This invention relates to foldable load lifting apparatus and more specifically to a lift tail gate for motor vehicles which is capable of folding into a compact area disposed completely under the vehicle.

This application is a continuation of my copending application, Serial Number 845,910, filed October 12, 1959, now abandoned.

Lift tail gates are employed on many motor vehicles at the present time to lift loads from the ground on which the vehicle rides to the level of the load carrying bed of the vehicle. These lift tail gates are very useful for their intended lifting purpose, but in some instances seriously interfere with the use of the vehicle; for instance, the lift tail gate is generally permanently disposed behind the vehicle thus making it impossible to back the vehicle up directly to standard loading docks without having the lift tail gate disposed between the loading docks and the load carrying bed of the vehicle. When the lift tail gate is disposed between a loading dock and the bed of the vehicle, it is often impossible to use standard fork lift trucks to load or unload the vehicle because the lift tail gate will not support the combined weight of such fork lift trucks and the loads they carry.

Accordingly, it is a principal object of this invention to provide a load lifting apparatus and particularly a lift tail gate which may be employed in a normal load lifting position and alternatively may be folded out of such normal position to a position in which it is laterally disposed from said normal position.

It is a further object of this invention to provide such a load lifting apparatus which may be folded and unfolded responsive to actuation of the power source which is employed to move the apparatus through its normal load lifting cycle.

It is a further object of this invention to provide a lift tail gate which is capable of folding into a compact area disposed completely under the load carrying bed of the vehicle on which it is used.

Other objects and advantages of the present invention will become apparent from the following description read in conjunction with the attached drawings, in which:

FIG. 1 is a side elevational view of a lift tail gate embodying the principles of this invention and in which the lift gate is illustrated in its horizontal, elevated position and is illustrated schematically in its lower horizontal position adjacent the surface on which the vehicle rides;

FIG. 2 is a rear view in elevation of the gate of FIG. 1 taken along the plane indicated by the line and the arrows at 2-2 in FIG. 1;

FIG. 3 is a side elevational view of a fragment of the apparatus illustrated in FIG. 1 and showing the lift tail gate of FIG. 1 rotated to a first, partially closed position;

FIG. 4 is a side elevational view similar to that of FIG. 3 but showing the gate of FIG. 3 further rotated to a second, partially closed position;

FIG. 5 is a side elevational view similar to FIGS. 3 and 4 but showing the gate of FIGS. 3 and 4 rotated to a third, fully closed position; and

FIG. 6 is a side elevational view similar to FIG. 1 illustrating an alternative form of lift tail gate embodying the principles of this invention.

Broadly stated, this invention comprises a foldable load lifting apparatus comprising a frame with respect to which a load is to be lifted, a normally horizontal load supporting member spaced from said frame, support means between said member and said frame for connecting said member to said frame, support means including a pair of tension arms each pivotally connected at one end to said frame with said member disposed between and pivotally connected to the other ends of the tension arms and a pair of compression arms one adjacent each tension arm on the side thereof remote from said member and pivotally connected at one end to said member and at the other end to said frame, said arms being normally parallel and of equal length thereby maintaining said member in a horizontal position, power means for swinging said support means from a lower position to an upper position with respect to said frame, and means permitting the arms of one of said pairs to change in length responsive to rotation of said member upwardly about its pivotal connection with the other pair of arms.

Referring now in detail to the drawings, and particularly to FIGS. 1 through 5, two support plates 10 are rigidly secured to each side of the load supporting frame 11 of the vehicle. A bracket 12 is rigidly secured to plates 10 on either side of the body 11 of the vehicle, and a vertical ear 13 extends rearwardly of the vehicle from each of the brackets 12. A compression arm 14 is pivotally connected to each of the ears 13 by means of a pivot pin 15 and the free end of compression arm 14 is pivotally connected to a load lifting platform 16 about a pivot pin 17. A tension arm 18 generally indicated at 18 is pivotally connected about pivot pin 19 to each of the ears 13, and the free ends of the tension arms 18 are pivotally connected to platform 16 about pivot pins 20.

In the normal working position of the apparatus in which the top surface of the platform 16 is horizontal, each of the tension arms 18 is extended to its maximum length and is equal in length to the compression arms. Each of the tension arms 18 includes a first strut 21 pivotally connected to platform 16 by means of pivot pin 20 and two parallel struts 22 overlapping strut 21 and pivotally connected by pivot pin 19 to ear 13. The free end of strut 21 is pivotally connected between parallel struts 22 by means of a pivot pin 23. In the normal position of platform 16 in which the top surface thereof is horizontal the axis of pivot pin 23 is laterally spaced from the plane including the axes of pivot pins 19 and 20, and a stop screw 24 is mounted on strut 22 positioned to adjustably contact strut 21 thereby adjusting the maximum length of tension arm 18.

