

A Composite Lifting Stage

Field of the Invention

The present invention relates to a lifting stage, in particular, a large-span composite lifting stage which is driven hydraulically.

Background of the Invention

A lifting platform for a stage is a mechanical device usually seen in a theater, which is arranged in stage area to perform a lifting movement in the vertical direction, in order to be used in a show and realize special performance effects. It can also be used to convey actors, settings and props. Common lifting platforms for stage in domestic and foreign theaters usually have a long and narrow shape, with a length of about 16m~18m which is corresponding to the width of a theater proscenium, and with a width of 3m~4m. The lifting movement of the lifting platform is realized by driving means such as using steel wire ropes, chains, gear racks, screws-nuts and so on at the both sides of the platform body structure. The specific driving means depends on speed, travel range, construction conditions and so on. The lifting platform has a platform structure of single layer or double layers, which can move up and down while the entire platform is being lifted.

Some special theaters require even longer lifting platforms, and a number of hoistable sub-stages can be arranged on the lifting platform in chessboard-like manner in order to meet more complex requirements of performance. For these lifting platforms, their use will be limited because of relatively large deformations of the lifting platforms caused by the weight of the platform body structure itself as well as the weight of its passengers. Therefore, traditional transmission routes and driving means cannot satisfy the application requirements.

Summary of the Invention

For solving the problem mentioned above, the present invention provides a stable composite lifting stage with a large-span, which has sub-stages movable

relative to each other.

The technical solution of the present invention lies in that: a composite lifting stage, comprising a main stage, sub-stages and a main control system. The main stage comprises a base structure, fixed guiding means for the main stage, and driving means for the main stage. The base structure is a steelwork, the fixed guiding means for the main stage are arranged at the both ends of the base structure, and the driving means for the main stage comprise symmetrically arranged hydraulic cylinders and hydraulic drivers. The top end of hydraulic cylinders are secured to a primary truss under the base structure, and the base structure is supported and driven to move vertically using hydraulic jacking. The hoistable sub-stages are fixed on platform surface of the main stage. While the main stage moves vertically, the sub-stages relatively move in the vertical direction, or, otherwise, the sub-stages move independently. The sub-stages can move either all synchronously, separately, or in groups.

Preferably, the fixed guiding means for the main stage comprise a fixed support and guide rails arranged thereon, and the base structure has its both ends designed to have guide shoes matching with the guide rails.

Preferably, the sub-stages have a sub-stage supporting structure, a sub-stage framework structure, and sub-stage driving means, wherein the sub-stage supporting structure is fixed on the platform surface of the base structure. The sub-stage framework structure is situated outside the sub-stage supporting structure. The sub-stage framework structure is rectangle-shaped, on frames of whose four inner corners guiding wheels are secured. At the four outer corners of the sub-stage supporting structure guiding rails are arranged to match the guiding wheels, and the sub-stage driving means is mounted on the platform surface of the base structure within each sub-stage hoistable structure to drive using a winch with steel wire ropes, which are connected to four frameworks of the sub-stage framework structure.

Preferably, both inner sides of each corner of the sub-stage framework structure are provided with the guiding wheels, and both outer sides of each corner of the sub-stage supporting structure are provided with the guiding rails.

Preferably, a motor of the winch with steel wire ropes is arranged in the middle position, whose power is divided into two parts by means of a power division gear box and transmission shafts, and then is distributed to an end steel wire rope roller through a double-stage reduction box.

Preferably, the driving means for lifting the main stage uses 8 hydraulic cylinders, which are balanced by means of position encoders and load sensors. Travel switches are installed to set up limited positions to which the lifting stage can reach and different positions within the travel range for the lifting stage to stop, and safety side detector devices are arranged beneath the lateral sides of the base structure.

Preferably, the main stage has a length of 18m to 33m, a width of 3m to 6m, and a lifting travel range for the main stage of 15.5m.

Preferably, the sub-stages are separated into two rows, with 11 in each row, with a cross section of 3m×3m, and with a lifting travel range of 4 m relative to the main stage.

Preferably, the sub-stages are secured on the platform surface of the main stage in a chessboard-like manner.

Preferably, four sides of the sub-stage framework structure all have a depth of 150 mm, on which four sides LED screens are mounted.

The advantageous effect of the present invention is that: the main-stage base structure is jacked using hydraulic cylinders to avoid large deformations of the lifting stage over a large span. With a composite manner, the lifting stage can move separately or simultaneously. The sub-stage hoistable structures can move either independently, synchronously, or in group with respect to each other. In such a way,

more flexible kinetic effect can be achieved to meet the requirements of better performance, and the travel range of the entire lifting stage can be increased.

