United States Patent [19]

Loeber

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[45] **Dec. 24, 1974**

[54] **ORTHOTROPIC TRAILER**

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[73] Assignee: **Ameron, Inc.,** Monterey Park, Calif.

[22] Filed: **Mar. 16, 1973**

[21] Appl. No.: **341,874**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 221,608, Jan. 28, 1972, abandoned.

[52] **U.S. Cl.** ..... **296/28 M,** 52/674, 105/422, 280/106 T

[51] **Int. Cl.** **B62d 33/02**

[58] **Field of Search** ..... 296/28 M, 28 F; 280/106 T; 105/422; 52/579, 656, 668, 673, 674, 732

[56] **References Cited**

UNITED STATES PATENTS

1,991,484	2/1935	Ball	296/28 M
2,056,137	9/1936	Idoine	105/422
2,494,404	1/1950	Nixon	105/422 X
2,773,718	12/1956	Bohlen	296/28 M
2,812,192	11/1957	Cole	280/106 T
3,049,198	8/1962	Dobbins et al.	52/579 X

FOREIGN PATENTS OR APPLICATIONS

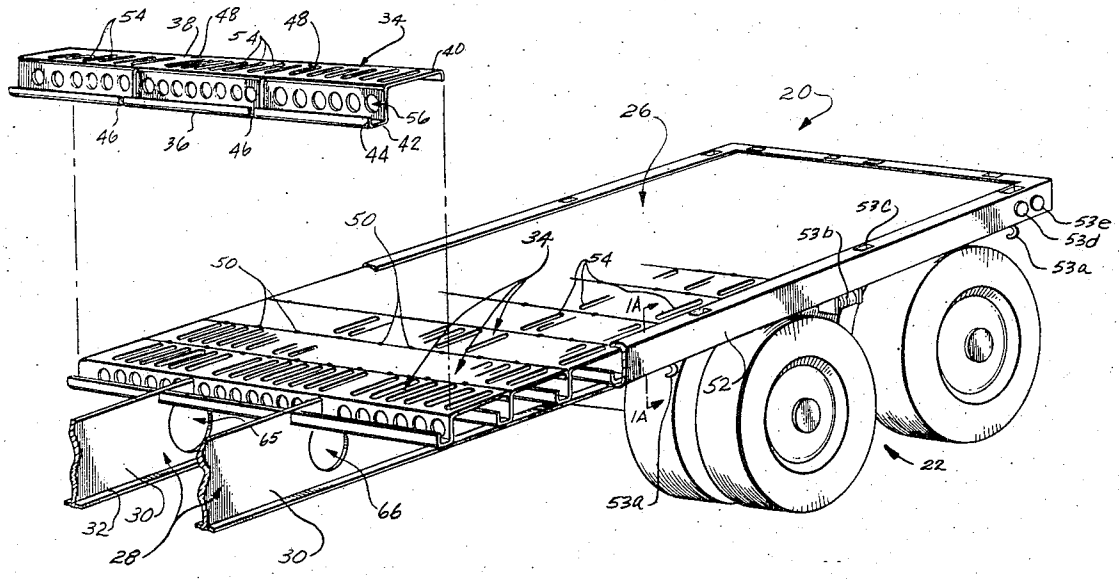
771,298	3/1957	Great Britain	296/28 M
108,279	8/1939	Australia	280/106 T

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Assistant Examiner—Leslie J. Paperner
Attorney, Agent, or Firm—Christie, Parker & Hale

[57] **ABSTRACT**

A highway trailer has a relatively low-weight, high-strength load-support bed which includes a pair of longitudinally extending, parallel, inverted T-beams, and a series of side-by-side transverse compound channel members, or pans, welded to the vertical webs of the T-beams in an orthotropic design. Preferably, each pan is substantially J-shaped in cross-section, and comprises a load-supporting horizontal top flange, a horizontal bottom flange, and a vertical web between the top and bottom flanges. The bottom flange and vertical web of each pan are slotted so the bottom of each top flange rests on the top edge of the T-beams. The top flanges are welded together to provide a continuous unitary deck surface extending the length of the T-beams. The top flange, bottom flange, and web of each pan are welded to the T-beams to provide shear continuity between the top deck flanges and the T-beams. A row of spaced apart longitudinal depressions are formed in each top flange to add stiffness to the top deck flanges.

15 Claims, 17 Drawing Figures



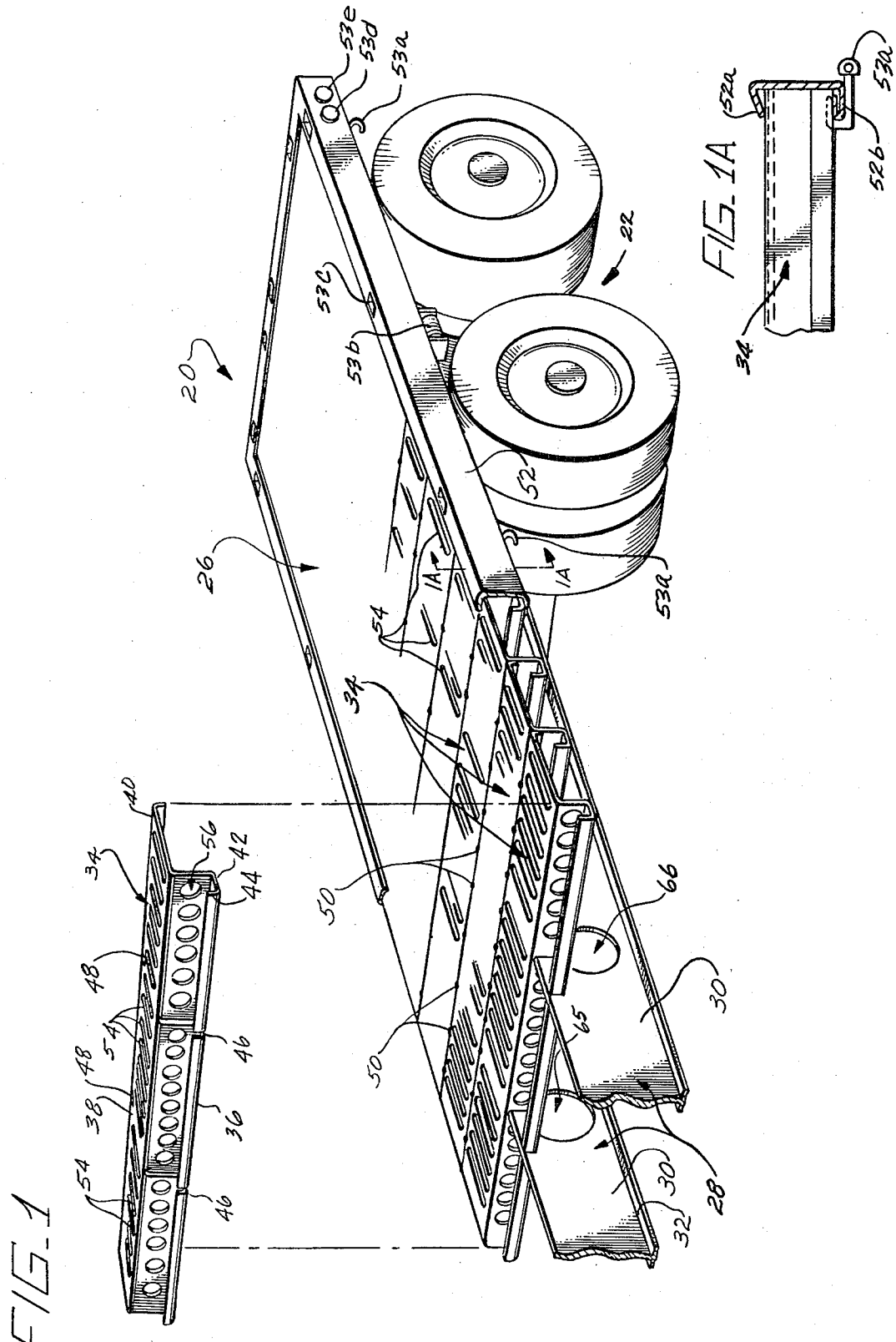

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53a
53b
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1A
1A

