

Title of Invention: Installation Method, Structure of Linear Motor and
Electrical Equipment thereof

Technical Field

5 The present invention relates to the field of linear motor, and in particular relates to the installation method of linear motor, structure and electrical equipment thereof.

Background

10 In the existing technology, linear motors are widely used in electronic and semiconductor equipments, UV inkjet printing industry, UV printing and dyeing industry, UV printing industry, UV glass industry, precision CNC machine tools, high-end medical equipment, mobile phone inspection industry, glass inspection industry and other fields due to their advantages such as fast
15 response and fast speed.

 There are two main types of linear motor structures used in existing CNC machine tools, including: conventional tiled structure, and opposite-vertical arrangement structure. Among them, the opposite vertical arrangement structure means that linear motor stators are arranged on both sides of the
20 center, the linear motor stators are connected to a base, the linear motor mover is connected to a moving component and arranged face to face with the linear motor stators. In practical applications of the opposite vertical arrangement structure, the magnetic attraction of the stator components of the linear motor reaches a force balance state through the opposite distribution, but due to the
25 far distance between the linear motor stator components, the magnetic attraction force is transmitted to the moving components and cause force deformation effects on the moving components. Therefore, in practical applications, the moving components cannot reach a complete force balance

state.

Meanwhile, whether it is a tiled type or an opposite vertical arrangement structure, due to the problem of magnetic attraction when the linear motor is operating, the stators and the mover of the linear motor are easily attracted together, which will affect the movement of the motor. Therefore, when a conventional linear motor is used, it will be completely embedded in a base to fix the stator of the linear motor to prevent the stator and the mover of the linear motor from being attracted together to generate friction due to the magnetic attraction problem, thereby affecting the movement of the motor.

However, this method requires hollowing out and drilling holes in the base to fix the motor, but in some application scenarios of precision equipments, it is difficult to accurately position and drill holes. Hollowing out the base not only raises a very high cost, but also greatly reduces the rigidity of the base and degrades the performance of linear motor application equipment.

In view of this, the inventor of the present application has designed a linear motor installation method, structure and electrical equipment thereof to address the above technical problems.

SUMMARY

A technical problem to be solved by the present invention is to overcome the defects in the prior art that an arrangement of a linear motor may easily cause a stator and a mover of the linear motor to be attracted together to generate a friction force and affect the movement of the motor, and the present invention provides an installation method, structure of linear motor and electrical equipment thereof.

The present invention solves the above technical problem through the following technical solutions:

A linear motor installation method, characterized in that the installation

method of linear motor includes: determining a height of motion centerline of the motion module; determining a height of measurement centerline of a measuring component; determining a height of thrust centerline of a power source; installing each component of the linear motor on different levels to
5 ensure that a motion center of the motion centerline, a measurement center of the measurement centerline, and a thrust center of the thrust centerline are located on the same straight line.

According to one embodiment of the present invention, the installation method of linear motor further includes: arranging a mass center, the motion
10 center, the measurement center, and the thrust center on one straight line.

According to an embodiment of the present invention, a mass centerline of a moving component is adjusted through a structural design; through the structural design, different components corresponding to the motion center, the measurement center, the thrust center and the mass center are installed on
15 different levels, in order to ensure that their respective centerlines are located on the same horizontal line.

According to an embodiment of the present invention, the motion center is a motion transmission center of the transmission component; the measurement center is a measurement center of the measurement feedback component; and
20 the thrust center is a thrust center of the power source.

According to an embodiment of the present invention, the mass center is a mass center of a moving component.

The invention also provides a linear motor, characterized in that the linear motor includes linear motor stators, linear motor movers, a workbench, a base
25 and a measuring device, both sides of the workbench are slidably connected to the base through at least one set of slide rails modules, a groove is provided in the base, the linear motor stators are arranged on the inner wall surfaces on both sides of the groove and are suspended and extended upwardly along the

corresponding inner wall surface, the linear motor movers are installed at the bottom of the workbench and extend downwardly;

or, the linear motor movers are fixed to the inner wall surfaces on both sides of the groove and are suspended and extended upwardly along the
5 corresponding inner wall surface, and the linear motor stators are installed at the bottom of the workbench and extend downwardly;

the linear motor stators are arranged in opposite to the linear motor rotors, and when the linear motor is operating, the linear motor movers move relative to the linear motor stators;

10 the measuring device is installed on the base and is used to measure a movement position of the linear motor movers;

a motion center of the slide rail module, a measurement center of the measuring device and a thrust center of the linear motor are located on the same straight line.

15 According to an embodiment of the present invention, each set of the slide rail modules includes one set of guide rails and at least one set of slide blocks, the slide blocks are installed on both sides at the bottom of the workbench, the guide rails are installed on both sides at the upper end of the base, and the slide block and the guide rail are slidably arranged relative to each other.

20 According to an embodiment of the present invention, the bottom of the workbench is provided with a mover mounting bracket extending downwardly, and the linear motor movers are installed on left and right sides of the mover mounting bracket.

According to an embodiment of the present invention, a set of stator
25 mounting brackets suspending and extending upwardly are provided on the left and right side walls of the groove, and the linear motor stator is installed on the left and right sides of the stator mounting bracket.

According to an embodiment of the present invention, an upper part of the

stator mounting bracket is configured as an upwardly suspended part, a bottom of the upwardly suspended part is locked with the base by a first locking mechanism, a bottom of the stator mounting bracket is locked with the base by the second locking mechanism.

5 According to an embodiment of the present invention, slots are provided on both sides at the bottom of the groove, and the bottom of the stator mounting bracket is inserted into and fixed in the corresponding slot; or, the bottom of the stator mounting bracket fits with the bottom of the groove, and a lower bottom plate is inserted between the stator mounting brackets on the left and right sides
10 to lock the stator mounting bracket with the base .

