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(54) **MASTS WITH A WHOLE LIFTING HEIGHT.**

HUBMASTE MIT VÖLLIGER HUBHÖHE.

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(73) Proprietor: **Varvara, Paolo**
70024 Gravina in Puglia (IT)

(72) Inventor: **Varvara, Paolo**
70024 Gravina in Puglia (IT)

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Description

FIELD OF THE INVENTION

[0001] The invention concerns telescopic lift mast assemblies for fork lift trucks able to perform a full free lift of the load, i.e. the lift of the load without the overall length of mast increases, and then a second lift of the load during which the mast assembly expands longitudinally. The mast assemblies operates by means of hydraulic cylinders.

BACKGROUND ART

[0002] Fork lift trucks use various types of telescoping lift masts, hydraulically operated, among which some perform a first lift of the load, usually positioned on a pair of forks, without any increment of the overall mast length, i.e. without the mast expansion. This is obtained by means of the so-called "full free lift masts" which usually comprise a stationary frame fixed to the fork lift truck chassis and one or two mobile frames, the "inner" and the "intermediate", sliding one into the other. Usually, full free lift masts for lift trucks comprise three hydraulic cylinders: one shorter, almost half of the length of the others two, deputed to the full free lifting and arranged in the middle of the mast assembly, and two cylinders arranged adjacent to the outer sides or rear of the mast assembly, deputed to the second lifting stage.

[0003] Sometimes, in order to improve forward visibility, instead of one shorter cylinder, two shorter cylinders with smaller cross sectional area, symmetrically arranged on sides within the mast assembly, are preferred and conseguently the cylinders are four.

[0004] In any case, the forward visibility through a full free lift mast is limited because of the presence of the cylinder, or the two cylinders, within the mast assembly.

[0005] In the past, full free lift mast were assembled with a single hydraulic two-step cylinder arranged in the middle of the mast: these types of masts are disclosed in FR 1325390 A (Lansing Bagnall LTD) and JP 49031055 A (?) with regard to masts comprising two mobile frames, and in US 3805681 A (Wible J) and US 3072219 (Olson John) with regard to masts comprising one mobile frame. All these masts, equipped with one hydraulic cylinder in the middle of the mast, have the disadvantage of hindering almost completely the operator's visibility.

[0006] The documents FR 1325390 A and US 3805681 A both disclose a full free lift telescopic mast for fork lift truck, that is able to perform a first lifting stage of the fork carriage without any increment of the overall mast length, hydraulically operated, comprising an outer stationary frame, an inner mobile frame, a fork carriage, or an equivalent load device, sliding in the inner mobile frame, a lifting device comprising chains and guiding pulleys.

[0007] Additionally said documents FR 1325390 A and US 3805681 A also disclose that said mast is operated by means of a single hydraulic two-step cylinder mounted in the middle of said mast; that the inner tubular rod of said single two-step cylinder is supported down on the outer frame; that the intermediate tube of said single two-step cylinder has radial holes for oil passage, sliding on the rod; that said single two-step cylinder has a stop collar; that said single two-step cylinder has an annular piston fixed to the outer surface of the intermediate tube; and that said single two-step cylinder has an outer tube, sliding on the intermediate tube, of such a length that its stroke is capable, by means of said lifting device, of raising completely the fork carriage along the inner frame.

[0008] To meet the market demand for full free lift masts with improved visibility, manufacturers have developed solutions among which the more diffused comprise, as already stated, three or four lifting hydraulic cylinders, of which one or two, having smaller sectional areas than that of a single two-step cylinder, are arranged in the middle of the mast.

DISCLOSURE OF THE INVENTION

[0009] The purpose of the present invention is to provide full free lift masts for fork lift trucks, with either one or two sliding frames, which are able to operate by means of only a pair of hydraulic two-step cylinders, arranged adjacent the outer sides or rear of the mast assembly, consequently obtaining an improved forward visibility with regard to the prior art.

[0010] This purpose is achieved by the provision of telescopie mast according to all the features, in combination, of claim 1. The device according to the aim of the invention relates to a lift mast assembly comprising two or three frames, one of which fixed to the fork lift truck chassis and one sliding frame or two sliding frames, a pair of hydraulic two-step cylinders wich are able, by means of a transmission device comprising chains and pulleys, to transmit the motion to the mobile parts of the mast assembly in such a way to perform a first lifting of the fork carriage without any increment of the overall mast length, that is the full free lift, and then a second lifting of the fork carriage up to the maximum lifting heigth, during which the mobile frame slides in the fixed one, or the two mobile frames slide reciprocally, respectively if two or three frames are comprised in the mast assembly.

[0011] Furthermore, an advantage in terms of cost reduction is that hydraulic two-step cylinders according to the present invention doesn't need any flexible pipes and any pertinent guide pulleys to be fed by hydraulic oil, because their inlet ports are stationary during all lifting stages.

[0012] There are various ways to transmit motion, by means of chains and pulleys, from the hydraulic two-step cylinders to the mobile parts of the mast assembly, either the mast assembly has one or two mobile frames.

BRIEF DESCRIPTION OF DRAWINGS

[0013] The invention will be disclosed hereinafter with reference to the annexed drawings wherein:

- Figs. 1 to 6 show the components of the hydraulic two-step cylinders of different types of construction;
- Figs. 7A-B-C show a schematized side view of the pattern of chain drive at various stages of lifting of a full free lift mast, comprising a stationary frame and a mobile frame, operating by means of two hydraulic two-step cylinders according to the present invention;
- Figs. 8A-B-C show a schematized side view of the pattern of chain drive at various stages of lifting of a full free lift mast according to the invention, comprising one fixed frame and two mobile frames, operating by means of two hydraulic two-step cylinders whose first stage stroke takes place in the opposite longitudinal direction to the second stage stroke;
- Figs. 9A-B-C show another schematized side view of the pattern of chain drive, different from the previous, at various stages of lifting of a full free lift mast, comprising one fixed frame and two mobile frames, operating by means of two hydraulic two-step cylinders according to the invention;
- Figs. 10A-B-C show a schematized side view of a different pattern of chain drive at various stages of lifting of a full free lift mast according to the invention, comprising one fixed frame and one mobile frame, operating by two hydraulic two-step cylinders in which the first stage stroke takes place in the opposite direction to the second stage stroke;
- Fig. 11 is an example which shows the front view of a full free lift mast, comprising one fixed frame and one mobile frame, operating in accordance to the pattern of chain drive illustrated in Figs. 7A-B-C and to the aim of the invention;
- Fig. 12 is an example which shows the rear view of a full free lift mast, comprising one stationary frame and two mobile frames, operating in accordance to the pattern of chain drive illustrated in Figs. 8A-B-C and to the aim of the invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0014] Fig. 1 shows a partial longitudinal section through the hydraulic two-step cylinder 1 in its neutral position. The cylinder assembly 1 operates as two hydraulic cylinders.

[0015] The hydraulic cylinder 1 comprises an outer mobile tube 2 whose length is about half that of the cylinder assembly 1. A bottom threaded cap 3 and an upper welded cap 5 are fixed to the ends of the outer tube 2. Both caps are axially drilled and have peripheral sealing gaskets 4.

[0016] An intermediate mobile tube 6 is mounted inside the tube 2, which is characterized by two different wall thicknesses 7 and 8 in order to differentiate the longitudinal hydraulic thrusts in the two sliding directions because of the cylinder 1 is an "immersion" type cylinder, that is the annular chambers above and below the piston 9 are communicating one with the other.

[0017] The intermediate tube 6 has a welded cap 13 at the upper end, provided with a radial hole and a screw 14 for air purge, and has at the other end a threaded cap 10 provided with sealing gaskets 11. At the bottom, a stop collar 12 is housed inside of the intermediate tube 6. At about half of the length of the tube 6, corresponding to the wall thickness variation 7 and 8, the piston 9 is welded to the outer surface of the tube 6.

[0018] The piston 9 has an inner circular hollow 15 and some longitudinal slots 16 on the periphery, through which and through the radial holes 17, provided on the wall of the tube 6, pressurized oil can flow into the upper and lower annular chambers, delimited by the tubes 2 and 6 and separated by the piston 9.

[0019] The outer tube 2 and the intermediate tube 6 establish an "immersion" type hydraulic cylinder, that is the two chambers separated by the piston 9 are in fluid communication and therefore the piston 9 hasn't any sealing gaskets.

[0020] Inside the tube 6 is the tubular piston-rod 18, at the top of which is screwed the threaded piston 19. The piston-rod 18 is the stationary component of the hydraulic two-step cylinder 1.

[0021] The piston 19 is drilled axially and has some radial holes 21 which allow the oil passage from inside the tubular rod 18 towards the annular chamber delimited by the rod 18 and tube 6. Also in this case, the inner hydraulic cylinder comprising the tube 6, the rod 18 and the piston 19 is an "immersion" type cylinder, i.e. without gaskets on the piston 19, hence the upper and lower chambers are in fluid communication.

[0022] The piston 19 mounts externally the guide collar 20 and internally the hollow valve 24 on which acts the spring 23. The valve 24 has radial orifices 25 and has the function of reducing the rate of speed of the tube 6 in the last lowering sector. In Fig. 1 the valve 24 is completely retracted because of the contact pressure of the cap 13 when the tube 6 is closed upon the piston 19. At the bottom, the tubular rod 18 ends with an axially drilled cap 22. The cap 22 is threaded externally for the inlet/outlet oil pipe connection and internally for housing a safety valve, not shown in Fig. 1, which prevents an accelerated movement of the pressurized oil inside the hydraulic cylinder 1 in case of rupture of the pipe connected to the cap 22.

[0023] From the functional point of view, the cylinder 1 operates like a pair of hydraulic cylinders, an inner and an outer cylinder. The outer hydraulic cylinder comprises the tube 2, tube 6 and piston 9 fixed to the tube 6. The inner hydraulic cylinder comprises the tube 6, the tubular rod 18 and the piston 19 fixed to the rod 18.

[0024] Fig. 2 represents a partial longitudinal section through the hydraulic two-step cylinder 1 when it has

completed the first stroke, the first step, due to the oil pressure provided by a hydraulic pump, shown in dashed lines. In this condition, the outer tube 2 is at the end of the stroke because the lower cap 3, stationary to the outer tube 2, is stopped by the contact with the piston 9 of the intermediate tube 6. Pressurized oil enters from the lower cap 22, passes through the tubular rod 18, the holes 21 of piston 19, fills the annular chamber between the rod 18 and the tube 6, passes through the radial holes 17 and the hollows 15, 16 of the piston 9 and reaches the outer cylinder. The oil pressure moves upward the outer tube 2.

[0025] Fig. 3, finally, represents cylinder assembly 1 at the end of second stage, during which the intermediate tube 6 slides on the tubular rod 18. During the second stage, the outer tube 2 and the intermediate tube 6 move together upwards. At the end of the second stage the cylinder 1 has reached its maximum extension as the stop collar 12 is in contact with the lower annular surface of the piston 19. When the hydraulic fluid within the cylinder 1 is discharged through the cap 22 towards the reservoir, shown in dashed lines, which is at atmospheric pressure, the reverse sequence of lowering is obtained, so that the intermediate tube 6 moves downward, sliding on the rod 18, and also drags the outer tube 2 without relative movement. After the downward run of the intermediate tube 6, the outer tube 2 begins to slide downward along the tube 6 until the cylinder assembly 1 returns to the neutral condition shown in Fig.1.

[0026] Fig. 4 shows the two-step cylinder 1 in the last sector of the lowering stroke of the intermediate tube 6, when the braking valve 24 begins to close. At this point, the upper cap 13 comes in contact with the valve 24 that begins to close and compress the spring 23. The oil in the shrinking chamber 26 cannot flow further through the uppermost opening of the hollow valve 24, but is forced to flow through the calibrated holes 25 of valve 24 and also could leak along the guide collar 20 of the piston 19, that, as stated, hasn't any gaskets. In this way, the damping effect, created by this hydraulic constriction, is braking the intermediate tube 6 in the last sector of its lowering stroke.

[0027] Figs. 5A-B-C show a variant of the hydraulic two-step cylinder assembly, as the outer tube 52 runs in the opposite direction to that of the intermediate tube 56.

[0028] Fig. 5A represents the two-step cylinder assembly 51 partially sectioned longitudinally in its neutral state. In this case, the hydraulic two-step cylinder 51 is arranged so that the first stage of the outer tube 52 runs downwards, in the opposite direction to the outer tube 2 of previous cylinder assembly 1 of Fig. 1.

[0029] When, by means of a hydraulic pump as in the previous case, pressurized oil flows through the tubular rod 18, the radial holes 21 of the piston 19, the radial holes 17 in the wall of the intermediate tube 56 and through the circular hollow 15 and the longitudinal slots 16 of the piston 54, the outer tube 52 moves downward because the wall thicknesses 57 and 58 of intermediate tube 56 are reversed compared to those 7 and 8 of the intermediate tube 6 of cylinder assembly 1 in Fig. 1, so that the longitudinal thrust of oil pressure acting on the outer tube 52 is in downward direction.

[0030] The inner tubular rod of hydraulic cylinder 51 remains identical to the rod 18 of cylinder 1. Instead, the axially drilled caps of the outer tube 52 are reversed compared to those of the cylinder assembly 1 in Fig. 1, i.e. the cap 3 is screwed at the top and the cap 5 is welded at the bottom, as shown in Fig. 5A.

[0031] The sequence of movements is described in Fig. 5B and Fig. 5C which show the front view of the cylinder 51 at the end of each stage. Respectively, Fig. 5B represents the cylinder assembly 51 when the outer tube 52 has completed its downward stroke, first stage, and Fig. 5C represents the cylinder 51 at the end of the second stage during which the intermediate tube 56 moves up to its uppermost position and drags simultaneously the outer tube 52.

[0032] When hydraulic oil within the cylinder assembly 51 is discharged towards the fluid reservoir at the atmosphere pressure, by means of a hydraulic valve, the reverse sequence occurs. Firstly the intermediate tube 56 moves downward jointly to the outer tube 52. so that the cylinder assembly 51 returns to the position shown in Fig. 5B. During the last sector of this stage, the braking valve 24 decelerates the tube 56, in the same way of the cylinder assembly 1. Secondly, after the first downward stroke is completed, the outer tube 52 moves upward because of gravity forces of the fork carriage, the forks and the load, if there, to which the tube 52 is linked by chains and pulleys (see Fig. 8A and Fig. 10A). At the end of second stage, the hydraulic cylinder assembly 51 returns to its neutral position shown in Fig. 5A.

[0033] Also for the cylinder assembly 51, the outer hydraulic cylinder, comprising the intermediate tube 56, the piston 54 and the outer tube 52 is an "immersion" hydraulic cylinder, i.e. without sealing gaskets arranged on the piston 54: this is not a restrictive condition of the present invention, because both two-step cylinder assemblies 1 and 51 can be arranged to carry out hydraulic cylinders of sealed type, as it will be described below.

[0034] Fig. 6 represents a partial longitudinal section through the hydraulic two-step cylinder 61 in its neutral state. The cylinder assembly 61 is the "sealed" version of the cylinder 1 in Fig. 1, i.e. the outer piston 69 is arranged with the sealing gasket 65 on the annular boundary with the inner surface of the outer tube 62. The differences between the "sealed" cylinder assembly 61 with the "immersion" cylinder assembly 1 are:

- the intermediate tube 66 has constant wall thickness;
- the sealing gaskets 65 of the piston 69 which seal the two chambers divided by the piston 69. The upper chamber receives the pressurized fluid, the lower chamber remains in communication with atmosphere;
- the longitudinal slots 63 don't extend along the entire

length of the piston 69. Similarly, it is easy to design a "sealed" hydraulic two-step cylinder equivalent to the "immersion" hydraulic two-step cylinder 51, i.e. the first stage moves in the opposite direction to the second stage.

