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(12) # EUROPEAN PATENT APPLICATION

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(54) **Device and method for cutting holes in a corrugated tube made of thermoplastic material**

(57) The invention relates to a device for cutting holes (5) in a corrugated tube (3) with annular or helical corrugations made of thermoplastic material, with cutters (14, 15, 16) attached to cutter shafts (4) mounted in rotatable fashion around axes running parallel to the longitudinal direction of the corrugated tube (3), where each cutter can take up an exact, predetermined position for cutting into the corrugated tube, depending on the rotation of its cutter shaft, and with at least one lead-screw (4'), whose thread (11) engages the corrugations of the tube in gear-like fashion, thus enabling the corrugated tube (3) to be transported at a predetermined speed. The invention also relates to a process for cutting holes in corrugated tubes. A disadvantage of the known devices and processes for this purpose is the need to exchange and resharpen the cutters. For the device according to the invention, it is proposed that each cutter shaft (4) be provided with at least two consecutive cutters (14, 15, 16), separated from each other in the direction of transport (A) and aligned such that, during operation, the time interval between reaching the cutting position of the first cutter (15) in the direction of transport and reaching the subsequent cutting position of the second cutter (16) in the direction of transport essentially corresponds to the time interval in which the corrugated tube (3) is transported by the distance between the cutters projected on the longitudinal direction.

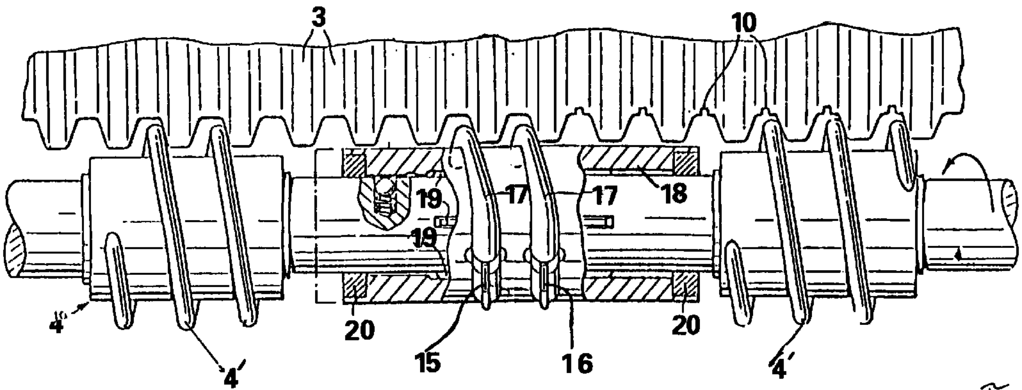

Fig.7

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Description

[0001] The invention relates to a device for cutting holes in a corrugated tube with annular or helical corrugations made of thermoplastic material, with cutters attached to cutter shafts mounted in rotatable fashion around axes running parallel to the longitudinal direction of the corrugated tube, where each cutter can take up an exact, predetermined position for cutting into the corrugated tube, depending on the rotation of its cutter shaft, and with at least one leadscrew, whose thread engages the corrugations of the tube in gear-like fashion, thus enabling the corrugated tube to be transported at a predetermined speed.

[0002] In a device of this kind known from DE 28 10 165, the corrugated tube is transported by leadscrews. Cutters which make holes in the corrugated tube work together with the leadscrews. In order to make the holes, a cutter attached to a cutter shaft cuts into the wall of the corrugated tube. In this configuration, the leadscrews are mounted on the cutter shafts. The tubes provided with holes are primarily used as drainage tubes or hoses.

[0003] A device is known from WO 90/13400 in which the cutter shafts fitted with a cutter and the leadscrews are of separate design. In this case, the leadscrews display straight and inclined threaded sections, which cause the corrugated tube to be transported in intermittent fashion. The cutter shafts are rotated in coordination with this transport motion in such a way that the cutters cut holes in the tube wall when the tube is standing still.

[0004] Conventional devices require a very sharp cutter for a precise cut in the tube wall and for a cleanly cut hole. This necessitates frequent sharpening of the cutters, which involves exchanging the cutters, assembly work and down times. The frequent resharpening of the cutters is particularly necessary when making holes in thick-walled tubes.

[0005] The invention is based on the task of providing a device for cutting holes in tubes which enables a precise cut of predetermined shape to be made in the tube wall with reduced wear on the cutters, even when making holes in thick tube walls.

