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W. C. BROEKHUYSEN ET AL

2,729,213

FEED CONTROL

Filed March 9, 1950

5 Sheets-Sheet 3

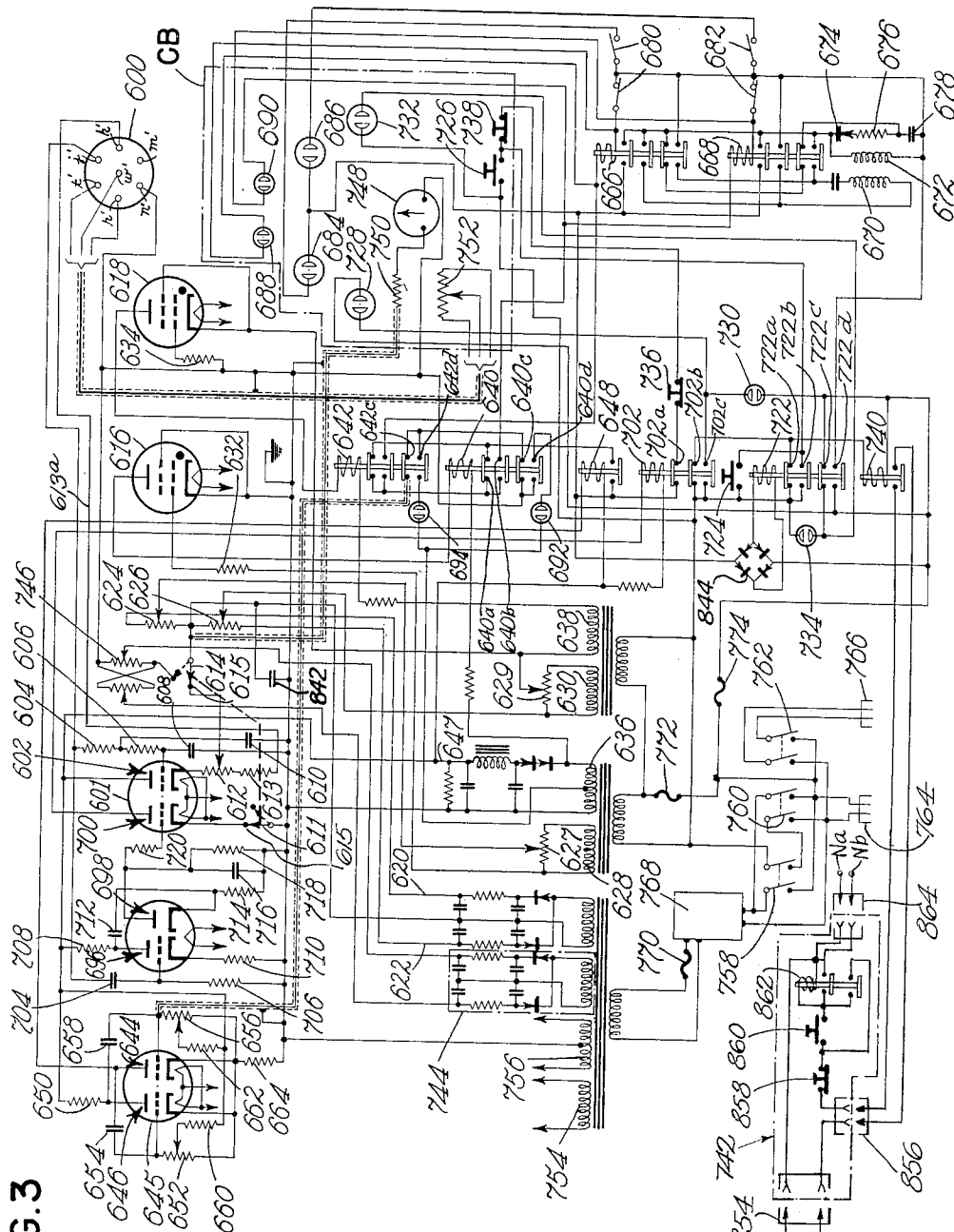


FIG. 3

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FIG.5

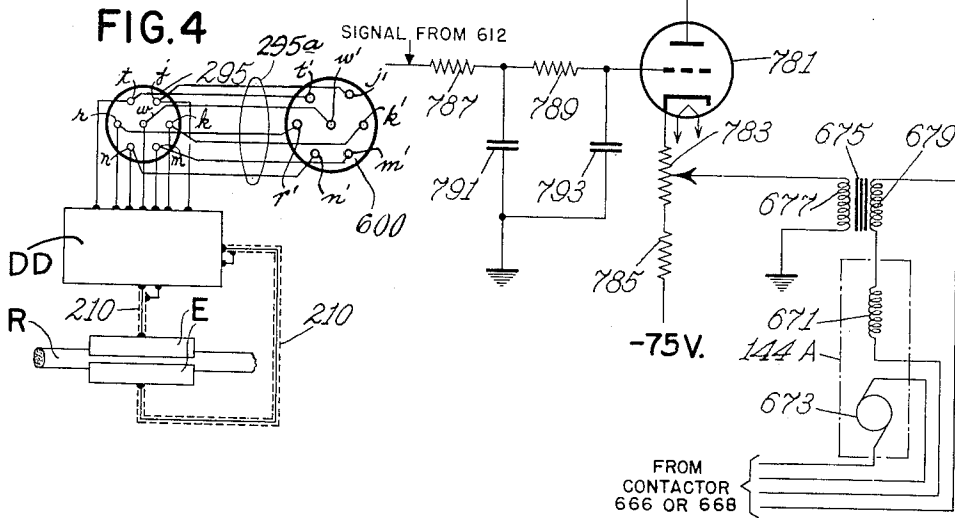
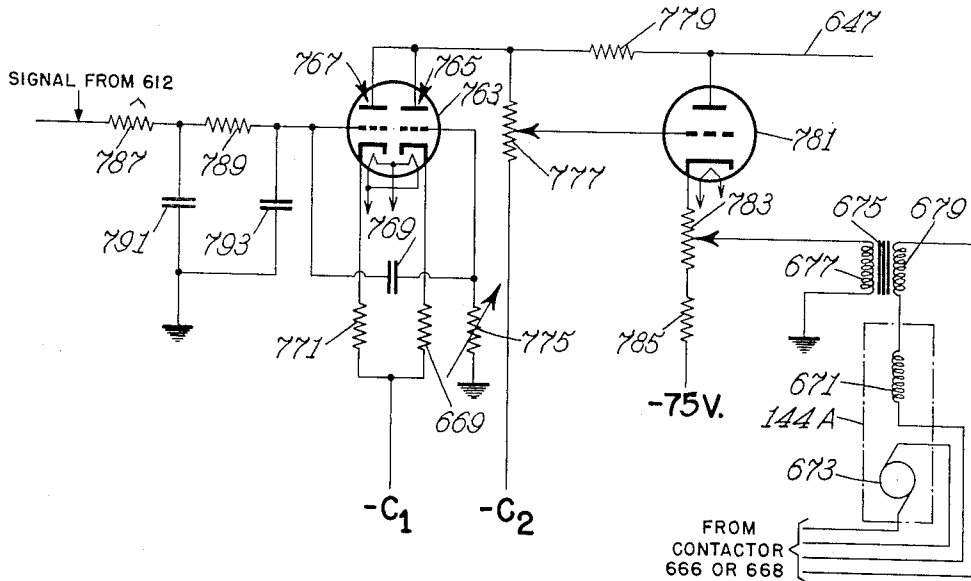


