A stress distributing cross member hanger system for an aluminum boat trailer includes a welded bracket assembly on an aluminum cross member for bolting the cross member to an aluminum side rail. The side rail can be either I-beam or tube shaped with mounting bolt holes through its web or side walls respectively. The cross member can be either tube shaped or I-beam shaped with a pair of aluminum brackets welded to either side at each end. The paired brackets are bolted to the side rail at the bolt holes. The length of the weld and the weld pattern is selected to distribute the stresses thereby reducing weld failures.
Fig. 7

(PRIOR ART)
STRESS DISTRIBUTING CROSS-MEMBER FOR TRAILER

BACKGROUND OF THE INVENTION

[0001] The present invention is directed to trailers, specifically boat trailers, a method of assembly of trailer members, and the trailer member structures resulting therefrom.

[0002] Boat trailers are vehicles which travel highways and are subjected to the same or similar regulations by the same regulatory agencies as motor vehicles. A boat trailer is designed to carry a load, which is a boat or other water craft. Very often the weight of the load can far exceed the weight of the trailer.

[0003] Boat trailer structural members can be subjected to several types of forces, including compression, tensile, bending, and torsion stresses. These structural members are subjected to both static and dynamic loads, as a trailer is parked or towed on a highway. The strength, durability, and assembly of the structural members of a boat trailer must be such that failures do not occur. Trailer structural failures will result in the trailer to become unsafe and the attendant test, and structural modifications, as well as product liability issues, just as with motor vehicles.

[0004] Trailer manufacturers must consider strength of materials, fatigue, stress points, meantime-between-failure. Trailer manufacturers conduct failure analysis and testing on trailer designs, structural members, and structural assemblies. These factors are weighed against the esthetics of the look of a trailer. As with motor vehicles, however, the consumer is attracted to a “good looking” trailer.

[0005] Boat trailers have been made of various materials and various combinations of materials. When combinations of materials are used “galvanic action” is a consideration. As boat trailers are designed to be immersed in water, either fresh water or sea water or both, corrosion and rusting is a primary consideration to a boat trailer manufacturer. Corrosion or rust, whether by galvanic action, oxidation, or chemical reaction, weakens trailer parts and can cause failures in structural members.

[0006] Boat trailers were originally made of carbon steel and were painted to protect against corrosion. Paints did not last long when constantly subjected to water emersion and when the structural members were subjected to the dynamic forces. Typically, painted surfaces developed paint cracks and painted surfaces faded, peeled and/or became porous. The result was the painted boat trailers required frequent care and repainting to maintain their structural integrity.

[0007] Galvanized (zinc coated) steel boat trailers were introduced as an improvement over painted trailers. Hot-dipped zinc coated boat trailer frames generally were more costly to manufacture than painted boat trailer frames, but they lasted longer without maintenance. Moreover, galvanized boat trailer frames have been commercially more esthetically appealing than the previously various color, or white or silver painted frames.

[0008] Both the painted trailers and the galvanized trailers had their frame members generally constructed of tubing, which was used for both the side rails and the cross members of the trailer frames, as well as the tongue “beam” member. It had always been difficult to coat the inside of the tubing with paint, even with electro-static dip paint coating, or with hot dip zinc coating. The flexure and torsion dynamic forces placed stresses on service coatings. Incomplete coating, too thick a coating in area and too thin a coating in areas often lead to more rapid coating failure and corrosion of frame members.

[0009] Boat trailer frame members have been joined with connection hardware, such as brackets, clamps and bolts. These have been of heat-tempered steel with a passive corrosion resistant coating. Such coating is generally applied “cold” so as not to anneal the part and therefore avoid modifying its hardness. These passive coatings become porous when exposed to the elements and then the parts often rust and must be replaced or repaired.

[0010] Stainless steel has always been available for boat trailer frame construction, i.e., for use in the manufacture of side rails, cross-members, tongue beams and the various connection hardware. However, the prices of stainless steel have made its use in boat trailer manufacture cost prohibitive.

