Office de la Propriété Intellectuelle du Canada
Un organisme d'Industrie Canada

Canadian Intellectual Property Office
An agency of Industry Canada

CA 2679650 C 2015/04/28

(11)(21) **2 679 650**

(12) **BREVET CANADIEN
CANADIAN PATENT**

(13) **C**

(86) Date de dépôt PCT/PCT Filing Date: 2008/03/14
(87) Date publication PCT/PCT Publication Date: 2008/10/16
(45) Date de délivrance/Issue Date: 2015/04/28
(85) Entrée phase nationale/National Entry: 2009/09/01
(86) N° demande PCT/PCT Application No.: US 2008/003447
(87) N° publication PCT/PCT Publication No.: 2008/123915
(30) Priorité/Priority: 2007/04/04 (US11/732,622)

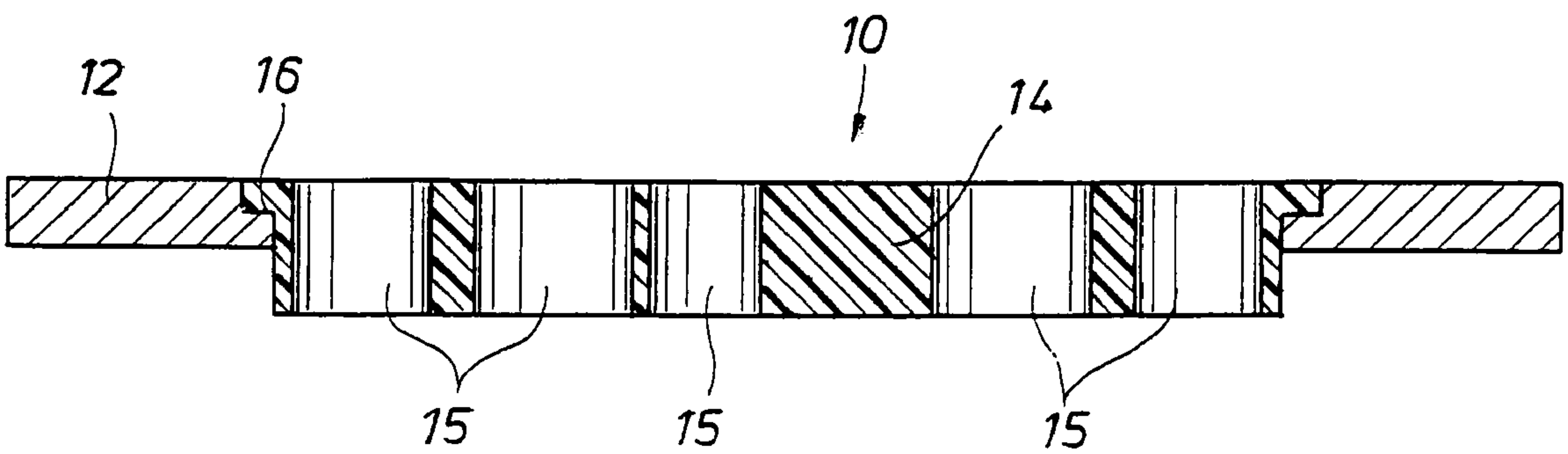
(51) Cl.Int./Int.Cl. *F16L 9/14* (2006.01), *B01F 5/00* (2006.01), *B29C 45/14* (2006.01), *B29C 49/26* (2006.01)

(72) Inventeurs/Inventors:
GALLAGHER, JAMES E., US;
GALLAGHER, MICHAEL D., US

(73) Propriétaire/Owner:
SAVANT MEASUREMENT CORPORATION, US

(74) Agent: KIRBY EADES GALE BAKER

(54) Titre : COMPOSANT DE TUYAUTERIE MULTIMATIERE
(54) Title: MULTIPLE MATERIAL PIPING COMPONENT



(57) Abrégé/Abstract:
The piping component is comprised in part of a metal housing that is positionable with a metal pipe. The metal housing forms an opening in which a piping component body is inserted. The body of the piping component can be fastened to the metal housing using an epoxy adhesive, a set screw connection, a threaded connection, press fit connection, a key connection or a pin connection or a combination of these connections. The body is comprised of plastic, which is less expensive than metal and facilitates forming, including machining or molding, while maintaining its structural integrity in a hostile fluid environment, such as in oil or gas. Piping components such as flowmeters, flow conditioners, small volume provers, static mixers, samplers, and valves are contemplated for use with these multiple materials.

CA 02679650 2009-09-01

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 October 2008 (16.10.2008)

PCT

(10) International Publication Number
WO 2008/123915 A1

(51) International Patent Classification:
F16L 9/14 (2006.01)

(21) International Application Number: PCT/US2008/003447

(22) International Filing Date: 14 March 2008 (14.03.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
11/732,622 4 April 2007 (04.04.2007) US

(71) Applicant *(for all designated States except US)*: **SAVANT MEASUREMENT CORPORATION** [US/US]; 3427 Rivers Edge Trail, Kingwood, TX 77339-2634 (US).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **GALLAGHER, James, E.** [US/US]; 1514 Scenic Shore Drive, Kingwood, TX 77345 (US). **GALLAGHER, Michael, D.** [US/US]; 1514 Scenic Shore Drive, Kingwood, TX 77345 (US).

(74) Agent: FLADUNG, Richard, D.; Strasburger & Price, LLP, 1401 McKinney Street, Suite 2200, Houston, TX 77010-4035 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declaration under Rule 4.17:
— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:
— *with international search report*

(54) Title: MULTIPLE MATERIAL PIPING COMPONENT

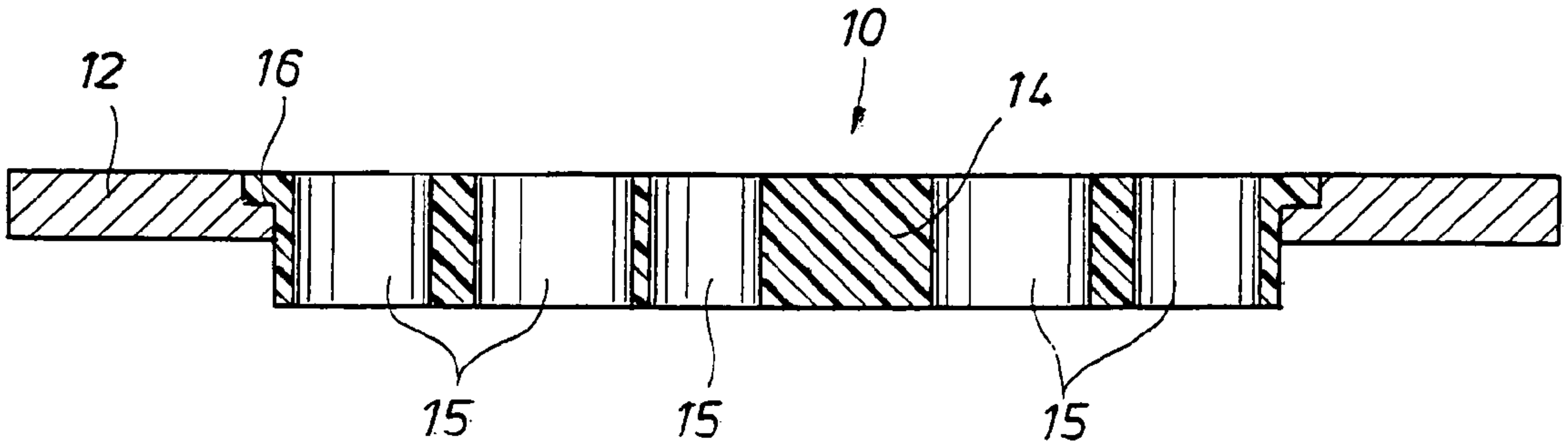


FIG. 2

(57) Abstract: The piping component is comprised in part of a metal housing that is positionable with a metal pipe. The metal housing forms an opening in which a piping component body is inserted. The body of the piping component can be fastened to the metal housing using an epoxy adhesive, a set screw connection, a threaded connection, press fit connection, a key connection or a pin connection or a combination of these connections. The body is comprised of plastic, which is less expensive than metal and facilitates forming, including machining or molding, while maintaining its structural integrity in a hostile fluid environment, such as in oil or gas. Piping components such as flowmeters, flow conditioners, small volume provers, static mixers, samplers, and valves are contemplated for use with these multiple materials.

WO 2008/123915 A1

MULTIPLE MATERIAL PIPING COMPONENT

BACKGROUND OF THE INVENTION

[0005] 1. Field of the Invention

The present invention relates to piping components for use with fluids in pipes. Particularly, this invention relates to piping components for use with fluids in piping in the oil, gas, petroleum and chemical industries.

[0007] 2. Description of the Related Art

Piping used in the oil gas, petroleum and chemical industries are regulated in part by the Department of Transportation ("DOT"). In addition, the American Society of Mechanical Engineers ("ASME") provides standards associated with oil and gas facilities.

[0009] For example, pipes carrying hazardous liquids such as hydrocarbons are regulated by DOT Title 49 C.F.R. § 195. This regulation states that piping and all associated connections be comprised of steel. This includes valves, fittings, branch connections, closures, flange connections, station piping, and other fabricated assemblies. Section 192 of Title 49 of the DOT Federal Regulations, which applies to all other piping for fluids, also requires that piping and all associated connections be comprised of steel if pressurized over 100 psig. In addition, ASME standards require all steel connections in an oil, gas, petroleum and/or chemical environment. Thus, DOT regulations and ASME standards require piping to have all steel containment when transporting hazardous liquids and carbon dioxide and/or transporting fluids that are pressurized over 100 psig.

[0010] Currently, most piping components have been comprised of all-steel, with the exception of wearing components, such as filters, gaskets and other sealing members. Steel has traditionally been used to comply with DOT regulations and ASME standards, as steel maintains its structural integrity in an environment that is typically corrosive and/or degrading in nature. However, the all-steel design of piping components make the manufacturing costs expensive.

[0011] For example, an all-steel profile plate is proposed in U.S. Patent Nos. 5,495,872 and 5,529,093. The same patents also disclose an anti-swirl device fabricated from all steel. While both the profile plate and anti-swirl device are effective piping components, they are expensive to manufacture.

[0012] Other examples of piping components that have traditionally been comprised of steel include flowmeters, such as ultrasonic flowmeters, orifice flowmeters and turbine flowmeters; flow nozzles; meter tubes; venturi flowmeters; and other products such as those distributed by Daniel Measurement and Control, Inc. of Houston, Texas. Valves such as gate valves, ball valves, check valves, globe valves, wafer valves, butterfly valves and control valves have been primarily comprised of steel. Also, piping components, such as static mixers, several of which are proposed in U.S. Patent Nos. 4,034,965, 4,072,296, 4,093,188, 4,314,974, 4,461,579, 4,497,751, 4,498,786, 4,600,544 and 4,806.288; small volume provers, several of which are proposed in U.S. Patent Nos. 3,421,360, 3,673,851, 3,877,287, 4,152,922, 4,627,267 and 4,649,734; and samplers, several of which are proposed in U.S. Patent Nos. 4,307,620, 4,390,957, 4,744,244, 4,744,255, 4,820,990, 4,926,674 and 5,129,267 preferably have a steel construction for the durable non-wearing components. These piping components and many other piping are expensive to manufacture due to their steel construction. However, the steel construction for durable non-wearing components was traditionally required to comply with ASME standards and DOT regulations so that the component holds up to the hostile fluid environment in the oil, gas, petroleum and chemical industries.

Other industries have proposed devices of different materials. For example, the water industry uses flow conditioners fabricated from polypropylene. In yet another industry, U.S. Patent No. 7,089,963 proposes a flow laminarization device to improve the performance of turbochargers, which emphasizes a device made from one material, preferably plastic. While, an all plastic device, such as these, would be more cost effective than the current all steel flow conditioners, it would not be acceptable in the oil, gas, petroleum and chemical industries because it would not meet DOT regulations, which require steel containment.

[0014] In yet another industry, the onboard marine vessel industry, a two material device has been developed to throttle fluid flow. U.S. Patent No. 5,327,941 proposes a cascade orificial resistive device ("CORD"), which is comprised of a hollow metal housing with multiple elastomeric CORD plates mounted within the body. While a two material device would be more cost effective than an all-steel piping component, the proposed cord device is not fabricated to operate in the hostile fluid environment of the oil, gas, petroleum and chemical industries.

[0016] It would be desirable to provide low cost piping components that both comply with DOT regulations, and ASME standards, as well as withstand the hostile fluid environment in the oil, gas, petroleum and chemical industries.

BRIEF SUMMARY OF THE INVENTION

[0017] In view of the described opportunities for improvement in the oil, gas, petroleum and chemical industries, this invention provides low cost piping components that comply with DOT regulations and ASME standards, as well as withstand the hostile fluid environment of the oil, gas, petroleum and chemical industries.

[0018] The piping component according to this invention is comprised in part of a steel housing that can be positioned with a steel piping. The steel housing of the invention serves to provide the continuous metal connection required by DOT regulations and ASME standards. The steel housing can be a flange, a ring, a casing, or a combination of these items that form an opening in which a piping component body is inserted, at least in part.

[0019] The piping component body is comprised of non-steel, or a combination of steel and non-steel parts. Ideally, the body is comprised of plastic, which is less expensive and facilitates forming, including machining or molding while maintaining its structural integrity in a hostile fluid environment, such as in oil, gas, petroleum or chemicals. Alternatively, ceramic could be used to fabricate the body.

[0020] Because plastic is easily formed, the bodies of various piping components can be formed in new and different shapes that previously could not be economically performed due to the limitations of working with metal. For example, the upstream and/or downstream sides of the bodies of plastic flow conditioners can be formed into concave or convex profiles with or without steps. It is contemplated that many piping component bodies will be able to take on different shapes and configurations than the current standard designs, because plastic can be formed easier and at a reduced cost.

[0021] It is further contemplated that piping components such as flowmeters, flow conditioners, turbine meters, flow nozzles, venturi meters, small volume provers, static mixers, samplers, and valves, which have preferably been made from steel, with the exception of wearing components, could now substitute plastic components for some of the metal components.

[0022] One embodiment of a piping component includes connecting the plastic body of the piping component to a steel ring so that the plastic body of the piping component extends into the steel pipe thereby complying with DOT regulations and ASME standards. Another embodiment of the piping component includes fastening the plastic body directly to the steel piping.

[0023] It is contemplated that the plastic body of the piping component can be fastened to the metal, such as steel, housing using an adhesive, a set screw connection, a threaded connection, press or compression fit connection, a key connection or a pin connection or a combination of these connections.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] A better understanding of the present invention can be obtained with the following detailed description of the various disclosed embodiments in the drawings:

[0025] FIG. **1** is a plan view of a flow conditioner profile plate according to one embodiment of the invention having a plastic body positioned in a steel housing or ring.

[0026] FIG. **2** is a sectional view taken along line 2-2 of FIG. **1**.

[0027] FIG. **3** is an enlarged detailed sectional view of a threaded connection between the plastic body of a piping component and the steel housing.

[0028] FIG. **4** is an enlarged detailed sectional view of a threaded connection between the plastic body of a piping component and the steel housing, similar to FIG. **3**, but with an extended threaded hub.

[0029] FIG. **5** is an enlarged detailed sectional view of a set screw connection between the plastic body of a piping component and the steel housing.

[0030] FIG. **6** is a plan view of the set screw connection shown in FIG. **5**.

[0031] FIG. **7** is an enlarged detailed sectional view of a radial set screw connection between the plastic body of a piping component and the steel housing.

[0032] FIG. **8** is a plan view of the radial set screw connection, as shown in FIG. **7**, with the set screw shown in phantom view.

[0033] FIG. **9** is an enlarged detailed sectional view of a snap ring connection between the plastic body of a piping component and the steel housing.

[0034] FIG. **10** is a bottom view of the snap ring connection as shown in FIG. **9**.

[0035] FIG. **11** is an enlarged detailed sectional view of a key connection between the plastic body of a piping component and the steel housing.

[0036] FIG. **12** is a bottom view of the key connection as shown in FIG. **11**.

[0037] FIG. **13** is an enlarged detailed sectional view of an adhesive connection between the plastic body of a piping component and the steel housing.

[0038] FIG. **14** is a bottom view of the adhesive connection as shown in FIG. **13**.

[0039] FIG. **15** is a sectional view of a piping component positioned between piping flanges.

[0040] FIG. **16** is a sectional view, similar to FIG. **15**, of a piping component positioned between recesses in piping flanges using a plurality of bolts and sealed by a gasket.

[0041] FIG. **17** is a sectional view, similar to FIG. **16**, of a piping component positioned between pipe flanges using a metal-to-metal seal instead of a gasket.

[0042] FIG. **18** is a sectional view, similar to FIG. **2**, of a piping component with a concave downstream face.

[0043] FIG. **19** is a sectional view, similar to FIG. **2**, of a piping component with a convex downstream face.

[0044] FIG. **20** is a sectional view, similar to FIG. **2**, of a piping component with a concave step downstream face.

[0045] FIG. **21** is a sectional view, similar to FIG. **2**, of a piping component with a convex step downstream face.

[0046] FIG. **22** is a sectional view of a flow conditioner piping component positioned between an anti-swirl device and a measuring device.

[0047] FIG. **23** is a sectional view of the flow conditioner piping component taken along lines 23-23 of FIG. **22**, with a portion of the flow conditioner cut away to show a set screw connection.

[0048] FIG. **24** is an enlarged detailed sectional view of a piping component body connected to a steel pipe using a roll pin.

[0049] FIG. **25** is an enlarged detailed sectional view of a piping component body connected to a steel pipe using a set screw that contacts a metal insert positioned within the plastic piping component body.

[0050] FIG. **26** is an enlarged detailed sectional view of a piping component body connected to a steel pipe using a set screw that is threaded with a casing positioned in the plastic piping component body.

[0051] FIG. **27** is a sectional view of a venturi nozzle positioned between a measuring device and a venturi flowmeter according to one embodiment of the invention wherein the venturi flowmeter and nozzle having a plastic body positioned in a steel housing.

[0052] FIG. **28** is an enlarged detailed sectional view of the flow nozzle of FIG. **27**.

[0053] FIG. **29** is a sectional view of a small volume prover according to one embodiment of the invention having an internal plastic body radially positioned about the plastic valve both positioned in a steel housing.

[0054] FIG. **30** is a perspective view of a flow conditioner according to one embodiment of the invention having a plastic body comprised of a plurality of equidistant spaced vanes positionable in a steel housing, such as shown in FIG. **22**, the outline of which is shown in phantom view.

[0055] FIG. **31** is a perspective view of a flow conditioner according to one embodiment of the invention having a plurality of honeycomb shaped plastic bodies positionable in a steel housing, such as shown in FIG. **22**, the outline of which is shown in phantom view.

[0056] FIG. **32** is a perspective view of a flow conditioner according to one embodiment of the invention having a plastic body comprising a bundle of tubes positionable in a steel housing, such as shown in FIG. **22**, the outline of which is shown in phantom view.

[0057] FIG. **33** is a sectional view of a sampler according to one embodiment of the invention having a plastic body threadedly positioned with a metal housing.

[0058] FIG. **34** is a plan sectional view of a butterfly valve according to one embodiment of the invention having a plastic valve body positioned in a metal housing.

[0059] FIG. **35** is a sectional view of a turbine flowmeter according to one embodiment of the invention having a plastic body positioned in a metal housing.

[0060] FIG. **36** is a sectional view of a static mixer according to one embodiment of the invention wherein the plastic body is positioned within a metal housing.

[0061] FIG. **37** is a sectional view of another static mixer according to one embodiment of the invention wherein the plastic body is positionable within a metal housing, such as shown in FIG. **36**.

[0062] FIG. **38** is a sectional view of a flow conditioner according to one embodiment of the invention wherein the insertion sleeve or plastic body comprises plastic flaps and fins wherein the body is epoxied to a steel housing or spool shown in phantom view.

[0063] FIG. **39** is a section view taken along lines 39-39 of the flow conditioner body of FIG. **38** to better show the plurality of plastic fins.

[0064] FIG. **40** is a section view taken along lines 40-40 of the flow conditioner body of FIG. **38** to better show the plastic flaps.

[0065] FIG. **41** is a sectional view of a flow conditioner according to one embodiment of the invention wherein the plastic body comprises plastic flaps and fins and is epoxied to a steel housing or spool.

[0066] FIG. 42 is a sectional view of a flowmeter according to one embodiment of the invention wherein an all plastic flow conditioner is held in place in the steel piping by an elongated plastic body positioned about an assembly comprising a plastic rotor, multiple plastic stators, and a shaft with bearings.

[0067] FIG. 43 is a front elevational view of the plastic flow conditioner in FIG. 42 held in place in the steel piping.

DETAILED DESCRIPTION OF THE INVENTION

[0068] Generally, the present invention provides a low cost piping component that complies with DOT regulations and ASME standards, as well as withstands the hostile fluid environment in the piping systems of the oil, gas, petroleum and chemical industries along with a method for manufacturing the piping component.

[0069] The piping component according to the present invention is comprised in part of a metal, such as steel, to fabricate a housing to be positioned with steel piping. The steel housing forms an opening in which the piping component body is positioned. The piping component body could be fabricated from plastic or ceramic or a combination of plastic or ceramic and metal. The plastic and ceramic should have properties that are compatible with the hostile oil, gas, petroleum and chemical environments. An exemplary ceramic for use in these environments is partially stabilized zirconia sold under the trademark NILCRA by ICI Australia Operations Proprietary Limited of Melbourne, Victoria, Australia. An exemplary thermoplastic for use in the oil, gas, petroleum and chemical industries is NORYL PPX® Resin PPX7200, a synthetic thermoplastic resin distributed by GE Plastics. NORYL PPX is a federally registered trademark of the General Electric Company of Schenectady, New York. The following table, last updated on 2/7/2006 by GE Plastics, describes the advantageous properties of this resin:

[0070] NORYL PPX® Resin PPX7200

PP+PPE+PS. Improved chemical resistance and surface aesthetics in injection molded applications. NSF61-capable. UL-94 HB listed.

TYPICAL PROPERTIES[1]	TYPICAL VALUE	UNIT	STANDARD
MECHANICAL			
Tensile Stress, yld, Type I, 2.0 in/min	4800	psi	ASTM D 638
Tensile Stress, brk, Type I, 2.0 in/min	3900	psi	ASTM D 638
Tensile Strain, yld, Type I, 2.0 in/min	10	%	ASTM D 638
Tensile Strain, brk, Type I, 2.0 in/min	130	%	ASTM D 638
Tensile Modulus, 2.0 in/min	179000	psi	ASTM D 638
Flexural Stress, yld, 0.05 in/min, 2 in span	7000	psi	ASTM D 790
Flexural Modulus, 0.05 in/min, 2 in span	209000	psi	ASTM D 790
Tensile Stress, yield, 50 mm/min	34	MPa	ISO 527
Tensile Stress, break, 50 mm/min	28	MPa	ISO 527
Tensile Strain, yield, 50 mm/min	8.2	%	ISO 527
Tensile Strain, break, 50 mm/min	115	%	ISO 527
Tensile Modulus, 1 mm/min	1670	MPa	ISO 527
Flexural Stress, yield, 2 mm/min	48	MPa	ISO 178
Flexural Modulus, 2 mm/min	1600	MPa	ISO 178
IMPACT			
Izod Impact, unnotched, 73°F	27	ft-lb/in	ASTM D 4812
Izod Impact, notched, 73°F	2.80	ft-lb/in	ASTM D 256
Izod Impact, notched, -22°F	0	ft-lb/in	ASTM D 256
Instrumented Impact Total Energy, 73°F	319	in-lb	ASTM D 3763
Izod Impact, unnotched 80*10*4 +23°C	NB	kJ/m^2	ISO 180/1U
Izod Impact, unnotched 80*10*4 -30°C	NB	kJ/m^2	ISO 180/1U
Izod Impact, notched 80*10*4 +23°C	14	kJ/m^2	ISO 180/1A
Izod Impact, notched 80*10*4 -30°C	8	kJ/m^2	ISO 180/1A

1) Typical values only. Variations within normal tolerances are possible for various colours. All values are measured at least after 48 hours storage at 230C/50% relative humidity. All properties, expect the melt volume rate are measured on injection moulded samples. All samples are prepared according to ISO 294.

2) Only typical data for material selection purposes. Not to be used for part or tool design.

3) This rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

4) Own measurement according to UL.

NORYL PPX® Resin PPX7200

TYPICAL PROPERTIES[1]	TYPICAL VALUE	UNIT	STANDARD
IMPACT			
Izod Impact, notched 80*10*4 -30°C	8	kJ/m^2	ISO 180/1A
Charpy 23°C, V-notch Edgew 80*10*4 sp=62mm	12	kJ/m^2	ISO 179/1eA
Charpy -30°C, V-notch Edgew 80*10*4 sp=62mm	6	kJ/m^2	ISO 1791/eA
Charpy 23°C, Unnotch Edgew 80*10*4 sp=62mm	NB	$kJlm^2$	ISO 179/1eU
Charpy -30°C, Unnotch Edgew 80*10*4 sp=62mm	80	kJ/m^2	ISO 179/1eU
THERMAL			
Vicat Softening Temp, Rate B/50	295	°F	ASTM D 1525
HDT, 66 psi, 0.125", unannealed	230	°F	ASTM D 648
HDT, 264 psi, 0.125", unannealed	160	°F	ASTM D 648
CTE, flow, -40°F to 100°F	5.50E-05	1/°F	ASTM E 831
CTE, xflow, -40°F to 100°F	6.00E-05	1/°F	ASTM E 831
CTE, -40°C to 40°C, flow	9.90E-05	1i°C	ISO 11359-2
CTE, -40°C to 40°C, xflow	1.08E-04	1/°C	ISO 11359-2
Ball Pressure Test, 75°C +/- 2°C	-		IEC 60695-10-2
Vicat Softening Temp, Rate B/50	103	°C	ISO 306
Vicat Softening Temp, Rate B/120	107	°C	ISO 306
HDT/Af, 1.8 MPa Flatw 80*10*4 sp=64mm	73	°C	ISO 75/Af
PHYSICAL			
Specific Gravity	0.99	-	ASTM D 792
Mold Shrinkage, flow, 0.125"	0.6-0.8	%	GE Method
Mold Shrinkage, xflow, 0.125"	0.6-0.8	%	GE Method
Melt Flow Rate, 260°C/5.0 kgf	16	g/10 min	ASTM D 1238
Density	0.03	lb/in^3	ISO 1183
Water Absorption, equilibrium, 73°F	0.05	%	ISO 62
Moisture Absorption (23°C / 50% RH)	0.02	%	ISO 62
Melt Volume Rate, MVR at 260°C/5.0 kg	18	cm^3/1 0 min	ISO 1133

1) Typical values only. Variations within normal tolerances are possible for various colours. All values are measured at least after 48 hours storage at 230C/50% relative humidity. All properties, expect the melt volume rate are measured on injection moulded samples. All samples are prepared according to ISO 294.

