

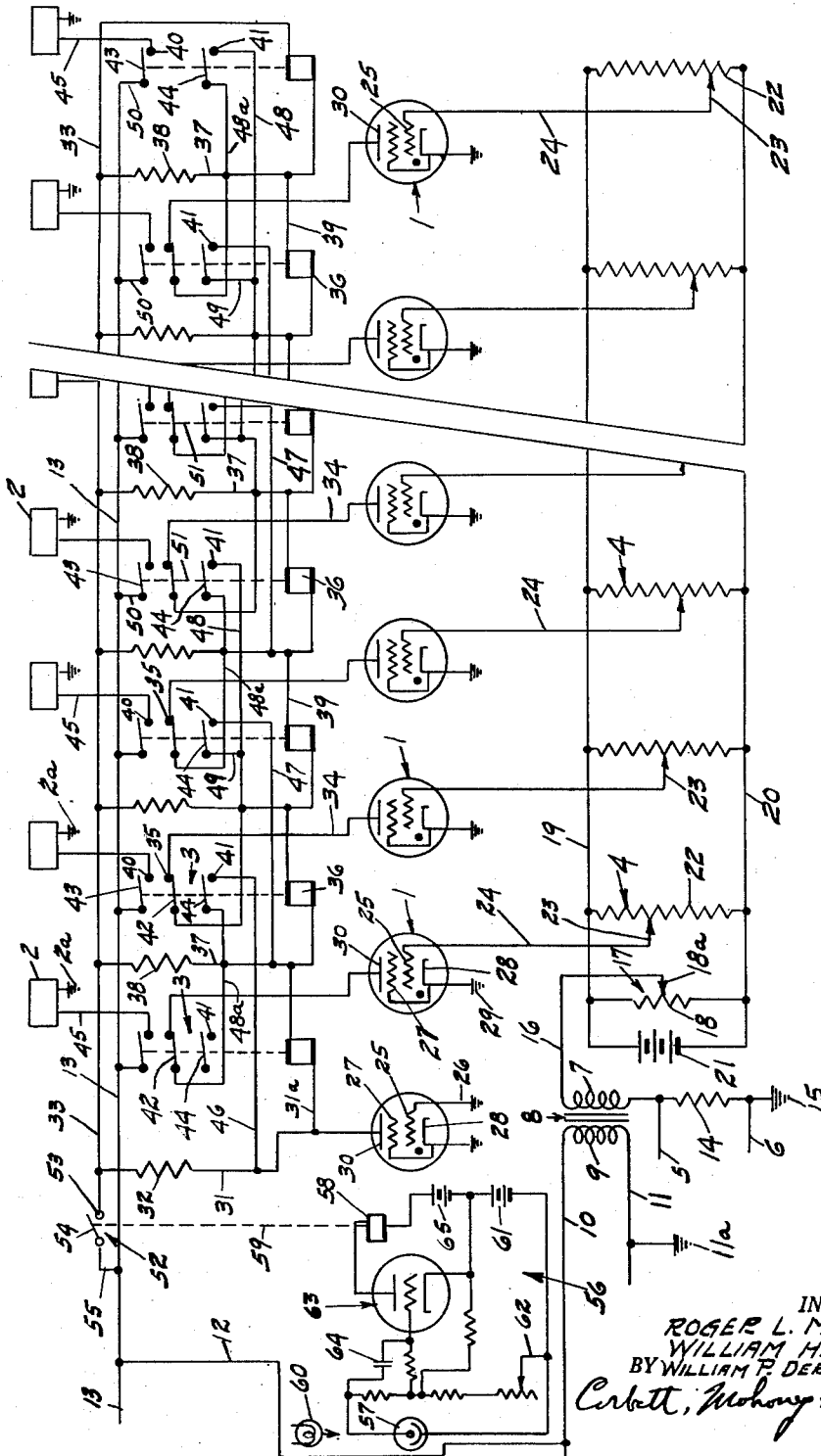
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DISTRIBUTION CLASSIFIER

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## DISTRIBUTION CLASSIFIER

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Our invention relates to a distribution classifier. It relates to a distribution classifier which is particularly useful in statistical quality control.

