United States Patent [19]

Boedecker, Jr. et al.

[11] **3,845,936**

[45] **Nov. 5, 1974**

[54] **MODULAR CRASH CUSHION**

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[73] Assignee: **United States Steel Corporation**, Pittsburgh, Pa.

[22] Filed: **July 16, 1973**

[21] Appl. No.: **379,688**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 364,192, May 25, 1973, abandoned, Continuation of Ser. No. 203,805, Dec. 1, 1971, abandoned.

[52] **U.S. Cl.** **256/1**, 256/13.1, 114/219, 104/254

[51] **Int. Cl.** **E04h 17/00**

[58] **Field of Search** 256/1, 13.1

[56] **References Cited**

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Primary Examiner—James R. Boler
Assistant Examiner—Conrad L. Berman
Attorney, Agent, or Firm—Robert J. Leek, Jr.

[57] **ABSTRACT**

A modular crash cushion is disclosed for a rigid roadside obstacle located on or beside a highway and having a contact surface facing the vehicular traffic. The modular crash cushion has a first line of drums extending forward from one side of the contact surface and a second line of drums extending forward from the other side of the contact surface and adjacent the first line of drums. Connector means connect together either adjacent drums in the first line of drums and in the second line of drums or adjacent drums in one line of the first line of drums and the second line of drums. The first line of drums and the second line of drums are connected at one end to the rigid roadside obstacle. Skid means are between the first line of drums and the highway and the second line of drums and the highway to permit the other end of the first line of drums and the second line of drums to move on impact between a vehicle and the modular crash cushion.

The connector means is also a part of this invention.

20 Claims, 33 Drawing Figures

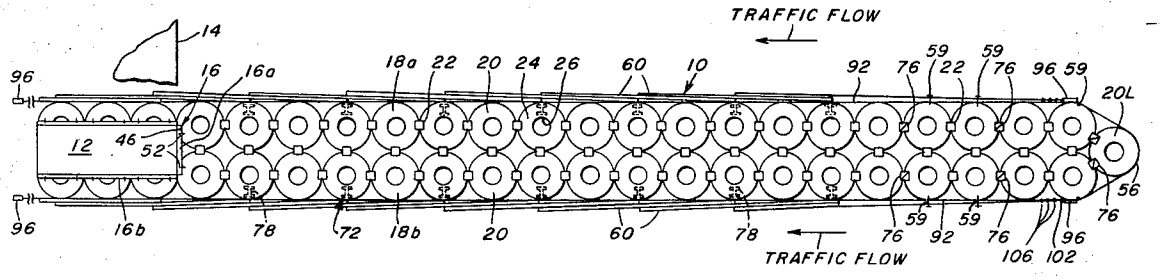


FIG. 1.

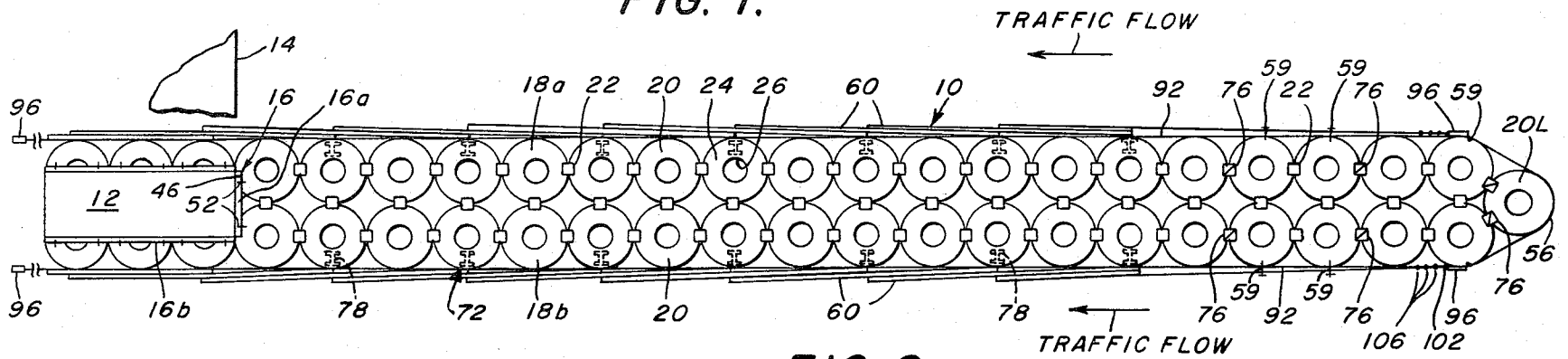


FIG. 2.

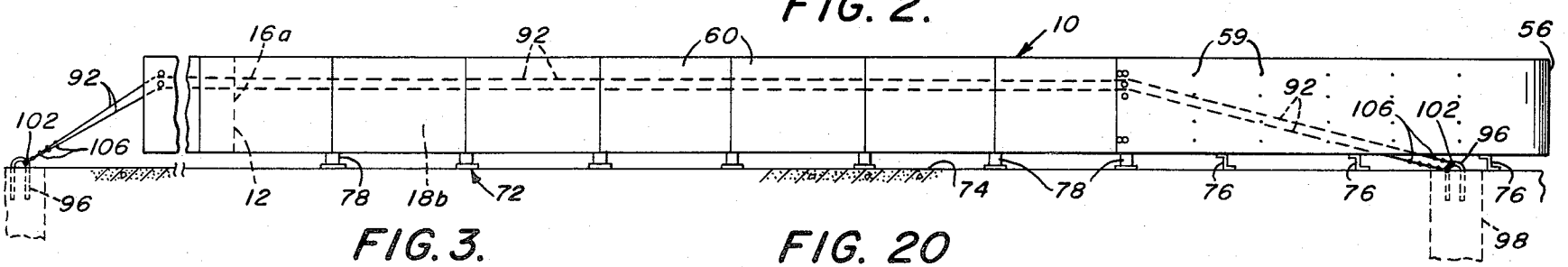


FIG. 3.

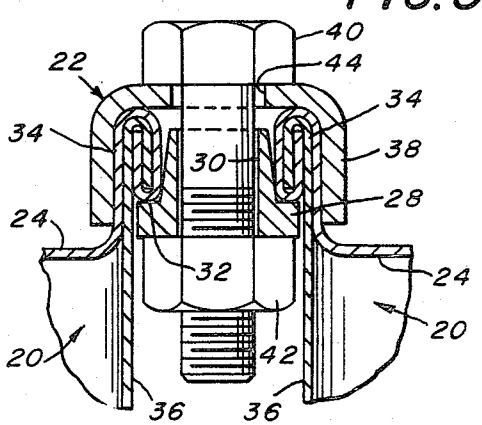


FIG. 20

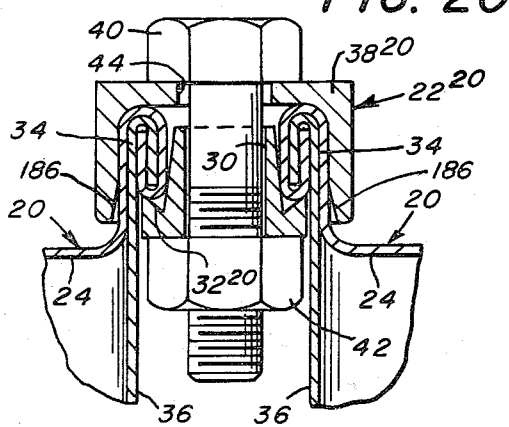


FIG. 5.

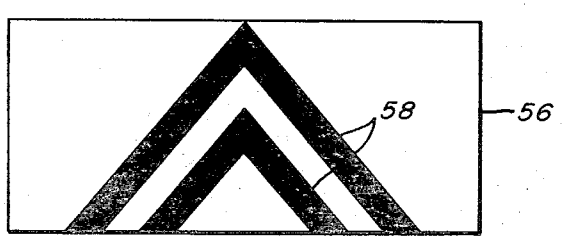


FIG. 4.

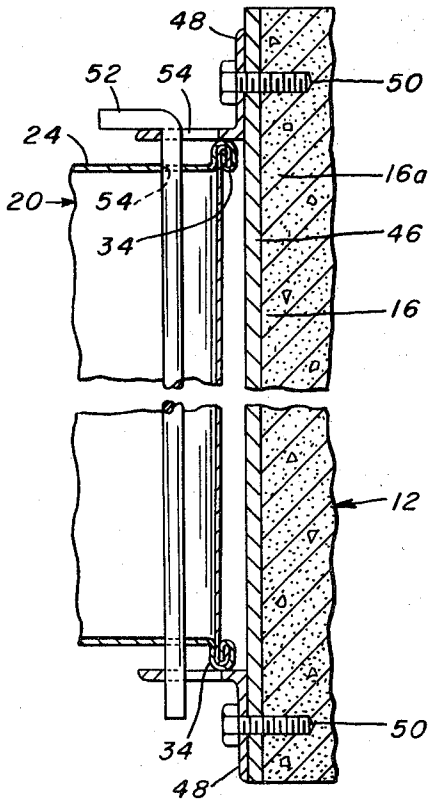


FIG. 6A.

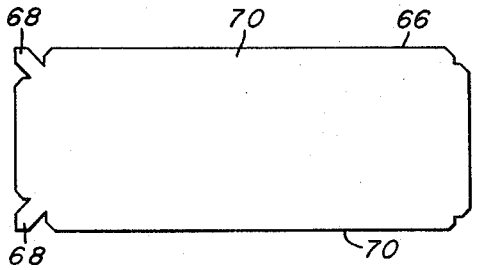


FIG. 6B.

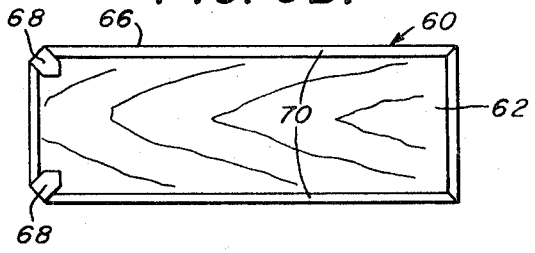


FIG. 6C.

