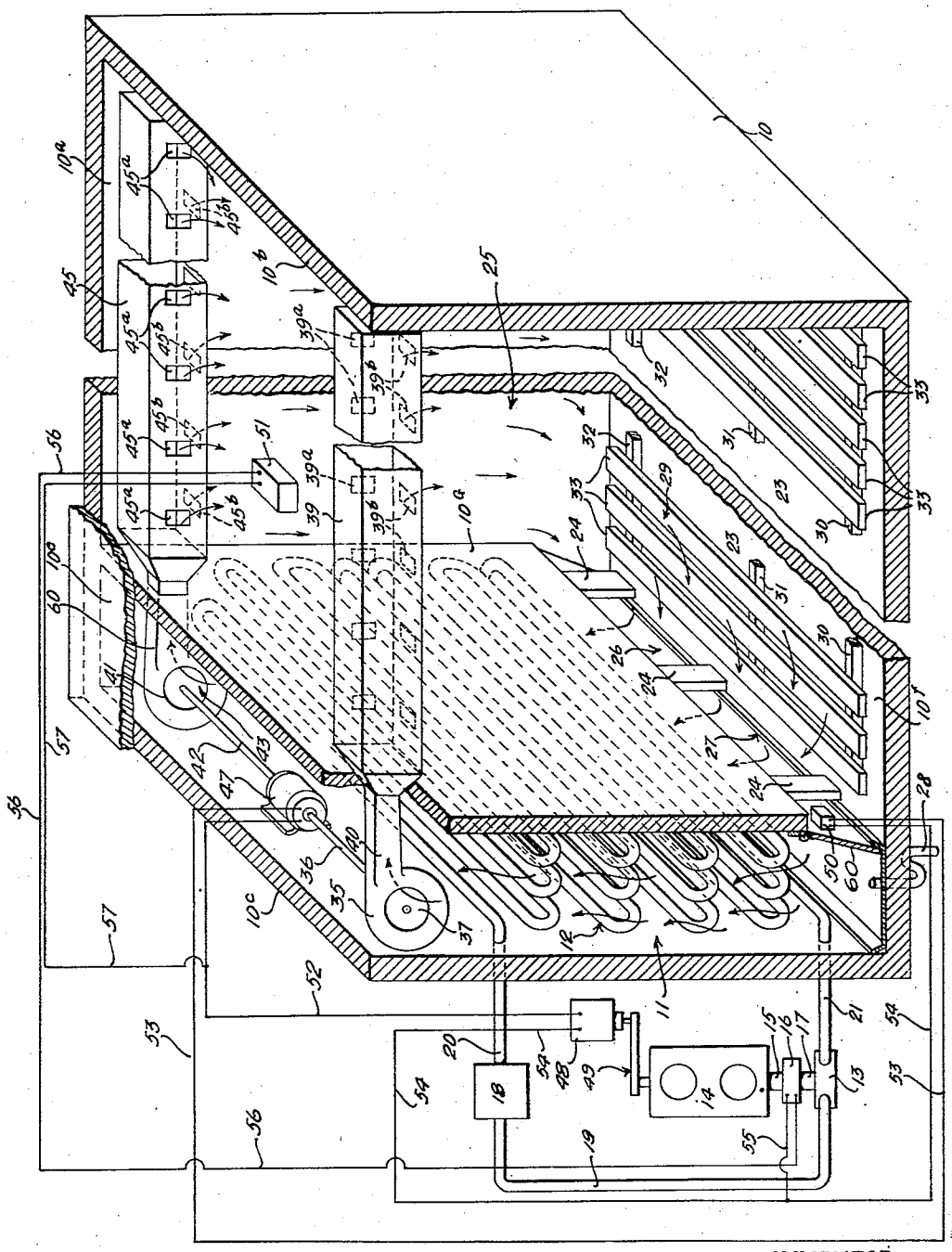
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REFRIGERATION

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REFRIGERATION

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This invention relates to refrigeration systems.