A trunnion 25 is rigidly connected between the brackets 12 on opposite sides of the vehicle, and trunnion 25 carries a rigid ear 26 connected thereto on the outer end of which an hydraulic cylinder 27 is pivotally connected by means of a pivot pin 28. A piston rod 29 extends from cylinder 27 and is pivotally connected by means of a pivot pin 30 to an ear 31 on a trunnion 32 which is rigidly mounted between the compression arms 14 on either side
of the vehicle. Fluid under pressure may be supplied to cylinder 27 by means of conduit 33 from any suitable source.

As illustrated in Fig. 2, the tension arms 18 are positioned on the opposite sides of the platform 16 and each compression arm 14 is positioned on the side of tension arms 18 remote from the platform 16, thus permitting tension arms 18 to pivot in planes inside the planes of compression arms 14 and permitting platform 16 to rotate in the area between the planes of the tension arms 18.

The rear portion of the bed of the vehicle is provided with a rigid bed extending platform 34 having a recess 35 therein into which gate 16 moves when it is moved into its upward position. A chain loop 36 is rigidly mounted on one of the compression arms 14 and a safety chain 37 is adapted to be connected thereto by any suitable snap or clasp; safety chain 37 is secured to the frame 11 of the vehicle by means of a bolt 38.

The load lifting apparatus of this invention is employed to lift loads through a vertical distance by placing the load on the platform 16 in its lowered position, as illustrated in Fig. 1, supplying fluids to cylinder 27 through conduit 33, thereby swinging the tension and compression arms 14 and 18, respectively, and platform 16 to the upper position illustrated in Fig. 1. The platform is returned to its lower position by venting the fluid in cylinder 27, and, alternatively, a directed downward fluid cylinder may be used in place of the cylinder 27. When it is desirable to discontinue lifting use of platform 16, platform 16 can be folded under the body of the vehicle by the steps illustrated sequentially in Figs. 3, 4 and 5. Such folding of platform 16 is accomplished by first lifting platform 16 from the lower position illustrated in Fig. 1 to the position illustrated in Fig. 3, during which lifting operation platform 16 pivots about pivot pin 17 on compression arm 14, and struts 21 and 22 of tension arm 18 pivot with respect to each other about pivot pin 23, thereby shortening tension arm 18 as pivot pin 20 rotates about pivot pin 21 until pivot pin 20 reaches its position closest to pivot pin 19; thereafter rotation of platform 16 to the position illustrated in Fig. 3 causes tension arm 18 to again straighten out until it is again under tension as illustrated in the position of Fig. 3. It should be noted that in the position illustrated in Fig. 3 the center of gravity of platform 16 lies almost directly above pivot pin 17 and extends slightly toward the vehicle body from the vertical plane through the axis of pivot pin 17. This feature of the device is incorporated into the structure illustrated by positioning the tensioning and compression arms in such a fashion that the angle 39 (Fig. 1) subtended at axis 17 by the planes of axes 19 and 17 and axes 17 and 20 is approximately equal to one-half of the angle 49 which a line from the center of gravity 41 of gate 16 to axis 17 makes with a vertical plane through axis 17. It should be noted that if angle 39 is substantially less than one-half of angle 49, one will be unable to lift gate 16 to the position illustrated in Fig. 3 without operating hydraulic cylinder 27. Also, if the structure of Fig. 3 has been illustrated and above described as being adapted for the platform 16 to be rotated to the position of Fig. 3 manually, power operated means may be employed for such rotation.

When gate 16 has been rotated to the position illustrated in Fig. 3, fluid under pressure is supplied to hydraulic cylinder 27 in the same manner as it is supplied to lift loads on gate 16 in normal operation, thus causing compression arm 14 to swing upwardly. As compression arms 14 swing upwardly the weight of platform 16 which is disposed between the vertical planes through axes 17 and 47 maintains under tension during the upward swing and hence causes progressive folding of platform 16 to the position illustrated in Fig. 4 where it rests against trunnion 32 in a position between the tension and compression arms 18 and 14, respectively, and substantially filling the space between said arms. Since platform 16 rests on trunnion 32, it is unable to rotate further with respect to compression arm 14 and hence remains fixed with respect to compression arm 14 as further rotation of compression arms 14 moves the lifting apparatus to the position illustrated in Fig. 5. During the latter part of such lifting operation struts 21 and 22 of tension arms 18 again pivot with respect to each other about pivot pin 23. When the load lifting apparatus is folded and reaches the position illustrated in Fig. 5, it is disposed only under the leading edge of the vehicle and totally inside the vehicle with respect to the outer edge of the extending bracket 34; accordingly, with the gate thus folded, the vehicle may be backed up directly to a loading dock with load extending bracket 34 contacting the loading dock and permitting vehicles to be driven directly from the loading dock onto the load carrying bed of the vehicle without subjecting platform 16 to any excessive load.

