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(54) **REFRIGERATION APPARATUS**

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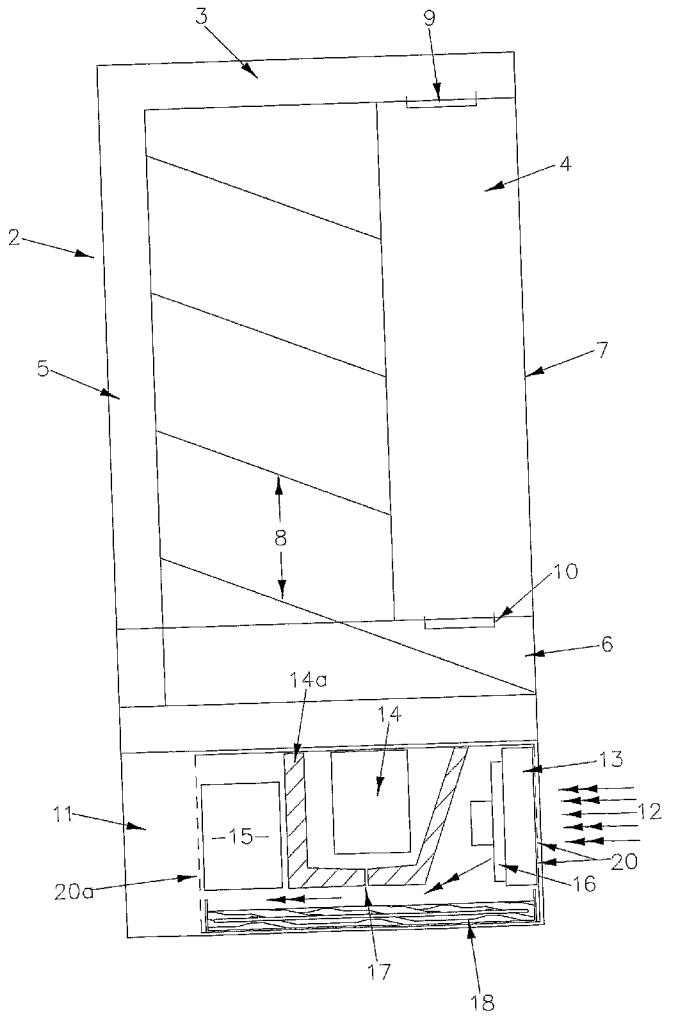
(57) **ABSTRACT**

Refrigeration apparatus which includes: an evaporator (**37**), a compressor (**33**) and a condenser (**38**), connected by pipe work in a known manner, a fan (**34**) and a tray (**35**) arranged to collect water during defrost cycle of the apparatus; wherein: a) at least the compressor (**33**), condenser (**38**), fan (**34**) and tray (**35**) are contained with in a housing (**36**) which is substantially closed except for air vents (**36***a*, **36***b*); b) at least part of the pipe work between compressor (**33**) and the condenser (**38**) is arranged to pass through the tray (**35**); c) the fan (**34**), housing (**36**) and tray (**35**) are designed and arranged such that in use the fan (**34**) moves air through the housing (**36**) so that substantially all of the air is directed over the surface of the tray (**35**).



