No. 741,591. PATENTED OCT. 13, 1903.

J. F. PLACE.

REFRIGERATING APPARATUS.

APPLICATION FILED JULY 22, 1901.

NO MODEL. 4 SHEETS—SHEET 1.

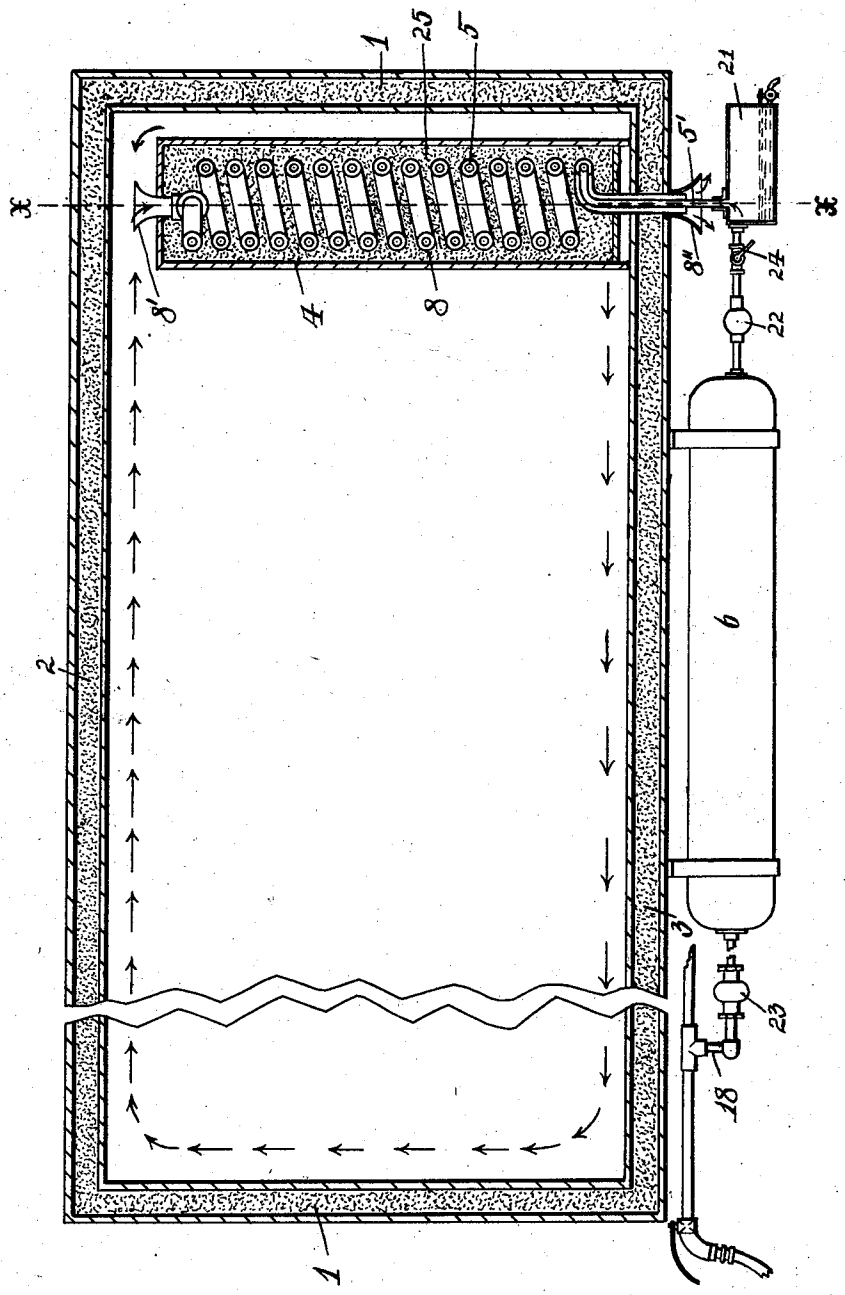


Fig. 1.

