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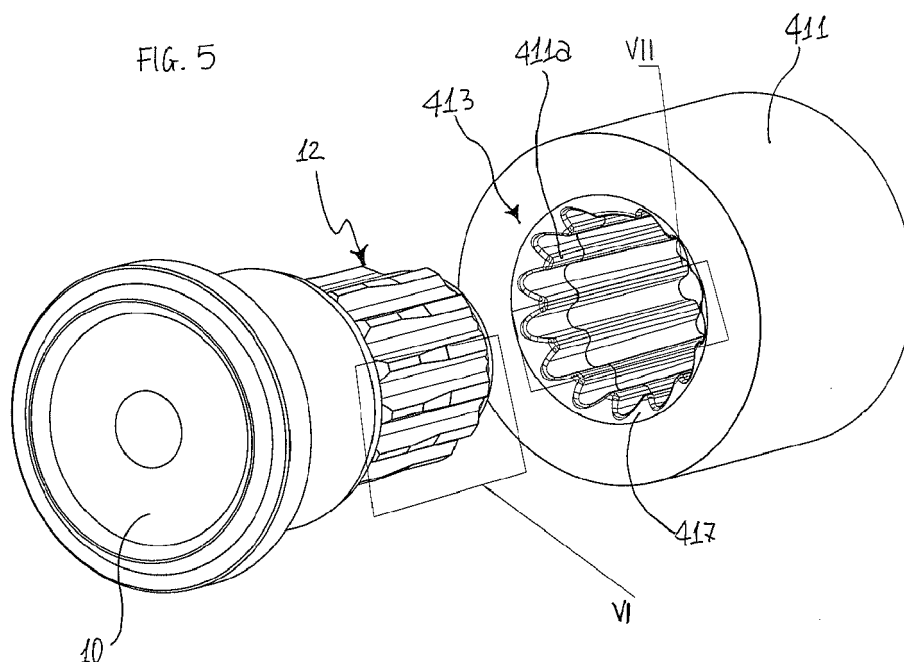
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(54) **Laundry treating machine**

(57) The present invention relates to laundry treating machines with a driving system comprising a shaft and a hub spline coupled to each other. According to the invention, a laundry treating machine (1) with a driving system (5) comprises a shaft (6, 8, 10, 310) and a hub (7, 9, 11, 211, 411) having respective splined coupling portions (12, 312, 13, 213, 413) with alternated teeth (12a, 312a, 13a, 213a, 413a) and grooves (12b, 312b, 13b,

213b, 413b) adapted to mesh with each other, said splined coupling portions (12, 312, 13, 213, 413) comprising respective spline surfaces defined by ridges of the respective teeth (12a, 312a, 13a, 213a, 413a). The laundry treating machine (1) is characterised in that the spline surface on at least one of said shaft (6, 8, 10, 310) and hub (7, 9, 11, 211, 411) comprises a tapered portion (10b, 11b) interposed between adjacent cylindrical portions (10a, 10c, 11a, 11c).



Description

[0001] The present invention relates to laundry treating machines with a driving system comprising a shaft and a hub spline coupled to each other.

[0002] A laundry treating machine of known type generally comprises a drum which is rotated through a driving system comprising a belt wound on a first pulley having a hub mounted on a motor output shaft and on a second pulley whose hub is mounted on a shaft connected to said drum. Generally, at least one of the pulley hubs is spline coupled to the respective shaft.

[0003] This coupling typically includes respective spline coupling portions on the hub and shaft with respective alternated teeth and grooves adapted to mesh with each other.

[0004] In a laundry treating machine of known type the drive pulley for rotating the drum is preferably obtained by injection moulding of a plastic, i.e. polymeric, material while the shaft, that is generally made of metal may be formed by turning or by die-casting. The spline coupling may be obtained, respectively, from the shape of the mold in a plastic pulley and in a die-casted shaft and by broaching or by milling in a turned shaft. In any case such known spline couplings are generally of cylindrical type, i.e. teeth formed respectively on the hub and the shaft project radially and the radially outer edge of each tooth is straight and aligned parallel to the longitudinal axis of the hub and the shaft. Grooves between two adjacent teeth formed in the shaft and in the hub have radially inner surfaces, i.e. roots, that extend along a direction parallel to the longitudinal axis of the hub and the shaft respectively.

[0005] Such known cylindrical spline coupling has some drawbacks. One of those consists in that fitting teeth formed on the hub coupling surface into grooves formed on the shaft outer surface may require an intense pressing force along the longitudinal axis of the shaft and the hub. This is due to the frictional forces that act as soon as the first portion of the shaft is inserted into the hub.

[0006] A further drawback consists in that relatively wide tolerances normally provided by the molding process of a plastic, i.e. polymeric, hub cause a rather slack backlash between coupled parts. In particular this may lead to a backlash of the pulley relatively to the longitudinal axis of the shaft (tilting) and a rotational slack relative to the shaft. Both movements bring about not only noise and wear of the components but also a wrong driving of the rotating drum. The pulley, after a relatively short use becomes visibly movable relative to the shaft.

[0007] The aim of the present invention is to provide a laundry treating machine having a driving system comprising a spline coupling between a shaft and a hub in which the following advantages are jointly matched:

- improving and simplifying the laundry treating machine assembling procedure, and, in particular, sim-

plifying the assembling phase of the spline coupling between a shaft and a hub;

- improving power transmission of a laundry treating machine driving system thereby reducing the overall power consumption of said laundry treating machine.
- reducing force needed for coaxially sliding mesh the spline coupling at least in a first phase of shaft/hub assembling procedure.
- improving the torque transfer ability of the spline coupling;
- reducing undesired backlash between the spline coupling components, in particular tilting and rotating slacks; and
- reducing discarded components in the assembly phase of the machine due to wrong assembly of a hub on a shaft of a driving system.

[0008] This aim is achieved with the present invention by a laundry treating machine including the features claimed in the appended claims.

[0009] The features and advantages of the invention will better appear from the following detailed description of four embodiments thereof given by way of a non limitative example with reference to the attached drawings in which:

- Figure 1 is schematic view of a laundry machine incorporating this invention;
- Figures 2, 3 and 4 are partial longitudinal section exploded schematic views of a shaft to hub splined coupling according to three respective embodiments of the present invention;
- Figure 5 is an isometric exploded view of a shaft and a hub according to a fourth embodiment of the present invention;
- Figures 6 and 7 are enlarged views of the details indicated by arrow VI and VII respectively in fig. 5;
- Figure 8 is a front view of the shaft and hub of fig. 5 in an engaged position;
- Figure 9 is longitudinal section taken along line IX-IX in fig 8;
- Figures 10 and 11 are longitudinal section views respectively taken along lines X and XI of Figure 8; and
- Figures 12 and 13 are partial cross sectional views respectively taken along lines XII and XIII of Figure 9.

