

[54] **OVERLOAD SWITCH-OFF DEVICE FOR HYDRAULIC LIFTING OR ADJUSTING MECHANISMS CONNECTED IN TANDEM, IN PARTICULAR FOR HYDRAULIC LOADING AND UNLOADING CRANES**

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[56] **References Cited**

UNITED STATES PATENTS

2,936,847	5/1960	Eitel.....	212/39 R
3,489,294	1/1970	Greb et al.	212/39 R
3,645,407	2/1972	Przybylski.....	212/39 R

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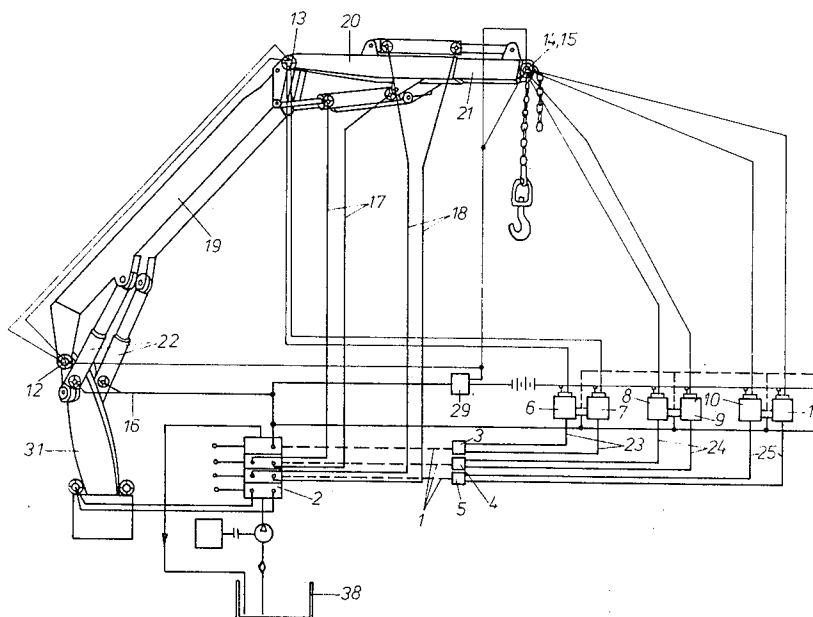
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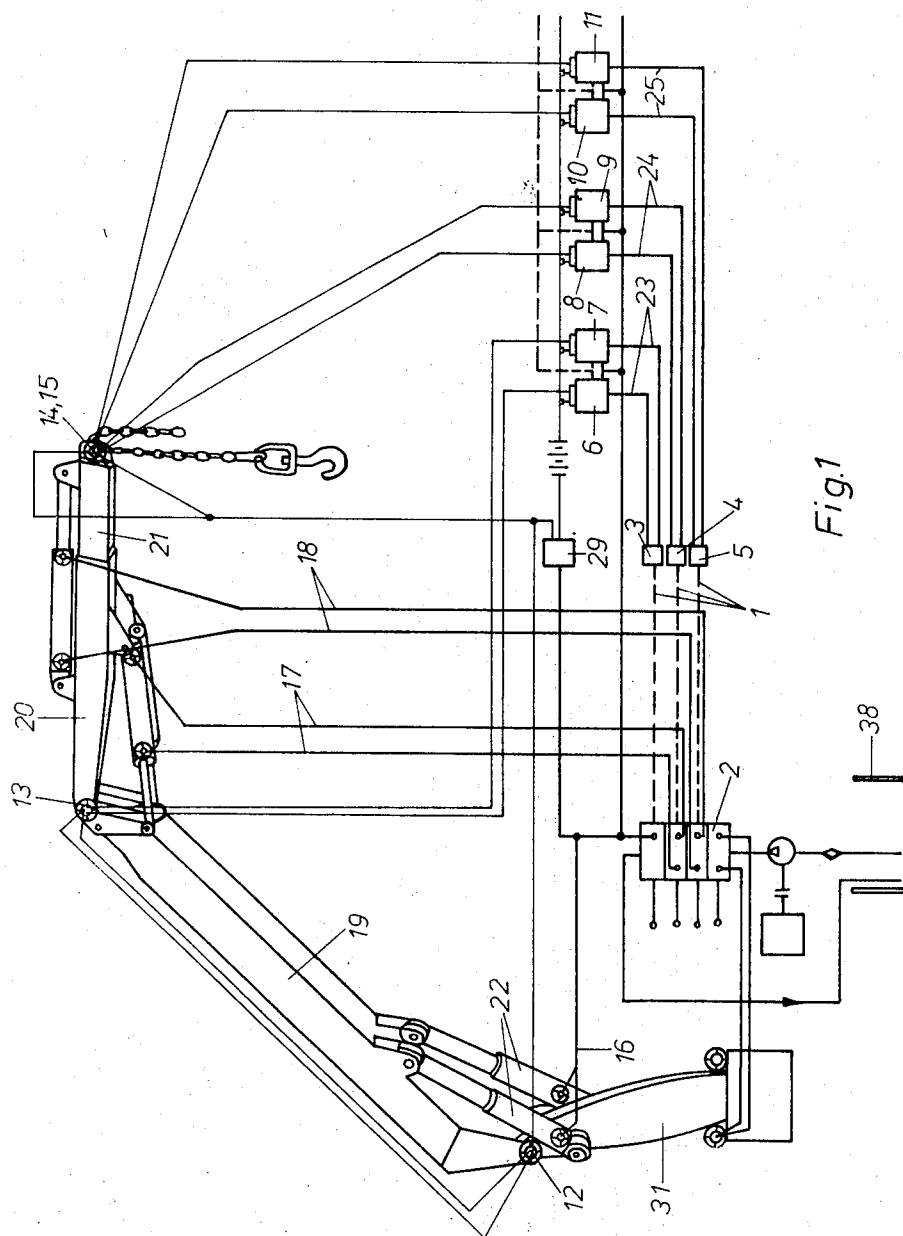
Attorney, Agent, or Firm—Markva & Smith

