My invention relates to an improvement in refrigeration units which may be applied for transportation use. The unit herein described and shown can be applied to trucks, trailers, freight cars and to other containers where refrigeration presents a similar problem. One purpose is to provide a simple and compact unit which may be supported, as a unit, at an optimum position. Another purpose is to provide an improved unit for cooling and recirculating the air within a truck, car or trailer. Another purpose is to provide an efficient unit which may be used, for example, in maintaining the air in refrigerator cars at a desired low temperature. Another purpose is to provide a refrigerator car which will be efficient in operation, can be operated at a low cost, and which shall have a comparatively low first cost. Another purpose is to provide a mechanical refrigerated car which is cooled by vacuum plates built into the car, and which are supplied by means of a refrigerating apparatus on the car operated by a suitable motor or engine or by connection with the car action. The mechanical refrigerator cars heretofore used have not been commercially successful because of the excessive weight, first high cost of the equipment, and the high cost and unreliability of the operation of the refrigerating apparatus, and also the great amount of space taken up by such apparatus.

The present invention has for its object to provide an efficient mechanical refrigerator car which will be free from these objections. The invention has as a further object to provide a mechanical refrigerator car cooled by vacuum plates with an air moving device which draws the air through a space between the plates and directs it into the upper part of the car so that it will be diffused throughout the car. This air, after passing through the car, passes back again through the vacuum plates so as to be again cooled.

The invention has as a further object to provide a refrigerator car provided with vacuum plates with an air moving device for moving the air cooled by these plates so as to distribute it throughout the car, with a refrigerating liquifying apparatus for supplying the refrigerant to the plates consisting of a compressor, condenser and receiver. The refrigerant passes to a multi-expansion valve and through this valve to the various plates and then back to the compressor.

The invention has as a further object to position the refrigerating means where it will cause a minimum loss of utilizable space. Another purpose is to provide a refrigerating unit which can be applied to a refrigerated car as a unit, and can be readily removed for servicing or the like. Other purposes will appear from time to time in the course of the specification and claims.

I illustrate the invention more or less diagrammatically in the accompanying drawings wherein:

- Figure 1 is a vertical, longitudinal section;
- Figure 2 is a section, on an enlarged scale, on the line 2—2 of Figure 1;
- Figure 3 is a perspective view, on an enlarged scale, of one end of the refrigerating unit;
- Figure 4 is a section on a still larger scale, on the line 4—4 of Figure 3.

Like parts are indicated by like symbols throughout the specification and drawings. Referring to the drawings, Figure 1 generally illustrates a wheeled support, which may be a car or a truck or a trailer, or any space which it is desired to refrigerate. My invention is particularly applicable to wheeled vehicles, but it will also be understood that it may be employed to refrigerate any restricted, insulated space, such as a locker room or a cooler room. However, in the present disclosure it is illustrated as applied to a wheeled vehicle. Referring to the vehicle shown, I may employ any suitable insulating structure, the details of which do not of themselves form part of the present invention. It will be understood, however, that any suitable bottom 1 may be employed in connection with a top wall 3, end walls 5 and at any suitable side walls not herein shown. I illustrate an outside container or housing in which any suitable means may be employed for cycling a volatile refrigerator. Diagrammatically shown therein are a compressor 8, a condenser 9 and a receiver 4. Extending from the receiver is any suitable supply duct or high pressure line 5, along which liquid refrigerant may flow at high pressure. 9 is any suitable return duct along which the evaporated refrigerant may flow to the suction side of the compressor 8. Whereas the container 7 has been illustrated as exterior to the refrigerated space, it will be understood that it may be placed at any suitable location either inside or outside of the insulated space. As an example, I illustrate in dotted line an area 14a within the refrigerated space, where a control housing might be placed. It is advantageous, however, to have the control housing outside of the refrigerator space.
The cooling unit includes primarily a group of cold plates. While I do not wish to be limited to the use of the specific plates herein shown, I find that vacuum plates may advantageously be employed. Referring, for example, to Figures 2, 3 and 4, I illustrate a group of vacuum plates, each plate having opposite side walls 11 and 13 connected by circumferential edge walls or flanges 15. For convenience in mounting, the plates may be brought together at the edges to form circumferential flanges 14. It will be understood that the plate interiors are preferably sealed from the outside atmosphere and are gas and liquid tight.

