United States Patent

Glaesener

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[45] **Dec. 5, 1972**

[54] **ROADWAY GUARD-RAIL ASSEMBLY**

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[52] **U.S. Cl.**.....**256/13.1,** 256/1

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

[58] **Field of Search**.....256/13.1, 1; 293/1, 60, 71 R, 293/71 P; 114/219

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[57] **ABSTRACT**

A guard rail for vehicular roadways consisting essentially of box-like rail members of downwardly open sheet-metal channels filled with a foamed elastomeric synthetic resin, with blade-like posts for the rails received in the synthetic resin mass. The walls of the channel are longitudinally corrugated or profiled.

7 Claims, 12 Drawing Figures

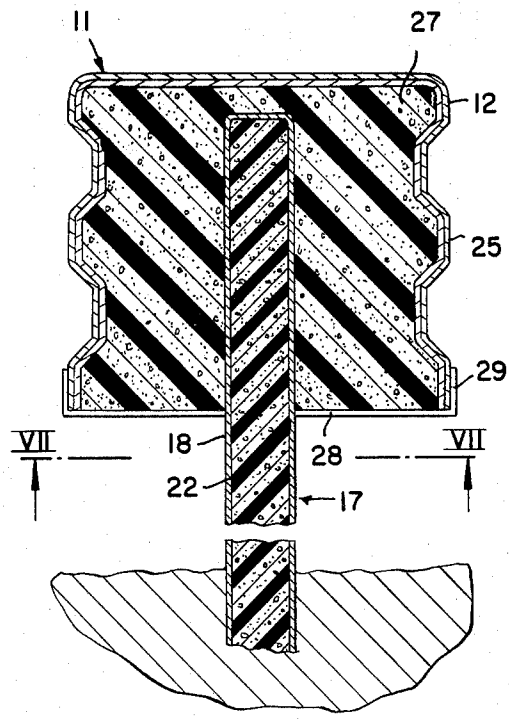


FIG. 1

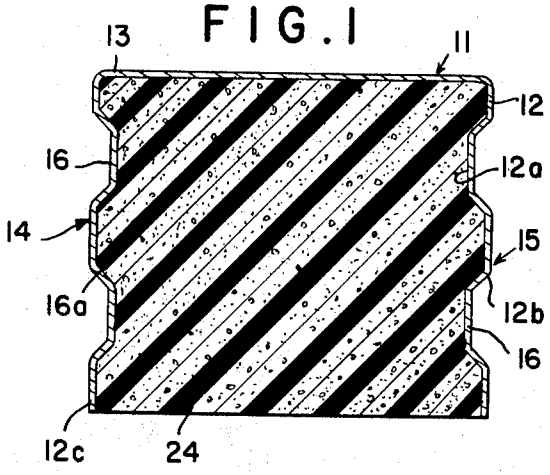
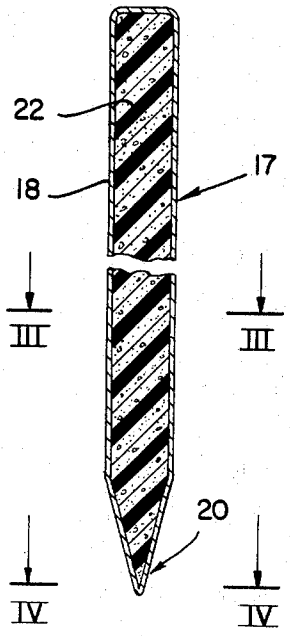


FIG. 2



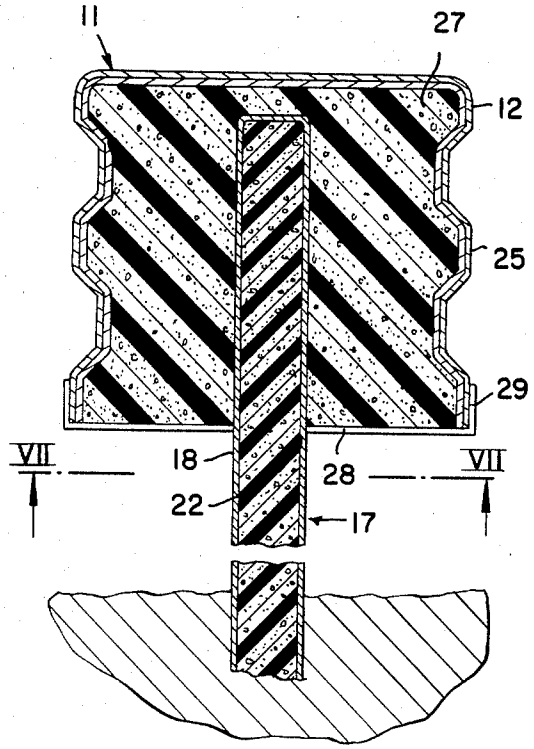
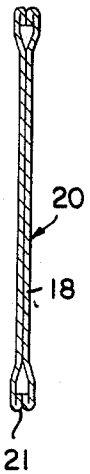


FIG. 4



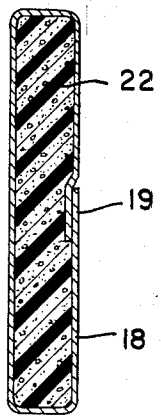


FIG. 3

FIG. 5

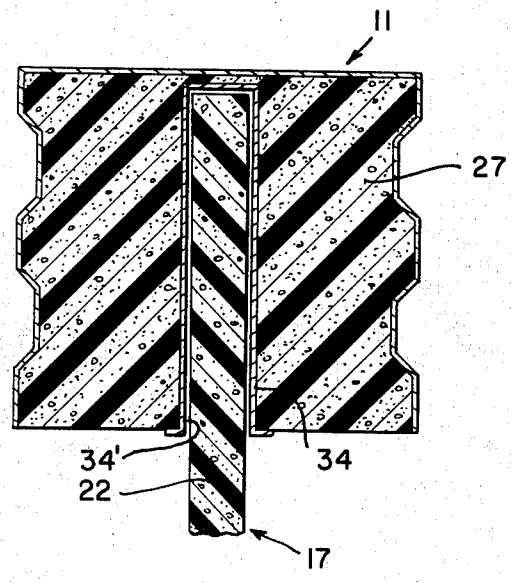
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FIG. 6



