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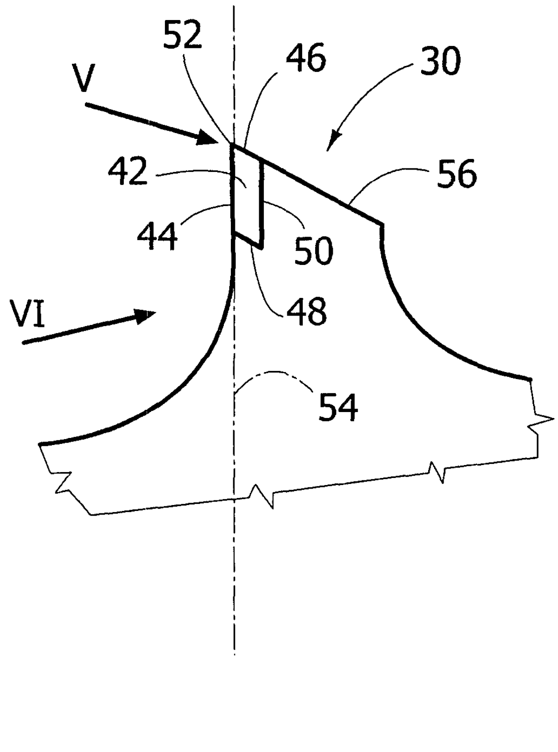
## (54) Apparatus for the defibration of sheets of cellulose

(57) An apparatus for the defibration of sheets of cellulose, comprising:
- a supporting case (12) having a cavity (14) and at least one radial slit (20) for feeding a sheet (S) to be defibrated; and
- a rotor (16) having a longitudinal axis (24), rotatably mounted within said cavity (14) about an axis of rotation coinciding with said longitudinal axis (24) and comprising a plurality of toothed disks (28) fixed to one another so as to form a pack, in which said toothed disks (28) extend in a direction orthogonal to the longitudinal axis (24) of the rotor (16) and each disk is provided with teeth (30) set at a distance from one another in a circumferential direction, and in which the disks (28) are arranged in said pack so that the teeth (30) of the adjacent disks (28) are angularly staggered with respect to one another. Each of said teeth (30) is provided with an insert (42) made of a material with high resistance to wear, having a impact surface (44) inclined by an angle comprised between +1° and -5° with respect to a plane (54) orthogonal to the axis of rotation (24) and passing through a tip (52) located at the end of the impact surface (44). The tip (52) has a surface (58) comprised between an internal arched surface (60) with a radius of 0.1 mm and an external arched surface (62) with a radius of 0.3 mm.

FIG. 4

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## Description

**[0001]** The present invention relates to an apparatus for the defibration of sheets of cellulose. Apparatuses of this type are used in general for converting sheets of fibrous material into a dispersion of fibres used as basic material for the production of absorbent masses, such as, for example, the so-called "fluff" used in disposable absorbent sanitary products.

**[0002]** More precisely, the present invention regards a defibration apparatus or defibrator of the disk type, including a supporting case having a seat, within which there is rotatably mounted a rotor comprising a pack of toothed disks. The cellulose sheets to be defibrated are fed to the defibration apparatus through one or more slits with an axial extension larger than the width of the sheet. The teeth of the rotor impact periodically against the leading edge of the sheet of material to be defibrated and transform the sheet into a dispersed mass of fibres.

**[0003]** The defibration process also produces waste materials, constituted basically by dust and nodules. Normally, a defibration process is considered acceptable if it enables a yield equal to or higher than 70% of fibres, with a production of dust not higher than 22%, and not more than 15% of nodules.

**[0004]** The biggest difficulties that are encountered for obtaining acceptable yields are represented by the diversity of chemico-physical characteristics of the starting material and by the variability of the flowrate of fibres produced. A defibrator should ideally be in a condition to ensure an acceptable yield with any starting material and with flowrates ranging from 150 to 1.600 kg/h of defibrated material.

**[0005]** A first known reference technique is described in the document No. US-A-4673136 filed in the name of the present applicant. In this known solution, the disks are made of hardened steel and are mounted inclined with respect to the axis of rotation of the rotor, in such a way that, during rotation, the periphery of each disk describes a cylindrical surface with a width greater than the width of the disk. The teeth of the disks have a substantially triangular shape with a front face directed radially. The plane of feed of the sheet of material to be defibrated forms an angle comprised between 10° and 60° and preferably in the region of 30° with respect to a radial plane of the rotor passing through the output edge of the slit for feed of the sheet.

