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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 4 : C01B 3/36	A1	(11) International Publication Number: WO 86/ 06055 (43) International Publication Date: 23 October 1986 (23.10.86)

(21) International Application Number: PCT/GB86/00198

(22) International Filing Date: 11 April 1986 (11.04.86)

(31) Priority Application Number: 8509271

(32) Priority Date: 11 April 1985 (11.04.85)

(33) Priority Country: GB

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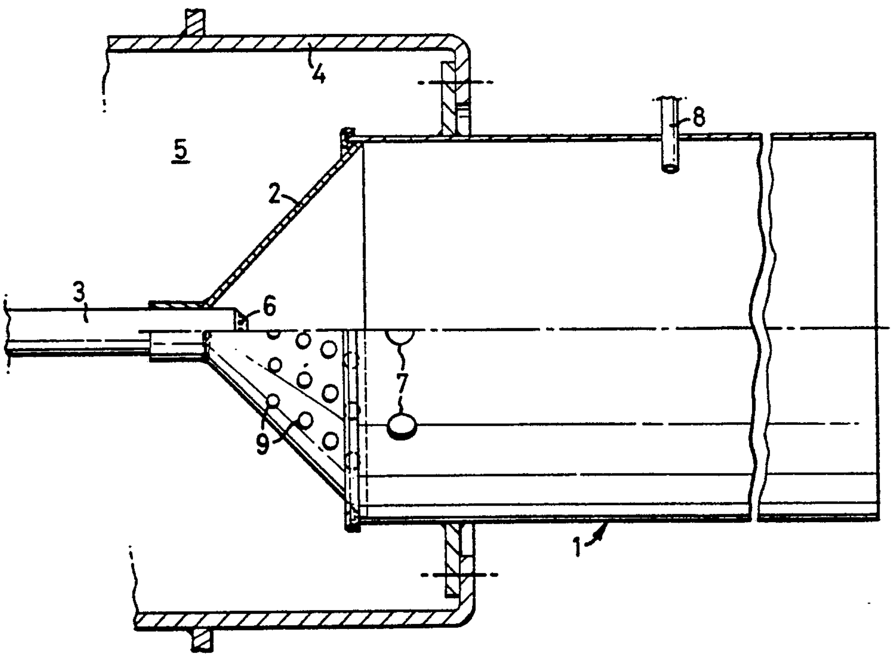
(81) Designated States: AU, DE, GB, JP, NL, NO, US.

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: PARTIAL COMBUSTION OF HYDROCARBONS



(57) Abstract

A process for the conversion of hydrocarbons in which a gaseous fuel is mixed with an oxygen containing gas in a reactor (1) by passing one component through an annular space (5) and then through the holes (9) of a foraminous cone (2) and the other component through the nozzle (3) located at the throat of the cone. The resultant fuel/oxygen containing gas composition is fuel rich and is ignited (B) and reacted in the reaction chamber. The product of the process may be withdrawn and collected.

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Partial combustion of hydrocarbons

The present invention relates to a process for the partial combustion of hydrocarbons to produce useful products.

It is desirable to convert readily available feedstocks such as natural gas into more commercially useful products such as higher hydrocarbons, unsaturated hydrocarbons, synthesis gas, and methanol. The present invention relates to a conversion process for such a purpose and which is flexible in operation.

Thus according to the present invention there is provided a process for the conversion of hydrocarbons comprising the steps of (a) passing a gaseous fuel or an oxygen containing gas through a foraminous cone so as to mix with oxygen containing gas or a gaseous fuel issuing from a nozzle located at the throat of the cone, (b) the fuel/oxygen containing gas composition being fuel rich, (c) igniting and reacting the resultant mixture, and (d) withdrawing the products of the process.

The fuel is suitably natural gas, liquid petroleum gas, residual fuels, liquid containing dispersed solid fuels etc. and the oxygen containing gas may be pure oxygen, oxygen-enriched air or air. The reactants are preferably pre-heated before introduction to the reactor.

The reactor for the process has an external housing which encloses the foraminous cone. The housing may have holes located downstream of the cone in order to allow quenching e.g. by the use of radially injected water, of the products to conserve any higher hydrocarbons. Also the products may be quenched with gaseous or liquid hydrocarbons to increase the yields of higher hydrocarbons. Thus the quenching stage may be used to control the final products of the claimed process.

