No. 778,482. PATENTED DEC. 27, 1904.

G. EPPRECHT.

# APPARATUS FOR COOLING OR HEATING AIR.

APPLICATION FILED APR. 20, 1903.

3 SHEETS—SHEET 1.

Fig. 1.

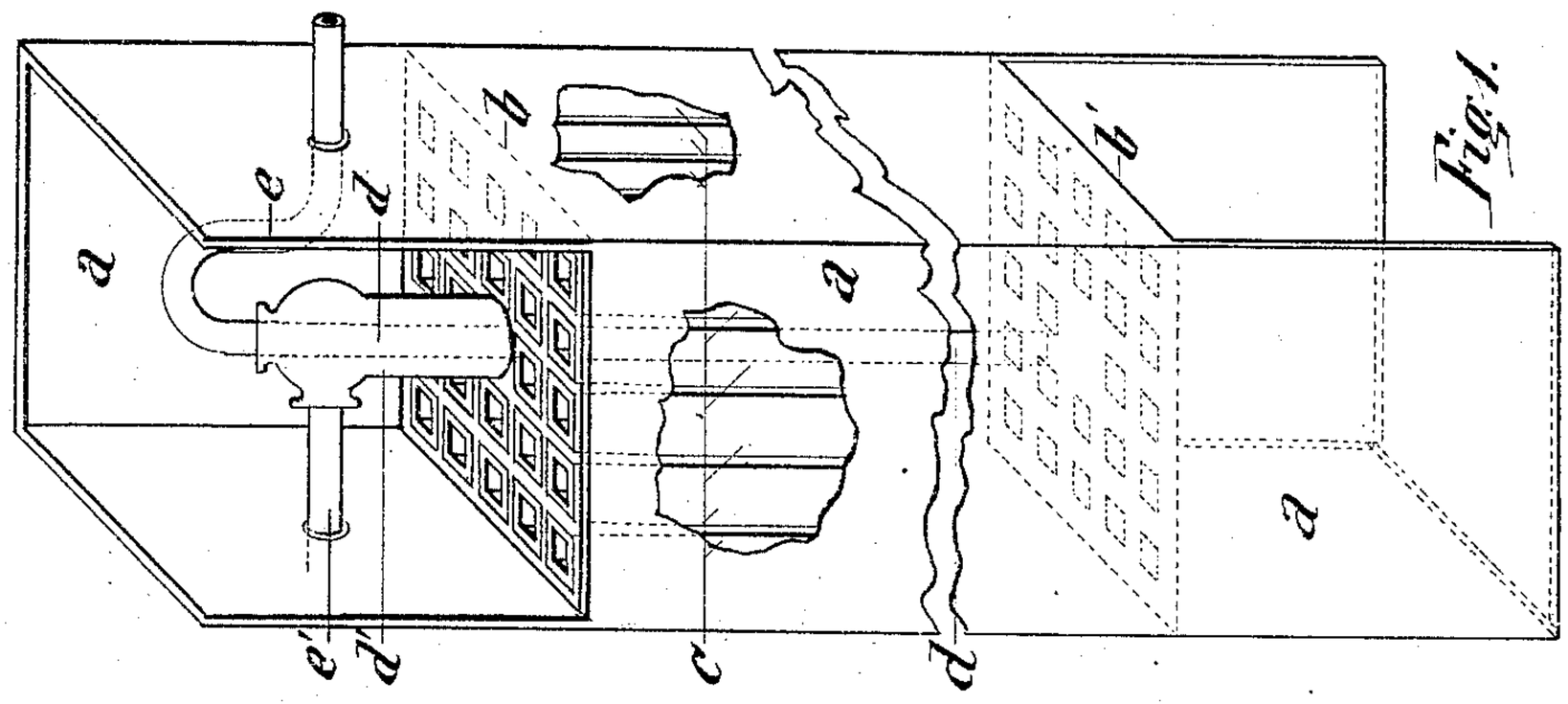



Fig. 3.