FIG. 1

52a
53a
52b
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FIG. 1A

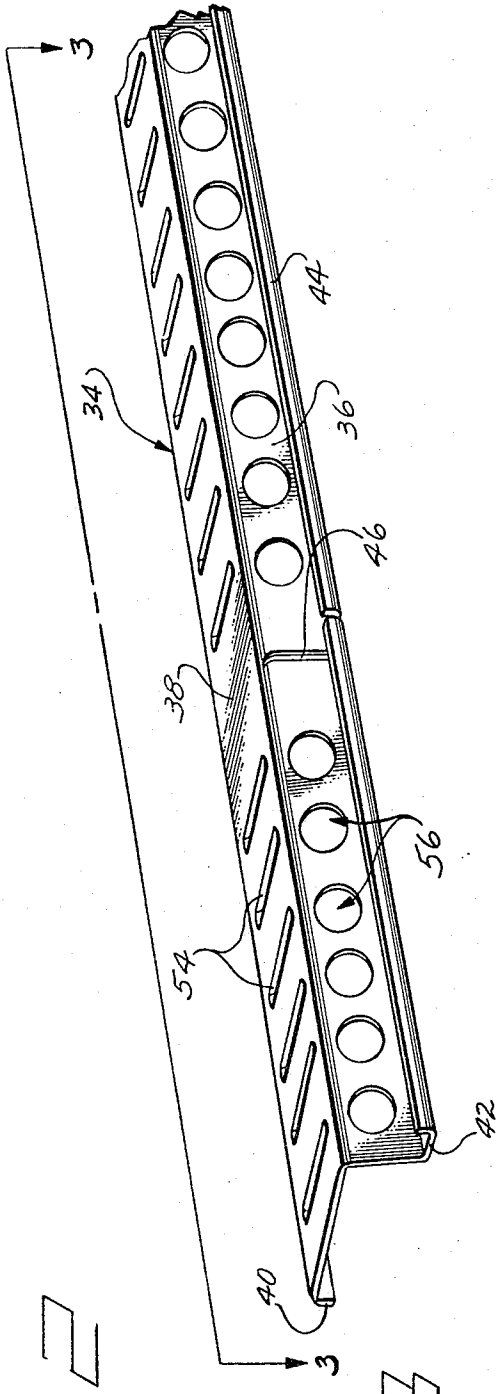


FIG. 2

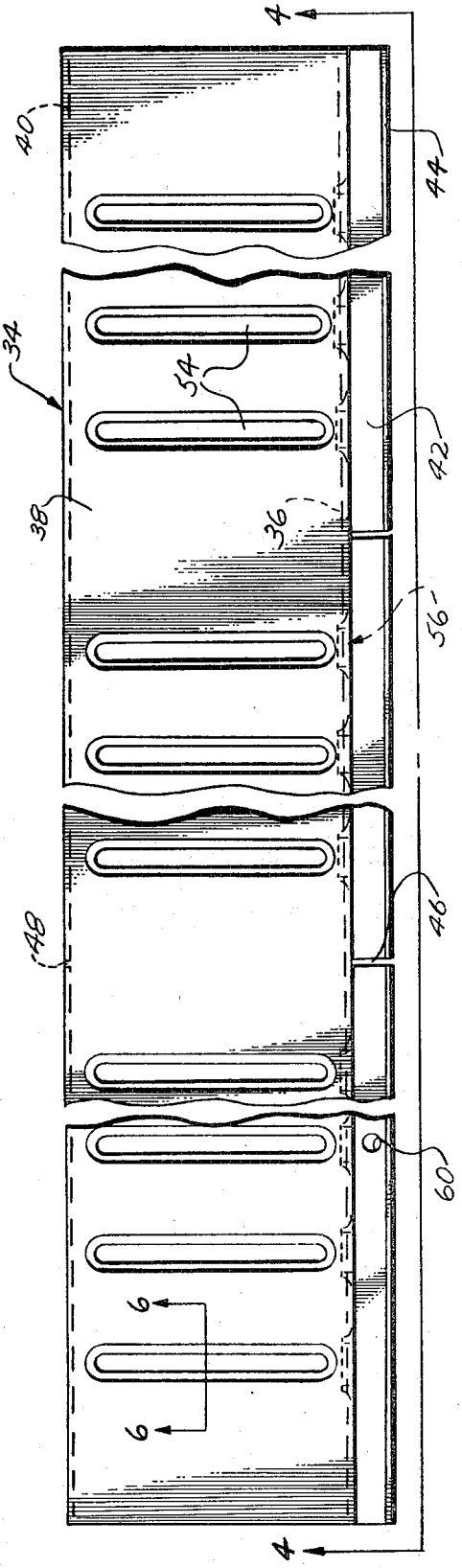


FIG. 3

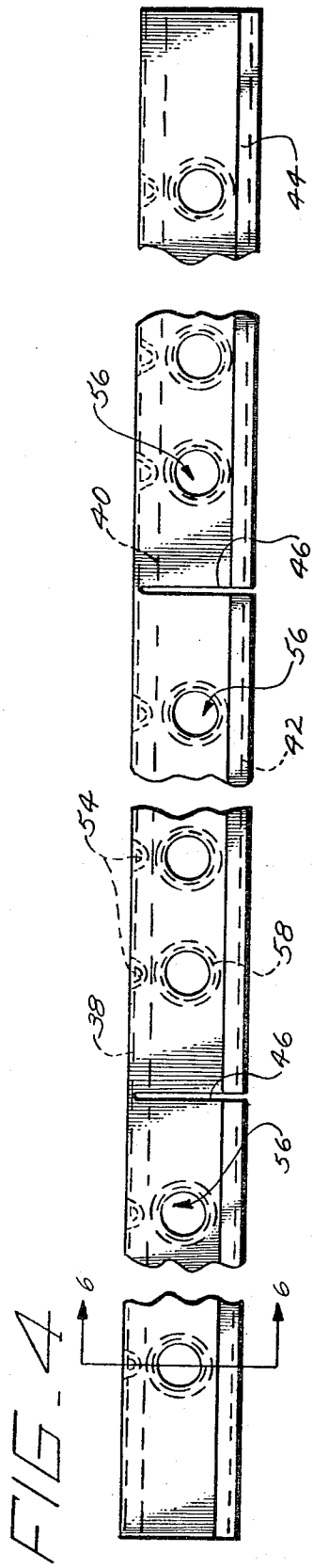


FIG. 4

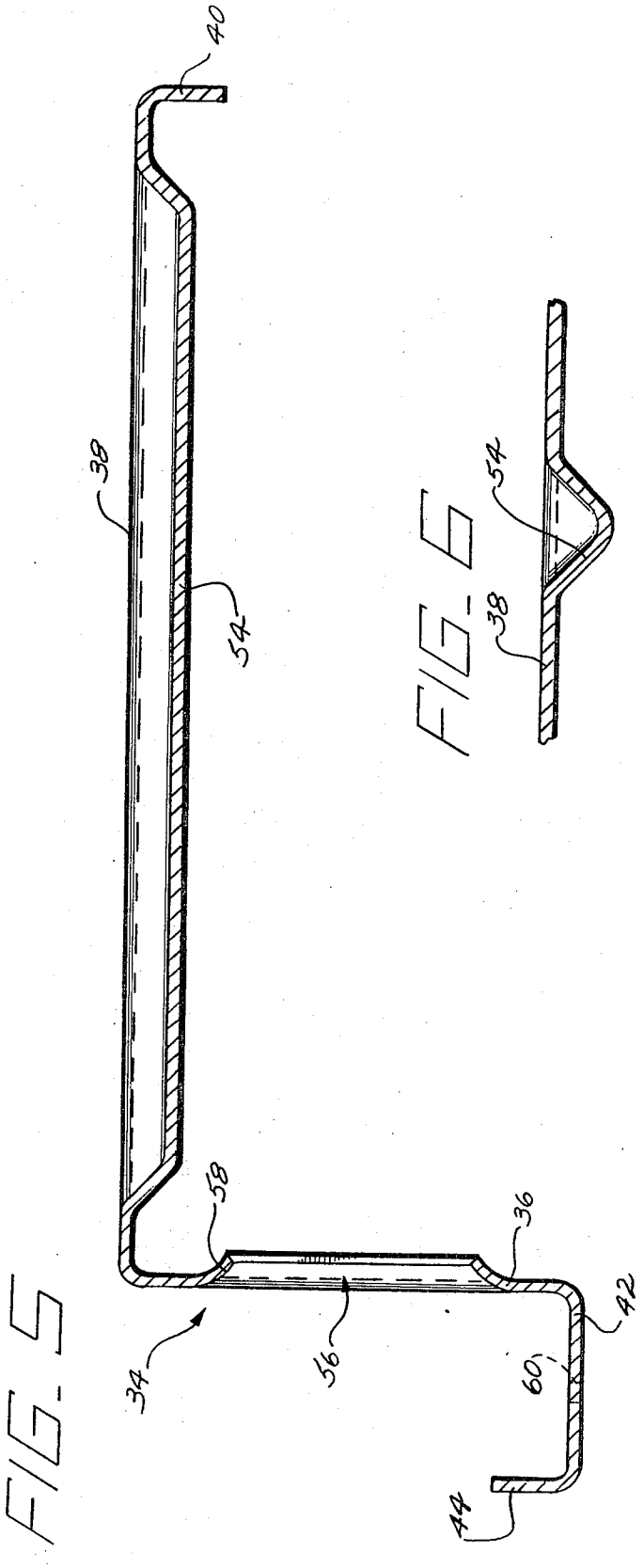


FIG. 5

FIG. 6

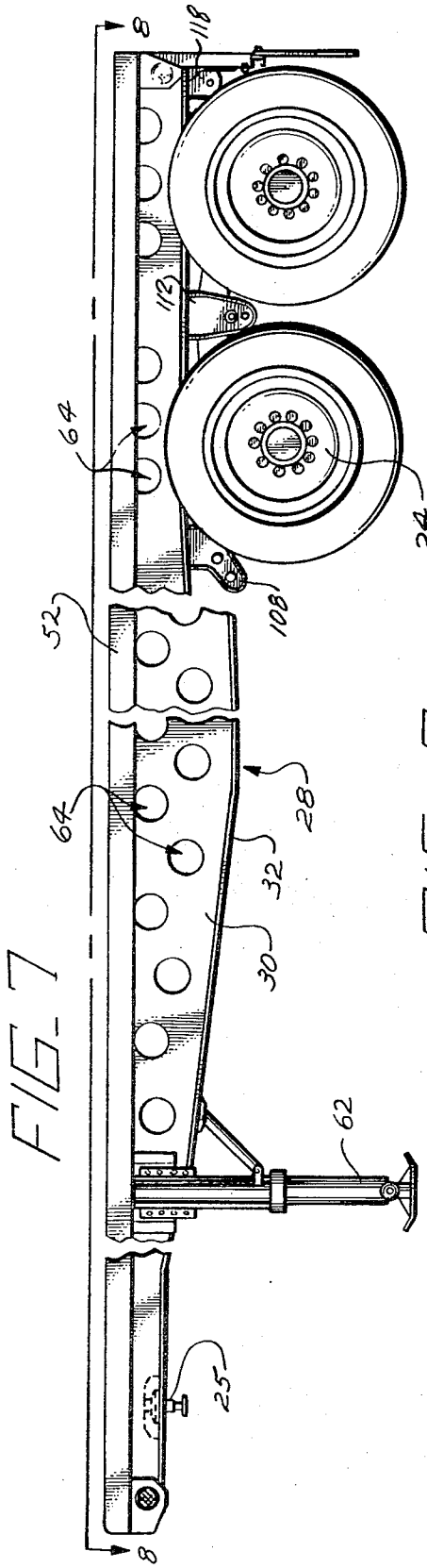

