(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 772 704 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.09.2014 Bulletin 2014/36

(51) Int Cl.:
F25B 17/08 *(2006.01)*

(21) Application number: **13157108.5**

(22) Date of filing: **28.02.2013**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

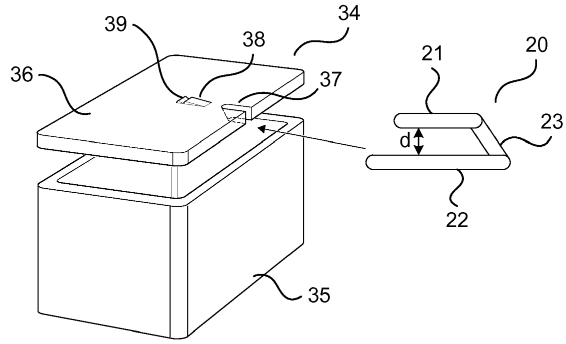
(71) Applicant: **Dometic Holding AB**
171 54 Solna (SE)

(72) Inventors:
- **Flemsäter, Björn**
181 30 Lidingö (SE)
- **Halin, Ingemar**
181 57 Lidingö (SE)

(74) Representative: **Kransell & Wennborg KB**
P.O. Box 27834
115 93 Stockholm (SE)

(54) Cooling system

(57) There is provided a cooling system, comprising: a portable cooling device comprising a fluid, a reactor containing a sorbent capable of sorption and desorption the fluid and a chamber for condensation and evaporation of the fluid, said reactor and said chamber being connected such that the fluid may flow between them; and an openable cooling box comprising insulating walls forming an interior space for cooling, said cooling box being adapted to receive the cooling device such that, in a closed configuration of the cooling box, heat may be transferred from the interior space to the chamber and from the reactor to an exterior cooling source, such as ambient air.



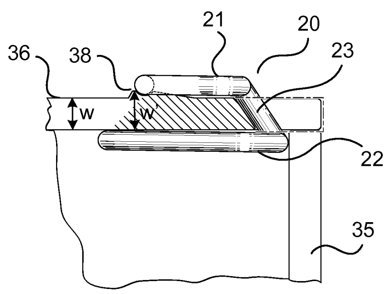


Fig. 3b

EP 2 772 704 A1

Description

TECHNICAL FIELD

[0001] The invention relates to cooling, in particular of temperature-sensitive products.

BACKGROUND

[0002] In food-deficit countries in the developing world, such as parts of Africa and Asia, where farmers' income and own food supply rely on and originate from agriculture, one of the key issues is to keep temperature-sensitive foods, crops or diaries cold when transporting to the local markets. Lack of sustainable and effective methods to ensure cooling during transportation could damage the farmers' valuable goods in a way such that it is lost. These farmers typically do not have access to reliable ways to secure the cold storage of their food. Transportation even over a short distance in hot weather (which is often the case) could be devastating and destroy the food. In some countries, such as India, some 30-40% of the agriculture produce is destroyed.

[0003] Also, over 1.6 million people die every year from smoke intoxication ("A Silent Killer of Rural Women in India", BBC report 2005) when using biomass-fired stoves indoors. According to Practical Action (2007), over 2.4 billion people use traditional biomass and other fossil fuels, such as wood, crop residues, charcoal or animal waste, for cooking.

[0004] In conclusion, a viable solution for ensuring cold storage in the food transportation chain in developing countries is needed. Further, there is need for replacing the fuels used today in the developing world for cooking with a fuel producing less toxic fumes.

SUMMARY

[0005] The inventors have realized that an affordable and easy-to-use stove concept fueled by a bio-combustible liquid, such as ethanol or methanol, may replace traditional firewood cook stoves as well as dangerous kerosene stoves. Combustion of ethanol and methanol results in almost no toxic flue gases, while being obtainable from renewable resources or natural gas. Further, it has been realized that waste heat from a burner in such a stove concept may be used for regenerating a portable cooling device that may provide cooling in a simple cooling box.

[0006] To meet the above-mentioned needs, there is provided a cooling device capable of batch cooling the contents of a cooling box. When the cooling capacity of the cooling device is consumed, it may be regenerated by heat in a heating device. The cooling box is designed to receive cooling device and utilize its cooling capacity. Likewise, the heating device is designed to receive the cooling device and regenerate it for another batch cooling. Also, the cooling device is designed to provide cooling in the cooling box and to be regenerated by the heating device. The cooling device, the cooling box and the heating device are separate units that may be handled separately of eachother.

[0007] Thus, there is provided an itemized listing of embodiments of the present disclosure, presented for the purpose of providing various features and combinations provided by the invention in certain of its aspects.

1.A portable cooling device comprising a fluid, a reactor containing a sorbent capable of sorption and desorption of the fluid and a chamber for condensation and evaporation of the fluid, said reactor and said chamber being connected such that the fluid may flow between them.

2.The cooling device of item 1, wherein a closable valve is arranged in the connection between the reactor and the chamber.

3.The cooling device of item 1 or 2, wherein the fluid is water or water-based and the sorbent is capable of sorption and desorption of gaseous water.

4.The cooling device of any one of items 1-3, wherein the sorbent is a salt or a microporous material, such as zeolite.

5.The cooling device of any one of items 1-4, wherein the reactor extends in a first plane and the chamber extends in a second plane, which is approximately parallel to the first plane.

6.The cooling device of any one of items 1-5, wherein the reactor is elongated and/or the chamber is elongated.

7. The cooling device of item 6, wherein the elongated reactor is curved or bent such that it is adapted to at least partly encircle a heat source, such as a flame, for heating the reactor.

8. The cooling device of item 6 or 7, wherein the elongated chamber is curved or bent such that it is adapted to at least partly encircle a burner providing a flame.

9.The cooling device of any one of items 6-8, wherein the reactor and/or the chamber is ring-shaped.

10. The cooling device of any one of items 7-9, wherein the elongated reactor defines a first area and the elongated chamber defines a second area, which is larger than the first area.

11. The cooling device of item 10, wherein the second area is at least 30 %, such as at least 50 %, such as at least 70 %, larger than the first area.

12. The cooling device of any one of item 6-11, wherein the cross section area of the elongated chamber along at least half of its length is 2-10 cm^2, such as 2-7 cm^2, such as 3-6 cm^2.

13. The cooling device of any one of item 6-12, wherein the cross section area of the elongated reactor along at least half of its length is 2-10 cm^2, such as 2-7 cm^2, such as 3-6 cm^2.

14. The cooling device of any one of the preceding items, wherein the volume of the chamber is 100-500 cm^3, such as 150-300 cm^3.

15. The cooling device of any one of the preceding items, wherein the volume of the reactor is 100-700 cm^3, such as 150-500 cm^3, such as 150-400 cm^3.

16. The cooling device of any one of the preceding items, further comprising at least one handle.

17. The cooling device of item 16, comprising at least two handles arranged on the outside of the chamber.

18. The cooling device of item 16 or 17, wherein each handle is provided with insulation to reduce heat transfer from the cooling device to a hand holding the handle.

19. An openable cooling box comprising insulating walls forming an interior space for cooling, wherein a portion of a wall of the cooling box is adapted to receive a portable cooling device comprising
a reactor extending in a first plane,
an evaporation and condensation chamber extending in a second plane, which is approximately parallel to the first plane and
a connection between the reactor and the chamber, such that, in a closed configuration of the cooling box, heat may be transferred from the interior space to the chamber and from the reactor to an exterior cooling source, such as ambient air,
wherein the wall portion comprises a groove extending from an edge of the wall into the wall, said groove being adapted to receive the connection such that the chamber is located inside the cooling box and the reactor is located outside the cooling box in the closed configuration.

20. The cooling box according to item 19, wherein the wall portion has a reduced thickness compared to the rest of the wall.

21. The cooling box of item 20, wherein the reduced thickness is a reduction of at least 4 mm, such as at least 8 mm, such as at least 12 mm.

22. The cooling box according to any one of items 19-21, wherein the wall portion comprises an elevation extending from the plane of the wall and a recess adapted to receive part of the reactor is provided at the top of the elevation such that the cooling device may be locked in a received position.

23. The cooling box according to item 22, wherein a part of the elevation between the recess and the edge from which the groove extends is tapering towards the edge from which the groove extends.

24. The cooling box of any one of items 19-23, wherein the average thickness of the walls is 2-7 cm, such as 3-6 cm.

25. The cooling box of any one of items 19-24, wherein the inner volume of the cooling box is 20-100 liters, such as 20-60 liters, such as 20-40 liters.