FIG.6



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FIG. 7

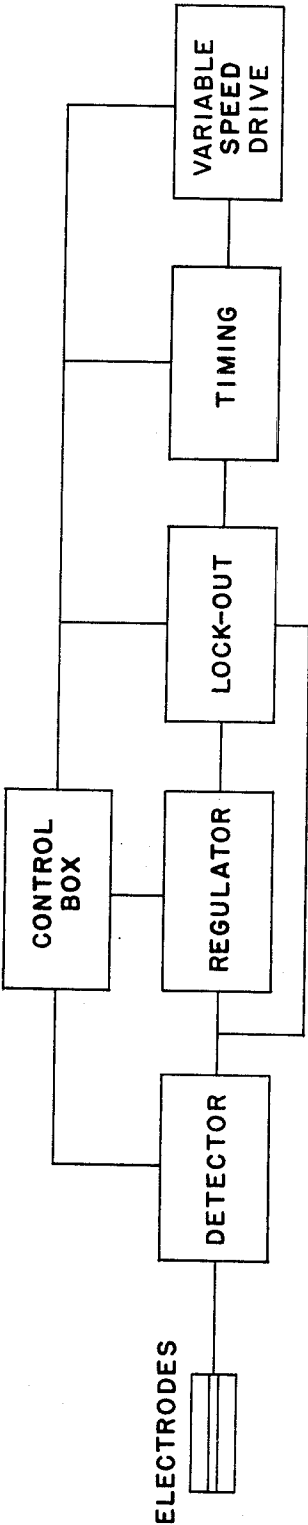
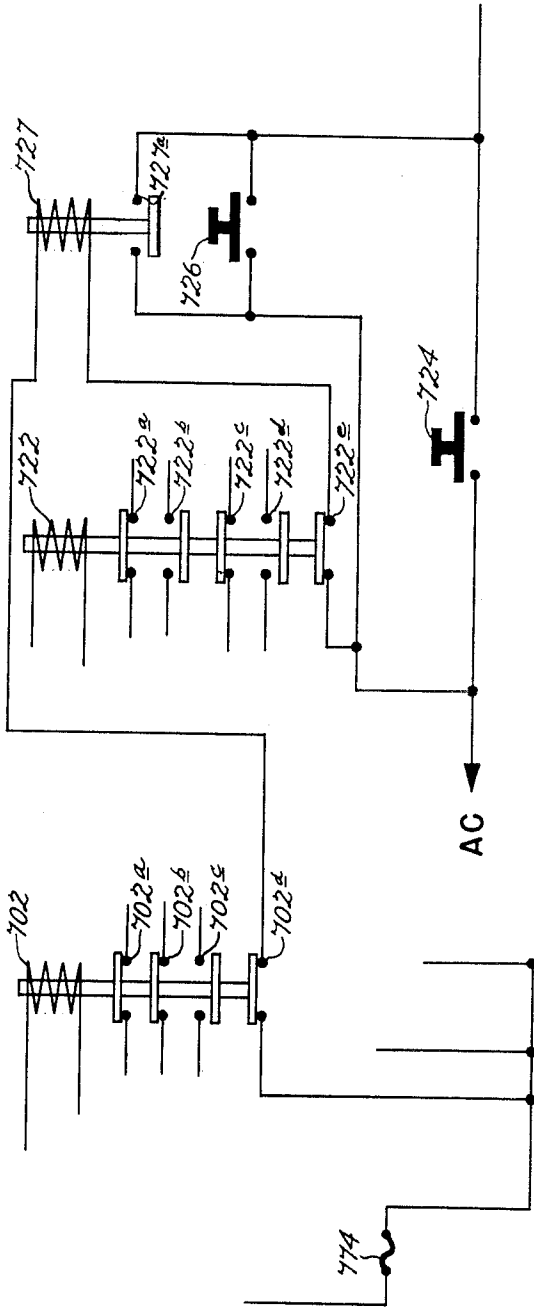


FIG. 8



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2,729,213

FEED CONTROL

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Application March 9, 1950, Serial No. 148,661

18 Claims. (Cl. 131—21)

This invention relates to automatic machine controls and particularly to controls such as are adaptable for automatically regulating the feed of a cigarette making machine.

Heretofore variable speed drives have been used in cigarette making machines to increase and decrease the rate at which tobacco is fed. Sometimes these variable speed drives have been connected with an automatic control mechanism such as disclosed in patent issued to U. A. Whitaker 2,357,860 granted September 12, 1944. In general such controls have had several disadvantages, one of the primary being that the amount of regulation needed could not be easily obtained in that the machine would either overrun in one direction or in another because of over correction. This was attributed in part to the fact that the drive required a substantial amount of horsepower and a variable speed drive that had to transmit this power would of course be of substantial construction. Consequently it was not possible to increase or decrease the speed in small increments or decrements and there tended to be an over or under correction which did not lead to satisfactory results. At other times corrections would be made for temporary variations found in the amount of tobacco when in fact no correction should have been made in the feed at all.

In the present invention there is provided a drive which permits a finer adjustment to be made in the rate of feed, and still permits the required amount of horsepower to be easily transmitted by the drive.

Another advantage of the invention is that after the defective material has been detected it permits a determination to be made as to whether such a defect requires the speed of the machine to be changed or whether such a defect is a temporary occurrence which does not require changing the speed of the machine to feed more or less tobacco.

A further object is to provide electrical means for averaging the weight of the material as it is being fed and correcting a feed when said averaged weight exceeds predetermined limits.

Another advantage of the invention is that it provides for a device which automatically stops the feeding operation of a machine whenever the material being produced stops moving in the machine or whenever something goes wrong in the machine so that the material itself disappears.

Another object of this invention is to detect an objectionable feature in a cigarette rod being manufactured and to then make a correction in the feed if the defect persists for a predetermined length of time and to immediately cease changing the rate of feed if the defective condition is eliminated.

Other objects and features of the invention will appear as the description of the particular physical embodiment selected to illustrate the invention progresses. In the accompanying drawings, which form a part of this specification, like characters of reference have been applied

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to corresponding parts throughout the several views which make up the drawings.

Fig. 1 is a front elevation, with part broken away, of a continuous rod cigarette machine in conjunction with the dielectric cigarette detecting, correcting and ejecting apparatus,

Fig. 2 is a side elevation of the tobacco feed of the continuous rod cigarette machine as seen from line 2—2 of Figure 1, illustrating the drive of the principal mechanism of the same,

Fig. 2A is a schematic view illustrating the driving mechanism inside of the differential pulley,

Fig. 3 is a diagram of the feed regulator control circuit,

Fig. 4 is a schematic illustration of a suitable detector of the dielectric type,

Fig. 5 is a modified form of the invention showing a circuit for making feed corrections which are proportional to the amount of deviation from the desired averaged weight,

Fig. 6 is a modified form of the invention showing a circuit for making feed corrections which are proportional to the extent of the deviation and to the rate of change of the deviation from the desired averaged weight,

Fig. 7 is a block diagram of the feed regulator, and

Fig. 8 is a modified form of the invention showing an automatic device for re-energizing the cut-out.

For purposes of illustration, applicants have chosen to illustrate how the features of this invention may be employed with the feeding apparatus of a cigarette making machine. The present invention has been shown but not claimed in copending application filed by William C. Broekhuysen and Vincent Petrucelly, Serial No. 148,662 on March 9, 1950, to which reference may be made for additional apparatus relating to a cigarette making machine of the type in which this feed control may be employed. To facilitate referring to the other copending application the same reference numerals are being employed in the present description.

To illustrate the invention there is shown in Fig. 1 a conventional continuous rod cigarette making machine which comprises a tobacco feed designated generally by the symbol F and a cigarette maker designated generally by the symbol M. The principal components of the cigarette maker M, comprise a rod folder tongue U, rod former V, a cigarette rod paster P, a rod sealer S, a cut off device C, and a cigarette catcher or collector B. The manner in which these components of a cigarette making machine function may be briefly described as follows:

The tobacco feed F showers tobacco continuously onto a traveling tape 78 which delivers the showered tobacco to the traveling paper web W. The paper web W is fed from a reel Y and is guided through the rod folder tongue U, the rod paster P which applies a strip of paste to the lap edge of the cigarette rod, the rod former V and the rod sealer S, by a continuously moving folding belt 22 driven by the drum 24. Drum 24 is secured to a shaft 26, having a bevel gear 28 driven by a gear 30 secured to the shaft 32. A second gear 34 is also fixedly mounted on the shaft 32 and is driven by a gear 36 secured to a shaft 38 on which is mounted a gear 40 driven by a gear 42. The gear 42 is secured to the shaft 44 and is driven by a motor N through coupling 46. As will later be seen, the motor N provides the drive for the entire cigarette making machine.

When the cigarette rod R emerges from the rod former V, it passes through the cigarette cutoff C wherein a knife 48, driven in proper timed relation with the movement of the cigarette rod from the shaft 38 through a pair of spiral gears 68 and a gear train (not shown), cuts off individual cigarettes L of a predetermined length from the cigarette rod.

These cigarettes pass through a guide 50 and each cigarette is delivered alternately to a pair of catcher belts 52 which deliver them to a suitable collecting receptacle. Belts 52 are driven in proper timed relation with the speed of the cigarette making machine by a roller 54 secured to a shaft 56 on which is mounted a bevel gear 58. The gear 58 is driven by a gear 60 secured to a shaft 62 on which is mounted a bevel gear 64 driven by a gear 66 secured to shaft 38.