[0010] In the attached drawings identical reference numerals are used to indicate identical parts.

[0011] Referring now to fig. 1 a laundry treating machine 1, which in the example is embodied by a top-loading washing machine but might also be a front-loading washing and/or drying machine, includes a frame 2 supporting in a known way a tub 3 within which a rotatable drum is mounted. The drum is driven by a motor 4 through a pulley and belt driving system 5. The driving system 5 includes a motor shaft 6, a first pulley 7 coupled by means of a splined connection to the motor shaft 6 and a second pulley 8 coupled by means of a splined connection to a drum shaft 9, the pulleys 7, 8 being coupled to each other by means of a belt 5a.

[0012] The teaching of the present invention may be applied to the splined coupling between either the motor shaft and the first pulley 6, 7, or the drum shaft and the second pulley 9, 8. For this reason reference is made in the following description and claims to a generic shaft 10, which might be either of the shafts 6 and 9, and to a corresponding hub 11, which may belong to either pulleys 7 and 8.

[0013] In a first embodiment of the present invention shown in Figure 2, shaft 10 and hub 11 have respective spline coupling portions 12, 13 each comprising a plurality of circumferentially arranged teeth 12a, 13a respectively separated by grooves 12b, 13b. Teeth 12a, 13a of the shaft 10 and hub 11 are adapted to mesh with grooves 13b and 12b of the hub 11 and shaft 10 respectively. Teeth 12a, 13a comprise spline surfaces defined by top ridges, or outer faces, 14, 15.

[0014] According to the present invention the spline surfaces of teeth 13a, 12a on at least one of hub and shaft 11, 10 include a tapered portion interposed between adjacent cylindrical portions. In the first embodiment of the present invention both shaft 10 and hub 11 have this feature. In the shaft 10, top ridges 14 of teeth 12a comprise two right-circular-cylindrical portions 10a, 10c that are coaxial and spaced apart from each other along a direction parallel to the shaft longitudinal axis. Cylindrical portion 10c of each top ridge 14 of teeth 12a is arranged in close proximity of the shaft insertion end 16 entering the hub 11 through a hub hole end 17, while the cylindrical portion 10a is arranged in a position longitudinally spaced apart from end 16, so as to remain in a position close to the hub hole end 17 when the shaft 10 is coupled to hub 11. The cylindrical portions 10a and 10c have different diameters with a larger diameter for portion 10a and a smaller diameter for portion 10c. The two cylindrical portions 10a, 10c are interconnected by a tapered portion 10b conical and coaxial to the cylindrical portions, the diameter of the cylindrical portions 10a, 10c corresponding to the diameter of the end sections of the adjacent tapered portion 10b. The tapered portion 10b diverges outwardly from the longitudinal axis of the shaft 10 while moving away from the shaft insertion end 16 entering the hub 11.

[0015] Grooves 12b, separating two adjacent teeth

12a of the shaft 10, comprise right-circular cylindrical roots 18 of uniform radius and coaxial with the shaft longitudinal axis. Grooves 12b receive hub teeth 13a therein.

[0016] Similarly to the shaft 10, in the hub 11, spline surfaces defined by top ridges, or outer faces, 15 of teeth 13a comprise two right-circular-cylindrical portions 11a, 11c that are coaxial and spaced apart from each other along a direction parallel to the shaft longitudinal axis. Cylindrical portion 11a of each top ridge 15 of teeth 13a is arranged in close proximity of the hub hole end 17 receiving the shaft 10 therein, while the cylindrical portion 11c is arranged in a position longitudinally spaced apart from hub hole end 17, i.e. deeper in the hub hole from the hole end 17. The cylindrical portions 11a and 11c have different diameters with a larger diameter for portion 11a and a smaller diameter for portion 11c. The two cylindrical portions 11a, 11c are interconnected by a tapered portion 11b conical and coaxial to the cylindrical portions, the diameter of the cylindrical portions 11a, 11c corresponding to the diameter of the end sections of the adjacent tapered portion 11c. The tapered portion 11b converges towards the longitudinal axis of the hub 11 while moving away from the hole end 17 along the insertion direction of the shaft into said hole end 17.

[0017] Grooves 13b, separating two adjacent teeth 13a of the hub 11, comprise right-circular cylindrical roots 19 coaxial with the shaft longitudinal axis. Grooves 13b receive shaft teeth 12a therein.

[0018] Shaft 10 and hub 11 have initial coupling ends 16, 17 facing to each other when the hub 11 is presented for coupling to the shaft 10, the tapered portion 10b in the shaft 10 converging toward the shaft longitudinal axis in the direction of the respective shaft insertion end 16. A chamfered surface 11d is provided at the initial coupling end 17 of the hub 11 for facilitating introduction of the shaft 10 into the hub 11.

[0019] Once the shaft 10 is spline coupled to hub 11, cylindrical portions 10a of the shaft teeth 12a and cylindrical portions 11c of the hub teeth 13a are press fitted into a region of the hub grooves 13b adjacent to the hub hole end 17 and into a region of the shaft grooves 12b adjacent to the shaft insertion end 16, respectively. In this way, passing circumferentially from one tooth 12a of the shaft 10 to one tooth 13a of the hub 11, the press fit coupling between the shaft 10 and the hub 11 is alternately located on the region close to the hub end 17 and on the region longitudinally spaced apart from hub hole end 17, i.e. deeper in the hub hole from the hole end 17. Therefore a uniform fit is obtained along the whole shaft coupling portion 12 received in the hub hole.

[0020] In a second embodiment of the present invention, shown in figure 3, the shaft 10 has the exact configuration of the first embodiment shown in figure 2 and therefore it will not be described again but reference is made to the description given for such figure. In this second embodiment the hub 211 has a coupling portion 213 having a chamfered surface 211d formed on the hub hole

end 217 for facilitating the introduction of the shaft 10 therein. A plurality of circumferentially arranged teeth 213a separated by grooves 213b are formed in the hub hole. Teeth 213a comprise spline surfaces defined by right-circular-cylindrical top ridges, or outer faces, 215. Grooves 213b comprise right-circular cylindrical roots 219 coaxial with the shaft longitudinal axis and receive shaft teeth 12a therein.

[0021] Once the shaft 10 is spline coupled to hub 211, cylindrical portions 10a of the shaft teeth 12a are press fitted into a region of the hub grooves 213b adjacent to the hub hole end 217, while hub teeth 213a are received in the shaft grooves 12b with a gap therebetween.

[0022] In a third embodiment of the invention, shown in figure 4, the hub 11 has the exact configuration of the first embodiment shown in figure 2 and therefore it will not be described again but reference is made to the description given for such figure. In this third embodiment the shaft 310 comprises a coupling portion 312 having a plurality of circumferentially arranged teeth 312a separated by grooves 312b. Teeth 312a comprise spline surfaces defined by right-circular-cylindrical top ridges, or outer faces, 314. Grooves 312b comprise right-circular cylindrical roots 319 coaxial with the shaft longitudinal axis and receive hub teeth 13a therein.