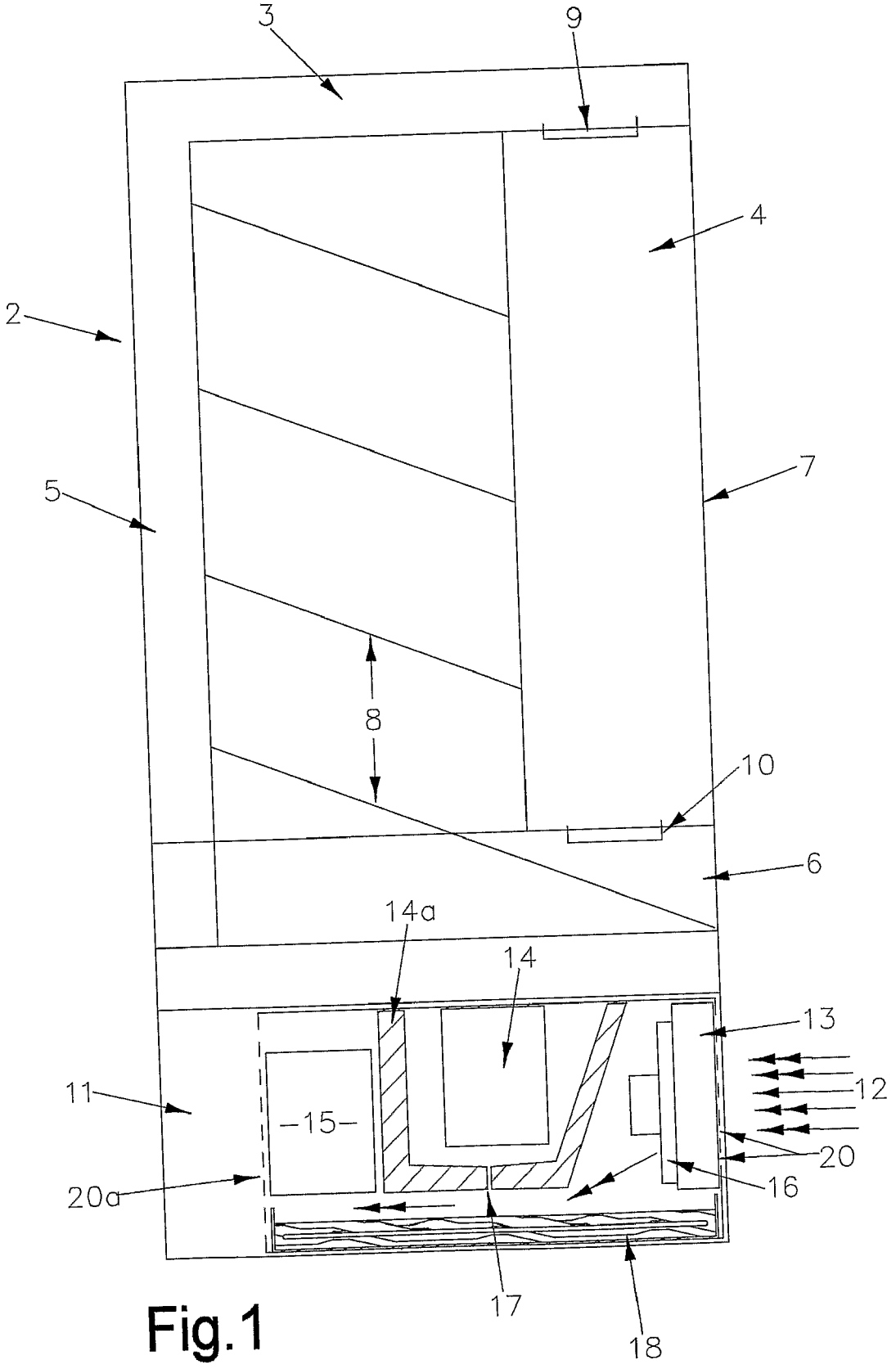


Fig.1

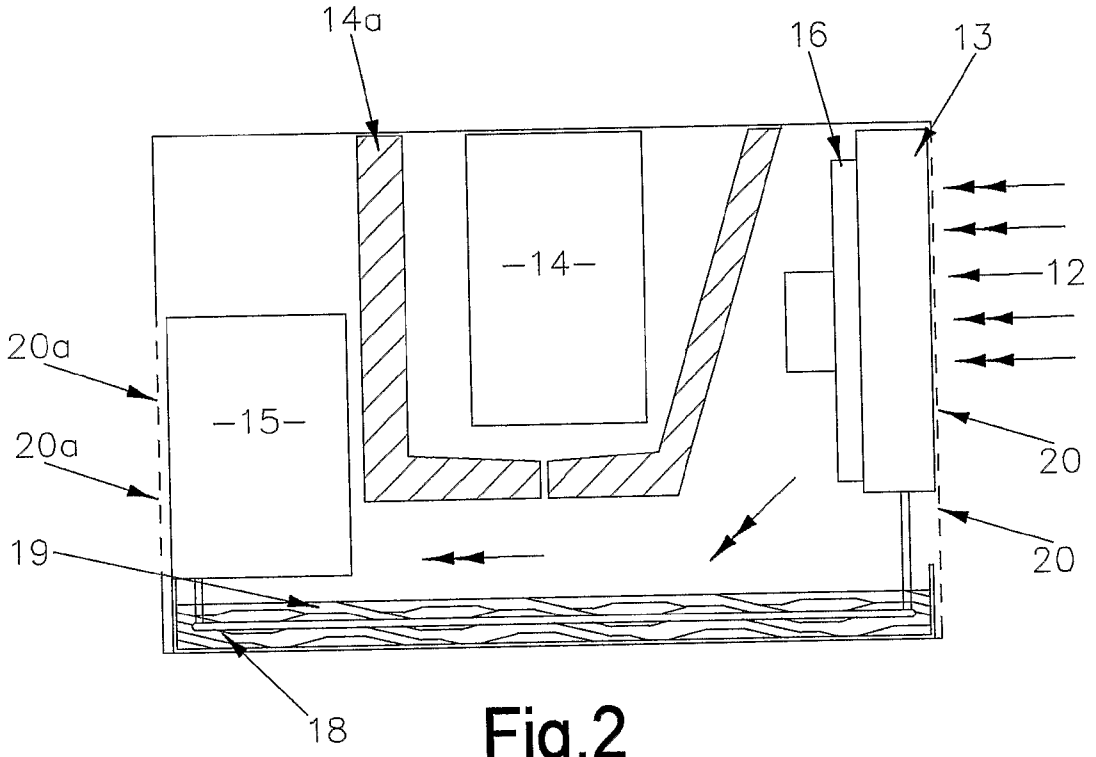

14a
16
13
12
20a
20a
