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Cheze

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[54] **METHOD OF DETECTING AN OVERSTEPPING OF A MAXIMUM PARAMETER ADMISSIBLE FOR THE OPERATION OF A MACHINE**

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[58] **Field of Search** .....340/267 C, 265, 267 R; 212/39 R, 39 MS, 39 A; 33/149 J, 148 D, 148 H

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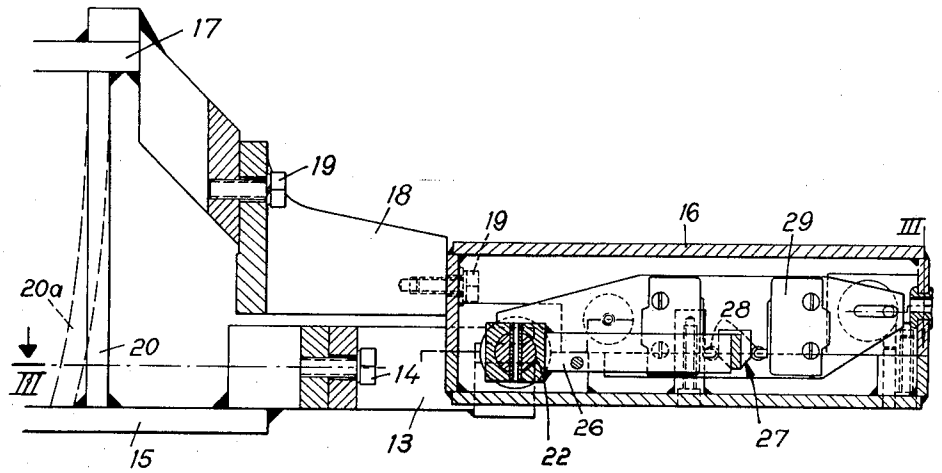
[57] **ABSTRACT**

A detecting apparatus for detecting excessive mechanical stresses on a machine having a one-piece structural element the first part of which moves with respect to a second part to an extent determined by the mechanical stress applied to the machine includes a casing rigidly secured to one of those parts and a plurality of electrical switches mounted in the casing. A first arm means is mounted on the other of the first and second parts of the machine and first cam means is rotatably mounted on the casing in contact with the first arm means for rotation thereby upon movement of the first part with respect to the second part. The cam means are operatively connected to the switch means to selectively actuate the switch means upon stressing of the structural elements of the machine.

16 Claims, 4 Drawing Figures



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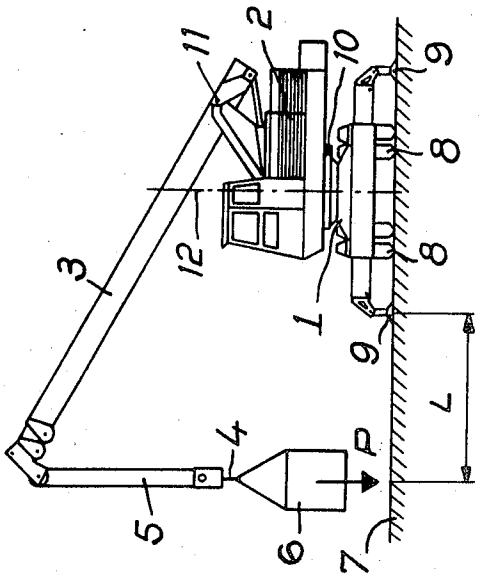

Fig. 1

Fig. 2

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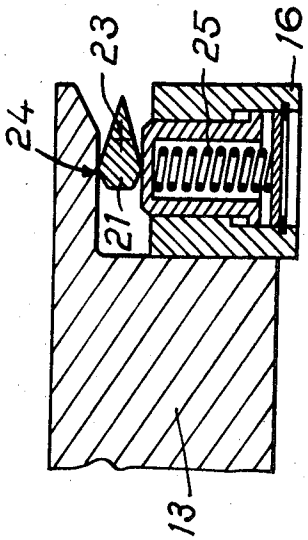

