EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

Date of publication: 18.09.2013 Bulletin 2013/38
Application number: 11831984.7
Date of filing: 23.06.2011

Int Cl.: B66C 23/72 (2006.01)

International application number: PCT/CN2011/076236

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

Priority: 14.10.2010 CN 201010507074

Applicants:
• Changsha Zoomlion Heavy Industry Science & Technology Development Co., Ltd.
  Changsha, Hunan 410013 (CN)
• Hunan Zoomlion Special Vehicle Co. Ltd.
  Changde, Hunan 415106 (CN)

Inventors:
• FENG, Jun
  Changsha
  Hunan 410013 (CN)
• FU, Yingxiong
  Changsha
  Hunan 410013 (CN)
• LIU, Difang
  Changsha
  Hunan 410013 (CN)

Representative: Peters, Hajo
Zacco GmbH
Bayerstraße 83
80335 München (DE)

TOWER CRANE AND BALANCE ARM TENSION ROD STRUCTURE THEREOF AND MOUNTING METHOD FOR THE STRUCTURE

The disclosure discloses a tower crane and a tie rod structure of a balance boom thereof, and a method for mounting the tie rod structure of the balance boom. The tie rod structure of the balance boom comprises two tie rods intersected with each other at a certain angle, each of the tie rods has a first end connected with a balance boom of the crane and a second end connected with a tower head of the crane, and the distance between the first ends of the two tie rods is greater than that between the second ends; an adapting member which is arranged at the second ends of the two tie rods and the second end of each of the tie rods is connected to the adapting member; and two separate first connecting members, wherein each of the first connecting members has a first end connected with the adapting member and a second end connected with the tower head of the crane by a first pin shaft. The mounting method adopts the tie rod structure of the balance boom mentioned above. The tie rod structure of the balance boom is stressed stably and rationally and safe and fast to mount.

Fig.4
Description

Technical field of the invention

[0001] The disclosure relates to the field of hoisting machinery, in particular to a tower crane and a tie rod structure of a balance boom thereof, and a method for mounting the tie rod structure of the balance boom.

Background of the invention

[0002] At present, in the super-large tower cranes, the tie rod of the balance boom can be divided into a parallel double-tie-rod structure and a triangular double-tie-rod structure. The parallel double-tie-rod structure refers to two parallel round-steel tie rods connecting a balance boom and a tower head (i.e., a supporting frame). The parallel double-tie-rod structure looks simple; whereas, the two tie rods are poor in overall stability and easy to break down when stressed unequally.

[0003] Compared with the former, the tie rods of the triangular double-tie-rod structure are better in overall stability. As shown in Fig. 1, in the triangular double-tie-rod structure, two tie rods 6 intersected at certain angle form two long sides of a triangle; one ends of the two tie rods 6 are connected with a balance boom by an adapting member 5, while the other ends of the two tie rods 6 are adjacent to each other; and each tie rod 6 is connected with the tower head (i.e., the supporting frame) by a connecting member 40.

Summary of the invention

[0007] The disclosure aims to provide a tie rod of a balance boom of a tower crane, in order to solve the problems of poor stress, inconvenient mounting and transportation and the like of the conventional tie-rod structure.

[0008] In one aspect, the disclosure provides a tie rod structure of a balance boom of a super-large tower crane. The tie rod structure of the balance boom comprises two tie rods which are intersected with each other at a certain angle, wherein each of the tie rods has a first end connected with a balance boom of the crane and a second end connected with a tower head of the crane, and the distance between the first ends of the two tie rods is greater than that between the second ends; the adapting member which is arranged at the second ends of the two tie rods and the second end of each of the tie rods is connected to the adapting member; and two first connecting members disposed separately, wherein each of the first connecting members has a first end connected with the adapting member and a second end connected with the tower head of the crane by a first pin shaft.

[0009] Furthermore, the adapting member comprises a C tie plate frame hinged with each of the first connecting members by a second pin shaft, and a B connecting plate hinged with the C tie plate frame by a third pin shaft; wherein each of the tie rods is provided with a first reversing plate which is connected to the B connecting plate by a fourth pin shaft; and the second end of each of the tie rods is connected to the first reversing plate by a fifth pin shaft.

