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

(11) EP 3 809 081 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
21.04.2021 Bulletin 2021/16

(51) Int Cl.:
F28D 1/053 *(2006.01)* ***F28D 1/03*** *(2006.01)*

(21) Application number: **19461590.2**

(22) Date of filing: **18.10.2019**

(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
Designated Validation States:
KH MA MD TN

(71) Applicant: **Valeo Autosystemy SP. Z.O.O.**
32-050 Skawina (PL)

(72) Inventors:
- **BARUS, Lukasz**
  32-050 SKAWINA (PL)
- **DULIBAN, Lukasz**
  32-050 SKAWINA (PL)
- **SZOSTEK, Dawid**
  32 050 SKAWINA (PL)
- **DOMITER, Artur**
  32 050 SKAWINA (PL)
- **WIDZYK, Lukasz**
  32 050 SKAWINA (PL)

(74) Representative: **Bialkowski, Adam**
Valeo Systèmes Thermiques
Industrial Property Department
ZA L'Agiot
8 rue Louis Lormand
CS 80517 LA VERRIERE
78322 Le Mesnil Saint Denis Cedex (FR)

(54) **A HEAT EXCHANGER**

(57) The invention comprises a heat exchanger (1), in particular for a motor vehicle, comprising a first manifold (2) and a second manifold (3) connected by a plurality of primary tubes (10) with a first cross-section (A-A) and at least one secondary tube (20) with a second cross-section (B-B), characterised in that the second cross-section (B-B) is different than the first cross-section (A-A), wherein the outer diameter of the secondary tube (20) is constantly the same as the outer diameter of the primary tubes (10).

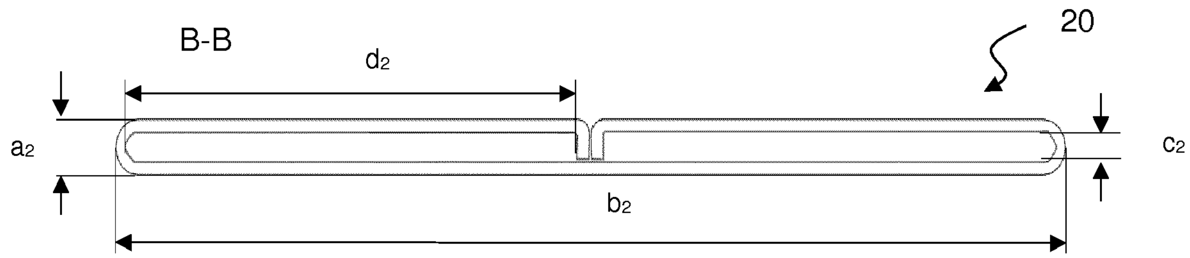

Fig. 3

EP 3 809 081 A1

Description

FIELD OF THE INVENTION

[0001] The invention relates to a heat exchanger, in particular to the heat exchanger for a motor vehicle.

BACKGROUND OF THE INVENTION

[0002] Automobile radiators are constructed of a pair of metal or plastic header tanks, linked by a core with many narrow passageways, giving a high surface area relative to volume. This core is usually made of stacked layers of metal sheet, pressed to form channels and soldered or brazed together. For many years radiators were made from brass or copper cores soldered to brass headers. Modern radiators have aluminum cores, and often save money and weight by using plastic tanks with rubber gaskets. This construction is more prone to failure and less easily repaired than traditional materials, yet it benefits from better heat transfer properties and lightweight construction.

[0003] However, the ongoing interest in continuous weight and size reduction of vehicle's sub-components may lead to undesired decrease in efficiency of the whole heat exchange system. This may be caused by, for example, uneven thermal expansion between heat exchanger's sub-components and also within the particular component, such as the core. The thermal expansion of the heat exchanger depends, for example, on the coolant fluid velocity in different sections of the heat exchanger.