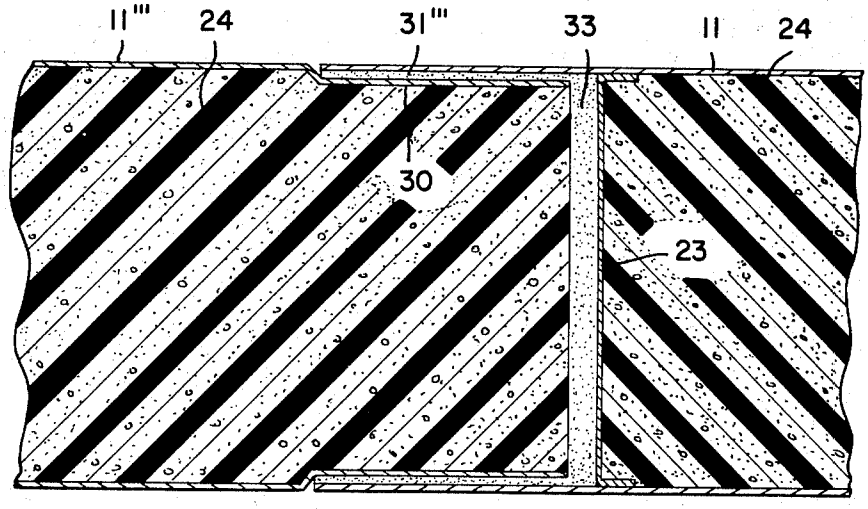
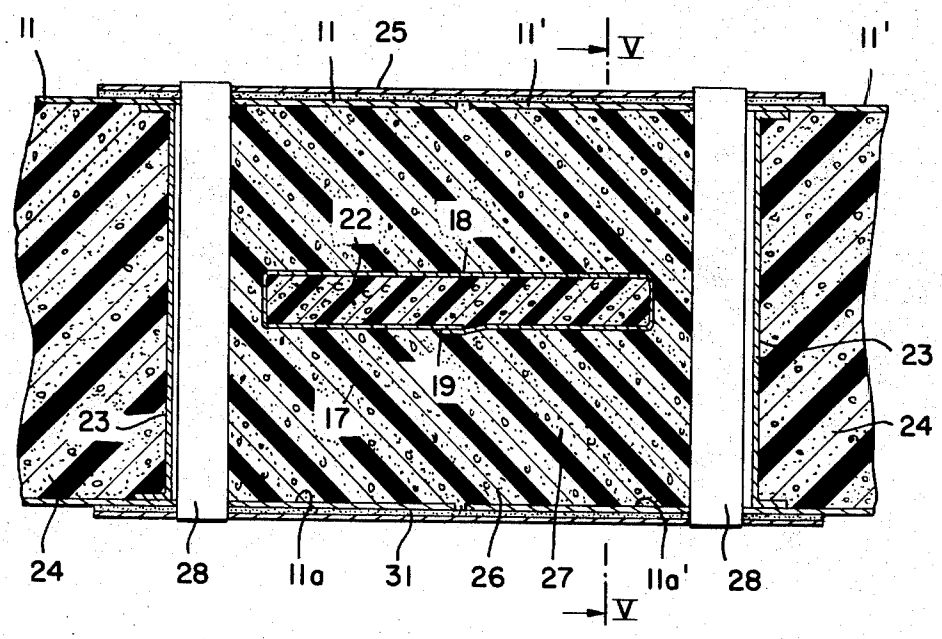