Fig. 4

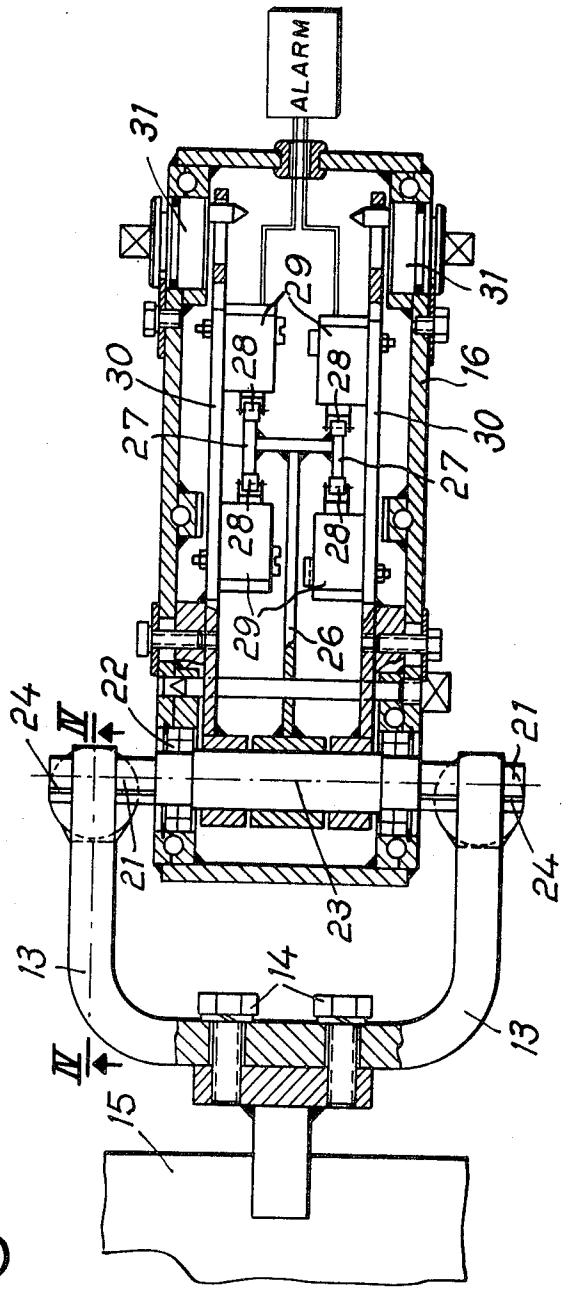

Fig. 3

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METHOD OF DETECTING AN OVERSTEPPING OF A MAXIMUM PARAMETER ADMISSIBLE FOR THE OPERATION OF A MACHINE

The present invention relates to a method for detecting whether a maximum parameter admissible for the operation of a machine has been exceeded.

It is known that public works or handling machines, particularly machines comprising a turret, are being used to an increasing extent. This type of machine is often preferred due to the facilities of utilisation that it offers. Concerning handling machines, they may be provided with jibs of fixed length or with jibs of variable length, particularly telescopic jibs. However, it is known that the machine must not be allowed to deteriorate by handlings of too heavy loads which could produce, in particular, permanent deformations of certain constituent parts of the machine. It is also known that concerning the movable machines which are not permanently anchored in the ground, it is necessary not to exceed certain limits of weight to be handled, that the dynamic effects due to wind should be resisted and that certain span limits should be respected in order not to risk the machine tipping over.

Attempts have heretofore been made automatically to detect the approach of the above-mentioned limits. The detector devices that were proposed at the time were exclusively adapted to machines with turrets and were constituted, apart from a few variants, by a lever integral with one of the bearings which may for example be conical, by which the turret was secured to the chassis of the machine, said lever being moreover articulated to the turret about an axis and coupled with said turret by means of a return spring. Theoretically, when tipping started, the lever moved with respect to the turret and could then actuate any safety and/or alarm device provided to this end in order to interrupt the manoeuvre undertaken or to warn of its danger.

Unfortunately, apart from the fact that these known devices were adapted only to machines with a turret, they also did not give the faithful detection for which they were intended. The assembly clearances at the articulations were sometimes of the same order as the displacements of the lever with respect to the turret and were alone sufficient to prevent the generalised use of the corresponding devices, by lack of fidelity of the detection obtained.