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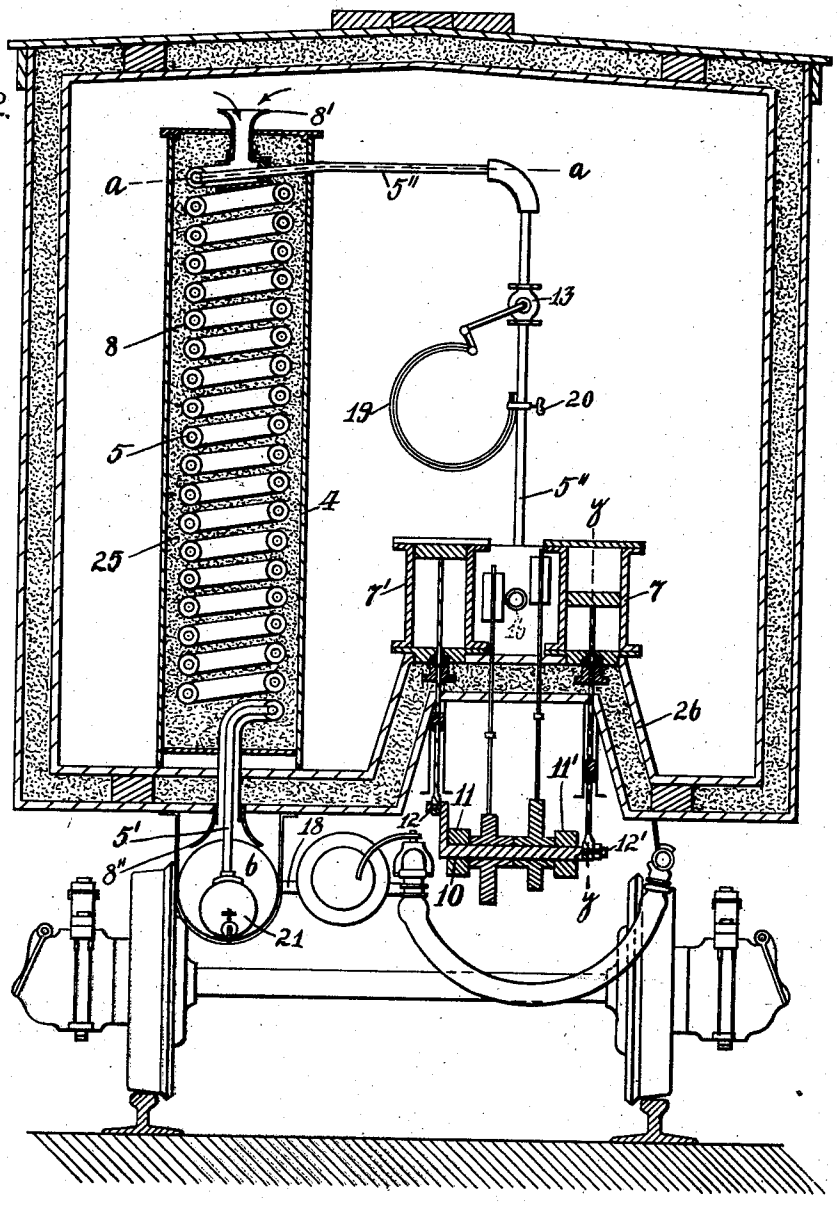
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NO MODEL. 4 SHEETS—SHEET 2

Fig. 2.



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NO MODEL. 4 SHEETS—SHEET 3.

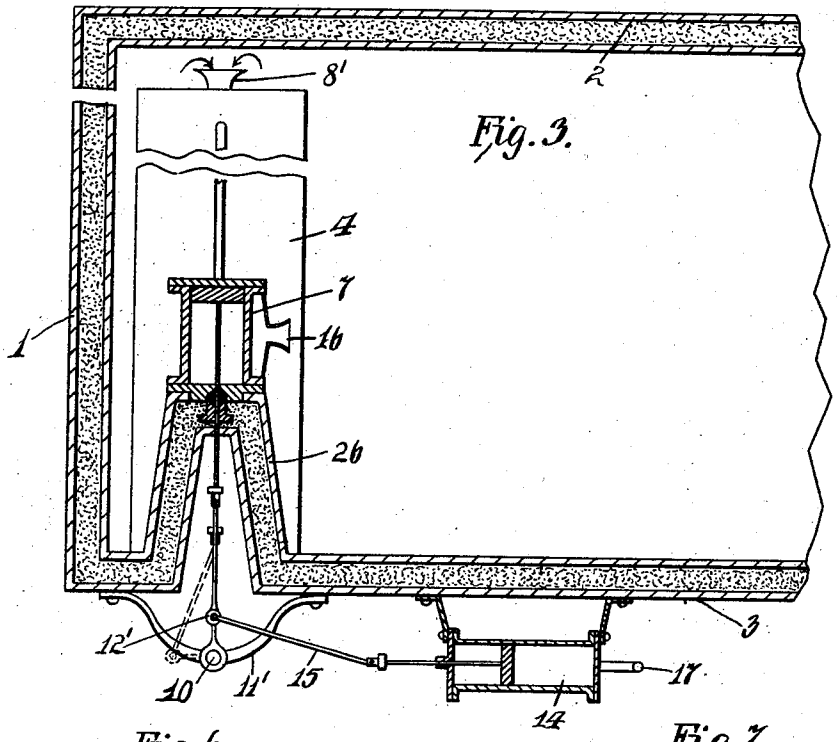


Fig. 3.

Fig. 6.

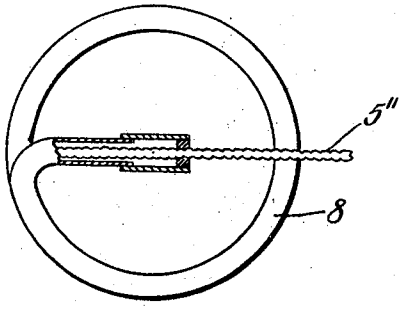


Fig. 5.

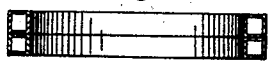


Fig. 7.



Fig. 8.

