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(71) Applicant: **YAMAUCHI CORPORATION**
7,2-chome, Shodai-tajika
Hirakata Osaka(JP)

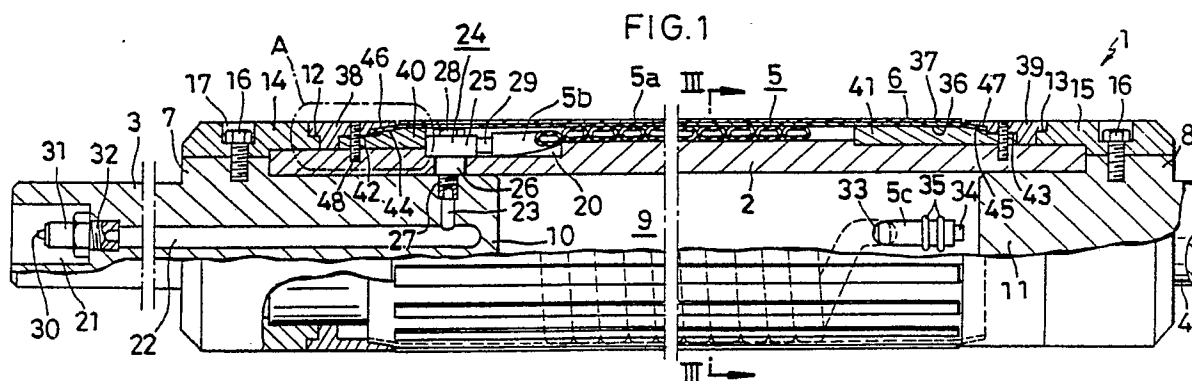
(72) Inventor: **Fukuyama, Yasuo**
c/o Yamauchi Corporation of 7 2-chome
Shodaitajika
Hirakata-shi Osaka(JP)

(74) Representative: **Patentanwälte TER MEER -**
MÜLLER - STEINMEISTER
Mauerkircherstrasse 45
D-8000 München 80(DE)

(54) **Shaft for use with core.**

(57) A core shaft comprising a shaft body (2), a pair of opposite journals (3, 4), an elastic tube (5) helically wound around the shaft body (2), inflatable by the pressure of a fluid introduced therein and holdable in its inflated state, and a tubular protective cover (6) covering the entire helical winding of the tube and variable in diameter with the inflation or contraction of the tube.

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SHAFT FOR USE WITH CORE

The present invention relates to shafts for use with cores, and more particularly to a shaft to be inserted into the hollow portion of a winding core in intimate contact therewith for winding paper, film, sheet or like material thereon or unwinding such a material therefrom for use in printing machines, paper machines, plastics processing machines, etc., the shaft being adapted to transmit a torque from a drive source to the core for winding or to transmit a braking force from a brake device to the core for unwinding.

Examined Japanese Patent Publication No. 24296/82 already discloses a shaft for transmitting a torque from a drive source to a paper tube or core. The disclosed shaft comprises a shaft body having a journal at each of its opposite ends and formed with at least one deep groove in its outer periphery, and at least one rubber tube accommodated in the groove inwardly of the outer peripheral surface of the shaft body, inflatable beyond the peripheral surface of the shaft body by the pressure of air introduced into the tube and capable of retaining the inflated state. With this shaft, the arrangement of the rubber tube on its outer periphery is restricted by the position of the groove, so that the area of contact of the entire inflated rubber tube with the core inner surface is not always sufficient for the transmission of torque. Moreover, since the rubber tube is invariably in pressing contact with the grooved wall when inflated by the pressure of air admitted into the tube, it is likely that the tube will not fully bulge out from the groove as required. Consequently, there is the likelihood that the torque transmission shaft will not be joined to the core during use, failing to effect proper torque transmission.

The present invention, which has overcome the above problem, provides a core shaft comprising a shaft body having a journal at each of its opposite ends, at least one elastic tube helically wound around the shaft body, inflatable by the pressure of a fluid introduced thereinto and holdable in its inflated state, and a tubular protective cover covering the helical winding of the elastic tube in its entirety and variable in diameter with the inflation or contraction of the elastic tube. When the shaft is inserted into a core, the tubular protective cover which increases in diameter with the inflation of the elastic tube comes into intimate contact with the inner surface of the core, so that the torque from a drive source or the braking force from a brake device can be perfectly transmitted to the core. Moreover, the cover protects the elastic tube from a break, damage or puncture.

The present invention will be described in greater detail with reference to the accompanying drawings.

Fig. 1 is a front view partly broken away and showing a core shaft embodying the invention;

Fig. 2 is an enlarged view showing the portion A in Fig. 1 in greater detail;

Fig. 3 is an enlarged view in section taken along the line III-III in Fig. 1 and showing the shaft as inserted in a core with a clearance formed therebetween before a fluid is introduced into the elastic tube of the shaft;

Fig. 4 is a view similar to Fig. 3 and showing the same with the protective cover of the tube in intimate contact with the inner surface of the core after the fluid has been introduced into the elastic tube;

Fig. 5 is an enlarged view in cross section showing the elastic tube which has inner and outer two layers;

Fig. 6 is an enlarged fragmentary perspective view of the protective cover which comprises an elastic sleeve and many strips integral with the outer surface of the sleeve and having a plurality of ridges;

Fig. 7 is a fragmentary view partly in vertical section and showing another core shaft embodying the invention;

Fig. 8 is a view in section taken along the line VIII-VIII in Fig. 7;

Fig. 9 is a fragmentary front view partly broken away and showing another core shaft embodying the invention;

Fig. 10 is a view in section taken along the line X-X in Fig. 9;

Fig. 11 is a fragmentary front view partly broken away and showing a modified shaft body; and

Fig. 12 is a fragmentary enlarged perspective view of a tubular protective cover including stretchable portions and nonstretchable portions arranged alternately circumferentially thereof.

