(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 268 096 B9**

(12) **CORRECTED NEW EUROPEAN PATENT SPECIFICATION**

(15) Correction information:
Corrected version no 1 (W1 B2)
Corrections, see
Description Paragraph(s) 21-34

(48) Corrigendum issued on:
18.05.2011 Bulletin 2011/20

(45) Date of publication and mention of the opposition decision:
23.02.2011 Bulletin 2011/08

(45) Mention of the grant of the patent:
18.01.2006 Bulletin 2006/03

(21) Application number: **01914060.7**

(22) Date of filing: **27.03.2001**

(51) Int Cl.:
B21C 25/02 *(2006.01)*

(86) International application number:
PCT/GB2001/001325

(87) International publication number:
WO 2001/074506 (11.10.2001 Gazette 2001/41)

(54) **EXTRUSION DIE**

STRANGPRESSWERKZEUG

FILIERE D'EXTRUSION

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR

(30) Priority: **01.04.2000 GB 0007948**

(43) Date of publication of application:
02.01.2003 Bulletin 2003/01

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Description

[0001] This invention relates to an extrusion die for use in the extrusion of metallic materials, and in particular to a die suitable for use in the extrusion of aluminium.

[0002] When extruding aluminium it is important to ensure that the speed of movement of the aluminium through the extrusion die is uniform across the die. This has been achieved in the past using a die having a die cavity of finite bearing length, and by varying the bearing length across the die. It has been found, however, that the extruded product sometimes contains surface imperfections resulting from the engagement between the bearing surface and the aluminium being extruded. Rather than provide the bearing surface downstream of the entrance to the die cavity, it is known to use a die having a so-called zero bearing, and to provide a chamber upstream of the die cavity of varying bearing length to control the extrusion speed over the die. Although the term zero bearing suggests that the die cavity is of zero bearing length, in practise the die cavity is likely to have a finite, but very small bearing length.

[0003] Another problem which has been faced when extruding aluminium is that, where the extrusion is, for example, of channel section, the sides of the channel tend to deflect thus, if the die is shaped to include a die cavity in which the parts thereof which form the sides of the channel are parallel to one another, the sides of a member extruded using the die may be splayed, rather than parallel to one another. In order to correct such splaying, it is known to provide a pre-chamber located upstream of the die cavity, the pre-chamber being of greater width than the part of the die cavity immediately adjacent thereto, the pre-chamber being offset laterally relative to the die cavity. Such a technique results in a side loading being applied to the metal being extruded. Although off-setting the pre-chamber laterally from the die cavity can correct splaying in some circumstances, it is of limited application and may not be able to apply a sufficient force to correct splaying in, for example, extrusions of relatively low wall thickness. Similar problems are experienced when hollow members are extruded using a die comprising a male part and a female part.

[0004] WO 99/65622 ,which forms the basis for the preamble of claim 1, describes an arrangement in which one side of a die cavity includes a leading edge located opposite a wall such that, upon deflection of the die, the leading edge remains opposite the said wall.

[0005] According to the present invention there is provided an extrusion die according to claim 1.

[0006] It has been found that, in prior arrangements, the magnitude of the load applied to the metal being extruded, and hence to the die, is sufficient to cause the male portion to deflect relative to the female portion. If the die is a zero bearing die, such deflection results in the leading edges of the die cavity being spaced apart in the extrusion direction. Such spacing results in side loadings being experienced by the metal being extruded and can result in splaying as described hereinbefore. By designing the die such that, at rest, the leading edges are not co-planar, this effect can be reduced as the die can be arranged such that the leading edges become co-planar or substantially co-planar when deflection occurs in use. Although it is convenient for the leading edges to become co-planar, the advantages of the invention also arise if, throughout the die, the leading edge of a part on one side of the cavity aligns with the part thereof on the other side of the cavity.

[0007] It should be noted that, in general, both of the male and female portions deflect, and that it is the relative deflection between these portions for which the invention is intended to compensate.

[0008] Although the description herein refers to deflection, it will be appreciated that some compression of the material of the die may also occur as a result of the application of loads thereto, in use, and that the invention can also be used to overcome disadvantages associated with misalignment of bearings caused, in use, by such compression.

[0009] The die cavity is preferably shaped such that its width increases from a minimum adjacent the leading edges thereof. Such an arrangement is referred to hereinafter as a zero bearing die.

[0010] The invention is particularly advantageous with zero bearing dies as a relatively small amount of deflection causes total misalignment of the bearings of such dies. In dies of the non-zero type, even when deflection has occurred, it is likely that a part of each bearing surface will remain aligned with a part of the opposite bearing surface.

[0011] The male portion of the cavity may take the form of a tongue portion. In such an arrangement, the die is used to form an extruded member including at least one elongate channel of any cross-sectional shape.

[0012] The die cavity may be shaped to define at least one further tongue portion. The die body may define at least one further die cavity.

[0013] In an alternative arrangement the die may be designed to produce an extruded member of hollow form, the male portion projecting into an opening formed in the female portion.

