(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
2 May 2008 (02.05.2008)

PCT

(10) International Publication Number
WO 2008/049885 A1

(51) International Patent Classification:
F15D 1/04 (2006.01)

(21) International Application Number:
PCT/EP2007/061473

(22) International Filing Date: 25 October 2007 (25.10.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10 2006 050 869.6 27 October 2006 (27.10.2006) DE
60/863,195 27 October 2006 (27.10.2006) US

(71) Applicant *(for all designated States except US)*: **AIRBUS DEUTSCHLAND GMBH** [DE/DE]; Kreetslag 10, 21129 Hamburg (DE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **POTSCHKA, Nikolai** [DE/DE]; Achtern Höben 14, 21717 Helmste (DE). **WILLIAMSON, Michael** [GB/GB]; High Trees, Picton, Yarm Cleveland TS15 OAG (GB).

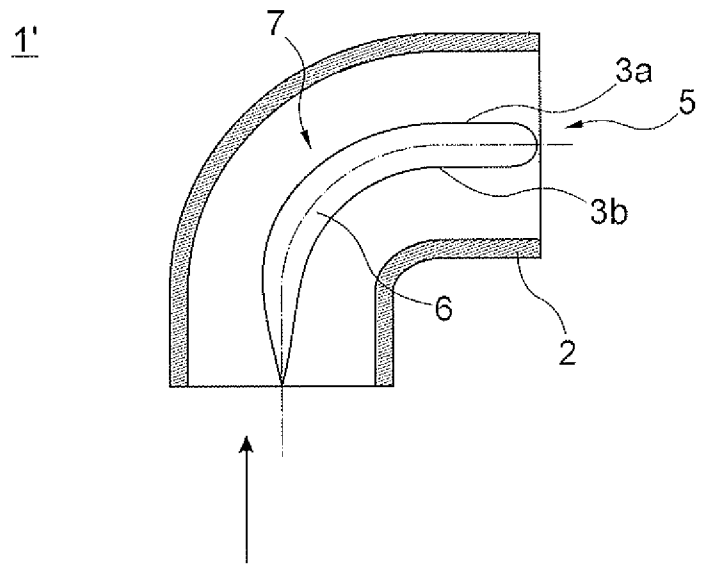
(74) Agent: **KOPF, Korbinian**; Maiwald Patentanwalts GmbH, Elisenhof, Elisenstr. 3, 80335 Munich (DE).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *with amended claims and statement*

(54) **Title:** SONIC ABSORPTION DEVICE FOR AN AIR PIPELINE OF AN AIRCRAFT, IN PARTICULAR OF AN AIR CONDITIONING SYSTEM OF AN AIRCRAFT



(57) **Abstract:** A sonic absorption device for an air pipeline of an aircraft, which sonic absorption device comprises at least one curved pipe section (1;1') whose respective interior wall is clad with a sound absorption material (2), wherein within the curved pipe section (1;1') at least one air guidance means is arranged for a flow optimisation, wherein for further weight-neutral sound absorption the air guidance means arranged within the curved pipe section (1;1') comprises a micropcrforation on at least one side surface (3a; 3b).

WO 2008/049885 A1

Sonic absorption device for an air pipeline of an aircraft, in particular of an air conditioning system of an aircraft

Reference to related applications

This application claims the benefit of the filing date of German Patent Application No. 10 2006 050 869.6 filed October 27, 2006 and of United States Provisional Patent Application No. 60/863,195 filed October 27, 2006, the disclosure of which applications is hereby incorporated herein by reference.

Technical Area

The present invention relates to a sonic absorption device for an air pipeline of an aircraft, which sonic absorption device comprises at least one curved pipe section whose respective interior wall is clad with sound absorption material, wherein within the curved pipe section at least one air guidance means is arranged for flow optimisation.

Background of the invention

Air pipelines used in aircraft construction are subject to particularly stringent requirements relating to sound protection and flow dynamics. At the same time, air pipelines in an aircraft are to be dimensioned such that flow losses are kept to the minimum possible, for example in order to minimise the energy required for conveying the conditioned air. As a result of the confined space within an aircraft, air pipelines comprise a substantial number of curved pipe sections. In these positions preferably dispersion sound absorbers are used, because they are particularly efficient in these circumstances. Furthermore, the change in direction of the airflow results in turbulence, which among other things reduces the flow speed of the air.

