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(54) Overload protection system for hydraulic boom cranes, especially of the type used on motor vehicles

(57) A hydraulic boom crane is protected from excessive loading by means of pressure sensors (16, 17) sensing the pressure in the lifting cylinder (8) for the boom (4) and signalling to a control and alarm box (18) to emit periodic alarm signals through a LED array (20) and a buzzer (21), when the first sensor (16) senses e.g. 90% max. load, and to interrupt operation by switching the dump valve (12) to dump and to emit continuous alarm signals, when the second sensor (17) senses 100% max. load. The box (18) also comprises release means for temporarily (such as 5 seconds) overriding the second sensor, thus allowing the operator to steer the crane away from the critical operating condition.

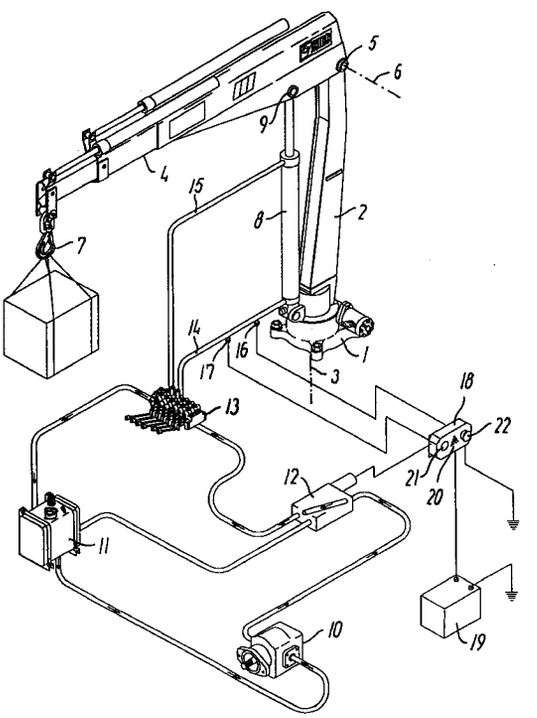

Fig. 1

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Description

TECHNICAL FIELD

The present invention relates to an overload protection system for hydraulic boom cranes, such as set forth in the preamble of Claim 1.

BACKGROUND ART

Previously known overload protection systems of this kind have been based upon the use of relatively complicated hydraulic and/or electronic circuitry, adapted to on the basis of various operating parameters to produce appropriate control signals constituting commands to the operation control means to limit or prevent movement of the boom in directions, in which there is an increase in the risk of overloading of the crane and/or toppling of the mounting, such as a motor vehicle on which the crane is mounted. Due to the relatively high cost of circuitry of the type referred to, the use of such circuitry on boom cranes at the lower end of the loading-capacity range will entail a high-percentage increase in the cost of the boom crane, thus making it less competitive on the market.

DISCLOSURE OF THE INVENTION

It is the object of the present invention to provide an overload protection system of the kind referred to above, in which the requisite protective functions are achieved by using simple, well-known and reliable equipment readily available on the market at low cost, and this object is achieved in an overload protection system of said kind, which according to the present invention is characterized as set forth in Claim 1. With this arrangement, a critical parameter, i.e. the pressure in the hydraulic cylinder, with which the boom is raised and lowered, is sensed by a highly reliable sensor available at low cost, reacting to an excessive pressure by causing the operation control means to limit or prevent movement of the boom in the requisite manner to avoid dangerous situations arising and to produce suitable alarm signals warning the operator.

Advantageous embodiments of the overload protection system according to the invention, the effects of which will be evident from the following detailed part of the present description, are set forth in Claims 2-7.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following detailed portion of the present description, the invention will be explained in more detail with reference to the exemplary embodiment of an overload protection system according to the invention shown in the drawings, in which

Figure 1 is a perspective view of the boom crane with an overload protection system according to the invention in the state of normal operation,

Figure 2 is a view similar to that of Figure 1, but with the crane in a locked, inoperative position,

Figure 3 is a simplified electrical diagram showing the functioning of the control and signalling box of the overload protection system shown in Figures 1 and 2,

Figure 4 is a sequence diagram showing possible situations occurring during the operation of the crane shown in Figures 1 and 2, and

Figure 5 is a sequence diagram showing situations and necessary actions occurring during an operation of releasing the crane from the locked position shown in Figure 2.

At this point it should be noted that the figures of the drawing are limited to showing solely those parts that are necessary for the proper understanding of the invention. Thus, as persons skilled in this art will know, additional equipment is required, such as that used for controlling the movement of the boom in various directions required during practical operation.

