March 6, 1951 C. D. BURNEY 2,543,889

QUICK-FREEZING MACHINE

Filed Jan. 22, 1947 6 Sheets-Sheet 1

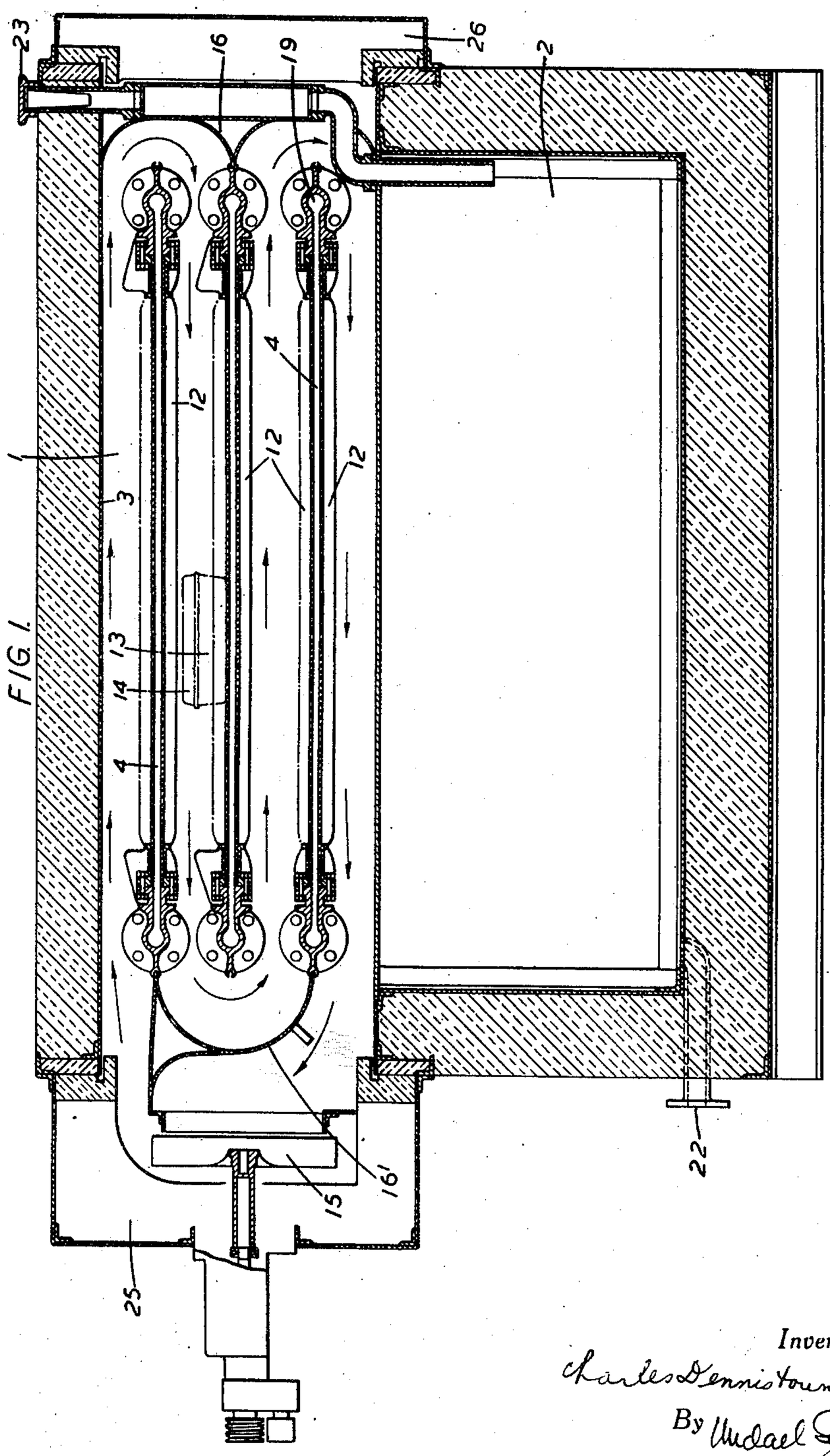

FIG. 1.

