March 12, 1968 H. KOCH ETAL 3,372,488

APPARATUS FOR CONDITIONING TOBACCO

Filed Nov. 17, 1964 6 Sheets-Sheet 1

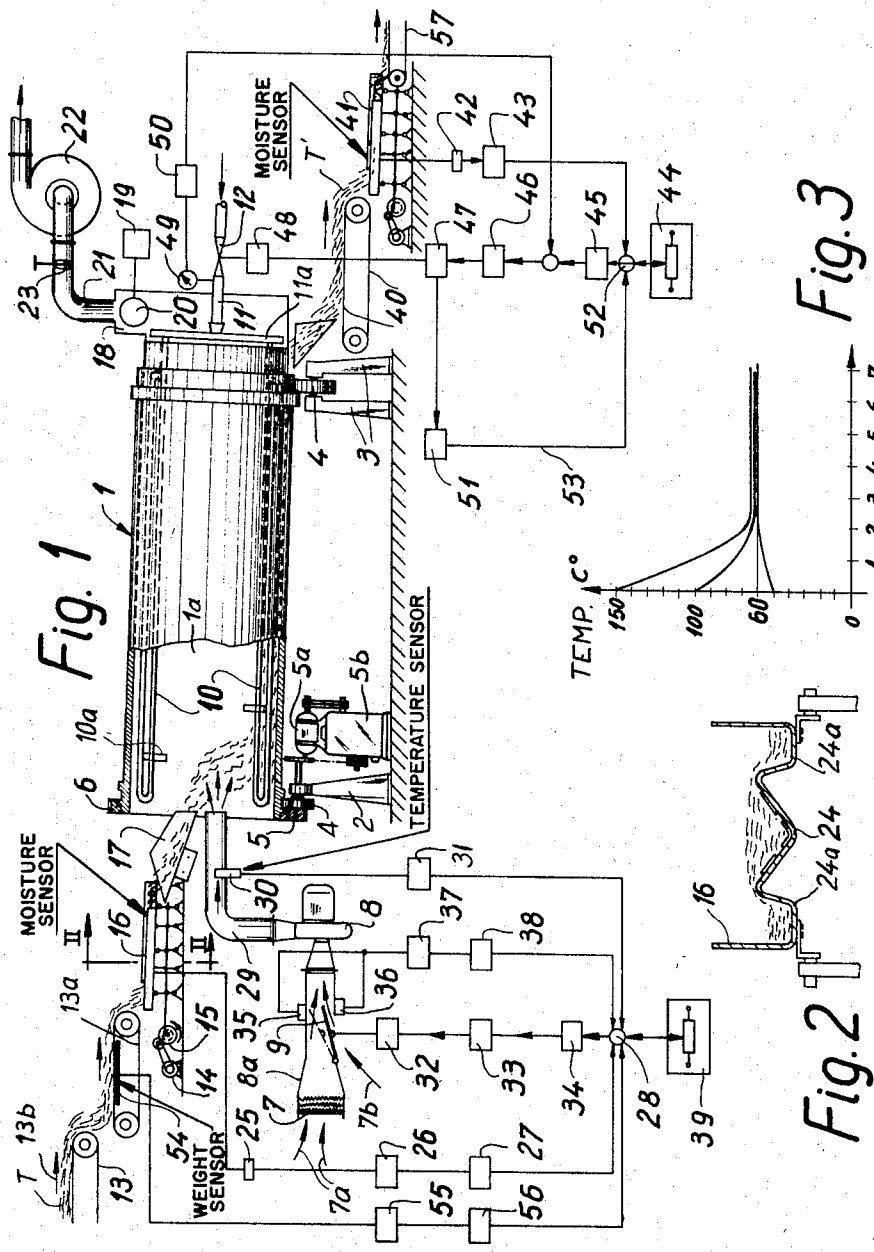


Fig. 1

Fig. 3

Fig. 2

Inventors:
HANS KOCH
WALDEMAR WOCHNOWSKI

BY Michael S. Striker

THEIR ATTORNEY

APPARATUS FOR CONDITIONING TOBACCO

Filed Nov. 17, 1964 6 Sheets-Sheet 2

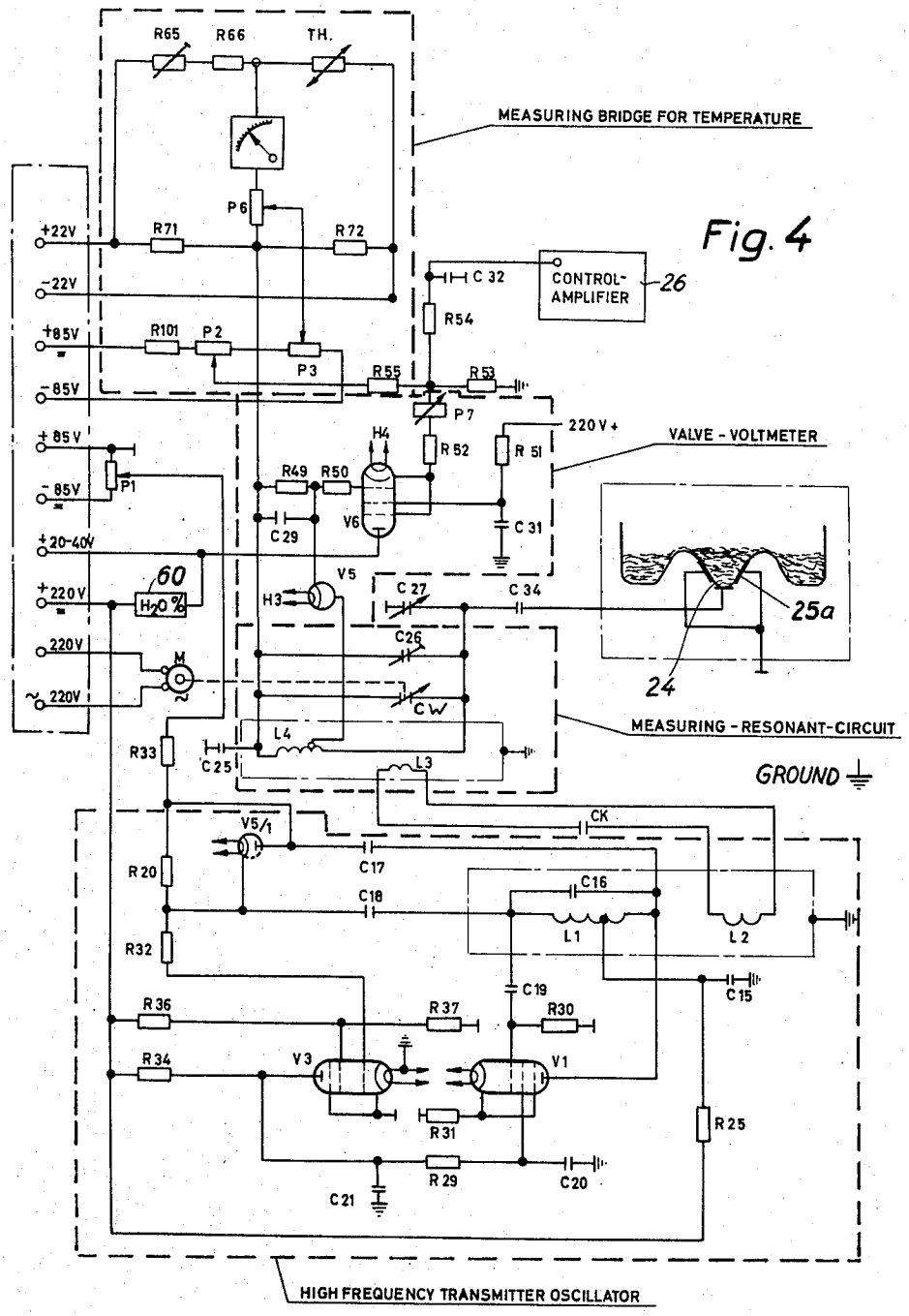


Fig. 4

Inventors:
HANS KOCH
WALDEMAR WOCHNOWSKI
BY Michael S. Striker
THEIR ATTORNEY

March 12, 1968 H. KOCH ET AL 3,372,488

APPARATUS FOR CONDITIONING TOBACCO

Filed Nov. 17, 1964 6 Sheets-Sheet 3

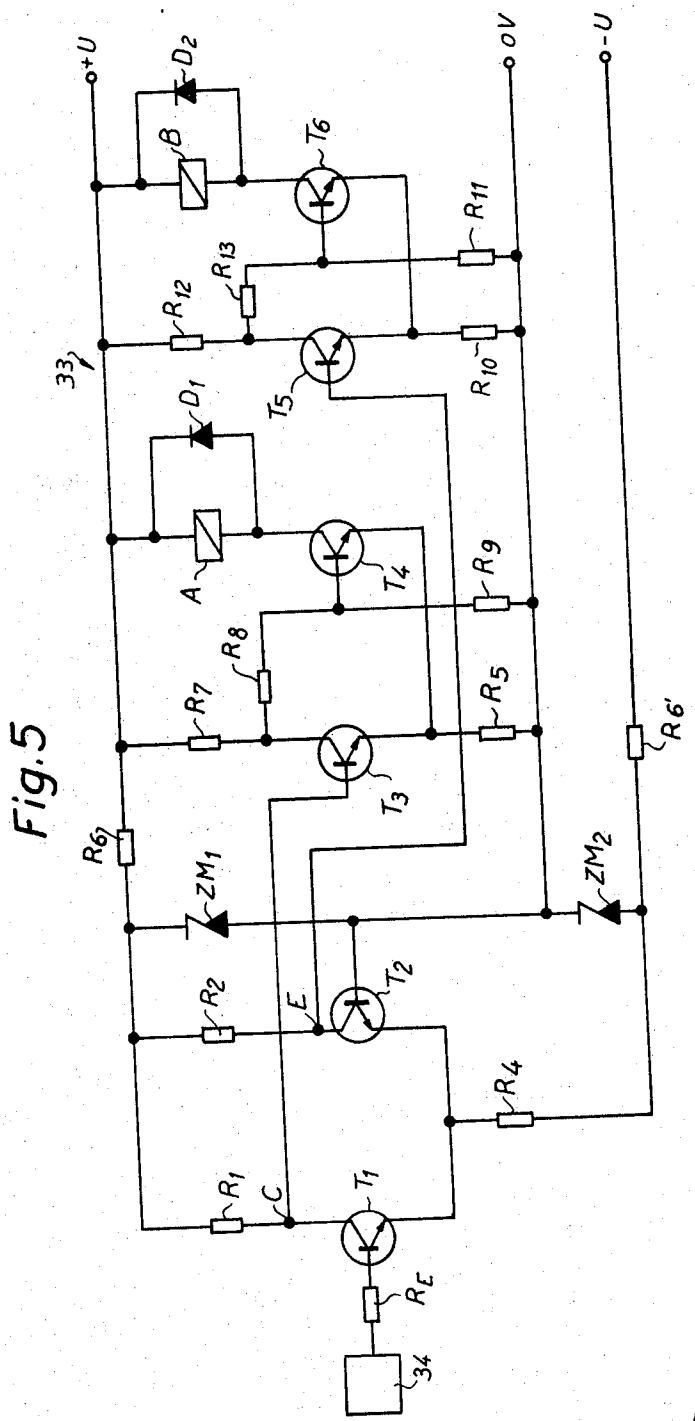


Fig.5

Inventors:
HANS KOCH
WALDEMAR WOCHNOWSKI

BY Michael S. Striker

THEIR ATTORNEY

March 12, 1968 H. KOCH ET AL 3,372,488

APPARATUS FOR CONDITIONING TOBACCO

Filed Nov. 17, 1964 6 Sheets-Sheet 4

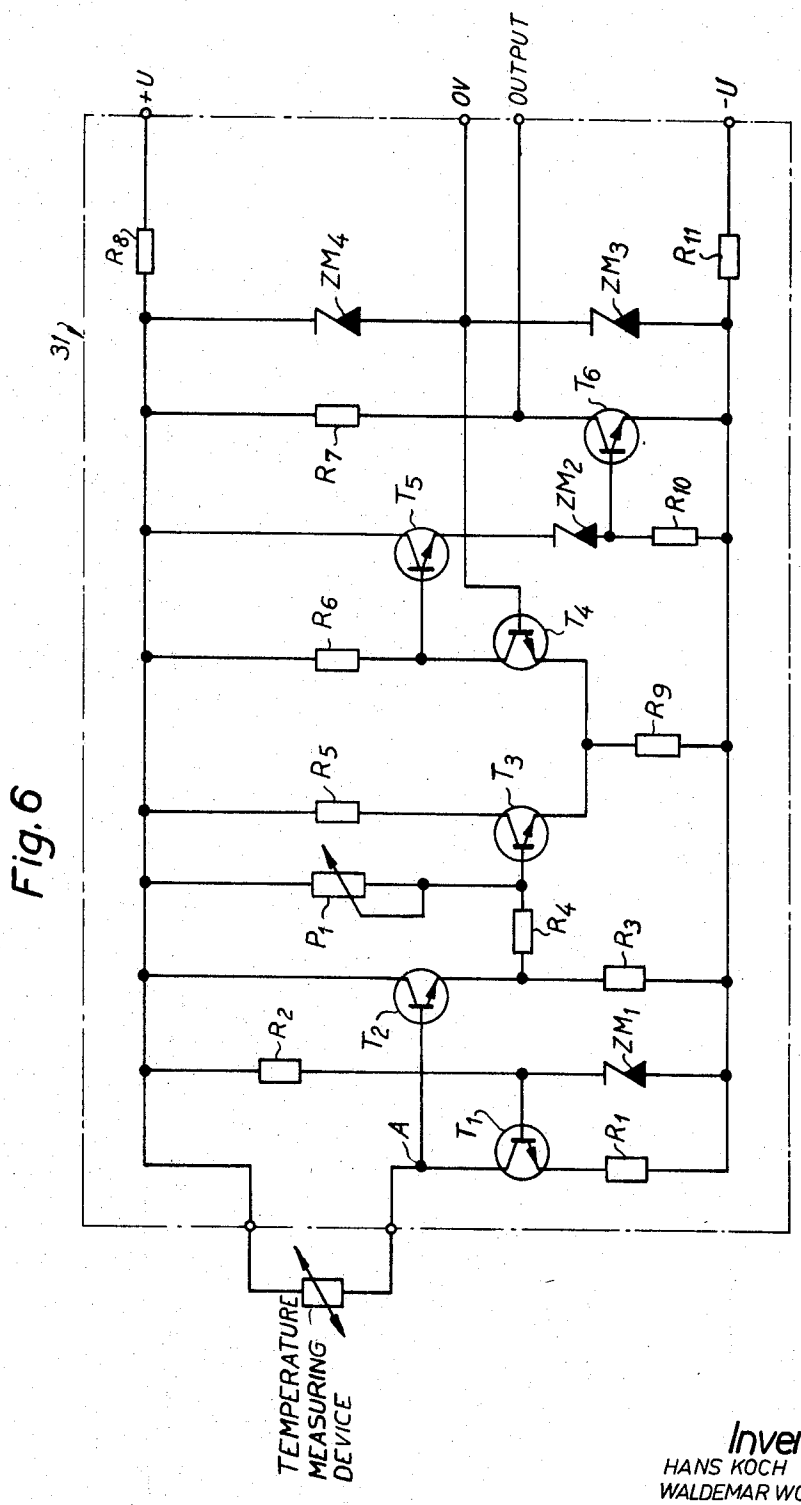


Fig. 6

Inventors:
HANS KOCH
WALDEMAR WOCHNOWSKI

BY Michael S. Striker
THEIR ATTORNEY

March 12, 1968 H. KOCH ET AL 3,372,488

APPARATUS FOR CONDITIONING TOBACCO

Filed Nov. 17, 1964 6 Sheets-Sheet 5

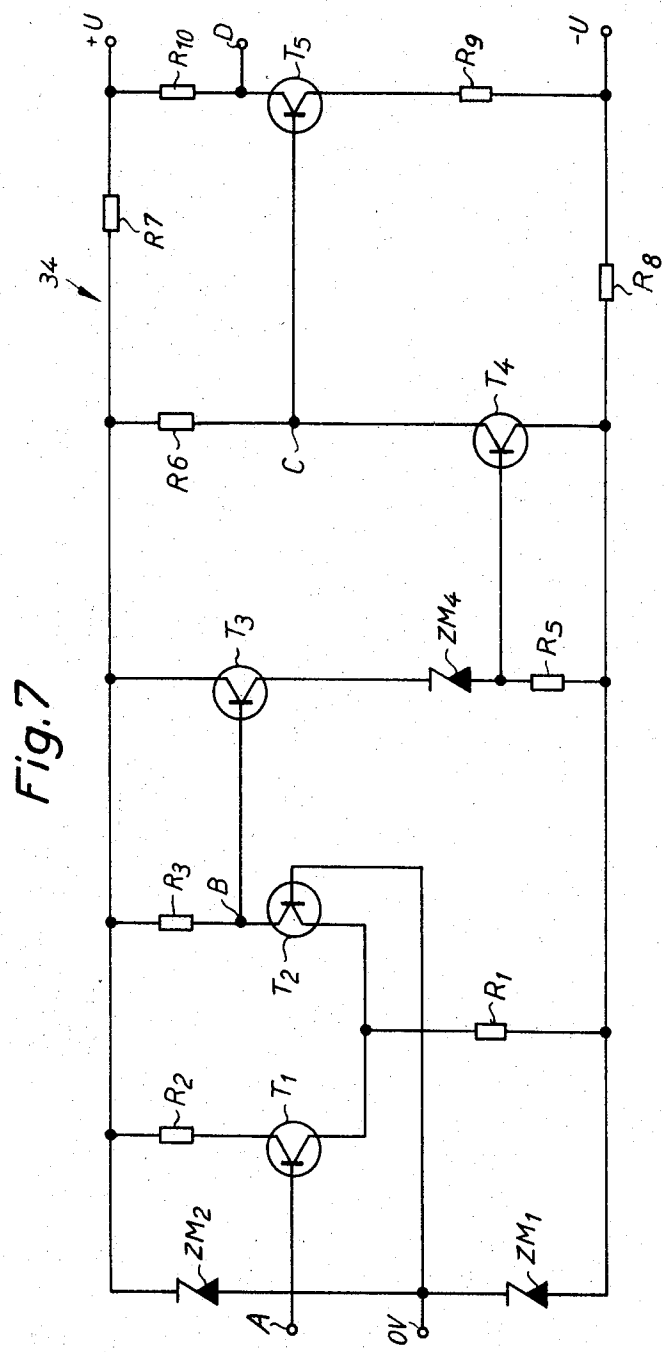


