US011767208B2

(12) **United States Patent**
Nguyen

(10) **Patent No.: US 11,767,208 B2**
(45) **Date of Patent: Sep. 26, 2023**

(54) **FORK ASSEMBLY FOR FORKLIFTS**

(71) Applicant: **Nhon Hoa Nguyen**, Bankstown (AU)

(72) Inventor: **Nhon Hoa Nguyen**, Bankstown (AU)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/708,330**

(22) Filed: **Mar. 30, 2022**

(65) **Prior Publication Data**

US 2023/0150807 A1 May 18, 2023

Related U.S. Application Data

(60) Provisional application No. 63/280,223, filed on Nov. 17, 2021.

(51) **Int. Cl.**
B66F 9/18 (2006.01)
B66F 9/20 (2006.01)
B66F 9/12 (2006.01)

(52) **U.S. Cl.**
CPC ***B66F 9/18*** (2013.01); ***B66F 9/122*** (2013.01); *B66F 9/20* (2013.01)

(58) **Field of Classification Search**
CPC B66F 9/122; B66F 9/143; B66F 9/145; B66F 9/146; B66F 9/20; B66F 9/18–188; B66F 9/19
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,763,390 A *	9/1956	Vandemark	B66F 9/18	294/207
2,941,683 A *	6/1960	Fowler	B66F 9/061	414/607
4,129,223 A *	12/1978	Probst	B66F 9/18	414/785

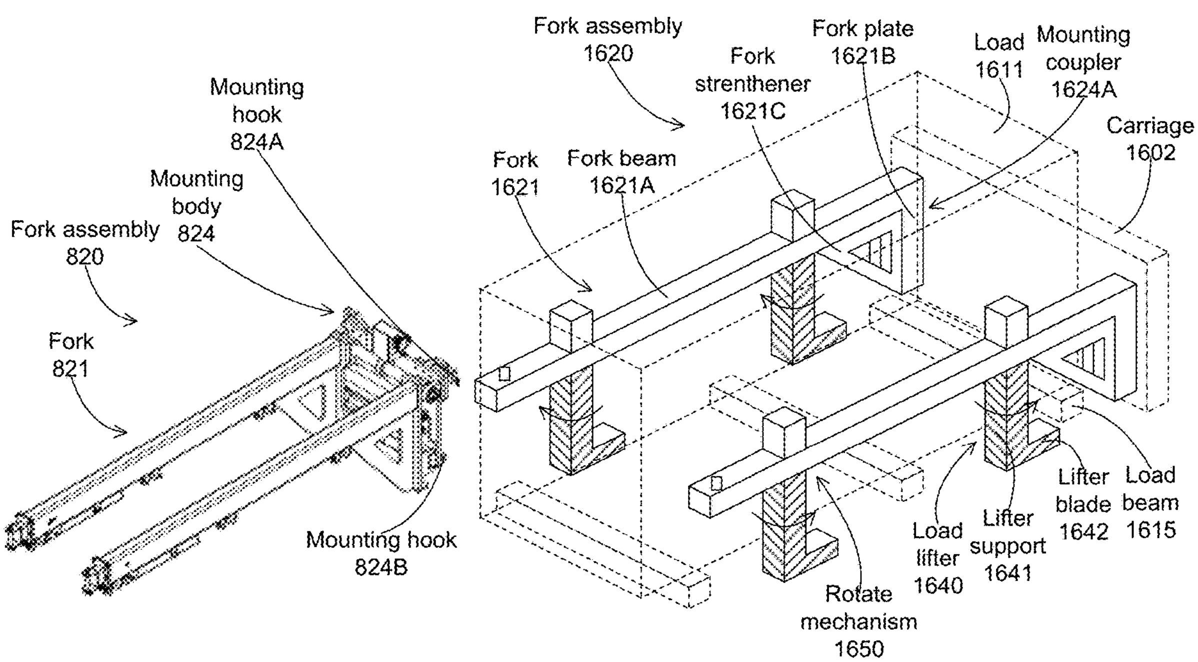
* cited by examiner

Primary Examiner — Tyrone V Hall, Jr.
(74) *Attorney, Agent, or Firm* — Tue Nguyen

(57) **ABSTRACT**

A fork assembly can include multiple forks configured to surround a load. Multiple attachments can be made on the forks to couple to straps for support a load. The fork assembly can further include multiple fork extensions having end attachments to couple to straps for pulling on the load. Alternatively, the fork assembly can include multiple fork lifters having blades rotatable between a non-lift position and a lift position. The fork extensions can also have blades rotatable between a non-pullable position and a pullable position. The blade rotation can be performed by a remote rotate mechanism by an operator operating the fork assembly.

20 Claims, 52 Drawing Sheets



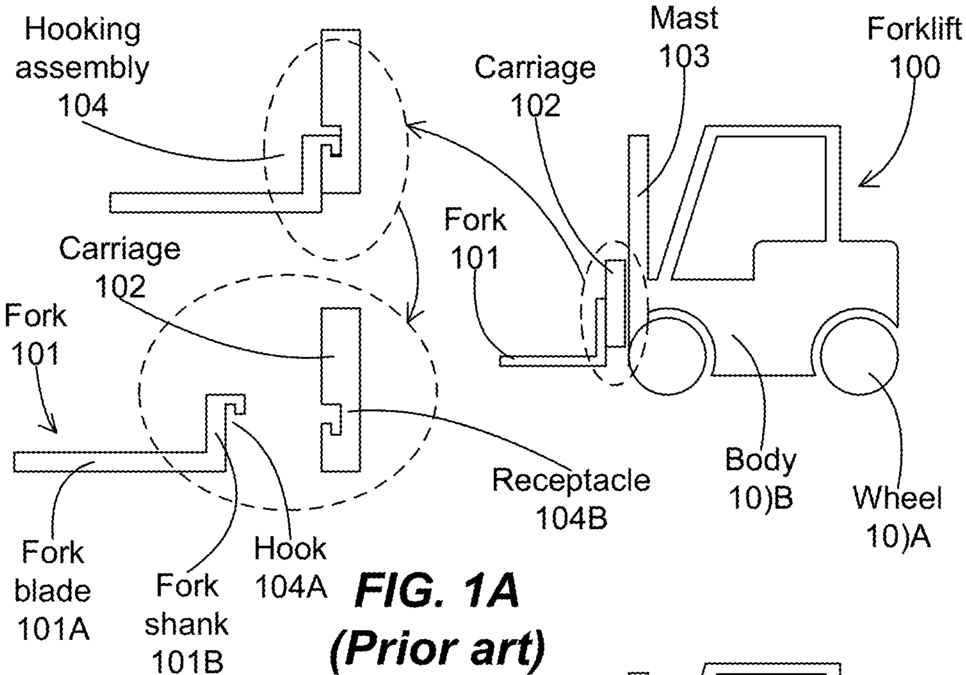


FIG. 1A
(Prior art)

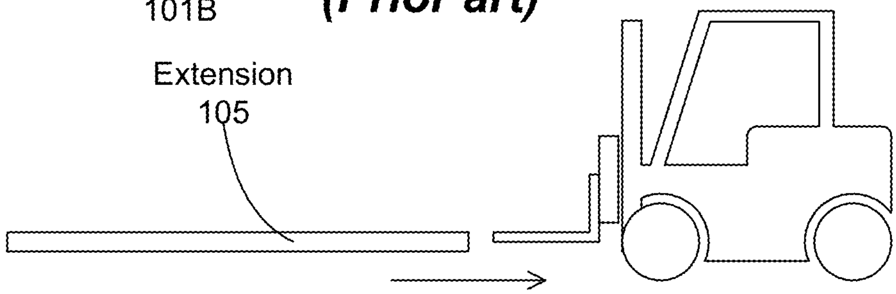


FIG. 1B
(Prior art)

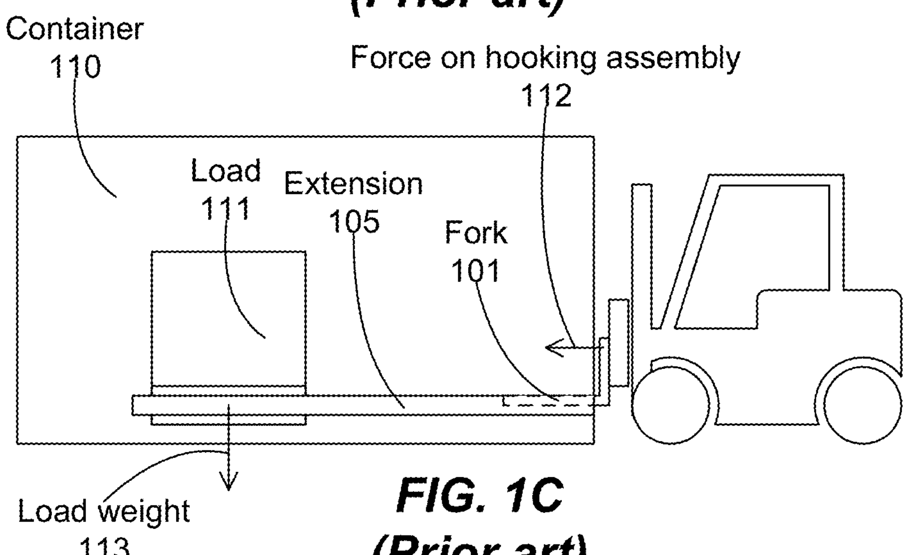


FIG. 1C
(Prior art)

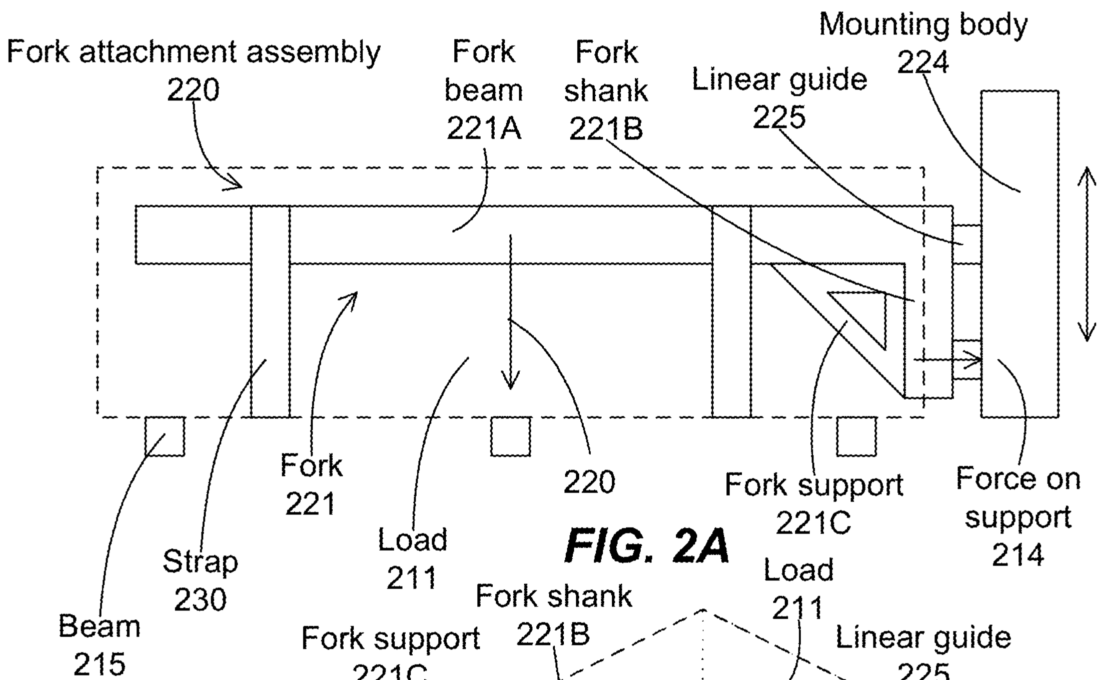

Fork attachment assembly
220
Fork
beam
221A
Fork
shank
221B
Linear guide
225
Mounting body
224
Fork
221
220
Fork support
221C
Force on
support
214
Load
211
Strap
230
Beam
215

FIG. 2A

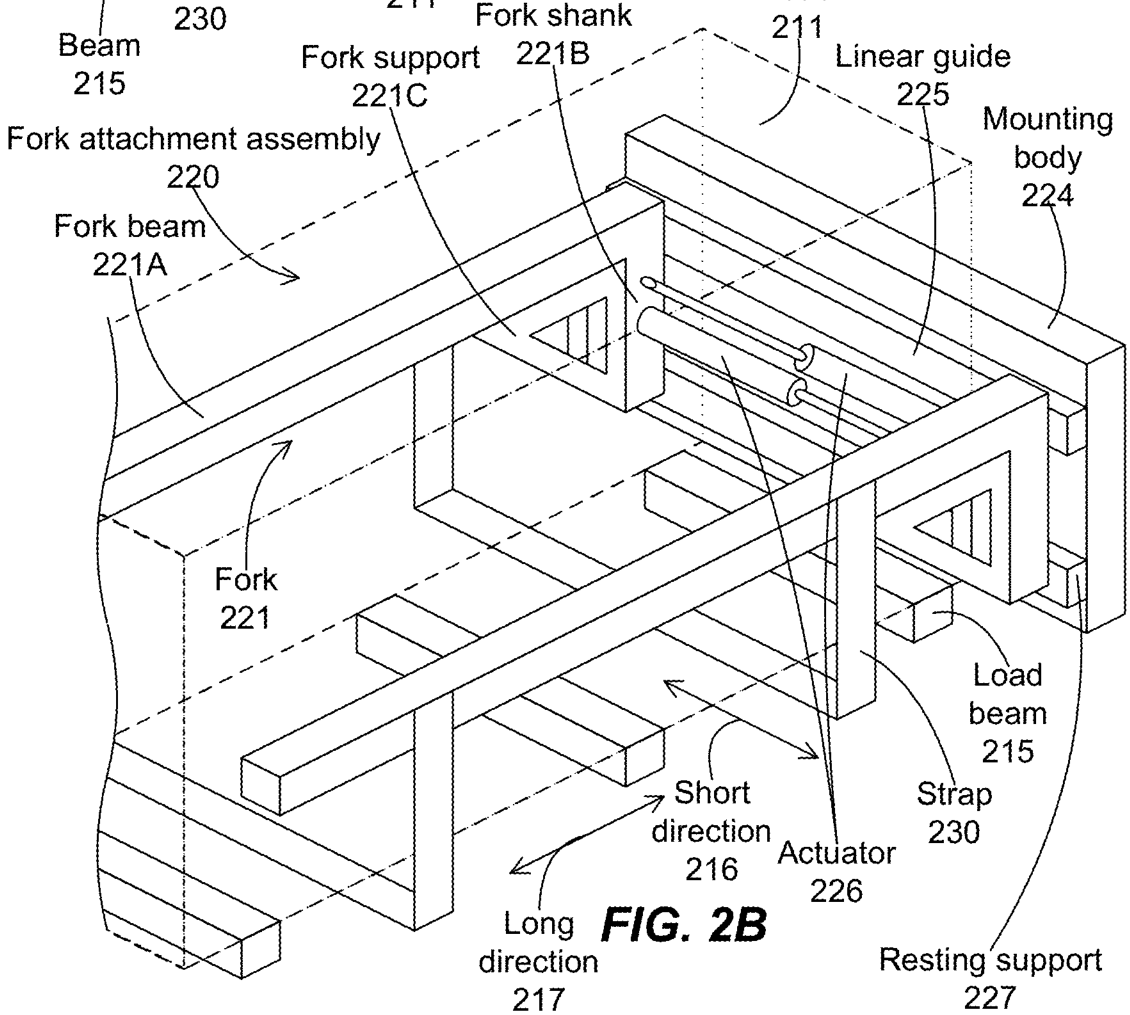

Load
211
Fork shank
221B
Fork support
221C
Linear guide
225
Mounting
body
224
Fork attachment assembly
220
Fork beam
221A
Fork
221
Load
beam
215
Strap
230
Short
direction
216
Actuator
226
Long
direction
217
Resting support
227

FIG. 2B

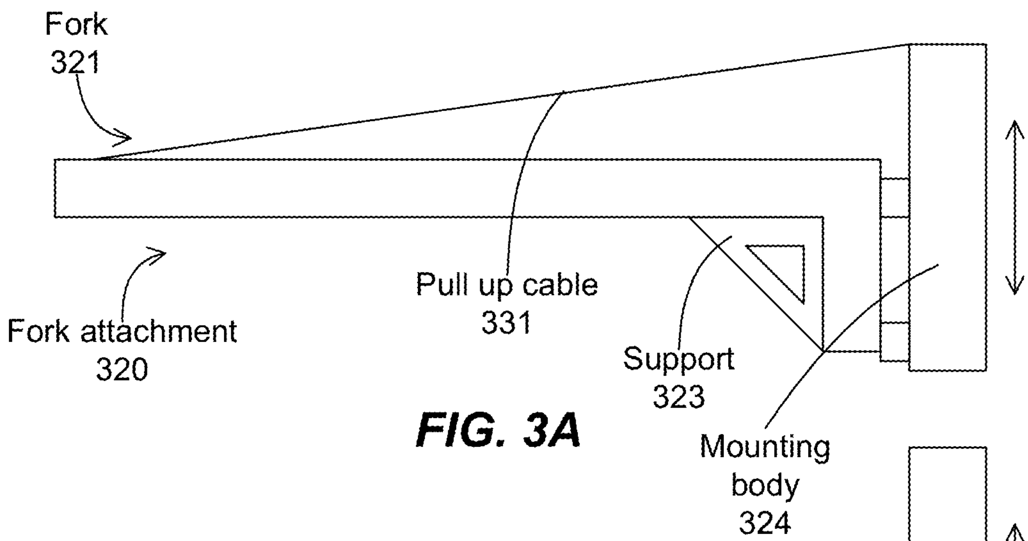


FIG. 3A

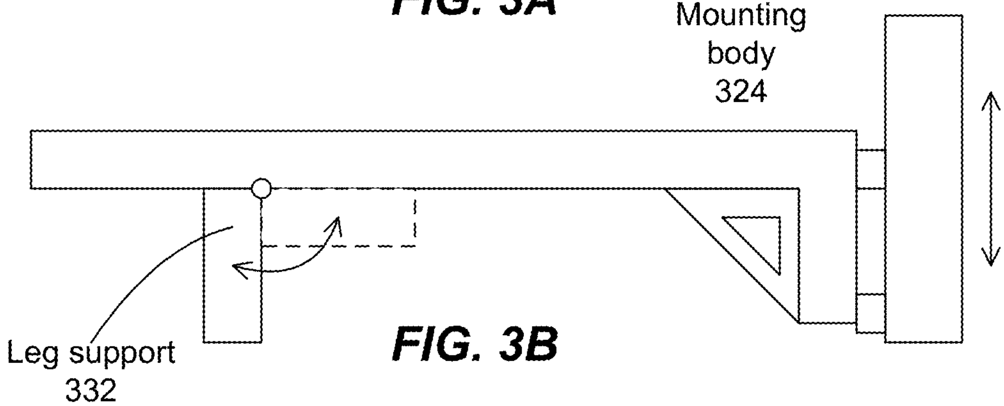


FIG. 3B

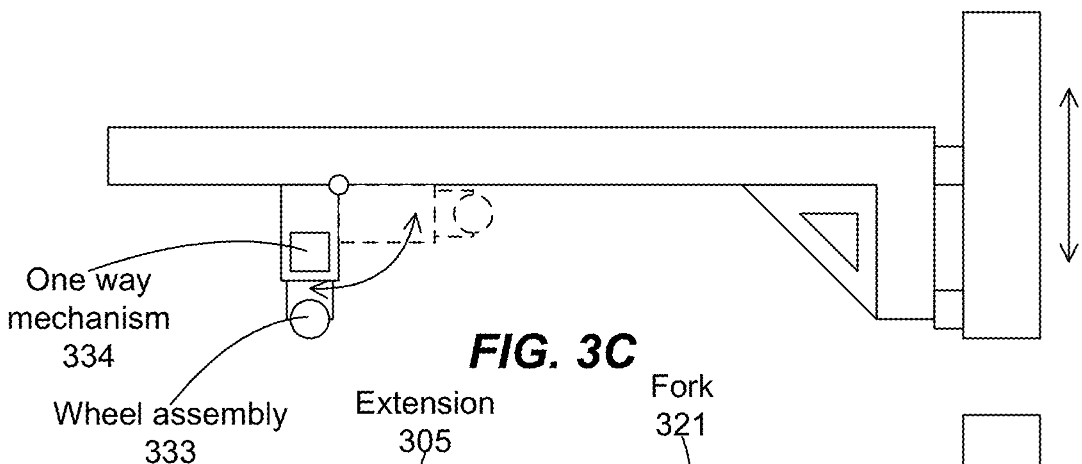


FIG. 3C

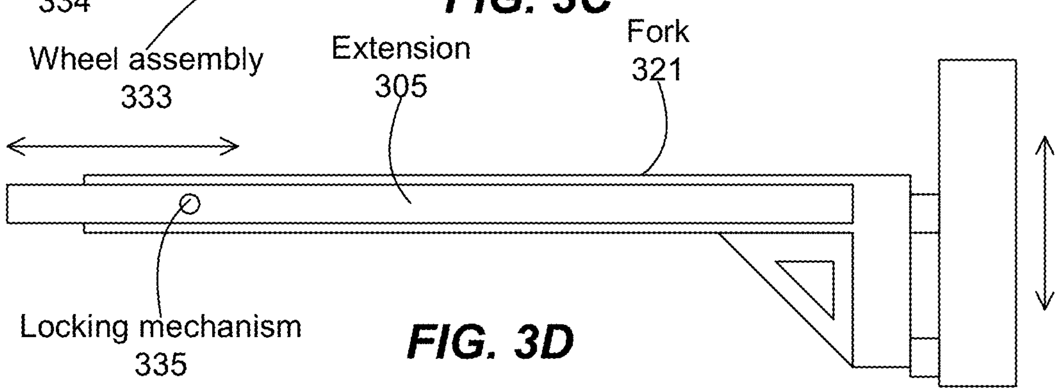


FIG. 3D

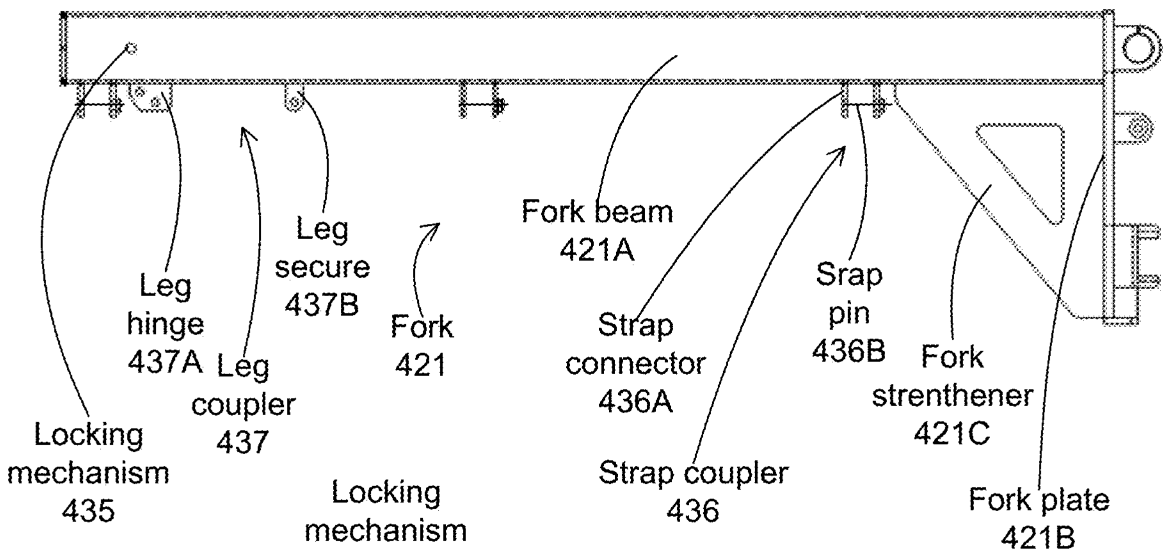

Fork beam 421A
Leg secure 437B
Fork 421
Leg hinge 437A
Leg coupler 437
Locking mechanism 435
Strap connector 436A
Srap pin 436B
Fork strenthener 421C
Strap coupler 436
Fork plate 421B

FIG. 4A

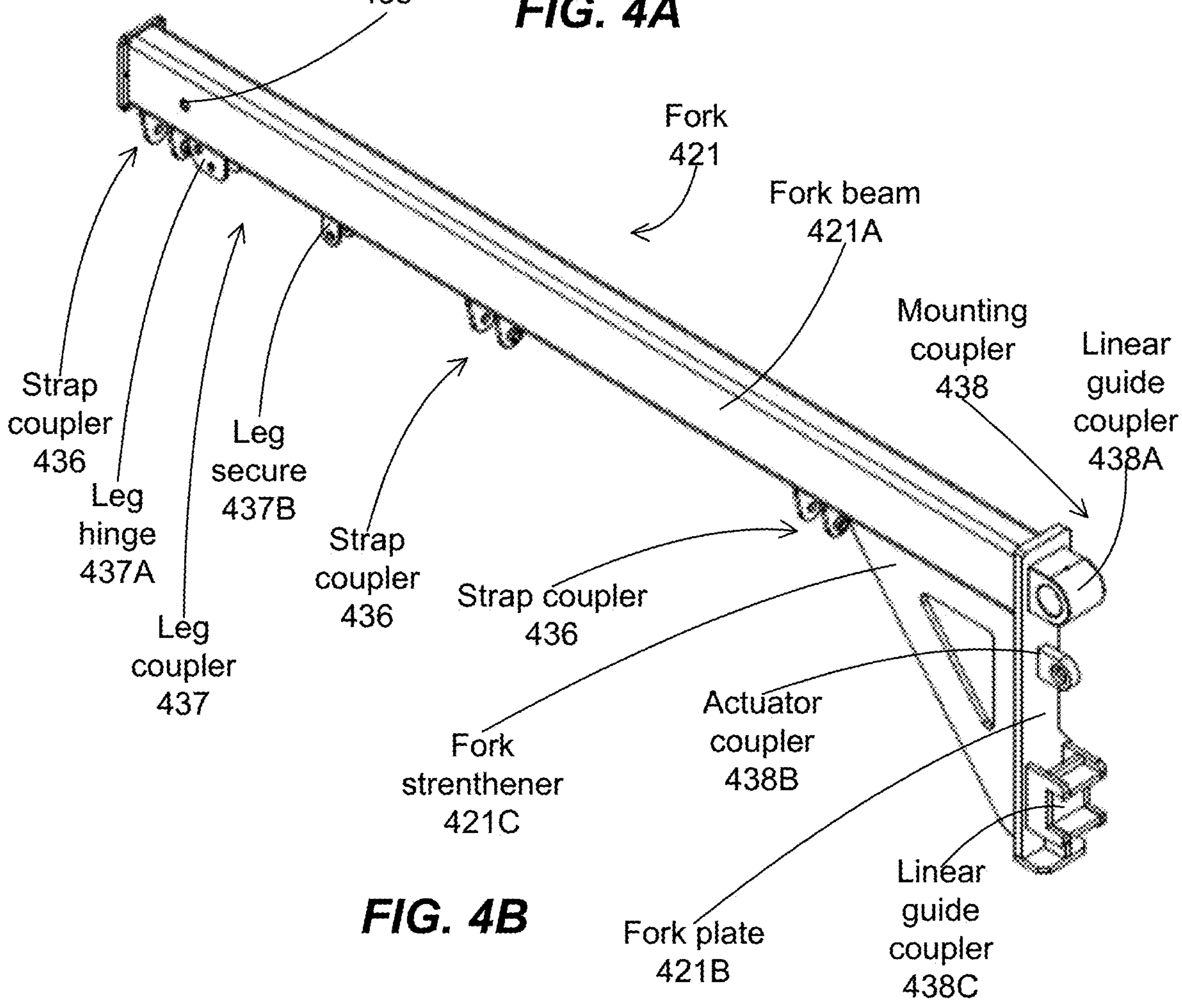

Locking mechanism 435
Fork 421
Fork beam 421A
Mounting coupler 438
Linear guide coupler 438A
Strap coupler 436
Leg hinge 437A
Leg secure 437B
Strap coupler 436
Leg coupler 437
Strap coupler 436
Fork strenthener 421C
Actuator coupler 438B
Fork plate 421B
Linear guide coupler 438C

FIG. 4B

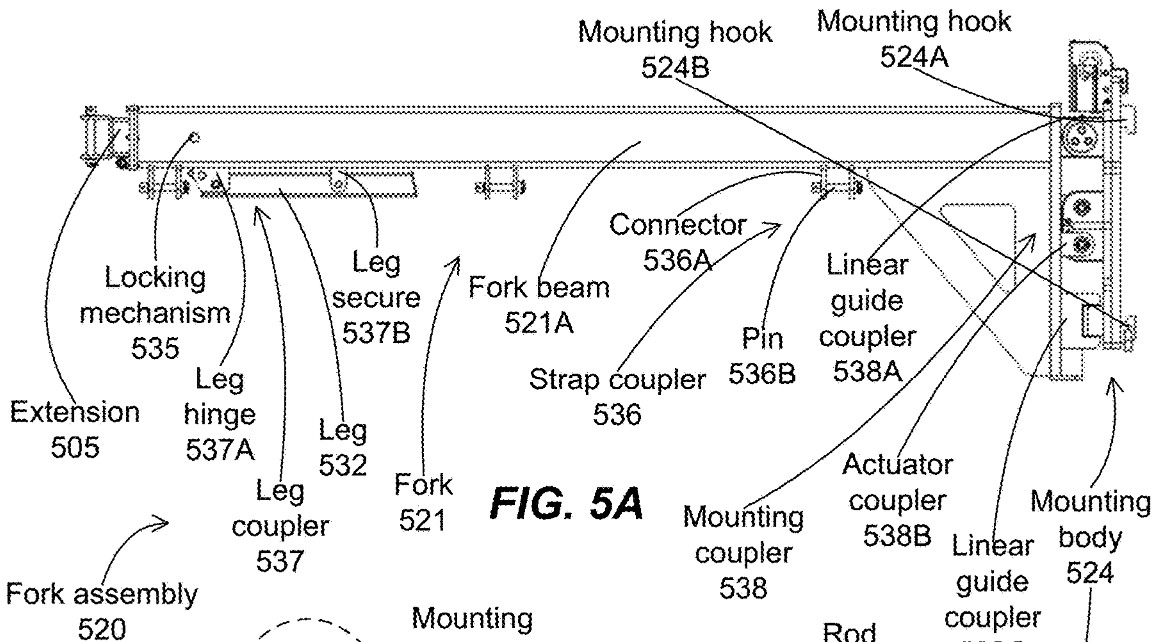


FIG. 5A

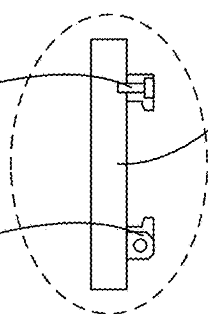


FIG. 5C

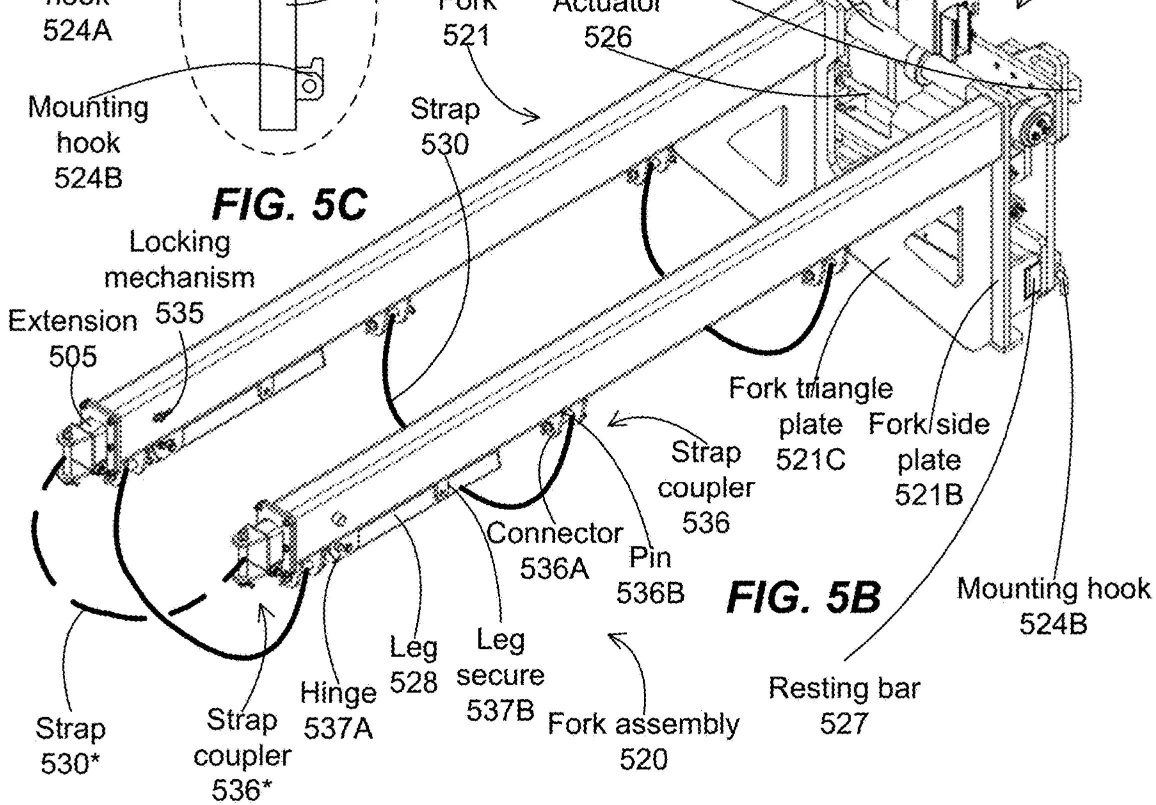
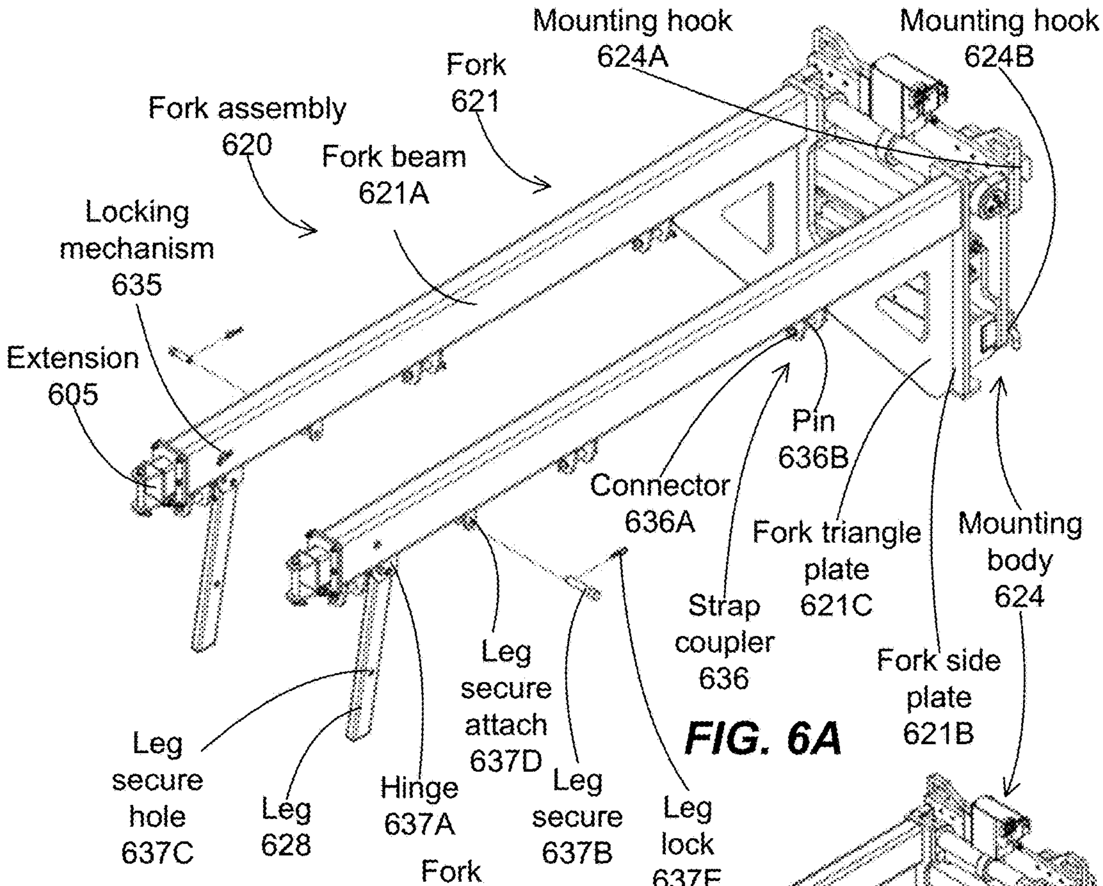
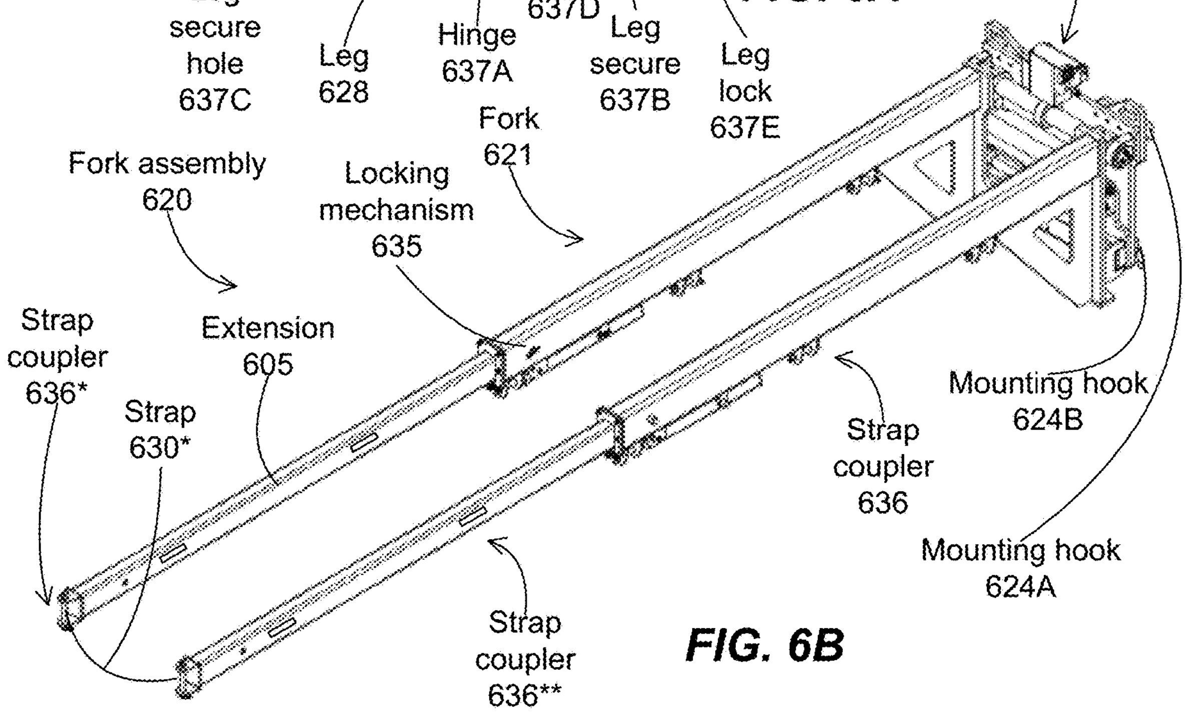


FIG. 5B



Mounting hook
624A
Mounting hook
624B
Fork
621
Fork assembly
620
Fork beam
621A
Locking
mechanism
635
Extension
605
Pin
636B
Connector
636A
Fork triangle
plate
621C
Mounting
body
624
Strap
coupler
636
Fork side
plate
621B
Leg
secure
attach
637D
Leg
secure
hole
637C
Leg
628
Hinge
637A
Leg
secure
637B
Leg
lock
637E

FIG. 6A



Fork
621
Fork assembly
620
Locking
mechanism
635
Strap
coupler
636*
Extension
605
Strap
630*
Mounting hook
624B
Strap
coupler
636
Mounting hook
624A
Strap
coupler
636**

