A refrigeration system with a plate-type condenser and a method for compacting it, to be applied to a refrigeration appliance presenting a compressor mounted in a hermetic shell (10), an evaporator coil (60), and a plate-type condenser (20). The refrigerant fluid coming from the compressor is supplied to a condenser tube (30), which is formed on a lower plate section (20a) and on an upper plate section (20b) of the condenser (20) and extends from the bottom to the top and back to the bottom. After manufacture, the lower plate section (20a) and the upper plate section (20b) are placed one over the other, the evaporator coil (60) is positioned by a suction tube (70) connected to the compressor.
REFRIGERATION SYSTEM WITH A PLATE-TYPE CONDENSER AND METHOD FOR COMPACTING IT

FIELD OF THE INVENTION

[0001] The present invention refers to a refrigeration system, which includes a plate-type condenser manufactured in different sections, in order to make the system more compact for handling and shipping. The present invention further refers to a method to make said system more compact.

PRIOR ART

[0002] Refrigeration systems formed by a compressor, an evaporator, a condenser, and other necessary components are well known. Such systems are used in various types of appliances for commercial and residential use, such as refrigerators, freezers, air-conditioners, and other cooling devices. Most refrigeration systems usually work, compressing a refrigerant fluid in the vapor state in a compressor, said refrigerant fluid subsequently transferring the heat to an external environment through a condenser, returning to the liquid state. The refrigerant fluid in the liquid state passes through an expansion device and, immediately after, in an evaporator, returning to the compressor in the vapor form.

[0003] Upon passing through the evaporator, the refrigerant fluid removes the heat from the surrounding atmosphere, such as the interior of a refrigerator cabinet, in order to cool that atmosphere. The refrigerant fluid flow is generally defined by controlling the operation of the compressor, that is, turning on and off the compressor as a function of the temperature of the area to be cooled. This is usually controlled by a device, such as a thermostat.

[0004] A condenser for such a type of refrigeration system is usually formed by a tube made of an adequate material, such as copper, which is bent in turns in order to define an elongated coil pattern. A refrigeration system, such as that shown in U.S. Pat. No. 5,881,567 uses a plate-type condenser, in which the coil shaped condenser tube is incorporated in a single metallic plate, which is mounted to the bottom of a refrigerator cabinet, serving as a structural element for the cabinet. The refrigeration capacity of the appliance dictates the specifications of the refrigeration system. Thus, a device with a high refrigeration capacity will correspondingly require a refrigeration system with a high capacity, which, on its turn, will require a large condenser.

[0005] In general, the manufacture and assembly of the parts of a refrigeration appliance are accomplished in different locations. For example, the refrigeration system can be produced in a factory in one location and then transported to another factory in a distinct location, where it will be mounted in a cabinet to form the final version of the refrigeration appliance, which will be later delivered to a consumer. When the refrigeration system is of the type that has a plate-type condenser, a practical problem appears, resulting from the fact that the dimension of the condenser is relatively large, making the transportation of the system more difficult and increasing the transportation costs of the refrigeration system from one place to the other. Accordingly, there is a need to provide a refrigeration system with a plate-type condenser, which can be more compact for handling and shipping, and which can be easily returned to its condition prepared for the final use in a refrigeration appliance.

OBJECT OF THE INVENTION

[0006] It is a generic object of the present invention to provide a refrigeration system having a plate-type condenser and an evaporator coil supported by an elongated suction tube connected to the compressor of the refrigeration system, in which the dimension of the latter can be reduced, by displacing part of the plate-type condenser and of the suction tube, in order to lower the position of the evaporator coil, so as to make easier and more efficient both the handling and the shipping of the refrigeration system.

[0007] It is a further object of the invention to provide a method for compacting said refrigeration system for its storage and transportation and prior to the assembly thereof.

SUMMARY OF THE INVENTION

[0008] According to the invention, a refrigeration system is provided, comprising the usual components of a compressor mounted in a hermetic shell; an evaporator coil; and a condenser. The condenser is of the plate type, formed by a lower plate section and an upper plate section that are spaced from each other. The high-pressure refrigerant fluid discharged from the compressor is supplied to a condenser tube, which is formed on the lower and on the upper plate sections, in a coil-type pattern from the bottom to the top and back to the bottom. In a final manufacturing step and when the present refrigeration system is in a condition of use, the plate sections of the condenser lie on the same vertical plane one over the other, with the upper section being disposed over the compressor shell.

