



US 20230043079A1

(19) **United States**

(12) **Patent Application Publication**
ZHANG

(10) **Pub. No.: US 2023/0043079 A1**

(43) **Pub. Date: Feb. 9, 2023**

(54) **LONG STROKE BEAM PUMPING UNIT**

Publication Classification

(71) Applicant: **APEX OILFIELD EQUIPMENT
(QINGDAO) CO., LTD**, Qingdao (CN)

(51) **Int. Cl.**
F04B 47/02 (2006.01)

(72) Inventor: **Cong ZHANG**, Qingdao (CN)

(52) **U.S. Cl.**
CPC **F04B 47/022** (2013.01); **F04B 47/028**
(2013.01); **F04B 47/026** (2013.01)

(73) Assignee: **APEX OILFIELD EQUIPMENT
(QINGDAO) CO., LTD**, Qingdao (CN)

(57) **ABSTRACT**

(21) Appl. No.: **17/958,454**

A long stroke beam pumping unit includes a base and a driving mechanism fixedly mounted at one end of the base. A walking beam is provided at the other end of the base via a bracket mechanism to form a beam structure, a donkey head is mounted at the front end of the walking beam, and the rear end of the walking beam is connected to the driving mechanism via a connecting rod to form a crank-connecting rod structure. A middle seat is mounted on the walking beam, the bracket mechanism includes a front bracket and a rear bracket connected to each other at top ends, and the other ends of the front bracket and the rear bracket are mounted at both sides of the base. The long stroke beam pumping unit reduces stress concentration by adjusting the size of the component and optimizing the bracket mechanism.