One of the objects of this invention is to provide a refrigeration system and apparatus which will be simple and durable in construction, thoroughly efficient and reliable in operation, and well adapted to meet certain peculiar conditions met with in practice. Another object is to provide a system and apparatus of the above character which will be of ready and economical operation, and convenient and easy of installation. Another object is to provide a system and apparatus of the above character which will insure efficient and thorough refrigeration or temperature regulation in all parts of a space or substances to be refrigerated. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

The single figure in the drawing is a perspective view of the system and apparatus as installed, certain parts being broken away to show certain features more clearly and certain other parts being shown diagrammatically.

As conducive to a clearer understanding of certain features of my invention, it might at this point be noted that, in refrigerating systems, particularly such as those installed in railway refrigerator cars and like vehicles, it is sometimes difficult to maintain all portions of the interior of the chamber or compartment, and hence all portions of the load, at a substantially uniform and constant temperature. Also, difficulties are sometimes encountered, due to condensation of moisture upon coils, pipes, or the like, that carry the refrigerant into the refrigerated space, it being difficult to safeguard effectively the load against damage, due to such condensed moisture. One of the dominant aims of this invention is to provide a thoroughly practical and highly efficient system and apparatus for refrigeration in which such difficulties and disadvantages as have just been pointed out may be dependably avoided or overcome.

Referring now to the drawing, there is shown, generally indicated at 10, an enclosure, which may be considered to be, for example, a railway refrigerator car; this enclosure is formed by suitable side walls, only one of which is shown at 10^a, and walls 10^b and 10^c, top wall 10^e, and bottom wall 10^f, these walls being preferably constructed in any suitable manner or of any suitable material to be of low heat conductivity. Closely adjacent one of the end walls, such as end wall 10^c, is a vertically extending wall or partition 10^g which divides the interior of the enclosure 10 into a relatively small compartment or chamber 11 and a relatively large compartment or chamber 25. Compartment 25, certain features of construction and arrangement of which will be more clearly described hereinafter, is to receive the material, goods or the like, to be maintained at or below a certain temperature.

Hinged to the bottom of partition 10^g is a door 60 so that its lower end preferably rests against one flange of pan 27 when in its closed position. Door 60 extends across the full width of partition 10^g and effectively prevents the passage of any air from the bottom of chamber 11 into the bottom of compartment 25. However, air passing along the false floor 29 or thereunder is free to pass into compartment 11 under door 60 which is capable of hinging about its axis to permit such passage and thus permit circulation of air in this direction.

Within the relatively small compartment 11 there is mounted and supported in any suitable manner an expansion or evaporator coil 12 of suitable exposed surface or area to abstract heat from a suitable medium passed into the refrigerator compartment 25 in a manner to be more clearly described hereinafter. Evaporator coil 12 may have any suitable vertical and horizontal expanse and is supplied with a liquid refrigerant which is adapted to evaporate in the evaporator coils 12.

To supply coils 12 with liquid refrigerant I provide a compressor 13 driven by an internal combustion engine 14 preferably adapted to run continuously for substantial periods of time. The crank shaft 15 of engine 14 is connected to one member of a clutch 16 and the other member of this clutch is connected to compressor 13 by a shaft 17. Thus when the members of this clutch are in engagement, engine 14 drives compressor 13. Clutch 16 is preferably of the electro-magnetically controlled type. Compressed gaseous refrigerant is passed from the compressor to the other parts, diagrammatically shown at 18, of my refrigeration system through a pipe 19; these parts 18 may include a condenser for cooling and hence liquefying the refrigerant, a receiver, an expansion valve, and any other suitable parts to effect the desired action of the compression-expansion refrigeration unit. The liquefied refrigerant is passed by a pipe 20 to coil 12 where subsequent evaporation thereof takes place, with resultant heat-withdrawal or cooling, and the expanded refrigerant is then returned to the intake side of compressor 13 by a pipe 21.

