

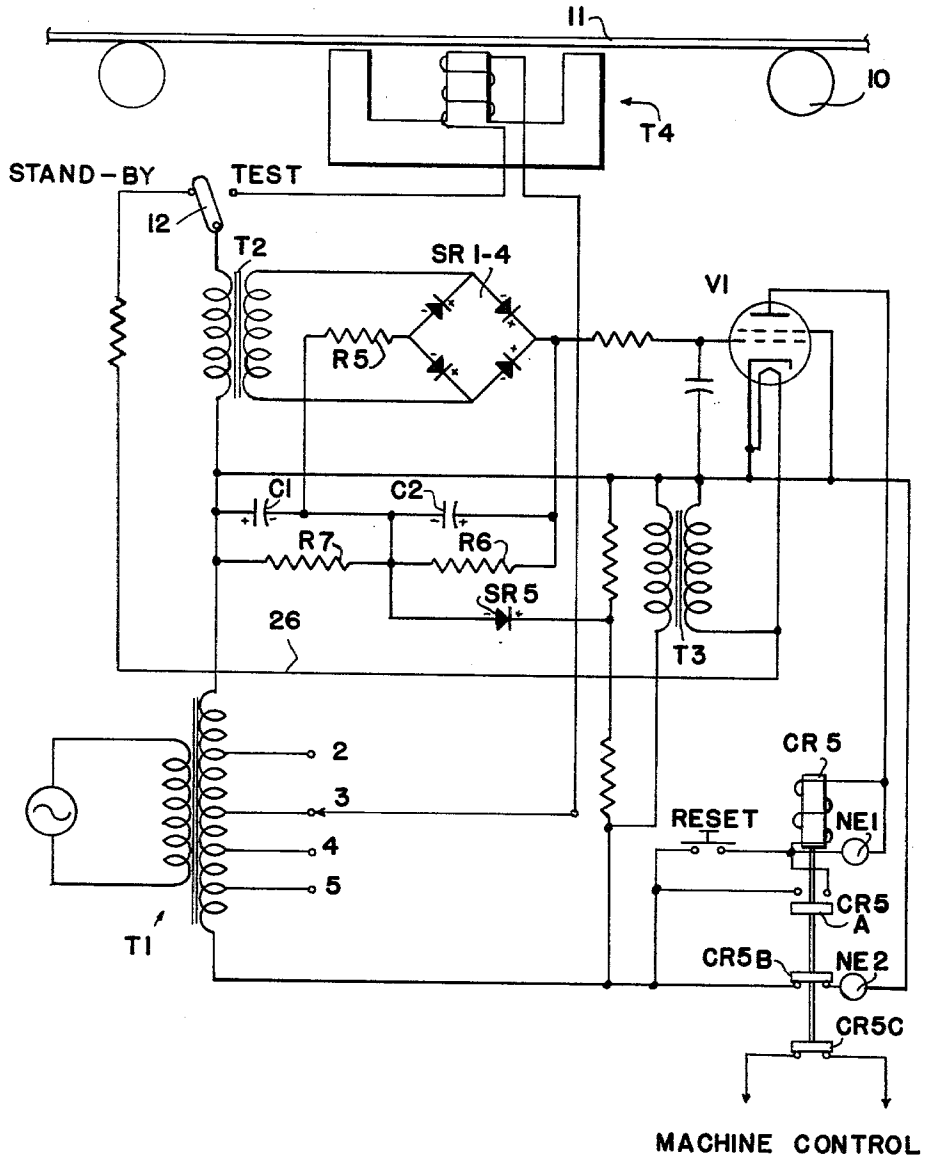
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DOUBLE SHEET DETECTING APPARATUS

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## DOUBLE SHEET DETECTING APPARATUS

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1 Claim. (Cl. 340-259)

This invention relates to apparatus for detecting the presence of multiple metal sheets at a detecting station, and more particularly to such apparatus which is simple and inexpensive yet entirely dependable in operation. In many manufacturing plants of an automated nature it is common practice to feed metal sheets from a stack in an automatic rapid manner to work stations such as forming presses, for example, and serious damage may result to this equipment if more than one sheet is entered at a time. The present invention provides an improved arrangement for automatically and dependably detecting the presence of more than one sheet at a time at a feeding station, and the primary object of the invention is the provision of such apparatus which is not only dependable but is also "fail-safe" in operation and which has inherent built-in provision for testing its operation at the start of every period of operation and at each restart following the correction of a multiple sheet incident.

