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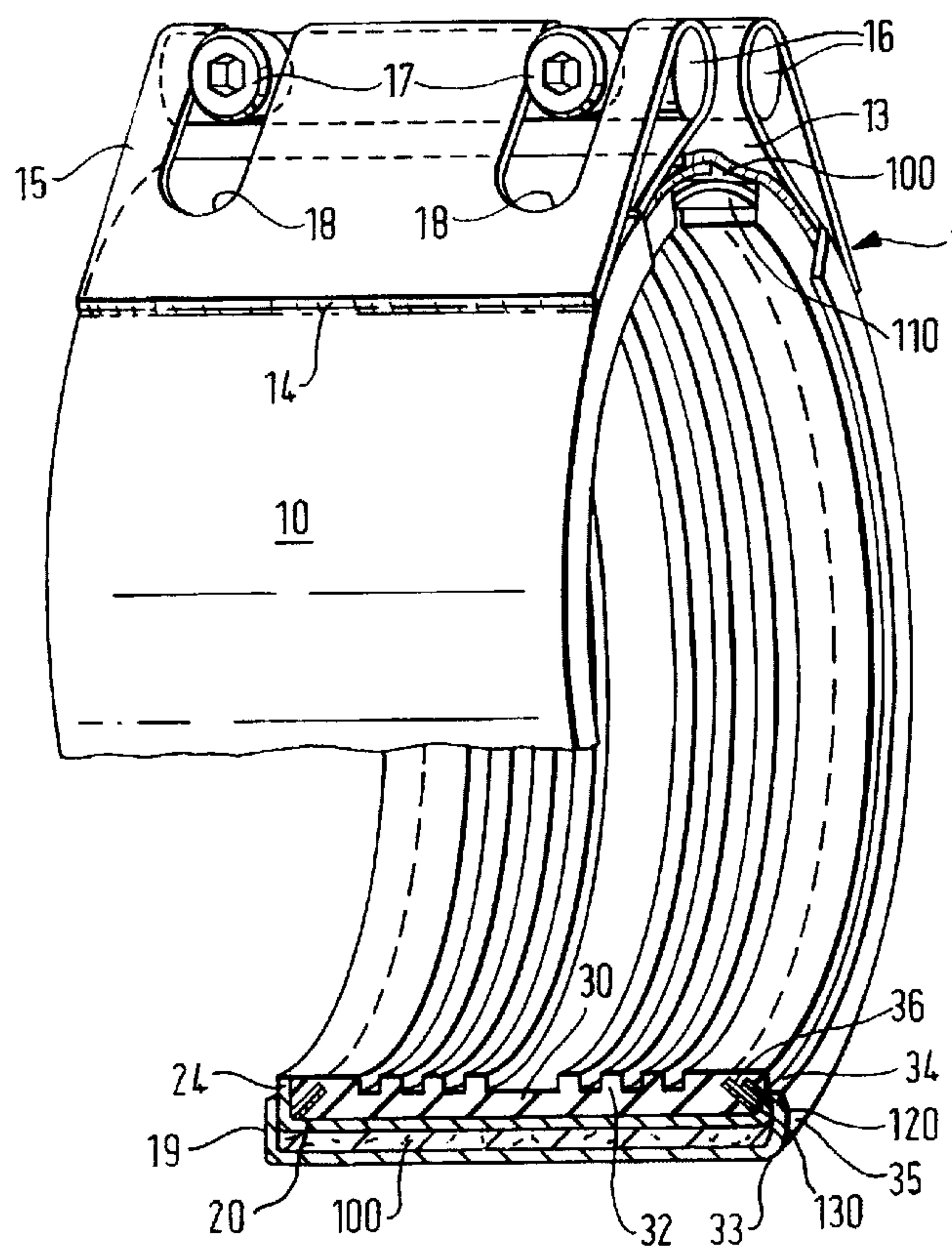

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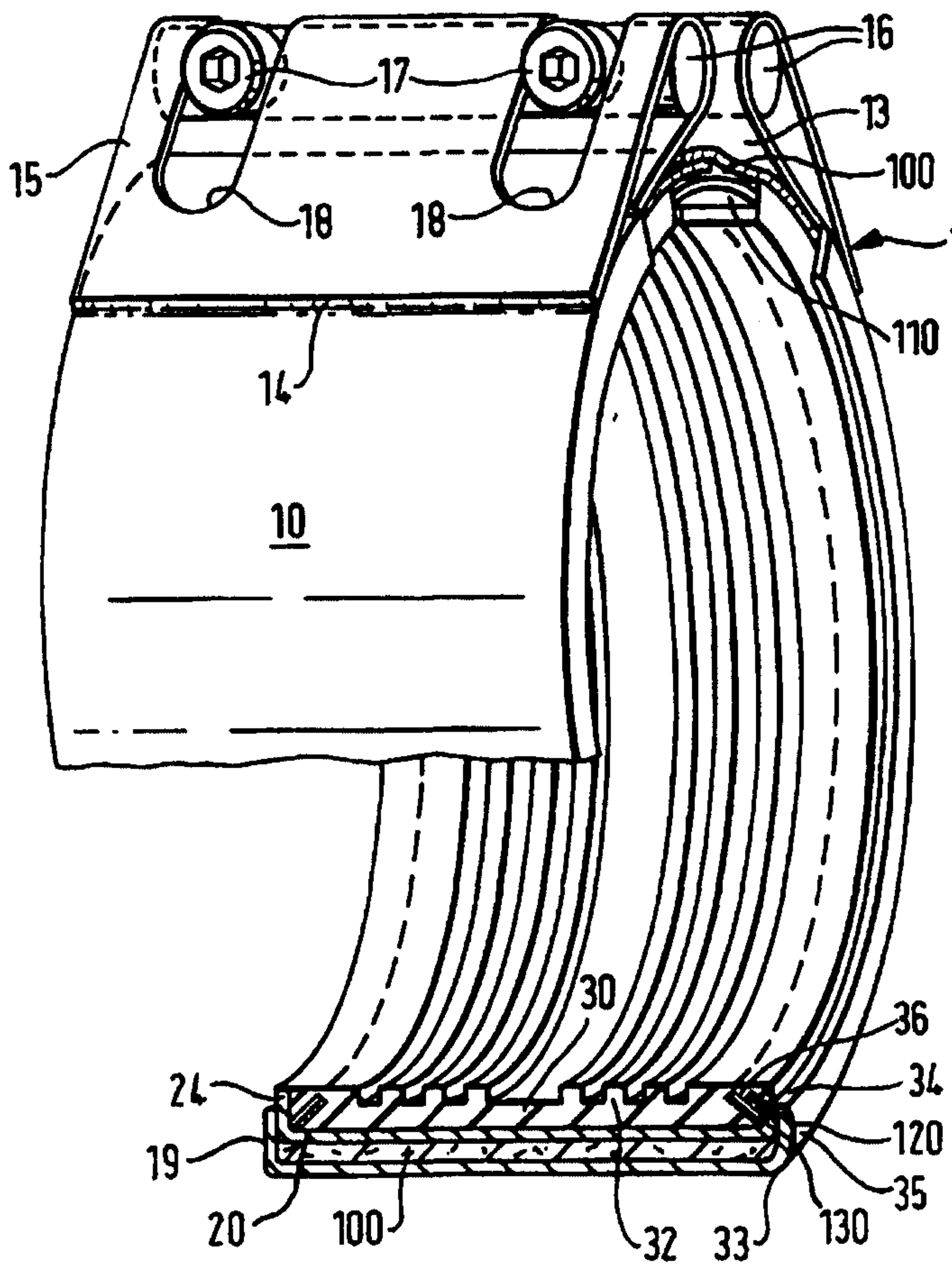
(54) Title: FIRE-RESISTANT PIPE COUPLING

