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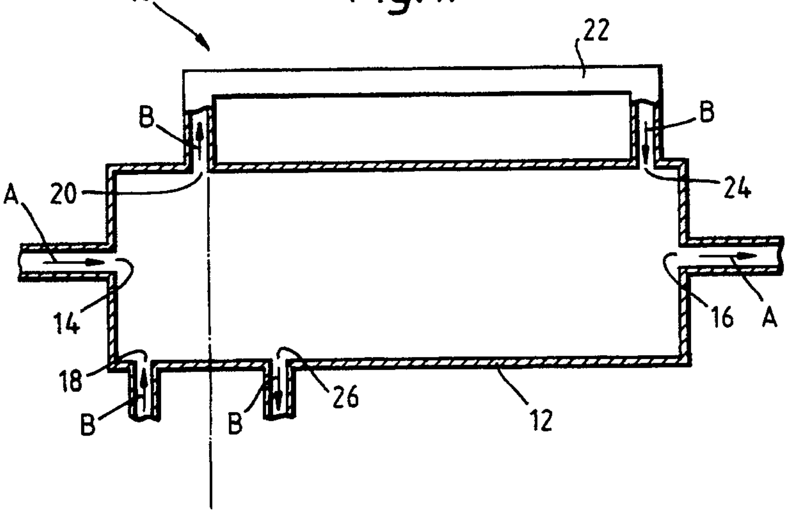
(54) An apparatus for and method of placing fluids in heat exchange relationship.

(57) A heat exchanger (10) for placing a first (A) and a second (B) fluid in heat exchange relationship with one another is provided with a primary (C,E) and secondary (D,F) region.

The primary (C,E) region of the heat exchanger (10) is adapted so that in operation there is a maximum temperature differential between the two fluids. The temperature differential being sufficient to prevent solidification of any liquid impurities entrained within the fluids on the heat exchanger internal surfaces.

In the secondary (D,F) region of the heat exchanger (10) the two fluids flow in opposite directions, contraflow, to provide efficient heat transfer.

Fig. 1.



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The present invention relates to a heat exchanger for placing fluids in heat exchange relationship so that heat is transferred from one fluid to another.

Heat exchangers normally operate to remove heat from a stream of hot fluid which requires cooling and transfers it to a stream of cold fluid which requires heating. Two types of heat exchanger are commonly known, parallel flow heat exchangers in which two fluids in heat exchange relationship flow in the same direction and contra flow heat exchangers in which two fluids flow in opposite directions along the heat exchanger.

Contra flow heat exchangers are more efficient than parallel flow heat exchangers and so may be smaller and lighter than a corresponding parallel flow design for a given inlet fluid temperature. In a contra flow heat exchanger the inlet for the cold fluid is adjacent the outlet of the hot fluid. The hot fluid has traversed the length of the heat exchanger losing heat so that the temperature differential between the outlet of the hot fluid and the inlet of the cold fluid is substantially reduced. The amount of heat transfer which occurs between the two fluids in this region of the heat exchanger and the temperature of the fluids is reduced. Ice can form on the heat exchanger internal walls adjacent the inlet for the cold fluid if the cold fluid contains water as a contaminant and if the temperature of the cold fluid is sufficiently low.

The present invention seeks to provide an efficient heat exchanger in which the formation of ice at the inlet for the cold fluid is substantially reduced.

According to the present invention a heat exchanger suitable for placing a first and a second fluid in heat exchange relationship with one another has a primary region adapted so that in operation a maximum temperature differential is provided between the two fluids in the primary region, the temperature differential and manner of heat exchange between said first and second fluids in the primary region being such that maximum heat transfer occurs between the two fluids in the primary region of the heat exchanger, said heat exchanger having a secondary region in which said first and second fluids are subsequently placed in contraflow heat exchange relationship.

The two fluids may either flow in the same direction in the primary region of the heat exchanger or in opposite directions.

In one embodiment of the present invention a heat exchanger for placing a first and a second fluid in heat exchange relationship with one another has a primary region in which in operation a first and a second fluid initially flow in parallel to one another, the temperature differential and manner of heat transfer in the primary region being such that maximum heat transfer occurs between the two fluids in the primary region of the heat exchanger, said heat exchanger having a secondary region in which the first and second fluids are subsequently placed in contraflow heat exchange relationship.