With reference to Figs. 1 to 4, a core shaft 1 comprises a shaft body 2, a pair of journals 3, 4 at the respective ends of the body 2, an elastic tube 5 helically closely wound around the shaft body 2, inflatable by the pressure of a fluid introduced thereinto and holdable in its inflated state, and a tubular protective cover 6 covering the entire helical winding 5a of the tube 5 and variable in diameter with the inflation or contraction of the elastic tube 5.

The shaft body 2 is a tube of carbon fiber reinforced plastics. Each journal 3 (4) has integrally

with its inner end a flange 7 (8) having a slightly smaller diameter than the shaft body 2 and in contact with the end face thereof, and a plug 10 (11) intimately fitted in a hollow portion 9 of the shaft body 2 at its end. An end ring 14 (15) having a step 12 (13) at its inner end is fitted around both the flange 7 (8) and the end of the shaft body 2 and is fastened to the flange 7 (8) with a setscrew 16. The end ring 14 (15) has the same outside diameter as the shaft body 2 and is formed with a recess 17 at the portion thereof where the setscrew 16 is inserted therethrough so that the screw head is positioned inwardly of the outer periphery of the end ring 14 (15). The elastic tube 5, which is generally elliptical in cross section, is made of nitrile rubber, polyurethane rubber, butyl rubber or like rubber. Also usable for the tube are thermoplastic polyurethane elastomer, thermoplastic polyester elastomer, polyvinyl chloride resin, polyurethane resin or the like. As seen in Fig. 5, the tube 5 has a double-layer structure including an inner layer 18 and an abrasion-resistant outer layer 19. The inner layer 18 may be made of chloroprene rubber or nitrile rubber, and the outer layer 19 of polyurethane rubber, thermoplastic polyurethane elastomer or thermoplastic polyamide elastomer. Preferably, the elastic tube 5 is made to have a smaller modulus of elasticity circumferentially thereof than axially thereof by incorporating into the material fibers oriented in parallel to the axis of the tube. Examples of useful fibers are cotton fiber, polyamide fiber, aromatic polyamide fiber and like stable fibers. The tube 5 has nonhelical portions 5b and 5c at the respective sides of the helical winding 5a. The left nonhelical portion 5b, which is shorter than the right nonhelical portion 5c, extends into a flat-bottomed recessed portion 20 formed in the outer periphery of the shaft body 2. A fluid channel 22 extends from the bottom of a cavity 21 formed in the outer end of the left journal 3 almost to the inner end of the plug 10 axially of the journal 3 and communicates with a fluid channel 23 extending radially through the journal 3 and communicating with the recess 20 of the shaft body 2. The left nonhelical portion 5b is held in communication with these channels 22, 23 through a hollow connector 24. The connector 24 comprises a block 25 bearing on the bottom of the recessed portion 20, a vertical leg 26 fitted in a hole formed in the circumferential wall of the shaft body 2, an externally threaded portion 27 extending downward from the leg 26 and screwed in an internally threaded portion formed in the plug 10, a hexagonal head 28 integral with the top of the block 25, and a horizontal spigot 29 fitted in the left-end opening of the tube 5. The connector 24 has a fluid channel extending through the spigot 29, bent at a right angle within the block 25 and further extending

through the leg 26 and the externally threaded portion 27 to communicate with the radial channel 23 of the plug 10. A joint 31 having an automatic shutoff valve 30 is formed with an externally threaded portion 32 which is screwed in an internally threaded portion formed in the journal 3 at the outer open end of the fluid channel 22. The joint 31 pairs up with another joint (not shown) having an automatic shutoff valve and attached to the forward end of a hose which is connected to a pressure fluid source. The joint 31 on the shaft 1 serves as a male member, and the joint on the hose as a female member. When the two joints are fitted together for connection, the valves abut against each other and are thereby pushed inward, automatically bringing the fluid channels thereof into communication with each other. When the joints are separated, the valves are returned to the original state by the respective return springs within the joints, whereby the valves are automatically closed. The longer right nonhelical portion 5c of the tube 5 extends into the hollow portion 9 through a hole 33 formed in the peripheral wall of the shaft body 2. A plug 34 is fitted in the right-end opening of the tube 5 and is fastened over the tube end with bands 35, whereby the opening is closed. A plurality of tubes may be helically closely wound around the shaft body 2 and closed each at one-end opening thereof, with the openings at the other ends thereof communicating with the fluid channel 22.

The protective cover 6 comprises an elastic sleeve 36, and a multiplicity of strips 37 each in the form of a slender plate and integral with the outer surface of the elastic sleeve 36. The strips 37 are made of a harder material than the sleeve 36, extend nearly over the entire length of the sleeve axially thereof and arranged at a spacing circumferentially thereof. While the elastic sleeve 36 is made of polyurethane-polyvinyl chloride copolymer, also usable are other materials including nitrile rubber, polyurethane rubber, butyl rubber and like rubbers, elastomers, upto 90 degrees in JIS A hardness, of thermoplastic polyurethane, polyester, polyamide, polystyrene, polyolefin and polyurethane-polyamide, polyvinyl chloride resin, and blend of polyurethane rubber and nitrile rubber. While the strips 37 are made of ABS resin, also usable are semi-rigid polyvinyl chloride resin, elastomers, at least 50 degrees in Shore D hardness, of thermoplastic polyurethane, polyester, polyamide, polystyrene, polyolefin and polyurethane-polyamide, etc. In the case where synthetic resins are used for both the elastic sleeve 36 and the strips 37, it is desirable to integrally form the cover 6 by two-color extrusion. Otherwise, the strips are adhered to the sleeve.