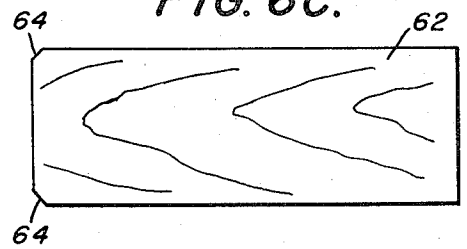


FIG. 8A.

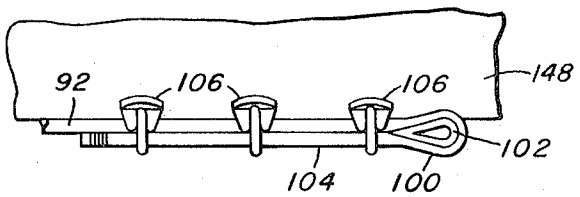


FIG. 8B.

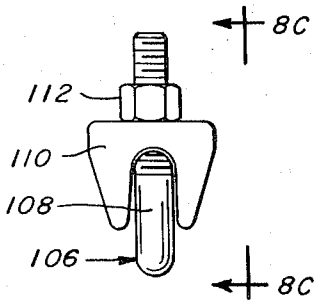


FIG. 8C.

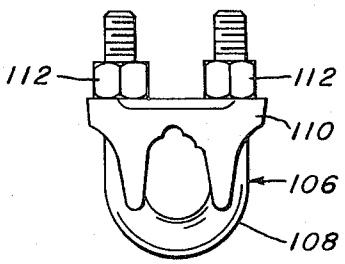


FIG. 7A.

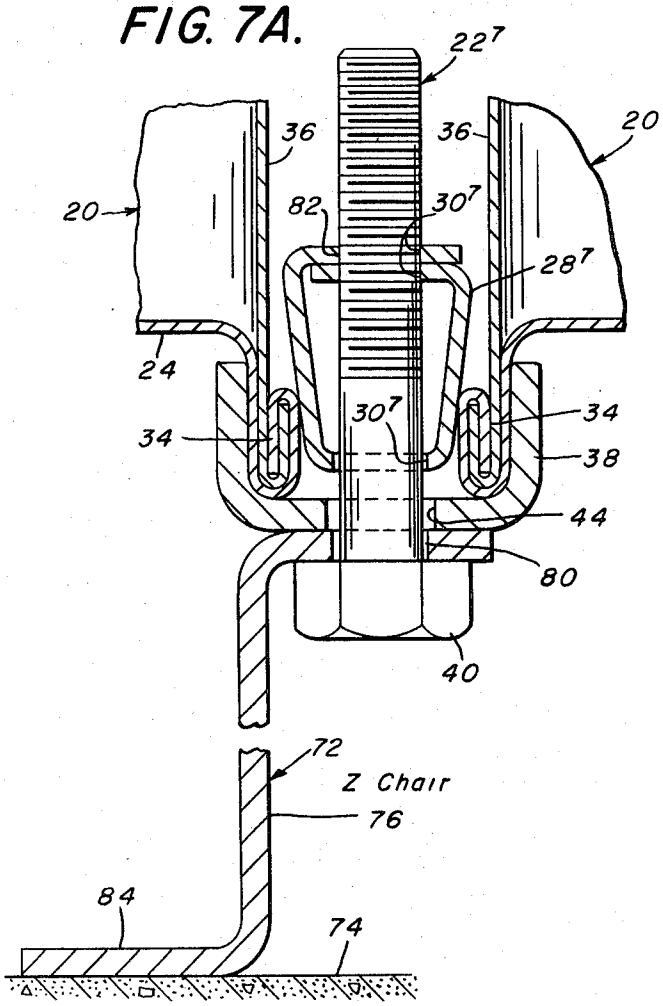


FIG. 7C.

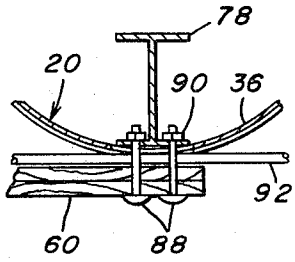


FIG. 7D.

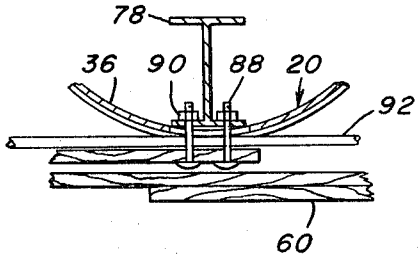
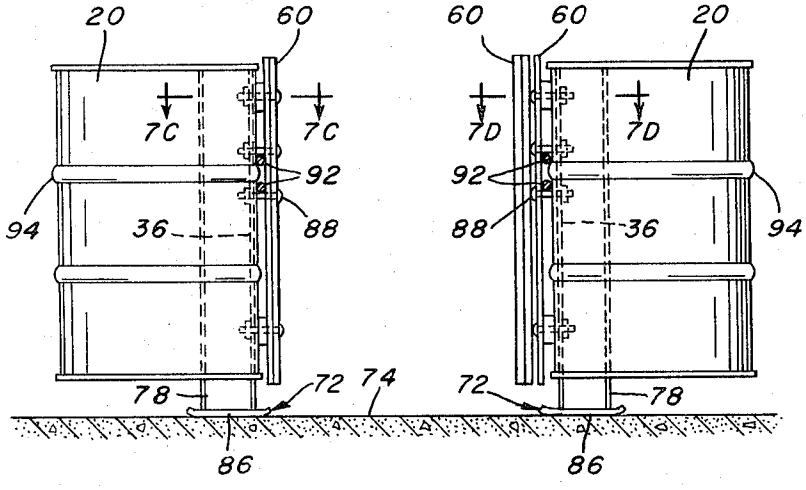


FIG. 7B.



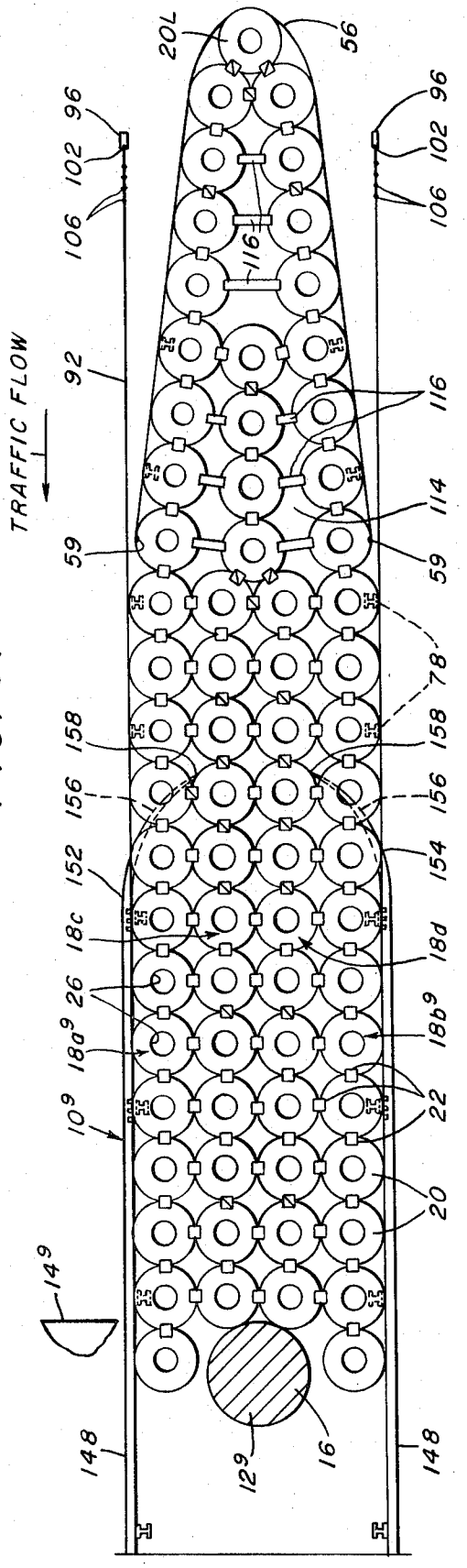

TRAFFIC FLOW
20L
56
96
102
106
116
92
59
114
78
158
156
154
152
18c
18d
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18a9
18b9
109
22
20
149
148
129
16

FIG. 9.

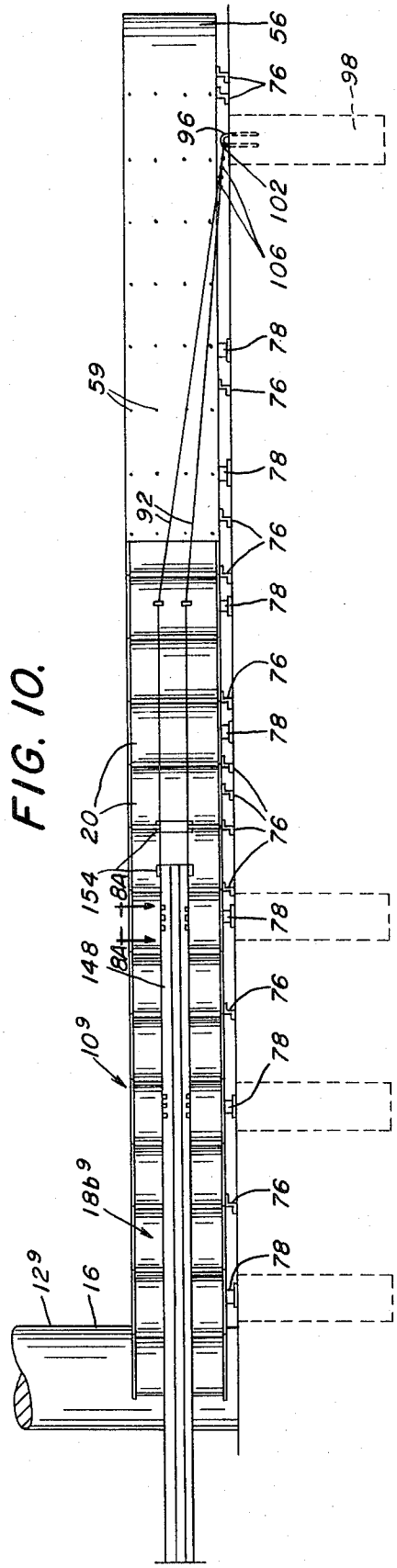

TRAFFIC FLOW
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FIG. 10.

