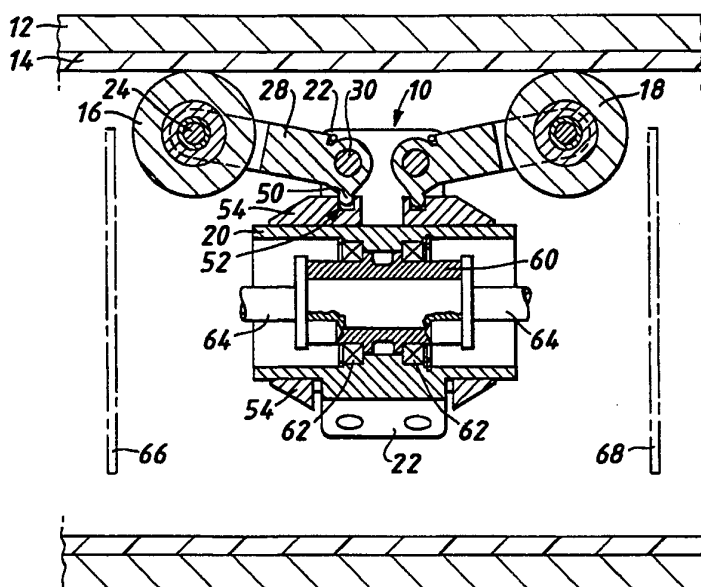




INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification ⁶ : F16L 55/26</p>	<p>A1</p>	<p>(11) International Publication Number: WO 96/37726 (43) International Publication Date: 28 November 1996 (28.11.96)</p>
<p>(21) International Application Number: PCT/GB96/01200 (22) International Filing Date: 20 May 1996 (20.05.96) (30) Priority Data: 9510317.2 22 May 1995 (22.05.95) GB (71) Applicant (for all designated States except US): BRITISH GAS PLC [GB/GB]; Rivermill House, 152 Grosvenor Road, London SW1V 3JL (GB). (72) Inventor; and (75) Inventor/Applicant (for US only): STOVES, Derek [GB/GB]; 28 Malaga Close, St. Johns, Newcastle upon Tyne NE5 1YB (GB). (74) Agent: KINRADE, John; British Gas plc, Intellectual Property Dept., 59 Bryanston Street, London W1A 2AZ (GB).</p>		<p>(81) Designated States: CA, CZ, HU, JP, PL, RU, SK, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>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.</i></p>

(54) Title: SELF-CENTERING SUSPENSION FOR IN-PIPE USE



(57) Abstract

A self-centering suspension (10) for use in supporting a vehicle or vehicles intended to travel in a pipeline (12) comprises a body (20) and two sets of three wheels (16, 18) spaced apart along the length of the body (20). Each wheel is mounted on a lever arm (28) biased by torsion springs (40, 42) against the inner surface of the pipeline. Each lever arm (28) has a stub arm (50) which is eccentrically arranged relative to a rotary joint in the form of a pin (30), and the stub arm slidingly engages a circumferential groove (52) in a ring (54). Each ring (54) slides on the body (20). A set of three wheels are thus constrained to move inwards and outwards together.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

- 1 -

SELF-CENTERING SUSPENSION FOR IN-PIPE USE

The invention relates to self-centering suspensions for in-pipe use.

In-pipe vehicles which require centering within the pipe are normally supported by polymer cups, wire brushes, or several wheels on independently spring loaded lever arms. The former two generate high levels of frictional resistance, and the latter requires relatively stiff springs on the lever arms partially to counteract the load exerted by the opposite lever arms. Therefore centralising a vehicle in a pipe to within accurate limits, whilst maintaining some automatic adjustment for variations in pipe size, is difficult to achieve and requires large forces, thus high frictional resistance to linear motion of the vehicle, and high resistance to traversing a pipe of reducing diameter.

According to the invention there is provided a self-centering suspension for use in supporting a vehicle or vehicle intended to travel in a pipeline, said suspension comprising a body and a set of wheels, each wheel being mounted at a first end of an arm having a second end connected to said body by a rotary joint permitting the wheel to move inwards and outwards to accommodate changes in the diameter of an inner surface of the pipeline as the wheels traverse the inner surface,

- 2 -

spring means arranged to be stressed by inward
movement of a said wheel, each arm having a stub arm
eccentrically arranged with respect to said rotary joint,
each stub arm slidingly engaging a circumferential groove
5 in a ring reciprocable on the body longitudinally
thereof, and the stub arms and ring together forming
coupling means arranged to allow only movement of all the
wheels in the set simultaneously.

