(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 005 360**
**A1**

# (12) EUROPEAN PATENT APPLICATION

(21) Application number: **79300741.0**

(22) Date of filing: **01.05.79**

(51) Int. Cl.²: **B 66 F 9/12**, B 60 P 1/02, B 60 K 7/00

(30) Priority: **10.05.78 GB 1865878**

(43) Date of publication of application: **14.11.79 Bulletin 79/23**

(84) Designated Contracting States: **AT BE CH DE FR GB IT LU NL SE**

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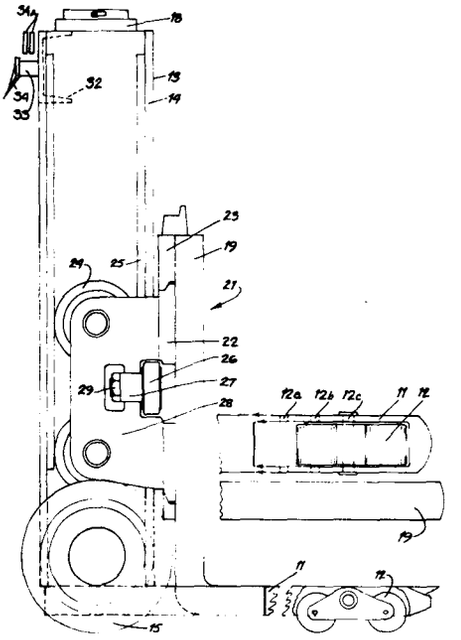
## (54) Improvements in mechanical handling equipment.

(57) Improvements in mechanical handling equipment comprising a mobile auxiliary lifting and lowering device intended for use with a power-driven truck, the device comprising a wheeled frame (11, 13) supporting generally horizontally-extending tines (19); means allowing the device to be selectively coupled and uncoupled respectively to and from the lifting carriage of the truck; first power-driven means (35) to raise and lower the tines of the device relative to the frame; and second power-driven means (15A) to drive each wheel (15) of a transversely-spaced-apart pair of the device's wheels independently in either direction of rotation; both said power-driven means (35, 15A) being adapted to be controlled from the truck. The last mentioned power-driven means (15A) may comprise two motor-in-wheel units (15A), one in each driven wheel (15), and each of the motor-in-wheel units (15A) may swivel about a respective steering axis.



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# "IMPROVEMENTS IN MECHANICAL HANDLING EQUIPMENT"

## FIELD OF THE INVENTION

The invention relates to mechanical handling equipment, and is particularly concerned with mobile auxiliary lifting and lowering devices intended for use with a power-driven lift truck.

## REVIEW OF THE PRIOR ART

There are already known several forms of mobile steerable auxiliary lifting and lowering devices, intended for use with power-driven parent lift trucks and comprising: a wheeled frame supporting generally horizontally extending tines; means allowing the device to be selectively coupled to and uncoupled from a lifting carriage of the parent truck; first power-driven means, adapted to be controlled from the parent truck, to selectively raise and lower the tines of the device relative to its wheels; and second power-driven means, also adapted to be controlled from the parent truck, to drive the uncoupled device on its wheels selectively away from and back towards the truck.

In use, the parent truck picks up the device and carries it as far as the open end of a container which is to be either loaded or unloaded. The device is then raised by the truck until it clears the floor of the container, the truck drives forward and deposits the device on the container floor, and the device is then coupled from the truck, driven forward into the container, manouevred so as to pick up, rearrange or deposit goods

within the container, and is finally brought back to the parent truck, picked up by it and carried away to a further site.

Throughout the whole operation, the device is controlled from the parent truck.

Examples of such devices are shown in U.K. patent specifications Nos. 1,440,062 (Weldall), 1,429,785 (Miller) and 1,453,387 (Miller). Also known to the applicants, although less relevant to the present invention, are U.S. patent specifications Nos. 2,944,689 (Arnot) and 2,833,435 (Levy).

The advantages given by these known forms of steerable auxiliary mobile lifting and lowering device are well known, and are fully described in the three patents first referred to above. Each of the three known patented devices, however, exhibits certain drawbacks. These drawbacks can best be illustrated by considering the devices described in the two Miller specifications 1,429,785 and 1,453,387, which have been commercially the most successful of such devices.

