

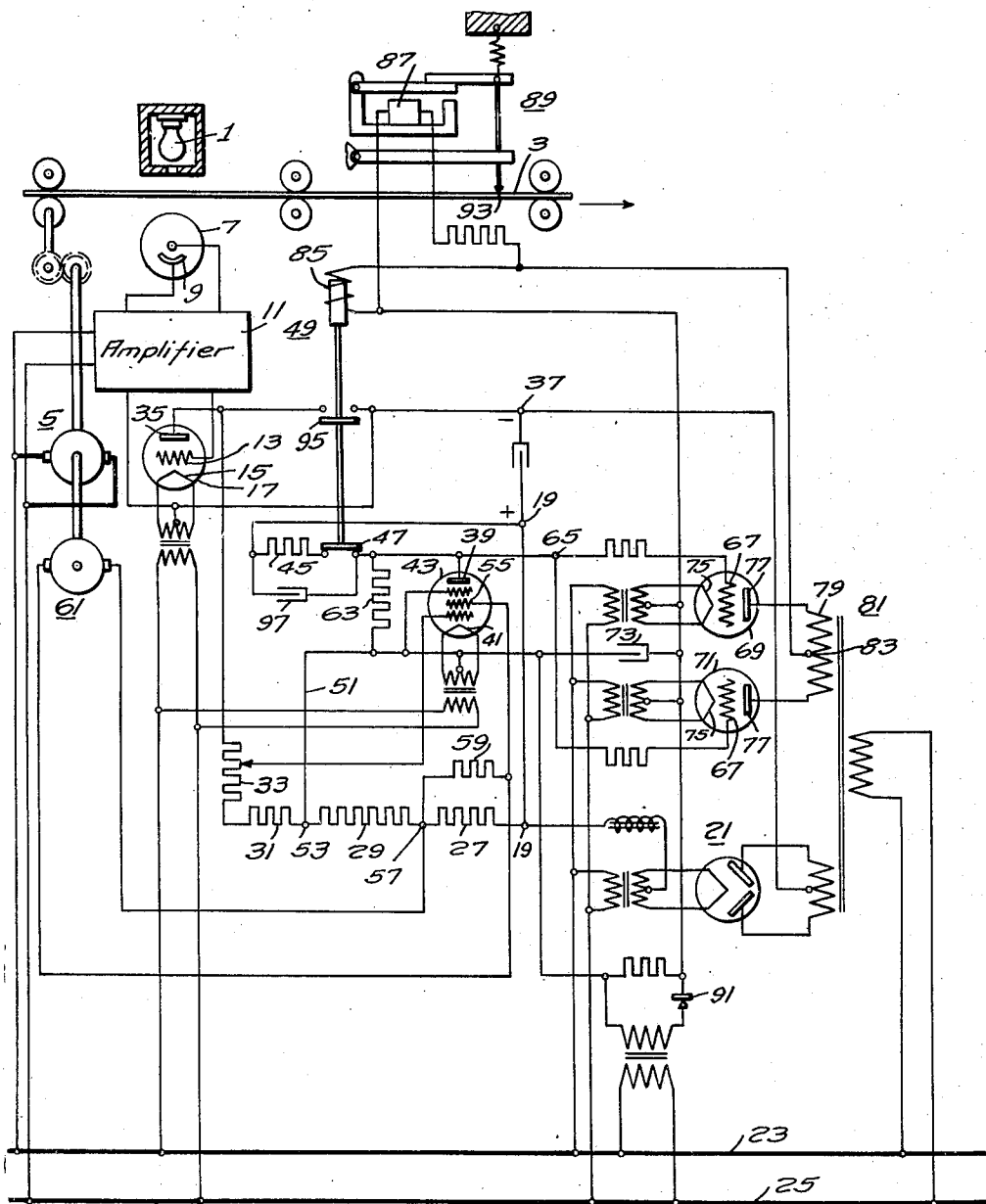
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MARKING DEVICE FOR HOLE DETECTORS

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MARKING DEVICE FOR HOLE DETECTORS

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Our invention relates to photo-sensitive apparatus and has particular relation to sorting and classifying apparatus used in the preparation of sheet steel or other sheet material for the canning industry.