(57) Abstract

A pipe coupling (1) for coupling together two pipes in a fluid-tight manner comprises a tubular casing, a tubular sealing gasket (30) located within the casing, and screws (17) for tensioning the casing around the gasket. The casing comprises an inner tubular casing (20) and an outer tubular casing (10), both of metal. A layer of fire-resistant thermally-insulating material (100) is disposed between the inner and outer casings (20, 10) to form a fire shield.



FIRE-RESISTANT PIPE COUPLING

The present invention relates to pipe couplings for connecting together two plain-ended pipes in a fluid-tight manner, of the type consisting of a tubular casing formed with a longitudinal gap, a sealing gasket of resilient flexible material typically of rubber or synthetic rubber, arranged within the casing, and tensioning means for reducing the width of the longitudinal gap so as to tighten the casing around the gasket. In use, the sealing sleeve is placed around the adjacent pipe ends and the tensioning means are tightened to clamp the sleeve against the outer surfaces of the pipe ends to form a fluid tight seal.

One known pipe coupling of this type is described in our patent specification EP-A-0542779.

Joining together pipes with plain ends with such couplings avoids the need for pipe preparation and is therefore quicker and more economical than other methods such as welding, screw threading, flanging, grooving or shouldering.

In the coupling of the above-mentioned patent specification, the sealing gasket has circumferential slots and a gripping ring with inwardly projecting gripping teeth in each slot. In use when the tensioning means are tightened around the casing the gripping teeth penetrate the sealing gasket at the bottom of the slot and engage the outer surface of the pipe to hold the pipe ends against axial displacement.

Couplings of the type described above are often required for use in systems where resistance to fire is required. For such applications the coupling may have to pass a specific fire test. Fire tests often require the coupling to perform when subjected to a flame temperature of, typically 800°C and under a variety of simulated pipeline conditions. The test conditions depend on the testing authority and/or the intended field of application. For some tests the pipes will be empty, for others they will be pressurized with cold water or with hot water at, typically, 80°C. After the test, which is typically of 30 minutes duration, the coupling will usually be expected to withstand a pressure test to the published maximum test pressure - typically 24 bars.

The known pipe couplings cope extremely well with most of these tests by virtue of the fact that within the time span of the tests, the rubber gaskets do not exceed the temperature performance limitations whereby the rubber will melt, revert or decompose and thus lose its sealing ability. In general, provided the gasket remains below, say 250°C, for the duration of the test, it will not fail.

There are some fire tests, particularly for sprinkler systems, where the pipes must be empty for the duration of the test and thus the rubber is not cooled by the internal pipe medium. Recently introduced new higher marine standards have meant that the coupling has to withstand flames of greater intensity or temperature than was previously required. This is generally reflective of a raising of standards in the shipping industry.

There is a requirement for a pipe coupling that can meet the higher fire performance requirements whilst retaining the advantages of the known gasketed mechanical coupling of time saving in installation, flexibility and ease of installation. One possibility is to wrap the coupling, after installation, with mineral wool and fire-shielding fabrics in order to reduce the temperature within the coupling to less than the critical value of approximately 250°C. There are, however, severe drawbacks with this approach. The materials needed are extremely expensive; they have to be expertly prepared to a given formula ensuring a certain number of wraps and an exact thickness of material, to ensure the desired degree of protection; each size of coupling will require a different length of material, and in many cases materials will have to be pre-prepared to fit round the coupling rather than being cut in situ. Consequently, this solution is feasible but impractical.

According to the present invention a pipe coupling for coupling together two pipes in a fluid-tight manner comprises a tubular casing, a tubular sealing gasket located within the casing, and means for tensioning the casing around the gasket, the casing comprising an inner tubular casing and an outer tubular casing, the inner casing fitting entirely inside the outer casing, a layer of fire-resistant thermally-insulating material being disposed between the inner and outer casings whereby the inner and outer casing are thermally insulated from one another.

The coupling of the invention combines the advantages of the fire-shielding materials with a pipe coupling such that the coupling maybe supplied complete with its own fire shield and be fitted in place without any further preparation. By placing a fire sleeve of, typically 3mm-5mm thickness between the inner and outer casing of the coupling such that when the coupling is tightened it will slide easily over the fire shield without rucking and close down around the pipe, a satisfactory fire performance can be achieved without affecting its other properties of sealing or anchoring the pipes.

The problems which have been solved in enabling this invention to work have been to reconcile the tolerance of the coupling to having an extra 6-10mm of diameter between the pipe surface and the outer casing of the coupling, to ensure that the fire shield does not ruck when the coupling is closed, and to ensure that the coupling is protected fully about its entire circumference at all times.

The difference over previous couplings is so great that a coupling in accordance with the present invention has been constructed which can withstand temperatures of 950°C without any deterioration. In unprotected couplings failure would occur under these conditions in less than 6 minutes.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, of which:-

Fig. 1 shows a perspective cut-away view of a coupling in accordance with the invention;

Fig. 2 shows an end view of the coupling of Fig. 1;

Fig. 3 shows a longitudinal section through the coupling of Fig. 1;

Fig. 4 shows a perspective view of the gripping ring of the coupling of Figs. 1 to 3;

Fig. 5 shows a detailed transverse cross section of the coupling of Figs. 1 to 4; and

Fig. 6 shows a detail longitudinal section of the coupling of Figs. 1 to 5.

