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(54) **MULTI-STAGE HYDRAULIC MULTIPLICATION PULLEY VERTICAL LIFTING-TYPE CLIMBING PLATFORM FIRE TRUCK**

(57) Provided is a multi-stage hydraulic multiplication pulley vertical lifting-type climbing platform fire truck, which belongs to the technical field of fire fighting and rescue devices. The multi-stage hydraulic multiplication pulley vertical lifting-type climbing platform fire truck comprises an automobile chassis (1), wherein a telescopic arm (2) is hinged to and mounted on the tail end of the automobile chassis (1), a rotary platform (7) is provided on the top end of the telescopic arm (2), a working arm is mounted on the rotary platform (7), and a working hopper (3) is mounted at one end of the working arm; an overturning hydraulic oil cylinder (5) is mounted on the automobile chassis (1), front hydraulic support legs (4) are mounted on the automobile chassis (1) close to the left and right positions of an automobile cab, rear hydraulic support legs (6) are mounted on the telescopic arm (2) away from the left and right positions of the automobile cab, an auxiliary supporting oil cylinder (41) is provided on the automobile chassis (1), and transition hydraulic oil cylinders (7) are mounted on the left and right positions of the tail end of the automobile chassis (1). The technical problems that the maximum height rescue radius of existing high-altitude fire trucks is small and that the maximum rescue height is limited by a hydraulic oil cylinder transmission form are solved, and the present invention is widely applied in high-altitude firefighting or rescue.

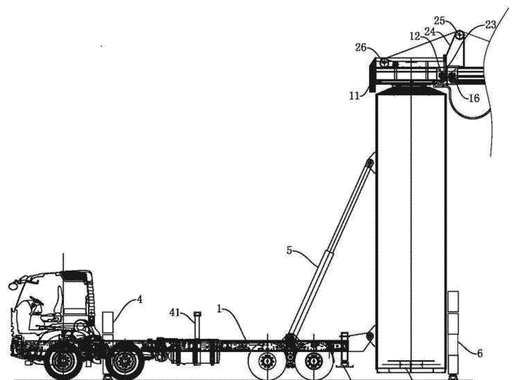

Fig. 3

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Description

Field of the Invention

[0001] The present invention relates to the technical field of firefighting and rescue apparatuses, and more particularly relates to a multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck.

Background of the Invention

[0002] More and more high-rise buildings have been built. The height of high-rise buildings is far higher than an elevating height of a rescue fire truck. For example, the high-altitude rescue fire truck currently highest in the world has a maximum rescue height of 112 meters, and it adopts a crank arm structure, with a truck body of 18.9 meters in length, 2.5 meters in width, and 4 meters in height. It has a maximum height rescue fire radius of 6 meters and a large turning radius. Such a colossus needs enough road turns to travel among a building complex in a community, which makes it impossible for such rescue vehicles to access to the currently dense building complexes. In addition, operation of the on-board crank arm turning structure relies on hydraulic support legs to maintain stability of the truck overall, which requires a high hydraulic power. Since the crank arm turning structure is mounted on the vehicle, the high gravitational centre causes insufficient stability and thus unsatisfactory high-altitude firefighting and rescue effect. Besides, the rotary platform of such high-altitude rescue fire truck is generally disposed at the bottom of a primary telescopic arm and mounted on the truck chassis, and the working cage is disposed at the top end of the primary telescopic arm, so that the rescue position is identified by rotating the bottom rotary platform. However, the existing high-altitude rescue trucks are mostly of a crank arm structure, and when the crank arm extends to its maximum height, the turning radius of the working cage will be small, which in turn limits the rescue reach. Particularly, due to load limitation of crank arms, the rescue truck with a crank arm turning structure can only work with full load capacity when the crank arm extends 70% or above, and therefore there appears rescue blind area during extension of the crank arm. For example, a fire truck with a rescue height of 88 meters cannot perform rescue at a height of under 60 meters. Therefore, once an 88-meter high-rise building has an accident, three fire trucks should be deployed to satisfy rescue for upper floors, middle floors, and lower floors, respectively, which significantly increases equipment investment and rescue costs.

[0003] Another telescopic arm structure is of a telescoping cylinder type, which has a limited number of sections. Telescopic arms of both types are actuated to elevate via telescoping of hydraulic cylinders, so that their elevating height are largely dependent on the transmission manner of the hydraulic cylinders. With this single transmission manner relying on telescoping of the stroke of hydraulic cylinders only, the rescue height of the telescopic arm can hardly access the height of current high-rise buildings.

[0004] In addition, telescopic arms of both structures are mounted in a tilting, telescoping manner, where the telescopic arm is mounted on the rotary platform. As such, they have common drawbacks: firstly, the higher the telescopic arm extends, the smaller its rescue radius; and secondly, the rotary platform has a large rotational momentum, resulting in a high energy consumption and a poor stability, and a slow rotational speed.

[0005] Therefore, in the field of firefighting and rescue apparatuses, there is still a need for study and improvement on a multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck, which is both the current hotspot and focus in the field of firefighting and rescue apparatuses, and the starting point from which the present invention is conducted.

Summary of the Invention

[0006] To this end, embodiments of the present invention provide a multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck to address the technical problem that the existing high-altitude fire trucks have a small maximum height rescue radius and a severely limited maximum rescue height by the transmission manner of hydraulic cylinders.

[0007] To achieve the objectives above, embodiments of the present invention provide the following technical solutions:

According to the embodiments of the present invention, there is provided a multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck, comprising a truck chassis, a telescopic arm is mounted to a tail of the truck chassis by hinging, and a rotary platform is provided on top end of the telescopic arm; wherein a working arm is mounted on the rotary platform, and a working cage is mounted at one end of the working arm; wherein a turning hydraulic cylinder is mounted on the truck chassis, with one end mounted on the truck chassis by hinging, and the other end mounted on the telescopic arm by hinging; wherein front hydraulic support legs are mounted on the truck chassis proximal to a driving cab on both the left and the right, wherein rear hydraulic support legs are mounted on the telescopic arm distal from the driving cab on both the left and the right, wherein an auxiliary supporting oil cylinder is provided on the truck chassis, with a piston rod extending vertically upward, and wherein transitional hydraulic cylinders are mounted at the tail end of the truck chassis on both the left and the right.

[0008] Furthermore, the working arm comprises a first fixed bracket having one end connected to a second fixed bracket and the other end formed as a first opening, wherein a first sliding bracket driven by a first power mechanism is slidingly mounted within the first fixed bracket, with a counterweight mounted at the end of the first sliding bracket extending out of the first opening, wherein the end of the second fixed bracket distal from the first fixed bracket is provided with a second opening, and wherein a second sliding bracket driven by a second power mechanism is slidingly mounted within the second fixed bracket, with the working cage mounted at the end of the second sliding bracket extending out of the second opening.

[0009] Furthermore, the second fixed bracket is mounted to the first fixed bracket by hinging via a hinge shaft, and a locating pin driven by a third power mechanism is provided between the second fixed bracket and the first fixed bracket.

[0010] Furthermore, a supporting arm is fixedly mounted at the end of the first fixed bracket proximal to the second fixed bracket, and a supporting rope pulley is rotatably mounted on the supporting arm, wherein a winch mechanism is provided at the first fixed bracket proximal to the first opening, wherein a hoisting arm is provided on the second fixed bracket, wherein a hoisting wire rope is provided among the winch mechanism, the supporting rope pulley and the hoisting arm, and wherein the end of the hoisting arm distal from a hoisting point of the hoisting wire rope is mounted to the second fixed bracket by hinging.

[0011] Furthermore, a first stopper for restricting a vertical position of the hoisting arm is provided on the second fixed bracket, and a second stopper for restricting the hoisting point of the hoisting arm to be lower than an outer plane of the second fixed bracket is provided on the second fixed bracket.

[0012] Furthermore, the telescopic arm comprises telescoping cylinders in a plurality of stages sequentially nesting together, each stage of telescoping cylinder comprising a plurality of telescoping sections nesting together, wherein each stage of telescoping cylinder is connected with a hydraulic wire-rope lifter, where the hydraulic wire-rope lifter connected to a first-stage telescoping cylinder is disposed within an outermost-layer telescoping section, and the hydraulic wire-rope lifter connected to the next stage of telescoping cylinder is disposed within an innermost-layer telescoping section of the previous stage of telescoping cylinder, wherein the hydraulic wire-rope lifter comprises a lifting hydraulic cylinder having a cylinder tube fixedly mounted at a bottom of the corresponding telescoping section, wherein a fixed pulley set is mounted on the cylinder tube of the lifting hydraulic cylinder, and a movable pulley set is mounted on a piston rod of the lifting hydraulic cylinder, wherein a lifting wire rope is provided between the lifting hydraulic cylinder and the corresponding telescoping section, with one end fixed, and the other end wound through the movable pulley set and the fixed pulley set before fixed on an innermost-layer telescoping section of the corresponding stage of telescoping cylinder; wherein an outermost-layer telescoping section of the next stage of telescoping cylinder is nested within an innermost-layer telescoping section of the previous stage of telescoping cylinder, and in which a tubing conveyer is mounted, for feeding fluid to the next stage of telescoping cylinder, wherein the working cage is mounted on the top of the innermost-layer telescoping section of a last-stage telescoping cylinder, and wherein the rear hydraulic support legs are mounted on an outer surface of the outermost-layer telescoping section of the first-stage telescoping cylinder.

[0013] Furthermore, a rope allocating pulley, for allocating the lifting wire rope of the corresponding fixed pulley set to a corresponding position, is mounted both at the bottom of the outermost-layer telescoping section of the first-stage telescoping cylinder and the bottom of the innermost-layer telescoping section of the previous stage of telescoping cylinder.

[0014] Furthermore, a through-wall pulley is mounted at the bottom of each telescoping section other than the outermost-layer telescoping section of the first-stage telescoping cylinder, wherein a bottom steering pulley is mounted both at the bottom inside of the outermost-layer telescoping section of the first-stage telescoping cylinder and at the bottom inside of the innermost-layer telescoping section of the previous stage of telescoping cylinder, and wherein a top steering pulley is mounted at the top inside of each telescoping section other than the innermost-layer telescoping section of the last-stage telescoping cylinder.

[0015] Furthermore, the through-wall pulley traverses the corresponding telescoping section, and the lifting wire rope is wound around the through-wall pulley for at least two turns from outside of the corresponding telescoping section and then passes to inside of the telescoping section.

[0016] Furthermore, the lifting wire rope of each stage of telescoping cylinder is wound through the corresponding movable pulley set and fixed pulley set, then the corresponding rope allocating pulley, the bottom steering pulley, the outermost-layer top steering pulley, and the through-wall pulley of the neighbouring-layer telescoping section, sequentially, and finally is fixed above the through-wall pulley of the innermost-layer telescoping section.

[0017] Furthermore, a swing arm is provided between every two neighbouring telescoping sections, with one end mounted to the outer-layer telescoping section by hinging, and the other end provided with an inclined guide surface, wherein the end of the swing arm proximal to the inclined guide surface is provided with a roller, wherein an adjusting screw is threadedly connected to a flange on the top end of the outer-layer telescoping section, with an end portion of the adjusting screw abutting against the inclined guide surface, and wherein, under the action of the adjusting screw, an outer edge of the roller abuts against an outer surface of the inner-layer telescoping section.

[0018] Furthermore, the tubing conveyer comprises a mounting bracket, on which a core-tube driven by a fourth power mechanism is rotatably mounted, wherein the core-tube is provided therein with a separator plate, which divides an inner cavity of the core-tube into an inlet chamber and a return chamber, wherein an inlet duct communicating with the inlet chamber is fixedly mounted on the core-tube, and a return duct communicating with the return chamber is fixedly mounted on the core-tube, wherein the inlet chamber is connected to an inlet line via a rotational joint, and the return chamber is connected to the return line via another rotational joint, wherein a web plate is fixedly mounted on an outer surface of the core-tube, with a dual-groove pulley disc fixedly mounted on the web plate, and the core-tube, the web plate and the dual-groove pulley disc are arranged co-axially, and wherein an inlet hose having an end connected to the inlet duct and a return hose having an end connected to the return duct are coiled within the dual-groove pulley disc, respectively.

[0019] Furthermore, a guide pulley is rotatably mounted on the mounting bracket, and a floating pulley is disposed under the guide pulley, and wherein both the inlet hose and the return hose are wound through the guide pulley and the floating pulley before connected to the lifting hydraulic cylinder of the next stage of telescoping cylinder.

[0020] Furthermore, a first sensor and a second sensor are provided on the mounting bracket, with the first sensor disposed under the guide pulley and above the floating pulley, and the second sensor disposed under the floating pulley, and wherein both the first sensor and the second sensor are connected to the fourth power mechanism.

[0021] Furthermore, a tension spring is provided between the floating pulley and the mounting bracket, with one end of the tension spring fixed on the floating pulley, and the other end thereof fixed on the mounting bracket.

[0022] Furthermore, the fourth power mechanism comprises an electric motor mounted on the fixed bracket, and an outer gear ring is fixedly mounted on the web plate, and wherein a transmission shaft is rotatably mounted on the mounting bracket, with one end of the transmission shaft mounted with a drive gear meshing with the outer gear ring, and the other end thereof in transmission connection with the electric motor.

[0023] The embodiments of the present invention offer the following advantages:

(1) In the present invention, the rotary platform is mounted at the top end of the telescopic arm and the working cage is mounted on the second sliding bracket, allowing for adjustment of the angles, positions, and extending length of the working cage based on the to-be-rescued object, and thus enabling a large turning radius of the working cage, increasing the rescue radius, and expanding the application range of the present invention. Moreover, by disposing the rotary platform on top, the rotational momentum is small, so that a small-power electric motor can drive the rotary platform to rotate, which significantly reduces energy consumption but greatly increases the rotational speed and stability. The telescopic arm is hinged on the tail end of the truck chassis, where in operation, the telescopic arm is turned to be vertical via a turning hydraulic cylinder, so that the bottom of the telescopic arm is close to the ground, which, compared with the conventional construction having the crank arm above the truck chassis, the present invention lowers the gravitational centre of the telescopic arm and increases stability of the telescopic arm. The vertical elevating of the telescopic arm makes the telescopic height equal to the rescue height.