2) Only typical data for material selection purposes. Not to be used for part or tool design.

3) This rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

4) Own measurement according to UL.

NORYL PPX® Resin PPX7200

PROCESSING PARAMETERS	TYPICAL VALUE	UNIT
Injection Molding		
Drying Temperature	140 – 150	°F
Drying Time	2 – 4	Hrs
Drying Time (Cumulative)	8	Hrs
Maximum Moisture Content	0.02	%
Melt Temperature	500 – 550	°F
Nozzle Temperature	500 – 550	°F
Front - Zone 3 Temperature	480 – 550	°F
Middle - Zone 2 Temperature	460 – 540	°F
Rear- Zone I Temperature	440 – 530	°F
Mold Temperature	90 – 120	°F
Back Pressure	50 – 100	Psi
Screw Speed	20 – 100	Rpm
Shot to Cylinder Size	30 – 70	%
Vent Depth	0.0015 - 0.002	in

1) Typical values only. Variations within normal tolerances are possible for various colours. All values are measured at least after 48 hours storage at 230C/50% relative humidity. All properties, expect the melt volume rate are measured on injection moulded samples. All samples are prepared according to ISO 294.
2) Only typical data for material selection purposes. Not to be used for part or tool design.
3) This rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.
4) Own measurement according to UL.

[0071] The piping component could be any piping component where the internal metal body could be replaced with plastic or ceramic, or plastic or ceramic and metal body. For example, the piping component could be a flow conditioner, generally indicated as **10,** in FIG. **1.** The flow conditioner **10** includes a plastic profile body **14** having a plurality of apertures **15** fastened to an external steel housing **12** with a compression fit. In this embodiment the housing **12** could be heated pressed together with the body **14** and then allowed to cool. While the steel housing **12** in FIG. **1** is comprised of a ring, the steel housing could be any type of flange, casing, piping or a combination of these items. FIG. **2** shows the body **14** engaging a blocking shoulder

16 on the housing **12** to block further movement of the plastic profile body **14** during the compression fit.

[0072] FIGS. **3** through **14** show other ways to fasten a body to a housing. However, it is contemplated that there could be other ways to fasten the two parts together. In addition, more than one type of fastening could be used to fasten the body to the housing.

[0073] FIGS. **3** and **4** show a threaded connection between the body **14A, 14B** of respective flow conditioner **10A, 10B** and its respective steel housing **12A, 12B**. FIG. **3** shows a threaded connection **18** between the body **14A** and steel housing **12A**. FIG. **4** is similar to FIG. 3, but shows an extended threaded connection **20** using a hub **21**.

[0074] FIGS. **5** and **6** illustrate a set screw **22** between the body **14C** of flow conditioner **10C** and steel housing **12C**. A threaded bore in the steel housing **12C** receives set screw **22** that engages body **14C** to fasten the body **14C** to the steel housing **12C**.

[0075] FIGS. **7** and **8** illustrate a radial set screw **24** for fastening the body **14D** of flow conditioner **10D** to the steel housing **12D**. A radial threaded bore in the steel housing **12C** receives set screw **24** in the steel housing **12C** of the piping component to apply a compression force on the body **14D** of the piping component.

[0076] FIGS. **9** and **10** show a snap ring **26** for fastening the body **14E** of flow conditioner **10E** to the steel housing **12E**. FIG. **9** shows snap ring **26** fastening the body **14E** to the steel housing **12E** when received in groove **26A** in the body **14E**.

[0077] FIGS. **11** and **12** show a key **28** for fastening the body **14F** of flow conditioner **10F** to the steel housing **12F**. Key **28** is slid into slot **28A** in the body **14F** and housing **12F** to prevent rotation between the body **14F** and the steel housing **12F**.

[0078] FIGS. **13** and **14** illustrate the use of an adhesive **30** for fastening the body **14G** of flow conditioner **10G** to the steel housing **12G**. The embodiment of FIGS. **13** and **14** without the bolt hole **32** has been actually reduced to practice and was manufactured for at least 30% less than the all-steel flow conditioner. The steel housing or ring **12G** has equidistant bolt holes, such as bolt hole **32**, as shown in FIG. **14**. An exemplary epoxy adhesive is the SCOTCH-WELD® epoxy adhesive. Minnesota Mining and Manufacturing Company of St. Paul, Minnesota reports the SCOTCH-WELD® Epoxy Adhesive DP420, is a high performance, two-part epoxy adhesive offering outstanding shear and peel adhesion, and very high levels of durability. It features high shear strength, high peel strength, outstanding environmental performance, easy mixing, controlled flow and a 20 minute worklife. Minnesota Mining and Manufacturing Company of St. Paul, Minnesota further reports the typical cured thermal properties as follows:

[0079] **Note:** The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

Product	**SCOTCH-WELD® Epoxy Adhesive DP420 Off-White**
Physical color	Opaque, off-white
Shore D Hardness	75-80
Thermal Coefficient of Thermal Expansion Below Tg (in./in./°C) Above Tg	 85×10^{-6} 147×10^{-6}
Thermal Conductivity (btu – ft./ft.^{2} – hr. - °F) @ 45°C	0.104
Electrical Dielectric Strength (ASTM D 149)	690 volts/mil
Volume Resistivity (ASTM D 257)	1.3×10^{14} ohm-cm

[0080] Minnesota Mining and Manufacturing Company of St. Paul, Minnesota reports the typical adhesive performance characteristics as follows:

Substrates and Testing:

A. Overlap Shear (ASTM D 1002-72)

Overlap shear (OLS) strengths were measured on 1 in. wide ½ in. overlap specimens. These bonds made individually using 1 in. x 4 in. pieces of substrate except for aluminum. Two panels 0.063 in. thick, 4 in. x 7 in. of 2024T-3 clad aluminum were bonded and cut into 1 in. wide samples after 24 hours. The thickness of the bondline was 0.005-0.008 in. All strengths were measured at 73°F (23°C).

The separation rate of the testing jaws was 0.1 in. per minute for metals, 2 in. per minute for plastics and 20 in. per minute for rubbers. The thickness of the substrates were: steel, 0.060 in.; other metals, 0.05-0.064 in.; rubbers, 0.125 in.; plastics, 0.125 in.

Epoxy Adhesive Off-White -- Stainless steel MEK/abrade/MEK[2] – 4000.

B. T-peel (ASTM D 1876-61T)

T-peel strengths were measured on 1 in. wide bonds at 73°F (23°C). The testing jaw separation rate was 20 inches per minute. The substrates were 0.032 in. thick.

Epoxy Adhesive DP420 Off-White -- Cold Rolled Steel – 17-20 mil bondline Oakite degreased – 40 -- MEK/abrade/MEK –25.

C. Other Substrates, Overlap Shear Tested @ 73 F°(23°C)

Scotch-Weld Epoxy Adhesive DP420 Off-White

Surf. Prep. 1: Polycarbonate – 400

Surf. Prep. 2: Polycarbonate – 550

D. Environmental Resistance, Aluminum (Etched) Measured by Overlap Shear Tested @ 73 F°(23°C) (PSI)[1] (ASTM D 1002-72)

Environment	Condition	SCOTCH-WELD® Epoxy Adhesive DP420 Off-White
73° F (23°C)/50% RH	30 d[2]	5100
Distilled Water	30 d, i[3]	4700
Water Vapor	120°F (49°C)/100% RH, 30 d 200°F (93°C)/100% RH, 14 d	4700 3000
Antifreeze/H_2O (50/50)	180°F (82°C), 30 d, i	4200
Isopropyl Alcohol	73°F (23°C), 30 d, i	5300
Methyl Ethyl Ketone	73°F (23°C), 30 d, i	4600
Salt Spray (5%)	95°F (35°C), 30 d	5100
Skydrol LD-4	150°F (66°C), 30 d, i	5400

[1] Data reported are actual values from the lots tested and may be higher than values published elsewhere.

[2] d = days

[3] i - immersion

[0081] The above SCOTCH-WELD® data was published by 3M Industrial Business – Industrial Adhesives and Tapes Division, 3M Center, Building 21-1W-10, 900 Bush Avenue, St. Paul, MN 55144-1000, ©3M March, 2004. SCOTCH-WELD is a federally registered trademark of the Minnesota Mining and Manufacturing Company of St. Paul, Minnesota.

[0082] FIGS. **15, 16,** and **17** illustrate flow conditioner piping component **10, 10G** positioned with a steel pipe. FIG. **15** illustrates flow conditioner **10** steel flange **12** between a pair of pipe flanges **34A, 36A** of respective steel pipe **34, 36.** Bolts, such as bolts **38A, 38B,** are spaced equidistant about the pipe flanges **34A, 36A** and torqued to ASME standards to hold the flow conditioner **10** between the pipe **34, 36.**

[0083] FIG. **16** illustrates flow conditioner **10G** steel flange **12G** set between a pair of flanges **40A, 42A** of respective steel pipe **40, 42.** Flow conditioner bolts, such as bolts **48A, 48B,** are fastened into holes, such as hole **32** shown in FIG. **14,** in the recess of downstream pipe flange **40A.** In addition, a gasket **46** seals the flanges **40A, 42A.** Similar to the FIG. **15,** bolts, such as bolts **44A, 44B,** are spaced equidistant about the flanges **40A, 42A** and torqued to ASME standards.

[0084] FIG. **17** illustrates a flow conditioner **10G** steel flange **12G** with bolts, such as bolts **58A, 58B,** that are threaded into a recess in the downstream pipe flange **50A.** A metal-to-metal seal **56** seals the pipe flanges **50A, 52A,** and bolts, such as bolts **54A, 54B,** are spaced equidistant and torqued as directed by ASME standards to join the steel pipe **50, 52.**

[0085] FIGS. **18, 19, 20,** and **21** illustrate ways that body **14H, 14I, 14J** and **14K** of respective flow conditioner **10H, 10I, 10J,** and **10K** in rings **12H, 12I, 12J,** and **12K** can be formed when fabricated from plastic. The direction of fluid flow **F** is indicated by an arrow on these FIGS. The upstream face **14H', 14I', 14J',** and **14K'** on the body of the flow conditioners receive the fluid flow **F**, and the fluid flow **F** exits from the respective downstream face **14H"**, **14I"**, **14J"**, and **14K"**.

[0086] FIG. **18** shows the body **14H** with a concave downstream face **14H"**. FIG. **19** shows the body **14I** with a convex downstream face **14I"**. FIG. **20** shows the body **14J** having a concave step downstream face **14J"**. FIG. **21** shows the body **14K** having a convex step downstream face **14K"**. While FIGS. **18** to **21** illustrate forming the downstream face, it is contemplated that the upstream face **14H'**, **14I'**, **14J'**, and **14K'** could also be formed in a variety of configurations. Furthermore, while these FIGS. show the body **14H, 14I, 14J, 14K** of a flow conditioner piping component, it is contemplated that the bodies of other piping components could also be formed in a variety of configurations because the plastic discovered is relatively inexpensive to form.

[0087] FIG. **22** illustrates a system for conditioning fluid. An anti-swirl device **62** piping component is placed upstream in a steel pipe **60** from a flow conditioner **10L** having a plurality of apertures **15L** and a measurement device **64**. An enlarged section view of the flow conditioner **10L** in FIG. **23** best shows set screw **66** threaded through an aperture in the steel housing **12L** into a recess **68** in plastic body **14L** so that the body **14L** is fastened to the steel housing **12L** of steel pipe **60**. The body **14L** of FIG. **23** has been actually reduced to practice and was manufactured for at least 50% less than an all-steel body.

[0088] FIGS. **24** to **26** illustrate alternative fastening of flow conditioner **10M, 10N,** and **10O** to steel housing **12M, 12N,** and **12O** provided by a steel pipe. FIG. **24** shows an aperture through steel housing **12M** which aligns with aperture **71** in the flow conditioner **10M** body **14M** to receive expandable roll pin **70**.

[0089] Turning to FIG. **25**, a threaded aperture **74** in the steel housing **12N** of the flow conditioner **10N** receives set screw **72.** Screw **72** engages metallic support **76** in plastic body **14N** to distribute the force applied by screw **72.** The flow conditioner **10O** in FIG. **26** illustrates a metal casing **80** with inwardly threads positioned in the plastic body **14O.** The screw **78** is received through an aperture **79** in the steel housing **12O** and threadly engages the casing **80.** Other fastening means are contemplated for fastening a flow conditioner into a housing, such as a pipe.

[0090] FIG. **27** illustrates several piping components, generally indicated at **88, 82,** embodying the present invention to drop the pressure in a piping system. Flow nozzle **88,** which is shown in detail in FIG. **28,** is positioned between a flow meter **90** and a venturi flowmeter **82.** Both the flow nozzle **88** and venturi flowmeter **82** have respective steel casings **12P, 84** and plastic bodies **14P, 86.** As best shown in FIG. **28,** the flanges **94A, 96A** of respective steel pipe **94, 96** hold the steel housing **12P** to give the piping system the required DOT continuous steel connection with the plastic body **14P** of the flow nozzle **88** within the pipe **94, 96.** Other venturi nozzles, such as distributed by Canada Pipeline Accessories of Calgary, Alberta, Canada, are contemplated for use with the multiple materials of the present invention.

[0091] FIG. **29** illustrates a small volume prover, generally indicated at **98,** according to the present invention wherein the solenoids and hydraulic system, which is collectively the body **14Q**, are fabricated from plastic. The body **14Q** of the small volume prover **98** is contained within the steel housing **12Q**, and operates when the bypass valve **102** is opened to fill the chamber, and the piston assembly **100** having a plastic member **101** is fully extended. When the bypass valve **102** is sealed, fluid flows past the piston assembly **100**, and fluid measurement is achieved. Examples of other small volume provers are proposed in U.S. Patent Nos. 3,421,360; 3,673,851; 3,877,287; 4,152,922 and 4,627,267.

[0092] FIGS. **30** to **32** illustrate flow conditioners **10R, 10S,** and **10T** having respective bodies **14R, 14S,** and **14T** extruded or molded from plastic. A pipe, indicated in phantom view **12R, 12S** and **12T,** is contemplated to encase the plastic bodies **14R, 14S** and **14T**. In FIG. **30**, the body **14R** includes a plurality of equidistant spaced vanes **104.** In FIG. **31**, the body **14S** is configured in a honeycomb **106** and in FIG. **32**, the body **14S** is formed from a bundle of tubes **108**. It is contemplated that a variety of other shapes could be fabricated because plastic is inexpensively extruded and/or molded.

[0093] FIG. **33** illustrates a sampler **110** piping component, wherein plastic body **14 U** is threaded onto the steel casing **12U.** The plastic body **14U** of the sampler **110** extending from the steel casing **12U** replaces the steel components as proposed in U.S. Patent Nos. 3,945,770 and 4,403,518. The collection head **112,** traditionally fabricated from rubber, provides resiliency, as does elastomer sealing members **114**. Sampler **110** illustrates how multiple non-steel materials could be used to fabricate the body of a piping component extending from a pipe. However, it is also envisioned that non-metallic materials, such as plastic and rubber, could also be combined with metallic materials, such as steel, to form the body of piping components.

[0094] Yet another embodiment of a piping component according to this invention is a valve **10V** shown in FIG. **34**. Butterfly valve **10V** includes a steel housing **12V** which contains a plastic butterfly body **14V** that rotates about axial member **118** moved either via actuator or by hand. The body **14V** aligns with the opposed elastomer seals **116A**, **116B** to close the valve **10V**. The axial member **118** is fabricated from steel similar to housing **12V** to maintain all steel containment per DOT regulations. Other types of valves are contemplated to be comprised of the multiple materials of the present invention.

[0095] A turbine flowmeter **10W**, illustrated in FIG. **35**, includes a plastic flow tube body **14W** with plastic propeller or turbine blades **120** mounted on bearings coaxially inside. Magnets **122** could be fastened onto the turbine blades **120** so that angular velocity can be determined from outside the steel housing **12W** by a sensor **124**. Other types of flowmeters are contemplated to be comprised of the multiple materials of the present invention.

[0096] FIGS. **36** and **37** illustrate static mixer plates **14X'**, **14Y'** piping components. The static mixer **10X** in FIG. **36** is mounted within a steel housing **12X** while a plurality of semi-elliptical plates **14X'** form the body, generally indicated at **14X**, which serve to mix fluid passing through the piping component. FIG. **37** illustrates a plurality of rods **14Y"** threaded through plates **14Y'** to form the body, generally indicated at **14Y**. Plastic body **14Y** can be positioned within a steel pipe, similar to steel housing **12X** in FIG. **36**. It is contemplated that the other static mixes proposed in the above identified U.S. Patents could be comprised of the multiple materials of the present invention.

[0097] Additional piping components include the flow conditioners **10Z**, **10AA** depicted in FIGS. **38** to **41**. Flaps **14Z'** and fins **14Z"** of insertion sleeve or body **14Z** can be fastened to the steel housing **12Z** using any of the fastening means discussed above. Also, the fins **14AA"** and flaps **14AA'** of the insertion body **14AA** can be easily formed from plastic. It is also contemplated that the flaps and fins illustrated in FIGS. **38** to **41** could be fabricated from plastic and fastened directly to the steel housing by any of the fastening means discussed above, including epoxy adhesive.

[0098] Yet another piping component includes a flowmeter as shown in FIG. **42** having a flow conditioner, generally indicated at **10BB,** having a body **14BB,** preferably fabricated from plastic, having apertures **15BB.** As best shown in FIGS. **42** and **43,** the plastic body 14**B**B is moved through the steel piping **12BB** until blocked by shoulder **12BB'**. An elongated plastic contoured contraction body **14BB'** is then positioned in the steel piping **12BB**. A plastic rotor **130** between plastic stators **128**, **132** on a shaft **134** with bearings is positioned with the elongated body **14BB'**. A waffle compression ring **126** is bolted by bolts, such as bolts **126A** and **126B**, to the steel body **12BB**. A pick-up coil and preamp **136** is positioned on the steel body 12BB as is known in the industry.

[0099] While Faure Herman Meter, Inc. of Houston, Texas provides an all steel flowmeter similar in configuration to the flowmeter shown in FIGS. **42** and **43**, it is contemplated that some or all of the following components, as shown in FIGS. **42** and **43**, could be fabricated from plastic: body **14BB**, elongated body **14BB'**, stators **128, 132,** and rotor **130.**

METHODS OF MANUFACTURE

[0100] Methods of manufacture include machining the steel housing, as is traditional, and fastening the formed non-metallic body into the housing. The non-metallic body, preferably fabricated from the NORYL PPX® Resin PPS7200 disclosed in detail above, is best fabricated by injection molding. However, as size increases over a foot, it may be necessary to machine plastic sheets. The sheet form, preferably fabricated from NORYL PPX® PPX7112 Resin (polyphenylene ether + PS + PP), is distributed by GE Plastics and sold by GE Polymershapes of South Houston, Texas. Yet another contemplated method of manufacturing the plastic body of a piping component is by blow molding.

[0101] It is contemplated that the non-metallic body of the piping component may require certain metal parts. Therefore, it is possible to manufacture a piping component body with both non-metal and metal parts. It is also foreseeable to have multiple types of non-metal parts, such as plastic, ceramic and rubber, in the piping component.

[0102] While as discussed above in detail, it is contemplated that fastening the body to the metal housing could be done in a variety of ways, the SCOTCH-WELD® epoxy adhesive, such as disclosed above in detail, is preferred to fasten the plastic body to the metal housing.

[0103] The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the details of the illustrated apparatus and system, and the construction and the method of operation may be made without departing from the spirit of the invention.

CLAIMS:

1. A piping component, comprising:

a metal flange having an opening;

a body fabricated from a non-metal material and positioned with said flange opening;

an upstream face on said body;

a downstream face on said body; and

a plurality of substantially circular spaced apart apertures extending between said body upstream face and said body downstream face in predetermined locations;

wherein one of said body faces being substantially flat; and wherein one of the faces on said body is substantially convex shaped.

2. A piping component, comprising:

a metal flange having an opening;

a body fabricated from a non-metal material and positioned with said flange opening;

an upstream face on said body;

a downstream face on said body; and

a plurality of substantially circular spaced apart apertures extending between said body upstream face and said body downstream face in predetermined locations;

wherein one of said body faces being substantially flat; and

wherein one of the faces on said body is step shaped.

3. A piping component, comprising:

a metal flange having an opening;

a body fabricated from a non-metal material and positioned with said flange opening;

an upstream face on said body;

a downstream face on said body; and

a plurality of substantially circular spaced apart apertures extending between said body upstream face and said body downstream face in predetermined locations;

wherein one of said body faces being substantially flat; and

wherein said body is fastened to said metal flange by an epoxy adhesive.

4. A piping component, comprising:
   a metal flange having an opening;
   a body fabricated from a non-metal material and positioned with said flange opening;
   an upstream face on said body;
   a downstream face on said body; and
   a plurality of substantially circular spaced apart apertures extending between said body upstream face and said body downstream face in predetermined locations;
   wherein one of said body faces being substantially flat; and
   wherein said body is fastened to said metal flange by a set screw.

5. A piping component, comprising:
   a metal flange having an opening;
   a body fabricated from a non-metal material and positioned with said flange opening;
   an upstream face on said body;
   a downstream face on said body; and
   a plurality of substantially circular spaced apart apertures extending between said body upstream face and said body downstream face in predetermined locations;
   wherein one of said body faces being substantially flat; and
   wherein said body is fastened to said metal flange by a key.

6. A piping component, comprising:
   a metal flange having an opening;
   a body fabricated from a non-metal material and positioned with said flange opening;
   an upstream face on said body;
   a downstream face on said body; and
   a plurality of substantially circular spaced apart apertures extending between said body upstream face and said body downstream face in predetermined locations;
   wherein one of said body faces being substantially flat; and
   wherein said body is fastened to said metal flange by a pin.

7. A method of manufacturing a flow conditioner, comprising the steps of:
providing a metal housing having an opening;
forming a body having an upstream face and a downstream face and fabricated from a non-metal material that can withstand a fluid requiring steel containment;
positioning said body at least in part within said metal housing opening; and
fastening said body to said housing by an epoxy adhesive;
wherein one of said body faces being substantially flat; and
wherein said body having a plurality of substantially circular spaced apart apertures extending through said body.

8. A method of manufacturing a flow conditioner, comprising the steps of:
providing a metal housing having an opening;
forming a body having an upstream face and a downstream face and fabricated from a non-metal material that can withstand a fluid requiring steel containment;
positioning said body at least in part within said metal housing opening; and
fastening said body to said housing a two part-epoxy adhesive that has a high shear and peel adhesion, and is durable in corrosive environments;
wherein one of said body faces being substantially flat; and
wherein said body having a plurality of substantially circular spaced apart apertures extending through said body.

9. A method of manufacturing a flow conditioner, comprising the steps of:
providing a metal housing having an opening;
forming a body having an upstream face and a downstream face and fabricated from a non-metal material that can withstand a fluid requiring steel containment;
positioning said body at least in part within said metal housing opening; and
fastening said body to said housing by a set screw;
wherein one of said body faces being substantially flat; and
wherein said body having a plurality of substantially circular spaced apart apertures extending through said body.

10. A method of manufacturing a flow conditioner, comprising the steps of:
providing a metal housing having an opening;
forming a body having an upstream face and a downstream face and fabricated from a non-metal material that can withstand a fluid requiring steel containment;
positioning said body at least in part within said metal housing opening; and
fastening said body to said housing by a key;
wherein one of said body faces being substantially flat; and
wherein said body having a plurality of substantially circular spaced apart apertures extending through said body.

11. A method of manufacturing a flow conditioner, comprising the steps of:
providing a metal housing having an opening;
forming a body having an upstream face and a downstream face and fabricated from a non-metal material that can withstand a fluid requiring steel containment;
positioning said body at least in part within said metal housing opening; and
fastening said body to said housing by a pin;
wherein one of said body faces being substantially flat; and
wherein said body having a plurality of substantially circular spaced apart apertures extending through said body.

12. A piping system, comprising:
a steel pipe;
a piping component releasably connected to said steel pipe, said piping component including:
a steel housing having an opening, said steel housing connecting with said steel pipe so that said steel housing opening is within said steel pipe; and
a body fabricated from a non-steel material and positioned with said steel housing opening so that said body does not directly contact said steel pipe while being positioned within said steel pipe;
wherein said body being fixed relative to said steel pipe;

wherein said body having a plurality of substantially circular spaced apart apertures extending through said body; and

wherein said non-steel material is attached with said steel housing with an epoxy adhesive.

13. A piping system, comprising:

a steel pipe; and

a piping component releasably connected to said steel pipe, said piping component including:

a steel housing having an opening, said steel housing connecting with said steel pipe so that said steel housing opening is within said steel pipe; and

a body fabricated from a non-steel material and positioned with said steel housing opening so that said body does not directly contact said steel pipe while being positioned within said steel pipe;

wherein said body being fixed relative to said steel pipe;

wherein said body having a plurality of substantially circular spaced apart apertures extending through said body; and

wherein said body having at least two faces and one of said faces on said body is convex shaped.

14. A piping system, comprising:

a steel pipe; and

a piping component releasably connected to said steel pipe, said piping component including:

a steel housing having an opening, said steel housing connecting with said steel pipe so that said steel housing opening is within said steel pipe; and

a body fabricated from a non-steel material and positioned with said steel housing opening so that said body does not directly contact said steel pipe while being positioned within said steel pipe;

wherein said body being fixed relative to said steel pipe;

wherein said body having a plurality of substantially circular spaced apart apertures extending through said body; and

wherein said body having at least two faces and one of said faces on said body is step shaped.

