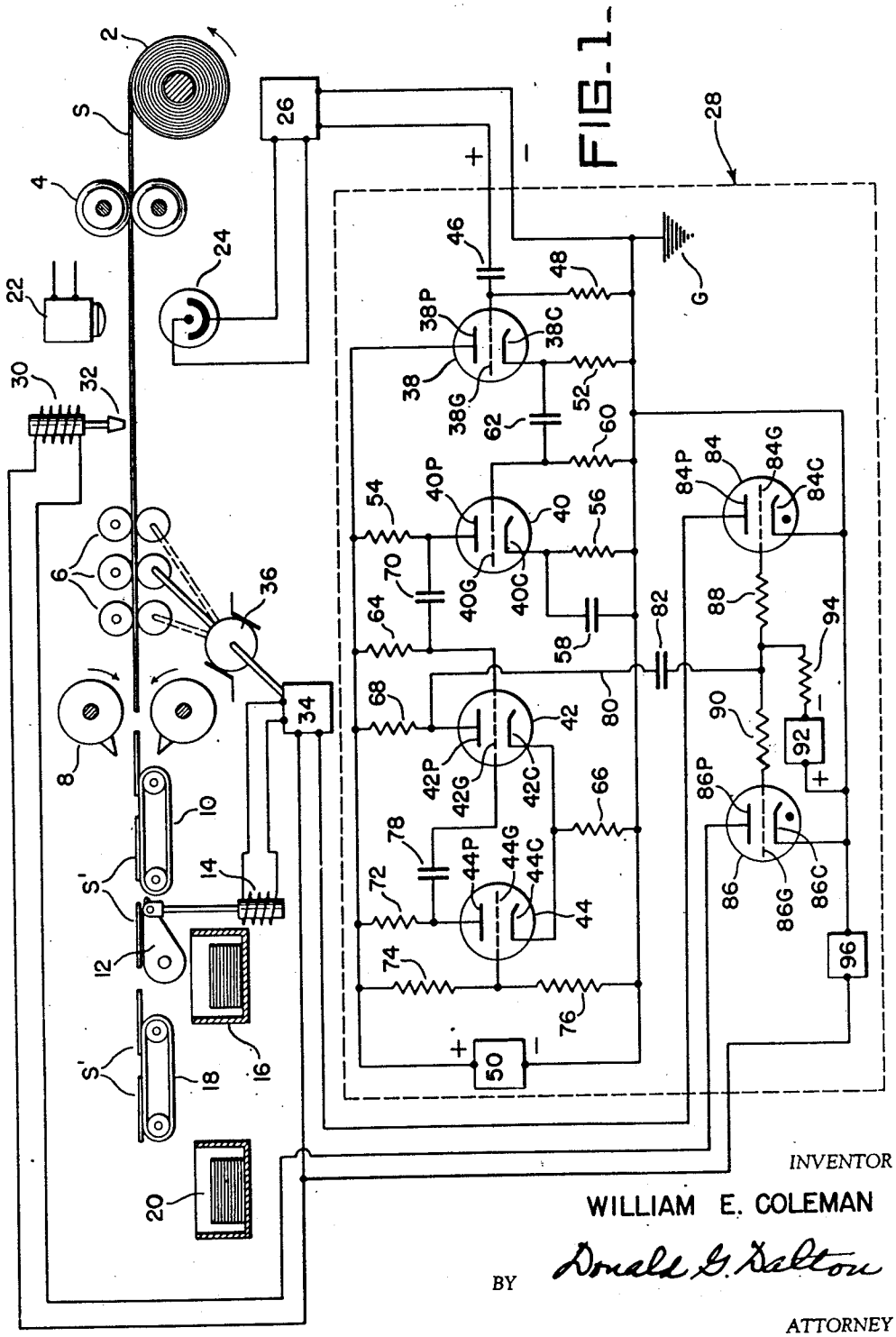
Oct. 13, 1953 W. E. COLEMAN 2,655,620

CONTROL UNIT FOR PINHOLE DETECTORS

Filed Feb. 27, 1952 2 Sheets-Sheet 1

FIG. 1.