Referring firstly to Figure 1, the hydraulic boom crane shown therein comprises a base 1 adapted to be secured to a suitable mounting (not shown), such as a loading platform or a motor vehicle. An approximately vertical column 2 is rotatably supported on the base 1 for rotation about a vertical axis 3, the base 1 for this purpose being equipped with a suitable actuator, well known to persons skilled in this art. A boom 4 is at one end pivotably supported on the top end of the column 2 by means of a horizontal pivot pin 5 extending along a horizontal axis 6 (during actual operation, the axes 3 and 6 may deviate somewhat from the vertical and horizontal directions respectively, when the base 1 is supported by a motor vehicle or similar movable mounting).

At the other end of the boom 4, the latter is provided with a hook 7, and further hooks (not shown) or other load-engaging means may be provided in other locations along the length of the boom.

The raising and lowering of the boom 4 about the pivot pin 5 is carried out by means of a hydraulic cylinder 8, the lower end of which is hingedly connected to the column 2, whereas its upper, extensible end is pivotably connected to the boom 4 by means of a pin 9 at a distance from the pivot pin 5.

The hydraulic system for the operation the boom 4 consists in a manner known per se of a pump 10 receiving hydraulic liquid, in the following text referred to as "oil", although other liquids may be used, from a reservoir 11 through a solenoid-operated dump valve 12, from which the oil, depending on the position of the dump valve 12, flows either back to the reservoir 11 or to a manually operable control-valve assembly 13, by means of which the oil, set under pressure by the pump 10, may be made to flow to the hydraulic cylinder 8, either through an "up" conduit 14 in order to raise the boom 4, or through a "down" conduit 15 in order to lower the boom, the oil from the piston-rod side of the piston in the cylinder 8

flowing in the conventional way out through either the "down" conduit 15 or the "up" conduit 14 respectively.

The crane with associated hydraulic system described above with reference to Figure 1 does not differ in principle from similar, previously known equipment of this kind. According to the present invention, however, the equipment also comprises two pressure sensors, viz. a first pressure sensor 16 and a second pressure sensor 17, both connected to the "up" conduit 14 so as to sense the pressure in the lowermost part of the hydraulic cylinder 8, and hence indirectly the downward moment exerted on the boom 4 about the horizontal axis 6. Both pressure sensors 16 and 17 are connected to a control and alarm box 18 to be described below with reference to Figure 3, and the first pressure sensor 16 is adjusted to react to a pressure corresponding to e.g. 90% of the pressure corresponding to the maximum permissible loading moment by sending a signal to the control and alarm box 18, whereas the second pressure sensor 17 is adjusted to react at the full value of said pressure and to react by sending a signal along a separate line to the control and alarm box 18.

The control and alarm box 18 receives DC voltage from a battery 19, that may or may not be the battery belonging to a motor vehicle, on which the crane is mounted, and uses this voltage to control the dump valve 12 in dependence on the signals received from the pressure sensors 16 and 17, and also to emit signals appropriate to the actual condition of the system. For the latter purpose, the box 18 comprises an LED array 20 and a buzzer 21. As will be seen from Figure 1, the control and alarm box 18 is also connected to the solenoid-operated dump valve 12.

The operating principle of the control and alarm box 18 will now be explained with reference to Figure 3. At this point it should, however, be noted that, for ease of understanding, the control and alarm box 18 is described as comprising a number of "traditional" circuit elements cooperating in the simplest possible manner, whereas in practice, the control and alarm box will to a great extent be based upon the use of electronic or semiconductor elements, such as transistors and/or integrated circuits. Further, and also for ease of understanding, the ON/OFF and emergency stop button 22 is represented in Figure 3 by an ON/OFF button 22a and an emergency stop button 22b, whereas of the LED array 20 shown in Figure 1, only the red part 20a is shown in Figure 3.

During normal operation, the ON/OFF button 22a will be in the ON position, thus supplying direct current through the emergency stop button 22b and the normally closed contact 17b on the second pressure sensor 17 (i.e. the sensor for 100%) and through a normally closed break delay timer 23 to the solenoid 12a of the dump valve 12, thus keeping the dump valve 12 in the operating position shown in Figure 1. With the system in this condition, the boom 4 may be manoeuvred according to need by using the control-valve assembly 13 in the conventional manner.

If the pressure in the "up" conduit 14 rises to 90% of the permissible value, the first pressure sensor 16 will react by closing the normally open contact 16a. This will supply direct current to a flashing relay 24, the latter through its normally open contact 24a supplying periodically interrupted direct current to the red part 20a of the LED array 20 so as to make it emit flashes of red light, and to the buzzer 21 so as to make the latter emit loud alarm signals, all this to warn the operator that the crane has entered a critical zone of operation.

If the operator takes heed of this warning, he will, of course, manipulate the handles concerned in the control-valve assembly 13 in an attempt to remove the crane from the critical zone, and the success of such an operation will be reflected in the operation of the first pressure sensor 16, the latter re-opening the contact 16a so as to interrupt the supply of direct current to the flashing relay 24 and hence stop the intermittent operation of the red part 20a of the LED array 20 and the buzzer 21.

