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POSITION DETECTING ARRANGEMENTS FOR MOBILE CRANES

This invention relates to position detecting arrangements for mobile cranes, particularly remote-controlled mobile cranes.

Recently, a large number of remote-controlled mobile cranes, driven by rubber-tyred wheels, are used in container yards or the like. These cranes, referred to herein as truckless cranes, and sometimes known as straddle cranes, are used for loading and unloading containers in container yards each having a plurality of container stacking areas. Such a truckless crane is moved between container stacking areas where a great number of containers are loaded and unloaded for operating at high efficiency.

The administration of the running of the truckless cranes is supervised at a central supervisory station, but as the area of the container yard is expanded to accommodate an increased number of the cranes, the efficiency of the supervision of the running of the truckless cranes can be increased if a computer is used rather than relying upon manual supervision.

For the purpose of efficiently supervising the running of many truckless cranes with a computer, it is necessary to input to the computer the positions of the truckless cranes from time to time. To this end, it is necessary to automatically detect the positions of the truckless cranes.

According to a prior art position detecting device, as disclosed in West German Patent No. 2,410, 985, detection coils are buried in the ground at a spacing of about 50 m for transmitting signals

utilized to identify the positions of the coils. The positions of the coils are used as position correcting points. Further, a plurality of transmission lines for transmitting data are buried in the surface of the road along which the truckless cranes run, and the transmission lines are crossed at a suitable spacing to form cross points. The position of a truckless crane is detected by counting the number of the cross points of the transmission lines passed by the crane starting from a buried coil acting as a position correction point. The accuracy of detection of this position is about 0.5 m. The positional information thus detected is transmitted to a central computer via the transmission lines.

Such a prior art system, however, requires coils and transmission lines to be buried in the ground in the container yard. Accordingly its construction cost is high and it is difficult and expensive to install such a system in existing container yards.

Accordingly, it is an object of this invention to provide an improved position detecting arrangement for truckless cranes in which it is not necessary to bury coils and information lines in a container yard.

According to this invention, there is provided a position detecting arrangement for a mobile crane running on resilient wheels, said arrangement comprising a plurality of ground elements installed in a path of said crane and arranged to provide specific positional information, a beam mounted by expandable

mounting means on a lower portion of said crane, further wheels disposed substantially beneath and substantially at opposite ends of said beam to permit said further wheels to engage the ground, and a
5 plurality of detecting means mounted on said beam to detect said plurality of ground elements to provide a signal representative of said specific positional information, said detecting means being mounted higher than the lower portions of said further wheels
10 to maintain said detecting means clear of the ground.

In the accompanying drawings:

Figure 1 is a plan view of a container yard;

Figure 2 is a side view showing one example of a truckless crane;

15 Figure 3 is a side view illustrating a position detecting arrangement embodying the invention for use in a truckless crane;

Figure 4 is a plan view of the ground elements; and

20 Figure 5 is an end view showing a modified embodiment of a position detecting arrangement according to this invention.

A container yard shown in Figure 1 has six lanes A through F, each having two container stacking
25 areas 1a and 1b. A truckless crane 2 runs along paths 3 extending in the longitudinal direction of the container stacking areas 1a and 1b and a shift passage 4 extending at right angles with respect to the paths 3 to move from one lane to another.
30 Passive ground devices 5 are disposed at positions a through h along the passages 3 at a spacing of about 50 m.

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As shown in Figure 2, the truckless crane 2 comprises rubber wheels 6a and 6b which are diametrically turnable and can be secured at two positions of 0° and 90°. Figure 2 shows the wheels 6a and 6b secured at a 0° position. A detecting device 7 is suspended from the bottom of the truckless crane structure 8 for detecting the position of the truckless crane 2 in cooperation with the ground devices 5. A detector 9 is driven by the rubber wheel 6b for detecting the distance run.