Preferably, said spring means comprises respective rotary
10 spring means arranged between a said arm in each case and
the body, and the spring means being arranged around the
respective rotary joint.

The invention will now be further described, by way of
example, with reference to the accompanying drawings in
15 which:

Fig. 1 is a diagrammatic three-dimensional view of
the suspension;

Fig. 2 is an end elevation of the suspension shown
in Fig. 1; and

20 Fig. 3 is a vertical cross-section on the line
III-III in Fig. 2, with parts removed.

Figs. 1 to 3 show a self-centering suspension 10 for use
in supporting a vehicle intended to travel in a pipeline

- 3 -

12. For example, the pipeline 12 is a cast iron gas main and contains a liner 14 of polyethylene upon the inner surface of which wheels 16, 18 run. There are three wheels 16 in a first set of wheels spaced apart
5 equiangularly around a body 20. There are three wheels 18 in a second set of wheels also spaced apart equiangularly around the body 20. The wheels 18 each lie in a common plane with a wheel 16 in this example. However, this is not essential and the wheels 16, 18 may
10 lie in different planes. The two sets of wheels 16, 18 are spaced apart along the length of the body 20.

The vehicle is intended to be used, in this example, for the purpose of cutting an aperture in the liner at an
15 offtake so that a plastic service pipe can be inserted in an existing steel service pipe and the plastic pipe joined to the liner at the aperture cut by the machine. However, the invention is operable in pipelines and ducts whether they are lined or not.

The body 20 carries three brackets 21 arranged
20 equiangularly about the body 20. Each bracket 21 terminates at opposite ends in arms 22.

The following description applies to the first set of wheels 16.

Each wheel 16 is mounted on a pin 24 between two arms 26
25 of a fork formed at one end of a lever arm 28. The other

- 4 -

end of the lever arm 28 is connected by a rotary joint in the form of a pin 30 to adjacent arms 22 of the brackets 21.

5 Torsion springs 40, 42 are arranged around the pin 30 between the lever arm 28 and the arms 22 fixed to the body 20. Inward movement of the wheel 16 and the lever arm 28 stresses the torsion springs 40, 42.

10 The lever arm 28 has a stub arm 50 eccentrically arranged with respect to the rotary joint or pin 30 and the end of the stub arm 50 slidingly engages opposite side walls of a circumferential groove 52 formed in the exterior surface of a ring 54. The ring 54 embraces the body 20 and is free to slide to and fro along the body 20 in the lengthwise direction.

15 Thus, the three wheels 16 of the first set are constrained to move together inwards and outwards relatively to the body 20 as the diameter of the inner surface of the liner 14 varies during travel of the suspension along the pipeline 12. The stub arm 50 and 20 the ring 54 together form a coupling means by which only movement of all of the lever arms 28 is allowed.

The description of the first set of wheels 16 just given above applies in similar fashion to the second set of wheels 18.

- 5 -

The body 20 is hollow and it contains a bearing member 60 supported on the body 20 by two ball bearings 62. The bearing member 60 is connected at each end to a coupling rod 64 which is connected to a vehicle in a train of
5 vehicles intended to travel along the inside of the pipeline 12. End plates 66, 68 are shown which are connected to the vehicles (not shown) on either side of the suspension 10. A suspension 10 which is last in the train of vehicles can support only one vehicle, of
10 course. The weight of the vehicles is supported only by the suspension 10 and by similar suspensions (not shown) arranged in similar fashion beyond the distant ends of the vehicles.

The provision of the bearings 62 enables the vehicles to
15 be rotated relatively to the suspension 10.

The springs 40, 42 are chosen so that there is a pre-load in the springs when the suspension 10 enters the pipeline 12. The pre-load is chosen so that the springs hold the vehicles centralised in the pipeline 12 for all the
20 diameters of the inner surface of the liner 14 to be encountered.

The suspension has been developed to achieve accurate centralisation, using a wheeled system to minimise resistance to linear motion, and interconnecting the
25 centralising lever arms to ensure that the only force on the supported body is to encourage centering of it rather

- 6 -

than opposing its centering.

Any displacement of the body 20 from the centre line of the pipe creates an inward force on the wheel or wheels opposing the displacement which in turn creates
5 deflection of the remaining wheel or wheels in the set. There is thus created a centering force on the body. There will remain a centering force on the body until all three arms again contact the pipe wall, thus removing the centering force and stabilising the body.