The embodiment of the present invention is preferably incorporated within a casing, the casing having at one end an inlet for a first fluid and at the other end an outlet for said first fluid so that the first fluid always flows in the same direction, the casing having an at least one inlet for a second fluid and an at least one outlet for said second fluid, the at least one inlet for the second fluid being adjacent the inlet of the first fluid so that in operation the first and second fluids flow in parallel adjacent the inlets.

In a further embodiment of the present invention a heat exchanger for placing a first and a second fluid in heat exchange relationship with one another has a primary region in which in operation a first and a second fluid flow in opposite directions to one another, the temperature differential and manner of heat exchange between the two fluids in the primary region being such that maximum heat transfer occurs between the two fluids in the primary region of the heat exchanger, said heat exchanger having a secondary region in which the first and second fluids are subsequently placed in contraflow heat exchange relationship.

Preferably this embodiment of the present invention is incorporated within a casing, the casing having at one end an inlet for a first fluid and at the other end an outlet for said first fluid so that the first fluid always flows in the same direction, the casing having an at least one inlet for a second fluid and an at least one outlet for a second fluid, the at least one outlet for the second fluid being adjacent the inlet for the first fluid so that in operation the first and second fluids flow in opposite directions adjacent the inlet for the first fluid.

A heat exchanger in accordance with any of the embodiments of the present invention in which a conduit may direct the second fluid from the primary region of the heat exchanger to the secondary region. The conduit may extend outwardly of the casing.

Preferably the first and second fluids flow in separate channels through the heat exchangers. The separate channels may be defined by cylindrical tubes.

Preferably the first fluid is to be heated and the second fluid is to be cooled. The first fluid is heated to a temperature sufficient to at least prevent solidification of any liquid impurities entrained within the fluids on the heat exchanger internal surfaces. The first fluid may be fuel and the second fluid may be oil.

The present invention will now be described by way of example and with reference to the accompanying drawings in which,

Figure 1 shows a schematic view of a heat exchanger in accordance with one embodiment of the present invention.

Figure 2 is a graph showing the temperature differential between two fluids in heat exchange relationship in a heat exchanger in accordance with the embodiment of the present invention shown in Figure 1.

Figure 3 shows a schematic view of a heat exchanger in accordance with a further embodiment of the present invention.

Figure 4 is a graph showing the temperature differential between two fluids in heat exchange relationship in a heat exchanger in accordance with the embodiment of the present invention shown in Figure 3.

Figure 1 shows a heat exchanger 10 in accordance with the present invention in which two fluids are placed in heat exchange relationship. The heat exchanger 10 comprises a casing 12 through which two fluids flow. A first fluid flows from an inlet 14 at one end of the casing 12, to an outlet 16 at the other end of the casing 12. The first fluid flows in the same direction through the heat exchanger as indicated by arrows A.

Adjacent the inlet 12 for the first fluid flow, there is an inlet 18 for a second fluid. The second fluid flows in the direction indicated by arrows B from the inlet 18 to an outlet 20 a short distance away. The second fluid is then ducted via a conduit 22 to a further inlet 24 at the opposite end of the casing 12. The second fluid re-enters through the inlet 24 and passes in an opposite direction to the first fluid along the remaining length of the casing 12 before exiting via an outlet 26.

In operation a first fluid, such as fuel, which requires heating, enters the casing 12 of the heat exchanger 10 via the inlet 14. The fuel flows in the direction indicated by arrows A, through the heat exchanger 10, to the outlet 16 at the opposite end of the casing 12.

A second fluid such as oil, which requires cooling, is placed in heat exchanger relationship with the fuel. The oil enters the casing 12 of the heat exchanger 10 via the inlet 18 before exiting through the outlet 20 a short distance away. The inlets for the fuel and oil, 14 and 18 respectively, are adjacent one another and the two fluids initially flow in parallel, in the same direction, in this primary region of the heat exchanger 10. The temperature differential is greatest at the inlets 14 and 18 as no heat transfer has yet occurred. Region C of Figure 2 shows the temperature differential between the two fluids in the primary region of the heat exchanger where the fluids flow in parallel. Due to the large temperature difference a high rate of heat transfer occurs between the fuel and the oil. The rate of heat transfer and the average temperature in this primary region are therefore sufficient to substantially reduce the likelihood of ice forming on the heat exchanger internal surfaces at the fuel inlet 14 when the fuel contains water as a contaminant and has an extremely low inlet temperature.