(2) Provision of the transitional hydraulic cylinder overcomes the instability issue during turning of the telescopic arm, offering operational stability of the embodiments of the present invention.

(3) Since the second fixed bracket is mounted on the first fixed bracket by hinging via the hinge shaft, the second fixed bracket is enabled to turn about the hinge shaft, which realizes folding transport and reduces footprint.

(4) The present invention utilizes one lifting hydraulic cylinder to elevate a plurality of telescoping sections, which not only decreases the number of lifting hydraulic cylinders in use and reduces manufacturing cost, but also saves mounting space, so that more telescoping sections may be arranged to increase the telescoping length, thereby addressing the technical problem that the current telescopic arm of a telescopic cylinder structure is restricted from further increasing height due to the transmission manner of hydraulic cylinder. In addition, the present invention enables to maximize the cross-sectional area of the telescoping sections, and thus increase their stability during telescoping.

(5) Due to the fact that a through-wall pulley is provided at the bottom of each telescoping section, the lifting wire rope is wound around the through-wall pulley for at least turns from the outside of the corresponding telescoping section and then passes to the inside of the telescoping section, the groove width of the through-wall pulley is only the diameter of three turns of lifting wire rope, and the pulley width direction is consistent with the steel plate thickness direction of the telescoping section, the inner space of the telescoping section is saved as much as possible, the utilization of the effective cross-sectional area of the telescoping section is increased, and a force is exerted from bottom when the telescoping section is hoisted by the lifting wire rope, so that each telescoping section is evenly acted upon by a force during lifting, resulting in a more stable lifting of telescoping sections.

(6) The present invention adopts a vertically lifting telescopic arm structure with the working cage mounted on the second sliding bracket, whereby the embodiments of the present invention enable a long-distance rescue radius throughout the whole telescoping range of the telescopic arm, thereby preventing occurrence of rescue blind area.

Brief Description of the Accompanying Drawings

[0024] To illustrate the technical solutions in the embodiments of the present invention or in the art, the drawings used in the description of the embodiments or the art would be briefly introduced below. Apparently, the drawings illustrated *infra* are only exemplary, to a person in the art, other drawings may be derived based on those provided without any inventive efforts.

[0025] The structures, scales, and sizes as illustrated herein are only provided for those familiar with such technology to understand and read in conjunction with the contents disclosed in the specification, not intended to limit implementable and restrictive conditions of the present invention, and thus have no technically substantive implications. Any modifications on structure, variation on scale or adjustments on size, without affecting the effect or objective achievable by the present invention, shall still fall within the scope covered by the technical contents disclosed in the present invention.

Fig. 1 is a structural diagram according to embodiments of the present invention;

Fig. 2 is a status schematic diagram of a telescopic arm during turning according to embodiments of the present invention;

Fig. 3 is a status schematic diagram of the telescopic arm after turned according to embodiments of the present invention;

Fig. 4 is a structural schematic diagram of the connection between a counterweight and a working cage according to embodiments of the present invention;

Fig. 5 is a sectional structural schematic diagram taken along A-A inFig.4;

Fig. 6 is a structural schematic diagram of a telescopic arm according to embodiments of the present invention;

Fig. 7 is a structural schematic diagram of the winding of a lifting wire rope of a first-stage telescoping cylinder according to embodiments of the present invention;

Fig. 8 is a structural schematic diagram of an outermost-layer telescoping section in Fig. 7;

Fig. 9 is a sectional structural schematic diagram taken along B-B in Fig. 8;

Fig. 10 is a sectional structural schematic diagram taken along C-C in Fig. 8;

Fig. 11 is a schematic diagram of a winding relationship of the lifting wire rope between two neighbouring telescoping sections according to embodiments of the present invention;

Fig. 12 is a structural schematic diagram of a connection between two neighbouring telescoping sections according to embodiments of the present invention;

Fig. 13 is a structural schematic diagram taken along D-D in Fig. 12;

Fig. 14 is an enlarged structural schematic diagram of E in Fig. 12;

Fig. 15 is a structural schematic diagram of a tubing conveyer according to embodiments of the present invention;

Fig. 16 is a structural schematic diagram taken along F-F in Fig. 15;

Fig. 17 is a hydraulic principle diagram of a hydraulic support leg according to embodiments of the present invention;

Fig. 18 is a structural schematic diagram of the hydraulic support leg according to embodiments of the present invention;

[0026] in the drawings: 1. truck chassis; 2. telescopic arm; 3. first-stage telescoping cylinder; 202. second-stage telescoping cylinder; 203. last-stage telescoping cylinder; 204. hydraulic wire-rope lifter; 20401. outermost-layer telescoping section; 20402. sub-outermost-layer telescoping section; 20403. innermost-layer telescoping section; 20404: lifting wire rope; 20405: rope allocating pulley; 20406. bottom steering pulley; 20407. top steering pulley; 20408. through-wall pulley; 20409. lifting hydraulic cylinder; 20410. movable pulley set; 20411. fixed pulley set; 20412. flange; 20413. swing arm; 20414. inclined guide surface; 20415. adjusting screw; 20416. locking nut; 20417. inner stopper; 20418. roller; 20419. outer stopper; 205. tubing conveyer; 20501. mounting bracket; 20502. dual-groove pulley disc; 20503. guide pulley; 20504. floating pulley; 20505. first sensor; 20506. second sensor; 20507. tension spring; 20508. core-tube; 205081. inlet chamber; 205082. return chamber; 20509. separator plate; 20510. inlet duct;

20511. return duct; 20512. web plate; 20513. inlet hose; 20514. return hose; 20515. electric motor; 20516. transmission shaft; 20517. outer gear ring; 20518: drive gear; 3. working cage; 4. front hydraulic support leg; 5. turning hydraulic cylinder; 6. rear hydraulic support leg; 7. transitional hydraulic cylinder; 8. rotary platform; 9. first fixed bracket; 10. first sliding bracket; 11. counterweight; 12. first electric motor; 13. first drive sprocket; 14. first driven sprocket; 15. first chain; 16. second electric motor; 17. second drive sprocket; 18. second driven sprocket; 19. second chain; 20. second fixed bracket; 21. second sliding bracket; 22. hinge shaft; 23. locating pin; 24. supporting arm; 25. supporting rope pulley; 26. winch mechanism; 27. hoisting arm; 28. hoisting wire rope; 29. first stopper; 30. second stopper; 31. second connecting plate; 32. horizontal oil cylinder; 3201. first cylinder tube; 3202. second cylinder tube; 3203. third cylinder tube; 3204. plunger piston; 3205. first central barrel; 3206. second central barrel; 3207. third central barrel; 3208. through-port; 3209. horizontal first actuator port; 3210. horizontal second actuator port; 33. vertical oil cylinder; 3301. first sleeve; 3302. second sleeve; 3303. third sleeve; 3304. fourth sleeve; 3305: fifth sleeve; 3306: sixth sleeve; 34. inlet line; 35. return line; 36. first directional valve; 37. second directional valve; 38. first hydraulic control check valve; 39. second hydraulic control check valve; 40. tilt sensor; 41. auxiliary support oil cylinder.

Detailed Description of the Embodiments of the Present Invention

[0027] Hereinafter, the embodiments of the present invention will be described by means of specific implementations, and those familiar with such technology may readily understand other advantages and effects of the present invention from the contents disclosed herein. Apparently, the implementations as described are only some implementations of the present invention, not all of them. All other implementations derived by those skilled in the art based on the implementations described herein without exercise of inventive work fall within the scope of the present invention.

[0028] The terms such as "front," "rear," "left," "right," "middle," "upper," and "lower" referred to herein only are served for a clear description, not intended to limit the implementable scope of the present invention, and therefore change or adjustment of relative positions or relationships without substantive alternation to the technical contents should also be deemed as falling within the scope of the present invention.

[0029] As illustrated in Fig. 1, Fig. 3, and Fig. 4 in combination, embodiments of the present invention provide a multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck, which comprises a truck chassis 1, to the tail of which a telescopic arm 2 is mounted by hinging, with the length from the hinging point therebetween to the bottom of the telescopic arm 2 smaller than or equal to the height of the truck chassis 1, so as to ensure that the telescopic arm 2 is turnable to a vertical position. A rotary platform 8 is provided on the top end of the telescopic arm 2, and a working arm is mounted on the rotary platform 8, with one end provided with a working cage 3. The working arm comprises a first fixed bracket 9 with one end connected to a second fixed bracket 20 and the other end formed as a first opening. A first sliding bracket 10 driven by a first power mechanism is slidingly mounted within the first fixed bracket 9, with a counterweight 11 mounted at the end of the first sliding bracket 10 extending out of the first opening. The end of the second fixed bracket 20 distal from the first fixed bracket 9 is provided with a second opening. A second sliding bracket 21 driven by a second power mechanism is slidingly mounted within the second fixed bracket 20. A working cage 3 is mounted at the end of the second sliding bracket 21 extending out of the second opening. Both the first fixed bracket 9 and the second fixed bracket 20 are of a square barrel-shaped structure and generally formed of steel beams by welding. Also, the first sliding bracket 10 and the second sliding bracket 21 are also of a square barrel-shaped structure formed by welding, with sectional profiles fitted with those of the inside of the first fixed bracket 9 and the second fixed bracket 20, respectively. A turning hydraulic cylinder 5 is mounted on the truck chassis 1, with one end mounted on the truck chassis 1 by hinging, the other end thereof mounted on the telescopic arm 2 by hinging. When in a vertical state, the hinging point between the turning hydraulic cylinder 5 and the telescopic arm 2 is higher than the hinging point between the telescopic arm 2 and the truck chassis 1, which not only reduces the height of gravitational centre and enhances stability, but also enables vertical lifting of the telescopic arm 2, so that the maximum telescopic length becomes the maximum rescue height. Front hydraulic support legs 4 are mounted on the truck chassis 1 proximal to a driving cab of the truck on both the left and the right, and rear hydraulic support legs 6 are mounted on the telescopic arm 2 distal from the driving cab of the truck on both the left and the right. An auxiliary support oil cylinder 41 is provided on the truck chassis 1, and a piston rod of the auxiliary support oil cylinder 41 extends vertically upwards to lift and bear the telescopic arm 2. The auxiliary support oil cylinder 41 first lifts the telescopic arm 2 to a certain height, and then the turning hydraulic cylinder 5 turns the telescopic arm 2 to be in a vertical state, which reduces a mounting tilt angle of the turning hydraulic cylinder 5 and saves height space above the truck chassis 1.

[0030] When the telescopic arm 2 is disposed on the truck chassis 1 horizontally, a mounting angle between an axis of the turning hydraulic cylinder 5 and the truck chassis 1 is smaller than 5 degrees, and the piston rod of the auxiliary support oil cylinder 41 abuts against the telescopic arm 2; with such structure, the height space above the truck chassis 1 occupied by the turning hydraulic cylinder 5 is significantly reduced, so that the limited height space above the truck chassis 1 is utilized for the cross-sectional area of the telescopic arm 2 as much as possible to maximize the effective rescue height of the telescopic arm 2.

[0031] As illustrated in Fig. 2, during the turning of the turning hydraulic cylinder 5, the rear hydraulic support legs 6 mounted on the telescopic arm 2 have not been supported on the ground yet, and it is hard for the truck to maintain balanced and stable only with the two front support legs 4 on the left and the right. Therefore, in order to address the instability issue during turning of the telescopic arm 2, the inventors of the present application have conducted an in-depth study to work out a technical solution of mounting a transitional hydraulic cylinder 7 at the tail end of the truck chassis 1on both the left and the right.

[0032] As illustrated in Fig. 4, the first power mechanism comprises a first drive sprocket 13 which is rotatably mounted on the first fixed bracket 9 at the end proximal to the second fixed bracket 20 and driven by a first electric motor 12, a first driven sprocket 14 which is rotatably mounted at the other end of the first fixed bracket 9, proximal to the first opening, and a first chain 15 surrounding the first drive sprocket 13 and the first driven sprocket 14 therebetween. A first connecting plate is fixedly mounted on the first chain 15. One end of the first connecting plate is fixed to the first chain 15, and the other end thereof is fixed to the first sliding bracket 10, so that the forward and reverse rotation of the first electric motor 12 brings the first sliding bracket 10 to reciprocally slide, enabling the movement of the counterweight 11 for balancing the working cage 3. Certainly, a pulley-slides assembly may be arranged between the first fixed bracket 9 and the first sliding bracket 10 to effect a smoother sliding.

[0033] As illustrated in Figs. 4 and 5, the second power mechanism comprises a second drive sprocket 17 which is rotatably mounted on the second fixed bracket 20 at the end proximal to the first fixed bracket 9 and driven by a second electric motor 16, a second driven sprocket 18 which is rotatably mounted the other end of the second fixed bracket 20, proximal to the second opening, and a second chain 19 surrounding the second drive sprocket 17 and the second driven sprocket 18 therebetween. A second connecting plate 31 is fixedly mounted on the second chain 19. One end of the second connecting plate 31 is fixed to the second chain 19, and the other end thereof is fixed to the second sliding bracket 21, so that the forward and reverse rotation of the second electric motor 16 brings the second sliding bracket 21 to reciprocally slide, enabling the movement of the working cage 3 for approaching a to-be-rescued object. Certainly, a pulley-slides assembly may be arranged between the second fixed bracket 20 and the second sliding bracket 21 to effect a smoother sliding.

[0034] The second fixed bracket 20 is mounted to the first fixed bracket 9 by hinging via a hinge shaft 22, so that the second fixed bracket 20 is turnable around the hinge shaft 22, enabling folding-transport and reducing space occupation. A locating pin 23 driven by a third power mechanism is provided between the second fixed bracket 20 and the first fixed bracket 9. In normal operation, the locating pin 23 is capable of connecting the first fixed bracket 9 with the second fixed bracket 20. The third power mechanism is generally a pneumatic cylinder, a hydraulic cylinder, or an electric drive pusher.

