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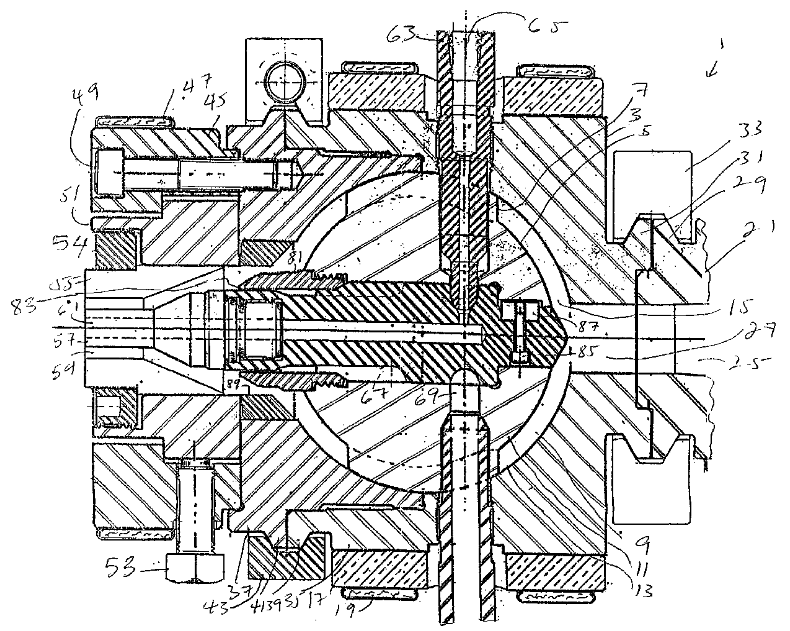
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: INLINE DIE APPARATUS WITH COMPENSATION FOR VOLUMES DISPLACED BY SUPPORTS OF MANIFOLD WITHIN CAVITY



(57) Abstract: An extrusion head (1) has a case (3) with a spherical cavity (9) and a manifold (5) with a spherical surface (13) inside the spherical cavity (9), the case (3) and the manifold (5) defining a spherical annular flow path (15) between them for molten plastic. The manifold (5) is supported in the cavity (9) by supports (7) which displace flow of the molten plastic. To compensate for such displacement, air, a second molten plastic, or both are injected inside the molten plastic.

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INLINE DIE APPARATUS WITH COMPENSATION FOR VOLUMES DISPLACED BY SUPPORTS OF MANIFOLD WITHIN CAVITY

Field of the Invention

The present invention is directed to an inline die for extrusion of single-layer or multi-layer plastic items and more particularly to such an inline die having inner and outer spherical (or other) configurations and a compensation for the volume displaced by the supports between the spherical configurations.

Description of Related Art

It is a common industrial practice to mold an item from a plastic material by blow molding. The plastic material is supplied to a head in a molten state and dispensed from the head into the mold. In the head, the molten plastic enters a flow path which forms an extrudate having an annular and uniform distribution with an empty space therein. In the blow molding art, such an extrudate is commonly called a parison. Air is blown into the empty space through an air duct concentric with the flow path to force the plastic against the sides of the mold. Desired qualities in the parison include uniformity of thickness and the absence of voids.

A particular kind of head for blow molding has an inline die defining a spherical annular flow path for uniform dispersion of the plastic in the parison. The spherical annular flow path is defined by inner and outer spherical configurations, or more specifically by a manifold having a spherical outer surface, disposed in a spherical cavity within a head case. However, the manifold must be supported within the spherical cavity. The supports required to do so are disposed within the spherical annular flow path and thus displace the flow.

Summary of the Invention

It will be readily apparent from the above that a need exists in the art to overcome the problems associate with such displacement caused by the supports. Therefore, an advantage of the present invention is compensation for the volume displaced by the spheres' supports.

This advantage is achieved by an inline die apparatus of the present invention for single-layer or multi-layer extrusion, having parts with two spherical (or other) configurations. The inner spherical configuration is modified to compensate for the volumes displaced by the spheres' supports.

An interchangeable mandrel can be located within the inner spherical configuration. Such a mandrel can introduce air, a complete or segmented secondary extrudate layer, or both within the primary extrudate. Alternatively, an affixable external flow dispersion device can be used to introduce a complete or segmented layer of extrudate over the primary extrudate layer or layers.