INVENTOR

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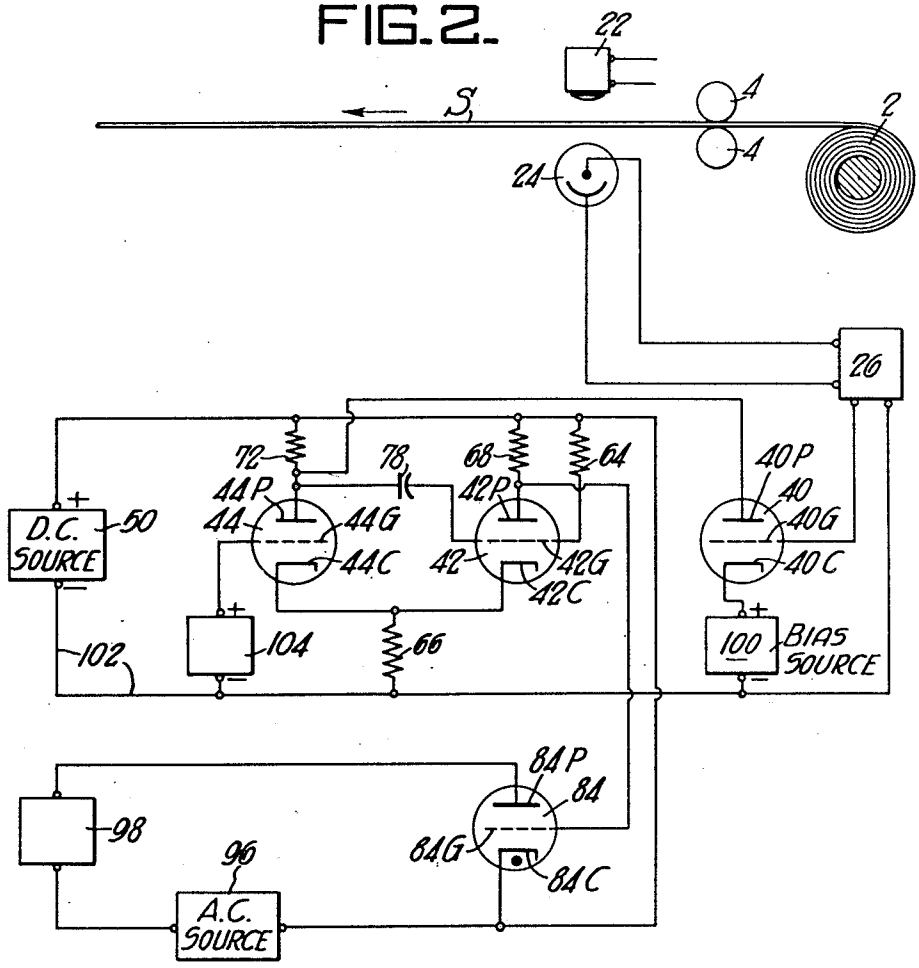
ATTORNEY

Oct. 13, 1953 W. E. COLEMAN 2,655,620

CONTROL UNIT FOR PINHOLE DETECTORS

Filed Feb. 27, 1952 2 Sheets-Sheet 2

FIG. 2.



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UNITED STATES PATENT OFFICE

2,655,620

CONTROL UNIT FOR PINHOLE DETECTORS

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Application February 27, 1952, Serial No. 273,697

14 Claims. (Cl. 317—123)

1

This invention relates to a control unit for pin hole detectors and is a continuation-in-part of my copending application, Serial No. 133,343, dated December 16, 1949, now abandoned. It pertains more particularly to such a device for detecting and—for counting small holes in thin sheet products such as sheet steel which is used in the manufacture of tin cans. The control unit is used in conjunction with a strip marker and a throw-out device which throws the imperfect sheet from the line when it reaches a spot some distance removed from the inspection station. The control units in present use require an appreciable time to permit proper operation of the throw-out device and the strip marker. During this period the control units are insensitive to further impulses which may occur due to holes closely following the first hole. In a strip moving 900 feet per minute, the operation should be fast enough to catch holes 18 inches apart. This means that the detector unit should complete its cycle of operation in less than 0.10 second. Conventional units will not do this so that some imperfect sheets pass inspection. The control unit may also be used in conjunction with a counter to count the number of pin holes in a strip.