26. The cooling box of any one of items 19-25, wherein a heat-exchanging plate composed of a heat-conducting material, such as a metal, is arranged on the outside of the wall such that said heat-exchanging plate is in physical contact with the reactor when the cooling device is received by the cooling box.

27. The cooling box of any one of items 19-26, wherein a heat-exchanging plate composed of a heat-conducting material, such as a metal, is arranged on the inside of the wall such that said heat-exchanging plate is in physical contact with the chamber when the cooling device is received by the cooling box.

28. The cooling box of item 26 or 27, wherein the heat-exchanging plate is distanced from the wall by spacers.

29. The cooling box of item 28, wherein the distance between the heat-exchanging plate and the wall is 2-10 mm, such as 2-6 mm.

30. The cooling box of any one of items 19-29, wherein the wall is a top wall or a side wall of the cooling box.

31. The cooling box of item 30, wherein the top wall is a lid allowing the cooling box to be opened.

32. The cooling box of any one of items 19-31, wherein the width of the groove is 15-50 mm, such as 20-40 mm.

33. The cooling box of any one of items 19-32, wherein the depth of the groove is 15-70 mm, such as 25-70 mm.

34. The cooling box of any one of items 19-33, wherein an edge of a second wall comprises a second groove that meets the groove of the wall in the closed

configuration and forms a common receiving space for the cooling device.

35. A cooker adapted to receive a portable cooling device comprising
a reactor extending in a first plane,
an evaporation and condensation chamber extending in a second plane, which is approximately parallel to the first plane and
a connection between the reactor and the chamber, said cooker comprising a metal frame having mainly vertical walls continuing into a mainly horizontal hob, the frame enclosing a burner and being adapted to enclose a fuel canister, wherein the frame is a bottomless frame formed of one piece so as to allow replacing of the fuel canister from the bottom side of the frame, said cooker further comprising one or several cooking utensil supports having an upper edge for supporting a cooking utensil in a position above the burner, the upper edge being provided with at least one recess for receiving the reactor of the cooling device.

36. The cooker of item 35, wherein the depth of the at least one recess is such that the reactor is not in contact with the cooking utensil when the reactor is received by the recess(es) and the cooking utensil is supported by the upper edge in the position above the burner.

37. The cooker of item 35 or 36, wherein the depth of the recess(es) is 15-50 mm.

38. The cooker of any one of items 35-37, wherein at least one hob is provided in the hob to receive the chamber.

39. A cooling system, comprising:

> a portable cooling device comprising a fluid, a reactor containing a sorbent capable of sorption and desorption the fluid and a chamber for condensation and evaporation of the fluid, said reactor and said chamber being connected such that the fluid may flow between them; and
> an openable cooling box comprising insulating walls forming an interior space for cooling, said cooling box being adapted to receive the cooling device such that, in a closed configuration of the cooling box, heat may be transferred from the interior space to the chamber and from the reactor to an exterior cooling source, such as ambient air.

40. The cooling system of item 39, wherein the chamber is located inside the cooling box and the reactor is located outside the cooling box when the cooling box in a closed configuration has received the cooling device.

41. The cooling system of item 39 or 40, wherein the reactor extends in a first plane and the chamber extends in a second plane, which is approximately parallel to the first plane and the distance between the reactor and the chamber in the direction perpendicular to the planes is approximately the same as the thickness of a wall portion of the cooling box adapted to receive the cooling device.

42. The cooling system of any one of items 39-41, wherein the average thickness of the walls of the cooling box is 2-7 cm, such as 3-6 cm.

43. The cooling system of any one of items 39-42, wherein the inner volume of cooling the box is 20-100 liters, such as 20-60 liters, such as 20-40 liters.

44. The cooling system of any one of items 39-43, wherein a heat-exchanging plate composed of a heat-conducting material, such as a metal, is arranged on an outer wall of the cooling box, said heat-exchanging plate being in physical contact with the reactor when the cooling device is received by the cooling box.

45. The cooling system of any one of items 39-44, wherein a heat-exchanging plate composed of a heat-conducting material, such as a metal, is arranged on an inner wall of the cooling box, said heat-exchanging plate being in physical contact with the chamber when the cooling device is received by the cooling box.

46. The cooling system of item 44 or 45, wherein the heat-exchanging plate is distanced from the wall by spacers.

47. The cooling system of item 46, wherein the distance between the heat-exchanging plate and the wall is 2-10 mm, such as 2-6 mm.

48. The cooling system of any one of items 39-47, wherein the top wall of the cooling box is a lid allowing the cooling box to be opened.

49. The cooling system of any one of items 39-48, wherein the cooling device is the cooling device according to any one of items 1-18.

50. The cooling system of any one of items 39-49, wherein the cooling box is the cooling box according to any one of items 19-34.

51. The cooling system of any one of the preceding items, further comprising a separate heating device adapted to receive the cooling device and heat the

reactor while the chamber is in contact with a cooling source, such as ambient air.

52. The cooling system of item 51, wherein the heating device comprises recesses adapted to receive the cooling device.

53. The cooling system of item 51 or 52, wherein the heating device is a cooker adapted to simultaneously heat a cooking utensil and the reactor of the cooling device.

54. The cooling system of any one of items 51-53, wherein the reactor extends in a first plane and the chamber extends in a second plane, which is approximately parallel to the first plane and, when the cooling device is received by the burner, the planes are approximately horizontal and the first plane is located above the second plane.

55. The cooling system of any one of items 51-54, wherein the heating device comprises a burner.

56. The cooling system of item 55, wherein the reactor is located closer to a flame of the burner than the chamber when the cooling device is received by the heating device.

57. The cooling system of any one of items 55-56, wherein the burner is a liquid fuel burner.

58. The cooling system of item 57, wherein the liquid fuel is methanol or ethanol.

59. The cooling system of any one of items 51-58, wherein the heating device comprises a detachable and replaceable fuel canister.

60. The cooling system of any one of items 51-59, wherein the heating device is the cooker according to any one of items 35-38.

61. Use of a cooling device of any one of items 1-18 for cooling the contents of a cooling box.

62. Use of a cooker according to any one of items 35-38 for regenerating a cooling device of anyone of claims 1-18.

63. Method of cooling contents of a cooling box of anyone of items 19-34, comprising the steps of:

a) arranging a cooling device according to anyone of items 1-18 such that it is received by the groove of the cooling box; and
b) allowing the liquid in the chamber to evaporate in a closed configuration of the cooling box to cool contents of the cooling box.

64. Method according to item 63, further comprising the step of regenerating the cooling device by heating the reactor before step a).

65. Method according to item 64, wherein a cooker of anyone of items 35-38 is used for heating the reactor.

[0008] Generally, all terms used in the items are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the element, apparatus, component, means, step, etc." are to be interpreted openly as referring to at least one instance of the element, apparatus, component, means, step, etc., unless explicitly stated otherwise. The steps of any method disclosed herein do not have to be performed in the exact order disclosed, unless explicitly stated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The invention is now described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of a cooker according to the present disclosure.

Fig. 2a-2c are perspective views of various embodiments of a cooling device according to the present disclosure.

Fig. 3a is a perspective view of an embodiment cooling box according to the present disclosure and a section view of such an embodiment which has received a cooling device according to the present disclosure.

Fig. 3b is a perspective view of another embodiment cooling box according to the present disclosure and a section view of such an embodiment which has received a cooling device according to the present disclosure.

Fig 4. is a perspective view of a cooker according to the present disclosure, which has received a cooling device according to the present disclosure and onto which a pot is placed.

DETAILED DESCRIPTION

[0010] As a first aspect of the present disclosure, there is provided a portable cooling device comprising a fluid, a reactor containing a sorbent capable of sorption and desorption of the fluid and a chamber for condensation and evaporation of the fluid, said reactor and said chamber being connected such that the fluid may flow between them. The fluid may comprise water and in such case, the sorbent is capable of sorption and desorption of gaseous water. The sorbent may be an absorbent or an adsorbent. Examples of sorbents are hygroscopic salts and microporous material, such as zeolite. When the reactor of the cooling device is heated, fluid desorption occurs and the gaseous fluid from the reactor condenses in the chamber. Thereby, the cooling device is regenerated. When the chamber of the regenerated cooling device is placed inside a cooling box, heat from the cooling box interior is used in the chamber for evaporating the fluid, which is resorbed by the sorbent. Thus, the resorption process drives the cooling inside the box. Preferably, the pressure in the cooling device is below atmospheric pressure to facilitate the thermodynamic processes therein. For example, the pressure may be such that the fluid has a boiling point between -10 °C and +5 °C, such as about 0 °C. One example of a suitable sorption/desorption process is ClimateWell's technology using a hygroscopic salt and an appropriate liquid, such as LiCl-water, see e.g. WO0037864 and US 2009/0249825.