FIG. 9

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FIG. 7



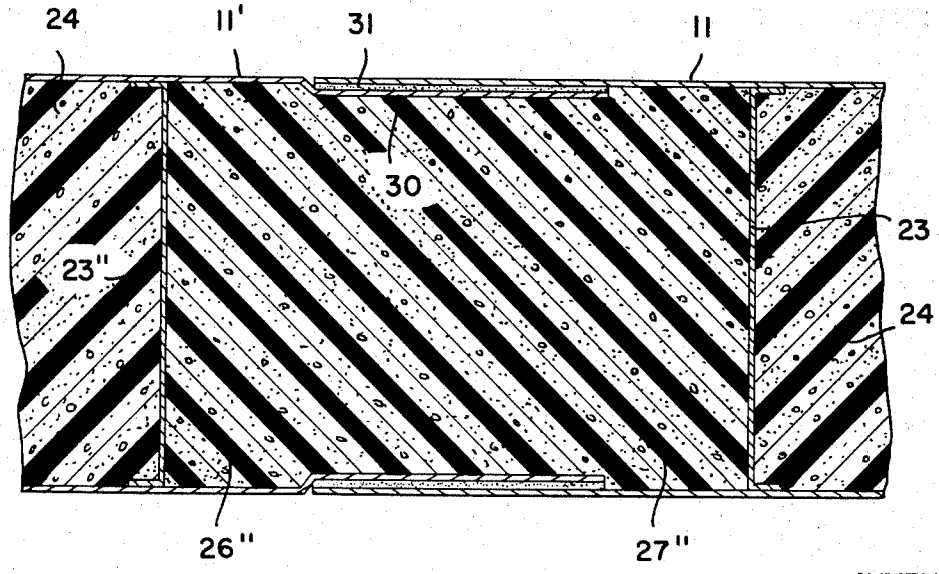


FIG. 8

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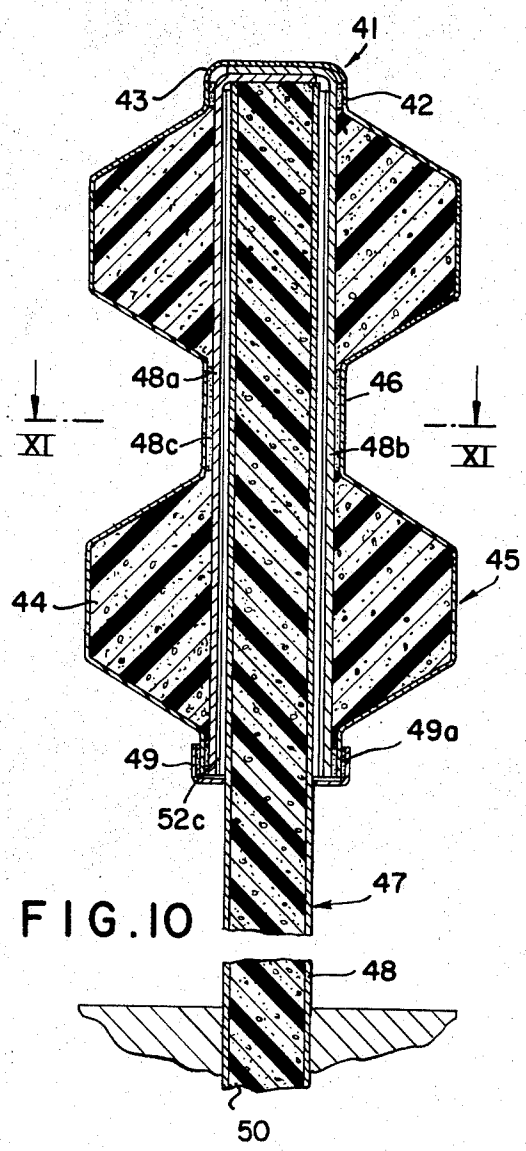
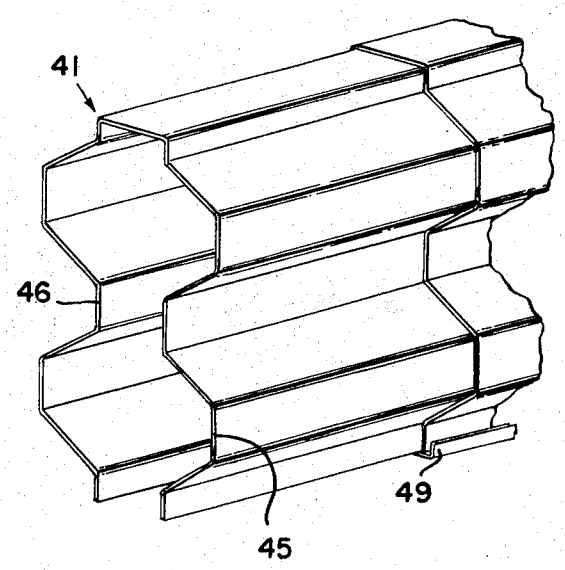


FIG. 10

FIG. 12



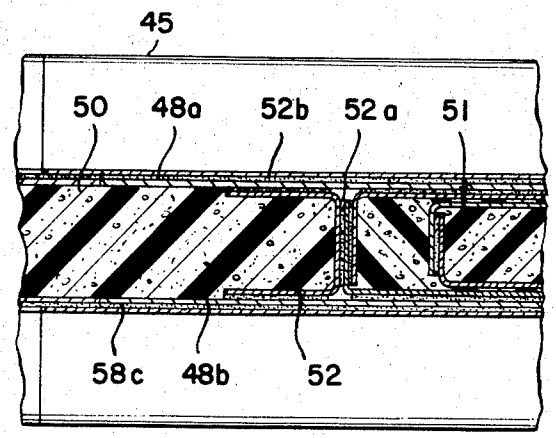
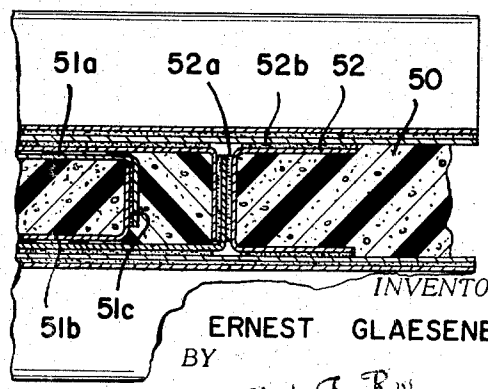


FIG. 11



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ROADWAY GUARD-RAIL ASSEMBLY

CROSS REFERENCE TO COPENDING APPLICATION

This application is related to my commonly assigned copending application Ser. No. 814,054 filed Apr. 7, 1969 (now U.S. Pat. No. 3,603,562 dated Sept. 7, 1971).

Field of the invention

The present invention relates to guard-rail structures adapted to be disposed along a roadway for preventing movement of vehicles off a road surface; more particularly, the invention relates to a guard-rail system in which a rail member is mounted upon posts alongside a roadway and is adapted to absorb the impact of a vehicle colliding with the rail.

Background of the invention

Numerous guard-rail systems have been proposed heretofore for lining the shoulders of a roadway where a precipitous drop or lack of supporting surface makes vehicular movement off the roadway dangerous to the vehicle and its occupants. Similar barriers have been provided along the medians of divided roadways to prevent vehicles traveling in one direction from passing into the lanes of vehicles travelling in the opposite direction. Guard rails have also been used on bridges, traffic-merger locations, transition strips between main roadways and exit roads, and elsewhere, wherever it is desired to protect the vehicle against movement off the roadway, movement from one lane to another, and movement into the path of oncoming vehicles.

While guard-rail structures for this purpose frequently receive the impact of negligently driven vehicles or those of distracted motorists, their principal utility is in preventing damage and limiting danger where loss of control of the vehicle is a problem. Consequently, the guard rails must be able to absorb the kinetic energy of impact in large measure, must be sufficiently yielding to prevent a rebound from the rail into lanes of moving traffic, must be sufficiently strong to prevent penetration of the rail by a colliding vehicle, and must be sufficiently inexpensive as to warrant use of the guard rail.

