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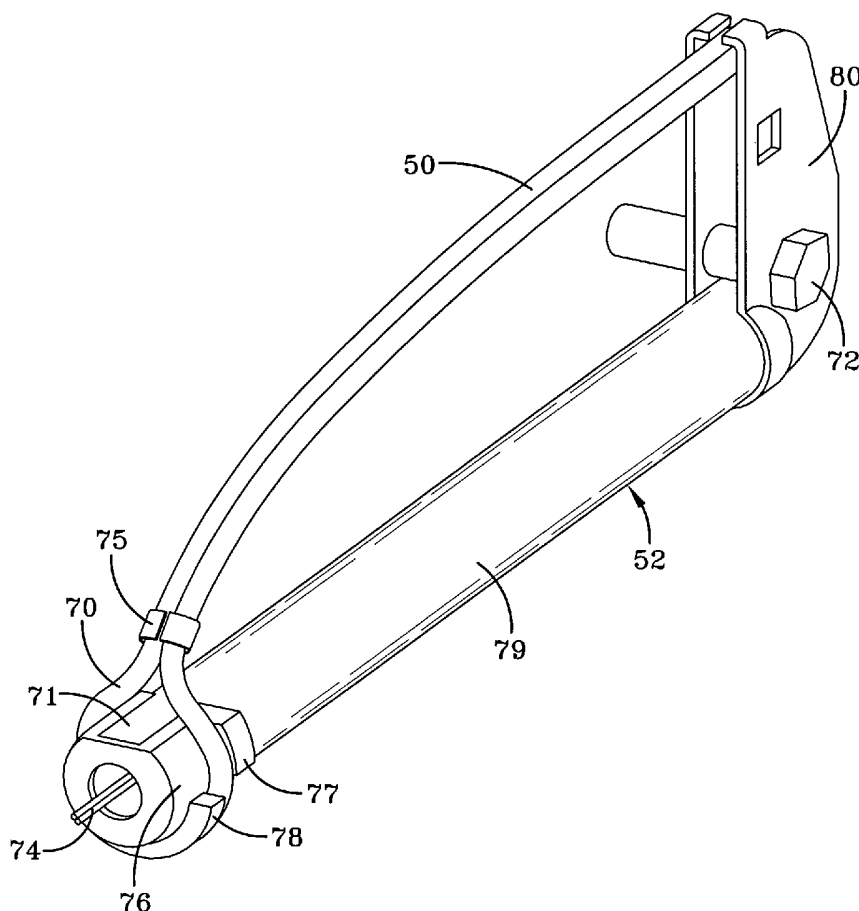
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(54) Title: SEAT BELT PRETENSIONER



(57) Abstract: A pretensioner for a three point seat belt has a cylinder (79) adapted to be attached to a structural member of the vehicle and a piston disposed within the cylinder (79). The piston can move translationally relative to the cylinder (79) in a pretensioning direction. A flexible member (50) is arranged in a curved profile with a seat belt webbing being attached to the flexible member. The flexible member (50) has a first end that can be pulled by the piston and a second end releasably connected to an exterior of the cylinder (79) such that when the piston moves translationally relative to the cylinder (79) the second end of the flexible member (50) moves translationally relative to the cylinder (79) along the exterior of the cylinder (79).



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SEAT BELT PRETENSIONER

The present invention relates to a pretensioner for a vehicle seat belt.

A seat belt comprises a length of seat belt webbing connected at three points to load bearing parts of a vehicle. One end is bolted to a door sill on one side of the seat, and is arranged to pass laterally across the hips of a vehicle occupant to a buckle mechanism fixed to the vehicle on the opposite side of the seat, and then diagonally across the torso of the vehicle occupant to a further fastening point on the B pillar of the door. The buckle mechanism engages a buckle tongue slideably attached to the webbing.

To increase the comfort of the vehicle occupant restrained by the seat belt a retractor is attached to the pillar end of the webbing. The retractor is biased to keep the webbing relatively taut about the vehicle occupant. A locking element locks the retractor against webbing pay out in a crash. A pretensioner can rapidly pull in any slack that may have developed in the seat belt to tighten the seat belt about the vehicle occupant in a crash. This more correctly positions the vehicle occupant in the seat to maximize the seat belt protection and of any secondary safety restraint such as an airbag.

Pretensioners use a force reservoir such as a pyrotechnically operated gas generator to provide an impulse of sufficient magnitude to tighten the seat belt. A typical known pretensioner may use rotational means to wind in belt webbing by rotating the retractor spool in a webbing rewind direction.

Pretensioners tend to be bulky, and are particularly difficult to use for the driver and front passenger seats of two-door vehicles because of the need for access to the rear of the vehicle past the front seats. A traditional retractor pretensioner mechanism in a front seat of a two-door vehicle causes an unacceptable obstruction.

Seat travel is greater in a two-door vehicle than in a four door vehicle to provide access to the rear seat and to accommodate this the door sill end of the webbing is usually attached to a so-called slider bar instead of being bolted to the floor. This allows the sill end of the webbing to be moved longitudinally forward and rearward to facilitate rear seat access and front

seat movement. The present invention provides an improved pretensioning mechanism that can be used in two-door, front seat applications.

According to the present invention there is provided a pretensioner for a three point seat belt comprising: a cylinder that can be attached to a structural member of a vehicle and a piston disposed within the cylinder. The piston can move in the cylinder in a pretensioning direction. A flexible member that is arranged in a curved profile with a seat belt webbing attached to the flexible member. The flexible member has a first end that can be pulled by the piston and a second end releasably connected to an exterior of the cylinder such that when the piston moves relative to the cylinder the second end of the flexible member also moves relative to the cylinder along the exterior of the cylinder.

Fig. 1 is a schematic side elevation view of a pretensioner according to a first embodiment of the invention.

Fig. 2 is an enlarged side elevation view of part of the pretensioner of Fig. 1 before pretensioning.

Fig. 3 is an enlarged side elevation view of part of the pretensioner of Fig. 1 after pretensioning.

Fig. 4 is a side elevation view of an alternative arrangement of the pretensioner of Fig. 1.

