An objective is to provide a reciprocating pump apparatus which can change a position where an adaptor to be fixed to a support is attached, while having a simple form.

In a reciprocating pump apparatus 10 having a crankshaft 14 directly connected to an output shaft of a driving source, positions of bolts 22a to 22d for fixing a bearing case 20 for closing an open end part of a crankcase 16 to the crankcase are determined such that an adaptor 40 for fixing the reciprocating pump apparatus to a support 58 is fastened to the crankcase together with the bearing case in a positionally changeable fashion. Since the position of the adaptor is changeable, the degree of freedom in the layout of apparatus improves in this structure. Also, since bolts for fixing a manifold to the crankcase are utilized for attaching the adaptor, a simple form is attained.
RECIPIROCATING PUMP APPARATUS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a reciprocating pump apparatus such as plunger pump and piston pump.

[0003] 2. Related Background Art

[0004] A reciprocating pump apparatus such as plunger pumps and piston pumps include those of types in which a crankshaft is directly connected to an output shaft of a driving source such as engine or motor. However, such reciprocating pump apparatus directly connected to driving sources have also been demanded for use in a stationary state, i.e., with their crankshafts fixed to a support such as apparatus frame without being directly connected to the output shaft of the driving source, while receiving a driving force through an appropriate transmission mechanism.

[0005] For such a demand, an adaptor (also known as “rail”) is attached to a crankcase, so as to be fixed to a support in the pump apparatus disclosed in the following Patent Document 1, for example.


SUMMARY OF THE INVENTION

[0007] In the reciprocating apparatus disclosed in the above-mentioned Patent Document 1, a boss for attaching the adaptor to the crankcase is provided on the outer surface of the crankcase, and the adaptor is fixed to the boss with a bolt.

[0008] Providing the crankcase with the boss, however, complicates the form of the crankcase, necessitates extra materials, and increases labor and cost of manufacture.

[0009] Also, since the boss is provided only in the lower part of the crankcase, the adaptor cannot be attached to the upper part in the reciprocating pump apparatus disclosed in the above-mentioned Patent Document 1. This limits the degree of freedom in the layout of the reciprocating pump apparatus. Though the boss may be provided in the upper part of the crankcase as a matter of course, this will further complicate the crankcase form and so forth.

[0010] Therefore, it is an object of the present invention to provide a reciprocating pump apparatus which can change a position where an adaptor is attached, while having a simple form.

[0011] For achieving the above-mentioned object, the present invention provides a reciprocating pump apparatus (10) comprising: a crankcase (16), having at least one open end part, for supporting a crankshaft (14); a closing member (20), removably fixable to the crankcase (16) with a first set of bolts (22a to 22d) so as to close the open end part of the crankcase (16); and a pump case (26) of a reciprocating pump (12), removably fixable to a side face of the crankcase (16) with a second set of bolts (28); wherein a position of the first set of bolts (22a to 22d) for fixing the closing member (20) to the crankcase (16) is determined such that an adaptor (40) for fixing the reciprocating pump apparatus (10) to a support (58) is fastened to the crankcase (16) together with the closing member (20) in a positionally changeable fashion.

[0012] Preferably, the first set of bolts (22a to 22d) are arranged symmetrically about a first plane (P1), which is including the center axes of the reciprocating pump (12) and the axis of rotation of the crankshaft (14).

[0013] Preferably, the first set of bolts (22a to 22d) are arranged symmetrically about a third plane (P3), which is orthogonal to the first plane (P1) and includes the axis of rotation of the crankshaft (14).

[0014] Preferably, the bolts (22a to 22d) of the first set are equally distanced from the axis of rotation of the crankshaft (14).

[0015] Preferably, the bolts (22a to 22d) of the first set are provided, having the same angles around the axis of rotation in the center.

[0016] When the position of the adaptor (40) is vertically changeable, it will be preferred if a position of the second set of bolts (28), for fixing the pump case (26) to the crankcase (16), is determined such that the pump case (26) is fixable to the crankcase (16) in a vertically reversed fashion.

[0017] Preferably, the second set of bolts (28) are arranged symmetrically about the first plane (P1).

[0018] Preferably, the second set of bolts (28) are arranged symmetrically about the second plane (P2), which is orthogonal to the first plane (P1) and includes the center axis of the reciprocating pump (12).

