

SUSPENDED LOAD SWING DISPLACEMENT DETECTOR

BACKGROUND OF THE INVENTION

This invention relates to a swing displacement detector for measuring the swing displacement of a suspended load in a crane.

The structure of a conventional crane is shown in Fig. 3.

As shown in Fig. 3, a crane upper structure 1 is supported on the ground via legs 2. Rails 3 are installed on the upper structure 1, and a trolley 4 is borne movably on the rails 3.

From the trolley 4, a rope 5 hangs down, and a suspended load 6 is attached to the front end of the rope 5, whereby the suspended load 6 is transported.

When an automatic run is to be performed in such a crane, control for steadying (i.e., stopping the swing of) the suspended load is necessary. To carry out the steadying control, it is necessary to measure the relative displacement of the trolley 4 and the suspended load 6 as a feedback signal.

To measure this displacement of the suspended load 6, a marker 11 is put on the suspended load 6. This marker 11 is shot with a camera 12 mounted on the trolley 4 vertically downwards. A picture of the marker 11 taken is entered into a suspended load displacement detector 15 which performs image processing of the picture to detect the displacement x_1 of the marker 11.

With such a crane, a long periodic wave component lasting about 5 to 10 seconds is observed in vibrations of the rope 5 about the position of mounting of the rope 5 on the trolley 4 as a fulcrum.

However, the measured value x_1 of swing displacement

based on the camera 12 mounted on the trolley 4 presents a signal comprising the long periodic wave component, the vibrations of the rope 5, superimposed by a short periodic wave component with a period of about 2 seconds, as illustrated in Fig. 4.

The reason is as follows: As shown in Fig. 5, the crane upper structure 1 supported by the legs 2 vibrates horizontally owing to a warp of the leg 2 (the vibration is designated as displacement x_2). In accordance with the vibrations, the trolley 4 and the camera 12 mounted on the trolley 4 also vibrate in the horizontal direction. Thus, the displacement x_2 from the vibrations of the crane upper structure 1 is detected at the same time.

Control for steadying of the suspended load 6 is aimed at stopping the long periodic vibrations of the rope 5. Such a short periodic component acts as a disturbance in the feedback signal for control, thus constituting a factor for lowering the control performance.

SUMMARY OF THE INVENTION

The present invention has been accomplished under these circumstances. The object of the invention is to provide a swing displacement detector which comprises a crane upper structure displacement detector for measuring the displacement of a crane upper structure; and an arithmetic means for performing processing of a difference between the measured value of a suspended load swing displacement detector and the measured value of the crane upper structure displacement detector; and which corrects the measured value of the suspended load swing displacement detector.

The present invention has the upper structure displacement detector for measuring the displacement of the crane upper structure, and based on its measured value,

corrects the measured value of the suspended load swing displacement detector. Thus, the invention can eliminate the vibrational component of the crane upper structure from the measured value of swing of the suspended load, thereby detecting the swing component of the suspended load highly accurately.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a structural view of a swing displacement detector in an embodiment of the present invention;

Fig. 2 is an output characteristic view of the swing displacement detector according to the present invention;

Fig. 3 is a structural view showing the outline of a conventional swing displacement detector;

Fig. 4 is an output characteristic view of the conventional swing displacement detector; and

Fig. 5 is a view showing the manner of vibration of a crane upper structure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A structural view of a swing displacement detector related to an embodiment of the present invention is shown in Fig. 1. The same parts as in the aforementioned earlier technology are assigned the same numerals and symbols, and explanations for them are omitted.

As shown in the drawing, a marker 13 is fixed on the ground, and a ground surface marker camera 14 is attached onto a crane upper structure 1.

The ground surface marker camera 14 shoots the marker 13, and sends its image signal to an upper structure displacement detector 16.

The upper structure displacement detector 16 performs image processing of the signal to determine the displacement

of the marker 13, that is, relative displacement between the upper structure 1 and the ground.

A suspended load displacement, x_1 , detected by a suspended load displacement detector 15, and an upper structure displacement, x_2 , detected by the upper structure displacement detector 17 are each sent to an arithmetic unit 17.

