

Serial No. 540,419
Filing Date 3 October 1995
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NOTICE

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CODE OCCC3
ARLINGTON VA 22217-5660

19960311 044

2 SPOOLED TAPE SEAL
3 FOR UNDERWATER GUN OPERATION

4 STATEMENT OF GOVERNMENT INTEREST

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

9 BACKGROUND OF THE INVENTION

10 (1) Field of the Invention

11 The present invention relates to an apparatus for preventing
12 the ingress of water into an underwater gun before, during and
13 after the firing of a projectile and a method for sealing an
14 underwater gun barrel opening.

15 (2) Description of the Prior Art

16 Little work has been done on apparatus for keeping water out
17 of a gun barrel because until recently it has not been practical
18 to shoot bullets underwater. Newly proven, supercavitation drag
19 reduction techniques now allow bullets to be fired underwater at
20 high enough speeds to cause damage. Accordingly, there is a need
21 for simple and effective means for sealing underwater gun barrels
22 to preclude the entry of water.

23 Excluding water from a gun barrel is important to underwater
24 gun operation. If water is allowed to enter the gun barrel

1 before or after firing the gun, the gun will not operate
2 effectively.

3 The prior art includes various devices relating to
4 underwater guns such as disclosed in U.S. Patent Nos. 44,631;
5 367,153; 1,270,988; 3,300,888; 3,616,561; 3,729,853; and
6 4,821,441. For example, U.S. Patent No. 44,631 discloses a
7 submarine shot conductor having an India-rubber valve mounted on
8 the open end of the shot barrel. Similarly, U.S. Patent No.
9 1,270,988 discloses an underwater gun whereby the gun muzzle is
10 sealed by a pivotally mounted cap portion. U.S. Patent No.
11 367,153 discloses a submarine gun and port whereby the port which
12 receives the gun barrel is exposed by means of a sliding gate.
13 Multishot guns for underwater use are disclosed in U.S. Patent
14 Nos. 4,821,441 and 3,729,853 and 3,616,561. These prior art
15 devices do not provide adequate sealing of the gun barrel to
16 preclude the entry of water and/or are overly complex and not
17 practical underwater guns.

18 U.S. Patent Nos. 3,323,457 to Biehl et al., 3,453,763 to
19 Barr et al. and 3,580,172 to Hendricks illustrate some other
20 underwater weapons. Keeping the barrel of the weapon clear of
21 water is important to underwater gun operation because it reduces
22 the energy required to eject the bullet, it increases the muzzle
23 velocities that can be achieved, and it reduces the strength
24 requirements and thus the weight of the barrel.

25 In the Biehl et al. patent, the underwater weapon comprises
26 a device for launching a projectile. One end of the projectile

1 is covered by a frangible diaphragm. The diaphragm is used to
2 maintain the watertightness of the launcher. In operation, the
3 projectile within the launcher is ejected through the frangible
4 diaphragm. The Barr et al. patent relates to an underwater ✓
5 pistol having a rotatable cylindrical magazine. During operation
6 of this pistol, a projectile is driven through a frangible, and
7 fully removable, sealed front barrel cover. The Hendricks patent
8 also illustrates an underwater weapon in which a projectile
9 resides within a launch tube or barrel having a removable plug
10 affixed at one end to prevent the ingress of water.

11 Other devices are known in the art to render firearms
12 waterproof. U.S. Patent No. 3,677,132 to Plenge illustrates a
13 muzzle attachment for the barrel of a firearm. The muzzle
14 attachment includes a device for sealing the muzzle behind a
15 bullet passing therethrough to prevent the escape of expanding
16 gases. This device takes the form of a plurality of polyurethane
17 discs sandwiched between flat metallic washers and spaced apart
18 by ring members. The plugs are x-slotted on both faces thereof
19 for permitting a bullet to pass therethrough without fragmenting
20 or rupturing the element. The disc or plug automatically closes
21 and reseals itself after a bullet has been fired. When the
22 muzzle attachment is threadably engaged with the gun barrel, the
23 weapon is waterproof from the barrel end thereof. U.S. Patent
24 No. 5,105,571 to Kinchin et al. also relates to a method and
25 apparatus for preventing moisture from entering a firearm. In
26 this patent, lightweight plastic covers are disclosed for use as

1 seals for the openings of a firearm such as the muzzle opening or
2 the magazine well opening. The plastic covers are removable
3 through manual operation. It is also possible to remove the
4 covers by actually firing the weapon.