[0006] In order to solve the above task, it is proposed that each cutter shaft be provided with at least two consecutive cutters, separated from each other in the direction of transport and aligned such that, during operation, the time interval between reaching the cutting position of the first cutter in the direction of transport and reaching the subsequent cutting position of the second cutter in the direction of transport essentially corresponds to the time interval in which the corrugated tube is transported by the distance between the cutters projected on the longitudinal direction. The first cutter in the direction of transport makes the first cut at a specific point on the tube wall. The second cutter or cutters in the direction of transport then cut further into the recess already made, once it has been transported from the position of the first-cutting cutter to the position of the subsequently cutting cutter. The time interval required to transport this point is calculated from the space between the cutters projected on the direction of transport, as the distance, and the transport speed of the tube, as the distance per time unit. This time interval corresponds to the time interval which lapses when turning the cutter shaft from the cutting position of the first cutter in the direction of transport to the cutting position of the second cutter in the direction of transport. The first-cutting cutter makes a recess in the tube wall. Depending on the dimensions of the cutter with its blade and the thickness of the tube wall, this recess can pierce the wall of the corrugated tube and thus cut an initial hole, or make only a partial cut into the wall. The recess is of oblong, slit-like shape along the circumference of the wall. The second cutter in the direction of transport makes another cut in the wall in the area of the recess. If no hole has yet been made in the tube, it can be cut by the second cutter. In accordance with the invention, a hole of specific shape is cut in the tube using several cutters. Therefore, each cutter has to cut and remove less material, thus reducing the wear and strain on the cutters and their blades and cutting edges. Thus, the cutters can be used in the device for longer periods of time and retain their sharpness in this context. It is also advantageous in the multi-stage cutting process according to the invention that special shapes can be selected for the cut and for the hole. For example, the first cutting cutter can make an oval recess in the tube wall, which is merely deepened in the centre by the second cutting cutter to form a hole. This hole shape in the tube wall can have an advantageous effect on the flow properties of a medium. An opening whose cross-section expands outward is particularly advantageous for water.

[0007] In a preferred configuration of the invention, the first cutter in the direction of transport has a blade with a cutting edge designed for chip removal. In the cutting position, the first cutter removes a chip from the tube wall, thus reducing the wall thickness for subsequent machining and forming a recess in the wall.

[0008] In a preferred configuration, the second cutter in the direction of transport has a blade with a cutting edge designed to make a cut in the corrugated tube. According to the invention, the second cutter cuts further into the recess. Due to the fact that the thickness of the wall has already been reduced here by the first cutter, the second cutter need not cut so deeply and retains its sharpness longer. In addition, the forces acting on the cutter during the cutting cycle are weaker when cutting a thinner section of the tube wall, this also lessening the torque acting on the cutter shaft.

[0009] In an advantageous configuration of the invention, a leadscrew is mounted on at least one cutter shaft at a distance from the cutters. Due to the fact that the leadscrew is mounted on the cutter shaft, the corrugated tube is transported by the rotation of the cutter shaft. In this context, the thread of the leadscrew can be provided in two areas of the cutter shaft. If the cutters are mounted in a central area, the threads can be located at a distance from the cutters in the end regions of the cutter shaft. If the leadscrew consists of several interrupted threads, they must be suitably positioned to achieve continuous transport of the corrugated tube.

[0010] In an expedient configuration of the invention, the cutters are mounted on a guide ridge partially extending around the circumference of the cutter shaft. During cutting, the guide ridge engages the corrugations of the tube in gear-like fashion, thus stabilising the tube. The arrangement of the cutter on the guide ridge stabilises the corrugated tube during cutting. This arrangement of the cutter also positions it closer to the wall of the corrugated tube, so that a cut can even be made here with a short blade, as a result of which the forces acting on the cutter are only transmitted to the cutter shaft via a short lever arm.

[0011] In another expedient configuration, at least one guide ridge is provided to the side of the cutters. In this context, the guide ridges can be provided to the side of each cutter, or to the side of several cutters. It is also possible for the cutters themselves to be mounted on the guide ridges, or directly on the cutter shaft. In this context, the side guide ridges again serve to stabilise the corrugated tube in the cutting position. For this purpose, the guide ridges are preferably provided in the range of angles of the cutter shaft in which the cutter takes up its cutting position.

[0012] In a particularly preferred configuration, each cutter shaft has a cylindrical sleeve mounted concentrically in relation to it, which cannot rotate relative to the cutter shaft, is mounted on the cutter shaft in a manner which permits it to move in the direction of transport and on which the guide ridges and cutters are located. The corrugated tube is transported during cutting. In order to make a cut in the corrugated tube in a circumferential plane perpendicular to the direction of transport, the cutting cutter and the tube wall must not move relative to one another along the direction of transport. Due to the fact that the cutters are mounted on a sleeve which can move in the direction of transport, the cutting cutter can move with the corrugated tube during the cutting cycle. In this context, the sleeve does not rotate relative to the cutter shaft, but rather the cutters cut into the corrugated tube with the rotation of the cutter shaft. During cutting, the sleeve is also moved a distance along the direction of transport. Before a new cutting cycle, the sleeve is moved back against the direction of transport in order to be ready for another cut.

[0013] In this context, a further configuration is particularly preferred in which the sleeve is spring-loaded against the direction of transport. After a cut is made, the spring force returns the sleeve back to its starting position.

[0014] The task on which the invention is based is also solved by a process for cutting holes in a corrugated tube with annular or helical corrugations made of thermoplastic material. In this process, the corrugated tube is transported in one direction. The task is solved in that a first cutter makes a recess in the corrugated tube and, in a subsequent cut, a second cutter in the direction of transport continues the cut to make a hole in the recess. In this context, the recess can go through the tube wall, so that an initial hole is formed by the first cut, which is then cut further by the second cutter in the direction of transport.

