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3,474,695

CONTROL FOR CUTTING PRESSES

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3 Claims

ABSTRACT OF THE DISCLOSURE

A hydraulic cutting press having a movable presser member and hydraulic power means for moving the member is provided with a control associated with the power means which is relatively immune to operator or component failure causing repeats and false trips of the press. The control has a power means governing device actuatable to initiate a stroke and normally biased to deactuated condition, a solenoid connected to the device for operation thereof, a trip switch and a capacitor connected to the solenoid in series with the switch for supplying, when sufficiently charged, electric energy for actuation of said device in response to closure of the switch. The control has a power supply connected to the solenoid for energizing it under the control of said trip switch to hold the device actuated and connected to the capacitor for charging it. The power supply is inoperative to energize the solenoid sufficiently for actuation and is inoperative to charge the capacitor sufficiently for actuation while the solenoid is drawing current from the power supply. The control also has a switching device for interrupting the solenoid circuit for automatic stroke termination and means for simultaneously preventing charging of the capacitor for actuation while the switching device is interrupting the solenoid circuit.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to improvements in controls for hydraulic cutting presses. In the controls, a device governing the application of hydraulic power is solenoid operated in effecting cutting strokes of a presser member. The strokes are initiated by actuation of the device in response to manual actuation of a trip switch and suitably are terminated automatically for reversal movement in response to the occurrence of a predetermined event, for example, contact between a cutting die and a conductive work support.

Presently proposed stroke controls for cutting presses are commonly subject to undesired reactuation of the hydraulic power governing device by accidental reactuation of the trip switch immediately after termination of the approach movement of the presser member, usually referred to as "stroke termination," and while, in the usual construction, the presser member is on its way up in its movement of separation. This "repeat" potential represents hazards of injury or damage.

It is also the case that many of such controls are subject to false actuation or reactuation by component failure without manual tripping. In the case of controls having a trip switch in series with the operating solenoid, false repeat may be caused by such failure where the trip switch has not been released after stroke termination.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a stroke control for cutting presses which will be relatively immune to false tripping and repeat because of operator or component failure. It is another object of the present invention to provide a stroke control for such presses in

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which reactuation of the trip switch is inoperative to re-actuate the hydraulic power governing device unless a predetermined time has elapsed after the trip switch has reopened.

To these ends and in accordance with a feature of the present invention, there is provided, in a hydraulic cutting press having a movable presser member, a control for causing cutting strokes of the presser member by manual actuation of a trip switch and having provision for automatic stroke termination in response to the occurrence of a predetermined event in which the hereinbefore-mentioned problems are obviated. In an illustrative embodiment described hereinafter the control comprises a solenoid operated device for governing the power means in effecting a cutting stroke. Therein electric energy for supplying the solenoid with sufficient current for causing the initiation of a stroke is provided by discharge of a capacitor while a conventional power supply supplies holding current to the solenoid for maintaining actuation in continuing the stroke under the control of a trip switch, the capacitor, solenoid and power supply circuits having such a relation as to achieve the aforesaid objects.

Other features and advantages of the invention will be understood from the following description taken together with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The figure is a diagrammatic representative of apparatus embodying the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the figure, the illustrative apparatus comprises a press 10 of the type more completely disclosed in U.S. Letters Patent No. 2,821,670, granted Jan. 28, 1958 on an application in the name of Robert W. Bradley.

The illustrative press has a presser member 12 and hydraulic power means comprising a fluid pressure operated motor 14 for effecting movement of the presser member 12 in cutting strokes wherein the member 12 has movement of approach and separation with respect to a conductive support member 16 on which work pieces to be cut are laid.

Hydraulic fluid for the motor 14 is supplied from a sump 18 under pressure provided by a pump 20.

In accordance with the present invention, a control associated with the power means comprises a device for governing the hydraulic power means and operated by a solenoid 22. The device includes a valve 24 having a valve spool (not shown but corresponding to the spool 28 of said patent) and relay means 26 comprising a battery 28, a valve spool operating coil 30, and normally open contacts 32 arranged in conventional relay association with the solenoid 22 for operation thereby in actuating and deactuating the device to cause movement of approach and separation respectively of the presser member. The conventional arrangement of the normally open contacts 32 biases the governing device to deactuated condition for returning the member 12 to a predetermined rest position. The operational relation of the solenoid with the contacts 32 provides electric operating characteristics, usual in electromagnetically operated devices such as relays, which characteristics include the requirement for a relatively higher energization for actuation for the device than for holding the device in actuated condition. In an appropriate situation, the solenoid may suitably be arranged if desired for direct operation of the hydraulic valve.