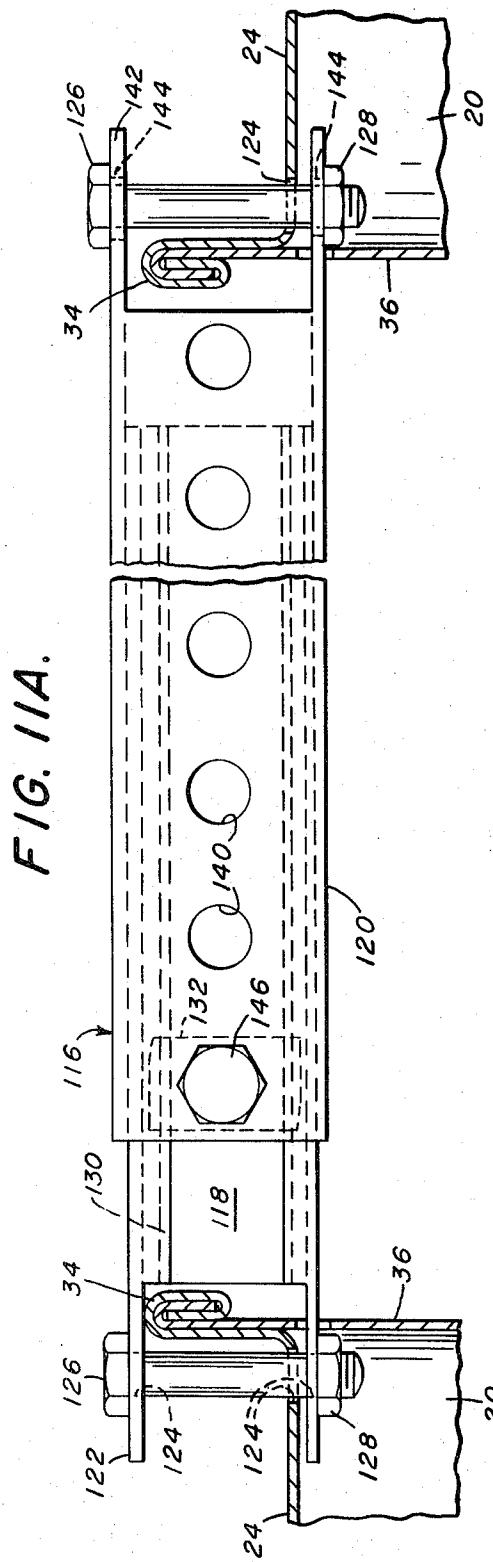


FIG. IIA.

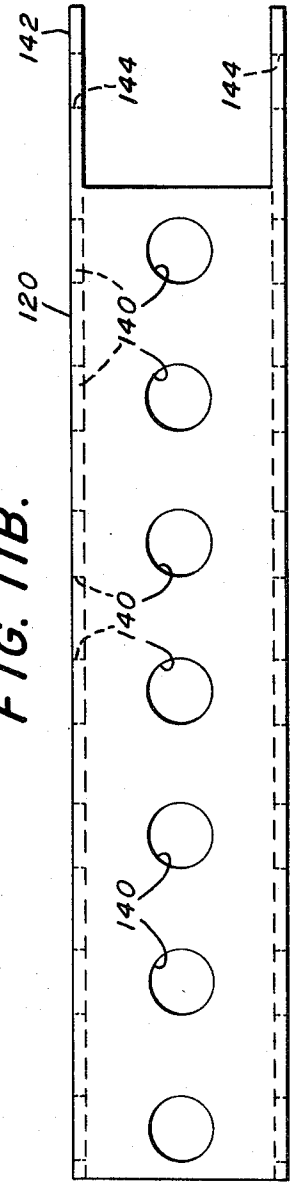


FIG. IIB.

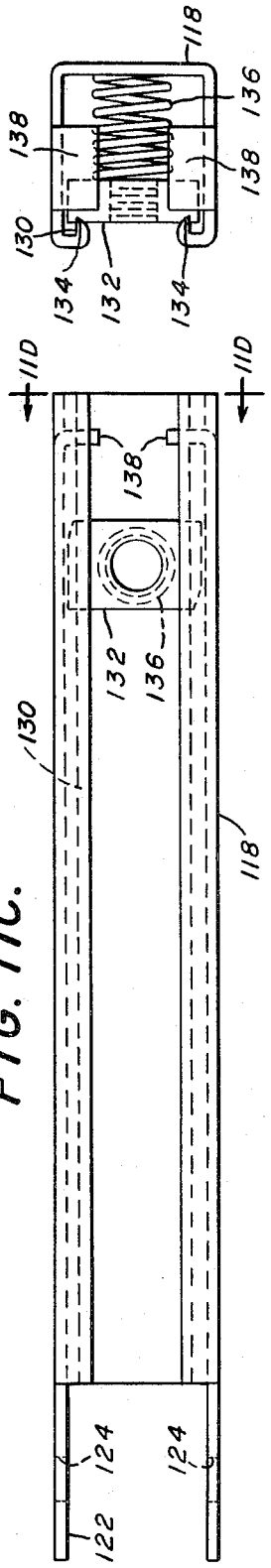


FIG. IID.

FIG. IIC.

FIG. 12.

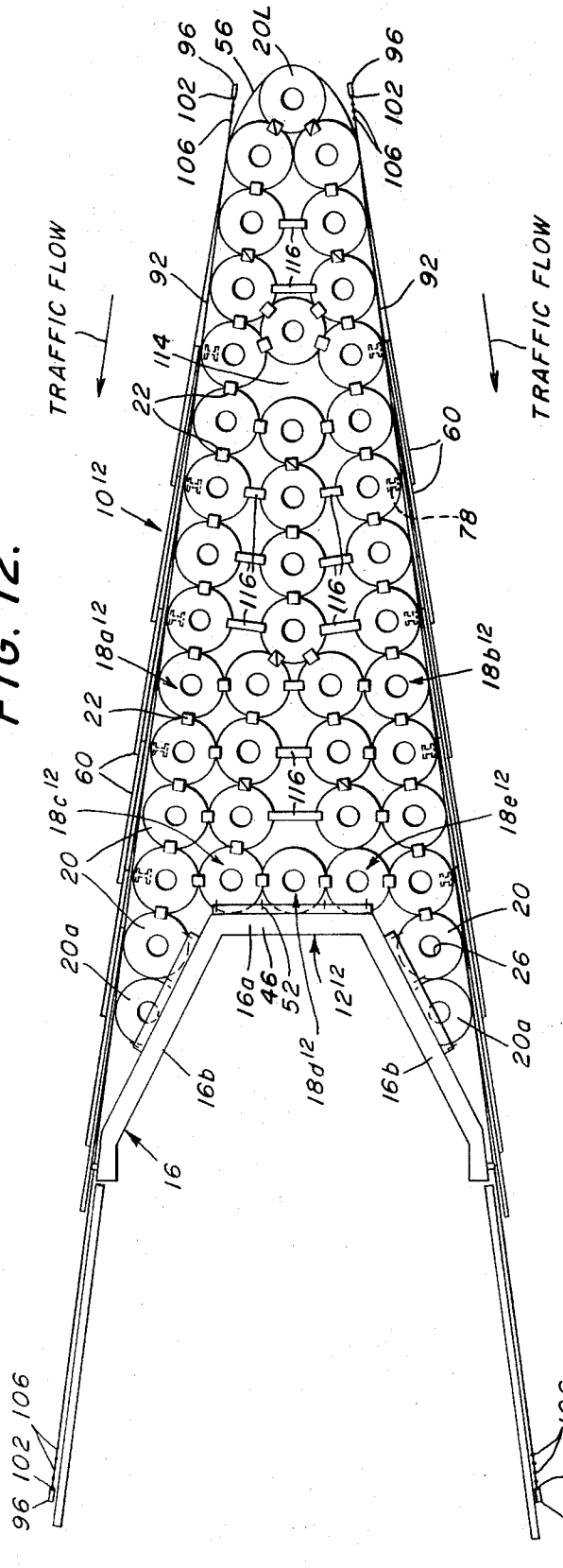

TRAFFIC FLOW
TRAFFIC FLOW
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18a 12
18b 12
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20a
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16b
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FIG. 13.

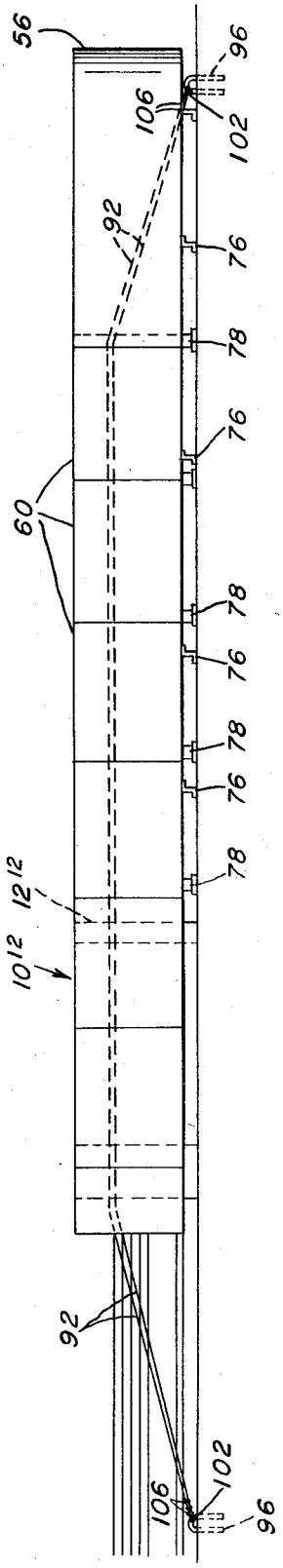

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FIG. 14.

