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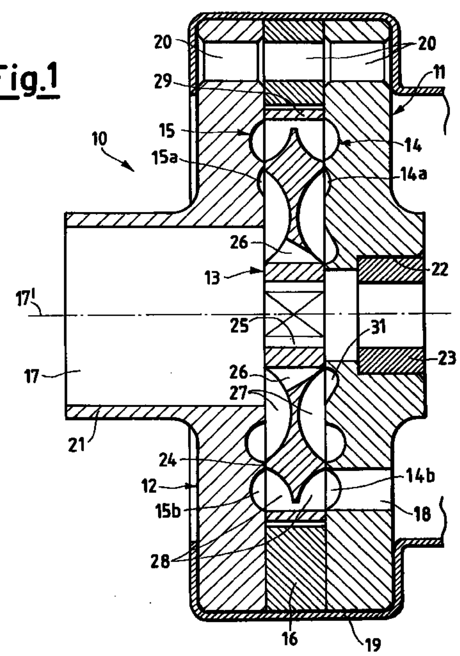
(54) Motor vehicle fuel pump of peripheral type

(57) A peripheral pump (10, 110) for feeding fuel to a motor vehicle internal combustion engine, comprising a hollow body provided with a fuel intake duct (17, 117) and a fuel delivery duct (18, 118) and within which there is arranged a rotor (13, 113) provided with blading and being of disc form, the pump body consisting of two parts (11, 12, 111, 112) coupled together and comprising, in their opposing inner surfaces, channel recesses (14, 15, 114, 115) of compound spiral form respectively facing at least two pluralities of pocket cavities provided in each of the two faces of the rotor to receive the fuel, said two faces being connected together by at least one passage (26, 126) provided within the rotor, said two pluralities of pocket cavities defining at least two stages of the pump (10, 110), which are connected together by an intermediate portion (14c, 15c, 114c, 115c) of said channel recesses (14, 15, 114, 115) of compound spiral form.

Fig.1



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Description

This invention relates to a pump of peripheral type for feeding fuel to injection-fed internal combustion vehicle engines.

The severity of regulations relating to pollutant emissions from internal combustion engines requires strict control of fuel quality and the manner of its feed to the engine. Any inequality, deformity or inadequateness of the physical fuel feed system compared with the scheduled theoretical feed model results in immediate increase in the quantity of pollutant substances.

Secondarily, the engine efficiency is negatively influenced, as often the engine is fed with a fuel quantity greater than the optimum value.

For this reason, motor vehicles are increasingly using injection feed systems. To achieve the pressure required by the injectors, pumps are usually used, positioned in the tank. Sometimes they are integrated into the fuel level measurement system or located along the line conveying the fuel from the tank to the engine.

These pumps, driven by an electric motor, are either positive displacement pumps of roller or lobe type, or pumps of the type generally known as peripheral.

Although considerable results have been achieved in terms of hydrodynamic efficiency and pump life, the performance of peripheral pumps could be increased with regard both to the achievable head and to the available capacity for a fixed head required by the customer.

An object of the present invention is to provide an at least two-stage peripheral pump for motor vehicles offering better performance than the known art, both in terms of the achievable head and in terms of the pump fuel capacity for equal operating variables.

A further object of the present invention is to provide a peripheral fuel pump for motor vehicles which is of small dimensions but of good hydraulic performance in terms of capacity, pressure and efficiency, compared with peripheral pumps of the known art.

A further object of the present invention is to provide a peripheral fuel pump for motor vehicles of simple, low-cost construction without the need to use complicated or costly techniques.

A two-stage pump for fuel feed to an injection-fed internal combustion engine is described, the pump being inserted into a vehicle fuel tank and comprising a hollow pump body provided with a fuel intake aperture and a fuel delivery aperture, and containing a rotor in the form of a disc provided with blading.

The pump body consists of two parts joined together and comprises, in its inner surfaces, opposing channel recesses of compound spiral form respectively facing at least two pluralities of pocket cavities provided in each of the two faces of the rotor to receive the fuel. The two faces of the rotor are connected together by at least one passage provided within the rotor, the pocket cavities defining at least two pump stages, which are connected together by an intermediate portion of said channel recesses of compound spiral form. The rotor is hence shaped to comprise two separate pressurization regions. The combined action of these two stages provides the pump head, ie the pressure rise undergone by the fuel to enable it to be injected into the engine. Said rotor also comprises a central passage enabling the fuel to be distributed over both the rotor faces and form two different zones of action.

Finally, those surfaces of the pump body facing the rotor comprise integrally formed channels enabling the fuel to pass from one stage to the next.

In a preferred embodiment of the present invention, the channel recesses of compound spiral form are divided into two parts connected together by an essentially straight intermediate portion. One of said two parts is preferably of constant cross-section. Advantageously, at least one of said two parts has a variable passage cross-section which increases from the beginning to the end of the recesses.

The two pluralities of pocket cavities are divided by a circumferential baffle which divides the rotor into two circular bands, namely an inner and an outer. The baffle is positioned at the intermediate portion of the channel recesses of compound spiral form. In this manner, the fuel can pass from a cavity pertaining to the first plurality of pocket cavities to a pocket cavity pertaining to the second plurality, by flowing exclusively through said intermediate portion of the recesses.

Correspondingly, the intermediate portion can be in the form of a hole provided in the respective region of the pump body to join together two recesses of circular form.

According to a further preferred embodiment of the present invention, the intermediate portion is also in the form of a recess, on which a plate-like element is positioned to conceal the intermediate portion from the rotor surface facing it. In particular, the plate is positioned in a shallow seat provided in the respective region of the pump body.

In a further preferred embodiment of the present invention, the pump body is composed of two parts joined together by way of an interposed spacer, said two pluralities of pocket cavities defining the stages present within the pump. In addition, the two rotor faces can either be connected together or not connected together by means of at least one passage, which is provided within the rotor and is preferably located in a position central to the rotor, ie in a position close to the rotation and/or keying axis. In order for both pump stages to be of peripheral type, the pocket cavities, forming respectively the inner and outer band of the rotor, are of similar geometry and configuration.

Specifically, said pocket cavities have a profile determined by two portions of rounded form which converge towards a section of minimum thickness. The pocket cavities of a first peripheral stage of the pump, which are positioned on the two opposing faces of the rotor, can communicate with each other via a passage provided in the thinnest part, in the immediate vicinity of the baffle which divides the two regions where the cavities are provided, or alternatively the pocket cavities of a first peripheral stage of the pump can be made non-communicating. In this case, a passage must be provided for connecting together the two faces of the rotor. The pump fuel intake aperture is coaxial with the pump axis, whereas the delivery aperture is located external to the rotor in a position peripheral to it, although remaining parallel to the pump axis. The passage connecting the two rotor faces can be positioned in correspondence with the intake aperture, close to the centre of the rotor. In this manner the fuel reaching the intake aperture is distributed equally between the two rotor faces. To facilitate this distribution, the passage can be tapered along the axial direction between the two rotor faces. In addition, the initial portion of a first part of the parts in which the channel recesses of compound spiral form are divided opens into said intake aperture.

According to a further preferred embodiment of the present invention, the pump intake body part comprises at the channel recesses a through hole acting as a vent hole. This increases the priming capacity of the system and enables the air present in the ducts to be discharged during starting. The hole is of very small dimensions. To balance the capacity loss due to the fuel passing through said hole (although the quantity of said fuel is very small), the cross-section of the peripheral channel preceding the vent hole can be enlarged in both body parts, ie intake and delivery.

Alternatively, according to a further preferred embodiment of the present invention, the pump intake body part has an annular entry section with three intake apertures extending in directions parallel to the central axis of the pump body. Said apertures are essentially of bean shape. They are arranged within an imaginary circular ring concentric with the intake part of the pump.

The peripheral pump of the present invention has extremely good operating properties. Its constructional and design characteristics minimize vibration so as to also reduce noise during operation. In particular, compared with currently used pumps, for equal conditions (engine r.p.m., fuel throughput, temperature) it provides a larger head because the fact of comprising two stages leads to greater efficiency than known designs. Alternatively, the pump of the present invention would rotate at a lower r.p.m. (and hence achieve an averagely greater life) for equal performance (head and capacity) requested by the client.

Finally the peripheral pump of the invention can be driven by a motor, preferably an electric motor, via a hollow shaft inserted through an aperture in the pump body and carrying the rotor keyed thereon. Said shaft is housed in a bearing provided in the aperture in the pump body.

Further advantages and characteristics of the present invention will be more apparent from the description given hereinafter by way of non-limiting example with reference to the accompanying drawings, in which:

Figure 1 is a schematic section through one embodiment of the pump of the present invention;

Figure 2 is a section through a part of the pump of Figure 1;

Figure 3 is a front view of one embodiment of a rotor inserted into the pump of the present invention;

Figure 4 is a section through the rotor of Figure 3 taken on the line IV-IV;

Figure 5 is a front view of one of the two constituent parts of the pump body of Figure 1, according to the present invention;

Figure 6 is a front view of the other of the two constituent parts of the pump body of Figure 1, according to the present invention;

Figure 7 is a section through a further embodiment of the rotor inserted in the pump according to the present invention;

Figure 8 is a front view of a further embodiment of the rotor inserted in the pump according to the present invention;

Figure 9 is a section through the rotor of Figure 8 taken on the line IX-IX;

Figure 10 is a front view of a further embodiment of the rotor inserted in the pump according to the present invention;

Figure 11 is a front view of a further embodiment of the rotor inserted in the pump according to the present invention;

Figure 12 is a front view of one of the two constituent parts of a further embodiment of the pump body according to the present invention;

Figure 13 is a section through the part shown in Figure 12 taken on the line XIII-XIII;

Figure 14 is a front view of the other constituent part of the pump body of Figure 12 according to the present invention;

Figure 15 is a section through the part shown in Figure 14 taken on the line XV-XV;

Figure 16 is a front view of one of the two constituent parts of a further embodiment of the pump body according to the present invention;

Figure 17 is a section through the part shown in Figure 16 taken on the line XVII-XVII;

Figure 18 is a front view of the other constituent part of the pump body of Figure 16 according to the present invention;

Figure 19 is a section through the part shown in Figure 18 taken on the line XIX-XIX;

Figure 20 is a schematic section through a further embodiment of the pump of the present invention;

Figure 21 is a section through a detail of the pump of Figure 20;

Figure 22 is a front view of a further embodiment of a rotor inserted in the pump according to the present invention;

Figure 23 is a section through the rotor of Figure 22 taken on the line XXIII-XXIII;

Figure 24 is a front view of one of the two constituent parts of the pump body of Figure 20 according to the present invention;

Figure 25 is a front view of the other of the two constituent parts of the pump body of Figure 20 according to the present invention;

Figure 26 is a front view of a further embodiment of a rotor inserted in the pump according to the present invention;

Figure 27 is a section through the rotor of Figure 26 taken on the line XXVII-XXVII;

Figure 28 is a front view of one of the two constituent parts of a further embodiment of the pump body according to the present invention;

Figure 29 is a section through the part shown in Figure 28 taken on the line XXIX-XXIX;

Figure 30 is a front view of the other of the two constituent parts of the pump body of Figure 28 according to the present invention;

Figure 31 is a section through the part shown in Figure 30 taken on the line XXXI-XXXI;

Figure 32 is a front view of one of the two constituent parts of a further embodiment of the pump body according to the present invention;

Figure 33 is a section through the part shown in Figure 32 taken on the line XXXIII-XXXIII;

Figure 34 is a front view of a spacer positioned within the pump of the present invention;

Figure 35 is a section through the spacer shown in Figure 34 taken on the line XXXV-XXXV;

Figure 36 is a front view of one of the two constituent parts of a further embodiment of the pump body according to the present invention;

Figure 37 is a section through the part shown in Figure 36 taken on the line XXXVII-XXXVII.

As can be seen from Figures 1 and 20, a pump, indicated overall by 10, 110, consists of two facing parts 11, 12, 111, 112, known respectively as the delivery part and the intake part, between which a rotor 13, 113 is positioned. Said rotor 13, 113 is in the form of a disc provided with blading. Recesses 14, 15, 114, 115 of substantially compound spiral form are provided in the delivery and intake parts 11, 12, 111, 112. The body of the pump 10, 110 is completed by a spacer 16, 116 arranged between the two parts 11, 12, 111, 112 comprising the recesses 14, 15, 114, 115, an intake duct 17, 117 provided in the intake part 12, 112 central to the rotor 13, 113 and about an imaginary central axis 17', 117' through the pump body, and a delivery duct 18, 118 peripheral to the rotor 13, 113 and provided in the delivery part 11, 111.

In embodiments not shown herein, said spacer 16, 116 could be an integral part of one of the two constituent parts 11, 111, 12, 112 of the pump body so as to reduce the number of pieces used in the construction of the pump 10, 110 and hence avoid a double measurement uncertainty deriving from two machining tolerances.

However when the spacer 16, 116 is formed as a separate piece, the possibility of machining those surfaces of the spacer 16, 116 facing the two parts 11, 12, 111, 12 and the rotor 13, 113 in a single operation allows improved fitting and sealing and correct assembly.

In the illustrated embodiment the delivery duct 18, 118 leaves from the side opposite the inlet of the intake duct 17, 117. In embodiments not shown herein this situation may not occur, and both ducts 17, 18, 117, 118 may open from the same side of the pump 10, 110. The pump body, essentially consisting of the two parts 11, 111, 12, 112 and the spacer 16, 116, is housed within a casing 19, 119 comprising a motor (not shown) which drives the rotor 13, 113 via a shaft (not shown) on which it is keyed.

The two parts 11, 12, 111, 112 are of disc configuration. The first part 11, 111 comprises the delivery duct 18, 118 with its axis parallel to but offset from the axis of the pump 10, 110, whereas the second part 12, 112 comprises the intake duct 17, 117 with its axis parallel to and coinciding with the axis of the pump 10, 110. The two parts 11, 12, 111, 112 and the spacer 16, 116, also of disc form, comprise aligned through holes 20, 120 for receiving known fixing elements (not shown). In other possible embodiments, not shown herein, alignment between the parts 11, 12, 111, 112 and the spacer 16, 116 can advantageously be achieved by suitable recesses and projections provided on the contacting parts. The intake duct 17, 117 of the part 12, 112 extends axially as a sleeve portion 21, 121 on the side not facing the rotor 13, 113. In order to house the end of the drive shaft, the delivery part 11, 111 comprises in the opposite portion to that containing the recessing 14, 114 a housing 22, 122 for a bearing 23, 123, through which said drive shaft is inserted. Said motor is preferably electric but can be of any type suitable for the purpose.

