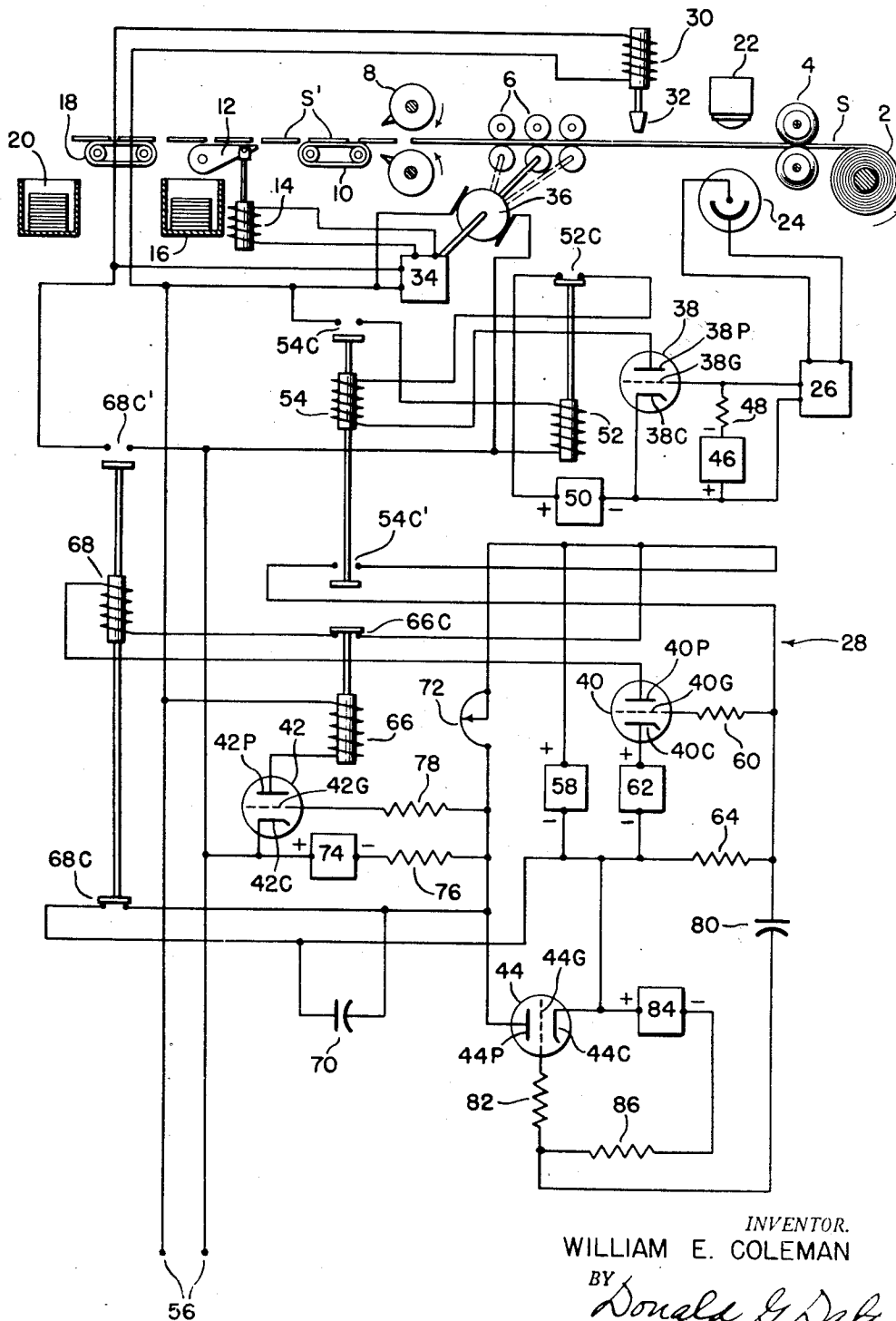


2,563,213

Filed June 1, 1949



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UNITED STATES PATENT OFFICE

2,563,213

CONTROL UNIT FOR PINHOLE DETECTORS

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Application June 1, 1949, Serial No. 96,563