In my Patent No. 2,563,213, dated August 7, 1951, I have disclosed and claimed a device which is sensitive to further pulses which may occur when the control unit is operating to mark and throw out a defective sheet. While this device has proved to be successful in practice, it, like other conventional units, utilizes relays which limit the speed of operation and which have moving contacts which require frequent cleaning and adjustment.

It is an object of my invention to provide a control unit for a pin hole detector which will complete its operation in a very short period of time and which does not utilize relays or other parts which otherwise require frequent repair.

Another object is to provide a control unit which will amplify a short impulse into an impulse of sufficient power and duration to operate an electrical device such as a solenoid.

These and other objects will be more apparent after referring to the following specification and attached drawings, in which:

Figure 1 is a schematic drawing showing a wiring diagram of the control unit connected to a strip inspecting and shearing line; and

Figure 2 is a schematic drawing, similar to Figure 1, showing the wiring diagram for a modified control unit.

2

Referring more particularly to Figure 1 of the drawings, 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 photocells. 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 Chamberlin 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. 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. If desired, the control unit 28 may also be used to provide an impulse to energize a solenoid of a counter.

My invention relates particularly to the control unit 28, which is provided with four grid controlled vacuum tubes 38, 40, 42 and 44. Each of these tubes is provided with a grid, plate, and cathode. The grid 38G is connected to the positive terminal of the amplifier 26 through a capacitor 46. The negative terminal of the amplifier 26 is connected to ground G and also to the grid 38G through a resistance 48. The plate 38P

is connected to the positive terminal of a direct current source 50. The cathode 38C is connected to the negative terminal of the power source 50 through a resistance 52. The tube 38 connected to the resistors 48 and 52 and D. C. power source 50 acts as an impedance reducing circuit which tends to stabilize the overall system by providing a certain amount of isolation between the amplifier 26 and the balance of the control circuit. While this impedance reducing circuit may be dispensed with, it is important in making the control unit commercially successful. The positive terminal of power source 50 is connected to the plate 40P through a resistance 54 and the negative terminal of power source 50 is connected to the cathode 40C through a resistance 56. A capacitor 58 is arranged in parallel with the resistance 56. The output pulse from tube 38 is developed across resistor 52 and is transmitted to a resistor 60 and the grid 40G through a capacitor 62. The resistor 56 and capacitor 58 limit the normal current flowing through tube 40. A battery or other D. C. power source could be substituted for the resistor 56 and capacitor 58. This battery could be installed in the circuit of cathode 40C in place of the resistor 56 and capacitor 58 with its positive terminal connected to the cathode, or it could be installed between the resistor 60 and the line from the negative terminal of D. C. power source 50. In the latter case, the negative terminal of the battery will be connected to the resistor 60. Tube 40 together with resistors 54, 56 and 60, capacitor 58 and constant voltage D. C. power source 50 act as an amplifier circuit which amplifies the pulse from tube 38 and also reverses its polarity. If the impulse is of sufficient magnitude this circuit could be omitted, in which case the capacitor 62 will be connected to the grid 44G. The positive terminal of D. C. power source 50 is connected to the grid 42G through a resistor 64 and its negative terminal is connected to the cathode 42C through a resistor 66. The plate 42P is connected to the positive terminal of D. C. power source 50 through a resistor 68. A capacitor 70 is connected in the line between resistors 64 and 54. The positive terminal of D. C. power source 50 is connected to the plate 44P through a resistor 72 and the negative terminal is connected to the cathode 44C through resistor 66. The grid 44G is connected to the D. C. power source 50 through a voltage divider consisting of resistors 74 and 76. The grid 44G will therefore be sufficiently negative with respect to cathode 44C that tube 44 will be normally non-conducting. A capacitor 78 is provided in the line between resistor 72 and grid 42G.