As can be seen from Figures 3 and 22, the rotor 13, 113 of the pump 10, 110 comprises two regions separated by a circumferential baffle 24, 124, said two regions consisting of an inner circular band and an outer circular band. Each of these circular bands is subdivided by radial ribs 27, 28 127, 128 into a plurality of pockets forming the blading, the number of pockets of the outer circular band being normally greater than the number of pockets of the inner circular band. These two regions, which can be of equal or different geometry and configuration (as can be seen by comparing said Figures 3 and 22), define the two pumping stages, which can be of similar or different hydraulic performance.

Alternatively the ribs 27, 28, 127, 128 forming the pocket cavities can be inclined to the corresponding radial directions by a predetermined angle.

Through the centre of the rotor 13, 113 there is a hole 25, 125 for receiving the motor shaft (neither the shaft nor the motor are shown) which operates the pump 10, 110 of the present invention.

About said central hole there are a plurality of passages 26, 126 which may be delimited by two successive ribs 27, 127 (as shown in Figure 3), or not (as shown in Figure 22). Said passages 26, 126 enable the fuel to flow from that rotor face facing the intake duct 17 to the opposite face facing the delivery duct 18. In one embodiment the passages are of decreasing cross-section from the intake side to the delivery side, in accordance with the desired hydraulic characteristics. In another embodiment the passages 126 are of constant cross-section. The rotor 13, 113 is provided with a perimetral ring 29, 129 of height equal to the thickness of the rotor 13, 113 to delimit the second stage of the pump 10, 110 and join together the outer ribs 28, 128.

Figures 2, 4, 21 and 23 show the two different configurations of the pockets provided in the rotor 13, 113 of the pump 10, 110, in two preferred embodiments of the present invention. In one embodiment, relative to Figures 2 and 4, the pockets forming the first stage and those forming the second stage are of curvilinear profile. In addition, the upper and lower profiles are symmetrical. Specifically, the pockets forming the first stage consist of rounded cavities the ends of which terminate at the lateral surface of the rotor 13, on one side at the passages 26 and on the other side at the circumferential baffle 24. The pockets forming the second stage consist of rounded cavities, which extend at both ends from the circumferential baffle 24, 124, to converge into a point of symmetry of the pocket, in a central plane parallel to the faces of the rotor 13, 113. It will also be noted that between the point of convergence of each pocket and the perimetral ring 29, 129 there exists a connection between the upper pocket and the lower pocket of the second stage of the pump 10, 110.

In a further embodiment, relative in particular to Figures 21 and 23, the pockets forming the first stage and those forming the second stage have a curved profile. In addition the upper and lower profiles are symmetrical and do not extend as far as the passage 126, so that their combination gives rise, in cross-section, to a figure similar to an arrow. More specifically, the pockets forming the first stage consist of rounded cavities, one end of which terminates at the lateral surface of the rotor 113 in a point external to the passage 126, and the other end of which connects to the circumferential baffle 124 in the central plane parallel to the faces of the rotor 113. The pockets forming the second stage of the pump 110 have a configuration equal to that of the pockets of the first stage.

Figures 5 and 24 show two preferred embodiments of the recesses 14, 114 of compound spiral form present in the inner surface of one of the two constituent parts of the pump body, namely the delivery part 11, 111. The ducts 18, 118 by which the fuel is delivered to the engine can be seen within the recesses 14, 114.

Specular to the recess 14, 114 provided in the inner surface of the delivery part 11, 111 there is a recess 15, 115 provided in the inner surface of the intake part 12, 112, as can be seen from Figures 6 and 25. In particular, in Figures 5 and 6 it can be seen that the width of each recess 14, 15 is smaller in its initial inner portion than in its final outer portion. In this manner the fluid fuel, by the effect of the rotation of the rotor 13 (and hence by the effect of the centrifugal force transmitted) flows through said recess 14, 15 in one direction encountering an ever increasing passage cross-section. This enables part of the kinetic energy of the fluid to be converted into pressure, so increasing the total efficiency of the pump 10.

In the embodiment shown in Figures 24 and 25, the inner terminal portion of the recess 115 opens into the intake duct 117.

In all embodiments of the pump 10, 110, each of the recesses 14, 15, 114, 115 is divided into two essentially circular parts 14a, 14b, 15a, 15b, 114a, 114b, 115a, 115b connected together by a substantially straight intermediate portion 14c, 15c, 114c, 115c. A plate 30, 130 of trapezoidal shape can be provided at the passage region to conceal the straight intermediate portion 14c, 15c, 114c, 115c precisely in correspondence with the circumferential baffle 24, 124 which separates the two stages and is present on both of the two surfaces of the rotor 13, 113. In this manner a compulsory passageway is created for the fluid fuel, which passes from the first to the second stage of the rotor 13, 113 via this closed channel. In the embodiment of Figures 24 and 25, each of said respective parts 114a, 114b and 115a, 115b is of substantially constant cross-section along its entire length.

In embodiments not shown herein, fuel passage can take place through a hole provided in that part comprising the recess 14, 15, 114, 115 to form a type of tunnel. Centrally within the delivery part 11, 111 of the pump 10, 110 there is provided an annular second recess 31, 131 coaxial with the axis of the seat 22, 122 housing the bearing 23, 123. This second recess 31, 131, of round section, feeds the fluid arriving from the passages 26, 126 towards the facing face of the rotor 13, 113 and towards the successive portions of the recess 14, 114.

In the embodiment of the pump 110 shown in Figure 24, the initial portion of the recess 114, which terminates in the delivery duct 118, communicates with the annular recess 131. The possible presence of a respective plate 30, 130 concealing a respective part 14c, 15c, 114c, 115c of the recess 14, 15, 114, 115 on each of the two constituent parts 11, 12, 111, 112 of the pump body is even more apparent in Figures 2 and 21. These figures show the recesses 32, 132 in which the respective plates 30, 130 are located, exactly in correspondence with the baffles 24, 124 separating the first from the second stage of the rotor 13, 113.

In a further preferred embodiment of the rotor 13, shown in Figure 7, the pockets of the first stage can be seen to have a flat base at constant depth. The pockets of the second stage however are of exactly the same pattern as that shown in Figures 4 and 13. In this embodiment, the front view of the rotor 13 is essentially similar to that shown in Figure 3.

Figures 8 and 9 show a further embodiment of the rotor 13 according to the present invention. In this embodiment, the upper part and lower part of the rotor 13 are symmetrical with regard to the first stage, whereas the ribs 28 forming the second stage are provided in alternate positions on the two faces, as can be easily seen from the sectional view of Figure 9. As a result, the pockets forming part of the second stage are present alternately in the upper part and lower part of the rotor 13 and have a common profile, of roundish pattern, similar to that already described for the preceding embodiments of the rotor 13. In this embodiment there is no radial ring 29, which usually delimits the second stage.

In the embodiment of the rotor 13 shown in Figure 10, the ribs 28 of the second stage of the pump 10 are inclined to the radial direction by a predetermined angle, preferably between 0° and 30°.

In the embodiment of the rotor 13 shown in Figure 11, the ribs 27 forming the first stage are not rectilinear (as in the other embodiments of the rotor 13), but instead are curvilinear, for example in the form of a circumferential arc. In this manner, part of the centrifugal component of the fluid motion, caused by the rotation of the rotor 13, is transformed into a tangential component, creating less friction and hence a lesser pressure drop, with the result that the pump 10 is of increased efficiency compared with the other embodiments. Both in the rotor 13 of Figure 10 and in the rotor 13 of Figure 11, the passage 26 connecting together the two opposing faces of the rotor 13 is of constant cross-section along its entire length.

Figures 12 to 19 show further embodiments of the intake part 11 and delivery part 12, into which a rotor 13 is inserted having the pockets of its second stage open (ie without the perimetral containing ring 29). The channels 14' and 15' provided in the surfaces facing the rotor 13 have their respective portions 14'b, 15'b not of roundish but of trapezoidal profile. It can be seen that in passing from the region 14'c, 15'c into the respective regions 14'b, 15'b, the cross-section available to the fluid decreases, so that the fluid is compelled to increase its velocity. In particular, as shown in Figures 16 and 18, the regions 14'c, 15'c have a cross-section respectively greater than the neighbouring regions 14'a, 14'b, 15'a, 15'b. In this manner, the fluid velocity further decreases within the passage region, with the result that the pressure drops decrease and the pressure increases, so that the conditions under which the fluid fuel enters the second stage are significantly better compared with the known art and the other already described and illustrated embodiments of the delivery part 11 and intake part 12.

Figures 26 and 27 show a further embodiment of the rotor 113 inserted into the pump 110 of the present invention. In this case, the pockets of the first stage of the pump 110, which are situated between the ribs 127, do not touch the circumferential baffle 124 with their pointed end. This means that an empty space 133 is created enabling the fuel to pass from the intake region to the delivery region. In this respect, the passage 26 between the two opposing surfaces of the rotor 13 is lacking. The upper part and the lower part of the rotor 113 are symmetrical with regard to the first stage, whereas the ribs 128 of the second stage are present in alternate positions on the two faces, as can be easily seen from the sectional view of Figure 27. As a result, the pockets of the second stage are present alternately in the upper part and lower part of the rotor 113 and have a common profile, of roundish pattern, similar to that already described for the preceding embodiments. In this embodiment the ring 29 which usually delimits the second stage in the radial direction is lacking.

As an alternative to these embodiments, in embodiments not illustrated herein it is possible to have a rotor 13, 113 in which the first stage comprises intercommunicating compartments between the delivery part 11, 111 and the intake part 12, 112 and an outer containing ring. Again, the first stage can be configured so as not to present intercommunicating compartments between the delivery part 111 and the intake part 112, the compartments of the second stage being staggered (as shown in Figure 26).

Figures 28 to 31 show further embodiments of the delivery part 111 and intake part 112. The channels 114', 115' present in the surfaces facing the rotor 113 have their respective portions 114'b, 115'b of trapezoidal profile. As is apparent from the said figures, the delivery part 111 lacks the central channel 31, visible in Figures 12 and 16, and can hence be associated only with a rotor 113 which does not have a central passage between the two faces. Alternatively, the delivery part 111, lacking the channel 31, can be associated with a rotor 113 having a central passage.

Figures 32 and 33 show a further possible embodiment of the intake part 112. In this embodiment, a small-dimension through vent hole 140 is provided along the fluid fuel passage duct in the intake body part (namely along the portion 115'b of the channel 115 of the first stage), or in the peripheral stage of the intake body part, to increase the priming capacity of the system, serving to discharge the air present in the ducts during starting. In this case, to balance the capacity loss the cross-section of the recess 115 can be increased in the portion 115'b prior to the through hole 140, in both the intake part 112 and the delivery part 111.

Figures 34 and 35 show a spacer 116 which can be used during the construction of the hydraulic part of the pump 10, 110. The provision of three separate parts (delivery part 11, 111, intake part 12, 112 and spacer 16, 116) during the manufacture of the pump 10, 110 is of fundamental importance in achieving levelling of the rotor 13, 113 and the spacer 16, 116 (usually done by a grinder) in a single operation. When the "open ring" version of the rotor 13, 113 is used, such as the rotor shown in Figure 26, in order to separate within the fluid the high pressure region (in correspondence with the delivery duct 18, 118) from the low pressure region (in correspondence with the region of entry of the fluid from the first stage into the peripheral stage, the spacer 16, 116 is suitably modified to present a sector between the points 141 and 142 of smaller diameter. In particular, in this sector the inner diameter of the spacer 16, 116 is just a few hundredths of a millimetre greater than the outer diameter of the rotor 13, 113, to prevent back flow of the liquid.

Finally, a further embodiment of the intake part 12, 112 (as visible in Figures 36 and 37) comprises three apertures 117a, 117b, 117c of bean shape arranged with their axes parallel to each other and parallel to but offset from the central axis 17', 117' of the pump 10, 110. Said apertures 117a, 117b, 117c lie within a hypothetical circular band having two radii of constant value starting from the central axis 17', 117' of the pump 10, 110.

As an alternative to the arrangements presented in the various embodiments of the pump 10, 110, the present invention is not limited to the particular combinations of the form of the rotor 13, 113, the geometry of the pockets of the first and second stage and the form of the recesses 14', 15', 114', 115'. All possible combinations of the various embodiments of the rotor 13, 113, the pockets and the embodiments of the delivery part 11, 111 and intake part 12, 112 fall within the general scope of the present invention.

In all cases the pump 10, 110 of the present invention, shown in its various embodiments on the accompanying drawings, presents high efficiency, head characteristics and a working life which are better than known pumps. In addition it has a low noise level and a lower production cost than the state of the art.

Claims

1. A fuel feed pump (10, 110) for motor vehicles with an injection-fed internal combustion engine, said pump (10, 110) being of peripheral type inserted into a fuel tank and comprising a hollow body provided with at least one fuel intake duct (17, 117, 117a, 117b, 117c) and a fuel delivery duct (18, 118) and within which there is arranged a rotor (13, 113) provided with blading and being of disc form, said body consisting of at least one intake part (12, 112) and at least one delivery part (11, 111), said parts (12, 112, 11, 111) being at least partly coupled together and comprising, in their inner surfaces, opposing channel recesses (14, 15, 114, 115) of compound spiral form respectively facing at least two pluralities of pocket cavities provided in each of the two faces of said rotor (13, 113) to receive the fuel, said two faces of the rotor (13, 113) being connected together by at least one passage (26, 126, 133) provided within the rotor, said two pluralities of pocket cavities defining at least two stages of the pump (10, 110), which are connected together by an intermediate portion (14c, 15c, 114c, 115c, 14'c, 15'c, 114'c, 115'c) of said channel recesses (14, 15, 114, 115) of compound spiral form.

2. A pump (10, 110) as claimed in claim 1, characterised in that said two pluralities of pocket cavities are separated by at least one circumferential baffle (24, 124) which divides each of the two faces of said rotor (13, 113) into two circular bands.

3. A pump (10) as claimed in claim 2, characterised in that said two pluralities of pocket cavities have a profile composed of curvilinear portions, a first plurality of said cavities comprising a series of ends which all terminate at the lateral surface of said rotor (13), on one side at said passage (26) and on the other side at said circumferential baffle (24), and a second plurality of said cavities being peripherally delimited by a circular ring (29).

4. A pump (10, 110) as claimed in claim 3, characterised in that said second plurality of pocket cavities comprises cavities having a first series of ends which extend from said circumferential baffle (24, 124), a second series of ends also extending from said circumferential baffle (24, 124) and converging into a point of cavity symmetry, in a central plane parallel to the faces of said rotor (13, 113), so that between the point of convergence of each cavity and said circular ring (29, 129) there exists a connection between each cavity positioned above and each cavity positioned below the aforesaid cavity.

