(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 045 718 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
30.04.2025 Bulletin 2025/18

(21) Application number: **20876431.6**

(22) Date of filing: **15.10.2020**

(51) International Patent Classification (IPC):
E01F 15/14 *(2006.01)* ***E01F 15/04*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
E01F 15/146

(86) International application number:
PCT/US2020/055797

(87) International publication number:
WO 2021/076767 (22.04.2021 Gazette 2021/16)

(54) CRASH IMPACT ATTENUATOR SYSTEMS

AUFPRALLDÄMPFER

SYSTÈMES D'ATTÉNUATEUR D'IMPACT DE COLLISION

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **15.10.2019 US 201962915592 P**
22.07.2020 US 202063054911 P

(43) Date of publication of application:
24.08.2022 Bulletin 2022/34

(73) Proprietor: **Traffix Devices, Inc.**
San Clemente, CA 92673 (US)

(72) Inventors:
- **MAUS, Geoffrey B.**
San Clemente, CA 92673 (US)
- **ALMANZA, Felipe**
San Clemente, CA 92673 (US)
- **KULP, Jack H.**
San Clemente, CA 92673 (US)

(74) Representative: **HGF**
HGF Limited
1 City Walk
Leeds LS11 9DX (GB)

(56) References cited:
EP-B1- 1 706 544
US-A1- 2001 014 254
US-A1- 2008 181 722
US-B2- 6 536 985
US-B2- 9 725 857
WO-A1-2018/151360
US-A1- 2008 085 153
US-B1- 6 461 076
US-B2- 6 905 281

EP 4 045 718 B1

Description

Background of the Invention

[0001] The present invention relates generally to crash impact attenuators, and more particularly to motor vehicle and highway barrier crash impact attenuators comprising fixed systems protecting leading edges of abutments and other fixed roadside hazards. A prior art crash attenuator is known from EP 1 706 544 B1.

[0002] Vehicular accidents on the highway are a major worldwide problem and are undoubtedly one of the largest causes of economic and human loss and suffering inflicted on the developed world today. In an effort to alleviate, in particular, the human toll of these tragic accidents, guardrails, crash cushions, truck-mounted crash attenuators, crash barrels, and the like have been developed to attenuate the impact of the vehicle with a rigid immovable obstacle, such as a bridge abutment.

[0003] A crash attenuator of the type described must absorb the vehicle impact energy without exceeding limits on the vehicle deceleration. In addition, it must accommodate both heavy and light weight vehicles. The lightest vehicle will set the limit on the maximum force produced by the attenuator and the heavy vehicle - which will experience a lower deceleration, and thus will determine the total impact deformation required. The force cannot exceed the light vehicle limit and therefore the initial force and deceleration is low, limiting the energy absorption. Increasing crash resistance as the vehicle "rides down" from its impact speed to zero is a vitally important feature of a crash attenuator system which meets rigid governmental safety standards. The present invention accomplishes this objective in an innovative, inexpensive, and very simple, but effective, manner.

[0004] The invention, together with additional features and advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying illustrative drawing.

Summary of the Invention

[0005] The present invention comprises, in one exemplary aspect, a crash attenuator system for deployment in front of a fixed structure, such as a bridge abutment. The system comprises a rail extending along a length of the crash attenuator system, a plurality of diaphragms initially disposed in spaced relation along the length of the rail, each of the plurality of diaphragms having a base end adapted to be movably engaged with the rail, so that when a front end of the crash attenuator system receives an impact force from an errant vehicle, a first one of the plurality of diaphragms moves rearwardly along the rail and impacts a second one of the plurality of diaphragms so that both the first and second ones of the plurality of diaphragms move further rearwardly along the rail, this process continuing with additional ones of the plurality of diaphragms until the impact forces have been fully attenuated. The system further comprises a tearing member on the crash attenuator system which is adapted to engage material forming a tearable member of the crash attenuator system, the tearing member and the tearable member being relatively movable when an impact force strikes the crash attenuator system so that the tearing member tears the tearable member, thereby increasing attenuation of the impact force.

[0006] The tearing member comprises a bolt, and is disposed on one of the plurality of diaphragms, such as on a base end of the first one of the plurality of diaphragms. The tearing member may comprise a plurality of tearing members.

[0007] The center rail extends along at least a portion of the length of the crash attenuator and includes a plurality of holes disposed therein, the plurality of holes extending along a length of the center rail and spaced lengthwise from one another. The bolt is engaged with one of the plurality of holes so that when an impact force is applied to the crash attenuator, relative motion occurs between the tearable member and the tearing member so that the relative motion causes the bolt to tear the material between adjacent ones of the plurality of holes, thereby creating a continuous slot, the tearing of the material functioning to attenuate the impact force.

[0008] In some embodiments of the invention, the holes are not evenly spaced along the length of the tearable member having the plurality of holes disposed therein. For example, adjacent ones of the plurality of holes nearer to one of the front and back ends of the crash attenuator may be more closely spaced than adjacent ones of the plurality of holes closer to the other of the front and back ends of the crash attenuator. In some circumstances, the plurality of holes are not uniform in size, respective to one another. For example, in the illustrated embodiment, the frontmost ones of the plurality of holes may be larger and more elongated than those of the plurality of holes which are located closer to the back end of the crash attenuator, though the directional orientation may be reversed depending upon application and desired attenuation characteristics.

[0009] In still other variants, the material forming the tearable member may be thinner toward one of the front and back ends of the crash attenuator, and thicker toward the other of the front and back ends of the crash attenuator. In any or all of the embodiments and variants discussed above, which may be utilized singly or in various combinations, the tearable member may comprise a plurality of stages as it extends from one of the front and back ends of the crash attenuator toward the other end of the front and back ends of the crash attenuator, wherein a first stage toward one of the front and back ends of the crash attenuator is softer than a second stage toward the other of the front and back ends of the crash attenuator.

[0010] In illustrated embodiments, the one of the front and back ends of the crash attenuator is the front end of the crash attenuator and the other of the first and second

ends of the crash attenuator is the back end of the crash attenuator.

[0011] The first stage may be softer because the material forming the first stage is thinner than the material forming the second stage. The first stage may also be softer because the holes of the plurality of holes which are disposed in the first stage are closer together than the holes of the plurality of holes which are disposed in the second stage. The first stage may be softer, as well, because the holes of the plurality of holes which are disposed in the first stage are larger in size than the holes of the plurality of holes which are disposed in the second stage.

[0012] According to the present invention, the rail comprises first and second outer rails spaced apart in a widthwise direction, and the tearable member comprises said center rail. A plurality of fender panels are disposed along each side of the crash attenuator along its length, wherein frontmost ones of the plurality of fender panels are adapted to slide alongside of rearmost ones of the plurality of fender panels when the crash attenuator is impacted by a vehicle. A nose box is disposed at the frontmost end of the crash attenuator. The tearable member is stationary and the tearing member moves responsive to the impact force, in particular embodiments, though this may also vary, depending upon design goals.