19
18
20
20
-14-
-15-

Fig.2

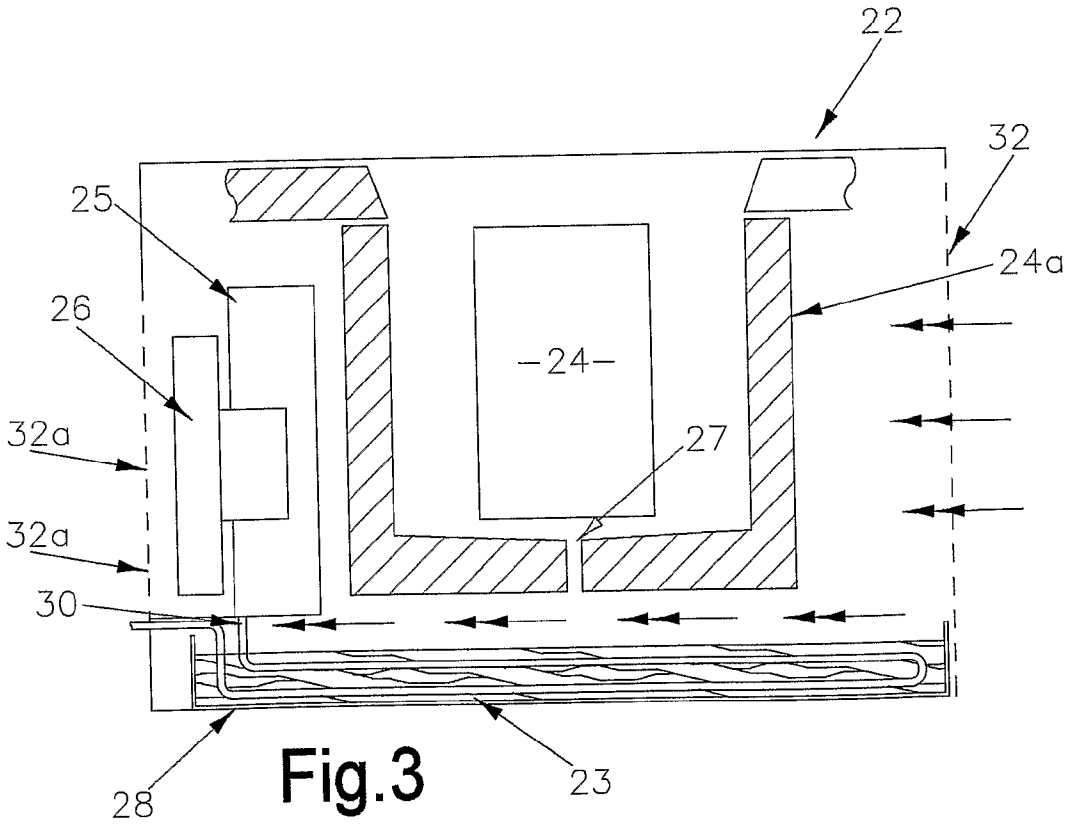
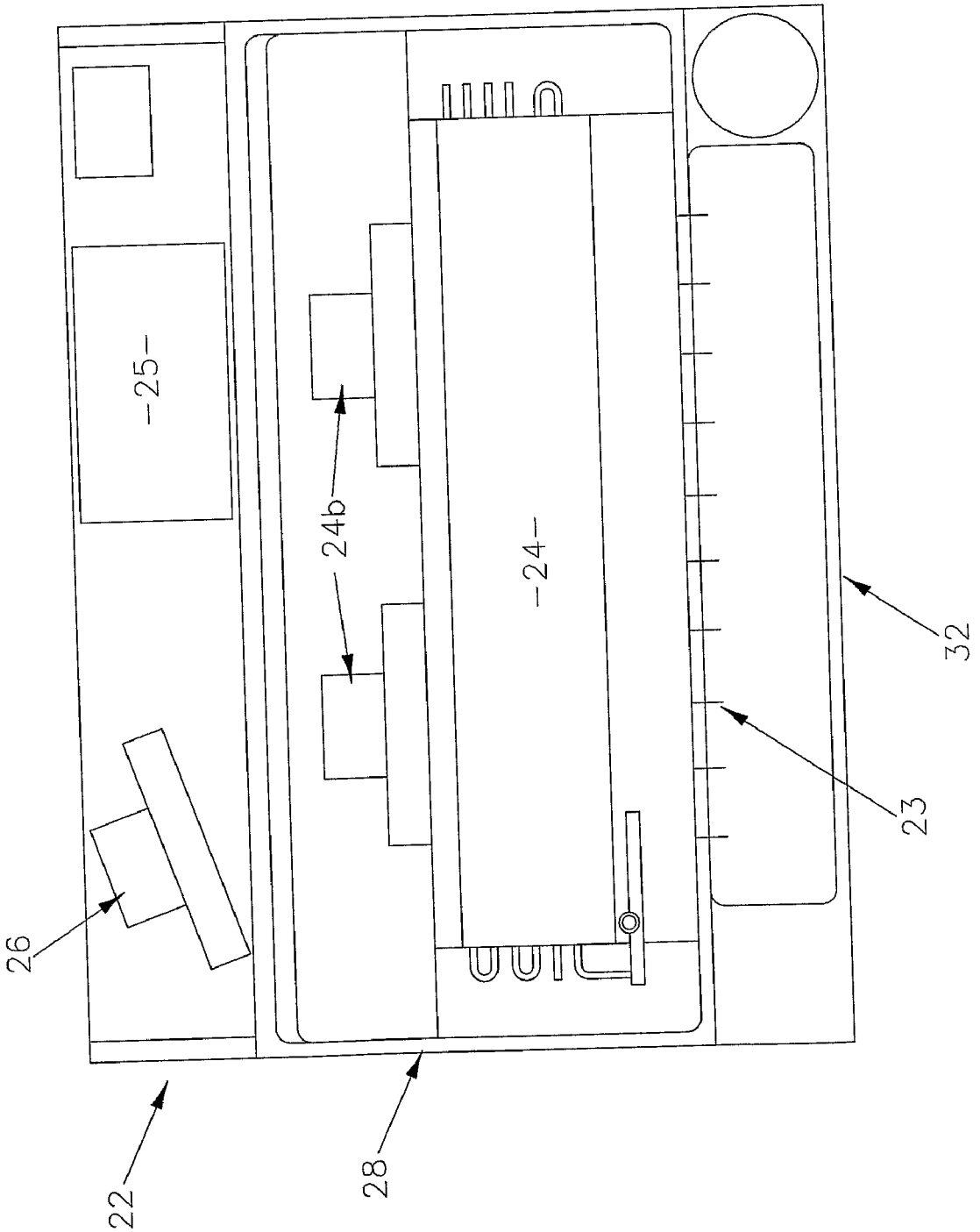

