

Serial Number 09/648,530
Filing Date 22 August 2000
Inventor Antonio M. Amaral
 Robert F. Doleski
 Stephen F. Oliver
 Stanley J. Olson

NOTICE

The above identified patent application is available for licensing. Requests for information should be addressed to:

OFFICE OF NAVAL RESEARCH
DEPARTMENT OF THE NAVY
CODE 00CC
ARLINGTON VA 22217-5660

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

20010626 099

2
3 TORPEDO JOINT BAND WITH IN-WATER SEPARATION

4 CAPABILITY UTILIZING FRANGIBLE LINK EEDS

5
6 STATEMENT OF GOVERNMENT INTEREST

7 The invention described herein may be manufactured and used
8 by or for the Government of the United States of America for
9 governmental purposes without the payment of any royalties
10 thereon or therefor.

11
12 BACKGROUND OF THE INVENTION

13 (1) Field of the Invention

14 The present invention relates generally to undersea
15 vehicles. More particularly, this invention relates to a joint
16 band assembly for securing and subsequently releasing a payload
17 section from a driving section of a torpedo.

18 (2) Description of the Prior Art

19 Torpedoes and other undersea vehicles place various payloads
20 at or near a distant target, and typically, torpedoes have a
21 forward or payload section mounted on a propulsion, or drive
22 section that may also contain guidance systems. Some tactical
23 situations may require that the payload section separate from the

1 drive section somewhere along the path of the torpedo's run, and
2 the drive section continues onward to another area.

3 Current devices for separating these sections, particularly
4 during a run, have not been fully effective. Some of the
5 separation devices include so many components that reliability is
6 compromised. Others have such amounts of explosive as to create
7 hazards for personnel that handle them onboard prior to launch,
8 and when some are detonated during deployment, parts of the
9 devices, fragments and concussion may damage the payload and
10 drive sections to prevent their proper operation.

11 Thus, in accordance with this inventive concept, a need has
12 been recognized for a cost-effective, reliable joint band
13 assembly for securing a payload section to a drive section of a
14 torpedo and subsequently releasing the payload section from the
15 drive section with fewer fragments, lower concussion, limited
16 explosive byproducts, and lower associated hazards.

17
18 SUMMARY OF THE INVENTION

19 A first object of the invention is to provide an apparatus
20 for securing and subsequently releasing a payload section from a
21 drive section of an undersea vehicle.

1 Another object of the invention is to provide a joint band
2 assembly for securing and subsequently releasing a payload
3 section from a drive section while a torpedo is making a run.

4 Another object of the invention is to provide an assembly
5 that reduces risk of damaging torpedo sections during separation
6 of sections.

7 Another object of the invention is to provide an assembly
8 having serially coupled electro-explosive devices that assure
9 fail safe operation if one device fails during separation of
10 sections.

11 Another object of the invention is to provide an assembly
12 having a pair of serially coupled electro-explosive devices that
13 reduce creation of metal fragments and explosive by-products
14 during detonation.

15 Another object of the invention is to provide an assembly
16 having a pair of nonfragmenting semicircular links to reduce
17 hazards to propellers or control surfaces of a torpedo's drive
18 section.

19 Another object of the invention is to provide an assembly
20 having serially coupled electro-explosive devices containing
21 explosive therein to reduce hazards from rapidly escaping gas
22 created during detonation.

1 An object of the invention is to provide a cost effective
2 joint band assembly for securing and subsequently releasing a
3 payload section from a drive section of a torpedo that is
4 lightweight, strong, and able to withstand the effects of
5 corrosive marine environments.

6 The present invention provides a joint band assembly for
7 securing and subsequently releasing a payload section from a
8 drive section of a torpedo. A pair of essentially semicircular
9 bands is arranged in a ring shape with adjacent ends being
10 separated from each other. Each band has a pair of parallel lip
11 portions inwardly extending to engage radially outwardly
12 extending annular rims of two parts of a separation section that
13 are respectively connected to the payload section and the drive
14 section. The bands are coupled together at both of their
15 adjacent ends by a separate electro-explosive device connected
16 between the adjacent ends. Each device has a tubular body
17 portion containing an explosive charge adjacent to an annular
18 undercut segment of the tubular body portion. The annular
19 segment has reduced thickness as compared to thickness of the
20 tubular body portion to rupture when the explosive charge is
21 detonated.

