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

(11) Publication number: **0 056 256**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **82100089.0**

(22) Date of filing: **08.01.82**

(51) Int. Cl.³: **E 05 F 3/10**

(30) Priority: **14.01.81 IT 330781**

(43) Date of publication of application: **21.07.82 Bulletin 82/29**

(84) Designated Contracting States: **AT BE CH DE FR GB LI LU NL SE**

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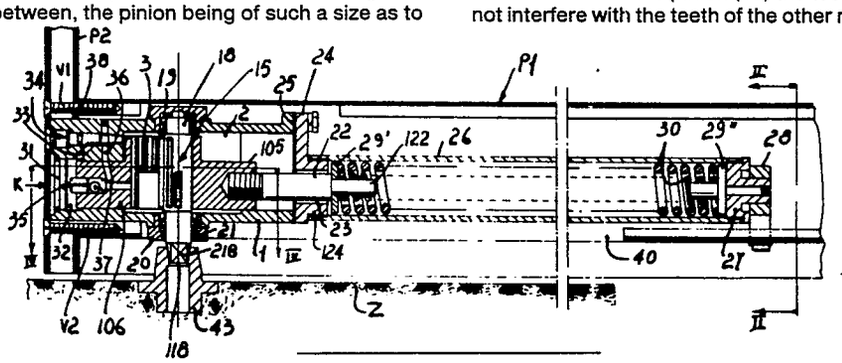
(54) A door closer.

(57) The door closer comprises:

- a toothed sector or pinion (15) having a shaft (18) which is rotatably supported by the body of said door closer, said shaft extending with an end portion so as to be keyed to a seat member (43) secured to the floor and to be used as one of the hinge pins upon which the door rotates; wherein the toothing of said pinion is comprised within an angle equal or less than 180°C, and wherein the first tooth and the last tooth (16, 17) of said pinion are of shorter length than the other teeth and are located preferably at the same level;
- a body of annular configuration formed by a pair of similar racks (3, 4) in parallel and opposite relationship receiving said pinion (15) therebetween, the pinion being of such a size as to mesh with either rack with no sliding movement; said annular body being guided longitudinally in the door closer and being urged longitudinally, in a predetermined direction, by suitable adjustable resilient means (30), the arrangement being such that, with the door closer at rest, the first and the last tooth (16, 17) of the pinion engage the first recesses (44, 45) at one end of each rack, so that the door will be kept firmly and with no backlash in the closed position (so-called 0° position); the teeth of both racks, excepted the last tooth of each rack which is of full length, being of reduced length and being located at a staggered level with respect to the teeth of reduced length of said pinion, so that during the opening of the door, when one rack rolls around the pinion (15) the teeth of the said pinion will not interfere with the teeth of the other rack.



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The present invention relates to door closers, i.e. to those devices that can be secured to a door, window or the like and cause them to close automatically. The main object to be solved in this particular field by the device of the invention is to provide a door closer of sufficient power and yet of such a small size as to be installed and concealed within one of the usual sections or shapes forming the wing of a door, bearing in mind that the door can be opened in either direction of rotation and, therefore, that the door closer must be of the double-acting type. To solve such a miniaturization problem, the device uses a mechanism comprising a pinion that, depending upon the direction of rotation of the door, must mesh with no backlash with either one of a pair of parallel and opposite racks, that is a mechanism capable of solving the following consequential problem:

- with the door closer at rest, the pinion must mesh positively with both racks, so that the door will be retained correctly and with no backlash in the closed or 0° position thereof;
- during the opening of the door, the pinion must remain

in the mesh position, and must be "enveloped" by one of the two racks with the necessary relative motion, while the teeth of the pinion must not interfere with the teeth of the other rack so as not to be hindered thereby.

The characteristics of the door closer according to the invention and the advantages resulting therefrom, will be apparent from the following description of a preferred embodiment thereof, shown as a non-limitating example in the Figures of the accompanying two sheets of drawings, in which:

Figure 1 is a side longitudinal sectional view of the device according to the invention, secured to a door and shown in the closed condition of the door; Figure 2 is a cross-sectional view of the device on the line II-II of Figure 1; Figure 3 shows some details concerning the operative arrangement of the door closer, as seen when looking in the direction indicated by the arrow K in Figure 1; Figure 4 is a sectional view on the line IV-IV of Figure 1 of further constructional and operational details of the mechanism comprising the pinion and double rack included in the door closer, said mechanism being shown in the rest position; Figure 5 is a cross-sectional view on the line V-V of Figure 4 of further constructional details of the pinion and racks mechanism; Figures 6 and 7 show the mechanism of Figure 4 in the

conditions corresponding to the widest opening amplitude of the door, depending upon the two opposed directions of rotation of the door, respectively.