 According to an embodiment of the present invention, the mover mounting bracket includes a mounting portion of the mover mounting bracket and a cantilever beam, and the cantilever beam is fixed to a lower end surface of the mover mounting bracket mounting part;

15 a mounting slot is provided at the bottom of the workbench, and the mounting portion of the mover mounting bracket is fixed in the mounting slot.

 According to an embodiment of the present invention, the mover mounting bracket adopts a frame structure, and the linear motor mover is embedded and fixed in the frame structure.

20 According to an embodiment of the present invention, the mover mounting bracket is T-shaped, L-shaped or Z-shaped.

 According to an embodiment of the present invention, the mover mounting bracket adopts an I-shaped structure, and upper and lower bottom surfaces and one side surface of the linear motor mover are fixed to the mover mounting
25 bracket.

 According to an embodiment of the present invention, the linear motor mover is fixed to the mover mounting bracket at top, at sides or detachably fixed to the mover mounting bracket.

The present invention also provides a linear motor, characterized in that the linear motor includes at least one first linear motor assembly, at least one second linear motor assembly, a workbench, a base and a measuring device, both sides of the workbench are slidably connected to the base through at least one set of slide rail modules, a groove is provided in the base, the first linear motor assembly is arranged in the groove, the second linear motor assembly is installed at a bottom of the workbench;

the first linear motor assembly and the second linear motor assembly are sleeved with each other, and when the linear motor is operating, the second linear motor assembly moves relative to the first linear motor assembly;

The measuring device is installed on the base and is used to measure the movement position of a linear motor mover;

a motion center of the slide rail module, a measurement center of the measuring device and a thrust center of the linear motor are located on a same straight line.

According to an embodiment of the present invention, the first linear motor assembly is a linear motor stator, and the second linear motor assembly is a linear motor mover;

or, the first linear motor assembly is a linear motor mover, and the second linear motor assembly is a linear motor stator.

According to an embodiment of the present invention, the linear motor mover includes a mover mounting bracket and a plurality of motor coils, the mover mounting bracket is installed at the bottom of the workbench, and the motor coils are central-symmetrically installed on the mover mounting bracket;

the linear motor stator includes a stator mounting bracket and a plurality of magnets, the stator mounting bracket is provided in a groove of the base, the magnets are central-symmetrically installed on the stator mounting bracket; the motor coils and the magnets are arranged relative to each other.

According to an embodiment of the present invention, the mover mounting bracket is a support frame structure, the stator mounting bracket is a frame-shaped bracket structure, and the mover mounting bracket is inserted into the stator mounting bracket.

5 According to an embodiment of the present invention, the linear motor mover includes a mover mounting bracket and a plurality of motor coils, the mover mounting bracket is arranged in the groove of the base, and the motor coils are central-symmetrically installed on the mover mounting bracket;

10 The linear motor stator includes a stator mounting bracket and a plurality of magnets, the stator mounting bracket is installed at the bottom of the workbench, the magnets are central-symmetrically installed on the stator mounting bracket; the motor coils and the magnets are arranged relative to each other.

15 According to an embodiment of the present invention, the mover mounting bracket is a frame-shaped bracket structure, the stator mounting bracket is a support frame structure, and the stator mounting bracket is inserted into the mover mounting bracket.

20 According to an embodiment of the present invention, each set of the slide rail modules includes one set of guide rails and at least one set of slide blocks, the slide blocks are installed on both sides at the bottom of the workbench, the guide rails are installed on both sides at the upper end of the base, and the slide block and the guide rail are slidably arranged relative to each other.

 According to an embodiment of the present invention, the motor coils are embedded in each inner wall surface of the mover mounting bracket.

25 According to an embodiment of the present invention, the mover mounting bracket and the stator mounting bracket is formed as regular polygon. The present invention also provides an electrical equipment, wherein the electrical equipment includes the linear motor as described above, or the electrical

equipment includes the linear motor as described above, or the electrical equipment includes a linear motor that adopts the installation method of linear motor as described above.

The positive progressive effects of the present invention are:

5 Compared with the existing technology, the installation method of linear motor, structure and electrical equipment thereof of the present invention have the following beneficial effects:

1. The motor can be configured as a suspending-extending arrangement or configured to counteract magnetic attraction forces;

10 2. It can reduce production cost of the base;

3. It can reduce difficulty of installing the locking mechanism at the bottom of the bracket;

4. It can increase the rigidity of the base; 5. It can maintain three centers on one line or four centers on one line to optimize adaptability of the motor and
15 mechanical structure.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features, properties and advantages of the present invention will become more apparent from the following description and
20 embodiments in conjunction with the figures, in the figures, same reference numeral refers to the same features throughout, in which:

Fig. 1 is a perspective view of a mounting structure of a linear motor of the present invention.

Fig. 2 is a longitudinal cross-sectional view of the mounting structure of
25 the linear motor of the present invention.

Fig. 3 is a schematic diagram of the installation between a linear motor mover and a mover mounting bracket in the linear motor of the present invention.

Fig. 4 is a schematic diagram of a measuring centerline of a grating ruler in the linear motor of the present invention.

Fig. 5 is a schematic diagram of a motion centerline of a linear guide rail in the linear motor of the present invention.

5 Fig. 6 is a schematic diagram of a thrust centerline of the linear motor in the linear motor of the present invention.

FIG. 7 is a perspective view of Embodiment 1 of the linear motor of the present invention.

10 Fig. 8 is a longitudinal cross-sectional view of Embodiment 1 of the linear motor of the present invention.

Fig. 9 is a perspective view of Embodiment 2 of the linear motor of the present invention.

Fig. 10 is a longitudinal cross-sectional view of Embodiment 2 of the linear motor of the present invention.