Another object of the invention is the provision of apparatus having the characteristics outlined above which is highly versatile in its applicability to sheet destacking and/or feeding lines. That part of the apparatus which must have close proximity with the sheets to be monitored can be made very rugged and thus capable of being subjected to severe conditions of service and, further, may be positioned either in a fixed spot or on a movable arm or other carrier of the destacking and/or feeding equipment.

The above and other objects and advantages of the invention will become apparent upon consideration of the following specification and the accompanying drawing wherein there is disclosed a preferred embodiment of the invention.

In the drawing, the reference numeral 10 designates a schematic showing of a feed conveyor on which is shown a sheet 11 to be tested. Suitable means, not shown, would be provided to stop sheet 11 at the position shown for testing. Likewise, suitable means, not shown, may be incorporated in the assembled apparatus to momentarily move a switch arm shown at 12 from the indicated "standby" position to the indicated "test" position and thence back to "standby" position after each successive sheet has been stopped at the station shown. The function of switch 12 will be explained below.

Having its core positioned closely adjacent the path of travel of the sheets to be detected is a reactor T4 the winding of which is supplied, during test, by variable voltages by means of the secondary of a transformer T1. In series with the winding of reactor T4 is the primary of a transformer T2 the secondary of which is connected to the input terminals of a full-wave rectifier SR1-4. As will appear below, the transformer T2 will be energized when switch 12 is in "standby" position and also when this switch is in "test" position if the conditions of the test are met.

Connected across the secondary winding of transformer T1 is a control circuit comprising in series either a "reset" switch shown or the contactor CR5A, the coil of relay CR5, and a grid-controlled gas discharge device V1. The control of tube V1 is determined by the resultant control grid bias supplied by the bucking capacitors C1 and C2 which, as shown, are connected in series between the cathode and control grid of this tube. Capacitor C1 is charged by rectifier SR5 in a direction tending to place

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a negative potential on the control grid of tube V1, while capacitor C2 is charged by the rectifier SR1-4 in a direction tending to place a positive potential on the control grid of the tube V1.

Connected across the secondary of the transformer T1 is a step-down transformer T3, the output or secondary voltage of which is used not only to supply the heater of tube V1 but also through conductor 26 to energize the transformer T2 when the switch 12 is in "standby" position. The various circuit parameters are so chosen that when the transformer T2 is so energized the output of rectifier SR1-4 is sufficient to keep capacitor C2 charged beyond the reference charge on capacitor C1 so that the tube V1 will normally remain conductive. It should be understood, of course, that the primary of transformer T1 will be connected to a suitable commercial A.C. source through a suitable switch, not shown. Upon closure of this last-named switch and with the switch 12 in "standby" position to ready the apparatus for operation the tube V1 will conduct (as soon as its cathode is heated) immediately upon the reset switch being momentarily closed. Conduction in tube V1 energizes relay CR5 causing the holding contactor CR5A to close after which the reset switch may be released. A neon indicating lamp NE1 is connected in parallel with the coil of relay CR5 so that after conditioning the apparatus as described and releasing the reset switch the operator can tell at a glance that the tube V1 is conducting and that the apparatus is ready for testing. In this manner the apparatus itself is always inherently pre-tested directly before being used to test the sheets being delivered by the conveyor 10.

Relay CR5 has a second but normally closed contactor CR5B which is in the energizing circuit for a second neon indicating lamp NE2, and the operator can readily determine by noting the energization of lamp NE2 that the apparatus is not ready for use or (if the apparatus is in use) that multiple sheets have been detected. This latter aspect of the function of lamp NE2 will be explained below. Relay CR5 has a second normally closed contactor CR5C whose cooperating contacts are in a control circuit, not completely shown, operative when relay CR5 is de-energized to automatically shut down the sheet feeder or the manufacturing line to enable and require the operator to remove the unwanted second sheet before the feed or line is restarted.

