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(54) **Refrigerator power connector**

(57) We describe a domestic refrigerator or freezer comprising: a thermally insulated cooled zone; a cooling system to cool said cooled zone, said cooling system comprising a mains powered compressor; a compressor control mounted on said compressor, to control operation of said compressor, said compressor control including a mains power supply connection for an incoming mains power supply for said compressor; a cover for said mains power supply connection of said compressor control to inhibit water ingress to said mains power supply connection, and a mains power supply cable to provide said incoming mains power supply; wherein said mains power supply connection comprises a two-part, uncouplable electrical mains power supply connector co-located with said compressor control and beneath said cover, said two-part, uncouplable electrical mains supply connector having a first part connected to said mains power supply connection of said compressor control and a mating part connected to said mains power supply cable, such that said mains power supply cable is detachable from said domestic refrigerator by means of said electrical mains power supply connector.

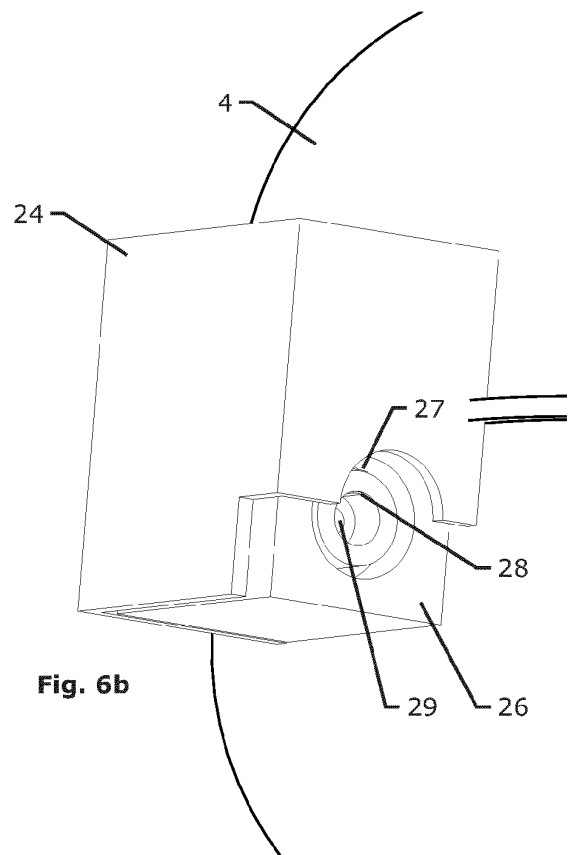


Fig. 6b

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Description

FIELD OF THE INVENTION

[0001] This invention relates to domestic and small commercial refrigerators, coolers and freezers operated from single-phase AC mains supply. Particularly it concerns the connection by cable of the appliance to a mains supply and more particularly to the arrangements for connection of the cable to the appliance.

BACKGROUND TO THE INVENTION

[0002] Refrigerators (including coolers, freezers etc.) for domestic or light commercial purposes typically have a mains supply cable that is permanently attached to the appliance.

[0003] Figure 1 shows a rear view of a typical refrigeration appliance 1. Mains cable 2 links between mains supply plug 3 and the appliance, terminating in the motorcompressor control 5 mounted on the side of motorcompressor 4. The compressor control 5 typically manages the starting and overload protection for the compressor and includes connections for incoming mains electricity supply, and connections to a thermostatic switch (typically electromechanical) and to an optional door switch and interior light.

[0004] Thus cable 6 connects the control 5 to other facilities in the appliance such as a thermostat or interior light. In addition there may be a run capacitor (not shown) connecting to the control 5. At the control 5, the mains cable typically terminates in "spade"/"faston" and/or screwed terminals that are manually fitted onto mating connection tabs built into the control assembly. A cable clamp, in the form of a plastic bridge secured by screws, fixes the cable to the mechanical body of the control to prevent movement of terminals or break of the wires as a result of pulling the cable.

[0005] Figure 2a shows an end view of a typical assembly of control 5 onto motorcompressor 4. Figure 2b is a sectional side view and Figure 2c is an end view with cover moulding 10 removed to show control body moulding 8, cable clamp 11, and terminals 12 and 13 enclosed within. Cover for the assembly is often as two mouldings, illustrated as 9 and 10 to provide access to make the connections but then covered to inhibit ingress of water from above (e.g. from the evaporator tray 7. The control assembly fixes to compressor fence 14, a plate that is integral with the housing of the motorcompressor.

[0006] Detachable cables are well known for other appliances and equipment and offer advantages such as the ability to substitute different types, for different geographic markets that use different types of mains plug.

[0007] A similar benefit is sought for refrigerators but this application has particular requirements that make a simple plug/socket arrangement unsuitable. In particular:

- Vibration can cause the plug/socket to disengage

- Water from evaporation tray 7 or elsewhere can trickle into the plug/socket causing a shock hazard

[0008] A further benefit that is sought is reduction of cost of components and of assembly and test of the appliance.

[0009] Refrigeration appliances use high voltages which are hazardous if the conductors are not properly protected. It is essential to protect against hazard in conditions both of normal and abnormal use. A particular requirement applies to the mains supply cable, it has to resist strong pulling and twisting without detaching or exposing hazardous voltages. This is compatible with the requirement for a detachable connection to resist vibration from the normal operation of the motorcompressor. However, the force applied is transmitted through the control to the body of the motorcompressor. So the fixing of the control onto the motorcompressor also has to resist high forces and this may be difficult to achieve at low cost. Particularly to minimise manufacturing cost, the assembly of the control onto the motorcompressor needs to be quick and preferably without screws. If this fixing is not sufficiently robust to withstand pulling of the cable there would be the risk that the control becomes detached from the compressor, exposing hazardous voltages.

[0010] We will describe techniques which address these issues.

SUMMARY OF THE INVENTION

[0011] According to a first aspect of the invention there is therefore provided a refrigerator or freezer, in particular a domestic refrigerator or freezer, the refrigerator or freezer comprising: a thermally insulated cooled zone; a cooling system to cool said cooled zone, said cooling system comprising a mains powered compressor; a compressor control mounted on said compressor, to control operation of said compressor, said compressor control including a mains power supply connection for an incoming mains power supply for said compressor; a cover for said mains power supply connection of said compressor control to inhibit water ingress to said mains power supply connection, and a mains power supply cable to provide said incoming mains power supply; wherein said mains power supply connection comprises a two-part, uncouplable electrical mains power supply connector co-located with said compressor control and beneath said cover, said two-part, uncouplable electrical mains supply connector having a first part connected to said mains power supply connection of said compressor control and a mating part connected to said mains power supply cable, such that said mains power supply cable is detachable from said domestic refrigerator by means of said electrical mains power supply connector.