[0035] A first illustrative embodiment of the present invention is a full free lift mast 70 comprising a fork carriage sliding in a mobile frame which is also sliding in a stationary outer frame. The fork carriage of mast assembly moves longitudinally by means of a pair of hydraulic two-step cylinders 1 shown in Fig. 1.

[0036] Figs. 7A-B-C are schematized side views representing the lifting sequence of the full free lift mast 70. Respectively, in neutral position Fig. 7A, at the end of the full free lift Fig. 7B, first step, and at the end of the second lifting stroke Fig. 7C, second step.

[0037] There are depicted the fork carriage 75, the mobile frame 72, the stationary outer frame 71 and all other parts according to the present invention.

[0038] In Figs. 7A-B-C, the tubular rod 18 of the cylinder assembly 1 rests on the stationary outer frame 71 at the bottom. The upper cap 13 of the intermediate tube 6 is fastened, in both longitudinal directions, to the upper tie-bar 79 of the mobile frame 72 in order to prevent reciprocal relative longitudinal motion. The outer tube 2 of the cylinder 1 is joined with the pulley 73. The pressurized fluid supplied through the cylinder inlet, i.e. the lower drilled cap 22, performs the first lifting stage, i.e. the full free lift, Fig. 7B: fluid pressure pushes upward the outer tube 2 that by means of the pulley 73 and the chain 74 lifts the fork carriage 75 and the forks at a 2:1 ratio relative to the movement of the tube 2. When the first stage is completed, oil pressure increases and the second lifting stage starts, during which the tube 6 of the cylinder 1 moves upward sliding on the rod 18 and drags simultaneously the mobile frame 72, the outer tube 2, the pulley 73, the chain 74 and the fork carriage 75 at a 1:1 ratio relative to movement of the tube 6. At the end of the second lifting stage, the mast assembly 70 is at its maximum elevation, as shown in Fig. 7C.

[0039] According to the aim of the invention, i.e. improving forward visibility through the mast assembly, Fig. 11 shows the front view of the full free lift mast 70, comprising an inner mobile frame 72 and a fixed outer frame 71, that operates according the above drawings of Figs. 7A-B-C. There are shown the stationary outer frame 71, the mobile frame 72, the fork carriage 75, the two hydraulic two-step cylinders 1 arranged adjacent to the outer sides of the mast assembly 70, the two chains 74 and the two pulleys 73, symmetrically arranged between the inner sides of the mast assembly 70. The two pulleys 73 are stationary to the the outer tubes 2 of the two-step cylinder assemblies 1 by means of the brackets 77 of the tie-bar 78.

[0040] The above embodiment of the present invention is for illustrative purposes and obviously you could use other configurations without departing from the functional scheme in Fig. 7A-B-C: for example, the two chains 74 and the pulleys 73 can be positioned adjacent to the outer sides of mast assembly 70, as done for the hydraulic cylinders 1.

[0041] Figs. 8A-B-C are schematized side views representing the lifting sequence of the full free lift mast 80 comprising two mobile frames 82, 83 and an outer stationary frame 81. For this mast, a pair of hydraulic two-step cylinders 51 in Fig. 5 are used, so that the first stroke is in the opposite longitudinal direction to the second stroke, as stated above and illustrated in Figs. 5A-B-C.

[0042] The schematized mast assembly 80 is shown in its neutral position, Fig. 8A, at the end of the first stage, the full free lift, Fig. 8B, and at the end of the second stage Fig. 8C, i.e. at the maximum elevation.

[0043] The tubular rod 18 of the cylinder assembly 51 rests on the stationary outer frame 81 at the bottom; instead at the top, the intermediate mobile tube 56 of the cylinder assembly 51 is secured longitudinally to the upper tie-bar 99 of the intermediate mobile frame 82. The chain 86 is anchored at one end to the stationary outer frame 81 and at the other end to the fork carriage 87. The chain 86 is guided by the pulley 84 that is stationary to the mobile tube 52 and by the pulley 85 that is stationary to the inner mobile frame 83.

[0044] Pressurized fluid supplied by a hydraulic pump through the cylinder inlet, Fig. 8B, performs the first lifting stage that moves downward the outer tube 52 and the pulley 84 that, by means of the chain 86 and of the pulley 85, lifts the fork carriage 87 with the forks. The fork carriage moves upward at a 2:1 ratio relative to the downward movement of the tube 52 and of the pulley 84.

[0045] Fig. 8C shows the mast assembly 80 when it has completed the second lifting stage. During the second stage, the intermediate tube 56 of cylinder assembly 51 moves upward along the rod 18 and drags, at its same speed, the outer tube 52, the pulley 84 and the intermediate mobile frame 82. By means of the pulley 88, stationary to the intermediate frame 82, and by means of the chain 89, anchored at one end to the stationary outer frame 81 and at the other end to the inner mobile frame 83, the upward movement is transmitted to the inner mobile frame 83 at a 2:1 ratio relative to movement of the intermediate mobile frame 82 and of the intermediate tube 56. The fork carriage 87 moves upward together with the inner mobile frame 83, without relative movement, by means of the chain 86.

[0046] Referring to the schematized drawings shown in Fig. 8A-B-C, it is possible to assemble full free lift masts for lift trucks by means of a pair of hydraulic two-step cylinders 51, mounted rear or adjacent the outer sides of the mast, in order to improve forward visibility according to the aim of the invention.

[0047] Infact, for example, to improve forward visibility according to the aim of the invention, Fig. 12 is an embodiment that refers to the functional scheme of drawings in Figs. 8A-B-C and shows the rear view of the full free lift mast 80 for lift truck.

[0048] There are shown the stationary outer frame 81, the intermediate mobile frame 82, the inner mobile frame 83, the fork carriage 87, the pair of hydraulic two-step cylinders 51, the two inner chains 86, the two pulleys 84 fixed to the tie-bar 98 which is stationary to the outer tubes 52 of the cylinders 51 by means of the brackets 97, the two pulleys 85 stationary to the inner mobile frame 83 by means of a tie-bar (hidden in the view of Fig. 12), the two outer chains 89 and the two pulleys 88 fixed to the upper tie-bar 99 of the intermediate mobile frame 82.

[0049] Also in this case, the embodiment shown in Fig. 12 is an illustrative example that doesn't want to restrict the practical applications according to the functional scheme in Fig. 8A-B-C.

[0050] Figs. 9A-B-C represent the schematized side view of a full free lift mast 90. As above, this mast comprises two mobile frames 82, 83 and one stationary frame 81. A hydraulic two-step cylinder assembly 1 of the type in Fig. 1 is shown, i.e. the two strokes of the two-step cylinder 1 are in the same longitudinal direction. The mast is schematically depicted in its neutral state in Fig. 9A, at the end of the first lifting stage, the full free lift, in Fig. 9B, and at the end of second lifting stage, i.e. at the maximum expansion of the mast, in Fig. 9C.

[0051] In this case, the transmission of movements from the moving parts of the cylinder 1, i.e. the outer tube 2 and the intermediate tube 6, to the moving parts of the mast assembly, i.e. the fork carriage 87, the intermediate frame 82 and the inner frame 83, is provided by a pair of chains 91 which are guided by three pairs of pulleys 92, 93 and 94.

[0052] The tubular rod 18 of cylinder 1 rests at the bottom on stationary frame 81, while at the top the intermediate tube 6 of the cylinder 1 is joined to upper tie-bar 99 of the intermediate mobile frame 82. The chain 91 is anchored to the stationary frame 81 at one end and to the fork carriage 87 at the other end. The chain 91 is guided by means of the pulley 92, which is stationary to the outer tube 2 of the cylinder 1, and by means of pulleys 93 and 94, which are stationary to the inner mobile frame 83.

[0053] By means of a bracket 95, or an equivalent device, fastened to the upper end of the inner mobile frame 83, the fork carriage 87 is able to engage and drag the inner mobile frame 83. When fluid pressure is acting in the cylinder 1, the outer tube 2 and pulley 92 move upward and lift the fork carriage 87 by means of the chain 91 and the pulleys 93 and 94, Fig. 9B. The upward motion of the fork carriage 87 is at a 2:1 ratio relative to movement of the outer tube 2 and of the pulley 92. At the end of the first lifting stage, the full free lift, the fork carriage 87 comes in contact with the bracket 95 stationary to the inner mobile frame 83.

[0054] Fig. 9C shows the mast assembly 90 has completed also the second stage of lifting, during the which the intermediate tube 6 of the cylinder 1 moves upward, sliding on the stationary rod 18, and drags the outer tube 2, the pulley 92 and the intermediate frame 82. The chain 91 pulls upward the fork carriage 87 which-being in contact with the bracket 95, drags the inner frame 83. The fork carriage 87 and the inner frame 83 move at a 2:1 ratio relative to the movement of the intermediate tube 6 and of the intermediate frame 82.

[0055] As for previous cases, with reference to the functional drawings of Fig. 9A-B-C, just described, it is possible to assemble full free lift masts comprising two mobile frames which operate by means of a pair of two-step cylinders 1 positioned on the outer sides or rear of the mast, according to the aim of the invention.

[0056] Another embodiment of the present invention relates to a full free lift mast (100) in Figs 10A-B-C, comprising a single mobile frame as in the case shown in Figs. 7A-B-C, characterized by a pair of hydraulic cylinders 51 shown in Fig. 5, i.e. two-step cylinders wherein the strokes of first and second stage are in the opposite directions.

[0057] Figs. 10A-B-C represent the functional sequence of a full free lift mast 100 comprising a single mobile frame 72: respectively, Fig. 10A shows the mast assembly 100 in its neutral state, Fig. 10B shows the mast 100 at the end of first stage, the full free lift, and Fig. 10C shows the mast 100 at the end of the second stage, at the maximum extension.

[0058] There are represented the fork carriage 75, the mobile frame 72, the stationary frame 71, the hydraulic two-step cylinder assembly 51 and the other main parts described below.

[0059] The tubular rod 18 of the cylinder 51 rests at the bottom on the stationary frame 71, while, at the top, the intermediate tube 56 of the cylinder 51 is joined to the upper tie-bar 79 of the mobile frame 72. The outer tube 52 of the cylinder 51 is stationary to the pulley 103. The pulley 102 is fixed to the mobile frame 72. The chain 101 is anchored to the fork carriage 75, at one end, and to the mobile frame 72, at the other end.

[0060] When oil pressure is acting in the cylinder 51, firstly we have the full free lift stage, shown in Fig. 10B. Oil pressure pushes downward the outer tube 52 and the pulley 103, that by means of the chain 101 lifts the fork carriage 75. Upward movement of the fork carriage 75 is at a 2:1 ratio relative to the downward movement of the outer tube 52.

[0061] At the end of the first lifting stage, then the second stage starts. During the second stage, the intermediate tube 56 is sliding along the tubular rod 18 and is dragging upwards the mobile frame 72, the outer tube 52 with the pulley 103 and the fork carriage 75. Fig. 10C represents the full free lift mast assembly 100 at its maximum elevation, i.e. at the end of second stage. The movement of fork carriage 75 during second stage is at a 1:1 ratio relative to the movement of the intermediate tube 56.

[0062] Also with reference to the functional scheme shown in Figs. 10A-B-C, it is possible to assemble a full free lift mast comprising a single mobile frame that operates by means of a pair of two-step cylinders 51 positioned adjacent the outer sides or rear of the mast as-

sembly, according to improving visibility, the aim of the invention.

Claims

1. Full free lift telescopic mast (80; 90; 70; 100) for fork lift truck, that is able to perform a first lifting stage of the fork carriage without any increment of the overall mast length, hydraulically operated, comprising an outer stationary frame (81; 71), an inner mobile frame (83; 72), optionally an intermediate mobile frame (82) a fork carriage, or an equivalent load device, sliding in the inner mobile frame (83; 72), a lifting device comprising chains and guiding pulleys, **characterized in that** it is operated by means of two hyraulic two-step cylinders (51;1) symmetrically mounted on both (left and rigth) outer sides of mast assembly, or rear of the mast, each hydraulic two-step cylinder (51;1) comprising:

   - an inner tubular rod (18), supported down on the outer frame (81; 71),
   - an intermediate tube (6; 56; 66) with radial holes (17) for oil passage, sliding on the rod (18);
   - a stop collar(12);
   - an annular piston (9; 54; 69) welded, or anyway fixed, to the outer surface of the intermediate tube (6; 56; 66);
   - an outer tube (2; 52; 62), sliding on the intermediate tube (6; 56; 66), of such a length that its stroke is capable, by means of said lifting device, of raising completely the fork carriage along the inner frame.

2. Full free lift telescopic mast (80) comprising an outer stationary frame (81), an intermediate mobile frame (82) sliding on the stationary one (81), an inner mobile frame (83) sliding on the intermediate frame (82), a fork carriage (87) sliding in the inner mobile frame (83) and two hyraulic two-step cylinders **as claimed in claim 1, characterized in that:**

   • said hydraulic two-step cylinders (51) perform the first stroke of the outer tubes (52) downward, in the opposite direction of the second upward stroke of the intermediate tubes (56), the intermediate tubes (56) being fixed to the upper tie-bar (99) of the intermediate mobile frame (82);
   • said lifting device comprises:

      o two chains (86), or equivalent means, anchored at one end to the fork carriage (87), or equivalent load carriage, and at the other end to the upper side of stationary outer frame (81);
      o two pairs of pulleys (84), (85), guiding the two chains (86), of which a pair of pulleys (85) are fixed to the upper side of the inner mobile frame (83) and the other pair (84) are stationary to the outer mobile tubes (52) of the two hydraulic cylinders (51) by means of the brackets (97) of a tie-bar (98);
      o two chains (89), or equivalent means, anchored to the bottom side of the inner mobile frame (83), at one end, and to the upper side of the stationary outer frame (81) at the other end;
      o a pair of pulleys (88), guiding the chains (89), fixed to the upper side of the intermediate mobile frame (82).

3. Full free lift telescopic mast (90) comprising an outer stationary frame (81), an intermediate mobile frame (82), an inner mobile frame (83), a fork carriage (87) and two hydraulic two-step cylinders **as claimed in claim 1, characterized in that:**

   • said hydraulic two-step cylinders (1) perform the first stroke of the outer tubes(2) upward, in the same direction of the second upward stroke of the intermediate tubes (6) which are fixed to the upper side of the intermediate mobile frame (82);
   • said lifting device comprises:

      o two chains (91), or equivalent means, anchored at one end to the fork carriage (87), or equivalent load carriage, and at the other end to the upper side of stationary outer frame (81);
      ◦ three pairs of pulleys, guiding the two chains (91), of which a pair of pulleys (94) are fixed to the upper side of the inner mobile frame (83), a pair (93) are fixed to the bottom side of the inner mobile frame (83) and the other pair (92) are stationary to the outer mobile tubes (2) of the two hydraulic cylinders (1) by means of brackets of a tie-bar;
      o a device (95) fixed to the upper side of the inner mobile frame (83) by means of which the fork carriage (87) is able to carry upward the inner frame (83).

4. Full free lift telescopic mast (70) comprising an outer stationary frame (71), an inner mobile frame (72), a fork carriage (75) and two hydraulic two-step cylinders **as claimed in claim 1, characterized in that:**

• said hydraulic two-step cylinders (1) perform the first stroke of the outer tubes (2) upward, in the same direction of the second upward stroke of the intermediate tubes (6) which are fixed to the upper tie-bar (79) of the inner mobile frame (72);
• said lifting device comprises:.

◦ two chains (74), or equivalent means, anchored at one end to the fork carriage (75), or equivalent load carriage, and at the other end to the mobile frame (72);
o a pair of pulleys (73), guiding the two chains (74), stationary to the outer tubes (2) of the cylinders (1) by means of the brackets (77) of a tie-bar (78).

