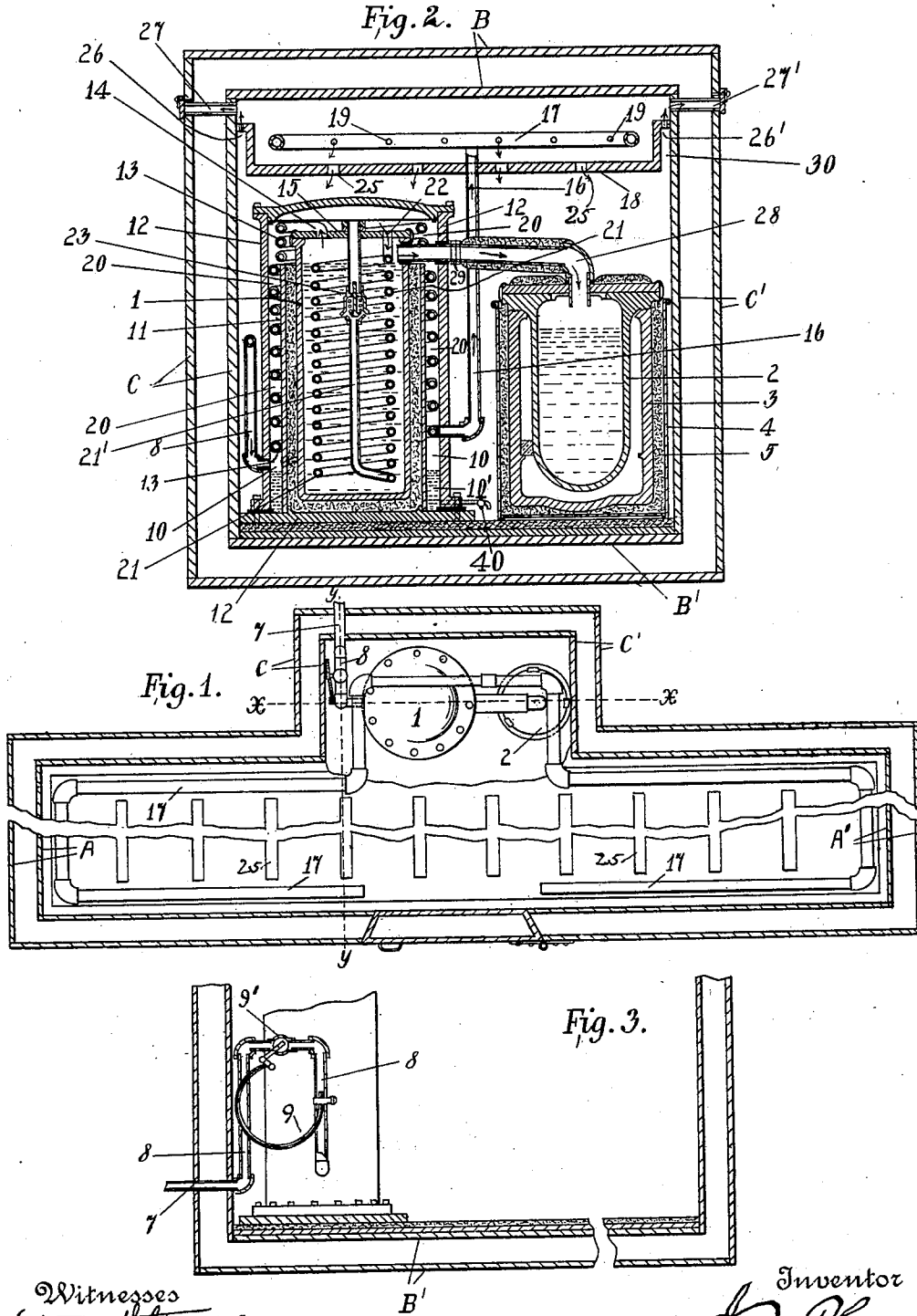


J. F. PLACE.
APPARATUS FOR COOLING BY LIQUID AIR.

(Application filed Aug. 29, 1900.)

2 Sheets—Sheet 1.

(No Model.)



