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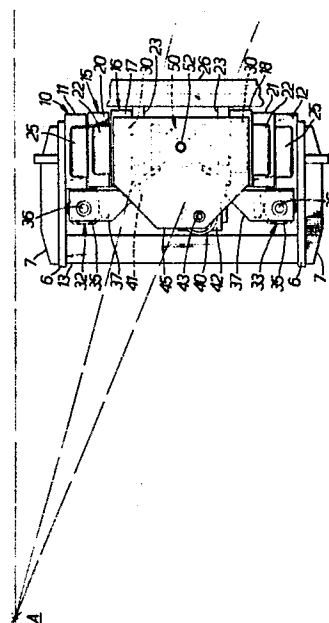
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Telescopic mast assembly.

A telescopic mast assembly for a fork-lift-truck comprises a fixed mast section (10) and two relatively movable mast sections (15, 16). A slidably mounted lifting carriage (26) is supported on the movable section (16) which is itself slidably mounted on the movable section (15). The carriage (26) is raised up the movable section (16) by a hydraulic cylinder (50) and the movable section (16) is raised up the movable section (15) by a hydraulic cylinder (40). The movable section (15) is raised up the fixed section (10) by a pair of cylinders which are arranged in series with the cylinders (50) and (40) so as to operate in sequence.



TELESCOPIC MAST ASSEMBLY

This invention relates to lift trucks and more particularly to mast assemblies for lift trucks of the kind having a telescopic mast assembly which is operable to move a lifting carriage, usually provided with forks, from a lowered position at ground level to a raised position at the top of the extended mast assembly.

For certain applications it is important for the overall height of the truck to be as low as possible, for example where the truck is to be used in areas of restricted head room such as ships holds. In order to achieve this, it has been proposed to make the mast assembly in three sections, comprising a fixed section secured to the chassis, and two telescopic sections movably mounted with respect to the fixed section. These movable sections comprise a first movable section on which the lifting carriage is slidably mounted, and a second movable section on which the first section is slidably mounted and which is itself slidably supported on the fixed section.

Means are provided for extending the movable sections and for moving the carriage along the first movable section. These usually comprise hydraulic cylinders coupled to the carriage and to one or more of the sections by chains.

The telescopic mast assembly and the lifting carriage are usually located forward of the driving position, and known arrangements of mast assembly frequently suffer from the disadvantage of restricting the driver's view of the load and the lifting carriage from the driving position. This problem is particularly aggravated in three-section telescopic mast assemblies, as the combined width of the sections and their operating cylinders seriously hampers the driver's view.

The invention provides a telescopic mast assembly which achieves much improved visibility through the mast assembly.

According to the invention, there is provided a telescopic mast assembly for a lift truck comprising a fixed mast section, and two relatively movable telescopic mast sections movably mounted with respect to the fixed section, said telescopic mast sections comprising a first movable section supporting a slidably mounted lifting carriage, and a second movable section slidably mounted with respect to the fixed section, and slidably supporting the first movable section, and means for extending the movable sections and raising the carriage up the first movable section, said means comprising first hydraulic cylinder means operating between the fixed section and the second movable section, second hydraulic cylinder means operating between the second movable section and the first movable section, and third hydraulic cylinder means operating between the first movable section and the carriage.

The use of hydraulic cylinder means has a number of advantages compared with the combination of hydraulic cylinders and lifting chains. Firstly, hydraulic cylinders are more reliable and have a longer life than chains and do not require the frequent adjustment which is usually necessary with a chain system. Secondly, the use of hydraulic cylinders enables the cylinders to be located in positions which do not unduly interfere with the driver's view.

Because the use of reeving chains in prior masts leads to a 2:1 ratio between the cylinder extension and travel of the carriage, relatively large cylinders must be used to provide the necessary power. In a mast assembly of the present invention smaller diameter cylinders may be used and this leads to a great improvement in the obtainable driver visibility.

The mast sections, as in conventional practice, each suitably comprise a pair of channel section uprights, and in a preferred

embodiment of the invention, the first hydraulic cylinder means which operates between the fixed mast section and the second movable section comprise a pair of matched hydraulic cylinders each of which is located behind the appropriate channel section upright. By locating the cylinders behind the channel section uprights, they are thus placed in the blind spot already created by the uprights, and thus do not further restrict the driver's view.