For the purpose of dispersion sound absorption, usually in particular the curved pipe sections of the air pipeline comprise or are lined with a sound absorption material. Furthermore, in particular in the case of highly curved pipe sections, turbulence in

the airstream occurs which has a negative effect on efficiency, with air guidance means counteracting said turbulence.

However, a combination of air guidance means and sound absorption cladding in a curved pipe section can have a negative effect on the efficiency of sound absorption. The reason for this is because, for example, two air baffles, arranged parallel in relation to each other, as air guidance means within a curved pipe section produce three separate channel sections which when individually considered, are not fully clad with sound absorption materials. In particular the middle duct, which is formed by two air baffles that are arranged at a distance from each other, is unprotected in this regard.

Attempts have already been made to counteract this problem by using an increase in the bending radius of the curved pipe section so that at the most one air guidance means within the curved pipe section is required. However, this measure requires more installation space within an aircraft, which design space is again at a premium. Furthermore, attempts have already been made to design air guidance means in the form of acoustic separators. An acoustic separator is an aerodynamically shaped air guidance means comprising a wing shape, with the interior space of said separator comprising a filling of a sound absorption material. The connection to the sound absorption material is established by way of conventional perforations of an extent of perforation of approximately 20%. The term "extent of perforation" refers to the area of the surface that is taken up by perforations. While such an acoustic separator itself acts as a sonic absorption device, due to the thickness of the acoustic separator, this solution, however, requires a correspondingly large installation space in the interior of the curved pipe section, which in turn increases the drop in pressure in a disadvantageous manner. Furthermore, it has been shown that an extent of perforation exceeding 10% in itself may form a source of sound.

Description of the invention

Accordingly, there may be a need to create a sonic absorption device for a curved pipe section of an air pipeline of an aircraft, which sonic absorption device distinguishes itself by high efficiency while at the same time requiring a minimum of installation space.

The need may be met with a sonic absorption device according to the preamble of claim 1 together with its characterising features. The subsequent dependent claims show advantageous improvements of the invention.

The invention includes the technical teaching that for further weight-neutral sound absorption the air guidance means arranged within a curved pipe section comprises a microperforation on at least one side surface.

The solution according to the invention is associated in particular with an advantage in that, thanks to the microperforation, only a slight turbulence in the airstream arises when said airstream moves along the air guidance means so that the air guidance means does not become a source of noise, or so there is no danger of a significant decrease in pressure occurring. In addition, the aerodynamic behaviour of the microperforated air guidance means according to the invention is similar to that of non-perforated conventional air guidance means. The solution according to the invention thus combines the aerodynamic advantages of conventional air guidance means on the one hand, with optimal sound absorption on the other hand. The coefficient of absorption of the sound absorption solution according to the invention can be set to the required frequency by changing the size and/or the distance of the openings of the microperforation. The measure according to the invention of microperforation of air guidance means has no influence on the weight and design space when compared to those of conventional solutions.

The air guidance means can be of various designs. For example, it is imaginable to design them in the manner of at least one air baffle or in the manner of an acoustic separator. In the former case the microperforations extend through the entire thickness of the air baffle. In the case of an acoustic separator the sheet metal housing enclosing the central absorption core of said separator comprises microperforations in the region of the inside or the outside of the acoustic separator. In the context of this document the term "inside" refers to the inwardly curved surface of the acoustic separator, whereas the term "outside" refers to the outwardly curved surface of the acoustic separator.

According to a further measure improving the invention as far as the acoustic separator is concerned, it is proposed that inside, which has no microperforation, or outside, which has no microperforation, of the sheet metal housing comprises a conventional perforation to an extent of at least 20% perforation. In particular in the case of larger radii of curvature of the curved pipe sections, with this measure it is possible to achieve optimum results with a view to sound absorption and flow guidance. Furthermore, trials have shown that the solution according to the invention is particularly successful in the case of flow speeds exceeding 5m/s.

The microperforation according to the invention is preferably implemented by individual circular or oval openings with a diameter of less than 1 mm. The microperforations are thus distinct from conventional perforations whose individual openings have a diameter of more than 2 mm. Furthermore, with the microperforation according to the invention an extent of perforation of less than 5% in relation to the entire surface is achieved.