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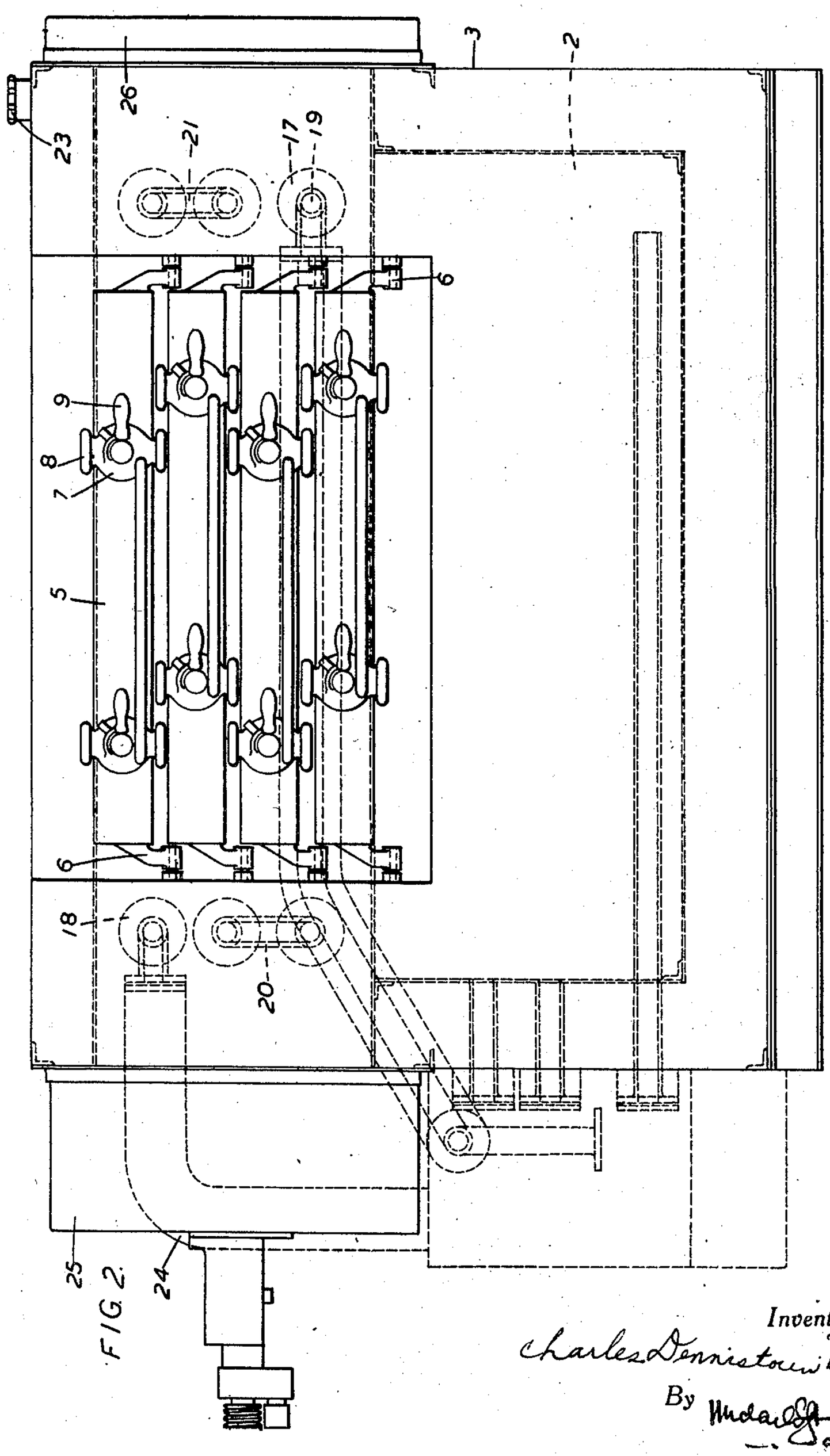

FIG. 2.

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QUICK-FREEZING MACHINE

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FIG. 3.