In a preferred embodiment of the invention, the third cylinder means which operates between the first movable section and the carriage comprises a single hydraulic cylinder assembly, the piston rod of which is fixed to the first movable section and the cylinder of which is fixed to the carriage. In the lowermost position of the carriage, the piston rod is fully extended, and in order to raise the carriage, the piston rod is retracted into the cylinder.

By arranging for the piston rod to be retracted in order to raise the carriage, the piston rod becomes the only element in the line of sight of the driver, and as this is substantially narrower than the cylinder a significant improvement in visibility is achieved. The use of a cylinder in tension also enables the bearing spread to be reduced thus maximizing the amount of extension available from the cylinder.

In an alternative embodiment the carriage is raised by a telescopic ram acting between the first movable section and the upper part of the carriage. In this embodiment the central part of the mast assembly above the carriage is completely clear.

Preferably, the second hydraulic cylinder means disposed between the second movable section and the first movable section comprises a single hydraulic cylinder which is off-set in relation to the central longitudinal axis of the assembly. By a corresponding off-setting of the driver's position, the restriction of visibility posed by the single hydraulic cylinder is substantially reduced.

The three hydraulic cylinder means are hydraulically interconnected so as to operate sequentially, the sequence comprising firstly the positioning of the carriage along the first movable section, secondly the raising of the first movable section relative to the second movable section, and thirdly the lifting of the second movable section relative to the fixed section. This sequential operation of the cylinders can be achieved using a single hydraulic circuit by appropriate choice of the piston diameters.

Further improvements in visibility can be made by the particular design of the mast sections. The channel section upright forming the mast sections are provided with strengthening flanges, and preferably the width of these flanges is substantially reduced. This can be done without unduly impairing the strength of the uprights by utilising rolled sections rather than welded sections, which have less strength in the corners than a rolled section. In a particular embodiment, the channel section uprights each comprise a pair of rolled angle sections which are welded together along the margins of the longer flange to produce the required channel section.

In order that the invention may be more fully understood, embodiments in accordance therewith will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 shows a side elevation of a mast assembly;

Fig. 2 shows a top view of the mast assembly of Fig. 1, and

Fig. 3 shows a front view of the mast assembly shown in Figs. 1 and 2.

Referring to the drawings, these show a telescopic mast assembly for a fork-lift truck in which the driver position is indicated by A. The mast assembly is formed from a fixed section 10 which is mounted on the chassis of the vehicle via mounting brackets 8, 9 and which

comprises a pair of channel section uprights 11, 12 interconnected by side plates 6, strengthening beams 7, and a transverse beam 13. In some instances the fixed section 10 may be tiltable in relation to the vehicle chassis.

Two telescopic sections 15, 16 are movably mounted with respect to the fixed section 10. These telescopic sections comprise a first movable section 16 formed from a pair of channel section uprights 17, 18, and a second movable section 15 formed from channel sections 20, 21.

The first movable section 16 is slidably mounted in the second movable section 15 by means of rollers 22 which engage inside the channel section uprights 20, 21. The second movable section 15 is slidably mounted in fixed section 10 by means of rollers 25 which engage within the channel section uprights 11, 12. Movably mounted in relation to the first movable section 16 is a carriage assembly 26 which carries forks 27 and which is slidable relative to the first movable section 16 by means of rollers 30 which engage within the channel section uprights 17, 18.

Thus, the carriage 26 is movable up and down the first movable section 16; the first movable section 16 is movable up and down the second movable section 15; and the second movable section 15 is movable up and down the fixed section 10.

Relative movement of these elements is provided by three hydraulic cylinder and piston assemblies. These comprise a first hydraulic piston and cylinder assembly composed of a pair of matched hydraulic cylinder and pistons 32, 33 which operate between the fixed mast section 10 and the second movable section 15. Each assembly comprises a cylinder 35 which is fixed at one end to the fixed section by means of a plate 34 and a piston rod 36 which is secured to a plate 37 connected to the second movable section 15. Pressurisation of cylinder 35 causes piston rod 36 to extend out of the cylinder, taking with it the second movable section 15.