15 Fig. 11 is a perspective view of Embodiment 3 of the linear motor of the present invention.

Fig. 12 is a longitudinal cross-sectional view of Embodiment 3 of the linear motor of the present invention.

20 Fig. 13 is a perspective view of Embodiment 4 of the linear motor of the present invention.

Fig. 14 is a longitudinal cross-sectional view of Embodiment 4 of the linear motor of the present invention.

Fig. 15 is a schematic diagram of the installation structure of the mover mounting bracket and the linear motor mover in Fig. 13.

25 Fig. 16 is a perspective view of Embodiment 5 of the linear motor of the present invention.

Fig. 17 is a front view of Embodiment 5 of the linear motor of the present invention.

Fig. 18 is a perspective view of Embodiment 6 of the linear motor of the present invention.

Fig. 19 is a front view of Embodiment 6 of the linear motor of the present invention.

5 Fig. 20 is a schematic structural diagram of three groups of central-symmetrically distributed linear motors with centers of motor coils concentrated in Embodiment 7 of the present invention.

10 Fig. 21 is a schematic structural diagram of three groups of central-symmetrically distributed linear motors with centers of magnets centers concentrated in Embodiment 7 of the present invention.

Fig. 22 is a schematic structural diagram of five groups of central-symmetrically distributed linear motors with centers of motor coils concentrated in Embodiment 7 of the present invention.

15 Fig. 23 is a schematic structural diagram of five groups of central-symmetrically distributed linear motors with centers of magnets concentrated in Embodiment 7 of the present invention.

Fig. 24 is a schematic structural diagram of six groups of central-symmetrically distributed linear motors with centers of motor coils concentrated in Embodiment 7 of the present invention.

20 Fig. 25 is a schematic structural diagram of six groups of central-symmetrically distributed linear motors with centers of magnets concentrated in Embodiment 7 of the present invention.

25 Fig. 26 is a schematic structural diagram of eight groups of central-symmetrically distributed linear motors with centers of motor coils concentrated in Embodiment 7 of the present invention.

Fig. 27 is a schematic structural diagram of eight groups of central-symmetrically distributed linear motors with centers of magnets concentrated in Embodiment 7 of the present invention.

Fig. 28 is a schematic diagram of another octagonal installation structure of the linear motor in Embodiment 7 of the present invention.

Fig. 29 is a schematic diagram of principles of Embodiment 5 to Embodiment 7 of the linear motor of the present invention.

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DESCRIPTION OF EMBODIMENTS

In order to make the aforementioned objects, characteristics and advantages of the present invention more apparently and readily to appreciate, a detailed description of the specific embodiments of the present invention will
10 be given in conjunction with the figures.

Embodiments of the present invention will now be described in detail with reference to the figures. Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the figures. Whenever possible, the same reference numbers will be used
15 throughout the figures to indicate the same or similar parts.

In addition, the terms used in the present invention are selected from well-known and commonly used terms, however some terms mentioned in the description of the present invention may be selected by the applicant based on his or her judgment, and specific meanings thereof are explained in relevant
20 sections of the description.

Furthermore, it is required that the present invention is understood not only by the actual terms used, but also by the meaning inherent in each term.

As shown in Figs. 1, 2 and 4 to 6, the present invention discloses an installation method of linear motor, which comprises:

25 determining a height of a motion centerline of a motion module. For example, in this embodiment, the motion module is preferably a linear guide rail;

determining a height of the measurement centerline of the measurement

component;

determining a height of a thrust centerline of the power source. For example, in this embodiment, the power source is preferably a linear motor assembly (including a linear motor mover and a linear motor stator).

5 The components of the linear motor are mounted on different levels to ensure that a motion center of the motion centerline, a measurement center of the measurement centerline, and a thrust center of the thrust centerline are located on a same straight line (as shown in Fig. 4 to Fig. 6). The same straight line described here may preferably be the same horizontal line.

10 The installation method of linear motor further comprises: arranging a mass center, the motion center, the measurement center, and the thrust center on a straight line (as shown in Figs. 4 to 6). Further preferably, the installation method of linear motor may further comprise:

15 adjusting the mass centerline of moving components with a structural design;

with the structural design, different components corresponding to the motion center, the measurement center, the thrust center and the mass center are mounted on different levels, to ensure their respective centerlines on the same horizontal line.

20 Among them, the motion center is preferably a motion transmission center of transmission components, that is, the motion center of a coupling surface of the transmission components, such as the motion center of a roller coupling surface of a linear guide rail and a slider.

25 The measurement center is preferably a measurement center of the measurement feedback component. The measurement feedback component described here is preferably a grating ruler, the structure of the grating ruler consists of a reading head and a ruler body, there is displacement value lines on the ruler body, the reading head of the grating ruler measures the position in

real time through optical principles and feeds it back to a motion control system. Therefore, a center of a coupling surface that the reading head of the grating ruler corresponds to the scale body is the measurement center.

The thrust center is preferably a thrust center of the power source. When
5 any object needs to move, there must be a force-exerting object, a force-exerting center of which is the thrust center of the power source. In this embodiment, the power source is preferably a linear motor assembly. In addition, the mass center, the motion center, the measurement center, and the thrust center can also be arranged on a straight line (as shown in Figs. 4 to 6).
10 With the structural design, different components corresponding to the motion center, the measurement center, the thrust center and the mass center are installed on different levels to ensure their respective centerlines on the same horizontal line.

The mass center is preferably a mass center of a moving component. The
15 mass center of the moving components is the center of gravity of the moving components when combined together.

The installation method of linear motor of the present invention adopts the arrangement of three centers on one line or four centers on one line, which can optimize adaptability of the motor and the mechanical structure, and can greatly
20 improve a complete performance of the overall structure.