10 Since all three lever arms are compressed simultaneously by any eccentric movement of the body, the individual spring stiffness and preload is considerably less than that required of independent lever arms. The energy absorbed in centering the vehicle is therefore lower, and
15 the frictional resistance to linear travel will therefore be lower.

This approach to suspending a the body of a vehicle concentrically within a pipe provides significant advantages, particularly where accuracy of centering is
20 important and where it is necessary to minimise the energy absorbed by traversing the vehicle along the pipe.

In a modification, not shown, the springs 40, 42 can be replaced by springs other than torsion springs. For example, the lever arms can act on compression springs,
25 on extension springs, on leaf springs or on blocks of resilient material.

- 7 -

CLAIMS

1. A self-centering suspension for use in supporting a vehicle or vehicles intended to travel in a pipeline, said suspension comprising a body and a set of wheels, each wheel being mounted at a first end of an arm having
5 a second end connected to said body by a rotary joint permitting the wheel to move inwards and outwards to accommodate changes in the diameter of an inner surface of the pipeline as the wheels traverse the inner surface, spring means arranged to be stressed by inward movement
10 of a said wheel, each arm having a stub arm eccentrically arranged with respect to said rotary joint, each stub arm slidingly engaging a circumferential groove in a ring reciprocable on the body longitudinally thereof, and the stub arms and ring together forming coupling means
15 arranged to allow only movement of all the wheels in the set simultaneously.
2. A suspension as claimed in Claim 1, in which said spring means comprises respective rotary spring means arranged between a said arm and the body, and the rotary
20 spring means being arranged around the respective rotary joint.

3. A suspension as claimed in Claim 1 or Claim 2, having three wheels in each set.
4. A suspension as claimed in any one preceding claim, in which said body has two said sets of wheels and there
- 5 being two said coupling means, one said coupling means allowing only movement of the wheels in one said set and the other said coupling means allowing only movement of the wheels in the other said set.

FIG. 1.