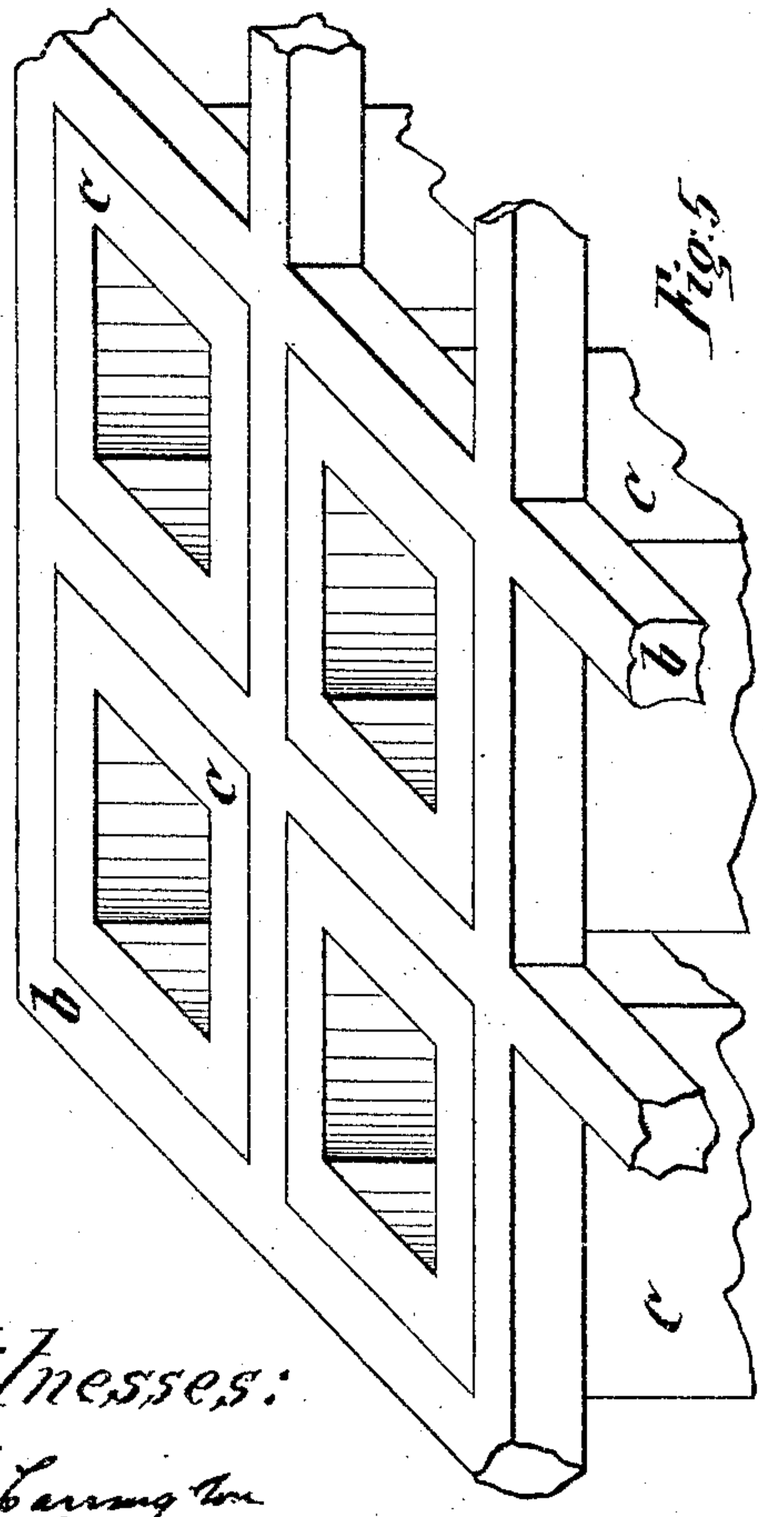
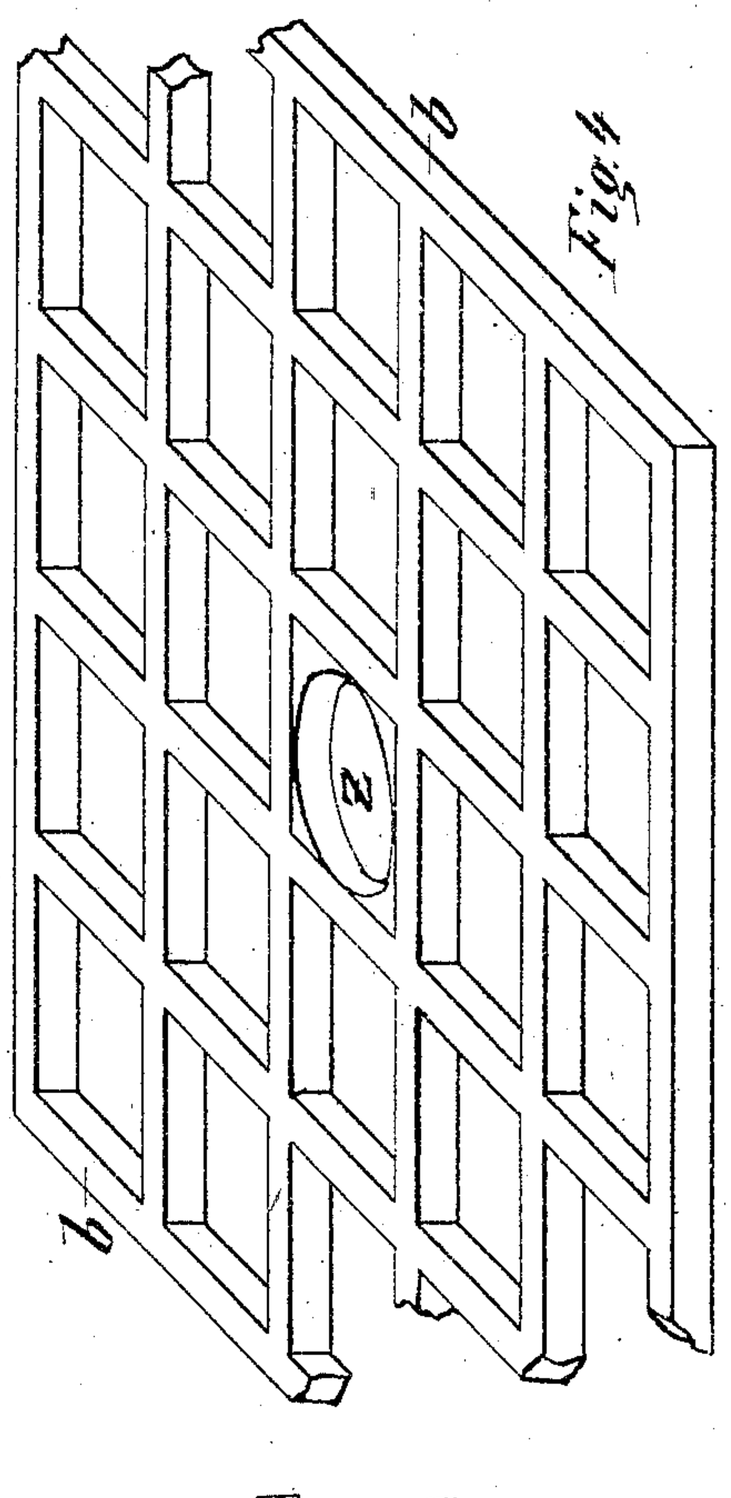