As shown, the voltage supplied through the sensing coil of reactor T4 may be adjusted by selecting one or the other of the plurality of taps on the secondary of transformer T1, and in actual practice the circuit is so calibrated that when the lowest voltage of tap No. 2 is selected and a single thin sheet is at the test station (or if no sheet is at the station) sufficient current will be applied to the primary of transformer T2 upon movement of switch 12 to "test" position to keep sufficient positive bias on tube V1 to hold it conducting. If now in the next test sequence an unwanted double sheet appears at the test station the extra iron of the extra sheet will so increase the flux induced in the legs of the core of reactor T4 that insufficient current will be applied to transformer T2 to overcome the negative bias provided by capacitor C1 that the tube V1 will become extinguished. When this happens relay CR5 drops out, the warning signal NE2 comes on, and the production line is stopped. Upon removal of the unwanted second sheet the increase in output of the sensing coil of the reactor T4 will condition the tube V1 for conduction upon actuation of the reset switch, and normal operations may be resumed.

If now heavier or thicker sheets are to be handled the greater mass of metal at the detector T4 will result in greater impedance in the supply circuit for T2 and therefore to maintain the operation described above it may be necessary to utilize one of the higher voltage taps of trans-

former T1. For example, tap No. 3 may be used for sheet thickness ranging from .015-.021" and tap No. 5 may be used for sheets in the .042-.048" thickness range. With proper calibration, a very sharp drop in the output of transformer T2 occurs when double sheets appear—to unfailingly extinguish the tube V1. This dependable operation is further enhanced by the fact that the sensing reactor T4 acts also as an electromagnet to actually draw the sheet down onto the pole faces of the core of the reactor to thereby eliminate uncertain results which would occur if air gaps were present between the stock and core. It should also be noted that if the tube V1 and its associated circuit fails for any reason the relay CR5 will drop out to indicate the inoperativeness of the apparatus, and the trouble must be overcome before production operation may be resumed. Also, once a double sheet has been detected, the second sheet must be removed before the line can be restarted. Merely closing the reset switch will, under these circumstances, accomplish nothing since the relay CR5 will not energize until restoration of a pre-selected output from transformer T2 overcomes the negative bias from tube V1, allowing this tube to conduct.

The function of the switch 12 is to energize the reactor T4 only during a short test interval in each cycle of operation to thereby avoid excessive vibration and noise and to reduce the heating of the reactor. The design of the switch 12 is such that the time required to move from one position to the other is much less than the time required for capacitor C2 to appreciably change its charge. However, capacitor C2 discharges sufficiently rapid through resistor R6 to cut off the tube V1 very early during the test interval in the event that a double sheet is detected and the output of SR1-4 falls off.

It should now be apparent that we have provided a simplified and improved apparatus for detecting the presence of multiple metal sheets at a test station which accomplishes the objects initially set out above. In addition to the features of dependability and safety commented on in the above specification it should be noted particularly that during the whole time of normal use of the apparatus, even when on "standby," the relay CR5 is not operated in an opening and closing manner but, rather, remains continuously energized. The same is true for the discharge device V1 so that these parts, particularly the relay, will have exceptional long life and be very dependable in operation. As explained above, however, at the start of each sustained period of operation or after correction of any trouble in the apparatus or after the removal of an excess sheet from the test station the apparatus is itself retested by manual momentary closing of the reset switch.

While we have shown our apparatus applied to a fixed test station it should be obvious that the detecting reactor

T4 is a piece of such apparatus as may be mounted on a movable carrier as, for example, the arms which carry the lifting vacuum cups or magnets of a sheet destacker. In such application the test switch 12 would, of course, be so synchronized with the operation of the destacker that the test would not take place until after the individual sheet is well removed from the mass of the stack so that the presence of the latter would have no effect on the operation of the detector.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

Double sheet detecting apparatus comprising a current-conductive sensing coil and an associated magnetic circuit adapted to be placed in proximity with a metal sheet to be tested whereby an increase in the mass or thickness of the sheet decreases the reluctance of said circuit and consequently increases the impedance of said coil, means to connect the primary winding of a transformer and a source of variable alternating potential in series with said coil, a grid-controlled electric discharge device having a source of alternating plate potential and the actuating coil of a relay in series in its plate circuit, means establishing a reference source of negative potential for the control grid of said device, means to rectify the output of said transformer and thereby establish a source of positive potential for said control grid in opposition to said reference source, an indicator controlled by said relay to show cessation of conduction in said device and consequently an excess of mass or thickness in the sheet being tested, means to disconnect said sensing coil from said source while connecting said primary winding to a source of sustaining alternating potential of sufficient strength to maintain said device conducting, the arrangement being such that during "standby" said sensing coil is unenergized while said device remains conductive and thus the apparatus is conditioned for immediate test of a sheet upon disconnecting said sustaining potential and reconnecting said source of variable potential to said sensing coil.

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