April 7, 1970 W. B. LOWMAN 3,504,679

CONTROL SYSTEM FOR A CIGARETTE-MAKING MACHINE

Filed June 8, 1960 2 Sheets-Sheet 1

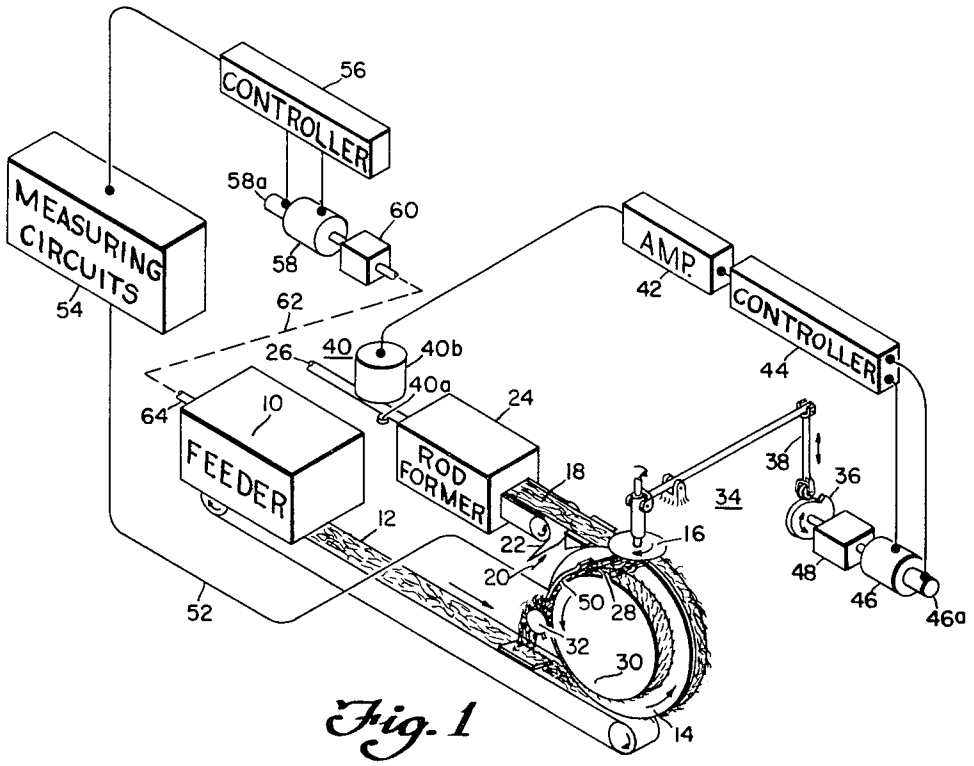

Fig. 1

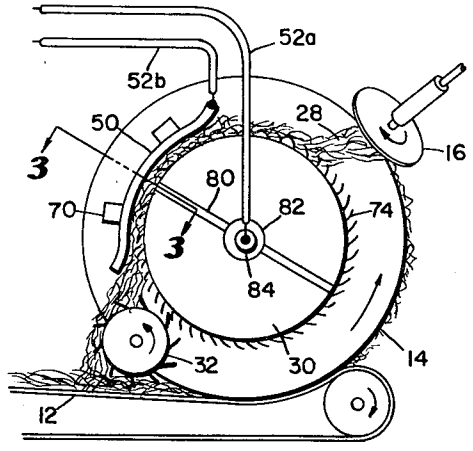

Fig. 2

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Filed June 8, 1960 2 Sheets-Sheet 2