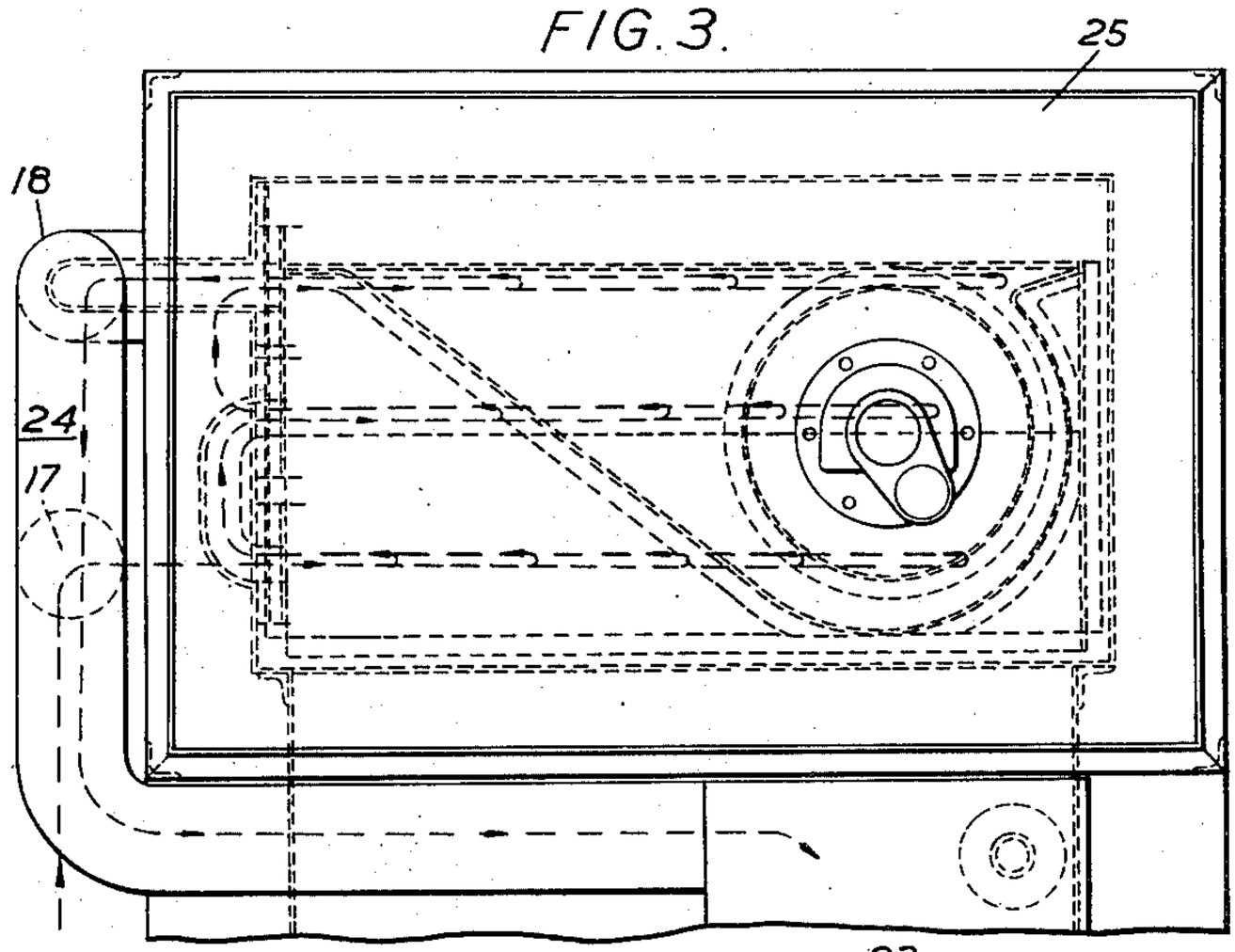
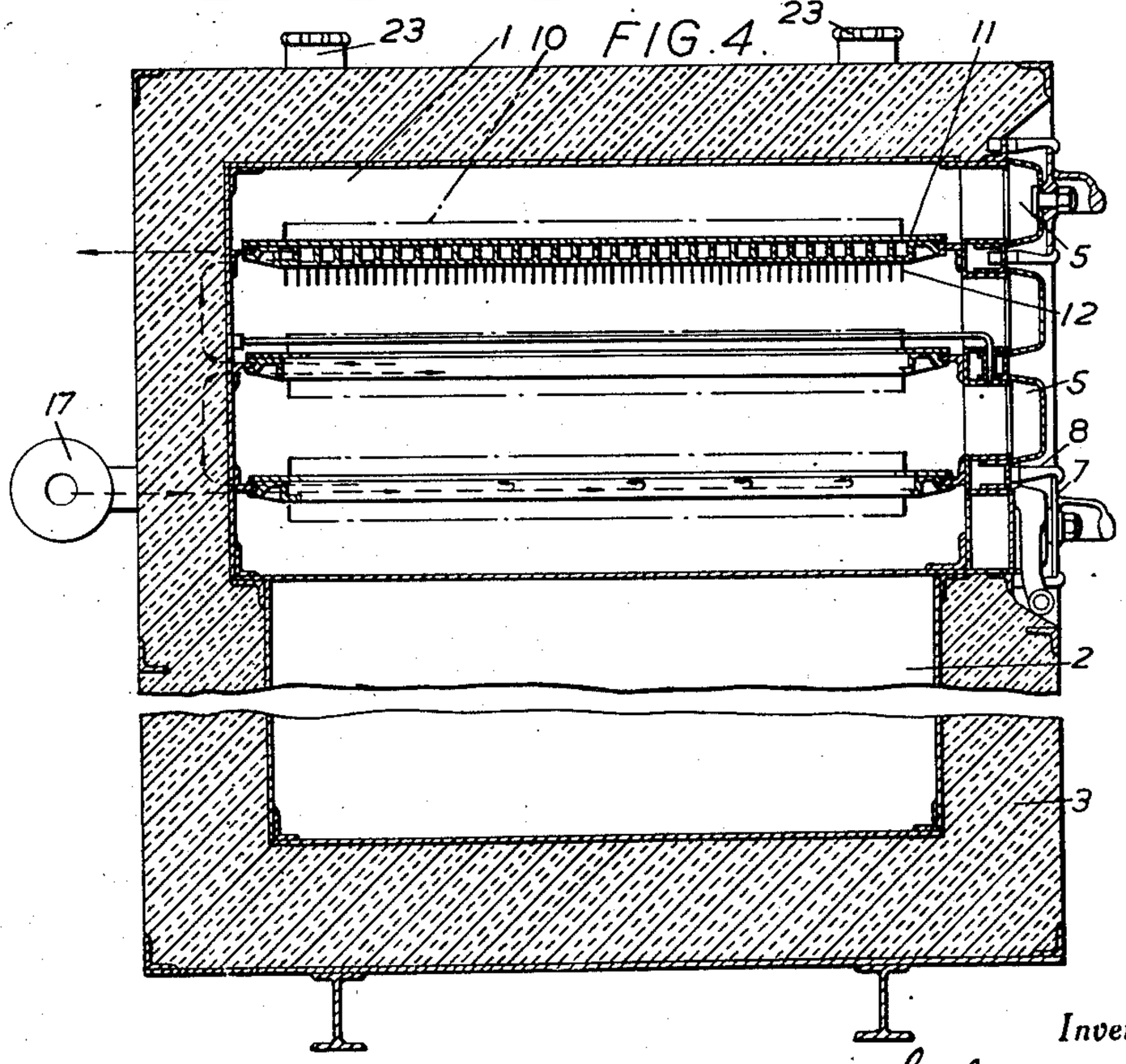


FIG. 4.



