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(54) **MELANGE DE FIL POUR DIMINUER LE FROTTEMENT**

(54) **YARN BLEND FOR FRICTION APPLICATIONS**

(57) L'invention concerne un fil coupé renfermant un mélange avec 35 à 90 pour cent en poids de fibres de polymère fluoré et 10 à 65 pour cent en poids d'un ou plusieurs type(s) de fibres mixtes.

(57) A staple yarn comprising a blend of 35 to 90 weight percent fluoropolymer fiber and 65 to 10 weight percent of one or more types of blend fiber.

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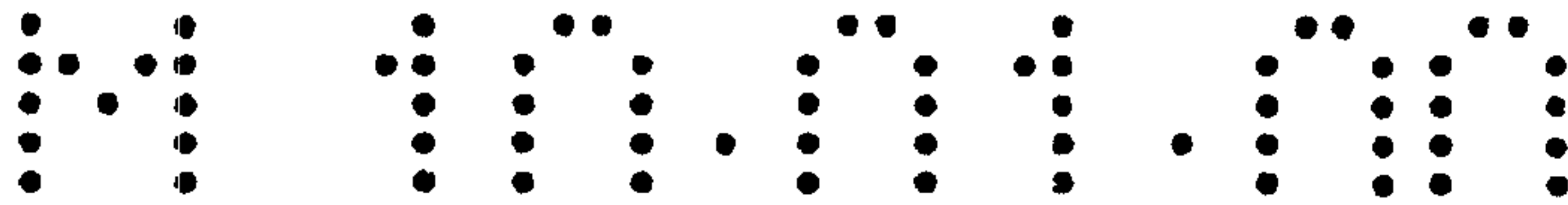


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(21) International Application Number: PCT/US99/01596 (22) International Filing Date: 26 January 1999 (26.01.99) (30) Priority Data: 60/073,305 28 January 1998 (28.01.98) US 60/086,776 26 May 1998 (26.05.98) US (71) Applicant: E.I. DU PONT DE NEMOURS AND COMPANY [US/US]; 1007 Market Street, Wilmington, DE 19898 (US). (72) Inventors: KRUSZEWSKI, Reginald, Thomas; 2404 Saint Regis Drive, Richmond, VA 23236 (US). NELSON, Arthur, Russell; 5310 Watercrest Road, Midlothian, VA 23112 (US). (74) Agent: TULLOCH, Rebecca, W.; E.I. du Pont de Nemours and Company, Legal Patent Records Center, 1007 Market Street, Wilmington, DE 19898 (US).	(81) Designated States: AU, BR, CA, CN, IN, JP, KR, MX, RU, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report. Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i>	
(54) Title: YARN BLEND FOR FRICTION APPLICATIONS (57) Abstract A staple yarn comprising a blend of 35 to 90 weight percent fluoropolymer fiber and 65 to 10 weight percent of one or more types of blend fiber.		



Fluoropolymer continuous filament may be spun by a variety of means, depending on the exact fluoropolymer composition desired. The fibers may be spun by dispersion spinning; that is, a dispersion of insoluble fluoropolymer particles is mixed with a solution of a soluble matrix polymer, and this mixture is then coagulated into filaments by extruding the mixture into a coagulation solution in which the matrix polymer becomes insoluble. The insoluble matrix material may later be sintered and removed if desired. Alternatively, if melt viscosities are amenable, filament may also be spun directly from a melt. Fibers may also be produced by mixing fine powdered fluoropolymer with an extrusion aid, forming this mixture into a billet and extruding the mixture through a die to produce fibers which may have either expanded or un-expanded structures.

After the spinning process, the continuous filament fibers are then cut to staple lengths in the range of 1.3 to 7.6 cm (0.5 to 3.0 inches). For the purposes of this invention the preferred staple length is from 3.8 to 5.1 cm (1.5 to 2.0 inches). Linear density per filament may range from 0.11 to 16.7 dtex (0.1 to 15 denier).