A pipe coupling 1 comprises an outer tubular casing 10 an inner tubular casing 20 and a sealing gasket 30. The outer tubular casing 10 is formed of rolled steel, with a longitudinal gap 13. The casing is folded back on itself at its free ends and welded at 14 to form loops 15 along opposite edges of the longitudinal gap 13. Pins 16 are inserted in the loops. Tensioning screws 17 pass through transverse holes in one of the pins 16 into tapped transverse holes in the other of the pins 16, so as to interconnect the two free ends of the outer casing 10.

Slots 18 are cut in the loops 15 so as to provide clearance for the screws. The axial end margins of the casing 10 are bent inwardly at right angles to form radial flanges 19.

The inner tubular casing 20 is of rolled steel and has a longitudinal gap 23. The axial end margins of the casing 20 are bent inwardly at right angles to form radial flanges 24. The casing 20 fits inside the outer casing 10, the axial length of the casing 20 being slightly less than that of the casing 10 so that the flanges 24 fit inside the flanges 19.

The technical advancement of the present invention has been achieved by forming the couplings of two circumferential casings, the outer casing 10 being formed deliberately larger than the inner casing 20 in order to accommodate an inserted fire shield 100.

The fire shield is a prepared strip of material cut to the circumference of the pipe inclusive of the thickness of the gasket and inner casing + 1% for overlap and tolerance. The shaping of the outer and inner casings are smooth and identical so that a low friction surface is offered to the fire shield for easy sliding when closing the coupling. This is important because a coupling which has only one casing will not provide low friction surfaces between the steel casing and the rubber gasket or sealing sleeve. Other designs of couplings have components in the coupling casing which would snag or prevent the casing from closing up against the fire shield.

The outer and inner steel casings 10 and 20 are insulated one from the other by the layer of fire-resistant thermally-insulating material or fire shield 100. In previous couplings the gaps in the inner and outer casings have been set diametrically opposite in order to give a continuous steel band over the gasket. In the preferred embodiment of coupling according to the invention, the gaps 13 and 23 are in line and an extra bridging component 110 completes the circumferential band. This is in order to control the smooth sliding of the fire shield when closing the coupling. The extra bridging component is termed a "sub-bridge". The component 110 is secured to the inner side of the inner casing by spot welding.

To prevent the two casings rotating relative to one another, anti-rotation notches 120 and 130 are provided in the end flanges 19 and 24 of the inner and outer casings which interengage at a point diametrically opposite the gaps 13 and 23 to lock the two casings together. It is important that the two casings do not rotate relative to one another. It is not possible to weld the casings together to prevent rotation because of the need to place the fire shield between the inner and outer casings, and also because there must be no thermal conductivity between the casings which a weld would allow.

The position of the fire shield 100 in the coupling is critical in achieving the correct resistance to temperature increase inside the casing, and also for the correct functioning of the coupling. When the fire shield is placed between the two casings the reduction in the temperature of the inner casing, in the event of a fire, compared with the arrangement when no fire shield is present, is sufficient to ensure that the inner casing conducts very little heat to the outer surface of the gasket. If, for example, the fire shield is placed directly against the rubber gasket, the shielding of the rubber from the heat is not so effective.

If a fire shield were to be positioned differently from the above description, it would have to be much thicker to achieve a similar temperature reduction and would therefore be more difficult to assemble, and more likely to ruck on closing. Even if the design of the outer and inner casings were different to the arrangement described above, the temperature reduction could still be achieved by placing the fire shield between two sliding metallic components with a rubber gasket placed inside the inner casing.

From the preceding description, it may be further defined that in a coupling of our invention, the construction and assembly of the coupling is such that the product consists of an outer tubular casing with locking or tightening parts, and an inner casing which contains the gasket and any other components, such as anchoring rings, for gripping the pipe. During assembly, the complete integral inner casing is placed within the outer casing, between which a fire shield layer is inserted to insulate the two.

In couplings of other designs the gasket and other components, such as anchor rings, are placed directly within the outer casing; or with only a part of the gasket surrounded by a partial inner casing with anchor rings and supplementary components seated directly in the outer casing. In either instance, it may be established that there is a functional difference between these couplings and the coupling described in this specification in respect of establishing the mutually exclusive insularity of the casings between which the fire shield is placed. Any direct conductivity of heat between the components will detract from the performance of the coupling.

The layer of fire retardant material 100, may comprise a layer of between 3mm and 5mm thickness.

It is made of inorganic materials, preferably predominantely silica, and preferably with a micro porous structure. The material sold as Microtherm Grade Hydrophobic quilt is the presently preferred material. The material has high thermal insulation properties and is capable of withstanding high temperatures. The material has the following composition:-

SiO_2	64.68%
TIO_2	31.9%
ZrO_2	0.23%
Al_2O_3	2.37%
Fe_2O_3	0.33%
Cr_2O_3	0.07%
P_2O_3	0.02%
B_2O_3	trace

These figures are by weight.

The material is formed in a rectangular strip which is wrapped around the inner casing. The ends of the strip overlap in the region of the gaps 13 and 23.

The sub-bridge subtends an angle of between 30° to 40° at the pipe axis. It is secured to the inner casing on one side of the gap only and is arranged to overlap the inner casing by approximately equal amounts on either side of the gap in the tightened position.

The details of the gasket construction will now be described.

The sealing gasket 30 is of rubber formed from a length of flat extrusion which is rolled into a tube and joined by welding to form a complete cylinder. Alternatively, the rubber gasket may be moulded. The outer surface 31 of the gasket is smooth but the inner surface is formed with two sets of annular sealing ribs 32 which project inwardly. In the present embodiment there are three ribs in each set. Towards each end of the gasket the inner surface is stepped inwardly to form lands 33. The extreme ends of the gasket are formed by axial extensions of the inner part of the gasket, which form end seals 34.

The gasket 30 fits inside the inner casing with the side flanges 24 fitting into a recess 35 formed behind the end seals 34.

A frustoconical slot 36 is formed in the outer surface of the gasket at each end of the gasket. The outer end of each slot lies at the axial end of the outer surface, the inner end of the slot lies close to the inner surface of the land 33. The slope of the slot is such that the inner end is nearer the axial middle of the gasket than the outer end.

A gripping device in the form of frustoconical ring 40 is located in the slot 36. The ring 40 is made of hard teeth 42 to penetrate through the gasket 30 at the bottom of the slot 36 and bite into the surface of the pipe, thereby providing locking of the coupling to the pipe against axial movement. The teeth are designed to make contact at approximately 5mm centres around the circumference with a width of approximately 2mm for each tooth, giving approximately 40% contact around the periphery of the pipe.

