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(54) EXTRUSION DIE HEADS

(71) I, HARALD FEUERHERM, a German Citizen of Alfred-Delp-Strasse 1, D.5210, Troisdorf, Western Germany, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to extrusion die heads for producing a tube in thermoplastics material, and comprising an accumulator chamber for the material which is bounded by a housing and a mandrel concentrically arranged thereto and furthermore comprising an annular piston that is axially movable in the chamber.

On a known extrusion die head of the aforementioned type, cylindrical mouths are separated only by a thin bushing and lead into a channel at the same annular piston side (German Offenlegungsschrift No. 2,100,192).

There is liable to occur a disadvantageous relative movement between the flows of material coming from two mouths. In order to prevent any damage in the containers to be produced, from the extruded tubes identical speeds of the two individual flows formed in the delivery channel are required. The higher the speed of the materials in these channels, the more difficult it is to coordinate the resistances in the channels.

According to this invention an extrusion die head for the extrusion of a tube of thermoplastics material comprises an accumulation chamber for the material which is bounded by a housing and a mandrel concentrically arranged thereto, an annular piston axially movable in the chamber, and a plurality of channels for supplying the material to the chamber, each of which channels has an annular mouth opening into the chamber, the diameters of the mouths being such that there is located between the mouths at least a portion of the annular piston.

An advantageous development is if the mouth of one of the channels has a minimum diameter which is at least equal to the outside diameter of the annular piston and that the annular piston separates the flows of material. Any pockets of material are thus prevented to a large extent, so that new material that is introduced into the chamber is no longer contaminated by old material after a short time. This makes it possible for materials of different colour or characteristics to be processed in quick succession in the course of the operation of the extrusion die head without a long interval resulting during which the materials are mixed.

Further advantageous developments of the invention allow the material to be supplied through more than two channels which are separated as far as the chamber.

Another advantageous development of the invention consists in that one or more feed channels are axially parallel to the annular piston in the area thereof and in that a respectively provided telescopic tube, which is also axially parallel to the annular piston, is located in the channel. The material is directly fed into the chamber through the telescopic tube, taken in the direction that is axially parallel to the annular piston, only with the deflections required for the formation of an annular cross section, so that there is not provided any point where the material can linger.

Several embodiments of the invention are diagrammatically shown by way of example in the accompanying drawings, in which:—

Figs. 1, 3, 5 and 7 each show a longitudinal section through different embodiments in accordance with the lines I—I in Fig. 2, III—III in Fig. 4, V—V in Fig. 6 and VII—VII in Fig. 8,

Figs. 2, 4, 6 and 8 are cross sections through the embodiments in accordance with the lines II—II in Fig. 1, IV—IV in Fig. 3, VI—VI in Fig. 5 and VIII—VIII in Fig. 7,

Figs. 9 and 10 each show a partial section through two further embodiments, and

Figs. 11 to 21 are further embodiments, partly shown in vertical section, partly in horizontal section.

Fig. 11 being a section on the line XII—XII of Fig. 12,

Fig. 12 being a section on the line XII—XII of Fig. 11,

Fig. 13 being a section on the line XIV—XIV of Fig. 14,

Fig. 14 being a section on the line XV—XV of Fig. 13,

Fig. 15 being a section on the line XVI—XVI of Fig. 16,

Fig. 16 being a section on the line XVII—XVII of Fig. 15,

Fig. 19 being a section on the line XX—XX of Fig. 20, and

Fig. 20 being a section on the line XXI—XXI of Fig. 19.

In the embodiments described hereafter, identical parts are provided with identical reference symbols, and a minuscule has been added to similar parts, in order to emphasise the difference.

The extrusion die head shown in Figs. 1 and 2 has a housing 1 which is designed in the manner of a hollow cylinder and into which an external bushing 2 and an internal bushing 3 are inserted. The conical underside of the external bushing 2 stands on a conical portion 4 of the housing 1. The internal bushing 3 has at its upper end an outwardly projecting flange 5 which surmounts the external bushing 2 and the housing 1 and stands on this latter. In the centre of the housing, there is arranged a mandrel 6 which is seated, at its conical upper end, in a corresponding recess of the internal bushing 3 and is held in the internal bushing by means of a nut 7. An annular piston 8, which is driven from the exterior by means of rods 9, which are not shown in their entirety, is mounted in an axially movable manner between the external bushing 2 and the internal bushing 3.

On the outside of the external bushing 2, there is provided a cardioid-shaped channel 10 which uniformly distributes the material coming from a feeding channel 11 on the circumference of the external bushing 2 so that it emerges in the shape of a tube from the orifice 12 of the cardioid-shaped channel 10.

On the outside of the mandrel 6, there is also provided a cardioid-shaped recess 13 which, together with the cone-shaped internal surface of the internal bushing 3, forms a cardioid-shaped channel 13, through whose orifice 14 the material delivered through a feeding channel 15 emerges in the shape of a tube. The parts of the feeding channels 11 and 15, which parts are arranged on an identical diameter, open into a radially arranged feeding channel 16, a separating wedge 17*a* in the area where channel 16 communicates with channels 11, 15 serving for the separation of the material supplied through the feeding channel 16 into two partial flows. The feeding channel 16 is connected to an extruder which is not shown. The feeding channels 11 and 15 may be separtely connected to different extruders extruding differently coloured and/or different materials. While the feeding channel 11 extends only on a portion of the circumference of the external bushing 2, the feeding channel 15 penetrates the external bushing 2 and the internal bushing 3, as shown in Fig. 2.