Among them, a most ideal design condition of the mechanism is that the above four centers are at one point, which can ensure that when the mechanism moves, firstly, there will be no inconsistent motion state due to any biased force induced by force biasing towards the center. When the motion state is
25 inconsistent, if the measurement center is deviated, the measurement error will increase. Secondly, it ensures that even if the rigidity of the installed components is weak, there will be no eccentric force that affects the accuracy, the three-center-on-one or four-center-on-one state can greatly improve

following error and operation control of moving components during movement.

The technical difficulties to be overcome in this invention comprise:

(1) The guarantee of the center heights of linear guide rails, measuring devices, and linear motor assemblies with different specifications and models,
5 as four centers should be kept on one line in the design;

(2) The rigidity of the mounting bracket after a half of the linear motor stator is suspended and extended upwardly during design;

(3) Rigidity and deformation control of cantilever type motor bracket.

Based on the above technical difficulties, the present invention pioneered
10 the definition of three centers on one line or four centers on one line. The technical difficulty that needs to be overcome is how to control the center position of each component with design methods in the process of realizing the design of three centers on one line or four centers on one line, in this process, the installation and adjustment methods of each component, structural stiffness,
15 manufacturing difficulties and cost should be considered. After the installation is completed, some measurement verification methods are needed to verify whether the installation is qualified, and some simulations and FRF experiments are needed to verify whether the rigidity of the mechanism satisfies design requirements.

20

Embodiment 1:

As shown in Figs. 1 to 8, the present invention further discloses a linear motor, which includes linear motor stators 10, a linear motor mover 20, a workbench 30, a base 40 and a measuring device 50. Among them, both sides of
25 the workbench 30 are slidably connected to the base 40 by at least one group of slide rail modules. A groove 41 is provided in the base 40, the linear motor stators 10 are arranged on the inner wall surfaces on both sides of the groove 41 and extend upwardly along the corresponding inner wall surfaces, and the linear

motor mover 20 is installed at the bottom of the workbench 30 and extends downwardly.

Alternatively, the linear motor movers 20 can also be fixed to the inner wall surfaces on both sides of the groove 41 and be suspended and extended upwardly along the corresponding inner wall surfaces, the linear motor stator 10 is installed on the bottom of the workbench 30 and extends downwardly. The linear motor stator 10 and the linear motor mover 20 are arranged opposite to each other. When the linear motor is operating, the linear motor mover 20 moves relative to the linear motor stator 10. Here, the installation positions of the linear motor stator and the linear motor mover can be interchanged, as long as they can be arranged relative to each other to achieve relative movement between the linear motor stator and the linear motor mover. The measuring device 50 is installed on the base 40 and is used to measure the movement position of the linear motor mover 20. A motion center of the slide rail module, a measurement center of the measuring device 50 and a thrust center of the linear motor assembly are located on a same straight line. The measuring device 50 described here can preferably be a grating ruler.

Preferably, each set of slide rail modules includes one set of guide rails 60 and at least one set of slide blocks 70, the slide blocks 70 are installed on both sides at the bottom of the workbench 30, and the guide rails 60 are installed on both sides of an upper end of the base 40, and the slider 70 and the guide rail 60 are slidably arranged relative to each other.

Further preferably, a mover mounting bracket 31 extending downwardly is provided at the bottom of the workbench 30, and the linear motor mover 20 is installed on the left and right sides of the mover mounting bracket 31.

The mover mounting bracket 31 may preferably be T-shaped, L-shaped or Z-shaped, and the linear motor mover 20 is fixed to various types of mover mounting brackets 31. For example, the linear motor mover 20 may be fixed to

the mover mounting bracket 31 at top, at sides or detachably fixed to the mover mounting bracket 31. Its main function is to connect the linear motor mover and the workbench to realize the movement of the workbench with the linear motor mover.

5 A set of stator mounting brackets 11 suspended and extended upwardly are respectively provided on the left and right side walls of the groove 41, and the linear motor stators 10 are installed on the left and right sides of the stator mounting brackets 11.

10 In particular, an upper part of the stator mounting bracket 11 is configured as an upwardly suspended part 111, a bottom of the upwardly suspended part 111 is locked with the base 40 by a first locking mechanism, a bottom of the stator mounting bracket 11 is locked with the base 40 by a second locking mechanism.

15 For example, in the embodiment, the bottom of the stator mounting bracket 11 fits with the bottom of the groove 41, a lower bottom plate 12 is inserted between the stator mounting brackets 11 on the left and right sides, and the stator mounting bracket 11 and the base 40 are locked by the lower bottom plate 12. In other words, firstly, the stator mounting bracket 11 is put into the base 40, and then the lower bottom plate 12 is inserted between the stator mounting
20 brackets 11 on the left and right sides to lock the stator mounting bracket 11 with the base 40.

25 In this structure, the second locking mechanism adopts a linear motor mounting structure with a bottom plate. Alternatively, in the structure, the bottom of the groove 41 can also be configured as a planar structure, the bottom of the stator mounting bracket 11 fits with the bottom of the groove 41, and then is locked with the base 40 by the second locking mechanism.

Of course, the above structure is only an example, the second locking mechanism between the stator mounting bracket and the base can have various

forms, which are all within the scope of protection of this application, as long as the principles are the same, which suffices to lock the stator mounting bracket with the base, no further details will be given here.

In particular, the locking mechanism in this application means: a means for
5 secure the linear motor stator mounting bracket on the base 40. The first locking mechanism is provided at a middle and upper part of the linear motor stator bracket and can fix the middle and upper part of the linear motor stator bracket with the base 40. The second locking mechanism is provided at the bottom of the linear motor stator bracket and can fix the lower part of the linear
10 motor stator bracket with the base 40. The first locking mechanism is provided at the middle and upper part of the linear motor stator bracket and can fix the middle and upper part of the linear motor stator bracket with the base 40.

