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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
21 December 2007 (21.12.2007)

PCT

(10) International Publication Number
WO 2007/146256 A2

(51) International Patent Classification:
E02D 29/14 (2006.01)

(21) International Application Number:
PCT/US2007/013731

(22) International Filing Date: 12 June 2007 (12.06.2007)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

60/812,757	12 June 2006 (12.06.2006)	US
60/889,553	13 February 2007 (13.02.2007)	US
60/921,975	6 April 2007 (06.04.2007)	US

(71) Applicant and
(72) Inventor: **STADLER, David, M.** [US/US]; 28421 Santa Barbara, Lathrup Village, MI 48076 (US).

(74) Agent: **BENEFIEL, John, R.**; 280 Daines, Suite 100 B, Birmingham, MI 48009 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, 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, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 2007/146256 A2

(54) Title: MANHOLE COVER SECURITY LOCK WITH CONTROLLED PRESSURE RELEASE

(57) Abstract: A controllably releasable security locking arrangement for a manhole cover allows a manhole cover to be locked into position but allows the manhole cover to rise up in stages upon development of upward forces in an explosion to vent gases developed by the explosion. A lock body mounts a latch slide which has an outer end and which can be extended to prevent removal of the manhole cover. When a shear pin fails the lock body pivots down, to a limited extent, and a secondary shear pin can also be included allowing the cover to be blown completely free upon development of pressures of a great magnitude. A slotted skirt directs venting gas flow so as to retard the inflow of free air and attenuate the explosion.

MANHOLE COVER SECURITY LOCK WITH CONTROLLED PRESSURE RELEASE

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. provisional patent applications No. 60/921,975 filed on No. April 6, 2007; 60/889,553 filed on February 13, 2007; and No. 60/812,757 filed on June 12, 2006.

BACKGROUND OF THE INVENTION

This invention concerns manhole covers used to close off access to utility passages extending beneath city streets. For security purposes, it is desirable to limit access to such passages by locking the manhole covers onto their supporting seats.

However, manhole covers are sometimes subjected to very high pressures caused by explosions as when an accumulation of methane gas, etc. in the passages below is ignited.

Manhole vault explosions usually blow the manhole covers out of their seats and into the air with great force. Since each manhole cover must be reinstalled as soon as possible after an explosion to cover up the hazardous open manhole, a significant maintenance cost is entailed.

Until a dislodged manhole cover can be replaced into its frame, the open manhole presents a serious hazard.

Pressure rises rapidly beneath a manhole cover in an explosion, and even a relatively small pressure rise will lift the manhole cover off its seat. For example, a momentary pressure rise of only one PSI beneath a 700 square inch manhole cover weighing 200 lbs. equates to a 500 lb. force available to dislodge the cover from its seat.

Although such explosive events are rare, when they do occur, manhole covers are often blown high into the air, can cause much damage, and even become deadly if a manhole cover strikes a passerby.

Typically, a metal manhole cover frame is cemented to the top of a manhole site chimney and set into the surrounding pavement.

A complicating factor is that the dislodging of the manhole cover acts to relieve gas pressure in the manhole during explosive events. Fixing manhole covers in place on their seats could cause damage to enclosing structures if there is no venting of the rapidly expanding gases. Pressure must somehow be relieved to avoid this potential structural damage.

It is an object of the present invention to provide a manhole cover security lock which allows a controlled pressure relief while avoiding launching of the manhole cover out of its seat when an explosion occurs in the space beneath the cover.

SUMMARY OF THE INVENTION

The above recited object as well as other objects which will become apparent upon a reading of the following specification and claims are achieved by mounting a lock body on the underside of a manhole cover at the perimeter thereof. A lug on the opposite side of the manhole cover can hook an inwardly sloping rim on the manhole seat defining structure. A latch slide is able to be extended out horizontally from the lock body by advance of an actuator bolt engaging a cam surface on the latch slide.

The lock body is pivoted at one end between a pair of mounting plates by a swivel pin. Advance of the actuator bolt with a special wrench engages a leading end thereof with the cam surface on the latch slide to force the latch slide to move radially outward

beyond the perimeter of the manhole cover. In that position, the latch slide will engage a sloping sidewall feature of the manhole cover enclosure when the cover is lifted up off its seat a short distance by the force of an explosion, creating a gap between the enclosure seat and the cover perimeter, allowing the venting of gas about the perimeter of the cover while preventing the manhole cover from being blown free.

The pivoted lock body is restrained from pivoting down by a primary shear pin which will fail at a predetermined force level, allowing the lock body to pivot down a short distance where a stop engages a side of an enlarged opening in the lock body to prevent any further downward pivoting motion. This arrangement allows the cover to rise a predetermined short increment higher to create a greater venting area for the exit of explosive gases while still preventing the cover from being blown free.

The stop may be comprised of a secondary shear pin designed to also shear at a very high pressure level, allowing the lock body to swing down completely and let the manhole cover be blown free if very large pressures are experienced during the explosion which cannot be sufficiently relieved by the partial venting to prevent great structural damage.

According to another feature of the present invention, the manhole cover depending skirt extending around its perimeter is formed with scalloped slots shaped to redirect the exiting gases back toward the clearance gap around the cover, retarding the entrance of fresh air into the manhole and to attenuate the explosive combustion of the unburned gases which would otherwise occur. This reduces the magnitude of the peak pressure developed beneath the manhole cover from that which would otherwise develop.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a fragmentary sectional view through a manhole metal enclosure and surrounding paving section with a manhole cover resting on a seat defined by the enclosure, having a security locking arrangement according to the present invention installed thereon including a lock body assembly and a fixed lug.

Figure 1A is a view of the arrangement shown in Figure 1 but with the manhole cover in the process of being installed.

Figure 2 shows the components shown in Figure 1 with the manhole cover lifted as by the force of an explosion to bring fixed lug and latch slide portions into abutment with a sloping feature on the inside of manhole enclosure.

Figure 3 shows the components shown in Figures 1 and 2 with the primary shear pin failed, resulting in a pivoting down of the lock body in turn allowing an additional incremental rise of the manhole cover off its seat to increase the area of the gap available for venting gases.

Figure 4 is a fragmentary sectional enlarged view of the lock body and latch slide components, with adjacent portions of the manhole cover and enclosure.

Figure 5 is a view of the components shown in Figure 4 with the lock body pivoted down a short distance.

Figure 6 is a fragmentary view of the manhole cover showing an end view of the lock body assembly components.

Figure 7 is a diagrammatic representation of the gas flow past the manhole cover in an explosion illustrating the redirection of gas flow induced by scalloped slots in the skirt on the inside of the manhole cover.