Fig. 4.




Witnesses:
C. F. Cunningham
L. L. Andrews Jr.

Inventor:
Gottlieb Epprecht
by Chapin Hayford Marble,
his attorneys.

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3 SHEETS—SHEET 2.

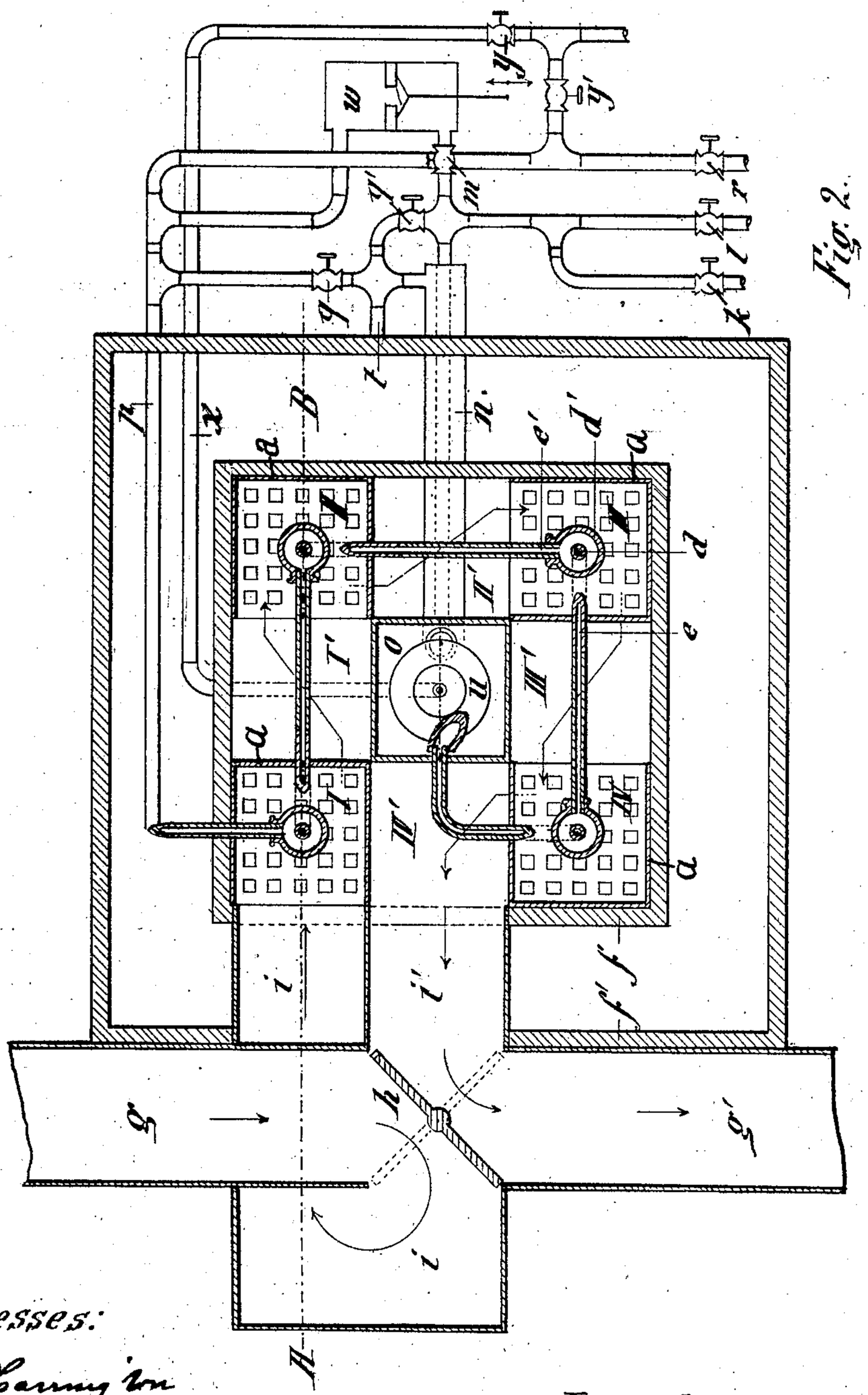