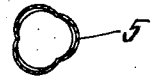
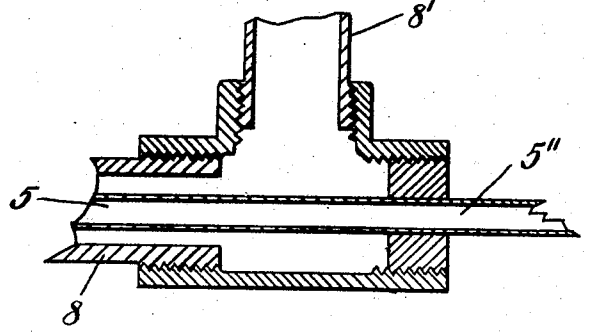


Fig. 9.



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APPLICATION FILED JULY 22, 1901.

NO MODEL. 4 SHEETS—SHEET 4.

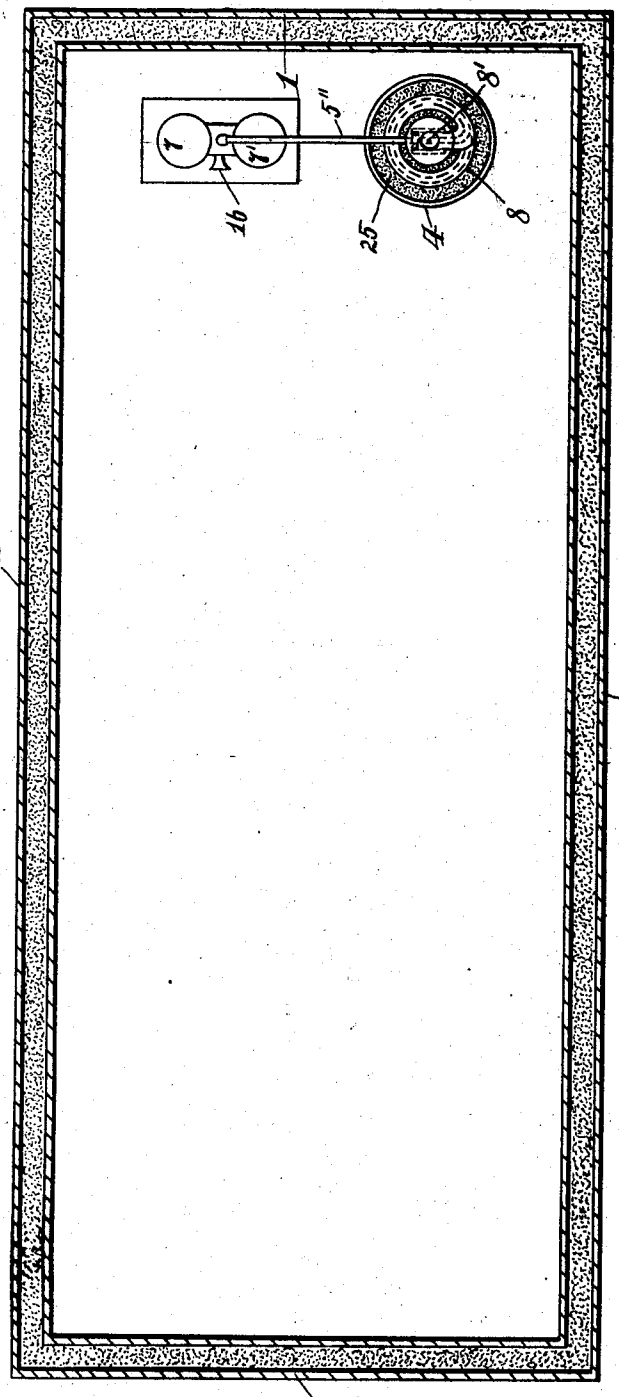


Fig. 4.

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No. 741,591. Patented October 13, 1903.

UNITED STATES PATENT OFFICE.

JAMES F. PLACE, OF GLENRIDGE, NEW JERSEY, ASSIGNOR OF TWO-THIRDS TO SAMUEL M. GARDENHIRE AND AARON P. JETMORE, OF NEW YORK, N. Y.

REFRIGERATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 741,591, dated October 13, 1903.

Application filed July 22, 1901. Serial No. 69,307. (No model.)

To all whom it may concern:

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

My invention relates to cooling cold-storage rooms, refrigerators, or other inclosed spaces where a low temperature is desired and maintaining such low temperature therein or any predetermined temperature below the normal temperature of the atmosphere in summer or above that of winter. It is also especially adapted to cooling and maintaining a cool temperature in refrigerator railway-cars in summer or for maintaining a temperature above freezing-point in such refrigerator-cars in winter. In this respect my present invention is an improvement on the plan outlined in my United States Patent No. 666,692.

The object of my invention is to reduce the cost of the cooling process and simplify the same, to also reduce the weight of the apparatus, and secure the easy regulation of the temperature, so that in the same room or refrigerator-car the temperature obtained may be at the freezing-point or below or above said freezing-point, as desired, and that whatever predetermined temperature is fixed upon the apparatus will automatically maintain that temperature regardless of the temperature of the atmosphere outside of the refrigerating room or car.

Moreover, a further object is to utilize the energy of the compressed air when expanded and in this way to secure a lower temperature by doing work as the pressure drops and to make use of the work done to help replenish the compressed air used, thus reducing to the minimum the cost and power required for cooling.

Another object is to secure a perfect circulation of pure dry air through the space to be cooled at all times and to make use of the escaping air to cool the incoming compressed air before expansion.