Fig. 5 is an exploded perspective view of the carriage and rail components the pretensioner of Fig. 1.

Fig. 6 is a schematic side elevation view of a second embodiment.

Fig. 7 is a side elevation view of a third embodiment.

Fig. 8 is a perspective view of the pretensioner of Fig. 7.

Fig. 9 is a perspective view of a fourth embodiment.

In Fig. 1, a slider bar 10 is positioned adjacent to a front seat 12 of a vehicle with an end of the seat belt webbing 14 passing around the slider bar 10 and is free to move back and forth along the slider bar 10.

The seat belt webbing 14 is of a conventional design and is attached at one end to a retractor mounted, adjacent a seat, to a structural member of the vehicle such as a vehicle side pillar (not shown). Webbing passes through a

shoulder support attached to the side pillar and has a buckle tongue, which is insertable into a buckle (not shown) located on the other side of the seat.

When in use, the seat belt webbing 14 is at one end of the slider bar 10 in the load bearing position shown in Fig. 1. When the seat belt is not in use the end of the webbing 14 may be moved in a rearward direction along the slider bar 10 so that it does not obstruct access to the rear seat of the vehicle.

As used herein and in the claims directions and positions such as "rearward" and "forward" are understood to be relative to the front and rear of a vehicle in which a seat belt system and pretensioner are installed.

One end of the slider bar 10 is attached to a carriage 16 that is mounted on a rail 18. The use of a rail is particularly beneficial since the pretensioning action can be constrained to a linear motion in one direction in a simple manner and without the need for complicated or bulky rotating parts. A cable 20 extends between the carriage 16 and a pyrotechnic unit 22. The pyrotechnic unit 22 contains a piston within a cylindrical housing and a gas generator. The gas generator is pyrotechnically activated to provide an impulse that forces the piston in a rearward direction and tensions the cable 20. The pyrotechnically operated gas driven piston-cylinder arrangement functions as a force reservoir. A pyrotechnic unit is particularly suited to this application since it provides an impulse of the required magnitude over a short time period. Positioning the piston and cylinder below the rail advantageously reduces the overall size of the pretensioner. The piston-cylinder arrangement may incorporate means to allow the second member to only move in a pretensioning direction, for example by ratchet teeth on the inside of the cylinder and at least one cooperating tooth on the piston.

Fig. 2 shows one arrangement of the carriage 16 and the rail 18 in greater detail. The rail 18 is attached at each end to support members 26 that are attached to a load bearing chassis member 24 by means of bolts 28. Such a load bearing chassis member 24 may be a structural member extending in a longitudinal direction down each side of the vehicle, or a load

bearing door sill and provides a suitable load bearing anchorage zone for the slider bar 10 adjacent to and slightly to the rear of each of the vehicle doors.

Prior to pretensioning, the carriage 16 is positioned for normal use of the seat belt webbing 14 at its forward most position, at the right hand side as shown in Fig. 2 of the rail 18. Upon sensing an acceleration of the vehicle above a predetermined criteria, a crash sensor generates a signal indicative of a crash condition which causes the pyrotechnic unit 22 to fire, creating a tension in the metal cable 20. Advantageously the crash sensor is activated when the vehicle exceeds a predetermined acceleration or deceleration threshold. The tension in the cable 20 pulls the carriage 16 and the slider bar 10 in a rearward direction i.e. the direction indicated by an arrow A in Fig. 2. The carriage 16 can be arranged to move rearwardly a distance in the region of 50 to 150 mm depending on the vehicle size and requirements.

The sudden movement of the slider bar 10 in a rearward direction provides tension in the seat belt webbing 14, which takes up any slack in the webbing 14 and pulls a vehicle occupant backwards into the seat 12 to correctly position the vehicle occupant within the seat 12 to maximize the benefit of the seat belt and correctly position the vehicle occupant for maximum effect of any secondary restraint such as an air bag.

Fig. 3 shows the position of the carriage immediately after pretensioning. After the pyrotechnic unit has fired, the carriage 16 is prevented from returning to its original position under the forward momentum of the vehicle occupant during a crash, by a ratchet mechanism within the carriage forming the second member 16. This ratchet mechanism is shown in Fig. 5.

Fig. 5 is an exploded view showing the ratchet mechanism. The rail 18 is attached at each of end to respective support members 26 by bolts 36 passing through cylindrical holes 38 at each end of the rail 18. The bolts 36 are secured with appropriate washers or spacers 55 and nuts 56. Locking ratchet teeth 30 are formed in one surface of the rail 18. The carriage 16 has two end plates 40 and a base plate 42 attached to a

side wall 44. A locking lever 32 extends from the base plate 42. Each of the end plates 40 and the locking lever 32 have a slot, allowing the rail 18 to pass through the center of the carriage 16.

An inner surface of the locking lever 32 is in contact with the teeth 30 in the surface of the rail 18 and is orientated at an angle such that the locking lever 32 can pass over the teeth 30 in one direction. The locking lever 32 is biased such that if it tries to move in the opposite direction, a locking edge of the inner surface of the locking lever 32 will be caught against a tooth 30 on the upper surface of the rail 18 and thus prevents the carriage 16 from sliding in a reverse direction. To facilitate this the teeth 30 may have a saw-tooth form. Locking the pretensioner against return movement prevents a loss of tension in the seat belt after pretensioning has been carried out.

The slider bar 10, the carriage 16 and ratchet mechanism, the rail 18, the support members 26 and the bolts 28, 36 and 46 are all preferably made of metal. Ratchet mechanisms are known for different seat belt restraint applications and so the pretensioner of the present invention can advantageously be constructed using standard parts and manufacturing processes, and thus offers a relatively low cost locking mechanism. The ratchet mechanism and the carriage 16 may be formed from parts of a height adjuster traditionally used to alter the height of the belt shoulder support.

In Fig. 4 the pyrotechnic unit is stored beneath the rail 18 and the bolts 36 and corresponding holes 38 in the rail may be used to fix the pyrotechnic unit 22 in relation to the rail 18. The operation of the pretensioner in Fig. 4 is substantially the same as that shown in Fig. 1, except that the cable 20 bends 180° to compensate for the different orientation of the pyrotechnic unit 22.