Fig. 2.

Witnesses:
C. F. Cunningham
L. L. Andrews Jr.

Inventor:
Gottlieb Epprecht
by Chapin Hayford Marble,
his attorneys.

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3 SHEETS—SHEET 3.

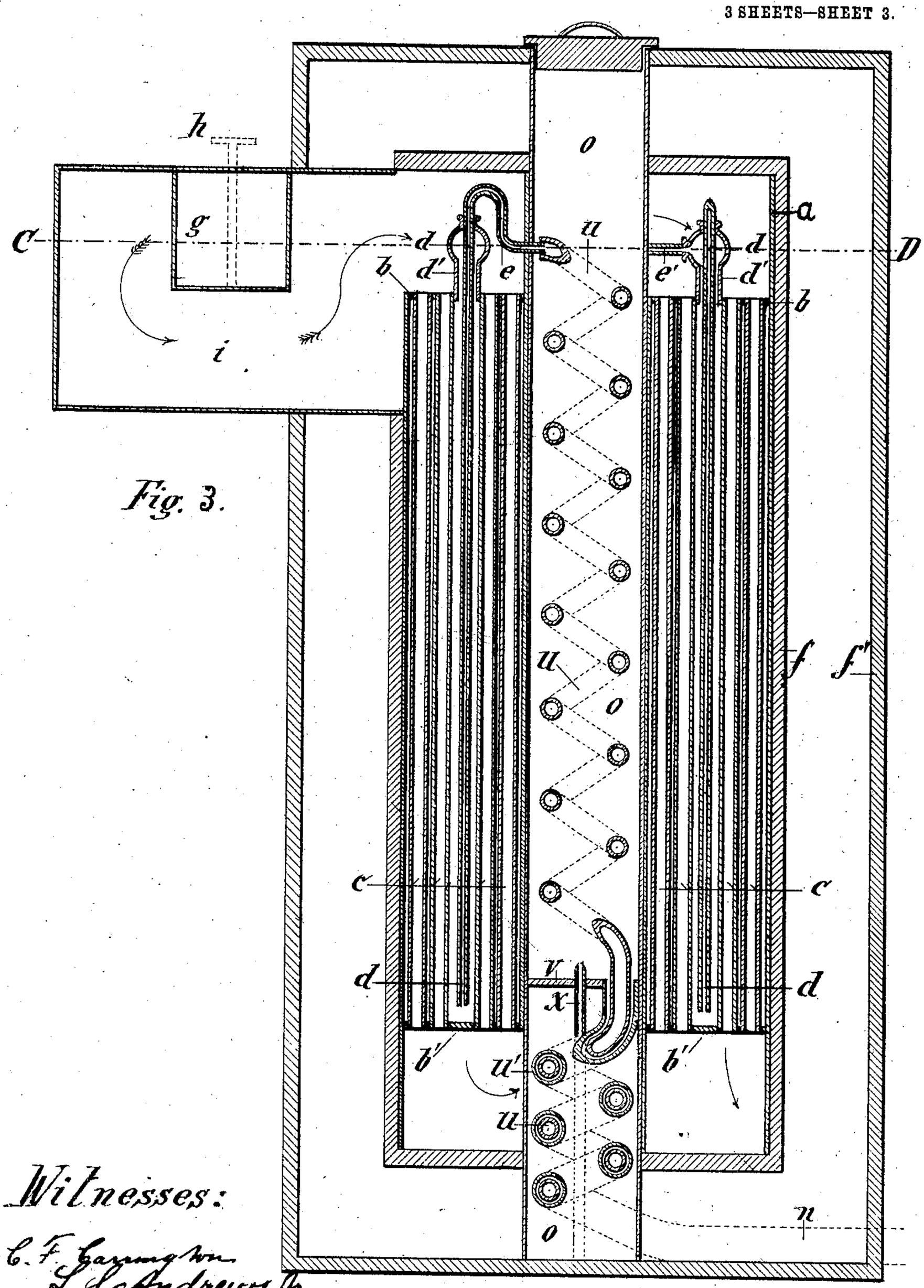


Fig. 3.

