Aug. 4, 1964 R. E. KNIGHTS ETAL 3,143,190

INDUSTRIAL TRUCKS

Filed June 13, 1962 3 Sheets-Sheet 1

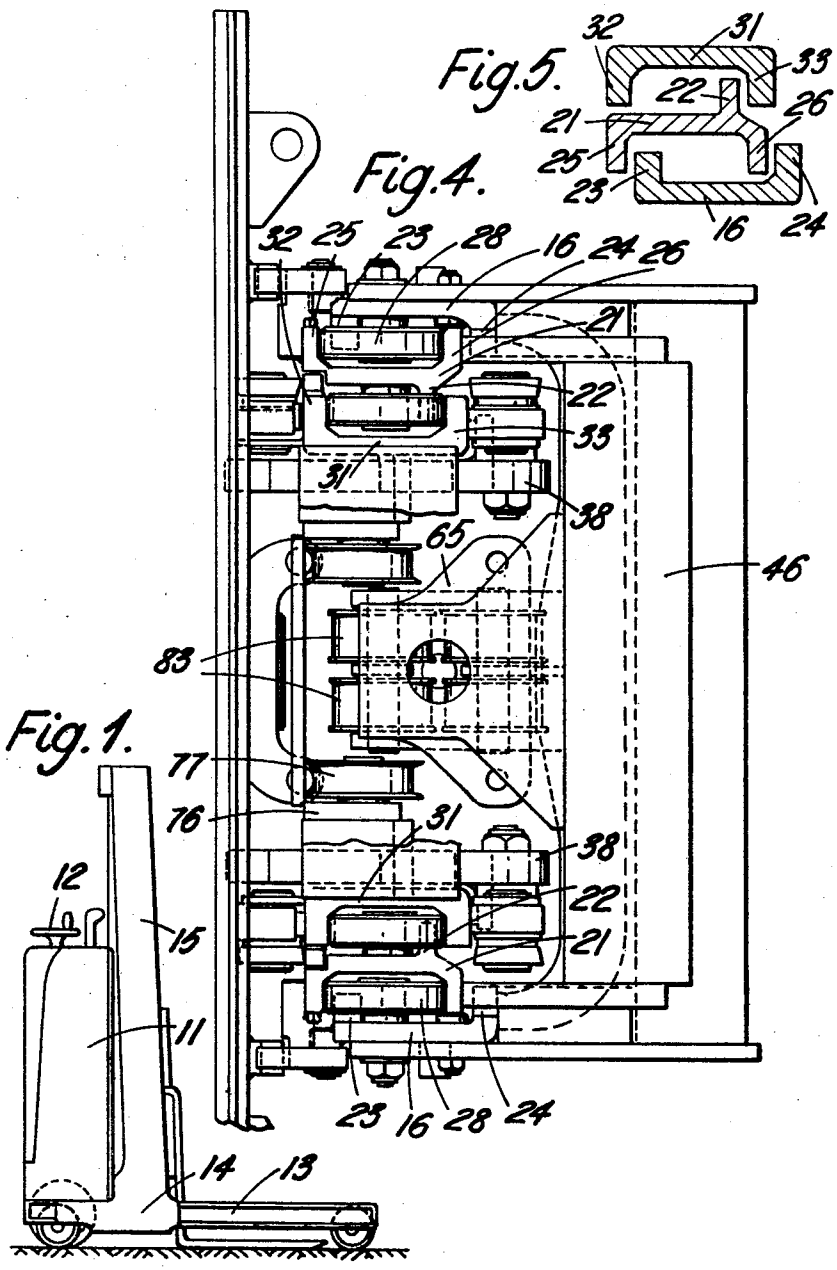


Fig. 4.