1 DESCRIPTION OF THE PREFERRED EMBODIMENTS

2 Referring to FIGS. 1, 2, and 3, joint band assembly 10 of
3 this invention has found specific application in torpedo 12 to
4 secure payload section 14 to drive section 16. Payload section
5 14 can be various types of ordnance such as a mine or a sensor
6 package that is to be transported to a remote location and
7 released from drive section 16 while it continues on its run.
8 Drive section 16 may also carry another ordnance or sensor
9 package and has the necessary guidance and propulsion systems
10 including control surfaces and counter rotating propellers or
11 pump-jet propulsor at its aft end.

12 Torpedo 12 includes separation section 18 interposed between
13 payload section 14 and drive section 16. Payload section 14 and
14 drive section 16 are sealed by watertight bulkheads, and the
15 intermediate region between bulkheads is flooded. Separation
16 section 18 may be made from high strength aluminum alloy and has
17 a first part 20 connected to payload section 14 and a second part
18 22 connected to drive section 16. First and second parts 20 and
19 22 have circumferential rims 24 and 26, respectively, that
20 contiguously abut when parts 20 and 22 are axially aligned and
21 brought next to each other. Payload and drive sections 14 and 16
22 are connected to parts 20 and 22 by standard torpedo metal joint
23 bands 14a and 16a. Bands 14a and 16a cover adjacent peripheral

1 strips of the parts and sections and have attached bolts, washers
2 and threaded inserts tightened to connect parts 20 and 22 of
3 separation section 18 and sections 14 and 16 together.

4 Joint band assembly 10 of this invention thusly engages
5 abutting circumferential rims 24 and 26 to secure payload section
6 14 to drive section 16 via separation section 18. However, joint
7 band assembly 10 of this invention also is capable of separating
8 payload section 14 from drive section 16 while torpedo 12 is
9 making a run in water.

10 Joint band assembly 10 includes two essentially
11 semicircularly-shaped bands 30 serially connected in a ring shape
12 by two electro-explosive devices (EEDs) 50 that function as
13 frangible links. Semicircularly-shaped bands 30 are virtually
14 identical, and EEDs 50 are virtually identical to secure payload
15 and drive sections 14 and 16 together, and reliably release these
16 sections without creating fragments that might hinder their
17 subsequent performance.

18 Referring also to FIGS. 4, 5, and 6, each band 30 has lip
19 portions 32 on opposite sides that inwardly extend to engage
20 tapered circumferential rims 24 and 26 of first and second parts
21 20 and 22 of separation section 18. Bands 30 may be fabricated
22 from high strength aluminum alloy to exert a substantial
23 compressive force radially inwardly on circumferential rims 24

1 and 26 when these bands are displaced as explained below. This
2 compressive force on circumferential rims 24 and 26 is of such
3 magnitude to hold them axially against each other and,
4 consequently, secure payload and drive sections 14 and 16
5 together. Pocket 34 is machined in one end 30a of band 30, and
6 smooth bore 36 extends from pocket 34 to coaxially aligned larger
7 bore, or rounded recess 38. Other end 30b of band 30 has slots
8 44 machined in it between end portions 46 that are provided with
9 aligned parts of traverse bore 48.