Witnesses:

C. F. Gunning Jr.

L. S. Andrews Jr.

Inventor:

Gottlieb Epprecht

by Chapin Raymond Mack,

his Attorneys.

No. 778,482. Patented December 27, 1904.

# UNITED STATES PATENT OFFICE.

GOTTLIEB EPPRECHT, OF PATERSON, NEW JERSEY.

## APPARATUS FOR COOLING OR HEATING AIR.

SPECIFICATION forming part of Letters Patent No. 778,482, dated December 27, 1904.

Application filed April 20, 1903. Serial No. 153,418.

*To all whom it may concern:*

Be it known that I, GOTTLIEB EPPRECHT, a citizen of the Confederation of Switzerland, residing at Paterson, county of Passaic, and State of New Jersey, have invented certain new and useful Improvements in Apparatus for Cooling or Heating Air, of which the following is a specification, reference being made to the accompanying drawings, forming a part thereof.

My invention relates to that class of apparatus in which an interchange of heat is effected by carrying the air through a channel or series of channels the walls of which are subjected to the action of a heat-conveying medium.

In my present invention the heat-conveying medium may be of a temperature less than the normal temperature of the air, whereby it will convey heat from the air to cool same, or it may be of a temperature greater than the normal temperature of the air, so as to convey heat thereto.

My invention comprises, substantially, a counter-current apparatus in which the air to be treated is carried in one direction throughout the apparatus, while the heat-conveying medium is carried in an opposite direction, commencing substantially at the point of delivery of the air and discharging from the apparatus at substantially the point at which the air is taken in. The apparatus is so arranged that while being used for cooling air the air will pass downwardly through vertical channels, while the heat-transferring medium which is taking heat from the air, and hence rising in temperature, will be passing upward through the channels conveying it.

My invention further consists in providing means for reversing the direction of the air and of the heat-conveying medium when it is desired to heat the air, so that during this operation the air while being heated will rise through the vertical channels provided, while the heat-transferring medium which is losing its heat at such time will be traveling downward through its vertical channels.

My invention also consists in certain details of construction and combination of parts, as will hereinafter be more fully pointed out, resulting in an exceedingly compact, durable, and inexpensive structure composed of but few parts and having a high efficiency of operation, and particularly in a novel construction in which the apparatus is built up of a plurality of units, each self-contained and a complete device in itself, so that a plurality comprising any number of these units may be put together to form an apparatus of the desired capacity.

The objects of my invention are, first, to efficiently heat or cool air for ventilating or other purposes in the same apparatus, so that the device may be used in summer-time for cooling the air and in winter-time for heating same; second, to accomplish this result in a quick, thorough, and inexpensive manner and to utilize to the highest degree the well-known system of heat interchange by the use of counter-currents, such interchange being effected progressively throughout the entire apparatus, and, third, to simplify the construction, increase the efficiency, and reduce the expense of manufacture of apparatus for the above purpose.

I will now proceed to describe an apparatus embodying my invention and will then point out the novel features in claims.

In the drawings, Figure 1 is a view in perspective, with certain parts broken away and other parts in section, of a portion of the apparatus comprising one segment or unit, of which a plurality form the apparatus herein set forth. Fig. 2 is a partial top view and a view partially in horizontal section of the whole apparatus, the plane of section being substantially upon the line C D of Fig. 3. Fig. 3 is a view in vertical section of the apparatus, the plane of section being taken substantially upon the line A B of Fig. 2. Fig. 4 shows a view in perspective and partly broken away, upon a larger scale than the previous figures, of a perforated diaphragm or grating which forms part of each unit or segment shown in Fig. 1. Fig. 5 is a detail view in perspective, showing the connection of the air-tubes with the diaphragm or grating.

The apparatus is made up substantially of a plurality of units or segments, one of which is illustrated in Fig. 1, each unit comprising a rectangular casing *a*, provided at the upper and lower ends with a perforated diaphragm

*b b'*. These diaphragms *b b'* are perforated throughout, as shown in detail in Figs. 4 and 5, and tubes *c* are fitted thereto and extend between them. The casing *a* and diaphragms *b b'* will preferably be composed of metal and will have some strength and rigidity, while the tubes *c*, also preferably made of metal, will be as thin as it is possible to make them consistent with sufficient strength and durability to withstand the action of the fluids passing through and around them. In other words, the tubes *c* are not intended to provide strength or rigidity to the apparatus as a whole, but merely to act as conduits for the passage of fluid. These tubes will preferably be composed of metal well adapted for conducting heat.