5. A pump (110) as claimed in claim 1 or 4, characterised in that said two pluralities of pocket cavities have a profile composed of curvilinear portions, a first plurality of said cavities comprising a first series of ends which terminate at the lateral surface of said rotor (113) external to said passage (126), and a second series of ends which connect to said circumferential baffle (124) in the central plane parallel to the faces of said rotor (113).

6. A pump (10, 110) as claimed in claim 1, characterised in that each of said channel recesses (14, 15, 114, 115) of compound spiral form is divided into two parts (14a, 14b, 15a, 15b, 114a, 114b, 115a, 115b, 14'a, 14'b, 15'a, 15'b, 114'a, 114'b, 115'a, 115'b) which are of essentially circular shape and are connected together by an essentially straight intermediate portion (14c, 15c, 114c, 115c, 14'c, 15'c, 114'c, 115'c).

7. A pump (10, 110) as claimed in claim 2 or 6, characterised in that said circumferential baffle (24, 124) is positioned in correspondence with a respective portion provided between said two parts (14a, 14b, 15a, 15b, 114a, 114b, 115a, 115b, 14'a, 14'b, 15'a, 15'b, 114'a, 114'b, 115'a, 115'b) of the chan-

nel recesses (14, 15, 114, 115) of compound spiral form.

8. A pump (110) as claimed in claim 1 or 2, characterised in that said passage existing between the two faces of the rotor (113) consists of an empty space (133) provided between each pocket cavity pertaining to said first plurality and said circumferential baffle (124).

9. A pump (10, 110) as claimed in claim 1, characterised in that said passage (26, 126) existing between the two faces of the rotor (13, 113) consists of at least one aperture axially aligned with said intake duct (17, 117) and situated in the vicinity of the central section of said rotor (13, 113).

10. A pump (10, 110) as claimed in claim 9, characterised in that said passage (26, 126) is of tapered form along the axial direction between the two faces of the rotor (13, 113).

11. A pump (10, 110) as claimed in claim 6, characterised in that said intermediate portion (14c, 15c, 114c, 115c, 14'c, 15'c, 114'c, 115'c) consists of a hole provided in the pump body, said hole joining together said two parts (14a, 14b, 15a, 15b, 114a, 114b, 115a, 115b, 14'a, 14'b, 15'a, 15'b, 114'a, 114'b, 115'a, 115'b) of the channel recesses (14, 15, 114, 115) of compound spiral form.

12. A pump (10, 110) as claimed in claim 6, characterised in that said intermediate portion (14c, 15c, 114c, 115c, 14'c, 15'c, 114'c, 115'c) consists of at least one recess, on which there is positioned at least one plate element (30, 130) which conceals said intermediate portion (14c, 15c, 114c, 115c, 14'c, 15'c, 114'c, 115'c) from that surface of the rotor (13, 113) facing it.

13. A pump (10, 110) as claimed in claim 12, characterised in that said plate element (30, 130) is positioned within a shallow seat (32, 132) in the body of the pump (10, 110).

14. A pump (10, 110) as claimed in claim 1, characterised in that said fuel intake duct (17, 117) is coaxial with the rotor (13, 113).

15. A pump (10, 110) as claimed in claim 1, characterised in that said intake part (12, 112) comprises three intake ducts (117a, 117b, 117c) of bean shape arranged with their axes parallel to each other and parallel to but offset from the central axis (17', 117') of the pump (10, 110), said plurality of intake ducts (117a, 117b, 117c) being positioned within a hypothetical circular band concentric with said intake part (12, 112).

16. A pump (10, 110) as claimed in claim 1, characterised in that at least one annular recess (31, 131) of rounded cross-section is provided in the delivery part (11, 111) in front of said passage (26, 126) between the two faces of the rotor (13, 113).

17. A pump (10, 110) as claimed in claim 6, characterised in that at least one of said two parts (14a, 14b, 15a, 15b, 114a, 114b, 115a, 115b, 14'a, 14'b, 15'a, 15'b, 114'a, 114'b, 115'a, 115'b) of each channel recess (14, 15, 114, 115) of compound spiral form is of trapezoidal cross-section.

18. A pump (10, 110) as claimed in claim 6, characterised in that said intermediate portion (14c, 15c, 114c, 115c, 14'c, 15'c, 114'c, 115'c) of the channel recesses (14, 15, 114, 115) of compound spiral form comprises at least one region of greater cross-section than the cross-section of each part (14a, 14b, 15a, 15b, 114a, 114b, 115a, 115b, 14'a, 14'b, 15'a, 15'b, 114'a, 114'b, 115'a, 115'b) of each channel recess (14, 15, 114, 115) of compound spiral form.

19. A pump (10, 110) as claimed in claim 6, characterised in that at least one of the two parts (14a, 14b, 15a, 15b, 114a, 114b, 115a, 115b, 14'a, 14'b, 15'a, 15'b, 114'a, 114'b, 115'a, 115'b) of each channel recess (14, 15, 114, 115) of compound spiral form is of variable cross-section, which increases from the beginning to the end of each recess (14, 15, 114, 115) of compound spiral form.

20. A pump (10, 110) as claimed in claim 6, characterised in that at least one of the two parts (14a, 14b, 15a, 15b, 114a, 114b, 115a, 115b, 14'a, 14'b, 15'a, 15'b, 114'a, 114'b, 115'a, 115'b) of each channel recess (14, 15, 114, 115) of compound spiral form is of constant cross-section.

21. A pump (10, 110) as claimed in claim 6, characterised in that both parts (14a, 14b, 15a, 15b, 114a, 114b, 115a, 115b, 14'a, 14'b, 15'a, 15'b, 114'a, 114'b, 115'a, 115'b) of each channel recess (14, 15, 114, 115) of compound spiral form are each of constant cross-section.

22. A pump (10, 110) as claimed in claim 1, characterised in that the pocket cavities pertaining to one of the two pluralities are staggered on the opposing faces of the rotor (13, 113).

23. A pump (10, 110) as claimed in claim 1, characterised in that the pocket cavities pertaining to one of said two pluralities are of flat profile, whereas the pocket cavities pertaining to the other plurality have a profile composed of curvilinear portions.

24. A pump (10, 110) as claimed in claim 1, characterised in that said two pluralities of pocket cavities comprise an assembly of ribs (27, 28, 127, 128) of curvilinear pattern.

25. A pump (10, 110) as claimed in claim 1, characterised in that said two pluralities of pocket cavities comprise an assembly of ribs (27, 28, 127, 128) positioned radially to said rotor (13, 113).

26. A pump (10, 110) as claimed in claim 24 or 25, characterised in that said ribs (27, 28, 127, 128) pertaining to said first and said second plurality of pocket cavities are inclined to the corresponding radial directions of the rotor (13, 113) by a predetermined angle.

27. A pump (10, 110) as claimed in claim 24 or 25, characterised in that said ribs (27, 28, 127, 128) pertaining to said first or said second plurality of pocket cavities are inclined to the corresponding radial directions of the rotor (13, 113) by a predetermined angle.

28. A pump (10, 110) as claimed in claim 26 or 27, characterised in that said angle of inclination of the ribs (27, 28, 127, 128) of the pocket cavities is between 0° and 30°.

29. A pump (10, 110) as claimed in claim 1, characterised in that said delivery part (11, 111) and said intake part (12, 112) of the body of the pump (10, 110) are housed with an interposed spacer (16, 116) within a casing (19, 119).

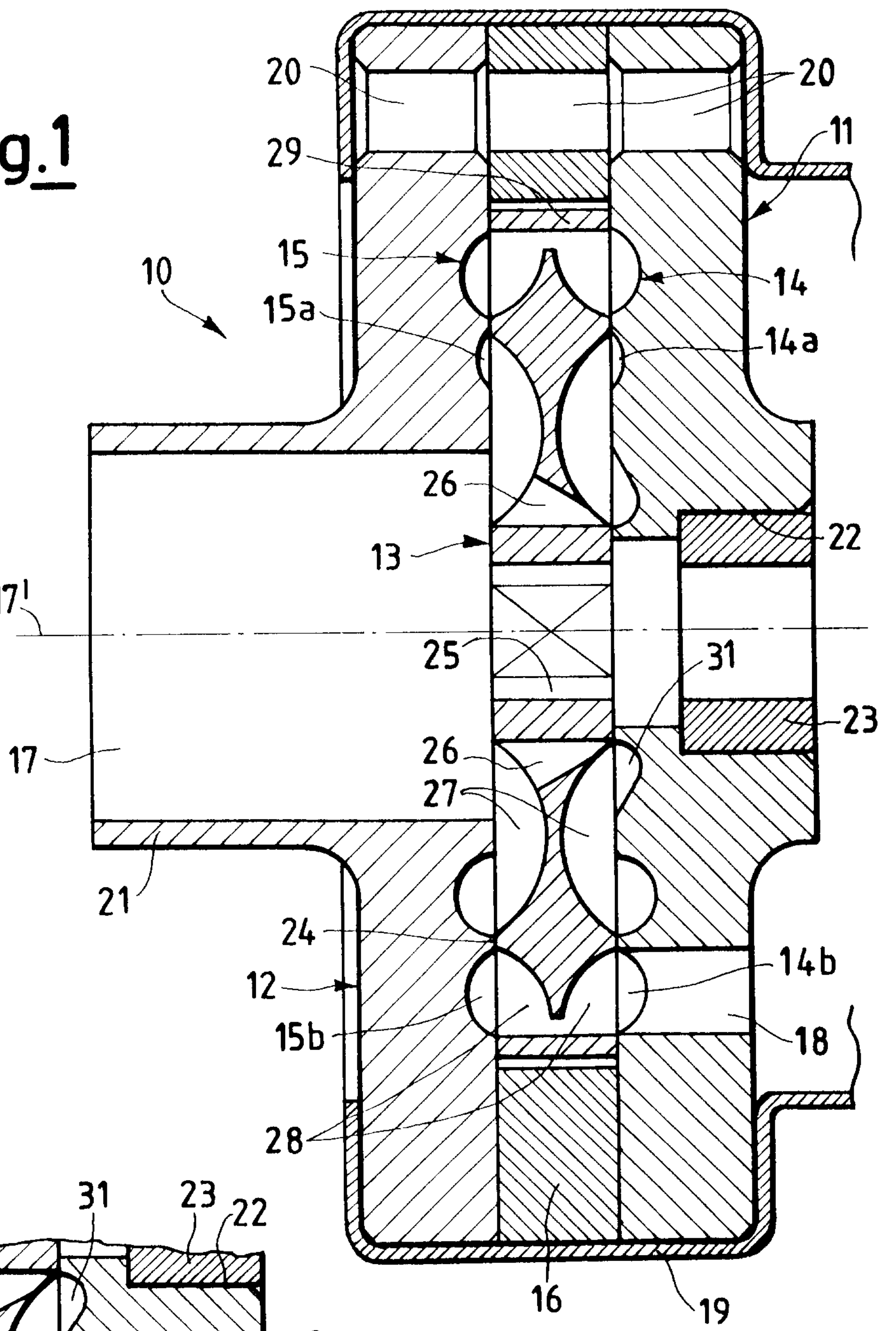
30. A pump (10, 110) as claimed in claim 29, characterised in that during the manufacture of said pump (10, 110), the rotor (13, 113) and the spacer (16, 116) are levelled by a single machining operation.

31. A pump (10, 110) as claimed in claim 30, characterised in that said machining operation is effected by at least one grinder.

32. A pump (10, 110) as claimed in claim 1, characterised in that in correspondence with at least one point on said channel recesses (14, 15, 114, 115) of compound spiral form there is provided at least one through vent hole (140) positioned along a fuel passage duct or within one of the stages of the pump (10, 110), said hole (140) communicating with the outside and enabling the air present within the ducts of the pump (10, 110) to be discharged during starting, to increase the priming capacity of the system, said channel recesses (14, 15, 114, 115) of compound spiral form having, in a region close to or preceding said through hole (140), a greater cross-section than the rest of the channel recess (14, 15, 114, 115) of compound spiral form, so as to balance the loss of capacity.

33. A pump (10, 110) as claimed in claim 29, characterised in that said spacer (16, 116) has a sector with a diameter greater than the outer diameter of the rotor (13, 113), said spacer (16, 116) being directly coupled to a rotor (13, 113) having staggered pocket cavities and lacking a circular ring (29, 129) delimiting a plurality of said pocket cavities, so as to achieve separation of the fluid fuel between a high pressure region in correspondence with said delivery duct (18, 118) and a region of lower pressure in correspondence with a region in which the fluid fuel from one of the stages of the pump (10, 110) enters a peripheral stage, so preventing any back flow of the fluid fuel.