[0011] Thus, the cooling device of the first aspect is an independent unit that may be easily moved by the user between a heating source and a cooling box. The cooling device is normally of a size that is easy to handle for the user.

[0012] In one embodiment of the first aspect, a closable valve is arranged in the connection between the reactor and the chamber. Thus, the cooling capacity may be stored as in a battery after regeneration of the cooling device. Only after the valve has been opened, the cooling action begins as fluid evaporating in the chamber is allowed to flow into the reactor. Thus, the cooling capacity may be employed when needed and not only shortly after regeneration.

[0013] In an embodiment of the first aspect, the reactor extends in a first plane and the chamber extends in a second plane, which is approximately parallel to the first plane. Such an embodiment allows the chamber to be located inside a cooling box while the reactor, which needs cooling, is located on the outside. Further, it allows the reactor to be placed close to a heating source while the chamber, which needs cooling during the regeneration, is below the heat source and thus further away from it.

[0014] In the context of the present disclosure, "approximately parallel" planes refers a maximum angle between the planes of 6° or less, preferably 5° or less, more preferably 3° or less.

[0015] The reactor and/or the chamber are preferably elongated, such as tube-shaped. Such shapes are relatively easy to manufacture. The elongated reactor may for example be curved or bent such that it is adapted to at least partly encircle a heat source, such as a flame. Thus, the reactor may cover a relatively large area around the flame of a burner in a stove, while a cooking utensil is placed above the flame. Thus, the heat not transferred to the cooking utensil, i.e. the heat not used for cooking ("waste heat"), may be taken up by the reactor. Thus, such a shape provides for efficient use of the available fuel. Also, the elongated chamber may be curved or bent that it is adapted to at least partly encircle the burner providing the flame. Such a chamber shape provides for efficient use of the space already occupied by a stove on which the burner is arranged. Also, the rounded or bent shape provides for increased safety as no parts of the cooling device points out from the stove and risks that the stove and/or cooking utensil is tilted during cooking. Accordingly, the reactor and/or the chamber may be ring-shaped, such that the reactor may form a ring around the flame and the chamber may form a ring around the burner. The elongated reactor and/or chamber may have the form of a full/continuous ring or an interrupted/non-continuous ring. In the latter case, the reactor and/or chamber is/are claw-shaped. Also, the reactor may have an oval shape such that some parts of the reactor may come closer to the flame and thus be exposed to a higher temperature. The oval reactor may also be full/continuous or interrupted/non-continuous (claw-shaped).

[0016] To be closer to the flame, the reactor may be bent or curved to a larger degree than the chamber, which is to be cooled during regeneration. Thus, when both the reactor and the chamber have the shape of ring, an oval or a claw, the elongated reactor may define a first area, which is smaller than a second area defined by the elongated chamber. For example, the second area may be at least 30 %, such as at least 50 %, such as at least 70 %, larger than the first area. Normally, the first area being smaller than the second area means that the elongated reactor is shorter than the elongated chamber. In some cases, the inner volume of the reactor shall be at least the same as, but preferably larger than, the inner volume of the chamber, which means that the average cross section area of the reactor will be larger than the average cross section area of the chamber.

[0017] For example, the cross section area of the elongated chamber along at least half of its length may be 2-9 cm^2, such as 2-6 cm^2, such as 3-5 cm^2 and the cross section area of the elongated reactor along at least half of its length may be 2-10 cm^2, such as 2.5-7 cm^2, such as 3-6 cm^2. The volume of the chamber may be 100-500 cm^3, such as 150-300 cm^3 and the volume of the reactor may be 100-700 cm^3, such as 150-500 cm^3, such as 150-400 cm^3. As mentioned above, the inner volume of the reactor may be larger than the inner volume of the chamber, such as at least 10 % larger.

[0018] To aid handling of the cooling device, it may comprise at least one handle. For example, it may comprise at least two handles radially extending from the chamber. Thus, the cooling device may be safely handled with both hands. Also, the handle may be arranged at the connection between the reactor and the chamber. Each handle is preferably provided with insulation to reduce heat transfer from the cooling device to a hand holding the handle.

[0019] As a second aspect of the present disclosure, there is provided an openable cooling box comprising

insulating walls forming an interior space for cooling, wherein a portion of a wall of the cooling box is adapted to receive a portable cooling device comprising
a reactor extending in a first plane,
an evaporation and condensation chamber extending in a second plane, which is approximately parallel to the first plane and
a connection between the reactor and the chamber,
such that, in a closed configuration of the cooling box, heat may be transferred from the interior space to the chamber and from the reactor to an exterior cooling source, such as ambient air.

[0020] The wall portion adapted to receive a portable cooling device may for example comprise a groove extending from an edge of the wall into the wall. Thereby, the groove is adapted to receive the connection such that the chamber is located inside the cooling box and the reactor is located outside the cooling box in the closed configuration. The groove may be provided in the top wall (e.g. the lid). Also, the groove may be provided in a side wall. If the groove is provided in the side wall, it is preferably extending downwardly from the upper edge of the side wall, such that the cooling device hangs in the groove. A benefit of providing the groove in the top wall/lid or at the upper edge of a side wall is that the chamber of the cooling box is positioned in the upper part of the interior of the cooling box during cooling, which facilitates efficient cooling and allows for efficient utilization of the interior space as the bottom of the cooling box interior is not occupied. Providing the groove in the lid is particularly beneficial in this regard. A sealing device may be arranged at the groove to prevent air leakages through the groove when it has received the connection.

[0021] If the top wall is a lid, the lid may be hinged or completely removable.

[0022] It may be that the distance between the chamber and the reactor of the cooling device is limited, for example by the space available between the hob of a stove and a cooking utensil placed on the stove above a burner. At the same time, a certain wall thickness may be required to provide sufficient insulation. In one embodiment, the wall portion adapted to receive the cooling device may therefore have a reduced thickness compared to the rest of the wall. Alternatively, it may have a reduced thickness compared to an average thickness of the walls of the cooling box. The reduced thickness may for example be a reduction of at least 4 mm, such as at least 8 mm, such as at least 12 mm.

[0023] It may be beneficial if the cooling device can be locked in a position where it is received by the cooling box, in particular if it is received by the lid (when the cooling device is hanging on the wall, there is less need for a locking mechanism). Therefore, the wall portion adapted to receive the cooling device may comprise an elevation extending from the plane of the wall, wherein a recess adapted to receive part of the reactor provided at the top of the elevation. Such an elevation may be provided on the inside or the outside of the wall. However, if it is provided on the inside, the recess is adapted to receive part of the chamber. For example, a part of the elevation between the recess and the edge from which the groove extends is tapering towards the edge from which the groove extends such that the height of the elevation is gradually increasing in a direction away from the edge in question. Another benefit of the elevation is that the reactor (if the elevation is provided on the outside) or the chamber (if the elevation is provided on the inside) is lifted from the wall such that heat transfer between the reactor or chamber and the wall is reduced.

[0024] Sufficient insulation may be obtained if the average thickness of the walls is 2-7 cm, such as 3-6 cm. The wall may for example comprise polyurethane foam (PUR foam) or styrofoam® as insulating material. The insulating material may be covered by sheets of plastic or metal. Examples of suitable inner volumes of the cooling box are 20-100 liters, such as 20-60 liters, such as 20-40 liters.

[0025] To facilitate a high cooling effect inside the box, a heat-exchanging plate composed of a heat-conducting material, such as a metal, may be arranged on the outside of the wall such that said heat-exchanging plate is in physical contact with the reactor when the cooling device is received by the cooling box. Such a heat-exchanging plate increases the surface area employed for cooling the reactor and a more efficient cooling of the reactor drives the evaporation in the chamber and thus the cooling inside the box.

[0026] The same type of heat-exchanging plate may be provided on the inside of the wall to increase the area available for transfer of heat to the chamber inside the box.

[0027] The heat-exchanging plate may be distanced from the wall by spacers, which further increases the available surface area. In such an embodiment, the distance between the heat-exchanging plate and the wall may for example be 2-10 mm, such as 2-6 mm.