According to the further embodiments that are described below the slide bar function is carried out by having the seat belt webbing connected to an elongate flexible member such as, for example, a cable, around which the seat belt webbing passes. One end of the cable is moveable and the other end is fixed. The flexible member preferably is a loop, in the general form of a slider bar, to provide the flexibility of movement for the webbing and access to the rear of a vehicle, required in two-door applications.

Fig. 6 shows the slider bar of the first embodiment is replaced by a flexible cable 50. The flexible cable 50 preferably forms a loop, in the general form of a slider bar, to provide the flexibility of movement for the seat belt webbing and access to the rear of a vehicle, required in two-door vehicle applications. The flexible cable may be directly attached to, or form at least a part of, the piston of the piston-cylinder arrangement which is preferably operated pyrotechnically. This embodiment can provide an even more space saving alternative for two-door applications of pretensioners.

Seat belt webbing (not shown) is looped round the cable 50 in the same manner as with the slider bar 10 of Fig. 1 and the cable provides similar range of movement for the webbing mounting, and at least the same degree of access to the rear seats of the vehicle.

One end 51 of the cable 50 is attached to a structural member of the vehicle, such as the sill, and the other end is attached to a piston 53 of a piston-cylinder pyrotechnic unit 52 which is attached to a structural member of the vehicle such as the floor of the vehicle, particularly to retain the door profile and avoid inhibiting access through the door.

The cable 50 forms a loop profile as shown and can be encouraged to hold such a profile in normal use by retaining clips or by an elastomeric plastic coating. A flexible elastomeric plastic tube may cause the cable 50 to increase its stiffness to the appropriate degree.

When a crash sensor indicates that a sudden deceleration or acceleration is taking place, the pyrotechnic unit 52 is activated to release gas to push the piston along the cylinder in the direction indicated by the arrow A, causing the cable 50 to retract to the profile indicated by the broken line 50'. This causes the seat belt webbing mounted on the cable 50 to be pulled in the direction indicated by the arrow A thus effecting the required pretensioning. A ratchet or other form of non-return mechanism may be built into the pyrotechnic unit 52.

Fig. 7 is a side elevation view of a pretensioner according to a third embodiment of the present invention. Fig. 8 is a perspective view of the pretensioner of Fig. 7. The cable may be a double cable, looped over the end

of the cylinder and attached at the end in a releasable manner, for example by a member that shears, or by a mechanically releasable means. In this third embodiment a cable 50 is attached to the piston at one end of the cylinder of the pretensioner, and this cable is attached to the other end 71 of the cylinder. In this embodiment the cable 50 is folded to form a double cable and the free end is formed as a loop 70 which extends around the cylinder 79 of the pyrotechnic unit 52 and is hooked over an end 71 of the cylinder of the pyrotechnic unit. The loop 70 is secured around the cylinder 79 by a frangible or mechanically releasable means for securing which in Figs. 7 and 8 is shown as a plastic attachment 76 mounted over the end 71 of the cylinder 79 with restraining abutments 77, 78 on either longitudinal side of the cable 50. As used herein and in the claims with respect to the restraining abutments "longitudinal" is understood to refer to the longitudinal axis of the cylinder 79. One of the abutments 77 shears when the cable 50 applies more than a predetermined force, releasing the loop 70 to slide along the cylinder of the pretensioner. Other suitable forms of means for securing the loop 71 to the end of the cylinder will be evident to a person skilled in the art.

In Fig. 7 the pyrotechnic unit 52 is attached to a structural member of a vehicle, such as a door sill or other load bearing beam, by a fastener 72, such as a threaded fastener, that extends through a first mounting member 80 located at the piston end of the cylinder 79 and a second mounting member (shown in Fig. 9) located at the other end 71 of the cylinder. According to a preferred embodiment, the structural member of the vehicle is a longitudinal chassis member such as the front door sill. The second mounting member, such as a structural member of the vehicle or a bracket bolted to the vehicle body, fits into the end of the cylinder to fix the pretensioner to the car in a load bearing manner. The second mounting member must withstand loads of around 15 kn, as specified in the standard vehicle anchorage pull test known as the R14 test. Suitable second mounting members will be evident to persons skilled in the art, and one is shown in Fig. 9 described below.

The cable loop 70 may be encased in a plastic tube allowing the cable loop to more easily slide along the cylinder 79. In addition a tie or clamp or

plastic tube 75 encases a section of the cable to maintain the shape of the loop 70 by holding the double cable together. This plastic tube 75 may be longer than illustrated in Figs. 7 and 8 to protect the fabric of a seat belt from chaffing by the cable. A pair of wires 74 is shown exiting from the end 71 of the cylinder 79. These wires are for actuation of the pyrotechnic unit 52 located inside the cylinder 79 and could exit the cylinder at another point.

In Fig. 9 a fourth embodiment is shown in which the cable 50 is a single cable and is attached to a carriage 90 that will slide along the cylinder 79 when the pretensioner is activated. The cable 50 is attached to the carriage 79 by welding the cable into a clamp or housing 91 mounted on the carriage 90. The carriage 90 is retained at the end 71 of the cylinder 79 by a tongue 92 on the carriage 90 fitting into a recess 93 of the cylinder 79. When the pyrotechnic unit 52 located inside of the cylinder 79 is activated, the pull on the cable will be sufficient to shear this tongue 92 and allow the carriage 90 to travel along the cylinder 79, pulling the seat belt in a pretensioning direction. Alternatively the tongue 92 can be arranged to bend to effect release of the carriage from the recess 93. A further alternative would be to use a mechanically releasable mechanism. In Fig. 9 the second mounting member is a bracket 94 fitting into an end of the cylinder 79, which can be bolted or screwed to a structural member of the vehicle. A carriage mechanism similar to that illustrated in Fig. 5 could be used.

