AUSTRALIA

IP 4910 AUS

Patents Act 1990

NOTICE OF ENTITLEMENT

675159

I (~~We~~) James W Guedry

authorised by INTERNATIONAL PAPER COMPANY

of Two Manhattanville Road, Purchase, NY 10577 U S A

the applicant in respect of an application for a patent for an invention entitled

COMPOSTABLE, BIODEGRADABLE FOAM CORE BOARD

filed under Australian Application No. 73250/94 , state the following:

PART 1 - *Must be completed for all applications.*

The person(~~s~~) nominated for the grant of the patent

☐ ~~is (are) the actual inventor(s)~~

or

☒ has, for the following reasons, gained entitlement from the actual inventor(s)

the nominated person is the Assignee of the invention from the actual inventors as recorded in Assignments filed in the United States Patent Office on July 22, 1994 at Reel 7077 Frame 0712-0714 (William C. Decker III) and Reel 7072 Frame 0106-0108 (William A. Wittosch, Jr.)

~~PART 2~~ - *Must be completed if the application is a Convention application.*

The person(s) nominated for the grant of the patent is (are):

☐ the applicant(s) of the basic application(s) listed on the patent request form

or

☐ entitled to rely on the basic application(s) listed on the patent request form by reason of the following:

The basic application(s) listed on the request form is (are) the first application(s) made in a Convention country in respect of the invention.

PART 3 - *Must be completed if the application was made under the PCT and claims priority.*

The person(~~s~~) nominated for the grant of the patent is (~~are~~):

☐ ~~the applicant(s) of the application(s) listed in the declaration under Article 8 of the PCT~~

or

☒ entitled to rely on the application(s) listed in the declaration under Article 8 of the PCT by reason of the following:

The nominated person is the assignee of the basic application from the said actual inventor(s)

The basic application(~~s~~) listed in the declaration made under Article 8 of the PCT is (~~are~~) the first application(~~s~~) made in a Convention country in respect of the invention.

Dated this 17th day of Janua 1996

Signed James W. Guedry Status

Signatory's Name James W. Guedry Secretary & Staff Vice-President

F.B. RICE & CO PATENT ATTORNEYS

AU9473250

(12) PATENT ABRIDGMENT (11) Document No. AU-B-73250/94
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 675159

(54) Title
COMPOSTABLE, BIODEGRADABLE FOAM CORE BOARD

International Patent Classification(s)
(51)[5] C08F 016/06 B32B 005/14

(21) Application No. : 73250/94 (22) Application Date : 08.07.94

(87) PCT Publication Number : WO95/02000

(30) Priority Data

(31) Number (32) Date (33) Country
090221 08.07.93 US UNITED STATES OF AMERICA

(43) Publication Date : 06.02.95

(44) Publication Date of Accepted Application : 23.01.97

(71) Applicant(s)
INTERNATIONAL PAPER COMPANY

(72) Inventor(s)
WILLIAM C DECKER III; WILLIAM A. WITTOSCH JR.

(74) Attorney or Agent
F B RICE & CO , 28A Montague Street, BALMAIN NSW 2041

(56) Prior Art Documents
US 5089535
US 4863655
US 3415714

(57) Claim

1. A compostable, biodegradable foam core board comprising:

a foam core sheet made of a foamable, biodegradable material selected from the group comprising a polyvinyl alcohol polymer, a starch-based thermoplastic polymer, a polylactic acid polymer, and other foamable, biodegradable polymers having structural rigidity when foamed; and

a facing sheet adhered to at least one side of said foam core sheet.

2. A compostable, biodegradable foam core board according to Claim 1, wherein said foam core sheet has selected structural properties including a foam core weight of about 25 to 80 lbs/msf, a foam density of about 1.5 to 15 lbs/ft^3, and a foam cell size of about 0.20 to 1.24 mm.

.../2

11. A compostable, biodegradable foam core board according to Claim 1, wherein said foam core material includes a blowing agent selected from the group comprising a low molecular weight alcohol, an endothermic blowing agent, an atmospheric gas, a hydrocarbon or halogenated hydrocarbon.