The control also comprises a manual trip switch 40 and a capacitor 42 connected to the solenoid in series with the trip switch and with a normally conducting

switching device 44 whose function is described below comprising a transistor shunted by a breakdown diode 46 protecting the transistor from possible detrimental transient voltages.

If the convenience or other attribute of a lock-up trip is preferred to the additional protection of a "manual hold" trip, it will be understood that another set of normally open contacts operated by the solenoid may be connected across the trip switch in which case the device 44 is relied upon to interrupt the supply of energy to the solenoid.

A source of electric energy comprises a full wave rectifier bridge 50 supplied from the secondary of a power transformer 52.

The negative terminal 54 of the bridge is connected directly to one pole of the capacitor 42 while the positive terminal 56 is connected to the other pole through resistors 58 and 60. Insofar as its function of supplying the solenoid 22 and the capacitor 42 is concerned, the source is considered as having an internal impedance which includes the series impedance provided by the resistors 58 and 60 and is connected across the capacitor and across the circuit branch comprising the solenoid and trip switch.

The open-circuit voltage of the source is designed to charge the capacitor 42 sufficiently for it to supply electric energy to the solenoid for actuation of the device when the trip switch is closed. Sufficient series impedance is provided by means comprising the resistors 58 and 60 to render the source inoperative to so charge the capacitor when the source is loaded by an impedance having a given maximum value not exceeded by the impedance of the solenoid. The series impedance is also sufficient to limit the current drawn by the solenoid from the source under the aforesaid conditions to a value insufficient for actuating the device but sufficient for holding the device actuated.

Accordingly, it will be seen that closure of the trip switch 40 can effect initiation of a cutting stroke only through discharge of the capacitor 42 through the solenoid 22 after the capacitor 42 has been charged from the source during an interval in which the source is not loaded by the solenoid. Therefore, a cutting stroke cannot be reinitiated by reclosure of the trip switch 40 immediately after it has been opened in terminating a cutting stroke.

It is well known in the cutting press art to terminate the stroke of a cutting press (that is, for example, to effect reversal of the movement of the presser member) in response to the occurrence of a predetermined event. The event may be, for example, movement of the presser member to a predetermined spacing from the support, or it may be the formation of a conductive path between the presser member and the support by penetration of the cutting die through the work.

Means for deenergizing the solenoid 22 for deactuation and stroke termination in response to the occurrence of a predetermined event comprises the transistor 44 and circuit means hereinafter to be described for causing the transistor to become non-conductive in response either to the formation of a conductive path between the presser member 12 and the support member 16, or to the actuation of a limit switch 62 suitably arranged for closure of its contacts by movement of the presser member to a predetermined spacing from the support member 16.

It will be appreciated that a cutting stroke may be terminated by the operator releasing the trip switch 40 thereby cutting off the holding energy for the solenoid 22. Although the charging period, which desirably is brief and in the order of 100 milliseconds, begins immediately upon opening of the switch 40, it is highly unlikely that the operator, having voluntarily released the switch could accidentally reclose it while the presser member is returning and after a sufficient charge has been built up in the capacitor 42 to effect actuation of the

hydraulic power controlling device. However, where the stroke is terminated by interruption of the solenoid holding circuit by reason of the transistor 44 becoming non-conductive in response to the occurrence of a predetermined condition, it is somewhat more likely that the operator might hold the switch 40 closed or accidentally reclose it during the movement of separation of the presser member. In this case were there no means for preventing charging of the capacitor, there might be a moment in such movement at which a charge sufficient for actuation has been built up and is being held off only by the non-conductivity of the transistor 44. If following this moment the transistor 44 should be turned on again as by reclosure of the limit switch or suffer failure in conduction, with the switch 40 closed, a repeat of the press would occur.

Accordingly, by another feature of the invention, means are provided for preventing such charging. Suitably this is accomplished by imposing on the source during the period that the transistor 44 is rendered non-conductive, a load sufficient, i.e. having an impedance not exceeding a certain maximum value, to render the source inoperative to charge the capacitor 42 sufficiently for actuation of the hydraulic power governing device. With a D.C. source the impedance suitably consists essentially of resistance. Conveniently, such load means is integrated with the automatic stroke terminating means in a circuit which will now be described.

The negative terminal 54 of the bridge is connected to a negative bus 64 and, when the trip switch 40 is closed, to a negative branch conductor 66. The transistor 44 is normally biased for conduction by connection of its base 67 to a voltage dividing circuit connected across the source from the junction of the resistors 58 and 60 to the branch conductor 66 and comprising a resistor 68, a resistor 70, a breakdown diode 72, and a resistor 74. A current normally flows through this dividing circuit and establishes the base 67 of the transistor 44 positive with respect to its emitter.

