,) connecting the lower opening, *c′*, with the upper opening, *c*, of the chamber B, and through which the air circulates, as indicated by the arrows in Fig. 1.

H H represent openings (having doors *h h*, that can be tightly closed) in the top of the uppermost refrigerating-apartment, to allow the discharge of air, when desirable. I represents a similar opening, similarly closed, in the top of the air-cooling chamber, to admit fresh air into that chamber when desired.

The operation is as follows: Ice being placed in the crib C, and all the exterior openings of the refrigerator being closed and the doors E E′ being opened, the air in proximity to the ice, becoming cooled, and therefore denser and heavier than the air in the refrigerating-apartments, descends through the air-cooling chamber, and thence, through the opening *c′*, out into the lower refrigerating-apartment, F. The current traverses this apartment horizontally, and thence passes upward, through the opening G, into the next apartment, F^1, and so on, to and fro, as shown in Fig. 1, until it passes, through the upper opening, *c*, into the air-cooling chamber again. The articles to be refrigerated are placed in the apartments F F^1 F^2 F^3, where they are subjected to the current of air flowing from the air-cooling chamber, and thereby cooled and dried. The air, in turn, becoming warmer, and having its specific gravity reduced, ascends from story to story, finally re-entering the air-cooling chamber, where it is again cooled, dried, and purified, and from whence it re-enters the refrigerating-apartments to repeat its work, the current being generated without auxiliary aid.

The air contained in all these connected apartments may be likened to an endless chain, no part of which can move or stop without all of it moving or stopping; and by opening or closing the valves at either of the openings *c c′*, or by operating a valve at any other desired point in the path of the current, the latter can be controlled accordingly.

The course of the air through the refrigerating-apartments F F^1 F^2 F^3, it is seen, is both horizontal and vertical, the horizontal and vertical currents being connected, forming one continuous current, that ultimately ascends and enters the air-cooling chamber at the upper level thereof.

Only the horizontal portions of the current are used for refrigerating, the vertical portions serving merely as connections to complete the circuit.

All the openings and spaces for the passage of the air should, in cross-section, not only be large enough to permit (when desired) air to pass throughout all the various apartments of the refrigerator in sufficient quantity to abstract the heat from the articles being refrigerated, but the entire flue, throughout its length, from the point where it leaves the air-cooling chamber to where it enters it again, should be as nearly as is practicable of uniform cross-section, to enable the air to pass freely and rapidly, and so as to abstract the heat as speedily as possible.

When the refrigerating-apartments are fully occupied, (as in a meat-packing establishment,) the articles being cooled I estimate will obstruct about one-half the air-space. Hence the openings *c c′* and G G^1 G^2, and all that portion of the flue not used for refrigerating, should be about one-half the area of that of the cross-section of the apartments F F^1.

The air-space in the chamber B should be proportionately spacious, and, as a general rule, in order to obtain the best results, it may be stated that after making allowance for the space occupied by the articles being cooled in the refrigerating-apartments, the remaining portion or portions of the entire flue (meaning the apartments and openings for the time being employed) should be nearly or quite uniform in cross-section.

As thus far described the various openings G G^1 G^2 at the ends of the floors of the refrigerating-apartments F F^1 F^2 have been considered permanent; but by making openings G^3 G^4 G^5 at both ends of the floors, and providing doors or valves g g^1 g^2 g^3 g^4 g^5 to close them at will, and by placing doors (swinging either vertically or horizontally) or vertical partitions J J across the refrigerating-apartments at the edge of the openings, and by properly adjusting said doors and partitions, the current of refrigerating-air may be thrown

through either or all of the refrigerating-apartments, or cut off from any of them at pleasure.

Some of the modes of diverting the air-current are illustrated by Figs. 9 to 20, inclusive, all of which are vertical longitudinal sections. The general construction may also, without departing from the principle of the invention, be modified by arranging a series of refrigerating-apartments on each side of the air-cooling chamber, or by placing the latter at the side of the refrigerating-apartments.

The air-cooling chamber also may be arranged differently. It may be placed above the refrigerating-apartments, or it may be removed from the immediate vicinity of the latter, and in either case be connected therewith by suitable flues.