[0035] A supporting arm 24 is fixedly mounted on the first fixed bracket 9 at the end thereof proximal to the second fixed bracket 20. A supporting rope pulley 25 is rotatably mounted on the supporting arm 24, and projects beyond the outer plane of the second fixed bracket 20. A winch mechanism 26 is provided at the first fixed bracket 9 proximal to the first opening. A hoisting arm 27 is provided on the second fixed bracket 20. The hoisting point of the hoisting arm 27 projects beyond the outer plane of the second fixed bracket 20 but is lower than the supporting rope pulley 25 in height. A hoisting wire rope 28 is arranged among the winch mechanism 26, the supporting rope pulley 25, and the hoisting arm 27. One end of the hoisting wire rope 28 is fixed to the winch mechanism 26, and the other end thereof is fixed to the hoisting point of the hoisting arm 27 after wound around the supporting rope pulley 25 tightly, so that, with the winching power, the second fixed bracket 20 is gradually pulled towards the first fixed bracket 9 around the hinge shaft 22. Once the second fixed bracket 20 is joined with the first fixed bracket 9 together, the third power mechanism pushes the locating pin 23 to connect the first fixed bracket 9 with the second fixed bracket 20. The winch mechanism 26 is known to those skilled in the art, and available to purchase and use as per the model needed, and thus not detailed here.

[0036] The end of the hoisting arm 27 distal from the hoisting point of the hoisting wire rope 28 is mounted to the second fixed bracket 20 by hinging. When in transport, the hoisting arm 27 may be turned below the outer plane of the second fixed bracket 20 to prevent over-height. A first stopper 29 for restricting the vertical position of the hoisting arm 27 is arranged on the second fixed bracket 20. The first stopper 20 has the function of blocking during lifting. A second stopper 30 for restricting the hoisting point of the hoisting arm 27 to be lower than the outer plane of the second fixed bracket 20 is arranged on the second fixed bracket 20. The second stopper 30 has the function of blocking during transportation.

[0037] During transportation, as illustrated in Fig. 1, the telescopic arm 2 is disposed on the truck chassis 1 horizontally, the first sliding bracket 10 is retracted within the first fixed bracket 9, the rotary platform 8 and the first fixed bracket 9 are mounted at the top of the telescopic arm 2, the locating pin 23 is released, the second fixed bracket 20 is then turned to the side surface of the telescopic arm 2 so as to be just at the top plane of the truck, and the hoisting arm 27 is then turned to the second stopper 30 so as to be hidden below the outer plane of the second fixed bracket 20. As such, the overall structure is compact with reduced footprint.

[0038] As illustrated in Fig. 6, the telescopic arm 2 comprises telescoping cylinders in a plurality of stages sequentially nesting together, each stage of telescoping cylinder comprising a plurality of telescoping sections nesting together. Each stage of telescoping cylinder is connected with a hydraulic wire-rope lifter 204. The hydraulic wire-rope lifter 204 connected to the first-stage telescoping cylinder 201 is disposed within an outermost-layer telescoping section 20401, and the hydraulic wire-rope lifter 204 connected to the next stage of telescoping cylinder is disposed in an innermost-layer telescoping section 20403 of the previous stage of telescoping cylinder. As illustrated in Fig. 7, Fig. 8, Fig. 9, and Fig. 10 in combination, the hydraulic wire-rope lifter 204 comprises a lifting hydraulic cylinder 20409 with a cylinder tube fixedly mounted at the bottom of an inner space of the corresponding telescoping section. A fixed pulley set 20411 is mounted on the cylinder tube of the lifting hydraulic cylinder 20409, and a movable pulley set 20410 is mounted on a piston rod of the lifting hydraulic cylinder 20409. A lifting wire rope 20404 is provided between the lifting hydraulic cylinder 20409 and the corresponding telescoping section. One end of the lifting wire rope 20404 is fixed, and this fixed end is generally the position for fixing to the cylinder tube of the lifting hydraulic cylinder 20409 or the outermost-layer telescoping section 20401. The other end of the lifting wire rope 20404 is wound through the movable pulley set 20410 and the fixed pulley set 20411 before fixed on the innermost-layer telescoping section 20403 of the corresponding stage of telescoping cylinder. The number of the movable pulleys in the movable pulley set 20410 and the fixed pulleys in the fixed pulley set 20411 may be set by those skilled in the art based on the number of telescoping sections, in such a manner that the stroke of the lifting hydraulic cylinder 20409 fixed within the outermost-layer telescoping section 20401 may enable all telescoping sections to telescope, i.e., the lifting hydraulic cylinder 20409 of the length of one telescoping section may enable all telescoping sections to telescope. For example, in the case that there are six telescoping sections in total, three movable pulleys are provided in the movable pulley set 20410 and three fixed pulleys are provided in the fixed pulley set 20411. One end of the lifting wire rope 20404 is fixed to the fixing position of the cylinder tube of the lifting hydraulic cylinder 20409, and the other end thereof is wound through the movable pulleys and fixed pulleys sequentially, and then is fixed on the innermost-layer telescoping section 20403. Such three-stage movable pulley construction provides a transmission ratio of 1:6, i.e., if the piston rod of the lifting hydraulic cylinder 20409 has a telescopic length of 1 meter, the telescoping sections may move a distance of 6 meters, such that a hydraulic cylinder with a stroke of 8 meters will enable telescoping sections with a 48-meter telescopic length. In this way, a rescue height of 144 meters may be achieved by connecting in series three stages of telescoping cylinders, where each stage of telescopic arm 2 has a telescopic length of 48 meters. By increasing the transmission ratio, the length of telescoping sections, or the stroke of lifting hydraulic cylinder 20409, the rescue height may be further increased to be far more than the current maximum rescue height of 112 meters, thereby overcoming the technical problem that the elevating height of the telescopic arm 2 with the telescoping cylinder structure is largely limited by the transmission manner of the lifting hydraulic cylinder 20409. The outermost-layer telescoping section 20401 of the next stage of telescoping cylinder is nested within the innermost-layer telescoping section 20403 of the previous stage of telescoping cylinder, and a tubing conveyer 205 for supplying the hydraulic fluid to the next stage of telescoping cylinder is mounted within the innermost-layer telescoping section 20403 of the previous stage of telescoping cylinder.

[0039] A rope allocating pulley 20405 for allocating the lifting wire rope 20404 of the corresponding fixed pulley set 20411 to corresponding position is mounted at the bottom of the outermost-layer telescoping section 20401 of the first-stage telescoping cylinder 201 and the bottom of the innermost-layer telescoping section 20403 of the previous stage of telescoping cylinder, respectively. Taking the telescopic arm 2 with a square-shaped cross section as an example, it is generally needed to arrange the hoisting points in all four directions, then the rope allocating pulley 20405 needs a four-groove construction, so as to allocate four lifting wire ropes 20404 to four different sidewalls, respectively, ensuring synchronization and balance during lifting of each telescoping section.

[0040] A through-wall pulley 20408 is mounted at the bottom of each of telescoping sections other than the outermost-layer telescoping section 20401 of the first-stage telescoping cylinder 201. As illustrated in Fig. 11, the through-wall pulley 20408 is rotatably mounted on the corresponding telescoping section via a bearing housing, and a through hole is formed on such telescoping section at a position corresponding to the through-wall pulley 20408, for the passing thereof. A bottom steering pulley 20406 is mounted at the bottom inside of the outermost-layer telescoping section 20401 of the first-stage telescoping cylinder 201 and at the bottom inside of the innermost-layer telescoping section 20403 of the previous stage of telescoping cylinder, respectively. A top steering pulley 20407 is mounted at the top inside of each telescoping section other than the innermost-layer telescoping section 20403 of the last-stage telescoping cylinder 203. The through-wall pulley 20408 traverses the corresponding telescoping section. The groove width of the through-wall pulley 20408 is only the diameter of about three turns of lifting wire ropes 20404, and the pulley width direction is consistent with the steel plate thickness direction of the telescoping section, which saves the inner space of the telescoping section as much as possible and increases utilization of the effective cross-sectional area of the telescoping sections. The lifting wire rope 20404 is wound around the through-wall pulley 20408 for at least two turns from the outside of the corresponding telescoping section, and then passes to the inside of the telescoping section. The number of turns of the winding may be set based on the wall plate thickness of the telescoping section and the thickness of the lifting wire rope 20404. Since the diameter of the lifting wire rope 20404 is generally larger than the wall plate thickness of the telescoping section, after wound for two turns, the lifting wire rope 20404 will pass to the inside from the outside of the telescoping section. By such winding of the lifting wire rope 20404, a force is exerted from bottom when the telescoping section is hoisted by the lifting wire rope 20404, so that each telescoping section is evenly acted upon by a force during lifting, resulting in a more stable lifting of telescoping sections.

[0041] The lifting wire rope 20404 of each stage of telescoping cylinder is wound through the corresponding movable pulley set 20410 and fixed pulley set 20411, and then wound through the corresponding rope allocating pulley 20405, the bottom steering pulley 20406, the outermost-layer top steering pulley 20407, and the through-wall pulley 20408 of the neighbouring-layer telescoping section, and is finally fixed above the through-wall pulley 20408 of the innermost-layer telescoping section 20403. Specifically, the outermost-layer telescoping section 20401 of the first-stage telescoping cylinder 201 is fixed, and the lifting wire rope 20404, after passing over the rope allocating pulley 20405, is wound through the bottom steering pulley 20406, upward to the top steering pulley 20407 of the outermost-layer telescoping section 20401, downward to the through-wall pulley 20408 of the sub-outermost-layer telescoping section 20402, and the lifting wire rope 20404 is now located outside of the sub-outermost-layer telescoping section 20402. Then the lifting wire rope 20404 is wound around the through-wall pulley 20408 for two turns, passing through the through-hole on the sub-outermost-layer telescoping section 20402 and to the inside of the sub-outermost-layer telescoping section 20402, further upward to the top steering pulley 20407 of the sub-outermost-layer telescoping section 20402, toward the through-wall pulley 20408 of the further-inner-layer, and by winding sequentially in this way, to the through-wall pulley 20408 of the innermost-layer telescoping section 20403, and finally passing to the inside of the innermost-layer telescoping section 20403, with the end fixed above the through-wall pulley 20408 of the innermost-layer telescoping section 20403. A hydraulic wire-rope lifting lifter 204 for lifting a second-stage telescoping cylinder 202 is provided within the innermost-layer telescoping section 20403 of the first-stage telescoping cylinder 201. The lifting wire rope 20404 at that position, after passing over the rope allocating pulley 20405, is wound through the bottom steering pulley 20406, upward to the top steering pulley 20407 of the innermost-layer telescoping section 20403 of the first-stage telescoping cylinder 201, downward to the through-wall pulley 20408 of the outermost-layer telescoping section 20401 of the second-stage telescoping cylinder 202, and the lifting wire rope 20404 is now located at the outside of the outermost-layer telescoping section 20401 of the second-stage telescoping cylinder 202. Then the lifting wire rope 20404 is wound around the through-wall pulley 20408 for two turns, passing through the through-hole on the outermost-layer telescoping section 20401 of the second-stage telescoping cylinder 202 and to the inside of the outermost-layer telescoping section 20401 of the second-stage telescoping cylinder 202, further upward to the top steering pulley 20407 of the outermost-layer telescoping section 20401 of the second-stage telescoping cylinder 202, toward the through-wall pulley 20408 of the inner-layer telescoping section of the second-stage telescoping cylinder 202, and by winding sequentially in this way to the through-wall pulley 20408 of the innermost-layer telescoping section 20403, and finally passing to the inside of the second-stage innermost-layer telescoping section 20403, with the end fixed above the through-wall pulley 20408 of the innermost-layer telescoping section 20403. By analogy, wire rope hydraulic lifting of all stages of telescoping cylinders is realized.

[0042] As illustrated in Fig. 12, Fig. 13, and Fig. 14 in combination, a flange 20412 is disposed on the top end of each telescoping section. An inner-layer telescoping section passes through the flange 20412 on the top end of an outer-layer telescoping section. The gap between a flange bore on the top end of the outer-layer telescoping section and the outer surface of the inner-layer telescoping section is formed as a sliding gap. A swing arm 20413 is provided between every two neighbouring telescoping sections. One end of the swing arm 20413 is mounted on an outer-layer telescoping section by hinging, and the other end thereof is provided with an inclined guide surface 20414, with which the symmetrical central surface of the swing arm 20413 forming an acute angle. A roller 20418 is provided at the end of the swing arm 20413 proximal to the inclined guide surface 20414, and the rotational centre of the swing arm 20413 is parallel to the rotational centre of the roller 20418. An adjusting screw 20415 is threaded to the flange 20412 on the top end of the outer-layer telescoping section, an end portion of the adjusting screw 20415 abutting against the inclined guide surface 20414, and due to the adjusting screw 20415, the outer edge of the roller 20418 abuts against the outer surface of the inner-layer telescoping section to reduce a gap for wobble between two neighbouring telescoping sections, ensuring that the inner-layer telescoping section is more stable during telescoping.

[0043] The telescoping sections have a square-shaped cross section, and each telescoping section is of a square barrel-shaped structure enclosed by four square plates. The square-shaped cross section of the telescoping sections avoids rotation during telescoping with improved stability.

[0044] At least two spaced groups of rollers 20418 are provided to abut against each panel of the inner-layer telescoping section, with the rollers 20418 located at corners of the corresponding telescoping sections, respectively. If the panel has a large breadth, more groups of rollers 20418 may be arranged; and corresponding rollers 20418 may be arranged at the corners and middle of the telescoping section to ensure that the inner-layer telescoping section is more stable during telescoping.

[0045] A locking nut 20416 is provided between the adjusting screw 20415 and the flange 20412. When the outer edge of the roller 20418 abuts against the outer surface of an inner-layer telescoping section, the locking nut 20416 is tightened, so that an end face of the locking nut 20416 abuts against an end face of the flange 20412, and thus avoiding looseness of the adjusting screw 20415 during telescoping of the telescoping section which causes the inner-layer telescope to create a too large gap for wobble.

[0046] An inner stopper 20417 is provided on an outer surface of the bottom of the inner-layer telescoping section; with the gap between the inner stopper 20417 and the inner surface of the outer-layer telescoping section adjusted to be smaller than the sliding gap. Correspondingly, an outer stopper 20419 is provided on an inner surface of the top of the outer-layer telescoping section, and likewise, with the gap between the inner stopper 20417 and the inner surface of the outer-layer telescoping section adjusted to be smaller than the sliding gap, so that the inner-layer telescoping section is more stable during telescoping. At least one group consisting of the inner stopper 20417 and the outer stopper 20419 is provided on each panel of the inner-layer telescoping section. Those skilled in the art may select the number of inner stoppers 20417 and outer stoppers 20419 used on each panel and arrange the mounting positions of the inner stoppers 20417 and outer stoppers 20419, dependent on the breadth size of the panels of the telescoping sections, which will not be detailed here. The upper surfaces of all inner stoppers 20417 are on the same horizontal plane, and the lower surfaces of all outer stoppers 20419 are on the same horizontal plane. When the inner stopper 20417 comes into contact with the outer stopper 20419, the inner-layer telescoping section has a coaxiality consistent with the outer-layer telescoping section, which ensures perpendicularity of the telescoping section during normal operation and further enhances operational performance of the present invention.