Chamber 11 is, as above noted, preferably located at one end of the enclosure 10 whose temperature is to be regulated, and is separated from compartment 25 by the partition 10^g. Partition 10^g extends from the top wall 10^e

to a point a short distance above the floor 10^f thereof, and is supported in this position by legs 24. Thus an opening 26 leading from the bottom of compartment 25 into the bottom of chamber 11 is provided. Due to the lower temperature of coils 12, moisture in the air may condense thereon, and to dispose of this moisture as it drops to the floor, a flanged drip pan 27 is positioned under the coils. A trap or liquid-sealed pipe 28 is connected to the bottom of this pan and leads through bottom or floor 10^f to the exterior, thus disposing of this moisture. Thus the material in compartment 25 as well as the compartment 25 itself is safeguarded against such condensation of moisture in the atmosphere.

A false bottom or floor, generally indicated at 29, lies on floor 23 of compartment 25. Floor 29 may be of any desired or suitable construction but preferably has transversely spaced members 30, 31 and 32 extending longitudinally along the bottom 10^f and spaced lateral or cross strips 33 secured to these members.

The material, goods, or the like, to be refrigerated rests upon the false bottom or floor 29 in compartment 25 and, as is clearly shown in the drawing, the space between the load supporting members 33 and the main floor or bottom 10^f terminates, at the left-hand bottom portion of compartment 25, adjacent the opening 26, this space being, in effect, subdivided by the longitudinally extending members 30, 31 and 32 into channels that terminate adjacent this opening 26. Moreover, this space, and hence these channels, are in communication with the interior of compartment 25 by way of the crosswise extending gaps between the members 33, the latter being, as is clear from the drawing, substantially uniformly distributed throughout the bottom of compartment 25 and providing thus uniformly distributed gaps throughout the bottom of compartment 25 communicating with the bottom portions of the material or goods stored therein. As will be more clearly described hereinafter, these uniformly distributed gaps that intervene the members 33 are exit passages for a cooling medium preferably taking the form of air.

Extending lengthwise and immediately underneath the ceiling or top wall member 10^e of compartment 25 is a suitable number of conduits, illustratively shown in the drawing as two in number and indicated at 39 and 45. These conduits are conveniently of sheet metal construction and may have any desired cross-section; illustratively, they are of rectangular or square cross-section and are provided with suitable discharge openings in their side and bottom walls.

Where two such conduits are employed, and in order to achieve the desired relatively uniform distribution throughout the upper part of compartment 25 of the cooling medium, I prefer to position each of the two conduits relatively closely spaced to a side wall, and hence I provide discharge openings preferably in the inwardly facing side wall of each conduit and in the downwardly facing wall of each conduit. More specifically, conduit 45 will be seen to be provided with inwardly directed discharge apertures 45^a and with downwardly directed top apertures 45^b; similarly, conduit 39 is provided with inwardly directed discharge openings 39^a and with downwardly directed discharge openings 39^b.

Conduit 39 is connected to a conduit 40 that passes through partition 10^g and is connected to the discharge outlet of a fan or blower 35, the inlet or intake opening 37 of which is exposed to the upper portion of chamber 11. Conduit 45 is connected to a conduit 60 passing through partition 10^g and terminating at the outlet of a fan or blower 41, similar to blower 35, the inlet or intake opening 43 of which is exposed to the upper portion of chamber 11.

The intakes of blowers 35 and 41 are thus effectively positioned to receive air from the upper end of the compartment 11; blowers 35 and 41 are driven preferably by a single motor 47 to which the rotary parts of the two fans or blowers are connected by shafts 36 and 42. The blowers and motor are supported in compartment in any suitable way.

When fans 35 and 41 are actuated by the motor 47, air is drawn upwardly in chamber 11, is cooled by the expansion coils 12, and is forced into conduits 39 and 45, and from thence through openings 39^a, 39^b and 45^a, 45^b, respectively, into compartment 25. At the same time that blowers 45 and 39 increase the pressure at the upper portions of chamber 25, the pressure is diminished at the bottom of chamber 11 and hence adjacent the transverse bottom opening 26. Thus the cooled air discharged by conduits 39 and 45 is forced to permeate uniformly the load or goods or material in compartment 25, and, heated, is returned to chamber 11 by the floor channels and opening 26.

