

March 15, 1955

D. W. MOLINS ET AL
AUTOMATIC MACHINES SUCH AS CIGARETTE
MAKING MACHINES OR THE LIKE

2,704,079

Filed March 23, 1951

6 Sheets-Sheet 1

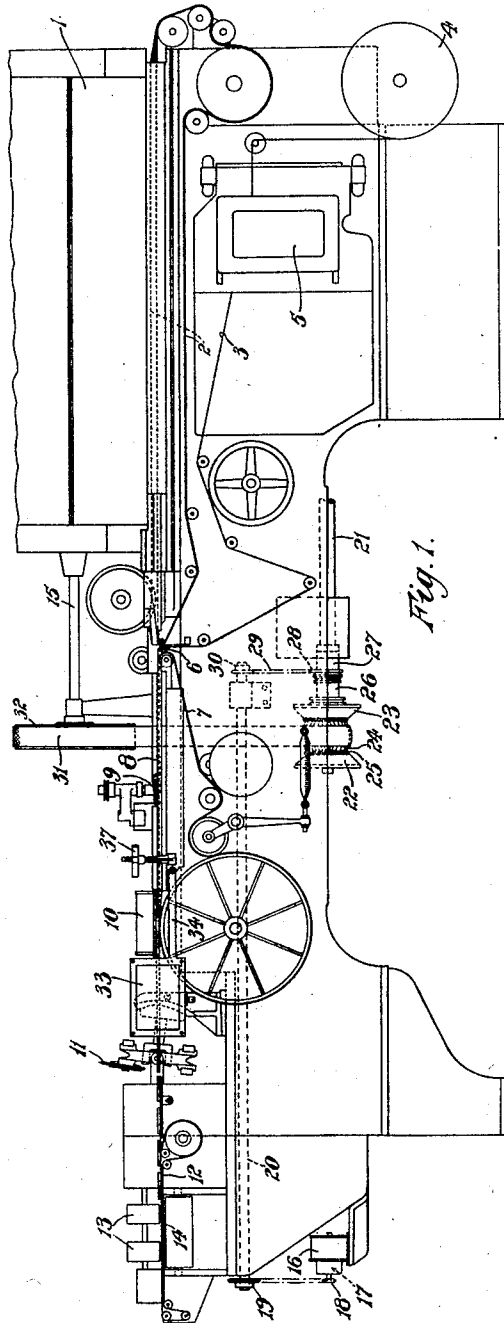


Fig. 1.

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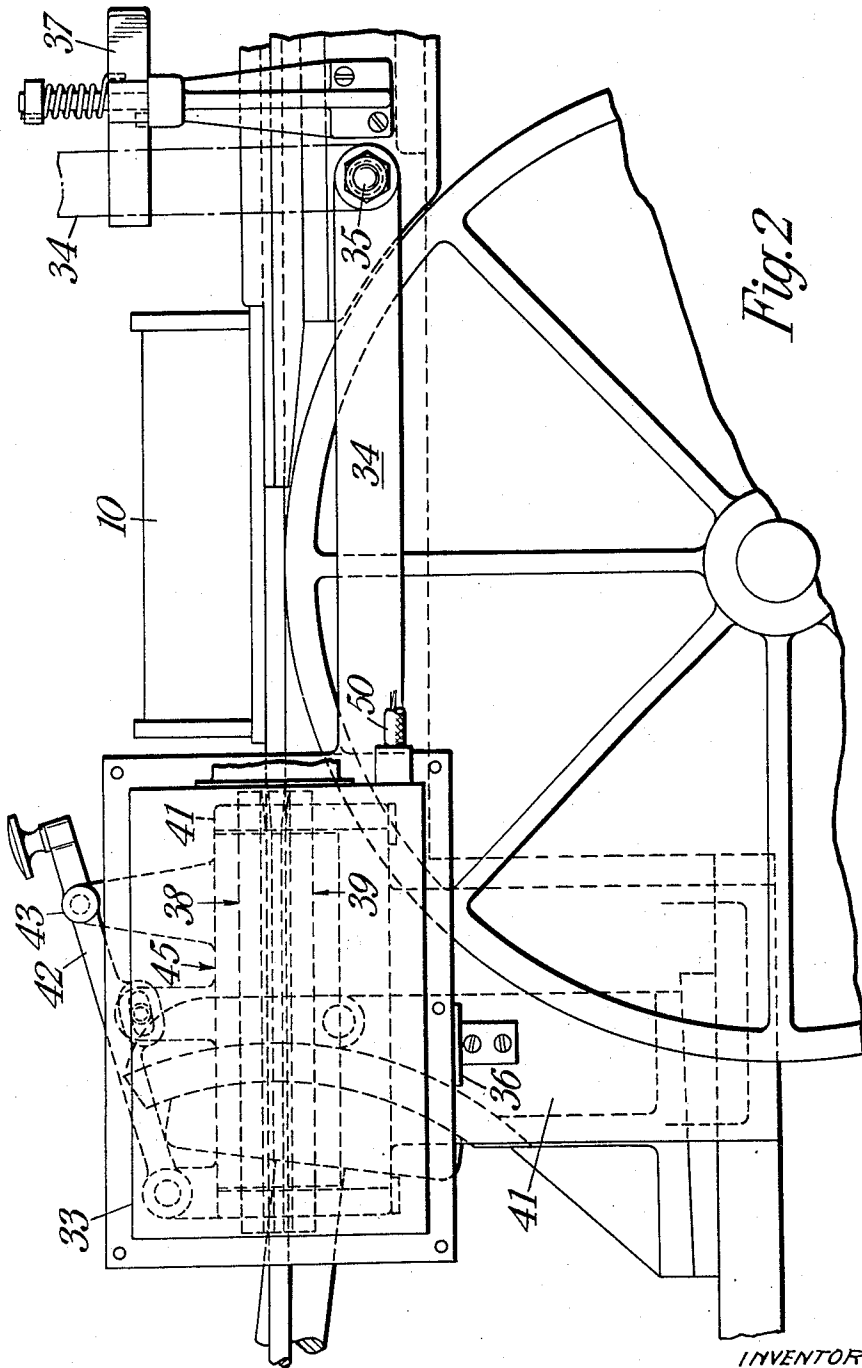
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6 Sheets-Sheet 2