OPI DATE 06/02/95 APPLN. ID 73250/94
AOJP DATE 16/03/95 PCT NUMBER PCT/US94/07625

AU9473250

(51) International Patent Classification 5 :
C08F 16/06, B32B 5/14

A1

(11) International Publication Number: WO 95/02000

(43) International Publication Date: 19 January 1995 (19.01.95)

(21) International Application Number: PCT/US94/07625

(22) International Filing Date: 8 July 1994 (08.07.94)

(30) Priority Data:
08/090,221 8 July 1993 (08.07.93) US

(71) Applicant: INTERNATIONAL PAPER COMPANY [US/US]; Two Manhattanville Road, Purchase, NY 10577 (US).

(72) Inventors: DECKER, William, C., III; 607 Rogers Hill Road, Glasgow, KY 42141 (US). WITTOSCH, William, A., Jr.; 28 Cedar Hill Drive, Warwick, NY 10990 (US).

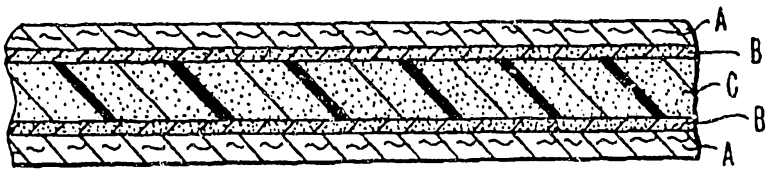
(74) Agent: ONOFRIO, Dara, L.; Ostrager, Chong & Flaherty, 300 Park Avenue, New York, NY 10022-7499 (US).

(81) Designated States: AT, AU, BB, BG, BF, BY, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, LV, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

675159

(54) Title: COMPOSTABLE, BIODEGRADABLE FOAM CORE BOARD



(57) Abstract

A compostable, biodegradable foam core board having a facing sheet (A) adhered to a foam core sheet (B) made of a foamable biodegradable material selected from a polyvinyl alcohol polymer, a strach-based thermoplastic polymer, a polyactic acid polymer, and other foamable, biodegradable polymers having structural rigidity when foamed. The foam core sheet has selected structural properties including a foam core weight in a preferred range of 30 to 50 lbs/msf, a foam density in a preferred range of 1.5 to 9.0 lbs/cu.ft, and a foam cell size in a preferred range of 0.30 to 0.70 mm. In one example, the foam core material is composed of a mixture of a polyvinyl alcohol polymer and high-melt-index polystyrene as a structural polymer additive. In another preferred example, the foam core material contains a blend of destructurized starch, polyethylene, polyvinyl alcohol, polyvinyl acetate, and glycerol as a plasticizer.

COMPOSTABLE, BIODEGRADABLE FOAM CORE BOARD

Field of the Invention

This invention generally relates to a compostable, biodegradable foam core board, and more particularly, to such foam core board having improved properties of rigidity, structural integrity, and ease and low cost of manufacture.

Background of the Invention

Conventional foam core board, such as used for art board, signage, and display board, is typically a laminated structure comprised of a paperboard facing adhered to a polystyrene foam core. Such conventional foam core board is sold, for example, under the brand name GATORFOAM™ by the Masonite Division of International Paper Company, located in Raleigh, North Carolina. In the solid waste stream, these are "high bulk" materials that do not degrade readily in a landfill nor can they be recycled with conventional technology. Although some biodegradable foam materials are known, they are not recognized in the industry as being suitable for use in foam core board.

Summary of the Invention

Accordingly, it is a principal object of the present invention to provide a foam core board that would degrade and/or be compostable, recyclable, or otherwise offer waste source reduction advantages that would be more environmentally acceptable than conventional polystyrene foam core boards. It is a particular object that such compostable, biodegradable foam core board have good rigidity and structural integrity for its conventional uses for art board, signage, and display board, and also be easy and inexpensive to manufacture.

In accordance with the present invention, a compostable, biodegradable foam core board comprises a facing sheet adhered to a foam core sheet made of a foamable, bio-degradable material selected from the group comprising a polyvinyl alcohol polymer, a starch-based thermoplastic polymer, a polylactic acid polymer, and other foamable, bio-degradable polymers having structural rigidity when foamed.