If, however, the operator does not succeed in his attempt at bringing the crane out of the critical zone, the situation will manifest itself by the second pressure sensor 17 reacting, thus opening the contact 17b and closing the normally open contact 17a. The opening of the contact 17b will interrupt the supply of direct current to the solenoid 12a of the dump valve 12, so that this valve will switch to the position shown in Figure 2, in which the oil from the pump 10 is recirculated to the reservoir 11, and the supply to the control-valve assembly and hence to the remainder of the hydraulic system is interrupted. Due to the action of the break delay timer 23, however, this action will be delayed by a fraction of a second, normally not more than one half of a second, in order to avoid oscillations or "hunting" caused by the interaction of the second pressure sensor 17 and the dump valve 12. The supply of direct current to the normally open contact 17a will provide a constant supply of direct current to the red part 20a of the LED array 20 and to the buzzer 21, so that the former will emit red light and the latter a warning signal, both continuously.

The situation is now as illustrated in Figure 2, i.e. the crane is locked in its present position, from which it cannot be moved except by executing the following release procedure:

Firstly, the operator - motivated by the loud noise from the buzzer 21 - will depress the emergency stop button 22b so as to silence the buzzer 21. Assuming that the ON/OFF button 22a is still in the ON position, re-setting of the emergency stop button 22b to the closed position shown will cause direct current to be supplied to a one-shot timer 25 adapted to close two normally open contacts 25a and 25b for a period of time of the order of five seconds, thus during that period of time energizing the solenoid 12a and hence re-positioning the dump valve 12 to the operating position shown in Figure 1, as well as energizing the flashing relay 24 so as to cause the red part 20a and the buzzer 21 to emit periodic optical and aucustical signals respectively. These periodic signals constitute a message to the operator that he can

exploit the presence of oil under pressure on the input side of the control-valve assembly 13 for changing the position of the crane so as to bring it out of the critical operating zone - for this operation the one-shut timer 25 will, in the example shown, give him five seconds.

If the operator has succeeded in bringing the crane out of the critical operating zone by manipulating the control-valve assembly 13, the pressure sensors 16 and 17 will revert to their normal position of rest, and operation may continue in the normal manner.

In addition to using electronic and/or semiconductor components instead of the "traditional" components shown in Figure 3, the practical embodiment of the control and alarm box 18 will also include so-called "fail-to-safety" functions so as to avoid dangerous situations arising if there is a failure in one or more of the component parts of the system. Persons skilled in this art will know how to devise the requisite means to achieve such functions.

As mentioned above, Figures 4 and 5 are sequence diagrams showing various situations that may arise during the operation of the crane. Generally speaking, these diagrams will speak for themselves, but it may be noted,

- that the "fault finding diagram" mentioned in the top right-hand corner of Figure 1 is not included, as it does not directly relate to the invention,
- the "release function diagram" referred to in the bottom right-hand corner of Figure 4 is in fact Figure 5, whereas
- the "system function diagram" referred to in the bottom right-hand corner of Figure 5 is in fact Figure 4.

Further, the "green LED" referred to in the second block from the top in the center column of Figure 4 is a green light-emitting diode 20b shown in Figure 3.

List of Parts

1	base
2	column
3	vertical axis
4	boom
5	pivot pin
6	horizontal axis
7	hook
8	hydraulic cylinder
9	pin
10	pump
11	reservoir
12	dump valve
12a	solenoid
13	control-valve assembly
14	"up" conduit
15	"down" conduit
16	first pressure sensor
16a	contact
17	second pressure sensor
17a	contact
17b	contact
18	control and alarm box
19	battery
20	LED array
20a	red part (of 20)
20b	green LED
21	buzzer
22	ON/OFF & emergency stop button
22a	ON/OFF button
22b	emergency stop button
23	break delay timer
24	flashing relay
24a	contact
25	one-shot timer
25a	contact
25b	contact

Claims

1. Overload protection system for hydraulic boom cranes of the type comprising

a) a base (1) adapted to be secured to a mounting, such as a motor vehicle,

b) a column (2) secured to or rotatable about said base (1) about a substantially vertical axis (3),

c) a boom (4), at one end pivoted about a substantially horizontal axis (6) to said column (2) at a location above said base (1), and having load-engaging means (7) at the opposite end and/or at locations between said two ends,

d) a hydraulic cylinder (8) connected at one end to a point on said column (2) at a distance below said horizontal axis (6) and at the opposite end to a point (9) on said boom (4) at a distance from said horizontal axis (6),

e) operating control means (12, 13 etc.) for supplying hydraulic liquid under pressure to and allowing such liquid to flow from said hydraulic cylinder (8) in order to raise and lower said boom (4) respectively,

