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(19)



(54) DIFFERENTIAL MOUNTING AND DRIVE ARRANGEMENT FOR VEHICLE WHEELS

(71) We, TOWMOTOR CORPORATION, a corporation organized and existing under the laws of the State of Ohio, United States of America, of 7111 Tyler Boulevard, Mentor, State of Ohio 44060, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to differential mounting and drive arrangements for vehicles such as fork lift trucks, which permit mounting differentials at various locations relative to the wheel axes.

The design of a particular fork lift truck is usually a compromise of many factors which affect the stability, handling and manoeuvrability of the truck. For example, some lift trucks have a short wheel base for maximum manoeuvrability within a confined base, while other lift trucks have a longer wheel base for greater stability. Another factor is the location of the drive train, i.e. engine, transmission and differential, since these components contribute greatly to the mass which counterbalances the load lifted by the lift trucks. For short wheel base trucks, the centre of gravity of the drive train is closer to the centreline of the front wheels than that of a longer wheel base truck. The vertical position of the drive line centre of gravity also effects the stability and is normally a compromise between stability and ground clearance and may be dictated by the type of tyres, i.e. cushion or pneumatic, used on the lift truck. Thus, several similarly sized lift trucks may have the same power requirements and a basic drive train may be employed on such similar machines. However, each particular lift truck design requires its own drive train mounting and one of the problems in the manufacturing of the lift trucks is that of providing maximum use of common basic

components for similar vehicles to reduce the manufacturing costs and number of components required.

According to the present invention a differential mounting and drive arrangement for driving vehicle wheels comprises an axle beam having a pair of vertically spaced upper and lower plates, a pair of side plates individually secured to the ends of the upper and lower plates and each side plate having an aperture extending therethrough, and a pair of vertically oriented plates secured to the forward edges of the upper and lower plates; a pair of spindles individually secured to the outer surfaces of the side plates and defining a horizontal axis extending there-through; a pair of drive gears individually journaled on the spindles; a differential disposed at least partially within the axle beam and secured to one of the pairs of plates; and a pair of jackshafts extending outwardly from opposite sides of the differential and through the apertures in the side plates, each of the jackshafts having a gear formed on its distal end and mating with the associated drive gear, the jackshafts and the apertures being radially offset from the horizontal axis a predetermined distance as determined by the mating relation between the gears, and wherein the aperture in each plate is located on one or other of a pair of diametrically opposite arcs of a circle having the horizontal axis as its centre and the predetermined distance as its radius, with one of the arcs being disposed forwardly of the horizontal axis.

The invention provides an improved differential mounting and drive arrangement which may be employed for several similarly sized lift trucks and permits positioning of the differential either forwardly or rearwardly of the centreline of the drive wheel by selective positioning of the side plate apertures.

Also the invention provides a differential

mounting and drive arrangement which utilizes a common, basic axle beam structure for use on several similarly sized lift trucks.

One example of a differential mounting and wheel drive arrangement according to the invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a side elevational view of a lift truck illustrating one position of a differential relative to the drive wheels;

Figure 2 is a front elevational view of the differential mounting and wheel drive arrangement embodying the principles of the present invention with portions in section for illustrative convenience;

Figure 3 is an enlarged sectional view taken along line III-III of Figure 2;

Figure 4 is a sectional view taken along line IV-IV of Figure 2.

Figure 5 is a sectional view taken along line V-V of Figure 2; and

Referring now to the drawings, a fork lift truck is generally indicated by the reference numeral 10 and includes an engine 11 and a transmission 12 mounted therein in the usual manner for powering a differential 13 through a short drive shaft 14. A lift mast assembly 15 is mounted on the forward end of the truck.

As more clearly shown in FIGS. 2 and 3, a differential mounting and wheel drive arrangement embodying the principles of the present invention is generally indicated by the reference numeral 16 and includes a fabricated axle beam 17 transversely disposed at the forward end of the lift truck. The axle beam includes a pair of transversely disposed vertically spaced elongated upper and lower plates 18 and 19, respectively. A pair of side plates 21 are individually secured to the adjacent ends of the upper and lower plates. As shown in FIGS. 4 and 5, each side plate has an aperture 22 and a plurality of threaded holes 23, extending therethrough. A pair of vertically oriented differential support plates 24 are secured to the forward edges of the upper and lower plates and are disposed inwardly from the side plates. Each support plate has a hook 25 formed thereon for receiving the mast assembly mounting, not shown.

A pair of wheel spindles 26 are individually secured to the outer surface of each of the side plates by a plurality of bolts 27 screw threaded into the threaded holes and have a horizontally disposed axis A extending therethrough. The horizontal axis is disposed rearwardly of the vertical plates 24. The spindle has a recess 28 formed therein in alignment with the aperture 22 in the side plate. A pair of axially spaced, reduced diameter portions 29 and 31 and an externally threaded portion 32 are formed on the wheel spindle concentric with the horizontal

axis. An annular hub 33 is rotatably mounted on each of the wheel spindles by a pair of bearings 34 and secured to the spindle with a nut 36 screw threaded onto the threaded portion. A wheel drive gear in the form of an internal ring gear 37 is formed in the hub as an integral part thereof and is disposed adjacent to the side plate. A wheel indicated by the dashed lines in Fig. 2 at 38 is suitably secured to the end of the hub in the usual manner. An annular cover 39 is secured to the outer surface of the side plate concentric with the horizontal axis by a plurality of bolts 41. The cover carries a seal 42 which seals against the peripheral surface of the hub. A dust cover 43 is secured to the end of the hub and cooperates with the seal to provide a sealed environment for the ring gear and bearings.