[0015] In an advantageous configuration of the process, the first cutter in the direction of transport cuts a recess. The recess does not go through the tube wall. The recess prepares for the cut to be made by the second cutter in the direction of transport. In this context, the recess in the tube wall can be of oblong, oval shape.

[0016] In a further configuration of the invention, the second cutter in the direction of transport makes a slit within the recess. In this way, the second cutter in the direction of transport only cuts in an area of the tube which has a smaller wall thickness.

[0017] In a preferred configuration of the process, the cutting edge of the first cutter in the direction of transport is positioned so far from the axis of its cutter shaft that the tube wall is not pierced. This process step is particularly advantageous for tubes with a thick wall, as the cutting edge of the cutter is subject to less strain during cutting and serves only to remove a chip.

[0018] In an expedient configuration of the process, at least one guide ridge is provided to the side of the cutters, which engages the corrugations of the tube in gear-like fashion while the cutters are cutting. The gear-like engagement of the guide ridges prevents the lateral movement of the corrugated tube during cutting.

[0019] In a preferred configuration of the invention, the cutters are moved along the cutter shaft in the direction of transport and at the speed of transport of the tube during cutting. Cutters of this kind, which move with the corrugated tube, make it possible to cut holes along the circumference of the moving corrugated tube, without the cuts being slanted due to relative movement between the wall and the cutter.

[0020] Preferred configurations of the device according to the invention are described below on the basis of the drawings. The drawings show the following:

Fig. 1 A perspective view of a device for cutting holes, with continuous leadscrews on the cutter shafts,

Fig. 2 A side view of a corrugated tube with cut holes,

Fig. 3 A cross-section of a corrugated tube along line III-III in Fig. 2,

Fig. 4 A side view of a corrugated tube with a cut recess and a slit,

Fig. 5 A perspective view of two cutter shafts with a corrugated tube,

Fig. 6 A perspective view of a cutter shaft,

Fig. 7 A perspective view of a cutter shaft with a movable sleeve, and

Fig. 8 A perspective view of a cutter shaft with a movable sleeve which is spring-loaded.

[0021] For the sake of clarity, like elements are referred to by the same reference numbers in the practical examples of the invention described below.

[0022] The device shown in Fig. 1 consists of two support housings 1 and 2, each having centre holes which are aligned with one another and form a passageway for corrugated tube 3. Corrugated tube 3 is advanced in direction of transport A by a number of leadscrews 4', which are arranged on cutter shafts 4. Cutter shafts 4 are arranged along the circumference of corrugated tube 3, where threads 11 provided on them engage the corrugated tube in gear-like fashion, so that the corrugated tube is transported in direction A when they are rotated. Cutter shafts 4 can be driven and rotated in a synchronised manner according to the known method. It is known from the prior art that all cutter shafts 4 can be coupled via toothed gears and driven by a motor from one of the support housings 1 or 2. In the configuration shown in Fig. 1, each of the cutters is mounted on the crest of thread 11.

[0023] Holes 5 in corrugated tube 3, shown in Fig. 2, are located in troughs 6 of the corrugations. The corrugations themselves display an essentially rectangular shape in the axial direction of the tube, where the width of a crest 7 roughly corresponds to the width of a trough 6. A cross-section along line III-III shows tube wall 8 with holes 5. Hole 5 is shown in detail in a magnified view in Fig. 4. Hole 5 has an outer recess 9 and a central slit 10, where slit 10 represents the actual perforation of the tube wall.

[0024] Figure 5 shows two cutter shafts 4 with their leadscrew 4' engaging corrugated tube 3 in gear-like fashion. Leadscrews 4' have threads 11 located at a distance from the cutters on the ends of cutter shaft 4. As is clearly shown in Fig. 5, cutter shafts 4 have an opposing sense of rotation during transport of the corrugated tube with the selected arrangement of threads 11. With an opposing sense of rotation such as this, the cutters cut into the corrugated tube from different directions, thus preventing the tube from rotating with the cutter when it makes contact.

[0025] The centre section of cutter shaft 4, in which thread 11 of the leadscrew is interrupted, displays five guide ridges 12. Guide ridges 12 each extend around part of the circumference of cutter shaft 4. Ends 13 of guide ridges 12 (only end 13 facing the observer is visible in Fig. 5) are bevelled in order to facilitate the engagement of the guide ridges in the corrugations. Guide ridges 12 extend radially in the plane perpendicular to the longitudinal direction of the corrugated tube. For the duration of the rotation in which they engage the corrugations, the movement of corrugated tube 3 is stopped in this region. Therefore, if corrugated tube 3 continues to be transported outside the centre section, it is compressed in front of the first guide ridge 12 in the direction of transport and expanded behind the last guide ridge 12.