15. A piping system, comprising:

a steel pipe; and

a piping component releasably connected to said steel pipe, said piping component including:

a steel housing having an opening, said steel housing connecting with said steel pipe so that said steel housing opening is within said steel pipe; and

a body fabricated from a non-steel material and positioned with said steel housing opening so that said body does not directly contact said steel pipe while being positioned within said steel pipe;

wherein said body being fixed relative to said steel pipe;

wherein said body having a plurality of substantially circular spaced apart apertures extending through said body; and

wherein said body is fastened to said steel housing by adhesive.

16. A piping system, comprising:

a steel pipe; and

a piping component releasably connected to said steel pipe, said piping component including:

a steel housing having an opening, said steel housing connecting with said steel pipe so that said steel housing opening is within said steel pipe; and

a body fabricated from a non-steel material and positioned with said steel housing opening so that said body does not directly contact said steel pipe while being positioned within said steel pipe;

wherein said body being fixed relative to said steel pipe;

wherein said body having a plurality of substantially circular spaced apart

apertures extending through said body; and
wherein said body is fastened to said steel housing by a set screw.

17. A piping system, comprising:
a steel pipe; and
a piping component releasably connected to said steel pipe, said piping component including:
a steel housing having an opening, said steel housing connecting with said steel pipe so that said steel housing opening is within said steel pipe; and
a body fabricated from a non-steel material and positioned with said steel housing opening so that said body does not directly contact said steel pipe while being positioned within said steel pipe;
wherein said body being fixed relative to said steel pipe;
wherein said body having a plurality of substantially circular spaced apart apertures extending through said body; and
wherein said body is fastened to said steel housing by a retainer ring.

18. A piping system, comprising:
a steel pipe; and
a piping component releasably connected to said steel pipe, said piping component including:
a steel housing having an opening, said steel housing connecting with said steel pipe so that said steel housing opening is within said steel pipe; and
a body fabricated from a non-steel material and positioned with said steel housing opening so that said body does not directly contact said steel pipe while being positioned within said steel pipe;
wherein said body being fixed relative to said steel pipe;
wherein said body having a plurality of substantially circular spaced apart apertures extending through said body; and
wherein said body is fastened to said steel housing by a key.

19. A piping system, comprising:

a steel pipe; and

a piping component releasably connected to said steel pipe, said piping component including:

a steel housing having an opening, said steel housing connecting with said steel pipe so that said steel housing opening is within said steel pipe; and

a body fabricated from a non-steel material and positioned with said steel housing opening so that said body does not directly contact said steel pipe while being positioned within said steel pipe;

wherein said body being fixed relative to said steel pipe;

wherein said body having a plurality of substantially circular spaced apart apertures extending through said body; and

wherein said body is fastened to said steel housing by a pin.

20. A flow conditioner chemically compatible with a fluid used in a steel pipe where steel containment is required, comprising:

a substantially circular steel ring having a ring upstream face and a ring downstream face and having a substantially circular opening extending between said ring upstream face and said ring downstream face, wherein said ring upstream face and said ring downstream face being substantially flat; and

a substantially circular body having a body upstream face and a body downstream face fabricated from a non-metal material that can withstand the fluid used in the steel pipe where steel containment is required and sized to be positioned with said ring opening, wherein one of said body faces being substantially flat;

wherein said body is fastened with said ring; wherein said body having a plurality of substantially circular spaced apart apertures formed through said body in predetermined locations each in a substantially straight path between said body upstream face and said body downstream face; and

wherein said body is fastened with said ring with an epoxy adhesive.