[0012] In some preferred embodiments the parts of the mains power supply connector are detachably held together in such a way that they resist detachment of the mains power supply cable by a small force, such as vi-

bration of the compressor, but permit detachment of the mains power supply cable when a larger force, in particular greater than a threshold force is applied. In this way the fridge "fails safe". It is particularly preferable that the threshold force is such that when a disengagement force is applied to the mains power supply cable the parts of the mains power supply connector separate or detach from one another rather than the compressor control being detached from the compressor.

[0013] In embodiments a locking feature is provided to hold the parts of the mains power supply connector together until a force greater than the threshold force is applied. Thus in some embodiments a portion of the refrigerator, in particular a portion of the compressor control cover, is arranged to bear upon or otherwise lock the mating part of the connector connected to the mains power supply cable into place. For example the mating part of the mains power supply connector may bear a physical feature such as a flange over which the cover fits to resist detachment of the mains power supply cable.

[0014] Additionally or alternatively the first and mating parts of the mains power supply connector may have a locking action or means which is releasable substantially without damage when sufficient force is applied. Thus, in embodiments, the connector is of a push-and-turn type having portions which interengage. Preferably, with sufficient force, the portions can be pulled past one another, but this is not essential. Additionally or alternatively one or more contacts of the connector may be shaped or sprung so that the parts of the connector, more particularly the contacts, are provided with a form of detent means. For example in a simple approach one connector portion may be sprung and another provided with a bump over which the sprung portion moves. In a still further approach the parts of the connector may be given a friction fit such that they do not substantially disengage until sufficient disengagement force is applied.

[0015] In embodiments the cover comprises first and second cover portions which are configured to mutually engage with one another to fasten over the mains power supply connection. One or both of these cover portions are provided with a catch to enable one cover portion to be disengaged from the other on application of a sufficient force to the mating part of the connector via the mains power supply cable. The catch may comprise a plastic moulding with a pair of opposing faces or ramps; the configuration of these features can be varied to vary the detachment force. In embodiments the first and second cover portions may be one-piece moulded and provided with a living hinge; alternatively the portions may be physically separable one from the other.

[0016] Preferred embodiments of the system also incorporate a technique to reduce water ingress. Thus in embodiments the cover has an outside edge which (when the cover is closed) is located above the mains power supply cable (which may be the portion of the mains power supply cable inside the connector). Preferably when the cover is closed the mating part of the mains power

supply connector connected to the mains cable is partially or wholly within the outside edge of the cover. In embodiments this outside edge may be provided with a drip-inhibiting formation to inhibit water drips from running under the outside edge towards the mating part of the mains power supply connector. Such a drip-inhibiting formation may comprise a groove or recess in a plastic moulding behind the outside edge of the cover (that is towards an interior of the covered region).

[0017] In a related aspect the invention provides a method of providing a detachable mains cable for a domestic refrigerator or freezer, the domestic refrigerator or freezer comprising: a thermally insulated cooled zone; a cooling system to cool said cooled zone, said cooling system comprising a mains powered compressor; a compressor control mounted on said compressor, to control operation of said compressor, said compressor control including a mains power supply connection for an incoming mains power supply for said compressor; a cover for said mains power supply connection of said compressor control to inhibit water ingress to said mains power supply connection, and a mains power supply cable to provide said incoming mains power supply; the method comprising: co-locating a two-part uncouplable electrical mains power supply connector with said compressor located beneath said cover, connecting a first part of said connector to said mains power supply connection of said compressor control and connecting a mating part of said connector to said mains power supply cable, and arranging said parts of said mains power supply connector to be held together to resist detachment of said mains power supply cable by a small force and to permit detachment of said mains power supply cable by a larger force greater than a threshold force.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Figure 1 shows a rear view of a typical refrigeration appliance

Figure 2 shows a typical arrangement of power feed cable and control for a motorcompressor in a refrigeration appliance. 2a shows the assembly as it appears in use, 2b is a sectional side view showing details of the connection between the cable and the control, 2c is an end view with a cover removed.

Figure 3 shows an embodiment of the invention. 3a is an end view, and 3b a side view, as it appears in use. 3c shows a cover opened to allow connection/disconnection and 3d a side view with cover open and connector removed.

Figure 4 shows an alternative embodiment of the invention. 4a is an end view, and 4b a side view, as it appears in use. 4c shows a sectional end view

showing the engagement of the supply connector with the control. 4d shows a side view of the control with cover and connector removed.

Figure 5 shows views of the supply connector for the embodiment shown in Figure 4. 5a is a view of the end that engages with the control, 5b is a side view, 5c is a top view and 5d is a perspective view.

Figure 6 shows views of the control with the alternative embodiment of the connector arrangement (as illustrated in Figures 4 and 5). 6a is a perspective view of a motorcompressor and control. 6b is a detailed view of the control with the supply connector removed.

Figure 7 shows a catch arrangement to retain a moving part of a cover but only with a limited retention force.

Figure 8 shows arrangements to inhibit ingress of water and also illustrates in Figure 8c how an inadequate feature could allow ingress.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0019] We will describe a detachable mains cable for refrigerators and means to secure it to a motor control assembly for a motorcompressor and to provide protection against ingress of water.