Elements of the described embodiments may be combined. For example the cable 50 could be attached to an arrangement such as the carriage 16 sliding on the rail 18, of Fig. 1. The pyrotechnic unit 52 could then be connected to the carriage 16 by another cable such as 20 in Fig. 1 and be mounted either in line with, or below, the rail 18. Pretensioners according to the invention having reduced or eliminated obstruction to rear seat access, smaller package sizes and are attached to an appropriate door sill anchorage zone.

CLAIMS

1. A pretensioner for a three point seat belt comprising:
a cylinder (79) adapted to be attached to a structural member of the vehicle and a piston disposed within the cylinder (79);
a means for moving the piston translationally relative to the cylinder (79) in a pretensioning direction; and
a flexible member (50) that is arranged in a curved profile with a seat belt webbing being attached to the flexible member, the flexible member (50) having a first end that can be pulled by the piston and having a second end releasably connected to an exterior of the cylinder (79) such that when the piston moves translationally relative to the cylinder (79) the second end of the flexible member moves translationally relative to the cylinder (79) along the exterior of the cylinder (79).
2. A pretensioner for a three point seat belt according to claim 1 wherein the flexible member is a cable (50).
3. A pretensioner for a three point seat belt according to claim 1 wherein a loop (70) is located at the second end of the flexible member (50), the loop (70) extending around the exterior of the cylinder (79), the loop (70) being secured to the cylinder (79) by a frangible member (71) or by a mechanically releasable member.
4. A pretensioner for a three point seat belt according to claim 2 wherein a loop (70) is located at the second end of the cable (50) the loop (70) extending around the exterior of the cylinder (79), the loop (70) being secured to the cylinder (79) by a frangible member (71) or by a mechanically releasable member.
5. A pretensioner for a three point seat belt according to claim 1 wherein the second end of the flexible member (50) is attached to a

carriage (90), the carriage (90) being configured to move along the exterior of the cylinder (79), the carriage (90) secured to the cylinder (79) by a frangible member (92) or by a mechanically releasable member.

6. A pretensioner for a three point seat belt according to claim 2 wherein the second end of the cable (50) is attached to a carriage (90), the carriage (90) being configured to move along the exterior of the cylinder (79), the carriage (90) secured to the cylinder (79) by a frangible member (92) or by a mechanically releasable member.

7. A pretensioner for a three point seat belt according to claim 5 or 6 further comprising a rail (18) that extends along the cylinder (79) and the carriage (90) is mounted for sliding movement on the rail (18).

8. A pretensioner for a three point seat belt according to claim 7 wherein the piston and the cylinder (79) are located below the rail (18).

9. A pretensioner for a three point seat belt according to claim 1 further comprising a means for restraining motion of the flexible member in a non-pretensioning direction.

10. A pretensioner for a three point seat belt according to claim 1 wherein the means for moving the piston is pyrotechnically activated.

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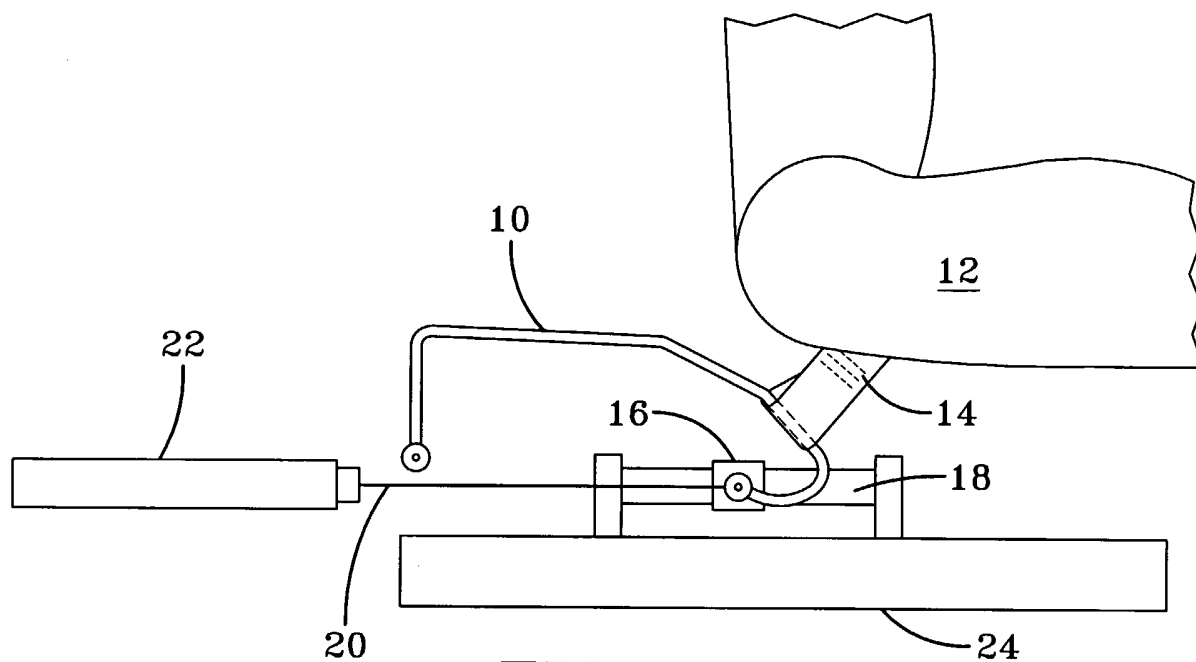