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FIG. 7

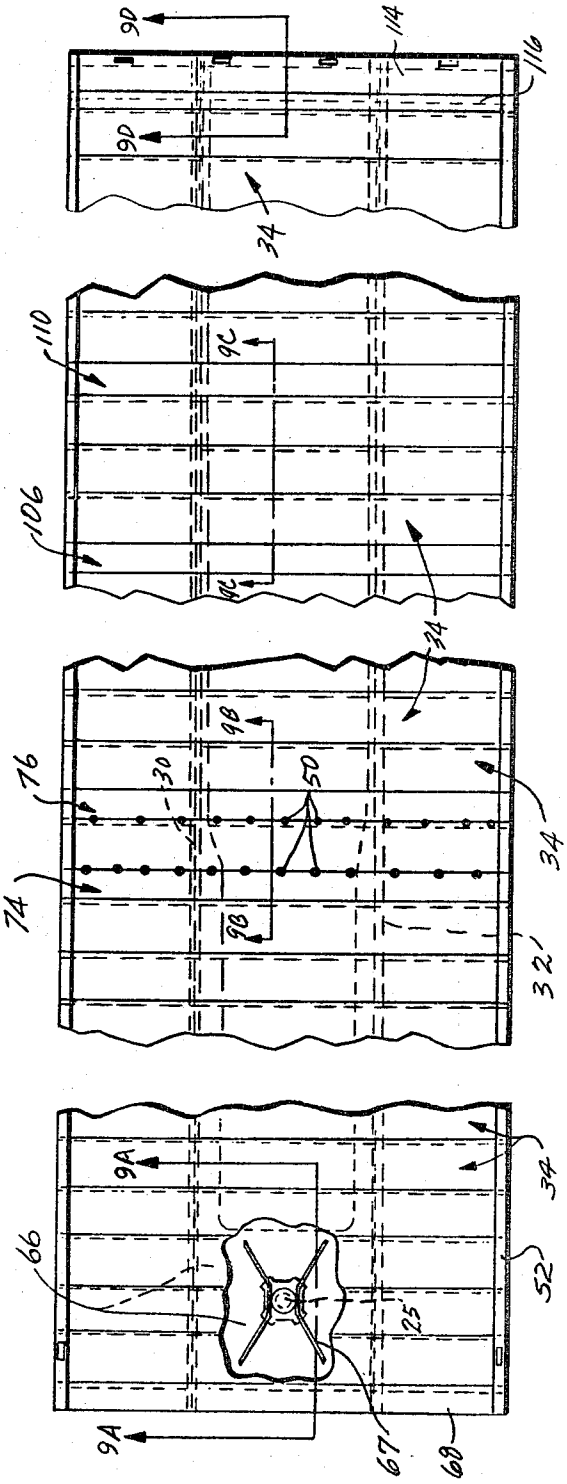

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9A
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66
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9A
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FIG. 8

