Claims:

1. A heat transfer device comprising:
a fluid flow means extending between a first surface and a second surface, at least a part of the fluid flow means being inclined to the horizontal;
the fluid flow means being partially filled with a liquid and being arranged so that the first surface is in thermal contact with the liquid in at least a first part of the fluid flow means inclined to the horizontal and containing the liquid; and
the first part of the fluid flow means being divided into a first fluid flow channel and a second fluid flow channel arranged so that the liquid in the first fluid flow channel is in better thermal contact with the first surface than the liquid in the second fluid flow channel;
wherein the part of the fluid flow means above the surface of the liquid is at least partially evacuated;
whereby, when the first surface is hotter than the second surface, heat energy from the first surface causes the liquid in the first fluid flow channel to vaporize, and the vapor travels through the liquid in the first fluid flow channel to the surface of the liquid, such that the liquid circulates around the first fluid flow channel and the second fluid flow channel;
vapor travels from the surface of the liquid to the second surface and condenses at the second surface; and
condensed liquid returns from the second surface to the first part of the fluid flow means;
whereby heat energy is transported from the first surface to the second surface.

2. A heat transfer device according to claim 1, wherein the first fluid flow channel is closer to the first surface than the second fluid flow channel.

3. A heat transfer device according to claim 1 or claim 2, wherein at least a part of the first fluid flow channel is located between the first surface and the second fluid flow

channel.

4. A heat transfer device according to claim 3, wherein the first fluid flow channel lies between the first surface and the second fluid flow channel.

5. A heat transfer device according to any preceding claim, wherein each of the first and second fluid flow channels has a section bounded by a perimeter, and a proportion of the perimeter of the first fluid flow channel which is in thermal contact with the first surface is greater than a proportion of the perimeter of the second fluid flow channel which is in thermal contact with the first surface.

6. A heat transfer device according to any preceding claim, wherein the cross sectional area of the first fluid flow channel and the cross sectional area of the second fluid flow channel are equal.

7. A heat transfer device according to any preceding claim, wherein the first fluid flow channel is in thermal contact with the first surface across a greater area than the second fluid flow channel.

8. A heat transfer device according to any preceding claim, wherein the first part of the fluid flow means is inclined to the horizontal by an angle of up to 90^0.

9. A heat transfer device according to any preceding claim, wherein at least a portion of at least one surface of the first fluid flow channel in thermal contact with the first surface comprises features arranged to promote vapor bubble nucleation.

10. A heat transfer device according to any preceding claim, wherein at least a portion of at least one surface of the first fluid flow channel in thermal contact with the first surface has a surface texture adapted to promote vapor bubble nucleation.

11. A heat transfer device according to claim 10, wherein said portion of at least one surface has a roughened surface texture.

12 A heat transfer device according to claim 11, wherein the roughened surface texture is provided by a solder layer.

13. A heat transfer device according to any preceding claim, wherein the first part of the fluid flow means is divided into a plurality of first fluid flow channels.

14. A heat transfer device according to claim 13, wherein the first part of the fluid flow means is divided into a plurality of first fluid flow channels and a plurality of second fluid flow channels.

15. A heat transfer device according to claim 14, wherein the number of first fluid flow channels is the same as the number of second fluid flow channels.

16. A heat transfer device according to claim 14 or claim 15, wherein the first and second fluid flow channels are located side by side with first fluid flow channels and second fluid flow channels interleaved.

17. A heat transfer device according to any preceding claim, wherein the or each first and second fluid flow channel has an upper end and a lower end, and the lower ends of the first and second fluid flow channels are connected together.

18. A heat transfer device according to any preceding claim, wherein the or each first and second fluid flow channel has an upper end and a lower end, and the upper ends of the first and second fluid flow channels are connected together.

19. A heat transfer device according to claim 18, wherein the upper ends of the first and second fluid flow channels are connected together by a manifold.

20. A heat transfer device according to claim 19, wherein the upper ends of the first and second fluid flow channels are connected together by a vapor manifold.

21. A heat transfer device according to claim 20, wherein vapor traveling from the surface of the liquid to the second surface passes through the manifold.

22. A heat transfer device according to claim 21, wherein condensed liquid returning from the second surface to the first part of the fluid flow means passes through the manifold.

23. A heat transfer device according to any preceding claim, wherein the liquid comprises water.

24. A heat transfer device according to any one of claims 1 to 22, wherein the liquid comprises ethanol.

25. A heat transfer device according to any preceding claim, wherein the liquid comprises a mixture of water and ethanol.

26. A heat transfer device according to claim 25, wherein the mixture comprises up to 25% ethanol.

27. A heat transfer device according to any preceding claim, wherein the second surface is located above the first surface such that the condensed liquid returns from the second surface to the first part of the fluid flow means by gravity.

28. A heat transfer device according to any preceding claim, wherein at least a portion of a surface of the first fluid flow channel in thermal contact with the first surface has a dimpled surface profile.

