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(56) Documents cited GB 1282123 GB 1212182 GB 1185062 GB 941283 GB 892901 GB 436827
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(54) Extrusion Die for Producing Plastics Net or Net-like Products

(57) The die comprises members 2, 3 having respective die orifices 4, 5 through which plastics material is introduced in a downward direction (as seen in the figure) the die members being relatively displaced during extrusion (as indicated by the arrows).

Rolling elements 8 are sandwiched between the members 2, 3 to provide rolling frictional contact with the die members, thus avoiding the deleterious effects of direct sliding frictional contact between the die members. The elements 8 may be held in a retainer 24 and may lie in an open channel 6 connected through passages 9, 10 with the die orifices 4, 5 so that the elements 8 are lubricated by the plastics material. Alternatively a closed channel (containing lubricant) may be used. The channel may be formed in both the die members 2, 3 or in one of these.

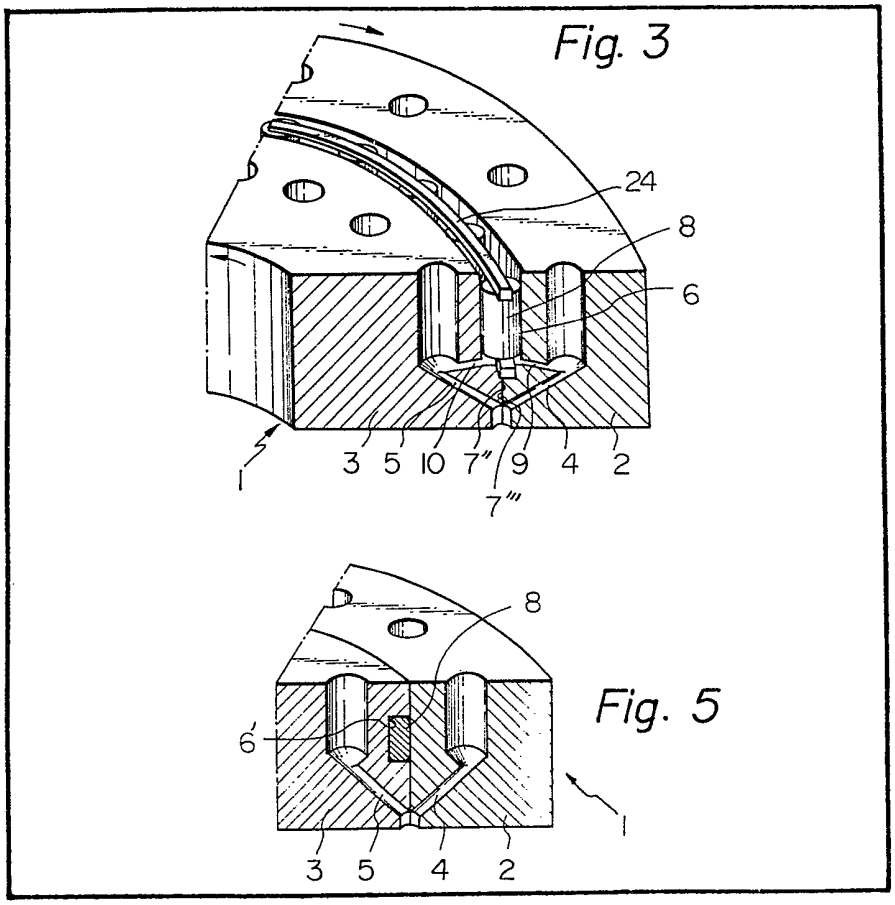

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Fig. 1

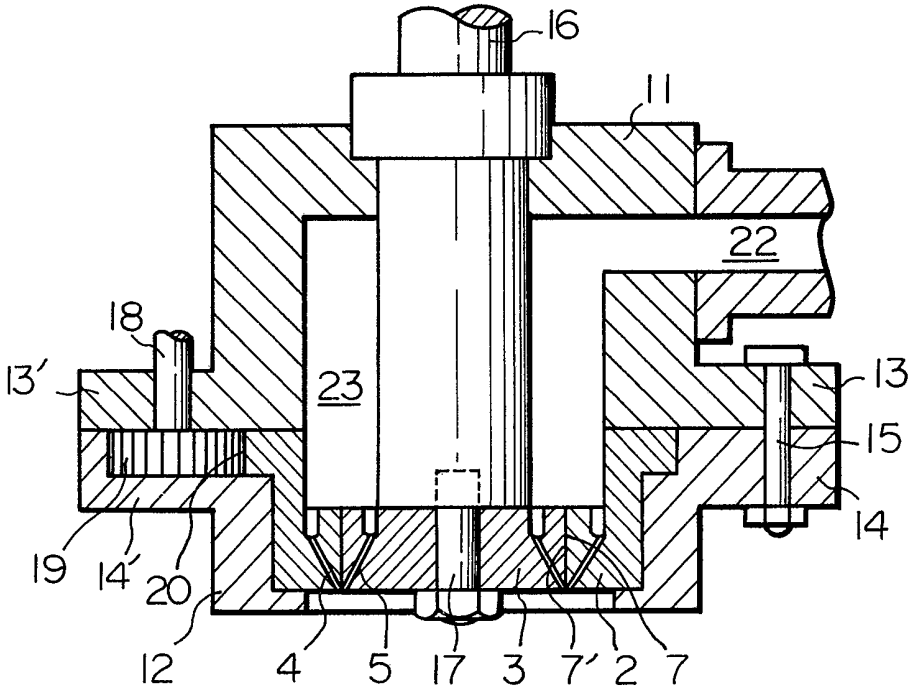


Fig. 2

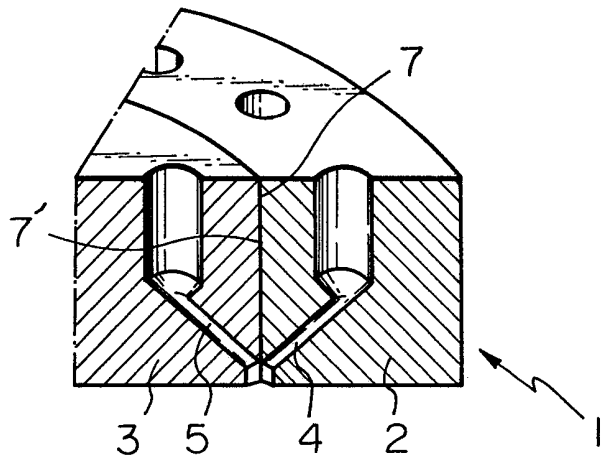


Fig. 3

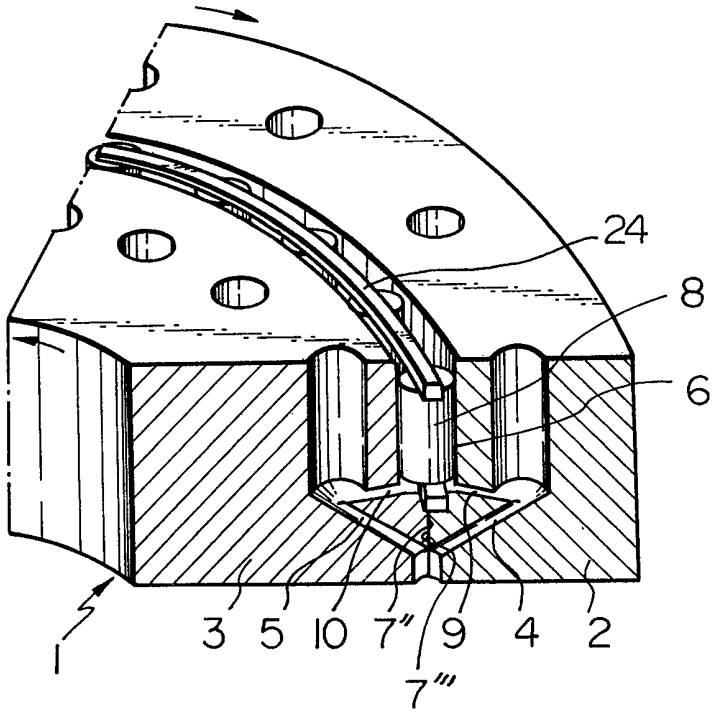


Fig. 4

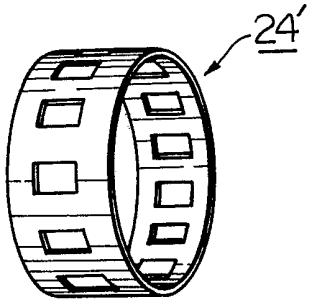
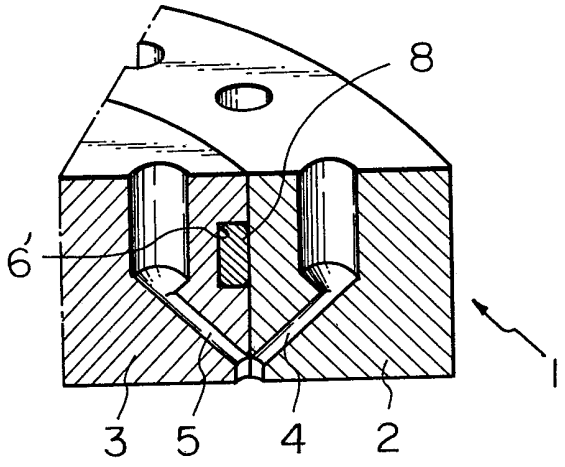


Fig. 5



SPECIFICATION

Apparatus for Producing Plastic Nets or Net-Like Products

This invention relates to an apparatus for producing plastic nets or net-like products.