The velocity of the air-current is in proportion to the height of the ice in the air-cooling chamber, and, consequently, the height of the column of cold air in the air-cooling chamber. Therefore, to obtain increased velocity, the air-cooling chamber and its interior arrangements may be placed or built higher than the refrigerating-apartments, whether the latter are arranged side by side, or one above the other.

The improvement may also be applied to a two-story house as well as to a house of more stories.

The house can be ventilated as well as cooled by opening the valves *h i* and allowing the air-currents to pass as indicated in Fig. 21, the external air being admitted through the opening *i*, and, after being passed through the apartments as desired, being discharged through the opening *h*.

Openings similar to *c c*^{1}, Fig. 1, connecting any one of the stories F^1 F^2 directly with the air-cooling chamber, can be made, if desired, through the wall of the chamber B, through which openings the cold air can flow into the refrigerating-apartments, as previously described, providing the ice in the chamber B extends above the opening in question; but when any of said last-named openings are to be used all other lower openings for the outflow of air from the air-cooling chamber should be closed.

It appears from the foregoing that the air, after leaving the air-cooling chamber, is moved bodily in a horizontal direction. Not merely a portion thereof, such as an upper stratum, but all the air entering the refrigerating-apartments is passed horizontally throughout the same. This method has several important advantages. By means of it stagnation is prevented in any portion of the apartment or apartments being refrigerated. The refrigerating-current can be thoroughly controlled and directed not only into any desired apartment of the building, but can be sent evenly and with equal force through every level of a refrigerating-apartment. The current can also be sent to a great distance from the air-cooling chamber, making it practicable to use refrigerating-apartments several hundred feet in length, the invention now being in use in a meat-preserving establishment and a pork-packing establishment having several refrigerating-apartments, each, respectively, fifty and one hundred and twenty-eight feet in length. By this means more floor area and refrigerating capacity, in proportion to the size of the air-cooling chamber, is obtained than when the refrigerating-current is sent in a vertical direction.

The invention is also especially valuable in a meat-packing establishment where the meat is stored in bulk upon the floor, frequently in a moist condition. In such case it is impracticable to perforate the floor and to use a vertical refrigerating-current, as the articles themselves obstruct the circulation of the air by closing the perforations, and the moisture drips through the perforations into the apartment or flue beneath. This difficulty is avoided by the present method, a tight floor thereby being made practicable.

While in most cases the natural flow of air throughout the construction is sufficient in quantity and velocity for accomplishing the desired results, it may, for some cause, as when the ice is getting low in the air-cooling chamber, be desirable to increase and strengthen it, which may be done by using a fan or blower, and at the same time providing a sufficient exposure of ice-surface in the air-cooling chamber.

The invention further has reference to the mode of utilizing the cold water produced by the melting of the ice. Such water has heretofore been applied to the cooling of air, but at the bottom of ice-chambers; but I claim that such application is not highly advantageous, for the reason that the air in the lower part of the ice-chamber is about as cold as the drip-water. The latter has also been used to cool external apartments by passing it through pipes or reservoirs placed in such apartments. I therefore disclaim the use of drip-water in the above-mentioned ways.

My improved method is as follows: The warmest air in the air-cooling chamber is at the upper level thereof, and consequently that is the point where the cold drip-water should be applied to be the most effective. It should be applied to the cooling of the air on its way to the ice, and thereby increase the effective cooling power of the air-cooling chamber, and diminish the consumption of the ice. I obtain this result preferably by means of a pipe, M, extending from the drip-water reservoir upward to the space above the ice, and thence, preferably, across and through this space a number of times, (to obtain cooling-surface,) and finally passing out of the air-cooling chamber. The upper part of this pipe should be of thin metal or other heat-conducting material.

The cold drip-water, by any suitable means, is made to pass from the reservoir up and through the pipe M, and thence to be discharged therefrom outside the air-cooling

chamber. The pipe being chilled by the cold water circulating through it cools the surrounding air above the ice, and thus the drip-water is caused to co-operate with the ice. The outer end of the drip-water pipe may be extended below the level of the water in the reservoir, and the entire pipe be made to act as a siphon, provided the height is not too great. The flow of water may be regulated by a cock, *m*, at the discharging-end of the pipe. The pipe in its course may be formed into any shape that will extend its cooling-surface and increase its efficiency as a cooling agent.