FIG. 6B

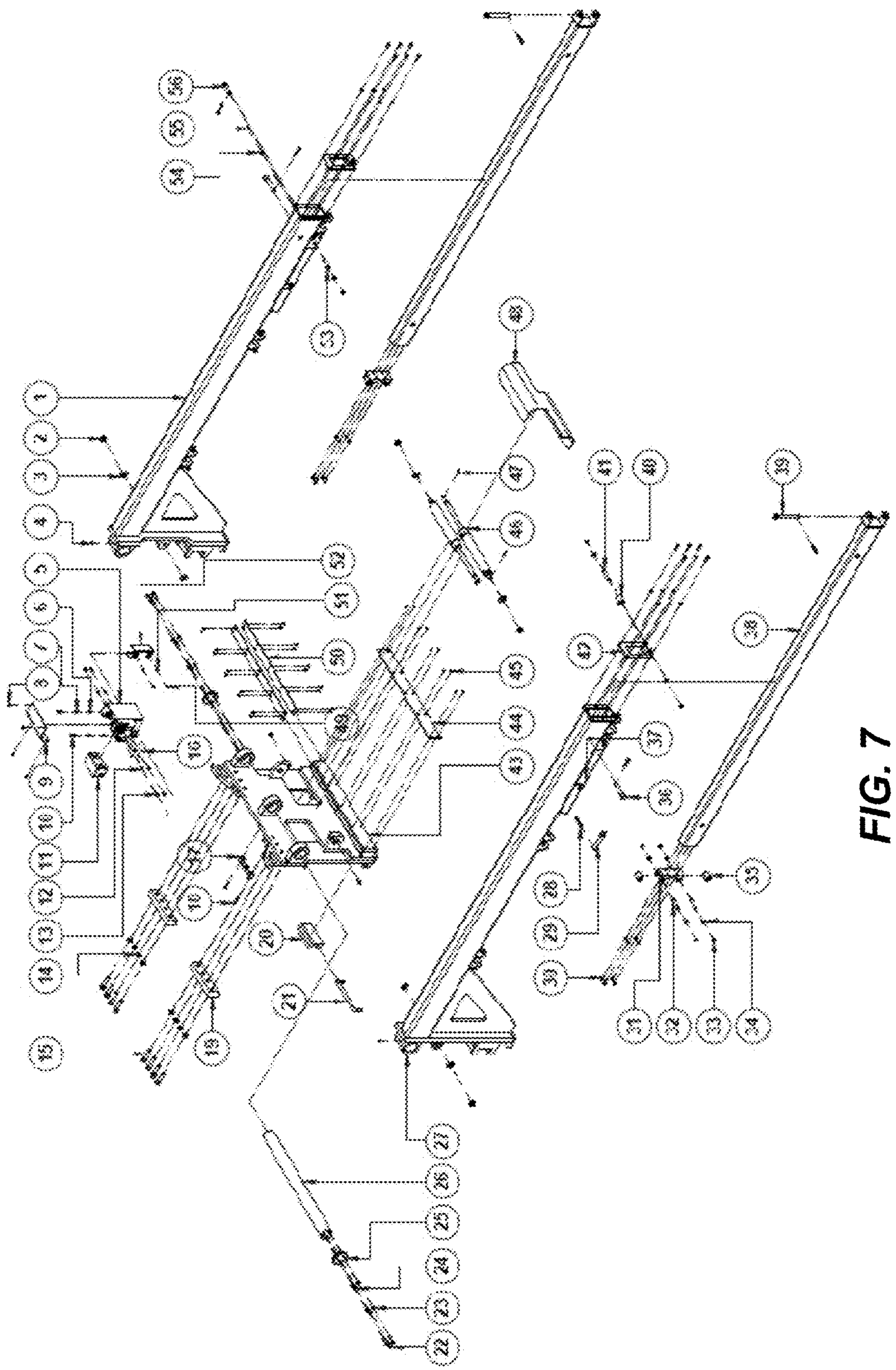

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56

FIG. 7

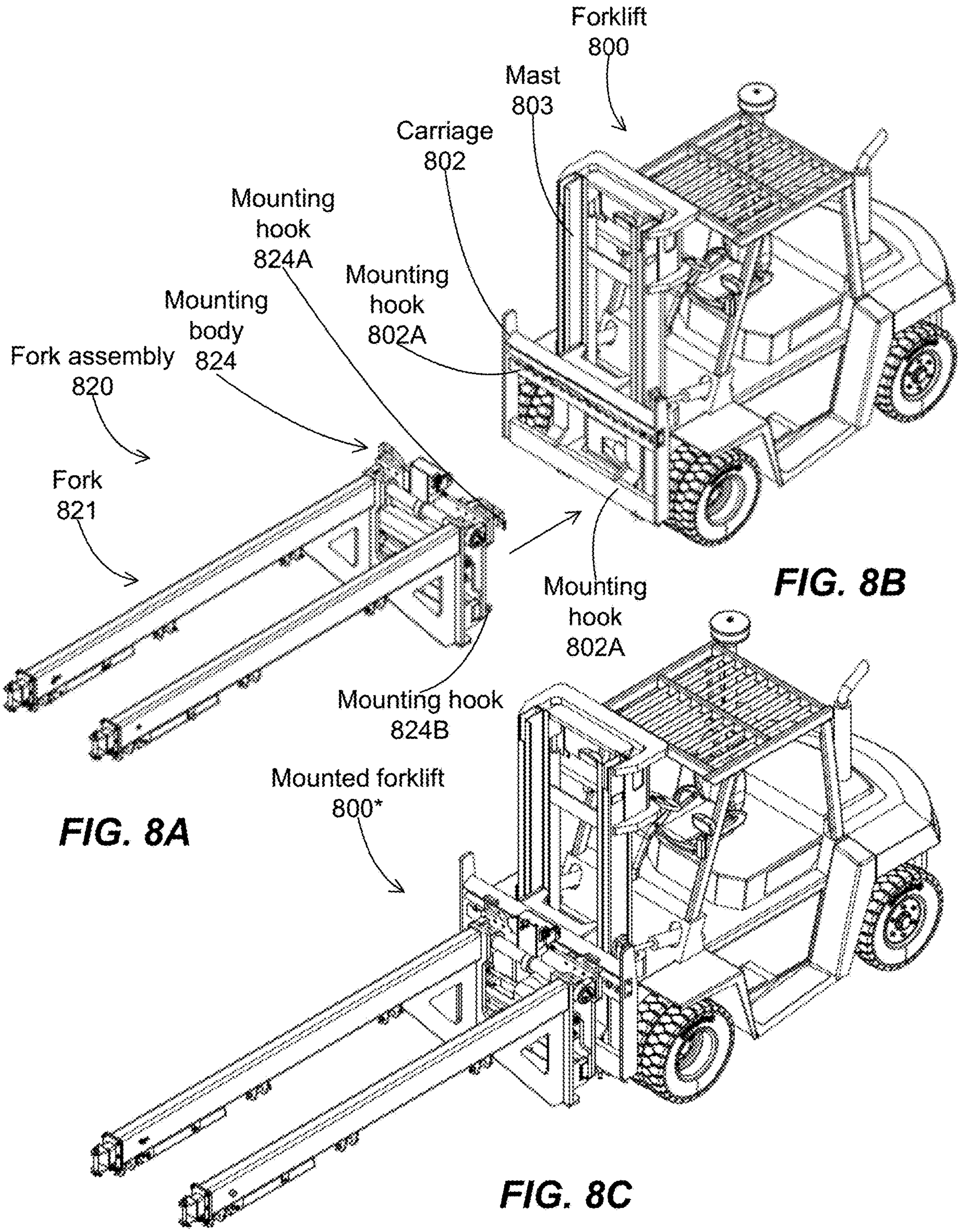


FIG. 8A

FIG. 8B

FIG. 8C

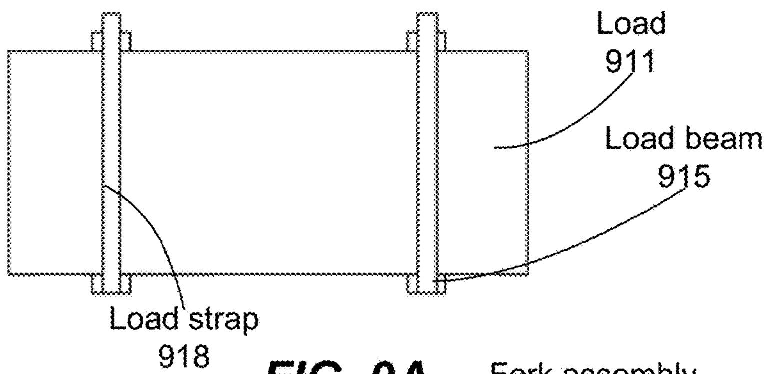


FIG. 9A

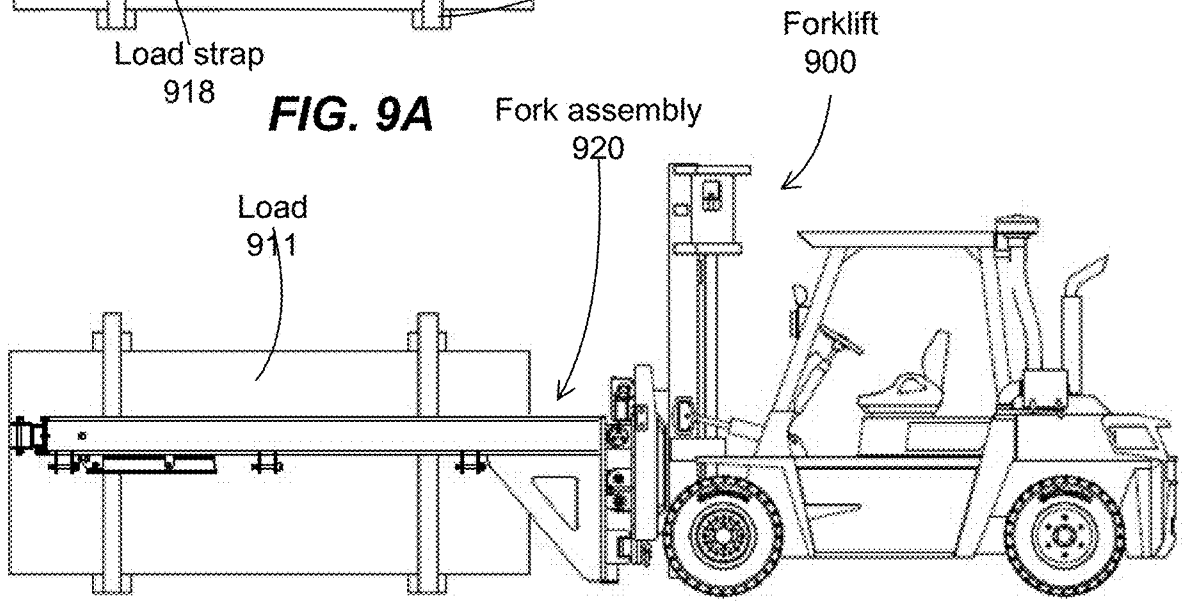


FIG. 9B

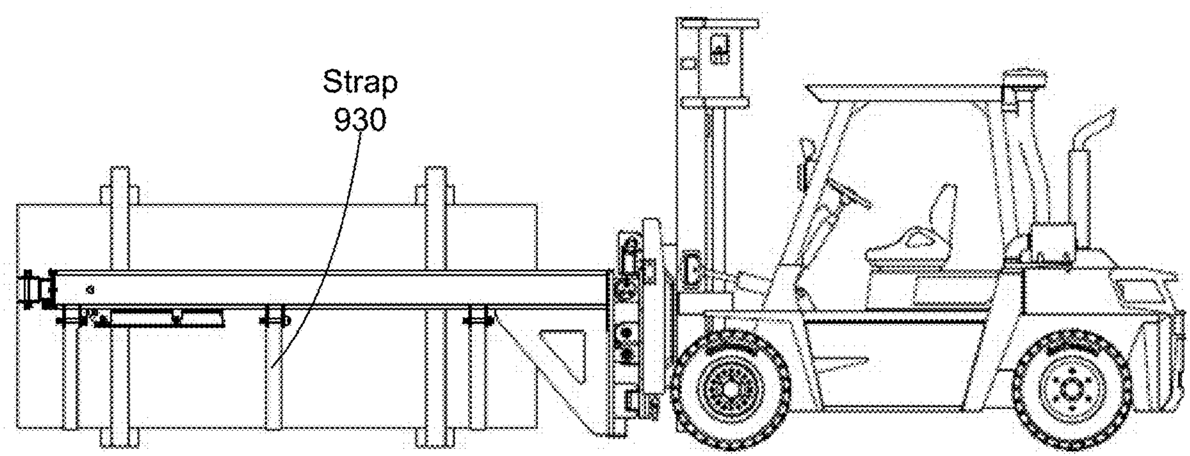


FIG. 9C

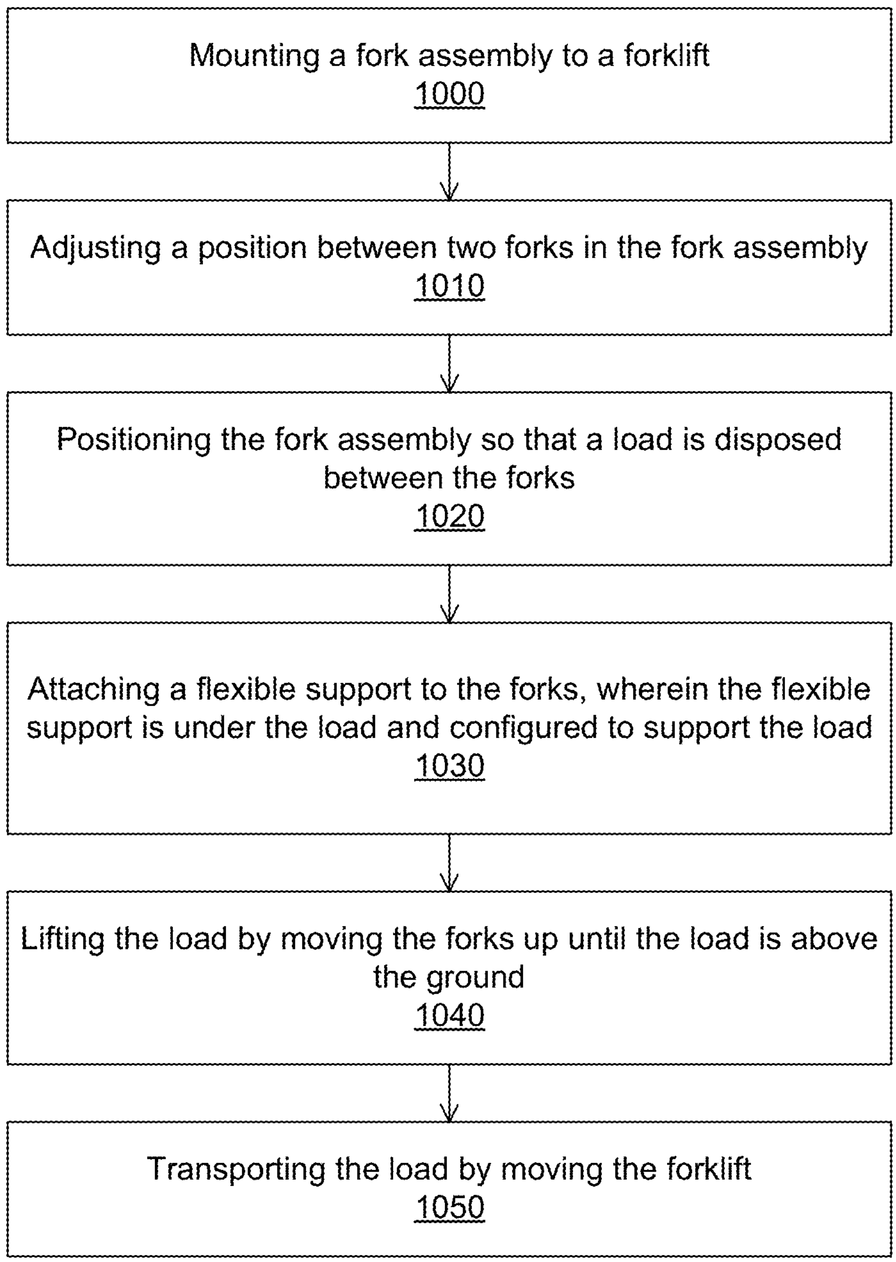

Mounting a fork assembly to a forklift
1000
Adjusting a position between two forks in the fork assembly
1010
Positioning the fork assembly so that a load is disposed between the forks
1020
Attaching a flexible support to the forks, wherein the flexible support is under the load and configured to support the load
1030
Lifting the load by moving the forks up until the load is above the ground
1040
Transporting the load by moving the forklift
1050

FIG. 10

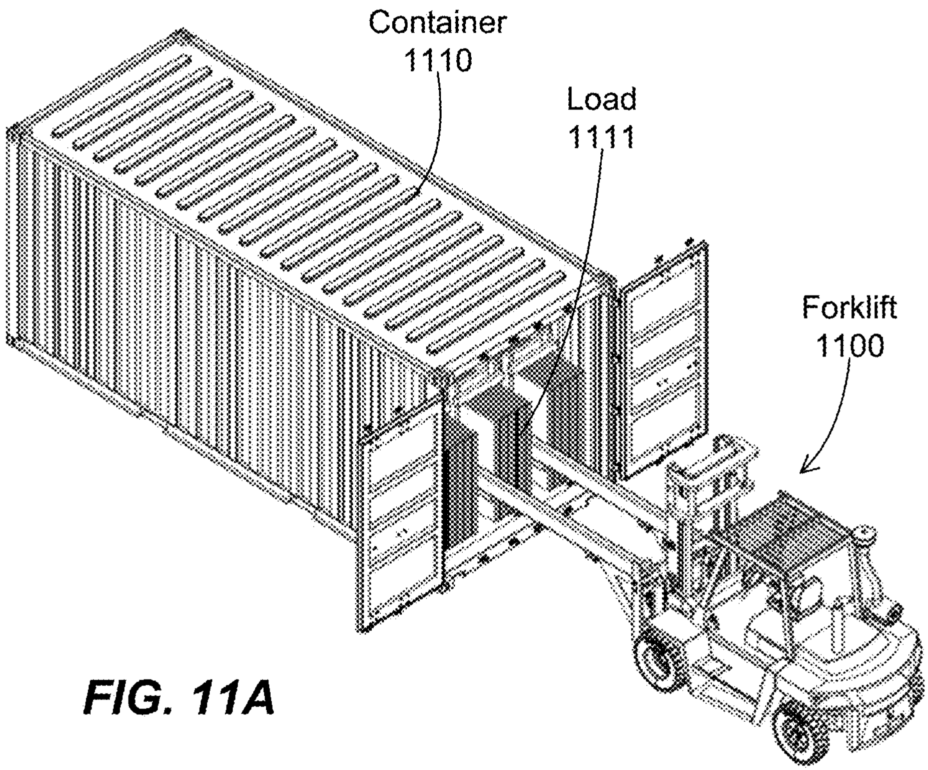


FIG. 11A

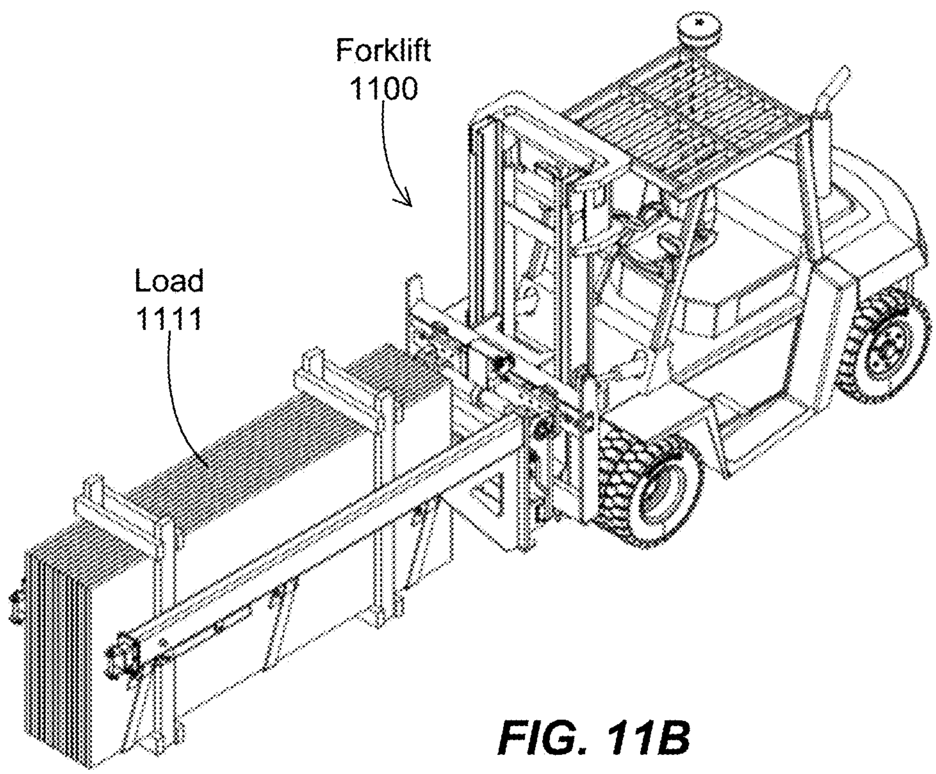


FIG. 11B

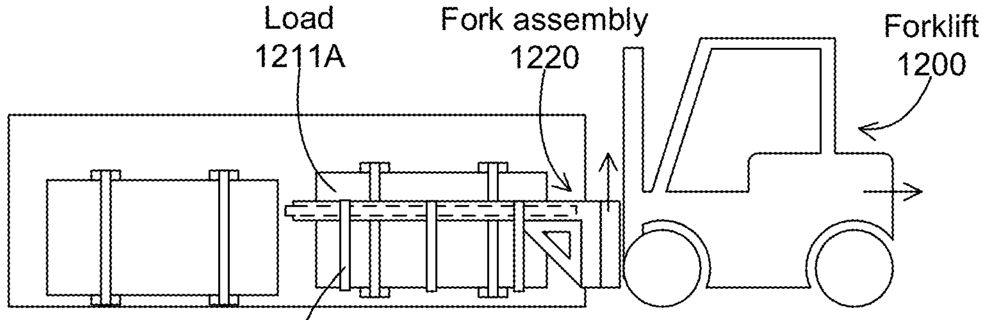


FIG. 12A

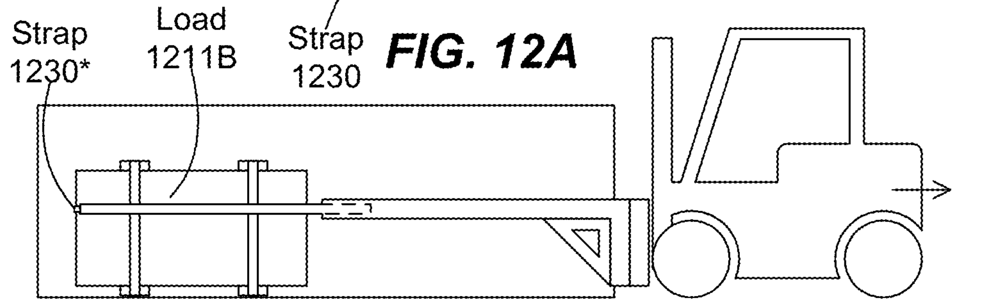


FIG. 12B

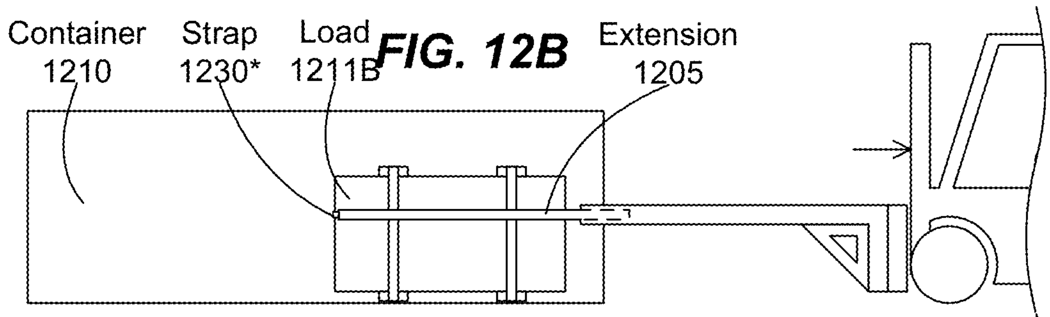


FIG. 12C

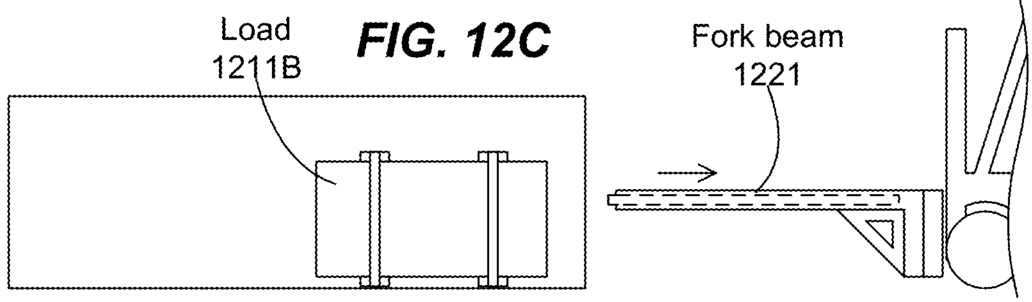


FIG. 12D

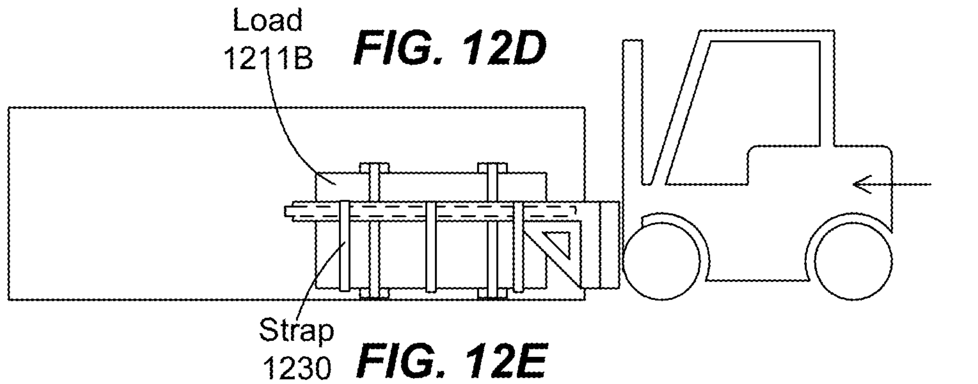


FIG. 12E

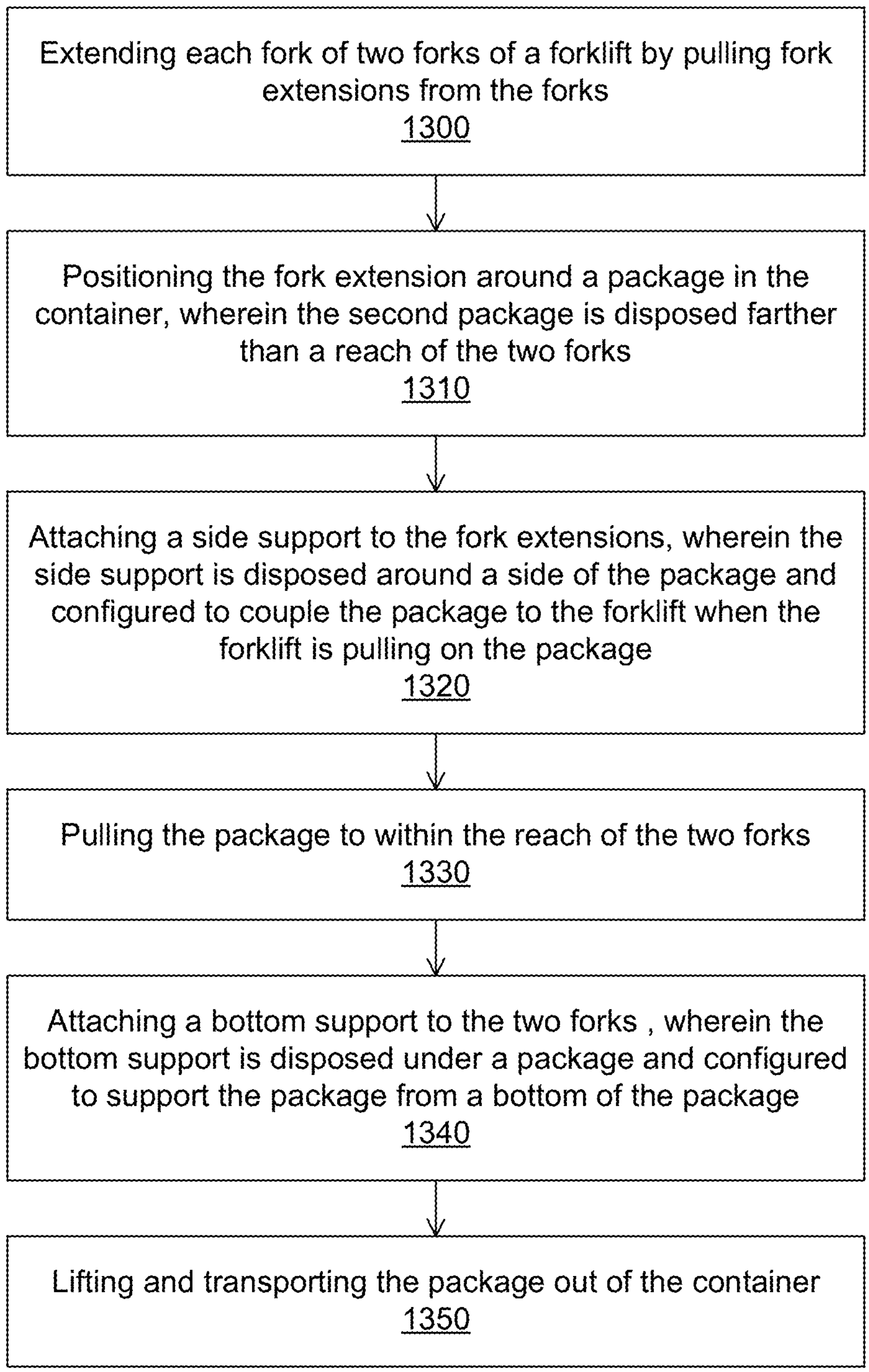

Extending each fork of two forks of a forklift by pulling fork extensions from the forks
1300
Positioning the fork extension around a package in the container, wherein the second package is disposed farther than a reach of the two forks
1310
Attaching a side support to the fork extensions, wherein the side support is disposed around a side of the package and configured to couple the package to the forklift when the forklift is pulling on the package
1320
Pulling the package to within the reach of the two forks
1330
Attaching a bottom support to the two forks , wherein the bottom support is disposed under a package and configured to support the package from a bottom of the package
1340
Lifting and transporting the package out of the container
1350

FIG. 13

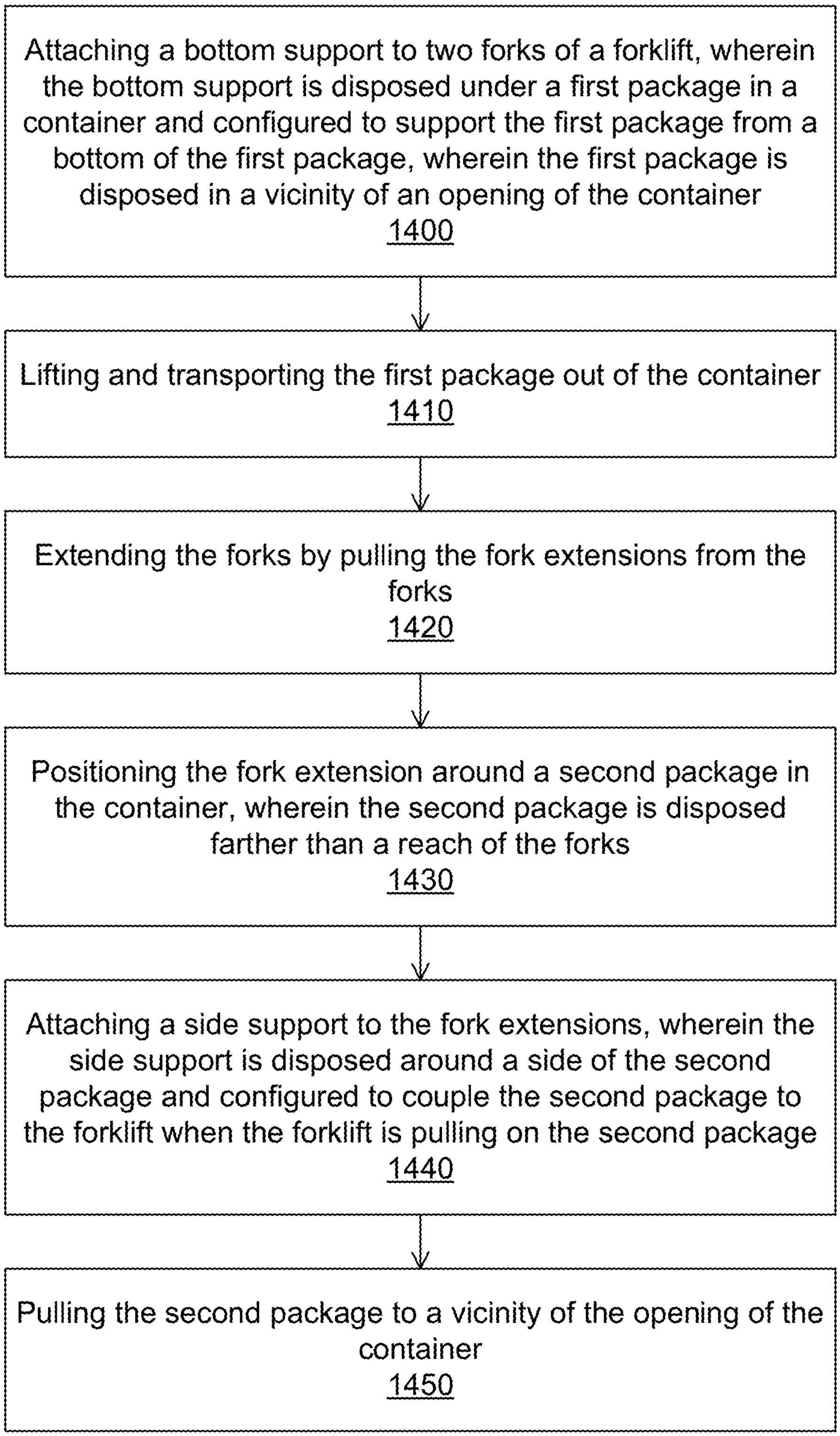

Attaching a bottom support to two forks of a forklift, wherein the bottom support is disposed under a first package in a container and configured to support the first package from a bottom of the first package, wherein the first package is disposed in a vicinity of an opening of the container
1400
Lifting and transporting the first package out of the container
1410
Extending the forks by pulling the fork extensions from the forks
1420
Positioning the fork extension around a second package in the container, wherein the second package is disposed farther than a reach of the forks
1430
Attaching a side support to the fork extensions, wherein the side support is disposed around a side of the second package and configured to couple the second package to the forklift when the forklift is pulling on the second package
1440
Pulling the second package to a vicinity of the opening of the container
1450

FIG. 14

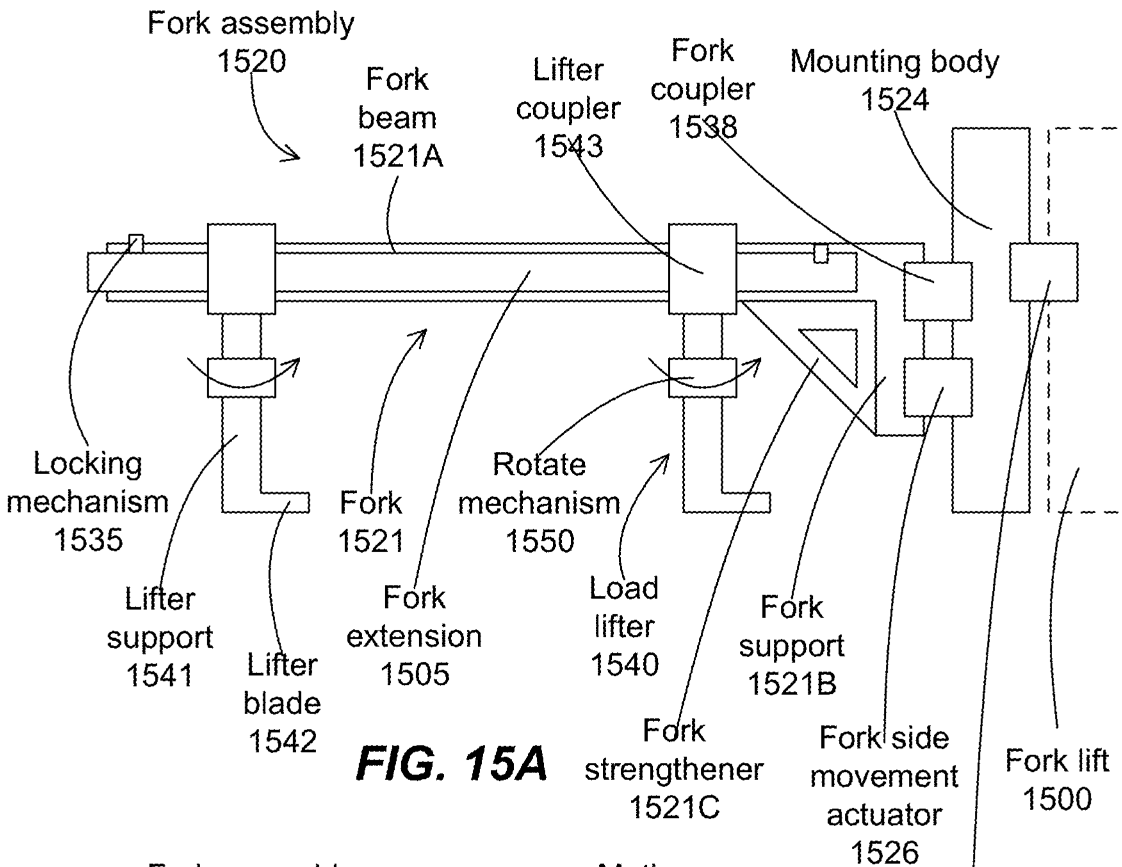


FIG. 15A

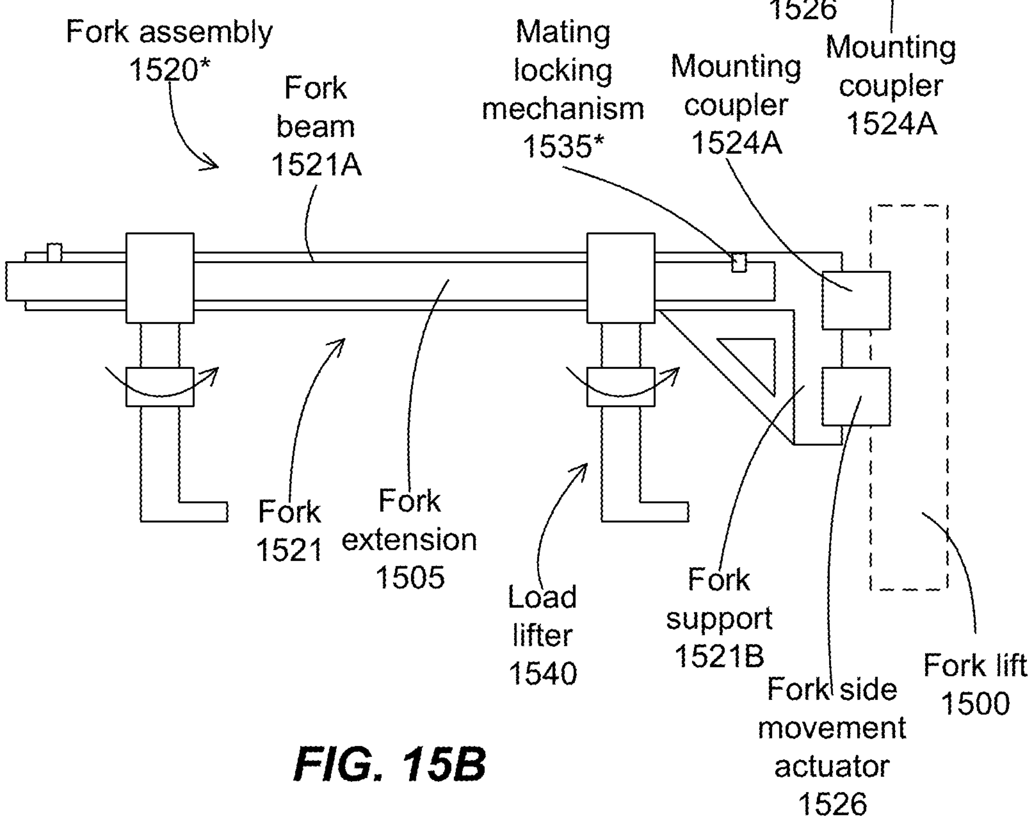


FIG. 15B

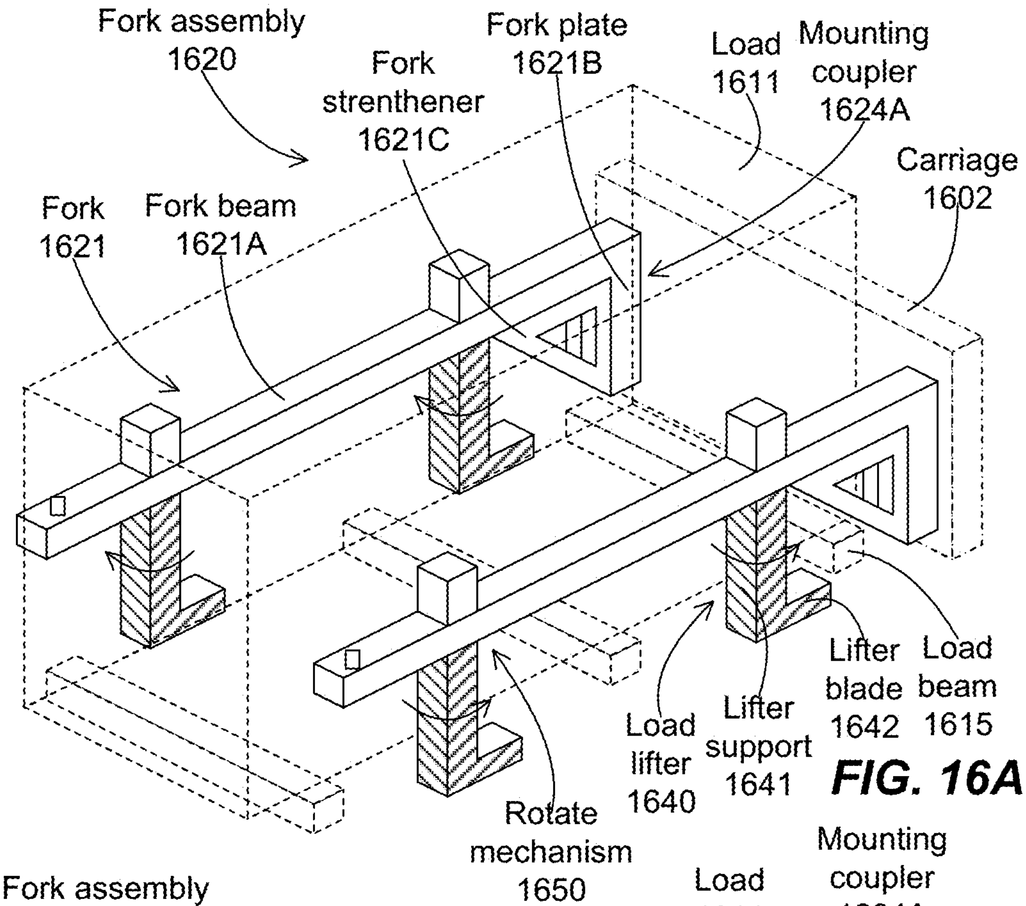


FIG. 16A

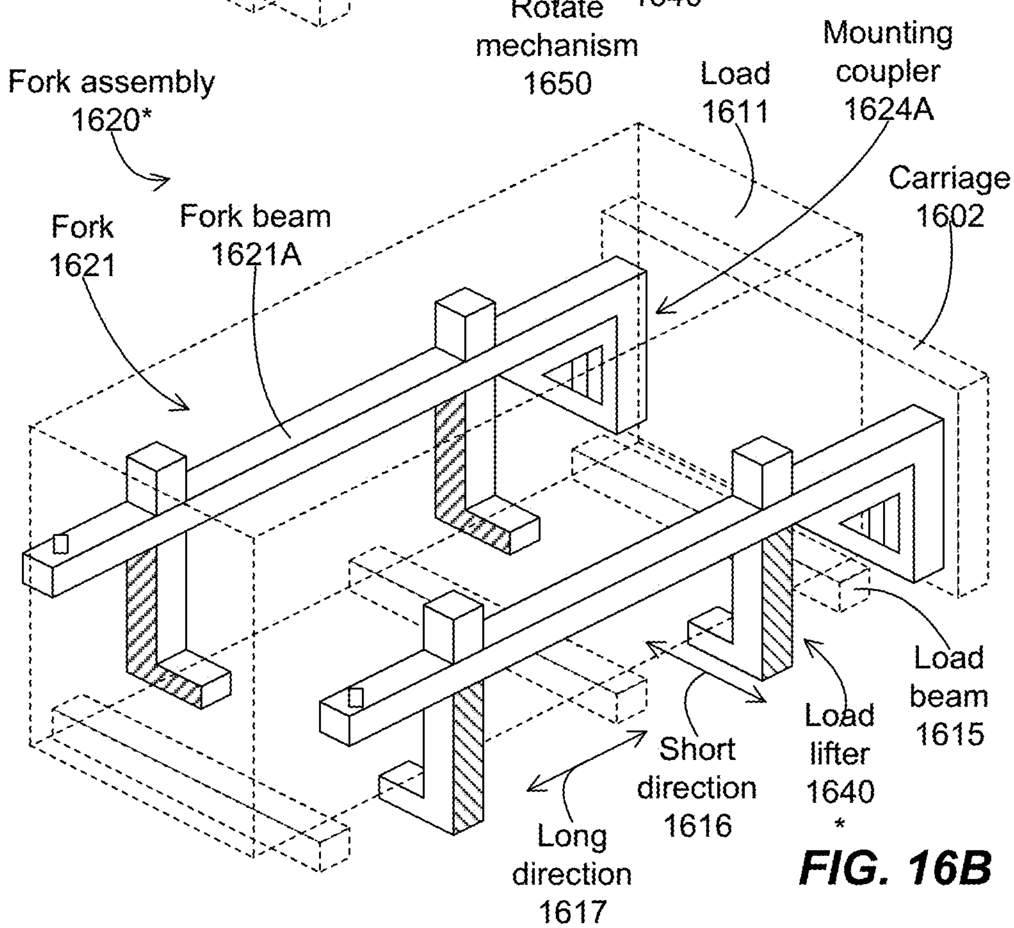


FIG. 16B

Forming a fork assembly configured to be coupled to a fork lift, wherein the fork assembly comprises
- one or more forks coupled to a mounting body, wherein the mounting body is configured to be coupled to the fork lift, wherein each fork comprises
-- a fork beam, wherein an end of the fork beam is configured to be coupled to the mounting body,
-- a fork lifter, wherein the fork lifter is coupled to the fork beam, wherein the fork lifter comprises
--- a fork blade coupled to a rotate mechanism, wherein the rotate mechanism is configured to rotate the fork blade between a first position in which the fork blade is at least partially disposed under a load and a second position in which the fork blade is not under the load, wherein the rotate mechanism comprises a remote operation mechanism for an operator in the fork lift to rotate the fork blade
1700

FIG. 17A

Forming a fork assembly configured to be coupled to a fork lift, wherein the fork assembly comprises
- a fork, wherein the fork comprises
-- a fork beam, wherein an end of the fork beam is configured to be coupled to the fork lift,
-- a fork lifter, wherein the fork lifter is coupled to the fork beam, wherein the fork lifter comprises
--- a fork blade coupled to a rotate mechanism, wherein the rotate mechanism is configured to rotate the fork blade between a first position in which the fork blade is at least partially disposed under a load and a second position in which the fork blade is not under the load, wherein the rotate mechanism comprises a remote operation mechanism for an operator in the fork lift to rotate the fork blade
1720

FIG. 17B

Moving a fork lift so that two fork beams of a fork assembly coupled to the fork lift surround a load, wherein blades of fork lifters coupled to the two fork beams are disposed outside the load
1800