[0011] A more recent modification to boat trailer frame construction has been the introduction of the aluminum side rail. These aluminum side rails are typically 1-beam shaped. Aluminum being a very reactive metal was often anodized in the past to retard corrosion. However, anodized aluminum trailer side rails are impractical as the stresses would quickly crack the anodized coating.

[0012] It was the introduction of aluminum alloys, with greater strength, and being less reactive and more non corrosive that permitted the use of aluminum 1-beam side rails in boat trailers. These aluminum side rail boat trailers became an immediate commercial success. They were “shiny”, did not easily discolor or corrode, and were lighter than and just as strong as their steel counterparts.

[0013] The use of brackets, clamps and bolts to join the cross members to the aluminum side rails continued, but has been eventually replaced with a bracket welded to the end of each steel cross member which is then bolted to the aluminum side rail.

[0014] It is desirable to eliminate the use of boat trailer steel cross members and to substitute aluminum cross members therewith.

[0015] It is also desirable to eliminate or minimize the use of hardened steel connection hardware in the assembly of aluminum cross members to aluminum side rails.

[0016] It is further desirable to develop a stress distributing cross member hunger system which will permit the incorporation of welds to facilitate a reduction in bracket hardware.

SUMMARY OF THE INVENTION

[0017] These objectives of the present invention are realized in an aluminum side rail boat trailer having aluminum cross members. A stress distributing hanger system is utilized which takes into account all of the stresses that are realized at the attachment points of each load carrying cross member in a modular trailer assembly. A welded attachment assembly replaces a bracketed attachment assembly. This welded attachment includes a bracket which is welded onto each end of each aluminum cross member to provide a
bracket capable of being bolted to the aluminum side rail with a pair high strength hardened steel bolts.

[0018] The bracket may be a unitary piece or a pair of bracket “ears” which require weld attachment on plural sides of the cross member to provide more linear weld length. The welds are positioned to minimize the effect of the dynamic and static load forces affecting the cross member joints with any compromising effects. An extremely durable junction-point weld results that is highly resistant to stress riser failures and fatigue related failures. Stress points are minimized and rotational forces are compensated.

[0019] The alloy chemistry of the aluminum cross member and the paired bracket ears, as well as the welding process, are selected to provide the strongest “joint”, i.e., bonding connection, between the cross member and each welded bracket and to compensate for the annealing the aluminum material typically associated with the welding of aluminum. Thermal stress points (stress risers) and/or stress concentration points in the weld puddle which could ultimately result in fatigue failure are avoided or minimized.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The features, advantage, and operation of the present invention will become readily apparent and further understood from a reading of the following detailed description with the accompanying drawings, in which like numerals refer to like elements, and in which:

[0021] FIG. 1 is perspective view of a steel-framed boat trailer employing bracket, clamp and bolt connection hardware for “hanging” cross members to the side rails;

[0022] FIG. 2 is an exploded perspective view of the connection hardware of FIG. 1;

[0023] FIG. 3 is a cross sectional view of the bracket connection “hanger” of a cross member onto a side rail of FIG. 1;

[0024] FIG. 4 is a plan view of a steel-framed boat trailer with an alternate cross member hanger connection structure;

[0025] FIG. 5 is a detail side view, partial cross section of the cross member hanger assembly taken as shown in FIG. 4;

[0026] FIG. 6 is a cross section of the cross member hanger connection taken as shown in FIG. 5;

[0027] FIG. 7 is a perspective view of a steel-framed boat trailer with a second alternate cross member hanger connection structure;

[0028] FIG. 8 is a perspective view of an a cross member hanger connection for a steel cross member to an aluminum side rail of a boat trailer;

[0029] FIG. 9 is a perspective view of the present invention being a welded hanger connection for an aluminum cross member to aluminum side rail of a boat trailer;

[0030] FIG. 10 is a partial side view of the cross member and fish plate brackets attached to a side rail;

[0031] FIG. 11 is a partial top view of a cross member having a pair of fish plate brackets welded thereto; and

[0032] FIG. 11 is an end view of a cross member with the paired brackets welded thereto.