29. A heat transfer device according to claim 28, wherein the dimpled surface profile comprises a regular array of dimples.

30. A heat transfer device according to claim 29, wherein the regular array of dimples comprises dimples arranged in rows separated by flat strips without dimples.

31. A heat transfer device according to any preceding claim, wherein the first and second fluid flow channels are located between first and second spaced apart plates.

32. A heat transfer device according to claim 31, wherein the first plate is in thermal contact with the first surface and forms a surface of the or each first fluid flow channel.

33. A heat transfer device according to claim 32, wherein there are a plurality of first fluid flow channels and a plurality of second fluid flow channels located side by side with first fluid flow channels and second fluid flow channels arranged alternately, and each first fluid flow channel is separated from an adjacent second fluid flow channel by a partition extending between and attached to the first plate and the second plate.

34. A heat transfer device according to claim 33, wherein the first plate has a dimpled surface profile comprising a regular array of dimples arranged in rows separated by flat strips without dimples, and each partition is attached to the first plate at a position located in one of the flat strips.

35. A heat transfer device according to claim 34, wherein the part of each partition extending between the first plate and the second plate is substantially flat.

36. A heat transfer device according to claim 34 or claim 35, wherein a plurality of the partitions are formed by a third plate.

37. A heat transfer device according to claim 36, wherein all of the partitions are formed

by a single third plate.

38. A heat transfer device according to claim 36 or claim 37, wherein the third plate is corrugated.

39. A heat transfer device according to any one of claims 31 to 38, wherein each of the plates comprises a metal or a metal alloy material.

40. A heat transfer device according to claim 39, wherein each of the plates comprises mild steel.

41. A heat transfer device according to claim 40, wherein each of the plates comprises tin coated mild steel.

42. A heat transfer device according to any one of claims 31 to 38, wherein the plates are bonded together by a bonding technique including at least one of: soldering; spot welding; roller welding; and an adhesive.

43. A heat transfer device according to claim 42, wherein the plates are bonded together by solder joints and at least a part of the first plate forming a surface of each first fluid flow channel is coated with solder.

44. A heat transfer device according to any preceding claim, wherein the heat transfer device comprises a substantially rigid heat conducting structure.

45. A heat transfer device according to any preceding claim, wherein the part of the fluid flow means above the surface of the liquid is at a pressure of 40mbar or less.

46. A heat transfer device according to claim 45, wherein the part of the fluid flow means above the surface of the liquid is at a pressure of 2 mbar or less.

47. A heat transfer device according to claim 46, wherein the part of the fluid flow means above the surface of the liquid is at a pressure of 1 mbar or less.

48. A heat transfer device according to claim 47, wherein the part of the fluid flow means above the surface of the liquid is at a pressure of 10^{-2} mbar or less.

49. A heat transfer device according to claim 48, wherein the part of the fluid flow means above the surface of the liquid is at a pressure of 10^{-3} mbar or less.

50. A heat transfer device according to claim 49, wherein the part of the fluid flow means above the surface of the liquid is at a pressure of 10^{-6} mbar or less.

51. A heat transfer device comprising:
a first fluid flow channel inclined to the horizontal and containing a liquid;
a second fluid flow channel connected to the first fluid flow channel and containing the liquid; and
a first surface in thermal contact with the liquid in the first fluid flow channel;
wherein heat energy from the first surface causes liquid in the first fluid flow channel to vaporize;
the vapor travels upwardly along the first fluid flow channel; and
the vapor drives a flow of liquid from the second fluid flow channel to the first fluid flow channel and upwardly along the first fluid flow channel;
whereby heat energy is transported away from the first surface.

52. A heat transfer device according to claim 51, wherein the first fluid flow channel is closer to the first surface than the second fluid flow channel.

53. A heat transfer device according to claim 51 or claim 52, wherein at least a part of the first fluid flow channel is located between the first surface and the second fluid flow

channel.

54. A heat transfer device according to claim 53, wherein the first fluid flow channel lies between the first surface and the second fluid flow channel.

55. A heat transfer device according to any one of claims 51 to 54, wherein each of the first and second fluid flow channels has a section bounded by a perimeter, and a proportion of the perimeter of the first fluid flow channel which is in thermal contact with the first surface is greater than a proportion of the perimeter of the second fluid flow channel which is in thermal contact with the first surface.

56. A heat transfer device according to any one of claims 51 to 55, wherein the cross sectional area of the first fluid flow channel and the cross sectional area of the second fluid flow channel are equal.

57. A heat transfer device according to any one of claims 51 to 56, wherein the cross sectional area of the first fluid flow channel and the cross sectional area of the second fluid flow channel are equal.

58. A heat transfer device according to any one of claims 51 to 57, wherein the first fluid flow channel is in thermal contact with the first surface across a greater area than the second fluid flow channel.

59. A heat transfer device according to any one of claims 51 to 57, wherein the first fluid flow channel is inclined to the horizontal by an angle of up to 90^0.

