



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
28.01.2009 Bulletin 2009/05

(51) Int Cl.:
B66F 9/08 (2006.01)

(21) Application number: **08161052.9**

(22) Date of filing: **24.07.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

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(30) Priority: **25.07.2007 JP 2007192712**

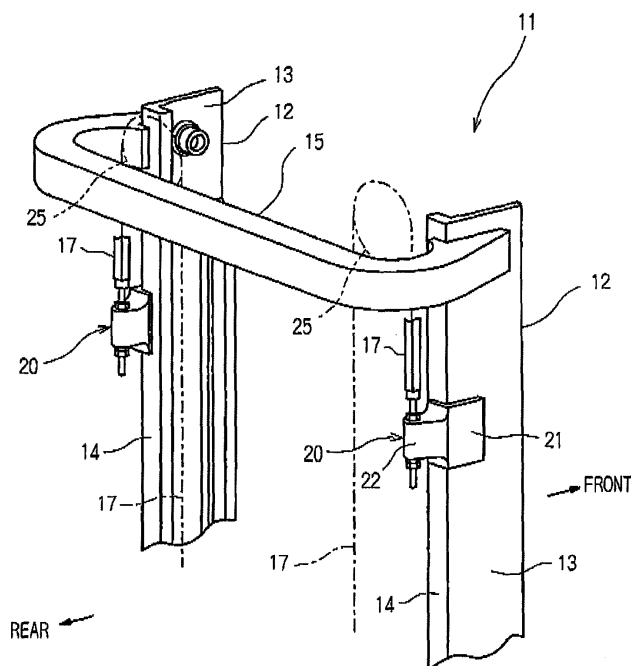
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(54) **Lift chain anchoring device and method for fixing a lift chain anchoring device for a forklift truck**

(57) A lift chain anchoring device for a forklift truck has a chain anchoring member and a lift chain. The chain anchoring member has a base portion and a chain connecting portion. The base portion includes a welded portion by which the chain anchoring member is fixed by welding to a side portion of each outer mast. The chain connecting portion projects horizontally from the base

portion. One end of the lift chain is fixed to a lift bracket. The other end of the lift chain is fixed to the chain anchoring member. The vertical length of the base portion is set longer than the vertical length of the chain connecting portion. At least one of the top and bottom surfaces of the chain anchoring member has an inside corner formed between the base portion and the chain connecting portion. The inside corner has an arcuate surface.

FIG. 1



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a lift chain anchoring device and a lift chain anchoring method for a forklift truck.

[0002] A typical example of conventional lift chain anchoring device for a forklift truck is shown in Fig. 8. This type of the lift chain anchoring device has a chain anchoring member 74 connected to the side wall surface of an outer mast 71 by welding. An inner mast 72 is provided vertically movably on the inner side of the outer mast 71. A lift bracket (not shown) is provided so as to be raised and lowered relative to the inner mast 72. The lift chain anchoring device further has a lift chain 73 whose one end serving as a movable end is connected to the lift bracket. The other end of the lift chain 73 serving as a fixed end is connected to the chain anchoring member 74.

[0003] The chain anchoring member 74 is welded to the outer mast 71 adjacent to the top end thereof. The chain anchoring member 74 includes a welded portion 74A welded to the outer mast 71, and a chain connecting portion 74B for connecting the lift chain 73. The chain anchoring member 74 is fixed to the side wall surface of the outer mast 71, and extends therefrom around the rear side of the outer mast 71, protruding horizontally outwardly. A headstay 75 is provided to connect the opposite outer masts 71 each other at positions adjacent to the top ends thereof. A reinforcing rib 76 is provided between the headstay 75 and the chain anchoring member 74.

[0004] An upward load acts on the chain anchoring member 74 to lift the chain anchoring member 74 through the lift chain 73. A part of the upward load is transmitted to the headstay 75 through the reinforcing rib 76, thereby reducing the stress concentration in the welded portion 74A.

[0005] As another background art, a tie beam structure of outer masts of a forklift truck is known as disclosed in Japanese Patent Application Publication No. 2004-210500. In this background art, support plates are welded to side wall surfaces of the paired outer masts, respectively. The support plate has a projecting portion extending from the rear wall of the outer mast. The projecting portion is formed integrally with a chain anchoring plate having a lift chain connecting portion. A cross beam is provided for connecting the projecting portions of the paired support plates.

[0006] As yet another background art, a chain anchoring device for a forklift truck is disclosed in Japanese Patent Application Publication No. 7-228496. This chain anchoring device has a chain anchoring plate mounted to the outer mast by a bolt. The chain anchoring plate is made of a bent plate. The chain anchoring plate is fixed to the rear wall surface of the outer mast such that the width of the chain anchoring plate extends in the vertical direction of the rear surface of the outer mast. One end

of the chain anchoring plate extends along the front and inner surfaces of the lift cylinder located rearward of the mast at a predetermined interval from the front and inner surfaces of the lift cylinder.

[0007] The one end of the chain anchoring plate has a connecting portion for fixing an anchor bolt of a lift chain. More specifically, the connecting portion at the one end of the chain anchoring plate is fixed to a vertical inner surface of the chain anchoring plate by welding. The vertical length of the connecting portion is set shorter than the vertical length of the one end of the chain anchoring plate. The connecting portion is located with its top surface positioned lower than the top surface of the one end of the chain anchoring plate. The rear surface of the one end of the chain anchoring plate forms an inside right-angle corner with the top surface of the connecting portion. The other end of the chain anchoring plate is provided with a substantially L-shaped stop portion extending around the outer surface of the mast in contact therewith.

[0008] In the background art shown in Fig. 8, the reinforcing rib 76 is needed to reduce the stress concentration in the welded portion 74A. Providing the reinforcing rib 76, the chain anchoring member 74 will inevitably increase its horizontal projection, and the number of the parts necessary for the lift chain anchoring device will be increased.

[0009] The lift chain anchoring device in the background art disclosed in Japanese Patent Application Publication No. 2004-210500 requires not only the chain anchoring plate, but also a support plate. Thus, the number of the parts for the lift chain anchoring device has little difference from the number of the parts for the lift chain anchoring device in the background art of Fig. 8. That is, the background art of Japanese Patent Application Publication No. 2004-210500 has the same problem in increased number of parts as the background art of Fig. 8.

[0010] The background art shown in Japanese Patent Application Publication No. 7-228496 has a problem of stress concentration. If a load acts on the chain anchoring plate through the lift chain, high stress concentrates in the vicinity of the inside corner between the rear surface of the aforementioned one end and the top surface of the connecting portion. According to this type of background art, an excessive stress concentration tends to occur in a specific portion of the chain anchoring plate. The chain anchoring plate of Japanese Patent Application Publication No. 7-228496 has no such a shape that can avoid the excessive stress concentration in a specific portion of the chain anchoring plate. Moreover, in this type of lift chain anchoring device, the bolts to fix the chain anchoring plate to the outer mast may be loosened as a result of repeated use of the forklift truck over the years.

[0011] The present invention is directed to a lift chain anchoring device and method for fixing a lift chain anchoring device for a forklift truck that avoid an excessive stress concentration in a specific portion of the chain anchoring member and also reduce the stress in the welded

portion.

SUMMARY OF THE INVENTION

[0012] In accordance with an aspect of the present invention, a lift chain anchoring device for a forklift truck has a mast mechanism, a chain anchoring member and a lift chain. The mast mechanism has outer masts, inner masts and a lift bracket which is operable to be raised and lowered relative to the mast mechanism. The chain anchoring member has a base portion and a chain connecting portion. The base portion includes a welded portion by which the chain anchoring member is fixed by welding to a side portion of each outer mast. The chain connecting portion projects horizontally from the base portion. One end of the lift chain is fixed to the lift bracket. The other end of the lift chain is fixed to the chain anchoring member. The vertical length of the base portion is set longer than the vertical length of the chain connecting portion. At least one of the top and bottom surfaces of the chain anchoring member has an inside corner formed between the base portion and the chain connecting portion. The inside corner has an arcuate surface.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The features of the present invention that are believed to be novel are set forth with particularity in the appended claims. The invention together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

Fig. 1 is a perspective view showing a lift chain anchoring device according to a first preferred embodiment;

Fig. 2 is a plan view showing the lift chain anchoring device according to the first preferred embodiment;

Fig. 3 is a fragmentary enlarged side view showing the lift chain anchoring device according to the first preferred embodiment;

Fig. 4 is a fragmentary enlarged side view showing the lift chain anchoring device according to a second preferred embodiment;

Fig. 5 is a fragmentary enlarged side view showing the lift chain anchoring device according to a third preferred embodiment;

Fig. 6 is a fragmentary enlarged side view showing the lift chain anchoring device according to a fourth preferred embodiment;

Fig. 7 is a fragmentary enlarged side view showing

the lift chain anchoring device according to a fifth preferred embodiment; and

Fig. 8 is a perspective view showing the lift chain anchoring device of the background art.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] The following will describe the first preferred embodiment of the present invention with reference to Figs. 1 through 3.