It is already known that plastic nets or net-like products can be produced by using an apparatus having one pair of die members each member having a plurality of die orifices, as disclosed, for example, in British Patent No. 836,555. A plastic material is extruded through two sets of die orifices, which sets are relatively displaced transversely to the direction of extrusion, into a net or a net-like product. The apparatus provided with two die members that move so that the respective sets of die orifices are displaced transversely to the direction of extrusion is herein referred to as a "moving die type apparatus" for brevity.

Heretofore proposed moving die type apparatuses have been classified into two types depending upon the particular mechanism and shape of the die members. The first type has two coaxially arranged circular die members, which move at different velocities so that relative rotary motion is imparted between the two die members. The first type of apparatuses are herein referred to as the "circular die type" for brevity, and a typical example of the circular die type apparatuses is illustrated in the accompanying Figure 1. The second type has two rectangular die members arranged in parallel which move at different velocities so that there is relative reciprocating or oscillatory motion between the two die members. The second type of apparatuses are herein referred to as "rectangular type" for brevity. By the term "velocity" used herein is meant a vector quantity in a particular direction.

The mechanism and operation of the conventional apparatuses will be explained with reference to Figure 1 and Figure 2, which are a sectional elevation of one form of the conventional circular die type apparatus and an enlarged perspective and sectional view of part of the circular die members of the apparatus illustrated in Figure 1, respectively.