Beneath the annular piston 8, which is shown in its uppermost lifted position, there is provided a material receiving chamber 17 which is bounded by the housing 1 and the mandrel 6. This chamber is bounded at its underside by a bounding element 18, which is wedge-shaped in cross section and comprises a conical surface on its inner side, and by a cone-shaped extension 19 of the mandrel 6. After a short cylindrical intermediate piece 20, this extension is followed by a conical reduction 21 which is adjoined, after a cylindrical part 22, by another conical extension 23. The upper portion of the conical reduction 21 is in a region of the lower portion of the bounding element 18. The angle of cone of the inner side of the bounding element 18 corresponds to the angle of cone of the conical part 21. A die body or nozzle member 24, which is arranged beneath the housing 1, is held by an annular member 25 attached to the housing 1. The inner side of the die body 24 is adapted to the parts 21 to 23 of the mandrel 6, an annular intermediate space, which gradually narrows to a slight extent in the direction of the mouth 26 of the die body 24, being left free.

The portion of the annular piston 8 that is adjacent to the bounding element 18 is in cross section designed in the manner of an equilateral triangle. The annular piston 8 can be lowered by means of the rods 9 and be lifted by the material flowing into the chamber 17. Its portion that is triangular in cross section corresponds to the internal cone of the bounding element 18 and the cone 19 of the mandrel 6. In the lowest position of the annular piston 8, the distance between the lower part of the piston 8 and the bounding element 18 and the cone 19 of the mandrel 6 is like that provided between the wall of the mandrel 6 and the inner wall of the annular piston 8, on the one hand, and the outside of the annular piston 8 and the inner wall of the housing 1, on the other hand. The material fed in a plastic condition into the chamber 17 through the orifices 12 and 14 lifts the annular piston 8 which, in the process of being lowered, drives the material stored in the chamber 17 from the mouth 26.

In the second exemplified embodiment shown in Figs. 3 and 4, the external bushing, which is designated here by 2*a*, also has a cardioid-shaped channel on its outer side, while its inner side partly serves as a slideway for the annular piston 8, as in the first exemplified embodiment. The internal bushing 3*a* is integral with the mandrel 6*a*. The conical top of the mandrel 6*a*, which does not extend to the level of the flange 5, is covered by a filler piece 7*a*. The feeding channel designated by 15*a* is a continuation of the feeding channel 16 and extends to the centre of the filler piece 7*a*, which has on its underside a conical space, into which the cone peak of the mandrel 6*a* projects. By this means, there is provided a channel 13*a* which is shaped like a hollow cone and continues as an annular cylindrical channel, in the part formed by the mandrel 6*a* and the internal bushing 3*a*, and ends in an externally widening conical part at whose end there is the orifice 14 in the area of the lower end of the raised anular piston 8. The internal bushing 3*a* and the mandrel 6*a* are connected by angularly spaced radial or tangential members 27 which are provided in the annular channel 13*a* and leave a space for the passage of plastic material.

In the third exemplified embodiment shown in Figs. 5 and 6, the outside of the annular piston 8*b* rests against the inside of the housing 1*b* and the inside of the annular piston 8*b* rests against the outside of the mandrel 6*b*, which is cylindrical in this area. Both on its outside and its inside the annular piston 8*b* has a cardioid-shaped depression, the depression on the outside forming a channel 10*b* with the inner wall of the housing 1*b* and the depression arranged on the inside of the annular piston 8*b* forming a channel 13*b* with the mandrel 6*b*. The channel 10*b* is connected to a telescopic tube 28 arranged thereabove, and the channel 13*b* is connected to a telescopic tube 29 arranged thereabove. The telescopic tubes 28 and 29 project into corresponding bores in the annular piston 8*b* and are held in position, at their enlarged head ends, between the housing 1*b* and the flange 5*b*. During its axial lifting and lowering movement, the annular piston 8*b* is displaced relative to the telescopic tubes 28 and 29. The bottom portion of the annular piston is also designed, in cross section, as an equilateral triangle. The feeding channels 11*b* and 15*b* are symmetrical with respect to the feeding channel or inlet 16*b* and lead to the interior of the tubes 28 and 29 respectively.

It is possible to connect a separate extruder to each of the telescopic tubes 28 and 29. For the production of an inner layer and/or an outer layer, there may be provided more than one telescopic tube which is connected to separate extruders. This is of advantage particularly for the production of large diameter tubes. If the material of one layer is delivered by more than one extruder, it is possible to use different materials, for example materials in different colours. The partial flows forming one layer are arranged diametrically opposite to one another. If it is not possible, for constructional reasons, to arrange the imagined lines respectively connecting a pair of partial flows of two pairs of partial flows, so that they are normal to one another, this has practically no disadvantageous effect.

In the fourth exemplified embodiment shown in Figs. 7 and 8, there is provided a recess for a cardioid-shaped channel 13 on the mandrel 6*c*, which recess, being bounded by the bushing 3*c*, forms the channel 13. The channel 10*c* is formed by two portions of the annular piston 8*c*, whose inner portion 30 carries a recess and whose outer portion 31, with its inner side, bounds the recess. The connected sides of the two portions 30 and 31 are stepped and the bottom faces thereof are conically outwardly inclined. The channel 10*c* communicates with the tube 28, whose widened head is arranged between the housing 1*c* and the bushing 3*c* and is secured to the housing 1*c*. The conical part 19*c*, which widens outwardly, of the mandrel 6*c* is adapted to the underside of the annular piston 8*c* and the part 21*c*, which tapers towards the bottom, is adapted to the bounding element 18. The feeding channel 15*c*, which initially extends on the outside of the bushing 3*c*, is in its end part taken through this bushing to the mandrel 6*c* (Fig. 8). On its outer side, the annular piston 8*c* is guided over a relatively long distance in the housing 1*c*.