Sheet steel is supplied from the rolling mill, in which it is pressed out, in the form of long continuous strips. Before the sheet is cut into sections, it is subjected to a photo-sensitive system which detects any pin holes that happen to be present in its surface. In response to the presence of a pin hole, a marking device is operated and a line is produced along the sheet in the region of the hole.

The speed of the sheet supplied from the mills commonly used in the metal welding industry varies over a wide range. It may be as low as 100 feet per minute and as high as 700 or 800 feet per minute. In apparatus constructed in accordance with the teachings of the prior art difficulties are encountered in marking the sheet so that the perforated regions may be readily identified because of the variation in speed. The mark produced varies in length over an extensive range and the location of the perforations cannot be determined with facility by examining it. If the marker is set to produce a line of moderate length, say 6 inches, at low speeds, the line produced at the maximum speeds is excessively long, i. e., of the order of $3\frac{1}{2}$ or 4 feet. The location of the hole with reference to the line three or four feet in length is hopeless. An analogous situation occurs if the marker is set to produce a short line at high speeds. Under such circumstances, a very short line is produced at low speeds and the operator often fails to observe its presence.

It is, accordingly, an object of our invention to provide a marking device that shall imprint an easily identifiable indication of the presence of a heterogeneity in sheet material.

Another object of our invention is to provide a marker for moving sheet material that, in the event of the presence of a heterogeneity in the material, shall imprint an indication independent of the speed at which the material is moving.

A more general object of our invention is to provide a contrivance, the operation of which shall vary in inverse proportion to the magnitude of a physical quantity.

Another general object of our invention is to provide a device that shall operate for an interval of time of length inversely proportional to the magnitude of a physical quantity.

An ancillary object of our invention is to provide an electrical circuit for timing the operation of a mechanism in accordance with the magnitude of a physical quantity.

5 More specifically stated, it is an object of our invention to provide a marking device for indicating the presence of pin holes in sheet metal in such manner that the perforated regions shall be identifiable with facility.

10 In accordance with our invention, we provide a timing arrangement comprising charge storing means, a source of current, and an electric discharge valve having a constant current-voltage characteristic over a substantial potential range. The current flow through the valve is controlled in accordance with the magnitude of the physical quantity on which the timing is to depend. To time the operation of a mechanism such as a working device, the storing means is charged from the source through the valve. The potential impressed on the storing means increases at a rate proportional to the current flow through the valve, and therefore, the time required by the storing means to charge to a predetermined potential is inversely proportional to the magnitude of the quantity under consideration.

In the application of our invention to the treatment of sheet metal, the current flow through the valve in the timing system varies in proportion to the speed of the sheet and the marking device is controlled from the timing system. When a perforated region is detected in the sheet, the operation of the marking mechanism is initiated and at the same time the storing means begins to charge through the valve. After an interval of time that is inversely proportional to the speed of the sheet, the storing means attains a potential sufficient to operate a relay for interrupting the operation of the marking mechanism.

The novel features that we consider characteristic of our invention are set forth with particularity in the claims. The invention itself, however, both as to its organization and its method of operation together with additional objects and advantages thereof, will best be understood from the following description of a specific embodiment when read in connection with the accompanying drawing, in which the single figure is a diagrammatic view showing a preferred embodiment of our invention.

The apparatus shown in the drawing comprises a source of radiant energy 1, such as an incandescent lamp, which projects radiations

across the surface of a moving strip 3 of sheet metal. The sheet 3 is advanced from a supply element such as a rolling mill or a supply reel, and is wound on a storage reel or is otherwise arranged for further treatment. The supply element and the storage element do not concern the present invention and are, therefore, not shown. Since the speed of movement of the sheet 3 is primarily involved here, the mechanism whereby the sheet is advanced is illustrated symbolically as a motor 5.

Below the sheet 3 and in line with the radiations from the source 1, a photo electric cell 7 or an array of parallel connected photo-electric cells is disposed. The specific structure of the photo-sensitive arrangement does not concern the present invention. Preferably it should be provided with a light-sensitive element 9 or a set of light-sensitive elements of such dimensions and so disposed that when there is a pin hole in the region of the sheet 3 passing between the source 1 and the cell 7, substantial photo-electric current flows. The photo-electric cell 7 is coupled to the input of a multistage amplifier 11 of the usual well known structure. The output potential of the amplifier is impressed between the control electrode 13 and the cathode 15 of an electric discharge valve 17 of the arc-like type. Normally the arc-like valve is biased so that it is non-conductive. When a perforated region of the sheet passes between the source 1 and the photo-electric cell 7, the amplifier 11 supplies a potential to counteract the bias and to render the arc-like valve 17 conductive.