60. A heat transfer device according to any one of claims 51 to 59, wherein at least a portion of at least one surface of the first fluid flow channel in thermal contact with the first surface comprises features arranged to promote vapor bubble nucleation.

61. A heat transfer device according to any one of claims 51 to 60, wherein at least a portion of at one surface of the first fluid flow channel in thermal contact with the first surface has a surface texture adapted to promote vapor bubble nucleation.

62. A heat transfer device according to claim 61, wherein said portion of at least one surface has a roughened surface texture.

63. A heat transfer device according to claim 62, wherein the roughened surface texture is provided by a solder layer.

64. A heat transfer device according to any one of claims 51 to 63, wherein the heat transfer device comprises a plurality of first fluid flow channels.

65. A heat transfer device according to claim 64, wherein the heat transfer device comprises a plurality of first fluid flow channels and a plurality of second fluid flow channels.

66. A heat transfer device according to claim 65, wherein the number of first fluid flow channels is the same as the number of second fluid flow channels.

67. A heat transfer device according to claim 66 or claim 66, wherein the first and second fluid flow channels are located side by side with first fluid flow channels and second fluid flow channels interleaved.

68. A heat transfer device according to any one of claims 51 to 67, wherein the or each first and second fluid flow channel has an upper end and a lower end, and the lower ends of the first and second fluid flow channels are connected together.

69. A heat transfer device according to any one of claims 51 to 68, and further comprising:

a second surface;

at least one vapor channel connecting the first and second fluid flow channels to the second surface;

whereby, when the first surface is hotter than the second surface, vapor travels from a surface of the liquid to the second surface through the vapor channel and condenses at the second surface; and

condensed liquid returns from the second surface to the first and second fluid flow channels;

whereby heat energy is transported away from the first surface to the second surface.

70. A heat transfer device according to claim 69, wherein the or each first and second fluid flow channel has an upper end and a lower end, and the upper ends of the first and second fluid flow channels are connected together.

71. A heat transfer device according to claim 70, wherein the upper ends of the first and second fluid flow channels are connected together by a manifold.

72. A heat transfer device according to claim 71, wherein the upper ends of the first and second fluid flow channels are connected together by a vapor manifold.

73. A heat transfer device according to claim 72, wherein vapor traveling from the surface of the liquid to the second surface passes through the manifold.

74. A heat transfer device according to claim 73, wherein condensed liquid returning from the second surface to the first part of the fluid flow means passes through the manifold.

75. A heat transfer device according to any one of claims 51 to 74, wherein the liquid comprises water.

76. A heat transfer device according to any one of claims 51 to 74, wherein the liquid

comprises ethanol.

77. A heat transfer device according to any one of claims 51 to 76, wherein the liquid comprises a mixture of water and ethanol.

78. A heat transfer device according to claim 77, wherein the mixture comprises up to 25% ethanol.

79. A heat transfer device according to any one of claims 51 to 78, wherein the second surface is located above the first surface such that the condensed liquid returns from the second surface to the first part of the fluid flow means by gravity.

80. A heat transfer device according to any one of claims 51 to 79, wherein at least a portion of a surface of the first fluid flow channel in thermal contact with the first surface has a dimpled surface profile.

81. A heat transfer device according to claim 80, wherein the dimpled surface profile comprises a regular array of dimples.

82. A heat transfer device according to claim 81, wherein the regular array of dimples comprises dimples arranged in rows separated by flat strips without dimples.

83. A heat transfer device according to any one of claims 51 to 82, wherein the first and second fluid flow channels are located between first and second spaced apart plates.

84. A heat transfer device according to claim 83, wherein the first plate is in thermal contact with the first surface and forms a surface of the or each first fluid flow channel.

85. A heat transfer device according to claim 84, wherein there are a plurality of first fluid flow channels and a plurality of second fluid flow channels located side by side with

first fluid flow channels and second fluid flow channels interleaved, and each first fluid flow channel is separated from an adjacent second fluid flow channel by a partition extending between and attached to the first plate and the second plate.

86. A heat transfer device according to claim 85, wherein the first plate has a dimpled surface profile comprising a regular array of dimples arranged in rows separated by flat strips without dimples, and each partition is attached to the first plate at a position located in one of the flat strips.

87. A heat transfer device according to claim 86, wherein the part of each partition extending between the first plate and the second plate is substantially flat.

88. A heat transfer device according to claim 86 or claim 87, wherein a plurality of the partitions are formed by a third plate.

89. A heat transfer device according to claim 88, wherein all of the partitions are formed by a single third plate.

90. A heat transfer device according to claim 88 or claim 89, wherein the third plate is corrugated.

91. A heat transfer device according to any one of claims 83 to 90, wherein each of the plates comprises a metal or a metal alloy material.

92. A heat transfer device according to claim 91, wherein each of the plates comprises mild steel.

93. A heat transfer device according to claim 92, wherein each of the plates comprises tin coated mild steel.

94. A heat transfer device according to any one of claims 83 to 93, wherein the plates are bonded together by a bonding technique including at least one of: soldering; spot welding; roller welding; and an adhesive.