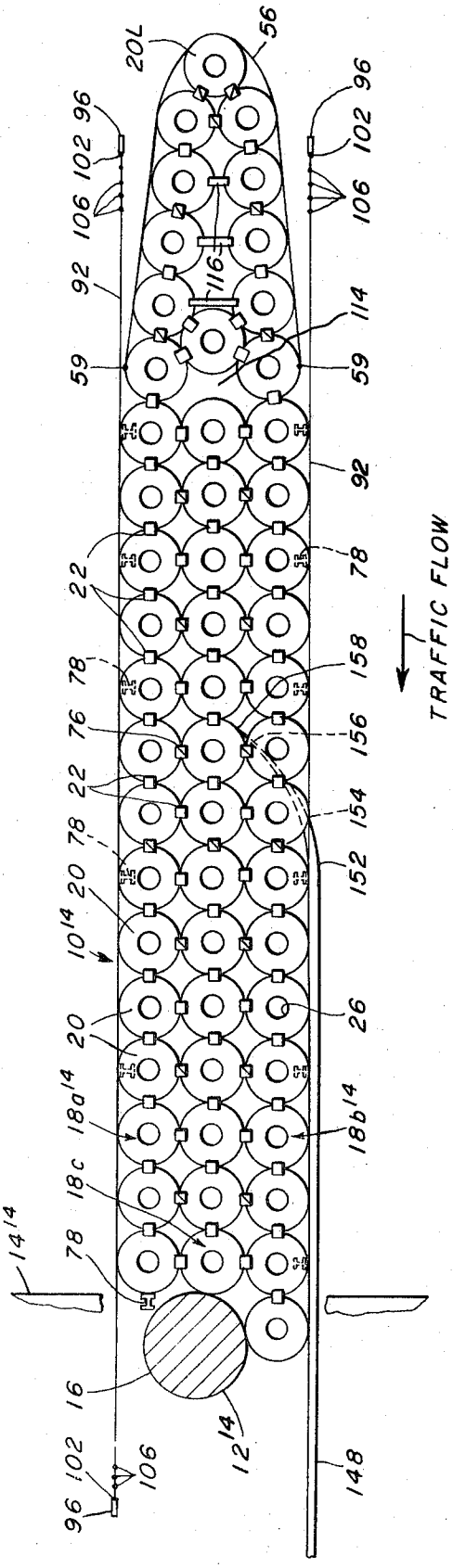
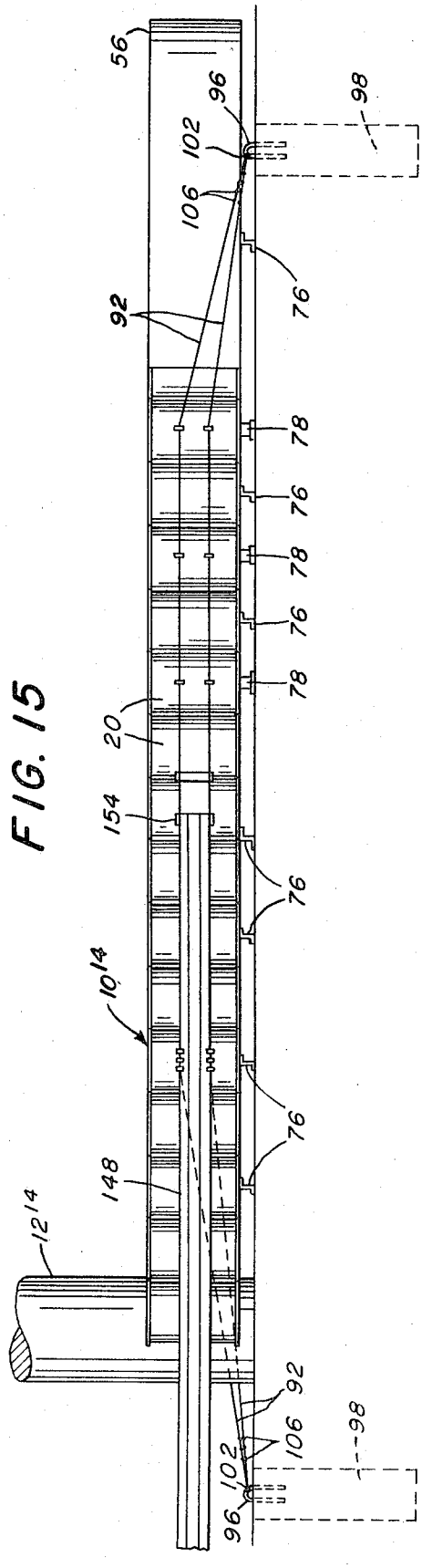


FIG. 15



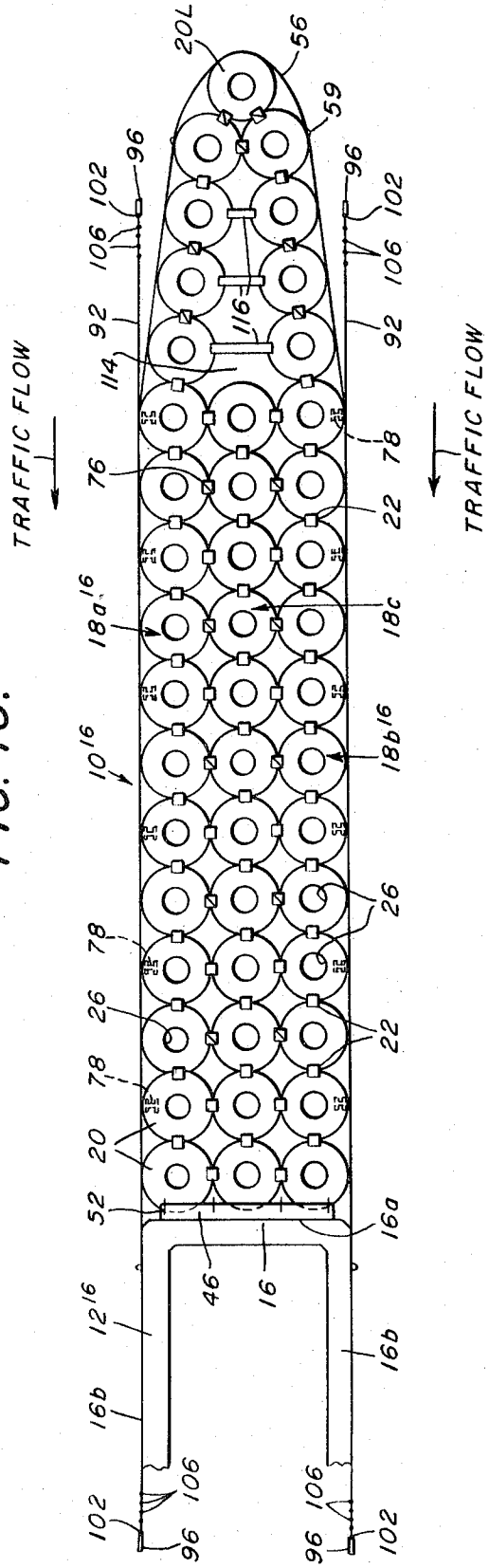

TRAFFIC FLOW
TRAFFIC FLOW
20L
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FIG. 16.

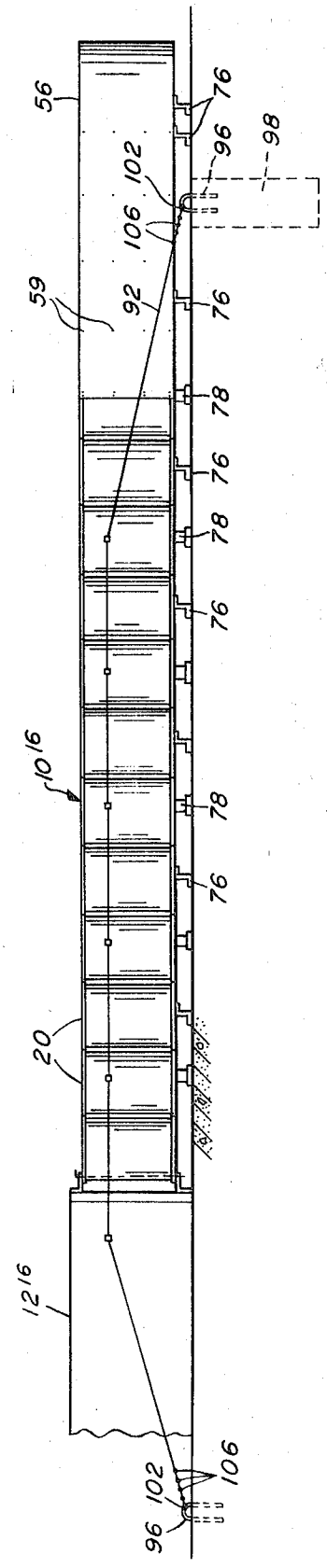

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FIG. 17.

FIG. 18.