[0014] The invention will further be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a sectional view of an extruded aluminium member;

Figure 2 is part of a view of a die used in the extrusion of the member of Figure 1;

Figure 3 is an enlargement of part of Figure 2;

Figure 4 is a diagrammatic sectional view along the line 4-4 of Figure 3;

Figure 5 is a view similar to Figure 4 illustrating an alternative embodiment;

Figure 6 is a view similar to Figure 2 illustrating an alternative die;

Figure 7 is a diagrammatic view illustrating one of the die cavities of the die of Figure 6;
Figure 8 is a diagrammatic sectional view along the Line 8-8 of Figure 7;
Figure 9 is a view similar to. Figure 6 illustrating a further alternative die;
Figure 10 is a diagrammatic sectional view illustrating an alternative die; and
Figure 1 is a plan view illustrating the die of Figure 10; and
Figure 12 is a diagrammatic view illustrating part of a method for use in manufacturing the dies of Figures 1 to 11.

[0015] Referring to Figures 1 to 4, Figure 1 illustrates an extruded aluminium member 10 of relatively complex shape. The member 10 includes several regions which can be regarded as channel-shaped regions 12 including limbs 14 which are generally parallel to one another. The pairs of limbs 14 forming several of the channel-shaped regions 12 illustrated in Figure 1 are denoted by the references 14a, 14b and 14c in the drawing.

[0016] Figure 2 illustrates part of the die body 16 of an extrusion die for use in the production of the member 10. The die body 16 is provided with openings defining a pair of die cavities 18, each die cavity 18 being designed for use in the production of the member 10. Figure 3 illustrates one of the die cavities 18 in greater detail.

[0017] As illustrated in Figure 3, each die cavity 18 comprises an opening shaped to conform, generally, with the cross-sectional shape of the member 10 to be extruded. The width of the cavity 18 increases from a minimum adjacent the leading edges 18a, 18b of the cavity 18 (see Figure 4), thus the die is of the zero bearing type.

[0018] The leading surface of the die body 16 is of generally planar form, and is provided with a recess 20 aligned with and of the same general shape as the cavity 18, but of greater width. An additional recess 22 (see Figure 4) is formed in the base of the recess 20, the recess 22 again being of the same general shape as the die cavity 18 but of greater width. As illustrated in Figure 4, the leading edges 18a, 18b of the die cavity 18 are defined at the intersection between the die cavity 18 and the recess 22.

[0019] As best shown in Figure 3, the part of the die body 16 located between the parts of the die cavity 18 which, in use, form each pair of limbs 14 takes the form of a tongue portion 24 received within a correspondingly shaped female portion 26 of the die body 16. In use, the application of a load to the material to be extruded tends to cause the tongue portions 24 to deflect relative to the female portions 26. In order to reduce the risk of such deflection causing the limbs 14 of the member 10 becoming splayed, or to reduce the degree by which they become splayed, the die is manufactured in such a manner that, when the die is not in use, the leading edges 18a of the die cavity 18 defined by parts of the tongue portions 24 are not co-planar with those defined by parts of the female portions 26 but rather are positioned such that the deflection of the tongue portions 24 (to the position shown in broken lines in Figure 4) brings the leading edges 18a associated therewith closer to the plane containing the leading edges 18b associated with the female portions 26, and preferably into the same plane. By ensuring that leading edges 18a, 18b are substantially co-planar, in use, the application of side loadings on the material being extruded, and hence splaying of the limbs 14 can be reduced.

[0020] In the embodiment of Figures 1 to 4, the recess 22 is not of uniform depth but rather, as illustrated in Figure 4, contains regions 22a on one side of the die cavity 18 of relatively small depth and regions 22b on the other side of the die cavity 18 of greater depth. The regions 22a are provided on the tongue portions 24, and the depths of the regions 22a, 22b are chosen to ensure that when the tongue portions 24 occupy their deflected positions, in use, the leading edges 18a, 18b are substantially co-planar.

[0021] If desired, the recess 22 may be off-set laterally from the opening of the die cavity 18 in some parts of the die, such lateral off setting also resulting in side loadings being applied to the metal being extruded to correct for splaying of the limbs 14 in the conventional manner. This technique may be used, for example, where the amount of splaying of the limbs 14 is relatively small and may be corrected relatively easily using this technique or where the use of providing parts of the recess 22 of different depth is not practical or it is not practical to fully correct splaying using this technique.

[0022] Although as described hereinbefore, in use, the leading edges of the die cavity become co-planar or substantially co-planar, this need not be the case. In order to achieve the benefit of the invention, all that is required is that, in use, the leading edges on opposing sides of the die cavity align or substantially align with one another. The plane in which the leading edges of one part of the die align need not be the same as that in which the leading edges of other parts of the die cavity align.

[0023] Figure 5 illustrates an alternative to the arrangement of Figures 1 to 4. In the arrangement of Figure 5, instead of using the recess 22 to cause the leading edges 18a, 18b to be non-co-planar, the leading face of the die body 16 is not of planar form but rather is shaped so that, for example, the leading face of the parts of the die body 16 defining the tongue portions 24 are raised relative to the parts defining the female portions 26.