The oil then exits through the outlet 20 and is ducted via the conduit 22 to a further inlet 24 adjacent the outlet 16 for the fuel. Although Figure 1 shows a conduit 22 extending outwardly of the casing 12, it will be appreciated to one skilled in the art that a conduit within the casing would suffice.

The oil re-enters the heat exchanger casing 12 through the inlet 24 and flows, in a direction opposite to that of the fuel, to the outlet 26. Region D of Figure 2 shows the temperature differential between the two fluids in this secondary region of the heat exchanger where they flow in opposite directions (contra flow). The contra flow in the secondary region of the heat exchanger 10 produces a more efficient heat transfer between the fuel and the oil.

Figure 3 shows a further embodiment of a heat exchanger 10a in accordance with the present invention. The reference numerals used in Figure 3 are the same as in Figure 1 for integers common to both. In the embodiment shown in Figure 3 the oil enters the casing 12a via the inlet 18a and passes to the outlet 20a a short distance away. The outlet 20a is adjacent the fuel inlet 14a so that the two fluids flow in opposite directions in the primary region of the heat exchanger 10a.

The oil is hottest at the inlet 18a. By introducing the hot oil into the heat exchanger 10a adjacent the fuel inlet 14a a high temperature differential exists between the two fluids. Region E of Figure 4 shows the temperature differential between the two fluids in the primary region of the heat exchanger 10a.

The large temperature differential between the two fluids in the primary region of the heat exchanger 10a results in a high rate of heat transfer occurring between the oil and the fuel. The high rate of heat transfer ensures that the average temperature of the fluids in this region is sufficient to substantially reduce the likelihood of ice forming on the heat exchanger internal surfaces at the fuel inlet 14a when water contaminated fuel is used at low temperatures.

The oil then exits through the outlet 20a and is ducted via the conduit 22a to a further inlet 24a adjacent the outlet 16a for the fuel. The oil re-enters the heat exchanger 10a through the inlet 24a and flows in a direction opposite to that of the fuel to an outlet 26a. Region F of Figure 4 shows the temperature difference between the two fluids in the secondary region of the heat exchanger.

Both embodiments provide efficient heat exchangers in which the formation of ice is substantially reduced when using water contaminated fluids at low temperatures.

Claims

1. A heat exchanger suitable for placing a first and a second fluid in heat exchange relationship with one another, said heat exchanger characterised in that it has a primary region adapted so that in operation a maximum temperature differential is provided between the two fluids in said primary region, the temperature differential and manner of heat exchange between said first and a second fluids being such that maximum heat transfer occurs between the two fluids in the primary region of the heat exchanger, said heat exchanger having a secondary region in which said first and second fluids are subsequently placed in contraflow heat exchange relationship.

2. A heat exchanger as claimed in claim 1 characterised in that the two fluids flow in the same direction in the primary region of the heat exchanger.

3. A heat exchanger as claimed in claim 1 characterised in that the two fluids flow in opposite directions in the primary region of the heat exchanger.

4. A heat exchanger suitable for placing a first and a second fluid in heat exchange relationship with one another, characterised in that said heat exchanger has a primary region in which in operation the first and second fluids initially flow in parallel to one another, the temperature differential and manner of heat exchange between the two fluids being such that maximum heat transfer occurs between the two fluids in the primary region of the heat exchanger, said heat exchanger having a secondary region in which the first and second fluids are subsequently placed in contraflow heat exchange relationship.

5. A heat exchanger as claimed in claim 4 characterised in that the heat exchanger is incorporated within a casing, the casing having at one end an inlet for a first fluid and at the other end an outlet for said first fluid so that the first fluid always flows in the same direction,

   the casing having an at least one inlet for a second fluid and an at least one outlet for the second fluid, the at least one inlet for the second fluid being adjacent the inlet of the first fluid so that in operation the first and second fluids flow in parallel adjacent the inlets.

6. A heat exchanger suitable for placing a first and a second fluid in heat exchange relationship with one another characterised in that said heat exchanger has a primary region in which in operation the first and second fluid flow in opposite directions to one another, the temperature differential and manner of heat exchange between the two fluids being such that maximum heat transfer occurs between the two fluids in the primary region of the heat exchanger, said heat exchanger having a secondary region in which the first and second fluids are subsequently placed in contraflow heat exchange relationship.

