

July 23, 1957

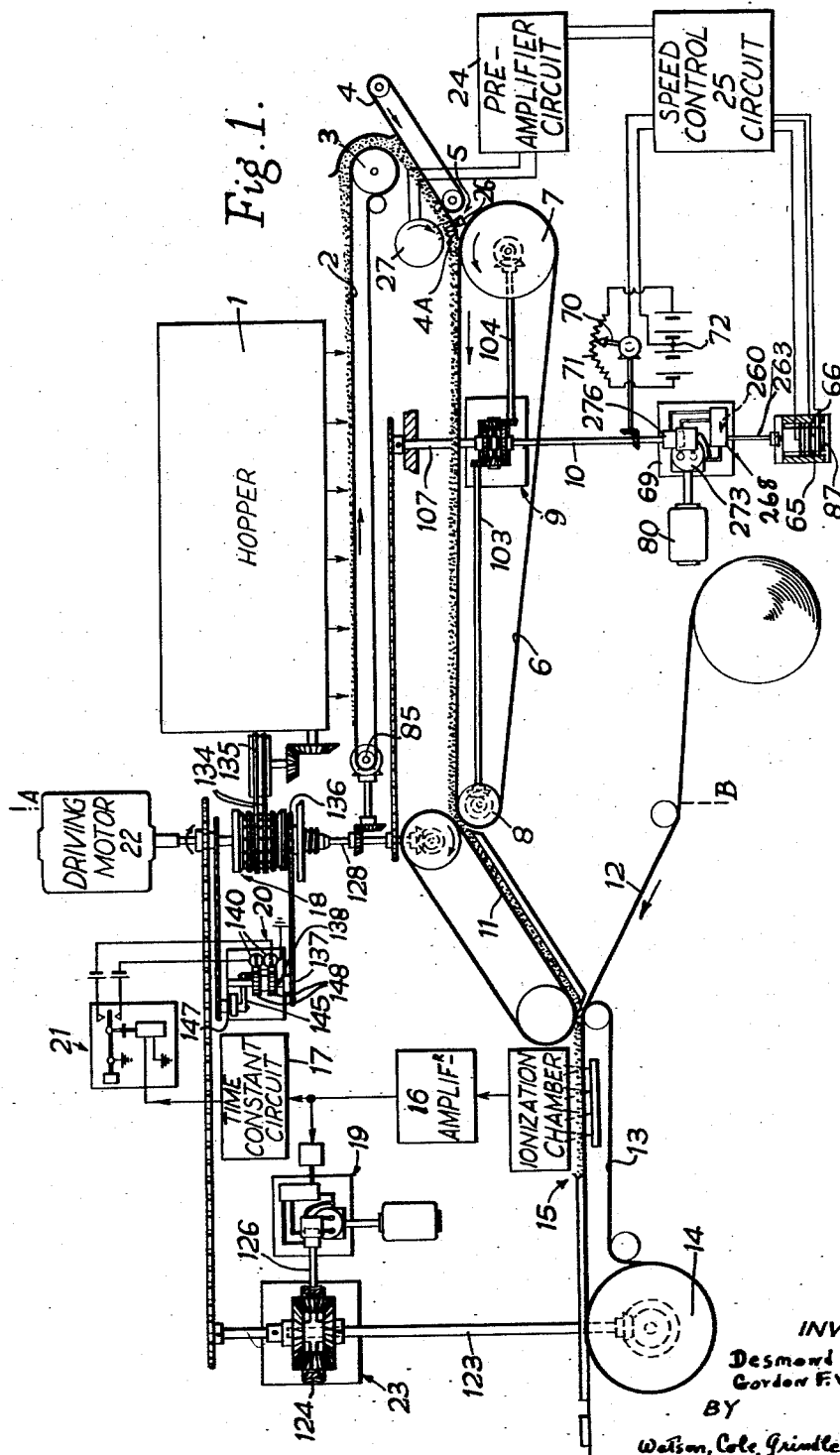
D. W. MOLINS ET AL.

2,800,131

MACHINES FOR MANIPULATING CUT TOBACCO

Filed March 15, 1954

6 Sheets-Sheet 1



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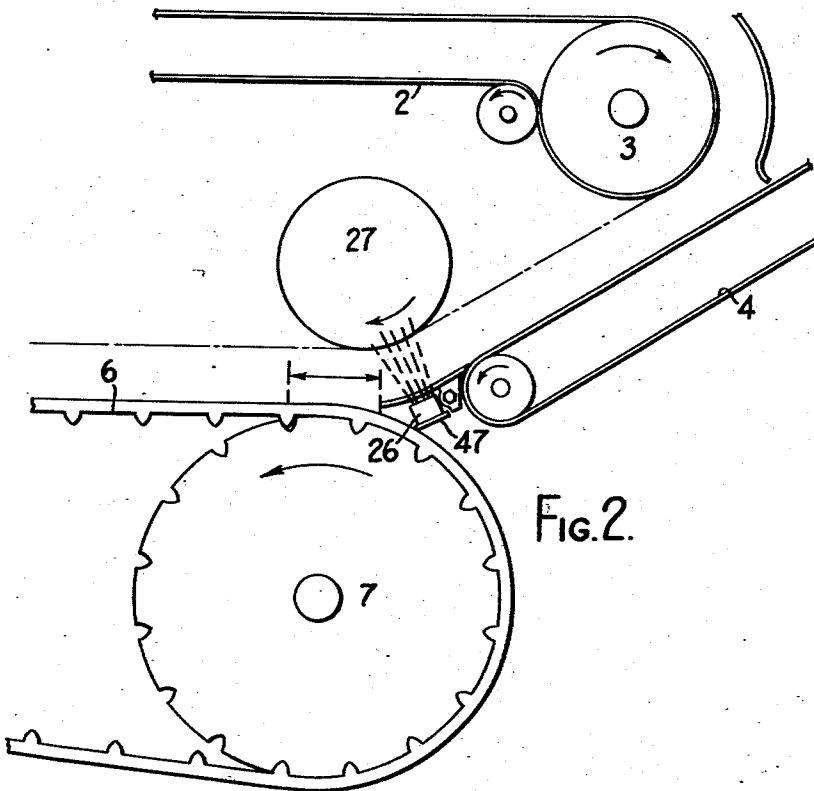
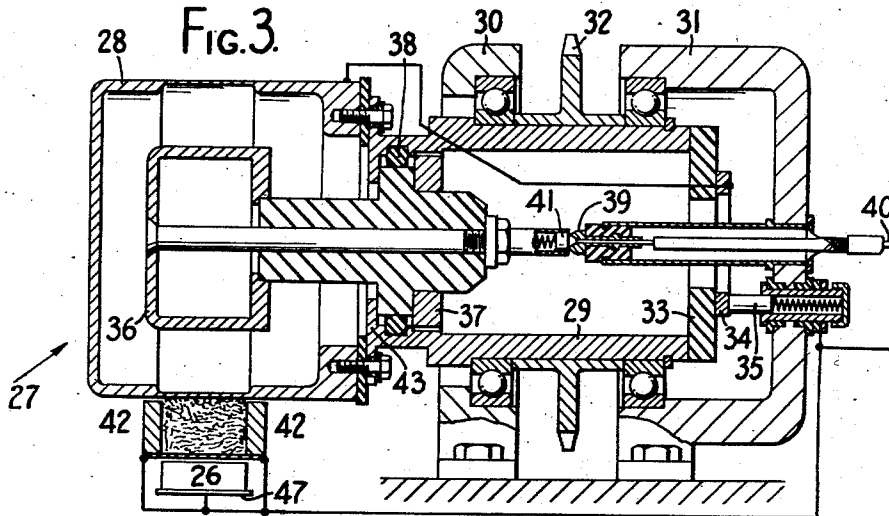
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6 Sheets-Sheet 2