The shaft body 2 has fitted therearound a cover end holding ring 38 (39) having the same out-

side diameter as the end ring 14 (15) and positioned adjacent thereto, and a cover end support ring 40 (41) adjacent to the ring 38 (39) and positioned closer the helical tube winding 5a. The support ring 40 (41) has toward its outer end a step 42 (43) and a tapered portion 44 (45) adjacent thereto. The holding ring 38 (39) is interposed between the end ring 14 (15) and the support ring 40 (41) and joined to these rings by shiplap. The holding ring 38 (39) has an inner peripheral flared portion 46 (47) opposed to the tapered portion 44 (45) of the support ring 40 (41) and spaced apart therefrom by a small clearance. The shiplapped joint between the holding ring 38 (39) and the support ring 40 (41) is fastened to the shaft body 2 with a setscrew 48. The ends of the elastic sleeve 36 of the protective cover 6 slightly project beyond the respective ends of the strips 37. The protective cover 6 covers the entire winding 5a of the tube 5 and has its opposite ends fitted over the support rings 40, 41. Each projection 49 of the sleeve 36 beyond the strips 37 is held between the tapered portion 44 (45) of the support ring 40 (41) and the flared portion 46 (47) of the holding ring 38 (39).

Fig. 3 shows the shaft 1 of the invention as it is merely inserted in the hollow portion 51 of a core 50 before a fluid is introduced into the elastic tube 5, with a large clearance formed within the hollow portion 51 of the core 50 around the shaft 1. Each of the journals 3, 4 is supported by an unillustrated bearing. In this state, the joint on the hose connected to the pressure fluid source is joined to the joint 31 as already stated to apply fluid pressure to the tube 5. Although compressed air is used as the pressure fluid, helium gas or other gas, or a liquid such as water or oil is alternatively usable. When the pressure fluid is introduced into the elastic tube 5, the tube 5 is inflated to increase the outside diameter of the helical winding 5a thereof, causing the protective cover 6 to intimately contact the inner surface of the core 50 defining the hollow portion 51 as seen in Fig. 4. When the joint 31 of the shaft 1 is thereafter separated from the joint of the hose, the valve of the joint 31 automatically closes to hold the tube 5 inflated. When the shaft 1 is connected to a torque source to use the core for winding a material thereon, the torque of the shaft 1 is transmitted to the core 50 for the core to rotate with the shaft 1. To remove the shaft 1 from the core 50, the valve 30 of the joint 31 is pushed in from outside against the force of spring, whereupon the valve 30 is opened to release the fluid pressure from the tube 5 via the fluid channels 22, 23 and the valve opening. The shaft 1 is connected to a brake device when the core 50 is used for unwinding.

The tubular protective cover 6 protects the helical tube winding 5a. With an increase in the

outside diameter of the helical winding 5a when the tube 5 is inflated, the protective cover 6 similarly increases in diameter and comes into intimate contact with the inner surface of the core 50, so that the cover 6 also serves to perfectly join the shaft 1 to the core 50. Since the multiplicity of strips 37 of the protective cover 6 are made of a harder material than the elastic sleeve 36, the strips 37 permit the cover 6 to retain its shape, rendering the shaft 1 smoothly insertable into or removable from the core hollow portion 51. For this purpose, the strip 37 is preferably formed on its outer surface with a plurality of ridges 52 extending longitudinally thereof as seen in Fig. 6.

Figs. 7 and 8 show another core shaft embodying the invention. The tube 5 of this embodiment has a flexible linear member 53 extending therethrough over its entire length and useful for winding the tube 5 helically and holding the tube in shape. The linear member 53, although inserted through the tube 5, may alternatively be embedded in the wall of the tube 5. Although a copper wire is used as the flexible linear member 53, other metal wire such as an aluminum wire is also usable. A polyamide yarn, polyester yarn or like yarn is similarly usable. A protective cover 54 comprises an elastic sleeve 55, and a multiplicity of strips 56 each in the form of an elongated metal plate, adhered to the outer surface of the sleeve 55, extending axially thereof and arranged at a spacing circumferentially thereof. The strip 56 is resilient. In reverse relation to the first embodiment, each strip 56 projects at its opposite ends beyond the respective ends of the elastic sleeve 55. Each of support rings 40, 41 is formed in the upper surface of its inner end with a step 77, around which the end of the sleeve 55 is fitted. Formed in each of tapered outer peripheral surfaces 44, 45 of these support rings 40, 41 are grooves 76 having fitted therein the projections 75 of the strips 56 at the end of each, the projections 75 being movable when the tube 5 is inflated. With the exception of these features, the second embodiment is the same as the first.

Figs. 9 and 10 show another core shaft embodying the invention. This embodiment has an elastic tube 57 which is circular in cross section and is helically wound as at 57a. A support ring 58 is secured to the shaft body 2 at each side of the winding 57a. A protective cover 59 is fitted at its opposite ends around the support rings 58. The cover 59 is in the form of a sleeve which is axially cut at one portion and is made of such a material that it is deformable to a larger diameter but can restore itself. Although the cover 59 of this embodiment is made of polycarbonate, also usable for the cover are other materials such as polyvinyl chloride resin, polyamide, polyethylene, iron and stainless

steel. Each open end of the shaft body 2 is internally threaded and has screwed therein an externally threaded portion 61 of a journal 60 at its inner end. A hexagonal flange 62 formed on the journal 60 at the outer end of the threaded portion 61 bears against the end face of the shaft body 2.