[0047] In the embodiments of the present invention, a swing arm 20413 is provided at the outer-layer telescoping section proximal to and abutting the flange 20412, and a roller 20418 is provided on the swing arm 20413. The adjusting screw 20415 abuts against the swing arm 20413, thereby the outer edge of the roller 20418 abuts against the outer surface of the inner-layer telescoping section, reducing the sliding gap between the neighbouring telescoping sections. Further, an inner stopper 20417 is placed at a bottom of the inner-layer telescoping section, so that the inner-layer telescoping section is more stable during telescoping. Meanwhile, the outer stopper 20419 on one hand has the function of position limiting, which effectively prevents runout of the inner-layer telescoping section. On the other hand, the consistency between axes of the inner-layer telescoping section and outer-layer telescoping section can be ensured, when the inner-layer telescoping section extends to its maximum length, i.e., when the inner stopper 20417 abuts against the outer stopper 20419, and thus this structure enables vertical elevation with high stability, so that the maximum rescue height of the telescopic arm 2 is equal to its own telescopic length.

[0048] As illustrated in Figs. 15 and 16, the tubing conveyer 205 comprises a mounting bracket 20501, on which a core-tube 20508 driven by a fourth power mechanism is rotatably mounted via a bearing housing. A separator plate 20509 is provided within the core-tube 20508, and divides an inner cavity of the core-tube 20508 into an inlet chamber 205081 and a return chamber 205082 which cannot communicate with each other. An inlet duct 20510 communicating with the inlet chamber 205081 is fixedly mounted on the core-tube 20506, and a return duct 20511 communicating with the return chamber 205082 is fixedly mounted on the core-tube 20508. Both the inlet duct 20510 and the return duct 20511 extend out of the outer surface of the core-tube 20508. The inlet chamber 205081 is connected to an inlet line 34 via a rotational joint, and the return chamber 205082 is connected to the return line 35 via another rotational joint. A web plate 20512 is fixedly mounted on the outer surface of the core-tube 20508, and a dual-groove pulley disc 20502 is fixedly mounted on the web plate 20512. The core-tube 20508, the web plate 20512, and the dual-groove pulley disc 20502 are co-axially arranged. An inlet hose 20513 and an return hose 20514 are coiled in the dual-groove pulley disc 20502, respectively. The inlet hose 20513 and the return hose 20514 are both of a high-pressure hose. The inlet hose 20513 has one end connected to the inlet duct 20510, and the return hose 20514 has one end connected to the return duct 20511. To save mounting space, the web plate 20512 is designed as a hollow cavity structure, with both the inlet duct 20510 and the return duct 20511 passing into the hollow cavity of the web plate 20512. The ends of the inlet hose 20513 and the return hose 20514 coiled in the innermost circle of the dual-groove pulley disc 20502 pass into the hollow cavity of the web plate 20512 and connected to the inlet duct 20510 and the return duct 20511, respectively.

[0049] A guide pulley 20503 is rotatably mounted on the mounting bracket 20501 and usually provided with dual grooves, corresponding to the dual-groove pulley disc 20502, so as to lead out the inlet hose 20513 and the return hose 20514, respectively. A floating pulley 20504 is disposed below the guide pulley 20503; and likewise, also provided with dual grooves. Both the inlet hose 20513 and the return hose 20514 are wound through the guide pulley 20503 and the floating pulley 20504 before connected to the lifting hydraulic cylinder 20409 of the next stage of telescoping cylinder. The floating pulley 20504 falls, under the gravitational force, on the inlet hose 20513 and a outlet hose to tension the inlet hose 20513 and the outlet hose, which enables stable releasing or coiling of the inlet hose 20513 and the return hose 20514; without affecting on the lifting of the telescopic arm 2 due to the inconstant linear speed of the inlet hose 20513 and the return hose 20514 on the dual-groove pulley disc 20502.

[0050] A first sensor 20505 and a second sensor 20506 are provided on the mounting bracket 20501. The first sensor 20505, disposed below the guide pulley 20503 and above the floating pulley 20504, and the second sensor 20506, disposed below the floating pulley 20504, are both connected to the fourth power mechanism. The first sensor 20505 is configured to detect an upper limit position of the floating pulley 20504, and the second sensor 20506 is configured to detect a lower limit position of the floating pulley 20504. When the first sensor 20505 detects the floating pulley 20504, the fourth power mechanism is activated to bring the dual-groove pulley disc 20502 to rotate to release the coiled inlet hose 20513 and return hose 20514. When the second sensor 20506 detects the floating pulley 20504, the fourth power mechanism is deactivated.

[0051] A tension spring 20507 is disposed between the floating pulley 20504 and the mounting bracket 20501. One end of the tension spring 20507 is fixed on the floating pulley 20504, and the other end thereof is fixed on the mounting bracket 20501, whereby a pretension force may be applied against the inlet hose 20513 and the return hose 20514, which presents the floating pulley 20504 from moving upward too fast or from moving too long and thus going beyond the detection range of the first sensor 20505.

[0052] The fourth power mechanism comprises an electric motor 20515 mounted on the fixed bracket. An outer gear ring 20517 is fixedly mounted on the web plate 20512, and a transmission shaft 20516 is rotatably mounted on the mounting bracket 20501. The transmission shaft 20516 is mounted with a drive gear 20518 in mesh with the outer gear ring 20517 at one end, and is in transmission connection with the electric motor 20515 at the other end. The rotation of the transmission shaft 20516 brings the web plate 20512 to rotate, and thus bringing the core-tube 20508 to rotate with the dual-groove pulley disc 20502, which enables releasing and coiling of the inlet hose 20513 and the return hose 20514. The electric motor 20515 and the transmission shaft 20516 are connected via chain transmission, and certainly, belt transmission or gear transmission is also possible, which may be discretionally set by those skilled in the art dependent on space need and is thus not detailed here.

[0053] Certainly, to simplify the structure, the tubing conveyer 205 may also adopt another technical solution. Specifically, the tubing conveyer 205 comprises a pulley disc driven by a torque motor or a servo motor, with the tubing coiled thereon to enable delivery stage by stage.

[0054] As illustrated in Fig. 17, each hydraulic support leg includes a vertical oil cylinder 33 with axis arranged vertically and a horizontal oil cylinder 32. The cylinder tube of the vertical oil cylinder 33 is mounted on the piston rod of the horizontal oil cylinder 32. The horizontal oil cylinder 32 has a rodless cavity communicating with port A of the first directional valve 36, and a rod cavity communicating with port B of the first directional valve 36. The first directional valve 36 has a port P communicating with the inlet line 34, and a port T communicating with the return line 35. The vertical oil cylinder 33 has a rodless cavity connected to port A of the second directional valve 37 via a first hydraulic control check valve 38, and a rod cavity connected to port B of the second directional valve 37 via a second hydraulic control check valve 39. The hydraulic control line of the second hydraulic control check valve 39 communicates with port A of the second directional valve 37, and the hydraulic control line of the first hydraulic control check valve 38 communicates with port B of the second directional valve 37. The first hydraulic control check valve 38 and the second hydraulic control check valve 39 can maintain current pressure of the vertical oil cylinder 33, thereby preventing leakage of hydraulic fluid due to load-bearing change and stabilizing output of the piston rod of the vertical oil cylinder 33. The second directional valve 37 is connected to a tilt sensor 40. The second directional valve 37 has a port P communicating with the inlet line 34, and a port T communicating with the return line 35. The first directional valve 36 is a 3-position, 4-way O-type solenoid directional valve, and the second directional valve 37 is a 3-position, 4-way Y-type solenoid directional valve. Specifically, the solenoid coil of the second directional valve 37 is connected to the tilt sensor 40, which is generally mounted on the telescopic arm 2, for detecting the perpendicularity to the ground of the telescopic arm 2 during elevation. The tilt sensor 40 is a commonly used device to those skilled in the art, which may be purchased for installation and use based on the required model. In use, the tilt sensor 40 feeds the detected signal to a control unit which is usually a PLC or a single-chip micro-computer, and then the control unit controls the corresponding directional valve to control a corresponding hydraulic actuating element. In operation, hydraulic fluid is fed into the rodless cavity of the horizontal oil cylinder 32 so that the horizontal oil cylinder 32 brings the vertical oil cylinder 33 to move horizontally. When the horizontal oil cylinder 32 extends to its maximum position, the first directional valve 36 is locked, and the 3-position, 4-way O-type solenoid directional valve switches to the middle position, maintaining the horizontal oil cylinder 32 in the current state. The hydraulic fluid begins entering the rodless cavity of the vertical oil cylinder 33, and meanwhile opens the second hydraulic control check valve 39, so that the hydraulic fluid in the rod cavity of the vertical oil cylinder 33 can return to the return line 35 to support the truck chassis 1 to elevate. When the truck chassis 1 is elevated to an appropriate position and all of the four corners thereof are horizontal, the 3-position, 4-way Y-type solenoid directional valve switches to the middle position, and no more hydraulic fluid enters the rod cavity of the vertical oil cylinder 33. Under the action of the first hydraulic control check valve 38 and the second hydraulic control check valve 39, the vertical oil cylinder 33 is maintained at the current position. Once a corner of the truck chassis 1 is tilted due to over loading, the tilt sensor 40 will switch on the solenoid coil of the second directional valve 37, and then the hydraulic fluid begins entering the rodless cavity of the vertical oil cylinder 33, whereby the piston rod of the vertical oil cylinder 33 extends to compensate for the tilt amount. Once the tilt sensor 40 resumes horizontal, the vertical oil cylinder 33 is maintained at that position.

[0055] It is known that the larger the support area of the truck chassis 1, the higher the stability of the truck chassis 1, and thus the stability of the telescopic arm 2. To this end, the horizontal oil cylinder 32 is provided as a two-stage hydraulic cylinder, which increases the horizontal extending length of the hydraulic support legs. Specifically, as illustrated in Fig. 18, the horizontal oil cylinder 32 comprises a first cylinder tube 3201 mounted at a fixed position, a second cylinder tube 3202 slidingly mounted within the first cylinder tube 3201, and a third cylinder tube 3203 slidingly mounted within the second cylinder tube 3202 and equivalent to the piston rod of the horizontal oil cylinder 32. A sliding seal mechanism is disposed between the second cylinder tube 3202 and the first cylinder tube 3201 and between the second cylinder body 3202 and the third cylinder tube 3203, respectively, to avoid leakage of hydraulic fluid. An end portion of the third cylinder tube 3203 is connected to the vertical oil cylinder 33. The first cylinder tube 3201 communicates with the second cylinder tube 3202. A plunger piston 3204 slidingly mounted within the second cylinder tube 3202 is fixed to the end portion of the third cylinder tube 3203. A third central barrel 3207 is provided inside the third cylinder tube 3203. One end of the third central barrel 3207 distal from the plunger piston 3204 is provided with a through-port 3208, and the other end thereof extends through the plunger piston 3204 into the second cylinder tube 3202. A second central barrel 3206 is nested within the third central barrel 3207, and adapted to the second cylinder tube 3202. A first central barrel 3205 is nested in the second central barrel 3206, and adapted to the first cylinder tube 3201. An end portion of the first central barrel 3205 is connected to a horizontal first actuator port 3209 which locates at an end portion of the first cylinder tube 3201and communicates with the through-port 3208. The end portion of the first cylinder tube 3201 is provided with a horizontal second actuator port 3210, which communicates with an inner cavity of the first cylinder tube 3201. The horizontal second actuator port 3210 communicates with port A of the first directional valve 36, and the horizontal first actuator port 3209 communicates with port B of the first directional valve 36. When entering via the horizontal second actuator port 3210, the hydraulic fluid in the inlet line 34 enters the first cylinder tube 3201, first pushing the plunger piston 3204 and bringing the third cylinder tube 3203 to extend out and meanwhile bringing the vertical oil cylinder 33 to move horizontally, and the hydraulic fluid in the third cylinder tube 3203 returns to the return line 3 5 via the through-port 3208. Even after the third cylinder tube 3203 completely extends out, the hydraulic fluid enters the first cylinder tube 3201 constantly, and the second cylinder tube 3202 extends outward constantly, and meanwhile continues to bring the vertical oil cylinder 33 to move horizontally. The horizontal oil cylinder 32 of such structure increases the horizontal movement distance of the vertical oil cylinder 33 as well as the support area, and thus enhancing support stability.

[0056] A first sleeve 3301 and a second sleeve 3302 are arranged in the third cylinder tube 3203 to parallel to each other. One end of the first sleeve 3301 is connected to the first hydraulic control check valve 38, and the other end thereof extends through the plunger piston 3204 into the second cylinder tube 3202. One end of the second sleeve 3302 is connected to the second hydraulically control check valve 39, and the other end thereof extends through the plunger piston 3204 into the second cylinder tube 3202. A third sleeve 3303 is nested within the first sleeve 3301, and a fourth sleeve 3304 is nested within the second sleeve 3302. Both the third sleeve 3303 and the fourth sleeve 3304 are adapted to the second cylinder tube 3202. A fifth sleeve 3305 is nested within the third sleeve 3303, and a sixth sleeve 3306 is nested within the fourth sleeve 3304. Both the fifth sleeve 3305 and the sixth sleeve 3306 are adapted to the first cylinder tube 3201. A sliding seal mechanism is provided between the first sleeve 3301 and the third sleeve 3303 and between the third sleeve 3303 and the second sleeve 3302, respectively, to prevent leakage of hydraulic fluid. Likewise, a sliding seal mechanism is provided between the second sleeve 3302 and the fourth sleeve 3304 and between the fourth sleeve 3304 and the sixth sleeve 3306, respectively, to prevent leakage of hydraulic fluid. The fifth sleeve 3305 has an end portion connected to port A of the second directional valve 37, and the sixth sleeve 3306 has an end portion connected to port B of the second directional valve 37. This structure sufficiently utilizes the internal space of the horizontal oil cylinder 32 with the inlet and return lines 35 of the vertical oil cylinder 33 built in, without dragging a plurality of external hydraulic fluid lines, thereby offering a simple and pragmatic structure.