Brief Description of the Drawings

Further measures that improve the invention are shown in more detail below, together with the description of preferred exemplary embodiments of the invention. The following are shown:

Figure 1 a lateral view of a curved pipe section with air guidance means in a first embodiment; and

Figure 2 a lateral view of a curved pipe section with air guidance means in a second embodiment.

Detailed Description of Exemplary Embodiments

According to Figure 1, conditioned air flows, in the direction shown by an arrow, through a curved pipe section 1 of an air pipeline (not further shown) of an aircraft. The interior wall of the pipe section is lined or clad with a sound absorption material 2, which in the embodiment shown is made from glass wool. Within the curved pipe section 1 two air baffles 4a and 4b, arranged parallel to the airflow, are installed. Over its entire thickness each of the air baffles 4a and 4b comprises through-microperforation for the purpose of sound absorption.

According to Figure 2, in the interior of an also curved pipe section 1' with a lining of sound absorption material 2 an acoustic separator 5 as an air guidance means is arranged. The acoustic separator 5, which is formed in a wing-like manner, comprises an inner absorption core 6 made of sound absorption material, which absorption core 6 is enclosed by a sheet metal housing 7. The sheet metal housing 7 forms the two side surfaces 3a and 3b of the acoustic separator 5, which side surfaces 3a and 3b are approximately opposite each other. In this embodiment the inside of the acoustic separator comprises a microperforation, whereas the outside 3a comprises a conventional perforation.

The invention is not limited to the two preferred exemplary embodiments described above. Instead, modifications thereof are imaginable which are covered by the scope of the following claims of the patent. For example, it is also possible to accommodate the acoustic separator and the air baffles together within a curved pipe section, should this be favoured for aerodynamic or sound-related reasons. The invention is not solely applicable to air pipelines of air conditioning systems, but also to inlet ducts or outlet ducts of turbines or the like.

List of reference numerals

1	Curved pipe section
2	Sound absorption material
3	Side surface
4	Direction of flow
5	Acoustic separator
6	Central absorption core

Claims

1. A sonic absorption device for an air pipeline of an aircraft, which sonic absorption device comprises at least one curved pipe section (1; 1') whose respective interior wall is clad with a sound absorption material (2), wherein within the curved pipe section (1; 1') at least one air guidance means is arranged for flow optimisation, wherein for further weight-neutral sound absorption the air guidance means arranged within the curved pipe section (1; 1') comprises a microperforation on at least one side surface (3a; 3b).

2. The sonic absorption device of claim 1,
wherein the air guidance means is designed in the manner of at least one air baffle (4a; 4b) which comprises a microperforation that extends through the entire thickness.

3. The sonic absorption device of claim 1,
wherein the air guidance means is designed in the manner of an acoustic separator (5) whose sheet metal housing (7) enclosing a central absorption core (6) comprises a microperforation in the region of the inner side surface (3b) or of the outer side surface (3a).

4. The sonic absorption device of claim 3,
wherein the non-perforated inner side surface (3b) or outer side surface (3a) of the sheet metal housing (7) comprises a conventional perforation to an extent of at least 20% perforation.

5. The sonic absorption device of one of claims 1 to 4, wherein the sound absorption material (2) comprises glass wool, mineral wool or open-pore foam.

6. The sonic absorption device of one of claims 1 to 5, wherein the microperforation comprises individual openings with a diameter of less than 1 mm.

7. The sonic absorption device of one of claims 1 to 6, wherein the extent of perforation of the microperforation is less than 5%.

8. The sonic absorption device of one of claims 1 to 7, wherein the flow speed through the curved pipe section (1; 1') during normal operation exceeds 5 m/s.

AMENDED CLAIMS
received by the International Bureau on 04 April 2008 (04.04.2008)

1. A sonic absorption device for an air pipeline of an aircraft, which sonic absorption device comprises at least one curved pipe section (1; 1') whose respective interior wall is clad with a sound absorption material (2), wherein within the curved pipe section (1; 1') at least one air guidance means is arranged for flow optimisation,
wherein for further weight-neutral sound absorption the air guidance means arranged within the curved pipe section (1; 1') comprises a microperforation on at least one side surface (3a; 3b); wherein the air guidance means is designed in the manner of an acoustic separator (5) whose sheet metal housing (7) enclosing a central absorption core (6) comprises
a) a microperforation in the region of the inner side surface (3b), wherein the non-microperforated outer side surface (3a) of the sheet metal housing (7) comprises a conventional perforation to an extent of at least 20% perforation or
b) a microperforation in the region of the outer side surface (3a), wherein the non-microperforated inner side surface (3b) of the sheet metal housing (7) comprises a conventional perforation to an extent of at least 20% perforation.

