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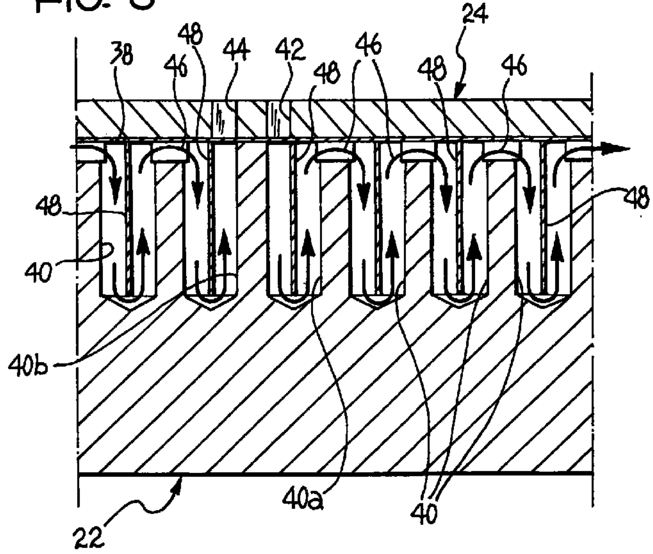
(54) A motor compressor for refrigerating apparatus and refrigerating apparatus including such motor compressor

(57) A reciprocating motor compressor for refrigerating apparatus comprises a sealed casing and a motor-compressor unit. The compressor of the unit comprises a piston, a cylinder (22) in which the piston is movable to and fro and a valved cylinder head (24). The cylinder (22), at least in the vicinity of the cylinder head (24), has at least one cooling cavity (40, 40a, 40b) in its wall with an inlet opening (42) and an outlet opening (44) to which respective cooling tubes lead which extend out from the motor compressor casing to be connected to an external coolant fluid circulation circuit for the cylinder (22).

FIG. 3



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Description

[0001] The present invention relates to a reciprocating motor compressor for refrigerating apparatus according to the preamble of Claim 1.

[0002] The invention has been developed for application to refrigerating apparatus and domestic freezers and for air conditioners which include a small motor compressor, but is not limited to these applications.

[0003] In refrigerating apparatus any arrangement capable of increasing the efficiency of the compressor is welcome.

[0004] The object of the invention is that of increasing the efficiency of the compressor in a refrigerating apparatus of the type considered.

[0005] According to the invention this object is achieved by means of a motor compressor as claimed.

[0006] The invention essentially lies in the idea of cooling the cylinder of the compressor.

[0007] In these conditions the compression phase takes place with a polytropic transformation which closely approaches an isothermic transformation with respect to what takes place in a conventional compressor.

[0008] The heat extracted by the cooling circuit causes a reduction in the temperature in the compressor with a consequent increase in the density of the aspirated refrigerant fluid.

[0009] The combination of the above-mentioned effects causes an increase in the performance and efficiency of the compressor.

[0010] The invention also relates to refrigerating apparatus which includes a motor compressor as claimed.

[0011] In a first preferred embodiment of the refrigerating apparatus the cylinder cooling circuit is a closed independent circuit which contains a heat exchange liquid which is cooled by passing it through a heat exchanger outside the compressor.

[0012] In another preferred embodiment of the refrigerating apparatus the cylinder cooling is achieved by directly utilising the coolant fluid pumped by the compressor, which at the end of a first condenser section of the apparatus is in the liquid phase.

[0013] This fluid is reintroduced into the compressor where it passes through the cylinder cooling circuit.

[0014] After this the fluid, which having extracted heat has an increased temperature, exits again from the compressor, is again cooled in a further condenser section and re-enters the normal path of the refrigerant circuit.

[0015] Further characteristics of the invention will become apparent from reading the detailed description which follows, with reference to the attached drawings provided purely by way of non-limitative example and in which:

Figure 1 is a very schematic plan view of a sealed motor compressor to which the invention is applied;

Figure 2 is a plan view of a first embodiment of a compressor cylinder, shown at its end corresponding to the cylinder head;

Figure 3 is a partial section taken on the arcuate line III-III of Figure 2;

Figure 4 is a diametral section of a second embodiment of the compressor cylinder;

Figure 5 is a schematic representation of refrigerating apparatus according to a first embodiment of the invention; and

Figure 6 is a similar schematic representation of refrigerating apparatus according to another embodiment of the invention.