Figure 8 is a plan view of the bottom of the manhole cover showing the slotted skirt and the lock arrangement components.

Figure 8A is a diagrammatic representation of the gas flow path induced by the slots.

Figure 9 is an enlarged fragmentary view of a portion of the slotted skirt on the manhole cover.

Figure 9A is an enlarged fragmentary view of another portion of the slotted skirt showing a centering guide.

Figure 10 is a sectional view of a modified form of the lock body assembly.

Figure 11 is a partially sectional view of a portion of a manhole frame with a manhole cover having a modified form of the lock body assembly mounted thereto.

Figure 12 is an inside view of the manhole cover having an explosion indicator rope hung from the inside of the manhole cover.

Figure 13 is an end view of the components shown in Figure 11.

Figure 14 is a side view of the lock body assembly in the fully pivoted down position completely releasing the manhole cover.

DETAILED DESCRIPTION

In the following detailed description, certain specific terminology will be employed for the sake of clarity and a particular embodiment described in accordance with the requirements of 35 USC 112, but it is to be understood that the same is not intended to be limiting and should not be so construed inasmuch as the invention is capable of taking many forms and variations within the scope of the appended claims.

Referring to the drawings, Figure 1 shows a manhole cover 10 resting on a seat 16 defined by a metal enclosure 12 recessed into street paving 14 and defining the manhole cavity itself. The enclosure 12 has an inwardly sloping annular feature 18 having the seat 16 defined on the top surface.

According to the present invention, a security locking arrangement is provided, comprised of a lock body assembly 20 fixed to the underside of the manhole cover 10 adjacent to the outer perimeter thereof in the space between two parallel extending ribs 11 extending across the underside of the cover 10. On the diametrically opposite side, a fixed lug 22 is integrally cast into the underside of the manhole cover 10 having an outwardly projecting portion 24 located to engage the sloping feature 18 when the manhole cover 10 is elevated off the seat 16 to a predetermined height.

The lock body assembly 20 includes a latching slide 26 which has an end portion 28 which will also engage the sloping feature 18 when extended out to the position shown in Figure 1.

Figure 1A shows the latching slide 26 retracted within a lock body 34 for installation of the manhole cover 10 by angling it into the manhole opening within the enclosure 12. After seating the manhole cover 10, an actuator bolt 30 is advanced, as will be described below, to shift the latching slide 26 radially to the extended position shown in Figure 1.

Figure 2 shows the initial upward movement of the manhole cover 10 resulting from an explosion. The vertical space between the sloping surface 18 of the enclosure 12 and the lug portion 24 and latching slide portion 28 as seen in Figure 1 allows the manhole cover 10 to lift up an inch or two before engagement of the portions 24, 28 with

the enclosure feature 18. The resulting gap around the perimeter of the cover 10 allows the venting of the hot gases generated by the explosion.

If the forces on the cover 10 created by the explosion exceed a predetermined level, a primary shear pin 32 holding the lock body 34 from pivoting about a pivot pin 36 will fail, allowing the lock body assembly 20 to pivot down to a shallowly angled position shown in Figure 3. This creates another inch or so clearance about the perimeter of the cover 10 as seen in Figure 3 such that the cover 10 can tilt up to open a larger gap, creating a staged additional venting area for the gases generated by the explosion so as to avoid structural damage by the development of high pressures in the manhole cavity.

Figure 4 shows internal details of the lock body assembly 20. The lock body 34 is pivoted at one end on the pivot pin 36 received between vertical ribs 11 to allow limited rotation down from the cover 10 when the primary shear pin 32 also received in the ribs 11 is sheared off by the forces acting through the slide portion 28.

The latch slide 26 is slidably received in a bore 38 formed in the lock body 34. A keeper blade 40 is received in a slot 42 in the latch slide 26 to prevent rotation of the latch slide 26 within the bore 38.

A spring 44 interposed between keeper blade 40 and an end wall 46 of the slot 42 urges the latch slide 26 to the left to tend to retract the portion 28 radially inwardly.

The actuator bolt 30 has a rounded end 48 which engages a sloping cam surface 50 on the top of the latch slide 26 which forces the latch slide 26 to the right when the bolt 30 is rotated to be advanced until the fully advanced position is reached as seen in Figure 4. The bolt can be turned using an anti-tamper special wrench tool 52 mating with a correspondingly specially shaped bolt head 51 to prevent unauthorized removal of the

manhole cover 10. Such a tool and bolt head is described in U.S. Patent No. 6,764,261. A plug 60 can enclose the bolt head 51 for protection and to keep debris from filling the recess within the cover 10 accommodating the bolt head 51.

A retainer ring 54 is fixed at one of the bore 38 preventing escape of the latch slide 26 to the left when the actuator bolt 30 is removed.

A stop pin 58 is received in an elongated arcuate slot 56. When the primary shear pin 32 releases, the latch body 34 pivots down a short distance until a bumper 62 contacts stop pin 58 in the position shown in Figure 5 preventing further pivoting.

The actuator bolt 30 has an annular curved shaped groove 64 near its end which is positioned in a hole in a flat at the end of the latch slide 26. This allows the latch slide 26 to be moved slightly further to the left by the spring 44 when the bolt 30 is fully advanced. When the bolt 30 is withdrawn, a slight camming action by the curved side of the groove 64 breaks the slide 26 free if ice or corrosion has developed seizing the latch slide 26 in the bore 38 allowing the spring 44 to again act to retract the latch slide 26 with portion 28 to enable removal of the manhole cover 10.

During a manhole explosion, a high velocity flow of gases are directed against the under side of the manhole cover 10. The high velocity gases thus produced fill a cup shaped cavity defined by a skirt 66 usually cast as an integral part of the manhole cover 10 for strengthening purposes (Figures 7 and 8). The cavity defined by the skirt 66 when filled with high velocity gases helps to propel the cover 10 out of enclosure 12 during a manhole explosion. According to another feature of the invention, the skirt 66 is formed with scalloped slots 68 comprising a plurality of semi-circular openings. The scalloped slot surfaces are angled down at between 30°and 45° and are also radially canted between

30°and 45° from alignment with the axis of the manhole cover 10. The canting of the slots 68 are reversed from each of the adjacent slots 60 to maximize swirl in the vertical pressure wave outside skirt 66 (Figure 8A). The skirt portions between the slots 68 disrupt and diffuse the radial pressure wave created when vertical pressure wave within the skirt 66 is forced to turn 90° and exit at high velocity radially.