[0013] In another aspect of the disclosure, there is provided a crash attenuator system for deployment in front of a fixed structure, the system comprising a base portion having a first outer rail extending along a length of the base portion, a second outer rail spaced from the first outer rail and also extending along a length of the base portion, and a plurality of spaced cross-members extending across a width of the base portion and joining the first outer rail to the second outer rail. An upper attenuator portion comprises a plurality of diaphragms initially disposed in spaced relation along the length of the base portion. Each of the plurality of diaphragms has a base end adapted to be movably engaged with each of the first outer rail and the second outer rail, so that when a front end of the upper attenuator portion receives an impact force from an errant vehicle, a first one of the plurality of diaphragms moves rearwardly along the first and second outer rails and impacts a second one of the plurality of diaphragms, so that both the first and second ones of the plurality of diaphragms move further rearwardly along the first and second outer rails, this process continuing with additional ones of the plurality of diaphragms until the impact forces have been fully attenuated. A tearing member is disposed on the upper attenuator portion, which is adapted to engage material forming a tearable member of the upper attenuator portion, the tearing member and the tearable member being relatively movable when an impact force strikes the crash attenuator system so that the tearing member tears the tearable member, thereby increasing attenuation of the impact force.

[0014] In yet another aspect of the disclosure, there is disclosed a method of attenuating a crash impact force imposed by an errant vehicle which would otherwise strike an immovable object. The method comprises steps of receiving an impact force at a front end of a crash impact attenuator having a base portion and an upper attenuator portion and causing one or more members of the upper attenuator portion to move rearwardly along the base portion responsive to the impact force. A further step is one of causing a tearing member disposed on the crash impact attenuator to tear tearable material disposed on the crash impact attenuator as the one or more members of the upper attenuator portion move rearwardly, wherein tearing of the material acts to attenuate the impact force.

[0015] In certain variants of the method, the tearing member is a projection disposed on one of the one or more members of the upper attenuator portion, which is initially engaged with a hole formed in the tearable material. There are a plurality of holes in the tearable material, arranged longitudinally in spaced relation, and the tearing step comprises tearing the tearable material between the initially engaged hole and an adjacent one of the plurality of holes, to form a slot. The one or more members of the upper attenuator portion comprise one or more diaphragms, and the tearable material comprises a rail forming a part of the base portion.

[0016] The invention, together with additional features and advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying illustrative drawings.

Brief Description of the Drawings

[0017]

Fig. 1 is an isometric view of an exemplary embodiment of a crash attenuator constructed in accordance with the principles of the present invention, disposed in a deployed orientation;

Fig. 2 is an isometric view similar to Fig. 1, wherein the crash attenuator is in a partially compressed orientation, illustrating the crash attenuator with an inventive tearing member removed so tearing does not occur and the holes or apertures in the center rail are visible;

Fig. 2a is an isometric view similar to Fig. 2 wherein the inventive tearing member is present and tearing of the forward apertures 38 has occurred to attenuate the impact forces;

Fig. 3 is an isometric view similar to Figs. 1 and 2, wherein the crash attenuator is in a fully compressed orientation, but the inventive tearing member has been removed so that tearing does not occur and the holes or apertures in the center rail are visible;

Fig. 3a is an isometric view similar to Fig. 3 wherein

the inventive tearing member is present and tearing of the forward apertures 38 has occurred to attenuate the impact forces; and

Fig. 4 is a rearward looking view from the front end of the crash attenuator.

Description of the Preferred Embodiment

[0018] Referring now more particularly to the drawings, Figs. 1-4 illustrate an exemplary embodiment of a fixed crash impact attenuator system 10 of the type discussed above, wherein the design is sacrificial, in that it is intended for a single impact only, after which it is replaced. Thus, it is designed to be relatively inexpensive and simple in design and construction, yet highly effective in protecting the occupants of vehicles striking the attenuator. In the following, one inch corresponds to 2,54 cm and one foot corresponds to 30,48 cm.

[0019] Design considerations for the system 10 are that it meets U.S. federal TL (Test Level) -3 crash attenuation specifications, that it is narrow in profile, bidirectional capable, MASH (Manual for Assessing Safety Hardware) compliant, inexpensive, and free-standing (does not need to butt to rigid object, although it can, of course). The system is of a simple design and easy to manufacture (materials are standard sizes and shapes and fender panels are standard Thrie Beam-based), easy to assemble, and ships as a complete assembly. The base is the drill template, and anchor holes can be drilled with the unit 10 assembled. The length of the unit is designed, in an exemplary embodiment, is approximately 20-24 feet. Its width is 32 inches or less, which permits the units 10 to be shipped three-wide on a truck. The height is 32 to 36 inches. The unit 10 may be anchored to concrete, asphalt, or a hybrid of both, and it is anchored using standard anchors and adhesives. It is suitable for use in temperatures ranging from -40 degrees to 150+ degrees F.

[0020] In the illustrated exemplary embodiment, the system 10 comprises a base portion 12 having a ladder frame design, comprising a plurality of cross members 14 supporting first and second outer rails 16 and 18, respectively, as well as a center rail 20. The cross members 14 include anchor holes 22 for anchoring the base to the ground using bolt anchors or other suitable mechanical fasteners. In some instances, adhesive may be used instead or as well. The anchor holes 22, in the illustrated embodiment, are spaced along a length of each cross member 14, both outside of and within the first and second outer rails 16, 18.

[0021] The system 10 further includes an upper attenuator portion 24, which comprises a nose box 26, a plurality of diaphragms 28, and a plurality of fender panels 30. The nose box 26 may comprise a notice sign 32, and may include a crushable element in the front, behind the sign 32. The nose box 26 supports loads related to frontal, side, and angled nose impacts, and is supported on rollers 34, which allow the nose panel to move rearwardly along the outer rails 16, 18. The rollers 34 are designed to prevent binding/locking in an angled nose impact. As the nose box 26 moves rearwardly after a vehicular impact, attenuation may be activated.

[0022] The diaphragms 28 are disposed in spaced relation behind the nose box 26. They are made from standard shapes and sizes and have cross braces sized for loads. Each cross brace is positioned for ease of assembly of the fender panels 30. Each diaphragm 28 is slidably mounted at their base ends 36 on each side to the outer rails 16, 18, as illustrated.

[0023] The fender panels 30 are standard in construction, being a standard Thrie beam panel, preferably fabricated of 10 or 12-gauge steel. When a vehicular impact occurs, and the attenuator is compacted, as shown successively in Figs. 2, 2a and 3, 3a, the fender panels 30 are preferably designed to nest or double over one another in a sliding pattern, as illustrated in the drawings. The length of the fender panels 30 is determined by loads in side impacts, and panels are preferably designed to be common and interchangeable where possible. Bolts secure the foremost fender panel 30 to the nose box 26, and also secure the fender panels to the diaphragms 28. The rear of the panels 30 are secured by clips, rather than slots, in illustrated embodiments, though other attachment methods may be used. The system 10 is designed for standard Thrie beam transition pieces.

[0024] The steel forming the fender panels may be galvanized, and may be A36, A513, or A517, for example.

[0025] Various approaches for attenuating the crash/impact forces are within the scope of the disclosure.

[0026] For example, ripper plates may be used, with varied and staged thicknesses and shapes to stage attenuation, laser/plasma cut patterns to stage attenuation, or a cutter located on the nose box 26, for example. Shearing bolts may be used, comprising double shear approaches or a cutter on the nose box 26, for example. Failing wire rope sections, comprising wire rope loops being pulled to failure, kinking of tube arches, cartridges with honeycomb (aluminum, steel, or plastic), crushable foam-filled cartridges, sand-filled cartridges, pea gravel filled cartridges, water-filled cartridges, cartridges filled with glass beads in oil, drawing a metal strip through offset rollers, a friction brake on a wire rope, a friction brake on bar stock, or velocity magnetics (magnetic attenuation) are all potential possibilities.