By "blend fiber" is meant commonly available fibers including polyesters, polyamides, aromatic polyamides, polypropylenes, polyethylenes and their copolymers; natural fibers such as cotton, rayon, and wool; fibers made from high performance polymers including poly(para-phenylene terephthalamide (PPD-T), poly(para-phenylene benzobisoxazole (PBO), ultrahigh molecular weight polyethylene (UHMWPE), anisotropic melt polyesters; and high modulus fibers such as carbon fibers, metal fibers and glass fibers and any of the previously mentioned classes or types of fibers with special coatings, such as metal-coated para-aramid fibers. The cut staple lengths of the blend fiber may be any length which is compatible with the

fluoropolymer staple. For the purposes of this invention, the preferred staple length is equal to or less than that of the fluoropolymer staple and is in the range of 1.3 to 5.1 cm (0.5 to 2.0 inches).

5 The fluoropolymer staple fiber and the blend staple fiber are combined and processed into a staple yarn using conventional methods. For example, the required amounts of each staple fiber can be blended together and then opened and carded to produce a carded
10 sliver. The carded sliver can then be drawn and further attenuated into a roving and finally ring spun into a staple yarn.

The yarns of the present invention contain 25 to 90 weight percent fluoropolymer fiber and 75 to 10
15 weight percent blend fiber. A preferred weight distribution is 35 to 75 weight percent fluoropolymer content; 65 to 25 weight percent blend fiber content. A more preferred weight distribution is 35 to 65% fluoropolymer, 65 to 35% blend fiber. The practical
20 frictional benefits of the fiber are reduced when the fluoropolymer content is below 35 weight percent for most industrial end uses. Above 90 weight percent fluoropolymer content, a usable staple fiber yarn is more difficult to produce since filament to filament
25 cohesion in the yarn bundle is low. Also the yarn becomes less cost effective. A preferred yarn of the present invention is a 50 weight percent PTFE and 50 weight percent blend fiber. The preferred blend fiber is polyester fiber.

30 The yarns of this invention have a low yarn-to-metal coefficient of friction and allow the tailoring of both yarn structure and fiber content for the particular load-bearing application. For example, the blend fiber may be selected to increase an inherent
35 deficiency in fluoropolymer fiber, such as low modulus by selecting as the blend fiber a high modulus fiber. If desired, continuous filament yarns can be added to the staple yarn of this invention to provide additional

strength of wear properties. For example, one or more
continuous filament yarns can be used as core yarns
with the blended staple fibers substantially wrapped
or overspun around these yarns. If very high tenacity
5 yarns with improved frictional or noise reduction
properties are desired, a high tenacity continuous
filament yarn could be wrapped by the staple fiber
composition of the present invention. Alternatively,
the blended staple fiber yarn can first be made and
10 then plied with the continuous filament yarns. It is
also possible for one or more continuous filament yarns
to substantially wrap the blended staple yarns. For
example, a continuous filament thermoplastic yarn could
wrap a fluoropolymer and thermoplastic blended staple
15 yarn wherein the filament yarn would act as a
sacrificial covering for the staple yarn.

Likewise, selection of blend fiber and/or the
actual yarn structure, for example, the length of the
staple fluoropolymer or blend fibers, the placement of
20 the staple fibers in the body of the yarn or the yarn
twist, may be optimized to compensate for shrinkage or
adhesion problems known to exist with fluoropolymer
fibers.

The yarns of this invention may be used in low
25 friction wound products or may be made into fabrics to
be used in many load-bearing applications. In both the
yarn and fabric forms, it is important that the fiber
spin finish on the blend yarn be compatible with the
fluoropolymer; that is, finishes applied to the blend
30 fiber do not negatively impact the frictional
performance of the yarn or the fabric. It is thought
that the best fabric frictional performance is obtained
when there is little or no finish on the blend yarn.
Finish used in manufacture of the blend fiber may be
35 removed by washing before the blend yarn is combined
with the fluoropolymer yarn.

The yarns of this invention may be used in fabric
liners for rubber parts to eliminate noise in

clear the low modulus of the PTFE fibers can be overcome by selecting blending fibers that have a very high modulus such as para-aramid, PBO, or high molecular weight polyethylene. The resultant pile fabrics have low friction but improved stiffness for an improved seal.

Such fabrics can be any type of knit, braided or woven fabric but preferably pile fabrics such as a knit fleece or a woven velour fabric. The actual seal is formed by taking the fabric and attaching or laminating it to a mounting bracket that is installed in the door frame so that it rests under pressure against the window to form a seal which keeps out moisture and wind while allowing easy up and down motion of the window.