Details of the ground devices 5 and the detecting device 7 on the crane are shown in Figure 3. Thus, a beam 10 is provided beneath the crane. Further wheels 11a and 11b are disposed at opposite ends of the beam 10, and a plurality of proximity switches $12_1 - 12_9$ acting as detecting means for the ground devices 5 are provided in a linear array along the beam 10 between the wheels 11a and 11b. The lower ends of the proximity switches $12_1 - 12_9$ are positioned above the lower portions of the wheels 11a and 11b. The beam 10, provided with the wheels 11a and 11b and proximity switches $12_1 - 12_9$, is hung from the bottom of the crane structure 8 by expandable mounting mechanisms 13. The ground devices 5 are constituted by ground elements $5_1 - 5_9$ (in the example shown in Figure 3, the ground elements 5_4 and 5_6 are not provided) made of steel plates. These passive ground elements $5_1 - 5_9$ are disposed in a linear array on the ground surface to oppose the proximity switches $12_1 - 12_9$ respectively i.e., to be registrable in one-to-one relationship therewith. By properly

combining presence and absence of the ground elements $5_1 - 5_9$ in a regular linear array, the position where each plurality of ground elements is installed can be specified and identified. When the truckless crane 2 is not loaded, wheels 11a and 11b are maintained at positions spaced from the ground surface as shown in Figure 3. Even at this spaced state, the proximity switches $12_1 - 12_9$ can detect the presence or absence of the ground elements $5_1 - 5_9$.

Figure 4 shows an arrangement of one of the ground devices 5. The ground elements 5_1 and 5_9 are used as information read commands, and both of these ground elements 5_1 and 5_9 are indispensable. Ground elements $5_2 - 5_4$ (in the example shown in Figure 4, the ground element 5_4 is not provided) represent lane numbers, that is lanes A - F shown in Figure 1, while ground elements $5_5 - 5_7$ (in the example shown in Figure 4 the ground element 5_5 is not provided) represent addresses, that is a - h shown in Figure 1. The ground element 5_8 is used as a parity code for detecting error. In this example, since the numbers and the addresses of the lanes are represented by combinations of three ground elements $5_2 - 5_9$ and ground elements $5_5 - 5_7$, it is possible to identify 8 types of the combinations, i.e. to provide 8 items of specific positional information.

The specific positional information detected by the position detecting device constituted by the ground devices 5 and the device 7 mounted on the crane 2 is transmitted to a computer, not shown, which performs an overall control of the truckless cranes through a wireless transmitter and a receiver, not shown, mounted on the truckless crane 2.

In operation, the truckless crane 2 runs along the passages 3 with its rubber wheels 6a and 6b fixed at the 0° positions. When the crane 2 is not loaded, since the proximity switches 12¹ - 12⁹ are spaced from the ground surface as shown in Figure 3, the crane can run freely. However, when the truckless crane 2 is loaded, the running rubber wheels 6a and 6b become compressed, and the crane structure 8 lowers as a whole.

At this time, although the proximity switches 12¹ to 12⁹ on the beam 10 are lowered, the wheels 11a and 11b at the opposite ends of the beam 10 land on the ground so that the lowering of the proximity switches 12 - 12 ceases.

Since the lower¹ ends of the proximity switches 12¹-12⁹ are situated above the lower portions of the wheels 11a and 11b, the proximity switches are maintained at positions a predetermined distance spaced from the ground surface, so that these switches do not make contact with the ground surface.

When the load is increased, the rubber wheels 6a and 6b are compressed further to further lower the crane structure 8. However, since wheels 11a and 11b have already landed on the ground surface, the beam 10 cannot move yet lower, and the expandable mechanism 13 contracts so as to prevent the beam from being forced downwards with a force larger than a predetermined value.

As described above, the truckless crane 2 travels while always maintaining the proximity switches 12¹-12⁹ at positions clear of the ground surface. When the detecting device 7 arrives at a position

immediately above and in register with the ground device 5 to detect both ground elements 5_1 and 5_9 , information indicative of the ground elements $5_2 - 5_8$ is read by the detecting device 7 on the crane, thus detecting the present specific position of the truckless crane.

As described above, since the ground devices 5 are installed at a spacing of about 50 m, the positions between the ground devices are finely detected by the running distance detector 9 operating in response to rotation of the rubber wheel 6b so that an accuracy of about 1 m can be obtained.

