May 29, 1956 E. J. ABBE 2,747,689

TIER LIFT TRUCK

Filed Aug. 30, 1952 3 Sheets-Sheet 1

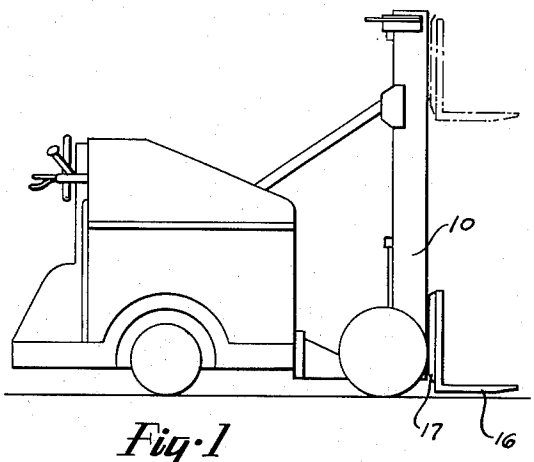


Fig. 1

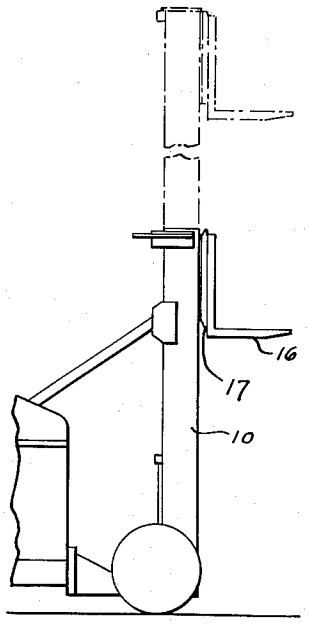


Fig. 2

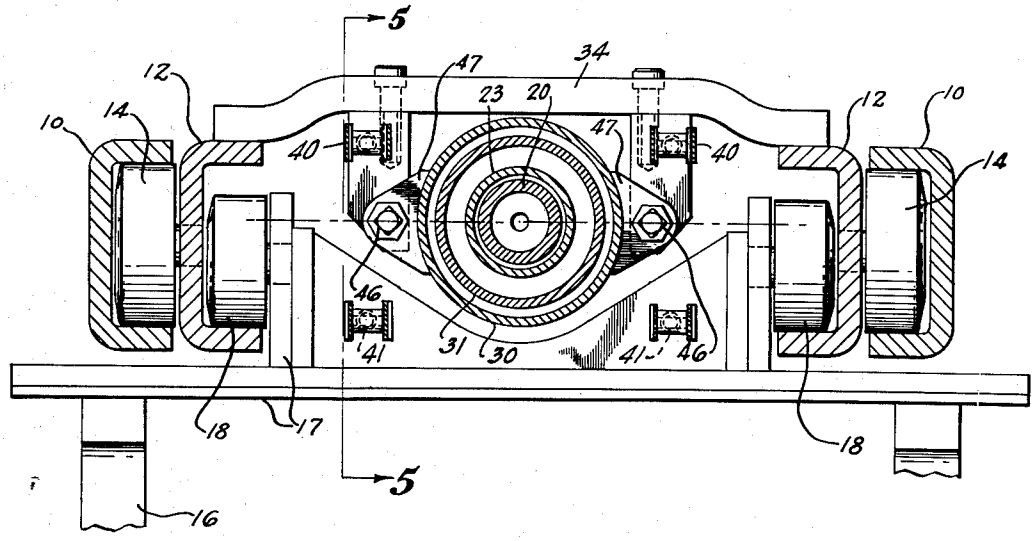


Fig. 4

INVENTOR.
EDWARD J. ABBE

BY

Albert R. Gotrick

ATTORNEY

May 29, 1956 E. J. ABBE 2,747,689

TIER LIFT TRUCK

Filed Aug. 30, 1952 3 Sheets-Sheet 2

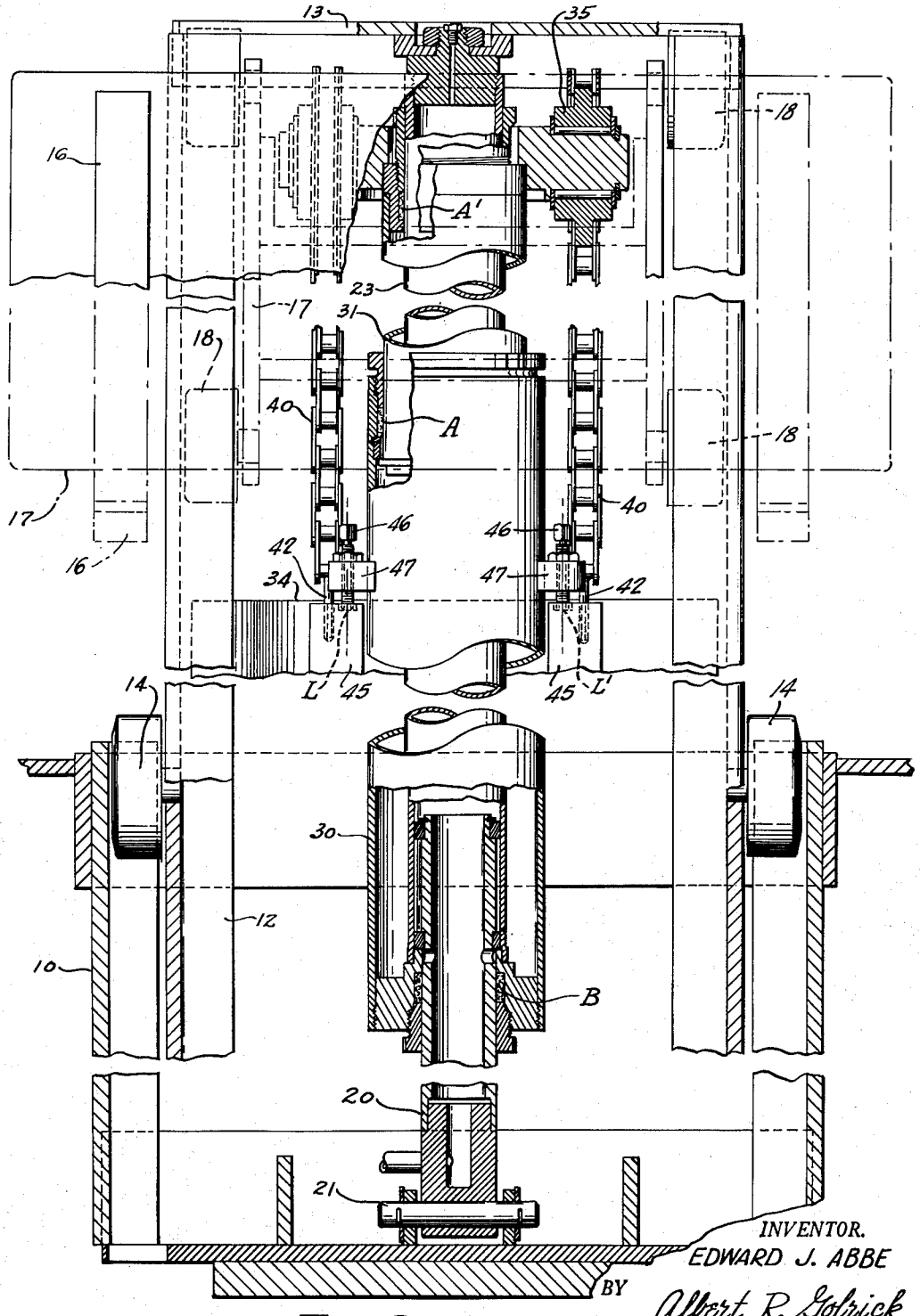


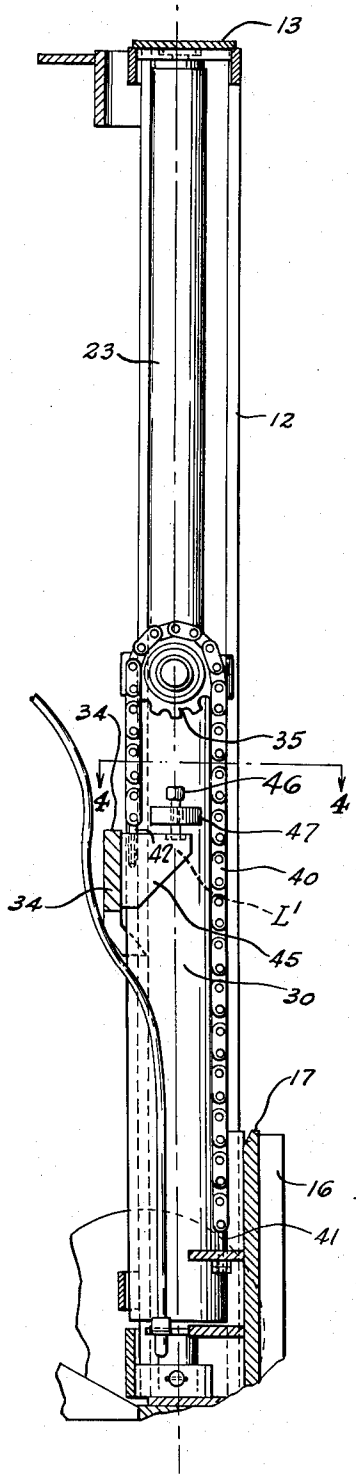
Fig. 3

INVENTOR.
EDWARD J. ABBE
BY
Albert R. Gobrick
ATTORNEY

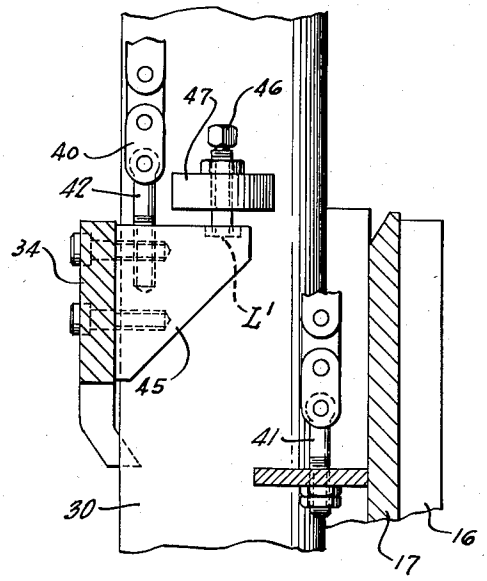
May 29, 1956 E. J. ABBE 2,747,689

TIER LIFT TRUCK

Filed Aug. 30, 1952 3 Sheets-Sheet 3



Fig·5



Fig·6

INVENTOR.
EDWARD J. ABBE

BY

Albert R. Gobrick

ATTORNEY

United States Patent Office

2,747,689

Patented May 29, 1956

2,747,689

TIER LIFT TRUCK

Edward J. Abbe, Cleveland Heights, Ohio, assignor to Elwell-Parker Electric Company, Cleveland, Ohio, a corporation of Ohio