Furthermore, these known devices were in addition adaptable only at the moment when the machine was designed, as they were integrated in the machine itself as regards the connection of its turret with the chassis, and sometimes even as regards the realisation of the turret. It was therefore not possible to equip the machines during operation which were not provided with the detection device when they were manufactured, at least without envisaging considerable modifications of said machine.

For these various reasons, in order to respect the limits of use of the present machines, reliance is at present placed only on the ability and experience of the driver of the machine in order to remain within said limits, and not all the ressources of the machines entrusted to the drivers are therefore used, nor the speed of execution which would make possible an automatic device for detecting excess loads, if it existed.

The invention intends to remedy these disadvantages and to this end proposes firstly a process, then detection, safety or alarm devices, with the aid of which the approach of the limits to be respected is automatically detected for as closely as is desired.

The invention therefore has for its object a method of detecting a possible overstepping of one of the maximum parameters admissible for the operation of a machine provided with an operating equipment disposed on an upper structure itself resting on a chassis.

The relative displacement of the two zones of a one-piece element of said structure, due to its deformation, is measured in correspondence with the overstepping of the maximum parameter admissible, by rendering integral with these two zones two relatively movable contacts of at least one switch device of the detection circuit.

The invention also has for its object a detection device, in which, as the upper structure is constituted by a turret and the working equipment is articulated about an axis on the turret, the switch device is mounted on the turret in a plane perpendicular to the axis of articulation of the working equipment on the turret.

The switch device is advantageously located opposite the working equipment, with respect to the axis of rotation of the turret, when the machine is in operation.

An arm, intrgral with thw lower part of the structure, may cooperate with the body of the switch device mounted integrally with the upper part of the structure in order selectively to open and close the detection circuit.

This arm is articulated to an eccentric cam integral with a shaft provided with a lever which is perpendicular thereto, and which is provided with at least one cam capable of actuating the control member of the switch device, said control member being mounted on the body of the switch device.

This control member of the switch device may be adjustably mounted on the body of said switch device.

The invention also has for its object a safety device applying the preceding detection device, and in which the detection of the overstepping of a maximum parameter admissible brings about the stopping of the supply of the drive member of the working equipment relative to the parameter exceeded.

Finally, the invention relates to an alarm device which applies the preceding detection device and in which the detection of the overstepping of a maximum parameter admissible actuates at least one alarm signal.

The invention will be more readily understood with reference to the accompanying drawings, in which :

FIG. 1 schematically shows an elevational view of a handling machine applying the method according to the invention.

FIG. 2 is a partial section through a detection, safety and alarm device according to the invention ;

FIG. 3 is a section along III—III of FIG. 2 ;

FIG. 4 is a section along IV—IV of FIG. 3.

Referring now to the drawings, FIG. 1 shows a movable crane. It comprises a chassis **1**, a turret **2** rotatably mounted on the chassis **1** and a jib **3** articulated to the turret **2**. Beneath the end of the jib **3**, a crane hook **4** is connected to said jib end by a cable **5**. A mass **6** is fixed to the hook **4** and is removed from the ground **7**. Furthermore, the chassis **1** rests on the ground **7** by its wheels **8** and, when handling is effected, is in abutment on the ground **7** either by its stabilisation stays **9** or by its wheels **8**.

It will be noted that the detection device **10**, whose constitution will be described hereinafter, is fixed to

the turret 2, in a plane perpendicular to the axis of articulation 11 of the jib 3 on the turret 2, which is substantially merged with the clearance plane of the jib 3. It is also noteworthy that the detection device 10 is located opposite the hook 4 with respect to the axis of rotation 12 of the turret 2.

Furthermore, it has been ascertained that the load 6 produces, when it is removed from the ground 7, a deformation of the turret 2, precisely in the plane and at the location of the detection device 10, and it was calculated that the above-mentioned deformation was substantially proportional to the tipping torque P × L, product of the weight P of the mass 6, by the distance L of the vertical passing through the centre of gravity of the mass 6 to the nearest line of the stabilisation stays. According to the invention, it was then that it was thought that by measuring the deformation of the turret, the tipping torque was known and the movement causing the possible tipping could therefore be stopped before said tipping was produced.

To this end, a detection device had to be produced, such as that described hereinafter with reference to FIGS. 2, 3 and 4.