For example, I may provide any suitable valve 15 through which air may be partially exhausted from the interior of the plates, by any suitable means, including but not limited to, a pump or compressor. The valve 15 may also be so formed as to permit it to be used as a filling valve for the entry of a eutectic. It will be understood that the plates may be employed dry, or, under some circumstances, partly or substantially filled with any suitable eutectic. It will be understood that the details of the valve 15 do not of themselves form part of the present invention and I will therefore not illustrate it. Any suitable means may be employed for permitting the entry of the eutectic and the partial exhaustion of air prior to any suitable sealing-up of the valve to prevent further unintended leakage.

In the structure herein shown, the group or battery of cold plates may be advantageously positioned in an upper part of the space to be cooled. Referring, for example, to Figures 1, 3 and 4, I illustrate hangers or supports 16 which may be bolted or otherwise secured, as at 17, to the roof of a building, truck or room which is being cooled. The hangers may support a bottom plate or plates 18, a top plate or plates 19, and a side plate or plates 20. The plates 20 may be hinged to the top plate 19, as at 21, to permit ready access to the space between the individual plates. Any suitable locking means or catches 22 may be employed for normally holding the plates 20 in the closed position in which they are shown in Figure 4. Where an elongated cooling unit is employed, with plates of substantial length, I may employ a plurality of side plates, as shown in Figure 1, which define between them lateral outlet apertures 23, the purpose of which will later appear. It will also be understood that the housing formed by the plates 18, 19 and 20 has an open discharge end indicated at 24 in Figures 1 and 2.

Air is circulated through the above-described structure by the employment of an air delivery housing 25 having an open inlet end 26. Any suitable motor 27 is mounted in or near the inlet, and serves to rotate any suitable fan blades 28, whereby air is drawn in and delivered through the housing 25, and can escape only through the side apertures 23 or the end aperture 24. Thus, the relatively warmer air of the space to be refrigerated is forced through the housing defined by the plates 18, 19 and 20, and between and around the refrigerant, being discharged at various points, but only after substantial subjection to the relatively cold surfaces of the plates 10.

In order to maintain the plates refrigerated, I may employ a cooling coil in each plate. Taking a typical plate, as shown in Figure 2, a zigzag coil 30 may be employed having an inlet duct 31 and an outlet duct 32. The coils of the individual plates 10 are shown as arranged in series, being connected by exterior ducts or passages 3. Any suitably pressure reduction device 37 may be employed, of which two are shown in Figure 3, which reduces the pressure of the liquid refrigerant at suitably reduced pressure, is delivered along the ducts 38, one of which flows from each of the elements 37. Thus, there is in the form of Figure 3 an upper series and a lower series of plates. The return or suction pipe 40 which returns to any suitable compressor. Thus, a volatile refrigerant, at proper pressure, is evaporated in each of the plates, and the exterior surfaces of all of the plates 10 are at generally the same temperature, the variation caused by the circulation being insufficient to be of any importance or disadvantage.

It will be understood that the volatile refrigerant may be circulated or cycled in any suitable manner. I illustrate, for example, in full line in Figure 1, a housing 1 in which 1 more or less uniformly diagnostically illustrate any suitable compressor 3, condenser 6 and receiver 4. The liquid passage 35 of Figure 3 terminates in or forms part of the delivery passage 8 of Figure 1, and the suction passage 40 of Figure 3 terminates in or forms part of the suction passage 9 of Figure 1. Whereas I have illustrated in full line the housing 7 of Figure 1 as located exterior to the space to be refrigerated, it will be understood that under some circumstances the refrigerating housing, as indicated in dotted line at 7, may be placed within the refrigerated space, or at least within the structure which surrounds the refrigerated space. However, it may be preferable to employ an exterior housing as shown at full line at 7 in Figure 1. It will be understood, however, that the details of the cycles and means and their location may be widely varied.