[0024] It will be appreciated that in both of the arrangements described hereinbefore, the spacing of the leading edges 18a, 18b in the direction of extrusion, varies smoothly and continuously over the face of the die, for example from a maximum at the tips of the tongue portions 24 to a minimum at the ends remote therefrom

[0025] Although in the arrangements described hereinbefore the recess 22 is of flat bottomed form, it could, if desired, be of angled form. A flow control pre-chamber of varying bearing length or shape may be provided up-

stream of the die cavity, if desired, to ensure that the extrusion speed across the die is substantially uniform. Alternatively, a bearing surface of variable bearing length may be provided downstream of the leading edges 18a, 18b of the die cavity to achieve this effect. Further, although in the description hereinbefore the tongue portions 24 are of parallel sided form, it will be appreciated that this need not be the case and that the invention is applicable to dies having tongue portions of any shape, for example of curved form or of V-shaped section. Several V-shaped tongue portions are illustrated in Figure 3 and denoted by reference numeral 28.

[0026] The distances through which the tongue portions deflect, and hence the distances through which the leading edges of the die cavity should be spaced when at rest are very small. Figure 6 illustrates a die having four die cavities 18 formed therein, each including several tongue portions 24 and corresponding female portions 26. Figure 7 is a view, to an enlarged scale, of one of the cavities 18 shown in Figure 6. In Figure 7, the shaded area is the die cavity 18. A recess 22 is formed around part of the die cavity 18 with the result that the leading edges 18a of the parts of the cavity defined by the tongue portions 24 lie in one plane and the leading edges 18b defined by the female portions 26 lie out of that plane. The recess 22 is only formed on the female portions 26 and is not of uniform depth. The depth of the recess 22 in various places is marked on the drawing. Further, the recess 22 is not of flat bottomed form, but rather is of angled form as illustrated in Figure 8.

[0027] Figure 9 illustrates a die for producing a member of an alternative cross-section, the die including two die cavities. The load experienced by the die body is not uniform but rather varies depending upon the distance from the edge of the die body. As a result, a tongue portion located near the centre of the die will deflect by a different amount from a similar tongue portion located near the edge of the die body. The spacing of the leading edges of the die cavities, at rest should be modified accordingly, and Figure 9 indicates the spacing of the leading edges 18a, 18b at various points around the two die cavities 18, at rest.

[0028] Comparing Figure 9 with Figure 2, it will be appreciated that in Figure 9 the two cavities are identical to one another, those of Figure 2 being mirror-images of one another. It is advantageous to produce identical extrusions as any treatment processes carried out immediately after extrusion can be simplified. The technique of the present invention allows dies containing several cavities arranged to produce identical extrusions to be manufactured relatively easily. In Figure 9, the chambers 22 are dimensioned to ensure that the correct proportions of metal to be extruded are supplied to the two die cavities 18.

[0029] The arrangement illustrated in Figures 10 and 1 differs from those described and illustrated hereinbefore in that it is intended for use in the extrusion of hollow members. The die comprises a female part 30 defining a plurality of openings. Each opening receives part of a male part 32. The male and female parts 30, 32 define therebetween die cavities 18. Each die cavity 18 is of zero bearing form and includes leading edges 18a defined by the male and female parts 30, 32. The male part 32 will deflect relative to the female part 30, in use, as described hereinbefore. Such deflection would, in a typical arrangement, result in the leading edges 18a , 18b becoming misaligned. In accordance with the invention the die is designed such that, at rest, the leading edges 18a defined by the male part 32 are spaced from those defined by the female part 30 in the extrusion direction and such that, in use, the deflection of the male part 32 results in the spacing of the leading edges 18a, 18b reducing, thus reducing, for example, the tendency of a circular cross-section extrusion to become elliptical. Preferably the spacing of the leading edges 18a, 18b is reduced to zero in the extrusion direction, in use, but reducing the spacing to a very small amount may be acceptable in some circumstances.

[0030] In order to manufacture an extrusion die in accordance with the invention it is necessary to determine how much each part of the die will deflect, in use. Once the deflection has been determined, the die can be designed to ensure that, in its deflected, in use condition, the leading edge at one side of the die cavity aligns or substantially aligns with that at the opposite side of the cavity for all parts of the die.

[0031] The determination of how much deflection will occur can be achieved using a range of techniques. For example, a skilled technician may be able to determine, from his own knowledge and to a reasonable degree of accuracy, how much deflection is likely. In an alternative technique, a computer model may be used to determine the forces likely to be experienced by parts of a die, and hence the likely deflection of those parts. The model conveniently uses a finite element analysis approach. In another technique, a die having a cavity and other characteristics similar to the die to be manufactured may have a load applied thereto and the deflection of parts thereof measured.