The further object is to avail myself for such cooling system of the surplus or reserve power of the locomotive-engine of trains and of the surplus reserve power of the air-brake system connected therewith and to utilize the same in and about the cooling and refrigeration of cars.

I attain these objects by the apparatus and mechanism shown in the accompanying drawings, of which—

Figure 1 is a vertical longitudinal section of a cold-storage room or insulated and inclosed space in a refrigerator railway-car, showing my counter-current heat-interchanger in section located in one end of the inclosed space. Fig. 2 is a transverse vertical section on the line *x x* of Fig. 1. Fig. 3 is a longitudinal vertical section of one end of the refrigerator-car or inclosed space to be cooled. Fig. 4 is a top plan view of the inside of car or inclosed space, the top being removed, so as to show location and proportionally small amount of space occupied by my improved cooling apparatus. Top of interchanger-case is removed to show coils of interchanger. Fig. 5 is a modification in manner of arranging the coils of my heat-interchanger and yet preserving their juxtaposition with each other. Figs. 6, 7, and 8 show details of high-pressure and low-pressure conduits, Fig. 6 being in horizontal section on the line *a a* of Fig. 2. Fig. 9 is an enlarged view, in vertical section, of the high-pressure and low-pressure coils where the latter leaves the former near the top of the interchanger on line *a a* of Fig. 2.

Similar reference-marks refer to similar parts throughout the several drawings.

1 is the insulated car-wall at the end, and 2 and 3 are the top and bottom of same, respectively.

4 is the case containing the counter-current interchanger, which comprises the high-pressure coil or conduit 5, which is fed from an outside source of compressed air through the compressed-air reservoir 6 and its connections, 5′ being the air-inlet end and 5″ the other end, which delivers to the air-engine 7 and 7′, and also the low-pressure coil. At 8 I show this low-pressure coil or conduit forming a part of this interchanger, which is connected with the inside of the car or inclosed space to be cooled and is open to the same by

the air-inlet 8′. This air-inlet end 8′ is located near the top inside of the car, so that the air of higher temperature in the car or room will be supplied to the low-pressure conduit through the air-inlet 8′ as it escapes from the space to be cooled. The other end of the low-pressure coil is shown at 8″, where it delivers to the atmosphere outside of the car or space to be cooled. It will be noticed that the high-pressure coil or conduit 5 is located inside the low-pressure conduit. This is the preferred construction; but these coils can be located one above the other, as shown by modification in Fig. 9. All that is required is that the two coils or conduits shall be fixed in juxtaposition, so that the heat of the incoming compressed air in one can readily be interchanged or transferred to the outgoing or escaping air carried by the other coil or conduit, and so arranged that the column or currents of air pass not only in juxtaposition, but in opposite directions, the compressed air going inwardly, while the expanded escaping air passes outwardly in close contact with the outside surface of the compressed-air conduit through the length of the coil. I make the low-pressure coil 8 enough larger, so that the annular space therein will allow the expanded air to pass out through it at about same speed as the compressed air in the high-pressure coil 5.

At 7 and 7′ I have an air-engine, preferably being built on duplex style and located, preferably, inside the car, as shown in Figs. 2 and 3. The cylinders being connected to the same shaft 10 outside the car by cranks 12 and 12′, set at quarter-turn or at right angles, there are no "dead-points" and the engine will be sure to operate under all circumstances whenever compressed air is admitted through the cock 13.

At 14 I show a small air-pump or air-compressor, which is operated by the air-engine 7 and 7′ by means of the connecting-rod 15, which is connected to the crank 12′. The air-engine 7 and 7′ exhausts at 16 into the inside of the car or inclosed space as the compressed air from the conduit 5′, 5, and 5″ is delivered to the same and as the pressure drops and the air is expanded while doing work in the engine. The small compressor 14 as it compresses air delivers it to the compressed-air reservoir 6 through the connections 17, thus helping to restore the compressed air which is drawn therefrom by the high-pressure coil or conduit 5.

Whenever my invention is used for cooling rooms, refrigerators, or other stationary inclosed spaces, the reservoir 6 should be supplied with compressed air by a stationary plant or by any other outside source, but when used for cooling railway refrigerator-cars compressed air should be taken from the air-brake system, as shown by the connections 18, or a separate air-compressor can be used on the locomotive to either furnish an independent supply of compressed air or as an auxiliary to increase the supply in the usual air-brake system.

At 19 I have a thermostatic governor, of any approved style and construction, which by being attached to one end to lever of the cock 13 more or less compressed air is admitted to the air-engine through the conduit 5″ as the temperature within the space to be cooled rises or falls. By adjusting the thumb-screw 20 any desired tension may be given the governor 19, so that any predetermined temperature may be secured and maintained within the car or room regardless of the temperature of the outside atmosphere.

At 21 I have a small trap or box for collecting any moisture which may be condensed in the high-pressure conduit 5 as the air passes up the coil and is cooled by the escaping air which is passing down the low-pressure coil 8.

At 22 I have a check-valve, and at 23 a reducing check-valve, which retains the pressure in the reservoir 6 at a fixed pressure when the pressure is lowered in the air-brake system or other source of supply.