The arithmetic unit 17 calculates the difference between the suspended load displacement x_1 and the upper structure displacement x_2 .

The measured value x_1 of suspended load displacement by the suspended load displacement detector 15 is a value comprising the swing displacement of the suspended load superimposed by the displacement of the upper structure 1, as shown in Fig. 2.

The upper structure displacement detector 16, on the other hand, measures the relative displacement between the marker 13 and the upper structure, namely, the vibrational displacement of the upper structure relative to the ground surface.

Hence, the difference between the suspended load displacement x_1 and the upper structure displacement x_2 is sequentially calculated by the arithmetic unit 17, whereby a corrected value, x_3 , of suspended load displacement unaffected by the vibrations of the upper structure 1 can be obtained as shown in Fig. 2.

It goes without saying that the means of detecting the displacement of the crane upper structure 1 may be a method using the image processing system disclosed in the instant embodiment, or a method of integrating, twice, the output of an accelerometer attached in the direction in which displacement is measured.

As described concretely based on the embodiment, the

present invention eliminates the vibrational component of the crane upper structure from the measured value of swing of the suspended load. Thus, it can constitute a highly accurate suspended load swing displacement detector even for a crane having a vibrational component in the crane structure.

CLAIMS

1. A suspended load swing displacement detector comprising a swing displacement detector for detecting relative displacement between a trolley and a suspended load in a crane suspending the suspended load by a rope or the like; a crane upper structure displacement detector for detecting the displacement of a crane upper structure supporting the trolley from the ground surface; and an arithmetic means for receiving as inputs the measured value of suspended load displacement by the swing displacement detector, and the measured value of crane upper structure displacement by the crane upper structure displacement detector, and for correcting the measured value of suspended load displacement based on the difference between the measured value of suspended load displacement and the measured value of crane upper structure displacement.
2. The suspended load swing displacement detector of claim 1, wherein the measured value of suspended load displacement corrected by the arithmetic means is free from a short periodic wave component associated with vibrations of the crane upper structure, and consists merely of a long periodic wave component associated with vibrations of the rope or the like.