[57] **ABSTRACT**

An overload switch-off device for hydraulic lifting or adjusting mechanisms connected in tandem, in particular for hydraulic loading and unloading cranes, wherein blocking valves intended for blocking the sliding spools in a main control valve block are arranged upstream of the latter. The blocking valves are capable of actuation by one or several control valves which are controlled by magnets that are actuated by means of a circuit closed by jib arm switches and an electrical pressure switch, as a result of which the flow to the hoses for the jib arms of a crane can be effected in such a way that the supply of a pressure medium (oil) to the driving elements for the lift arm, the luffing arm and the telescopic arm is interrupted if the permissible load limit is reached, while alternatively the supply for such operations is blocked which if carried out would cause further loading of the jib arms which are already loaded to their maximum permissible limit.

3 Claims, 2 Drawing Figures





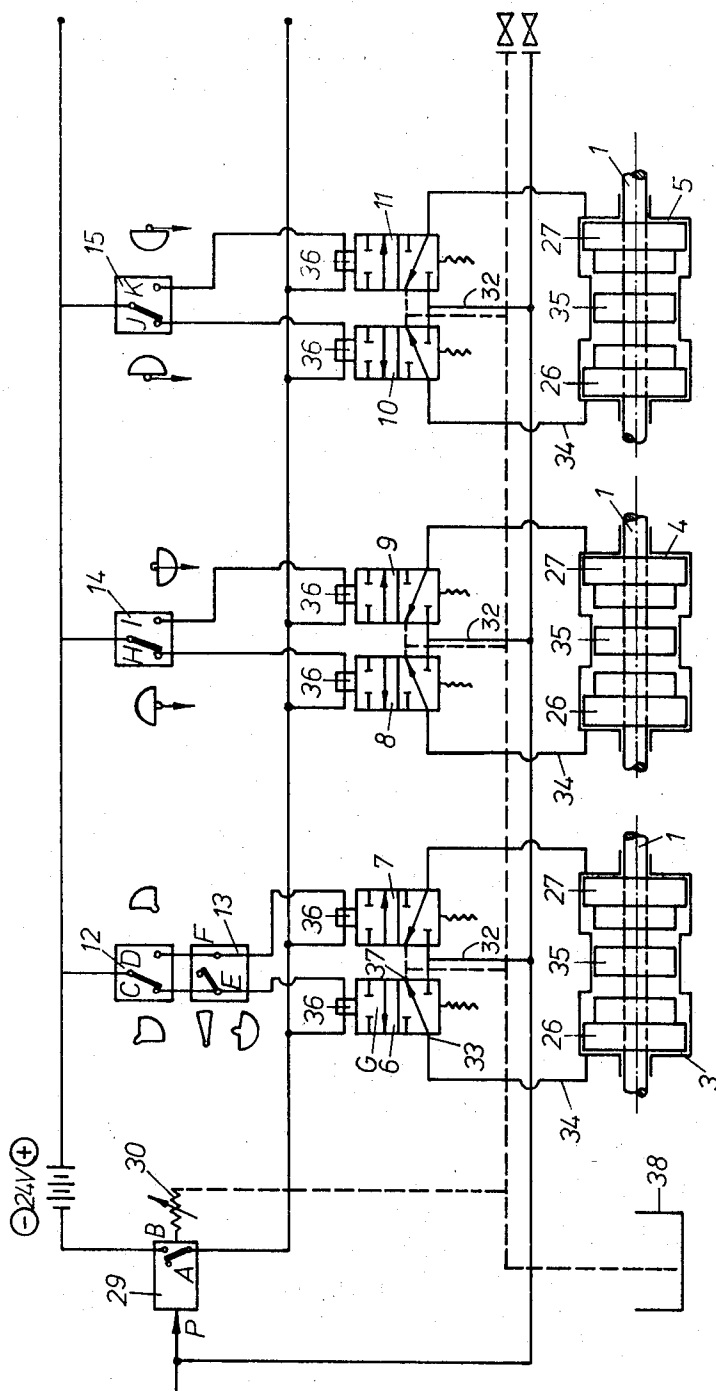


Fig. 2

OVERLOAD SWITCH-OFF DEVICE FOR HYDRAULIC LIFTING OR ADJUSTING MECHANISMS CONNECTED IN TANDEM, IN PARTICULAR FOR HYDRAULIC LOADING AND UNLOADING CRANES

BACKGROUND OF THE INVENTION

This invention relates to an overload switch-off device for hydraulic lifting or adjusting mechanisms connected in tandem, in particular for hydraulic loading and unloading cranes.

It is known that a hydraulic loading and unloading crane can carry a greater load with a short crane jib or a small reach than is the case with a longer crane jib or a greater reach. Hence, a loading and unloading crane can lift its maximum load when the crane jib is completely retracted. However, if after lifting the reach is increased while the load is suspended, e.g. by hydraulically extending or luffing out the jib, there arises a risk of overloading the crane or its actuators.

Hitherto conventional systems in which a lifting force brought about hydraulically is limited with the aid of a pressure reducing valve installed in the hydraulic system and acting in the manner of a relief or pressure control valve do not prevent such overloads from occurring, while in addition entailing the disadvantage that at the said overloads the load may start to descend in an uncontrollable manner with the corresponding risk of damage to goods and accidents.