FIG. 1

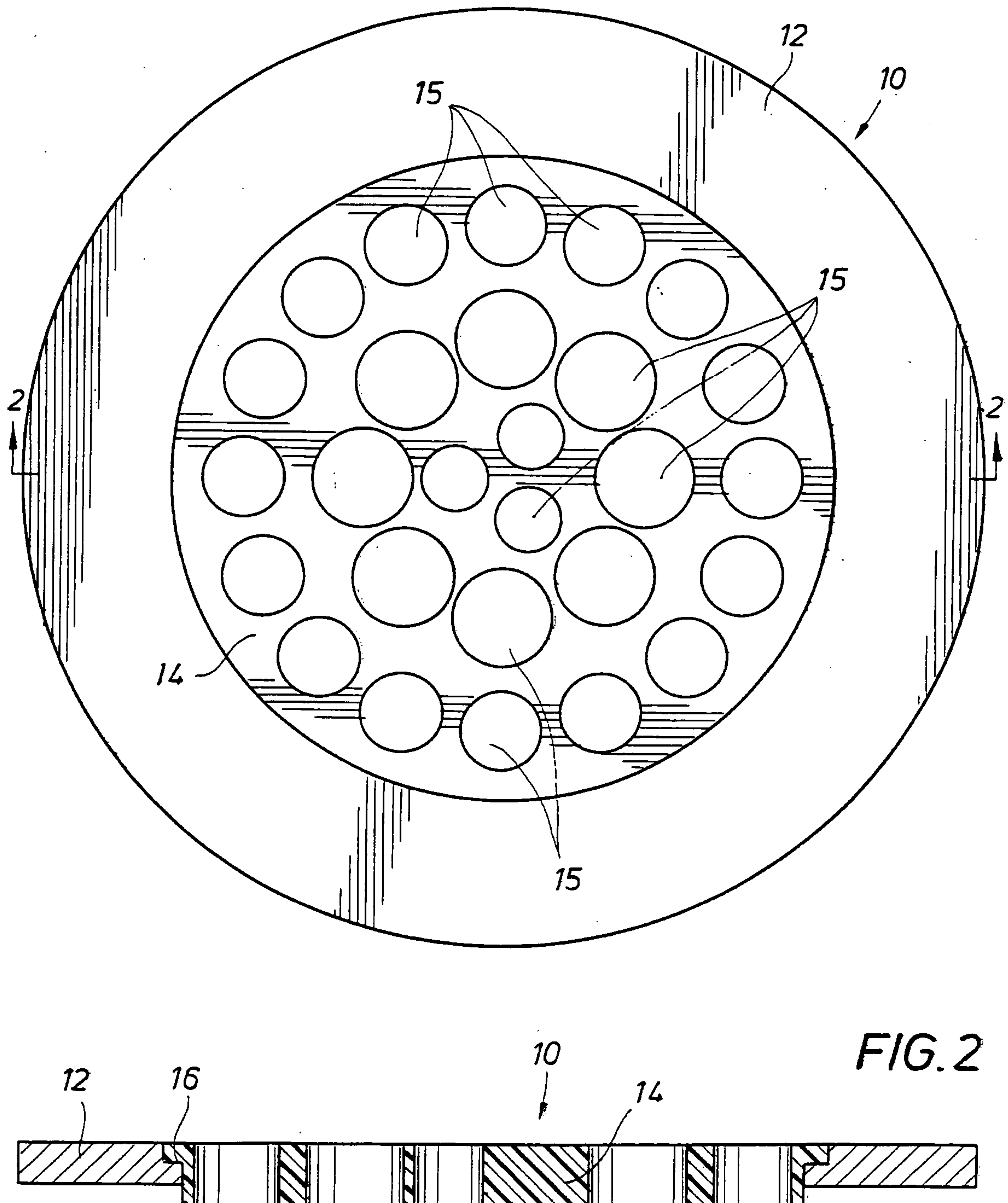


FIG. 2

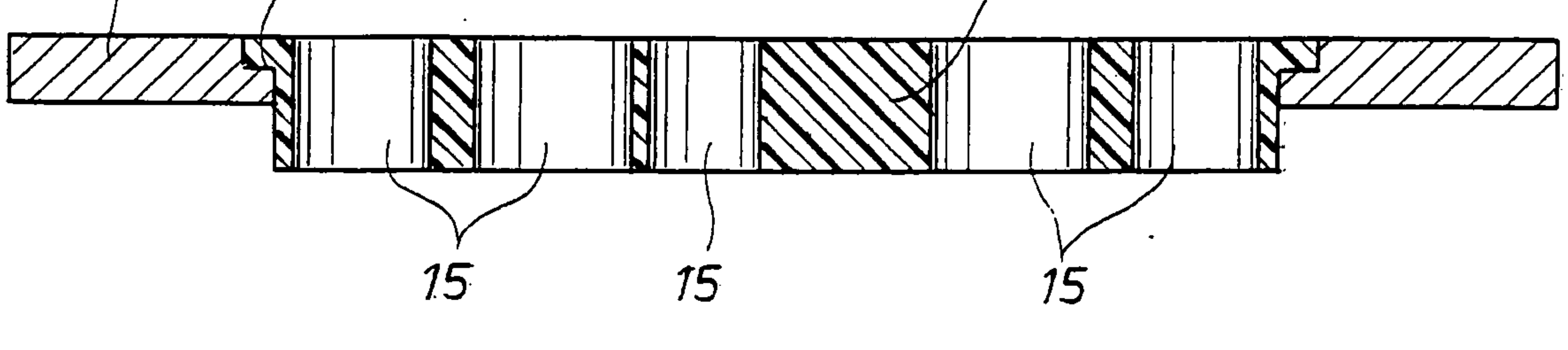


FIG. 3

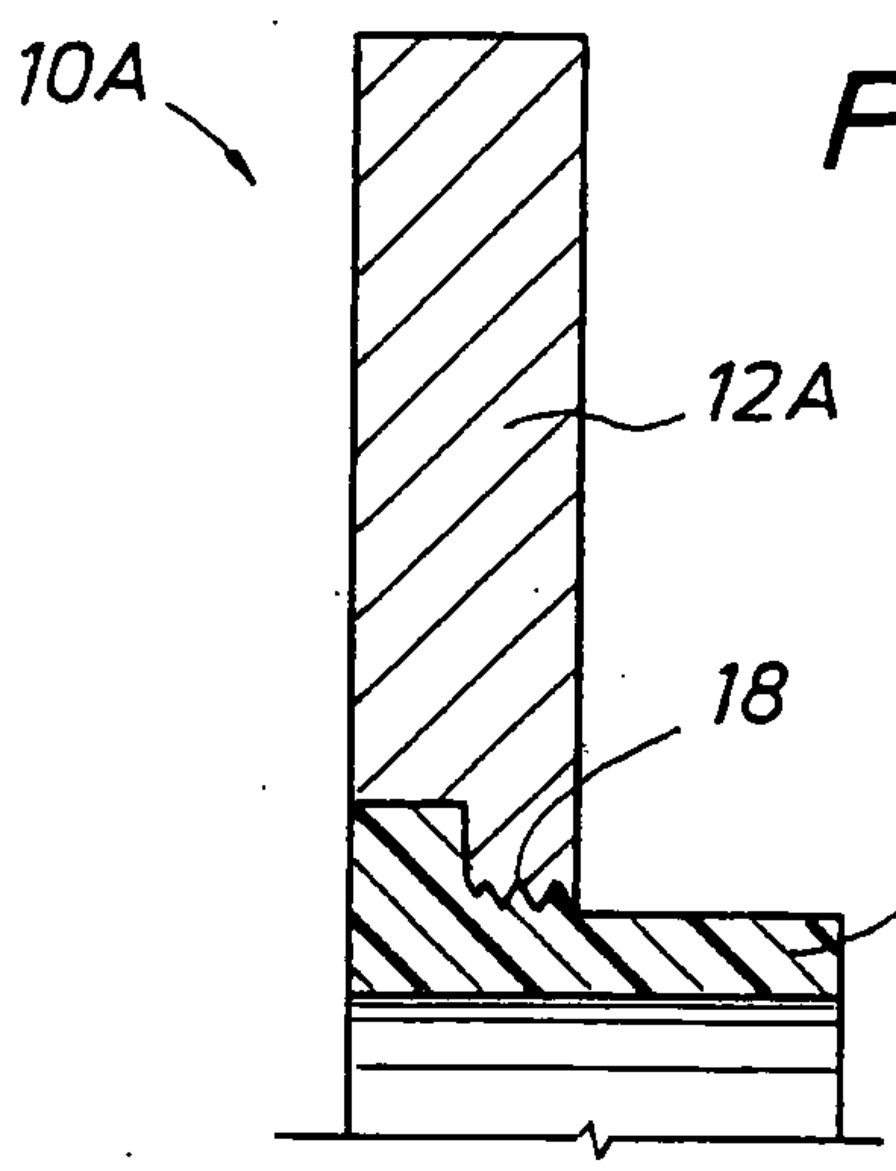


FIG. 4

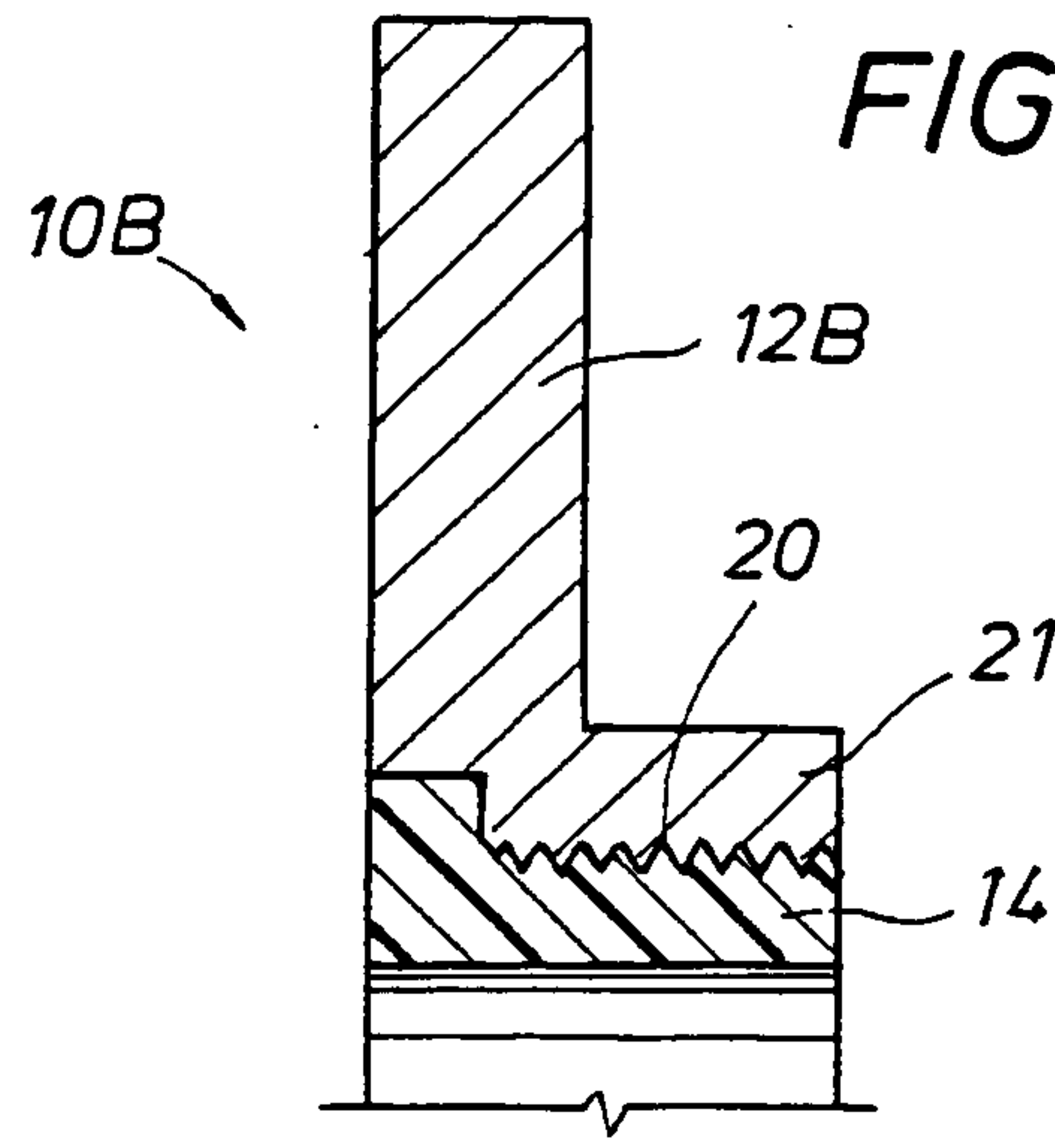


FIG. 5

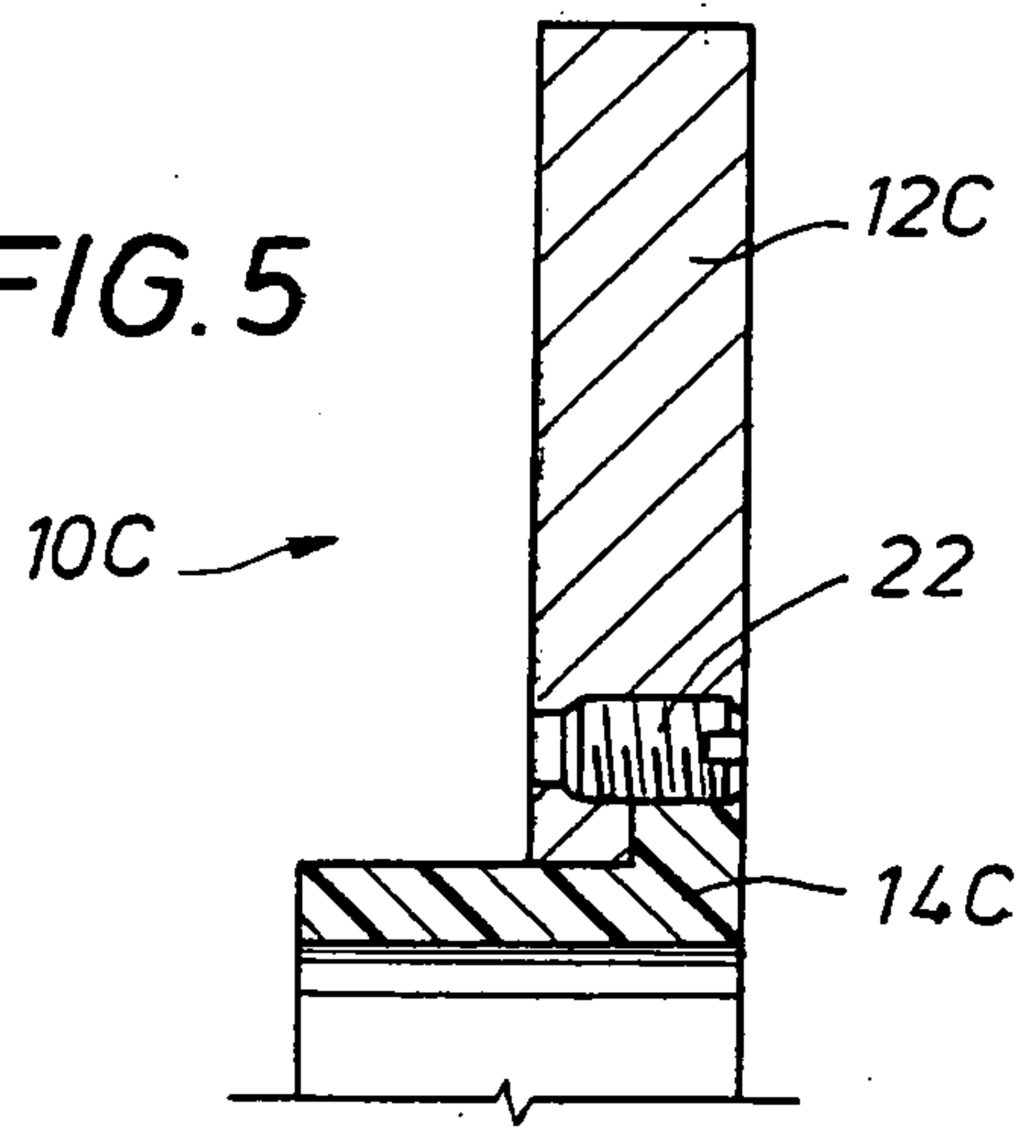


FIG. 6

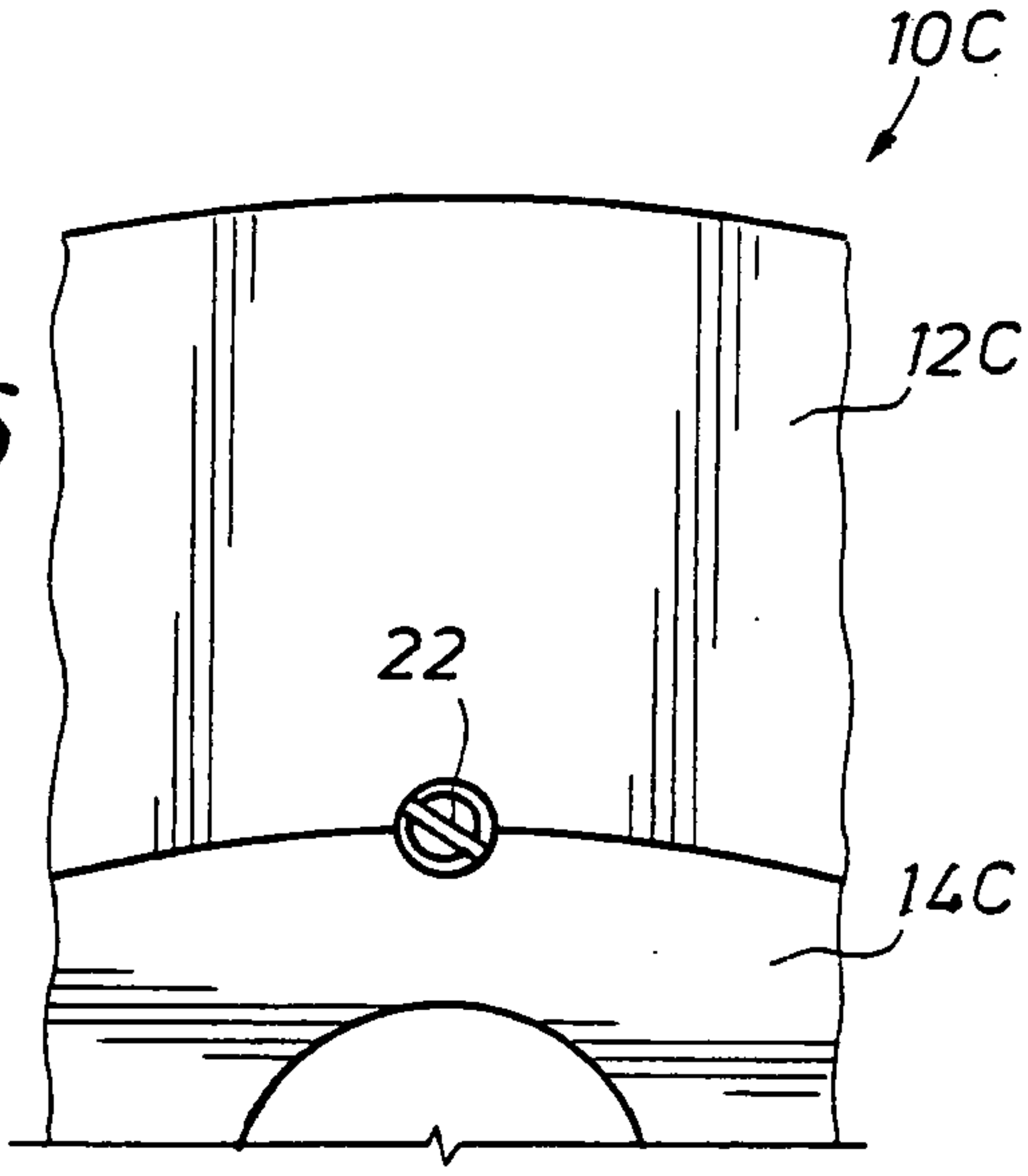


FIG. 7

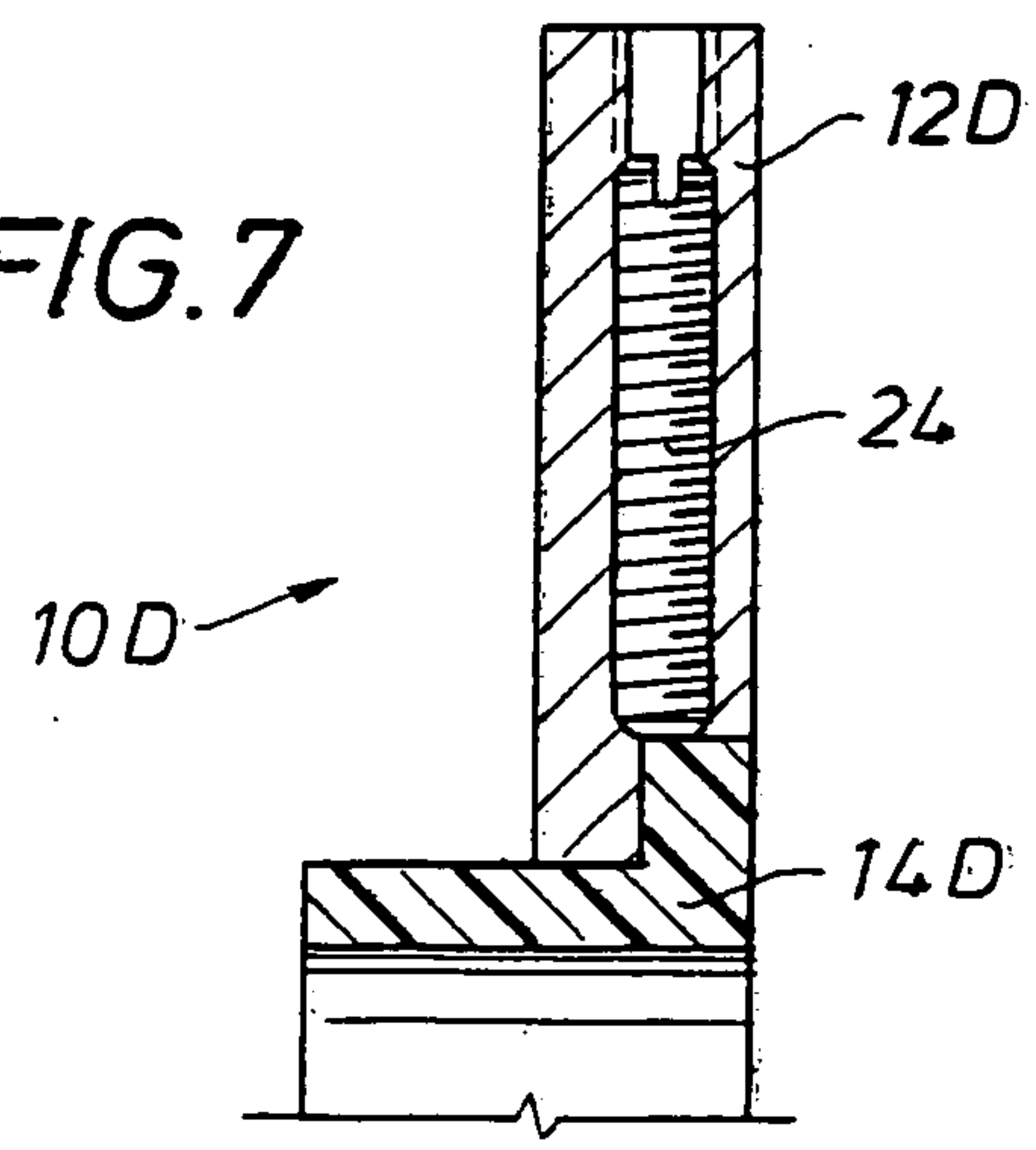
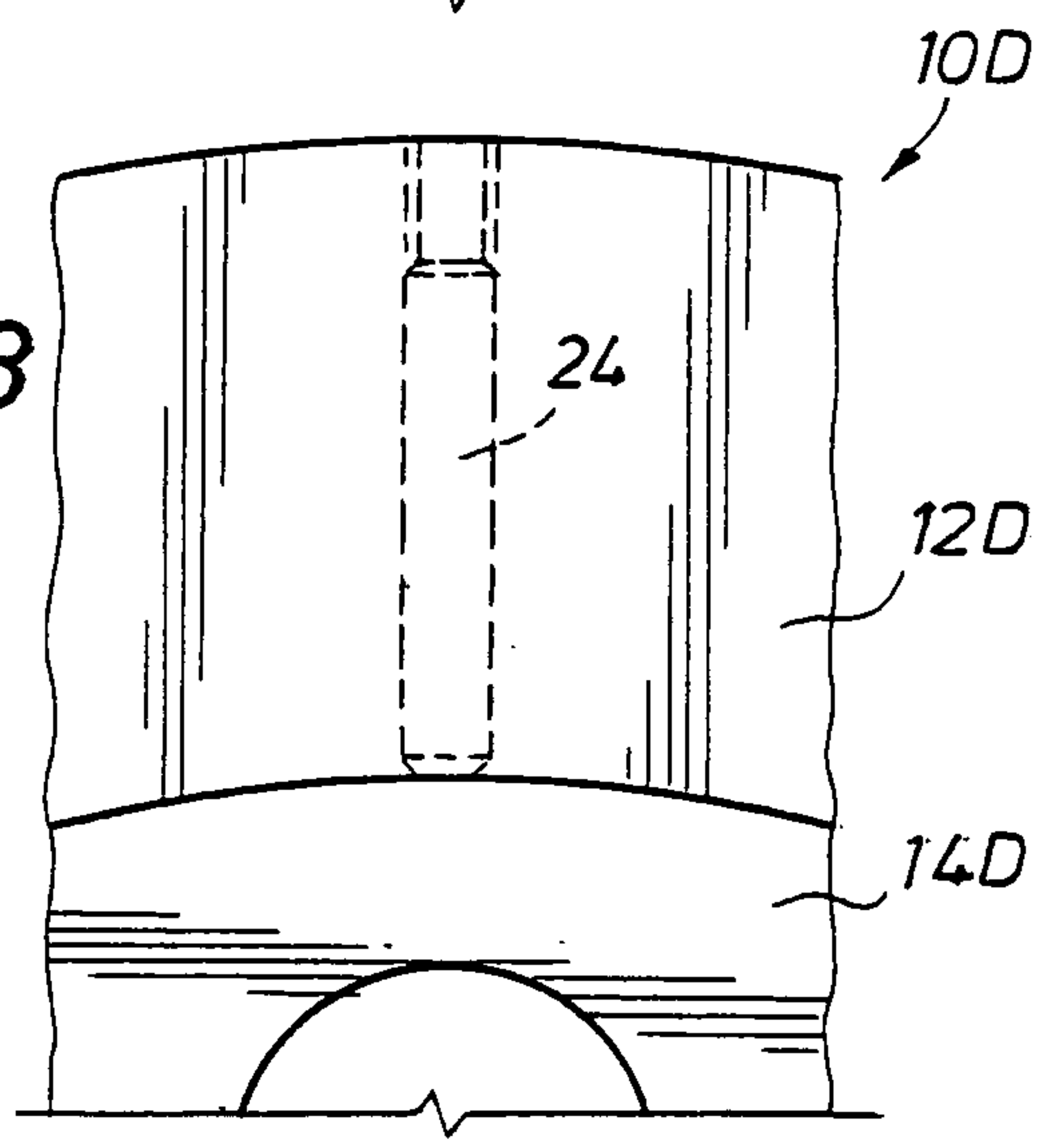