The device illustrated particularly in Figures 5 to 9 of the earlier specification, 1,429,785, is clearly a prototype. It has, as far as is known, never been put into commercial production. As shown in Figure 5, it is clearly inherently unstable and lacks the rigidity needed for repeated operation under heavy conditions of load. The later Miller specification 1,453,387 describes and illustrates a device which has been developed from the prototype of specification 1,429,785, and which is in all essential respects identical to the commercial device now available. In this later device, one sees for example stabilising wheels 33 and an extensively detailed lifting, lowering and steering mechanism as well as a properly designed box frame and coupling means to join the device to the lifting carriage of its parent truck.

All three of these known devices (even including

the later Miller device just discussed) have drawbacks which are a direct and inherent result of their basic principles of operation. All three of them are restricted-lift devices in which, as the lifting tines are raised, the auxiliary wheels beneath the projecting ends of the tines are automatically lowered. This not only restricts the amount by which the tines can be lifted: it also means that the entire weight of the device has to be lifted every time the tines are raised, because the tines do not move relative to the main frame of the device. This clearly puts considerable strain on the linkages which connect the auxiliary wheels to the lifting ram. It also means that the payload which the device can lift is restricted because of the need to lift virtually the entire weight of the device each time the tines are raised. Because the frame is lifted with the tines and the payload, excessive strain is placed on the frame and this can cause the frame to warp with repeated use. Because individual linkages to the auxiliary wheel are needed, they have to be individually adjusted and they, like the frame, may bend and twist with use.

A further series of drawbacks arises from the use of a single power-driven steerable wheel in the two Miller designs. As the later Miller patent 1,453,387 clearly shows, separate stabilising wheels are needed on either side of this central steerable power-driven wheel. Even worse, the steering angle is severely restricted because of the amount of machinery surrounding the central wheel. Because the stabilising wheels are relatively small, they can only resist a limited load on them; they need a separate linkage to automatically raise and lower them, bringing with it the drawbacks discussed above in relation to the main auxiliary wheel lowering linkages; and because they cannot be steered they will

tend to drag or scuff sideways every time the device is steered through its main power-driven wheel.

Finally, and perhaps most seriously from a practical commercial point of view, there is no way in which the Miller device can have its overall width varied, or the length and spacing of its tines altered, without special components having to be built in each case because of the need to incorporate the various linkages used. It is very often desirable to vary the overall width of the main frame (to increase the load supporting capacity) or to adjust the length and spacing of the lifting tines (to cater for special pallets or restricted manouevring conditions). The inability to do this, combined with the restricted lift available from the device, makes the known devices singularly unadaptable to different working conditions.

## SUMMARY OF THE INVENTION

The invention takes as its starting point the state of the art defined by the known devices discussed above. Having analysed the drawbacks of those known devices in the manner outlined above, the invention attempts to provide a steerable mobile auxiliary lifting and lowering device which will reduce those drawbacks significantly whilst still incorporating all the advantages given by devices of this general type.

According to the invention, a mobile steerable auxiliary lifting and lowering device, intended for use with a power-driven lift truck and having the known general features outlined at the beginning of this specification, is characterised by a novel and inventive combination of three essential features: firstly, one end of the frame of the device is supported on a pair of wheels which are drivable independently of one another and in either direction of rotation; secondly, the said driven wheels are widely transversely spaced apart from

one another across said one end of the device; and thirdly the power-driven lifting tines of the device can be raised or lowered, in relation to the frame, without raising or lowering the frame in relation to the wheels.

Many advantages flow from such a construction. The ability to drive each of the power driven main wheels independently in either direction enables the device to be steered with precision, a much tighter turning circle can be achieved, and there is no theoretical limit to the angle of turning. Because two widely spaced apart main wheels are provided, rather than a single steerable central wheel, no additional stabilising wheels are needed. Since most of the load is sustained by these main drivable wheels, which can be made relatively large and of heavy duty type, the load carrying capacity is far greater than that of a single central main wheel with small stabilising outboard wheels. The main frame of the device can be a simple rectangular frame, whereas with a single central wheel the horizontal portion of the main frame would have to be cranked inwardly in order to clear the necessary stabilising wheels. Because steering is available without the steerable wheels having to swivel about a steering axis, the hydraulic fluid supply lines to the power-driving motors do not have to bend and twist. Most important of all, perhaps, because the tines can be raised and lowered without raising and lowering the frame and its associated components, the payload capacity of the device is increased, the strain on the frame is reduced, the power-driven raising and lowering means is placed under less strain for a given payload, and the amount of lift is unrestricted.