Current flows through the arc-like valve 17 in a circuit extending from the positive terminal 19 of a rectifier 21, supplied from the main conductors 23 and 25 of an alternating current source (not shown) which may be of the usual commercial 60 cycle type, through a plurality of resistors 27, 29 and 31, a voltage divider 33, the anode 35 and cathode 41 of the valve, to the negative terminal 37 of the rectifier. By reason of the current flow through the resistors 27, 29 and 31, a potential is impressed between the anode 39 and the cathode 41 of an electric discharge device 43, the current flow through which is independent of the potential over a wide potential range. For the device 43 we prefer to use a pentode which is designated commercially as an RCA-58 tube. The pentode 43 is connected in a circuit which extends from the positive terminal 19 of the rectifier through a resistor 45, the normally closed contactor 47 of a relay 49, the anode 39 and the cathode 41 of the pentode, a conductor 51 to the junction point 53 of two of the resistors 29 and 31 supplied from the rectifier 21. By reason of the current flow through the resistors 27, 29 and 31, a potential is impressed between the anode 39 and the cathode 41 of the pentode 43 and current flows through the device.

While the current flow through the pentode 43 is independent of the voltage impressed between its anode and its cathode, it is dependent on the potential impressed between one of its grid electrodes 55, which we may designate herein as the control electrode, and the cathode 41. Over a portion of the characteristic of the pentode, the current flow between the anode 39 and cathode 41 is directly proportional to the potential impressed between the control electrode 55 and the cathode, and we prefer to operate along this portion of the characteristic. The control

electrode 55 is therefore connected to the junction point 51 of the resistors 27 and 29 through another resistor 59 and the resistor 29 between the control electrode 55 and the cathode 41 is preferably selected for this purpose. On the bias potential a potential proportional to the speed of the sheet 3 is superimposed. The latter potential is derived from a generator 61 coupled to the motor 5 in such manner that the output potential of the generator is proportional to the speed of the sheet 3. The potential impressed from the generator 61 renders the current flow through the pentode 43 proportional to the speed of the sheet.

The pentode 43 is shunted by a suitable resistor 63 and the parallel network consisting of the pentode and the resistor is connected at one terminal to the common junction point 65 of the control electrodes 67 of a pair of auxiliary arc-like valves 69 and 71 and at the other terminal to a capacitor 73 which is connected to the cathodes 75 of the auxiliary valves. The anodes 77 of the auxiliary valves 69 and 71 are connected to the terminal taps of the secondary section 79 of a transformer 81 supplied from the line conductors 23 and 25. The intermediate tap 83 of the secondary section 79 is connected to the cathodes 75 of the auxiliary valves 69 and 71 through the exciting coil 85 of the relay 49 and through the energizing element 87 of a marking device 89 which is connected in parallel with the exciting coil 85. The capacitor 73 is charged from the line conductors 23 and 25 through a rectifier 91 and serves to impress a blocking potential between the control electrodes 67 and the cathodes 75 of the auxiliary valves 69 and 71.

When the pentode 43 is rendered conductive by the current flow through the resistors 27, 29 and 31 in series with the rectifier 21, the biasing potential supplied by the capacitor 73 is counteracted and the auxiliary valves 69 and 71 are rendered conductive. The current flow through the auxiliary valve energizes the relay 49 and causes the marker 89 to operate. The marker is provided with a stylus 93 which engages the sheet 3 when it is in operation. The stylus is located adjacent to the source 1 but displaced a short distance therefrom in the direction of the movement of the sheet. The position of the stylus 93 is so selected that, taking into consideration the delay in the operation of its energizing element 87, lines drawn perpendicular to the mark produced by the stylus at its ends from one edge of the sheet to the other define a region of the sheet in which a hole is located.