[0027] An attenuation approach which is illustrated in Figs. 1-4 involves the center rail 20. As illustrated, the rail 20 is fixedly mounted to the cross members 14 of the base portion 12, in an upright orientation. As shown in Figs. 2a and 3a, a plurality of holes or apertures 38 are disposed in spaced relation along a length of the rail 20.

[0028] Attenuation occurs as the upper attenuator portion 24 moves rearwardly upon impact by a vehicle, thus absorbing impact energy from the crash, and this attenuation capability is greatly enhanced by the employ-

ment of one or more inventive shear bolt or tearing member 40 (Figs. 2b, 3b, and 4), which extends from the attenuator portion 24, and engages the holes 38. It should be noted, at this point, that Figs. 2a, 3a are illustrated with the tearing member 40 removed, so that the holes 38 are shown, whereas Figs. 2b, 3b show the crash attenuator with the tearing member 40 in place, as would be the case in an actual installation. It should also be noted that the terms "tear", "rip", "shear", "slice", "cut", and the like are used interchangeably throughout this application to identify any process by which a slit is created in material to dissipate and attenuate impact energy. The terms "tear", "tearing", "tearable" and the like are used herein and in the appended claims as stand-ins for any of the above mentioned terms for creating a lengthwise slit in a crash attenuator component to attenuate impact energy, and are intended to be broad enough in scope to include any of these terms.

[0029] In the illustrated embodiment, the tearing member 40 is disposed on the frontmost diaphragm 28, as shown, but it is within the scope of the invention to employ a plurality of tearing members 40, spaced widthwise on one diaphragm 28 to tear corresponding structural members like rail 20, or opposing sides of the rail 20, or, alternatively, to employ one or more tearing members 40 on more than one of the plurality of diaphragms 28. As shown in Figs. 2b, 3b, as the attenuator portion 24 moves rearwardly, the holes 38 are ripped by the tearing member 40, thus absorbing much of the crash impact forces by ripping the material forming the rail 20, between the holes 38, creating a slot 42 in the rail 20. The holes 38 may be tuned to optimize the tearing, and thus attenuation effect, by changing their spacing in different sections of the rail 20, and/or by changing the size of the holes. For example, the holes 38 may be more closely spaced in front portions of the rail 20, and may also be more elongated, to make the rail "softer" when crushed, whereas the holes 38 in more rearward portions of the rail 20 may be smaller and less elongated, and farther spaced apart, in order to make these portions of the attenuator "harder" when crushed, to attenuate higher forces. Additionally, if desired, the rail 20 may be made of thinner material (gauge) in the forward sections, and thicker material (gauge) in the rearward sections, for similar reasons. This adds to the "tuning" of the rail 20. Also, if desired, the material of the rail itself might be changed as the attenuator travels along the rail from front to rear, from one stage to the next. Of course, though in the illustrated embodiment it is desired that the softer portions be forward and the harder portions be rearward, differing design considerations may dictate a different orientation, such as softer portions being rearward and harder portions being forward.

[0030] The diaphragms 28 serve to transfer the load of a side impact from the diaphragm to the pavement, through the cross members 14 and anchors 22. This anchoring to the pavement makes the pavement itself a structural member for the attenuator system 10.

[0031] Thus, important features of the present invention include, for example:

1) low cost;
2) free standing (not an end treatment - not relying on the structure being shielded for structural support);
3) easy assembly - a 20 ft. assembly may be trucked to the site and easily bolted to the ground - standard material lengths make for easier shipping;
4) tunability may be altered to adapt to different crash standards and applications.

[0032] Accordingly, although an exemplary embodiment of the invention has been shown and described, it is to be understood that all the terms used herein are descriptive rather than limiting, and that many changes, modifications, and substitutions may be made by one having ordinary skill in the art without departing from the scope of the appended claims.

Claims

1. A crash attenuator system (10) for deployment in front of a fixed structure, the system comprising:

first and second outer rails (16, 18) spaced apart in a widthwise direction and extending along a length of the crash attenuator system;
a center rail (20); and
a plurality of diaphragms (28) initially disposed in spaced relation along the length of the first and second outer rails, each of the plurality of diaphragms having a base end (36) adapted to be movably engaged with the first and second outer rails, so that when a front end of the crash attenuator system receives an impact force from an errant vehicle, a first one of the plurality of diaphragms moves rearwardly along the first and second outer rails and impacts a second one of the plurality of diaphragms so that both the first and second ones of the plurality of diaphragms move further rearwardly along the first and second outer rails, this process continuing with additional ones of the plurality of diaphragms until the impact forces have been fully attenuated; and **characterized in that** the system comprises:

a bolt (40) on one of the plurality of diaphragms which is adapted to engage material forming the center rail (20) of the crash attenuator system, the bolt and the center rail being relatively movable when an impact force strikes the crash attenuator system so that the bolt tears the center rail, thereby increasing attenuation of the impact force, the center rail being tuned to optimize the tearing of the center rail;

wherein the center rail extends along at least a portion of the length of the crash attenuator and includes a plurality of holes (38) disposed therein, the plurality of holes extending along a length of the center rail and spaced lengthwise from one another, the bolt being engaged with one of the plurality of holes so that when an impact force is applied to the crash attenuator, relative motion occurs between the center rail and the bolt so that the relative motion causes the bolt to tear the material between adjacent ones of the plurality of holes, thereby creating a continuous slot (42), the tearing of the material functioning to attenuate the impact force.

2. The crash attenuator system as recited in Claim 1, wherein the bolt is disposed on a base end of the first one of the plurality of diaphragms.

3. The crash attenuator as recited in Claim 1, wherein the bolt comprises a plurality of bolts.

4. The crash attenuator as recited in Claim 1, wherein the center rail is tuned by arranging the plurality of holes so that the plurality of holes are not evenly spaced along the length of the center rail.

5. The crash attenuator as recited in Claim 1, wherein adjacent ones of the plurality of holes nearer to one of the front and back ends of the crash attenuator are more closely spaced than adjacent ones of the plurality of holes closer to the other of the front and back ends of the crash attenuator.

6. The crash attenuator as recited in Claim 1, wherein the center rail is tuned by arranging the holes so that the plurality of holes are not uniform in size, respective to one another.

7. The crash attenuator as recited in Claim 5, wherein ones of the plurality of holes nearer to the one of the front and back ends of the crash attenuator are larger and more elongated than those of the plurality of holes which are located closer to the other of the front and back ends of the crash attenuator.

8. The crash attenuator as recited in Claim 1, wherein the center rail is tuned so that the material forming the center rail is thinner toward one of the front and back ends of the crash attenuator, and thicker toward the other of the front and back ends of the crash attenuator.

9. The crash attenuator as recited in Claim 1, wherein the center rail is tuned by comprising the center rail of a plurality of stages as it extends from one of the front and back ends of the crash attenuator toward the other of the first and second ends of the crash attenuator, wherein a first stage toward the one of the front and back ends of the crash attenuator is softer than a second stage toward the other of the first and second ends of the crash attenuator.

10. The crash attenuator as recited in Claim 9, wherein the one of the front and back ends of the crash attenuator is the front end of the crash attenuator and the other of the first and second ends of the crash attenuator is the back end of the crash attenuator.

11. The crash attenuator as recited in Claim 9, wherein the first stage is softer because the material forming the first stage is thinner than the material forming the second stage.