95. A heat transfer device according to claim 94, wherein the plates are bonded together by solder joints and at least a part of the first plate forming a surface of each first fluid flow channel is coated with solder.

96. A heat transfer device according to any one of claims 51 to 95, wherein the heat transfer device comprises a substantially rigid heat conducting structure.

97. A heat transfer device according to any one of claims 51 to 96, wherein the heat transfer device above the liquid is at least partially evacuated.

98. A heat transfer device according to claim 97, wherein the heat transfer device above the liquid is at a pressure of 40mbar or less.

99. A heat transfer device according to claim 98, wherein the heat transfer device above the liquid is at a pressure of 2 mbar or less.

100. A heat transfer device according to claim 99, wherein the heat transfer device above the liquid is at a pressure of 1 mbar or less.

101. A heat transfer device according to claim 100, wherein the heat transfer device above the liquid is at a pressure of 10^{-2} mbar or less.

102. A heat transfer device according to claim 101, wherein the heat transfer device above the liquid is at a pressure of 10^{-3} mbar or less.

103. A heat transfer device according to claim 102, wherein the heat transfer device above

the liquid is at a pressure of 10^{-6} mbar or less.

104. A heat transfer device comprising:
a first surface;
a second surface;
a liquid reservoir in thermal contact with the first surface and containing a liquid; and
a tube connecting the liquid reservoir to the second surface;
wherein the liquid reservoir comprises a first fluid flow channel inclined to the horizontal and containing the liquid and a second fluid flow channel connected to the first fluid flow channel and containing the liquid;
the first surface is in thermal contact with the liquid in the first fluid flow channel; and
at least a part of the tube is at least partially evacuated;
whereby, when the first surface is hotter than the second surface, heat energy from the first surface causes liquid in the first fluid flow channel to vaporize;
the vapor travels upwardly along the first fluid flow channel and through the tube, and condenses at the second surface;
the vapor drives a flow of liquid from the second fluid flow channel to the first fluid flow channel and upwardly along the first fluid flow channel; and
condensed liquid returns from the second surface to the liquid reservoir;
whereby heat energy is transported away from the first surface to the second surface.

105. A heat transfer device according to claim 104, wherein the first fluid flow channel is closer to the first surface than the second fluid flow channel.

106. A heat transfer device according to claim 104 or claim 105, wherein at least a part of the first fluid flow channel is located between the first surface and the second fluid flow channel.

107. A heat transfer device according to claim 106, wherein the first fluid flow channel lies

between the first surface and the second fluid flow channel.

108. A heat transfer device according to any one of claims 104 to 107, wherein each of the first and second fluid flow channels has a section bounded by a perimeter, and a proportion of the perimeter of the first fluid flow channel which is in thermal contact with the first surface is greater than a proportion of the perimeter of the second fluid flow channel which is in thermal contact with the first surface.

109. A heat transfer device according to any one of claims 104 to 108, wherein the cross sectional area of the first fluid flow channel and the cross sectional area of the second fluid flow channel are equal.

110. A heat transfer device according to any one of claims 104 to 109, wherein the first fluid flow channel is in thermal contact with the first surface across a greater area than the second fluid flow channel.

111. A heat transfer device according to any one of claims 104 to 110, wherein the first fluid flow channel is inclined to the horizontal by an angle of up to 90^0.

112. A heat transfer device according to any one of claims 104 to 111, wherein at least a portion of at least one surface of the first fluid flow channel in thermal contact with the first surface comprises features arranged to promote vapor bubble nucleation.

113. A heat transfer device according to any one of claims 104 to 112, wherein at least a portion of at least one surface of the first fluid flow channel in thermal contact with the first surface has a surface texture adapted to promote vapor bubble nucleation.

114. A heat transfer device according to claim 113, wherein said portion of at least one surface has a roughened surface texture.

115 A heat transfer device according to claim 114, wherein the roughened surface texture is provided by a solder layer.

116. A heat transfer device according to any one of claims 104 to 115, wherein the liquid resevoir comprises a plurality of first fluid flow channels.

117. A heat transfer device according to claim 116, wherein the first part of the fluid flow means is divided into a plurality of first fluid flow channels and a plurality of second fluid flow channels.

118. A heat transfer device according to claim 117, wherein the number of first fluid flow channels is the same as the number of second fluid flow channels.

119. A heat transfer device according to claim 117 or claim 118, wherein the first and second fluid flow channels are located side by side with first fluid flow channels and second fluid flow channels arranged alternately.

120. A heat transfer device according to any one of claims 104 to 119, wherein the or each first and second fluid flow channel has an upper end and a lower end, and the lower ends of the first and second fluid flow channels are connected together.

121. A heat transfer device according to any one of claims 104 to 120, wherein the or each first and second fluid flow channel has an upper end and a lower end, and the upper ends of the first and second fluid flow channels are connected together.