Numerous guard-rail structures have been proposed. Perhaps the simplest conventional guard-rail system is a concrete median or barrier cast in situ and having the principal disadvantage of being nonyielding so that, if the vehicle itself does not absorb the kinetic energy of collision by crushing of the vehicle structure, it tends to leap the median and render the latter ineffective.

Another common guard-rail structure provides a plurality of posts in spaced apart relationship along the side of the road, and corrugated or profiled sheet-metal members spanning these posts which are spaced apart at the relatively small distances of 2 to 4 meters. Such rails are composed of relatively heavy sheet metal to provide the necessary resistance to penetration by collision, but are characterized by a high elasticity so that the vehicles contacting such rails are often thrown back into the path of moving traffic. A part of the problem, of course, is the relatively close spacing of the posts which limit the yielding of the rail. Attempts to increase the distance between the posts have failed because the sheet metal rail planks tend to twist if required to span large distances.

Lesser used systems include cable arrangements in which a synthetic-resin body is provided upon one or more cables and the latter are spanned between pairs of posts. In these systems the synthetic resin is incapable of absorbing more than a minor part of the kinetic energy of collision, the greater portion being applied to the cable. Since the cable acts as an elastic member, it tends to spring the vehicle back into the path of traffic.

In my copending application Ser. No. 814,054, entitled "Vehicle Guard Rails" and identified earlier, I have described systems capable of avoiding these disadvantages and including arrangements in which the guard rail is a downwardly open channel composed of a sheet metal whose thickness is not sufficient in itself to resiliently resist the colliding vehicle. Various arrangements have been described for strengthening the rail or reinforcing the latter, and for making the rail self-supporting over long distances.

More particularly, the application describes and claims a vehicle barrier adapted to be positioned along a road and comprising an elongated vehicle-guard rail having an external surface formed from sheet metal of a thickness of at most 3 mm and of hollow profile construction. The guard rail has a pair of downwardly extending flanks connected at a bight along the top of the channel, at least one of these flanks being formed with an outwardly facing trough running the length of the guard rail and an outwardly projecting bulge extending longitudinally therealong, the troughs and bulges defining the corrugations or profiles of the channel walls. The guard rail cross-section thus includes an inwardly convex portion corresponding to the path and an inwardly concave portion corresponding to the bulge. Since the bottom of the guard rail is open, i.e. the mouth opens downwardly, the flanks of the guard rail form a longitudinally extending slot between them along the lower side of the guard rail. The posts are formed as flat keys of appropriate profile and are inserted through the slot and thereafter rotated through 90° to lock the posts in place. Each of the keys or posts has a blade portion of a configuration complementary to that of the interior of the guard rail and a shank portion extending from the blade portion and receivable in a socket driven into or otherwise disposed in the ground. Preferably, each guard rail has complementary or geometrically similar inner and outer walls defining a space between them, and a filler received in this space. The entire guard-rail structure may be filled with an impact dampening filler between the keys, this filler supporting the lateral walls of the channel. While such systems have proved to be effective, it has been considered desirable to provide less expensive structure utilizing some of the principles of the afore-mentioned application.

Objects of the invention

It is, therefore, the principal object of the present invention to provide an improved vehicle guard rail avoiding the disadvantages of the prior-art systems and extending principles of my earlier application.

Another object of this invention is to provide a guard-rail structure of simple manufacture, low mounting cost, high strength and resistance to impact of vehi-

cles, low elasticity to prevent undesirable rebounding, and high resistance to corrosive attack or weathering.

It is also an object of this invention to provide a guard-rail structure for the purposes described which has a long useful life, reduced tendencies to rebound vehicles or enable them to roll over the barrier, and low production and mounting costs.

Summary of the Invention

These objects and others which will become apparent hereinafter are attained, in accordance with the invention, in a vehicle barrier or guard-rail structure comprising a guard rail and posts supporting same, the guard rail being formed of a downwardly open box-shaped channel of thin sheet metal, preferably unitary (i.e. in one piece) over at least three sides, the interior of which is filled from flank to flank with a foamed or cellular elastomeric synthetic resin bonded to the inner basis of the channel and enforced transmitting relationship between the afore-mentioned flanks. Advantageously, the inner surface of the sheet-metal channel (as well as the outer surface thereof) is provided with a corrosion-resistant coating by, for example, hot galvinizing (i.e. zinc coating by hot dipping), which has been found to increase the strength of the bond formed between the sheet-metal channel and the synthetic resin. The guard rails advantageously span lengths between posts far in excess of those provided heretofore and at least about 10 meters, the foamed synthetic-resin filling (apparent density of 30 to 80 kg/m^3) within the channel serving to provide the requisite stiffness and self-supporting character. In other words, whereas the sheet-metal channel is composed of such thin sheet metal as to preclude self-supporting spans of **10** meters or more, the presence of the foam body, bonded to all of the internal surfaces of the channel and filling the latter, stiffens the guard rail without significantly increasing the tendency of vehicles to rebound therefrom, sufficiently to span such distances. Moreover, the channel is preferably non-closed, i.e. free from any rigid force transmitting member between the flanks and the free ends thereof. This is not to say that a sheet-metal enclosure member cannot be provided at the open end of the channel where the closure member does not act in inward force-transmitting relationship between the flanks of the channel. Consequently, the channel appears to have an open end and permits the synthetic-resin filler to transmit all force between the flanks of the channel.