[0015] The lift chain anchoring device for a forklift truck according to the first preferred embodiment (hereinafter referred to merely as "lift chain anchoring device") is a device for anchoring the lift chain of the forklift truck. The forklift truck has a mast mechanism 11. Referring to Fig. 1, the mast mechanism 11 includes a pair of outer masts 12. The outer masts 12 form a part of the mast mechanism 11 with a pair of inner masts 16 shown in Fig. 2. As indicated by two arrows in opposite longitudinal directions of the forklift truck, the upper right and lower left sides of the mast mechanism as viewed in Fig. 1 correspond to the front and rear sides thereof. In the front of the mast mechanism 11, a lift bracket (not shown) is provided, while in the rear of the mast mechanism 11, a truck body (not shown) is provided.

[0016] Each outer mast 12 of the first preferred embodiment has a substantially L-shaped cross section, and includes a main wall portion 13 and a rear wall portion 14. The main wall portion 13 has outer and inner surfaces extending substantially in the longitudinal direction of the forklift truck. The rear wall portion 14 is provided extending in the direction substantially perpendicular to the longitudinal direction of the forklift truck. The rear wall portion 14 has front and rear surfaces facing forward and rearward, respectively. The outer surface of the main wall portion 13 and the rear surface of the rear wall portion 14 correspond to the side portion of the outer mast 12.

[0017] The paired outer masts 12 are connected to each other through a horizontally located headstay 15 at a position adjacent to the top ends of the outer masts 12. The ends of the headstay 15 are connected to the side portions of the outer masts 12 by welding, respectively. The headstay 15 having a substantially U-shape as seen from a top view of the outer masts 12 projects rearward of the outer masts 12.

[0018] A pair of inner masts 16 is provided inside the outer masts 12, as shown in Fig. 2. The inner masts 16 are operable to be raised and lowered relative to the outer masts 12. A lift cylinder (not shown) is provided adjacent to the inner mast 16. The rod end of the lift cylinder is connected to the inner mast 16. The inner mast 16 is raised and lowered in accordance with the elevating motion of the lift cylinder. A chain anchoring member 20 is fixed by welding to each outer mast 12 at a position below the headstay 15.

[0019] The chain anchoring member 20 is composed

of two portions. One is a base portion 21 fixed to the side portion of the outer mast 12, and the other is a chain connecting portion 22 for fixing one end of a lift chain 17. According to the first preferred embodiment, the one end of the lift chain 17 serving as the fixed end is connected to the chain anchoring member 20, as shown Fig. 1. Each lift chain 17 is turned around a chain wheel 25 located adjacent to the top of the mast mechanism 11. The chain wheel 25 is provided to be raised and lowered with the inner mast 16.

[0020] The other end of the lift chain 17 serving as the movable end is connected to the lift bracket. The lift bracket is operable to be raised and lowered relative to the inner mast 16. A part of the lift bracket extends to the rear of the inner mast 16. According to the first preferred embodiment, the fixed end of the lift chain 17 is located behind the outer mast 12. The chain wheel 25 is disposed so that portions of the lift chain 17 on the fixed end side and on the movable end side with respect to the chain wheel 25 are substantially horizontally parallel to each other. The chain wheels 25 are disposed such that their axes S are oriented in the longitudinal direction of the forklift truck, as shown in Fig. 2.

[0021] For the sake of convenience of the description, the boundary between the base portion 21 and the chain connecting portion 22 of the chain anchoring member 20 is shown by the two-dot chain line G as shown in Fig. 3. It is noted, however, that the base portion 21 and the chain connecting portion 22 of the chain anchoring member 20 are actually formed integrally, so that the boundary between the base portion 21 and the chain connecting portion 22 is not visible. The base portion 21 includes a side plate portion 21 A extending along the main wall portion 13 of the outer mast 12, and a rear plate portion 21 B extending along the rear wall portion 14. The side plate portion 21A is formed continuously with the rear plate portion 21B. As shown in Fig. 2, the base portion 21 has a contacting surface 21C formed therein. The contacting surface 21C is in contact with the outer mast 12 from the surface of the main wall portion 13 to the surface of the rear wall portion 14 of the outer mast 12.

[0022] As shown in Fig. 3, the base portion 21 has a top surface 21 D and a bottom surface 21 E, each of which extends horizontally over the side plate portion 21 A to the rear plate portion 21 B of the base portion 21. The side plate portion 21A has a side end 21F facing forward, and a welded portion 23 is formed vertically along the side end 21F. As shown in Fig. 2, the rear plate portion 21B has a side end 21 G facing inward, and another welded portion 24 is formed vertically along the side end 21 G of the rear plate portion 21B. The welded portions 23, 24 of the base portion 21 have welded areas extending vertically and substantially corresponding to the vertical length (H1) of the base portion 21, as shown in Fig. 3. According to the first preferred embodiment, the welded portions 23, 24 are provided by the vertically extending welded areas.

[0023] The welded area of the welded portion 23 is

formed along the side end 21 F of the base portion 21, and the welded area of the welded portion 24 is formed along the side end 21 G of the base portion 21. The chain anchoring members 20 are fixed to the outer masts 12 by the welded portions 23, 24, respectively. The lengths of the welded portions 23, 24 are set such that each of the welded portions 23, 24 has a strength enough to resist the stress due to a load applied to the chain anchoring member 20 through the lift chain 17. It can be said that the vertical length (H1) of the base portion 21 is set based on the lengths of the welded portions 23, 24 that meets the strength requirement. In designing of the chain anchoring member 20, the vertical length (H1) is of first priority.

[0024] The chain connecting portion 22 of the chain anchoring member 20 projects horizontally from the base portion 21. In the first preferred embodiment, the chain connecting portion 22 projects rearward from the rear wall portion 14 of the outer mast 12. As shown in Fig. 3, the chain connecting portion 22 has a hole 22A formed therethrough extending vertically adjacent to the projecting end (or rear end) of the chain connecting portion 22. An anchor bolt 18 is inserted through the hole 22A for fixing the fixed end of the lift chain 17, and fixed to the chain connecting portion 22 by two nuts 19 positioned vertically. The vertical position of the anchor bolt 18 relative to the chain connecting portion 22 is adjustable by loosening and tightening the nuts 19. The tension of the lift chain 17 is adjustable by changing the vertical position of the anchor bolt 18.

[0025] As shown in Fig. 2, the horizontal width of the chain connecting portion 22 as measured in the width-wise direction of the forklift truck is reduced toward the projected end. The vertical length (H2) of the chain connecting portion 22 is set such that the chain connecting portion 22 has a strength enough to resist against the tension of the lift chain 17. The vertical length (H2) of the chain connecting portion 22 is set irrespective of the vertical length (H1) of the base portion 21, but set shorter than the vertical length (H1) of the base portion 21. In designing of the chain anchoring member 20, the vertical length (H2) of the chain connecting portion 22 is of a second priority after the vertical length (H1) of the base portion 21. According to the first preferred embodiment, the chain connecting portion 22 is formed such that the top surface 22B thereof is positioned lower than the top surface 21 D of the base portion 21, as shown in Fig. 3. An inside corner Fa is formed on the top surface of the chain anchoring member 20 between the top surface 22B of the chain connecting portion 22 and a rear surface 21 H of the base portion 21. The rear surface 21 H of the base portion 21 serves as a vertical surface on the projecting side of the base portion 21.