As will be seen from Fig. 2, the cylinder assemblies 32, 33 are located immediately behind the uprights 11, 12 of the fixed mast section 10, and thus do not impair visibility through the mast assembly.

Relative movement between the second movable section 15 and the first movable section 16 is controlled by a single hydraulic piston and cylinder assembly 40 the lower end of which is fixed to a plate 42 which is welded onto a cross-bar 41 interconnecting the uprights 20, 21 of the second movable section. The piston rod 43 is connected to plate 45 which in turn is connected to and braces the uprights 17, 18 of the first movable section 16.

As will be seen from Fig. 2, cylinder assembly 40 is off-set from the centre line of the mast assembly, and as the driving position A is also off-set, a corresponding improvement in visibility is achieved.

Relative movement between the carriage 26 and the first movable section 16 is controlled by a single hydraulic cylinder assembly 50 operating in tension, and the piston rod 52 of which is secured to plate 45 by brackets 55 and the cylinder 51 of which is secured at its free end to the carriage 26 via a cross brace, trunnions 24, and carriage stiles 23. As will be seen from Fig. 3, the extended position of the piston rod 52 corresponds to the lowermost position of the carriage 26, and in this position only the narrow piston rod is disposed in front of the driver's view. Thus, by arranging for retraction of the piston rod to raise the carriage, substantially improved visibility is achieved.

During operation, the hydraulic jacks operate sequentially so that on initial operation of the lifting circuit, the carriage 26 is moved upwardly along the first movable section from the lowermost position to the uppermost position shown in dotted lines in Fig. 1. It will be appreciated that this can be achieved without extending the height of the mast assembly. Once the carriage has reached its uppermost position, cylinder assembly 40 is then operated to act between the plate 45 and cross-bar 41 to raise the first movable section

along the second movable section. When the first movable section has moved to its maximum height relative to the second movable section, the pair of cylinders 32, 33 then act on plates 37 to raise the second movable section, with the first movable section and carriage, upwardly relative to the fixed section 10 so as to bring the mast to its full height.

It will be seen from Fig. 2 that the rollers which guide the telescopic movement of the sections are substantially the same width as the channel section uprights themselves. The very minimal width of the flanges forming these channel section uprights is achieved by using rolled sections which have correspondingly greater strength in their corner regions than welded sections. The driver's sight-lines are shown in Fig. 2, and it will be appreciated from this drawing that the use of larger flanges on the uprights themselves would substantially interfere with the free visibility provided. It will be appreciated that the crucial element in driver visibility is the ability of the driver to see the tips of the forks during a lifting operation, and as will be seen from Fig. 2, this is adequately achieved with the mast section according to the invention.

CLAIMS

1. A telescopic mast assembly for a lift truck comprising a fixed mast section, and two relatively movable telescopic mast sections movably mounted with respect to the fixed section, said telescopic mast sections comprising a first movable section supporting a slidably mounted lifting carriage, and a second movable section slidably mounted with respect to the fixed section, and slidably supporting the first movable section, and means for extending the movable sections and raising the carriage up the first movable section, said means comprising first hydraulic cylinder means operating between the fixed section and the second movable section, second hydraulic cylinder means operating between the second movable section and the first movable section, and third hydraulic cylinder means operating between the first movable section and the carriage.

2. A mast assembly as claimed in Claim 1 wherein the third cylinder means comprises a single hydraulic cylinder, the piston rod of which is fixed to the first movable section and the cylinder of which is fixed to the carriage.

3. A mast assembly as claimed in Claim 1 or Claim 2 wherein the second hydraulic cylinder means comprises a single hydraulic cylinder which is off-set in relation to the central longitudinal axis of the assembly.

4. A mast assembly as claimed in any preceding claim wherein the three hydraulic means are hydraulically connected in series to operate sequentially; the sequence comprising firstly the positioning of the carriage along the first movable section, secondly the raising of the first movable section relative to the second movable section and thirdly the lifting of the second movable section relative to the fixed section.

5. A mast assembly as claimed in any preceding claim wherein each mast section comprises a pair of channel section uprights.