Even if a crane jib is sufficiently sturdy in order to support the above-mentioned overload also with the jib extended to the fullest degree, this does not alter the fact that a considerably higher load can be lifted if lifting takes place at a low reach and that a subsequent increase of the jib reach necessarily entails the risk of such overloads. In unfavourable circumstances the entire arrangement may even tip over. Such an increase of reach may be brought about in different ways, e.g., by extending the extensible part of the crane jib after lifting the load, or, for instance, in the case of a crane jib with articulated top or fly-jib, if the fly-jib is raised after lifting the load or if the crane jib is inclined upward or downward and is adjusted to a more horizontal position while the load is suspended.

According to the regulations for the prevention of accidents power operated lifting mechanisms and power operated jib retraction mechanisms must be provided with devices which switch off the system if the permissible load moment is exceeded. Such switching-off means that if the permissible load moment is exceeded all movements tending to increase the load moment are automatically discontinued. It must be possible to carry out all movements required in order to reduce the load moment. The overload safety system shall prevent the permissible stability values from being exceeded at a certain reach owing to excessive loading which would give rise to a danger of tipping over. In the case of heavy truck cranes mechanical safety devices are used, which are provided with lever transmissions, springs, control cams etc. and operate electrical relays and switches. On the other hand, electronic load moment limiters are known, which consist of a pressure detector (hydraulic pressure cylinder, strain gauge), an angle detector (potentiometer) and an electronic computer. The measured values (actual values) emanating from the angle detector and the pressure detector are com-

pared in the computer with the design values. At a certain difference of the two values a relay is operated, and the crane is stopped, e.g. with the aid of an electro pneumatic valve. The above-mentioned overload safety systems are relatively expensive to manufacture and to buy, and they are therefore not suitable for hydraulic truck cranes since, as has been shown, the acquisition of an overload safety system costs substantially the same as the crane itself.