**[0006]** A second known reference technique in the sector of defibrators with disks is described in the document No. US-A-3825194 filed in the name of Procter & Gamble Company. In this solution, the rotor is formed by a pack of toothed disks mounted orthogonal with respect to the axis of rotation of the rotor and with the teeth of the adjacent disks angularly staggered with respect to one another. The surface of impact of each tooth forms an angle that ranges from 15° to 40° with respect to a radius of the rotor passing through the tip of the tooth. The surface of impact terminates with a rounded tip with a radius of approximately 0.8 mm.

**[0007]** Practical experience has shown that the first known solution enables a larger number of arrangements with an acceptable yield as the characteristics of the sheet of material to be defibrated and the hourly flowrate of the defibrated material vary.

**[0008]** The second known technique described previously enables arrangements with acceptable yields in a smaller number of cases, but in the favourable cases the yield is better (higher percentage of fibre obtained).

**[0009]** The purpose of the present invention is to provide a defibrator that will enable the advantages of both of the known solutions described previously to be achieved, and that in particular will present a high number of arrangements with acceptable yields according to the type of material to be defibrated and the hourly flowrate of defibrated material, and that will afford a yield higher than the one provided by each of the known solutions discussed previously, in the same operating conditions.

**[0010]** According to the present invention, said purpose is achieved by an apparatus having the characteristics forming the subject of Claim 1.

**[0011]** The characteristics and advantages of the present invention will become clear in the course of the detailed description which follows, provided purely by way of non-limiting example, with reference to the attached plates of drawings, in which:

- Figure 1 is a schematic cross section of an apparatus according to the solution described herein;
- Figure 2 is a longitudinal cross section of the rotor indicated by the arrow II in Figure 1;
- Figure 3 is a front view of one of the disks making up the rotor of Figure 2;
- Figure 4 is a view in greater detail of the part indicated by the arrow IV in Figure 3;
- Figure 5 is a very enlarged detail of the part indicated by the arrow V in Figure 4;
- Figure 6 is a side view according to the arrow VI of Figure 4; and
- Figure 7 is an enlarged detail of the part indicated by the arrow VII in Figure 1.

**[0012]** With reference to Figure 1, the reference number 10 designates an apparatus for defibration of cellulose sheets. The apparatus 10 comprises a stationary supporting case 12 provided with a cavity 14, inside which a rotor with disks 16 is rotatably mounted.

**[0013]** The case 12 comprises a feed section 18 provided with at least one slit 20 for feeding cellulose sheets to be defibrated. In the example illustrated in the figures, the case 12 is provided with two slits 20 associated to respective roller feed assemblies 22 that operate alternately. Each of the two slits 20 is oriented according to a radial plane with respect to the axis of rotation 24 of the rotor 16 and extends in a longitudinal direction throughout the length of the rotor 16. The sheets of material to be defibrated are thus fed towards the inside of the case 12 according to substantially radial directions.

**[0014]** With reference to Figure 2, the rotor with disks 16 of the apparatus 10 comprises a shaft 26 rotatably supported at its ends and the longitudinal axis of which coincides with the axis of rotation 24. A pack of disks 28 is fixed on the shaft 26. The disks 28 extend in a direction orthogonal to the axis of rotation 24 of the rotor 16.

**[0015]** With reference to Figure 3, each disk 28 comprises a plurality of teeth 30 set at a distance from one another in a circumferential direction. Preferably, a resting portion 32 is provided, set between each pair of adjacent teeth 30. Each resting portion 32 has a top surface, which is displaced radially towards the inside with respect to the tips of the teeth 30, which are aligned on a circumference 34 that defines the cutting profile of each disk 28. Each disk 28 is provided with a central hole 36 for mounting on the shaft 26. Preferably, each disk 28 is also provided with a plurality of holes 38 with their centres set on a circumference 40, which are designed to provide mutual fixing of the various disks 28. The angular pitch between the centres of the holes 38 along the circumference 40 is preferably equal to half of the angular pitch between each pair of adjacent teeth 30 and equal to the angular pitch between each tooth 30 and the resting portion 32 adjacent thereto.

**[0016]** With reference to Figures 4 and 6, each tooth 30 is provided with an insert 42, which forms the cutting part of the tooth. Preferably, the disks 28 are made of hardened steel, for example C72, and the inserts 42 are made of material with higher resistance to wear, preferably sintered material, for example, HM K10 sintered tungsten carbide.