6. A mast assembly as claimed in any preceding claim wherein the carriage is mounted for sliding movement relative to the first movable section by means of rollers fixed to the carriage and running in the channel section uprights of the first movable section.

7. A mast assembly as claimed in any preceding claim wherein the first movable section is mounted for sliding movement relative to the second movable section by means of rollers fixed to the first movable section and running in the channel section uprights of the second movable section.

8. A mast assembly as claimed in any preceding claim wherein the second movable section is mounted for sliding movement relative to the fixed section by means of rollers fixed to the second movable section and running in the channel section uprights of the fixed section.

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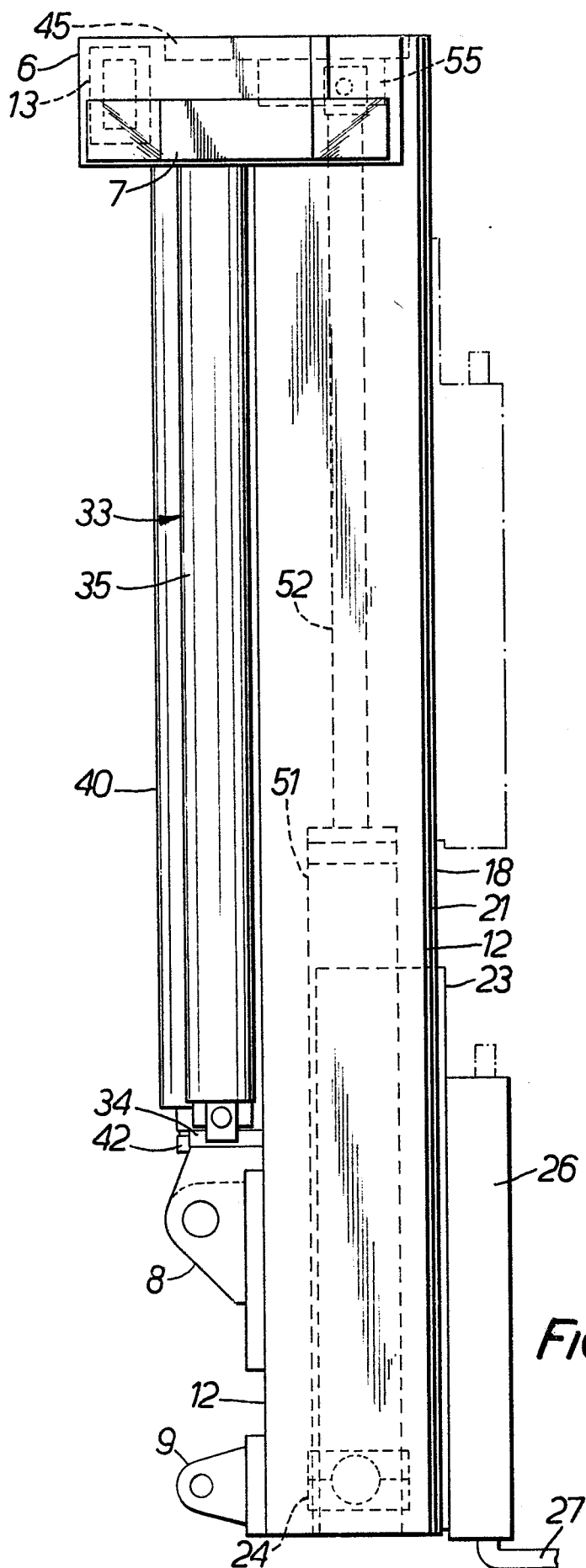
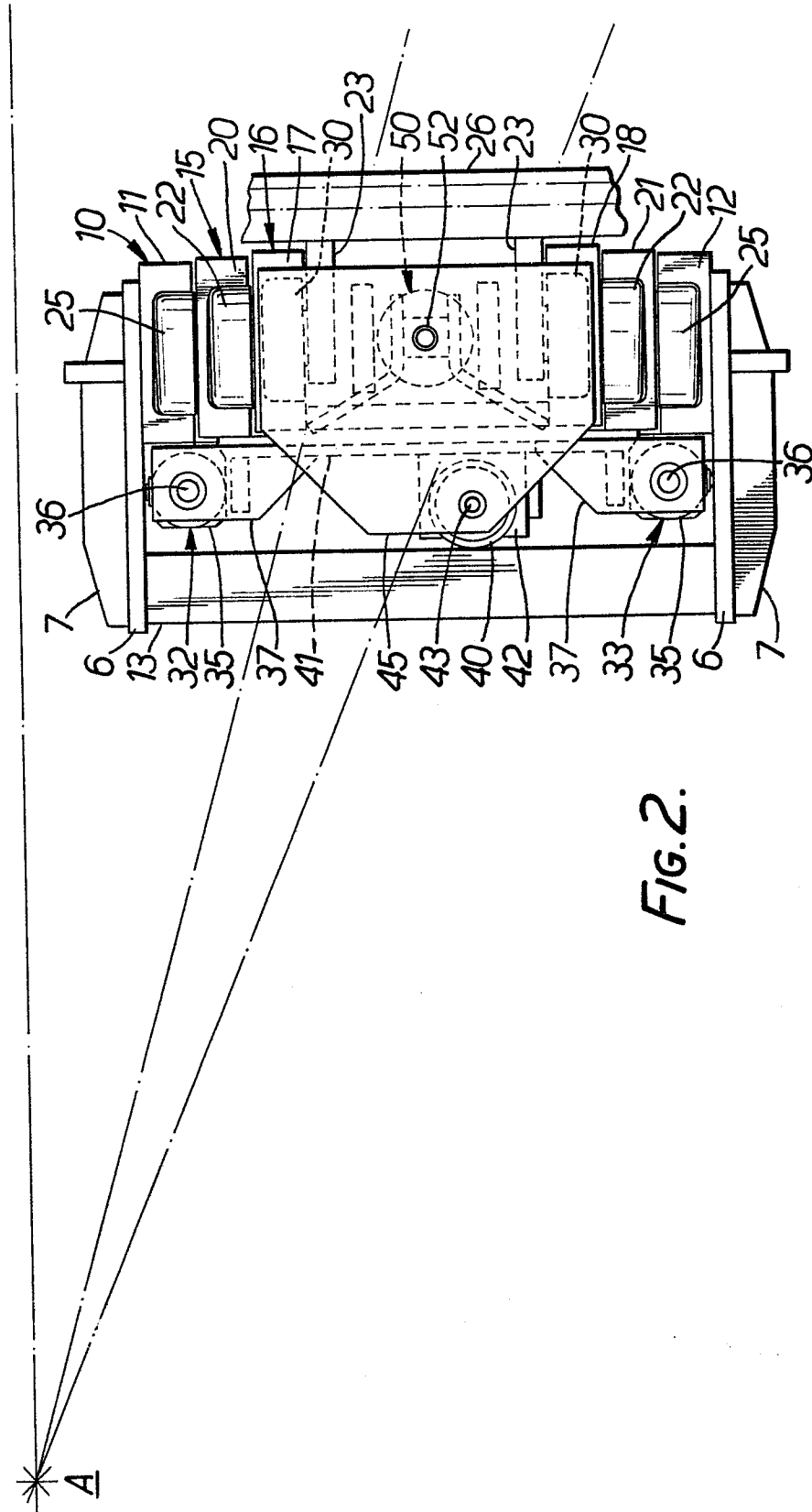