[0010] Furthermore, the tie rod structure of the balance boom further comprises two second tie plate frames, each of which is arranged at the first end of each of the two tie rods, and each of the two tie rods is connected with one of the second tie plate frames by a second reversing plate, wherein one second reversing plate is connected with one of the second tie plate frames by a first rotating shaft Q, and the other second reversing plate is connected with the other of the second tie plate frames by a second rotating shaft R; a second connecting member, one end of which is connected with the two second tie plate frames by a second connecting plate, and the other end of which is provided with a structure connected with the balance boom of the crane; a box- type supporting beam which is connected between the two second tie plate frames and comprises a bottom surface, a top surface parallel to the bottom surface and a first end surface and a second end surface perpendicular to the bottom surface, wherein the first end surface is parallel to the second end surface, the plane formed by the two tie rods is in the middle between the bottom surface and the
top surface, the first end surface is within the plane formed by the first rotating shaft Q and the second rotating shaft R and the distance of the second end surface departing away from the adapting member is larger than that of the first end surface; and a first sheave block which is arranged on the supporting beam.

Furthermore, each of the tie rods comprises a first tie rod and a second tie rod which are connected by a sixth pin shaft, wherein the first tie rod is connected to one of the two first connecting members by the adapting member; the each second tie rod is connected with one of the second tie plate frames by one of the second reversing plates.

Furthermore, the tie rod structure of the balance boom can be divided into a first segment, a second segment and a third segment which are connected in sequence, wherein the first segment comprises the first tie rods, the adapting member and the first connecting members; the second segment of the tie rod structure of the balance boom comprises the second tie rods, the second reversing plates, the second tie plate frames, the second connecting plate, the supporting beam and the first sheave block, one of the second reversing plates is connected to one of the second tie rod by a seventh pin shaft, and one of the second tie plate frame is connected with one of the second reversing plates by the first rotating shaft Q or the second rotating shaft R; and the third segment is hinged with the second connecting plate and is provided with a structure hinged with the balance boom of the crane.

Furthermore, the first connecting pieces comprise two parallel D tie plate frames, each of which is provided with an A connecting plate hinged therewith and being parallel thereto; the A connecting plate is connected with the C tie plate frame; each one of the D tie plate frame is provided with a structure hinged with the tower head of the tower crane by the first pin shaft.

Furthermore, the second connecting member forms the third segment which comprises two third connecting plates, a third tie plate frame and a second sheave block, wherein each of the two third connecting plates is hinged with one of the second tie plate frames by an eighth pin shaft; one end of the third tie plate frame is hinged with the two third connecting plates by two ninth pin shafts, and the other end is provided with a structure hinged with the balance boom of the crane; and the second sheave block is arranged on the third tie plate frame and is connected with the first sheave block by a steel cable.

Furthermore, the third pin shaft connecting the B connecting plate with the C tie plate frame, the fourth pin shaft connecting the B connecting plate with the first reversing plate, the first rotating shaft Q and the second rotating shaft R are parallel to one another; the pin shafts of the first to ninth pin shafts, excepting for the third pin shaft, the fourth pin shaft, the first rotating shaft Q and the second rotating shaft R, are parallel to one another; and the third pin shaft, the fourth pin shaft, the first rotating shaft Q and the second rotating shaft R are perpendicular to the rest pin shafts of the first to ninth pin shafts.

Furthermore, the third tie plate frame is provided with a stop component for stopping the third connecting plates.

Furthermore, each first reversing plate comprises: a vertical connecting plate and a horizontal connecting plate which are vertically connected with each other; the vertical connecting plate is perpendicular to the plane formed by the two tie rods; the horizontal connecting plate is within the plane formed by the two tie rods; the fourth pin shaft connects the horizontal connecting plate with the B connecting plate; and the fifth pin shaft connects one of the tie rods with the vertical connecting plate.

The disclosure further provides a tower crane, which comprises the tie rod structure of the balance boom mentioned above.

In another aspect, the disclosure further provides a method for mounting a tie rod structure of the balance boom of a tower crane, wherein the tie rod structure of the balance boom is the one mentioned above.

The method comprises the following steps: pre-mounting the first segment on the tower head and the third segment on the balance boom, arranging the second segment on a balance boom bracket and a trolley, and connecting the second segment with the third segment.

Furthermore, the method further comprises: connecting a hoisting boom with an upper base to connect the tie rods of the hoisting boom into a whole.

Due to the adoption of the adapting member which is connected with one end of each tie rod adjacent to the tower head of the crane, the force of the two tie rods is combined by the adapting member to form resultant force, and the resultant force is connected with the tower head by the two first connecting members disposed separately. Therefore, the two first connecting members and the two tie rods are balanced in force under the action of the same adapting member, and the problems that the tie rods are poor in overall stability and easy to break down after being connected to the tower head are solved.

In addition, the supporting beam is arranged in a vertical plane in which the arm of force of a bending moment is zero, so as to eliminate the bending moment of the tie rod structure of the balance boom.

