PROTECTIVE CIRCUIT ARRANGEMENT FOR BAND CUTTER MACHINES

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Filed: Aug. 28, 1973

Appl. No.: 392,276

U.S. Cl. 317/146, 317/DIG. 2
Int. Cl. H01h 47/12

Field of Search 317/DIG. 2, 146; 340/38 L

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ABSTRACT

A protective circuit arrangement for a motor driven band cutter machine, wherein the band cutter is electrically insulated from the rest of the machine and is connected as capacitance in a bridge circuit which is balanced during normal operation and which when unbalanced provides an output signal by which full braking of the band cutter is triggered.

11 Claims, 6 Drawing Figures
PROTECTIVE CIRCUIT ARRANGEMENT FOR BAND CUTTER MACHINES

FIELD OF THE INVENTION

This invention relates to a protective circuit arrangement for band cutting machines provided with a motor driven band cutter.

BACKGROUND OF THE INVENTION

Particularly in the case of band cutting machines used in the textile industry for cutting out garment blanks, a large number of accidents, some very serious, have occurred as a consequence of the operator touching the moving band cutter. Wires partly covering the band cutter have already been provided as a protective device but these obstruct to some extent the operator's view and even make accidents more serious if the operator passes his hand between the protective wires and the band cutter, since his hand then becomes trapped.

German Auslegeschrift No. 1,247,265 discloses a light barrier protective device in a paper cutting machine which has a clamping bar holding a stack of paper which is to be cut and a beam cutter guided downwards perpendicularly on this clamping bar and cutting through the stack. In this known paper cutting machine a number of light barriers are provided in front of the plane in which the cutter moves, these light barriers stopping the drive of the cutter if part of the body of the operator should interrupt these light barriers. Light barrier protective circuit arrangements of this kind are very suitably where it is not necessary for the operator to bring his hands into the region of the cutter during the cutting operation, in order for example to guide the object which is being cut. When, however, this can not be avoided because of the type of cutting operation, for example in the cutting of materials in clothing factories, light barrier protective circuit arrangements of this kind cannot be used because they would be continually interrupted and thus stop the machine.

SUMMARY OF THE INVENTION

The object of the invention, therefore, is to provide a protective circuit arrangement suitable for a motor driven band cutter and which immediately stops the band cutter when it is touched.

According to the present invention there is provided a protective circuit arrangement for a band cutting machine having a motor driven band cutter, wherein the band cutter is electrically insulated from the rest of the machine and is connected as capacitance in a bridge circuit which is balanced during normal operation and which when unbalanced provides an output signal by which full braking of the band cutter is triggered. The bridge circuit is advantageously energized by an oscillator voltage. Furthermore, it is advantageous for the bridge circuit to be followed, with the interposition of an amplifier circuit, by a circuit element for switching off the drive motor. When the drive motor provided is a three-phase current motor, it is particularly advantageous to provide a D.C. supply source, which for rapid braking purposes is connected to the motor when the latter has been switched off. Furthermore, the braking action can be additionally improved by providing an electromechanical brake which is operated by the circuit element. An arrangement which is particularly reliable in operation is achieved by so adjusting the bridge and/or so designing the circuit element and/or the amplifier circuit that in the event of the band cutter being touched by the objects which are normally to be cut the switch element is not operated.

The essential effect consists in that when the band cutter is touched by the operator the capacitance of the rotating band cutter is changed in such a manner that the bridge, which was previously balanced, transmits a signal which after suitable amplification operates a circuit element by which the drive motor is switched off and alternatively or additionally the direct current braking of the motor and additional electromechanical braking are brought into effect.

Experiments have shown that with a protective circuit arrangement in accordance with the invention it is possible for a band cutter to be stopped in about 1/200th second, so that at the usual speed of rotation of the band cutter of 14 meters per second the run-on distance amounts to 3 – 5 cm. At the usual rates of feed of objects to be cut which are guided by hand, this run-on distance cannot lead to serious injury.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows a circuit diagram of one protective circuit arrangement in accordance with the invention.

FIG. 2 diagrammatically illustrates a band cutting machine.

FIG. 3 shows the control circuit.

FIG. 4 shows the energizing circuit of the drive motor.

FIG. 5 shows a modified control circuit.

FIG. 6 shows the associated energizing circuit of the drive motor when using the modified control circuit.

DETAILED DESCRIPTION

In a power unit 1, known per se, a main's alternating voltage is rectified and smoothed. The smoothed D.C. voltage is connected to a likewise known oscillator 2, in which an alternating voltage of 25–65 kHz is produced, the frequency depending on the sensitivity of response required (25 kHz for low sensitivity and 65 kHz for high sensitivity). The output voltage of the oscillator is connected to a bridge circuit 3 which is balanced in the quiescent state and which is described more fully below. The output from the bridge 3 is connected to an amplifier circuit 4, which is also known per se, and which in the event of the bridge becoming unbalanced amplifies at the oscillator frequency the output signal from the bridge, rectifies and smooths it to produce a smoothed D.C. voltage for operating the relay R1 whereby its contact pair R11, and R12 is closed.