[0026] The inside corner Fa facing upward has an arcuate surface 22C. The arcuate surface 22C is formed by rounding the corner between the top surface 22B of the chain connecting portion 22 and the rear surface 21 H of the base portion 21. The arcuate surface 22C serves

as a means for avoiding excessive stress concentration tending to occur in the inside corner Fa when the tension of the lift chain 17 is applied to the chain anchoring member 20. Thus, the radius of curvature of the arcuate surface 22C may be set such that the excessive stress concentration hardly occurs in the inside corner Fa. In the first preferred embodiment, the chain connecting portion 22 is formed such that the bottom surface 22D thereof is positioned higher than the bottom surface 21 E of the base portion 21, as shown in Fig. 3. Another inside corner Fb facing downward is formed on the bottom surface of the chain anchoring member 20 between the bottom surface 22D of the chain connecting portion 22 and the rear vertical surface 21I of the base portion 21. The inside corner Fb has an arcuate surface 22E. The arcuate surface 22E is formed by rounding the corner between the bottom surface 22D of the chain connecting portion 22 and the rear surface 21I of the base portion 21. The arcuate surface 22E of the first preferred embodiment has substantially the same radius of curvature as the arcuate surface 22C facing upward.

[0027] The following will describe the operation of the lift chain anchoring device according to the first preferred embodiment. The chain anchoring member 20 is subjected to an upward load applied thereto through the lift chain 17. Application of load to the chain anchoring member 20 result in generation of stress in the welded portions 23, 24. The vertical lengths of the welded portions 23, 24 are set such that the stress acts on each of the welded portions 23, 24 may be sufficiently reduced as compared to a known chain anchoring member. Therefore, if the stress caused by the upward force acts on the welded portions 23, 24, the chain anchoring member 20 may keep anchored tightly to the outer mast 12 against the stress caused by the upward load acting on the welded portions 23, 24.

[0028] When the upward force acts on the chain anchoring member 20, stress concentration occurs in the inside corner Fa of the chain anchoring member 20. Stress (compression stress) occurs at the inside corner Fa in such a way that the top surface 22B of the chain connecting portion 22 and the rear surface 21 H of the base portion 21 are moved toward each other. Because the inside corner Fa has the arcuate surface 22C, the stress which causes the top surface 22B and the rear surface 21 H to be moved toward each other is distributed and spread along the arcuate surface 22C of the inside corner Fa. Since the stress in the inside corner Fa is distributed and spread along the arcuate surface 22C, an excessive stress concentration adjacent to the inside corner Fa is avoided.

[0029] Stress (tensile stress) which causes the bottom surface 22D of the chain connecting portion 22 and the rear surface 21I of the base portion 21 to be moved away from each other occurs in the inside corner Fb facing downward. Since the inside corner Fb has the arcuate surface 22E, the stress by which the bottom surface 22D and the rear surface 21I are moved away from each other

occurs widely along the arcuate surface 22E of the inside corner Fb. Thus, excessive stress concentration adjacent to the inside corner Fb is avoided. According to the first preferred embodiment, excessive stress concentration is avoided by the chain anchoring member 20 having inside corners Fa, Fb.

[0030] According to the first preferred embodiment, the following advantageous effects are obtained.

(1) According to the lift chain anchoring device of the first preferred embodiment, excessive stress concentration may be avoided by each of the inside corners Fa, Fb of the chain anchoring member 20. The stress in the welded portions 23, 24 may be reduced in comparison with a known chain anchoring member.

(2) The vertical length (H1) of the base portion 21 is set longer than the vertical length (H2) of the chain connecting portion 22.

Thus, the vertical lengths of the welded portions 23, 24 may be increased longer than the vertical length of the chain connecting portion 22. Since the vertical lengths of the welded portions 23, 24 are increased longer as compared with those in the background art, the stress acting on the welded portions 23, 24 are reduced, accordingly.

(3) An upward force acts on the chain anchoring member 20 through the lift chain 17. However, the stress in the inside corners Fa, Fb are distributed and spread along the arcuate surfaces 22C, 22E, respectively, so that excessive stress concentration may be avoided by each of the inside corners Fa, Fb.

(4) The lengths of the welded portions 23, 24 are set such that the welded portions 23, 24 may resist the stress due to an upward force applied to the chain anchoring member 20. The length of the chain connecting portion 22 is set such that the chain connecting portion 22 may have a strength enough to resist the tension of the lift chain 17. Therefore, the chain connecting portion 22 may be downsized, and an excessive stress hardly acts on the welded portions 23, 24. The downsized chain connecting portion 22 helps to reduce the cost of material and the weight of the mast mechanism 11.

(5) According to the lift chain anchoring device of the first preferred embodiment, it is not necessary to provide a reinforcing rib of a known chain anchoring member. Therefore, the number of parts of the lift chain anchoring device may be reduced. The absence of the reinforcing rib helps to prevent the base portion 21 of the chain anchoring member 20 from projecting in the width direction (outward direction) of the outer mast 12. The chain anchoring member 20 is prevented from projecting, so that the weight

of the mast mechanism 11 may be reduced and the forward visibility of an operator on operator's seat may be improved.

(6) The welded portions 23, 24 are formed vertically along the opposite side ends of the base portion 21. Thus, only two welded portions are required, so that the work and time for the welding may be reduced. The welded portions 23, 24 have welded areas corresponding to the vertical length of the base portion 21 formed along the side ends 21 F, 21 G, respectively. Therefore, the welding is performed more easily than the welding for the conventional chain anchoring member.

[0031] The following will describe a lift chain anchoring device according to the second preferred embodiment of the present invention.

[0032] The reference numerals used for the description of the first preferred embodiment will be used to denote the same or similar elements of the second preferred embodiment, and the description of such elements will be omitted.

[0033] As shown in Fig. 4, the second preferred embodiment differs from the first preferred embodiment in that the chain anchoring member 30 has an inside corner Fa facing upward, but has no inside corner facing downward.

[0034] The inside corner Fa has an arcuate surface 32C formed by rounding the corner between the top surface 32B of the chain connecting portion 32 and the rear surface 31 H of the base portion 31 which is a vertical surface on the projected side of the base portion 31. The arcuate surface 32C is substantially the same as the arcuate surface 22C of the first preferred embodiment. The top surface 32B of the chain connecting portion 32 is positioned lower than the top surface 31 D of the base portion 31. The bottom surface 32D of the chain connecting portion 32 is positioned at substantially the same height as the bottom surface 31 E of the base portion 31. The chain connecting portion 32 has a hole 32A formed vertically therethrough. The anchor bolt 18 is inserted through the hole 32A. As shown in Fig. 4, a welded portion 33 is formed in the vertical direction at the side end 31 F of the side plate portion 31A of the base portion 31. Another welded portion (not shown) is formed in the vertical direction at the side end (not shown) of the rear plate portion 31 B. Only the welded portion 33 formed at the side end 31 F of the side plate portion 31A is shown in Fig. 4.

[0035] The length of the welded portion 33 which is determined depending on the vertical length of the base portion 31 is set so that the welded portion 33 may have a strength enough to resist the stress due to the aforementioned upward load. The vertical length of the chain connecting portion 32 is set such that the chain connecting portion 32 has a strength enough to resist the tension of the lift chain 17. In the second preferred embodiment,

the chain anchoring member 30 has no inside corner facing downward. Thus, the vertical length of the chain connecting portion 32 is larger than the counterpart in the first preferred embodiment, so that the strength of the chain connecting portion 32 enough to resist the tension of the lift chain 17 is reinforced.

[0036] When the upward force acts on the chain anchoring member 30, stress concentration occurs in the inside corner Fa of the chain anchoring member 30. Accordingly, stress (compression stress) occurs in the inside corner Fa. The stress causes the top surface 32B of the chain connecting portion 32 and the rear surface 31 H of the base portion 31 to be moved toward each other. The stress by which the top surface 32B and the rear surface 31 H are moved toward each other is distributed and spread along the arcuate surface 32C. Since the stress in the inside corner Fa is distributed and spread along the arcuate surface 32C, excessive stress concentration in the chain anchoring member 30 may be avoided.

[0037] According to the lift chain anchoring device of the second preferred embodiment, there is no inside corner facing downward. However, as in the case of the first embodiment, excessive stress concentration in the inside corner Fa of the chain anchoring member 30 may be avoided successfully. In addition, the stress in the welded portion 33 may be reduced as compared to a known chain anchoring member. Moreover, in the second preferred embodiment wherein only the inside corner Fa facing upward is provided, the advantage of the reduction of the material is reduced in comparison to the chain anchoring member 20 of the first preferred embodiment. However, only one arcuate surface may be required. Thus, the chain anchoring member 30 may be easy to be assembled as compared to the first preferred embodiment.