f) overload sensing means (16, 17) adapted to produce an overload control signal, when said boom (4) is subjected to a loading moment about said horizontal axis (6) close to or at a permissible limit, and

g) overload protection control means (18) adapted to receive said overload control signal and to react to same by influencing said operation control means (12, 13 etc.) in a manner preventing further movement of said boom (4) or parts thereof in directions causing said moment on said boom to be increased,

characterized in

h) that said overload sensing means comprise at least one pressure sensor (16, 17) adapted

to sense the hydraulic pressure in that part of said hydraulic cylinder (8) exerting a lifting force on said boom (4) or in a conduit (14) immediately communicating therewith.

2. Overload protection system according to claim 1, characterized by two pressure sensors as stated in item h of claim 1, viz.

a) a first pressure sensor (16) adapted to react, when said pressure rises to a fraction of the permissible maximum pressure, such as nine-tenths thereof, to activate alarm-signalling devices (20a, 21), and
b) a second pressure sensor (17) adapted to react, when the pressure rises to the maximum permissible pressure, and connected to said overload protection control means (18) so as to make the latter influence said operation control means (12, 13 etc.) in a manner preventing any movement of said boom (4) or parts thereof.

3. Overload protection system according to claim 1 or 2, characterized by signalling means (20, 21), e.g. emitting light (20) and/or sound (21), operatively connected to each pressure sensor (16, 17) so as to emit light and/or sound when the sensor reacts to an increase in pressure as set forth in claim 1 or 2.

4. Overload protection system according to claim 3, characterized by such an arrangement, that the overload protection control means (18) delays its influence upon the operation control means (12, 13 etc.) to make the latter prevent movement of said boom (4) for a period of time, e.g. up to 0,5 second, after the pressure sensor (16, 17) concerned has reacted to a pressure increase.

5. Overhead protection system according to claim 2 and 3 or 4, characterized in that said signalling means (20, 21) are adapted to emit light and/or sound

a) intermittently, when the first pressure sensor (16) reacts, and
b) continuously, when also the second pressure sensor (17) reacts.

6. Overhead protection system according to any one or any of the claims 2-5, characterized by manually operable release means (25) adapted to override the function of said second pressure sensor (17) for a short period of time, such as 3-5 seconds.

7. Overhead protection system according to claim 6, characterized in that said release means (25) is/are adapted to cause the signalling means (20, 21) to operate intermittently during said period of time.