In the case of hydraulic loading and unloading cranes every function such as operation of the lift arm, operation of the luffing arm and retraction as well as withdrawal of the telescopic arm has been provided with overflow or overload valves. This method of load moment limiting does not fully comply with the requirements of the regulations for the prevention of accidents since operation of the telescopic arm, e.g. extension, will act on the overload valve of the lifting cylinder at a given reach and weight, but will not stop the system but will cause the jib to be lowered slowly owing to overflow through the safety valve.

In addition, a shut-off valve has become known in which the oil circulation of the pump is short-circuited upstream of the control valves so that no oil can flow into the control valves, if a certain pressure in the lifting cylinder of the crane is exceeded. However, this arrangement does not always permit of a movement to reduce the load moment, e.g., the telescopic arm can no longer be retracted and the lift arm can no longer be raised. This is however necessary if the lift arm and the luffing arm are above the horizontal plane passing through the jib articulation point.

In addition, shut-off valves have become known, which are controlled by the pressure of the lifting cylinder and are installed on the downstream side of the control valve in the feed line leading to the given hydraulic cylinder. These valves block, e.g., the function of luffing out as well as extension of the telescopic arm, when a certain lifting cylinder pressure is approached.

SUMMARY OF THE INVENTION

It is the object of the invention to overcome the aforementioned disadvantages and to provide an improved device for automatic limitation of the load acting on driving elements actuated by pressure media, whereby, in particular, with maximum loading of one of the operating elements, supply of pressure media to another operating element such as would tend to increase the load is prevented.

To attain this object the present invention provides an overload switch-off device for hydraulic lifting or adjusting mechanisms connected in tandem, in particular for hydraulic loading and unloading cranes, wherein blocking valves intended for blocking sliding spools in a main control valve block are arranged upstream of the latter, said blocking valves being capable of actuation by one or several control valves controlled by magnets that are actuated by means of a circuit closed by jib arm switches and an electrical pressure switch, as a result of which the flow to the hoses for the jib arms of a crane can be effected in such a way that the supply of a pressure medium (oil) to the driving elements for the lift arm, the luffing arm and the telescopic arm is interrupted if the permissible load limit is reached, while alternatively the supply for such operations is blocked which if carried out would cause fur-

ther loading of the jib arms which are already loaded to their maximum permissible limit.

A further characteristic of the invention consists in the fact that one of the blocking valves is preferably connected with the lifting cylinders for the lift arm via auxiliary lines such as hydraulic hoses of known design. The blocking valves are positively connected with the control valve or valves via pressure lines or the like.

Lastly it should be noted that if several control valves are provided each blocking valve has two pistons which block the given sliding spool of the main control valve block. If only one 3-2 control valve is employed, only one of these pistons is required, since in this case blocking takes place only in one direction.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the invention will now be described by way of example and with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic presentation of an overload switch-off device in accordance with the invention as applied to a hydraulic loading and unloading crane, and

FIG. 2 is a circuit diagram of the device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now to FIG. 1, assuming that the pressure in the two lifting cylinders 22 of a crane is characteristic for the load moment and must in any case not exceed a certain value, the pressure may be utilised for actuating an electrical pressure switch 29. The d.c. circuit of, e.g., 24 volts is thus closed at the primary point, and the jib arm switches 12, 13, 14 and 15 have a certain closed position depending on the positioning and angular position of the three jib arms 19, 20 and 21 of the crane so that several parallel circuits are formed, each of which actuates a magnet 36 (FIG. 2). Six 3-2 control valves 6 to 11 magnetically actuated in this way allow the pressure medium, which may be hydraulic oil, e.g., from the lifting cylinders 22 or the main oil circuit, or air, e.g., from the brake air storage tank of the truck, to flow to one side or to both sides of three blocking valves 3, 4 or 5. As a result, a sliding spool 1 of a given control function is blocked in one or in both directions of actuation. The jib arm switches 12, 13, 14 and 15 are arranged at the articulation points between the jib arms 19, 20 and 21 and switch over at a certain angular position.