Instead of the cardioid-shaped recess 13 on the outer circumference of the mandrel 6*c*, there may be provided a cardioid-shaped channel corresponding to that of the cardioid-shaped channel 10 of the first embodiment. In this case, the annular piston is tapered in the other direction on its underside and is guided on the mandrel, which is cylindrical in design as far as the interior of the die body 24 and between whose cylindrical part, on the one hand, and whose cylinder-shaped part 22, on the other hand, there is provided only a short conical reduction 21.

In the fourth exemplified embodiment shown in Figs. 7 and 8, it is possible to provide on the outer surface of the annular piston 8*c* an additional cardioid-shaped recess which is bounded on its outer side by the cylinder-shaped housing 1*c*. Into each of the, in this case, three cardioid-shaped channels there may be fed from separate extruders plastic material that differs from the material produced by another extruder. It is thus possible to extrude tubes which, as viewed from the exterior into the interior, comprise three different layers which may be different in colour and/or have different characteristics and/or comprise different plastics materials.

Other combinations of the afore-described constructions may lead to differently designed extrusion die heads which have the same characteristics as the extrusion die heads described above.

In the exemplified embodiment described hereafter, as shown in Figs. 9 and 10, the same reference symbols have been used for parts acting in the same manner as those outlined in the preceding exemplified embodiments and illustrate other forms of channel in heads having two or more channels.

In the exemplified embodiment shown in Fig. 9, the cardioid-shaped channel 10*a* is provided on the outside of the annular piston 8*a* and a channel 33*a* also opens to the outside. The annular piston 8*a* is tapered inwardly, the longer portion of the annular piston 8*a* thus being in the area of the cylindrical portion of mandrel 6*a*, to whose underside the downwardly tapering frusto-conical portion 21*a* is connected.

In the exemplified embodiment shown in Fig. 10, the cardioid-shaped channel 10*b* is formed by two portions of the annular piston 8*b*, whose inner portion 30 carries a recess and whose outer portion 31 bounds the recess with its cylindrical inside. The two portions 30 and 31 are of stepped design at their joined sides and are tapered on their undersides in the same way as the annular piston 8*a*. The channel 10*b* communicates with the tube 28, whose widened head is fastened between the housing 1 and the bushing 3. It is also possible to taper the annular pistons 8*a*, 8*b* shown in Figs. 9, 10 in the direction other than that shown with a corresponding adaptation of the mandrel 6*l* and the bounding element 18.

According to the exemplified embodiment shown in Figs. 11 and 12, the distributor channels 11*d*, 15*d* between a common material supply line 16*d* and the feeding channels are arranged along the legs of an isosceles triangle. The telescopic tube 34*a* is again stationary at its upper end so the annular piston moves axially relative to it when it is lowered. The annular piston may consist as shown of three parts 8*d*, 8*e*, 8*f*, but may also be made in one piece, depending on the type of construction of the channels.

In the exemplified embodiment shown in Figs. 13 and 14, the feeding channels 11*e* are radially carried from the exterior and end in three telescopic tubes 34*b*. These are stationary so that the annular piston formed by annular parts 8*g*, 8*h*, will move axially to the tubes. The piston is flowed about at its outer and inner peripheral surfaces so that the plastics material is distributed from each telescopic tube in three concentric streams.

Figs. 15 and 16 illustrate a different construction for the production of two partial flows which flow downwardly through the channels 10*d* and 10*e*. In Fig. 15, the two-part anular piston 8*k*, 8*m* is shown in its lowest position.

In Fig. 17, there is shown an exemplified embodiment wherein the distributor channels 11*f*, 11*g* are connected to the centres of two semi-circular feeding channels 11*h*, 11*k*. These two semi-circular feeding channels have different radii or diameters. The ends of the feeding channels communicate with telescopic tubes, not shown in Fig. 17, which lie diametrically opposite to one another. As shown in the drawing, the telescopic tube pairs are staggered on the circumferential direction, deviating from a right angle by an acute angle α. In this manner, it can be ensured that the seam areas of the individual flows are also staggered by this angle α.

Fig. 18 shows an alternative channel design of a telescoping tube 34*c* whose lower end is fastened in the annular piston 8*n* and which is displaceable relative to a stationary sleeve 35.

Fig. 21 shows an exemplified form of channel where after the distribution of the material over the circumference an intermediate ring 37, which is held by members 36, is interposed before the entry to the chamber 17 is effected. This intermediate ring 37 provides a distribution of the material so as to form two concentric partial flows which are subsequently reunited.

Fig. 19 and 20 illustrate a similar construction comprising an intermediate ring 37*a* and two tubes 34*d* and 34*e*, which communicate with the distributor lines 11*f* and 15*f*. The web members shown on the inside of the intermediate ring 37*a* may alternatively be arranged on the outer surface, that is to say between the annular piston and the intermediate ring, so that the intermediate ring is vertically displaceable with the annular piston.

As illustrated in the left-hand portion of Fig. 19 the web members may be inclined in such a way that they displace the flows of material, which have been divided by the intermediate ring 37*a*, relative to one another on the circumference. This brings about a lateral distribution of the material. The intermediate ring 37 or 37*a* may be arranged either between the mandrel and the annular piston or between the annular piston and the housing. The inclined members may optionally be provided on the outside and/or the inside of the intermediate ring.