Brief Description of the Drawings

A preferred embodiment of the present invention will be set forth in detail with reference to the drawings, in which:

Fig. 1 shows a cross-sectional view of a crosshead according to the preferred embodiment;

Fig. 2 shows an enlargement of a portion of Fig. 1;

Figs. 3 and 4 show mandrels which can replace the mandrel shown in Fig. 1;

Fig. 5 shows an external flow dispersion device which can replace various components of the crosshead of Fig. 1; and

Fig. 6 shows a mandrel which can be used with the external flow dispersion device of Fig. 5.

Detailed Description of the Preferred Embodiments

A preferred embodiment of the present invention will be set forth in detail with reference to the drawings, in which like reference numerals refer to like components throughout.

Fig. 1 shows an extrusion head 1 according to the preferred embodiment of the present invention. Fig. 2 shows, at a different scale, part of the head 1 of Fig. 1.

The extrusion head 1 includes a head case 3 and a manifold 5 supported by supports 7 within a spherical cavity 9 of the head case 3. The spherical inner surface 11 of the spherical cavity 9 and the spherical outer surface 13 of the manifold 5 define a spherical annular flow path 15. The head case 3 is provided with an outer shell 17 and a heater 19.

Attached to the head case 3 is an inlet manifold 21 having a heater 23. The inlet manifold 21 has a central bore 25 which is in communication with a inlet opening 27 of the head case 3 and thus with the spherical annular flow path 15. The inlet manifold 21 is attached to the head case 3 by holding a flange 29 of the inlet manifold 21 and a flange 31 of the head case 3 together with a ring 33.

The head case 3 is formed of a rear portion 35 and a front portion 37, which are held together by holding a flange 39 of the rear portion 35 and a flange 41 of the front portion 37 together with a ring 43. An outer outlet portion 45, having its own heater 47, is bolted onto the front portion 37 with a bolt 49. An inner outlet portion 51 is bolted onto the outer outlet portion 45 with a bolt 53. A retaining ring 54 is threadably engaged with the inner outlet portion 51 to retain a die 55.

An extrusion mandrel 57 is mounted in the spherical manifold 5 and extends through the die 55 to form a space 59 between the mandrel 57 and the die 55. The space 59 is in communication with the spherical annular flow path 15. The mandrel

57 has a central bore 61 in communication with an air inlet 63 having a central bore 65.

Referring to Fig. 2, the mandrel 57 also has a separate flow path 67 for molten plastic. The separate flow path 67 has an inlet 69 for receiving the molten plastic from an inlet manifold 71 having a central bore 73, a heater 75, a gasket 77 and a pipe 79. An inner die 81, threadably engaged with the spherical manifold 5, defines a space 83 around the mandrel 57. The space 83 is in flow communication with the flow path 67.

The mandrel can be removably secured within the spherical manifold 5 with a screw 85 and a block 87. A ring 89 can be removably secured within the front portion 37 of the head case 3 to allow removal of the mandrel 57. The manifold 5 can be constructed to allow access to the screw 85, e.g., by providing a screw hole or by forming the manifold 5 in two parts.

The crosshead 1 operates in the following manner. Molten plastic introduced through the inlet manifold 21 flows through the spherical annular flow path 15 and out the space 59 between the mandrel 57 and the die 55 to form the extrudate. To compensate for the volume of the flow path 15 occupied by the supports 7, a separate flow of molten plastic is supplied through the inlet manifold 71, the flow path 67 and the space 83 to form a separate layer of extrudate, either complete or segmented, within the extrudate to form a multi-layer or co-extruded product. Air supplied through the air inlet 63 can be used for blow molding or the like.

As noted above, the mandrel 57 is removable. Thus, the mandrel can be replaced with different mandrels such as those which will be described with reference to Figs. 3 and 4.

The mandrel 91 of Fig. 3 differs from the mandrel 57 of Figs. 1 and 2 in that the flow path 67 and inlet 69 are absent. Instead, air from the central bore 61 is conveyed through air channels 93 to a modified flow path 95, from which it exits through the space 83. Thus, when the mandrel 91 is installed in the head 1 in place of the mandrel 57, air is injected inside the extrudate.