When load lifting platform 16 is located in its folded position illustrated in Fig. 5 and it is desirable again to employ this apparatus in a position illustrated in Fig. 1, supplying fluids to cylinder 27 through conduit 33, thereby swinging the tension and compression arms 14 and 18, respectively, and platform 16 to the upper position illustrated in Fig. 1. As fluid escapes from hydraulic cylinder 27 gate 16 will unfold through the positions illustrated in Figs. 5, 4 and 3 in the reverse manual power cylinder unfolding. Thus, after the load lifting mechanism is lowered to the position illustrated in Fig. 4, tension arms 18 will again have straightened out and be under tension so that further lowering of the apparatus causes gate 16 to unfold automatically to the position illustrated in Fig. 3. Thereafter one need merely apply a slight force to the top edge of gate 16, pulling it rearwardly of the vehicle, to completely unfold the gate, thus avoiding the necessity of reaching in underneath the vehicle to lift the heavy gate 16 from an awkward position. It should be noted that the more nearly is angle 39 (Fig. 1) equal to one-half of angle 40, the greater will be the extent of the above described automatic unfolding of the platform from the position illustrated in Fig. 4 to the position illustrated in Fig. 3. Accordingly, it is preferable to construct the load lifting apparatus of this invention with angle 39 approximately equal to one-half of angle 40.

The particular lift tail gate illustrated in Figs. 1 through 4, vehicle body extending platform 16 and arms of the arm; however it is obvious that any other contractable tension arm may be employed which has a maximum length and is free to shorten. Furthermore, the lift tail gate may be constructed with a rigid tension arm and an extensible compression arm, as illustrated in Fig. 6, in which a rigid bar 18 is employed as the tension arm and the compression arm is constructed of a hollow tube 42 carrying an ear 43 thereon pivotally connected to the vehicle about pivot pin 15; a tube 45 is telescopically mounted in tube 42 and carries an ear 46 on the remote end thereof pivotally connected to gate 16 by means of pivot pin 17. In Fig. 6, the trunnion 32 is supported from the tension arms 18 by hinge 48, which is carried by the arms 18. A flange 47 is provided on tube 45 positioned to abut against the outer end of tube 42 restricting the minimum length of the compression arm to a length equal to that of the tension arm 18. Furthermore, it is obvious that a combination of an extensible compression arm and a contractile tension arm may be employed in accordance with this invention.

An important aspect of this invention is the fact that, as opposed to prior art structures, the structure of the invention employs compression arms disposed laterally outside of the tension arms supporting the lift gate. This feature, coupled with the fact that the arms are also outside the outer surfaces of the gate, permits the construction of the gate to fall upon the supporting arms under the vehicle. In addition, the outwardly dis-
posed compression arms insure greater lateral rigidity of platform 16, permit the replacement of cylinder 27 by two cylinders disposed outwardly of compression arms 14 thereby avoiding obstructions under the vehicle, and permit the construction of the folding lifting apparatus of this invention with such dimensions that the gate 16 will not be folded under the vehicle at an oblique angle as illustrated in FIG. 5 but instead will rotate beyond the plane of the compression arms to a position where it is substantially vertical under the vehicle, thus permitting the edge of the gate to be coplanar with the load carrying bed of the vehicle and thus replace the bed extension bracket 34.  

Said member still many additional variations of the structure illustrated herein can be made without departing from the spirit and scope of this invention and accordingly this invention is defined by the following claims.

1 claim:

1. A foldable load lifting apparatus comprising a frame with respect to which a load is to be lifted, a normally horizontal load supporting member spaced from said frame, support means between said member and said frame for connecting said member to said frame, said support means including a pair of tension arms, each pivotally connected at one end to said frame, with said member disposed wholly between and pivotally connected to the other ends of said tension arms, and a pair of compression arms, one adjacent each tension arm on the side thereof remote from said member, pivotally connected at one end to said member and at the other end to said frame, said arms being normally parallel and of equal length thereby normally maintaining said member in a horizontal position, power means for swinging said support means from a lower position to an upper position with respect to said frame, and means embodied between the ends of the arms of one of said pairs permitting said arms to change in length responsive to rotation of said member upwardly about its pivotal connection with the other pair of arms.

2. The apparatus of claim 1, said last mentioned means being associated with said compression arms and permitting elongation thereof.

3. The apparatus of claim 2 in which each of said compression arms comprises two rigid tubes telescopically mounted one within the other pivotally connected together to change the length of said arm, means for pivotally connecting one end of one of said tubes to said frame, and means for pivotally connecting the remote end of the other of said tubes to said member, the minimum length of said compression arm being equal to the maximum length of said tension arms.