The engine 7 and 7′ I thoroughly insulate under the lower cylinder-heads and around the stuffing-boxes of piston-rods and eccentric-rods, so that no more heat can pass into the car at that point than at any other, and by carrying the bottom of car up, as shown at 26, a convenient foundation is supplied for the engine, and by having the crank-shaft 10 and small air-compressor 14 arranged, as shown, outside and under the car or room the heat of compression in the compressor 14 cannot be conducted into either the engine or the space to be cooled through the rods or connections, as the length of such connections exposed to the outside atmosphere precludes the passage of such heat without complete radiation or conduction to the atmosphere before it reaches the car-body.

In the operation of the apparatus by opening the cock 24 compressed air is admitted to the high-pressure conduit 5, and if the temperature of the car or room inside is above the desired temperature the cock 13 will be open and the air-engine begins to work. Whatever the temperature may be in the pipe 5′ and 5″ the exhaust 16 from the engine will be at lower degree and the escaping air passing in the air-inlet 8′ and down through the low-pressure annular conduit 8 will be correspondingly colder. Thus the next lot of compressed air leaving the interchanger and entering the conduit 5″ will also be colder. This lowering of temperature in the car or room is continued until any further fall of temperature will be checked by the action of the thermostatic governor 19 on the cock 13 and the air-engine will slow up and the amount of cold expanded air from the engine-exhaust 11 into the car will be correspondingly reduced. Thus the flow of compressed air through the conduit 5′, 5, and 5″ and the speed of the engine will be regulated to exactly correspond

with the passage of heat through the insulated car-body or room partitions. It will be noticed that the compressed air in the high-pressure conduit 5 will be uniform and of relatively high pressure; but its temperature will fall, decreasing from the inlet end 5′ at the bottom outside as its heat is interchanged or transferred to the escaping expanded air in the low-pressure annular conduit 8, until when it leaves the interchanger at the top 5″ it will be of the same temperature as that of the inclosed space or that of the escaping air entering the low-pressure conduit at the top of the inlet end 8′. Also the air escaping from the space to be cooled through the inlet 8′ and conduit 8, being of a relatively low but uniform pressure, will pass down and out through the annular conduit around the incoming compressed air with a rising temperature, increasing from the air-inlet 8′ at the top and correspondingly expanding until it is delivered to the atmosphere outside.

The conduit 5 should be made of copper or other metal of low conductivity and the shell or walls as thin as can with safety stand the pressure, (about sixty pounds.) The preferred construction is with a rope-twist tube, as shown in Figs. 6, 7, and 8, so as to give the air a helical movement in order to aid in the rapid transference of heat through the conduit-walls to the escaping air which is passing down and out. The outside or low-pressure coil or conduit 8 should be preferably made of iron. These interchanger-coils should be thoroughly insulated by hair felt 25 or other non-conducting material and inclosed in the outside case 4.

It is well known that there is a large surplus or reserve power in freight-locomotives which can be availed of on level runs or downgrades. By my system this surplus power can be availed of and only a small portion thereof will be needed to run the air-brake air-pump to compress air and store the same in the air-brake system or in auxiliary compressed-air reservoirs under each car to be used for cooling or maintaining a relatively low temperature or any predetermined temperature in the cars. If required, a separate air-pump can be attached to and run by the locomotive to increase the supply of compressed air in the air-brake system or to supply the separate air-reservoirs 6 for my cooling system.

It is important that the high-pressure tube, conduit, or inlet-pipe 5′ 5 and the low-pressure tube, conduit, or outlet-pipe 8, which comprise the heat-interchanger, shall be so arranged or located as to be in close longitudinal juxtaposition with each other, and it is also important that the high-pressure conduit shall be an ascending conduit from its inlet, so that the moisture in the compressed air as it ascends and condenses under the fall of temperature caused by being subjected to the cooling action of the outgoing or descending expanded air will run back and down into the water tank or trap 21. This is important in order that all moisture may be taken out of the air before it is allowed to pass into the air-expanding engine 7 and 7′; otherwise under the great fall of temperature therein it would freeze and cause trouble.

The heat or thermal interchanger, comprising the high-pressure helical conduit or coiled tube and the low-pressure annular helical conduit or coiled tube, having its air-inlet at or near the top of the inside of the car, so that it is fed from the expanded-air supply in the car while escaping therefrom and by the warmer portions thereof which rise to the top of the space to be cooled, I locate in the car; but it must be thoroughly insulated from the surrounding atmosphere, wherever located, by some packing or covering made of material of relatively low heat conductivity, and the preferred construction is as shown and the preferred location is within the car in an upright position and with an ascending inlet or high-pressure conduit and a descending outlet or low-pressure conduit for expanded air escaping from the space to be cooled, for the reasons stated herein.

The air-expanding engine 7 and 7′ must be located within the car or space to be cooled and exhaust into the same, as shown, so that any heat absorbed through the cylinder-walls shall be taken from the air in said car or space. It may be the ordinary type of expanding-engine with cut-off inlet-valves, as shown, so long as the air is expanded therein expansively while doing work, thus insuring the greatest fall of temperature in the air as the pressure drops and delivering same cold to the inside of the car or space to be cooled.