FIG-1

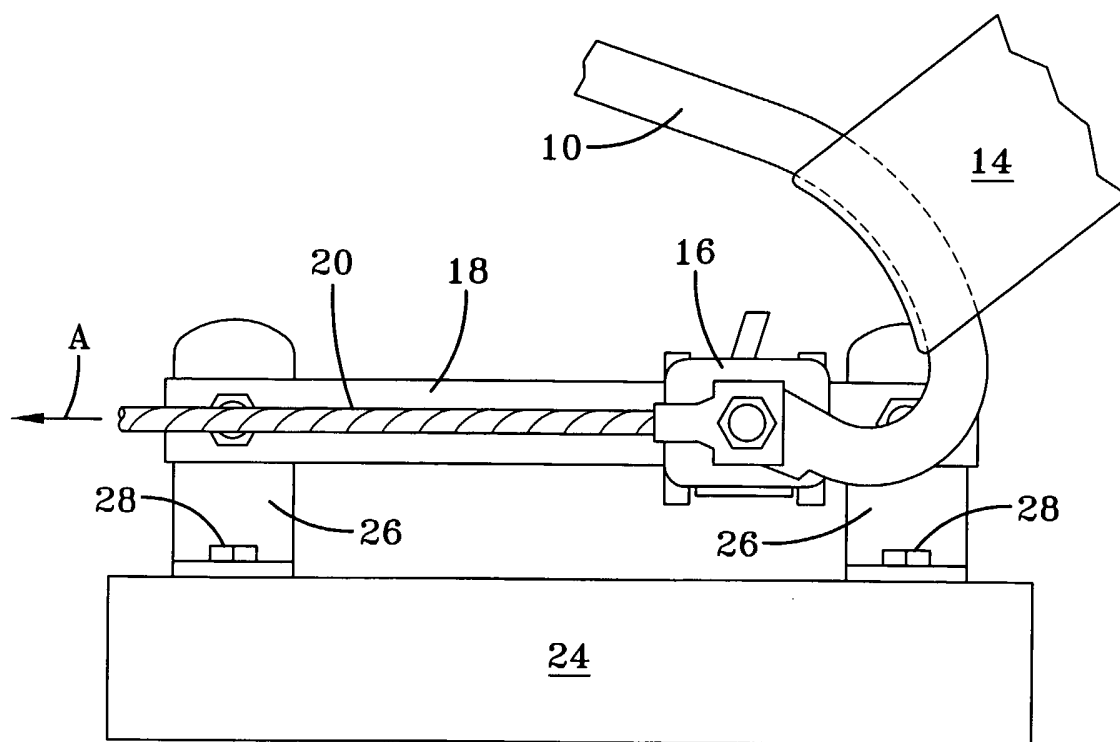


FIG-2

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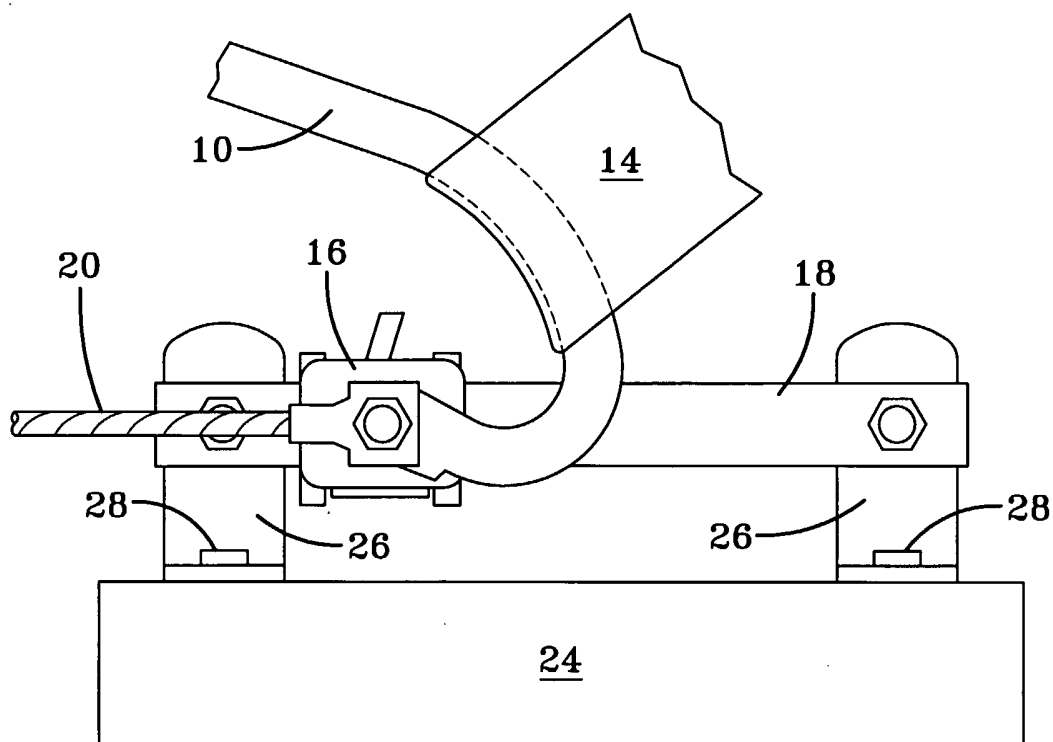


