

[54] DEVICES FOR MEAN VALUE INDICATION

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[22] Filed: **Nov. 14, 1972**

[21] Appl. No.: **306,425**

[30] **Foreign Application Priority Data**

Nov. 17, 1971 Great Britain..... 53338/71

[52] U.S. Cl..... **235/183, 235/151.13, 328/127, 131/21 R**

[51] Int. Cl..... **G06g 7/18**

[58] Field of Search..... 235/151.13, 183; 131/21 R, 131/21 A, 21 B, 21 C, 21 D; 328/127

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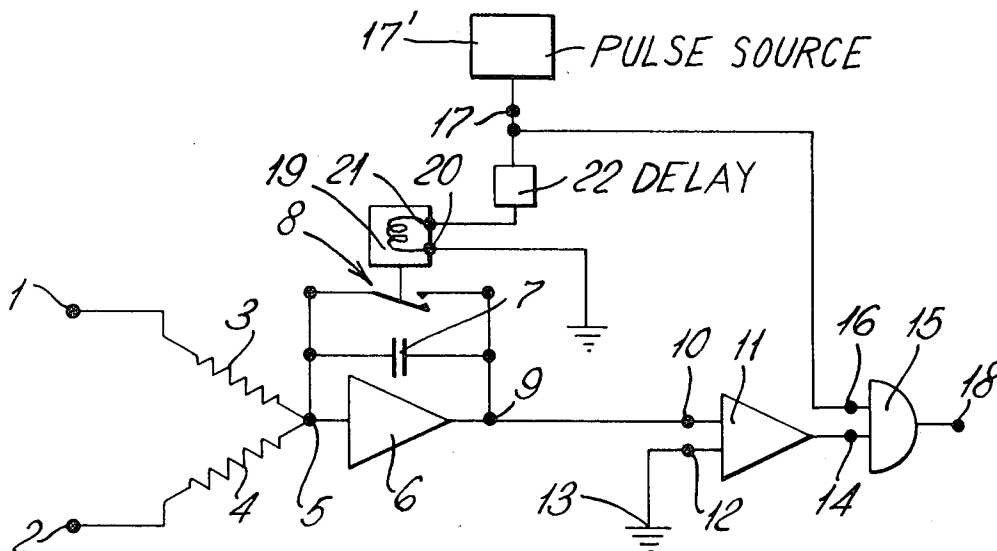
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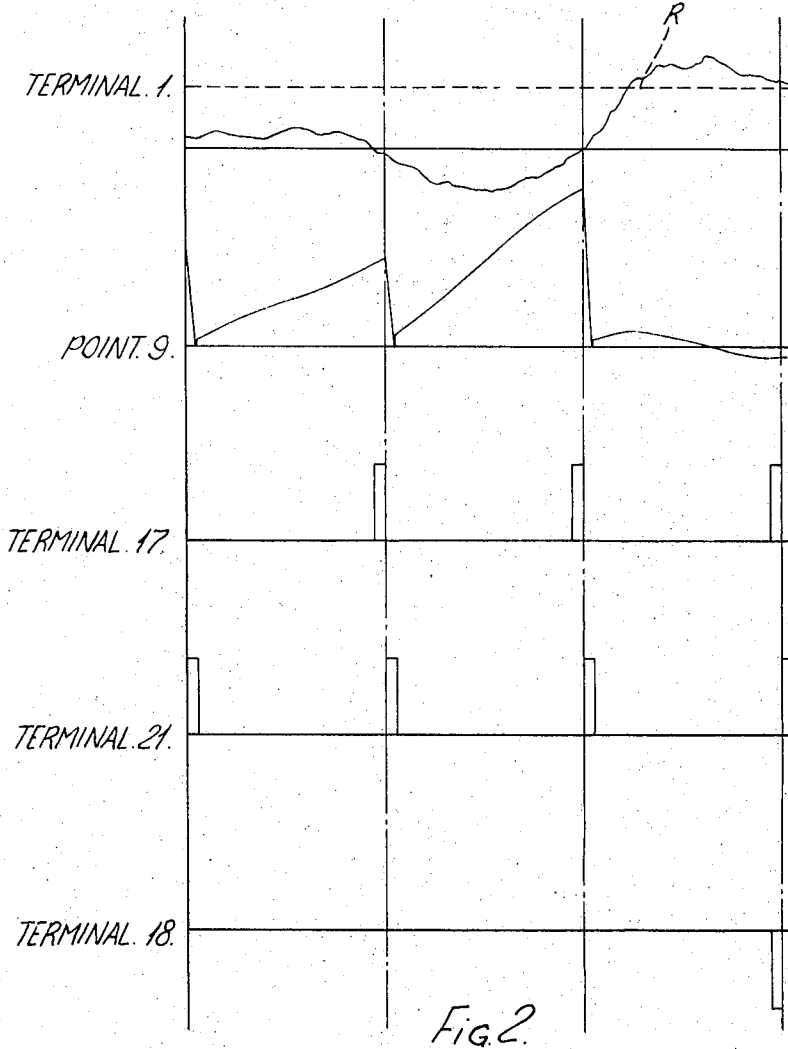
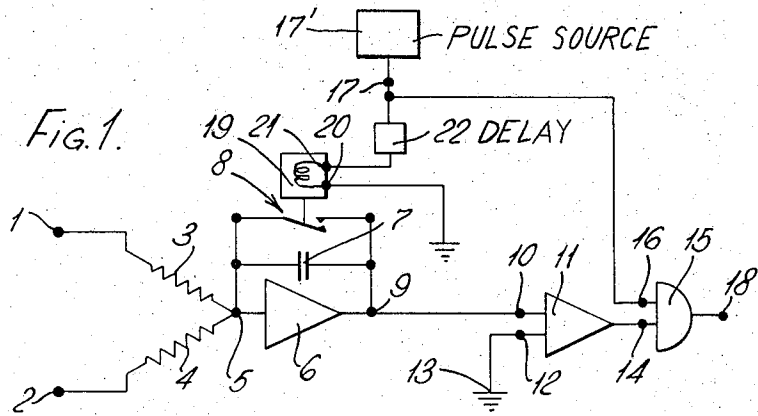
[57] **ABSTRACT**