The tube 57 has a nonhelical portion 57b which is secured by a fastener 64 to a flat portion 63 of the circular support ring 58 and which extends into the hollow portion 9 of the shaft body 2 through a hole 65 in the shaft body peripheral wall. The journal 60 has a fluid channel 66 extending centrally therethrough. A hollow connector 67 inserted in the channel 66 as attached to the journal inner end has a spigot 68, to which the open left end of the tube 57 is fastened with bands 69. As in the embodiment of Fig. 1, the outer end of the fluid channel 66 is provided with a joint 31 having an automatic shutoff valve 30. Each nonhelical portion 57b of the tube 57 is covered with a nonstretchable member 70. An adhesive cloth tape, used as the nonstretchable member 70, is closely wound around the nonhelical portion 57b, whereby the tube 57 is prevented from inflation at this portion. The nonstretchable member may alternatively be a metal wire which is closely wound on the nonhelical portion, or a thermally shrinkable synthetic resin tube which is thermally shrunk as fitted around the nonhelical portion. With the exception of the above features, the third embodiment is substantially the same as the embodiment of Fig. 1.

As shown in Fig. 11, the outer peripheral surface of the shaft body 2 may be formed with a shallow helical groove 71 for guiding the elastic tube 57 when it is wound on the body 2. Fig. 12 shows a protective cover 72 in the form of a tube which comprises a multiplicity of stretchable portions 73 and a multiplicity of non-stretchable portions 74 extending longitudinally of the cover and arranged alternately circumferentially thereof. The stretchable portions 73 can be made of thermoplastic polyurethane elastomer, thermoplastic polyester elastomer, polyvinyl chloride resin, polyurethane resin or the like. It is suitable to prepare the nonstretchable portions 74 from polypropylene. The stretchable portions 73 and the nonstretchable portions 74 are formed integrally by two-color extrusion.

Claims

1. A shaft for use with a core comprising a shaft body, a pair of opposite journals, at least one elastic tube helically wound around the shaft body, inflatable by the pressure of a fluid introduced thereinto and holdable in its inflated state, and a

tubular protective cover covering the entire helical winding of the elastic tube and variable in diameter with the inflation or contraction of the elastic tube.

2. A shaft as defined in claim 1 wherein the shaft body is in the form of a tube made of carbon fiber reinforced plastics.

3. A shaft as defined in claim 1 wherein the shaft body is formed in its outer peripheral surface with a shallow groove for guiding the elastic tube when the tube is wound around the shaft body.

4. A shaft as defined in claim 1 wherein the shaft body is made of a rubber.

5. A shaft as defined in claim 1 wherein the tube has a double-layer structure including an inner layer and an abrasion-resistant outer layer, and the inner layer is made of a material selected from the group consisting of chloroprene rubber and nitrile rubber, the outer layer being made of a material selected from the group consisting of polyurethane rubber, thermoplastic polyurethane elastomer and thermoplastic polyamide elastomer.

6. A shaft as defined in claim 1 wherein the tube has a smaller modulus of elasticity circumferentially thereof than axially thereof.

7. A shaft as defined in claim 1 wherein the tube has incorporated in its material fibers oriented in parallel to the axis thereof.

8. A shaft as defined in claim 1 wherein the tube is provided in its interior with a flexible linear member extending over the entire length thereof and serving to helically winding the tube and to hold the tube in shape.

9. A shaft as defined in claim 1 wherein the tube a nonhelical portion at each side of its helical winding.

10. A shaft as defined in claim 9 wherein the nonhelical portion is covered with a nonstretchable member.

11. A shaft as defined in claim 10 wherein the nonstretchable member is a cloth tape helically closely wound around the nonhelical portion of the tube 12. A shaft as defined in claim 10 wherein the nonstretchable member is a metal wire closely wound around the nonhelical portion of the tube.

13. A shaft as defined in claim 10 wherein the nonstretchable member is a thermally shrinkable synthetic resin tube shrunk by heating as fitted around the tube.

14. A shaft as defined in claim 1 wherein the protective cover is an elastic sleeve.

15. A shaft as defined in claim 1 wherein the protective cover is a sleeve axially cut at one portion and made of a material permitting the sleeve to deform to a larger diameter and to restore itself.

16. A shaft as defined in claim 1 wherein the protective cover comprises an elastic sleeve, and a multiplicity of strips each in the form of a slender plate and integral with the outer surface of the

elastic sleeve, the strips being made of a harder material than the elastic sleeve, extending almost over the entire length of the sleeve axially thereof and arranged at a spacing circumferentially thereof.

17. A shaft as defined in claim 16 wherein each of the strips has on its outer surface a plurality of ridges extending longitudinally thereof.

18. A shaft as defined in claim 1 wherein the protective cover is a tube comprising a multiplicity of stretchable portions and a multiplicity of non-stretchable portions both extending longitudinally of the cover and arranged alternately circumferentially thereof.