The foam core sheet has selected structural properties including a foam core weight of about 25 to 80 lbs/msf, preferably in a desired range of 30 to 50 lbs/msf, a foam density of about 1.5 to 15 lbs/ft^3, preferably in a desired range of 2.0 to 9 lbs/ft^3, and a foam cell size of about 0.20 to 1.24 mm, preferably in a desired range of 0.30 to 0.70 mm.

Other objects, features, and advantages of the present invention will become apparent from the following detailed description explained with reference to the drawings, of which:

Brief Description of Drawings

Fig. 1 is a sectional side view showing a foam core board in accordance with the present invention having a facing sheet adhered to a foam core sheet by an adhesive layer.

Fig. 2 is a sectional side view showing another embodiment of a foam core board of the present invention having a facing sheet adhered in contact with an extruded foam core sheet.

Detailed Description of the Invention

The properties of conventional foam core board are well known in the industry. For example, the GATORFOAM™ board manufactured by the Masonite Division of International Paper Company is a heavy-duty "sandwich"

board with a foam center and hard veneer outer surfaces, sold in 3/16, 1/2, 3/4, 1, and 1-1/2 inch thicknesses. The foam core is made of a white, high-density Styrofoam™ material from Dow Chemical Corp. The surface facing is a resin-impregnated bleached white kraft paper sold under the name Luxcell™ veneer from International Paper Company. The foam board has excellent properties for application of inks, paints, panel glues, and hot melt formulations, as well as suitability for cutting, mounting, and weather resistance. It has good rigidity and structural properties, of which the following are representative:

Table I

Panel Thickness:	0.210 inch
Panel Weight:	275 lbs/msf
Panel Density:	15 lbs/ft^3
Foam Thickness:	0.160 inch
Foam Weight:	29 lbs/msf
Foam Density:	2.1 lbs/ft^3
Facing Thickness:	0.025 inch
Facing Weight:	110 lbs/msf
Modulus of Rupture:	3,000 psi
Modulus of Elasticity:	226,000 psi
Compression Strength:	35 psi (to 10% compression)
Internal Bond Strength:	90 psi (to foam failure)

A biodegradable/compostable material can be defined as one which when exposed to suitable conditions is capable of being decomposed by microorganisms or available chemicals to carbon dioxide, water, and environmentally innocuous materials. A "foam" material is a solid plastic material having an expanded cellular construction. Biodegradable foam materials are known in the industry for other uses, but heretofore have not been developed for use in foam core board. In the present invention, biodegradable foam materials are selected and

adapted for use in foam core board based upon their having desirable structural properties, suitability for easy and inexpensive manufacture, and susceptability to decomposition or other recycling from solid waste. The criteria for foam core physical properties suitable for purposes of the present invention were as follows:

Foam Weight: 25 to 80 lbs/msf; preferred range, 30 to 50 lbs/msf.

Foam Density: 1.5 to 15 lbs/ft^3; preferred range, 2.0 to 9 lbs/ft^3.

Foam Cell Size: 0.20 to 1.24 mm; preferred range, 0.30 to 0.70 mm.

Forming: capable of conventional foaming and sheet extrusion or injection molding.

Laminate: capable of forming good bond with environmentally benign adhesive, or contact bonding with extrusion or molding.

Dissolvability: at least partially water soluble to diminshed form.

Dissolved Residue: environmentally benign, diluent polymers.

Based upon the above criteria for physical properties, a biodegradable material found to be suitable for foam core board is a thermoplastic composition of polyvinyl alcohol (PVA) material combined with other, structural polymers and processed with selected blowing and forming agents so as to have the desired structural, forming, and decomposition properties. Thermoplastic compositions for water soluble foams are disclosed, for example, in U.S. Patent 5,089,535, issued in the names of Nelson E. Malwitz and Shau-Tarng Lee, and assigned to Sealed Air Corporation, of Saddle Brook, New Jersey, which is incorporated herein by reference.