The materials of construction of the reactor include metals, such as stainless steel, and ceramics and are chosen to withstand the temperature and conditions of reactor operation.

The foraminous cone is preferably a cone having rows of holes extending along radial lines from the throat of the cone. The rows may be straight or have a curved configuration. The cross-section of the holes may increase from the throat to the mouth of the cone. The hole size is dependent on the required throughput and pressure drop of the reactor (the pressure drop usually being of the order 2-3½% of the pressure in the system). The holes may be of various shapes such as circular, square, diamond-like, oval etc.

The nozzle preferably has a plurality of outlets, each outlet preferably being adapted to direct fuel or oxygen containing gas between the rows of holes, most preferably one outlet being associated with a specific row of holes. The nozzle may be cooled e.g. by a steam or water line.

A reactor arrangement which may be adapted for use in the present invention is disclosed in UK patent application No 1575641.

At atmospheric pressure the preferred fuel rich composition is 1.1 to 5 times the ratio of fuel/oxygen for complete combustion to carbon dioxide and water (stoichiometric ratio), but these limits are extendable if operation at system pressures of greater than atmospheric are envisaged. The composition will vary dependent upon the fuel used. Commercial reactor systems would probably be operated at elevated pressures of up to 100 bar.

It is also envisaged that hydrogen or steam may be co-fed with either the hydrocarbon fuel or the oxygen containing gas or both.

The products of the reaction vary depending upon the reactants, conditions, quenching etc. and may include carbon monoxide, hydrogen, water, carbon dioxide, methane and higher hydrocarbons.

It is envisaged that for the conversion of large quantities of fuel, an array of reactors could be used.

The invention will now be described by way of example only and with reference to Figures 1 and 2 of the accompanying drawings.

The reactor takes the form of cylindrical housing 1 which encloses a foraminous cone 2. A nozzle is located at the throat of the cone 2 for supplying either oxygen or fuel to the interior of the cone. The nozzle is supplied by tube 3 which has its longitudinal axis co-axial with the axis of the housing.

In the present example, oxygen is supplied from feed pipes (not shown) into the annular space 5 between the housing 4 and the tube 3 and passes through the holes 9. An intermediate tube (not shown) is connected to a source of water or steam which acts as a coolant for the nozzle 3. The tube 3 is connected to a fuel supply (not shown) and the fuel emerges from outlets 6 in the nozzle.

The cone 2 which may be fabricated from say stainless steel, ceramic materials, or quartz has rows of holes 9 extending along radial lines from the throat of the cone. The rows have a slightly curved configuration and the cross-section of the holes increases in size from the throat to the mouth of the cone. In the present example the diameter of the holes was in the range 2 to 3 mm (Figure 2).

The nozzle has a plurality of outlets capable of directing fuel along the internal surface of the cone. The nozzle outlets are adapted to direct the fuel between the rows of holes, each outlet being associated with one row of holes.

The reactor may be used either (a) with fuel gas emerging from the nozzle outlets so as to mix with oxygen or an oxygen containing gas passing through the holes of the cone or alternatively (b) with oxygen or an oxygen containing gas emerging from the nozzle outlets so as to mix with fuel passing through the holes of the cone. The present example is directed towards alternative (a).

During use of the reactor, fuel gas in the form of methane is supplied to the tube 3 and emerges in a series of jets from the nozzle outlets. Oxygen or oxygen-enriched air is supplied from the plenum chamber (not shown) and emerges from outlets into the annular space 5 and thereby passes through the holes into the interior of the cone. The angle of the methane and oxygen jets intimately mixes the methane and oxygen. The methane/oxygen mixture is ignited within the cone by means of a spark igniter 8. The products of the reaction are drawn off downstream from the cone.

Further holes 7 in the housing may be used to pass quenching steam or water into the reaction zone.

Figure 2 shows the cone 2 in greater detail. The ten datum lines 20 are equi-spaced at 36° intervals. For example, relative to each datum line is a row of four holes, there being a total of forty holes in the cone. The cross section of the hole increases in the direction from the throat to the mouth of the cone. Figure 2(a) is a view from the inside of the cone and figure 2(b) is a side view.

The table shows results obtained for the conversion process using natural gas as fuel and oxygen or oxygen enriched air as the oxygen containing gas. There was no pre-heating of the reactant gases and there was little or no soot formation.