Aug. 4, 1964 R. E. KNIGHTS ETAL 3,143,190

INDUSTRIAL TRUCKS

Filed June 13, 1962 3 Sheets-Sheet 2

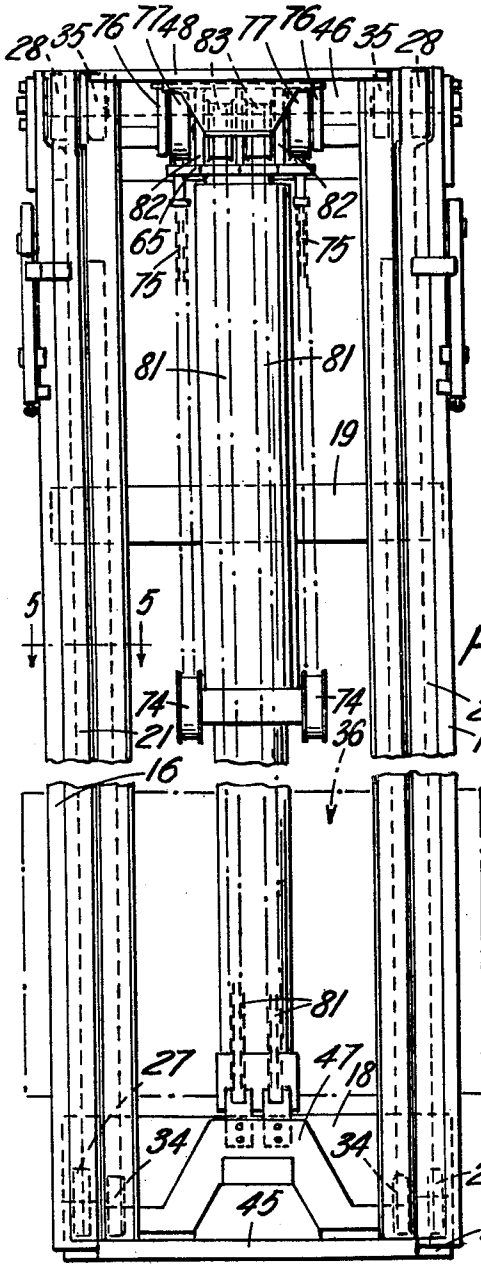


Fig. 2.

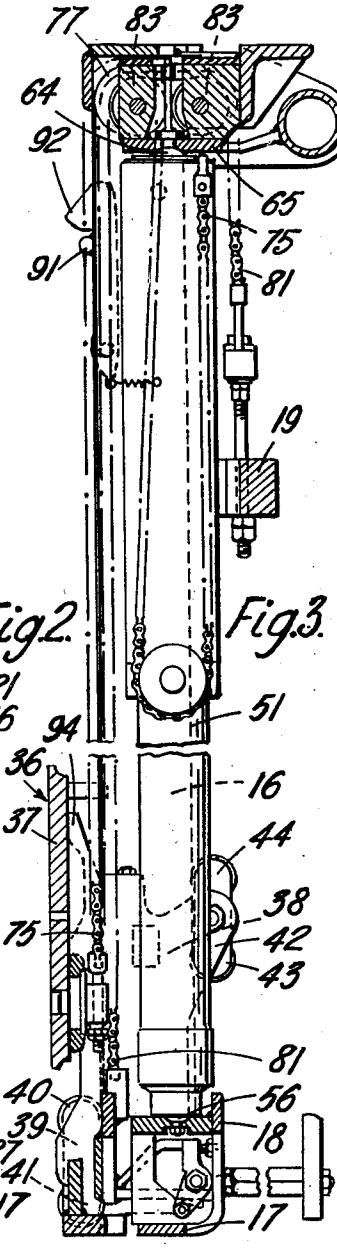


Fig. 3.

Aug. 4, 1964 R. E. KNIGHTS ETAL 3,143,190

INDUSTRIAL TRUCKS

Filed June 13, 1962 3 Sheets-Sheet 3

Fig.6.