Fig. 7

Inventors:
HANS KOCH
WALDEMAR WOCHNOWSKI

BY Michael S. Striker
THEIR ATTORNEY

March 12, 1968 H. KOCH ET AL 3,372,488

APPARATUS FOR CONDITIONING TOBACCO

Filed Nov. 17, 1964 6 Sheets-Sheet 6

Fig.8

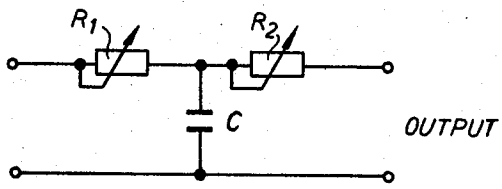


Fig.9

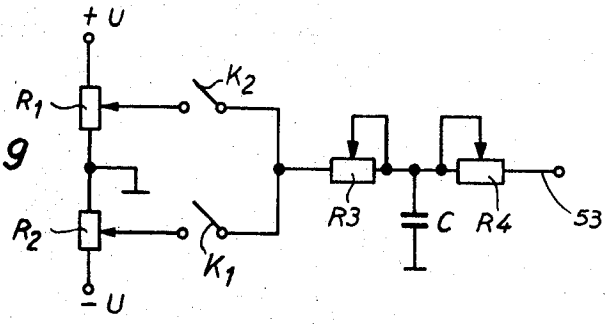
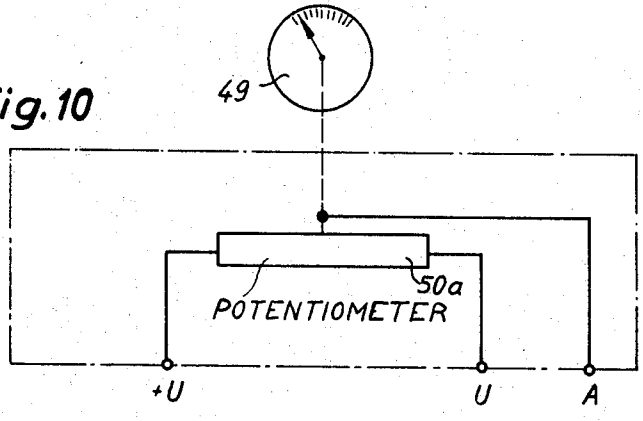


Fig.10



Inventors:
HANS KOCH
WALDEMAR WOCHNOWSKI

BY Michael S. Striker
THEIR ATTORNEY

United States Patent Office 3,372,488
Patented Mar. 12, 1968

3,372,488

APPARATUS FOR CONDITIONING TOBACCO

Hans Koch, Hamburg-Rahlstedt, and Waldemar Wochnowski, Hamburg, Germany, assignors to Hauni-Werke Korber & Co. K.G., Hamburg-Bergedorf, Germany

Filed Nov. 17, 1964, Ser. No. 411,788
Claims priority, application Great Britain, Nov. 18, 1963, 45,434/63
10 Claims. (Cl. 34—46)

ABSTRACT OF THE DISCLOSURE

Moist tobacco is advanced through a conditioning chamber receiving two heated fluids one of which expels some and the other of which expels the remainder of surplus moisture from tobacco. A detector measures the moisture content upstream of the conditioning