Referring to Figure 1, a housing comprising an upper block member 11 and a lower block member 12 is provided with two circular first and second rotary die members 2 and 3, which are coaxially arranged. The upper and lower block members 11 and 12 are detachably attached to each other at respective flange portions 13 and 14 by screw-threaded or other means 15. A second rotatable drive shaft 16 for rotating the second die member 3 is borne by bearing means (not shown) on a central through hole of the upper block member 11, and the lower end of the drive shaft 16 is detachably coupled to the second die member 3 by screw-threaded or other means 17. A first rotatable drive shaft 18 for rotating the first die member 2 is borne by bearing means (not shown) on a through hole in a flange portion 13' of the upper block member 12. A driving gear 19 secured to the lower end of the first drive shaft 18 is located in a recess in a flange portion 14' of the second block member 13, where the driving gear 19 engages with gears on surface 20 of the first die member 2. The first die member 2 and the second die member 3 can rotate at different velocities, i.e., can be relatively displaced, by suitably selecting the rates of revolution of the first and second drive shafts 18 and 16. In the operation of this apparatus, a net-forming thermoplastic polymeric material in a suitably molten state is forced through a passage 22 into an annular passageway 23. Then, the molten polymeric material is extruded throough a first set of die orifices 4 and a second set of die orifices 5 to form a net or net-like product.