[0026] A cutter 14 projects from both the second and fourth guide ridges along the leadscrew. Cutter 14 consists of a blade with a cutting edge and a holder. The connection to the cutter shaft can be made, for example, by screwing the cutter holder onto the leadscrew, as is known from the prior art.

[0027] Guide ridges 12 of rotating cutter shaft 4 engage the corrugations of tube 3 in gear-like fashion. As guide ridges 12 are inclined relative to thread 11, the part of corrugated tube 3 which engages guide ridges 12 is prevented from moving along feed direction A, as explained above. Cutters 14 thus cut into the stationary section of corrugated tube 3. Cut hole 5 runs radially in the plane perpendicular to the longitudinal axis of the corrugated tube. However, as shown in the alternative configuration in Fig. 1, the cutters can also project from a continuous thread on the cutter shaft, so that - if the process is carried out using a continuously rotating leadscrew - they cut in a plane which is at an angle to the longitudinal axis of the corrugated tube.

[0028] Cutters 15 and 16 are mounted on two guide ridges 12 of cutter shaft 4. As shown in the perspective view in Fig. 6, both cutters 15 and 16 are mounted at the same angle on the circumference of cutter shaft 4. If a corrugated tube 3 is fed along cutter shaft 4 in feed direction A, cutter 15 makes the first cut in the wall. In this context, the tube is supported by guide ridges 12' and 12''. While guide ridges 12, 12', 12'' and 12''' engage the corrugations of the tube, this section of the corrugated tube is not transported. This section of the corrugated tube is not transported further until guide ridges 12 to 12''' no longer engage the tube corrugations due to the rotation of cutter shaft 4. Therefore, the elasticity of the tube to be cut must be taken into account when dimensioning the distance between first and last guide ridges 12 and 12''' and the thread. After cutter 15 has made an initial recess in the tube wall and corrugated tube 3 is no longer being held by guide ridges 12 to 12''', it is transported further until, for example, one complete turn causes guide ridge 12'' to engage the trough of the corrugation in which cutter 15 previously made a cut. After another turn, cutter 16 then cuts into the recess made by cutter 15.

[0029] The cutters need not necessarily take up their cutting position only after complete turns of the cutter shaft. On the contrary, it is also possible for the two cutting cutters to be mounted in an offset position on the circumference of the cutter shaft in such a way that they cut after a partial turn of the cutter shaft. If, with this arrangement of the cutters, the corrugated tube is transported without being rotated about its longitudinal axis, the recess is transported further while the next cutting cutter is rotated into its cutting position. The second cutting cutter then cuts further into the recess made previously. If the cutters are distributed around the circumference of the cutter shaft at angles of 60°, for example, guide ridges 12 can also be offset on the cutter shaft at a corresponding angle to one another. Offsetting the guide ridges in this way shortens the distance between the first and last guide ridges, thus helping to reduce the expansion and compression of the corrugated tube.

[0030] Another configuration of a cutter shaft 4 is shown in Fig. 7. Corrugated tube 3 is transported past cutter shaft 4, where holes 10 have already been made in the tube wall upstream in the direction of transport. Corrugated tube 3 is transported by leadscrews 4' on both sides of cutter shaft 4. Second cutter 16 in the direction of transport and first cutter 15 in the direction of transport are each mounted on a guide ridge 17. Guide ridges 17 and cutters 15 and 16 are mounted on a movable sleeve 18. Sleeve 18 is mounted in movable fashion with bearing rings 20 in several longitudinal slots 19 distributed around the circumference on cutter shaft 4. In this context, sleeve 18 cannot rotate relative to cutter shaft 4. While cutters 15 and 16 are in cutting position, sleeve 18 is simultaneously moved in the direction of transport. After cutting, the sleeve is returned to the starting position by guide ridges 17. For this purpose, a section of guide ridges 17, which engages the corrugations of the tube after the cutting position, is curved in such a way that engagement returns the sleeve to its starting position.

[0031] In an alternative configuration of cutter shaft 4, shown in Fig. 8, cutter shaft 4 is pretensioned by spring 21. This configuration of cutter shaft 4 differs from that described above in that sleeve 18 has projections 23 which engage recesses 24 and is mounted in these recesses such that it can move along the direction of transport, but cannot rotate around the axis of rotation of cutter shaft 4. Sleeve 18 is not mounted on the cutter shaft in the configuration shown, but rather is designed as a separate element of the cutter shaft. Sealing rings 25 seal off the inside of cutter shaft 4.

[0032] The two cutters 15 and 16 are mounted on sleeve 18. When cutting into the corrugated tube, the tube is stabilised by guide ridges 22. As the sleeve is repositioned by spring 21 in this case, the guide ridges can be located parallel to the corrugations of tube 3. Both cutters in this configuration are mounted directly on cutter shaft 4, and its leadscrew 4' is located on the end.