[0038] The following will describe a lift chain anchoring device of the third preferred embodiment of the present invention.

[0039] The reference numerals used for the description of the first preferred embodiment will be used to denote the same or similar elements of the third preferred embodiment, and the description of such elements will be omitted.

[0040] As shown in Fig. 5, a chain anchoring member 40 of the third preferred embodiment differs from that of the first preferred embodiment in that the chain anchoring member 40 has an inside corner Fb facing downward, but has not inside corner facing upward.

[0041] The inside corner of the chain anchoring member 40 has an arcuate surface 42E formed by rounding the corner between the bottom surface 42D of the chain connecting portion 42 and the rear surface 41I of the base portion 41. The rear surface 41I of the base portion 41 is a vertical surface on the projecting side of the base portion 41. The arcuate surface 42E is substantially the same as the arcuate surface 22E of the first preferred embodiment. The bottom surface 42D of the chain con-

necting portion 42 is positioned higher than the bottom surface 41 E of the base portion 41. The top surface 42B of the chain connecting portion 42 is positioned at substantially the same height as the top surface 41 D of the base portion 41. As shown in Fig. 5, the welded portion 43 is formed in the vertical direction at the side end 41 F of the side plate portion 41 A of the base portion 41. The chain connecting portion 42 has a hole 42A formed vertically therethrough for receiving therein the anchor bolt 18. A welded portion (not shown) is formed in the vertical direction at the side end (not shown) of the rear plate portion 41 B. Only the welded portion 43 formed at the side end 41 F of the side plate portion 41A is shown in the fig. 5.

[0042] As in the case of the first and second embodiments, the length of the welded portion 43 is set such that the welded portion 43 has a strength enough to resist the stress acting on the welded portion 43 due to the aforementioned upward force. The chain anchoring member 40 of the third preferred embodiment has no inside corner facing upward. Thus, the vertical length of the chain connecting portion 42 is set larger than that of the chain connecting portion 22 of the first preferred embodiment as in the case of the second preferred embodiment.

[0043] Stress concentration occurs in the inside corner Fb of the chain anchoring member 40. Stress (tensile stress) occurs in the inside corner Fb. The stress causes the bottom surface 42D of the chain connecting portion 42 and the rear surface 41I of the base portion 41 to be moved away from each other. Since the inside corner Fb has an arcuate surface 42E, the above stress by which the bottom surface 42D and the rear surface 41I are moved away is distributed and spread along the arcuate surface 42E. Since the stress in the inside corner Fb of the chain anchoring member 40 is distributed and spread along the arcuate surface 42E, excessive stress concentration in the chain anchoring member 40 is avoided.

[0044] Though the lift chain anchoring member 40 of the third preferred embodiment has no inside corner facing upward, excessive stress concentration in the inside corner Fb of the chain anchoring member 40 may be reduced as in the case of the first preferred embodiment. Thus, the stress in the welded portion 43 may be reduced as compared to the conventional chain anchoring member. Since only the inside corner Fb facing downward is formed, only one arcuate surface is required to form. The chain anchoring member 40 of the third preferred embodiment is easy to assemble as the same as the chain anchoring member 30 of the second preferred embodiment. Also, the chain anchoring member 40 is easier to manufacture as compared to the chain anchoring member 20 of the first preferred embodiment.

[0045] The following will describe a lift chain anchoring device according to the fourth preferred embodiment of the present invention.

[0046] The reference numerals used for the description of the first preferred embodiment will be used to de-

note the same or similar elements of the fourth preferred embodiment, and the description of such elements will be omitted.

[0047] As shown in Fig. 6, a chain anchoring member 50 of the lift chain anchoring device according to the fourth preferred embodiment has an inside corner Fc facing upward and an inside corner Fd facing downward.

[0048] The inside corner Fc facing upward has two arcuate surfaces 52C, 52D, and an inclined surface 52E through which the arcuate surfaces 52C, 52D are connected. The other inside corner Fd facing downward also has two arcuate surfaces 52G, 52H, and an inclined surface 52I through which the arcuate surfaces 52G, 52H are connected. Thus, the chain anchoring device of the fourth preferred embodiment differs from the chain anchoring device of the first preferred embodiment in that each of the inside corners Fc, Fd has a plurality of arcuate surfaces, i.e. surfaces 52C, 52D for the inside corner Fc and surfaces 52G, 52H for the inside corner Fd. The radii of curvature of the arcuate surfaces 52C, 52D, 52G, 52H are set smaller than the radii of curvature of the arcuate surfaces 22C, 22E of the first preferred embodiment. The vertical lengths of the welded portion 53 and the chain connecting portion 52 are set substantially the same as the first preferred embodiment.

[0049] The base portion 51 of the chain anchoring member 50 has a side plate portion 51 A and a rear plate portion 51 B. The welded portion 53 is formed in the vertical direction at the side end 51 F of the base portion 51. The chain connecting portion 52 of the chain anchoring member 50 is formed such that the top surface 52B of the chain connecting portion 52 is positioned lower than the top surface 51 D of the side plate portion 51 A. The bottom surface 52F of the chain connecting portion 52 is positioned higher than the bottom surface 51E of the side plate portion 51A. The chain connecting portion 52 has a hole 52A formed therethrough.

[0050] When the aforementioned upward force acts on the chain anchoring member 50, stress concentration occurs at the inside corners Fc, Fd of the chain anchoring member 50. Stress (compression stress) occurs in the inside corner Fc facing upward. The stress causes the top surface 52B of the chain connecting portion 52 and the rear surface 51 H of the base portion 51 to be moved toward each other. Since the inside corner Fc has two arcuate surfaces 52C, 52D and the inclined surface 52E through which the arcuate surfaces 52C, 52D are connected, such stress is distributed and spread along the arcuate surfaces 52C, 52D and the inclined surface 52E of the inside corner Fc.

[0051] Stress (tensile stress) occurs in the inside corner Fd. The stress causes the bottom surface 52F of the chain connecting portion 52 and the rear surface 51I of the base portion 51 to be moved away from each other. Such stress is distributed and spread along the arcuate surfaces 52G, 52H and inclined surface 52I. Though the stress in each of the inside corners Fc, Fd of the fourth preferred embodiment is distributed and spread less

evenly than the stress in the inside corners Fa, Fb of the first preferred embodiment, excessive stress concentration in the chain anchoring member is avoided successfully.

[0052] The following will describe a lift chain anchoring device according to the fifth preferred embodiment of the present invention.

[0053] The reference numerals used for the description of the first preferred embodiment will be used to denote the same or similar elements of the fifth preferred embodiment, and the description of such elements will be omitted.

[0054] As shown in Fig. 7, the base portion 61 of the chain anchoring member 60 of the chain anchoring device is fixed to the outer mast 12 by welding.

[0055] The length of the side plate portion 61A of the base portion 61 as measured in the longitudinal direction of the forklift truck is longer than the length of the side plate portion 21A of the anchoring member 20 of the first preferred embodiment. Rear surfaces 61 H, 61I of the base portion 61 of the fifth preferred embodiment are formed substantially the same as the rear surfaces 21 H, 21I of the first preferred embodiment. The chain connecting portion 22 of the fifth preferred embodiment is also formed substantially the same as the chain connecting portion 22 of the first preferred embodiment. The length of the side plate portion 61A in the longitudinal direction is set substantially large, By so making the chain anchoring member 60, the welded portion 63 formed in the vertical direction at the side end 61 F is positioned further from the lift chain 17 as compared to the first preferred embodiment. A welded portion (not shown) is formed in the vertical direction at the side end of the rear plate portion 61 B. The welded portion (not shown) is substantially the same as the welded portion 23 of the first preferred embodiment. Only the welded portion 63 formed at the side end 61 F of the side plate portion 61A is shown in Fig. 7. Under substantially the same conditions of the load acting through the lift chain 17 and the vertical length of the welded portion 63, the stress occurring in the welded portion 63 is decreased with an increase of the distance of the welded portion 63 from the lift chain 17.