As will be seen in Fig. 2, the feed F is of the general type wherein a customary carded feed drum 70 picks up tobacco from a supply hopper and conveys it to a position where it is removed by a picker roller 72 and deposited in the form of a layer upon a wide feed belt 74 which conveys it forward into a concave 76 where it is formed into a mat of uniform density. The tobacco from this mat is then removed by the concave picker roller 77 and falls into a guide channel 79 and is deposited in a uniform ribbon like layer upon a continuously moving belt 78 which conveys the tobacco to the paper web as seen in Fig. 1.

The tobacco feed F is driven from the shaft 44 (Fig. 1) which through a gear reduction drive 80, drives a pulley 82 which is integral with a double pulley 84. Double pulley 84 drives a double pulley 86 through belts 90. The double pulley 86 comprises part of a differential pulley 88 having a sun gear 89 and a spider 91 carrying planetary gears 93 which mesh with the sun gear 89 and the internal teeth of double pulley 86, as shown schematically in Fig. 2A.

A conical pulley 92 of a conventional variable speed drive such as described in U. S. patent to J. A. Stein 1,810,932 granted June 23, 1931, is mounted on the output shaft of the differential pulley 88. The other coacting pulley 94 of the variable speed drive is driven by means of belt 96 which connects it to the pulley 92. The speed ratio of the variable speed drive may be changed by means of the hand wheel 98 extending through the frame of the tobacco feed F in the manner fully described in the above mentioned patent granted to J. A. Stein. Pulley 94 and gear 102 are both fixedly mounted on the shaft 100. Gear 102 through a conventional gear train such as shown in Fig. 2 drives a gear 104 secured to a shaft 106 on which is mounted a tobacco feed drum 70. In this conventional type of feed, a carded refuser drum 108 mounted on shaft 110, coacts with the feed drum 70 to limit the amount of tobacco picked up by the feed drum, and is driven by a gear 112, secured to shaft 106, through an idler gear 114 which in turn drives a gear 116 secured to shaft 110.

The output shaft of the differential pulley 88 also has a gear 118 mounted thereon which drives a gear 120 secured to a shaft 122 carrying a second gear 124. Gear 124 drives a gear 126 secured to a shaft 128 on which is mounted a gear 130 driving gear 132 secured to a shaft 134. A sprocket 136 fixedly mounted on shaft 134 drives a chain 138 which in turn drives sprockets 140 and 142. Secured to the shafts upon which these sprockets 140 and 142 are mounted, are rollers which drive the feed belt 74.

The output speed of the differential pulley 88 is varied by means of a variable speed transmission one type being that shown in U. S. Patent 2,253,921 granted to Victor H. Van Sant on August 28, 1941, to which reference may be made for a detailed description and illustration of the same. The principal features of this unit may be briefly described as follows:

The transmission unit receives driving power from the pulley 82 and transmits this power to the driven pulley 156 through a double variable ratio pulley 152 having cone faced belt engaging discs. The double pulley 152 is of such construction that the center belt engaging disc is movable toward either of the outer cone faced walls so as to vary the effective diameter of each

of the pulleys making up the double pulley 152. In other words, the effect of moving the center belt engaging disc of the double pulley 152 is to increase the diameter of one pulley and decrease the diameter of the other pulley comprising the double pulley 152. In this way the speed ratio between pulley 82 and pulley 156 may be varied. Power is transmitted by means of the belt 154 between pulley 82 and one side of the double pulley 152. Power so received is transmitted by means of belt 158 from the other side of the double pulley 152 to the pulley 156 to which the sun gear 89 is connected.

The double pulley 152 is pivotally mounted on a floating link 155 pivotally connected to bracket 153 to allow for changes in the outstretched lengths of the belts 152 and 158 due to changes made in the speed ratio. The hub of center disc of double pulley 152 is so mounted on a shaft that when the flexible coupling 150 is turned it will move the center disc longitudinally along its axis of rotation and in a direction determined by the direction of rotation of the flexible coupling 150.

As previously mentioned the differential pulley 88 is of conventional design employing a sun gear 89 and planetary gears 93 which revolve around the sun gear 89 (Fig. 2A). When the internal teeth of the double pulley 86 and the teeth of the sun gear 89 engage with the planetary gears 93, the speed of rotation of the pulley 156 and the double pulley 86 are both reflected simultaneously in the speed with which the planetary gears 93 are compelled to revolve. As a consequence any change in the variable ratio double pulley 152 will be reflected immediately in some fixed proportion in the speed at which the planetary gears 93 revolve. The planetary gears 93 are connected by means of a conventional spider 91 to the output shaft of the differential pulley 88.

The speed ratio of the double pulley 152 is automatically changed by means of a reversible gear reduction adjusting motor 144 which through gears 146 and 148 rotates the flexible coupling 150 to make whatever adjustment is desired. Since the variable ratio double pulley 152 has a limited range, limit switches operated by gear 148 are enclosed in the housing 149 so as to prevent the reversible gear reduction adjusting motor 144 from moving the variable ratio double pulley 152 beyond its range. If the feed F has to be adjusted to a greater degree than is obtainable within the range of the variable speed drive 152 the hand knob 98 of the Reeves drive is turned to obtain a greater change in the speed of the feed drum 70 and the components coacting therewith.

It will thus be seen that the variable ratio pulley 152 is automatically adjusted within a limited range due to signals received from the detecting apparatus hereinafter described so as to increase or decrease the speed of the output shaft of the differential pulley 88. By means of the connections previously described the speed of the output shaft is immediately reflected in the change in the speed of feed drum 70 and also in the speed of the feed belt 74.

The drive just described has a number of very desirable features which enables it to be used for many purposes other than that specifically chosen to illustrate the invention. For example a great deal of power can be transmitted through the multiple pulleys 84 and 86 without losing any variability which is obtained through the variable ratio pulley 152. This is made possible because of a decreased gear ratio between the planetary drive and the sun gear. In this way the change in speed of the variable ratio pulley is much greater than the change in speed of the planetary drive resulting in increased accuracy and sensitivity of speed change in the planetary drive, and decreased power requirements for the variable ratio pulley. By using the same source of power for driving the machine and also driving the variable speed

drive, differences in the fluctuations in the speed of two different motors is also avoided.

The feed regulator FR described herein requires a signal consisting of an electrical voltage whose polarity or direction of variation is determined by whether the material being manufactured is lighter or heavier than the required weight and whose magnitude is proportional to the deviation of the weight of the cigarette from the required weight. This deviation may be expressed in terms of weight of the cigarette above or below the desired weight. While any suitable detecting device can be employed to provide an electrical voltage which indicates whether the material being manufactured is too light or too heavy, we have in illustrating the invention, referred to the type of dielectric detector which is fully disclosed and described in copending application filed in the names of Broekhuysen and Petrucelly, S. N. 148,662 as a suitable device for providing a signal to the feed regulating circuit.

In that application Fig. 16 shows the electrodes E which are used to detect variations in the characteristics and especially the density of a cigarette rod as it is being manufactured and a circuit which converts the measurements as picked up at the electrodes E to a signal suitable for conductance to the feed control circuit disclosed herein. These electrodes and circuit are represented in the schematic illustration shown in Fig. 4 of the present specification.

The feed regulator circuit (Figs. 3 and 7) which causes more or less tobacco to be fed acts essentially as an electronic switch which energizes the correcting motor 144 when the detector signal indicates a weight deviation greater than a predetermined deviation of the cigarette weight from its desired value for an uninterrupted period greater than a predetermined length of time. The polarity of this signal is used to determine the direction in which the correcting motor 144 will operate and the total amount of correction is controlled by the length of time that the weight deviation persists, or by any combination of the amount of deviation, the rate of change of deviation and the time that the deviation persists.

An averaging circuit is used so that the regulator operates from the equivalent average weight of a number of cigarettes. Also, to prevent the regulator from trying to correct for short time variations in average weight with which it is difficult to cope, a waiting interval is first instituted when the averaged signal exceeds the value which is predetermined, as the point at which the regulator will operate. This value is called the "operating point" of the regulator. The operating point, for example, may be that signal value which corresponds to a cigarette weight 2% above or below the required weight. The following description applies to corrections which depend on the length of time that the weight deviation persists.