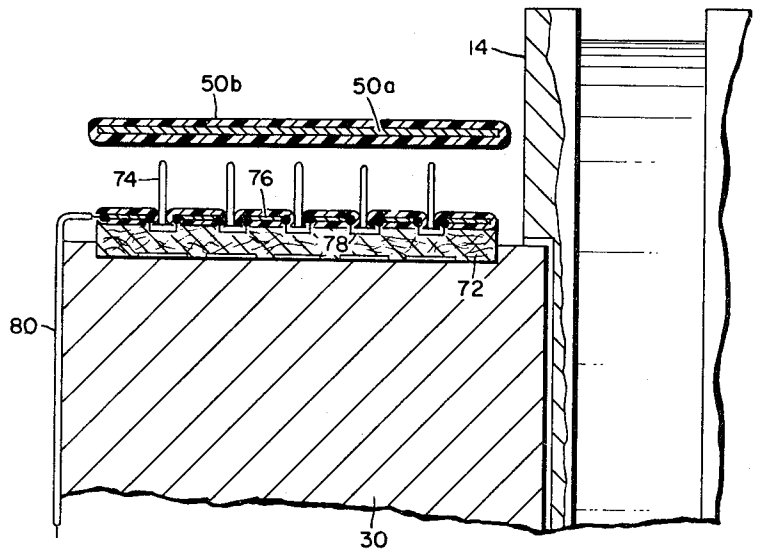

Fig. 3

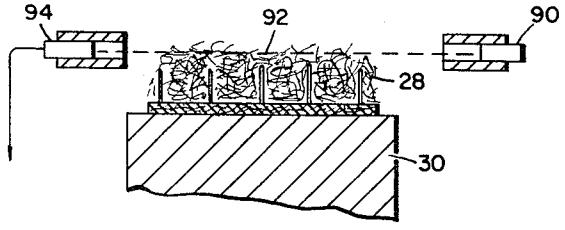

Fig. 4

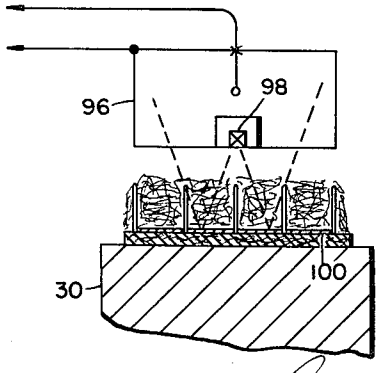

Fig. 5

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CONTROL SYSTEM FOR A CIGARETTE-MAKING MACHINE

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Int. Cl. A24c 5/34

U.S. Cl. 131—21

3 Claims

This invention relates to cigarette manufacture, and more particularly it relates to improvements in a system for automatically controlling the weight per unit length of the cigarette rod formed by a continuous cigarette-making machine.

In a relatively new type of cigarette-making machine, a stream of tobacco is delivered to a point near the entrance of the cigarette rod forming apparatus. The weight per unit length of said stream is arranged to be somewhat in excess of the desired weight per unit length of the tobacco filler within the wrapped cigarette rod. Specifically, the excess is desirably large enough to encompass all the unavoidable variations which occur as the stream is being formed from cut tobacco. Thereupon, at the point aforesaid, the excess tobacco in the stream is removed. In a preferred type of removal device, removal of the excess is effected by a rotating knife which slices off the top layer of the stream, and in theory thereby removes most of the lumps, bunches and other irregularities in the stream which would otherwise appear in the finished cigarette rod. Means are provided for adjusting the depth of the knife relative to the channel which carries the stream, and it has been proposed that the knife position be automatically controlled in response to measurements of the cigarette rod.

The knife position control device aforesaid, on a machine of the type described, has an inherent theoretical advantage over the conventional feeder control systems now in use. This advantage obtains by reason of the short transportation delay, that is, the time required for the stream leveled by the knife to be formed into the cigarette rod and measured by the gauge. However, the theoretically possible improvements in cigarette quality have not been achieved in practice.

In retrospect, it is now known that much of the difficulty previously encountered was the result of non-uniformity of the feed. Previously, the operation of the tobacco feed mechanism, which determines the rate at which the tobacco was fed to the stream, was regulated to some extent by utilizing limit switches actuated on overtravel of the knife position adjusting mechanism. Thus when the knife adjustment reached a point near the limit of travel, an incremental increase or decrease in the speed of the tobacco feed mechanism would result.

In accordance with his invention it has been found that the effectiveness of the knife control is much more dependent on slight variations in the tobacco feed than had heretofore been realized. That is to say, it appears that there is an optimum value of the weight per unit length of the tobacco stream which is presented to the equalizer knife for leveling thereby. Moreover, this optimum value is subject to variation depending on the individual machine and the physical characteristics of the tobacco to be processed.

Further in accordance with this invention it has been found that the return flow of the aforesaid excess tobacco removed from the main stream is a useful indicator of the performance of the tobacco feed mechanism. This is particularly true in the case of one previously known type of cigarette-making machine more fully described hereinafter, wherein the excess stream of tobacco is returned forthwith by conventional means to the primary stream

which has been metered out by the feed mechanism. Hence I provide an automatic feed control system responsive to direct measurements of the return flow of tobacco. As one feature thereof, the invention provides novel gauge arrangements for measuring the flow of tobacco caried by a carded drum.