[0023] Once the shaft 310 is spline coupled to hub 11, cylindrical portions 11c of the hub teeth 13a are press fitted into a region of the shaft grooves 312b spaced apart from hub hole end 17, i.e. deeper in the hub hole from the hole end 17. Shaft teeth 312a are received in the hub grooves 13b with a gap therebetween.

[0024] The second and the third embodiment of the invention provide a press fit connection between the shaft 10, 310 and the hub 211, 11, respectively, only on part of the longitudinal extension of teeth 12a, 13a. This arrangement allows the shaft 10, 310 to be easily inserted into the hub 211, 11 through the hub opening 217, 17. In this way assembling operations are simplified.

[0025] Referring now to a fourth embodiment of the invention shown in figures 5 to 13 the shaft 10 has the same configuration of the first and the second embodiments shown in figures 2 and 3 respectively. Therefore the shaft 10 will not be described again but reference is made to the description given with reference to figure 2. In this fourth embodiment, the hub 411 comprises a coupling portion 413 having a plurality of circumferentially arranged teeth 413a separated one another by grooves 413b. Similarly to the previously described hub embodiments, a chamfered surface 411d is provided at the initial coupling end 417 of the hub 411 for facilitating introduction of the shaft 10 into the hub 411. Teeth 413a comprise top ridges, or outer faces, 415 having a right-circular-cylindrical portions 411a that are coaxial and extend along a direction parallel to the shaft longitudinal hub. Each right-circular-cylindrical portion 411a is arranged in close proximity of the hub hole end 417 receiving the shaft 10 therein. Preferably, such portion 411a extends from the chamfered surface 411d to the inner region of

the hub hole for a length or 1 to 10 millimetres, and more preferably 6 millimetres. Said top ridges 415 further comprise tapered portions 411e each extending from the right-circular-cylindrical portions 411a more deeply into the hub hole. The tapered portions 411e converge towards the longitudinal axis of the hub 411 moving away from portion 411a.

[0026] Grooves 413b comprise right-circular cylindrical roots 419 coaxial with the hub longitudinal axis and receive shaft teeth 12a therein.

[0027] Once the shaft 10 is spline coupled to hub 411 as shown in figures 8 to 13, cylindrical portions 10a of the shaft teeth 12a are press fitted into the portions closer to the hub end 417 of the right-circular-cylindrical roots 419 as shown in figures 10 and 13. Tapered portions 10b and right-circular-cylindrical portions 10c of shaft teeth 12a are spaced apart from roots 419 of grooves 413b, i.e. a clearance 420 exists therebetween as shown in figures 10 and 12.

[0028] In figure 11 it is shown an enlarged view of the spline coupling between hub teeth 413a and shaft grooves 12b. Tapered portions 411e of hub teeth 413a are, at least in part, press fitted into a part of the shaft groove right-circular cylindrical roots 18 closer to the shaft insertion end 16. The right-circular-cylindrical portions 411a of hub teeth 413a and a part of the tapered portions 411e departing from said right-circular-cylindrical portions 411a are spaced apart from shaft groove right-circular cylindrical roots 18, i.e. a clearance 421 exists therebetween as shown in figures 11 and 13.

[0029] For further improving the spline coupling, in the fourth embodiment of the invention, the hub groove width gets more and more narrow while moving away from the hub end 417 towards the inner region of the hub hole, i.e. along the shaft insertion direction within the hub hole. In other words, hub teeth 413a are uniformly tapered in width along their longitudinal length so that sides 423, 424 of each hub tooth 413a (see figures 7, 12 and 13) diverges thereby making the hub grooves 413b converging inwardly from the hub end 417. With such arrangement, it is possible to have a longitudinally increasing interference between hub teeth sides 423, 424, engaging shaft teeth sides 23, 24, respectively (see figure 7), i.e. an interference that increases in a longitudinal direction from the hub end 417 to the shaft insertion end 16 when they are spline coupled. Such interference may be appreciated by comparing figures 12 and 13.

[0030] In this way, passing circumferentially from one tooth 12a of the shaft 10 to one tooth 413a of the hub 411, the press fit coupling between the shaft 10 and the hub 411 is alternately located on the region close to the hub end 417 and on the region longitudinally spaced apart from hub hole end 417, i.e. deeper in the hub hole from the hole end 417. Therefore a uniform fit is obtained along the whole shaft part received in the hub hole.

[0031] According to all the embodiments of the invention described herein, the shaft coupling portion 12 is advantageously provided with a blind threaded hole 25

wherein a screw (not shown in the drawings) is threadly received and the hub coupling portion 13, 213, 413 is provided with a seat 26 where the head of said screw abuts so as to pull the hub 11, 211, 411 towards the shaft 10, 310 when the screw is screwed into the threaded hole 25.

[0032] Preferably, the hub is made of a polymeric material by injection moulding or by die-casting an aluminium alloy material, while the shaft is made of steel by turning. Alternatively, the shaft may be made of an aluminium alloy by die-casting.

[0033] The spline coupling may be obtained, respectively, from the shape of the mold in a polymeric hub and in a die-casted shaft and by broaching or by milling in a turned shaft.

[0034] The coupling thereby obtained through the present invention is stable with regard both to tilting and rotating slacks. Wear over time is remarkably reduced as well as noise of the transmission during operation. Insertion of the shaft into the hub is thereby eased because frictional forces acting when the shaft begins entering the hub hole are reduced compared to spline coupling known in the art.