Moving the fork assembly downward so that blades contact a surface, wherein the movement activates rotating mechanisms coupled to the fork lifters to rotate the blades from outside the load toward under the load
1810

Moving the fork assembly upward so that blades contact the load or a spring pushes the blades downward, wherein the movement activates the rotating mechanisms to rotate the blades to be under the load
1820

FIG. 18A

Moving a fork assembly coupled to a fork lift downward so that blades contact a surface, wherein the movement activates rotating mechanisms coupled to the fork lifters to rotate the blades from under the load toward outside the load
1840

Moving the fork assembly upward so that blades contact the load or a spring pushes the blades downward, wherein the movement activates the rotating mechanisms to rotate the blades to be outside the load
1850

Moving the fork lift away from the load
1860

FIG. 18B

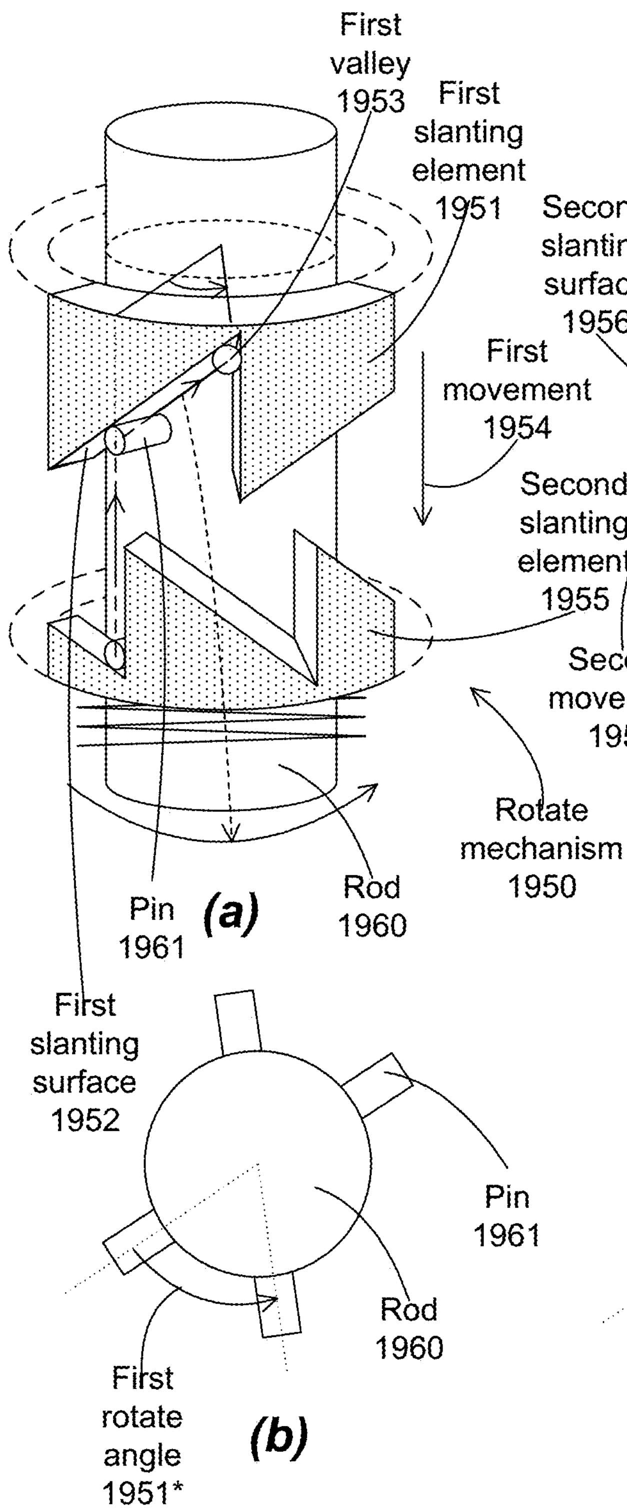


FIG. 19A

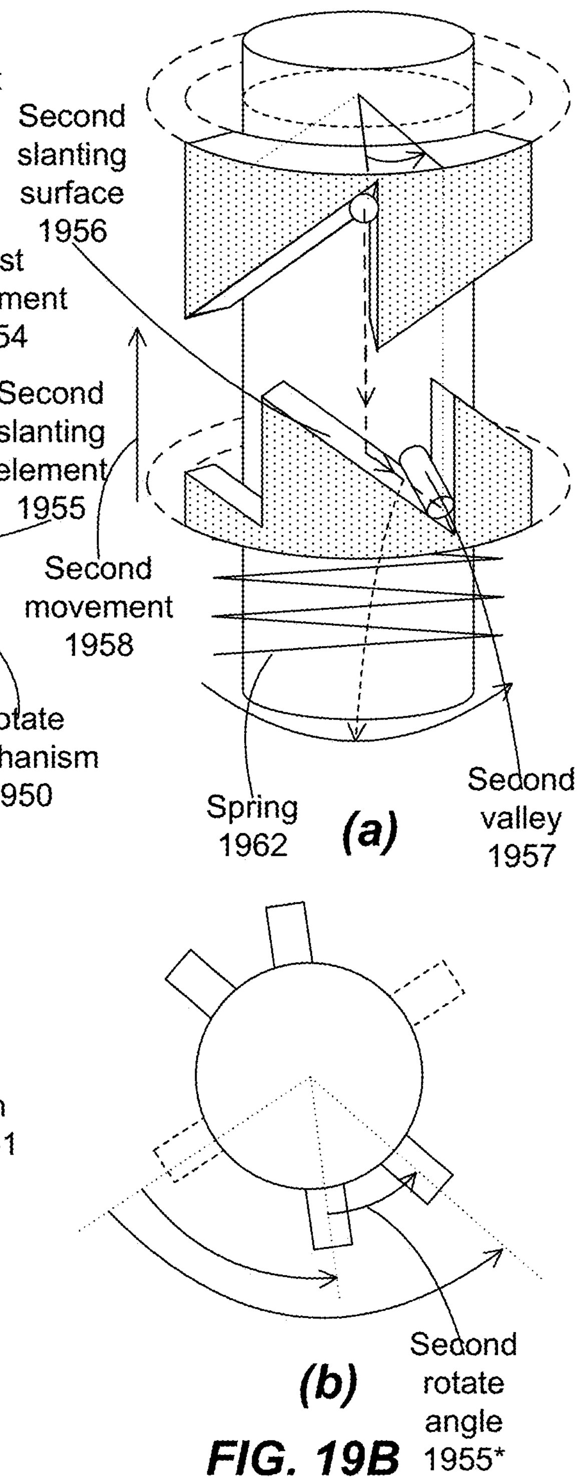


FIG. 19B

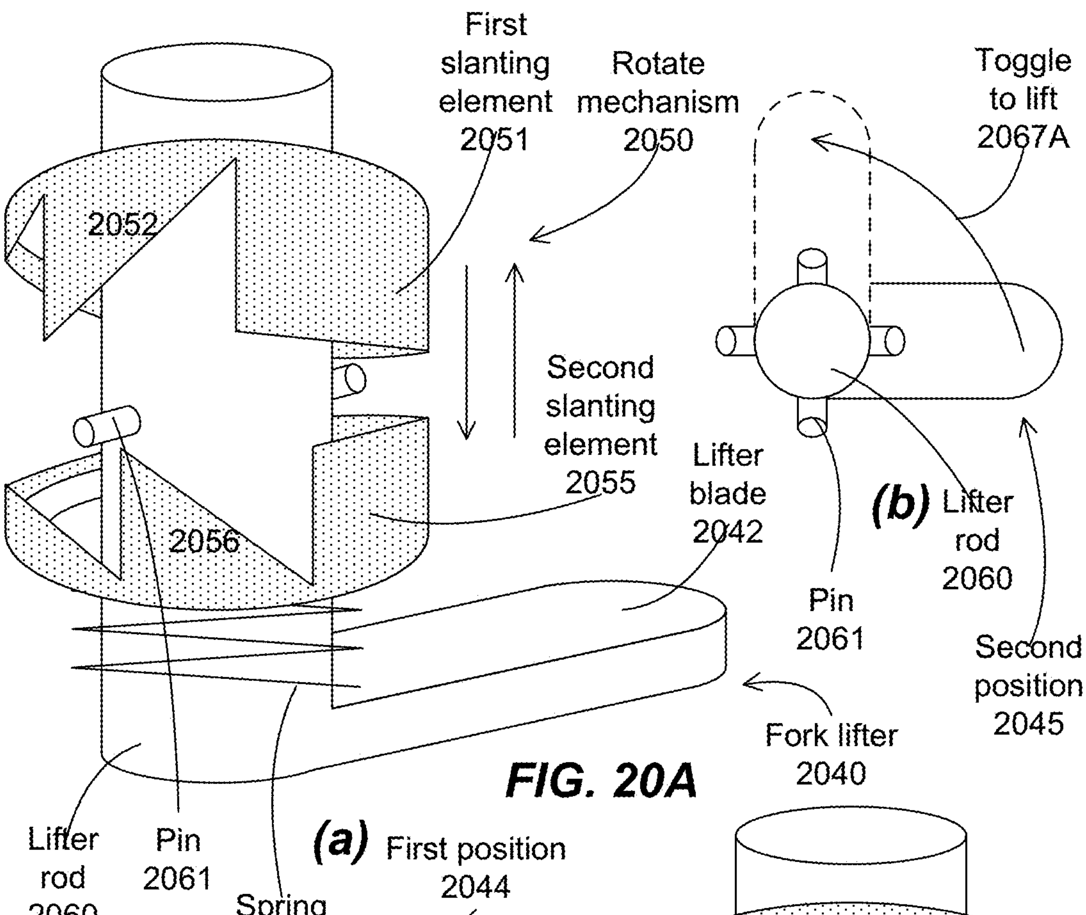


FIG. 20A

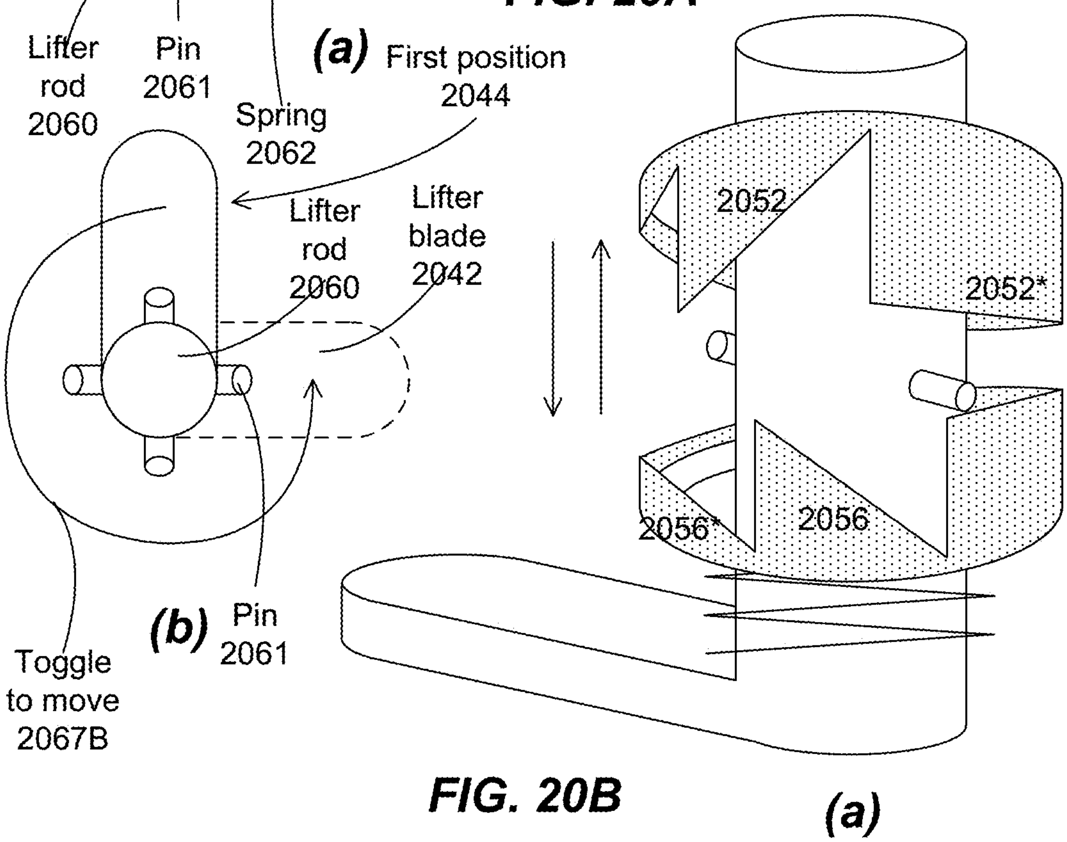


FIG. 20B

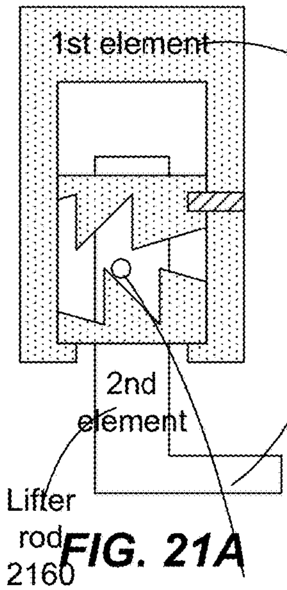


FIG. 21A

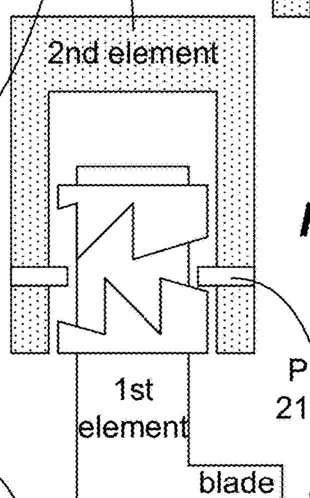


FIG. 21B

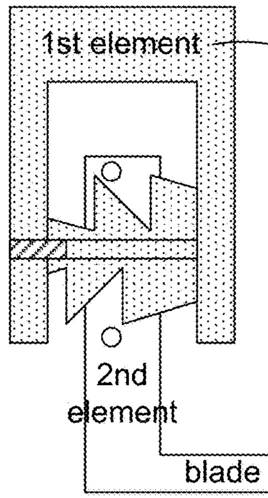


FIG. 21C

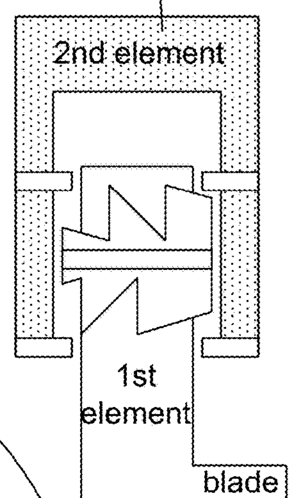


FIG. 21D

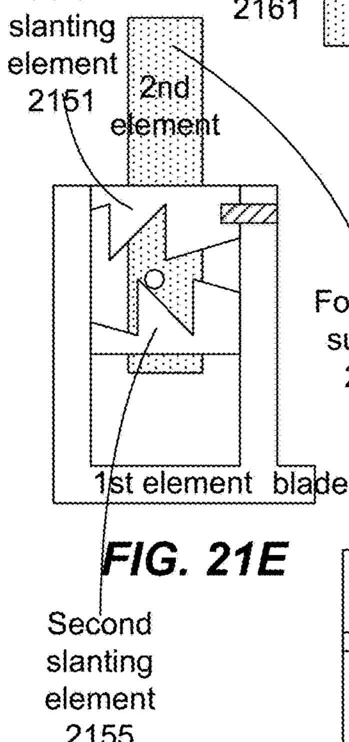


FIG. 21E

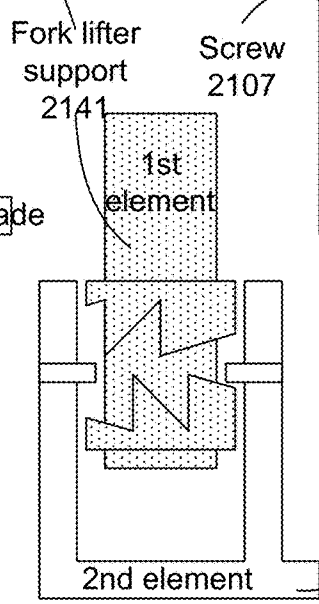


FIG. 21F

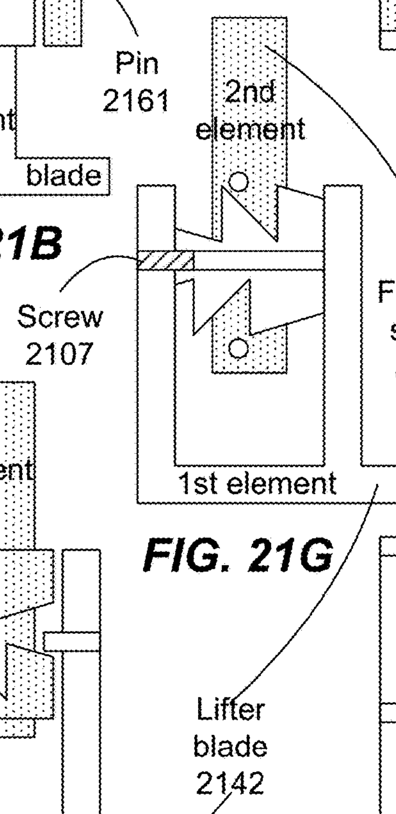


FIG. 21G

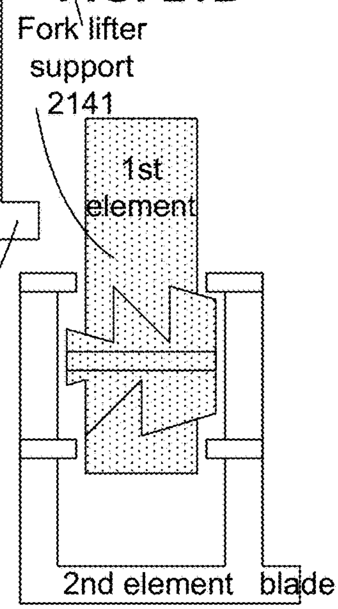


FIG. 21H

Forming a rotate mechanism, the rotate mechanism comprises
- a first element comprising a first slanting surface connected to a first valley, and a second slanting surface connected to a second valley,
-- the first slanting surface is spaced from the second slanting surface
-- the first and second slanting surfaces form an angle greater than zero
- a second element comprising one or more pins configured to interact with the first and second slanting surfaces through relative motions between the one or more first elements and the one or more second elements,
-- the relative motions comprise a first movement in which the one or more pins relatively move along the first slanting surface to rest at the first valley and to cause the one or more pins to rotate a first angle relative to the one or more elements
-- the relative motions comprise a second movement in which the one or more pins relatively move along the second slanting surface to rest at the second valley and to cause the one or more pins to rotate a second angle relative to the one or more elements

2200

FIG. 22A

Forming a rotate mechanism, the rotate mechanism comprises
- a first element comprising a first slanting surface, and a second slanting surface,
- a second element comprising one or more pins configured to interact with the first and second slanting surfaces to rotate a blade between a first and a second positions, wherein the blade or a fork beam are coupled to either the first or second element respectively,
-- in the first position, the blade is disposed under a load
-- in the second position, the blade is disposed outside the load

2220

FIG. 22B

Toggling a lifter blade between a first position and a second position of a fork lifter coupled to a fork assembly of a fork lift, wherein the toggling process is activated when the fork assembly is positioned around the load with the lifter blade in a vicinity of a ground, wherein in the first position, the lifter blade is disposed under the load for lifting the load, wherein in the second position, the lifter blade is outside the load for not lifting the load
2300

FIG. 23A

Moving a fork lifter coupled to a fork assembly of a fork lift downward, wherein when the fork lifter contacts a surface and then releases from the surface, a toggling mechanism is activated to toggle a blade of the fork lifter between a first position and a second position, wherein in the first position, the lifter blade is disposed under a load for lifting the load, wherein in the second position, the lifter blade is outside the load for not lifting the load
2320

FIG. 23B

Moving a fork assembly of a fork lift in two opposite directions to toggle a blade of a fork lifter coupled to the fork assembly between under a load for lifting the load and outside the load for not lifting the load
2340

FIG. 23C

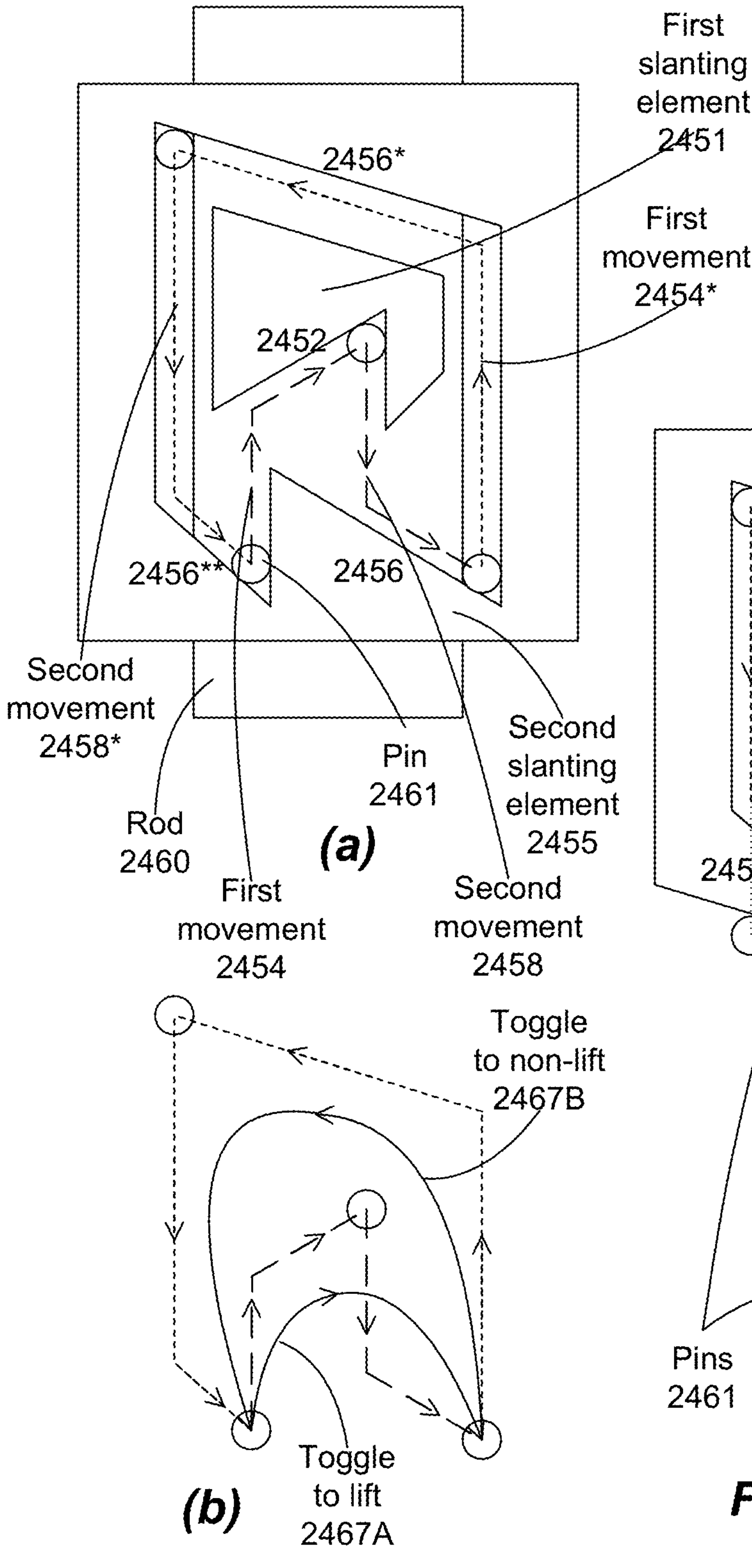


FIG. 24A

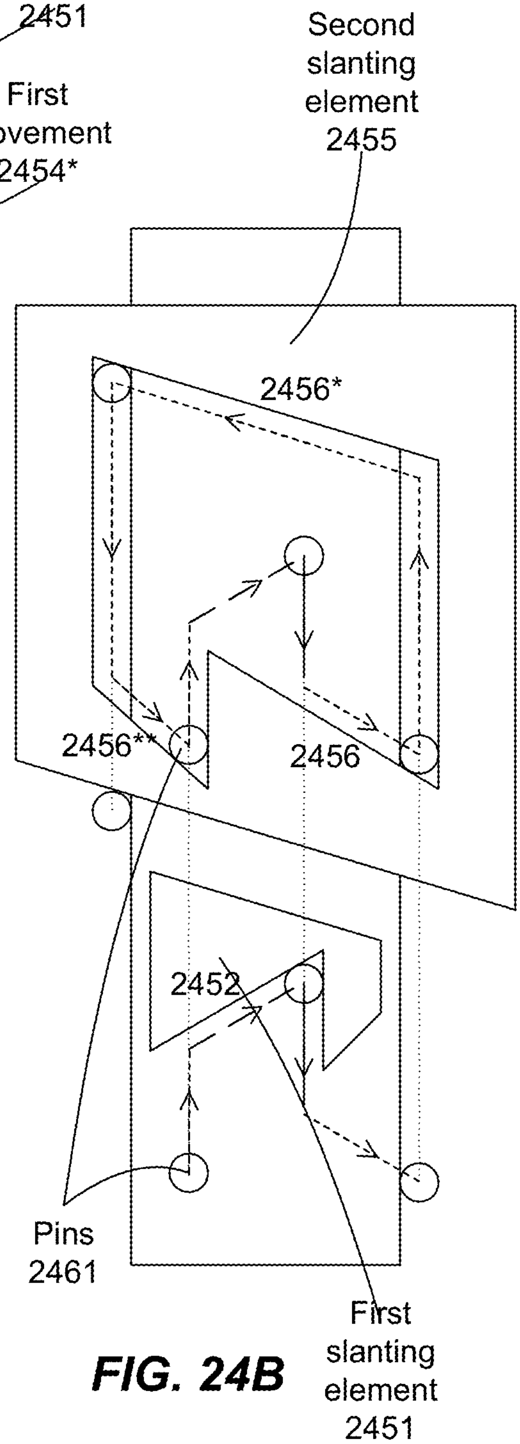


FIG. 24B

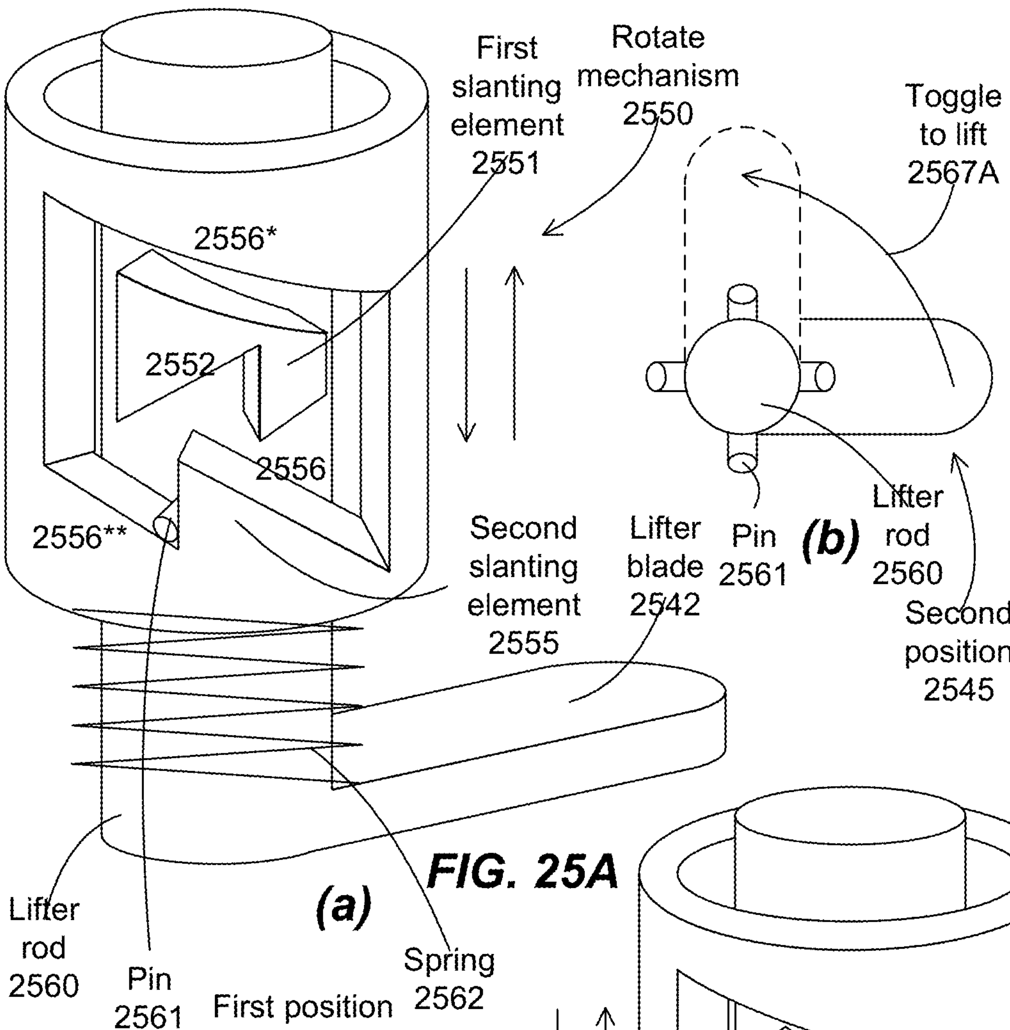


FIG. 25A

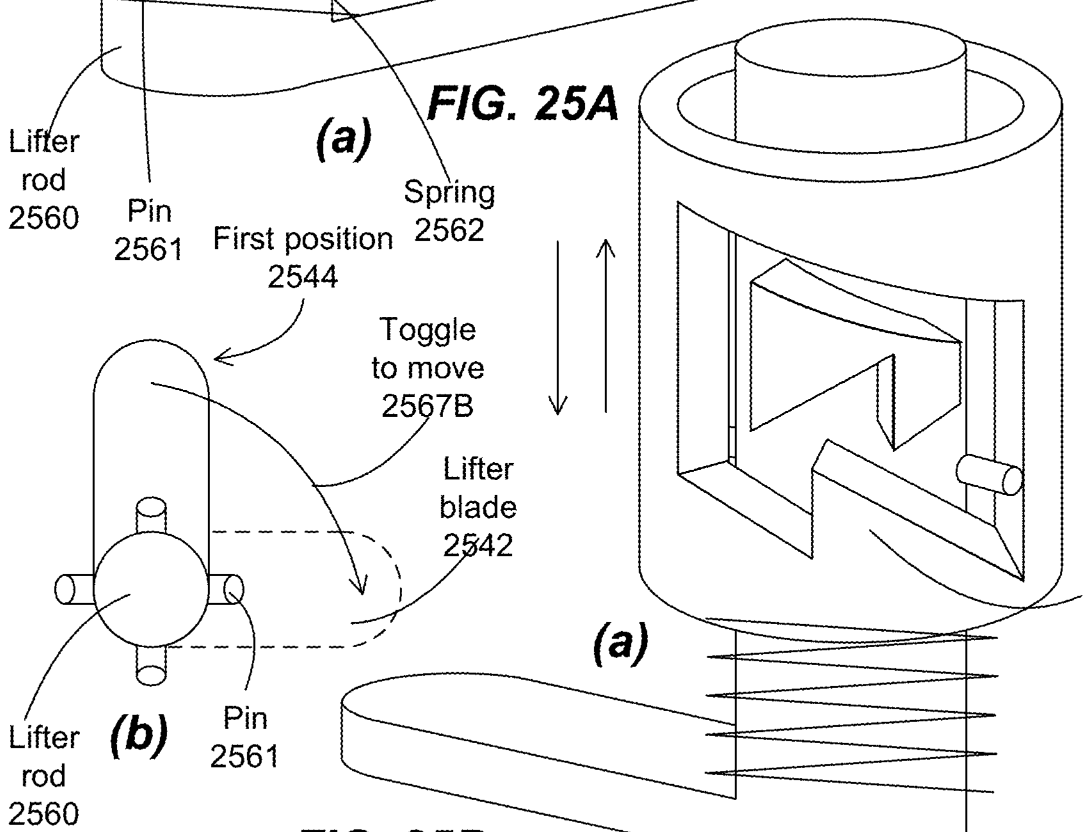
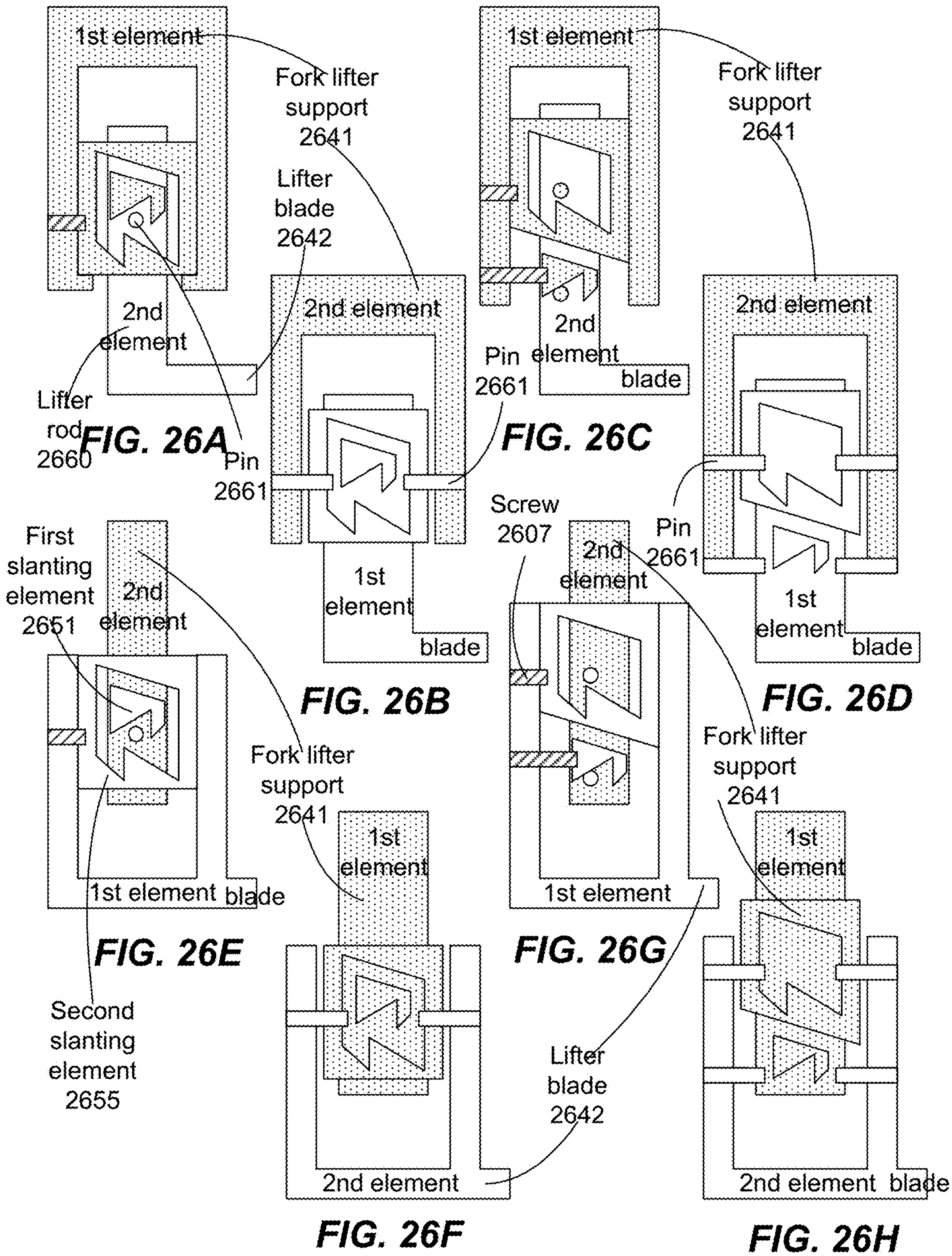


FIG. 25B


1st element
Fork lifter support 2641
Lifter blade 2642
2nd element
Lifter rod 2660
Pin 2661
FIG. 26A
2nd element
1st element
blade
FIG. 26B
1st element
Fork lifter support 2641
2nd element
Pin 2661
blade
FIG. 26C
2nd element
Pin 2661
1st element
blade
FIG. 26D
First slanting element 2651
2nd element
1st element
blade
FIG. 26E
Second slanting element 2655
Fork lifter support 2641
1st element
2nd element
FIG. 26F
Screw 2607
2nd element
1st element
FIG. 26G
Lifter blade 2642
Fork lifter support 2641
1st element
2nd element
blade
FIG. 26H

Forming a rotate mechanism,
the rotate mechanism is configured to rotate a lifter blade 270 degree in a first rotation direction from a first position to a second position of a fork lifter coupled to a fork assembly of a fork lift,
the rotate mechanism is configured to rotate a lifter blade 270 degree in the first rotation direction from the second position to the first position,
wherein in the first position, the lifter blade is disposed under the load for lifting the load, wherein in the second position, the lifter blade is outside the load for not lifting the load
2700

FIG. 27A

Forming a rotate mechanism,
the rotate mechanism is configured to rotate a lifter blade 270 degree in a first rotation direction from a first position to a second position of a fork lifter coupled to a fork assembly of a fork lift,
the rotate mechanism is configured to rotate a lifter blade 270 degree in a second rotation direction opposite the first rotation direction from the second position to the first position,
wherein in the first position, the lifter blade is disposed under the load for lifting the load, wherein in the second position, the lifter blade is outside the load for not lifting the load
2700