[0020] An embodiment of the invention is illustrated in Figure 3. Figure 3a shows an end view, Figure 3b a side view, Figure 3c a side view with cover 15 opened to provide access to make or break the mains connection and Figure 3d an end view with cover 15b opened and connector 18 removed. Cover 15 is provided in two parts, 15a and 15b preferably hinged together at 15c, for example using a moulded "living hinge" so that the entire cover component can be injection-moulded in one operation. Body 19 of the control is enclosed within the cover and fixes onto the compressor fence 14 or otherwise onto the compressor. It is provided with a receptacle 21 and plug contacts 22 to accept a mains supply socket 18 that is fitted to the end of the mains supply cable 17. Many types of connector are known to be suitable for such a mains connection but preferably the connector is a type to the international standard IEC60320 C13 (for the cable socket) and C14 for the plug that is integral with the body 19. Alternatively, a special type of connector may be used to prevent use of standard types of mains cable assemblies. Preferably the connector is engaged by a simple push-fit, for example socket 18 pushes into receptacle 21 (preferably moulded into body 19), so that contacts 22 engage with the corresponding contact in socket 18. Cover 15b is subsequently hinged down so the socket is retained into the receptacle 21. Slot 20 is provided in cover 15b sufficient for passage of the cable or part of

the socket body, while being narrow enough to inhibit passage of the connector body (or remainder thereof), keeping the connector engaged. Cover 15b is retained in the down position by one or more clips (one is illustrated as 16a and 16b) integral with the cover. The shape of the cover is arranged so that, in the down position, it sheds water falling from above to inhibit ingress into the control or the connector. To remove the connector 18 from the receptacle 21, the latches (e.g. 16a 16b) first have to be released so that cover 15b can be raised, allowing the connector to be removed.

[0021] Other arrangements of connector that provide locking in position and protection against ingress of water are possible, using either standard types of connector or special types. An example is illustrated in Figures 4, 5 and 6. Referring to Figure 4, mains supply cable 25, fitted with connector 23, connects to the control assembly by fitting into features moulded as part of control body 26. Cover 24 substantially inhibits ingress of falling water to body 26. Connector 23 is arranged to be largely axisymmetric, allowing it to be pushed into the corresponding feature in the body then it can be rotated. More detailed views of connector 23 are in Figure 5a (end view), 5b (side view), 5c (top view) and 5d (perspective view). Connector 23 optionally includes axial contact 32 and radial contacts 30 and 31. Flange 33 is on the outside of the body of the connector. To insert the connector into control body 26, the connector is first axially aligned with the corresponding features of body 26, and with flange 33 lowermost. It is then pushed into the body and subsequently rotated by approximately 180 degrees so that flange 33 is captured behind the projecting face 24a of cover 24. The engagement of flange 33 behind face 24a inhibits connector 23 from being pulled or vibrating free of the body 26. For further security, connector 23 and body 26 can be provided with latch or bump features which resist rotation of 23 after it has been engaged. Figure 4d shows a side view of body 26 but with the connector 23 and cover 24 both removed. Optionally, a number of contacts may be included: Axial contact 29 to connect with axial contact 32 of connector 23, and radial contacts 27 and 28 to connect with radial contacts 30 and 31 (respectively) of connector 23. Typically, axial contacts 29 and 32 may be used for an Earth connection because they can be arranged to make contact before the radial contacts when the connector is fitted to the body. Connector 23 is designed to inhibit hazard of electrical shock (for example, according to international safety standards). Particularly the radial cavity that holds contacts 30 and 31 is arranged with a small radial width so that the contacts are not accessible. Note also that the orientation of the radial contacts is such that they make contact only when connector 23 has been rotated sufficiently to engage flange 33 behind face 24a. This ensures that the appliance is not powered until the connector is properly engaged. If connector 23 is not pushed sufficiently into body 26 before being turned (e.g. with flange 33 outside of face 24a) then the radial contacts may be

inhibited from making connection by ensuring they are not sufficiently long to touch in this condition. Figure 6 shows further views of the control assembly on the motorcompressor, without connector 23 fitted, to illustrate the arrangement of cover 24, body 26 and the features that mate with connector 23.

[0022] We now consider the desire that the system remains safe when strong pulling or twisting forces are applied to the supply cable. The skilled person will appreciate that the locking of a detachable cable connector (e.g. 17 or 23) can be made sufficiently robust to withstand high forces. This force, however, is transmitted to the motorcompressor and the fixing of the control onto the body of the motorcompressor is subjected to similar level of force. It is a requirement that the system remains safe when subjected to these high levels of force but a risk is that the control becomes detached from the motorcompressor, exposing hazardous voltages.

[0023] One strategy is to ensure that the fixing of the control onto the motorcompressor is sufficiently robust to withstand the force but this may make the manufacture more expensive. An alternative strategy is to make the locking of the detachable cable connector less robust, so that when high pulling or twisting forces are applied the connector detaches from the control before the control detaches from the motorcompressor. This is safe behaviour because a mains power connector is generally configured so that there is no shock hazard when it is detached. The skilled person will appreciate that there are many ways in which the locking force of such a connector can be reduced. Preferably, the locking features of the components are arranged so that they deflect sufficiently to allow disengagement when high forces are applied. The deflection is preferably temporary so that the connector can be reengaged and locked so the system continues to operate normally and provide the desired performance and safety. Breaking of the features is not desired as this is likely to reduce the subsequent locking performance. Preferably, the locking features are designed to give a predictable and accurate threshold force for disengagement of the connector. To accommodate geometric tolerances, this generally requires larger size of features and of deflection distances. Consider the arrangement of Figure 3 and the pull force on the cable that the engagement it provides. The locking relies on the behaviour of the catch 16 and this can be arranged to provide a controlled locking force. Figure 7a illustrates a possible design for the catch 16 that locks the cover 15b which, in turn, maintains the engagement of the connector 18 in the control. The catch parts 16a and 16b are arranged in a manner very commonly used for holding moulded plastic components together. Feature 16a is elongated and provided with an overlap over feature 16b. To engage or disengage the catch feature 16a deflects away from housing 15a. This is facilitated by ramps on one or both features. Generally two sets of ramps may be provided, one set to facilitate engagement and another set for disengagement. It is well known that the en-

gage/disengage force depends on several factors that can be preset in the design. Referring to Figure 7b, for the disengage force, it depends mainly on the:

- overlap distance 34
- angle of the ramp 36
- length, thickness and width of the elongate section 35
- Material of the component 35
- Surface finish of the mating faces at the overlap

[0024] By setting these parameters, the disengagement force can be determined. This can be set at an appropriate level to resist normal levels of pull on the cable but not so high as to risk a high pull force causing detachment of the control from the motorcompressor. The skilled person will appreciate that arrangements can be designed to provide similar function for other connector engagement methods, and both for pulling and twisting of the cable.