2. The sonic absorption device of claim 1,
wherein the air guidance means is designed in the manner of at least one air baffle (4a; 4b) which comprises a microperforation that extends through the entire thickness.

3. The sonic absorption device of claim 1,
wherein the sound absorption material (2) comprises glass wool, mineral wool or open-pore foam.

4. The sonic absorption device of one of claims 1 to 3,
wherein the microperforation comprises individual openings with a diameter of less than 1 mm.

5. The sonic absorption device of one of claims 1 to 4,
wherein the extent of perforation of the microperforation is less than 5%.

6. The sonic absorption device of one of claims 1 to 5,
wherein the flow speed through the curved pipe section (1; 1') during normal operation exceeds 5 m/s.

INFORMAL STATEMENT

1. The present invention relates to a sonic absorption device for an air pipeline of an aircraft, which sonic absorption device comprises at least one curved pipe section. One object of the present invention is to achieve optimum results with a view to sound absorption and flow guidiance, particularly in the case of flow speeds exceeding 5 m/s.

This object will be solved by the subject matter of Claim 1, according to which a respective interior wall of the sonic absorption device is clad with a sound absorption material, wherein within the curved pipe section at least one air guidance means is arranged for flow optimisation, wherein for further weight-neutral sound absorption the air guidance means arranged within the curved pipe section comprises a microperforation on at least one side surface, wherein the air guidance means is designed in the manner of an acoustic separator whose sheet metal housing enclosing a central absorption core comprises

a) a microperforation in the region of the inner side surface, wherein the non-microperforated outer side surface of the sheet metal housing comprises a conventional perforation to an extent of at least 20% perforation or

b) a microperforation in the region of the outer side surface, wherein the non-microperforated inner side surface of the sheet metal housing comprises a conventional perforation to an extent of at least 20% perforation.

2. Document D1, US 2002/084138 A1, is regarded as the closest prior art and describes an elbow silencer which comprises a casing and a baffle defining a flow channel. In one embodiment, the baffle is a perforated facing plate (D1, page 2, [0023]).

A microperforation is not disclosed in D1. Thus, even the inventive combination of microperforation and conventional perforation is not disclosed in D1.

To solve the object of the invention, the person skilled in the art would consider D2, which shows microperforation of a perforated sheet in a sound absorbent (D2, page 14, line 14 to 17). However, a combination of different perforation regions is not disclosed in D2.

D4, US 5 495 754 A, shows an acoustically treated turning vane used in wind tunnels with one curved acoustic treated turning vane in two different embodiments (Figs. 6 and 7). According to Fig. 6, the vane may include a perforated plate 62 (Column 3, line 52 to 55) on the inner side and one curved acoustic panel 58 on the outer side. The panel 58 is constructed of acoustic material as fibreglass batts of loosely woven fibreglass cloth bags filled with loose fibreglass strand material which held in place by a thin sheet of perforated metal (col. 4, line 1 to 4).

Further, it is known from D4, that in regions where flow velocities are low, acoustic absorption panels be constructed of closed cell foam blocks (col. 4, line 6 to 10). Thus, D4 solves the object of the invention in a different way by using perforated metal for one side and closed cell foam blocks for the other side if the flow velocity is low (which is the case by a flow velocity of e.g. 5 m/s).

D4 would be not considered by the skilled person, because the technical field of D4 are wind tunnels with uses much higher velocities (100 mph (D4, col. 5, line 23) as air pipelines of aircrafts. But if the person skilled in the art would combine D1 and D4 he would not arrive the subject-matter of Claim 1 because D4 shows a different solution of the object.

Thus, subject matter of Claim 1 is novel over Document D1is based on an inventive step over the prior art.