10 Each EED 50 may be made from stainless steel or other strong
11 and corrosion resistant material and is sized to fit within
12 pocket 34 and keep space 34a between it and part 34b of band 30
13 next to pocket 34. EED 50 has tubular body portion 52 provided
14 with annular segment 54 of reduced thickness that acts as a
15 separation line next to shoulder 52a. A shackle portion 56 is
16 provided at one end and a threaded bore 60 is provided at the
17 other end. Explosive charge cutter 62 is fitted into tubular
18 body portion 52 adjacent annular segment 54, and electrical lead
19 64 extends through feeder block 66 and under wire tie 68 to drive
20 section 16. Wire tie 68 holds all parts of electrical leads 64
21 and feeder block 66 on tubular body member 54 before explosive
22 charge 62 is detonated to avoid damage to leads during assembly
23 and weapon handling. Fragments are eliminated in the self-

1 contained EED avoiding possible damage to the payload and drive
2 sections 14 and 16.

3 Shackle portion 56 has two arms 58 provided with aligned
4 parts of a lateral bore 70 to receive stainless steel pin 72.
5 Use of two arms 58 minimizes stress on pin 72. Arms 58 fit into
6 slots 44 in band 30 to align parts of traverse bore 48 (that is
7 the same diameter as lateral bore 70) in end portions 46 of band
8 30 with lateral bore 70. Pin 72 extends through aligned parts of
9 lateral bore 70 and aligned parts of traverse bore 48 to connect
10 this end of EED 50 to band 30. Bonding agent 72a is applied to
11 pin 72 and at least some aligned parts of traverse bore 48 to
12 retain the pin 72 in the band 30 and permit free rotation of the
13 EED shackle 56 about the pin 72.

14 When explosive charge cutter 62 is detonated rupturing
15 annular segment 54 and separating tubular body portion 52,
16 bonding agent 72a (after being cured) assures that pin 72,
17 shackle portion 56, and the part of tubular body portion 52 that
18 is attached to shackle portion 56 are retained on band 30. This
19 reduces the possibility of damage to payload and drive sections
20 14 and 16.

21 Threaded bore 60 at the other end of EED 50 is sized and
22 threaded to mate with threaded bolt 74 that slidably extends
23 through smooth bore 36 in band 30. Larger bore 38 in band 30

1 defines an annular bearing surface 40 about the mouth of smooth
2 bore 36 in band 30 for head 76 of bolt 74.

3 A spherical washer set 42 is provided adjacent annular
4 bearing surface 40 and receives bolt 74. Spherical washer set 42
5 has convex portion 42a that contacts head 76 as bolt 74 is
6 tightened and concave portion 42b adjacent bearing surface 40.
7 The hole through portion 42b is larger than the hole through
8 portion 42a so that portion 42a is free to rotate and be
9 displaced relative to portion 42b. This relative rotational
10 displacement prevents transfer of possibly destructive torsional
11 or other uneven bending forces from head 76 to band 30 that may
12 otherwise over stress the annular segment 54 and induce premature
13 EED separation. Threaded bolt 74 can be rotated by an
14 appropriate mating tool to engage threaded bore 60 and draw bands
15 30 toward each other to increase the compressive force exerted by
16 lip portions 34 on rims 24 and 26 and preload annular segment 54.

17 Semicircular bands 30 optionally can have a retaining
18 aperture formed therein for mounting a lanyard. Lanyard joins
19 bands 30 with payload section 14 or drive section 16 for keeping
20 bands 30 and associated parts away from propellers and control
21 surfaces of torpedo 12.

22 Compressed steel or stainless steel spring 80 is retained on
23 tubular body portion 52 between shoulder 52a at one end and

1 stainless steel retaining ring 52b on shoulder 52c. Retaining
2 ring 52b may be a high strength snap-ring type that securely
3 engages an outer surface tubular body portion 52 and/or shoulder
4 52c. Retaining ring 52b may be used by itself to hold its end of
5 spring 80 on tubular body portion 52 or may be used in
6 conjunction with a washer to help bear the biasing force, or
7 urging of spring 80. Spring 80 spans the width of the separation
8 line of annular segment 54 that is adjacent shoulder 52a. Spring
9 80 creates an additional force of about 100 pounds to help
10 separate EED 50 when explosive charge 62 is detonated and
11 separates, or ruptures tubular body portion 52 along rupturable
12 annular segment 54.