The bridge consists of an ohmic resistor Rn, a potentiometer Rb, a capacitor C and a second capacitance Cm, the index "m" standing for "band cutter." This capacitance Cm is formed in the following way. In an ordinary commercially available band cutting machine for cutting fabrics in garment factories, as shown in FIG. 2, an endless band cutter 5 runs over guide rollers 6, 7, 8 and a drive pulley 9 driven by the motor M. The guide rollers 6, 7, 8 and the drive pulley 9, and motor M are mounted on a machine frame 10, which also carries a cutting table 11. At the cutting position 11' the band cutter 5 runs vertically through an opening in the cutting table. This cutting position 11' is the danger spot where an operator may be injured by the band cut-
3 ter 5 which moves at very high speed. The guide rollers 6, 7, and 8 and the drive pulley 9 are electrically insulated on their periphery, for example by a rubber covering or the like, so that there is no electrically conductive connection between the band cutter 5 and the remainder of the band cutter machine.

A pair of sliding contacts or, as shown, contact rollers 12 are provided on the machine frame 10 but are electrically insulated from it. The rollers 12 are electrically connected to the band cutter 5 so that this pair of contact rollers 12 together with the band cutter 5 constitutes the capacitance C_mn connected in the bridge circuit 3. In order to reduce the capacitance of the contact rollers 12, these may consist of loosely wound metal wires which are cast with the aid of synthetic resin to form rollers, so that although electrical connection is made between their peripheries, which are in contact with the band cutter 5, and their hubs, which enable connection in the bridge 3, nevertheless the capacitance of these rollers is not too high.

If the operator should touch the band cutter, the capacitance C_mn is thereby changed in such a manner that the bridge 3 becomes unbalanced and a voltage is transmitted from the bridge 3 to the amplifier circuit 4, the output from which causes operation of the relay R1. Rapid braking of the motor M and consequently of the drive pulley 9 is thereby effected as will be described. The design of the bridge 3 prevents the capacitance C_mn from being varied in such a manner that the bridge 3 is unbalanced when the material which is to be cut touches the band cutter. This effect can however be achieved by using predetermined threshold values for the amplifier 4 or for the relay R1.

The rapid braking of the motor will now be explained with reference to FIGS. 3 and 4, FIG. 3 showing the control circuit and FIG. 4 the motor circuit. In both FIGS. 3 and 4 all relay contacts are shown for the deenergized condition of their associated relays. The control circuit as shown in FIG. 3 is connected between the neutral line Mp and the line R of a three-phase supply system. When the main ON switch is closed a relay H1 is energized. Relay contact h1 connected in series with the contact pair R11 - R12 is thereby closed. In addition, the contact h12 bridging the main ON switch is closed so that the relay R11 self-holds and the main switch can be in the form of a push-button switch. In addition, the relay h13 connected in the control circuit closes, so that relay c1 is energized and by way of its contacts c1_a (FIG. 4) connects the three-phase drive motor M to the mains R, S and T. The drive motor M is thereby set into operation, so that the band cutter 5 is driven. If the band cutter should be touched by the operator so that the bridge 3 is unbalanced and consequently the relay R1 in the control circuit is energized, this causes closing of contact pair R11 - R12 in the control circuit so that relay H2 is energized and its contact h2, in the energizing line for the relay c1 is opened so that relay c1 drops out. The drive motor M1 is thus disconnected from the mains. At the same time, through the closing of relay contacts h2_a a relay c2 is energized. Its contact c2 (FIG. 3) in the energizing line for the relay C1 is thereby opened. At the same time, through the energization of the relay c2, a relay contact pair c2_a (FIG. 4) is closed, so that a transformer-rectifier arrangement 13 connects a direct voltage to two phases of the drive motor M and full D.C. braking of the drive motor M is effected. At the same time, with the contact h14 and the contact c2, closed, an alternating voltage is applied by way of a transformer-rectifier circuit arrangement 14 to an electromechanical brake, by which, for example, the drive pulley 9 or flywheel of the motor M is additionally braked, so that the band cutter 5 stops in less than 1/100th second. A contact c2_b, which closes on energization of the relay c2, is connected in parallel with the switch contacts h2_a for the relay c2, so that even with the immediate de-energization of the relay R1 of the relay c2 is self-holding and the full braking of the motor M is completed. On the closing of the contact h2_a, furthermore, a time delay relay d1 is energized, and after a predetermined time interrupts the control circuit by way of a contact d1_b, and thus interrupts the supply of direct current to the motor M, so that the motor or the magnet brake will not be damaged after full braking.