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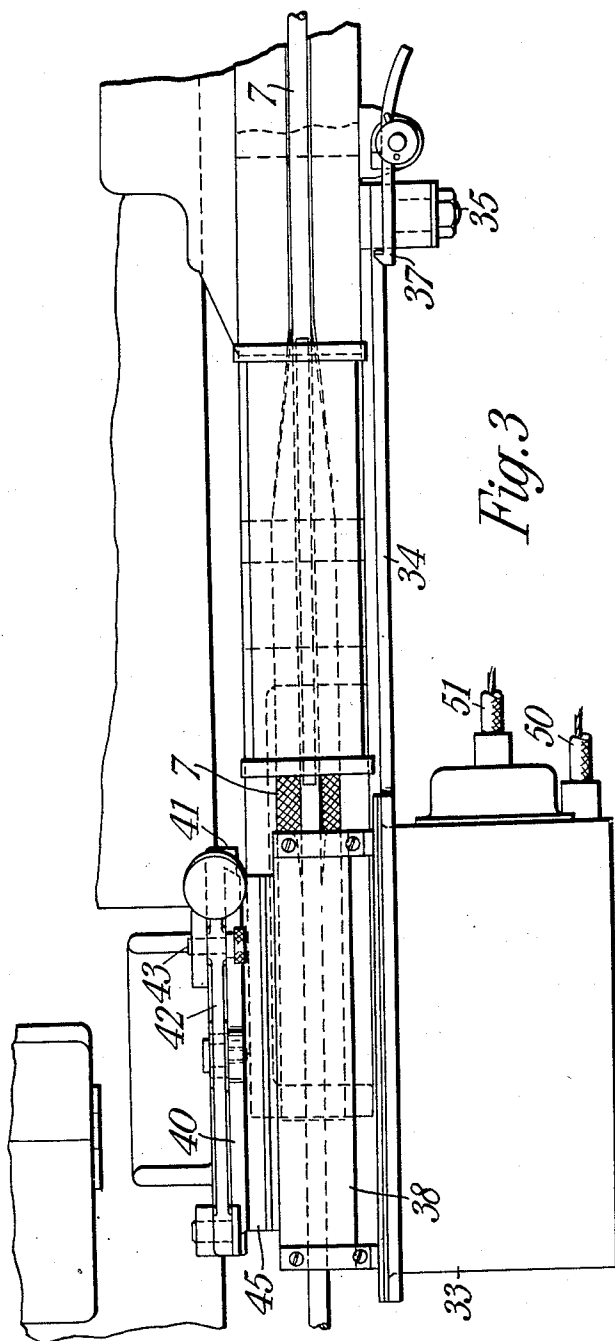
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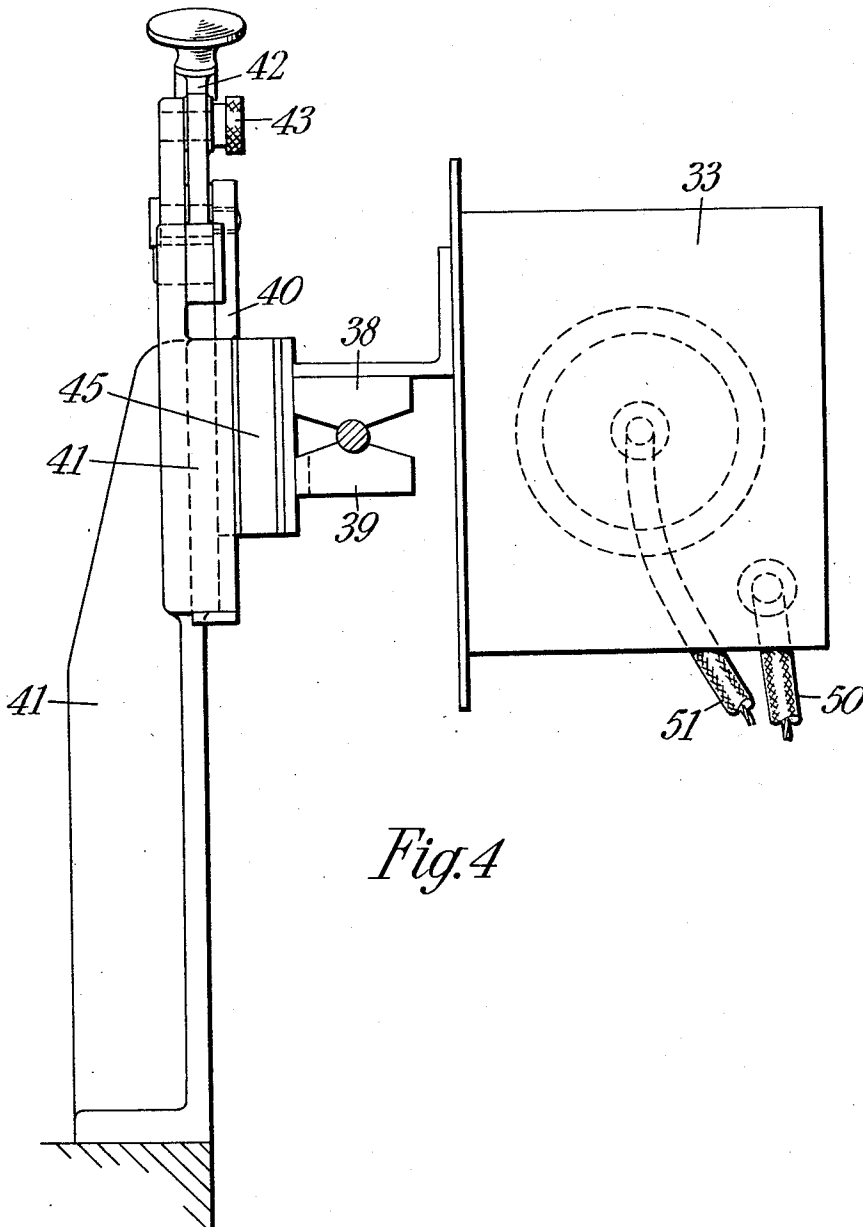