5. Full free lift telescopic mast (100) comprising an outer stationary frame (71), a inner mobile frame (72), a fork carriage (75) and two hyraulic two-step cylinders as claimed in claim 1, **characterized in that**:

• said hydraulic two-step cylinders (51) perform the first stroke of the outer tubes (52) downward, in the opposite direction of the second upward stroke of the intermediate tubes (56) which are fixed to the upper tie-bar (79) of the inner mobile frame (72);
• said lifting device comprises:

◦ two chains (101) anchored at one end to the fork carriage (75) and at the other end to the upper side of the mobile frame (72);
o two pairs of pulleys, guiding the two chains (101), of which a pair (102) are fixed to the upper side of the inner mobile frame (72) and the other pair are fixed to the outer tubes (52) of the cylinders (51) by means of the brackets of a tie-bar.

6. Full free lift telescopic mast as claimed in one of claim 2 to 5, **characterized in that** at least one of the two hydraulic two-step cylinders is equipped with a braking valve. (24) arranged within the piston (19), being the valve (24) equipped with a spring (23) and calibrated radial holes (25).

Patentansprüche

1. Vollfreihub-Teleskopmast (80; 90;70;100) für Gabelstapler, der mittels eines Hydraulikantriebs in der Lage ist, eine erste Hebestufe der Gabelträger ohne Erhöhung der Gesamtmastlänge durchzuführen, mit einem stationären Außenrahmen (81;71), einem beweglichen Innenrahmen, als Option mit einem beweglichen Zwischenrahmen (82), einem Gabelträger oder einer entsprechenden Ladevorrichtung, die im inneren Rahmen (83;72) gleitet, mit einer Hebevorrichtung und Führungsscheiben, **dadurch gekennzeichnet, dass** er mit zwei zweistufigen Hydraulikzylindern (51;1) betrieben wird, die symmetrisch an den beiden Außenseiten der Rahmeneinheit (links und rechts), oder auf der Rückseite des Masts montiert sind, wobei jeder zweistufige Hydraulikzylinder (51; 1) Folgendes umfasst:

➢ eine innere Rohrstange (18), die sich am äußeren Rahmen (81;71)
abstützt;

➢ ein Zwischenrohr (6; 56; 66) mit radialen Bohrungen (17) als Ölkanal,
und das auf der Stange (18) gleitet;

➢ ein Anschlagbund (12);

➢ einen angeschweißten oder auf andere Art befestigten Ringkolben (9; 54; 69) an der Außenfläche des Zwischenrohrs (6; 56; 66);

➢ ein Außenrohr (2; 52; 62), das auf dem Zwischenrohr (6; 56; 66) gleitet
und eine solche Länge aufweist, dass sein Hub mittels der Hebevorrichtung in der Lage ist, den Gabelträger entlang des Innenrahmens vollständig anzuheben.

2. Vollfreihub-Teleskopmast (80) mit einem stationären Außenrahmen (81), einem beweglichen Zwischenrahmen (82), der auf dem stationären Rahmen (81) gleitet, einem beweglichen Innenrahmen (83), der auf dem Zwischenrahmen (82) gleitet, einem Gabelträger (87), der im beweglichen Innenrahmen (83) gleitet und zwei zweistufigen Zylindern **gemäß Anspruch 1, dadurch gekennzeichnet:**

• **dass** die zweistufigen Hydraulikzylinder (51) den ersten Hub der äußeren Rohre (52) in Abwärtsrichtung und in die entgegen gesetzte Richtung den zweiten Aufwärtshub der Zwischenrohre (56) ausführen, wobei die Zwischenrohre (56) an der oberen Strebe (99) des beweglichen Zwischenrahmens (82) befestigt sind;
• diese Hebevorrichtung umfasst:

o zwei Ketten (86) oder entsprechende Elemente, die auf einer Seite am Gabelträger (87) oder entsprechenden Ladevorrichtung und auf der anderen Seite an der Oberseite des stationären Außenrahmens (81) verankert sind;
o zwei Kettenscheibenpaare (84), (85) zum Führen der beiden Ketten (86), wobei ein Kettenscheibenpaar (85) an der Oberseite des beweglichen Innenrahmen (83) ist, und das andere Paar (84) mittels den Halterun-

gen (97) einer Strebe (98) stationär zu den beweglichen Rohren (52) der beiden Hydraulikzylinder (51) befestigt ist;
o zwei Ketten (89) oder entsprechende Elemente, die auf einer Seite an der Unterseite des beweglichen Innenrahmens (83), und auf der anderen Seite an der Oberseite des stationären Außenrahmens (81) verankert sind;
o zwei Kettenscheibenpaare (88) zum Führen der Ketten (89), die an der Oberseite am beweglichen Zwischenrahmen (82) verankert sind.

3. Vollfreihub-Teleskopmast (90) mit einem stationären Außenrahmen (81), einem beweglichen Zwischenrahmen (82), einem beweglichen Innenrahmen (83), einem Gabelträger (87) und zwei zweistufigen Zylindern **gemäß Anspruch 1, dadurch gekennzeichnet:**

• **dass** die zweistufigen Hydraulikzylinder (1) den ersten Hub der äußeren Rohre (2) in Aufwärtsrichtung und in dieselbe Richtung den zweiten Aufwärtshub der Zwischenrohre (6) ausführen, die an der Oberseite des beweglichen Zwischenrahmens (82) befestigt sind;
• diese Hebevorrichtung umfasst:

o zwei Ketten (91) oder entsprechende Elemente, die auf einer Seite am Gabelträger (87) oder entsprechenden Ladevorrichtung, und auf der anderen Seite an der Oberseite des stationären Außenrahmens (81) verankert sind;
o drei Kettenscheibenpaare zum Führen der beiden Ketten (91), wobei ein Kettenscheibenpaar (94) an der Oberseite des beweglichen Innenrahmen (83), ein Kettenscheibenpaar (93) an der Unterseite des beweglichen Innenrahmens (83) und das andere Paar (92) mittels den Halterungen einer Strebe stationär zu den beweglichen Außenrohren (2) der beiden Hydraulikzylinder (1) befestigt ist;
o eine Vorrichtung (95), die an der Oberseite des beweglichen Innenrahmens (83) befestigt ist, womit der Gabelträger (87) in der Lage ist, den Innenrahmen (83) nach oben zu fahren.

4. Vollfreihub-Teleskopmast (70) mit einem stationären Außenrahmen (71), einem beweglichen Innenrahmen (72), einem Gabelträger (75) und zwei zweistufigen Zylindern **gemäß Anspruch 1, dadurch gekennzeichnet:**

• **dass** die zweistufigen Hydraulikzylinder (1) den ersten Hub der äußeren Rohre (2) in Aufwärtsrichtung und in dieselbe Richtung den zweiten Aufwärtshub der Zwischenrohre (6) ausführen, die an der oberen Strebe (79) des beweglichen Zwischenrahmens (72) befestigt sind;
• diese Hebevorrichtung umfasst:

o zwei Ketten (74) oder entsprechende Elemente, die auf einer Seite am Gabelträger (75) oder entsprechenden Ladevorrichtung, und auf der anderen Seite am beweglichen Rahmen (72) verankert sind;
o ein Kettenscheibenpaar (73) zum Führen der beiden Ketten (74), das mittels den Halterungen (77) einer Strebe (78) stationär zu den Außenrohren (2) der Zylinder (1) befestigt ist;

5. Vollfreihub-Teleskopmast (100) mit einem äußeren stationären Rahmen (71), einem beweglichen Innenrahmen (72), einem Gabelträger (75) und zwei zweistufigen Zylindern **gemäß Anspruch 1, dadurch gekennzeichnet:**

• **dass** die zweistufigen Zylinder (51) den ersten Hub der Außenrohre (52) in Abwärtsrichtung und in die entgegen gesetzte Richtung den zweiten Aufwärtshub der Zwischenrohre (56) ausführen, die an der oberen Strebe (79) des beweglichen Innenrahmens (72) befestigt sind;
• diese Hebevorrichtung umfasst:

o zwei Ketten (101) oder entsprechende Elemente, die auf einer Seite am Gabelträger (75) und auf der anderen Seite am beweglichen Rahmen (72) verankert sind;
o zwei Kettenscheibenpaare zum Führen der beiden Ketten (101), wobei ein Kettenscheibenpaar (102) an der Oberseite des beweglichen Innenrahmens (72) und das andere Paar mittels den Halterungen einer Strebe an den Außenrohren (52) der Zylinder (51) befestigt ist;

6. Vollfreihub-Teleskopmast **gemäß einem der Ansprüche 2 bis 5, dadurch gekennzeichnet, dass** mindestens einer der beiden zweistufigen Zylinder über ein Bremsventil (24) im Kolben (19) verfügt, wobei das Ventil (24) über eine Feder (23) und kalibrierte radial angeordnete Bohrungen (25) verfügt.

Revendications

1. Mât télescopique avec plein levée libre (80, 90, 70, 100) pour chariot élévateur à fourche, qui est capable d'effectuer une première étape de levage du ta-

blier porte-fourche, sans aucune augmentation de la longueur totale du mât, à commande hydraulique, comprenant un chassis fixe extérieur (81, 71), un chassis intérieur mobile, éventuellement, un chassis mobile intermédiaire (82), un tablier porte-fourche, ou un dispositif de charge équivalente, coulissant dans le chassis mobile interne (83, 72), un dispositif de levage comprenant des chaînes et des poulies de guidage, **caractérisé en ce qu** 'il est actionné au moyen de deux vérins hydrauliques à deux étapes (51, 1) montés de manière symétrique sur les côtés extérieurs (gauche et droite) de l'assemblage de mât, ou à l'arrière du mât, chaque vérin hydraulique à deux étapes (51; 1), comprenant:

- une tige tubulaire intérieure (18), supporté sur le chassis extérieur (81, 71);
- un tube intermédiaire (6, 56, 66) avec des trous radiaux (17) pour le passage d'huile, coulissant sur la tige (18);
- un collier d'arrêt (12);
- un piston annulaire (9, 54, 69) soudée, ou de toute façon fixée, à la surface extérieure du tube intermédiaire (6, 56, 66);
- un tube extérieur (2, 52, 62), coulissant sur le tube intermédiaire (6, 56, 66), d'une longueur telle que sa course est capable, au moyen dudit dispositif de levage, de soulever complètement le tablier porte-fourche le long du chassis intérieur.

2. Mât télescopique avec plein levée libre (80) comprenant un châssis fixe extérieur (81), un châssis mobile intermédiaire (82) coulissant sur l'une fixe (81), un châssis mobile interne (83) coulissant sur le châssis intermédiaire (82), un tablier porte-fourche (87) coulissant dans le châssis interne mobile (83) et deux cylindres hydrauliques en deux étapes selon la revendication 1, **caractérisé en ce que:**

- lesdits vérins hydrauliques à deux étapes (51) exécute la première course des tubes extérieurs (52) vers le bas, dans la direction opposée de la seconde course vers le haut des tubes intermédiaires (56), les tubes intermédiaires (56) étant fixés à l'barre de liaison supérieure (99) du châssis intermédiaire mobile (82);
- ledit dispositif de levage comprend:
  - o deux chaînes (86) ou des moyens équivalents, ancrés à une extrémité sur le tablier porte-fourche (87), ou de transport de charge équivalent, et à l'autre extrémité à la face supérieure du chassis extérieur fixe (81);
  - o deux paires de poulies (84), (85), les deux chaînes de guidage (86), dont une paire de poulies (85) sont fixés sur le côté supérieur du châssis mobile interne (83) et l'autre paire (84) sont fixes sur les tubes mobiles extérieures (52) des deux vérins hydrauliques (51) au moyen des crochets (97) d'une barre de liaison (98);
  - o deux chaînes (89) ou des moyens équivalents, ancrées à la partie inférieure du châssis mobile interne (83), à une extrémité, et à la face supérieure du chassis extérieur fixe (81) à l'autre extrémité;
  - o une paire de poulies (88), le guidage des chaînes (89), fixés à la face supérieure du châssis intermédiaire mobile (82).

3. Mât télescopique avec plein levée libre (80) comprenant un châssis fixe extérieur (81), un châssis mobile intermédiaire (82), un châssis mobile interne (83), un tablier porte-fourche (87) et deux vérins hydrauliques à deux étapes selon la revendication 1, **caractérisé en ce que:**

- lesdits vérins hydrauliques à deux étapes (1) effectuent la première course des tubes extérieur (2) vers le haut, dans le même sens de la seconde course vers le haut des tubes intermédiaires (6) qui sont fixés sur le côté supérieur du chassis mobile intermédiaire (82);
- ledit dispositif de levage comprend:
  - o deux chaînes (91) ou des moyens équivalents, ancrés à une extrémité sur le tablier porte-fourche (87), ou de transport de charge équivalent, et à l'autre extrémité à la face supérieure du chassis extérieur fixe (81);
  - o trois paires de poulies de guidage, les deux chaînes (91), dont une paire de poulies (94) sont fixés sur le côté supérieur du châssis mobile interne (83), une paire (93) sont fixés sur le côté inférieur de l'chassis intérieur mobile (83) et l'autre paire (92) sont à l'arrêt pour les tubes mobiles externes (2) des deux cylindres hydrauliques (1) au moyen de crochets d'une barre de liaison;
  - o un dispositif (95) fixé sur le côté supérieur du châssis mobile interne (83) au moyen duquel le chariot porte-fourche (87) est capable de transporter vers le haut le chassis intérieur (83).

4. Mât télescopique avec plein levée libre (70) comprenant un chassis extérieur fixe (71), un châssis mobile interne (72), un tablier porte-fourche (75) et deux vérins hydrauliques à deux étapes selon la revendication 1, **caractérisé en ce que**:

• dit vérins hydrauliques en deux étapes (1) exécutent la première course des tubes extérieurs (2) vers le haut, dans le même sens de la deuxième course vers le haut des tubes intermédiaires (6) qui sont fixés à la barre de liaison supérieure (79) du châssis mobile interne (72);
• ledit dispositif de levage comprend:

o deux chaînes (74) ou des moyens équivalents, ancrés à une extrémité sur le tablier porte-fourche (75), ou de transport de charge équivalent, et à l'autre extrémité à le châssis mobile (72);
o une paire de poulies (73), de guidage pour les deux chaînes (74), stationnaires par rapport aux deux tubes extérieures (2) des vérins (1) par l'intermédiaire des supports (77) d'une barre de liaison (78).

5. Mât télescopique avec plein levée libre (100) comprenant un chassis extérieur fixe (71), un châssis mobile intérieure (72), un tablier porte-fourche (75) et deux vérins hydrauliques en deux étapes selon la revendication 1, **caractérisé en ce que:**

• lesdits vérins hydrauliques à deux étapes (51) exécute la première course des tubes extérieurs (52) vers le bas, dans la direction opposée de la seconde course vers le haut des tubes intermédiaires (56) qui sont fixés à la barre de liaison supérieure (79) du châssis mobile interne (72);
• ledit dispositif de levage comprend:

o deux chaînes (101) ancrés à une extrémité sur le tablier porte-fourche (75) et à l'autre extrémité à la partie supérieure du châssis mobile (72);
o deux paires de poulies, de guidage pour les deux chaînes (101), dont une paire (102) sont fixés à la partie supérieure du châssis intérieure mobile (72) et l'autre paire sont fixés sur les tubes extérieurs (52) des cylindres (51) au moyen des crochets d'une barre de liaison.

6. Mât télescopique avec plein levée libre **selon l'une des revendications 2 à 5, caractérisé en ce qu** 'au moins un des deux vérins hydrauliques en deux étapes est équipé d'une soupape de freinage (24) disposé à l'intérieur du piston (19), et le soupape (24) est équipé d'un ressort (23) et des trous radiaux calibrés (25).