12. The crash attenuator as recited in Claim 9, wherein the first stage is softer because the holes of the plurality of holes which are disposed in the first stage are closer together than the holes of the plurality of holes which are disposed in the second stage.

13. The crash attenuator as recited in Claim 9, wherein the first stage is softer because the holes of the plurality of holes which are disposed in the first stage are larger in size than the holes of the plurality of holes which are disposed in the second stage.

14. The crash attenuator as recited in Claim 1, and further comprising a plurality of fender panels (30) disposed along each side of the crash attenuator along its length, wherein frontmost ones of the plurality of fender panels are adapted to slide alongside of rearmost ones of the plurality of fender panels when the crash attenuator is impacted by a vehicle.

15. The crash attenuator as recited in Claim 1, wherein the center rail is stationary and the tearing member moves responsive to the impact force.

Patentansprüche

1. Aufpralldämpfersystem (10) zum Einsatz vor einer festen Struktur, wobei das System Folgendes umfasst:

eine erste und zweite äußere Schiene (16, 18), die in einer Breitenrichtung beabstandet sind und sich entlang einer Länge des Aufpralldämpfersystems erstrecken;
eine Mittelschiene (20); und
eine Vielzahl von Membranen (28), die anfänglich in einer beabstandeten Beziehung entlang der Länge der ersten und zweiten äußeren Schiene angeordnet sind, wobei jede der Viel-

zahl von Membranen ein Basisende (36) aufweist, das angepasst ist, um bewegbar mit der ersten und zweiten äußeren Schiene in Eingriff zu treten, sodass, wenn ein vorderes Ende des Aufpralldämpfersystems eine Aufprallkraft von einem fehlgeleiteten Fahrzeug empfängt, sich eine erste aus der Vielzahl von Membranen entlang der ersten und zweiten äußeren Schiene nach hinten bewegt und auf eine zweite aus der Vielzahl von Membranen trifft, sodass sich sowohl die erste als auch die zweite aus der Vielzahl von Membranen entlang der ersten und zweiten äußeren Schiene weiter nach hinten bewegen, wobei dieser Prozess mit zusätzlichen aus der Vielzahl von Membranen fortgesetzt wird, bis die Aufprallkräfte vollständig gedämpft wurden; und **dadurch gekennzeichnet, dass** das System Folgendes umfasst:

einen Bolzen (40) an einer der Vielzahl von Membranen, der angepasst ist, um in Material einzugreifen, das die Mittelschiene (20) des Aufpralldämpfersystems bildet, wobei der Bolzen und die Mittelschiene relativ bewegbar sind, wenn eine Aufprallkraft auf das Aufpralldämpfersystem auftrifft, sodass der Bolzen die Mittelschiene zerreißt, wodurch die Dämpfung der Aufprallkraft erhöht wird, wobei die Mittelschiene abgestimmt ist, um das Zerreißen der Mittelschiene zu optimieren;
wobei sich die Mittelschiene entlang mindestens eines Abschnitts der Länge des Aufpralldämpfers erstreckt und eine Vielzahl von darin angeordneten Löchern (38) beinhaltet, wobei sich die Vielzahl von Löchern entlang einer Länge der Mittelschiene erstreckt und in Längsrichtung voneinander beabstandet ist, wobei der Bolzen mit einem aus der Vielzahl von Löchern in Eingriff steht, sodass, wenn eine Aufprallkraft auf den Aufpralldämpfer aufgebracht wird, eine relative Bewegung zwischen der Mittelschiene und dem Bolzen auftritt, sodass die relative Bewegung bewirkt, dass der Bolzen das Material zwischen benachbarten aus der Vielzahl von Löchern zerreißt, wodurch ein kontinuierlicher Schlitz (42) erzeugt wird, wobei das Zerreißen des Materials dazu dient, die Aufprallkraft zu dämpfen.

2. Aufpralldämpfersystem nach Anspruch 1, wobei der Bolzen an einem Basisende der ersten der Vielzahl von Membranen angeordnet ist.

3. Aufpralldämpfer nach Anspruch 1, wobei der Bolzen eine Vielzahl von Bolzen umfasst.

4. Aufpralldämpfer nach Anspruch 1, wobei die Mittelschiene durch Anordnen der Vielzahl von Löchern abgestimmt ist, sodass die Vielzahl von Löchern nicht gleichmäßig entlang der Länge der Mittelschiene beabstandet ist.

5. Aufpralldämpfer nach Anspruch 1, wobei benachbarte der Vielzahl von Löchern, die sich näher an einem von dem vorderen und hinteren Ende des Aufpralldämpfers befinden, enger beabstandet sind als benachbarte der Vielzahl von Löchern, die sich näher an dem anderen von dem vorderen und hinteren Ende des Aufpralldämpfers befinden.

6. Aufpralldämpfer nach Anspruch 1, wobei die Mittelschiene durch Anordnen der Löcher abgestimmt ist, sodass die Vielzahl von Löchern jeweils bezogen aufeinander keine gleichmäßige Größe aufweist.

7. Aufpralldämpfer nach Anspruch 5, wobei einzelne der Vielzahl von Löchern, die sich näher an dem einen von dem vorderen und hinteren Ende des Aufpralldämpfers befinden, größer und ausgedehnter sind als diejenigen der Vielzahl von Löchern, die sich näher an dem anderen von dem vorderen und hinteren Ende des Aufpralldämpfers befinden.

8. Aufpralldämpfer nach Anspruch 1, wobei die Mittelschiene abgestimmt ist, sodass das Material, das die Mittelschiene bildet, in Richtung eines von dem vorderen und hinteren Ende des Aufpralldämpfers dünner und in Richtung des anderen von dem vorderen und hinteren Ende des Aufpralldämpfers dicker ist.

9. Aufpralldämpfer nach Anspruch 1, wobei die Mittelschiene abgestimmt ist, indem sie die Mittelschiene einer Vielzahl von Stufen umfasst, wenn sie sich von einem von dem vorderen und hinteren Ende des Aufpralldämpfers in Richtung des anderen von dem ersten und zweiten Ende des Aufpralldämpfers erstreckt, wobei eine erste Stufe in Richtung des einen von dem vorderen und hinteren Ende des Aufpralldämpfers weicher ist als eine zweite Stufe in Richtung des anderen von dem ersten und zweiten Ende des Aufpralldämpfers.

10. Aufpralldämpfer nach Anspruch 9, wobei das eine von dem vorderen und hinteren Ende des Aufpralldämpfers das vordere Ende des Aufpralldämpfers ist und das andere von dem ersten und zweiten Ende des Aufpralldämpfers das hintere Ende des Aufpralldämpfers ist.

11. Aufpralldämpfer nach Anspruch 9, wobei die erste Stufe weicher ist, da das die erste Stufe bildende Material dünner als das die zweite Stufe bildende Material ist.

12. Aufpralldämpfer nach Anspruch 9, wobei die erste Stufe weicher ist, da die Löcher der Vielzahl von Löchern, die in der ersten Stufe angeordnet sind, näher beieinander liegen als die Löcher der Vielzahl von Löchern, die in der zweiten Stufe angeordnet sind.

13. Aufpralldämpfer nach Anspruch 9, wobei die erste Stufe weicher ist, da die Löcher der Vielzahl von Löchern, die in der ersten Stufe angeordnet sind, größer sind als die Löcher der Vielzahl von Löchern, die in der zweiten Stufe angeordnet sind.