With reference firstly to Figures 1 to 4, the door closer of the invention comprises a body 1 of parallelepiped or any other suitable shape and of such size as to be accommodated within one of the transverse sections that usually from a door wing, as best described hereinafter. Formed in the body 1 there is a chamber 2 at the interior of which a double rack of annular configuration in plan view (see Figure 4) is guided and can move longitudinally. As shown in Figure 4, the two racks 3 and 4 have the same shape and are parallely opposite to each other and are connected to each other at their ends by means of suitably merging portion 5 and 6. The racks have the same number of teeth, and the teeth of one rack are perfectly in line and in opposite relation to the teeth of the other. The teeth 7, 8, 9 of rack 3 and the teeth 10, 11, 12 of rack 4 are of reduced length, that is they extend on the body of each rack only for a fraction of its height, and these teeth are all located at the same level, as shown for example in Figure 5 where these teeth are located on the upper portion of said racks. However, the teeth 13 and 14 of the two racks are of normal or entire length as shown in Figure 5.

A toothed sector 15 having the same number of teeth as the

recesses in the toothing of each rack is arranged between the two racks, and said teeth are located in a sector of circumference having an amplitude of 180° or less. The configuration and size of the pinion 15 are such as to permit the pinion to mesh with no backlash and roll on either racks 3-4 depending on the direction of rotation imparted to the latter, as explained below. As shown in Figure 4, when the door closer is at rest, the first and the last tooth of pinion 15, indicated by numerals 16 and 17, respectively, are both contacting the body of the racks 3 and 4 (see below), which are urged longitudinally as indicated by the arrow F, by suitable resilient means which will be described hereinafter. To insure said meshing condition with no backlash between the pinion 15 and rack 3 or 4, the teeth 16, 17 of said pinion 15 are of reduced length with respect to the intermediate teeth, and said teeth 16, 17 are located in such a position to avoid any interference with the reduced teeth of the racks 3 and 4 (see also Figure 5). Of course, the racks and pinion 15 are made of a suitable material and are suitably treated to withstand all mechanical stresses exerted thereagainst during the normal operation of the door closer.

Reverting to Figure 1, it will be seen that the pinion 15 is provided with an integral shaft 18 which is rotatably supported by the body 1 through a pair of bushings 19-20 and respective bearings. The end portion 118 of the shaft 18 sealingly projects from the bushing 20 through an annular sealing ring 21, and said end portion is formed with at least one flattered portion 218 or any other

suitable means to be fixedly connected to a member which will be discussed hereinafter in connection with the arrangement of the door-closer in the operating position.

Formed at the end 5 of the double rack there is an integral stub member 105, to which there is a rod 22 perpendicular to said shaft 18 and projecting with clearance through a bore 23 of a cover 24 that sealingly closes said chamber 2 with the aid of a gasket 25. On a stub member 124 of said cover 24 there is sealingly secured, by screw connection, a tubular member 26 which is sealingly closed at the opposite end by a plug 27 provided with an inverted "U" support 28, having the purpose set forth hereinafter. The rod 22 co-axially projects into said tubular member 26 with a reduced portion 122 supporting a spring-bearing disc 29'. A similar spring-bearing disc 29'' with an axial centering pin is provided within said tubular member 26 adjacent said plug 27. Between the discs 29' and 29'' there is mounted a compression-loaded assembly 30 comprising the springs that urge the racks 3-4 in the direction indicated by the arrow F (Figure 4). Opposed to the stub member 105 and co-axial with the rod 22 at the other end 6 of the double rack is integrally formed a piston 106 of round cross-section, sealingly slidable axially in a corresponding bore formed in the body 1 and closed at the outer end by a plug 31. The compression chamber 32, the volume of which changes as a function of the axial movement of the piston 106, communicates permanently with the chamber 2 through a duct 33 and a variable restrictor 34, preferably of thermostatic type, suitably mounted in the

body 1.

