United States Patent [19]

Charles et al.

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[54] **ENERGY ABSORBING HIGHWAY GUARDRAIL**

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[52] **U.S. Cl.** **256/13.1**

[51] **Int. Cl.** **E01f 15/00**

[58] **Field of Search** ..... 256/13.1; 61/48; 114/219; 104/254, 255, 256; 293/71 R, 72, 98; 267/139, 140

[56] **References Cited**

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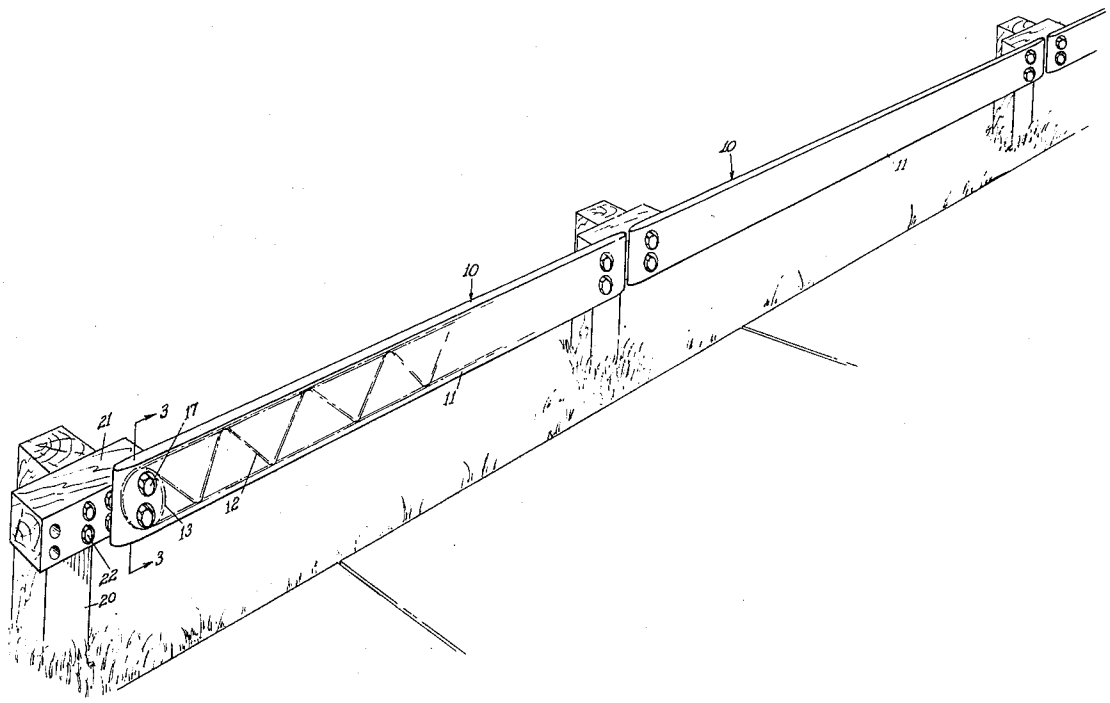
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Assistant Examiner—Conrad L. Berman
Attorney—William V. Miller et al.

[57] **ABSTRACT**

A maintenance-free guardrail for use on highways or similar use with a built-in and predictable failure rate. It is formed of a body of thermoplastic resin material, which is noncorrosive and sunlight resistant, and which has a steel rod insert embedded therein, the insert being of predetermined geometry to produce a controlled failure pattern when the guardrail is subjected to sufficient impact.