[0025] Engagements and locks as described above can resist high levels of pulling, twisting and vibration. It is important, however, to consider separately normal and abnormal conditions. In normal conditions, it is desirable that the connector should remain engaged so the appliance continues to operate. In abnormal conditions it is acceptable for the connector to disengage. For a particular appliance it could be that only a low retention force is needed for normal operation (e.g. if the motorcompressor exhibits only low levels of vibration) and that abnormal conditions impose a high level of force. In this case, the connector engagement may only need low retention force, and that it is acceptable that the retention force can vary considerably. The retention force must remain above the minimum needed for normal conditions but below a level that e.g. could cause detachment of the control from the motorcompressor. It is possible to provide a low retention force, but with considerable tolerance, simply by the friction of the engagement of the contacts in the detachable connector with the corresponding contacts in the control. So, in some applications, it may not be necessary to provide additional locking features.

[0026] Generally it is desired only to inhibit ingress of water or other liquids that fall from above the motorcompressor or control. Preferably the control is enclosed in an water resistant cover (illustrated as 15, 24 or 38). This substantially covers the top and sides of the control so that liquids falling from above run down the sides and drop off as illustrated in Figure 8a. It is convenient for users, however, that a detachable cable (39 and 40) enters from the side of the control. This increases the risk that liquid could enter the connection region or elsewhere into the control, causing malfunction or shock hazard. Preferably the cover includes features to reduce the risk of this. A suitable arrangement is a "drip edge" 41 which forces the liquid to break away from the cover and to drop vertically. The liquid then may fall harmlessly onto the connector or cable where they pass under the cover.

These are arranged to be impervious parts of the cable/connector so are not affected by the liquid. Optionally the connector 42 may be provided with a similar drip edge feature 43 to ensure the liquid drops off the connector rather than running along its surface and into the region of the connections.

[0027] Referring to Figure 8b, an effective drip edge (groove or recess) should have sufficient downwards extension 44 and lateral clearance 45 to ensure that the liquid drops off. Minimum dimensions for 44 and 45 depend on the material and surface finish of the cover, presence of any surface contamination (e.g. dust) and the nature of the liquid. For typical moulded plastics and water, each should preferably be a minimum of 2mm and preferably 3mm or more.

[0028] If the feature is absent or the dimensions are inadequate, the liquid may adhere to the surface of the cover and run along the underside of the cover where (for example) it projects over the connector. This is illustrated in Figure 8c, and could lead to ingress or liquid into the connector region or elsewhere in the control causing malfunction or a shock hazard.

[0029] The skilled person will appreciate that other designs will fulfil some or all of the desired characteristics of a connector arrangement:

- Minimum of two and preferably 3 insulated connections, suitable for mains supply and (optionally) a safety earth connection
- Gaps, clearances and other dimensions of the connector on the end of the mains supply cable are arranged so the supply contacts are shrouded sufficiently to avoid causing any shock hazard
- The engagement of the connector with the control body is arranged to inhibit disengagement as a result of vibration and, optionally, as a result of pulling of the supply cable
- The control body, the connector and any additional cover components are arranged substantially to inhibit ingress of falling water into the control or the engagement between the connector and the control.
- The supply contacts and engagement features are arranged to inhibit connection of power to the appliance unless the connector is engaged properly with the control so that it is resistant to vibration and ingress of water.
- Limited disengagement force so the connector detaches from the control if the cable is pulled and/or twisted strongly to inhibit damage to the control or detachment of the control from the motorcompressor.

[0030] Preferably, the connector and engagement features are designed for manufacture and assembly, and test at low cost. For example:

[0031] The supply connector (e.g. as illustrated generally as 18 or 23) is made by automatic or semi-automatic termination and moulding processes as used typ-

ically for connectors to the international standard IEC60320 C13.

[0032] The corresponding engagement features in the control body are made by a moulding process used also to make the whole or part of the control body

[0033] Contacts in the control that connect with the supply connector are made integral with other features desirable for interconnection within the control. For example, they can be made by low-cost pressing operations to make complex shapes that allow the electrical connections to route within the control. Preferably they are arranged so that they can be assembled to supporting and other components by automated assembly methods

[0034] Once the control is installed in an appliance, the supply and optional earth contact in the control are accessible for a supply connection to made by a special automated connector. This enables automated testing of the appliance as part of the manufacturing process.

[0035] No doubt many other effective alternatives will occur to the skilled person. It will be understood that the invention is not limited to the described embodiments and encompasses modifications apparent to those skilled in the art lying within the scope of the claims appended hereto.

Claims

1. A domestic refrigerator or freezer, the domestic refrigerator or freezer comprising:

a thermally insulated cooled zone;
 a cooling system to cool said cooled zone, said cooling system comprising a mains powered compressor;
 a compressor control mounted on said compressor, to control operation of said compressor, said compressor control including a mains power supply connection for an incoming mains power supply for said compressor;
 a cover for said mains power supply connection of said compressor control to inhibit water ingress to said mains power supply connection, and
 a mains power supply cable to provide said incoming mains power supply;

wherein said mains power supply connection comprises a two-part, uncouplable electrical mains power supply connector co-located with said compressor control and beneath said cover, said two-part, uncouplable electrical mains supply connector having a first part connected to said mains power supply connection of said compressor control and a mating part connected to said mains power supply cable, such that said mains power supply cable is detachable from said domestic refrigerator by means of said electrical mains power supply connector.