Witnesses
Edgeworth Bruce
Edmund W. Powers

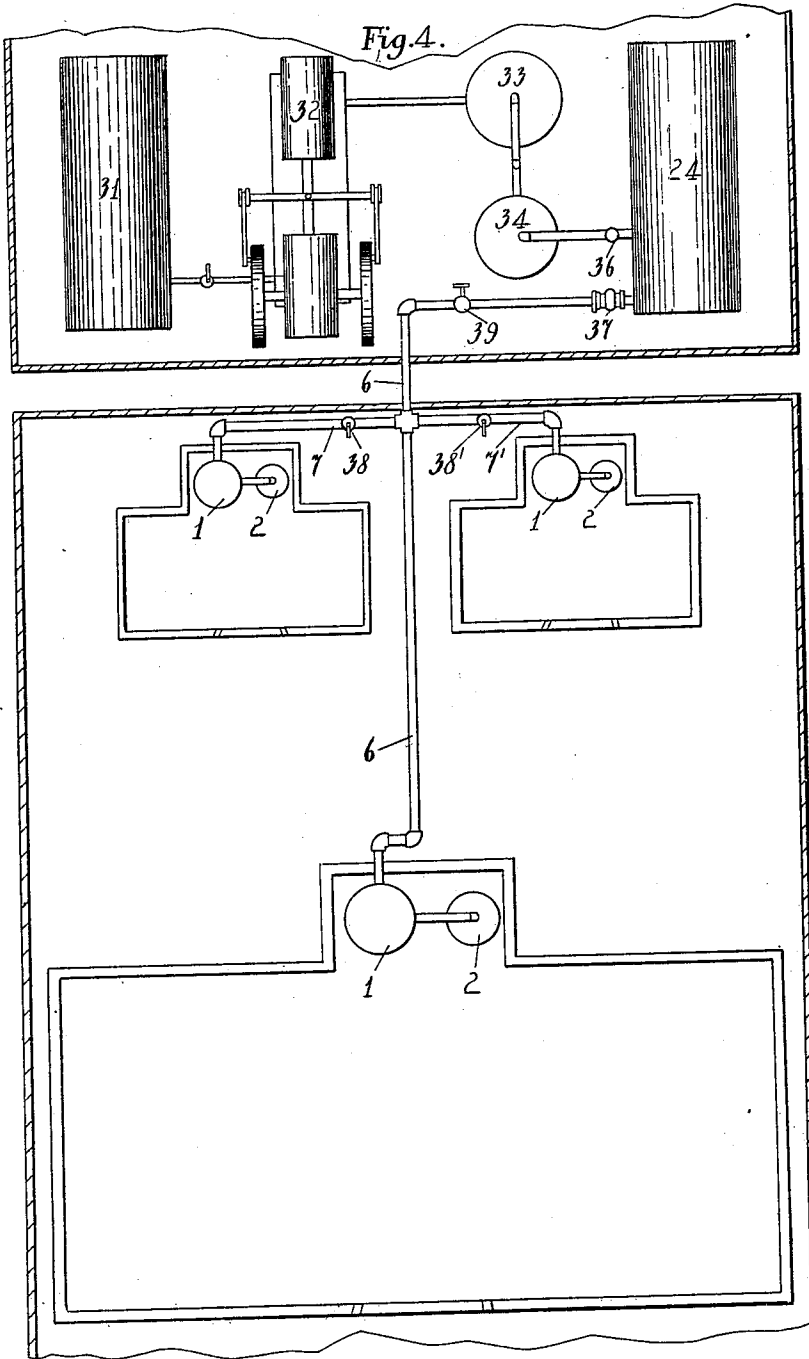
Inventor
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J. F. PLACE.
APPARATUS FOR COOLING BY LIQUID AIR.

(Application filed Aug. 29, 1900.)

2 Sheets—Sheet 2.

(No Model.)



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UNITED STATES PATENT OFFICE.

JAMES F. PLACE, OF GLENRIDGE, NEW JERSEY, ASSIGNOR TO JAMES CAVANAGH AND SAML. WEIL, TRUSTEES.

APPARATUS FOR COOLING BY LIQUID AIR.

SPECIFICATION forming part of Letters Patent No. 666,693, dated January 29, 1901.

Application filed August 29, 1900. Serial No. 28,445. (No model.)

To all whom it may concern:

Be it known that I, JAMES F. PLACE, a citizen of the United States, residing in Glenridge, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Apparatus for Cooling by Liquid Air, of which the following is a specification.