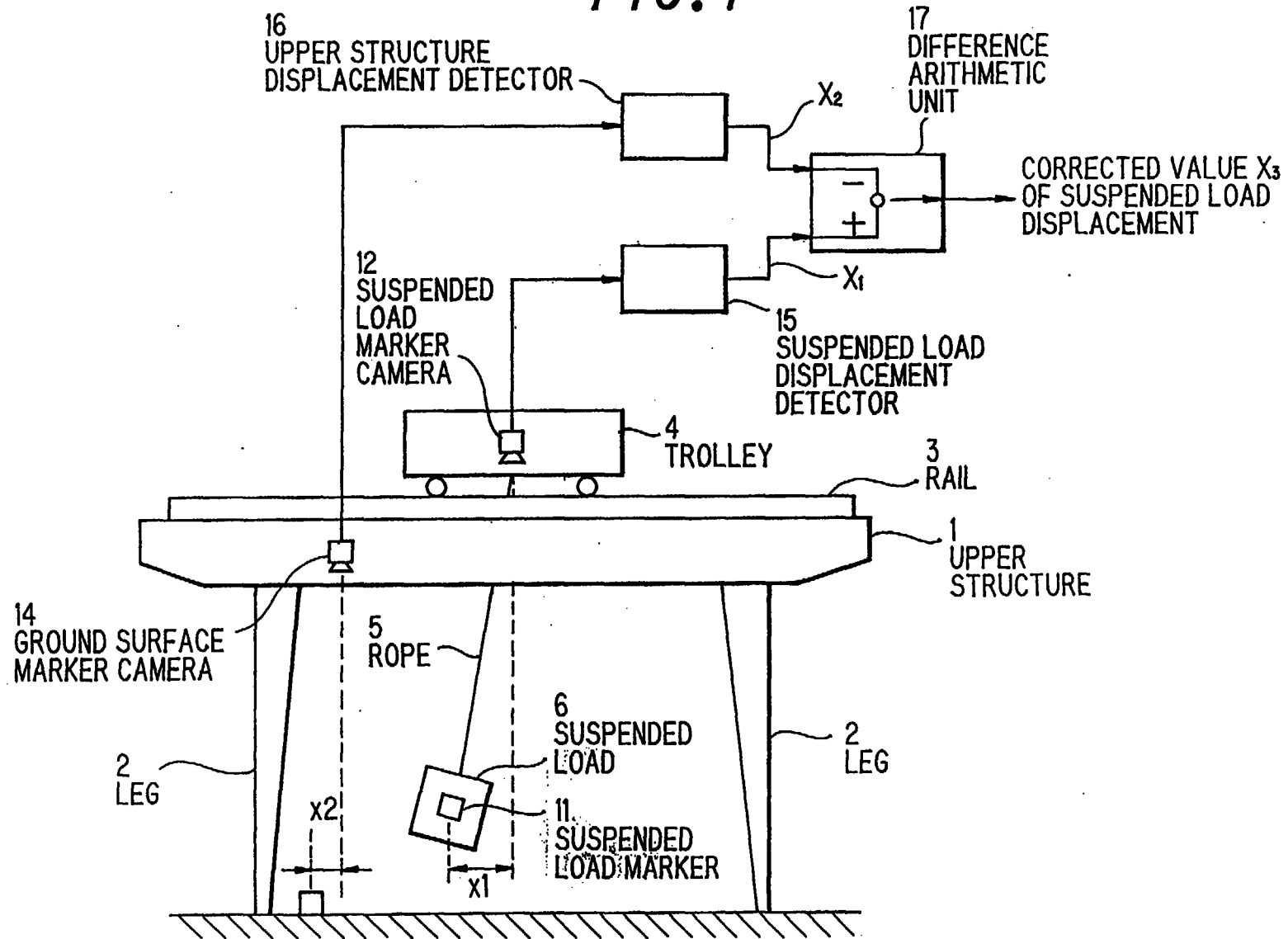
ABSTRACT

SUSPENDED LOAD SWING DISPLACEMENT DETECTOR

A swing displacement detector comprises a swing displacement detector 15 for detecting relative displacement x_1 between a trolley 4 and a suspended load 6 in a crane suspending the suspended load 6 by a rope 5 or the like; a crane upper structure displacement detector 16 for detecting the displacement of a crane upper structure 1 supporting the trolley 4 from the ground surface; and an arithmetic means 17 for receiving as inputs the measured value x_1 of suspended load displacement by the swing displacement detector 15, and the measured value x_2 of crane upper structure displacement by the crane upper structure displacement detector 16, and for correcting the measured value x_1 of suspended load displacement based on the difference between the measured value x_1 of suspended load displacement and the measured value x_2 of crane upper structure displacement. Thus, the vibrational component of the crane upper structure can be eliminated from the measured value of swing of the suspended load, whereby the swing component of the suspended load can be detected highly accurately.