[0009] An evaporator, which is formed by a tube that is wound like a coil in a generally cylindrical form, is positioned above the upper plate section of the condenser, transversally to the lower and upper plate sections. The evaporator coil receives the refrigerant fluid from the condenser through a capillary tube, extending from the lower part of the lower plate section to the evaporator coil. An elongated suction tube extends from the evaporator coil along the height of the lower and upper plate sections of the condenser, back to the compressor for admission of the refrigerant fluid that will be compressed. The suction tube is obtained from an adequate material and presents the necessary strength to support the evaporator coil when said coil is not otherwise supported, as it occurs before its assembly in the cabinet of the refrigeration appliance.

[0010] In order to reduce the general dimension of the refrigeration system for handling and shipping, the capillary tube and the suction tube are made of a material that allows bending, said tubes being bent to a form that produces the lowering of the evaporator coil from a position above the upper plate section of the condenser to a position generally above the compressor shell, preferably in a position below the upper end of the lower plate section of the condenser. The upper plate section of the condenser is then bent downwardly to reduce the total height of the system.

[0011] In a first embodiment of the invention, the upper plate section of the condenser is bent rearwardly, in order to lie parallel to the lower plate section. In a second embodiment, the upper plate section is bent so as to lie transversal to the lower plate section, overlapping the evaporator coil. Both embodiments of the invention reduce the total dimension of the refrigeration system as a whole, making it easier to handle and its transportation more efficient and less expensive.
[0012] When the system, received in the compact form, is conducted to be mounted in the cabinet of the refrigeration appliance, the upper plate section is bent back to its original position, and the suction tube and the capillary tube are straightened, in order to elevate the evaporator coil and arrange all components in an adequate position to be mounted in the cabinet of the refrigeration appliance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The invention will be described below, with reference to the enclosed drawings, in which:

[0014] FIG. 1 is a front elevational perspective view of a refrigeration system, illustrated in the condition to be used in the refrigeration system, and which also represents the final condition of the manufacturing process;

[0015] FIGS. 2 and 3 are front elevational perspective views, showing the refrigeration system in different dimension compaction steps, according to a first embodiment of the invention; and

[0016] FIGS. 4 and 5 are, respectively, front and bottom perspective views of the refrigeration system illustrated in a final compaction step, according to a second embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0017] FIG. 1 shows a refrigeration system having the usual conventional components, but with a plate-type condenser constructed according to the invention. The refrigeration system is shown with a general arrangement of its components being positioned in the form they are designed to be mounted in the cabinet of a refrigeration appliance (not illustrated), and which also represents the final form after the manufacturing steps and test procedures. When mounted in the cabinet of the refrigeration appliance, the several components are supported by the adequate structural mounting members.

[0018] The system presents, at the bottom thereof, a compressor with a conventional construction mounted in a hermetic shell 10, which presents a mounting support 11, through which the hermetic shell 10 is mounted in the cabinet of the refrigeration appliance. The compressor compreses a high-pressure refrigerant fluid, which is supplied to a discharge tube 12 mounted to the hermetic shell 10 and which leads to a plate-type condenser 20. The plate-type condenser 20 is formed by a lower plate section 20a and an upper plate section 20b with a spacing 21 therebetween. The lower plate section 20a and the upper plate section 20b generally lie on the same vertical plane and can have the same size, with the same width and height, or with the height of the upper section 20b being slightly smaller than that of the lower section 20a. The sections 20a and 20b are made of any adequate material, usually a galvanized steel plate, to avoid corrosion. The lower plate section 20a and the upper plate section 20b present holes 22 for the assembly thereof to the cabinet of the refrigeration appliance.

[0019] A condenser tube 30, which is an extension of the discharge tube 12 of the refrigerant fluid, is mounted to the lower plate section 20a and to the upper plate section 20b of the plate-type condenser 20 by any conventional means, such as clamps or other types of fixation means. The condenser tube 30 is typically made of copper, and it is formed in a coil pattern, with several alternate small and large turns or loops, which have a first segment extending upwardly, from the discharge tube 12 in the lower plate section 20a through the spacing 21, and then to the upper end of the upper plate section 20b. The condenser tube 30 continues, with a second segment extending downwardly, in small and large alternate turns or loops, which are entwined with the small and large turns of the first segment, said second segment developing downwardly again, toward the lower end of the upper plate section 20b, passing through the spacing 21 and toward the lower end of the lower plate section 20a. It should be noted that, in the spacing 21, the first and the second segments of the condenser tube 30, extending upwardly and downwardly, are close and substantially parallel to each other in a median region 31.