DETAILED DESCRIPTION OF THE INVENTION:

[0033] The present invention is a hanger assembly for connecting aluminum cross members to aluminum side rail members in the frame for a boat trailer. Boat trailer frames include side rails which are separated by cross members and are joined at a front point to a tongue beam. The wheel and axle assembly is mounted to the side rails. Boat hull supports, i.e., bunk beams or roller assemblies are mounted directly onto the cross members. The boat’s weight is carried directly by the cross members. The size of a trailer including the size of its side rails and cross members, as well as, the number of cross members is determined by the intended maximum payload for the trailer.

[0034] The load bearing forces on the cross members are transferred to the side rails, and ultimately the axle and wheel and the trailer hitch, by cross member hangers. A cross member hanger is a term of art for the connection hardware used for connecting a cross member to a side rail.

[0035] Any bending moments, or compression and torsion forces, generated by the loading and unloading of a boat hull are imparted to the cross members and then to the cross member hanger assembly. Any torsion forces imparted to the side rails during high speed movement are transferred to the hanger assemblies and the cross members. The hanger assemblies maintain the rigidity of every trailer frame and must withstand all of the static and dynamic forces to which the trailer is subjected.

[0036] FIGS. 1-7 show prior art steel-framed trailers with cross member connection hardware comprising brackets, clamps and bolts. The prior art trailer frame 10, FIG. 1, has each cross member connected between the left and right side rails 13 with a bracket assembly 15.

[0037] In the exploded view of a bracket assembly 15, FIG. 2, the cross member 11 is clamped 17 to a stepped hanger bracket 19 which abuts a box-shaped end 21 of the cross member 11, FIG. 3. The stepped bracket 19 which is clamped to the cross member 11 is bolted 23 to the side rail 13, FIGS. 2 and 3.

[0038] The prior art trailer frame 20, FIG. 4 has its cross member 25 mounted between the side rails 27 with an alternate bolted bracket assembly 27, FIGS. 5 and 6. This assembly includes an L-shaped bracket 29 which has one leg resting on the top face of a side rail 27. The L-shaped bracket other leg has a dog-leg offset and is welded to the end of the steel cross member 25. The L-shaped bracket 29 is held secure to the side rail by bolts 31.

[0039] Prior art trailer frame 30, FIG. 7, has its cross members 33 secured between its side rails 35 by a drop-in hanger brackets 37. These hanger brackets 37 have U-shaped walls for receiving and cradling the end of a cross member 33. A pair of longitudinal flanges on the bracket are pinned or bolted to the side rail and a pair of transverse flanges on the bracket 37 are pinned or bolted to the cross member.

[0040] Prior art aluminum side rail trailer frame 40, FIG. 8, generally, has I-beam shaped side rails 39, with steel cross members 41 mounted in between with bolts 43. The aluminum side rail 39 can alternately be tube-shaped. The steel cross member 41 can alternately be I-beam shaped.
The bolting of each cross member 41 to a respective side rail 39 is implemented with a flat steel plate 45 welded to each end of the cross member 41. The plate 45 extends longitudinally beyond the cross member walls and carries bolt holes for mounting to the side rail 39 with a pair of bolts 43. The multiple parted bracket, clamp and bolt connection assemblies of the other trailer frames, FIGS. 1-7 is eliminated and replaced with a simple bracket plate in the frame of FIG. 8.

The prior art composite metal frame 40, FIG. 8, has the advantage of fewer parts and less labor cost involved in assembly. The steel plate 45, which forms an end bracket on the cross member, may be galvanized as well as the steel cross member being galvanized. The zinc coating on these parts is disturbed only at the weld bead 47. This weld area is a weak point for rusting and must be passively coated to prevent the premature degradation of the trailer.