122. A heat transfer device according to claim 121, wherein the upper ends of the first and second fluid flow channels are connected together by a manifold.

123. A heat transfer device according to claim 122, wherein the upper ends of the first and second fluid flow channels are connected together by a vapor manifold.

124. A heat transfer device according to claim 123, wherein vapor traveling from the surface of the liquid to the second surface passes through the manifold.

125. A heat transfer device according to claim 124, wherein condensed liquid returning from the second surface to the first part of the fluid flow means passes through the manifold.

126. A heat transfer device according to claim 125, wherein the liquid comprises water.

127. A heat transfer device according to any one of claims 104 to 126, wherein the liquid comprises ethanol.

128. A heat transfer device according to any one of claims 104 to 127, wherein the liquid comprises a mixture of water and ethanol.

129. A heat transfer device according to claim 128, wherein the mixture comprises up to 25% ethanol.

130. A heat transfer device according to any one of claims 104 to 129, wherein the second surface is located above the first surface such that the condensed liquid returns from the second surface to the first part of the fluid flow means by gravity.

131. A heat transfer device according to any one of claims 104 to 130, wherein at least a portion of a surface of the first fluid flow channel in thermal contact with the first surface has a dimpled surface profile.

132. A heat transfer device according to claim 131, wherein the dimpled surface profile comprises a regular array of dimples.

133. A heat transfer device according to claim 132, wherein the regular array of dimples comprises dimples arranged in rows separated by flat strips without dimples.

134. A heat transfer device according to any one of claims 104 to 133, wherein the first and second fluid flow channels are located between first and second spaced apart plates.

135. A heat transfer device according to claim 134, wherein the first plate is in thermal contact with the first surface and forms a surface of the or each first fluid flow channel.

136. A heat transfer device according to claim 135, wherein there are a plurality of first fluid flow channels and a plurality of second fluid flow channels located side by side with first fluid flow channels and second fluid flow channels arranged alternately, and each first fluid flow channel is separated from an adjacent second fluid flow channel by a partition extending between and attached to the first plate and the second plate.

137. A heat transfer device according to claim 136, wherein the first plate has a dimpled surface profile comprising a regular array of dimples arranged in rows separated by flat strips without dimples, and each partition is attached to the first plate at a position located in one of the flat strips.

138. A heat transfer device according to claim 137, wherein the part of each partition extending between the first plate and the second plate is substantially flat.

139. A heat transfer device according to claim 137 or claim 138, wherein a plurality of the partitions are formed by a third plate.

140. A heat transfer device according to claim 139, wherein all of the partitions are formed by a single third plate.

141. A heat transfer device according to claim 139 or claim 140, wherein the third plate is

corrugated.

142. A heat transfer device according to any one of claims 134 to 141, wherein each of the plates comprises a metal or a metal alloy material.

143. A heat transfer device according to claim 142, wherein each of the plates comprises mild steel.

144. A heat transfer device according to claim 143, wherein each of the plates comprises tin coated mild steel.

145. A heat transfer device according to any one of claims 134 to 144, wherein the plates are bonded together by a bonding technique including at least one of: soldering; spot welding; roller welding; and an adhesive.

146. A heat transfer device according to claim 145, wherein the plates are attached together by solder joints and at least a part of the first plate forming a surface of each first fluid flow channel is coated with solder.

147. A heat transfer device according to any one of claims 104 to 146, wherein the heat transfer device comprises a substantially rigid heat conducting structure.

148. A heat transfer device according to any one of claims 104 to 147, wherein the tube is at a pressure of 40mbar or less.

149. A heat transfer device according to claim 148 wherein the tube is at a pressure of 2 mbar or less.

150. A heat transfer device according to claim 149, wherein the tube is at a pressure of 1 mbar or less.

151. A heat transfer device according to claim 150, wherein the tube is at a pressure of 10^{-2} mbar or less.

152. A heat transfer device according to claim 151, wherein the tube is at a pressure of 10^{-3} mbar or less.

153. A heat transfer device according to claim 152, wherein the tube is at a pressure of 10^{-6} mbar or less.

154. A heat transfer device comprising:
a first surface;
a second surface;
a liquid reservoir in thermal contact with the first surface and containing a liquid; and
a tube connecting the liquid reservoir to the second surface;
wherein at least a part of the tube is at least partially evacuated;
whereby, when the first surface is hotter than the second surface, heat energy from the first surface causes liquid in the liquid reservoir to vaporize;
the vapor travels through the tube and condenses at the second surface; and
condensed liquid returns from the second surface to the liquid reservoir;
whereby heat energy is transported from the first surface to the second surface.

155. A heat transfer device according to claim 154, wherein at least a portion of a surface of the fluid reservoir in thermal contact with the first surface comprises features arranged to promote vapor bubble nucleation.

156. A heat transfer device according to claim 154 or claim 155, wherein at least a portion of a surface of the fluid reservoir in thermal contact with the first surface has a surface texture adapted to promote vapor bubble nucleation.