5 U.S. Patent No. 4,848,209 to Almeras discloses sealing a
6 driving apparatus for an underwater device. The apparatus /
7 includes a barrel holder, a barrel for guiding a fastener
8 intended to be driven by the gases of a propulsive charge and a
9 percussion system for setting of the charge. The barrel of the
10 device is closed by a closure device made by a material which may
11 be perforated by the projectile disposed inside the tubular
12 element or gun barrel.

13 U.S. Patent No. 4,742,775 to Harris illustrates still
14 another approach for sealing an end of an underwater device. In
15 the Harris patent, a sealing compound is used to prevent water
16 from penetrating the casing.

17 Despite the existence of these devices for sealing the end
18 of underwater weapons and the like, there is still a need for a
19 more efficient approach for preventing the ingress of water into
20 a gun barrel and, in particular, to an approach wherein a series
21 of shots can be fired without water entering the weapon.

22 SUMMARY OF THE INVENTION

23 Accordingly, it is an object of the present invention to
24 provide an improved apparatus for keeping water out of a gun
25 barrel.

1 It is a further object of the present invention to provide
2 an apparatus as described above which allows a bullet or
3 projectile within a gun barrel to be enveloped in gas until it
4 leaves the barrel.

5 Still further, it is an object of the present invention to
6 provide an improved method for sealing a gun barrel.

7 The foregoing objects are attained by the apparatus and
8 method of the present invention.

9 In accordance with the present invention, an underwater
10 weapon has a tube, such as a gun barrel, having an opening, such
11 as a muzzle, through which a projectile, such as a bullet, is to
12 be discharged. The underwater weapon is also provided with means
13 for sealing the opening to prevent the ingress of water. In a
14 preferred embodiment of the present invention, the sealing means
15 comprises a tape which covers and seals the opening in the tube.
16 The tube is preferably provided with a surface against which the
17 tape is seated by hydrostatic pressure to prevent the ingress of
18 water. In a preferred embodiment, the tape is a non-metallic or
19 metallic tape. In a preferred embodiment, sprockets are provided
20 to advance the tape and to maintain the tape taut when sealing
21 the opening of the tube or gun barrel.

22 The method of the present invention broadly comprises
23 providing a replaceable tape across the opening of a gun barrel;
24 perforating a section of the tape with a bullet or projectile
25 discharged from the gun barrel opening; and advancing the tape so

1 that a perforated section is replaced by a non-perforated
2 section.

3 Other details, objects and advantages of the present
4 invention are set forth in the following detailed description and
5 the accompanying drawings wherein like reference numerals depict
6 like elements.

7 BRIEF DESCRIPTION OF THE DRAWINGS

8 FIG. 1 is a view of the sealing system of the present
9 invention mounted to a gun barrel;

10 FIG. 2 is a sectional view taken along lines II-II
11 illustrating the sealing tape as it covers the gun barrel
12 opening;

13 FIG. 3 is a front view of the tape sealing system of the
14 present invention;

15 FIG. 4 is a schematic representation of a first alternative
16 embodiment of the gun sealing system of the present invention;
17 and

18 FIG. 5 is a schematic representation of a second alternative
19 embodiment of the gun sealing system of the present invention.

20 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

21 Referring now to the drawings, FIG. 1 illustrates the gun
22 sealing system 10 of the present invention as it is mounted to a
23 gun barrel 12. As shown best in FIG. 2, the gun barrel has an
24 opening 14 through which a projectile (not shown) within the gun

1 barrel 12 is discharged. The gun barrel 12 preferably has
2 attached to one end a piece of thermoplastic such as LEXAN or
3 other deformable material 16 which acts as a mating surface for a
4 sealing means 18 which extends across the opening 14.