Fig.1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14a
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17'
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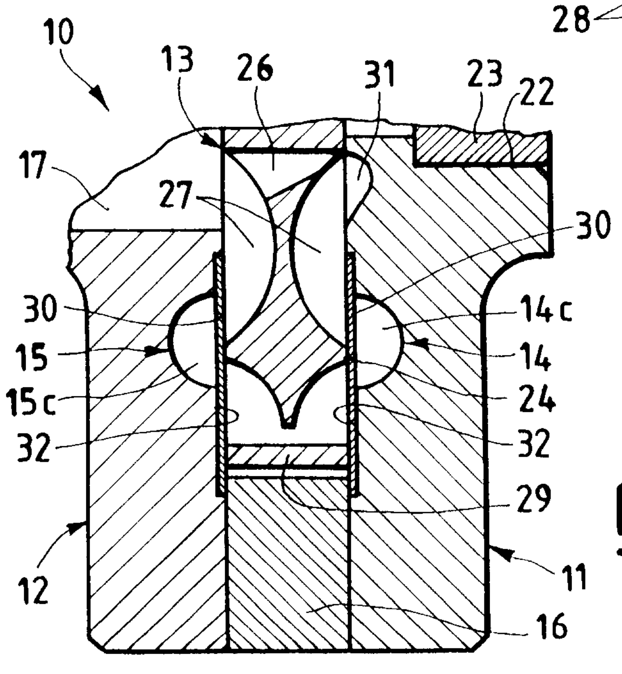
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Fig.2

Fig.3

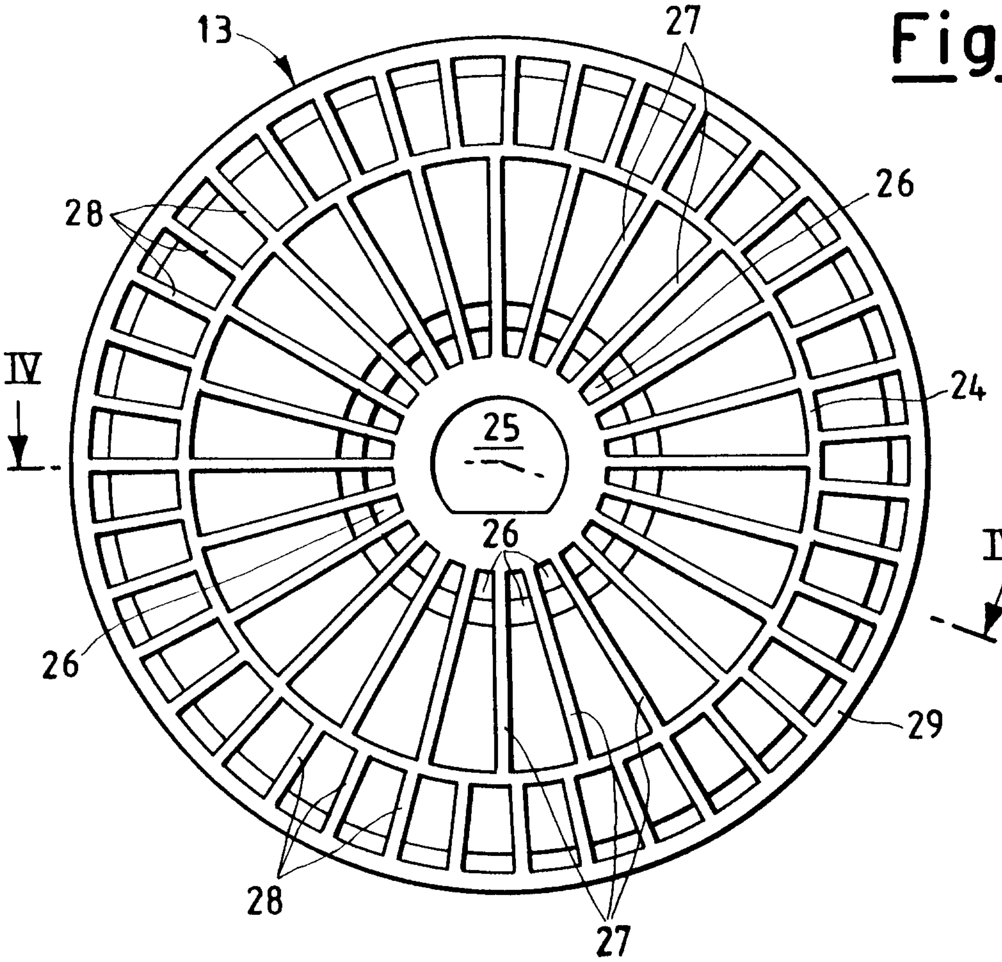


Fig.4

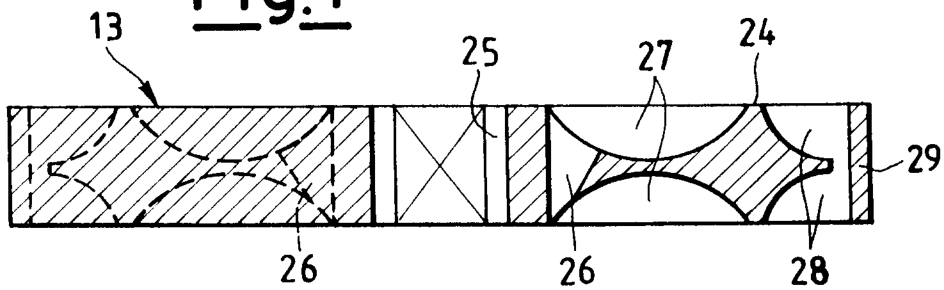


Fig.7

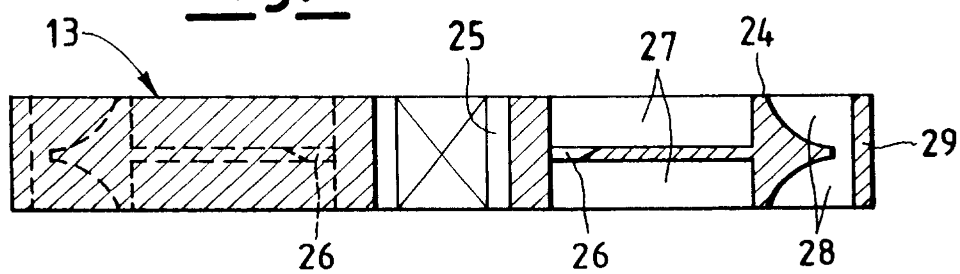


Fig.5

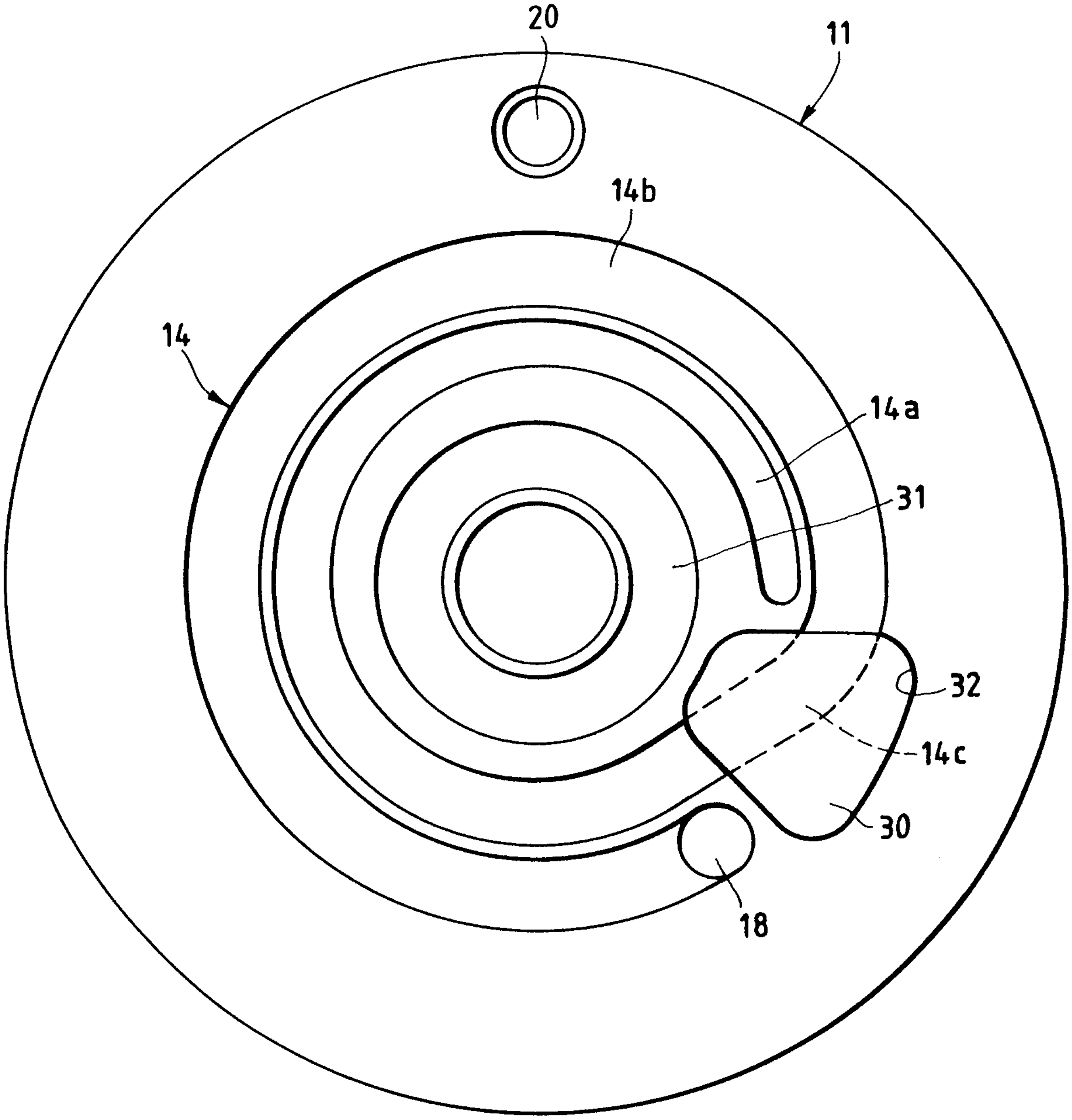


Fig.6

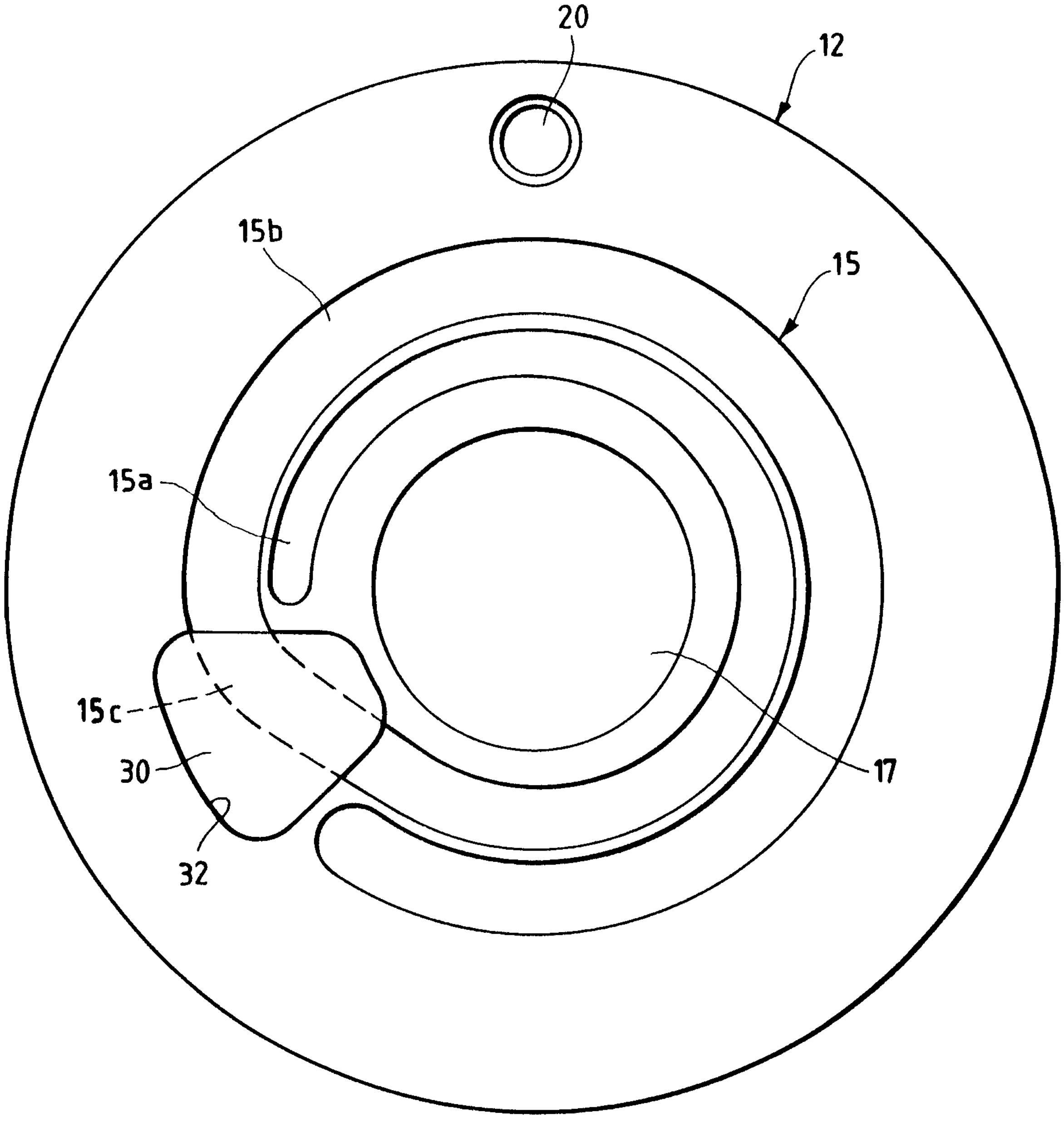


Fig.8

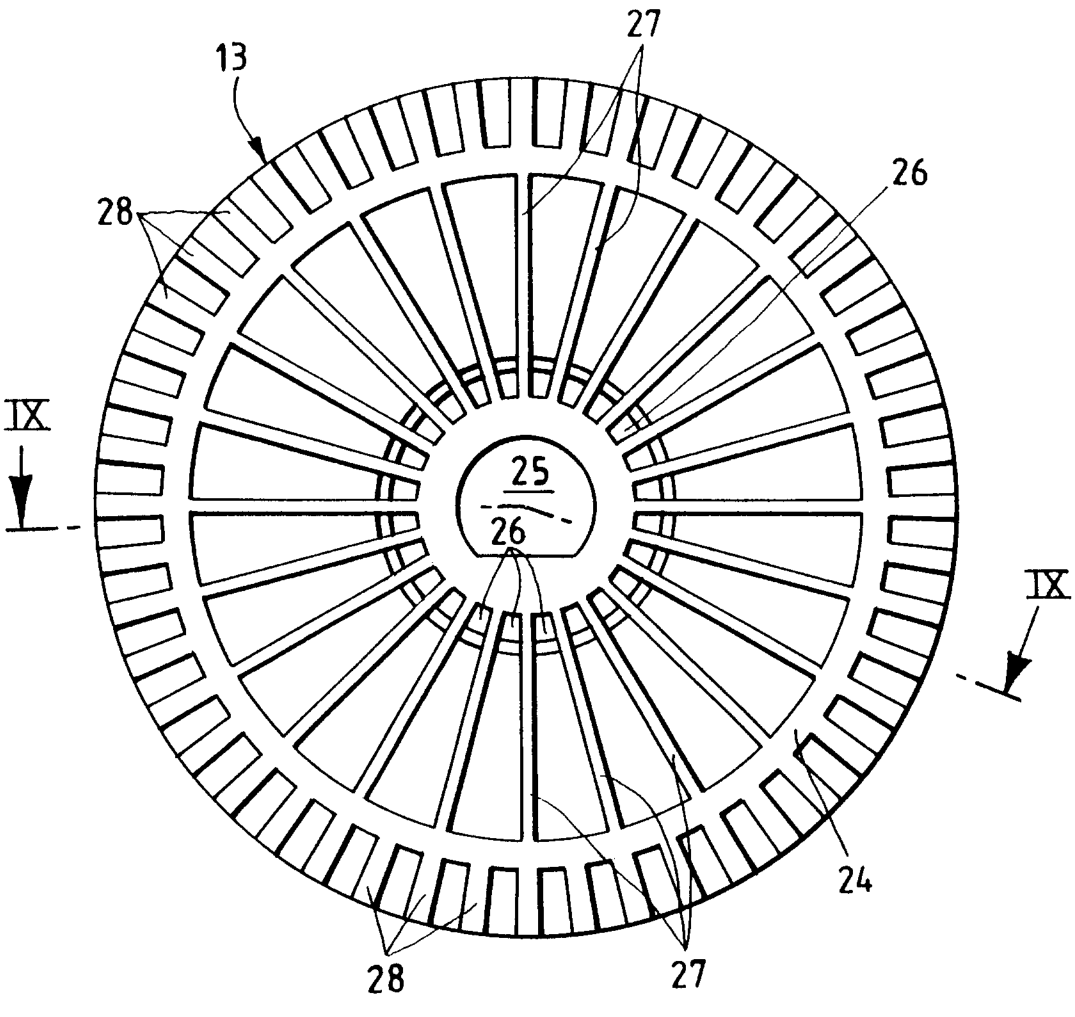
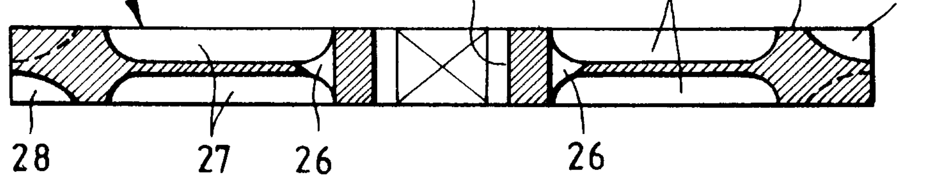