Application August 30, 1952, Serial No. 307,349

6 Claims. (Cl. 187—9)

This invention is directed to improvements in compound action hydraulic tier lift trucks and is concerned particularly with improvements in the hydraulic ram mechanisms of such trucks.

In tier lift trucks of the type referred to, primary and secondary hydraulic rams operate in sequence, one serving to elevate the load platform and the other to elevate both the load and a telescopic mast structure relative to the truck per se. Some advantage exists in arranging the two ram mechanisms in a concentric assembly, i. e. the piston and cylinder of one ram mechanism is arranged within the other ram mechanism and the outer or larger dimentioned ram mechanism operates first to elevate the load on the telescopic mast structure when both rams are connected to a common source of fluid pressure by reason of its larger piston area.

Of necessity, packing glands or rings must be provided particularly to seal the larger piston as it is operated in a vertical direction to lift the load and this packing gland means has been the source of considerable leakage of the hydraulic fluid due to the fact that the tolerances between telescopic mast members must be liberal if the trucks are to be practical at all. Hence there is a tendency of the hydraulic rams to sway somewhat when subjected to the load lifting burdens, thus causing a wearing and distorting of the packing glands with resulting leakage.

The general object of the present invention therefore is to provide an arrangement of load lifting stress distribution which will relieve the piston and cylinder packings, in the mechanism above referred to, of the burden of having to serve as side thrust stabilizers, when the rams are raising and lowering and transporting loads.