The mandrel 97 of Fig. 4 combines features of the mandrels 57 and 91 of Figs. 1-3. The inlet 69 is present, and also, air channels 93 convey air from the central bore 61 to a modified flow path 99 in communication with the inlet 69. Thus, molten plastic received through the inlet 69 is extruded through the space 83, and air from the central bore 61 is injected inside that molten plastic. Again, the molten plastic received through the inlet 63 can be used to form a complete or segmented extrudate.

As an alternative to injection of air or another layer of plastic from inside, another layer of plastic can be applied from the outside, using a flow dispersion device 101 shown in Fig. 5. The flow dispersion device 101 is used in the crosshead 1 in place of the outer outlet portion 45, the inner outlet portion 51, the retaining ring 54 and the die 55. The flow dispersion device 101 is formed from an outer component 103 and an inner component 105. The outer component 103 has a inlet 107 to receive molten plastic, which is channeled through flow paths 109 formed between the outer component 103 and the inner component 105 to be dispersed over the plastic flowing over the mandrel to form a complete or segmented extrudate. The flow paths 109 can be those used in known striping devices.

The mandrel used with the flow dispersion device can be any of the mandrels 57, 91, and 97 already described. Alternatively, a mandrel 111 shown in Fig. 6 can be used. The mandrel 111 has neither the inlet 63 nor the air channels 95, but it does have the central bore 61.

In all of the above embodiments, the volume of air or of the secondary extrudate introduced within or upon the primary extrudate is selected to compensate for the volume displaced by the supports 7.

Other embodiments can be realized within the scope of the present invention. For example, while a central bore 61 has been shown for blow molding, other extrusion techniques do not require the central bore 61. Also, while various components have been shown as separate for ease of assembly and disassembly, other provisions for assembly and disassembly can be made. Further, while the preferred embodiment uses a spherical annular flow path, the invention is applicable in the context of flow paths having other shapes.

Although only preferred embodiments are specifically illustrated and described herein, it will be appreciated that many modifications and variations of the present invention are possible in light of the above teachings and within the purview of the appended claims without departing from the spirit and intended scope of the invention.

What is claimed is:

1. An inline die apparatus for extrusion of a molten material to form a primary extrudate, the apparatus comprising:

an inner component with a first surface;

an outer component with a second surface;

a support for supporting the inner component within the outer component such that the first surface and the second surface together define a flow path for a uniform dispersion of the molten material to form the primary extrudate; and

a mandrel disposed within the inner component to introduce, within the primary extrudate, an additional material to compensate for a volume of the molten material displaced by the support.

2. The inline die apparatus of claim 1, wherein the mandrel is removably mounted within the inner component to be interchangeable.

3. The inline die apparatus of claim 1, wherein:

the additional material comprises air; and

the mandrel has an air channel to introduce the air within the primary extrudate.

4. The inline die apparatus of claim 1, wherein:

the additional material comprises an additional molten material; and

the mandrel has a flow path to introduce the additional molten material within the primary extrudate to form a secondary extrudate.

5. The inline die apparatus of claim 4, wherein:

the additional material further comprises air; and

the mandrel has an air channel to introduce the air within the primary extrudate.

6. The inline die apparatus of claim 1, wherein the mandrel has a central bore for introducing air within the primary extrudate for blow molding.

7. The inline die apparatus of claim 1, wherein the first and second surfaces are spherical and define the flow path as a spherical annular flow path.

8. An inline die apparatus for extrusion of a first molten material to form a primary extrudate and of a second molten material to form a secondary extrudate on the primary extrudate, the apparatus comprising:

an inner component with a first surface;

an outer component with a second surface;

a support for supporting the inner component within the outer component such that the first surface and the second surface together define a flow path for a uniform dispersion of the first molten material to form the primary extrudate; and

an external flow dispersion device, affixed to at least one of the inner component and the outer component to be in communication with the flow path, for introducing the second molten material onto the primary extrudate to form the secondary extrudate on the primary extrudate and to compensate for a volume of the first molten material displaced by the support.

9. The inline die apparatus of claim 8, wherein the external flow dispersion device is affixed to be removable.

10. The inline die apparatus of claim 8, wherein the first and second surfaces are spherical and define the flow path as a spherical annular flow path.