**[0017]** With reference to Figure 6, each insert 42 has a width W slightly larger than the width W' of the disk 28. In a preferred embodiment, the width W of the insert 42 is approximately 4 mm, whilst the width W' of the steel disk 28 is preferably in the region of 3.5 mm. The width W' of the insert 42 could range between 3 and 8 mm. Each disk 28 has a uniform width W' slightly smaller than the width of the inserts.

**[0018]** With reference to Figure 4, each insert 42 has a plane impact surface 44, a rake surface 46, an internal surface 48, and a rear surface 50. The internal surface 48 and the rear surface 50 are fixed to corresponding surfaces of the tooth 30 using any technique known in the field of tools with inserts for example, by means of brazing.

**[0019]** Each insert 42 has a tip 52 in the joining area between the impact surface 44 and the rake surface 46. The tip 52 extends throughout the width of the impact surface 44.

**[0020]** With reference to Figure 4, the impact surface 44 is preferably contained in a plane 54 orthogonal to the axis of rotation of the rotor 16 and passing through the tip 52 of the insert 42. The radial arrangement of the impact surface 44 is to be considered preferred, but a variation of a few degrees with respect to the perfectly radial arrangement is also possible. In particular, the angle comprised between the impact surface 44 and the plane 54 may be of +1°, -5°, where the angles measured in a clockwise direction with reference to the plane 54 in the representation of Figure 4 are considered positive and the angles measured in a counterclockwise direction are considered negative. The angle between the impact surface 44 and the rake surface 46 is not critical and can assume any value less than 90°. The rake surface 46 of each insert 42 is preferably aligned to a dorsal surface 56 of the tooth 30.

**[0021]** A critical element of the solution described here is the shape of the tip 52 of each insert 42, defined by a joining surface between the impact surface 44 and the rake surface 46. Experimental tests conducted by the present applicant have shown that the best results in terms of yield and stability of the defibration process are obtained with inserts 42 with a tip 52 that approximates a radius of 0.2 mm. Even though the radius of 0.2 mm represents an optimal reference value, it is possible to maintain excellent results if the surface 58 of the tip 52 (Figure 5) is comprised between an internal cylindrical surface 60 with radius of 0.1 mm and an external cylindrical surface 62 with radius of 0.3 mm. For the purposes of the solution described here, it is not essential for the surface 58 of the tip 52 to be perfectly shaped like the arc of a circle. In the example illustrated in Figure 5, the surface 58 is formed by two plane portions that approximate an arched surface with a radius of 0.2 mm. The two plane portions 64, 66 are joined to one another by a radiusing portion with a radius R = 0.08 mm. Each of the two plane portions 64, 66 has a length comprised between 0.16 and 0.2 mm. The inclinations $\alpha$ any $\beta$ of the two portions 64, 66 can be respectively 45° and 25°.

**[0022]** The disks 28 are fixed to one another to form a pack, with the adjacent disks angularly staggered with respect to one another. The teeth 30 of each disk 28 are staggered with respect to the teeth 30 of each adjacent disk. Each insert 42 is set in a position corresponding to a respective resting portion 32. The inner surfaces 48 of the inserts 42 that project laterally with respect to the disk 28 rest on the top surface of the resting portions 32. The disks 28 are fixed by means of tie rods 68 (Figure 2) inserted in the aligned holes 38 of the pack of disks 28.

**[0023]** Figure 7 is a schematic view showing the operation of the apparatus previously described. A sheet S of cellulose is fed through a slit 20 in a radial direction with respect to the axis of rotation of the rotor. The leading edge of the sheet S is periodically struck by the impact surfaces 44 of the inserts 42 and is transformed into fibres. As is illustrated in Figure 7, applied in a position corresponding to the terminal portion of the slit 20 is an anvil 68, which supports the end stretch of the sheet S. The distance G between the anvil 68 and the circumference 34 defined by the tips 52 of the inserts 42 constitutes the gap of the apparatus. The gap G can be in the region of 0.4-1.2 mm, and is preferably comprised between 0.6 and 1.0 mm. A particularly important characteristic of the present solution is that the yield of the machine is particularly stable as the gap G varies. This characteristic is particularly appreciated because it enables adoption of a very large gap G as compared to the solutions of a known type. A large gap enables a reduction in the energy consumption and a reduction in heating of the fibres. Consequently, it is possible to eliminate or reduce considerably any burning of the fibres and thus reduce the risk of fire. As compared to the solutions according to the known art described in the introductory part of the description, the present solution enables an energy saving in the region of 20-25%.