[0004] Another factor that may handicap the flow of the coolant fluid is the deployment of the inlet and the outlet on the header tanks. In industry, the deployment of the inlet and the outlet is usually predefined by the vehicle's manufacturer requests which are not necessarily feasible in terms of even flow of the coolant fluid. Infeasible deployment of the inlet and outlet in the heat exchanger may lead to undesired flow disruption that can impact its performance and longevity.

[0005] It would be desired to provide the means of promoting the flow of the coolant fluid in the neglected parts of the heat exchanger core.

SUMMARY OF THE INVENTION

[0006] The object of the invention is, among others, a heat exchanger, in particular for a motor vehicle, comprising a first manifold and a second manifold connected by a plurality of primary tubes with a first cross-section (A-A) and at least one secondary tube with a second cross-section, characterised in that the second cross-section (B-B) is different than the first cross-section (A-A), wherein the outer diameter of the secondary tube is constantly the same as the outer diameter of the primary tubes.

[0007] Preferably, at least one secondary tube is deployed on one of the peripheral ends of the manifolds.

[0008] Preferably, at least one primary tube is deployed between at least two secondary tubes.

[0009] Preferably, the first cross section (A-A) has bigger hydraulic diameter than the second cross section (B-B).

[0010] Preferably, the second cross section comprises corrugations on the inner side of the secondary tube.

[0011] Preferably, the second cross section comprises surplus material on the inner side of the secondary tube compared to the first cross section.

[0012] Preferably, the primary tubes and the secondary tubes are made from the folded sheet of metal.

[0013] Preferably, the primary tubes and the secondary tubes are extruded.

BRIEF DESCRITPTION OF DRAWINGS

[0014] Examples of the invention will be apparent from and described in detail with reference to the accompanying drawings, in which:

Fig. 1 shows a schematic view of a heat exchanger comprising two different types of tubes.

Fig. 2 shows a cross section of the primary tube.

Fig. 3 shows a cross section of the secondary tube.

Fig. 4 shows an exemplary deployment of the primary and secondary tubes in one of the examples.

DETAILED DESCRIPTION OF EMBODIMENTS

[0015] The invention relates to heat exchangers, in particular radiators used in automobiles. The heat exchanger is configured to convey a cooling medium, such as a coolant through its sub-components so that the temperature of the cooling medium flowing out of the heat exchanger would be lower than the temperature of the cooling medium flowing into the heat exchanger thanks to heat exchange with a second medium, e.g. air.

[0016] The cooling medium is usually delivered into the heat exchanger by an inlet and collected by an outlet. Depending on the architecture, i.e. the number of passes, desired heat exchanger deployment in the engine bay, etc., the inlet and the outlet are usually deployed either on the opposite sides of the heat exchanger, or on the same side thereof. The inlet and the outlet have usually circular cross-section protruding from inlet and/or outlet of the tanks respectively.

[0017] Fig.1 presents a heat exchanger 1, in particular for a motor vehicle, comprising a first manifold 2 and a second manifold 3 connected by a plurality of primary tubes 10 and at least one secondary tube 20. The manifolds 2, 3 are usually associated with an assembly of the header and the tank, wherein the header may be configured to receive the primary tubes 10 or secondary tubes 20 and the tank may provide a coolant fluid distribution and fluidal communication with the rest of the system. The first manifold 2 may comprise the inlet to the heat exchanger, whereas the outlet may be located on the second manifold. Alternatively, the configuration of the inlet and the outlet may be different from the aforementioned one, i.e. the inlet could be located on the second manifold 3, whereas the outlet could be located on the first manifold 2. Alternatively, both inlet and the outlet may be located on the same manifold 2, 3. Multiple inlets and outlets are also envisaged.

[0018] The primary tubes 10 and the secondary tubes 20 are usually made of a single sheet of metal which is folded inwardly, so that the terminal ends of metal sheet create an inner wall that can be attached (e.g. by brazing) to the flat, portion of the tube. The inner wall may be deployed between the two opposite walls of the tube. Alternatively, the tubes 10, 20 can be made in the process of extrusion. It is also possible for the tubes 10, 20 to not comprise any inner walls 5.