My invention relates to an improved apparatus for cooling by liquid air any given cold-storage inclosure, warehouse, market, or refrigerating-compartment, or a plurality of such compartments, and to maintain in the same any predetermined and relatively low temperature, the construction herein employed being mainly intended for cooling the compartments by compressed air supplied from a stationary air-compressing plant located outside of the compartment or compartments to be cooled, so that one plant can be used for a plurality of cold-storage compartments or chambers.

For this purpose the invention consists of an apparatus for cooling by liquid air comprising the compartment to be cooled, a liquid-air condenser located in said compartment and consisting of a liquid-air reservoir adapted to receive an initial charge of liquid air, a submerged liquefying-coil therein and delivering thereto, a low-pressure coil surrounding said liquid-air reservoir and connected with the same, a high-pressure channel between the convolutions of said low-pressure coil, said channel being connected at its lower end with a source of supply of compressed air and at its upper end with a liquefying-coil, and cold-air-distributing pipes connected with the lower end of the low-pressure coil and delivering into the compartment to be cooled.

The invention consists, further, in the combination, with the liquid-air condenser described and the compartment to be cooled, of an outside source of supply of compressed air and a horizontal partition extending at the upper part of the compartment to be cooled below the air-distributing pipes, said compartment being provided with openings and with angular perforated extensions at opposite sides, so as to establish a current of warm air in upward direction toward the upper part

of the compartment and to the outside of the same; and the invention consists, lastly, of certain details of construction and combinations of parts, which will be fully described hereinafter and finally pointed out in the claims.

In the accompanying drawings, Figure 1 represents a horizontal section of a refrigerating compartment or chamber, showing a portion of the horizontal partitions arranged near the top of the compartment removed, so as to show the liquid-air condenser. Fig. 2 is a vertical transverse section through the refrigerating-compartment and the liquid-air condenser in the same, taken on line *xx*, Fig. 1. Fig. 3 is a vertical section on line *yy*, Fig. 1, showing the inlet-cock of the compressed-air-supply pipe in connection with the thermostatic governor; and Fig. 4 is a plan view of an air-compressing plant connected with a plurality of compartments and apparatus for cooling the same by liquid air.

Similar characters of reference indicate corresponding parts.

In the drawings, A and A' are the side walls of the cold-storage compartment or refrigerating-chamber, B B' the top and bottom walls of the same, and C C' are projecting walls, which form a part of the compartment or chamber in the nature of an extension, in which the apparatus for cooling by liquid air is located.

1 is a liquid-air reservoir, and 2 a storage-tank for liquid air, which is connected with the upper part of the reservoir 1 by a jacketed pipe 28. The storage-tank is insulated by a vacuum-jacket 3 and an outside casing 4, the latter being again insulated by a packing 5.

6 represents a compressed-air-supply pipe, which is connected by branch pipes 7 and 7' with several refrigerating-chambers.

8 is that portion of the compressed-air pipe which is located at the inside of each compartment or chamber. 9 is a thermostatic governor, also located inside the compartment or chamber to be cooled, whereby the amount of compressed air admitted to the liquid-air reservoir through the conduit 8 is regulated by the temperature of the atmosphere in the refrigerating-chamber. The thermostatic governor 9 is made in the usual way of two