The differential 13 is disposed partially within the axle beam and is secured to the vertical support plates by a pair of brackets 44, each of which is fastened to its respective vertical plate by a pair of bolts. Each of a pair of jackshafts 47 extends horizontally outwardly from the differential and through a bearing 48 disposed within the aperture 22 in the side plate 21. A gear 46 is formed on the distal end of each jackshaft and meshes with the ring gear 37 for driving the hub 33 and wheel 38. The gear is positioned within the recess 28 of the wheel spindle 26. The centerline of the differential is the same as the center of the jackshafts.

The apertures 22 formed in the side plates 21 and the jackshafts 47 extending outwardly from the differential 13 are offset radially from the horizontal axis A a predetermined distance as determined by the sizes and meshing relation of the gears 37 and 46. The differential is positioned by the brackets so that the jackshafts are in alignment with the apertures. When the axle beam 17 is employed in one particular lift truck design, the apertures 22 are machined in the position shown by the solid lines in FIG. 4. In such position, the apertures are disposed forwardly of the horizontal axis and rearwardly of the vertical plates 24.

However, when the axle beam 17 is employed in other lift truck designs, each of the apertures 22 is located in one of a plurality of positions which are disposed on a pair of diametrically opposed arcs of a circle which has the horizontal axis A of the spindle 26 as its center and the predetermined distance that the aperture is offset from the axis as its radius R. One such position is shown by the broken line position in FIGS. 4 and 5 wherein the apertures and jackshafts are disposed rearwardly of and above the horizontal axis.

Since the jackshafts 47 extending outwardly from the differential 13 must be aligned with the apertures 22, the differential

is positioned within the axle beam in accordance with the location of the aperture such as shown by the broken line position of the differential in FIGS. 3 and 5. With the differential in the broken line position, a spacer 51 is disposed between each of the brackets 44 and its respective vertical support plate 24. The wheel spindles 26 may also be positioned so that the recess 28 is aligned with the apertures.

In view of the foregoing, it is readily apparent that the present invention provides an improved differential mounting and drive arrangement which may be used for a variety of similarly sized lift trucks. This is accomplished by mounting the wheel spindle to the axle beam so that the horizontal axis extending through the spindle is disposed rearwardly of the vertical plates of the axle beam. This permits the aperture through which the jackshaft extends, to be machined within the side plate forwardly or rearwardly of the horizontal axis. Thus, the differential may be mounted within the axle beam in a selected one of several positions to permit the basic axle beam structure to be used on several similarly sized trucks by preselecting the position at which the apertures are machined to suit the particular truck.

WHAT WE CLAIM IS:—

1. A differential mounting and drive arrangement for driving vehicle wheels, the arrangement comprising an axle beam having a pair of vertically spaced upper and lower plates, a pair of side plates individually secured to the ends of the upper and lower plates and each side plate having an aperture extending therethrough, and a pair of vertically oriented plates secured to the forward edges of the upper and lower plates;

a pair of spindles individually secured to the outer surfaces of the side plates and defining a horizontal axis extending there-through; a pair of drive gears individually journaled on the spindles; a differential disposed at least partially within the axle beam and secured to one of the pairs of plates; and a pair of jackshafts extending outwardly from opposite sides of the differential and through the apertures in the side plates, each of the jackshafts having a gear formed on its distal end and mating with the associated drive gear, the jackshafts and the apertures being radially offset from the horizontal axis a predetermined distance as determined by the mating relation between the gears, and wherein the aperture in each plate is located on one or other of a pair of diametrically opposite arcs of a circle having the horizontal axis as its centre and the predetermined distance as its radius, with one of the arcs being disposed forwardly of the horizontal axis.

2. A differential mounting and drive arrangement according to claim 1, wherein the differential is disposed forwardly of the horizontal axis and the jackshafts are located in the apertures of the arcs disposed forwardly of the horizontal axis.

3. A differential mounting and drive arrangement according to claim 1 or claim 2 wherein the differential is secured to the vertical plates.

4. A differential mounting and drive arrangement according to claim 1, substantially as described with reference to the accompanying drawings.

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and a pair of jackshafts extending outwardly from opposite sides of the differential and through the apertures in the side plates, each of the jackshafts having a gear formed on its distal end and mating with the associated drive gear, the jackshafts and the apertures being radially offset from the horizontal axis a predetermined distance as determined by the mating relation between the gears, and wherein the aperture in each plate is located on one or other of a pair of diametrically opposite arcs of a circle having the horizontal axis as its centre and the predetermined distance as its radius, with one of the arcs being disposed forwardly of the horizontal axis.

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