When the relay 49 is energized, its normally open contactor 95 closes and a short-circuit is established across the arc-like valve 17, rendering the latter non-conductive. The apparatus is thus reset for another operation. The normally closed contactor 47 of the relay 49 is moreover opened and the resistor 45 originally connected to the anode 39 of the pentode 43 is now replaced by a timing capacitor 97. The circuit through the pentode 43 now extends from the positive terminal 19 of the rectifier 21 through the capacitor 97, the anode 39 and cathode 41 of the pentode 43, the resistor 31, the voltage divider 33, the closed contactor 95 of the relay 49, to the negative terminal 37 of the rectifier.

The timing capacitor is thus charged by the current conducted through the pentode 43. Since the current flow through the pentode 43 is independent of the potential impressed be-

tween its anode 39 and cathode 41, the capacitor 97 is charged at a constant rate which varies directly with the speed of the sheet 3, as a result of the control potential impressed on the pentode 43 from the generator 61. The time required for the capacitor 97 to charge to a predetermined potential is, therefore, inversely proportional to the speed of the sheet. The capacitor continues to charge in this manner until the anode-cathode potential of the pentode 43 is completely counteracted. In general, the net potential impressed between the anode 39 and the cathode 41 of the pentode may become negative by reason of the distributed inductance present in the conductors and the other elements of the circuit. If the distributed inductance is insufficient and the negative potential is desirable, a small lumped inductance may be added. Whatever alternative is adopted, the pentode is rendered non-conductive at a predetermined instant and the blocking potential 73 impressed in the control circuits of the auxiliary valves 69 and 71 again predominates. At this point the auxiliary valves are rendered non-conductive, the relay 49 is deenergized and the operation of the marker 89 is interrupted. Because the timing capacitor 97 is charged at a constant rate dependent on the speed of movement of the sheet, the time during which the marker 89 is in operation is inversely proportional to the speed of the sheets. By reason of the inverse proportion, the line produced is of the same length regardless of the variations in the speed.

Although we have shown and described a certain specific embodiment of our invention, we are fully aware that many modifications thereof are possible. Our invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

We claim as our invention:

1. For use in operating a mechanism for marking a moving sheet to indicate the presence of a heterogeneity the combination comprising charge storing means, a source of potential, a discharge device of the type the current flow through which is independent of the principal potential, means responsive to the presence of a heterogeneity in said sheet for connecting said storing means in circuit with said source and device, means responsive to the resultant current flow through said device for rendering said mechanism operative, means for varying said current flow in accordance with the speed of said sheet and means responsive to the potential impressed on said storing means for interrupting the operation of said mechanism when said potential attains a predetermined magnitude.

2. For use in operating a mechanism for marking a moving sheet to indicate the presence of a heterogeneity the combination comprising charge storing means, a source of direct current potential, a discharge device of the type the current flow through which is independent of the principal potential, means responsive to the presence of a heterogeneity in said sheet for connecting said storing means in circuit with said source and device, means responsive to the resultant current flow through said device for rendering said mechanism operative, means for varying said current flow in accordance with the speed of said sheet and means responsive to

the potential impressed on said storing means for interrupting the operation of said mechanism when said potential attains a predetermined magnitude.

3. For use in operating a mechanism for marking a moving sheet to indicate the presence of a heterogeneity, the combination comprising charge storing means, a source of direct current potential, a pentode having a control circuit, means responsive to the presence of a heterogeneity in said sheet for connecting said storing means in circuit with said source and pentode, means responsive to the resultant current flow through said pentode for rendering said mechanism operative, means for impressing a potential varying in accordance with the speed of said sheet in said circuit to vary said current flow in accordance with the speed of said sheet and means responsive to the potential impressed on said storing means for interrupting the operation of said mechanism when said potential attains a predetermined magnitude.

4. For use in operating a mechanism for marking a moving sheet to indicate the presence of a heterogeneity, the combination comprising charge storing means, a source of direct current potential, a pentode having a control circuit, means responsive to the presence of a heterogeneity in said sheet for connecting said storing means in circuit with said source and pentode, means responsive to the resultant current flow through said pentode for rendering said mechanism operative, means for impressing a potential proportional to the speed of said sheet in said circuit to vary said current flow in accordance with the speed of said sheet and means responsive to the potential impressed on said charge storing means for interrupting the operation of said mechanism when said potential attains a predetermined magnitude.