With the described die heads, the annular piston presses first out of the mouth 26 the material first delivered to the chamber 17. Given the largest possible ranges of different materials to be processed in succession and/or different throughput rates per unit of time, the flows of material entering the accumulation chamber 17 from the cylindrical mouths 10, 12, 14 have the lowest possible relative speed. Due to the separation of the flows up to the chamber, these are individually fed directly into the chamber, causing the speed of the individual flows to be very low while they are united as well as preventing to a large extent orientations and markings in the finished parts. For example, it is possible to feed two different colours or two different materials into the baffle chamber with virtually no mixing thereof. In this advantageous development, too, the extrusion die head is space-saving and rugged in design.

The extrusion die head comprises few large components, and in particular the annular piston can be formed in one part. It is therefore possible to manufacture the extrusion die head at low cost. Furthermore, the outside diameter can be kept relatively small. The small outside diameter allows the distance between the extrusion die heads in major installations, comprising multiple heads, to be substantially reduced.

WHAT I CLAIM IS:—

1. An extrusion die head for the extrusion of a tube of thermoplastics material and comprising an accumulation chamber for the material which is bounded by a housing and a mandrel concentrically arranged thereto, an annular piston axially movable in the chamber, and a plurality of channels for supplying the material to the chamber, each of which channels has an annular mouth opening into the chamber, the diameters of the mouths being such that there is located between the mouths at least a portion of the annular piston.

2. An extrusion die head as claimed in Claim 1, in which the mouth of one of the channels has a minimum diameter which is at least equal to the outside diameter of the annular piston which separates the mouths.

3. An extrusion die head as claimed in Claim 1 or Claim 2 in which at its end which exerts pressure on material in the chamber during axial movement the annular piston is formed in cross section in the manner of a triangle and the housing and the mandrel are in part shaped correspondingly to the end of the annular piston.

4. An extrusion die head as claimed in claim 3, in which the triangle is isosceles.

5. An extrusion die head as claimed in any one of claims 1 to 4, comprising two angularly spaced cardioid-shaped supply channels, one of which is provided on the exterior surface of the mandrel, and between the housing and the mandrel there is arranged a bushing which comprises on its outside a depression forming the other cardioid-shaped channel.

6. An extrusion die head as claimed in any one of Claims 1 to 4, in which the inner channel has a feed passage that is coaxial to the mandrel and is penetrated by tangential or radial members, and between the housing and the mandrel there is arranged a bushing which comprises on its outside a recess for the formation of a cardioid-shaped channel.

7. An extrusion die head as claimed in any one of Claims 1 to 4, in which at least on one side the annular piston is provided with a cardioid-shaped recess which, together with the part adjoining the annular piston at this point, bounds a cardioid-shaped supply channel.

8. An extrusion die head as claimed in Claim 1 or Claim 4, in which the annular piston consists of two bush-like parts, between which a cardioid-shaped supply channel is arranged.

9. An extrusion die head as claimed in Claim 7 or Claim 8, in which a feed channel passing to the annular piston comprises a tube which co-operates with the latter in telescope-like manner.

10. An extrusion die head as claimed in Claim 9, in which in the area of the annular piston one or more feed channels are axially parallel thereto and in which a said tube, which is also axially parallel to the annular piston is located.

11. An extrusion die head as claimed in Claim 10, in which the tube or tubes are fixedly arranged and engage in the annular piston to a varying extent, depending on the position to which the piston is moved.

12. An extrusion die head as claimed in Claim 10 or Claim 11, in which in the area of its cardioid-shaped channel the annular piston is shorter in the axial direction than it is at the side remote therefrom.

13. An extrusion die head as claimed in Claim 7 or 8, in which a tube is firmly connected to the annular piston and is slidable in the feed channel, a sleeve being interposed.

14. An extrusion die head as claimed in any one of Claims 10 to 13, in which after the material has been distributed circumferentially by the feed channel or channels, an intermediate ring held by members is interposed before the material enters the chamber.

15. An extrusion die head as claimed in any one of Claims 10 to 14, in which the distributor passages between a common material feed channel and the feed channels are arranged along the legs of an isosceles triangle as viewed axially.

16. An extrusion die head as claimed in any one of Claims 10 to 15, including a plurality of feed channels in which distributor passages communicate with the tubes so that the telescopic tubes associated in pairs lie diametrically opposite to one an-

other and the tube pairs are staggered on the circumference by an acute angle.

17. An extrusion die head as claimed in Claim 14, in which the members are inclined outside and/or inside the intermediate ring in such a way that they displace the flows of material, which have been divided by the intermediate ring, circumferentially relative to one another.

18. An extrusion die head for the extrusion of a tube of thermoplastics material substantially as hereinbefore described with reference to and as shown in Figs. 1 and 2, or Figs. 3 and 4, or Figs. 5 and 6, or Figs. 7 and 8, or Fig. 9 or Fig. 10, or Figs. 11 and 12, or Figs. 13 and 14, or Figs. 15 and 16, or Fig. 17, or Fig. 18, or Figs. 19 and 20, or Fig. 21 of the accompanying drawings.