Such a detection device comprises two parts ; a first part, in the form of a forked member 13, is fixed by screws 14 to the lower zone 15 of the turret 2, said zone 15 being located near the swivel wheel of the turret 2 with respect to the chassis 1, whilst a second part in the form of a casing 16 is rendered integral with the zone 17 of the turret 2 by means of a rigid square 18 and screws 19.

The deformation of the turret 2, due to the mass 6, is illustrated in FIG. 2, which shows the wall 20 connecting the lower and upper zones 15 and 17 respectively, which passes to 20*a* when the crane lifts the mass 6.

A first eccentric cam 21 is mounted to rotate in bearings 22, of axis 23, integral with the casing 16. The two ends of the fork 13 are furthermore disposed opposite the cam 21 and may cause it to tip about the axis 23 by abutting on the contact edge 24. It will be noted that the tipping of the cam 21 thus caused is then produced against the action of an antagonistic spring 25 which, to this end, abuts on the body of the casing 16.

The cam 21 in fact constitutes a shaft with which one lever 26 is integral, the axis 23 and the lever 26 being moreover perpendicular. A second set of cams 27 is integral with the end of the lever 26. The cams 27, four in number, are disposed opposite the control members 28 of contactors 29, mounted on the casing 16 by means of supports 30, adjustable with respect to said casing, by cams 31. It will be noted that in the possible case of a clearance of the lever 26, due to a rotation of the cams 21, the cams 27 interfere with the members 28 and are then capable of actuating the contactors 29.

The type of these contactors 29 is not specified, as it is in fact possible to use contactors of several different designs, particularly hydraulic, pneumatic or electric. On the contrary, it may be noted that two of the contactors, located on the same side of the lever 26, may correspond to the operation of the crane on its tyres, the other two to the operation of the crane on its stabilisation stays. In each case, one of the two contactors of the group in question may actuate a warning signal which works when a limit that is not to be exceeded is being approached, whilst the second contactor of the same group cuts off the supply of the drive member of the working equipment, such as for example the jacks or lifting winches or jacks for telescoping the jib 3, if this latter is telescopic and, concomitently, warns that the limit in question has been reached by a sound and/or visual signal.

The operation and advantages of the devices described hereinbefore will be understood more readily from an example which will be given thereof.

When the crane lifts the mass 6, the wall 20 is deformed and moves to 20*a*. The fork 13, integral with the lower zone 15 tips angularly with respect to the upper zone 17 and abuts by its ends on the edge 24 of the cam 21, causing said latter to rotate about axis 23. The lever 26 is thus rotated with respect to the casing 16, so that the cams 27 move with respect to the control members 28 of the contactors 29 integral with the casing 16. If the mass 6 is close to a limiting value, whilst remaining lower than this value, the member 28 of one of the contactors 29 is actuated by the corresponding cam 27 and triggers the warning signal which it controls. If the mass 6 were accidently higher than the limiting value admitted, it would be the second contactor, of the group of two contactors, which would cause the cut-off of the supply of the lifting of the mass 6, and at the same time would warn, by the signal that it controls, of the poor manoeuvre that has been stopped.

Of course, it will be understood that the tipping thresholds are not the same, that the machine rests on its tyres or on its stabilisation stays, that two groups of two contactors should therefore be provided, one of the groups corresponding to the manoeuvre on tyres, the other to the manoeuvre on stabilisation stays.

There is an obvious advantage in the provision of an adjustment of the position of the contactors 29 with respect to the cams 27, by means, in the example shown, of the cams 31 which adjust the position of the supports 30 of the groups of contactors with respect to the casing 16, the two contactors of one group being disposed on the same support 30.

The selection of the group of the detection contactors may be manual or automatic. Furthermore, it will be noted that the detection, warning and cut-off of the feed circuit are relative to the lifting, telescoping and other circuits, the detection obviously being easily adaptable to the movements watched over and to possible modifications in the characteristics of the machine, by the above-mentioned adjustment of the position of the contactors 29 in the casing 16. It will be specified that the cams 31 are advantageously dependent on the inclination of the jib with respect to the ground, for example, or on another variable characteristic of the operation of the machine.