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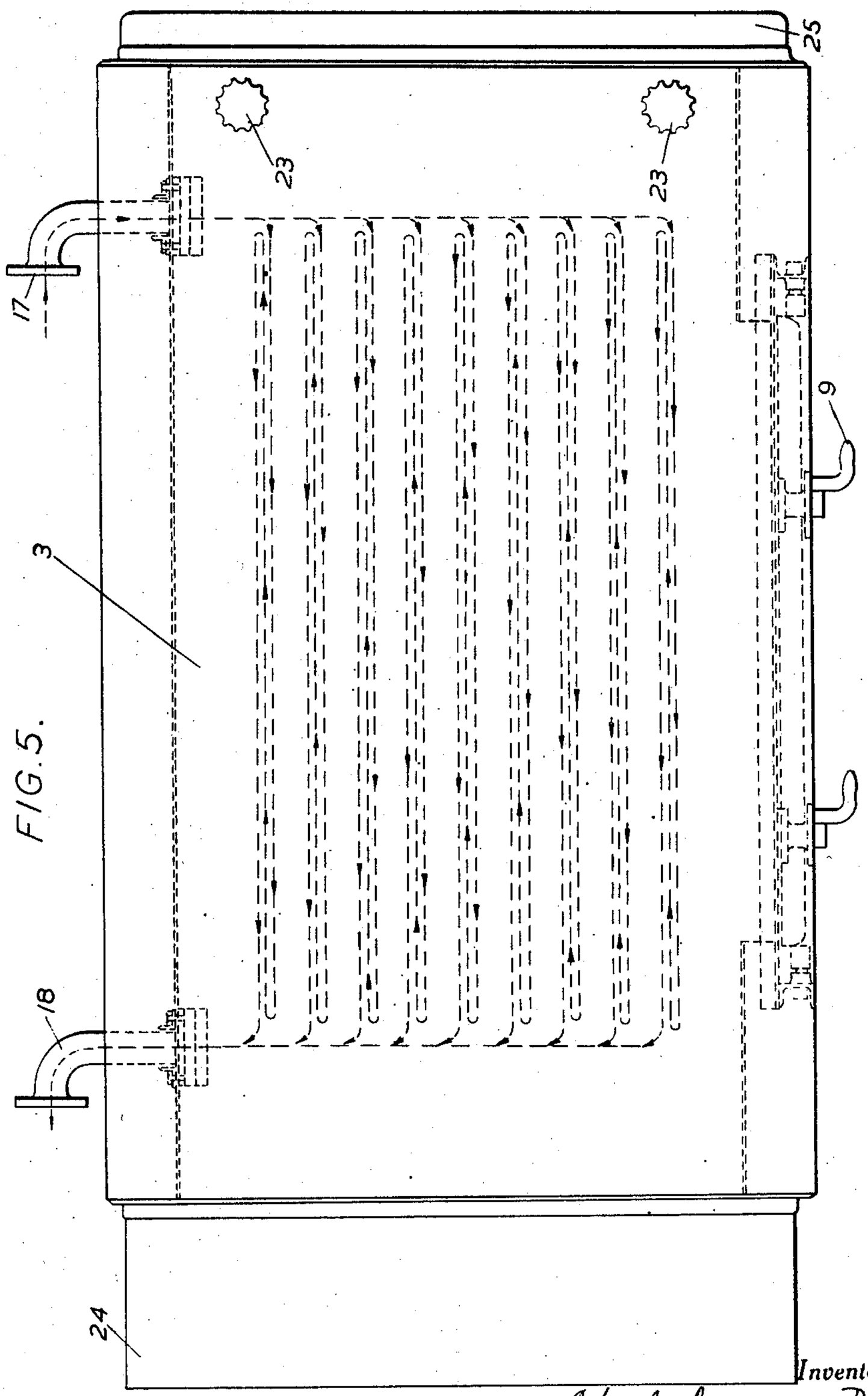

FIG. 5.

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FIG. 6.

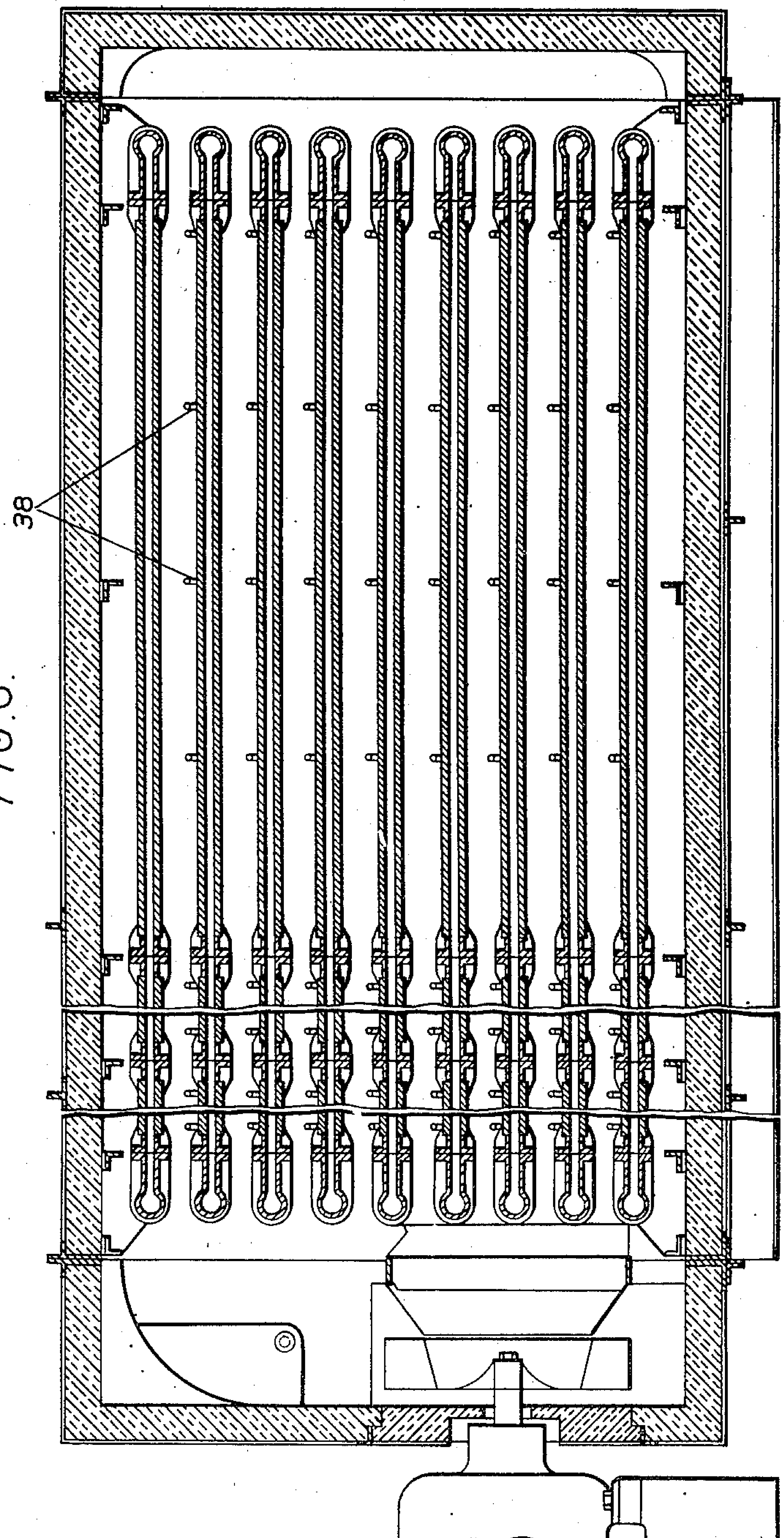

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FIG. 7.