Referring to Figure 2, the conventional circular die type apparatus has the first (outer) die member 2 and the second (inner) die member 3, which members have two sets of die orifices 4 and 5, the orifices of each set being bored equidistant from each other through the first and second die members 2 and 3, respectively. When the first and second die members 2 and 3 are relatively displaced, the contacting surfaces or circular slideways 7 and 7' are subject to sliding friction. The two circular slideways 7 and 7' are faced so as to exactly accord with each other. In order to minimize the sliding friction and the wearing on the slideways, and further, to prevent leakage of the molten polymeric material between the contacting surfaces of the slideways 7 and 7', the two slideways are hardened and carefully ground to a precise fit. However, when the rotational axes of the first and second die members 2 and 3 do not exactly accord with each other, namely, the rotational axes are inclined toward each other even at a very slight angle or are located apart from each other even by a very slight distance, or, when the first and second die members 2 and 3 bear axially asymmetrical load distribution, the sliding friction between the two slideways and the wearing on the two slideways become conspicuous. This leads to a reduction in the lifetime of the plastic net producing apparatus, in the production efficiency and in the quality of the plastic net or net-like product. At the worst, the first and second die members rub against each other to such an extent that the die members cannot be displaced any more. As a matter of fact, even when the slideways of the two die members are hardened and carefully ground to a precise fit, it is difficult or even impossible to completely avoid the above-mentioned disadvantages.

It is, therefore, a main object of the present invention to provide a moving die type apparatus for producing plastic nets or net-like products, wherein the two die members bear a uniform and far reduced load, and thus the sliding friction between the slideways of the die members and the wearing on the slideways thereof can be avoided or minimized.

In accordance with the present invention, there is provided an apparatus for extruding a plastic material through two sets of die orifices to produce a plastic net or net-like product, which comprises a pair of die members each having a set of die orifices, and means for relatively displacing the die members transversely to the direction of extrusion for placing the die orifices of each die member into positions of registration and non-registration with one another, the invention being characterized by a plurality of rolling elements sandwiched between facing side walls of the two die members, which elements are rolled by the relative displacement of the die members, whereby the die members are relatively displaced through a rolling frictional contact with the rolling elements.

Figure 1 is a sectional elevation of one form of the conventional circular die type apparatus;

Figure 2 is an enlarged perspective and sectional view of part of the rotary die members of the apparatus illustrated in Figure 1;

Figure 3 is an enlarged perspective and sectional view of part of the rotary die members of one form of the circular die type of the invention;

Figure 4 is a perspective view of a retainer used in the circular die type apparatus of the invention; and,

Figure 5 is an enlarged perspective and sectional view of part of the rotary die members of another form of the circular die type apparatus of the invention.

Referring to Figure 3, the circular die type apparatus of the invention has a first die member 2 and a second die member 3, which members are relatively displaced in opposite directions as indicated by the arrows. The respective die members 2 and 3 have pluralities of die orifices 4 and 5, spaced at constant distances from each other, respectively, through which a plastic material is forced. Facing side walls of the die members 2 and 3 form a circular open channel 6 therebetween, and a plurality of rolling elements 8 are fitted into the channel 6 so that the periphery of each rolling element 8 comes in contact with the side walls of the channel 6. The two die members 2 and 3 are faced in accord with one another at the slideways 7″ and 7‴, respectively. There are provided passages 9 and 10 connecting the channel 6 with the die orifices 4 and 5, respectively, whereby a plastic material can be introduced from the channel 6 into the die orifices 4 and 5.

When the two die members 2 and 3 are relatively displaced, i.e., either rotationally or reciprocally moved in opposite directions as indicated by the arrows in Figure 3, the plastic material continuously extruded through both sets of the die orifices 4 and 5 forms a net or net-like product. That is, when the die orifices 4 and 5 of the respective sets are in register with one another, a net intersection-forming stream of plastic issues from each registered pair of die orifices, which together frm a composite extrusion orifice. As rotation of the die members proceeds, these intersection streams are divided with a shearing action on the plastic within the die orifices 4 and 5 to form non-intersection portions of the net or net-like product.

The two die members 2 and 3 are in antifrictional contact with the rolling elements 8 fitted in the channel 6. The rolling elements 8 are retained in position within the channel 6 preferably by using a retainer 24. The plastic material fills the channel 6 and lubricates the rolling elements 8. The plastic material filling the channel flows through passages 9 and 10 into the die orifices 4 and 5, respectively. Thus, the plastic material does not stagnate within the channel 6 and hence, is not subject to thermal degradation or deterioration.