[0016] Referring now to Figure 1, a reciprocating motor compressor for refrigerating apparatus has, in a known way, a sealed casing 10.

[0017] Within the casing 10 there is a motor compressor unit, generally indicated 12. The electric motor of the unit 12 is indicated 14 and its compressor is generally indicated 16.

[0018] The compressor 16 comprises a piston 18 connected to the motor 14 by means of a crank mechanism 20.

[0019] The piston 18 is movable to and fro in a cylinder 22 having a valved cylinder head 24.

[0020] From the valved cylinder head 24 extends a delivery tube 26 which, in a known way, leads out of the casing 10 and, as will be seen more herein below, is directed to the condenser of a refrigerating apparatus.

[0021] A suction tube 28 which, passing through the space within the casing 10, also leads to the valved cylinder head 24, extends out of the casing 10 and, as will be explained in more detail below, comes from the evaporator of the refrigerator apparatus.

[0022] According to the invention, the compressor 16 is provided with coolant tubes 30 and 32 which extend out through the casing 10 to be connected to an external cylinder coolant fluid circulation circuit for the cylinder 22.

[0023] Referring now to Figures 2 and 3, the inner cylindrical surface of the cylinder 22 in which the piston 18 of the compressor slides to and fro is generally indicated 34.

[0024] The reference numeral 36 designates a flange on which, by means of a seal 38, the cylinder head or valve plate 24 is fixed.

[0025] The wall of the cylinder 22 has a circular series of angularly equidistant blind holes 40, 40a, 40b which are parallel to the axis of the cylinder 22 and which extend adjacent to the cylinder 32 facing the cylinder head or valve plate 24 at least in the region of the compression chamber defined between the cylinder head 24 and the piston 18 (Figure 1) of the compressor.

[0026] These blind holes 40, 40a, 40b constitute a cooling cavity.

[0027] The holes 40, 40a, 40b are interconnected by communication ducts, except for the holes 40, 40a, 40b which are contiguous and which are not interconnected.

[0028] In the region of the hole 40a the valve plate 24 has an input opening 42 to which the coolant tube 30 (or 32) (Figure 1) is connected. In correspondence with the blind hole 40b the valve plate 24 has an outlet opening 44 to which the tube 32 (or 30) of the cooling circuit is connected.

[0029] Preferably, as shown, the intercommunication ducts between the blind holes 40, 40a, 40b are constituted by circumferential channels 46 formed in the end face of the cylinder 22 facing the cylinder head 24 and constituted by the flange 36.

[0030] Each blind hole 40, 40a, 40b contains a central partition, for example as shown in the form of a flat strip 48 fitted in a diametral position in the associated blind hole.

[0031] The partitions 48 extend close to the bottom of the associated hole 40, 40a, 40b and subdivide the latter into an onward and a return path for the coolant fluid, which communicates with respective opposite channels 46 except in the case of the hole 40a the onward path of which starts with the inlet opening 42 and except in the case of the hole 40b the return path of which leads to the outlet opening 44.

[0032] As can be seen in Figure 3, in the blind holes 40, 40a, 40b the coolant liquid follows along a labyrinth path to provide an effective cooling of the cylinder 22 (Figure 1) below the temperature which it would assume, in known compressors, in the absence of the cooling in question.

[0033] In Figure 4 there is shown a variant of the cylinder cooling cavity.

[0034] The compressor cylinder is designated 122 and its cylinder head or valve plate is designated 124.

[0035] In the embodiment of Figure 4 there is a single annular cooling cavity designated 140 which is concentric with the axis of the cylinder 122, which is formed, also in this case, from the end face which faces the cylinder head 124 and which has a blind bottom.

[0036] The annular cavity 140 communicates with the outside via an inlet opening 142 and an outlet opening 144.

[0037] The inlet opening 142 is connected to the coolant tube 30 (or 32) of Figure 1 and the outlet opening 144 is connected to the coolant tube 32 (or 30) of Figure 1.