FIGURE 1

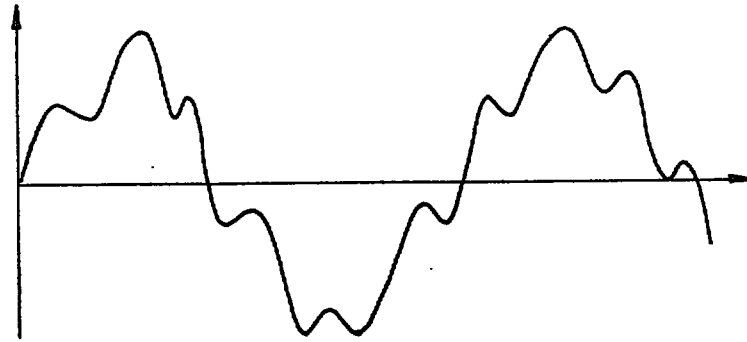
FIG. 1



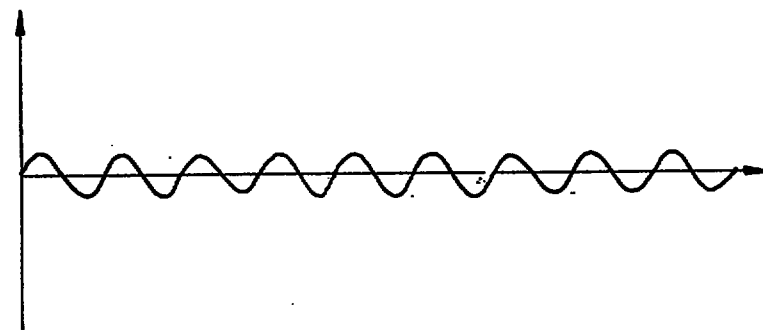
2/5

FIG.2

x_1
DETECTED VALUE OF
SUSPENDED LOAD DISPLACEMENT



x_2
DETECTED VALUE OF
STRUCTURE DISPLACEMENT



x_3
CORRECTED VALUE OF
SUSPENDED LOAD DISPLACEMENT

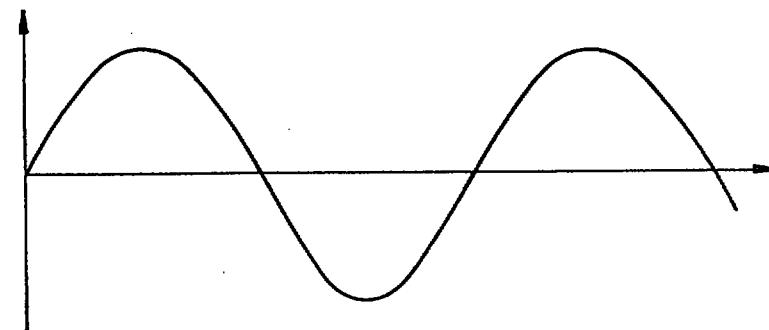


FIG. 3 (PRIOR ART)