157. A heat transfer device according to claim 156, wherein said portion of the surface has a roughened surface texture.

158. A heat transfer device according to claim 157, wherein the roughened surface texture is provided by a solder layer.

159. A heat transfer device according to any one of claims 154 to 158, wherein condensed liquid returning from the second surface to the fluid reservoir travels through the tube.

160. A heat transfer device according to any one of claims 154 to 159, wherein the liquid comprises water.

161. A heat transfer device according to any one of claims 154 to 159, wherein the liquid comprises ethanol.

162. A heat transfer device according to any one of claims 154 to 161, wherein the liquid comprises a mixture of water and ethanol.

163. A heat transfer device according to claim 162, wherein the mixture comprises up to 25% ethanol.

164. A heat transfer device according to any one of claims 154 to 163, wherein the second surface is located above the first surface such that the condensed liquid returns from the second surface to the fluid reservoir by gravity.

165. A heat transfer device according to any one of claims 154 to 164, wherein at least a portion of a surface of the fluid reservoir in thermal contact with the first surface has a dimpled surface profile.

166. A heat transfer device according to claim 165, wherein the dimpled surface profile

comprises a regular array of dimples.

167. A heat transfer device according to claim 166, wherein the regular array of dimples comprises dimples arranged in rows separated by flat strips without dimples.

168. A heat transfer device according to any one of claims 154 to 167, wherein the tube is at a pressure of 40mbar or less.

169. A heat transfer device according to claim 168, wherein the tube is at a pressure of 2 mbar or less.

170. A heat transfer device according to claim 169, wherein the tube is at a pressure of 1 mbar or less.

171. A heat transfer device according to claim 170, wherein the tube is at a pressure of 10^{-2} mbar or less.

172. A heat transfer device according to claim 171, wherein the tube is at a pressure of 10^{-3} mbar or less.

173. A heat transfer device according to claim 172, wherein the tube is at a pressure of 10^{-6} mbar or less.

174. A heat transfer device according to any one of claims 154 to 173, wherein the heat transfer device comprises a substantially rigid heat conducting structure.

175. A heat transfer device having a working fluid capable of circulating around a fluid flow path, the circulation around the fluid flow path bringing the working fluid in and out of thermal contact with a heat source, the heat transfer device comprising:
a fluid containing portion internally defining a working fluid flow path;

a heat source at least partially in thermal contact with the fluid containing portion;

a gas substance generator at least partially within the fluid containing portion, and arranged to generate bubbles of gas or vapor capable of driving the working fluid along a portion of the working fluid flow path in thermal contact with the heat source;

wherein, in use, the driven working fluid absorbs heat from the heat source and transports the heat away from the heat source; and

the driven working fluid returns to the gas substance generator to be recycled about the fluid flow path.

176. A heat transfer device according to claim 175, wherein the gas substance generator comprises a hot vapor generation surface configured to at least partially heat-vaporize the working fluid such that vapor bubbles generated within the working fluid drive the working fluid along the fluid flow path defined internally of the fluid containing portion.

177. A heat transfer device according to claim 176, wherein the heat source is the hot vapor generation surface of the gas substance generator.

178. A heat transfer device according to any one of claims 175 to 177, wherein the fluid flow path defined internally of the fluid containing portion is arranged such that the driving of the working fluid along the portion of the working fluid flow path in thermal contact with the heat source is unimpeded by the returning of the driven working fluid to the gas substance generator.

179. A heat transfer device according to any one of claims 175 to 178, wherein the fluid flow path comprises a plurality of portions of the working fluid flow path in thermal contact with the heat source.

180. A heat transfer device according to any one of claims 175 to 179, wherein the fluid flow path comprises a plurality of return portions returning the driven working fluid to

the gas substance generator.

181. A heat transfer device according to any one of claims 175 to 180, wherein the heat transfer device is configured so that the driven working fluid travels with an upward component of direction along the portion of the working fluid flow path in thermal contact with the heat source, and returns to the gas substance generator at least partially under the action of gravity.

182. A heat transfer device according to any one of claims 175 to 181, wherein at least a partial vacuum is maintained in the fluid containing portion above the working fluid.

183. A heat transfer device according to any one of claims 175 to 182, wherein the rate of gas substance generation is determined, at least in part, by an operating temperature of the heat transfer device.

184. A heat transfer device according to claim 183, wherein the heat transfer device is configured so that the operating temperature achieving a predetermined rate of gas substance generation is controllable by means of varying a pressure level in the fluid containing portion above the working fluid.

185. A heat transfer device according to any one of claims 175 to 184, the heat transfer device further comprising at least one photovoltaic element having a first light incident surface and a second heat emitting surface, wherein said heat source is configured to be provided with heat from the heat emitting surface of the at least one photovoltaic element.

186. A heat transfer device according to claim 185, wherein the heat transfer device comprises a plurality of photovoltaic elements.