14. Aufpralldämpfer nach Anspruch 1, und ferner umfassend eine Vielzahl von Kotflügelplatten (30), die entlang jeder Seite des Aufpralldämpfers entlang seiner Länge angeordnet sind, wobei die vordersten der Vielzahl von Kotflügelplatten angepasst sind, um entlang der hintersten der Vielzahl von Kotflügelplatten zu gleiten, wenn ein Fahrzeug auf den Aufpralldämpfer auftrifft.

15. Aufpralldämpfer nach Anspruch 1, wobei die Mittelschiene stationär ist und sich das Aufreißelement als Reaktion auf die Aufprallkraft bewegt.

Revendications

1. Système d'atténuateur de collision (10) destiné à être déployé devant une structure fixe, le système comprenant :

des premier et second rails externes (16, 18) espacés dans une direction de la largeur et s'étendant le long d'une longueur du système d'atténuateur de collision ;
un rail central (20) ; et
une pluralité de diaphragmes (28) initialement disposés en relation espacée sur la longueur des premier et second rails externes, chacun de la pluralité de diaphragmes possédant une extrémité de base (36) adaptée pour être en prise de manière mobile avec les premier et second rails externes, afin que lorsqu'une extrémité avant du système d'atténuateur de collision reçoit une force d'impact d'un véhicule errant, un premier diaphragme de la pluralité de diaphragmes se déplace vers l'arrière le long des premier et second rails externes et impacte un second diaphragme de la pluralité de diaphragmes afin que les premier et second diaphragmes de la pluralité de diaphragmes se déplacent davantage vers l'arrière le long des premier et second rails externes, ce processus se poursuivant avec des diaphragmes supplémentaires de la pluralité de diaphragmes jusqu'à ce que les forces d'impact aient été complètement atténuées ; et **caractérisé en ce que** le système comprend :

un boulon (40) sur l'un de la pluralité de diaphragmes qui est adapté pour se mettre en prise avec le matériau formant le rail central (20) du système d'atténuateur de collision, le boulon et le rail central étant relativement mobiles lorsqu'une force d'impact frappe le système d'atténuateur de collision afin que le boulon déchire le rail central, augmentant ainsi l'atténuation de la force d'impact, le rail central étant réglé pour optimiser la déchirure du rail central ; ledit rail central s'étendant sur au moins une partie de la longueur de l'atténuateur de collision et comprenant une pluralité de trous (38) disposés dans celui-ci, la pluralité de trous s'étendant sur une longueur du rail central et espacés longitudinalement les uns des autres, le boulon étant en prise avec l'un de la pluralité de trous afin que lorsqu'une force d'impact est appliquée à l'atténuateur de collision, un mouvement relatif se produise entre le rail central et le boulon afin que le mouvement relatif amène le boulon à déchirer le matériau entre des trous adjacents de la pluralité de trous, créant ainsi une fente continue (42), la déchirure du matériau fonctionnant pour atténuer la force d'impact.

2. Système d'atténuateur de collision selon la revendication 1, ledit boulon étant disposé sur une extrémité de base du premier diaphragme de la pluralité de diaphragmes.

3. Atténuateur de collision selon la revendication 1, ledit boulon comprenant une pluralité de boulons.

4. Atténuateur de collision selon la revendication 1, ledit rail central étant réglé en agençant la pluralité de trous afin que la pluralité de trous ne soient pas espacés uniformément sur la longueur du rail central.

5. Atténuateur de collision selon la revendication 1, lesdits trous adjacents de la pluralité de trous plus proches de l'une des extrémités avant et arrière de l'atténuateur de collision étant plus étroitement espacés que les trous adjacents de la pluralité de trous plus proches de l'autre des extrémités avant et arrière de l'atténuateur de collision.

6. Atténuateur de collision selon la revendication 1, ledit rail central étant réglé en agençant les trous afin que la pluralité de trous ne soient pas de taille uniforme, les uns par rapport aux autres.

7. Atténuateur de collision selon la revendication 5, lesdits trous de la pluralité de trous plus proches de l'une des extrémités avant et arrière de l'atténuateur de collision étant plus grands et plus allongés que ceux de la pluralité de trous qui sont situés plus proches de l'autre des extrémités avant et arrière de l'atténuateur de collision.

8. Atténuateur de collision selon la revendication 1, ledit rail central étant réglé afin que le matériau formant le rail central soit plus mince vers l'une des extrémités avant et arrière de l'atténuateur de collision, et plus épais vers l'autre des extrémités avant et arrière de l'atténuateur de collision.

9. Atténuateur de collision selon la revendication 1, ledit rail central étant réglé en comprenant le rail central d'une pluralité d'étages tandis qu'il s'étend à partir de l'une des extrémités avant et arrière de l'atténuateur de collision vers l'autre des première et seconde extrémités de l'atténuateur de collision, un premier étage vers l'une des extrémités avant et arrière de l'atténuateur de collision étant plus tendre qu'un second étage vers l'autre des première et seconde extrémités de l'atténuateur de collision.

10. Atténuateur de collision selon la revendication 9, l'une des extrémités avant et arrière de l'atténuateur de collision étant l'extrémité avant de l'atténuateur de collision et l'autre des première et seconde extrémités de l'atténuateur de collision étant l'extrémité arrière de l'atténuateur de collision.

11. Atténuateur de collision selon la revendication 9, ledit premier étage étant plus tendre parce que le matériau formant le premier étage est plus mince que le matériau formant le second étage.

12. Atténuateur de collision selon la revendication 9, ledit premier étage étant plus tendre parce que les trous de la pluralité de trous qui sont disposés dans le premier étage sont plus proches les uns des autres que les trous de la pluralité de trous qui sont disposés dans le second étage.

13. Atténuateur de collision selon la revendication 9, ledit premier étage étant plus tendre parce que les trous de la pluralité de trous qui sont disposés dans le premier étage sont plus grands que les trous de la pluralité de trous qui sont disposés dans le second étage.

14. Atténuateur de collision selon la revendication 1, et comprenant en outre une pluralité de panneaux de protection (30) disposés le long de chaque côté de l'atténuateur de collision sur sa longueur, lesdits panneaux de protection les plus à l'avant de la pluralité de panneaux de protection étant adaptés pour glisser le long des panneaux de protection les plus à l'arrière de la pluralité de panneaux de protection lorsque l'atténuateur de collision est heurté par un véhicule.

15. Atténuateur de collision selon la revendication 1, ledit rail central étant fixe et ledit élément de déchirure se déplaçant en réponse à la force d'impact.