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6 Sheets-Sheet 3

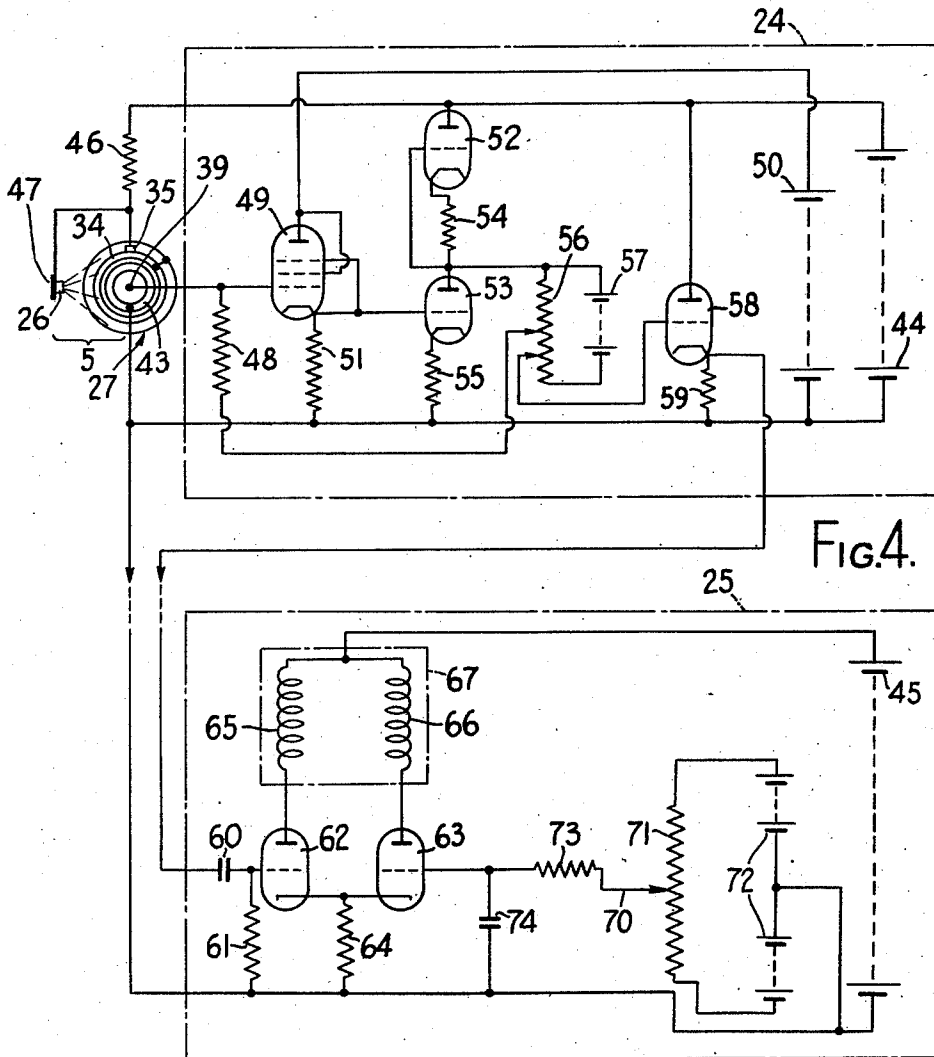
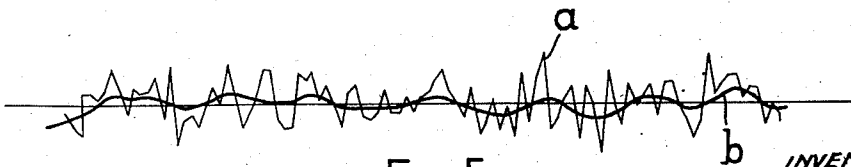


FIG. 4.

FIG. 5.



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Fig. 6.

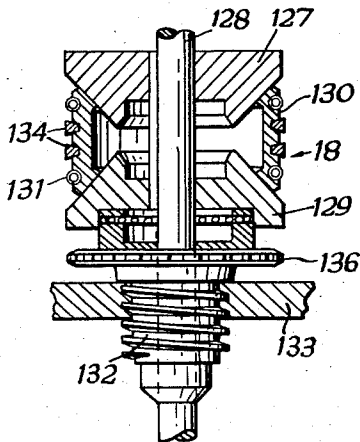


Fig. 7.

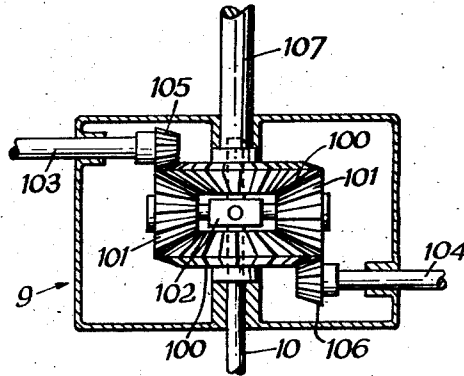


Fig. 8.

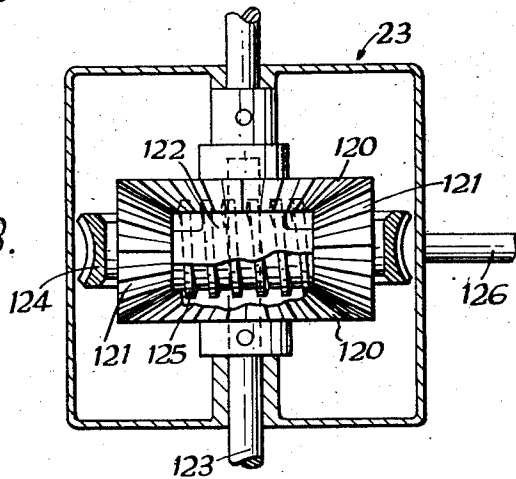
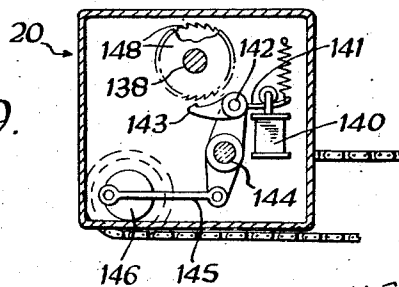


Fig. 9.