Furthermore, the tie rod structure of the balance boom is arranged segmentally, so as to be convenient to dismount, transport and mount. Furthermore, the tie rod structure of the balance boom further adopts various reversing plates and pin shafts connected in different directions. So that the tie rods can rotate in both the horizontal and vertical directions, and the motion flexibility of the tie rod structure of the balance boom is improved.

The method for mounting the tie rod structure of the balance boom of the tower crane adopts the tie rod structure of the balance boom mentioned above, so that the mounting is convenient and fast, efficient and safe.
Brief description of the drawings

[0025] Drawings, which form a part of the description and are provided for further understanding of the present invention, show the preferred embodiments of the present invention, and explain the principle of the present invention together with the description. In the drawings:

Fig. 1 shows a conventional tie rod structure of a balance boom;
Fig. 2a is a top view showing the structure of a tie rod structure of a balance boom according to a first embodiment of the disclosure;
Fig. 2b is a top view showing the structure of a tie rod structure of a balance boom according to a second embodiment of the disclosure; Fig. 3 is a front view showing the structure of Fig. 2b;
Fig. 4 shows the structure of a first segment in Fig. 2b;
Fig. 5 shows the structure of a second segment in Fig. 2b;
Fig. 6 is a top view showing the structure of a third segment in Fig. 2b;
Fig. 7 is a front view showing the structure of a third segment in Fig. 6;
Fig. 8 shows the state of a tie rod structure of a balance boom when a tower head is inclined to a hoisting boom at an angle of alpha in a mounting process;
Fig. 9 is a diagram showing the state of mounting a hoisting boom and a hoisting boom tie rod; and
Fig. 10 shows the state of mounting the second and third segments of a tie rod structure of a balance boom.

Detailed description of the embodiments

[0026] The embodiments of the present invention will be described in detail below with reference to drawings, however the present invention may be implemented by various different ways defined and covered by the claims. In the drawings, identical components are indicated by identical reference number.

[0027] As shown in Fig. 2a, a tie rod structure of a balance boom of a tower crane according to a first embodiment of the disclosure comprises: two tie rods 6 intersected at a certain angle, an adapting member 17 and first connecting members 10.

[0028] The two tie rods 6 form two long sides of a triangle and are generally the same in length and structure so as to be stressed equally and form resultant force which is on the bisecting line of the included angle between the two tie rods 6; one ends of the two tie rods 6 adjacent to the balance boom of the crane, i.e., the first ends of the tie rods 6 (the left ends in Fig. 2a) are provided with a structure connected with the balance boom of the crane, for example, are connected on the balance boom of the crane by various connecting members; and the other ends of the two tie rods 6 adjacent to the tower head of the crane, i.e., the second ends of the tie rods 6 (the right ends in Fig. 2a), are adjacent to each other, namely, the distance between the first ends of the two tie rods 6 is greater than that between the second ends of the two tie rods 6.

[0029] The adapting member 17, such as a connecting plate, a connecting frame or an assembly formed by connecting plates and the like, is connected with one end of each tie rod 6 adjacent to the tower head of the crane, i.e., the second ends of the tie rods 6 at the same time; and the two first connecting members 10 disposed separately are connected with the adapting member 17 respectively, and each of the first connecting member 10, such as a connecting plate, a connecting frame or an assembly formed by connecting plates and the like, is provided with a structure which is hinged with the tower head of a tower crane (i.e., a supporting frame) by a first pin shaft 51. Due to the adapting member 17 above, each tie rod 6 can be connected to the tower head flexibly so as to be convenient to adjust, dismount and reverse.

[0030] Due to the adoption of the adapting member 17 which is connected with one end of each tie rod 6 adjacent to the tower head of the crane, the force of the two tie rods 6 is combined on the adapting member 17 to form resultant force which is connected with the tower head by the two separate first connecting members 10, at the moment, the two first connecting members 10 and the two tie rods 6 are balanced in force under the action of the same adapting member 17 and can be regulated automatically when stressed unequally, therefore, the problems that the tie rods are stressed unequally, poor in overall stability and easy to break down after being connected to the tower head are solved.

[0031] As shown in Figs. 2a, 2b, 3 and 4, the adapting member 17 can be a connecting plate or a connecting frame. Furthermore, the adapting member 17 comprises: a platelike C plate frame 13 hinged with each first connecting member 10 by a second pin shaft 52, and a B connecting plate 14 hinged with the C plate frame 13 by a third pin shaft 53. Each tie rod 6 is provided with a first reversing plate 15 which is connected to the B connecting plate 14 by a fourth pin shaft 54, wherein one end of each tie rod 6 adjacent to the tower head of the crane is connected to one first reversing plate 15 by a fifth pin shaft 55.