In industry, the frequency histogram or polygon is a popular representation of a frequency distribution for a particular variable on a given production line. It enables management, at a glance, to detect lack of statistical control of quality. The compilation of data for such a frequency distribution polygon, when undertaken manually, is a time consuming, laborious procedure. While there are checking and recording machines presently available which determine and record the variable for each individual article or product, there is no known device which classifies such data into the desired classes, groups, or categories, in order to create a frequency polygon.

In statistical quality control, where the control employed is the type where no standard is given, it is necessary to obtain the average of the standard deviations for each class or group of a plurality of samples, in addition to the average for each individual sample. Where the number of observations in a sample is greater than ten, it is usually far more efficient to be able to classify the data into the various classes, groups or categories by means of an automatic device, rather than by manual means.

It is, therefore, the main object of our invention to provide an automatic distribution classifier which will record and classify a selected variable for a given number of observations into the desired classes, groups or categories.

Various additional objects of our invention will become apparent from the following description when read in conjunction with the accompanying drawing, wherein the figure is a wiring diagram of a distribution classifier.

Our device can be employed with a weight-checking scale or machine of the type known as the "Selectrol" which is manufactured by the Exact Weight Scale Company of Columbus, Ohio, and which is disclosed in United States Patent No. 2,323,023, issued to Flanagan et al. on June 29, 1943. This machine includes an electric circuit which produces an output voltage that is proportionate to the amount of weight, of the package or article, that is above or below a selected desired weight. This voltage will be negative or positive depending upon whether the package or article being checked is overweight or underweight. However, it is to be understood that our device may be employed with various

types of checking machines which determine the variable for each individual article and convert it into an electrical impulse or voltage.

The device of our invention is an electronic device. In general, the device comprises a plurality of thyratrons, that is, gas-filled electron tubes of the controlled ionization type, which are of equal size and have similar grid characteristics. These thyratrons are so arranged that, depending upon the value of the variable under consideration, which determines the input voltage, certain of the thyratrons will fire and certain of the thyratrons will not fire. A difference in potential will therefore exist between the plate of the last thyatron to fire and the plate of the next thyatron which is the first thyatron that does not fire, and this difference in potential is utilized to actuate a counter. Provision is also made to lock out adjacent counters to insure that border-line situations will not result in more than one counter reporting information.

With reference to the drawing, our device is shown as comprising a circuit which includes a plurality of substantially identical units or cells. In the drawing, we have shown only seven of these cells but, as indicated by broken lines, any number of these cells may be provided. Each of these cells includes a thyatron 1, a counter 2, a relay-actuated switch 3, and a voltage divider 4. Each of the counters 2 is of such a nature that it records one unit each time the electrical circuit in which it is connected is closed. Each thyatron tube is characterized by the fact that it will not fire unless a critical grid voltage is reached. However, once the thyatron tube does fire, and the grid voltage is decreased below that critical value, it will continue to fire until a much lower plate voltage is obtained.

The input for the circuit is the lines 5 and 6. These lines will receive the input voltage, either positive or negative, from the checking machine. For example, the lines 5 and 6 may be connected to the lines 57a and 58a of the circuit of the machine disclosed in Patent No. 2,323,023. These lines 5 and 6 are in series with the secondary coil 7 of a peaking transformer 8. The primary coil 9 of the transformer is connected by lines 10 and 11 to a suitable source of 60 cycle A. C. current, line 11 being grounded at 11a. A lead 12 runs from the line 10 to a line 13, which as will appear later, is for supplying operating voltage to the counters 2. A resistance 14 is connected between input lines 5 and 6 and is grounded by ground 15. The secondary 7 of the transformer

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is connected by lead 16 to a voltage divider 17. This divider includes the resistance branch or element 18 which is connected across the lines 19 and 20 that lead from a D. C. source shown, for example, as a battery 21. Associated with resistance 18 is an adjustable contact or resistance divider 18a which is connected to the line 16.

Each of the voltage dividers 4 consists of a resistance branch or element 22, which is connected across the lines 19 and 20, and a resistance divider or adjustable contact 23 associated therewith. Each contact 23 is connected to a lead 24 from the associated thyatron 1.

Each of the thyratrons 1, with the exception of the first, has one of its grids 25 connected to the lead 24 which leads to adjustable contact 23. The first thyatron has its grid 25 grounded by the ground 26. Each of the thyratrons has its other grid 27 and cathode 28 connected together and to a ground 29. The plate 30 of the first thyatron is connected by line 31, which includes resistance 32, to a line 33. Each of the plates 30 of the other thyratrons is connected by a line 34 to a fixed contact point 35 of relay-actuated switch 3.