[0020] The lower end of the condenser tube 30 is connected to the inlet end of a drying filter 40, whose outlet end is connected to the capillary tube 50 of a smaller diameter. The capillary tube 50 comprises a capillary tube coil 51 in its median portion to provide expansion of the refrigerant fluid, with the capillary tube 50 being upwardly elongated, toward a point located at or above the upper end of the upper plate section 20b, where the upper end of the elongated capillary tube 50 is connected to the lower end inlet of an evaporator coil 60, with a cylindrical development, which is formed by a certain number of turns of a copper tube. The outlet of the evaporator coil 60 is connected, by its upper end, with an elongated suction tube 70, downwardly extending through the height of the lower plate section 20a and the upper plate section 20b. The suction tube 70 has its lower end connected to the hermetic shell 10 of the compressor, in order to supply the low pressure refrigerant fluid back to the compressor in a suction inlet 14. During the manufacturing period of the system, the suction tube 70 presents sufficient strength and rigidity to maintain the evaporator coil 60 in the position illustrated in FIG. 1. When the system is mounted in the cabinet of the refrigeration appliance, the evaporator coil 60 will be mounted to another member.

[0021] In a conventional manner and as illustrated, the capillary tube 50 has a smaller diameter and is made of a metal that is softer than that of the suction tube 70. The materials of the condenser tube 30, of the suction tube 70 and of the capillary tube 50 are selected so that they can be bent or curved at least twice from the embodiment illustrated in FIG. 1: the first time, when the system has its dimension reduced, and later, when the system has its form reestablished to that one required to allow its assembly to the refrigeration system, without damaging the integrity of the deformed parts.

[0022] In the prior art, the plate-type condenser is made with a single piece plate, so that the total dimension of the refrigeration system cannot be made smaller than that corresponding to the dimension of the single plate of the condenser. Thus, the system would be bulky and rather difficult to handle and costly to transport. By making the condenser in plate sections, as shown in FIG. 1, the total dimension of the system can be reduced for an easier and more efficient handling and for obtaining a more economic transportation.

[0023] A first embodiment of the invention, which allows attaining the desired result, is illustrated in FIGS. 2 and 3.
FIG. 2 shows a first step in the process for compacting the dimension of the refrigeration system illustrated in FIG. 1 to a smaller size assembly. As shown, the elongated suction tube 70 and the capillary tube 50 were bent to form a coil with a generally circular single turn, which is positioned parallel to the plane of symmetry of the hermetic shell 10 of the compressor, and disposed slightly above said hermetic shell 10, but below the upper end of the lower plate section 20a. This causes the lowering of the evaporator coil 60 to a position in which its top remains below the upper end of the lower plate section 20a of the condenser 30. FIG. 3 shows the second process of compaction, in which the upper plate section 20b is downwardly bent about 180° away from the upper plate section 20a, such that its rear surface (without a condenser tube 30) faces the rear surface of the lower plate section 20a. Upon curving the upper plate section 20b, the parts of the condenser tube 30 in the spacing 21 between the lower plate section 20a and the upper plate section 20b are bent, in order to allow said curving to occur and that both parts 31 of the condenser tube 30, which were in the spacing 21, be disposed at the top of the compacted system. As seen, the dimension (total height) of the refrigeration system is reduced, from the condition shown in FIG. 1, to that in which the only height is that of the lower plate section 20a. This produces a substantial size reduction, making the refrigeration system easier to handle and its shipping much more economic.

[0024] When the system has to be mounted in the cabinet of the refrigeration appliance, the upper plate section 20b is bent back to its original position and the suction tube 70 and the capillary tube 50 are straightened to elevate the evaporator coil 60. Thus, all the components of the system are placed in the adequate position to be mounted in the cabinet of the refrigeration appliance.

[0025] FIGS. 4 and 5 show another embodiment of the invention, in which the same reference numbers are used for similar components. As it occurs in the embodiment of FIGS. 2 and 3, the suction tube 70 and the capillary tube 50 are bent to such a shape that the evaporator coil 60 is lowered to a position slightly above the hermetic shell 10 of the compressor and similar to that shown in FIG. 2. In this condition, the upper plate section 20b is forwardly bent at about 90°, curving the parts 31 of the condenser tube 30 in the spacing 21, so that the upper plate section 20b remains generally perpendicular to the lower plate section 20a and generally parallel to the evaporator coil 60. As it occurs with the embodiment of FIGS. 2 and 3, the total dimension of the refrigeration system, as a whole, is substantially reduced to the height of the lower plate section 20a.

[0026] The embodiment of FIGS. 4 and 5 presents the advantage that no part of the condenser tube 30 is exposed, while in FIG. 3, the parts of the condenser tube 30 in the upper plate section 20b and in the spacing 21 remain exposed. Also in the embodiment of FIGS. 4 and 5, the evaporator coil 60 is covered by the upper plate section 20b after the latter has been adequately bent. The return of the refrigeration system to a configuration to be mounted to the cabinet of the refrigeration system is processed as already described above. As it can be seen, the invention provides a refrigeration system that has a novel form for the plate-type condenser that allows the total dimension of the system to be reduced during certain steps of its manufacture and use.