The yarns of this invention can also be used in fabric bearings which are not impregnated with thermoset resins. Fabric bearing made from 100% PTFE fiber can experience problems under some conditions; the natural tendency is for PTFE to cold flow, especially under continuous loads that exceed 703 kg/cm² (10,000 psi). The yarns of this invention offer a practical solution to this problem, by combining the fluoropolymer fibers with other high strength, high modulus fibers to make possible a fabric having both improved weight bearing properties in combination with the lubricity and improved cold flow resistance. The preferred high modulus fibers useful in this spun yarn include para-aramid, PBO, carbon, glass, and UHMWPE fibers.

The yarns of this invention can also be used to make composite bearings. As described previously, the bearing is made by using either a fabric tube or flat fabric or individual yarns that have bonding fibers twisted around them and then wrapped around a mandrel that can be either round, hex, square or a variety of shapes. This is wetted with epoxy and then heat set. Glass fiber or some other reinforcing fiber is then filament wound around the core. This is then heat set

and afterwards the tube is pushed off the core allowing it to be cut into individual bearings. The outer fiber reinforced surface can also be machined to a proper outer diameter. The use of thermoplastic fiber as the blend fiber in the yarn of this invention eliminates the need for the addition of the bonding fiber used in the making of bearings made according to the present invention. The elimination of the separate step of wrapping individual fluoropolymer yarns with a bonding fiber, or in the case of fabric tubes, the addition of blended staple yarns, means the epoxy can better wet and uniformly impregnate the wound yarn or fabric tube, resulting in a more uniform composite bearing. This results in fewer manufacturing defects and higher yields. By using blend fibers having either high temperature fibers with good abrasion resistance (aramids, PBO, and UHMWPE) or blend fibers having good thermal conductivity (graphite, metal, aramids coated with metals, carbon, and graphite filled fibers) bearings having broader operating ranges are possible.

The yarns of this invention are useful in other types of composite bearing such as those made by laminating fabrics to metal. This type of bearing benefits from a fabric that is thermally conductive. Fibers with good thermal conductivity allow higher operating velocities because heat dissipates from the fabric surface through the backing. This improvement increases the load carrying capability of the final parts and helps simplify the manufacturing process by eliminating the need for heat setting of the fabric.

As an additional advantage of the present invention, it has also been found that yarns containing less than 35 wt% fluoropolymer have additional benefits when used in bearings and bushings even though the frictional benefits are reduced. It has been found that yarn made with as little as 10% fluoropolymer fiber can significantly reduce the noise during operation of the bearing or bushing.

The following example illustrates the present invention, but is not intended to limit the invention.

Example

5 This example illustrates the performance of a fabric of the present invention in an automotive stabilizer bar bushing application.

10 Stabilizer bars are used in many automobiles to provide stiffness and stability in cornering. The bushings used in stabilizer bars are generally made of a 100% PTFE fiber knitted with polyester fiber such that the 100% PTFE fiber is exposed primarily on one face of the fabric (the PTFE face) while the other face of the fabric has exposed primarily polyester fiber.

15 This fabric is molded into the bushing so that the PTFE face of the fabric contacts the metal surface of the stabilizer bar. Although costly these fabrics, having approximately 100% PTFE faces (~50% by weight PTFE) are preferred because they eliminate noise.

20 Test fabrics made according to the present invention, were knitted as described below and tested in an apparatus designed to simulate the stabilizer, bushing and housing assembly of a stabilizer bar system.

25 The apparatus and its components used in the testing are shown in Figures 1A to 1C. The apparatus consists of a split metal block which represents the housing and has the dimensions 10.2 x 7.6 x 3.8 cm (4 x 3 x 1.5 inches). The block is cut so that there are

30 two half-cylindrical cutouts in the face of each half of the split block. The top half of the split block, 1, has drilled through its body two 0.95 cm (3/8 inch) diameter holes, 3, through which bolts, 5, are inserted; the bottom half, 2, is tapped with 0.95 cm

35 (3/8 inch) threads, 4, so that the two halves of the split block can be held together by a predetermined force applied to the bolts. In this apparatus the stabilizer bar is represented by a metal rod, 6, having

a length of 10.2 cm (4 inches) and a diameter of 2.5 cm (1 inch). To the top of this rod is welded a 2.5 cm (1 inch) diameter hexagonal head. The head allowed a torque wrench to be used to apply a turning force to the rod once it is secured in the housing.