On the piston 106 there is mounted a unidirectional valve 35 permitting the free communication between the chambers 2 and 32, but preventing automatically any communication in the contrary direction. The regulating section of the door closer is completed by a hole 36 formed in the body 1 and communicating with the chamber 32 through an invariable port of the restrictor 34. When the piston 106 is at the end of its retraction stroke in the chamber 32, said hole 36 communicates with a hole 37 formed in said piston and in open communication with the chamber 2. The chambers 2, 32 and tubular member 26 are filled with oil or any other suitable liquid.

The door closer described above is arranged preferably at the interior of the lower transverse channel section P1 of the door wing. In Figure 1, V1 and V2 indicate the screws usually securing the section member P1 to the section member P2 of the door wing. In order to mount the door-closer in the operative position thereof, the sections P1 and P2 are to be submitted to the following operations. An opening 38 is formed in the back concealed wall of the section member P2, in the region abutted by the section member P1, while the front wall of P2, opposite said opening 38, is formed with a hole 39 and a number of further holes for the insertion of screws (see below). A length of the channel section P1, in continuation of the channel P2, is formed with a longitudinal bottom opening 40. The door-closer is introduced into the channel section

P1 through the opening 40, whereafter the end of the body 1 is introduced into the opening 38 to abut the outer wall of the channel P2. The body 1 is then secured to the latter wall by screws 42 (see Figure 3). It will be apparent from this Figure that through the hole 39 the restrictor 34 can be regulated in order to change the braking mode of the door closer. By means of suitable holes in the bottom wall of the channel section P1, said support 28 is fixed to the latter wall, so that the device can be fixedly connected to the door wing. Thereafter, the door will be arranged in place. For this purpose, the upper transverse channel is provided with a hinge pivot co-axial with said shaft 18, whose end portion 118 is keyed to a bushing 43 secured in the floor Z. When the door is in the closed position thereof, the mechanism comprising the pinion and double rack is in the condition shown in Figure 4 and the teeth 16-17 due to the action of the springs 3 in the direction F bear against the flanks 44-45 of the teeth of said racks 3-4. Obviously, in these conditions, the door will be kept closed with no backlash.

When the door is rotated in the opening direction, as by pushing it towards the sheet of drawings (looking at Figure 1), the assembly 3-4 will be rotated in the direction indicated by the arrow F1 in Figure 4. During this rotation, before the half tooth 16 moves off the flank 44 of the body of rack 3, the first complete tooth of the pinion 15 moves into the space between the teeth 7-8 and bears mainly against the tooth 7, so as to ensure a smooth meshing and evolving with non backlash between

the members 15 and 3. While the rack 3 moves around the stationary pinion 15, the reduced tooth 17 of this pinion moves off the cooperative engagement with the teeth of the passive rack 4, because this reduced tooth 17 faces the reduced staggered tooth 10 of said rack 4. While the rack 3 moves around the pinion 15, the end portion 5 of the assembly 3-4 moves away from this pinion, whereby the springs 30 will be loaded progressively and the chamber 32 increases in volume while the oil flows freely therein through the valve 35. On completion of the door rotation, which can occur even through a considerable angle A, the complete tooth 13 of the rack 3 contacts against the reduced tooth 17 of the pinion 15, and the reduced tooth 16 of the pinion contacts against the complete tooth 14 of the rack 4 (Figure 6).

When an opened door is released, the rack 3 is forced to rotate in a direction contrary to F1 by the action of the springs 30. While the rack 3 rolls around the pinion 15 in the direction causing the closing rotation of the door, the springs 30 extend progressively and the chamber 32 decreases in volume. The oil in this chamber, being prevented to escape therefrom through the valve 35, now closed, flows into the chamber 2 through the restrictor 34, which, therefore, suitably dampens the closing rotation of the door. When the door reaches the end of this rotation (Figure 1), the hole 37 will be in communication with the holes 36-33, so that the chamber 32 will communicate with the chamber 2, rather than through the restricted orifice of the restrictor 34, through a wider passage.