2. A domestic refrigerator as claimed in claim 1 wherein said parts of said mains power supply connector are detachably held together to resist detachment of said mains power supply cable with a small force and to permit detachment of said mains power supply cable with a larger force greater than a threshold force. 5
3. A domestic refrigerator as claimed in claim 1 or 2 wherein a portion of said refrigerator is configured to hold said parts of said mains power supply connector together. 10
4. A domestic refrigerator as claimed in claim 3 wherein said portion of said refrigerator comprises said cover. 15
5. A domestic refrigerator as claimed in claim 4 wherein said cover comprises first and second cover portions configured to mutually engage to fasten over said mains power supply connector, and wherein one or both of said first and second cover portions is provided with a catch to enable said first and second cover portions to be disengaged on application of a disengagement force to said mains power supply cable. 20
6. A domestic refrigerator as claimed in any preceding claim wherein said first and mating parts of said electrical mains power supply connector are configured to mutually engage to lock with one another, and to be disengaged on application of a disengagement force to said mains power supply cable substantially without damage. 25
7. A domestic refrigerator as claimed in any preceding claim wherein said first and mating parts of said mains power supply connector are configured to mutually engage by a push-and-turn action. 30
8. A domestic refrigerator as claimed in any preceding claim wherein said mating part of said mains power supply connector bears a physical feature over which said cover fits to resist detachment of said mains power supply cable. 35
9. A domestic refrigerator as claimed in any preceding claim wherein said cover has an outside edge which, when said cover is closed, is located above said mains power supply cable, and wherein said mating part of said mains power supply connector, when said cover is closed, is partially or wholly within said outside edge of said cover. 40
10. A domestic refrigerator as claimed in claim 9 wherein said outside edge of said cover has a drip-inhibiting formation, to inhibit water drips running under said outside edge towards said mating part of said mains power supply connector. 45
11. A domestic refrigerator as claimed in any preceding claim configured such that on application of a disengagement force to said mains power supply cable said parts of said mains power supply connector detach in preference to detachment of said compressor control from said compressor. 50
12. A method of providing a detachable mains cable for a domestic refrigerator or freezer, the domestic refrigerator comprising:
 - a thermally insulated cooled zone;
 - a cooling system to cool said cooled zone, said cooling system comprising a mains powered compressor;
 - a compressor control mounted on said compressor, to control operation of said compressor, said compressor control including a mains power supply connection for an incoming mains power supply for said compressor;
 - a cover for said mains power supply connection of said compressor control to inhibit water ingress to said mains power supply connection, and
 - a mains power supply cable to provide said incoming mains power supply;
 - the method comprising:
 - co-locating a two-part uncouplable electrical mains power supply connector with said compressor located beneath said cover, connecting a first part of said connector to said mains power supply connection of said compressor control and connecting a mating part of said connector to said mains power supply cable, and arranging said parts of said mains power supply connector to be held together to resist detachment of said mains power supply cable by a small force and to permit detachment of said mains power supply cable by a larger force greater than a threshold force. 55