List of reference numbers

[0033]

1. Support housing
2. Support housing
3. Corrugated tube
4. Cutter shaft

4'. Leadscrew

5. Hole
6. Trough
7. Crest
8. Recess
9. Recess
10. Slit
11. Thread
12. Guide ridge
13. End
14. Cutter
15. First cutter
16. Second cutter
17. Guide ridge
18. Sleeve
19. Longitudinal slot
20. Bearing ring
21. Spring
22. Guide ridge
23. Projection
24. Recess
25. Sealing ring

Claims

1. Device for cutting holes (5) in a corrugated tube (3) with annular or helical corrugations made of thermoplastic material, with cutters (14, 15, 16) attached to cutter shafts (4) mounted in rotatable fashion around axes running parallel to the longitudinal direction of the corrugated tube (3), where each cutter can take up an exact, predetermined position for cutting into the corrugated tube (3), depending on the rotation of its cutter shaft (4), and with at least one leadscrew (4'), whose thread (11) engages the corrugations of the tube (3) in gear-like fashion, thus enabling the corrugated tube (3) to be transported at a predetermined speed, **characterised in that** each cutter shaft (4) is provided with at least two consecutive cutters (14, 15, 16), separated from each other in the direction of transport (A) and aligned such that, during operation, the time interval between reaching the cutting position of the first cutter (15) in the direction of transport and reaching the subsequent cutting position of the second cutter (16) in the direction of transport essentially corresponds to the time interval in which the corrugated tube (3) is transported by the distance between the cutters (14, 15, 16) projected on the longitudinal direction.

2. Device according to Claim 1, **characterised in that** the first cutter (15) in the direction of transport (A) has a blade with a cutting edge designed for the chip removal (9) on the corrugated tube (3).

3. Device according to Claim 2, **characterised in that** the second cutter (16) in the direction of transport (A) has a blade with a cutting edge designed to make a cut (10) in the corrugated tube (3).

4. Device according to one of the Claims 1 to 3, **characterised in that** a leadscrew (4') is mounted on at least one cutter shaft (4) at a distance from the cutters (15, 16).

5. Device according to one of the Claims 1 to 4, **characterised in that** each cutter is mounted on a guide ridge (12, 17, 22) partially extending around the circumference of the cutter shaft (4).

6. Device according to one of the Claims 1 to 5, **characterised in that** at least one guide ridge (12, 17, 22) is provided to the side of the cutters (14, 15, 16).

7. Device according to Claim 5 or 6, **characterised in that** each cutter shaft (4) has a cylindrical sleeve (18) mounted concentrically in relation to it, which cannot rotate relative to the cutter shaft (4), is mounted on the cutter shaft in a manner which permits it to move in the direction of transport (A) and on which the guide ridges (17, 22) and cutters (15, 16) are located.

8. Device according to Claim 7, **characterised in that** the sleeve (18) is spring-loaded (21) against the direction of transport.

9. Process for cutting holes in a corrugated tube with annular or helical corrugations made of thermoplastic material, where the corrugated tube is transported in one direction, **characterised in that** a first cutter (15) makes a recess (9) in the corrugated tube (3) and, in a subsequent cut, a second cutter (16) in the direction of transport (A) continues the cut to make a hole (5) in the recess (9).

10. Process according to Claim 9, **characterised in that** the first cutter (15) in the direction of transport (A) cuts a recess (9).

11. Process according to Claim 10, **characterised in that** the second cutter (16) in the direction of transport makes a slit (10) within the recess.

12. Process according to one of the Claims 9 to 11, **characterised in that** the cutting edge of the first cutter (15) in the direction of transport (A) is positioned so far from the axis of its cutter shaft (4) that the tube wall is not pierced.

13. Process according to one of the Claims 9 to 12, **characterised in that** at least one guide ridge (12, 17, 22) is provided to the side of the cutters (14, 15, 16), which engages the corrugations of the tube (3) in gear-like fashion while the cutters (15) are cutting.

14. Process according to one of the Claims 9 to 13, **characterised in that** the cutters (14, 15, 16) are moved along the cutter shaft (4) in the direction of transport (A) and at the speed of transport of the tube (3) during cutting.