A tap 80 from the plate 42P leads through a capacitor 82 to the grids 84G and 86G of grid controlled gas rectifier tubes 84 and 86. If desired, the tap 80 might be taken from the grid 44G, but it is not preferred to do so. A resistor 88 is installed in the line between grid 84G and capacitor 82 and a similar resistor 90 is installed in the line between grid 86G and capacitor 82. Tubes 84 and 86 are normally held non-conducting by the application of the negative voltage from their cathodes to their grids from a D. C. power source 92 through resistors 88, 90 and 94. An A. C. power source 96 has one terminal connected to cathodes 84C and 86C and the other terminal connected to the solenoid 30 and the solenoid in proportional timer 34. The plates 84P and 86P are connected to the solenoid of timer 34 and solenoid 30, respectively.

The operation of the device is as follows: When a hole is detected by means of a voltage generating device such as the electric eye 24 the impulse created thereby is amplified in the amplifier 26 and is impressed on the grid 38G. The tube 38 is normally partially conducting but when the positive impulse is impressed on its grid 38G, the current flowing through the tube is increased, thus causing a rise in the voltage across resistor 52, which voltage rise is transmitted to the grid 40G through the capacitor 62. The tube 40 is also normally partially conducting but the positive impulse on its grid increases the conduction thereof. The pulse is transmitted as a negative pulse from the plate 40P through capacitor 70 to the grid 42G of tube 42 which is normally conducting. This normal current in tube 42 develops a voltage drop across resistor 66 which makes the cathode 44C positive with respect to the negative side of the power source 50. When the negative pulse appears on grid 42G it reduces the current through tube 42, which in turn lowers the voltage drop across resistor 66 and lowers the potential of cathode 44C sufficiently to permit conduction to start in tube 44. This current flows from power source 50 through resistor 72 and the voltage drop thus occurring across resistor 72 causes the plate 44P to drop in potential. This drop in potential is transmitted through capacitor 78 back to grid 42G, thus further reducing its potential. This action is cumulative and instantaneous and drives the voltage of grid 42G with respect to cathode 42C well beyond the current cut-off point of tube 42. The cumulative action stops when the current in tube 44 can no longer increase due to saturation in tube 44 at which time capacitor 78 begins to discharge through resistors 72 and 64, thus permitting the potential of grid 42G to increase at a rate determined by the values of capacitor 78 and resistors 72 and 64. When the tube 42 is cut off the potential of plate 42P suddenly increases and remains high as long as the tube is cut off. Thus a relatively long positive impulse is produced at plate 42P in place of the short negative impulse at grid 42G. This impulse is transmitted through capacitor 82 and resistors 88 and 90 to the grids 84G and 86G, respectively. The positive impulse fires tubes 84 and 86 and permits current from the A. C. power source 96 to pass through the tubes and energize marker solenoid 30 and the solenoid in proportional timer 34. When the potential of grid 42G reaches the level where conduction starts in tube 42 the cumulative actions mentioned above are reversed so that the tube 42 becomes conducting and the tube 44 non-conducting. This permits the tubes 84 and 86 to cease conducting and the circuit is again ready for a new impulse. In case the solenoid 30 and the solenoid of timer 34 were normally energized and would complete a circuit when deenergized, a negative impulse could be used to trigger tubes 84 and 86. In this case, D. C. power source 92 could be omitted.

In brief, it is seen that a short positive pulse of as little as .001 second in duration or less from the amplifier 26 is amplified and inverted in tube 40 and is again inverted and converted to a longer pulse of about .10 second in tubes 42 and 44. This longer impulse is transmitted to tubes 84 and 86, which conduct long enough to operate the solenoids of the timer and marker.

Figure 2 shows a somewhat simplified embodiment of my invention in which the impedance reducing circuit and one of the gas tubes are

omitted. In this embodiment the same reference numerals are used as in Figure 1 to indicate like elements. The grid 40G and the cathode 40C are connected to the amplifier 26 as shown. The connection to the cathode is provided with a bias source 100 such as a battery. The plate 40P is directly connected to the plate 44P. The negative side of D. C. power source 50 is connected to the grid 44G through a connection 102. Means such as a battery 104 is provided in the connection 102 for the purpose of maintaining the grid 44G normally positive with respect to the negative side of the D. C. power source 50. The plate 42P is connected to the grid 84G and the cathode 84C is connected to the positive side of D. C. power source 50. One side of the A. C. power source 96 is connected to the cathode 84C and the other side is connected through an electrical device 98 to the plate 84P. The electrical device 98 may be the solenoid of a counter, marker or timer. The operation of this circuit is substantially the same as that of Figure 1. If the electrical device 98 is a counter it will count the number of pin holes occurring in the sheet S.