[0032] As shown in Figs. 3 and 4, each first reversing plate 15 comprises, for example, a vertical connecting plate 151 and a horizontal connecting plate 153 which are vertically connected with each other and can be welded together. The vertical connecting plates 151 are perpendicular to the plane formed by the two tie rods 6, and the horizontal connecting plates 153 are within the plane formed by the two tie rods 6. The fourth pin shaft 54 connects the horizontal connecting plates 153 with the B connecting plate 14, and the fifth pin shaft 55 connects the tie rods 6 with the vertical connecting plates 151. Through the connection of the first reversing plates 15 and the pin shafts, the tie rods 6 can be reversed and rotate in both the horizontal and vertical directions, so as to improve the hoisting flexibility. Due to the adapting
member 17 above, each tie rod 6 can be connected to the tower head flexibly, so as to be convenient to adjust, dismount and reverse.

Furthermore, as shown in Figs. 2b and 5, at the ends of the two tie rods 6 adjacent to the balance boom of the crane, i.e., the first ends of the tie rods 6, one tie rod 6 is connected with a platelike second tie plate frame 23 by a rotating shaft Q, and the other tie rod 6 is connected with another second tie plate frame 23 by a rotating shaft R; one end of a second connecting member, such as a connecting plate, a connecting frame or an assembly formed by a plurality of connecting plates and the like, is connected with the two second tie plate frames 23, and the other end is provided with a structure connected with the balance boom of the crane; and a box-type supporting beam 28 is connected between the two second tie plate frames 23 and comprises a bottom surface, a top surface parallel to the bottom surface, and a first end surface and a second end surface which are perpendicular to the bottom surface and parallel to each other.

The bottom surface, the top surface, the first end surface and the second end surface form the box-type structure of the supporting beam 28 and can be made of steel plates; and the plane formed by the two tie rods 6 is in the middle between the bottom surface and the top surface, that is to say, the distance between the bottom surface and the plane formed by the two tie rods 6 is the same as that between the top surface and the plane formed by the two tie rods 6, therefore, the force can be born rationally. The first end surface is within the plane formed by the first rotating shaft Q and the second rotating shaft R; and the distance of the second end surface departing away from the adapting member 17 is larger than that of the first end surface, namely, the second end surface is adjacent to the third segment 3 in Fig. 2b. Of course, the supporting beam 28 can be of other forms, such as a platelike form, but is not as firm as the box-type supporting beam.

The first sheave block 27 is arranged on the supporting beam 28, and is used for connecting the tie rods 6 with the third segment 3 in the mounting process as shown in Fig. 2b. As shown in Figs. 1 and 2b, the force applied to the beam 28 from the sheave block 27 can be divided into the pressure F along the length direction of the beam 28 and the pressure N in the gravity direction perpendicular to the beam 28, and the arm of force of the pressure F on the beam 28 is the distance d between the beam 28 and the QR connecting line between the first rotating shaft Q and the second rotating shaft R. The first end surface of the beam 28 is within the plane formed by the first rotating shaft Q and the second rotating shaft R, and the whole beam 28 is basically in the triangular plane of the QR connecting line perpendicular to the two tie rods 6, therefore, the arm of force of the pressure F and the pressure N on the beam 28 is zero, and the bending moment of the pressure F on the beam 28 or the second tie plate frames 23 is zero. Even there is a certain mounting error in the actual mounting process, the arm of force of the pressure F and the pressure N on the beam 28 can also be reduced greatly to be approximate to zero, and accordingly, the bending moment can also be reduced greatly, therefore, the stability of the beam 28, the second tie plate frames 23 and the whole tie rod structure of the balance boom is improved, and the mechanical structure of the tie rod structure of the balance boom is more rational.

Furthermore, as shown in Figs. 2b to 5, each tie rod 6 comprises a first tie rod 16 and a second tie rod 26 which are connected by a sixth pin shaft 56; each first tie rod 16 is connected to one first connecting member 10 by the adapting member; and each second tie rod 26 is connected with one second tie plate frames 23. Each tie rod 6 is divided into two segments so as to be convenient to transport and mount.

Furthermore, as shown in Figs. 2b and 3, the tie rod structure of the balance boom is divided into a first segment 1, a second segment 2 and a third segment 3 which are connected in sequence. For example, the first segment 1 can be pre-mounted on the tower head and transported with the tower head; the third segment 3 is, for example, mounted on the balance boom and transported with the balance boom; and finally, it is only necessary to connect the second segment 2 with the first segment 1 and the third segment 3 respectively to implement the internal connection of the tie rod structure of the balance boom and the connection between the tie rod structure of the balance boom and the tower head and the balance boom, therefore, the tie rod structure of the balance boom is convenient to dismount, transport and mount, saves time, reduces the mounting process and decreases the working strength.

