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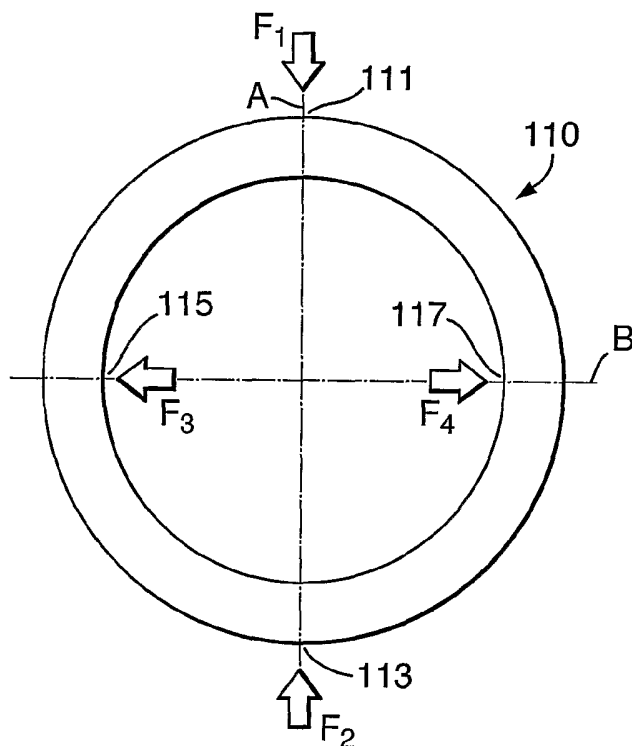
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[Continued on next page]

(54) Title: DEFORMED FORGING



(57) Abstract: A method of manufacturing a forging (110) for forming a split casing comprising the steps of creating a forging (110), for example, by a ring rolling process and then deforming the forging (110) by compressing it along a first axis (A) and/or extending it along a second axis (B).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— *with international search report*

Deformed Forging

The present invention relates to a method of
5 manufacturing a forging for forming a split casing. It particularly relates to forgings which are used to form the casing for a gas turbine engine.

The current process for forming a gas turbine engine casing is illustrated in Figs. 1A, 1B, 1C and 1D. Fig. 1A
10 illustrates a forging 10 created using a ring rolling process. The forging 10 has a cylindrical shape, where the axis of the cylinder extends into the page. The cross-section of the forging 10 illustrated in Fig. 1A is annular. The inner surface 12 of the forging 10 and the
15 outer surface 14 of the forging 10 are concentric cylinders.

The forging 10 is used to form an axial split casing 20 for a gas turbine engine. It may be formed from corrosive resistant steel, titanium or nickel alloy.

20 Fig. 1B illustrates a rough machining which is carried out on the forging 10 of Fig. 1A before the casing 10 is split to form the casing 20. If an orthogonal coordinate system (X, Y) is defined with the origin on the axis of the cylindrical forging 10, then the forging is rough machined
25 in the following way:

a. A lathe is used to remove material from the interior of the forging 10. The lathe cuts a cylindrical tube of radius R1 centred at $(-X1, 0)$.

30 b. A lathe is used to remove material from the interior of the forging 10. The lathe cuts a cylindrical tube of radius R1 centred at $(X1, 0)$.

c. A lathe is used to remove material from the exterior of the forging 10. The lathe cuts a cylindrical tube of radius R2 centred at $(0, Y2)$.

d. A lathe is used to remove material from the exterior of the forging 10. The lathe cuts a cylindrical tube of radius $R2$ centred at $(0, -Y2)$.

In Fig. 1B, the circular dashed lines indicate the original boundaries of the forging 10 before rough machining. The solid lines indicate the boundaries of the forging after rough machining. The dotted lines indicate lines at $Y = -X1$ and $Y = +X1$.

The forging is then axially split by removing the material between $-X1$ and $+X1$ as shown in Fig. 1C to form first 20a and second 20b portions of the axial split casing 20. Fine machining of the portions 20a, 20b is then carried out for example, by milling the interior and exterior of the portions.

The two portions 20a, 20b are then joined as shown in Fig. 1D, to form the axial split casing 20. It will be appreciated, that the axial split casing has a substantially cylindrical shape.

The rough machining of the interior and exterior of the forging illustrated in Fig. 1B is required to compensate for the removal of material between $-X1$ and $+X1$ when the forging is split axially so that the finished product, the axial split casing 20 is substantially cylindrical.