The feed control device is utilized as one stage in an overall cigarette maker control system which also includes means responsive to the weight per unit length of the cigarette rod for controlling the position of the knife. The knife control is designed to operate with a high velocity constant, taking full advantage of the short transportation delay to level out the short term variations in the stream, whereas the feed control maintains the unleveled stream at an optimum value of weight per unit length such that the knife control is enabled to operate in its most effective range. Because the tobacco cut off by the knife is recirculated by adding it to the stream of tobacco supplied from the feed mechanism, any persistant variation in this stream from the feed mechanism is amplified. That is, any excess supply keeps accumulating, and any shortage accumulates until there is virtually no tobacco in the return flow. Since small errors in the feed mechanism cause a large cumulative error in the return flow, no great accuracy or stability is required of the measuring device for the return flow, which can be of a type which is simple, inexpensive and capable of installation with a minimum of modification of a cigarette-making machine.

Therefore, it is the object of this invention to provide a new and improved control system for cigarette-making machines whereby short term variations as well as mean value variations in the weight per unit length of the cigarette rod are substantially reduced.

It is also an object to provide, in combination with a machine for forming a stream of tobacco and a device for removing a variable portion of said stream, a control system including means for automatically adjusting said removal means to maintain the remainder of said stream at a substantially constant weight, and means for automatically adjusting said stream forming means whereby the stream is continuously adapted to be operated on by said removal means in the most effective manner.

It is another object to provide novel means for measuring the flow of cut tobacco on a carded drum.

It is still another object to provide, in cigarette-making apparatus having means for forming a tobacco stream, means for removing the excess in said stream and means for forming the remainder of said stream into a cigarette rod, an improved system for automatically controlling the stream forming means in accordance with direct measurements of said excess.

Further objects and advantages will become apparent in the following detailed description of one preferred embodiment of the invention, taken in connection with the appended drawings, in which:

FIG. 1 is a simplified schematic showing of a cigarette-making apparatus having a control system in accordance with the invention.

FIG. 2 is a more detailed showing, in elevation, of a portion of the apparatus of FIG. 1.

FIG. 3 is a fragmentary sectional view taken on the line 3–3 of FIG. 2.

FIG. 4 is a fragmentary sectional view showing how another type of measuring device may be adapted for use in the control system of FIG. 1.

FIG. 5 is a fragmentary sectional view showing how still another measuring device may be adapted for use in the system of FIG. 1.

Referring now to the drawings, FIG. 1 is a simplified schematic showing of a specific type of cigarette-making machine, for example, a machine such as the "Garant"

Twin Rod Spiral Machine which is manufactured by Hauni Werke Korbe & Company, KG., Hamburg, Germany. Herein the numeral **10** indicates a conventional feed mechanism which showers cut tobacco onto a horizontal belt **12** passing under a first drum **14** having a peripheral groove (no shown).

The tobacco on belt **12** is pressed into the groove in drum **14** and retained therein by partial vacuum, supplied through the hollow interior of the drum. The tobacco stream is carried over the drum and under a rotating equalizer knife **16**. The leveled tobacco stream **18** is then transferred to the usual traveling paper web **20** and carried thereon by the usual tube belt **22** into the rod former **24** which forms the cigarette rod **26**.

The excess tobacco **28**, including most of the bunches and irregularities in the tobacco stream carried over drum **14**, is received by a second, carded drum **30** rotating in the same direction as drum **14** but at a different speed. A picker roller **32** coacting with drum **30** removes the tobacco **28** therefrom, and the same is forthwith returned to belt **12** to merge with the tobacco supplied from the feeder **10**.

The equalizer knife **16** is adjustable through a distance of about one millimeter toward and away from the drum **14** through a lever system **34** including a cam **36** and follower **38** device. In accordance with this invention the position of the cam **36** is continuously readjusted by a measuring and feedback control system comprising a suitable gauge transducer **40** responsive to the weight per unit length of the rod **26**, an amplifier-controller device **42–44**, and a servo motor **46** and gear box **48** for driving the cam **36**. The gauge-controller system **40–48** is preferably of the type described in the copending application of Philip Spergel and Sidney A. Radley, Ser. No. 641,414, filed Feb. 20, 1957, now Patent No. 2,955,206 issued Oct. 11, 1960. The gauge transducer **40** preferably comprises a radiation source **40***a* and a radiation detector **40***b* in an arrangement somewhat as described in the copending application of Sidney A. Radley and Philip Spergel, Ser. No. 641,357, filed Feb. 20, 1957, now Patent No. 2,954,775 issued Oct. 4, 1960. As is set forth in said Ser. No. 641,414, the control system employs a tachometer **46***a* coupled to or integral with the servo motor and forming part of an internal feedback loop whereby the control system functions as a special analog device for computing the time integral of the error in weight per unit length of the cigarette rod **26** and repositioning the cam **36** in accordance with the value of said integral.