**[0024]** The feed of the sheets S within the slits 20 is radial with respect to the axis of rotation of the rotor in order not to modify the angle of the sheet with respect to the impact surfaces 44, which represents one of the critical factors of the present solution. Preferably, the height of the slits 20 for feeding the sheet S is less than twice the thickness of the sheets S. Since the thickness of the sheets S is in the region of 1.3-1.5 mm, it is preferable for the height of the slits 20 to be in the region of 2.5 mm. In addition, the thickness T of the anvil 68 should be in the region of 1.5 mm.

**[0025]** Experimental tests conducted by the present applicant have shown that the present solution enables a considerable stability of the yield as a function of the variation of flowrate to be obtained. In particular, the tests conducted by the present applicant have shown that the present solution enables an acceptable yield of the process of defibration to be obtained with a flowrate that varies between 150 and 1.200 kg/h of defibrated material.

**[0026]** The present solution enables moreover a stability of the yield as the impact rate varies. The yield of the defibration process is also particularly stable over time.

## Claims

**1.** An apparatus for the defibration of sheets of cellulose, comprising:

- a supporting case (12) having a cavity (14) and at least one radial slit (20) for feeding a sheet (S) to be defibrated; and
- a rotor (16) having a longitudinal axis (24), rotatably mounted within said cavity (14) about an axis of rotation coinciding with said longitudinal axis (24) and comprising a plurality of toothed disks (28) fixed to one another so as to form a pack, in which said toothed disks (28) extend in a direction orthogonal to said longitudinal axis (24) of the rotor (16) and each disk is provided with teeth (30) set at a distance from one another in a circumferential direction, and in which the disks (28) are arranged in said pack so that the teeth (30) of the adjacent disks (28) are angularly staggered with respect to one another,

said apparatus being **characterized in that** each of said teeth (30) is provided with an insert (42) made of a material with high resistance to wear, having a impact surface (44) inclined by an angle comprised between +1° and -5° with respect to a plane (54) orthogonal to said longitudinal axis (24) and passing through a tip (52) located at the end of the impact surface (44) and **in that** said tip (52) has a surface (58) comprised between an internal arched surface (60) with a radius of 0.1 mm and an external arched surface (62) with a radius of 0.3 mm.

**2.** The apparatus according to Claim 1, **characterized in that** the angle between said impact surface (44) and said plane (54) orthogonal to the axis of rotation (24) and passing through said tip (52) is substantially equal to 0°.

**3.** The apparatus according to Claim 1, **characterized in that** said tip (52) has a surface (58) that approximates a radius of 0.2 mm.

**4.** The apparatus according to Claim 3, **characterized in that** the surface (58) of said tip (52) comprises two rectilinear portions (64, 66) inclined with respect to one another, each with a length comprised between 0.16 and 0.2 mm.

**5.** The apparatus according to Claim 1, **characterized in that** said insert (42) has a width (W) larger than the width (W') of the disk (28).

**6.** The apparatus according to Claim 5, **characterized in that** said insert (42) has a width (W) comprised between 3 and 8 mm.

**7.** The apparatus according to Claim 6, **characterized in that** the width (W) of said insert (42) is substantially equal to 4 mm.