FIG. 27B

FIG. 28A

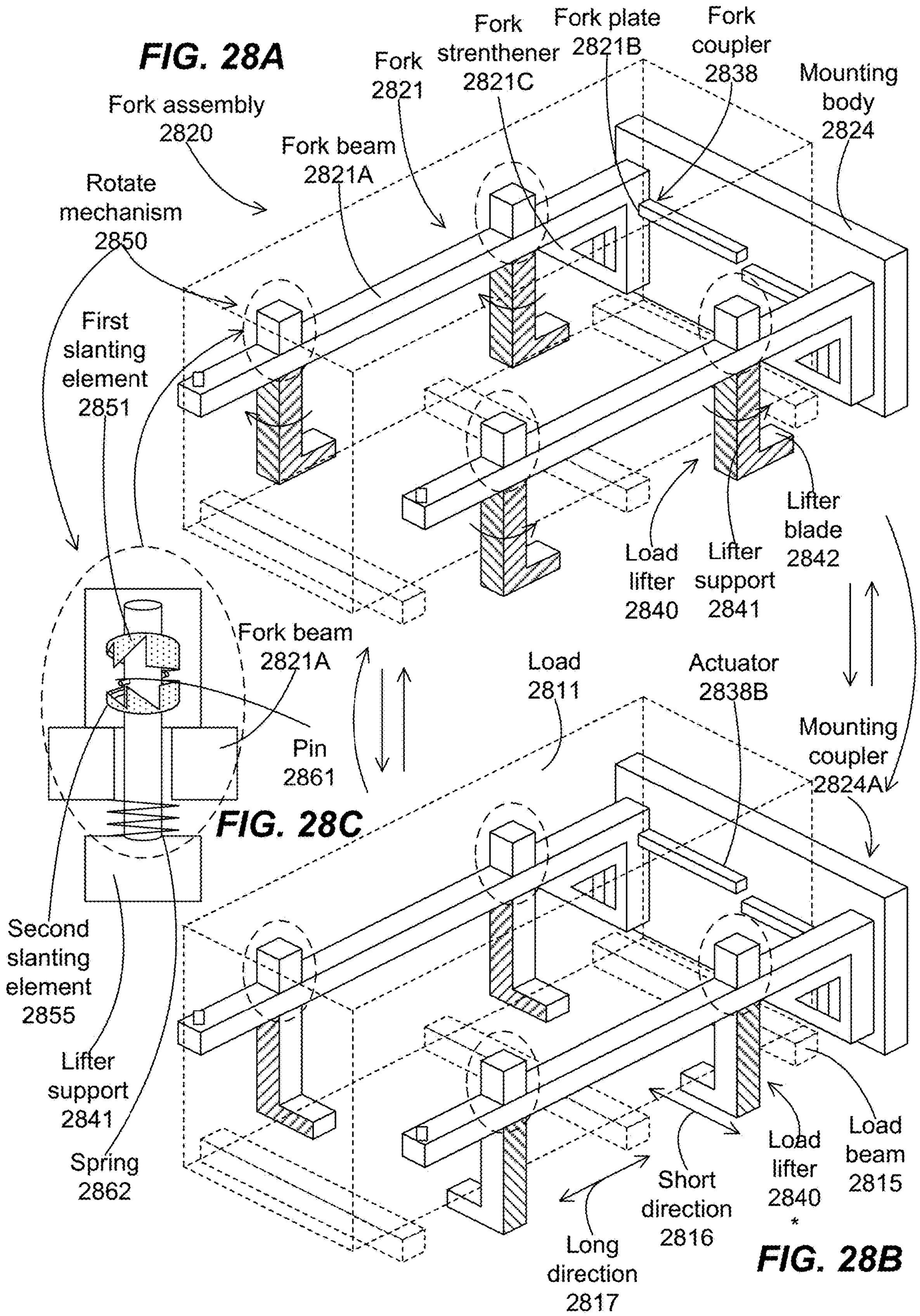


FIG. 28C

FIG. 28B

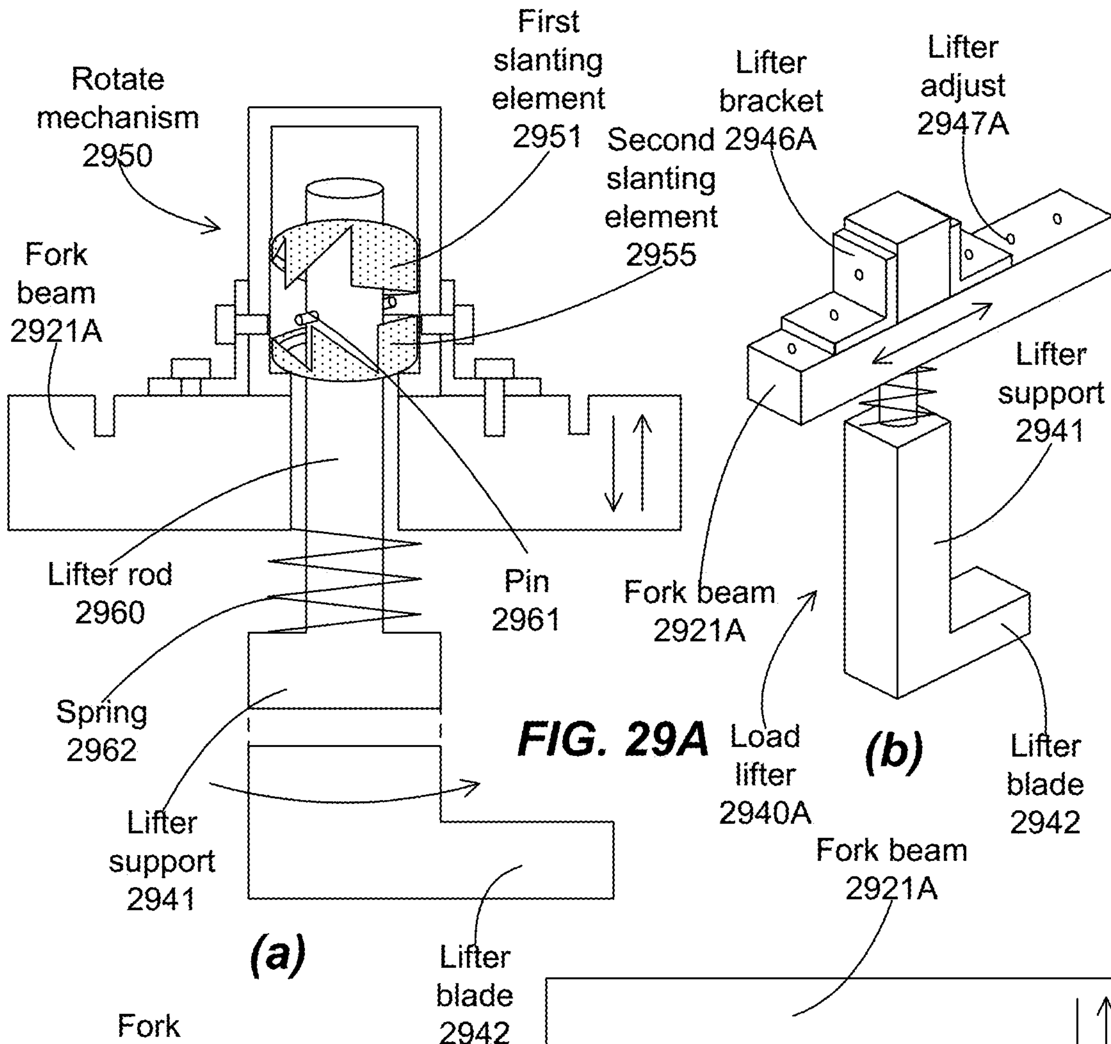


FIG. 29A

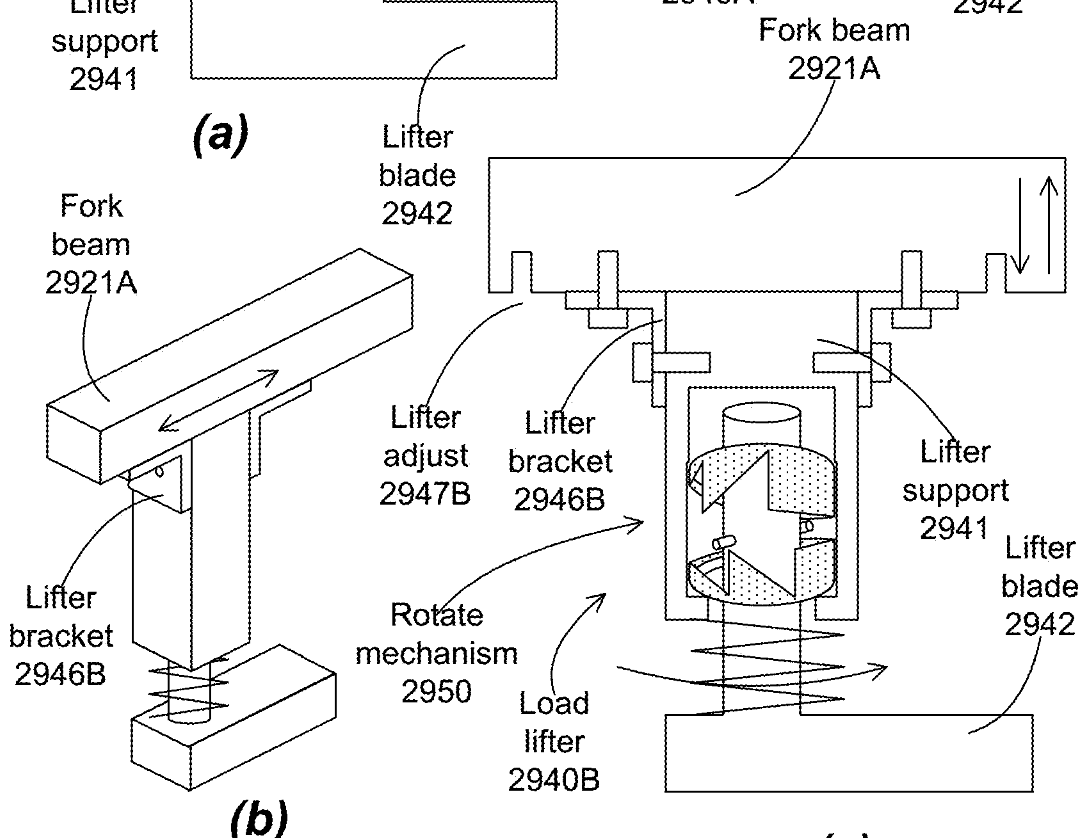


FIG. 29B

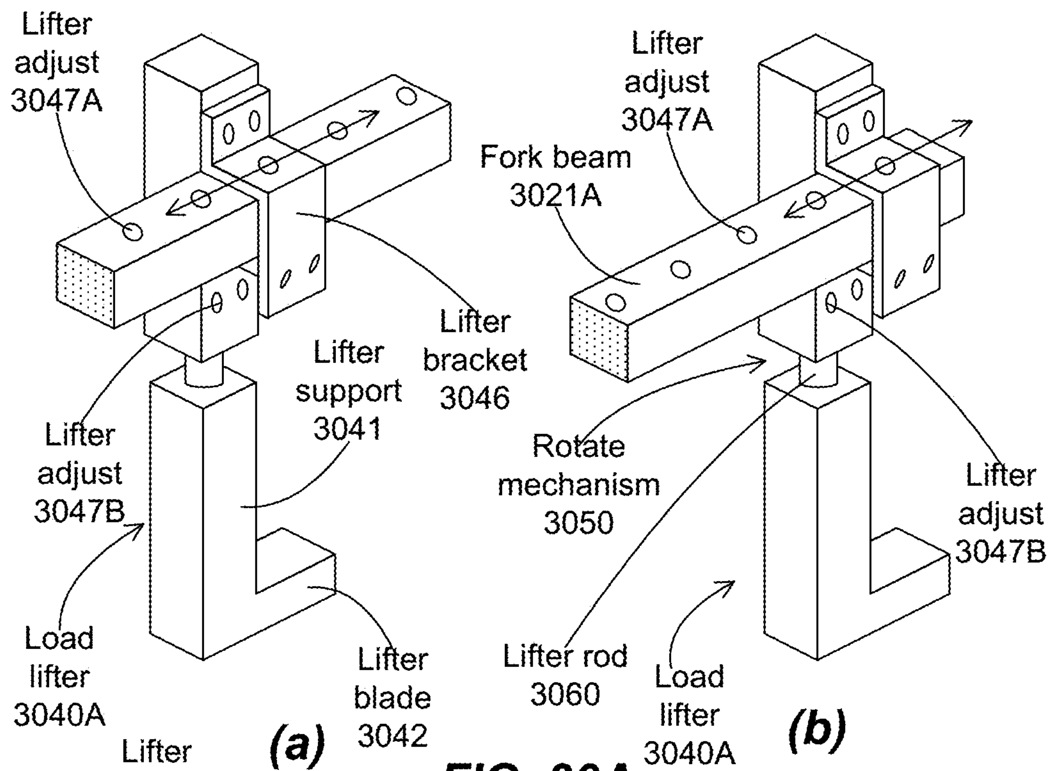


FIG. 30A

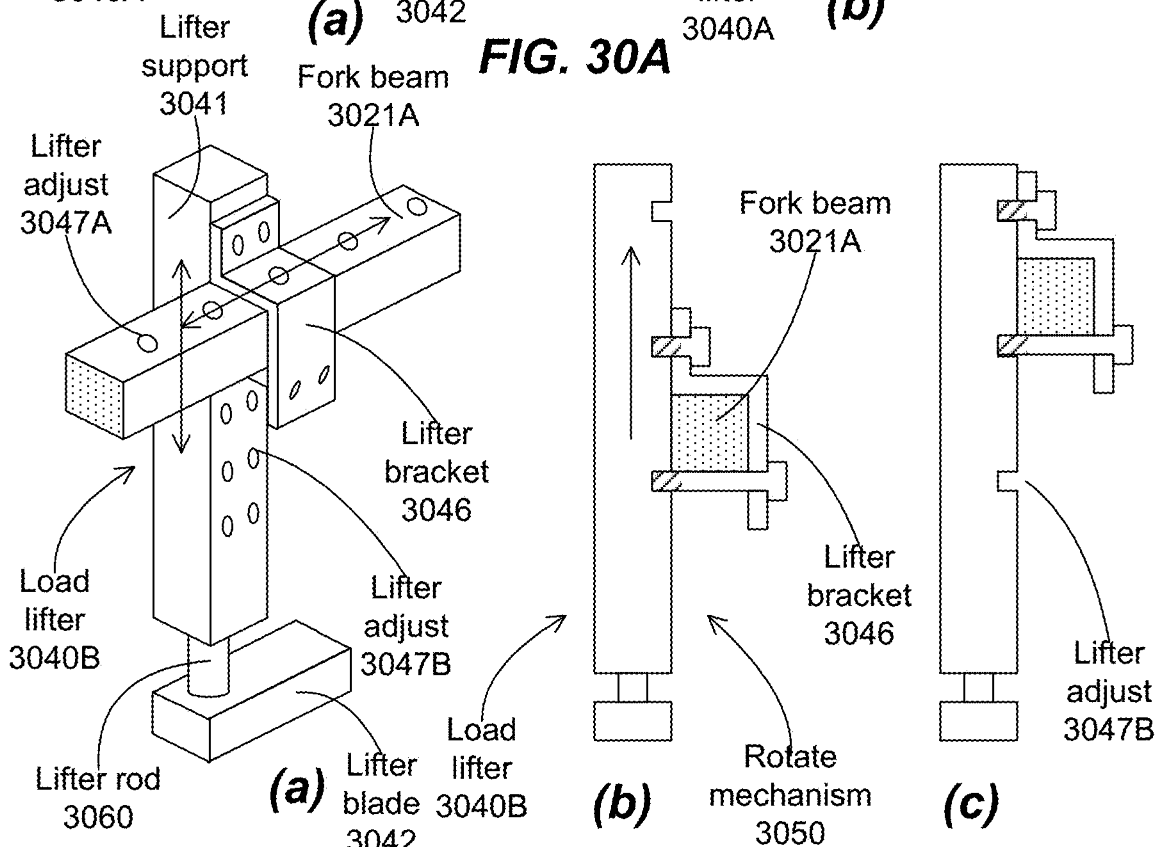


FIG. 30B

Forming a load lifter coupled to a fork for lifting a load,
the load lifter comprises a rotate mechanism coupled to the fork and a blade coupled to the rotate mechanism,
the rotate mechanism is configured to rotate the blade between under the load and outside the load,
the load lifter is configured to be coupled to the fork at discrete or continuous locations along a fork beam of the fork,
the load lifter is configured to be coupled to the fork at discrete or continuous locations to adjust a height of the load lifter
3100

FIG. 31A

Coupling a load lifter to a fork for lifting a load,
the load lifter comprises a rotate mechanism coupled to the fork and a blade coupled to the rotate mechanism,
the rotate mechanism is configured to rotate the blade between under the load and outside the load,
the load lifter is configured to be coupled to the fork at discrete or continuous locations along a fork beam of the fork,
the load lifter is configured to be coupled to the fork at discrete or continuous locations to adjust a height of the load lifter
3120

FIG. 31B

Adjusting a load lifter to a fork for lifting a load,
the load lifter is positioned along a fork beam of the fork so that a blade of the load lifter is capable of rotating to under the load without obstruction,
the load lifter is positioned along a support of the load lifter so that the blade is capable of rotating to under the load without obstruction
3140

FIG. 31C

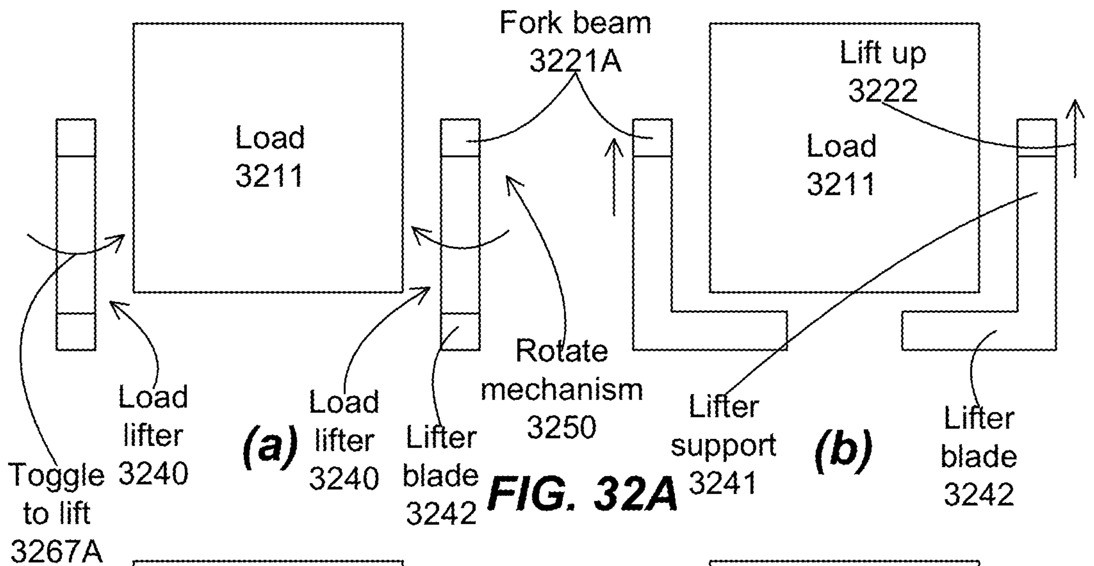


FIG. 32A

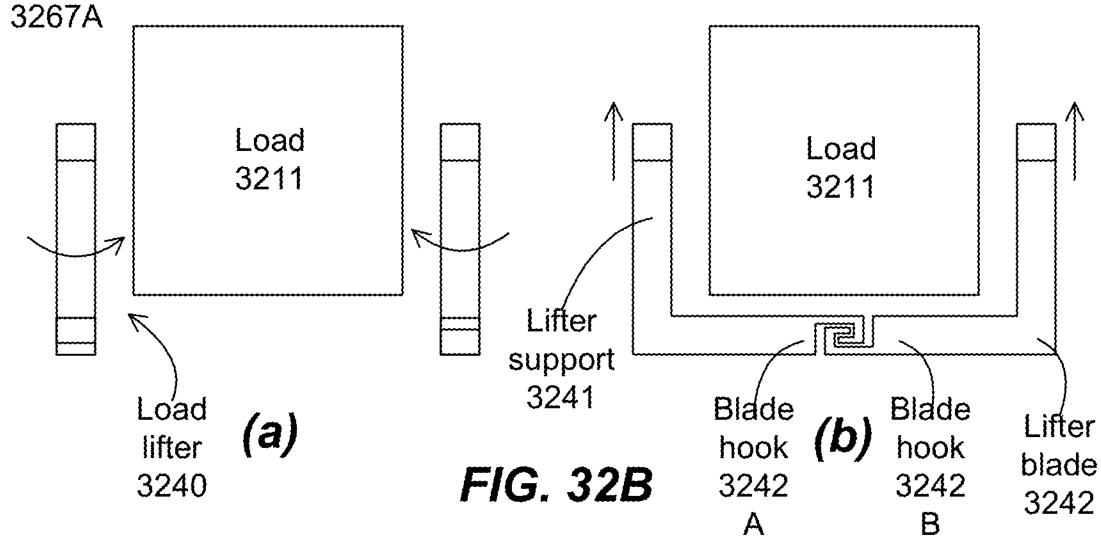


FIG. 32B

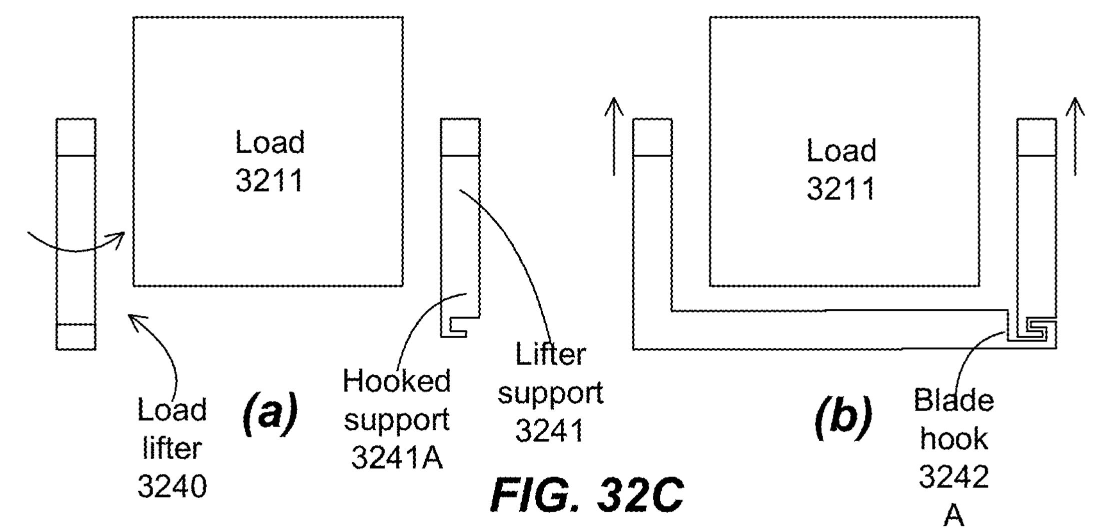


FIG. 32C

Coupling a load lifter to each fork of a two-fork fork assembly,
wherein one of
- blades of the load lifters are configured to operate independently for lifting the load, OR
- the load lifters are disposed in opposite sides of the load, blades of the load lifters are configured to be coupled together under the load when rotated to be under the load
3300

FIG. 33A

Forming a fork assembly comprising two forks,
- coupling a first load lifter to a first fork of the two forks, the first load lifter comprises a rotate mechanism for rotating a blade, the blade comprises a hook at an end,
- coupling a second load lifter to a second fork of the two forks, the second load lifter is configured not to be rotated and comprises a mating hook at an end
3320

FIG. 33B

- Coupling a first load lifter to a first fork of a two-fork fork assembly, the first load lifter comprises a rotate mechanism for rotating a blade, the blade comprises a hook at an end,
- Coupling a second load lifter to a second fork of a two-fork fork assembly, the second load lifter is configured not to be rotated and comprises a mating hook at an end
3340

FIG. 33C

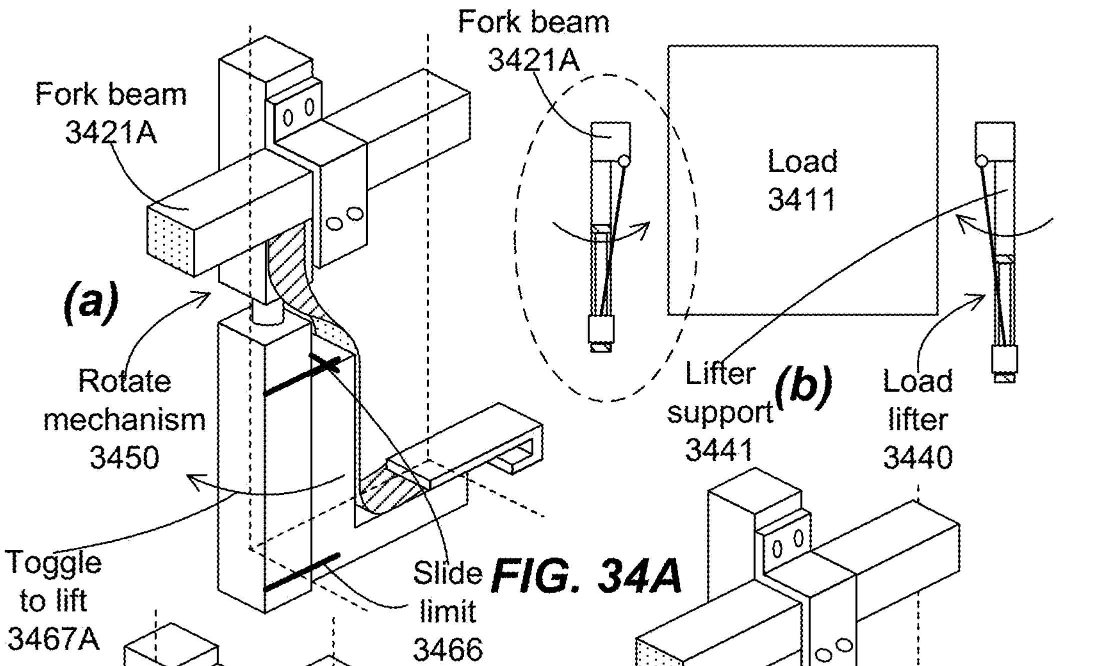


FIG. 34A

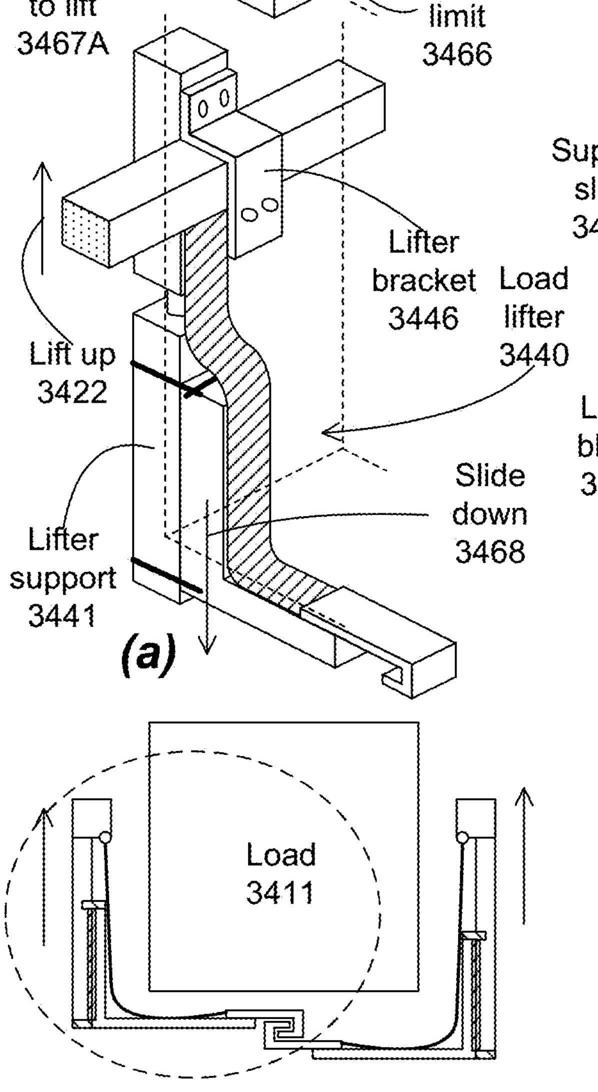


FIG. 34B

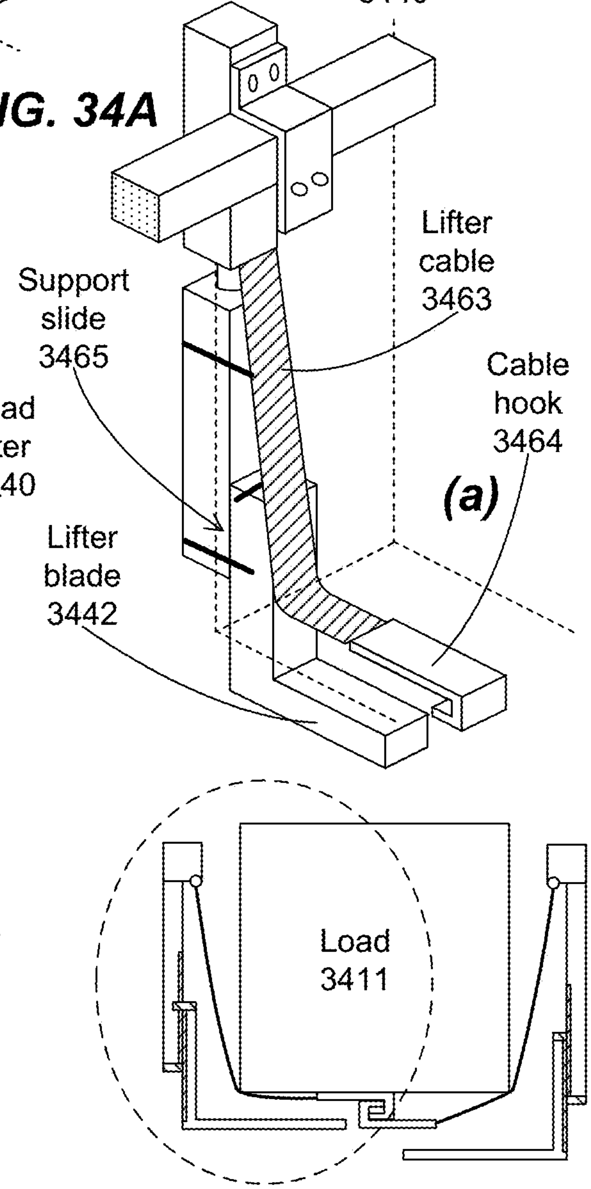


FIG. 34C

Forming a fork assembly comprising two forks,
- coupling a first load lifter to a first fork of the two forks,
the first load lifter comprises a first rotate mechanism for rotating a first blade,
the first load lifter comprises a first sliding mechanism for sliding the first blade relative to the first fork,
the first load lifter comprises a first cable disposed on the first blade,
the first cable comprises a first hook at an end,
- coupling a second load lifter to a second fork of the two forks,
the second load lifter comprises a second rotate mechanism for rotating a second blade,
the second load lifter comprises a second sliding mechanism for sliding the second blade relative to the second fork,
the second load lifter comprises a second cable disposed on the second blade,
the second cable comprises a second hook at an end,
- the second hook is configured for mating with the first hook when the first and second load lifters rotate so that the first and second blades are disposed under the load.
the first and second cable are configured to move from the first and second blade, respectively, to support the load when the fork assembly is raised up
3500

FIG. 35A

- Activating rotate mechanisms of load lifter coupled to a fork assembly to rotate blades under a load so that hooks coupled to cables on the blades are coupled together
- Lifting up the fork assembly so that the coupled cables supports the load and the blades slide down the load lifters
3520

FIG. 35B

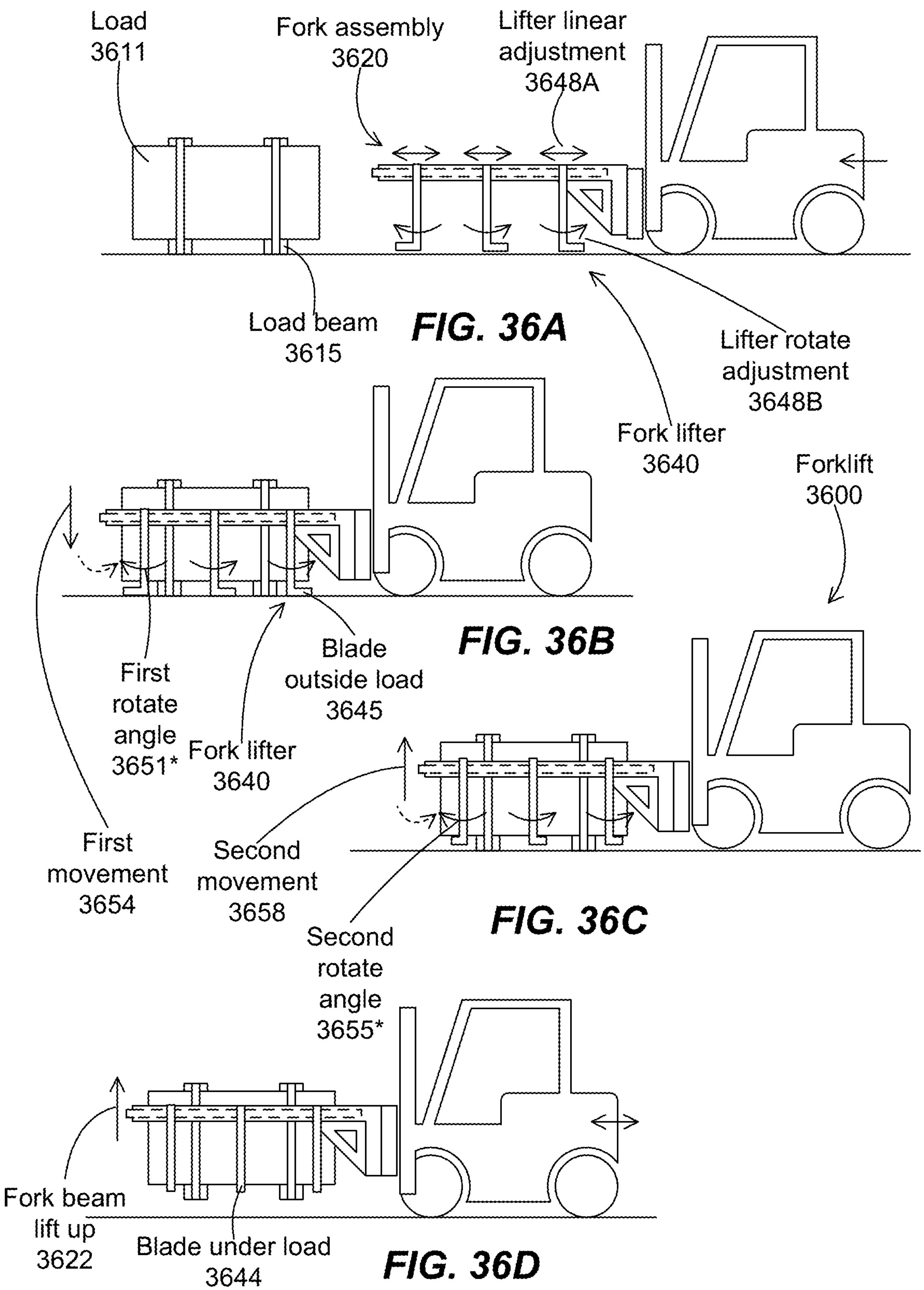


FIG. 36A

FIG. 36B

FIG. 36C

FIG. 36D

3700 - Mounting a fork assembly to a forklift

3710 - Adjusting a lateral position of a load lifter along a fork beam of a fork of the fork assembly to clear a rotation of a blade of the fork lifter from a load beam

3720 - Adjusting a height of the load lifter to allow the blade to freely move to a gap between a bottom of a load and the ground

3730 - Adjusting a distance between the forks of the fork assembly to be larger than a dimension of the load

3740 - Moving the fork lift to position the load to be between 2 forks of the fork assembly and the blade above the ground

3750 - Moving the fork assembly downward to exert an upward force on the blade for rotating the blade a first angle to be under the load

3760 - Moving the fork assembly upward to exert a downward force on the blade for rotating the blade a second angle to be under the load

3760A - Optionally mating hooks on the blades

3760B - Optionally mating hooks on cables disposed on the blades

3770 - Continuing moving the fork assembly upward to lift the load off the ground

3770A - Optionally moving upward for the blades to contact the load

3770B - Optionally moving upward for the cables to contact the load

3780 - Transporting the load by moving the fork lift to a destination

FIG. 37

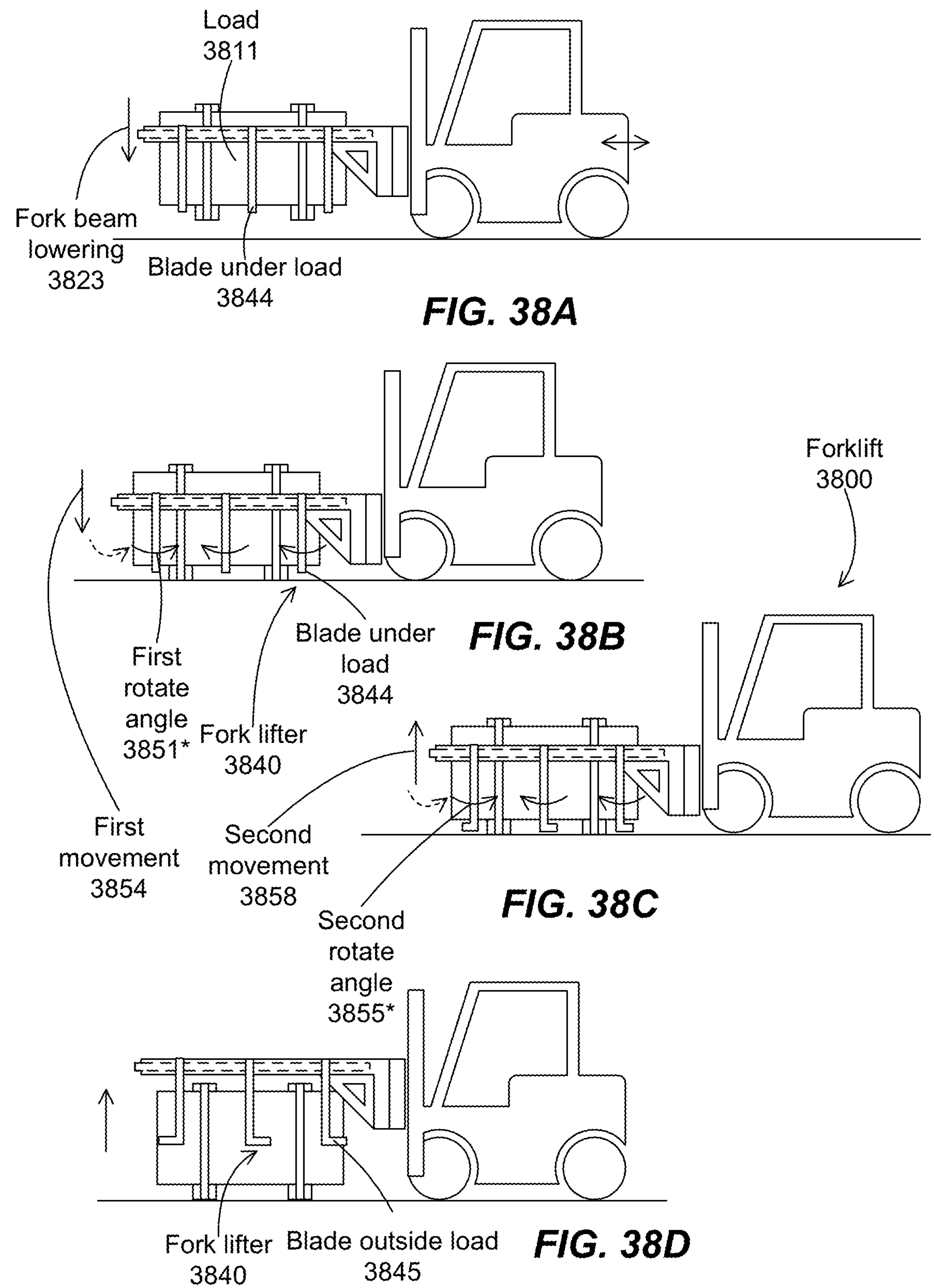


FIG. 38A

FIG. 38B

FIG. 38C

FIG. 38D

3900B – Optionally moving the fork assembly downward until cables of fork lifters coupled to the fork assembly are disposed on blades of the fork lifters

3910 - Moving the fork assembly downward to exert an upward force on the blade for rotating the blade a first angle toward outside the load

3910A - Optionally releasing hooks on the blades

3910B - Optionally releasing hooks on the cables

3920 - Moving the fork assembly upward to exert a downward force on the blade for rotating the blade a second angle to be outside the load

3930 - Continuing moving the fork assembly upward to clear the blades off the ground

3940 - Moving the fork lift away from the load

3950 - Optionally unmounting the fork assembly from the fork lift

FIG. 39

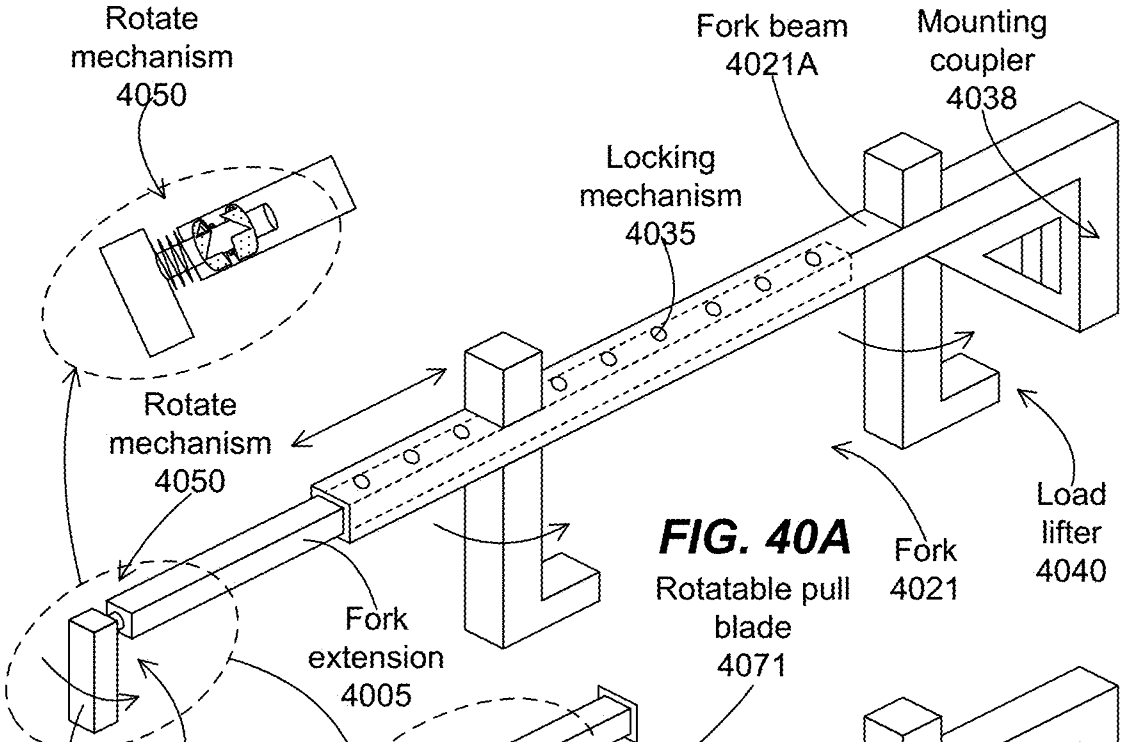


FIG. 40A

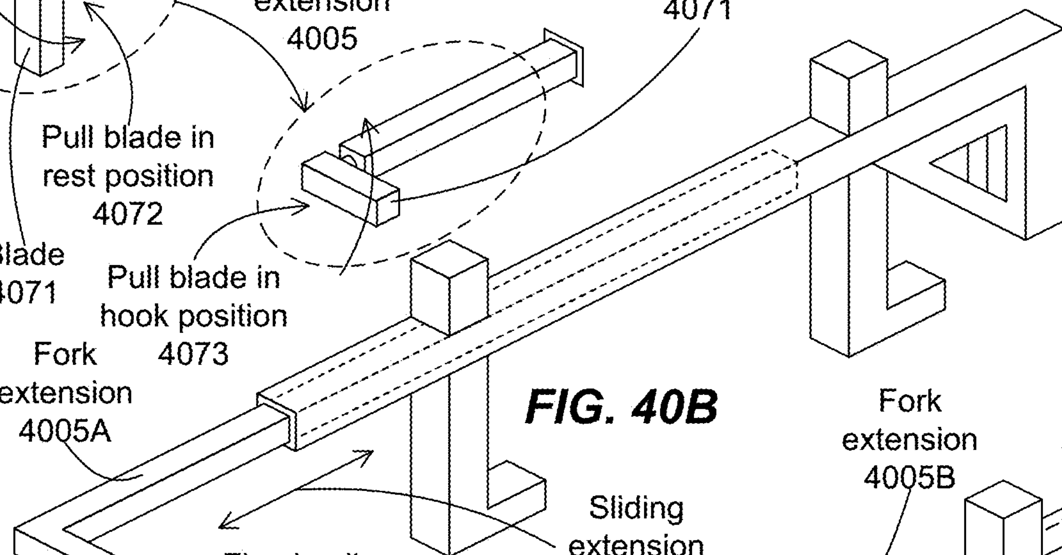


FIG. 40B

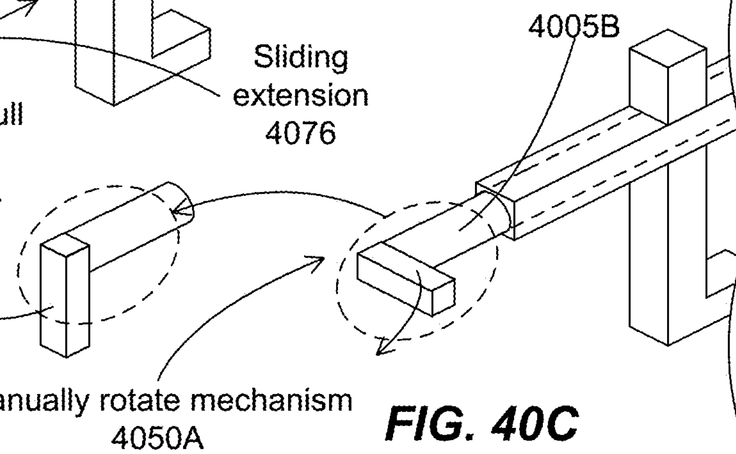


FIG. 40C

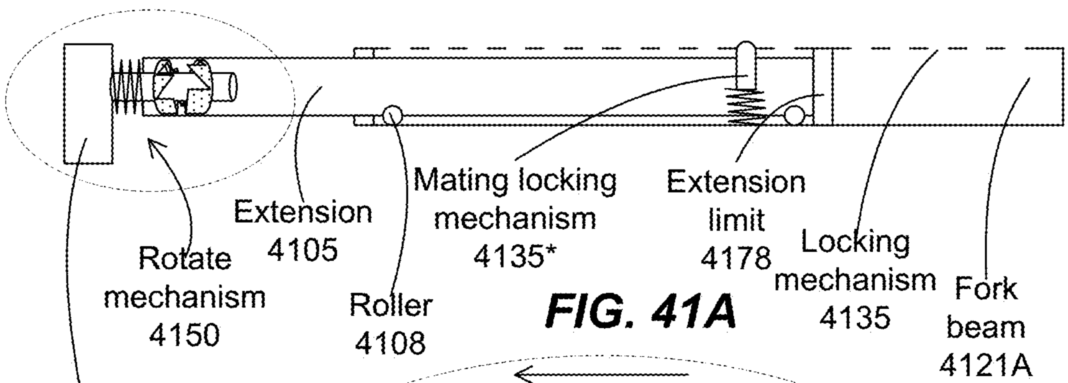


FIG. 41A

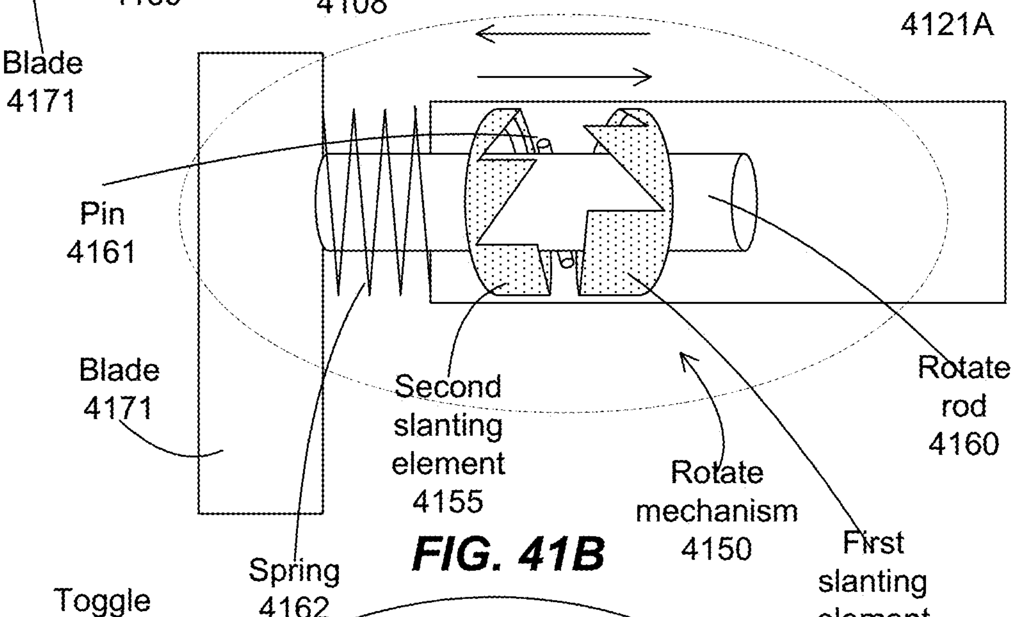


FIG. 41B

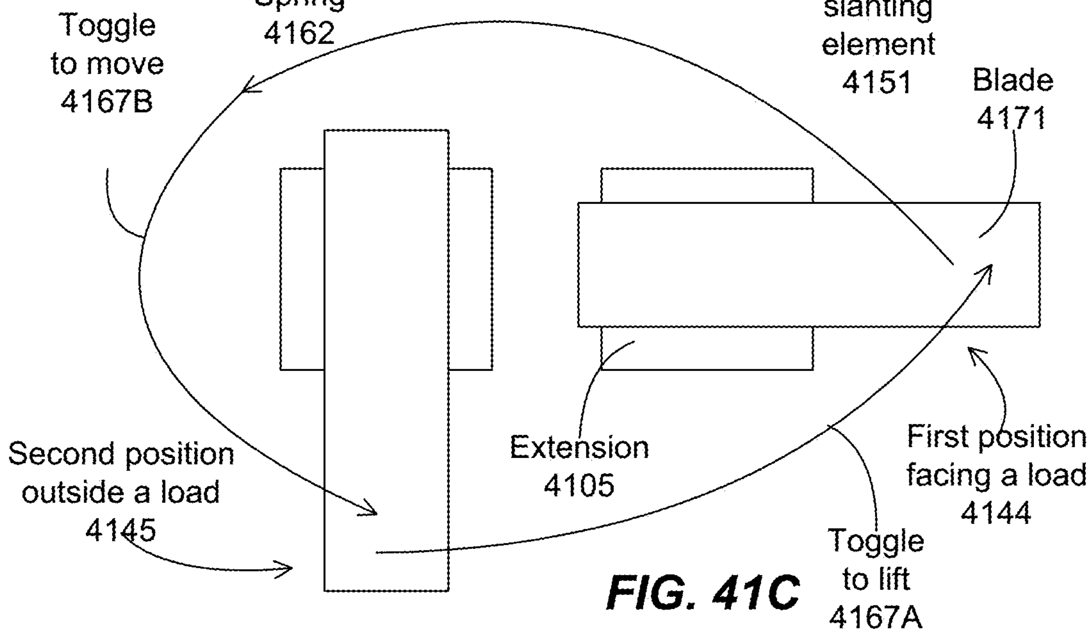


FIG. 41C

Forming a fork comprising a fork extension for extending a length of the fork,
- the fork extension is configured to be slidable along the length of the fork.
-- the fork extension optionally comprises a limiter for preventing the fork extension from sliding out of the fork,
-- the fork extension optionally comprises rollers for ease of sliding,
-- the fork extension optionally comprises a locking mechanism for locking to discrete extension positions along the fork length,
- the fork extension comprises a rotate mechanism coupled to the fork extension and a blade coupled to the rotate mechanism,
-- the rotate mechanism is configured to rotate the blade between facing the load (sideway toward the load) and outside the load (downward or upward)
4200