Having thus fully described my invention, I claim and desire to secure by Letters Patent of the United States—

1. In an apparatus for cooling by air expansion the combination of an air-expanding engine within the space to be cooled, having mechanism for doing work outside of said inclosed space; with an upright counter-current thermal interchanger, also located within the inclosed space to be cooled, and thoroughly insulated from the air within said space by coverings of hair felt or other material of low heat conductivity, said insulated thermal interchanger comprising a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit, or coiled tube, surrounding or longitudinally inclosing said high-pressure conduit or tube; said high-pressure helical conduit being fed from an outside source of compressed-air supply and having a trap or box for collecting condensed moisture at its lower or inlet end; and delivering to the space to be cooled through said air-expanding engine; and said low-pressure helical annular conduit having its inlet near the top of the inclosed space to be cooled and being fed by the warmer air escaping therefrom, substantially as shown and described.

2. In an apparatus for cooling by air expan-

sion the combination of an air-expanding engine within an inclosed space to be cooled, and having mechanism for doing work outside of said inclosed space; with an upright counter-current thermal interchanger, also located within the space to be cooled, and thoroughly insulated from the air within said space by coverings of hair felt or other materials of low heat conductivity, said insulated thermal interchanger comprising a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit or coiled tube, surrounding or longitudinally inclosing said high-pressure conduit or tube; said high-pressure helical conduit carrying compressed air of relatively high temperature, and being fed from an outside source of compressed-air supply, and having a trap or box for collecting condensed moisture at its lower or inlet end; and delivering to the space to be cooled through said air-expanding engine; and said low-pressure helical annular conduit carrying expanded air of relatively low temperature and having its inlet near the top of the inclosed space to be cooled, and being fed by the warmer air within and near the top of said space as it escapes therefrom, substantially as shown and described.

3. In an apparatus for cooling by air expansion the combination of an air-expanding engine which is located within the inclosed space to be cooled and which is arranged to exhaust expanded air into said space, and is provided with mechanism for doing work outside thereof; with an upright counter-current thermal interchanger, also located within the space to be cooled and thoroughly insulated from the air within said space by coverings of hair felt or other material of low heat conductivity, said insulated thermal interchanger comprising a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit or coiled tube surrounding or longitudinally inclosing said high-pressure conduit or coiled tube—said conduits being thus fixed in longitudinal juxtaposition with each other; said high-pressure conduit being connected at its air-inlet end with and fed from a source of compressed-air supply outside of the space to be cooled and having a trap or box for collecting condensed moisture at its lower or inlet end, and connected with and delivering to said inclosed space at the other end through said air-expanding engine; and said low-pressure helical conduit being connected at its air-inlet end with said inclosed space at or near the top thereof, and fed from the expanded-air supply in said space by the warmer expanded air escaping therefrom, substantially as shown and described.

4. In an apparatus for cooling by air expansion the combination of an air-expanding engine which is located within the inclosed space to be cooled and which is arranged to exhaust expanded air into said space and is provided with mechanism for doing work outside thereof; with an upright counter-current thermal interchanger, also located within the space to be cooled and thoroughly insulated from the air within said space by coverings of hair felt or other material of low heat conductivity, said insulated thermal interchanger comprising a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit or coiled tube surrounding or longitudinally inclosing said high-pressure conduit or coiled tube—said conduits being thus fixed in longitudinal juxtaposition with each other; said high-pressure conduit being connected at its air-inlet end with and fed from a source of compressed-air supply outside of the space to be cooled and having a trap or box for collecting condensed moisture at its lower or inlet end, and connected with and delivering to said inclosed space at the other end through said air-expanding engine; and said low-pressure helical conduit being connected at its air-inlet end with said inclosed space at or near the top thereof, and fed from the expanded-air supply in said space by the warmer expanded air escaping therefrom, and delivering at the other end to the atmosphere outside of said inclosed space, substantially as shown and described.

5. In an apparatus for cooling by air expansion the combination of an air-expanding engine within an inclosed space to be cooled, and having mechanism for doing work outside of said inclosed space; with an upright counter-current thermal interchanger, also located within the space to be cooled, and thoroughly insulated from the air within said space by coverings of hair felt or other materials of low heat conductivity, said insulated thermal interchanger comprising a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit or coiled tube surrounding or longitudinally inclosing said high-pressure conduit or tube; said high-pressure helical conduit carrying compressed air of relatively high temperature, and being fed from an outside source of compressed-air supply and having a trap or box for collecting condensed moisture at its lower or inlet end, and delivering to the space to be cooled through said air-expanding engine; and said low-pressure helical annular conduit carrying expanded air of relatively low temperature and having its inlet near the top of the inclosed space to be cooled, and being fed by the warmer air within and near the top of said space as it escapes therefrom, whereby said compressed air carried by said high-pressure conduit is cooled by the escaping air in said low-pressure conduit and is expanded in said air-expanding engine while doing work, and the extremely-cold expanded exhaust-air is thus delivered from said engine to the space to be cooled, substantially as shown and described.