Suitable thermoplastic compositions as mentioned in that patent comprise a resin mixture containing polyvinyl

alcohol material, an optional diluent polymer selected for added structural properties, and optional additives such as nucleating agents, aging modifiers and ionomer resins, and a volatile blowing agent. Suitable polyvinyl alcohol materials include copolymers of vinyl alcohol and internal plasticizers. Commercially available examples of polyvinyl alcohol materials include a variety of internally plasticized polyvinyl alcohol plastics from Air Products and Chemicals, Inc., of Allentown, Pennsylvania, under the trade name Vinex™. A preferred resin is Vinex™ 2025, which is a high melt index (MI=17) PVOH blend.

Diluent polymers compatible with polyvinyl alcohol are blended into the thermoplastic resin mixture to provide structural properties in the extruded foam. Suitable diluent polymers include aryl and olefinic polymers. Examples of aryl polymers include polystyrene, substituted derivatives, and copolymers thereof. Examples of olefinic polymers include polyethylene, polypropylene, substituted derivatives, and copolymers thereof. A particularly suitable diluent polymer is a high-melt-index polystyrene available under the name Huntsman 203 from Huntsman Chemical Corp. which will produce a stiff and rigid foam having good structural properties for foam core board. Although the diluent polymers may not be as readily biodegradable, they are needed in comparatively smaller amounts than the polyvinyl alcohol, and therefore a significant solid waste reduction is nevertheless obtained by the overall resin mixture.

Preferred blowing agents for the polyvinyl alcohol resin mixture include low molecular weight alcohols, such as those with a boiling point between 46°C and 100°C (at standard temperature and pressure). Examples of such blowing agents include methanol, ethanol, propanol, and

butanol. Other preferred blowing agents include endothermic blowing agents, such as those available from Reedy International Corp., of Keyport, New Jersey. These materials include sodium salts of carbonic, polycarbonic, polycarboxylic acids and carbonate compounds belonging to the chemical family of aliphatic acids and carbonates.

Example 1

A specific example will now be described with reference to the two-sided foam core board structure illustrated in Fig. 1. A foam core sheet "C" produced by extrusion was obtained from Sealed Air Corp. containing Vinex™ polyvinyl alcohol material from Air Products Co. and a high-melt-index diluent polymer. The foam core sheet "C" was adhesively bonded to top and bottom facing sheets "A", which were 18-point Val-U-Cote™ uncoated paperboard obtained from International Paper Company. The adhesive layers "B" were made of Airflex™ 400 latex binder from Air Products Co. A slight pressure was applied to the "sandwich" structure until the adhesive bonding was set. The samples had an approximate total thickness of 3/16 to 1/4 inch.

As a decomposition test, the samples were placed in a mechanical stirrer with water for about 15 seconds. The foam core was found to be completely broken up and dissolved, and the paperboard was reduced to fiber. Small clumps of residue material and undigested fiber were visible.

Another suitable biodegradable material for foam core board is foam created from polymer compositions containing destructurized starch. Starch-based resin compositions for water soluble foams are disclosed, for example, in U.S. Patent 5,095,054 issued in the names of Gustav Lay et al., and assigned to Warner-Lambert Company, of Morris Plains, New Jersey, which is

incorporated herein by reference. Suitable starch-based resin compositions are available from Novon Products Division of Warner-Lambert Company under the names Novon Type R0323 and R0351, and contain a blend of starch, polyethylene, polyvinyl alcohol, polyvinyl acetate, and glycerol as a plasticizer. These starch-based resin mixtures use water as a blowing agent where polystyrene is added as a diluent polymer. Polyethylene, polypropylene or other aryl polymers or olefinic polymers, derivatives, or copolymers thereof can be used as the diluent polymers. Other blowing agents, such as endothermic blowing agents from Reedy International Corp., or low molecular weight alcohols, atmospheric gases, hydrocarbons, or halogenated hydrocarbons may also be used.