[0028] However, the heat-exchanging plate may also be distanced from the inside of the wall to such a degree that a slot adapted to receive the chamber is formed between the wall and the plate. In such case, the width of the slot may be approximately the same as the width of the chamber (the outer diameter of the chamber in case of a circular cross section). Thus, the width of the slot may for example be 15-50 mm, such as 20-40 mm. Such a slot may function as a locking mechanism. Also, the slot reserves a space for the cooling device even if the cooling box is filled with contents (e.g. produce) before the cooling device is put into place. Such a reserved space may be particularly beneficial if the cooling device is received by a side wall of the cooling box.

[0029] Likewise, the heat-exchanging plate may be distanced from the outside of the wall to such a degree that a slot adapted to receive the chamber is formed between the wall and the plate. In such case, the width of the slot may be approximately the same as the width of the reactor (the outer diameter of the reactor in case of a circular cross section). Thus, the width of the slot may for example be 15-50 mm, such as 20-40 mm. Such an outside slot may also function as a locking mechanism.

[0030] The width of the groove is preferably adapted to size of the connection. For example, it may approximately correspond to the outer diameter of the connection in case the connection has a circular cross section. Thus, the width of the groove may for example be 15-50 mm, such as 20-40 mm.

[0031] The depth of the groove may be adapted to the size of the connection and optionally the thickness of the wall that meets the groove. The depth of the groove may for example be 15-80 mm, such as 15-70 mm, such as 25-70 mm.

[0032] The depth of the groove may be reduced if the wall that meets the groove comprises a second groove such that a common space for receiving the cooling device is formed in the closed configuration of the cooling box.

[0033] As a third aspect of the present disclosure, there is provided a cooker adapted to receive a portable cooling device comprising
a reactor extending in a first plane,
an evaporation and condensation chamber extending in a second plane, which is approximately parallel to the first plane and
a connection between the reactor and the chamber,
said cooker comprising a metal frame having mainly vertical walls continuing into a mainly horizontal hob, the frame enclosing a burner and being adapted to enclose a fuel canister/container, wherein the frame is a bottomless frame formed of one piece so as to allow replacing of the fuel canister/container from the bottom side of the frame, said cooker further comprising one or several cooking utensil supports having an upper edge for supporting a cooking utensil in a position above the burner, the upper edge being provided with at least one recess for receiving the reactor of the cooling device.

[0034] The cooker of the third aspect may for example be a cooker according to WO 02/084175, provided that the cooking utensil supports (denoted 47 in WO 02/084175) are provided with at least one recess for receiving the reactor. Further, the cooker of WO 02/084175 may be provided with a recess in the wind protecting part (denoted 49 in WO 02/084175) for receiving the connection when used according to the third aspect.

[0035] Also, the cooker of the third aspect may for example be a cooker according to WO 2008/058566, provided that the cooking utensil supports (denoted 6 in WO 2008/058566) are provided with at least one recess for receiving the reactor. Further, the cooker of WO 2008/058566 may be provided with a recess in the wind protector (denoted 7 in WO 2008/058566) for receiving the connection when used according to the third aspect.

[0036] The depth of the at least one recess in the cooking utensil supports may be such that the reactor is not in contact with the cooking utensil when the reactor is received by the recess(es) and the cooking utensil is supported by the upper edge of the cooking utensil supports in the position above the burner. Thus, the depth of the recess(es) may for example be 15-50 mm, such as 20-40 mm.

[0037] The cooker of the third aspect may for example comprise at least one hob recess provided in the hob to receive the chamber. Thus, the cooling device may be stabilized in the received position. Further, when the chamber rests in such (a) hob recess(es), heat may be transferred from the chamber to the metal frame of the cooker. Thus, the metal frame may contribute to the cooling of the chamber (in which the fluid condenses), which facilitates an efficient regeneration process.

[0038] As a fourth aspect of the present disclosure, there is provided a cooling system, comprising:

> a portable cooling device comprising a fluid, a reactor containing a sorbent capable of sorption and desorption the fluid and a chamber for condensation and evaporation of the fluid, said reactor and said chamber being connected such that the fluid may flow between them; and
> an openable cooling box comprising insulating walls forming an interior space for cooling, said cooling box being adapted to receive the cooling device such that, in a closed configuration of the cooling box, heat may be transferred from the interior space to the chamber and from the reactor to an exterior cooling source, such as ambient air.

[0039] The chamber is preferably located inside the cooling box and the reactor is located outside the cooling box when the cooling box in a closed configuration has received the cooling device.

[0040] As mentioned above in connection with the first aspect, the reactor of the cooling device may extend in a first plane and the chamber of the cooling device may extend in a second plane, which is approximately parallel to the first plane. In such an embodiment, the distance between the reactor and the chamber in the direction perpendicular to the planes may be approximately the same as the thickness of a wall portion of the cooling box adapted to receive the cooling device. If the wall portion includes one or two heat-exchanging plates (see below), the relevant thickness is that including the heat-exchanging plate(s) and the spacers, if any, provided that the heat-exchanging plate(s) is not forming (a) slot(s) for receiving the cooling device.

[0041] As mentioned in connection with the second aspect, the average thickness of the walls of the cooling box of the fourth aspect may be 2-7 cm, such as 3-6 cm and the inner volume of the cooling box of the fourth aspect may be 20-100 liters, such as 20-60 liters, such as 20-40 liters. As also mentioned in connection with the second aspect, a heat-exchanging plate composed of a heat-conducting material, such as a metal, may be arranged on an outer wall of the cooling box of the fourth aspect. The outer heat-exchanging plate is in physical contact with the reactor when the cooling device is received by the cooling box. Likewise, a heat-exchanging plate composed of a heat-conducting material, such as a metal, may be arranged on an inner wall of the cooling box. Such an inner heat-exchanging plate is in physical contact with the chamber when the cooling device is received by the cooling box. The outer or inner heat-exchanging plate may be distanced from the wall by spacers. The distance between the heat-exchanging plate and the wall may be 2-10 mm, such as 2-6 mm.

[0042] As discussed above in connection with the second aspect, the heat-exchanging plate may alternatively be distanced from the inside of the wall to such a degree that a slot adapted to receive the chamber is formed between the wall and the plate. In such case, the width of the slot may be approximately the same as the width/thickness of the chamber (the outer diameter of the chamber in case of a circular cross section). Thus, the width of the slot may for example be 15-50 mm, such as 20-40 mm.

[0043] Likewise, the heat-exchanging plate may be distanced from the outside of the wall to such a degree that a slot adapted to receive the chamber is formed between the wall and the plate. In such case, the width of the slot may be approximately the same as the width/thickness of the reactor (the outer diameter of the reactor in case of a circular cross section). Thus, the width of the slot may for example be 15-50 mm, such as 20-40 mm.

[0044] The top wall of the cooling box of the fourth aspect may be a lid allowing the cooling box to be opened.

[0045] The cooling device of the cooling system of the fourth aspect may for example be the cooling device of the first aspect (see above). Likewise, the cooling box of the cooling system of the fourth aspect may for example be the cooling box according to the second aspect (see above).

[0046] In embodiments of the fourth aspect, the cooling system further comprises a separate heating device adapted to receive the cooling device and heat the reactor while the chamber is in contact with a cooling source, such as ambient air. Such a heating device may comprise recesses adapted to receive the cooling device. The heating device of the fourth aspect may for example be a cooker adapted to simultaneously heat a cooking utensil and the reactor of the cooling device. Thus, waste heat from the cooking may be recovered. Alternatively, the heating device is an arrangement adapted to exclusively regenerate one or more cooling devices. Such an arrangement may for example be a central unit adapted to regenerate cooling devices from several users/families. The central unit may use locally available fuel, such as biomass (e.g. wood) or locally produced biogas.

[0047] When the reactor of the cooling device of the fourth aspect extends in a first plane and the chamber of the cooling device of the fourth aspect extends in a second plane, which is approximately parallel to the first plane and the cooling device is received by the burner, the planes are preferably approximately horizontal and/or the first plane is preferably located above the second plane. Thus, the reactor in the first plane may be placed closer to the heat source than the chamber in the second plane, which ends up in a position below the heat source. The heating device of the fourth aspect may comprise a burner. Thus the reactor may be located closer to a flame of the burner than the chamber when the cooling device is received by the heating device. The burner may be a liquid fuel burner. The liquid fuel may be methanol or ethanol, which may be obtained from renewable resources. Further, methanol may be produced from waste streams in the oil industry. The heating device may for example comprise a detachable and replaceable fuel canister.