5 Claims, 11 Drawing Figures



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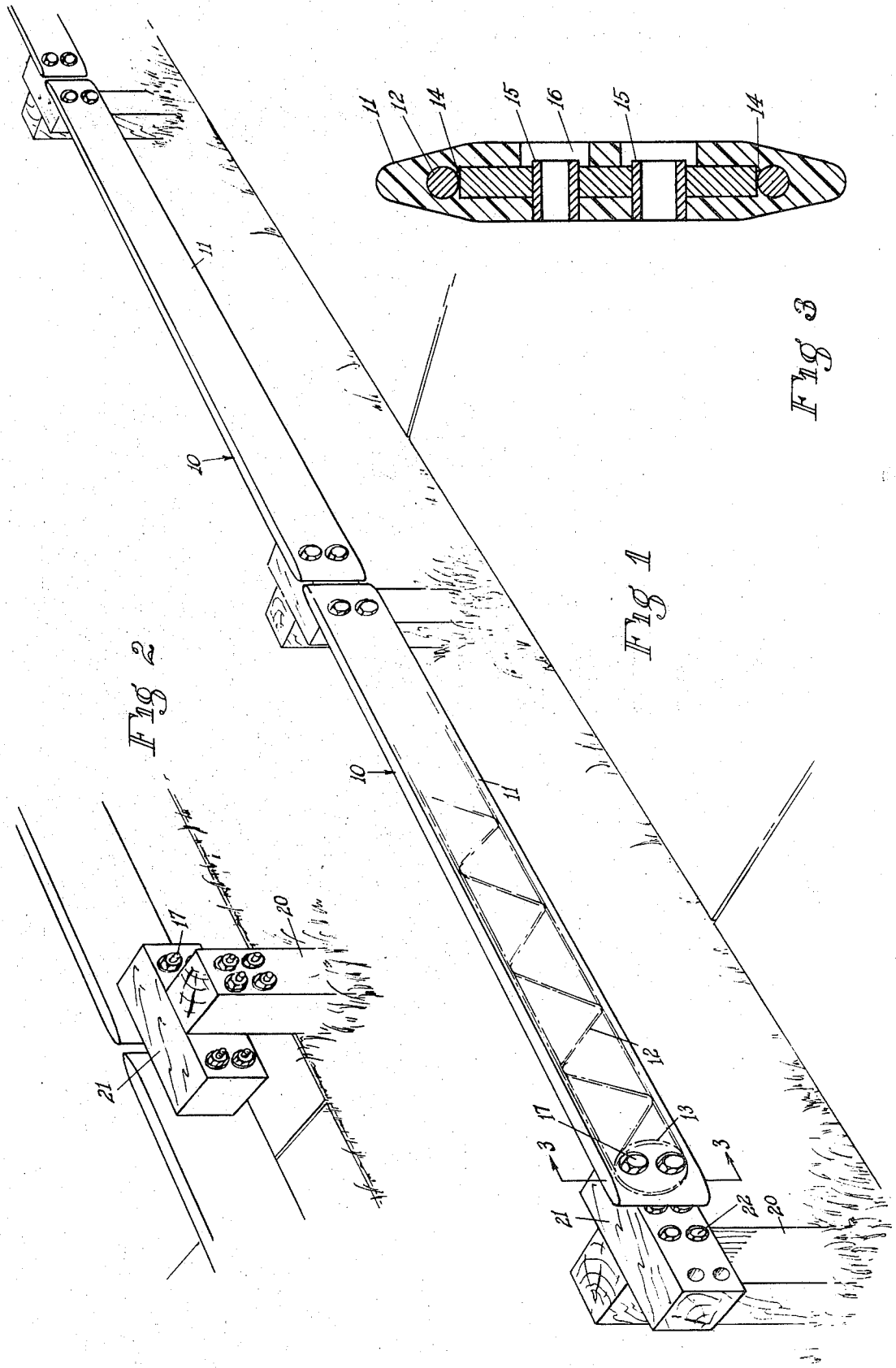