FIG. 8



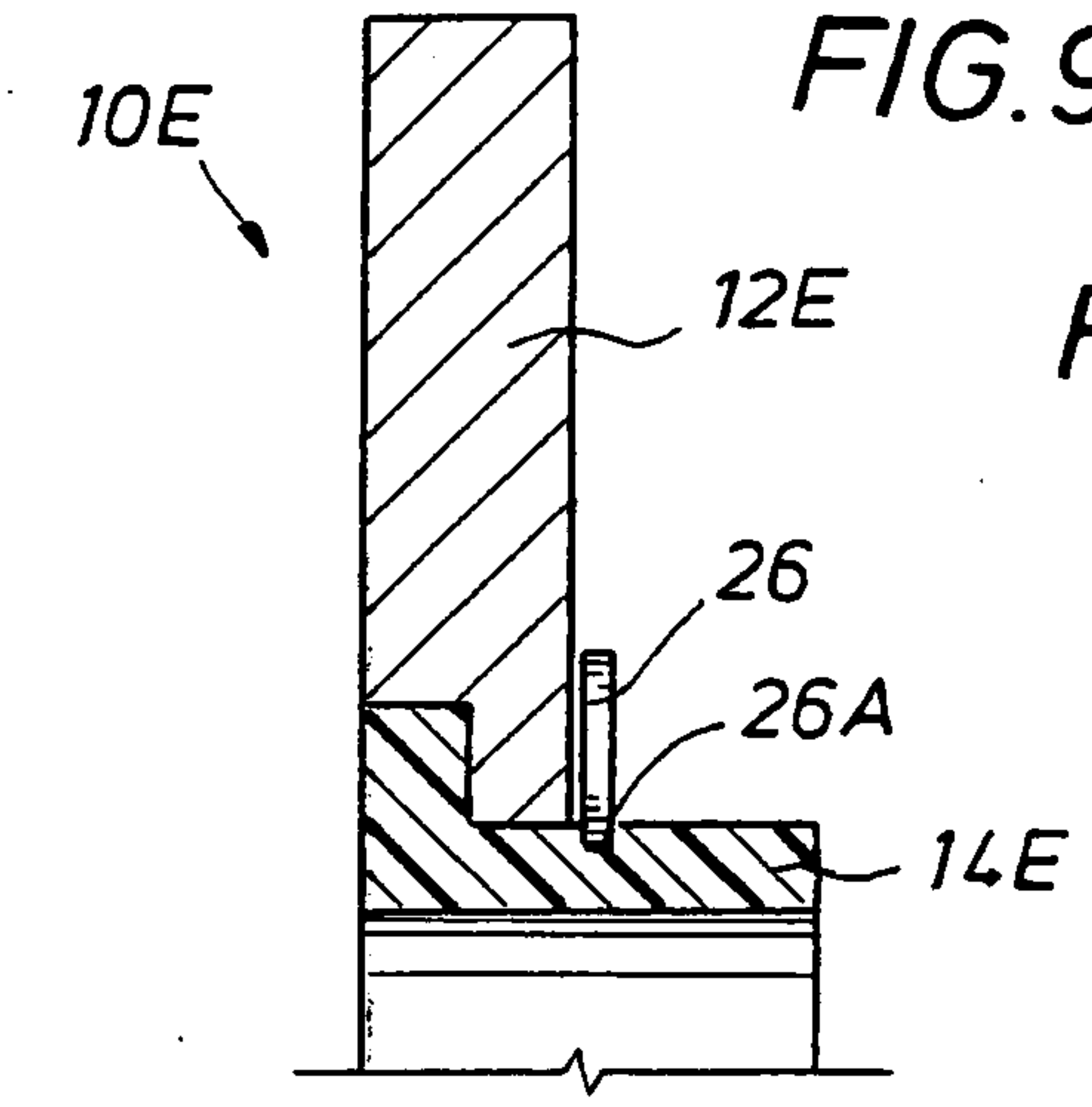


FIG.9

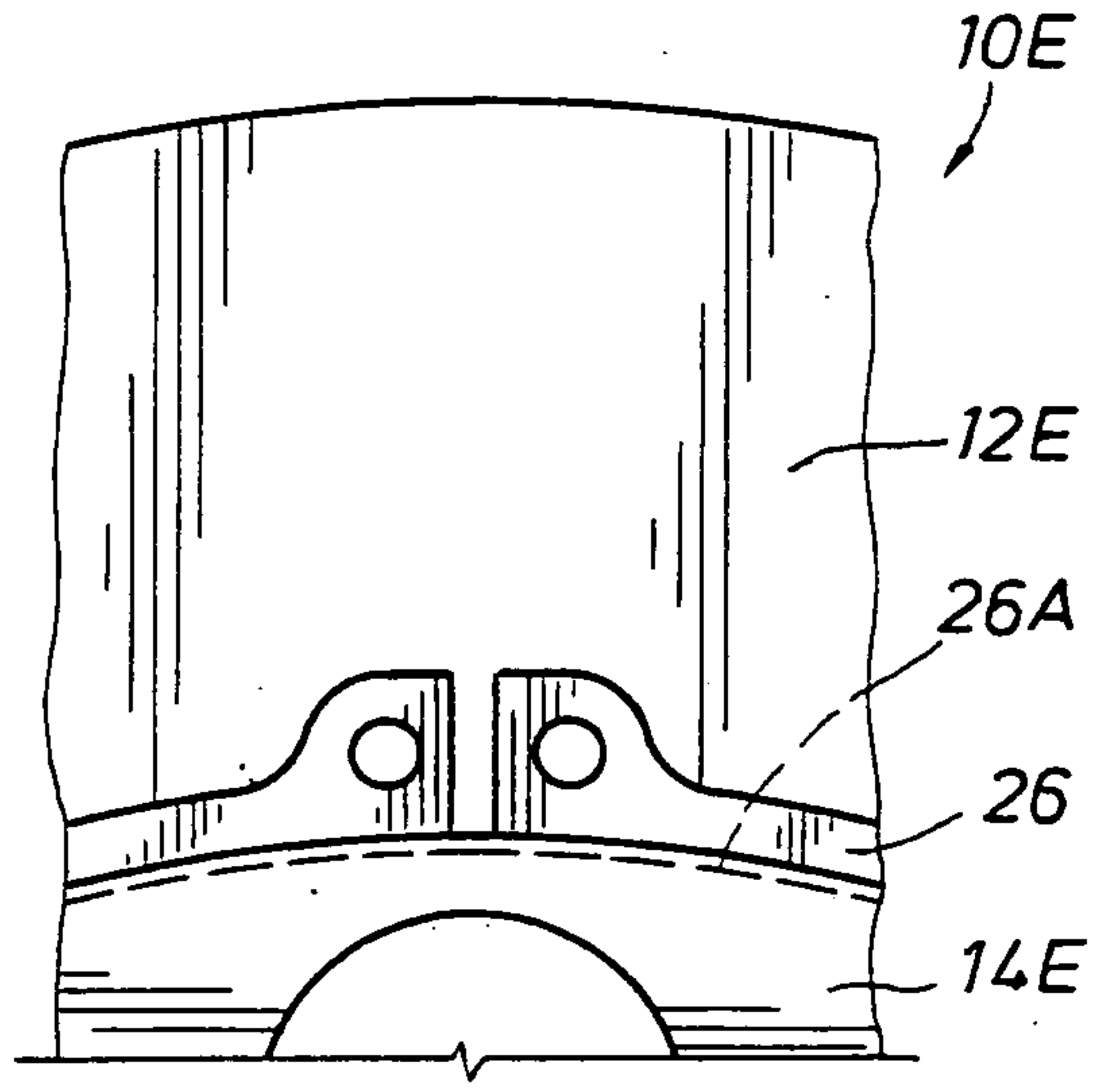


FIG.10

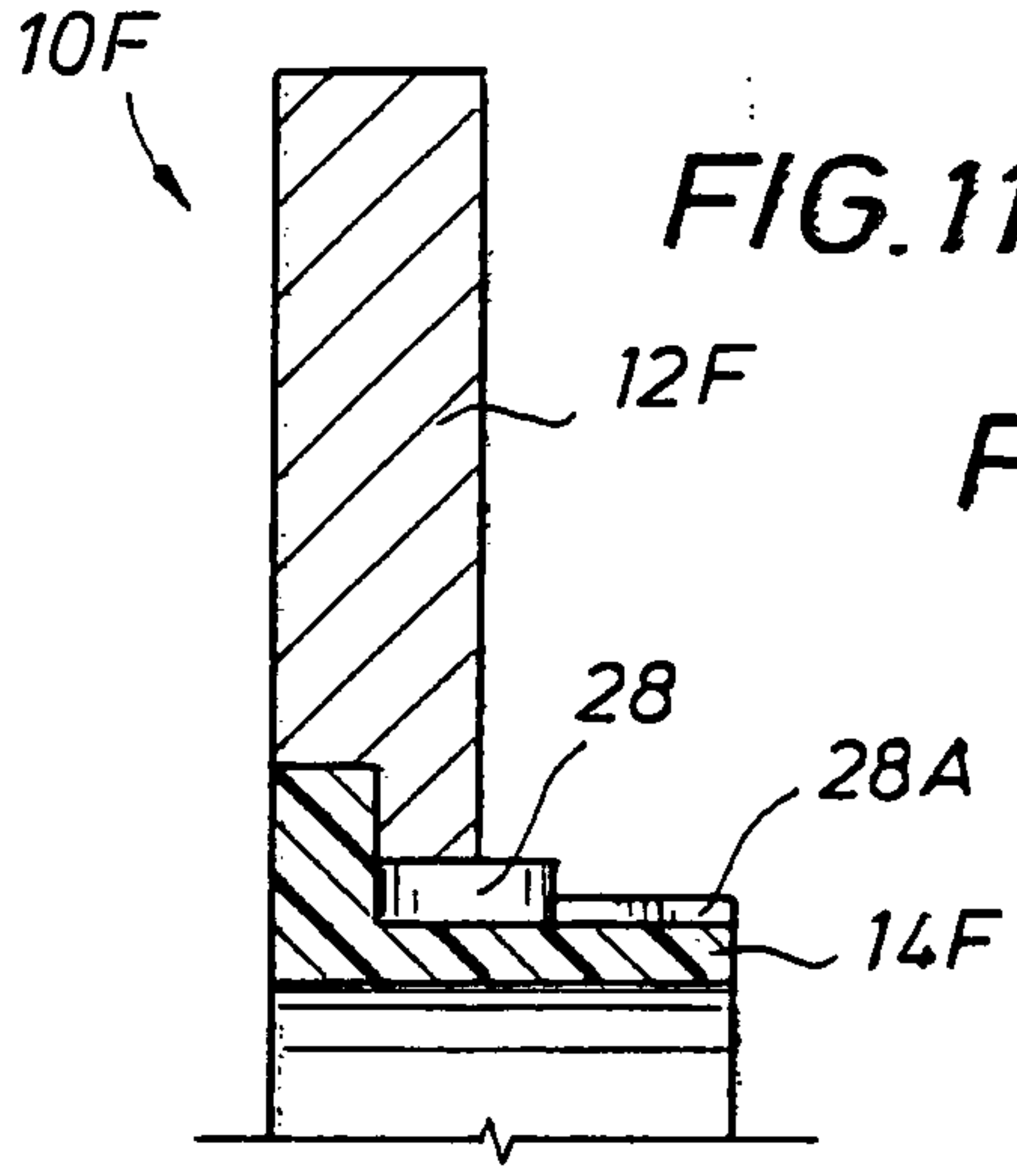


FIG.11

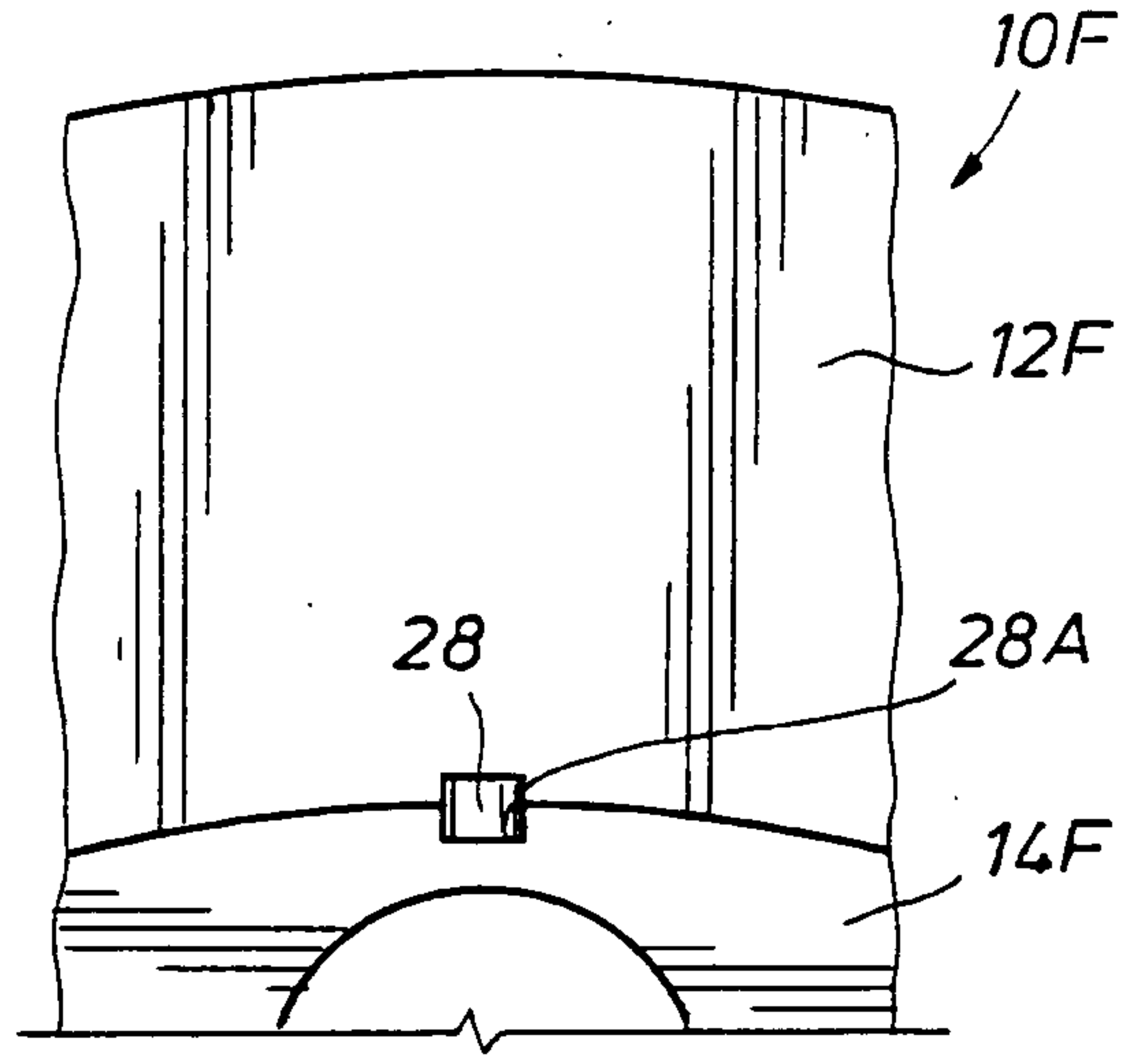


FIG.12

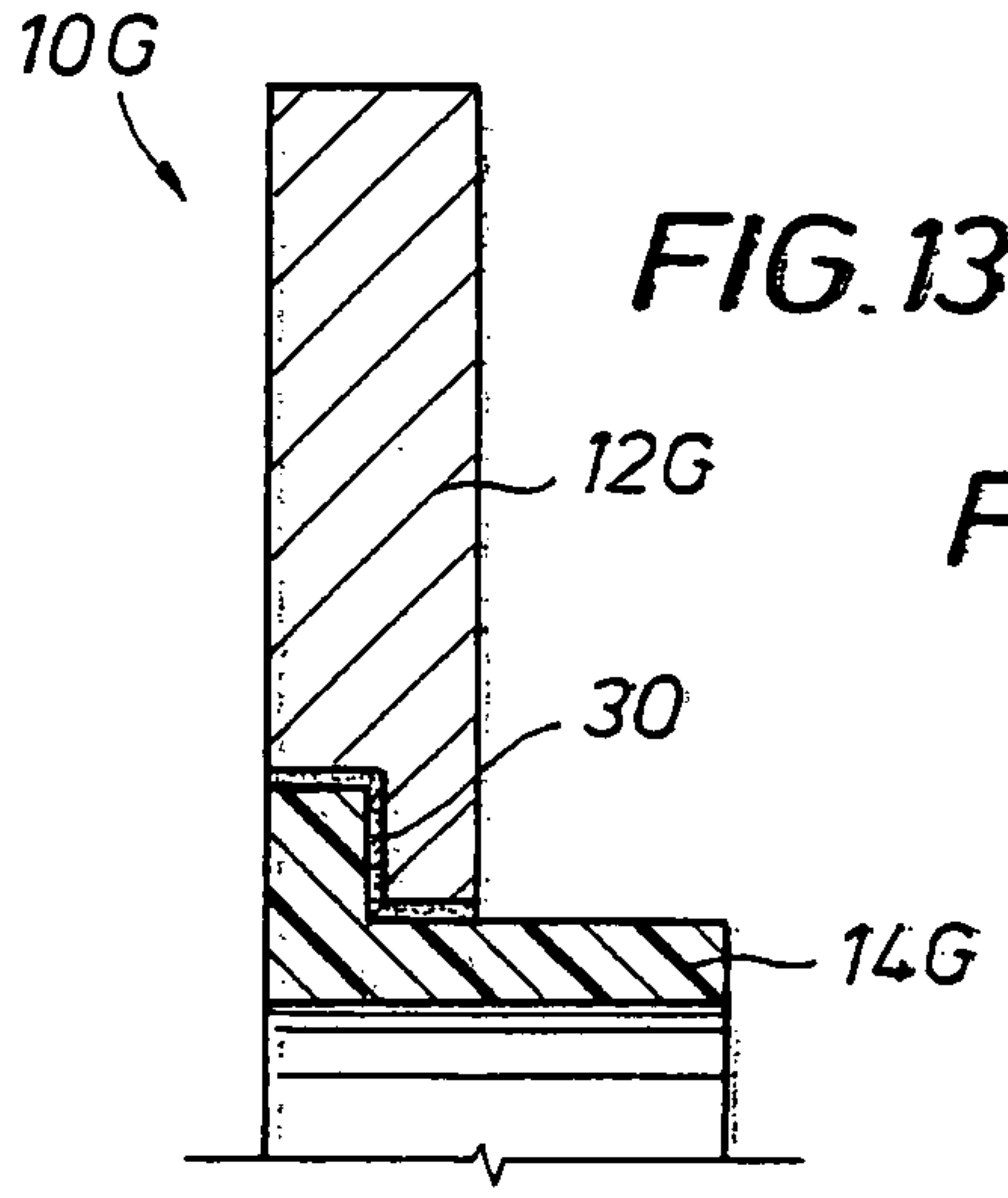


FIG.13

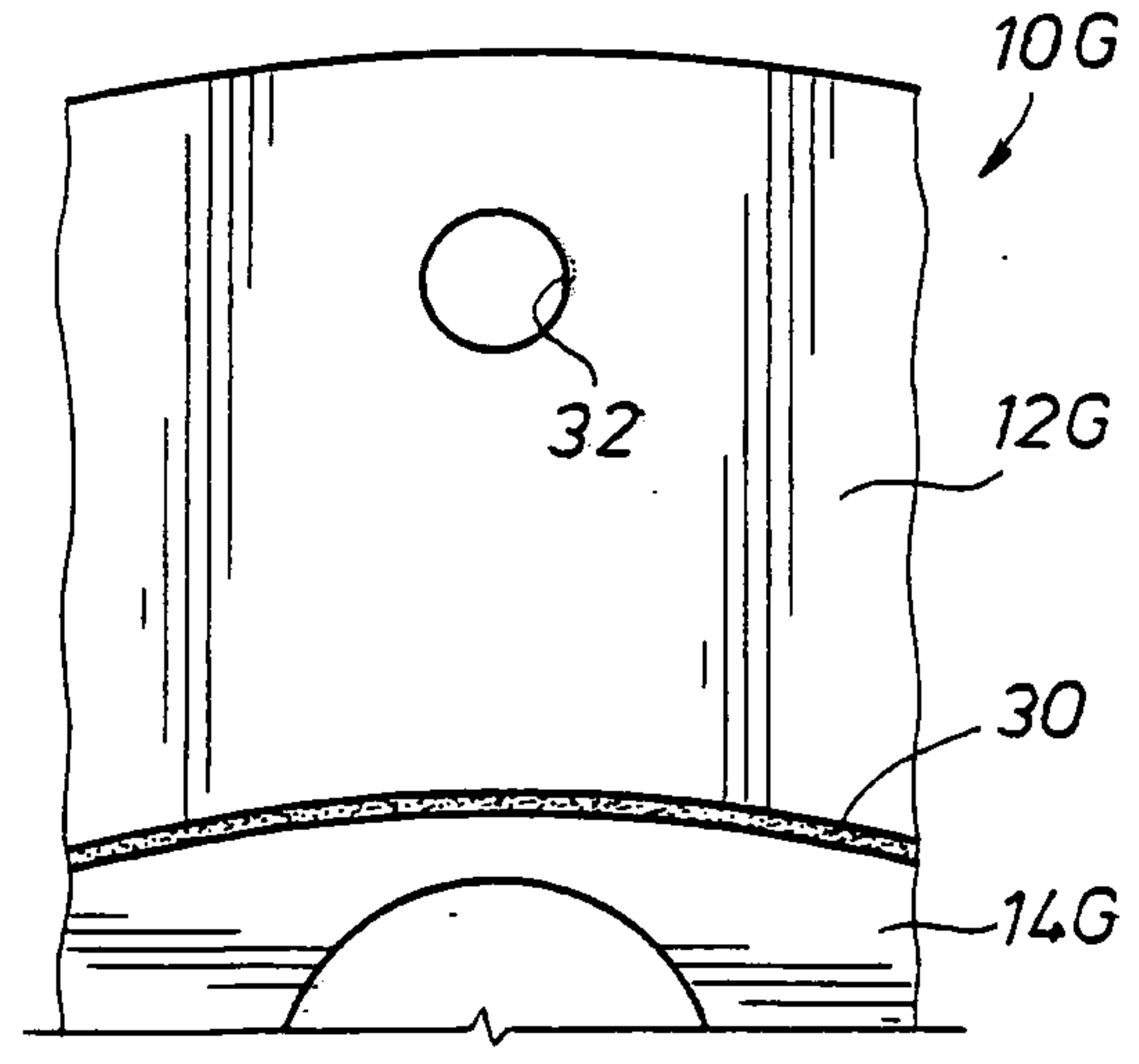


FIG.14

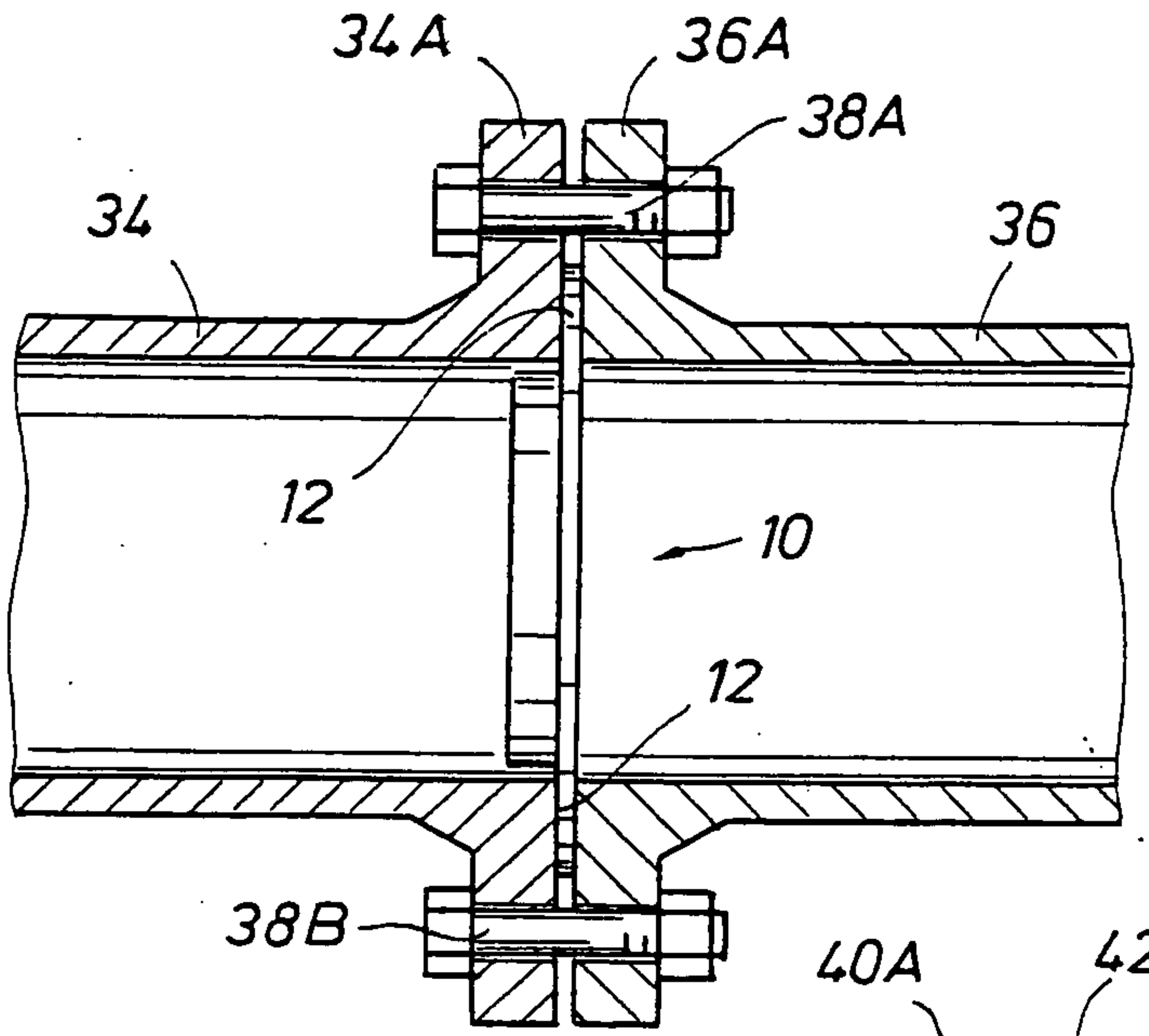
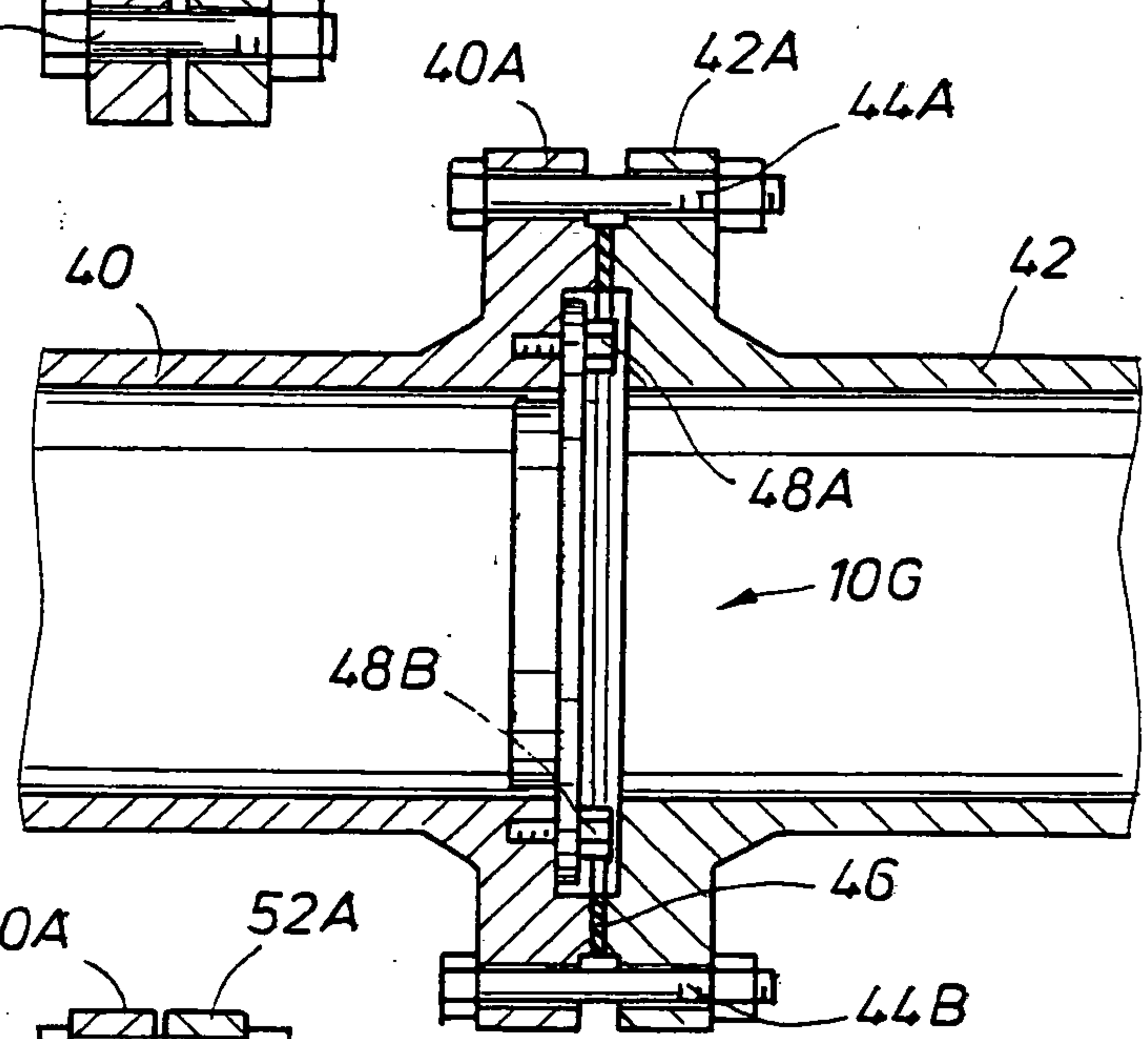


FIG.15

FIG.16



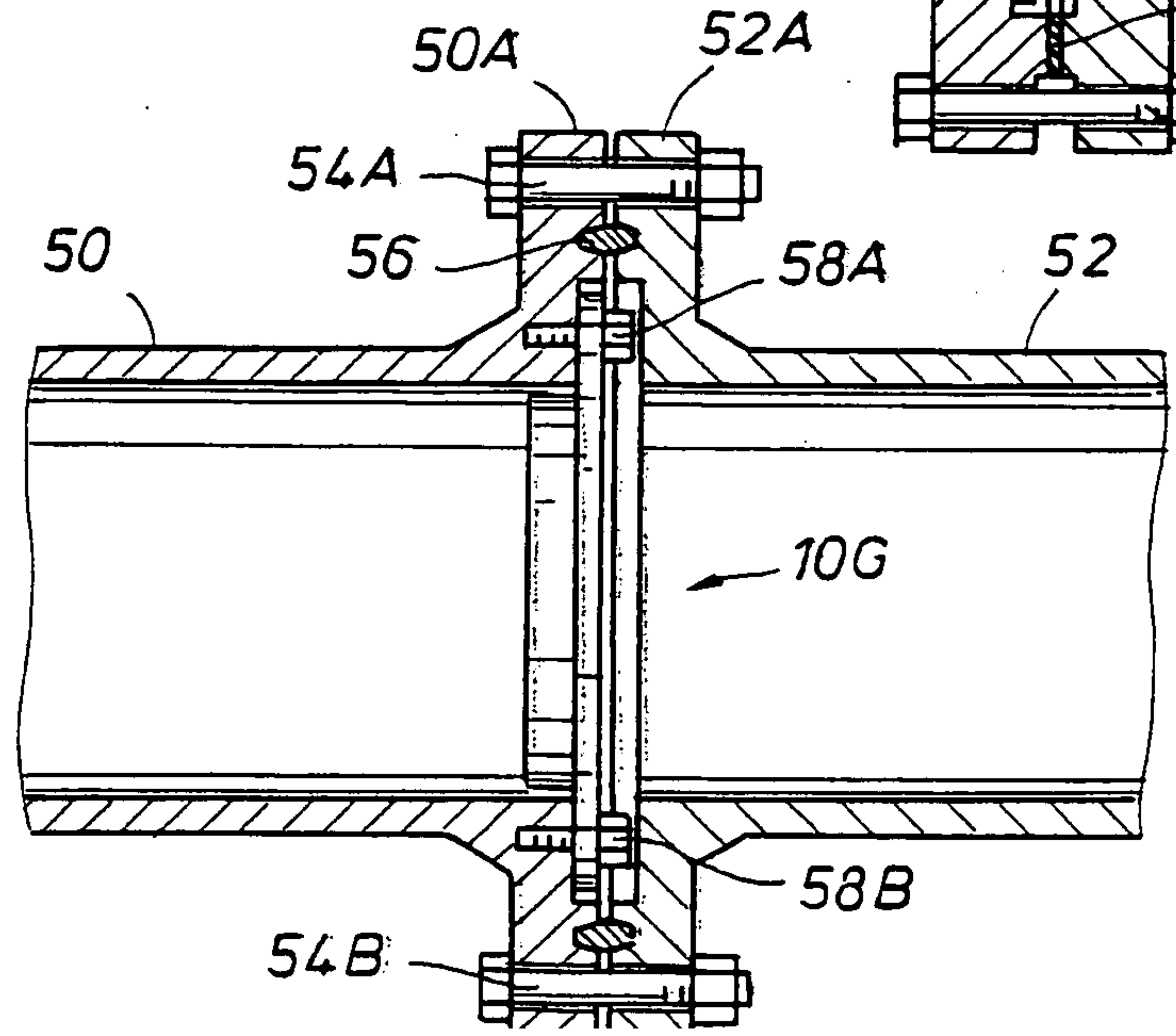


FIG.17

FIG.18

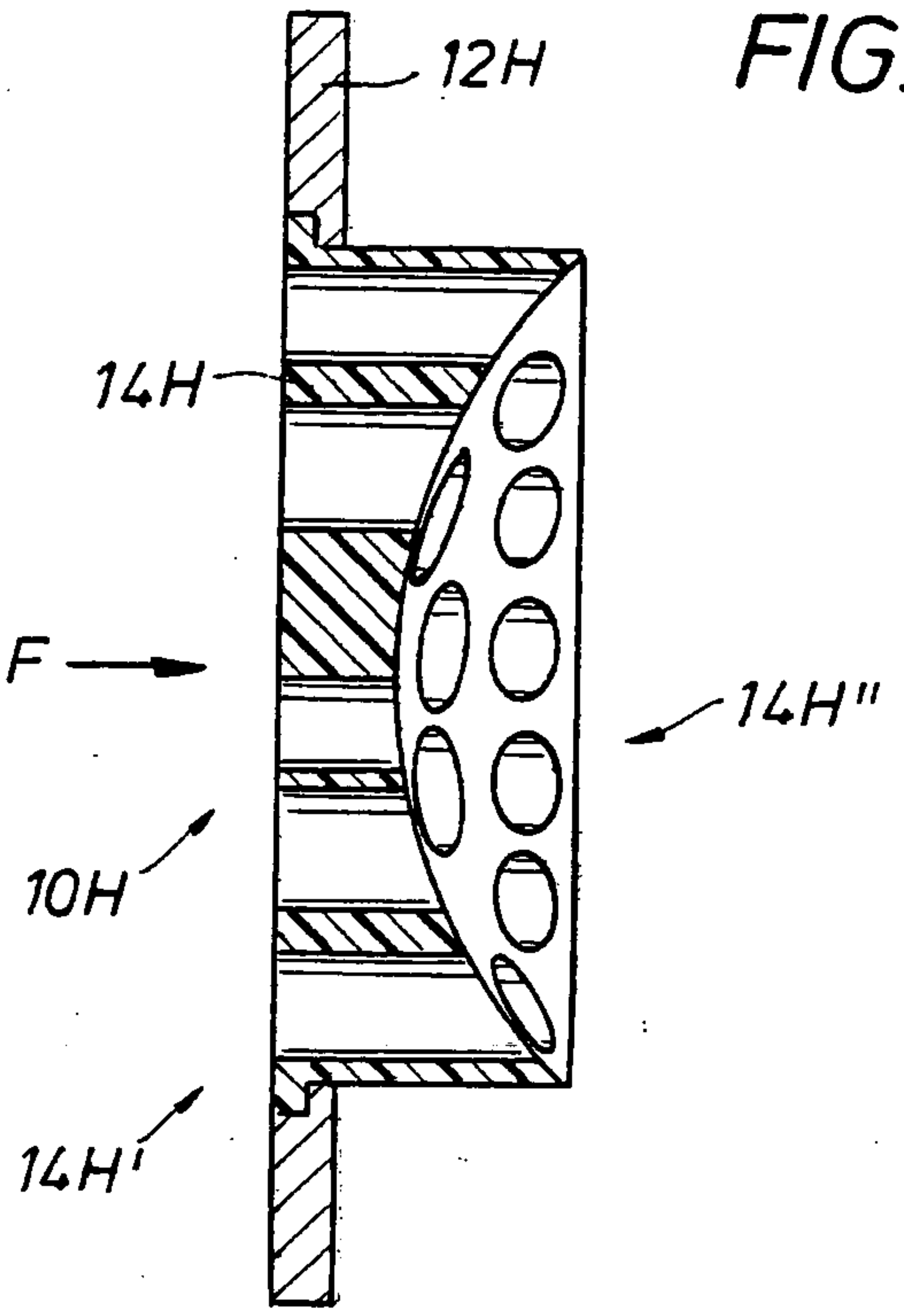


FIG.19

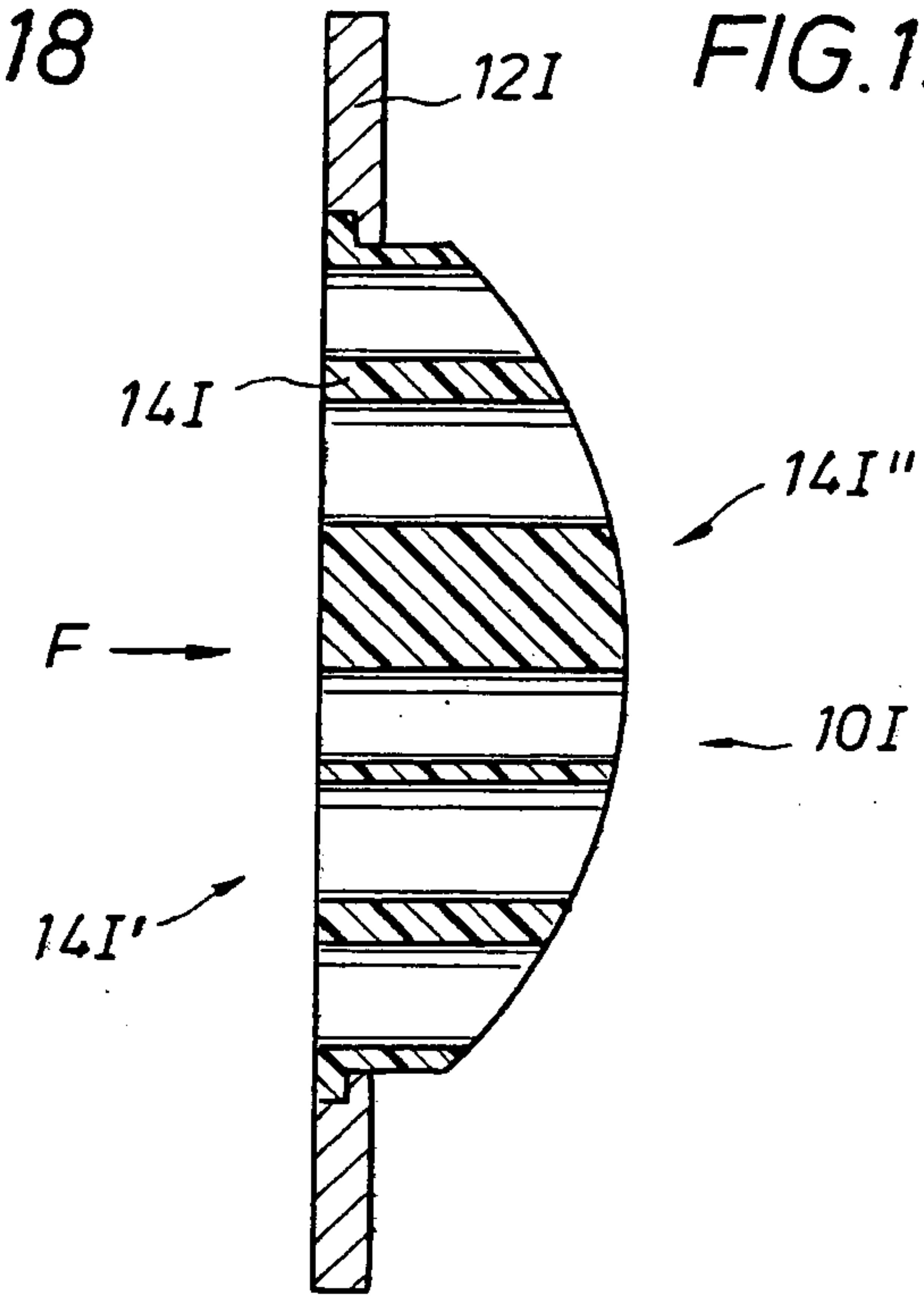


FIG.20

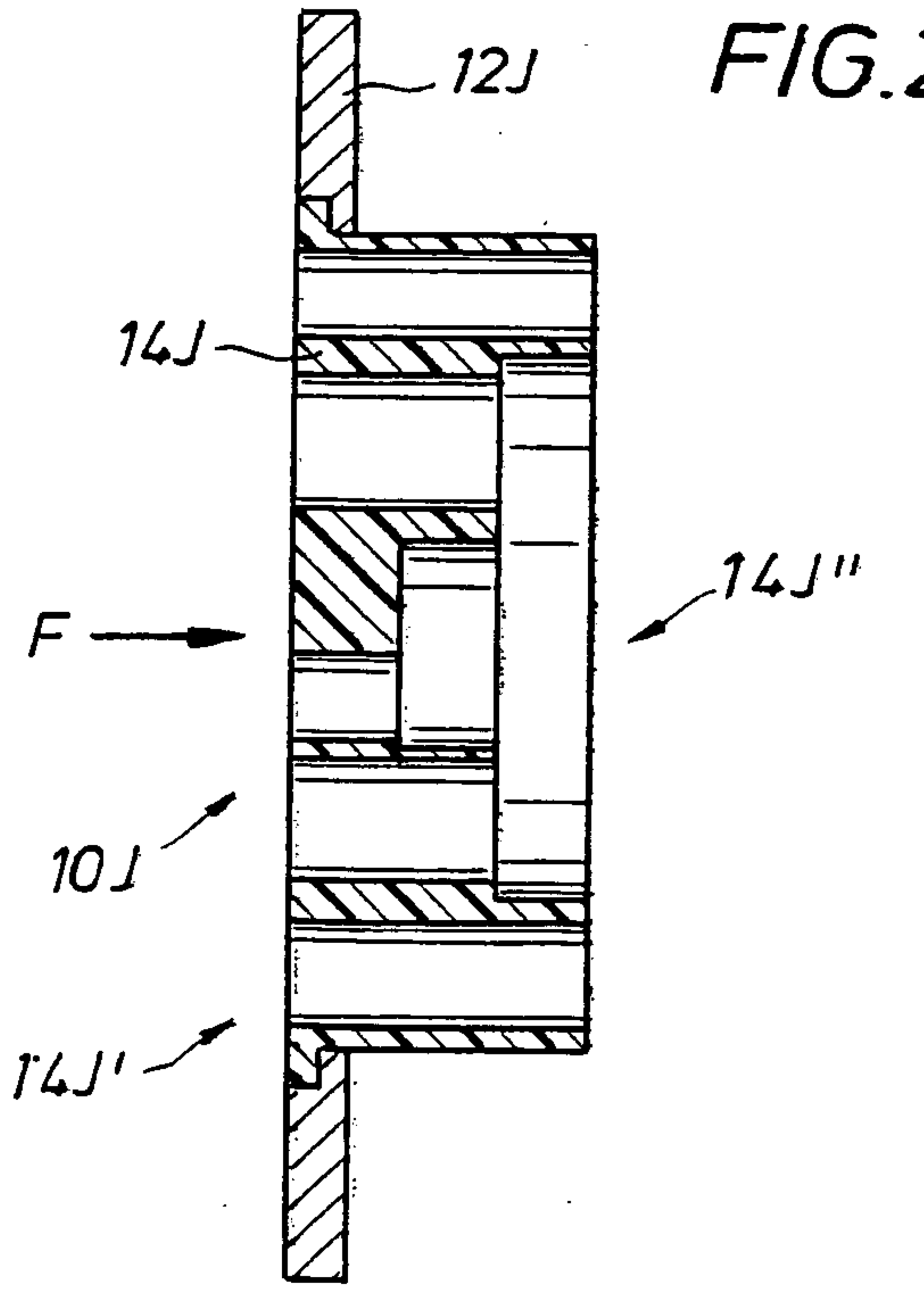
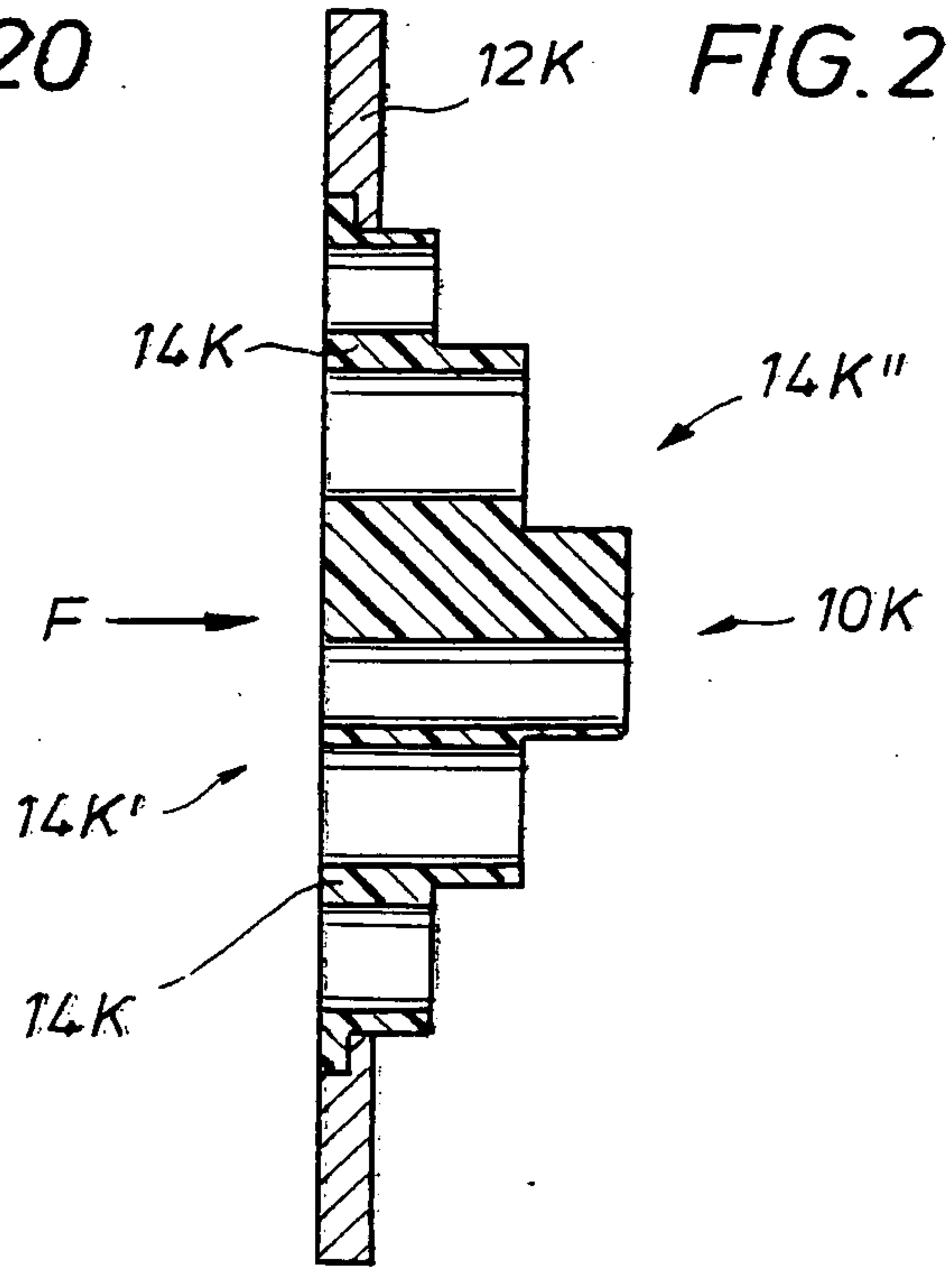