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Fig. 10.

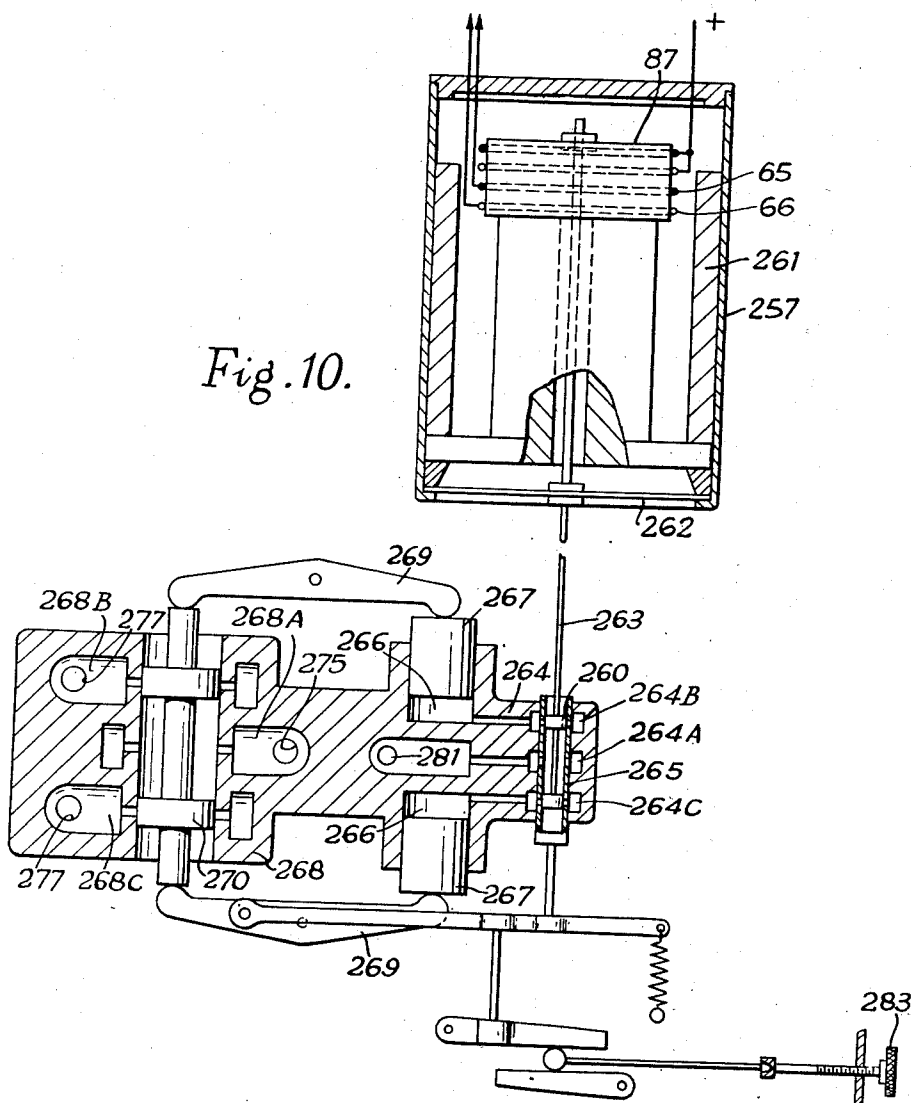


Fig. 11.

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MACHINES FOR MANIPULATING CUT TOBACCO

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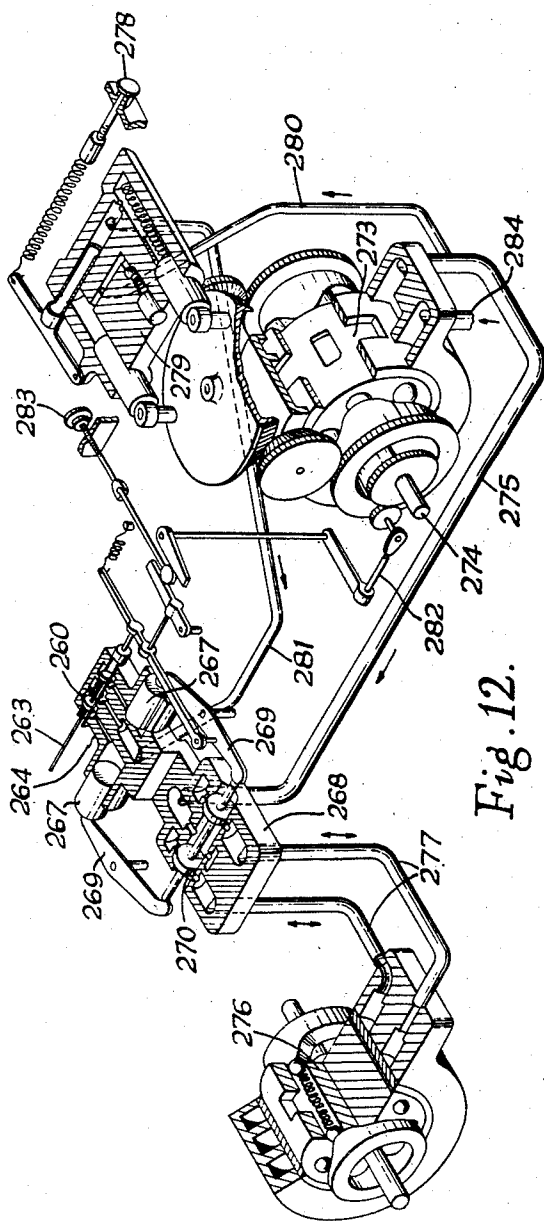


Fig. 12.

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MACHINES FOR MANIPULATING CUT TOBACCO

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Application March 15, 1954, Serial No. 416,374

Claims priority, application Great Britain March 16, 1953

14 Claims. (Cl. 131—21)

This invention concerns improvements in or relating to machines for manipulating cut tobacco, for example, cigarette making machines, and refers more particularly to the kind of machine wherein the mass of a length of moving tobacco filler is measured by a detector, for example, by subjecting the length to rays from a radioactive source of penetrative radiation, for example beta rays, the ionization powers of which are absorbed by the material in known proportion to its mass, and determining changes in the absorption with variations in the tobacco mass by an ionization chamber and applying the current due to the ionization to regulate at some stage in the machine the rate at which tobacco is being fed at that stage for the formation of the final product. Machines of this kind are hereafter called "machines of the kind referred to."