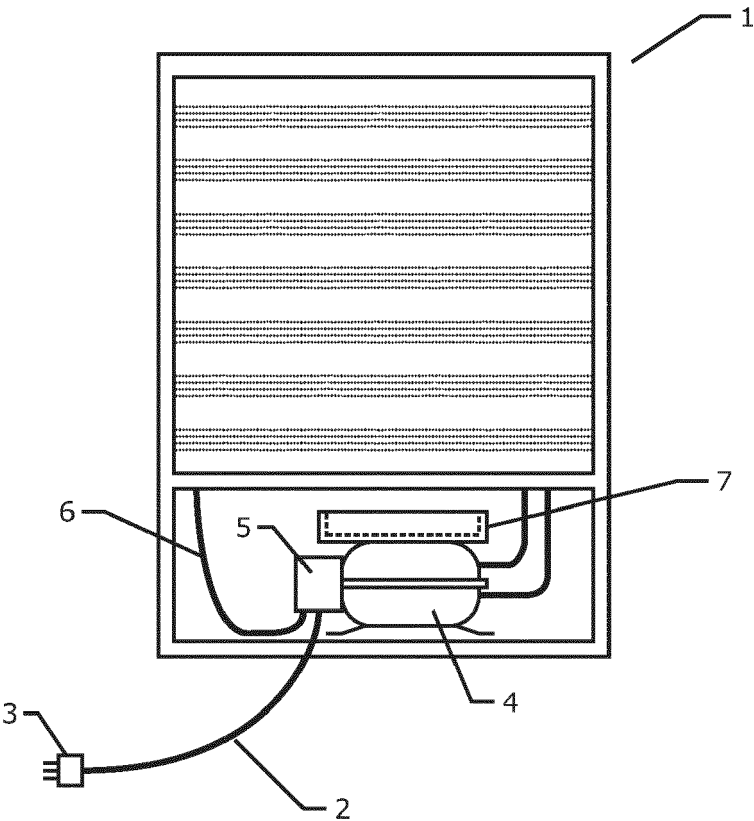


Fig 1

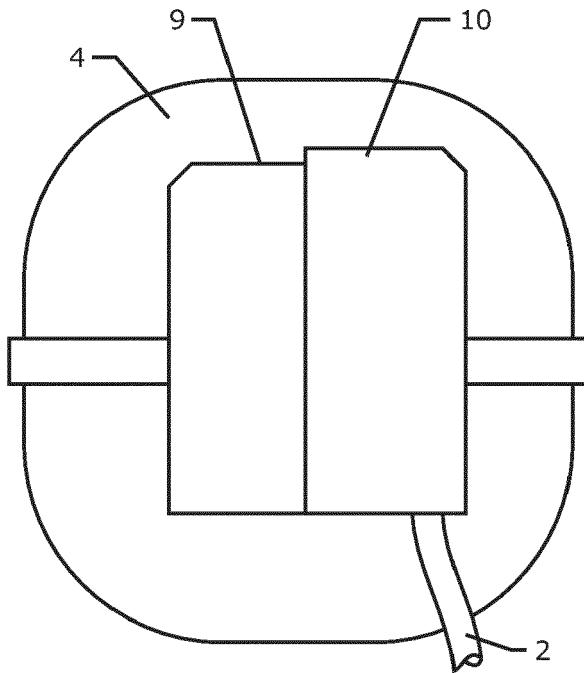


Fig 2a

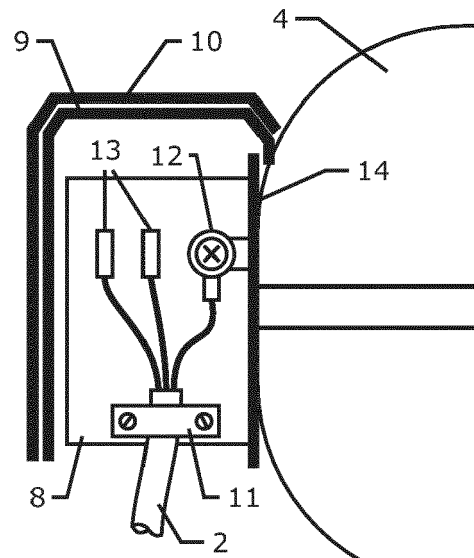


Fig 2b

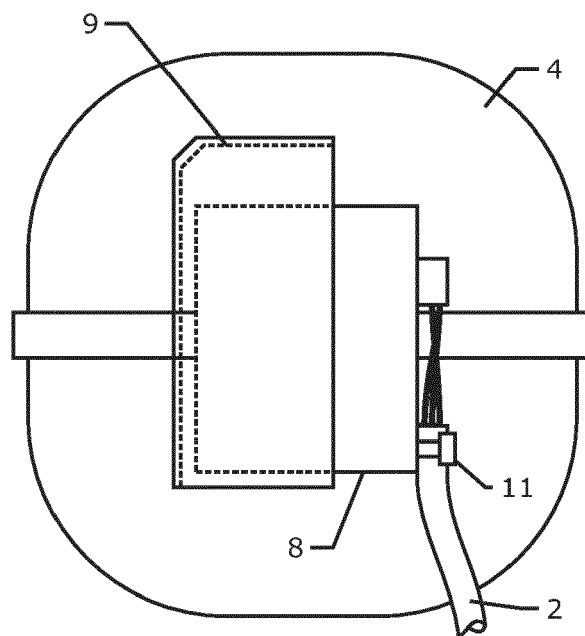


Fig 2c

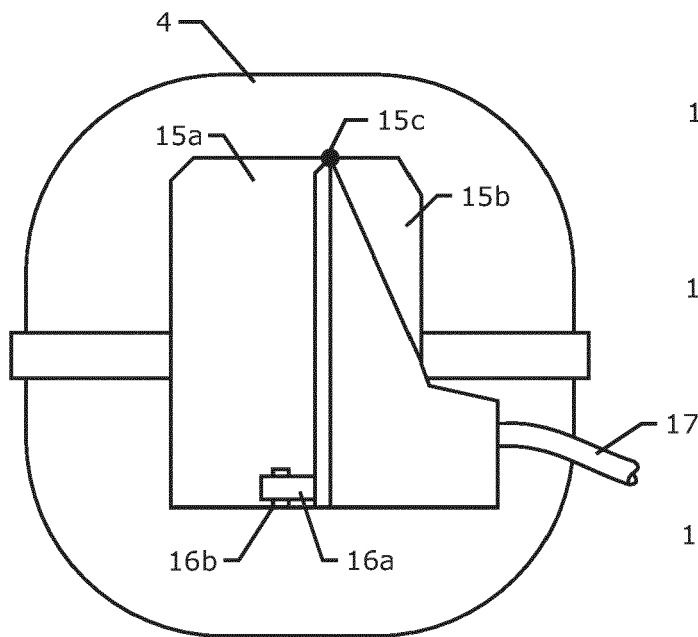


Fig 3a

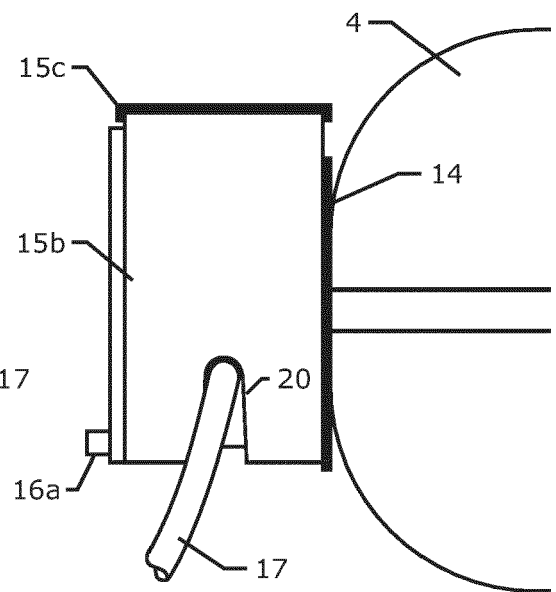


Fig 3b