[0057] In operation, a truck carries the telescopic arm 2 to a designated position and the front hydraulic support legs 4 and the transitional hydraulic cylinders 7 extend out to support the truck chassis 1 stably. Then, the turning hydraulic cylinder 5 commences extending out to push the telescopic arm 2 to turn. When the telescopic arm 2 is turned to be in vertical state, that is, perpendicular to the ground, the rear hydraulic support legs 6 extend out to support on the ground. At this point, the transitional hydraulic cylinders 7 are retracted, and the truck and the telescopic arm 2 are supported on the ground via the front hydraulic support legs 4 and the rear hydraulic support legs 6. Now, the telescopic arm 2 is able to elevate to operate. Such structure provides a large support area and a lower gravitational centre of the telescopic arm 2, and thus a higher stability. In need of adjusting the perpendicularity of the telescopic arm 2, the transitional hydraulic cylinders 7 extend out to compensate, in cooperation with the rear hydraulic support legs 6 on the telescopic arm 2, for the tilt angle of the telescopic arm 2. Since the transitional hydraulic cylinders 7 and the rear hydraulic support legs 6 are near to the telescopic arm 2, and thus facilitate the adjustment, they need to work together at this point. When the telescopic arm 2 is turned to be in vertical state, with the winching power, the second fixed bracket is gradually pulled towards the first fixed bracket 9 around the hinge shaft 22. Once the second fixed bracket 20 is joined with the first fixed bracket 9 together, the third power mechanism pushes the locating pin 23 to connect the first fixed bracket 9 with the second fixed bracket 20. Depending on the distance from the to-be-rescued object, the second sliding bracket 21 extends out, and meanwhile the first sliding bracket extends out, and the working cage 3 is balanced with the counterweight 11 to ensure a successful rescue. During elevation of the telescopic arm 2, the lifting wire rope 20404 is wound sequentially and fixed, before the piston rod of the lifting hydraulic cylinder 20409 of the last-stage telescoping cylinder 203 extends out. The innermost-layer telescoping section 20403 of the last-stage telescoping cylinder 203, which is the lightest in weight thereamong, is firstly elevated, and then the remaining telescoping sections of the last-stage telescoping cylinder 203 are elevated sequentially and section by section. Afterwards, the lifting hydraulic cylinders 20409 of the sub-last-stage telescoping cylinder commence being elevated. By analogy, all other telescoping cylinders are elevated stage by stage till the telescopic arm 2 is elevated to a desired height. In order to descend, the piston rod of the lifting hydraulic cylinder 20409 of the first-stage telescoping cylinder 201 is retracted, and the sub-outermost-layer telescoping section 20402, which is the heaviest in weight, descends first, and then the other telescoping sections of the first-stage telescoping cylinder 201 descend sequentially and section by section. Afterwards, the piston rod of the lifting hydraulic cylinder 20409 of the second-stage telescoping cylinder 202 is retracted, enabling the second-stage telescoping cylinder 202 to be retracted, and going on in this way, stage by stage, till the last-stage telescoping cylinder 203 is retracted. The outermost-layer telescoping section 20401 of the first-stage telescoping cylinder 201 is disposed on the ground, so that the pressure fluid of the lifting hydraulic cylinder 20409 of the first-stage telescoping cylinder 201 may be directly introduced from the inlet line 34 and the return line 35. While the lifting hydraulic cylinder 20409 of the second-stage telescoping cylinder 202 is mounted inside the innermost-layer telescoping section 20403 of the first-stage telescoping cylinder 201, it is necessary to mount a tubing conveyer 205 at the bottom of the outermost-layer telescoping section 20401 of the first-stage telescoping cylinder 201 so as to feed fluid to the lifting hydraulic cylinder 20409 of the second-stage telescoping cylinder 202. Likewise, a tubing conveyer 205 is also provided within the innermost-layer telescoping section 20403 of the first-stage telescoping cylinder 201 so as to feed fluid to the lifting hydraulic cylinder 20409 of the third-stage telescoping cylinder. By analogy, a tubing conveyer 205 is provided in the innermost-layer telescoping section 20403 of the previous stage of telescoping cylinder so as to feed fluid to the lifting hydraulic cylinder 20409 of the next stage of telescoping cylinder, till enable feeding fluid to the lifting hydraulic cylinder 20409 of the last-stage telescoping cylinder. The hydraulic fluid from the previous stage of telescoping cylinder is not only fed to the lifting hydraulic cylinder 20409 of the next stage of telescoping cylinder, but also to the tubing conveyer 205 within the next stage of telescoping cylinder, so as to enable the constant delivery of hydraulic fluid power with elevating/descending of the telescopic arm 2.

[0058] In the embodiments of the present invention, the telescopic arm 2 is hinged to the tail end of the truck chassis 1. In operation, the telescopic arm 2 is turned to be in vertical state by the turning hydraulic cylinder 5, with the bottom of the telescopic arm 2 close to the ground. Compared with conventional structure that the crank arm is above the truck chassis 1, the gravitational centre of the telescopic arm 2 is lowered, which increases stability of the telescopic arm 2.

[0059] The construction with telescoping sections vertically elevatable and nested together significantly reduces the length of truck body, where the truck body may have a length of 15.3 meters, a width of 2.5 meters, and a height of 4 meters, a maximum rescue height of 144 meters and a maximum height rescue fire radius of 15 meters, and also relatively reduces the turning radius. Compared with the fire truck with equivalent rescue height, the present invention has a wider applicability and a higher flexibility, particularly within the height range of 144 meters, the present invention has no rescue blind area and enables a 15-meter rescue radius throughout the height of 144 meters, so that only one fire truck can satisfy all rescue tasks throughout a high-rise building.

[0060] Although the present invention has been described in detail through generic description and specific implementations, some modifications or alterations may be made based on the present invention, which are obvious to those skilled in the art. Therefore, all such modifications or alterations without departing from the spirits of the present invention fall within the scope of the present invention.

Claims

1. A multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck, comprising a truck chassis, **characterized in that**,

a telescopic arm is mounted to a tail of the truck chassis by hinging, and a rotary platform is provided on a top end of the telescopic arm;
wherein a working arm is mounted on the rotary platform, and a working cage is mounted at one end of the working arm;
wherein a turning hydraulic cylinder is mounted on the truck chassis, with one end mounted on the truck chassis by hinging, and the other end mounted on the telescopic arm by hinging;
wherein front hydraulic support legs are mounted on the truck chassis proximal to a driving cab on both the left and the right,
wherein rear hydraulic support legs are mounted on the telescopic arm distal from the driving cab on both the left and the right,
wherein an auxiliary supporting oil cylinder is provided on the truck chassis, with a piston rod extending vertically upward, and
wherein transitional hydraulic cylinders are mounted at the tail end of the truck chassis on both the left and the right.

2. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 1, wherein the working arm comprises a first fixed bracket having one end connected to a second fixed bracket and the other end formed as a first opening,

wherein a first sliding bracket driven by a first power mechanism is slidingly mounted within the first fixed bracket, with a counterweight mounted at the end of the first sliding bracket extending out of the first opening,
wherein an end of the second fixed bracket distal from the first fixed bracket is provided with a second opening, and
wherein a second sliding bracket driven by a second power mechanism is slidingly mounted within the second fixed bracket, with the working cage mounted at the end of the second sliding bracket extending out of the second opening.

3. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 2, wherein the second fixed bracket is mounted to the first fixed bracket by hinging via a hinge shaft, and a locating pin driven by a third power mechanism is provided between the second fixed bracket and the first fixed bracket.

4. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 3, wherein a supporting arm is fixedly mounted at the end of the first fixed bracket proximal to the second fixed bracket, and a supporting rope pulley is rotatably mounted on the supporting arm,

wherein a winch mechanism is provided at the first fixed bracket proximal to the first opening,
wherein a hoisting arm is provided on the second fixed bracket,
wherein a hoisting wire rope is provided among the winch mechanism, the supporting rope pulley and the hoisting arm, and
wherein the end of the hoisting arm distal from a hoisting point of the hoisting wire rope is mounted to the second fixed bracket by hinging.

5. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 4, wherein a first stopper for restricting a vertical position of the hoisting arm is provided on the second fixed bracket, and a second stopper for restricting the hoisting point of the hoisting arm to be lower than an outer plane of the second fixed bracket is provided on the second fixed bracket.

6. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 1, wherein the telescopic arm comprises telescoping cylinders in a plurality of stages sequentially nesting together, each stage of telescoping cylinder comprising a plurality of telescoping sections nesting together,

wherein each stage of telescoping cylinder is connected with a hydraulic wire-rope lifter, where the hydraulic wire-rope lifter connected to a first-stage telescoping cylinder is disposed within an outermost-layer telescoping section, and the hydraulic wire-rope lifter connected to the next stage of telescoping cylinder is disposed within an innermost-layer telescoping section of the previous stage of telescoping cylinder,
wherein the hydraulic wire-rope lifter comprises a lifting hydraulic cylinder having a cylinder tube fixedly mounted at a bottom of the corresponding telescoping section,
wherein a fixed pulley set is mounted on the cylinder tube of the lifting hydraulic cylinder, and a movable pulley set is mounted on a piston rod of the lifting hydraulic cylinder,
wherein a lifting wire rope is provided between the lifting hydraulic cylinder and the corresponding telescoping section, with one end fixed, and the other end wound through the movable pulley set and the fixed pulley set before fixed on an innermost-layer telescoping section of the corresponding stage of telescoping cylinder;
wherein an outermost-layer telescoping section of the next stage of telescoping cylinder is nested within an innermost-layer telescoping section of the previous stage of telescoping cylinder, and a tubing conveyer for feeding fluid to the

next stage of telescoping cylinder is mounted in the innermost-layer telescoping section of the previous stage of telescoping cylinder,
wherein the working cage is mounted on the top of the innermost-layer telescoping section of a last-stage telescoping cylinder, and
wherein the rear hydraulic support legs are mounted on an outer surface of the outermost-layer telescoping section of the first-stage telescoping cylinder.

7. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 6, wherein a rope allocating pulley, for allocating the lifting wire rope of the corresponding fixed pulley set to a corresponding position, is mounted both at the bottom of the outermost-layer telescoping section of the first-stage telescoping cylinder and the bottom of the innermost-layer telescoping section of the previous stage of telescoping cylinder.

8. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 7, wherein a through-wall pulley is mounted at the bottom of each telescoping section other than the outermost-layer telescoping section of the first-stage telescoping cylinder,

wherein a bottom steering pulley is mounted both at the bottom inside of the outermost-layer telescoping section of the first-stage telescoping cylinder and at the bottom inside of the innermost-layer telescoping section of the previous stage of telescoping cylinder, and
wherein a top steering pulley is mounted at the top inside of each telescoping section other than the innermost-layer telescoping section of the last-stage telescoping cylinder.

9. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 8, wherein the through-wall pulley traverses the corresponding telescoping section, and the lifting wire rope is wound around the through-wall pulley for at least two turns from outside of the corresponding telescoping section and then passes to inside of the telescoping section.

10. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 9, wherein the lifting wire rope of each stage of telescoping cylinder is wound through the corresponding movable pulley set and fixed pulley set, then the corresponding rope allocating pulley, the bottom steering pulley, the outermost-layer top steering pulley, and the through-wall pulley of the neighbouring-layer telescoping section, sequentially, and finally is fixed above the through-wall pulley of the innermost-layer telescoping section.

11. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 10, wherein a swing arm is provided between every two neighbouring telescoping sections, with one end mounted to the outer-layer telescoping section by hinging, and the other end provided with an inclined guide surface,

wherein the end of the swing arm proximal to the inclined guide surface is provided with a roller,
wherein an adjusting screw is threadedly connected to a flange on the top end of the outer-layer telescoping section, with an end portion of the adjusting screw abutting against the inclined guide surface, and
wherein, under the action of the adjusting screw, an outer edge of the roller abuts against an outer surface of the inner-layer telescoping section.

12. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to any of claims 6 to 11, wherein the tubing conveyer comprises a mounting bracket, on which a core-tube driven by a fourth power mechanism is rotatably mounted,

wherein the core-tube is provided therein with a separator plate, which divides an inner cavity of the core-tube into an inlet chamber and a return chamber,
wherein an inlet duct communicating with the inlet chamber is fixedly mounted on the core-tube, and a return duct communicating with the return chamber is fixedly mounted on the core-tube,
wherein the inlet chamber is connected to an inlet line via a rotational joint, and the return chamber is connected to the return line via another rotational joint,
wherein a web plate is fixedly mounted on an outer surface of the core-tube, with a dual-groove pulley disc fixedly mounted on the web plate, and the core-tube, the web plate and the dual-groove pulley disc are arranged co-axially, and
wherein an inlet hose having an end connected to the inlet duct and a return hose having an end connected to the return duct are coiled within the dual-groove pulley disc, respectively.

13. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 12, wherein a guide pulley is rotatably mounted on the mounting bracket, and a floating pulley is disposed under the guide pulley, and wherein both the inlet hose and the return hose are wound through the guide pulley and the floating pulley before connected to the lifting hydraulic cylinder of the next stage of telescoping cylinder.

14. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 13, wherein a first sensor and a second sensor are provided on the mounting bracket, with the first sensor disposed under the guide pulley and above the floating pulley, and the second sensor disposed under the floating pulley, and
wherein both the first sensor and the second sensor are connected to the fourth power mechanism.

15. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 14, wherein a tension spring is provided between the floating pulley and the mounting bracket, with one end of the tension spring fixed on the floating pulley, and the other end thereof fixed on the mounting bracket.

16. The multi-stage hydraulic multiplication pulley vertical lifting-type elevating platform fire truck according to claim 15, wherein the fourth power mechanism comprises an electric motor mounted on the fixed bracket, and an outer gear ring is fixedly mounted on the web plate, and
wherein a transmission shaft is rotatably mounted on the mounting bracket, with one end of the transmission shaft mounted with a drive gear meshing with the outer gear ring, and the other end thereof being in transmission connection with the electric motor.