When a change is made in the speed of the feed F, it takes an interval of time for this change to become apparent at the detector electrodes E. This total time is made up of the time required for the changed flow of tobacco to go from out of the concave 76 through the forming mechanism of the cigarette machine M and through the electrodes E, plus the time required to change the speed of the feed F which is made up of slippage of belts, sheaves, backlash, and the effects of inertia and friction. It is therefore necessary to wait at least this interval of time after making the correction to see what the effect of this correction has been before further corrections are made.

For the reasons just mentioned, corrections are made in the form of discrete adjustments with a waiting time between each adjustment. This interval between corrections may be made the same as the initial waiting time or may be greater or smaller. If, during an interval between corrections, the signal should become less than the "operating point," a full initial waiting period is again

started as soon as the operating point is again exceeded. If during a correction, the deviation should become less than the "operating point," the correction will immediately cease, and a full initial waiting time is instituted as soon as the operating point is again exceeded.

If the cigarette rod R ceases to move through the electrode E due to some failure in the cigarette making machine, the detector DD would normally either measure a rod R having an insufficient quantity of tobacco as in the case where there is no rod between the electrodes, or it will measure a cigarette rod R of constant weight as would be the case if the rod became stationary between the electrodes E. If the portion of cigarette rod R which became lodged between the electrodes E were overweight or underweight or if the rod R was entirely missing from between the electrodes E, the regulator FR would normally automatically adjust the feed F to compensate for the measurement made. This action on the part of the regulator FR in such a case would be erroneous and to eliminate this possibility from occurring, a circuit called the "lockout" (Fig. 3) is disclosed herein. This circuit disconnects the regulator FR whenever the rod R ceases its motion between the electrodes E, regardless of whether the rod R is or is not between the electrodes E.

In Fig. 3 the contacts $j', k', m', n', r', t', w'$, of connector 600 connect the regulator FR to the corresponding contacts j, k, m, n, r, t, w , of connector 295 (Fig. 4) of the dielectric detector DD (Fig. 1) by means of a suitable cable 295a. After the signal is brought from the detector DD, it is passed through the averaging circuit consisting of resistors 604 and 606 and condensers 608 and 610 into the grid of a triode section 602 of a dual triode tube 601. These resistors and condensers form what is commonly known as a low-pass filter. It is preferable for accurate averaging that the time constant of each filter section be approximately one-quarter of the total required averaging time. Consequently, the over-all response time of both sections of the filter taken together is considerably less than the selected averaging time, so that the filter charges to the average voltage in less time than elapses during a full averaging period. This triode section 602 also acts as a cathode follower to electrically isolate the feed regulator circuit (Fig. 1) enclosed in housing FR from the detector DD or other signal source. The cathode resistor consisting of potentiometer 612 and series resistor 613 are connected by wire 613a to a suitable negative voltage from any suitable source such as from the detector DD.

The slider of the potentiometer 612 is connected to one terminal of a double pole, double throw switch 615, one moving blade 614 of which connects with the input circuits of two thyratrons 616 and 618. The thyratrons 616 and 618 have separate biases both A. C. and D. C. The bias for thyatron 616 is obtained from potentiometer 624 across the D. C. power supply 620, and an A. C. bias in series with it is obtained from a potentiometer 627 across the insulated transformer winding 628. Condenser 842 provides a low impedance ground return for the A. C. bias current. The bias of thyatron 618 is obtained from potentiometer 626 across D. C. power supply 622 and an A. C. bias obtained from a potentiometer 629 across the insulated transformer winding 630.

The input to thyatron 616 goes through its bias and resistor 632 to its control grid; the cathode of that tube 616 being at ground potential. The input to thyatron 618 goes through the biases to its cathode; the grid of that tube 618 being grounded through resistor 634. The plates of the two thyratrons 616 and 618 are energized by A. C. through separate transformer windings; namely thyatron 616 from winding 636 and that of thyatron 618 from winding 638. The polarity of the A. C. biases and the A. C. plate voltages for both thyatron tubes 616 and 618 are so adjusted that the grid to cathode A. C. voltage is negative when the plate to cathode A. C. voltage is positive.

Potentiometer 612 is adjusted so that the voltage of

its slider is zero with respect to ground when a normal weight cigarette is in the electrode E, and the biases on thyratrons 616 and 618 are so adjusted so that neither thyatron "fires" under these conditions. Then if a signal comes from the detector DD so that the slider of potentiometer 612 becomes positive and of large enough value its effect will be to "fire" thyatron 616, and increase the bias on thyatron 618, to prevent thyatron 618 from firing also.

Similarly if a negative signal comes from the detector DD, so that the voltage at the slider of potentiometer 612 becomes negative enough, it will fire only thyatron 618 and increase the bias on thyatron 616. As a further precaution against both thyratrons 616 and 618 firing at the same time the plate voltage polarities are so adjusted that the plate of thyatron 618 is positive with respect to its cathode when the plate of thyatron 616 is negative with respect to its cathode.

The use of the A. C. bias in addition to the D. C. bias allows the thyratrons 616 and 618 to fire for almost a full half-cycle of the plate voltage, and allows the thyratrons 616 and 618 to be adjusted so that their operation is almost independent of line voltage variations. This is so because a variation in the A. C. plate voltage is more or less compensated by a proportional change in the A. C. bias. In the plate circuit of thyatron 616 is a relay 640 which is energized when thyatron 616 "fires," and similarly relay 642 is energized when thyatron 618 "fires."

The triode sections 644 and 646 of tube 645 comprise with their accompanying components a multivibrator. This multivibrator is used to establish the initial waiting time after a deviation in weight has passed a set value; to establish the length of time that the correcting motor 144 is energized; and to establish the interval of time between successive corrections. The plates are energized from the D. C. power supply 647 and in the plate circuit of triode 644 is a relay 648, while in the plate circuit of triode 646 is a resistor 650 whose resistance is the same as that of the coil of relay 648. When triode 644 is conducting, the relay 648 is energized and from multivibrator action, triode 646 is not conducting. Similarly when triode 646 is conducting triode 644 is not conducting, and relay 648 is not energized. Relay 648 is used to energize the correcting motor 144.

Potentiometer 652 and condenser 654 determine the time that triode 644 conducts and therefore how long relay 648 is energized. This therefore determines the length of time that the correcting motor 144 is energized and is called the "on" time. Potentiometer 656 and condenser 658 determine the time triode 644 does not conduct and is therefore the "off" time. Potentiometers 652 and 656 are variable so that the "on" and "off" time can be adjusted and the sliders of the potentiometers 652 and 656 are returned to the D. C. supply voltage 647 through resistors 660 and 662 to make the transition operation of the multivibrator more precise.

It is seen that the cathodes of the multivibrator are returned to ground potential through resistor 664. This determines the initial waiting period. When neither of the thyratrons 616 and 618 is conducting, one contact 642c of relay 642 and one contact 640c of relay 640 are closed and in series and connect the grid of triode 644 to ground. Because either triode 644 or triode 646 is conducting currents of the same magnitude, the cathodes of triode 644 and triode 646 are positive with respect to ground by the amount of the voltage drop of this current through resistor 664. If the grid of triode 644 is held at ground potential, it is negative with respect to its cathode and triode 644 cannot conduct. This means that triode 646 must conduct.

If either thyatron 616 or 618 fires, either relay 640 or relay 642 will be energized and the grid of triode 644 will be disconnected from ground and will start to approach its cathode potential at a rate determined by the time constant of the effective part of potentiometer 656

and condenser 658. This means that relay 648 will not be energized until a definite time after relay 640 or relay 642 have become energized. This time is determined by the value of the resistance 664 compared to resistance 650, and will be approximately equal to the "off" time when it has the same value as resistance 650.

Two windings 670 and 672 of a single phase condenser type squirrel cage motor 144 are schematically shown in lower right hand corner of Fig. 3. Winding 670 is a high resistance, auxiliary winding, whereas winding 672 is the connected, low resistance, main winding. These windings 670 and 672 are connected to the contacts of a reversing contactor which consists of two contactors 666 and 668 so that the correcting motor 144 (which is used to operate a variable speed drive such as the variable ratio pulley 152 shown in Fig. 1), will rotate in one direction when contactor 666 is energized and in the other direction when contactor 668 is energized.