6 Claims. (Cl. 175—320)

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This invention relates to a control unit for pin hole detectors and more particularly to such a device that will detect small holes in thin sheet products such as sheet steel which is used in the manufacture of tin cans. Conventional pin hole detectors have the disadvantage that they fail to detect the second pin hole when the holes are closely spaced. In some instances the control fails to detect even more than one pin hole when several occur in close succession. Thus some imperfect sheets will pass inspection and be subject to the expense of further processing before the defect is discovered.

It is an object of my invention to provide a control unit for a pin hole detector, which unit will operate to detect pin holes regardless of how closely spaced the pin holes may be.

This and other objects will be more apparent after referring to the following specification and attached drawing, in which the single figure is a schematic drawing showing a wiring diagram of the control unit connected to a strip inspecting and shearing line.

Referring more particularly to the drawing the reference numeral 2 indicates an uncoiler for a strip S. The strip S passes from the uncoiler 2 through side trimming knives 4 and measuring rolls 6 to the shearing drums 8, where the strip is sheared into sheets S' of the desired length. The sheared sheets pass over the conveyor 10 to a deflector 12 which is operated by means of a solenoid 14 to deflect imperfect sheets to a salvage piler 16. The perfect sheets pass over the deflector 12 to a conveyor 18, which delivers the sheets to a prime sheet piler 20. A high intensity light source 22 is located above the strip adjacent the side trimming knives 4 and a bank of light sensitive photoelectric cells 24 is located in a shielded housing under the light sources 22 below the strip. When a section of strip containing a hole passes between the light source 22 and photoelectric cells 24, light passes through the hole and strikes one or more of the photo-cells. This generates a small voltage impulse which is transmitted to a voltage amplifier 26 where the impulse is amplified to a value of sufficient magnitude to operate the controls of the control unit 28. The pin hole detector may be of the type shown in the patent to Chamberlain et al. No. 2,229,638. The control unit 28 converts the short impulse from the amplifier 26 into an impulse of sufficient power and duration to operate a solenoid 30 of a strip marker 32 which places a visible mark next to the hole, thus identifying the section of strip containing the hole.

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The control unit also provides an impulse to energize a solenoid in a proportional timer 34 which is driven by a motor 36 which also drives the measuring rolls 6. Thus the timer 34 is in synchronism with the movement of the strip. The proportional timer 34 is preferably of the type shown in the patent to Ladrach No. 2,217,342 and is equipped with a contact mechanism which energizes the solenoid 14 to tilt the deflector 12 upwardly and direct the sheet containing the pin hole downwardly into the salvage piler 16.

The general combination described above is old but has failed to function properly because the control unit does not detect all the holes occurring at close intervals in the strip.

My invention relates particularly to the control unit and provides an overlapping time delay which permits all impulses from the hole detector to be transmitted to the timer 34. The control unit is provided with four grid controlled gas rectifier tubes 38, 40, 42 and 44. Each of these tubes is provided with a grid, plate and cathode. The tubes have indirectly heated cathodes of the conventional type, heaters for which are not shown. These tubes could contain a second or screen grid as well as the control grid shown without changing the operation as described hereinafter. The control grid is able to initiate the flow of current from the plate to the cathode through the tube, but once the current starts to flow the grid no longer is in control. The current can then be stopped only by making the plate potential zero or negative with respect to the cathode. Thus, if the grid is initially sufficiently negative with respect to the cathode, the tube will not conduct, but when the grid voltage is raised in the positive direction even for a very short period of time, the tube will conduct if the plate is positive with respect to the cathode. Conduction will continue until the plate voltage is made zero or negative by external means. A direct current power source 46, such as a battery or rectifier, has its positive side connected to the cathode 38C and its negative side connected to the grid 38G through the resistance 48 so that the grid is normally sufficiently negative to prevent conduction in the tube 38. The amplifier 26 is connected to the grid and cathode so that when a hole occurs in the strip the impulse from the amplifier 26 will make the grid 38G positive with respect to the cathode 38C. The plate 38P is normally connected to a D. C. power source 50 through the normally closed contact 52C of a relay 52 and a relay coil 54. Thus, since its plate is positive with respect to its cathode the tube 38 will