FIG. 42A

Forming a fork comprising a fork extension for extending a length of the fork,
- the fork extension comprises a fixed blade at an end facing the load (sideway toward the load)
4220

FIG. 42B

Forming a fork comprising a fork extension for extending a length of the fork,
- the fork extension comprises a fixed blade coupled to a manually rotate mechanism configured to rotate the blade between facing the load (sideway toward the load) and outside the load (downward or upward)
4240

FIG. 42C

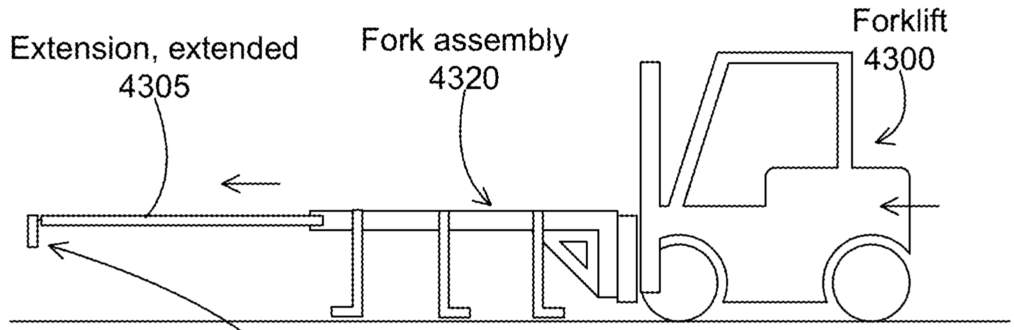


FIG. 43A

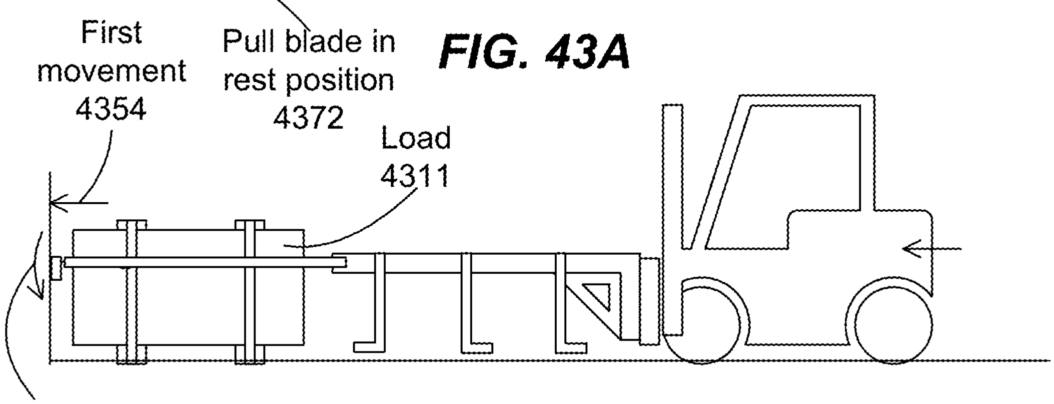


FIG. 43B

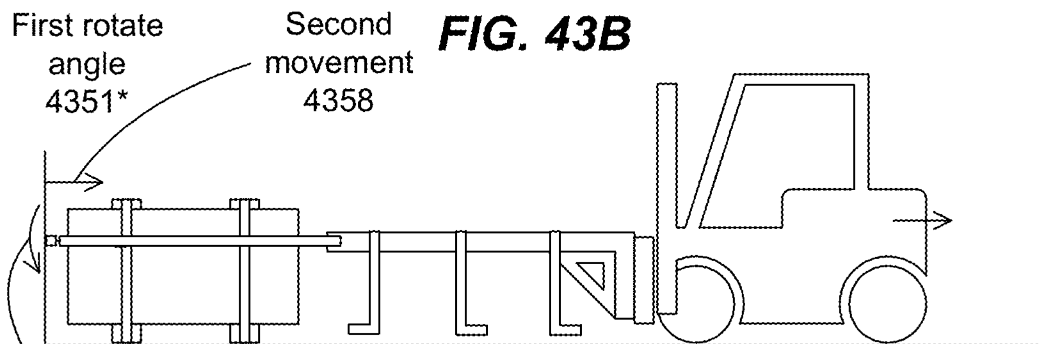


FIG. 43C

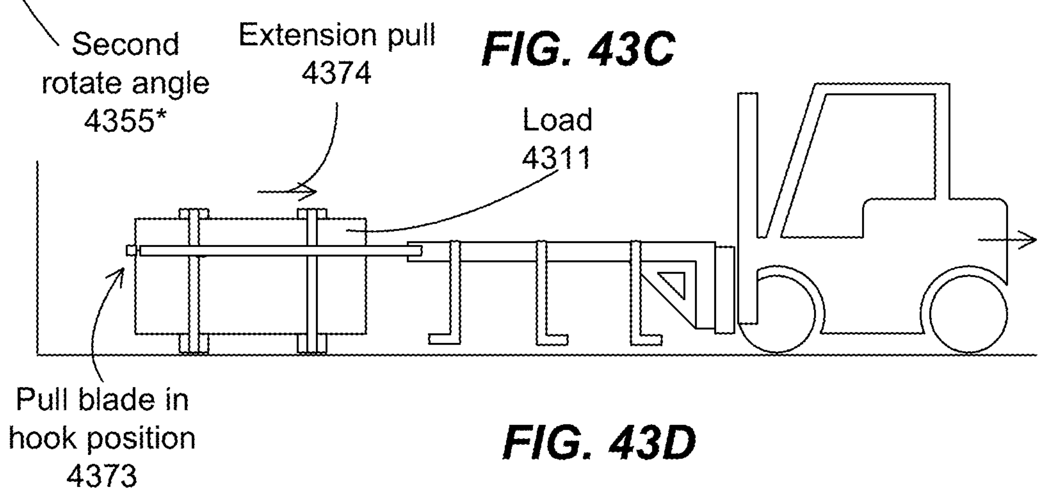


FIG. 43D

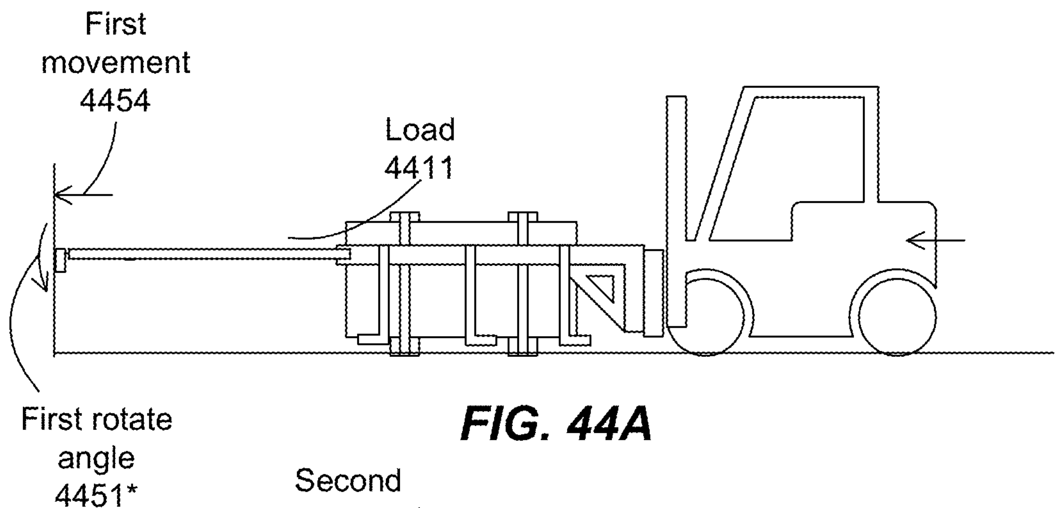


FIG. 44A

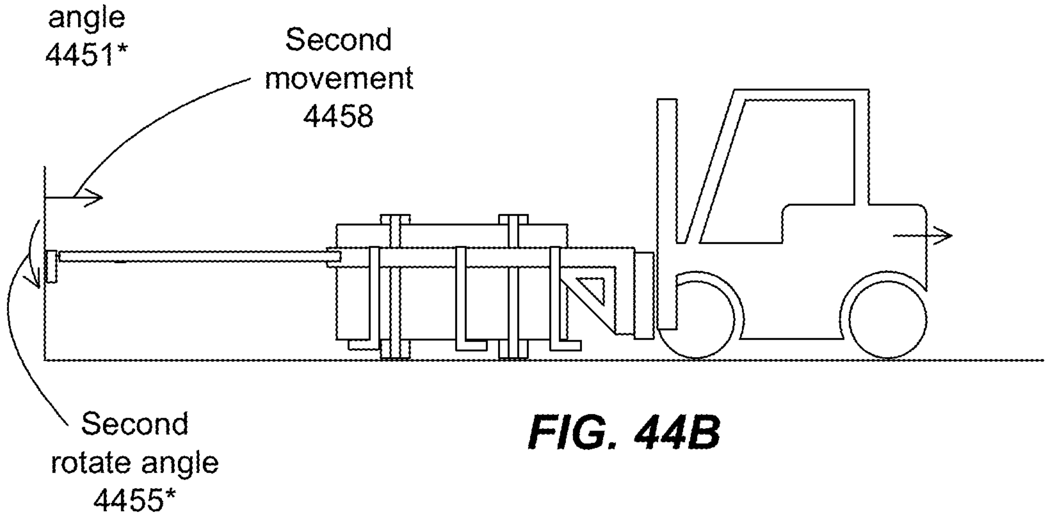


FIG. 44B

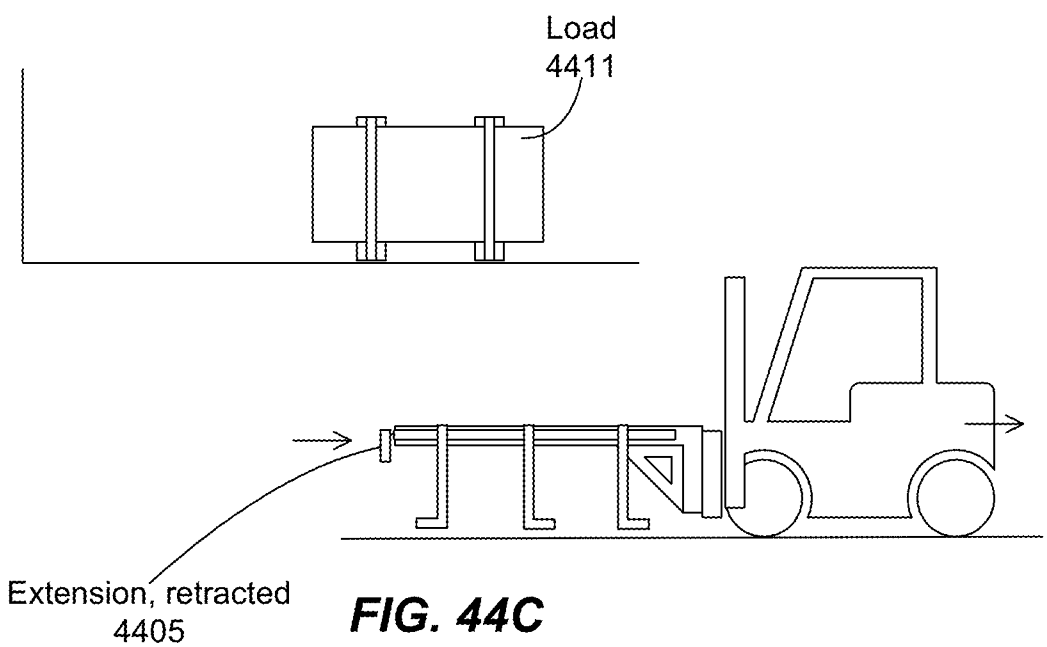


FIG. 44C

4500 - Extending a fork extension out of a fork of the fork assembly

4510 - Adjusting a blade of the fork extension to be outside of a load (downward, upward, or outward from the load)

4520 - Moving the fork lift to position the load to be between 2 fork extensions of the fork assembly

4530 - Moving the fork assembly forward to contact a surface to exert a force toward the fork extension on the blade for rotating the blade a first angle toward facing the load

4540 - Moving the fork assembly backward to exert a force away from the fork extension on the blade (by hooking on the load or by a bias spring) for rotating the blade a second angle to be facing the load

4550 - Continuing moving the fork assembly backward to pull the load toward the fork lift

FIG. 45A

4560 - Moving the fork assembly forward to contact a surface to exert a force toward the fork extension on the blade for rotating the blade a first angle toward outside the load

4570 - Moving the fork assembly backward to exert a force away from the fork extension on the blade (by hooking on the load or by a bias spring) for rotating the blade a second angle to be outside the load

4580 - Continuing moving the fork assembly backward to move the fork assembly away from the load

FIG. 45B

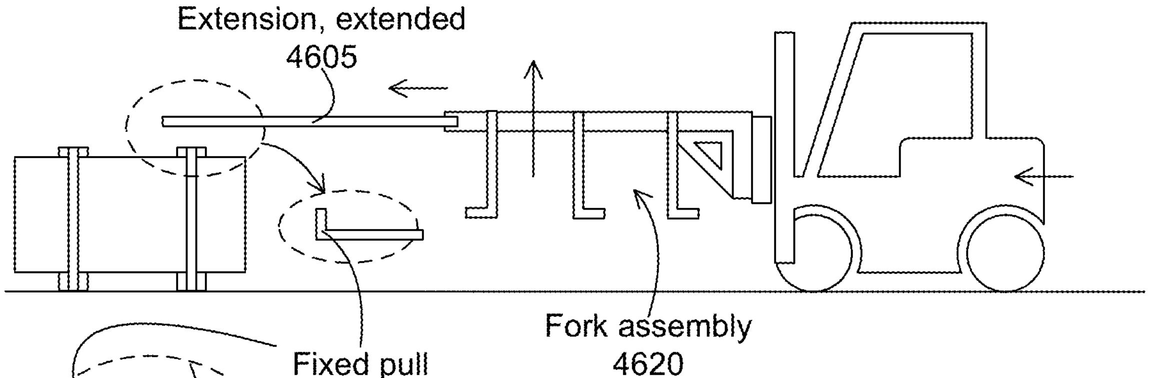


FIG. 46A

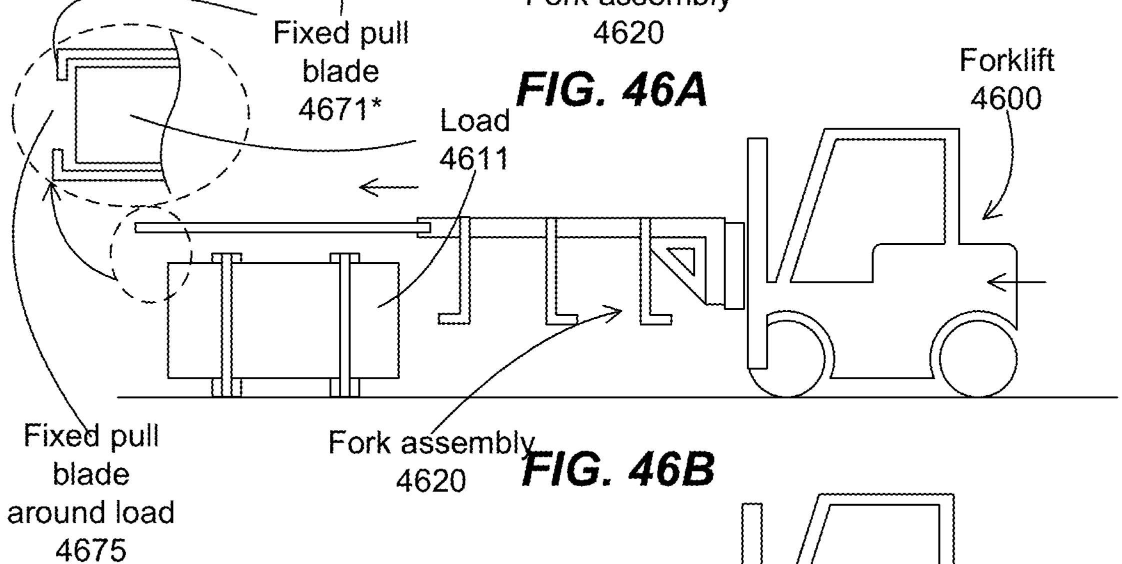


FIG. 46B

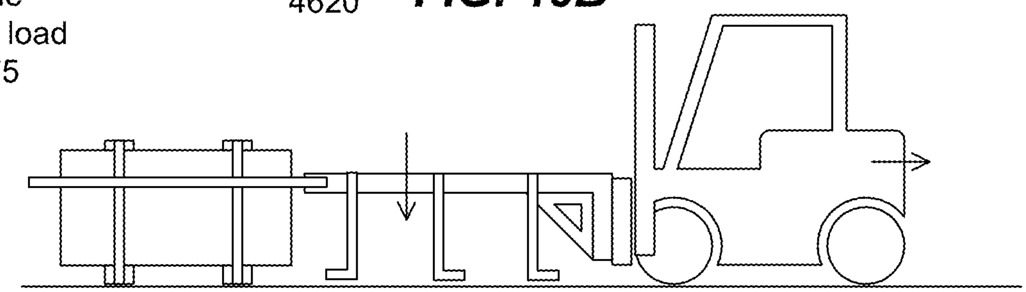


FIG. 46C

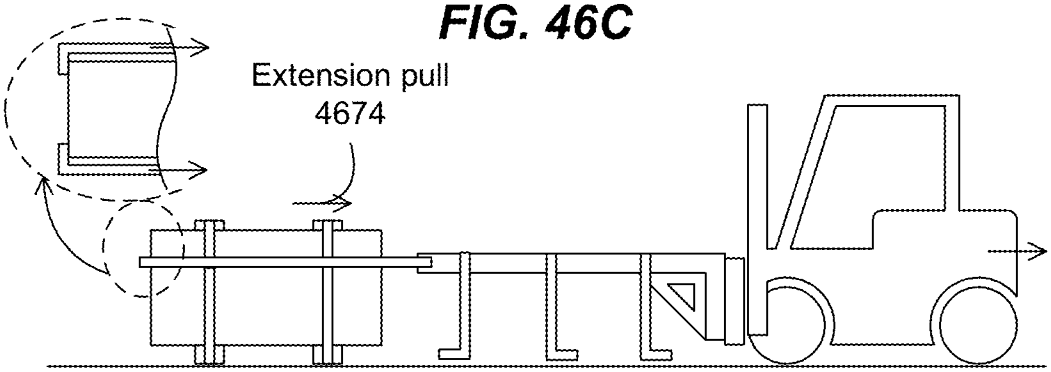


FIG. 46D

4700 - Extending a fork extension out of a fork of the fork assembly

4710 - Optionally adjusting a blade of the fork extension to be outside of a load (downward, upward, or outward from the load)

4720 - Moving the fork lift to position the load to be under and between 2 fork extensions of the fork assembly

4730 – Lowering the fork assembly downward for the blade to face the load

4740 - Moving the fork assembly backward to pull the load toward the fork lift

FIG. 47A

4760 - Moving the fork assembly forward and upward to clear a fork extension extended from a fork of a fork assembly

4770 - Moving the fork assembly backward to move the fork assembly away from the load

FIG. 47B

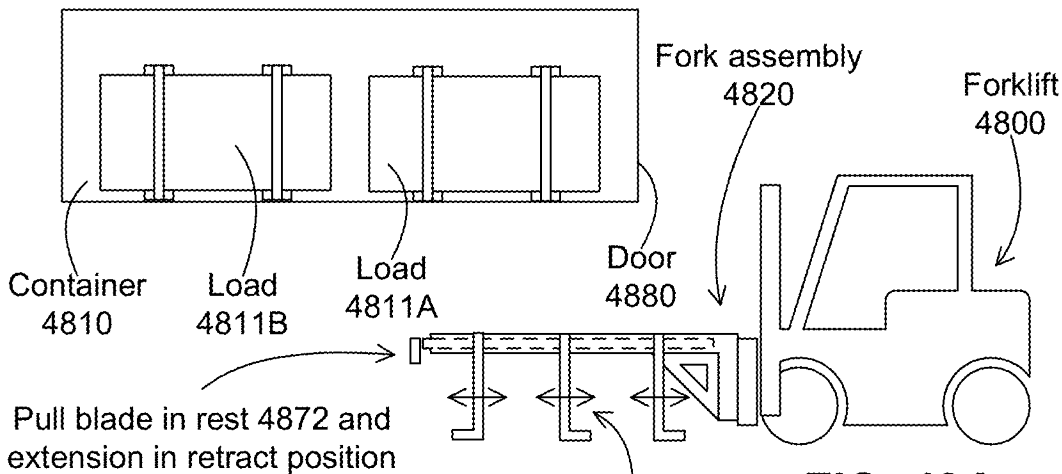


FIG. 48A

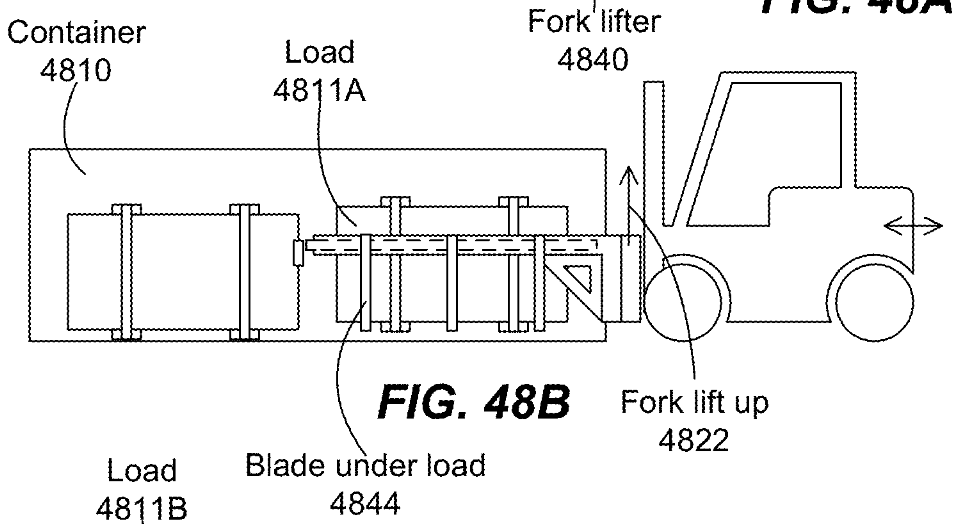


FIG. 48B

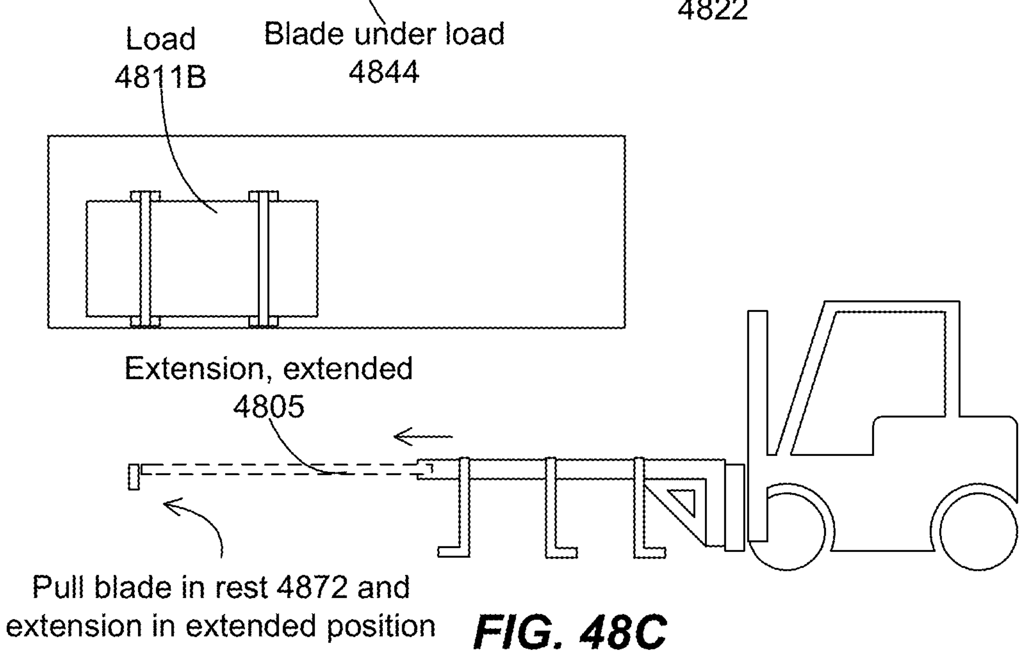


FIG. 48C

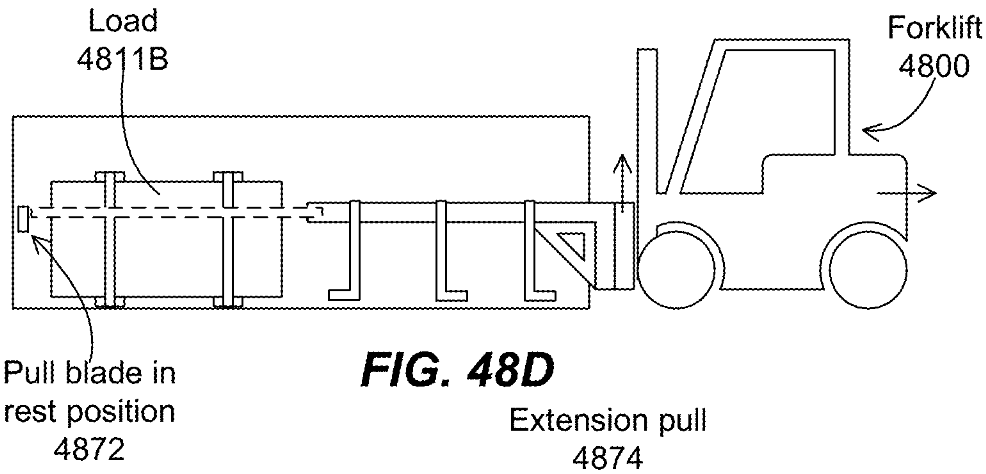


FIG. 48D

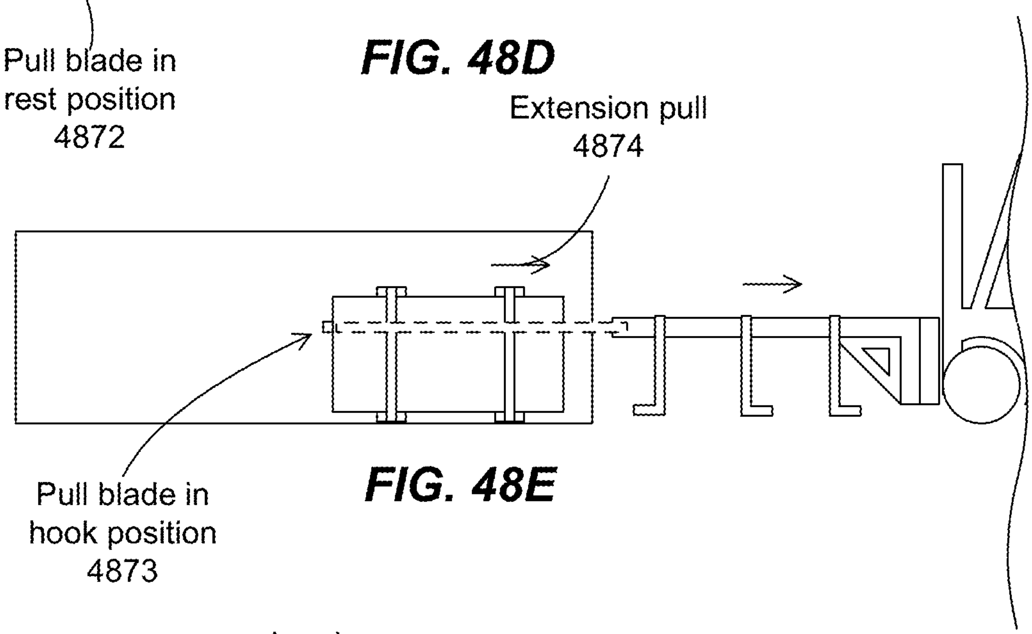


FIG. 48E

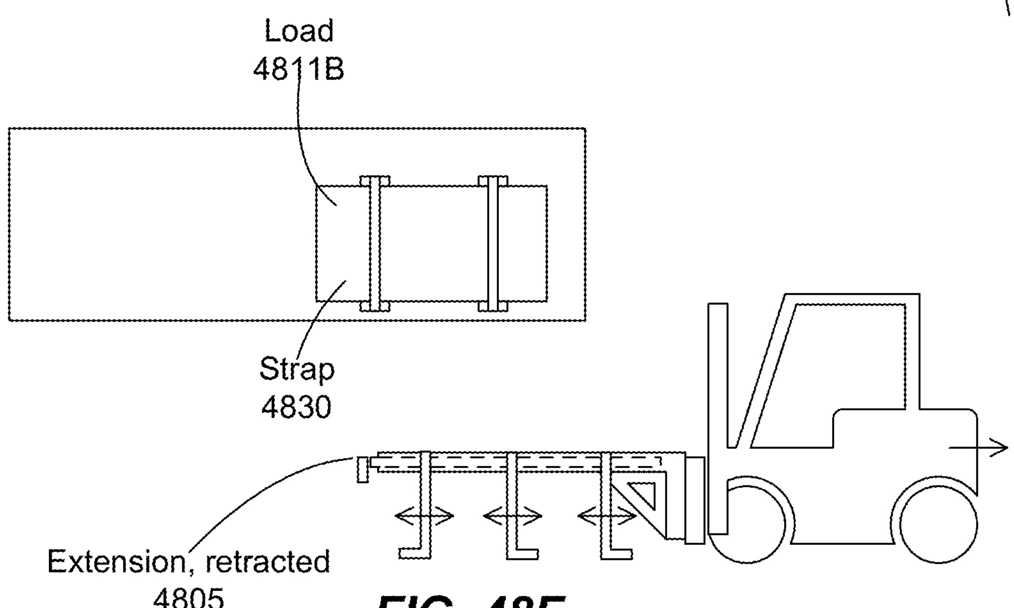


FIG. 48F

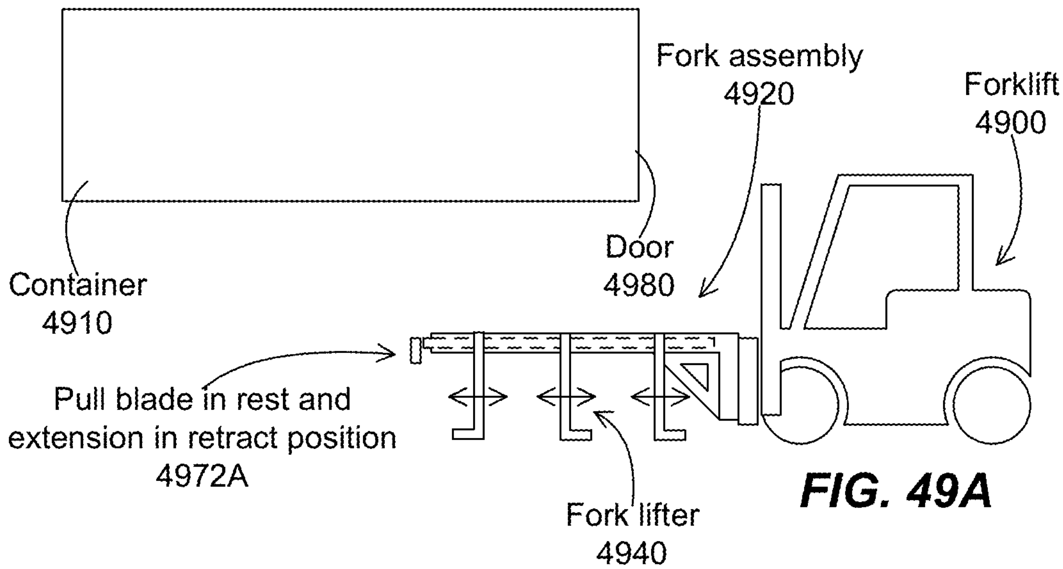


FIG. 49A

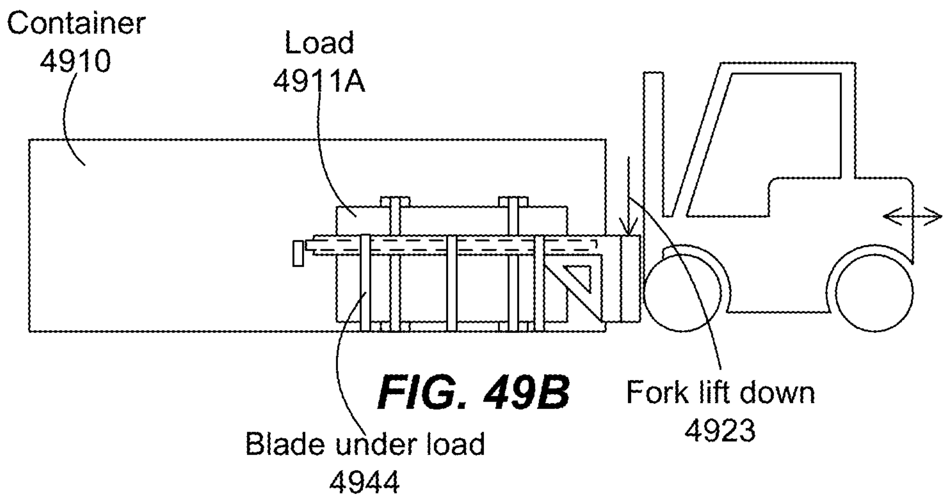


FIG. 49B

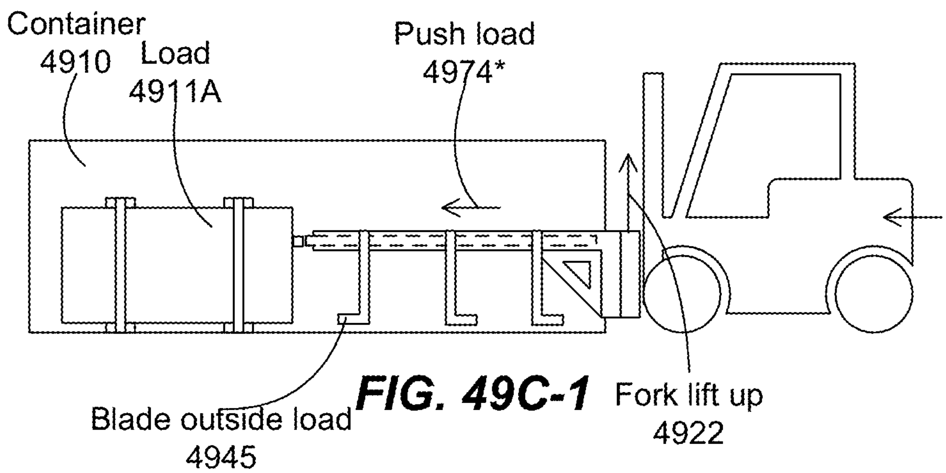


FIG. 49C-1

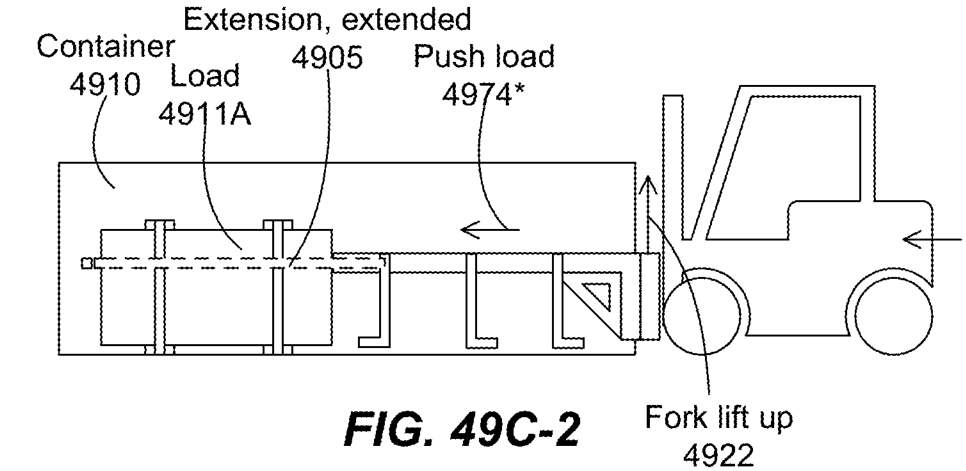


FIG. 49C-2

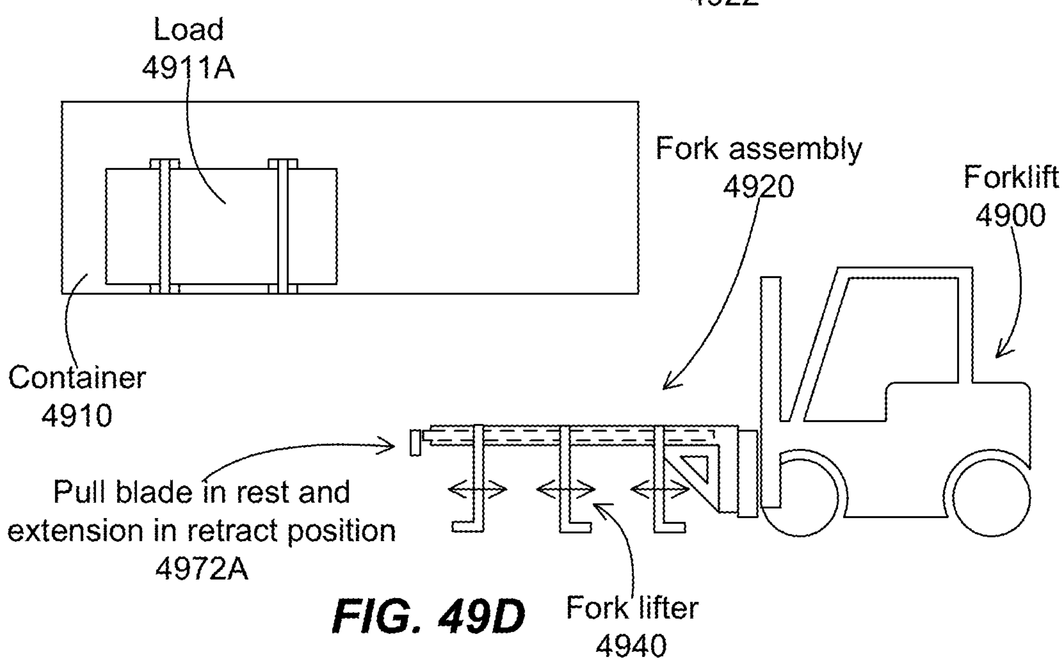


FIG. 49D

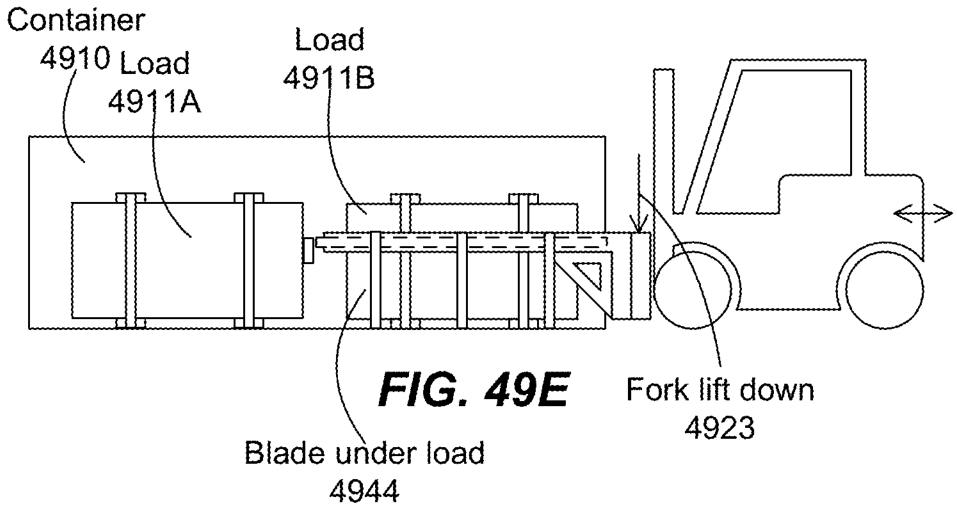


FIG. 49E

5000 - Configuring a fork assembly on a forklift to unload an outer load in a container

5001 - Unloading the outer load to a first destination

5002 - Extending a fork extension from a fork of the fork assembly

5003 - Pulling an inner load in the container to an outer position

5004 – Retracting the fork extension

5005 - Configuring the fork assembly to unload the inner load at the outer position

5006 - Unloading the inner load to a second destination

FIG. 50A

5010 - Configuring a fork assembly on a forklift to unload a first load to a container

5011 - Unloading the first load to an outer position in a container

5012 - Extending a fork extension from a fork of the fork assembly

5013 – Pushing the first load to an inner position in the container

5014 – Retracting the fork extension

5015 - Configuring the fork assembly to unload a second load to the container

5016 - Unloading the second load to an outer position in the container

FIG. 50B

FORK ASSEMBLY FOR FORKLIFTS

BACKGROUND OF THE INVENTION

Forklifts include powered industrial moving trucks, e.g., forklift vehicles, and manual pallet trucks. Forklifts can be used to lift and move materials, such as pallets or loads, over short distances, such as within a building or a warehouse.

A forklift can include a truck frame, which is the base of the forklift machine to which components of the forklift are attached. The forklift can include a mast, which is a vertical assembly that can be tilted for tilting the load. The mast can function as a support for a carriage to move along in a vertical direction. Forks, typically two, are mounted to the carriage, and function to support the load. By raising or lowering the carriage, the forks also move, which then raises or lowers the load.

Forklifts or forklift vehicles are used to lift a load and or transport a load from one location to another location. To lift a load, the forklift vehicle will drive the one or more forks beneath the load, and position the forks in contact with the underside of the load. The forks are then raised by the mast of the forklift vehicle, lifting the load resting upon the forks. The load lifted by the forklift vehicle is commonly a standard sized container or pallet, however it is not uncommon for the forklift vehicle to be used to lift or transport an abnormally shaped load, or load that is not properly sized for transport by a forklift vehicle.

Certain forklift vehicles allow the forks to be moved on a horizontal plane together or separately. Horizontal movement of the forks together allows the forks to be repositioned to the left or right of center of the forklift vehicle, and is commonly used when the forklift vehicle cannot be centered directly in front of the load. Horizontal movement of the forks separately allows the forks to be horizontally separated from one another, increasing or decreasing the width between the forks of the forklift vehicle. However, the distance between the forks of the forklift vehicle is limited by the structural design of the forklift vehicle, and not all forklift vehicles allow for the horizontal movement of the forks.