Each of the relay-actuated switches 3 includes a relay coil or solenoid 36. The first solenoid is connected to the line 31 by branch 31a and all the succeeding solenoids 36 are connected in series with each other, the last being connected to the line 33. Each solenoid 36, with the exception of the first, is connected by line 37 to the line 33, a resistance 38 being incorporated in line 37. A line 39 runs from the line 37 to the next preceding solenoid 36 in each instance.

Each of the switches 3 includes the fixed contact point 40, spaced above point 35, and the fixed contact point 41, spaced below point 35. Associated with point 35 is a switch arm 42, with point 40 is a switch arm 43, and with point 41 is a switch arm 44. Each point 40 is connected by a lead 45 to an associated counter 2 which is grounded by ground 2a. The point 41 and the arm 44 of the first switch 3 are free of any lines. The point 41 of the second switch 3 is connected by a line 46 to line 31. The point 41 of the third switch and that point of each succeeding switch is connected to the arm 44 of the preceding switch. It will be noted that this is accomplished by having the point 41 of the fourth switch, and that of each succeeding alternate switch, connected to a line 48 which runs back to the next preceding switch where it is connected to a line 49 that connects to arm 44 of that switch; and the point 41 of the third switch, and that of each succeeding alternate switch, connected to a line 47 which runs back to the line 37 of the next preceding switch. It will be noted that line 48a also connects with the line 37, which it crosses. The arm 42 of each switch 3 is connected to the arm 44 of the next succeeding switch. This is accomplished between the first and second switches by means of connecting line 48a, which crosses and connects with line 37, and between the second and third switch by lines 48 and 49, this alternate arrangement being repeated. Each arm 43 of the switches 3 is connected by lead 50 to line 13. Obviously, the last switch 3 is not provided with the arm 42 and its associated contact point 35. The switch arms 42, 43, and 44 of each switch 3 are ganged together by a mechanical connection 51 which is actuated by the associated solenoid 36. It will be noted that normally, that is, when solenoid 36 is deenergized,

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the switch arms of its associated switch 3 are as follows: switch arm 42 is in closed position in contact with point 35; switch arm 43 is in open position spaced from point 40; and switch arm 44 is also in open position spaced from point 41.

A keying switch 52 is associated with line 33, ahead of its connection to line 31. This switch includes a fixed contact point 53 which is connected to line 33 and a movable contact arm 54 which is connected to line 13 by lead 55. This keying switch is normally open but it is closed each time our device is to function. This switch will be actuated each time an article passes from the checking machine with which our device is associated. It may be actuated mechanically or electrically by the article moving from such machine. For example, it may be actuated by means of the photoelectric cell circuit 56. This circuit includes the photocell 57 and the relay 58 which is connected by mechanical connection 59 to switch arm 54. A light source 60 is associated with photocell 57. The photocell circuit also includes a source of current 61 for cell 57, adjustable by voltage divider, and a triode tube 63, having a condenser 64 associated therewith. Another source of current 65 is connected to tube 63 and relay 58.

The switches 3 of our device are normally in the condition indicated above and shown in the drawing, with switch 52 open and with no input through lines 5 and 6 from the checking machine. 60 cycle A. C. is supplied to the primary coil 9 of the transformer and by means of this transformer the current with a peaked wave form is continuously impressed upon the grid 25 of each tube 1, with the exception of the first tube, through the medium of the lines 19 and 20, voltage dividers 4, and lines 24. The D. C. source 21 supplies D. C. current to lines 19 and 20 for the purpose of biasing each tube at a D. C. level corresponding to the setting of its respective voltage divider 4. However, this is merely a control voltage and the tubes will not fire, regardless of the value of the grid or control voltage, unless there is a plate voltage. The movable contacts 23 of the successive voltage dividers 4 are set on the resistance divider branches 22, as shown, so that they vary in a selected ratio. Thus, the input voltage required in order to fire successive tubes will vary proportionately and will be either positive or negative depending upon whether the divider branch for a particular tube has its contact 23 set above or below its zero point. It will be seen that the 60 cycle A. C. source is also a source of operating voltage for the counters 2 through the medium of lines 12 and 13 and switches 3 when they are selectively actuated. Each plate 30 of each thyatron tube 1, with the exception of the first tube, is connected by line 34, through switch arm 42 and line 48 or 48a to the switch arm 44 of the first succeeding switch 3. The stationary contact point 41, in each case, is connected to one side of the preceding solenoid 36. When none of the solenoids 36 is energized, solenoid 36 and plate 30, in every case, are connected to the common line 33. The plate 30 of the first tube 1 is connected by line 31 and resistance 32 to line 33 and the associated solenoid 36 is connected by lines 31a and 31 and resistance 32 to line 33. With all the other tubes 1, the plate 30 of each is connected by line 34, switch arm 42, line 48 or 48a, line 37 and resistance 38 to line 33; and the associated solenoid 36 is connected directly by line 37 to line 33.