Rectifier 674, resistor 676 and condenser 678 operate to apply a braking action to the motor 144 when it is de-energized, so that a minimum of coasting results after the motor 144 is deenergized. When the motor 144 is energized in either direction the condenser 678 is charged up through the rectifier 674 and resistor 676. When the motor 144 is de-energized the condenser 678 is preferably discharged through the low resistance winding 672 of the correcting motor 144. It has been found however that a braking action will be effected on the motor 144 if the condenser 678 is discharged through either of the windings 670 or 672 but as just stated it is preferable to use the low resistance winding 672 because the stopping action has been found to be somewhat more prompt than when the high resistance winding 670 is employed.

The operation of the major portion of the regulator circuit may be described as follows:

When the material such as a cigarette rod R passing between the electrodes E deviates from the required weight it causes a corresponding averaged electrical voltage deviation to appear at the grid of triode 602. This voltage deviation will cause the voltage at the slider of potentiometer 612 which had been set at ground potential for a normal cigarette to change in the same polarity and approximately the same amount. Due to the adjustments of the D. C. bias potentiometers 624 and 626, this voltage deviation will have no effect on thyratrons 616 or 618 until it exceeds a preset value. If the voltage deviation is positive and greater than this value, thyatron 616 will "fire" and thus energize relay 640. This causes the contacts 640c of relay 640 to open thereby disengaging the grid of 644 from ground and starts the initial waiting period mentioned above. At the same time contact 640b partially completes the circuit of the contactor 668 side of the reversing contactor for energizing.

At the end of the initial waiting period, triode 644 starts conducting and triode 646 ceases conducting and relay 648 is energized. The contacts of this relay 648 complete the circuit for contactor 668 and it becomes energized and the correcting motor 144 starts to operate, and the brake condenser 678 starts to charge. At the end of the "on" period triode 646 starts conducting and triode 644 ceases conducting, and relay 648 is de-energized which then de-energizes contactor 668. This de-energizes the correcting motor 144 and at the same time connects the condenser 678 across winding 672 thus supplying a surge of direct current which effects a braking action on the motor.

If the original weight and voltage deviations are still maintained so that thyatron 616 is not interrupted in its firing, a full "off" period of time will result and then triode 644 will conduct again and reenergize the correcting motor 144 in the manner stated above. However, if at any time within this cycle, the voltage deviation should decrease below the minimum value, thyatron 616 will immediately stop "firing" (because of the A. C. plate voltage), relay 640 will be de-energized, and the grid

of triode 644 will be grounded, thereby reestablishing the conduction in triode 646 regardless of where in the cycle it had been and therefore the initial waiting period is re-established for any future operation.

If the voltage deviation be negative with respect to ground and greater than the minimum value, then a similar series of actions results except that thyatron 618 "fires" and relay 642 and contactor 666 are energized, and the motor 144 when energized finally by relay 648 will rotate in the opposite direction.

These directions of operation are so established that they change the ratio of the variable ratio pulley 152 so as to change the speed of the variable speed transmission 38 so that the speed of the feed and therefore the amount of tobacco fed is increased when the original voltage deviation shows the cigarettes are too light, and decreased when the cigarettes are too heavy.

The variable ratio pulley 152 has maximum and minimum limits beyond which it cannot be adjusted. If the variation in average cigarette weight is sufficiently great this limit of adjustment may be reached, and if further adjustment in that direction were attempted, the variable ratio pulley 152 would not operate. To prevent this from happening, limit switches 680 and 682 (Fig. 3) operated from the correcting motor 144 are incorporated in the motor operating circuit so that when the limit in one direction is reached it disconnects the reversing contactor 666 or 668 for that direction so that no further corrections in that direction can be made but continues to allow corrections to be made in the opposite direction. At the same time that the limit switch 680 or 682 disconnects the motor 144, it energizes one of the indicating lights 684 or 686 on the control panel. This informs the machine operator to turn the hand wheel 98 (Fig. 2) of the variable speed drive described heretofore in the required direction to bring the feed within the automatic range of the regulator.

The indicating lights 688 and 690 on the control panel are energized at the same time that either contactor 666 or contactor 668 are energized and light up to show when a correction is made and in what direction. This is a visual indication of the operation of the correcting motor 144.

Indicating lights 692 and 694 are mounted on the regulator panel FR and operate from contact 640d and 642d to show when relays 640 and 642 are energized and allow for visual adjustment of the operating points. Contacts 640a and 642a of relays 640 and 642 comprise an electrical interlock so that even if both thyatrons 616 and 618 fire both sides of reversing contactor 666 and 668 will not be energized.

The lock out circuit previously mentioned is comprised essentially of a triode 696, a diode 698, a triode 700 and a relay 702.

The signal comes from the detector DD (not averaged) to the grid of triode 696 through condenser 704. The combination of condenser 704 and resistor 706 comprises a D. C. component stripping or blocking circuit since the condenser 704 will not pass D. C. voltage, but allows only the alternating component of the detector signal to appear at the grid of triode 696. When the cigarette rod R ceases movement, whether it remains in the electrodes E or not, there will be no alternating component of signal and no signal will therefore appear at this grid.

Triode 696 with resistors 708 and 710 constitutes an amplifier which is then resistance capacitively coupled to a diode 698 by a condenser 712 and resistor 714. The diode 698 is so connected that only the negative portion of the A. C. signal can pass through and this negative portion is accumulated in an accumulator circuit comprising condenser 716 and resistor 718 which is connected to the grid of triode 700 through a current limiting resistor 720.

If the cigarette rod R is traveling at normal speed

through the electrodes E, there is enough variation in properties and arrangement of the ingredients of the cigarette rod to produce an A. C. component or pulsations of the signal. It should be understood that this A. C. component could also be produced by using a magnetic field instead of a dielectric field. It will be understood that the signal we refer to has A. C. and D. C. components which can be separated so that either may be used. The A. C. component is removed from the D. C. component, amplified, and the negative portion is accumulated and applied to the grid of triode 700 in the plate circuit of which is relay 702. Enough negative potential is accumulated to prevent triode 700 from conducting and relay 702 is not energized. When the cigarette rod R ceases moving, there is no A. C. component of signal, and the accumulator condenser 716 discharges through resistor 718 until the grid of triode 700 approaches its cathode potential. This allows triode 700 to conduct and energize relay 702. This causes contact 702a to open thereby deenergizing the power circuit to the correcting motor 144, preventing any further correction regardless of other operation of the electronic circuit. When this occurs indicating lights 728 and 730 are energized through relay contact 702c.

The values of condenser 716 and resistor 718 and operating characteristics of triode 696 are so chosen that with the amount of A. C. signal available from a normally moving rod, the triode 700 is prevented from conducting. These values could be changed to accommodate other variations produced by materials other than a tobacco rod.

A further circuit called a "cut-out" is incorporated to prevent the regulator FR from being energized immediately after the cigarette machine is restarted after a stop. When a cigarette machine is started from a stop, there is usually a transient period of non-representative average weights during which the regulator should not be operative.

This "cutout" circuit consists of relay 722 energized by D. C. voltage received from bridge rectifier 844. The relay is de-energized when the lock-out relay 702 is energized, and cannot become energized again, even when relay 702 is reenergized, except by operating either push button 724 or 726. When this cut-out circuit is de-energized preventing action of the regulator, indicating lights 732 and 734 are energized. If desired, a conventional timing relay could be used instead of the push buttons 724 and 726 to re-energize the cut-out relay 722 at a definite time after the cigarette rod starts its normal travel through the electrodes E.

In the latter case, an additional contact 702d is added to relay 702, and a time delay relay 727 is connected as shown in Fig. 8. It will thus be evident that when relay 702 is de-energized when a cigarette rod is moving through the electrodes, as in the case when a cigarette machine is started in operation, the operating mechanism of time delay relay 727 is energized through the additional contact 702d on relay 702.

After a time as determined by the setting of the time delay relay 727, the normally open contact 727a of the time delay relay 727 which is connected in parallel with push buttons 724 and 726 is closed. This will energize cut out relay 722 in the same manner as closing push button 724 or 726 as mentioned hereinbefore.

An additional normally closed contact 722e on relay 722 is added as shown in Fig. 8. This contact 722e opens the energizing circuit of time delay relay 727 after relay 722 has been energized and allows the time delay relay 727 to open up and reset.

Push buttons 736 and 738 have been provided to shut off the regulator FR even when the cigarette rod R is operating normally without affecting the electronic circuits in the event it is not desired to have the regulator operate on certain types or batches of tobacco placed in the feed hopper.