FIGS. **1A**-**1C** illustrate a prior art forklift vehicle and its operations. In FIG. **1A**, a forklift **100** can include a truck frame, which has a body **100**B and wheels **100**A for moving as a vehicle. The forklift **100** can include a mast **103**, which is coupled to the forklift body, and is disposed in a typically vertical direction. The mast can be tilted to tilt the forks and the load supported by the forks. The forklift can include a carriage **102**, which is movably coupled to the mast **103** for sliding along the mast, e.g., to be raised or lowered along the mast.

Two forks **101** can be mounted on the carriage **102**, for example, by a hooking assembly **104**. A fork can have a hook **104**A, which is mounted to a mating hook receptacle **104**B in the carriage. The hook receptacle can be formed along the carriage, thus can allow the fork to move in a horizontal direction, for example, to adjust a relative distance between the forks. The fork can include a blade **101**A coupled at an angle to a shank **101**B.

In operation, the forklift can move toward the load, and position the forks to be under the load. The load can be placed on a pallet, so that the load is raised from the floor. The pallet can have openings to accept the forks. The forks can then be raised to lift the load from the ground. The forklift then can move to transport the load to a destination. At destination, the forks can be lowered to place the pallet on the ground. The forks can be further lowered to be

separated from the pallet. The forklift can move backward to move the forks away from the pallet.

In FIG. **1B**, a fork extension **105** can be used to extend the length of a fork **101**. The fork extension can have a hollow portion to accept the fork. The fork extension can be used to lift loads from a distance farther than the reach of the forks. The fork extension can also be used to lift longer loads, in order to evenly distribute the weight of the load on the forks.

In FIG. **1C**, fork extensions **105** are used to extend the length of the forks, to allow the forklift to reach a load **111** disposed far away from the opening of a container **110**. With the fork extension, the force **112** acting on the fork mounting area, e.g., on the hooking assembly, can be large, due to the force **113** of the load is far away from the rotating center of the forks.

SUMMARY OF THE EMBODIMENTS

In some embodiments, the present invention discloses an accessory, such as an attachment, for a forklift vehicle, such as a fork assembly for attaching to the forklift vehicle for lifting and pulling a load. The fork assembly is designed to releasably attach to the forklift vehicle on a front end of the forklift vehicle, such as on the carriage of the forklift vehicle, e.g., the carriage that the original forks are attached to, with the original forks removed from the carriage before attaching the present fork assembly. By attaching to the carriage, the fork assembly can move up and down, can move sideway as a whole, or can be tilted.

The fork assembly can be used to modify the carrying capacity of the forklift vehicle, such as lifting loads from a side and lifting loads positioned with only a small gap in between. In addition, the fork assembly can include fork extensions configured for pulling loads closer to the forklift vehicle, so that the fork assembly can be used to pick up the load.

In some embodiments, the fork assembly can include multiple forks, such as 2 forks disposed in parallel, and configured to surround a load. Multiple attachments can be made on the forks, so that straps under the load can be connected to the attachments. The straps can be used for support the load, so that the fork assembly can lift the load.

In some embodiments, the fork assembly can include multiple fork extensions which can protrude from the forks. Attachments can be made at the ends of the fork extension, so that a strap can be connected. The strap at the fork extensions can be used for pulling on the load.

In some embodiments, the fork assembly can include multiple fork lifters having rotatable blades. The blades can be rotatable between a non-lift position, e.g., a position that the blades are disposed outside the load and are not able to lift the load, and a lift position, e.g., a position that the blades are disposed under the load and thus are able to lift the load. The rotation of the blades can be performed by a rotate mechanism, which can remotely activated by an operator operating the forklift vehicle. The remote rotate mechanism can allow the operator to lift and transport the load without the need to leave the forklift vehicle.

In some embodiments, the fork assembly can include multiple fork extensions having rotatable blades, such as blades coupled to the fork extensions through a rotate mechanism. The blades can be rotatable between a non-pullable position, e.g., a position that the blades are disposed outside the load and are not able to pull on the load when the forklift vehicle moves backward, and a pullable position, e.g., a position that the blades are pointing toward the load and thus are able to pull the load. The rotate mechanism can be a remotely rotate mechanism, which can allow the operator to lift and transport the load without the need to leave the forklift vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1**A-**1**C illustrate a prior art forklift vehicle and its operations.

FIGS. **2**A-**2**B illustrate a fork attachment assembly according to some embodiments.

FIGS. **3**A-**3**D illustrate additional components for a fork assembly according to some embodiments.

FIGS. **4**A-**4**B illustrate a portion of a fork of a fork assembly according to some embodiments.

FIGS. **5**A-**5**C illustrate a fork assembly according to some embodiments.

FIGS. **6**A-**6**B illustrate configurations for a fork assembly according to some embodiments.

FIG. **7** illustrates an exploded view of a fork assembly according to some embodiments.

FIGS. **8**A-**8**C illustrate a process for installing the fork assembly to a forklift according to some embodiments.

FIGS. **9**A-**9**C illustrate a process for transporting a load according to some embodiments.

FIG. **10** illustrates a flow chart for transporting a load according to some embodiments.

FIGS. **11**A-**11**B illustrate a process for removing a load from a container according to some embodiments.

FIGS. **12**A-**12**E illustrate a process for removing multiple loads from a container according to some embodiments.

FIG. **13** illustrates a flow chart for transporting a load according to some embodiments.

FIG. **14** illustrates a flow chart for transporting a load according to some embodiments.

FIGS. **15**A-**15**B illustrate schematic configurations of a fork assembly according to some embodiments.

FIGS. **16**A-**16**B illustrate a schematic operation of a fork assembly according to some embodiments.

FIGS. **17**A-**17**B illustrate forming processes for a fork assembly according to some embodiments.

FIGS. **18**A-**18**B illustrate processes for loading and unloading a load according to some embodiments.

FIGS. **19**A(*a*)(*b*)-**19**B(*a*)(*b*) illustrate a schematic of a conversion mechanism according to some embodiments.

FIGS. **20**A(*a*)(*b*)-**20**B(*a*)(*b*) illustrate a fork lifter configuration with a rotate mechanism according to some embodiments.

FIGS. **21**A-**21**H illustrate configurations for a rotate mechanism according to some embodiments.

FIGS. **22**A-**22**B illustrate processes to form a rotate mechanism according to some embodiments.

FIGS. **23**A-**23**C illustrate processes for activating the rotate mechanism with the fork assembly according to some embodiments.

FIGS. **24**A(*a*)(*b*)-**24**B illustrate a schematic of a conversion mechanism according to some embodiments.

FIGS. **25**A(*a*)(*b*)-**25**B(*a*)(*b*) illustrate a fork lifter configuration with a rotate mechanism according to some embodiments.

FIGS. **26**A-**26**H illustrate configurations for a rotate mechanism according to some embodiments.

FIGS. **27**A-**27**B illustrate processes to form a rotate mechanism according to some embodiments.

FIGS. **28**A-**28**C illustrate a schematic operation of a fork assembly with rotate mechanisms according to some embodiments.

FIGS. **29**A(*a*)(*b*)-**29**B(*a*)(*b*) illustrate coupling configurations of a fork lifter according to some embodiments.

FIGS. **30**A(*a*)(*b*)-**30**B(*a*)(*b*)(*c*) illustrate coupling configurations of a fork lifter according to some embodiments.

FIGS. **31**A-**31**C illustrate a fork lifter for a fork assembly according to some embodiments.

FIGS. **32**A(*a*)(*b*)-**32**B(*a*)(*b*)-**32**C(*a*)(*b*) illustrate configurations for fork lifter blades in a fork assembly according to some embodiments.

FIGS. **33**A-**33**C illustrate configurations for blades of a fork lifter according to some embodiments.

FIGS. **34**A(*a*)(*b*)-**34**B(*a*)(*b*)-**34**C(*a*)(*b*) illustrate a process for operating a cable lifter according to some embodiments.

FIGS. **35**A-**35**B illustrate a cable lifter for a fork assembly according to some embodiments.

FIGS. **36**A-**36**D illustrate a process for lifting and transferring a load according to some embodiments.

FIG. **37** illustrates a flow chart for moving a forklift to take and transport a load according to some embodiments.

FIGS. **38**A-**38**D illustrate a process for releasing a load after reaching a destination according to some embodiments.

FIG. **39** illustrates a flow chart for moving a forklift to release a load according to some embodiments.

FIGS. **40**A-**40**C illustrate configurations for a fork extension according to some embodiments.

FIGS. **41**A-**41**C illustrate a configuration of a fork extension having a rotate mechanism according to some embodiments.

FIGS. **42**A-**42**C illustrate configurations for a fork extension according to some embodiments.

FIGS. **43**A-**43**D illustrate a process for pulling a load according to some embodiments.

FIGS. **44**A-**44**C illustrate a process for retracting the fork extensions according to some embodiments.

FIGS. **45**A-**45**B illustrate operations of the fork extensions according to some embodiments.

FIGS. **46**A-**46**D illustrate an operation of a fork extension having fixed or manually rotate blade according to some embodiments.

FIGS. **47**A-**47**B illustrate flow charts for an operation of the fork extensions according to some embodiments.

FIGS. **48**A-**48**F illustrate a process for unloading outer and inner loads from a container according to some embodiments.

FIGS. **49**A-**49**E illustrate a process for loading loads to outer and inner areas of a container according to some embodiments.

FIGS. **50**A-**50**B illustrate flow charts for unloading multiple loads from a container and for loading multiple loads to a container.

DETAILED DESCRIPTION OF THE EMBODIMENTS

In some embodiments, the present invention discloses a fork attachment assembly for a forklift or a forklift vehicle. The fork attachment can be releasably attached to the forklift or forklift vehicle to expand, extend, or modify the ability of the forklift or forklift vehicle.

The fork assembly can include one or more forks, such as two forks, which, in some embodiments, are disposed away from the ground, e.g., the forks, even in their lowest position, are still above the ground, for example, at a distance greater than 10 cm, greater than 20 cm, or greater than 50 cm, such as between 10 cm and 1 m, between 20 cm and 1 m, or between 50 cm and 1 m. For example, the fork shank is coupled to the fork beam in a downward direction, in contrast to a fork shank coupled to a fork blade in an upward direction in a prior art forklift. The forks can be mounted to a body, which can be mounted to a carriage of a forklift, such as fixedly mounted to the carriage. The carriage can be moved up and down along a mast of a forklift. The mast can be tilted with respect to the body of the forklift.

Support elements, such as straps, cable, wire or chain can be used to couple the load to the forks. For example, the support elements can be disposed under the load and secured to the forks. Thus, when the forks are lifted up, the support elements can raise the load up. The above ground forks, together with the support elements, can be used to lift loads that do not offer a clear path under the load for the prior art forks to enter. For example, a load can be put on multiple parallel beams or the load can include a box having multiple parallel beams at the bottom panel of the box. A forklift thus can put the forks in the direction parallel to the parallel beams but cannot be used to lift the load from a direction perpendicular to the parallel beams.

FIGS. **2**A-**2**B illustrate a fork attachment assembly according to some embodiments. FIG. **2**A shows a side view and FIG. **2**B shows a perspective view of a fork assembly **220**. As shown, the fork attachment assembly **220** has two forks **221**. Other configurations can be used, such as one fork, or more than two forks.

A fork **221** can include a fork beam **221**A having an L shape with a fork shank **221**B coupled through a triangle support **221**C. The fork shank is coupled to the fork beam toward a portion below the beam, e.g., toward the gravity downward direction. Thus, the fork beam can be disposed off the ground, even at the lowest position of the fork. Since the load lifting mechanism is from load lifting elements, such as straps, connected between the fork beams under the load, the fork beams can normally be above the ground for better load stability. Alternatively, the fork shank can be coupled to the fork beam above the fork beam, to form a back rest support for the load, as in conventional forklift.

The forks **221** can be coupled to a fork assembly mounting body **224**. The forks can be slidably coupled to the body, e.g., the forks can slide toward or away from each other, on a linear guide **225** to narrow or to enlarge a distance between the forks. The linear guide can be in the form of a hooking assembly, with the fork **221** having a hook portion and the mounting body **224** having a hook receptacle portion. The forks can rest on a resting support **227**, which can be configured to be a consumable part, since the forks can exert a high force on the resting support **227**. The movements of the forks can be performed by actuators **226**, such as one actuator for moving one fork.

A load **211** can be disposed between the forks **221**. The distance between the forks can be adjusted to be larger than a dimension of the load. Load lifting elements, such as straps **230**, can be placed under the load with two ends of the straps coupled to the forks **221**.

In some embodiments, the fork assembly can be used to lift a load that does not offer access under the load in the direction facing the forklift. As an example, an elongated load **211** can have multiple parallel beams **215** along a short direction **216** of the load. Thus the forklift can access the elongated load in a direction parallel to the short side **216**, and not in a direction parallel to the long side **217**. This situation can cause difficulty when the elongated load is placed inside a container with the short side of the load facing the only opening of the container. In this example, the fork assembly can be used with the forks placing along the load along the long direction **217**, and the load lifting elements, e.g., the straps **230**, passing under the load along the short direction **216**.

In some embodiments, the fork assembly can include other components to provide additional functionalities or to provide better stability for the fork assembly.

FIGS. **3**A-**3**D illustrate additional components for a fork assembly according to some embodiments. The additional components can include a pulled up cable or cylinder **331**, a leg **332** for supporting the fork **321**, a wheel assembly **333** for a leg support together with an optional one way movement mechanism **334** to allow the leg to be lengthened by pulling and shortened by disabling the one way movement mechanism with pushing on the leg, and a fork extension **305**.

FIG. **3**A shows a fork assembly having a pulled up cable or a cylinder **331**. The fork **321** can be long, and there can be a sag portion at the tip of the fork **321** due to the load weight. A cable or a hydraulic cylinder can be used to pull up the tip of the fork. One end of the cable or cylinder can be coupled to the tip of the fork. The other end of the cable or cylinder can be coupled to a high portion, such as to a top portion of a mounting body **324** of the fork attachment assembly **320**, or to the carriage or even to the mast of the forklift. A tensioner can be added to increase the tension of the cable.

In some embodiments, the triangle support **323** at the corner of the L shape fork can be lengthened, e.g., toward the tip of the fork **321** in order to provide better support to the fork.

FIG. **3**B shows a fork assembly having a leg **332**. The leg can be used to support the fork assembly when not being mounted to the forklift, e.g., to raise the fork **321** from the ground. The leg can be mounted to the fork using a hinge, which can allow the leg to be folded along the length of the fork when the fork assembly is being used, e.g., after being mounted to the forklift.

FIG. **3**C shows a fork assembly having a fork support that can have a wheel **333** at one end. The fork support can be configured so that the wheel contacts the ground, and thus can offer support for the fork during moving the load. The wheel can be a caster wheel, e.g., an omnidirectional wheel which can be moved in any direction. The wheel portion can be coupled to a body portion through a one way movement mechanism **334**, such as a spring or a tooth wheel. The one way mechanism can allow the wheel portion to be extended, so that the wheel always contacts the ground when the fork assembly is lifted up. The one way mechanism can prevent the wheel from being retracted into the body, so that the fork support can offer support to the fork against the load weight. A release mechanism, such as a button, can be used to disable the one way mechanism, to allow the wheel portion to retract. The fork support can be mounted to the fork using a hinge, which can allow the fork support to be folded along the length of the fork, for example, when the fork support is not used.

FIG. **3**D shows a fork assembly having a fork extension **305** along the length of the fork **321**. For example, the fork **321** can include a hollow tube, such as a hollow square tube, and the fork extension can be disposed in the hollow portion of the hollow fork. The fork extension can be configured to lengthen the length of the fork assembly, for example, to reach loads disposed at the farthest end of a container.

A locking mechanism, such as a pin **334**, can be used to secure the fork extension to the fork, in either the extended configuration or in the retract configuration. Further, a limiter can be used to prevent the extension from extending too far out of the fork.

FIGS. **4**A-**4**B illustrate a portion of a fork of a fork assembly according to some embodiments. FIG. **4**A shows a side view and FIG. **4**B shows a perspective view of a fork ready to be coupled to a fork attachment assembly.

A fork **421** can include a beam or a fork **421**A, coupled to a fork shank **421**B, which can be a side plate, to form a downward L shape. A triangle plate **421**C can be coupled between the fork beam **421**A and the fork side plate **421**B to provide support to the fork beam, such as to support the fork beam against the weight of the load. The fork beam can include multiple strap couplers **436** for the attachment of load support elements, such as straps running under the load. A coupler **436** can include connectors **436**A and a pin **436**B passing through holes in the connectors. One end of the strap can be coupled to the coupler **436**, for example, by looping through the pin **436**B. The strap couplers can be fixedly coupled to the fork beam, such as by welding or by bolting. Alternatively or additionally, the strap couplers can be configured to be slidably coupled to the fork beam, in order to adjust the positions of the straps, such as to avoid the load beams located under the load.

The fork beam can include a leg coupler **437**, which includes a hinge **437**A for rotatably coupling to a leg, and a leg secure element **437**B for securing the leg along the fork beam when the leg is folded for not in use. The length of the leg can be about the same as the fork side plate **421**B, so that the leg is unfolded, e.g., rotating around the hinge, the leg can stand on the ground, together with the fork side plate **421**B for standing up the fork attachment assembly.

The fork side plate **421**B can include a mounting coupler **438** for coupling to a fork mounting body, such as to a linear guide or to an actuator between the fork and the fork mounting body. The coupling elements **438** can include a first linear guide coupler **438**A, which can have a round hollow cylinder shape, which can slidably mated to the fork mounting body through a rod. The round hollow cylinder shape **438**A can allow the fork to slidably couple to the fork mounting body along the direction of the rod, e.g., the hollow cylinder shape **438**A and the rod function as a linear guide to allow the fork to move toward or away from the other fork. The coupling elements **438** can include an actuator coupler **438**B, which can be used to coupled to an actuator, such as to a hydraulic or pneumatic cylinder, for moving the fork along the direction of the rod, e.g., toward or away from the other fork. The coupling elements **438** can include a second linear guide coupler **438**C, which can have a U shape, and can rest on and mated to a bar coupled to the fork mounting body. The U shape **438**C can allow the fork to slidably couple to the fork mounting body along the direction of the bar, e.g., the U shape **438**B and the bar function as a linear guide to allow the fork to move toward or away from the other fork. The rod and the bar are configured to be parallel, to serve as a linear guide for guiding the movements of the fork.

The fork beam can include a fork extension, slidably coupled to the interior of the fork beam. Rollers can be included at the fork and at the fork extension to allow smooth movements of the fork extension. In addition, movement limiter can be included to prevent the fork extension from slipping out of the fork. A secure element **435** can be used to secure the fork extension, such as securing the fork extension in an extended configuration or in a retract configuration.

FIGS. **5**A-**5**C illustrate a fork assembly according to some embodiments. FIG. **5**A shows a side view and FIG. **5**B shows a perspective view of a fork assembly **520**. As shown, the fork assembly **520** includes 2 forks **521**. Other configurations can be used, such as 1 fork, or more than 2 forks.

A fork **521** can include a beam **521**A, coupled to a side plate **521**B through a triangle plate **521**C. The fork beam can include multiple strap couplers **536** having connectors **536**A and pins **536**B. Each end of a strap **530** can be coupled to a strap coupler **536**, for example, by looping through the pin **536**B under the load. The straps **530** can be used to lift a load by positioning the forks in both sides of the load and the straps under the load.

The fork beam can include a leg coupler **537**, which includes a hinge **537**A for rotatably coupling to a leg **528**, and a leg secure element **537**B for securing the leg along the fork beam when the leg is not in use.

The fork **521** can include a mounting coupler **538** for coupling the fork **521** to a fork mounting body **524** to form a fork attachment assembly **520**. The mounting body **524** in FIG. **6**C is configured to couple the fork assembly **520** to a forklift, such as to a carriage of the forklift. For example, the mounting body **524** can have two mounting hooks **524**A and **524**B, which are configured to be attached to the carriage. The mounting coupler **538** can include a first linear guide coupler **538**A, which can have a round hollow cylinder shape, which can slidably mated to the fork mounting body **524** through a rod **525** functioned as a linear guide for guiding the linear guide coupler **538**A. The round linear guide **538**A can allow the fork to slidably couple to the fork mounting body **524** along the direction of the rod **525**, e.g., the fork can move toward or away from the other fork. The mounting coupler **538** can include an actuator coupler **538**B, which can be used to coupled to an actuator, such as a hydraulic or pneumatic cylinder **526**, for moving the fork along the direction of the rod **525**, e.g., toward or away from the other fork. The mounting coupler **538** can include a second linear guide coupler **538**C, which can have a U shape, and can rest on and mated to a linear bar **527** coupled to the fork mounting body **524**. The U shape **538**C can allow the fork to slidably couple to the fork mounting body along the direction of the bar, e.g., the U shape **538**B and the bar function as a linear guide to allow the fork to move toward or away from the other fork. The rod and the bar are configured to be parallel, to serve as a double linear guide for guiding the movements of the fork.

The fork beam can include a fork extension **505**, slidably coupled to the interior of the fork beam. A secure element, e.g., a locking mechanism **535** can be used to secure the fork extension, such as securing the fork extension in an extended configuration or in a retract configuration. Additional strap couplers **536*** can be coupled to the end of the extension, which can be used to secure a strap **530***, for contacting a load for pulling when he forklift is retracted.

FIGS. **6**A-**6**B illustrate configurations for a fork assembly according to some embodiments. FIG. **6**A shows a leg support configuration and FIG. **6**B shows an extension configuration of a fork assembly **620**.

In FIG. **6**A, a fork assembly **620** can include a fork **621** coupled to a mounting body **624**, with the mounting body **624** configured have mounting attachments **624**A and **624**B for coupling to a forklift, such as to a carriage of a forklift. The fork **621** can include a beam **621**A coupled to a side plate **621**B through a triangle plate **621**C. The fork beam can include multiple strap couplers **636** having connectors **636**A and pins **636**B. The ends of a strap can be coupled to the strap coupler **636**, for example, by looping through the pins **636**B and passing under the load.

The side plate **621**B can be coupled to a fork mounting body **624** through linear guide couplers, which allows the forks to move toward or away from each other. The fork beam can include a fork extension **605**, slidably coupled to the interior of the fork beam. A locking mechanism, such as a secure element **635**, can be used to secure the fork extension to the fork, such as securing the fork extension in an extended configuration or in a retract configuration.

The fork beam can include a leg coupler **637**, which includes a hinge **637**A for rotatably coupling to a leg **628**, and a leg secure element **637**B for securing the leg along the fork beam when the leg is not in use. The leg **628** can include a hole **637**C, for mating with a leg secure attachment **637**D, for example, by the leg secure element **637**B. A lock pin **637**E can be used to secure the leg secure element **637**B. As shown, the fork assembly **620** is at a resting configuration, with the legs **628** extended to support the ends of the forks. The mounting body **624** supports the opposite ends of the forks.

In FIG. **6**B, the fork assembly **620** is shown with the fork extension **605** in an extended configuration, e.g., the fork extension is extended from the fork beam. A secure element, or a locking mechanism **635**, can be used to secure the fork extension, such as securing the fork extension in an extended configuration or in a retract configuration.

At the end of the fork extension **605**, there can be a strap coupler **636*** for connecting to an end load support element, such as a strap **630***. The strap **630*** can be connected after a load is placed between the two forks. Thus, when the forklift moves backward, the strap **630*** can pull on the load, dragging the load in the direction of the forklift movement. Additional straps can be used to connect to strap coupler **636**, for lifting the load.

FIG. **7** illustrates an exploded view of a fork assembly according to some embodiments. A fork beam **1** has a rectangular hollow tube configuration, with a fork extension **38** freely slidable within the hollow portion. At the ends of the fork beam, there are welded blocking portions. In the hollow portion, there are welded connectors and sliders. The fork beam also includes a triangular support and multiple couplers for connecting to straps. The fork extension **38** has rectangular hollow tube configuration, which is slightly smaller than the inner dimension of the fork beam. At the inner end of the fork extension, there is a welded an end portion to prevent the fork extension from falling out of the fork beam. At the outer end of the fork extension, there is a U shape coupler for connecting to a strap.

A fork assembly body **43** is in the form of a plate with one side of the plate having welded couplers for rod **26** for coupling with the fork beam side support **27**.The plate also has welded attachments for hydraulic cylinders **46**, and guiding portions for guiding the fork beams when moving toward or away from each other. At the opposite side of the plate, there is a top hook portion **19** and a bottom hook portion **20** for coupling to the carriage of the forklift. The top and bottom hook portions **19** and **20** have mating portions in the carriage of the forklift, functioned to secure the fork assembly to the carriage. The top hook is assembled by bolts and the bottom hook by locking rod **21**.

Coupler rod **26** has a cylindrical shape, with lock rings **25** at two ends. The rod **26** functions to couple the fork beam **1** with the fork assembly **43**, together with acting as a linear guide for the movements of the two fork beams when moving toward or away from each other.

Pins **29** function as connector for strap to support the bottom of the load. Pins **29** have cylindrical shape, with one flattened end for hand turning, and the other end having screw configuration for bolting to the coupler of the fork beam. Secure pins can be used to prevent loosing the pins **29**.

Inner support **31** is attached to the inner end of the fork extension, and having supports for roller attachment for rolling the fork extension on the inner wall of the fork beam.

Outer fork end support **42** is attached to the outer end of the fork beam, having supports for roller installation for rolling fork extension. The outer end fork support can be used to prevent complete removal of the fork extension from the fork beam.

FIGS. **8**A-**8**C illustrate a process for installing the fork assembly to a forklift according to some embodiments. FIG. **8**A shows a fork assembly **820** having a fork **821** coupled to a mounting body **824**. The fork assembly **820** is positioned on the ground, with the legs **828** extended for putting the mounting body parallel to the carriage. The mounting body can include mounting hooks **824**A and **824**B, which are configured to mount on corresponded mounting receptacles **802**A and **802**B on the forklift, such as on the carriage **802** of the forklift, respectively. FIG. **8**B shows a forklift **800** having the forks removed. The forklift can be driven to the fork assembly, so that the mounting body is facing and contacting the carriage. The fork assembly can then be mounted to the carriage **802** of the forklift, such as using the mounting hooks on the mounting body on mated receptacles on the carriage. Alternatively, the mounting hooks can be unbolted from the mounting body, and then rebolted to secure the fork assembly to the forklift. FIG. **8**C shows the forklift **800** having the fork assembly **820** installed. After being mounted, the legs **828** can be folded in the storage position, and secured with locking pins.

FIG. **9**A-**9**C illustrate a process for transporting a load according to some embodiments. FIG. **9**A shows a load **911** having outer straps **918** for securing the load. The load **911** can have load beams **915** for raising the load above the ground.

In FIG. **9**B, a forklift **900** approaches the load and placing the load between the two forks. The distance between the forks can be adjusted to be slightly larger than the dimension of the load.

In FIG. **9**C, straps **930** are used to secure the load to the forks. The strap can be coupled to the couplers on the forks, and passing under the load for supporting the load from the bottom. Alternatively, or additionally, the straps can be slidably coupled to the forks, such as forming a loop around the fork beam. Thus, the straps can be adjusted to balance the load and to avoid the load beams **915**. After securing the load, the fork assembly can be lifted up, for example, by activating actuators for lifting the carriage in the forklift. After the load is off the ground, the forklift can transport the load to the destination.

FIG. **10** illustrates a flow chart for transporting a load according to some embodiments. Operation **1000** mounts a fork assembly to a forklift. Operation **1010** adjusts a position between two forks in the fork assembly, for example, to accommodate the load dimensions. Operation **1020** positions the fork assembly so that the load is disposed between the forks. For example, the forklift can be driven toward the load and maneuvered to guide the forks around the load.

Operation **1030** attaches a flexible support to the forks. The flexible support can be a strap, and going under the load and configured to support the load. There can be multiple supports. Operation **1040** lifts the load by moving the forks up until the load is above the ground. Operation **1050** transports the load by moving the forklift.

FIGS. **11**A-**11**B illustrate a process for removing a load from a container according to some embodiments. In FIG. **11**A, a forklift **1100** can approach and enter the container **1110** with the forks disposed on both sides of the load **1111** to be transported. Straps can then be secured to the forks under the load. In FIG. **11**B, the forklift can lift the load and then transport the load to a destination.

FIGS. **12**A-**12**E illustrate a process for removing multiple loads from a container according to some embodiments. In FIG. **12**A, a forklift **1200** can approach the container **1210** with the forks of the fork assembly **1220** disposed on both sides of an outer load **1211**A to be transported. Straps **1230** can be secured to the forks under the load. The forklift can lift the load and transport the load to a destination.

In FIG. **12**B, the forks **1220** can have the fork extensions **1205** extended to reach the inner load **1211**B. Strap **1230*** can be attached to the hook ends of the fork extensions and covered the load **1211**B at the far end of the load **1211**B. In FIG. **12**C, the forklift moves backward, pulling the load **1211**B toward the opening on the container. The strap **1230*** is then removed. In FIG. **12**D, the fork extensions **1205** are retracted to the fork beams **1221**.

In FIG. **12**E, the forklift moves forward, with the forks **1221** disposed on both sides of the load **1211**B, and the fork extensions retracted in the forks. Straps **1230** can be secured to the forks under the load. The forklift can lift the load **1211**B and transport the load to a destination.

FIG. **13** illustrates a flow chart for transporting a load according to some embodiments. Operation **1300** extends each fork of two forks of a forklift by pulling fork extensions from the forks. Operation **1310** positions the fork extension around a load in the container, with the second load disposed farther than a reach of the two forks. Operation **1320** attaches a side support to the fork extensions, with the side support disposed around a side of the load and configured to couple the load to the forklift when the forklift is pulling on the load. Operation **1330** pulls the load to within the reach of the two forks. Operation **1340** attaches a bottom support to the two forks, wherein the bottom support is disposed under a load and configured to support the load from a bottom of the load. Operation **1350** lifts and transports the load out of the container.

FIG. **14** illustrates a flow chart for transporting a load according to some embodiments. Operation **1400** attaches a bottom support to two forks of a forklift, wherein the bottom support is disposed under a first load in a container and configured to support the first load from a bottom of the first load, wherein the first load is disposed in a vicinity of an opening of the container. Operation **1410** lifts and transports the first load out of the container. Operation **1420** extends the forks by pulling the fork extensions from the forks. Operation **1430** positions the fork extension around a second load in the container, wherein the second load is disposed farther than a reach of the forks. Operation **1440** attaches a side support to the fork extensions, wherein the side support is disposed around a side of the second load and configured to couple the second load to the forklift when the forklift is pulling on the second load. Operation **1450** pulls the second load to a vicinity of the opening of the container.

Alternate fork assembly

In some embodiments, the present invention discloses another configuration for a fork assembly, which can lift a load from a side without a need for the operator to leave the forklift vehicle. For example, the fork assembly can provide rotatable blades for side lifting of the load, with the blades configured to swing from a first position parallel to the fork assembly to a second position under the load for lifting the load. Using the blade swinging action, the fork assembly can be able to lift loads that are positioned close to each other, with only a small gap in between, such as in space-premium location such as in a container used for shipping the load.

In some embodiments, the swinging action of the blades is performed remotely, e.g., from an operator operating the forklift vehicle. For example, the operator can move the fork assembly downward and upward, which can toggle the blades between a lifting position, e.g., positioned partially or totally under the load for lifting the load, and a non-lifting position, e.g., positioned outside of the load, such as parallel to the load or pointing outward away from the load.

In some embodiments, the strap fork assembly described above and the rotatable blade fork assembly can share common elements and features, and thus can be omitted or only briefly mentioned in the description. However, all common features in one fork assembly can be used in another fork assembly.

FIGS. **15**A-**15**B illustrate schematic configurations of a fork assembly according to some embodiments. In FIG. **15**A, a fork assembly **1520** can include one or more forks **1521**, which are coupled to a mounting body **1524**. For example, two forks **1521** can be parallely coupled to the mounting body, with optional actuators **1526** for adjusting a distance between the two forks.

Each fork **1521** can couple to the mounting body **1524** through a fork coupler **1538**. An optional actuator **1526** can couple the fork **1521** to the mounting body **1524**, for example, to move the fork **1521** relative to the mounting body, such as to adjust a distance between two forks **1521** coupled to the mounting body. The mounting body can include a removable mounting coupler **1524**A, which is configured to mount the mounting body to a forklift vehicle **1500**, such as to a carriage of the forklift vehicle. With the carriage movable in up/down, sideway, and tilted direction, the fork assembly can also be moved to position the forks at appropriate locations for lifting a load.

The fork assembly can be configured to be used with different types of forklift vehicles, and also to other lifting devices, such as by using different mounting couplers **1524**A, to provide a carrying capacity for lifting, transporting, and depositing loads that outside the carrying capacity of forklift vehicles not equipped with the present fork assembly.

A fork **1521** can include a fork beam **1521**A, which extends from the mounting body, e.g., extending from the forklift vehicle. A fork support **1521**B and a fork strengthener **1521**C can be coupled to the fork beam **1521**A, to provide strength to the fork beam when the fork beam is coupled with the mounting body.

A fork extension **1505** can be slidably coupled to the fork beam **1521**A, such as to slide within the fork beam. For example, the fork beam can be a hollow tube, such as a hollow square tube or a hollow round tube. The fork extension can have a matching dimension, such as a square tube or bar for a hollow square tube fork, or a round tube or bar for a hollow round tube fork, with the outer dimension of the fork extension matching the inner dimension of the fork beam. Thus, the fork extension can slide within the fork beam, and can extend the length of the fork beam. A locking mechanism **1535**, e.g., a stop element, can be provided on an outer end of the fork beam, and a mated locking mechanism **1535*** can be provided on an inner end of the fork extension, for example, to prevent the fork extension from falling out of the fork beam when extending too far away from the fork beam.

One or more load lifters **1540** can be coupled to the fork beam **1521**A, such as fixed coupled, slidably coupled, or removably coupled. For example, a load lifter **1540** can be coupled to the form beam through a lifter coupler **1543**, which can be welded to the fork beam, or which can be configured for continuously or discretely sliding along the fork beam, or which can be secured to the fork beam at discrete locations.

The load lifter **1540** can include a lifter support **1541**, such as a tube or a bar extending downward from the fork beam. The load lifter **1540** can include a blade **1542**, which can be an integral part of the lifter support **1541** or which can be coupled to the lifter support **1541**, for positioning under a load for lifting the load. The blade can be a tube, a bar, or a flat plate configured to slide under the load, such as to swing from a position outside the load to a position under the load.

A rotating mechanism **1550** can be coupled to the fork assembly, such as coupled to the fork beam **1521**A, coupled to the load lifter **1540**, coupled between the fork beam and the load lifter, coupled to the lifter support **1541**, or coupled between the lifter support **1541** and the blade **1542**. The rotate mechanism **1550** is configured to rotate the blade **1542** between a position outside the load and a position under the load. As shown, the rotate mechanism is coupled between two portions of the lifter support **1541**, which can allow the bottom portion, including the blade, to rotate.

The rotate mechanism can be manually operated or can be automatically operated, e.g., remotely operated by an operator driving the forklift vehicle. For example, the rotate mechanism can be actuated, e.g., performing a rotation, by the operator moving the fork assembly downward until contacting a surface, and the moving the fork assembly upward. The rotate mechanism can be a toggling mechanism, e.g., by performing a same actuating operation of moving the fork assembly downward and upward, the rotate mechanism can rotate the blade from an under-the-load position to an outside-the-load position, and from an outside-the-load position to an under-the-load position.

The shapes and sizes of the components of the fork assembly **1520**, such as the fork beam **1521**A, the fork extension **1505**, the lifter support **1541**, and the blade **1542**, are schematically shown. In practice, different shapes and sizes can be used to accommodate the requirements of engineering and applications. For example, a width dimension of the fork beam **1521**A, e.g., the dimension parallel to the ground surface, can be as small as possible, in order to place the fork beam between two loads positioned next to each other. Or a thickness dimension of the blade **1542**, e.g., the dimension of the blade perpendicular to the ground surface, can be as thin as possible while providing adequate strength for lifting, in order to place the blade in a gap between a bottom surface of the load and the ground surface.

In FIG. **15**B, a fork assembly **1520** can include one **1521**, which is configured to be coupled to the forklift vehicle. For example, a fork **1521** can include a mounting coupler **1524**A configured to couple the fork to the forklift vehicle, such as to the carriage of the forklift vehicle. Two or more fork assemblies can be coupled to the carriage, with optional actuators **1526** coupled between the fork assemblies and the carriage for changing a distance between the fork assemblies. Each fork **1521** can include a fork extension with locking mechanisms, one or more load lifter **1540** with blade and rotate mechanism.

Operation of a fork assembly

During use, the fork assembly is first secured to the lift chassis of a forklift vehicle, such as to the carriage of the forklift vehicle, by positioning the mounting body of the fork assembly near the carriage so that the mounting couplers on the fork assembly can be coupled to the carriage. For example, the mounting body can have a fixed mounting coupler in the form of a hook for hooking on the carriage. The mounting body can have a quick-connect mounting coupler in the form of a hook. After the fixed mounting coupler is coupled to the carriage, the quick-connect mounting coupler can be connected to secure the mounting body, e.g., and also the fork assembly, to the carriage.

A distance between the forks of the fork assembly can be adjusted to be slightly larger than a width of a load. Positions of the load lifters can be optionally adjusted along the fork beams of the forks, for example, to avoid the foot beams that are coupled to the bottom of the load. Heights of the load lifters can also be optionally adjusted so that the blades of the load lifters can fit into the gaps between the load bottom surface and the ground surface generated by the foot beams. Alternatively, the fork assembly can be raised up or lowered down, instead of adjusting the heights of the load lifters.

The forklift vehicle can move to put a load between the forks of the fork assembly, with the blades just slightly above the ground. In resting position, the blades are outside the load, such as parallel to the fork beam. After the fork assembly is positioned surrounding the load, the rotate mechanisms can be actuated to rotate the blades to be under the load. The fork assembly then can be lifted up, and the load can then be transported to a destination.

The fork assembly can allow the forklift vehicle to side lifting loads with a minimum separation between the loads. Long fork beams in the fork assembly can also allow the lifting and transporting of long load from a shorter dimension of the load. In some embodiments, the fork assembly can be suitable for loading and unloading loads in a container, with long loads stored in the container very close to each other and with the shorter side of the loads facing the opening door of the container.

FIGS. **16**A-**16**B illustrate a schematic operation of a fork assembly according to some embodiments. In FIG. **16**A, a fork assembly **1620** is mounted on a forklift vehicle, such as mounting to a carriage **1602** of the forklift vehicle, through mounting couplers **1638**. The fork assembly can include two forks **1621**, with each fork **1621** having a fork beam **1621**A coupled to a fork plate **1621**B and a fork strengthener **1621**C. Two fork lifters **1640** can be coupled to each fork beam, with each fork lifter having a lifter support **1641** coupled to a lifter blade **1642**. The fork blades are positioned not for lifting a load, e.g., so that the forklift vehicle can maneuver the fork assembly around the load **1611**. For example, the blades can be positioned parallel to the fork beams, in order to minimize the effective width of the fork.

The forklift vehicle is driven toward the load **1611**, so that the fork assembly surrounds the load with the fork beams positioned parallel with the long direction **1617** of the load, and the forklift vehicle facing the short direction **1616** of the load. The load **1611** can have foot beam or load beam **1615** running along the short direction **1616**. The fork lifters are positioned at positions on the fork beams so that the blades **1642** can rotate to the gaps under the load bottom surface and not contacting the load beams **1615**.

FIG. **16**B shows a lifting configuration for the fork assembly **1620**. After the fork assembly is properly positioned surrounding the load **1611**, the rotate mechanism **1650** is activated to rotate the blades toward the load, e.g., so that the blades can be positioned under the load for lifting. The fork assembly then can be raised up by the forklift vehicle actuating the carriage, which can lift the load. The forklift vehicle can then move backward, and toward a destination for placing the load.

After reaching the destination, the fork assembly can be lowered until the load contacts the ground. The rotate mechanism can then be actuated to rotate the blades outside the load, such as to the position parallel to the fork beam. The forklift vehicle can then move backward to clear the fork assembly from the load.

Fork configuration for a fork assembly

FIGS. **17**A-**17**B illustrate forming processes for a fork assembly according to some embodiments. FIG. **17**A shows a process for forming a double fork assembly. Operation **1700** forms a fork assembly configured to be coupled to a forklift, with the fork assembly including one or more forks coupled to a mounting body, which is configured to be coupled to the forklift. Each fork includes a fork beam, with an end of the fork beam configured to be coupled to the mounting body, and a fork lifter, with the fork lifter coupled to the fork beam. The fork lifter includes a fork blade coupled to a rotate mechanism, which is configured to rotate the fork blade between a first position in which the fork blade is at least partially disposed under a load and a second position in which the fork blade is not under the load. The rotate mechanism includes a manual operation or a remote operation mechanism for an operator in the forklift to rotate the fork blade.

FIG. **17**B shows a process for forming a single fork assembly. Operation **1720** forms a fork assembly configured to be coupled to a forklift, with the fork assembly includes a fork, which has a fork beam, with an end of the fork beam configured to be coupled to the forklift, and a fork lifter coupled to the fork beam. The fork lifter includes a fork blade coupled to a rotate mechanism, which is configured to rotate the fork blade between a first position in which the fork blade is at least partially disposed under a load and a second position in which the fork blade is not under the load. The rotate mechanism includes a manual operation or a remote operation mechanism for an operator in the forklift to rotate the fork blade.

In some embodiments, the fork assembly can include a mounting body configured to accept one or more forks. The mounting body is coupled to the forklift through a mounting coupler. The mounting coupler includes one or more mounting hooks, with a first fixed coupled to the mounting body, and a second hook quick-releasably coupled to the mounting body. The fork beam can include one or more fork couplers, with the fork couplers configured to be coupled to mating elements on the mounting body to function as a linear guide. An actuator can be coupled between the fork beam and the mounting body to move the fork beam along the linear guide. The fork beam can be configured to accept a fork extension slidable within the fork beam, with a locking mechanism to prevent falling out, with rollers for ease of sliding.

In some embodiments, the fork lifter can be configured to move along the fork beam, and can be configured to couple to the fork beam at different heights of the fork lifter.

In some embodiments, the rotate mechanism can be configured to rotate only the fork blade or the fork blade and a portion of a lifter support coupled to the fork blade. The rotate mechanism can optionally include an actuator such as a spring to bias the fork blade in a downward or extend direction from the fork beam. The rotate mechanism can be activated by moving the fork beam in one direction (such as down) so that the fork blade contacts a surface to push the blade toward to fork beam, followed by a moving in an opposite direction (such as up) to extend the fork blade away from the fork beam.

In some embodiments, the rotate mechanism can include 2 slanting surfaces interacting with one or more pins for rotating the one or more pins. The pins can rotate in one direction for rotate the blades. Alternatively, the pins can rotate in opposite directions for toggle the blades back and forth.

Moving a fork assembly for load and unload a load

FIGS. **18**A-**18**B illustrate processes for loading and unloading a load according to some embodiments. FIG. **18**A shows a process to put blades of a fork assembly under the load using a rotate mechanism. Operation **1800** moves a forklift so that two fork beams of a fork assembly coupled to the forklift surround a load, with blades of fork lifters coupled to the two fork beams disposed outside the load. Operation **1810** moves the fork assembly downward so that blades contact a surface, with the downward movement activating rotating mechanisms coupled to the fork lifters to rotate the blades from outside the load toward under the load. Operation **1820** moves the fork assembly upward so that blades contact the load or a spring pushes the blades downward, with the upward movement activating the rotating mechanisms to rotate the blades to be under the load.

FIG. **18**B shows a process to put blades of a fork assembly outside the load using a rotate mechanism. Operation **1840** moves a fork assembly coupled to a forklift downward so that blades contact a surface, with the downward movement activating rotating mechanisms coupled to the fork lifters to rotate the blades from under the load toward outside the load. Operation **1850** moves the fork assembly upward so that blades contact the load or a spring pushes the blades downward, with the upward movement activates the rotating mechanisms to rotate the blades to be outside the load. Operation **1860** moves the forklift away from the load.

Rotate mechanism—Rotate in one direction

In some embodiments, the fork assembly can include one or more rotate mechanisms, with each rotate mechanism configured to rotate at least a blade, for example, between a position outside the load, such as parallel to the fork beam for not interfere with the load when the fork assembly moves, and a position under the load, such as pointing toward the load for lifting the load.

The rotate mechanism can be configured with a remote operation, e.g., an operator running the forklift vehicle can activate the rotate mechanism for rotate the blade while sitting at the control of the forklift vehicle, e.g., without the need to leave the forklift vehicle to the location of the load for rotating the blade.