[0048] The heating device of the cooling system of the fourth aspect may for example be the cooker according to the third aspect.

[0049] The invention will now be described more fully hereinafter with reference to the accompanying drawings, in which certain embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth below; rather, these embodiments are provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout the description.

[0050] A cooker according to the present disclosure is shown in Fig. 1. The cooker comprises a bottomless frame 10. This frame may be manufactured in one piece, preferably by deep drawing, and consists of for instance stainless steel in order to withstand corrosion as far as possible. The frame may also consist of aluminum. The frame may at its lower part rest on an outwardly flanged foot portion 11 and has a surrounding mainly vertical wall 12 continuing into a horizontal hob 13. The hob 13 may comprise a recess 14 adapted to receive the chamber of a cooling device of the present disclosure. The recess is preferably circular. When chamber is received by the recess, the frame may function as a cooling element for the chamber. The side portions of the vertical wall 12 may have several small openings 12a through which combustion air may flow into the frame. Cooking utensil supports 15 are arranged on the upper side of the hob 13. The cooking utensil supports in Fig. 1 comprise three radially (with respect to the burner) directed plates. However, it may instead comprise four, five or six radially directed plates. The upper edge of each plate comprises a recess 16 adapted to receive the reactor of a cooling device of the present disclosure.

[0051] A burner tube 17 is arranged centrally in the frame. Above the burner tube 17, a flame spreader 18 is arranged. The flame spreader 18 comprises a U- or Ω-shaped strip for securing to the hob 13 of the frame 10.

[0052] A wind protector 19 is arranged around the burner tube 17, preferably outside the cooking utensil supports 15. The wind protector may be a circular plate, which may be perforated. The upper edge of the wind protector may comprise a recess 19a adapted to receive the connection of a cooling device of the present disclosure.

[0053] Fig. 2a-2c shows various embodiments of a cooling device according to the present disclosure. A reactor 21 comprising a sorbent extends in a first plane and the chamber 22 for condensation and evaporation of a fluid extends in a second plane, which is approximately parallel to and below the first plane. In the first plane, the reactor defines a first area A1, which is smaller than a second area A2 defined by the chamber in the second plane (see e.g. 2a: vi and 2c: v).

[0054] The reactor 21 and the chamber 22 is connected by a connection 23, in which a valve 24 may be arranged (see 2a: i, ii and iii; 2b: i and ii; and 2c: i, ii and iv). The valve 24 may be opened and closed by hand.

[0055] The cross section of the reactor 21 and/or the chamber 22 may for example be circular 25 or oval 26.

[0056] The cooling device may comprise one or more handles 27, which may be provided on the chamber 22 such that the cooling device may be conveniently put in place and removed (e.g. from the cooker) using two hands. Thus, the handles 27 may radially extend from the chamber.

[0057] The reactor 21 may form a full ring (see 2a: i, ii, iv and v; and 2c: i, ii and iii). The ring-shaped reactor may be circular (see 2a: i, ii, iv and v) or oval (see 2c: i, ii and iii). Alternatively, the reactor 21 may form an interrupted ring/claw (see 2a: iii, vi and vii; and 2c: iv and v). The ring-shaped reactor may be circular (see 2a: iii, vi and vii) or oval (see 2c: iv and v).

[0058] The chamber 22 is preferably circular. The circular chamber may form a full ring (see 2a: i, ii, iv and v; and 2c: i, ii, and iii). Alternatively, the circular chamber forms an interrupted ring/claw (see 2a: iii, vi and vii; and 2c: iv and v).

[0059] The rings of the reactor and the chamber are preferably concentric such that they have a common central point. The connection 23 may be designed to connect the shortest distance between the reactor 21 and the chamber 22 (see 2a: i, ii, iii, iv and vi; 2b and 2c). In such case, the connection may be a straight tube. However, to reduce the necessary depth of the groove in the cooling box that receives the cooling device, the connection may have an alternative shape, such as an L-shape (e.g. one right angle, see 2a: v) or an U-shape (e.g. two right angles, see 2a: vii). The connection may also be curved (not shown).

[0060] The cooling device may also consist of a single tube bent and curved to form the circular reactor in the first plane and the circular chamber in the second plane (see 2b).

[0061] Fig. 3a shows a cooling box 30 according to the present disclosure comprising four side walls 31 and a lid 32. A groove 33 is provided in the upper edge of one of the side walls 31. The groove 33 is adapted to receive the connection 23 of the cooling device 20. The width (w) of the wall at the groove is approximately the same as the distance (d) between the reactor 21 and the chamber 22 in the cooling device 20.

[0062] Fig. 3b shows another cooling box 34 according to the present disclosure comprising four side walls 35 and a lid 36. A groove 37 is provided in an edge of the lid 36. The groove 37 is adapted to receive the connection 23 of the cooling device. Further, an elevation 38 is provided at the top of the lid 36. The elevation 38 is tapering towards the groove 37. At the top of the elevation 38, a recess 39 is provided such that the cooling device 20 may be locked in a received position.

[0063] The thickness/width (w) of the lid at the groove 37 is approximately the same as the distance (d) between the reactor 21 and the chamber 22 in the cooling device 20. However, the thickness/width (w') of the lid 36 at the top of the elevation 38 is greater than the distance (d) between the reactor 21 and the chamber 22 in the cooling device 20.

[0064] Fig 4 shows a cooking utensil/pot 41 placed on the cooker, such that the pot 41 may be heated by a flame 40 of the cooker. In Fig. 4, the cooling device 20 is simultaneously regenerated by the cooker. Heat from the flame 40 is transferred to the cooling device's reactor 21, which is received by the recesses 16 in the cooking utensil supports 15. The depth of the recesses 16 is such that a small space is left between the bottom of the pot 41 and the top of the reactor 21. Flue gases may thus flow between the bottom of the pot 41 and the top of the reactor 21 when the flame 40 is burning. The connection 23 of the cooling device is received by the recess 19a in the wind protector 19. Also, the chamber 22 of the cooling device is received by the recess 14 in the hob 13.

Claims

1. A portable cooling device comprising a fluid, a reactor containing a sorbent capable of sorption and desorption of the fluid and a chamber for condensation and evaporation of the fluid, said reactor and said chamber being connected such that the fluid may flow between them, wherein the reactor extends in a first plane and the chamber extends in a second plane, which is approximately parallel to the first plane.

2. The cooling device of claims 1, wherein the reactor is elongated and/or the chamber is elongated.

3. The cooling device of claim 2, wherein the elongated reactor is curved or bent such that it is adapted to at least partly encircle a heat source, such as a flame, for heating the reactor and the elongated chamber is curved or bent such that it is adapted to at least partly encircle a burner providing a flame.

4. The cooling device of claims 3, wherein the reactor and/or the chamber is/are ring-shaped.

5. An openable cooling box comprising insulating walls forming an interior space for cooling, wherein a portion of a wall of the cooling box is adapted to receive a portable cooling device comprising
a reactor extending in a first plane,
an evaporation and condensation chamber extending in a second plane, which is approximately parallel to the first plane and
a connection between the reactor and the chamber, such that, in a closed configuration of the cooling box, heat may be transferred from the interior space to the chamber and from the reactor to an exterior cooling source, such as ambient air,
wherein the wall portion comprises a groove extending from an edge of the wall into the wall, said groove being adapted to receive the connection such that the chamber is located inside the cooling box and the reactor is located outside the cooling box in the closed configuration and
wherein the wall portion has a reduced thickness compared to the rest of the wall.

6. The cooling box according to claim 5, wherein the wall portion comprises an elevation extending from the plane of the wall and a recess adapted to receive part of the reactor is provided at the top of the elevation such that the cooling device may be locked in a received position.

7. The cooling box according to claim 6, wherein a part of the elevation between the recess and the edge from which the groove extends is tapering towards the edge from which the groove extends.

8. The cooling box of any one of claims 5-7, wherein an edge of a second wall comprises a second groove that meets the groove of the wall in the closed configuration and forms a common receiving space for the cooling device.