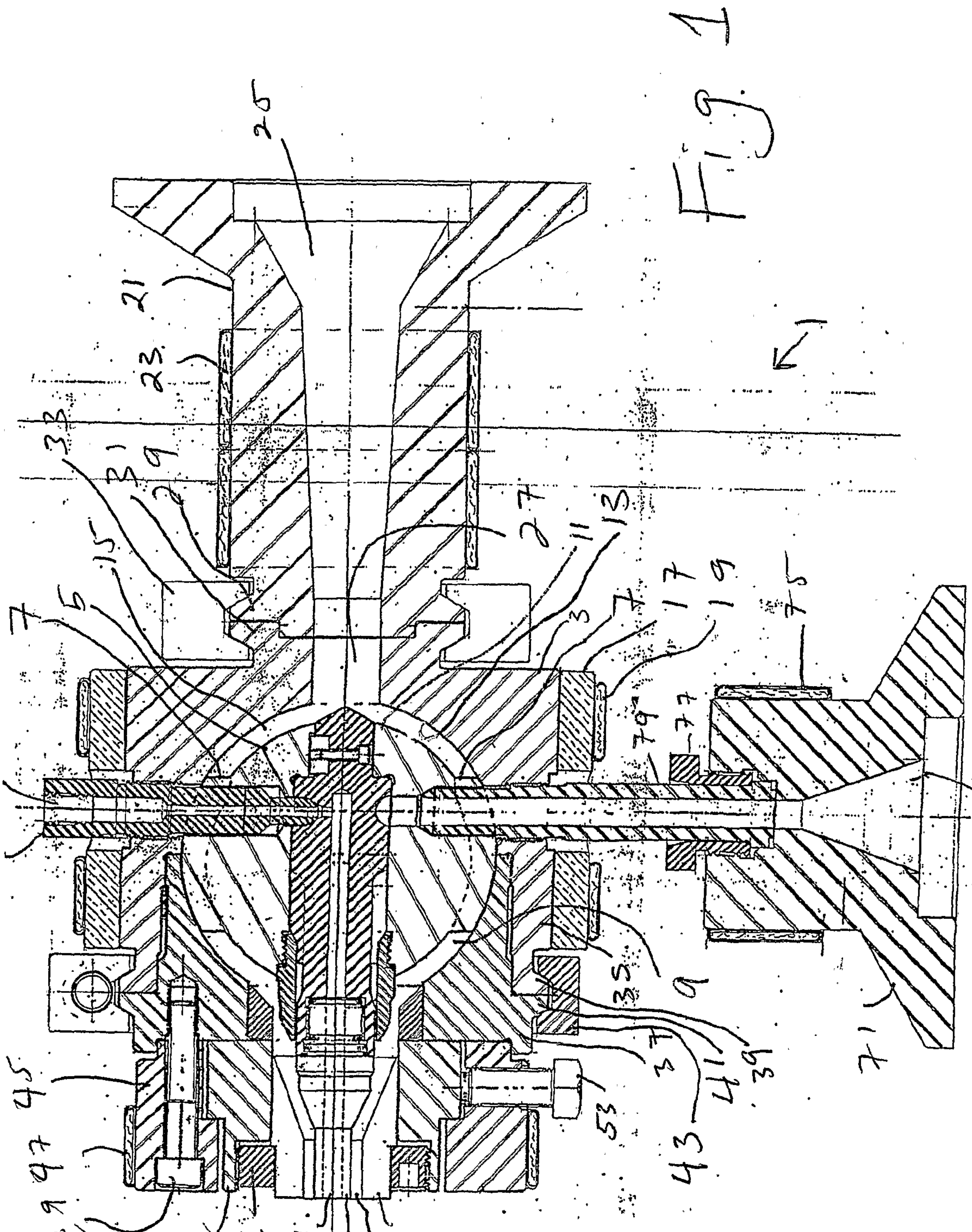

Fig. 1

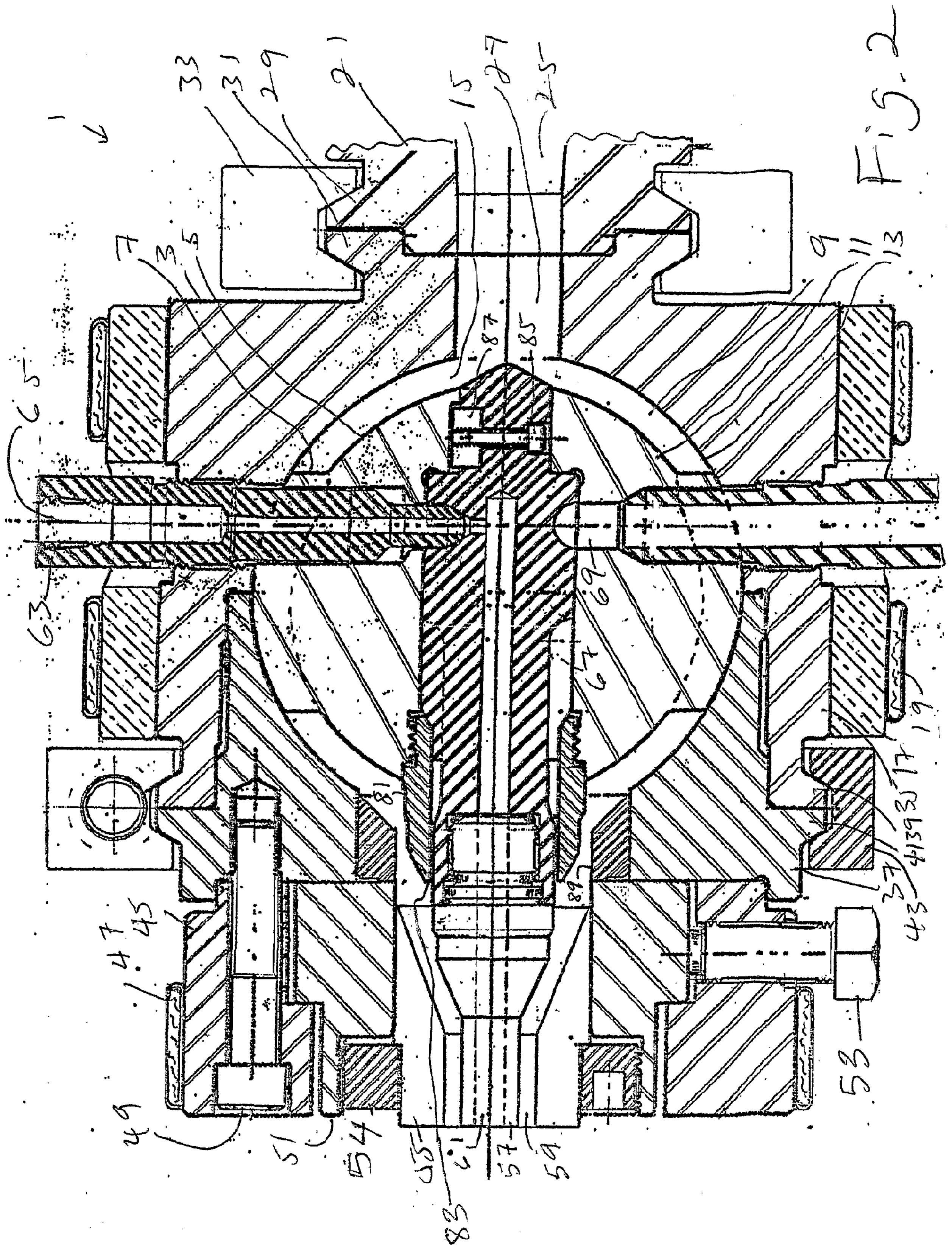
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Fig. 2