According to a more specific feature of the invention, the cellular elastomer entirely fills the channel whose lateral walls lie at right angles to a planar top surface, the elastomer filling being flush with the mouth of the channel. The elastomer is preferably a stiff or hard polyurethane foam of the closed-cell type which is formed in situ within the channel and thus bonds effectively to all of the interior surfaces thereof. During manufacture of the guard rail, pockets or openings may be left in the polyurethane foam filling to receive the support posts which are designed to resist torsion and preferably are generally flat with a broad surface oriented parallel to the guard rail. In other words, the bending resistance of the support post is greater in the longitudinal direction (of the guard rail) than in the transverse direction thereof. To provide a suitable mounting of the guard rail upon the post, it has been found to be advantageous to dimension the interior of the socket or pocket in which it is received to be larger than the external dimensions of the posts received therein. A torsion-free mounting of the guard rail upon the post can be realized by lining the pocket with sheet metal which is bonded (during manufacture of the guard rail) to the polyurethane foam mass and may be secured to the post by an adhesive, preferably an elastic adhesive such as polyurethane.

Where the sheet metal of the channel is extremely thin (preferably of a thickness below 2mm), the guard rail filled with the polyurethane foam is found to be light compared to equal lengths of conventional guard rails. However, the bonding of the polyurethane foam at all of the interior surfaces provides resistance to torsion and bending within the guard rail and enables the latter to span distances of, say, 10 to 20 meters between support posts and hence some 4 to 6 times greater distances than the conventional post spacing. Furthermore, the mounting of the guard rail upon the posts, the manufacture of post and guard rail, and the low cost of both the guard rail and the posts represent major advantages of the present system over those of the prior art.

A further advantage of the present system can be found in the manner in which the guard rail absorbs the energy of impact of heavy vehicles, such as trucks. Heretofore, a collision between the truck and the roadside barrier has resulted in breakage of the barrier unless the latter was dimensioned to resist such breakage. In these cases, a large number of posts were provided to distribute the force of the collision and, where resistance to impact was high, there was always the danger that the truck would roll over or jump the barrier. Not only was this a disadvantage, but a close spacing of the supports invariably increased the cost of the barrier manifold. The system of the present invention provides a crushable rail designed to take up the energy of impact, limit rolling over or rebound and does so at low cost. Unless the force of collision is sufficient to break the barrier, the usual permanent distortion of the guard rail is avoided in the case of the present system because of the self-restoring quality of a filling bonded to the sheet-metal walls.

The barrier of the present invention, although composed of metal sheet as previously described, is characterized by a membrane-like engagement with the vehicle. Hence, a vehicle colliding with the barrier will deflect the latter into an S-curve or undulation which will ride along the barrier together with the vehicle, thereby precluding rebounding of the latter onto the roadway. The barrier of the present invention may have the vehicle-guide surface located significantly above the height of present barriers and, consequently, a barrier height of 70cm has been found to be advantageous. This height is capable of preventing rollover of heavy vehicles.

The system has been found to be particularly advantageous in corrosive environments, i.e. in locations in which the application of salt or other chemicals to the road is common as an ice-melting measure. A particular problem with prior-art sheet-metal barriers has been the rapid deterioration of the sheet metal due to corrosion. According to an essential feature of the in-

vention, the hot-dipped or hot-galvanized sheet-metal channel is provided to reduce corrosive attack. With closed-cell foams, as described earlier, moisture penetration into the channel is precluded, even when the lower end thereof is uncovered or open. Furthermore, the zinc coating has been found to augment the bond between the sheet metal and the polyurethane foam.

According to yet another feature of the present invention, the lengths of guard rail are formed at opposite ends with plug-and-socket formations. For example, the plug end may be filled with the polyurethane foam and may be of a cross-section reduced by the thickness of the sheet-metal channel. The socket end may have an equal length free from the synthetic-resin foam and designed to receive the plug end of a longitudinally contiguous guard rail. When the two guard rail lengths are joined in this manner, the surface exposed to the vehicles is substantially continuous. Alternatively, the junction between two guard rails may be formed by providing a connecting socket arrangement of steel sheet which covers the upper surface and walls of each channel and is bonded thereto with an adhesive. The junction may also be filled with an elastomeric material, e.g. a foam polyurethane, capable of bonding to the zinc-coated sheet-metal surfaces. This filler maintains the corrosion resistance, strength and impact characteristics of the rail even at the junctions.

DESCRIPTION OF THE DRAWING

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is a vertical cross-sectional view through a guard rail in accordance with the present invention;

FIG. 2 is a longitudinal cross-section through a support post for the guard rail of FIG. 1;

FIG. 3 is a horizontal section through the post of FIG. 2 along the line III — III thereof;

FIG. 4 is a horizontal section along the line IV — IV of FIG. 2;

FIG. 5 is a vertical cross-sectional view, generally similar to that of FIG. 1 but showing the erected guard rail and post according to another embodiment of the invention, the view being taken generally along the line V—V of FIG. 7;

FIG. 6 is a diagrammatical cross-sectional view showing the pocket receiving the post with clearance according to an embodiment of the invention;

FIG. 7 is a view taken generally along the line VII — VII of FIG. 5;

FIG. 8 is a cross-section through a guard rail junction according to the present invention;

FIG. 9 is a view similar to FIG. 8 according to another embodiment of the invention;

FIG. 10 is a vertical cross-section through a guard rail structure according to another embodiment of the invention;

FIG. 11 is a longitudinal section taken along line XI — XI of FIG. 10; and

FIG. 12 is a perspective view showing the junction zone between longitudinally adjoining rails according to the invention.

Specific Description

In FIG. 1 of the drawing, I have shown in cross-section a guard-rail structure embodying the present invention. The guard rail **11** comprises a three-sided channel **12** of sheet metal, preferably steel, which is coated on its internal surface **12***a* and upon its external surface **12***b* with corrosion-resistant layers. Preferably the channel **12** is hot-galvanized, i.e. coated with zinc internally and externally by hot dipping. Prior to galvanizing, the sheet metal has a thickness between 0.2 mm and 2.5 mm, preferably about 1.2 mm. The channel **12** is generally box-shaped, i.e. provided with an upper wall **13** and a pair of parallel flanks **14** and **15**, lying at right angles to the upper wall **13**. The upper wall **13** is planar and horizontal whereas the flanks **14** and **15** are profiled or corrugated, as described in the aforementioned copending application. More specifically, a pair of generally trapezoidal recesses **16** are provided in vertically spaced relation on each side of the channel and extend the full length thereof, i.e. in the longitudinal direction. Between these recesses **16** is a longitudinally extending bulge **16***a* of trapezoidal cross-sectional configuration.