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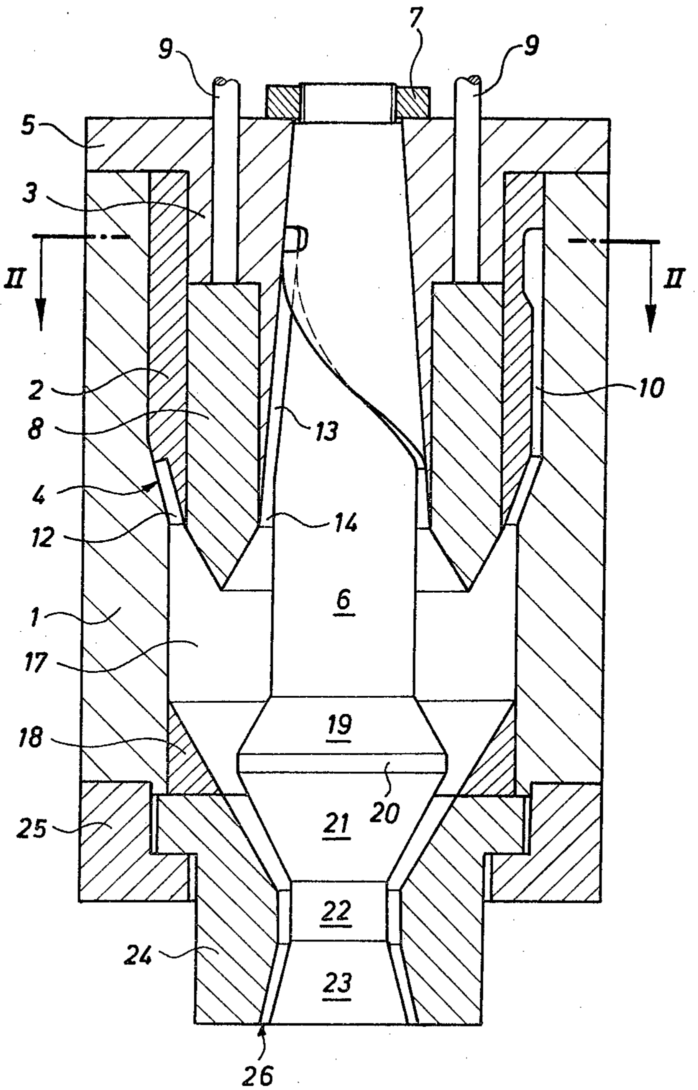

Fig. 1

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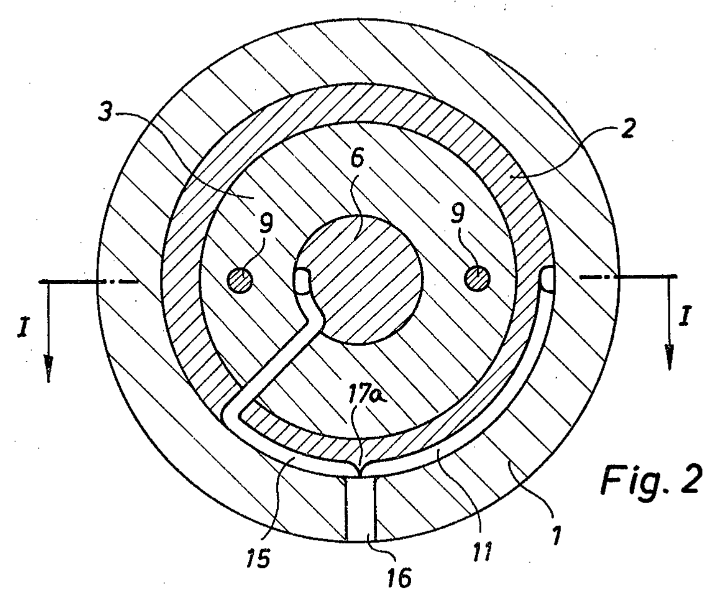