FIG-3

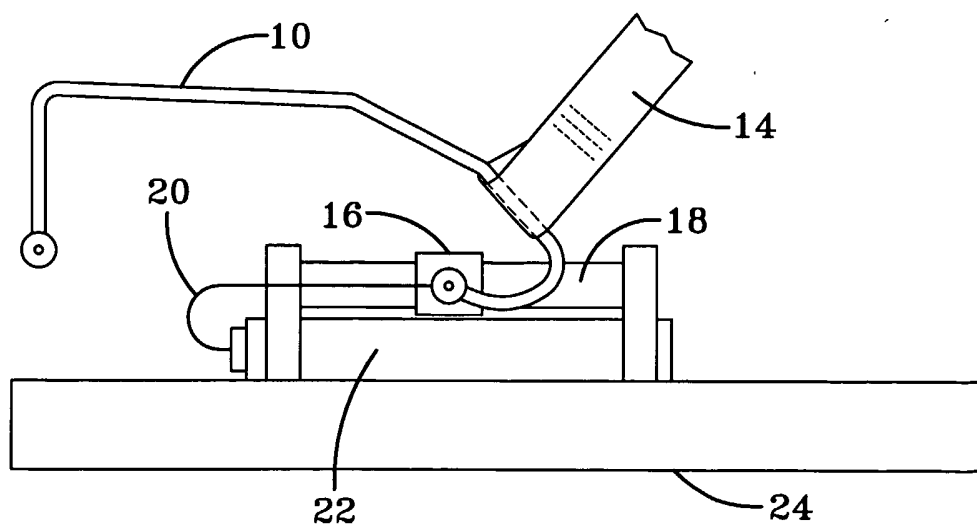


FIG-4

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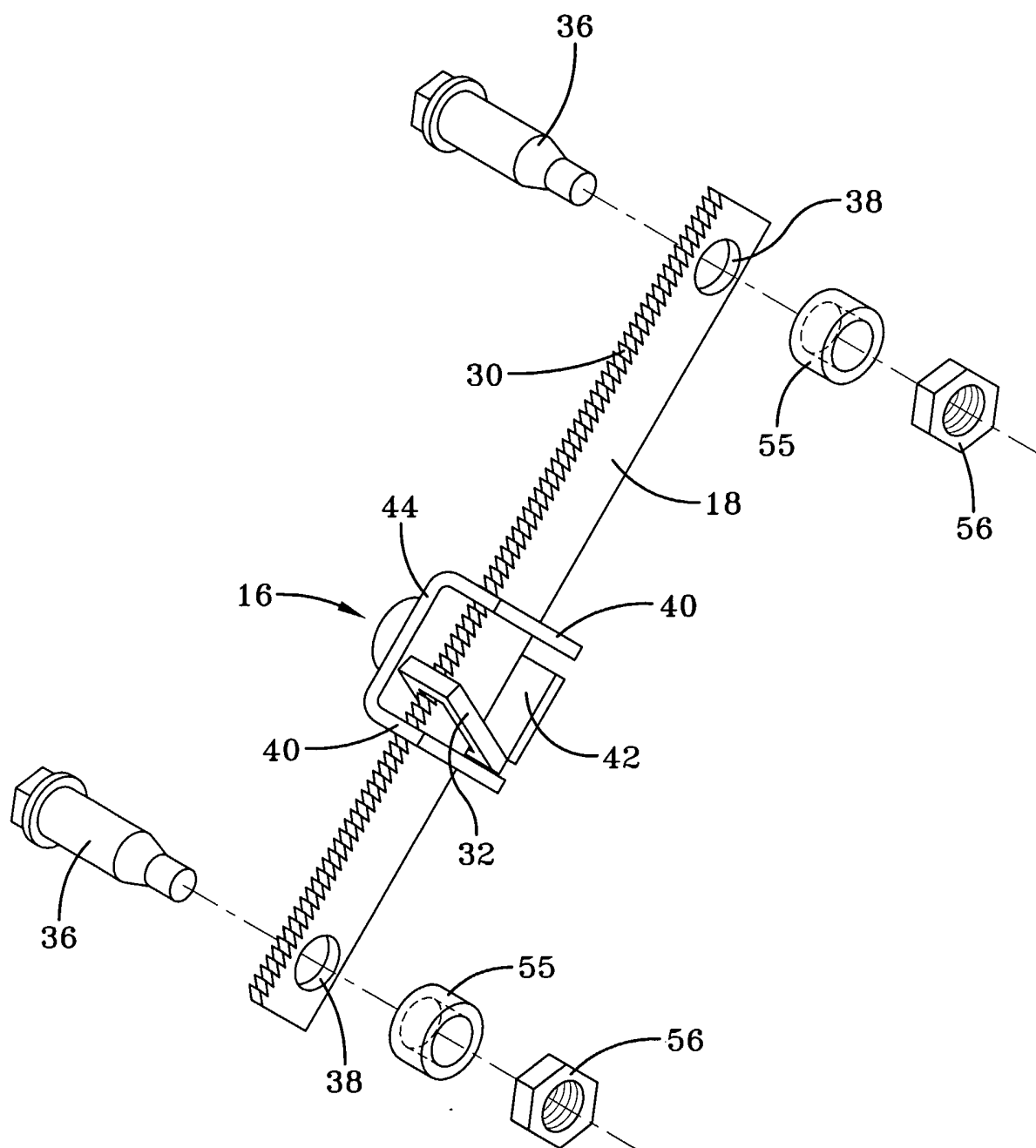