The slots 68 direct high pressure gases radially into the advancing vertical flame front outside the skirt 66. Consequently, the vertical flame front outside the slotted skirt 66 is disrupted and diffused.

Angular pressure waves are shaped and directed by the slots 68 into the vertical column of expanding gases outside the skirt 66. These actions disrupt laminar gas flow axially and radially by generating diffusion in these respective flame fronts. Diffusion induces swirl and tumble in the respective air masses, lowers temperatures, and shortens radial flame travel on street surface. Shortened flame travel lessens injury potential to pedestrians near manhole explosions.

According to another aspect of this feature, a flow retarding action is created by the slotted skirt 66 extending below the underside of the cover 10 (Figures 7-9). A portion of the expanding gases from an explosion in passing through the series of downwardly angled slots 68 are directed down into the gap 70 where the outflow of gas occurs. This creates turbulence and an increased static pressure which retards the inflow of fresh air. This in turn attenuates the continued burning of the flammable gases such as methane to reduce the peak force of the explosion by reducing the amount of available oxygen to combust the flammable gases.

A series of centering guides 92 (Figure 9A) are affixed around the outer perimeter of the cover to insure that the cover 10 will drop back into the seat 16 after the pressure returns to normal.

Figures 10-14 shows some modifications in the lock body assembly 20. A plastic liner sleeve 72, as of Teflon, may enclose the slide bore 38 to prevent seizing and insure free movement of the latch slide 26 therein. A stop roll pin 74 may be used to limit travel of the latch block 26 to the left instead of the retainer ring 54.

An enlarged bore 76 provides the stop for the secondary shear pin 58, an easier feature to machine than the arcuate slot 56 described above.

The integrally cast reinforcement ribs 11A can be reduced in height at the middle by a radiused contour as seen in Figure 11.

An RFID "sparse pulse" transmitter 78, solar battery/charger 80 can be included (Figure 11) for detecting an explosion event or unauthorized cover removal at a monitoring station.

The lock body assembly 20 can be mounted on detachable retainer plates 82 secured to the underside of the cover with bolts 84 received in threaded holes in the cover rather than directly to the ribs 11. This allows the entire assembly to be manufactured and assembled separately from the cover 10, and to be easily installed or removed. In that case, the opposite ends of the pivot pin 36 can be captured in respective blind holes formed in the two plates 82. Also, the lug 22A can be a separate piece attached to ribs 11 with screws as shown.

The stop 58 can be designed to act as a secondary shear pin, which when sheared will release the lock body assemble 20 to pivot down to a sharply angled position (Figure

14), allowing the cover 10 to blow free in the event of a very powerful explosion of a magnitude that could still create great damage despite being partially vented.

Figure 12 shows an indicator rope or strip 86 hung on an eye 90 which strip 86 will be blown out through the gap 88 in an explosion with a tag on end of rope (danger call utility). This will enable maintenance crews to be alerted to the fact that an explosion has occurred at the site of a particular manhole after the cover 10 has dropped back into its normal position.

CLAIMS

1. A controlled release security locking arrangement for a manhole cover fit into a manhole opening defined by a surrounding enclosure comprising:

a lock body assembly secured to the underside of the manhole cover adjacent a perimeter of said cover and including a latch slide mounted to said lock body selectively movable radially;

an actuator element drivingly engaged with said latch slide and accessible from the top of said manhole cover to enable outward radial movement of said latch slide to position an outer portion thereof to be engageable with a feature on the inside of said enclosure upon upward movement of said cover to prevent removal of said cover; and

a clearance space between said feature and said outer portion of said latch slide to allow limited rise of said manhole cover to create a gas venting gap around said manhole cover in the event of an explosion;

2. The locking arrangement according to claim 1 further including a controlled release mounting of said lock body assembly allowing movement downwardly of said latch slide portion upon application of an upward force on said manhole cover of a predetermined magnitude to create a greater perimeter gap between said manhole cover and said enclosure allowing a staged increased venting of gases from within said enclosure.

3. The locking arrangement according to claim 1 further including a lug mounted to said cover adjacent said perimeter thereof opposite said lock body assembly and having a portion projecting out radially to be engageable with a feature of said enclosure with upward movement of said cover.

4. The locking arrangement according to claim 3 wherein said latching slide and lug portions are spaced below a point where engagement with said enclosure feature occurs with said manhole cover resting on a seat defined in said enclosure, whereby said manhole cover rises up to a limited extent before said engagement occurs to create a perimeter gap and thereafter preventing further upward movement of said cover, whereby gases can flow out through said perimeter gap to reduce the pressure of gases generated in an explosion acting on said manhole cover.

5. The locking arrangement according to claim 2 wherein said controlled release mounting comprises a pivot pin at one end of said lock body generally opposite said latch slide portion and a shear pin engaging said lock body to normally prevent pivoting down of said lock body about said pivot pin until after said shear pin fails at a predetermined upward force exerted on said manhole cover.

6. The locking arrangement according to claim 4 further including a stop limiting said downward pivoting movement of said lock body assembly upon failure of said shear pin so as to allow reengagement of said latch slide portion with said enclosure feature with further lifting of said manhole cover to create a greater perimeter gap through which gases can be vented.

7. The locking arrangement according to claim 6 wherein said stop comprises a secondary shear pin failing at a predetermined upward force exerted thereon by said manhole cover during an explosion in said enclosure to allow free pivoting down of said lock body to an extent allowing said manhole cover to be blown completely free of said enclosure.

8. The locking arrangement according to claim 1 wherein said manhole cover has a perimeter skirt depending from the inside thereof, with a series of scalloped slots contoured to redirect the flow of gases downwardly towards said gap to retard inflow of air in an explosion.

9. The locking arrangement according to claim 1 wherein said actuator element comprises a bolt received in a threaded bore and having an end engaging a cam surface on said latch slide to cause movement in a radially outward direction upon advance of said bolt in said threaded bore.

10. The locking arrangement according to claim 9 wherein said bolt has a head accessible from the top within an opening in said manhole cover.

11. The locking arrangement according to claim 6 wherein a pair of ribs extends across said manhole cover on the underside thereof to stiffen said manhole cover and said lock body is pivotally mounted between said ribs.

12. The locking arrangement according to claim 7 wherein successive slots are canted radially in opposite directions an angle of about 30° - 45°.

13. The locking arrangement according to claim 7 wherein said slots are angled downwardly an angle of about 30° - 45°.

14. The locking arrangement according to claim 5 wherein a pair of retainer plates are removably attached to the underside of said cover and said lock body assembly to pivotally mounted between said retainer plates.