An example of such a machine is described in U. S. patent application Serial No. 304,412, filed August 14, 1952, and in that case regulation is effected by altering the speed of a conveyor which carries the tobacco filler. This kind of regulation is referred to herein as "conveyor speed control."

While the regulation as carried out by the apparatus described in said specification is very good it is desired further to improve the uniformity of the finished product, in the example described, cigarettes.

For brevity the term "ray device" will be used hereafter to mean "a radio-active source of penetrative radiation" and the term "source-gap-chamber" will mean a ray box and its associated parts, for adjustment, screening and shielding; the space between ray source and ionization chamber; and the ionization chamber and its associated parts for mounting and adjusting it. The three words source, gap, and chamber, will be used to refer to any separate item of the triple combination.

As will be seen later measuring and regulation are effected at two positions, or stages, in the machine. The idea of the two-stage method is, briefly, to keep the conveyor speed control substantially as described in U. S. patent application Serial No. 304,412 as a second-stage control to take care of the "longer-term irregularities" in mass (as hereafter defined) and, most particularly, to keep a very accurate control of the mean weight, and to have, in addition, a very quick-acting first-stage control to smooth out the unevenness of the hopper output or shower, that is to take care of "shorter-term irregularities," which term is also defined later.

According to the invention there is provided a machine of the kind referred to having means for improving the consistency of a filler, said means comprising an endless conveyor which receives a filler at one end and discharges it from the other end and whose linear speed at the discharging end is constant, means for feeding the filler to said conveyor, a detector responsive to variations in the mass of the filler being fed to said conveyor and means controlled by the detector to spread the filler on to the endless conveyor at the receiving end substantially in

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accordance with the detector responses, whereby irregularities in the filler are, at least partly, corrected.

Further according to the invention there is provided a machine of the kind referred to having means for improving the consistency of a filler, said means comprising an endless conveyor support on and geared to two driving pulleys, the pulley at the discharging end of the conveyor rotating at a uniform speed and the pulley at the receiving end rotating at a variable speed controlled by a detector responsive to variations in the mass of a filler being delivered to said receiving end, said conveyor being elastic so that parts of the conveyor extending between the pulleys can stretch to contract to accommodate changes in the speed of the pulley at the filler receiving end and the filler being fed to the conveyor on that part of the conveyor which is in contact with the surface of the pulley at the receiving end, and is thus neither stretched nor contracted, and on which it is spread in accordance with the speed of said part and later is discharged from said part on which it has been fed, when said part passes over the uniformly rotating pulley at the discharge end of the conveyor. The term "unstretched" means that no change is made in the normal tension existing in the belt, for naturally the belt is stretched to some extent when it is mounted on the pulleys, as is usual with belts. The filler may be delivered to said elastic conveyor from a hopper tape which collects a shower from a tobacco feed in the known manner.

The arrangements recited in the two preceding paragraphs are of particular value for smoothing-out short term (or high frequency) variations in a filler and further according to the invention the filler may be discharged from the elastic conveyor to a further conveyor having a detector associated therewith and regulating mechanism controlled thereby to effect conveyor speed control as herein defined.

Conveyor speed control is of particular value for correcting long-term irregularities in the filler.

Further according to the present invention there is provided a machine of the kind referred to comprising means for detecting shorter-term irregularities occurring in a moving filler during time periods not exceeding one second and manipulating the filler to, at least partly, correct them and means for detecting mean irregularities in the manipulated filler over time periods of at least three seconds and further manipulating the filler (e. g. by conveyor speed control) to, at least partly, correct them.

In all cases the detector may be a source-gap-chamber device as herein defined.

Other features of the invention will appear in the following description and are recited in the appended claims.

The invention will be more fully described with reference to the accompanying drawings in which:

Figure 1 is a diagram of a continuous rod cigarette making machine, showing the application of the invention thereto,

Figure 2 shows to a larger scale details of a pulley and conveyor shown in Figure 1,

Figure 3 is a longitudinal section of a source-gap-chamber device shown in Figure 1, and drawn to a larger scale,

Figure 4 is a circuit diagram of the connections between an ionization chamber and the coils of a magnetically operated valve positioning device,,

Figure 5 is a diagrammatic chart or graph having a thin line curve whose points of inflexion indicate the weights of a succession of weighed cigarettes and a thick line curve drawn by hand to show the general trend of weight variation, the graph being provided for the

purpose of explaining certain terms used in the specification,

Figure 6 is a sectional plan of a variable speed pulley shown in Figure 1 and drawn to a larger scale,

Figure 7 is a view, partly in section, of a differential gear shown in Figure 1 and drawn to a larger scale,

Figure 8 is a view, partly in section and partly broken away, of another differential gear shown in Figure 1 and drawn to a larger scale,

Figure 9 is a sectional elevation of a device shown in Figure 1 for adjusting the variable pulley of Figure 6, and drawn to a larger scale,

Figure 10 is a sectional view of a control valve shown in Figure 12 drawn to a larger scale and also showing an operating magnet,

Figure 11 is a plan of a spring shown in Figure 10, and

Figure 12 is a perspective view, partly in section, of a device known as an oil unit and shown diagrammatically in Figure 1.

Before proceeding with the detailed description of the drawings the meanings of the terms "longer-term irregularities" and "shorter-term irregularities" will be explained in some detail.

In machines of the kind referred to, tobacco is fed from a mass in a hopper by carded rollers and other contrivances and in view of the nature of the material and the available feeding devices there are inevitable variations and irregularities in the quantity of tobacco fed out of the hopper in a given time. The variations or fluctuations appear to be generally random. However, it appears that while over extremely long periods the total output may be roughly constant, there are in any such long period, times when the output is above a desired rate and times when it is below such rate. Similarly, if a shorter period is considered there are still times within this period when the rate is higher or lower than the desired rate. Further, however short the period considered may be, there seem to be comparatively sharp and relatively short-term deviations from what may be regarded as the general rate of output at any time. It will be seen then that if the output of, say, several seconds is considered, there may be a general change in output over such a period which can be called a longer-term variation while more rapid deviations within the period may be called shorter-term variations and, more generally stated, changes in any given period may be separated into "longer-term irregularities" and "shorter-term irregularities" respectively. These terms are used in the specification and claims and are to be considered as having these meanings.

The terms can be understood more easily from the diagram shown in Figure 5 in which *a* is representative of the sort of "curve" obtained when a succession of equal lengths of cigarette rod as made by a machine, are weighed individually and recorded consecutively as ordinates on a chart. The horizontal line shows the actual weight desired and each angle point in the "curve" *a* shows how far that particular length differs from the desired weight. The curve *b* is drawn by hand as near as may be, to show the trend of the weight deviation along the succession of weighings. Thus the curve *a* shows "shorter-term irregularities" while the curve *b* shows "longer-term irregularities." It must be understood that the curves have been drawn solely for the purpose of explaining the above terms and have no other significance.