While two embodiments of my invention have been shown and described it will be apparent that other adaptations and modifications may be made without departing from the scope of the following claims.

I claim:

1. A control unit for a pin hole detector having detecting means for generating a voltage impulse when a pin hole occurs in a sheet, a timer and means responsive to actuation of the timer for classifying the sheets; said control unit comprising a pair of vacuum tubes each having a grid, cathode and plate, means including a capacitor for connecting the grid of the first of said tubes to the plate of the second of said tubes, a D. C. power source, a direct current connection between the positive side of said power source and the grid of the second tube, a direct current connection between the negative side of said power source and the grid of the second tube, a resistor in each of said last named connections providing a voltage divider, a connection between the cathodes of said tubes, a connection between said last named connection and the negative side of said D. C. power source, a resistor in said last named connection, connections between the positive terminal of said power source and the plates of each of said tubes, a resistor in each of the last named connections. a direct current connection between the positive terminal of said power source and the grid of the first tube, a resistor in the last named connection, means for connecting the detecting means to one of said grids, a grid controlled gas rectifier tube having a grid, cathode, and plate, means including a capacitor for connecting the grid of said gas tube to the plate of one of the pair of tubes, an A. C. power source having one terminal connected to the cathode of said gas tube and the other terminal connected to one side of the timer, and a connection between the other side of the timer and the plate of the gas tube.

2. A control unit for a pin hole detector having detecting means for generating a voltage impulse when a pin hole occurs in a sheet, a timer and means responsive to actuation of the timer for classifying the sheets; said control unit comprising a pair of vacuum tubes each having a grid, cathode and plate, means including a capacitor for connecting the grid of the first of said tubes to the plate of the second of said tubes, a D. C. power source, a direct current connection between the positive side of said power source and the grid of the second tube, a direct current connection between the negative side of said power source and the grid of the second tube, a resistor in each of said last named connections providing a voltage divider, a connection between the cathodes of said tubes, a connection between said last last named connection and the negative side of said D. C. power source, a resistor in said last named connection, connections between the positive terminal of said power source and the plates of each of said tubes, a resistor in each of the last named connections, a direct current connection between the positive terminal of said power source and the grid of the first tube, a resistor in the last named connection, means for connecting the detecting means to one of said grids, a grid controlled rectifier tube having a grid, cathode, and plate, means for connecting the grid of said rectifier tube to the plate of one of the pair of tubes, means for maintaining the grid of said rectifier tube normally negative with respect to its cathode, an A. C. power source having one terminal connected to the cathode of said rectifier tube and the other terminal connected to one side of the timer, and a connection between the other side of the timer and the plate of the rectifier tube.

3. A control unit according to claim 2 having a second grid controlled rectifier tube, means connecting the grid of said second rectifier tube to the connection to the grid of the first rectifier tube, means connecting the cathode of the second rectifier tube to one terminal of the A. C. power source, means for connecting the other termianl of the A. C. power source to the plate of the second rectifier tube, and a solenoid in said last named connection.

4. A control unit according to claim 2 in which the means for connecting the voltage generating means to one of said grids includes a third vacuum tube having a grid, cathode and plate, means for connecting the voltage generating means to the grid of said third tube, and means for connecting the D. C. power source to the cathode and plate of the third tube.

5. A control unit according to claim 4 having a second grid controlled rectifier tube, means connecting the grid of said second rectifier tube to the connection to the grid of the first rectifier tube, means connecting the cathode of the second rectifier tube to one terminal of the A. C. power source, means for connecting the other terminal of the A. C. power source to the plate of the second rectifier tube, and a solenoid in said last named connection.