Fig 3

Fig 1

Fig 2

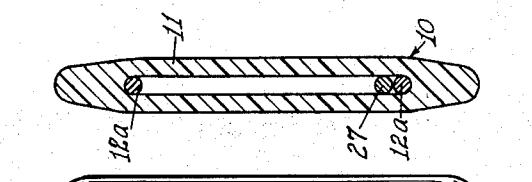


Fig 5

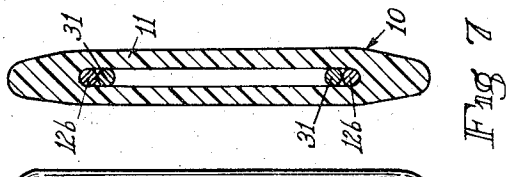


Fig 7

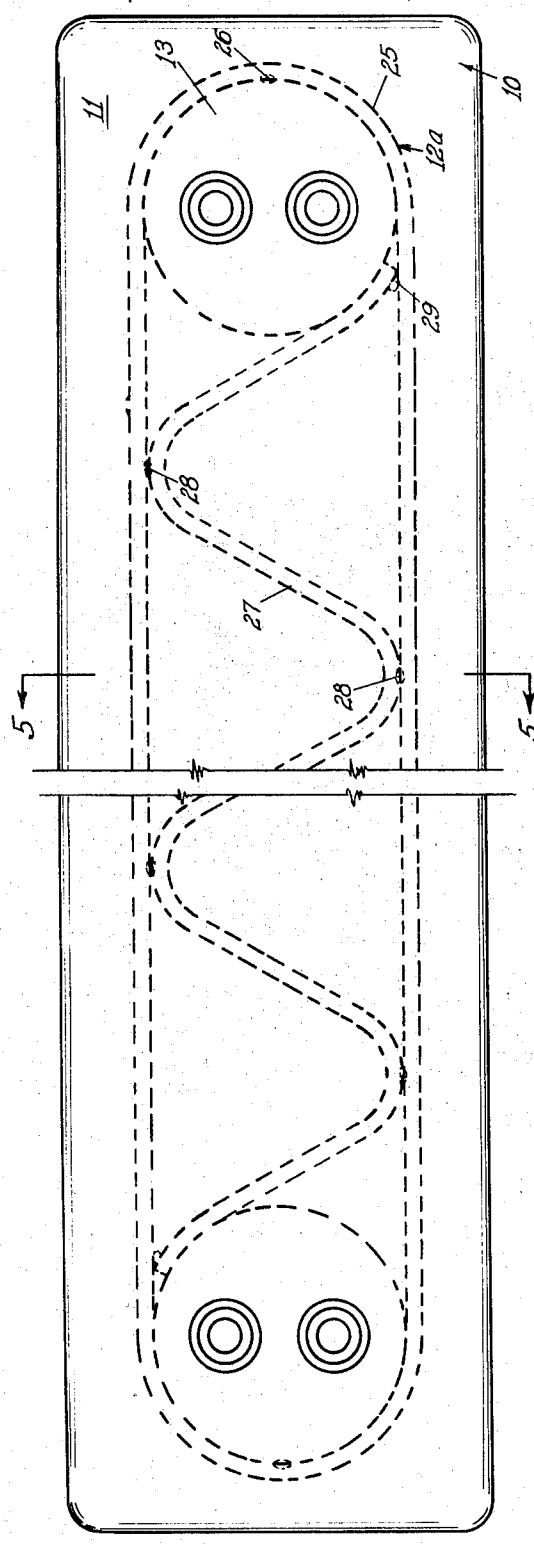


Fig 4

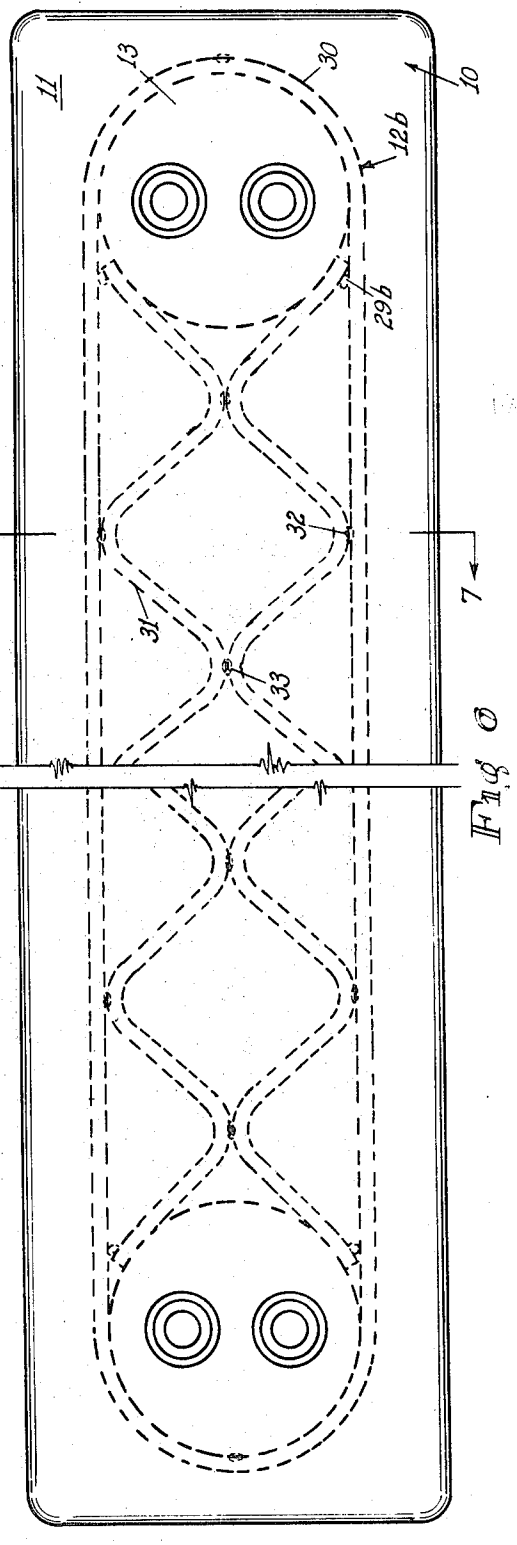


Fig 6