It will have been noted that the deformation of the turret is detected directly without the clearance of an articulation of a lever coupled to the swivel wheel of the turret having to be made up for, as was the case beforehand. Now, the deformation of a structure, within the limits of the resilient deformations, is faithful, contrary to a making up of clearances.

Furthermore, it will have been noted how extremely simple it is to place the device in position, even on a machine already in service, since the screws 14 and 19 are sufficient to fix it to the machine whether or not said latter comprises a turret.

Finally, it will be understood that the application of a device according to the invention extends to the

checking of the deformation of any structure under the effect of given stresses, forces, torques and/or moments. This structure may then be that of a jib coupled to the machine by a support girder for example.

What is claimed is:

1. Detection apparatus for detecting excessive mechanical stress in a machine that has a structural element subject to deflection upon application of a load to said machine, said structural element having a first portion which moves with respect to a second portion thereof to an extent determined by the mechanical stress appied to said machine, said detection apparatus comprising a casing, means for rigidly connecting said casing to said first portion of said structural element, a plurality of electrical swiches mounted in said casing, first arm means, means for connecting said first arm means to said second portion of said structural element, first cam means rotatably mounted in said casing in contact with said first arm means for rotation thereby upon movement of said first portion of said structural element with respect to said second portion of said structural element, and means, operatively connected between said cam means and said switches for selectively actuating said switches in response to rotation of said first cam means.

2. Apparatus as defined in claim **1** wherein said electrical switches each include a contact member and said means for selectively actuating said switches comprises a second arm rigidly connected to said first cam means for rotation therewith and second cam means mounted on said second arm for selectively contacting said contact members to actuate said switches in response to rotation of said first cam means.

3. Apparatus as defined in claim **2** wherein said machine is selectively stabilized by support on a wheeled base or on a plurality of stabilizing stays, whereby said machine has first and second tipping thresholds, said switch means being located in two groups respectively associated with said first and second tipping thresholds and said second cam means includes first and second cam members respectively associated with said first and second groups of switches and having different predetermined configurations to selectively actuate said first and second groups of swiches upon attainment of said first and second tiping thresholds.

4. The invention as defined in claim **3** comprising, in addition, alarm means connected to said switch means in each of said groups to be respectively actuated thereby upon attainment of said first and second tipping thresholds.

5. The invention as defined in claim **4** comprising, in addition, means for controlling the operation of said machine, said first and second groups of switch means being connected thereto to stop the operation of said machine when said switch means is actuated upon attainment of said first and second tipping thresholds.

6. The invention as defined in claim **2** in which said machine comprises a turret and a base, said turret being mounted on said base to pivot about a turret axis and said turret comprising said structural element and working equipment mounted on said turret to pivot about a second axis in a plane perpendicular to said turret axis, said apparatus being mounted on said structural element in a plane perpendicular to said second axis.

7. The invention as defined in claim **6** comprising, in addition: means for controlling the operation of said machine, said switch means being connected thereto to stop the operation of said machine when said switch means is actuated.

8. The invention as defined in claim **6** comprising, in addition, alarm means connected to said switch means to be actuated thereby.

9. The invention as defined in claim **6** in which said casing is located on the opposite side of said turret axis from said working equipment when said machine is in operation.

10. The invention as defined in claim **9** comprising, in addition, alarm means connected to said switch means to be actuated thereby.

11. The invention as defined in claim **10** comprising, in addition: means for controlling the operation of said machine, said switch means connected thereto to stop the operation of said machine when said switch means is actuated.

12. Apparatus as defined in claim **2** wherein said first cam means includes a shaft rotatably mounted in said casing and an eccentric cam rigidly secured to said shaft; and said second arm means comprises a lever rigidly secured to said shaft.

13. The invention as defined in claim **12** comprising, in addition, alarm means connected to said switch means to be actuated thereby.

14. The invention as defined in claim **13** comprising, in addition: means for controlling the operation of said machine, said switch means being connected thereto to stop the operation of said machine when said switch means is actuated.

15. Apparatus as defined in claim **2** including means for adjusting the position of said switches with respect to said second cam means.

16. The invention as defined in claim **15** comprising, in addition, alarm means connected to said switch means to be actuated thereby.

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