chamber and regulates the operation of an adjuster which controls the admission of the one heated fluid. A weighing device measures the weight of tobacco ahead of the conditioning chamber and regulates the operation of a second adjuster which also controls admission of the one heated fluid.

The present invention relates to apparatus for conditioning tobacco, and more particularly to improvements in drying of tobacco leaves or shreds. Still more particularly, the invention relates to drying of tobacco by means of two fluids, such as hot air and steam.

In conditioning of tobacco, it is very important that the moisture content should remain constant. Tobacco which is too moist might contaminate certain parts of the machine to bring about disturbances and lengthy interruptions in operation. Also, and when the tobacco is used in the manufacture of cigarettes, excessive or insufficient moisture content might affect the quality of cigarettes. A particularly serious drawback of tobacco whose moisture content varies is that changes in moisture content affect the weight of cigarettes. If the tobacco is too dry, the weight of the cigarettes is reduced and, in order to increase the weight, the manufacturer must use more tobacco which adds considerably to the manufacturing cost. Dry tobacco breaks up easily and produces too much dust.

Accordingly, it is an important object of the present invention to provide a novel apparatus for conditioning tobacco in such a way that the actual moisture content of conditioned tobacco corresponds exactly or approximates very closely the desired moisture content, that the moisture content may be maintained at a desired value despite eventual changes in the rate (in kilograms per hour) at which the tobacco is being fed to the conditioning apparatus, and that the apparatus may automatically respond to a number of factors which might affect the moisture content of treated material.

Another object of the invention is to provide a conditioning apparatus for tobacco leaves or shredded tobacco and to construct the apparatus in such a way that its component parts will respond automatically to a series of different factors which might influence the moisture content.