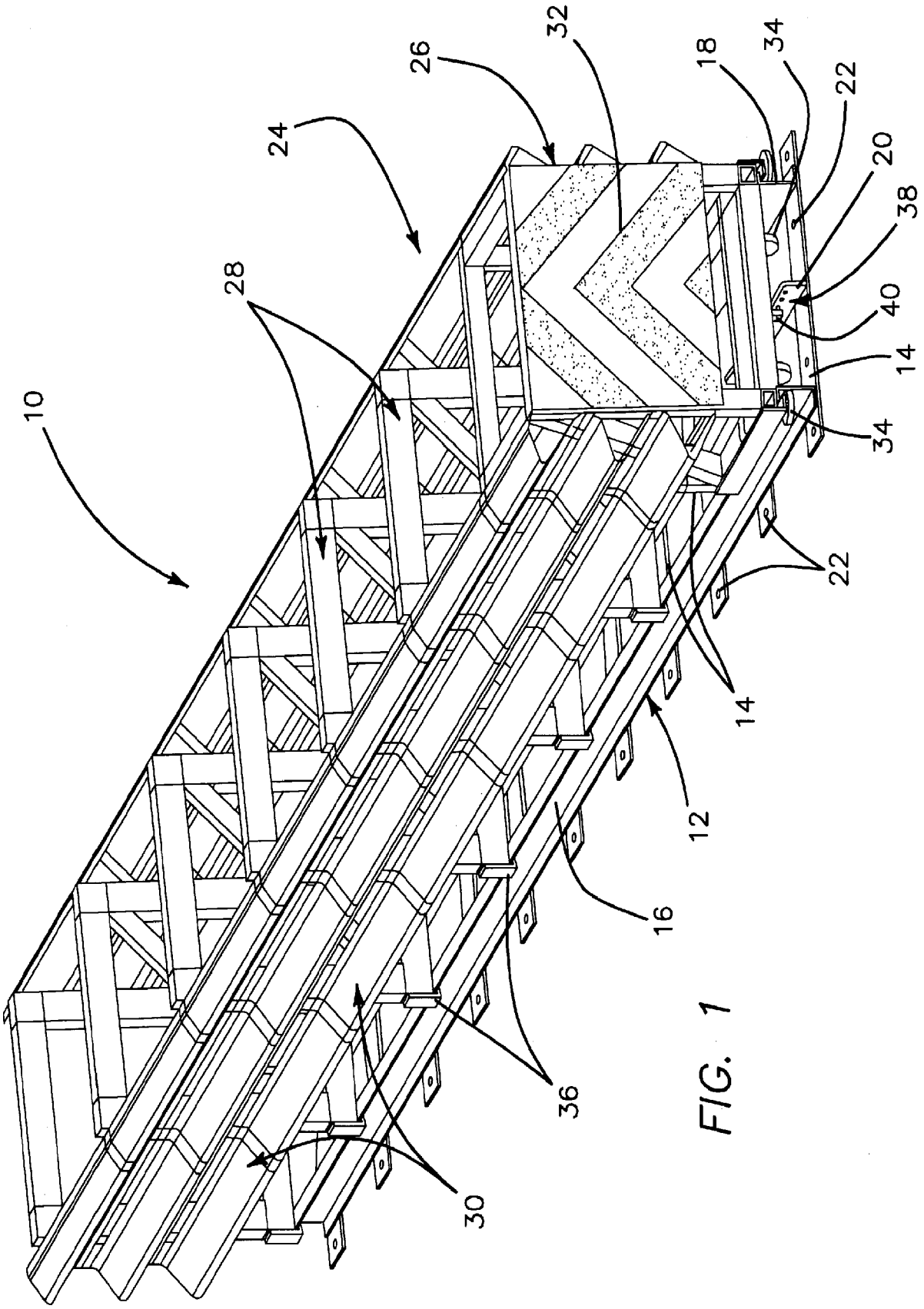

FIG. 1

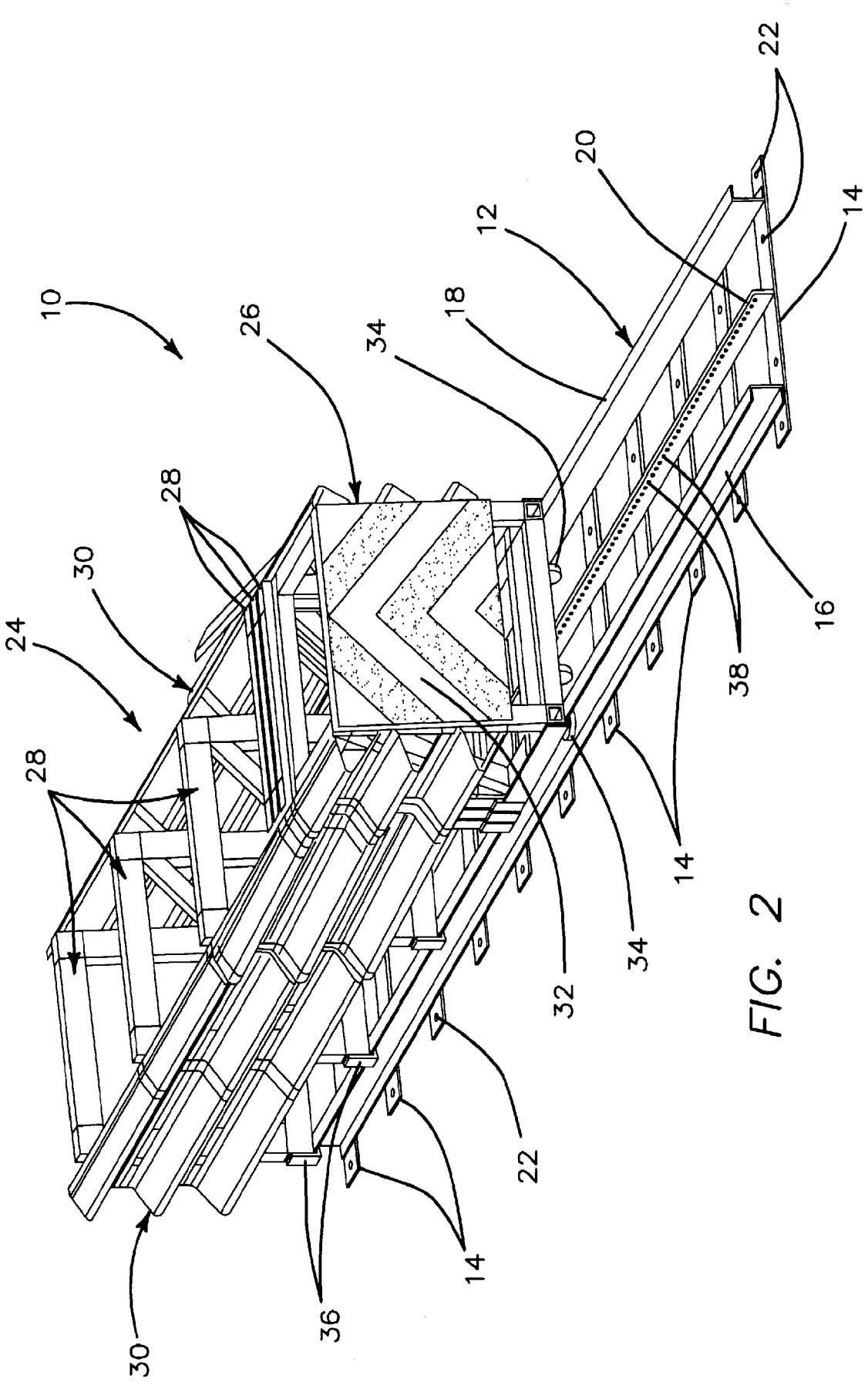

FIG. 2

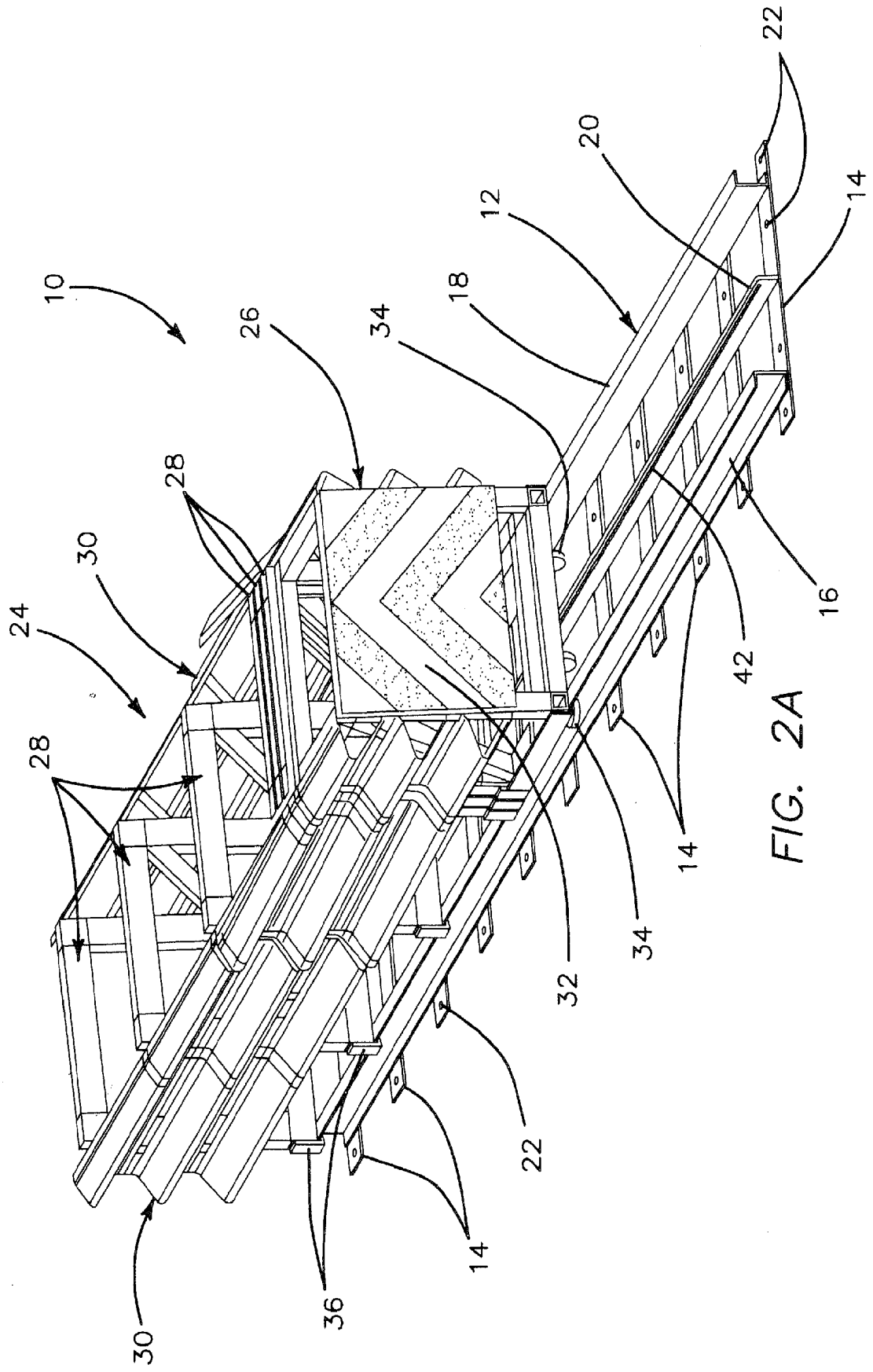