There are several problems associated with the above mentioned process. A considerable amount of material may need to be removed from the interior and the exterior of the forging during the rough machining process. This is a waste of material and also results in excessive wear to the lathes used to perform the rough machining.

It would therefore be desirable to provide an improved process for forming an axial split casing.

According to a first aspect of the present invention there is provided a method of manufacturing a forging for forming a split casing comprising the steps of: creating a forging; and deforming the forging to compress it along a first axis and/or extend it along a second axis perpendicular to the first axis.

For a better understanding of the present invention reference will now be made by way of example only to the following Figs. in which:

10 Figs. 1A to 1D illustrate the prior art process for forming a split casing; and,

Figs. 2A to 2D illustrate a new method of forming a split casing according to one embodiment of the present invention.

15 The forging 110 illustrated in Fig. 2A is formed by a ring rolling process and it may, for example, be made from corrosion resistant steel, titanium or a nickel alloy. The forging 110 has a cylindrical tubular shape, where the axis of the cylindrical tube extends into the page. The cross-section of the cylindrical tubular forging 110 illustrated in Fig. 2A is annular. The inner surface 112 of the forging 110 and the outer surface 114 of the forging 110 are concentric cylinders.

25 The forging 110 of Fig. 2A is deformed to form the deformed forging 118 illustrated in Fig. 2B. The deformation may be achieved by compressing the forging along the axis A, which passes through the axis of the cylindrical forging 110, dividing it into two equal portions. Alternatively, or in addition, the cylindrical forging may be deformed by extending the cylindrical forging of Fig. 2A along the axis B which extends through the axis of the cylindrical forging and divides the cylindrical forging into two equal portions. The first axis A and the second axis B are orthogonal to each other

and to the axis of the cylindrical forging 110. The deformation is achieved by using mandrels to apply force to the forging 110. For example, to compress the forging along the axis A, a first mandrel is used to apply a force
5 F1 along the first axis towards the axis of the cylindrical forging 110 at position 111 and a second mandrel is used to apply an opposing force F2 at position 113 along the axis A towards the axis of the cylindrical forging 110. In order to extend the forging along the second axis B, a third
10 mandrel applies a force F3 to the interior surface of the cylindrical forging at a position 115 along the axis B away from the axis of the cylindrical forging 110 and a fourth mandrel applies a force F4 to the interior surface of the cylindrical forging at a position 117 along the axis B away
15 from the axis of the cylindrical forging 110.

The deformed forging 110 is then split along the first axis A. The splitting of the deformed cylindrical forging produces first 120a and second 120b portions of an axial split casing 120. When joined the portions 120a, 120b
20 create a substantially cylindrical tubular casing 120 as shown in Fig. 2D.

Thus, the deformation of the cylindrical forging reduces or obviates the need to perform off-centre rough machining to ensure that portions of the forging, when
25 split and rejoined, form a substantially cylindrical tubular casing. Consequently, the original forging provided in Fig. 2A will be smaller and cheaper than that provided in Fig. 1A as less material will need to be removed. In addition, there will be substantially less
30 wear on the tools used for rough machining.

Although embodiments of the present invention have been described in the preceding paragraphs with reference to various examples, it should be appreciated that modifications to the examples given can be made without the

parting from the scope of the invention as claimed. For example, although the deformation of a forging has been described with relation to a cylindrical forging only, it is possible to apply the principle of the invention to
5 other shapes of forging.

Whilst endeavouring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any
10 patentable feature or combination of features hereinbefore referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

Claims

1. A method of manufacturing a forging for forming a split casing comprising the steps of: creating a forging;
5 and characterised by deforming the forging by compressing it along a first axis and/or extending it along a second axis.
2. A method of manufacturing a forging as claimed in claim 1, wherein the step of creating a forging uses a ring
10 rolling process.
3. A method as claimed in claim 2, wherein the forging created by the ring rolling process is substantially cylindrical in shape.
4. A method as claimed in claim 3, wherein the split
15 casing to be formed is substantially cylindrical in shape.
5. A method as claimed in any preceding claim, wherein the first and second axes are orthogonal.
6. A deformed forging formed by the method of any preceding claim.
- 20 7. A method or forging substantially as hereinbefore described with reference to and/or as shown in Figs. 2A to 2D of the accompanying drawings.
8. Any novel subject matter or combination including novel subject matter disclosed, whether or not within the
25 scope of or relating to the same invention as the preceding claims.

Fig.1A.