As shown in Fig. 4, the first segment 1 comprises two parallel first connecting members 10 which connected with the tower head, and two first tie rods 16 which are intersected at a certain angle and connected to the first connecting members 10 by the adapting member 17. For example, the first tie rods 16 are mounted on a supporting frame (the tower head) and transported there with, so as to save the mounting time in the field mounting process. Furthermore, each first connecting member 10 comprises: two parallel platelike D tie plate frames 11 each provided with an A connecting plate 12 hinged with and parallel to itself, wherein the A connecting plates 12 are connected with the C plate frame 13; and each D tie plate frame 11 is provided with a structure hinged with the tower head of the tower crane by the first pin shaft 51. Therefore, each tie rod 6 can be connected to the tower head flexibly, and is convenient to adjust, dismount and reverse.

As shown in Fig. 5, the second segment 2 comprises the second tie rods 26 and two second reversing plates 25, wherein the second tie rods 26 are connected with the first tie rods 16 respectively by the sixth pin shaft 56; the first tie rods 16 are connected with the second tie
rods 26 by a second connecting plate 22 to form the tie rods 6; the first tie rods 16 can be hinged with the second connecting plate 22; the sixth pin shaft 56 axially connects the second connecting plate 22 with the first tie rods 16 to enable the first tie rods 16 to be connected with the second tie rods 26; the second tie rods 26 can be placed on a platform or a trolley of the balance boom in the mounting process; each second reversing plate 25 is connected to one second tie rod 26 by a seventh pin shaft 57; the second reversing plates 25 are basically the same as the first reversing plates 15 in structure and also comprise two connecting plates mutually connected; one connecting plate is hinged with the second tie rods 26 by the seventh pin shaft 57, and the other connecting plate is hinged with the second tie plate frames 23 by the rotating shaft Q or the rotating shaft R; and the seventh pin shaft 57 is perpendicular to the mounting direction of the rotating shaft Q or the rotating shaft R. Therefore, under the cooperation of the pin shafts, the rotation of the second tie rods 26 in the horizontal and vertical directions can be well met; the two second tie plate frames 23 are connected with one second reversing plate 25 by the rotating shaft Q or the rotating shaft R respectively; the supporting beam 28 is connected between the second tie plate frames 23; the first sheave block 27 is arranged on the supporting beam 28; and the second reversing second connecting plates 24 are respectively arranged on the two second tie plate frames 23 to connect the third segment 3.

As shown in Figs. 2b and 3, the second connecting member forms the third segment 3 which is hinged with the second tie plate frames 23 and is provided with a structure hinged with the balance boom of the crane. The third segment 3 is, for example, mounted on the balance boom and transported with the balance boom, so as to save the mounting time during the field mounting.

Furthermore, as shown in Figs. 6 and 7, the third segment 3 comprises two parallel third connecting plates 32, a third tie plate frame 33 and a second sheave block 37, wherein the two third connecting plates 32 are connected with the second tie plate frames by an eighth pin shaft 58 respectively, for example, each third connecting plate 32 is hinged with the second connecting plate 24 by the eighth pin shaft 58; one end of the third tie plate frame 33 is hinged with the third connecting plates 32 by a ninth pin shaft 59, and the other end (i.e., the left end in Fig. 6) is provided with a structure hinged with the balance boom of the crane; and the second sheave block 37 is arranged on the third tie plate frame 33 and is connected with the first sheave block 27 by a steel cable. The first sheave block 27 and the second sheave block 37 can be provided with four sheaves. After connecting the first sheave block 27 with the second sheave block 37, the steel cable forms a cable line of the steel cable to connect the third segment 3 with the second segment 2 and further straighten the third segment 3 and the second segment 2 between which a certain included angle is originally formed into a line conveniently.

Furthermore, as shown in Fig. 7, the third tie plate frame 33 is provided with a stop component 35 for locating the third connecting plates 32. For example, the stop component 35 is a block, the third connecting plates 32 are oval or elongated plates, and the stop component 35 is arranged at a predetermined position outside the oval plates to limit the rotation range of the oval or elongated plates at the predetermined position, so that the third connecting plates 32 can rotate around a pin shaft within a limited range to be convenient for mounting.