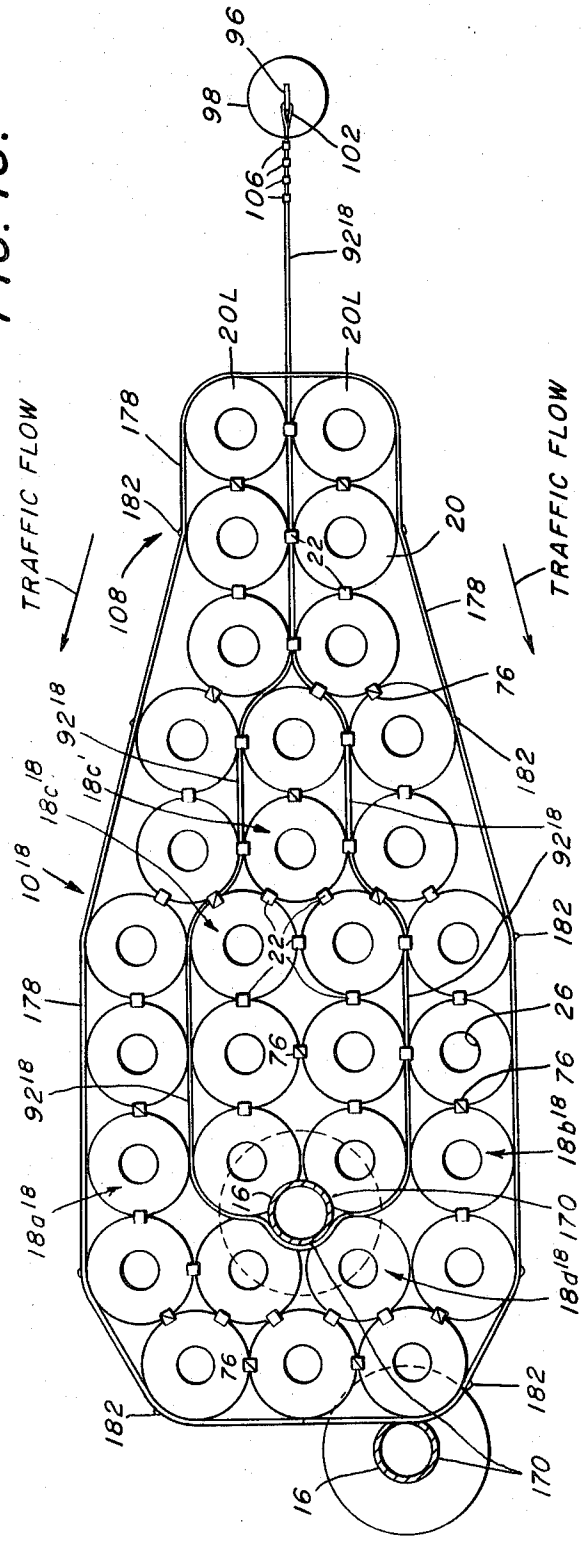

96
98
102
106
92^18
20L
20L
178
182
TRAFFIC FLOW
108
22
20
178
TRAFFIC FLOW
76
182
92^18
18c'
18c^18
92^18
10^18
182
22
178
26
92^18
76
76
18b^18
18a^18
16
170
18d^18
76
182
182
170
16

FIG. 19.

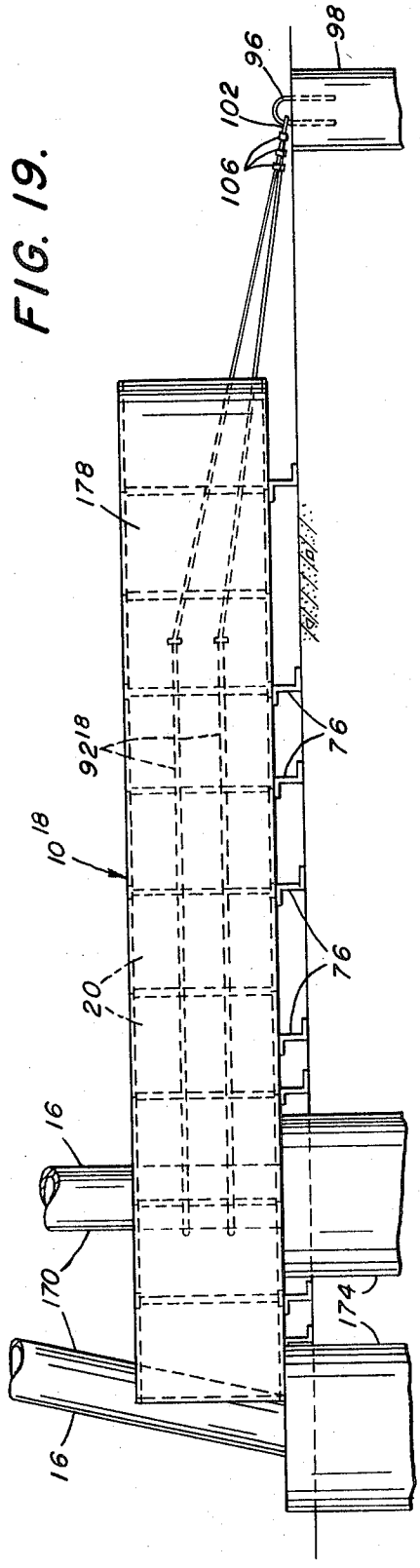

98
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102
106
178
92^18
76
10^18
76
20
76
16
170
174
16

FIG. 21.

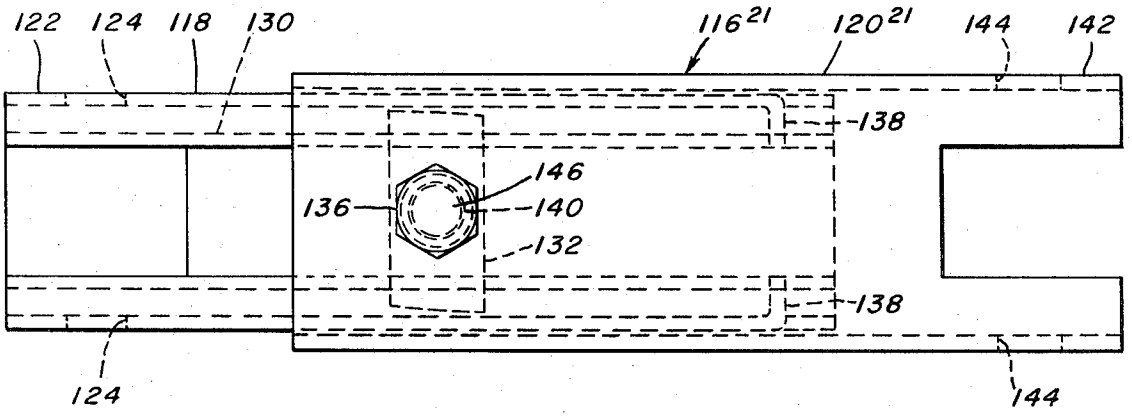


FIG. 22.

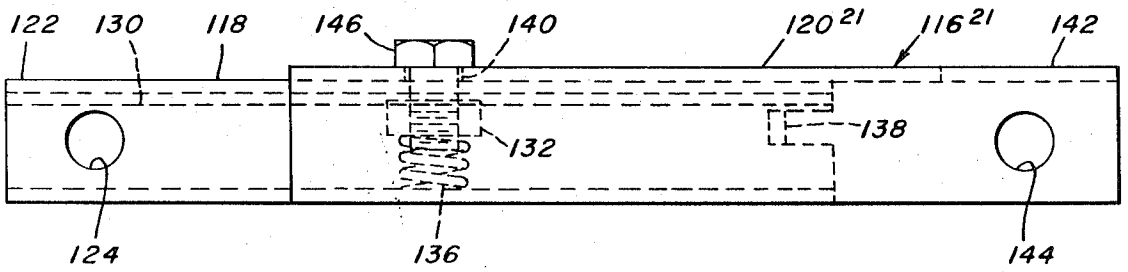
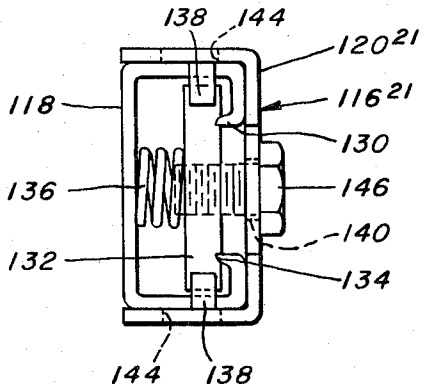


FIG. 23.



MODULAR CRASH CUSHION

This application is a continuation-in-part of U.S. Pat. Application Ser. No. 364,192 filed May 25, 1973 by the subject inventors and assigned to the same assignee as the subject application, which U.S. Application Ser. No. 364,192, now abandoned, is a continuation of U.S. Patent Application Ser. No. 203,805, now abandoned, filed on Dec. 1, 1971 by the subject inventors and assigned to the same assignee as the subject application.

BACKGROUND OF THE INVENTION

Heretofore, rigid obstacles located beside highways and freeways of the United States account for a large percentage of accident fatalities. Statistics indicate that this percentage varies between 20 and 35 percent, depending on the location from which the statistics were obtained.

A device that would cushion the impact forces on vehicles that collide with these rigid obstacles could thus save the lives of and decrease injuries to occupants of colliding vehicles, and minimize property damage to colliding vehicles.

OBJECTS OF THE INVENTION

It is the general object of this invention to avoid and overcome the foregoing and other difficulties of and objections to prior art practices by the provision of a modular crash cushion for a rigid roadside obstacle located beside a highway or freeway, which modular crash cushion:

a. uniformly cushions the impact forces created by vehicles which would otherwise collide with the rigid obstacle;
b. saves the lives of and decreases injuries to occupants in such colliding vehicles;
c. minimizes property damage to such colliding vehicles;
d. is free to slide along the surface upon impact with such vehicles;
e. is practical, economical, and aesthetically pleasing in appearance;
f. causes the vehicle to slide off the modular crash cushion to prevent pocketing of the vehicle in such modular crash cushion; and
g. in cases of impact with the cushion normal to the outer surface of the cushion will decelerate the vehicle.