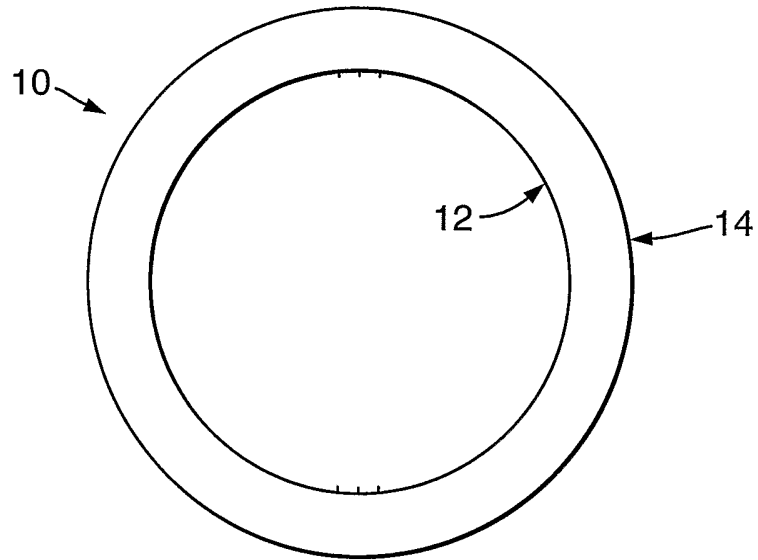


Fig.1B.

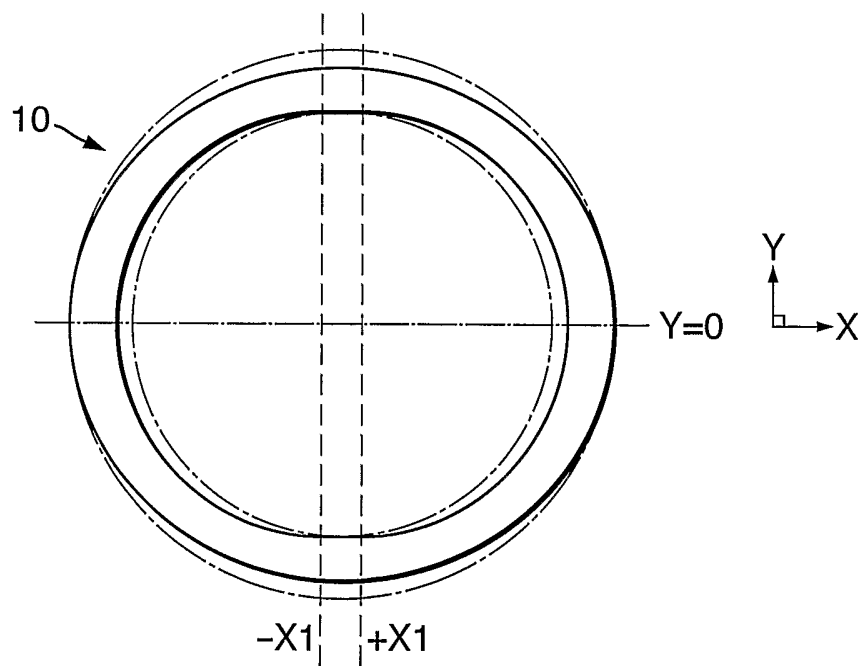


Fig.1C.

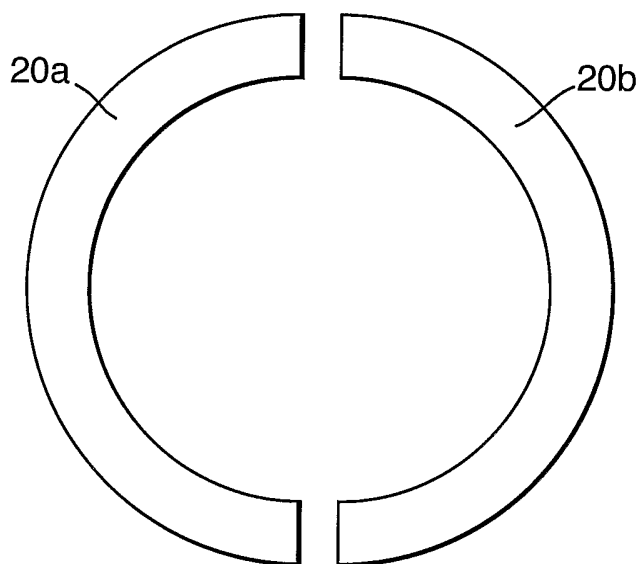


Fig.1D.