If a connection is made between the junction of the resistor 68 and 70 and the branch conductor 66, all positive base emitter voltage will be removed from the transistor 44 rendering it non-conductive, and the resistor 68 will be connected across the source as a load thereon, a suitable value for the resistor 68 rendering the source inoperative to charge the capacitor 42 sufficiently for actuating the hydraulic power governing device. Means for making such a connection in response to the occurrence of a predetermined event comprises the limit switch 62.

Another means for making such a connection comprises two switching devices, suitably silicon-controlled rectifiers 76 and 78 having their main electrodes connected in series between the junction of the resistors 68 and 70 and the conductor 66. When these SCR's are conducting, the aforesaid junction is slightly positive with respect to the conductor 66 because of forward voltage drop in the devices. The purpose of the diode 72 is to hold off this small voltage to insure that under these circumstances there will be no forward bias on the transistor 44.

The SCR's 76 and 78 are controlled to be fired in response to a conductive connection between a striking plate 80 carried by the presser member 12 and insulated therefrom and a conductive portion of the work support 16. The means for so firing the SCR's comprises a circuit of conventional design in which unijunction transistors 82 and 84 are connected to the gate electrodes of SCR's 76 and 78 respectively for firing them in response to the reaching of threshold emitter voltages intermediate the base 1 and base 2 voltages of the uni-junction transistors. The emitter of the transistor 84 is thus normally biased at a non-firing value (assuming the switch 40 to be closed) by connection of the emitter to a voltage divider comprising resistors 90, 92, and 94 extending from a DC bus 96 regulated by a Zener diode 97 to the conductor 64. When contact is made between the plate 80 and the sup-

port 16 through a die, forming a shunt and resistor 90, more current flows through the resistor 94 raising the emitter voltage. In response the transistor 84 conducts, pulsing the gate of SCR 78, which then conducts, energizing a time constant circuit comprising resistance means 96 and capacitance means 98 providing a variable time delay for the firing of the SCR 76 in a manner similar to that previously described for the SCR 6.

While the source is loaded by the resistor 68 either by operation of the aforesaid circuit or by closure of the limit switch 62, the voltage at the junction of the resistors 54 and 60 is reduced to a value insufficient to charge the capacitor 42 for initiating the aforesaid governing device. If the load has been imposed by the firing of the SCR's, it will remain until the SCR circuit is opened by opening the switch 40.

Where the load has been imposed on the source by operation of the switch 62, it will be relieved as soon as the switch is reopened but if the switch 40 is still held closed, the load will be transferred from the resistor 68 to the solenoid 22 by reason of conduction of the transistor 44 before sufficient charge has been built up on the capacitor 42 to cause the solenoid to initiate the governing device. Therefore, again the switch 40 must be released for a charging period before reactuation can be effected.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In a cutting press having a support member, a presser member mounted for movement of approach and separation with respect to said support member and hydraulic power means for effecting such movement of the presser member, in combination therewith, control means associated with the power means for causing the power means to effect such movement, said control means comprising a device for governing the operation of said power means, said device being actuatable to cause said movement of approach and being normally biased to deactuated condition to cause said movement of separation to a predetermined rest position, solenoid means connected to said device for operation thereof in actuation and deactuation, said solenoid means including at least one winding, a source of electric energy, a trip switch having contacts and manually operated means for effecting circuit closure

therebetween, means for connecting said source to a winding of said solenoid means through said contacts of said trip switch, said source and said solenoid means being cooperative for maintaining actuation of said device during closure of said trip switch while being inoperative for the supply of sufficient current to effect actuation of the device from its deactuated state in response to closure of said trip switch, a capacitor, means for connecting said capacitor to a winding of said solenoid means for discharge of the capacitor through said winding and through contacts of said trip switch, and for connecting said capacitor to said source for cooperation therewith in storing a charge operative for effecting actuation of said device in response to closure of said trip switch, said capacitor and said source being inoperative to store sufficient charge for actuation of said device while said source is supplying a load having an impedance of a given maximum value, the winding supplied by said source having an impedance not exceeding said given value.

2. Apparatus as in claim 1 in which said control means additionally comprises means including switching means for interrupting the supply of holding current from said source to said solenoid for deactuation of said device to cause stroke termination in response to the occurrence of a predetermined event and means for preventing charging of the capacitor for actuation while the switching means is interrupting the supply of current to said solenoid.

3. Apparatus as in claim 2 in which said means for preventing charging of the capacitor for actuation comprises means for imposing a load on said source having an impedance not exceeding said given value.

References Cited

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