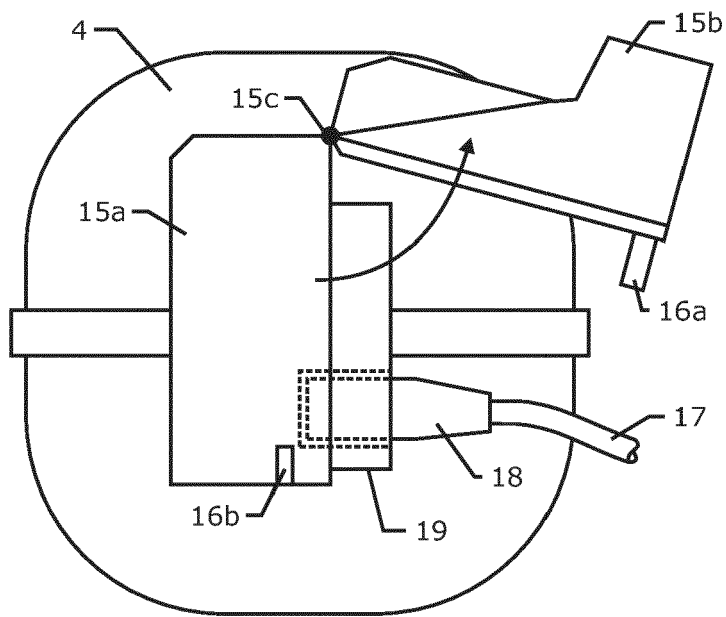


Fig 3c

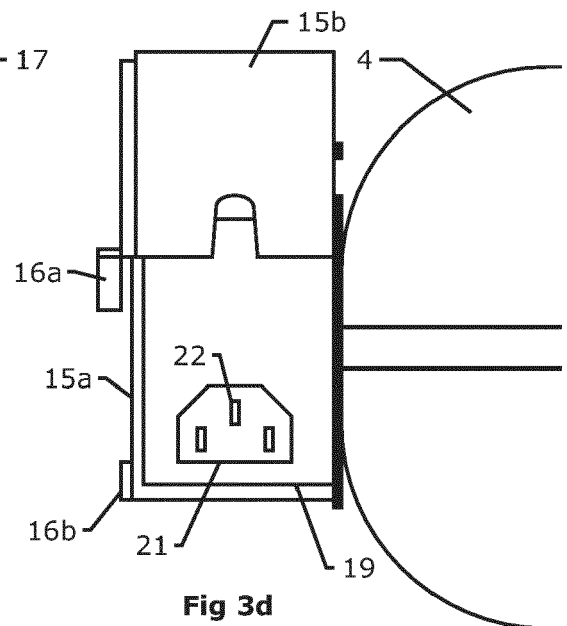


Fig 3d

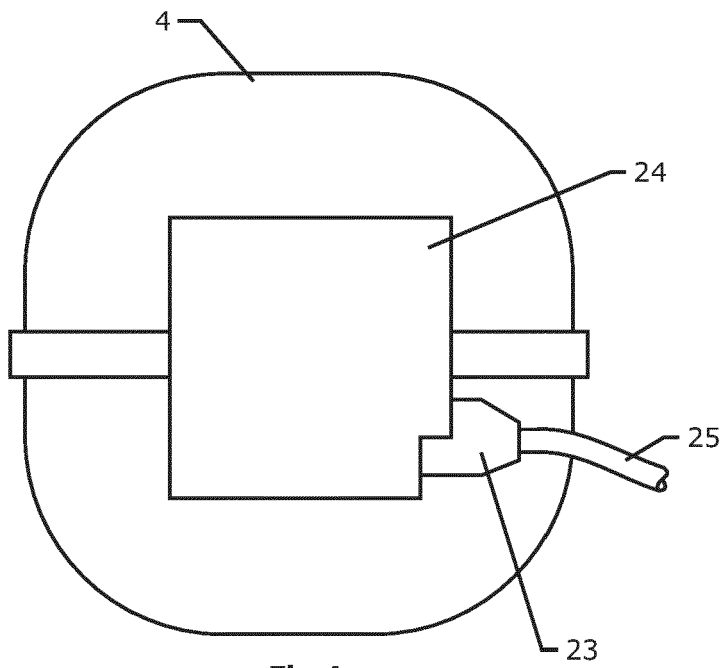


Fig 4a

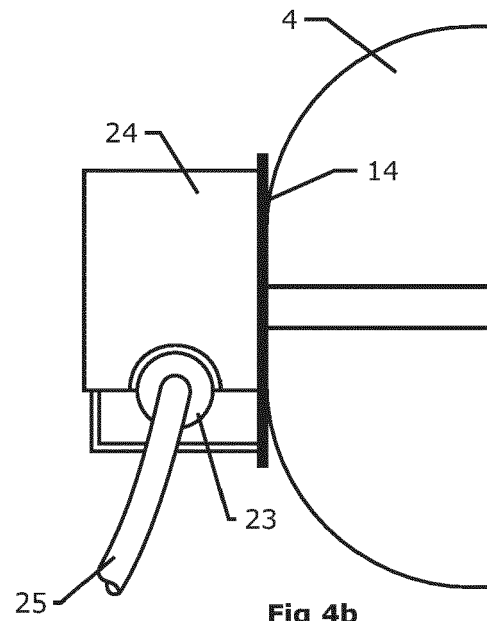


Fig 4b

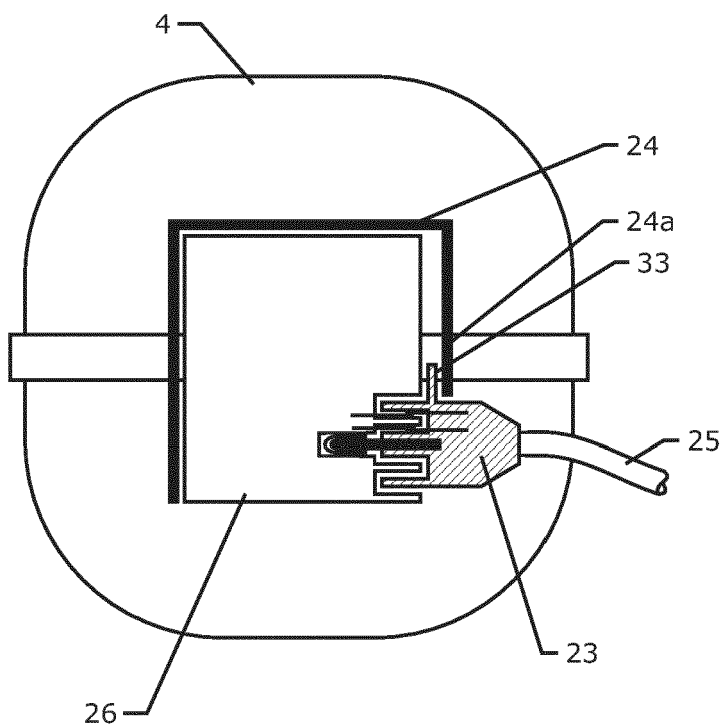


Fig 4c

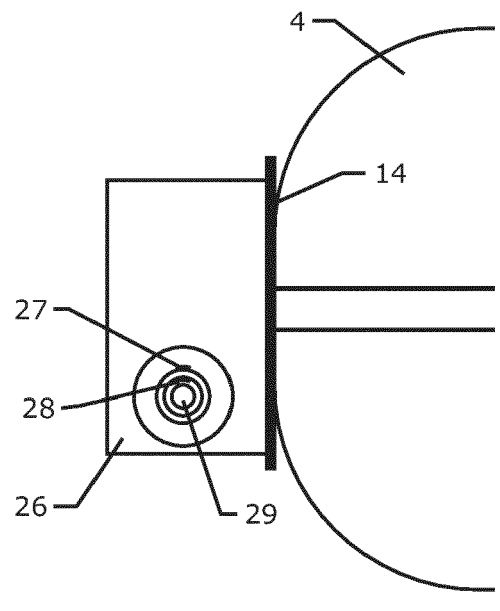


Fig 4d

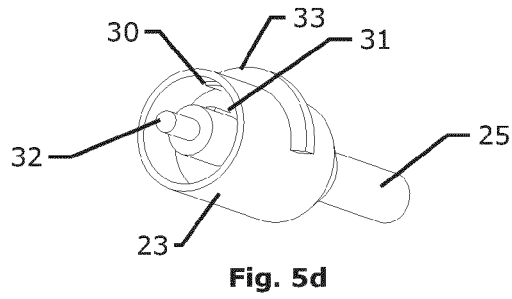