The channel is provided with a mouth **12***c* open downwardly and uncovered in FIG. **1**. The guard rails, having the profile illustrated in FIG. **1**, preferably extend unitarily over lengths of 10–20 meters, usually about **16** meters. The interior of the channel is filled completely with a foamed synthetic resin, preferably a closed-cell compression-resistant polyurethane foam which is foamed and cured in situ within the channel and in contact with the galvanized walls of the sheet-metal channel. Surprisingly, such a firm bond is formed between the foam filling and the galvanized walls that the foam not only acts as a packing for the transfer of transverse forces between the parallel walls of the channel, but also as a bending resistance for the rail structure as a whole. More specifically, the elimination of any slip or relative movement between the foam-rubber body and the walls of the channel at the interface between them rigidifies the structure and increases its bending moment so that, in spite of the small thickness of the sheet metal, the guard rail is self-supporting. This surprising result is underlined by the fact that rubber surfaces generally have not been bonded successfully hereto fore to galvanized sheet metal.

While the modulus of elasticity, resistance, compression, strength, density and apparent density of the foam will be established in accordance with the desired resistance to bending and strength of the guard rail and, therefore, in accordance with the transverse dimensions of the box-like rail structure, it has been found that certain parameters should be observed. Preferably, the transverse width of the rail should be about 350 mm while the flank height is about 300 mm. When such a system is used as a medium separator between two lengths of oppositely moving traffic, it is desirable to employ a channel having a sheet metal thickness of 1.2 mm and a polyurethane hard foam with an apparent density of 50 kg/m^3. The polyurethane foam is produced by casting, immediately after formation, a mixture of 41 percent polyester resin containing alcoholic or hydroxylic functional groups, 53 percent of a di-isocyanate and about 6 percent of a fluorinated hydrocarbon such as that marketed under the name FREON or FRIGAN. Since the art describes many

polyurethane foam compositions of similar hardness, substantially any of these can be substituted, provided that approximately equivalent compressive characteristics are obtained. In fact, practically any of the di- or polyisocyanates hitherto used for the production of polyurethane foam and practically any of the polyfunctional alcohols which have been provided in connection therewith, may be used in accordance with the present invention as well. I prefer to use the foam designated commercially as MOLTOPREN.

The advantages of such a system are manifold. For example, the polyurethane-foam filling transfers force from one flank of said wall to the other with some dissipation and absorption of energy, although the overalll configuration need not be significantly distorted. As a consequence, the composite body retains its strength during impact of a vehicle therewith and the vehicle encounters a guard rail with significantly greater strength than guard rails of thinner sheet metal. The rebounding effect is nil. The system can be used with strong posts since a good deal of the collision-energy absorption is provided within the guard rail prior to transfer to the post. Finally, kinking of the guard-rail structure is avoided since the mass within the guard rail resists local penetration and endeavors to re-establish its original configuration immediately upon release of any applied force.

It has already been pointed out that the mouth **12***e* of channel **12** can remain open. By this I means that no special measures are required to close the mouth of the channel to gain additional strength. For example, I may provide the lower ends of the walls **14** and **15** with inwardly extending flanges or lips, adapted to underlie the body of foam polyurethane within the channel. Alternatively, I may taper the walls **14** and **15** downwardly and inwardly to provide a narrow slot through which the post may be inserted. Also, as described in connection with FIG. **5**, it is possible to cover the mouth of the channel with a plate which may bridge the two walls, but need not be disposed in force-transmitting relationship between them insofar as inward forces are concerned.

The closed-cell polyurethane foam utilized in accordance with the present invention has the advantage that it is impenetrable to moisture. The body of foam polyurethane thus seals the interior of the channel against corrosion resulting from contact with moisture, constitutes a weather-resistant filler and provides structural support for the thin sheet-metal walls. Since the guard rails of the present invention can span exceptionally long distances, they are able to follow bends in the roads more successfully and to be deformed in accordance with road curvatures without special machinery or preparation.

The polyurethane foam is polymerized and cured within the channel at the time of its manufacture and any conventional method of molding polyurethane may be used to this end. Generally, the components are mixed together and poured or injected into the channel while the latter is held in an inverted, upwardly open state, the ends of the channel being provided with walls of any desired configuration.

A smooth surface for the eventual underside of the guard rail and for the upper surface at the time the guard rail is produced by the use of a strike board or by providing a temporary cover for the channel mouth; the cover is coated with a parting material to which the polyurethane foam is not adherent.

The recesses or corrugations **16** forming the sidewalls **14** and **15** of the channel increase the resistance to compression on collision with the vehicle and also form guides restricting the tendency of an impacting vehicle to ride up along the rail. After forming and galvanization, the channel is advantageously degreased prior to the casting of the forming mixture therein. In some cases it has been found to be advantageous to apply a wash-primer or some other bonding coating, preferably of the volatile-solvent type, to increase adhesion between the foam polyurethane and the walls of the channel. A suitable primer is the solvent containing adhesive EC 1357 marketed by the 3M Company.