Further in accordance with the invention there is provided means for measuring the return flow of excess tobacco **28** around the drum **30**. In one preferred from of the invention as illustrated a dielectric gauge is employed for this measurement. This gauge includes a curved capacitor plate **50** spaced from the carded drum **30** and connected through a cable **52** to suitable capacitance measuring circuits **54**. The capacitance measuring system **54** may be any of several types well known in the art which are adapted to provide a suitable signal to a controller **56**. The controller **56** includes circuits for actuating a motor **58** which is connected through a gear box **60** and suitable mechanical drive arrangement represented by the dotted line **62** to the control shaft **64** of the feeder mechanism **10**. The feeder **10** is driven by a variable speed mechanism in a manner similar to that which is described and illustrated in the above-referenced application Ser. No. 641,357, the angular position of shaft **64** thereby determining the rate at which the feeder deposits tobacco on belt **12**. The controller **56** may be of the same type as the controller **44**, in which case the motor **58** is equipped with a tachometer **58***a*. Alternately, the controller **56** may be of the type which is illustrated in FIG. 2 of Patent No. 2,895,888, in which case the tachometer **58***a* is omitted.

In order to visualize the operation of the knife control, first assume that an optimum stream of tobacco is flowing on belt **12**, that the knife **16** is in, say, the center of its positional range and that the cigarette rod **26** has the correct weight per unit length. Under these conditions no action is taken by the control system. Now if for some reason the rod **26** becomes light, say, the controller **44** will raise the knife **16**, allowing more tobacco to pass into the rod former **24** but returning less tobacco around drum **30** to belt **12**. It is apparent that the return flow **28** of tobacco constitutes a small reservoir which can be manipulated by the equalizer knife control so as to "iron out" medium or short-term variations in the feed.

If it is the case that the light condition of the rod aforesaid results from an insufficiency in the mean flow of tobacco on belt **12**, the knife control action becomes regenerative. That is, the raising of the knife results in less return flow **28**, which in turn decreases the amount of tobacco carried by drum **14**, requiring a further raising of knife **16** by the controller, still further decreasing the return flow **28**, and so on.

If this situation were to continue, the stream of tobacco on drum **14** would soon become so sparse that the irregularities in the stream could not be effectively removed by knife **16**, which would only skim off the tops of the lumps and bunches therein, resulting in the production of cigarettes having excessive weight variane.

An opposite sequence of operation occurs in the event that the stream of tobacco from the feeder is excessive, eventually resulting in choking of the return flow system.

It is now apparent that the regenerative behavior of the knife control device, in maintaining constant the mean weight of the cigarette rod when an improper tobacco feed rate obtains, is reflected in the return flow of tobacco around drum **30**. That is to say, a relatively slight but persistent error in the rate of feed is manifested as a relatively large variation in the return flow **28**, the feed rate variation being virtually amplified in the return flow variation by the action of the knife control system.

In the past many attempts have been made to measure the flow of loose tobacco, or tobacco carried by a belt or carding drum. To the best of applicant's knowledge none of these schemes has been successful, for the simple reason that these measurements cannot be made very accurately. However, in the present control system, for the reason set forth it is found that the device used to measure the return flow **28** of tobacco on drum **30** does not need to be particularly accurate or stable, and hence any one of several prior art measuring devices, suitably modified, can be used for this purpose.

FIGS. 2 and 3 show details of a capacitance gauging head for measuring the return flow of tobacco. The capacitor plate **50** of FIG. 1 comprises a metal shoe **50***a* which is preferably imbedded in an integral sheath **50***b* of molded polytetrafluoroethylene resin, as is marketed under the trademark Teflon, and secured to the frame of the machine by suitable insulating supports as at **70**. The Teflon sheath presents an anti-friction, anti-gumming surface to the tobacco **28** passing thereunder, while its insulating quality eliminates spurious signal variations due to contact conductance.

The other capacitor plate is provided by a modification of the carded drum **30** which carries the return flow **28** of tobacco. The drum is conventionally constructed with a leather or canvas facing **72** having a plurality of rows of carding points as at **74** resembling bent carpet tacks extending therethrough. In accordance with one feature of the present invention, a plurality of hoop-like metal bands as at **76** are compressively secured around the periphery of the facing between the rows of carding points. The bands are preferably constructed of thin metal strip material such as shim stock having an extruded sheath of Teflon plastic which serves to electrically insulate the metal strips from the hygroscopic facing and thereby minimize leakage currents through the ground capacitance of the machine. The bands **76** are electrically

connected together as indicated by the wire loops as at **78**, and are further connected by flat insulated conductors as at **80** to a contact button (not shown) mounted in a phenolic insulating disc **82** secured to drum **30** at the hub axis thereof. The lead wire **52***a* to the measuring circuits **54** is connected to a spring loaded contact brush **84** which bears against the rotating contact button.