Referring now to the remaining figures of the drawings 1, Figure 1, is the hopper of the machine, from which tobacco is showered in the usual way on to a hopper tape 2, which is arranged to run in the opposite direction to that usually employed. The tape 2 passes round a pulley 3 and delivers the collected shower or loose filler to a belt conveyor 4 which conveys the tobacco downwards as shown and delivers it over a thin curved guide plate 4A to a conveyor belt 6. At the lower end

of the conveyor 4 is a source-gap-chamber device 5 which is of special construction and will be described in detail later, with reference to Figure 3. It will be noted that the tobacco is received on the conveyor belt 6 at a position where the belt is supported by a pulley 7.

The belt 6 is of elastic material and is driven at the left-hand end of the figure by a pulley 8 running at constant speed and at the right-hand end by the pulley 7. These two pulleys, which are toothed in the manner shown in Figure 2, ensure that while the belt is in full engagement with the teeth, the linear speed of the belt is controlled, while the elastic belt itself allows of variation in the speed of the pulley 7 relatively to the pulley 8. The pulley 7 and belt 6 are shown in detail in Figure 2. The belt has teeth (e. g. metal teeth bonded to the belt) arranged on its inner side. The teeth are pointed and have involute flanks. The pulley is provided with correspondingly shaped grooves and it will be seen that the part of the belt which receives the filler is held on the pulley 7 and is therefore unstretched for the distance shown by the double-headed arrow. The upper and lower runs of the belt will frequently be stretched during operation, as explained more fully later, but as the stretch is not excessive, the points of the teeth will enter the grooves in the pulley, even when somewhat out of pitch, and so the belt readily mates with the pulley 7 although the lower run may be stretched. The spaces between the grooves on the pulley are, in effect, teeth and the pulleys have been referred to as toothed pulleys.

The action is as follows:

The pulley 7 is coupled with the front pulley 8 through a small differential gear 9. This differential gear is shown to a larger scale in Figure 7 and comprises sunwheels 100 and planet wheels 101, the latter being mounted on a planet arm 102 fixed to a shaft 10. The sunwheels 100 drive the pulleys 8 and 7 through shafts 103 and 104 respectively, said shafts being coupled to the sunwheels by bevel gear wheels 105 and 106 engaging teeth formed on the back of the respective sunwheels. The upper sunwheel, Figure 1, of the gear is fixed to a shaft 107 driven by chain gearing from the driving motor shaft and thus the drive to the pulley 8 is at unvarying speed. If planet carrier 102 is fixed in position, the pulley 7 is also driven at unvarying speed but by varying the speed of the input shaft 10 (that is, the planet control shaft) of the gear from zero in a positive or negative direction, the speed of the pulley 7 relatively to the front pulley 8 can be varied. As will appear later the speed of the pulley 7, at any instant, is determined by reactions from the source-gap-chamber device 5.

The tobacco filler on the elastic belt 6 is passed down a sloping passage 11, constructed and operating as described in U. S. Patent No. 2,671,452, issued March 3, 1953, and delivered to the cigarette paper web 12 which is moved by a garniture tape 13 driven by a tape drum 14, in the usual manner of continuous rod cigarette machines. The tape drum is driven from a differential gear 23 controlled by an oil unit 19 which is shown in detail in Figures 10 to 12 and described later. Another source-gap-chamber device is disposed at 15 and is of normal construction.

Referring particularly to Figure 1 of the drawing, it will be seen that conditions to the left of the vertical line A—B are the same as those described in U. S. patent application Serial No. 304,412 referred to earlier, except that the output from the amplifier and feed-back filter at 16 is taken to a long-time constant circuit at 17 to control (through an actuator 20, which itself is controlled by a relay unit 21, explained more fully later) a variable speed pulley drive 18 to the hopper 1, in addition to going to the variable speed oil unit 19. This scheme has already been proposed in the specification just mentioned and it is necessary because the existing differential gear in that specification can only change the

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speed of the machinery it drives by $\pm 10\%$ so that if the mean hopper output changes by, say, 10% heavy, then no shorter-term correction can be applied on the heavy side, as the limit of control will have been reached. A further consideration is that with the feed-back amplifier described in said specification any deviation from the mean is not completely brought back to the zero line but the deviation is reduced by a factor of

$$\frac{1}{1+K}$$

where K is the gain of the feed-back used; in that case about 25 is convenient, so that for a persistent mean error of the hopper of 10% the output mean error would be

$$\frac{10\%}{26} = 0.38\%$$

On the other hand the actuator 20 will continue to correct until the mean weight is returned to within preset limits and this ensures that the feed-back amplifier will deal with smaller variations from the mean, say 2% maximum, so the mean error would not exceed

$$\frac{2\%}{26} = 0.077\%$$

Further by this means the output in cigarettes per minute is kept very nearly constant. The time-constant of this overriding correction is long compared with the "integral" time constant of the feed-back amplifier and the rate of correction small to ensure that they do not conflict with one another.

The machine is driven by a motor 22 which is shown as coupled to the differential gear 23 by chain gearing and to the hopper tape 2 by toothed gears engaging the left-hand pulley 85 which, together with the pulley 3, supports the hopper tape 2. The differential gear 23 is best seen in Figure 8 and comprises sunwheels 120 and planet wheels 121 mounted on a planet carrier 122 rotatable on a shaft 123 which drives the tape drum 14 through bevel gear wheels. The planet carrier and planet wheel assembly are carried by a cage having a wormwheel 124 formed on its exterior and this is driven from the oil unit 19, Figure 1, by a worm 125 fixed to a shaft 126.

The variable speed pulley 18, shown in detail in Figure 6, is of well known construction comprising a cone 127 fixed to a shaft 128 which is illustrated in Figure 1 as an extension of the shaft of the motor 22. Another cone 129 is slidable on a spline on the shaft 128 and between the cones are a number of segments 130 which can slide in grooves (not shown) in the cones as the latter move toward and away from one another, and are held to the cones by spring rings 131. The movable cone is moved by a screw 132 working in a nut formed in a frame member 133. Belts 134 couple the variable speed pulley to a pulley 135, Figure 1, which drives the hopper through the bevel gear wheels shown. The screw 132 is rotated in either direction by a sprocket wheel 136 integral therewith. This sprocket wheel is connected by a chain to another sprocket wheel 137, Figure 1, fixed to a shaft 138 of an actuator 20 now to be described.

Referring mainly to Figure 9, the actuator, which is a well known device, consists of a pair of solenoids 140 whose plungers are connected each to one arm 141 of two double-armed levers which are pivoted at 142. The other arm of each of said double-armed levers is formed as a pawl 143.