The space inclosed by the casing *a* around the tubes *c* is a single chamber—that is to say, the spaces around all the tubes are in connection with each other. The tubes discharge into common chambers above and below the diaphragms or gratings *b b'*; but the tubes have no connection with each other at points intermediate their ends. The area of the tubes is very much larger than the area of the space between them, and the tubes are intended for conveying air therethrough, while the space between them is intended for the heat-conveying medium.

Means are provided for admitting and conveying away the heat-conveying medium in two pipes—an outer pipe *d'*, which terminates at the upper diaphragm or grating, and an inner pipe *d*, which passes through the upper diaphragm or grating and terminates at a point somewhat above the lower diaphragm or grating. As a matter of construction there is no tube *c* occupying the extreme center of the unit, and the space thereby left in the grating *b* (designated by the reference character Z in Fig. 4) may conveniently be utilized for connection with the pipe *d'*. The pipe *d* passes down into the interior of the chamber in the space left by the omission of the pipe *c* at that point.

The pipe *d* is shown as telescoped by the pipe *d'* and passes therethrough into the said chamber, whereby both pipes are arranged to communicate with the said chamber through the upper diaphragm with but a single connection.

A pipe *e* leads to the interior pipe *d*, while the pipe *e'* leads from the exterior pipe *d'*. When the apparatus is used for cooling air, the inner pipe *d* is the admission-pipe for the heat-conveying medium, while the outer pipe *d'* is the discharge-pipe therefor; but when the apparatus is used for heating air the outer pipe *d'* is employed for admission of the heat-conveying medium, while the inner pipe *d* is used for the discharge thereof.

While a single unit, as shown in Fig. 1, could be made to form an effective apparatus, it would necessitate the same being of such great length as to be impracticable for ordinary purposes, and for this purpose I preferably employ a plurality of units constructed as shown in Fig. 1 and connect them together by means of air-passages and pipes, so as to form a complete continuous apparatus. As many units may be employed as is desired to produce the required result in both temperature and volume, and they may be grouped in any manner desired.

In Figs. 2 and 3 I have shown an apparatus comprising four such units, which, together with certain air-ducts and pipe connections and a suitable outer casing, comprises a complete and compact device of high efficiency.

I have grouped four units similar to that shown in Fig. 1 around a central chamber *o*, having substantially the same cross-sectional area as one of the units. These units I have numbered I, II, III, and IV in Fig. 2 of the drawings, and by such arrangement it will be seen that besides the central chamber other chambers (marked I', II', III', and IV') are formed, which may be utilized for the purpose of conveying air from one unit to the other. The walls of the casing of each unit are preferably extended at the top and bottom above and below the diaphragms or gratings *b b'* on three sides, the fourth side being left open, so as to communicate with the next adjacent chamber on one side. In this way unit I may connect at the bottom with chamber I', while unit II may connect at the top with the same chamber and at the bottom with chamber II'. In like manner unit III may connect with chamber II' at the top and with chamber III' at the bottom, and so on throughout the apparatus. Unit I connects at the top with a duct or channel *i*, and chamber IV' connects at it supper end with a duct or channel *i''*.

*g* designates an inlet for air to be treated, and *g'* a discharge for the same after it has been treated. A gate *h* connects each of the ducts or channels *i i''* with either of the passages *g g'*, respectively, in accordance with its position. When the apparatus is employed for cooling air, the inlet-passage *g* is connected with the duct or channel *i* and the discharge-passage *g'* with the duct or channel *i''*, while when the apparatus is employed for heating air the inlet-passage *g* will be connected with the duct or channel *i''*, while the discharge-passage *g'* will be connected with the duct or channel *i*. The central chamber *o* has provided therein a coil *u* and is divided into two parts by means of a diaphragm *v*. Below the diaphragm *v* a second coil *u'* surrounds the inner coil *u*. The outer coil *u'* terminates in the diaphragm *v* and connects with the interior space within the chamber *o* above same.

When it is desired to use the apparatus for cooling air, the action is as follows: Air enters through passage *g* and passes by the gate *h* into the duct or channel *i* to the upper end of the unit I, down through the tubes *c* of the