22
32
25
24a
26
32a
32a
30
28
23
27
-24-

Fig.3

Fig.4



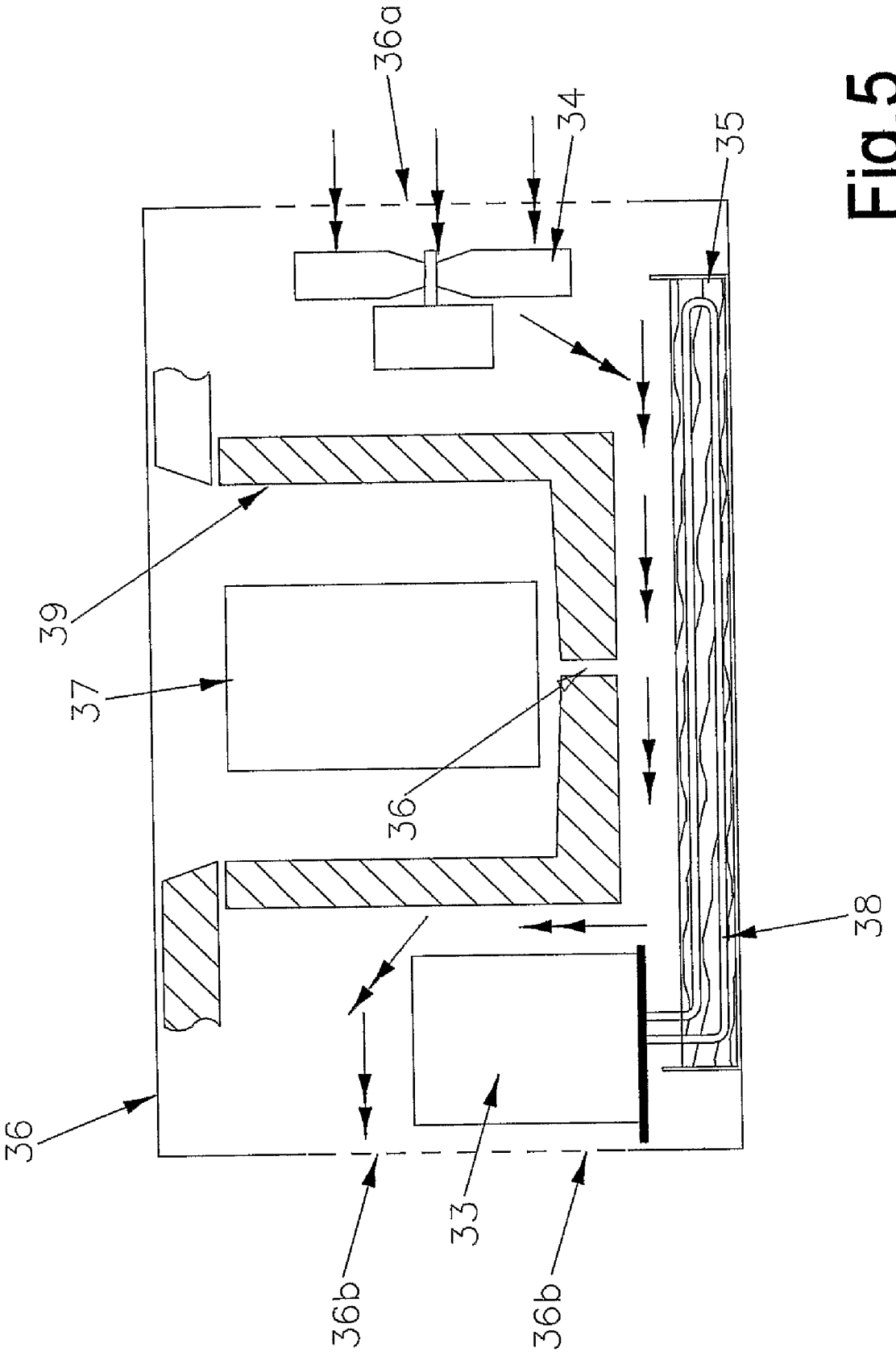
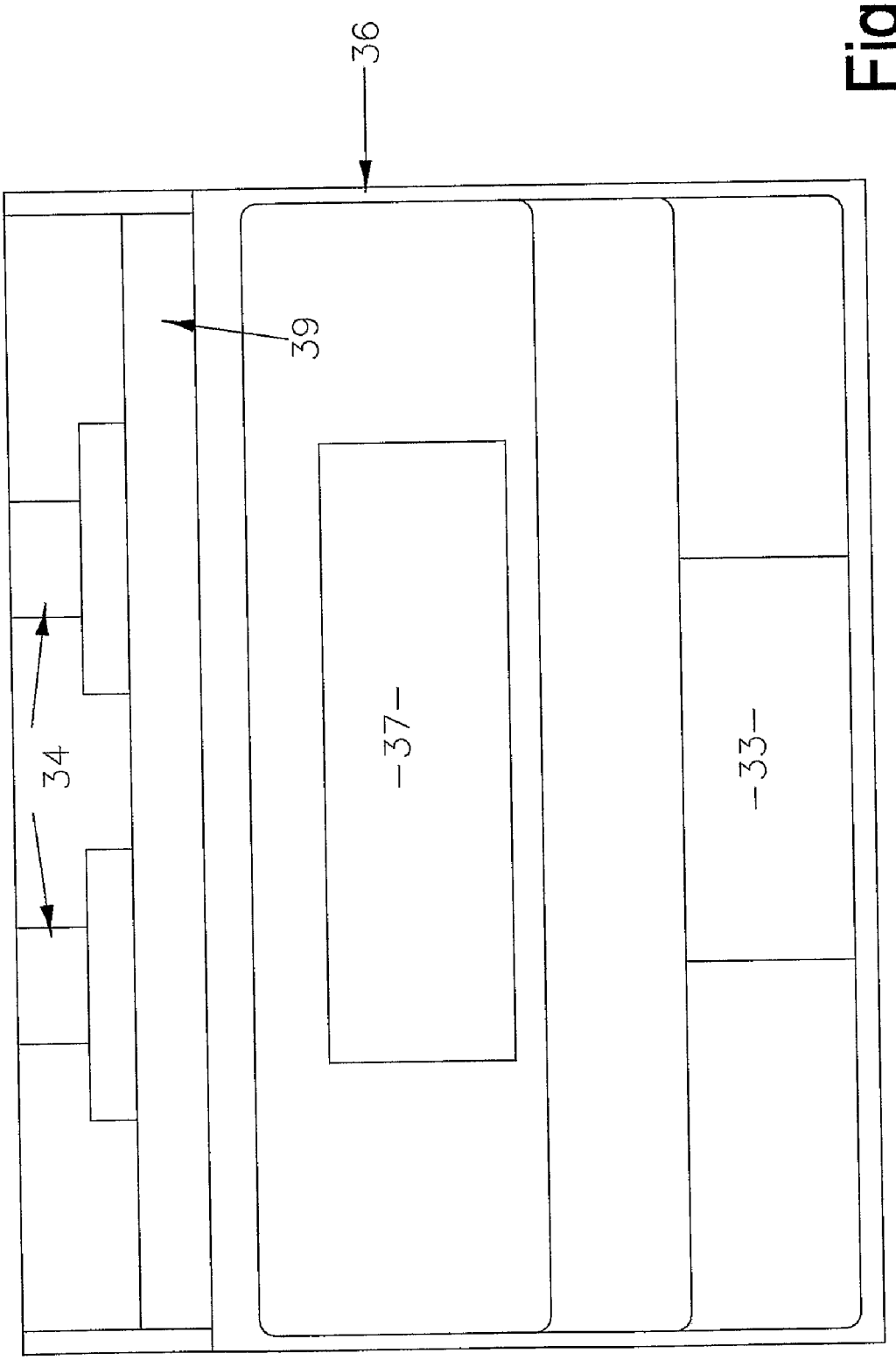