6. In an apparatus for cooling by air expansion the combination of an air-expanding engine located within the inclosed space to be cooled, and provided with mechanism for do-

ing work outside thereof; with an upright counter-current thermal interchanger, also located within the space to be cooled and thoroughly insulated from the air within said space by coverings of hair felt or other material of low heat conductivity, said insulated thermal interchanger comprising a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit or coiled tube surrounding or longitudinally inclosing said high-pressure helical conduit; said conduits being thus fixed in longitudinal juxtaposition with each other; said high-pressure conduit being connected at its air-inlet end with and fed from a source of compressed-air supply outside of the space to be cooled and having a trap or box for collecting condensed moisture at its lower or inlet end and carrying air of relatively high but uniform pressure and having a falling temperature which decreases from said air-inlet; and connected with and delivering to said inclosed space at the other end, through said air-expanding engine which exhausts into said inclosed space; and said low-pressure helical annular conduit being connected at its air-inlet end with said inclosed space at or near the top thereof, and carrying air of relatively low but uniform pressure with a rising temperature which increases from said inlet, said low-pressure annular conduit being fed from the expanded-air supply in said inclosed space by the warmer expanded air escaping therefrom, substantially as shown and described.

7. In an apparatus for cooling by air expansion the combination of an air-expanding engine located within the inclosed space to be cooled, and provided with mechanism for doing work outside thereof; with an upright counter-current thermal interchanger, also located within the space to be cooled and thoroughly insulated from the air within said space by coverings of hair felt or other material of low heat conductivity, said insulated thermal interchanger comprising a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit or coiled tube surrounding or longitudinally inclosing said high-pressure helical conduit—said conduits being thus fixed in longitudinal juxtaposition with each other; said high-pressure conduit being connected at its air-inlet end with and fed from a source of compressed-air supply outside of the space to be cooled and having a trap or box for collecting condensed moisture at its lower or inlet end and carrying air of relatively high but uniform pressure and having a falling temperature which decreases from said air-inlet—and connected with and delivering to said inclosed space at the other end, through said air-expanding engine which exhausts into said inclosed space; and said low-pressure helical annular conduit being connected at its air-inlet end with said inclosed space at or near the top thereof, and carrying air of relatively low but uniform pressure with a rising temperature which increases from said inlet, said low-pressure annular conduit being fed from the expanded-air supply in said inclosed space by the warmer expanded air escaping therefrom, and delivering at the other end to the atmosphere outside of said inclosed space, substantially as shown and described.

8. In an apparatus for cooling by air expansion the combination of an air-expanding engine located within the inclosed space to be cooled, and provided with mechanism for doing work outside thereof; with an upright counter-current thermal interchanger, also located within the space to be cooled and thoroughly insulated from the air within said space by coverings of hair felt or other material of low heat conductivity, said insulated thermal interchanger comprising a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit or coiled tube surrounding or longitudinally inclosing said high-pressure helical conduit; said conduits being thus fixed in longitudinal juxtaposition with each other; said high-pressure conduit being connected at its air-inlet end with and fed from a source of compressed-air supply outside of the space to be cooled and having a trap or box for collecting condensed moisture at its lower or inlet end and carrying air of relatively high but uniform pressure and having a falling temperature which decreases from said air-inlet—and connected with and delivering to said inclosed space at the other end, through said air-expanding engine which exhausts into said inclosed space; and said low-pressure helical annular conduit being connected at its air-inlet end with said inclosed space at or near the top thereof, and carrying air of relatively low but uniform pressure with a rising temperature which increases from said inlet, said low-pressure annular conduit being fed from the expanded-air supply in said inclosed space by the warmer expanded air escaping therefrom, whereby said compressed air carried by said high-pressure conduit is cooled by the escaping air in said low-pressure conduit and is expanded in said air-expanding engine while doing work, and the extremely-cold expanded exhaust-air is thus delivered from said engine to the space to be cooled, substantially as shown and described.

9. In an apparatus for cooling by air expansion the combination of an air-expanding engine located within the inclosed space to be cooled, and provided with mechanism for doing work outside thereof; with an upright counter-current thermal interchanger, also located within the space to be cooled and thoroughly insulated from the air within said space by coverings of hair felt or other material of low heat conductivity, said insulated thermal interchanger comprising a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit or coiled

tube surrounding or longitudinally inclosing said high-pressure helical conduit; said conduits being thus fixed in longitudinal juxtaposition with each other; said high-pressure conduit being connected at its air-inlet end with and fed from a source of compressed-air supply outside of the space to be cooled and having a trap or box for collecting condensed moisture at its lower or inlet end and carrying air of relatively high but uniform pressure and having a falling temperature which decreases from said air-inlet—and connected with and delivering to said inclosed space at the other end, through said air-expanding engine which exhausts into said inclosed space; and said low-pressure helical annular conduit being connected at its air-inlet end with said inclosed space at or near the top thereof, and carrying air of relatively low but uniform pressure with a rising temperature which increases from said inlet, said low-pressure annular conduit being fed from the expanded-air supply in said inclosed space by the warmer expanded air escaping therefrom, and means for regulating by the temperature of the air within the space to be cooled the amount of compressed air delivered to said air-expanding engine, substantially as shown and described.