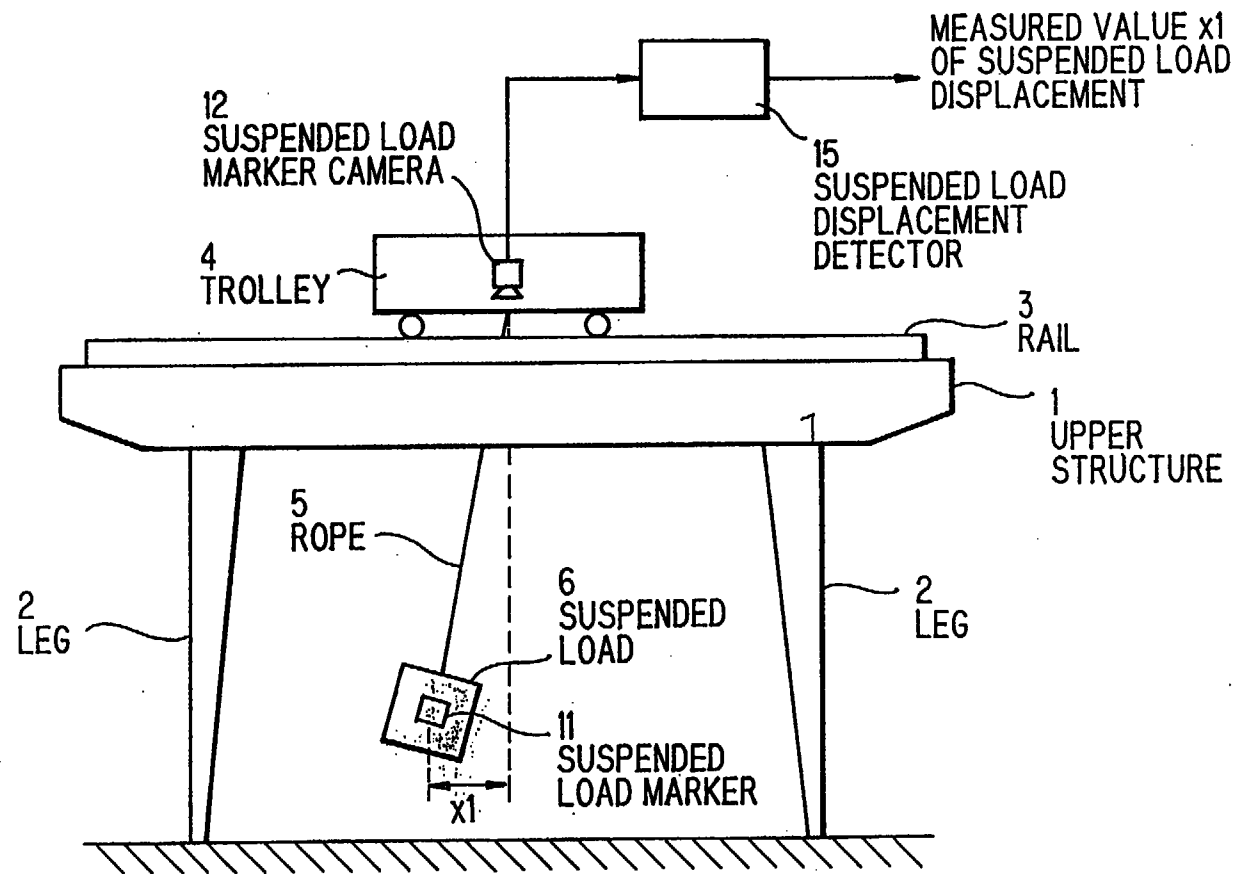


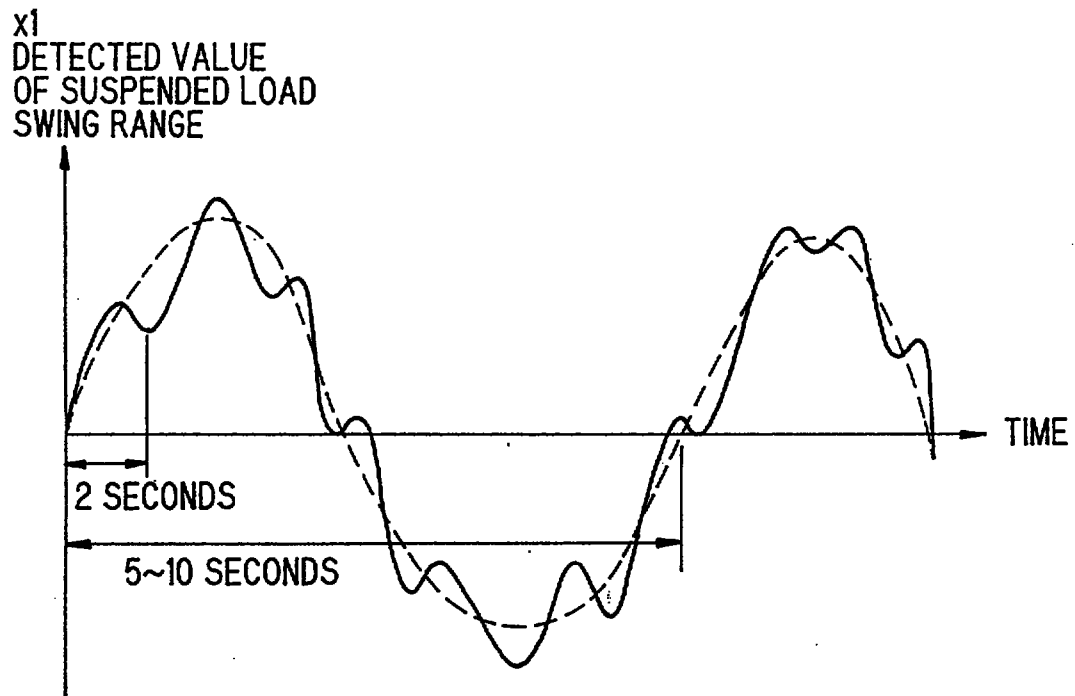
FIG. 4 (PRIOR ART)

FIG. 5