A further object of the invention is to provide an apparatus of the just outlined characteristics which is capable of conditioning large quantities of tobacco per unit of time, which is of compact construction, which operates automatically, and which may be used with equal advantage in treatment of shredded tobacco or in treatment of tobacco leaves.

An additional object of the invention is to provide a tobacco conditioning apparatus which is constructed in such a way that it can detect, and counteract the influence of, factors which might result in changes in moisture content before the treatment is completed so that such influences may be eliminated or counteracted before the corresponding batch of tobacco leaves the apparatus.

Briefly stated, one feature of the present invention resides in the provision of apparatus of controlling the moisture content of tobacco which contains a surplus of moisture. The apparatus comprises the steps of conveying a stream of moist tobacco through a conditioning zone in which the tobacco is relieved of surplus moisture by exchanging heat with two fluids one of which expels from tobacco some surplus moisture and the other of which expels the remainder of surplus moisture, means for measuring the moisture content of the stream ahead of the conditioning zone, means for adjusting the exchange of heat between the tobacco stream and the one fluid when the measured moisture content deviates from a predetermined value, means for measuring the weight of tobacco per unit length of the tobacco stream ahead of the conditioning zone, and means for adjusting the exchange of heat between the stream and the one fluid when the measured weight deviates from a predetermined value.

In accordance with another important feature of the present invention, the apparatus may also include means for measuring the moisture content of conditioned tobacco at a point past the conditioning zone and means for adjusting the exchange of heat between the tobacco stream and the other fluid when the measured moisture content of conditioned tobacco deviates from a predetermined value. The adjustment in the exchange of heat between the tobacco stream and the other fluid may be effected in stepwise fashion and the arrangement is preferably such that the one fluid (for example, heated air) exchanges heat with the tobacco stream before the tobacco is treated by the other fluid. If necessary, the ratio of surplus moisture which is expelled by the fluids may be varied, i.e., one of the fluids may expel a greater or lesser percentage of surplus moisture and the other fluid will expel the remainder of such surplus moisture. The one fluid preferably comes in direct heat exchanging contact with the tobacco stream and the exchange of heat between the tobacco stream and the other fluid preferably takes place indirectly, for example, through the walls of the drier which defines the conditioning zone.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved apparatus itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of a specific embodiment with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic side elevational view of an apparatus for conditioning shredded tobacco which is constructed in accordance with our invention;

FIG. 2 is an enlarged transverse vertical section as seen in the direction of arrows from the line II—II of FIG. 1 and illustrates a portion of a dielectric moisture detector;

FIG. 3 is a diagram showing the manner in which the temperature of heating air changes in response to changes in the rate of tobacco flow and/or in response to changes in the moisture content of incoming tobacco;

FIG. 4 is a schematic circuit diagram showing the elements and connection of the moisture content and temperature sensing and measuring devices indicated in FIG. 1;

FIG. 5 is a schematic circuit diagram of a servo amplifier unit employed in the apparatus of FIG. 1;

FIG. 6 is a schematic circuit diagram of a temperature measuring device which is used in the apparatus of FIG. 1;

FIG. 7 is a schematic circuit diagram of a control amplifier which is used in the apparatus of FIG. 1;

FIG. 8 is a schematic circuit diagram of one form of time-delay device employed in the apparatus of FIG. 1;

FIG. 9 is a schematic circuit diagram of another time-delay device; and

FIG. 10 is a schematic diagram of a pressure gauge and means for sensing changes therein.

Referring to FIG. 1, there is shown a conditioning apparatus for tobacco including an inclined cylindrical drier **1** mounted on rollers **4** provided at the upper ends of supporting legs **2, 3**. This drier comprises an annulus of teeth **6** which mesh with a pinion **5**. The pinion **5** is driven by an electric motor **5***a* through the intermediary of a variable speed transmission **5***b*. The apparatus further comprises an electric heater **7** which is provided at one end of the drier **1** and serves to heat a current of air which enters in the direction indicated by arrows **7***a*. Such air is drawn by a suction fan **8** whose suction side is connected with a suction duct **8***a*, and the inlet of this suction duct accommodates the heater **7**. The pressure side of the fan **8** is connected with a supply duct **29** which directs the current of preheated air into the left-hand end (intake end) of the conditioning chamber or zone **1***a* defined by the drier **1**. The suction duct **8***a* has a lateral inlet opening which may be sealed or exposed by a damper valve **9** to admit requisite quantities of unheated air into the current of preheated air which flows to the fan **8**, i.e., the temperature of the air current in the supply duct **29** may be regulated independently of the heater **7** by changing the position of the valve **9**. The direction in which a second current of air may be admitted into the suction duct **8***a* is indicated by an arrow **7***b*. The heater **7** may but need not be of the adjustable type and this heater may be replaced by an oil, gas or steam heater.

The conditioning chamber **1***a* of the drier **1** accommodates a series of heating coils **10** which convey steam or another heating fluid. The inlets of the coils **10** are connected to a header **11***a* which receives steam from a supply conduit **11** provided with a suitable steam valve **12**. The supply conduit **11** is located at the right-hand end (discharge end) of the drier **1**. This discharge end is closed by a hood **18** which serves to collect spent air and accommodates a filtering drum **20** driven by an electric motor **19**. The hood **18** is connected with an evacuating conduit **21** provided with an adjustable valve **23** and connected to the suction side of an exhaust fan **22**. Instead of conveying steam, the supply conduit **11** may admit hot combustion products or another fluid medium.

The material to be conditioned forms a stream T of shredded tobacco particles which are fed by an endless belt conveyor **13** to descend onto the upper stringer of a second belt conveyor **13***a* cooperating with a weighing device **54**. From the belt conveyor **13***a*, the stream T descends into a channel **16** forming part of a dielectric moisture detector **25** and thereupon into an inclined chute **17** which feeds the particles into the intake end of the drier **1**. The channel **16** is vibrated by an electric motor **14** through the intermediary of an eccentric **15**.