This invention is mainly concerned with the checking of the masses of tobacco in individual cigarettes produced on a continuous-rod cigarette making machine. The signal from a Beta-ray scanning device (which is indicative of the mass of tobacco in a given portion of the continuous rod) is compared with a reference signal equivalent to an acceptable mass.

The device is formed by an integrator; an input circuit for the integrator to receive both the continuously varying voltage from the Beta-ray device and the reference voltage, and to deliver to the integrator a voltage which at any instant is proportional to the algebraic sum of the two input voltages; a level discriminator connected to the output of the integrator; a normally-closed gate connected to the output of the discriminator; and a source of pulses for opening the gate briefly at the end of a defined period which corresponds to that portion of the continuous rod which will after cut-off constitute a cigarette, the source of pulses also being arranged to reset the integrator to zero immediately after completion of each brief opening of the gate. A memory device operates a rejection device to reject individual cigarettes which contain portions of the continuous rod having unacceptable masses.

8 Claims, 2 Drawing Figures





DEVICES FOR MEAN VALUE INDICATION

This invention relates to devices for indicating when the mean value of a continuously variable electric signal, taken over a defined period, is beyond a defined limit. The invention is particularly applicable to apparatus for checking the value of some property of articles which are manufactured as a continuous product from which individual articles are obtained by subdivision.

An example of such a use is the checking of the masses of tobacco in individual cigarettes produced by a machine of the continuous-rod type; it is generally desirable that the mass of tobacco in each cigarette shall be controlled within quite close limits, as the high cost of tobacco makes it uneconomic to sell cigarettes containing materially more tobacco than the exact amount desired, while if the actual content of tobacco is materially less than said amount the cigarette is not of satisfactory quality.

It has therefore become a common practice to provide continuous-rod cigarette-making machines with quite complex devices for control of the mass of tobacco per unit length of the cigarette rod produced, so that when said rod is cut into individual cigarettes their mass shall be as uniform as possible. A rod scanning device commonly fitted to such machines for this purpose directs a beam of radiation (usually Beta-radiation) across the path of the cigarette rod to a detector device which produces an electric output signal varying with the intensity of the received beam; said beam is attenuated during its passage through the rod, the attenuation varying with the mass of tobacco per unit length in the portion of rod traversed by the beam, so that the output signal from the detector device provides a continuous indication of said mass per unit length; the detector device and associated electrical circuits most conveniently are arranged so that said output signal is in the form of a voltage directly proportional to said mass per unit length.