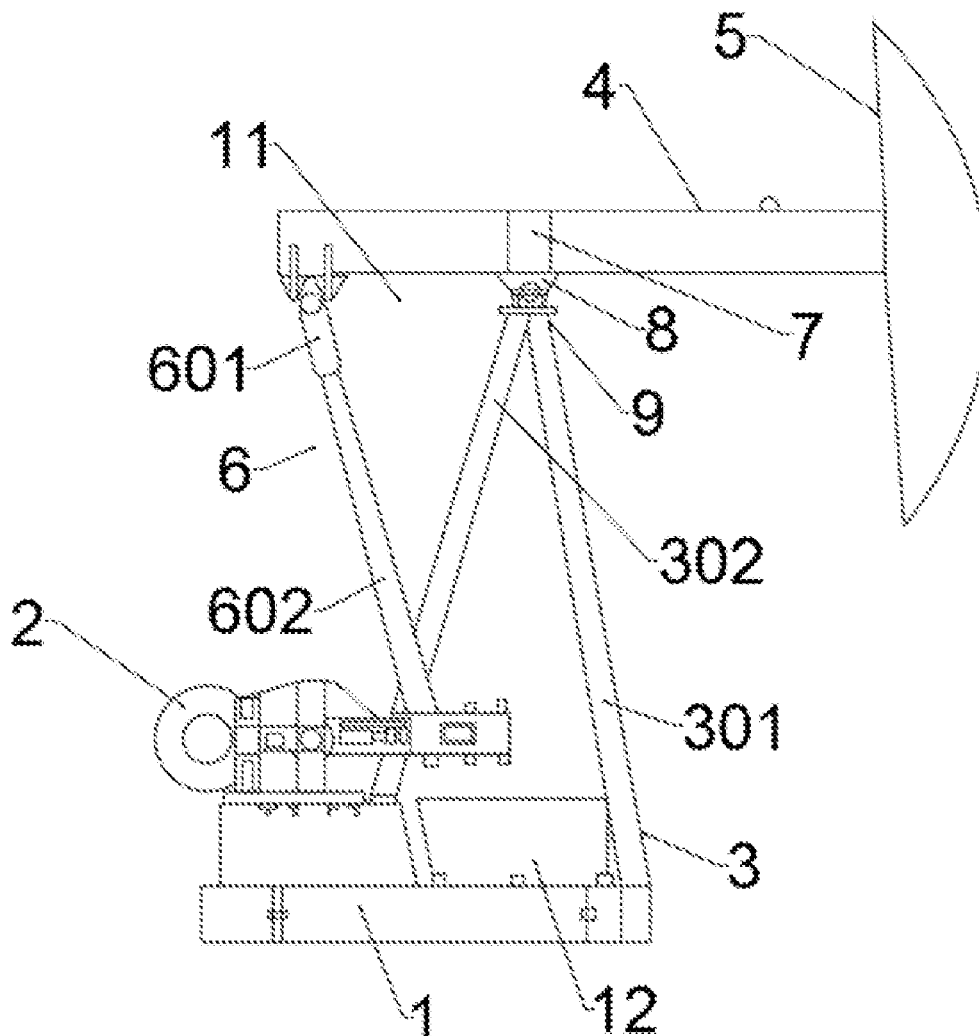
(22) Filed: **Oct. 3, 2022**

Related U.S. Application Data

(63) Continuation of application No. PCT/CN2022/074870, filed on Jan. 29, 2022.

