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(71) Applicant *(for all designated States except US)*: **KINGSPAN HOLDINGS (IRL) LIMITED** [IE/IE]; Dublin Road, Kingscourt, County Cavan (IE).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **ST. QUINTON, David** [GB/GB]; 4 Highdale Avenue, Scarborough, YO12 6DD (GB).

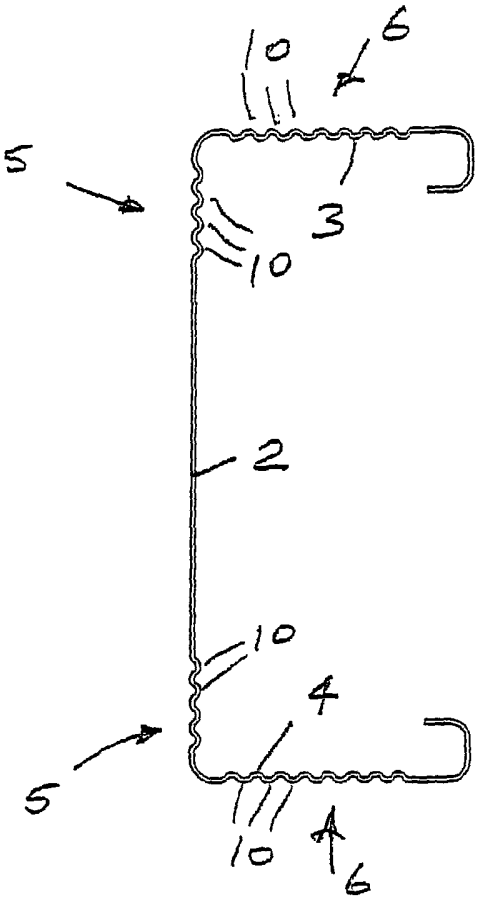
(74) Agents: **O'BRIEN, John, A.** et al.; c/o John A. O'Brien & Associates, Third Floor, Duncairn House, 14 Carysfort Avenue, Blackrock, County Dublin (IE).

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[Continued on next page]

(54) Title: A STRUCTURAL ELEMENT



(57) Abstract: A structural element (1, 20, 30, 40) comprises a web (2) extending between a pair of flanges (3, 4). The areas of particular structural importance are the portions (5, 6) of theweb and flanges adjacent to the junction between the web and the flanges. Material is gathered into these structurally important areas of an otherwise thin component. This is achieved by providing a plurality of small ribs (10) to absorb the material in these structurally important areas (5, 6). The ribs (10) are on a pitch of 2 to 8 times the wall thickness t. The pitch is approximately the same as a typical self drilling, self tapping fastener to prevent skating of the fastener, on fixing. The ribs (10) are of a depth of between 1.5t and 3.0t, where t is the metal thickness. These parameters ensure that in terms of fixing, the ribs allow a fastening screw to be used and to perform in the same manner as with a flat faced flange or web.

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"A Structural Element"

Introduction

The invention relates to structural elements of the type comprising a web extending between a pair of flanges. Such structural elements are generally of roll formed steel section.

A large number of structural elements of this type are known and used widely, for example in building construction. Various complex sections have been developed to provide particular structural performance. Such known sections are however generally inefficient in terms of the amount of material required to achieve a desired structural performance because they are derived from a strip of uniform thickness. Generally the dimensions of the section are altered to achieve desired properties. For example, the width of the flanges may be increased to strengthen the section. However, this has the disadvantage of destabilising the section by moving the centre of rotation of the section (typically a C or sigma section) further away from the centroid of the section. This increases the need for struts and rotational restraints or a deeper indent in the web in a sigma or zed section which thereby loses the advantage of material saving. With zed type sections, the effect is to change the angle of the neutral axis, which in most lower pitch applications will move the performance away from optimum. There is also a threshold at which a long slender element becomes ineffective and prone to buckling.

The thickness of the section may be increased to improve structural properties. However, this results in higher material costs and the additional cost is not proportional to the improvement in structural properties.