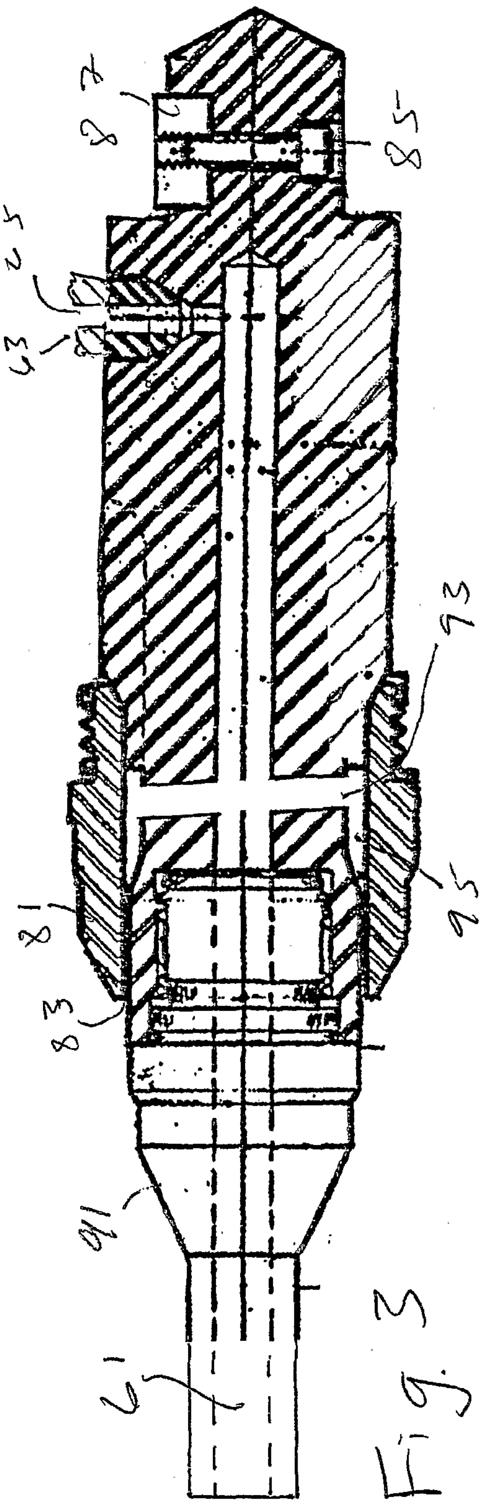


Fig. 3

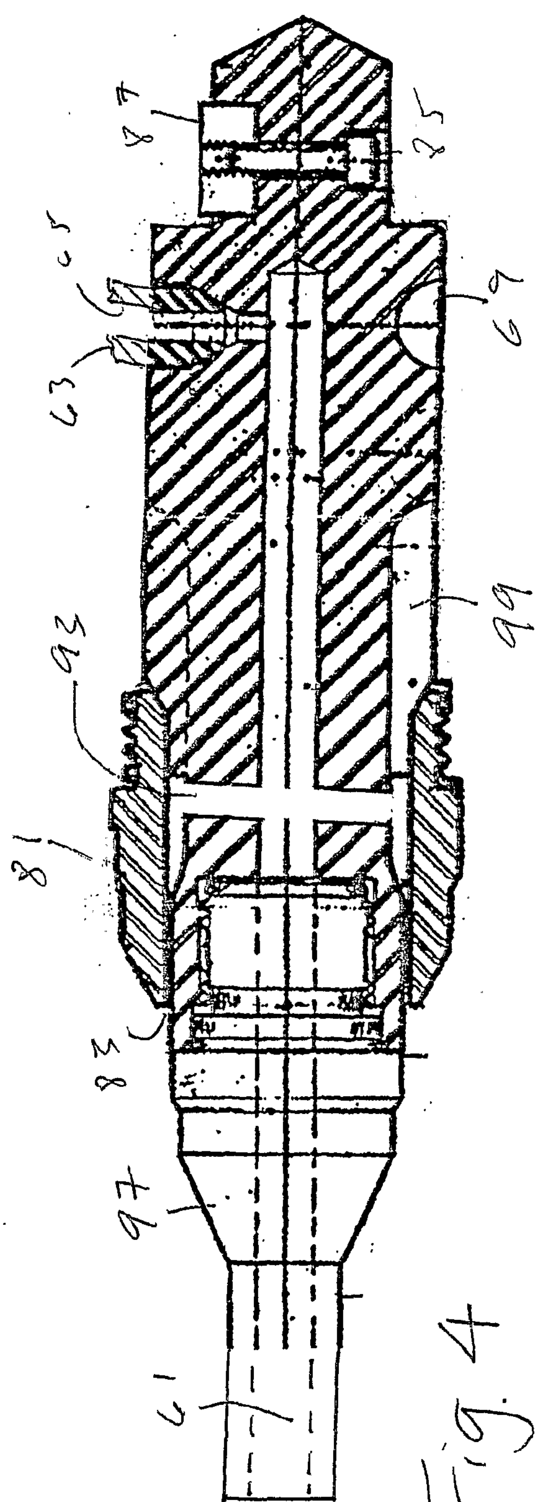


Fig. 4

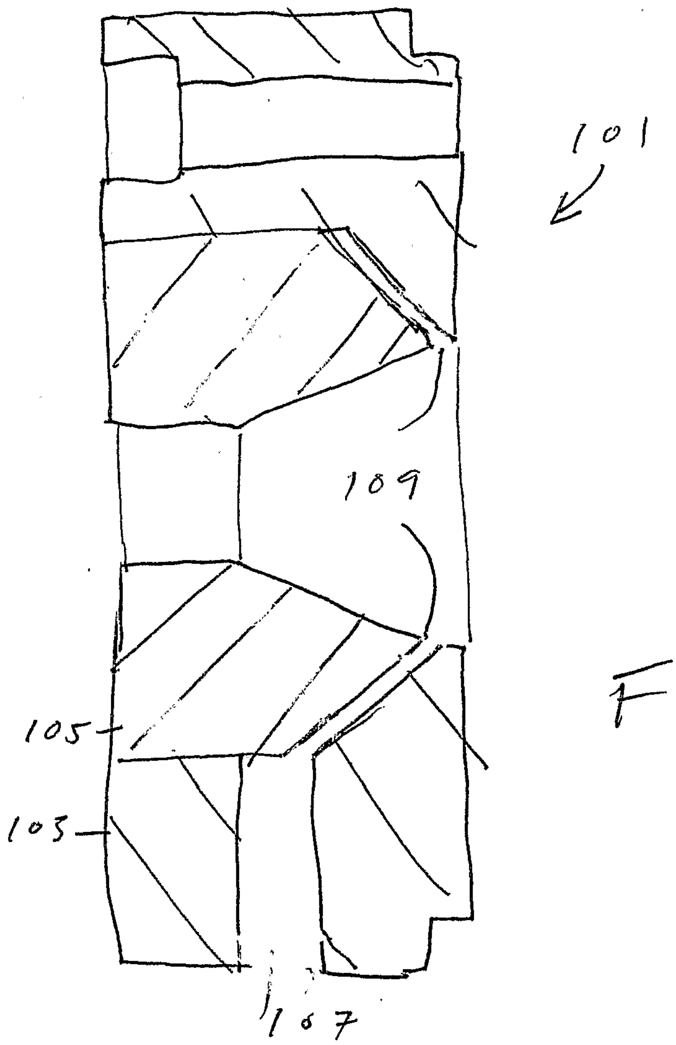
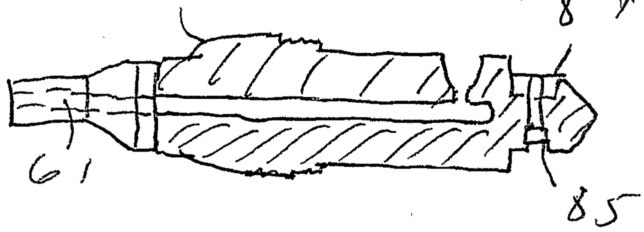


Fig. 5

Fig. 6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/42349

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : B29C 47/06, 47/28
US CL : 425/133.1, 192R, 380, 462, 467, 532
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)
U.S. : 425/133.1, 192R, 380, 462, 467, 532

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.
X --- Y	US 3,649,148 A (WALTMAN et al.) 14 March 1972 (14.03.1972), see figs. 7 and 9.	1-3, 6 --- 5, 7
X --- Y	US 3,962,396 A (ONO et al.) 8 June 1976 (08.06.1978), see fig. 1.	1, 2. 4 --- 5, 7
X --- Y	US 2,501,690 A (PRENDERGAST) 28 March 1950 (28.03.1950), see fig. 1.	8, 9 --- 10
Y	US 5,460,772 A (OHTA) 24 October 1995 (24.10.1995), see fig. 39.	7,10
Y	US 4,061,461 A (HESSENTHALER) 6 December 1977 (06.12.1977), see fig. 1.	5
Y	US 4,134,952 A (YOSHIKAWA et al.) 16 January 1979 (16.01.1979), see fig. 1.	5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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