Fig.9



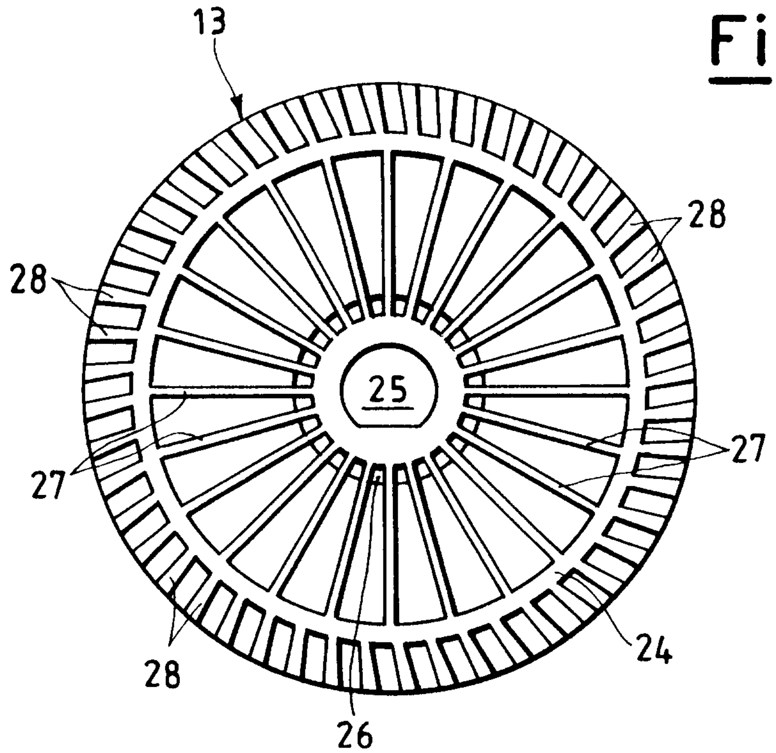


Fig.10

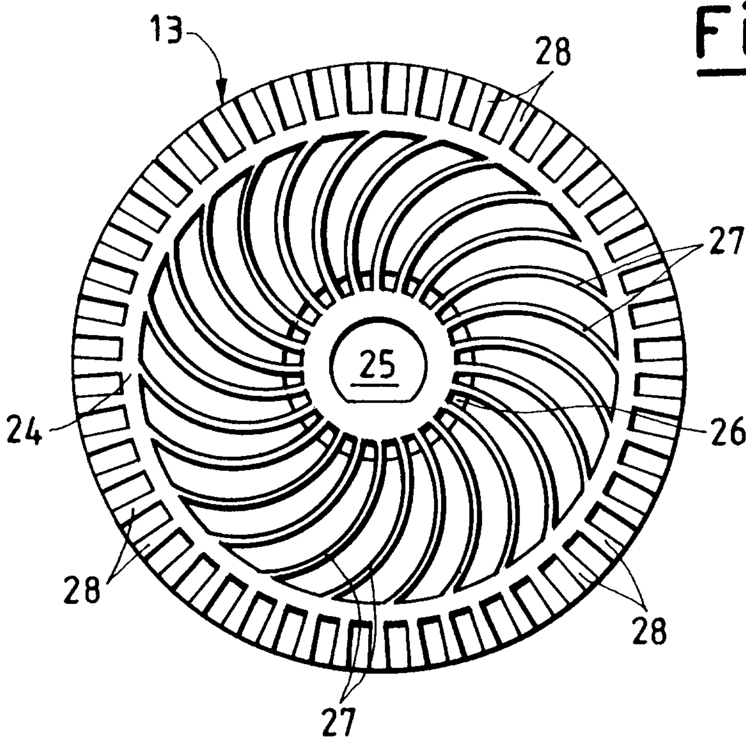


Fig.11

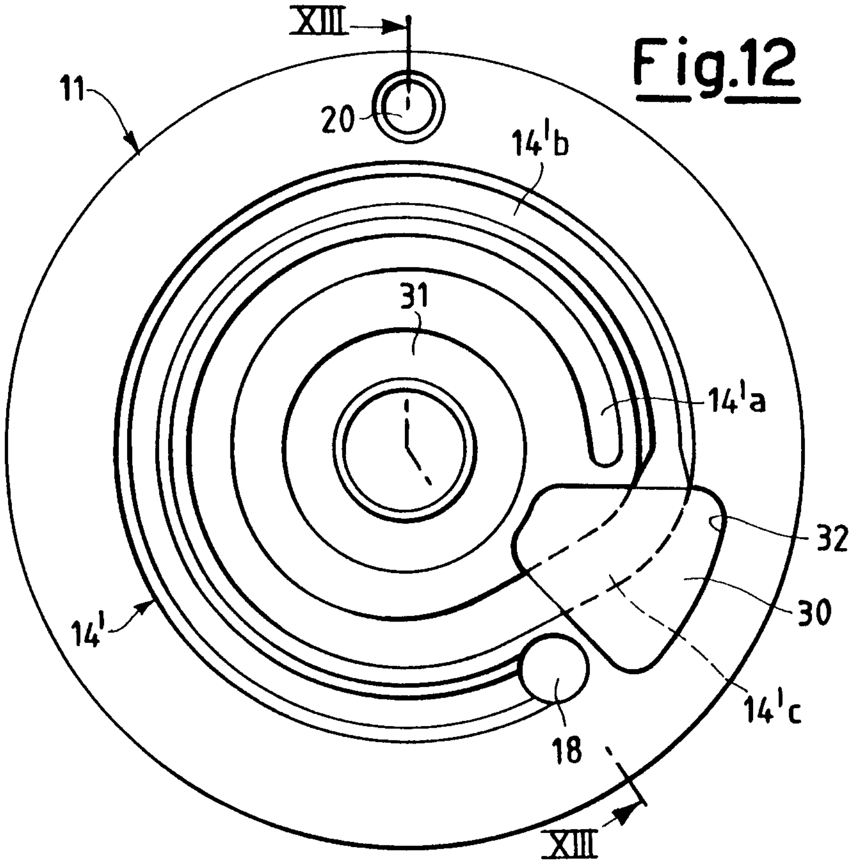


Fig.12

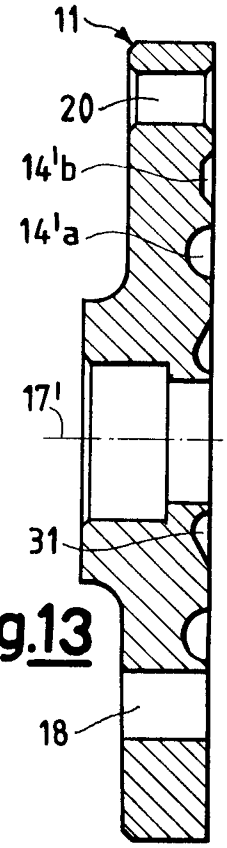


Fig.13

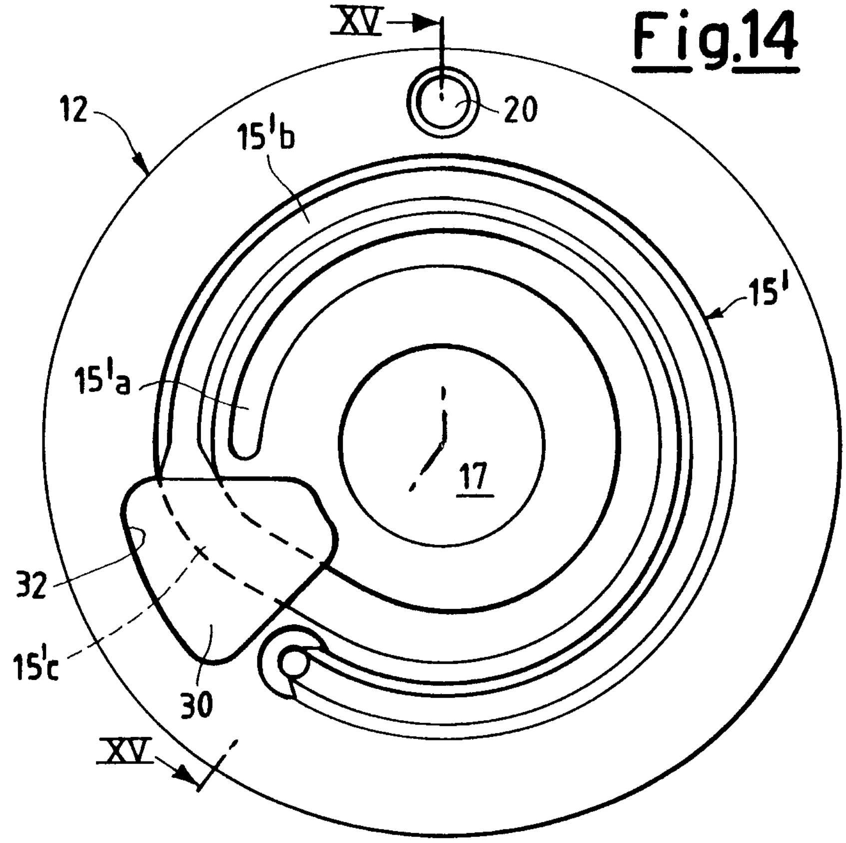


Fig.14

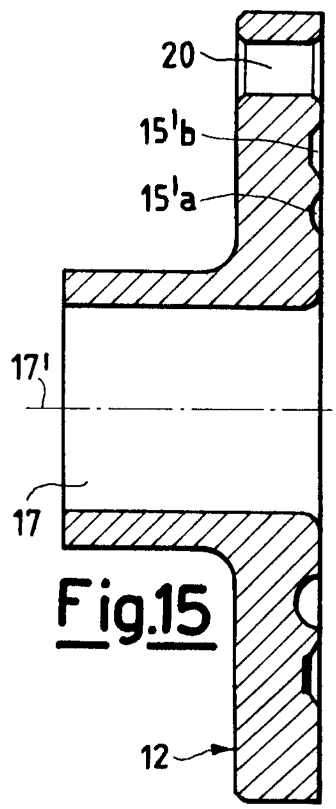


Fig.15

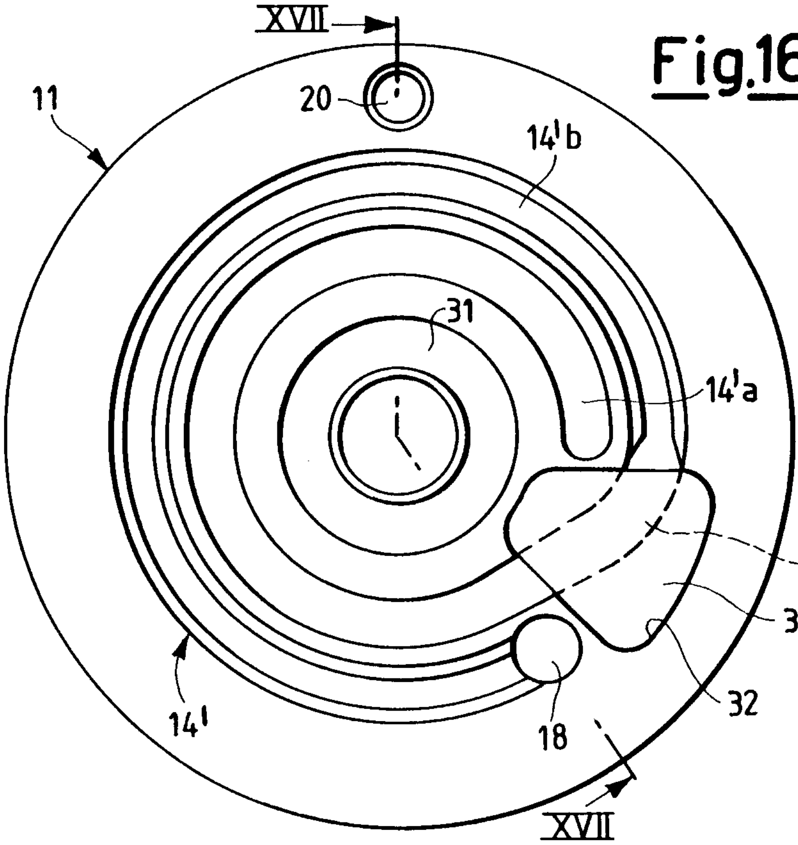


Fig.16

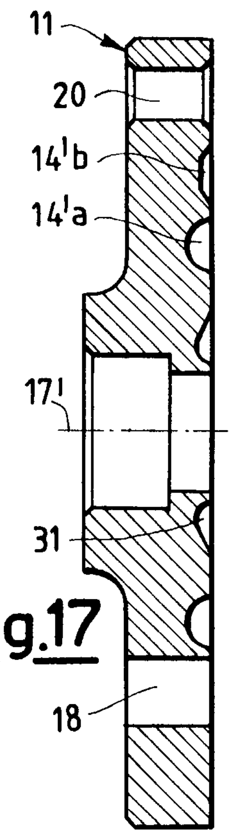


Fig.17

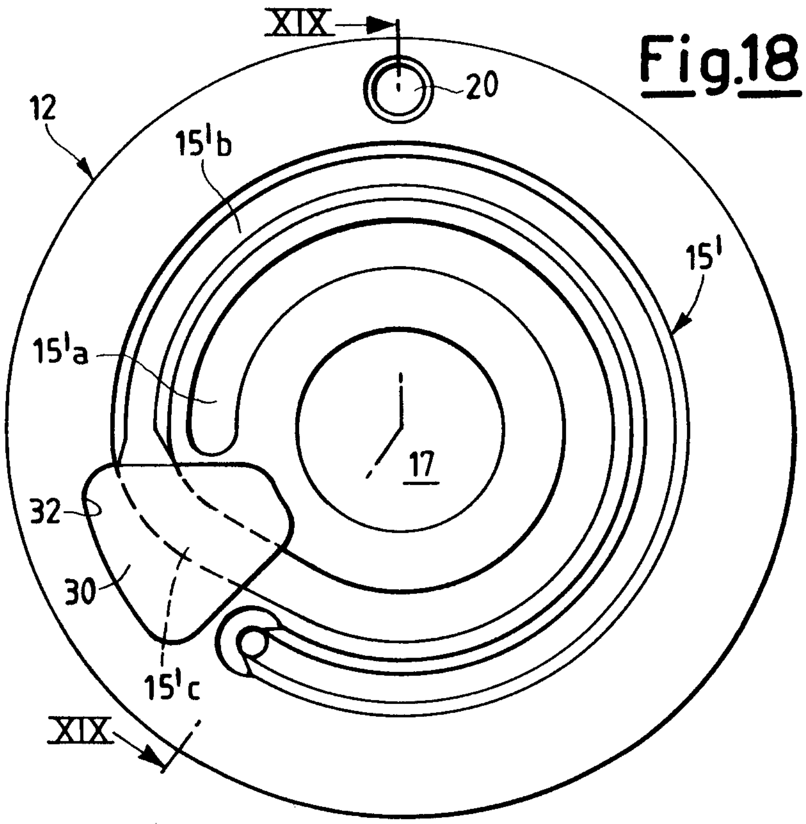


Fig.18

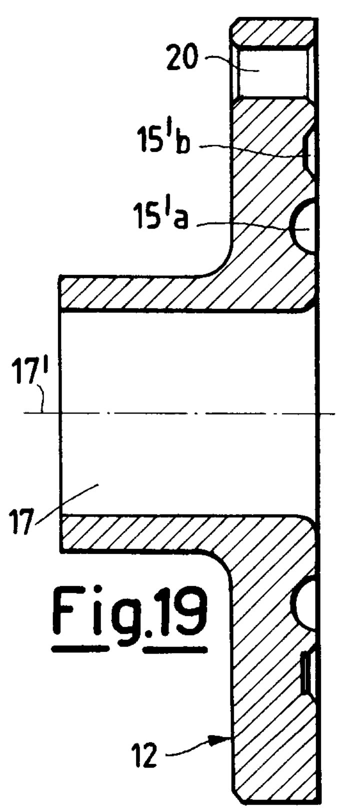
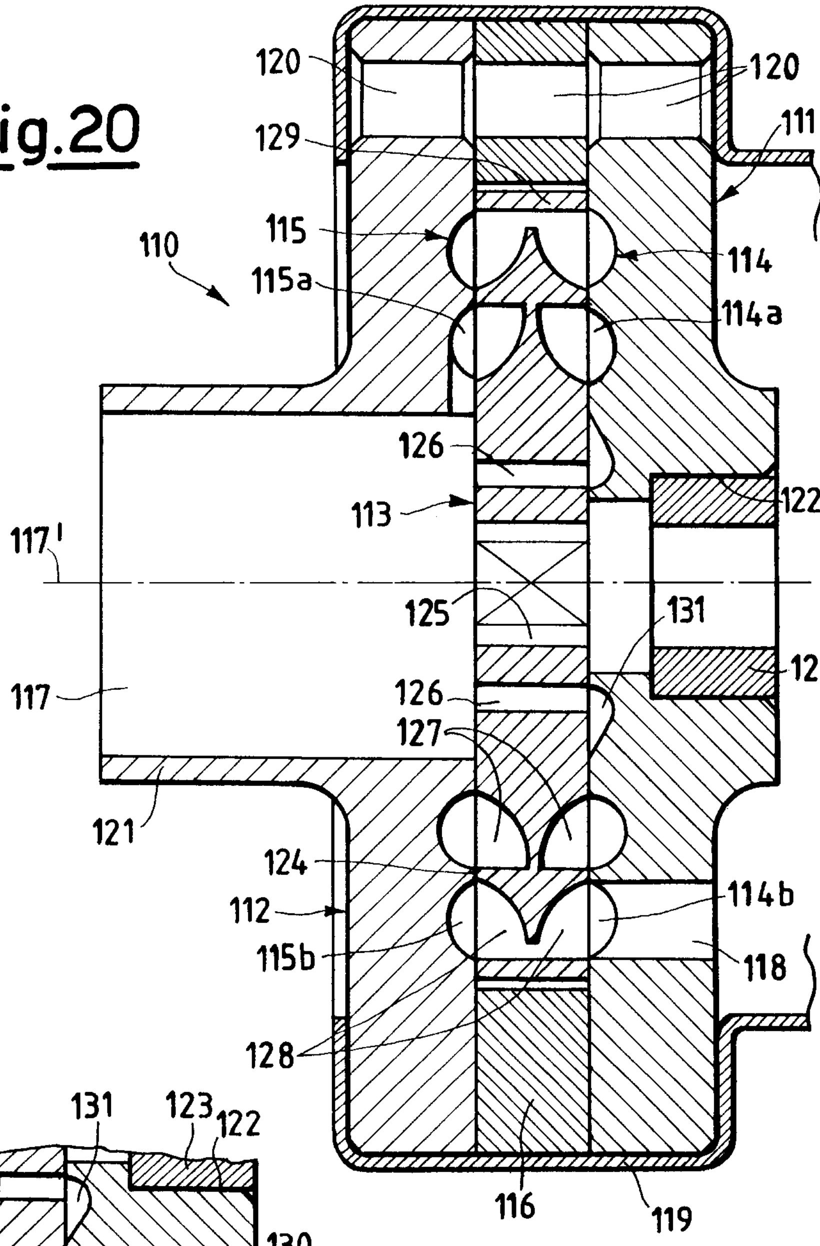


Fig.19