The channel **16** is shown in FIG. 2. It comprises a centrally located V-shaped measuring trough **24** which is completely filled with tobacco. The remainder of tobacco descends into lateral troughs **24***a*. The manner in which the dielectric detector **25** determines the moisture content of tobacco in the trough **24** is disclosed in the copending application Serial No. 192,834 of Albert Esenwein, filed May 7, 1962, now Patent No. 3,320,528. This detector **25** determines the percentage of moisture in the tobacco stream and feeds such information to a control amplifier **26** which sends electrical impulses through a time delay device **27** to a synchronizing device **28**.

A temperature measuring device **30** extends into the supply duct **29** and is connected with the synchronizing device **28** through a control amplifier **31**. The measuring device **30** enables the apparatus to regulate the temperature of the air current which enters at **7***a* by controlling the position of the valve **9**. This valve is connected with the synchronizing device **28** through a control amplifier **34**, a servo amplifier unit **33** which converts electrical impulses into mechanical impulses, and a servomotor **32** which is coupled to the valve **9**. In the area of the valve **9**, there are provided two limit switches **35, 36** which are connected to a control amplifier **37** and to a programming device **38**. The programming device **38** is connected with the synchronizing device **28**. The temperature measuring device **30**, the control amplifiers **31, 34**, the servo amplifier unit **33** and the servomotor **32** constitute a temperature regulating circuit which also includes a rated value selecting or setting device **39** connected with the synchronizing device **28**.

An endless belt conveyor **40** is located at a level beneath the discharge end of the drier **1** and receives the stream T' of conditioned tobacco to deliver the stream to the channel **41** of a second dielectric moisture detector **42** which is identical with or analogous to the aforementioned detector **25**. This second dielectric detector **42** is connected with a control amplifier **43** and with a synchronizing device **52**. The device **52** is connected with a second rated value selecting or setting device **44**. The valve **12** is adjustable by a servomotor **48** which receives impulses from a servo amplifier unit **47** connected with the synchronizing device **52** and with two control amplifiers **45, 46**. The devices **42, 43, 44, 45, 46, 47** and **48** form a moisture regulating circuit which will detect and, if necessary, control the moisture content of tobacco in the stream T' issuing from the drier **1**. The tobacco stream T' passing through and beyond the channel **41** is fed onto the upper stringer of a take-off belt **57** which delivers the stream to the next processing station, for example, to a cigarette machine. The temperature regulating circuit **30–34, 39** is completed by the tobacco passing through the channel **16** and by heated air passing through the supply duct **29**.

A third regulating circuit comprises a pressure gauge **49** which measures the steam pressure in the conduit **11** downstream of the valve **12** and a control amplifier **50** which is connected in the conductor between the control amplifiers **45, 46**. This third circuit is integrated into the second circuit and includes the parts **12, 46, 47, 48, 49** and **50**. The amplifier **47** produces an electric current which charges a time delay device **51** and produces a discharge current in a conductor **53** connecting the device **51** with the synchronizing device **52**.

In accordance with a very important feature of the present invention, the belt conveyor **13***a* cooperates with the weighing device **54** which is connected with the synchronizing device **28** through a control amplifier **55** and a time delay device **56**. The weighing device **54** determines the quantity of tobacco per unit of time (for example, in kilograms per hour) and feeds such information to the amplifier **55** which produces electrical impulses and sends such impulses to the synchronizing device **28**. The first regulating circuit **30–34, 39** is controlled by the impulses which are transmitted by the amplifiers **26, 55** through the time delay devices **27, 56** and which are respectively generated by the measuring device **25** and weighing device **54**. The limit switches **35, 36** effect stepwise return movement of the valve **9** into a neutral (median) position by simultaneous stepwise regulation of the heating effect upon the walls of the drier **1**.

Referring to FIG. 4, there is shown the electric circuit of the devices **25** to **27**. It will be seen that the tobacco stream T whose moisture content is to be measured passes through the channel **16** one end portion of which supports a measuring condenser **25***a*. Frequency and oscillation amplitude of the channel **16** (and hence the speed of the tobacco stream T'' and the limits of the measuring trough **24**) are controlled in such a way that the trough **24** always contains the same quantity of tobacco particles.

The condenser **25***a* forms part of a high frequency oscillating circuit which further includes three con-

densers C25, C26, C27, C34, a coil L4, and a variable rotary condenser CW which is driven at constant speed by a motor M. Coils L2, L3 and a condenser CK couple the high frequency oscillating circuit in three-point connection with a high frequency generator formed of a pentode V1, a coil L1 and condensers C16, C19, R30 is a grid leak resistor, and R31 is a grid resistor. Condensers C18, C17 couple the high frequency generator with a high frequency rectifier V5/1. The control grid of a pentode V3 is actuated through a resistor R32. The plate voltage of the pentode V3 actuates the screen grid of the pentode V1. Condensers C15, C20 and C21 are filter condensers. R33, R20, R36 and R37 are voltage divider resistors. R34 and R25 are plate resistors.

A high frequency rectifier V5, resistors R49, R50, a condenser C29 and a pentode V6 form a vacuum tube voltmeter. In the plate circuit of the pentode V6 is inserted a meter 60 to indicate the percentage of moisture. Actuating impulses for the regulation of drying by hot air are taken off at the cathode of the pentode V6 over resistors R52, R54 and a variable resistor (potentiometer) P7. The resistor P7 controls the accuracy of the moisture content measurement. C32 is a filter condenser. R101, P2, R55 and R53 are voltage divider resistors. A thermistor TH and resistors R66, R65, R71, R72 and P6 (potentiometer) form a Wheatstone bridge circuit. Voltage changes on the resistor P6 are conducted by potentiometers P3, P2, P7 and resistors R55 and R52 to the suppressor grid of the pentode V6 of the vacuum tube voltmeter. C31 is a filter condenser and R51 is the biasing resistor for the suppressor grid of the pentode V6.