The operation of our device is as follows:

By means of the transformer 8, 60 cycle A. C. with a peaked wave form is continuously impressed upon the grid of each thyatron tube 1, except the first tube 1, which has a grounded grid. The grid voltage, however, does not reach the control value until input voltage is received from the checking machine, through the lines 5 and 6. This input voltage will correspond to the weight variable of a particular package and this input, emphasized by the peaking transformer, will be added to the 60 cycle A. C. input. Depending upon the value of the input from the checking machine, certain thyatrons 1 will fire and others will not when the keying switch 52 is closed by the said package passing from the checking machine. Assuming that the value of the input voltage from the checking machine is such that the first three thyatrons fire and the remaining do not, this would indicate that the value of the input voltage is representative of a value of weight which would put that particular package in the cell corresponding to the counter 2 which is located between the thyatron which last fired, that is, the third one, and the next succeeding thyatron which did not fire, that is, the fourth one. There would then be a difference of potential existing between the plate of the third thyatron, the last to fire, and that of the fourth thyatron which did not fire. Tracing the circuit shows that the third solenoid 36 is connected between the plate circuit of the third thyatron 1 and the plate circuit of the fourth thyatron 1. When neither of these thyatrons has fired, both of the plates are still at the same potential. When the third thyatron fires and the fourth thyatron does not fire, however, there is a difference of potential because of the voltage drop in the resistor 38 connected between the line 33 and the plate 30 of the third thyatron 1, as determined by the fired voltage characteristic of the thyatron, while there is no such voltage drop in the resistor 38 connected between the line 33 and the plate 30 of the fourth thyatron 1. Therefore, a potential difference is present across the third solenoid 36 at this time, but not before, and the third solenoid 36 is thereby energized at this time, but not before, so as to move the arms 42, 43 and 44, of the third switch 3, downwardly.

Closing of switch arm 43 will complete a circuit from line 13 through the third counter 2 and will cause it to register. Switch arm 42 will move to open position and arm 44 will move to closed position. Opening of switch arm 42 interrupts the circuit from the plate 30 of the fourth thyatron 1, which has not fired, to the next succeeding or fourth solenoid 36 so that such solenoid cannot possibly be actuated, whereby the next or fourth counter could register. Closing of switch arm 44 shorts out the next preceding or second solenoid 36 and thereby prevents that solenoid from operating and causing the second counter to register. Consequently, only a single counter 2 can register and this will be the one between the last tube to fire, the third, and the first tube that will not fire, the fourth, the counter in this example being the third.

Each end cell will register all packages classified therein and extending therebeyond. The thyatron 1 at the left end, that is, the first thyatron always fires when keying switch 52 is closed, and the absence of a thyatron at the opposite or extreme right end is equivalent to the presence of a thyatron that never fires.

The switch 52, as previously indicated, is con-

trolled by the photocell circuit 56. As long as photocell 57 is exposed to light source 60, it has a comparatively low resistance. As soon as the light rays to it are interrupted by an article leaving the checking machine, current will not flow through the photocell and, consequently, the condenser 64 will discharge, thereby increasing the grid voltage in tube 63 to a sufficiently high value to permit current to flow through the tube 63 and thus energize the relay. The relay 58 requires a certain minimum current to energize it and, consequently, since it is normally deenergized, upon discharge of the condenser the relay will be energized, thereby closing switch arm 54. However, as condenser 64 discharges, the voltage on the grid of tube 63 will decrease until it reaches a value at which there is insufficient current flowing in the relay 58 to maintain the relay energized, thereby permitting switch arm 54 to open.