The apparatus was assembled as follows to test fabrics:

The fabric strips to be tested were placed on a strip of rubber 3.8 x 8.9 cm (1.5 x 3.5 inches) and 0.3 cm (1/8 inch) thick. The rubber and fabric were wrapped around the rod with the PTFE fabric face in contact with the rod as in Figure 1C, and the rod was positioned in the cut-outs of the split block. The bolts were inserted into the drilled holes, and they were screwed into the threads pulling the two halves of the split block together. The bolts were tightened to a torque of 484 kg-cm (35lbs-ft). This amount of torque assured that the rod and sample were tightly held in position between the two halves of the split block. The split block was secured to a bench top. The torque wrench was then attached to the hex head of the rod, and force was applied to the torque wrench to turn the rod. The amount of force required to break the rod free was measured in kg-cm (pound-feet). The amount of force to continue to turn the rod after it broke free was also measured. As the rod was turned any noise produced was noted.

The fabrics tested were pleat knitted. This is the type of knitting used in making fabrics for use in stabilizer bar bushings, and this type of knitting allows two types of yarn to be knitted together such that one side of the knitted fabric has one yarn surface and the other side has the other yarn surface. Test fabrics were knitted using as one yarn 100% polyester and as the second yarn, blends of polyester and PTFE staple fiber according to the present invention. The control fabric had 100% PTFE yarn knitted with the polyester yarn. Just as in bushing manufacture, the polyester fabric side was placed next

to the rubber strip and the PTFE staple fiber blend
 faced the metal rod as shown in Figure 1C. In the
 test, as the rod turned, it turned against the fabric
 side containing the PTFE blend. The rubber strip was
 5 held fast in the split block.

Data from the test is shown below. Fabrics were
 characterized as the weight percent of PTFE in the
 PTFE/polyester blend staple yarn and by the total
 weight % of PTFE in the fabric. Because the fabric is
 10 knitted from two yarns the weight % of PTFE in the
 fabric is approximately one half that of the total yarn
 in the knitted fabric. The forces measured were the
 torque to break the rod free and to begin the rotation
 (the force to overcome inertia) and the rotating force.
 15 The torque was measured using a round beam torque
 wrench. In all cases of fabrics containing PTFE, as
 100% of the fabric face or as a component of a blended
 staple yarn fabric face, no noise was heard in the
 breaking free of the rod or in the rotation of the rod.

20

	Yarn Wt %PTFE	Fabric Wt% PTFE	Force to Break		Force to rotate	
			Kg-cm	(lbs-ft)	kg-cm	(lbs-ft)
	100	50	415	(30)	138	(10)
	50	25	415	(30)	166-207	(12-15)
25	25	12.5	484	(35)	176	(20)

We Claim:

1 1 0 0 1 0 0

1. A staple yarn comprising a blend of 35 to 90 weight percent fluoropolymer fiber and 65 to 10 weight percent of one or more types of blend fiber.

2. The yarn of Claim 1 wherein the blend is from 35 to 75 weight percent fluoropolymer and from 65 to 25 weight percent blend fiber.

3. The yarn of Claim 1 wherein the blend is from 35 to 65 weight percent fluoropolymer and from 65 to 35 weight percent blend fiber.

4. The yarn of Claim 1 wherein the fluoropolymer is selected from the group consisting of poly(tetrafluoroethylene), fluorinated olefinic polymers, copolymers of tetrafluoro-ethylene and hexafluoropropene, copolymers of tetrafluoroethylene and perfluoroalkyl-vinyl esters, and copolymers of perfluoroethyl-vinyl ether and fluorinated olefinic terpolymers.

5. The yarn of Claim 3 wherein the fluoropolymer is selected from the group consisting of poly(tetrafluoroethylene), fluorinated olefinic polymers, copolymers of tetrafluoro-ethylene and hexafluoropropene, copolymers of tetrafluoroethylene and perfluoroalkyl-vinyl esters, and copolymers of perfluoroethyl-vinyl ether and fluorinated olefinic terpolymers.

6. The yarn of Claim 1 wherein the blend fiber is selected from fibers from the group consisting of polyesters, polyamides, aromatic polyamides, polypropylenes, polyethylenes and their copolymers, cotton, rayon, and wool, poly(para-phenylene terephthalamide), poly(meta phenylene isophthalamide), poly(para-phenylene benzobisoxazole, ultrahigh

molecular weight polyethylene, anisotropic melt polyesters, carbon fibers, metal fibers, glass fibers and metal-coated para-aramid fibers.