According to a preferred subsidiary feature of the invention, the power-driven means to drive the device on its wheels comprises two independently power-driven

motor-in-wheel units, one in each of the two spaced apart driven wheels. This enables the spacing of the wheels to be varied entirely independently of one another, and so each power driven motor-in-wheel unit can be attached to a main frame of any desired dimension. Since there are no linkages to lower the auxiliary wheels, and no steering linkages on the driven wheels, the entire dimensions of the frame and the tine spacings can be varied within any suitable limits because the wheels can simply be added as independent units: they have the minimum of effect on the parameters within which the frame can be designed.

Thus, the spacing of the wheels, tines and frames can be varied independently without affecting one another. For example, the frame or the tines, or both, could be outboard of the wheels.

In a further development of the invention, U-section or I-section uprights are incorporated into the main frame of the device. Because the frame is not lifted when the tines are lifted, the main frame can be made extremely rigid. In addition, the flanges of the U-section or I-section uprights form ideal bearing surfaces for the necessary rotary bearings on which the tines and carriage plate of the device must run. They also lend themselves directly to incorporating renewable hard wear strips for the carriage plate bearings.

In yet another development of the invention, the frame of the device incorporates means for securing each auxiliary wheel to the frame at selectively different distances from the projecting ends of the tines. Because these auxiliary wheels incorporate no linkages to automatically raise or lower them as the tines are lowered and raised, such adjustment is readily achieved and this is another significant advantage given by the invention which would be impossible with the known constructions.

In an especially advantageous further development, the invention includes a fitment which can selectively be used to limit the effective height by which the tines can be raised, but which can also be rendered inoperative. This allows the device to operate as a lowlift pallet truck or as an ordinary full-lift fork truck. It is then no longer necessary to keep two different kinds of truck available to cover all possible types of lifting and lowering operation. By contrast, each of the known devices referred to above can only operate as a lowlift pallet truck.

If the power-driven means on the device are fluid pressure operated, and the necessary fluid supply line enters the device via a rotary union, such an arrangement lends itself ideally to a slip-ring electrical contact for the necessary electrical connections between the solenoid valves on the device and the electrical supply line to the parent truck.

It is already known to couple and uncouple these auxiliary devices to their parent trucks by the use of hooked projections which project from the back of the device and engage recesses already formed in the carriage plate of the parent truck. The invention takes this concept further, by providing each such projection of the device with a head which also functions as a hook, and by providing a number of spaces to fit removably over the projections between the head or hook and the cooperating lifting carriage recess. The operator can thus vary selectively, by relatively small and hence precise amounts, the distance by which the device projects from the lifting carriage of its parent truck when it is being carried.

In the broadest aspect of the invention, two independently driven motor-in-wheel units provide the steering effect without themselves swivelling about

a steering axis. The fluid supply line from each motor to its actuating solenoid valve can be rigid, and will thus not be subjected to any twisting or bending stresses because there is no relative movement between the motor and its valve.

If however each motor-in-wheel unit can swivel about a vertical steering axis, it is still only necessary to provide the minimum length of flexible pipe from the motor to the nearest adjacent part of the frame; the motors can be swivelled independently to give the smallest possible turning circle for the device; and, if they are swivelled in the same direction as one another, the device can proceed "crab-wise". None of these manouevres is possible with the known devices referred to above.

The invention includes within its scope a combination of a power-driven parent lift truck with a device having any or all of the features outlined above, the truck being fitted with means to control the power-driven means which raise and lower the tines of the device and which power the device's wheels.

## BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

Figures 1 to 3 show one device embodying the invention in, respectively, side elevation, end elevation and plan;

Figure 1A shows a modified part of the device; and

Figure 4 shows the device being used in combination with a power-driven lift truck.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

The device illustrated is built around a wheeled frame which is in two sections. The first section consists of two transversely spaced apart hollow box beams 11 which extend generally horizontally. The forward ends of these horizontally extending beams support freely-rotatable auxiliary rollers 12, on which the device runs when in use. The rearward ends of the horizontal beams 11 support the second section of the main frame of the device, this second section consisting of

two transversely spaced apart I-section beams 13 which extend vertically with their major flanges 14 facing outwardly. This second section 13 of the frame, in addition to housing the main drive and control components of the device, also provides the track on which the lifting carriage of the device moves vertically up and down when in use.

At the rear of the device, i.e. at the bottom of the vertically extending I-section beams 13, the main traction wheels 15 are situated. There are two of these wheels, and as Figure 2 shows they are widely spaced apart. Each wheel consists of a solid (or pneumatic) rubber-tyred rim, housing a motor-in-wheel hydraulic-actuated drive unit 15A. The motors incorporate load-absorbing roller bearings, and the motor shafts are secured to the main frame 11, 13 of the device so that the motor casings rotate with the wheels 15.