[0019] Since the position of the adaptor used for turning the originally driving source direct connection type reciprocating pump apparatus into a stationary type is changeable, the degree of freedom in the layout of apparatus improves in the structure mentioned above.

[0020] Since the bolt for fixing the closing member, which is a member essential for the reciprocating pump apparatus, to the crankcase is utilized for attaching the adaptor, there is no need to provide the crankcase with bosses or turn it into other special forms, whereby the crankcase can attain a simple form. This can reduce the labor and cost of manufacturing the reciprocating pump apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] [FIG. 1] A perspective view showing an embodiment of the reciprocating pump apparatus in accordance with the present invention.

[0022] [FIG. 2] A perspective view showing the reciprocating pump apparatus in accordance with the present invention seen in a direction opposite from that of FIG. 1.

[0023] [FIG. 3] A view showing a state where the reciprocating pump apparatus shown in FIG. 1 is fixed onto a support through an adaptor, in which (a) is a front view, (b) is a left side view, and (c) is a right side view.

[0024] [FIG. 4] A view showing another state where the reciprocating pump apparatus shown in FIG. 1 is fixed onto the support through the adaptor, in which (a) is a front view, (b) is a left side view, and (c) is a right side view.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0025] In the following, preferred embodiments of the reciprocating apparatus in accordance with the present invention will be explained in detail with reference to the drawings. Parts identical or equivalent to each other in the drawings will be referred to with numerals identical to each other. In this specification and accompanying claims, “upper” and “lower” are based on the state where the reciprocating pump apparatus is fixed to a support (see FIGS. 3 and 4).
[0026] FIG. 1 is a perspective view showing an embodiment of the reciprocating pump apparatus in accordance with the present invention, whereas FIG. 2 is a perspective view thereof when seen in a direction opposite to that of FIG. 1. The reciprocating pump apparatus 10 in accordance with the depicted embodiment is of a triple type in which three plunger pumps (reciprocating pumps) 12 are provided in parallel. Forces for driving the plunger pumps 12 are transmitted through a crankshaft 14. The depicted reciprocating pump apparatus 10 is of a driving source direct connection type in which the crankshaft 14 is directly connected to an output shaft of a driving source such as engine or motor.

[0027] The crankshaft 14 is rotatably held within the crankcase 16. The crankcase 16 has a bottomed cylindrical form (bell form) having one end closed and the other end opened. A bearing is placed within the crankcase 16 on its closed end part 18 side, so as to support one end of the crankshaft 14. A bearing case (closing member) 20 provided with a bearing is removably fixed to the open end part of the crankcase 16 with bolts 22a to 22d (a first set of bolts), so as to close the open end part. The crankshaft 14 is supported by the bearing within the bearing case 20 and further penetrates through the bearing case 20, thereby projecting to the outside. In this embodiment, the projected end part of the crankshaft 14 is formed with a key groove 24 so as to make it easier to connect directly with the output shaft of the driving source.

[0028] Each plunger pump 12 is arranged such that its center axis (i.e., the center axis of its cylinder) is orthogonal to the axis of rotation of the crankshaft 14. The three plunger pumps 12 are arranged in a row such that their center axes are parallel to each other while being equally spaced along the axis of rotation of the crankshaft 14. A manifold 26 which also functions as a pump case for these plunger pumps 12 is removably fixed to a side face of the crankcase 16 with bolts 28 (a second set of bolts).

[0029] The bolts 28 for fixing the manifold 26 to the crankcase 16 are passed through their corresponding through holes 30 formed in the manifold 26, so as to engage screw holes 32 provided in a side face of the crankcase 16. As can also be seen from (a) of FIG. 3, there are a plurality (8 in this embodiment) screw holes 32, which are arranged by 4 by 4 on the upper and lower sides while being symmetrical about a first plane P1 including the center axes of the plunger pumps 12 and the axis of rotation of the crankshaft 14. Namely, the bolts 28 are arranged symmetrically about the first plane P1. The screw holes 32 are also arranged 4 by 4 on the right and left sides while being symmetrical about a second plane P2 which is orthogonal to the first plane P1 and includes the center axis of the center plunger pump 12. Namely, the bolts 28 are arranged symmetrically about the second plane P2. In other words, the screw holes 32 and the bolts 28 are arranged rotationally symmetrically with an order of 2. Thus arranging the screw holes 32 above makes it possible to attach the manifold 26 in a vertically reversed state to the crankcase 16.