Fig. 2

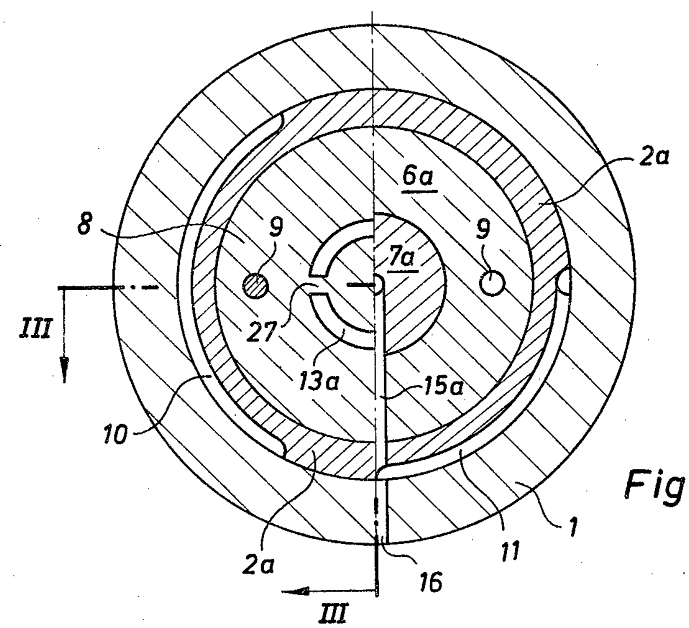

Fig. 4

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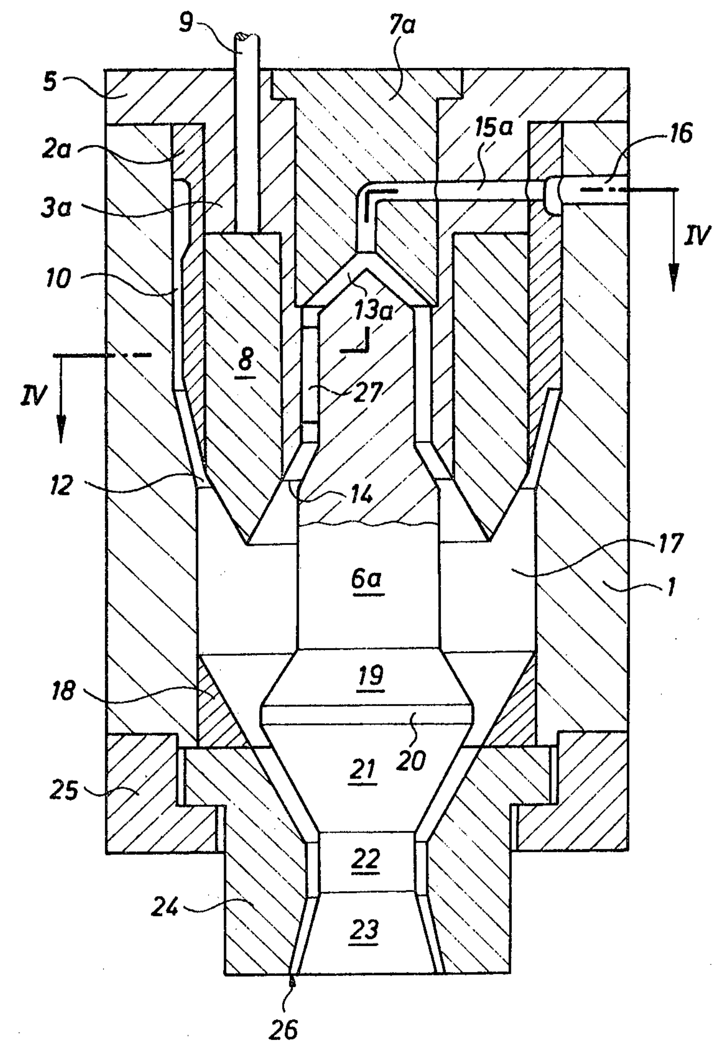

Fig. 3

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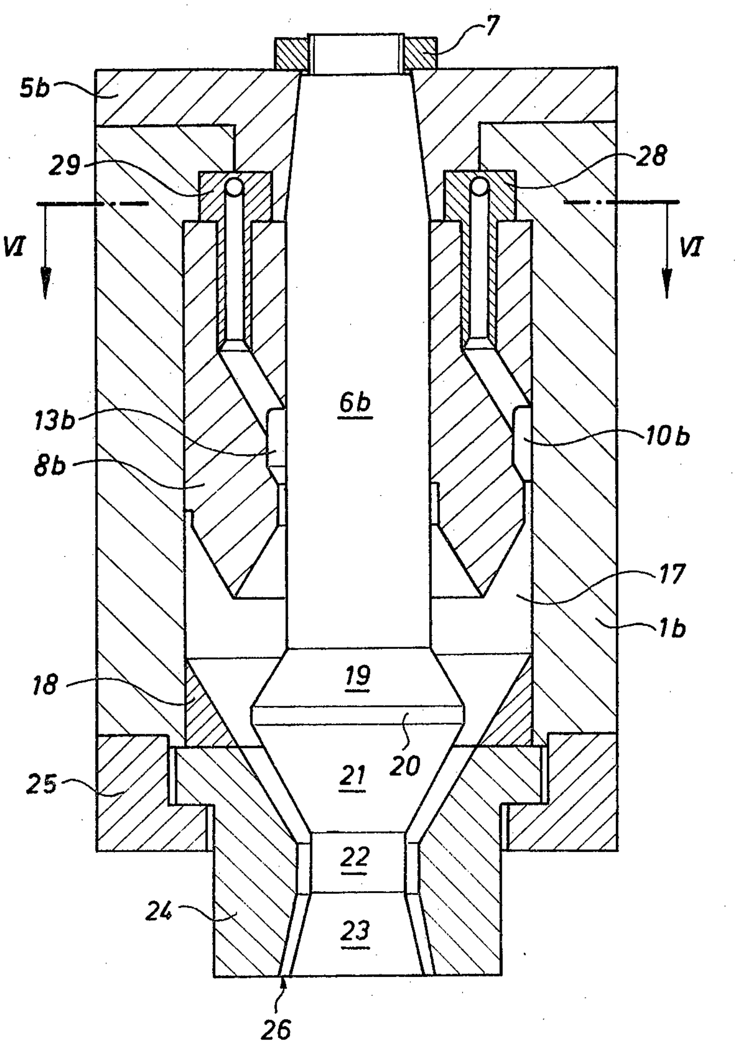