Preferably, the mover mounting bracket 31 includes a mounting portion
311 of the mover mounting bracket and a cantilever beam 312, which is fixed to
15 a lower end surface of the mover mounting bracket mounting portion 311. A mounting slot 32 is formed at the bottom of the workbench 30, and the mounting portion 311 of the mover mounting bracket is fixed in the mounting slot 32.

Among them, the cantilever beam 312 is a simplified model obtained in
20 materials mechanics to facilitate calculation and analysis, one end of the cantilever beam 312 is a fixed support and the other end is a free end.

Embodiment 2:

As shown in Figs. 9 and 10, the structure of the embodiment is
25 substantially the same as that of Embodiment 1, the difference therebetween lies in: there are slots 411 provided on both sides of the bottom of the groove 41, and the bottom of the stator mounting bracket 11 is inserted and fixed in the corresponding slot 411.

In this structure, the second locking mechanism adopts a linear motor mounting structure with slot, which locks the stator mounting bracket 11 and the base 40 by forming slots on the left and right sides of the base.

This installation structure can make the stator mounting bracket and the
5 base 40 more firmly fixed, and improve the stability of the linear motor stator.

Embodiment 3:

As shown in Figs. 11 and 12, the structure of the embodiment is substantially the same as that of Embodiment 1, the difference therebetween
10 lies in: the mover mounting bracket 31 adopts an I-shaped structure, and the upper and lower surfaces and one side surface of the linear motor mover 20 are attached to the mover mounting bracket 31.

This installation structure can realize the fixation of the upper and lower surfaces and one side surface of the linear motor mover 20, which is more
15 stable than the T-shaped mover mounting bracket.

Embodiment 4:

As shown in Figs. 13 to 15, the structure of the embodiment is substantially the same as that of Embodiment 1, the difference therebetween
20 lies in: the mover mounting bracket 31 adopts a frame structure, and the linear motor mover 20 is embedded and fixed in the frame structure.

In this installation structure, the mover mounting bracket 31 is configured as a frame type, which can fix at least one back surface and eight sides of the linear motor mover 20 .

25 Compared with the T-shaped structure, this structure of the mover mounting bracket 31 can reduce a lateral thickness of the lower end of the T-shaped bracket and a lateral thickness of the two linear motor movers, and disperse the fixing force to each side of the linear motor mover, to reduce the

amount of materials, reduce the installation space, and reduce the space occupied by the linear motor installation structure in the equipment.

In addition, the present invention also discloses an electrical equipment, which includes a linear motor as described above, or the electrical equipment
5 includes a linear motor using the linear motor which adopts the installation method of linear motor as described above.

According to the above description of structure, the principle of the linear motor of the present invention is to adjust the opposing arrangement structure of the original multi-motors, move the mover components of the linear motor to
10 the middle position, and move the stator components of the linear motor to the opposite sides. This adjustment allows the magnetic attraction force borne by the mover components of the linear motor to be transferred to the same point, so that the mover components of the linear motor receive the magnetic attraction forces having the same magnitude in two directions, and the action
15 points of magnetic attraction forces is the same point, thus achieving the force equilibrium state. Furthermore, the external force that originally affected the moving components disappears, the dynamic performance of the moving components is better, and the following error of the moving components is greatly reduced.

20 The linear motor of the present invention makes the motor to have a suspending and extending arrangement, which can reduce the production cost of the base, reduce the difficulty of installing the locking mechanism at the bottom of the bracket, increase the rigidity of the base, and can also maintain three centers and one line or four centers and one line.

25

Embodiment 5:

As shown in Figs. 16 and 17, the present invention further provides a linear motor, which is a linear motor that can counteract magnetic attraction

force, and which includes at least one first linear motor assembly 100, at least one second linear motor assembly 200, a workbench 30, a base 40 and a measuring device 50. Both sides of the workbench 30 are slidably connected to the base 40 by at least one set of slide rail modules, and a groove 41 is formed in the base 40. The first linear motor assembly 100 is provided in the groove 41, and the second linear motor assembly 200 is installed at the bottom of the workbench 30. The first linear motor assembly 100 and the second linear motor assembly 200 are sleeved with each other, and when the linear motor is operating, the second linear motor assembly 200 moves relative to the first linear motor assembly 100.

A measuring device 50 is installed on the base 40 and is used to measure the movement position of the linear motor mover.

The motion center of the slide rail module, the measurement center of the measuring device and the thrust center of the linear motor are collinear.

In this embodiment, the first linear motor assembly 100 may be preferably a linear motor stator, and the second linear motor assembly 200 may be preferably a linear motor mover.

Further preferably, the linear motor mover (i.e., the second linear motor assembly 200) includes a mover mounting bracket a1 and a plurality of motor coils b1, the mover mounting bracket a1 is installed at the bottom of the workbench 30, and the motor coils b1 are central-symmetrically installed on the mover mounting bracket a1. The linear motor stator (i.e., the first linear motor assembly 100) includes a stator mounting bracket a2 and a plurality of magnets b2, the stator mounting bracket a2 is provided in the groove 41 of the base 40, and the magnets b2 are central-symmetrically installed on the stator mounting bracket 110. Here, the motor coil b1 and the magnet b2 are arranged oppositely.

Alternatively, in the embodiment, the first linear motor assembly 100 may also be preferably a linear motor mover, and the second linear motor assembly

200 may also be preferably a linear motor stator (not shown in the figure).