5 The sealing means of the present invention comprises a
6 sealing tape 18 which extends across the opening 14 of the gun
7 barrel. A supply of the sealing tape 18 is maintained on a
8 feeding spool 20 mounted to the gun barrel 12. The manner in
9 which the feeding spool 20 is mounted to the gun barrel 12 does
10 not form part of the present invention and is therefore not
11 described in detail. Any suitable means known in the art may be
12 used to mount the spool 20 to the gun barrel 12.

13 A take-up spool 22 may be provided to gather up perforated
14 portions of the tape 18. The take-up spool 22 is preferably
15 replaceable, as is the feeding spool 20. The manner in which the
16 take-up spool 22 is mounted to the gun barrel 12 does not form
17 part of the present invention and therefore is not described in
18 detail. Any suitable means known in the art may be used to mount
19 the take-up spool 22 to the gun barrel 12.

20 Sealing tape 18 can be made from a variety of metallic and
21 non-metallic materials which can be bent around spool 20. The
22 tape 18 used to seal the gun barrel opening or muzzle is
23 preferably formed from an aromatic polyamide fiber material such
24 as KEVLAR, a polyester film material such as MYLAR, or other,
25 non-metallic or metallic material suitable for sealing against
26 salt water. The tape 18 is preferably reinforced along its edges

1 in order to provide it with strength even though it has been
2 perforated by a discharged projectile. Any suitable means known
3 in the art may be used to reinforce the tape. For example, a
4 sandwich construction using the same or different flexible
5 materials may be used to provide a reinforced tape.

6 As shown in FIG. 3, the tape 18 is provided with a series of
7 slots 24 along its lateral edges 26 and 28. The slots 24 extend
8 along the edges of the tape 18 in the manner of a film strip.
9 As shown in FIGS. 1 and 3, drive sprockets 30 are provided to
10 advance the tape 18 from the feeding spool 20 to the take-up
11 spool 22. Additionally, free wheeling guide sprockets 32 are
12 provided to maintain the tape 18 in a proper position. The guide
13 sprockets 32 and the drive sprockets 30 are also used to maintain
14 the tape 18 taut across the opening 14 of the gun barrel 12.

15 The manners in which the drive sprockets 30 and the take-up
16 spool 22 are driven do not form part of the present invention and
17 therefore are not described in detail. Any suitable means known
18 in the art may be used to drive the drive sprockets 30 and the
19 take-up spool 22, including electric motors, gas actuation, or
20 actuation taking power from any ammunition feed system employed
21 by the operation of the gun.

22 As shown in FIG. 2, guides 34 may be provided to ensure that
23 the tape 18 advances in a manner which aligns it with the opening
24 14 so as to effectively seal the opening 14. The guides 34, may
25 be mounted to the gun barrel 12 by a bracket arrangement 38 such
26 as that shown in FIG. 1. A practical bracket arrangement might

1 require incorporation of a spring means (not shown) to allow the
2 seal to lift from the muzzle as the gas ahead of the projectile
3 is compressed during launch. Any suitable bracket arrangement 38
4 and spring means known in the art may be used.

5 The gun barrel 12 may have either a flat end in which the
6 opening 14 is provided or a curved configuration in which the gun
7 opening 14 and the mating surface 16 are provided as shown in
8 FIG. 2. By properly arranging the guides 34, the tape 18
9 conforms to the shape of the gun barrel 12.

10 In operation, a non-perforated portion of the tape 18 is
11 moved in front of the gun barrel opening 14. Hydrostatic
12 pressure causes the tape 18 to seal against the mating surface
13 16. In this way, water is kept out of the gun barrel 12 so that
14 a projectile or bullet (not shown) within the gun barrel 12 is
15 enveloped in gas until it leaves the barrel. Once the projectile
16 or bullet is discharged from the gun barrel, it will perforate
17 that portion of the tape 18 in front of the opening 14. At this
18 time, the gun barrel 12 is kept clear of water by the exhaust
19 gases of combustion. During this period, the tape 18 is advanced
20 to a new position by sprockets 30 so that a non-perforated
21 portion of the tape 18 is positioned in front of the opening 14
22 and the perforated portion of the tape is moved away from the
23 opening 14. The external hydrostatic pressure re-seats the tape
24 18 against the mating surface 16, thereby resealing the gun
25 barrel 12.