7. A heat exchanger as claimed in claim 6 characterised in that the heat exchanger is incorporated within a casing, the casing having at one end an inlet for a first fluid and at the other end an outlet for said first fluid so that the first fluid always flows in the same direction,

   the casing having an at least one inlet for a second fluid and an at least one outlet for the second fluid, the at least one outlet for the second fluid being adjacent the inlet for the first fluid so that in operation the first and second fluids flow in opposite directions adjacent the inlet for the first fluid.

8. A heat exchanger as claimed in any preceding claim characterised in that a conduit directs the second fluid from the primary region of the heat exchanger to the secondary region.

9. A heat exchanger as claimed in claim 8 characterised in that the conduit extends outwardly of the casing.

10. A method as claimed in any preceding claim characterised in that the first and second fluids flow in separate channels through the heat exchanger.

11. A heat exchanger as claimed in claim 10 characterised in that the separate channels are defined by cylindrical tubes.

12. A heat exchanger as claimed in any preceding claim characterised in that the first fluid is to be heated and the second fluid is to be cooled.

13. A heat exchanger as claimed in claim 12 characterised in that the first fluid is heated to a temperature sufficient to at least prevent solidification of any liquid impurities entrained within the fluids on the heat exchanger internal surfaces.

14. A heat exchanger as claimed in claim 12 characterised in that the first fluid is fuel and the second fluid is oil.

Fig.1.

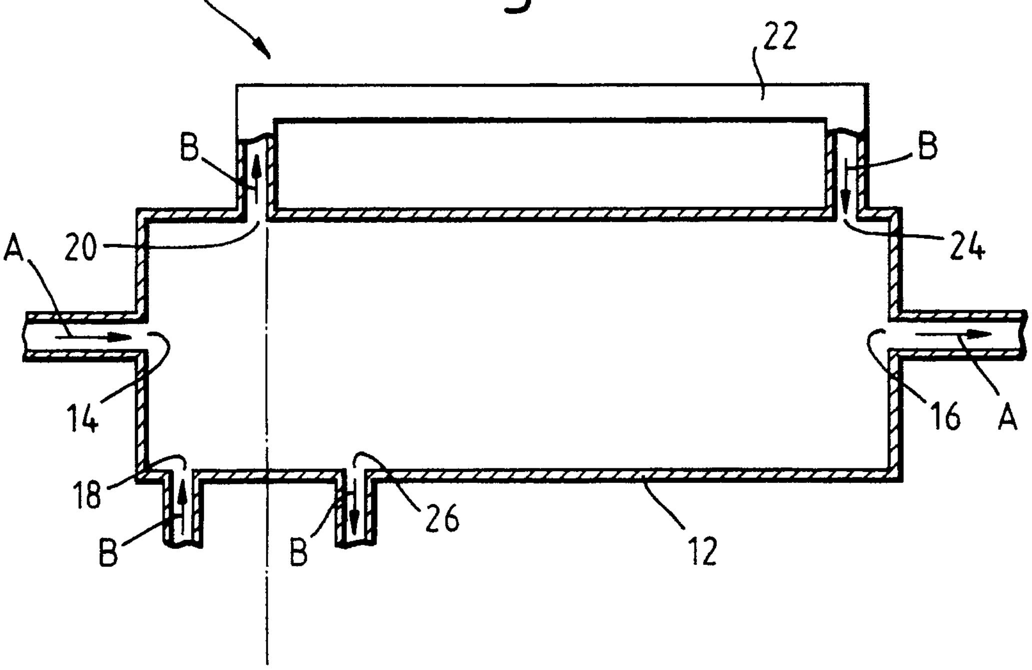

10
22
B
B
A
20
24
14
16
A
18
26
12
B
B

Fig.2.