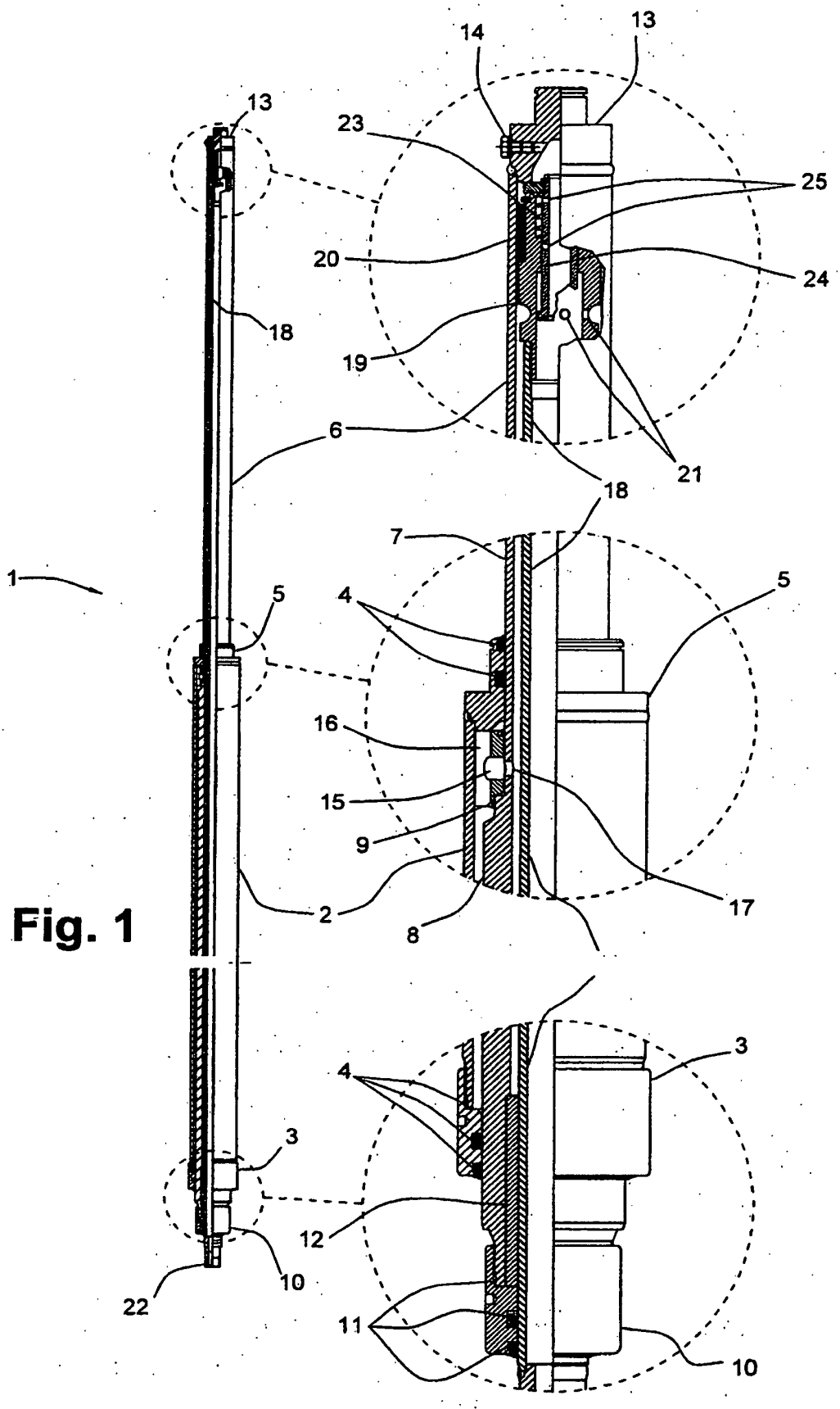

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Fig. 1

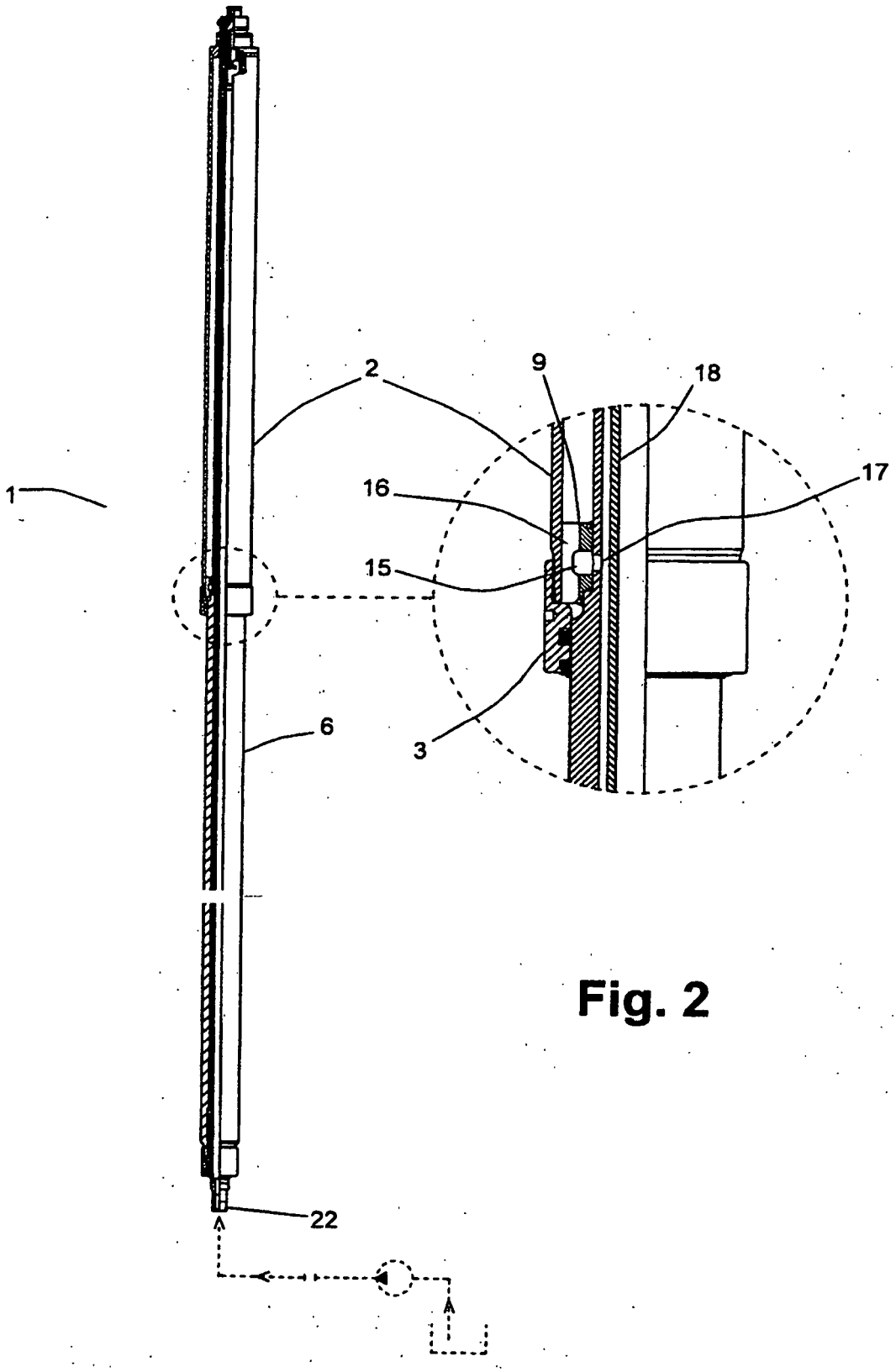


Fig. 2

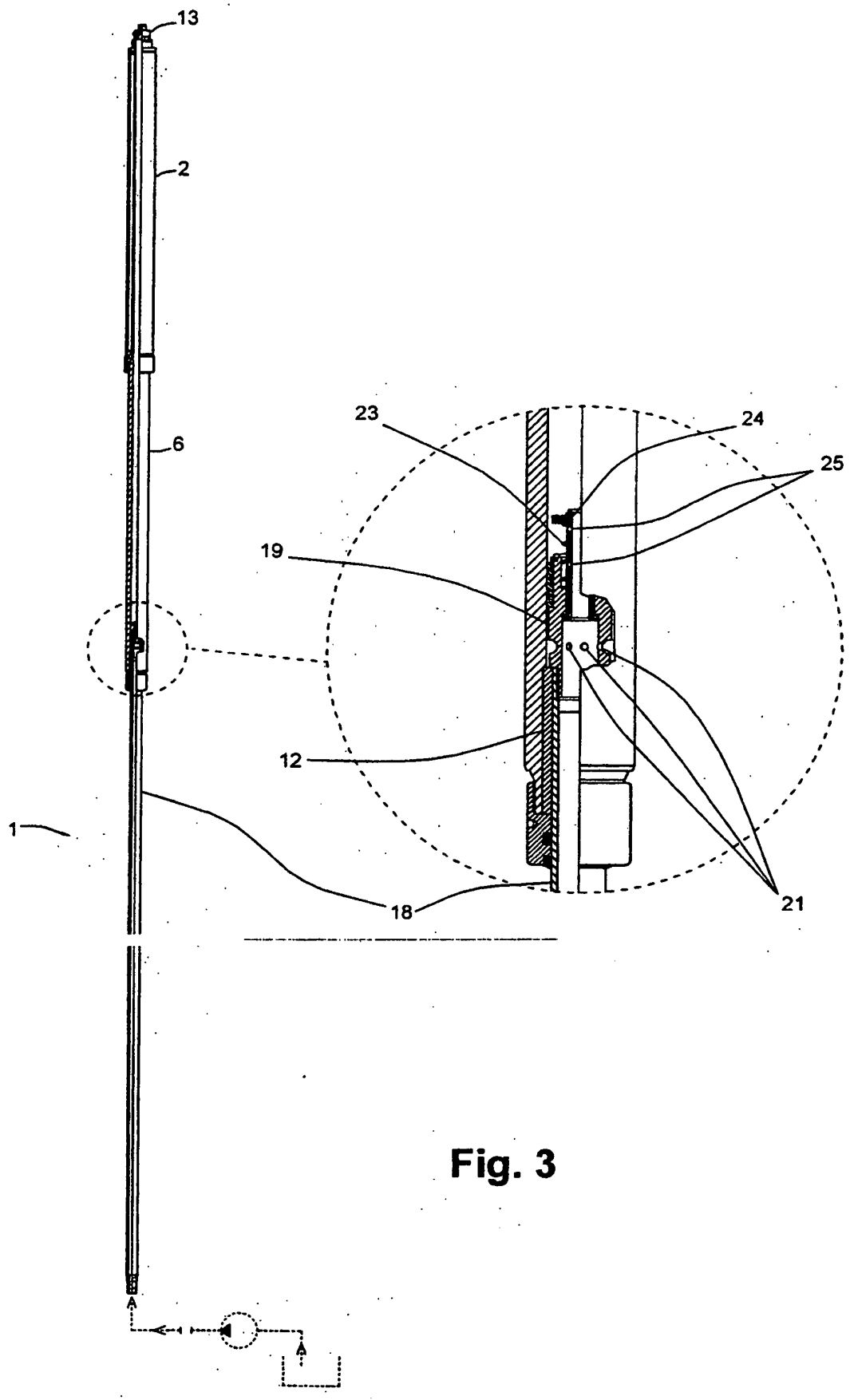


Fig. 3

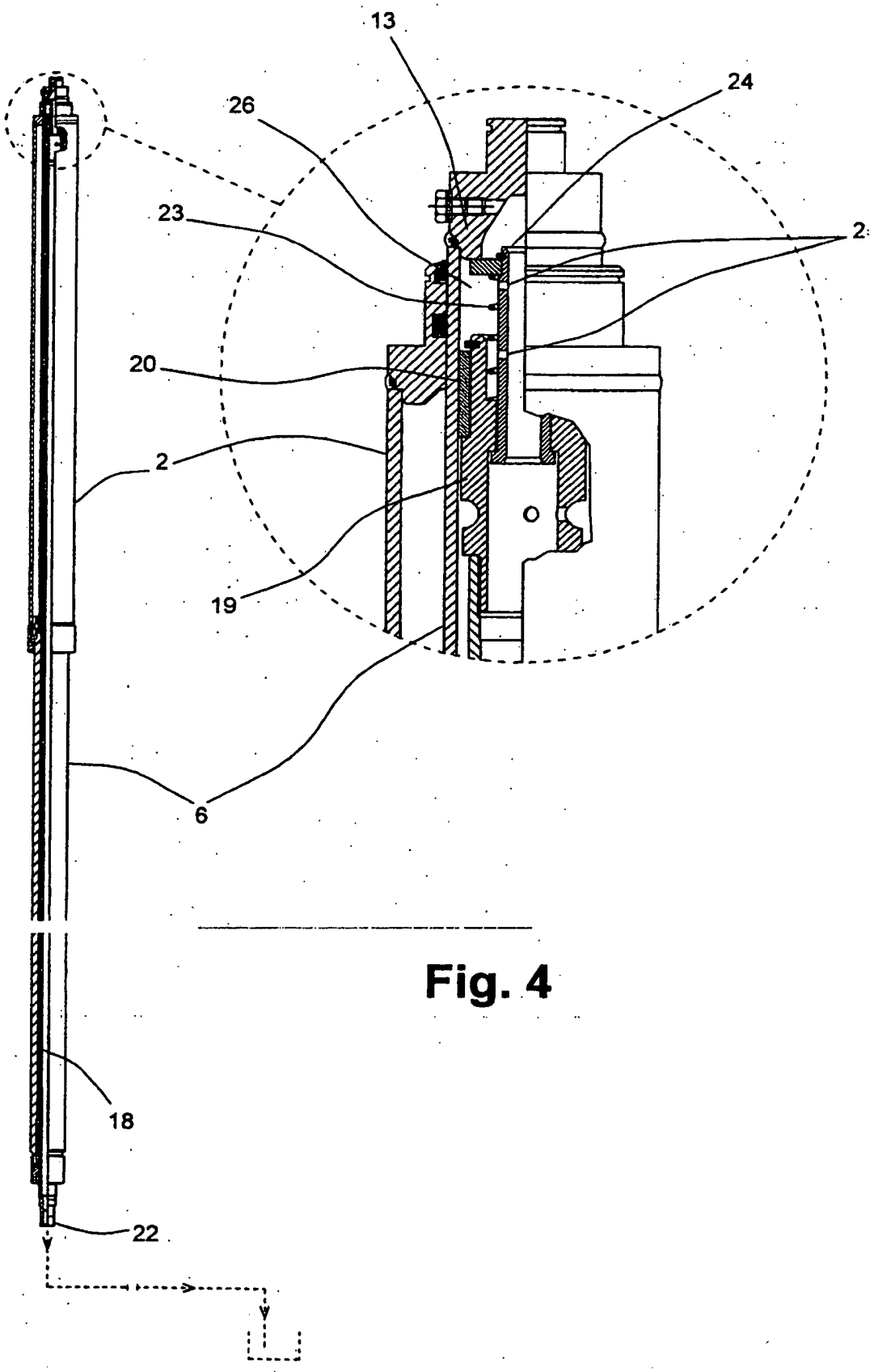


Fig. 4