5. For use in operating a mechanism for marking a moving sheet to indicate the presence of a heterogeneity, the combination comprising charge storing means, a source of potential, a discharge device of the type the current flow through which is independent of the principal potential, an electric discharge valve of the arc-like type to be rendered conductive in response to the presence of a heterogeneity in said sheet for connecting said storing means in circuit with said source and device, means responsive to the resultant current flow through said device for rendering said mechanism operative, means for varying said current flow in accordance with the speed of said sheet and means responsive to the potential impressed on said storing means for interrupting the operation of said mechanism when said potential attains a predetermined magnitude.

6. A timing system comprising charge storing means, a source of potential, an electric discharge device of the type the current flow through which is independent of the principal potential, means for connecting said source and said device in circuit to render said device conductive to actuate a load-device for a predetermined time, means responsive to the current flow through said device to interpose said storing means in circuit with said source and said device and means responsive to the potential of said storing means for controlling said load-device.

7. For use in operating a mechanism for marking a moving sheet to indicate the presence of a heterogeneity, the combination comprising charge storing means, a source of potential an electric

discharge device of the type the current flow through which is independent of the principal potential, means responsive to a heterogeneity in said sheet for connecting said device in circuit with said source, means for varying the current flow through said device in accordance with the speed of said sheet, means responsive to the current flow through said device for interposing said storing means in circuit with said device and said source, means also responsive to said current flow to render said mechanism operative and means responsive to the potential impressed on said storing means for interrupting the operation of said mechanism.

8. A timing system comprising charge storing means, a source of potential, an electric discharge device of the type the current flow through which is independent of the principal potential, an electric discharge valve of the arc-like type and means for rendering said valve conductive for connecting said source and said device in circuit to render said device conductive to actuate a load-device for a predetermined time, means responsive to the current flow through said device to interpose said storing means in circuit with said source and said device and to render said valve non-conductive and means responsive to the potential of said storing means for controlling said load-device.

9. For use in operating a mechanism for marking a moving sheet to indicate the presence of a heterogeneity, the combination comprising charge storing means, a source of potential, an electric discharge device of the type the current flow through which is independent of the principal potential, means including a discharge valve of the arc-like type to be rendered conductive in response to a heterogeneity in said sheet for connecting said device in circuit with said source, means for varying the current flow through said device in accordance with the speed of said sheet, means responsive to the current flow through said device for interposing said storing means in circuit with said device and said source and for rendering said valve non-conductive, means also responsive to said current flow to render said mechanism operative and means responsive to the potential impressed on said storing means for interrupting the operation of said mechanism.

10. A timing system comprising charge storing means, a source of potential, a pentode, means for connecting said source and said pentode in circuit to render said pentode conductive to actuate a load-device for a predetermined time, means responsive to the current flow through

said pentode to interpose said storing means in circuit with said source and said pentode and means responsive to the potential of said storing means for controlling said load-device.

11. For use in detecting a heterogeneity in a moving sheet the combination comprising, means for marking said sheet with a mark that lends itself only to visual identification, means responsive to a heterogeneity in said sheet for actuating said marking means to mark said sheet and means responsive to the speed of said sheet and cooperative with said actuating means independently of said mark for maintaining said marking means actuated for a time interval determined by said speed.

12. For use in detecting a heterogeneity in a moving sheet the combination comprising, means for marking said sheet with a mark that lends itself only to visual identification, means responsive to a heterogeneity in said sheet for actuating said marking means to mark said sheet and means responsive to the speed of said sheet and cooperative with said actuating means independently of said mark for maintaining said marking means actuated for a time interval inversely proportional to said speed.

13. For use in operating a mechanism for marking a moving sheet to indicate the presence of a heterogeneity the combination comprising electrical energy storing means, means responsive to a heterogeneity in said sheet for supplying energy to said storing means, means cooperative with said responsive means and responsive to the speed of said sheet for maintaining the quantity of energy stored in said storing means dependent on the speed of said sheet and means, responsive to the energy stored in said storing means, for actuating said marking means for a time interval dependent on the quantity of said energy stored.

14. For use in operating a mechanism for marking a moving sheet to indicate the presence of a heterogeneity the combination comprising charge storing means, means responsive to a heterogeneity in said sheet for charging said storing means, means cooperative with said responsive means and responsive to the speed of said sheet for maintaining the potential of said storing means inversely proportional to the speed of said sheet and means, responsive to the energy stored in said storing means, for actuating said marking means for a time proportional to said potential.

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