Fig.20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115
114
115a
114a
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117'
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124
114b
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115b
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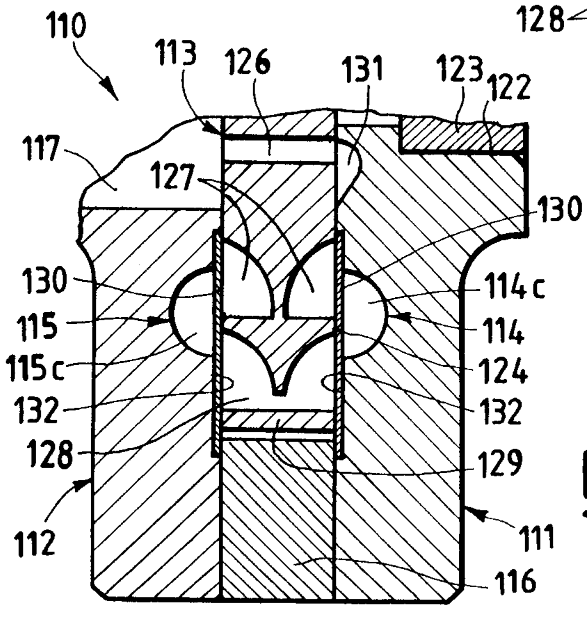
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Fig.21

Fig.22

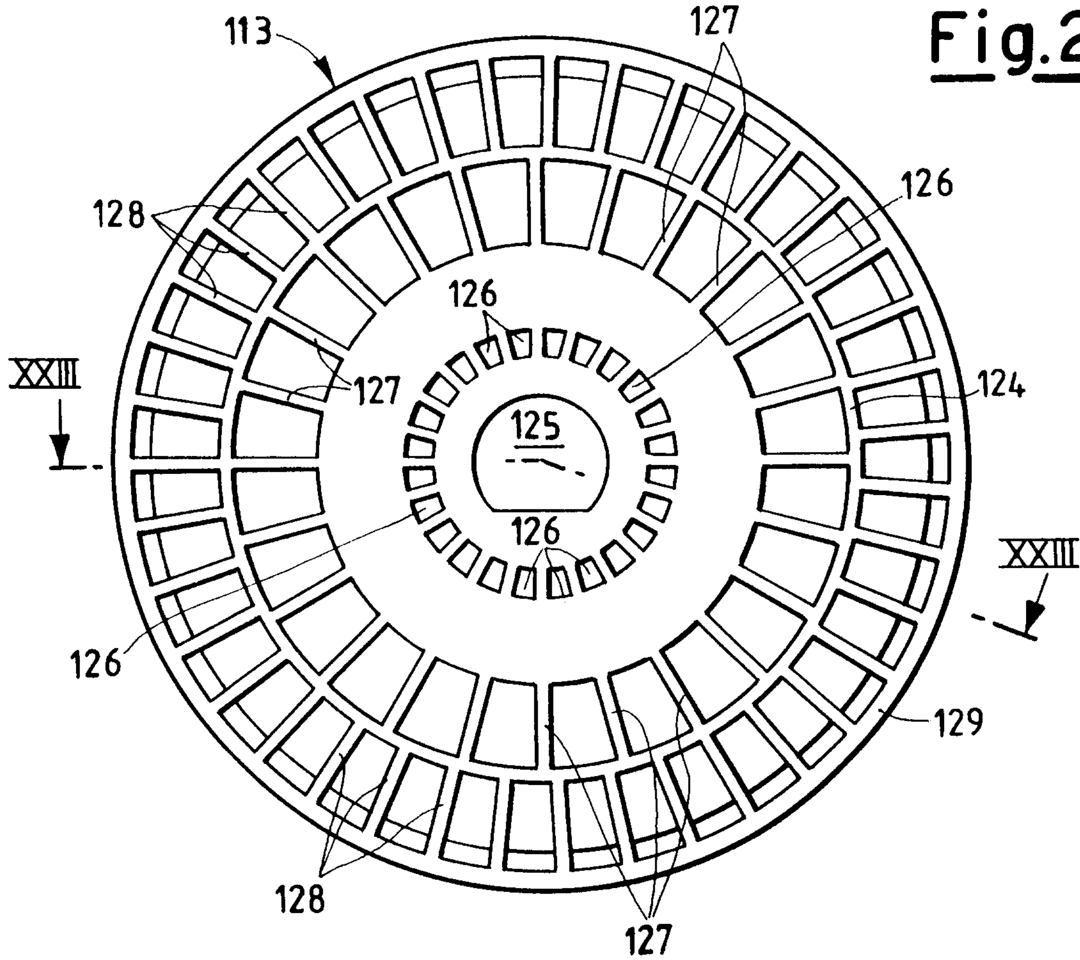
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Fig.23

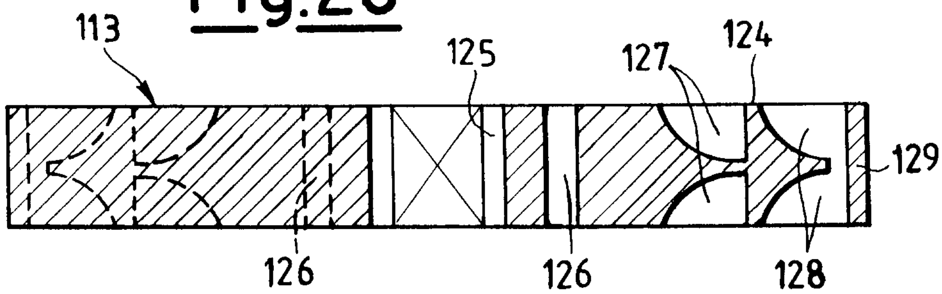
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Fig.24