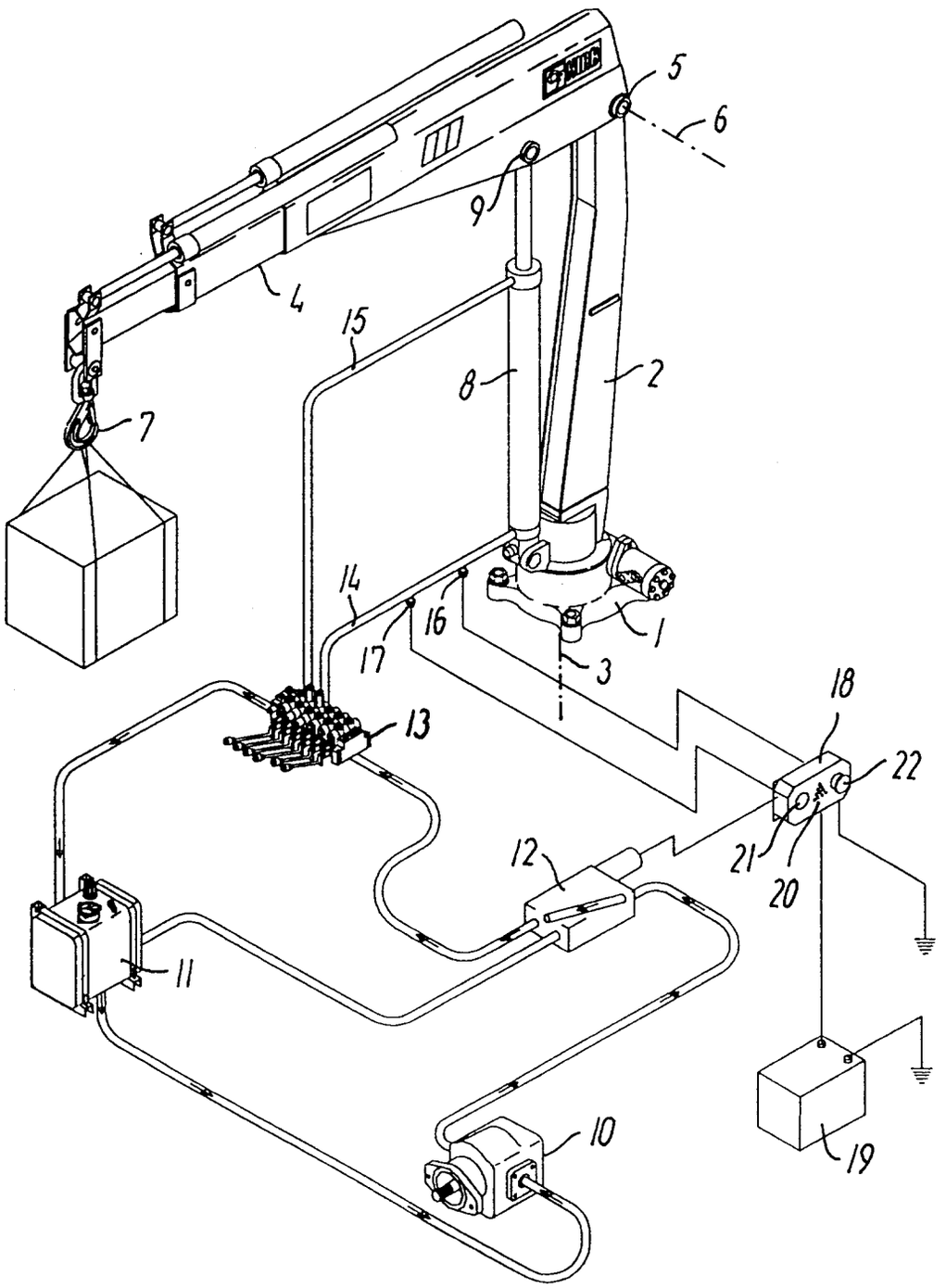

Fig. 1

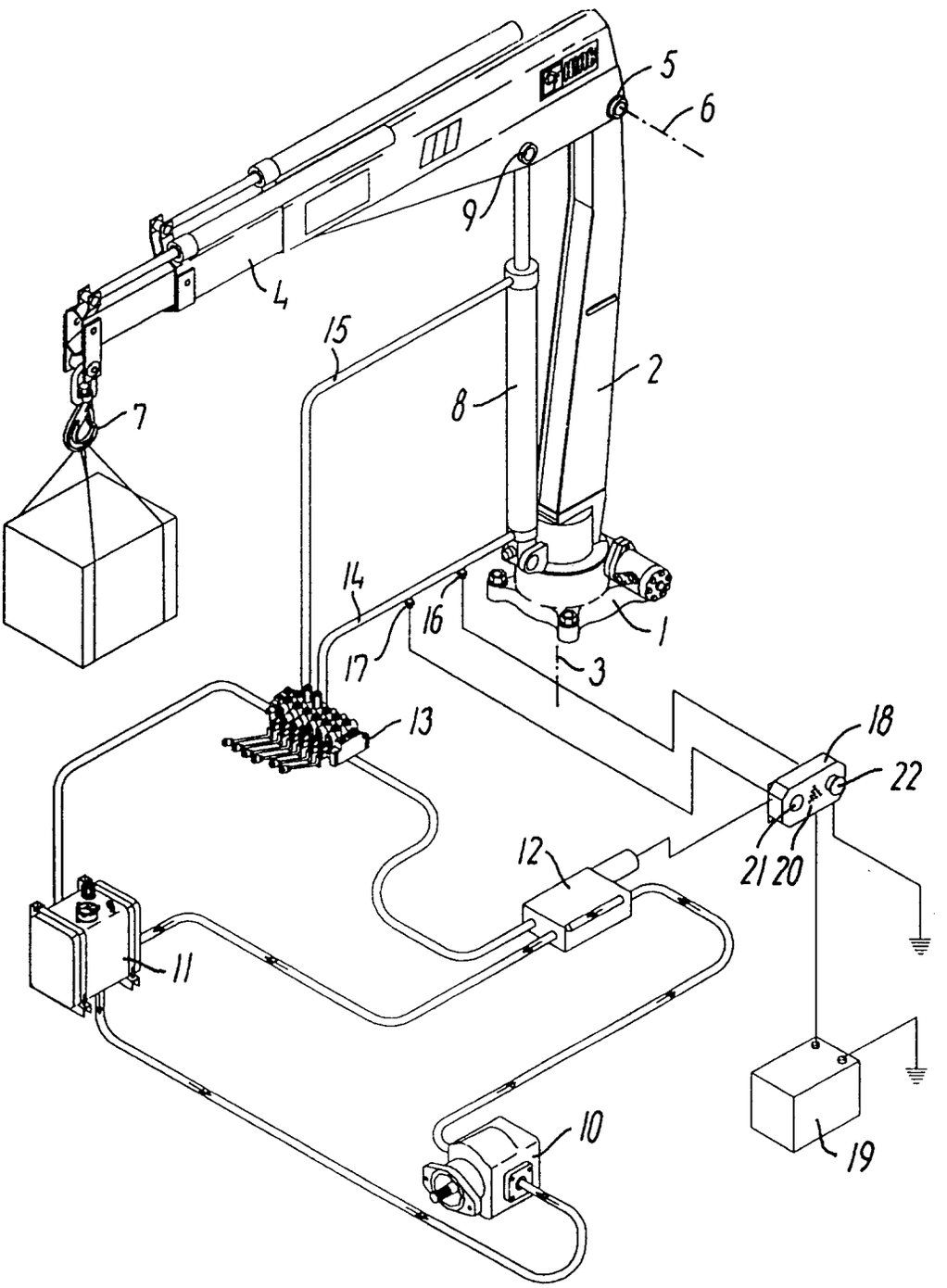

Fig. 2