start to conduct and continue to conduct until the voltage of plate 38P is reduced to zero. The relay coil 52 and normally open contact 54C are connected in series to an A. C. power source 56. When relay coil 54 is energized, due to conduction in tube 32, it closes contacts 54C and 54C'. Closing of contact 54C energizes relay coil 52 which opens contact 52C and interrupts the current through tube 38, thus deenergizing relay coil 54 and opening contacts 54C and 54C' which prepares this portion of the circuit for the reception of another pulse. This cycle of operation is completed in less than $\frac{1}{16}$ of a second, thus enabling it to be activated by closely spaced impulses. Closing of contact 54C' provides a positive pulse to the grid 40G of tube 40 from D. C. power source 58 through a resistor 60. The tube 40 is normally held in a non-conducting state by means of a D. C. power source 52, which has its positive terminal connected to the cathode 40C and its negative terminal connected to the grid 40G through resistances 60 and 64. Application of a positive impulse to the grid 40G from the D. C. power source 58 overcomes this normal condition and causes the tube 40 to conduct through a normally closed contact 66C and a relay coil 68. Normally closed contact 68C of relay 68 is connected in parallel with a capacitor 70, power being supplied thereto from the D. C. power source 58 through an adjustable rheostat 72. When relay coil 68 is energized, due to conduction in tube 40, contact 68C will open, thus permitting the capacitor 70 to start charging. A D. C. power source 74 has its positive terminal connected to the cathode 42C and its negative terminal connected to the grid 42G through resistors 76 and 78, thus making the grid 42G negative with respect to cathode 42C and holding the tube 42 in the non-conducting state. The plate 42P is connected to the A. C. power source 56 through the relay coil 66. As the capacitor 70 charges the voltage of the control grid 42G gradually increases until it becomes sufficiently positive to start the tube 42 conducting. This energizes relay coil 66 causing contact 66C to open, which in turn causes the tube 40 to cease conducting. This closes contact 68C and discharges capacitor 70, which in turn permits the grid of tube 42 to again become negative with respect to its cathode. Since the plate 42P is connected to an alternating current power source, the plate to cathode potential of tube 42 will alternate in polarity and when control grid 42G becomes negative, the tube 42 will stop conducting on the first half cycle that its plate becomes negative. This deenergizes relay coil 66, thus reclosing contact 66C to prepare the system for receiving another impulse. Energization of relay 68 causes the contact 68C' to close, thus completing a circuit to the timer 34 which in turn causes the solenoid 14 to move the deflector 12 to deflect the sheets into the piler 16 at the proper time. Closing of contact 68C' also energizes relay 30 to cause the marker 32 to place a mark on the strip adjacent the pin hole.

If a second hole occurs while the relay coil 68 is still energized, relay coil 54 will be energized thereby providing a second impulse through contact 54C' to the grid 40G. This impulse will have no effect on the tube 40 since it is already conducting. However, the impulse will be transmitted through a capacitor 80 and resistor 82 to the grid 44G of tube 44. A D. C. power source 84 has its positive terminal connected to the cathode 44C and its negative terminal connected

to the grid 44G through resistances 82 and 86, this functioning to normally maintain the grid negative with respect to the cathode. The capacitor 70 is connected directly between the plate 44P and cathode 44C and there will be a potential between the plate and cathode only while the capacitor 70 is charging. The second impulse which is transmitted through capacitor 80 to the grid 44G will make the grid positive with respect to its cathode long enough to start the tube 44 conducting. This will discharge capacitor 70, thus reducing the potential of plate 44P to zero. This stops the tube 44 from conducting and allows the capacitor 70 to start recharging. The operation will then continue as described above.