The motor of each motor-in-wheel unit 15A can be driven selectively in either direction of rotation, and operates independently of the motor in the other motor-in-wheel unit. Respective solenoid valves 16, 17 carried on the device are linked by fluid-carrying conduit (not shown) to each respective motor-in-wheel unit, and are fed from similar conduit which enters the device via a rotary union 18 (or other means) pivotally mounted at the top of the main frame 13.

The lifting tines 19 of the device are mounted on a carriage assembly 21, and there is provision to adjust the lateral spacing between the tines 19 and also to adjust the position of each tine individually on the carriage plate 22. This adjustment is achieved by castellating the top of the carriage plate 22 and by providing each tine with a hook 23 which can be engaged selectively in any of the notches provided by the castellations.

The carriage runs on relatively large-diameter roller bearings 24, each side of the carriage being supported in two such bearings. These bearings travel along the insides

of the major flanges 14 of the I-section beams 13 which rise vertically as parts of the main frame of the device. The flange faces incorporate renewable hardened steel wear strips 25, secured to the flanges 14 by countersunk screws 26, and the bearings 24 travel on these wear strips as the carriage moves up and down.

Side thrust rollers 26 are provided, and (although only one is shown) there are two such side thrust rollers on one side of the carriage acting in combination with a single third roller on the other side. Each of these three side thrust rollers 26 is removably mounted in a respective boss 27 welded to an associated one of the carriage side plates 28, and the side plates are provided with cut-outs to accommodate the mounting nut 29 of each side thrust roller.

The main bearings 24 of the carriage are secured to the inside of their respective associated carriage side plates 28 by hexagon-headed socket screws 31.

A U-section beam 32 is welded across the upper ends of the I-section frame beams 13 to brace the entire structure. The rotary union 18 previously referred to is mounted on this beam 32. Two transversely-spaced-apart projections 33 are welded to the outer face of the U-section bracing beam 32, and each projection has a downwardly depending head or hook 34 formed and welded to it. These projecting hooks allow the tines 19 to be selectively coupled and uncoupled respectively to and from the lifting carriage of a power driven lift truck, the tines of the truck first having been removed from the carriage, by engaging corresponding recesses in the truck's carriage plate.

A single hydraulic ram 35 is mounted approximately on the vertical centre-line of the device. The head end of the ram is secured via a limited-swivel joint 36 to a U-section bracket 37 welded to the main frame of the device. The rod end of the ram is similarly secured between two links 38 which project rigidly upward from the lifting

carriage 21 of the device. In this particular example, the ram is a double-acting ram, and, if desired, it can be fully extended to raise the tines 19 of the device virtually the full height of the main I-section beams 13.

The pressurized hydraulic supply to the ram 35 enters the device through the same rotary union 18 as that which supplies the solenoid valves 16, 17 controlling the drive motors of the device's main wheels 15. A third solenoid valve 39 is mounted adjacent these two valves 16, 17, the third valve controlling the extension and retraction of the hydraulic ram itself.

The device incorporates a stroke-limiting device, which can selectively be used to limit the amount by which the tines 19 can be raised from the frame 11, 13. Figures 2 and 3 show the device. One of the rigid links 38 previously referred to as projecting upwardly from the device's carriage 21 has a stop 41 pivotally secured to it. A spring-loaded ball detent (not shown) normally holds the stop 41 in the position shown in Figures 2 and 3, in which it lies alongside the rigid link 38 to which it is secured. However, the stop 41 can if desired be swung out (as shown by the arrows in Figure 3) to project at right angles to the link 38. With the stop in this position, the knurled headed end of an elongate screw 42 (shown best in Figure 2) lies directly in the path of upward movement of the stop 41 as the carriage 21 is raised. The other end of the screw is square-ended, and the screw engages a co-operating threaded bore in a boss 43 which is welded to the inside face 14 of one of the main I-beams 13 of the frame.

A nut 44 allows the knurled headed end of the screw 42 to be secured in any desired position within the limits imposed by the length of the screw. When the stop 41 hits the knurled end of the screw during its upward movement, the supply of hydraulic fluid to the ram 35 is automatically cut off or the ram is stalled. The respective knurled and

square-ended ends of the screw 42 allow the screw to be adjusted from either end, whichever happens to be more convenient at the time.

Referring for a moment to Figure 1, it will be seen that the auxiliary rollers 12 which, in use, support the front end of the device on the ground, can be pivotally secured to their associated box frame beam 11 in any one of a number of different positions 12a, 12b, 12c. The rollers 12 themselves project into their associated box beam 11, which is cut away to allow this. Because the auxiliary rollers 12 are secured to the frame beams 11 independently of the tines 19, they do not limit the amount by which the tines can be raised from the frame whilst still keeping the auxiliary rollers in contact with the ground.