An auxiliary relay 740 operates from the lock-out and cut-out relays to stop the machine when the cigarette rod R stops moving between the electrodes E by interrupting the machine drive motor starting circuit enclosed in box 742 (Fig. 3). Box 742 contains a conventional motor start circuit having start and stop buttons and a relay holding circuit across the start contactor. Thus the start circuit is connected to the power lines through connecting plug 354. In series with one side of the line are the contacts closed by the armature of relay 740, connected to the line through plug 356. Also in series with the same side of the line as the contacts of relay 740 are a stop button 358, and a start button 360 with associated contacts.

Connected across the start button 360 and through a pair of normally open contacts on relay 362 is a shunting line which provides a holding circuit for relay 362 after the start button is pressed and the relay is energized. Relay 362 has a second pair of normally open contacts which are closed when relay 362 is energized. This pair of contacts is connected to the same side of the line as the start and stop buttons so that when relay 362 is energized these contacts act as the starting switch for operating motor M shown in Fig. 1. The output of starter box 742 is connected through plug 364 by means of a suitable cable to motor M in Fig. 1. The connections Na and Nb as shown in Fig. 3 are connected to terminals Na and Nb on motor N as shown in Fig. 1. When relay 702 is energized it de-energizes the machine drive motor starter and when relay 722 is de-energized it prepares the drive motor circuit 742 for re-energizing when the start-button in motor circuit disposed in box 742 is depressed.

A test voltage circuit is provided to allow the regulator values and operating points to be adjusted without taking into account the operation of the cigarette machine or signal source. This comprises a D. C. power supply enclosed by box 744 (Fig. 3), and dual potentiometer 746 so connected that when the moving blade 614 of double pole double throw switch 615 is connected to it at the point shown, a positive or negative potential can be applied to the inputs of the thyratrons 616 and 618. This voltage is variable by means of the sliders on dual potentiometer 746. At the same time that switch blade 614 of double pole double throw switch 615 is set on the test position, another arm 611 of the same switch disconnects the cathode of lock-out triode 739 from ground and prevents it from conducting. This allows the regulator FR to operate without a cigarette rod R. The correcting motor 144 can be energized if desired and all other functions of the regulator FR can be pursued by means of this test signal.

An indicating meter 748 with its calibrating resistor 750 is used to indicate the polarity and magnitude of the signal being applied to thyratrons 616 and 618. A weight adjustment potentiometer 752, which is connected to the detector DD through connector 600 is used to adjust the operating zero of the regulator by varying the bias on the grid of the output tube 260 of detector DD as shown in Fig. 16 of copending application of Broekhuysen and Petrucelly, S. N. 148,662.

The heater of the thyatron 618 is connected to its own power source-transformer winding 754 while the heaters of all the remaining tubes are connected to the center-tap grounded winding 756.

The feed regulator circuit is connected to a suitable source of power (not shown) by means of a plug 764. Switches 758 and 760 are used to turn the equipment on and off. Switches 758 and 760 are so connected that regardless of which is turned on first, the filament and D. C. bias circuits are first energized, and similarly when both are on, the first one turned off de-energizes the plate circuit voltages first.

Power for the detector DD is obtained from the power source through the plug 766 and switch 762. A line voltage regulator 768 is employed to maintain heater

and bias voltages at a constant value regardless of line voltage variations. Fuses 770, 772 and 774 are employed for protecting the various circuits of the regulator.

If desired, the above described regulator FR may be modified to provide corrections which are proportional to the deviation of the average cigarette weights while maintaining all other operating advantages previously described. In the latter case, a variable speed motor is substituted for the induction correcting motor 144, so that the speed of this motor 144A is controllable by means of varying the applied alternating voltage. The intermittent spaced corrections will then be made variable by varying the voltage applied to motor 144A and therefore its speed as a function of the magnitude of the signal received from the detector DD instead of being of uniform extent as is the case when the circuit shown in Fig. 3 is used.

Fig. 5 shows one way of accomplishing this result by modifying the circuit shown in Fig. 3. For purposes of simplicity, the corresponding contactor and other relay controls of timing shown in Fig. 3 are omitted.

Fig. 5 shows a reversible series motor 144A consisting of field winding 671 and armature 673 so connected to reversing contactors 666 and 668 that the same intermittent reversible operation as previously described for motor 144 is obtained. Triode 781 is an additional cathode follower to electrically isolate the proportional control from the other control functions of the regulator FR. The plate of this triode is connected to the D. C. supply voltage 647 and the grid is connected to the slider of potentiometer 612 as shown in Fig. 5.

Resistors 787 and 789 and condensers 791 and 793 connected also as a two-section low-pass filter provide averaging over a longer period of time so that the proportional part of the control is not so sensitive to short time fluctuations in average weight as the remainder of the control. Under some circumstances of machine operation, this additional averaging may not be required. The cathode resistor consists of potentiometer 783 and series resistor 735 and is connected to minus 75 volts of the detector or other source. The slider of potentiometer 783 is connected to the control winding 677 of a suitable saturable reactor schematically represented by 675. The power winding 679 of the saturable reactor 675 is connected in series with the motor 144A. The slider of potentiometer 783 is adjusted so that its voltage is at ground potential when the voltage of slider of potentiometer 612 is at ground potential.

The operation of the circuit may be briefly described as follows:

With no voltage across the control winding 677 of saturable reactor 675, the inductance and therefore the reactance of the power winding 679 is a maximum and if the circuit to the motor 144A is completed by contactor 666 or 668, the voltage across motor 144A would be the difference between the drop through the saturable reactance winding 679 and the applied voltage, and would therefore be a minimum. As the signal from the detector DD becomes positive or negative, the voltage at the slider of potentiometer 612 becomes positive or negative and similarly, the voltage at the slider of potentiometer 783 becomes positive or negative. With a voltage of either polarity across the control winding 677 of saturable reactor 675, a current flows through this winding 677 and the effect of this current is to reduce the reactance of the power winding 679. This would thereby increase the effective voltage across the motor 144A so that its speed would be greater. The saturable reactor 675 is designed so that the resultant speed of the motor 144A is essentially proportional to the voltage at the slider of potentiometer 783 which is essentially proportional to the averaged deviation of the cigarette weights.

When the deviation of average cigarette weights goes beyond the value necessary to "fire" thyratrons 616 or 618, one or the other "fires," initiating the multivibrator

645 action. As previously described when either contactors 666 or 668 is energized, the correcting motor 144A operates, but its speed is now directly proportional to the deviation from normal of the average cigarette weights. The time that the motor 144A is energized and de-energized remains the same as previously described because of the multivibrator 645 action, so that now the amount of correction for each "on" period is directly proportional to the speed of the correcting motor 144A and therefore to the deviation of the average weight of the cigarette from the required value.

A further modification of our invention to provide not only proportional control but in addition a control which is proportional to the rate of change of the deviation of the average cigarette weights is shown in the circuit illustrated in Fig. 6.

The signal comes from the slider of potentiometer 612 to an averaging circuit consisting of resistors 787 and 789 and condensers 791 and 793, as before, into the grid of triode 767 of tube 763. A connection is made from the grid of triode 767 to grid of triode 765 through a conventional differentiating circuit consisting of condenser 769 and resistor 775, so that the voltage applied to the grid of triode 765 is proportional only to the rate of change of the signal voltage applied to the grid of tube 767.

The use of common plate resistor 779 connected to D. C. voltage source 647 provides an adding circuit so that the voltage drop in resistor 779 is proportional to the algebraic sum of the voltages appearing at the grids of tubes 767 and 765. Cathode resistors 771 and 669, plate resistor 779 and load potentiometer 777 and the negative bias voltages C₁ and C₂ are so proportioned that the voltage appearing at slider of potentiometer 777 is closely equal to the algebraic sum of the voltages appearing at the grids of triode 767 and 765, but is opposite in sign.

It can be seen then that the voltage appearing at the slider of potentiometer 777 is the algebraic sum of some mathematical function of the averaged deviation of the cigarette weights from their desired value and some mathematical function of the rate of change of this averaged deviation, although the algebraic sign of this sum is reversed. By making the resistor 775 of the differentiating circuit adjustable, any adjustable part of the rate of change of the deviation of the average weights can be added to the deviation itself so that optimum operation can be obtained.

The sum of the two values obtained from the slider of potentiometer 777 are again introduced into the control winding of saturable reactor 675, using an isolating cathode follower consisting of triode 781 and potentiometer 783 and series resistor 785 as shown previously, if electrical conditions make such isolation necessary.