13 A safety wire 82 is tied to spring 80 and under one of the
14 two local gaps in the bore of retaining ring 52b to avoid
15 scattering of these parts and other debris and ensure that they
16 remain with band 30 after detonation of explosive charge 62 and
17 separation of tubular body portion 54. The possibility of damage
18 to payload and drive sections 14, 16 is thus reduced. Inspection
19 port 84 in band 30 permits observation and checking of clearance
20 between band 30 and the outside surface of retaining ring 52b or
21 tubular body portion 52 of EED 50. Such checking assures that
22 EED 50 does not contact band 30 to such an extent that it becomes

1 twisted, possibly jammed and/or breaks part 34b of band 30 after
2 threaded bolt 74 is tightened.

3 The tensile load at one end of EED 50 is transferred from one
4 end 30a of one band 30 through bolt 74 and distributed to
5 spherical washer set 42 on annular bearing surface 40 to minimize
6 bending moments on the separation zone of EED 50 adjacent annular
7 segment 54. The tensile load on the other end of EED 50 is
8 transferred from the other end 30b of the other band 30, through
9 end portions 46, through pin 72, and to two arms 58 of shackle
10 portion 56. These loads are equally shared by arms 58 of the EED
11 attached with bolt 74 to bearing surface 40 on one band 30 and
12 end portions 46 in the other band 30, so the possibility of
13 jamming and over stressing is reduced.

14 Joint band assembly 10 provides a series arrangement of EEDs
15 50 and bands 30 to assure fail-safe operation if either EED 50
16 fails to detonate or otherwise not separate. Only two bands 30
17 are needed to span the circumference of torpedo 12 as compared to
18 contemporary systems that have more band segment structures.
19 Thus, pin 72 on a possibly failed EED 50 is able to pivot to open
20 assembly 10 when the other EED 50 on the other side is initiated
21 and thereby permit payload section 14 and drive section 15 to
22 separate successfully.

1 Other than the insignificant amount of material that might
2 possibly be created during rupturing of annular segment 54 of EED
3 50, EED 50 is essentially nonfragmenting. Since explosive charge
4 62 is contained in EED 50, rapidly escaping gas and noise are
5 greatly reduced as compared to existing bolt cutter joint band
6 systems using a four-segment joint band.

7 EEDs 50 are smaller and lighter than the explosive devices
8 of the existing system and are potentially less expensive.
9 Accordingly, bands 30 are not damaged by detonation so they can
10 be retrieved and reused. EEDs 50 are coupled to larger and
11 stronger bands 30 than those used in the existing system but do
12 not require extra space between payload section 14 and drive
13 section 16. Only two EEDs 50 secure bands 30 as compared to
14 eight bolts used in the existing system. EEDs 50 and bands 30 of
15 this invention have at least the same structural integrity of
16 standard joint rings and do not create fragments or other debris
17 that might damage payload section 14 or the rest of torpedo 12.

18 Because of the reliable design of joint band assembly 10,
19 EEDs 50 and pins 72 may be made from stainless steel so that
20 assembled EEDs 50 may be stored in flooded torpedo tubes with
21 minimal corrosion potential. This feature further distinguishes
22 from the existing system that is plated steel and was intended to
23 be stored in air prior to being deployed in seawater.

1 Having the teachings of this invention in mind,
2 modifications and alternate embodiments of this invention may be
3 fabricated. For examples, in accordance with this invention,
4 joint band assemblies 10 could be fabricated from alternative
5 materials, such as various aluminum and stainless steel alloys,
6 composites, plating, welding, and coatings. These materials
7 could be incorporated in joint band assembly 10 to minimize the
8 thickness of bands 30 yet provide sufficient local end thickness
9 to attach EEDs 50. Designs could be modified to expedite mass
10 production and further reduce costs even for more unique designs
11 and specialized machining or multiple part band assemblies.

12 The disclosed components and their arrangements as disclosed
13 herein all contribute to the novel features of this invention.
14 This invention provides a reliable and cost-effective joint band
15 assembly 10. Therefore, joint band assembly 10, as disclosed
16 herein is not to be construed as limiting, but rather, is
17 intended to be demonstrative of this inventive concept.