Claims

1. A laundry treating machine (1) with a driving system (5) comprising a shaft (6, 8, 10, 310) and a hub (7, 9, 11, 211, 411) having respective splined coupling portions (12, 312, 13, 213, 413) with alternated teeth (12a, 312a, 13a, 213a, 413a) and grooves (12b, 312b, 13b, 213b, 413b) adapted to mesh with each other, said splined coupling portions (12, 312, 13, 213, 413) comprising respective spline surfaces defined by ridges of the respective teeth (12a, 312a, 13a, 213a, 413a), **characterised in that** the spline surface on at least one of said shaft (6, 8, 10, 310) and hub (7, 9, 11, 211, 411) comprises a tapered portion (10b, 11b) interposed between adjacent cylindrical portions (10a, 10c, 11a, 11c).
2. The laundry treating machine (1) according to claim 1 wherein said cylindrical portions (10a, 10c, 11a, 11c) have diameters corresponding to the diameters of the end sections of the adjacent tapered portion (10b, 11b).
3. The laundry treating machine (1) according to claim 1 or 2 wherein the tapered portion (10b) is formed on said shaft (6, 8, 10).
4. The laundry treating machine (1) according to claim 3 wherein the tapered portion (10b) diverges outwardly from the longitudinal axis of the shaft (6, 8, 10) while moving away from a shaft insertion end (16) entering the hub (7, 9, 11, 211, 411).
5. The laundry treating machine (1) according to any of claims 1 to 4 wherein the other of said hub (211) and shaft (310) have respective spline surfaces substantially cylindrical throughout their longitudinal length.
6. The laundry treating machine (1) according to any of claims 1 to 4 wherein said tapered portion (10b, 11b) interposed between adjacent cylindrical portions (10a, 10c, 11a, 11c) is formed on both the shaft (6, 8, 10) and the hub (7, 9, 11) spline surfaces.
7. The laundry treating machine (1) according to claim 6 wherein the tapered portion (11b) formed in the hub (7, 9, 11) converges towards the longitudinal axis of the hub while moving away from a hole end (17) receiving the shaft (6, 8, 10, 310) therein along the insertion direction of the shaft into said hole end (17).
8. The laundry treating machine (1) according to any preceding claim wherein the shaft (6, 8, 10) and/or the hub (7, 9, 11) having a spline surface comprising a tapered portion (10b, 11b) interposed between adjacent cylindrical portions (10a, 10c, 11a, 11c) further comprise grooves (12b, 13b) having roots (18, 19) which are substantially cylindrical throughout their longitudinal length.
9. The laundry treating machine (1) according to any of claims 1 to 4 wherein the spline surface of the hub (411) comprises teeth (413a) having ridges (415) including cylindrical portions (411a) arranged in close proximity of a hub hole end (417) receiving the shaft (10) and tapered portions (411e) converging towards the hub longitudinal axis following said cylindrical portions (411a).
10. The laundry treating machine (1) according to claim 9 wherein teeth (413a) are uniformly tapered in width along their longitudinal length so that sides (423, 424) of each tooth (413a) diverges along the shaft insertion direction within the hub.
11. The laundry treating machine (1) according to any claim 1 to 4 or according to claim 9 wherein, passing circumferentially from one tooth (12a) of the shaft (10) to one tooth (13a, 413a) of the hub (11, 411), a press fit coupling between the shaft (10) and the hub (11, 411) is alternately located on a region close to the hub end (17, 417) and on a region longitudinally spaced apart from hub hole end (17, 417).
12. The laundry treating machine (1) according to any of the preceding claims, wherein said hub (7, 9, 11, 211, 411) is formed by injection moulding of a polymeric material or by die-casting an aluminum-alloy material.

13. The laundry treating machine (1) according to any of the preceding claims wherein said shaft (6, 8, 10) is made of steel or aluminum-alloy material.