The circuit of FIG. 4 operates as follows:

The motor M drives the rotatable condenser CW at constant speed so that the fundamental frequency of the high frequency circuit L4, C26 and measuring condenser 25*a* will be periodically varied. The frequency of the high frequency generator is amplitude stabilized by means of coupling of tubes V5 and V3, and this frequency is so selected that it lies about in the middle of the periodically changing fundamental frequency. Consequently, the extent of the frequency variation caused by rotation of the condenser CW is selected in such a way that, even when the measuring condenser 25*a* in the trough 24 is loaded and the predetermined extent of moisture content in the cycle reached, the high frequency circuit will once during each revoution of the rotating condenser CW be in resonance with the high frequency generator within the desired range of the moisture content. In this manner, there will exist at the measuring condenser 25*a* a high frequency field with the frequency of the high frequency generator the amplitude of which is modulated with the frequency of the rotating condenser CW. Inasmuch as the vacuum tube voltmeter measures only the voltage peaks, and such peaks always bear a linear relationship to the contents (moisture content and quantity) of the measuring condenser 25*a*, the indicator of the vacuum tube voltmeter can be calibrated to indicate the percentage of moisture content.

Inasmuch as, with every high frequency measurement, here also the measurement indication depends on the temperature of the contents of the measuring condenser 25*a*, this condenser has built into it the temperature feeler or sensor TH so that one receives at the potentiometer P6 of the Wheatstone bridge circuit voltage changes which correspond to changes in tobacco temperature. Such voltage changes will vary the grid potential of the pentode V6 of the vacuum tube voltmeter so that faulty measurements because of temperature variations of the tobacco stream T are compensated for. The voltages appearing at the cathode of the pentode V6 are hence a measure of the moisture content.

The circuit of the devices 42, 43 is analogous to the circuit of FIG. 4.

Referring to FIG. 5, there is shown the circuit of the servo amplifier unit 33 which is employed in the apparatus of FIG. 1 for the purpose of adjusting the servomotor 32 in response to impulses received from the control amplifier 34.

There are two output relays A and B one of which will operate to make a positive correction, that is to say to remedy a positive deviation. The other relay will be operated to correct what woud amount to a negative deviation from normal operation. the Resistors R6 and R6', in connection with the Zener diodes ZM1 and ZM2 stabilize the operating voltage of the push-pull first stage of the amplifier which includes transistors T1 and T2, working resistors R1 and a common emitter resistor R4. The first stage of the amplifier is followed by a Schmitt trigger stage with relay outputs. The Schmitt trigger stages include transistors T3, T4, and T5, T6 respectively, resistors R7, R5, R8, R9 and R10, R11, R12, R13 respectively, and the output relays A, B respectively. The diodes D1 and D2 are protective diodes. Referring further to the circuit shown in FIG. 5, it will be seen that a signal or impulse received from the amplifier 34 will appear as a signal across or on entrance resistance RE and this signal will be ampified by the first stage of the amplifier unit 34. Now, depending upon the nature of the signal, that is to say whether it requires a positive correction or a negative correction, the effect will be felt either at a point C near transistor T1, or at a point E near transistor T2. When the signal appearing at C calls for correction, it is fed further into the related Schmitt trigger stage so as to actuate the relay A which may be connected by suitable wiring to close the circuit of the servomotor 32 for correcting in a positive sense the valve 9 in any well known manner. Similarly, if the impulse is registered at point E in FIG. 5 indicating that a negative correction is needed, then that impulse is amplified in the amplifier stage and will influence its corresponding Schmitt trigger stage so as to actuate the relay B and thus bring about a correspondingly desired correction of the position of the valve 9. Relays A and B are as mentioned connectable through power lines to control or regulate the operation of the servomotor 32. The circuit of the amplifier 47 is analogous to the circuit of FIG. 5.

Referring now to FIG. 6, there is shown the circuit of the control amplifier 31 which amplifies the temperature indications of the temperature measuring device 30 and at the same time produces output impulses or voltages responsive to the temperature variations, but in linear relationship to these temperature variations. In order to do this, the circuit shown in FIG. 6 shows the temperature measuring device 30 or as also called a thermistor, feeding into an initial circuit stage with a transistor T1 connected with a resistor R1, Zener-diode ZM1 and a resistor R2 to maintain at a constant level the current despite the changing resistance of the measuring device 30. The point A is connected through the adapter transistor T2 with the emitter resistor R3 and the resistor R4 to a push-pull amplifier stage T3, T4, R4, R3, R5, R6, R9. This arrangement is followed by a voltage amplifier stage with transistors T5, T6, Zener diode ZM2, and resistors R10, and R7. Referring again to the circuit diagram, P1 is a matching potentiometer and resistors R11, R8 and Zener diodes ZM3, ZM4 serve for voltage stabilization in the circuit.

The circuit of FIG. 6 operates as follows:

By means of the transistor stage T1, the resistance variations which are dependent upon temperature changes in the temperature measuring device 30 have normally resulting current variations blocked at point A in the circuit so that a linear relationship between the temperature of the thermistor and the voltage at point A arises. In the push-pull amplifier stage which includes the transistors T3 and T4, for power amplification, the influence of variations in the temperature of surrounding air is eliminated and as a result with voltage amplified by transistors T5 and T6, there is available at the output

terminal of the circuit from transistor T6, a voltage which is in linear correspondence and relationship with the temperature of the measuring device 30.

In FIG. 7 there is shown the circuit diagram of the control amplifier 34 which might be called a regulating amplifier by which amplification is provided for impulses transmitted to the servo amplifier unit 33. As shown in this view, the resistors R7, R8 and the Zener diodes ZM1, and ZM2, serve for the stabilization of the supply voltage. The transistors T1 and T2 with their working resistors R2 and R3 and the emitter resistor R1 form a push-pull amplifier stage, which is coupled by a coupling network including transistor T3, Zener diode ZM4 and resistor R5 with the transistor T4 and the resistor R6, with a voltage amplifier stage connected to its output, the voltage amplifier stage being in turn followed by a current amplifier stage which includes the transistor T5 and the two resistors R9 and R10. The operation of the circuit shown in FIG. 7 may be explained briefly as follows. When a signal or impulse coming from the synchronizing device 28 appears at a point A of the input of the control amplifier 34, it will then appear thereafter at point B with its power amplified, and at point C with its voltage amplified, and at point D with its current amplified. Thus it is seen that at the point D of the amplifier a proportionally high amplified deviation signal impulse appears. The push-pull amplifier stage shown in the circuit, renders the control amplifier unresponsive to ambient temperature variations. The circiut of the amplifier 45 or 46 is analogous to the circuit of FIG. 7.