9. A cooker adapted to receive a portable cooling device comprising
a reactor extending in a first plane,
an evaporation and condensation chamber extending in a second plane, which is approximately parallel to the first plane and
a connection between the reactor and the chamber, said cooker comprising a metal frame having mainly vertical walls continuing into a mainly horizontal hob, the frame enclosing a burner and being adapted to enclose a fuel container, wherein the frame is a bottomless frame formed of one piece so as to allow replacing of the fuel canister from the bottom side of the frame, said cooker further comprising one or several cooking utensil supports having an upper edge for supporting a cooking utensil in a position above the burner, the upper edge being provided with at least one recess for receiving the reactor of the cooling device.

10. The cooker of claims 9, wherein at least one hob recess is provided in the hob to receive the chamber.

11. A cooling system, comprising:

a portable cooling device comprising a fluid, a reactor containing a sorbent capable of sorption and desorption the fluid and a chamber for condensation and evaporation of the fluid, said reactor and said chamber being connected such that the fluid may flow between them; and
an openable cooling box comprising insulating walls forming an interior space for cooling, said cooling box being adapted to receive the cooling device such that, in a closed configuration of the cooling box, heat may be transferred from the interior space to the chamber and from the reactor to an exterior cooling source, such as ambient air.

12. The cooling system of claim 11, wherein the reactor extends in a first plane and the chamber extends in a second plane, which is approximately parallel to the first plane and the distance between the reactor and the chamber in the direction perpendicular to the planes is approximately the same as the thickness of a wall portion of the cooling box adapted to receive the cooling device.

13. The cooling system of claim 11 or 12, wherein the cooling device is the cooling device according to anyone of claims 1-4 and/or the cooling box is the cooling box according to anyone of claims 5-8.

14. The cooling system of any one of the preceding claims, further comprising a separate heating device adapted to receive the cooling device and heat the reactor while the chamber is in contact with a cooling source, such as ambient air.

15. The cooling system of claims 14, wherein the heating device is the cooker according to claim 9 or 10.

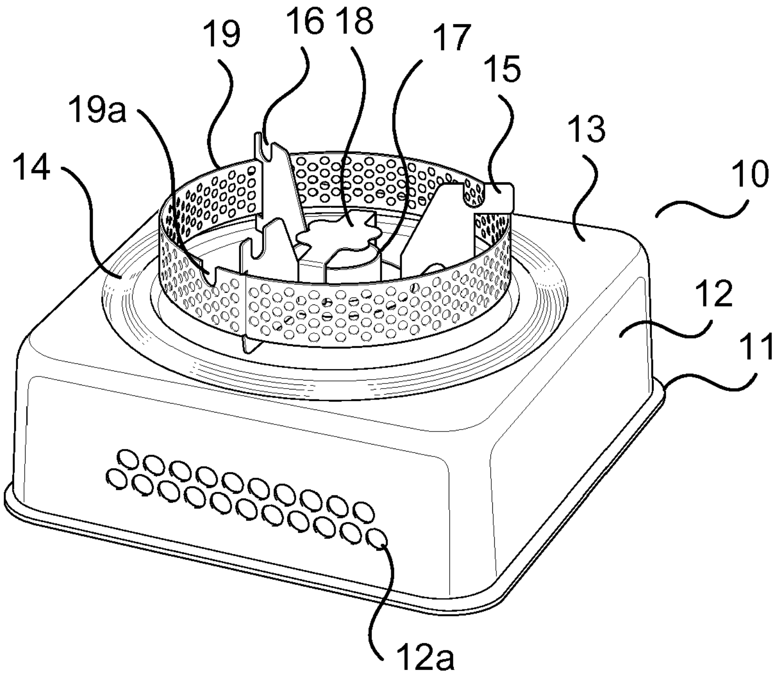


Fig. 1

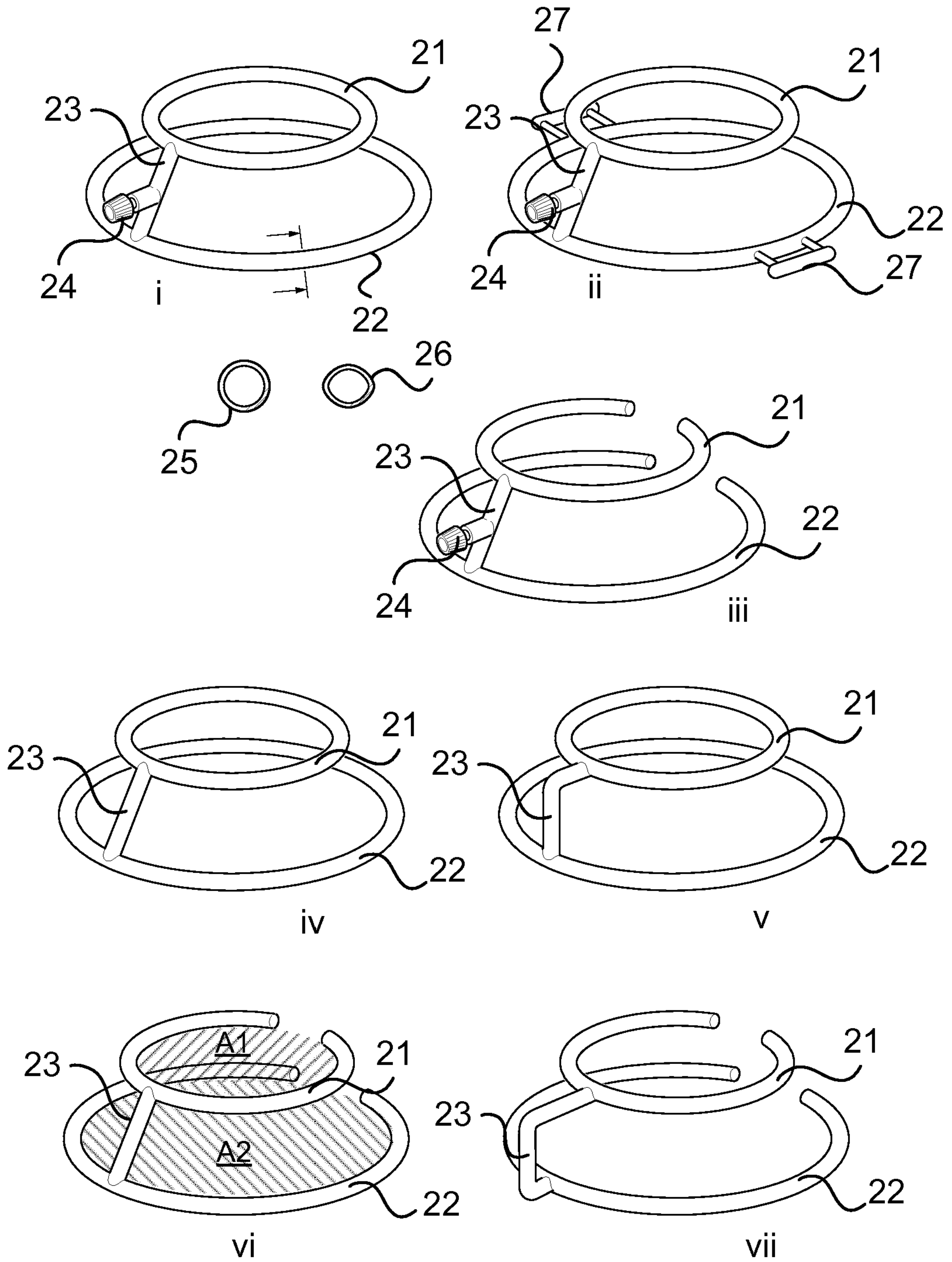

21
23
24
i
22
27
21
23
22
24
ii
27
26
25
21
23
22
24
iii
23
21
22
iv
21
23
22
v
A1
23
21
A2
22
vi
21
23
22
vii