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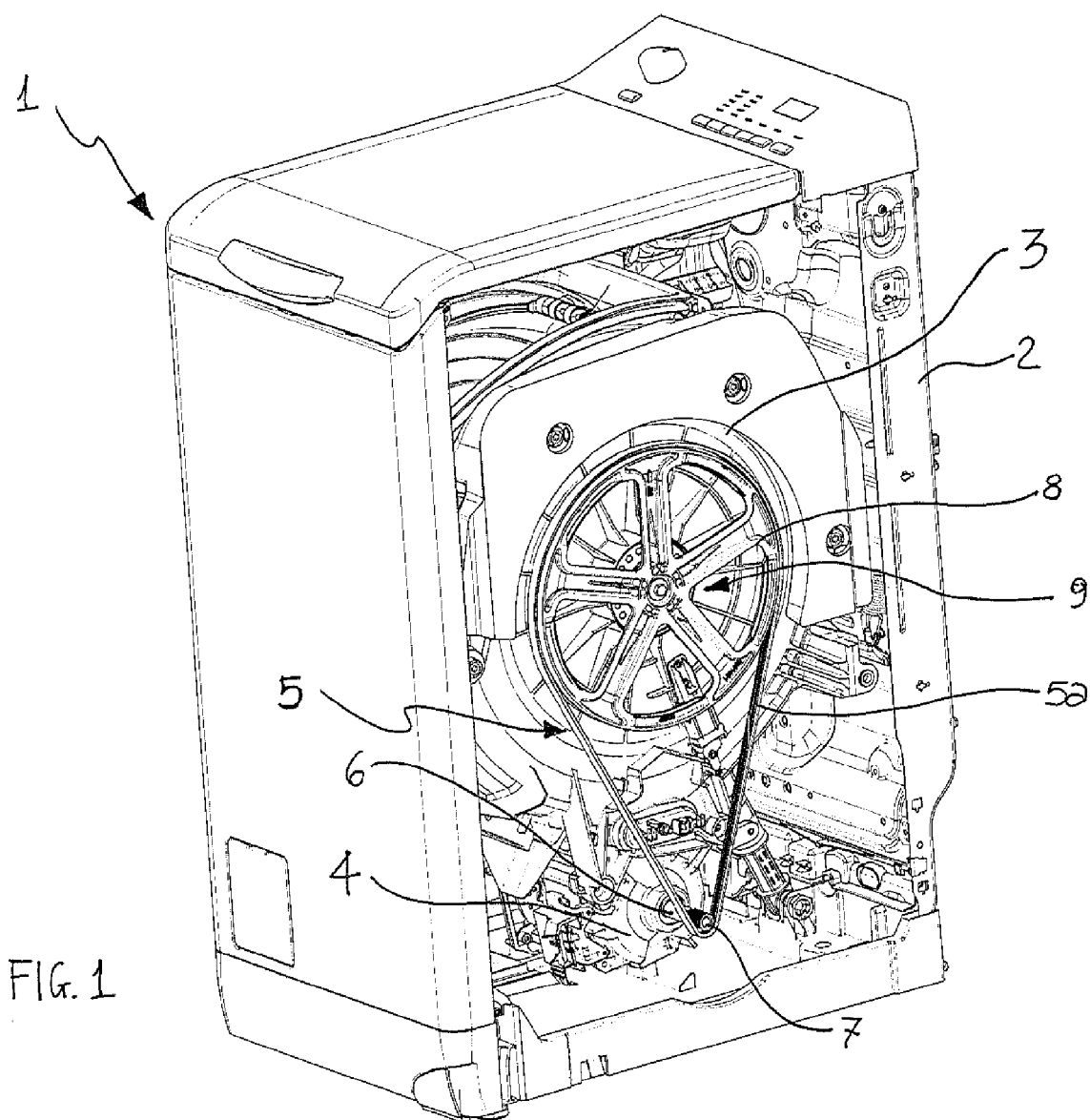
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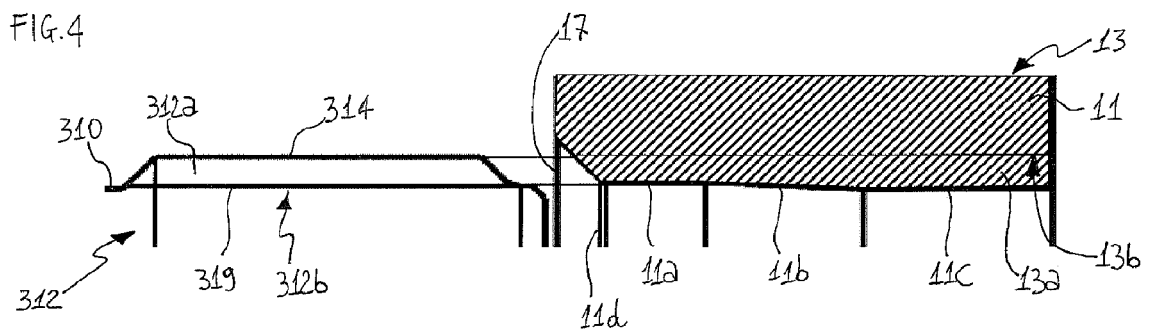