Current for motor 47 is supplied by a generator 48 driven by engine 14 by any desired means generally indicated at 49. A thermostatic switch 50 is positioned near the bottom of compartment 25 near opening 26, and a second thermostatic switch 51 is positioned preferably near the top of compartment 25 for controlling the actuation of various parts of the system according to the temperature of the air in that particular vicinity as will be more fully described later. Thermostat 50 although being located immediately adjacent compartment 11, as pointed out above, is substantially unaffected by the temperature in compartment 11 due to the fact that only cold air produced therein for example by way of coils 12 drops and is trapped by door 60.

A line 52 leads from one side of generator 48 to motor 47 and a line 53 leads from the other side of motor 47 to thermostatic switch 50 whence line 54 completes the circuit to the generator 48. Generator 48 is connected to the coil of clutch 16 by a circuit controlled by the thermostatic switch 51, the circuit extending from generator 48, conductor 54, conductor 55, coil of clutch 16, conductor 56, switch 51 in chamber 25, conductor 57, and thence by way of conductor 52 back to generator 48.

Considering now the action of this system, let it be assumed for purposes of illustration, that chamber 11 and compartment 25 are part of the interior of a railroad car. Let it also be assumed that this car has just been loaded with perishable goods which must be maintained between certain definite temperature limits for efficient and sanitary preservation thereof. The articles or packages or the like to be transported have been packed into the car, resting on the false floor 29. For greater efficiency, it is desirable to pack the goods loosely, leaving substantially vertical spaces or channels between the articles, running from the top to the bottom of the car.

Let it be further assumed that the interior of

compartment 25 is above the preferred temperature, due, for example, to outside climatic conditions or to heat generated by the goods contained in the compartment, as is often the case when vegetables and fruit are stored. Engine 14 having been started, generator 48 is actuated through driving means 49, supplying current to my system. As the temperature within the compartment 25 is above that preferred, thermostatic switch 51 closes, a circuit is thus completed between generator 48 and magnetic clutch 16, and the clutch is actuated to cause engine 14 to drive compressor 13. As compressor 13 is now being driven and coacting with the various other parts 18 of the refrigeration unit, liquid refrigerant is supplied to cooling coils through pipe 20. As the refrigerant evaporates in coils 12, heat is absorbed from the air surrounding the coils 12 and the expanded or evaporated gas leaves the coils through pipe 21 to be conducted to the intake side of the compressor. This action continues as long as compressor 13 is being driven by engine 14.

Simultaneously, with the above described action, thermostatic switch 50 at the bottom of compartment 25 closes to complete a circuit between generator 48 and motor 47 and thus fans 35 and 41 are actuated by shafts 36 and 42 respectively.

The air, now being cooled by coils 12, is drawn into intake openings 37 and 43 of the fans and is then forced into conduits 45 and 39. As this action continues, the air leaves conduits 45 and 39 through the openings therein, somewhat as is indicated by the arrows in the drawing. The air now passes down the sides of the compartment 25 and also through the various spaces between the articles as described above. Upon reaching the bottom of compartment 25 and having circulated through all portions thereof, the action of fans 35 and 41, forces the air along the spaces between the false floor 29 and floor 23, and through opening 26 at the bottom of partition 10^{s}, and thence into cooling chamber 11 by way of door 60; in the latter the heat absorbed by the air from the stored load is abstracted therefrom by coils 12, whence the cycle is repeated. Thus cooled air is brought continuously to all portions of the space in compartment 25 and adequate provision is made for insuring that all of the articles contained therein are cooled.

As this action continues, the temperature within compartment 25 gradually comes down to that preferred, and as the air contained therein is circulated through all portions of the compartment, the temperature of all articles stored in the compartment reaches that preferred. The cool air is entering compartment 25 through the openings 46 and 40, so the temperature of the top of the compartment reaches that preferred before that portion near the bottom, this usually being true because the air at the bottom has passed down through the various articles stored therein and during this process has absorbed heat therefrom. When the top of the compartment reaches the preferred temperature, thermostatic switch 51 opens to break the circuit between clutch 16 and generator 48. The de-energization of clutch 16 disconnects the compressor 13 from the engine, and compressor 13 becomes inactive. The cooling effect of coils 12 is now reduced as the liquid refrigerant contained therein evaporates and as no more refrigerant is supplied to the coils. Coils 20 still retain their cooling ability for a time, and fans 35 and 41 are still in action so cooling is continued in compartment 25 while the compressor and other moving parts of the refrigeration unit are inactive.