FIG-5

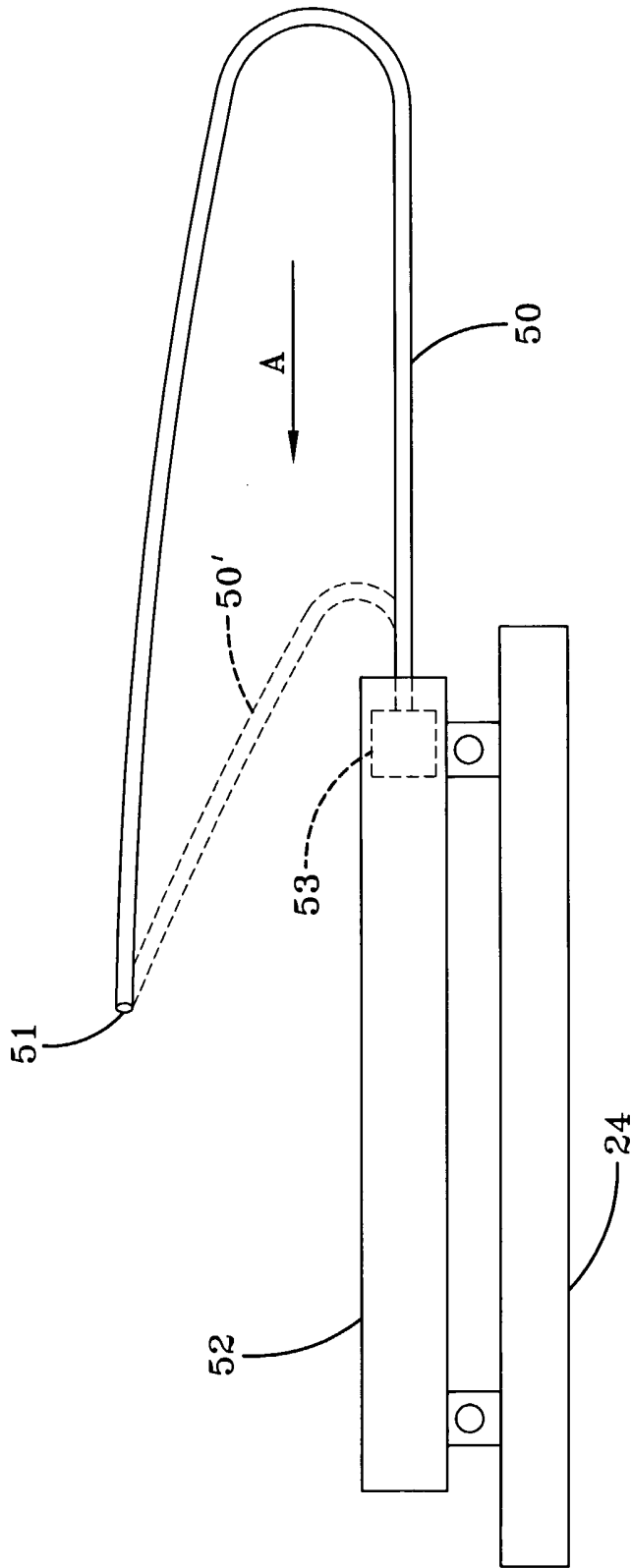


FIG-6

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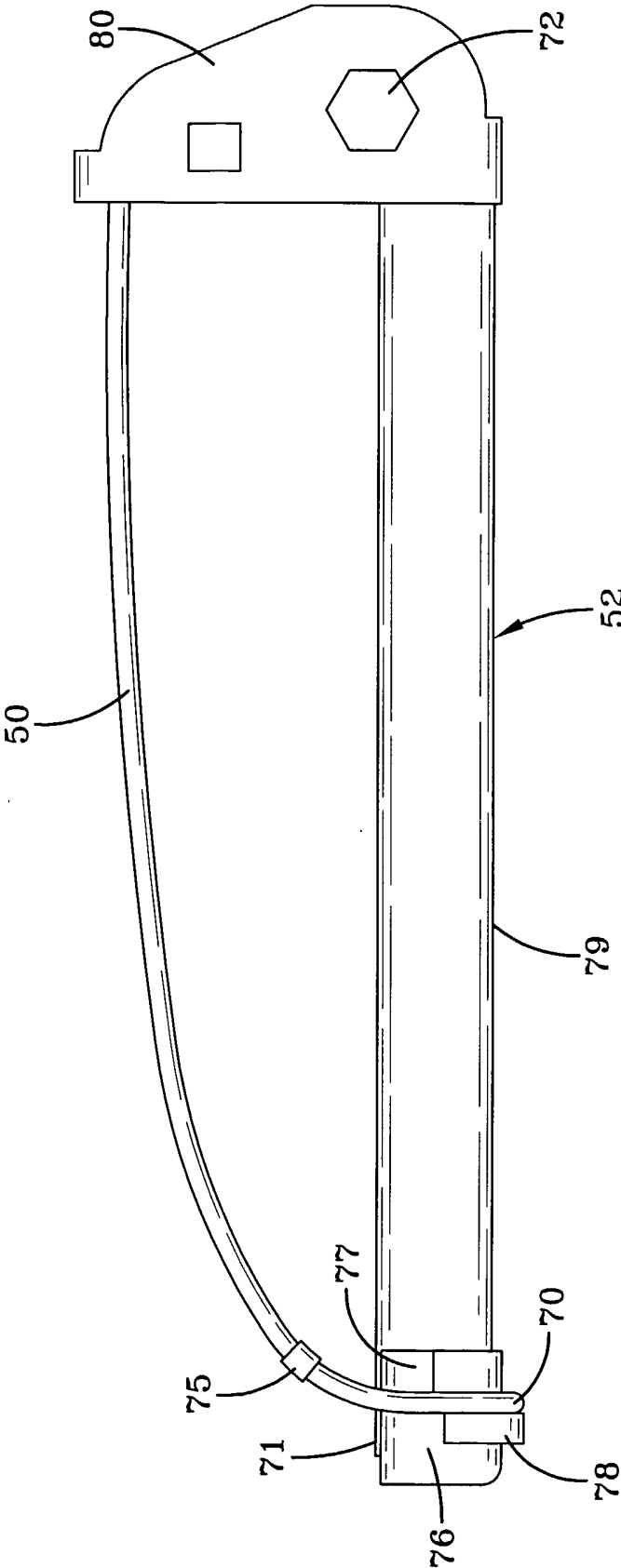
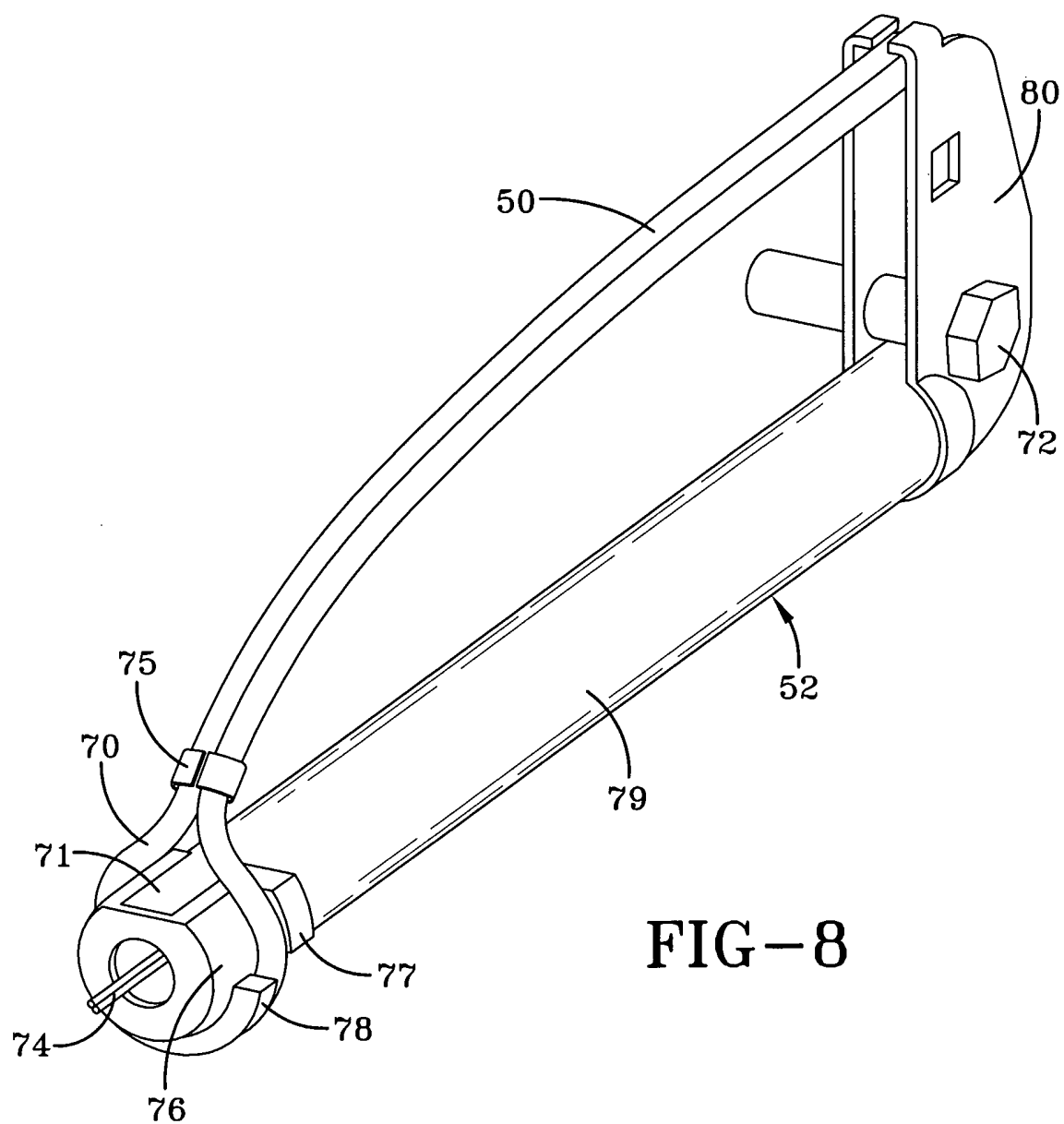