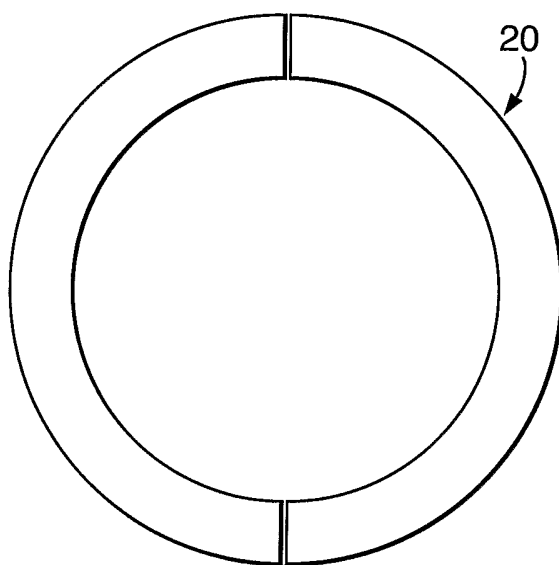


Fig.2A.

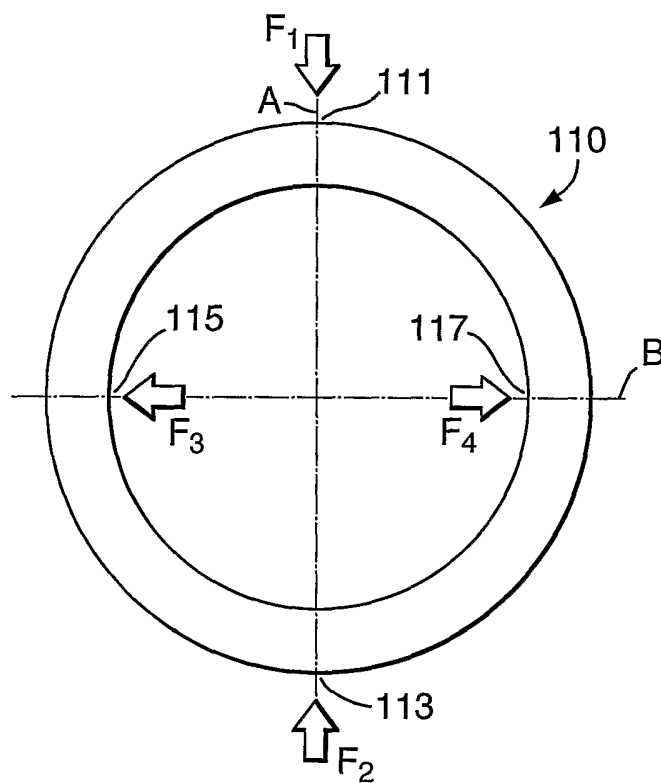


Fig.2B.

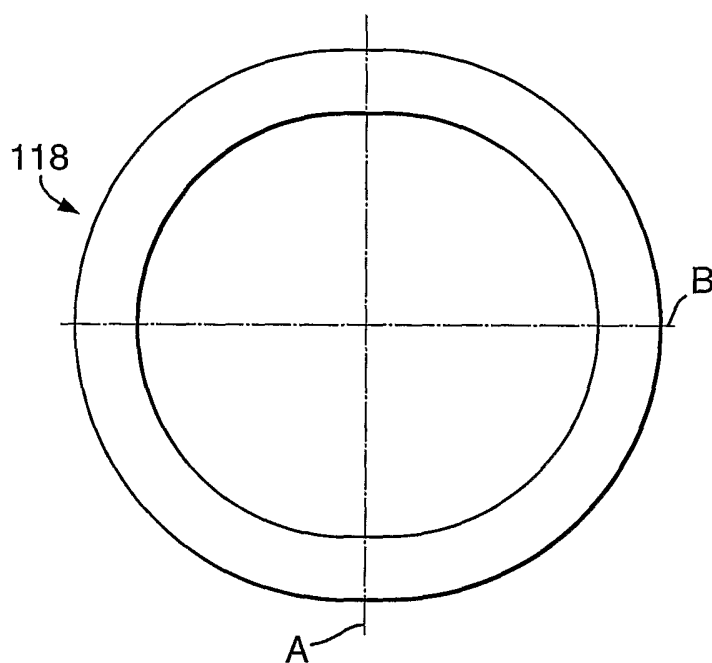


Fig.2C.