Furthermore, as shown in Fig. 2b, the third pin shaft 53 connecting the B connecting plate 14 with the C plate frame 13, the fourth pin shaft 54 connecting the B connecting plate 14 with the first reversing plate 15, the rotating shaft Q and the rotating shaft R are parallel to one another, for example, the pin shafts and the rotating shafts are arranged in the vertical direction. All the first to the ninth pin shafts are parallel to one another except for the third pin shaft, the fourth pin shaft, the rotating shaft Q and the rotating shaft R, for example, they are arranged horizontally; and the third pin shaft, the fourth pin shaft, the rotating shaft Q and the rotating shaft R are perpendicular to the rest pin shafts of the first to the ninth pin shafts. Due to each pin shaft, rotating shaft, connecting plate and reversing plate and their connecting relationship, the tie rods can rotate in both the horizontal and vertical directions; in addition, the first and second segments of the tie rods are connected by a pin shaft to be reversed to the horizontal direction. In addition, most of the pin shafts are arranged horizontally in order to be convenient to dismount except for the pin shafts and the rotating shafts which are arranged vertically for reversing; and particularly, the pin shaft 56 connecting the first segment with the second segment of the tie rods is arranged horizontally, therefore, the pin shafts are dismounted horizontally in the important steps in the connecting process, the mounting time is saved and the mounting difficulty is reduced. Of course, under the condition of meeting the rotation of the first tie rods 16 in the horizontal and vertical directions, the pin shafts and the connecting members can be further added or reduced, and the arrangement direction of each pin shaft is not limited to the way above.

In another aspect, the disclosure further provides a method for mounting a tie rod of a balance boom of a tower crane. The tie rod structure of the balance boom is the one mentioned above which comprises a first segment, a second segment and a third segment; as shown in Figs. 8 to 10, the method comprises the following steps: pre-mounting the first segment 1 and the third segment 3 on a tower head 70 and a balance boom 60 respectively; arranging the second segment 2 on a balance boom bracket and a trolley; and connecting the second segment 2 with the third segment 3. For example, the first segment 1 is mounted and transported with the tower head 70, and the third segment 3 is mounted and transported with the balance boom 60, so as to save the
mounting time and bring convenience to the transportation of the first segment 1 and the third segment 3.

Furthermore, the method further comprises: connecting the tie rods of the whole hoisting boom into a whole.

The process of the mounting method is as follows: for example, as shown in Fig. 8, the balance boom 60 is mounted, the first segment 1 is mounted and transported with the balance boom 60, the third segment 3 is mounted and transported with the tower head 70, the tower head 70 is hoisted to a position where it can be mounted with the balance boom 60 by hoisting equipment (not shown), and the tower head (the supporting frame) 70 is connected with the balance boom 60 by a pin shaft 91 to form an inclined angle with the balance boom 60.

The first tie rods 16 of the first segment on the tower head 70 and the second tie rods 26 of the second segment on the balance boom bracket (on the balance boom 60) and the trolley (on the balance boom 60) are connected by the sixth pin shaft 56 through the second connecting plate 22; the second sheave block 37 of the third segment and the first sheave block 27 of the second segment are connected by an auxiliary steel cable 90; and then the auxiliary steel cable 90 is fixed on the third segment 3.

As shown in Fig. 9, the hoisting boom 72 is hoisted to a position where it can be connected and mounted with the upper base 80, the hoisting boom 72 is connected with the upper base 80 by a pin shaft 93, and the angle of the hoisting boom 72 is regulated; as shown in Fig. 10, the hoisting boom tie rod on the tower head 70 and the hoisting boom tie rod lying on the hoisting boom are connected by a pin shaft 94 to connect the tie rods 75 of the whole hoisting boom into a whole; the second segment 2 and the third segment 3 of the tie rods of the balance boom are tied together by the auxiliary steel cable; and the third connecting plate 32 is connected with the A connecting plate 12 and the second tie plate frames 23 by the ninth pin shaft 59, and the hoisting equipment is dismounted. The tie rods of the whole balance boom are divided into three segments, and each segment is divided into several sections so as to meet the mounting and transportation requirements of a large tower crane; and in addition, the first segment 1 is mounted and transported with the balance boom 60, and the third segment 3 is mounted and transported with the tower head 70 so that the tie rods of the balance boom are convenient, fast, efficient and safe to mount in the whole process.

Above contents only describe the preferred embodiments of the present invention and are not intended to limit the present invention; for one skilled in the art, the present invention may have various modifications and changes. Any modifications, equivalent replacements and improvements made within the spirit and principle of the present invention should be included within the protection scope of the present invention.

Claims

1. A tie rod structure of a balance boom of a tower crane, characterized by comprising:
   - two tie rods (6) intersected with each other at a certain angle, wherein each of the tie rods (6) has a first end connected with a balance boom (60) of the crane and a second end connected with a tower head (70) of the crane, and the distance between the first ends of the two tie rods (6) is greater than that between the second ends;
   - an adapting member (17) which is arranged at the second ends of the two tie rods (6) and the second end of each of the tie rods (6) is connected to the adapting member (17) and two first connecting members (10) disposed separately, wherein each of the first connecting members (10) has a first end connected with the adapting member (17) and a second end connected with the tower head (70) of the crane by a first pin shaft (51).