The extensions 34 are trapped between the flanges 19 and 24 on the inner and outer casings and the outer surfaces of the pipe ends to form end seals. Thus liquid and dirt is prevented from entering the coupling from outside.

By using a series of ribs a seal is achieved which is effective at high hydrostatic pressures, for example 16 bars. However, the axial length of the gasket that is exposed to the hydrostatic pressure is small compared with the overall length L of the coupling. This means that the tendency for the casing to bulge is less than with known couplings where almost the entire length of the gasket is exposed to the hydrostatic pressure of the fluid. As a result, the casing of the coupling of the present invention can be of lighter construction than an equivalent conventional coupling. For example, with a coupling for joining together two pipes of around 20cm in diameter, (approximately 8 inches), the thickness of the outer casing can be approximately 3mm, and the thickness of the inner casing approximately 2.5mm. An advantage of using thinner metal is that the machinery required to form the casings is less expensive.

By locating the gripping ring in a slot in the outside of the gasket, the teeth are protected when the coupling is not in use and the coupling can be handled easily without a risk of the operator being cut. The resilience of the gripping ring and of the rubber of the gasket causes the teeth to retract back into the slot when the coupling is unfastened so that they no longer project through the inner surface of the gasket. The end seals keep out contamination which might enter the seals from outside and thereby affect performance. The use of low alloy, or high carbon, steel to produce hard teeth on the gripping ring renders them prone to corrosion. The end seals prevent the ingress of moisture, for example sea water, which could cause such corrosion.

The arrangement for holding the gripping rings is of simple construction and apart from the casings and the gasket, involves no separate parts. The entire structure is accommodated within the two pairs of annular flanges 19 and 24 which gives the total structure great strength and stability.

Because of the resilience in the gripping ring and the rubber, the clamping arrangement releases itself when the coupling is released.

The axial restraints operate independently of the gasket.

The teeth do not cut through the gasket entirely, they merely pierce it at 5mm intervals and so the coupling can be repeatedly used.

Because the toothed ring is placed in a wide slot it is free to find its own settlement. The outer edge is located in the angle between the flange and web portions of the inner casing, and the position of the inner edge is merely determined by the position where it bites into the pipe. As the coupling is tightened the teeth bite deeper into the pipe. The angle of approximately 45 degrees which is established between the ring and the pipe surface when the ring first bites is maintained as the coupling is tightened. The angle is in the inner casing bears directly against the outer edge of the gripping ring.

Because the toothed ring bears against the angle in the inner casing, the reaction forces from the toothed ring can be spread through the surface of the inner casing to the outer casing. This further reduces the tendency of the casing to bulge, compared to a single piece casing.

CLAIMS

1. A pipe coupling for coupling together two pipes in a fluid-tight manner comprises a tubular casing, a tubular sealing gasket located within the casing, and means for tensioning the casing around the gasket, the casing comprising an inner tubular casing and an outer tubular casing, the inner casing fitting entirely inside the outer casing, characterised in that a layer of fire-resistant thermally-insulating material is disposed between the inner and outer casings whereby the inner and outer casings are thermally insulated from one another.

2. The pipe coupling according to claim 1, wherein the layer of fire resistant material is 3mm-5mm thick.

3. The pipe coupling according to claim 1 or 2, wherein the layer of fire resistant material is placed between the inner and outer casing of the coupling such that when the coupling is tightened the outer casing will slide easily over the layer of fire resistant material without causing rucking of the fire resistant layer.

4. The pipe coupling according to any one of claims 1 to 3, wherein the layer of fire resistant material is a prepared strip of material cut to the circumference of the pipe inclusive of the thickness of the gasket and inner casing with an overlap.

5. The pipe coupling according to claim 4, wherein the overlap is approximately 1% of the length of the strip.

6. The pipe coupling according to any one of claims 1 to 5, wherein the inner and outer casings each have a longitudinally extending gap, the gaps of the inner and

outer casing being in line, a bridging component extending across the gaps.

7. The pipe coupling according to claim 6, wherein the bridging component is secured to the inner side of the inner casing by welding.

8. The pipe coupling according to any one of claims 1 to 7, wherein the inner and outer casings have anti-rotation notches which interengage to prevent the casings rotating relative to one another.

9. The pipe coupling according to claim 8, wherein the anti-rotation notches are provided in end flanges of the casings at a point diametrically opposite the gaps.

10. The pipe coupling according to any one of claims 1 to 9, wherein the inner casing contains anchoring rings for gripping the pipe.

11. The pipe coupling according to any one of claims 1 to 10, wherein the layer of fire resistant material is made of inorganic materials.

12. The pipe coupling according to claim 11, wherein the inorganic material is predominately silica.

13. The pipe coupling according to claim 11 or 12, wherein the inorganic material has a micro porous structure.

14. The pipe coupling according to claim 6, wherein the bridge component subtends an angle of between 30° to 40° at the pipe axis.

15. The pipe coupling according to any one of claims 1 to 14, wherein the inner and outer casings are of thermally-conductive material.

16. The pipe coupling according to any one of claims 1 to 15, wherein the inner and outer casings are of metal.

17. The pipe coupling according to any one of claims 1 to 16, wherein the layer of insulating material extends along the entire axial length of the casing.

18. The pipe coupling according to any one of claims 1 to 17, wherein the inner and outer casing each have a pair of annular flanges which project radially inwardly from their respective terminal edges, the annular flanges of the inner casing being disposed axially inwardly of the annular flanges of the outer casing.

19. The pipe coupling according to any one of claims 1 to 18, wherein the tensioning means are provided on the outer casing.

20. The pipe coupling according to any one of claims 1 to 19, wherein a pair of anchoring rings for gripping the pipes are disposed in slots in the sealing gasket adjacent the opposite axial ends.

21. The pipe coupling according to any one of claims 1 to 20, wherein the outer circumferential surface of the inner casing is straight-cylindrical, and the inner circumferential surface of the outer casing is straight-cylindrical.