In FIGS. **2–4**, I have shown a post adapted to be received in the body **24** of the foam polyurethane within the channel. The post **17** comprises a sheet-steel hollow profile **18** filled at **22** with a polyurethane and preferably a polyurethane foam. The thickness of the sheet metal **18** may be about 2.5 mm and the length of the post about 400 mm while the width is about 50 mm. The height of the post can be about 1900 mm of which 1200 mm is below ground while 700 mm project upwardly above grade. As is apparent from these Figures, moreover, the support post is preferably generally flat, i.e. with a transverse width which is a minor fraction of the transverse width of the guard rail mounted thereon. The length of the support post in the longitudinal direction of the guard rail should be from 5 to 8 times the transverse width of the post. The sheet metal **18** of the post is overlapped and welded in a vertical seam **19**. When welding is not desirable, it is possible to provide a polyurethane adhesive for joining the ends of the sheet metal together. Advantageously, the sheet metal is hot-galvanized and thus bonds readily to the polyurethane filler **22**. At the lower end of the post, the sides thereof taper inwardly to a blade or edge **20** provided on opposite longitudinal sides with beads **21** in the form of reinforcing folds which enable the blade or edge to be driven readily into the ground. The folds **21**, of course, increase the stiffness of the edge.

While I prefer to use a polyurethane filler for the posts of the type described in connection with the channel filler, other synthetic resins, preferably with organic or inorganic fillers or aggregates, can be used. For instance, a wood core may be provided with the galvanized iron or steel sheet metal according to the invention. Where a resin is cast into the interior of the post, the sealing of the overlap seam **19** can coincide with the casting process.

In FIGS. **5–7**, there is illustrated another embodiment of the invention wherein, however, the same reference numerals as previously employed have been used to designate equivalent structural elements. In these Figures, a guard rail **11** is shown to be mounted upon posts **17** and a junction between the guard rails has also been illustrated. In FIG. **7**, for example, the end of one guard rail **11** is shown to be provided internally with a sheet-metal wall **23** and to have a socket portion **11***a* in the form of a portion of the channel free from the foam polyurethane **24**. An identical guard rail **11'** likewise has a foam-free portion **11***a'* aligned with

the end of guard rail **11**. The two rails **11** and **11'** are brought substantially into abutting relationship as indicated in FIGS. **5** and **7** and a pair of plates **25** provided on the opposite flanks to overlie the ends of the guard rails. Straps **28** extending over the bottoms of the guard rails, and forming saddles overlying the plates **25**, are cemented to both the guard rail surfaces and the plate surfaces contacted thereby. The support **17** is shown to extend into the chamber **26** defined between the ends of the guard rails **11** and **11'**, this chamber being filled with a polyurethane foam **27**.

In FIG. **8**, the end **11''** of one guard rail beyond the end wall **23''** thereof, is stepped inwardly by the thickness of the sheet metal as shown at **30** to form a plug and is received in the socket of the other guard rail **11**. The space **26''** between the guard rails is filled with the polyurethane foam **27''**. Here too the junction can receive a post as described in connection with FIG. **7**. Layers of polyurethane adhesive at **25** and **31** may be provided to bond the sheet-metal parts together.

In FIG. **6**, there is illustrated a pocket **34'** for the post **17** as formed by a sheet-metal sleeve **34** bonded to the foam polyurethane mass at the time of manufacture. The sleeve fits loosely upon the post. FIG. **5** illustrates an arrangement in which a lower stirrup **28** is provided across the mouth of the channel and has lateral flanges **29** extending upwardly along the lateral plates **25** in the region of the junction. The stirrup **28**, of course, is cemented with a polyurethane adhesive to these plates and is further composed, like the plates, of hot-galvanized steel sheet to bond to the polyurethane foam **27**, etc. in the junction. The stirrup **28**, of course, allows the foam to be introduced into the chambers **26**, **26''**, etc. at the erection site. The connecting plates **25** preferably are somewhat thicker than the sheet metal **12** and are of the same profile so that they lie sealingly against the lateral walls **14** and **15** and against the upper surface **13**. Where the plates **25** are of channel configuration, their internal diameter may be slightly less than the external diameter of the channels **12** so that they may be shifted over the ends of the guard rails with slightly outward springing whereby the internal resilience of the channel **25** retains the latter against the walls **13–15** in a sealing relationship. The polyurethane filling **27**, **27''** can have a higher filler content and is more dense than the foam filling of the remainder of the guard rails although other resins than polyurethane may be used here as well. The junction shown in FIG. **8** may be snug so that the lengths of the guard rail may be snapped together.

In FIG. **9**, the setback of the guard rail **11''** permits it to be inserted into the guard rail **11'''** while a further body of adhesive **33** fills the remaining spaces between the end wall **23** of one guard rail and the mass **24** of foamed polyurethane of the other. The mass **33** can be a high-density polyurethane foam as already noted.

Specific Example

A series of guard rails having the configurations illustrated in FIGS. **1** and **7** are made from hot-galvanized steel sheet with a thickness of 1.2 mm. The channels had lengths of 16 meters, widths across the flat surface **13** of 350 mm and heights along the walls **14** and **15** of 300 mm. The troughs **16** had overall widths of about 60 mm and depths of approximately 40 mm. The channels were filled with Moltopren polyurethane foam (41 percent by weight polyesterpolyol, 53 percent by weight isocyanates and 6 percent by weight Frigen 11S foaming agent). The foam had an apparent density of **50** kg/m^3. The guard rails were joined together as illustrated in FIG. **7** with a channel **25** of hot-galvanized sheet metal with a thickness of 2.4 mm and the ends of the individual guard rails were closed with sheet metal end plates such as that shown at **23** of the same profile as the interior cross-section and a thickness of 1.2 mm. The end plates were inserted during casting of the foam and bonded at their zinc layers **2** to the foam. The channel **25** had a length of about 65 cm and saddles or stirrups were provided across the bottom as shown at **28** in FIG. **5** at a spacing of about 400 mm. A socket **34** was inserted to loosely receive the post **17** which had a height of 1900 mm and was inserted in the ground so that the upper edge of the barrier stood 70 cm above grade. The composition **27** introduced into the space around the posts was, in one case, a polyurethane foam with a modulus of elasticity of 30,000 kp/cm^2. A similar rigid connection was formed at other joints using a mixture of bitumine and polyethylene in equal parts with a modulus of elasticity of 100 kp/cm^2. Thus the system demonstrates that practically any desired rigidity or elasticity of mounting can be provided in accordance with soil conditions. The barrier was tested in impacts with vehicles of various weights, was found to undulate upon glancing impact and to dissipate large amounts of energy with breakage, permanent deformation or a tendency of the vehicle to roll over.