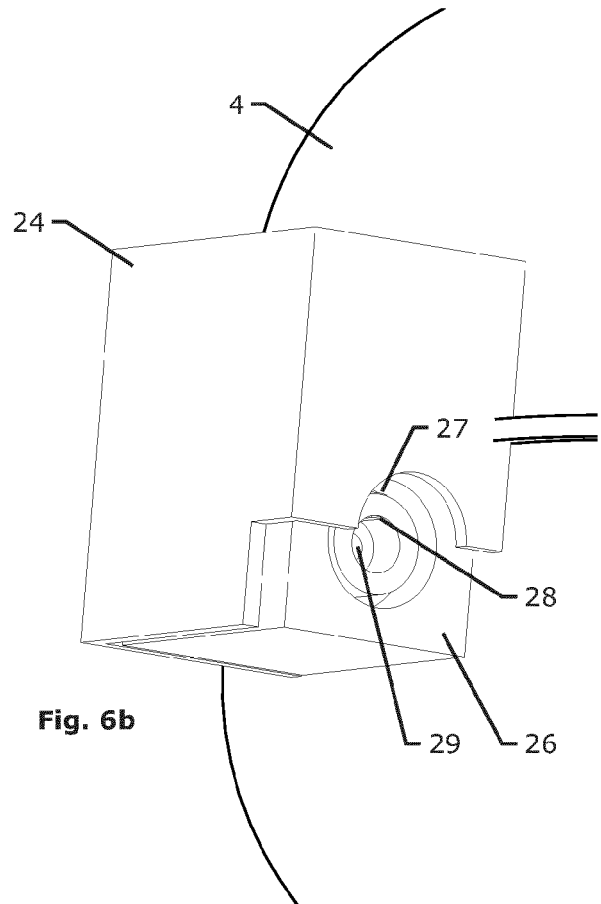
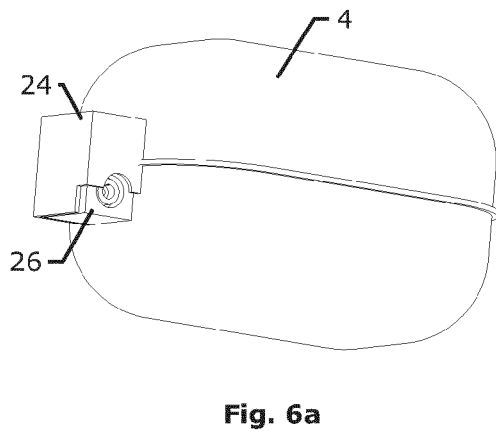
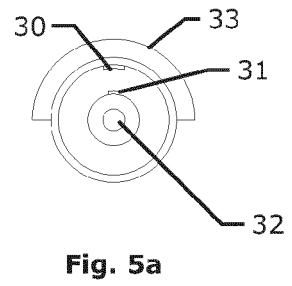
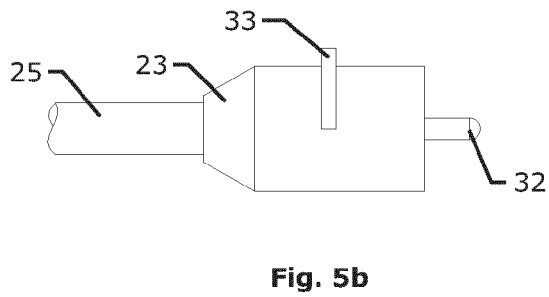
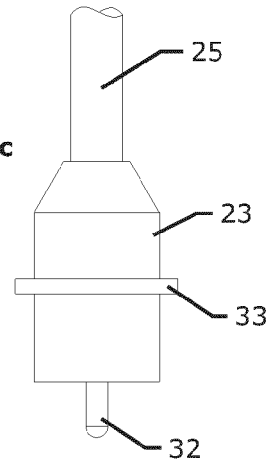


Fig. 5c



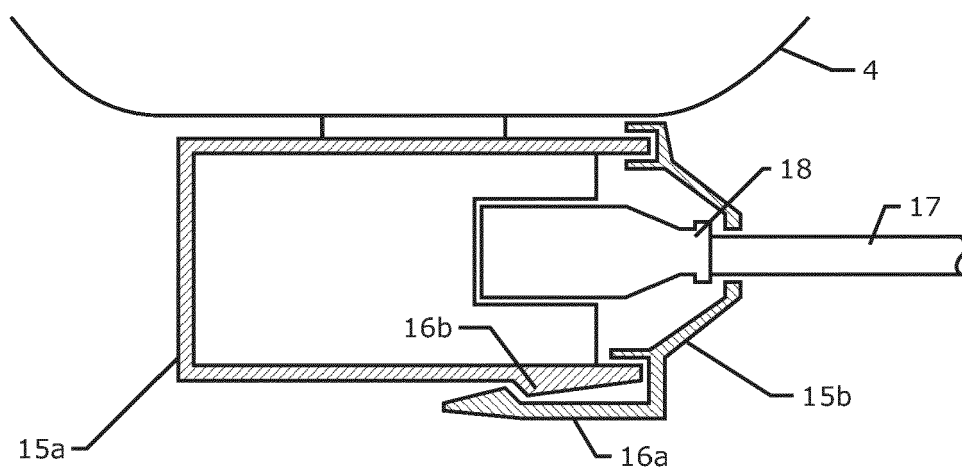


Fig. 7a

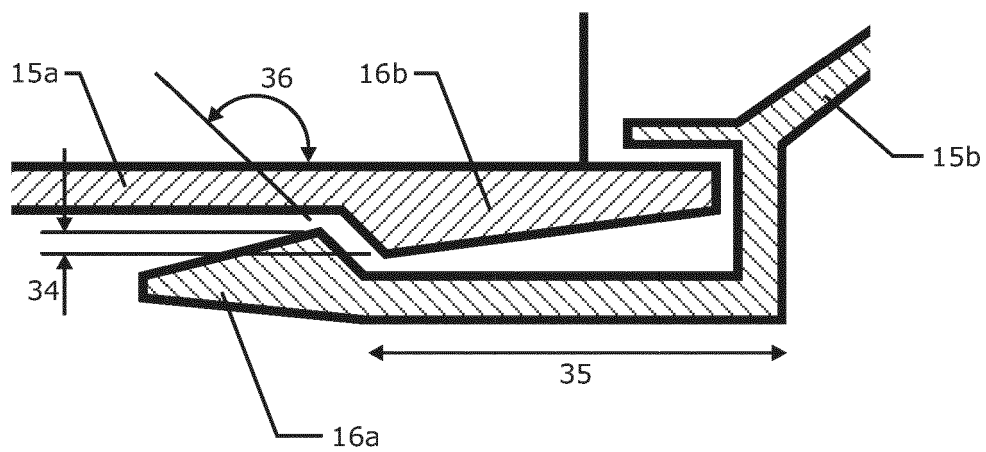


Fig. 7b