In brief, the operation of the device is as follows:

When a hole is detected by means of the electric eye 24, the impulse created thereby is amplified in the amplifier 26 and is impressed on the grid 38G, thus causing the tube 38 to conduct. This energizes relay coil 54, which closes contact 54C. This in turn energizes relay coil 52, which opens contacts 52C and stops the tube 38 from conducting. During the time that relay coil 54 is energized, it closes contact 54C' thus causing the tube 40 to conduct and energizing relay coil 68. Energization of relay coil 68 closes contact 68C' and opens contact 68C. Closing of contact 68C' energizes the timer 34, which functions to operate solenoid 14 to move deflector 12 at the desired time to deflect the imperfect sheet to the piler 16. At the same time, relay coil 30 is energized to operate the marker 32. Opening of contact 66C causes the capacitor 70 to start charging and continue charging until the tube 42 starts conducting. When tube 42 conducts relay coil 66 is energized, thus opening contact 66C and stopping the tube 40 from conducting. This in turn deenergizes relay coil 68 and closes contact 68C and opens contact 68C'. The deflector 12 then moves back to its normal position so that the sheets continue into the prime piler 20. If a second impulse occurs while the tube 40 is still conducting, the tube 44 will conduct and cause the capacitor 70 to discharge and lengthen the time that tube 42 conducts. Thus the deflector 12 will remain in position to deflect the sheets into piler 16 for a longer period of time.

If the timer 34 can be made to operate fast enough, or if the pin holes are not too closely spaced, the timer circuit can be energized directly from relay 54 with contact 54C' replacing contact 68C'. In such a case that part of the control between the contacts 54C' and 68C' will be omitted.

While one embodiment of my invention has been shown and described, it is apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. A control unit operable by a voltage impulse comprising a grid controlled gas rectifier tube having a grid, cathode and plate, means for maintaining the grid negative with respect to the cathode, means for applying the voltage impulse to said grid, a direct current power source, a normally closed contact, a relay coil, means for connecting the direct current power source to said cathode and plate through said contact and said relay coil, a normally open contact operated by said relay, a second relay coil for operating the said normally closed contact, a circuit in-

cluding said normally open contact and said second relay coil in series, a second normally open contact for the first named relay, a second grid-controlled gas rectifier tube in circuit with said second normally open contact, means for maintaining the grid of the second tube negative with respect to the cathode, a second normally closed contact, a third relay coil, said last named contact and the third relay coil being connected in series with the plate of the second tube, a normally open contact operated by said third relay coil, a normally closed contact operable by the third relay coil, a D. C. power source, a capacitor connected in parallel with said last named contact to said last named power source, a third rectifier tube, means for maintaining the grid of the third tube negative with respect to the cathode, said capacitor being connected to the grid of the third tube, a fourth relay coil connected in series with the plate of the third tube, said fourth relay coil operating the second normally closed contact, and an A. C. power source connected to the plate of the third tube.

2. A control unit according to claim 1 having a second capacitor, a fourth gas rectifier tube having its grid connected through said second capacitor in circuit with said second normally open contact, the first named capacitor being connected between the plate and cathode of the said fourth tube, and means for maintaining the grid of the fourth tube negative with respect to the cathode.