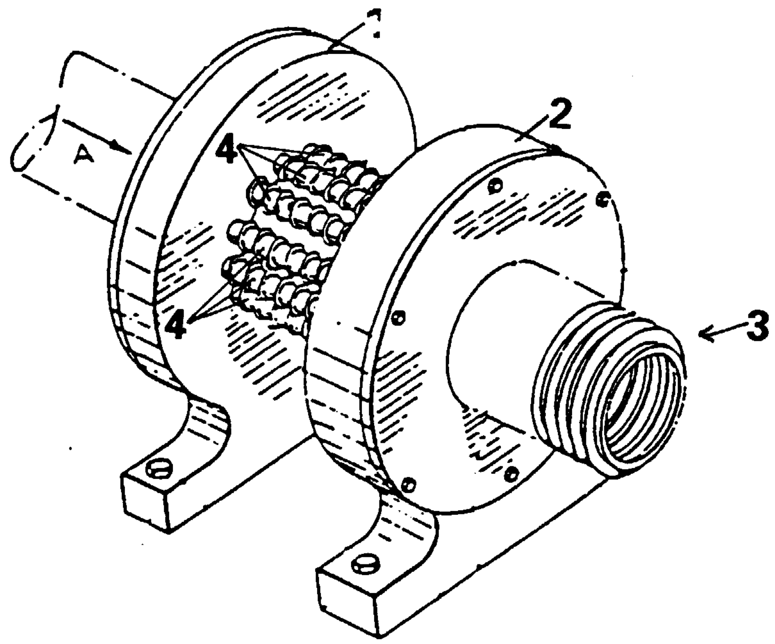

Fig. 1

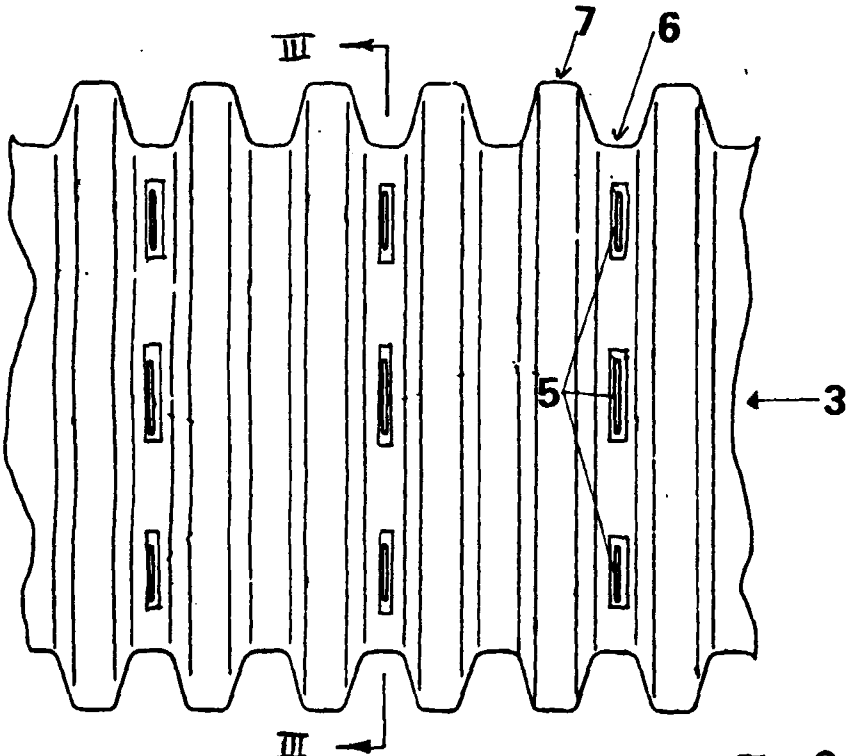

Fig. 2

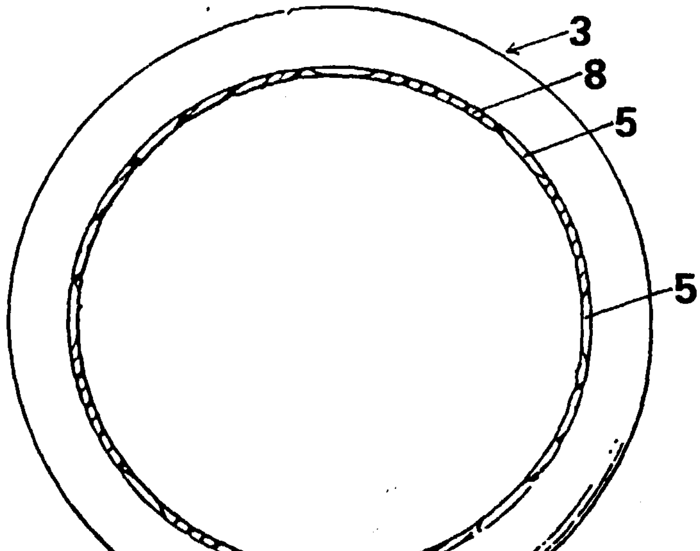

Fig. 3

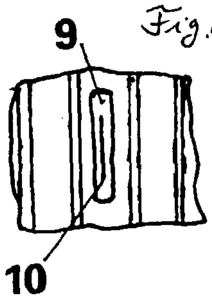

Fig. 4

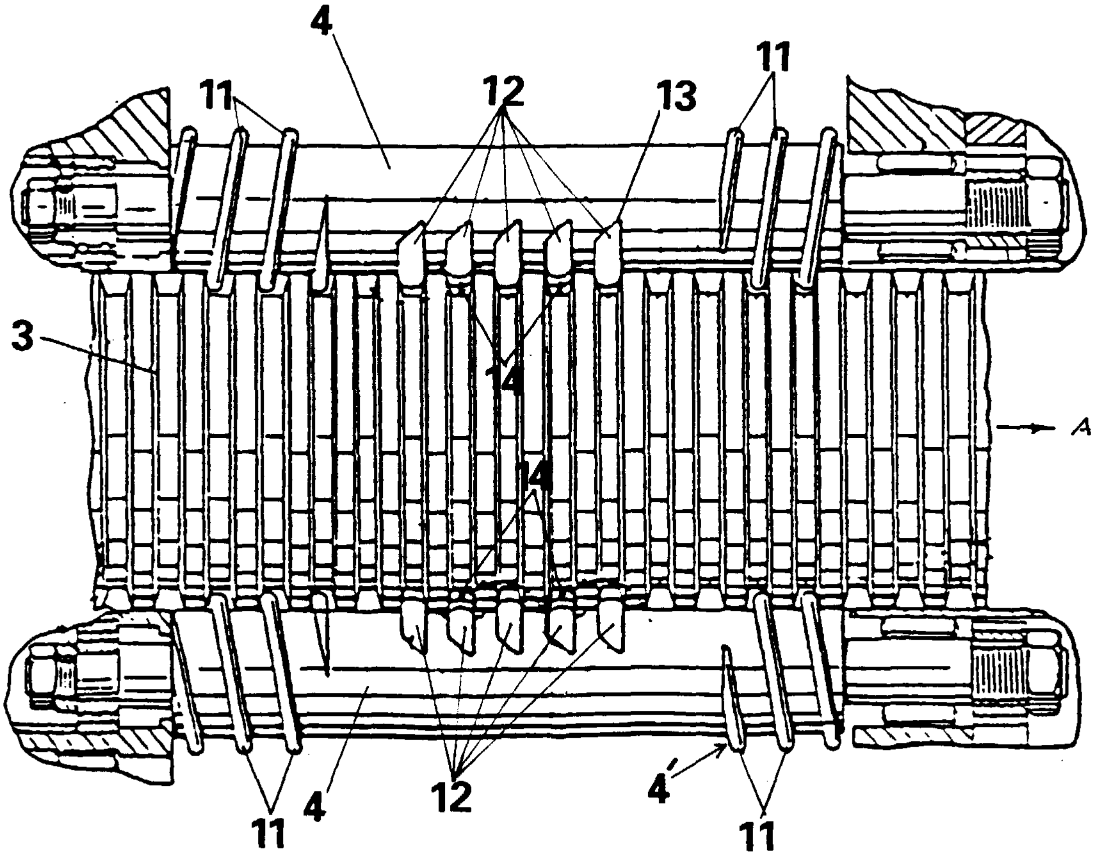

Fig.5

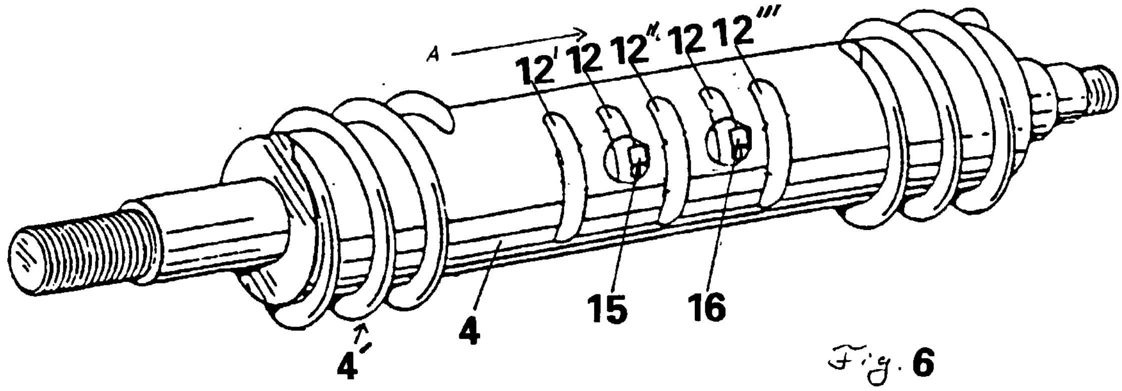

Fig. 6

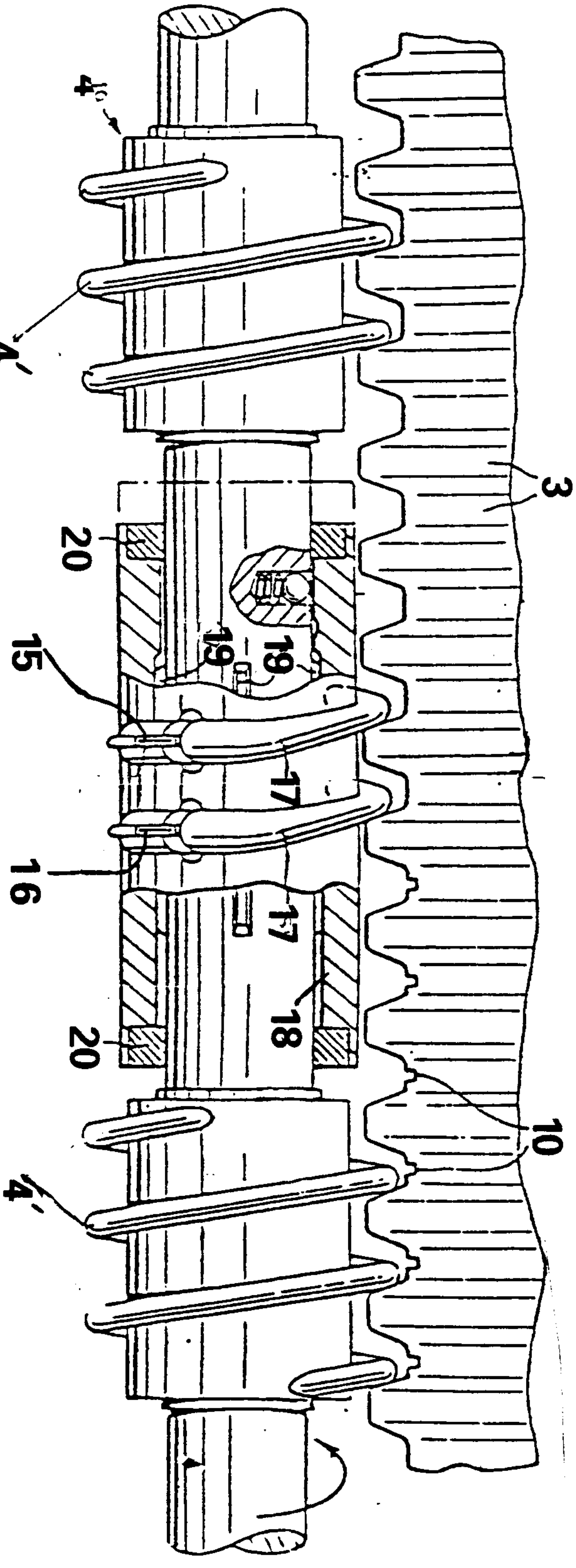

Fig. 7

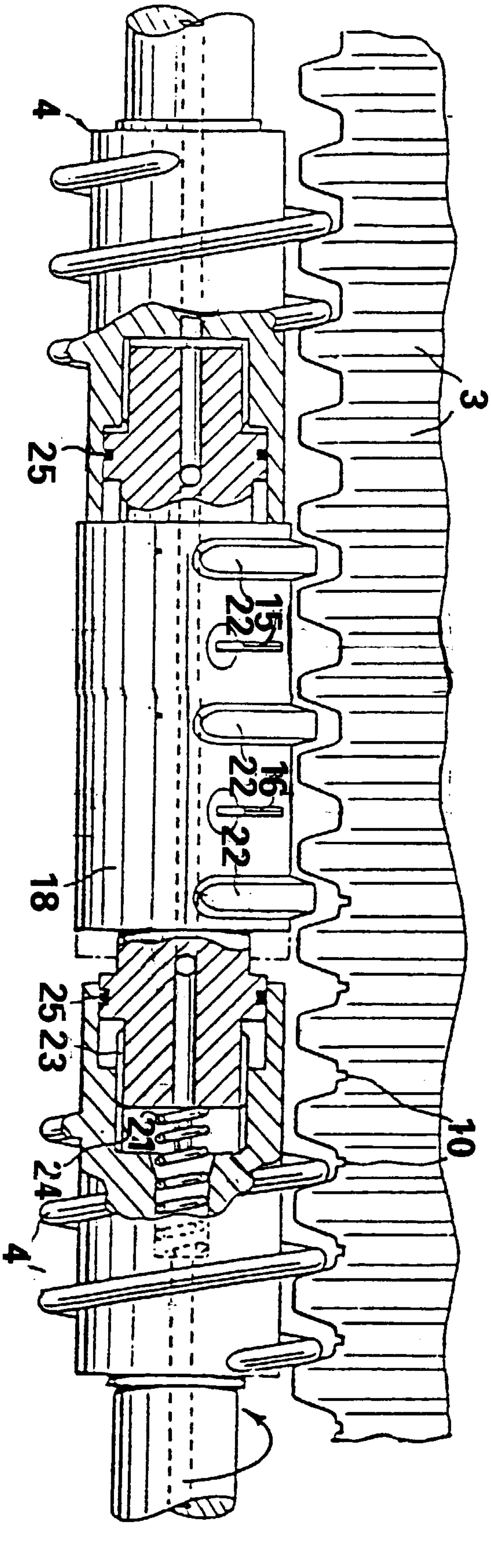

Fig. 8

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 11 5695

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP 0 085 770 A (HEGLER WILHELM) 17 August 1983 * page 5, line 1 - page 11, line 30; figures 2,7-9 *	1,14	B26F1/00
A	WO 94 07662 A (ORSING ERNST) 14 April 1994 * page 3, line 20 - page 4, line 25 *	1,9	
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A	EP 0 013 626 A (LUPKE MANFRED ARNO ALFRED ;LUPKE GERD PAUL HEINRICH (CA)) 23 July 1980 * page 11, paragraph 2 - page 12, paragraph 1; figures 21-25 *	14	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B26F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	12 January 1999	Vaglienti, G

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 98 11 5695

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