BRIEF SUMMARY OF THE INVENTION

The aforesaid objects of this invention and other objects which will become apparent as the description proceeds are achieved by providing a modular crash cushion for a rigid roadside obstacle located on or beside the highway and having a contact surface facing the vehicular traffic. The modular crash cushion has a first line of drums extending forward from one side of the contact surface and a second line of drums extending forward from the other side of the contact surface and adjacent the first line of drums. Connector means connect together either adjacent drums in the first line of drums and in the second line of drums or adjacent drums in one line of the first line of drums and the second line of drums. The first line of drums and the second line of drums are connected at one end to the rigid roadside obstacle. Skid means are between the first line of drums and the highway and the second line of drums and the highway to permit the other end of the first line of drums and the second line of drums to move on impact between a vehicle and the modular crash cushion.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

For a better understanding of this invention, reference should be had to the accompanying drawings wherein like numerals of reference indicate similar parts throughout the several views and wherein:

FIG. 1 is a plan view showing a cement pier of a bridge as the rigid roadside obstacle and further showing a modular crash cushion having a first line of drums and a second line of drums extending forward in contiguous engagement from the contact surface of the pier, a warning nose portion of the modular crash cushion, the connecting means for adjacent drums, fish scales along the sides of the modular crash cushion, and Z-chairs and I-beams affixed to selected drums in the first line of drums and the second line of drums for use as skid means for the modular crash cushion;

FIG. 2 is a side elevational view of the cement bridge pier and modular crash cushion shown in FIG. 1;

FIG. 3 is a fragmentary vertical sectional view of one form of the connector means for connecting two adjacent drums and showing the bottom of the adjacent drum chimes resting in spaced relation on an annular shoulder on the block of the connector means, the saddle of the connector means secured about the outside of such chimes and fastening means extending through the block and the saddle for securing the adjacent chimes within the connector means;

FIG. 4 is a side elevational view of the details for securing a drum from one line of the first line of drums and the second line of drums to a backup plate on the front portion of the cement bridge pier;

FIG. 5 is a front elevational view of the warning nose portion of the modular crash cushion which nose portion is shown in its projected or flat form and is provided with warning indicia visible at a great distance from the modular crash cushion;

FIG. 6A is a side elevational view of the painted sheet metal employed as an outside surface on a typical fish scale for the modular crash cushion;

FIG. 6B is a rear view of the assembled fish scale showing the plywood sheet with the painted sheet metal affixed to the outer face of the plywood sheet;

FIG. 6C is a side elevational view of a typical plywood panel employed as a fish scale for the modular crash cushion;

FIG. 7A is a fragmentary vertical sectional view showing the bottom chimes of two adjacent drums secured in an alternate form of the connector means, wherein the bottom chimes are secured between the outer tapered surface of the block and the inner surface of the saddle and showing a Z-chair secured to the bottom of the saddle by the fastener means and extending between the fastener means and the highway pavement as one form of the skid means utilized in the modular crash cushion;

FIG. 7B is a side elevational view of two drums, and I-beam secured to each drum and projecting beyond its bottom and provided with a skid plate, the cables secured between the fish scales and the outer surface of

each drum and separated by a projection formed in the drum body;

FIG. 7C is a horizontal sectional view of the means utilized to attach a lead fish scale and the cables to an I-beam secured to a drum taken along the line 7C—7C of FIG. 7B in the direction of the arrows;

FIG. 7D is a view similar to FIG. 7C showing the attachment of intermediate and final fish scales to the I-beam secured to a drum taken along the line 7D—7D of FIG. 7B in the direction of the arrows;

FIG. 8A is a fragmentary side elevational view of the end portion of one of the cables adjacent a guard rail and showing the cable wrapped around a wire rope thimble with its free end secured to the main portion of the cable by a plurality of, for example, three wire rope clips taken along the line 8A—8A of FIG. 10 in the direction of the arrows;

FIG. 8B is an enlarged side elevational view of one of the wire clips;

FIG. 8C is a side elevational view taken along the line 8C—8C of FIG. 8B in the direction of the arrows;

FIG. 9 is a view similar to FIG. 1 of an alternative embodiment of the modular crash cushion showing a round bridge pier protected by another form of the modular crash cushion having four lines of drums and the use of outer tapered side portions along the first line of drums and second line of drums (which defined a drum cavity) thereby requiring the use of spacer means to connect the lines of drums adjacent the tapered portions of the modular crash cushion, eliminating the use of the fish scales and showing a guard rail surrounding the round bridge column embedded in the plural lines of drums to prevent impalement of a vehicle on the ends of such guard rail;

FIG. 10 is a view similar to FIG. 2 of the alternative embodiment of the modular crash cushion shown in FIG. 9;

FIG. 11A is a side elevational view partially in vertical section showing the spacer means employed for connecting two adjacent drums in the drum cavity and utilizing a tube as a mounting member;

FIG. 11B is a side elevational view of the tube of the spacer means;

FIG. 11C is a side elevational view of the channel of the spacer means;

FIG. 11D is an end elevational view taken along the lines 11D—11D of FIG. 11C in the direction of the arrows of the channel of the spacer means;

FIG. 12 is a view similar to FIGS. 1 and 9 and showing a concrete abutment protected by another alternative embodiment of the modular crash cushion having five lines of drums and generally tapered side portions, fish scales, and the use of the spacing means due to the tapered construction of the modular crash cushion;

FIG. 13 is a side elevational view of the alternative embodiment of the modular crash cushion shown in FIG. 12;

FIG. 14 is a plan view of another alternative embodiment of the modular crash cushion having three lines of drums for surrounding a pier of a bridge and showing the elimination of the fish scales, the embedding of the end portions of the guard rail in the lines of drums in the modular crash cushion and the use of tapered end portions on the free or outer end of the modular crash cushion thereby necessitating the use of the spacing means;

FIG. 15 is a side elevational view of the alternative embodiment of the modular crash cushion shown in FIG. 14;

FIG. 16 is a plan view of another alternative embodiment of the modular crash cushion having three lines of drums for protecting a toll booth, eliminating the use of fish scales, employing a tapered outer portion on the modular crash cushion and showing the attendant spacing means employed in the outer portions of the modular crash cushion;

FIG. 17 is a side elevational view of the toll booth and modular crash cushion shown in FIG. 16;

FIG. 18 is a plan view of yet another embodiment of the modular crash cushion having four lines of drums, employed to protect the support columns for a sign on the highway and showing the cement base for supporting the sign leg, the interior cable arrangement disposed about an internal grouping of the drums and extending forward through the nose portion to the stirrup anchored in the highway foundation or concrete;

FIG. 19 is a side elevational view of the sign legs and modular crash cushion shown in FIG. 18;

FIG. 20 is a side elevational view similar to FIG. 3, of another alternative embodiment of the connector means showing an upwardly tapered shoulder on the block, a fully threaded hole through the block and tapered guide portions on the extremities of the saddle;

FIG. 21 is a view similar to FIG. 11A of an alternative embodiment of the spacer means wherein the mounting member is a channel;

FIG. 22 is a side view of the spacer means shown in FIG. 21; and

FIG. 23 is an end view of the spacer means shown in FIG. 22 and taken from the right side of FIG. 22.

Although the principles of this invention are broadly applicable to modular crash cushions, this invention is particularly adapted for use in conjunction with modular crash cushions for a rigid roadside obstacle located either beside or on a highway and hence it has been so illustrated and will be so described.

DETAILED DESCRIPTION

With specific reference to the form of this invention illustrated in the drawings and referring particularly to FIGS. 1 and 2, a modular crash cushion is indicated generally by the reference numeral 10.

This modular crash cushion 10 is used in conjunction with a rigid roadside obstacle, such as a cement bridge pier 12 for a bridge 14 (FIG. 1) or the like, which cement bridge pier 12 has a contact surface 16 facing the vehicular traffic and including its front portion 16*a* and side portions 16*b*.

The modular crash cushion 10 has a first line 18*a* of drums 20 extending forward from one side (in this case, the right side as you face the cement bridge pier 12 in FIG. 1) of the front portion 16*a* of contact surface 16. A second line 18*b* of the drums 20 extends forward from the other side (in this case, the left hand side as you face the front portion 16*a* of the contact surface 16 for the cement bridge pier 12) and adjacent the first line 18*a* of the drums 20.

Connector means 22 (FIGS. 1, 3) are employed for connecting together either adjacent drums 20 in the first line 18*a* of the drums 20 and in the second line 18*b* of the drums 20 or adjacent drums 20 in either line 18*a*, 18*b*. As shown in FIG. 1, each of the adjacent drums 20

has a drum head 24 on both ends, each head 24 being provided with a hole 26 to facilitate the uniform cushioning collapse of the drums 20 upon impact by the vehicle (not shown) and the modular crash cushion 10.

Connector Means 22

The connector means 22 has a block 28 (FIG. 3) provided with a centrally located clearance hole 30 and an angular shoulder 32 adapted to receive the bottom portions of the spaced chimes 34 formed by the end portions of the drum head 24 and a drum body 36 of the adjacent drums 20. For the purpose of securing the outer portions of the chimes 34 against the angular shoulder 32 on the block 28, a saddle 38 (FIG. 3) is disposed about the outer portions of the chimes 34. Fastener means, such as a bolt 40 and a nut 42 or the like are employed. The bolt 40 extends through a centrally located hole 44 in the top of the saddle 38 and through the clearance hole 30 in the block 28 for affixment of the nut 42 on the projecting or depending end of the bolt 40.

Backup Plate Mounting

The means utilized to mount the left hand drum 20 in the first line 18*a* of the drums 20 and in the second line 18*b* of the drums 20 to a backup plate 46 (FIG. 4) on the front portion 16*a* of the contact surface 16 of the cement bridge pier 12 comprises, as shown in FIG. 4, a pair of angles 48 projecting from the top and bottom of the backup plate 46 and secured to the top and bottom of the backup plate 46 as by welding (not shown) or as by bolts 50 or the like. In order to permit an L-shaped attachment rod 52 (FIG. 4) to pass through the angles 48 and the adjacent drum 20 positioned between the angles 48, suitable holes 54 are provided in the angles 48 and in the drum heads 24 of the drum 20.