Contacts b1 and c1_a are connected in series with the contacts h2_a and c2_a, the contact b1 being opened simultaneously during the operation of the main ON switch, which is in the form of a push-button switch, while the switch contact c1_a is closed only on the dropping out of the relay c1, so that the contact c2_a is closed only when the switch contact pair c1_a is open.

In FIGS. 5 and 6 is shown a simplified form of control circuit and energizing circuit for the drive motor. In both figures the contacts are shown in the relay de-energized condition and the same reference notations have been used as in the previous figures. The control circuit of FIG. 5 is connected between the neutral line Mp and the line R of the alternating current supply. Upon closing of the main ON switch the relay c1 in series with it is energized, which by its relay contact c1_a connects the three-phase drive motor M to the supply R, S and T, while however, as is apparent from FIG. 5 only two phases R and T are connected to the neutral line Mp. Thus the motor M is set into operation so that the band cutter 5 is driven. If the bridge 3 becomes unbalanced by the operator touching the band cutter 5 and thereby the relay R1 is energized, the relay contact pairs R11 - R12 and R13 - R14 close and the contact pair R12 - R14 opens. The relay c1 remains energized, so that its contact c1_a, which bridges the ON switch remains closed.

Through the opening of the contact pair R13 - R14 and through closing of the contact pair R12 - R11 an electronic reversing switch 15 (of the type Rewimat 2000 — R1 of the firm Rheinisch — Westfälische Isolatoren-Werke, of Siegburg, West Germany) is so actuated, that the drive motor M, whose terminal arrangement is shown in FIG. 6, is switched to rotate in the opposite direction. Simultaneously the relay c2 is closed so that the electro-mechanical brake is energized. Upon closing of the contact pair R11 - R12 the time delay relay d1, as in the case of the FIGS. 3 and 4 arrangement, is energized, so that after a predetermined time the control circuit is disconnected by the relay contact d1_a, and the relay c1 is de-energized and the motor circuit opened. The relay c2 is thereby de-energized and the braking circuit opened, so that after a full braking neither the motor nor the magnet brake can be damaged. The delay time of the time delay relay d1 is such that the motor M comes directly to standstill without turning in the reverse direction.

The foregoing description of the specific embodiment will also fully reveal the general nature of the invention so that others can, by applying current knowl-
edge, readily modify such specific embodiment and/or adapt it for various applications without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiment.

It is to be understood that the phraseology or terminology employed herein is for the purposes of description and not of limitation.

What is claimed is:

1. A protective device for use in cutting machines having a moving cutting member comprising:
   safety circuit means, responsive to touching of the cutting member by an operator, for generating an output signal; and
   braking means electrically connected to said safety circuit means for substantially instantaneously stopping the cutting member in response to said generated output signal of said safety circuit means.

2. The protective device of claim 1 wherein said cutting member comprises a band cutter having a drive motor; and said safety circuit means comprises a bridge circuit balanced during normal operation and when unbalanced by the operator touching the band cutter provides an output signal by which full braking of said band cutter is triggered, wherein said band cutter is electrically insulated from the rest of the cutting machine and is connected as capacitance in said bridge circuit.

3. A protective device according to claim 2 wherein said bridge circuit is energized by an oscillator voltage.

4. A protective device according to claim 2 comprising an amplifier circuit and a circuit element connected to said output from said bridge circuit by way of said amplifier circuit.

5. A protective device according to claim 2 comprising a D.C. supply connected to the drive motor for the rapid braking of said drive motor when said drive motor is switched off, wherein said drive motor is a three-phase electric motor.

6. A protective circuit arrangement according to claim 2 wherein the band cutter has an electromechanical brake which is operated when the drive motor is switched off.

7. A protective device according to claim 4, wherein the balancing of said bridge circuit and the design of said circuit element and of said amplifier circuit is such that when said band cutter is touched by objects which are normally to be cut said circuit element is not operated.

8. A protective device according to claim 2 comprising an amplifier, and a reversing switch connected to said output from said bridge circuit by way of said amplifier, said reversing switch reversing the direction of said drive motor upon operation of said reversing switch.

9. A protective device according to claim 3 comprising an amplifier, and a reversing switch connected to said output from said bridge circuit by way of said amplifier, said reversing switch reversing the direction of said drive motor upon operation of said reversing switch.

10. A protective device according to claim 7 comprising an amplifier, and a reversing switch connected to said output from said bridge circuit by way of said amplifier, said reversing switch reversing the direction of said drive motor upon operation of said reversing switch.

11. A protective device according to claim 3 comprising an amplifier circuit, and a circuit element connected to said output from said bridge circuit by way of said amplifier circuit.