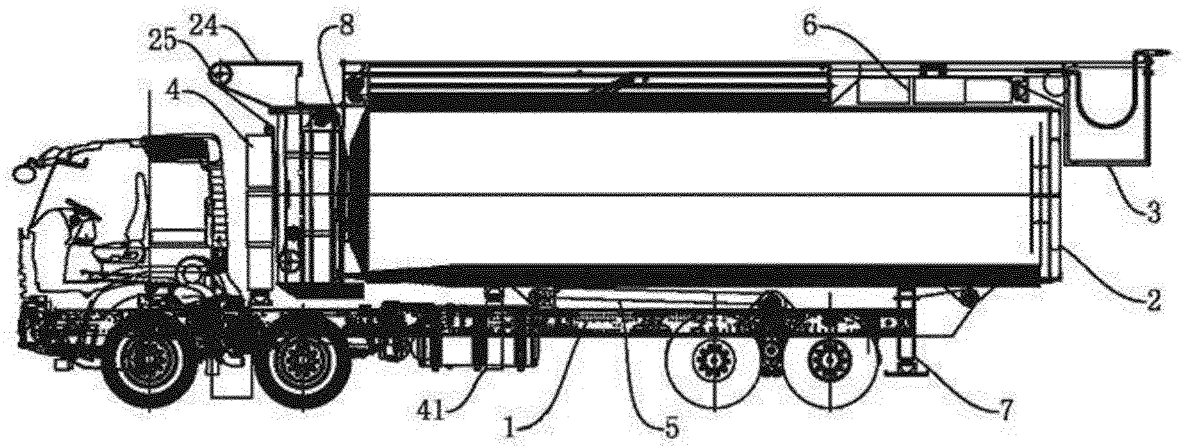
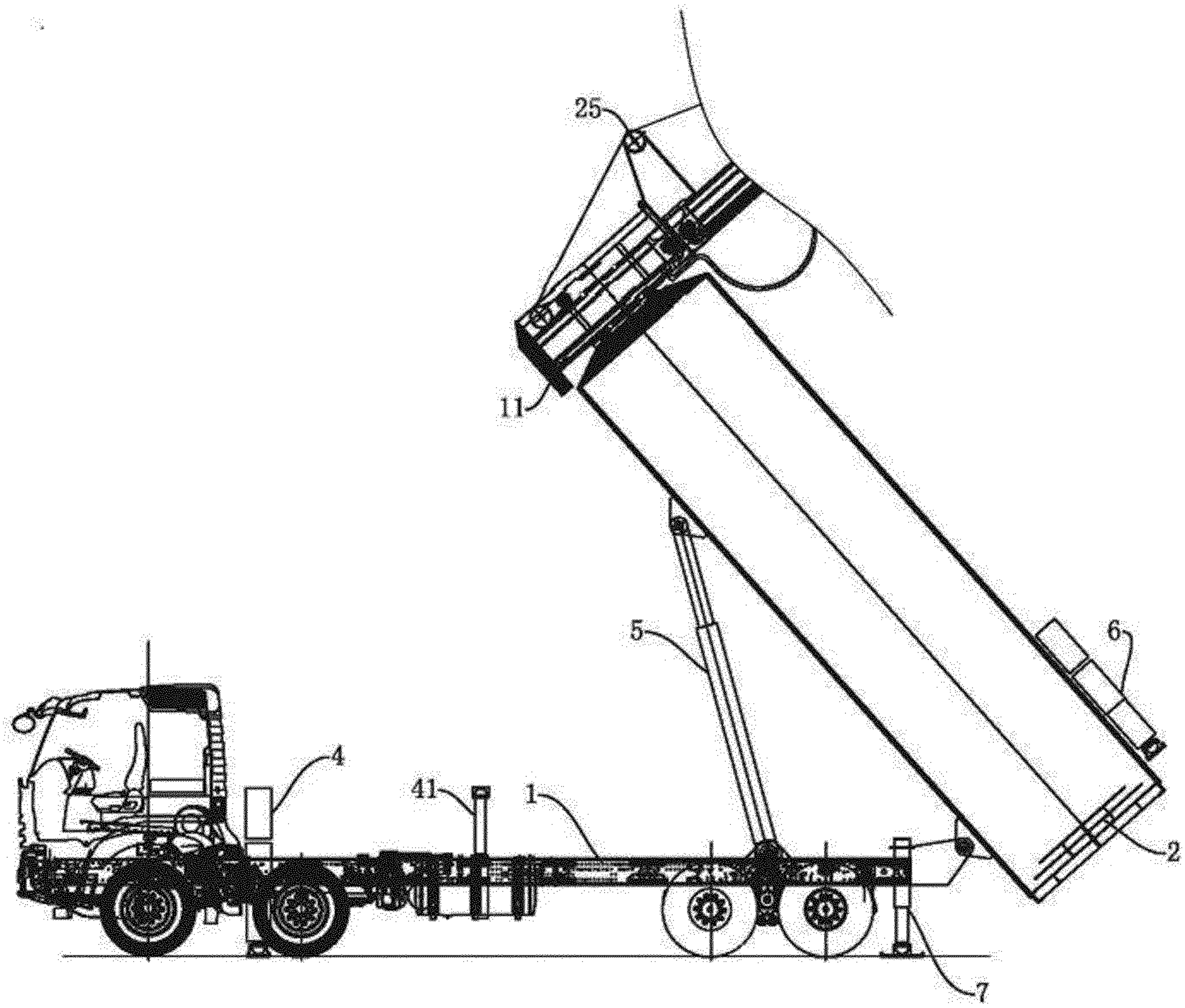


Fig. 1



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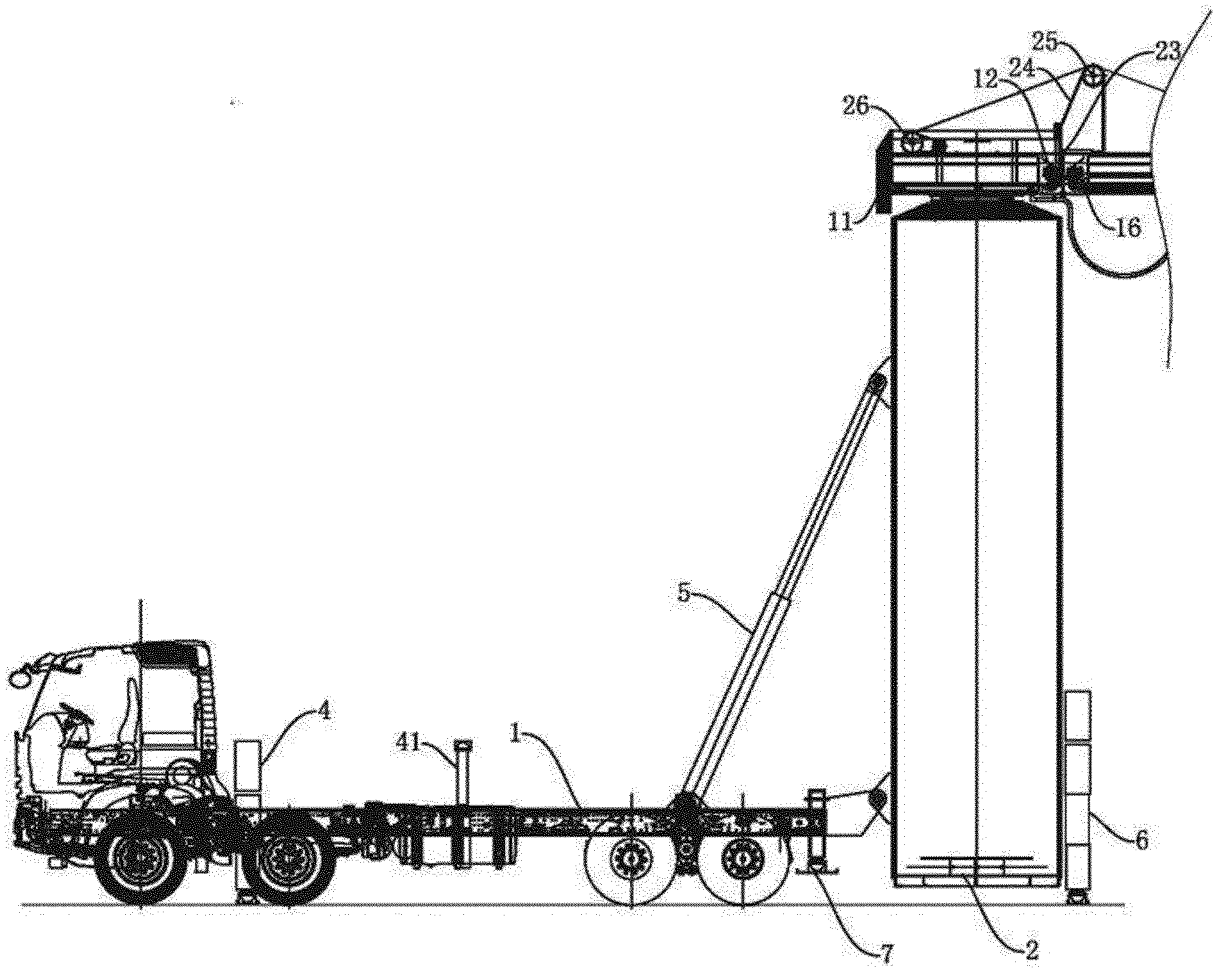

Fig. 3

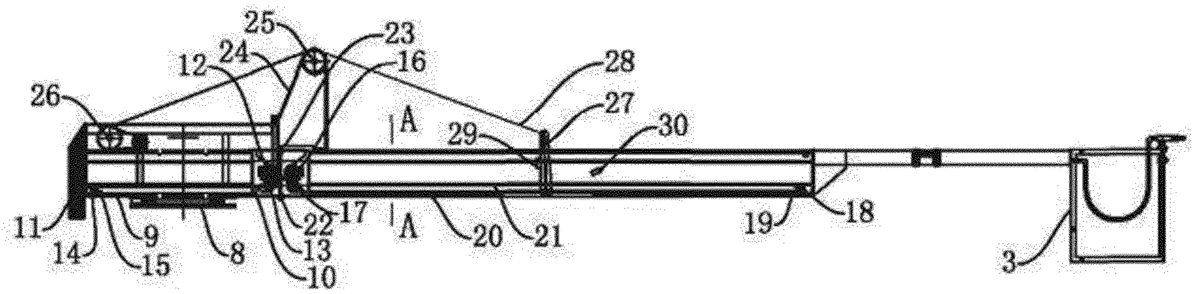
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Fig. 4

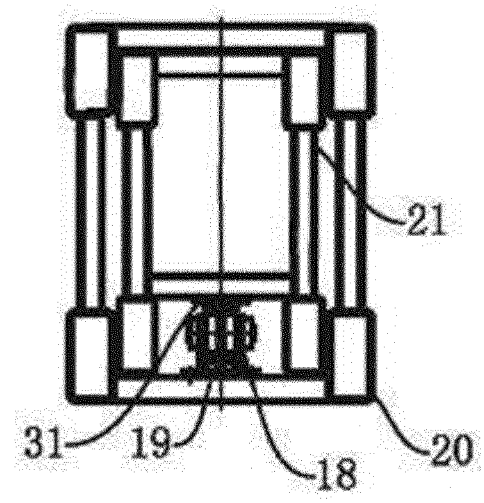
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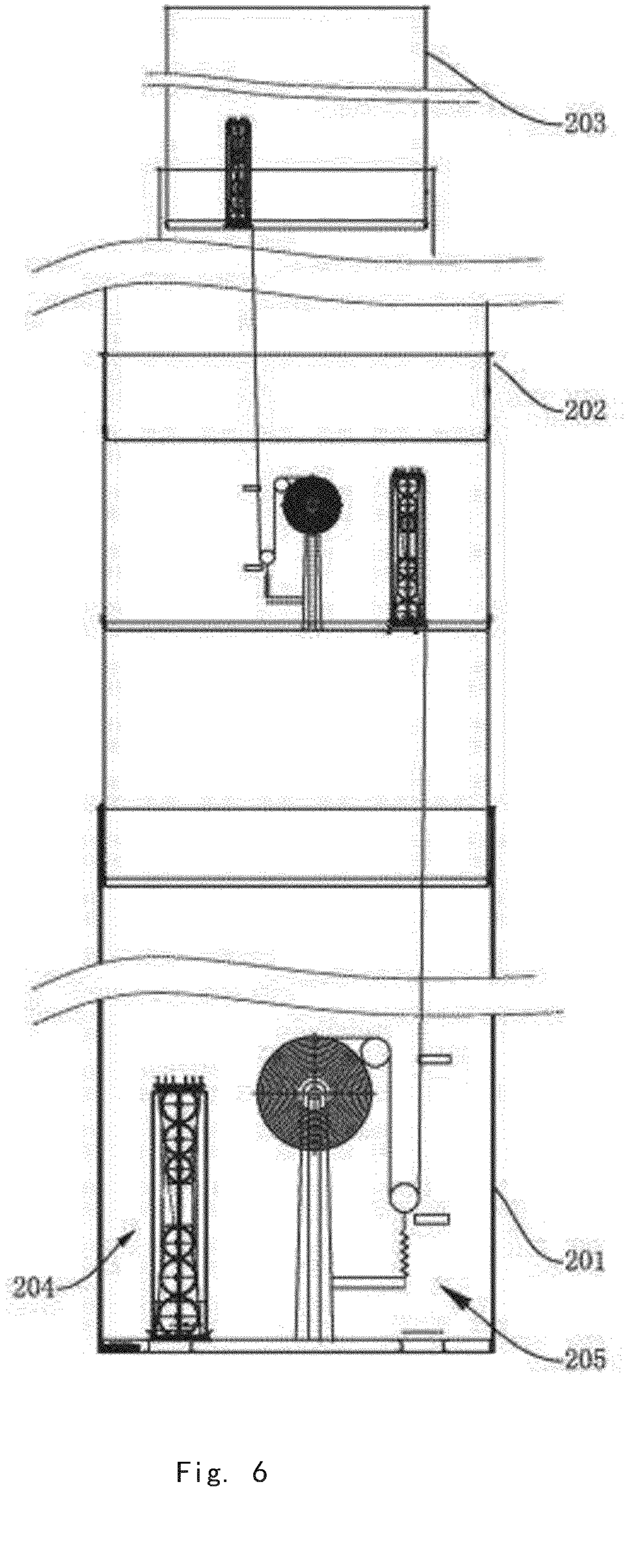
Fig. 5