It is known to provide a large rib in the flange and/or web of such a section in an attempt to stiffen the flange by reducing the effective width. However known sections of this type have the disadvantage that they reduce the effective width of the flange

which can be screwed into when fastening cladding or the like to the section. If the rib is hit by a cladding fastener, the fastener will skate to the bottom of the rib and thereby elongate the hole into which the fastener is held and the fastening is therefore not complete. With deep ribs conventional fasteners may not be long enough to fasten efficiently at the bottom of the rib leading to potential puncturing of the cladding with an elongate hole. There is a further problem if the outer part of the web is to be stiffened by a larger rib since such a large rib may prevent the use of normal fasteners in the most advantageous fixing position.

There is therefore a need for an improve structural element which will address these problems. In particular, there is a need for a structural element which can be manufactured from the thinnest metal without sacrificing structural strength.

Statements of Invention

According to the invention there is provided a structural element comprising a web and at least one flange extending from the web, the element comprising a plurality of curved stiffening ribs extending along the longitudinal length of the element, the ribs being formed in the structural element at regions of structural importance of the element without substantially reducing the wall thickness, the pitch of the ribs being from 2 to 8 times the wall thickness of the structural element.

In one embodiment the pitch of the ribs is from 3 to 7 times the wall thickness of the structural element.

In another embodiment the pitch of the ribs is from 3mm to 8mm. Preferably the pitch of the ribs is from 3.8mm to 7.8mm.

In one embodiment the depth of the ribs is from 1.5 to 3 times the wall thickness of the structural element.

In another embodiment the bend radius of the ribs is from 0.5 to 3 times the wall thickness of the structural element. Preferably the bend radius of the ribs is substantially equal to the wall thickness of the structural element.

In one embodiment the rib has a bottom radius which subtends an arc of between 20° and 128°. Preferably the radius subtends an arc of between 70° and 100°.

In one embodiment the structural element comprises a pair of flanges and the web extends between the flanges.

In another embodiment the ribs are provided in the or each flange of the structural element.

In a further embodiment the ribs are provided on the web of the structural element.

In one embodiment the ribs are provided adjacent a corner portion between the web and at least one of the flanges.

In another embodiment the ribs are provided adjacent corner portions between the web and the flanges.

In one embodiment the flanges extend from the web in the same direction.

In another embodiment the flanges extend from the web in opposite directions.

In one embodiment the web is substantially straight.

In another embodiment the web has one or more bends therein.

Brief Description of the Drawings

The invention will be more clearly understood from the following description thereof given by way of example only with reference to the accompanying drawings, in which:-

Fig. 1 is a cross sectional view of a structural element according to the invention;

Fig. 1a is an enlarged view of a rib detail of the structural element;

Fig. 1b is an enlarged view showing a detail of a single rib.

Fig. 2 is a cross sectional view of another structural element;

Fig. 3 is a cross sectional view of a further structural element; and

Fig. 4 is a cross sectional view of another structural element according to the invention.

Detailed Description

Referring to the drawings there are illustrated profiles of various structural elements according to the invention. These profiles are indicative only and the invention may be applied to a wide variety of sections of this type.

In Fig. 1 the structural element 1 has a generally C-profile comprising a web 2 extending between a pair of flanges 3, 4 which in this case extend generally at right angles to the web 2 from the same side of the web. The areas of particular structural importance are the portions 5, 6 of the web and flanges adjacent to the junction

between the web and the flanges. According to the invention material is gathered into these structurally important areas of an otherwise thin component. This is achieved by forming a plurality of small ribs 10 to absorb the material in these structurally important areas 5, 6. The ribs 10 are on a pitch which is approximately the same as a typical self drilling, self tapping fastener to prevent skating of the fastener, on fixing. The pitch p of the ribs is from 2 to 8 times, most preferably from 3 to 7 times the wall thickness (t) of the structural element. The ribs 10 are of a depth x of between 1.5t and 3.0t. The bend radius r of the ribs is from 0.5 to 3 times the wall thickness t, most preferably approximately equal to the wall thickness.

The typical size of fixings used for cladding is between 4.8mm and 6.5mm. The pitch p of the ribs should preferably be between 0.8d and 1.2d, where d is the fastener diameter. Thus, the pitch p should be from about 3 to about 8mm, preferably from 3.8mm to 7.8mm. These parameters ensure that in terms of fixing the ribs allow a fastening screw to be used and to perform in the same manner as with a flat faced flange or web. A large portion of the flange is subject to plastic deformation in the manufacturing process, thereby increasing the yield strength of a large part of the flange.