[0038] The inlet opening 142 is constituted by a radial lateral hole situated in the region of the blind bottom of the cavity 140; the outlet opening 144 is constituted by a hole formed in the valve plate 144.

[0039] Naturally, the functions of the two openings 142 and 144 could be exchanged.

[0040] To obtain a long heat exchange path for the coolant liquid in the cavity 140 this latter contains a partition 148 which defines an indirect path for the liquid from the inlet opening 142 to the outlet opening 144.

[0041] Preferably, the partition 148 is in the form of a helical plate fitted into the cavity 140.

[0042] Reference will now be made to Figure 5 to describe a first embodiment of refrigerating apparatus which includes a sealed compressor such as that of Figure 1, incorporating a cooled cylinder such as that of Figures 2 and 3 or that of Figure 4.

[0043] The apparatus of Figure 5 comprises a classic refrigerating circuit in which a condenser 50 is traversed by a serpentine tube 52 which is a continuation of the delivery tube 26 and leads, via a dryer 54 to an evaporator 56.

[0044] From the evaporator 56 the refrigerant fluid in gaseous state returns to the compressor through the suction tube 28.

[0045] The path of the refrigerant fluid through the refrigerating apparatus is indicated by the arrows F1.

[0046] The cylinder 22 (Figures 2 and 3) or 122 (Figure 4) is cooled by means of a coolant circuit in which a heat exchange liquid circulates with an external fluid having a lower temperature, preferably with ambient air.

[0047] In Figure 5 the cooling circuit for the cylinder 22 or 122 exits via the outlet tube 30 and leads to a heat exchange radiator 58 for heat exchange with the ambient air.

[0048] In the radiator 58 the heat exchange liquid passes through a serpentine 60 and then returns via the inlet tube 32 into the cooling cavity of the compressor cylinder.

[0049] The direction of circulation of the heat exchange liquid is indicated by the arrows F2. The heat exchange liquid contained in the cooling circuit may be a refrigerant fluid such as that utilised in the refrigerating circuit of which the condenser 50 and evaporator 56 form part. In any case the cooling circuit of which the radiator 58 forms part is so arranged that the coolant fluid therein remains in the liquid state and at a temperature such as to produce an effective cooling of the cylinder 22 (Figures 2 and 3) or the cylinder 122 (Figure 4).

[0050] Alternatively, the heat exchange liquid contained in the cooling circuit may be the same lubricating oil as that contained in the sealed casing 10 (Figure 1) for lubricating the compressor.

[0051] The use of refrigerant fluid or lubricating oil as heat exchange liquid for the compressor is quite preferable in place of a liquid of different nature such as water since possible losses of liquid through the seal 38 (Figure 3) do not risk contaminating the refrigerant fluid which circulates in the refrigerating apparatus.

[0052] Preferably, for reasons of economy, the cooling circuit which includes the radiator 58 for exchanging heat with the ambient air is so arranged as to cause circulation of the heat exchange liquid according to the thermosiphon principle.

[0053] If the thus-obtained thermosiphon circulation were not sufficient a forced circulation electric pump could be interposed in the coolant circuit, as indicated by the broken outline 62 in Figure 5.

[0054] The pump 62 could be arranged to cause at least for a part of the time a forced circulation of the heat exchange liquid under the control of a thermostat (not shown).

[0055] Reference will now be made to Figure 6 to describe a second preferred embodiment of the refrigerating apparatus incorporating the sealed motor compressor according to the invention.

[0056] In Figure 6 the arrows F3... F7 indicate the direction of circulation of the refrigerant fluid in the apparatus.

[0057] The apparatus includes a condenser 150 through which passes a serpentine tube sub-divided into two sections 152a, 152b.

[0058] The first of these two sections 152a connects the delivery outlet from the cylinder by means of the delivery tube 26 to the inlet tube 30 of the cylinder cooling cavity, passing through the first section 152a of the serpentine of the condenser 150 (arrows F3 and F4); the second section 152b of the serpentine connects the outlet tube 32 from the cylinder cooling cavity of the compressor to the dryer 54 and then to the evaporator 56, passing through a second part of the condenser 150 (arrows F5 and F6).