Nose Portion 56

As shown in FIGS. 1, 2, and 5, a warning nose portion 56 shown in flat projected form in FIG. 5 is provided with painted reflectorized warning indicia 58 and is built around a leading drum 20L (FIG. 1) on the right hand end as viewed in FIGS. 1 and 2 of the modular crash cushion 10, around the next two adjacent drums 20 in the first line 18*a* of the drums 20 and the second line 18*b* of the drums 20, and secured thereby as by screws 59 (FIG. 1) or the like.

Fish Scales 60

For the purpose of diverting a vehicle upon impact with the modular crash cushion 10, and of preventing pocketing of the vehicle (not shown) in one side of one line 18*a* or 18*b* of the drums 20, and of preventing the resultant spinning around of the vehicle (not shown) after such pocketing, sheet-like fish scales 60 (FIGS. 1, 2, 6A–6C) extend along the side portions of the first line 18*a* of drums 20 and the second line 18*b* of the drums 20. Each fish scale 60 has a plywood sheet 62 (FIGS. 6B, 6C) provided on the left-hand end (as viewed in FIGS. 6B, 6C) with a chamfer 64, and a painted metal sheet 66 (FIGS. 6A, 6C) formed with corner tab portions 68 and bendable peripheral marginal portions 70. As shown in FIG. 6B, the tabs 68 and the marginal portions 70 of the painted metal sheet 66 are formed around the back of the plywood sheet 62 to form the completed fish scale 60 shown in FIG. 6B. The method of attaching the fish scales 60 to the first line 18*a* of drums 20 and the second line 18*b* of the drums 20 is shown in FIGS. 7B–7D and will be described in detail hereinafter.

Skid Means 72

In order to provide a skid means 72 (FIGS. 1, 2, 7A) between the first line 18*a* of the drums 20 and the highway pavement 74 and the second line 18*b* of the drums 20 and the highway pavement 74 so that the free or right hand end as viewed in FIGS. 1 and 2 of the lines 18*a*, 18*b* of drums 20 may move when impacted by a vehicle (not shown), a Z-chair 76 (FIGS. 1, 2, 7A) and I-beams 78 (FIGS. 1, 2, 7B–7D) are employed.

As shown in FIG. 7A, a connector means 22^7 is employed to secure adjacent chimes 34 of adjacent drums 20 between the tapered sides of the block 28^7 and the saddle 38. The fastener means, such as a bolt 40 or the like, extends through a hole 80 (FIG. 7A) in the top of the Z-chair 76, the hole 44 in the saddle 38 and holes 30^7 in the block 28^7. It will be understood that the nut 42 shown in FIG. 3 is eliminated since the threaded bolt 40 engages threads 82 in the upper-most holes 30^7 in the top of the block 28^7. As shown in FIG. 7A, the bottom arm 84 of the Z-chair 76 engages the pavement 74.

Alternatively, the I-beam 78 shown in FIGS. 1, 2, 7B–7D is mounted tangentially to the inner periphery of a drum 20 and has its bottom portions extending beyond the bottom of the drum 20 to elevate the drum 20 from the highway surface 74 (FIG. 7B). The bottom portion of the I-beam 78 is provided with a skid plate 86 (FIG. 7B) which rests on the highway pavement 74 and has arcuate outer portions.

Fish Scale Mounting

As shown in FIGS. 7B-7D, a lead fish scale panel 60 may be secured by bolts 88 and nuts 90, which bolts 88 extend through the drum body 36 and a flange of the I-beam 78. As shown particularly in FIG. 7B, an intermediate fish scale 60 may be similarly secured by the bolts 88 and nuts 90 and may be covered by a final fish scale 60.

It will be noted from a consideration of FIGS. 7B–7D that a pair of wire cables 92 are disposed about a protuberance 94 (FIG. 7B) formed in the drum body 36 and are secured between fish scales 60 and drum body 36.

These cables 92 hold the modular crash cushion 10 together, confine the lines 18a, 18b, etc. of the drums 20 and anchor the forward portions of the modular crash cushion 10.

Cables 92

As shown in FIGS. 1, 2, 8A–8C, a pair of wire cables 92 and anchored at both ends, as viewed in FIGS. 1 and 2, in a stirrup 96 (FIGS. 1, 2) which stirrup 96 is suitably secured in concrete 98 (FIG. 2) or the like. Each of the cables 92, in addition to its securement to the I-beams 78 (FIGS. 7B–7D) is secured to the stirrup 96 in a manner similar to that shown in FIGS. 8A–8C where such cable 92 is secured to a guard rail 148. The cable 92 as described above, is provided at its end portion with a loop 100 (FIG. 8A) formed about a wire rope thimble 102 and has its free end 104 secured by wire rope clips 106 (FIGS. 8A–8C) to the main portion

of the wire cable **92**. As shown in FIGS. **8B** and **8C**, the wire clips **106** have a threaded U-portion **108** and a clamp portion **110**, which clamp portion **110** is secured on the threaded legs of the U-portion **108** in gripping engagement with the wire cable **92** by means of nuts **112** threadable on the threaded legs of the U-portion **108**. The thimble **102** prevents the cable **92** from being pulled out of the wire clips **106** when the modular crash cushion **10** is hit by a vehicle (not shown).

ALTERNATIVE EMBODIMENTS

It will be understood by those skilled in the art that alternatively, as shown in the modular crash cushion 10^9 of FIGS. **9, 10**, the right-hand portion as viewed in FIGS. **9** and **10** of the first line $18a^9$ and the second line $18b^9$ of the drums **20** may taper forwardly toward the leading drum **20L**. The intermediate lines **18***c*, **18***d* fill a drum cavity **114** (FIG. **9**) defined by the first line $18a^9$ and the second line $18b^9$ of the drum **20**, along the straight portions of the first line $18a^9$ and second line $18b^9$. However, along the tapered portion of the first line $18a^9$ and second line $18b^9$ where whole drums **20** cannot be inserted in the drum cavity **114** in substantially abutting engagement, spacing means **116** (FIGS. **9, 10, 11A–11D**) are employed as connecting means to connect adjacent whole spaced drums **20**.

Spacing Means 126

This spacing means **116** (FIGS. **9, 10, 11A–11D**) has a channel **118** which is slidably mountable in a mounting member, such as a tube **120** (FIGS. **11A–11D**) or the like. The channel **118** has a connecting portion **122** provided with registering holes **124** which holes **124** permit the insertion of a bolt **126** through such holes **124** and a similar hole **124** in the drum head **24** of a drum **20** so that a nut **128** may secure the connection portion **122** to the left-hand drum **20**, as viewed in FIG. **11A**, with the chime **34** of the drum **20** secured between the flanges of the connecting portin **122** of the channel **118**. This channel **118**, as shown in FIGS. **11A, 11C**, and **11D**, is provided with a track **130** in which a nut **132** (provided with a track groove **134**) rides. The means utilized to bias the nut **132** against the track **130** is a spring **136** or the like. In order to prevent the nut **132** from leaving the right-hand end of the channel **118**, one or more stop tabs **138** (FIGS. **11C, 11D**) are formed in the end wall of the channel **118**.

The tube **120**, suitably a box-like structure provided with a plurality of spaced holes **140** in all four sides thereof has a similar connecting portion **142** which enables a bolt **126** to pass through suitable holes **144** in the connecting portion **142** of the tube **120** and a hole **144** in the drum head **24** of the right-hand drum **20**, as viewed in FIG. **11A**, so that a nut **128** may secure the tube **120** to the right-hand drum **20** as viewed in FIG. **11A**.

In order to anchor the channel **118** (affixed to the left-hand drum **20**, as viewed in FIG. **11A**) with respect to the tube **120** (affixed to the right-hand drum **20**, as viewed in FIG. **11A**), a bolt **146** is inserted in one of the spaced holes **140** in the tube **120** and the nut **132** in the channel **118** thereby locking the drums **20** (FIG. **11A**) in the desired spaced relation with respect to each other in the modular crash cushion 10^9.

As shown in FIG. **9**, the modular crash cushion 10^9 has two guard rails **148**, each being a W-type vertically sectioned plate (FIGS. **9** and **10**), and extending along the straight portions of the first line $18a^9$ of the drums **20** and the second line $18b^9$ of the drums **20** to a point **152** where such guard rail or plate **148** turns inwardly and passes through suitable holes **154** in the drums **20** so that the end portion **156** of each guard rail **148** is secured at **158**, as by bolts, screws, or the like (not shown) to a drum **20** in line **18***c*, thereby preventing impalement of a vehicle (not shown) on the end portions **156** of the guard rails **148**.

It will be noted from FIGS. **9** and **10** that the fish scales **60** shown in FIGS. **1** and **2** have been eliminated and the nose section **56** extends along the forward tapered portion of the cushion 10^9.

FIGS. **12** and **13** show a concrete abutment 12^{12} as the rigid roadside obstacle. In FIGS. **12** and **13**, the first line $18a^{12}$ of drums **20** and the second line $18b^{12}$ of drums **20** taper continuously along their length and terminate in the leading drum **20L**. Fish scales **60** are employed in this construction and spacing means **116** are used extensively between the five lines $18a^{12}$, $18b^{12}$, **18***c*, **18***d*, and **18***e* of drums **20**.

The rigid roadside obstacle shown in FIGS. **14** and **15** and protected by the cushion 10^{14} is a pier 12^{14} for a bridge 14^{14}. The modular crash cushion 10^{14} is substantially three lines $18a^{14}$, $18b^{14}$, and **18***c* of the drums **20**. The guard rail **148** along the side of traffic flow indicated by the arrow has its end portion **156** embedded in the lines $18b^{14}$ and **18***c* of the drums **20**. The fish scales **60** are eliminated and the spacing means **116** are employed in the tapered forward portions of the lines $18a^{14}$, $18b^{14}$ of the drums **20**.