Fig. 4

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6 Sheets-Sheet 5

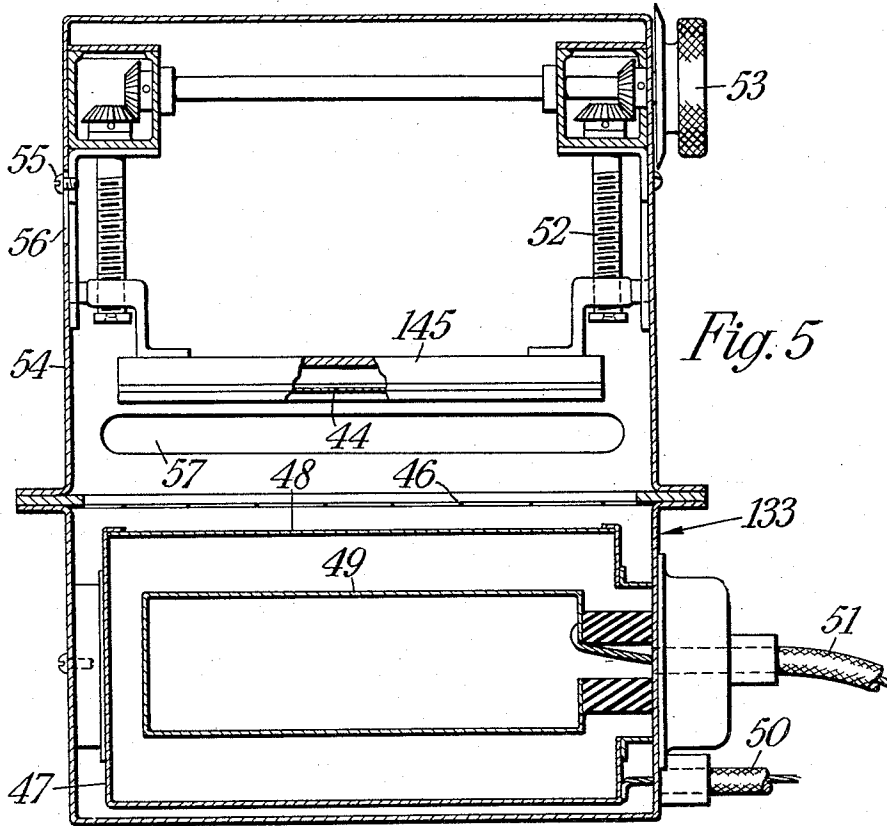


Fig. 5

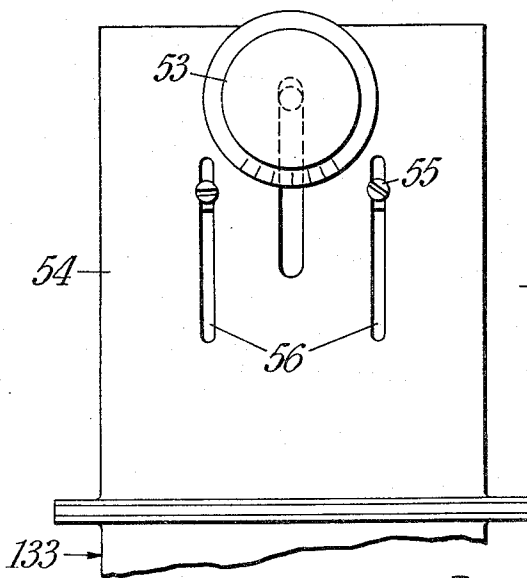


Fig. 6

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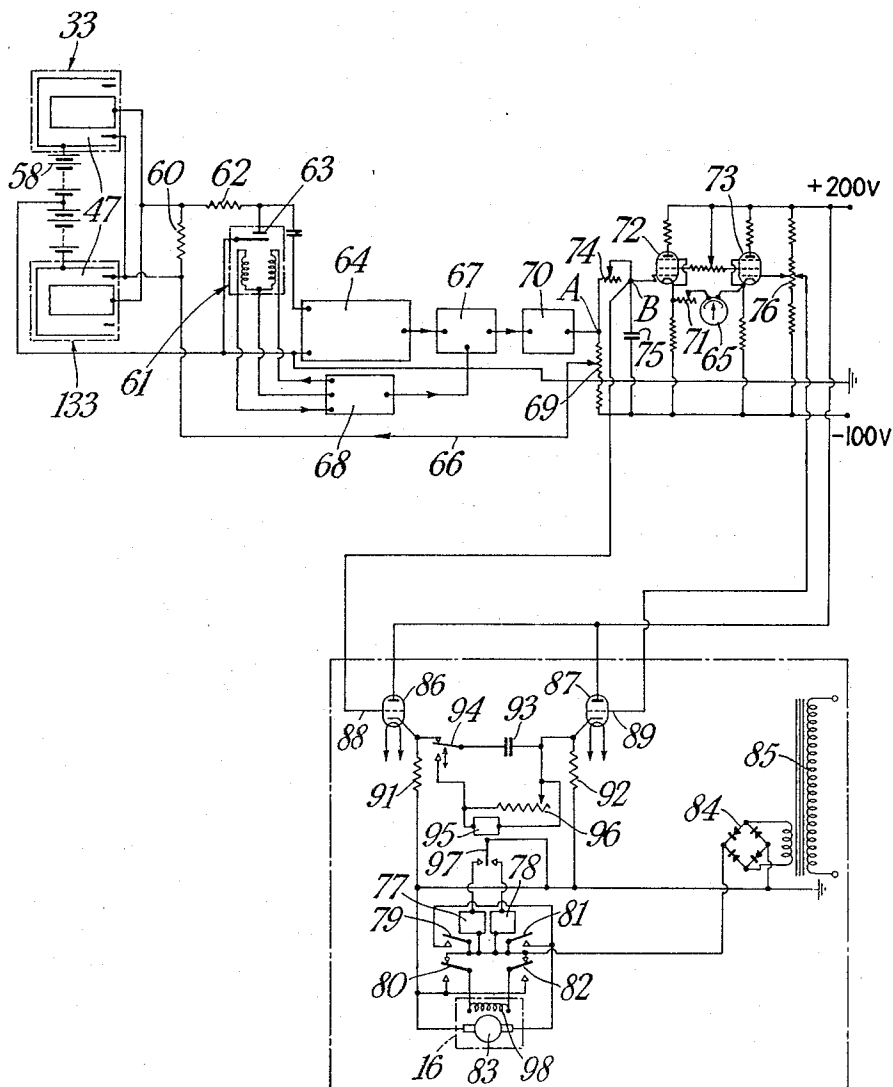


Fig. 7

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2,704,079

AUTOMATIC MACHINES SUCH AS CIGARETTE MAKING MACHINES OR THE LIKE

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Application March 23, 1951, Serial No. 217,124

Claims priority, application Great Britain March 27, 1950

2 Claims. (Cl. 131—21)

This invention concerns improvements in or relating to automatic machines such as cigarette making machines, or the like, in which material is fed and subsequently issues from the machine in separated portions (e. g. as cigarettes in a cigarette making machine or as packages in a tobacco packaging machine). Such machines are referred to herein as automatic machines as specified.

Cigarette making machines of the continuous rod type are provided with tobacco feeding apparatus in which a mass of tobacco is placed in a hopper and removed therefrom by carded rollers or like devices and subjected to various brushing and combing operations and finally delivered on to a distributor, for example, a carded roller from which it is removed by a picking operation and showered on to a conveyor by means of which it is formed into a tobacco rod or core which is afterwards wrapped in paper.

Owing to the nature of the mechanism used in the tobacco feeding apparatus, the quantity of tobacco picked from the distributor varies according to several conditions, such for example, as the moisture contained in the tobacco, the temperature, the nature of the tobacco and the degree to which it is tangled when it is first placed in the hopper and many attempts have been made to improve the uniformity of distribution (i. e. the density) of the tobacco in the resulting rod. Usually the practice has been to alter the speed of the distributor so that more or less tobacco is picked therefrom.

The most usual practice employed for checking the average density of the cigarettes produced has been to weigh them either singly or in batches at suitable intervals and the result of the weighing operations has been used, usually by automatic means, to alter the speed of the distributor by means of a variable speed gear which is employed on a continuous rod cigarette making machine so that the speed of the tobacco feeding apparatus can be altered without altering the speed of the cigarette making machine proper.

More recently various proposals have been made by means of which the density of tobacco has been checked or maintained by taking advantage of the electrical characteristics of the tobacco, usually by measuring the resistance thereof to high frequency currents or by determining the capacity of a quantity of tobacco passing through a condenser device. The result of the electrical measurement is used to alter the speed of the tobacco feeding apparatus through a system of relays and other electrical apparatus.