(30) **Foreign Application Priority Data**

Mar. 31, 2021 (CN) 202120653404.6



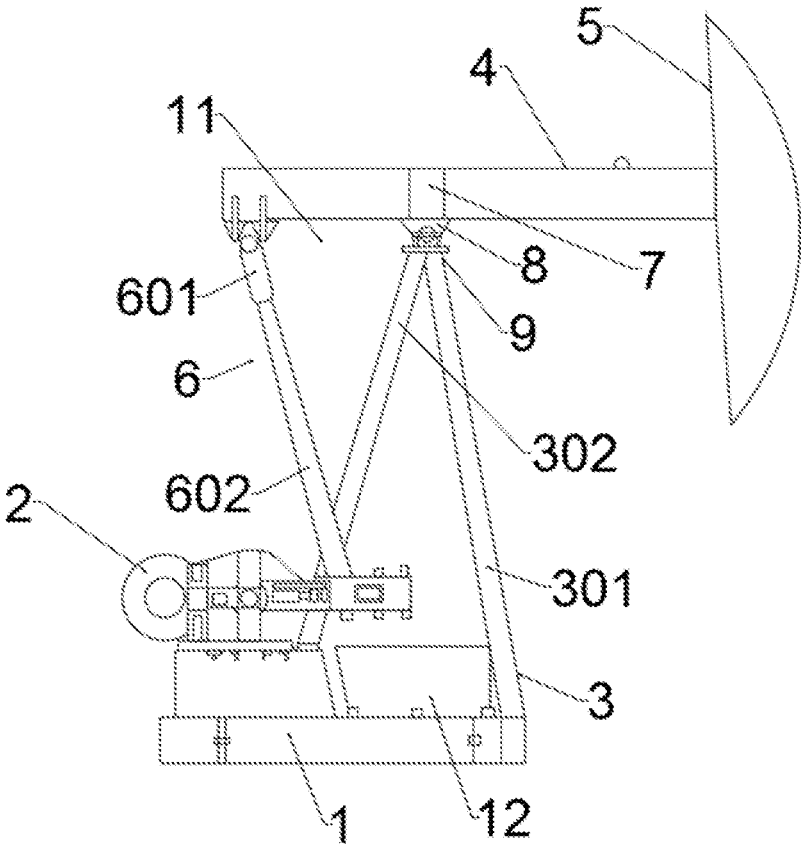


FIG. 1

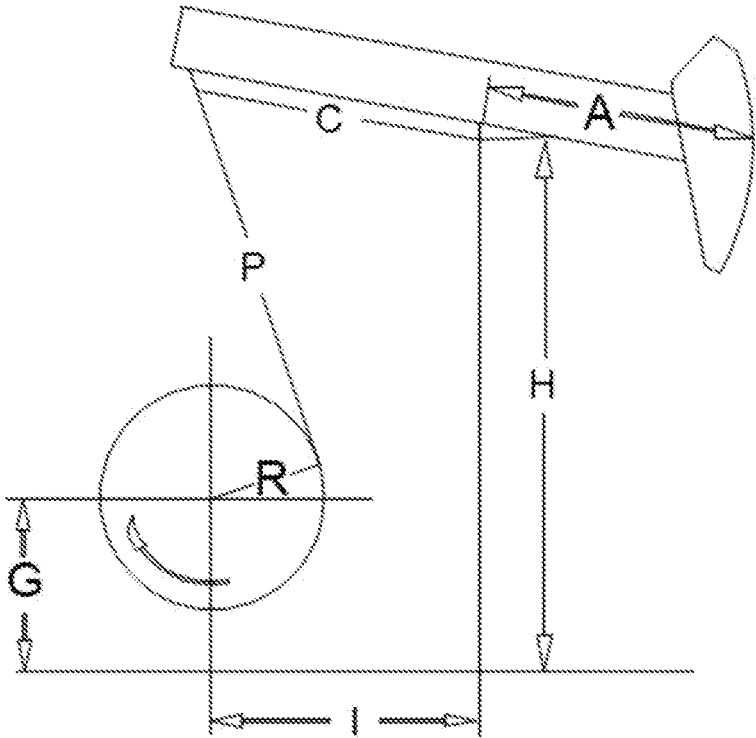


FIG. 2

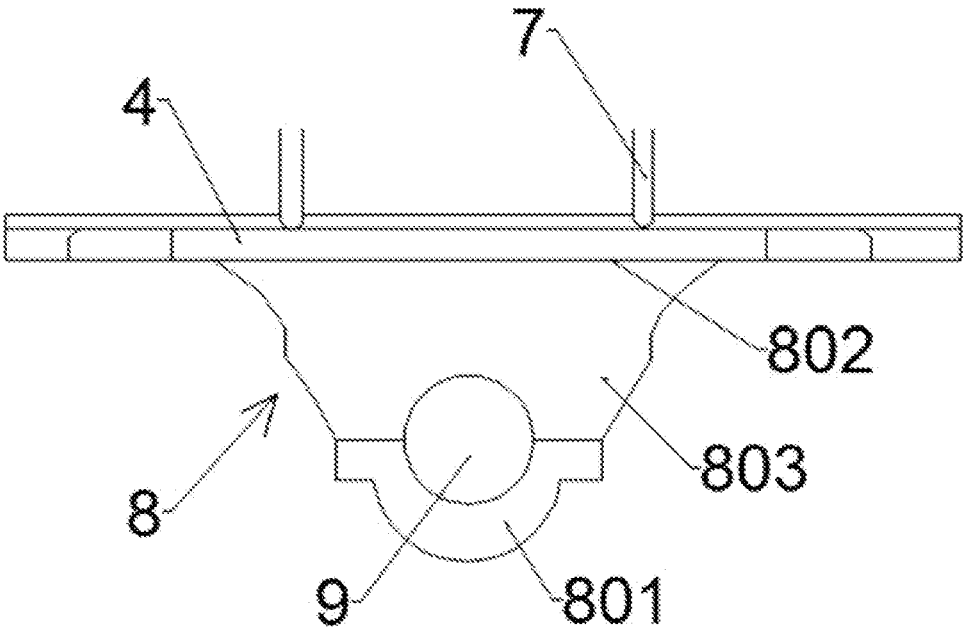


FIG. 3

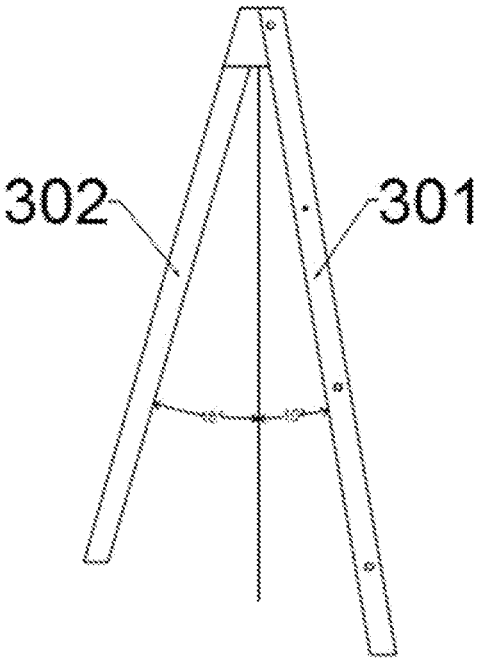


FIG. 4

LONG STROKE BEAM PUMPING UNIT

CROSS REFERENCE TO THE RELATED APPLICATIONS

[0001] This application is the continuation application of International Application No. PCT/CN2022/074870, filed on Jan. 29, 2022, which is based upon and claims priority to Chinese Patent Application No. 202120653404.6, filed on Mar. 31, 2021, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] The present disclosure relates to the technical field of pumping units, and in particular to a long stroke beam pumping unit.