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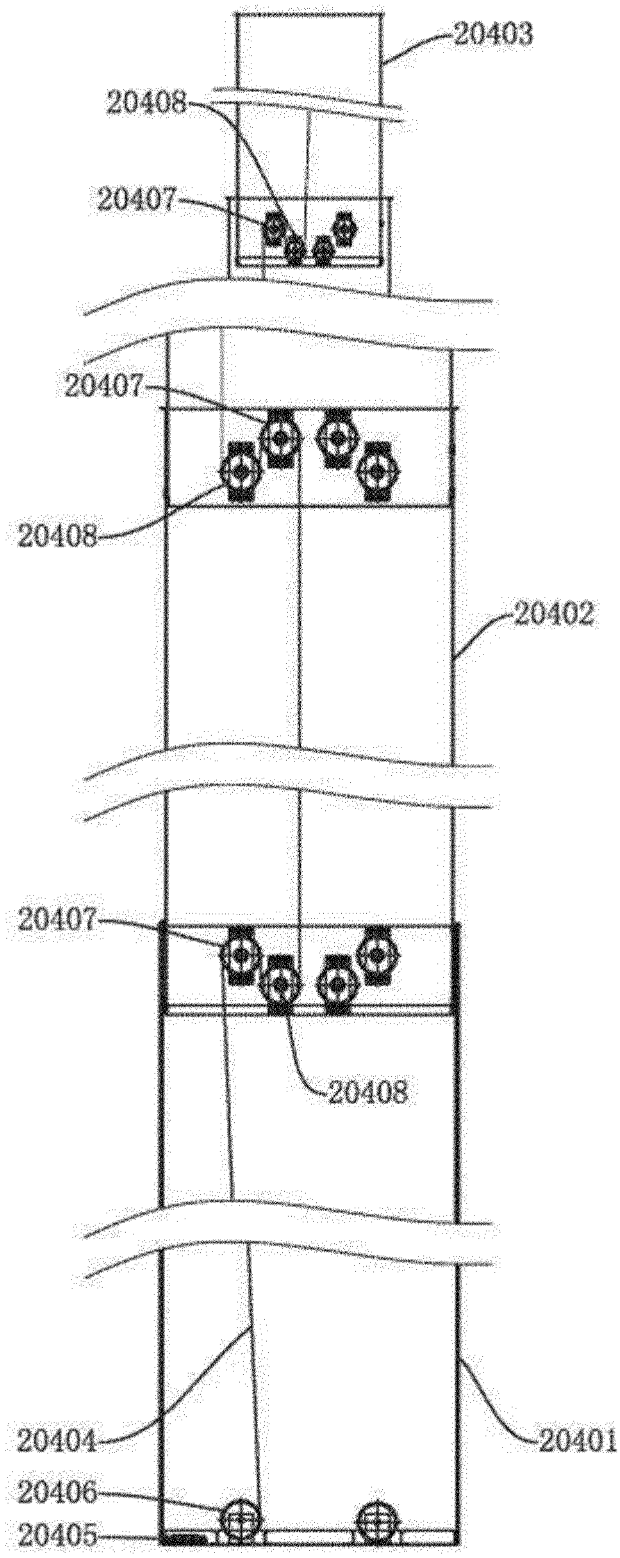
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Fig. 7

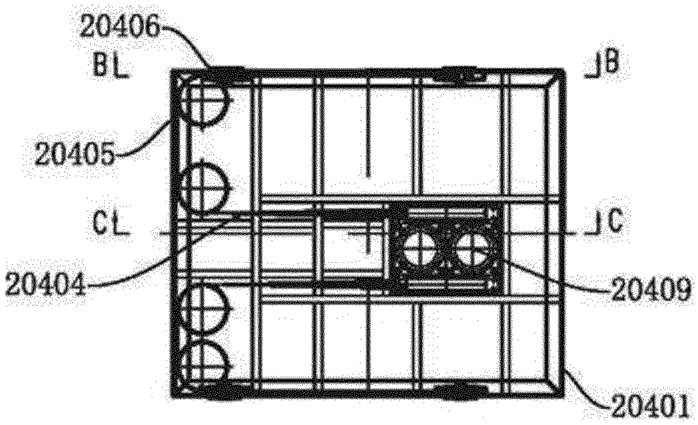
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Fig. 8

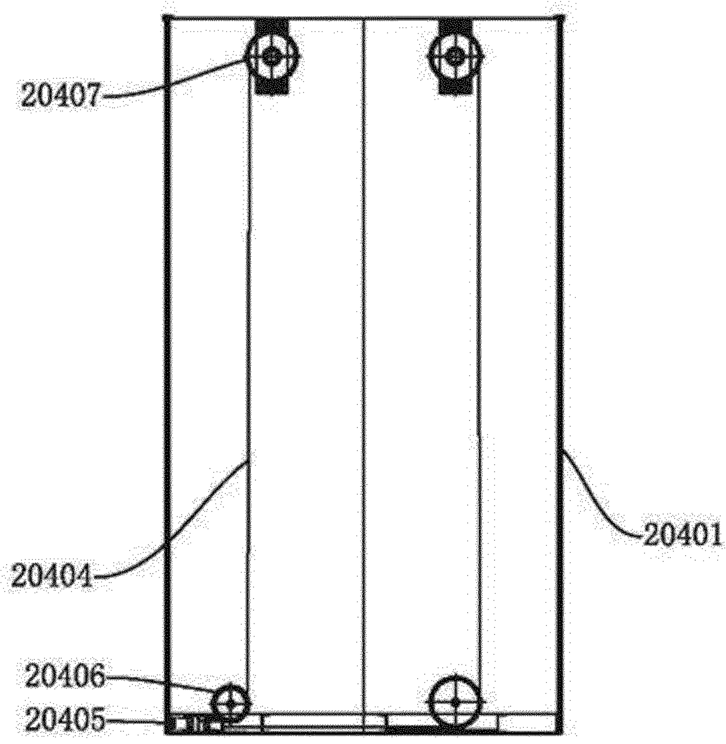
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Fig. 9

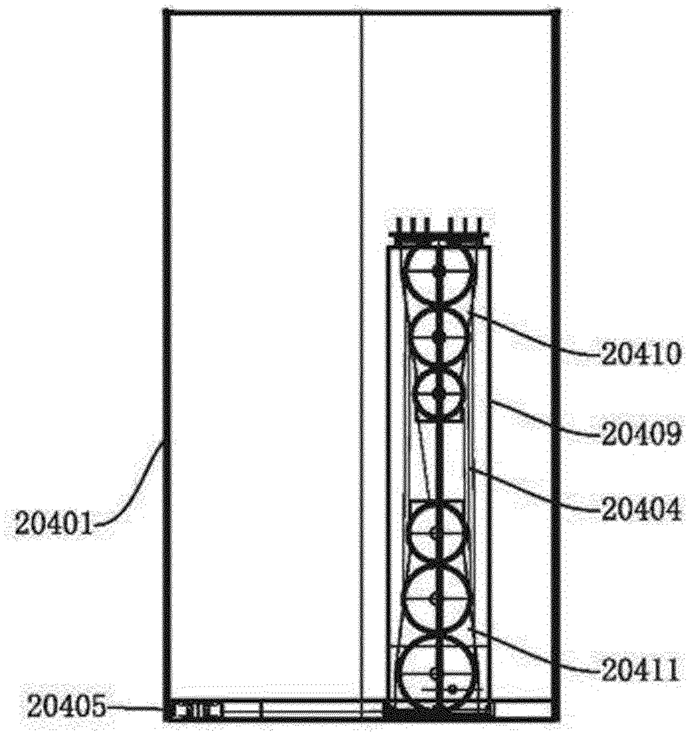
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Fig. 10

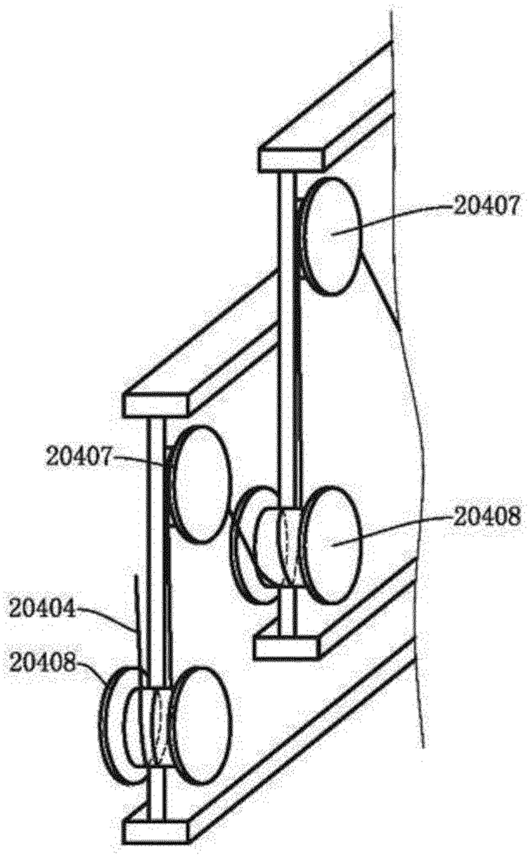
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Fig. 11

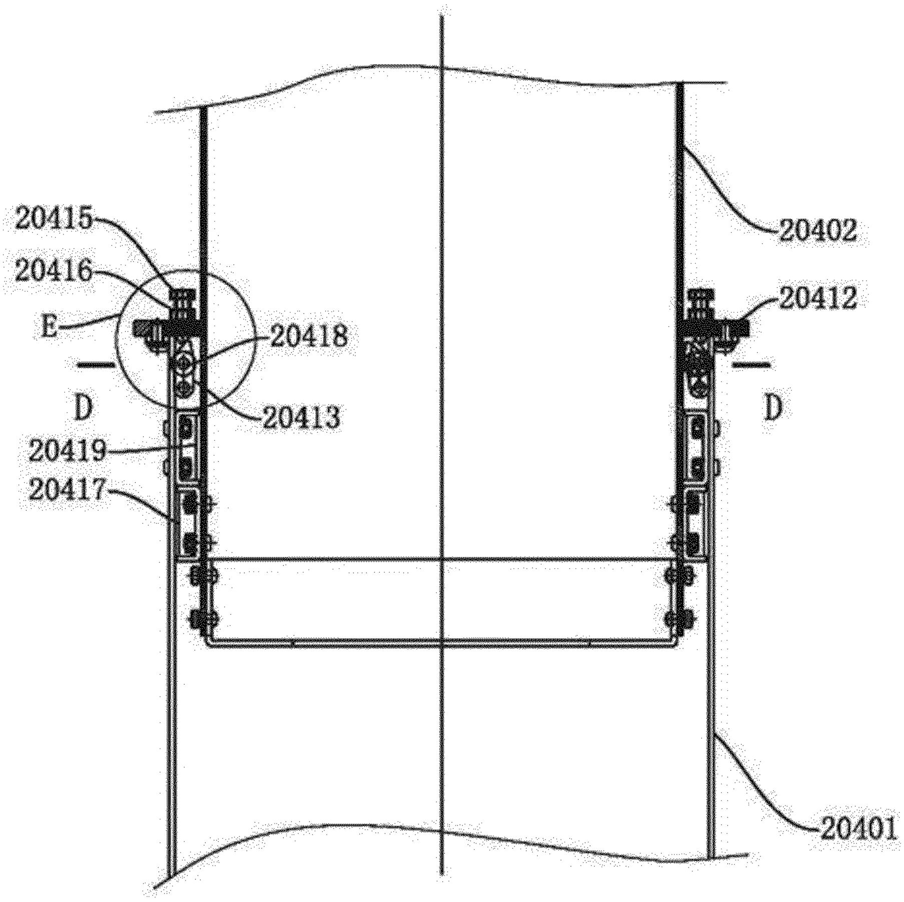
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Fig. 12

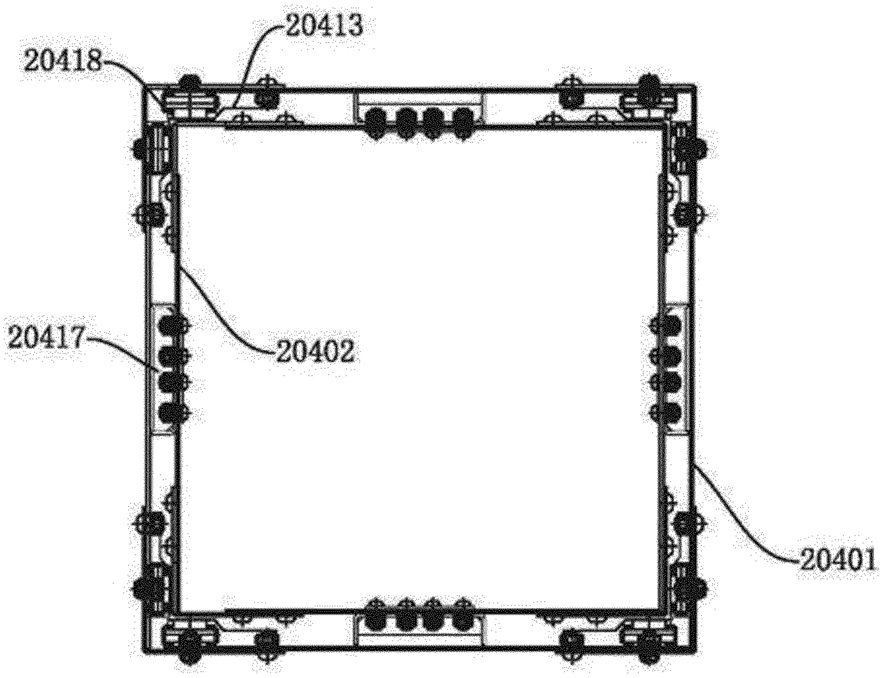
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Fig. 13