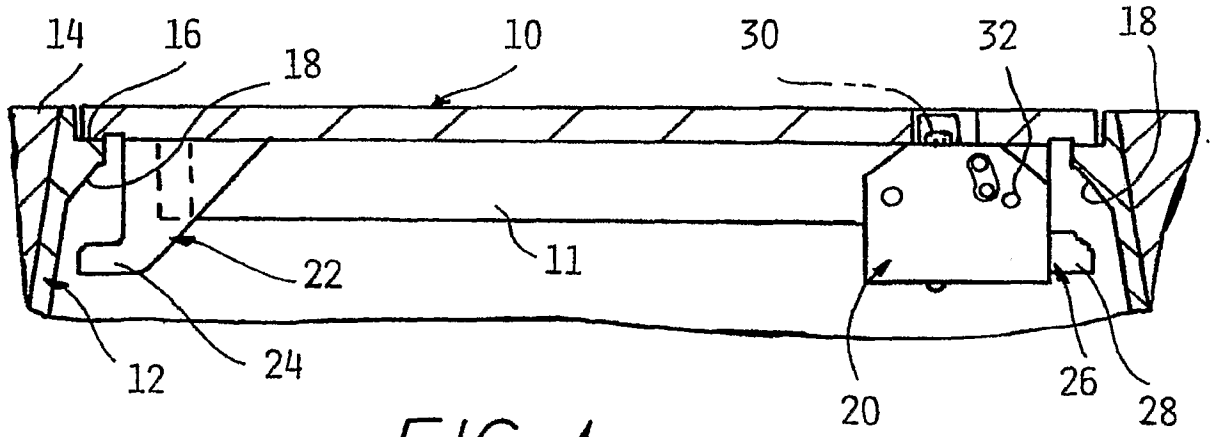


FIG. 1

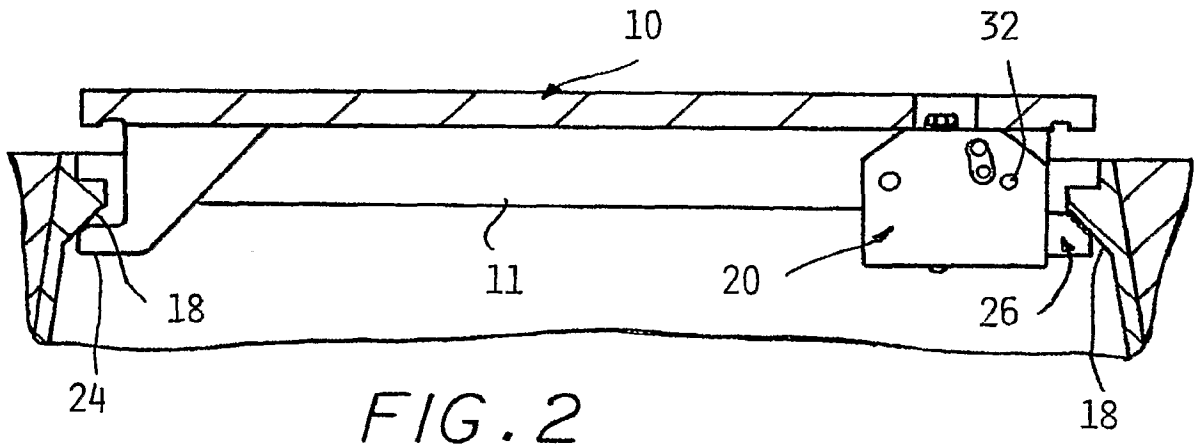


FIG. 2

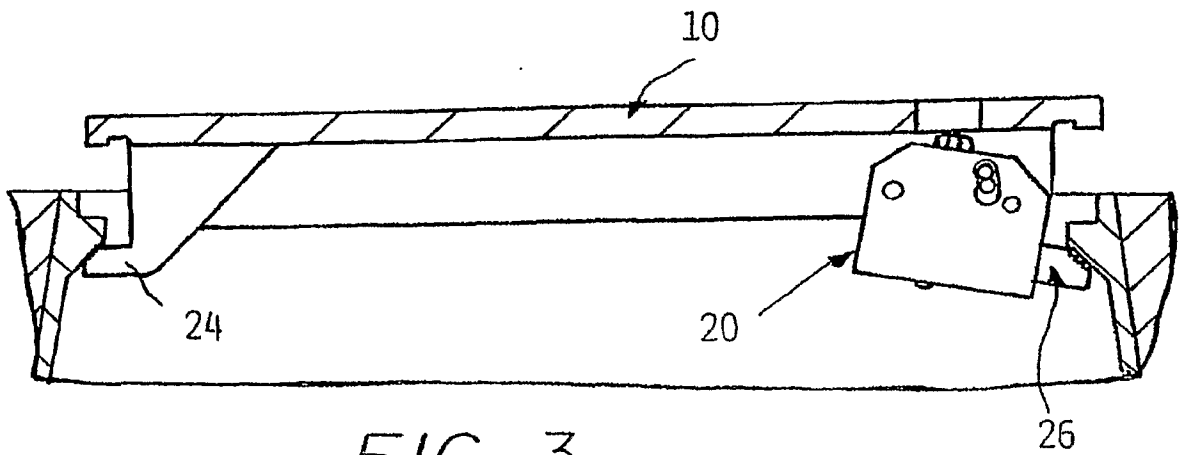


FIG. 3

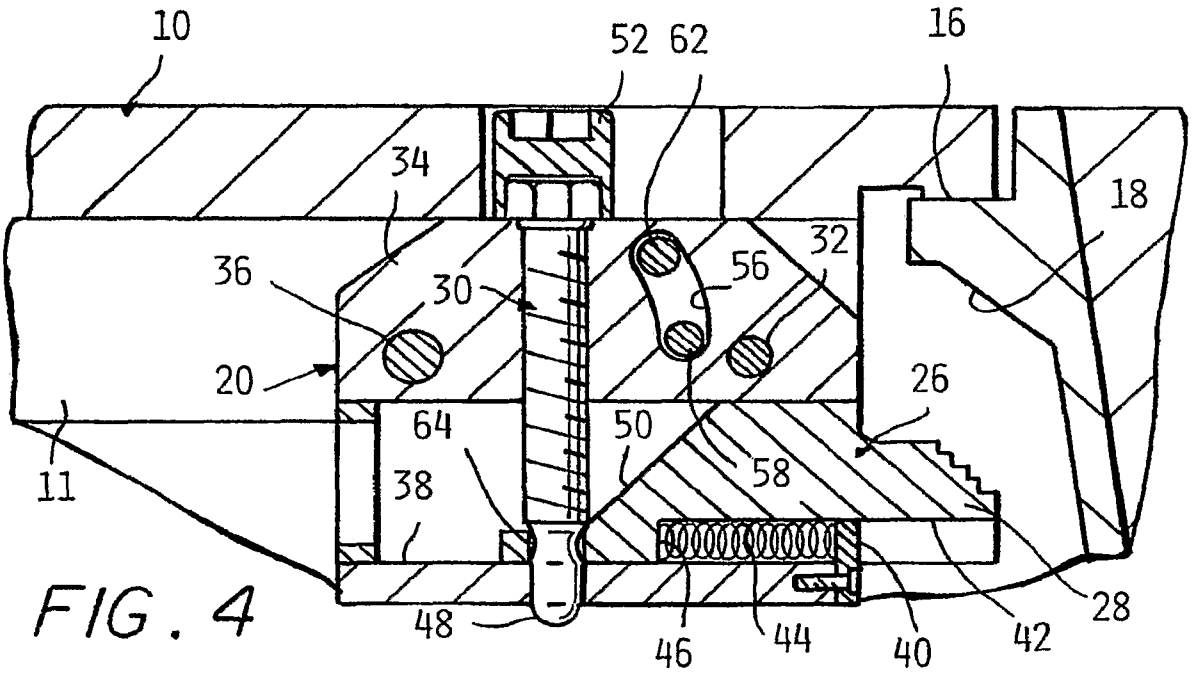