It is an object of the present invention to provide a device capable of receiving a continuously variable electric voltage (such as the output signal from the rod scanning device mentioned above) and producing an indication whenever the mean value of such voltage over a defined period is beyond a selected limit. Such an indication may be used in a variety of ways; it may be merely displayed for the information of a machine operator, it may be used to produce useful statistical information by counting the number of such indications, and it may be employed as a rejection signal controlling the disposition of articles produced by an associated machine.

According to the invention, there is provided a device for producing an indication whenever the mean value over a defined period of a continuously varying voltage is beyond a selected limit, said device comprising an integrator, an input circuit for said integrator arranged to receive both said continuously varying voltage and a reference voltage representing said selected limit and to deliver to said integrator a voltage which at any instant is proportional to the algebraic sum of the two received voltages, a level discriminator connected to the output of said integrator, a normally closed gate connected to the output of said discriminator, and means for opening said gate briefly at the end of said defined period, said means also being arranged

to reset said integrator to zero immediately after completion of each brief opening of said gate.

The means for opening the gate conveniently comprises a source of electric pulses, and the gate may then be a two-input AND gate having one of its inputs connected to the discriminator output and the other input connected to the pulse source. When a device embodying the invention is employed in association with a continuous-rod cigarette-making machine having a Beta-ray scanning device as mentioned above, the pulse source may be a timing pick-off device which in operation is fitted to the machine and arranged to produce pulses in synchronism with the operation of a cut-off mechanism which sub-divides the continuous cigarette rod into uniform lengths constituting individual cigarettes. Said timing pick-off device is then so timed relative to the cut-off mechanism that it emits a pulse whenever a portion of rod which will later be cut by the cut-off mechanism is within the beam of the Beta-ray scanning device.

When a device embodying the present invention is employed for one or more of the purposes noted above, the selected limit of the mean value of the continuously varying voltage will normally be a constant and hence the reference voltage will have a fixed value. It is possible however to use such a device for other purposes and then the reference voltage may be varied during operation; examples of such uses are to be found in co-pending application Ser. No. 306,460 of even date herewith, entitled "Improvements in calculating apparatus," assigned to the same assignee as the present application.

Various preferred features of a device embodying the invention will be apparent from the following more detailed description of a preferred embodiment of the present invention. The device to be described, which is suitable for use with a continuous-rod cigarettemaking machine fitted with a Beta-ray scanning device, is shown in the accompanying drawings in which:

FIG. 1 is a schematic circuit diagram of a preferred form of device embodying the invention; and

FIG. 2 is a graphical illustration of the voltages at various points in the circuit of FIG. 1 during operation.

The device shown in FIG. 1 has two input terminals 1, 2 connected through respective resistors 3, 4 to a common point 5; also connected to said point 5 are the input of an inverting amplifier 6 of very high gain, one side of a capacitor 7, and one side of a normally-open reset switch 8. The output of the amplifier 6, the other side of the capacitor 7 and the other side of the reset switch are all connected to another common point 9 to which one input 10 of a level discriminator 11 is also connected, the other input 12 of said discriminator being connected to earth as indicated at 13. The output of the discriminator 11 is connected to one input 14 of a two-input AND gate 15, and the other input 16 of said gate is connected to a further input terminal 17 of the device, the output of said gate 15 being connected to an output terminal 18 for the device.

The reset switch is diagrammatically shown as an electromechanical relay, including a winding 19 of which one terminal 20 is connected to earth while the other terminal 21 of said winding is connected via a delay circuit 22 to the further input terminal 17. In practice, a faster response is likely to be required than such a relay can give and an electronic device such as

a field-effect transistor is therefore used as the reset switch.