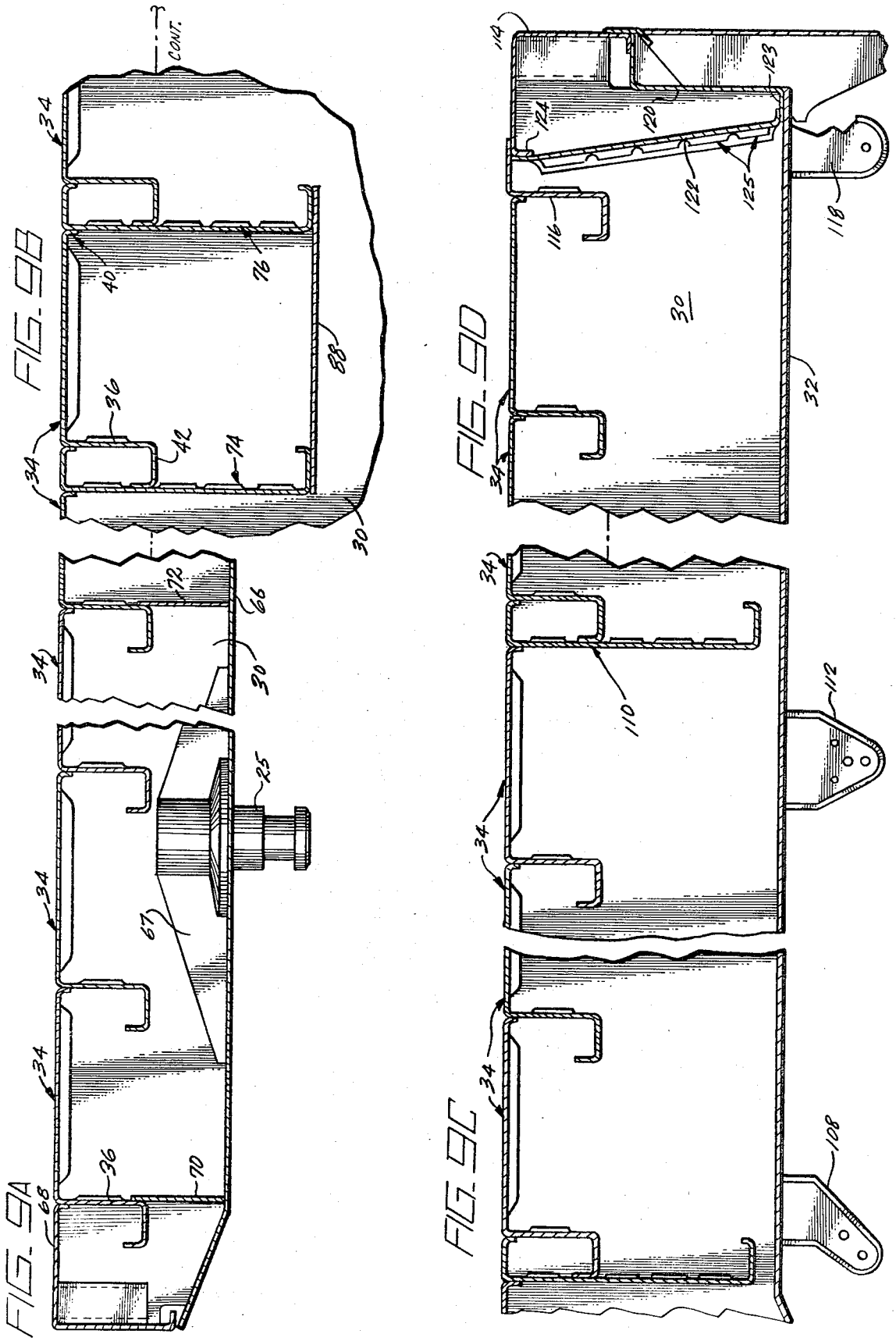
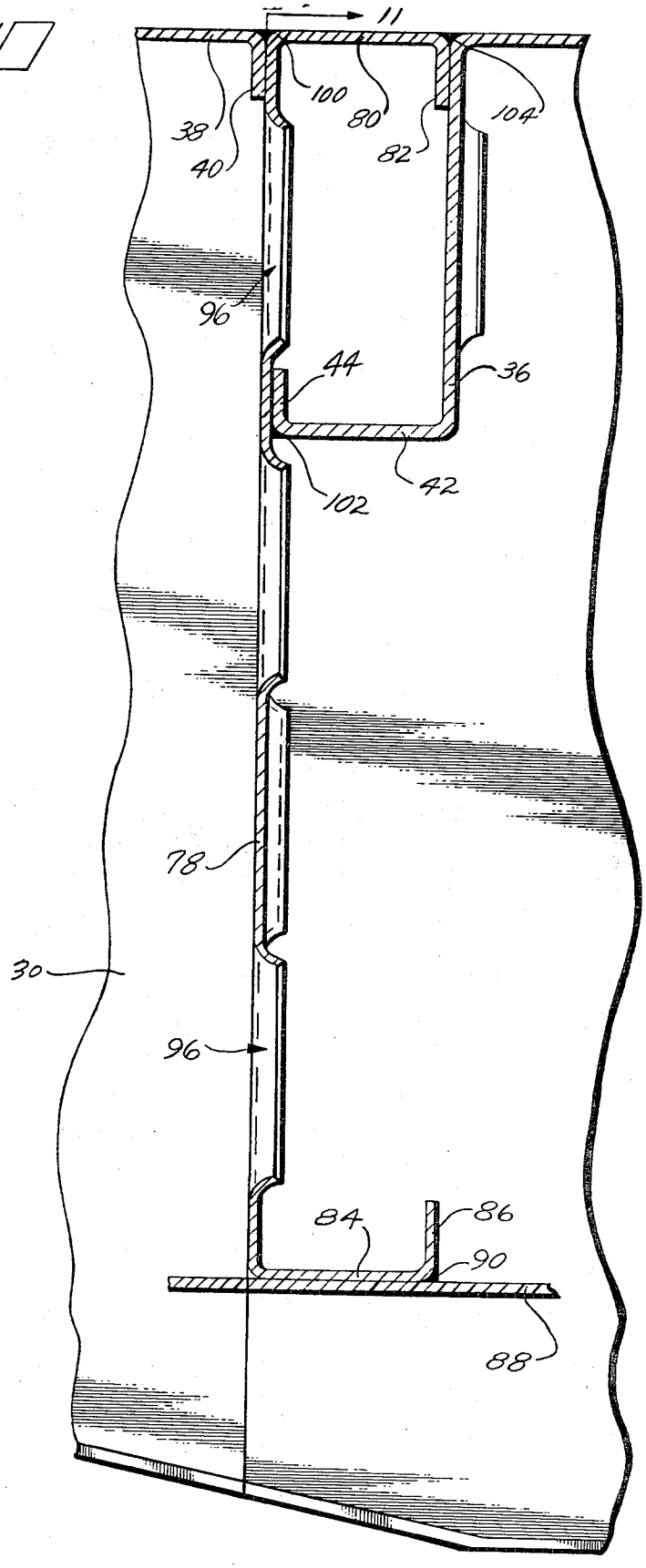

FIG. 9A
FIG. 9B
FIG. 9C
FIG. 9D
CONT.
34
36
68
70
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25
72
66
30
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74
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123
124
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FIG. 10