Therefore, the door, in the final portion of its closing rotation, will be damped to a lesser degree in the last portion of its closing stroke, so that the door can move to a perfect closing position, even if spring latches or locking bolts of a look are provided.

If the door will be opened instead by rotation in the direction of the arrow F2 in Figure 4, the rack 4 will mesh and move around the toothed sector 15 to the limit position shown in Figure 7. The operation of the door--closer is similar to that set forth above with reference to Figures 1-4-6 and, therefore, will not be further discussed.

It is to be understood that the description has been made with reference to a preferred embodiment of the invention, and that many changes and modifications can be made thereto, especially as to the construction thereof. These changes, for example, may consist of means to change the regulation of the springs 3 to suit the characteristics of any door, or may consist of means permitting to regulate the positioning of the bushing 43, even after the installation of the door. The piston 106 can be secured differently to the double racks 3-4 and these latter, on turn, can be of composite construction, so as to simplify the machining of the partial teeth. It is also to be understood that the door closer falls within the limits of the invention even if designed to be mounted externally on the door or in the floor. These and other changes and modifications, obvious to those skilled in the art, will

fall within the basic principle of the invention, as described above, and as claimed hereinafter.

CLAIMS

1. A door closer of reduced dimensions particularly adapted for installation at the interior of a section member forming the wing of a door or the like to be opened by swinging in either direction, characterized by the fact that it comprises:

- a toothed sector or pinion (15) having a shaft (18) which is rotatably supported by the body of said door closer, said shaft extending with an end portion so as to be keyed to a seat member (43) secured to the floor and to be used as one of the hinge pins upon which the door rotates; wherein the toothing of said pinion is comprised within an angle equal or less than 180°, and wherein the first tooth and the last tooth (16, 17) of said pinion are of shorter length than the other teeth and are located preferably at the same level;
- a body of annular configuration formed by a pair of similar racks (3, 4) in parallel and opposite relationship receiving said pinion (15) therebetween, the pinion being of such a size as to mesh with either rack with no sliding movement; said annular body being guided longitudinally in the door closer and being urged longitudinally, in a predetermined direction, by suitable adjustable resilient means (30), the arrangement being such that, with the door closer at rest, the first and the last tooth (16, 17) of the pinion engage the first recesses (44, 45) at one end of each rack, so that the door will be kept firmly and with no backlash in the closed position (so-called 0° position); the

teeth of both racks, excepted the last tooth of each rack which is of full length, being of reduced length and being located at a staggered level with respect to the teeth of reduced length of said pinion, so that during the opening of the door, when one rack rolls around the pinion (15) the teeth of the said pinion will not interfere with the teeth of the other rack.

2. A door closer according to claim 1, characterized by the fact that it comprises further braking means (2, 32, 34) for effecting a controlled braking action on the rotating movement of the racks-and-pinion assembly (3, 4, 15) moving back to the rest position after each rotational displacement, under the action of the resilient means (30) which have been loaded by the opening movement of the door.

3. A door closer according to claim 2, characterized by the fact that the braking means comprises a piston-and cylinder assembly, the movement of the piston (106) at the interior of the cylinder being controlled by means of suitable restrictor valve means (34).

4. A door closer according to claim 1, characterized by the fact that each rack (4, 5) comprises four teeth and five recesses, and that the pinion (15) presents five teeth.