When the crane 2 reaches the shift passage 4, the rubber wheels 6a and 6b are diametrically turned and fixed at 90° positions, and then crane 2 is moved to a suitable lane. Thereafter, the rubber wheels 6a and 6b are diametrically turned and fixed at the 0° positions and the crane is run along a predetermined lane. The position detection of the crane along a new lane can be made in the same manner as in the previous lane.

A modification shown in Figure 5 is similar to that shown in Figure 3 except that the opposite ends of the beam 10 are connected to lifting devices 14 secured to the lower portion of the crane structure 8, through chains 15. The lifting devices 14 are operated to raise the beam 10 in an interlocked relation with the operation of fixing the rubber wheels 6a and 6b at 90° positions.

The modification shown in Figure 5 operates substantially in the same manner as the previous embodiment.



Thus, when it is desired to move the truckless crane 2 to another lane, the crane 2 is run to the shift passage 4 at which time the rubber wheels 6a and 6b are diametrically turned and fixed at the 90° positions. At this time, the lifting devices 14 are simultaneously operated to raise the beam 10 and to separate the wheels 11a and 11b away from the ground surface. During the lifting operation, since the wheels 11a and 11b are diametrically turned 90°, it is not necessary to detect positions while the crane 2 runs along the shift passage 4. These operations are performed for the purpose of protecting the proximity switches 12₁ - 12₉.

When the crane 2 reaches a desired lane after passing through the shift passage 4, the rubber wheels are returned to the 0° positions, and then the beam 10 is lowered to cause the wheels 11a, 11b to engage the ground surface. Then, the crane is run along a new lane to detect again the positions.

As described above, the position detecting device of a truckless crane embodying the invention, comprises a plurality of ground elements installed at predetermined positions of the path of movement of the crane, a pair of wheels on the bottom of the crane, a beam hung by expandable mechanisms and a plurality of proximity switches which cooperate with the ground elements to detect the positions. Consequently, different from the prior art detecting devices, it is not necessary to embed information wires and coils in the container yard. In other words, it is only necessary to install ground elements which can be made very easily with a small cost.

CLAIMS

1. A position detecting arrangement for a mobile crane running on resilient wheels, said arrangement comprising a plurality of ground elements installed in a path of said crane and arranged to provide specific positional information, a beam mounted by expandable mounting means on a lower portion of said crane, further wheels disposed substantially beneath and substantially at opposite ends of said beam to permit said further wheels to engage the ground, and a plurality of detecting means mounted on said beam to detect said plurality of ground elements to provide a signal representative of said specific positional information, said detecting means being mounted higher than the lower portions of said further wheels to maintain said detecting means clear of the ground.

2. An arrangement according to claim 1 wherein each said ground element comprises a metal plate.

3. An arrangement according to claim 1 or claim 2 wherein each said detecting means comprises a proximity switch.

4. An arrangement according to any one of claims 1 to 3 wherein a number of said pluralities of ground elements are provided in different predetermined positions, each said plurality comprising a different linear array of passive ground elements specific to its position, and wherein said detecting means are arranged in a linear array along said beam.



5 5. An arrangement according to claim 4 wherein each said array of passive ground elements comprises a ground element present or absent in each of said predetermined number of spaced element positions, and wherein said detecting means are arranged in a row registrable in one-to-one relationship with said spaced element positions.

10 6. An arrangement according to any one of claims 1 to 5 including a running distance detector arranged to operate in response to rotation of one of said resilient wheels.

15 7. An arrangement according to any one of claims 1 to 6 including lifting devices operable to lift said beam upwardly to take the further wheels clear of the ground.

20 8. An arrangement according to any one of claims 1 to 7 for a container-moving crane in a container yard, said yard having a plurality of parallel lanes interconnected by a shift passage perpendicular to said lanes, and said crane being adapted to shift through said shift passage from one lane to another by diametrically turning said resilient wheels through a right angle.

25 9. A position detecting arrangement for a mobile crane substantially as described herein with reference to the accompanying drawings.