FIG. 2A

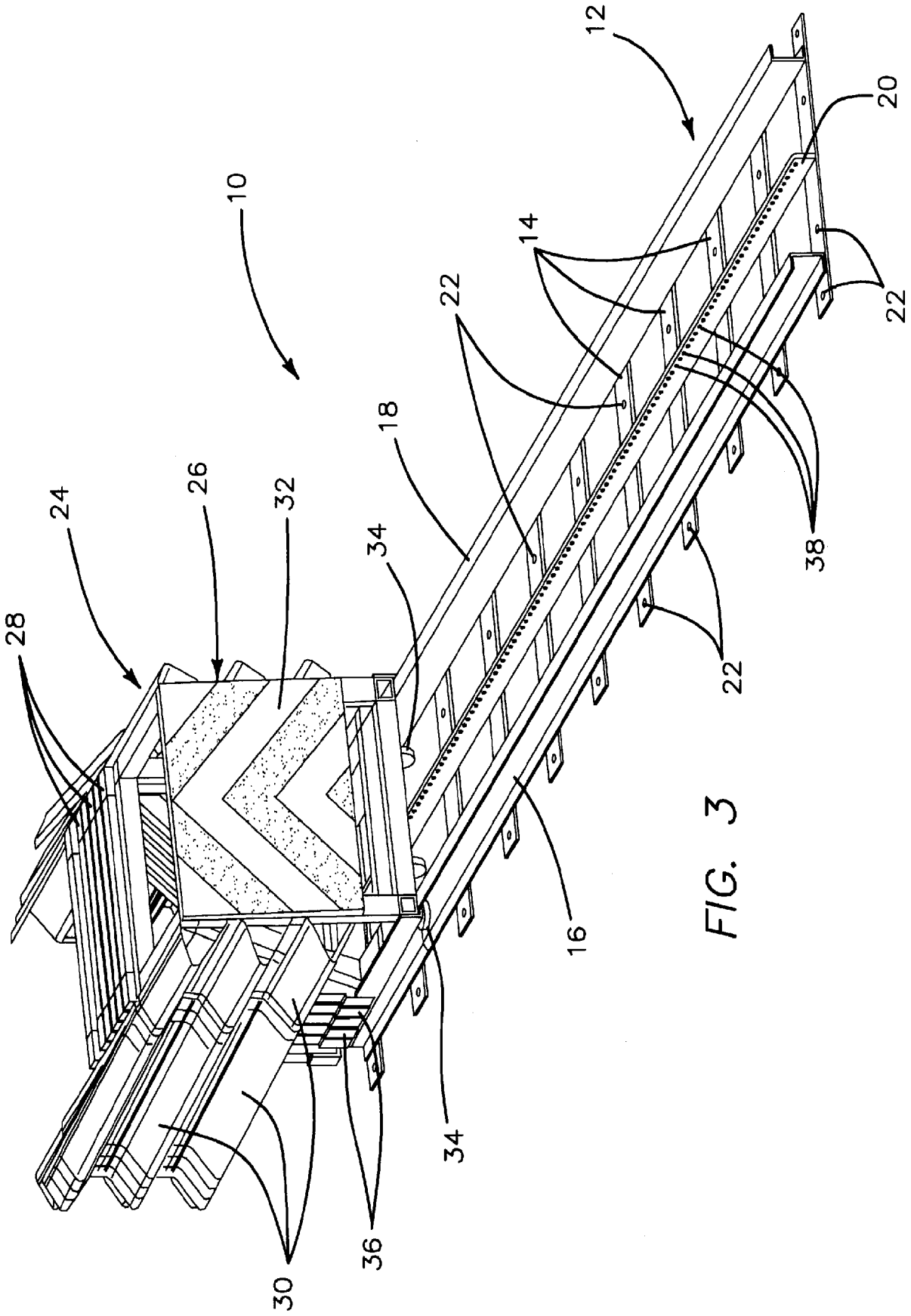

FIG. 3

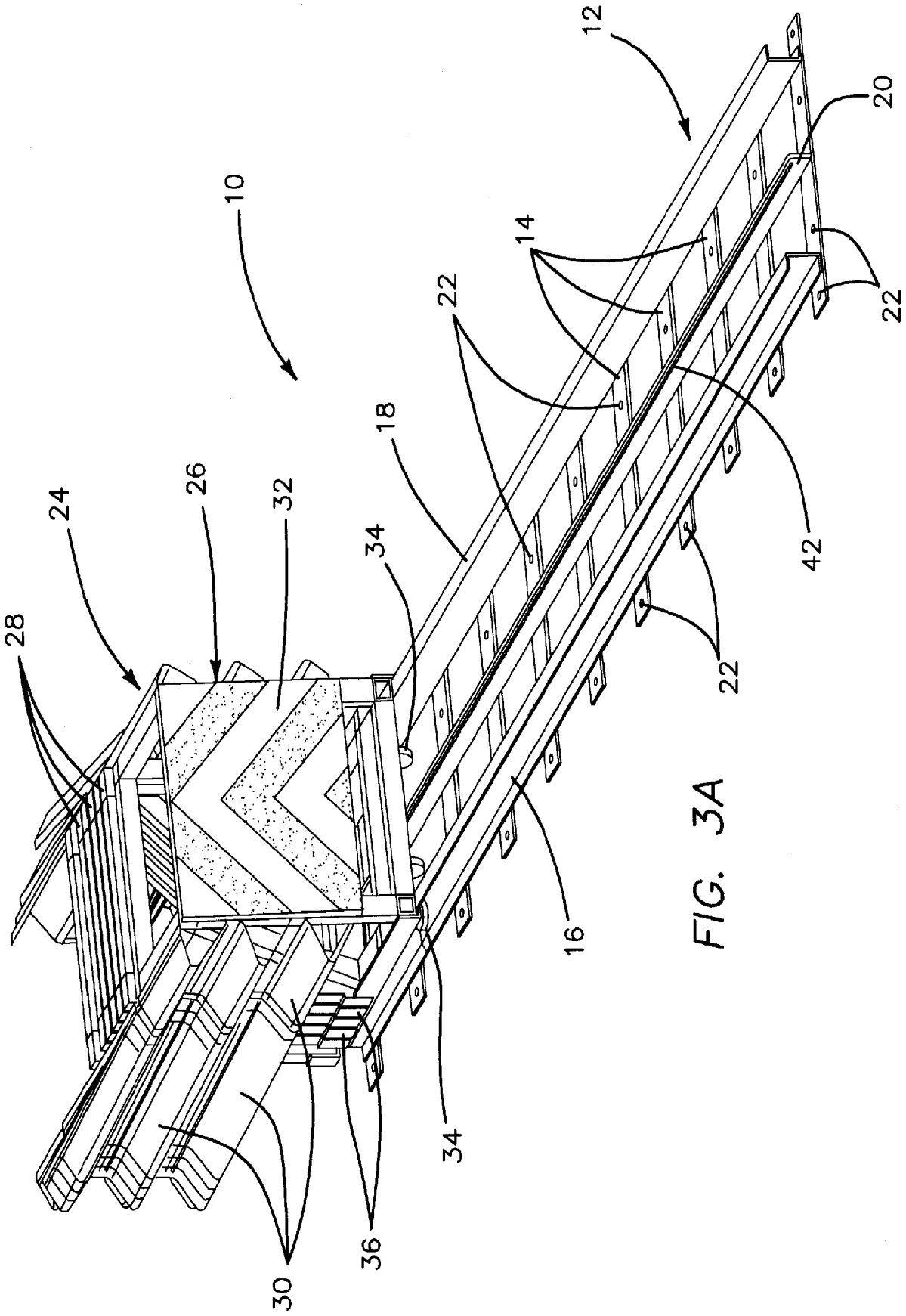

FIG. 3A