Run numbers 1 to 4 show the effect of increasing oxygen content of the reactant gases, and run numbers 5 to 10 show the production of C_2+ in the products. By variation of the oxygen content of the reactant gases, the relative yields of C_2+, carbon monoxide and hydrogen in the product gases may be controlled. Further flexibility of control may be achieved by suitable application of a quenching step (run numbers 5 to 12 are the subject of water quenching) to give enhanced yields of C_2+.

Table

Run Number	O_2/f % v/v	% O_2 in oxidant	Product gas (% mol dry)						Selectivity %		Conversion %
			CO	CO_2	H_2	C_2^+	CH_4	N_2	CO	C_2^+	
1	1.2	27.5	13.5	5.0	11.6	0.36	0.31	68.6	70.2	3.7	98.2
2	0.82	25.0	14.8	3.9	16.7	1.54	2.48	60.1	67.8	13.9	88.6
3	1.13	49.0	26.5	5.7	30.2	0.0	0.0	37.7	82.4	0.0	100.0
4	0.89	49.5	24.0	3.4	38.4	0.71	0.87	31.8	83.2	4.9	96.7
5	0.55	100.0	26.2	4.1	49.2	6.1	12.3	2.0	59.7	30.9	75.7
6	0.55	100.0	25.7	5.3	50.1	5.3	9.5	2.0	60.8	29.9	77.8
7	0.52	100.0	24.6	5.7	47.7	5.6	12.4	2.0	58.1	32.9	72.1
8	0.54	100.0	25.3	4.7	49.6	5.1	11.4	2.0	63.6	27.5	75.5
9	0.54	100.0	24.4	5.7	48.8	5.3	11.9	2.0	63.4	29.6	74.0
10	0.57	100.0	25.5	4.9	50.9	5.5	9.2	4.0	61.6	28.5	80.0
11	0.65	100.0	30.8	4.9	51.3	2.0	6.8	4.0	76.0	11.9	82.8
12	0.68	100.0	32.7	4.2	51.7	1.8	5.5	4.0	74.6	12.1	87.2

Claims:

1 A process for the conversion of hydrocarbons comprising the steps of (a) passing a gaseous fuel or an oxygen containing gas through a foraminous cone so as to mix with oxygen containing gas or a gaseous fuel issuing from a nozzle located at the throat of the cone, (b) the fuel/oxygen containing gas composition being fuel rich, (c) igniting and reacting the resultant mixture, and (d) withdrawing the products of the process.

2 A process according to claim 1 in which the gaseous fuel is natural gas or methane.

3 A process according to claim 1 or claim 2 in which the oxygen containing gas is pure oxygen, oxygen-enriched air or air.

4 A process according to any of claims 1 to 3 in which the cone has rows of holes extending along radial lines from the throat of the cone.

5 A process according to claim 4 in which the rows are straight or have a curved configuration.

6 A process according to claim 4 or claim 5 in which the cross-section of the holes increases from the throat to the mouth of the cone.

7 A process according to any of the preceding claims in which the nozzle has a plurality of outlets.

8 A process according to claim 7 in which each outlet is adapted to direct the fuel or the oxygen containing gas between the rows of holes of the cone.

9 A process according to claim 8 in which each outlet is associated with a specific row of holes.

10 A process according to any of the preceding claims in which the products of the reaction are quenched prior to withdrawal.

11 A process according to any of the preceding claims in which hydrogen or steam is co-fed with the fuel or the oxygen containing gas or both.

12 A process according to any of the preceding claims which is operated at elevated pressure.

13 A process according to any of the preceding claims in which one or both of the gaseous fuel and oxygen containing gas are pre-heated prior to ignition and reaction.