[0019] The primary tubes 10 and the secondary tubes 20 comprise two open ends, and they are usually deployed in parallel to each other between the first manifold 2 and the second manifold 3, wherein the open ends of the tubes 10, 20 are received in a slots of the headers. To provide a tight connection, the manifolds 2, 3 and the tubes 10, 20 may be brazed together.

[0020] Fig. 2 presents a cross-section (A-A) of the single primary tube 10. The primary tube 10 comprises three dimensions characterising its outer periphery, i.e. a tube height ai, a tube width bi and a tube length (not shown), wherein the length is perpendicular to the cross-section (A-A) presented in the Fig.2. The primary tube 10 comprises also three dimensions characterising its inner dimensions, i.e. a channel height ci, a channel width di, and a channel length (not shown) which is essentially the same as the tube length. The inner dimensions of the primary tube 10 presented in Fig. 2 are indicated for a single channel as in one of the embodiments the aforementioned inner wall 5 may be omitted.

[0021] Fig. 3 presents a cross-section (B-B) of the single secondary tube 20. The secondary tube 20 comprises three dimensions characterising its outer dimensions, i.e. a tube height a_2, a tube width b_2 and a tube length (not shown), wherein the length is perpendicular to the cross-section (B-B) presented in the Fig.3. The primary tube 10 comprises also three dimensions characterising its inner dimensions, i.e. a channel height c_2, a channel width d_2, and a channel length (not shown) which is essentially the same as the tube length. The inner dimensions of the secondary tube 20 presented in Fig. 3 are indicated for a single channel as in one of the embodiments the aforementioned inner wall 5 may be omitted.

[0022] The outer dimensions may be used to determine, for example, the approximate outer diameter of the primary tubes 10 and the secondary tubes 20, as well as the inner dimensions may be used to determine, for example, the approximate inner diameter of the primary tubes 10 and the secondary tubes 20.

[0023] According to Figs. 2 and 3 the second cross-section (B-B) is different than the first cross-section (A-A), wherein the outer diameter of the secondary tube 20 is constantly the same as the outer diameter of the primary tubes 10. Consequently, the first cross section (A-A) has different hydraulic diameter than the second cross section (B-B). The second cross-section (B-B) may be for example bigger that the first cross-section (A-A), so that the primary tubes comprise a bigger hydraulic diameter than the secondary tubes 20.

[0024] Using the different cross-section (B-B) of the secondary tubes 20 may significantly improve the heat exchanger's performance by increasing the coolant fluid velocity at the certain sections of the heat exchanger 1, depending on the deployment of the secondary tubes 20 in the stack.

[0025] The secondary tubes 20 may comprise a smaller hydraulic diameter in comparison with the primary tubes 10. The smaller internal dimensions of the secondary tubes 20 forces grater velocity of the coolant fluid thanks to increased local hydraulic pressure.

[0026] For example, Fig. 3 presents an example, wherein at least one secondary tube 20 is deployed on one of the peripheral ends of the manifolds 2,3. In this particular example, the heat exchanger 1 comprises two secondary tubes 20 deployed on the bottom of the stack to increase the coolant fluid in that area.

[0027] Analogically, the heat exchanger 1 could comprise at least one secondary tube 20 deployed on the top of the stack to increase the coolant fluid in that area. Alternatively, the heat exchanger 1 could comprise at least one primary tube 10 deployed between at least two secondary tubes 20. Such configuration is covered, for example by Fig.1, however other deployments are also envisaged. For example, the section of secondary tubes 20 stacked, for example on the top of the stack, could be separated by at least one primary tube 10 to ensure a precise coolant fluid flow in that area.