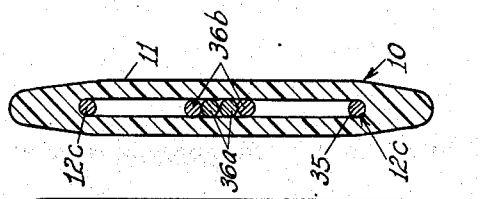


Fig. 9

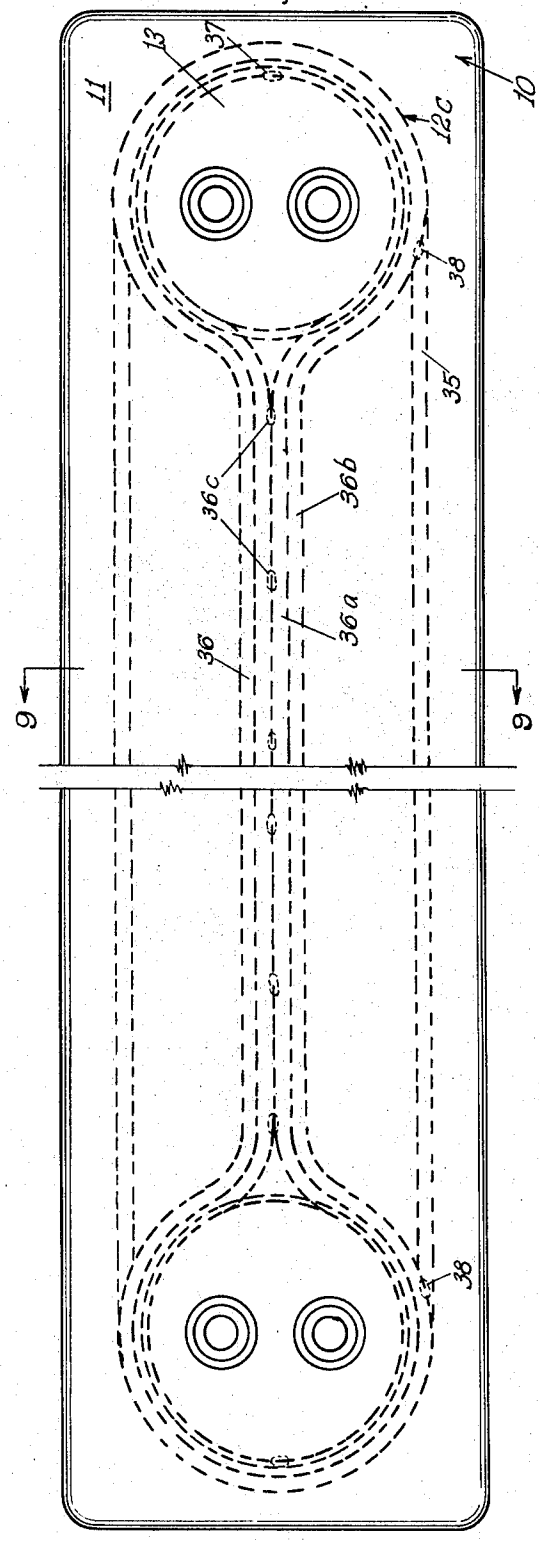


Fig. 8

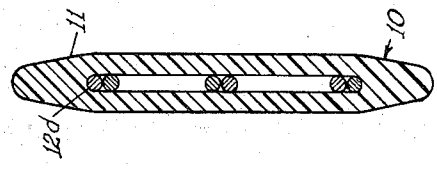


Fig. 11

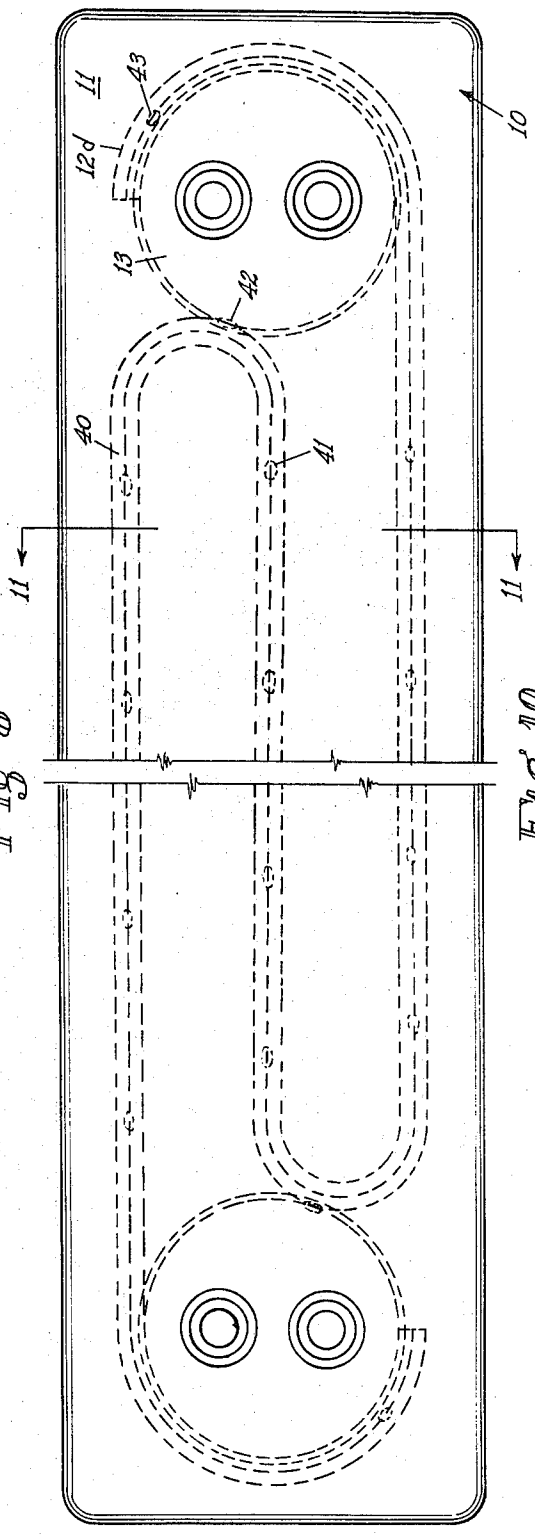


Fig. 10

ENERGY ABSORBING HIGHWAY GUARDRAIL

Steel guardrails are commonly used along highways in critically high accident areas. These do not provide sufficiently for controlled failure rate, energy absorbing capabilities, low maintenance, sign implants or color coding.