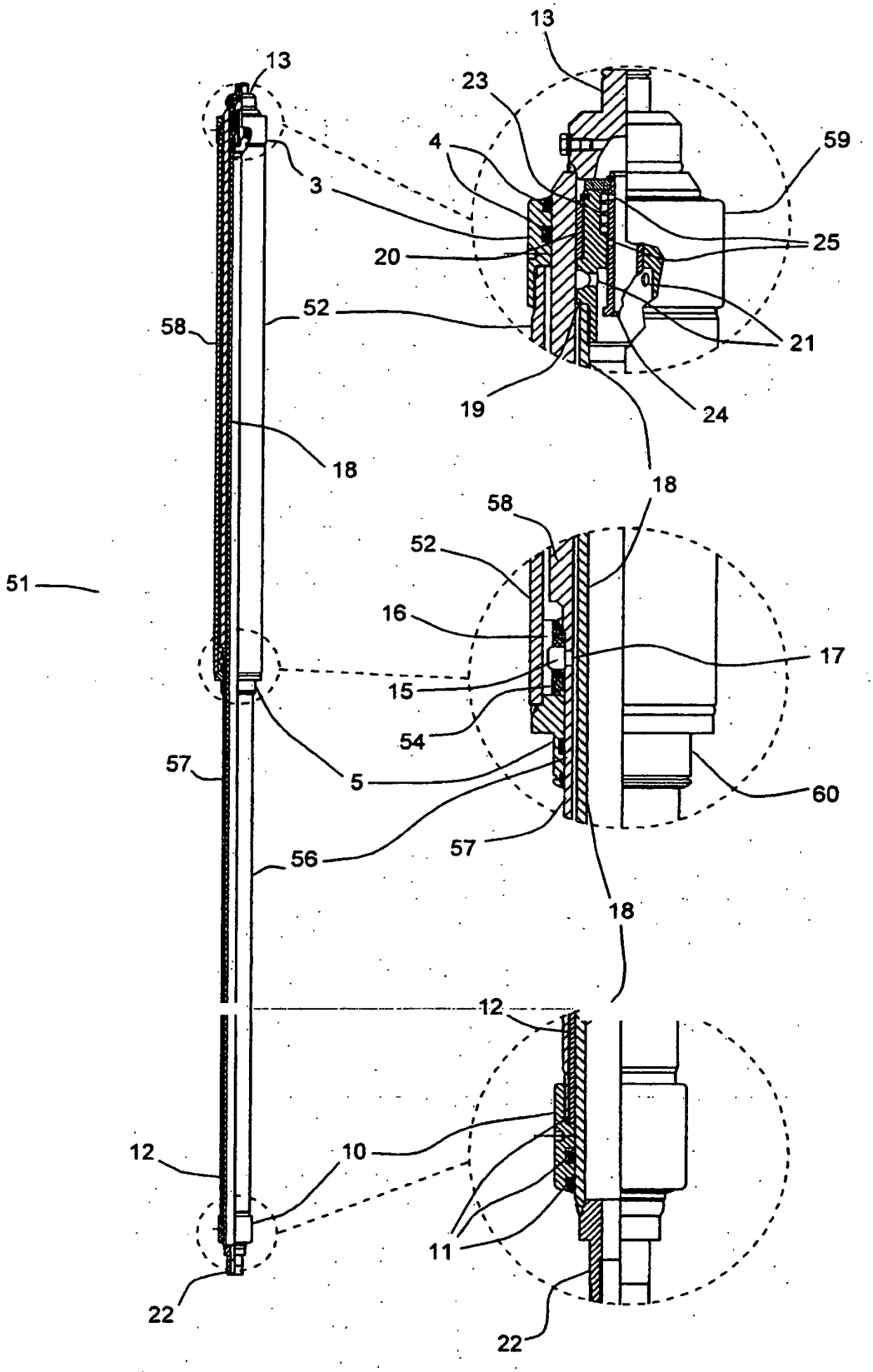

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Fig. 5A

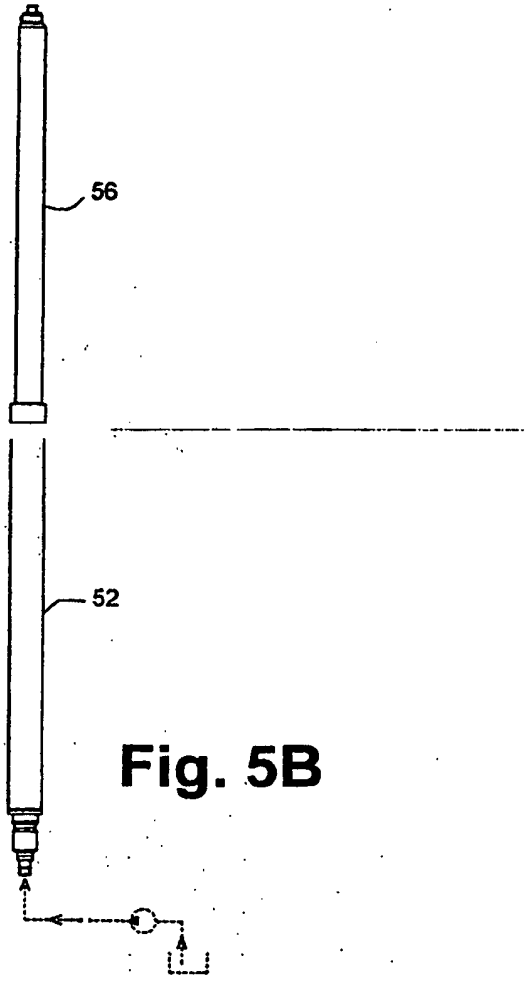


Fig. 5B

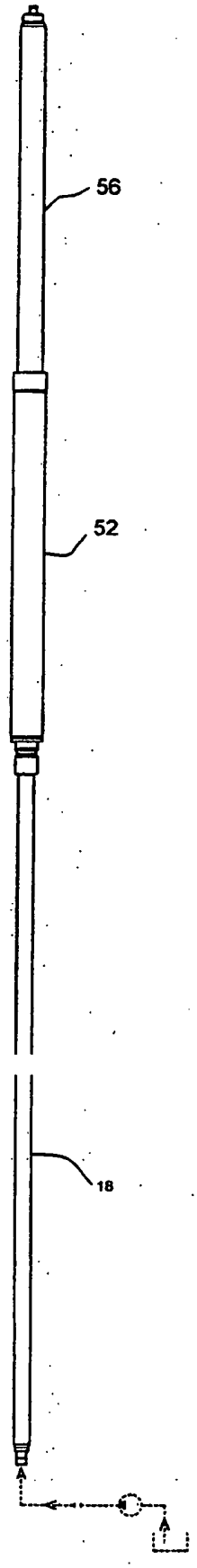


Fig. 5C

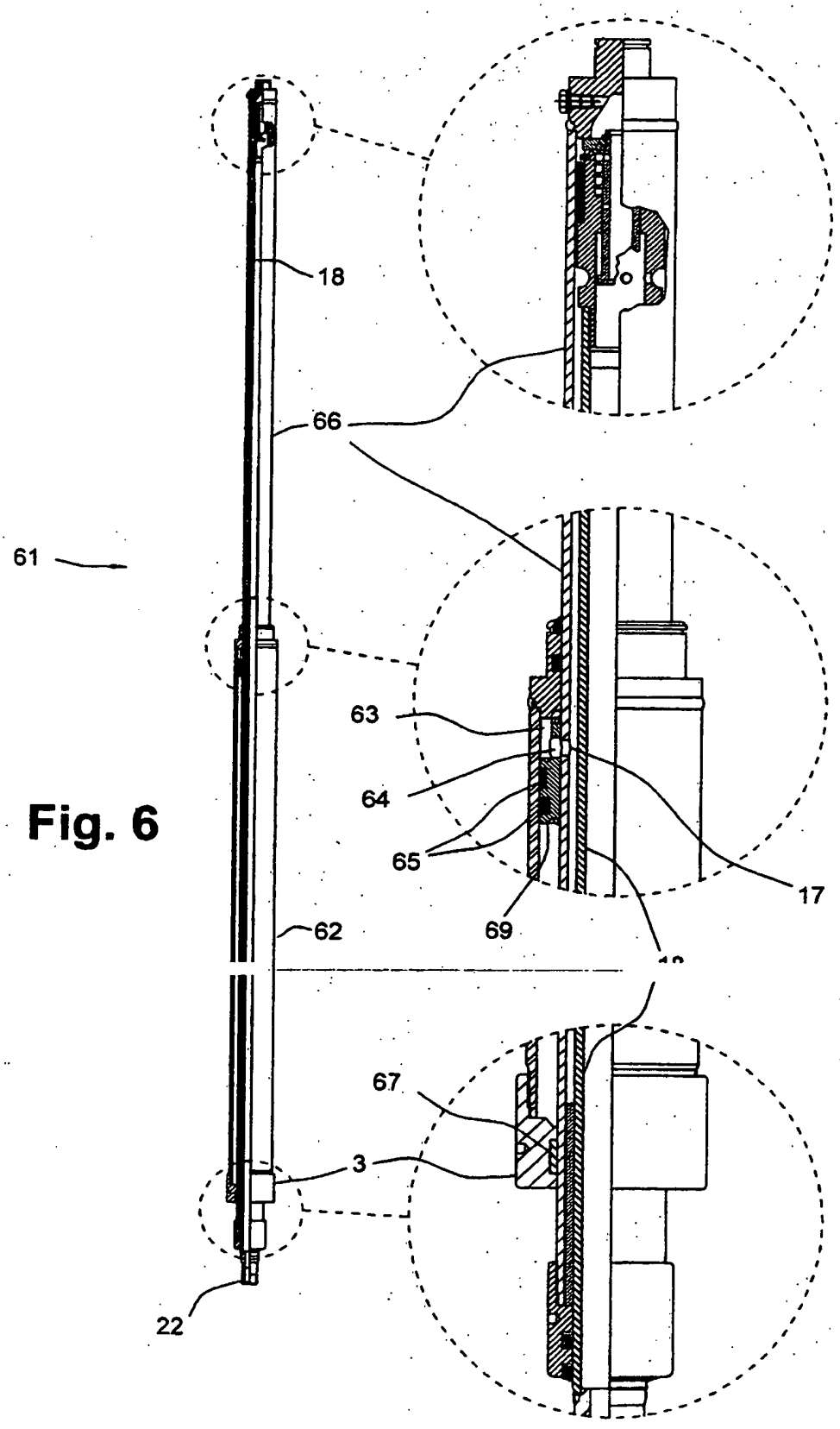


Fig. 6