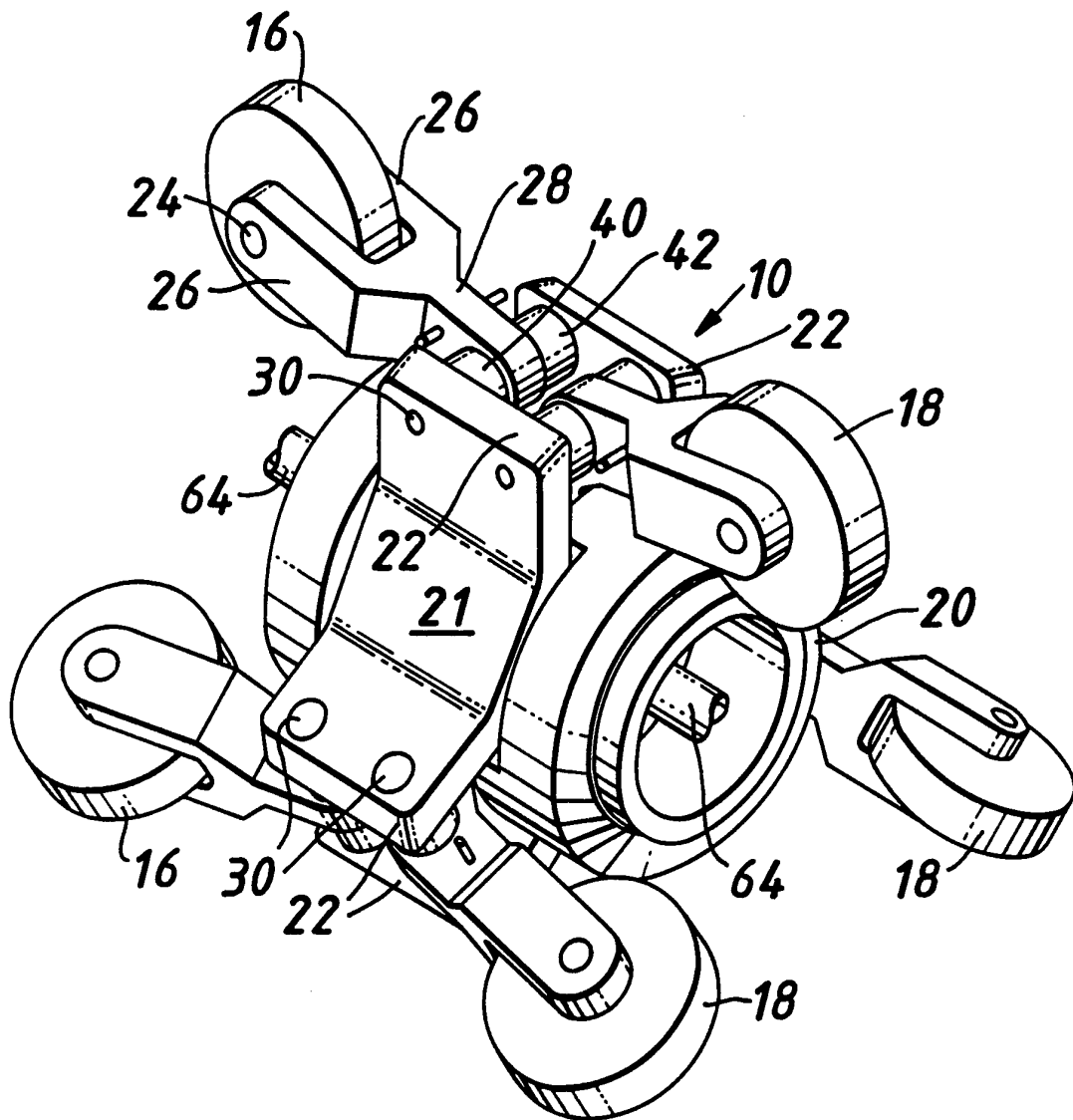
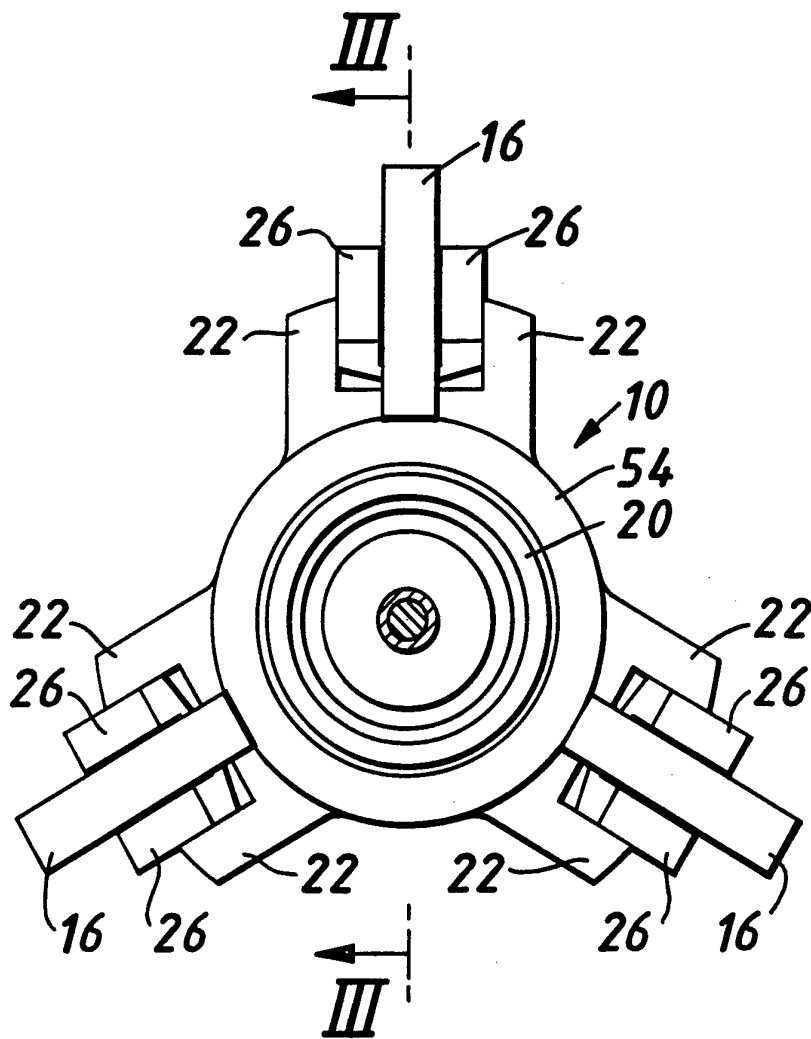


FIG. 2.