The two double-armed levers are pivoted at 142 on a further double-armed lever pivoted at 144 and whose lower end is coupled to a connecting rod 145 driven by a crank disc 146. As shown in Figure 1 the disc is on a crankshaft 147 driven by chain gearing from the shaft 128 of the motor 22 so that while the machine is working both pawls are in continuous oscillation. Above

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the pawls are two ratchet wheels 148 with oppositely directed teeth so that if one pawl is caused to engage its ratchet wheel, the shaft 138 will be turned one way, while if the other pawl is caused to engage its ratchet wheel, the shaft 138 will be turned in the opposite direction. Pawl engagement is caused by energization of a solenoid 140 which pulls down the lever arm 141 against a spring.

Referring now to the right-hand side of the vertical line A—B, Figure 1, the measurement in the source-gap-chamber 5 is effected on a very short length of filler and the measurement of ionization current is performed in a simple manner, as explained later when the circuits are described as compared with the use of the vibrating reed electrometer for the second stage and as in U. S. patent application Serial No. 304,412.

Only the irregular components of this measurement are used, that is, no attempt is made to control the mean output at this point but the measurement is used only to reduce the shorter-term irregularities in the tobacco stream, that is, irregularities akin to those of the thin curve of Figure 5. The filter networks of the two stages are so chosen that at the frequencies where the first measurement leaves off, the second takes over and the actuator 20 controlling the hopper speed deals only with the persistent mean drifts, that is, changes akin to those shown by the thick line curve of Figure 5. The above described actuator 20 is similar to that described in U. S. patent application Serial No. 303,636, filed August 11, 1952, but is briefly described later and the solenoid operation is controlled from the relay unit 21 consisting of a limit relay switch with close limits, the unit itself being under control of the time-constant device 17. The whole system is intended to cover variations from zero frequency to a high frequency, limited mainly by random source emission, variation in the packing of the filler, and the length of the first source-gap-chamber combination.

The remaining items in Figure 1 will be described together with Figures 3 and 4 because some items of the circuit are subject to mechanical control and are indicated both in Figures 1 and 3 and some electrical items operate on mechanical contrivances and are therefore shown in both figures. In Figure 1 the box marked 24 contains the circuit elements shown in the top part of Figure 4, where the box is shown in chain lines. The enclosed apparatus is termed the pre-amplifier. The lower box 25 in both figures contains the circuit elements for the speed control stage.

For the source-gap-chamber device 5 the source 26 is located as close as possible to the delivery point of the tobacco on to the belt 6 and is very short, and the ionization chamber of the combination, which chamber is generally represented by the reference 27 is constructed in pulley form with a rim of approximately 0.010" thickness for the width of the tobacco stream. The chamber section can be seen in Figure 3, where it will also be seen that the outer part 28 of the chamber is fixed to a long hollow hub 29 running in ball races in housings 30 and 31. A sprocket wheel 32 is fixed to the hub, whereby the chamber is rotated at the required speed. An insulating ring 33, fixed at one end of the hub carries a slip ring 34 contacted by a brush 35 to apply the polarizing voltage to the outer part 28 of the chamber. The inner part 36 of the chamber is clamped to the part 28 by a nut 37 with a sealing ring 38 between the parts. Contact is made to the rotating part 36 by a contact 39 at the end of the signal cable 40, the contact engaging a spring-pressed stud 41. The end of the hub is shaped to form the guard ring 43 of the chamber and is thus grounded through the hub, bearings and housings. Side guides 42 for the tobacco filler are also shown.

Referring now to the upper part of Figure 4 the polarizing voltage for the rotary chamber is fed from a battery 44 through a current limiting resistor 46 and this same

potential is applied to the source mounting plate 47 and the adjacent guides 42, Figure 3, to prevent a potential difference across the tobacco stream.

The ionization chamber collector electrode 36 is connected through the contact 39 to the upper end of an input resistor 48, and to the grid of the electrometer tube 49 shown operating as a triode-connected cathode follower and with its anode voltage supplied from a battery 50, the tube circuit being completed by a cathode resistor 51.

The output from the tube 49, is applied to the series-connected triodes 52 and 53 provided with cathode resistors 54 and 55 and forming a stable and linear amplification stage with a gain of approximately half the amplification factor of the individual tubes. The output of this stage is taken from the anode of the tube 53 and applied to the upper end of a resistor 56 and the positive terminal of a battery 57. The upper slider of the resistor 56 provides a voltage which is negative relative to the anode of the tube 53 and which is applied to the lower end of the input resistor 48, the whole circuit from the upper end of resistor 48, through 49, the series amplifier formed by tubes 52 and 53 and through resistor 56 forming a loop with considerable gain, connected so as to degenerate the capacitance across the input signal cable and to provide the shortest possible measuring time-constant compatible with the source random emission and the arrangement of the loose tobacco in the tobacco stream. The upper sliding contact on resistor 56 is so adjusted that with an ionization current resulting from the desired mean weight of tobacco stream, flowing in the high value resistor 48, the resultant potential applied to the grid of the electrometer tube 49 is sufficiently negative for optimum conditions. The lower slider of the resistor 56 is connected to the grid of a tube 58 which, with a resistor 59, forms a cathode-follower stage to give an output which is a faithful copy of the input, but with a low impedance, for connection to the circuit elements in the speed control stage box 25, which may be located some distance away.

The output signal from the tube 58 is connected through a resistance-capacity coupling of long-time constant provided by a capacitor 60 and a resistor 61 to the grid of a tube 62 which, with a tube 63, forms a common cathode amplifier with a cathode resistor 64.

In the anode circuit of the tubes 62 and 63, which are supplied with anode voltage from a battery 45, are coils 65, 66 which are wound on a moving coil element 87 which operates as a valve positioning device, Figures 1 and 10. These coils are connected to form a differential linear-movement solenoid device of known kind, which is illustrated in Figure 10 and described below, and provided with a permanent magnet field and arranged so that with equal current in both coils there is no resultant force on the coil assembly. The coil assembly itself is provided with a positioning spring spider 262, Figure 13, described below, with linear deflection force characteristics, which accurately positions the moving coil element at all times.

When the current through the tube 62 increases, the current through the tube 63 decreases, and the resultant out-of-balance force between the two coils 65-66 causes an axial movement of the assembly which continues until the spring spider exerts an equal and opposite force.

When the current through the tube 62 decreases, the current through the tube 63 increases, and an axial movement is obtained in the opposite direction.