FIG.21



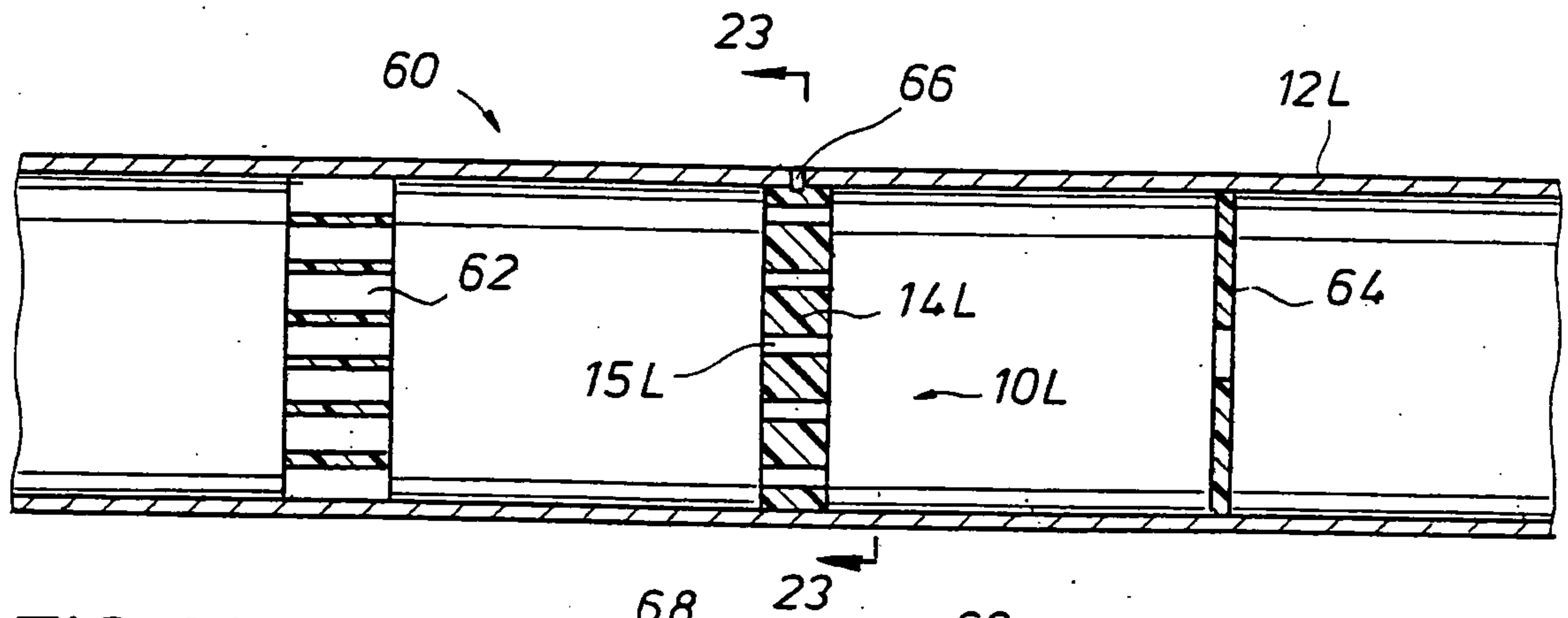


FIG. 22

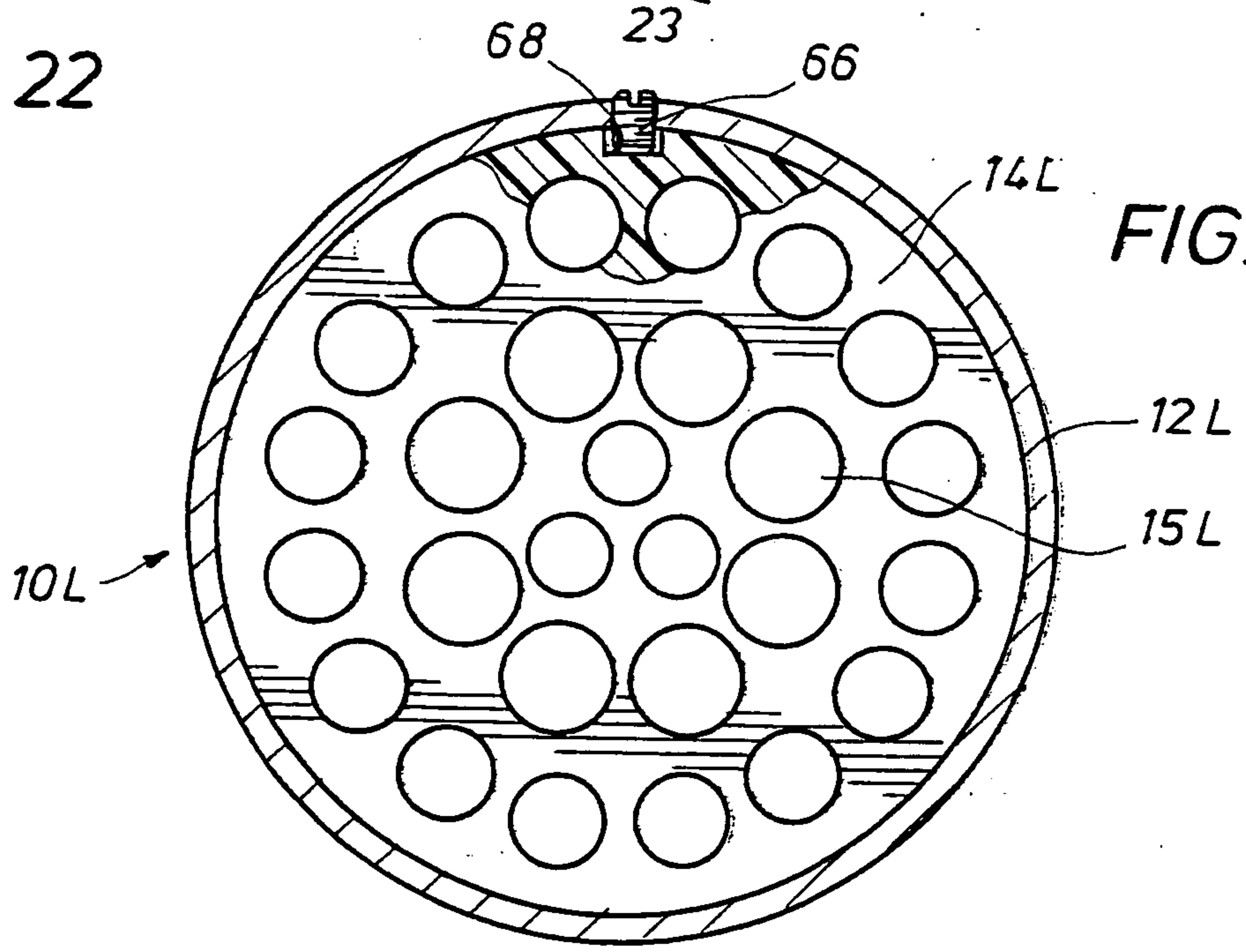


FIG. 23

FIG. 24

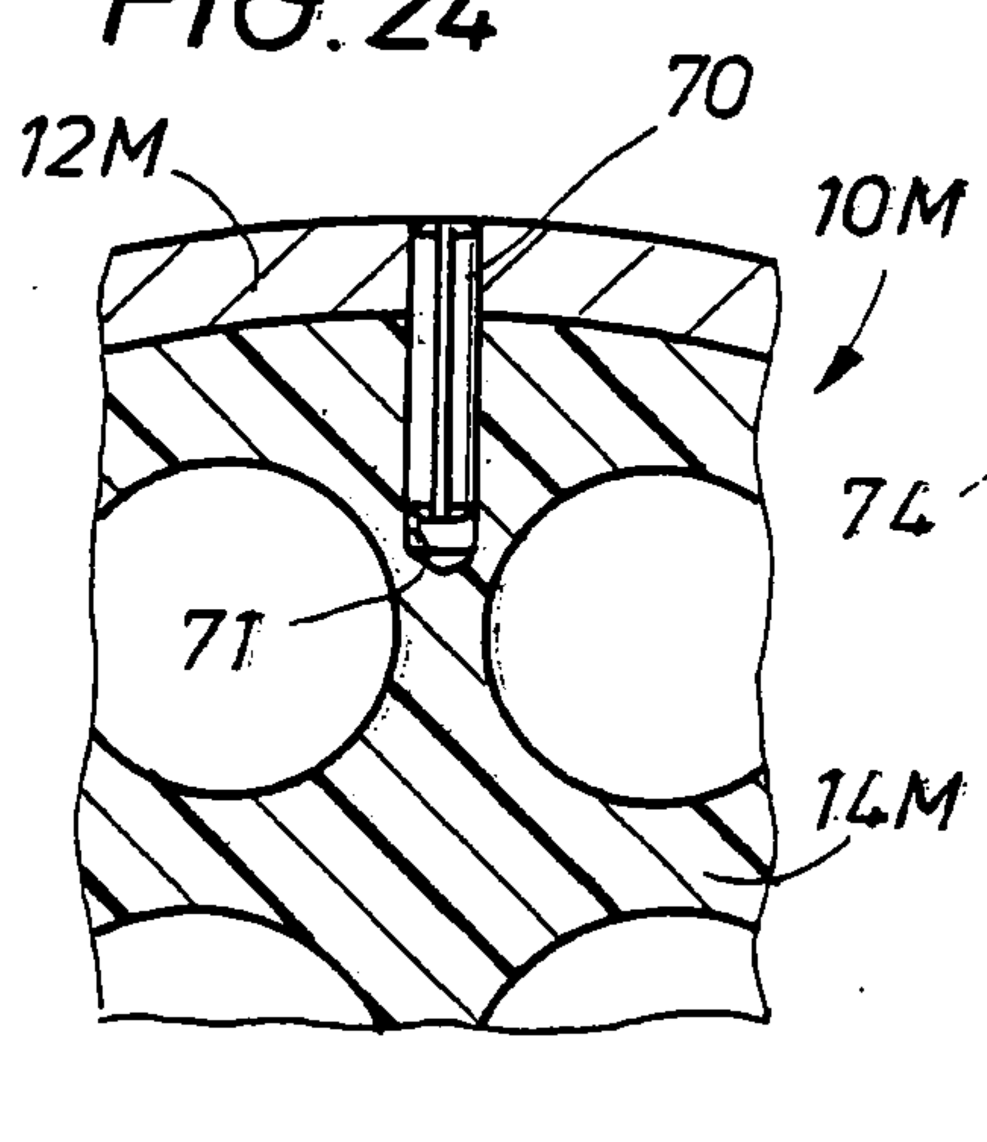


FIG. 25

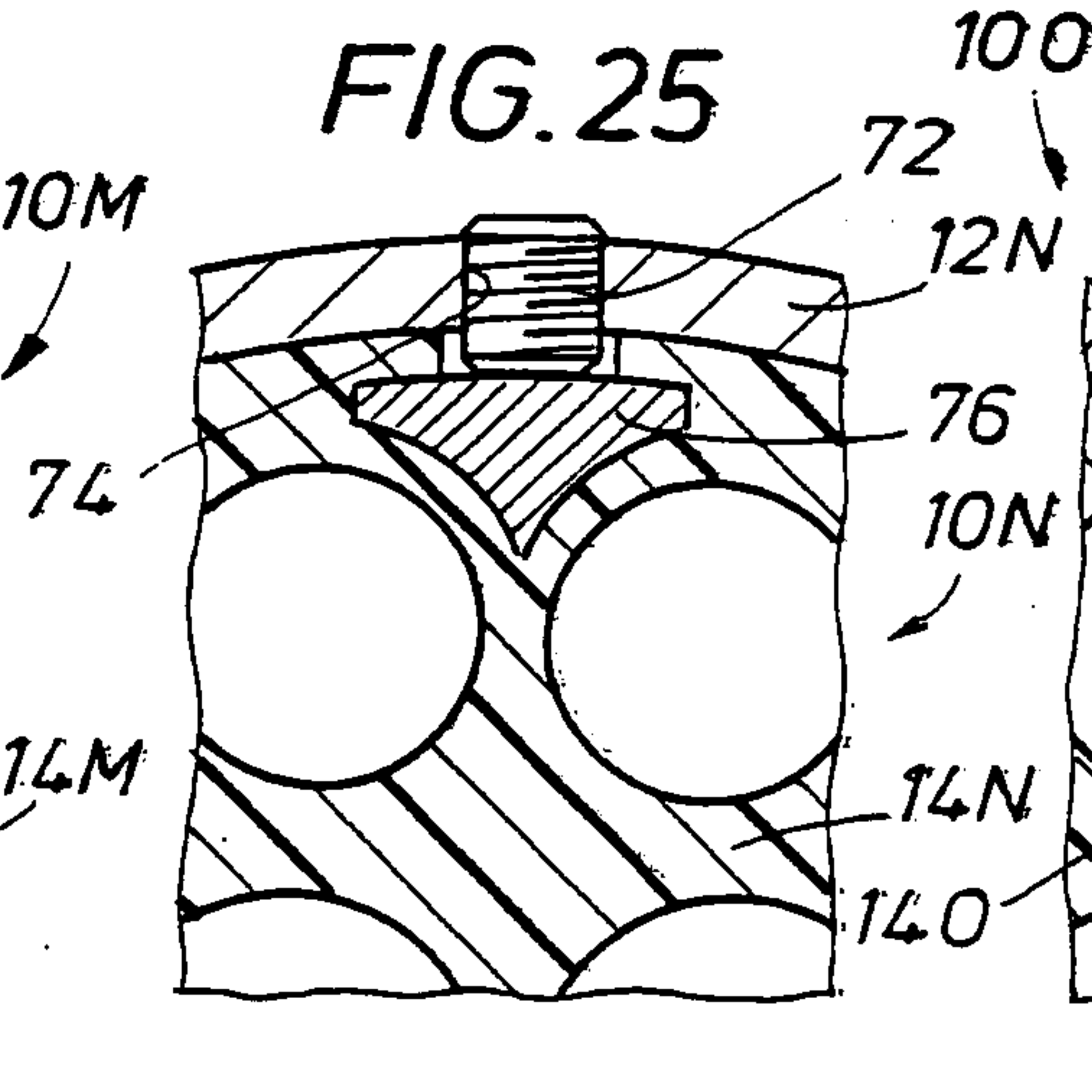


FIG. 26

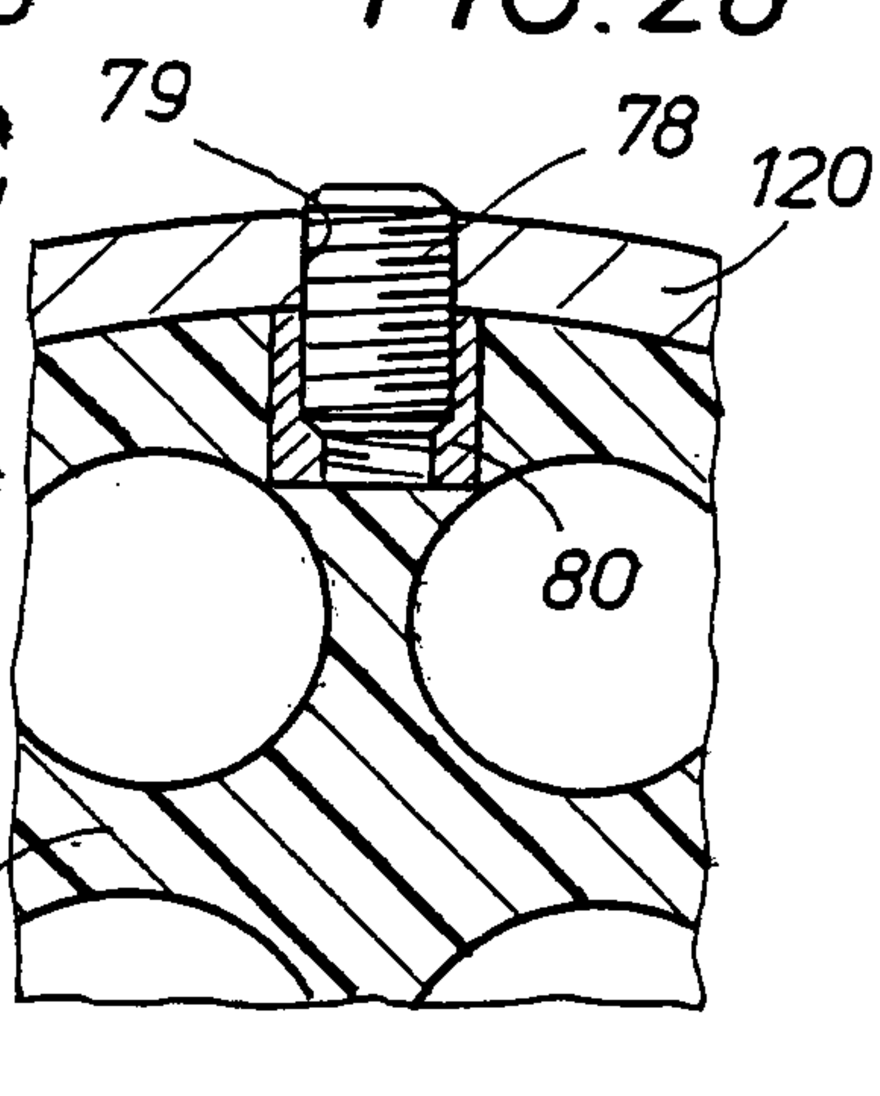
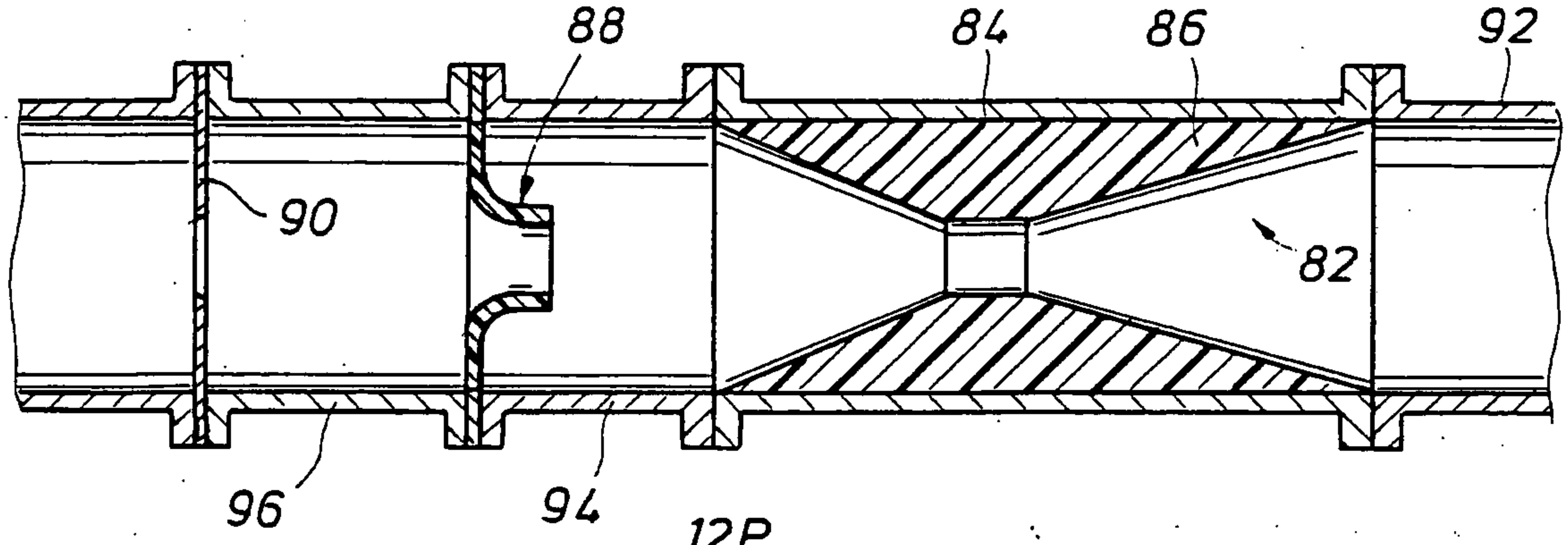