More specifically, my invention is directed to the provision of a manner of supporting the outer cylinder upon the inner telescoping part of the mast structure during the actuation periods of both the outer and inner ram mechanisms while permitting the reactive forces due to load lifting to be transmitted to the truck body.

A further purpose of the present invention is to attain the foregoing while using acceptable packing gland or piston ring structures to seal the hydraulic fluid within the pistons and cylinders.

Other objects of the present invention will become apparent from the following description referring to the accompanying drawings illustrating a preferred mode of practicing the same.

In the drawings

Figure 1 shows a tier lift truck in side elevation which incorporates my invention;

Figure 2 is a view similar to Fig. 1 but showing the telescopic mast and ram mechanisms in elevated extension as indicated by the dot and dash lines thereof;

Figure 3 is a front elevational view of the mast structure and compound hydraulic ram mechanism; and

Figure 4 is a horizontal cross section taken through the mast and ram structures substantially along a plane indicated by the line 4—4 of Fig. 5;

Figure 5 is an elevational view of the mast structure when telescoped; and

Figure 6 is an enlarged sectional view of a connecting support for one of the ram mechanisms.

A tiering truck of the type hereinabove referred to comprises generally a fixed mast structure usually in the form of a pair of spaced apart channel members **10** in which a telescopic mast frame is mounted to slide vertically. Such an inner mast frame may comprise a pair of channels **12** having rollers **14** riding between the flanges of the outer channels **10**. Suitable cross frame members, rigidly connecting the two channels **10** together, are so shaped as to permit vertical movement of the inner channel members **12** and the latter are cross connected in like manner so as not to interfere with the cross members of the outer channel structure **10** and to permit the mounting therein of a load elevating carriage mechanism which can traverse the height of the inner channel members. Thus the load carriage may comprise load engaging forks **16** mounted on a carriage frame **17**, the latter having rollers **18** riding between the flanges of inner channels **12**.

The compound or duplex hydraulic ram mechanism comprises an inner, hollow piston pivotally attached to the lower end of the outer channel frame on rocker pin **21**, and a cylinder **23** therefor attached at its upper end to the cross member **13** of the telescopic mast structure. This inner piston and cylinder set **20—23** is adapted to elevate the inner upright channels **12** relative to the outer upright channels **10**.

To elevate the load carriage **17** along the inner channel structure a second ram mechanism is provided comprising an outer cylinder **30** slidably mounted on the inner piston and a piston **31** disposed to operate in the outer cylinder between the walls thereof and the walls of the inner piston ram unit. The piston **31** has a mounting for a pair of sprockets **35** on the upper external end thereof over which extend chain reaches **40** having outer ends thereof attached at **41** to the carriage structure and the other or inner ends anchored at **42** to a cross frame member **34** which is part of the telescopic frame structure, in a manner and for a purpose to be described. Both ram mechanisms are in hydraulic communication from a common source of fluid pressure at all times.

In operation the above outlined load elevating mechanism has a sequence of movement of first the movement of the load engaging carriage relative to its supporting telescopic mast structure, which is effected by a 1 to 2 ratio of vertical movement of the sprockets **35** by the outer larger ram unit, and secondly the vertical movement of the telescopic mast structure with the carriage and load vertically extended thereon in unison by the inner ram piston acting on cross frame member **13**. This vertical movement is limited by internal stops between the inner piston and cylinder members or otherwise as desired. A more detailed description of the construction and operation of the mechanism is set forth in my Patent No. 2,666,501, only sufficient description thereof being set forth here to show the operative environment of the troublesome packing glands at the top and bottom of the outer cylinder **30** generally indicated by the reference letters A and B respectively in Figure 3. In the disclosure of the application referred to, the inner ends of the sprocket chains **40** are fixed to a bracket secured to the outer cylinder and the sum total of all load lifting reactions was transmitted directly to the bottom mounting of the inner, small piston **20** and the outer piston unit had no other vertical guiding influence except its sliding contact in the packing gland structure at A and at B. When the ram units became extended under load, a tendency to "jack knife" or rock out of a center line alignment took place and particularly to-

ward the channel rails. Resulting distortion and wear of the packing glands was bound to follow.