[0027] Specific aspects of the invention are shown in the drawings for convenience only, since each aspect can be combined with other aspects according to the invention. Alternative embodiments will be understood as possible by those skilled in the art and intended to be included in the scope of the claims. Thus, the above description should be understood as illustrative and not limiting of the protection scope of the invention. All evident alterations and modifications are within the protection scope defined by the enclosed claims.

1. A refrigeration system including a compressor provided in a hermetic shell (10), having a discharge tube (12) for the high-pressure refrigerant fluid, which is supplied to a condenser tube (30) of a plate-type condenser (20) for transferring heat and then conducted to an evaporator coil (60) presenting a suction tube (70) that returns to a suction inlet (14) of the compressor, characterized in that the plate-type condenser (20) comprises a lower plate section (20a) and an upper plate section (20b) with a spacing (21) therebetween, onto which sections the condenser tube (30) is mounted in an entwined coil pattern, the lower plate section (20a) and the upper plate section (20b), in a condition of the refrigeration system, being positioned one over the other in the same vertical plane, with the evaporator coil (60) being held by the suction tube (70) at or above the upper plate section (20b), and, in a second condition for reducing the dimension of the refrigeration system, the suction tube (70) is curved in order to lower the evaporator coil (60) that will be placed above the hermetic shell (10) and below the upper end of the lower plate section (20a), with the upper plate section (20b) being downwardly bent.

2. The system as set forth in claim 1, characterized in that, in the second condition, the upper plate section (20b) is rearwardly bent to be substantially parallel to the lower plate section (20a).

3. The system as set forth in claim 1, characterized in that, in the second condition, the upper plate section (20b) is bent to be substantially perpendicular to the lower plate section (20a) and to overlap the evaporator coil (60).

4. The system as set forth in claim 1, characterized in that the condenser tube (30) on the lower plate section (20a) and on the upper plate section (20b) is formed with a first segment upwardly extending from the compressor, towards the top of the upper plate section (20b), and by a second segment downwardly extending towards the lower end of the lower plate section (20a), the median regions (31) of each of said first and second segments of the condenser tube (30), which are positioned across the spacing (21) between the lower plate section (20a) and an upper plate section (20b), being generally parallel.

5. The system as set forth in claim 1, characterized in that it comprises a capillary tube (50) extending from the lower end of the lower plate section (20a) to the evaporator coil (60), and in said first condition of the refrigeration system, the suction tube (70) and the capillary tube are curved to allow the evaporator coil (60) to be lowered.

6. The system as set forth in claim 1, characterized in that the suction tube (70) and the capillary tube (50) are curved in the form of a coil, which is provided above the hermetic shell (10) and below the upper end of the lower plate section (20a).

7. Method to reduce the dimension of a refrigeration system including a compressor provided in a hermetic shell (10), having a discharge tube (12) for the high-pressure
refrigerant, which is supplied to a condenser tube (30) of a plate-type condenser (20) for heat absorption, and thence to a capillary tube (50) and subsequently to an evaporator coil (50), and then to an evaporator coil (60) presenting a suction tube (70) which returns to a suction inlet of the compressor, characterized in that comprises the steps of:

forming the plate-type condenser (20) with a lower plate section (20a) and an upper plate section (20b) with a spacing (21) therebetween;

mounting the condenser tube (30) on the lower plate section (20a) and on the upper plate section (20b) in an entwined coil pattern;

positioning, in a first condition of the refrigeration system, the lower plate section (20a) and the upper plate section (20b) one over the other in the same vertical plane and affixing the evaporator coil (60) through the suction tube (70) at or above the upper plate section (20b); and

reducing, in a second condition of the refrigeration system, the dimension of said system, by curving the suction tube (70) in order to lower the evaporator coil (60) to a position above the hermetic shell (10) and below the upper end of the lower plate section (20a) downwardly bending the upper plate section (20b).

8. The method as set forth in claim 7, characterized in that, in the second condition, the upper plate section (20b) is rearwardly bent in order to stay substantially parallel to the lower plate section (20a).

9. The method as set forth in claim 7, characterized in that, in the second condition, the upper plate section (20b) is bent to remain substantially perpendicular to the lower plate section (20a) and to overlap the evaporator coil (60).

10. The method as set forth in claim 7, characterized in that the condenser tube (30) on the lower plate section (20a) and on the upper plate section (20b) is formed with the first segment extending over the compressor, toward the top of the upper plate section (20b), and with the second segment downwardly extending toward the lower end of the lower plate section (20a), the median regions (31) of the first and the second segments of the condenser tube (30), which are provided across the spacing (21) between the lower plate section (20a) and the upper plate section (20b), being generally parallel.