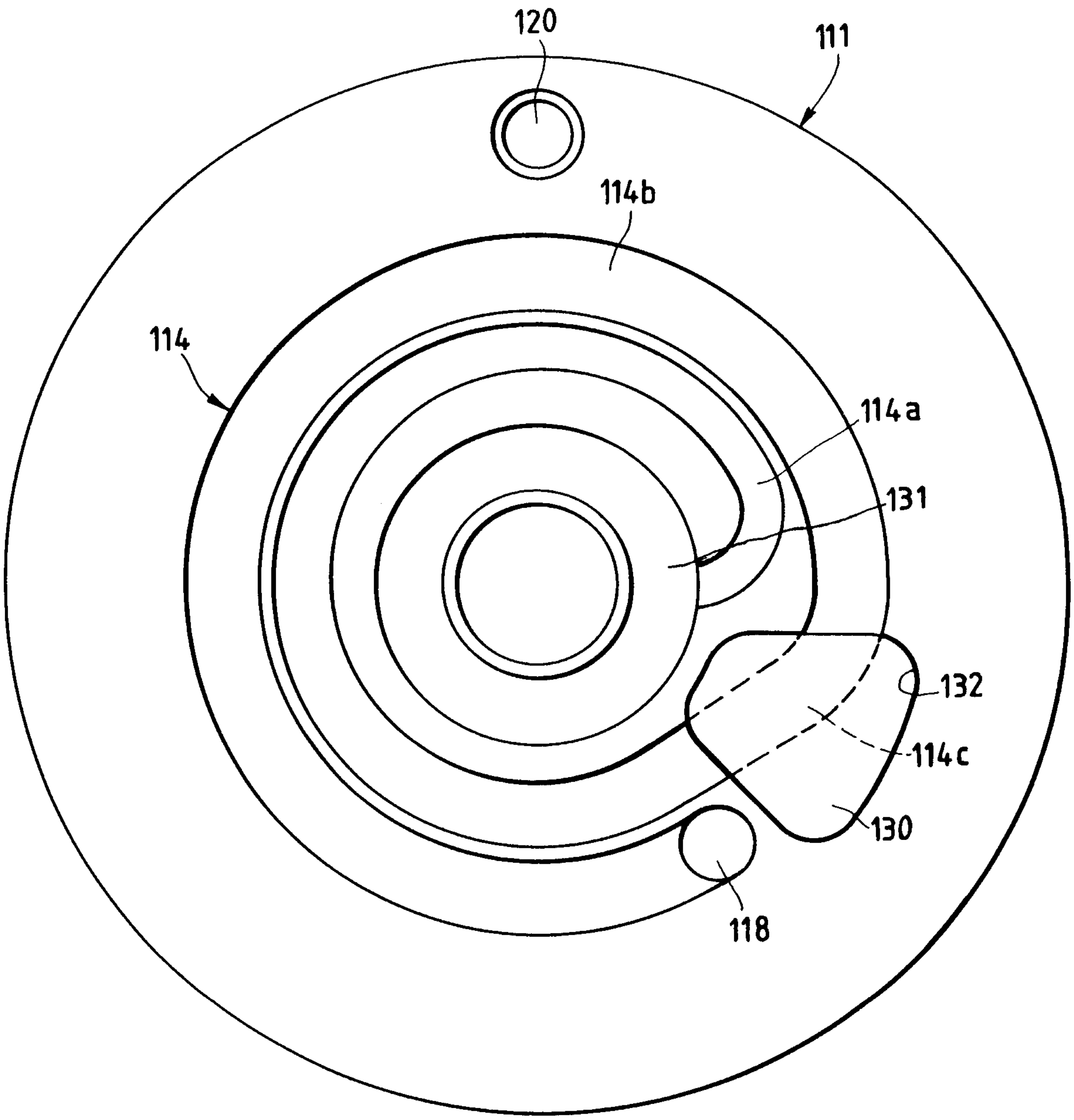


Fig.25

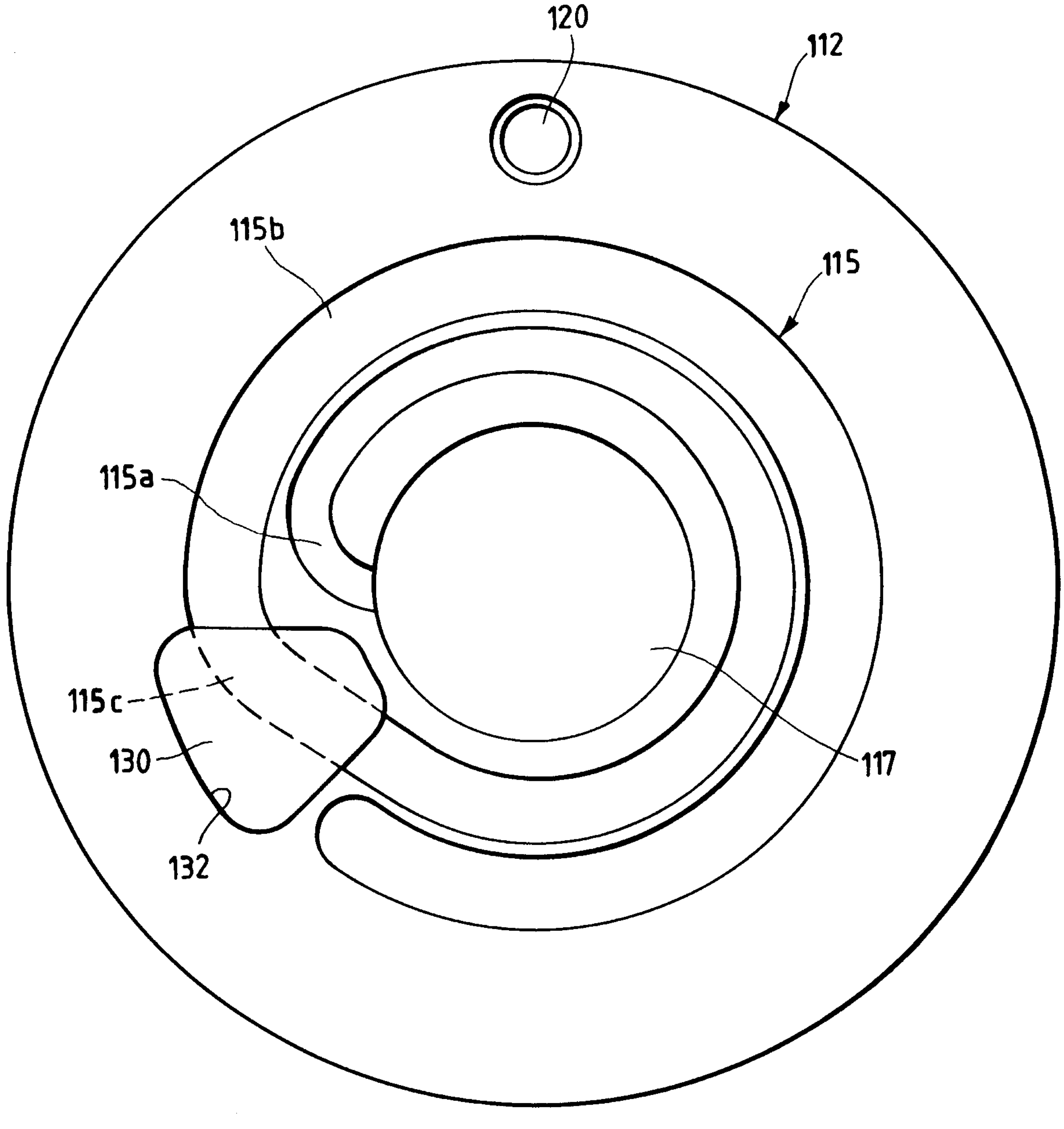
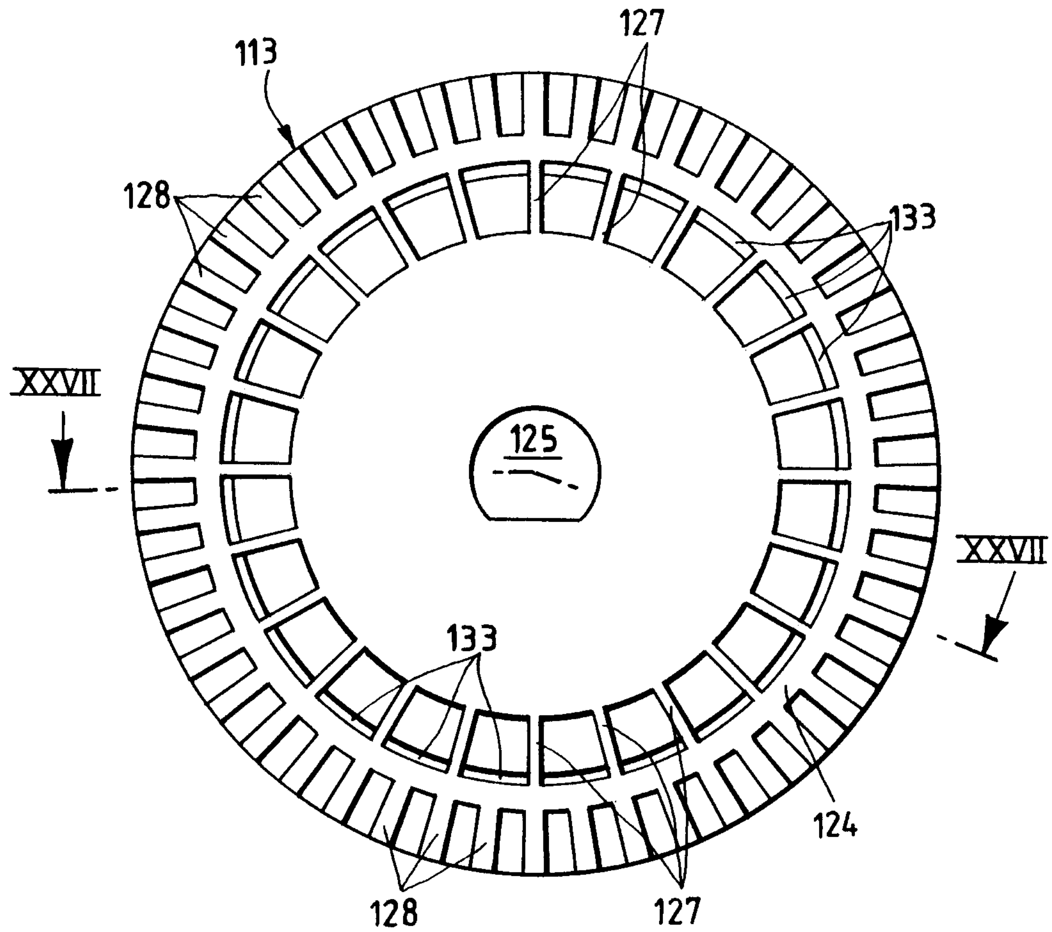


Fig.26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XXVII
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XXVII
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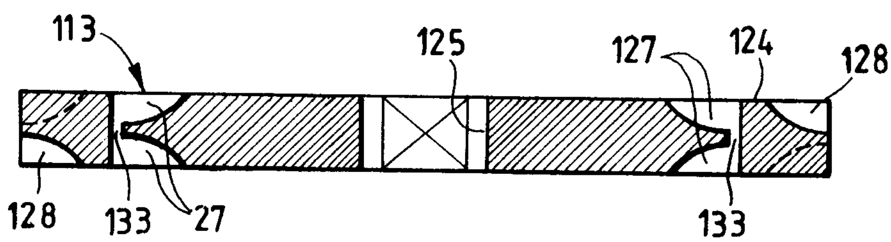
128
127

Fig.27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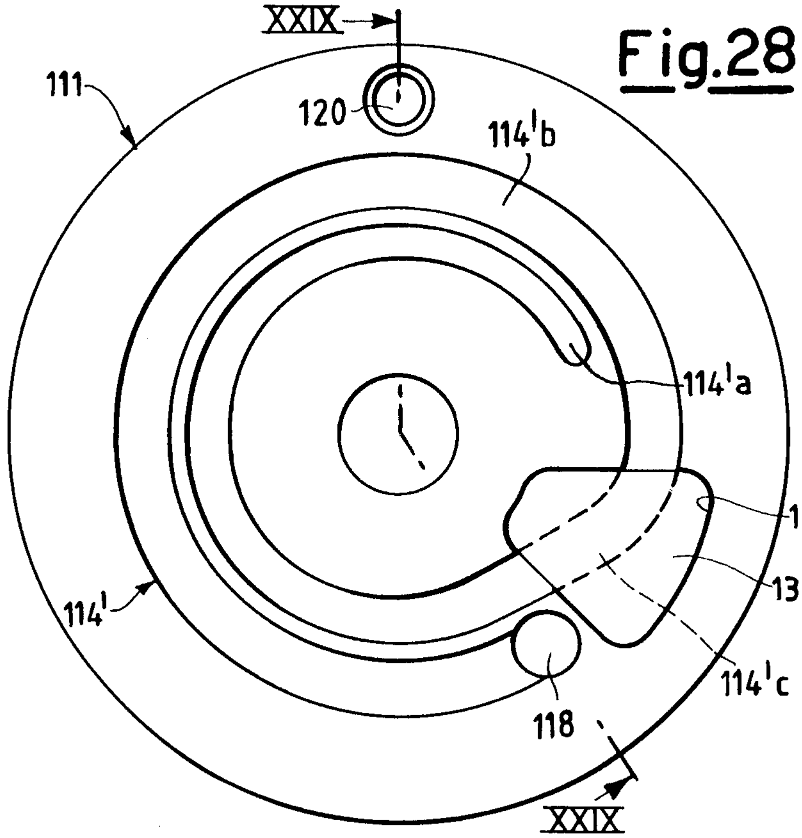