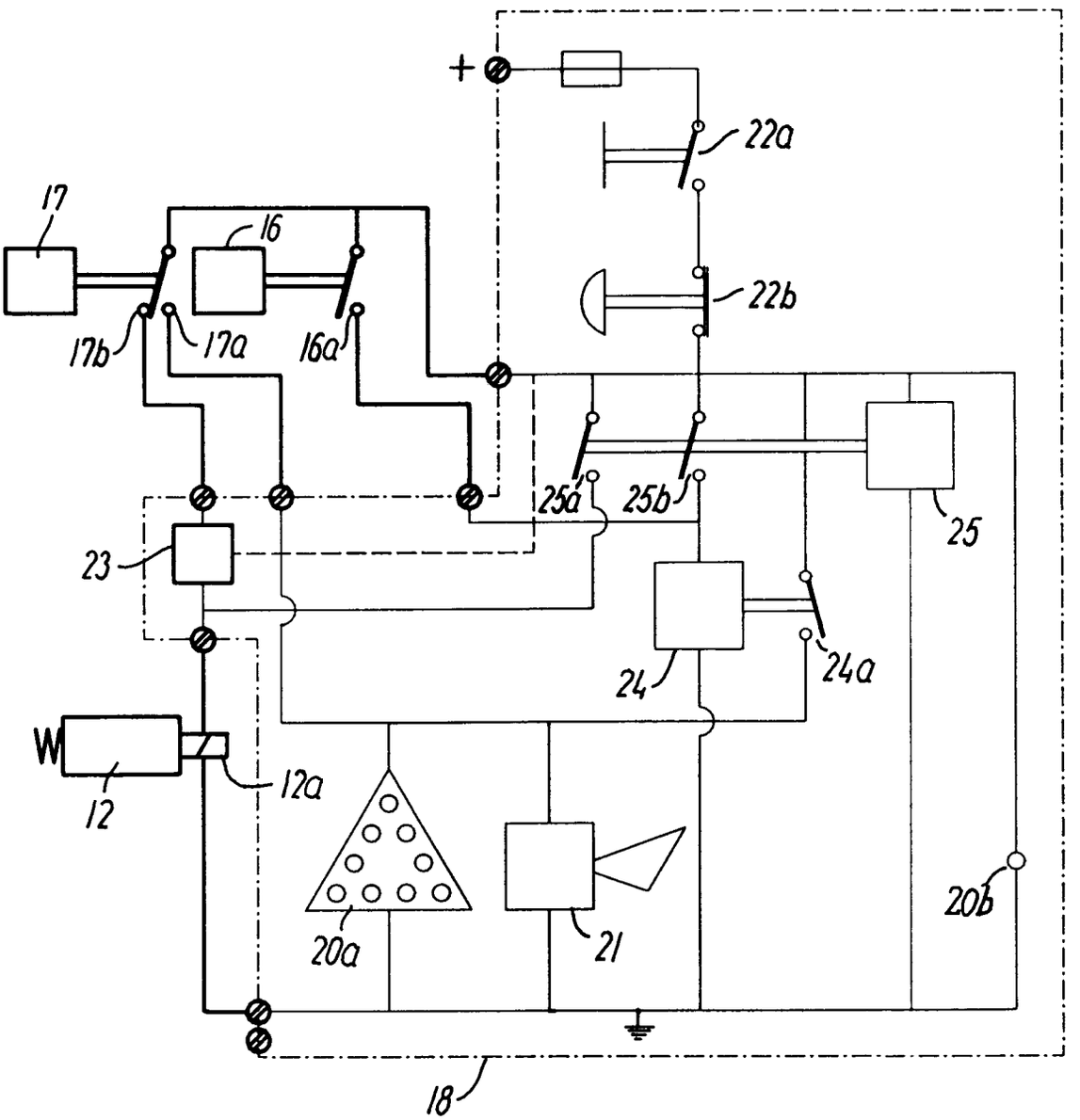
+
22a
22b
17
16
17b
17a
16a
25a
25b
25
23
24
24a
W
12
12a
20a
21
20b
18