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FIG. 1

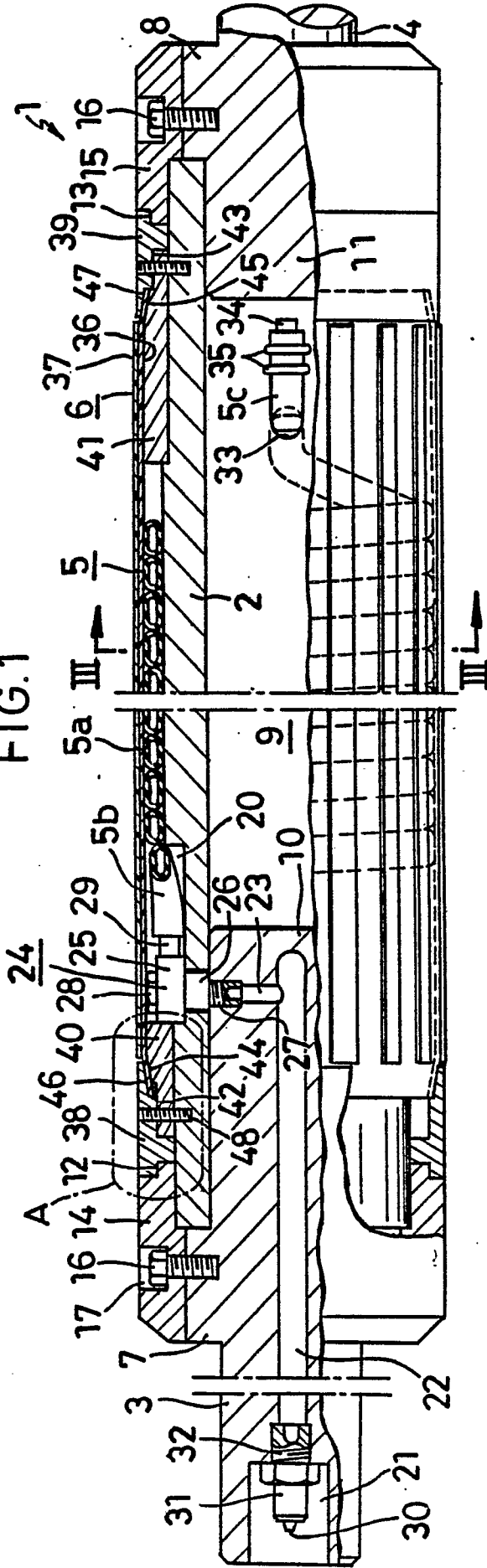


FIG. 2

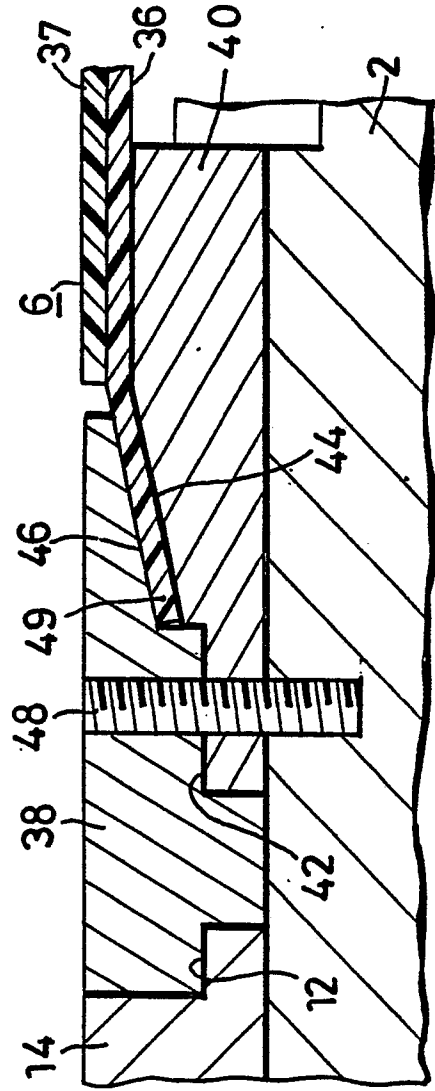


FIG.3

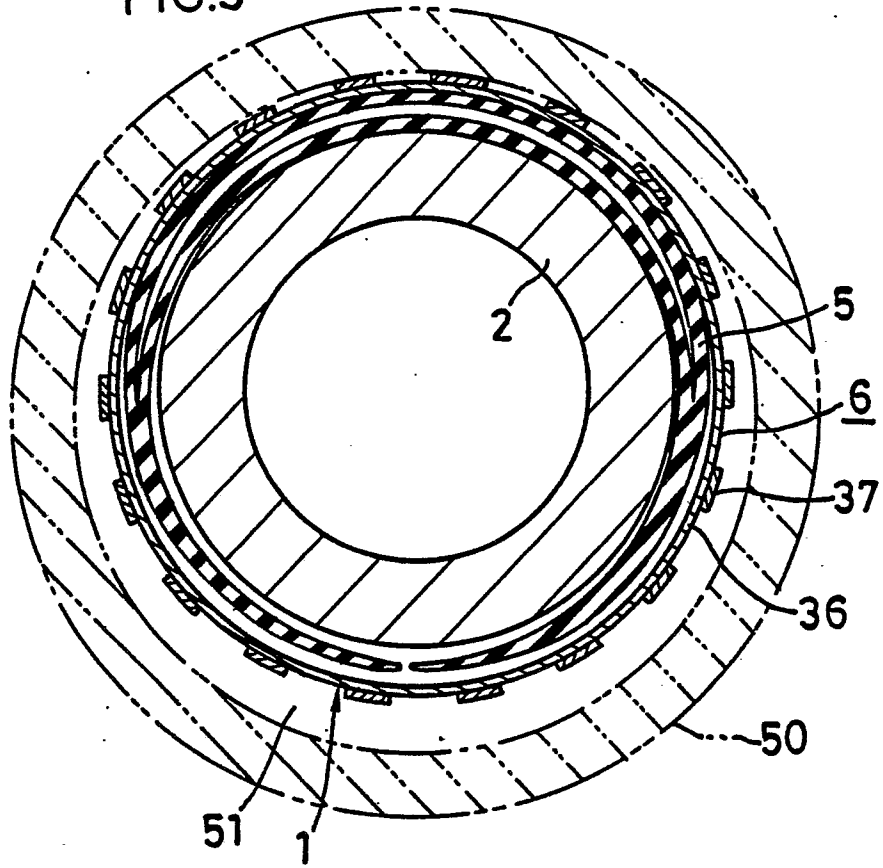
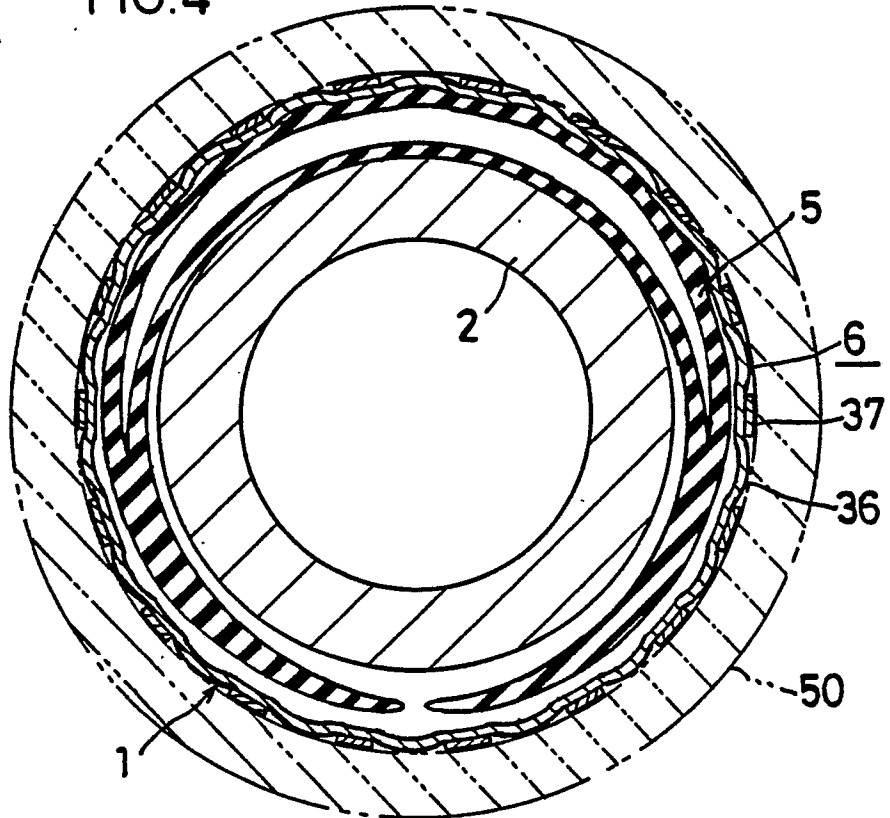