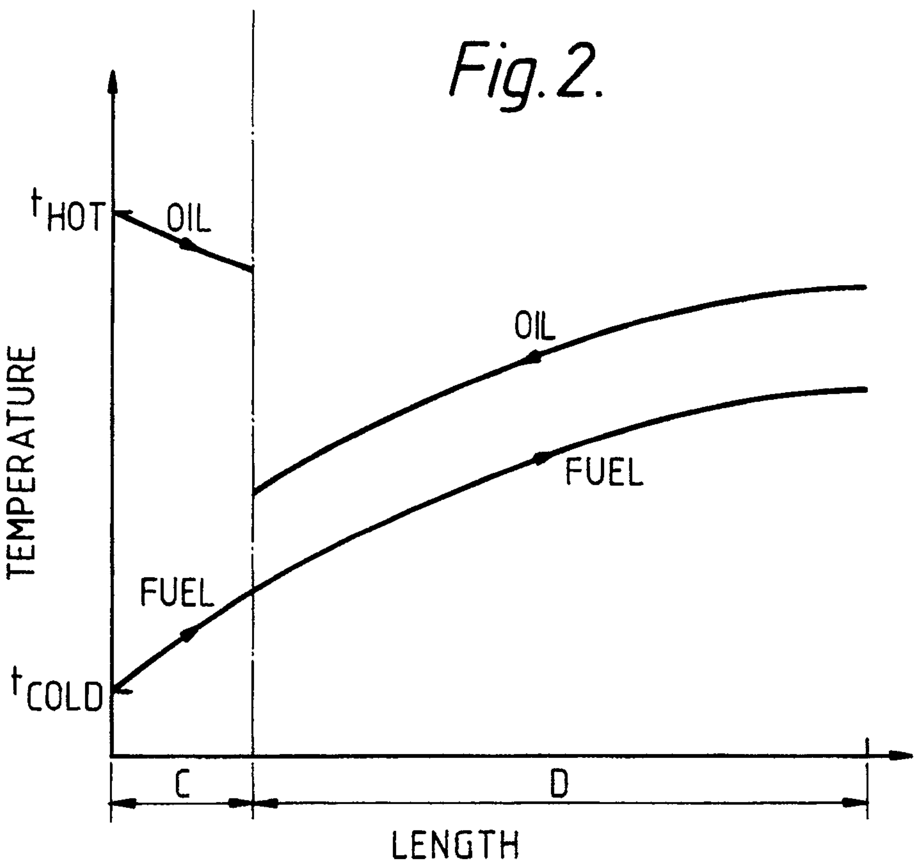
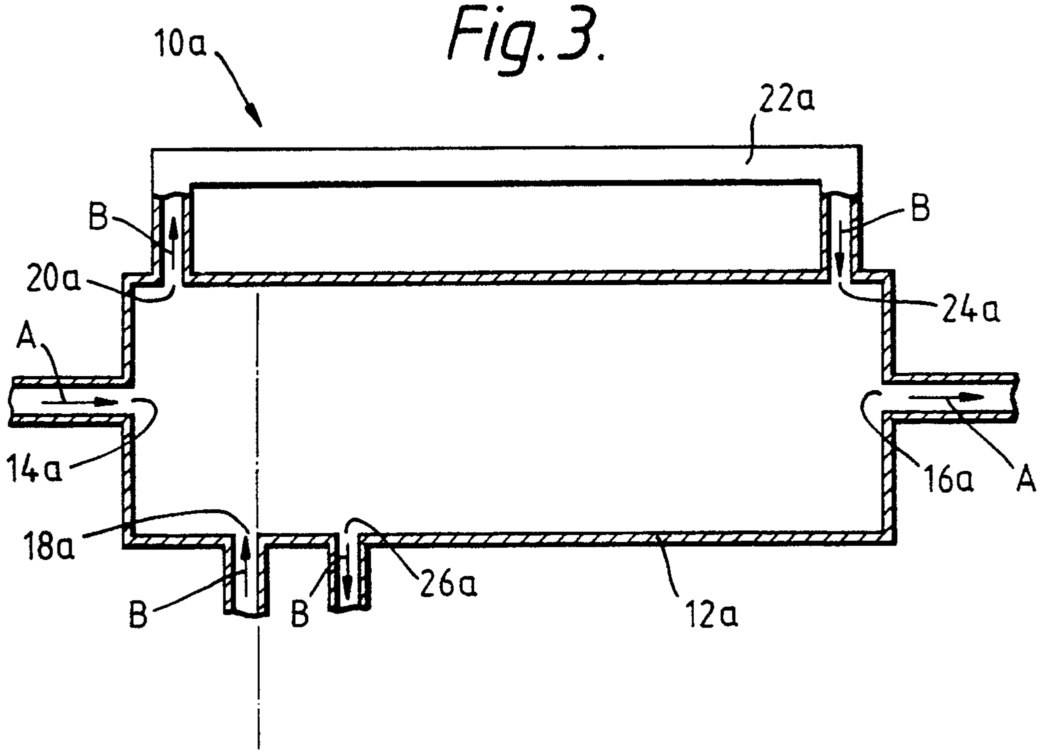

t_{HOT}
OIL
OIL
FUEL
FUEL
t_{COLD}
TEMPERATURE
C
D
LENGTH

Fig. 3.