By the present invention I provide a means which will take the lifting reaction due to the effort of the outer ram unit while stabilizing the alignment of this unit with the inner ram unit centerline by transmitting it to the telescopic mast structure. This is possible since the outer cylinder never moves vertically except concurrently with movement of the telescopic mast structure due to the difference in the effective pressure areas of the two rams. I accomplish this load transmittal in outrigger fashion by providing a pair of load bearing points at L and L' on load bearing brackets 45 rigidly fixed to the cross bar 34 of the inner movable mast frame. These load bearing pads are countersunk to receive the rounded ends of adjustable screw members 46 which are in threaded engagement with outrigger ears 47 fixed or welded to the face of the outer cylinder 30 at each side of the cylinder in a plane passing through the center line of the hydraulic rams, the sprocket axes which extend parallel to the trackways of the channels 10. The gland mechanism A is subjected to more wear than gland B since it frequently occurs in the use of the truck that transporting and tiering work is done at such elevations as to not require the extra vertical lift afforded by the inner ram mechanism. In any event, under all load elevating conditions the reaction to lifting during the first stage of elevating the carriage is transmitted by the outer ram mechanism directly to the inner telescopic mast structure and thereby to the bottom of the fixed frame without columnar passage or transmission down through the inner ram mechanism.

By having a loose point contact between the screws 46 and the counterbored bottom surfaces of the brackets 45 in the described planular relation to the axes of the ram mechanisms some slight shifting of the outer cylinder is permitted, thus permitting the packing glands on this outer cylinder structure to follow the cylindrical surfaces slidingly sealed against leakage.

Since the load bearing thrust on the outer cylinder is transmitted to the movable mast structure the latter remains down and in a telescoped relation to the outer frame structure during any traversing movement of the carriage upon the inner mast frame. When the carriage reaches the top of the innermost frame and there encounters an obstruction to further elevation, pressure in the inner ram then causes the outer ram mechanism, the carriage and the inner mast structure to elevate relative to the outer mast structure during which action the load transmitting screws 45 remain seated in the countersunk wells of the load bearing brackets 46. When pressure is released in the system to permit gravity to lower the mast, carriage and outer hydraulic mechanism, the same will lower in unison since the effective area of the inner piston is less than that of the outer piston and the screws 46 will remain in contact with the mast brackets 45. The adjustability thereof permits an aligning setting of the cylinder 30.

As distinguished from the arrangements heretofore used, the present compound ram mechanism mounting comprises three points of load bearing support without in any way interfering with the efficient use and operation of the tiering truck and maintenance costs and loss of truck usage are greatly reduced by the increased operative life of the packing glands. Both ram mechanisms are connected at some point to the innermost structure.

I claim:

1. A load tiering mechanism comprising a telescopic mast structure consisting of a relatively fixed frame and an elevatable frame, a load carriage elevatable on the elevatable frame, a compound hydraulic mechanism disposed within the frame members comprising two hollow pistons and two cylinders forming two ram mechanisms hydraulically arranged to be in communication through ports formed in the cylindrical walls thereof whereby one piston and its cylinder are operable as a ram mechanism to effect complete vertical extension of the mast structure, sprocket chain means anchored to the carriage and to the elevatable frame, sprocket means carried by the piston of other of the hydraulic ram mechanisms and over which the sprocket chain means extends for acting on the sprocket chain means to effect elevating movement of the carriage relative to the elevatable frame, and a loose load transmitting connection between the elevatable frame and the last named hydraulic ram mechanism.

2. A load tiering mechanism comprising a telescopic mast structure consisting of a relatively fixed frame and an elevatable frame, a load carriage elevatable on the elevatable frame, a duplex hydraulic mechanism disposed within the frame members comprising two hollow pistons and two cylinders hydraulically in communication and the pistons and cylinders being concentrically arranged to provide an inner piston and cylinder and a second piston and cylinder slidable relative respectively to the inner cylinder and piston, the inner piston and its cylinder being operable to effect complete vertical extension of the mast structure, a flexible means connected to the carriage and to the elevatable frame of the mast structure, means carried by the piston of the second named cylinder and over which the flexible means extends for acting on the flexible means to effect elevating movement of the carriage relative to the elevatable frame of the mast structure, and a loose load transmitting connection between the elevatable frame of the mast structure and said second cylinder.