In general, the rotate mechanism is configured to convert a linear movement to a rotational movement, for example, through a pin interfacing with a slanting surface, e.g., a surface curved and slanted around a cylinder, such as a helical curve.

FIGS. **19**A(*a*)(*b*)-**19**B(*a*)(*b*) illustrate a schematic of a conversion mechanism according to some embodiments. A linear movement can be converted to a rotational movement through an interaction of a component, such as a pin, with a slanting surface, such as a curve helix surface around a cylinder. To allow for a repeat conversion, two linear movements can be used, which can be converted into two rotational angles.

FIG. **19**A(*a*)-**19**A(*b*) show a perspective view and a top view, respectively, of a conversion of a linear upward movement to a counterclockwise rotation in a rotate mechanism. The rotate mechanism can include a first element having a first slanting element **1951**, which includes a first slanting surface **1952** curving around a cylindrical shape, such as a helical curve. The first slanting surface can curve up, and stop at a first valley **1953**, e.g., the first slanting element **1951** can have an abrupt surface transitioned from the first slanting surface **1952**. The rotate mechanism can include a pin **1961** protruded from a rod **1960**.

In operation, the pin **1961** can be pushed up to contact the first slanting surface **1952**, for example, by pushing the rod **1960** upward relative to the first slanting element **1951** (or the first slanting element **1951** can be pushed downward relative to the rod **1960**). After contacting the first slanting surface **1952**, the pin **1961** can slide along the first slanting surface **1952** until reaching the first valley **1953**. When the pin slides along the first slanting surface, the rod rotates a first rotate angle **1951***.

FIG. **19**B(*a*)-**19**B(*b*) show a perspective view and a top view, respectively, of a conversion of a linear downward movement to another counterclockwise rotation in the rotate mechanism. The rotate mechanism can include the first element having a second slanting element **1955**, which has a second slanting surface **1956** curving around a cylindrical shape, such as a helical curve. The second slanting surface can curve down, and stop at a second valley **1957**, e.g., the second slanting surface **1956** can have an abrupt transitioned surface.

In operation, the pin **1961** can be pushed down from the first valley **1953** to contact the second slanting surface **1956**, for example, by pushing the rod **1960** downward relative to the second slanting element **1955** (or the second slanting element **1955** can be pushed upward relative to the rod **1960**). An actuator, such as a spring **1962** can be used to provide the pushing up of the second slanting element **1955**. After contacting the second slanting surface **1956**, the pin **1961** can slide along the second slanting surface **1956** until reaching the second valley **1957**. When the pin slides along the second slanting surface, the rod rotates a second rotate angle **1955***.

Thus, the rotate mechanism can include a first element having first and second slanting elements **1951** and **1955** having one or more slanting surfaces, and a second element having one or more pins **1961**. As shown, the pins are coupled to a rod disposed within a hollow portion of the first element.

By moving up and down of the rod relative to the first slanting elements, the rod can rotate a combination of a first rotate angle **1951*** and a second rotate angle **1955***.

Fork lifter having a one-directional rotate mechanism

FIGS. **20**A(*a*)(*b*)-**20**B(*a*)(*b*) illustrate a fork lifter configuration with a rotate mechanism according to some embodiments. FIGS. **20**A(*a*)-**20**A(*b*) show a perspective view and a top view of a fork lifter in a second position, which is a position outside the load, to be transitioned to a first position, which is a position under the load. A fork lifter **2040** can include a lifter rod **2060** coupled to a lifter blade **2042**. The lifter rod can be a bottom portion of a lifter support. A rotate mechanism **2050** can be coupled to the bottom portion and to a top portion of the lifter support. For example, the rotate mechanism **2050** can include one or more pins **2061**. The pins **2061** can be disposed in opposite directions on the lifter rod **2060**, such as protruding from the lifter rod from a center point of the lifter rod.

The rotate mechanism can include a first element having a first slanting element **2051** having first slanting surfaces **2052** and **2052***, and a second slanting element **2055** having second slanting surfaces **2056** and **2056***, which are coupled to the top portion of the lifter support of the fork lifter. The rotate mechanism can further include a second element, such as a lifter rod, having one or more pins, which are configured to rotate the lifter rod when the pins slide on the slanting surfaces. The rotate mechanism can optionally include an actuator, such as a spring **2062**, which is configured to bias the bottom portion of the lifter away from the top portion, e.g., the spring **2062** can function to push the blade away from the fork beam.

In operation, the top portion can move down, relative to the bottom portion, e.g., the top portion can move down or the bottom portion can move up. The downward movement of the top portion (or the upward movement of the bottom portion) can be performed by an operator lowering the fork assembly while sitting in the forklift vehicle and actuating the carriage on which the fork assembly is attached to. For example, when contacting a surface, such as the ground surface, the ground can exert a force on the bottom portion, such as the blade, to push the bottom portion upward. With the upward movement of the blade, the pins can contact and slide on the slanting surface **2052** of the first slanting element to rotate a first angle.

The top portion then can move up, relative to the bottom portion, e.g., the top portion can move up or the bottom portion can move down. The upward movement of the top portion (or the downward movement of the bottom portion) can be performed by an operator raising the fork assembly while sitting in the forklift vehicle and actuating the carriage. For example, when the fork assembly is lifted up, gravity, e.g., the weight of the blade or the load can exert a force on the bottom portion, such as the blade, to pull the bottom portion downward. Alternatively, the upward movement of the top portion (or the downward movement of the bottom portion) can be performed by the spring, which can pull down the bottom portion relative to the top portion. With the downward movement of the blade, the pins can contact and slide on the slanting surface **2056** to rotate a second angle.

The combination of the first angle and the second angle can toggle **2067**A the blade to a lift position, e.g., to rotate the blade from the second position **2045** to the first position **2044**. The rotation angle can be 90 degrees, e.g., from the blade parallel and outside the load to the blade under and perpendicular toward the load.

FIGS. **20**B(*a*)-**20**B(*b*) show a perspective view and a top view of a fork lifter in the first position, to be transitioned to the second position, using repeated movements of the fork assembly to generate the relative downward movement followed by the relative upward movement of the top portion.

For example, the top portion can move down, relative to the bottom portion. The downward movement of the top portion can be performed by an operator lowering the fork assembly while sitting in the forklift vehicle and actuating the carriage. When contacting the ground surface, the ground can exert a force on the blade to push the bottom portion upward. With the upward movement of the blade, the pins can contact and slide on the slanting surface **2052*** of the first element to rotate another first angle.

The top portion then can move up, relative to the bottom portion. The upward movement of the top portion can be performed by an operator raising the fork assembly while sitting in the forklift vehicle and actuating the carriage. When the fork assembly is lifted up, gravity or the spring force can exert a force on the blade to pull the bottom portion downward. With the downward movement of the blade, the pins can contact and slide on the slanting surface **2056*** to rotate another second angle.

The combination of the another first angle and the another second angle can toggle **2067**B the blade to a non-lift position, e.g., to rotate the blade from the first position **2044** to the second position **2045**. The rotation angle can be 270 degrees, e.g., from the blade under and perpendicular toward the load to the blade parallel and outside the load.

Variations of one-directional rotate mechanisms

In general, the rotate mechanism can include a first element having a first slanting surface and a second slanting surface. The rotate mechanism can include a second element having a component, such as one or more pins, for interacting with the first and second slanting surfaces. In practice, there can be multiple configurations of the rotate mechanism, including coupling configurations of the rotate mechanism to the fork assembly, and structural configurations of the rotate mechanism.

In the coupling configurations, the rotate mechanism can be coupled between a fork beam of the fork assembly and a blade of the fork lifter. For example, the rotate mechanism can be coupled between the fork beam and a lifter support of the fork lifter. The rotate mechanism can be coupled between a top portion and a bottom portion of the lifter support. The rotate mechanism can be coupled between the bottom portion and the blade of the fork lifter.

In the coupling configurations, the rotate mechanism can have the slanting surfaces in the first element facing each other. Alternatively, the rotate mechanism can have the slanting surfaces in the first element facing away from each other.

The rotate mechanism can have the first element having the slanting surfaces coupled to the fork beam and the second element having the pins coupled to the blade. Alternatively, the rotate mechanism can have the first element having the slanting surfaces coupled to the blade and the second element having the pins coupled to the fork beam.

The rotate mechanism can have the first element having the slanting surfaces slidably disposed within the second element having the pins. Alternatively, the rotate mechanism can have the first element having the slanting surfaces slidably disposed surrounding the second element having the pins coupled to the fork beam.

FIGS. **21**A-**21**H illustrate configurations for a rotate mechanism according to some embodiments. Each rotate mechanism includes a first element having first and second slanting surfaces, and a second element having one or more pins. The first and second elements can be arranged in different configurations to form a rotate mechanism. As shown, the rotate mechanism is coupled between a lifter support **2141** and a lifter blade **2142** of a fork lifter. The rotate mechanism can also be coupled to different components of the fork assembly, such as between the fork beam and the fork lifter, or between portions of the fork lifter.

FIG. **21**A shows a rotate mechanism in which the first element is coupled to a fork lifter support **2141**, and the second element is coupled to a fork blade **2142**. The first element has first and second slanting surfaces facing each other, with the pins **2161** of the second element disposed in between the slanting surfaces, and protruded outward toward the slanting surfaces. Further, the second element is disposed inside the first element, such as the first element has annular shape slanting surfaces, and the second element has a rod **2160** shape component configured to be slidable inside the annular first element. A secure element, such as a screw **2107**, can be used for securing the first element to the fork lifter support.

FIG. **21**B shows a rotate mechanism in which the second element is coupled to a fork lifter support **2141**, and the first element is coupled to a fork blade **2142**. The first element has first and second slanting surfaces facing each other, with the pins **2161** of the second element disposed between the slanting surfaces, and protruded inward toward the slanting surfaces. Further, the first element is disposed inside the second element, such as the second element has annular shape with the pins pointing inward, and the first element has a rod shape fixedly coupled to the first and second slanting surfaces. The first element is configured to be slidable inside the annular second element.

FIG. **21**C shows a rotate mechanism in which the first element is coupled to a fork lifter support **2141**, and the second element is coupled to a fork blade **2142**. The first element has first and second slanting surfaces facing away from each other, with the pins **2161** of the second element disposed on both sides of the slanting surfaces, and protruded outward toward the slanting surfaces. Further, the second element is disposed inside the first element, such as the first element has annular shape slanting surfaces, and the second element has a rod shape component configured to be slidable inside the annular first element. A secure element can be used for securing the first element to the fork lifter support.

FIG. **21**D shows a rotate mechanism in which the second element is coupled to a fork lifter support **2141**, and the first element is coupled to a fork blade **2142**. The first element has first and second slanting surfaces facing away from each other, with the pins **2161** of the second element disposed on both sides of the slanting surfaces, and protruded inward toward the slanting surfaces. Further, the first element is disposed inside the second element, such as the second element has annular shape with the pins pointing inward, and the first element has a rod shape fixedly coupled to the first and second slanting surfaces. The first element is configured to be slidable inside the annular second element.

FIG. **21**E shows a rotate mechanism in which the second element is coupled to a fork lifter support **2141**, and the first element is coupled to a fork blade **2142**. The first element has first and second slanting surfaces facing each other, with the pins **2161** of the second element disposed in between the slanting surfaces, and protruded outward toward the slanting surfaces. Further, the second element is disposed inside the first element, such as the first element has annular shape slanting surfaces, and the second element has a rod shape component configured to be slidable inside the annular first element. A secure element can be used for securing the first element to the fork lifter support.

FIG. **21**F shows a rotate mechanism in which the first element is coupled to a fork lifter support **2141**, and the second element is coupled to a fork blade **2142**. The first element has first and second slanting surfaces facing each other, with the pins **2161** of the second element disposed between the slanting surfaces, and protruded inward toward the slanting surfaces. Further, the first element is disposed inside the second element, such as the second element has annular shape with the pins pointing inward, and the first element has a rod shape fixedly coupled to the first and second slanting surfaces. The first element is configured to be slidable inside the annular second element.

FIG. **21**G shows a rotate mechanism in which the second element is coupled to a fork lifter support **2141**, and the first element is coupled to a fork blade **2142**. The first element has first and second slanting surfaces facing away from each other, with the pins **2161** of the second element disposed on both sides of the slanting surfaces, and protruded outward toward the slanting surfaces. Further, the second element is disposed inside the first element, such as the first element has annular shape slanting surfaces, and the second element has a rod shape component configured to be slidable inside the annular first element. A secure element can be used for securing the first element to the fork lifter support.

FIG. **21**H shows a rotate mechanism in which the first element is coupled to a fork lifter support **2141**, and the second element is coupled to a fork blade **2142**. The first element has first and second slanting surfaces facing away from each other, with the pins **2161** of the second element disposed on both sides of the slanting surfaces, and protruded inward toward the slanting surfaces. Further, the first element is disposed inside the second element, such as the second element has annular shape with the pins pointing inward, and the first element has a rod shape fixedly coupled to the first and second slanting surfaces. The first element is configured to be slidable inside the annular second element.

Forming a one-directional rotate mechanism

In some embodiments, the rotate mechanism can be configured to convert linear movements, such as up/down, to rotational moving in one direction. For example, a first set of linear movements can rotate the blade from an outside position to an under position in one rotational direction, such as counterclockwise (or clockwise). A second set of linear movements can rotate the blade from the under position to the outside position in the same rotational direction, such as counterclockwise (or clockwise).

FIGS. **22**A-**22**B illustrate processes to form a rotate mechanism according to some embodiments. FIG. **22**A forms a rotate mechanism having slanting surface and interactive pins. Operation **2200** forms a rotate mechanism, with the rotate mechanism including a first element and a second element. The first element includes a first slanting surface connected to a first valley, and a second slanting surface connected to a second valley. The first slanting surface is spaced from the second slanting surface. The first and second slanting surfaces form an angle greater than zero.

The second element includes one or more pins configured to interact with the first and second slanting surfaces through relative motions between the one or more first elements and the one or more second elements. The relative motions include a first movement in which the one or more pins relatively move along the first slanting surface to rest at the first valley and to cause the one or more pins to rotate a first angle relative to the one or more elements. The relative motions includes a second movement in which the one or more pins relatively move along the second slanting surface to rest at the second valley and to cause the one or more pins to rotate a second angle relative to the one or more elements.

FIG. **22**B forms a rotate mechanism coupled to at least one of a fork beam, a fork lifter body, or a blade. Operation **2220** forms a rotate mechanism, with the rotate mechanism including a first element including a first slanting surface and a second slanting surface, and a second element including one or more pins configured to interact with the first and second slanting surfaces to rotate a blade between a first and a second positions.

The blade or a fork beam is configured to couple to either the first or second element respectively. In the first position, the blade is disposed under a load. In the second position, the blade is disposed outside the load.

In some embodiments, the first element can include a first slanting element and a second slanting element, each having at least a slanting surface. The second element can include one second component coupled to at least a pin, with the pin disposed between the two slanting surfaces of the first and second slanting elements.

In some embodiments, the first element is coupled to a fork beam, and the second element is coupled to a blade. Alternatively, the first element is coupled to a blade, and the second element is coupled to a fork beam.

In some embodiments, the second component is disposed inside the first two components. Alternatively, the first two components are disposed inside the second component.

In some embodiments, the first element can include a first slanting element having a first slanting surface and a second slanting element having a second slanting surface, with the two slanting surfaces facing away from each other. The second element can include one second component coupled to at least two pins, with the pins disposed outside the two slanting surfaces.

In some embodiments, the first element is coupled to a fork beam, and the second element is coupled to a blade. Alternatively, the first element is coupled to a blade, and the second element is coupled to a fork beam.

In some embodiments, the second component is disposed inside the first two components. Alternatively, the first two components are disposed inside the second component.

Moving or toggling a blade between 2 positions

FIGS. **23**A-**23**C illustrate processes for activating the rotate mechanism with the fork assembly according to some embodiments. FIG. **23**A provides a process for toggling a blade between an under a load position and an outside the load position. Operation **2300** toggles a lifter blade between a first position and a second position of a fork lifter coupled to a fork assembly of a forklift. The toggling process is activated when the fork assembly is positioned around the load with the lifter blade in a vicinity of a ground. In the first position, the lifter blade is disposed under the load for lifting the load. In the second position, the lifter blade is outside the load for not lifting the load.

FIG. **23**B provides a process for toggling a blade by fork lifter moving to contact a surface and then moving in an opposite direction. Operation **2320** moves a fork lifter coupled to a fork assembly of a forklift downward. When the fork lifter contacts a surface and then releases from the surface, a toggling mechanism is activated to toggle a blade of the fork lifter between a first position and a second position. In the first position, the lifter blade is disposed under a load for lifting the load. In the second position, the lifter blade is outside the load for not lifting the load.

FIG. **23**C provides a process for toggling a blade by moving a fork assembly in two opposite directions. Operation **2340** moves a fork assembly of a forklift in two opposite directions to toggle a blade of a fork lifter coupled to the fork assembly between under a load for lifting the load and outside the load for not lifting the load.

Rotate mechanism-Rotate in two opposite directions

In some embodiments, the rotate mechanism can be configured to rotate back and forth, instead of continuously in one direction. The slanting surfaces can be configured to be nested, e.g., one slanting surface is within the other slanting surface to allow rotations in forward direction then backward direction.

FIGS. **24**A(*a*)(*b*)-**24**B illustrate a schematic of a conversion mechanism according to some embodiments. The pins can be configured to move in one direction, and then return in an opposite direction.

FIGS. **24**A(*a*)-**24**A(*b*) show a side view of a rotate mechanism having a conversion of linear upward/downward movements to counterclockwise/clockwise rotations in a rotate mechanism. The rotate mechanism can include a first element including a first slanting element **2451** and a second slanting element **2455**. The first slanting element **2451** can have multiple first slanting surfaces, and the second slanting element **2455** can have one second slanting surface, configured so that the multiple first slanting surfaces surround the second slanting surface. For example, the first slanting element **2451** can have first slanting surface **2452**. The second slanting element **2455** can have second slanting surfaces **2456**, **2456***, and **2456****. The second element can have a pin **2461**.

In operation, in a first movement **2454**, the pin **2461** can be pushed up to contact the first slanting surface **2452**, for example, by pushing the rod **2460** upward relative to the first slanting element **2451**. After contacting the first slanting surface **2452**, the pin **2461** can slide along the first slanting surface **2452** until reaching a first valley. When the pin slides along the first slanting surface **2452**, the rod rotates a first rotate angle.

In a second movement **2458**, the pin **2461** can be pushed down to contact the second slanting surface **2456**, for example, by pushing the rod **2460** downward relative to the second slanting element **2455**. After contacting the second slanting surface **2456**, the pin **2461** can slide along the second slanting surface **2456** until reaching a valley. When the pin slides along the second slanting surface **2456**, the rod rotates a second rotate angle. The combination of the first and second rotation angles rotates the blade between the first and second positions, such as toggle the blade to a lift position **2467**A.

For the next blade rotation, another first movement **2454*** can cause the pin to move upward to contact and slide along the second slanting surface **2456***. The movement can cause the rod to rotate another first rotate angle. Then, another second movement **2458*** can cause the pin to move downward to contact and slide along the second slanting surface **2456****. The movement can cause the rod to rotate another second rotate angle. The combination of the another first and second rotation angles rotates the blade between the first and second positions, such as toggle the blade to a non-lift position **2467**B.

FIG. **24**B shows a side view of another rotate mechanism having a conversion of linear upward/downward movements to counterclockwise/clockwise rotations in a rotate mechanism. The rotate mechanism can include a first element having a first slanting element **2451** and a second slanting element **2455**, with the first and second slanting surfaces configured so that the multiple first slanting surfaces are separated from the second slanting surface. In addition, the second element includes 2 pins separated a fixed distance, with one pin configured to contact and slide along a first or second slanting surface at a time.

Fork lifter having a one-directional rotate mechanism

FIGS. **25**A(*a*)(*b*)-**25**B(*a*)(*b*) illustrate a fork lifter configuration with a rotate mechanism according to some embodiments. FIGS. **25**A(*a*)-**25**A(*b*) show a perspective view and a top view of a fork lifter in a second position, which is a position outside the load, to be transitioned to a first position, which is a position under the load. A fork lifter **2540** can include a lifter rod **2560** coupled to a lifter blade **2542**. The lifter rod can be a bottom portion of a lifter support. A rotate mechanism **2550** can be coupled to the bottom portion and to a top portion of the lifter support. For example, the rotate mechanism **2550** can include one or more pins **2561**. The pins **2561** can be disposed in opposite directions on the lifter rod **2560**, such as protruding from the lifter rod from a center point of the lifter rod.

The rotate mechanism can include a first element having a first slanting element **2551** having first slanting surfaces **2552**, and a second slanting element **2555** having second slanting surfaces **2556**, **2556***, and **2556****, which are coupled to the top portion of the lifter support of the fork lifter. The rotate mechanism can further include a second element, such as a lifter rod, having one or more pins, which are configured to rotate the lifter rod when the pins slide on the slanting surfaces. The rotate mechanism can optionally include an actuator, such as a spring **2562**, which is configured to bias the bottom portion of the lifter away from the top portion, e.g., the spring **2562** can function to push the blade away from the fork beam.

In operation, the top portion can move down, relative to the bottom portion. The relative downward movement of the top portion can be performed by an operator lowering the fork assembly. With the upward movement of the blade, the pins can contact and slide on the slanting surface **2552** of the first slanting element to rotate a first angle.

The top portion then can move up, relative to the bottom portion. The relative upward movement of the top portion can be performed by an operator raising the fork assembly. With the downward movement of the blade, the pins can contact and slide on the slanting surface **2556** to rotate a second angle.

The combination of the first angle and the second angle can toggle **2567**A the blade to a lift position, e.g., to rotate the blade from the second position **2545** to the first position **2544**. The rotation angle can be 90 degrees, e.g., from the blade parallel and outside the load to the blade under and perpendicular toward the load.

FIGS. **25**B(*a*)-**25**B(*b*) show a perspective view and a top view of a fork lifter in the first position, to be transitioned to the second position, using repeated movements of the fork assembly to generate the relative downward movement followed by the relative upward movement of the top portion.

For example, the top portion can move down, relative to the bottom portion. With the upward movement of the blade, the pins can contact and slide on the slanting surface **2556*** to rotate another first angle.

The top portion then can move up, relative to the bottom portion. With the downward movement of the blade, the pins can contact and slide on the slanting surface **2556**** to rotate another second angle.

The combination of the another first angle and the another second angle can toggle **2567**B the blade to a non-lift position, e.g., to rotate the blade from the first position **2544** to the second position **2545**. The rotation angle can be -90 degrees, e.g., from the blade under and perpendicular toward the load to the blade parallel and outside the load, in opposite direction.

Variations of one-directional rotate mechanisms

FIGS. **26**A-**26**H illustrate configurations for a rotate mechanism according to some embodiments. Each rotate mechanism includes a first element having first and second slanting surfaces, and a second element having one or more pins. The first and second elements can be arranged in different configurations to form a rotate mechanism. As shown, the rotate mechanism is coupled between a lifter support **2641** and a lifter blade **2642** of a fork lifter. The rotate mechanism can also be coupled to different components of the fork assembly, such as between the fork beam and the fork lifter, or between portions of the fork lifter.

FIG. **26**A shows a rotate mechanism in which the first element is coupled to a fork lifter support **2641**, and the second element is coupled to a fork blade **2642**. The first element has first and second slanting surfaces nesting in each other, with the pins **2661** of the second element disposed in between the slanting surfaces, and protruded outward toward the slanting surfaces. Further, the second element is disposed inside the first element, such as the first element has annular shape slanting surfaces, and the second element has a rod **2660** shape component configured to be slidable inside the annular first element. A secure element, such as a screw **2607**, can be used for securing the first element to the fork lifter support.

FIG. **26**B shows a rotate mechanism in which the second element is coupled to a fork lifter support **2641**, and the first element is coupled to a fork blade **2642**. The first element has first and second slanting surfaces nesting in each other, with the pins **2661** of the second element disposed between the slanting surfaces, and protruded inward toward the slanting surfaces. Further, the first element is disposed inside the second element, such as the second element has annular shape with the pins pointing inward, and the first element has a rod shape fixedly coupled to the first and second slanting surfaces. The first element is configured to be slidable inside the annular second element.

FIG. **26**C shows a rotate mechanism in which the first element is coupled to a fork lifter support **2641**, and the second element is coupled to a fork blade **2642**. The first element has first and second slanting surfaces separated from each other, with the pins **2661** of the second element disposed on both sides of the slanting surfaces, and protruded outward toward the slanting surfaces. Further, the second element is disposed inside the first element, such as the first element has annular shape slanting surfaces, and the second element has a rod shape component configured to be slidable inside the annular first element. A secure element can be used for securing the first element to the fork lifter support.

FIG. **26**D shows a rotate mechanism in which the second element is coupled to a fork lifter support **2641**, and the first element is coupled to a fork blade **2642**. The first element has first and second slanting surfaces separated from each other, with the pins **2661** of the second element disposed on both sides of the slanting surfaces, and protruded inward toward the slanting surfaces. Further, the first element is disposed inside the second element, such as the second element has annular shape with the pins pointing inward, and the first element has a rod shape fixedly coupled to the first and second slanting surfaces. The first element is configured to be slidable inside the annular second element.

FIG. **26**E shows a rotate mechanism in which the second element is coupled to a fork lifter support **2641**, and the first element is coupled to a fork blade **2642**. The first element has first and second slanting surfaces nesting in each other, with the pins **2661** of the second element disposed in between the slanting surfaces, and protruded outward toward the slanting surfaces. Further, the second element is disposed inside the first element, such as the first element has annular shape slanting surfaces, and the second element has a rod shape component configured to be slidable inside the annular first element. A secure element can be used for securing the first element to the fork lifter support.

FIG. **26**F shows a rotate mechanism in which the first element is coupled to a fork lifter support **2641**, and the second element is coupled to a fork blade **2642**. The first element has first and second slanting surfaces nesting in each other, with the pins **2661** of the second element disposed between the slanting surfaces, and protruded inward toward the slanting surfaces. Further, the first element is disposed inside the second element, such as the second element has annular shape with the pins pointing inward, and the first element has a rod shape fixedly coupled to the first and second slanting surfaces. The first element is configured to be slidable inside the annular second element.

FIG. **26**G shows a rotate mechanism in which the second element is coupled to a fork lifter support **2641**, and the first element is coupled to a fork blade **2642**. The first element has first and second slanting surfaces separated from each other, with the pins **2661** of the second element disposed on both sides of the slanting surfaces, and protruded outward toward the slanting surfaces. Further, the second element is disposed inside the first element, such as the first element has annular shape slanting surfaces, and the second element has a rod shape component configured to be slidable inside the annular first element. A secure element can be used for securing the first element to the fork lifter support.

FIG. **26**H shows a rotate mechanism in which the first element is coupled to a fork lifter support **2641**, and the second element is coupled to a fork blade **2642**. The first element has first and second slanting surfaces separated from each other, with the pins **2661** of the second element disposed on both sides of the slanting surfaces, and protruded inward toward the slanting surfaces. Further, the first element is disposed inside the second element, such as the second element has annular shape with the pins pointing inward, and the first element has a rod shape fixedly coupled to the first and second slanting surfaces. The first element is configured to be slidable inside the annular second element.

Forming a one-directional rotate mechanism

In some embodiments, the rotate mechanism can be configured to convert linear movements, such as up/down, to rotational movements moving in one direction or in opposite directions.

FIGS. **27**A-**27**B illustrate processes to form a rotate mechanism according to some embodiments. FIG. **27**A forms a rotate mechanism for rotating a blade repeatedly in a same direction. Operation **2700** forms a rotate mechanism, with the rotate mechanism configured to rotate a lifter blade 270 degree in a first rotation direction from a first position to a second position of a fork lifter coupled to a fork assembly of a fork lift, and with the rotate mechanism configured to rotate a lifter blade 90 degree in the first rotation direction from the second position to the first position. In the first position, the lifter blade is disposed under the load for lifting the load. In the second position, the lifter blade is outside the load for not lifting the load.

FIG. **27**B forms a rotate mechanism for rotating a blade backward and forward in two opposite directions. Operation **2720** forms a rotate mechanism, with the rotate mechanism configured to rotate a lifter blade 90 degree in a first rotation direction from a first position to a second position of a fork lifter coupled to a fork assembly of a fork lift, and with the rotate mechanism configured to rotate a lifter blade 90 degree in a second rotation direction opposite the first rotation direction from the second position to the first position. In the first position, the lifter blade is disposed under the load for lifting the load. In the second position, the lifter blade is outside the load for not lifting the load.

Operation of a fork assembly having a rotate mechanism

The rotate mechanism can be incorporated into a fork assembi for automatically (or remotely) rotate the lifter blades from an outside-the-load position to an under-the-load position. The outside-the-load position can be parallel to the fork beams, to minimize the width of the fork beam.

The under-the-load position can be perpendicular to the fork beam and pointing toward the load, for lifting the load. The rotate mechanism can allow the lifter blades to rotate from a fork-assembly-moving configuration, in which the fork assembly is configured for moving to position around the load, to a fork-assembly-lifting configuration, in which the fork assembly is configured for lifting the load, all with the operator remaining in the driver seat of the forklift vehicle.

Further, the rotate mechanism can allow the fork assembly to deliver the load to a destination, and then automatically (or remotely) rotate the blades to the outside-the-load position, so that the fork assembly can withdraw from the load, and ready to approach another load for pick up.

FIGS. **28**A-**28**C illustrate a schematic operation of a fork assembly with rotate mechanisms according to some embodiments. In FIG. **28**A, a fork assembly **2820** is mounted on a forklift vehicle, such as mounting to a carriage of the forklift vehicle, through mounting couplers **2824**A. The fork assembly can include two forks **2821**, with each fork **2821** having a fork beam **2821**A coupled to a fork plate **2821**B and a fork strengthener **2821**C. The forks can be coupled to the mounting body through fork couplers **2838**. Optional actuators **2838**B can be coupled between the forks and the mounting body for adjusting a distance between the forks. Multiple fork lifters **2840** can be coupled to each fork beam, with each fork lifter having a lifter support **2841** coupled to a lifter blade **2842**. A rotate mechanism **2850** can coupled between the fork beam and each fork lifter. The fork blades are positioned not for lifting a load, e.g., so that the forklift vehicle can maneuver the fork assembly around the load **2811**. For example, the blades can be positioned parallel to the fork beams, in order to minimize the effective width of the fork.

During operation, the forklift vehicle is driven toward the load **2811**, so that the fork assembly surrounds the load with the fork beams positioned parallel with the long direction **2817** of the load, and the forklift vehicle facing the short direction **2816** of the load. The load **2811** can have foot beam or load beam **2815** running along the short direction **2816**. The fork lifters are positioned at positions on the fork beams so that the blades **2842** can rotate to the gaps under the load bottom surface and not contacting the load beams **2815**.

FIG. **28**B shows a lifting configuration for the fork assembly **2820**. After the fork assembly is properly positioned surrounding the load **2811**, the rotate mechanism **2850** is activated to rotate the blades toward the load, e.g., so that the blades can be positioned under the load for lifting. The activation process can include lowering the fork assembly, followed by raising the fork assembly. After actuating the lifter blades, the fork assembly then can continue raise up to lift the load. The forklift vehicle can then move toward a destination for placing the load.

After reaching the destination, the fork assembly can be lowered until the load contacts the ground. The rotate mechanism can then be actuated to rotate the blades outside the load, such as to the position parallel to the fork beam. The same activation process can be used, e.g., including lowering the fork assembly, followed by raising the fork assembly. The forklift vehicle can then move backward to clear the fork assembly from the load.

FIG. **28**C shows a rotate mechanism coupled between the fork beam **2821**A and the lifter support **2841**. For example, first and second slanting elements **2851** and **2855** are coupled to the fork beam **2821**A. The lifter blade **2841** includes one or more pins **2861** disposed between the slanting surfaces of the first and second slanting elements. An optional spring **2862** is included for biasing the lifter support against the fork beam.

The rotate mechanism can allow the fork blades to rotate by an operator lowering and raising the fork assembly from the driver seat of the forklift vehicle.

Fork lifter coupled to fork with a rotate mechanism

FIGS. **29**A(*a*)(*b*)-**29**B(*a*)(*b*) illustrate coupling configurations of a fork lifter according to some embodiments. FIGS. **29**A(*a*)-**29**A(*b*) show a perspective view and a top view of a coupling configuration in which fork lifter is coupled to a top side of a fork beam. A fork lifter **2940**A can include a lifter support **2941** coupled to a lifter blade **2942**, with the lifter support coupled to a lifter rod **2960**. The lifter rod can be a top portion of the lifter support. A rotate mechanism **2950** can be coupled to a top portion of a fork beam **2921**A. For example, the rotate mechanism **2950** can include a housing containing first and second slanting elements **2951** and **2955**. The housing can be coupled to the fork beam through lifter brackets **2946**A. Multiple lifter adjusts **2947**A can be formed along the fork beam, to allow adjustments of the load lifter along the fork beam.

The rotate mechanism **2950** can include the lifter rod **2960** disposed within the first and second slanting elements **2951** and **2955**. One or more pins **2961** can be protruded from the lifter rod, such as disposing in opposite directions on the lifter rod **2960**, for interacting with the first and second slanting elements **2951** and **2955**.

The rotate mechanism can optionally include an actuator, such as a spring **2962**, which is configured to bias the bottom portion of the lifter away from the top portion, e.g., the spring **2962** can function to push the blade away from the fork beam.

In operation, the fork beam can move down, e.g., toward the ground, for example, by an operator operating a carriage of the forklift vehicle in which the fork assembly is attached to. The ground contacting action due to the downward movement of the fork beam can exert a force on the blade, to push the lifter rod upward so that the pins can contact and slide on the slanting surface of the first slanting element to rotate a first angle.

The fork beam then can move up, for example, by the operator. Gravity, e.g., the weight of the blade or the load, can exert a force on the blade, to pull the lifter rod downward so that the pins can contact and slide on the slanting surface of the second slanting element to rotate a second angle. The combination of the first angle and the second angle can toggle the blade, from a non-liftable position to a lift position, such as from a position in which the blade is parallel to the fork beam to a position in which the blade is perpendicular to the fork beam and under the load.

FIGS. **29**B(*a*)-**29**B(*b*) show a perspective view and a top view of another coupling configuration in which fork lifter is coupled to a bottom side of a fork beam. A fork lifter **2940**B can include a lifter support **2941** coupled to a lifter blade **2942**, with the lifter support being the lifter rod **2960**. Other configuration can be used, such as the lifter rod can be a top portion of the lifter support. A rotate mechanism **2950** can be coupled to a bottom side of a fork beam **2921**A. For example, the rotate mechanism **2950** can include a housing containing first and second slanting elements. The housing can be coupled to the fork beam through lifter brackets **2946**B. Multiple lifter adjusts **2947**B can be formed along the fork beam, to allow adjustments of the load lifter along the fork beam.

Adjusting a fork lifter position on a fork beam

FIGS. **30**A(*a*)(*b*)-**30**B(*a*)(*b*)(*c*) illustrate coupling configurations of a fork lifter according to some embodiments.

FIG. **30**A(*a*) shows a side coupling of a fork lifter to a fork beam. FIG. **30**A(*b*) shows a side coupling of the fork lifter to another location on the fork beam. A fork lifter **3040**A can include a lifter support **3041** coupled to a lifter blade **3042**, with the lifter support coupled to a lifter rod **3060** at a top portion of the lifter support. A rotate mechanism **3050** can be coupled to a top portion of the fork lifter. The fork lifter can be coupled to a side of the fork beam **3021**A through lifter brackets **3046**. Multiple lifter adjusts **3047**A can be formed along the fork beam, to allow horizontal adjustments of the load lifter along the fork beam. The fork lifter can be coupled to the fork beam **3021**A at lifter adjusts **3047**B among multiple lifter adjusts **3047**B formed along the fork lifter, to allow vertical adjustments of the load lifter.

FIG. **30**B(*a*) shows a perspective view of a side coupling of another fork lifter to a fork beam. FIGS. **30**B(*b*)-**30**B(*c*) shows side views of the coupling of the fork lifter to different locations on the fork lifter. A fork lifter **3040**B can include a lifter support **3041** coupled to a lifter blade **3042**, with a lifter rod **3060** disposed between the lifter support and the lifter blade. A rotate mechanism **3050** can be coupled to a bottom portion of the lifter support. For example, the rotate mechanism **3050** can be disposed within the lifter support, including first and second slanting elements with the lifter rod disposed within the first and second slanting elements.

The fork lifter can be coupled to the fork beam through lifter brackets **3046**. Multiple lifter adjusts **3047**A can be formed along the fork beam, to allow horizontal adjustments of the load lifter along the fork beam. Also, multiple lifter adjusts **3047**B can be formed along the lifter support, to allow vertical adjustments of the load lifter at a particular position on the fork beam.

Forming a lifter

FIGS. **31**A-**31**C illustrate a fork lifter for a fork assembly according to some embodiments. FIG. **31**A shows a process to form a fork lifter, or a load lifter configured to lift a load, to allow an automatic rotation of a blade of the load lifter, e.g., the blade rotation can be controlled by an operator operating a forklift vehicle.

Operation **3100** forms a load lifter coupled to a fork for lifting a load. The load lifter includes a rotate mechanism coupled to the fork and a blade coupled to the rotate mechanism. The rotate mechanism is configured to rotate the blade between under the load and outside the load. The load lifter is configured to be coupled to the fork at discrete or continuous locations along a fork beam of the fork. The load lifter is configured to be coupled to the fork at discrete or continuous locations to adjust a height of the load lifter.

FIG. **31**B shows a process to couple a fork lifter to a fork assembly depending on the load, e.g., the fork lifter can be positioned along a fork beam to balance a load and to allow a blade of the fork lifter to swing to a gap under the load.

Operation **3120** couples a load lifter to a fork for lifting a load. The load lifter includes a rotate mechanism coupled to the fork and a blade coupled to the rotate mechanism. The rotate mechanism is configured to rotate the blade between under the load and outside the load. The load lifter is configured to be coupled to the fork at discrete or continuous locations along a fork beam of the fork. The load lifter is configured to be coupled to the fork at discrete or continuous locations to adjust a height of the load lifter.

FIG. **31**C shows a process to adjust a fork lifter along a fork assembly or at a location on the fork assembly e.g., the fork lifter can be positioned along a fork beam or can be adjusted up or down so that the blades can be slightly above the ground.

Operation **3140** adjusts a load lifter to a fork for lifting a load. The load lifter is positioned along a fork beam of the fork so that a blade of the load lifter is capable of rotating to under the load without obstruction. The load lifter is positioned along a support of the load lifter so that the blade is capable of rotating to under the load without obstruction.

Blade Configurations

In some embodiments, the fork lifter includes a blade configured to lift a load. Multiple blades from multiple fork lifters can be arranged around and under the load with good balance to prevent tipping. For example, a fork assembly can include 2 opposite forks configured to be placed at two sides of the load, such as at two parallel planes that are perpendicular to the front face of the forklift vehicle. Each fork can have two or more fork lifters disposed at or near two ends of the fork. For example, there can be 4 or 6 fork lifters disposed on two forks, e.g., there can be 2 or 3 fork lifters on each fork. The fork lifters can be disposed facing each other from two opposite forks, or can be disposed in any other configurations.

FIGS. **32**A(*a*)(*b*)-**32**B(*a*)(*b*)-**32**C(*a*)(*b*) illustrate configurations for fork lifter blades in a fork assembly according to some embodiments. FIGS. **32**A(*a*)-**32**A(*b*) show a configuration in which two blades of two opposite fork lifters are disposed under the load for supporting the load. A forklift vehicle can move a fork assembly toward a load so that a fork assembly surrounds the load with two fork lifters **3240** disposed on opposite sides of a load **3211**. The fork lifters can be facing each other, or can be offset from each other. As shown, the length of the blades is shorter than half the width of the load, e.g., the blades from two opposite fork lifters do not overlap or touch.

FIG. **32**A(*a*) shows two fork beams **3221**A disposed on both sides of a load **3211**, for example, by a forklift vehicle moving a fork assembly around the load. A fork lifter **3240** is coupled to a fork beam, with a blade **3242** of the fork lifter disposed in parallel with the load. The fork lifters can be toggled to lift **3267**A, for example, by rotating the fork support **3241**, to move the blades from the position parallel to the load to a position under the load.

FIG. **32**A(*b*) shows the blades after the toggling process to be under the load. As shown, the blades are shorter than half the width of the load, and do not touch or contact each other. The fork assembly can be lifted up **3222**, e.g., the fork beam moving up. The blades contact the bottom of the load and the support the load for transferring to a new destination.

FIGS. **32**B(*a*)-**32**B(*b*) show a configuration in which two blades of two opposite fork lifters are hooked together under the load for strengthening the support for the load. FIG. **32**B(*a*) shows two fork beams disposed on both sides of a load **3211**. FIG. **32**B(*b*) shows the blades after being toggled to be under the load. As shown, the blades are slightly longer than half the width of the load, and are configured to hook together. For example, at the end of each blade, there is a hook, such as a hook **3242**A for one blade and a mating hook **3242**B for the opposite blade. The hooks are configured to couple the opposite blades in a direction along the length of the blades, e.g., in the direction across the load for strengthening the blade support for the load. The hooks are also configured to allow the blades to engage and release the hooks by rotating.

After rotating to the lift position, the blades are hooked together. The fork assembly can then move up to lift and transfer the load to a new destination.

FIGS. **32**C(*a*)-**32**C(*b*) show a configuration in which a blade includes a hook to hook into a mating hook at a body of an opposite fork lifter. FIG. **32**C(*a*) shows two fork beams disposed on both sides of a load **3211**, with each fork beam having one or more fork lifters. A fork lifter on a fork beam has a blade with an end hook. This fork lifter has a rotating mechanism for rotate the blade. Another fork lifter on an opposite fork beam does not have a blade, and has a mating hook. This fork lifter does not have a rotating mechanism. Thus, this fork lifter can be just a beam with one end coupled to the fork beam and an opposite end having a mating hook.

FIG. **32**C(*b*) shows the blade of the fork lifter having a blade after being toggled to be under the load. As shown, the blade is longer than the width of the load, and is configured to hooked with the mating hook on the opposite fork lifter support. After rotating to the lift position, the blades are hooked together. The fork assembly can then move up to lift and transfer the load to a new destination.

Blade configurations

FIGS. **33**A-**33**C illustrate configurations for blades of a fork lifter according to some embodiments. The blades can be configured to rotate to be under the load and not touching or hooked together. Alternatively, a blade can be configured to hook to a support of the opposite fork lifter.

FIG. **33**A shows configurations in which one or two blades are disposed hooked or unhooked under the load. Operation **3300** couples a fork lifter to each fork of a two-fork fork assembly. The fork assembly includes two forks, with a first fork lifter coupled to a first fork of the two forks, and a second fork lifter coupled to a second fork of the two forks. Each fork lifter has a rotating mechanism for rotating a blade from a position outside the load to a position under the load.

The blades of the fork lifters are configured to operate independently for lifting the load. In this case, the blades are straight blades, e.g., without any hook. Alternatively, the blades of the fork lifters are configured to be coupled together under the load when rotated to be under the load, with the fork lifters disposed in opposite sides of the load. In this case, one blade includes a hook at an end, and the other blade includes a mating hook at an end, with the hook and the mating hook configured to couple together when the fork lifters rotate to the lift position.

FIG. **33**B shows a configuration in which there is only one blade configured to hook to a support of an opposite fork lifter. Operation **3320** forms a fork assembly having two forks, with a first fork lifter coupled to a first fork of the two forks, and a second fork lifter coupled to a second fork of the two forks. Only one fork lifter has a rotating mechanism for rotating a blade from a position outside the load to a position under the load, with the blade having a hook at an end. The other fork lifter is configured not to be rotated, such as not having a rotating mechanism, and not having an attached blade. The other fork lifter can have just a fork support beam, extended from the fork beam. The other fork lifter has a mating hook configured to be mated with the hook at the end of the blade of the opposite fork lifter. For example, the other fork lifter can have hook at an end of the fork support beam.

FIG. **33**C shows a coupling process for a fork assembly having only one blade configured to hook to a support of an opposite fork lifter. Operation **3340** couples a fork lifter to each fork of a two-fork fork assembly. The fork assembly has two forks, with a first fork lifter coupled to a first fork of the two forks, and a second fork lifter coupled to a second fork of the two forks. Only one fork lifter has a rotating mechanism for rotating a blade from a position outside the load to a position under the load, with the blade having a hook at an end. The other fork lifter is configured not to be rotated, such as not having a rotating mechanism, and not having an attached blade. The other fork lifter can have just a fork support beam, extended from the fork beam. The other fork lifter has a mating hook configured to be mated with the hook at the end of the blade of the opposite fork lifter. For example, the other fork lifter can have hook at an end of the fork support beam.