5 7. The yarn of Claim 3 wherein the blend fiber is selected from fibers from the group consisting of polyesters, polyamides, aromatic polyamides, polypropylenes, polyethylenes and their copolymers, cotton, rayon, and wool, poly(para-phenylene
10 terephthalamide), poly (meta phenylene isophthalamide), poly(para-phenylene benzobisoxazole, ultrahigh molecular weight polyethylene, anisotropic melt polyesters, carbon fibers, metal fibers, glass fibers and metal-coated para-aramid fibers.

15 8. The yarn of Claim 1, 2 or 3 wherein the blend fiber is poly(para-phenylene terephthalamide) or poly (meta phenylene isophthalamide).

20 9. A low friction wound product comprising the yarn of Claims 1, 2 or 3.

 10. A fabric for load bearing applications comprising the yarn of Claim 1, 2 or 3.

25 11. A yarn comprising a continuous filament yarn and a blend of staple fibers wherein the staple fibers comprise from 35 to 90 weight percent fluoropolymer fiber and 65 to 10 weight percent of one or more types
30 of blend fiber.

 12. The yarn of Claim 11 wherein the one or more continuous filament yarns are substantially wrapped or overspun by the staple fibers.

35 13. The yarn of Claim 11 wherein the one or more continuous filament yarns substantially wrap the staple fibers.