10
52 62
16
34
18
36
30
32
56
20
26
64
50
11
38
58
48
46
44
40
42
28

FIG. 4

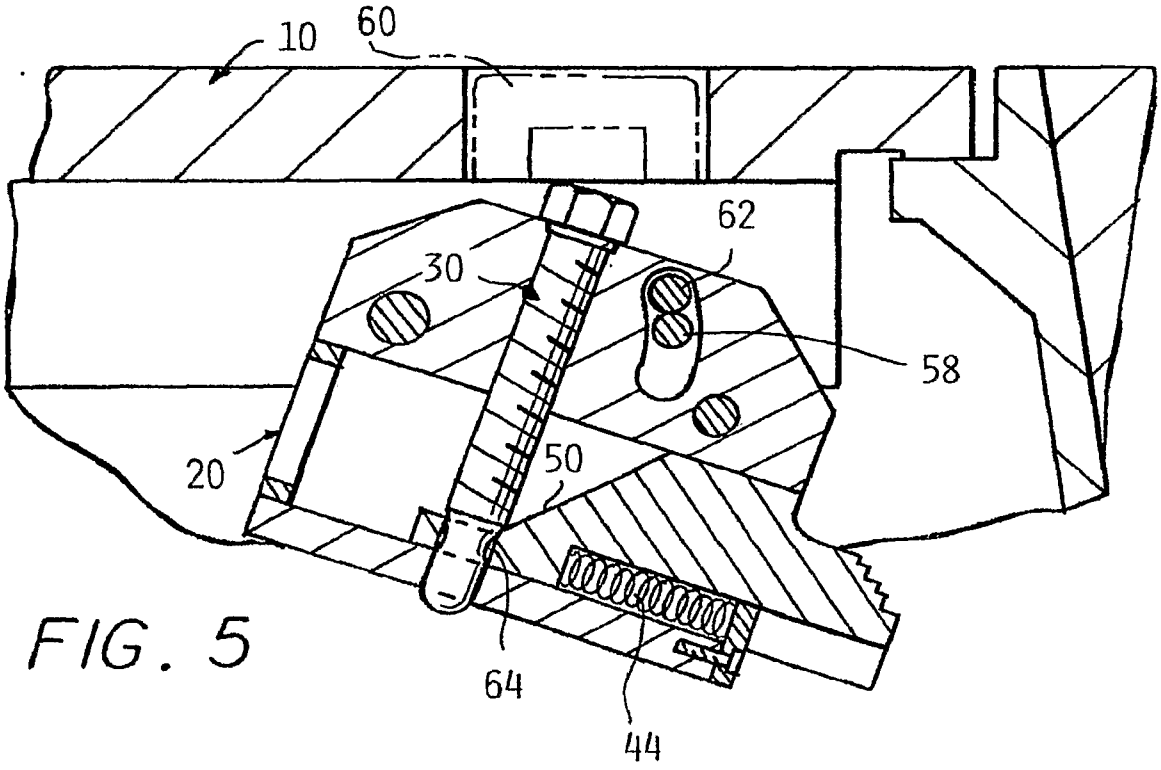

10
60
62
30
58
20
50
64
44

FIG. 5

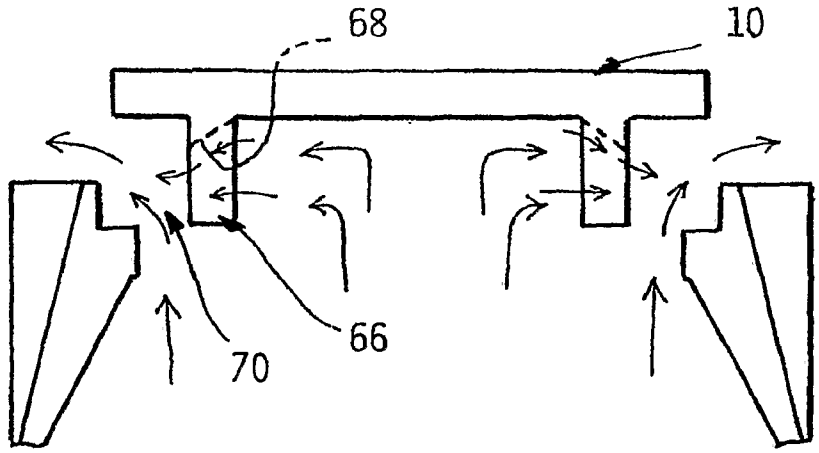