BACKGROUND

[0003] As one of the major energy sources in the world, the demand for petroleum products is increasing with the development of automobile and other manufacturing industries. Therefore, the demand for oil extraction equipment is also increasing. However, there are thousands of geological differences around the world, so different performance requirements are put forward for the oil extraction equipment.

[0004] At present, the oil extraction equipment in the world is mainly divided into a beam pumping unit and a tower pumping unit. The beam pumping unit is mainly used in the medium and small stroke (240 in. or less), and the tower pumping unit is used in the long stroke (above 240 in.). Therefore, there is no beam-type application in long-stroke pumping units, mainly tower-type.

[0005] However, in practical applications, it has been found that the reliability of beam pumping units is fifty percent higher than that of the tower pumping units, and the manufacturing cost of the beam pumping units is thirty to fifty percent lower than that of the tower pumping units. Therefore, there is a need for a beam pumping unit with practicality to achieve long stroke operation.

SUMMARY

[0006] An object of the present disclosure is directed to provide a long stroke beam pumping unit to solve the technical problems in the prior art.

[0007] In order to solve the above technical problems, the present disclosure specifically provides the following technical solutions.

[0008] A long stroke beam pumping unit comprises a base and a driving mechanism fixedly mounted at one end of the base, wherein a walking beam is provided at the other end of the base via a bracket mechanism, a donkey head is mounted at the front end of the walking beam, and the rear end of the walking beam is connected to the driving mechanism via a connecting rod; and a middle seat is mounted on the walking beam, the bracket mechanism includes a front bracket and a rear bracket connected at top ends, and the other ends of the front bracket and the rear bracket are mounted on both sides of the base; setting: A is a distance from the donkey head to the middle seat; C is a distance from the middle seat to the rear end of the walking beam; and the A=5791-7395 mm and the C=3050-3611 mm.

[0009] Further, it is set that I is a distance between the rotation center of the driving mechanism and the projection

of the middle seat on the base; P is a length of the connecting rod; H is a distance between the middle seat and the base; G is a distance from the rotation center of the driving mechanism to the base; R is a rotation radius of the driving mechanism; and the I=3050-3569 mm, the P=5759-7386 mm, the H=8636-10838 mm, the G=2819-3643 mm, and the R=1524-2047 mm.

[0010] Further, the beam pumping unit adjusts the distance, the length and the rotation radius by the cut-and-trial, and a dynamic characteristic curve of the beam pumping unit is output by the dynamic simulation calculation; and the distance, the length and the rotation radius are adjusted again according to feedback of the dynamic characteristic curve until the dynamic characteristic curve is optimal.

[0011] Further, the walking beam is connected to a crank of the driving mechanism via the connecting rod to form a crank-connecting rod structure; the walking beam and the bracket mechanism form a long-stroke beam structure by adjusting the distance, the length and the rotation radius; the connecting rod includes a bottom rod hinged to the walking beam and a transmission rod hinged to the driving mechanism, respectively; and the transmission rod is connected to the bottom rod via a telescopic rod built in the transmission rod, and the telescopic rod and the bottom rod are also hinged.

[0012] Further, an extension column is provided on both sides of a hinge; the front bracket and the rear bracket are respectively sleeved on the extension column on both sides of the hinge; and the front bracket and the rear bracket are movably mounted on the base along the long axis direction of the walking beam so as to adjust an included angle between the front bracket and the rear bracket.

[0013] Further, the vertical line of the middle seat is set as a center line, the included angle between the front bracket and the center line is 0-10° and the angle between the rear bracket and the center line is 0-16°.