Referring in particular to Fig. 1(b) each rib is symmetrical about a longitudinal axis and has lead–in portions defined by arcs and a bottom with a radius which subtends an arc α of between 20° and 128°, most preferably 70° to 100°.

Small ribs of this type (ratio of pitch to bolt to be less than 0.75 of the diameter) may be used in the locality of fixing bolts with a benefit to the bearing capacity of the connection by virtue of the increased area of metal contact with the bolt. Such localities comprise the web of the structural element, the bolts being used to fix the web to a cleat.

The following properties of structural elements of the invention are improved:

1. Section modulus Z_{xx}
2. Section moment of inertia I_{xx}
3. Local yield strength Y_a
4. Specific tortional stiffness (compared to weight and thickness of parent material)
5. Screw pull out capacity
6. Screw spin out capacity
7. Material distribution in section

The following properties of structural elements of the invention are not adversely affected:

1. Angle of section neutral axis
2. The freedom to position section fastening bolts in the web
3. The freedom to position fasteners in the flange.

In the invention, the material which would produce a wide flange with the attendant problems described above is condensed into a narrower flange using a plurality of small ribs formed in the flange. A similar effect is achieved in the web.

Referring to Fig. 2 there is illustrated another structural element 20 which is similar to that described with reference to Fig. 1 and like parts are assigned the same reference numerals. In this case the web has an indent 21 and the section is of sigma shape.

Referring to Fig. 3 another structural element 30 of zed section is illustrated in which the flanges extend on opposite sides of the web.

Another structural element 40 similar to the element of Fig. 3 is illustrated in Fig. 4. The web in this case has an indent 41.

The material of the structural elements is generally galvanised steel.

The sections may be of a range of different shapes and sizes. For example, small ribs could be provided in structurally significant regions of any suitable thin gauge components. For example, the invention may be applied to profiled metal sheet decking of the type described in WO 00/04250A. Such ribs could be applied to the flanges of such decking to enhance the deflecting and bending capacity of the decking.

The invention is not limited to the embodiments hereinbefore described which may be varied in detail.

CLAIMS

1. A structural element comprising a web and at least one flange extending from the web, the element comprising a plurality of curved stiffening ribs extending along the longitudinal length of the element, the ribs being formed in the structural element at regions of structural importance of the element without substantially reducing the wall thickness, the pitch of the ribs being from 2 to 8 times the wall thickness of the structural element.

2. A structural element as claimed in claim 1 wherein the pitch of the ribs is from 3 to 7 times the wall thickness of the structural element.

3. A structural element as claimed in claim 1 or 2 wherein the pitch of the ribs is from 3mm to 8mm.

4. A structural element as claimed in any of claims 1 to 3 wherein the pitch of the ribs is from 3.8mm to 7.8mm.

5. A structural element as claimed in any preceding claim wherein the depth of the ribs is from 1.5 to 3 times the wall thickness of the structural element.

6. A structural element as claimed in any preceding claim wherein the bend radius of the ribs is from 0.5 to 3 times the wall thickness of the structural element.

7. A structural element as claimed in claim 6 wherein the bend radius of the ribs is substantially equal to the wall thickness of the structural element.

8. A structural element as claimed in any preceding claim wherein the rib has a bottom radius which subtends an arc of between 20° and 128°.

9. A structural element as claimed in claim 8 wherein the radius subtends an arc of between 70° and 100°.

10. A structural element as claimed in any preceding claim wherein the structural element comprises a pair of flanges and the web extends between the flanges.

11. A structural element as claimed in any preceding claim wherein the ribs are provided in the or each flange of the structural element.

12. A structural element as claimed in any preceding claim wherein the ribs are provided on the web of the structural element.

13. A structural element as claimed in any preceding claim wherein the ribs are provided adjacent a corner portion between the web and at least one of the flanges.

14. A structural element as claimed in claim 13 wherein the ribs are provided adjacent corner portions between the web and the flanges.

15. A structural element as claimed in any preceding claim wherein the flanges extend from the web in the same direction.

16. A structural element as claimed in any of claims 1 to 15 wherein the flanges extend from the web in opposite directions.