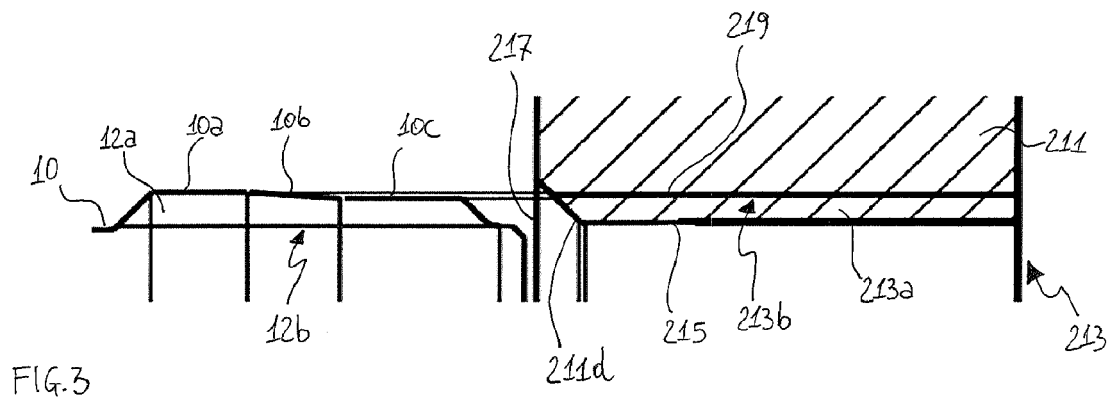
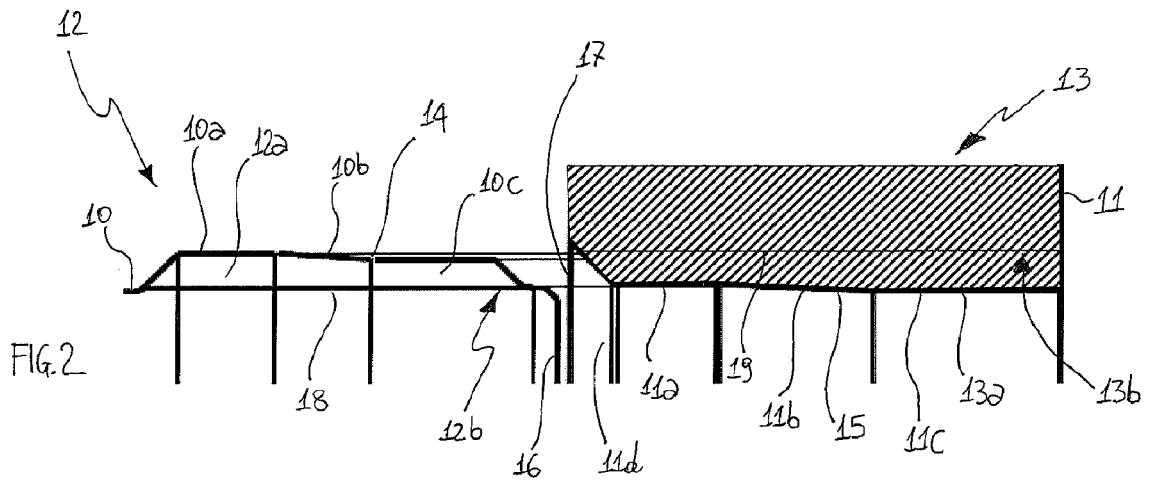
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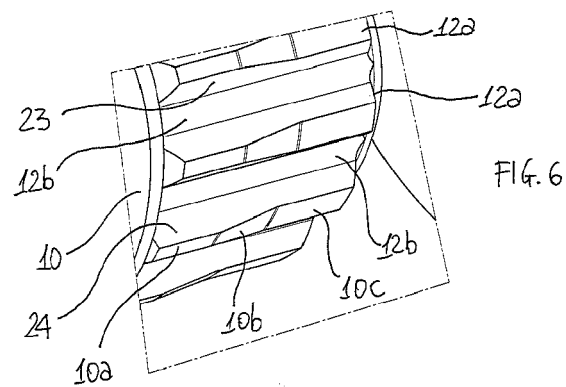