[0032] Once the likely deflection has been determined, recesses are formed around the die cavity, the recesses being shaped, and in particular the depth of the recesses being controlled, to ensure that, in its deflected state, proper alignment of the leading edges occurs. The formation of the recesses is conveniently achieved using a grinding process. Figure 12 illustrates a grinding wheel 40 having a grinding surface 42 of frusto-conical shape. The grinding wheel 40 is mounted for rotation about an axis angled to the intended extrusion direction to form a recess, the base of which is angled at 10° to the front face of the die. The wheel 40 is conveniently of diameter approximately 15mm.

[0033] In order to improve the wear resistance of the die, a nitriding process is also preferably undertaken.

[0034] Although as described above a grinding technique may be used to form the recess, other techniques

could be used, if desired.

Claims

1. An extrusion die comprising a die body having a die cavity (18) formed therein, the die body defining a male portion which projects into a female portion, wherein a leading edge (18a) of a part of the die cavity (18) defined by the male portion and a leading edge (18b) of an opposing part of the die cavity (18) defined by the female portion are out of alignment with one another when the die is not in use, the leading edge (18a) of the part of the die cavity (18) defined by the male portion being spaced, upstream in the extrusion direction, from the leading edge (18b) of the part of the die cavity (18) defined by the female portion by a distance, the spacing being such that deflection of the male portion, in use, brings the leading edges (18a,18b) substantially into alignment, a recess (22) of non-uniform depth being provided on the die, at least part of at least one of the leading edges (18a,18b) being defined at the intersection between the die cavity and the recess, **characterised in that** the distance is not uniform around the die cavity (18).

2. A die as claimed in Claim 1, wherein the die cavity (18) is of zero bearing form.

3. A die as claimed in any one of the preceding claims, wherein the male and female portions co-operate to produce, in use, an extrusion having at least one channel shaped region.

4. A die as claimed in any one of the preceding claims wherein the male and female portions co-operate to produce, in use, an extrusion including at least one hollow region.

Patentansprüche

1. Ein Strangpresswerkzeug, das einen Werkzeugkörper mit einem darin ausgebildeten Werkzeughohlraum (18) aufweist, wobei der Werkzeugkörper eine Patrize definiert, die in eine Matrize hineinragt, wobei eine Vorderkante (18a) eines durch die Patrize definierten Teils des Werkzeughohlraums (18) und eine Vorderkante (18b) eines durch die Matrize definierten gegenüberliegenden Teils des Werkzeughohlraums (18) nicht miteinander fluchten, wenn das Werkzeug nicht in Gebrauch ist, wobei die Vorderkante (18a) des durch die Patrize definierten Teils des Werkzeughohlraums (18) in Extrusionsrichtung stromaufwärts von der Vorderkante (18b) des durch die Matrize definierten Teils des Werkzeughohlraums (18) in einem Abstand angeordnet ist, wobei der Abstand so beschaffen ist, dass im Gebrauch das Durchbiegen der Patrize die Vorderkanten (18a, 18b) im Wesentlichen miteinander fluchtet, wobei eine Aussparung (22) von ungleichmäßiger Tiefe an dem Werkzeug vorgesehen ist, wobei zumindest ein Teil mindestens einer der Vorderkanten (18a, 18b) an der Schnittstelle zwischen dem Werkzeughohlraum und der Aussparung (22) definiert ist, **dadurch gekennzeichnet, dass** der Abstand um den Werkzeughohlraum (18) herum nicht gleichmäßig ist.

2. Ein Werkzeug nach Anspruch 1, wobei der Hohlraum (18) eine führungsfreie Form aufweist.

3. Ein Werkzeug nach einem der vorhergehenden Ansprüche, wobei die Patrize und die Matrize zusammenwirken, um im Gebrauch eine Extrusion zu erzeugen, die mindestens einen U-förmigen Bereich aufweist.

4. Ein Werkzeug nach einem der vorhergehenden Ansprüche, wobei die Patrize und die Matrize zusammenwirken, um im Gebrauch eine Extrusion zu erzeugen, die mindestens einen hohlen Bereich aufweist.

Revendications

1. Moule d'extrusion comprenant un corps de moule ayant une cavité de moule (18) formée à l'intérieur de ce dernier, le corps de moule définissant une partie mâle qui fait saillie dans une partie femelle, dans lequel un bord d'attaque (18a) d'une partie de la cavité de moule (18) définie par la partie mâle et un bord d'attaque (18b) d'une partie opposée de la cavité de moule (18) définie par la partie femelle, ne sont pas alignés l'un par rapport à l'autre lorsque le moule n'est pas utilisé, le bord d'attaque (18a) de la partie de cavité de moule (18) définie par la partie mâle étant espacé, en amont dans la direction d'extrusion, du bord d'attaque 18b, de la partie de cavité de moule (18) définie par la partie femelle selon une distance, l'espacement étant de sorte que la déviation de la partie mâle, à l'usage, amène les bords d'attaque (18a, 18b) sensiblement en alignement, un évidement (22) de profondeur non uniforme étant prévu sur le moule, au moins une partie d'au moins l'un des bords d'attaque (18a, 18b) étant définie à l'intersection entre la cavité de moule et l'évidement, **caractérisé en ce que** la distance n'est pas uniforme autour de la cavité de moule (18).