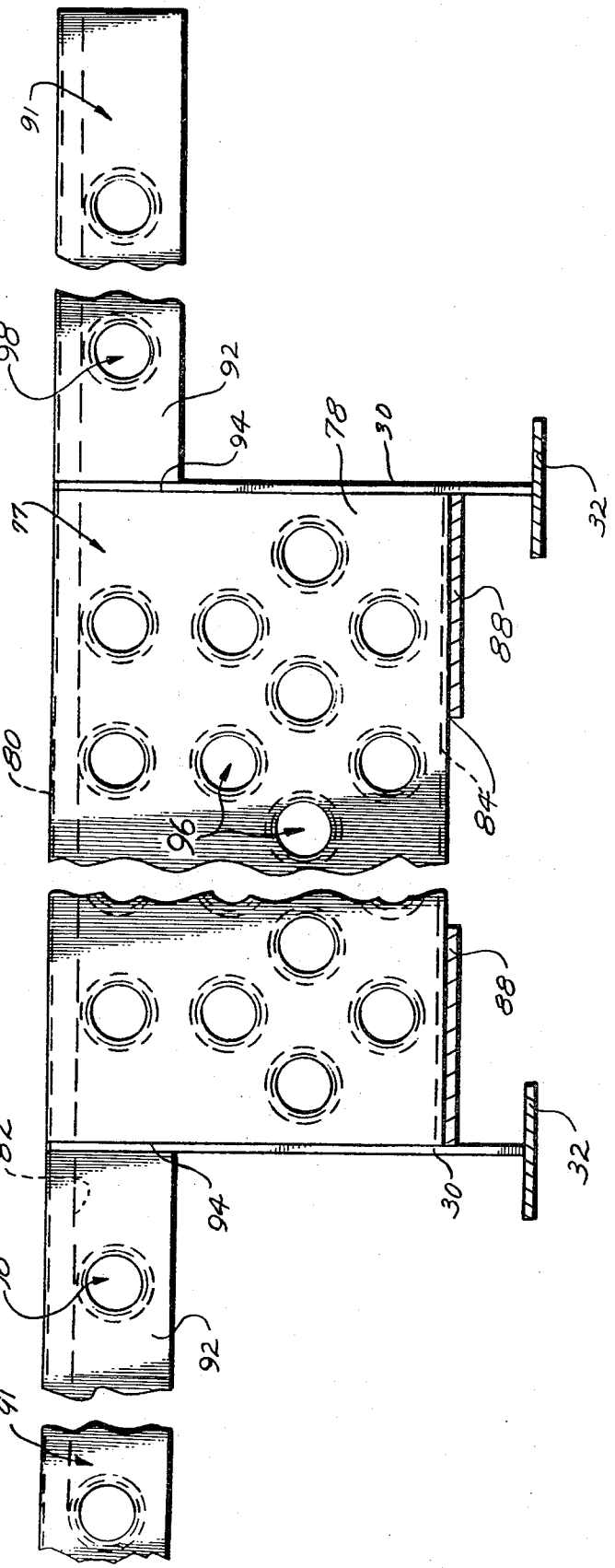


FIG. 11

FIG. 12

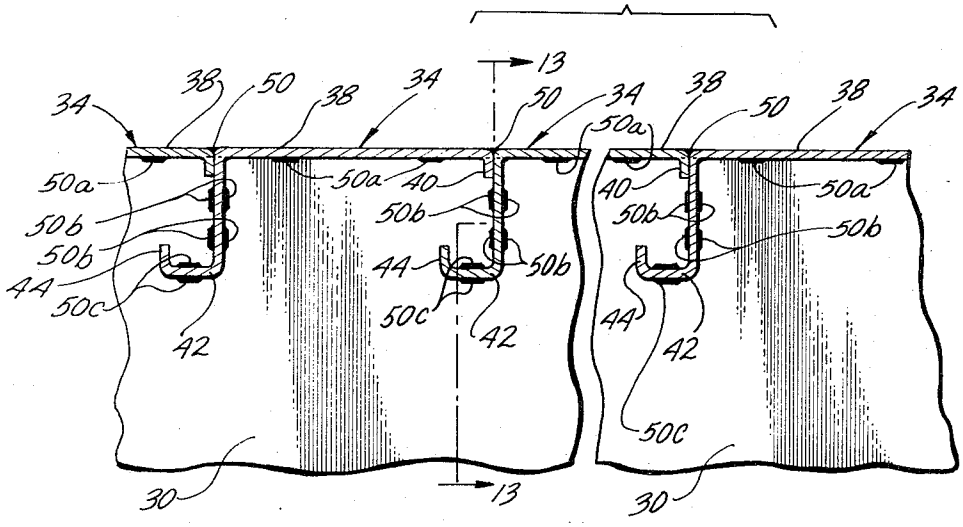
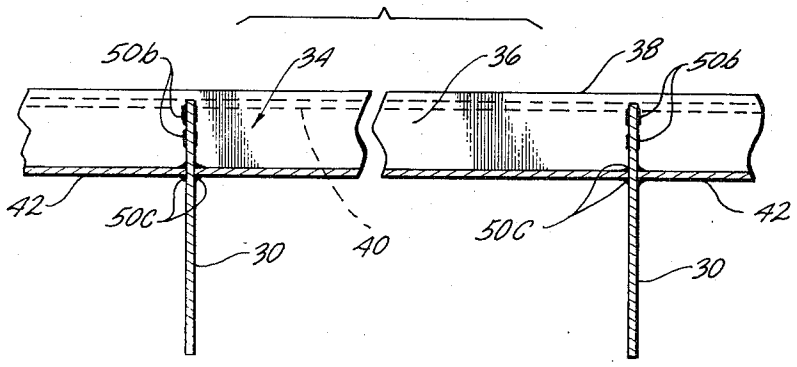

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50c
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50b
50a
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50b
50b
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50c
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13
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FIG. 13


50b
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36
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50b
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50c
30
40
50c
42
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ORTHOTROPIC TRAILER

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of my application Ser. No. 221,608, filed Jan. 28, 1972, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to highway trailers, and more particularly to a relatively low-weight and high-strength trailer bed.

All states have laws which limit axle loads imposed by vehicles using public highways and streets. Thus, there is a strong economic incentive for truck and trailer manufacturers and companies shipping cargo on fleets of trucks to minimize tare weights of the vehicles so as to maximize pay loads. Substantial economic advantages are gained by reducing the tare weight of trucks carrying maximum pay loads during a large percentage of their total mileage.

Besides the increased pay load resulting from highway tractors and trailers of reduced weight, a low-weight vehicle also produces lower running costs in the form of less maintenance, increased tire life, and an overall increase in fuel economy.

Thus, a trailer having a weight reduction of 1,500 lbs. to 2,000 lbs, can produce substantial cost savings, which can be in the neighborhood of several hundred dollars per week.

SUMMARY OF THE INVENTION

This invention provides a highway trailer having a load-support bed of orthotropic design which is extremely low in weight and easily fabricated from a few similar parts.

Briefly, the trailer bed includes a pair of spaced apart, elongated, rigid open-section beams, and a series of rigid, open-section load-support members rigidly secured to the beams in an orthotropic design to provide a unitary deck for the trailer bed. Each load-support member includes a horizontal top flange, a bottom flange spaced below the top flange, and a vertical web integral with and extending between the top and bottom flanges. The load-support members are mounted on the open-section beams in a side-by-side relation, with the bottom of each top flange resting on the top of each beam. The top flanges of the load-support members are rigidly secured together to form a substantially continuous unitary deck panel extending lengthwise relative to the beams. The top flange, bottom flange, and web of each load-support member are rigidly secured to the open-section beams to provide "shear continuity," i.e., continuous load-carrying capacity uninterrupted by elastic losses, between the open-section beams and the continuous deck panel formed by the top flanges. Moreover, the orthotropic design of the trailer bed enables the continuous deck panel to act as both a compressive member and a tensile member capable of resisting bending in two mutually perpendicular directions. That is, the deck panel acts as the compressive flange of the longitudinal open-section beams to resist bending about a transverse axis through the load-support bed, and also acts as the tensile flange of the vertical webs of the load-support members to resist bending about a longitudinal axis through the load-support bed.

The trailer bed provided by this invention is relatively low in weight and high in strength because of the shear continuity between the structural components of the bed and the ability of the integral deck panel to resist bending in two directions.

In a preferred form of the invention, a series of laterally spaced apart depressions are formed in each top flange. The depressions provide additional stiffness for the top flanges of the load-support members, thereby increasing the ability of the deck panel to carry planar compressive loading.

Additional strength also is provided by several closed-section stiffening members rigidly secured between certain load support members in the bed.

Thus, the trailer bed has high strength and low weight, which makes it possible to carry pay loads of increased weight, thereby providing substantial cost savings for companies shipping cargo on public highways and streets. Moreover, the design of the bed lends itself to fabrication from only a few similar parts, which provides substantial cost savings for trailer manufacturers.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the invention will be more fully understood by referring to the following detailed description and the accompanying drawings in which:

FIG. 1 is a fragmentary perspective view showing a highway trailer;

FIG. 1A is an elevation view, partly in section, taken on line 1A—1A of FIG. 1;

FIG. 2 is a fragmentary perspective view showing a loadsupport member from which the bed of the trailer is constructed;

FIG. 3 is a fragmentary plan elevation view taken on line 3—3 of FIG. 2;

FIG. 4 is a fragmentary plan elevation view taken on line 4—4 of FIG. 3;

FIG. 5 is a sectional elevation view taken on line 5—5 of FIG. 4;

FIG. 6 is a fragmentary sectional elevation view taken on line 6—6 of FIG. 3;

FIG. 7 is a fragmentary elevation view showing the construction of the longitudinal T-beams which support the load-support members;

FIG. 8 is a fragmentary plan elevation view taken on line 8—8 of FIG. 7;

FIG. 9A is a fragmentary sectional elevation view taken on line 9A—9A of FIG. 8;

FIG. 9B is a fragmentary sectional elevation view taken on line 9B—9B of FIG. 8;

FIG. 9C is a fragmentary sectional elevation view taken on line 9C—9C of FIG. 8;

FIG. 9D is a fragmentary sectional elevation view taken on line 9D—9D of FIG. 8;

FIG. 10 is an enlarged sectional elevation view showing means for stiffening the load-support members;

FIG. 11 is a fragmentary sectional elevation view taken on line 11—11 of FIG. 10;

FIG. 12 is a fragmentary sectional elevation view showing means for welding the load-support members to the T-beams; and

FIG. 13 is a fragmentary sectional elevation view taken on line 13—13 of FIG. 12.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. **1** and **2**, a highway trailer **20** is supported on a conventional rear running gear **22.** Preferably, the weight of the running gear is reduced by using forged disk aluminum wheels **24.** During use of the trailer, a king pin **25** (see FIG. **7**) at the front of the trailer is connected to a conventional highway tractor (not shown).

Trailer **20** has a high-strength, low-weight load supporting bed **26** of orthotropic design. The bed includes a pair of longitudinally extending, parallel open-section inverted T-beams **28,** each T-beam having a vertical web **30** and a horizontal bottom flange **32.** The T-beams comprise the main load-carrying structural members of the trailer bed.