3. A load tiering mechanism comprising a telescopic mast structure consisting of a relatively fixed frame and an elevatable frame, a load carriage elevatable on the elevatable frame, a compound hydraulic ram mechanism disposed within the frame members comprising two hollow pistons and two cylinders concentrically arranged to provide two ram mechanisms and hydraulically in communication whereby one piston and its cylinder are operable as one ram mechanism to effect complete vertical extension of the mast structure, a flexible means anchored to the carriage and to the elevatable frame, receiving means carried by the piston of the other of the ram mechanisms over which the flexible means extends for acting on the flexible means to effect elevating movement of the carriage relative to the elevatable frame, and a plurality of loose load bearing connections disposed between the elevatable frame and the last named ram mechanism and located in a plane common to the vertical center line of the ram mechanisms.

4. A lift truck comprising a chassis, a mast mounted thereon comprising a lower section coupled to the chassis and an extensible upper section telescoping with the lower section, a load-supporting carriage movable along the mast, a mast ram for extending the mast comprising a cylinder coupled to the upper section and a plunger coupled to the lower section, a carriage ram comprising a cylinder surrounding said mast ram cylinder, said carriage ram cylinder being open at its upper end fixed at its lower end to said mast ram cylinder and in fluid-tight relation therewith, a carriage ram plunger surrounding said mast ram cylinder, said plunger including a downwardly-directed extension tube for disposition between said mast and carriage ram cylinders, adjustable packing means between the upper end of said carriage ram cylinder and said carriage ram plunger as well as between the latter and said mast ram cylinder, a motion multiplying connection between the carriage ram plunger and the carriage to elevate the carriage relative to the upper mast section, and an adjustable loose load transmitting connection between the carriage ram cylinder and the extensible upper section for transmitting the carriage ram reaction thrust to the extensible upper section of the mast.

5. In an industrial truck having a pair of outer vertical guides, a pair of inner vertical guides slidably mounted on said outer guides and movable endwise thereof, a load elevating member slidably mounted on said inner guides, a hydraulically operated mechanism consisting of a plurality of relatively movable concentrically related cylinder-piston elements forming a plurality of ram devices one of which elements is provided with diametrically related reeving devices, flexible members engaging said reeving devices and connected to said load elevating member and to said inner guides, a second of said elements being mounted on the truck frame and a third of said elements being connected to said inner guides, and all of said elements being arranged to be subjected to a common source of fluid pressure, packing means for retaining the fluid located between the piston-cylinder elements, and oppositely disposed loose load transmitting connections between the inner slidable guides and the piston-cylinder reeving device arranged diametrically relative to the said cylinder-piston elements, whereby one of the ram devices is supported on the truck frame and the other ram device is loosely supported on the inner guides.

6. A lift truck comprising a chassis, a mast mounted thereon comprising a lower section coupled to the chassis and an extensible upper section telescoping with the lower section, a load-supporting carriage movable along the mast, a mast ram for extending the mast comprising a cylinder coupled to the upper section and a plunger coupled to the lower section, a carriage ram comprising a cylinder surrounding said mast ram cylinder, said carriage ram cylinder being open at its upper end and fixed at its lower end to said mast ram cylinder and in fluid-tight relation therewith, a carriage ram plunger surrounding said mast ram cylinder, said carriage ram plunger including a downwardly-directed extension tube for disposition between said mast and carriage ram cylinders, sealing means slidably sealing said carriage ram plunger to said carriage ram and mast cylinders, a motion multiplying connection between the carriage ram plunger and the carriage to elevate the carriage relative to the upper mast section, and a loose load transmitting connection between the carriage ram cylinder and the extensible upper section for transmitting the carriage ram reaction thrust to the extensible upper section of the mast.

References Cited in the file of this patent

UNITED STATES PATENTS

2,502,465	Lehman	Apr. 4, 1950
2,505,009	Schroeder	Apr. 25, 1950
2,514,052	Gunning	July 4, 1950
2,598,566	Lehmann	May 27, 1952
2,666,501	Abbe	Jan. 19, 1954
2,678,746	Gibson	May 18, 1954