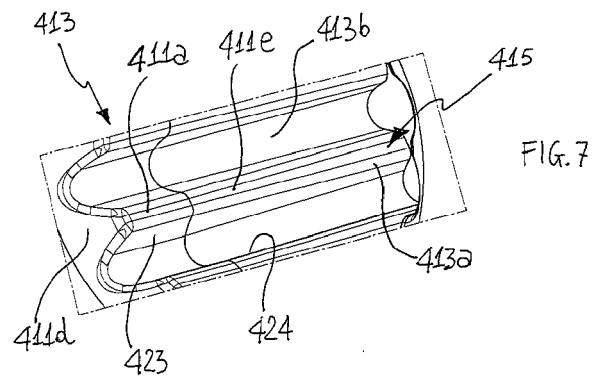
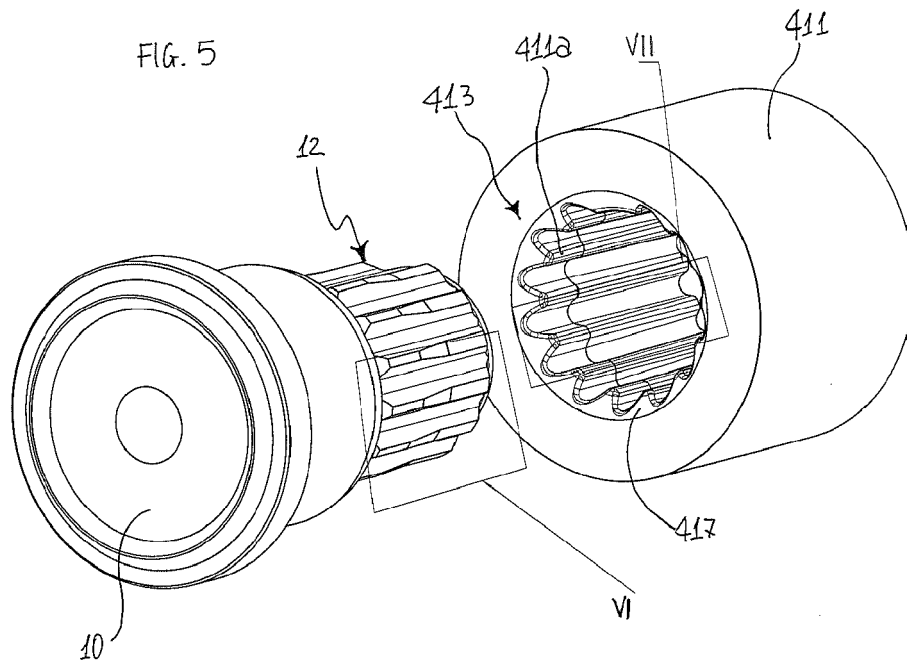
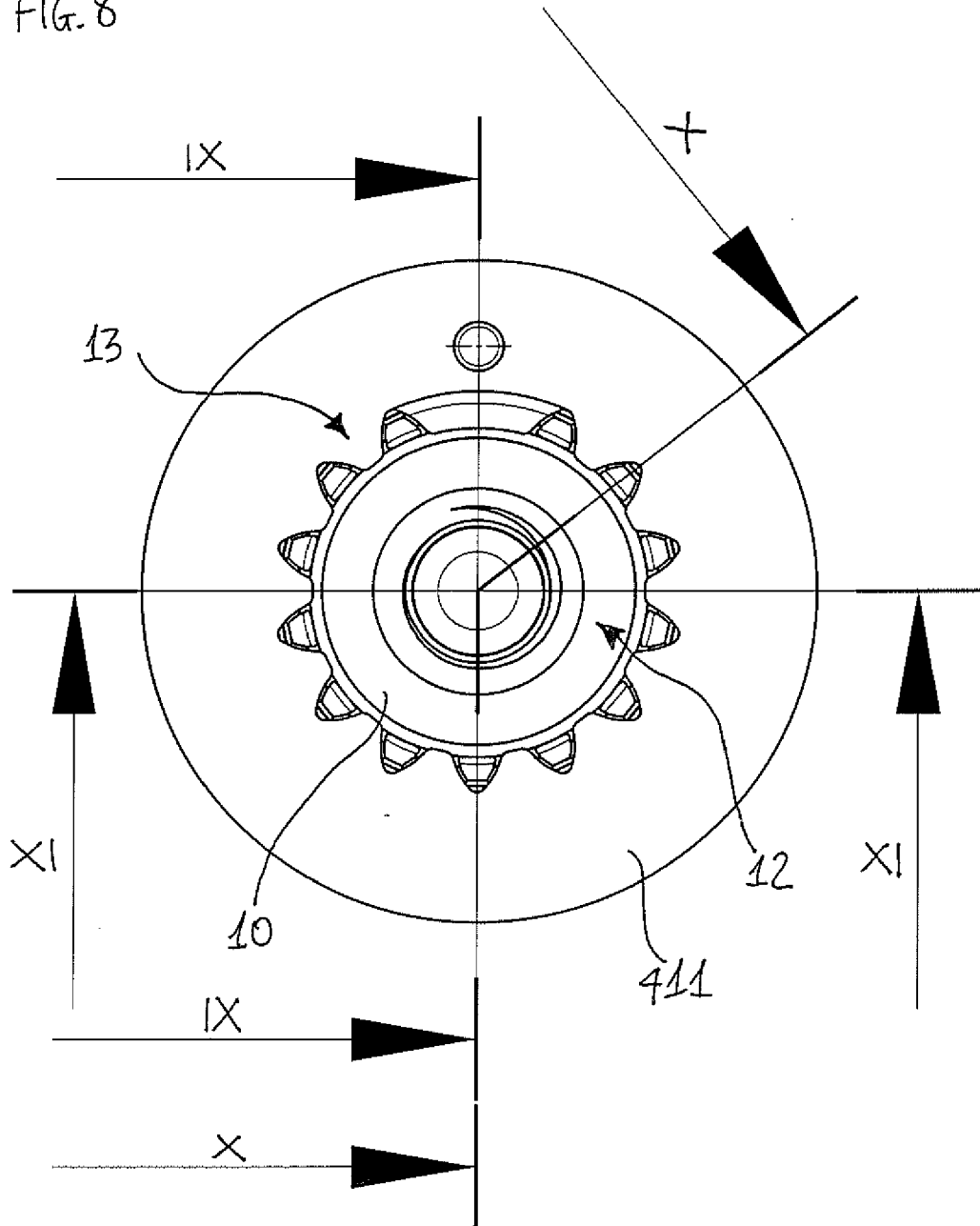
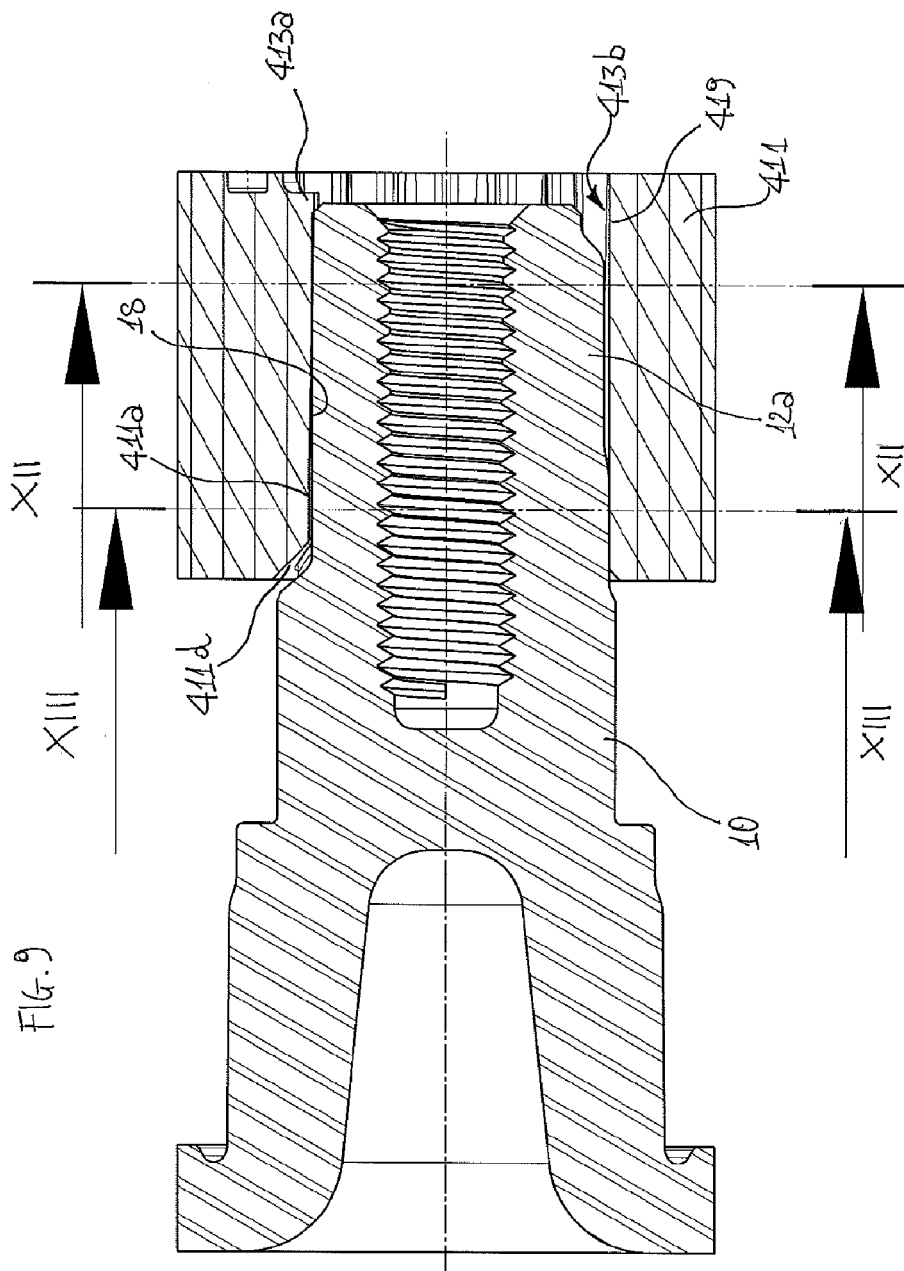