As may be seen in FIGS. **10** through **12**, the guard rail structure **41** comprises an outer shell **43** with longitudinally extending trapezoidal bulges **45** spaced apart by a trapezoidal channel **46** and filled with foamed polyurethane at **44** in the manner previously described. The rail receives a post **47** of a flattened configuration previously described and having a sheet metal shell **48** filled with polyurethane foam at **50**. Also from FIG. **10**, it will be apparent that the walls of the outer shell at **42** and **46** closely surround a downwardly open sheet metal sleeve **48*a*** (forming a socket) which is sealed by an adhesive **48*c*** to the outer shell. The socket as shown in FIG. **10** is constituted by a pair of sheet metal members, one of which is shown at **48*b*** to overlap at the top of the other member **48*a***. At the base of the socket, a strap **49** closes the mouth of the unit and is secured by an adhesive **49*a*** to the downwardly extending flanks of the shell **43**. These flanks are in turn bonded by an adhesive to the socket **48*a***, **48*b***. A further layer of adhesive may be introduced into the space **52*c*** to bond the socket to the post.

From FIG. **11**, it is evident that the caps at the ends of each of the rails, which are filled with the less dense polyurethane foam **50**, are channels **52** which may be bonded by adhesive layers **52*a*** to the socket members **48*a*** and **48*b***. In addition, adhesive layers **52*b*** may be provided between the vertical flanks of the end pieces **52** and the inner walls **43** of the outer shell. The outer walls **43**, in turn, are bonded by adhesive layers **52*b*** to the junction sockets by which the rails are joined longitudinally. The walls **51*a*** and **51*b*** of the post (generally designated at **51** in FIG. **11**), are likewise bonded by polyurethane layers to the inner walls of the socket which may be filled with foamed polyurethane as illustrated in this Figure.

Suitable dimensions for the guard rail structure of FIGS. **10** through **12** are as follows:

Thickness of all sheet metal: 0.75 to 2.5 mm, preferably 1.25 mm;

Broad-base width of trapezoidal bulges: 75 to 250 mm, preferably **110**mm;

Depth of trapezoidal recess: between 30 and 80 mm, preferably about 54 mm;

Narrow base of trapezoidal bulges and recess: between 25 and 100 mm, preferably 48 to 50 mm;

Overall transverse width of guard rail: 125 to 250 mm, preferably about 170 mm;

Overall height of rail structure: between 200 and 400 mm, preferably about 310 mm;

Overall height of post and guard rail structure: between 1500 and 2300 mm, preferably 1900 mm;

Height of guard rail above grade: 600 to 900 mm, preferably 750 mm;

Thickness of post: between 30 and 50 mm, preferably 40 mm;

Overall width of post in the longitudinal direction of the guard rail: between 300 and 500 mm, preferably 400 mm;

Overall length of socket in longitudinal direction of guard rail: between 400 and 600 mm, preferably 500 mm;

Extent of overlap of plug and socket joint: between 200 and 300 mm, preferably about 250–260 mm.

Thickness of adhesive layers: 0.5 to 1.5 mm;

Post to post spacing: preferably 16,000 mm;

Approximate length of guard rail units, discounting overlap length of about 500 mm: 4,000 mm.

I claim:

1. A vehicle barrier forming a guard rail for a roadway, comprising:

a plurality of longitudinally aligned downwardly open sheet-metal channels of generally rectangular cross section defined by a flat horizontal wall and a pair of downwardly extending lateral walls at right angles to the horizontal wall;

a plurality of posts received with all-around clearance in said channels and extending downwardly therefrom at intervals spaced therealong of at least **10** meters, each of said posts being of generally flat blade-like configuration and having broad faces lying parallel to the longitudinal dimension of said channels;

a foamed elastomeric body filling each of said channels and interposed between each post and the sheet metal of the respective channels;

junction means interconnecting successive channels along the guard rail and defining chambers between successive channels; and

a synthetic-resin mass filling each of said chambers.

2. The vehicle barrier defined in claim **1** further comprising respective sheet metal sockets imbedded in the elastomeric body and respectively receiving each post with play.

3. The vehicle barrier defined in claim **1** wherein said lateral walls are formed with longitudinally extending recesses and bulges of generally trapezoidal configuration.

4. The vehicle barrier defined in claim **3** wherein said posts comprise a sheet-metal sleeve and a foamed-synthetic resin filling said sleeve.

5. The vehicle barrier defined in claim **4** wherein successive channels are interconnected by plug-and-socket joints, said channels are composed of hot-galvanized sheet metal with a wall thickness of **0.9** to **1.5** mm, said elastomeric body consists of a polyurethane foam with an apparent density of **30** to **80**kg/m^2, and the transverse width of each of said channels is in excess of **15** cm.

6. The vehicle barrier defined in claim **5** wherein at least one of said channels is provided with an end plate bonded to the respective elastomeric body.

7. The vehicle barrier defined in claim **5** wherein the syntehtic resin of said chambers has a higher apparent density than that of the elastomer body.

* * * * *

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,704,861 Dated 5 December 1972

Inventor(s) Ernest GLAESENER

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Between line [21] and line [52] insert:

--[30] FOREIGN APPLICATION PRIORITY DATA

29 May 1970 Germany P 20 26 224.2

29 May 1970 Germany P 20 26 225.3--

Signed and sealed this 29th day of January 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

RENE D. TEGTMEYER
ActingCCommissioner of Patents