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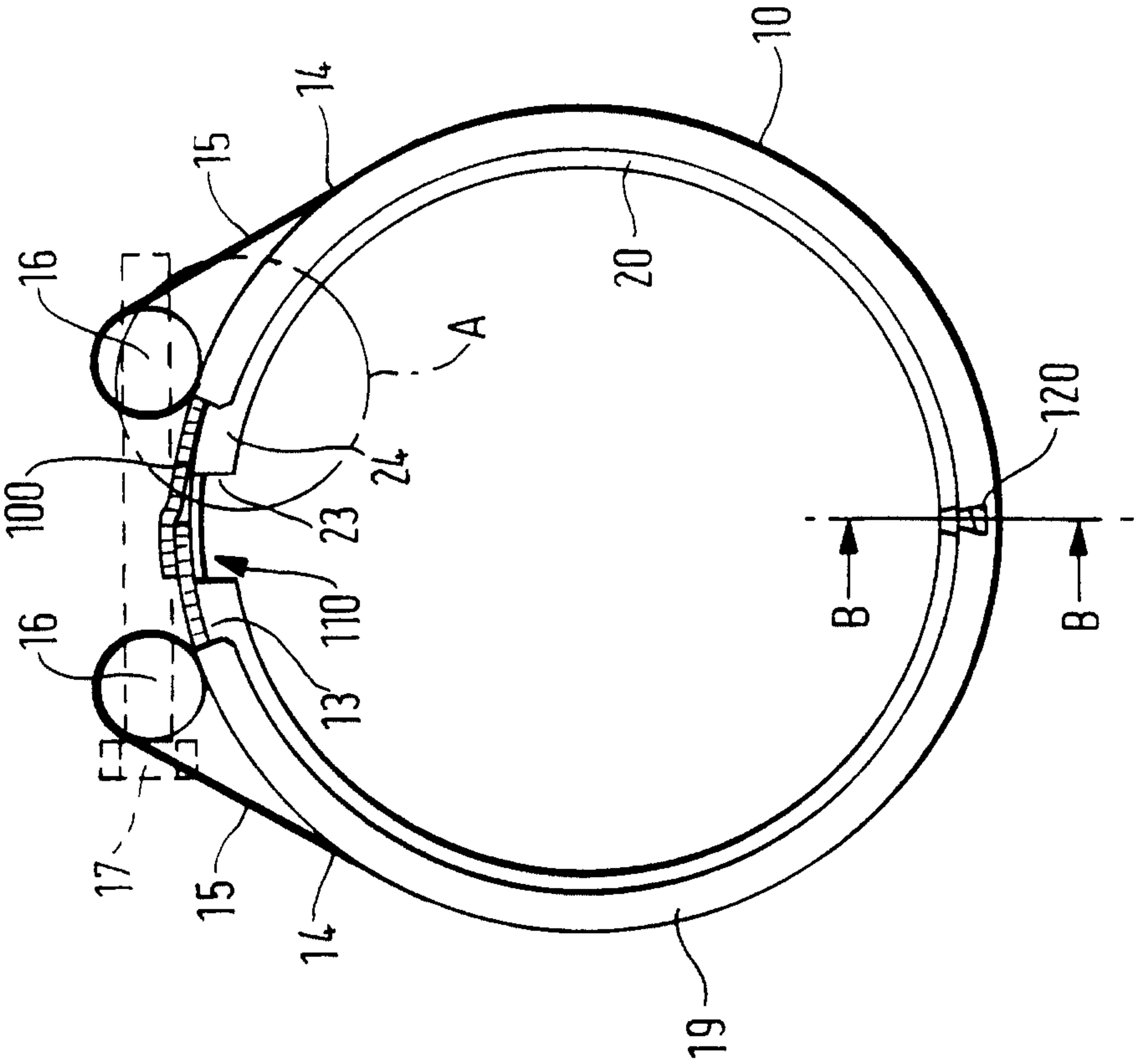