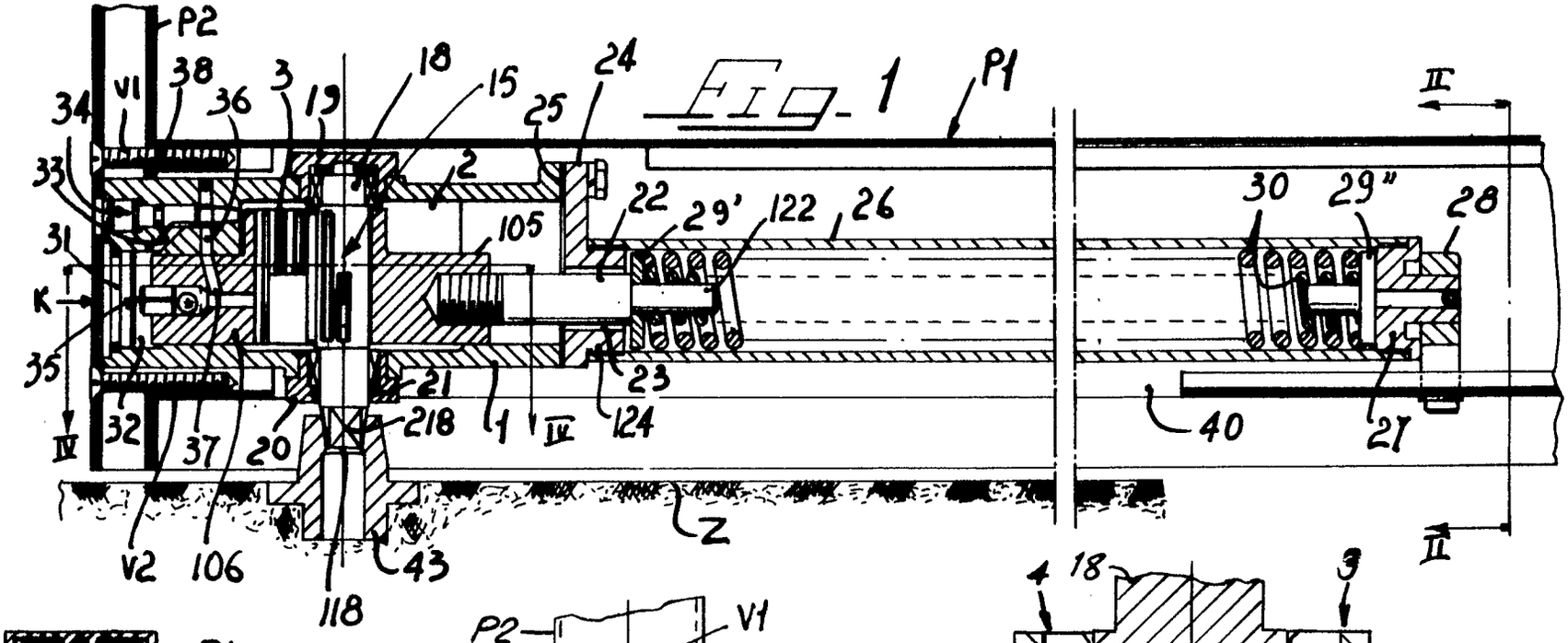

Fig. 1

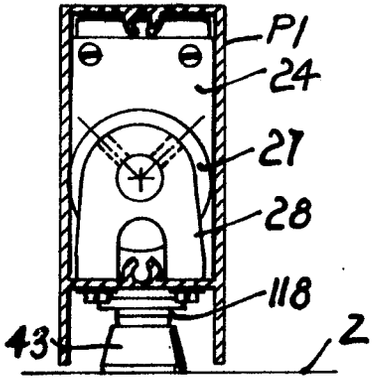

Fig. 2

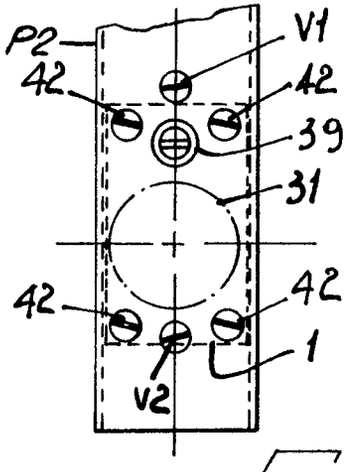

Fig. 3

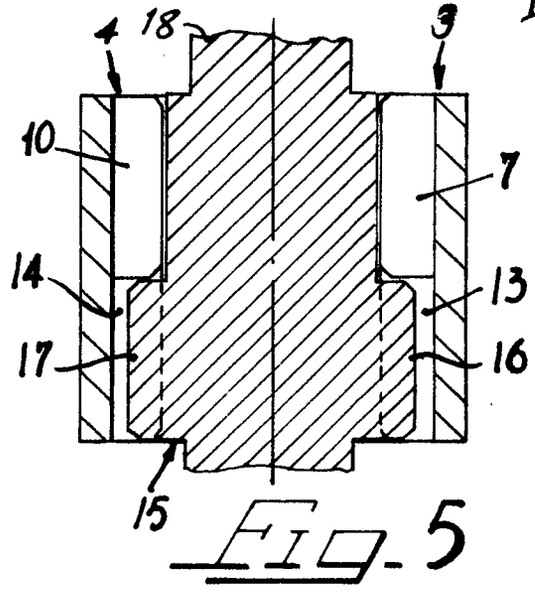