Fig.5

Fig.5a



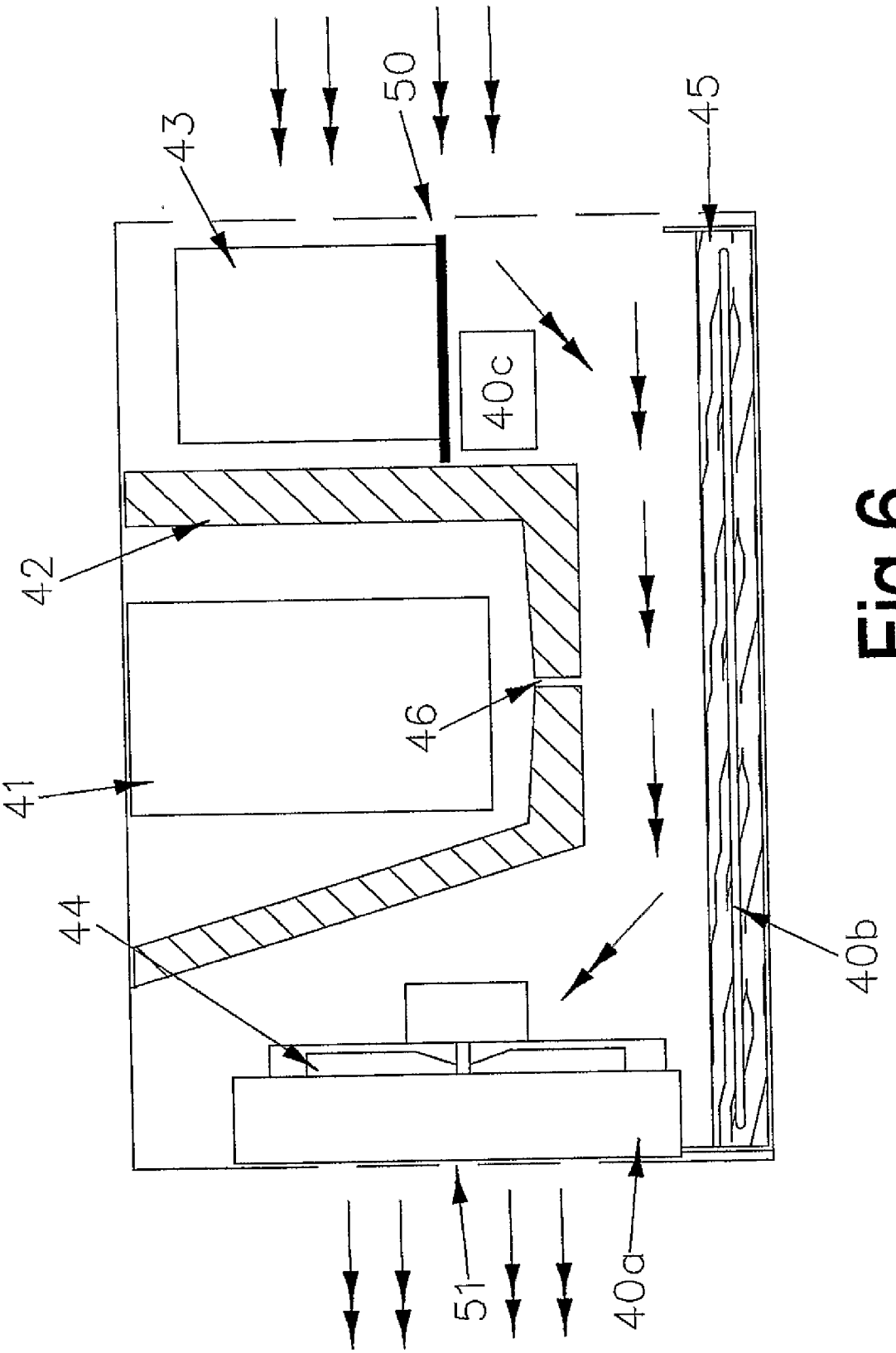


Fig.6

REFRIGERATION APPARATUS

TECHNICAL FIELD

[0001] The present invention relates to an improved refrigeration apparatus. The apparatus of the present invention has been designed with particular reference to refrigeration apparatus which in use produces a significant amount of water when the apparatus is defrosted, such as open deck refrigeration cabinets, which have a refrigerated air curtain rather than doors over the front of the storage area. However, the present invention also could be used in combination with other types of refrigerated cabinets.

BACKGROUND OF THE INVENTION

[0002] At present, a refrigeration apparatus disposes of the water produced when the apparatus is defrosted in one of four ways:—

[0003] 1. The tray which receives the water is electrically heated to evaporate the water. This is effective, but increases the power requirement of the apparatus, especially if relatively large volumes of water are involved.

[0004] 2. The tray which receives the water also contains a multifolded cloth wick; the water soaks through the cloth and this greatly increases the area from which the water can evaporate. This design has the drawback of maintaining a large area of damp, porous cloth in a warm dark environment:—the conditions are ideal for fungal/bacterial growth and the equipment can be very difficult to keep clean.

[0005] 3. The water is ducted into a drainage pipe. This is an excellent solution to the problem, from the point of view of requiring no additional power and producing no hygiene problems, but it means that the refrigeration apparatus is permanently connected to a drain and thus cannot be relocated without re-plumbing.

[0006] 4. The tray which receives the water is heated by the hot gas from the compressor by way of tubing which runs from the compressor to the condenser coil, through the tray. However, this is only partially effective because in general there is insufficient air flow over the tray to effectively remove the water vapour.

DISCLOSURE OF INVENTION

[0007] An object of the present invention is the provision of refrigeration apparatus which disposes of the water produced during defrosting efficiently and hygienically, with little or no additional power requirement, and without limiting the placement of the apparatus (i.e. the apparatus does not need to be plumbed-in).

[0008] The present invention provides refrigeration apparatus which includes:

[0009] an evaporator, a compressor and a condenser connected by pipework in known manner, a fan, and a tray arranged to collect water during the defrost cycle of the apparatus; wherein:

[0010] a) at least the compressor, condenser, fan and tray are contained within a housing which is substantially closed except for air vents;

[0011] b) at least part of the pipework between the compressor and the condenser is arranged to pass through the tray;

[0012] c) the fan, housing and tray are designed and arranged such that in use the fan moves air through the housing so that substantially all of the air is directed over the surface of the tray.