FIG. 2

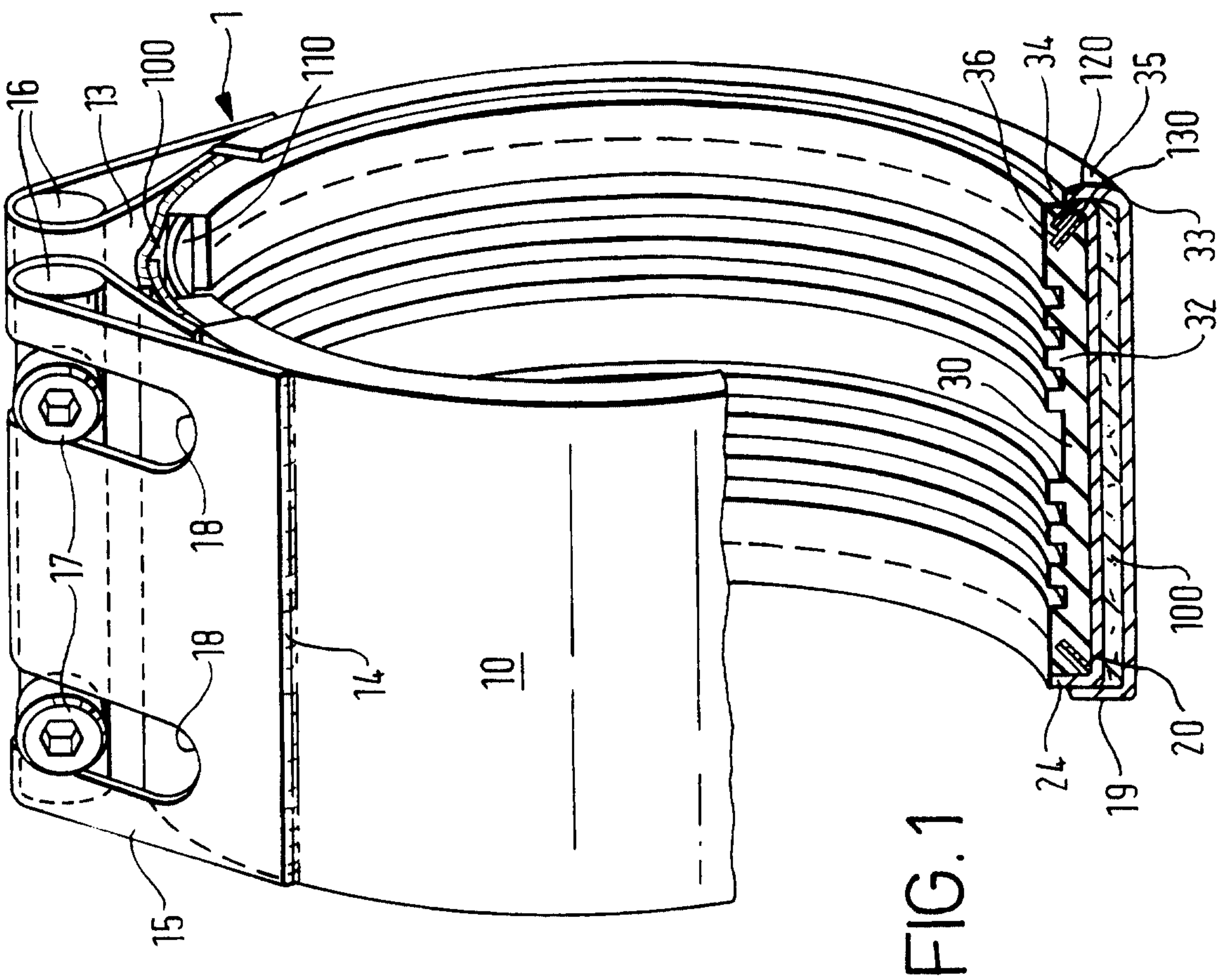

FIG. 1

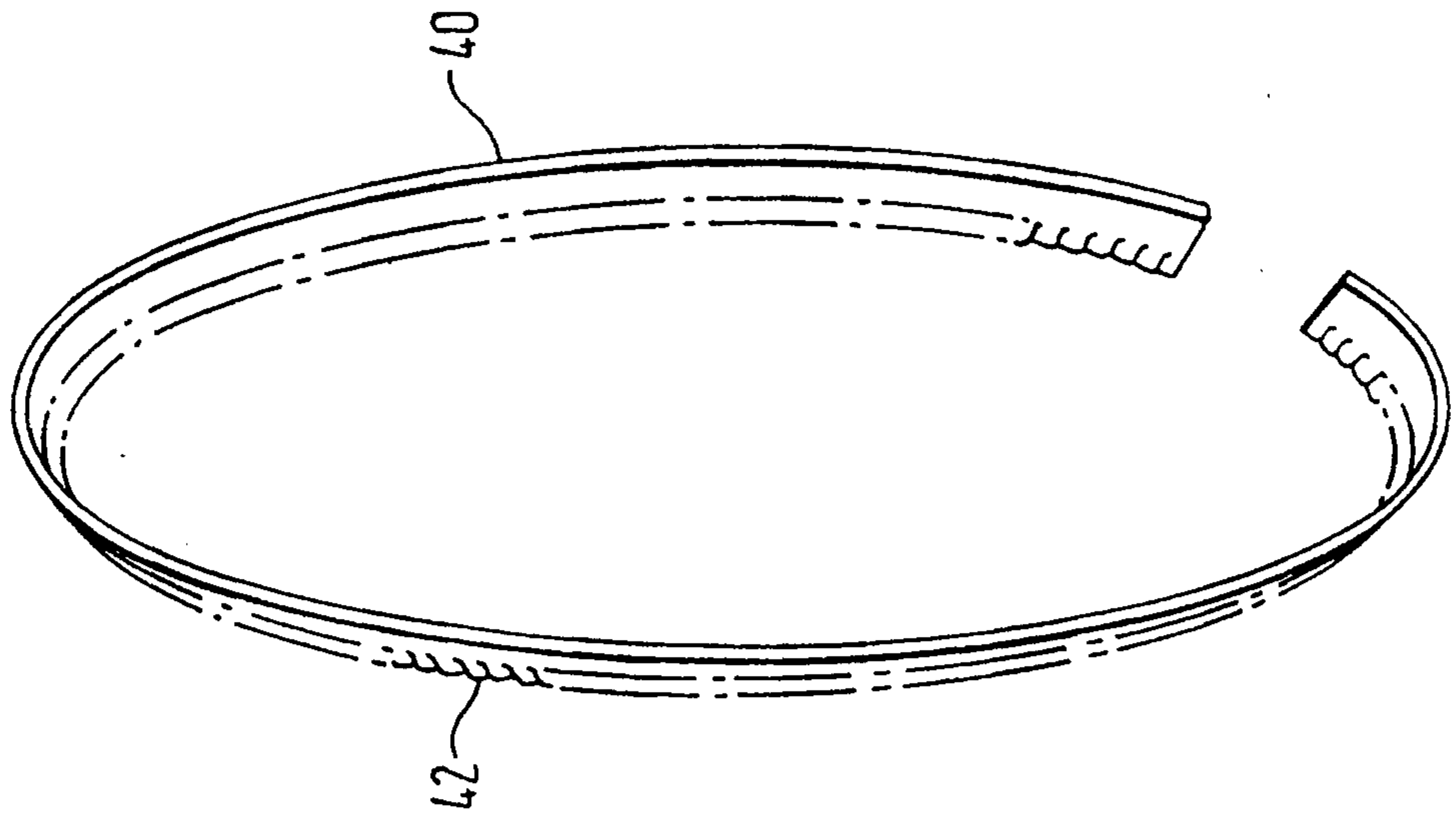

FIG. 4