2. The tie rod structure of the balance boom according to claim 1, characterized in that, the adapting member (17) comprises:
   - a C tie plate frame (13) hinged with each of the first connecting members (10) by a second pin shaft (52) and
   - a B connecting plate (14) hinged with the C tie plate frame (13) by a third pin shaft (53); wherein each of the tie rods (6) is provided with a first reversing plate (15) which is connected to the B connecting plate (14) by a fourth pin shaft (54); and
   - the second end of each of the tie rods (6) is connected to the first reversing plate (15) by a fifth pin shaft (55).

3. The tie rod structure of the balance boom according to claim 1, characterized in that, further comprising:
   - two second tie plate frames (23), each of which is arranged at the first end of each of the two tie rods (6), and each of the two tie rods (6) is connected with one of the second tie plate frames (23) by a second reversing plate (25), wherein one second reversing plate (25) is connected with one of the second tie plate frames (23) by a first rotating shaft (Q), and the other second reversing plate (25) is connected with the other of the second tie plate frames (23) by a second rotating shaft (R);
   - a second connecting member, one end of which is connected with the second tie plate frames (23) by a second connecting plate (24),
and the other end of which is provided with a structure connected with the balance boom of the crane;
a box-type supporting beam (28) which is connected between the second tie plate frames (23) and comprises a bottom surface, a top surface parallel to the bottom surface and a first end surface and a second end surface perpendicular to the bottom surface, wherein the first end surface is parallel to the second end surface, the plane formed by the two tie rods (6) is within the middle between the bottom surface and the top surface, the first end surface is within the plane formed by the first rotating shaft (Q) and the second rotating shaft (R), and the distance of the second end surface departing away from the adapting member (17) is larger than that of the first end surface; and a first sheave block (27) which is arranged on the supporting beam (28).

4. The tie rod structure of the balance boom according to claim 3, characterized in that, each of the tie rods (6) comprises a first tie rod (16) and a second tie rod (26) which are connected by a sixth pin shaft (56); the first tie rod (16) is connected to one of the two first connecting member (10) by the adapting member (17); and the second tie rod (26) is connected with one of the second tie plate frames (23) by one of the second reversing plates (25).

5. The tie rod structure of the balance boom according to claim 4, characterized in that, the tie rod structure of the balance boom is divided into a first segment (1), a second segment (2) and a third segment (3) which are connected in sequence, the first segment (1) comprises the first tie rods (16), the adapting member (17) and the first connecting members (10); the second segment (2) of the tie rod structure of the balance boom comprises the second tie rods (26), the second reversing plates (25), the second tie plate frames (23), the second connecting plate (24), the supporting beam (28) and the first sheave block (27), one of the second reversing plates (25) is connected to one of the second tie rod (26) by a seventh pin shaft (57), and one of the second tie plate frame (23) is connected with one of the second reversing plates (25) by the first rotating shaft (Q) or the second rotating shaft (R); and the third segment (3) is hinged with the second connecting plate (24) and is provided with a structure hinged with the balance boom of the crane.

6. The tie rod structure of the balance boom according to claim 5, characterized in that, the first connecting members (10) comprise two parallel D tie plate frames (11), each of which is provided with an A connecting plate (12) hinged therewith and being parallel thereto; the A connecting plate (12) is connected with the C tie plate frame (13); and each one of the D tie plate frame (11) is provided with a structure hinged with the tower head of the tower crane by the first pin shaft (51).

7. The tie rod structure of the balance boom according to claim 6, characterized in that, the second connecting member forms the third segment which comprises:

two third connecting plates (32), each of which is hinged with one of the second tie plate frames (23) by an eighth pin shaft (58); a third tie plate frame (33), one end of which is hinged with the two third connecting plates (32) by two ninth pin shafts (59) and the other end of which is provided with a structure hinged with the balance boom of the crane; and a second sheave block (37) which is arranged on the third tie plate frame (33) and is connected with the first sheave block (27) by a steel cable.

8. The tie rod structure of the balance boom according to claim 7, characterized in that, the third pin shaft (53) connecting the B connecting plate (14) with the D tie plate frame (11), the fourth pin shaft (54) connecting the B connecting plate (14) with the first reversing plate (15), the first rotating shaft (Q) and the second rotating shaft (R) are parallel to one another; the pin shafts of the first to ninth pin shafts, excepting for the third pin shaft (53), the fourth pin shaft (54), the first rotating shaft (Q) and the second rotating shaft (R), are parallel to one another; and the third pin shaft (53), the fourth pin shaft (54), the first rotating shaft (Q) and the second rotating shaft (R) are perpendicular to the rest pin shafts of the first to ninth pin shafts.

