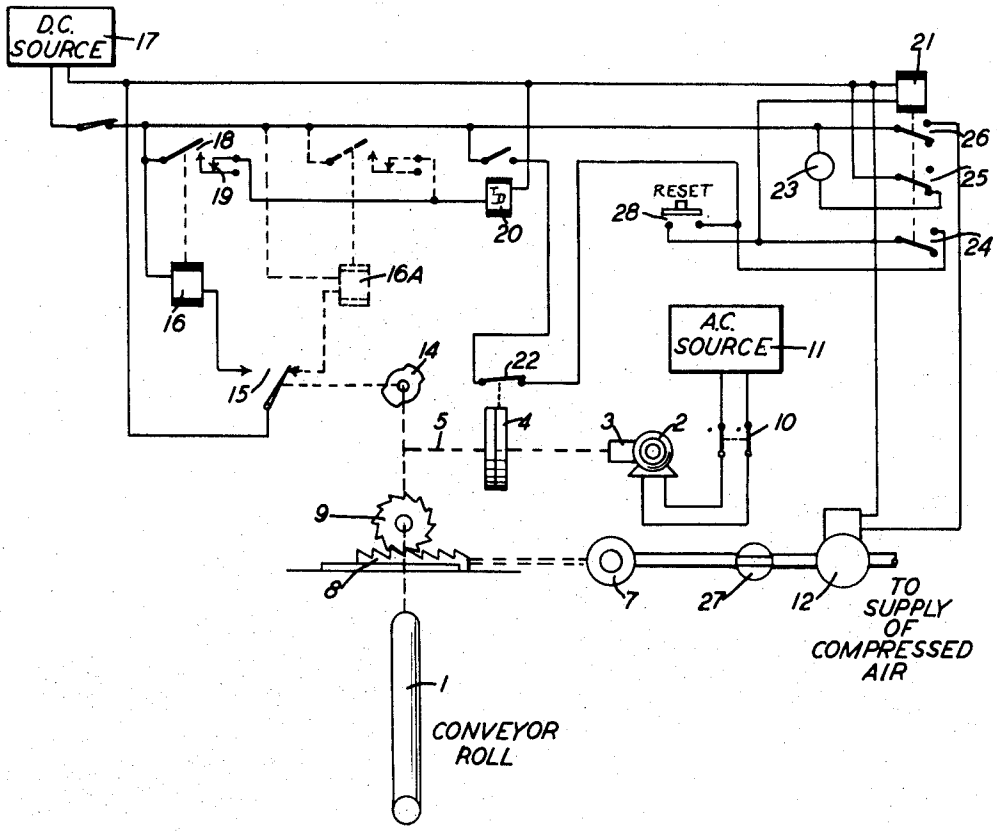
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SLOWLY RECURRING MOTION STOPPAGE INDICATOR

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SLOWLY RECURRING MOTION STOPPAGE INDICATOR

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This invention relates to a device for detecting the stoppage of a slowly recurrent motion and particularly to such a device for detecting the stoppage of the conveyor rolls of a roller hearth furnace.

One of the problems encountered with roller hearth furnaces such as are used in the production heat treatment of copper-oxide varistor discs is that of preventing the destruction of the expensive nickel-chromium alloy conveyor rolls, which slowly transport the articles through the furnace, by warpage due to excessive and non-uniform heat exposure. Replacement of such warped rolls, which may be of the order of seven feet in length, requires a time consuming repair operation during which the furnace must be shut down. One of the main causes for roll warpage in the past has been power or mechanical failures in the drive mechanism for the rolls while the furnace continues to deliver full heat. There has been a need therefore to detect the stoppage of the rolls as soon as possible after a failure so that the furnace may be cooled off before warpage results from the uneven heat exposure. Normally these rolls are rotated at a very slow rate, for example, one revolution a minute for the aforementioned heat treating operation, so that it is not possible to detect the stoppage of the rolls by conventional means such as centrifugal switches or electrical tachometer generators which require fairly high rates of speed for their operation.

An object of the invention is a device for indicating the stoppage of such slowly moving parts.

A further object is an auxiliary drive for the slowly moving parts which automatically goes into operation after the part has been stopped for a prescribed interval of time.

According to the general principles of the invention, an indicator is maintained inoperative as long as periodic energizing pulses are provided therefor, the continuous movement of the slowly moving part being utilized for generating the pulses.

In a preferred embodiment of the invention adapted to indicate the stoppage of the conveyor rolls of a hearth furnace, an actuator on one of the conveyor rolls periodically closes an energizing circuit for a relay which operates to transmit a short energizing pulse to a time delay control relay. The control relay operates immediately on receiving an electrical energizing pulse to render an indicator or alarm circuit ineffective. The control relay releases at a prescribed time after the termination of an energizing pulse, the time required for the time delayed release being slightly greater than the period between energizing pulses resulting from the periodic operation of the energizing relay; consequently, the control relay will continue to hold the indicator circuit inoperative until the recurring energizing pulses are discontinued as would result from the stoppage of the rolls. When a failure does occur, in addition to sounding an alarm or energizing an indicator, the control relay also

controls the starting of an auxiliary drive for the rolls which operates while the trouble with the main drive is being repaired.

These and other features of the invention will be more fully understood from the following detailed description taken in conjunction with the diagrammatic representation of a preferred embodiment of the invention as used with the conveyor rolls of a roller hearth furnace.

Referring now to the drawing, roller hearth furnace conveyor rolls, such as 1, are driven for the aforementioned heat treatment operation at one revolution a minute in order to transport the copper-oxide varistor discs through the furnace in the time prescribed for the operation. The main drive for the rolls 1 includes an alternating current motor 2, which is energized from a main power source 11 through a control switch 10, a gear reduction unit 3, a clutch 4, and other drive belts or chains represented diagrammatically by dashed line 5. As a feature of the invention, the rolls are also provided with a second or auxiliary drive which consists of an air motor 7 for reciprocating a rack 8, which in turn rotates a ratchet 9 to drive the rolls at substantially the same speed as the main drive. The air motor is actuated by compressed air supplied through a solenoid-controlled valve 12, making it possible to operate the rolls even in the event of a failure in the main power source 11.

In the stoppage indicator and auxiliary drive control system for the conveyor rolls, a double rise cam 14 is rotatable directly by one of the conveyor rolls 1 for periodically actuating a switch 15 in the energizing circuit of a relay 16. This relay then is operated twice for each revolution of the roll 1. A direct current source 17 across which the energizing circuit for relay 16 is connected may be a battery or other source, preferably independent of the main supply source 11. When relay 16 is energized, contacts 18 and 19 sequentially close and open respectively, or "make and then break," to momentarily close an energizing circuit across the source 17 for a time delay control relay 20, the time delay relay being one of various mechanisms selected for performing a time delayed switching operation. The operation of relay 16 effectively delivers an electrical energizing pulse to relay 20 immediately after the switch 15 closes. Relay 20 operates immediately on receiving an energizing pulse and remains operated for a prescribed time after the termination of the pulse when the energizing circuit is opened. In the present case, relay 20 will remain operated for slightly more than half a minute before it will release and its contacts open. However, since relay 16 is operated once every half minute by the roll 1 rotating at one revolution per minute, an energizing pulse will be received by relay 20 before the end of its time delay interval. Consequently, the relay 20 will remain operated until the energizing pulses are discontinued, as would occur with the failure of the drive motor 2, the gear reducer 3, the clutch 4, or the other drive structure, as well as in the event of a failure of the power source 11.

The contacts of relay 20 are serially connected in an alarm or indicator circuit which includes the source 17, a switch 22 (controlled by the clutch 4), normally open contacts 24 of a relay 21 and the winding of relay 21. The relay 21 controls the operation of the solenoid air valve 12 as well as an alarm 13. Under normal operating conditions, relay 21 is operated, being energized through the operated contacts of control relay 20. Operated contacts 26 complete the energizing circuit for valve 12 as well as an alarm 23. Under normal operat-operated contacts 25 hold the energizing circuit for the alarm 23 open. In the event of a failure in the main drive and the control relay 20 fails to receive an en-

ergizing pulse within a half a minute or if the clutch switch **22** is opened, which occurs whenever the clutch **4** is operated to disengage the rolls from the main drive motor **2**, relay **21** will be de-energized and immediately releases. When relay **21** releases the alarm **23**, which may be of the visual or audible type, is connected directly across the source **17** and is energized and the air valve **12** is de-energized and opens to start the air motor **7**. The auxiliary drive then continues to operate while the trouble is being cleared. It is to be noted that it is not the position of the cam **14** but rather the failure of the cam to periodically actuate the switch **15** that makes the device operative.

When it is desired to switch back to the main drive, i.e., after the trouble has been cleared, an air valve **27** between the valve **12** and the air motor **7** is manually closed, stopping the air motor, and the motor switch **10** is closed to start the main drive motor after which the clutch **4** is operated. The stoppage indicator and control circuit is then reset by closing and holding the "Reset" switch, which is connected in parallel with normally open disabling contacts **24** of relay **21**, until the control relay **20** is operated to open the alarm circuit and close the air valve **12**. The manually operated valve **27** may then be opened to again prepare the air motor **7** for emergency operation. Contacts **24** are provided in the energizing circuit for relay **21** to prevent operation of relay **21** after its initial release when the auxiliary drive takes over and energizing pulses are again being supplied to the control relay **20**.

While in the embodiment shown in the drawing, the switch **15** is operated by a rotating cam **14**, it is to be understood that the switch **15** could just as well be operated by a part or member movable in any other slowly recurrent motion, for example, in a slowly moving reciprocating motion. The invention, therefore, is applicable to detecting the stoppage of a member having any slowly recurrent motion and is not limited to the rotary motion only. In accordance with the requirements of a particular use, the stoppage indicator could be modified to operate for shorter or longer periods by varying the time delay release interval of the relay **20**, or by changing the number of energizing pulses supplied to relay **20**. The latter may be accomplished by changing the number of rises on cam **14** or by adding another pulse generating relay **16A** similar to relay **16** as shown in dashed lines which would be energized by back contacts on switch **15** to provide an energizing pulse for relay **20** whenever the switch **15** is released.

It is to be understood that the above described arrangements are simply illustrative of the application of the principles of the invention. Numerous other arrangements may be readily devised by those skilled in the art which will embody the principles of the invention and fall within the spirit and scope thereof.

What is claimed is:

1. A device for detecting the stoppage of a slowly recurrent motion of a member comprising an indicator, a first relay, a second relay having normally open contacts which close substantially immediately as an electrical energizing pulse is received thereby and release at a prescribed time after the termination of a pulse, means operable by the release of said contacts for actuating the indicator, means controlled by the member for periodically operating the first relay and means controlled by the first relay for transmitting an energizing pulse to the second relay whenever the first relay is operated, the normal interval between pulses being of shorter duration than said prescribed time interval required for the release of the contacts of the second relay.

2. A device for detecting the stoppage of a slowly recurrent motion of a member comprising an indicator, a first relay having normally open and normally closed contacts arranged to successively close and open, respectively, when the relay is operated, a second relay and an energizing circuit therefor including the contacts of the first relay for producing an energizing pulse whenever the first relay is operated, the second relay having normally open contacts which close substantially immediately as an electrical energizing pulse is received by the second relay and release at a prescribed time after the termination of a pulse, means operable by the release of said contacts for actuating the indicator, and means controlled by the member for periodically operating the first relay, the normal interval between pulses being of shorter duration than said prescribed time interval required for the release of the contacts of the second relay.