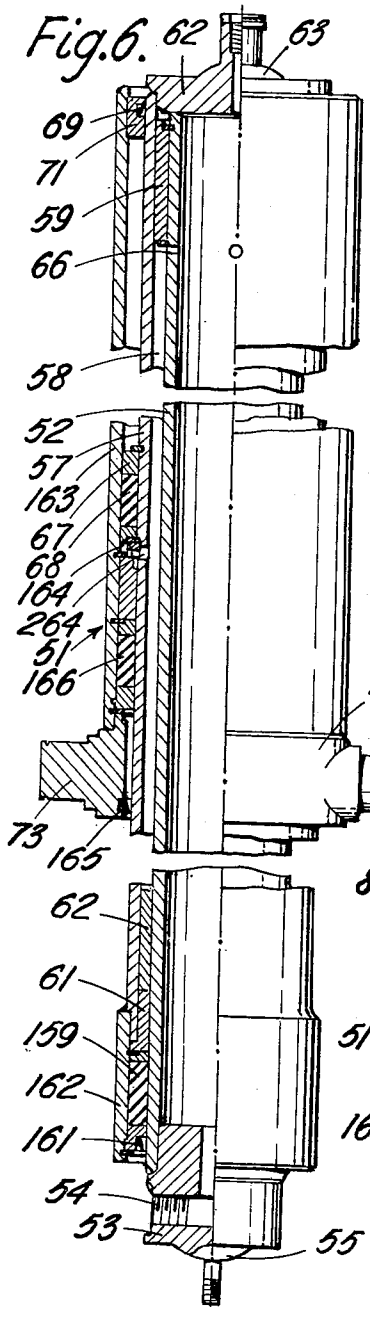


Fig.7.

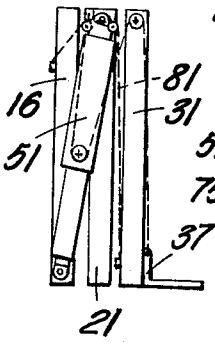


Fig.8.

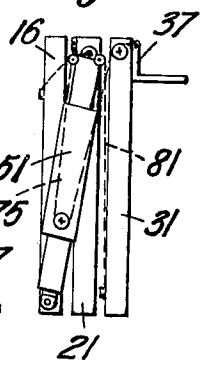


Fig.9.

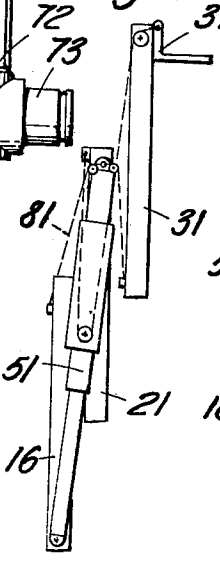
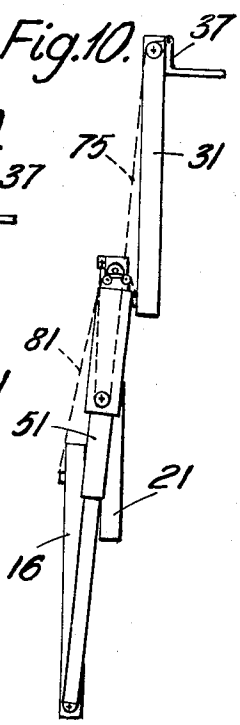


Fig.10.



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3,143,190

INDUSTRIAL TRUCKS

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4 Claims. (Cl. 187—9)

This invention comprises improvements in or relating to masted industrial lift-trucks and relates particularly to telescopic-masted industrial lift trucks. In telescopic-masted trucks it is important that the load lifting carriage which runs up and down the mast should be capable of being lifted to the top of the mast before the mast itself begins to extend because this enables loads to be picked up and if necessary loaded into shelves in stores, or carried through door-ways with a truck at its minimum height, the extra height available through the telescopic masts being only utilized in places where there is room for it.

At the same time, it is desirable in the interest of simplicity of control that the hydraulic connections of the hydraulic jack means employed for effecting lifting should have a single supply and should not be subject to supply through long lengths of flexible hose. Various solutions have been proposed for this problem one of which is shown in our previous British Patent No. 803,066.

The present invention relates to a truck with a triple-lift mast, in which the problems related to are accentuated and in which more-over the arrangement of the mast sections to afford the greatest simplicity of the parts and the maximum room for the hydraulic connections referred to offers problems of its own.

According to the invention a mast system for a telescopic-masted industrial lift-truck comprises a triple section telescopic mast with a lifting carriage mounted to slide on the top section, a main direct-lift jack connecting two adjacent sections of the mast, chain or equivalent means connecting said adjacent sections to the other section so that when the jack extends said adjacent sections the other section is caused to be extended, and chain or equivalent means extending from the carriage upwardly over a pulley at the upper end of the top section and under a pulley operated by a subordinate jack subject to the same hydraulic pressure as the main jack and thence to an anchorage. Preferably the size of the subordinate jack compared with that of the direct-lift jack is such as to extend and lift the carriage before the direct-lift jack lifts the mast sections.