The details of the plates themselves may be widely varied. Whereas I have illustrated vacuum plates, it will be realized that other types of plate may be advantageously employed, although I prefer, in the main, to employ plates having plane surfaces, and spaced more or less uniformly apart in parallel relationship. It will be noted that in the plates specifically shown herein, the side flanges 14 are staggered, being at the upper part of each plate 10 along one side, and being at the lower part along the other side. It may be advantageous simply to weld the side flanges 14 to the hangers 16, or, if desired, they may be removably mounted thereon, any suitable guides or supports being employed.

It will be realized that whereas I have described and shown in a practical and operative device, nevertheless many changes may be made in size, shape, number and disposition of parts. I therefore wish my description and drawings to be taken as in a broad sense illustrative or diagrammatic rather than as limiting to my specific showable-in.

The use and operation of my invention are as follows:

I find it advantageous, in refrigerating the interiors of rooms, cars and trucks, to provide a battery or group of refrigerating plates, suitably cooled, and to circulate air between them. I have illustrated and described herein an advantageous assembly which may be removably secured to the
interior of a room or truck or car without any structural change or modification of the car. Assuming that it is desired to refrigerate a suitably insulated room or container, my above-described unit may be secured by the hangers 16, to the lower surface of the top wall or ceiling. The length of the unit may be varied to suit a length of the space to be refrigerated. Where a group of relatively short plates are employed, the side housing plates 20 may extend the entire length of the unit. But where a car or truck is being refrigerated, it may be advantageous to use one or more side openings, such as are shown at 23 in Figure 1. Thus, some of the cooled air flows more or less laterally out of the side openings, and the balance flows out of the end openings. The fan 28 recirculates the air and maintains a constant cooling flow. It is advantageous, where a long unit is employed, to make the housing side ends 22 removable or movable. A convenient method is to hinge them so that they can be lifted. This renders it easy to inspect the surfaces of the plates 10 and to remove the frost when necessary. However, with the relatively close spacing of the plates, and the delivery of air therebetween at substantial velocities, the formation and building-up of frost does not constitute an important problem.

I claim:

1. In a cooling unit for cooling cars, trucks and the like, a plurality of generally horizontal refrigerating plates having substantially plane, opposed surfaces, spacing means for maintaining said plates in predetermined and generally parallel relationship with generally uniform spacing between the opposed plane surfaces of adjacent plates, a housing surrounding said plates and defining, with said plates, air spaces between adjacent plates, said housing and plates being of substantially greater length than the width of the plates, an air delivery housing communicating with the interior of said first mentioned housing, and means for directing air through said air delivery housing and into the first mentioned housing and along and between the plates in said plate surrounding housing, said plate surrounding housing having a plurality of outlets intermediate the ends of said plates, in communication with the spaces between said plates, and having an end outlet at the end of said housing opposite to said air delivery housing, and supporting means for positioning said air delivery housing and said plate surrounding housing adjacent the roof of the car.

5. In a cooling unit for cooling cars, a car enclosing the space to be cooled, a plurality of generally horizontally extending refrigerating plates having substantially plane opposed surfaces, spacing means for maintaining said plates in predeterred and generally parallel relationship with generally uniform spacing between the opposed plane surfaces of adjacent plates, a housing surrounding said plates and defining, with said plates, air spaces between adjacent plates, said housing and plates being of substantially greater length than the width of the plates, an air delivery housing communicating with the interior of said first mentioned housing, and means for directing air through said air delivery housing and into the first mentioned housing and along and between the plates in said plate surrounding housing, said plate surrounding housing having a plurality of outlets intermediate the ends of said plates, in communication with the spaces between said plates, and having an end outlet at the end of said housing opposite to said air delivery housing, and supporting means for positioning said air delivery housing and said plate surrounding housing adjacent the roof of the car.

Herman W. Kleist.

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