FIG-7

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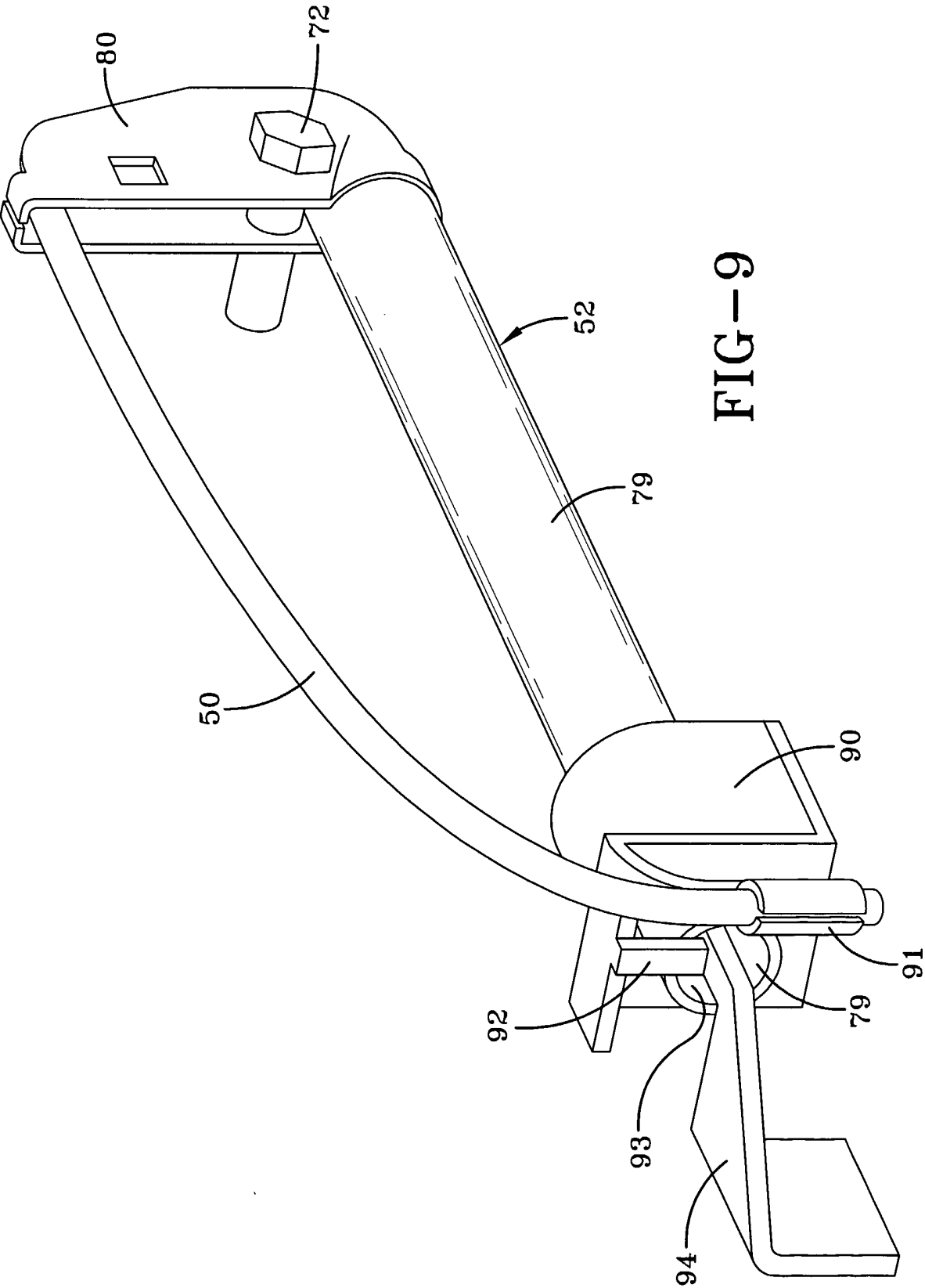


FIG-9