A series of side-by-side elongated transverse load-support members or pans **34** are mounted on the top edges of webs **30** of the T-beams. The pans are open-section members rigidly secured to the T-beams in an orthotropic design. Each pan is formed from sheet metal to provide a substantially J-shaped cross-sectional configuration which includes a vertically extending web **36,** and a relatively wide, downwardly opening top channel having a flat, horizontal top flange **38** integral with the top edge of web **36** and a downwardly turned marginal lip **40** at the remote edge of top flange **38.** Each pan also includes a relatively narrow, upwardly opening bottom channel having a flat horizontal bottom flange **42** integral with the bottom edge of web **36.** Bottom flange **42** extends away from web **30** in a direction opposite that of upper flange **38.** An upwardly turned marginal lip **44** extends along the remote edge of bottom flange **42.**

A pair of laterally spaced apart, parallel, slotted openings **46** are formed in web **36,** bottom flange **42,** and lip **44.** A separate pair of laterally spaced apart and parallel slotted openings **48** are formed in lip **40.** Each slot **46** is aligned longitudinally with a respective one of slots **48** so that each pan can slip over webs **30** of the T-beams, with the bottoms of top flanges **38** resting on the top edges of webs **30.**

Thus, top flanges **38** of the adjacent pans provide a continuous deck panel extending the length of the T-beams.

As shown best in FIG. **1** the pans are mounted on T-beams **28** so that lip **40** of each top flange **38** abuts against the top portion of the web of the neighboring pan continuously for the width of the trailer bed. The abutting portions of the adjacent pans are rigidly bonded together by stitch-welding **50** (see FIGS. **1, 8** and **12**) so the top flanges provide a rigid load-supporting unitary deck panel. Preferably, each weld **50** is about 1½ inches wide, and has a naturally V-shaped configuration which substantially prevents fatigue or localized stress occurring in the weld as a result of loads on the deck panel. The purpose of the welds at **50** is to interconnect top flanges **38** so they form the equivalent of a continuous, rigid load-supporting deck panel. It is critical to the orthotropic design of the load-support bed to maintain the structural continuity of the top flanges. For example, certain methods of bolting the top flanges together would be unacceptable, if they would produce elastic losses at the joints which, in turn, would prevent the top flanges from acting as a continuous, rigid flange.

As shown in FIG. **12,** the bottom of each top flange **38** is rigidly bonded by stitch-welding **50***a* to both sides of each T-beam web **30.** This rigid connection provides "shear continuity" between the top deck panel and the webs of the main load-carrying T-beams. "Shear continuity" between structural members is defined herein as the capability of maintaining load-carrying ability with stiffness, uniterrupted by elastic losses, between component structural members such that the resulting composite structure has stiffness, or rigidity, equal to that of the basic structural members. For example, the load-carrying top flanges **38** rest on the tops of T-beam webs **30,** and are rigidly bonded thereto as an integral unit. This provides shear continuity between flanges **38** and webs **30.** On the other hand, shear continuity between these members would be destroyed if (1) the top flanges were bolted to the webs **30** in a manner which would result in elastic losses at the joints, (2) the load-supporting plane of the top flanges is spaced apart from webs **30,** or not bonded to the webs, or (3) a material such as aluminum or wood having a substantially lower Young's modulus than that of the steel top flanges and webs is interposed between the top flanges and the webs. In the latter instance, loading on the trailer bed would cause the material of lower modulus to develop shear between the deck panel and the T-beam webs which would absorb energy and therefore would prevent the transmission or continuity of shear between the load-supporting deck panel and the T-beams. In the trailer bed this invention, the T-beams, pans, and other transverse members between the pans are made of steel or other structural metal having a modulus equivalent to that of steel, i.e., in the neighborhood of 30×10^6 psi.

Referring to FIGS. **12** and **13,** the vertical web **36** of each pan is rigidly bonded by stitch-welding **50b** to each side of each T-beam web **30.** This rigid connection provides shear continuity between top deck panel flanges **38** and webs **36.**

Bottom flange **42** of each pan is rigidly bonded by stitch-welding **50c** to each side of each T-beam web **30.** This rigid connection provides shear continuity between webs **36** and bottom flanges **42.**

The structural integrity of load-support bed **26** enables the continuous deck panel to act as both a compressive member and a tensile member capable of resisting bending in two mutually perpendicular directions. For example, the deck panel acts as the compressive flange of the longitudinal T-beams to resist bending about a transverse axis through the load-support bed, and it also acts as the tensile flange of the vertical webs of the pans to resist bending about a longitudinal axis through the load-support bed. Moreover, bottom flanges **42** also have compressive and tensile continuity under loads imposed on the load-support bed.

Referring to FIGS. **1** and **1A**, a pair of elongated side channel members or rub rails **52,** each having a substantially C-shaped cross-sectional configuration, are fitted over the ends of pans **34.** Preferably, the rub rails are formed from **10**-gauge sheet metal, and may take a variety of suitable shapes for fitting over the ends of the channel members to protect them from impact damage and abrasion. FIG. **1A** shows a typical rub rail configuration which includes an upwardly turned, diagonally extending top flange **52a** and a substantially horizontally extending and inwardly projecting bottom flange **52b** which is turned back on itself to provide a

channel which makes a tight friction fit over the ends of the pans. Rub rail **52** is the main support member for a variety of auxiliary load supporting equipment such as load hooks **53***a* (see FIG. 1A), cargo winches **53***b*, stake pockets **53***c*, reflectors **53***d*, running lights **53***e*, and the like. The rub rail is also welded in place so it can serve as the top flange of the trailer deck panel.

The detailed construction of pans **34** is understood best by referring to FIGS. **3–6.** The pans are formed from 14-gauge sheet steel, preferably carbon steel capable of work-hardening. The pans are preferably 8 feet long, with each pan being continuous for the width of the trailer bed. Top flange **38** is preferably 10½ inches wide, web **36** is preferably 4 inches deep, and bottom flange **42** is preferably 1¾ inches wide. Each return lip **40** and **44** is about three-fourth inch in depth. The bending of the sheet steel to form the substantially J-shaped configuration work-hardens the steel and thereby increases its physical strength.

A series of laterally spaced apart, parallel, longitudinally extending and downwardly projecting elongated depressions or dimples **54** are formed in top flange **38** of each pan. Depressions **54** are continuous for most of the width of the top flange, and are substantially V-shaped in cross-section, as viewed in FIG. **6.** Each depression is about three-eighth inch deep. The depressions are uniformly spaced apart, except that depressions are omitted in those portions of the top flange supported by vertical webs **30** of the T-beams.

During use of trailer bed **26,** loads carried on the bed put top flanges **38** in compression. When the trailer bed carries heavy loads, particularly loads which maximize the pay load capacity of the vehicle, there is a natural tendency for the top flanges to buckle or sag. However, the T-beams directly support the continuous load-carrying deck panel provided by the top flanges, and thereby act as transverse stiffening members to keep the top flanges in a common load-supporting plane, thereby resisting the tendency of the flanges to buckle. The working of the steel to form depressions **54** work-hardens the steel to provide additional strength for the top flanges, which increases their ability to stay in a flat plane resisting the tendency to buckle. The work-hardening of the steel increases the strength of the pans to such a degree that additional transverse stiffening members, such as additional T-beams, or closed-section beams, are not needed to prevent buckling of the pans. Thus, a substantial savings of weight results from the use of the high-strength, work-hardened pans.

A series of laterally spaced apart lightening holes **56** are punched through web **36** of each pan. As shown best in FIGS. **3** and **4,** each lightening hole preferably is aligned longitudinally with a respective one of the depressions **54.** The holes are punched so that the metal surrounding each hole bends away from the plane of web **36** to form a circular flange or lip **58** bordering the hole. The bending of the steel during forming of the holes work-hardens the steel to provide additional strength for the web of each pan. Moreover, the lightening holes produce a considerable weight reduction for the pans.

During use of the trailer bed, loads on the bed put bottom flanges **42** in tension. Bottom flanges **42** provide transverse beam strength for the trailer bed when the bed is subjected to heavy loading. The strength of the bottom flanges **42** is enhanced by return lip **44** which stiffens the edge of each bottom flange to prevent it from deforming under loading. Each bottom flange also includes several laterally spaced apart drain holes **60.**

The presently preferred J-shaped configuration of the pans is shown in the drawings. The pans also can be substantially C-shaped (i.e., by turning bottom flange **42** in an opposite direction) without departing from the scope of the invention. The J-shaped configuration is preferred because it is easier to fabricate.