1 The technique of the present invention requires that the
2 material used to seal the gun barrel 12 be strong enough that it
3 can be advanced without tearing, yet weak enough that a bullet or
4 other projectile can perforate it without being thrown off course
5 or losing excessive kinetic energy. For use in marine
6 applications, the tape material must be capable of withstanding a
7 salt water environment.

8 Referring now to FIG. 3, if desired, the sealing system of
9 the present invention can be provided with an optional roller 40
10 for smoothing or flattening any burr which occurs when the tape
11 is perforated by the bullet. When the tape 18 and the mating
12 surface 16 are flat, a cylindrical roller may be used to flatten
13 any burr and the tape 18 so that it can be collected on the take-
14 up spool 22. When the tape 18 and the mating surface 16 are
15 curved, as shown in FIG. 2, a curved roller may be used to
16 flatten any burr and the tape 18 so that it can be collected on
17 the take-up spool 22.

18 Alternatively, the optional roller 40 can be replaced by a
19 cutting device 42 (see FIG. 4) such as a knife. The knife can be
20 used to remove any burr in the tape 18 before winding the tape 18
21 on the take-up spool 22. The knife can be used with the tape and
22 the mating surface being either curved or flat.

23 In yet another alternative embodiment (see FIG. 5), the take
24 up spool 22 and the roller 40 are eliminated. Instead, a tape
25 cutting device 44 is mounted to the gun barrel 12 in a position
26 immediately downstream of the drive sprockets 30. The tape

1 cutting device 44 is used to cut off sections of the tape 18.
2 Tape cutting device 44 can be an electrically actuated shearing
3 device for use with metallic tape, a hot wire cutting device for
4 use with non-metallic tape, or any other well known means for
5 cutting tape. This arrangement can also be used when the tape
6 and the mating surface are either curved or flat.

7 As can be seen from the foregoing description, an effective
8 system for sealing the gun barrel of an underwater weapon has
9 been described. The gun sealing system of the present invention
10 keeps the gun barrel clear of water during operation of the gun.
11 This helps reduce the energy required to eject a projectile or
12 bullet. It also increases the muzzle velocities which can be
13 achieved and reduces the strength requirements and the weight of
14 the gun barrel. The sealing system of the present invention is
15 advantageous in that it may be used in connection with a wide
16 variety of underwater weapons. Additionally, the gun sealing
17 system of the present invention can be automated and thereby
18 eliminates the need to manually replace a device for sealing the
19 gun barrel during operation.

20 It is apparent that there has been provided in accordance
21 with this invention a spooled tape seal for underwater gun
22 operation which fully satisfies the objects, means, and
23 advantages set forth hereinbefore. While the invention has been
24 described in combination with specific embodiments thereof it is
25 evident that many alternative, modifications, and variations will
26 be apparent to those skilled in the art in light of the foregoing

1 description. Accordingly, it is intended to embrace all such
2 alternatives, modifications, and variations,

3

1 Navy Case No. 76837

2 SPOOLED TAPE SEAL
3 FOR UNDERWATER GUN OPERATION

4
5 ABSTRACT OF THE DISCLOSURE

6 The present invention relates to an underwater weapon having
7 a system for sealing the opening of a gun barrel to prevent the
8 ingress of water. The sealing system includes a non-metallic or
9 metallic tape for covering and sealing the opening and a mating
10 surface on the gun barrel against which the tape is seated to
11 prevent the ingress of water. The sealing system further
12 includes sprockets for advancing the tape across the opening of
13 the gun barrel and for maintaining the tape in a taut position
14 during operation.