Example 2

An example of the starch-based resin foam core will now be described with reference to the two-sided foam core board structure illustrated in Fig. 1. Samples were produced having foam core sheets "C" produced by extrusion of foam containing Novon Type R0323 and R0351 starch-based resin compositions from Novon Products Division of Warner-Lambert Company, using Safoam™ RIC-50 endothermic blowing agent from Reedy International Corp. A slot die of "coat-hanger" design was used with the extruder to obtain foam core thicknesses of about 1/16 to 1/8 inch. Different combinations of surface facings "A" were tested: (a) both sides faced with bleached paperboard having a thickness of 0.010 to 0.025 inch; (b) both sides faced with resin saturated bleached paperboard with a thickness of 0.010 to 0.025 inch; (c) one side faced with bleached paperboard and the opposite side faced with unbleached kraft board with a thickness of 0.010 to 0.050 inch; (d) one or both sides faced with a

white-clay-coated board with a thickness of 0.010 to 0.025 inch; (e) one or both sides faced with a white-clay-coated board with a thickness of 0.010 to 0.065 inch; (f) variations including colored facing sheets; (g) variations including recycled paper or paperboard. The samples were laminated using Airflex™ 421 self-catalyzing polyvinyl acetate water-based adhesive from Air Products Co. roller-coated as the adhesive layers "B", and pressed in a Pasedena press at 5-20 psi heated to 150-175°F with a residence time of 2 to 4 minutes.

The samples were found to have good facing-to-core bonding. In decomposition tests, the samples were found to be well broken up by mechanical stirring and dissolved by immersion in water after a short time, and the paperboard was reduced to fiber. Small clumps of residue material and undigested fiber remained.

Other foamable biodegradable polymers may be used to form a biodegradable foam core board. In particular, polylactic acid polymers are capable of forming sheets by common extrusion methods, and have good decomposition properties in a suitable environment. Such polylactic acid polymers for degradable resins are obtainable, for example, from Cargill Corp., of Minneapolis, Minnesota. The principal requirement for use as foam core board is that the foam material be selected and combined with suitable additives of diluent polymers and other blowing and forming agents so as to have sufficient structural rigidity when formed. Other foamable degradable polymers include, but are not limited to, hydroxy buterate valerate, polyethylene oxide blends, polycaprolactone, and blends of these materials with other diluent polymers.

The foam core board laminate may also be formed in other ways besides roller-coated water-based adhesives. Paper adhesives, adhesives made of the same materials as

the foam core materials, and other suitable bonding adhesives may also be used. The press for press-bonding the layers together can be thermally and mechanically controlled to obtain the desired bonding between the foam core and facings and to maintain composite thickness control. The foam core may also be thermally bonded to the facings by melting the surfaces of the foam core at the point of contact with the facing material at the entrance to a continuous press. A heat-activated adhesive could instead be pre-applied to the foam-contacting side of the facing material and then mated with the foam core. The lamination step can be done in continuous fashion from pre-extruded supply rolls of the foam core and facing sheets, or in batch processing with cut sheets. Alternatively, the molten foam sheet may be directly extruded between the two facing layers at the entrance to a continuous press. This alternative is illustrated in Fig. 2 having the foam core sheet "C" contact bonded directly to the facing sheets "A".

The facing material is not limited to paper or paperboard, but may also be other surfacing or support materials, such as wood, metal, polymer sheets or films, or laminate structures.

Numerous modifications and variations are of course possible given the above disclosure of the broad principles and best mode of carrying out the invention. It is intended that all such modifications and variations be considered as within the spirit and scope of the invention, as defined in the following claims.

CLAIMS

1. A compostable, biodegradable foam core board comprising:

a foam core sheet made of a foamable, biodegradable material selected from the group comprising a polyvinyl alcohol polymer, a starch-based thermoplastic polymer, a polylactic acid polymer, and other foamable, biodegradable polymers having structural rigidity when foamed; and

a facing sheet adhered to at least one side of said foam core sheet.

2. A compostable, biodegradable foam core board according to Claim 1, wherein said foam core sheet has selected structural properties including a foam core weight of about 25 to 80 lbs/msf, a foam density of about 1.5 to 15 lbs/ft^3, and a foam cell size of about 0.20 to 1.24 mm.

3. A compostable, biodegradable foam core board according to Claim 2, wherein said foam core sheet has a foam core weight of 30 to 50 lbs/msf, a foam density of 2.0 to 9 lbs/ft^3, and a foam cell size of 0.30 to 0.70 mm.