187. A heat transfer device according to claim 186, wherein the plurality of photovoltaic

elements are comprised in an array.

188. A heat transfer device according to claim 187, wherein the heat emitting surface of the at least one photovoltaic element is thermally coupled to the heat source across a predetermined area such that, in use, the heat source is configured to be provided with heat from all, or substantially all, of the heat emitting surfaces of the array of photovoltaic elements.

189. A heat transfer device according to claim 188, wherein the heat transfer device is configured such that the heat source maintains a substantially uniform temperature across the predetermined area.

190. A heat transfer device according to any one of claims 175 to 189, wherein the heat transfer device further comprises a heat exchanger configured so that, in use, the heat exchanger cools the working fluid.

191. A heat transfer device according to claim 190, wherein the heat transfer device is configured so that, in use, the working fluid is at least partially heat-vaporized to generate vapor, the vapor passes through the fluid containing portion to the heat exchanger and condenses at the heat exchanger, whereby the heat exchanger cools the working fluid.

192. A heat transfer device according to claim 191, wherein the heat transfer device is configured so that, in use, the heat exchanger is at least partially in contact with the working fluid.

193. A heat transfer device according to any one of claims 175 to 192, wherein at least a part of the heat transfer device is located in an envelope under at least a partial vacuum.

194. A heat transfer device according to claim 193, wherein the envelope is one of: a cylindrical tube; an elliptical tube.

195. A heat transfer device according to claim 194, wherein the envelope is formed, at least in part, of glass.

196. A heat transfer device according to claim 194 or 195, wherein a plurality of tubes are mounted in a solar energy collecting array.

197. A heat transfer device according to claim 196, wherein at least one of the plurality of tubes is rotatable to track light incident on the solar energy collecting array.

198. A heat transfer device according to claim 197, wherein the plurality of tubes are rotatable to track light incident on the solar energy collecting array.

199. A heat transfer device according to any one of claims 175 to 198, wherein the heat transfer device comprises a substantially rigid heat conducting structure.

200. An energy generator comprising a heat transfer device according to any preceding claim, and at least one photovoltaic element, the energy generator having an electrical output and a heated fluid output.

201. A heat transfer device substantially as shown in, or as described with reference to, the accompanying figures.

Claims:

1. A heat transfer device comprising:
a first fluid flow channel inclined to the horizontal and containing a liquid;
a second fluid flow channel connected to the first fluid flow channel and containing the liquid, wherein the heat transfer device above the liquid is at least partially evacuated; and
a first surface in thermal contact with the liquid in the first fluid flow channel;
wherein heat energy from the first surface causes liquid in the first fluid flow channel to vaporize;
and wherein the vapor travels upwardly along the first fluid flow channel by means of a rolling boil such that the vapor drives a flow of liquid from the second fluid flow channel to the first fluid flow channel and upwardly along the first fluid flow channel;
whereby heat energy is transported away from the first surface.

2. A heat transfer device according to claim 1, wherein the first fluid flow channel is closer to the first surface than the second fluid flow channel.

3. A heat transfer device according to claim 1 or claim 2, wherein at least a part of the first fluid flow channel is located between the first surface and the second fluid flow channel.

4. A heat transfer device according to claim 3, wherein the first fluid flow channel lies between the first surface and the second fluid flow channel.

5. A heat transfer device according to any preceding claim, wherein each of the first and second fluid flow channels has a section bounded by a perimeter, and a proportion of the perimeter of the first fluid flow channel which is in thermal contact with the first surface is greater than a proportion of the perimeter of the second fluid flow channel which is in thermal contact with the first surface.

6. A heat transfer device according to any preceding claim, wherein the cross sectional area of the first fluid flow channel and the cross sectional area of the second fluid flow channel are equal.

7. A heat transfer device according to any preceding claim, wherein the first fluid flow channel is in thermal contact with the first surface across a greater area than the second fluid flow channel.

8. A heat transfer device according to any preceding claim, wherein the first part of the fluid flow means is inclined to the horizontal by an angle of up to 90^0.

9. A heat transfer device according to any preceding claim, wherein at least a portion of at least one surface of the first fluid flow channel in thermal contact with the first surface comprises features arranged to promote vapor bubble nucleation.

10. A heat transfer device according to any preceding claim, wherein at least a portion of at least one surface of the first fluid flow channel in thermal contact with the first surface has a surface texture adapted to promote vapor bubble nucleation.

11. A heat transfer device according to claim 10, wherein said portion of at least one surface has a roughened surface texture.

12. A heat transfer device according to claim 11, wherein the roughened surface texture is provided by a solder layer.

13. A heat transfer device according to any preceding claim, wherein the first part of the fluid flow means is divided into a plurality of first fluid flow channels.

14. A heat transfer device according to claim 13, wherein the first part of the fluid flow means is divided into a plurality of first fluid flow channels and a plurality of second fluid flow channels.