pieces of metal of different degrees of expansion, so that any variation of the temperature from a predetermined point may be regulated, the governor opening or closing more or less, according to the rising or falling of the temperature in the refrigerating-chamber, so as to admit either an additional supply of compressed air or diminish the supply of the same to the liquid-air condenser. The amount of compressed air admitted to and liquefied in the condenser governs the rapidity of evaporation, and thereby the amount of cold dry vapor delivered to the compartment or chamber to be cooled. The greater the quantity of cold vapor delivered within a given time the lower will be the temperature and the smaller the quantity of vapor delivered the higher will be the temperature in the compartment. The liquid-air reservoir 1 is surrounded by an interior casing 11, which is filled with a suitable packing and which is again inclosed by an exterior closed casing 12, having a tightly-fitting cover, an annular space being formed between the interior and exterior casings. The liquid-air reservoir 1 is also provided with a cover 15 and above the same with a cold-air chamber formed between the covers of the liquid-air reservoir 1 and exterior casing 12. The cold-air chamber is connected with the upper end of a liquefying-coil 21, that is suspended in the liquid-air reservoir 1 and submerged in the charge of liquid air placed in the same. The lower end of the liquefying-coil 21 is bent inwardly toward the center of the coil and then upwardly, so as to form an upright pipe, which is provided with a delivery-valve 23, through which the air liquefied in the coil 21 is discharged into the liquid-air reservoir, so as to replace gradually the initial charge of liquid air placed in the same when the refrigerating apparatus is started. In the annular space between the interior casing 11 and the exterior casing 12 is arranged a low-pressure helical coil 13, between the convolutions of which a helical passage 20 is formed, to the lower portion of which compressed air is supplied from a source of supply outside of the compartment to be cooled. The compressed air is conducted from the lower part of the annular chamber to the upper end of the same, said lower end being connected with the part 8 of the compressed-air-supply pipe located inside of the refrigerating-chamber, as shown in Fig. 2. The upper end of the low-pressure coil 13 is connected through the opening 14 in the cover of the liquid-air reservoir with the interior of the same, so that the cold vapors pass from the upper part of the reservoir in downward direction through the low-pressure coil and then from the lower end of said coil through the pipe 16 to the cold-air-distributing pipes 17 and through the delivery-holes 19 of the same to the upper part of the refrigerating compartment or chamber, as shown clearly in Fig. 2. The compressed air from the outside source of compressed air passes through the supply-

pipe 8 within the compartment or chamber to be cooled, enters into the lower part of the annular space between the interior and exterior casings, passes then up through the helical channel 20, formed between the convolutions of the low-pressure coil, and is conducted into the cold-air chamber above the liquid-air reservoir 1 and from the same through a connecting-joint 22, passing through the cover 15 to the upper end of the liquefying-coil 21. The compressed air passes in a counter-current to the low-pressure vapor, which is conducted in downward direction through the low-pressure coil 13 and is delivered at a low temperature into the liquefying-coil 21, then passed downward through the same into the central upright portion of the same, and through the check-valve 23 into the liquid-air reservoir, being liquefied by the extreme cold to which the same is subjected by its passage through the liquefying-coil. The low temperature to which the compressed air is first subjected while passing in the helical channel between the convolutions of the low-pressure coil and the convolutions of the liquefying-coil in the liquid-air reservoir reduces the temperature of the compressed air to such an extent that it is delivered in liquid condition through the check-valve 23 into the reservoir, so as to replenish the supply of liquid air evaporated from the same. The cold dry vapors evaporated at the upper part of the reservoir are taken up by the low-pressure pipe 13 and forced in a downward direction through the same, so as to absorb the heat from the inwardly and upwardly passing body of compressed air while the same passes through the helical passage 20. If any moisture has been left in the compressed air, it will be condensed and settle in the lower part 10' of the annular space 10, from which it is removed through the pet-cock 40. (Shown in Fig. 2.) The cold vapors that are conducted in downward direction through the low-pressure coil 13 are delivered at the lower end of the same to an upwardly-extending pipe 16, which connects with the perforated distributing-pipe 17 at the upper part of the compartment to be cooled. Below the distributing-pipe 17 is arranged a horizontal partition 18, which is provided with a number of openings 25, through which the cooled air passes in downward direction through the compartment or chamber to be cooled, so as to circulate therein and reduce the temperature in the same. As it becomes gradually heated it passes along the walls of the compartment or chamber in an upward direction and through the perforations 26 and 26' in the angular upwardly-extending portions at the ends of the horizontal partitions 18, said angular portions forming spaces 30, that extend above the distributing-pipe 17 around the compartment, so as to permit the warm air to pass up and create a current through the holes 26 and 26' into the space above the partition 18 and then out to

the outside of the refrigerating-compartment through the vent-tubes 27 and 27' to the atmosphere. The vent-tubes 27 and 27' are provided at their outer ends with flap-valves, which permit the escape of the air from the inside of the compartment to the outside, but prevent the ingress of the outside air into the compartment.

The compressed air is supplied to the supply-pipe 6 from a storage-tank 24, to which the compressed air is delivered from an air-compressor 32, which receives its steam from a boiler 31. (Shown in Fig. 4.) The compressed air is conducted from the air-compressor through a purifying brine-tank 33 and a moisture-extracting calcium-chlorid tank 34, which are of the ordinary construction. The heat of compression is removed from the air by a cooler that is interposed between the moisture-extractor 34 and the storage-tank 24 for the compressed air, or the tank 34 can be used as a cooler. From the storage-tank 24 the compressed air is conducted through the pipes 6 and branch pipes 7 and 7' to the refrigerating apparatus, located in the different refrigerating compartments or chambers, as shown in Fig. 4.