4. A compostable, biodegradable foam core board according to Claim 1, wherein said foam core material is composed of a mixture of a polyvinyl alcohol material and a diluent polymer.

5. A compostable, biodegradable foam core board according to Claim 4, wherein said diluent polymer of said foam core material is a high-melt-index polystyrene.

6. A compostable, biodegradable foam core board according to Claim 1, wherein said foam core sheet is adhesively bonded to top and bottom facing sheets.

7. A compostable, biodegradable foam core board according to Claim 1, wherein facing sheet is adhesively bonded to said foam core sheet with an adhesive bonding layer.

8. A compostable, biodegradable foam core board according to Claim 1, wherein said foam core material is a polymer composition containing destructurized starch.

9. A compostable, biodegradable foam core board according to Claim 8, wherein said starch-based foam core material contains a blend of starch, polyethylene, polyvinyl alcohol, polyvinyl acetate, and glycerol as a plasticizer.

10. A compostable, biodegradable foam core board according to Claim 1, wherein said foam core material includes a diluent polymer added for structural properties.

11. A compostable, biodegradable foam core board according to Claim 1, wherein said foam core material includes a blowing agent selected from the group comprising a low molecular weight alcohol, an endothermic blowing agent, an atmospheric gas, a hydrocarbon or halogenated hydrocarbon.

12. A compostable, biodegradable foam core board according to Claim 1, wherein said facing sheet is made of a material selected from the group comprising paper, paperboard, wood, metal, and polymer sheet or film.

13. A compostable, biodegradable foam core board according to Claim 1, wherein said foam core material is a polylactic acid polymer, copolymer or derivative thereof.

14. A compostable, biodegradable foam core board according to Claim 1, wherein said foam core sheet is thermally bonded to the facing sheet.

15. A compostable, biodegradable foam core board according to Claim 1, wherein said foam core sheet is bonded to said facing sheet by direct extrusion in contact with the facing sheet.

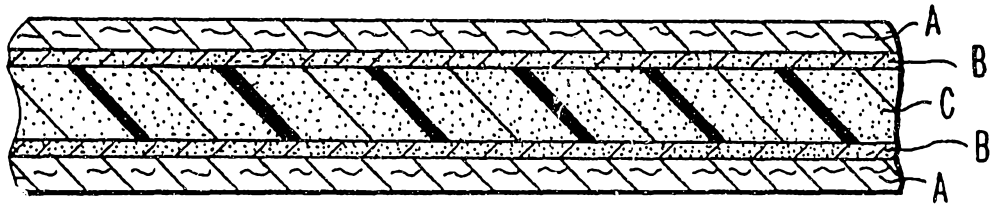


FIG.1

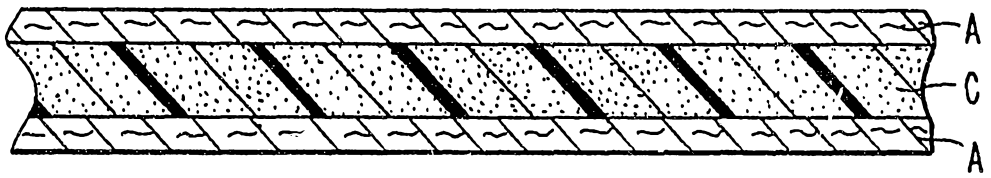


FIG.2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US94/07625

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :C08F 16/06; B32B 5/14
US CL :428/304.4, 308.4, 318.4, 319.1; 521/141, 916
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)

U.S. : 428/304.4, 308.4, 318.4, 319.1; 521/141, 916

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

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 3,415,714 (HIDER) 10 December 1968, see entire document.	1-15
Y	US, A, 4,863,655 (LACOURSE ET AL) 05 September 1989, see entire document.	1-15
Y	US, A, 5,089,535 (MALWITZ ET AL) 18 February 1992, see entire document.	1-15

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

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

"E" earlier document 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
16 AUGUST 1994	AUG 29 1994
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer Lene Weaver for BLAINE R. COPENHEAVER Telephone No. (703) 308-2351

Form PCT/ISA/210 (second sheet)(July 1992)*