[0028] The secondary tubes 20 may be in fact manufactured using several different methods. One of the methods may comprise using a metal sheets of different thickness for the primary tubes 10 and the secondary tubes 20. For example, the sheet of metal used for manufacturing the primary tubes 10 could be thinner than the sheet of metal used for manufacturing the secondary tubes 20. Another method for increasing the cross section (B-B) of the secondary tubes 20 could comprise corrugations on the inner surface of the channel, so as to decrease its inner dimensions. The corrugations could increase the fluid velocity in the secondary tubes 20, analogically to aforementioned method, however the costs of manufacturing a secondary tube 20 of the corrugated sheet of metal would be significantly higher compared to the thicker sheet of metal. Another method for increasing the cross section (B-B) of the secondary tubes 20 could comprise surplus material on the inner side of the secondary tube 20. The surplus material could have different physical properties than the secondary tube 20, yet it would be desired so that is remains unreactive to coolant fluid i.e. the surplus material should keep its form, so it is not, for example, washed out from the inner side of the secondary channel.

[0029] Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of drawings, the disclosure, and the appended claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to the advantage.

Claims

1. A heat exchanger (1), in particular for a motor vehicle, comprising a first manifold (2) and a second manifold (3) connected by a plurality of primary tubes (10) with a first cross-section (A-A) and at least one secondary tube (20) with a second cross-section (B-B), **characterised in that** the second cross-section (B-B) is different than the first cross-section (A-A), wherein the outer diameter of the secondary tube (20) is constantly the same as the outer diameter of the primary tubes (10).

2. The heat exchanger (1) according to claim 1, wherein at least one secondary tube (20) is deployed on one of the peripheral ends of the manifolds (2,3).

3. The heat exchanger (1) according to any of the preceding claims, wherein at least one primary tube (10) is deployed between at least two secondary tubes (20).

4. The heat exchanger (1) according to any of the preceding claims, wherein the first cross section (A-A) has bigger hydraulic diameter than the second cross section (B-B).

5. The heat exchanger (1) according to any of the preceding claims, wherein the second cross section comprises corrugations on the inner side of the secondary tube (20).

6. The heat exchanger (1) according to any of the preceding claims, wherein the second cross section comprises surplus material on the inner side of the secondary tube (20) compared to the first cross section.

7. The heat exchanger (1) according to any of the preceding claims, wherein the primary tubes (10) and the secondary tubes (20) are made from the folded sheet of metal.

8. The heat exchanger (1) according to any of the preceding claims, wherein the primary tubes (10) and the secondary tubes (20) are extruded.