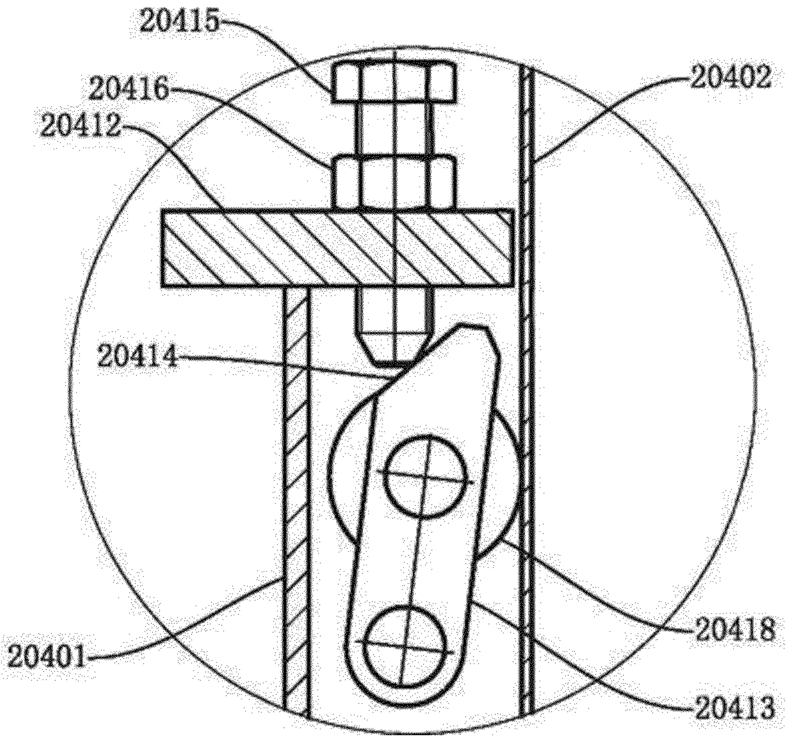

Fig. 14

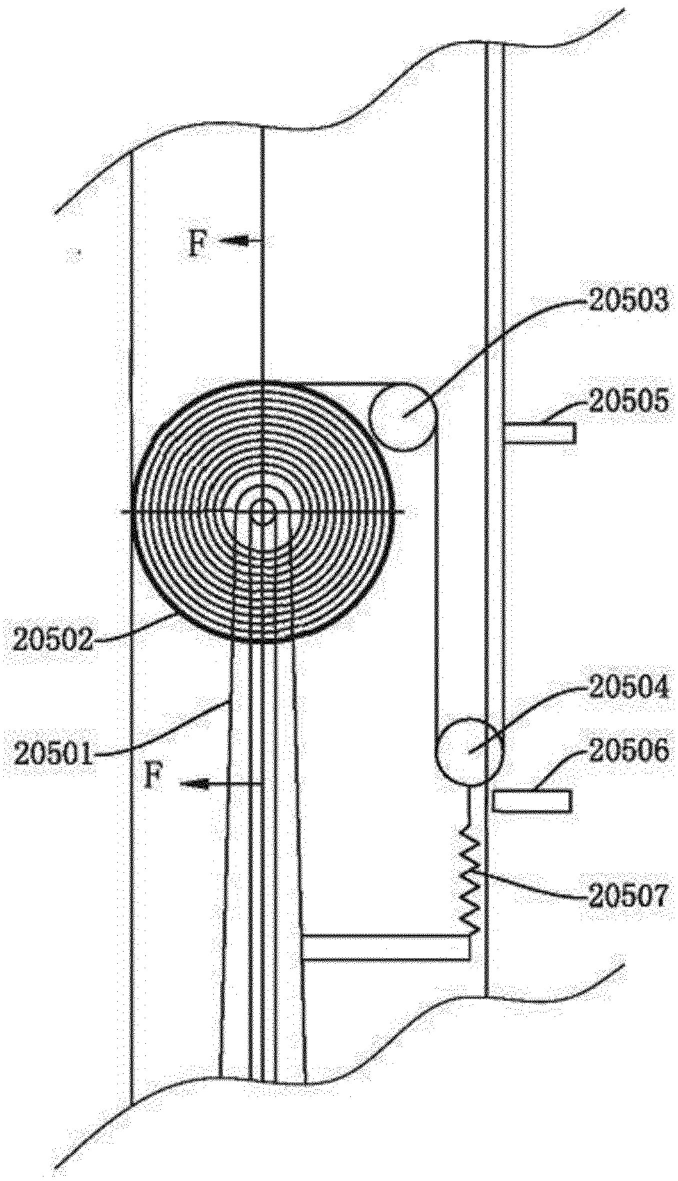

Fig. 15

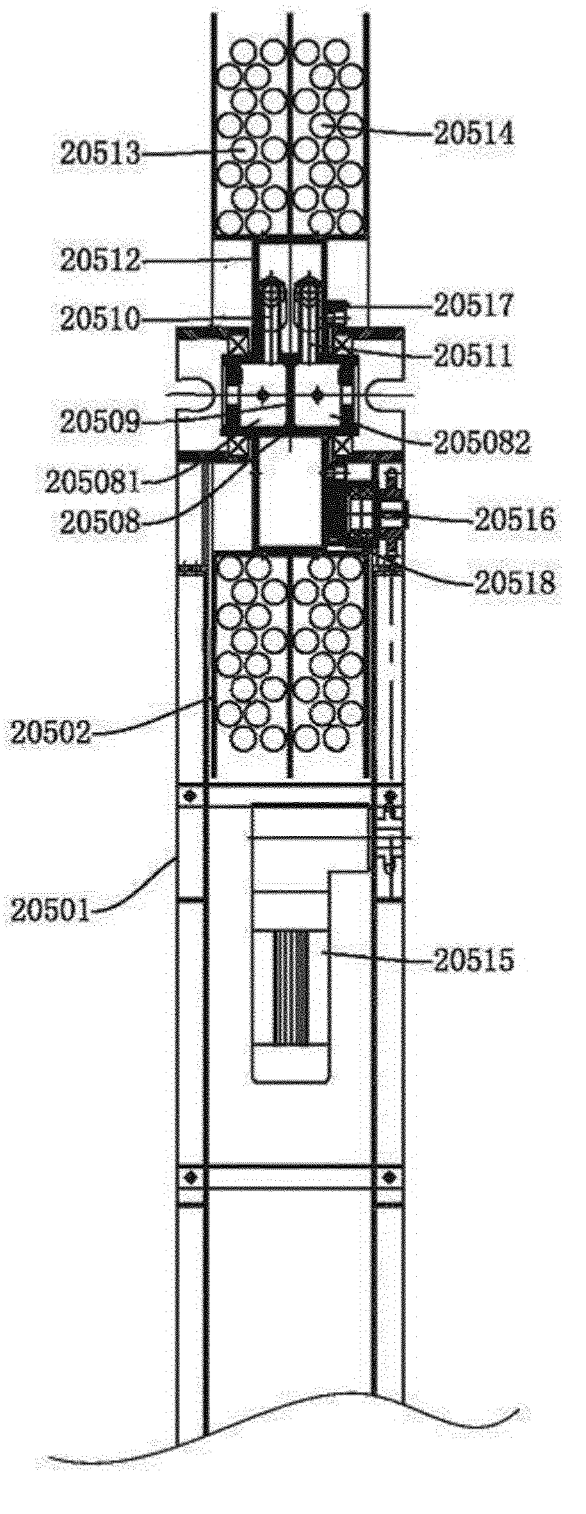
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Fig. 16

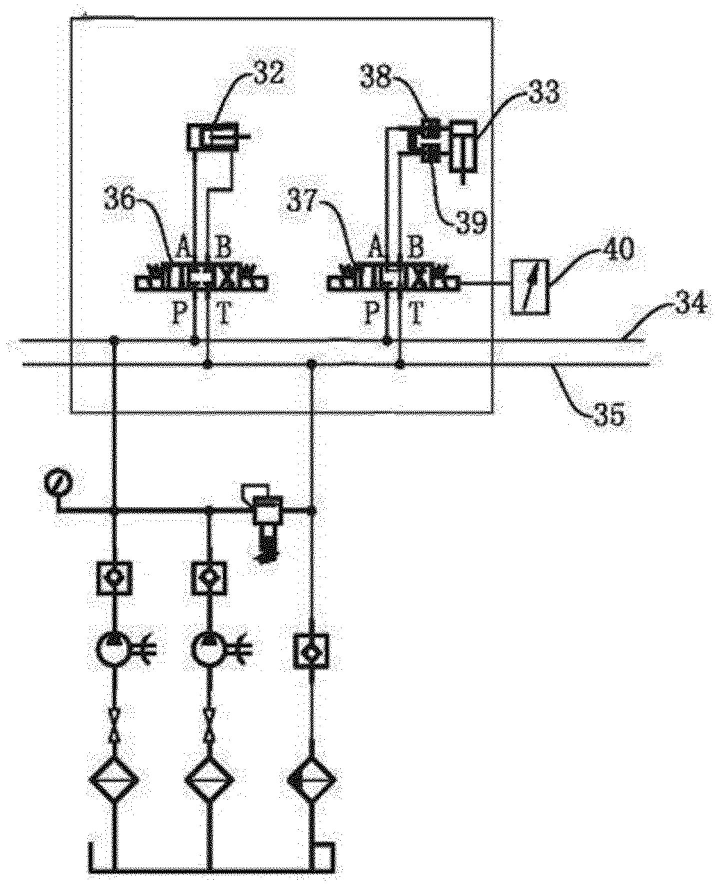
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Fig. 17

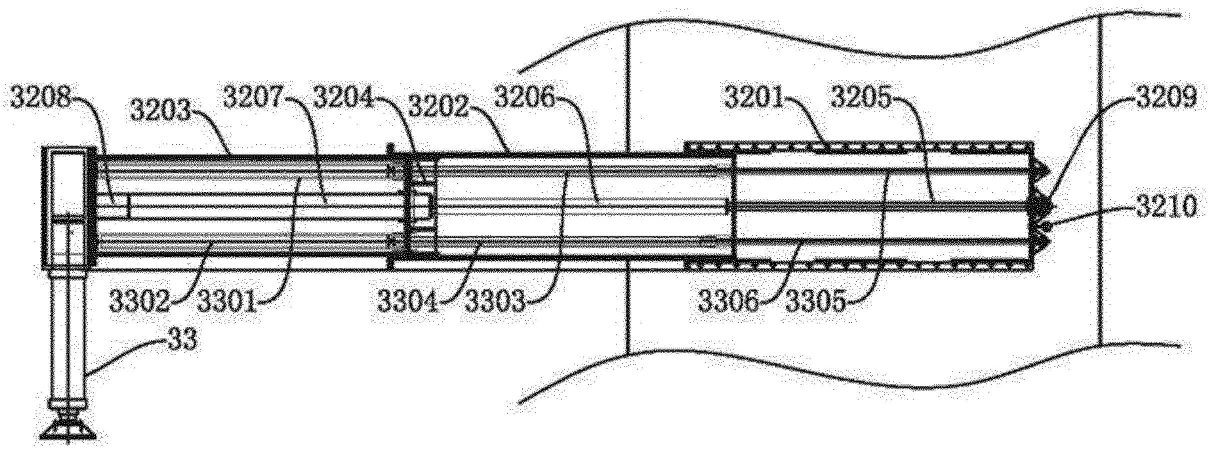
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Fig. 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/089604

A. CLASSIFICATION OF SUBJECT MATTER

A62C 27/00(2006.01)i; B66F 11/04(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A62C; B66F; B66C

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

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

CNABS; CNTXT; DWPI; SIPOABS; VEN; USTXT; EPTXT; WOTXT: 消防, 救援, 疏散, 液压, 倍增, 倍速, 油缸, 动滑轮, 绳, 缆, 线, 云梯, 高层, 配重, 对重, 平衡重, 平, 移, 范围, 区域, 扩展, 折叠, 塔吊, 塔机, 平台, 车, 伸缩, 臂, 桁架, rescu+, evaculat+, urgen+, area+, scop+, exten+, rang+, rope?, cable?, pull+, fold+, crane?, tower?, ladder?, boom?, horizon+, direct+, platform?, vehicle?, telescop+.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	CN 106422127 A (WANG MINGZHONG) 22 February 2017 (2017-02-22) description, paragraphs 4-40, and figures 1-17	1-3, 6-10, 12-16
Y	CN 202143760 U (CHEN ZUOYING et al.) 15 February 2012 (2012-02-15) description, paragraphs 17-92, and figures 1-6	1-3, 6-10, 12-16
Y	CN 110745720 A (CHEN YISONG) 04 February 2020 (2020-02-04) description, paragraphs 19-42, and figures 1-6	1-3, 6-10, 12-16
Y	CN 207511581 U (XUZHOU HAOYI CONSTRUCTION MACHINERY TECHNOLOGY CO., LTD.) 19 June 2018 (2018-06-19) description, paragraphs 9-14, and figure 1	12-16
PX	CN 113753773 A (DAYANG PARKING CO., LTD.) 07 December 2021 (2021-12-07) description, paragraphs 6-84, and figures 1-18	1-16
A	CN 106976826 A (ZHAO LIUJIN) 25 July 2017 (2017-07-25) entire document	1-16
A	CN 104973519 A (NANJING TECH UNIVERSITY et al.) 14 October 2015 (2015-10-14) entire document	1-16

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
14 June 2022	**18 July 2022**
Name and mailing address of the ISA/CN **China National Intellectual Property Administration (ISA/CN)** **No. 6, Xitucheng Road, Jimenqiao, Haidian District, Beijing 100088, China**	Authorized officer
Facsimile No. **(86-10)62019451**	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2022/089604

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 207404728 U (TIANJIN ZHONGZHONG METAL STRUCTURE CO., LTD.) 25 May 2018 (2018-05-25) entire document	1-16
A	JP 2009091135 A (KOBELCO CRANES CO., LTD.) 30 April 2009 (2009-04-30) entire document	1-16

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2022/089604

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
CN	106422127	A	22 February 2017	None			
CN	202143760	U	15 February 2012	None			
CN	110745720	A	04 February 2020	CN	211733680	U	23 October 2020
CN	207511581	U	19 June 2018	None			
CN	113753773	A	07 December 2021	CN	113753773	B	01 March 2022
CN	106976826	A	25 July 2017	CN	206858094	U	09 January 2018
CN	104973519	A	14 October 2015	CN	104973519	B	03 October 2017
CN	207404728	U	25 May 2018	None			
JP	2009091135	A	30 April 2009	None			

Form PCT/ISA/210 (patent family annex) (January 2015)