FIG. 27



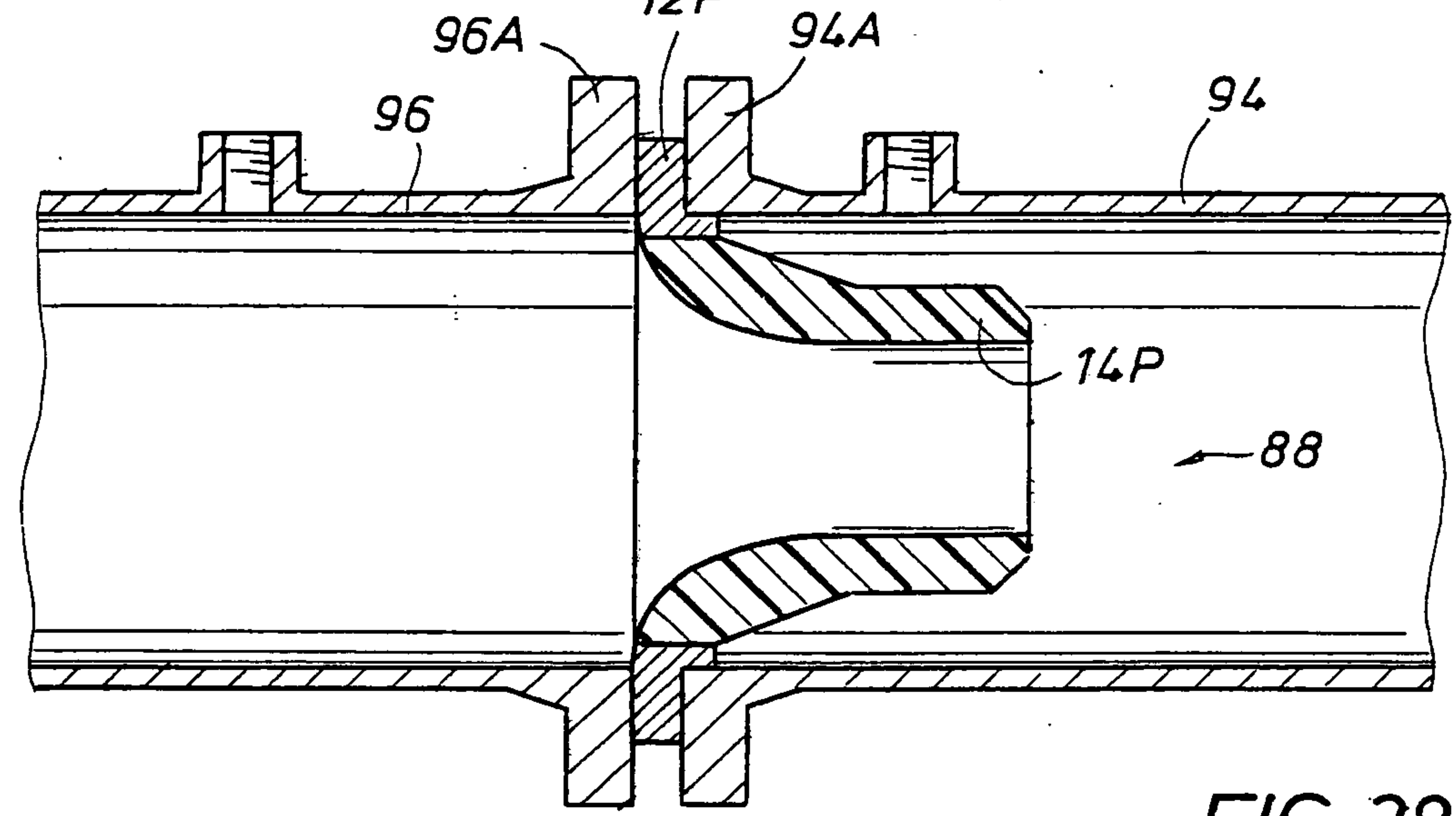


FIG. 28

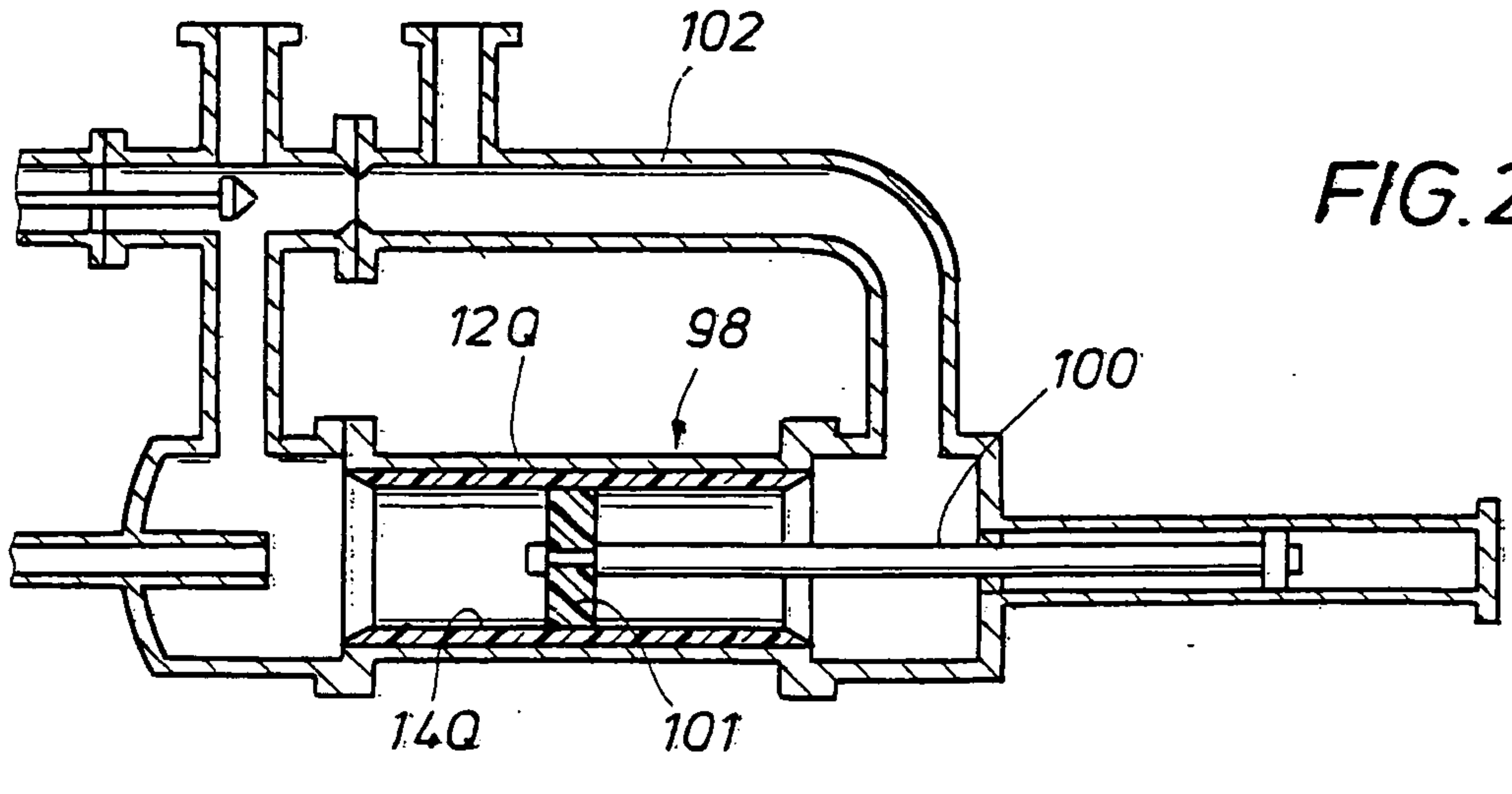


FIG. 29

FIG.30

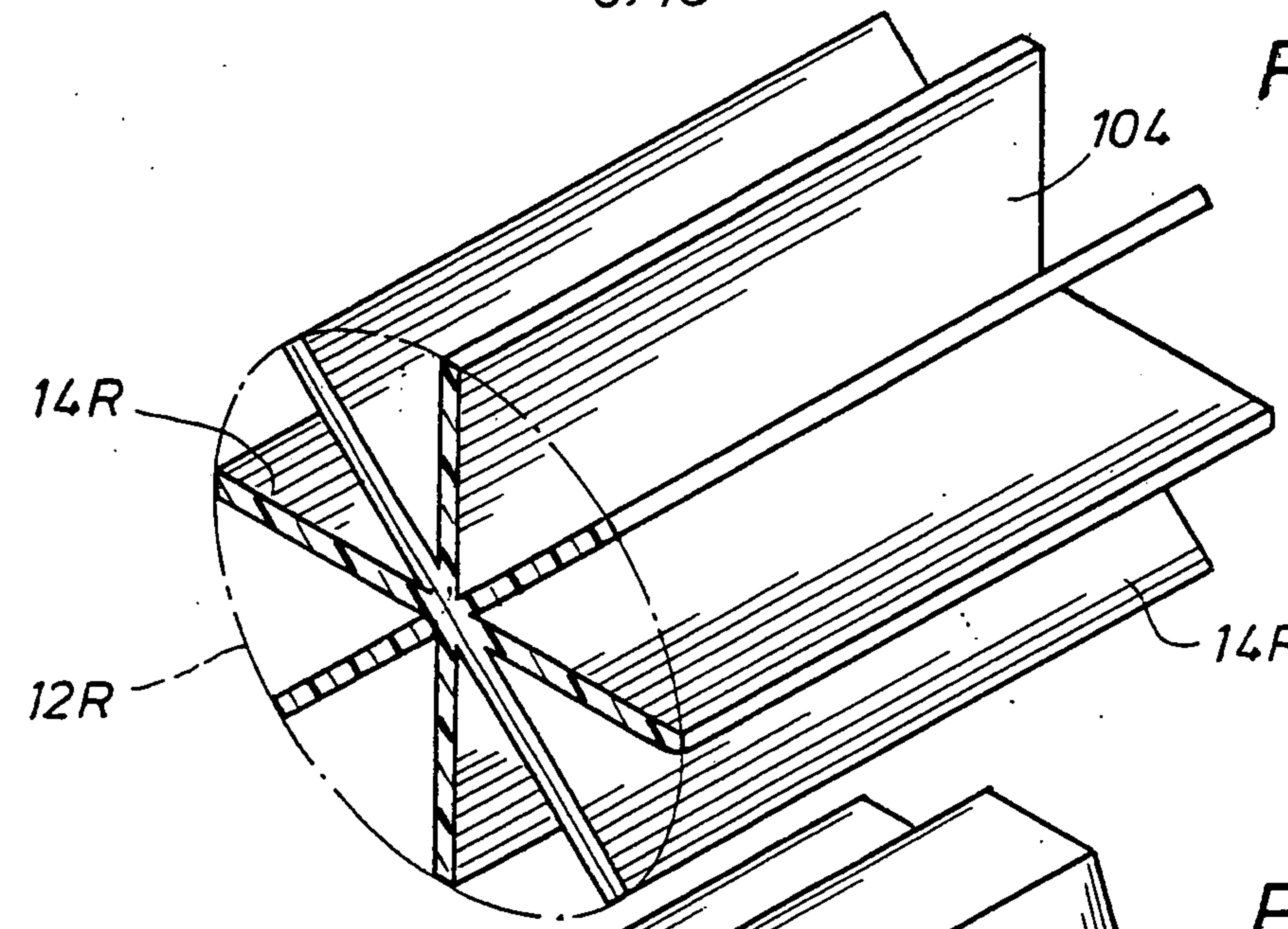


FIG.31

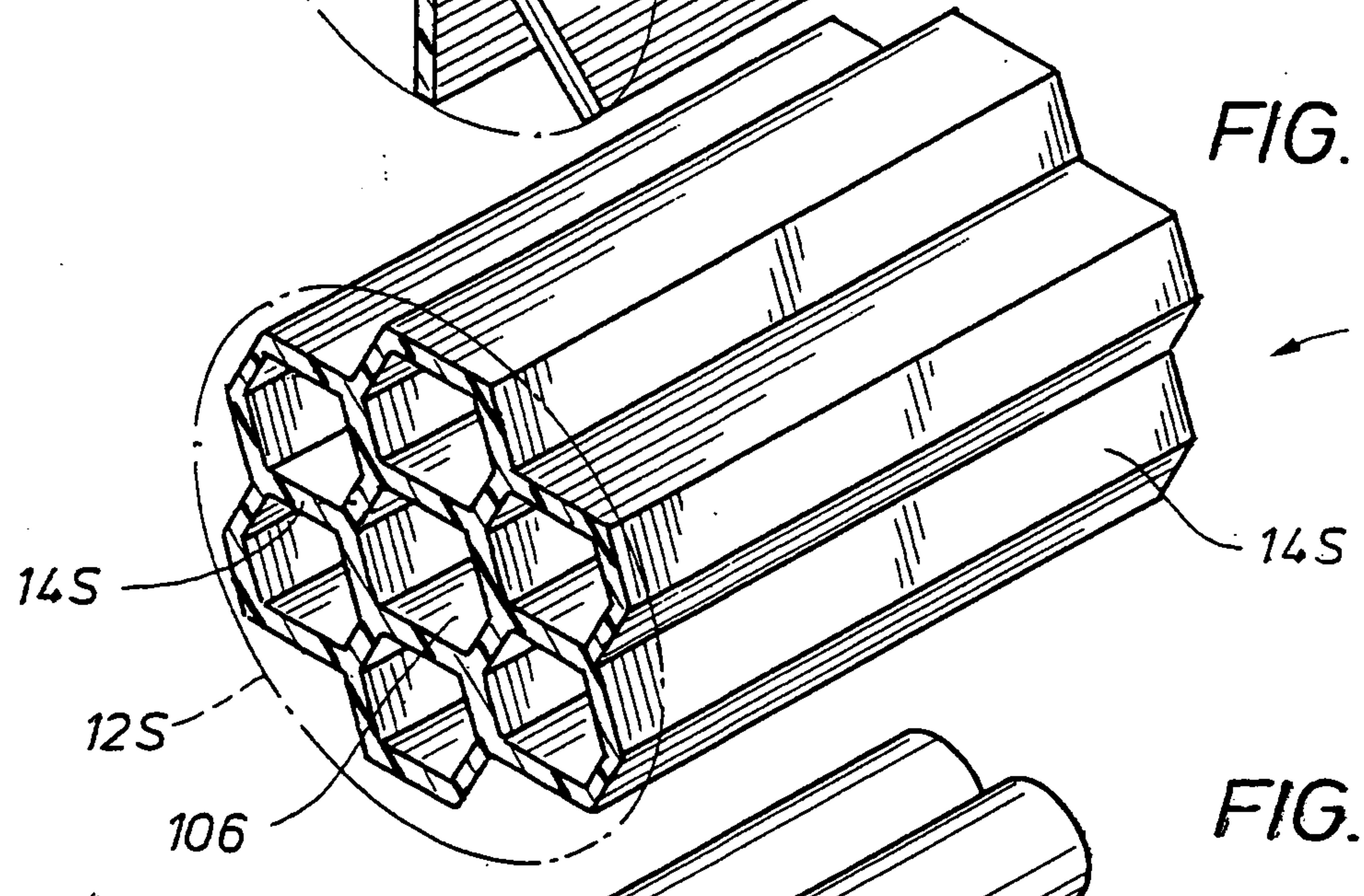
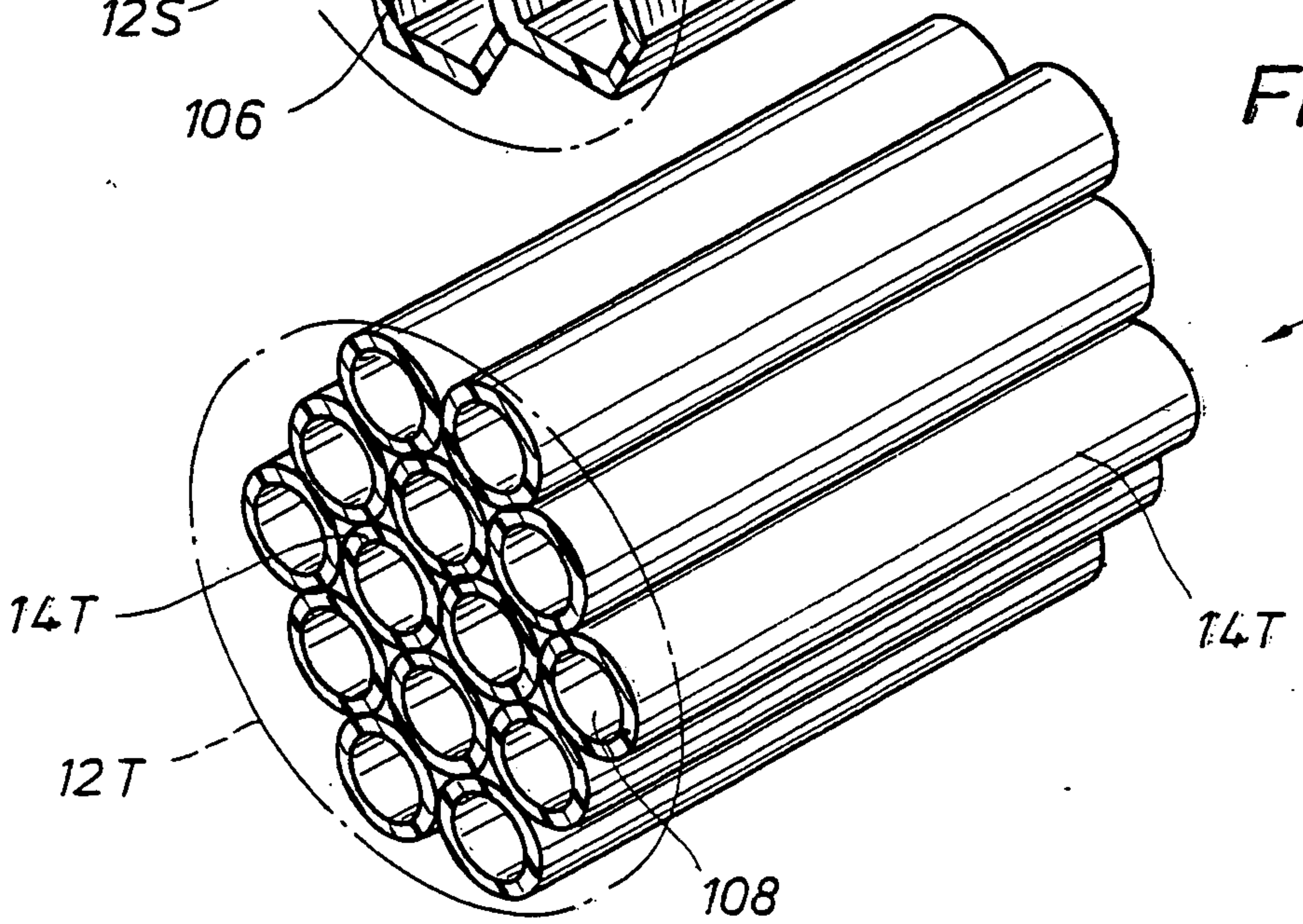


FIG.32



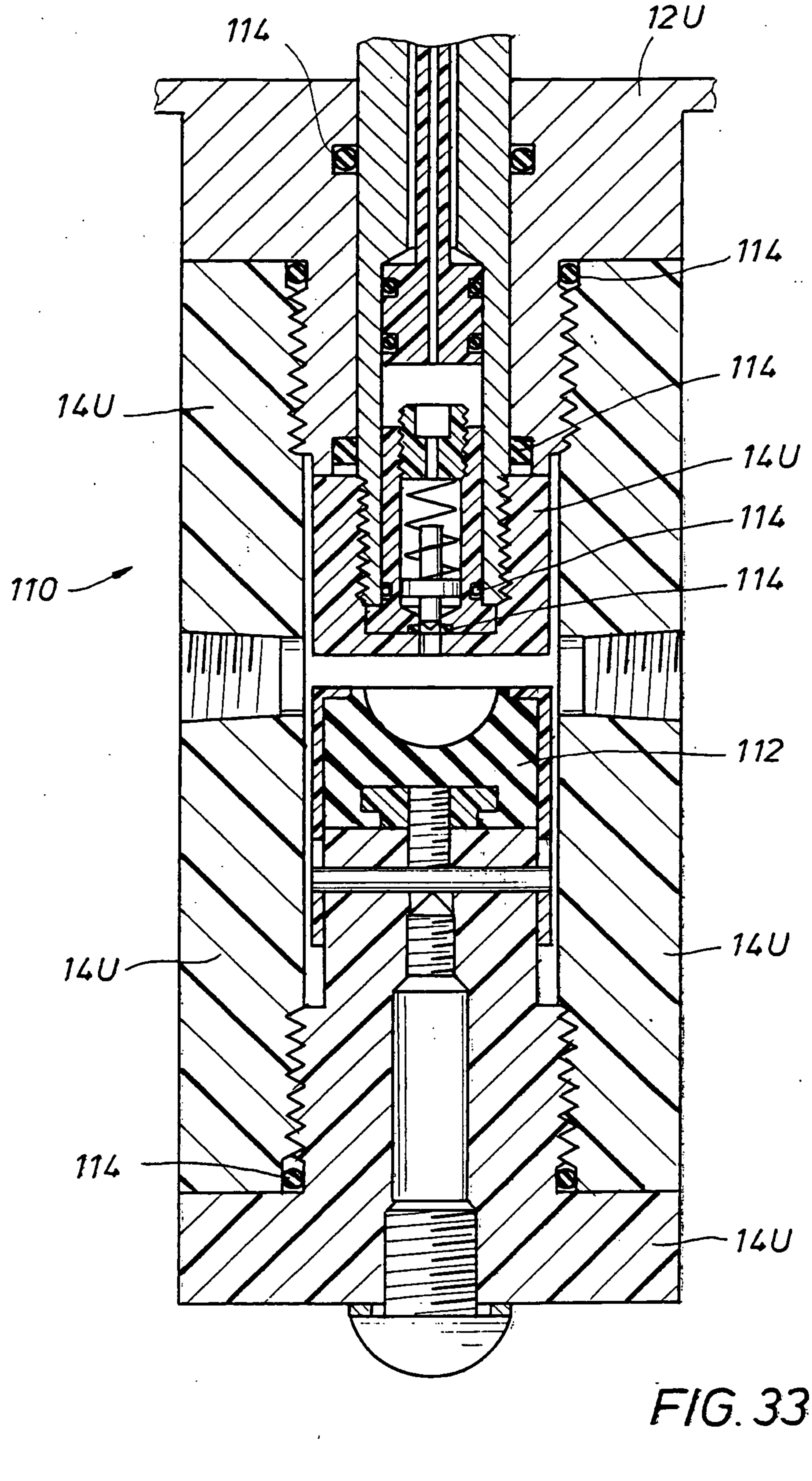
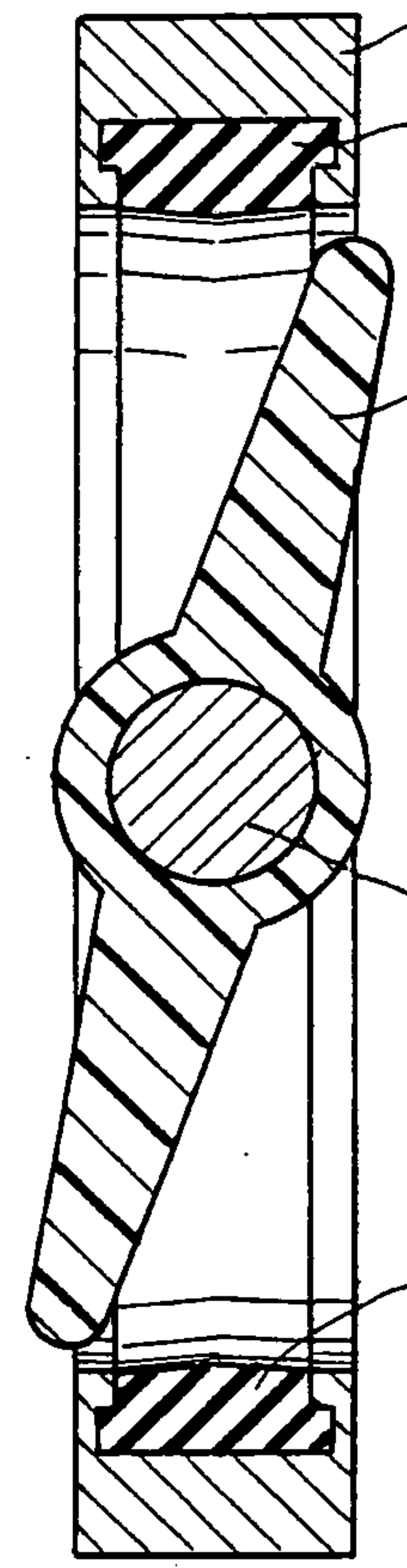