Figure 4 shows the way in which the device is used. A power-driven lift truck 45 has its own lifting tines removed, and its carriage is used to pick up the device via the inter-engagement of the projections 33, 34 with recesses (not shown) which are conventionally formed in the lift truck's carriage plate 46 to accept its own tines. Two freely rotatable drums 47 are mounted on top of the roll-over cage of the truck, each drum supporting hydraulic hose 48 which emerges from the hollow centre of the drum's spindle and continues to an appropriate fluid power connection on the body of the truck. The other end of each hose passes over a guide 49 and is connected by a quick-release self-sealing valve (not shown) to the rotary union 18 on top of the frame of the device.

One of the drums 47 also carries electrical cable which is taped to the hose 48 and which again is connected to the device in order to actuate the solenoid valves 16, 17, 39. Power controls (not shown) for operating the device are provided as an attachment to fit on the truck, in a position convenient for the truck driver, and are driven from the hydraulic power circuit of the truck.

In use, the truck 45 picks up the device and carries it as far as the open end of a container 51 which is to be either loaded or unloaded. The device is then raised by the truck until it clears the floor of the container, the truck drives forward, and the device is deposited on the container floor. The control gear on the truck is then operated to drive the device forward into the container, the device's own lifting carriage 21 and tines 19 are used to pick up, re-arrange or deposit goods 52 within the container, and when the operation is finished, the device is brought back to the truck and is picked up by it and carried away to a further site.

Throughout the whole operation, the device is controlled from the parent truck and the necessary fluid and electrical power supply lines automatically unreel themselves from the drums 47 on the truck. As the device comes back towards the truck, the drum, which is spring-loaded, automatically reels in the power-supplying hose and cable 48.

Modifications can be made to the device illustrated, whilst still remaining within the scope of the invention as defined by the claims at the end of this specification. It has been mentioned that each of the motor-in-wheel units 15A could be swivelled about its own steering axis by a hydraulic torque drive 15B as shown in Figure 1A (in which an arrow indicates the swivelling movement). In another modification, illustrated in the drawings, horseshoe-shaped spacers 34A are provided to fit over the projection 33. In use, several such spacers can fill the gap between the head 34 on the end of each projection 33 and the U-beam 32 to which each projection 33 is welded. The spacers can thus be used to vary selectively the amount by which the carried device projects from the lifting carriage of its parent truck.

CLAIMS:

1. A mobile steerable auxiliary lifting and lowering device intended for use with a power-driven lift truck, the device comprising: a wheeled frame supporting generally horizontally-extending tines; means allowing the device to be selectively coupled to and uncoupled from the lifting carriage of the parent truck; first power-driven means, adapted to be controlled from the parent truck, to selectively raise and lower the tines of the device relative to its wheels; and second power-driven means, also adapted to be controlled from the parent truck, to drive the uncoupled device on its wheels selectively away from and back towards the truck; characterised in that one end (13) of the frame (11,13) is supported on a pair of wheels (15) which are drivable, by the second power-driven means (15A), independently of one another and in either direction of rotation; in that the said driven wheels (15) are transversely spaced apart from one another across said one end (13) of the device; and in that the first power-driven means (35), when operated, selectively raises or lowers the tines (19) of the device in relation to the frame (11, 13) without raising or lowering the frame (11, 13) in relation to the wheels (12, 15).

2. A device according to claim 1, characterised in that the second power-driven means comprises two motor-in-wheel units (15A), one in each driven wheel (15), and in that each driven wheel (15) is independent of any other wheel (12) of the device.

3. A device according to claim 2, characterised in that each of the motor-in-wheel units (15A) swivels about a respective steering axis independently of the other unit (15A).

4. A device according to any of the preceding claims, characterised in that the tines (19) move up and down on rotary bearings (24) and in that said bearings (24) run inside the flanges (14) of U-section or I-section uprights (13) forming part of the frame (11, 13) of the device.

5. A device according to claim 4, characterised in that the bearings (24) run on renewable wear strips (25) which are secured to the flanges (14) of the uprights (13).

6. A device according to any of the preceding claims, characterised in that the other end (11) of the frame (11, 13) is supported on auxiliary wheels (12) and in that said auxiliary wheels (12) are secured to the frame (11,13) independently of the tines (19).

7. A device according to claim 6, characterised in that the said other end (11) of the frame (11, 13) incorporates means (12a, 12b, 12c) for securing the auxiliary wheels (12) to the frame (11) at selectively different distances from the projecting ends of the tines (19).