[0059] From the evaporator 56 the refrigerant fluid in gaseous state returns to the compressor through the suction tube 28 (arrow F7).

[0060] The condenser 150 has been shown schematically as a unitary element in which the cooling fins, schematically represented at 154, are in common with the first and second serpentine sections 152a, 152b, but the two parts of the condenser 150 could be entirely separate.

Claims

1. A reciprocating motor compressor for refrigerating apparatus, comprising a sealed casing (10) and a motor-compressor unit (12) contained in the casing and the compressor (16) of which comprises a piston (18) a cylinder (22; 122) in which the piston is movable to and fro, and a valved cylinder head (24; 124), characterised in that the cylinder (22; 122), at least adjacent the cylinder head (24; 124) has in its wall at least one cooling cavity (40, 40a, 40b; 140) with an inlet opening (42; 142) and an outlet opening (44; 144) to which respective coolant tubes (30, 32) lead which extend out from the casing (10) to be connected to an external cooling fluid circuit for the cylinder (22; 122).

2. A motor compressor according to Claim 1, characterised in that the said cooling cavity is constituted by a circular series of holes (40, 40a, 40b) formed in the wall of the cylinder (22), parallel to the axis of the cylinder and interconnected by communication ducts (46).

3. A motor compressor according to Claim 2, characterised in that the said cooling holes (40, 40a, 40b) are blind holes, in that the intercommunication ducts are constituted by circumferential channels (46) formed in the said surface connecting the cylinder (22) with the cylinder head (24), and in that each blind hole (40, 40a, 40b) contains an intermediate partition (48) which extends close to the bottom of the hole and divides the hole into an onward path and a return path for the cooling fluid communicating with respective opposite channels (46).

4. A motor compressor according to Claim 3, characterised in that two contiguous blind holes (40a, 40b) have no intercommunication duct and one of the onward and return paths of one of these holes is connected to one of the said cooling tubes (30, 32) by means of an inlet opening (42) formed in the cylinder head (24), whilst the other of the onward and return paths of the other of these holes is connected to the other cooling tube by means of an outlet opening (44) also formed in the cylinder head (24).

5. A motor compressor according to Claim 1, characterised in that the cylinder (122) has an annular cooling cavity (140) in its wall concentric with the axis of the cylinder (122), extending from the contact surface with the cylinder head (124) and having a blind bottom, and in that the annular cavity (140) contains a partition (143) which defines an indirect path for the cooling fluid from an inlet opening (142) to an outlet opening (144) of the cooling cavity.

6. A motor compressor according to Claim 5, characterised in that the partition (148) is in the form of a helical plate fitted in the cavity (140).

7. Refrigerating apparatus including a motor compressor according to any of Claims 1 to 6, characterised in that it further includes an external cooling circuit (60; 152a) to which the said cooling tubes (30, 32) are joined.

8. Refrigerating apparatus according to Claim 7, characterised in that the external cooling circuit (60) is a circuit containing a heat exchange liquid, and which is closed through the said coolant tubes (30, 32) and the coolant cavity or cavities (40, 40a, 40b; 140) of the cylinder (22, 122), and in that this external circuit further includes a heat exchanger (58) in which the heat exchange liquid gives up heat to an external fluid having a lower temperature.

9. Refrigerating apparatus according to Claim 8, characterised in that the heat exchanger is a radiator (58) for exchanging heat with the ambient air.

10. Refrigerating apparatus according to Claim 9, characterised in that the external cooling circuit (60) is

so arranged as to cause circulation of the heat exchange liquid at least in part according to the thermosiphon principle.

11. Refrigerating apparatus according to Claim 9 or Claim 10, characterised in that there is a circulation pump (62) in the cooling circuit so arranged as to cause a forced circulation of heat exchange liquid at least for part of the time.

12. Refrigerating apparatus according to any of Claims 8 to 11, characterised in that the heat exchange liquid is a refrigerant fluid such as that utilised in the refrigerating circuit in which the motor compressor is fitted, and in that the cooling circuit (60) is so arranged that the coolant fluid remains in the liquid state therein.