10. In an apparatus for cooling by air expansion the combination of an air-expanding engine located within the inclosed space to be cooled, and provided with mechanism for doing work outside thereof; with an upright counter-current thermal interchanger, also located within the space to be cooled and thoroughly insulated from the air within said space by coverings of hair felt or other material of low heat conductivity, said insulated thermal interchanger comprising a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit or coiled tube surrounding or longitudinally inclosing said high-pressure helical conduit; said conduits being thus fixed in longitudinal juxtaposition with each other; said high-pressure conduit being connected at its air-inlet end with and fed from a source of compressed-air supply outside of the space to be cooled and having a trap or box for collecting condensed moisture at its lower or inlet end, and carrying air of relatively high but uniform pressure and having a falling temperature which decreases from said air-inlet—and connected with and delivering to said inclosed space at the other end, through said air-expanding engine which exhausts into said inclosed space; and said low-pressure helical annular conduit being connected at its air-inlet end with said inclosed space at or near the top thereof, and carrying air of relatively low but uniform pressure with a rising temperature which increases from said inlet, said low-pressure annular conduit being fed from the expanded-air supply in said inclosed space by the warmer expanded air escaping therefrom, and delivering at the other end to the atmosphere outside of said inclosed space, and means for regulating by the temperature of the air within the space to be cooled the amount of compressed air delivered to said air-expanding engine, substantially as shown and described.

11. In an apparatus for ventilating and supplying pure air to a railway-car, and maintaining a relatively low temperature therein by air expansion, the combination with said car of an air-expanding engine located therein and provided with mechanism for doing work outside thereof; an upright counter-current thermal interchanger also located within said car and thoroughly insulated from the air therein by coverings of hair felt or other material of low heat conductivity, said interchanger consisting of a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit or coiled tube surrounding or longitudinally inclosing said high-pressure helical conduit—said conduits being thus fixed in longitudinal juxtaposition with each other; said high-pressure conduit being connected at its air-inlet end with and fed from a source of compressed-air supply outside of said car and having a trap or box for collecting condensed moisture at its lower or inlet end and carrying air of relatively high but uniform pressure, having a falling temperature which decreases from said air-inlet end, and which is connected at the other end with and delivers to the inside of said car, through said air-expanding engine which exhausts into said car while doing work outside thereof; and said low-pressure helical annular conduit being connected at its air-inlet end with the inside of said car at or near the top thereof, and carrying air of relatively low but uniform pressure having a rising temperature which increases from said air-inlet, said low-pressure conduit being fed from the expanded-air supply within the car by the warmer portions thereof at or near the top of said car as it escapes therefrom, substantially as shown and described.

12. In an apparatus for ventilating and supplying pure air to a railway-car, and maintaining a relatively low temperature therein by air expansion, the combination with said car of an air-expanding engine located therein and provided with mechanism for doing work outside thereof; an upright counter-current thermal interchanger also located within said car and thoroughly insulated from the air therein by coverings of hair felt or other material of low heat conductivity, said interchanger consisting of a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit or coiled tube surrounding or longitudinally inclosing said high-pressure helical conduit—said conduits being thus fixed in longitudinal juxtaposition with each other; said high-pressure conduit being connected at its air-inlet end with and fed from a source of compressed-air supply outside of said car and having a trap or box

for collecting condensed moisture at its lower or inlet end and carrying air of relatively high but uniform pressure, having a falling temperature which decreases from said air-inlet end, and which is connected at the other end with and delivers to the inside of said car, through said air-expanding engine which exhausts into said car while doing work outside thereof; and said low-pressure helical annular conduit being connected at its air-inlet end with the inside of said car at or near the top thereof, and carrying air of relatively low but uniform pressure having a rising temperature which increases from said air-inlet, said low-pressure conduit being fed from the expanded-air supply within the car by the warmer portions thereof at or near the top of said car as it escapes therefrom, and delivering at its other end to the atmosphere outside of said car, substantially as shown and described.

13. In an apparatus for ventilating and supplying pure air to a railway-car, and maintaining a relatively low temperature therein by air expansion, the combination with said car of an air-expanding engine located therein and provided with mechanism for doing work outside thereof; an upright counter-current thermal interchanger also located within said car and thoroughly insulated from the air therein by coverings of hair felt or other material of low heat conductivity, said interchanger consisting of a high-pressure helical conduit or coiled tube, and a low-pressure helical annular conduit or coiled tube surrounding or longitudinally inclosing said high-pressure helical conduit—said conduits being thus fixed in longitudinal juxtaposition with each other; said high-pressure conduit being connected at its air-inlet end with and fed from the air-brake system of said car and having a trap or box for collecting condensed moisture at its lower or inlet end and carrying air of relatively high but uniform pressure, having a falling temperature which decreases from said air-inlet end, and which is connected at the other end with and delivers to the inside of said car, through said air-expanding engine which exhausts into said car while doing work outside thereof; and said low-pressure helical annular conduit being connected at its air-inlet end with the inside of said car at or near the top thereof, and carrying air of relatively low but uniform pressure having a rising temperature which increases from said air-inlet, said low-pressure conduit being fed from the expanded-air supply within the car by the warmer portions thereof at or near the top of said car as it escapes therefrom, substantially as shown and described.

Signed at New York, in the county of New York and State of New York, this 20th day of July, A. D. 1901.

JAMES F. PLACE.

Witnesses:
LAURENCE LEVY,
FREDERICK J. GARDENHIRE.