[0014] Further, the middle seat and the bracket mechanism is connected at a connection by a stress arc patch.

[0015] Further, the stress arc patch extends arcuately along the long axis of the walking beam towards both ends.

[0016] Further, the stroke of the long stroke beam pumping unit is above 6.1 meters.

[0017] Further, the driving mechanism comprises an electric motor connected to a speed reducer via a belt, the speed reducer having a connecting rod connected via a crankshaft.

[0018] Further, the middle seat is slidably mounted on the walking beam; the top ends of the front bracket and the rear bracket are connected to each other via a hinge; the other ends of the front bracket and the rear bracket are slidingly mounted on both sides of the base.

[0019] The present disclosure has the following advantageous effects compared to the prior art. The present disclosure achieves the goal of achieving both long strokes and reducing the weight and volume of the equipment by providing a specific AT size design. Preferably, the present disclosure also reduces stress concentrations by providing the stress arc patch and optimizing the out-of-sync sliding of the bracket mechanism to adjust its included angle to the line connecting the hinge and the projection point, which serves the application of the crank-connecting rod mechanism to the long stroke beam pumping unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] In order to more clearly illustrate the embodiments of the present disclosure or technical solutions in the prior art, the following will briefly introduce the accompanying drawings that need to be used in the description of the embodiments or the prior art. It is obvious that the drawings in the following description are only exemplary and that a person skilled in the art, without involving any inventive effort, can derive other implementation figures from the provided drawings.

[0021] FIG. 1 is a schematic structural diagram of an embodiment according to the present disclosure;

[0022] FIG. 2 is a schematic structural diagram of a beam pumping unit according to the present disclosure;

[0023] FIG. 3 is a schematic structural diagram of a stress arc patch according to the present disclosure;

[0024] FIG. 4 is a schematic view of an included angle of a bracket mechanism and the center line according to the present disclosure.

[0025] Reference numerals in the drawings denote the followings, respectively. 1-base; 2-driving mechanism; 3-bracket mechanism; 4-walking beam; 5-donkey head; 6-connecting rod; 7-middle seat; 8-stress arc patch; 9-extension column; 301-front bracket; 302-rear bracket; 601-bottom rod; 602-transmission rod.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0026] The technical solutions in the embodiments of the present disclosure will be clearly and completely described below with reference to the accompanying drawings in the embodiments of the present disclosure. Obviously, the described embodiments are only a part of the embodiments of the present disclosure, but not all of the embodiments. Based on the embodiments in the present disclosure, all other embodiments obtained by a person skilled in the art without involving any inventive effort are within the scope of protection of the disclosure.

[0027] As shown in FIG. 1, this particular embodiment provides a long stroke beam pumping unit, including a base 1 and a driving mechanism 2 fixedly mounted at one end of the base 1, wherein a walking beam 4 is provided at the other end of the base 1 via a bracket mechanism 3 to form a beam structure, a donkey head 5 is mounted at the front end of the walking beam 4, and the rear end of the walking beam 4 is connected to the driving mechanism 2 via a connecting rod 6 to form a crank-connecting rod structure.

[0028] In the present embodiment, a beam structure is formed by providing a walking beam 4 at the other end of the base 1 via a bracket mechanism 3, and a crank-connecting rod structure is formed by connecting the rear end of the walking beam 4 with the driving mechanism 2 via the connecting rod 6. Namely, for the first time, the principle of the crank-connecting rod mechanism (a four-connecting rod) is applied to a walking beam pumping unit with a long stroke (240 in, namely, above 6.1 m).

[0029] Wherein the driving mechanism includes an electric motor connected to a speed reducer via a belt, and the speed reducer is connected to a connecting rod 6 via a crankshaft.

[0030] In the prior art, the beam pumping unit is mainly used in the medium and small stroke (240 in. or less), and the tower pumping unit is used in the long stroke (above 240

in.). Therefore, there is no beam-type application in long-stroke pumping units, mainly tower-type.