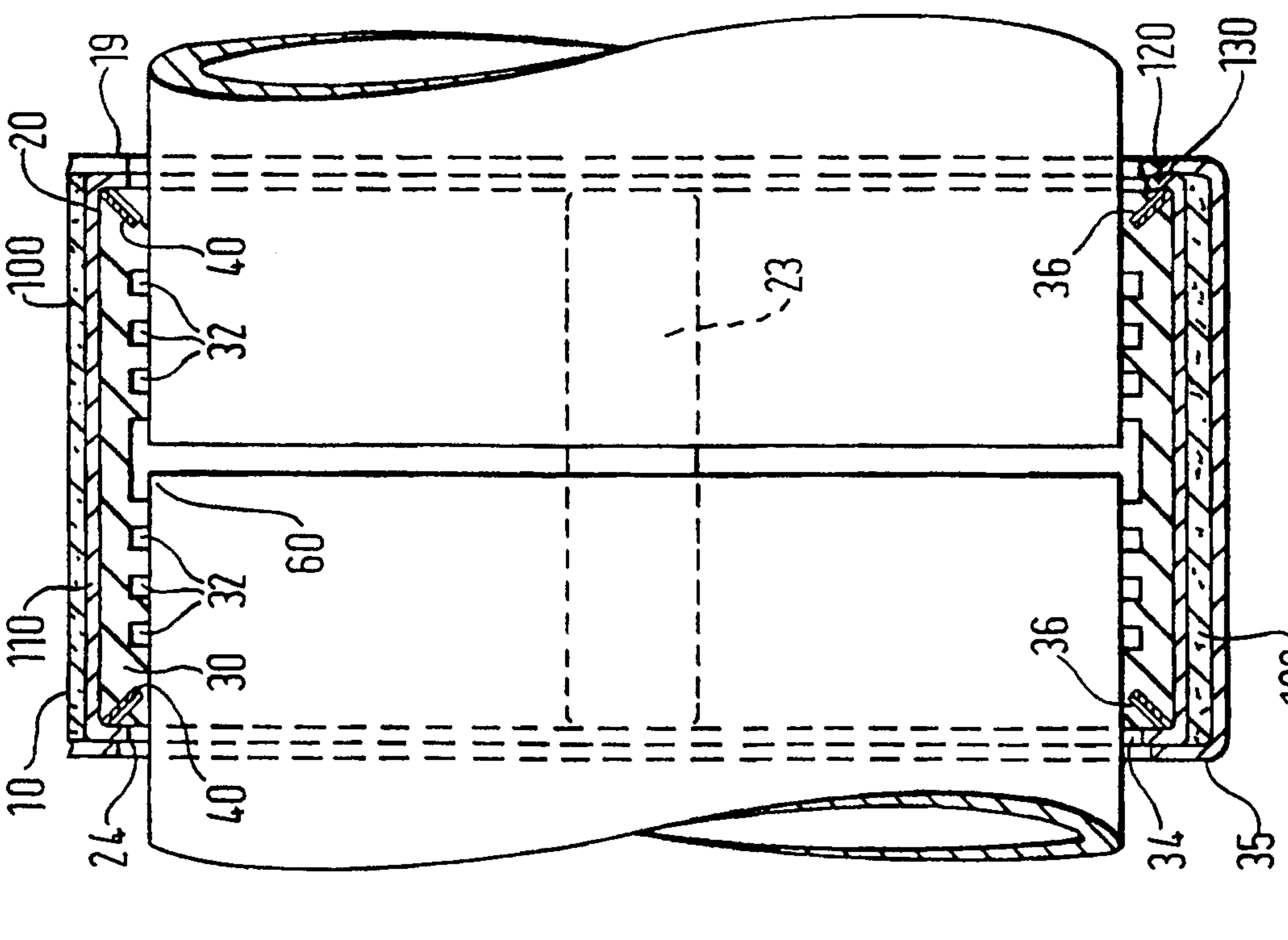

FIG. 3

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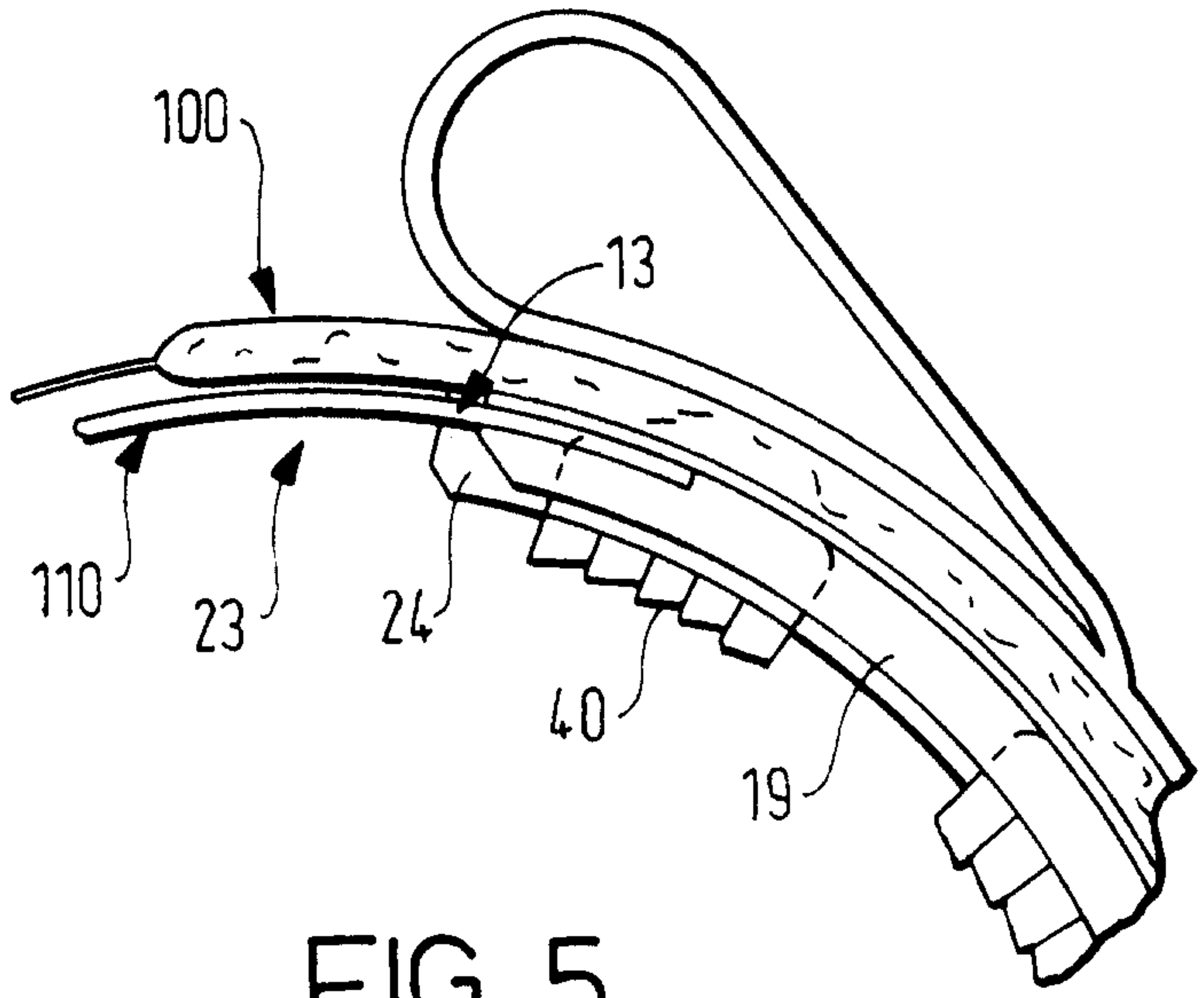