Further preferably, the linear motor mover (i.e., the first linear motor assembly 100) includes a mover mounting bracket a1 and a plurality of motor coils b1, the mover mounting bracket a1 is provided in the groove 41 of the
5 base 40, and the motor coils b1 are central-symmetrically installed on the mover mounting bracket a1. The linear motor stator (i.e., the second linear motor assembly 200) includes a stator mounting bracket a2 and a plurality of magnets b2, the stator mounting bracket a2 is installed at the bottom of the workbench 30, and the magnets b2 are central-symmetrically installed on the
10 stator mounting bracket a2. The motor coil b1 and the magnet b2 are arranged oppositely. In this embodiment, the mover mounting bracket a1 may preferably be a support frame structure, and the stator mounting bracket a2 may preferably be a frame-shaped bracket structure, the mover mounting bracket a1 is inserted into the stator mounting bracket a2. Here, the mover mounting bracket a1 and
15 the stator mounting bracket a2 may preferably be regular polygons, such as triangles, pentagons, hexagons or octagons. In this case, the linear motor has a structure with the motor coils are concentrated in the center.

For example, as shown in Figs. 16 and 17, the embodiment takes a centrally symmetrical distribution of three groups of linear motors with
20 centralized motor coils as an example, by installing a triangular magnet support frame (i.e. the stator mounting bracket 110) and a triangular motor support frame (i.e. the mover mounting bracket 210) in the linear motor, the stator mounting bracket a2 is locked with the base 40, and the mover mounting bracket a1 is locked with the workbench 30. When the linear motor operates,
25 the mover drives the workbench 30 to move.

In addition, the linear motor that can counteract the magnetic attraction force in the present invention can also include a measuring device 50, which can be installed on the base 40 and used to measure the movement position of

the linear motor mover. The motion center of the slide rail module, the measurement center of the measuring device 50 and the thrust center of the linear motor are collinear.

The measuring device 50 described here can preferably be a grating ruler. For example, the grating ruler is fixed to the base 40 , and a reading head 31 is driven by the workbench 30 and moves linearly along the grating ruler (i.e., the measuring device 50) through a reading head bracket 32 .

Preferably, each set of slide rail modules includes at least one set of guide rails 60 and at least one set of slide blocks 70, the slide blocks 70 are installed on both sides at the bottom of the workbench 30, and the guide rails 60 are installed on both sides of the upper end of the base 40, and the slide block 70 and the guide rail 60 are slidably arranged relative to each other.

Embodiment 6:

As shown in Figs. 18 and 19, the structure of the embodiment is substantially the same as that of Embodiment 1, the difference therebetween lies in: in this embodiment, the mover mounting bracket a1 may also be preferably a frame-shaped bracket structure, and the stator mounting bracket a2 may also be preferably a support frame structure, the stator mounting bracket a2 is inserted into the mover mounting bracket a1. Here, the mover mounting bracket a1 and the stator mounting bracket a2 may preferably be regular polygons, such as triangles, pentagons, hexagons or octagons.

For example, as shown in Figs. 18 and 19, the embodiment takes a centrally symmetrical distribution of three groups of linear motors with centralized motor coils as an example, by installing a triangular magnet support frame (i.e. the stator mounting bracket as) and the triangular motor support frame (i.e. the mover mounting bracket a1) in the linear motor, the stator mounting bracket a2 is locked with the base 40, and the mover mounting

bracket a1 is locked with the workbench 30. When the linear motor operates, the mover drives the workbench 30 to move.

Embodiment 7:

5 The structure of this embodiment is substantially the same as that of Embodiment 1, and the difference lies in: the mover mounting bracket a1 and the stator mounting bracket a2 may preferably have various polygonal structures. In practical applications, the magnets can be assembled into different lengths by a parallel splicing method to ensure that the coupling
10 between the magnets and the motor coils remains unchanged within a required range of stroke. According to the different configurations of motor coils and magnets, two different assembling structures are designed for each of the triangular mounting structure, the pentagonal mounting structure, the hexagonal mounting structure, and the octagonal mounting structure. The two assembling
15 structures are mainly two implementations formed by exchanging the positions of the motor coils and magnets.

Of course, in addition to the two different assembling structures exemplified in the embodiment, other structures are also within the protection scope of this application, as long as their principles and structures are similar
20 and the functions achieved are consistent.

As shown in Fig. 20, a central-symmetrically distributed installation structure of three groups of linear motors with centralized motor coils is adopted, the motor coils b1 are central-symmetrically installed on an outer wall of the mover mounting bracket a1, and the magnets b2 are
25 central-symmetrically installed on an inner wall of the stator mounting bracket a2, and the motor coils b1 and the magnet b2 are oppositely arranged, respectively.

As shown in Fig. 21, a central-symmetrically distributed installation

structure of three groups of linear motors with centralized magnets is adopted, the motor coils b1 are central-symmetrically embedded in an inner wall surface of the mover mounting bracket a1, and the magnets b2 are central-symmetrically installed on an outer wall of the stator mounting bracket a2, and the motor coils b1 and the magnets b2 are oppositely arranged, respectively.

As shown in Fig. 22, a central-symmetrically distributed installation structure of five groups of linear motors with centralized motor coils is adopted, the motor coils b1 are central-symmetrically installed on an outer wall of the mover mounting bracket a1, and the magnets b2 are central-symmetrically installed on an inner wall of the stator mounting bracket a2, and the motor coils b1 and the magnets b2 are oppositely arranged, respectively.

As shown in Fig. 23, a central-symmetrically distributed installation structure of five groups of linear motors with centralized magnets is adopted, the motor coils b1 are central-symmetrically embedded in an inner wall surface of the mover mounting bracket a1, and the magnets b2 are central-symmetrically installed on an outer wall of the stator mounting bracket a2, and the motor coils b1 and the magnets b2 are oppositely arranged, respectively.

As shown in Fig. 24, a central-symmetrically distributed installation structure of six groups of linear motors with centralized motor coils is adopted, the motor coils b1 are central-symmetrically installed on an outer wall of the mover mounting bracket a1, and the magnets b2 are central-symmetrically installed on an inner wall of the stator mounting bracket a2, and the motor coils b1 and the magnets b2 are oppositely arranged, respectively.