FIG. 7

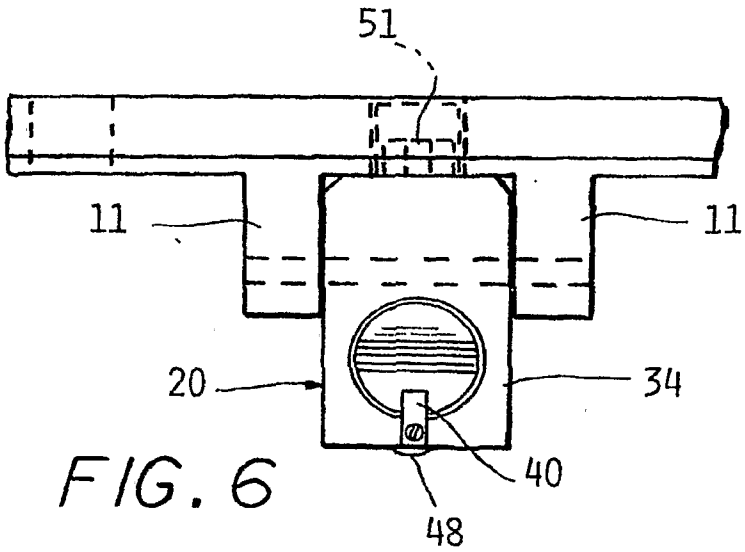


FIG. 6

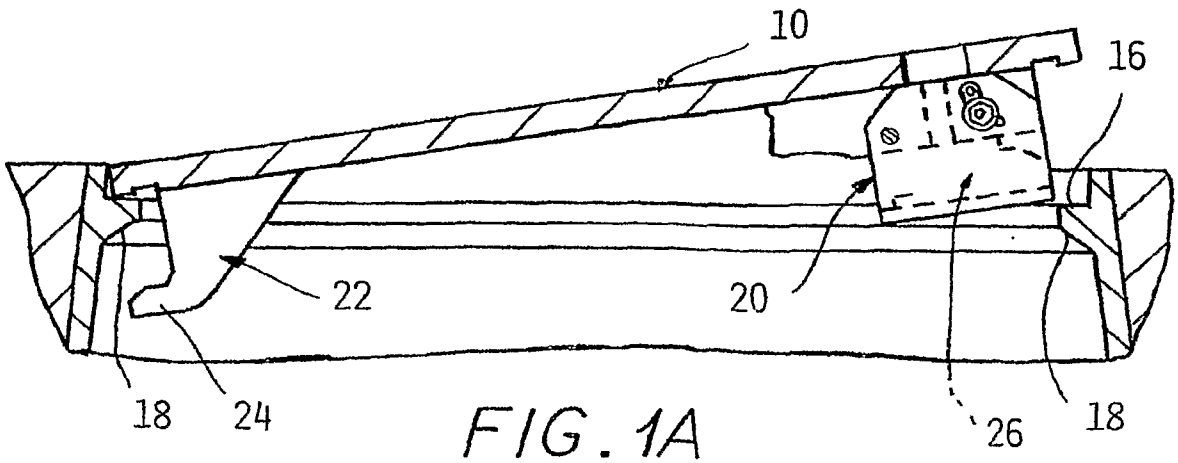


FIG. 1A

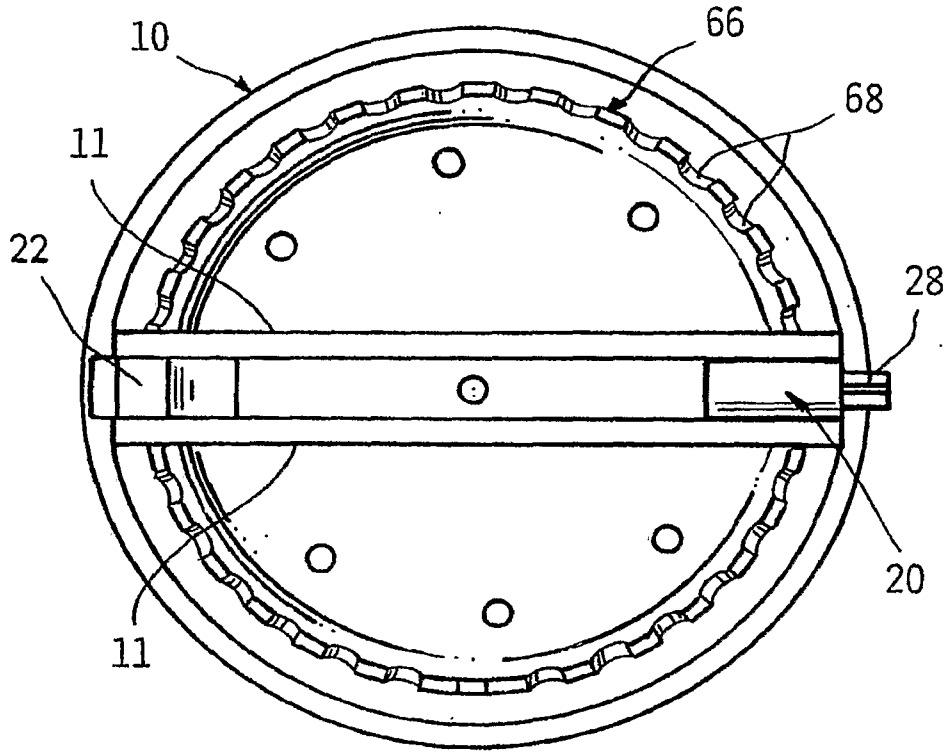


FIG. 8

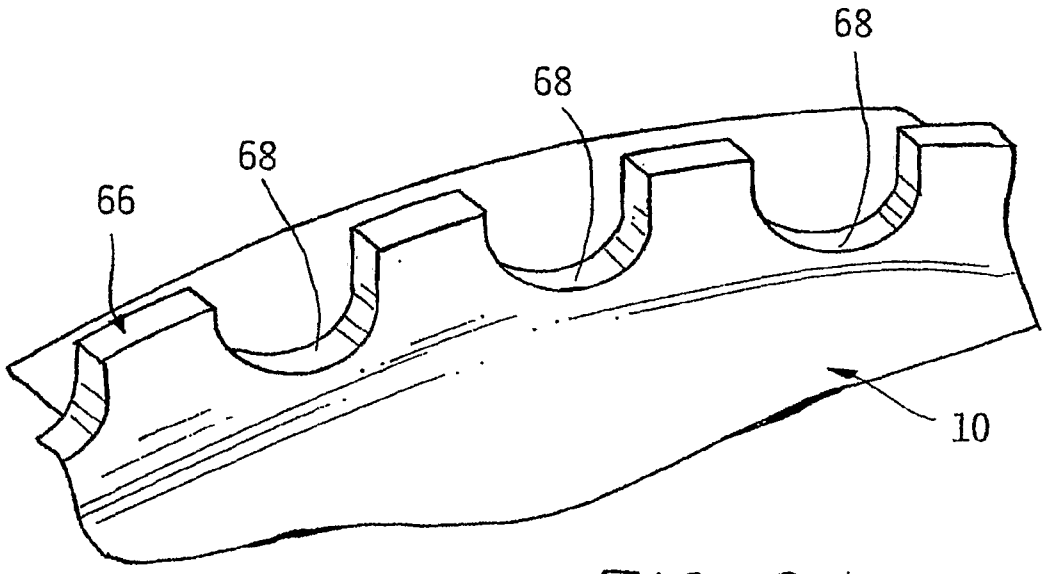