FIG. 33

FIG. 34



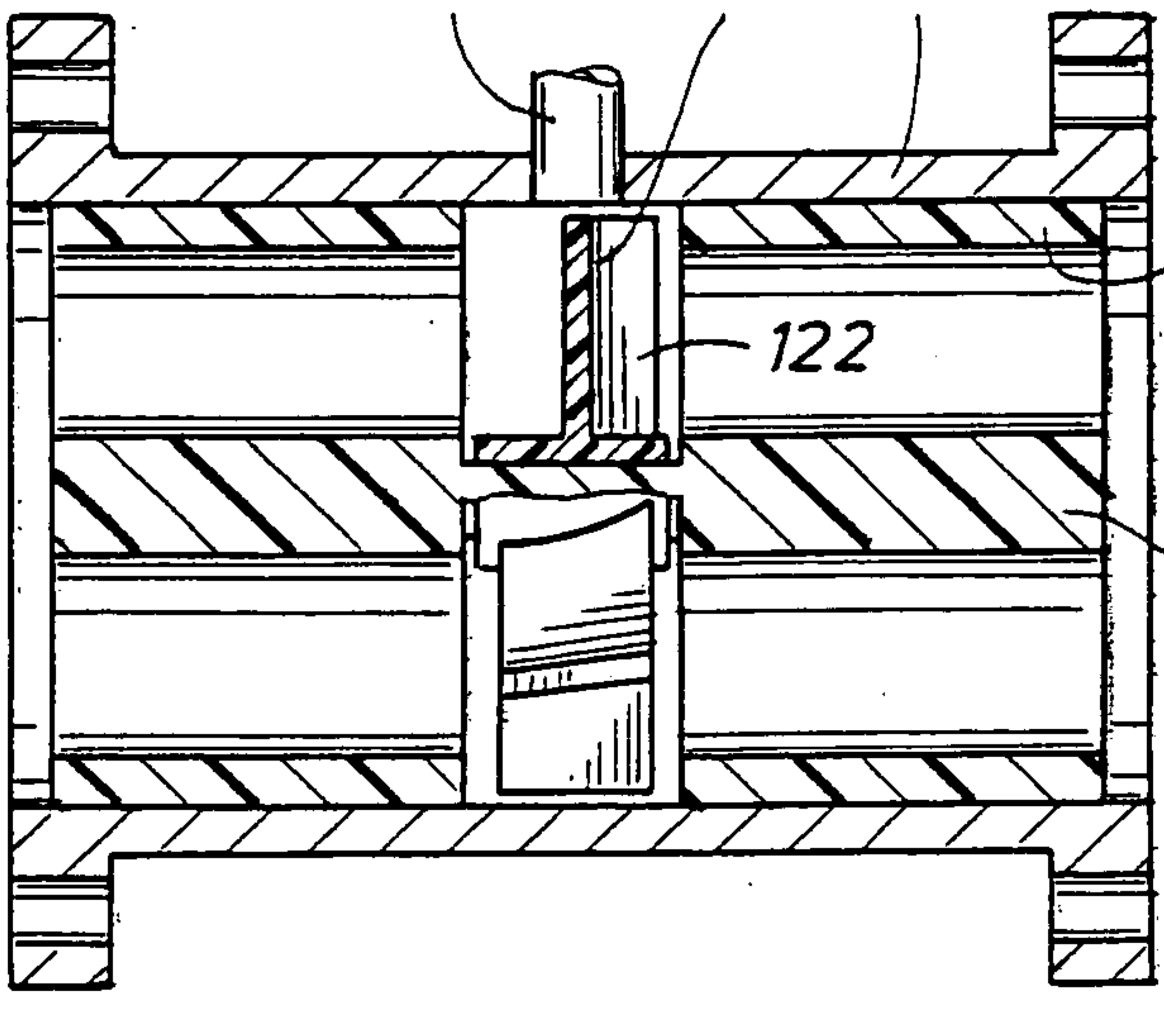


FIG. 35

FIG. 36

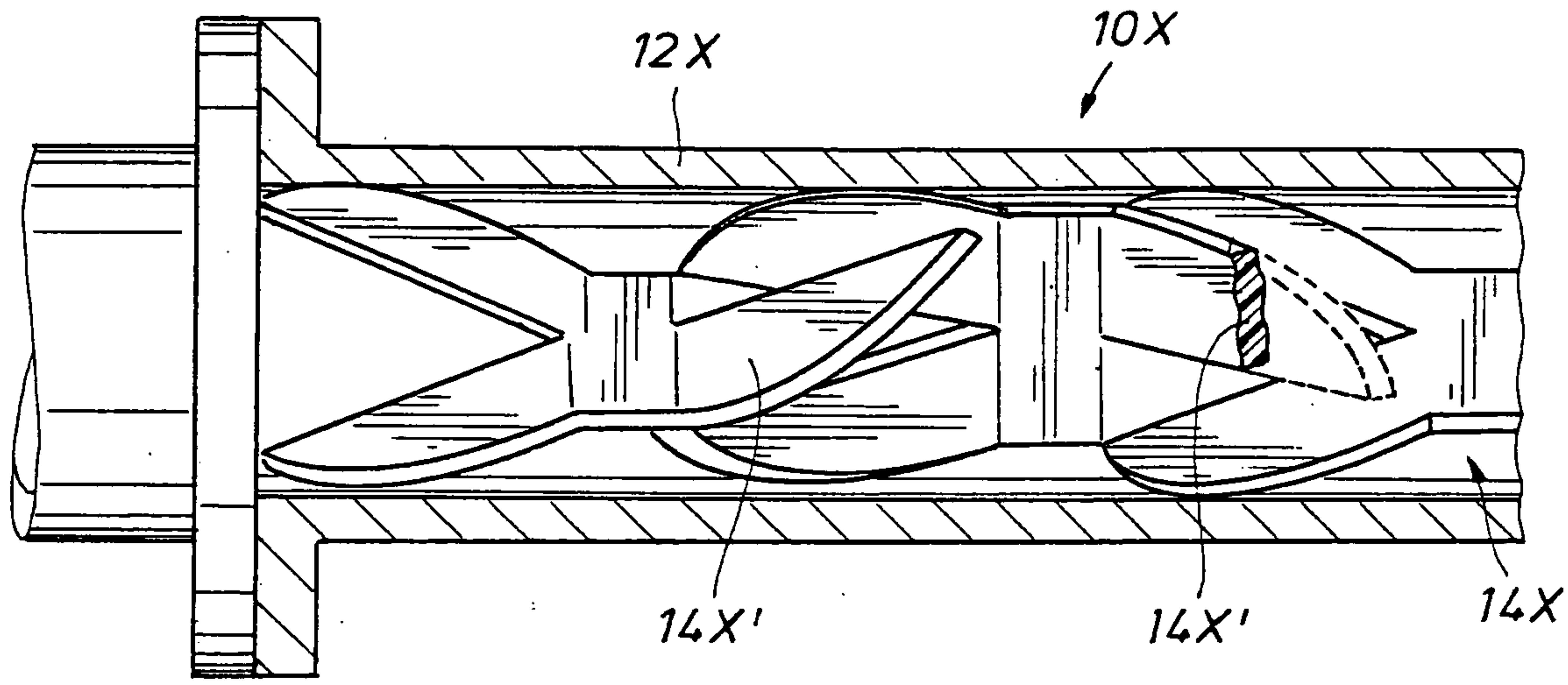


FIG. 37

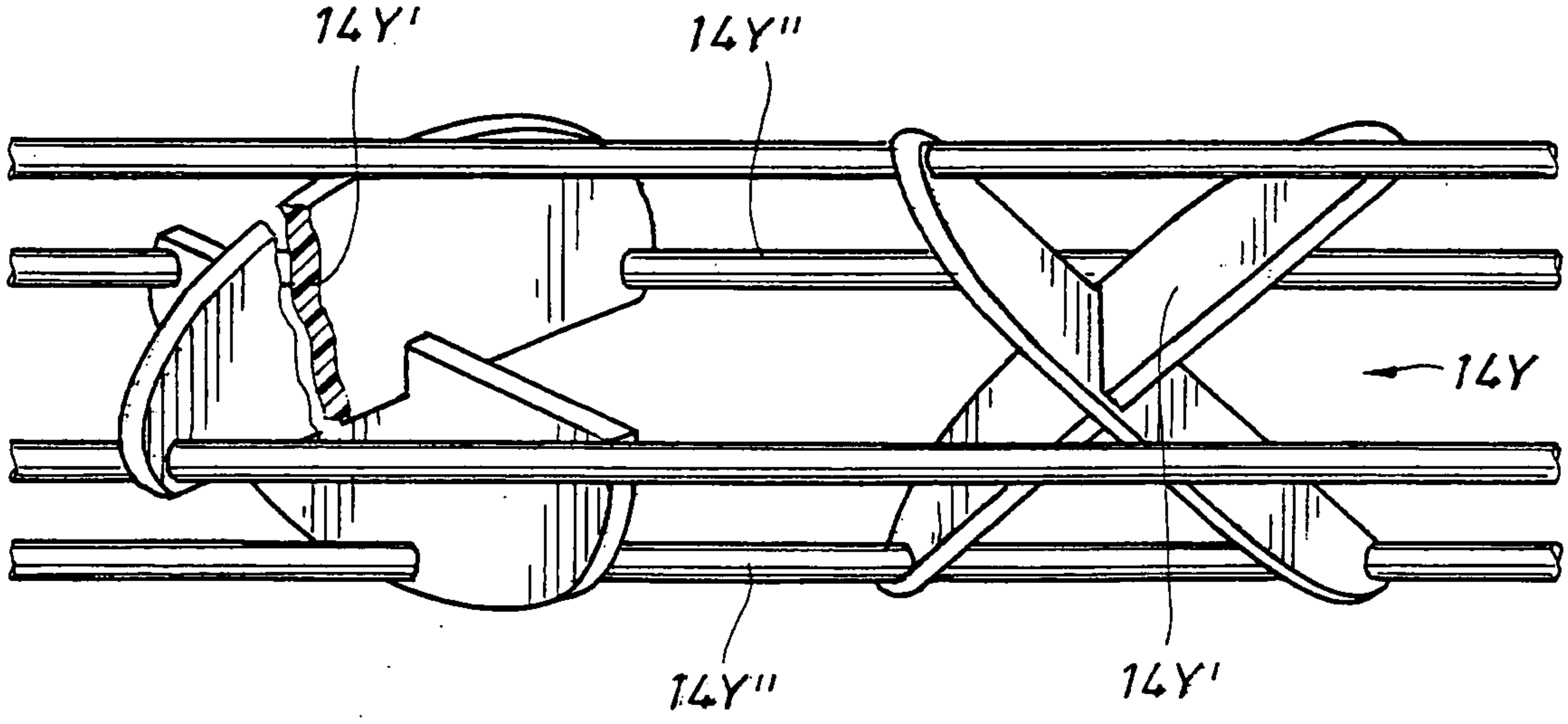


FIG. 38

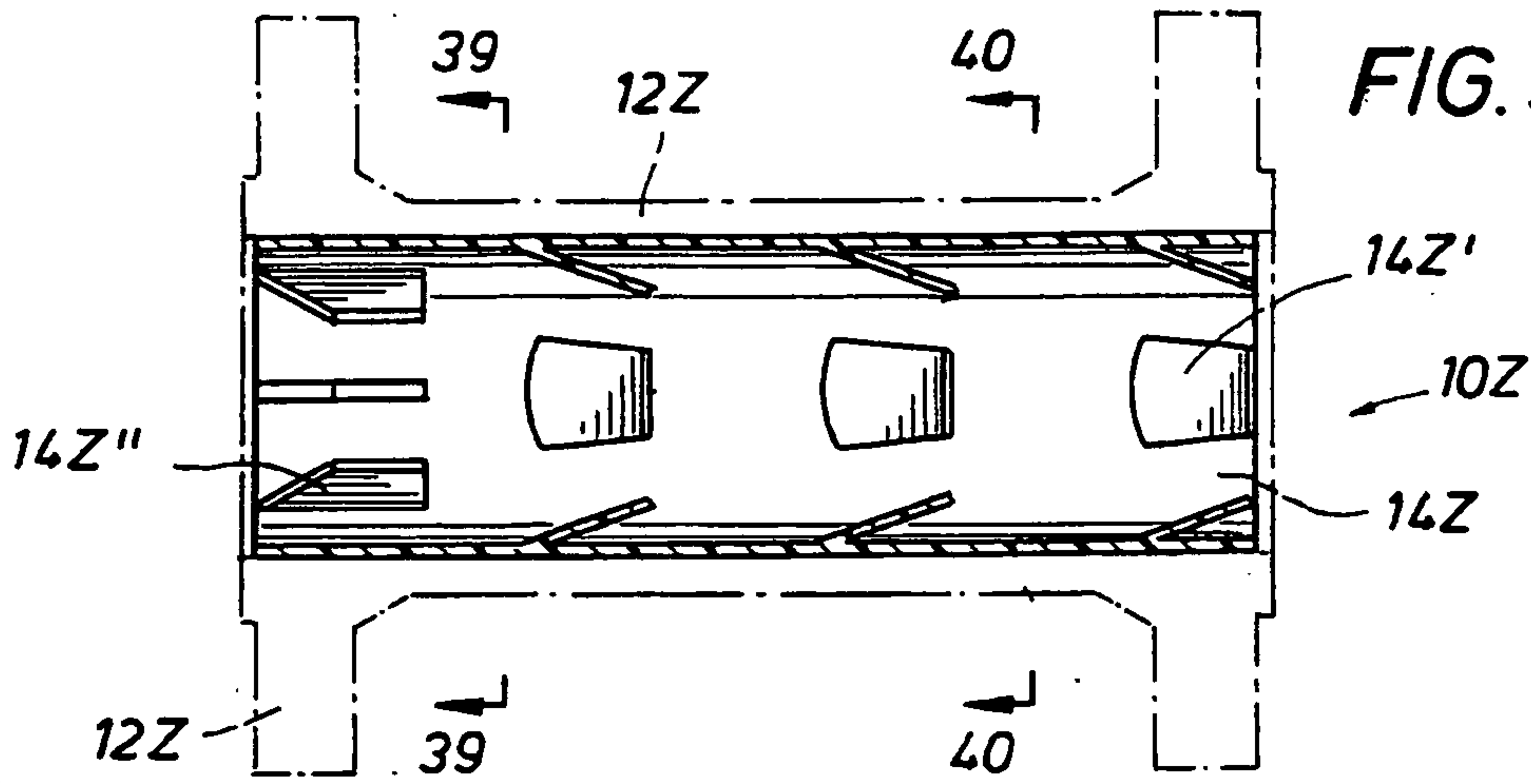


FIG. 39

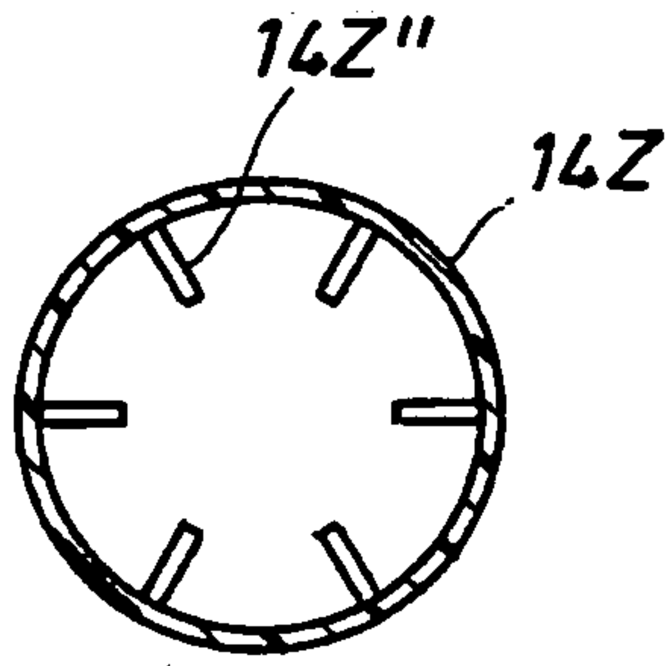


FIG. 40

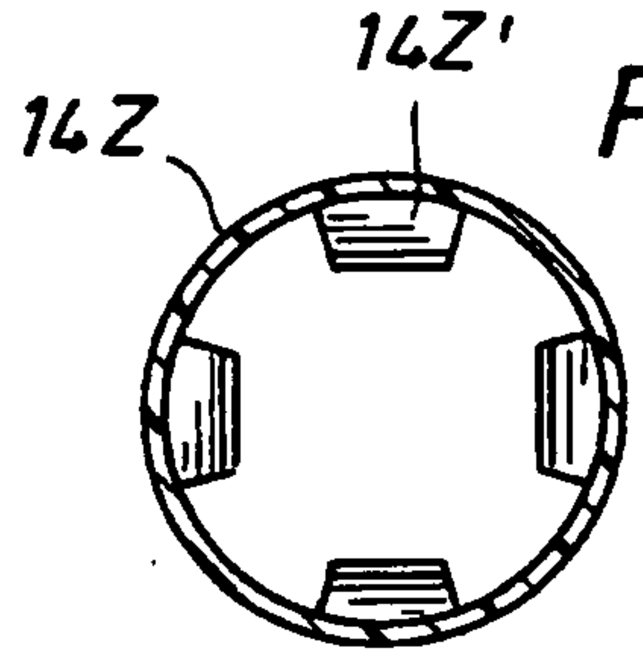


FIG. 41

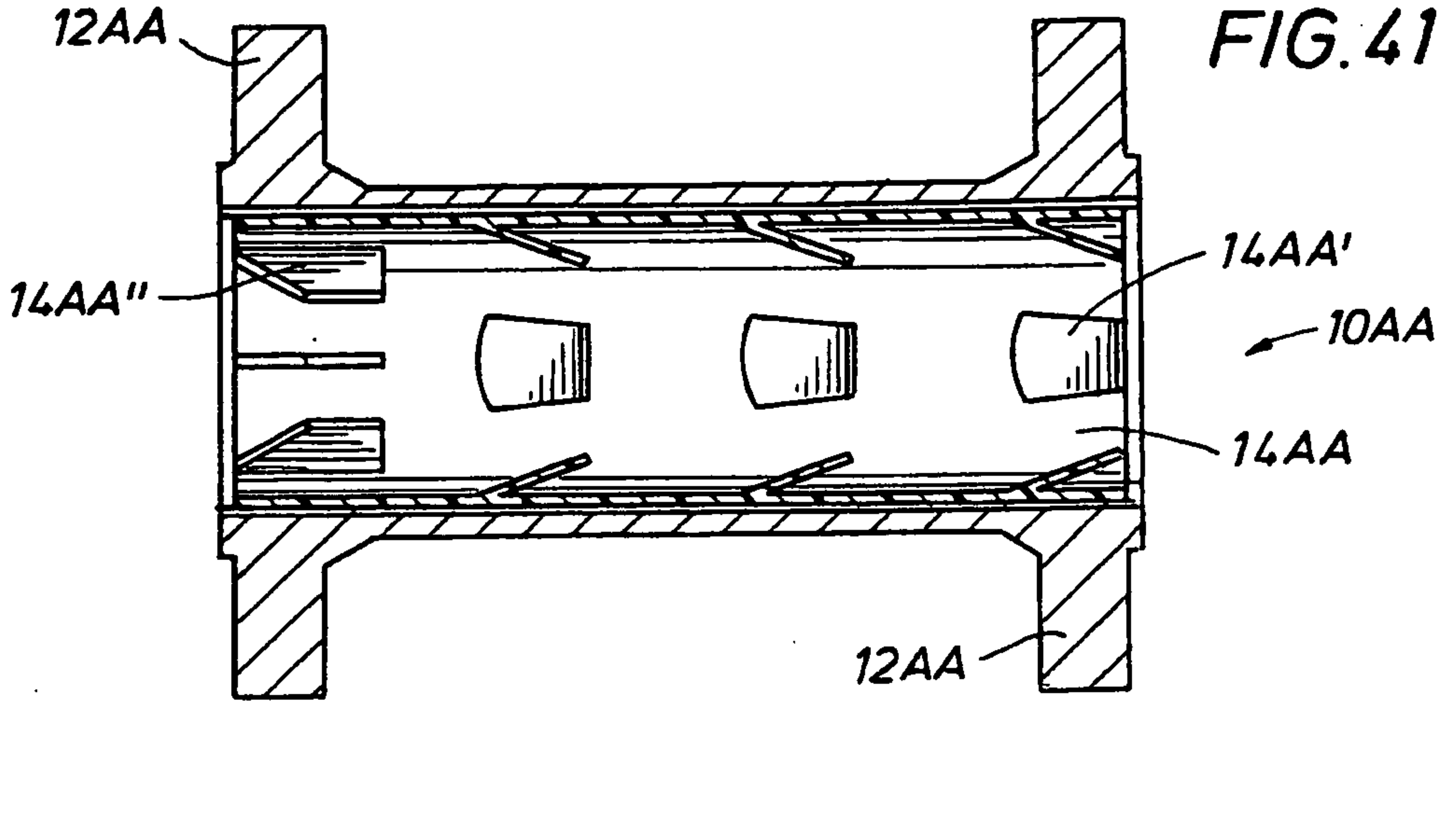
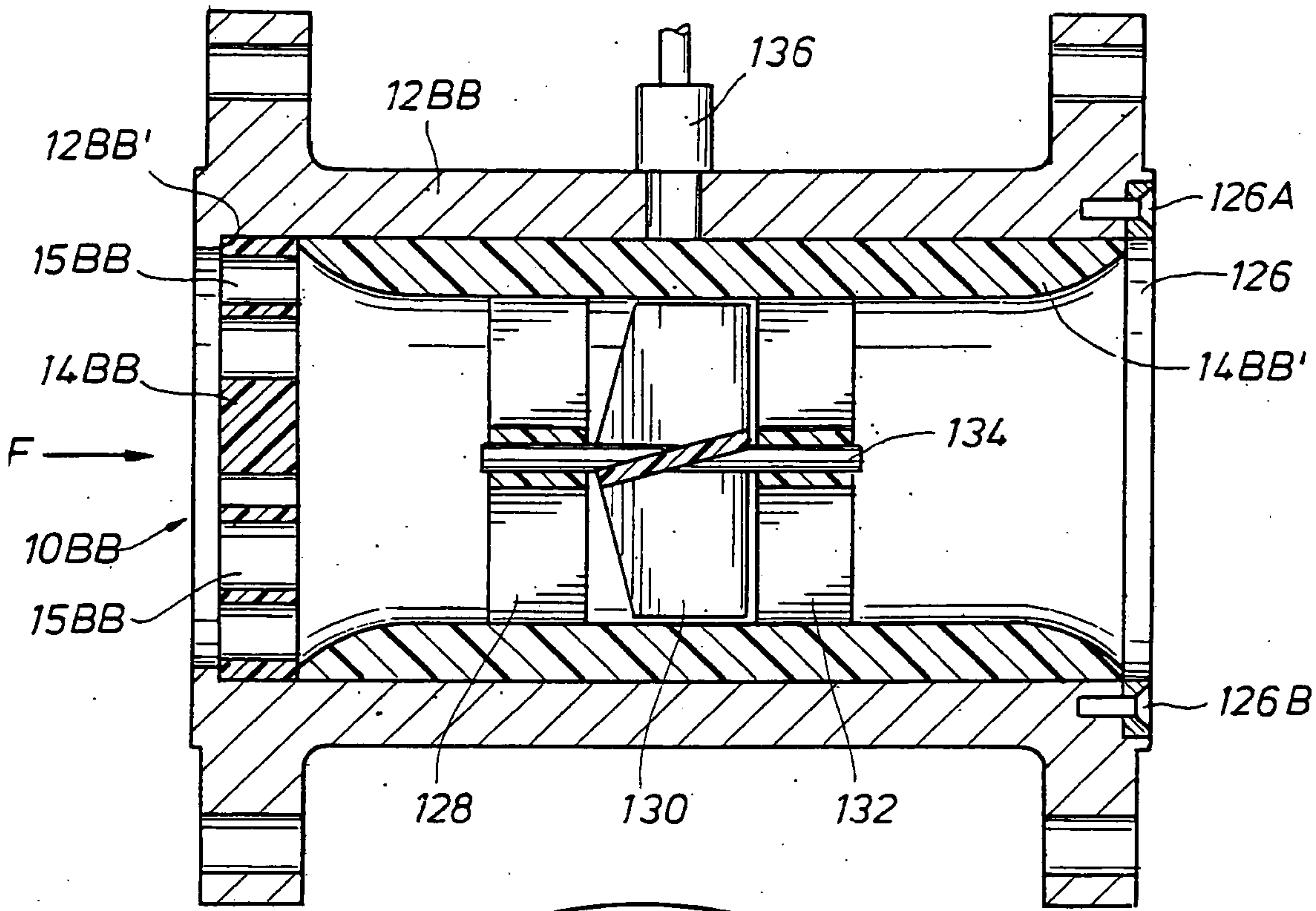


FIG. 42


136
12BB
12BB'
126A
15BB
126
14BB
14BB'
F
134
10BB
15BB
126B
128
130
132

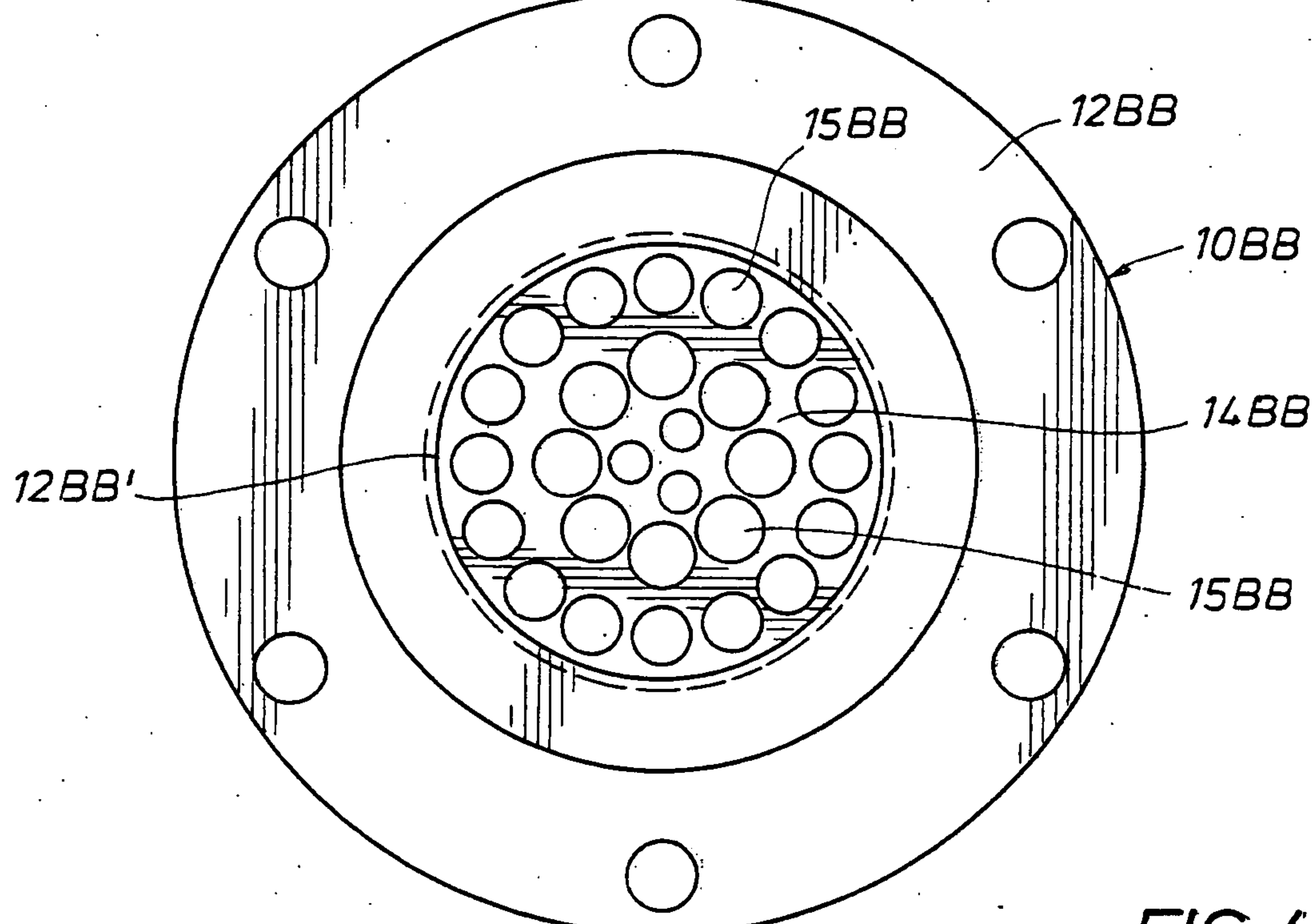
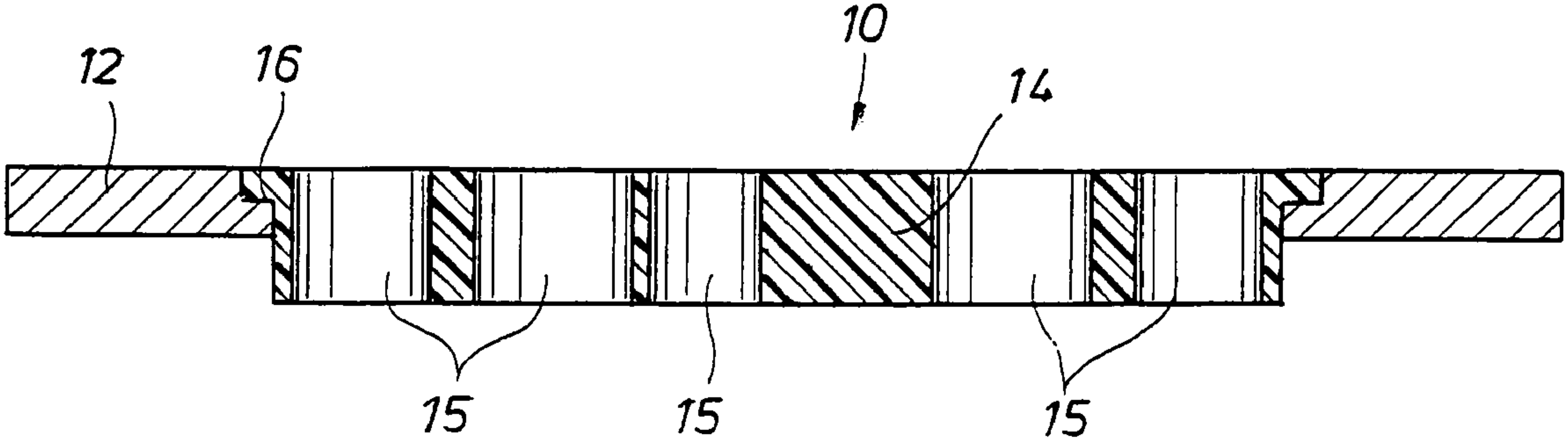

15BB
12BB
10BB
14BB
12BB'
15BB

FIG. 43


10
12
16
14
15
15
15