Fig.28

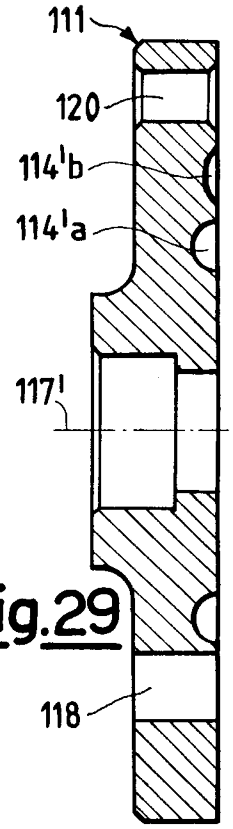


Fig.29

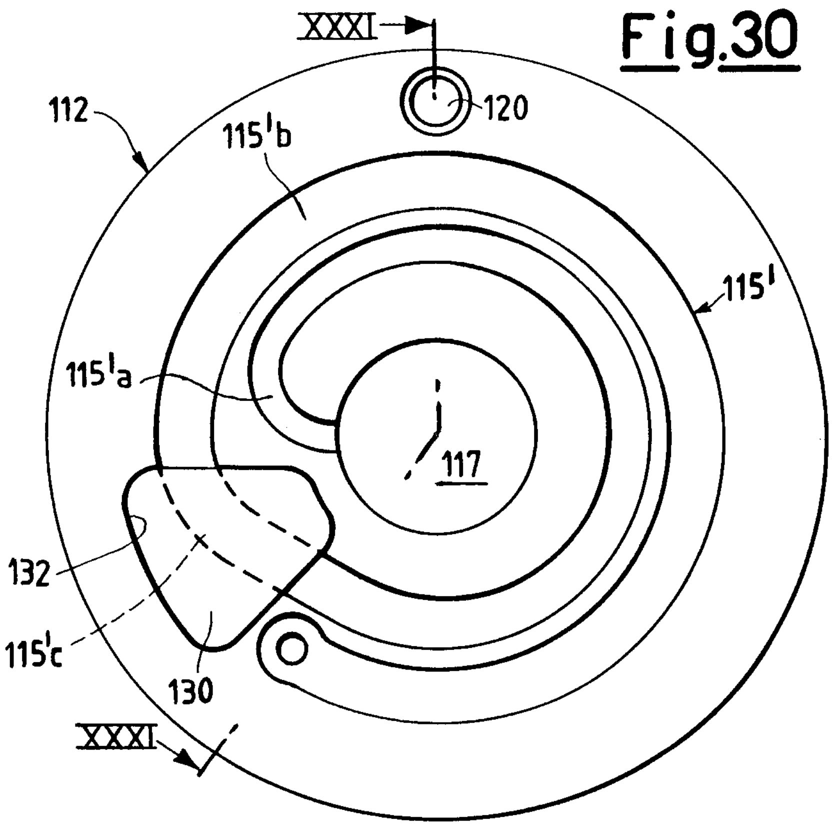


Fig.30

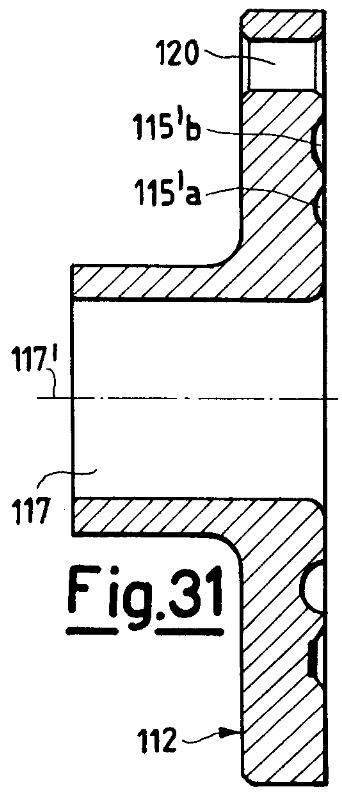
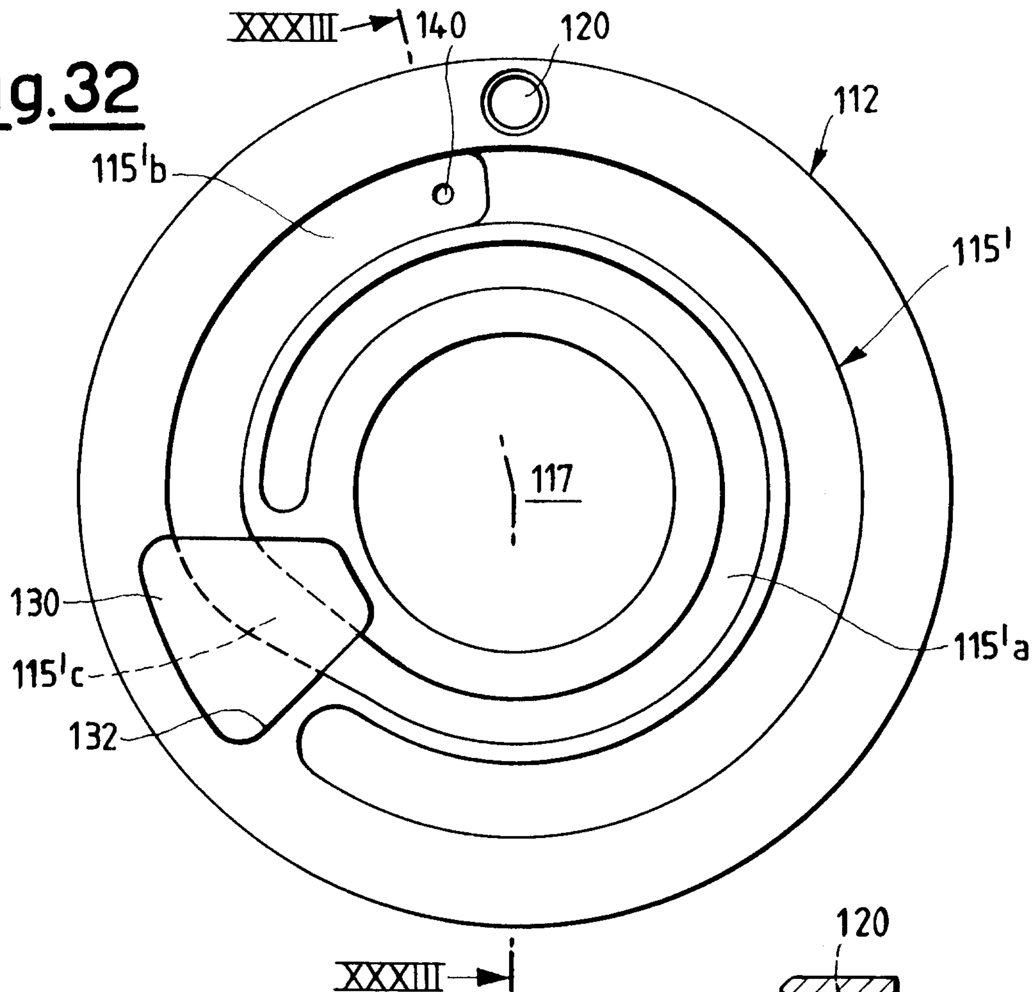


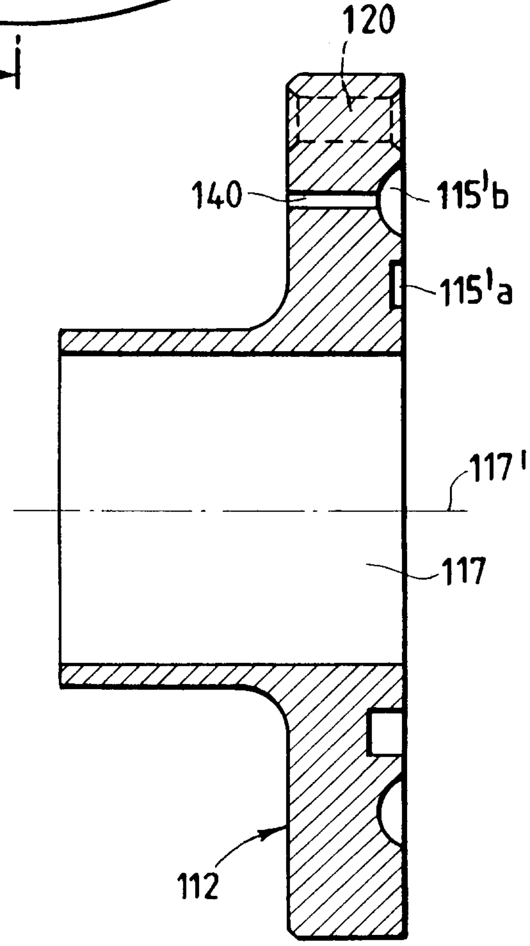
Fig.31

Fig.32



XXXIII
140
120
112
115'b
115'
117
130
115'c
115'a
132
XXXIII

Fig.33



120
140
115'b
115'a
117'
117
112

Fig.35

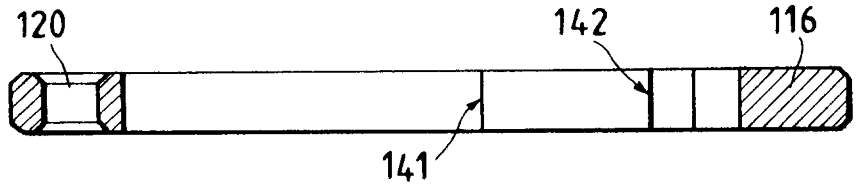


Fig.34

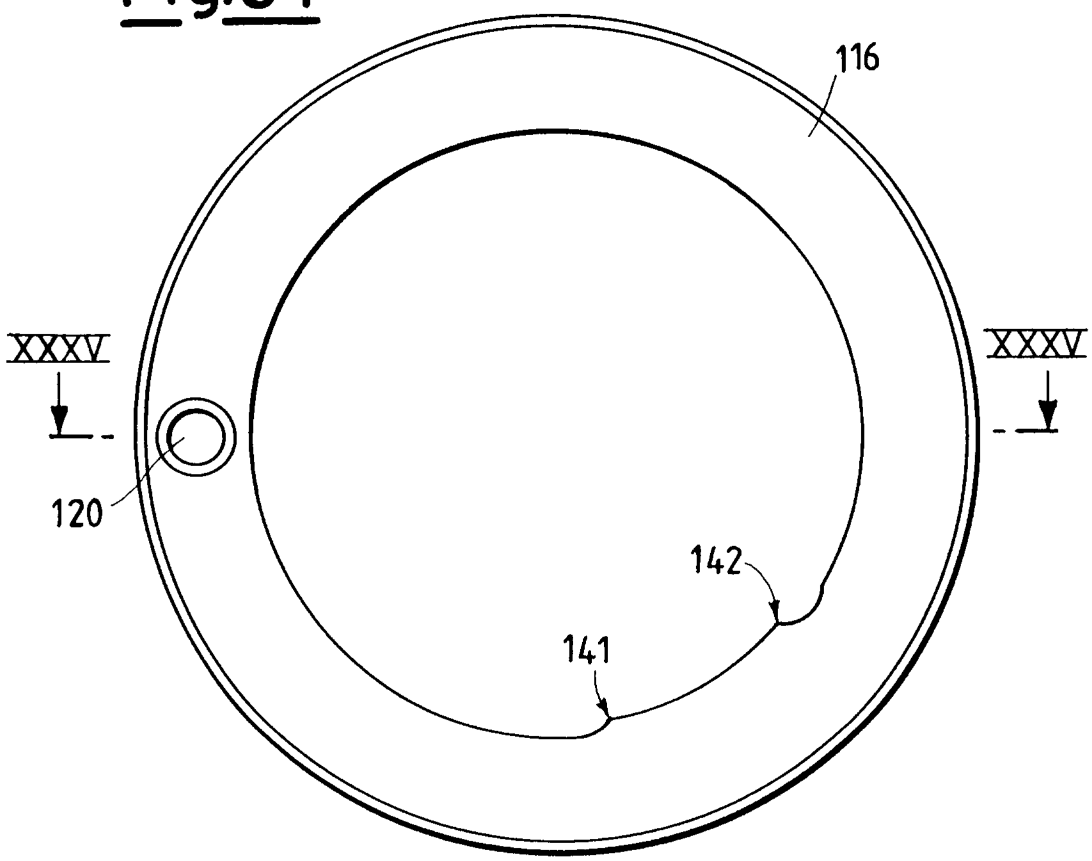
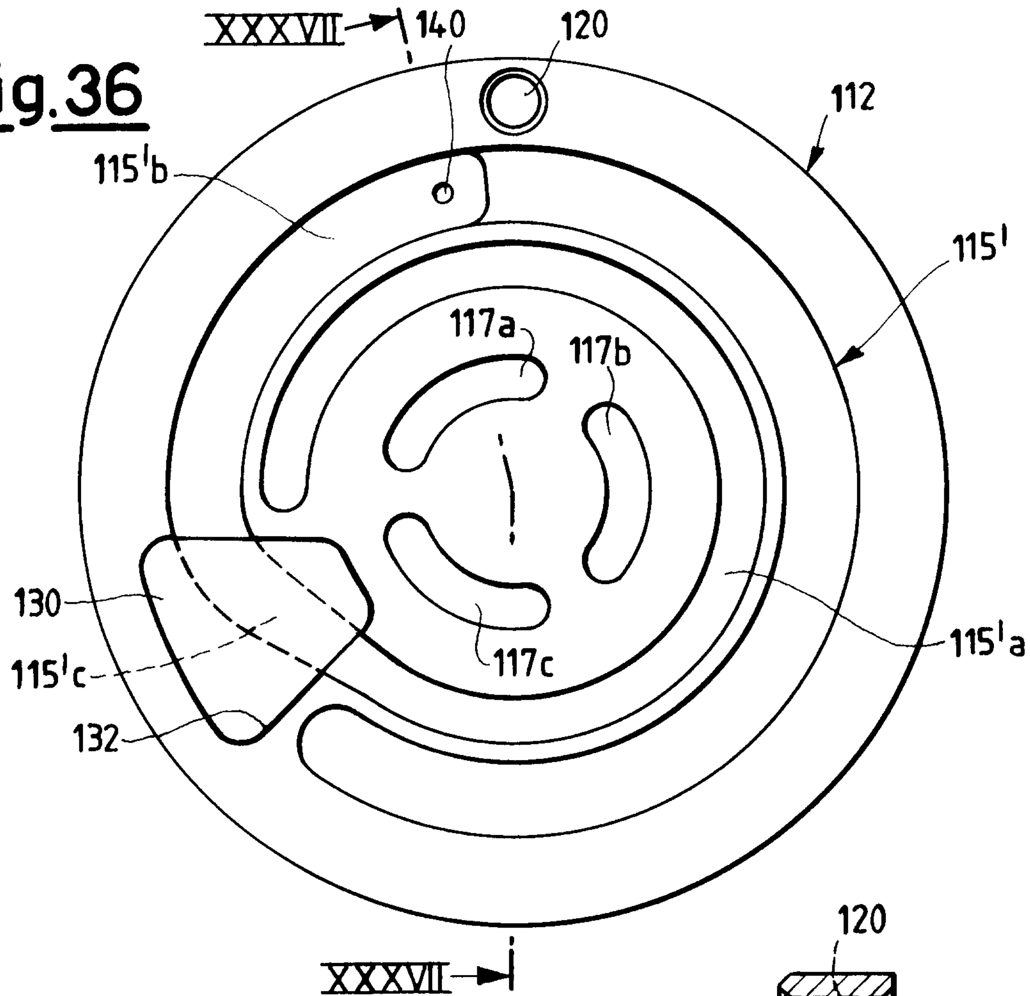


Fig.36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117b
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115'c
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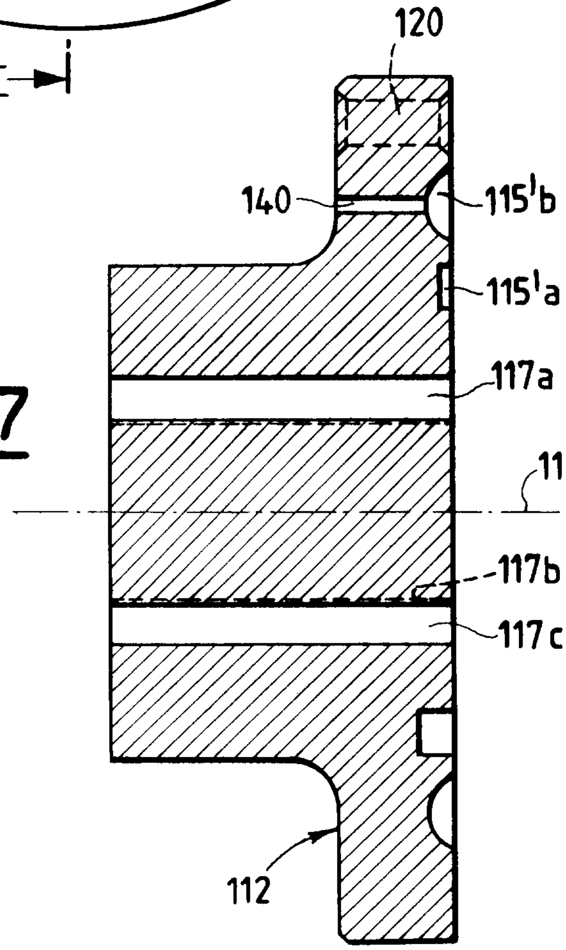
117c
115'a
XXXVII

Fig.37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115'a
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117'
117b
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