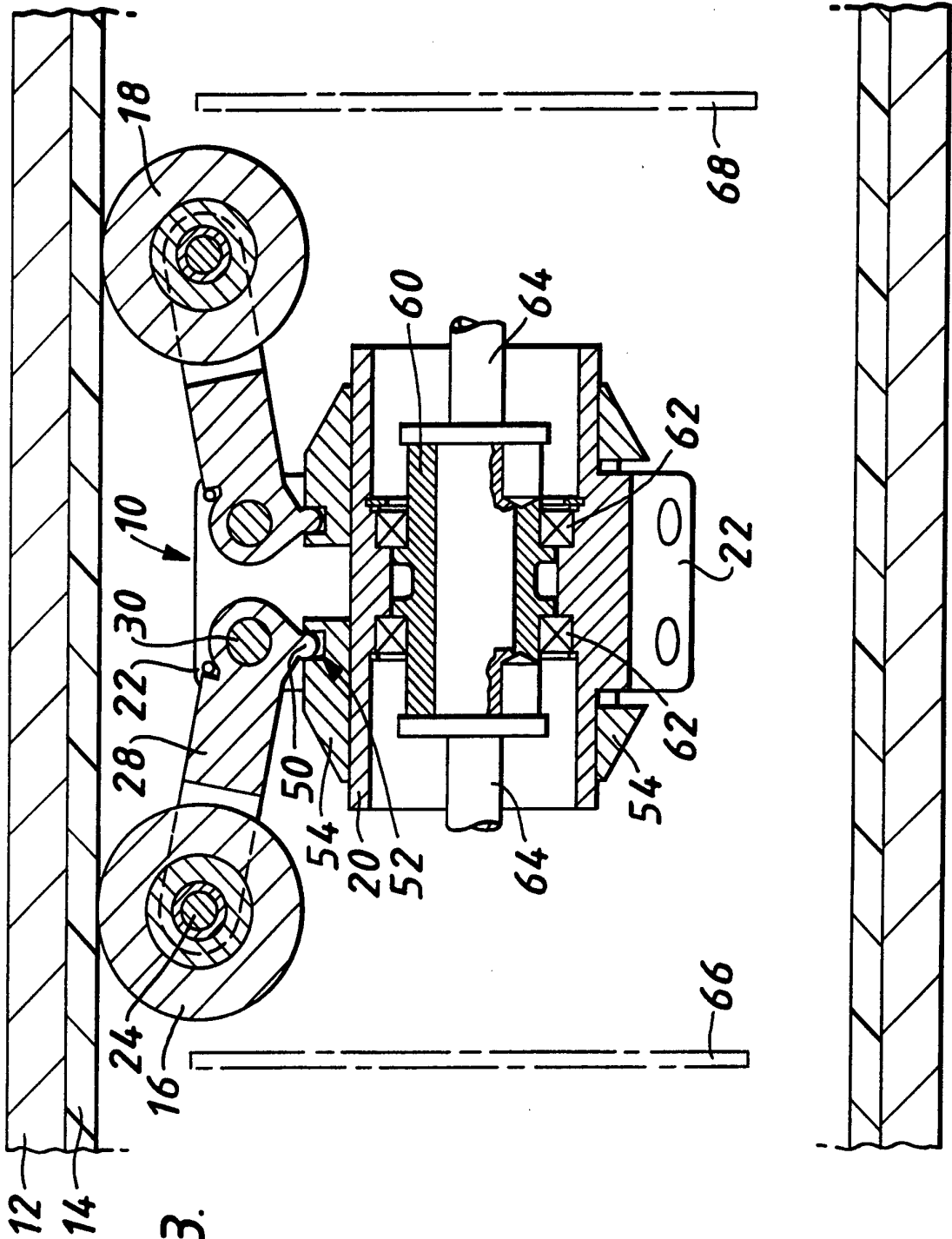



FIG. 3.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/GB 96/01200

A. CLASSIFICATION OF SUBJECT MATTER		
IPC6: F16L 55/26 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)		
IPC6: B08B, F16L, G21C		
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 practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB, A, 2122713 (MANNESMANN AKTIENGESELLSCHAFT), 18 January 1984 (18.01.84), page 1, line 104 - line 112, figure 1 --	1
A	EP, A1, 0105418 (HITZEL, RAINER), 18 April 1984 (18.04.84), page 14, line 9 - line 22, figure 5 -- -----	1
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> 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
4 Sept 1996		- 4. 11. 96
Name and mailing address of the ISA/  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		Authorized officer Axel Lindhult

SA 135128

INTERNATIONAL SEARCH REPORT

Information on patent family members

31/07/96

International application No.

PCT/GB 96/01200

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A- 2122713	18/01/84	DE-A, C- 3224498	02/02/84
		FR-A, B- 2529295	30/12/83
		JP-C- 1673502	12/06/92
		JP-B- 3038149	07/06/91
		JP-A- 59013200	23/01/84
EP-A1- 0105418	18/04/84	DE-A- 3236947	12/04/84