2. Moule selon la revendication 1, dans lequel la cavité de moule (18) a une forme à appui nul.

3. Moule selon l'une quelconque des revendications précédentes, dans lequel les parties mâle et femelle

coopèrent pour produire, à l'usage, une extrusion ayant au moins une région en forme de canal.

4. Moule selon l'une quelconque des revendications précédentes, dans lequel les parties mâle et femelle coopèrent pour produire, à l'usage une extrusion comprenant au moins une région creuse.

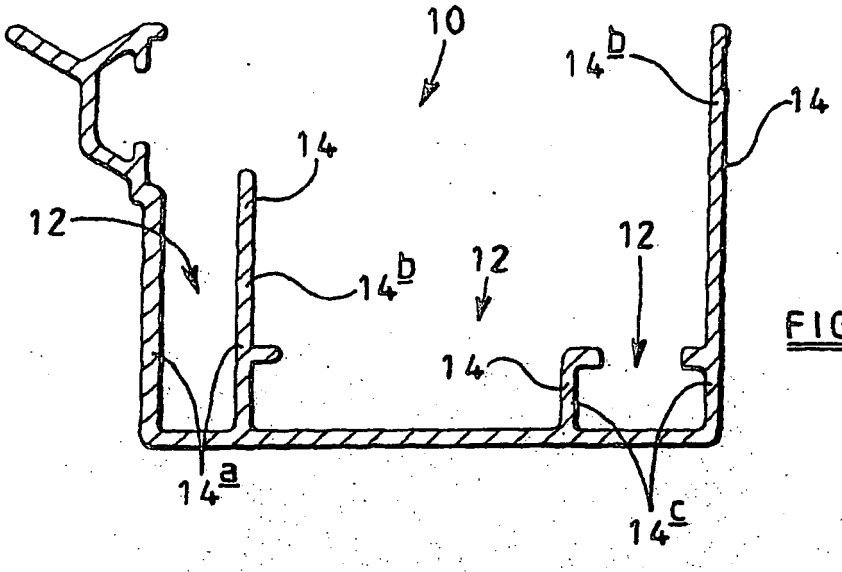


FIG 1

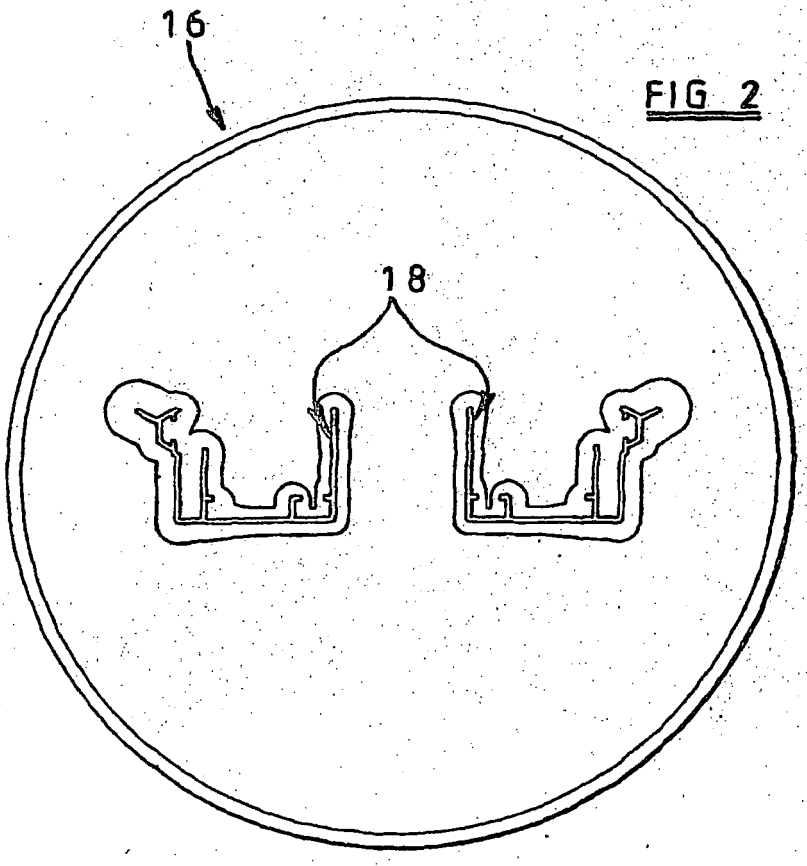


FIG 2

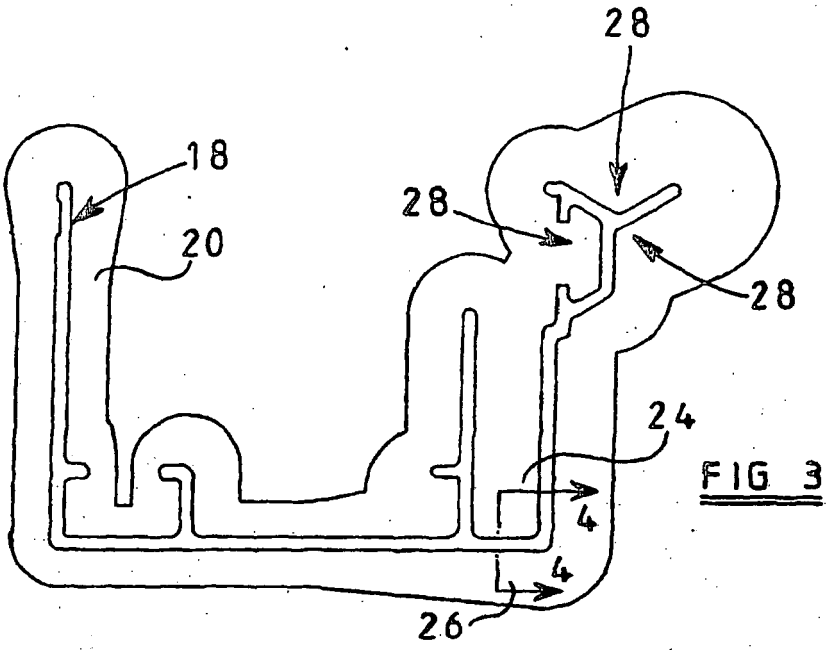


FIG 3

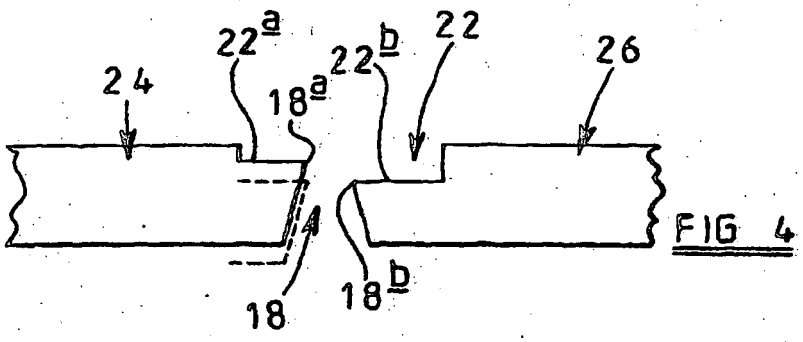


FIG 4

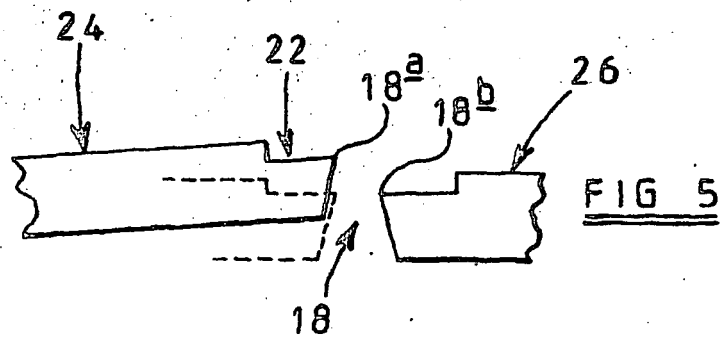