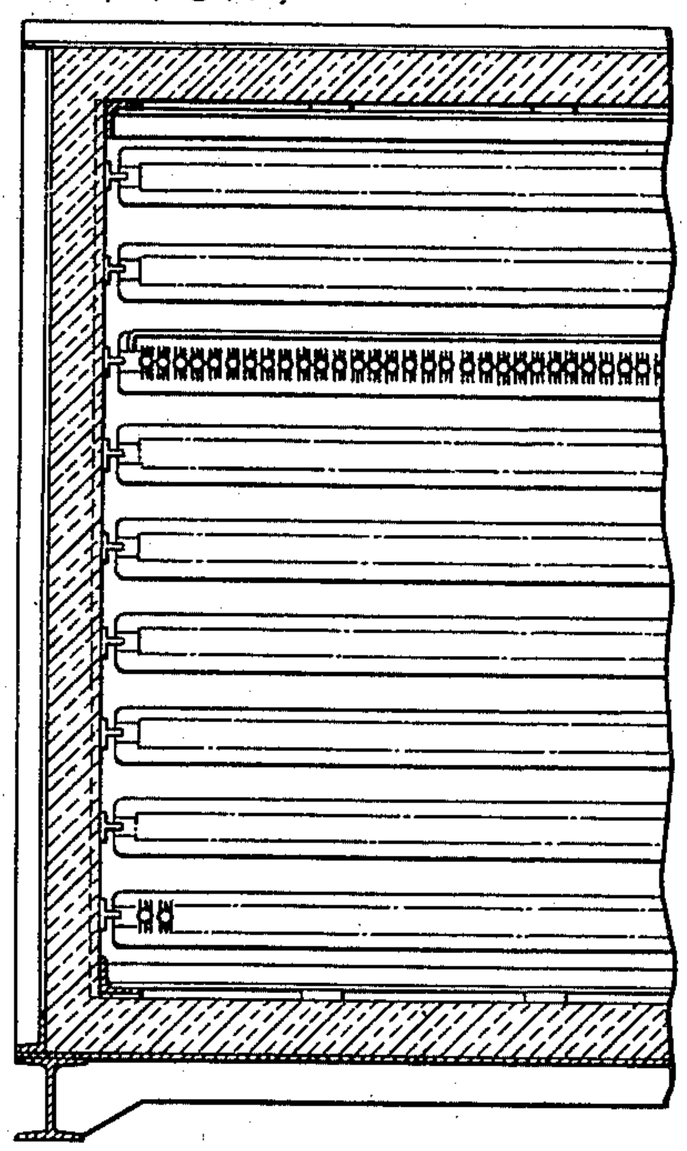


FIG. 8.

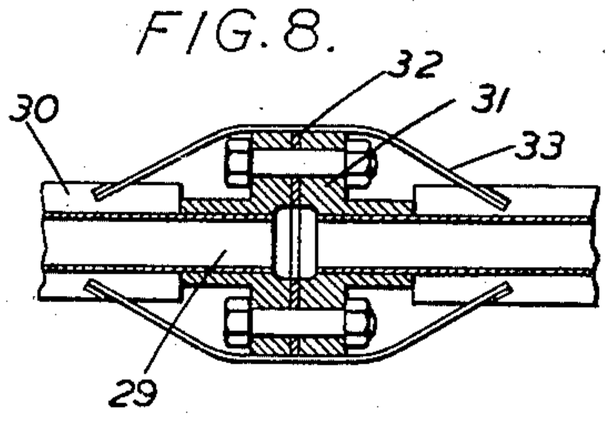


FIG. 9.