The hanger assembly of FIG. 8 is of simple design, has few parts and is easy to assemble. However, it cannot be implemented with an aluminum cross member and an aluminum end plate welded as shown in FIG. 8. The design of FIG. 8, with implemented in aluminum parts will fail under the static and dynamic loads applied to the trailer frame.

The present invention shown in FIG. 9, is an improvement over the hanger assembly shown in FIG. 8 and permits all parts to be built of aluminum, except for the high strength harden steel bolts 49. The invention trailer frame 50 has an I-beam shaped aluminum side rails 51 between which rectangular, tube-shaped, cross members 53 are bolted 49. Welded to each side wall 55 of each cross member 53 is an L-shaped aluminum bracket 57. The L-bracket 57 has a long leg 59 which extends parallel to a side wall 55 of the cross member 53, and a short leg 61 which extends along the web portion 63 of a side rail 51. The L-bracket 57 short leg forms an “ear” at the end of the cross member 53.

Each cross member 53 terminates in a pair of horizontally opposed “ear” bracket legs 61 which are bolted to the side rail 51 with the pair of bolts 49. The shapes of the cross members 53 and the side rails need not be limited to those shown in FIG. 9. Other shapes will suffice with the stress distributing cross member hanger system of the present invention.

Each L-bracket 57 long leg 59 is sized to match the dimensions of the side wall 55 of the cross member and is welded on its top edge 65, its end edge 67 and its bottom edge 69 to form a total peripheral weld bead or fillet around the long leg 59.

While it is advantageous to build a welded cross member hanger system, with an aluminum cross member and an aluminum bracket, it is widely known that aluminum is the most difficult alloy to weld. Aluminum oxide must be thoroughly cleaned from the weld surfaces. The proper selection between heat treatable and non-heat treatable alloys must be selected. The significant decrease in tensile strength which can occur when welding due to over aging must be considered. The selection of the specific aluminum alloy, the metallurgy of the rod, the welding process, and the welding rate are all important factors in achieving a durable weld which will not fatigue. In addition to the presence of oxide, the thermal conductivity, thermal expansion coefficient and melting characteristics of the alloy must be considered.

Generally, wrought aluminum alloys are grouped into nine groups, 1xxx through 9xxx, with unalloyed, pure aluminum being designated as 1xxx, and 9xxx being reserved for future use, and where the “x” refers to other numbers designating percentage of alloying, i.e., the exact chemistry of the alloy constituents.

The cross member 53 and the L-shaped brackets are made of hardened aluminum alloy. This alloy can be chosen from the entire range of 2xx-8xx series alloys, including 9xx series when available. However, each series has different relative qualities and differing physical and chemical characteristics so that the physical properties would vary depending upon the series selected and the exact chemistry of that series.

Variations in physical properties include variations in heat treatment ranges, relative hardness, weldability, corrosion resistance, formability, machinability, strength and mechanical working. Several of the series aluminum alloys are more desirable for use in trailer frame members as they have a more desirable strength and temper ranges, better resistance to corrosion, and reasonably good welding characteristics for producing a higher quality and durable trailer frame.

Series 5xxx and/or 6xxx aluminum alloys were selected for the hanger system of FIG. 9. Alloys in the 5xxx series have magnesium as their major alloying element. The magnesium is often combined with manganese to result in a moderate-to-high strength, work-hardenable alloy. Series 5xxx alloys possess relatively good welding characteristics and relatively good resistance to corrosion in marine environments.

Alloys in the 6xxx series contain silicon and magnesium approximately in the proportions required formation of magnesium silicide (Mg2Si), thus making them heat treatable. Although not as strong as most 2xxx and 7xxx alloys, 6xxx alloys have relatively good formability, weldability, machinability, and relatively good corrosion resistance, with medium strength.