[0056] As shown in Fig. 7, the welded portion 63 of the fifth preferred embodiment has a vertically welded area 63A and two horizontally welded areas 63B, 63C. The welded area 63A is formed in the vertical direction at the side end 61 F. The welded areas 63B, 63C extend in the horizontal direction from top and bottom ends of the vertically welded area 63A toward the rear ends of the base portion 61, respectively. The horizontally welded area 63B is formed along part of the top surface 61 D in such a range that excessive stress hardly acts on the welded area 63B. The other horizontally welded area 63C is formed along part of the bottom surface 61 E also in such a range that an excessive stress hardly acts on the welded area 63C. That is, the lengths of the horizontal welded areas 63B, 63C from the top and bottom ends of the vertical welded area 63A toward the rear ends of the base

portion 61 are limited such that excessive stress hardly occurs in the welded areas 63B, 63C. The welded portion 63 having the horizontal welded areas 63B, 63C along the top surface 61 D and the bottom surface 61 E, respectively, has a U-shape as viewed from a side. According to the fifth preferred embodiment, the stress acting on the welded portion 63 may be further decreased, and the strength of the welded portion 63 may be further improved as compared to the above preferred embodiments.

[0057] The present invention is not limited to the embodiments described above but may be modified in various alternative embodiments as exemplified below.

[0058] According to the first through fifth preferred embodiments, welded portions are formed in the vertical direction along side ends of the base portions for fixing the chain anchoring members to the outer masts. Alternatively, the position of the welded portion is not limited to the position in the above preferred embodiments, but the welded portion may be formed, for example, along the top or bottom surface of the base portion. In other words, the chain anchoring member may be welded to the outer mast at any position other than the side end of the base portion. In this case, it is preferable that the welded portion is formed such that excessive stress hardly acts on the welded portion.

[0059] In the first through fifth preferred embodiments, the base portions have the side plate portions and rear plate portions, respectively. Alternatively, the base portion may be formed mainly by a plate corresponding to the rear plate portion. In this case, it is preferable that the vertical length of the welded portion of such a plate should be set as longer as possible by forming the base portion of the chain anchoring member with an extended vertical length.

[0060] Therefore, the present examples and embodiments are to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein but may be modified within the scope of the appended claims.

[0061] A lift chain anchoring device for a forklift truck has a chain anchoring member and a lift chain. The chain anchoring member has a base portion and a chain connecting portion. The base portion includes a welded portion by which the chain anchoring member is fixed by welding to a side portion of each outer mast. The chain connecting portion projects horizontally from the base portion. One end of the lift chain is fixed to a lift bracket. The other end of the lift chain is fixed to the chain anchoring member. The vertical length of the base portion is set longer than the vertical length of the chain connecting portion. At least one of the top and bottom surfaces of the chain anchoring member has an inside corner formed between the base portion and the chain connecting portion. The inside corner has an arcuate surface.

Claims

1. A lift chain anchoring device for a forklift truck having a mast mechanism (11), the mast mechanism (11) having outer masts (12), inner masts (16) and a lift bracket which is operable to be raised and lowered relative to the mast mechanism (11), the lift chain anchoring device comprising:
 - a chain anchoring member (20, 30, 40, 50, 60) having a base portion (21, 31, 41, 51, 61) including a welded portion (23, 24, 33, 43, 53, 63), by which the chain anchoring member (20, 30, 40, 50, 60) is fixed by welding to a side portion of each outer mast (12), and a chain connecting portion (22, 32, 42, 52) projecting horizontally from the base portion (21, 31, 41, 51, 61); and a lift chain (17) one end of which is fixed to the lift bracket, the lift chain (17) the other end of which is fixed to the chain anchoring member (20, 30, 40, 50, 60),

characterized in that the vertical length of the base portion (21, 31, 41, 51, 61) is set longer than the vertical length of the chain connecting portion (22, 32, 42, 52), and

in that at least one of the top and bottom surfaces of the chain anchoring member (20, 30, 40, 50, 60) has an inside corner (Fa, Fb, Fc, Fd) formed between the base portion (21, 31, 41, 51, 61) and the chain connecting portion (22, 32, 42, 52), the inside corner (Fa, Fb, Fc, Fd) having an arcuate surface (22C, 22E, 32C, 42E, 52C, 52D, 52G, 52H).
2. The lift chain anchoring device for a forklift truck according to claim 1, **characterized in that** the welded portion (23, 24, 33, 43, 53, 63) has a vertical welded area corresponding to the vertical length of the base portion (21, 31, 41, 51, 61), and **in that** the vertical welded area is formed along a side end (21 F, 21 G, 31F, 41 F, 51 F, 61 F) of the base portion (21, 31, 41, 51, 61).
3. The lift chain anchoring device for a forklift truck according to claims 1 or 2, **characterized in that** the welded portion (63) has horizontally welded areas (63C, 63D) extending in the horizontal direction from top and bottom ends of the vertically welded area (63A) toward the rear ends of the base portion (61), and **in that** the horizontally welded areas (63B, 63C) are formed along a part of the top surface (61 D) and a part of the bottom surface (61 E) of the base portion (61).
4. The lift chain anchoring device for a forklift truck according to any one of claims 1 through 3, **characterized in that** the top surface (21 D, 31 D, 51 D, 61 D) of the chain connecting portion (22, 32, 52) is positioned lower than the top surface (21 D, 31 D, 51 D, 61 D) of the base portion (21, 31, 51, 61), and **in that** the inside corner (Fa, Fc) is formed between the top surface (22B, 32B, 52B) of the chain connecting portion (22, 32, 52) and a vertical surface on the projecting side of the base portion (21, 31, 51, 61).
5. The lift chain anchoring device for a forklift truck according to any one of claims 1 through 4, **characterized in that** the bottom surface (21 E, 41 E, 51 E, 61E) of the chain connecting portion (22, 42, 52) is positioned higher than the bottom surface (21 E, 41 E, 51 E, 61 E) of the base portion (21, 41, 51, 61), and **in that** the inside corner (Fb, Fd) is formed between the bottom surface (21 E, 41 E, 51 E, 61 E) of the chain connecting portion (22, 42, 52) and a vertical surface on the projecting side of the base portion (21, 41, 51, 61).
6. The lift chain anchoring device for a forklift truck according to any one of claims 1 through 5, **characterized in that** the arcuate surface (22C, 22E, 32C, 42E, 52C, 52D, 52G, 52H) of the inside corner (Fa, Fb, Fc, Fd) is formed by rounding the corner between one of the top and bottom surfaces (21 D, 21 E, 31 D, 31 E, 41 D, 41 E, 51 D, 51 E, 61D, 61 E) of the chain connecting portion (22, 32, 42, 52) and the vertical surface on the projecting side of the base portion (21, 31, 41, 51, 61).
7. The lift chain anchoring device for a forklift truck according to any one of claims 1 through 6, **characterized in that** the inside corner (Fc, Fd) has at least two arcuate surfaces (52C, 52D, 52G, 52H) and at least one inclined surface (52E, 52I) through which the arcuate surfaces (52C, 52D, 52G, 52H) are connected.
8. A method for fixing a lift chain anchoring device of a forklift truck, the forklift truck having a mast mechanism (11) with a chain anchoring member (20, 30, 40, 50, 60) and a lift chain (17), outer masts (12) and lift bracket which is operable to be raised and lowered relative to the mast mechanism (11), comprising the steps of:
 - forming the chain anchoring member (20, 30, 40, 50, 60) having a chain connecting portion (22, 32, 42, 52) and a base portion (21, 31, 41, 51, 61) the vertical length of which is set longer than the vertical length of the chain connecting portion (22, 32, 42, 52),
 - forming an inside corner (Fa, Fb, Fc, Fd) on at least one of a top surface and a bottom surface of the chain anchoring member (20, 30, 40, 50, 60) between the base portion (21, 31, 41, 51, 61) and the chain connecting portion (22, 32,

42, 52);
fixing the chain anchoring member (20, 30, 40,
50, 60) by a welded portion (23, 24, 33, 43, 53)
formed vertically along a side end (21 F, 21 G,
31 F, 41 F, 51 F, 61F) of the base portion (21, 5
31, 41, 51, 61) to a side portion of the outer mast
(12) so as to project the chain connecting portion
(22, 32, 42, 52) horizontally from the base por-
tion (21, 31, 41, 51, 61),
fixing one end of the lift chain (17) to the lift brack- 10
et; and
fixing the other end of the lift chain (17) to the
chain anchoring member (20, 30, 40, 50, 60).