FIG. 1

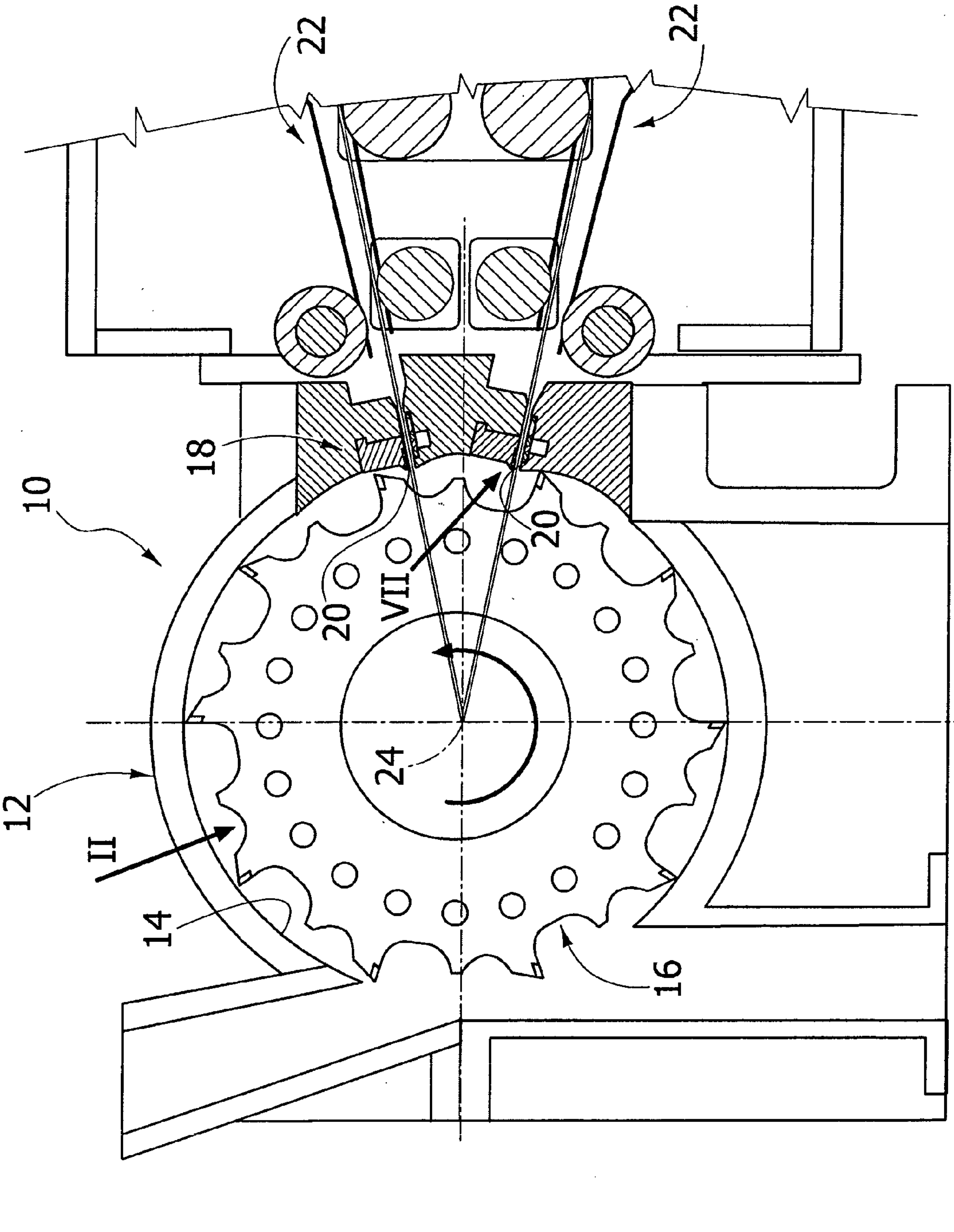


FIG. 2

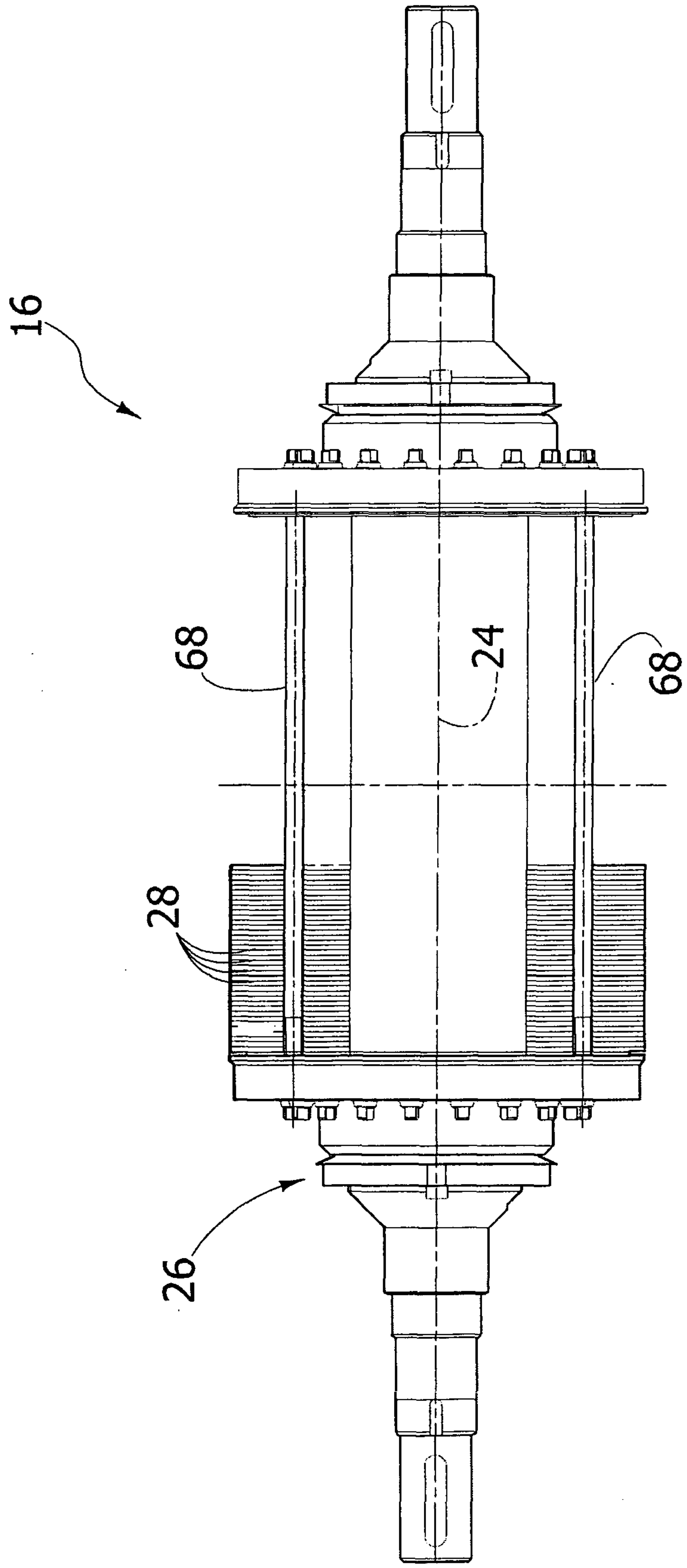


FIG. 3

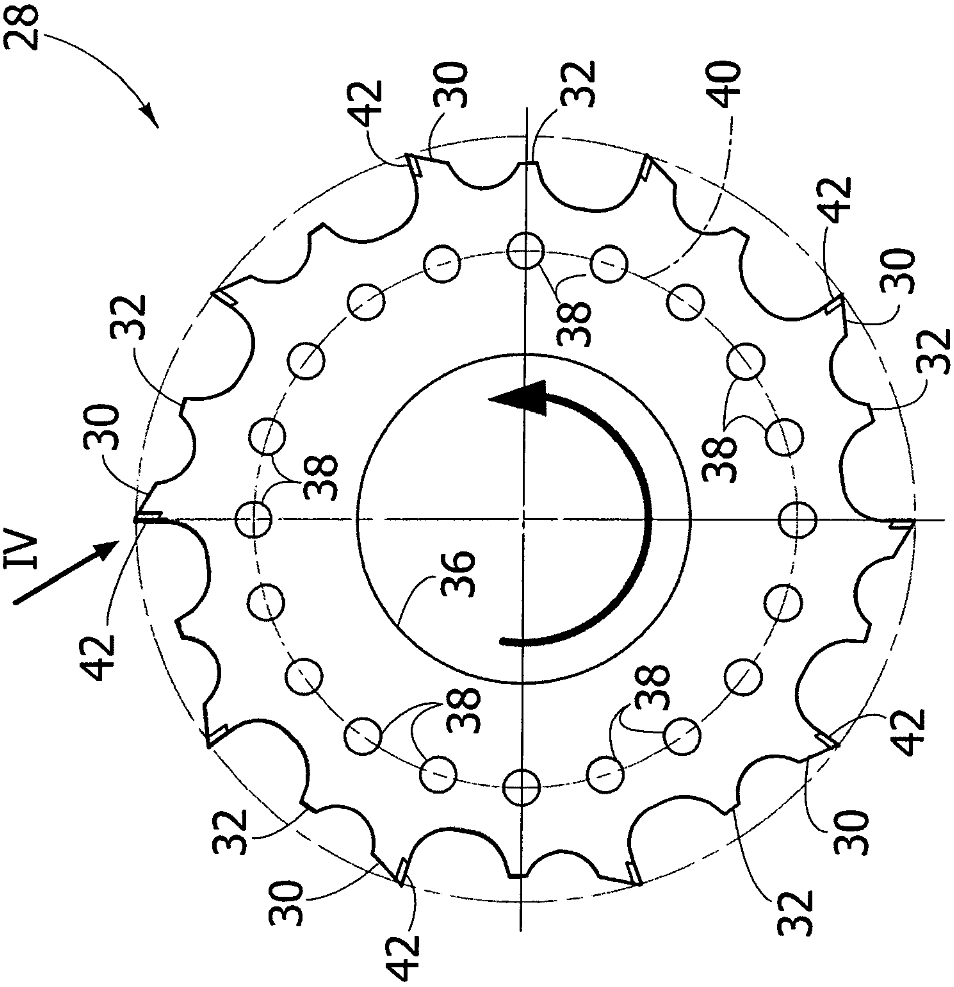


FIG. 4