Fig. 5

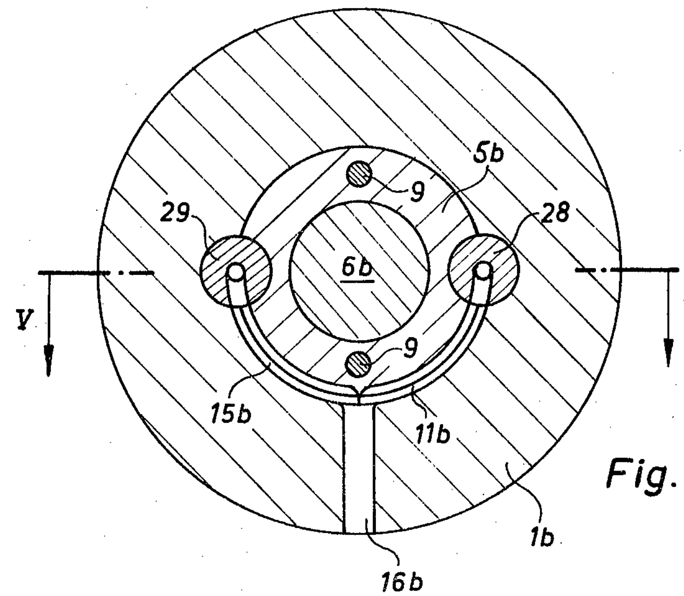

Fig. 6

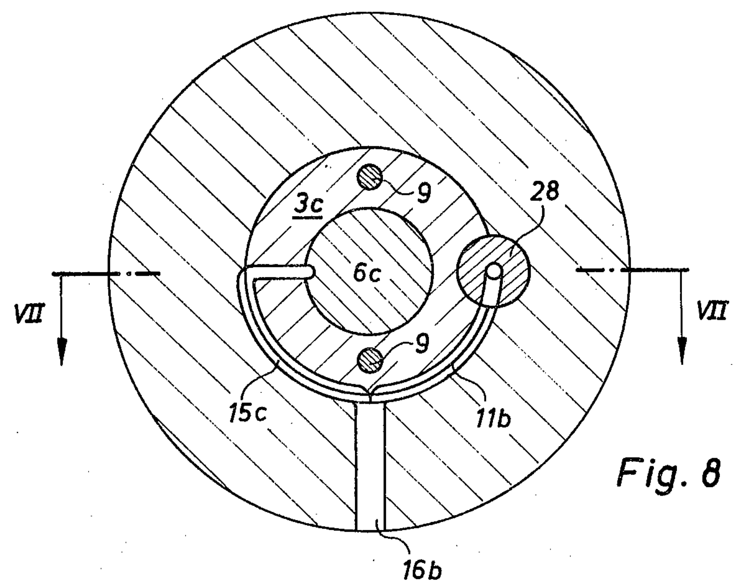

Fig. 8

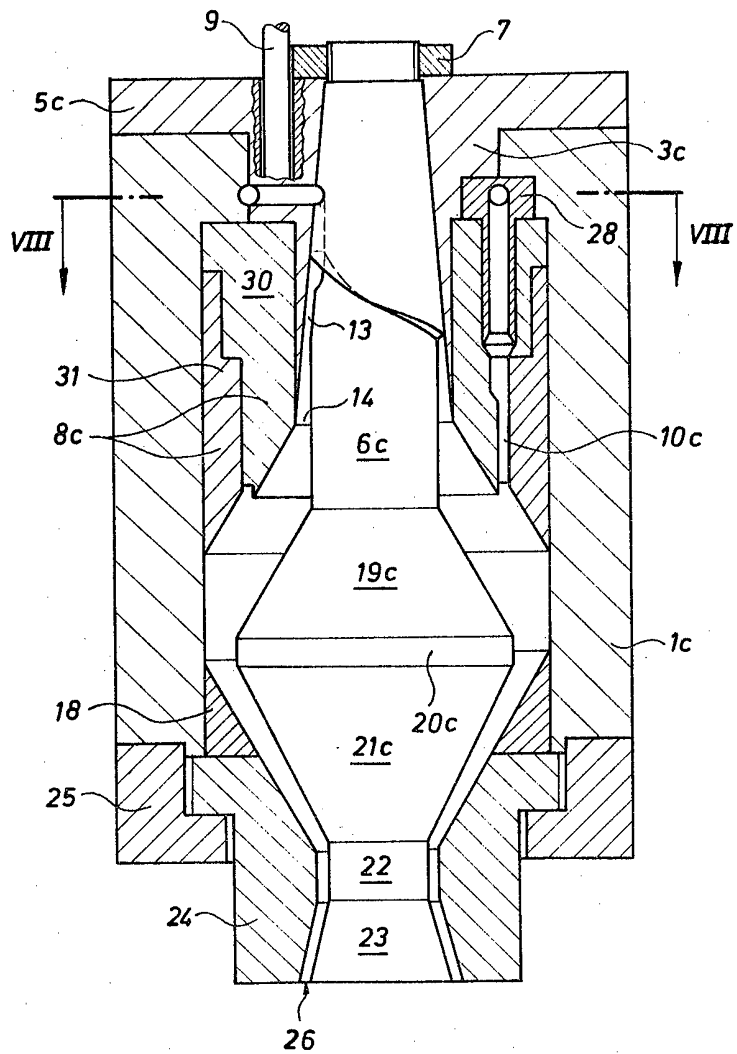
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Fig.7

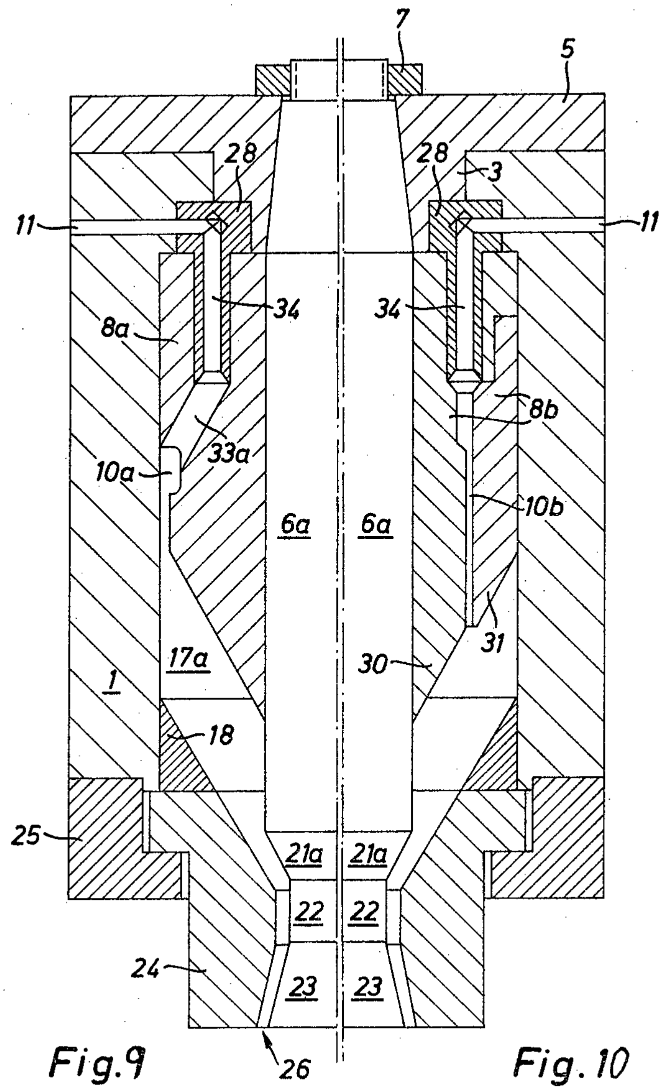
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Fig.9 Fig.10