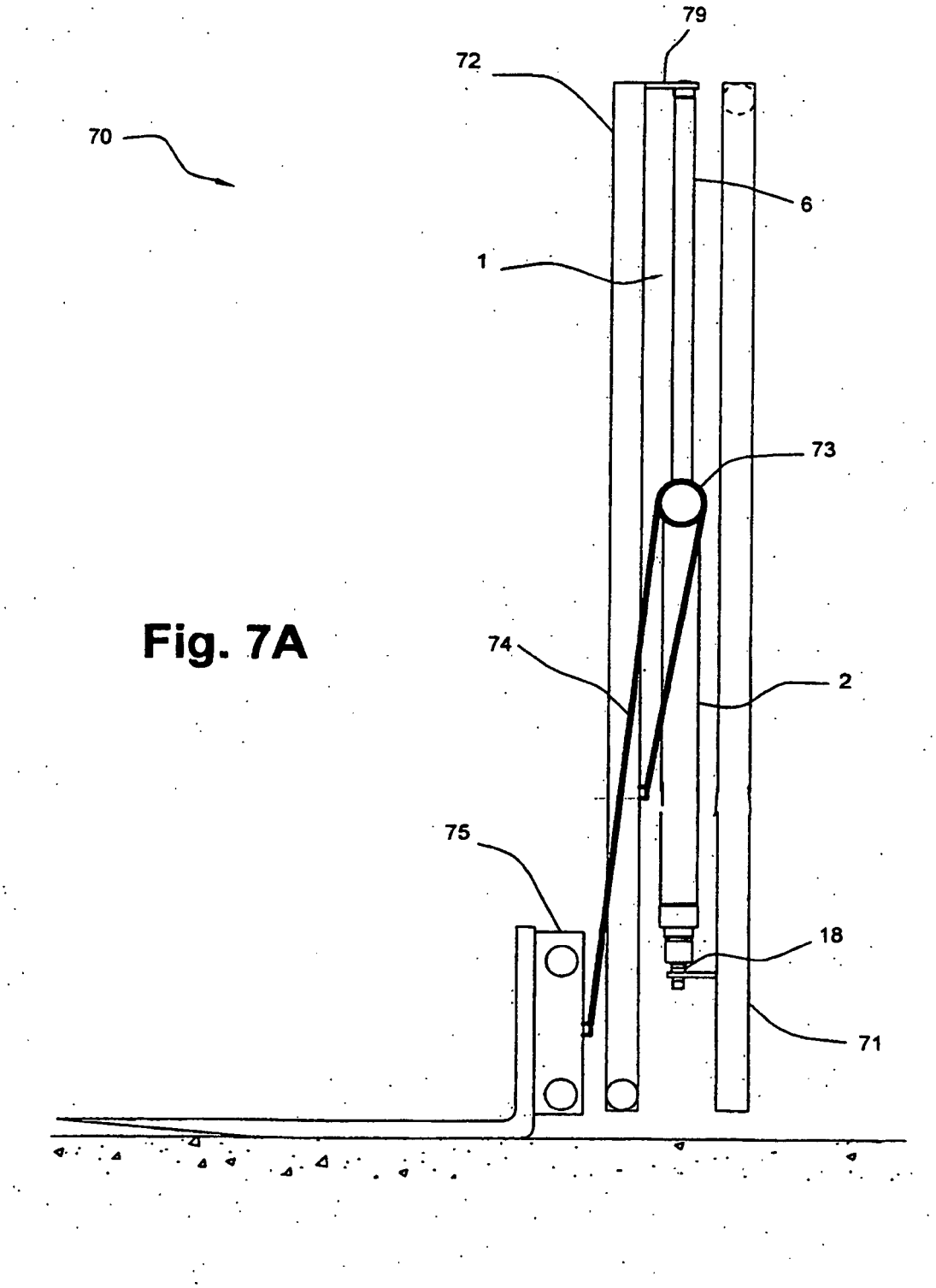


Fig. 7A

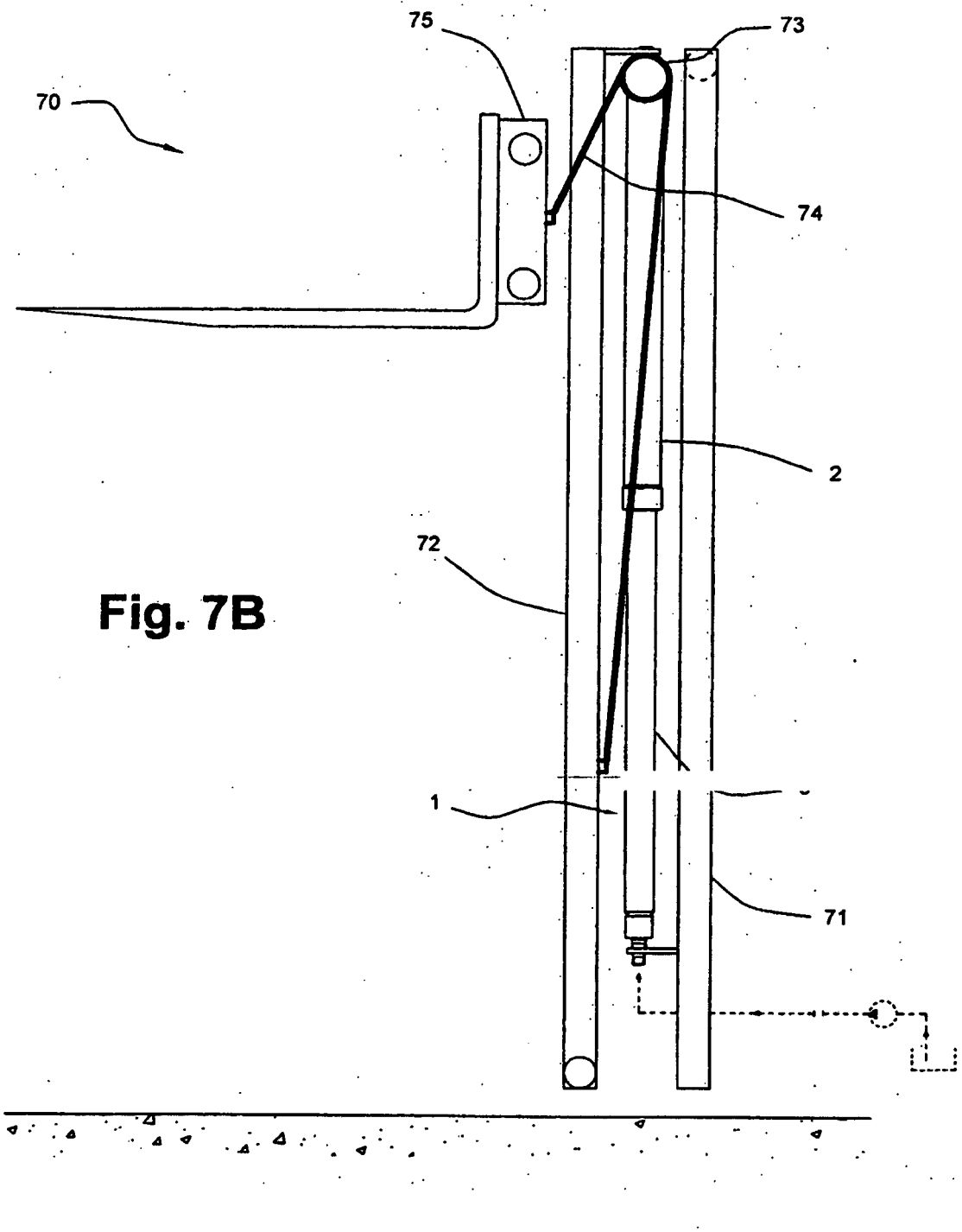


Fig. 7B

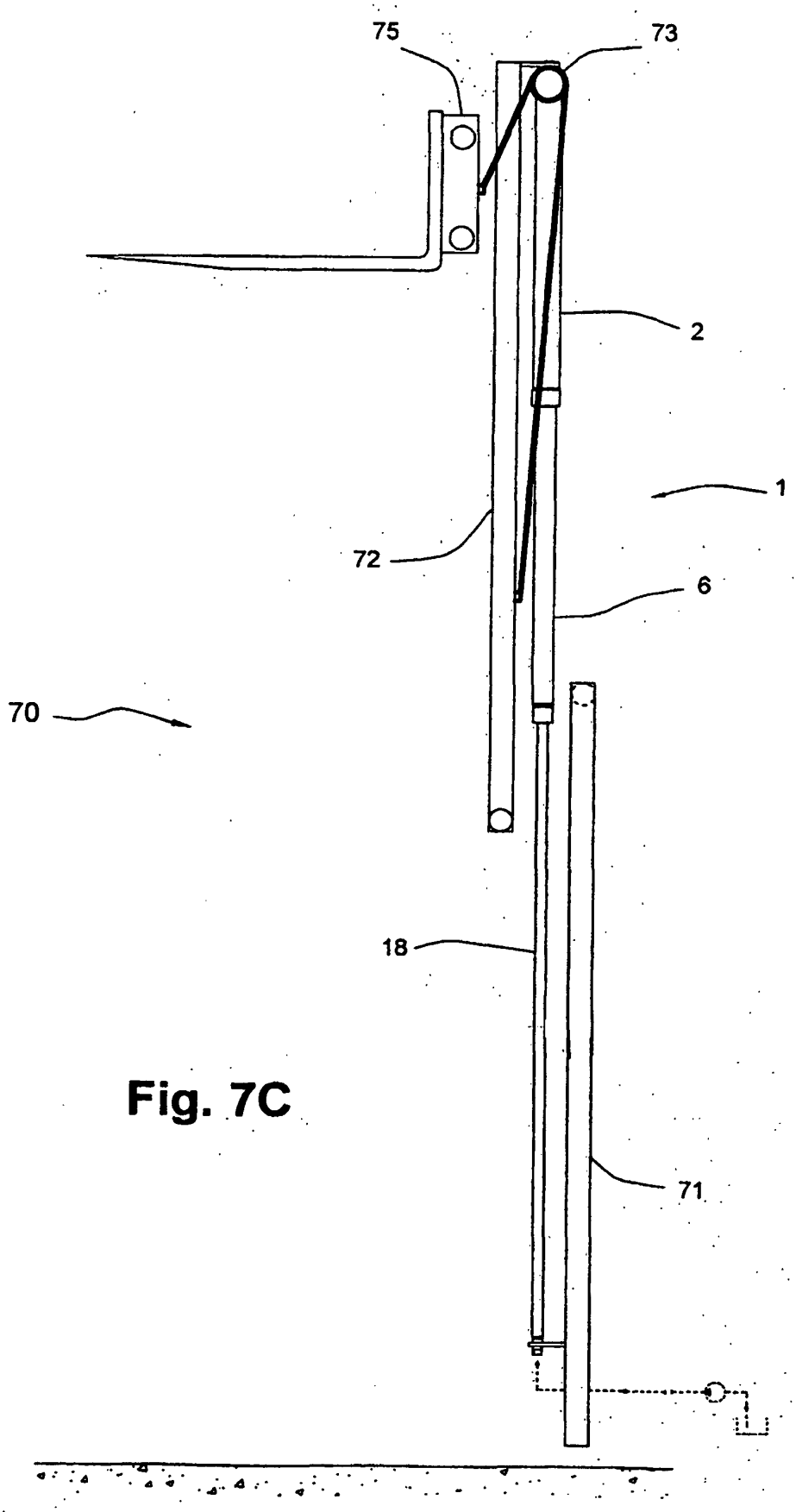


Fig. 7C

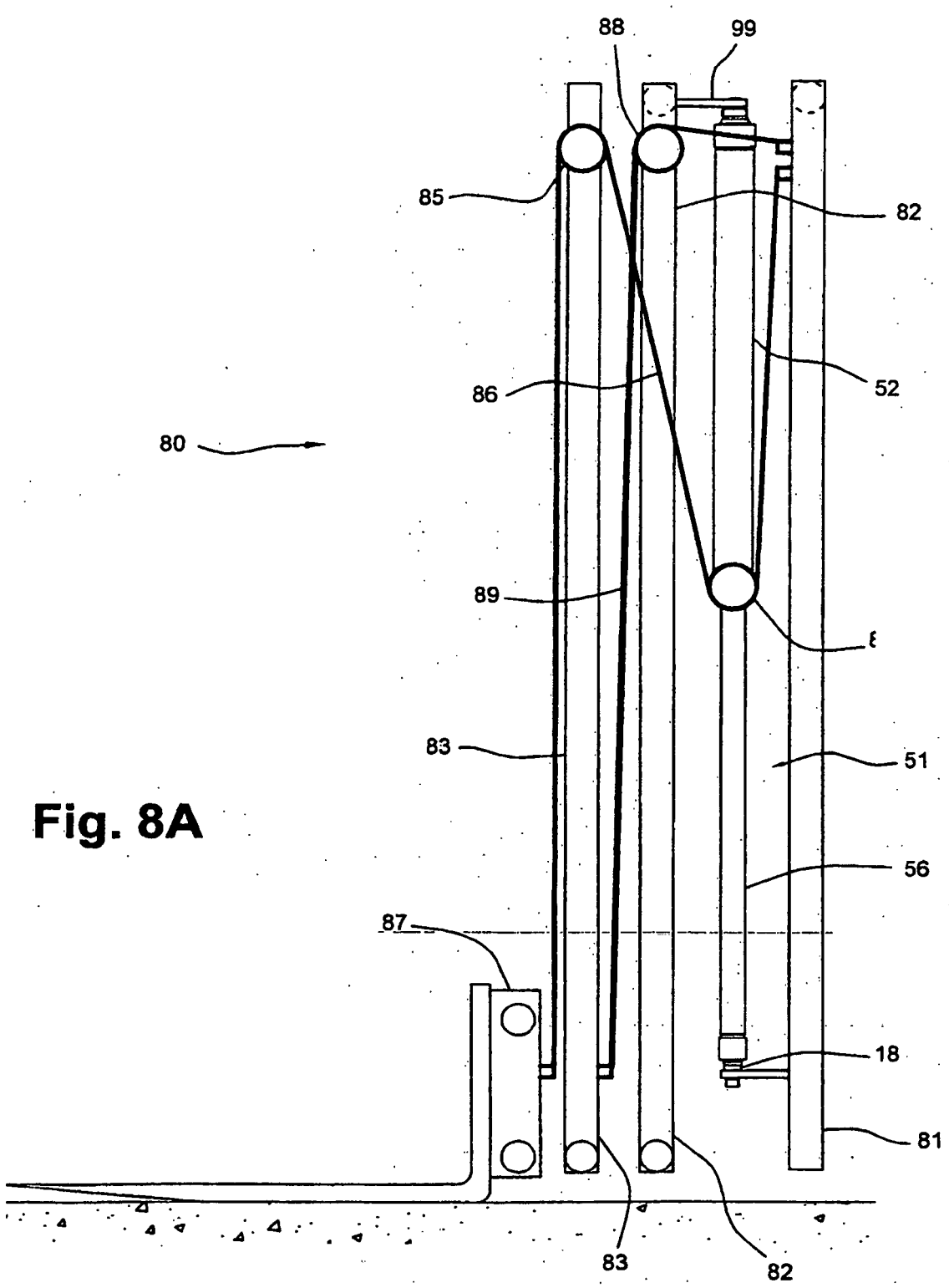


Fig. 8A

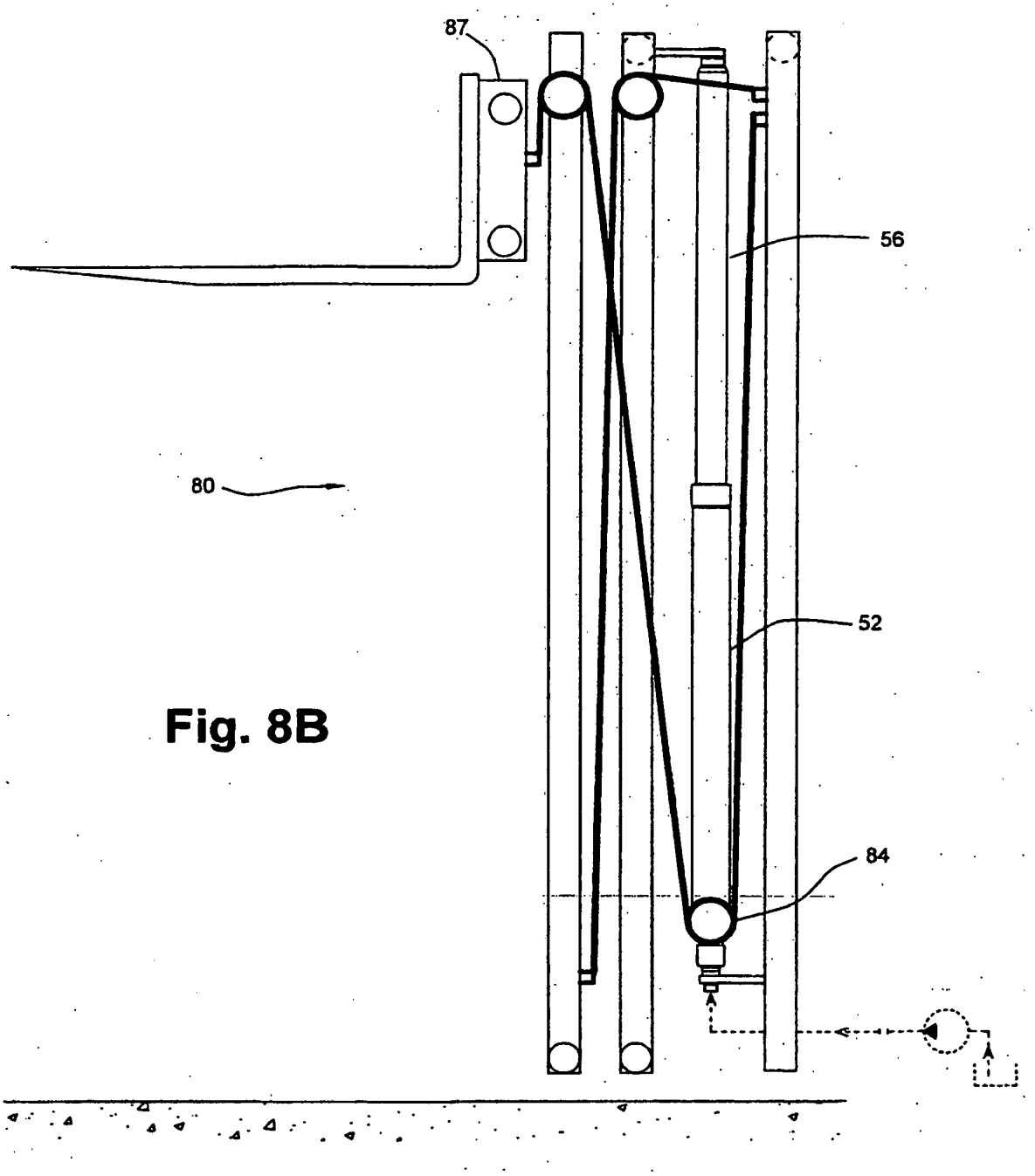


Fig. 8B

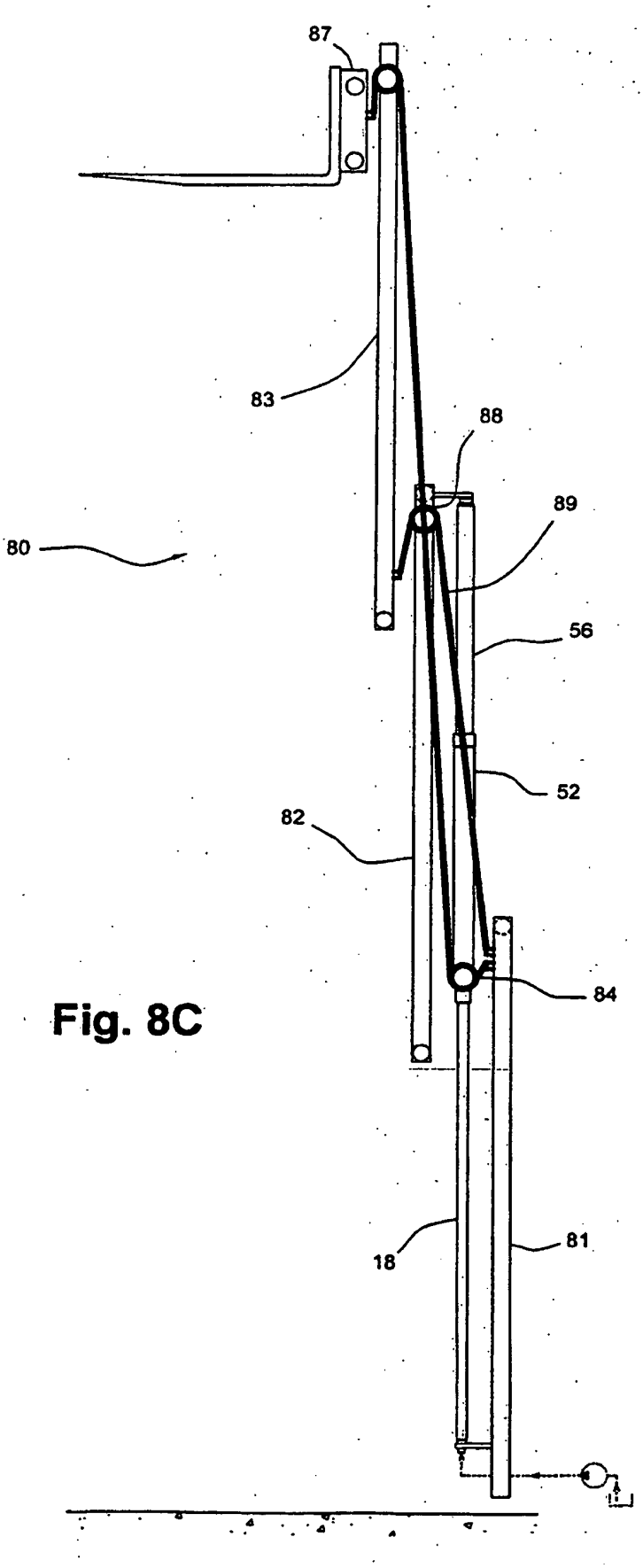