18 It will be understood that many additional changes in the
19 details, materials, steps and arrangement of parts, which have
20 been herein described and illustrated in order to explain the
21 nature of the invention, may be made by those skilled in the art
22 within the principle and scope of the invention,
23

2
3 TORPEDO JOINT BAND WITH IN-WATER SEPARATION

4 CAPABILITY UTILIZING FRANGIBLE LINK EEDS

5
6 ABSTRACT OF THE DISCLOSURE

7 A joint band assembly secures payload and drive sections of a
8 torpedo together and subsequently separates them while the
9 torpedo is making a run. A pair of essentially semicircular
10 bands is arranged in a ring shape have radially inwardly
11 extending lip portions that compressively engage circumferential
12 rims radially outwardly extending from a separation section
13 having first and second parts connected to the payload and drive
14 sections. Adjacent ends of the semicircular bands are coupled
15 together by electro-explosive devices (EEDs) that each has a
16 tubular body portion containing an explosive charge adjacent an
17 annular segment of the tubular body portion. The annular segment
18 has reduced thickness as compared to thickness of the tubular
19 body portion to assure its rupture and separation of the body
20 portion and the interconnected bands. The serial arrangement of
21 bands and EEDs assures separation in the event that one of the
22 electro-explosive devices should fail to detonate, and safety
23 wire and a bonding agent hold separated parts together after

- 1 detonation to prevent scattering of fragments and possible damage
- 2 to the payload or drive sections.