With cost and member size, i.e., wall thickness and other dimensions, a factor in frame member construction, the 5xxx series alloys or the 6xxx series alloys are a more desirable selection for trailer frame members given the combination of static and dynamic stresses to which a trailer is subjected. Alloys of the 6xxx heat-treatable group can be formed in the T4 temper (solution heat treated but not precipitation heat treated) and strengthened after forming to T5 temper or to a full T6 temper properties by precipitation heat treatment. Examples of an aluminum alloy are 6061 T6 alloy and 6105 T5 alloy.

MIG welding (gas metal arc welding) was selected for its high deposition rate and for its ability to make long welds.

When designing铝inum components for boat trailer structural applications, such as cross members, several factors must be considered which are not as critical when designing with steel components. The modulus of elasticity of aluminum is about one half that of steel. The external forces acting on the trailer frame produce tension, compression, bending, shearing, or torsion stresses within the material of which the cross members and hanger systems are made. With the elastic limit, or modulus of elasticity, of
aluminum being much different than that of steel, the design practices be followed with aluminum must deviate from those with steel. The steel end plate welded bracket 45, FIG. 8, welded to the end of the cross member 41, cannot be successfully implemented in aluminum. The design of FIG. 8 concentrates stresses at the weld, where if the cross member 41 and the plate 45 were made of aluminum, an aluminum weld 47 would fatigue and fail.

[0056] Manufacturing processes, such as welding of aluminum have a negative strength effect on the aluminum material. Welding of metal requires very high temperature. This temperature causes a condition in aluminum known as a heat affected zone. As a result of this process, the tensile strength of the material is reduced in the localized welded area. To compensate for this reduced strength, the amount of weld must be increased in order to compensate for the lost strength due to welding.

[0057] Boat trailers are subjected to constant and varying dynamic loading. Various road conditions such as potholes, etc. stress the trailer’s structure as it carries the boat (payload) along all types of road conditions and at different speeds (load cycles). The attachment junction points of the trailer’s cross members are subject to high stress conditions as a result, and must be suitably designed in order to achieve their intended goal as well as safe performance.

[0058] The aluminum “ears”, L-brackets 57 used in the present invention are independent of each other, allowing for each ear to be individually welded to the side of the cross member tube 55. This departs from the steel flat plate 45 welded over the ends of a steel cross member 41, FIG. 8, the conventional industry method.

[0059] In individual L-brackets 57 act as their own “fish plates” distributing the stress over a greater area which in turn better resists the dynamic loading. The “ears” (L-brackets) 57 with long leg 59, FIG. 10, are each miter cut on their edges to compensate for the bowed shape of a cross member 53, when a boat trailer incorporates bowed cross members. This mitered compensation permits the short legs 61 of the paired brackets 57 to maintain parallelism for bolting to the side rail 51 web 61, yet permit welding to the two opposed side walls 55 of a cross member 53 along sides of each bracket long leg 59. Each long leg 59 is welded on each of four sides, top 65, bottom 69 end 67 and at the bend 71, FIGS. 11 and 12. The bend weld 71 which is adjacent the open end of the tubular cross member 53.

[0060] For a 3 inch by 4 inch cross member, which is designed to carry a payload up to 8,000 pounds, the long leg 59 of the L-bracket 57 is 4 inches high and 2.5 inches long, so that the length of weld is 13 inches for all four sides. Providing double welds in the X-Y plane provides strength against torsion forces as well as shear forces. In that the “ears” 57 are paired at each end of a cross member 53, the weld length per end for this loading is twice 13 inches or 26 inches of weld.

[0061] The two X plane welds 65, 69 are at the edges, i.e., bends of the cross member 53, which is a strong point. With the increased linear amount of weld and the “boxed weld pattern”, i.e., the fish plate design, the reduction of material strength due to the heat affected zone is compensated for with the present design.

