June 8, 1965 K. ROELSGAARD 3,187,996

HERMETICALLY ENCLOSED REFRIGERATING MACHINE

Filed July 13, 1962

FIG. 1

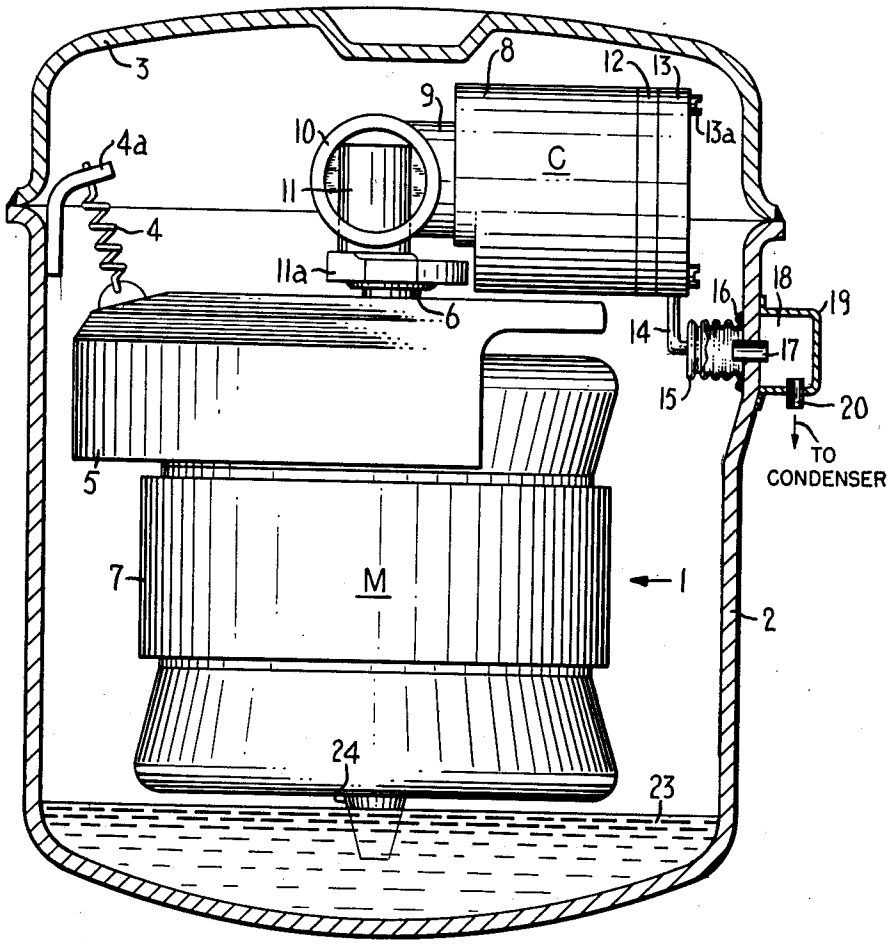
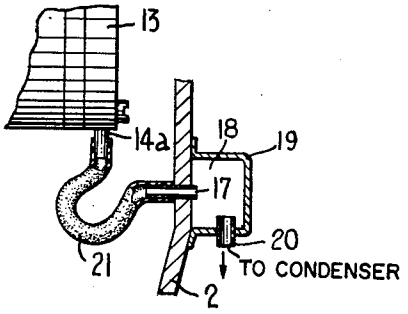


FIG. 2



United States Patent Office 3,187,996 Patented June 8, 1965

3,187,996

HERMETICALLY ENCLOSED REFRIGERATING MACHINE

Knud Reelsgaard, Nordborg, Denmark, assignor to Danfoss ved ing. M. Clausen, Nordborg, Denmark, a company of Denmark

Filed July 13, 1962, Ser. No. 209,630
Claims priority, application Germany, July 15, 1961, D 36,573
7 Claims. (Cl. 230—232)

The present invention relates to hermetically sealed refrigerating units in which the compressor and driving motor are hermetically sealed inside a chamber or capsule. The inside of the capsule is preferably at subatmospheric pressure.

In hermetically sealed refrigerating units, the dissipation of heat generated inside the capsule presents a serious problem. The heat is generated in the windings of the electrical motor driving the compressor, by compression of the refrigerant in the compressor and by the friction of the moving parts.