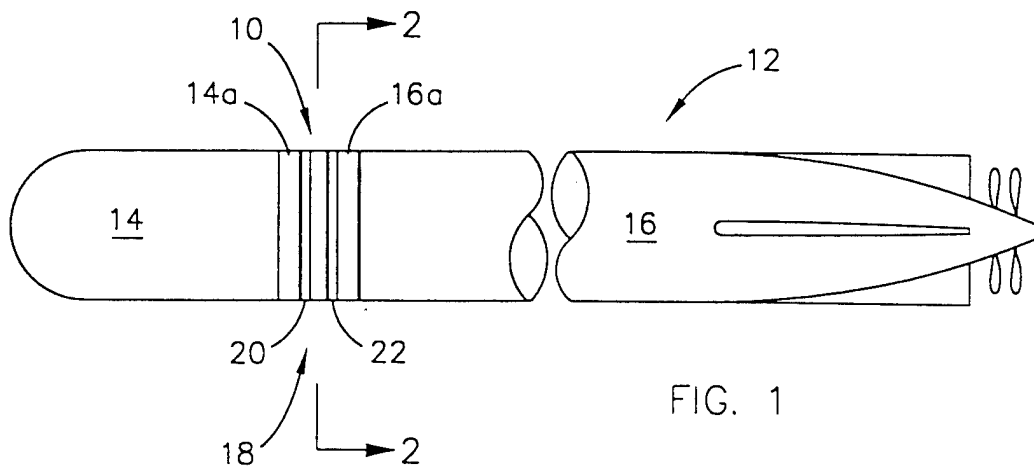


FIG. 1

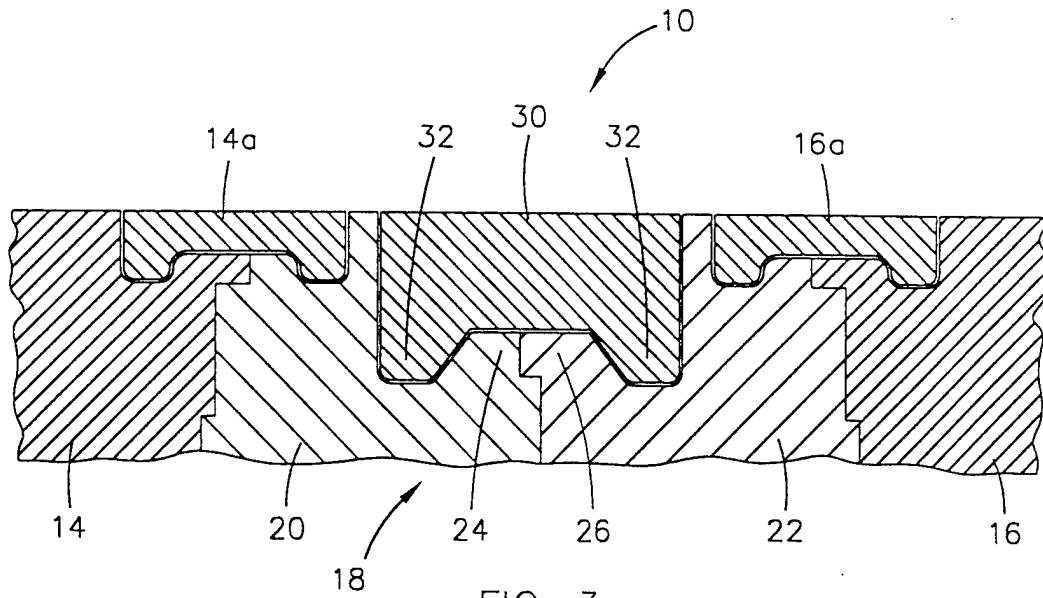


FIG. 3