The operation of saturable reactor 675 on the speed of correcting motor 144A is the same as described previously except that the speed is now proportional to the algebraic sum of mathematical functions of the deviation of the averaged weights and the rate of change of that deviation. The reversal of the sign of the algebraic sum has no effect, for if both the deviation of the average and the rate of change of this deviation have their signs reversed, the operation of the saturable reactor 675, which is designed to operate equally as well for positive and negative currents in its control windings, will be independent of the sign of the combined voltage and will depend only on the magnitude of the sum.

In all the circuits previously shown where a differentiating function is to be performed or where an AC coupling is required, it has been shown as a combination of capacitance and resistance. As is well known in the art, the same could be accomplished by means of transformer action either for coupling or differentiation.

The invention above described may be varied in construction within the scope of the claims, for the par-

ticular device selected to illustrate the invention is but one of many possible embodiments of the same. The invention, therefore, is not to be restricted to the precise details of the structure shown and described.

What is claimed is:

1. The method of regulating the rate of feed of a machine feeding material continuously from a feeder which method comprises, detecting the density of the material as it is fed from said feeder, converting said detection to an electrical voltage whose polarity is determined by whether the material is lighter or heavier than a predetermined density and whose magnitude depends on the deviation of the density of the material from the required density, operating a device for increasing or decreasing in accordance with said polarity and magnitude the speed of said feed each time the electrical voltage falls outside predetermined limits, delaying the operation of said device each time the electrical voltage falls outside said predetermined limits for a predetermined fixed period of time which is not less than the time it takes the material to travel from said feed to said detecting station before allowing a correction to be made, and incapacitating the operation of said device each time the deviation of the characteristics of the material returns within the predetermined limits within the time the operation of said device is being delayed.

2. The method of regulating the rate of feed of a machine feeding material continuously from a feeder which method comprises, detecting the density of the material as it is fed from said feeder, converting said detection to an electrical voltage whose polarity is determined by whether the material is lighter or heavier than a predetermined density and whose magnitude depends on the deviation of the density of the material from the required density, operating a device for increasing or decreasing in accordance with said polarity and magnitude the speed of said feed each time the electrical voltage falls outside predetermined limits, delaying the operation of said device each time the electrical voltage falls outside said predetermined limits for a predetermined fixed period of time which is not less than the time it takes the material to travel from said feed to said detecting station before allowing a correction to be made, and incapacitating said device from making further corrections whenever the deviation of the density of the material returns within said predetermined limits during the time the speed of said feed is in the process of being changed.

3. The method of controlling the material feeder of a machine manufacturing articles of substantially uniform density from heterogeneous, non-metallic material comprising feeding said material past a plurality of spaced electrodes, impressing a voltage on said electrodes, translating variations in the density of successive increments of the material passing between said electrodes into pulsations in said voltage, and rendering said material feeder inoperative when said pulsations cease due to the disappearance or failure of said material to move through the machine.

4. The method of stopping the operation of a machine which comprises detecting variations in density of successive increments of a product being produced in a continuous length from heterogeneous, non-metallic material, translating said variations into an alternating voltage of varying frequency, maintaining said machine in continuous operative condition as long as said alternating voltage continues, and rendering said machine inoperative when the alternating voltage ceases due to the disappearance or failure of said material to move through the machine.

5. Apparatus for regulating the rate of feed of a machine producing a product of substantially uniform density from non-metallic heterogeneous material in a continuous length comprising, a feed, a detector for detecting deviations in the density of said material from a predetermined norm as it is fed from said feed, a device for

increasing or decreasing the rate of feed by increments proportional to the amount of deviation from said norm to correct the rate of feed of said material whenever the deviation exceeds predetermined limits, and means for delaying the operation of said device each time for a period not less than the time it takes the material to travel from said feed to said detector before allowing a correction to be made.

6. Apparatus for regulating the rate of feed of a machine producing material in a continuous length comprising, a feed, a detector for detecting deviations from a norm of the density of the material as it is fed from said feed, a device for increasing or decreasing the rate of feed by amounts proportional to the amount of deviation from said norm to correct the rate of feed of said material whenever the deviation detected by the detector exceeds predetermined limits, means for delaying the operation of said device each time for a period not less than the time it takes the material to travel from said feed to said detector before allowing a correction to be made, and a control for cancelling any correction in the rate of feed each time the deviation fails to exceed said predetermined limits before said period is completed.

7. Apparatus for regulating the rate of feed of a machine producing material in a continuous length comprising, a feed, a detector for detecting deviations from a norm of the density of the material as it is fed from said feed, a device for increasing or decreasing the rate of feed by amounts proportional to the amount of deviation from said norm to correct the rate of feed of said material whenever the deviation detected by the detector exceeds predetermined limits, means for delaying the operation of said device each time for a period not less than the time it takes the material to travel from said feed to said detector before allowing a correction to be made, and a control for stopping the operation of said device from further increasing or decreasing the rate of feed whenever the deviation fails to exceed said predetermined limits during the time the rate of feed is in the process of being increased or decreased by said device.

8. A feed regulator for correcting the rate of feed in a machine producing material in a continuous length comprising, a feed for feeding material continuously, a variable speed drive for controlling the speed of operation of said feed, a detector responsive to the material produced by said machine to determine the density thereof and to convert the deviations from a predetermined normal density into an electrical signal, a regulator control circuit, a constant speed adjusting motor operated periodically by said regulator control circuit for adjusting said variable speed drive, said circuit providing a predetermined full waiting period each time the detector indicates that the density of the material produced has deviated beyond a predetermined value, means included in said circuit for stopping the correction or terminating the waiting period at any time that said deviation decreases below the predetermined value and for reinstituting a full initial waiting period whenever the deviation again exceeds the said predetermined value.

9. In a cigarette making machine of the type manufacturing cigarettes in a continuous rod form, a feed for feeding cigarette tobacco in a continuous stream to be formed into a continuous cigarette rod, a detector for detecting variations in the density of the continuous rod as it is being manufactured, a circuit for converting said variations into an electrical signal, a device for varying the speed at which said feed operates, an averaging circuit interposed between said circuit and said device to provide a signal constantly averaged over a length of rod for operating said device when the averaged signal goes beyond predetermined limits to correct the rate of feed, said averaging circuit comprising two similar sections of low pass filters each consisting of a series resistor and a shunt capacitor wherein the time constant of each filter

section is substantially one quarter of the required averaging time.

10. A feed regulator for correcting the rate of feed in a machine producing material in a continuous length comprising, a feed for feeding material continuously, a variable speed drive for controlling the speed of operation of said feed, a density detecting device for detecting the density of said material, means for converting said density detections into an electrical signal, a feed regulator control circuit, a constant speed adjusting motor operated periodically by said feed regulator control circuit for adjusting said variable speed drive, a multivibrator having two electronic amplifier tubes, said multivibrator comprising a part of said feed regulator control circuit for determining a fixed amount of correction to the speed of said feed and predetermining the waiting interval between said corrections, the cathodes of said multivibrator tubes being connected together, and a resistor jointly connected at one end to the cathodes of said multivibrator tubes and the other end of said resistor being connected to ground potential, the grid of the electronic amplifier tube which is conducting when the fixed amount of correction is being made to the speed of the feed being connected through normally closed relay contacts to ground so that said grid is normally grounded when the deviation of the densities of a cigarette rod is below the predetermined value, said resistor being proportioned to the resistances in the plates of the said electronic amplifier tubes so that when the said grid is disconnected from ground potential by opening of the normally closed relay contacts it will require a predetermined interval of time for that grid to reach the conducting potential of said electronic amplifier tube, which time will be determined by the extent of the voltage drop of the current through the other electronic amplifier tube of the multivibrator through said cathode resistor.

11. In a cigarette making machine having a feed for feeding tobacco at a substantially constant rate, mechanism for forming said stream of tobacco into a cigarette rod, a device for varying the rate at which tobacco is fed by said feed, an electrical control for operating said device, said control comprising, a detector responsive to changes in density of the cigarette rod to determine variations in the density of the cigarette rod, a circuit for converting said variations as detected by said detector into an electrical voltage, an averaging circuit for averaging the variations as determined by said detector over a predetermined length of cigarette rod which has already passed through the detector, a variable speed adjusting motor for varying the quantity of the tobacco fed from said feed, a feed regulator control circuit operated by a signal received from said averaging circuit to operate said variable speed adjusting motor in accordance with a predetermined timing sequence whenever said averaged variations exceed a predetermined value and remains in excess of said value for a period longer than a predetermined minimum time, such adjustments being made intermittently so long as the averaged variation remains in excess of the said predetermined value, each adjustment being made for the same length of time, a variable reactor interposed between said regulator control circuit and said adjusting motor, and a circuit to vary the reactance in proportion to the extent of the variation of the said averaged signal beyond the said predetermined value to make the speed of the said adjusting motor proportional to said extent of the variation of the averaged signal beyond the said predetermined value such that the amount of adjustment becomes proportional to said extent of the variation of the averaged signal beyond the predetermined value.