unit I, and thence from the unit I to the lower end of the chamber I′, up through the chamber I′ to the upper end of the unit II, down through the tubes in the unit II to the lower end of the chamber II′, up through the chamber II′ to the upper end of the unit III, down through the tubes *c* in the unit III to the lower end of the chamber III′, up through the chamber III′ to the upper end of the unit IV, down through the tubes in the unit IV to the lower end of the chamber IV′, up through the chamber IV′ to the duct or channel *i*″, out past the gate *h*, through the passage *g*′. During this time water under city pressure may enter through the pipe containing the valve *k*, (open for this purpose,) through the inner pipe of the two pipes designated by the reference character *n* in the drawings, such pipes connecting, respectively, with the inner and outer coils *u u*′, up through the inner coil *u* into the pipe *e* of the fourth unit, and thence through the inner pipe *d* to the bottom of the chamber inclosed by the said unit, filling the said chamber and discharging through the outer pipe *d*′ and pipe *e*′ to the inlet of the next unit III, and so on through units II and I and out through return-pipe *p* and valve *q* to waste-pipe *t*. The chamber *o* may be filled with ice, so that the water in passing through the coil *u* in chamber *o* will be robbed of its heat, and hence in passing through the units IV, III, II, and I will absorb a greater quantity of heat from the air circulating through the tubes *c* thereof. As the ice in the chamber *o* absorbs heat and returns to a liquid condition the water resulting therefrom will pass down through the outer coil *u*′ in an opposite direction to the incoming water through the coil within same and will absorb still further heat until finally it is discharged through the outer member of the compound pipes *n* through to the waste-pipe *t*.

I have illustrated conventionally a small pump *w*, which may be employed if the available water-pressure is not sufficient to drive water through the apparatus or if it be desired to use the same water over and over again. In this case valve *m* will be open and the pump operated to draw return water therethrough and return the same through the apparatus through pipe *p*, as before.

When it is desired to employ the apparatus for the purpose of heating the air—that is to say, conveying heat thereto instead of cooling the air and conveying heat therefrom—the gate *h* will be thrown to the dotted position shown in Fig. 2 and air admitted through the duct or channel *i*″ to the lower end of the unit IV, up through the said unit to the upper end of the chamber IV′, and so on throughout the apparatus, discharging from the upper end of the unit I to the channel *i* and through the discharge-passage *g*′. It will now be seen that while the air descended through the various units when being cooled it will now ascend therethrough while being heated. In this way the most efficient and economical operation will result. The heat-conveying medium in this case will be a fluid at a higher temperature than the air and may conveniently be hot water, steam, or water heated by steam within the apparatus itself. If water heated from an outside source is supplied to the apparatus, it may be admitted to the apparatus and carried therethrough in the same manner as described for the cold water above, except that its direction will be reversed. This may be done by properly operating the valves provided—namely, by closing valves *k* and *q* and opening valves *r* and *l*, valve *r* admitting hot water directly to the pipe *p* and to the upper end of the unit I, from whence it discharges through the inner pipe *d* and *e* to the pipe *e*′ and out of pipe *d* of the next unit, and so on through the apparatus. It finally passes down through the inner coil *u*′ and out through the pipe containing the valve *l*. Valves *q* and *k* are closed at this time, as is also the pump-valve *m*. If steam is utilized, water from city main may pass through the apparatus or may be circulated therethrough by the pump *w*, while steam is admitted into the chamber *o* through a pipe *x*, provided for the purpose and which penetrates the diaphragm *v* in said chamber. Condensed steam will pass away through the outer coil *u*′ to waste, while water passing through the inner coil *u* will take up heat from the steam in the chamber *o* and from the hot water of condensation passing out through outer coil *u*′.

Steam may be used directly for heating purposes, if desired, and in this case the steam will enter unit I through the pipe *p*, valves *y*′ *q*′ being open, while valves *y q m l k r* are closed. The steam will pass successively through the units I, II, III, and IV, finally passing out through the coil *u* in the chamber *o* to discharge. The steam that condenses in the various units I, II, III, and IV will be readily discharged, because directly the water begins to rise in the said units it will act as a seal upon the lower ends of inner pipes *d* and will then be lifted therethrough by the pressure on the top of same and discharged successively through the various pipes and finally through the coil *u*. Briefly, then, the position of the valves during the operation of the apparatus under different conditions will be as follows: First, when water is used as a cooling medium and is permitted to go to waste the valves *k* and *q* will be open and the other valves closed; second, when water is continuously circulated through the apparatus by the pump the valve *m* should be open and the other valves closed; third, when hot water is circulated through the apparatus valves *r* and *l* will be open and the other valves closed; fourth, when water circulating through the pipe *n* under the conditions above stated in clause one or clause two is to be

heated by steam in the chamber *o* the valve *y* will be open, in addition to the other valves *k* and *q* or the valve *m;* fifth, when steam is used for direct heating valves *y'* and *q'* will be open and the other valves closed.

By the foregoing it will be seen that I have provided an extremely simple apparatus in which air may be either cooled or heated in a most efficient, practical, and economical manner, the area of the air-conveying conduits being so proportioned to the area of the heat-conveying medium as to give the best results, while the air and the heat-conveying medium are given directions of flow advantageously designed with a view to utilizing their natural tendency to rise or fall, in accordance to whether they are absorbing or giving off heat.