If desired, the water may be forced up into a reservoir, and from the reservoir be allowed to flow into pipes or open troughs in the top of the air-cooling chamber, thence to pass out, as before described.

In practice, the drip-water, even after it issues from the air-cooling chamber, is still sufficiently cool to be further utilized. To this end the pipe M is conducted into another refrigerating-apartment, N, where it may be formed into a close coil, *n*. The pipe M may thence be extended into and through a refrigerating-trough, O, and thence into and through a refrigerating-apartment, P, and afterward be finally discharged.

The apartment N may contain (to be cooled) water or other liquid or air. If the latter, the apartment should be inclosed. The trough O is intended to contain any liquid that it may be desired to cool. One aim and advantage in cooling water in this way is, that the drip-water, which is generally somewhat impure, does not mix or come in contact with the water or liquid being cooled.

By closely coiling the pipe in forming the coil *n* a flue is formed in the apartment N. It should be placed as near the top of the apartment as possible after leaving sufficient space above it for the liquid or air, as the case may be, to pass over and into the flue. Space must also be left between the coil and the floor of the apartment for the air or liquid to pass out from the lower end of the flue. The coil being cooled by the circulation therein of the drip-water, a downward current in consequence is generated within the flue. The air or liquid without the pipe becoming cooler and heavier, descends and passes from the bottom of the flue out into the apartment, while the warmer air or liquid is flowing into the flue at the top. A circulation through the flue of all the air or liquid in the apartment is thus maintained, resulting in the rapid cooling of the air or liquid, for the latter is drawn in a volume through the flue. The circulation is still further promoted by placing a casing or jacket, *n'*, (open above and beneath,) around the coil, and thereby forming another (annular) flue between the casing and coil. It is preferable in forming the coil *n* to wind the pipe M from the bottom upward, so as to bring the warmest air or liquid in contact with the warmest part of the coil first, and afterward with the coldest part.

The drip-water pipe M, as it passes through the various apartments above described, may be formed into any shape that may be most advantageously applied to accomplish the desired effect. For instance, it may be increased in width to cover the inside of the top or roof of an apartment or railway-car, to protect the apartment or car from the heat of the sun.

The invention further has reference to what I term the "sun-protecting wall" and the air-flue connected therewith, and to the construction of the roof of the building.

Referring to Figs. 1, 2, 5, 6, 7, 8, Q represents a wall, built outside and a few inches from the main wall *a* of the building, forming a space or flue, Q', between the two walls. There are openings *q* in the lower part of the wall Q leading from the outer air into the flue Q'. The combined areas of the openings *q* should be equal, or thereabout, to the cross-sectional area of the flue Q', and the openings are provided with valves *q'*, that can be opened or closed when desired.

The flue or space Q' extends upward, opening at a point above the refrigerating-apartments of the house, and either directly into the open air, as at R, Fig. 8, or into the open space S immediately beneath the roof T, as in Figs. 6 and 7, or into a flue or space, U, constructed in, on, or immediately under and next to the roof, as in Figs. 1, 3, 4, and 5.

The roof-flue U is practically a continuation of the flue Q', and it performs the same office with respect to the roof as the flue Q' does to the wall of the building.

In operation, when the sun-wall Q has by the sunshine become heated through so as to heat the air in the flue Q', so that it is warmer than the external air, the valves *q'* should be opened, admitting the cooler external air into the flue Q' to supply the place of the warmer air, which ascends and escapes through the flues R, S, or U, as the case may be, into the open air.

By this means the heat of the sun, which otherwise would fall directly upon the main wall *a* and be absorbed by it and conducted through it, is warded off and received by the sun-wall. A large portion of the heat received by the sun-protecting wall Q would be conveyed to the main wall *a* were it not for the intervening current of cooler air, which is allowed to pass through the flue Q' and carry the heat off until the protecting-wall Q is cooled down to the temperature of the external air. This operation is particularly beneficial when the sun, after shining hot, becomes obscured by clouds, or sets, and the temperature of the external air falls. Then the cooler external air passes through the openings *q*, and ascends through the flue Q', and the absorbed heat of the protecting-wall is thus carried off from the building.