14. A bearing, bushing, or seal made using the yarn of Claim 1, 2, 3, 4, 5, 6, 7, 8, 11, 12, or 13.

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FIG. 1A

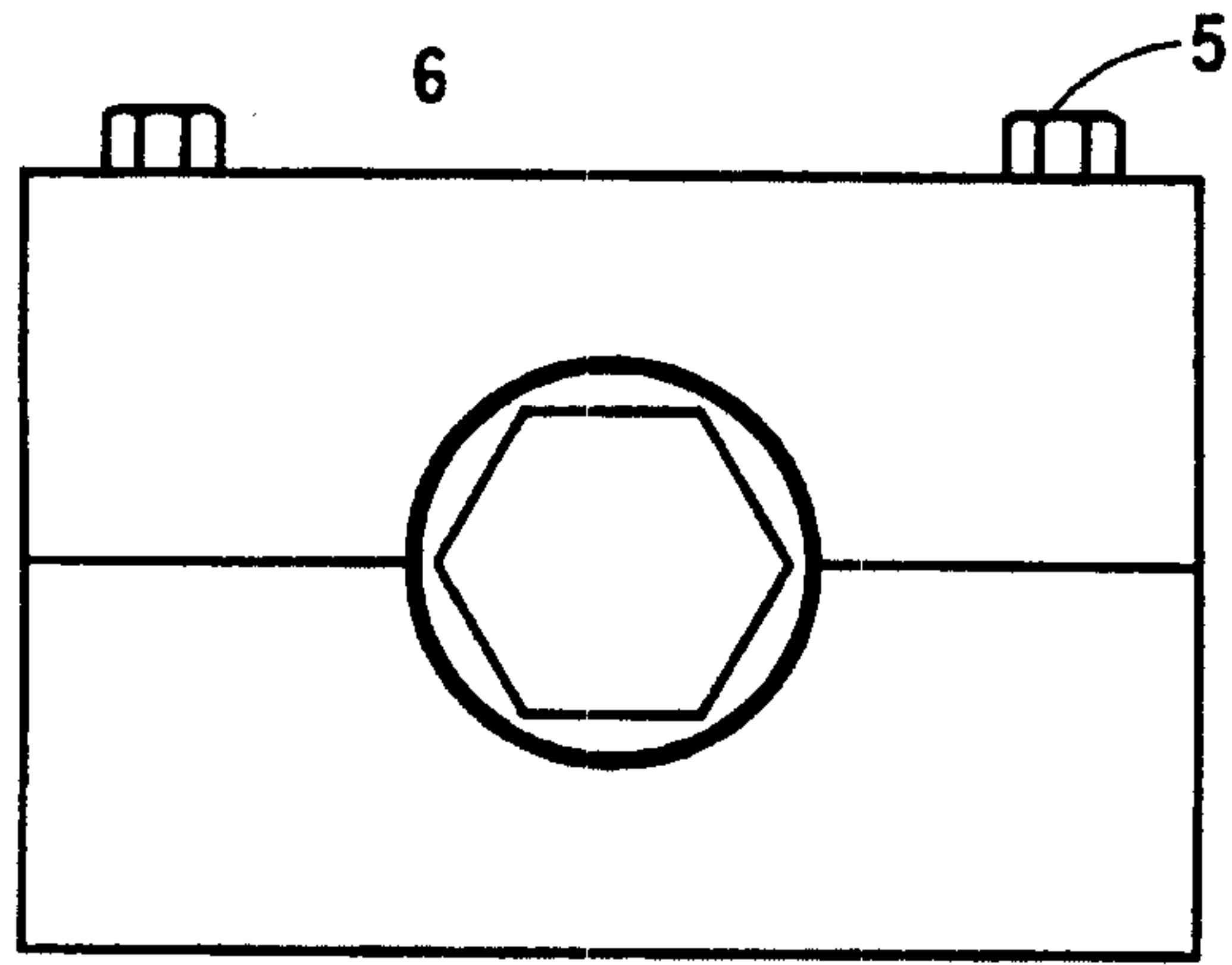
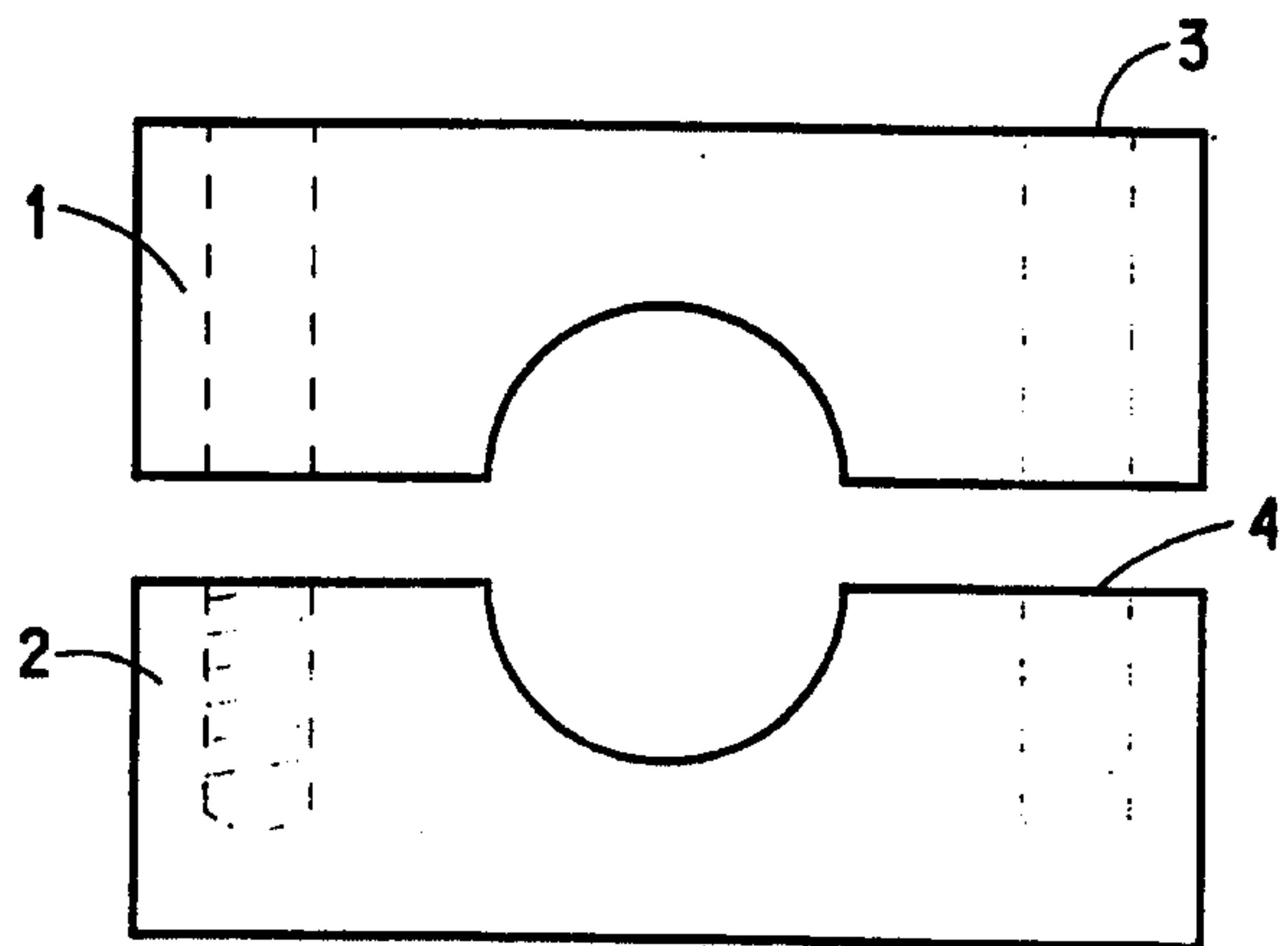