13. Refrigerating apparatus according to any of Claims 8 to 11, characterised in that the heat exchange liquid is the same lubricating oil as that contained in the sealed casing (10) for lubricating the compressor (16).

14. Refrigerating apparatus according to Claim 7, characterised in that, in a known way, the valved cylinder head (24) of the compressor (16) has a delivery opening and a suction opening for a refrigerant fluid, in that the apparatus includes, also in a known way, a condenser (150), an evaporator (56) and a closed circuit in which the refrigerant fluid circulates and which includes a tube with extends from the delivery opening of the compressor cylinder to the evaporator (56) passing through the condenser (150), and in that the said external cooling circuit utilises the refrigerant fluid as coolant fluid and the said tube of the refrigerant fluid circulation circuit is sub-divided into two sections the first (152a) of which connects the delivery opening of the cylinder to the inlet opening (42; 142) of the cylinder cooling cavity (40, 40a, 40b; 140) passing through a first part of the condenser (150) and the second of which (152b) connects the outlet opening (44; 144) of the cooling cavity to the evaporator (56) passing through a second part of the condenser (150).

15. Refrigerating apparatus according to Claim 14, characterised in that the first and second parts of the condenser are constituted by two respective separate condensers.

16. Refrigerating apparatus according to Claim 14, characterised in that the first and second condenser parts are integrated in a single condenser (150).