[0031] The main reasons for this are as follows: the stroke size of the beam pumping unit is mainly related to A value and H value. The longer the stroke, the larger the A value and H value. Under the same wellhead load, according to the existing design teaching, the size of beam pumping unit constructed according to the traditional size model based on the mutual influence of various parameters of beam pumping unit will be very large when the stroke exceeds 240 in., which not only brings difficulties in transportation, but mainly because of the increase of structural weight, the force requirements of various parts will be completely different from that of beam pumping unit with small strokes. This makes it difficult for the beam pumping unit to operate in an environment with a stroke above 240 in.

[0032] Ideally, it can not only make the force transmission relatively high and stable, but also meet the sports performance (complete a long stroke), and also the structural strength can be satisfied and economical. Because of the characteristics of the crank-connecting rod mechanism, these requirements are contradictory, which limits the development of beam pumping unit in the long stroke direction. As shown in FIG. 2, in the present embodiment, the walking beam 4 is connected to a crank of the driving mechanism 2 via the connecting rod 6 to form a crank-connecting rod structure; the walking beam 4 and the bracket mechanism 3 form a long-stroke beam structure by adjusting the distance, the length and the rotation radius; and the crank-connecting rod structure, the stress arc patch 8 and the bracket mechanism 3 cooperate with the long-stroke beam structure. The crank connecting rod mechanism is applied in the long stroke beam pumping unit to improve reliability thereof and reduce manufacturing costs. Specifically, the beam pumping unit adjusts the distance, the length and the rotation radius by the cut-and-trial, and a dynamic characteristic curve of the beam pumping unit is output by the dynamic simulation calculation; and the distance, the length and the rotation radius are adjusted again according to feedback of the dynamic characteristic curve until the dynamic characteristic curve is optimal.

[0033] Specifically, in one preferred embodiment of the present embodiment, it is set that:

[0034] A is a distance from the donkey head 5 to the middle seat 7;

[0035] C is a distance from the middle seat 7 to the rear end of the walking beam 4;

[0036] I is a distance from the rotation center of the driving mechanism 2 to the projection of the middle seat 7 on the base 1;

[0037] P is a length of the connecting rod 6;

[0038] H is a distance between the middle seat 7 and the base 1;

[0039] G is a distance from the rotation center of the driving mechanism 2 to the base 1; and

[0040] R is a rotation radius of the driving mechanism 2.

[0041] The stroke size of beam pumping unit is mainly related to A value and H value. The longer the stroke is, the larger the A value and H value are. Thus, the force of all structural parts is less ideal in the case of the same wellhead load (the force is greater than the material strength, or the stress concentration occurs, which causes the structural parts to crack). If the force state is improved by changing other values, the motion characteristics will be poor (low force

transfer ratio, and low efficiency). Therefore, it can not only make the force transmission relatively high and stable, but also meet the sports performance (complete a long stroke), and also the structural strength can be satisfied and economical. Because of the characteristics of the crank-connecting rod mechanism, these requirements are contradictory, which thus limits the development of beam pumping unit in the long stroke direction.

[0042] In the present embodiment, the respective size values are optimized as follows.

A(mm)	C(mm)	I(mm)	P(mm)	H(mm)	G(mm)	R(mm)
5791-7395	3050-3611	3050-3569	5759-7386	8636-10838	2819-3643	1524-2047

[0043] In this embodiment, in order to enable the connecting rod 6 to adapt to changes in the length and angle of the bracket mechanism 3, the length of the connecting rod 6 can be adapted according to actual requirements. Specifically, the connecting rod 6 includes a bottom rod 601 hinged to the walking beam 4 respectively and a transmission rod 602 hinged to the driving mechanism 2; and the transmission rod 602 is connected to the bottom rod 601 via a telescopic rod built in the transmission rod 602, and the telescopic rod and the bottom rod 601 are also hinged. The telescopic rod is a conventional telescopic structure, such as a telescopic structure of a double-set rod, but it needs to be stated that the telescopic structure needs to be used in combination with a locking structure, namely, the telescopic rod can be locked at any length when adjusting the length.