FIG. 9

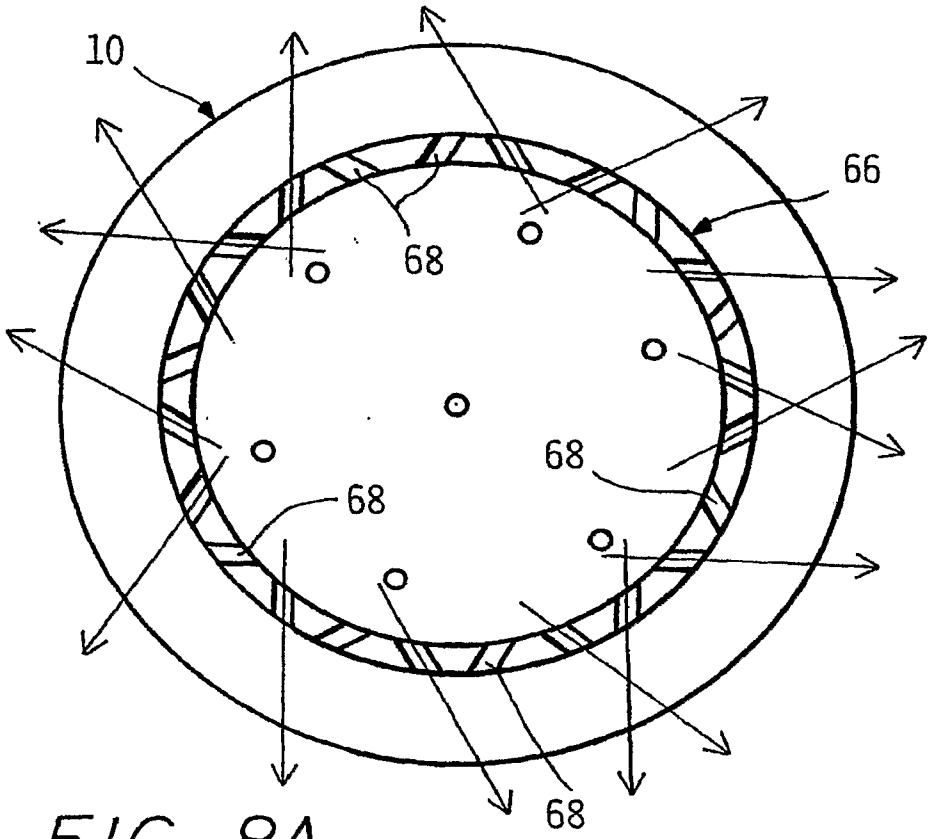


FIG. 8A

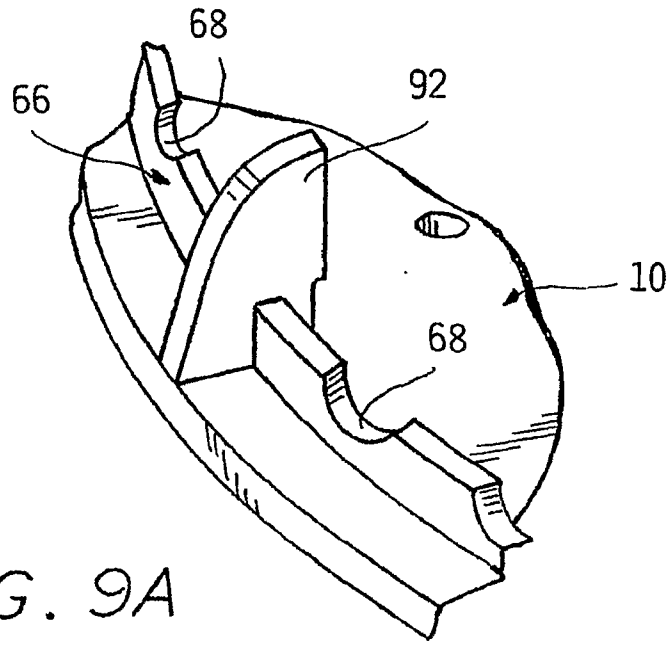


FIG. 9A

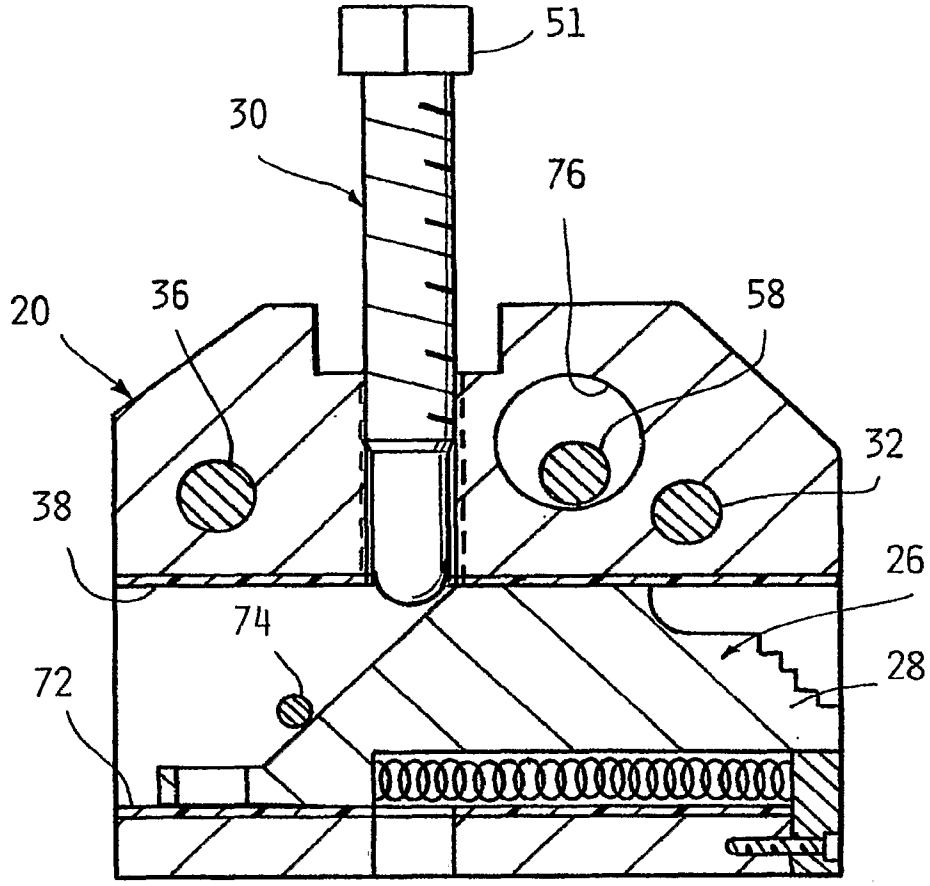


FIG. 10