17. A structural element as claimed in any preceding claim wherein the web is substantially straight.

18. A structural element as claimed in any of claims 1 to 17 wherein the web has one or more bends therein.

19. A structural element substantially as hereinbefore described with reference to the accompanying drawings.

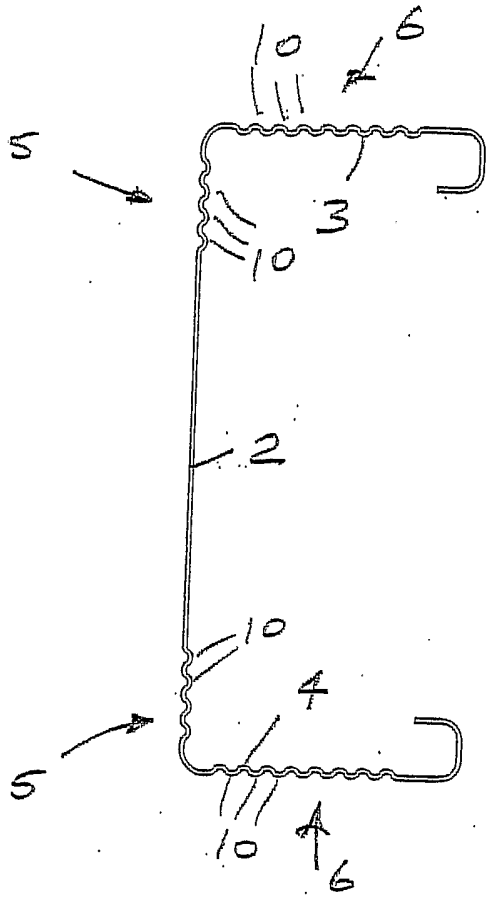


Fig. 1

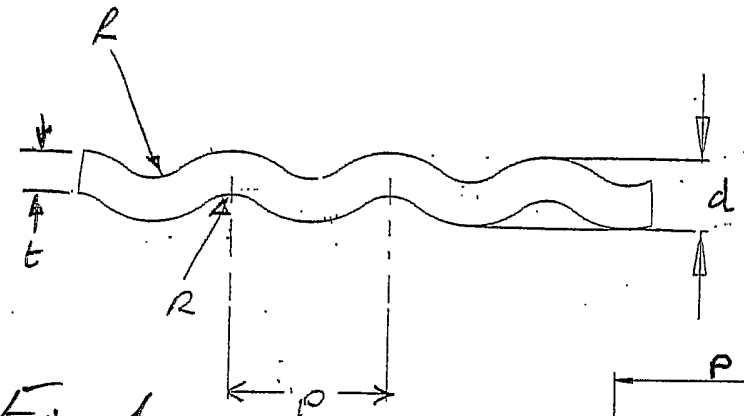


Fig. 1(a)

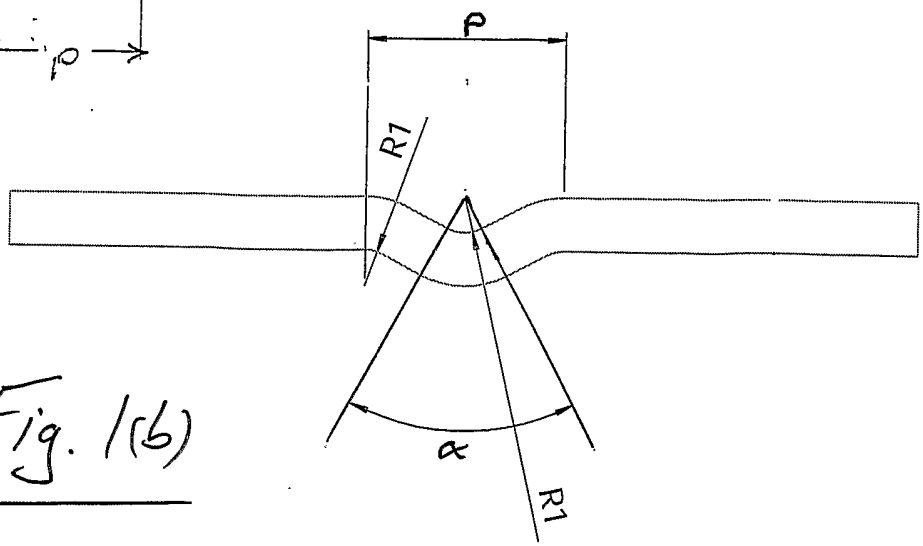


Fig. 1(b)