[0062] While the present design has the L-brackets 57 mounted to opposite side walls 55 of a cross member, i.e., being juxtaposed, in the alternative, the brackets 57 could be mounted (welded) to opposed top and bottom walls (top side and bottom side) or even one side wall and one of the top and bottom walls (sides). In such instance the length of the long leg 59 of a bracket 57 may have to be increased to maintain the total length of weld.

[0063] Further, if a cross member is to be hung between other members which extend parallel to the sides of the cross member, the L-bracket 57 w

[0064] Many changes can be made in the above-described invention without departing from the intent and scope thereof. It is therefore intended that the above description be read in the illustrative sense and not in the limiting sense. Substitutions and changes can be made while still being within the scope and intent of the invention and of the appended claims.

What is claimed is:

1. A stress distributing cross member for a trailer, comprising:
   a cross member; and
   a pair of brackets on each end of said cross member, each said bracket having a leg thereof being welded to a side of said cross member, wherein said weld extends around said leg of said bracket.

2. The stress distributing cross member of claim 1 wherein said bracket leg is sized and shaped to the size and shape of the side of said cross member to which it is welded, wherein said weld about the edges of said bracket leg is also about edges of said cross member.

3. The stress distributing cross member of claim 2 wherein said bracket is L-shaped, having a transverse leg to said weld leg.

4. The stress distributing cross member of claim 3 wherein said cross member is of aluminum alloy, and wherein said L-shaped bracket is of aluminum alloy.

5. The stress distributing cross member of claim 4 wherein said weld is an MIG aluminum weld.

6. The stress distributing cross member of claim 5 wherein said cross member and said L-bracket are of hardened aluminum alloy material.

7. The stress distributing cross member of claim 6 wherein said hardened aluminum material is 6xxx series aluminum alloy.

8. The stress distributing cross member of claim 6 wherein said hardened aluminum material is 5xxx series aluminum alloy.

9. A stress distributing cross member for an aluminum side rail boat trailer, comprising:
   an aluminum cross member; and
   a first aluminum bracket boltable to said side rail and welded to said cross member,

   wherein said weld forms a fish plate attachment structure of said bracket to said cross member.

10. The stress distributing cross member of claim 9, wherein said weld is a boxed weld pattern.

11. The stress distributing cross member of claim 10, wherein said cross member is a tube-shaped member with a rectangular tube cross section, and wherein said first bracket is an L-shaped plate.
12. The stress distributing cross member of claim 10 wherein one leg of said first L-shaped plate bracket is welded on one leg thereof to a side of said tube-shaped cross member and is boltable to said side rail on the other leg thereof.

13. The stress distributing cross member of claim 12 wherein said weld extends about each free edge of said first L-shaped bracket welded leg and along the bend forming the L-shape thereof.

14. The stress distributing cross member of claim 13 wherein said first L-shaped bracket is positioned at the end of said tube-shaped cross member, and also including a second L-shaped bracket welded to the opposite side of said tube-shaped cross member juxtaposed said first L-shaped bracket.

15. The stress distributing cross member of claim 14 wherein said tube-shaped cross member, and said first and second L-shaped brackets are of hardened aluminum alloy.

16. The stress distributing cross member of claim 15 wherein said tube-shaped cross member and said first and second L-shaped brackets are tempered to a range of T5-T6.

17. The stress distributing cross member of claim 15 wherein said tube-shaped cross member and said first and second L-shaped brackets are hardened aluminum alloy is in the range of 5xxx-6xxx series aluminum alloy.

18. The stress distributing cross member of claim 16 wherein said welds are MIG welds.

19. The stress distributing cross member of claim 17 wherein said welds are MIG welds

20. An aluminum cross member hanger system for a boat trailer, comprising:

an aluminum cross member; and

a pair of juxtaposed aluminum hanger brackets each being welded to opposite sides of said aluminum cross member;

wherein said hanger brackets each have a leg extending along the cross member from the end thereof; and

and wherein said weld extends completely about each said leg which extends along the cross member, said weld joining said bracket leg to said cross member in a stress distributing manner.