In the operation of the feed control system it is apparent that an increase in the return flow **28** of tobacco around the drum **30** results in an increase in capacitance between the shoe **50***a* and the revolving bands **76**, whereas a decrease in the return flow results in a decreased capacitance therebetween. In a well-known manner similar to the operation of the electrodes described in U.S. Patent No. 2,729,213 to W. C. Broekhuysen et al., in providing a signal for a controller, capacitance changes are utilized by the measuring circuits **54** to provide suitable error signals to controller **56**, whereby predetermined variations in the return flow **28** result in actuation of the motor **58** in one direction or the other to reset the control shaft **64** of the variable speed transmission (not shown) driving the feeder **10**, thus restoring the rate of flow of tobacco on the feed belt **12** to the proper value.

It is apparent that other devices for measuring the return flow **28** of tobacco can be employed. For example, as is shown in FIG. 4, a light source **90** may be used to direct a beam of light, along a line **92** properly spaced from the periphery of drum **30**, toward a photoelectric detector **94**. Since the light beam is variably attenuated by the return flow **28** of tobacco in accordance with the amount thereof carried by the drum **30**, the signal output of detector **94** may be employed to control the feeder **10**.

In FIG. 5 it is seen that a beta ray backscatter measuring device can also be employed. In this device the measuring head comprises an ionization chamber **96** having a radioactive beta radiation source holder **98** mounted therein to direct a beam of beta radiation radially toward the carded drum **30**. The theory of operation and further constructional details of the backscatter head are more fully described in the aforesaid Patent No. 2,895,888. In adapting this system to the measuremsnt of tobacco on the drum **30**, it is proposed that bare metal bands **100** be mounted on the drum, extending continuously around the same and joined together between rows of teeth so as to afford the smallest possible exposure of the carding cloth to the beta radiation beam. Thus good contrast is achieved in accordance with the principles set forth in said patent, and the effects of variations in the drum facing are minimized.

Suitable, spring-loaded mechanical or electro-mechanical feeler gauges, working between the carding points, can also be used to measure the thickness of the return flow tobacco on the drum **30**.

What is claimed is:

1. For use in a cigarette-making machine which includes adjustable stream forming means for forming a primary tobacco stream, means defining a final tobacco stream whence a cigarette rod is formed, conveying means between said primary and final streams, and a removal means adjacent the conveying means, said conveying means including a forward feeding conveyor for conveying tobacco from a discharge end of the primary stream to said removal means, said removal means acting to divide the tobacco reaching it into said final stream and an excess stream, and said conveying means further including a return feed conveyor for receiving the excess stream and conveying it to the discharge end of the primary stream adjacent the upstream end of the conveying means:

apparatus for maintaining a substantially constant rate of flow of tobacco in said excess stream, which apparatus comprises

(a) a first detector disposed adjacent said final stream for measuring the amount of tobacco per unit length in said final stream,

(b) means responsive to said first detector for controlling said removal means to adjust the portion of the flow from said forward feeding conveyor which is diverted to form said excess stream and to maintain the amount of tobacco per unit length in said final stream substantially constant,

(c) a second detector disposed adjacent said return feed conveyor for measuring the amount of tobacco in said excess stream,

(d) means responsive to said second detector for controlling said adjustable stream forming means to maintain substantially constant the rate of flow of tobacco in said excess stream as formed by said removal means,

(e) said removal means including a carded drum for returning said excess stream to said primary stream, and wherein said second detector comprises gauging means mounted adjacent said drum for measuring the amount of tobacco carried thereby, and

(f) said carded drum including a facing peripherally mounted thereon, a plurality of carding points projecting from said facing, and means providing a metal surface at least partially overlying said facing, said metal surface being operatively associated with said gauging means.

2. Apparatus as in claim **1** wherein said gauging means includes an ionizing radiation source mounted adjacent said carding drum for directing a beam of radiation into said metal surface, and means for quantitatively detecting radiation reflected from said surface and returned backwardly through said excess flow of tobacco carried by said drum.

3. Apparatus as in claim **1** wherein said gauging means includes a metal shoe mounted adjacent said carded drum and spaced therefrom, and means for measuring the electrical capacitance between said metal surface and said shoe.

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U.S. Cl. X. R.

131—84