When the device illustrated in FIG. 1 is used in association with a continuous-rod cigarette-making machine fitted with a Beta-ray scanning device for measuring the tobacco mass per unit length of the cigarette rod before the latter is cut into individual cigarettes, the terminal 1 is connected to receive the output from the Beta-ray scanning device. Accordingly, terminal 1 receives a continuously-varying voltage the value of which at any instant is directly related to the tobacco mass per unit length of the portion of the rod then within the radiation beam of the Beta-ray scanning device. With a typical Beta-ray device, the voltage at terminal 1 is positive when the mass per unit length is less than the desired mean, and the magnitude of this voltage increases as the tobacco mass per unit length falls. The terminal 17 receives spaced pulses, from source 17, one of said pulses occurring each time that there passes through said radiation beam a portion of cigarette rod which will later be cut to separate an individual cigarette from the succeeding portion of rod; these pulses will be referred to as "end-of-cigarette pulses" and they are of short duration as compared with the interval between each pulse and the next. The voltages on terminals 1 and 17 are represented in FIG. 2 on the lines marked "TERMINAL 17" respectively.

The terminal 2 is supplied with a d.c. reference voltage which is of opposite polarity from the signal on terminal 1; in magnitude, said reference voltage is equal to a value of the voltage at terminal 1 which represents a defined level of tobacco mass per unit length (corresponding to a preselected mass of an individual cigarette, as cigarette length is uniform). In FIG. 2, a dashed line R indicates the voltage level at terminal 1 corresponding to said defined level of tobacco mass per unit length, line R thus representing a voltage equal in magnitude but opposite in polarity to the reference voltage at terminal 2.

The resistors 3, 4 are of mutually equal values, hence the total input current to the point 5 at any instant is proportional to the algebraic sum of the voltages at the terminals 1, 2. The amplifier 6 and capacitor 7 together serve to integrate the combined input (from terminals 1 and 2) to the point 5, the amplifier taking a negligible input current due to its high gain so that the capacitor 7 receives, for all practical purposes, the whole of the combined input current through resistors 3, 4. Whenever the voltage at point 5 tends to change, the very high gain amplifier 6 responds by producing a large voltage change at point 9, so that the charging current of capacitor 7 is kept in balance with the combined currents from resistors 3, 4. The charge on the capacitor 7 at any instant thus represents the integral of the algebraic sum of the voltages at terminals 1 and 2 over the period since the reset switch 8 last opened. Each time the switch 8 closes, the capacitor 7 is discharged so that when the switch 8 opens again, integration restarts from zero. The closing of the switch occurs whenever a pulse appears at the terminal 21, and a pulse appears at said terminal 21 immediately after each pulse at terminal 17, due to the presence of delay circuit 22, which introduces a time delay equal to the duration of a pulse at terminal 17 so that the leading edge of each pulse at terminal 21 occurs at the same time as the trailing edge of the corresponding pulse at terminal 17.

The pulses at terminal 21 are represented in FIG. 2 against the legend "TERMINAL 21" and the voltage produced by integration of the varying voltage at point 2 is represented against the legend "POINT 9."

The voltage at point 9 is at all times applied to input 10 of the level discriminator 11, which delivers an output to terminal 14 of the gate 15 whenever the voltage at terminal 10 is negative relative to that at terminal 12, but no output when the voltage at terminal 10 is equal to or more positive than that at terminal 12. The discriminator 11 is desirably of high sensitivity, so that only a small negative voltage at terminal 10 (relative to terminal 12) is required to cause an output to be delivered.

When an end-of-cigarette pulse appears at terminal 17, it energises the input 16 of gate 15 and if the input 14 of said gate is energised at the same time, i.e., if the discriminator 11 is then delivering an output, the output terminal 18 of the device will be energised. The voltage at terminal 18 is shown in FIG. 2 against the legend "TERMINAL 18." It will be apparent from the preceding description that at this time the discriminator 11 will be delivering an output to terminal 14 if terminal 10 is more negative than terminal 12 and, as the latter is connected to earth, terminal 10 must be negative relative to earth. This will only be so if the voltage output of the integrator is negative which is equivalent to saying that the mean magnitude of the voltage at terminal 1 over the period since the preceding operation of switch 8 must have been greater than the magnitude of the reference voltage at terminal 2, and thus the mass of the portion of cigarette rod which passed through the beam of the Beta-ray device during the period in question (which portion will become a discrete cigarette) is less than the limit defined by the reference voltage at terminal 2.