Fig. 8C

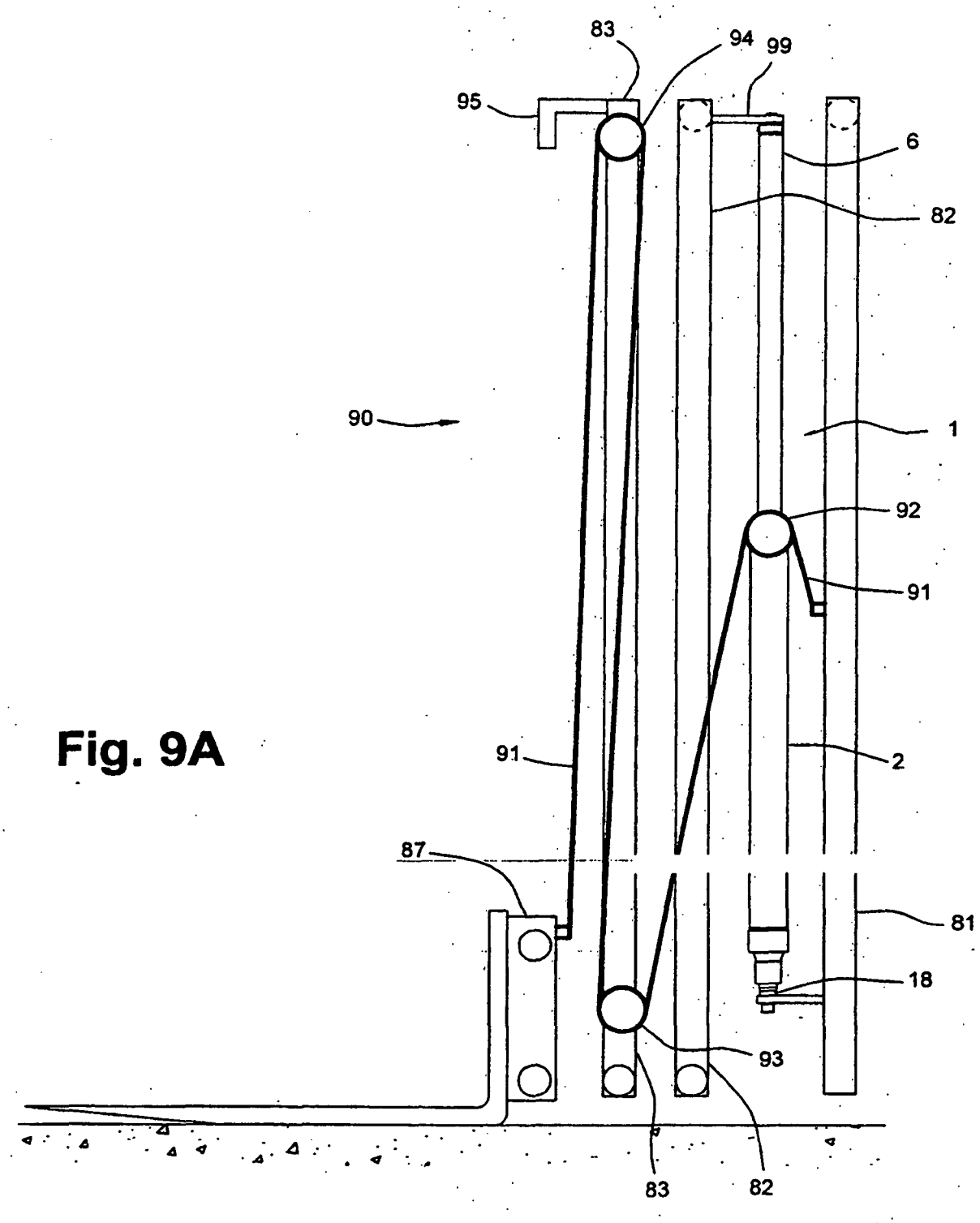


Fig. 9A

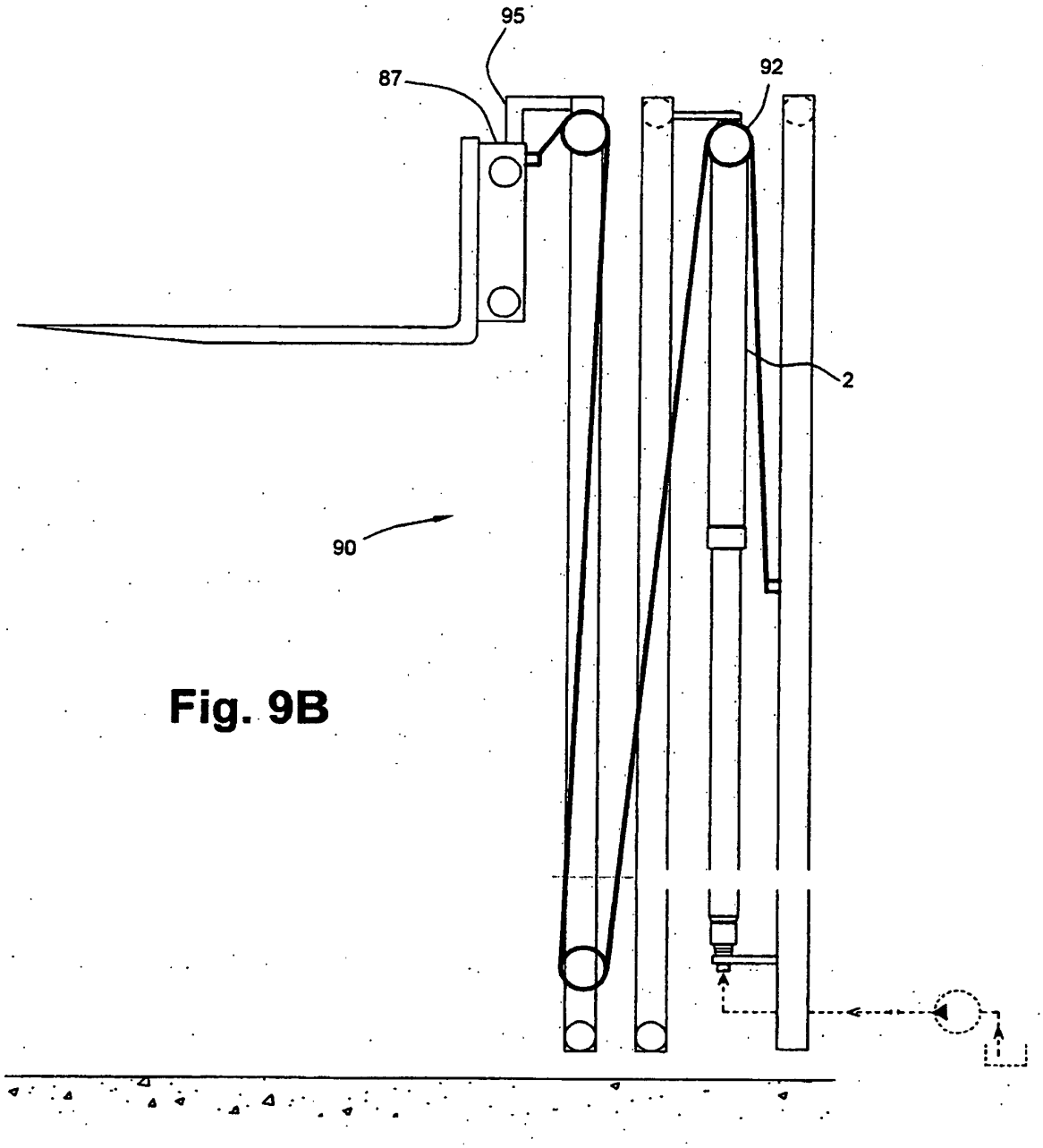


Fig. 9B

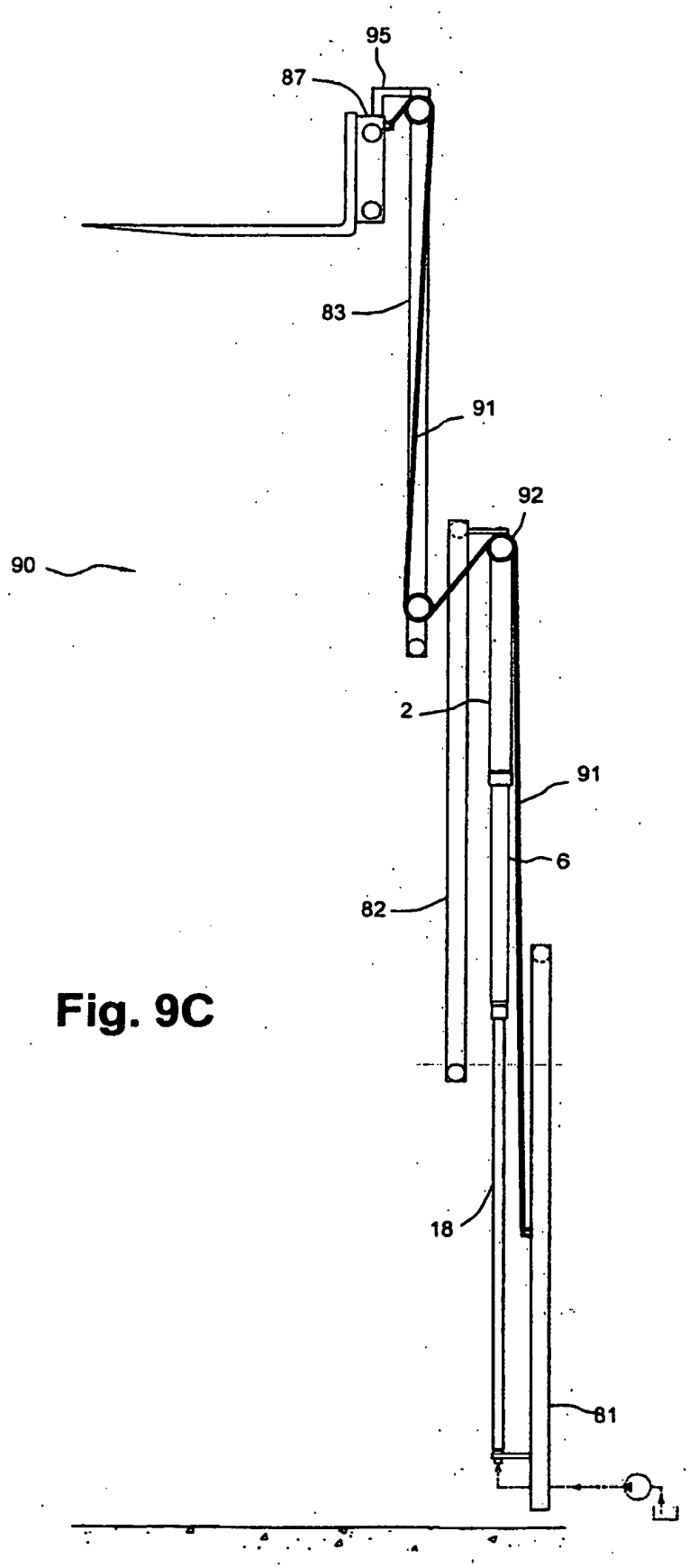


Fig. 9C

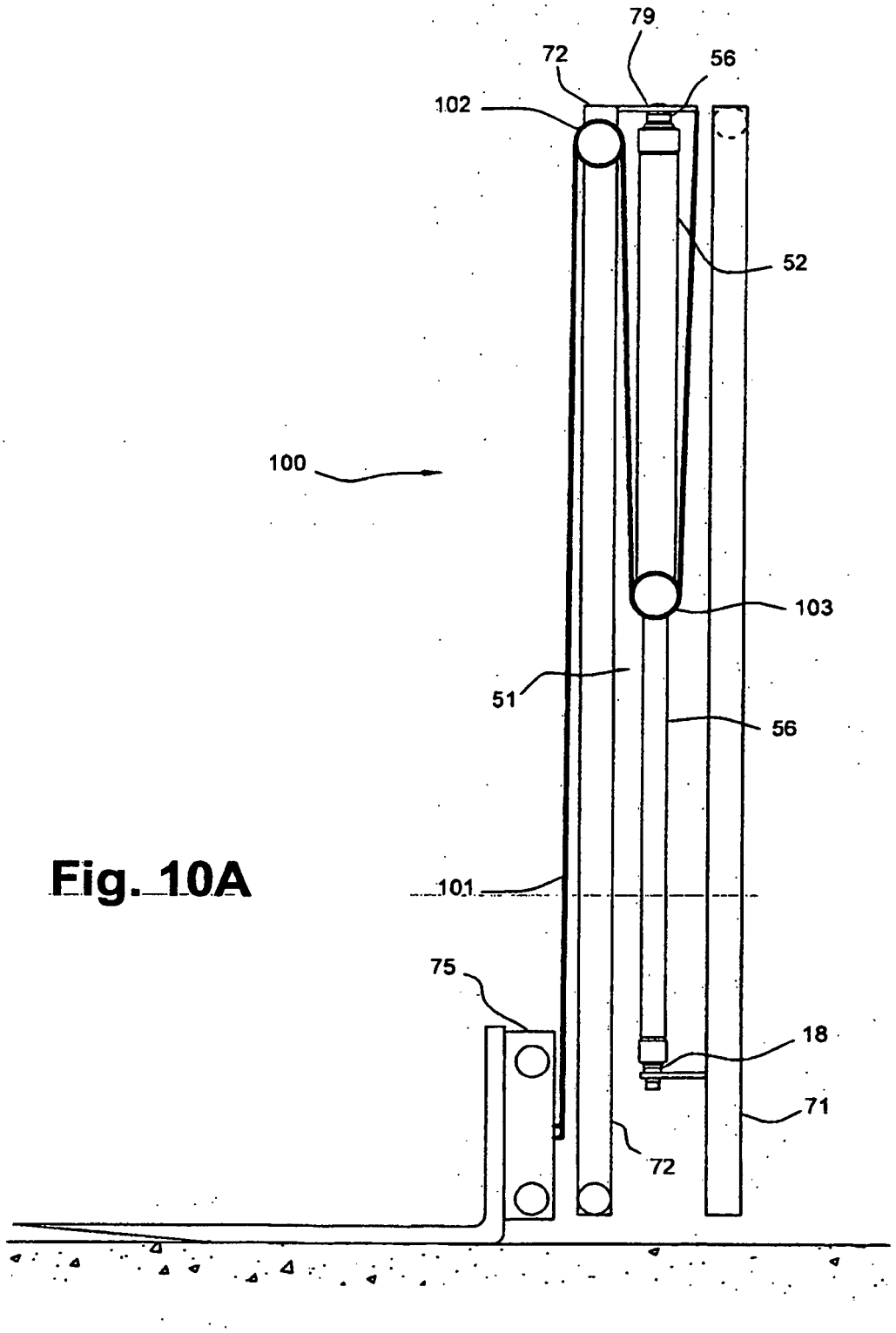


Fig. 10A

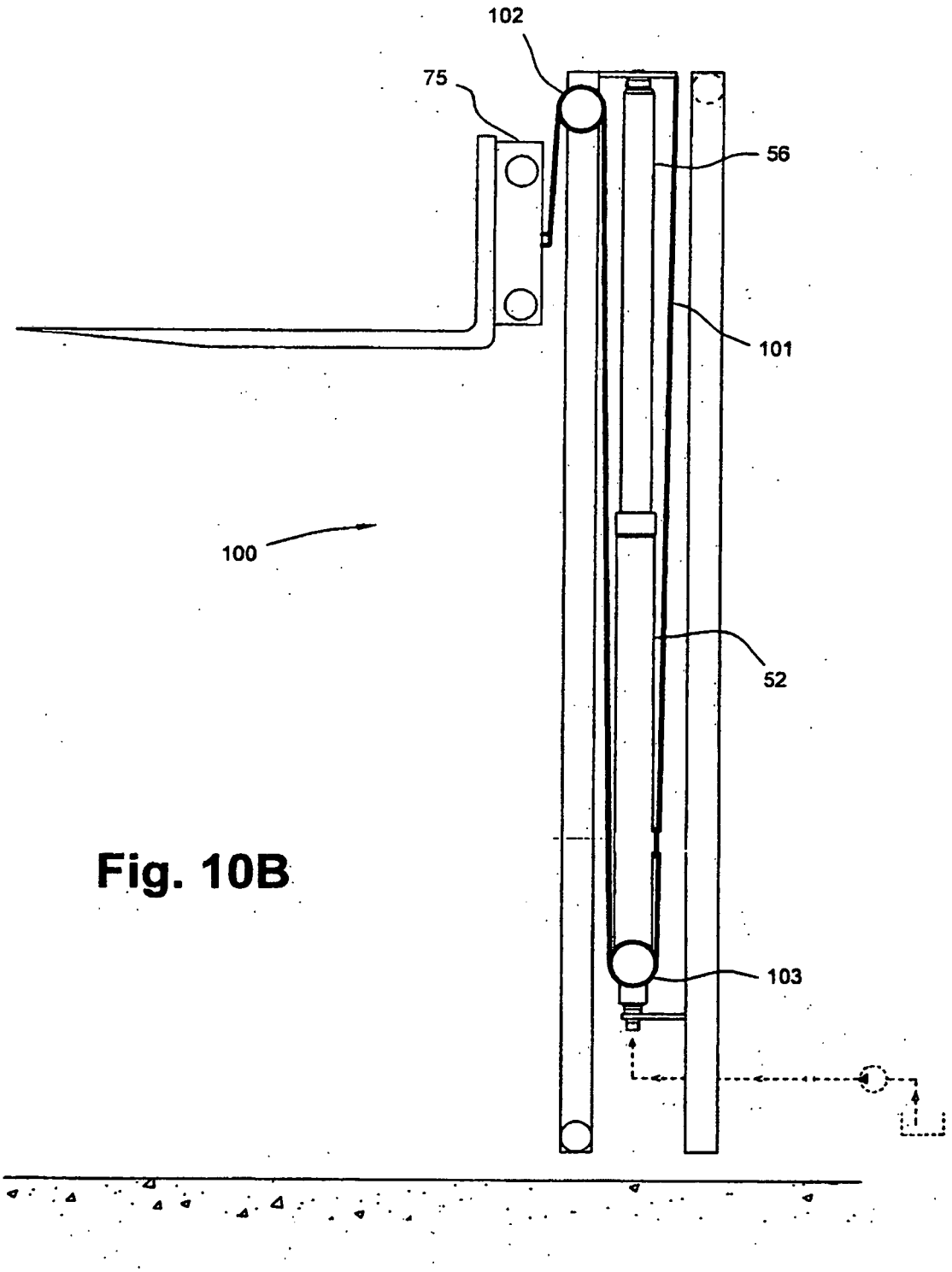