According to the present invention there is provided in an automatic machine as specified a method of measuring the mass of tobacco occupying a given space by subjecting the tobacco to the radiation of beta or other suitable rays which are absorbed by the material in known proportion to its mass, and determining the absorption by an ionization chamber.

The current resulting from a voltage applied to the electrodes of the chamber, when the gas therein is ionized, may be, by suitable amplifying and other apparatus, caused to control a suitable electric motor and the movements of this motor can be utilised to vary the speed of the tobacco hopper with respect to the speed of the rest of the machine. For this purpose the motor may be arranged to move the regulating shaft of a variable speed gear which drives the tobacco hopper from the main shaft of the machine.

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Apparatus for carrying the method into effect may comprise two ionization chambers, each with its co-operating source of rays, one chamber and ray source being arranged to test the tobacco mass and the other chamber and source being arranged to act as a standard, having a given material mass positioned between source and chamber. The standard may be adjustable, as by shifting the source towards or away from the chamber or by inserting a greater or lesser quantity of the said material mass.

The tobacco could be measured while forming part of a flowing stream or the like, for example, a sheet or fleece may be made in the tobacco feeding apparatus as in British Patent No. 441,402, and a given area of said fleece continuously subjected to the radiation. The measurement may take place over a narrow strip extending the whole length of the hopper so as to take into consideration all factors which might affect the feeding rate. The measurement may be made on the loose filler or the cigarette rod and the latter is chosen in the specific example described later.

The thickness of the fleece may be made as small as required for the particular kind of radiation used as some of the rays must pass through the material to enable the absorption rate to be measured and as it is necessary to have the detector at one side of the material and the radiator at the other it is necessary to arrange a fleece of tobacco so that this can be done and the apparatus described in the aforesaid specification may be modified accordingly.

The invention will be more fully described with reference to the accompanying drawings which show the application of a beta ray device to the control of a cigarette making machine and in which:

Figure 1 is a diagrammatic front elevation of a continuous rod cigarette making machine showing the location of the radiation device and chamber.

Figure 2 is an enlarged view of part of Figure 1 showing further details of the radiation device and chamber.

Figure 3 is a plan of Figure 2.

Figure 4 is an end elevation of part of Figure 2.

Figure 5 is a sectional elevation of an ionization chamber used as a standard.

Figure 6 is an end elevation of the upper part of Figure 5.

Figure 7 is a circuit diagram of the electrical apparatus employed.

Referring first to Figure 1 of the drawings the cigarette machine is provided with a tobacco feeding apparatus 1 which showers tobacco on a travelling endless belt 2. The paper web 3 is drawn from a reel 4 over the various rollers shown, passing through a printer or the like 5 and finally over a small roller 6 which leads it on to an endless tape 7. The tobacco on the belt 2 is delivered on to the paper web 3 at the position occupied by the roller 6, and the tape 7 carries the loaded web through the folders and other devices indicated by the reference 8 where the paper is wrapped around the tobacco core to form a continuous cigarette rod. The edges of the paper are secured together by paste from a paster 9 whereafter the rod passes beneath a heater 10 which dries the paste after which the rod is severed into separate cigarettes by a cut-off 11. These cigarettes pass on to an endless travelling tape conveyor 12, which carries them to a deflector device 13 where the deflector blades move the cigarettes out of the rod line and deliver them to a catcher band 14.

In order to vary the feed of tobacco to the belt 2, should the weights of the cigarettes produced deviate too much from the desired weight, there is provided a hopper driving shaft 15 whose speed is regulated by a reversible electric motor or actuator 16 through gearing now to be described. The motor 16 which comprises a reduction gear at 17 has a sprocket wheel 18 on its shaft and this drives a further sprocket wheel 19 on a shaft 20. On a shaft 21, which may be the main driving shaft of the cigarette machine, or one coupled to it, there is provided an expanding pulley device. This consists of a fixed cone 22 and a movable cone 23 slidable on a spline on the shaft 21. Between the cones are a number of curved segments 24 which can slide in grooves in the cones as the latter move towards and away from one another and

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are held to the cones by spring rings 25. The cone 23 is moved by a screwed bush 26 which runs on a fixed screw 27 the bush being rotated by a sprocket wheel 28 driven from the shaft 20 by a chain 29 and sprocket 30. Suitable thrust rings are provided and as the bush rotates one way the cone 23 is moved in towards the other, or in the reverse direction, the pull of a belt 31 opens the cones. A jockey pulley (not shown) is provided to take up the slack in the belt and the latter passes over a large pulley 32 on the shaft 15.

The movements of the motor 16 to vary the speed of the tobacco feed are obtained from the apparatus shown in the circuit diagram Figure 7 but before this is described a short description of the basic ideas of the invention will be given.

The principle employed is based on the use of a source of rays such as beta rays (or high speed electrons), and an ionization chamber. The cigarette rod, the weight of which it is desired to measure, is arranged between the beta-ray source and the ionization chamber in such a way, see Figure 4, that the only radiation affecting the ionization chamber is that passing through the more central slice of the cigarette rod. The source of the rays may be a radio-active material such as Thallium "204" or Strontium "90." The ionization chamber is in circuit across a source of D. C. voltage with a resistance of high value. The effect of the high speed electrons entering the chamber is to ionize the contained gas (air) and to cause a minute current to flow in the resistance. The value of this current is substantially proportional over the working range to the number and energy of the electrons entering the chamber and causing ionization and this number, and hence the current, depends on the absorption taking place in the cigarette and this depends on the weight of the rod being scanned by the source. The current in the chamber is too small for direct practical use and it is amplified to a sufficient degree to operate a direct indicating meter and a circuit to operate the motor 16 to correct the tobacco fed to form the cigarette rod so as to keep this of uniform weight.