The dissipation of the heat is made more difficult by reason of the fact that, particularly in small units, the motor-compressor assembly is mounted inside the capsule by helical springs so as to reduce the noise level. This mounting provides a very poor thermal connection to the wall of the capsule. The resilient mounting of the motor-compressor unit gives rise to the further difficulty, that because of the relative movement permitted by the spring mount between the motor-compressor unit and the capsule, the high pressure line leading from the discharge of the compressor, through the capsule wall and to the condenser must be relatively long to avoid restricting this movement. Ordinarily, the portion of the pressure line inside the capsule comprises several coils or sinuous corrugations in order to permit movement of the motor-compressor unit on its spring mount. As the high pressure line carries refrigerant at high temperature, it represents a heat emitting surface which materially increases the amount of heat that must be carried away from inside the capsule.

The resulting temperature rise inside the capsule is not only deleterious to the motor windings, but also considerably reduces the viscosity and lubricating characteristics of the lubricating oil in the unit. Moreover the increased temperature inside the capsule superheats the refrigerant vapor in the inlet line leading to the compressor and thereby decreases compressor efficiency and capacity.

It is an object of the present invention to reduce the amount of heat emitted inside the capsule of the refrigerating unit thereby reducing the amount of heat that must be dissipated. The resulting reduction in temperature inside the capsule results in higher efficiency and longer life of the unit.

In accordance with the invention, the emission of heat inside the capsule chamber is materially reduced by shortening the line carrying the high pressure refrigerant inside the capsule and thus reducing the area of the heat emitting surface.

In order to differentiate from known designs, the expressions "short" and "small" as herein used indicate a value of 50% or less of the value commonly in use previously. Heretofore, very long pressure lines have been considered essential in order to enable the compressor to move freely in both an axial and rotating direction without being obstructed by the pressure line forming the connection between the movable compressor and the fixed capsule. For example, a unit of known design employs three or more coil windings of the high pressure line around the motor-compressor. In contrast with such

design, in accordance with the present invention has a line corresponding in length to only 1½ windings and preferably only one winding or less. Another unit of known design employs a corrugated pressure line consisting of six or more corrugations. In accordance with the present invention, the pressure line has a length corresponding to maximum of three corrugations, but preferably even shorter, for example, corresponding to a single corrugation or less. As a further indication of the length of the portion of the pressure line inside the capsule, it is less than half, and preferably less than one quarter, the diameter or distance across the capsule.

Owing to the shorter pressure line, special provisions must be made to ensure the movability of the motor-compressor. In one embodiment of the invention, the relatively rigid pressure line heretofore used is replaced by a short flexible tube. This tube is made of a synthetic plastic resistant to heat, refrigerant and oil. For example, a suitable material is nylon, which is a long-chain polymeric amide which has recurring amide groups as an integral part of the main polymeric chain. Another synthetic material that has been found suitable is that which is sold under the trade name "Viton." A pressure line made of synthetic material has the advantage that it adheres easily to the inlet and outlet connection. Furthermore, the material has a lower thermal conductivity than metal and hence serves to insulate the inside of the capsule from the heat of the compressed refrigerant. The synthetic tube does not have to be completely gas tight since any refrigerant defused through the pressure line remains within the capsule.

In accordance with another embodiment of the invention, the pressure line is composed chiefly of a bellows. The resiliency of the bellows not only allows a sufficient movement of the pressure unit, but greatly reduces the emission of heat from the high pressure line since the true heat-transmitting surface of the bellows consist in effect of the cylindrical surface of the casing since the surface between the corrugations acts only in a very small degree as a heat emitting surface. The more corrugations the bellows has, the greater are the afore-mentioned advantageous properties of the bellows.

Moreover, in accordance with the invention, it is preferable to locate the muffler or silencer in the high pressure line outside the capsule, preferably in such a manner that the capsule wall forms part of the enclosure for the silencer. The location of the silencer outside the capsule further reduces the emission of heat in the capsule chamber.

The nature and advantages of the invention will appear more fully from the following description and claims in conjunction with the accompanying drawings in which:

FIGURE 1 is a side view partially in section of a hermetically sealed refrigerating unit in accordance with the invention, and

FIGURE 2 is a fragmentary view partially in section showing a modification.