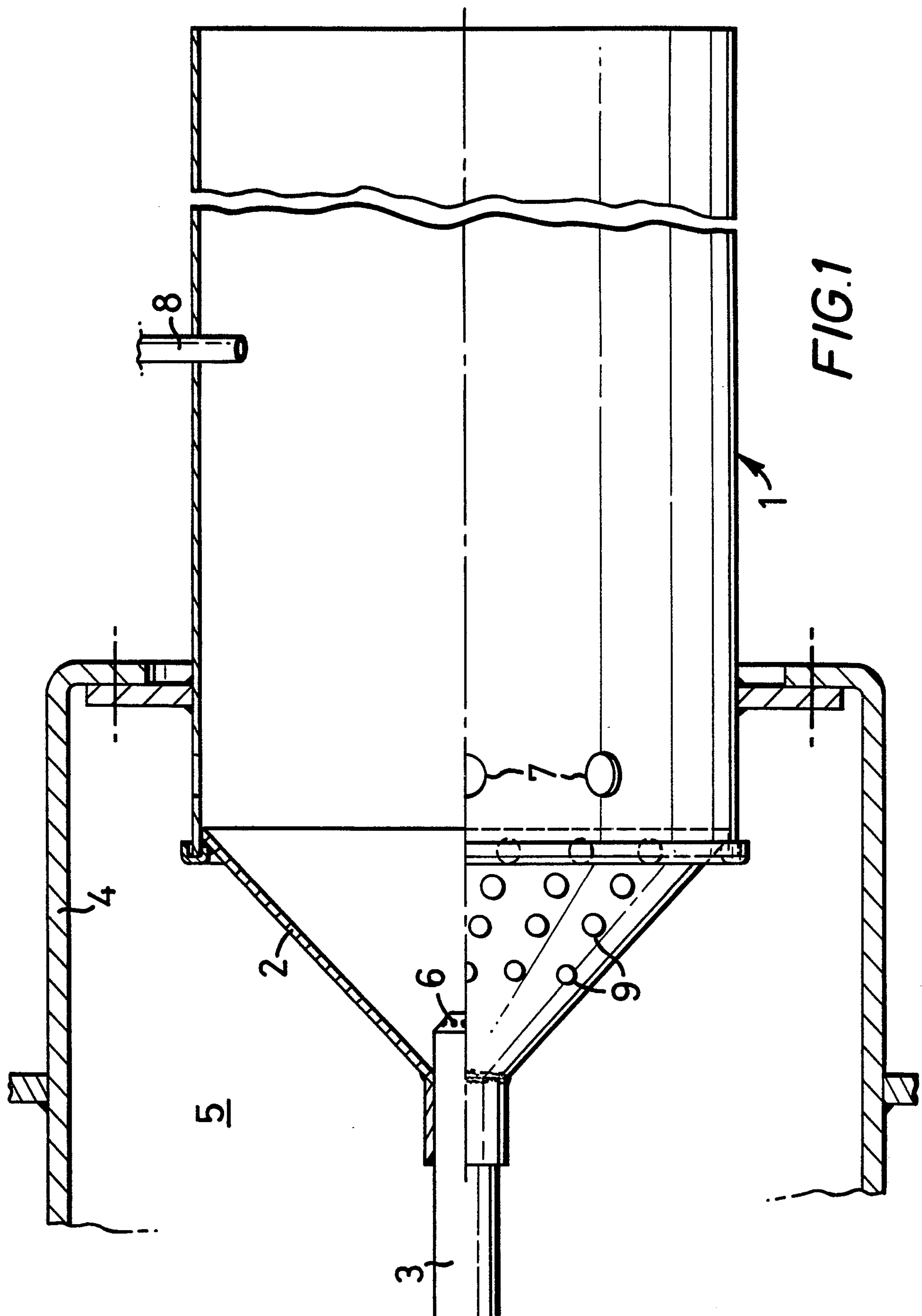

FIG.1

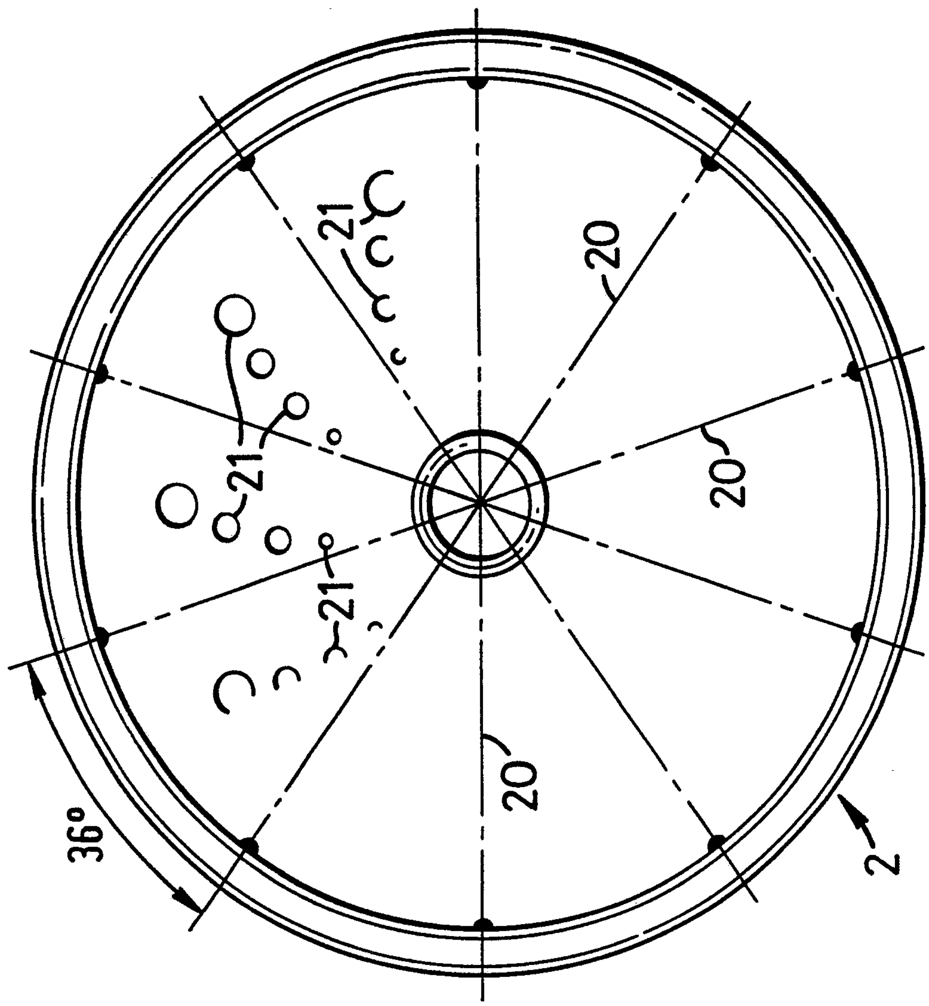

FIG. 2(a)

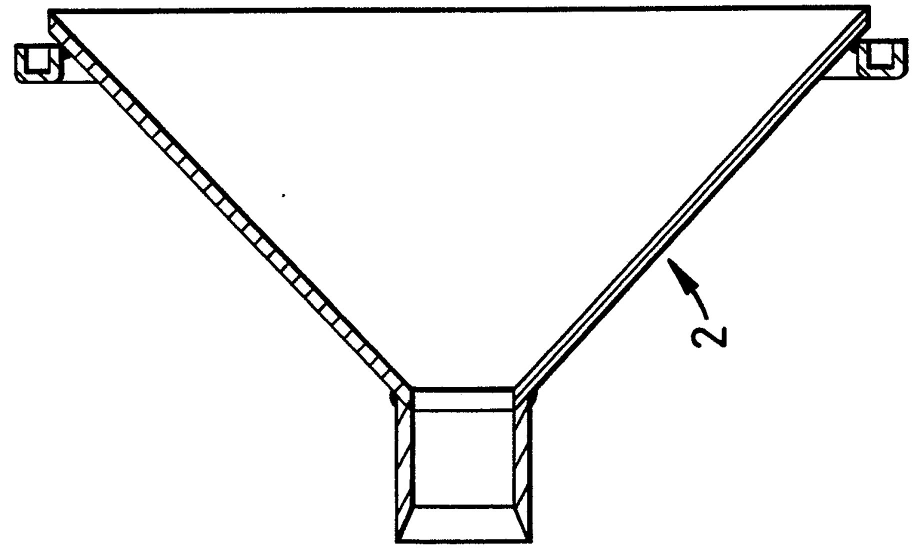

FIG. 2(b)

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 86/00198

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC^4: C 01 B 3/36

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC^4	C 01 B 3/00

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	GB, A, 827719 (R.P. FRASER) 10 February 1960 see figure 2; page 3, lines 69-84; lines 109-123; page 4, lines 1-27	1,3
X	GB, A, 827720 (R.P. FRASER) 10 February 1960 see figure 2; page 1, lines 23-44 and lines 57-60; page 1, line 79 - page 2, line 44; page 2, lines 75-82; line 120 - page 3, line 33	1,3
A	US, A, 2701756 (DU BOIS EASTMAN et al.) 8 February 1955	
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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
8th August 1986	10 SEP 1986
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	L. ROSSI

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 86/00198 (SA 12929)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 25/08/86

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A- 827719		None	
GB-A- 827720		None	
US-A- 2701756		None	
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