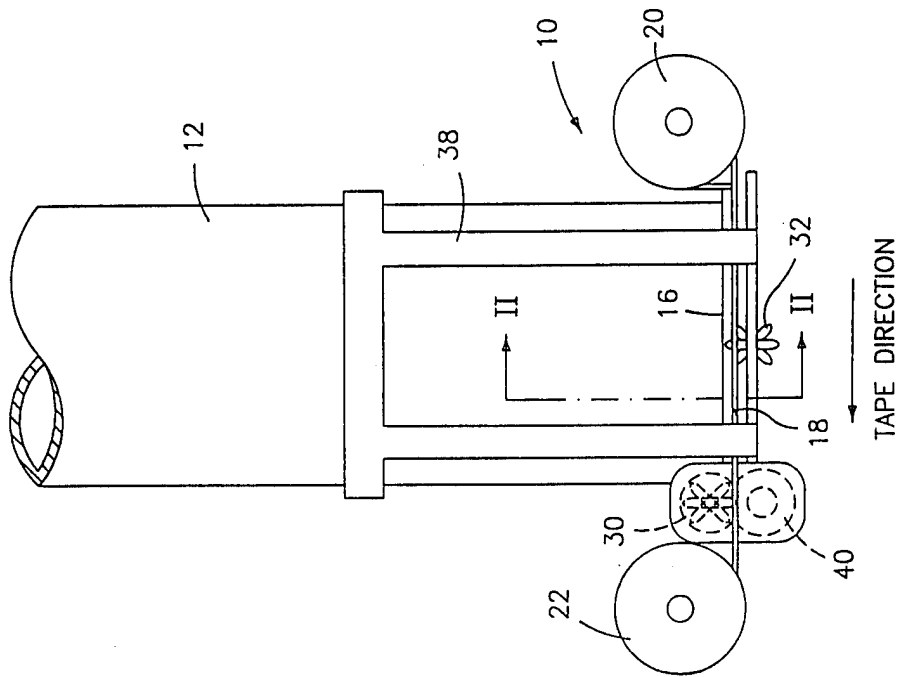


FIG-1

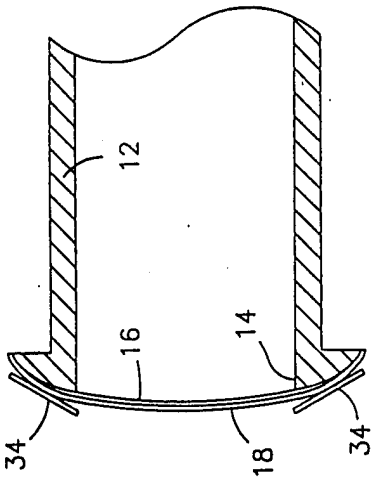