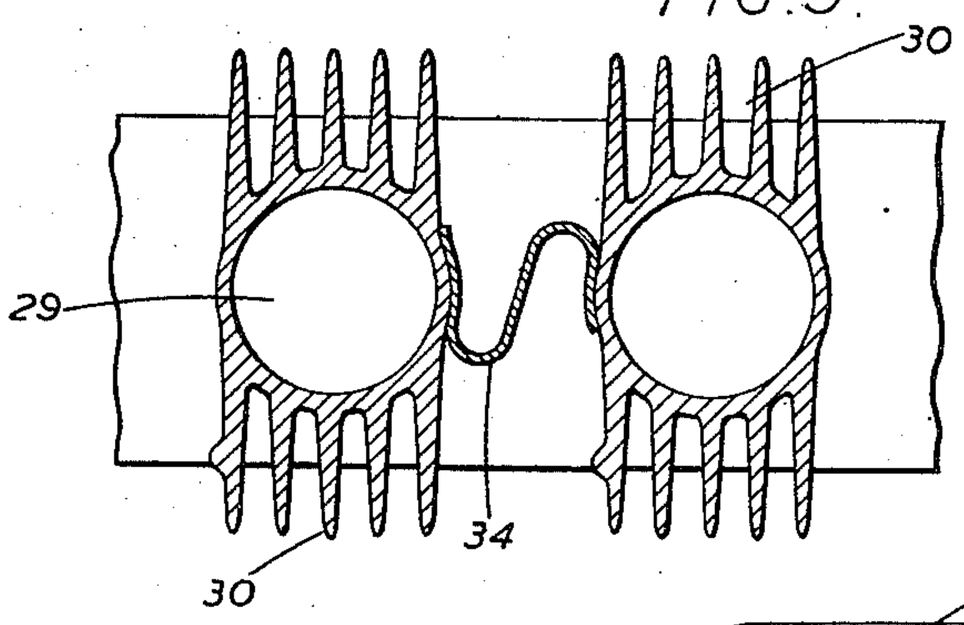
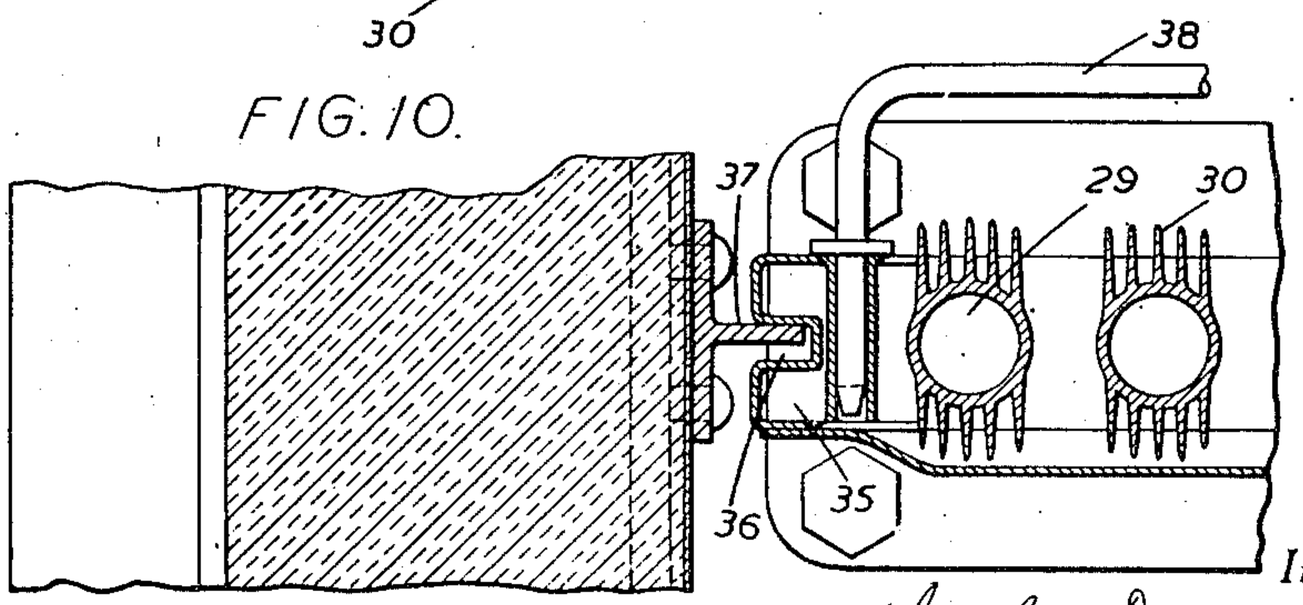


FIG. 10.



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Patented Mar. 6, 1951 2,543,889

UNITED STATES PATENT OFFICE

2,543,889

QUICK-FREEZING MACHINE

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Application January 22, 1947, Serial No. 723,475
In Great Britain January 25, 1946

8 Claims. (Cl. 62—114)

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The present invention relates to "quick" freezing machines intended mainly for the preservation of food stuffs, particularly fish, and its main object is to provide an improved construction of machine giving a more rapid and greater reduction of temperature of the goods to be frozen than has hitherto been customary.

The machine is generally of the known type in which the goods are cooled partly by conduction of their heat to shelves on which they are placed, said shelves being cooled by pipes through which a liquid coolant, such as chilled brine or trichloroethylene, is circulated, and partly by transfer of heat to air circulated between the shelves on which the goods are laid.

Prior to this invention the circulating air in passing through the machine has gradually become warmed up by the heat picked up from the goods, and in some cases to allow for this, the air has been cooled down or chilled before admission to the machine.

According to the present invention the goods are cooled mainly by the flow thereover of a high speed current of air, and provision is made within the machine for rapidly cooling the air in its passage therethrough. This rapid internal cooling of the air is effected by transferring heat absorbed by the air from the goods to a liquid coolant circulating through finned tubes within the machine. Thus the circulating air acts as a heat transfer medium which picks up heat from the goods and simultaneously gives up heat to the liquid coolant. The rate of heat transfer is accordingly considerably increased and the amount of heat absorbed is also increased so that an increased freezing effect is obtained.

According to the invention the rapid exchange of heat between the circulating air and the cooling tubes is promoted by providing said tubes with fins on their upper and/or their under surfaces, which run parallel to the direction of air flow. Those fins materially increase the area of cooled metal surface in contact with the flowing air and thus cause the more rapid extraction from the air of the heat imparted to it by the goods.

The finned tubes are preferably assembled side by side in parallel relationship, so as to produce a flat upper surface for the support of trays containing the goods. The lower sides or bases of the trays are consequently cooled by contact between the metal base of the tray and the metal of the pipes or the covering thereof. The pipes may have fins on both their upper and their lower surfaces, and in this case the air flow passes not only over but also beneath the trays, thus again promoting more rapid heat

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transfer between the goods and the air on those portions of the base of the tray not in contact with the fins. Alternatively if fins are only provided on the lower surfaces of the tubes, the upper surfaces of the tubes are formed or provided with a continuous flat surface on which the trays rest and the whole of the heat transfer from the base of the tray is effected by contact. This flat surface may be produced by the use of juxtaposed tubes with flat upper surfaces, or by using a flat surfaced casting of light metal alloy, with side by side tubular spaces cast therein. Fins may be cast integral with either the lower or upper surface of the casting, or both.