6. A control unit for a pin hole detector having detecting means for generating a voltage impulse when a pin hole occurs in a sheet, a timer and means responsive to actuation of the timer for classifying the sheets; said control unit comprising a vacuum tube having a grid, cathode and plate, means including a capacitor and resistor for connecting the detecting means to said grid, a direct current power source, means for connecting the direct current power source to said cathode and plate, a resistance in the connection between said power source and said cathode, a second vacuum tube having a grid, cathode and plate, a connection between the cathode of the first tube and the grid of the second tube, a capacitor in said last named connection, a con-

nection between the grid of the second tube and the negative side of said D. C. power source, a resistor in said last named connection, means for connecting one terminal of the D. C. power source to the second named plate, a resistor in said last named connecting means, means for connecting the other terminal of the D. C. power source to the second named cathode, means for limiting the normal amount of current flowing in the second tube, a third vacuum tube having a grid, cathode and plate, means including a capacitor for connecting the plate of the second tube to the grid of the third tube, a connection between the positive terminal of said D. C. power source and the grid and plate of the third tube, a resistor in each of the last named connections, a fourth vacuum tube having a grid, cathode and plate, a connection between the cathodes of said third and fourth tubes, a connection between said last named connection and the negative side of said D. C. power source, a resistor in said last named connection, a direct current connection between the positive side of said power source and the grid of the fourth tube, a direct current connection between the negative side of said power source and the grid of the fourth tube, a resistor in each of said last named connections providing a voltage divider, a connection between the positive terminal of said D. C. power source and the plate of the fourth tube, a resistor in said last named connection, a connection including a capacitor between the grid of the third tube and the plate of the fourth tube, a grid controlled rectifier tube having a grid, cathode and plate, means for maintaining the grid of the rectifier tube negative with respect to its cathode, means for connecting the plate of the third tube to the grid of the rectifier tube, an A. C. power source having one terminal connected to the cathode of said rectifier tube and the other terminal connected to one side of the timer, and a connection between the other side of the timer and the plate of the rectifier tube.

7. A control unit according to claim 6 having a second grid controlled rectifier tube, means connecting the grid of said second rectifier tube to the connection to the grid of the first rectifier tube, means connecting the cathode of the second rectifier tube to one terminal of the A. C. power source, means for connecting the other terminal of the A. C. power source to the plate of the second rectifier tube, and a solenoid in said last named connection.

8. A control unit for energizing an electrical device in response to an impulse from a voltage generating means comprising a pair of vacuum tubes each having a grid, cathode and plate, means including a capacitor for connecting the grid of the first of said tubes to the plate of the second of said tubes, a D. C. power source, a connection between the negative side of said power source and the grid of the second tube, means in said connection for maintaining the grid of said second tube normally positive with respect to the negative side of said power source, a connection between the cathodes of said tubes, a connection between said last named connection and the negative side of said D. C. power source, a resistor in said last named connection, connections between the positive terminal of said power source and the plates of each of said tubes, a resistor in each of the last named connections, a direct current connection between the positive terminal of said power source and the grid of the first tube, a resistor in the last named connection, means for connecting said voltage generating means to one of said grids, a grid controlled rectifier tube having a grid, cathode and plate, means for connecting the grid of said rectifier tube to the plate of one of the pair of tubes, means for maintaining the grid of said rectifier tube normally negative with respect to its cathode, an A. C. power source having one terminal connected to the cathode of said rectifier tube and the other terminal connected to one side of the electrical device, and a connection between the other side of the electrical device and the plate of the rectifier tube.

9. A control unit according to claim 8 having a second grid controlled rectifier tube, means connecting the grid of said second rectifier tube to the connection to the grid of the first rectifier tube, means connecting the cathode of the second rectifier tube to one terminal of the A. C. power source, means for connecting the other terminal of the A. C. power source to the plate of the second rectifier tube, and a solenoid in said last named connection.

10. A control unit according to claim 8 in which the means for connecting the voltage generating means to one of said grids includes a third vacuum tube having a grid, cathode and plate, means for connecting the voltage generating means to the grid of said third tube, and means for connecting the D. C. power source to the cathode and plate of the third tube.