Fig. 3

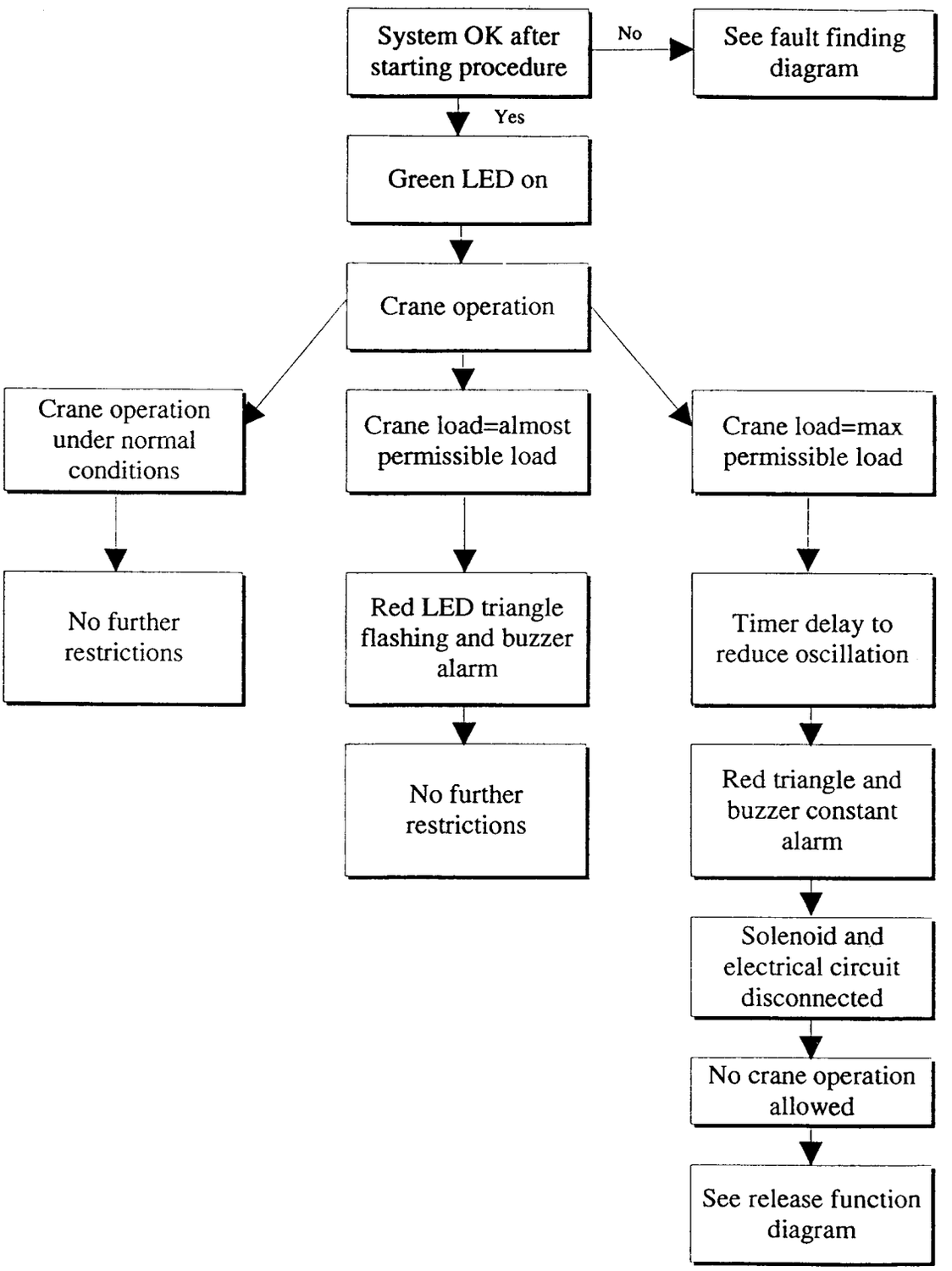
System OK after starting procedure
No
See fault finding diagram
Yes
Green LED on
Crane operation
Crane operation under normal conditions
Crane load=almost permissible load
Crane load=max permissible load
No further restrictions
Red LED triangle flashing and buzzer alarm
Timer delay to reduce oscillation
No further restrictions
Red triangle and buzzer constant alarm
Solenoid and electrical circuit disconnected
No crane operation allowed
See release function diagram