As shown in Fig. 25, a central-symmetrically distributed installation structure of six groups of linear motors with centralized magnets is adopted, the motor coils b1 are central-symmetrically embedded in an inner wall surface of

the mover mounting bracket a1, and the magnets b2 are central-symmetrically installed on an outer wall of the stator mounting bracket a2, and the motor coils b1 and the magnets b2 are oppositely arranged, respectively.

As shown in Fig. 26, a central-symmetrically distributed installation structure of eight groups of linear motors with centralized motor coils is adopted, the motor coils b1 are central-symmetrically installed on an outer wall of the mover mounting bracket a1, and the magnets b2 are central-symmetrically installed on an inner wall of the stator mounting bracket a2, and the motor coils b1 and the magnets b2 are oppositely arranged, respectively.

As shown in Fig. 27, a central-symmetrically distributed installation structure of eight groups of linear motors with centralized magnets is adopted, the motor coils b1 are central-symmetrically installed on an inner wall surface of the mover mounting bracket a1, and the magnets b2 are central-symmetrically installed on an outer wall of the stator mounting bracket a2, and the motor coils b1 and the magnets b2 are oppositely arranged, respectively.

As shown in Fig. 28, a central-symmetrically distributed installation structure of eight groups of linear motors with staggered motor coils and magnets is adopted, the motor coils b1 and the magnets b2 are installed on an inner wall surface of a frame-shaped bracket structure (i.e., the mover mounting bracket a1) and an outer wall surface of the support frame structure (i.e., the stator mounting bracket a2) in a staggered manner at intervals, and the motor coils b1 and the magnets b2 are oppositely arranged, respectively.

As described in Embodiment 5 to Embodiment 7 above, the present invention provides a linear motor that can counteract magnetic attraction and includes at least three groups of linear motor stators and linear motor movers. As shown in Fig. 29, groups of linear motor stators and linear motor movers are

distributed around one center point A, and the magnetic forces of groups of linear motor stators and linear motor movers are F1, F2, and F3 respectively, which are counteracted at the center point A (reaching a state of force balance).

The linear motor uses the balance principle of force to distribute at least
5 three groups of linear motor assemblies around one center point, and the magnetic forces of each group of the linear motor stators and linear motor movers are counteracted at the center point. Combined with the common mechanical structures that achieve equilibrium and subtle balance of power in nature, the regular pentagon with the golden ratio, the regular hexagon of the
10 honeycomb structure, and the regular octagon structure that are often used in long-span structures are adopted as examples to develop the design of novel linear motor installation structure.

This structure of linear motor that can counteract magnetic force is able to accommodate more motors in the same volume, with greater thrust and higher
15 loss tolerance. Because the magnetic forces of the respective groups of motors are balanced at the center point, the deformation caused by the bending moment is greatly reduced, thereby stabilizing the air gap size and making the output force more stable, the closed structure can remain stable for a long time in high-frequency operation, reducing structural creep and improving the control
20 of bandwidth.

In summary, compared with the existing technology, the installation method of linear motor, structure and electrical equipment thereof in the present invention have the following beneficial effects:

1. The motor can be made as a suspending-and-extending arrangement or
25 has an arrangement that counteracts the magnetic forces;
2. It can reduce the production cost of the base;
3. It can reduce the difficulty of installing the locking mechanism at the bottom of the bracket;

4. It can increase the rigidity of the base;

5. It can maintain three centers on one line or four centers on one line to optimize the adaptability of the motor and mechanical structure.

Although specific embodiments of the present invention have been
5 described above, those skilled in the art will understand that these are only
examples, and the protection scope of the present invention is defined by the
appended claims. Those skilled in the art can make various changes or
modifications to these embodiments without departing from the principles and
essence of the present invention, but these changes and modifications all fall
10 within the protection scope of the present invention.

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Claims

1. An installation method of linear motor, wherein the installation method
5 of linear motor comprises: determining a height of motion centerline of a
motion module; determining a height of measurement centerline of a measuring
component; determining a height of thrust centerline of a power source;
installing components of the linear motor on different levels to ensure that a
motion center of the motion centerline, a measurement center of the
10 measurement centerline, and a thrust center of the thrust centerline are located
on a same straight line.

2. The installation method of linear motor according to claim 1, wherein:
the installation method of linear motor further comprises: arranging a mass
15 center on the same straight line with the motion center, the measurement center,
and the thrust center.

3. The installation method of linear motor according to claim 2, wherein a
mass centerline of a moving component is adjusted through a structural design;
20 through the structural design, different components corresponding to the motion
center, the measurement center, the thrust center and the mass center are
installed on different levels to ensure their respective centerlines are located on
the same horizontal line.

25 4. The installation method of linear motor according to claim 1, wherein
the motion center is a motion transmission center of transmission components;
the measurement center is a measurement center of a measurement feedback
component; and the thrust center is a thrust center of a power source.

5. The installation method of linear motor according to claim 2, wherein the mass center is a mass center of a moving component.

5 6. A linear motor, wherein the linear motor includes linear motor stators, linear motor movers, a workbench, a base and a measuring device, both sides of the workbench are slidably connected to the base through at least one set of slide rails modules, a groove is provided in the base, the linear motor stators are arranged on inner wall surfaces on both sides of the groove and suspendedly
10 extend upwardly along the corresponding inner wall surfaces, the linear motor movers are installed at the bottom of the workbench and extend downwardly;

or, the linear motor movers are fixed to the inner wall surfaces on both sides of the groove and suspendedly extend upwardly along the corresponding inner wall surface, and the linear motor stators are installed at the bottom of the
15 workbench and extend downwardly;

the linear motor stators are arranged in opposite to the linear motor rotors, and when the linear motor are operating, the linear motor movers move relative to the linear motor stators;

the measuring device is installed on the base and is used to measure a
20 movement position of the linear motor movers;

a motion center of the slide rail module, a measurement center of the measuring device and a thrust center of the linear motor are located on a same straight line.