Preferably the subordinate jack is made concentric with and in a single unit with the direct-lift jack.

Preferably the mast sections comprise an outer mast section with channel-shaped sides the flanges of which are inwardly directed, an inner mast section with channel-shaped sides the flanges of which are outwardly directed and an intermediate mast section the sides of which consist of channels having both normal channel flanges and also an extra flange running down the back of their webs so that the extra flange of each side can enter between the flanges of one of the other mast sections and the normal channel with flanges on each side can co-operate with the flanges of the other mast section.

The following is a description by way of example of one construction of industrial lift truck in accordance with the invention, wherein reference is made to the accompanying drawings, in which—

FIG. 1 is a side view of the entire truck;

FIG. 2 is a front elevation of the mast;

FIG. 3 is a side view of the mast, partly in section;

FIG. 4 is a plan view of the mast;

FIG. 5 is a sectional view on line 5—5 of FIG. 2, looking in the direction of the arrows;

FIG. 6 is an elevation of the mast, partly in section and partly broken away; and

FIGS. 7, 8, 9 and 10 are schematic side views illustrating successive positions of the mast sections as the lifting carriage is lifted.

The truck shown diagrammatically in FIGURE 1 comprises the usual low wheeled chassis **11** provided with steering mechanism **12** and propelling mechanism (not shown) and on the front of the chassis there are forwardly extending reach guides **13** on which is mounted a reach carriage **14** for supporting a mast **15**. The mast is mounted on the reach carriage and its reach is controlled by appropriate mechanism which forms no part of the present invention. Referring to FIGURES 2 to 5 the mast comprises a bottom section which consists of two outer channel members **16** with front and rear flanges **23, 24** directed inwardly, which are united at the bottom by a strong cross member in the form of an angle plate with a horizontal bottom flange **17** and a vertical rear flange **18**. The flanges **24** of the bottom section of the mast are also united higher up by a cross member **19** extending across between the rear flanges **24** of the channels **16** and welded to the outside of these flanges.

Between the sides of the bottom section of the mast are two side members **21** of an intermediate section. These side members are of channel shape with normal front and rear channel flanges **25, 26** directed outwardly and an extra flange **22** running down the back of the web near the rear edge of the web but offset forwardly from the rear of the edge by an amount which is a little more than the thickness of the flange **26**. The sides of the intermediate mast section **21** where their flanges extend outwardly are interlocked with the flanges of the bottom section **16**, the front flange **25** overlapping the front flange **23** and the rear flange **26** overlapping the rear flange **24** of the corresponding side of the bottom section. This is best seen in FIGURE 5. Rollers **27, 28** are provided on each side of the mast between the bottom section and the intermediate section to facilitate sliding movement. The rollers **27** are located near the lower end on the intermediate channels **21** to roll between the flanges of the bottom section channels **16**, and the rollers **28** are located near the upper end on the channels **16** to roll in the flanges of the intermediate section **21**. The channels **21** are united by cross member **45** at their lower end and by cross member **46** at their upper end.

Within the intermediate section **21** of the mast there is a third telescopic section the sides of which consist of channel members **31** with their front and rear flanges **32, 33** directed outwardly and the rear flange **33** of each side member of the upper section is assembled behind the extra flanges **22** which run down the webs of the side members **21** of the intermediate section. The top section of the mast is spaced from the intermediate section by rollers **34, 35** provided on each side of the mast to facilitate sliding movement. The rollers **34** are located near the lower end on the top section channels **31** to roll on the extra flanges **22**, and the rollers **35** are located near the upper end on the intermediate channels **21** to roll in the flanges of the top section **31**. The flanges of the intermediate and top sections at the front of the mast are in the same plane as one another. The channels **31** are united by cross member **47** at their lower end and by cross member **48** at their upper end.

On the top section of the mast there runs a lifting carriage **36** which comprises a front plate **37** having two rearwardly directed vertical webs **38** added to its back face at such a spacing that they will run between the inner faces of the webs of the channels **31**. These webs **38** carry near their lower ends pivoted frames **39** on which

are rollers 40, 41 forming a wheeled bogie to run on the front of the outside of the flanges 32 of the top section of the mast. At a higher level and behind the mast the webs carry similar pivoted bogies 42 with rollers 43, 44 to run on the outside of the rear flanges of the top section. The vertical plate 37 of the carriage is fitted to carry forks (not shown).