While the air in the flue Q' is cooler than

the external air the inlet-valves q' should be kept closed, thereby retaining the cool air in the flue. If this is not done the cool air in the flue will descend and escape through the lower openings, and thus a current of descending air will be cooled by the main wall a, and the aim of this feature of the invention be frustrated. Hence the valves q' are indispensable in securing the full benefit of the sun-protecting wall Q.

The construction and operation of the flue U in the roof are based upon similar principles. This last-named flue may be used without the flue Q′, as in Figs. 1 and 4; or in combination therewith, as in Figs. 1, 5, and 7; or the two flues, U and Q′, may be both used, but independently. In all cases it is desirable, and especially when the flue U is used independently, to employ a valve, u, to close the lower end of the flue U, to prevent the descent of air therein, as above described, in connection with the flue Q′.

The outlet, whether of the flue Q′ or U, should be constructed and arranged so that the air therein, in its upward course, will meet with no resistance, such as a counter-current arising from the wind without the building. To this end the outlet of the wall-flue Q′ (when the latter is used independently) should open upward, as in Fig. 8, and not outwardly from the side of or through the wall Q, for in such case the wind, when blowing against the outlet, would cause a descending current in the flue. The outlet of the flue U is preferably constructed as shown. The valves for closing the inlets to the flues Q′ and U may be made and operated in any suitable manner.

When the outlet from the air-cooling chamber into the first of the refrigerating-apartments is not made coextensive with the end of the refrigerating-apartment, and is confined to the lower level of such apartment, a pocket of warmer air is sometimes formed in the apartment immediately above the outlet from the air-cooling chamber, and to facilitate the escape of this warm air it is sometimes desirable to make small openings in the partition or ceiling that separates the first refrigerating apartment from the adjoining apartment, and near the outlet from the air-cooling chamber, through which openings the air can pass off.

I claim—

1. In a refrigerator or refrigerating-house, two or more refrigerating-compartments the largest dimension of which is in a horizontal direction, the compartments being connected with each other at alternate ends, and the first and last compartments being at their ends respectively connected, without any intervening refrigerating-compartments, with an air-cooling chamber, forming a continuous endless flue, for the purpose described.

2. The combination, in a refrigerator or refrigerating-house, of an ice-chamber and a refrigerating-compartment, the latter being connected with the former by an opening or flue leading from the lower part of the ice-chamber, and also by another opening or flue leading into the upper part of the ice-chamber, and having one or more imperforate partitions or floors extending from the wall of the apartment nearest the ice-chamber and between said openings or flues horizontally across said compartment, and provided with openings at one or both ends, for the purpose of directing the flow of the refrigerating air-current, in the manner described.

3. The combination, in a refrigerator or refrigerating-house, of an air-cooling chamber and a refrigerating-compartment, the former extending to or above the level of the latter and connected therewith by an opening or flue leading from the lower part of the ice-chamber, and also by another opening or flue leading into the upper part of the ice-chamber, and said refrigerating-compartment having one or more imperforate partitions or floors extending from the wall of the compartment nearest the ice-chamber, and between said openings or flues horizontally across said apartment, and provided with openings at one or both ends, for the purpose of directing the flow of the refrigerating air-current, in the manner described.

4. The combination, in a refrigerator or refrigerating-house, of the floors or partitions, forming a series of refrigerating-compartments whose largest dimension is in a horizontal direction, and that are connected with each other, at their ends only, with valves to shut off the refrigerating-current from any of said compartments, to enable a refrigerating air-current to be sent through all of said compartments successively, or a portion only of said compartments, substantially as described.

5. The combination, in the house A, of the ice-chamber B, provided with openings c c', with the compartments F F^1 F^2 F^3, without any intervening refrigerating-compartments, the latter opening into each other at G G^1 G^2 only, substantially as described.

D. W. C. SANFORD.

Witnesses:
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