Previous attempts have been made to measure the density of the cigarette rod by measuring the change in capacity, dielectric loss or a combination of both in the cigarette rod, but it has been found that should the moisture content increase or decrease by only a small percentage the apparatus indicates a substantial change in mass even though the true mass may not have changed at all. As it is required to maintain a constant weight or mass of the finished cigarettes these electrical methods can only be satisfactory where the moisture content of the tobacco can be controlled within very fine limits. Where density is measured by weighing, the time interval before correction can be made is longer than is desirable as the cigarettes are completely finished and then selected for weighing, usually as groups. Naturally only a certain proportion of the output can be so selected.

The present method which can be applied earlier than the weighing method does not suffer from any difficulties due to moisture content because, as is known, the absorption of beta rays depends, for a constant section, entirely on the mass of material through which the rays are trying to pass, and in the case of tobacco with a certain moisture content, if the moisture content be increased, the mass of the rod will be increased, and the ionization current will be decreased in proportion and an indication of the true weight will be obtained, which is as required.

Tobacco is of fibrous nature unlike homogenous material and the packing of the fibres may vary a small amount along the formed rod even though the true mass of the rod is substantially constant; because of this the measuring circuit is designed to have a time constant of 1 to 2 seconds so that the reading of weight obtained is the average over this period. This arrangement is satisfactory because if corrections to the feeding arrangements from the tobacco hopper were made too frequently over-correction and hunting would result.

A length of rod of about 6" is scanned and because of the shape of the guides 38 and 39 described later, only the centre part of the rod is scanned so that the inevitable small up and down movement of the rod causes as small a change as possible in the length of tobacco through which the rays pass.

Referring now also to Figures 2, 3 and 4 an ionization chamber contained in a casing 33 is supported at the

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front of the machine. Normally this casing would be fixed but in the machine illustrated, which represents a type in very extensive use, it is not convenient for the following reason to have the casing fixed. At times in the running of a cigarette machine, particularly when the machine is first started and before a satisfactory rod has been formed, the operator bends the rod outwards to the front so that it does not pass the cutting position. When he is satisfied with the shape and consistency of the rod he breaks it and allows the unbroken part to pass to the cut-off. In the machine illustrated, the chamber 33 and some other parts referred to below would hinder this manipulation of the rod and so the chamber is pivoted on a lever 34, pivoted at 35 and located in the working position by a stop 36. The chamber may be swung upwards on its pivot so that the lever 34 can be caught and held by a spring latch device 37. At the testing position the rod runs through guide blocks 38 and 39 and the upper one is attached to the chamber 33 for movement therewith. The lower block 39 is fixed to a box 45 described below and the part 45 is fixed to a slide 40 movable up and down in a guide bracket 41. Movement is effected by a lever 42 and the guide 39 is held in its operative position by a dowel 43 which locks the lever 42. These several devices for moving the chamber and guides out of the way can of course be dispensed with if the machine is made longer so that rod breaking can take place beyond the chamber position or the parts to the right of the chamber are put closer together for example by using a smaller drum on which the tape 7 runs. The box 45 encloses the material forming the source of the beta rays. It will be noted from Figure 4 that the guides 38 and 39 are only separated by a comparatively narrow gap so as to restrict the passage of the rays to the central slice of the cigarette rod. The interiors of the casing 33 and box 45 are in all material respects similar to those of a casing 133 and box 145 shown in Figure 5 and this figure will now be described.

The casing 133 has a wire mesh guard 46 over its open side. Inside the casing 133 is an inner casing 47 which constitutes the ionization chamber and has a thin metal window 48 through which the rays can pass. The chamber 47 also functions as one electrode of the device. The box 145 is similarly provided with a window 44. Inside the chamber 47 is an inner electrode 49. The chamber 47 is hermetically sealed and contains air. Cables 50 and 51 connect the two electrodes to the electrical apparatus described later with reference to Figure 7.

As the device shown in Figure 5 is for use as a kind of standard as explained later, the box 145 is movable up and down by screws 52 operated by a knob 53, this arrangement constituting a fine adjustment. Coarser adjustment is provided by shifting all the parts shown inside a casing 54 up and down by screws 55 running in slots 56 in the casing. The long side walls of the casing each have a slot 57 and thin sheets of metal or other material can be passed through to provide a material mass for the rays to penetrate. The device is adjusted so as to pass a current equivalent to that which would be passed if a cigarette rod of the desired mass were substituted for the said material mass.

The operation of the apparatus will now be described with reference to Figure 7.

The window in the casing 33 is positioned opposite the radio-active source in box 45 so that the rays that penetrate the cigarette rod pass into the chamber 47. A source of D. C. voltage, e. g. battery 58, in series with a high value resistance, is applied between the inner and outer electrodes. The beta particles that enter the chamber 47 cause ionization of the gas (air) in the presence of the applied potential and the resultant current, which is a measure of the energy of the rays penetrating the tobacco, develops a voltage across a resistance 60. This voltage must be amplified before it can be put to practical use, and because it is essentially a direct current, a form of D. C. amplifier is necessary.