15. A heat transfer device according to claim 14, wherein the number of first fluid flow channels is the same as the number of second fluid flow channels.

16. A heat transfer device according to claim 14 or claim 15, wherein the first and second fluid flow channels are located side by side with first fluid flow channels and second fluid flow channels interleaved.

17. A heat transfer device according to any preceding claim, wherein the or each first and second fluid flow channel has an upper end and a lower end, and the lower ends of the first and second fluid flow channels are connected together.

18. A heat transfer device according to any preceding claim, wherein the or each first and second fluid flow channel has an upper end and a lower end, and the upper ends of the first and second fluid flow channels are connected together.

19. A heat transfer device according to claim 18, wherein the upper ends of the first and second fluid flow channels are connected together by a manifold.

20. A heat transfer device according to claim 19, wherein the upper ends of the first and second fluid flow channels are connected together by a vapor manifold.

21. A heat transfer device according to any one of claims 1 to 20, and further comprising a second surface.

22. A heat transfer device according to claim 21 when dependent on claim 20, wherein

vapor traveling from the surface of the liquid to the second surface passes through the manifold.

23. A heat transfer device according to claim 22, wherein condensed liquid returning from the second surface to the first part of the fluid flow means passes through the manifold.

24. A heat transfer device according to any preceding claim, wherein the liquid comprises water.

25. A heat transfer device according to any one of claims 1 to 23, wherein the liquid comprises ethanol.

26. A heat transfer device according to any preceding claim, wherein the liquid comprises a mixture of water and ethanol.

27. A heat transfer device according to claim 26, wherein the mixture comprises up to 25% ethanol.

28. A heat transfer device according to any preceding claim, wherein the second surface is located above the first surface such that the condensed liquid returns from the second surface to the first part of the fluid flow means by gravity.

29. A heat transfer device according to any preceding claim, wherein at least a portion of a surface of the first fluid flow channel in thermal contact with the first surface has a dimpled surface profile.

30. A heat transfer device according to claim 29, wherein the dimpled surface profile comprises a regular array of dimples.

31. A heat transfer device according to claim 30, wherein the regular array of dimples comprises dimples arranged in rows separated by flat strips without dimples.

32. A heat transfer device according to any preceding claim, wherein the first and second fluid flow channels are located between first and second spaced apart plates.

33. A heat transfer device according to claim 32, wherein the first plate is in thermal contact with the first surface and forms a surface of the or each first fluid flow channel.

34. A heat transfer device according to claim 33, wherein there are a plurality of first fluid flow channels and a plurality of second fluid flow channels located side by side with first fluid flow channels and second fluid flow channels arranged alternately, and each first fluid flow channel is separated from an adjacent second fluid flow channel by a partition extending between and attached to the first plate and the second plate.

35. A heat transfer device according to claim 34, wherein the first plate has a dimpled surface profile comprising a regular array of dimples arranged in rows separated by flat strips without dimples, and each partition is attached to the first plate at a position located in one of the flat strips.

36. A heat transfer device according to claim 35, wherein the part of each partition extending between the first plate and the second plate is substantially flat.

37. A heat transfer device according to claim 35 or claim 36, wherein a plurality of the partitions are formed by a third plate.

38. A heat transfer device according to claim 37, wherein all of the partitions are formed by a single third plate.

39. A heat transfer device according to claim 37 or claim 38, wherein the third plate is

corrugated.

40. A heat transfer device according to any one of claims 32 to 39, wherein each of the plates comprises a metal or a metal alloy material.

41. A heat transfer device according to claim 40, wherein each of the plates comprises mild steel.

42. A heat transfer device according to claim 41, wherein each of the plates comprises tin coated mild steel.

43. A heat transfer device according to any one of claims 32 to 39, wherein the plates are bonded together by a bonding technique including at least one of: soldering; spot welding; roller welding; and an adhesive.

44. A heat transfer device according to claim 43, wherein the plates are bonded together by solder joints and at least a part of the first plate forming a surface of each first fluid flow channel is coated with solder.

45. A heat transfer device according to any preceding claim, wherein the heat transfer device comprises a substantially rigid heat conducting structure.

46. A heat transfer device according to any preceding claim, wherein the part of the fluid flow means above the surface of the liquid is at a pressure of 40mbar or less.

47. A heat transfer device according to claim 46, wherein the part of the fluid flow means above the surface of the liquid is at a pressure of 2 mbar or less.

48. A heat transfer device according to claim 47, wherein the part of the fluid flow means above the surface of the liquid is at a pressure of 1 mbar or less.

49. A heat transfer device according to claim 48, wherein the part of the fluid flow means above the surface of the liquid is at a pressure of 10^{-2} mbar or less.

50. A heat transfer device according to claim 49, wherein the part of the fluid flow means above the surface of the liquid is at a pressure of 10^{-3} mbar or less.

51. A heat transfer device according to claim 50, wherein the part of the fluid flow means above the surface of the liquid is at a pressure of 10^{-6} mbar or less.