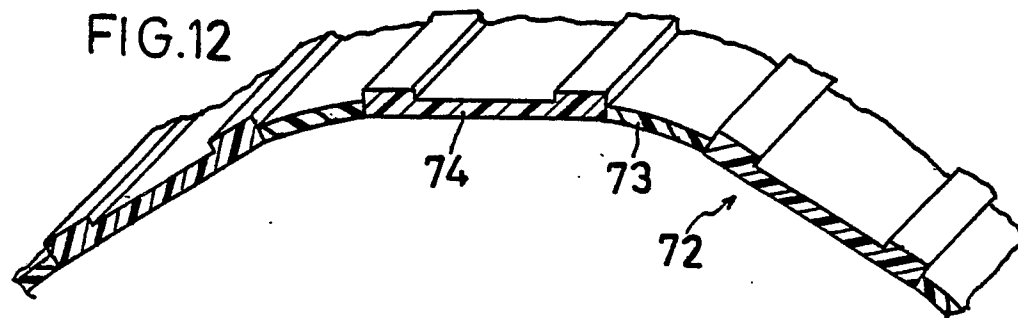
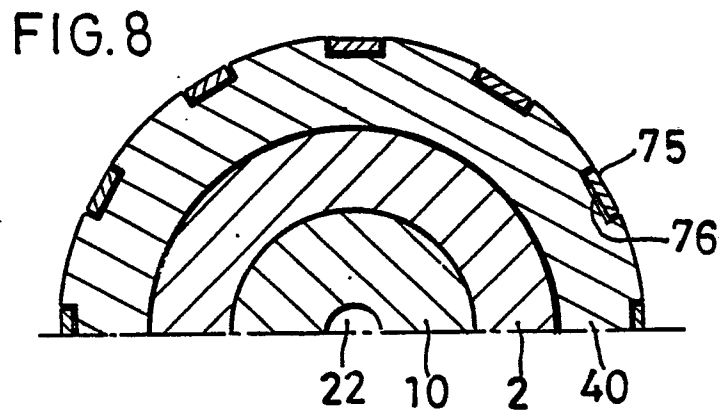
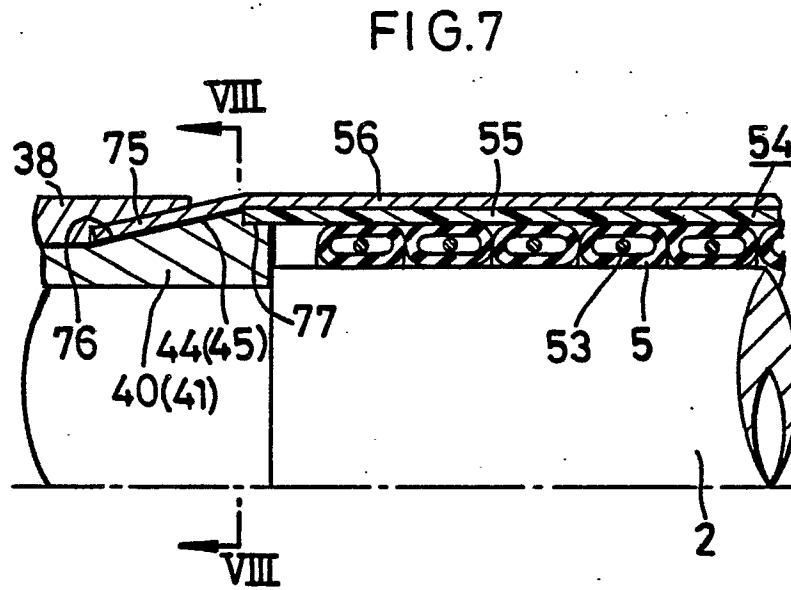
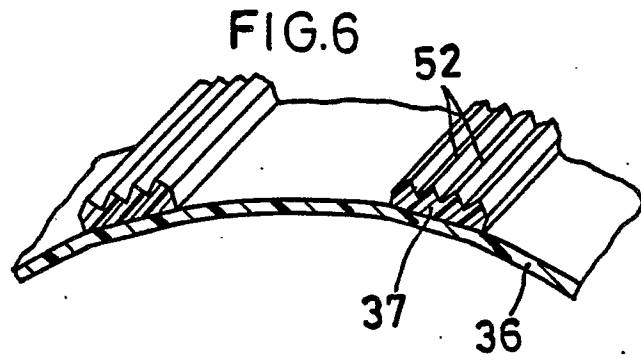
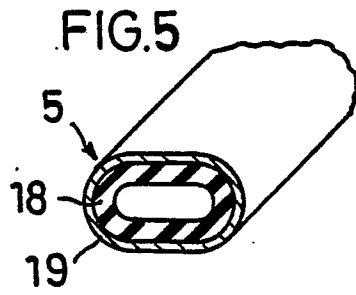