The device proposed by the invention operates in the following manner as shown in FIG. 1:

On a loading and unloading crane known per se arm switches 12, 13, 14 and 15 are provided at the articulation points between the jib arms 19, 20 and 21, the said arm switches being capable of being switched over at a certain mutual position of the jib arms 19, 20 and 21. Hence, one or the other circuit is closed. The primary switch is located within the electrical pressure switch 29. The characteristic pressure of the lifting cylinders 22 actuates the said pressure switch 29, as a result of which current can flow to the magnets 36 of the control valves 6 to 11, depending on which circuit is closed by the jib arm switches 12 to 15. The control valves 6 to 11 as proposed by the invention are magnetically actuated 3-2 control valves. In the non-actuated state the connecting line leading to the blocking valve 3, 4 or 5 acts as a leakage oil line. If one of the control valves 6

to 11 is actuated, the pressure medium, which in the embodiment shown and described is the pressurised oil of the lifting cylinder 22, flows through a pressure hose 16, via the control valves 6 to 11 and via pressure lines 23, 24 and 25 into one or the other side of one of the blocking valves 3 to 5. The blocking valves 3 to 5 as proposed by the invention are designed so as to prevent control of a certain function. This is achieved by a mechanical connection being provided between the sliding spool 1 of a main control valve block 2 and the blocking valve 3, 4 or 5. The mechanical connection can be formed by the sliding spool 1 itself or by a control rod with lever transmission. The electrical feed lines are, as far as necessary, indicated in FIG. 1 by thin dashed lines. Hoses 17 and 18 convey the pressure medium from the main control valve block 2 to the pressure cylinders for the luffing arm 20 and the telescopic arm 21.

In FIG. 2 a schematic circuit diagram shows how the device proposed by the invention functions. The characteristic pressure of the lifting cylinder 22 acts on the electrical pressure switch 29. The latter can be so adjusted with the aid of a spring and an adjusting screw 30 as to switch the switch 29 from position A to position B, at a certain pressure. At this moment, the circuit of a d.c. battery of, e.g., 24 volts is closed. The circuit is further switched to position C or D by the jib arm switch 12. In this connection switch position C signifies that column 31 and lift arm 19 form an acute angle. The position D signifies that the lift arm 19 is swung further beyond the horizontal line. The critical switch position thus occurs at the right angle between the column 31 and the lift arm 19. A further arm switch 13 between the lift arm 19 and the luffing arm 20 enables the current in position E to flow to control valve 6 or to control valve 7. In position F both control valves 6 and 7 are connected in parallel. The arm switch 13 is provided because, owing to the possibility of the luffing arm 20 luffing inward, the conditions for blocking of the lift arm 19 in one or the other direction are not so easy to follow. The arm switch 13 causes the circuits to be connected in parallel if the luffing arm 20 is by more than 20° below the extended position of the two arms 19 and 20. Another angle than the angle mentioned above would have been equally suitable as a starting point. The angle depends on the design and should, as far as possible, be so selected that there are no great differences between the load moment in the extended jib position and when the jib is inclined, e.g., by 20°. Should the luffing arm 20 drop below 20°, the entire lift arm operating mechanism is blocked, as previously stated. Only the luffing arm operating mechanism or the telescopic arm operating mechanism is available for reducing the overload moment. If in this state one of the magnets 36 or both magnets 36 of the control valve 6 are actuated, position G of the control valve 6 is obtained. In this position oil flows from connection 32 to connection 33 via a pressure line known per se into the connection 34 of the blocking valve 3. There a piston 26 is moved to the right so that a piston disc 35 which is positively connected with the sliding spool 1 (control rod) of the main control valve block 2 can no longer be moved to the left, i.e., raising of the lift arm 19 is impeded. In the zero position of the control valve 6 oil can flow back from the connection 34 via the connection 33 to connection 37 and into a tank 38. What has been said in respect of control valve 6 applies also to control