8. A device according to any of the preceding claims, characterised by the provision of means (41, 42) which can selectively be rendered operative or inoperative and which, when rendered operative, automatically limit the amount by which the tines (19) can be raised from the frame (11, 13).

9. A device according to any of the preceding claims, in which either or both of the power-driven means is a fluid-pressure-operated means, characterised in that the necessary fluid supply line (48) enters the device via a rotary hydraulic union (18).

10. A device according to any of the preceding claims, characterised in that the means to couple and uncouple the device to and from the lifting carriage of the parent truck comprise projections (33) which engage respective co-operating recesses on the lifting carriage plate (46) of the parent truck, in that said projections (33) end in heads (34), and in that removable spacers (34A) are provided to fit over said projections (33) between each head (34) and the co-operating recess in the lifting carriage plate (46) and thus vary selectively, by precisely variable amounts, the distance by which the device projects from the lifting carriage.

11. A device according to any of the preceding claims, in combination with a power-driven parent lift truck (45) fitted with means (47, 48) to control the power driven means (15A, 35) of the device.

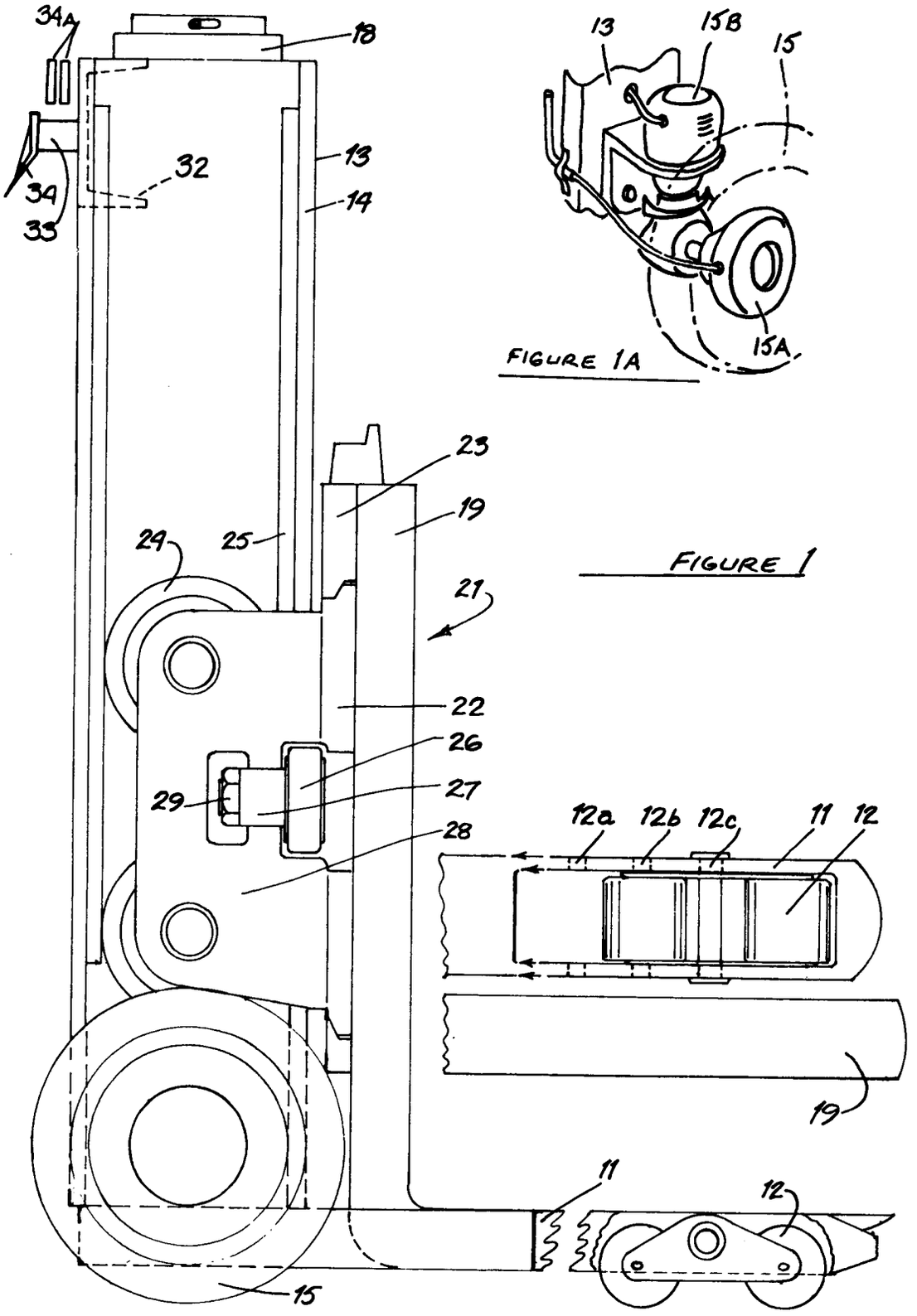


FIGURE 1




FIGURE 1A

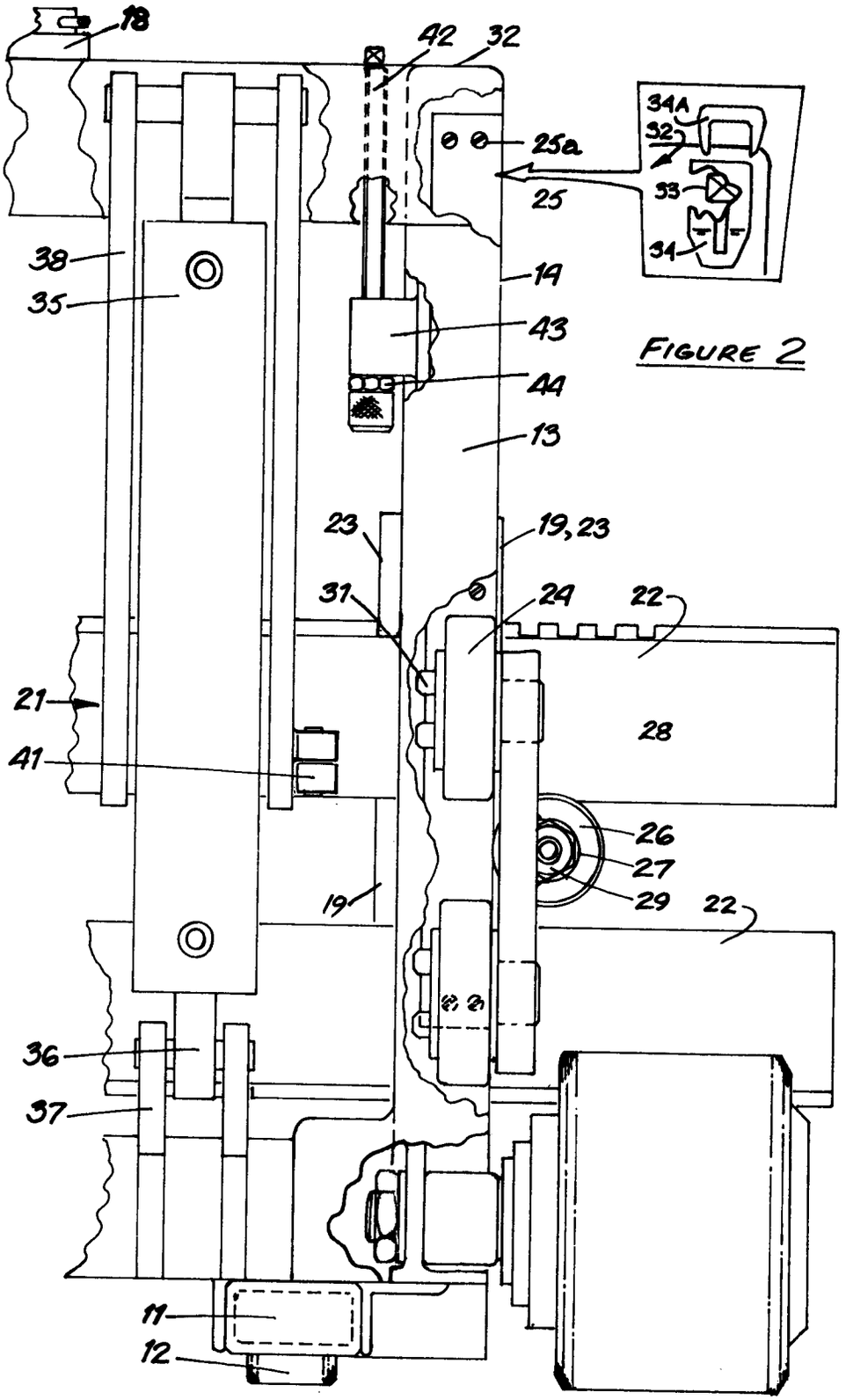
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FIGURE 2