In sum, therefore, the device described produces an output signal at terminal 18 whenever an end-of-cigarette pulse at terminal 17 occurs at the end of a period (since the preceding end-of-cigarette pulse) in which the portion of cigarette rod which passes the Beta-ray device will become a cigarette containing a mass of tobacco less than the limit represented by the voltage at terminal 2.

The output signal thus obtained may be used in a variety of ways; for example, if the reference voltage at terminal 2 corresponds to the lowest mass acceptable in a cigarette, then an output signal at terminal 18 indicates that a length of cigarette rod which has just passed the Beta-ray scanning device will, when it has been separated from the rest of the rod by cutting, become a cigarette which should be rejected. The output signal at terminal 18 may therefore be stored for a time equal to that required for the length of rod concerned to pass the cut-off mechanism and reach a selective rejector, and then the stored signal may be delivered to the rejector so that the latter operates on the cigarette in question.

Cigarettes which are of greater mass than an appropriate limiting value may be similarly detected and rejected; in this case the device embodying the invention will be supplied with a reference voltage at terminal 2 which is of opposite polarity from that supplied when cigarettes of unduly low mass are to be rejected as above described, moreover the connections to the inputs of the level discriminator 11 will be reversed so that the discriminator delivers an output when the

input it receives from the integrator is positive relative to earth. A single cigarette-making machine may be provided with two devices embodying the invention so that cigarettes with masses greater or less than preselected upper and lower limits respectively may all be rejected, and the two devices may be connected to control separate rejectors or one common rejector as preferred.

We claim:

1. A device for producing an indication whenever the mean value over each of a succession of defined periods of a continuously varying voltage is beyond a selected limit, said device comprising an integrator, input circuit means for said integrator connected to receive both said continuously varying voltage and a reference voltage representing said selected limit to deliver continuously to said integrator a voltage which at any instant is proportional to the algebraic sum of the two received voltages, a level discriminator connected to the output of said integrator, a normally closed two-input AND gate having one input connected to the output of said discriminator, and a source of electric pulses connected to the other input of said gate to open said gate briefly at the end of each of said defined periods, and reset means connected to said source of electric pulses and to said integrator to reset said integrator to zero immediately after completion of each brief opening of said gate.

2. A device as claimed in claim 1, wherein said reset means comprises reset switch means connected to said integrator and responsible to an electric pulse from said source of electric pulses to reset the integrator to zero and a delay circuit connected between the pulse source and the reset switch means.

3. A device as claimed in claim 1, wherein said input circuit means comprises a first resistor connected between a first input terminal and the input of said integrator and a second resistor connected between a second input terminal and the input of said integrator, said first input terminal being connected to continuously receive said continuously varying voltage and said second input terminal being connected to continuously receive

said reference voltage.

4. A device as claimed in claim 1 wherein said discriminator has a pair of inputs, one of the inputs of said discriminator being connected to the output of said integrator and the other input being connected to ground.

5. A device for indicating whenever the mean value over each of a succession of defined periods of a continuously varying voltage deviates from a selected limit, comprising input circuit means for continuously adding said continuously varying voltage and a reference voltage representing said selected limit, an integrator having an input connected to the output of said input circuit means, a discriminator having a first input connected to the output of said integrator and a second input connected to ground, gating means for selectively connecting the output of said discriminator to an output terminal of the device, pulse control means connected to said gating means to operate said gating means briefly at the end of each of said defined periods, and reset means connected to said pulse control means and said integrator to reset said integrator to zero immediately after each operation of said gating means.

6. A device as claimed in claim 5, wherein said input circuit means comprises a first resistor connected between a first input terminal and the input of said integrator and a second resistor connected between a second input terminal and the input of said integrator, said first input terminal being connected to continuously receive said continuously varying voltage and said second input terminal being connected to continuously receive said reference voltage.

7. A device as claimed in claim 5, wherein said pulse control means comprises a source of electric pulses coincident with the end of each of said defined periods.

8. A device as claimed in claim 7, wherein said reset means comprises reset switch means connected to said integrator and responsive to an electric pulse from said source of electric pulses to reset the integrator to zero and a delay circuit connected between the pulse source and the reset switch means.

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