25 7. The linear motor according to claim 6, wherein each set of the slide rail modules includes one set of guide rails and at least one set of slide blocks, the slide blocks are installed on both sides at the bottom of the workbench, the guide rails are installed on both sides of the upper end of the base, and the slide

block and the guide rail are slidably arranged relative to each other.

8. The linear motor according to claim 6, wherein the bottom of the workbench is provided with a mover mounting bracket extending downwardly,
5 and the linear motor movers are installed on left and right sides of the mover mounting bracket.

9. The linear motor according to claim 6, wherein a set of stator mounting brackets that upwardly and suspendedly extend are provided on the left and
10 right side walls of the groove, and the linear motor stators are installed on the left and right sides of the stator mounting bracket.

10. The linear motor according to claim 9, wherein an upper part of the stator mounting bracket is configured as an upwardly suspended part, a bottom
15 of the upwardly suspended part is locked with the base by a first locking mechanism, and a bottom of the stator mounting bracket is locked with the base by the second locking mechanism.

11. The linear motor according to claim 10, wherein: slots are provided on
20 both sides at the bottom of the groove, and the bottom of the stator mounting bracket is inserted into and fixed in the corresponding slot;

or, the bottom of the stator mounting bracket fits with the bottom of the groove, and a lower bottom plate is inserted between the stator mounting brackets on the left and right sides to lock the stator mounting bracket with the
25 base .

12. The linear motor according to claim 8, wherein the mover mounting bracket includes a mounting portion of the mover mounting bracket and a

cantilever beam, and the cantilever beam is fixed to a lower end surface of the mover mounting bracket mounting part;

a mounting slot is provided at the bottom of the workbench, and the mounting portion of the mover mounting bracket is fixed in the mounting slot.

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13. The linear motor according to claim 8, wherein the mover mounting bracket adopts a frame structure, and the linear motor mover is embedded and fixed in the frame structure.

10 14. The linear motor according to claim 8, wherein: the mover mounting bracket is T-shaped, L-shaped or Z-shaped.

15 15. The linear motor according to claim 8, wherein the mover mounting bracket adopts an I-shaped structure, and upper and lower bottom surfaces and one side surface of the linear motor mover are fixed to the mover mounting bracket.

20 16. The linear motor according to claim 8, wherein the linear motor mover is fixed to the mover mounting bracket at top, at sides or detachably fixed to the mover mounting bracket.

25 17. A linear motor, wherein the linear motor includes at least one first linear motor assembly, at least one second linear motor assembly, a workbench, a base and a measuring device, both sides of the workbench are slidably connected to the base through at least one set of slide rail modules, a groove is provided in the base, the first linear motor assembly is arranged in the groove, the second linear motor assembly is installed at a bottom of the workbench;

the first linear motor assembly and the second linear motor assembly are

sleeved with each other, and when the linear motor is operating, the second linear motor assembly moves relative to the first linear motor assembly;

the measuring device is installed on the base and is used to measure a movement position of a linear motor mover;

5 a motion center of the slide rail modules, a measurement center of the measuring device and a thrust center of the linear motor are located on a same straight line.

18. The linear motor according to claim 17, wherein the first linear motor
10 assembly is a linear motor stator, and the second linear motor assembly is a linear motor mover;

or the first linear motor assembly is a linear motor mover, and the second linear motor assembly is a linear motor stator.

15 19. The linear motor according to claim 18, wherein the linear motor mover includes a mover mounting bracket and a plurality of motor coils, the mover mounting bracket is installed at the bottom of the workbench, and the motor coils are central-symmetrically installed on the mover mounting bracket;

the linear motor stator includes a stator mounting bracket and a plurality of
20 magnets, the stator mounting bracket is provided in a groove of the base, the magnets are central-symmetrically installed on the stator mounting bracket; the motor coils and the magnets are arranged relative to each other.

20. The linear motor according to claim 19, wherein the mover mounting
25 bracket has a support frame structure, the stator mounting bracket has a frame-shaped bracket structure, and the mover mounting bracket is inserted into the stator mounting bracket.

21. The linear motor according to claim 18, wherein the linear motor mover includes a mover mounting bracket and a plurality of motor coils, the mover mounting bracket is arranged in the groove of the base, and the motor coils are central-symmetrically installed on the mover mounting bracket;

5 the linear motor stator includes a stator mounting bracket and a plurality of magnets, the stator mounting bracket is installed at the bottom of the workbench, the magnets are central-symmetrically installed on the stator mounting bracket; the motor coils and the magnets are arranged relative to each other.

10

22. The linear motor according to claim 21, wherein the mover mounting bracket is a frame-shaped bracket structure, the stator mounting bracket is a support frame structure, and the stator mounting bracket is inserted into the mover mounting bracket.

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23. The linear motor according to claim 17, wherein: each set of the slide rail modules includes one set of guide rails and at least one set of slide blocks, the slide blocks are installed on both sides at the bottom of the workbench, the guide rails are installed on both sides at the upper end of the base, and the slide
20 blocks and the guide rails are slidably arranged relative to each other.

24. The linear motor according to claim 19 or 21, wherein the motor coils are embedded in each inner wall surface of the mover mounting bracket.

25 25. The linear motor according to claim 19 or 21, wherein the mover mounting bracket and the stator mounting bracket are formed as regular polygon.

26. An electrical equipment, wherein the electrical equipment includes the linear motor according to any one of claims 6 to 16, or the electrical equipment includes the linear motor according to any one of claims 17 to 25, or the electrical equipment includes a linear motor that adopts the installation method
5 of linear motor according to any one of claims 1 to 5.