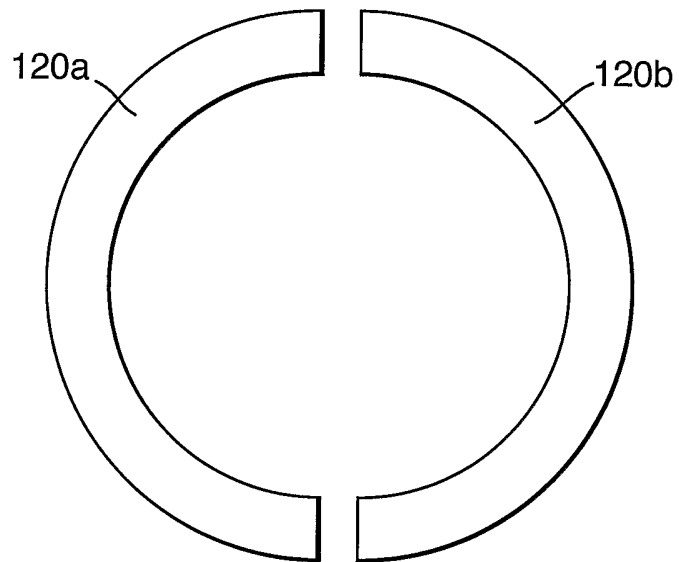
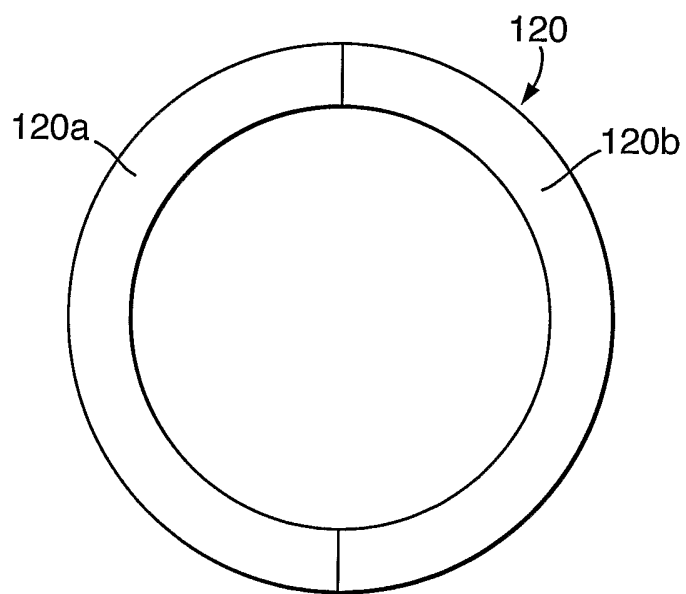


Fig.2D.



INTERNATIONAL SEARCH REPORT

International Application No
T/GB2004/002989

A. CLASSIFICATION OF SUBJECT MATTER IPC 7 B21K21/16 F01D25/24 B21H1/06		
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) IPC 7 B21K F01D B21H F01C F04D F16M B21D B21C		
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, PAJ, 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	PATENT ABSTRACTS OF JAPAN vol. 2003, no. 08, 6 August 2003 (2003-08-06) -& JP 2003 117632 A (DAIDO STEEL CO LTD), 23 April 2003 (2003-04-23) abstract; figures 2,3,5,6 -----	1-3
A	US 4 208 777 A (VOYER PETER E ET AL) 24 June 1980 (1980-06-24) the whole document -----	1,4
A	US 6 506 018 B1 (BRENNAN RAYMOND J) 14 January 2003 (2003-01-14) column 2, line 50 - line 67; figure 5 -----	1
A	CH 135 555 A (ESCHER WYSS MASCHF AG) 30 September 1929 (1929-09-30) the whole document -----	1
-/--		
<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in 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 <p style="text-align: center;">4 October 2004</p>	Date of mailing of the international search report <p style="text-align: center;">28/10/2004</p>	
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 <p style="text-align: center;">Ritter, F</p>	

INTERNATIONAL SEARCH REPORT

International Application No
T/GB2004/002989

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 33 16 134 A (VORSPANN TECHNIK GMBH) 3 November 1983 (1983-11-03) claim 1; figures 1,3,4 -----	1,5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB2004/002989

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.: 6-8
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 6-8

The subject-matter of claims 6 to 8 is so unclear that no meaningful search can be carried out. Claim 6 seeks to define a product by features relating to its method of manufacturing, but does not contain one single substantive product feature. Claims 7 and 8 generally refer to the drawings and the complete disclosure without indicating any specific feature.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.5), should the problems which led to the Article 17(2) declaration be overcome.

INTERNATIONAL SEARCH REPORT

International Application No
T/GB2004/002989

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