Brief Description of the Drawings

Figure 1 is a structure diagram of an embodiment according to the present invention.

Figure 2 is a structure diagram illustrating the connection of the fixed guiding means for the main stage and the base structure according to the present invention.

Figure 3 is a schematic of the main-stage structure and the sub-stage hoistable structure according to the present invention when lifted to the highest position.

Figure 4 is a schematic of the main-stage structure according to the present invention when lifted to the highest position.

Figure 5 is a schematic of the main-stage structure and sub-stage hoistable structure according to the present invention when moved to the lowest position.

Figure 6 is a schematic of the sub-stage supporting structure according to the present invention.

Figure 7 is a schematic of the sub-stage framework structure according to the present invention.

Figure 8 is a schematic illustrating the connection of the sub-stage framework structure and the sub-stage supporting structure according to the present invention.

Figure 9 is a schematic of the sub-stage driving means according to the present invention.

Detailed Description of Embodiments

The present invention will be further illustrated hereinafter with reference to the drawings:

A composite lifting stage, as shown in Figure 1, comprises a main stage, sub-stages and a main control system, wherein the main stage comprises a base structure 1, fixed guiding means 2 for the main stage, and driving means 3 for the main stage. The base structure 1 is a rectangular steelwork. This structure is designed to meet the requirements for the supporting and fixing of the sub-stage hoistable structures under rated load. The bending deformation of the structure does not exceed 1/750 of the span of the main stage, and the levelness and repositioning resolution is ± 2 mm.

The fixed guiding means 2 for the main stage are arranged at the both ends of the base structure 1. It comprises a fixed support 21 and guide rails 22 arranged thereon. The base structure 1 has its both ends designed to have guide shoes 11 matching with the guide rails 22, as shown in Figure 2, to ensure stable operation of the main stage. The driving means 3 for the main stage comprise symmetrically arranged hydraulic cylinders and hydraulic drivers. The top end of the hydraulic cylinders are secured to a primary truss under the base structure. The foundations of the hydraulic cylinders are stored in a foundation pit in the base. The hydraulic drivers are located in a machine room.

In this embodiment, the base structure 1 is jacked and driven to move vertically using eight hydraulic cylinders. The arrangement of the hydraulic cylinders ensures evenly distributed stress. The hydraulic cylinders are balanced by means of position encoders and load sensors to ensure the levelness and positioning resolution of the lifting stage.

Travel switches are installed to set up to limit the height to which the lifting stage can reach and different positions within the travel range for the lifting stage to stop, such as to ensure safe operation of the lifting stage. Safety side detector devices are arranged beneath lateral sides of the base structure 1. Once the lower part of the sides touches any object in the lifting process, the sensors will send a signal to the main control system. Then, the main control system will shut down the power immediately to stop running of the lifting stage to ensure the safety of personnel and equipment.

The sub-stages are secured on the platform surface of the main stage in a chessboard-like manner. While the main stage moves vertically, the sub-stage hoistable structures relatively move in the vertical direction, or, otherwise, the sub-stages move independently. As shown in Figures 6-8, the sub-stages comprise a sub-stage supporting structure 4, a sub-stage framework structure 5, and sub-stage driving means 6.

The sub-stage supporting structure 4 is fixed on the platform surface of the base structure 1. The sub-stage framework structure 5 is situated outside the sub-stage supporting structure 4. The sub-stage framework structure 5 is rectangle-shaped, on frames of whose four inner corners adjustable guiding wheels 51 are secured. The four outer corners of the sub-stage supporting structure 4 are provided with guiding rails 41 to match the guiding wheels 51, so that the sub-stages will not shake in the lifting process due to movement of the actors and offset load applying thereon. Thus smooth operation of the sub-stage framework structure 5 can be achieved.

The guiding wheels 51 can move vertically along the guiding rails 41 of the sub-stage supporting structure 4. Both of the inner sides of each corner of the sub-stage framework structure 5 are provided with guiding wheels 51. Both of the outer sides of each corner of the sub-stage supporting structure 4 are provided with guiding rails 41.

The sub-stage driving means 6 is mounted on the platform surface of the base structure 1 within each sub-stage hoistable structure to move them vertically using a winch with steel wire ropes. A motor 61 is arranged in the middle position, whose power is divided into two parts by means of a power division gear box and transmission shafts, and then distributed to an end steel wire rope roller 63 through a double-stage reduction box 62. The steel wire ropes are connected to four frameworks of the sub-stage framework structure 5. Such arrangements can enable the lifted four points to work synchronously, as shown in Figure 9. Each of the sub-stages are driven to move vertically through the winch with steel wire ropes and

guiding wheels. Alternatively, the sub-stages can move relative to each other while moving integrally.