Fig. 5

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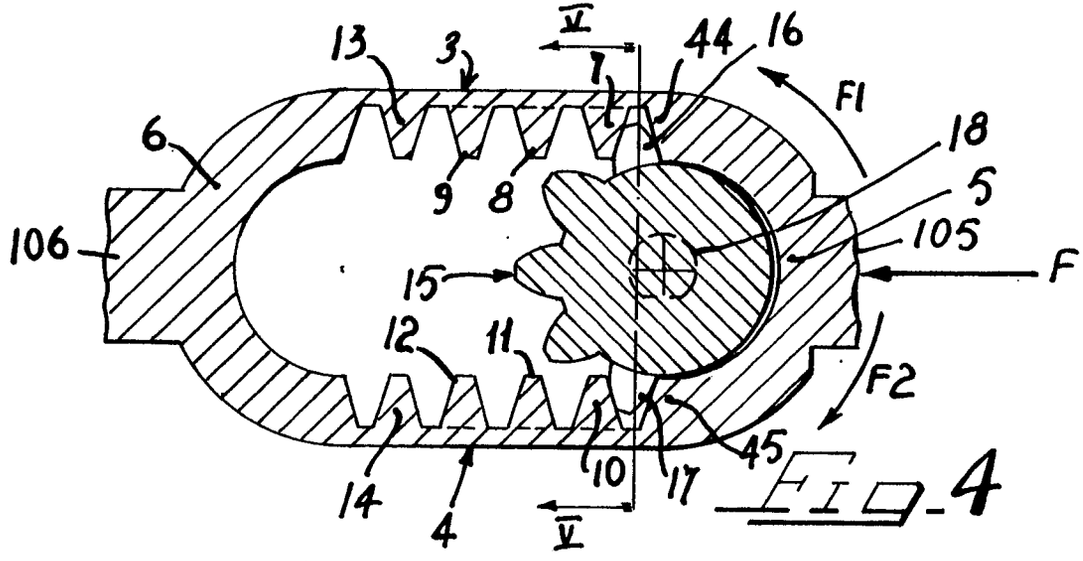

Fig. 4

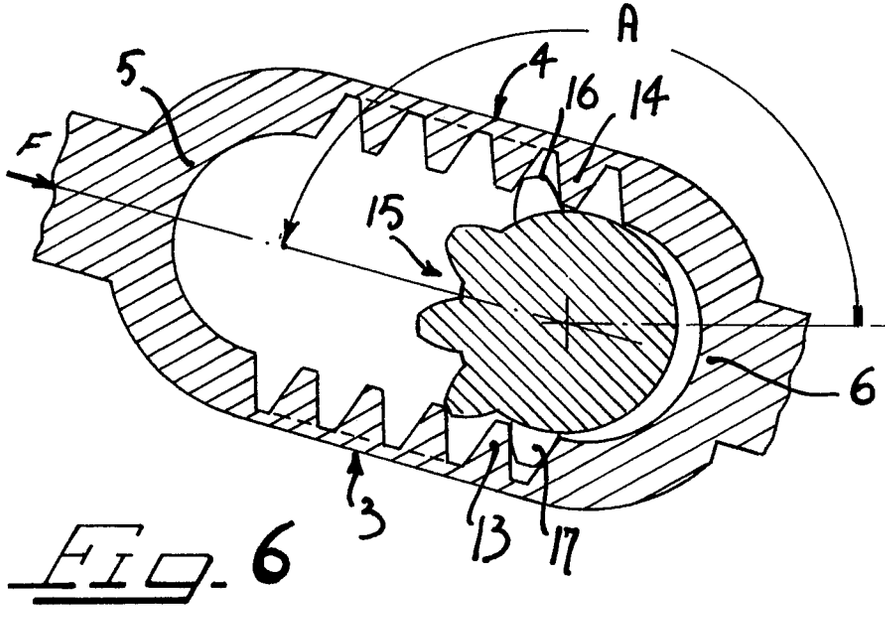

Fig. 6

Fig. 7