According to another feature of the invention the trays themselves are provided with fins running parallel to the direction of air flow. Such fins will be provided on the covers of the trays and may also be provided on the bottom and end surfaces thereof.

Preferably the shelf surfaces are formed with recesses, ribs, or equivalent means to locate the trays and hold them against lateral movement along the shelves, which is a feature of considerable importance when the machine is installed upon a ship, liable to roll.

An important feature of the invention is elimination of the production of frictional heat within the machine due to the high speed air current used. Thus although air may be circulated sinuously through the machine from one shelf space to the next in succession, it is preferably passed in one direction in parallel through all the shelf spaces in the upper part of the cooling chamber and back in parallel through the shelf spaces in the lower half of the chamber. This materially reduces the length of the air path through the machine and thus the amount of frictional heat which can be generated and picked up. Furthermore all joints between the tubes of adjacent sections of the machine are preferably streamlined to reduce friction and the generation of heat thereby.

The use of covers on the trays has the effect of protecting the goods from the air current, which is a matter of some importance when the goods are of such a nature as to be damaged by the air current; as for example, when they consist of filleted fish. In the absence of covers the filleted fish would become damaged by a high speed air current, and therefore the use of covers enables an air current of high speed to be used with such goods.

The freezing machine may be built up from standard sections to various lengths according to the capacity required. Thus it may be built up from end sections and any desired number of intermediate sections, each intermediate section

comprising tubular shelves whose tubes are adapted to be connected up at their ends to the tubes of the corresponding shelves of adjacent sections, with the appropriate hinged doors for permitting access to said shelves.

The cooling chamber may occupy the upper part of the machine and a storage chamber for cooled brine or other coolant may occupy the lower part of the machine, to serve as an accumulator for the cooled brine.

In order that the invention may be more clearly understood and readily carried into practice, it is illustrated, by way of example only, in the accompanying drawings, in which:

Figure 1 is a longitudinal section elevation of a "quick" freezer constructed in accordance with the invention.

Figure 2 is a longitudinal external elevation, or front view.

Figure 3 is an elevation.

Figure 4 is a cross sectional view,

Figure 5 is a plan view,

Figure 6 shows in longitudinal section a modified construction adapted to be built up to any desired length from standard end units and any number of standard intermediate units.

Figure 7 is a partial cross sectional view of the modified construction, and,

Figures 8, 9 and 10 are detailed views thereof to a larger scale.

Referring to the drawings, the "quick" freezer (hereinafter called the machine) comprises a freezing chamber 1 mounted above a storage tank 2 for brine or other coolant, and the whole are enclosed within a cabinet 3, the walls of which comprise heat insulating material of any suitable kind. Within the chamber 1 are disposed a number of shelves 4 which divide the interior space of the chamber 1 into a number of separate compartments (in this case four) and access to the compartments is obtained through a corresponding number of separate doors 5. These doors 5 are carried by downwardly depending arms 6 mounted on pivots or trunnions, and when closed they are locked by rotating latches 7, co-operating with catches 8 on the outside of cabinet 3. There are two latches 7 for each door, which are linked together by rods 8 for simultaneous operation by means of handles 9 on the latches 7. There may be one door 5 for each compartment of chamber 1 (as shown), or one door may be provided for a pair of adjacent compartments. By sub-dividing the door of the cabinet 3 in this manner the admission of outside humidity, responsible for inside frosting, when the shelves are being loaded or unloaded is minimised. At the same time losses due to the leakage entry of extraneous heat are also reduced.

The hollow shelves 4 are formed with tubular spaces 10 disposed side by side in the same horizontal plane, and may be either built up of a plurality of separate side-by-side tubes, preferably having flat upper surfaces, or being as shown, formed by flat castings having parallel tubular spaces cast therein over which a cover plate 11 is fixed. The upper surface of the shelves 4, formed by the cover plate, or by the side-by-side tubes is therefore flat, and suited to receive the trays. The under surface of the shelf casting, or, of the side-by-side tubes, has or have parallel fins 12 cast thereon running parallel to the lengths of the shelves or tubes.

The goods to be frozen are loaded into metal trays 13, which are placed on the flat shelf surfaces, and the trays are provided with metal cover

plates having parallel fins 14 on their outer surfaces.

Brine or other liquid coolant is circulated through the shelves 4, and may be accumulated in a storage tank 2, which may be located away from the freezing chamber 1, but in the example shown in Figures 1–5 is disposed in the same cabinet beneath the freezing chamber 1. The coolant may be cooled down continuously at a convenient point in its circulation, or from time to time as required, by means of a normal refrigerating machine.

Removable end covers 25 and 26 are fitted to the cabinet 3 to facilitate assembly, cleaning, and maintenance. The machine is preferably constructed with an internal frame and an external shell which are spaced from each other by insulation of a yielding nature, such as expanded synthetic rubber, so that the frame floats within the outer shell and can freely contract as its temperature falls.

The brine or coolant may be supplied to the shelves 4 through inlet and outlet connections 17, 18 (Figure 5), to which external insulated flow and return pipes are connected, the return pipe 24 being shown in full lines in Figure 3. The direction of circulation is preferably opposite to that of the air, i. e. upwardly, so that any gas liberated therefrom may be carried out with the flowing liquid and will not impede its flow. The brine circulating pipe system is indicated by dotted lines in Figure 2. The brine is admitted to one end of the lower shelf 4 at 19 (Figure 1), transferred from the other end of the shelf to the middle shelf, through transfer pipe 20, and again transferred from the opposite end of the middle shelf to the top shelf, by transfer pipe 21, finally leaving the machine at outlet connection 18. In Fig. 5 the dotted lines appear in groups of three, in each of which the upper dotted line represents the pipe in the upper shelf, the middle dotted line represents the pipe in the middle shelf, and the lower dotted line represents the pipe in the lowermost shelf.