FIG. 1

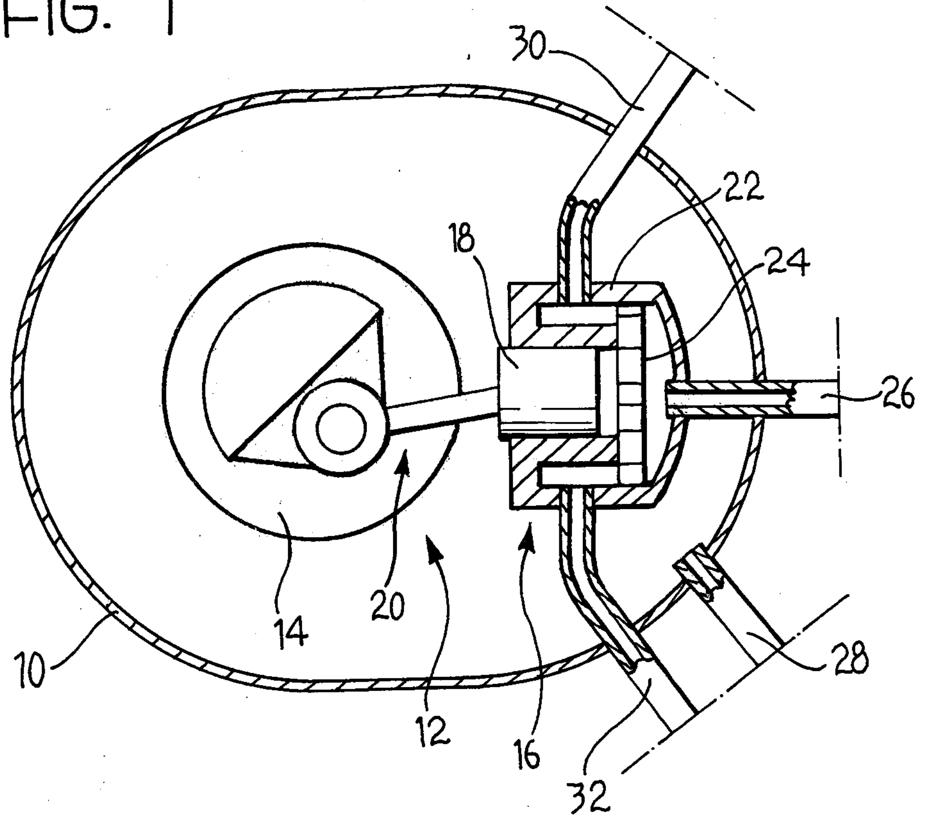


FIG. 4

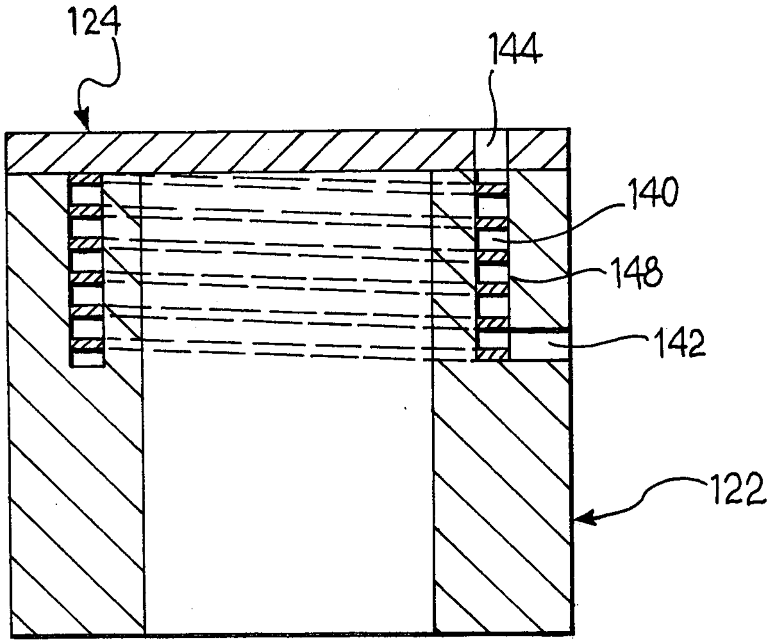
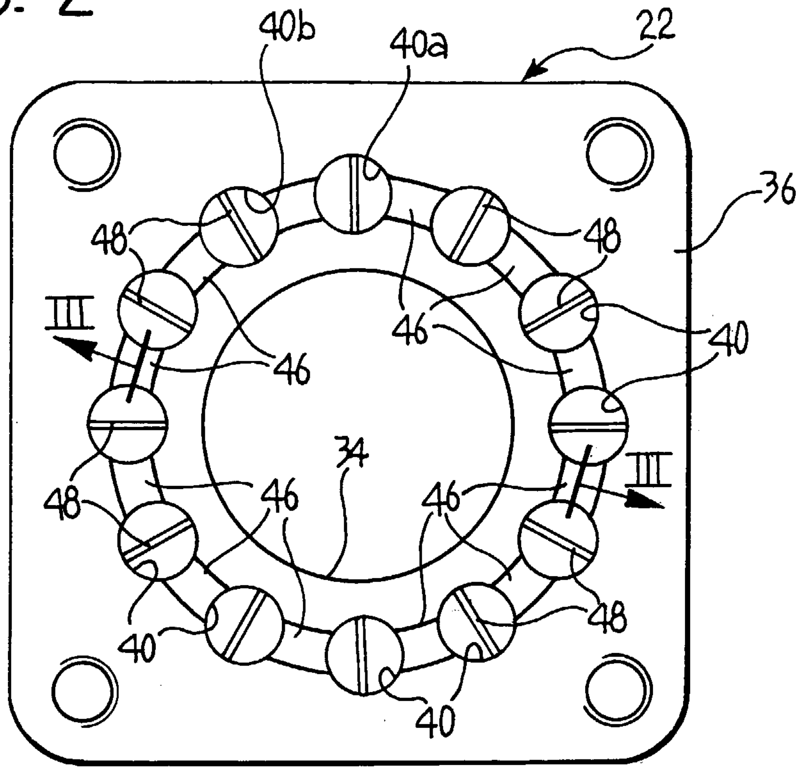


FIG. 2


40b
40a
22
36
48
48
48
III
46
46
46
40
40
34
III
48
46
46
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40
48
40
40