The clearance between each rolling element 8 and the respective side walls of the die members 2 and 3 defining the channel 6 should be adjusted so that the facing slideways 7″ and 7‴ do not come into frictional contact with one another. For this puspose, the deviation of each rolling element 8 in the radial direction thereof should be minimized as much as possible and further, the clearance between each rolling element 8 and the respective side walls of the die members 2 and 3 should be made to be smaller than the clearance between the facing slideways 7″ and 7‴.

another form of a retainer 24′, illustrated in Figure 4, may be fitted in the channel 6 (shown in Figure 3) in order to retain the rolling elements 8 in position within the channel 6. The rolling elements 8 are fitted into the respective holes bored in the circular retainer 24′.

In the embodiment illustrated in Figure 3, the rolling elements 8 can roll within the open channel 6 without any conventional lubricant because the plastic material filling the channel has a function of lubricating the rolling elements. Alternatively, as illustrated in Figure 5, rolling elements 8 may be encased, together with a lubricant, in a closed channel 6′. A retainer may or may not be inserted in the closed channel 6′. Even though no retainer is inserted, the rolling elements can be retained in position within the closed channel 6′ provided that a row of the rolling elements are fitted in the closed channel 6′ in succession.

The channel in which the rolling elements are fitted may be either open, as illustrated in Figure 3, or closed, as illustrated in Figure 5. Furthermore, the channel may be formed either in both of the die members, as illustrated in Figure 3, or in one of the die members as illustrated in Figure 5. It is advantageous that the channel is formed in one of the die members to facilitate the manufacture of the die members.

The rolling elements used in the apparatus of the invention may be of any convenient shape such as, for example, sphere, cylinder or needle.

It will be understood that, with the apparatus provided with rolling elements in rolling frictional contact with the two die members, the facing side walls of the die members are not subject to

substantial frictional contact with one another and thus, the die members bear a far reduced load as compared with conventional apparatuses. Consequently, the lifetime of the apparatus, the production efficiency and the quality of the net or net-like product are enhanced.

The apparatus of the invention will be further illustrated by the following example of operation.

Using an apparatus similar to that illustrated in Figure 1 but provided with die members illustrated in Figure 3, a polyamide was melt extruded into a net. Needle-like rolling elements were placed in a groove formed between the die members, together with a circular retainer similar to that illustrated in Figure 4. The die members were made of alloy tool steel (SKD—11) and hardened. The clearance between the facing slideways of the die member was 30 microns and the deviation of the rolling elements was 10 microns or less. The side wall surfaces of the die members to be brought into contact with the rolling elements were abraded so as to exactly accord with the rolling elements while the rolling elements were repeatedly fitted into the groove. It was observed that the die members bore a load of only a negligible extent. The produced net was of good quality.

Claims

1. An apparatus for extruding a plastic material through two sets of die orifices to produce a plastic net or net-like product, which comprises a pair of die members each having a set of die orifices, and means for relatively displacing the die members transversely to the direction of extrusion for placing the die orifices of each die member into positions of registration and non-registration with one another, characterized by a plurality of rolling elements sandwiched between facing side walls of the two die members, which elements are rolled by the relative displacement of the die members, whereby the die members are relatively displaced through a rolling frictional contact with the rolling elements.

2. The apparatus according to claim 1 wherein the facing side walls of the two die members are circular and coaxially arranged, and the two die members are rotated at different velocities.

3. The apparatus according to claim 1 or claim 2, wherein the two die members have an open channel defined by the upper parts of the facing side walls of the two die members, in which channel the rolling elements are fitted.

4. The apparatus according to claim 3, wherein the die members have passages through which the plastic material is introduced from the open channel into the respective sets of the die orifices.

5. The apparatus according to claim 1 or 2, wherein the two die members have a closed channel defined by the facing side walls of the die members, in which channel the rolling elements are fitted.

6. The apparatus according to any one of claims 3 to 5, wherein the channel is formed in one of the two die members.

7. The apparatus according to any one of claims 3 to 6, which has a circular retainer for retaining the rolling elements in position within the channel between the facing side walls of the two die members.

8. The apparatus according to any one of the preceding claims, wherein the rolling elements are of a spherical, cylindrical or needle-like shape.

9. An apparatus for producing a plastic net or net-like product substantially as shown in Figure 3 of the accompanying drawings (whether or not having the modification shown in Figure 4 or Figure 5) and described herein with reference thereto.

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