It has been determined that a guardrail consisting of a body of suitable plastic, preferably thermoplastic, having steel reinforcing embedded therein of a predetermined pattern can provide for all the desirable characteristics indicated above which are not provided for by the standard steel guardrail.

The primary objective of this invention is to provide a guardrail of the type indicated above with a built-in predictable failure rate. When struck by a high speed moving object, it will elongate but when doing so, tremendous amounts of deformation energy will be absorbed by two sources; first, the steel rod insert will absorb energy from straightening and later from elongation through tensile strain; and second, the plastic of the body will absorb energy due to massive deformation caused by the steel insert acting upon it. Thus, the moving vehicle should be completely stopped before total failure occurs.

Secondary objectives of this invention are to create a maintenance-free guardrail capable of being easily installed and designed to be interchangeable with standard steel guardrail. No up-keep will be required because the thermoplastic material used for the body shall be non-corrosive and sunlight resistant.

Other features possible include sign and signal capabilities which can be designed in the plastic body, both of which will be maintenance free and integral parts of the guardrail.

A remaining objective is to design a guardrail with all of the above features, and to keep its selling price reasonable.

The best mode contemplated in carrying out this invention is illustrated in the accompanying drawings in which:

FIG. 1 is a front perspective view, partly broken away, illustrating several lengths of the guardrail of this invention along a highway.

FIG. 2 is a rear perspective view showing the mounting and connection of two of the lengths of the guardrail.

FIG. 3 is an enlarged transverse sectional view taken along line 3—3 of FIG. 1.

FIG. 4 is a face elevational view of the guardrail having one pattern of steel rod embedded in the plastic body thereof.

FIG. 5 is a transverse vertical sectional view taken along line 5—5 of FIG. 4.

FIG. 6 is a view similar to FIG. 4 showing another pattern of steel rod embedded in the guardrail.

FIG. 7 is a transverse vertical sectional view taken along line 7—7 of FIG. 6.

FIG. 8 is a view similar to FIGS. 4 and 6 showing another pattern of steel rod embedded in the guardrail.

FIG. 9 is a transverse sectional view taken along line 9—9 of FIG. 8.

FIG. 10 is a view similar to FIGS. 4, 6 and 8 showing another pattern of steel rod embedded in the guardrail.

FIG. 11 is a transverse sectional view taken along line 11—11 of FIG. 10.

According to this invention, the guardrail is made in the usual lengths and widths and is adapted to be attached to the usual posts spaced at longitudinal intervals along the highways. It is disposed upright with its width extending vertically and with upper and lower edges parallel. Each guardrail length comprises a body of thermoplastic resin of suitable thickness, which is preferably translucent or transparent and sunlight-resistant but it could be opaque. A suitable plastic is a polycarbonate known as "Lexan" which is manufactured by the General Electric Company. Another suitable plastic is "Ultrex" which is manufactured by the Spivatex Company. Steel reinforcing rods of the type commonly used in concrete are embedded in the plastic body and are arranged in a selected geometric pattern. This insert pattern of steel-reinforcing rod extends longitudinally substantially the entire length of the guardrail and each end is fixed, such as by welding, to the circumferential edge of a mounting or anchoring plate or disc which is also embedded in the plastic parallel to its front and rear surfaces. These mounting discs or plates are provided with bushings fixed thereon and through which bolts may be passed to mount the guardrail length on the support posts. Thus, the reinforcing rod patterns are connected to the posts. This arrangement of plastic body and reinforcing steel rod will result in a guardrail with a builtin and predictable failure rate when struck with sufficient force. The steel rod insert will first absorb energy by straightening and later, through elongation, due to tensile strain. The plastic mass of the body will also absorb energy due to massive deformation caused by the steel insert acting upon it during deformation of the steel.