[0013] The fan may be located at the front or at the rear of the housing, i.e. to blow air through the housing or to draw air through the housing. As used herein, the term "front of the housing" means that end of the housing which is upstream relative to the airflow through the housing. This is the end of the housing which normally would face outwards in use, but this need not be the case. The term "rear of the housing" correspondingly means the end of the housing which is downstream relative to the airflow, i.e. through which the air leaves the housing.

[0014] As used herein, the term "fan" refers to a single fan or to two or more fans, as appropriate for the size of the apparatus and the particular application of the apparatus.

[0015] The condenser may be located at the front or at the rear of the housing, or even split between these positions. Preferably, the condenser is located in the tray but it is also possible to split the condenser between the tray and the front or rear positions, i.e. to have part of the condenser in the tray and part at the front or the rear of the housing.

[0016] The refrigeration apparatus may be built into a refrigeration cabinet in the usual way, but preferably is made as a removable cassette which can be withdrawn from the cabinet without dismantling the cabinet.

[0017] If the apparatus is made as a removable cassette, then the evaporator must be contained within the housing. If a removable cassette is not required, then the evaporator may be located apart from the remainder of the refrigeration apparatus, and the defrost water from the evaporator piped or ducted to the tray.

BRIEF DESCRIPTION OF DRAWINGS

[0018] By way of example only, preferred embodiments of the present invention are described in detail with reference to the accompanying drawings in which:—

[0019] FIG. **1** is a diagrammatic longitudinal section through an open deck refrigeration cabinet incorporating a first embodiment of the present invention;

[0020] FIG. **2** is a view of the lower portion of FIG. **1** on a larger scale;

[0021] FIG. **3** is a diagrammatic longitudinal section through a second embodiment of the present invention;

[0022] FIG. **4** is a plan view of the second embodiment of the invention;

[0023] FIG. **5** is a diagrammatic longitudinal section through a third embodiment of the present invention;

[0024] FIG. **5***a* is plan view of the third embodiment; and

[0025] FIG. **6** is a diagrammatic longitudinal section through a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0026] Referring to FIGS. **1** and **2**, an open deck refrigeration cabinet **2** comprises an insulated enclosure which provides a top **3**, side walls **4**, a rear wall **5** and a base **6**, but which is open over substantially all of the front surface **7**. Shelves **8** for displaying products are mounted between the side walls **4**. An air curtain for providing a curtain of refrigerated air down the open front **7** is of known type and has an air outlet **9** in the top **3** and a return air vent **10** in the base **6**.