36 is a check-valve for retaining the proper pressure within the storage-reservoir 24.

37 is a pressure-reducing valve which is located in the supply-pipe 6 and by which uniform predetermined pressure is maintained in the supply pipes, coils, and passages of the refrigerating apparatus, regardless of the pressure of the compressed air in the storage-reservoir 24.

38 and 38' are cocks located in the branch supply-pipes 7 and 7', so that the compressed air may be shut off from any one of the compartments to be cooled without shutting off the others. 39 is a similar cock or valve in the main supply-pipe 6, so as to close up the supply of compressed air in the main supply-pipe.

I am aware that refrigerating apparatus in which a liquid-air reservoir is supplied with an initial charge of liquid air and in which the evaporated air is replaced by new quantities of liquid air produced from an outside supply of compressed air by the gradual lowering of its temperature is well known. Neither do I claim the air-compressing mechanism, purifying means, and compressed-air-storage reservoir, as the same have been used heretofore for refrigerating purposes; but I am not aware that the improved construction of the liquid-air condenser, and especially the arrangement by which the incoming compressed air is cooled by the outgoing or evaporating cold dry vapors that pass in a counter-current to the incoming compressed air through the low-pressure coil, has been known before nor the arrangement of a horizontal partition at the upper part of the compartments or chambers to be cooled and the ventilating-spaces at the upper part of the same,

by which a continuous current of the warm air in upward direction is produced, nor the arrangement of a storage chamber or tank for the liquid air in connection with the liquid-air condenser.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. In an apparatus for cooling by liquid air, the combination, with the compartment to be cooled, of a liquid-air condenser comprising a liquid-air reservoir adapted to receive an initial charge of liquid air, a submerged liquefying-coil therein and delivering thereto, an interior casing surrounding said liquid-air reservoir and said reservoir provided with a cover, a closed exterior casing, a low-pressure coil located in the annular space between the interior and exterior casings, the upper end of said coil being connected with the upper end of the liquid-air reservoir, a high-pressure channel formed between the convolutions of said low-pressure coil, the lower end of said channel being connected with a source of supply of compressed air at the outside of the compartment to be cooled, and the upper end with the chamber formed between the covers of the exterior casing and the reservoir, said chamber being connected with the upper end of the liquefying-coil, and perforated cold-air-distributing pipes connected with the lower end of the low-pressure coil and delivering into the compartment to be cooled, substantially as set forth.

2. In an apparatus for cooling by liquid air, the combination, with the compartment to be cooled, of a liquid-air condenser comprising a liquid-air reservoir adapted to receive an initial charge of liquid air, a submerged liquefying-coil therein and delivering thereto, a low-pressure coil surrounding the liquid-air reservoir and connected with the upper part of the same, a high-pressure channel formed between the convolutions of the low-pressure coil, said channel being connected at its lower end with a source of supply of compressed air at the outside of the compartment to be cooled and at its upper end with the liquefying-coil, a jacketed storage-tank sidewise of the liquid-air condenser, a jacketed pipe connecting the upper part of the liquid-air reservoir with the upper part of said storage-tank, and cold-air-distributing pipes connecting the lower end of the low-pressure coil with the compartment to be cooled, substantially as set forth.

3. In an apparatus for cooling by liquid air, the combination, with the compartment to be cooled, provided with a horizontal partition at its upper part having openings and upwardly-extending side channels, of a liquid-air condenser located in the compartment to be cooled, and comprising a liquid-air reservoir adapted to receive an initial charge of liquid air, a submerged liquefying-coil therein and delivering thereto, a low-pressure coil

surrounding the liquid-air reservoir and connected with the upper part of the same, a high-pressure channel formed between the convolutions of the low-pressure coil and connected at its lower end with a source of supply of compressed air and at its upper end with said liquefying-coil, and cold-air-distributing pipes connected with the lower end of the low-pressure coil and delivering into

the compartment to be cooled, substantially as set forth.

Signed at New York, in the county of New York and State of New York, this 28th day of August, A. D. 1900.

JAMES F. PLACE.

Witnesses:

EDMUND W. POWERS,
G. HARRY LISTER.