As illustrated in FIGURE 1, a unit in accordance with the invention comprises a motor-compressor **1**, spring mounted inside a capsule 2 which is hermetically sealed by a cover 3 welded to the upper edge of the capsule. The motor-compressor assembly comprises a supporting member 5 on which are mounted an electric motor M and a compressor C driven by the motor. The supporting member 5 is supported in the capsule by a plurality of coil springs 4 attached to brackets *4a* projecting inwardly from the capsule wall. There are preferably three such springs and brackets, although only one can be seen in the drawing. The motor M comprises a rotor (not shown) on a rotor shaft 5 rotatably supported in a stator 7 which is carried by the supporting member **5**. The compressor C is also mounted on the supporting member

5 and comprises a cylinder 8 and a piston 9 which is reciprocated in the cylinder by means of a Scotch yoke 10 driven by a crank pin 11 which projects upwardly from a crank wheel 11*a* mounted on the upper end of the motor shaft 6. The crank pin 11 is mounted excentrically of the motor shaft 6 so that rotation of the rotor produces reciprocation of the piston 9 in the cylinder 8.

The compressor C further comprises an intermediate valve plate 12 which is fixed on the cylinder 8 with its inner surface substantially at the upper dead-center of the piston and contains intake and exhaust valves (not shown), communicating respectively with intake and discharge chambers formed in a cover plate 13. A plurality of screws 13*a* secure the cover plate 13 and the intermediate valve plate 12 to the cylinder 8 with fluid tight seals.

A suitable suction line (not shown) is connected to the intake chamber of the compressor. A pressure line leads from the discharge chamber of the compressor to a condenser located outside of the capsule 2.

In accordance with the invention as illustrated in FIGURE 1, the pressure line comprises a short elbow-shaped line 14 leading from the compressor to a bellows 15 having a flange 16 welded to the wall of the capsule 2. The bellows 15 is of a larger diameter than the line 14 and preferably has at least three corrugations. A short length of tubing 17 extends through the wall of the capsule 2 and connects the interior of the bellows 15 to a muffler or sliencer 19 which is welded on the outside of the capsule wall. By reason of the silencer being mounted on the outside of the capsule, the heat emitted by the silencer by reason of the high temperature compressed refrigerant passing through it, is dissipated externally and is not given off inside the capsule. A line 20 leads from the silencer 19 to the condenser (not shown).

With the construction shown, the length of the pressure line and the area of the heat emitting surface of that portion of the line inside the capsule are many times less than the pressure lines generally in use. As illustrated, the total length of the portion of the pressure line inside the capsule, such as the combined length of the tube 14 and bellows 15 is less than one quarter the diameter of the capsule. The construction thus greatly ameliorates the problem of avoiding excessive temperatures inside of the capsule. Moreover, the welding of the bellows flange 16 directly to the capsule wall provides good heat conductivity, particularly since the cross-sectional area of the bonding of the bellows to the wall is relatively large. Thus, heat from the bellows 15 and the connected line 14 is conducted to and dissipated by the capsule wall which thus acts as a heat sink. At the same time, the flexibility of the bellows provides adequate freedom of movement of the motor-compressor on its spring mount provided by the springs 4. The tube 14 and bellows 15 are illustrated as being made of metal, although other suitable materials such as synthetic resin may be used as desired.

In FIGURE 2, there is illustrated another embodiment in which the high pressure line of the compressor comprises a flexible tube 21 extending between the tube 17 which passes through the capsule wall and a short tube 14*a* projecting from the compressor at right angles to the tube 17. The flexible tube 17 is hermetically sealed to the connecting tubes 14*a* and 17 respectively, for example by adhesive or by suitable clamps. It is formed of synthetic material such as nylon or Viton which is sufficiently strong to stand the pressure of the refrigerant and is not deleterously affected by the refrigerant or by the oil 23 which is sealed in the capsule 2 and is circulated by means of a pump 24. The material must also be sufficiently heat resistant to withstand the temperature of the compressed refrigerant. The flexible tube 21 is preferably formed with a U-shaped bend as shown in order to avoid abrupt turns or corners and provide still greater

freedom of movement of the motor-compressor on its spring mount. By reason of its relatively low heat conductivity, which is appreciably lower than metal, the material of the tube 21 in effect, insulates the interior of the capsule 2 from the hot refrigerant in the pressure line and thereby minimizes the emission of heat into the chamber. By reason of the short length of the tube 21 and its heat insulating characteristics, the amount of heat dissipated by the pressure line into the interior of the capsule is only a small fraction of that emitted by the pressure lines of compressor units now in use. The tube 21 is shown as having a length approximately one quarter the diameter of the capsule 2.