A two-stage hydraulic jack 51 (FIGURE 6) is provided to act between the cross member 17, 18 at the lower end of the outer mast portion and the cross member 46 joining the top of the channels 21 of the intermediate mast portion. The hydraulic jack 51 has an inner cylindrical tubular sleeve 52 closed at its lower end by a bearing block 53 except for an inlet port 54, the bearing block being provided with a spherical lower surface 55 which bears on a mating spherical surface 56 on the cross member 17, 18 of the outer mast portion 16. A second cylindrical sleeve 57 of a length similar to that of the inner sleeve 52 surrounds the inner sleeve leaving a small gap 58 between the sleeves and bears on the inner sleeve 52 to provide a sliding fit by means of two split bushes, one bush 59, fixed at the top of the inner sleeve, and the other bush 61 fixed to the lower end of the second sleeve. This second sleeve 57 is closed at its upper end, and the closure member 62 is provided with a spherical surface 63 which bears on a mating spherical surface 64 on a horizontal plate 65 which forms part of the cross member 46 across the channels 21 of the intermediate mast portion. The inner sleeve is ported at 66 near its upper end to permit fluid within the inner sleeve to flow into the space 58 between the sleeves. A chevron seal 159 and a wiper seal 161 are provided in an annular seal housing 162 at the bottom of the second sleeve to seal the space between the sleeves 52 and 57 at the lower end. An outer sleeve 163 of about half the length of the other sleeves 52 and 57 surrounds the second sleeve leaving a substantial gap 164 between the outer sleeve and the second sleeve. The space 164 is closed by an annular stop 67 locked in position around the second sleeve just above its mid-point and by a chevron seal 68 below the stop between the second sleeve 57 and the outer sleeve 163; a wiper seal 69 is also provided on an annular stop 71 at the top of the outer sleeve and bears on the second sleeve 57. The lower end of the outer sleeve carries an annular closure member 72 which seals the space 164 between the outer and second sleeves by means of a wiper seal 165 and a chevron seal 166. The closure member 72 is part of a trunnion block with two trunnions 73 which carry two chain guide rollers (not shown in FIGURE 6). The second sleeve 57 is ported just below the annular stop 67 to allow fluid to flow into the space 164.

In the upper position, the inner sleeve, the space 58 between the inner and second sleeves and the space 164 between the second and outer sleeves below the stop on the second sleeve are filled with fluid. Supply of further fluid under pressure first forces down the outer sleeve by means of fluid flowing into the space 164 from the inlet 54, through the ports 66 in the inner sleeve to the space 58 between the sleeves and through the port 264 in the second sleeve to act on the annular closure member 72 and trunnion block. When the stops 67, 71 on the second and outer sleeves engage, no further movement of the outer sleeve can take place; thus the supply of further fluid under pressure extends the second sleeve 57 with respect to the inner sleeve 52. The inner and second sleeves 52, 57 act as a main jack and the second and outer sleeves 57, 63 act as a subordinate jack.

Two chains 75 are attached to the plate 65, which forms part of the cross member 46. The two chains 75 lead downwardly under the chain pulleys 74 on the trunnions 73 of the jack 51 and then upwardly between chain guides in the cross-member 48 which unites the upper ends of the side members of the top section of the mast. The chain guides consist of two vertical webs 76

on the cross member on which are pivoted two chain pulleys 77 one at each side of the mast. From the chain pulleys 74 the chains 75 come back up the mast, across over the pulleys 77 to the front of the mast and thence downwardly to the carriage 36. Thus by extending the subordinate jack the chain pulleys 74 are moved down and the chains 75 are caused to lift the carriage.