It will be apparent from the above that we have provided an automatic distribution classifier which will record and classify a selected variable for a given number of observations into the desired classes, groups or categories.

Having thus described our invention, what we claim is:

1. A distribution classifier comprising an electronic circuit for receiving an input voltage and classifying such voltage according to its value, said circuit comprising a plurality of cells connected in said circuit successively for receiving the input voltage, each of said cells including a thyatron tube and the tubes of all cells being identical, and means connected in said circuit for causing the first tube to respond and fire to a predetermined input voltage and for causing each succeeding tube to respond and fire to a greater input voltage than that required for firing of the preceding tube, each of said cells also including a solenoid for controlling a counter connected in said cell, and means in said circuit connecting each said solenoid between the plate of the tube in its cell and the plate of the succeeding tube for actuating the solenoid of the cell having the last tube to be fired upon the occurrence of a difference in plate potentials between said such tube and the succeeding tube which is not fired.

2. A distribution classifier comprising an electronic circuit for receiving an input voltage and classifying such voltage according to its value, said circuit comprising a plurality of cells connected in said circuit successively for receiving the input voltage, each of said cells including a thyatron tube and the tubes of all cells being identical, means connected in the circuit for impressing grid voltage on the tubes, means connected in the circuit for impressing the input voltage on the tubes, and means connected in said circuit for causing the first tube to respond and fire to a predetermined input voltage and for causing each succeeding tube to respond and fire to a greater input voltage than that required for firing of the preceding tube, said means including adjustable voltage dividers in said circuit connected to the tubes, each of said cells also including a solenoid for controlling a counter connected in said cell, and means in said circuit connecting each said solenoid between the plate of the tube in its cell and the plate of the succeeding tube for actuating the solenoid of the cell having the last tube to be fired upon the occurrence of a difference in plate potentials between

said such tube and the succeeding tube which is fired.

3. A distribution classifier comprising an electronic circuit for receiving an input voltage and classifying such voltage according to its value, said circuit comprising a plurality of cells connected in said circuit successively for receiving the input voltage, each of said cells in the circuit including a thyratron tube and the tubes of all cells being identical, means connected in the circuit for impressing grid voltages on the tubes, means connected in the circuit for impressing the input voltage on the tubes, means connected in the circuit for causing the first tube to respond and fire to a predetermined input voltage and for causing each succeeding tube to respond and fire to a greater input voltage than that required for firing by the preceding tube, said means including adjustable voltage dividers in the circuit connected to the tubes, each of said cells also including a counter, a source of operating current for the counters, each cell also including a relay-actuated switch for connecting the counter of the last cell in which the tube thereof is fired to said source of current, said relay-actuated switch including a solenoid connected to the plate of the tube, the solenoids of all the switches being connected to a common line, a keying switch in said line, means for actuating said keying switch each time an input voltage is supplied to the circuit, said relay-actuated switch of each cell including means to lock-out any counter of a cell preceding or succeeding the cell having the tube being fired, said means comprising separable contacts connected to the plate of the tube of the succeeding cell and to the solenoid of such cell, and engageable contacts connected to the solenoid of the preceding cell for shorting it out.

4. A distribution classifier according to claim 3 wherein a voltage divider is connected to each of said tubes of the circuit with the exception of the tube of the first cell in said circuit.

5. A distribution classifier comprising an electronic circuit for receiving an input voltage and

classifying such voltage according to its value, said circuit comprising a plurality of cells connected in said circuit successively for receiving the input voltage, each of the cells in the circuit including a thyratron tube and the tubes of all cells having equal plate-to-cathode voltages when fired, each of said cells also including a counter, means connected in the circuit for impressing grid voltage in the tubes, means connected in the circuit for impressing the input voltage on the tubes, means connected in the circuit for causing the first tube to respond and fire to a predetermined input voltage and for causing each succeeding tube to respond and fire to a greater input voltage than that required for firing of the preceding tube, a source of operating current for said counters, each cell also including a relay-actuated switch for connecting only the counter of the last cell in which the tube thereof is fired to said source of current, said relay-actuated switch including a solenoid connected to the plate of said cell, the solenoids of all the switches being connected to a common line, a keying switch in said line, and means for actuating said keying switch each time an input voltage is supplied to said circuit.

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