When the temperature of the air passing through opening 26 at the bottom of compartment 25, reaches that preferred, thermostatic switch 50 opens to break the circuit between motor 47 and generator 48. This action does not take place until the air passing through the lower portion of compartment 25 toward chamber 11 is at the preferred temperature, so it may now be assumed that the entire compartment is at the preferred temperature. At this point in its path of circulation the air, having absorbed heat from the articles contained in compartment 25, is warmer than at any other position therein. Thus thermostatic switch 50 does not open to stop motor 47 until the preferred temperature is reached in all portions of the compartment.

The circuit being broken between motor 47 and generator 48, the motor stops, and consequently, fans 35 and 41 cease operation. The inactivity of the fans stops the forced circulation of air between cooling chamber 11 and compartment 25. The parts remain in this condition until the temperature of compartment 25 rises above that preferred. The top of the compartment usually rises above the preferred temperature before the bottom thereof, convection causing the warmer air to rise to the top. Thus, thermostatic switch 51 closes to energize clutch 16 and the refrigeration unit operates before the actuation of fans 35 and 41. In this manner, coils 12 are prepared for immediate cooling action when so required, and upon the closing of thermostatic switch 50, the above described action repeats itself, to maintain compartment 25 and the stored goods at the preferred temperature.

It will thus be seen that I have provided in this invention a system and apparatus which achieve the above noted objects as well as many thoroughly practical advantages.

As many possible embodiments may be made of the above invention, and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawing is to be interpreted as illustrative, and not in a limiting sense.

I claim:

1. In a device of the character described, in combination, means forming a space whose temperature is to be controlled and having an entry and an exit for a fluid, a refrigeration unit including means adapted to abstract heat from a fluid coming into thermal contact therewith, means for forcing a circulation of a fluid in a path that includes said entry, said space, said exit and said heat-abstracting means, thermostatic means responsive to the affect of said fluid near the entry end of said space, and thermostatic means responsive to the affect of said fluid near the exit end of said space, one of said thermostatic means controlling said forcing means, and the other thermostatic means controlling said heat-abstracting means.

2. In a device of the character described, in combination, means forming a space whose temperature is to be regulated, a refrigeration unit including means adapted to abstract heat from a fluid coming into thermal contact therewith,

means for causing the circulation of air in a path from the bottom of said space past said heat-abstracting means and thence into the top of said space, means responsive to the temperature of the air at the bottom of said space for controlling said circulating means, and means responsive to the temperature of the air at the top of said space for controlling the actuation of said refrigeration unit.

3. In a refrigeration system, in combination, means forming a space whose temperature is to be regulated, refrigeration apparatus including heat extracting means, means for forcing air from said heat extracting means into the top of said space and drawing air from the bottom of said space back to said heat extracting means, thermostatic controlling means located substantially at the top of said space, and thermostatic controlling means located substantially at the bottom of said space, one of said thermostatic means adapted to control said forcing means and the other of said thermostatic means adapted to control the operation of said refrigeration apparatus.

4. In a refrigeration system, in combination, means forming a space whose temperature is to be regulated, a refrigeration unit including heat extracting means separated from said space, means for forcing air from said heat extracting means into the top of said space and for forcing air from the bottom of said space back to said heat extracting means, thermostatic means located substantially at the top of said space, and thermostatic means positioned substantially at the bottom of said space near the outlet to said heat extracting means, one of said thermostatic means adapted to control said refrigeration unit and the other of said thermostatic means adapted to control said forcing means.