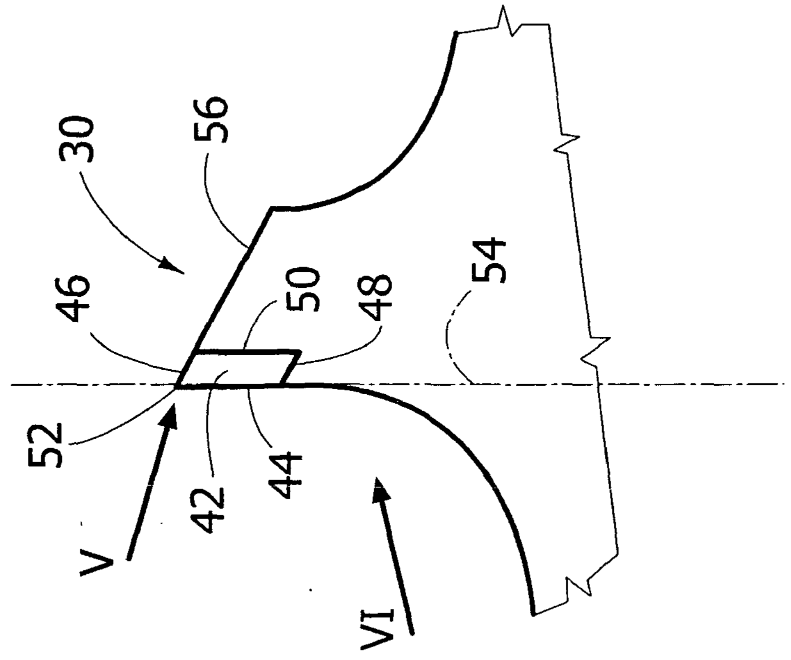



FIG. 5

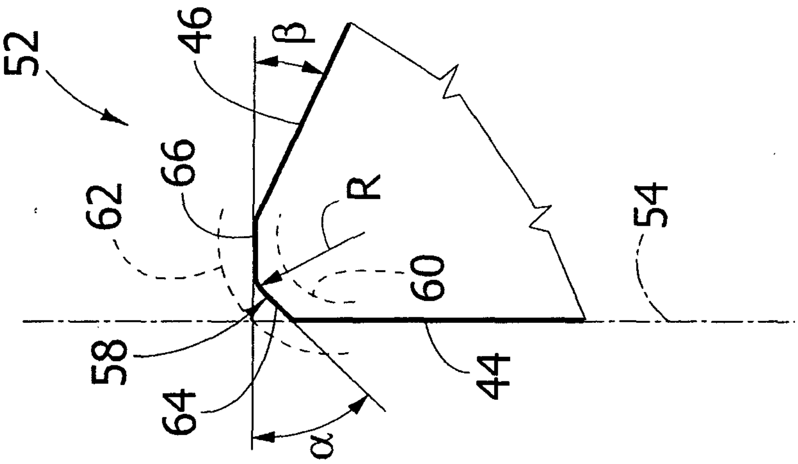



FIG. 6

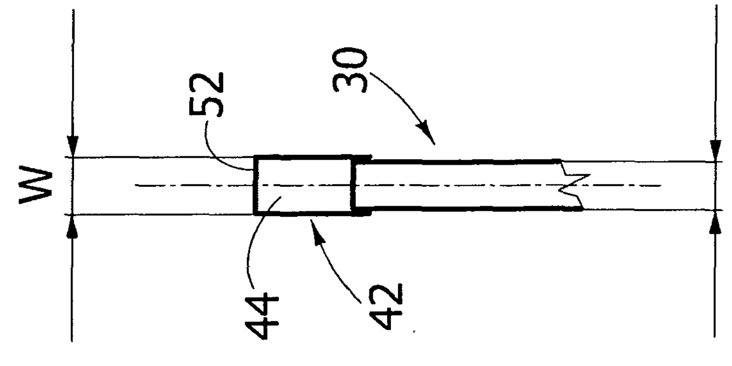
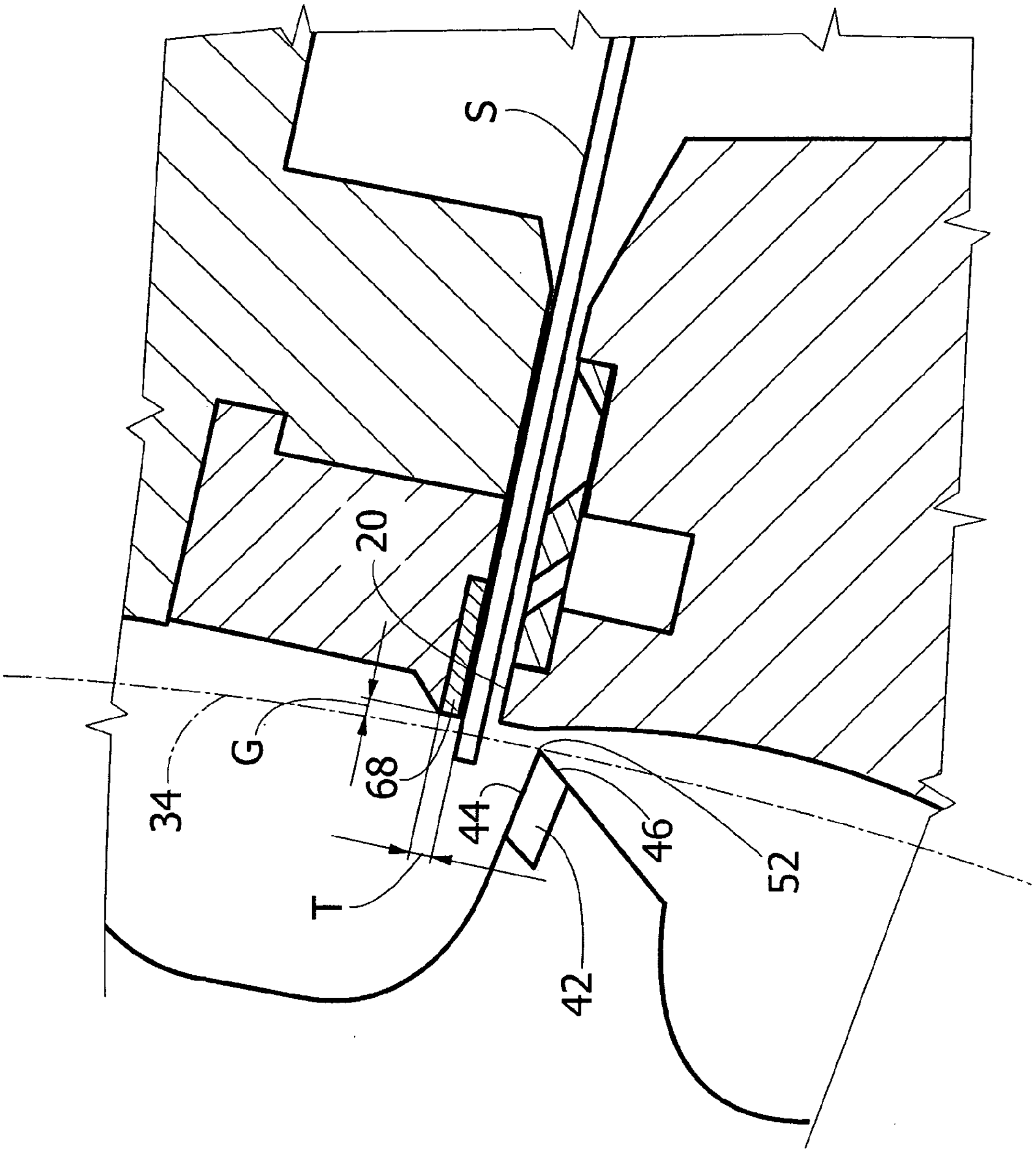


FIG. 7



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Application Number
EP 07 42 5575

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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
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| Munich | 14 January 2008 | Helpiö, Tomi |

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