FIG. 5

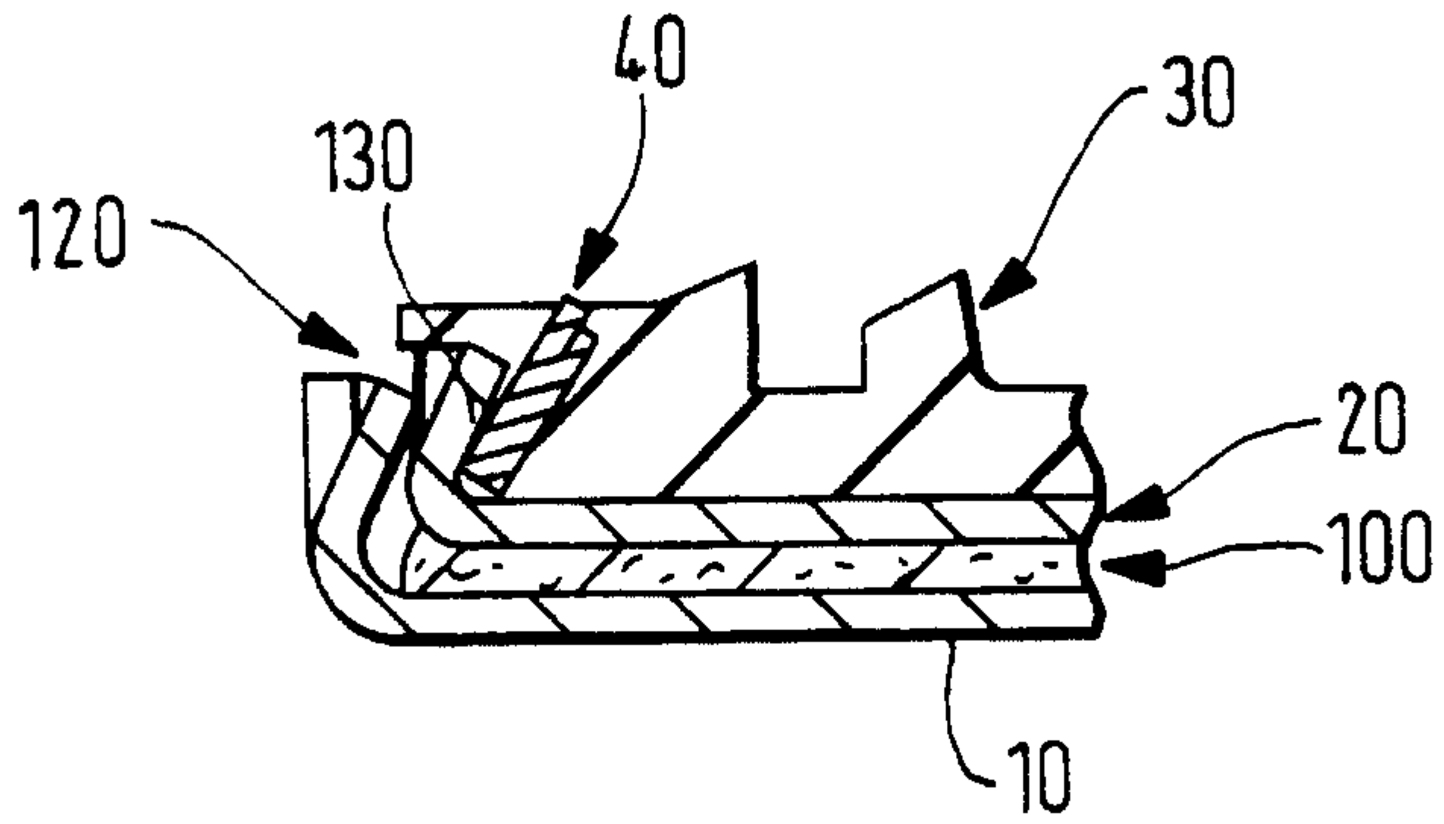
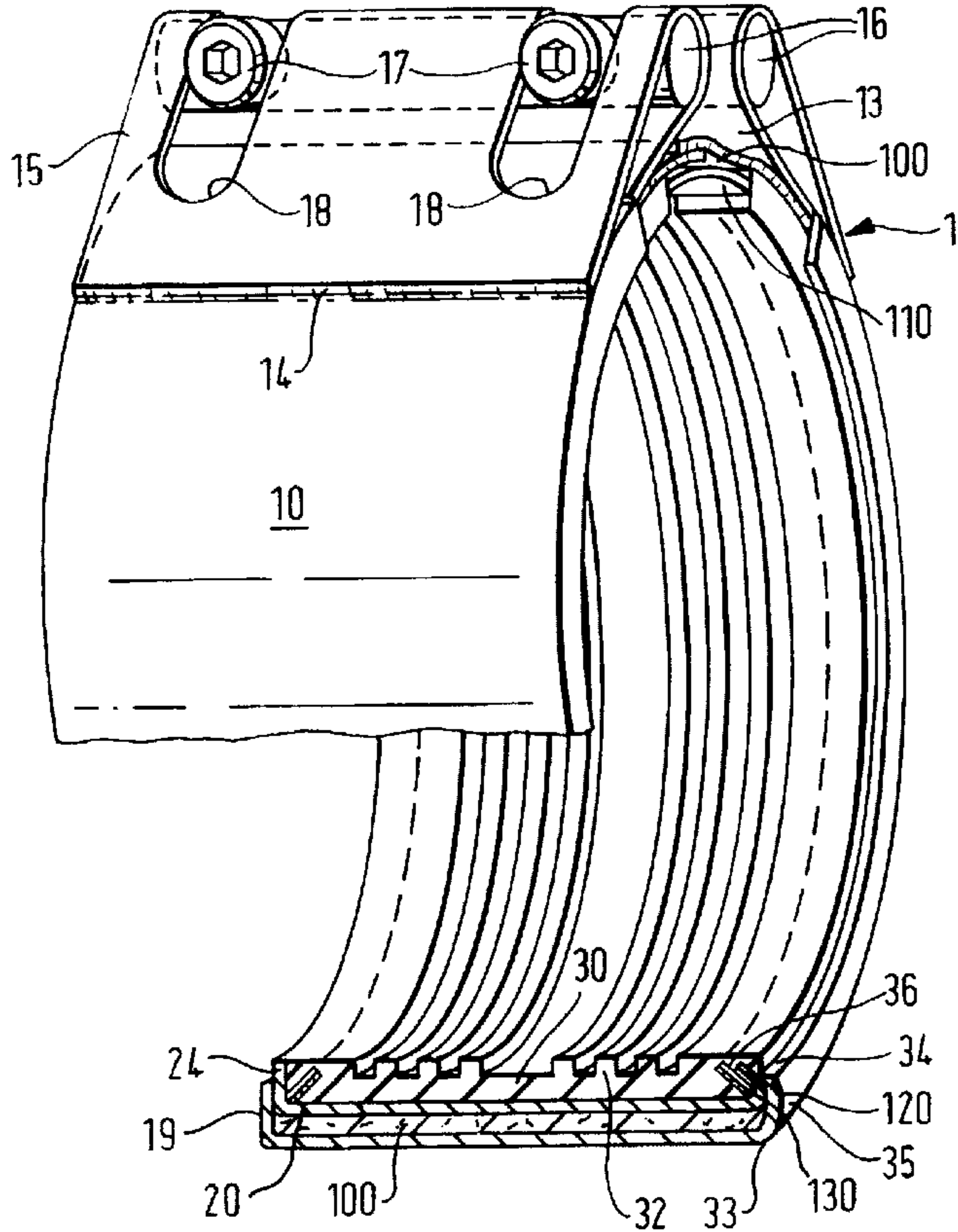


FIG. 6



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