The differential solenoid device has its moving coil element 87 coupled to a valve, which valve constitutes the sensitive valve of another oil unit 69. This unit is the same as the oil unit 19, previously referred to, and the construction of the oil unit 69 will now be described with reference to Figures 10 and 12, this description also serving for the oil unit 19. The unit consists of a high pressure oil pump 273 and a sensitive valve 260 which controls the feed of oil to an oil motor 276 and determines its direction and speed of rotation, the speed

being approximately proportional to the displacement of the sensitive valve 260. This valve body is diagrammatically indicated in Figure 1 by a rectangle marked 268. This valve is coupled by a rod 263 to the moving coil element 87, on which is wound the differential coil winding 65, 66, and which is movable in a magnetic field provided by a permanent magnet 261. The center stable spring spider 262, referred to previously, is thus subjected to a force proportional to, and in a direction depending on the relative currents in the coils 65 and 66. The valve 260 is formed as a piston valve working in a sleeve 265 having three ports. This sleeve vibrates in a valve body 264 also having three ports 264A, 264B and 264C, the outer ones 264B and 264C leading to cylinders 266 with pistons 267. Oil supplied through a pipe 281 to the middle port 264A can go into either of the outer ports depending on the position of the sensitive valve, and the corresponding piston 267 is moved outward. The sleeve 265 is called a "ditherer" and it is oscillated or vibrated by an eccentric rod 282, Figure 12, so as to ensure that at all times the ports are freely lubricated, for if the sensitive valve remained in one position for a long time, it might not move quite freely under the impulse of the magnet and it is important that this valve should follow magnetic movements without hesitation. Adjustment of the dithering movement from rod 282 is by a screw 283. The pistons 267 operate pivoted levers 269 which press on the main valve 270 and determine its position in the main valve body 268. The main valve body 268 has three outlets 268A, 268B and 268C, the outer ones 268B and 268C leading to the oil motor 276, Figure 12, and the middle one 268A receiving oil from the oil pump 273, as will be explained with reference to Figure 12. The oil unit is driven, as shown in Figure 1, by an electric motor 80 and this runs all the time the machine is working. Thus the oil unit pump continuously pumps oil through a pipe 275 to the main valve body 268 previously described with reference to Figure 10, from which oil to the oil motor 276 is fed through pipes 277. One pipe is the feed and one the exhaust, according to the position of the main valve 270. Oil coming back through the exhaust pipe drops out of the valve body 268 into a sump (not shown) formed in the casing of the unit and oil from the sump is sucked up by the oil pump 273 through a pipe 284. The main valve has its position controlled by the moving coil element 87, as previously described with reference to Figure 10, and consequently the movements of the oil motor 276 depend entirely on the position of the sensitive valve 260 which position is controlled by the element 87. The shaft of the oil motor is integral with or directly coupled to the planet control shaft 10 of the differential gear 9. An adjustment is provided at 278 for the pressure of the oil in the system by regulation of a pressure controller 279 which receives oil from a by-pass 280 from the main oil supply pipe 275.

This oil unit is a known contrivance and has been largely used for the control of gunnery, particularly for anti-aircraft guns, and it has the virtue that the oil motor movements correspond very accurately indeed with the position of the sensitive valve 260, and that there is no appreciable lag in the whole system.

Thus it will be apparent that the speed of the pulley 7 depends on the output from the ionization chamber 27 and changes with alterations in said output.

If the balance of the currents in the coils 65, 66 is upset by an input signal, the output shaft 10 rotates at a speed proportional to the input signal and in a direction depending on the polarity of the signal.

The conveyor belt 6 is, as previously mentioned, of an elastic nature, thus permitting relative peripheral speed changes of the pulleys 7 and 8. The permissible total of relative movement while ample for the purpose

is, however, limited and it is essential that the output shaft 10 of the oil motor, irrespective of its instantaneous velocity does not make more than a limited number of revolutions from a mean datum. Such an event might occur if there were a small change in the output sensitive valve position-characteristics, or a change in the characteristics of tubes 62 and 63.

To ensure that this excessive movement cannot happen, the output shaft of the oil motor of the coil unit 69 is coupled, as shown in Figure 1, to the arm 70 of a rotary potentiometer 71, the ends of which are connected to a source 72 of medium voltage. In the circuit diagram, Figure 4, the potentiometer and its arm are shown only diagrammatically, that is, not as a rotary device. Connections are taken from the centre tap of the source 72 of E. M. F. and from the arm 70 of the potentiometer 71. The voltage appearing across these leads will be dependent for magnitude and polarity on the amount of rotation of the output shaft 10 from its desired mean position. These leads are taken to an integrating circuit formed by a resistor 73 and a capacitor 74 and from the output of this circuit to the control grid of the tube 63.

Consider now the action of the device. Variations from the desired mass of the tobacco stream cause variations in the ionization current in resistor 48 and variations in the grid potential of the tube 49. The presence of the amplifier loop formed by the connection from the slider of the resistor 56 to the lower end of resistor 48 causes less variation in the grid potential of 49 for a given ionization current than would otherwise be the case, and as previously stated, effectively reduces the time-constant of the measuring circuit. The resulting output signal is fed through the tube 58 to the resistance-capacity coupling 60, 61, which due to its long time-constant passes to the control grid of the tube 62 all the oscillating components of the deviation signal with which we are concerned but attenuates and modifies the lower frequencies due to any changes in the mean mass of the tobacco stream, these changes being substantially corrected later in the second stage corrector. In other words the devices just described do not respond effectively to a change in the mean.

Consider for the moment that the grid of the tube 63 is at earth potential, then the variation signals arriving at the grid of the tube 62 cause variations in the anode current and approximately equal but opposite variations in the anode current of tube 63. These out-of-balance currents flowing through the coils 65, 66 of the solenoid positioning device 67 cause a change in the position of the sensitive valve in the casing 68 with a resulting rotation of the oil motor with a velocity proportional to amplitude of the deviation signal. The output shaft 10 of the oil motor is as aforesaid coupled to the differential gear 9 and increases or decreases the peripheral velocity of the belt pulley 7, on to which the tobacco stream is fed. The connections and proportions are made so that should the tobacco stream for a short instance become, say, 10% heavy then the peripheral speed of the pulley 7 is increased by 10% so that the spreading of the tobacco on the unstretched piece of belt on top of the pulley remains as near as practicable to the desired uniformity; and vice versa.

Returning now to the grid circuit of tube 63, any movement of the oil motor shaft from its desired neutral position causes a voltage to be applied to the integrator circuit 73, 74, but this is arranged with a long time-constant so that the voltage applied to the grid of the tube 63 from the upper end of capacitor 74, and which is arranged to return the output shaft of the oil motor towards its neutral position, rises so slowly that it does not interfere with the excursions of the oil motor output shaft but ensures that should the output shaft tend to remain away from its neutral position for longer periods than are desirable then it is urged to return towards its neutral position.

The elastic belt 6 may be of any suitable material. If rubber is objectionable to any users a suitable plastic may be used.