[0044] In the present embodiment, the crank connecting rod mechanism is applied to a long stroke beam pumping unit according to optimization of parameters. Further, as shown in FIGS. 1 and 3, a middle seat 7 is slidably mounted on the walking beam 4. The middle seat 7 and the bracket mechanism 3 is connected at a connection by a stress arc patch 8, and the bracket mechanism 3 includes a front bracket 301 and a rear bracket 302 connected via a hinge at the top ends, and the other ends of the front bracket 301 and the rear bracket 302 are both slidably mounted on both sides of the base 1.

[0045] A stress arc patch 8 is used to connect the middle seat 7 and the bracket mechanism 3, so as to reduce the stress on the middle seat 7 and improve the fatigue strength. In particular, the stress arc device 8 includes a bearing seat 801 connected to the bracket mechanism 3 and a patch body 802 connected to the middle seat 7.

[0046] The cross section of the bearing seat 801 is trapezoidal, and the bearing seat 801 and the patch body 802 are connected via an arc-shaped extension body 803. The bearing seat 801, the arc-shaped extension body 803 and the patch body 802 are of an integrated structure. The main reason is that a long stroke beam pumping unit would cause a large value of A, and therefore the walking beam would have a poor stress state. A stress concentration would occur, and the service life of the structure would be greatly reduced. In this particular embodiment, a stress arc structure is used to release the stress concentration. According to the experimental results, the stress is reduced from 310 Mpa to 98 Mpa.

[0047] In a second aspect, an extension column 9 is provided on both sides of a hinge; the front bracket 301 and the rear bracket 302 are respectively sleeved on the exten-

sion column 9 on both sides of the hinge; and the front bracket 301 and the rear bracket 302 are movably mounted on the base 1 along the long axis direction of the walking beam 4 so as to adjust an included angle between the front bracket 301 and the rear bracket 302. It is set that the vertical line of the middle seat 7 is a center line. The angles of the front and rear legs of the support are optimized, improving the stress state of the support and the reliability, and continuously adjusting the angles of the front and rear legs by the cut-and-trial for dynamic and finite element analysis until the strength requirements are met. As shown in FIG. 4, the angle between the front bracket 301 and the center line is 10°, and the angle between the rear bracket 302 and the center is 16°.

[0048] In view of the above, it is essential in this embodiment to provide a range of the walking beam sizes to achieve long strokes and reduce the overall mass of the equipment. In addition to this, the stress arc patch 8 is provided and the out-of-sync sliding of the front bracket 301 and the rear bracket 302 is optimized to adjust the included angle thereof with the center line of the line connecting the hinge and the projection point to reduce stress concentration, thereby serving the application of the crank-connecting rod mechanism to a long stroke beam pumping unit.

[0049] The above examples are merely illustrative examples of the present application and are not intended to limit the present application, the scope of which is defined by the claims. Various modifications and equivalent arrangements within the spirit and scope of the present application may be devised by those skilled in the art, which should be considered as falling within the scope of the present application.

What is claimed is:

1. A long stroke beam pumping unit comprising a base and a driving mechanism fixedly mounted at a first end of the base, wherein a walking beam is provided at a second end of the base via a bracket mechanism, a donkey head is mounted at a front end of the walking beam, and a rear end of the walking beam is connected to the driving mechanism via a connecting rod; a middle seat is mounted on the walking beam; and the bracket mechanism comprises a front bracket and a rear bracket, wherein a top end of the front bracket and a top end of the rear bracket are connected, and a bottom end of the front bracket and a bottom end of the rear bracket are mounted on both sides of the base;

setting: A is a distance from the donkey head to the middle seat; C is a distance from the middle seat to the rear end of the walking beam; and the A=5791-7395 mm and the C=3050-3611 mm.

2. The long stroke beam pumping unit according to claim 1, wherein

I is a distance between a rotation center of the driving mechanism and a projection of the middle seat on the base; P is a length of the connecting rod; H is a distance between the middle seat and the base; G is a distance from the rotation center of the driving mechanism to the base; R is a rotation radius of the driving mechanism; and

the I=3050-3569 mm, the P=5759-7386 mm, the H=8636-10838 mm, the G=2819-3643 mm, and the R=1524-2047 mm.