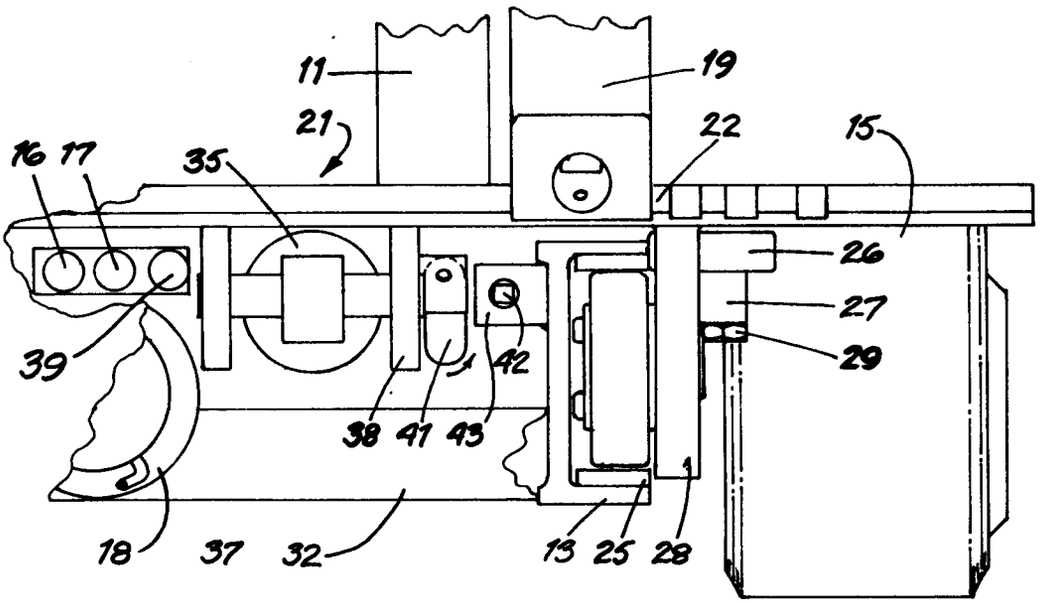


FIGURE 3

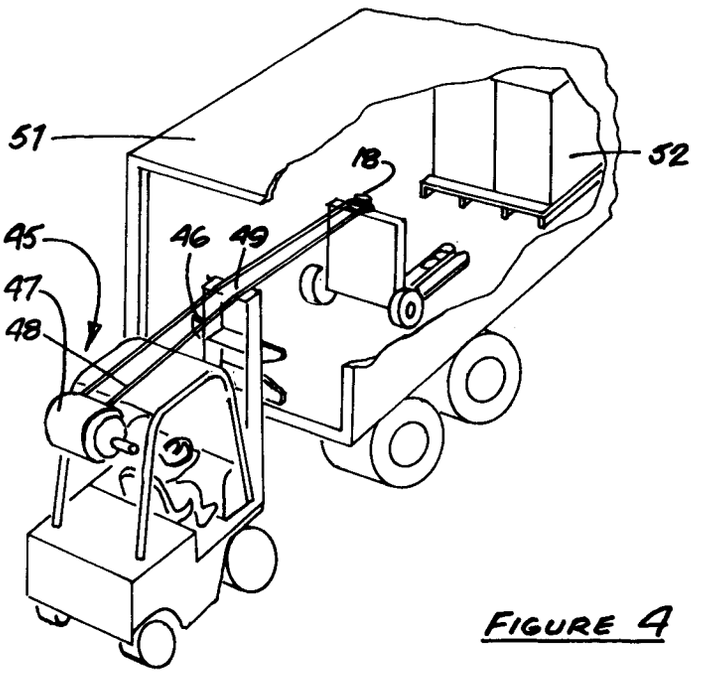


FIGURE 4

European Patent Office

# EUROPEAN SEARCH REPORT

0005360
Application number
EP 79 30 0741

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim |
|---|---|---|
| AD | GB - A - 1 440 062 (WELDALL) | |
| A | FR - A - 2 320 897 (TOTAL MECHANICAL HANDLING) | |
| A | FR - A - 1 252 876 (KEMPF) | |
| A | US - A - 2 940 625 (HOLM) | |
| A | FR - A - 1 142 453 (KAYE) | |

CLASSIFICATION OF THE APPLICATION (Int. Cl.²)

B 66 F 9/12
B 60 P 1/02
B 60 K 7/00

TECHNICAL FIELDS SEARCHED (Int.Cl.²)

B 66 F
B 60 P

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 10-08-1979 | VAN DEN BERGHE |

EPO Form 1503.1 06.78