5. In a refrigeration system, in combination, means forming a space whose temperature is to be regulated, a refrigeration unit including a heat extracting element, a partition separating said heat extracting element from said space, means for forcing air from said heat extracting element into the top of said space and through an outlet near the bottom of said space back to said heat extracting element, thermostatic means positioned substantially at the top of said space adapted to control the action of said refrigeration unit, and thermostatic means positioned at the bottom of said space substantially near said outlet and adapted to control the action of said forcing means.

6. In a refrigeration system, in combination, means forming a space whose temperature is to be regulated, refrigeration means including a compressor and a heat extracting coil, driving means for said compressor, electrically responsive clutch means disposed between said driving means and said compressor, a source of current for said last-mentioned means, means for forcing air from said heat extracting coil to the top of said space and from the bottom of said space back to said heat extracting coil, a thermostatic switch positioned substantially at the top of said space and in the circuit of said source of current and said clutch means, and thermostatic means positioned substantially at the bottom of said space and adapted to control said forcing means.

7. In a refrigeration system, in combination, means forming a space whose temperature is to be regulated, refrigeration means including a compressor and a heat extracting coil separated from said space, driving means for said compressor, electrically responsive clutch means disposed between said driving means and said compressor, a source of current for said last-mentioned means, means for forcing air from said heat extracting coil to the top of said space and from the bottom of said space back through an inlet to said heat extracting coil, a thermostatic switch positioned substantially at the top of said space and in the circuit of said source of current and said clutch means, and thermostatic means located at the bottom of said space and substantially near said inlet for controlling said forcing means.

8. In a refrigeration system, in combination, means forming a space whose temperature is to be regulated, a refrigeration unit for said space including a compressor and expansion coils, a partition separating said expansion coils from said space, driving means for said compressor, an electrically responsive clutch disposed between said driving means and said compressor, means for forcing air from said coils to the top of said space and back to said coils from the bottom of said space through an inlet through said partition, thermostatic means located substantially at the top of said space, and thermostatic means located at the bottom of said space substantially near said inlet, one of said thermostatic means adapted to control the action of said clutch means and the other of said thermostatic means adapted to control said forcing means.

9. In a refrigeration system, in combination, means forming a space whose temperature is to be regulated, a refrigeration unit for said space including a compressor and expansion coils, fans adapted to force air from said expansion coils to the top of said space and from the bottom of said space back to said expansion coils, a motor adapted to drive said fans, a generator for supplying current to said motor, driving means for said compressor and said generator, an electrically responsive clutch disposed between said driving means and said compressor, a thermostatic switch located at the top of said space, and a thermostatic switch located at the bottom of said space, one of said thermostatic switches controlling the circuit between said generator and said clutch and the other of said thermostatic switches controlling the circuit between said motor and said generator.

10. In a refrigeration system, in combination, means forming a space whose temperature is to be regulated, a refrigeration unit for said space including a compressor and expansion coils, fans adapted to force air from said expansion coils to the top of said space and from the bottom of said space back to said expansion coils, a motor adapted to drive said fans, a generator for supplying current to said motor, driving means for said compressor and said generator, an electrically responsive clutch disposed between said driving means and said compressor, a switch thermally responsive to the temperature of the top portion of said space and adapted to control the circuit between said generator and said clutch, and a switch thermally responsive to the temperature of the bottom portion of said space and adapted to control the circuit between said motor and said generator.

11. In a refrigeration system, in combination, means forming a space whose temperature is to be regulated, a refrigeration unit for said space

including a compressor and expansion coils, a partition separating said expansion coils from said space, fans adapted to force air from said expansion coils to the top of said space and from the bottom of said space through an inlet in said partition back to said expansion coils, a motor adapted to drive said fans, a generator for supplying current to said motor, driving means for said compressor and said generator, an electrically responsive clutch disposed between said driving means and said compressor, a switch thermally responsive to the temperature of the top portion of said space and adapted to control the circuit between said generator and said clutch, and a thermostatic switch positioned near the bottom of said space substantially near said inlet and adapted to control the circuit between said motor and said generator.