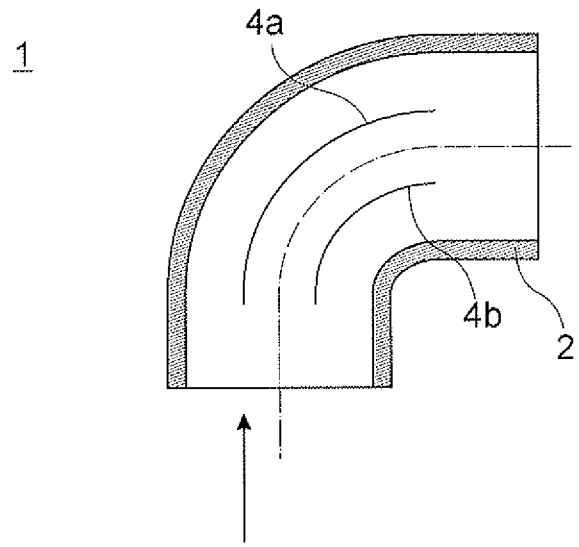


Fig. 1

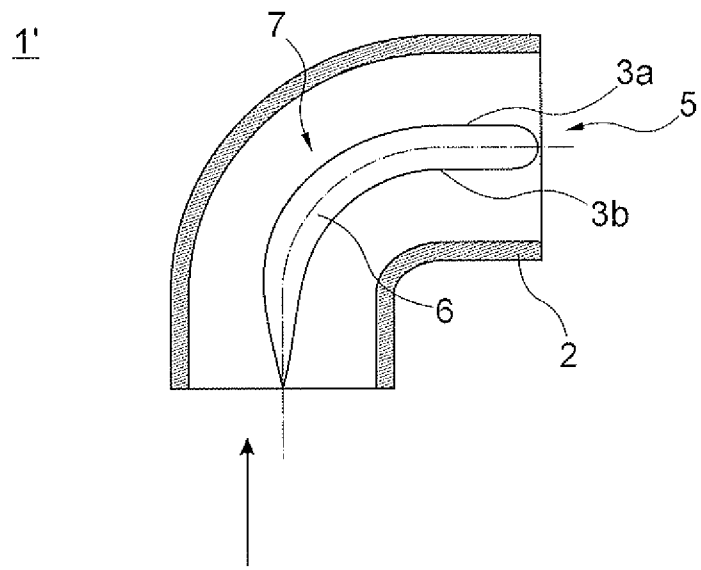


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/061473

A. CLASSIFICATION OF SUBJECT MATTER
INV. F15D1/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F15D F24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/084138 A1 (WEINSTEIN JONATHAN [US]) 4 July 2002 (2002-07-04) paragraphs [0022] - [0027]; figure 2c	1,3,5,8
Y		7
X	WO 02/23099 A (FLAEKT AB [SE]; AABOM MATS [SE]; JOHANSSON CLAES GOERAN [SE]) 21 March 2002 (2002-03-21) page 4, lines 8-26 page 14, lines 10-20 page 15, line 20 - page 16, line 6; figure 4	1,2,6
X	GB 2 250 356 A (SARGENTS ACOUSTICS LIMITED [GB]) 3 June 1992 (1992-06-03) page 4, paragraph 5 - page 7, paragraph 1; figure 1	1,3

-/--

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 January 2008	05/02/2008

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Busto, Mario

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2007/061473

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 495 754 A (STARR JR ROGERS F [US] ET AL) 5 March 1996 (1996-03-05) column 3, line 49 - column 4, line 11 column 3, lines 35-39; figures 4-7	1,3,4
X	US 5 861 585 A (VAN EVERY DAVID H [CA] ET AL) 19 January 1999 (1999-01-19) column 4, line 37 - column 5, line 51; figures 1,3	1
A	DE 197 30 355 C1 (FRAUNHOFER GES FORSCHUNG [DE]) 18 March 1999 (1999-03-18) column 1, lines 22-28; figures 1,10	1-6
Y		7

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2007/061473

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2002084138 A1	04-07-2002	NONE	
WO 0223099 A	21-03-2002	AT 321248 T	15-04-2006
		AU 8817701 A	26-03-2002
		DE 60118221 T2	12-04-2007
		EP 1319156 A1	18-06-2003
		NO 20031212 A	16-05-2003
		US 2004099477 A1	27-05-2004
GB 2250356 A	03-06-1992	NONE	
US 5495754 A	05-03-1996	NONE	
US 5861585 A	19-01-1999	EP 0905499 A2	31-03-1999
DE 19730355 C1	18-03-1999	NONE	