3. The long stroke beam pumping unit according to claim 2, wherein the long stroke beam pumping unit adjusts the distance, the length and the rotation radius by a cut-and-trial,

and a dynamic characteristic curve of the long stroke beam pumping unit is output by a dynamic simulation calculation; and the distance, the length and the rotation radius are adjusted again according to feedback of the dynamic characteristic curve until the dynamic characteristic curve is optimal.

4. The long stroke beam pumping unit according to claim 3, wherein the walking beam is connected to a crank of the driving mechanism via the connecting rod to form a crank-connecting rod structure; the walking beam and the bracket mechanism form a long-stroke beam structure by adjusting the distance, the length and the rotation radius; the connecting rod comprises a bottom rod hinged to the walking beam and a transmission rod hinged to the driving mechanism, respectively; and the transmission rod is connected to the bottom rod via a telescopic rod built in the transmission rod, and the telescopic rod and the bottom rod are hinged.

5. The long stroke beam pumping unit according to claim 1, wherein an extension column is provided on both sides of a hinge; the front bracket and the rear bracket are respectively sleeved on the extension column on both sides of the hinge;

and the front bracket and the rear bracket are movably mounted on the base along a long axis direction of the walking beam to adjust a first included angle between the front bracket and the rear bracket.

6. The long stroke beam pumping unit according to claim 5, wherein a vertical line of the middle seat is set as a center line, a second included angle between the front bracket and the center line is 0-10°, and a third angle between the rear bracket and the center line is 0-16°.

7. The long stroke beam pumping unit according to claim 1, wherein the middle seat and the bracket mechanism is connected at a connection by a stress arc patch.

8. The long stroke beam pumping unit according to claim 7, wherein the stress arc patch extends arcuately along a long axis of the walking beam towards both ends.

9. The long stroke beam pumping unit according to claim 1, wherein a stroke of the long stroke beam pumping unit is above 6.1 meters.

10. The long stroke beam pumping unit according to claim 4, wherein the driving mechanism comprises an electric motor, wherein the electric motor is connected to a speed reducer via a belt, and the speed reducer is connected to a connecting rod via a crankshaft.

11. The long stroke beam pumping unit according to claim 1, wherein the middle seat is slidably mounted on the walking beam; the top end of the front bracket and the top

end of the rear bracket are connected to each other via a hinge; and the bottom end of the front bracket and the bottom end of the rear bracket are slidably mounted on both sides of the base.

12. The long stroke beam pumping unit according to claim 2, wherein the middle seat and the bracket mechanism is connected at a connection by a stress arc patch.

13. The long stroke beam pumping unit according to claim 3, wherein the middle seat and the bracket mechanism is connected at a connection by a stress arc patch.

14. The long stroke beam pumping unit according to claim 4, wherein the middle seat and the bracket mechanism is connected at a connection by a stress arc patch.

15. The long stroke beam pumping unit according to claim 5, wherein the middle seat and the bracket mechanism is connected at a connection by a stress arc patch.

16. The long stroke beam pumping unit according to claim 6, wherein the middle seat and the bracket mechanism is connected at a connection by a stress arc patch.

17. The long stroke beam pumping unit according to claim 2, wherein the middle seat is slidably mounted on the walking beam; the top end of the front bracket and the top end of the rear bracket are connected to each other via a hinge; and the bottom end of the front bracket and the bottom end of the rear bracket are slidably mounted on both sides of the base.

18. The long stroke beam pumping unit according to claim 3, wherein the middle seat is slidably mounted on the walking beam; the top end of the front bracket and the top end of the rear bracket are connected to each other via a hinge; and the bottom end of the front bracket and the bottom end of the rear bracket are slidably mounted on both sides of the base.

19. The long stroke beam pumping unit according to claim 4, wherein the middle seat is slidably mounted on the walking beam; the top end of the front bracket and the top end of the rear bracket are connected to each other via a hinge; and the bottom end of the front bracket and the bottom end of the rear bracket are slidably mounted on both sides of the base.

20. The long stroke beam pumping unit according to claim 5, wherein the middle seat is slidably mounted on the walking beam; the top end of the front bracket and the top end of the rear bracket are connected to each other via a hinge; and the bottom end of the front bracket and the bottom end of the rear bracket are slidably mounted on both sides of the base.

* * * * *