FIG 5

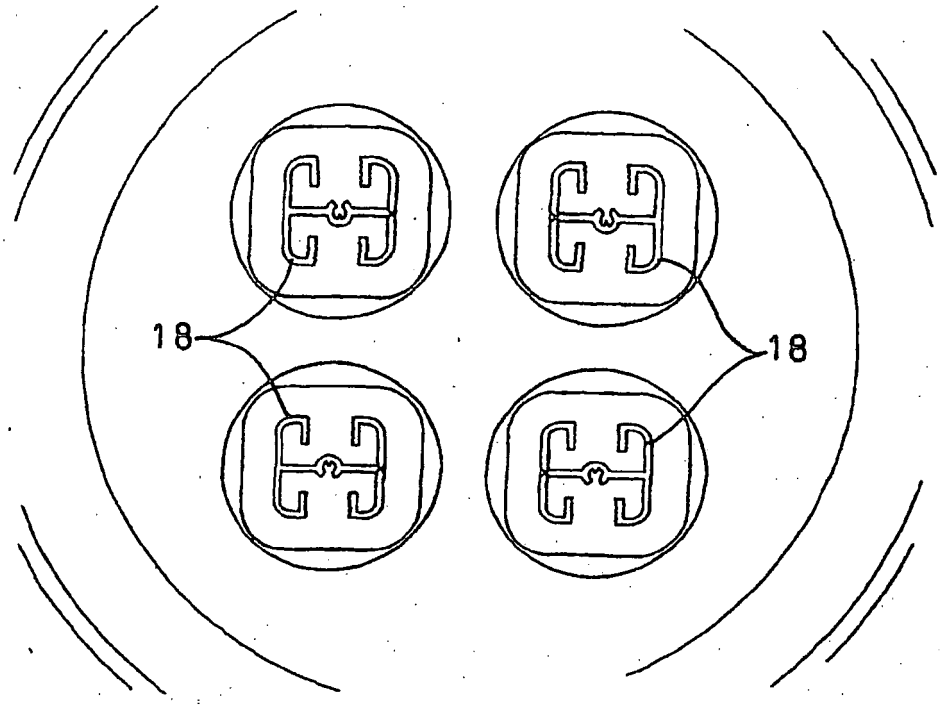


FIG 6

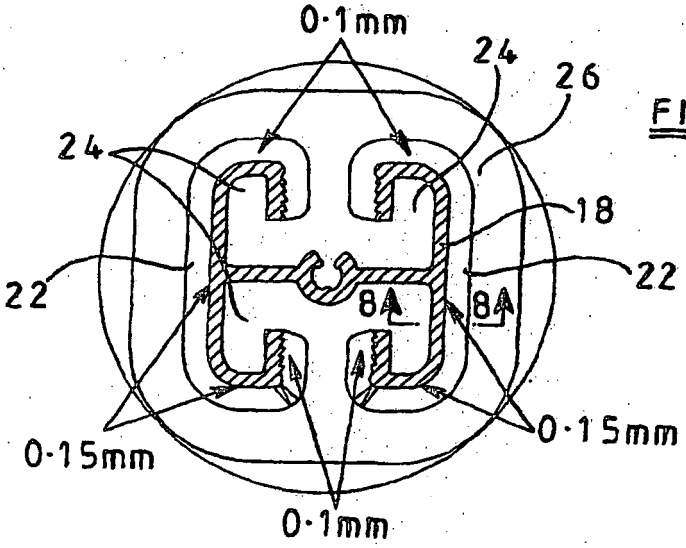


FIG 7

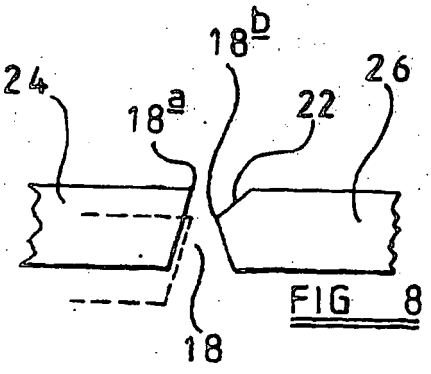
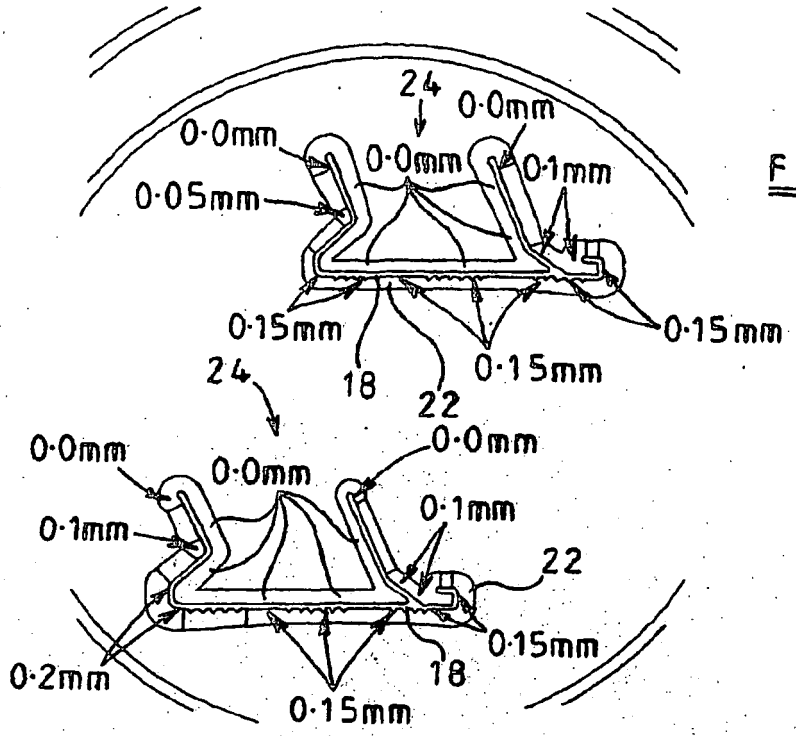


FIG 8


24
0·0mm
0·0mm
0·0mm
0·1mm
0·05mm
0·15mm
0·15mm
0·15mm
18
22
24
0·0mm
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0·1mm
0·1mm
22
0·15mm
0·2mm
18
0·15mm