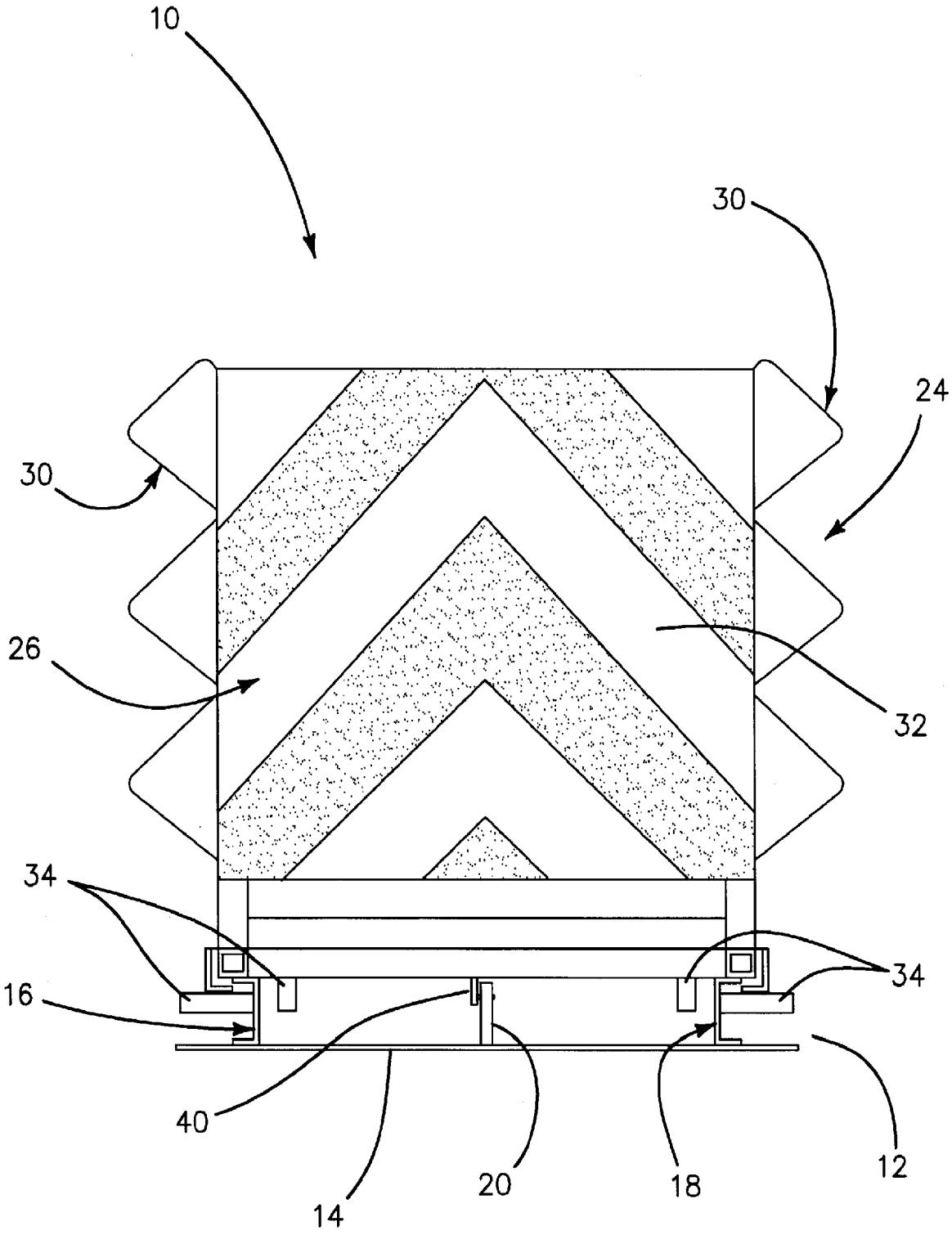

FIG. 4

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- EP 1706544 B1 **[0001]**