Defrosting when required can be carried out by means of an electric heater (not shown) having a finned surface, which is located in the air passage adjacent to the fan, this being switched on when required. Provision may be made for stopping the brine circulation when required and even for drawing off the brine via outlet connection 22. The brine storage tank may be filled through filler connections 23, one of which permits the escape of air while the other is being used for filling.

In the modified construction illustrated by Figures 6–10, the machine is built up of any desired extended length from standard end sections 26, 27 and any desired number of intermediate sections 28. In this case, instead of being directed by baffles through all the shelf spaces in succession, the air current flows in parallel from left to right through the four upper shelf spaces and back again from right to left through the four lower shelf spaces.

Figure 8 shows the method of connecting up the ends of tubes in one section with the shelf tubes of the adjacent section. The ends of the tubes project beyond their fins 30 and their upset or flanged ends are drawn together by flanged members 31 and bolts 32. In order to reduce friction the joints are covered with a streamline sheathing 33.

The shelves are built up from spaced parallel tubes 29 of circular section, with fins 30 extend-

ing upwardly and downwardly to equal heights, the spaces between the tubes 29 being filled in by expanding distance strips 34 of copper or the like.

The shelves are preferably removably mounted in the cooling chamber, being, for example, supported in frames 35 having grooves 36 engageable on rails 37 in the wall of the chamber.

As shown in Figures 6 and 10 transverse rails 38 may be provided at intervals along the shelves to serve as locating means for the trays placed on the shelves, to prevent lateral movement thereof along the shelves, due for example, to the roll of a ship carrying the machine.

What I now claim is:

1. In a freezing apparatus, in combination, an exterior insulating frame; a freezing compartment formed in said frame; a plurality of superimposed vertically spaced substantially horizontal shelves mounted in said freezing compartment for supporting the trays thereon; the shelves having parallel tubular spaces formed therein; means for circulating a refrigerant through said tubular spaces; means for circulating a stream of air in a sinuous path along said shelves so as to contact the same at their upper side and at their under side; and fins provided on at least the under side of said shelves parallel to the current of air set up by said circulating means.

2. In a freezing apparatus, in combination, an exterior insulating frame; a freezing compartment formed in said frame; a plurality of tubes arranged in superimposed vertically spaced horizontal rows, the tubes of each row being substantially contiguous so as to form a plurality of substantially continuous shelves; means for circulating a refrigerant through said tubes; means for circulating a stream of air in a sinuous path along said tubes so as to contact their upper side and their under side; and fins fixed lengthwise on the under side of said tubes and parallel to the current of air set up by said circulating means.

3. In a freezing apparatus, in combination, an exterior insulating frame; a freezing compartment formed in said frame; a plurality of superimposed vertically spaced substantially horizontal shelves mounted in said freezing compartment for supporting the trays thereon; parallel tubes spaced formed in said shelves; means for circulating a refrigerant through said tubular spaces in a direction ranging from one vertical end member of the shelves to the other end member and upwardly from one shelf to the next shelf thereabove; means for circulating a stream of air in a sinuous path in a direction opposite to said direction of the refrigerant along said shelves so as to contact the same at their upper side and at their under side; and fins provided on at least the under side of said shelves parallel to the current of air set up by said circulating means.

4. In a freezing apparatus, in combination, an exterior insulating frame; a freezing compartment formed in said frame; a plurality of superimposed vertically spaced substantially horizontal shelves mounted in said freezing compartment for supporting the trays thereon; the shelves having parallel tubular spaces formed therein; means for circulating a refrigerant through said tubular spaces in a direction ranging from the bottom shelf to the top shelf; means for circulating a stream of air in a sinuous path

in a direction opposite to said direction of the refrigerant along said shelves so as to contact the same at their upper side and at their under side, and fins provided on at least the under side of said shelves parallel to the current of air set up by said circulating means.

5. In a freezing apparatus, in combination, an exterior insulating frame; a substantially rectangular freezing cabinet formed in said frame; a plurality of vertically spaced substantially horizontal shelves extending lengthwise in said freezing compartment for supporting trays thereon; the shelves having parallel tubular spaces formed lengthwise therein; means for circulating a refrigerant through said tubular spaces; means for circulating a stream of air lengthwise along said shelves in a sinuous path so as to contact the same at their upper surface and at their under surface; and fins fixed lengthwise on at least the under side of said shelves so as to extend parallel to the current of air set up by said circulating means.

6. In a freezing apparatus in combination, an exterior insulating frame; a freezing compartment formed in said frame; a plurality of superimposed vertically spaced substantially horizontal shelves mounted in said freezing compartment for supporting the trays thereon; the shelves having parallel tubular spaces formed therein; means for circulating a refrigerant through said tubular spaces; means for circulating a stream of air in a sinuous path along said shelves so as to contact the same at their upper side and at their under side; fins fixed on the underside of said shelves parallel to the current of air set up by said circulating means; covered trays arranged on said shelves; and fins fixed on the upper side of said covered trays parallel to the current of air set up by said circulating means.

7. A freezing apparatus constructed in accordance with claim 1, including an outer shell and a separate inner shell, said inner shell housing the shelves and being spaced from said outer shell by insulation of a yielding nature adapted to permit contraction of the inner shell.

8. A quick freezing machine, including the combination, with a heat insulating casing, of a frame structure within the latter comprising a tier of superposed substantially horizontal metal shelves vertically spaced apart and having tubular passages traversing them; the upper sides of the shelves forming supporting areas for supporting goods to be frozen; means for circulating a fluid refrigerant through the tubular passages within the shelves; means for circulating a current of air sinuously through the spaces between the shelves; and a plurality of fins fixed on the lower sides of said shelves in parallelism with the flow of said current of air circulated between said shelves.

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