Fig. 2a

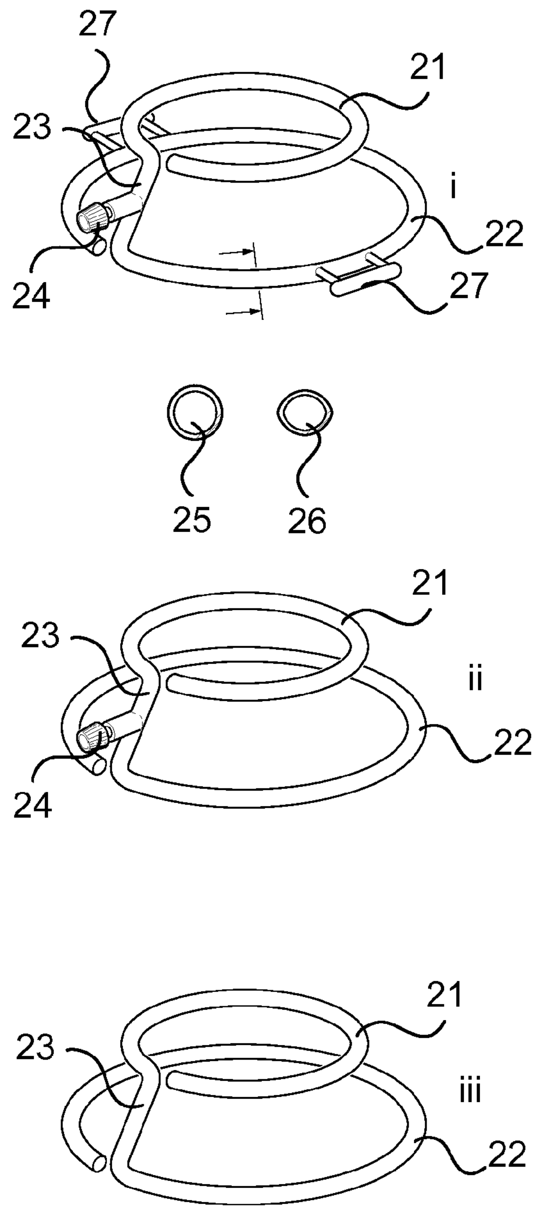


Fig. 2b

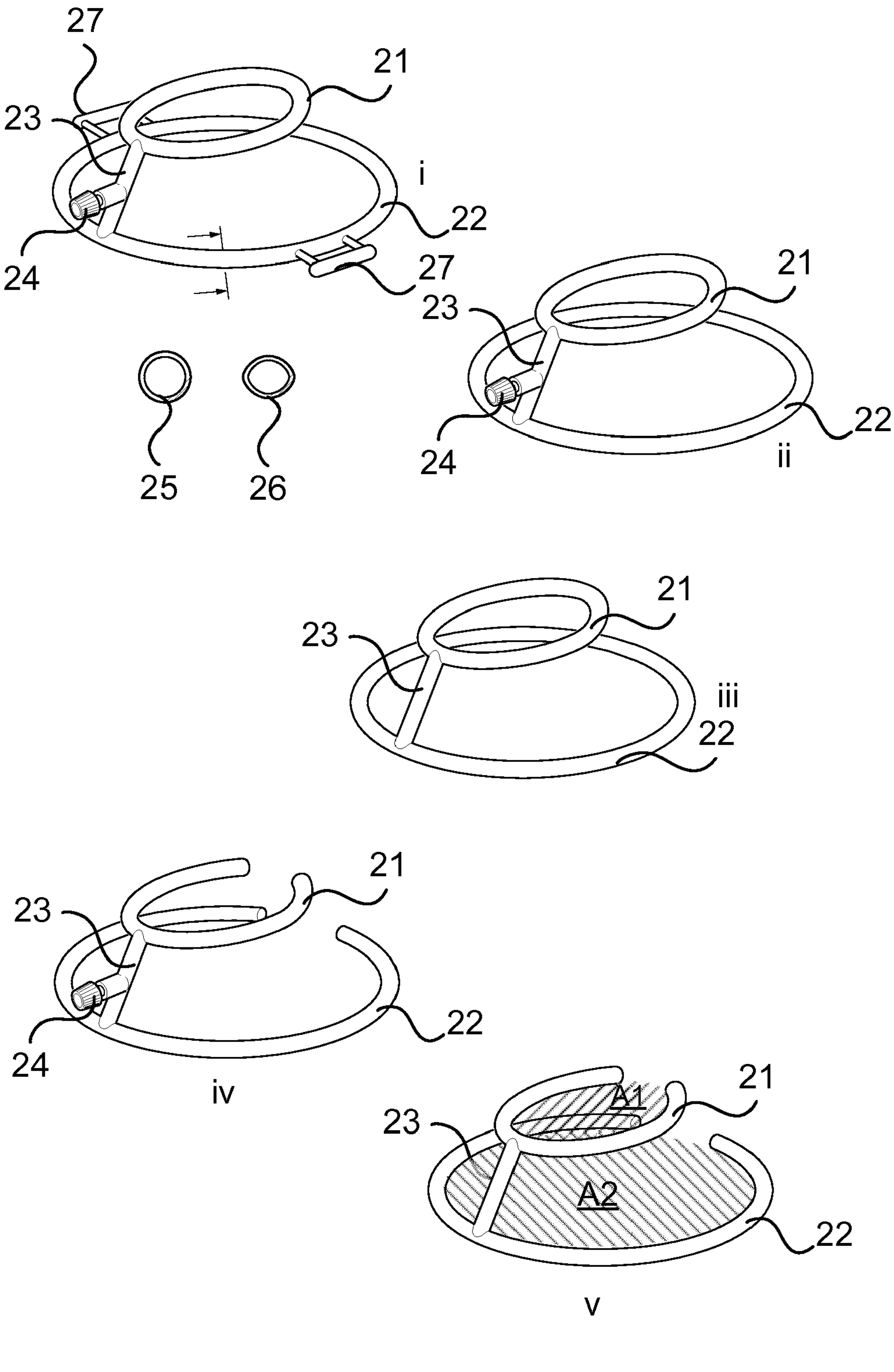
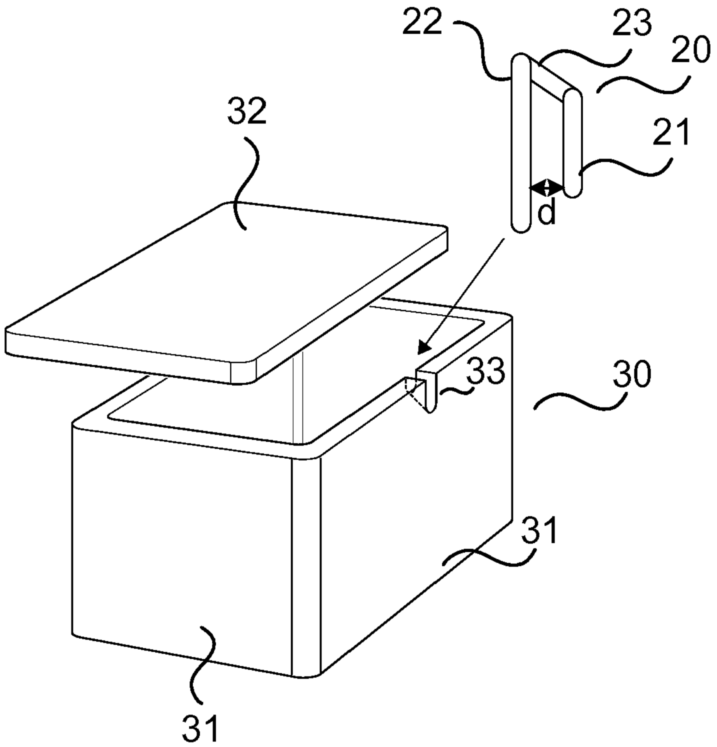

27
21
23
i
22
24
27
21
23
24
22
25
26
ii
21
23
iii
22
21
23
24
22
iv
21
A1
23
A2
22
v