FIG-2

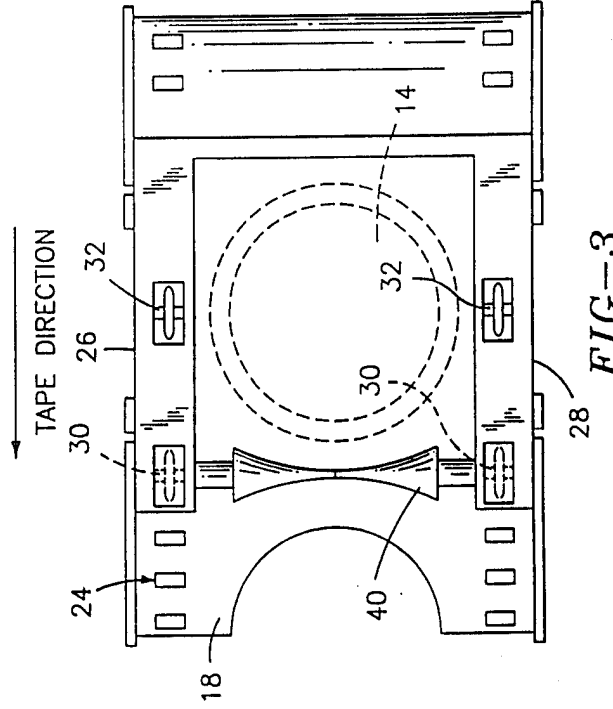


FIG-3