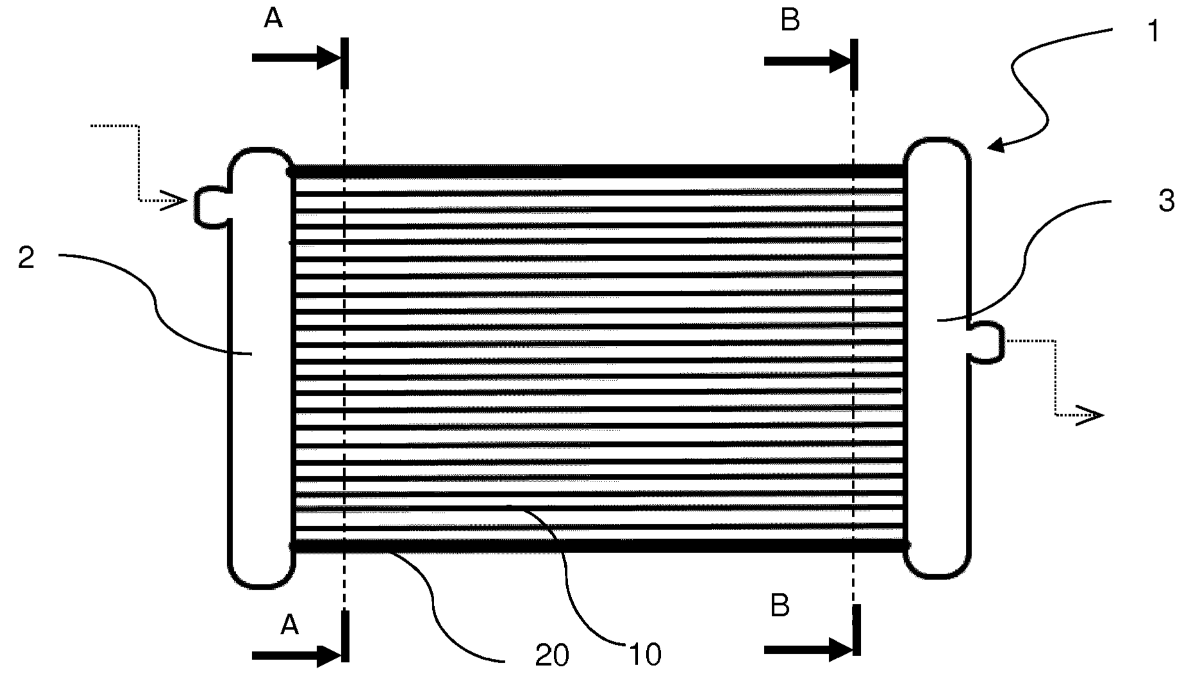

Fig. 1

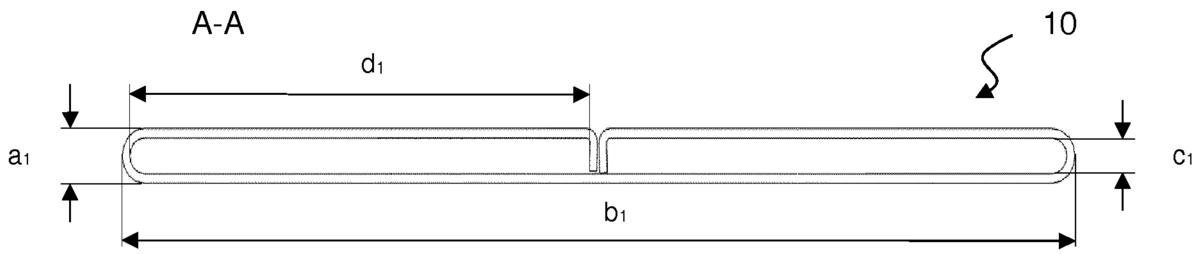

Fig. 2

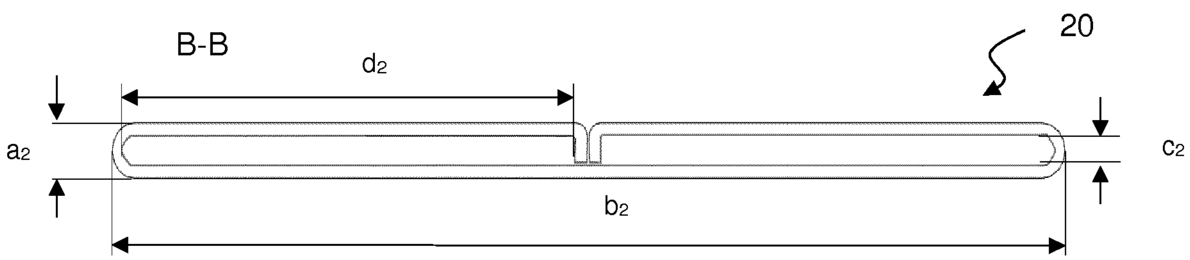

Fig. 3

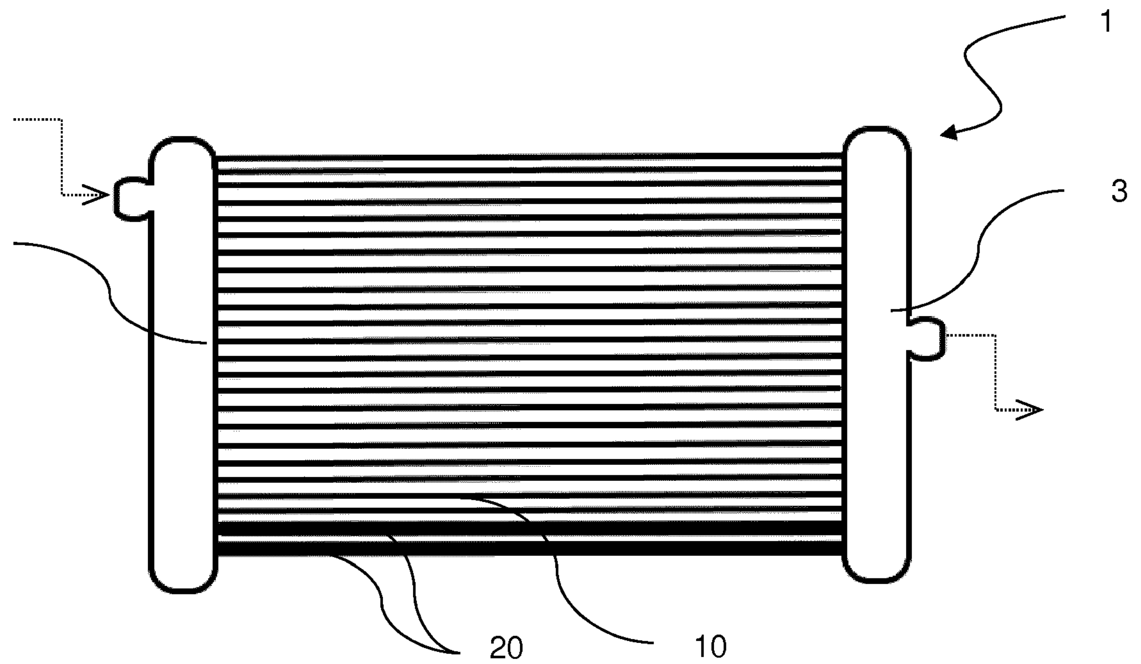

Fig. 4

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 19 46 1590

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	EP 3 134 695 A1 (TITANX ENGINE COOLING HOLDING AB [SE]) 1 March 2017 (2017-03-01) * paragraphs [0029], [0045] - paragraph [0049]; figures 14-16 *	1-5,8	INV. F28D1/053 F28D1/03
X	US 6 394 176 B1 (MARSAIS CHRISTIAN [FR]) 28 May 2002 (2002-05-28) * column 4, line 11 - line 29; figures 1-3 *	1-4,6,8	
X	US 2012/000634 A1 (ROD JANUSZ [PL] ET AL) 5 January 2012 (2012-01-05) * paragraph [0025] - paragraph [0044]; figures 1-3 *	1-4	
X	WO 2008/019117 A2 (MODINE MFG CO [US]; AMBROS PETER [DE] ET AL.) 14 February 2008 (2008-02-14) * paragraph [0131] - paragraph [0132]; figure 42 *	1-7	
X	US 5 765 393 A (SHLAK PETER [US] ET AL) 16 June 1998 (1998-06-16) * figures 3-6 *	1,2,4,6,8	

TECHNICAL FIELDS SEARCHED (IPC)
F28F
F28D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	8 April 2020	Jessen, Flemming

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)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 19 46 1590

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.

08-04-2020

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 3134695	A1	01-03-2017	BR	112016024518	A2	15-08-2017
			CN	106662407	A	10-05-2017
			EP	3134695	A1	01-03-2017
			JP	2017514096	A	01-06-2017
			SE	1450473	A1	23-10-2015
			US	2017045312	A1	16-02-2017
			WO	2015163811	A1	29-10-2015
US 6394176	B1	28-05-2002	AT	261573	T	15-03-2004
			BR	9905655	A	12-09-2000
			DE	69915431	T2	19-08-2004
			EP	1003005	A1	24-05-2000
			ES	2217672	T3	01-11-2004
			FR	2786259	A1	26-05-2000
			US	6394176	B1	28-05-2002
US 2012000634	A1	05-01-2012	CN	102207357	A	05-10-2011
			EP	2375208	A1	12-10-2011
			PL	2375208	T3	31-05-2013
			US	2012000634	A1	05-01-2012
WO 2008019117	A2	14-02-2008	NONE			
US 5765393	A	16-06-1998	NONE			

EPO FORM P0459

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