It will be appreciated that the expressions longer-term and shorter-term irregularities are to be considered as limited to irregularities occurring over periods of time which can both be measured and dealt with by the machine. For instance, in the specific example the longer-term irregularity is corrected by altering the speed of the paper web.

In dealing with these errors they are treated as if they were sinusoidal, irrespective of their actual nature. Every effort is made to reduce the measurement lags and time-constants of the measuring devices but in the particular apparatus described no improvement is really noticeable until the longer-term error has a period of the order of three seconds.

The purpose of the first stage measuring and correcting device is to improve the uniformity of the filler in respect of shorter-term errors, without materially interfering with the functioning of the second stage measurement control and no attempt is made in the first stage to deal with variations in the mean hopper errors or the longer-term errors which are dealt with later by the second stage.

The construction described in the example for dealing with the shorter-term irregularities is capable of effecting an improvement for periods down to less than one second.

The period, as has been stated above, depends upon the measuring time-constant and the response of the oil unit, and accordingly any apparatus made according to the principles outlined above will depend upon the equipment which is available for obtaining higher speeds of response and, of course, the random emission of the source itself and the packing of the tobacco.

However, it will be appreciated that the invention is not limited to periods shown in the specific example, but to any longer and shorter periods which can be handled by a machine. Thus the corrections are made in two stages, one stage in which a detection is made in one kind of error alone, independently of any other error upon which it is superimposed (that is to say a longer-term irregularity or error) and in a second stage a device is used to measure the filler or the tobacco stream after it has been detected by the first detector and given a correction, and irregularities over a longer period are then measured and an adjustment made in the machine to attempt to correct longer-term errors so measured.

What we claim as our invention and desire to secure by Letters Patent is:

1. A machine of the kind referred to having means for improving the consistency of a filler, said means comprising an endless conveyor which receives a filler at one end and discharges it from the other end and whose linear speed at the discharging end is constant, means for feeding the filler to said conveyor, a detector responsive to variations in the mass of the filler being fed to said conveyor and means controlled by the detector to spread the filler onto the endless conveyor at the receiving end substantially in accordance with the detector responses, whereby irregularities in the filler are, at least partly, corrected.

2. A machine of the kind referred to having means for improving the consistency of a filler, said means comprising an endless conveyor and means for feeding said filler thereto, two pulleys for supporting said conveyor and both geared thereto, the pulley at the discharging end of the conveyor rotating at a uniform speed and the pulley at the receiving end rotating at a variable speed, a detector responsive to variations in the mass of a filler being fed to said receiving end, and adapted to control the speed of the pulley at the receiving end, said conveyor being elastic so that the parts of the conveyor extending between the pulleys can stretch and contract to accommodate changes in the speed of the pulley at the filler receiving end and the filler being fed to the conveyor on that part of

the conveyor which is in contact with the surface of the pulley at the receiving end, and is thus neither stretched nor contracted, and on which it is spread in accordance with the speed of said part and later is discharged from said part on which it has been fed, when said part passes over the uniformly rotating pulley at the discharging end of the conveyor.

3. A machine as claimed in claim 2 comprising a tobacco hopper and means for showering tobacco, a hopper tape to collect said shower and form a filler and deliver said filler to said elastic conveyor.

4. A machine as claimed in claim 2 comprising a further conveyor to which the filler is discharged from the elastic conveyor, said further conveyor having associated therewith a detector responsive to variations in the mass of said filler and regulating mechanism controlled by said detector to vary the speed of said further conveyor substantially in accordance with the detector response.

5. A machine as claimed in claim 3 comprising a further conveyor to which the filler is discharged from the elastic conveyor, said further conveyor having associated therewith a detector responsive to variations in the mass of said filler, and regulating mechanism controlled by said detector to vary the speed of said further conveyor substantially in accordance with the detector responses.

6. A machine of the kind referred to comprising means for detecting irregularities occurring in a moving filler during time periods not exceeding one second and manipulating the filler to, at least partly, correct them and means for detecting mean irregularities in the manipulated filler over time periods of at least three seconds and further manipulating the filler to, at least partly, correct them.

7. A machine of the kind referred to comprising an endless conveyor and means for delivering a filler thereto, a detector for detecting irregularities occurring during time periods not exceeding one second in said filler as it is being delivered to said conveyor and means controlled by the detector to spread the filler as it is received on said conveyor substantially in accordance with the detector responses, whereby said irregularities in the filler are, at least partly, corrected, a further conveyor to which said filler is discharged by the first said conveyor, said further conveyor having a detector associated therewith for detecting mean irregularities in said discharged filler over time periods of at least three seconds and means for controlling the speed of said further conveyor to spread the discharged filler on the further conveyor substantially in accordance with responses from the detector associated with said further conveyor whereby the said mean irregularities in the said discharged filler are, at least partly, corrected.

8. A machine as claimed in claim 6 having a tobacco hopper and means for feeding and showering tobacco therefrom, a hopper tape to collect said shower and form said moving filler and means for regulating the speed of

the tobacco feeding means when the output thereof varies above or below a given tolerance.

9. A machine as claimed in claim 4, having a tobacco hopper and means for feeding and showering tobacco therefrom, a hopper tape to collect said shower and form said filler and comprising means controlled by the detector associated with said further conveyor for regulating the speed of the tobacco feeding means when the output thereof varies above or below a given tolerance.

10. A machine as claimed in claim 9 having driving mechanism for the pulleys of the elastic conveyor, a differential gear in said driving mechanism, an oil unit comprising an oil driven motor whose shaft is connected to the planet carrier of said differential gear, a valve controlling oil flow in said oil unit and controlled by the detector associated with the elastic conveyor.

11. A machine as claimed in claim 10 comprising a device for controlling the movements of said valve, said device being geared to the shaft of the oil motor whereby excessive rotation of said shaft in one direction is restrained and the valve is operated to urge the shaft to return toward its neutral position.

12. A machine as claimed in claim 1 wherein the detector comprises a radio-active source of penetrative radiation and a ray responsive device, and said filler is moved between said source and said device.

13. A machine as claimed in claim 7 wherein the detector comprises a radio-active source of penetrative radiation and an ionization chamber, said chamber comprising a rotatable hollow member having a circular periphery forming the outer electrode of the chamber and adapted to coact with and guide the filler being detected, an inner rotatable electrode within said hollow member, and means for effecting electrical connections with the rotating electrodes of the chamber.

14. A machine of the kind referred to comprising means for detecting irregularities occurring in a moving filler during time periods not exceeding one second and manipulating the filler to, at least partly, correct them, a conveyor to receive said manipulated filler and means for discharging said filler thereto, a detector associated with said conveyor for detecting mean irregularities in the manipulated filler over time periods of at least three seconds and regulating mechanism controlled by said detector to vary the speed of said conveyor substantially in accordance with the responses of the detector associated therewith.

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