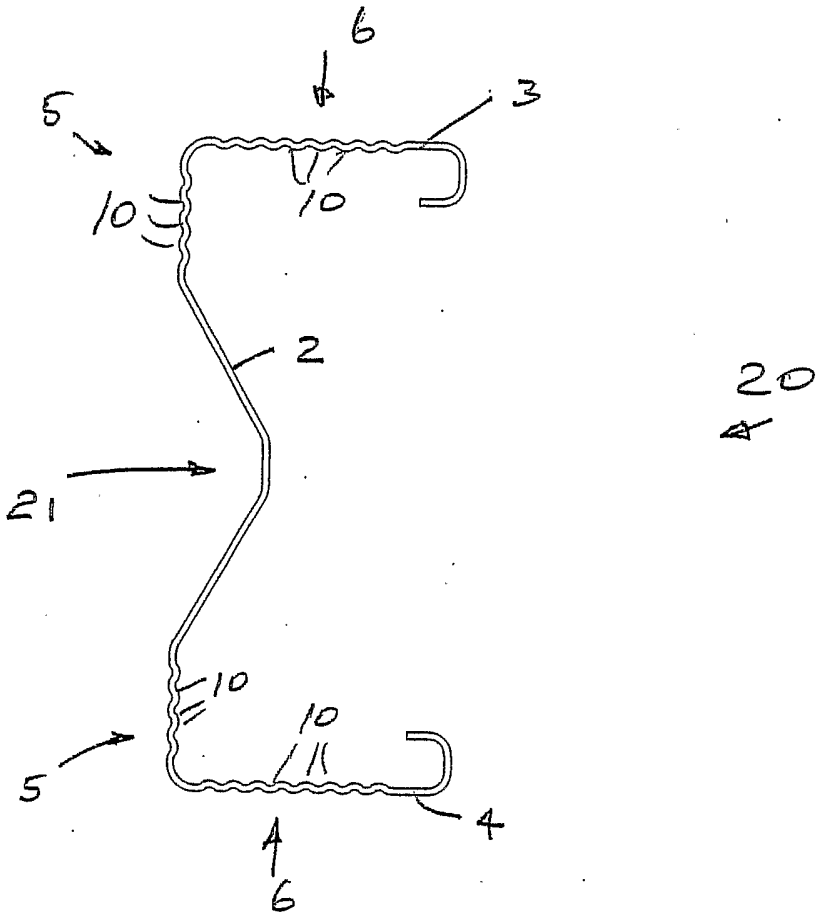


Fig. 2

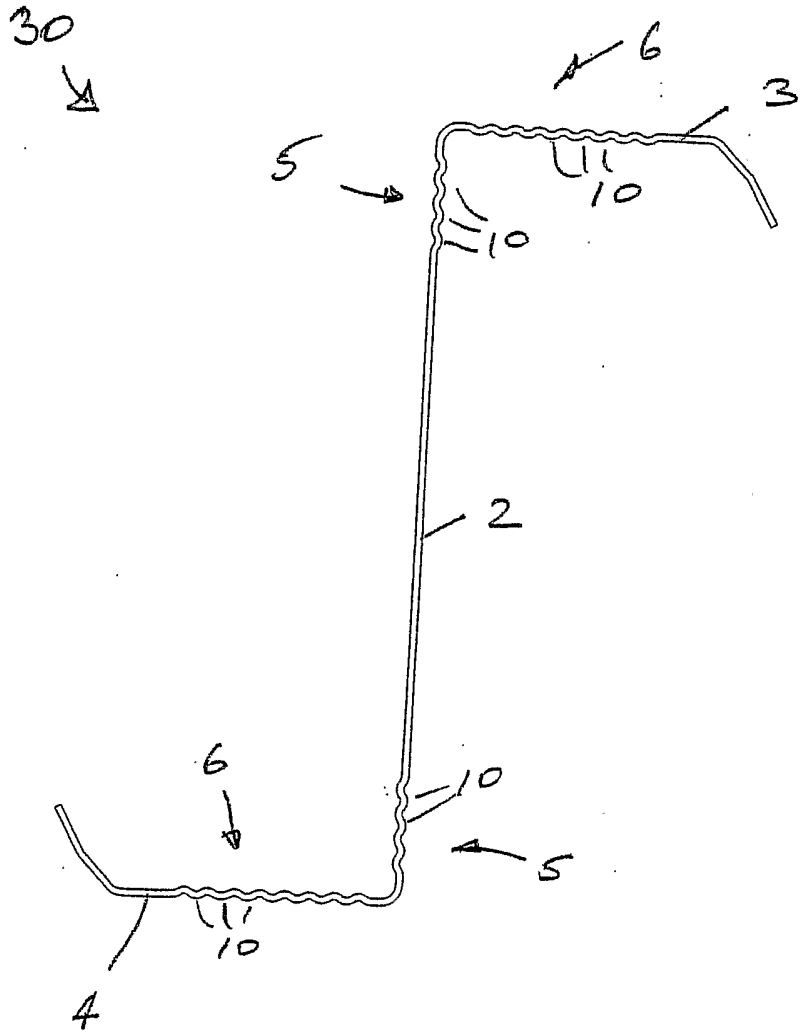


Fig. 3

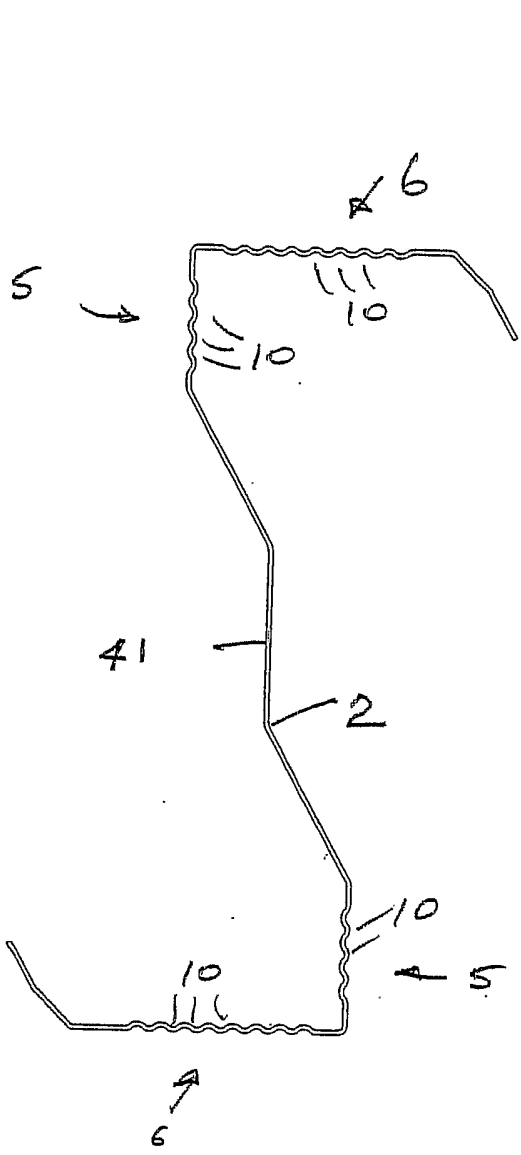


Fig. 4

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E04B2/78 E04C3/07

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 E04B E04C

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 092 349 A (TRENERRY JOHN ALLAN) 25 July 2000 (2000-07-25) column 3, line 14 - line 24; figures 1-3	1-17,19
X	GB 2 228 752 A (STEELPRESS) 5 September 1990 (1990-09-05) page 1, line 23 -page 2, line 8; claim 8; figures 1-5,8	1-19
X	GB 2 181 467 A (HADLEY SECTIONS LIMITED) 23 April 1987 (1987-04-23) page 1, line 86 - line 119; figure 1	1-11,13, 14,16, 18,19
X	DE 199 50 890 C (HENGST THOMAS ;WILDOER JOERG (DE)) 31 October 2001 (2001-10-31) paragraph '0043!; figure 1	1,19

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 July 2003	05/08/2003

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INTERNATIONAL SEARCH REPORT

In on patent family members

Internati Application No
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