Fig. 10B

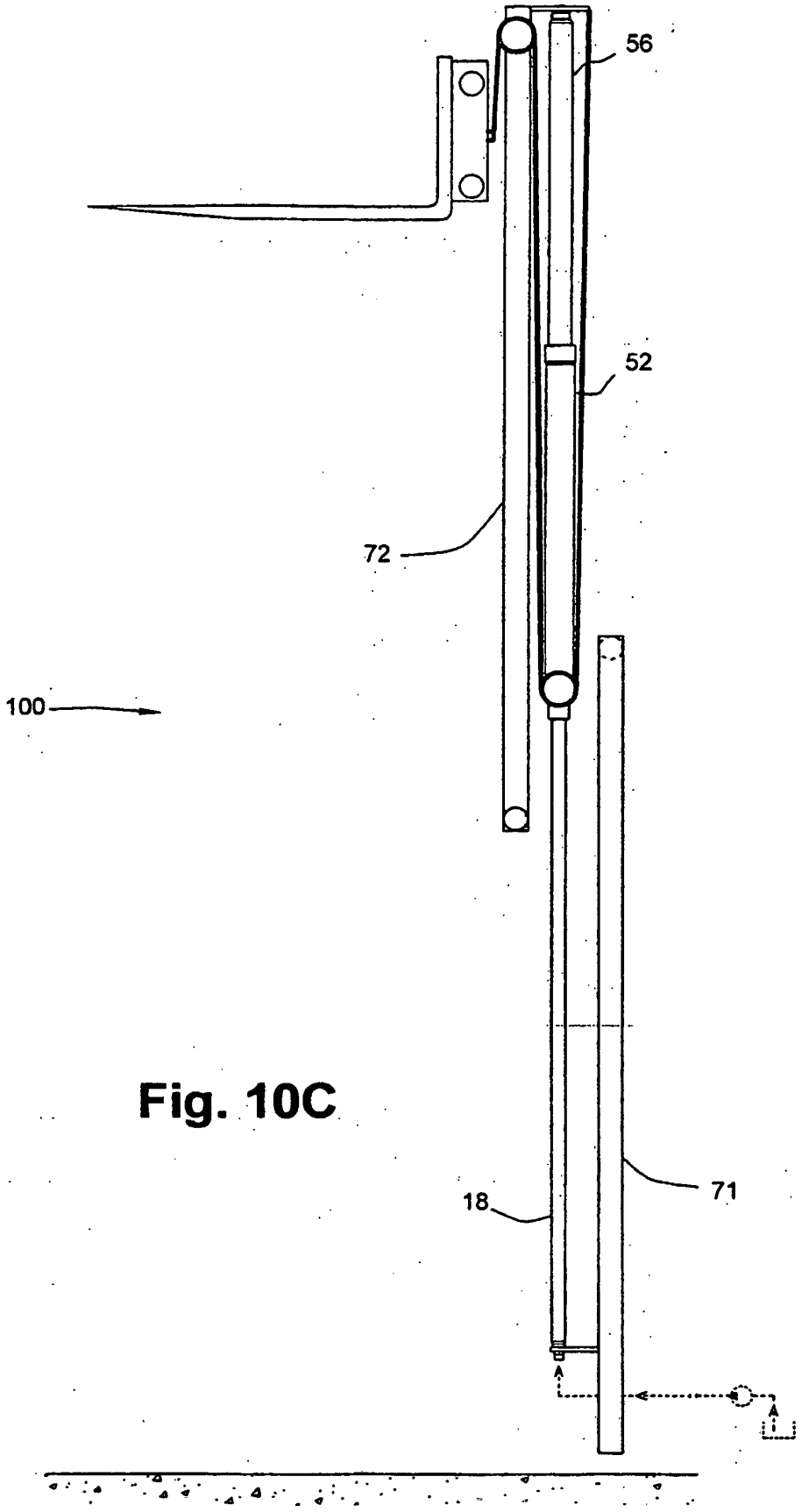


Fig. 10C

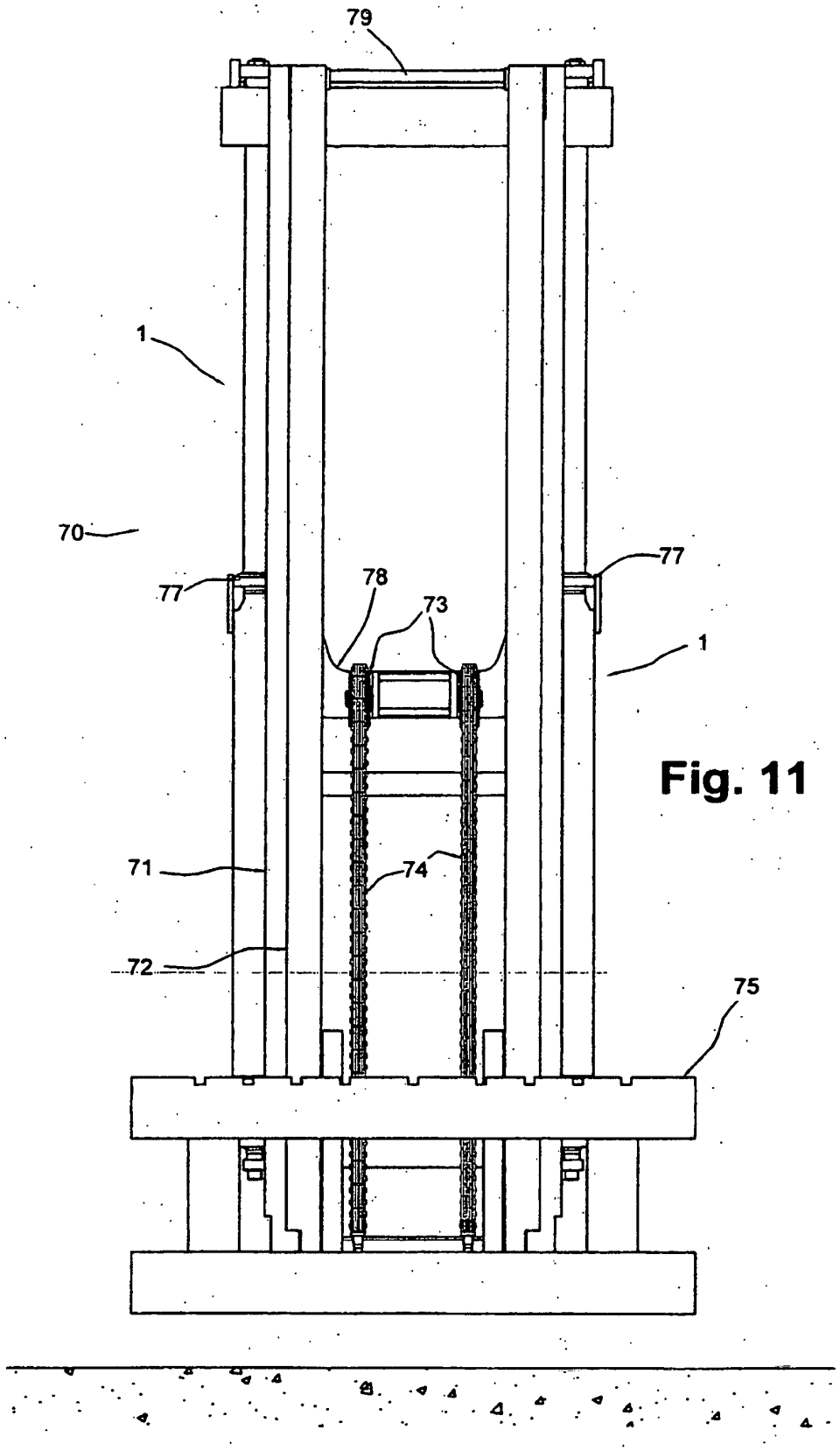


Fig. 11

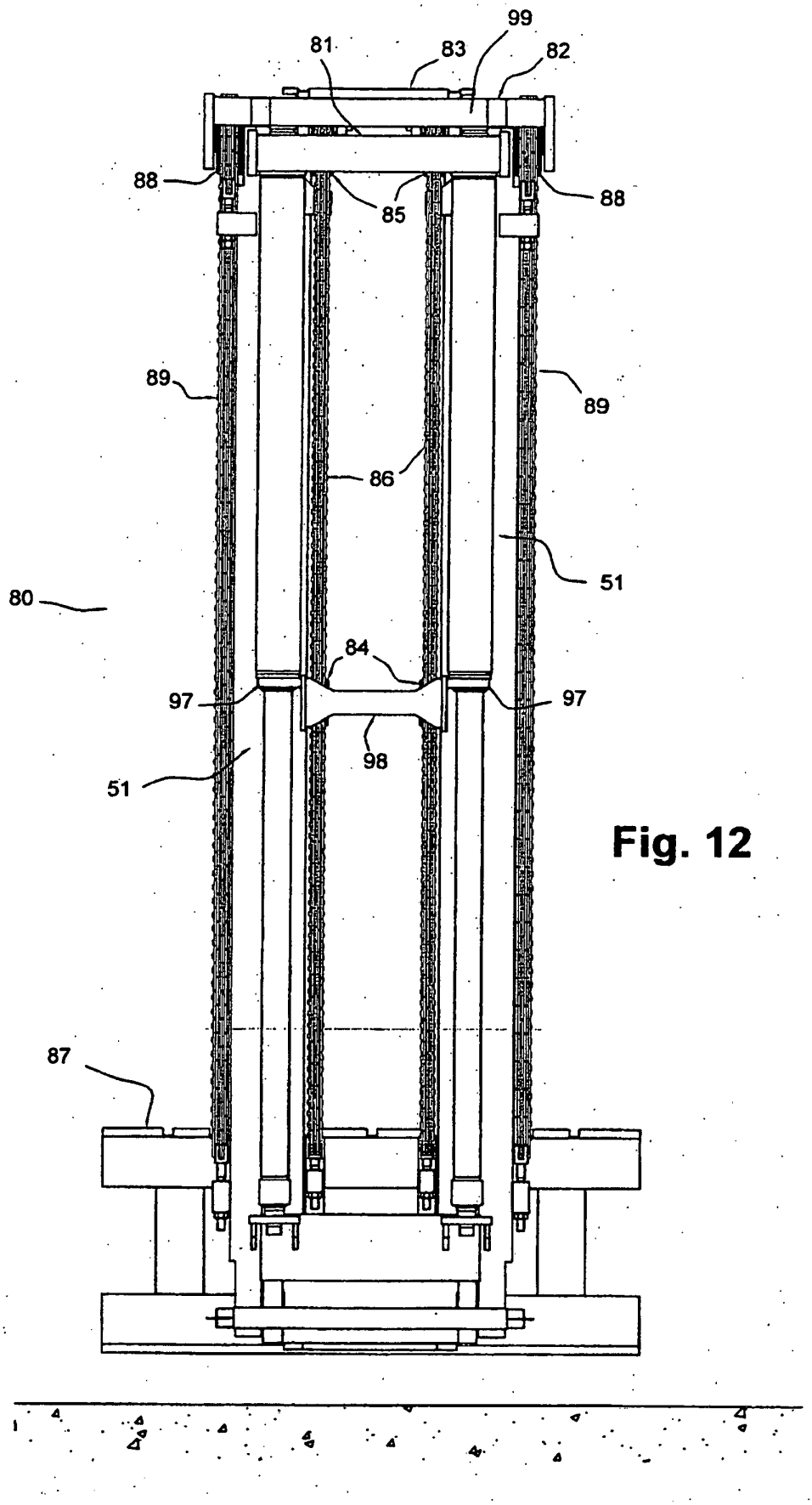


Fig. 12

REFERENCES CITED IN THE DESCRIPTION

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