It has been found most satisfactory to use a vibrating condenser electrometer 61 in which the input D. C. potential is first converted to A. C. by applying it through a resistance 62 to a condenser 63 the capacity of which changes at a suitable frequency (500 cycles). An A. C. voltage proportional to the D. C. input is developed across this condenser, which is passed into a conventional A. C. amplifier 64 and subsequently rectified.

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The output voltage, in addition to energising a direct reading meter 65 and operating a correcting circuit is applied to the input as negative feed back along line 66 and this allows considerable variations in the gain of the amplifier without any significant change in the output.

The value of the resistance 60 referred to earlier is of the order of 10^{10} to 10^{11} ohms. It is found that resistances with a high value like this are rather unstable, that is, the voltage developed across the resistance changes slightly with time. Because of this it has been found desirable to use an additional radioactive source and ionization chamber, i. e. the box 145 and casing 133 to form a "standard," which, for the desired weight of cigarette rod is arranged to pass a current equal and opposite to that from the chamber 47 in the casing 33, measuring the density of the rod. The box 133, its battery and connections are shown in Figure 7. The resistor 60 then only conducts the difference in the two currents and, at balance, small fluctuations in the value of this resistance are unimportant. To balance the absorption of the cigarette rod between the source and the measuring chamber, a sheet of thin metal such as brass or aluminium is used between the "standard" source 145 and chamber, being inserted in the slots 57, Figure 5, and for fine adjustment of balance the means described with reference to Figure 5 are provided to adjust the distance of the source from the thin metal absorber.

From the amplifier 64 current passes to a phase-sensitive rectifier 67 which works in synchronism with a maintaining circuit 68 for the vibrating condenser 61; by this means the output voltage developed at point A, Figure 7, across a cathode follower load resistance 69 which receives current from a cathode follower 70 and is normally at the same potential as the earth line, will change to a positive value or a negative value dependent on whether the output from the measuring chamber in casing 33 relative to that from the standard in casing 133 is greater or lesser; in addition the feed-back voltage which is developed across 69 is always fed back in the right phase.

The indicating meter 65 is connected in series with a variable resistance 71 (to control the sensitivity of the meter) between the cathodes of two tubes 72 and 73. The circuits of these tubes are arranged by adjusting resistance 76 so that with point A at earth potential the two cathodes are at the same potential and there is no current in the centre-zero meter 65. The circuits of the phase-sensitive rectifier 67 and cathode follower 70 are also arranged so that when the output from the measuring chamber in casing 33 is the same as that from the standard chamber in casing 133, point A is at earth potential.

As a result, when the meter 65 is in the zero position the density of the cigarette rod is at the desired value and when this value varies, the indication on the meter will follow the change, a change of 1% in weight from the desired value causing full scale deflection, when the variable resistance 71 is set for maximum sensitivity.

As previously mentioned tobacco is not a homogeneous material, and it has been found necessary to introduce an integrating circuit between the amplifier and the measuring and correcting circuits so that the indication and the correction will be in accordance with the average density measured over a short period. This is accomplished by the integrating circuit formed by a resistance 74 and condenser 75. When the potential of point A changes, the control grid of tube 72 cannot follow immediately because of the large capacity of condenser 75 which must alter its charge, and the speed at which this takes place depends on the value of resistance 74 which is adjustable.

As described with reference to Figure 1 means are provided for adjusting the feeding rate of tobacco from the hopper to the conveyor on which the cigarette rod is formed. The motor shown in Figure 1 is also shown on Figure 7. The motor 16 is an "electronic" balancing motor. All the time that this motor is stationary the relative speeds of the shafts 15 and 21 will remain constant. When, however, the motor is moving in one direction the shaft 20 will alter the variable speed gear of Figure 1 to, say, increase the hopper speed, and when the rotation of the motor is reversed the speed of the shaft 15 will be decreased.

For practical reasons the electronic motor or actuator and its power supply and associated circuits are arranged separately from the main detector circuits, as indicated by the outline in broken lines on Figure 7, but the error

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signal is taken from a point B, at the grid of tube 72, and the 200 volt H. T. supply is also taken from the main detector circuit supply. Referring now mainly to the lower part of Figure 7 the direction of rotation of the actuator 16 is controlled by magnetically operated switches 77-78 having contact arms 79, 80 and 81, 82 respectively.

The armature 83 of the control motor 16 is supplied with direct current, from a bridge-connected metal rectifier 84 and a winding on a transformer 85. The circuit comprises two tubes 86 and 87 and the grid 88 of the tube 86 is connected to point B of tube 72 and the grid 89 of tube 87 is connected to an adjustable tapping on the resistance 76 shown in the upper part of the view. The tubes 86 and 87 have cathode resistors 91 and 92 of equal value and the voltage of grid 89 is adjusted to equal that of the grid 88 under conditions of balance, that is at earth potential. Under these conditions the two tubes 86 and 87 form a balanced pair of cathode followers and there is no difference in potential between their cathodes.