FIG. 8





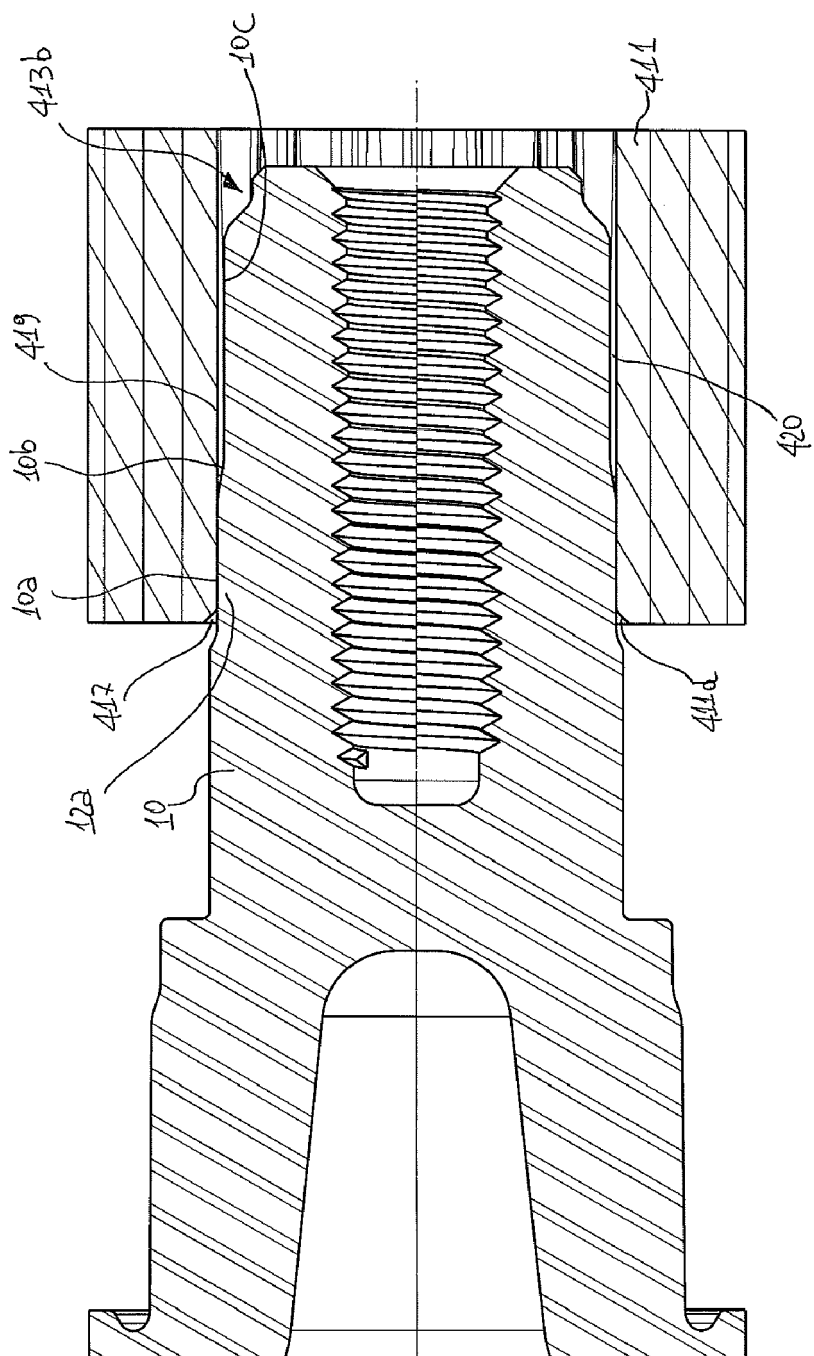
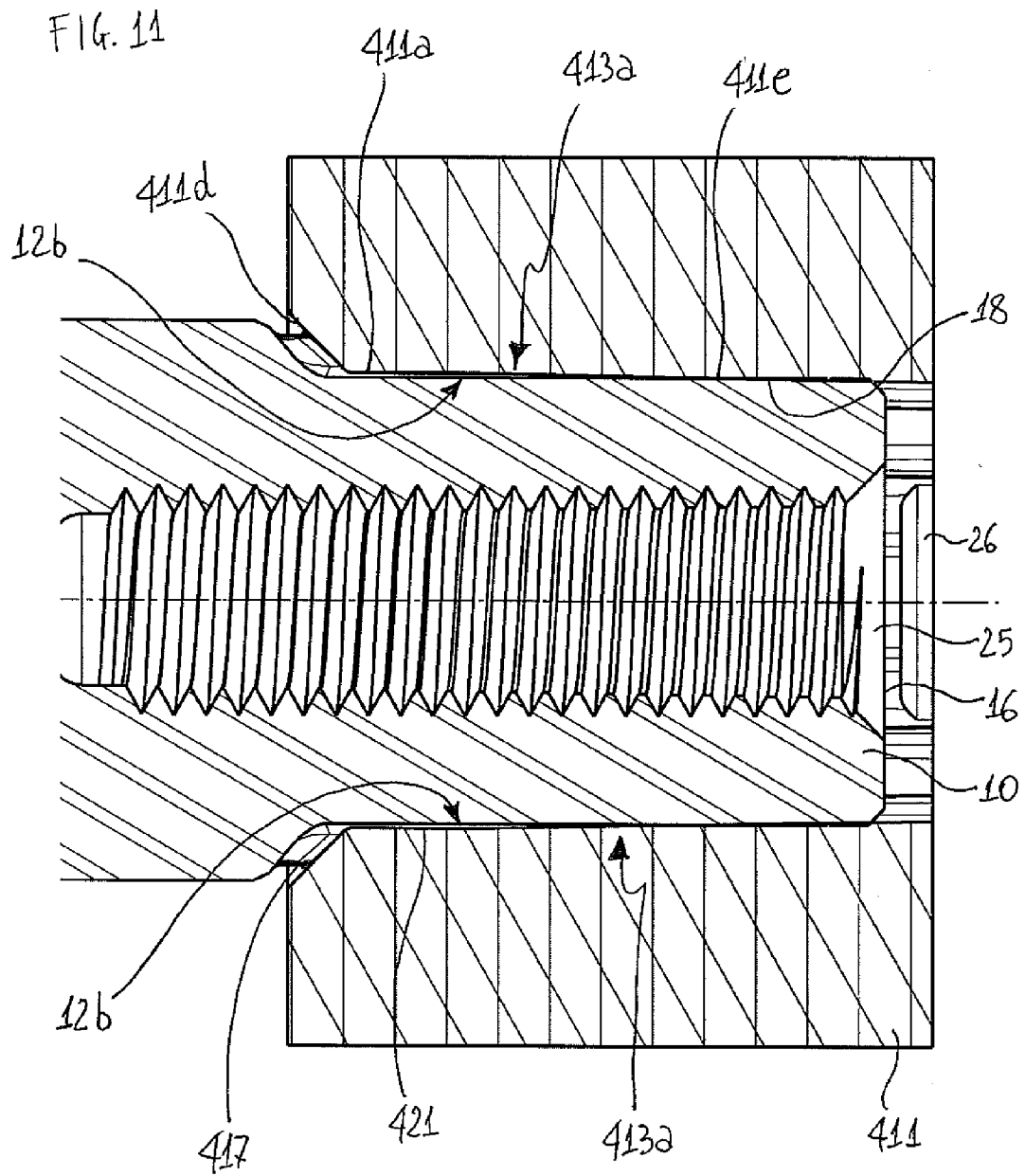
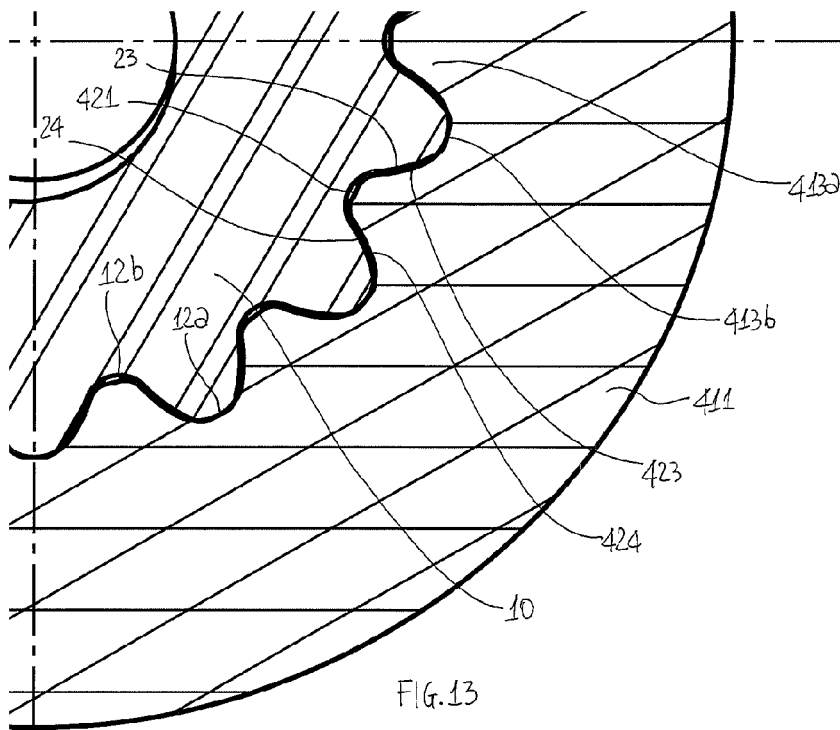
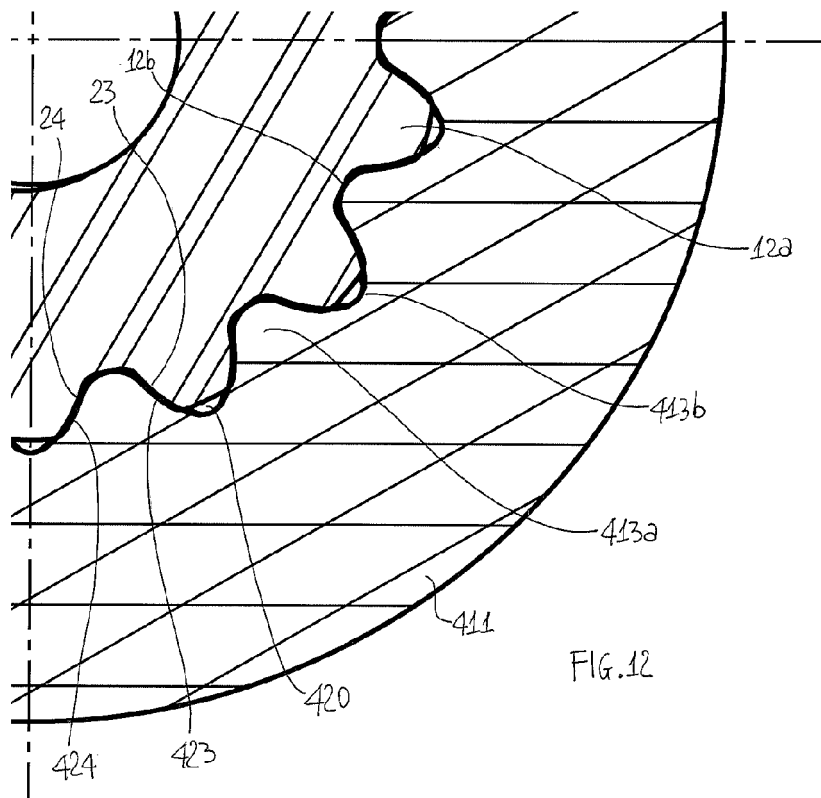


FIG. 10







EUROPEAN SEARCH REPORT

Application Number
EP 11 17 6916

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Place of search Munich		Date of completion of the search 20 February 2012	Examiner Hannam, Martin
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 11 17 6916

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