Fig. 2c



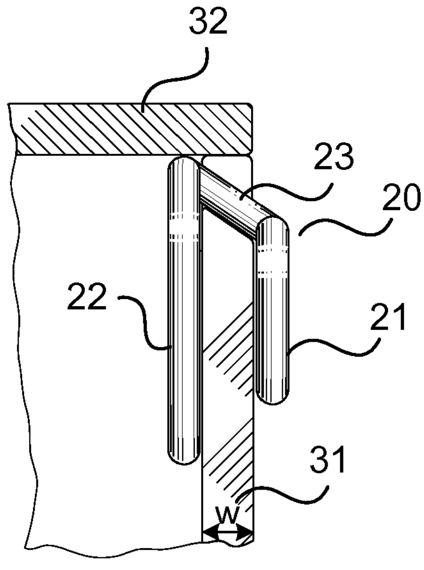
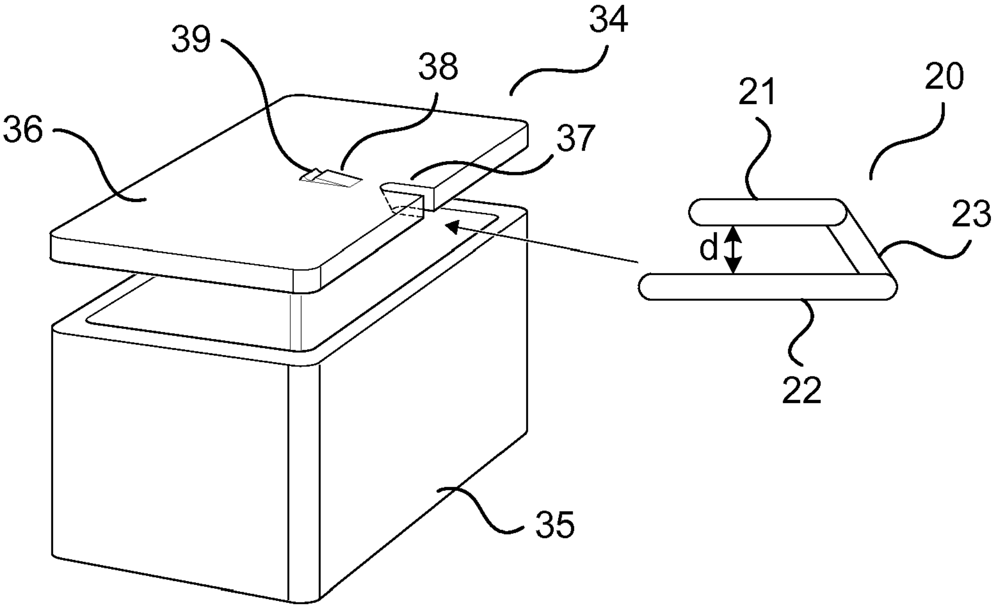


Fig. 3a



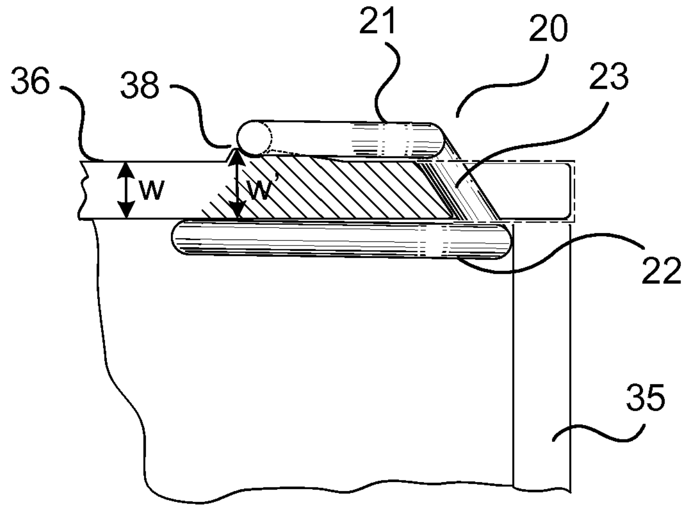


Fig. 3b

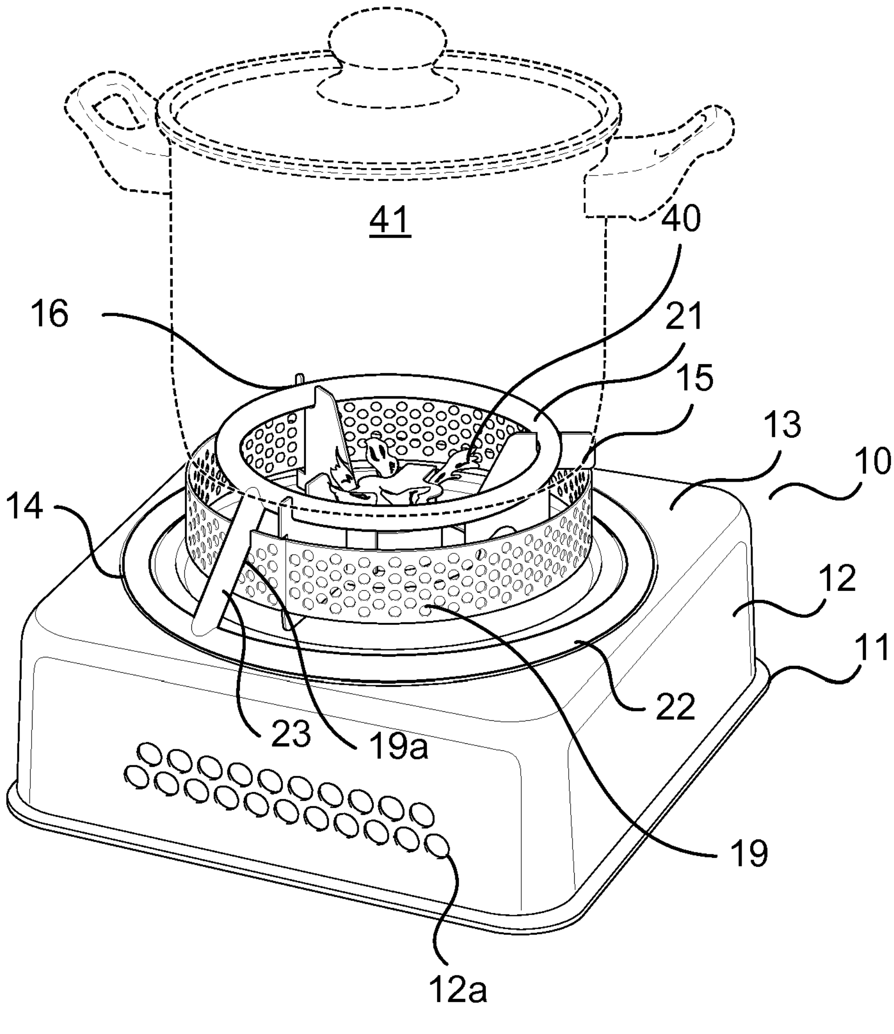


Fig. 4

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 13 15 7108

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	JP 2008 215808 A (ZEOLITH TECH) 18 September 2008 (2008-09-18) * the whole document * -----	1,5-8, 11-14 2-4	INV. F25B17/08
Y	US 4 205 531 A (BRUNBERG ERNST-AKE [SE] ET AL) 3 June 1980 (1980-06-03) * figures 1,2,4 * -----	2-4	
X	US 4 752 310 A (MAIER-LAXHUBER PETER [DE] ET AL) 21 June 1988 (1988-06-21) * figures 1-3 * -----	1,5,11	
X	US 4 993 239 A (STEIDL GARY V [US] ET AL) 19 February 1991 (1991-02-19) * figure 1 * -----	1	

TECHNICAL FIELDS SEARCHED (IPC)

F25B
F25D

1

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
The Hague	19 June 2013	Kuljis, Bruno

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
European Patent Office
Office européen des brevets

Application Number

EP 13 15 7108

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-8, 11-14

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

Europäisches Patentamt
European Patent Office
Office européen des brevets

LACK OF UNITY OF INVENTION SHEET B

Application Number
EP 13 15 7108

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-8, 11-14

   A portable cooling device, with a reactor for sorption and desorption of a sorbent and a chamber for condensation and evaporation of a fluid, and an openable cooling box.

   ---

2. claims: 9, 10, 15

   A cooker comprising a metal frame enclosing a burner, several cooking utensil supports and recess for a reactor.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 15 7108

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

19-06-2013

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2008215808 A	18-09-2008	EP 1967799 A2	10-09-2008
		JP 5294655 B2	18-09-2013
		JP 2008215808 A	18-09-2008
		SG 145659 A1	29-09-2008
		US 2008216508 A1	11-09-2008
US 4205531 A	03-06-1980	AU 522354 B2	03-06-1982
		AU 3670378 A	06-12-1979
		BR 7803447 A	10-07-1979
		DE 2823563 A1	14-12-1978
		FR 2393246 A1	29-12-1978
		GB 1594307 A	30-07-1981
		JP S53148753 A	25-12-1978
		SE 7706357 A	01-12-1978
		US 4205531 A	03-06-1980
US 4752310 A	21-06-1988	DE 3425419 A1	23-01-1986
		DE 8420664 U1	22-03-1990
		EP 0167989 A2	15-01-1986
		JP S61153342 A	12-07-1986
		US 4752310 A	21-06-1988
US 4993239 A	19-02-1991	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 0037864 A **[0010]**
- US 20090249825 A **[0010]**
- WO 02084175 A **[0034]**
- WO 2008058566 A **[0035]**

Non-patent literature cited in the description

- A Silent Killer of Rural Women in India. *BBC report,* 2005 **[0003]**