FIG. 3

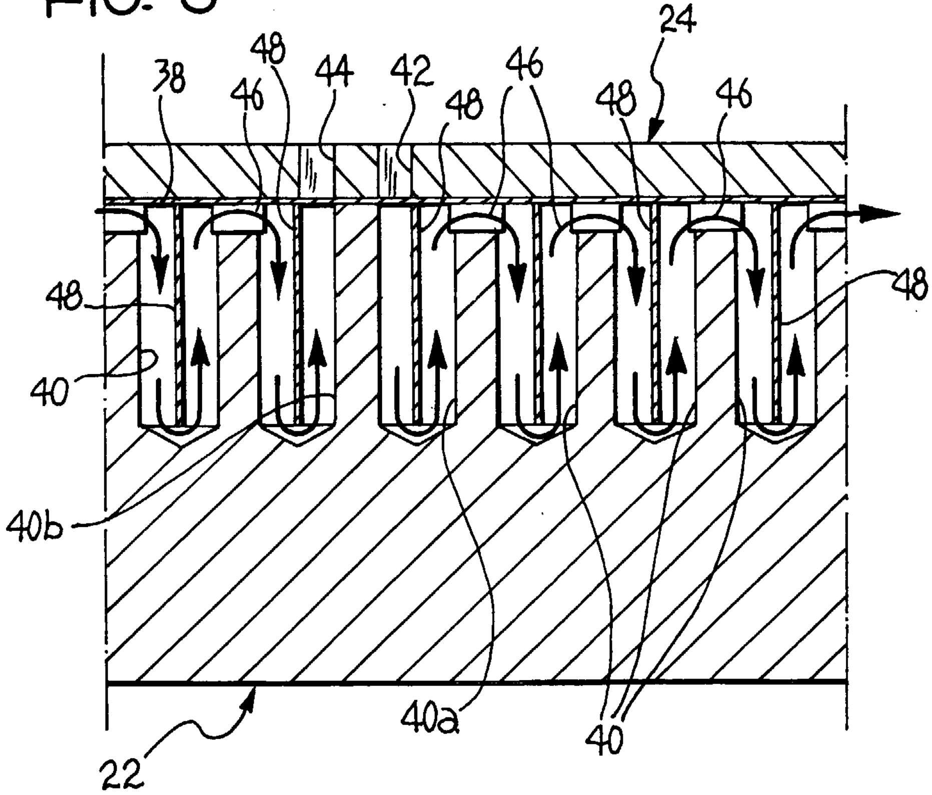

24
38
48
46
44
42
48
46
46
48
46
48
48
40
40b
40a
40
22

FIG. 5

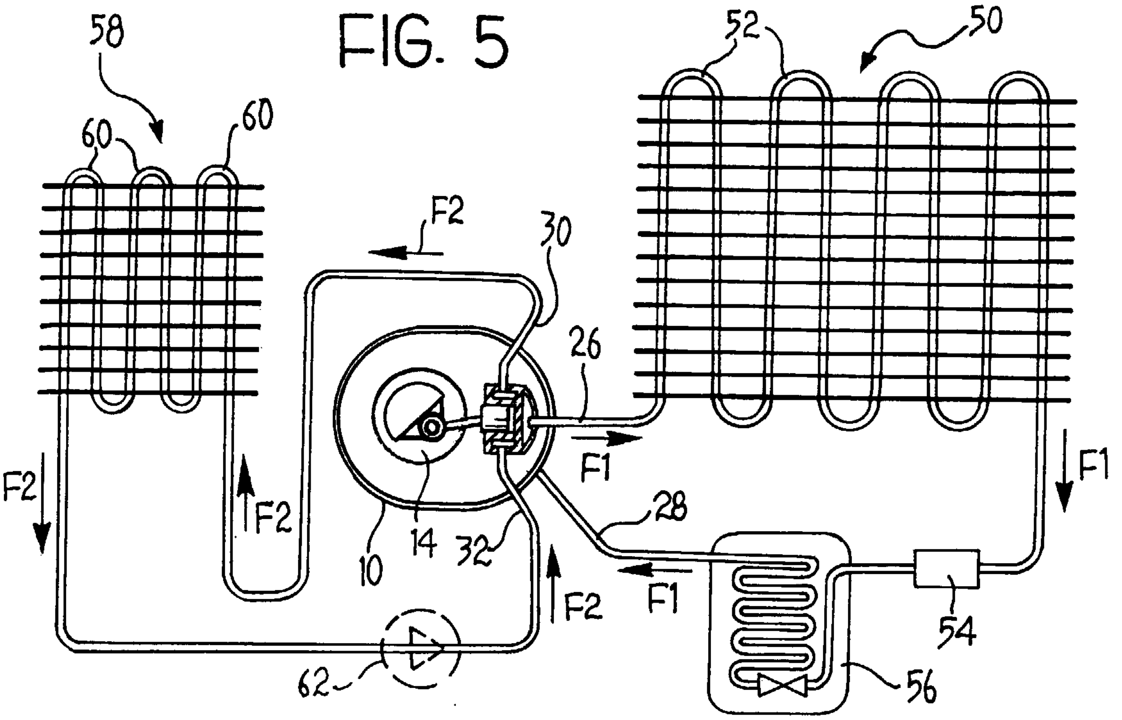