[0030] The bolts 22a to 22d for attaching the bearing case 20 to the open end part of the crankcase 16 are passed through their corresponding through holes 34a to 34d formed in the bearing case 20, so as to engage screw holes 36a to 36d provided in the open end part of the crankcase 16. There are a plurality of (6 in this embodiment) screw holes 36a to 36d, which are arranged symmetrically about the above-mentioned first plane P1. Namely, the bolts 22a to 22d are arranged symmetrically about the first plane P1. The screw holes 36a to 36d are also arranged symmetrically about a third plane P3 which is orthogonal to the first plane P1 and includes the axis of rotation of the crankshaft 14. Namely, the bolts 22a to 22d are arranged symmetrically about the third plane P3. In the depicted embodiment, the screw holes 36a to 36d and also the bolts 22a to 22d are equally distanced from the axis of rotation of the crankshaft 14 and are provided at intervals of 90° about the axis of rotation.

[0031] As shown in FIG. 2, the closed end part 18 of the crankcase 16 is provided with two screw holes 38. These screw holes 38 are symmetrical about the third plane P3 and about the axis of rotation of the crankshaft 14. The screw holes 38 are used when attaching an adaptor 40 which will be explained in the following.

[0032] When the above-mentioned reciprocating pump apparatus 10 of driving source direct connection type 10 is used as a stationary type, the crankcase 16 having the bell form is hard to place directly onto a support such as apparatus frame. Hence, the adaptor 40 is employed. This adaptor 40 is a sheet made of a highly rigid material such as metal, and is constituted by a lower part 42 and first and second side parts 44, 46 rising from respective ends of the lower part 42. The gap between the first and second side parts 44, 46 is substantially equal to the distance from the outer face of the closed end part 18 of the crankcase 16 to the outer face of the bearing case 20, so that the crankcase 16 and bearing case 20 can be placed between the first and second side parts 44, 46 as shown in (a) to (c) of FIG. 3. Two through holes 48a, 48b are formed in the uppermost part of the side part 44. These through holes 48a, 48b are formed with the same pitch as with the lower or upper two through holes 34a, 34b, 34c, 34d in the bearing case 20 and the lower or upper two screw holes 36a, 36b, 36c, 36d in the crankcase 16. Two through holes 50 are formed in the uppermost part of the second side part 46 with the same pitch as with the two screw holes 38 formed in the closed end part 18 of the crankcase 16.

[0033] When attaching the adaptor 40 to the reciprocating pump apparatus 10 in the mode shown in (a) to (c) of FIG. 3, the lower two bolts 22a, 22b securing the bearing case 20 are removed at first. Then, the crankcase 16 and bearing case 20 are held between the first and second side parts 44, 46 of the adaptor 40, the through holes 48a, 48b are aligned with the through holes 34a, 34b and screw holes 36a, 36b, and the through holes 50 are aligned with the screw holes 38. Finally, the bolts 22a, 22b, 52 are passed through the through holes 48a, 48b, 50 of the first and second side parts 44, 46, so as to engage the screw holes 36a, 36b, 38 of the crankcase 16. When fastened with the bolts 22a, 22b, 52, the adaptor 40 and bearing case 20 can simultaneously be fixed to the crankcase 16. Since the screw holes 36a, 36b for securing the bearing case 20 are utilized for attaching the adaptor 40, it is unnecessary to provide a boss as in the reciprocating pump apparatus disclosed in the above-mentioned Patent Document 1 or turn the crankcase 16 and the bearing case 20 into other special forms. Therefore, simple molds are sufficient for manufacturing the crankcase 16 and bearing case 20, which can reduce the labor and cost of manufacture. This also contributes to reducing the weight of the reciprocating pump apparatus 10, since there are no extra bosses and the like.
When the adaptor 40 is attached, the lower part 42 of the adaptor 40 is substantially parallel to the axis of rotation of the crankshaft 14 and the center axes of the plunger pumps 12 as shown in (a) to (c) of FIG. 3. When the adaptor 40 is fixed to the support 58 such as apparatus frame with bolts/nuts 56 utilizing through holes 54 formed in the lower part 42, the reciprocating apparatus 10 can be secured to the support 58. In this state, a driving force from a driving source fixed to the support 58 or the like is transmitted to the crankshaft through an appropriate transmission mechanism such as belt transmission mechanism.