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FIG. 1

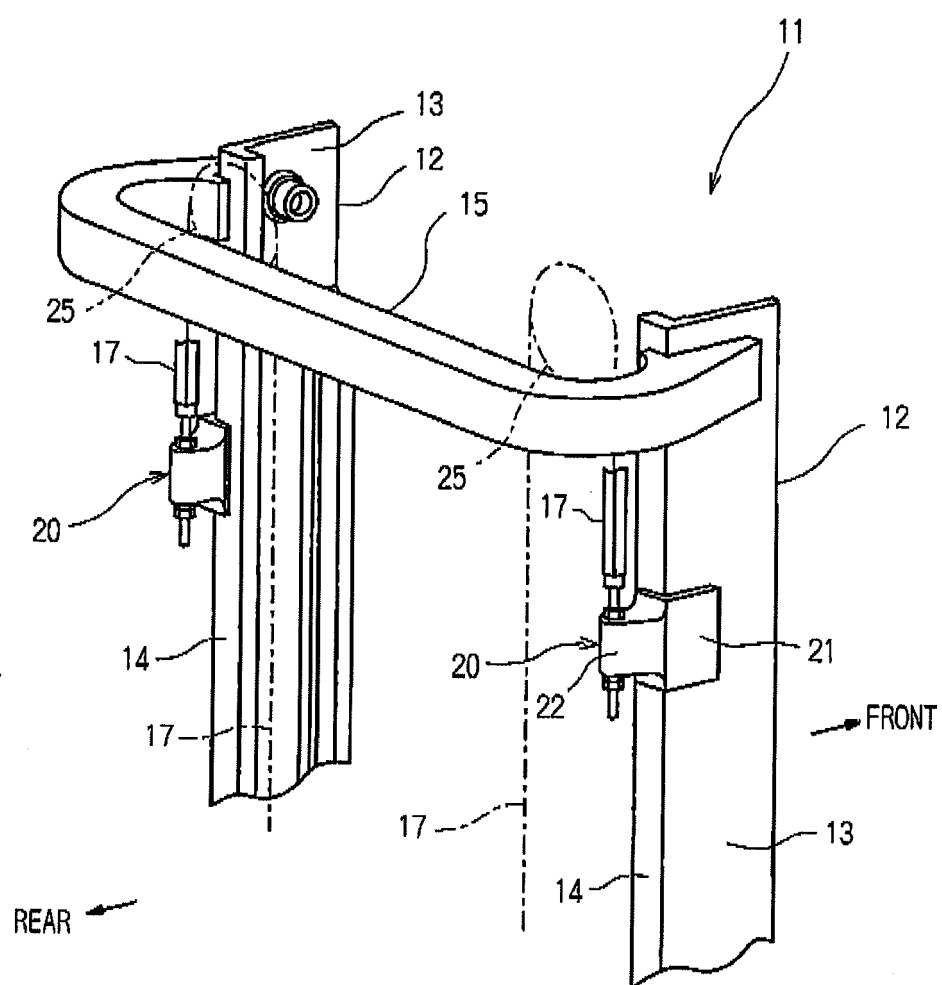


FIG. 2

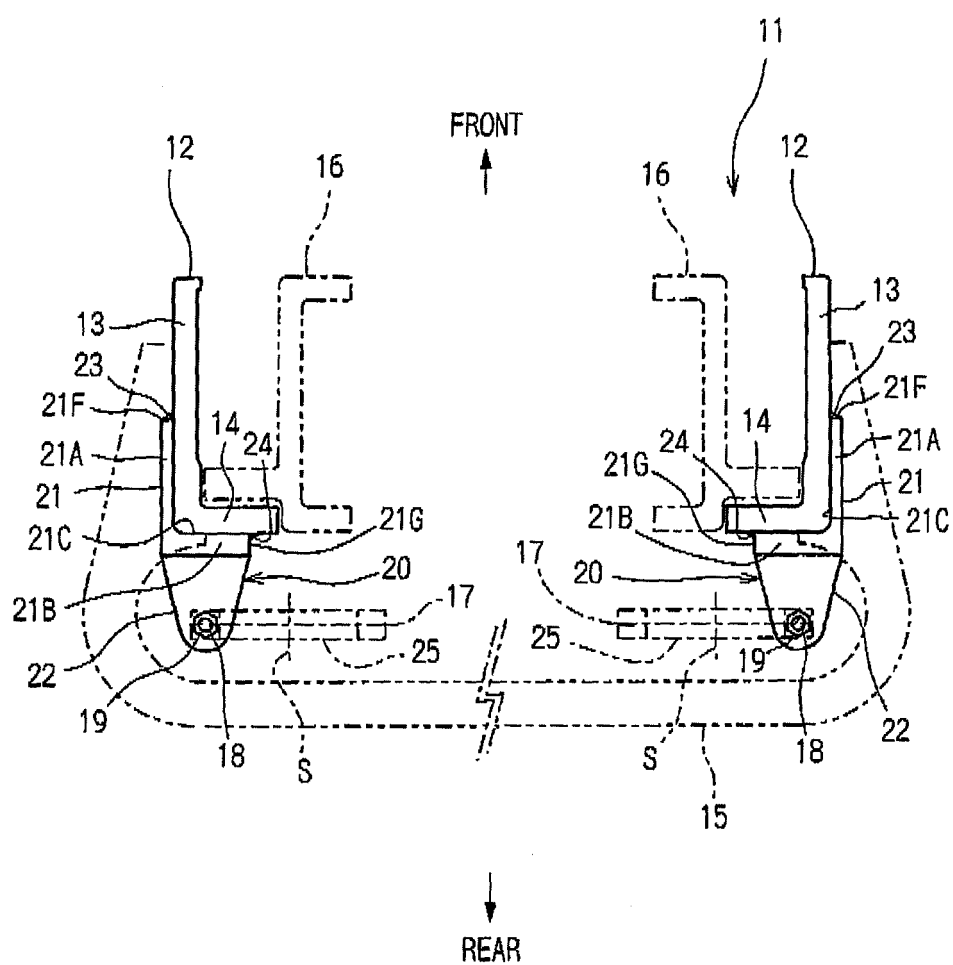


FIG. 3

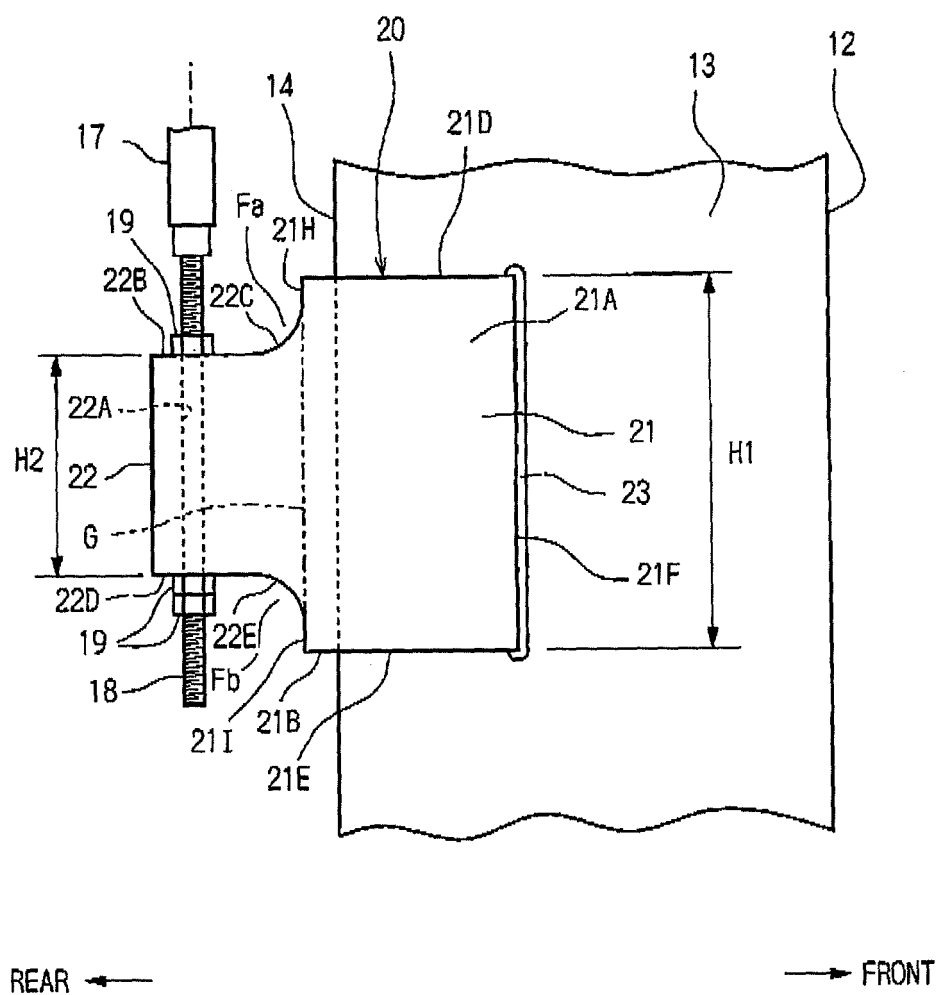


FIG. 4

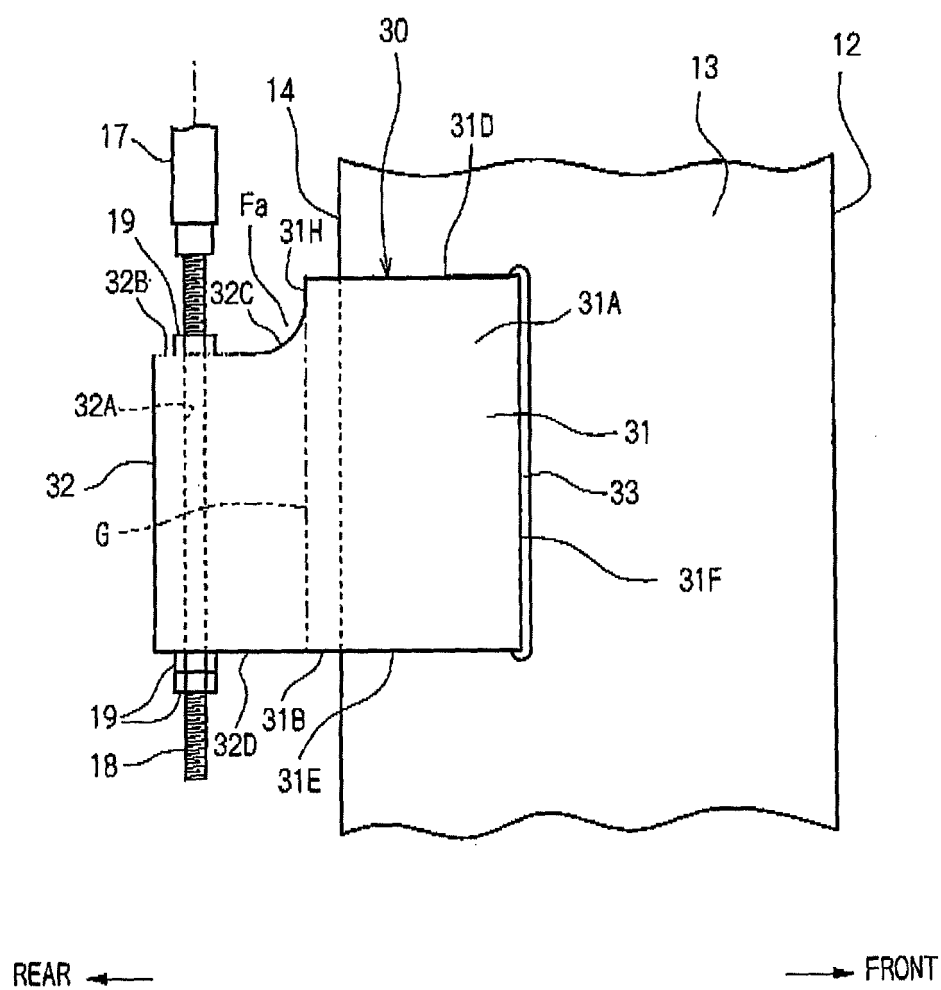


FIG. 5

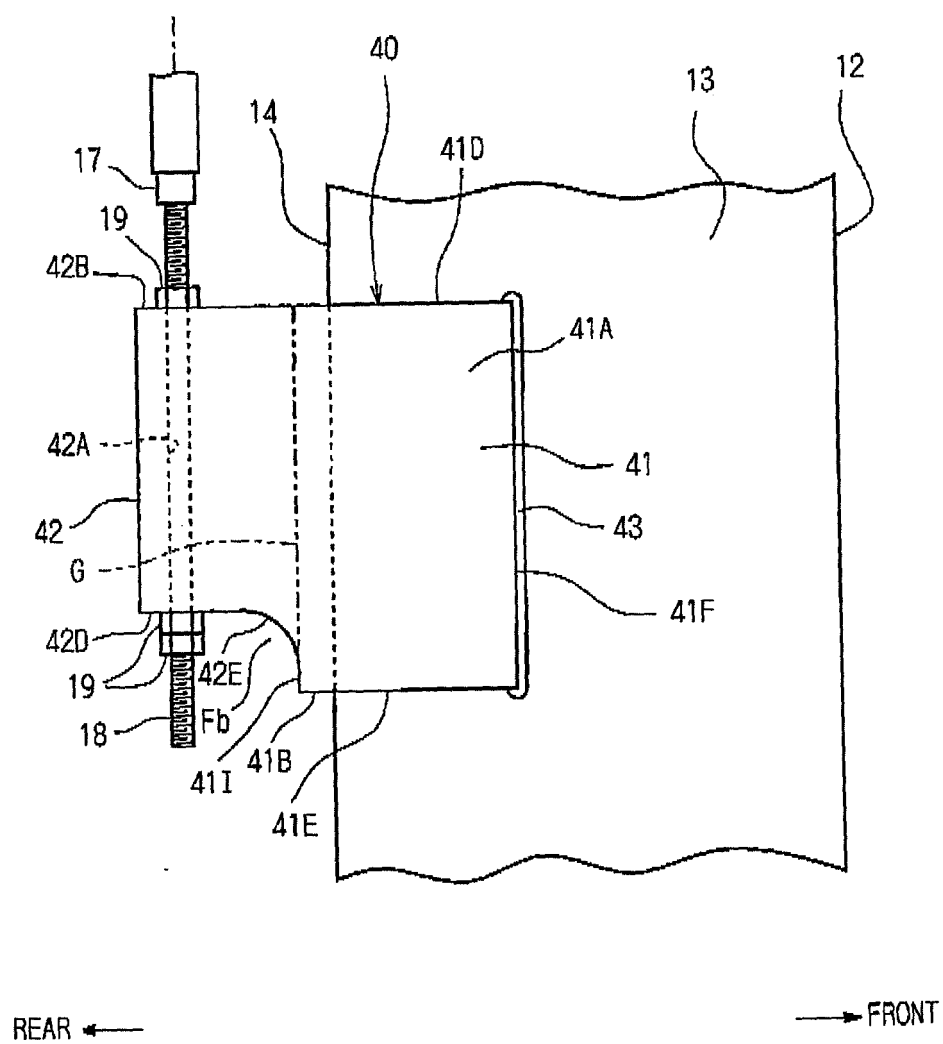


FIG. 6

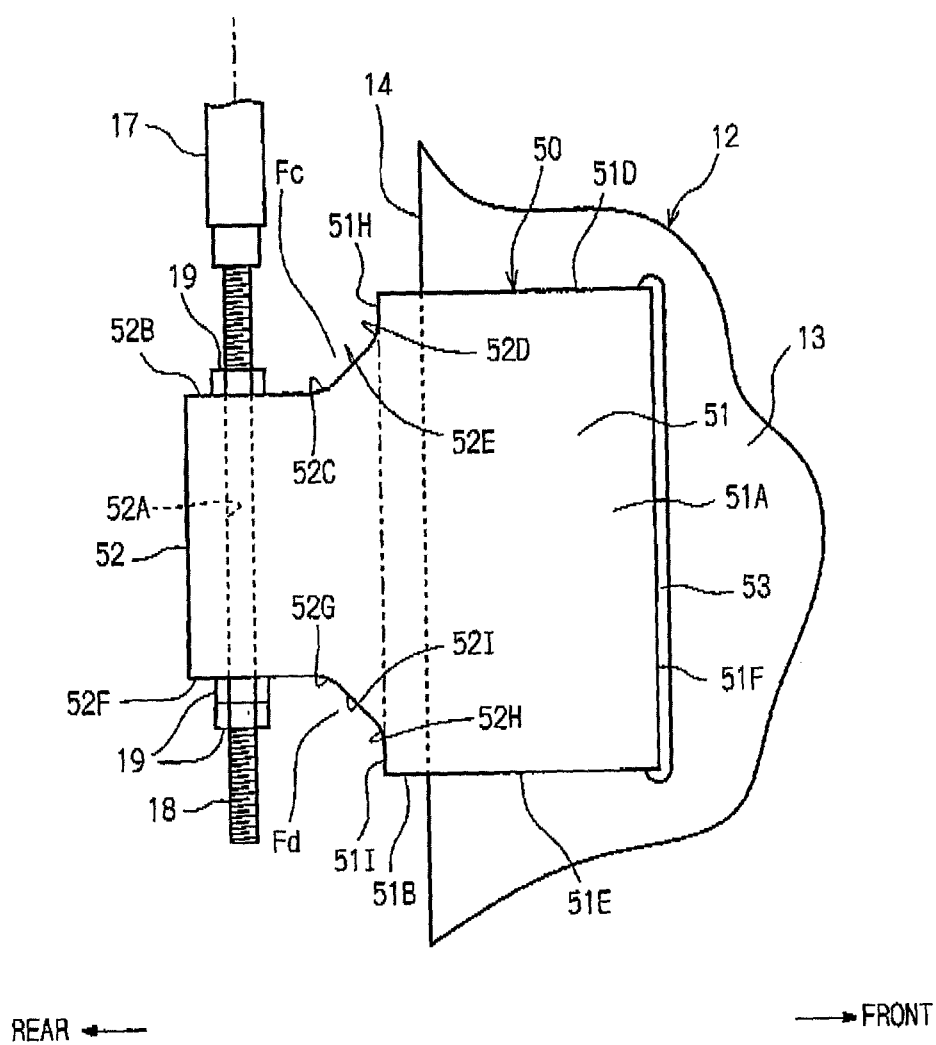


FIG. 7