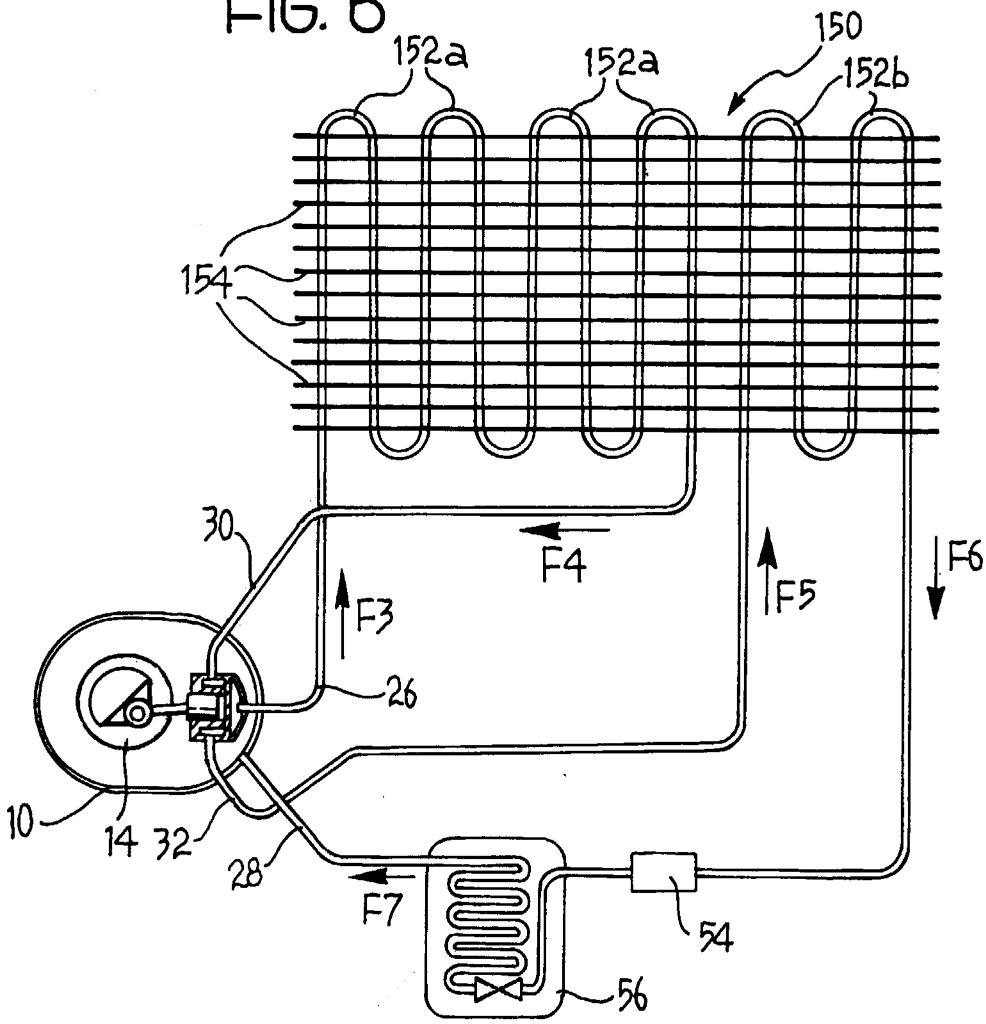

58
60
60
52
50
F2
30
26
F1
F2
F2
F1
14
10
32
28
F2
F1
54
62
56

FIG. 6


152a
152a
150
152b
154
30
F4
F3
F5
F6
26
10
14
32
28
F7
54
56