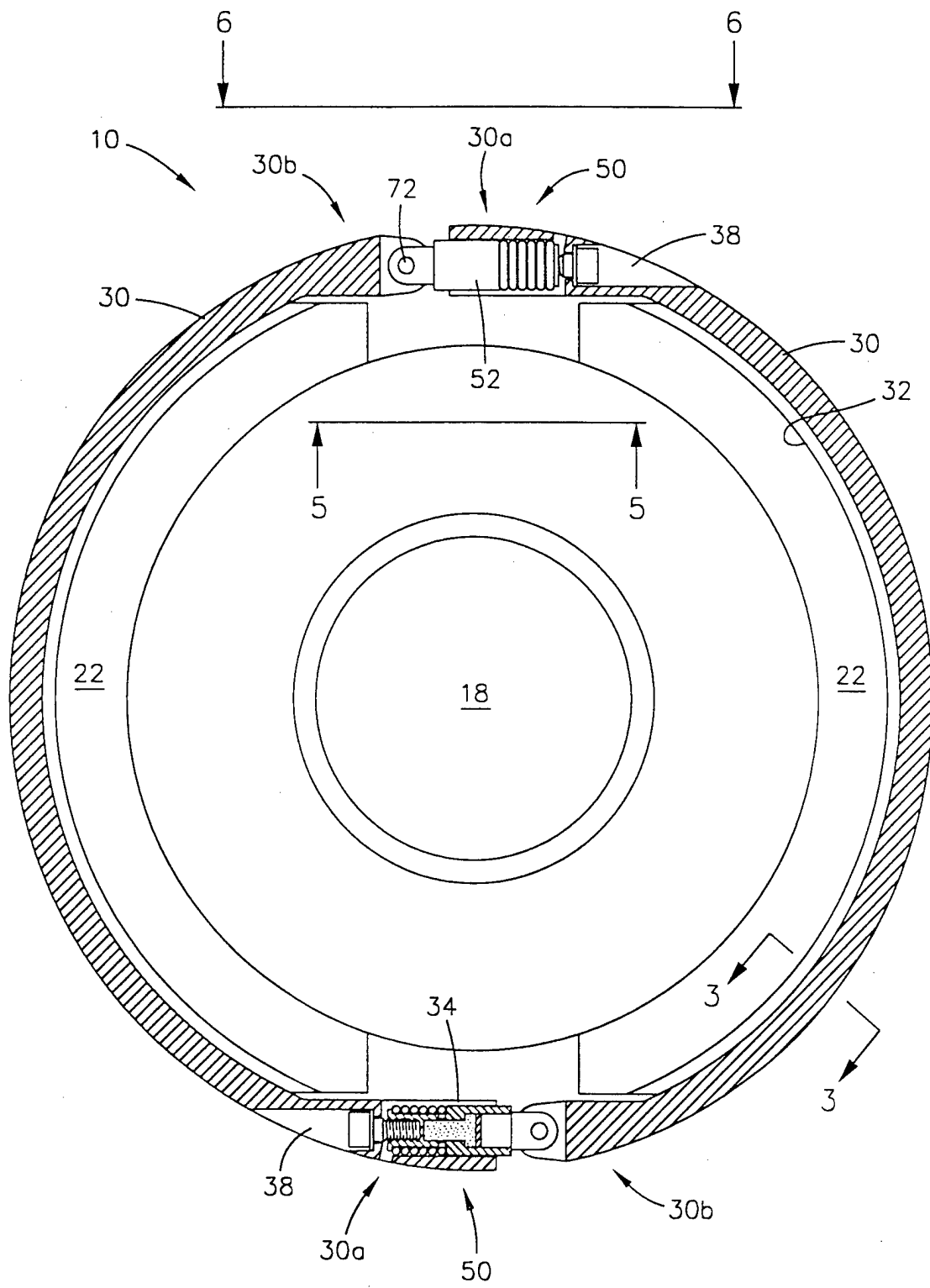


FIG. 2

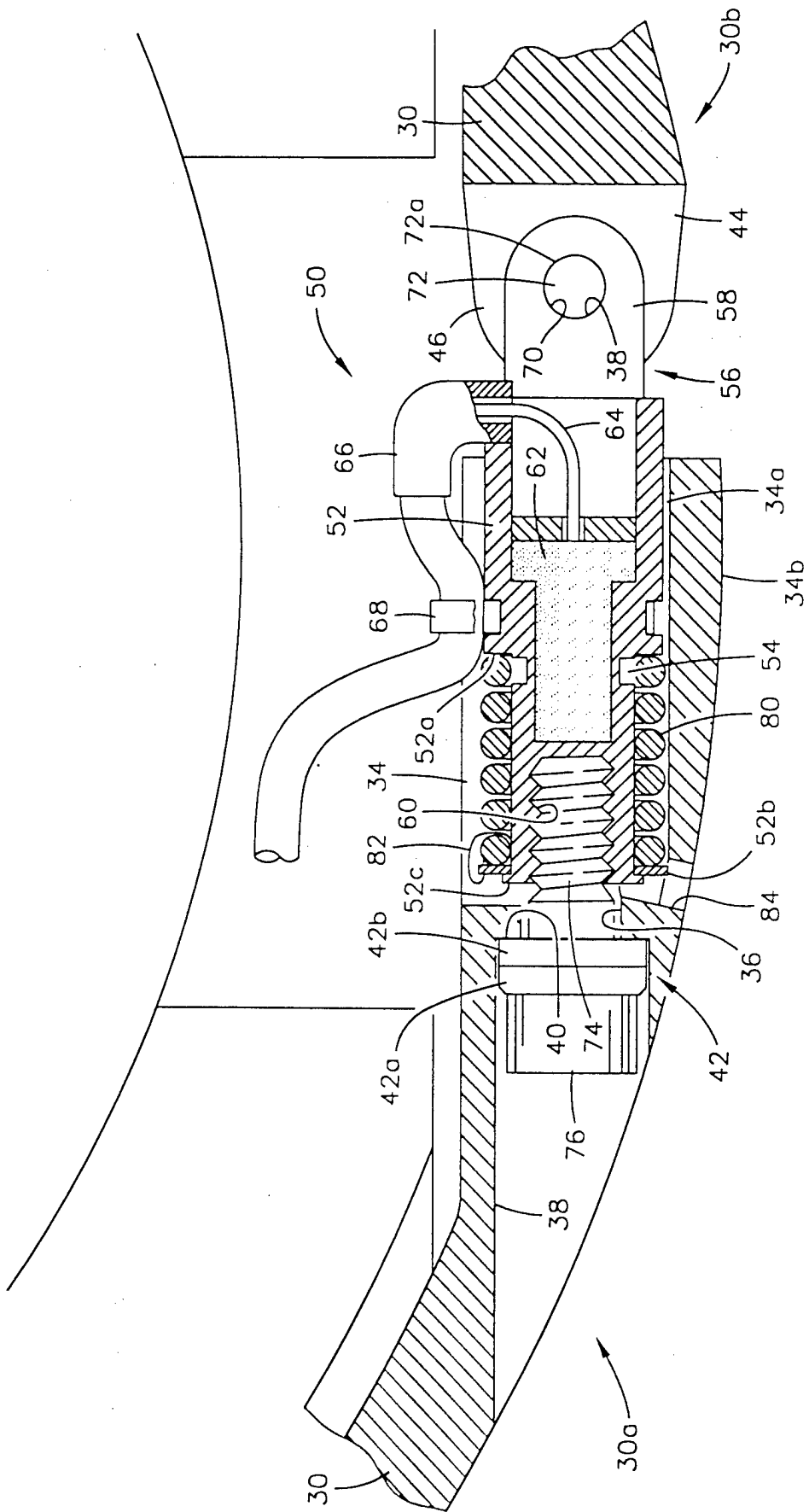


FIG. 4