A depression 60 is formed at the center part in the upper edge of the second side part 46 of the adaptor 40, so that a projection 62 at the center of the closed end part 18 in the crankcase 16 fits into the depression 60. Therefore, when the first side part 44 of the adaptor 40 is bolted, the second side part 46 is supported by the projection 62. Hence, though the second side part 46 is not necessarily bolted, the bolts 52 are preferably used for securing the adaptor 40 more reliably.

In FIG. 4, (a) to (c) are views showing another mode of attaching the adaptor 40. Here, the bolts 22c, 22d on the upper side in (a) to (c) of FIG. 3 are removed, and the first side part 44 of the adaptor 40 is attached there. When fixed to the support 58, the reciprocating pump apparatus 10 in this case is vertically reversed from the attached state of FIG. 3. Since the crankshaft 14 projects only one end thereof in this embodiment, the reciprocating pump apparatus 10 is easily applicable to various driving source positions if it can be fixed to the support 58 in a vertically reversed fashion, whereby the degree of freedom in the layout of the reciprocating pump apparatus 10 also increases.

In the state shown in (a) to (c) of FIG. 4, a discharge port 64 of the manifold 26 is located on the lower side. Though a lid 66 for taking out the valve on the discharge port 64 side faces down and thus narrows the clearance from the support 58 in this state, this embodiment can vertically reverse the manifold 26 as mentioned above, so that the lid 66 can face up as well. Similarly, the manifold 26 can vertically be reversed in the state shown in (a) to (c) of FIG. 3 such that the lid 66 faces down. Namely, the reciprocating pump apparatus 10 in accordance with this embodiment can be fixed to the support 58 in four modes, which further improves the degree of freedom in the layout.

Though a preferred embodiment of the present invention is explained in detail in the foregoing, the present invention is not limited to the above-mentioned embodiment as a matter of course.

For example, the reciprocating pumps may be piston pumps, and are not required to be of a multiple type. Also, the number of screw holes is not limited to those of the above-mentioned embodiment. Further, the bolts 22a, 22d, which are located on the lower and upper sides in (a) and (b) of FIG. 3, may be utilized for securing the adaptor 40, so that the adaptor 40 is erected with the manifold 26 facing up. Furthermore, the form of the adaptor can be changed in various ways.

What is claimed is:

1. A reciprocating pump apparatus comprising:
   a crankcase, having at least one open end part, for supporting a crankshaft;
   a closing member, removably fixable to the crankcase with a first set of bolts so as to close the open end part of the crankcase; and
   a pump case of a reciprocating pump, removably fixable to a side face of the crankcase with a second set of bolts;
   wherein a position of the first set of bolts for fixing the closing member to the crankcase is determined such that an adaptor for fixing the reciprocating pump apparatus to a support is fastened to the crankcase together with the closing member in a positionally changeable fashion.

2. A reciprocating pump apparatus according to claim 1, wherein the first set of bolts are arranged symmetrically about a first plane, which is including the center axes of the reciprocating pump and the axis of rotation of the crankshaft.

3. A reciprocating pump apparatus according to claim 1, wherein the first set of bolts are arranged symmetrically about a third plane, which is orthogonal to the first plane and includes the axis of rotation of the crankshaft.

4. A reciprocating pump apparatus according to claim 1, wherein the bolts of the first set are equally distanced from the axis of rotation of the crankshaft.

5. A reciprocating pump apparatus according to claim 1, wherein the bolts of the first set are provided, having the same angles around the axis of rotation in the center.

6. A reciprocating pump apparatus according to claim 1, wherein the position of the adaptor is vertically changeable; and
   a position of the second set of bolts, for fixing the pump case to the crankcase, is determined such that the pump case is fixable to the crankcase in a vertically reversed fashion.

7. A reciprocating pump apparatus according to claim 6, wherein the second set of bolts are arranged symmetrically about the first plane.

8. A reciprocating pump apparatus according to claim 6, wherein the second set of bolts are arranged symmetrically about the second plane, which is orthogonal to the first plane and includes the center axis of the reciprocating pump.

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