A condenser 93 is connected across the two cathodes through a switch 94 which, as indicated by the double-headed arrow, is operated in timed relationship with the machine. When switch 94 is in the position shown, the condenser 93 is connected between the two cathodes but when the moving switch blade moves away from the upper contact and engages the lower contact the condenser 93 is disconnected from the cathode of tube 86 and shunted by a micro-amp relay 95 which has a variable resistance 96 in parallel with it.

The switch 94 is so operated that its moving blade changes cyclicly from the upper contact to the lower. In practice a cycle of the order of 5 seconds is found satisfactory, and of this total time the blade engages the upper contact for 3 seconds and the lower for the rest of the period.

When the switch blade is in the upper position the condenser 93 will acquire a charge when a potential difference exists between the cathodes of tubes 86 and 87 without imposing any load on the main detector circuit and because of the low output impedance of the cathode follower a voltage will quickly develop across condenser 93, when the potential of point B changes with respect to earth. The polarity of the voltage depends on the direction of the out-of-balance signal.

Let us assume the machine is running normally and the density of the rod is as desired. At the start of a cycle of switch 94 the condenser 93 is connected between the cathodes of tubes 86 and 87 and because there is no error signal at point B no voltage is developed across the condenser terminals. After 3 seconds the switch 94 changes over and the condenser is connected to the micro-amp relay 95. As there is no charge in the condenser, no current flows through the relay and the motor 16 remains stationary.

Assume now that for some reason the density of the rod is less than it should be. The voltage of point B will now change in a positive direction and the cathode of tube 86 will become more positive than that of tube 87. When the switch 94 connects the condenser 93 between these two cathodes a voltage will develop across the condenser which will rise and equal this voltage, the left-hand plate of the condenser being positive with respect to the right-hand plate. When the moving blade of the switch 94 engages the lower contact, a current will flow from the condenser through the relay 95 from left to right and if of sufficient value will cause its associated contact arm 97 to close and complete a circuit to the magnetic switch 78, which in turn will, through its associated contacts 81 and 82 complete a circuit to the armature 83 and field 98 of the actuator motor 16 and cause it to turn the adjusting shaft 20 of Figure 1.

The motor 16 is a reversible D. C. motor with epicyclic gearing incorporated, and enclosed in the casing 17 Figure 1. The gearing gives a slow speed with ample torque on its output shaft. The rectifier 84 in addition to supplying current for the motor, feeds the switches 77 and 78.

The amount of alteration made by the adjusting shaft 20 of the variable speed gear Figure 1, in any one second cycle depends on the time that the actuator 16 runs and this depends on the time during which sufficient current flows from the condenser 93 to the micro-amp switch 95 to close its contacts. This time, of course,

depends on the original charge in the condenser and therefore on the amount by which the density of the cigarette rod deviates from the desired density.

It will be appreciated that if the change in rod density had been an increase, the events described would be the same but as the condenser 93 would have been charged with reverse polarity the relay 95 would operate switch 77 so that the motor would run the other way and the variable speed gear would have been altered to reduce hopper speed.

The micro-amp relay 95 is selected so that it will only operate when a suitable voltage is applied from capacitor 93. This is necessary as there is a certain deviation from the standard density which is permissible without correction taking place, and the relay must not operate when voltages below this value are developed across the condenser.

As already stated the amount of correction depends on the degree of out-of-balance which controls the voltage across the condenser 93 and the time necessary before the current through relay 95 will decay to a value where the relay contacts open and stop the alteration to the variable speed gear.

Resistance 96 which is variable is shunted across the relay so that the time-constant of the current decay can be varied as desired.

Where the device is applied for measuring the density of a fleece or carpet of tobacco it may be arranged to measure the carpet step by step. That is, a strip of carpet of suitable length, as measured in the direction of movement of the carpet, will be scanned and any necessary adjustments of the machine will be carried out in response to said scanning. Then a succeeding strip will be measured. A suitable timed switch may be incorporated in the apparatus for this purpose.

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

1. In apparatus for measuring the density of tobacco particles in a moving cigarette core, the combination with a first source of penetrative radiation disposed at one side of the core, a first ionization chamber having electrodes therein at the other side of the core, a device having a standard density, a second source of penetrative radiation disposed at one side of said device, a second ionization chamber having electrodes therein at the other side of

said device, means combining in opposition the outputs from the electrodes of said first and second ionization chambers to produce a net current representative of the difference in density of said core and said device, mechanism controlled in response to variations in said net current, a condenser adapted to receive a charge proportional to said net current, and means including a timing device for selectively and alternately connecting said condenser to receive said charge, and to discharge said charge to said mechanism to effect actuation of the latter.

2. In apparatus for measuring the density of tobacco particles in a moving cigarette core, a cigarette making machine comprising means to feed tobacco as a moving cigarette core, means for measuring the density of tobacco particles in said cigarette core comprising a first source of penetrative radiation disposed at one side of the core, a first ionization chamber having electrodes therein at the other side of the core, a device having a standard density, a second source of penetrative radiation disposed at one side of said device, a second ionization chamber having electrodes therein at the other side of said device, means combining in opposition the outputs from the electrodes of said first and second ionization chambers to produce a net current representative of the difference in density of said core and said device, mechanism controlled in response to variations in said net current to regulate said first named means to vary the density of tobacco in said core, a condenser adapted to receive a charge proportional to said net current, and means intermittently operable to apply said charge to said mechanism.

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