FIG. 1.

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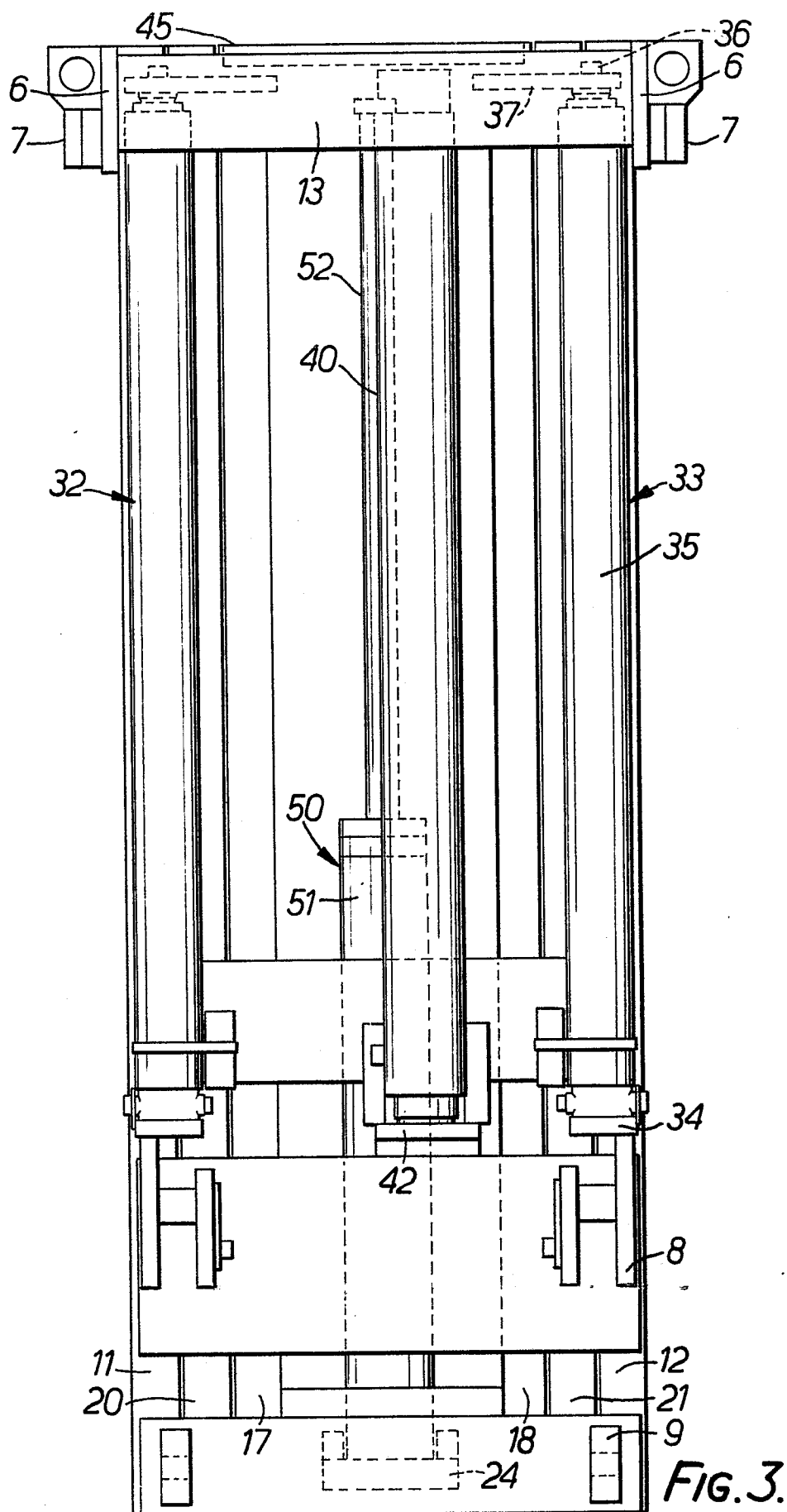


Fig. 3.



European Patent
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EUROPEAN SEARCH REPORT

0126634

Application number

EP 84 30 3378

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
Y	WO-A-8 103 014 (TOWMOTOR CORP.) * Page 3, lines 11-31; page 4, lines 1-4, 29-31; page 5, lines 1-32; page 6, lines 1-31; page 7, lines 26-33; page 8, lines 1-4; page 9, lines 16-24 *	1,4-8	B 66 F 9/08
Y	FR-A-2 351 908 (AU DUREAU) * Whole document *	1,4-8	
A	FR-A-2 453 820 (CLARK) * Page 7, lines 31-38; page 8, lines 1-10 *	3	
A	GB-A-2 045 208 (CLARK)		
A	GE-A-1 186 458 (EATON)		
A	FR-A-1 033 795 (BATIGNOLLES-CHATILLON)		
A	DE-A-2 713 808 (LINDE)		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
Place of search THE HAGUE		Date of completion of the search 17-08-1984	Examiner VAN DEN BERGHE E.J.J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			