The apparatus as a whole may conveniently be supplied with an outer casing of wood or other non-heat-conducting material, a dead-air space being left between the said units and the casing to further insulate same.

It is obvious that the foregoing is but one embodiment of my invention and that the same is capable of many and varied modifications within the spirit and scope of my invention, and, further, that certain parts may be employed in connection with other parts of different construction. Hence I do not desire to be limited only to the precise details of construction and combination of parts herein set forth.

What I claim is—

1. An apparatus for cooling or heating air, having contiguous channels for the passage of air and a heat-conveying medium, provided with means for reversing the direction of the air through its channel, in accordance with the character of the heat-conveying medium employed.

2. An apparatus for cooling or heating air, having contiguous channels for the passage in opposite directions of air and a heat-conveying medium, provided with means for reversing the direction of the air and the heat-conveying medium through their respective channels, in accordance with the character of the heat-conveying medium employed.

3. In an apparatus for cooling or heating air, the combination with a plurality of units, each consisting of an inclosed chamber for receiving a heat-conveying medium, a plurality of air pipes or conduits extending therethrough, and means connected with the chamber for admitting and discharging the heat-conveying medium, of channels connecting the ends of said air pipes or conduits together, means connecting the discharge for the heat-conveying medium of one unit with the intake therefor of the next succeeding unit, and a regenerating-coil in connection therewith through which the said heat-conveying medium is arranged to pass.

4. In an apparatus for cooling or heating air, the combination with a plurality of units arranged vertically and side by side, each consisting of an inclosed chamber for receiving a heat-conveying medium, a plurality of vertical air pipes or conduits extending therethrough, and admission and discharge connections for said chamber, said units spaced apart to form a channel or chamber between adjacent units, said channel or chamber serving to connect the upper ends of the air pipes or conduits of one unit with the lower ends of the air pipes or conduits of the next succeeding unit; and connections between the discharge for the heat-conveying medium of one unit with the intake therefor of the next succeeding unit.

5. In an apparatus for cooling or heating air, the combination with an inclosed chamber having upper and lower diaphragms, a plurality of parallel pipes or conduits connected at opposite ends with the said diaphragms and discharging therethrough, and inlet and discharge connections for the said chamber, of a coil permitting passage therethrough of a heat-conveying medium, to which coil one of said connections is connected, a chamber inclosing said coil, a diaphragm separating said chamber into two parts at a point intermediate the ends of the said coil, and a second coil surrounding that portion of the first-mentioned coil contained in one part of said chamber, said coil in communication with the other part of said chamber.

6. In an apparatus for cooling or heating air, the combination with a plurality of units, each consisting of an inclosed chamber for receiving a heat-conveying medium, a plurality of air pipes or conduits extending therethrough, and admission and discharge connections for said chamber, and connections between the discharge from the heat-conveying medium of one unit with the intake therefor of the next succeeding unit, of a coil permitting passage therethrough of the heat-conveying medium, to one end of which coil a said connection from the end unit of a series is connected, a chamber inclosing said coil, a diaphragm separating said chamber into two parts at a point intermediate the ends of said coil, and a second coil surrounding that portion of the first-mentioned coil contained in one part of said chamber, said coil in communication with the other part of said chamber.

7. In an apparatus for cooling or heating air, the combination with four units, each consisting of an inclosed chamber for receiving a heat-conveying medium, a plurality of air pipes or conduits extending therethrough, and admission and discharge connections for said chamber, of a central chamber around which said units are grouped, each of said units spaced apart from the next succeeding unit to form a channel or chamber between them, said channel or chamber serving to connect the opposite ends of the said air pipes or con-

duits of adjacent units, connections between the discharge for the heat-conveying medium of one unit with the intake therefor of the next succeeding unit, and a coil for the heat-conveying medium within said central chamber, said coil connected at one end with one of the said connections of the end unit of the series.

8. In an apparatus for cooling or heating air, the combination with four units, each consisting of an inclosed chamber for receiving a heat-conveying medium, a plurality of air pipes or conduits extending therethrough, and admission and discharge connections for said chamber, of a central chamber around which the said units are grouped, each of said units spaced apart from the next succeeding unit to form a channel or chamber between them, said channel or chamber serving to connect the opposite ends of the said air pipes or conduits of adjacent units, connections between the discharge for the heat-conveying medium of one unit with the intake therefor of the next succeeding unit, a coil for the heat-conveying medium within said central chamber, said coil connected at one end with one of the said connections of the end unit of the series, a diaphragm separating said central chamber into two parts, and arranged at a point therein intermediate the ends of the said coil, and a second coil surrounding that portion of the first-mentioned coil contained in one part of the said chamber, said coil in communication with the other part of the said chamber.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

G. EPPRECHT.

Witnesses:
MAURICE BRIX,
FELIX G. PITTET.