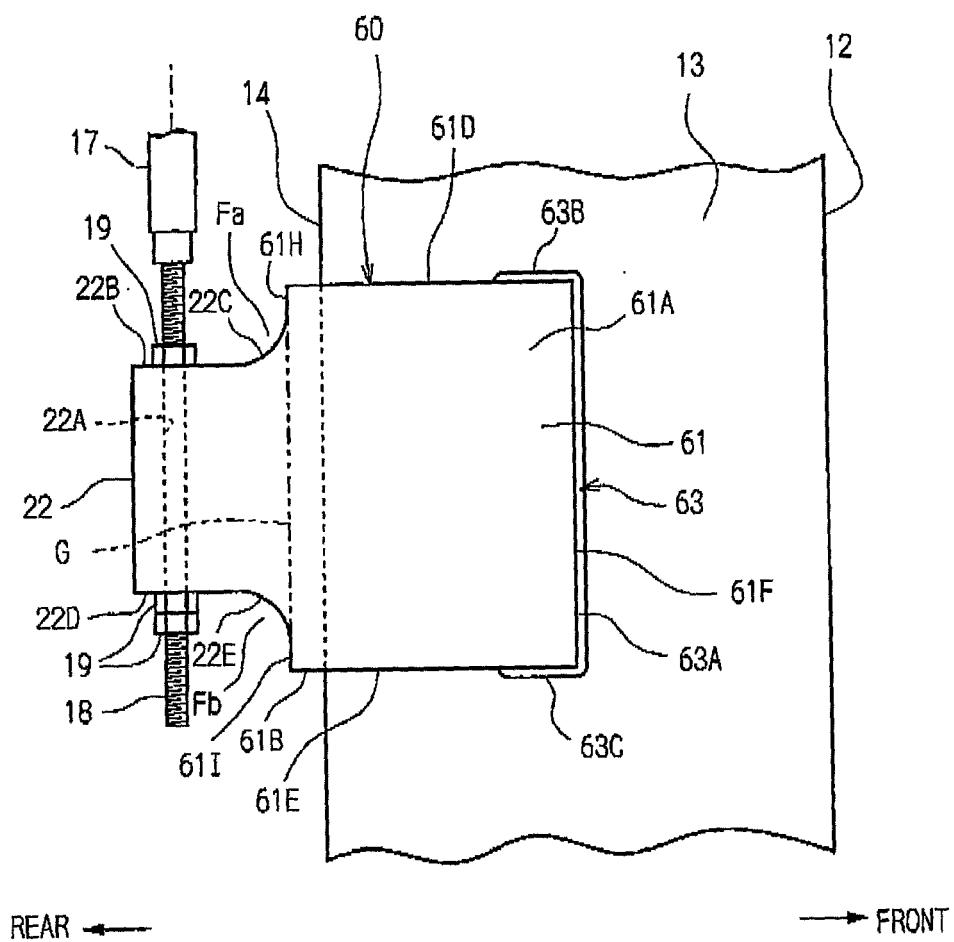
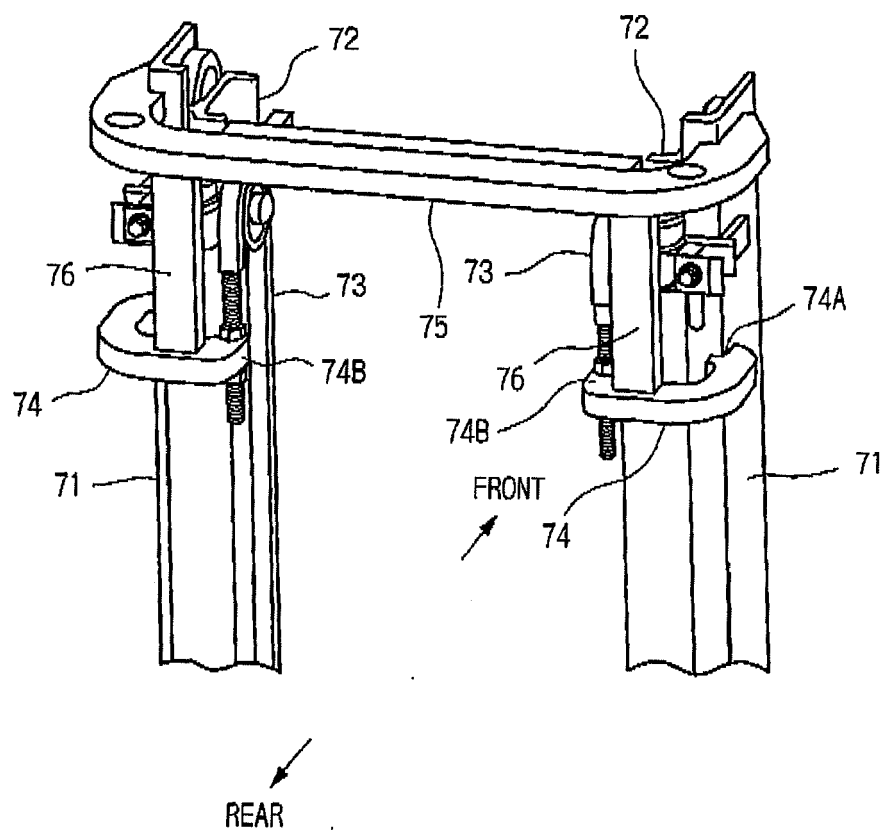


FIG. 8
(Background Art)





EUROPEAN SEARCH REPORT

Application Number
EP 08 16 1052

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP 07 228496 A (TOYODA AUTOMATIC LOOM WORKS) 29 August 1995 (1995-08-29) * abstract; figures 1-4 *	1-8	INV. B66F9/08
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A	US 4 355 703 A (BARTOW RICHARD J) 26 October 1982 (1982-10-26) * abstract; figures 6-12 *	1-8	
			TECHNICAL FIELDS SEARCHED (IPC)
			B66F
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 12 November 2008	Examiner Faymann, L
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12-11-2008

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