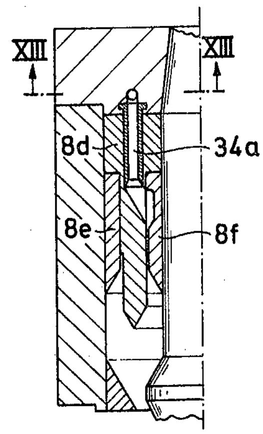

Fig. 11

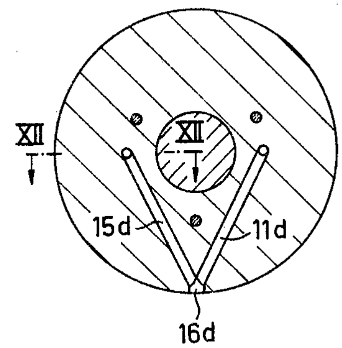

Fig. 12

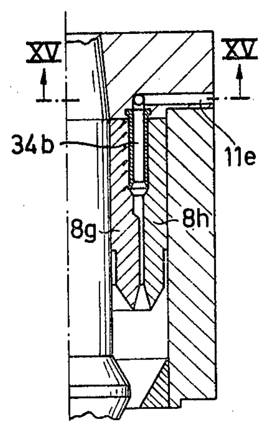

Fig. 13

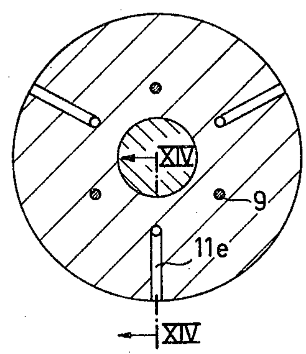

Fig. 14

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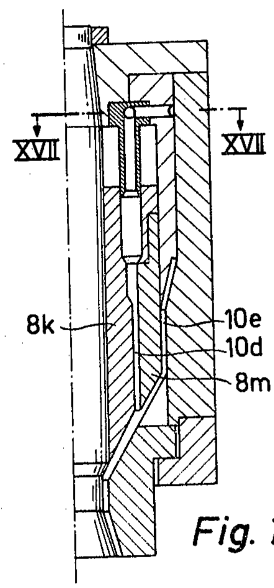

Fig. 15

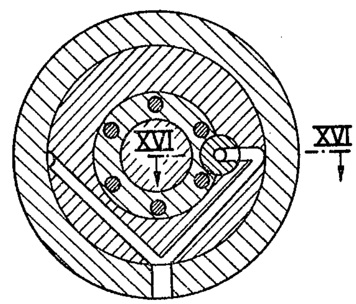

Fig. 16

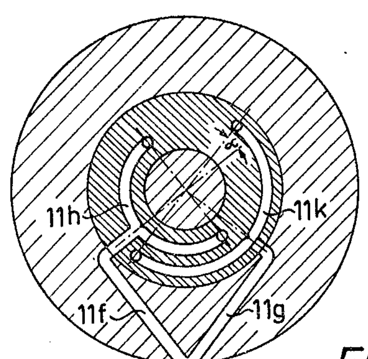

Fig. 17

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Sheet 10

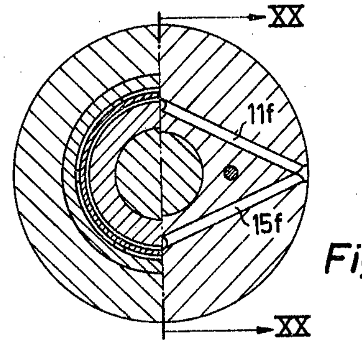

Fig. 20

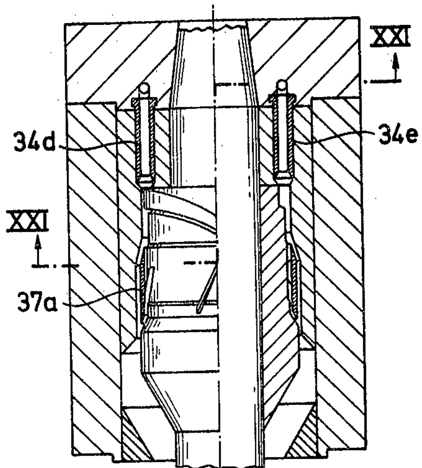

Fig. 19

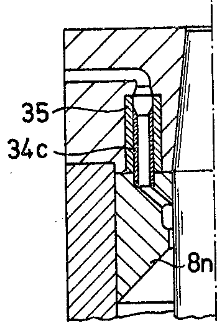

Fig. 18

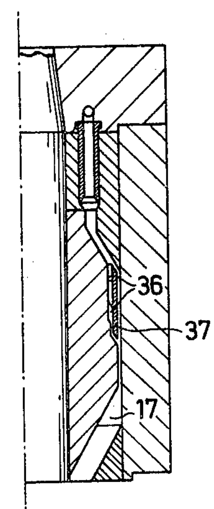

Fig. 21