The geometry of the pans also can be varied to increase the capacity for localized loading. For example, changes such as (a) depth increase, (b) increase in the width of bottom flange **42,** (c) decrease in the width of top flange **38,** (d) increase in metal thickness, and (e) increase in the density of depressions **54** can be made to increase the capacity of the pans for given localized loading situations. Consideration of the above changes together with attendant fabrication advantages can yield an optimum cost/weight profile to suit a given application.

The detailed construction of the trailer bed lower support structure is best understood by referring to FIGS. **7** and **8.** The front of the trailer is supported independently of the tractor on a conventional telescoping landing gear **62.** A series of spaced apart lightening holes **64** are punched through web **30** of each T-beam rearward of the landing gear. Holes **64** serve substantially the same purpose as holes **56** in the pans. Each lightening hole **64** is formed by bending the metal surrounding it away from the plane of flange **30** to work-harden the steel and thereby provide additional strength for the T-beams. Moreover, each lightening hole **64** provides a substantial weight savings.

As shown best in FIG. **8,** the vertical dimension of each T-beam web **30** is relatively narrow at the front end of the trailer, tapering wider toward the load-bearing intermediate portion of the trailer, and tapering narrower toward the end of the trailer. Two series of holes **64** are formed in the wide intermediate portion of web **30,** with a single series of the holes being formed in the narrower front and rear portions of the web. Alternatively, a single series of wider holes **65** (shown in FIG. **1**) may be formed in webs **30,** although it is preferred to use a large number of smaller holes, as shown in FIG. **7,** because the additional working of the steel provides greater work-hardening and therefore a stronger structural member.

Each bottom flange **32** of the T-beams is fabricated from alloy steel and bent at several longitudinally spaced points to conform to the lower edge contour of web **30.** The two members are then welded together continuously to provide shear continuity between web **30** and flange **32.** Preferably, web **30** is sheared out of 10-gauge sheet steel, preferably a type of carbon steel capable of work-hardening.

As shown best in FIG. **8,** the front portions of flanges **32** are interconnected by a continuous flat, horizontally disposed plate section **66.** The plate section supports a king pin mounting bracket assembly **67.**

FIGS. **9A** through **9D, 10,** and **11** show the detailed construction of the trailer bed, including means for providing additional stiffness for the bed. The front of the trailer bed includes a rearwardly opening, substantially C-shaped elongated transverse channel member **68** extending the width of the bed. Channel member **68** is slotted in a manner identical to pans **34** so the channel member fits over webs **30** of the T-beams. The top

flange, bottom flange, and web of member **68** are welded to T-beam flange **30** in a manner similar to that of pans **34** to maintain the desired shear continuity.

Referring to FIG. **9A**, additional stiffness in the area of king pin **25** is provided by a vertical stiffening plate **70** extending laterally between vertical webs **30** of the T-beams. The top edge of the plate is stitch-welded to the bottom edge of web **36** of a pan forward of king pin **25.** The bottom of plate **70** is stitch-welded to the top of horizontal plate section **66.** An identical vertical stiffening plate **72** is spaced rearwardly from plate **70** and rigidly secured between webs **30** of the T-beams at a point behind king pin **25.** Stiffening plates **70** and **72** stiffen the bed in the area of the king pin which is subjected to substantial stress when the trailer is hitched and pulled by a tractor.

FIG. **9B** shows means for providing additional stiffness for the trailer bed on both sides of landing gear **62.** A narrow, vertically extending transverse, elongated stiffening channel **74** is sandwiched between a pair of pans **34.** Stiffening channel **74** extends the width of the trailer bed and is located forward of the landing gear. An identical stiffening channel **76** is sandwiched between a pair of pans to the rear of the landing gear.

As shown best in FIGS. **10** and **11,** each stiffening channel has an intermediate portion **77** which includes a vertical web **78,** and a downwardly opening top channel which includes a horizontal top flange **80** integral with the top edge of web **78** and continuous for the width of the trailer bed, and a downwardly turned marginal lip **82** along the remote edge of top flange **80.** The stiffening channels also include an upwardly opening bottom channel having a horizontal bottom flange **84** integral with the bottom edge of web **78,** and an upwardly turned marginal lip **86** extending along the remote edge of bottom flange **84.** Top and bottom flanges **80** and **84** extend in the same direction from the plane of web **78** to form a substantially C-shaped configuration when the intermediate portion of the stiffening channel is viewed in transverse cross-section.

As shown best in FIG. **11,** top flange **80** is continuous for the entire width of the trailer bed. Top flange **80** is welded to the top flanges of the adjacent pans **34** to maintain the desired structural integrity of the deck panel. The bottom of top flange **80** is welded to the top of T-beam webs **30** to maintain the desired shear continuity.

The intermediate portion of each stiffening channel is continuous between webs **30,** and is supported at its bottom by a pair of horizontal support plates **88** welded to the inner vertical side walls of webs **30.** Stitch-welds **90** (see FIG. **10**) rigidly secure the bottom of each intermediate portion **77** to support plates **88.** Support plates **88** prevent fatigue failure of the connection of vertical web **78** to main web **30.**

Each stiffening channel also has a pair of outer portions **91** each including a vertical web **92** extending downwardly from the edge of top flange **80** in the same plane as vertical web **78.** Each web **92** is separated from web **78** by a respective slotted opening **94** which receives a web **30** of a respective T-beam. Webs **92** are welded to the sides of webs **30** to maintain the desired shear continuity.

Several vertically spaced apart and horizontally extending series of lightening holes **96** are formed through vertical web **78** of each stiffening channel. A single row of laterally spaced apart lightening holes **98** are formed through outer vertical webs **92** of the stiffening channels. The purpose of holes **96** and **98** is identical to that of the lightening holes **56** in the pans, i.e., they reduce weight and provide added strength because of the work-hardening of the steel surrounding the holes.

As shown best in FIGS. **9B** and **10,** stiffening channel **74** cooperates with web **36** and bottom flange **42** of the pan to its rear to form the equivalent of an elongated closed-section transverse stiffening beam extending the width of the trailer bed at a point forward of landing gear **62.** Stiffening member **76** forms an identical closed-section stiffening beam rearward of the landing gear. Each closed-section stiffening beam is formed by rigidly securing the top of web **78** to upper lip **40** of the neighboring pan forward of the stiffening channel by stitch-welds **100.** Stitch-welds **102** rigidly secure the rear face of web **78** to bottom lip **44** of the neighboring pan rearward of the stiffening channel. Stitch-welds **104** rigidly secure upper lip **82** of the stiffening channel to the top of the web **36** of the neighboring pan to the rear of the stiffening channel. The closed-section stiffening beams provide additional physical strength in the areas of the trailer bed which are subjected to heavy loading when the trailer rests on landing gear **62.**

FIG. **9C** shows means for stiffening the trailer bed to withstand heavy loading above rear running gear **22.** A stiffening channel **106** (identical in construction to channels **74** and **76**) is rigidly secured between a pair of adjacent pans, in a manner identical to that described above for stiffening channels **74, 76,** to form a closed-section stiffening beam above a spring hanger **108** forward of the front set of wheels. A second identical stiffening channel **110** is identically welded between a pair of pans above an intermediate spring hanger **112** to form a closed-section stiffening beam between the front and rear set of wheels.

FIG. **9D** shows the detailed construction of the rear of trailer bed **26.** A substantially C-shaped transverse channel member **114** spans the width of the trailer bed at the rear of the trailer. A substantially J-shaped transverse channel member **116** rigidly connects the forward or free end of rear channel member **114** to the rearwardmost pan **34** of the trailer bed. Channel member **116** is slotted so it fits over webs **30** of the T-beams, with its top flange acting as part of the deck surface. Channel member **116** is welded to web **30,** its neighboring pan **24,** and channel **114** in a manner identical to that described above for pans **24** to provide the desired shear continuity.

The equivalent of a closed-section beam stiffens the rear of the trailer bed above a rear spring hanger **118.** The rear stiffening beam includes a substantially Z-shaped transverse channel member **120** extending laterally between the vertical webs of the T-beams. Channel member **120** has a top flange rigidly secured to the bottom edge of channel member **114,** and a bottom flange rigidly secured to the inner portions of flanges **32** of the T-beams. An upright diagonally upwardly extending plate **122** extends between a bottom flange **123** of channel member **120** and a downwardly extending lip **124** at the front of rear channel **114.** Plate **122** has several series of vertically spaced apart and horizontally extending rows of lightening holes **125** formed through it to work-harden the metal for strengthening the plate sufficiently to provide additional strength for the rear of the trailer. Channel member **120** is so con-

structed to allow for protecting flush mounting of lights, signals and license plates.