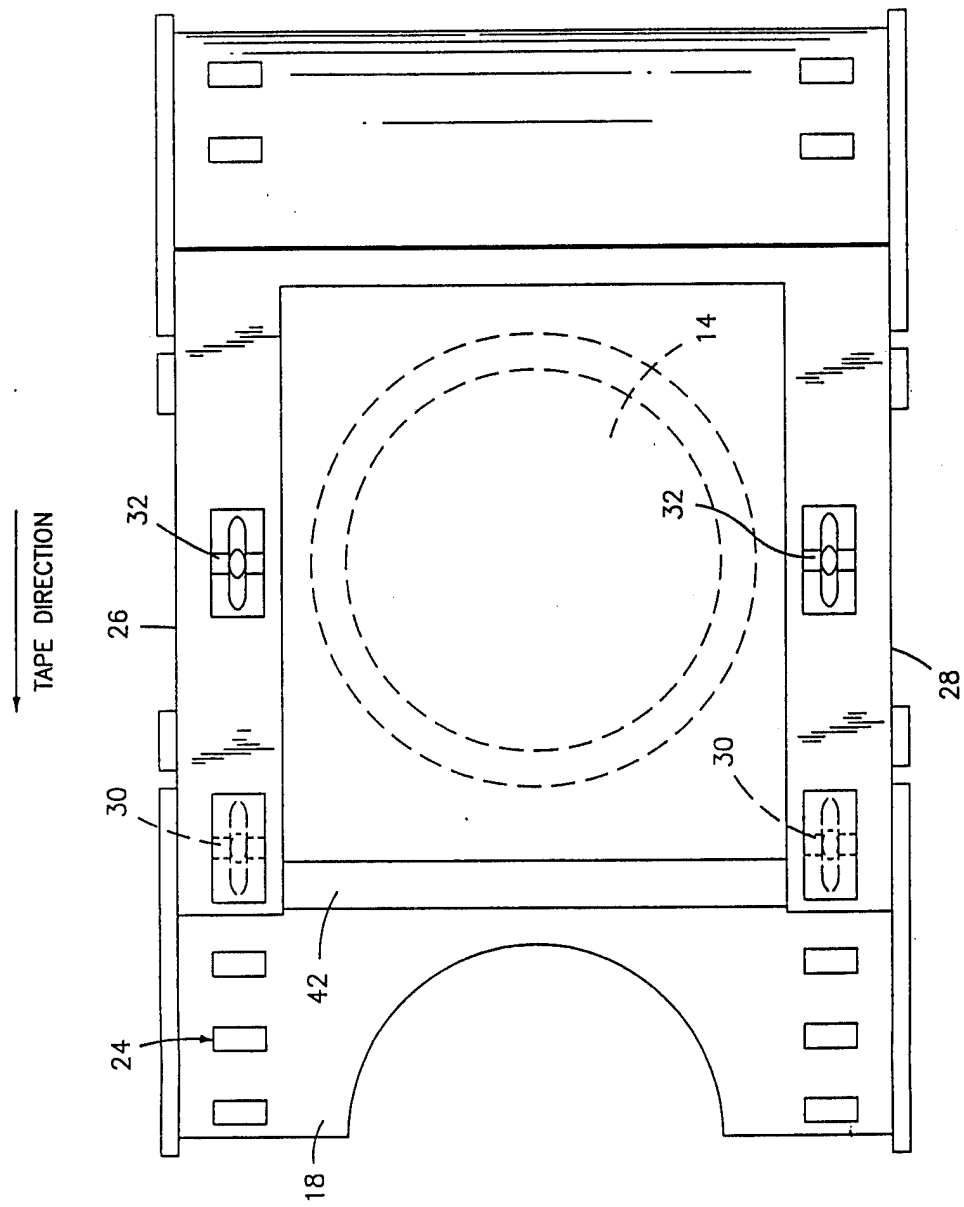


FIG-4

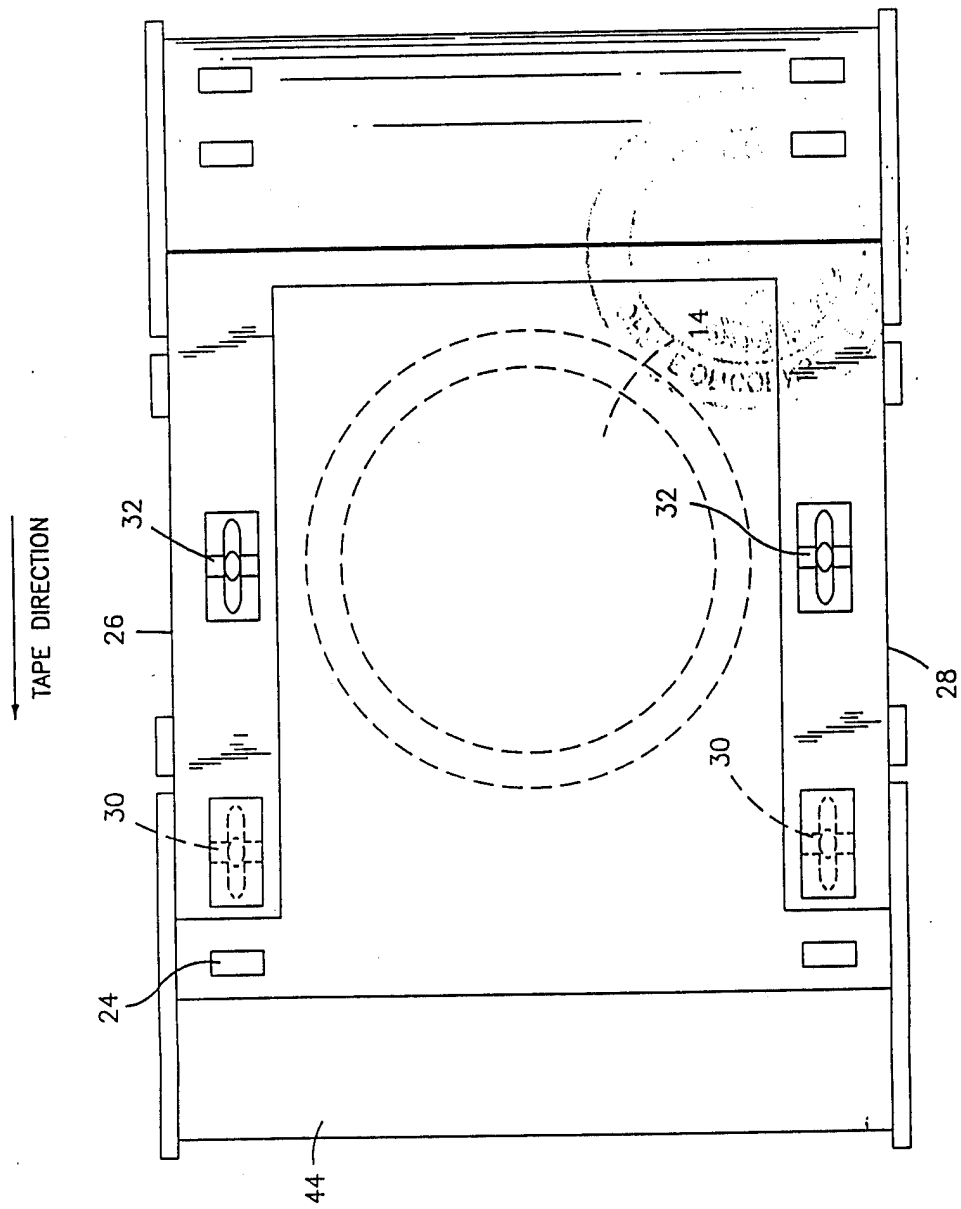


FIG-5