FIG. 1B

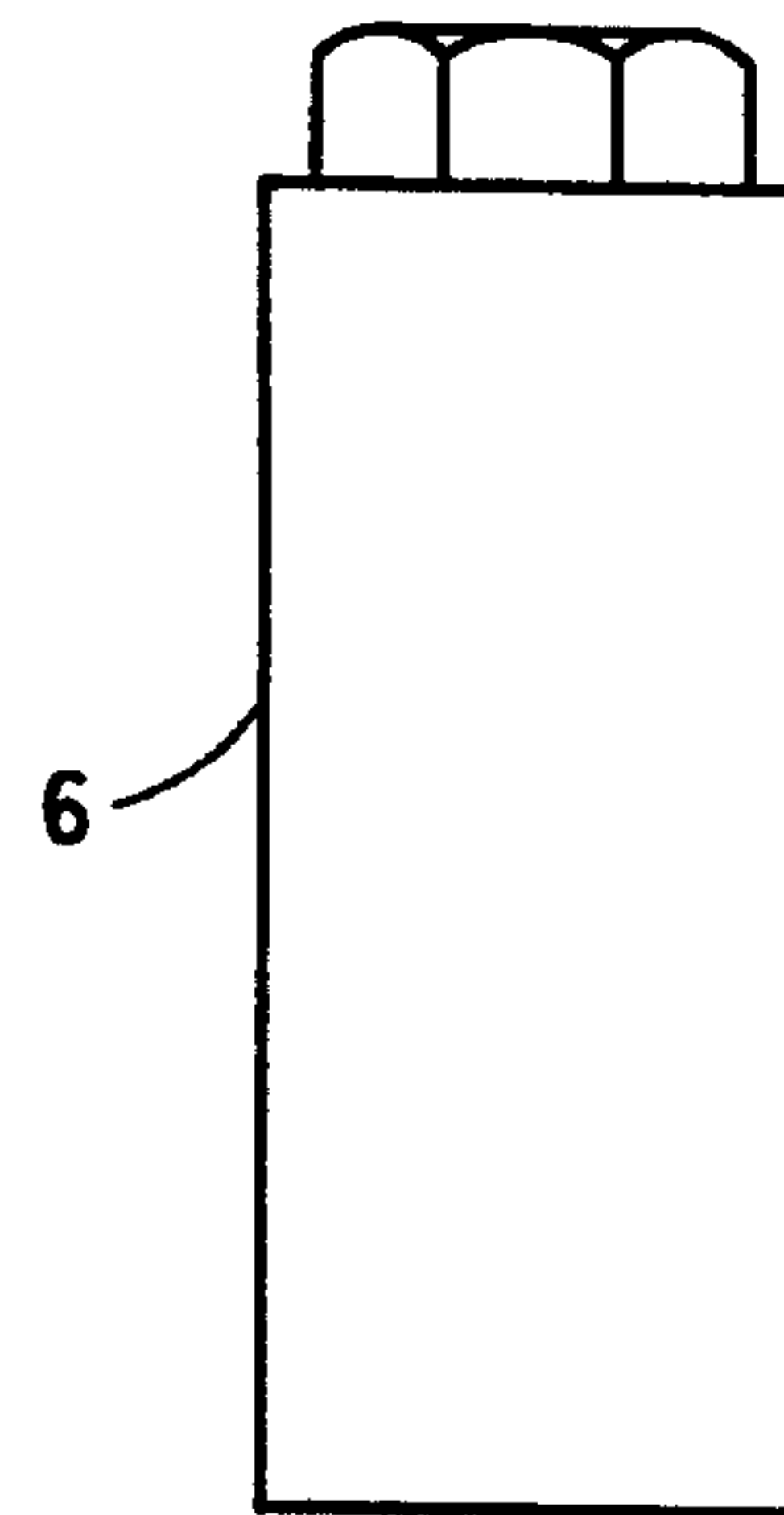


FIG. 1D

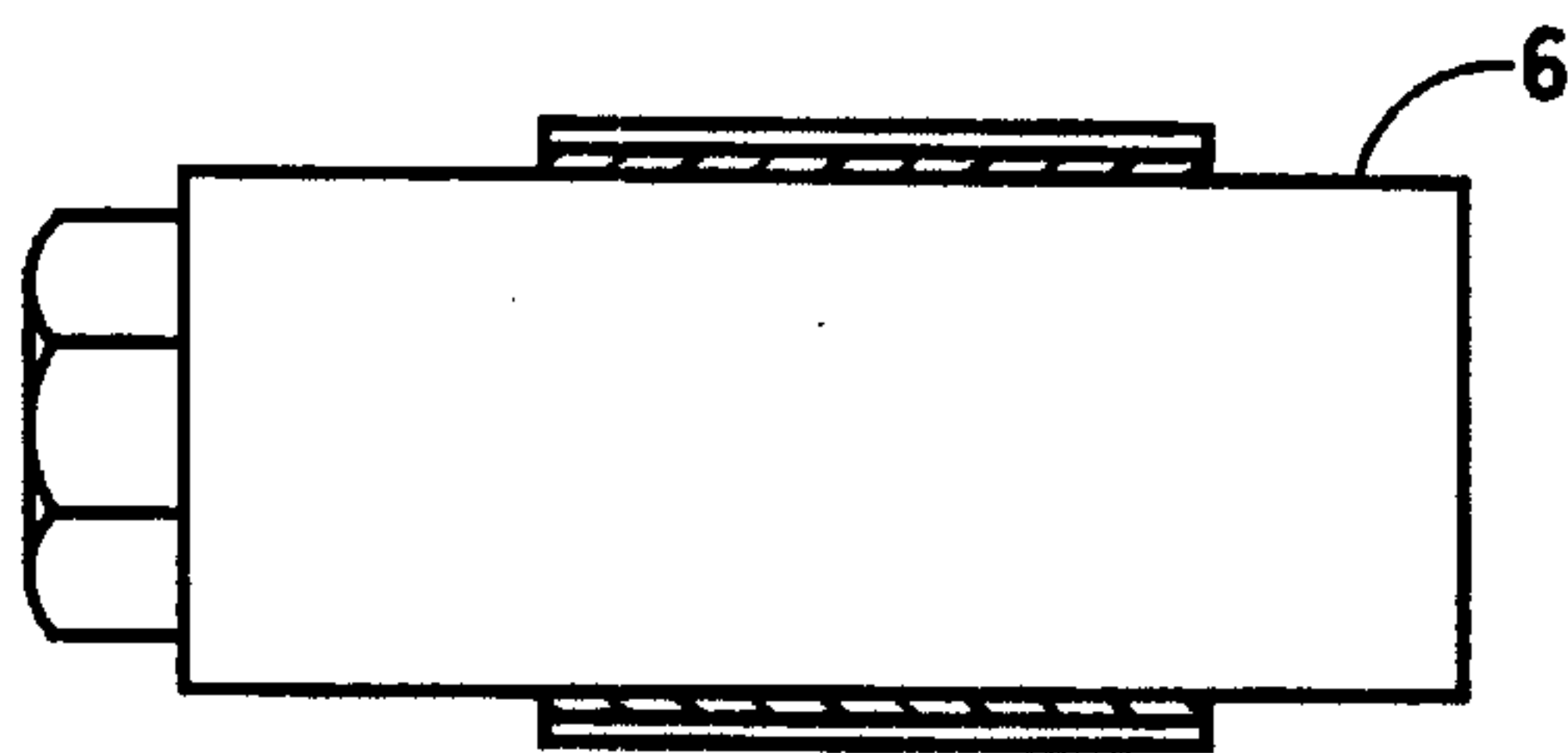


FIG. 1C