4. The apparatus of claim 1, said last mentioned means being associated with said tension arms and permitting the effective length thereof to be decreased.

5. The apparatus of claim 4 in which each of said tension arms comprises two struts pivotally connected together about a first axis, means for pivotally connecting one of said struts to said member about a second axis, means for pivotally connecting the other of said struts to said frame about a third axis, and means carried by one of said struts limiting relative rotation of said struts about said first axis to prevent said struts from assuming a position in which said first, second and third axes are coplanar.

6. The apparatus of claim 4 characterized further in that said pair of tension arms is pivotally connected to said frame about a first axis and pivotally connected to said member about a second axis, said pair of compression arms is pivotally connected to said member about a third axis, and when said support means is in said normal, lower position, the magnitude of the interior angle at said third axis defined by the plane containing said first and third axes and the plane containing said second and third axes is approximately equal to one-half of the angle defined between a line extending from the center of gravity of said member to said third axis and a line extending vertically upward from said third axis.

7. The apparatus of claim 6 in which each of said tension arms comprises struts pivotally connected together about a fourth axis, and means carried by one of said struts limiting relative rotation of said struts about said fourth axis to prevent said struts from assuming a position in which said first, second and fourth axes are coplanar.

8. A foldable lift tail gate for motor vehicles comprising a vehicle frame having a rearwardly projecting load carrying bed, a normally horizontal load supporting platform, support means disposed under said load carrying bed for connecting said platform to the frame of said vehicle, said support means including a pair of tension arms, each pivotally connected at one end to said vehicle, with said platform disposed wholly between the other ends of said tension arms and pivotally connected thereto, and a pair of compression arms, one adjacent each tension arm on the side thereof remote from said platform, pivotally connected at one end to said vehicle and at the other end to said platform, all of said arms being normally parallel and of equal length, thereby normally maintaining said platform in a horizontal position, power means for swinging said support means from a lower position adjacent the ground on which said vehicle rides to an upper position adjacent said load carrying bed, and means for folding said platform to a position overlaying said support means and disposed under said load carrying bed, said means comprising means embodied between the ends of the arms of one of said pairs permitting said arms to change in length responsive to rotation of said platform upwardly about its pivotal connection with the other pair of arms.

9. The lift tail gate of claim 8 characterized further in that said last mentioned means is associated with said tension arms and permits the effective length thereof to be decreased, said pair of tension arms is pivotally connected to said vehicle about a first axis and pivotally connected to said platform about a second axis, said pair of compression arms is pivotally connected to said platform about a third axis, and, when said platform is in its lower horizontal position adjacent the surface on which said vehicle rides, the magnitude of the interior angle at said third axis defined by the plane containing said first and third axes and the plane containing said second and third axes is approximately equal to one-half of the angle defined between a line extending from the center of gravity of said platform to said third axis and a line extending vertically upward from said third axis.

10. The lift tail gate of claim 9 characterized further in that each of said tension arms comprises two struts pivotally connected together about a fourth axis and means carried by one of said struts limiting the relative rotation of said struts about said fourth axis to prevent said struts from assuming a position in which said first, second and fourth axes are coplanar.

11. The apparatus of claim 2 characterized further in that said pair of compression arms is pivotally connected to said frame about a first axis and pivotally connected to said member about a second axis, said pair of tension arms is pivotally connected to said member about a third axis, and when said support means is in said normal, lower position, the magnitude of the exterior angle at said third axis defined by the plane containing said first and third axes and the plane containing said second and third axes is approximately equal to one-half of the angle defined between a line extending from the center of gravity of said member to said third axis and a line extending vertically upward from said third axis.

12. A foldable lifting apparatus comprising a frame with respect to which a load is to be lifted, a normally horizontal load supporting member spaced from said frame and having a forward end and a rearward end, support means between said member and said frame for
connecting said member to said frame, said support means including a pair of tension arms, each pivotally connected at one end to said frame, with said member being disposed wholly between and being pivotally connected adjacent its rearward end to the other ends of said tension arms, and a pair of compression arms, one adjacent each tension arm on the side thereof remote from said member pivotally connected at one end to said member adjacent the rearward end thereof and at the other end to said frame, said arms being normally parallel and of equal length, thereby normally maintaining said member in a horizontal position, power means for swinging said tension and compression arms from a lower position to an upper position with respect to said frame, and means associated with the arms of one of said pair of arms operative to enable the pivotal connection between said member and said one pair of arms to arcuately swing around a center of rotation constituted by the pivotal connection between said member and the other pair of arms and thereby reposition said member so that the forward end thereof is directed toward the pivotal connections between said pairs of arms and said frame.

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