FIG 9

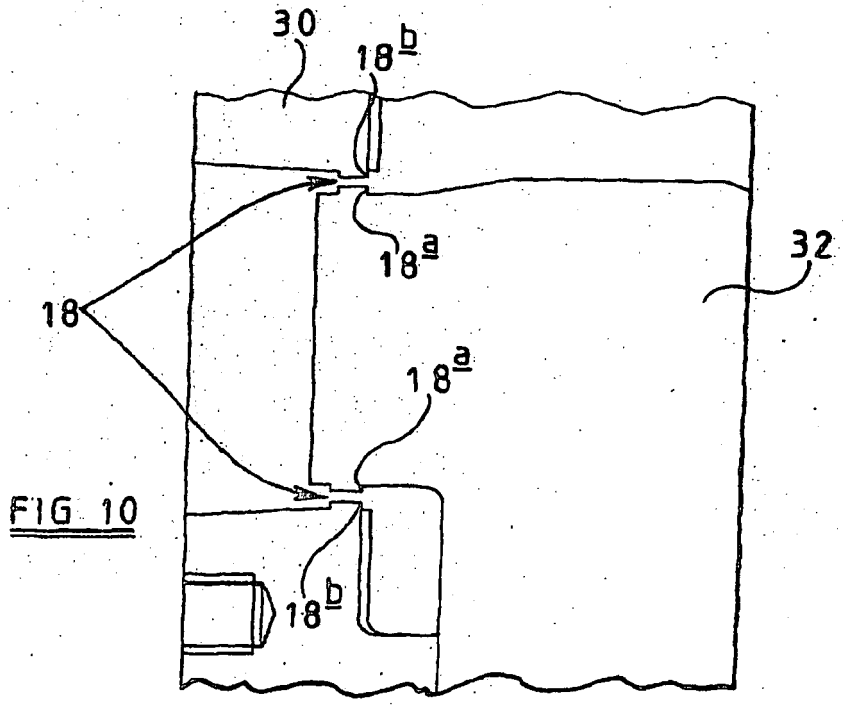

30
18b
18a
32
18
18a
18b

FIG 10

FIG 11

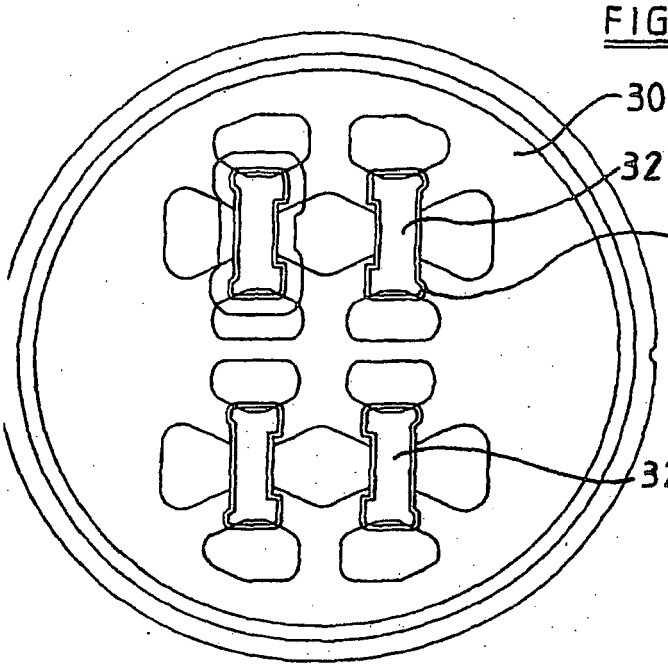
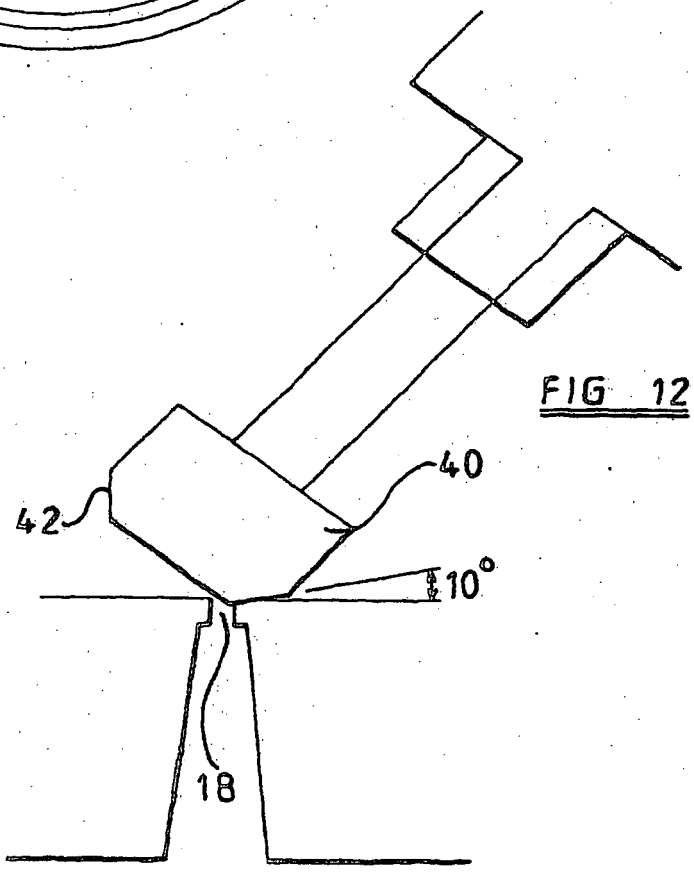


FIG 12



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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