The present invention thus represents an important advance in the improvement of hermetically sealed refrigerating units. While preferred embodiments of the invention have been illustrated in the drawings and herein particularly described, it will be understood that the invention is in no way limited to these embodiments.

What I claim is:

1. In a sealed refrigerating unit comprising a hermetically sealed chamber having a wall, a compressing unit comprising a motor and a compressor driven by said motor and having a discharge passage adapted for connection with a condenser outside said chamber, and means resiliently mounting said compressing unit in said chamber to provide a cushioned support permitting movement of said compressing unit in said chamber, the improvmeent comprising a flexible expandable passage means mounted on the inner surface of the wall of said chamber near the discharge passage of said compressor, conduit means connecting said passage means with said discharge passage and a passage extending through the wall of said chamber and leading from said passage means to said condenser.

2. A sealed refrigerating unit comprising a hermetically sealed chamber having a wall, a compressing unit comprising a motor and a compressor driven by said motor and having a discharge passage adapted for connection to a condenser outside said chamber, means resiliently mounting said compressing unit in said chamber to provide a cushioned support permitting movement of said compressing unit in said chamber, a flexible expandable passage means mounted on the inner surface of the wall of said chamber near the discharge passage of said compressor, conduit means connecting said passage means with said discharge passage, a silencer mounted on the outside surface of said wall adjacent said passage means and having a cavity, means connecting said cavity with said passage means and means for connecting said silencer with said condenser.

3. A sealed refrigerator unit according to claim 2, in which said passage means comprises a bellows.

4. A sealed refrigerator unit according to claim 3, in which a portion of the wall of said chamber forms an end wall of said bellows and a wall of said cavity of the silencer.

5. A sealed refrigerator unit according to claim 3, in which said conduit means comprises an L-shaped tube connected at one end with said discharge passage of the compressor and at the other end with an end of said bellows.

6. A sealed refrigerating unit comprising a hermetically sealed chamber having a wall, a compressing unit comprising a motor and a compressor driven by said motor and having a discharge port adapted for connection to a condenser outside said chamber, means resiliently mounting said compressing unit in said chamber to provide a cushioned support permitting movement of said compressing unit in said chamber, a silencer mounted on the outside surface of said wall near said discharge port of the compressor and having a cavity, means for connecting said cavity with said condenser and a short, flexible non-metallic tube of lower heat conductivity than copper connecting said cavity with said discharge port of

the compressor to minimize heat transfer to the interior of said chamber from hot compressed gas discharged from said compressor, while permitting movement of said compressor unit relative to said chamber.

7. A sealed refrigerating unit comprising a hermetically sealed chamber having a wall, a compressing unit comprising a motor and a compressor driven by said motor and having a discharge port adapted for connection to a condenser outside said chamber, means resiliently mounting said compressing unit in said chamber to provide a cushioned support permitting movement of said compressing unit in said chamber, a silencer mounted on the outside surface of said wall near said discharge port of the compressor and having a cavity, means for connecting said cavity with said condenser and a short flexible passage-defining means connecting said cavity with said discharge port and comprising a flexible passage

wall having annular corrugations imparting greater flexibility to said passage wall to permit movement of said compressor unit relative to said chamber and reducing heat transfer to the interior of said chamber from hot compressed gas discharged from said compressor.

References Cited by the Examiner

UNITED STATES PATENTS

3,006,160	10/61	Heidorn	62—296
3,008,628	11/61	Gerteis	230—58
3,044,688	7/62	Frank, et al.	230—232
3,065,901	11/62	Neubauer	230—232 X
3,066,857	12/62	McCloy	230—232

LAURENCE V. EFNER, *Primary Examiner.*

ROBERT M. WALKER, *Examiner.*