12. In a cigarette making machine comprising, a feed, a source of supply of tobacco for said feed, an adjustable speed drive for operating said feed to feed varying quantities of tobacco, a rod former for converting tobacco fed by said feed into a continuous cigarette rod, a detector

for detecting variations in the density of said cigarette rod, a circuit for converting the variations in said density of said cigarette rod to proportional variations in an electrical voltage, an averaging circuit for averaging the variations of the said proportional electrical voltage over a predetermined length of time, a differentiating circuit for producing a second voltage proportional to the rate of change of said averaged electrical voltage, an adding circuit for producing a signal voltage which is the algebraic sum of said averaged voltage and said second voltage, a variable speed motor whose speed can be controlled connected to said adjustable speed drive to regulate the speed thereof, a control circuit interposed between said signal voltage and said variable speed motor, said circuit comprising means for energizing said variable speed motor in either direction corresponding to the polarity of said signal voltage, said energizing being for a definite period with waiting intervals between successive energizing periods, and means for varying the speed of said variable speed motor in accordance with the magnitude of said signal voltage, so that each energizing period provides an adjustment to said adjustable speed drive which is proportional to said signal voltage.

13. Apparatus for incapacitating the operation of a cigarette making machine whenever a continuous cigarette rod ceases to move therethrough, comprising a detector for detecting the density of a continuously moving cigarette rod as it moves through a cigarette making machine, said detector having an output voltage comprising direct and alternating current components representative of the density of said moving rod, means for removing the direct current components from said voltage so that the output voltage of said direct current component removing means has only alternating voltage components representative of changes in the density of said continuously moving cigarette rod, electrical energy storing means, a rectifier for rectifying said alternating voltage in order that a varying direct current voltage is provided for charging said energy storing means, and operating means for said machine responsive to the amount of charge in said energy storing means, whereby the deficiency of charge below a predetermined level in said energy storing means renders said machine inoperative.

14. Apparatus for indicating the absence of density variations in a continuous cigarette rod being manufactured in a cigarette making machine comprising a detector for detecting the density of a continuously moving cigarette rod as it moves through a cigarette making machine, said detector having an output voltage comprising direct and alternating current components representative of the density of said moving rod, means for removing the direct current components from said voltage so that the output voltage of said direct current removing means has only alternating voltage components representative of changes in the density of said continuously moving cigarette rod, electrical energy storing means, a rectifier for rectifying said alternating voltage in order to provide a varying direct current voltage for charging said energy storing means, and indicating means responsive to a deficiency of charge in said storage means below a predetermined level and adapted to indicate said deficiency when absence of density variations in said rod cause said energy storing means to be depleted.

15. Apparatus for incapacitating the operation of a cigarette making machine whenever a continuous cigarette rod ceases to move therethrough, comprising a detector for detecting the density of a continuously moving cigarette rod as it moves through a cigarette making machine, said detector having an output voltage comprising direct and alternating current components representative of the density of said moving rod, means for removing the direct current components from said voltage so that the output voltage of said direct current component removing means has only alternating voltage components representative of changes in the density of said

continuously moving cigarette rod, electrical energy storing means, a rectifier for rectifying said alternating voltage in order that a varying direct current voltage is provided for charging said energy storing means, a relay responsive to a predetermined level of deficiency of charge in said storage means, and means actuated by said relay when said charge is depleted to said predetermined level to render said machine inoperative.

16. A regulating apparatus for regulating the amount of shredded heterogeneous material fed to a mechanism which manufactures said material into a product having a continuous length and uniform density comprising a feed, a variable speed drive for operating said feed to feed said material at a substantially uniform rate, a regulating motor for changing the speed of operation of said variable speed drive, a circuit for energizing said regulating motor, said circuit comprising a detector responsive to deviations in the density of successive increments of said material from a predetermined norm, for supplying an electrical voltage having a polarity representative of the direction of said deviation from said norm and having a magnitude representative of the extent of said deviation, an averaging circuit to average continuously said voltage for a predetermined number of said successive increments, a thyatron for each polarity of signal, sources of alternating current and direct current biases connected to said thyatrons so that one of said thyatrons fires at a predetermined positive polarity of signal and the other of said thyatrons fires at a predetermined negative polarity of said signal, connections for said thyatrons permitting only one thyatron to fire at a time, a timing circuit for energizing said regulating motor during the period that one of said thyatrons remains firing for a predetermined length of time after a fixed waiting period, said waiting period being initiated before each successive energization of said regulating motor as long as one of said thyatrons remains firing, a motor reversing starter which is partially energized when either of said polarity thyatrons is fired and is completely energized when the timing cycle is completed and an independent variable voltage source connected so that it may be used to adjust the regulator to predetermined operating conditions.

17. A feed regulator for correcting the rate of feed in a machine producing material in a continuous length comprising a feed, a drive for operating said feed at a predetermined rate of speed, a variable speed drive connected to said first named drive for changing the rate of speed at which said feed is operated, a detector responsive to the material fed from said machine to indicate the extent the density of said material deviates from predetermined limits as it is manufactured by said machine, a variable speed adjusting motor for regulating said variable speed drive to change the rate of speed at which said feed is operated, means responsive to the extent of said deviations in density for actuating said variable speed motor with a voltage having a magnitude proportional to the extent of said deviations in density, means for delaying the operating of said first named means each time for a period not less than the time it takes the material to travel from said feed to said detector before allowing a correction to be made, and a control for stopping the operation of said first named means from further increasing or decreasing the rate of feed whenever the deviation returns within said predetermined limits during the time the rate of feed is in the process of being increased or decreased by said device.

18. In a cigarette making machine of the type manufacturing cigarettes in a continuous rod form, a feed for feeding cigarette tobacco in a continuous stream to be formed into a continuous cigarette rod, a detector for detecting variations in the density of the continuous rod as it is being manufactured, said detector having an output voltage representative of said variations, a circuit for translating said output voltage into a signal for varying the speed of said feeder in response to variations in said signal from a predetermined norm, said circuit com-

prising means for averaging the variations of said output voltage over the length of at least one cigarette; a differentiating circuit for producing a second voltage proportional to the rate of change of said averaged electrical voltage, and an adding circuit for producing said signal voltage which is the algebraic sum of said averaged voltage and said differentiated voltage, whereby said feeder is varied in response to both the deviations in average cigarette density and the rate of change of said deviations.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 23,368	Grob et al.	May 22, 1951
1,703,280	Minorsky	Feb. 26, 1929
1,864,728	Hawkins et al.	June 28, 1932
2,000,593	Happel	May 7, 1935
2,163,415	Stephano	June 20, 1939
2,179,933	Heyer	Nov. 14, 1939
2,191,997	Side	Feb. 27, 1940
2,249,820	Gulliksen	July 22, 1941

2,322,373
2,337,132
2,357,860
2,374,652
2,407,866
2,416,595
2,460,199
2,516,768
2,519,089
2,535,027
2,535,930
2,576,772
2,609,448
2,654,864

15

587,210

20

Lowe	June 22, 1943
Shaw	Dec. 21, 1943
Whitaker	Sept. 12, 1944
Cohen	May 1, 1945
Bower	Sept. 17, 1946
Reynolds	Feb. 25, 1947
Taylor et al.	Jan. 25, 1949
Grob et al.	July 25, 1950
Whitaker	Aug. 15, 1950
Anderson	Dec. 26, 1950
Jones	Dec. 26, 1950
Bernet et al.	Nov. 27, 1951
Bedford et al.	Sept. 12, 1952
Tuck	Oct. 6, 1953

FOREIGN PATENTS

Great Britain	Apr. 17, 1947
---------------------	---------------

OTHER REFERENCES

Electronics Dictionary, by N. M. Cooke and J. Markus. First Edition. Published by McGraw-Hill Book Co., New York, N. Y., page 92. Copyright 1945.