[0027] The insulated enclosure is mounted on a base **11** in which the refrigeration apparatus is mounted in the form of a removable cassette **12** which can be withdrawn from the base without dismantling the cabinet.

[0028] The refrigeration apparatus consists of a condenser **13**, an evaporator **14** in an insulated enclosure **14***a*, and a compressor **15**; a fan **16** is mounted directly behind the condenser **13**, to draw ambient air through the condenser in use.

[0029] The condenser, evaporator and compressor are of known type and will not be described in detail. The refrigeration cycle is the usual one:—a refrigerant fluid is circulated between the condenser and the evaporator through tubing (not shown). The compressor **15** draws refrigerant fluid in gaseous form from the evaporator **14**, compresses the gas and circulates the compressed gas to a condenser **13** where the gas is condensed by a combination of the increased pressure and the loss of heat. The liquid refrigerant is then circulated to the evaporator **14**. In the evaporator **14**, the pressure is reduced and the refrigerant fluid evaporates to a gas, absorbing heat from the surrounding air as it does so. The refrigerant gas is then drawn back into the compressor **15** and the cycle continues. The upper part of the cabinet is refrigerated by the air curtain formed by air circulated over the evaporator **14**, in known manner.

[0030] Since the air circulated over the evaporator **14** is chilled, moisture in the air condenses out and freezes onto the outer surface of the evaporator and other chilled surfaces of the cabinet. During the defrost cycle this frost becomes water again and drains through the aperture **17** in the base of the insulating enclosure **14** a into a tray **18** in the base of the cassette **12**.

[0031] For refrigerators with closed doors, the quantity of water draining into the tray **18** is relatively small. However, with open deck refrigeration cabinets much more ambient air gets into the cabinet, and the quantity of water draining into the tray **18** can be relatively large:—for example, a 1200 millimetre wide cabinet typically has an air curtain flow of about 55 litres per second and about a 0.9 litres per hour of water draining into the tray.

[0032] In the present invention, the water in the tray **18** is evaporated with a combination of two mechanisms:—firstly, the pipe **19** used to circulate the comparatively warm refrigerant fluid from the compressor **15** to the condenser **13** is arranged to pass along the length of the tray **18**, thus heating the water in the tray **18**. Secondly, the top, base, and sides of the cassette **12** are closed, so that substantially all of the ambient air drawn through the condenser **13** by the fan **16** (indicated by double headed arrows) must enter the housing through the front vents **20**, pass over the surface of the water in the tray **18**, and leave by the rear vents **20***a*, since the refrigerant fluid is condensed in the condenser, thus giving up its heat of evaporation, the air drawn through the condenser is heated. This combination of heating and rapid warm airflow over the surface of the tray is effective in evaporating in the water from the tray.

[0033] Air leaving the housing through the rear vents **20***a* first passes around the compressor **15**, cooling the compressor.

[0034] Referring to FIGS. **3** and **4**, in a second embodiment of the invention, the components are arranged in a similar manner to the first embodiment, except that the condenser and the condenser fan are re-located, as described below.

[0035] As in the first embodiment, the refrigeration apparatus is in the form of a removable cassette **22** located in the base of a refrigerated cabinet (not shown). An evaporator **24** is located beneath the central portion of the cabinet in an insulated enclosure **24***a*. Evaporator fans **24***b* (FIG. **4** only) are mounted behind the evaporator. A compressor **25** is mounted at the rear of the cassette, with a condenser fan **26** alongside it.

[0036] A tray **28** is mounted along the base of the cassette, to collect the defrost water draining through aperture **27** in the enclosure **24***a*. The condenser **23** is located in the tray **28** and may be either partially or fully submerged in the defrost water; a pipe **30** (FIG. **3** only) ducts the refrigerant gas from the compresser **25** to the condenser **23**, where the gas is condensed back to liquid, giving up its heat of evaporation. This heat of evaporation is used to heat the defrost water in the tray **28**. The liquid refrigerant is returned to the evaporator **24** in known manner.

[0037] The defrost water in the tray **28** is also warmed and evaporated by the air drawn over the surface of the tray **28** by the condenser fan **26**. As in the first embodiment, the cassette is sealed along top, base and sides, so that all the air drawn through the front vents **32** of the cassette passes over the surface of the water in the tray **28**. This air flow is shown by double-headed arrows in FIG. **3** only. The air passes over the compressor **25**, to cool it, before leaving the housing through the rear vents **32***a*.

[0038] The positioning of the condenser **23** in the tray **28** has the additional advantage that, since the condenser is at least partially submerged in cold water, a much wider fin spacing can be used in the condenser, without compromising its function. This is a considerable practical advantage because condensers with the conventional narrow spacing (typically 315 fins/metre) are easily clogged with dust and dirt, and are a frequent cause of equipment failure/maintenance. In the present invention, it is believed that a fin spacing of 60 fins/metre will be acceptable; this should significantly reduce maintenance and increase efficiency.

[0039] Using heat exchange to simultaneously cool the condenser and evaporate the water significantly increases efficiency and reduces the energy consumption of the system.

[0040] In the embodiments shown in FIGS. **5** and **6**, only the lower portion of an open deck refrigeration cabinet is shown:—the upper portion of the cabinet is as shown in FIG. **1**.