Fig. 4

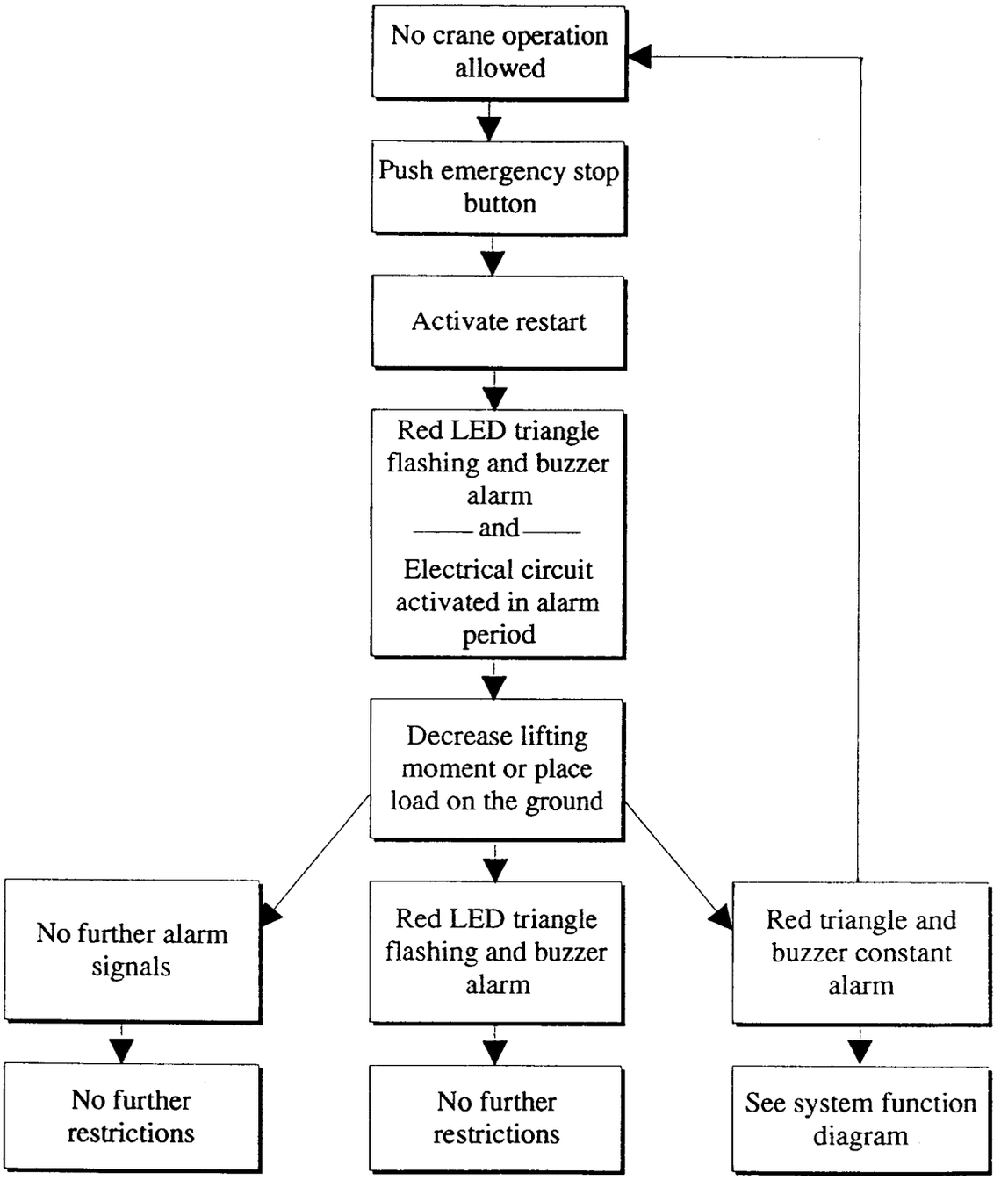
No crane operation allowed
Push emergency stop button
Activate restart
Red LED triangle flashing and buzzer alarm
— and —
Electrical circuit activated in alarm period
Decrease lifting moment or place load on the ground
No further alarm signals
Red LED triangle flashing and buzzer alarm
Red triangle and buzzer constant alarm
No further restrictions
No further restrictions
See system function diagram

Fig. 5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 11 3387

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X A	FR-A-2 677 629 (SENERGY) * the whole document *	1,2,6 4	B66C1/00 B66C23/90
X	US-A-3 757 066 (STERNER) * the whole document *	1-3	
X A	GB-A-2 078 197 (HIAB-FOCO) * the whole document *	1,2 4	
X	FR-A-2 592 368 (CORMACH) * page 7, line 9 - page 10, line 3 *	1,3	
A	US-A-3 123 814 (AITKEN)		
A	GB-A-1 403 046 (WEIMER-KOMBINAT)		

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

B66C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 February 1996	Van den Berghe, E

CATEGORY OF CITED DOCUMENTS

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