valve 7 if the arm switch 12 is in the position D. In this position, the lift arm lowering function is blocked. Simultaneously with the switching on of the electrical pressure switch 29 the circuit for the control valves 8 or 9, respectively, is released, depending on whether the arm switch 14 is in position H or I. The arm switch 14 is located within the arm system at the tip of the crane, where the load carrying device is connected (see FIG. 1). The position H arises if the direction of the load forms an angle of 90° to 270° with the direction of the luffing arm 20. Between 270° and +90° the position I obtains. The control valves 8 and 9 are switched on in the same way as the control valves 6 and 7. The above also applies to blocking of the telescopic arm 21 of the crane and to the actuation of the blocking valve 5. The decision as to whether the control valve 10 or 11 is actuated depends on the arm switch 15 which can be arranged at the same point as the arm switch 14, which switches to position J if the angle between the direction of the load and the luffing arm 20 amounts to from 180° to 360°. The position K is reached if the luffing arm 20 and the direction of the load form an angle between 0° and 180°. In accordance with the circuit diagram as shown in FIG. 2 further control valves, blocking valves and arm switches can be provided. This depends on the number of elements of which the jib arm system is composed. If the arm system comprises more than two jibs additional arm switches capable of being actuated simultaneously must be provided, in accordance with the lift arm function. These arm switches correspond to arm switch 13 which at the same time causes the appropriate control valve 6 to 11 to be blocked in both directions.

It is also possible to reduce the overload switch-off device proposed by the invention to only one of the 3-2 control valves 6 to 11 if, e.g., no arm switches 12, 13, 14 and 15 are required. The arm switches can be dispensed with if the operations are restricted to certain arm position zones, in which case monitoring of the load switch-off device is of secondary importance. If a single 3-2 control valve is used, the blocking valves 3, 4 and 5 are actuated by this one control valve. Since in this case blocking need only take place in one direction, pistons 27 in the blocking valves 3, 4 and 5 can be dispensed with. The pistons 26 in the blocking valves 3, 4 and 5 are simultaneously actuated by the 3-2 control valve.

The invention may be embodied in other specific forms without departing from the spirit of essential characteristics thereof. The embodiment is therefore to be considered in all respects as illustrative and not restrictive.

What is claimed is:

1. An overload switch-off arrangement for hydraulic loading and unloading cranes comprising a plurality of jib arms connected in tandem for relative movement with respect to each other; a plurality of hydraulic actuating means, each associated with adjacent jib arms, for moving said adjacent jib arms relative to each other; a

plurality of hydraulic conduit means, each connected to one of said hydraulic actuating means for conducting hydraulic fluid to and from each of said actuating means; and a plurality of main control valves, each connected to one of said hydraulic conduit means for controlling hydraulic fluid flow therethrough; said overload switch-off arrangement comprising:

- a. a pressure-sensitive switch in at least one of said conduit means and sensitive to a predetermined maximum hydraulic pressure,
- b. a plurality of switches, each associated with adjacent sets of said jib arms and arranged to be actuated when said adjacent sets of jib arms are moved to obtain a predetermined position relative to each other,
- c. a plurality of valve means, each associated with one of said switches,
- d. means operatively connecting said pressure-sensitive switch, switches and valve means,
- e. a plurality of hydraulically operated blocking valves, each operatively connected to one of said main control valves, and
- f. a plurality of further hydraulic conduit means, each extending between one of said valve means and one of said blocking valves,
- g. whereby an overload is detected by at least one of said valve means when actuated by closure of said pressure-sensitive switch and at least one of said switches associated with adjacent sets of said jib arms, and the associated blocking valve is actuated closing the associated main control valve, interrupting the supply of hydraulic fluid to one of said hydraulic actuating means, and those operations of the jib arms attending to increase the overload are blocked, while those operations of the jib arms tending to reduce the overload are permitted.

2. An overload switch-off arrangement in accordance with claim 1 wherein said pressure-sensitive switch is an electrical pressure-sensitive switch, said switches associated with adjacent sets of said jib arms are electrical switches, said valve means associated with each switch is a solenoid-control valve means and said means connecting said pressure-sensitive switch, switches and valve means is an electrical circuit means, whereby an overload is detected by at least one of said solenoid-control valve means when actuated by closure of said electrical pressure-sensitive switch and at least one of said electrical switches associated with adjacent sets of said jib arms, and the blocking valve associated with said one solenoid-control valve is actuated closing the associated main control valve, interrupting the supply of hydraulic fluid to one of said hydraulic actuating means.

3. An overload switch-off arrangement in accordance with claim 1, wherein the blocking valves are each provided with two pistons which block the associated main control valve.

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