11. A control unit according to claim 10 having a second grid controlled rectifier tube, means connecting the grid of said second rectifier tube to the connection to the grid of the first rectifier tube, means connecting the cathode of the second rectifier tube to one terminal of the A. C. power source, means for connecting the other terminal of the A. C. power source to the plate of the second rectifier tube, and a solenoid in said last named connection.

12. A control unit for energizing an electrical device in response to an impulse from a voltage generating means comprising a vacuum tube having a grid, cathode and plate, means including a capacitor and resistor for connecting the voltage generating means to said grid, a direct current power source, means for connecting the direct current power source to said cathode and plate, a resistance in the connection between said power source and said cathode, a second vacuum tube having a grid, cathode and plate, a connection between the cathode of the first tube and the grid of the second tube, a capacitor in said last named connection, a connection between the grid of the second tube and the negative side of said D. C. power source, a resistor in said last named connection, means for connecting one terminal of the D. C. power source to the second named plate, a resistor in said last named connecting means, means for connecting the other terminal of the D. C. power source to the second named cathode, means for limiting the normal amount of current flowing in the second tube, a third vacuum tube having a grid, cathode and plate, means including a capacitor for connecting the plate of the second tube to the grid of the third tube, a connection between the positive terminal of said D. C. power source and the grid and plate of the third tube, a resistor in each of the last named connections, a fourth vacuum tube having a grid, cathode and plate, a connection between the cathodes of said third and fourth vacuum tubes, a connection between

said last named connection and the negative side of said D. C. power source, a resistor in said last named connection, a direct current connection between the positive side of said power source and the grid of the fourth tube, a direct current connection between the negative side of said power source and the grid of the fourth tube, a resistor in each of said last named connections providing a voltage divider, a connection between the positive terminal of said D. C. power source and the plate of the fourth tube, a resistor in said last named connection, a connection including a capacitor between the grid of the third tube and the plate of the fourth tube, a grid controlled rectifier tube having a grid, cathode and plate, means for maintaining the grid of the rectifier tube negative with respect to its cathode, means for connecting the plate of the third tube to the grid of the rectifier tube, an A. C. power source having one terminal connected to the cathode of said gas tube and the other terminal connected to one side of the electrical device, and a connection between the other side of the electrical device and the plate of the rectifier tube.

13. A control unit according to claim 12 having a second grid controlled rectifier tube, means connecting the grid of said second rectifier tube to the connection to the grid of the first rectifier tube, means connecting the cathode of the second rectifier tube to one terminal of the A. C. power source, means for connecting the other terminal of the A. C. power source to the plate of the second rectifier tube, and a solenoid in said last named connection.

14. A control unit for a pin hole detector having detecting means for generating a voltage impulse when a pin hole occurs in a sheet, a timer and means responsive to actuation of the timer for classifying the sheets; said control unit comprising a pair of vacuum tubes each having a grid, cathode and plate, means including a capacitor for connecting the grid of the first of said tubes to the plate of the second of said tubes, a D. C. power source, a direct current connection between the positive side of the power source and the grid of the second tube, a direct current connection between the negative side of said power source and the grid of the second tube, a resistor in each of said last named connections providing a voltage divider, a connection between the cathodes of said tubes, a connection between said last named connection and the negative side of said D. C. power source, a resistor in said last named connection, connections between the positive terminal of said power source and the plates of each of said tubes, a resistor in each of the last named connections, a direct current connection between the positive terminal of said power source and the grid of the first tube, a resistor in the last named connection, means including a third vacuum tube for connecting the detecting means to one of said grids, said third vacuum tube having a grid, cathode and plate, means for connecting said voltage generating means to the grid of said third tube, means for connecting the D. C. power source to the cathode and plate of the third tube, a grid controlled rectifier tube having a grid, cathode, and plate, means for connecting the grid of said rectifier tube to the plate of one of the pair of tubes, means for maintaining the grid of said rectifier tube normally negative with respect to its cathode, an A. C. power source having one terminal connected to the cathode of said rectifier tube and the other terminal connected to one side of the timer, and a connection between the other side of the timer and the plate of the rectifier tube.

WILLIAM E. COLEMAN.

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