The trailer bed deck panel may have a variety of surfaces to resist abrasion and the like from loads carried on the deck. The deck surface can be a coating (not shown) of epoxy, urethane, or similar material loaded with abrasive material such as sand, carborundum dust, or like media. Alternatively, the deck can be covered with plywood (not shown) treated to withstand abuse, weather conditions, and so forth. As a further alternative, the deck can have a non-skid tape (not shown) applied selectively over critical portions.

The structural members of the load-supporting bed are made of work-hardening steel. Preferably, a medium strength steel such as high manganese/silicon steel, is used as the initial material. The rolling, bending, and dimpling of the steel work-hardens it to such an extent that the members are of high strength steel when work-hardening is completed. The structural members of the bed are better able to take heavier loads and resist dents and the like because of the work-hardening. Moreover the use of medium strength work-hardening steel as the starting material provides substantial cost savings when compared with the use of high strength carbon steel.

Thus, highway trailer **20** has relatively high strength and low weight because of the work-hardened open-section transverse structural members of orthotropic design which are low in weight and have good physical strength. Moreover, the pans of the trailer bed are supported on only a pair of longitudinal open-section beams which are themselves low in weight and work-hardened to provide good physical strength. Thus, the need for a large number of structural members to support the compound channel members is eliminated, which provides a substantial savings in weight.

An additional weight savings is provided by the welded unitary construction of the bed, which eliminates the need for cross-ties or other similar means for rigidly holding the deck-forming structural members in place.

The trailer also exhibits greater stiffness than conventional designs. The open-section pans are supported by the T-beams so that top flanges **38** of the pans provide the equivalent of a stiff orthotropic deck panel which resists bending in longitudinal and transverse directions. Thus, the continuous deck plate provided by top flanges **38** acts as a combination compression flange-tension flange which reduces substantially the structural members required to support loads without buckling, which also is a factor in the reduced weight of the trailer bed. The orthotropic design provides good stiffness vertically and laterally, while remaining torsionally flexible. Thus, the trailer is able to carry maximum pay loads, and yet is flexible enough in torsion to resist the tendency to buckle under heavy loads and prevent shock from being transferred to the load.

The trailer also is relatively inexpensive to fabricate because it is manufactured from a few similar parts.

I claim:

1. In a highway trailer, a load-support bed including a pair of spaced apart and generally parallel, rigid, elongated open-section metal beams each having at least a vertical web and a bottom flange, and a series of rigid, elongated open-section load-support members each being made of metal and shaped to provide a top flange, a bottom flange below the top flange, and a web integral with and extending between the top flange and the bottom flange, the series of load-support members being mounted on the beams in a side-by-side relation with the bottom of each top flange being in substantially continuous contact with the top of each beam and being rigidly bonded to each beam, the web and the botton flange of each load-support member also being rigidly bonded to each beam, the top flanges of the load-support members being rigidly bonded together to form a continuous rigid panel extending lengthwise relative to the beams for providing a load-supporting deck and also serving as a compression flange for the vertical webs of the beams and a tension flange for the webs of the load-support members to form a stiff, unitary load-support bed of orthotropic design.

2. Apparatus according to claim **1** including a series of spaced apart depressions formed in each top flange to stiffen the top flanges.

3. Apparatus according to claim **1** in which each beam is inverted T-shaped in cross-section and including slotted openings in the web and bottom flange of each load-support member to permit the vertical web of each beam to fit into the slotted openings, with the top edge of the vertical web of each inverted T-shaped beam continuously supporting the bottom surface of each top flange.

4. Apparatus according to claim **1** in which the web and bottom flange of each load-supporting member is bonded to both sides of the vertical flange of each beam

5. Apparatus according to claim **1** including a series of spaced apart openings formed in the web of each load-supporting member.

6. Apparatus according to claim **1** including several stiffening members for providing additional stiffness at longitudinally spaced apart points in the bed, each stiffening member being rigidly secured between a pair of adjacent loadsupport members and shaped so it cooperates with at least one of the load-support members to form a closed-section beam extending parallel to the load-support members.

7. Apparatus according to claim **1** in which the load-support members are made of work hardening steel.

8. In a highway trailer, a load-support bed including a pair of spaced apart rigid, elongated open-section metal beams, a series of rigid, elongated open-section load-support members each being made of metal and shaped to provide a substantially planar top flange, a bottom flange below the top flange, and a web integral with and extending between the top flange and the bottom flange, the series of load-support members being mounted on the beams in a side-by-side relation with the bottom of each flange being bonded to each beam, the web and bottom flange of each load-support member also being bonded to each beam, and the top flanges of the load-support members being bonded together to form a continuous rigid load-supporting deck panel extending lengthwise relative to the beams, and several stiffening beams mounted on the open-section beams for providing additional stiffness at longitudinally spaced apart locations in the trailer bed, each stiffening member being disposed between a pair of adjacent load-support members and having a load-supporting top flange, and a web transverse to the top flange, the top flange of each stiffening beam being in the same plane as the top flanges of the adjacent load-support members, and including means bonding the top

flange of each stiffening beam to the top flange of its adjacent load-support members, the bottom flange of at least one adjacent load-support member being bonded to the web portion of the stiffening beam so that said one adjacent load-support member and the stiffening beam cooperate to form a transverse closed-section beam, the entire composite structure forming a stiff, unitary load-support bed of orthotropic design.

9. Apparatus according to claim **8** including a series of spaced apart openings extending through the web of the stiffening member.

10. In a highway trailer, a load-support bed including a pair of spaced apart and generally parallel, rigid, elongated open-section beams which are inverted T-shaped in cross-section and define a vertical web and a bottom flange, the open-section beams being made of a material having a Young's modulus on the order of that of steel, and a series of rigid, elongated open-section load-support members each being made of a material having a Young's modulus on the order of that of steel and being shaped to provide a top flange, a bottom flange below the top flange, a web integral with and extending between the top flange and the bottom flange, and a series of spaced apart depressions formed in each top flange to stiffen the top flanges, each load-support member having slotted openings in the web and bottom flange thereof, the series of load-support members being mounted on the beams in a side-by-side relation with the vertical web of each beam fitting into the slotted openings of the load-support members, and the bottom of each top flange being in substantially continuous contact with the top edge of the vertical web of each beam, the bottom of each top flange being bonded to the web of each beam, the web and bottom flange of each load-support member being bonded to each beam, and the top flanges of the load-support members being bonded to each other to form a continuous, rigid panel extending lengthwise relative to the beams for providing a load-supporting deck and also serving as a compression flange for the vertical webs of the beams and a tension flange for the webs of the load-support members to form a stiff, unitary load-support bed of orthotropic design.

11. Apparatus according to claim **10** in which the web and bottom flange of each load-support member is bonded to both sides of the vertical web of each open-section beam.

12. Apparatus according to claim **10** including a series of spaced apart openings formed in the web of each load-support member.

13. Apparatus according to claim **10** including several stiffening members mounted on the open-section beams for providing additional stiffness at longitudinally spaced apart points in the bed, each stiffening member being rigidly secured between a pair of adjacent load-support members and being shaped so it cooperates with at least one of its adjacent load-support members to form a closed-section beam extending parallel to the load-support members.

14. Apparatus according to claim **13** in which each stiffening member has a load-supporting top flange, and a web transverse to the top flange, the top flange of each stiffening member being in the same plane as the top flanges of its adjacent load-support members, and including means bonding the top flange of each stiffening member to the top flanges of its adjacent load-support members, the bottom flange of at least one adjacent load-support member being bonded to the web portion of the stiffening member so that said one adjacent load-support member and stiffening member cooperate to form a transverse closed-section beam.

15. Apparatus according to claim **14** including a series of spaced apart openings extending through the web of the stiffening member.

* * * * *

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,856,344 Dated December 24, 1974

Inventor(s) Frederick W. Loeber

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

Col. 4, line 30, after "bed" insert -- of --.

Col. 10, line 7 (Claim 1) "botton" should read -- bottom --.

Col. 10, line 28 (Claim 4) "load-supporting" should read -- load-support --

Col. 10, line 30 (Claim 4) after "beam" insert a period

Col. 10, line 38 (Claim 6) "loadsupport" should read -- load-support --

Signed and sealed this 17th day of June 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks