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[54] **APPARATUS FOR DETECTING CONDUCTIVE MATERIAL UTILIZING A VAPOR LAMP**
8 Claims, 1 Drawing Fig.

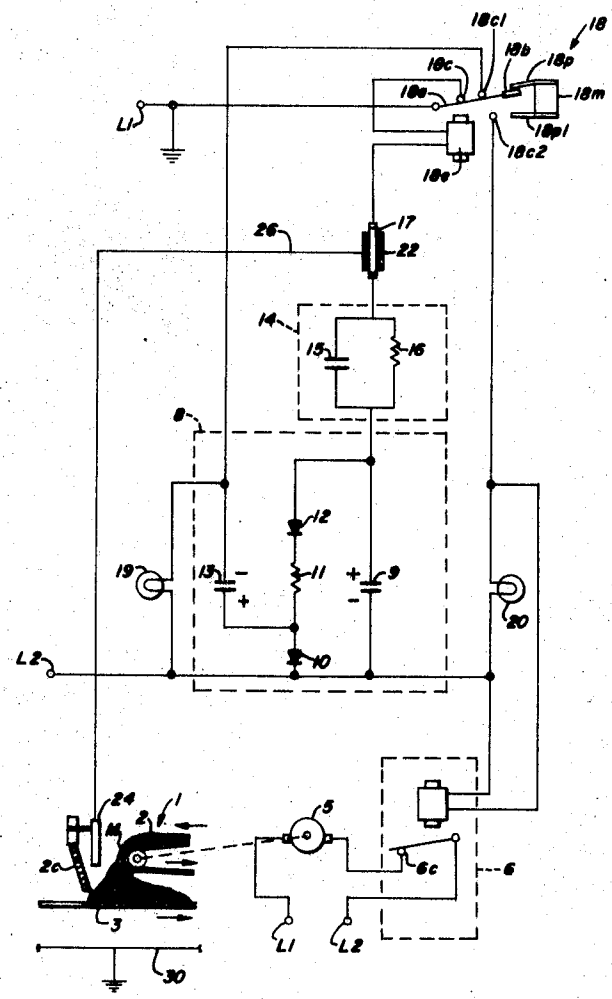
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[51] **Int. Cl.** **G01n 27/00**
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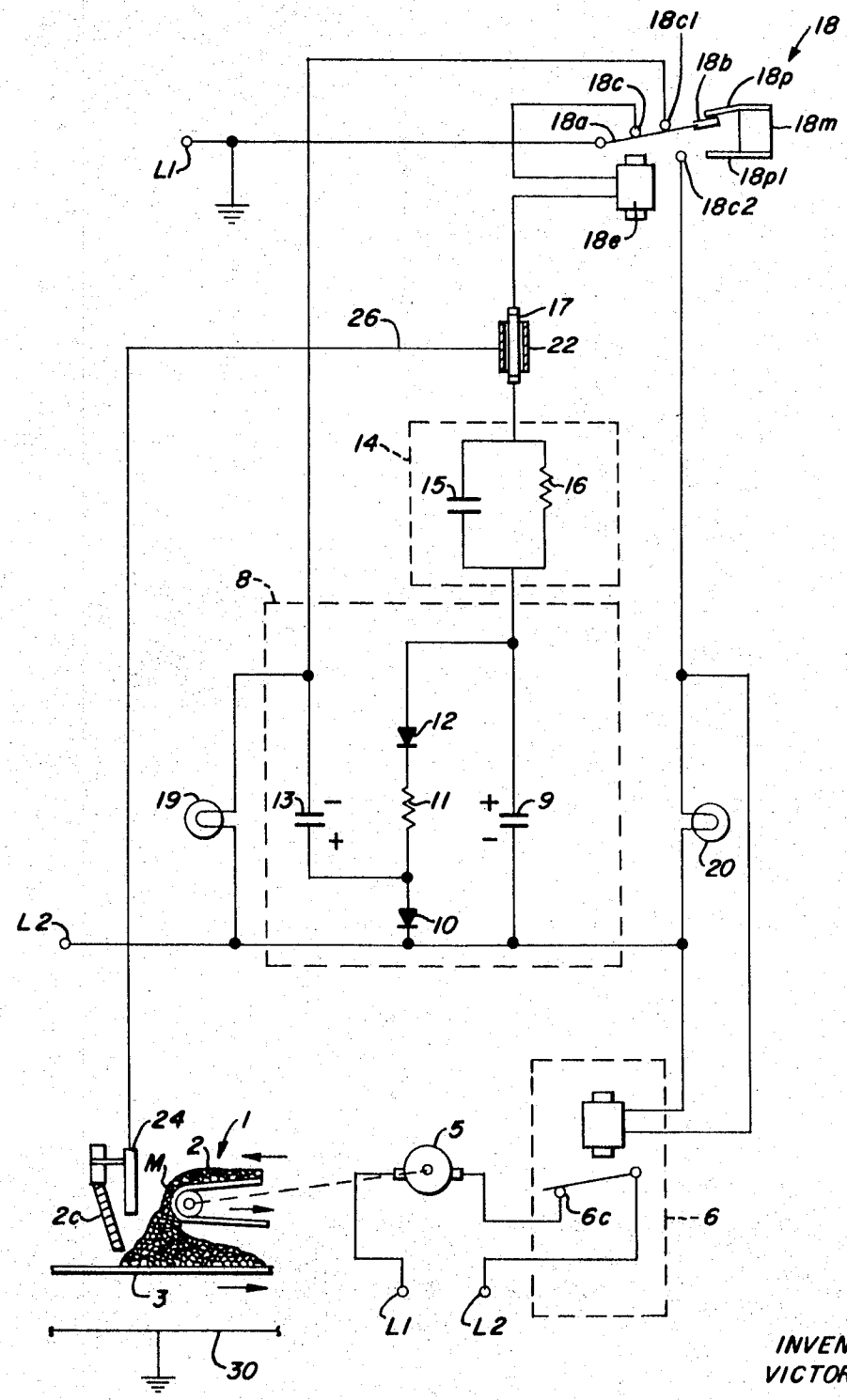
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ABSTRACT: A proximity or a probe contact control for a conveyor carrying electrically conductive material has a shielded fluorescent lamp, a sensing probe connected to the shield, a direct current plate potential charging means for the lamp, a discharge circuit connected in series with the lamp, a relay means responsive to the discharge circuit wherein the static bias on the lamp shield is changed by the change in level of conductive material initiating current flow in the lamp to actuate responsive relay means.





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APPARATUS FOR DETECTING CONDUCTIVE MATERIAL UTILIZING A VAPOR LAMP

This application is a continuation-in-part of my copending application, Ser. No. 721,972, filed Apr. 17, 1968, now abandoned.

The application relates to apparatus for detecting conductive material such as the buildup of moist iron ore at the end chute or enclosure of a conveyor. Such material, being moist and of a fine texture, tends to pack and build up in the discharge end chute of the conveyor. To prevent electrical overloading and stopping of the conveyor prime mover, spillage and wasted time, it necessary to include in the conveyor system means to monitor transfer of material at the discharge end of the conveyor. Presently, personnel in the general area monitor this transfer; however, their attention is often diverted and thus they are ineffective for this function.

It is therefore an object of my invention to provide relatively inexpensive apparatus for detecting the presence of conductive material.

A further object is to provide apparatus for controlling a conveyor carrying conductive material which will automatically shut down the conveyor if the material builds up in the chute at the discharge end.

A still further object of my invention is to provide indication of the condition of the control system at a central location. These and other objects will be more apparent after referring to the following specification and drawing, in which:

The single figure is a schematic view showing the detector and control of my invention connected to control a conveyor. Referring more particularly to the drawing, a first conveyor 1 transports electrical conductive material M to its discharge end 2 where the material is guided and shifted by means of chute 2*c* to a second conveyor 3 which moves the material in the direction of the arrow. The first conveyor 1 is powered by an electric motor 5 responsive to control relay 6. The parts so far described are conventional.

A 115 alternating-current source provides power to terminals L1 and L2. The source at terminal L1 is connected to earth potential or grounded. Connected to terminal L2 is a direct-current-biasing circuit 8 composed of a polarized plate-charging capacitor 9 in parallel with rectifier 10, resistor 11, rectifier 12 and a polarized capacitor 13 which has its positive terminal connected to a point between the cathode of rectifier 10 and resistor 11. Rectifiers 10 and 12 may be of the selenium disc type. Capacitors 9 and 13 are polarized electrolytic. The rectifiers 11 and 12 are oriented with their anodes toward terminal L2 and the capacitor 9 with its negative contact toward terminal L2. In series with capacitor 9 is a current-limiting circuit 14 composed of a polarized capacitor 15 oriented positive contact to positive contact with capacitor 9 and in parallel with resistor 16. In series with the plate-charging circuit 8 and current-limiting circuit 14 is a vapor lamp 17, which in the preferred embodiment is a fluorescent lamp. The lamp 17 is connected in series with energizing coil 18*e* and contact 18*c* of relay 18. The circuit is normally closed to power supply contact L1 through relay armature 18*a* which has an auxiliary ferrous metal portion 18*b*. Relay 18 includes normally closed contacts 18*c* and 18*c*1, normally open contact 18*c*2 and permanent magnet 18*m* having magnetic pole pieces 18*p* and 18*p*1 connected to its poles.

Relay 18 is constructed so that in the normally closed position its contacts 18*b* and 18*c* are held closed by the magnetic attraction of pole piece 18*p* to the metallic portion 18*b* of armature 18*a*. Contact 18*c*1 is connected to the negative terminal of capacitor 13. When relay coil 18*e* is energized the magnetic attraction of its metallic core attracts armature 18*a* from magnetic pole piece 18*p* to magnetic pole piece 18*p*1 thus opening relay contacts 18*c* an 18*c*1. Coil 18*e* is wound of sufficiently heavy wire to allow conduction of a momentarily heavy surge current. Magnetic attraction of the core of coil 18*e* and inertia of armature 18*a* moves the armature abruptly to a position where metallic portion 18*b* is attracted and held by magnetic pole piece 18*p*1 to close contact 18*c*2 Relay 18 may be replaced by a relay with a similar coil and with toggle action armature movement.

A indicator lamp 19 is connected between terminal L2 and contact 18*c*1.

An indicator light 20 is connected between terminal L2 and the relay contact 18*c*2 and in parallel with the energizing coil of control relay 6.

The outer periphery of lamp 17 is covered with a conductive shield 22 which is connected to an electrically conductive sensing probe 24 adjacent the conveyor 1 by means of an electrical conductor 26. The probe 24 is preferably a length of copper conductor and shield 22 preferably a length of copper conductor and shield 22 preferably an aluminum sheet shorter than the glass portion of the lamp 17 and positioned over the glass portion. Care is exercised to insure adequate insulation of shield 22, conductor 26 and probe 24 from conducting surfaces to prevent inadvertent discharge of lamp 17. The probe 24 is located at the discharge end of conveyor 1 relative to (the maximum permissible buildup of conductive material M. The parts 22, 24 and 26 may be unitary or separate, it only being necessary that together they provide an electrically conductive means surrounding at least a portion of the lamp 17 and extending to a position adjacent the conductive material.

In operation, relay armature 18*a* is positioned to close contacts 18*c* and 18*c*1 permitting the direct current plate-charging circuit 8 to build a potential in capacitor 9 and to establish potential across lamp 17. During this buildup of potential, current alternatively flows to the apparatus through terminal L1 or L2, the 155AC source. Current from L1 flows through armature 18*a*, contact 18*c*1 and to capacitor 13, charging the capacitor according to its polarization From capacitor 13, the current flows through rectifier 10 and to source contact L2. Alternating current also flows through indicator lamp 19, giving visual indication of source potential supply to plate-charging circuit 8.

During the alternate part of the cycle, current flows from source L2 through capacitor 9, charging it electrically according to its polarization, through rectifier 12, through protective resistance 11, to capacitor 13, then through relay contact 18*c*1 through relay armature 18*a* and to source contact L1. The protective resistance 11 limits the current to a value that will not destroy the direction of the existing charge of capacitor 13, and a value below rated rectifier capacity. After several cycles, the charge of capacitor 13 approaches the peak value of the source potential L1 to L2 and the charge of capacitor 9 approaches the sum of the potential charge of capacitor 13 added to the peak value of the L1, L2 source. A point in the subsequent half cycle from L1 and L2 will produce a peak potential across the lamp 17 approaching three times the peak value of the L1, L2 source. The shield 22 maintains a relatively stable condition within lamp 17. It is theorized that the charged ions within the lamp 17 are repelled by the free electron charge available within the shield 22 so that no current flows through the lamp 17 and the remainder of the circuit including coil 18*e* so long as the capacitance between the sensing probe 24 and the ground plane 30 remains unchanged. The surface of probe 24 and the ground plane 30 at earth potential may be considered as a capacitor, the spaces separating these surfaces may be considered as a dielectric. As soon as substantial material M buildup occurs between probe 24 and the ground plane 30 and material M closely approaches or contacts probe 24, the capacitance of the probe ground plane capacitor changes. Material M on conveyor 3 is an electrically conductive extension of the material M within chute 2*c* Material m may be electrically insulated or electrically connected to the ground plane potential. It is theorized that at this change in capacitance, the free electron charge of shield 22 being repelled by the charged ions and mercury particles within tube 17 relocate toward the ground plane to probe 24. Lamp 17 then ignites and current flows through the lamp circuit including energizing coil 18*e*. This flow is the surge of source potential at a portion of the half cycle added in series to motor the stored potential of capacitor 9. Regardless of the theory involved, the lamp 17 does ignite under these conditions and current flowing through energizing coil 18*e* pulls the relay armature 18*a* form

magnetic pole piece 18*p* to magnetic pole piece 18*p*1 This opens contacts 18*c* and 18*c*1 and closes contacts 18*c*2 Closing of contact 18*c*2 energizes the energizing coil of relay 6 by placing it in series with the L1, L2 source. This actuates its armature and opens its contact 6*c* to stop power supply to motor 5 and stops movement of conveyor 1. This also connects indicator light 20 to power source L1, L2 through contact 18*c*2 and gives visual indication that relay 6 is energized. The opening of contacts 18*c* and 18*c*1 disconnects indicator lamp 19, the plate charging circuit 8 and lamp 17 from source L1. Capacitor 15 of the current-limiting circuit 14 is selected to be smaller in capacitive value than capacitor 9 so that, during the discharge surge through lamp 17, capacitor 15 acquires such a potential charge that further passage of current through this capacitor is impeded. Resistor 16 is of higher resistance than resistor 11. During the surge of current through lamp 17 the potential of capacitor 9 decreases slightly.

Current-limiting circuit 14 limits excessive discharge of capacitor 9 through relay coil 18*e* and lamp 17 in the event that mechanical hesitancy is encountered in movement of armature 18*a* and the opening of contacts 18*c* and 18*c*1 Current flow through lamp 17 and the associated circuit stops with the opening of relay contacts 18*c* and capacitor 15 receives no further current. Capacitor 15 then slowly discharges through resistance 16. After a lapse of time, capacitor 15 discharges sufficiently and relay armature 18*a* may be reset to open contact 18*c*2 and to close contacts 18*c* and 18*c*1.

Resetting of relay 18 is accomplished by moving its armature 18*a* manually from the attraction of magnetic pole piece 18*p*1 to the magnetic attraction of pole piece 18*p*. The pole pieces are sufficiently spaced to permit wide separation of contact 18*c*2 at reset. Thus, a relatively large current and voltage may be controlled through these contacts.

A nonconductive mechanical linkage may be used to actuate armature 18*a* in resetting.

While one embodiment of my invention has been shown and described, it will be apparent that other adaptations and modifications may be made.

I claim:

1. Apparatus for detecting conductive material comprising a vapor lamp; electrically conductive means surrounding at least a portion of the periphery of said lamp and extending to a position adjacent the conductive material; an AC power source; a biasing circuit for supplying a high-potential DC charge to said lamp, said circuit including a first capacitor in series with said lamp, a first rectifier, a second rectifier, a resistance connected between said rectifiers, said rectifiers and resistance being connected in parallel with said first capacitor, and a second capacitor having one side connected to one lead of said power source and the other side connected between said first rectifier and resistance; a relay coil in series with said lamp and said first capacitor, and means operable by said relay coil to indicate the presence of said conductive material.

2. Apparatus according to claim 1 wherein the electrically conductive means surrounding the periphery of said lamp includes a shield for said lamp, a conductive probe mounted adjacent the conductive material, said conductive material being located between said probe and ground, and means connecting the probe to said shield.

3. Apparatus according to claim 2 wherein the vapor lamp is a fluorescent lamp.

4. Apparatus according to claim 1 in which said conductive material is carried on a conveyor, and said apparatus includes means operable by said relay coil to control the conveyor operation.

5. Apparatus according to claim 4 wherein the electrically conductive means surrounding the periphery of said lamp includes a shield for said lamp, said conductive material being located between said probe and ground, a conductive probe mounted adjacent the conveyor, and means connecting the probe to said shield.

6. Apparatus according to claim 5 wherein the vapor lamp is a fluorescent lamp.

7. Apparatus according to claim 5 including a current-limiting circuit connected in series between said lamp and said first capacitor.

8. Apparatus according to claim 1 in which said relay coil operates two normally closed contacts and a normally open contact, said relay coil being connected in series with first normally closed contact, said second capacitor being connected in series with the second normally closed contact, and said normally open contact being connected in series with the indicating means.

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