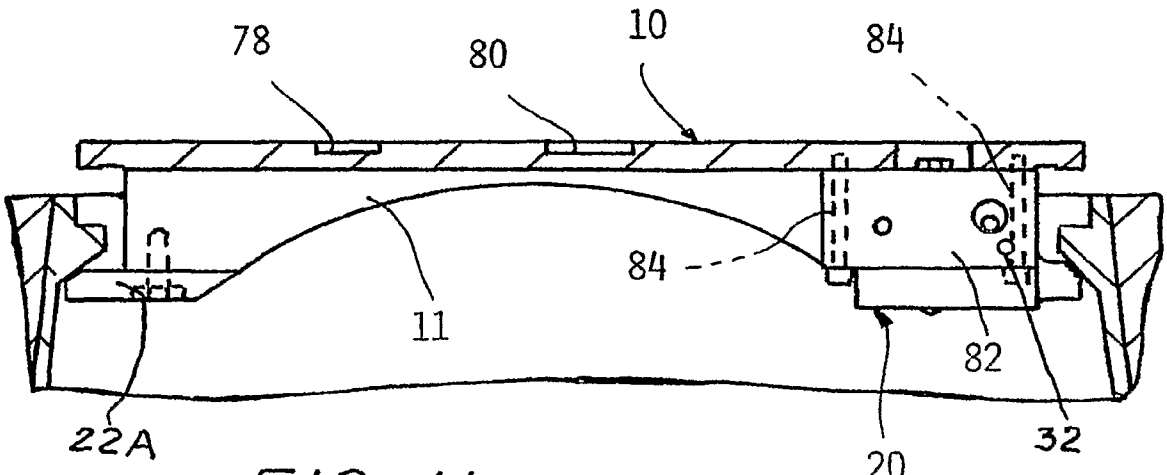


FIG. 11

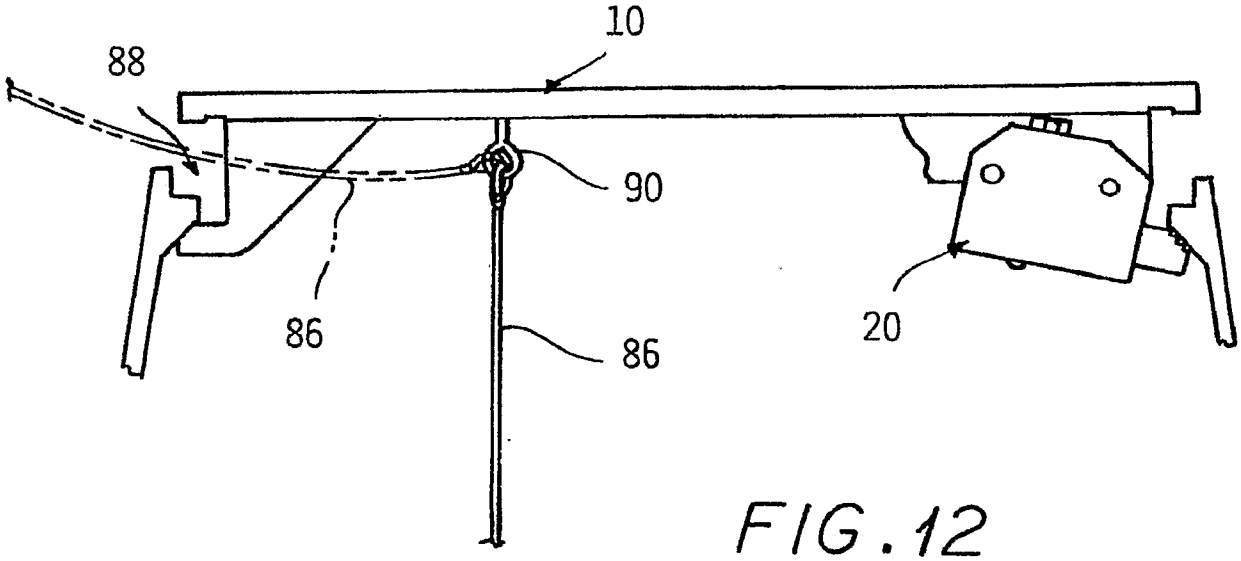


FIG. 12

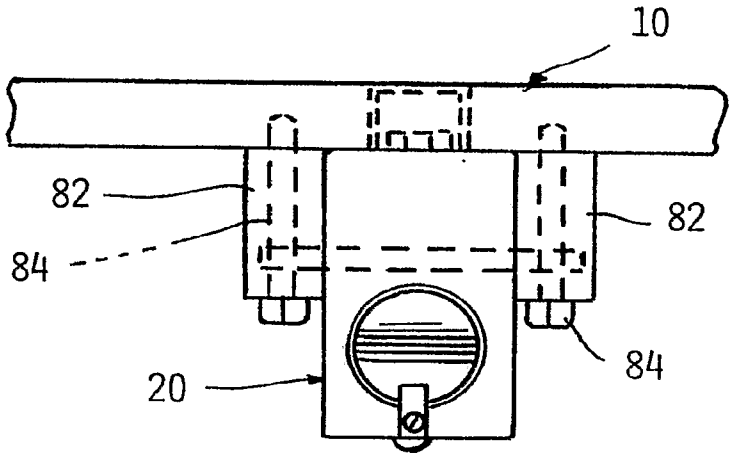


FIG. 13

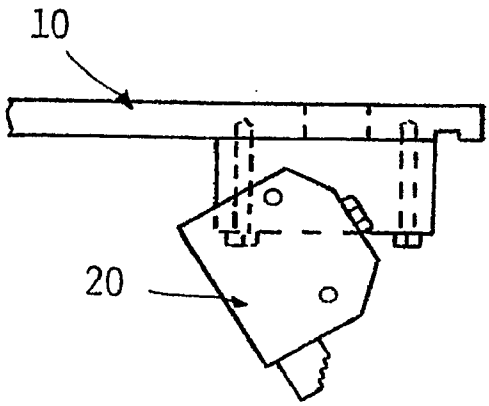


FIG. 14