In FIGS. **16** and **17**, a toll booth 12^{16} is employed with the modular crash cushion 10^{16} having along its straight portions three lines $18a^{16}$, $18b^{16}$, and **18***c* of the drums **20**. In this embodiment, the front contact portion **16***a* of the toll booth 12^{16} is connected to the adjacent drums **20** by the construction and the attachment rods **52** and backup plate **46** shown in FIG. **4**, but not shown in detail in FIG. **16**. The fish scales **60** are not employed, but the spacing means **116** is utilized in the tapered forward portions of the first line $18a^{16}$, the second line $18b^{16}$, adjacent the leading drum **20L**.

In FIGS. **18** and **19**, the rigid roadside obstacle (i.e., a sign post, not shown in FIGS. **18, 19**) is protected by cushion 10^{18} and comprises a pair of legs **170** for the sign post. The legs **170** extend upwardly from concrete piers **174** (FIGS. **18, 19**) and the right hand leg **170** (FIGS. **18, 19**) is surrounded by drums **20** of the third line **18***c* and the fourth line **18***d* of the drums **20**. The generally S-shaped configuration of the first line $18a^{18}$ of the drums and the second line $18b^{18}$ of the drums **20** is employed. Internal, rather than external, cables 92^{18} are utilized in FIGS. **18, 19**. Each such cable 92^{18} extends around the right hand leg **170** for the sign post (not shown) and selected drums **20** of the third line $18c^{18}$ and $18d^{18}$ and then extends forwardly from a double line of six drums **20** in lines **18***c*, **18***d*, around two drums **20** of a middle line **18***c*′ and thence adjacent the forward portions of the crash modular cushion 10^{18} between the remaining three drums **20** of the first line $18a^{18}$ and $18b^{18}$ to the anchorage stirrup **96** upstanding from a concrete pier **98**. In FIGS. **18** and **19**, the fish scales **60** of prior embodiments are replaced by a sheet metal covering **178** secured to the adjacent drums **20** as by screws **182**.

FIG. **20**, which is a view similar to FIG. **3** of an alternative embodiment of the connector means 22^{20}, em-

ploys V-shaped shoulders 32^{20} to engage the bottom portions of the chimes **34.** The annular central hole **30** in the block 28^{20} is fully threaded throughout its length. The saddle 38^{20} is provided with generally square top corner portions and has a generally rounded bottom guide portion **186** on its lower extremities to permit the guided disposition of the saddle 38^{20} about the outer portions of the chimes **34.**

The drums **20** may be formed of galvanized steel, aluminized steel, high strength steel, or the like, or of a plastic, such as high density polyethylene, fiberglass, fiber board or the like. In addition, the energy absorbing properties of the modules **10,** etc. may be improved by filling the interior of each drum **20** with smaller containers, such as plastic bottles, metal cans or the like; ping-pong balls, foamed plastics, such as polyurethane, polyethylene, or the like, and if the holes **26** in the drum **20** are covered by plugs, by a fluid such as salt water, anti-freeze solution, chopped rubber tires, or the like.

In FIGS. **21–23,** the mounting member or tube **120** of spacer means **116** of FIGS. **11A–11D** is replaced by a mounting member 120^{21} (in the form of a channel) of spacer means 116^{21}.

SUMMARY OF THE ACHIEVEMENTS OF THE OBJECTS OF THE INVENTION

It will be recognized by those skilled in the art that the objects of this invention have been achieved by providing an improved modular crash cushion **10** (FIGS. **1–8C**), 10^{9} (FIGS. **9–11D**), 10^{12} (FIGS. **12** and **13**), 10^{14} (FIGS. **14** and **15**), 10^{16} (FIGS. **16** and **17**), and 10^{18} (FIGS. **18** and **19**). These modular crash cushions are employed adjacent a rigid roadside obstacle, such as a cement bridge pier **12** of a bridge **14** (FIGS. **1-8A**), a round bridge column 12^{9} for a bridge 14^{9} (FIGS. **9** and **10**), a concrete abutment 12^{12} (FIGS. **12** and **13**), a round concrete pier 12^{14} for a bridge 14^{14} (FIGS. **14** and **15**), a toll booth 12^{16} (FIGS. **16** and **17**), and legs **170** for a roadside sign (not shown), FIGS. **18** and **19.** These modular crash cushions easily and uniformly cushion the impact forces created by a vehicle (not shown) which may collide with such rigid roadside obstacles; save the lives of and decrease injuries to occupants in such colliding vehicle (not shown); minimize property damage to the colliding vehicle (not shown); are free to slide along the highway pavement upon impact by the vehicle (not shown) and cause the vehicle (not shown) to slide off the modular crash cushion to prevent pocketing of a vehicle (not shown) in the modular crash cushion and in cases of impact with such cushion substantially normal to the outer surface of the module to decelerate the vehicle (not shown).

While in accordance with the patent statutes, preferred and alternative embodiments of this invention have been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.

We claim:

1. For a rigid roadside obstacle located beside or on a highway and having a contact surface facing the vehicular traffic, a modular crash cushion having:

a. a first line of drums extending forward from one side of said contact surface;

b. a second line of drums extending forward from the other side of said contact surface and adjacent said first line of drums;

c. spacer means for connecting together adjacent drums in said first line of drums and in said second line of drums in spaced relation;

d. said first line of drums and said second line of drums being connected at one end to said rigid roadside obstacle;

e. skid means between said first line of drums and said highway and said second line of drums and said highway to permit the other end of said first line of drums and said second line of drums to move on impact with a vehicle; and

f. a pair of adjacent drums in one line of said first line of drums and said second line of drums each having a drum body and a drum head and a chime defined by the ends of said drum body and said drum head and said spacer means has:

1. a mounting member connected to one drum of said first drum and said second drum;

2. a channel slidable in said mounting member, projecting from said mounting member and connected at its projecting end to the other drum of said first drum and said second drum; and

3. fastener means for securing said channel to said mounting member;

4. said channel having a track, a nut disposed in said track, biasing means engaging said nut to maintain said nut in said track, and said fastener means extending through said mounting member into said nut.

2. The modular crash cushion recited in claim **1** wherein one of said drums has a drum head, said drum head being provided with a hole to facilitate the uniform cushioning collapse of said drum on impact between said vehicle and said modular crash cushion.

3. The modular crash cushion recited in claim **1** and having a sheet-like nose portion extending around said other end of said first line of drums and said second line of drums to warn a driver of a vehicle of the presence of the rigid roadside obstacle.

4. The modular crash cushion recited in claim **1** and having sheet-like fish scales extending along the side portions of one line of said first line of drums and said second line of drums to divert said vehicle upon impact with said modular crash cushion and to prevent pocketing of said vehicle in said one line and the resultant spinning around of said vehicle after said pocketing.

5. The modular crash cushion recited in claim **1** wherein another pair of adjacent drums in one line of said first line of drums and said second line of drums each have their bottom portions secured together by a connector means and a Z-chair is connected to said connector means and disposed between said connector means and said highway.

6. The modular crash cushion recited in claim **1** wherein said skid means has a beam secured to a drum in one line of said first line of drums and said second line of drums, said beam extending beyond the bottom of said drum to elevate said drum from said highway, and said beam having a skid member on the bottom of said beam and in engagement with said highway.

7. The modular crash cushion recited in claim **1** and having a cable fastened to one line of said first line of drums and said second line of drums to integrate said modular crash cushion and to hold it together, said cable being anchored to said highway at one end of said one line to anchor said other end of modular crash

cushion in a predetermined position with respect to said rigid roadside obstacle.

8. The modular crash cushion recited in claim **1** and having a guard rail extending from said rigid roadside obstacle along a portion of one line of said first line of drums and said second line of drums, said guard rail having its forward end buried behind said one line.

9. The modular crash cushion recited in claim **1** and having connector means for connecting together another pair of adjacent drums in said first line of drums and in said second line of drums, said connector means having:

a. a block adapted to receive one end of said adjacent chimes in spaced relation;

b. a saddle adapted to engage the outside of said adjacent chimes; and

c. fastener means extending through said block and said saddle between said adjacent chimes for securing said chimes in said connector means.

10. The connector means recited in claim **9** wherein said block is provided with a shoulder for receiving the bottom of said chimes.

11. The connector means recited in claim **9** wherein said fastener means is a bolt and a nut.

12. The connector means recited in claim **9** wherein said fastener means is a threaded member threaded into said block.

13. The connector means recited in claim **9** wherein said block is provided with a V-shaped shoulder for receiving one end of said chimes.

14. The connector means recited in claim **9** wherein said block is a resilient hollow sheet metal member.

15. For a modular crash cushion having a first drum and a second drum disposed in spaced relation with respect to each other, each of said drums having a drum body and a drum head and a chime defined by the ends of said drum body and said drum head, spacer means having:

a. a mounting member connected to one drum of said first drum and said second drum;

b. a channel slidable in said mounting member, projecting from said mounting member and connected at its projecting end to the other drum of said first drum and said second drum;

c. fastener means for securing said channel to said mounting member; and

d. said channel having a track, a nut disposed in said track, biasing means engaging said nut to maintain said nut in said track, and said fastener means extends through said mounting member into said nut.

16. The spacer means recited in claim **15** wherein said channel has stop means on the end of said channel to prevent said nut from leaving said channel.

17. The modular crash cushion recited in claim **1** wherein said mounting member is a tube.

18. The modular crash cushion recited in claim **1** wherein said mounting member is a channel.

19. The spacer means recited in claim **15** wherein said mounting member is a tube.

20. The spacer means recited in claim **15** wherein said mounting member is a channel.

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