Cable lifter for a fork assembly

In some embodiments, the fork lifter can include a cable, e.g., a cable lifter, which can be used instead of the blade for lifting the load. The cable lifter can have a cable with a hook at an end for coupling with a mating hook of a cable from an opposite cable lifter. For example, a cable with an end hook can be disposed along a lifter support and a lifter blade. Two opposite cable lifters can rotate so that the hooks from the two cables engaged. The fork assembly can then be lifted up so that the cables support the load.

FIGS. **34**A(*a*)(*b*)-**34**B(*a*)(*b*)-**34**C(*a*)(*b*) illustrate a process for operating a cable lifter according to some embodiments. FIGS. **34**A(*a*)-**34**A(*b*) show a perspective view of a cable lifter and a front view of a fork assembly surrounding a load, e.g., after a forklift vehicle moves the fork assembly toward the load with the cable lifter being at rest or non-lifting configuration, such as the blade is parallel to the fork beam. A cable lifter **3440** can include a lifter support **3441** coupled to a lifter blade **3442**. The cable lifter is coupled to a fork beam **3421**A by a lifter bracket **3446** at a suitable location so that the blade can rotate to be under the load. As shown, a top portion of the lifter support is coupled to the fork beam. A rotating mechanism **3450** can be coupled to the cable lifter **3440**, such as coupled between a top portion and a bottom portion of the lifter support, as indicated by a rod joining the two portions. The rod has one or more disposed between first and second slanting elements for rotating the rod when pushed against the first and second slanting elements. Other configurations for the rotating mechanism can be used, such as coupling to the top portion or to the bottom portion of the lifter support.

The lifter blade **3442** is coupled to the lifter support **3441** through a support slide **3465**, which is configured to slide the lifter blade along a length of the lifter support. Optional slide limits **3466** can be included, to prevent the lifter blade from sliding away from the lifter support, or to prevent the lifter blade from sliding too far up the lifter support. The slide limits can include a magnetic coupling or a mechanical blockage at a bottom end or at an area of the lifter support. For example, the slide limits can include two limit bars extending from the lifter support at two extreme limit positions. The slide limits can include a contact bar coupled to a top end of the blade, which extends outward to contact the limit bars. Thus, the lifter blade can be constrained to slide along the lifter support between two slide limit bars. The slide limits can include a magnetic material, so that the contact bar can adhere to the limit bar with a weak force, e.g., the adhesion can be easily broken by exerting a force.

The cable lifter **3440** also includes a lifter cable **3463**, which is coupled to a top potion of the cable lifter, such as to the top portion of the lifter support. The lifter cable **3463** runs along the lifter support and the lifter blade, such as along a side of the lifter support and then on top of the lifter blade. At the end of the lifter cable is a cable hook, which is configured to mate with a mating cable hook from a lifter cable of an opposite cable lifter.

FIGS. **34**B(*a*)-**34**B(*b*) show a perspective view of the cable lifter and a front view of the fork assembly after the cable lifter toggles to a lift position **3467**A, e.g., the blade rotates to be under the load. The cable hooks are mated, e.g., the hooks from the opposite cables engage after the opposite cable lifters rotate to the lift positions. The hooks can be configured to engage to each other along a direction along the blades, e.g., across the load between the two forks of the fork assembly. The hooks can be configured to allow the blades carrying the cables to engage or disengage the hooks. The fork assembly can be lifted up **3422**, for example, by the forklift vehicle. After the blades engage with the load, a force on the blade can cause the blade to slide down **3468**.

FIGS. **34**C(*a*)-**34**C(*b*) show a perspective view of the cable lifter and a front view of the fork assembly after the fork assembly continues to lift up, causing the cables to be tightened under the load and the blades sliding down along the support slide **3465**. The blade can continue to slide down until being stopped by the slide limits **3466**. The load is now supported by the cables stretching between the forks of the fork assembly.

FIGS. **35**A-**35**B illustrate a cable lifter for a fork assembly according to some embodiments. FIG. **35**A forms a fork assembly having one or more cable lifters. Operation **3500** forms a fork assembly having two forks. At least a fork lifter, or a cable lifter, is coupled to at least a fork of the two forks. The fork lifter includes a rotate mechanism for rotating a blade. The fork lifter includes a sliding mechanism for sliding the blade relative to another component of the fork lifter, such as to a fork support, or relative to the fork. The fork lifter includes a cable disposed on the blade, with the cable having a first hook at an end of the cable. The hooks from opposite fork lifters are configured for mating with each other.

In operation, when the opposite fork lifters rotate so that the blades of the fork lifters are disposed under the load, the hooks are hooked together. The cables are configured to move from the fork lifters to support the load when the fork assembly is raised up.

FIG. **35**B operates a fork assembly having one or more cable lifters. Operation **3520** activates rotate mechanisms of load lifter coupled to a fork assembly to rotate blades under a load so that hooks coupled to cables on the blades are coupled together. Afterward, the fork assembly is lifted up so that the coupled cables support the load and the blades slide down the load lifters.

Moving a forklift to take a load

In some embodiments, the fork assembly having fork lifters is configured for lifting and transferring a load. The load lifting is performed from sides of the load, for example, to account for loads that can only approach, but cannot be accessed, from the front. An advantage of the fork assembly is the ability to lift and transfer the load by an operator running the forklift vehicle, e.g., similar to a forklift vehicle accessing a load from the front of the load.

FIGS. **36**A-**36**D illustrate a process for lifting and transferring a load according to some embodiments. In FIG. **36**A, a forklift vehicle **3600** is driven toward a load **3611** to face the load at a direction parallel to load beams **3615** used to support the load. The forklift vehicle can have a fork assembly **3620**, such as by attaching the fork assembly **3620** to the forklift vehicle, for example, to a carriage of the forklift vehicle so that the forklift vehicle can operate the fork assembly by an operator sitting at a console of the forklift vehicle. The fork assembly **3620** can include fork lifters **3640** coupled to the forks of the fork assembly for lifting the load from opposite sides of the load. The fork lifters can include rotation mechanisms for remote rotating blades of the fork lifters. The blades are positioned in non-lift position **3645**, e.g., in a position to be outside the area between the forks, such as parallel to the forks. If the blades are positioned in lift position **3644**, e.g., pointing toward the area between the forks or having any portion of the blades to be under a load to be picked up by the fork assembly, an operator can operate the fork assembly, such as moving the fork assembly down and up, to rotate the blades to the non-lift position.

The fork lifters can be adjusted, for example, to adjust **3648**B the rotation direction of the blades from the non-lift position to the lift position, such as the fork lifters can be configured to provide the blades to be able to rotate to be under the load. For example, external blades can be positioned to rotate inward toward the load. As shown, the blade at the far left can be configured to rotate clockwise toward the load, while the blade at the far right can be configured to rotate counterclockwise toward the load.

The positions of the fork lifters along the forks can be adjusted, for example, to adjust **3648**A the position of the lifter supports to avoid obstacles, such as to avoid the support beams **3615** under the load **3611**.

In FIG. **36**B, the forklift vehicle moves toward the load to place the load between the forks of the fork assembly. The forklift vehicle can have minor adjustment on the positions of the blades by moving the fork assembly toward or away from the load, such as to avoid the load beams. The operator of the forklift vehicle then can move the fork assembly downward in a first movement **3654** so that the blades contact the ground to provide an upward force on the blades. The force on the blades activates the rotate mechanism, such as to drive a pin up to contact a first slanting surface, which can rotate the blades a first rotate angle **3651***, so that the blades rotate from the position outside the load **3645** to a position partially under the load.

In FIG. **36**C, the operator of the forklift vehicle then can move the fork assembly upward in a second movement **3658** so that the blades contact the bottom of the load to provide a downward force on the blades. Alternatively, optional springs on the rotate mechanisms can exert a downward force on the blades. The force on the blades activates the rotate mechanism, such as to drive the pin down to contact a second slanting surface, which can rotate the blades a second rotate angle **3655***, so that the blades rotate from the position partially under the load to a position under the load **3644**.

In FIG. **36**D, the operator of the forklift vehicle then can continue to move the fork assembly upward **3622** to lift the load from the ground using the blades under the load. For the case of cable lifters, the support on the load can be provided by the cables instead of by the blades. The forklift vehicle then can move the load to a destination.

FIG. **37** illustrates a flow chart for moving a forklift to take and transport a load according to some embodiments. Operation **3700** mounts a fork assembly to a forklift. Operation **3710** optionally adjusts a lateral position of a load lifter along a fork beam of a fork of the fork assembly to clear a rotation of a blade of the fork lifter from a load beam. Operation **3720** optionally adjusts a height of the load lifter to allow the blade to freely move to a gap between a bottom of a load and the ground. Operation **3730** optionally adjusts a distance between the forks of the fork assembly to be larger than a dimension of the load. Operation **3740** moves the forklift to position the load to be between 2 forks of the fork assembly and the blade above the ground. Operation **3750** moves the fork assembly downward to exert an upward force on the blade for rotating the blade a first angle to be under the load. Operation **3760** moves the fork assembly upward to exert a downward force on the blade for rotating the blade a second angle to be under the load. Operation **3760**A optionally mates hooks on the blades in the case of hooked blades. Operation **3760**B optionally mates hooks on cables disposed on the blades in the case of cable lifters having hooked cables. Operation **3770** continues moving the fork assembly upward to lift the load off the ground. Operation **3770**A optionally moves upward for the blades to contact the load. Alternatively, operation **3770**B optionally moves upward for the cables to contact the load. Operation **3780** transports the load by moving the forklift to a destination.

Moving a forklift to release a load

FIGS. **38**A-**38**D illustrate a process for releasing a load after reaching a destination according to some embodiments. In FIG. **38**A, a forklift vehicle **3800** drives a load **3811** to a destination, with the blades of the fork lifters coupled to the fork assembly are in lift position **3844**. After reaching the destination, the operator of the forklift vehicle then can move the fork assembly downward, e.g., the fork beams of the forks are lowered **3823**.

In FIG. **38**B, the operator of the forklift vehicle then can further move the fork assembly downward in a first movement **3854** so that the blades contact the ground to provide an upward force on the blades. The force on the blades activates the rotate mechanism, such as to drive a pin up to contact a first slanting surface, which can rotate the blades a first rotate angle **3851***, so that the blades rotate from the position under the load **3844** to a position partially under the load.

In FIG. **38**C, the operator of the forklift vehicle then can move the fork assembly upward in a second movement **3858** so that the blades contact the bottom of the load to provide a downward force on the blades. Alternatively, optional springs on the rotate mechanisms can exert a downward force on the blades. The force on the blades activates the rotate mechanism, such as to drive the pin down to contact a second slanting surface, which can rotate the blades a second rotate angle **3855***, so that the blades rotate from the position partially under the load to a position outside the load **3846**.

In FIG. **38**D, the operator of the forklift vehicle then can continue to move the fork assembly upward to velar the fork assembly from the load. The forklift vehicle then can move the empty fork assembly away from the load. The forklift vehicle can move to a new load for lifting and transferring the new load to a new destination. Alternatively, the fork assembly can be un-mounted from the forklift vehicle.

FIG. **39** illustrates a flow chart for moving a forklift to release a load according to some embodiments. Operation **3900**B optionally moves the fork assembly downward until cables of fork lifters coupled to the fork assembly are disposed on blades of the fork lifters, in the case of cable lifters coupled to the fork assembly. Operation **3910** moves the fork assembly downward to exert an upward force on the blade for rotating the blade a first angle toward outside the load. Operation **3910**A optionally releases hooks on the blades. Operation **3910**B optionally releases hooks on the cables. Operation **3920** moves the fork assembly upward to exert a downward force on the blade for rotating the blade a second angle to be outside the load. Operation **3930** continues moving the fork assembly upward to clear the blades off the ground. Operation **3940** moves the forklift away from the load. Operation **3950** optionally unmounts the fork assembly from the forklift.

Fork extension with rotate mechanism

In some embodiments, the present invention discloses an accessory for a forklift vehicle, such as a fork assembly having fork extensions for attaching to the forklift vehicle for pulling a load. The fork extensions coupled to the fork assembly can function as a towing attachment, configured for pulling on a load disposed far away from the forklift vehicle, e.g., farther than the reach of the for assembly. In conjunction with the forks on the fork assembly for lifting a load, the fork extension can be used for pulling the load from far-away toward the forklift vehicle so that the forks can be used to lift the load.

FIGS. **40**A-**40**C illustrate configurations for a fork extension according to some embodiments. FIG. **40**A shows a configuration in which a fork extension **4005** can be remotely rotated, for example, by an operator operating a forklift vehicle. The remote rotation ability can be accomplished by a rotate mechanism **4050** having one or more pins interfacing with two slanting surfaces.

A fork **4021** of a fork assembly can include a fork beam **4021**A, such as a hollow tube. A mounting coupler **4038** can be coupled to an end of the fork beam so that the fork beam can be coupled to a mounting body or to a forklift vehicle. One or more fork lifters **4040** can be coupled to the fork beam for lifting the load. The fork lifters can include a rotate mechanism for remotely rotating blades between a non-lift position and a lift position.

Coupling to an opposite end of the fork beam is the fork extension **4005**. For example, the fork extension **4005** can be disposed within a hollow portion of the fork beam, e.g., the fork extension can slide **4076** along the fork beam. In a fully retract position, the fork extension can be mostly stored in the fork beam. In a fully extended position, the fork extension can extend a length of the fork beam to be almost double the length of the fork beam.

A locking mechanism **4035** can be included to secure the fork extension to the fork beam, such as to place the fork extension at a particular extended position or to prevent the fork extension from slipping away from the fork beam. For example, the locking mechanism **4035** can include multiple spaced holes along the length of the fork beam. The locking mechanism **4035** can include a pin at the fork extension, such as a pin biased to be protruded from the fork extension by a spring. The pin is configured to mate with any of the multiple spaced holes, so that the pin can come out of any hole and secure the fork extension to the fork beam. Alternatively, or additionally, the fork beam can have a guard at the extended end, and the fork extension can be a guard plate at an inner end, e.g., the end in the fork beam. The guard can be mated with the guard plate, to prevent the fork extension from moving out of the fork beam.

At the outer end, e.g., the exposed end, of the fork extension, there is a blade **4071**, which can be configured for pulling on a load. For example, the blade **4071** can be at a rest position **4072**, which can be pointing not-toward from the load, such as away from the load or parallel to the load, e.g., either pointing upward or downward as shown. The blade **4071** can be at a hook position **4073**, which can be pointing toward the load, such as parallel to the load as shown. For example, in the hook position, the left blade, e.g., the blade from the fork extension on the left fork beam as view from the operator sitting on the forklift vehicle, points to the right toward the load, and the right blade points to the left, also toward the load. With the blade in hook position, the fork extension can be able to pull the load when the forklift vehicle moves backward.

In some embodiments, the blade **4071** on the fork extension **4005** can be configured to be remotely or automatically rotate between a rest position **4072**, e.g., a non-pullable position **4072** in which the blade is not configured for pulling on a load, to a hook position **4073**, e.g., a pullable position **4073** in which the blade is configured for pulling on a load. A rotate mechanism **4050** can be coupled to the blade **4071** so that the blade **4071** can rotate by an operator operating the fork assembly having the forks **4021**, such as pushing the fork assembly to contact a surface, and to retract the fork assembly from the surface.

FIG. **40**B shows another configuration of a fork extension **4005**A in which a blade **4071**A is fixed coupled to the fork extension. For the fixed blade configuration, the two forks on the fork assembly can be open wide, e.g., the distance between the two forks can be so that distance between the tips of the blades is larger than the width of the load. In this configuration, the fork assembly can move forward so that the load is disposed between the two fork extensions. The forks can then narrow, e.g., the two forks move toward each other until the blades can hook on the load.

Alternatively, the fork assembly can be lifted up above the load so that the blades are clear from the load. The fork assembly can move forward until the blades pass the end of the load. The fork assembly then can lower, until the blades can hook on the load.

FIG. **40**C shows another configuration of a fork extension **4005**B in which a blade **4071**B is fixed coupled to the fork extension with the fork extension manually rotatable in the fork beam. Alternatively, the blade can be manually rotatably coupled to the fork extension, with the fork extension not rotatable in the fork beam. In these configurations, an operator can manually rotate the blades to a pullable position from the two fork extensions after the fork extensions surround the load. Alternatively, the fork extension having a manually rotatable blade can be operated as a fork extension having a fixed blade, by rotating the blade into the pullable position.

FIGS. **41**A-**41**C illustrate a configuration of a fork extension having a rotate mechanism according to some embodiments. The rotate mechanism can be a remote rotate mechanism, e.g., rotatable by an operator operating the forklift vehicle. In some embodiments, the remote rotate mechanism can be considered as an automatic rotate mechanism, sine the rotate mechanism can automatically rotate a blade without an operator contacting the blade.

FIG. **41**A shows a side view of a fork extension **4105** coupled to a fork beam **4121**A. The fork extension **4105** can include a blade **4171** coupled to the fork extension through a rotate mechanism **4150**. The fork extension is coupled to the fork beam by sliding within the hollow portion of the fork beam. Rollers **4108** can be used for ease of sliding, for example, a roller can be disposed at the extreme inner end of the fork extension, and another roller can be disposed at the opening of the fork beam.

An extension limit **4178** can be used to prevent the fork extension from dropping out of the fork beam, e.g., preventing the fork extension from extending too far from the fork beam. The extension limit **4178** can include a guard plate at the extreme inner end of the fork extension and a guard at the opening of the fork beam. The guard can have an opening for the fork extension to pass through, but not the guard plate at the end of the fork extension.

A locking mechanism **4135** and **4135*** can be used to secure the fork extension at a desire extended length. The locking mechanism **4135** can include one or more holes on the fork beam. The locking mechanism **4135*** can include a pin biased by a spring on the fork extension. The pin can be configured to mate with the holes on the fork beam, such as a diameter of the pin is slightly smaller than the diameter of the holes. When the fork extension is extended, the locking mechanism **4135** can secure the fork extension at discrete locations, by the pin protruding into an appropriate hole.

FIG. **41**B shows an enlarged view of a rotate mechanism **4150**. The rotate mechanism **4150** can include first and second slanting elements **4151** and **4155**, with each slanting element having one or more slanting surfaces. A rod **4160** can be disposed within the slanting elements, with one or more pins **4161** disposed between the first and second slanting elements. The pins are configured to interface with the slanting surfaces on the slanting elements for rotating the rod **4160**. An actuator **4162**, such as a spring, can be used to bias the rod against the fork beam. For example, the spring can be used to bias the rod to an extended position, e.g., so that the pins contact the slanting surfaces on the second slanting element. A blade **4171** is coupled to the rod, such as fixed coupled.

In operation, the fork extension can move in a direction from the fork beam toward the blade until hitting a surface. After contacting the surface, the fork extension can move a little further, so that the blade and the rod are pushed toward the fork extension. The pins then contact the first slanting element and the rod rotates a first angle when the pins slide along the slanting surface of the first slanting element.

The fork extension can then move in an opposite direction, e.g., in the direction from the blade toward the fork extension. The spring **4162** can push the blade and the rod away from the fork extension, causing the pins to contact the slanting surface of the second slanting element. Alternatively, the blade can contact the load and caused the rod to move from the first slanting element to the second slanting element. The rod then rotates a second angle when the pins slide along the slanting surface of the second slanting element. The combination of the first and second angle can toggle **4167**B the blade between a rest position, e.g., a second position outside a load **4145**, and a pull position, e.g., a first position facing the load **4144**, as shown in FIG. **41**C.

FIGS. **42**A-**42**C illustrate configurations for a fork extension according to some embodiments. FIG. **42**A shows a fork extension with a rotate mechanism. Operation **4200** forms a fork having a fork extension for extending a length of the fork. The fork extension is configured to be slidable along the length of the fork. The fork extension optionally has a limiter for preventing the fork extension from sliding out of the fork. The fork extension optionally has rollers for ease of sliding. The fork extension optionally has a locking mechanism for locking to discrete extension positions along the fork length. The fork extension has a rotate mechanism coupled to the fork extension and a blade coupled to the rotate mechanism. The rotate mechanism is configured to rotate the blade between facing the load (sideway toward the load) and outside the load (downward or upward).

FIG. **42**B shows a fork extension with a fixed blade. Operation **4220** forms a fork having a fork extension for extending a length of the fork. The fork extension has a fixed blade at an end facing the load (sideway toward the load).

FIG. **42**C shows a fork extension with a manual rotate mechanism. Operation **4240** forms a fork having a fork extension for extending a length of the fork. The fork extension has a fixed blade coupled to a manually rotate mechanism configured to rotate the blade between facing the load (sideway toward the load) and outside the load (downward or upward).

Fork extension for pull load

In some embodiments, the fork assembly having fork extensions is configured for pulling a load closer to the forklift vehicle so that the forks can lift and transfer the load. The load pulling is performed by the fork extensions, for example, with the blades on the fork extensions rotated to the pullable position. The rotation of the blades can be performed remotely by an operator running the forklift vehicle.

FIGS. **43**A-**43**D illustrate a process for pulling a load according to some embodiments. In FIG. **43**A, a forklift vehicle **4300** can have a fork assembly **4320**, such as by attaching the fork assembly **4320** to the forklift vehicle, for example, to a carriage of the forklift vehicle so that the forklift vehicle can operate the fork assembly by an operator sitting at a console of the forklift vehicle. The fork assembly **4320** can include fork extensions **4305** coupled to the fork beams of the fork assembly. The fork extensions are extended, for example, by a distance to reach an end of the load **4311**.

The fork extensions can include rotation mechanisms for remote rotating blades of the fork extensions. The blades are positioned in non-pullable or rest position **4372**, e.g., in a position to be outside the area between the forks, such as parallel to the forks. If the blades are positioned in pullable or hook position **4373**, e.g., pointing toward the area between the forks or having any portion of the blades to be contacted by a load when pulling, an operator can operate the fork assembly, such as moving the fork assembly forward and backward, to rotate the blades to the non-pullable position.

In FIG. **43**B, the forklift vehicle moves toward the load to place the load between the fork extensions of the fork assembly. The operator of the forklift vehicle then can move the fork assembly forward in a first movement **4354** so that the blades contact a surface to provide a backward force on the blades. The force on the blades activates the rotate mechanism, such as to drive a pin backward to contact a first slanting surface, which can rotate the blades a first rotate angle **4351***, so that the blades rotate from the position **4372** outside the load to a position partially toward the load.

In FIG. **43**C, the operator of the forklift vehicle then can move the fork assembly backward in a second movement **4358** so that the blades contact the load to provide a forward force on the blades. Alternatively, optional springs on the rotate mechanisms can exert a forward force on the blades. The force on the blades activates the rotate mechanism, such as to drive the pin forward to contact a second slanting surface, which can rotate the blades a second rotate angle **4355***, so that the blades rotate from the position partially toward the load to a position **4373** for pulling the load.

In FIG. **43**D, the operator of the forklift vehicle then can continue to move the fork assembly backward **4374** to pull the load backward using the blades contacting the load. The forklift vehicle stops pulling when the load is pulled to a desired location, such as a location that the load can be accessible by the fork assembly.

Fork extension retract after pull load

FIGS. **44**A-**44**C illustrate a process for retracting the fork extensions according to some embodiments. In FIG. **44**A, after finish pulling a load **4411** to a desired location, the forklift vehicle **4400** can move forward passing the load in a first movement **4454** so that the blades contact a surface to provide a backward force on the blades. The force on the blades activates the rotate mechanism, such as to drive a pin backward to contact a first slanting surface, which can rotate the blades a first rotate angle **4451***, so that the blades rotate from the pullable position, e.g., the position toward the load, to a position partially toward the load.

In FIG. **44**B, the operator of the forklift vehicle then can move the fork assembly backward in a second movement **4458** so that the springs on the rotate mechanisms can exert a forward force on the blades. The force on the blades activates the rotate mechanism, such as to drive the pin forward to contact a second slanting surface, which can rotate the blades a second rotate angle **4455***, so that the blades rotate from the position partially toward the load to a non-pullable position.

In FIG. **44**C, the fork extensions can be retracted, for example, by the operator of the forklift vehicle.

Operation of fork extension

FIGS. **45**A-**45**B illustrate operations of the fork extensions according to some embodiments. FIG. **45**A shows a process for pulling a load using the fork extensions. Operation **4500** extends a fork extension out of a fork of the fork assembly. Operation **4510** adjusts a blade of the fork extension to be outside of a load (downward, upward, or outward from the load). Operation **4520** moves the forklift to position the load to be between 2 fork extensions of the fork assembly. Operation **4530** moves the fork assembly forward to contact a surface to exert a force toward the fork extension on the blade for rotating the blade a first angle toward facing the load. Operation **4540** moves the fork assembly backward to exert a force away from the fork extension on the blade (by hooking on the load or by a bias spring) for rotating the blade a second angle to be facing the load. Operation **4550** continues moving the fork assembly backward to pull the load toward the forklift.

FIG. **45**B shows a process for return the fork extensions to non pullable positions. Operation **4560** moves the fork assembly forward to contact a surface to exert a force toward the fork extension on the blade for rotating the blade a first angle toward outside the load. Operation **4570** moves the fork assembly backward to exert a force away from the fork extension on the blade (by hooking on the load or by a bias spring) for rotating the blade a second angle to be outside the load. Operation **4580** continues moving the fork assembly backward to move the fork assembly away from the load. The fork extensions can be retracted back into the fork beams of the fork assembly.

FIGS. **46**A-**46**D illustrate an operation of a fork extension having fixed or manually rotate blade according to some embodiments. In FIG. **46**A, a forklift vehicle **4600** can have a fork assembly **4620**, such as by attaching the fork assembly **4620** to the forklift vehicle, for example, to a carriage of the forklift vehicle so that the forklift vehicle can operate the fork assembly by an operator sitting at a console of the forklift vehicle. The fork assembly **4620** can include fork extensions **4605** coupled to the fork beams of the fork assembly. The fork extensions are extended, for example, by a distance to reach an end of the load **4611**.

The fork extensions can include fixed blades **4671*** pointing toward the load, or manually rotatable blades rotated toward the load, or remotely rotatable blades rotated toward the load. The blades are positioned in pullable or hook position, e.g., pointing toward the area between the forks or having any portion of the blades to be contacted by a load when pulling.

The fork assembly is lifted up, for example, by the operator operating the forklift vehicle, to be above the load.

In FIG. **46**B, the forklift vehicle moves toward the load so that the blades pass the load, e.g., the load is positioned under the fork extensions and the blades. Thus, the blades, such as the fixed blades, are positioned around the load **4675**.

In FIG. **46**C, the operator of the forklift vehicle then can move the fork assembly downward so that the fork extensions are lower than the top surface of the load. In some embodiments, the fork extensions are lowered to be as close to a middle of the load as possible, in order to have a better balance when pulling on the load. The lowering of the fork extensions is constrained by the fork lifter blades contacting the ground, thus, the fork extensions can be lowered until the blades of the fork lifters almost touch the ground.

In FIG. **46**D, the operator of the forklift vehicle then can move the fork assembly backward to pull **4674** on the load.

FIGS. **47**A-**47**B illustrate flow charts for an operation of the fork extensions according to some embodiments. FIG. **47**A shows a process for the fork extensions to pull on a load. Operation **4700** extends a fork extension out of a fork of the fork assembly. Operation **4710** optionally adjusts a blade of the fork extension to be outside of a load (downward, upward, or outward from the load). Operation **4720** moves the forklift to position the load to be under and between 2 fork extensions of the fork assembly. Operation **4730** lowers the fork assembly downward for the blade to face the load. Operation **4740** moves the fork assembly backward to pull the load toward the forklift.

FIG. **47**B shows a process for the fork extensions to move away from a load. Operation **4760** moves the fork assembly forward and upward to clear a fork extension extended from a fork of a fork assembly. Operation **4770** moves the fork assembly backward to move the fork assembly away from the load.

Unload **2** loads from container

In some embodiments, the fork assembly having fork extensions can be used for unloading loads from a container. The loads can be stored in a container in two rows, e.g., one or more inner loads arranged in an inner area of the container, and one or more outer loads arranged in an outer area of the container. The container can have a door to provide access to the loads, with the door positioned at the outermost portion of the outer area.

In some embodiments, the fork assembly can be configured to lift and transfer the outer loads using the fork lifters coupled to the fork beams of the fork assembly. The fork assembly then can have the fork extensions extended, which can be used to pull the inner loads to the outer area of the container. The fork assembly then can be configured to lift and transfer the inner loads positioned at the outer area.

FIGS. **48**A-**48**F illustrate a process for unloading outer and inner loads from a container according to some embodiments. FIG. **48**A shows a container **4810** with a door **4880** at one side and walls at other sides. The container can be configured to store loads at multiple rows. For example, as shown, there are two rows of loads, such as a load **4811**B placed at an inner area (relative to the door **4880**) or a far-door area of the container and a load **4811**AB placed at an outer area (relative to the door **4880**) or a near-door area of the container. The loads **4811**A and **4811**B can be arranged with the long direction of the load running along the long direction of the container. Further, the loads can have support beams and straps along the short direction. Thus, the loads can be picked up from the sides, e.g., from the area facing the long direction. Further, the inner load, e.g., the load placed at the inner area, can be too far and out of reach for the fork assembly. Thus, fork extensions can be used for pulling the load toward nearer the door to be picked up.

A forklift vehicle **4800** having a forklift assembly **4820** can be prepared for unloading the loads from the container. The fork extensions on the fork assembly are retracted **4872**, with the pull blades at rest position. The fork lifters are optionally adjusted for picking the loads.

In FIG. **48**B, the forklift vehicle moves to the container door, and then extending the fork assembly surrounding the outer load **4811**A for unloading the outer load. The unloading process can include toggling the blades on the fork lifters for rotating to the lift position **4844**, and then lifting up **4822** the fork assembly for lifting the load **4811**A. The forklift vehicle then moves backward to clear the loads from the container, and then moves to transfer the load to a destination.

In FIG. **48**C, after dropping the load **4811**A at the destination, the forklift vehicle moves back to the container. The fork extensions **4805** on the fork assembly are extended, with the pull blades still at rest position **4872**.

In FIG. **48**D, the forklift vehicle moves to the container door, and then extending the fork assembly into the container so that the fork extensions surround the inner load **4811**B for pulling the inner load to be nearer the container door. The pulling process can include toggling the blades on the fork extensions for rotating to the pull or hook position **4873**. The toggling process can including moving the fork assembly forward until the blades of the fork extensions push on the inner wall of the container, followed by moving the fork assembly backward.

In FIG. **48**E, the forklift vehicle then moves backward to pull the load **4811**B from the inner area to the outer area nearer the door of the container. Since the blades of the fork extensions are in pullable position or hook position **4873**, moving the fork extensions backward also functions to pull the load **4811**B backward.

The fork assembly can then move forward, until the blades of the fork extensions hitting the inner wall of the container, and then moves backward. The forward and backward movements activate the rotate mechanism to rotate the blades of the fork extensions to the rest position **4872**.

In FIG. **48**F, the fork extensions **4805** on the fork assembly are retracted, with the pull blades at rest position **4872**. The forklift vehicle then moves to the container door, and then extending the fork assembly surrounding the inner load **4811**B, now disposed at the outer area, for unloading the inner load.

FIGS. **49**A-**49**E illustrate a process for loading loads to outer and inner areas of a container according to some embodiments. FIG. **49**A shows a container **4910** with a door **4980** at one side and walls at other sides. The container can be configured to store loads at multiple rows.

A forklift vehicle **4900** having a forklift assembly **4920** can be prepared for loading the loads to the container. The fork extensions on the fork assembly are retracted **4972**, with the pull blades at rest position. The fork lifters are optionally adjusted for picking the loads.

In FIG. **49**B, the forklift vehicle moves to a load **4911**A and picks up the load. The picking process can include toggling the blades on the fork lifters for rotating to the lift position **4944**, and then lifting up the fork assembly for lifting the load **4911**A. The forklift vehicle then moves to the container door, and then extending the fork assembly carrying a load **4911**A into the container for loading the load **4911**A to an outer area of the container, e.g., to place the load at the outer area. The loading process can include lowering **4923** the load to the floor of the container, and then toggling the blades on the fork lifters for rotating to the non-lift position **4945**. The forklift vehicle then moves backward to clear the fork assembly from the load **4911**A.

In FIG. **49**C-**1**, the blades of the fork extensions (still in the retract position) are toggled to the pullable position, e.g., to the position toward the load. The toggling process can including moving the fork assembly forward until the blades of the fork extensions push on a surface, followed by moving the fork assembly backward. For example, the fork assembly can move sideway, such as to the left, so that a right fork of the fork assembly can contact the load **4911**A. The fork assembly then moves forward until the right blade of the right fork extension hitting the load, which rotates the right blade a first angle. After the fork assembly moves backward, the right blade rotates a second angle. The combination of the first and second angles toggles the right blade from a rest position to a pullable position. The process is repeated for the left blade of the left fork extension. For example, the fork assembly can move sideway to the right, so that a left fork of the fork assembly can contact the load **4911**A. The fork assembly then moves forward until the left blade of the left fork extension hitting the load, which rotates the left blade a first angle. After the fork assembly moves backward, the left blade rotates a second angle. The combination of the first and second angles toggles the left blade from a rest position to a pullable position.

The forklift vehicle then moves forward, using the blades in pullable position to push **4974*** on the load **4911**A to an inner area of the container.

FIG. **49C-2** shows an alternate process for moving the load **4911**A from the outer area to the inner area of the container. The fork extensions are extended, with the blades in pullable position around the load. By moving the forklift vehicle forward, the fork extensions can guide the load to the inner area.

In FIG. **49**D, the forklift assembly **4920** is prepared for loading a new load **4911**B to the container. The fork extensions on the fork assembly are retracted **4972**, with the pull blades at rest position. The fork lifters are optionally adjusted for picking the loads.

The forklift vehicle moves to a load **4911**B and picks up the load. The picking process can include toggling the blades on the fork lifters for rotating to the lift position **4944**, and then lifting up the fork assembly for lifting the load **4911**B. The forklift vehicle then moves to the container door, and then extending the fork assembly carrying a load **4911**B into the container for loading the load **4911**B to an outer area of the container, e.g., to place the load at the outer area. The loading process can include lowering **4923** the load to the floor of the container, and then toggling the blades on the fork lifters for rotating to the non-lift position (FIG. **49**E).

Operation unload/load 2 loads from/to container

FIGS. **50**A-**50**B illustrate flow charts for unloading multiple loads from a container and for loading multiple loads to a container. FIG. **50**A shows a process for unloading two loads at inner and outer positions in a container. Operation **5000** configures a fork assembly on a forklift to unload an outer load in a container. Operation **5001** unloads the outer load to a first destination. Operation **5002** extends a fork extension from a fork of the fork assembly. Operation **5003** pulls an inner load in the container to an outer position. Operation **5004** retracts the fork extension. Operation **5005** configures the fork assembly to unload the inner load at the outer position. Operation **5006** unloads the inner load to a second destination.

FIG. **50**A shows a process for loading two loads at inner and outer positions in a container. Operation **5010** configures a fork assembly on a forklift to unload a first load to a container. Operation **5011** unloads the first load to an outer position in a container. Operation **5012** extends a fork extension from a fork of the fork assembly. Operation **5013** pushes the first load to an inner position in the container. Operation **5014** retracts the fork extension. Operation **5015** configures the fork assembly to unload a second load to the container. Operation **5016** unloads the second load to an outer position in the container.

In some embodiments, the element labeling can be similar for the last two digits, e.g., two elements having same last two digits in their labels are similar. For example, a fork assembly can be labeled as X20, such as 220, 1520, 1620, or 4920.

What is claimed is:

1. A fork assembly for attaching to a forklift vehicle for lifting a load, the fork assembly comprising

one or more forks configured to be coupled to the forklift vehicle,

wherein a fork of the one or more forks comprises a fork beam configured to be extended away from the forklift vehicle,

one or more lifter assemblies,

wherein at least a lifter assembly of the one or more lifter assemblies is configured to be coupled to the fork of the one or more forks,

one or more rotate mechanisms,

wherein at least a rotate mechanism of the one or more rotate mechanisms is configured to be coupled between the fork beam of the fork and a blade of the at least a lifter assembly,

wherein the at least a rotate mechanism is configured to rotate the blade relative to the fork beam by moving the fork assembly,

wherein the at least a rotate mechanism is configured to rotate the blade relative to the fork beam between a first position and a second position,

wherein in the first position, the blade is disposed under the load,

wherein in the second position, the blade is disposed outside the load.

2. A fork assembly as in claim **1**,

wherein the one or more forks are coupled to a mounting body with the mounting body comprising multiple attachments for coupling to a movable component of the forklift vehicle,

wherein the one or more forks are coupled to a mounting body through a linear guide and an actuator configured to adjusting a distance between the one or more forks.

3. A fork assembly as in claim **1**,

wherein the blade comprises a hook configured to mate either with a second hook of a second blade of a second lifter assembly, or with a second hook of a body of a second lifter assembly.

4. A fork assembly as in claim **1**,

wherein the at least a lifter assembly comprises a sliding mechanism for sliding the blade relative to a body of the at least a lifter assembly,

wherein the at least a lifter assembly comprises a cable disposed on the blade,

wherein the cable comprises a hook configured to mate with a second hook of a second cable of a second lifter assembly.

5. A fork assembly as in claim **1**,

wherein the at least a lifter assembly is configured to be coupled to the fork beam at discrete or continuous locations along a length of the fork beam,

wherein the at least a lifter assembly is configured to be coupled to the fork beam at discrete or continuous locations along a length of the at least a lifter assembly.

6. A fork assembly as in claim **1**, wherein one of

the at least a rotate mechanism is coupled between a body of the at least a lifter assembly and the blade for rotating the blade relative to the at least a lifter assembly, the at least a rotate mechanism is coupled between the fork beam and a body comprising the blade of the at least a lifter assembly for rotating the blade relative to the fork beam, or

the at least a rotate mechanism is coupled between a first portion coupled to the fork beam of the at least a lifter assembly and a second portion coupled to the blade of the at least a lifter assembly for rotating the second portion comprising the blade relative to the first portion.

7. A fork assembly as in claim **1**,

wherein the at least a rotate mechanism is configured to rotate the blade relative to the fork beam by moving the fork assembly downward and then upward.

8. A fork assembly as in claim **1**,

wherein the at least a rotate mechanism comprises a first element comprising two slanting surfaces and a second element comprising one or more pins configured to interface with the two slanting surfaces,

wherein when the one or more pins interface with each slanting surface of the two slanting surfaces, the second element rotates an angle relative to the first element.

9. A fork assembly as in claim **8**, wherein one of

the first element is directly coupled to the fork beam or indirectly coupled to the fork beam through at least a first portion of a body of the at least a lifter assembly, and

the second element is directly coupled to the first blade or indirectly coupled to the first blade through at least a second portion of a body of the at least a lifter assembly;

or

the second element is directly coupled to the fork beam or indirectly coupled to the fork beam through at least a first portion of a body of the at least a lifter assembly, and

the first element is directly coupled to the first blade or indirectly coupled to the first blade through at least a second portion of a body of the at least a lifter assembly.

10. A fork assembly as in claim **8**, wherein one of

the first element is at least partially disposed inside the second element so that the one or more pins protrude inward for contacting the two slanting surfaces; or

the second element is at least partially disposed inside the first element so that the one or more pins protrude outward for contacting the two slanting surfaces.

11. A fork assembly as in claim **8**,

wherein the two slanting surfaces are configured to be facing toward each other or facing away from each other to rotate the first blade in a same direction when rotating from the first position to the second position and when rotating from the second position to the first position.

12. A fork assembly as in claim **8**,

wherein the two slanting surfaces are configured to be nested to rotate the first blade in two opposite directions when rotating from the first position to the second position and when rotating from the second position to the first position.

13. A fork assembly as in claim **1**, further comprising

one or more fork extensions,

wherein at least a fork extension of the one or more fork extensions is configured to be slidable along the fork beam of the fork for extending a length of the fork beam,

wherein the at least a fork extension comprises a second blade coupled to an end of the at least a fork extension.

14. A fork assembly as in claim **1**, further comprising

one or more fork extensions,

wherein at least a fork extension of the one or more fork extensions is configured to be slidable along the fork beam of the fork for extending a length of the fork beam,

wherein the at least a fork extension comprises a second blade coupled to an end of the at least a fork extension,

wherein the at least a fork extension comprises a second rotate mechanism coupled between an end of the fork beam and the second blade.

wherein the at least a second rotate mechanism is configured to rotate the second blade around an axis of rotation parallel to the at least a fork extension by moving the fork assembly in forward and backward directions,

wherein the at least a second rotate mechanism is configured to rotate the second blade around the axis of rotation between a third position and a fourth position,

wherein in the third position, the second blade points toward the load,

wherein in the fourth position, the second blade points away from the load or parallel to the load.

15. A fork assembly as in claim **1**, further comprising

one or more fork extensions,

wherein at least a fork extension of the one or more fork extensions is configured to be slidable along the fork beam of the fork for extending a length of the fork beam,

wherein the at least a fork extension comprises a second blade coupled to an end of the at least a fork extension,

wherein the at least a fork extension comprises a second rotate mechanism coupled between an end of the fork beam and the second blade.

wherein the at least a second rotate mechanism is configured to rotate the second blade around an axis of rotation parallel to the at least a fork extension by manually turning the second blade around the axis of rotation,

wherein the at least a second rotate mechanism is configured to rotate the second blade around the axis of rotation between a third position and a fourth position,

wherein in the third position, the second blade points toward the load,

wherein in the fourth position, the second blade points away from the load or parallel to the load.

16. A fork assembly as in claim **1**, further comprising

one or more fork extensions,

wherein at least a fork extension of the one or more fork extensions is configured to be slidable along the fork beam of the fork for extending a length of the fork beam,

wherein the at least a fork extension comprises a second blade fixedly coupled to an end of the at least a fork extension,

wherein the second blade points toward the load.

17. A fork assembly for attaching to a forklift vehicle for lifting a load, the fork assembly comprising

one or more forks configured to be coupled to the forklift vehicle,

wherein a fork of the one or more forks comprises a fork beam configured to be extended away from the forklift vehicle,

one or more lifter assemblies,

wherein at least a lifter assembly of the one or more lifter assemblies is configured to be coupled to the fork of the one or more forks,

one or more first rotate mechanisms,

wherein at least a first rotate mechanism of the one or more first rotate mechanisms is configured to be coupled between the fork beam of the fork and a first blade of the at least a lifter assembly,

wherein the at least a first rotate mechanism is configured to rotate the first blade relative to the fork beam by moving the fork assembly in upward and downward directions,

wherein the at least a first rotate mechanism is configured to rotate the first blade relative to the fork beam between a first position and a second position,

wherein in the first position, the first blade is disposed under the load,

wherein in the second position, the first blade is disposed outside the load,

one or more fork extensions,

wherein at least a fork extension of the one or more fork extensions is configured to be slidable along the fork beam of the fork for extending a length of the fork beam,

wherein the at least a fork extension comprises a second blade coupled to an end of the at least a fork extension,

wherein the at least a fork extension comprises a second rotate mechanism coupled between an end of the fork beam and the second blade.

wherein the at least a second rotate mechanism is configured to rotate the second blade around an axis of rotation parallel to the at least a fork extension by moving the fork assembly in forward and backward directions,

wherein the at least a second rotate mechanism is configured to rotate the second blade around the axis of rotation between a third position and a fourth position,

wherein in the third position, the second blade points toward the load,

wherein in the fourth position, the second blade points away from the load or parallel to the load.

18. A fork assembly as in claim **17**,

wherein the first blade is configured to lift the load when in the first position, activated by the fork assembly moving downward and then upward.

19. A fork assembly as in claim **17**,

wherein the first blade is configured to pull the load when in the third position, activated by the fork assembly moving forward and then backward.

20. A fork assembly for attaching to a forklift vehicle for lifting a load, the fork assembly comprising

one or more forks configured to be coupled to the forklift vehicle,

wherein a fork of the one or more forks comprises a fork beam configured to be extended away from the forklift vehicle,

wherein the fork beam comprises one or more first cable attachments for attaching first cables configured to support the load for lifting,

one or more fork extensions,

wherein at least a fork extension of the one or more fork extensions is configured to be slidable along the fork beam of the fork for extending a length of the fork beam,

wherein the at least a fork extension comprises a second cable attachment coupled to an end of the fork extension,

wherein the second attachment is configured for attaching a second cable around the load configured to for pulling the load.

* * * * *