[0041] Referring in particular to FIGS. **5** and **5***a*, the refrigeration apparatus consists of a condenser **38**, an evaporator **37** in an insulated enclosure **39**, a compressor **33** and pair of fans **34**. The refrigeration apparatus is mounted in a housing **36** made as a removable cassette located in the base of a refrigeration cabinet; the top, the base and sides of the cassette are closed, so that the ambient air drawn through the cassette (indicated by the double headed arrows) must travel as indicated by those arrows, i.e. into the housing through the front vents **36***a*, over the surface of the tray **35** as discussed below, and out of the rear vents **36***b*.

[0042] The evaporator **37**, compressor **33** and condenser **38** are interconnected by pipe work in known manner; this pipe work represents the standard refrigeration cycle and is omitted for clarity.

[0043] As in the embodiment described with reference to FIGS. **3** and **4**, the condenser **38** is mounted in a tray **35** which extends along the base of the cassette; the tray collects the defrost water draining through aperture **36** in the enclosure **39**.

[0044] The compressor **33** is mounted at the rear of the cassette, and air is drawn through the front vents **36***a* of the cassette by the fan **34**. Since the top, the base and sides of the cassette are closed, substantially all of the incoming air is forced to travel over the surface of the tray **35**. Before leaving the housing through the rear vents **36***b*, the air passes around the compressor **33** to cool it.

[0045] This embodiment has the advantages of the embodiment described with reference to FIGS. **3** and **4**, but with the additional advantage that the fan **34** (which may be a single fan or multiple fans) blows air into the cassette rather than pulling air through the cassette:—the fan/fans have been found to be more effective working in this way.

[0046] Referring to FIG. **6**, the refrigeration apparatus consists of a condenser **40** (shown as **40***a*, **40***b* and **40***c* as described below), an evaporator **41** in an insulated enclosure **42**, compressor **43** and a fan **44**. A tray **45** for catching the condensate trickling through the aperture **46** is located along the base of the cassette which, as in the other embodiments, has a closed top, base and sides so that all incoming air (shown by double headed arrows) enters only through the front vents so, passes over the compressor **43** to cool it, then passes over the surface of the water in the tray **45**, before leaving through the rear vents **51**. As in the other embodiments, the refrigeration components are interconnected by pipe work of known type.

[0047] In this embodiment, the compressor **43** is located at the front of the cassette and the fan **44** (which, as in other embodiments, may be a single fan or multiple fans) is mounted at the rear of the cassette. The condenser **40** may be split, i.e. partly located adjacent the fan **44** as shown by reference **40***a* and/or located in the tray **45** as shown by reference **40***b* and/or partly at the front as shown by reference **40***c*; alternatively, the condenser **40** can be located as a single condenser in any of these positions, or any combination thereof.

[0048] This embodiment has the advantages of the embodiment described with reference to FIGS. **3** and **4**, but with the additional advantage that the incoming air is first drawn over the surface of the tray **45** to evaporate the water in the tray, and thus will tend to be cooled by the evaporative cooling effect, so that the air which finally reaches the condenser **40** a will be cooler than the ambient air. This will give an overall gain in efficiency.

1. Refrigeration apparatus which includes:
an evaporator, a compressor and a condenser, connected by pipework in known manner, a fan, and a tray arranged to collect water during the defrost cycle of the apparatus;
wherein:
a) at least the compressor, condenser, fan and tray are contained within a housing which is substantially closed except for air vents;
b) at least part of the pipework between the compressor and the condenser is located within the tray;
c) the condenser is located in the tray:
d) the fan, housing and tray are designed and arranged such that in use the fan moves air through the housing so that substantially all of the air is directed over the surface of the tray.

2. The refrigeration apparatus as claimed in claim **1**, wherein the condenser is provided with cooling fins having a spacing not more than 60 fins/metre.

3. The refrigeration apparatus as claimed in claim **1** or claim **2**, wherein the fan is located at the front of the housing and is designed to blow air through the housing.

4. The refrigeration apparatus as claimed in claim **1** or claim **2**, wherein the fan is located at the rear of the housing and is designed to draw air through the housing.

5. (canceled)

6. (canceled)

7. The refrigeration apparatus as claimed in claim **1**, wherein the evaporator also is contained within the housing, and the housing and its contents are designed as a removable cassette which can be withdrawn from the remainder of the refrigeration apparatus without dismantling the apparatus.

8. Refrigeration apparatus which includes:
an evaporator, a compressor and a condenser connected by pipework in known manner, a fan, and a tray arranged to collect water during the defrost cycle of the apparatus;
wherein:
a) the evaporator, compressor, condenser, fan and tray are contained within a housing which is substantially closed except for air vents;
b) the condenser is located in the tray;
c) the fan is located at the front of the housing and is designed to blow air through the housing;
d) the fan, housing and tray are designed and arranged such that in use the fan blows air through the housing so that substantially all of the air is directed over the surface of the tray.

9. Refrigeration apparatus which includes:
an evaporator, a compressor and a condenser, connected by pipework in known manner, a fan, and a tray arranged to collect water during the defrost cycle of the apparatus;
wherein:
a) the evaporator, compressor, condenser, fan and tray are contained within a housing which is substantially closed except for air vents;
b) the fan is located at the rear of the housing and is designed to draw air through the housing;
c) the fan, housing and tray are designed and arranged such that in use the fan moves air through the housing so that substantially all of the air is directed over the surface of the tray;
d) at least part of the pipework between the compressor and the condenser is located within the tray;
e) the condenser is located in the tray.

* * * * *