In addition to the carriage-lifting chains 75 already described there is a second pair of chains 81 which are anchored to the cross member 19 at the back of the bottom section 16 of the mast and extend upwardly therefrom. The two chains 81 go between two chain guides at the top of the intermediate section 21 of the mast and thence down to the bottom of the upper section 31. The chain guides consist of two webs 82 on each of which are pivoted two chain rollers 83 at the same level one behind the other. The two pairs of rollers enable the chains to pass from back to front of the mast. This second pair of chains 81 can be described as mast lifting chains and when the main jack is extended, to raise the intermediate section with respect to the lower section the mast lifting chains, being anchored to a fixed point at the lower section 16 of the mast and passing over pulley means on the intermediate section, draw the top section 31 upwardly so that both the movable sections of the triple mast extend together, with the upper sections moving up relatively to the intermediate section.

The operation of the mast is best understood by referring to FIGURES 7 to 10. The piston areas of the two jacks, which both receive the same hydraulic pressure at all times, are such that the subordinate jack will extend first and raise the carriage (FIGURE 8). As the carriage lifting chain passes over guide means at the top of the upper section of the mast, the tension in the carriage lifting chain at this stage of the operation tends to keep the mast down. Also there is a locking means comprising two pins 91 welded to the channels 21 of the intermediate section and two latch members 92 pivoted to the outer mast section and spring urged by springs 93 to engage the pins 91 which locking means prevents extension of the mast; however when the carriage is fully raised, two cam faces 94 on the back of the plate 37 release the latch member and permit the mast to be raised. When the carriage has been fully lifted it butts against a stop, the hydraulic pressure rises and the main jack is extended, causing the intermediate section of the mast to lift (FIGURES 9 and 10). During this lifting motion the subordinate jack is collapsed by the pull of its chain on the pulleys and the top section 31 is raised relatively to the intermediate section by the chains 81.

We claim:

1. A mast system for a telescopic-masted industrial lift truck, comprising a first fixed mast section, a second mast section which runs on the first mast section, a third mast section which runs on the second mast section, a lifting carriage which runs on the third mast section, a two-stage jack comprising three elements disposed in line with each other between the first and second mast sections whereof the first element has one end connected to the fixed mast section adjacent the bottom of the latter, whereof the second element has one end connected to the second mast section adjacent the top of the latter, and whereof the third element is disposed intermediate and is in telescopic engagement with the first element and the second element, a first flexible tension member connected between the carriage, the third jack element, and the upper end portion of the second mast section for lifting the carriage along the third mast section as the second and third jack elements are extended relative to each other, and a second flexible tension member connected between the bottom end portion of the third mast section, the top end portion of the second mast section and the first mast section for lifting the third mast section as the first and third jack elements are extended relative to each other.

2. An extensible mast structure for an industrial lift truck comprising in combination a first mast section

adapted to be fixed to the truck on which the structure is mounted, a second mast section running on said first mast section, a third mast section running on said second mast section, a lifting carriage running on said third mast section, first guide means mounted adjacent the upper end of said second mast section, a first flexible tension member connected at one end to the lower portion of said third mast section and extending therefrom upwardly over the first guide means and thence downwardly, the other end of the flexible member being secured to said first mast section, fluid pressure means including a two-stage jack comprising first and second telescopic jack elements, which first element is connected to the lower portion of said first mast section and which second element is connected to the upper portion of said second mast element and is upwardly movable to raise said second and third mast sections, and a third jack element slidable downwardly on the second jack element for raising the lifting carriage on said third mast section, second guide means mounted adjacent the upper end of said third mast section, third guide means mounted on said third jack element, and a second flexible tension member connected at one end to the lifting carriage and extending therefrom upwardly over the second guide downwardly under the third guide means and upwardly to where its other end is anchored on the upper end of said second mast section.

3. An extensible mast structure as claimed in claim 2, wherein the three jack elements are so relatively proportioned that on application of fluid under pressure to the jack said third jack element slides downwardly to raise

the lifting carriage on said third mast section and thereafter said second jack element moves upwardly to raise said second and third mast sections.

4. An extensible mast structure as claimed in claim 2, wherein the first mast section has channel-shaped sides the flanges of which are inwardly directed, the third mast section has channel-shaped sides the flanges of which are outwardly directed and the second mast section is disposed between the first and third mast sections and has sides which each consist of a channel having both normal channel flanges and also an extra flange running down the back of its web, said extra flange of each side of said second mast section co-operating with the flanges of one of the other mast sections and the normal channel flanges of each side of said second mast section co-operating with the flanges of the other mast section, said co-operation being maintained by rollers between the mast sections.

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