The four sides of the sub-stage framework structure 5 all have a depth of 150mm. LED screens are mounted on these four sides, on which video programs can be played during the performance according to the story to accentuate the performance and improve the performance effect. By controlling the lifting of the sub-stages and the combinations of the sub-stages at different positions, various effects of the changing stage can be presented, and the director may fully express his imagination and expression.

The main stage can have a length of 18m-33m, a width of 3m-6m, and a lifting travel range of 15.5m. In this embodiment, the main stage has a length of 33m, a width of 6m. The sub-stages are separated into two rows, with 11 in each row, which are used to constitute various heights of performance and appearances of the main stage during performance. Each of the sub-stages has a cross section of $3\text{m} \times 3\text{m}$, and a travel range of 4m relative to the main stage. When cooperating with the main stage, its effective stage showing area can vary from the height of 4m above to 15.5m below the surface of the main stage. In the lowest position, the setting of the set storage area in understage below the stage can be moved to the composite lifting stage.

The movement of the main stage and the sub-stages is controlled by the main control system. They can move separately or synchronously. The sub-stages can move independently, synchronously or operate in group, such that more flexible kinetic effects can be achieved to meet the requirements of better performance, and the travel range of the entire lifting stage can be increased.

The description above is merely to illustrate some preferred embodiments of the present invention, and in no way means to limit the scope of the present invention. Any equivalent alternations and modifications made within the claimed scope of the present invention are believed to fall into the scope of the present invention.

CLAIMS

1. A composite lifting stage, comprising a main stage, sub-stages and a main control system, characterized in that, the main stage comprises a base structure, fixed guiding means for the main stage, and driving means for the main stage, wherein the base structure is a steelwork, the fixed guiding means for the main stage are arranged at the both ends of the base structure, and the driving means for the main stage comprises symmetrically arranged hydraulic cylinders and hydraulic drivers; the hydraulic cylinders are secured to a primary truss under the base structure on their top, the base structure is supported and driven to move vertically using hydraulic jacking; the hoistable sub-stages are fixed on a platform surface of the main stage; while the main stage moves vertically, the sub-stages relatively move in a vertical direction, or, otherwise, the sub-stages move independently; and the sub-stages can move either all synchronously, separately, or in group, wherein on sides of each sub-stages LED screens are mounted, and on the LED screens video can be played during performance according to story, the sub-stages have a sub-stage supporting structure, a sub-stage framework structure, and sub-stage driving means, the sub-stage supporting structure is fixed on a platform surface of the base structure, the sub-stage framework structure is situated outside the sub-stage supporting structure, the sub-stage framework structure is rectangle-shaped, on frames of whose four inner corners guiding wheels are secured, at four outer corners of the sub-stage supporting structure guiding rails are arranged to match the guiding wheels, and the sub-stage driving means is mounted on the platform surface of the base structure to drive using a winch with steel wire ropes which are connected to four frameworks of the sub-stage framework structure.

2. The composite lifting stage according to claim 1, characterized in that the fixed guiding means for the main stage comprises a fixed support and guide rails arranged thereon, while the base structure has its both ends designed to have guide shoes matching with the guide rails.

3. The composite lifting stage according to claim 1, characterized in that both inner sides of each corner of the sub-stage framework structure are provided with the guiding wheels, and both outer sides of each corner of the sub-stage supporting

structure are provided with the guiding rails.

4. The composite lifting stage according to claim 1 or 3, characterized in that a motor of the winch with steel wire ropes is arranged in a middle position of the sub-stage driving means, whose power is divided into two parts by means of a power division gear box and transmission shafts, and then distributed to an end steel wire rope roller through a double-stage reduction box.

5. The composite lifting stage according to claim 1, characterized in that four sides of the sub-stage framework structure all have a depth of 150 mm, on which four sides the LED screens are mounted.

6. The composite lifting stage according to claim 1, characterized in that the driving means for lifting the main stage uses 8 hydraulic cylinders which are balanced by means of position encoders and load sensors, travel switches are installed to set up limited positions to which the lifting stage can reach and different positions within a travel range for the lifting stage to stop, and safety side detector devices are arranged beneath lateral sides of the base structure.

7. The composite lifting stage according to claim 1, characterized in that the main stage has a length of 18m to 33m, a width of 3m to 6m, and a lifting travel range of the main stage of 15.5m.

8. The composite lifting stage according to claim 7, characterized in that the sub-stages are separated into two rows with 11 in each row, a cross section of $3\text{m} \times 3\text{m}$, and a lifting travel range with respect to the main stage of 4m.

9. The composite lifting stage according to claim 1, characterized in that the sub-stages are secured on the platform surface of the main stage in a chessboard-like manner.