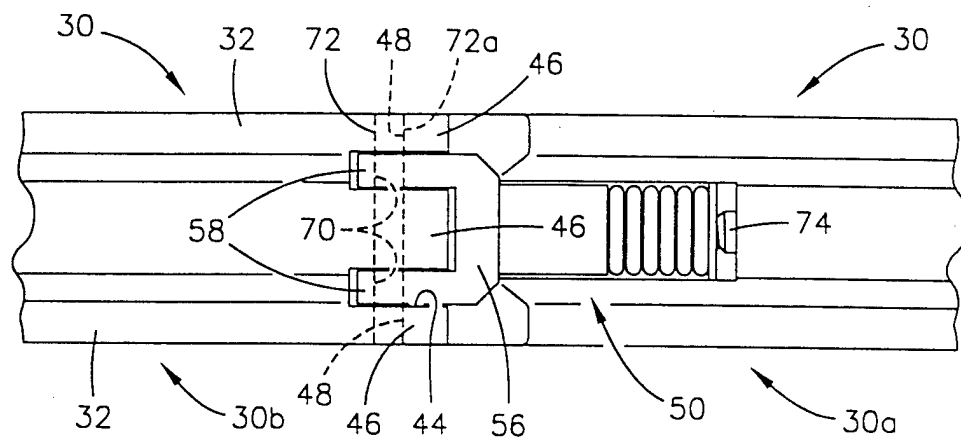


FIG. 5

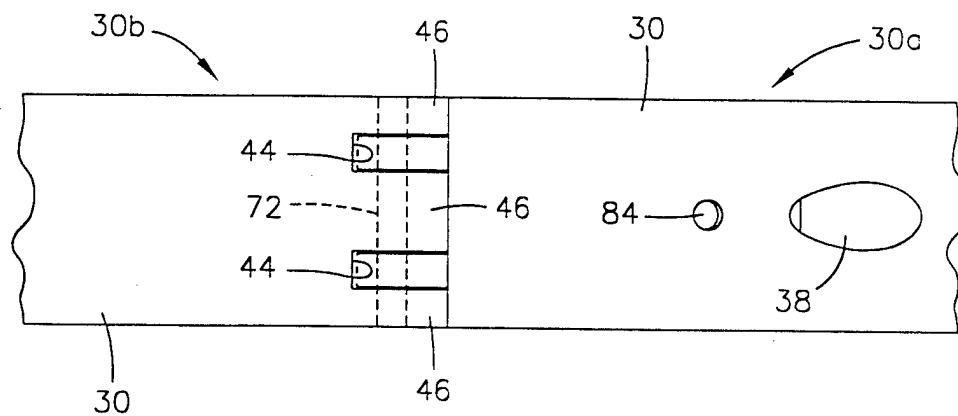


FIG. 6