In FIGS. 1 to 3, there are illustrated guardrail lengths 10 embodying this invention. Each length comprises a body 11 of plastic, having a steel rod reinforcing insert 12 therein and extending the length thereof. The anchoring or mounting discs at each end are indicated at 13. The discs and rod insert are embedded in the plastic in a common plane midway between the front and rear surfaces thereof. The discs and inserts are shown in broken lines but if the body is diaphanous they would be visible. Each end of the rod insert 12 is welded at 14 to the circumference of the adjacent disc 13. Each disc is shown as having a pair of vertically spaced bushings 15 welded in openings therein and extending front to rear. Each bushing (FIG. 3) extends from the rear surface of the plastic body to a countersunk opening 16 formed in the front surface thereof. High tensile strength mounting bolts 17 will extend through these bushings and their heads will be in the countersunk openings 16.

In mounting the guardrail lengths 10, the ends are fastened to adjacent vertical posts 20 having their lower ends embedded along the side edge of the highway. The ends will be fastened by a pair of bolts 17 to one end of a block 21 which, in turn, is bolted crosswise by the bolts 22 to the upper end of the posts 20. The ends of the adjacent lengths 10 will be close to each other but will not abut, as indicated in FIGS. 1 and 2.

Four different patterns of the reinforcing rod insert are indicated in FIGS. 4, 6, 8 and 10. In each case the insert extends longitudinally substantially the complete length of the body of the guardrail in which it is embedded coplanar with the anchoring discs 13.

In the first example shown in FIGS. 4 and 5, the reinforcing rod insert 12*a* consists of a loop 25 which ex-

tends around the discs **13** and is spot-welded to the circumferences thereof at **26.** Another reinforcement rod portion **27** extends between the sides of the loop **25** and is of serpentine or wave form having its peaks and valleys spot-welded to the sides, as indicated, at the points **28.** The ends of portions **27** extends between the sides of the loop and the adjacent circumferences of the discs **13** at the points **29** where they are spot-welded to the discs and the sides.

In the second example shown in FIGS. **6** and **7,** the insert **12***b* consists of a loop **30,** like the loop **25** of FIG. **6,** but between the sides of the loop, two strips of rods **31** of serpentine wave form are provided and are welded to the sides of the loop at their vertices as indicated at **32.** Also, the vertices of adjacent strips contact and are welded together as indicated at **33.** The ends of the strips **31** extend between the circumferences of the discs **13** and the sides of the loop at **29***b* where they are welded to the discs and the sides.

FIGS. **8** and **9** show the third rod insert example **12***c* which also includes the outer sides **35** of a loop extending around the discs, and between the sides of the loop are the double-eye reinforcing strips **36** which wind around the discs at their ends and have straight portions extending longitudinally. The discs in this instance have their edges grooved. The strips comprise the inner portion **36***a* and the outer portion **36***b*, which have their straight adjacent portions spot-welded together at **36***c*. The inner portion of the eye-ends are welded to the discs **13** at **37.** The eyes may also be welded together at contacting points **38,** the sides **35** of the loop are formed by straight strips which have their ends welded at **38** to the outer eyes of the strips **36.**

A fourth example is indicated in FIGS. **10** and **11.** In this case the rod insert **12**d consists of a double strip **40** of Z-form which consists of reverse loops welded together at **41** and having curved closed end portions which are welded to the adjacent circumferences of the grooved discs **13** at **42.** The end extremities of the double rod turn around the opposed discs **13** in reverse directions and are welded thereto at the points **43.**

The failure characteristic common to all four design concepts are: Initial deformation occurs within the steel insert and not the plastic filler or body **11** which is a sunlight-resistant thermoplastic with a tensile strength of 6,000 psi or more. The plastic filler is deformed by the insert as it changes configuration. The mounting plates for all models are the same and interchangeable with each other. All models are designed to absorb a large amount of energy during impact with a moving vehicle through cold working of the plastic filler by the steel insert.