12. In a refrigeration system, in combination, means forming a chamber whose temperature is to be regulated, means for supporting articles to be refrigerated above the level of the floor of said chamber, a compartment containing cooling apparatus, a partition separating said compartment from said chamber, and means for forcing air from said compartment to the top of said chamber and back to said compartment in a path between said floor and said second-mentioned means.

13. In a refrigeration system, in combination, means forming a chamber whose temperature is to be regulated, means for supporting articles to be refrigerated above the level of the floor of said chamber, a compartment containing cooling apparatus, a partition separating said compartment from said chamber, conduits extending from said compartment through said partition into the top of said chamber, an inlet from said chamber to said compartment through the bottom of said chamber, and fans adapted to force air from said compartment through said conduits into said chamber and back substantially along the floor of said chamber directly through said inlet to said compartment.

14. In a refrigeration system, in combination, means forming a chamber whose temperature is to be regulated, means for supporting articles to be refrigerated above the level of the floor of said chamber, a compartment containing cooling apparatus, a partition separating said compartment from said chamber, conduits extending from said compartment through said partition into the top of said chamber, an inlet from said chamber to said compartment through the bottom of said chamber, fans adapted to force air from said compartment through said conduits into said chamber and back substantially along the floor of said chamber directly through said inlet to said compartment, and thermostatic means for controlling the action of said fans and said cooling apparatus.

15. In a refrigeration system, in combination, a chamber, a partition separating said chamber into a storage section and a cooling section, said partition being spaced from the floor of said chamber, an evaporating coil in said cooling section, refrigeration means for supplying a heat extracting fluid to said evaporating coil, motive means for driving an element of said refrigeration means, a series of fans in said cooling section, conduits connected with said fans and extending along the top of said storage section whereby air is forced from said cooling section into said storage section when said fans are actuated, an electric motor for driving said fans, a source of current for said electric motor, a thermostatic switch located substantially near the top of said storage section for controlling the circuit between said source of current and said motor, and a thermostatic device located substantially near the bottom of said storage section and adapted to control the driving connection between said motive means and said element.

16. The herein described art which consists in cooling a body of fluid, forcing said fluid into the top of a compartment to be cooled, circulating said fluid downwardly and out substantially near the bottom of said compartment, controlling said cooling in accordance with the temperature near the top of said compartment, and controlling said forcing in accordance with the temperature near the bottom of said compartment.

17. In a refrigeration system, in combination, a chamber, a partition separating said chamber into a storage section and a cooling section, said partition being spaced from the floor of said chamber, refrigeration apparatus in said cooling section, a series of fans near the top of said cooling section, conduits connected to said fans and extending through said partition along the top of said storage section, said conduits having apertures therein, and a false bottom on the floor of said storage section whereby upon the operation of said fans air is forced from said cooling section out through said apertures in said conduits thence downwardly into said storage section and back into said cooling section through the space between the floor of said chamber and the bottom of said partition.

18. In refrigerator vehicle construction, in combination, a vehicle, a partition extending across said vehicle to divide the interior thereof into an apparatus compartment and a storage compartment, said partition being spaced from the floor of said vehicle to allow passage of air along said bottom from said storage compartment to said apparatus compartment, refrigeration apparatus disposed within said apparatus compartment, a pair of conduits extending from the top of said apparatus compartment along the sides of said storage compartment and substantially near the top thereof, said conduits having openings therein, and fan means adapted to force air from said apparatus compartment through said conduits into said storage compartment.

19. In refrigerator vehicle construction, in combination, a vehicle, a partition extending across said vehicle to divide the interior thereof into an apparatus compartment and a storage compartment, said partition being spaced from the floor of said vehicle to allow passage of air along said bottom from said storage compartment to said apparatus compartment, refrigeration apparatus disposed within said apparatus compartment, a pair of conduits extending from the top of said apparatus compartment along the sides of said storage compartment and substantially near the top thereof, said conduits having openings facing each other to direct air toward each other along the top of said storage compartment and openings facing the bottom of said storage compartment to direct air downwardly from said conduits, and fan means adapted to force air from said apparatus compartment through said conduits into said storage compartment.

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