FIG.4





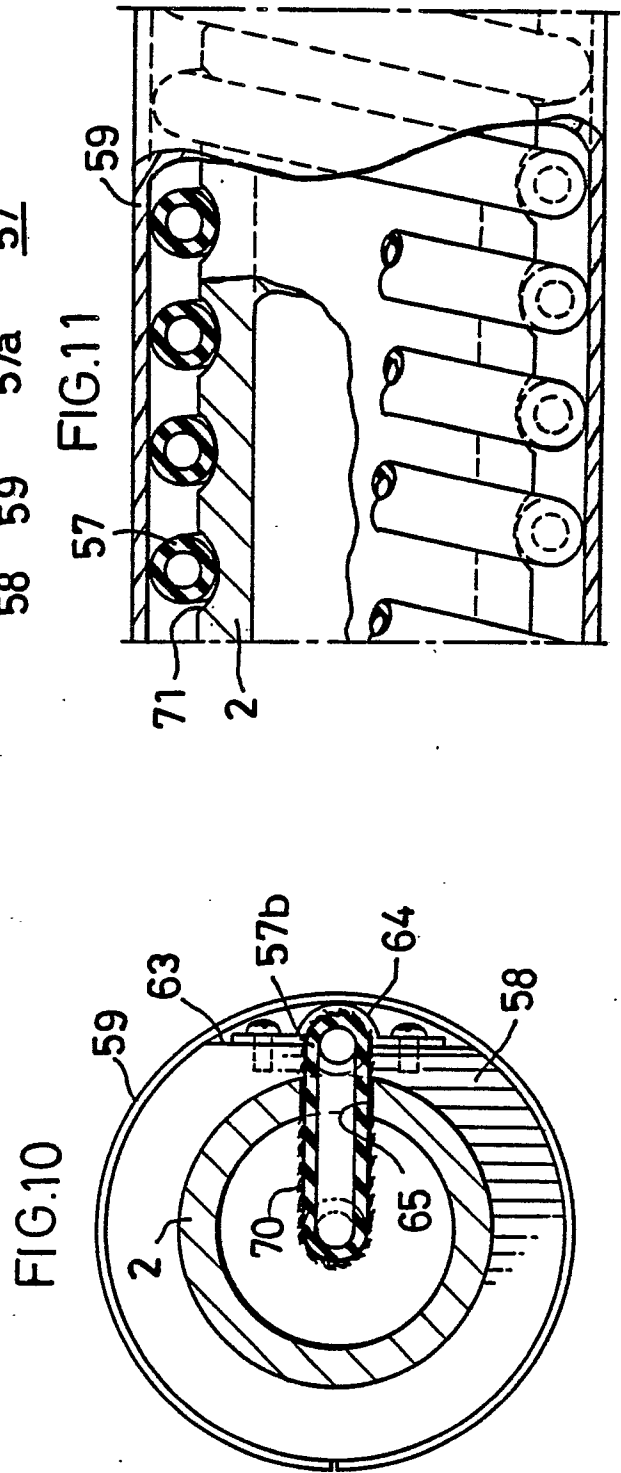
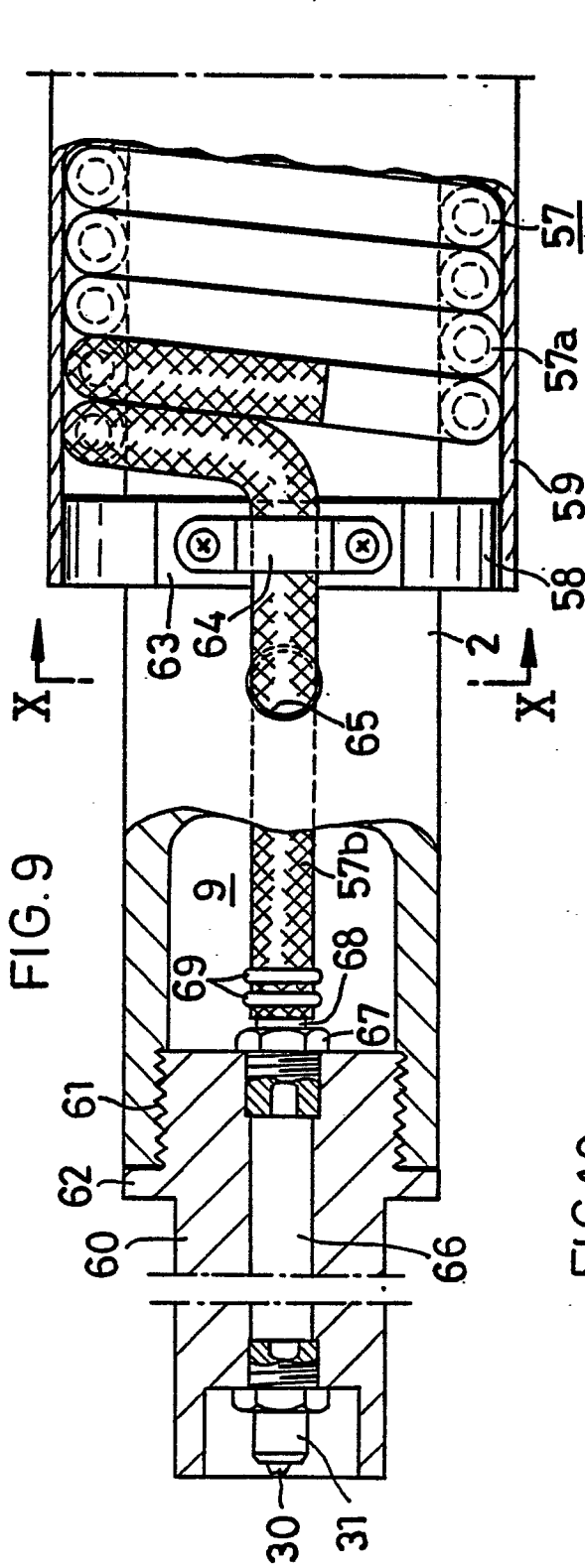
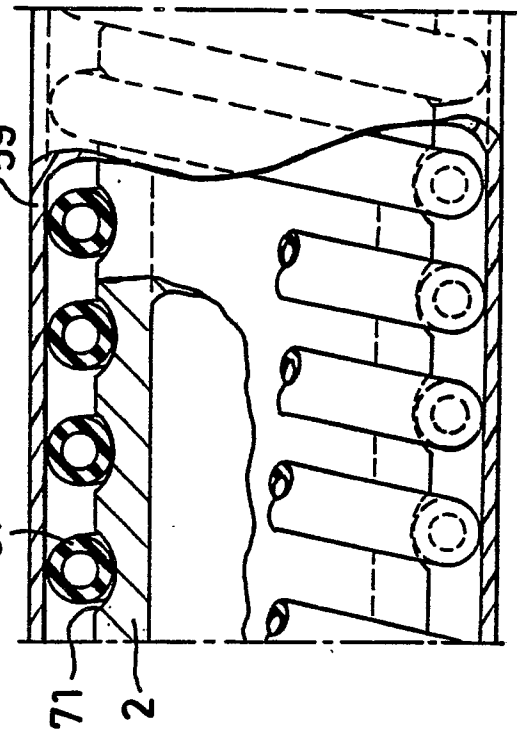


FIG.11





European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 88 12 1729

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-3937412 (L R DAMOUR) * column 3, line 42 - column 4, line 22 * * column 5, line 4 - column 6, line 34 * ---	1, 3, 14, 16, 17, 18	B65H75/24
X	US-A-3825167 (A J KOMOREK; L R DAMOUR) * claim 1; figures 1-15 * ---	1, 3, 9, 16, 17	
X	CA-A-654990 (CANADIAN GENERAL ELECTRIC COMPANY) * page 11, line 8 - page 12, line 27 * * page 13, line 20 - page 15, line 23 * * page 18, line 26 - page 19, line 10 * ---	1, 14, 15	
A	CA-A-653299 (B.F. GOODRICH COMPANY) * page 6, line 15 - page 8, line 20 * * page 11, line 20 - line 28 * ---	5, 6, 7	
A	US-A-4632328 (M E BISHOP; D E THENLIS) * the whole document * ---	5, 6, 7	
X	US-A-3834257 (W GANSER) * the whole document * ---	1, 14	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
X	DE-A-2041860 (W BRAHM) * page 5, line 13 - page 6, line 17 * * page 9 - 11 * ---	1, 3, 6, 14, 15	B65H
X	US-A-3917187 (L R DAMOUR) * claim 1; figures 1-10 * ---	1, 3	
A	US-A-4436252 (W BÜRKLE; D OPITZ) ---		
A	CH-A-457073 (POLYTYPE A G) ---		
A	DE-U-8004622 (TH. GOLDSCHMIDT) ---		
A	US-A-3425642 (B.F. GOODRICH COMPANY) -----		
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 22 MARCH 1989	Examiner D HULSTER E.W.F.
CATEGORY OF CITED DOCUMENTS X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application I: document cited for other reasons ----- &: member of the same patent family, corresponding document			