The first example will react as follows when struck by a moving vehicle: First, the loop border reinforcement rod weldments **12***a* will be broken and next the border rod will elongate causing considerable tensile stresses in the plastic filler. Second, the border rods will break resulting in elongation of the plastic filler and straightening of the interior reinforcement rod **27.** Finally, when the rods **27** become straight and all of the plastic deforms, the rods will fail from tensile stress if the moving vehicle has not been stopped.

It is the design objective to stop all moving vehicles (automobiles) before the interior reinforcing rod **27** fails.

The second example will fail very similar to the first with the only difference being in the interior rods **31.** After the border rods **30** have failed and the plastic filler stretched, the interior rods **31** will also be straightened and separated due to the centerline weld pattern. Once they are straight and parallel in respect to each other, they may fail if subjected to further external forces.

The third example is similar to the fourth and different from both the first and second. When subjected to the impact of a moving vehicle; the border rod **35** first elongates, causing limited deformation within the plastic. Then, the internal rods **36** are also stretched and initiate a complex stress geometry within the plastic and around the mounting plates **13.** If the external force from the vehicle continues; the border rod **35** will fail from tensile stress/strain, and next the centerline welds of the internal rods **36** will be broken. If further failure occurs, the plastic filler will have to split on a longitudinal basis, and finally the parallel portions of rods **36** will be broken from tensile stress/strain.

The fourth example will start its failure pattern by breaking the two welds **42** between the internal rods **40** and the mounting plates **13.** After this has occured, the loosened insert **12**d will deform the plastic filler while it straightens the rods. There is a tendency for the rods to rotate during the straightening cycle, but this should not occur because of the restrictive forces provided by the plastic filler. Final failure will take place when the rods **40** are straight, in respect to the mounting plates **13,** and if the external force continues, the rods will fail from tensile stress/strain.

It will be apparent from the above that this invention provides a guardrail which will include a body of plastic that will be pleasing in appearance, since it can be diaphanous of various colors and of pleasing contour. It can have signs and letters incorporated in the plastic or formed in its surface. It is further contemplated that low cost sign and signalling devices can be embedded in the thermoplastic by utilizing light emitting diodes set in the patterns required. Also, the guardrail can have fluorescent of phophorescent colors embedded therein and even reflective surface formations. However, the main advantages result from its structural characteristics which provide it with a built-in predictable failure rate. When struck by a high-speed moving object it will elongate but, when doing so, tremendous amounts of deformation energy will be absorbed by the two sources, that is, first the deformation of the reinforcing rods and then the deformation of the mass of plastic.

The rail will be interchangeable with the common steel rail, will be free of maintenance because the plastic is noncorrosive and resistant to sunlight, and will be of relatively low cost.

Having thus described the invention, what is claimed is:

1. A guardrail for use along highways or the like comprising a body of thermoplastic resin material extending longitudinally and having front and rear surfaces, upper and lower edges and opposed ends, and a reinforcing steel rod insert embedded in said thermoplastic resin body, anchoring steel discs embedded in the plastic body adjacent to but spaced from the respective edges, ends and faces thereof, said discs carrying bushings with their axes so disposed that they receive mounting bolts to extend through the body, said reinforcing rod insert being embedded in the body so that it is coplanar with the discs being spaced from the

edges and the front and rear surfaces of the body and extending longitudinally substantially fron one end to the other between the discs with portions curved around the circumferences of the respective discs and secured thereto.

2. A guardrail according to claim 1 in which the reinforcing rod insert is in the form of a loop extending around the circumferences of the discs, and an internal reinforcing rod of wave-form secured to the opposed sides of the loop and extending longitudinally from disc to disc.

3. A guardrail according to claim 1 in which the internal rod of wave-form is provided as a pair of rods secured to each other and to the sides of the loop.

4. A guardrail according to claim 1 in which the insert is in the form of a reinforcing rod of double-eye form including inner and outer members having portions extending around the discs and straight longitudinal portions extending between the discs, and straight side portions extending between the outer eyes of said members and welded thereto.

5. A guardrail according to claim 1 in which the rod insert is of Z-form with its ends curving around the discs and secured thereto.

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