3. A control unit operable by a voltage impulse comprising a grid controlled gas rectifier tube having a grid, cathode and plate, a direct current power source connected to said grid, means for applying the voltage impulse to said grid, a second direct current power source, a normally closed contact, a relay coil, means for connecting the second direct current power source to said cathode and plate through said contact and said relay coil, a normally open contact operated by said relay, a second relay coil for operating the said normally closed contact, a circuit including said normally open contact and said second relay coil in series, a second normally open contact for the first named relay, a second grid controlled gas rectifier tube in circuit with said second normally open contact, a direct current power source having its positive side connected to the cathode of the second tube and its negative side connected to the grid, a resistance in the connection to the last named grid, a second normally closed contact, a third relay coil, said last named contact and the third relay coil being connected in series with the plate of the second tube, a normally open contact operated by said third relay coil, a normally closed contact operable by the third relay coil, a D. C. power source, a capacitor connected in parallel with said last named contact to said last named power source, a third rectifier tube, a direct current power source having its positive side connected to the cathode of the third tube and its negative side connected to the grid, a resistance in the connection to the last named grid, said capacitor being connected to the grid of the third tube, a fourth relay coil connected in series with the plate of the third tube, said fourth relay coil operating the second normally closed contact, and an A. C. power source connected to the plate of the third tube.

4. A control unit operable by a voltage impulse comprising a grid controlled gas rectifier tube having a grid, cathode and plate, a direct current power source connected to said grid, a second

direct current power source, a normally closed contact, a relay coil, means for connecting the second direct current power source to said cathode and plate through said contact and said relay coil, a normally open contact operated by said relay, a second relay coil for operating the said normally closed contact, a circuit including said normally open contact and said second relay coil in series, a second normally open contact for the first named relay, a second grid controlled gas rectifier tube in circuit with said second normally open contact, a direct current power source having its positive side connected to the cathode of the second tube and its negative side connected to the grid, a resistance in the connection to the last named grid, a second normally closed contact, a third relay coil, said last named contact and the third relay coil being connected in series with the plate of the second tube, a normally open contact operated by said third relay coil, a normally closed contact operable by the third relay coil, a D. C. power source, a capacitor connected in parallel with said last named contact to said last named power source, a third rectifier tube, a direct current power source having its positive side connected to the cathode of the third tube and its negative side connected to the grid, a resistance in the connection to the last named grid, said capacitor being connected to the grid of the third tube, a fourth relay coil connected in series with the plate of the third tube, said fourth relay coil operating the second normally closed contact, an A. C. power source connected to the plate of the third tube, a second capacitor, a fourth gas rectifier tube having its grid connected through said second capacitor in circuit with said second normally open contact, the first named capacitor being connected between the plate and cathode of the said fourth tube, a direct current power source having its positive side connected to the cathode of the fourth tube and its negative side connected to the grid, and a resistance in the connection to the last named grid.

5. A control unit operable by a voltage impulse comprising a grid controlled gas rectifier tube having a grid, cathode and plate, means for maintaining the grid negative with respect to the cathode, means for applying the voltage impulse to said grid, a power source, a normally closed contact, a relay coil, means for connecting the power source to said cathode and plate through said contact and said relay coil, a normally open contact operated by said relay, a second relay coil for operating the said normally closed contact, a circuit including said normally open contact and said second relay coil in series, a second normally open contact for the first named relay, a second tube in circuit with said second normally open contact, means for maintaining the grid of the second tube negative with respect to the cathode, a second normally closed contact, a third relay coil, said last named contact and the third relay coil being connected in series with the plate of the second tube, a normally open contact operated by said third relay coil, a normally closed contact operable by the third relay coil, a power source, a capacitor connected in parallel with said last named contact to said last named power source, a third tube, means for maintaining the grid of the third tube negative with respect to the cathode, said capacitor being connected to the grid of the third tube, a fourth relay coil connected in series with the plate of the third tube, said fourth relay coil operating the second nor-

mally closed contact, and a power source connected to the plate of the third tube.

6. A control unit according to claim 5 having a second capacitor, a fourth tube having its grid connected through said second capacitor in circuit with said second normally open contact, the first named capacitor being connected between the plate and cathode of the said fourth tube, and means for maintaining the grid of the fourth tube negative with respect to the cathode.

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