9. The tie rod structure of the balance boom according to claim 7, characterized in that, the third tie plate frame (33) is provided with a stop component (35) for stopping the third connecting plates (32).

10. The tie rod structure of the balance boom according to claim 2, characterized in that, the first reversing plate (15) comprises:
a vertical connecting plate (151) and a horizontal connecting plate (153) which are vertically connected with each other; the vertical connecting plate (151) is perpendicular to the plane formed
by the two tie rods (6); the horizontal connecting plate (153) is within the plane formed by the two tie rods (6); the fourth pin shaft (54) connects the horizontal connecting plate (153) with the B connecting plate (14); and the fifth pin shaft (55) connects one of the tie rods (6) with the vertical connecting plate (151).

11. A tower crane, characterized in that, comprising the tie rod structure of the balance boom according to any one of claims 1 to 10.

12. A method for mounting a tie rod structure of a balance boom of a tower crane, characterized in that the tie rod structure of the balance boom is the one mentioned in any one of claims 7 to 10, and the mounting method comprises: pre-mounting the first segment (1) on the tower head (70) and the third segment (3) on the balance boom, arranging the second segment (2) on a balance boom bracket and a trolley, and connecting the second segment (2) with the third segment (3).

13. The mounting method according to claim 12, characterized in that, it further comprises: connecting a hoisting boom (72) with an upper base (80) to connect the tie rods of the hoisting boom into a whole.
# INTERNATIONAL SEARCH REPORT

## A. CLASSIFICATION OF SUBJECT MATTER

B66C 23/72 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B66C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, CNPAT, CNKI; DERRICK, CRANE, HOIST, POLE, STAFF, ROD, WAND, HAUL, LUG, DRAW, TIE, PULL, DISTANCE, LENGTH, LONGNESS, EXTENT

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PX</td>
<td>CN101979308 A (CHIANGSHA ZHONGLIAN HEAVY IND TECHNOLOGY) 23 Feb. 2011 (23.02.2011) See claims 1-13, description, page 3, line 28 to page 7, line 6 and figs.2-10</td>
<td>1-13</td>
</tr>
<tr>
<td>PX</td>
<td>CN201850091 U (CHIANGSHA ZHONGLIAN HEAVY IND TECHNOLOGY) 01 Jun. 2011 (01.06.2011) See claims 1-11, description, page 3, line 28 to page 7, line 6 and figs.2-10</td>
<td>1-13</td>
</tr>
</tbody>
</table>

※ Further documents are listed in the continuation of Box C. ※ See patent family annex.

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search: 18 Aug. 2011 (18.08.2011)

Date of mailing of the international search report: 13 Oct. 2011 (13.10.2011)

Name and mailing address of the ISA/CN
The State Intellectual Property Office, the P.R.China
6 Xitucheng Rd., Jiren Bridge, Haidian District, Beijing, China 100088
Facsimile No. 86-10-62019451

Form PCT/ISA/210 (second sheet) (July 2009)

Authorized officer: XIANG Hu
Telephone No. (86-10)62065284
### INTERNATIONAL SEARCH REPORT

**C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>See the whole document</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>EP1749790 A2 (LIEBHERR WERK BIBERACH) 07 Feb. 2007 (&lt;07.02.2007&gt;)</td>
<td>1-13</td>
</tr>
<tr>
<td></td>
<td>See the whole document</td>
<td></td>
</tr>
</tbody>
</table>
## INTERNATIONAL SEARCH REPORT

Information on patent family members

<table>
<thead>
<tr>
<th>Patent Documents referred in the Report</th>
<th>Publication Date</th>
<th>Patent Family</th>
<th>Publication Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN101979308 A</td>
<td>23.02.2011</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>CN201850091 U</td>
<td>01.06.2011</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>US6422408 B1</td>
<td>23.07.2002</td>
<td>KR20000053630 A</td>
<td>25.08.20000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RU2258664 C2</td>
<td>20.08.2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES2241563 T</td>
<td>01.11.2005</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP1024106 A1</td>
<td>02.08.2000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE6020275 T</td>
<td>11.05.2006</td>
</tr>
<tr>
<td>CN201334326 Y</td>
<td>28.10.2009</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE102006029714 A1</td>
<td>15.02.2007</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT443025 T</td>
<td>15.10.2009</td>
</tr>
<tr>
<td>CN2509164 Y</td>
<td>04.09.2002</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

Form PCT/ISA/210 (patent family annex) (July 2009)