10a
22a
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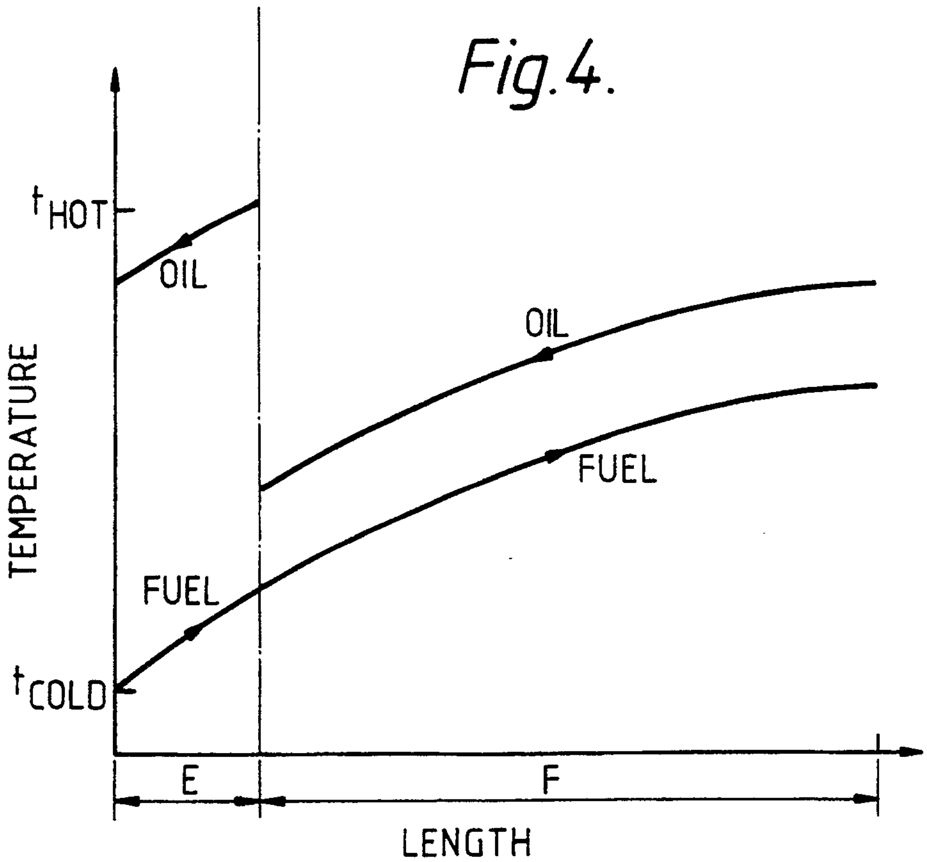
B
20a
24a
A
14a
16a
A
18a
B
B
26a
12a

Fig. 4.


t_{HOT}
OIL
OIL
TEMPERATURE
FUEL
FUEL
t_{COLD}
E
F
LENGTH

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 30 1905

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-A-3 421 746 (APPARATEBAU WIESLOCH GMBH) * page 6, line 26 - page 7, line 10; figure 1 * – – –	1,2,4,5,8, 10,11	F 28 F 19/00 F 28 F 9/22
X	US-A-4 147 209 (PERSSON) * column 3, line 12 - column 4, line 12; figure 1 * – – –	1,3,6,7, 10,11	
A	CH-A-2 781 09 (S.A.DE &DECAZEVILLE) * page 5, line 68 - page 6, line 6; figures 7-9 * – – – – –	1,6-12	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F 28 F F 28 C

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	23 July 91	BELTZUNG F.C.

CATEGORY OF CITED DOCUMENTS

- X : particularly relevant if taken alone
- Y : particularly relevant if combined with another document of the same catagory
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- D : document cited in the application
- L : document cited for other reasons
- &: member of the same patent family, corresponding document