3. A device for detecting the stoppage of a slowly rotating member comprising an indicator, a first relay, an energizing circuit for the relay, a second relay having normally open contacts which close substantially immediately as an electrical energizing pulse is received thereby and release at a prescribed time after the termination of a pulse, means operable by the release of said contacts for actuating the indicator, means controlled by the first relay for transmitting an energizing pulse to the second relay whenever the first relay is operated, and means controlled by the rotating member for periodically closing the energizing circuit for the first relay, the normal interval between pulses being of shorter duration than said prescribed time interval required for the release of the contacts of the second relay.

4. A device for detecting the stoppage of a slowly recurrent motion of a member comprising a detector, two relays each having normally open and normally closed contacts arranged to successively open and close respectively when the relays are operated, the contact of one relay being connected in parallel with the contacts of the other, a time delay relay having normally open contacts which are closed when the relay is energized and released at a predetermined time after the relay is de-energized, means for actuating the detector when the time delay relay contacts open, an energizing circuit for the time delay relay including the parallel connected contacts for delivery a momentary energizing pulse to the time delay relay when one of said two relays is operated and means controlled by said member for alternately operating said two relays, the prescribed time for releasing the contacts of the second relay being greater than the normal interval between the operation of said two relays.

5. In a heat processing machine having a driven conveyor for transporting articles therein with an auxiliary driver therefor and means for energizing the auxiliary driver, means responsive to the stoppage of the conveyor for a predetermined time for driving the conveyor with the auxiliary driver comprising a first relay having normally open and normally closed contacts arranged to successively close and open respectively when the relay operates, a second relay for controlling the auxiliary driver energizing means said second relay having normally open contacts which are closed when it is energized and released at a predetermined time after it is de-energized, an energizing circuit for the second relay including the contacts of the first relay for delivering a momentary energizing pulse to the second relay when the first relay is operated and means controlled by the conveyor for periodically operating the first relay, said predetermined time for releasing the contacts of the second relay being greater than the normal operating period of the first relay.

6. In a heat processing machine having a driven conveyor for transporting articles therein and having a main driver and an auxiliary driver therefor, means responsive to the stoppage of the conveyor for a predetermined time for driving the conveyor with the auxiliary driver comprising a first relay, a second relay having normally open contacts which close substantially immediately as an electrical energizing pulse is received thereby and release at a prescribed time after the termination of the pulse, means

operable by the release of said contacts for actuating the auxiliary driver, means controlled by the first relay for transmitting an energizing pulse to the second relay whenever the first relay is operated, and means controlled by the member for periodically operating the first relay to transmit periodic pulses, the interval between pulses being of shorter duration than said prescribed time interval required for the release of the contacts of the second relay.

7. A system for automatically controlling an auxiliary driver for a member movable in a slowly recurrent motion, the member being normally driven by a main driver, said system comprising a first relay, a second relay having normally open contacts which close substantially immediately as an electrical energizing pulse is received by the second relay and release at a prescribed time after the termination of the pulse, a third relay for controlling the auxiliary driver, said third relay having an energizing circuit including the contacts of the second relay, means controlled by the member for periodically operating the first relay, and means controlled by the first relay for transmitting an energizing pulse to the second relay whenever the first relay is operated, the interval between pulses being of shorter duration than said prescribed time interval required for the release of the contacts of the second relay whereby the release of the second relay on the failure of the main driver causes the release of the third relay which starts the auxiliary driver.

8. In a system according to claim 7 in which the main driver drives the member through a clutch, a switch controlled by the clutch which is opened whenever the clutch is disengaged, said switch being serially connected in the energizing circuit for the third relay to make the auxiliary driver operative when the clutch is disengaged.

9. In a system according to claim 7 in which a normally open reset switch is connected in series with the energizing circuit for the third relay and the third relay has normally open contacts connected in parallel arrangement with the reset switch.

10. In a system according to claim 9 in which the auxiliary driver is an air motor operable by compressed air supplied through a solenoid-controlled air valve and a manually controlled valve and the third relay controls the operation of the solenoid valve.

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