Referring now to FIG. 8, there is shown the circuit of the time delay device 56 which is used in order to delay impulses which are received from the weighing device 54 to be integrated into the circuit at a later stage, namely at a stage to insure that the temperature of air in the supply duct 29 changes at the time when that portion of the tobacco stream T which has caused the weighing device 54 to send an impulse to the amplifier 55 reaches the intake end of the drier 1. In the circuit the input is shown at the left and the output is shown at the right, it being seen that there is a resistance-capacitance circuit formed of a variable resistance R1 in series and bridging capacitor C, there being an output series resistor R2 following the capacitor C. In accordance with well known circuit principles, the time constant of the circuit is determined by the values of the resistance R1 and the capacitor, and when the capacitor has been fully charged it then discharges after the predetermined time interval, through output resistor R2 at which time the impulse can be employed in the synchronizing device 28 as explained. The construction of the time delay device 57 is analogous.

FIG. 9 shows the circuit of the time delay device 51. This circuit is of particular utility in connection with the servo amplifier unit 47 shown in FIG. 5. It comprises resistors R1 and R2 connected in series across output terminals plus U, and minus U of the power amplifier circuit seen in FIG. 5, with their center tap grounded. The movable arms of resistors R1 and R2 are respectively connected to switches K2 and K1 which are normally open and the remote terminals of both switches are connected together and to variable resistor R3 which with capacitor C forms a time delay network somewhat similar to the network seen in FIG. 8, there being an output series resistor connected to the network, as seen at R4, through which the capacitor C is discharged after the predetermined time interval as set by the time constant of the circuit, thus passing on the impulse after the desired time delay. The impulse is transmitted by closing of either of contacts K1 or K2.

FIG. 10 shows one means for deriving an impulse or signal from the pressure gauge 49. As seen in this brief detailed view, the amplifier 50 includes a potentiometer 50*a* which may be connected at its ends to a fixed source of voltage and with its movable potentiometer arm connected to an output terminal. The movable potentiometer arm may be rotatable and may be thereby mechanically coupled to the rotatable shaft of the pressure gauge 49 seen in FIG. 1 so that as it assumes one position or another from a zero position or a no position variations in position of its potentiometer arm cause different or varied voltages to appear at the output A. It is also apparent that the circuit of FIG. 10 may also be employed for other purposes relating to various movable parts of the machine seen in FIG. 1 such as to indicate a displacement of a weighing scale on the device 54.

The apparatus of FIG. 1 operates as follows:

The tobacco stream T advances in the direction indicated by an arrow 13*b* and passes from the belt conveyor 13 onto the belt conveyor 13*a* so that the weighing device 54 determines the weight per unit of time (kg./h.) and feeds such information to the amplifier 55. The tobacco stream T then advances into the channel 16 of the dielectric detector 25 and the latter determines the moisture content (in percent) of that portion of the tobacco stream which passes through the trough 24 of the channel 16 to deliver corresponding impulses to the amplifier 26. The thus weighed and measured tobacco stream T then enters the chute 17 and is admitted into the drive 1. The drier is inclined downwardly in a direction toward the discharge end so that the stream T advances from the intake end toward the discharge end and is conditioned by hot air issuing from the supply duct 29 and by heat radiated from the cylindrical wall which is heated by the coils 10. The coils 10 carry agitating blades or paddles 10*a* which exchange heat with tobacco particles to insure more uniform conditioning of the tobacco stream. The current of air issuing from the supply duct 29 is effective mainly in the region of the intake end of the drier 1 because the direction of air flow is concurrent with the direction in which the tobacco stream T advances through the conditioning chamber 1*a*. The moisture which is withdrawn from the tobacco stream T is evacuated through the hood 18 by passing through the evacuating conduit 23 and to the outlet of the exhaust fan 22.

The tobacco stream T' which is discharged from the conditioning chamber 1*a* of the drier 1 descends onto the belt conveyor 40 and is fed into the channel 41 of the dielectric detector 42 whereby the detector produces impulses which are amplified at 43 and are transmitted to the synchronizing device 52. If the measured result (i.e., the percentage of moisture in the stream T' passing in the channel 41) deviates from a desired value, the dielectric detector 42 will initiate a change in the pressure of steam which circulates through the coils 10 to thereby alter the heating effect upon the tobacco stream in the chamber of the drier 1.

It is now assumed that as the drier 1 rotates, that the heater 7 heats the inflowing air current to a certain temperature, and that the coils 10 heat the cylindrical wall of the drier 10 to a certain temperature so that the tobacco stream T' issuing from the chamber 1*a* has a moisture content which corresponds exactly to a desired value. In such instance, the sum of all current impulses generated by the devices 25, 54, 30, 39 and transmitted to the synchronizing device 28 equals zero. Thus, the position of the valve 9 remains unchanged. The sum of all impulses transmitted to the synchronizing device 52 also equals zero and the position of the valve 12 remains unchanged.

If the quantity of tobacco in the stream T passing over the belt conveyor 13 changes, the weighing device 54 will cause the amplifier 55 to send an impulse which is delayed by the device 56 and is transmitted to the synchronizing device 28 which sends a corresponding impulse to the servomotor 32 so that the latter adjusts the valve 9 until the ratio of heated air (arrows 7*a*) to unheated atmospheric air (arrow 7*b*) is altered sufficiently to insure that the moisture content of tobacco issuing from the drying chamber 1*a* again equals the desired

value. Such adjustment in the temperature of air which comes in contact with tobacco is effected without delay because the cooling effect of air entering at **9** is instantaneous. Of course, as the temperature of air flowing through the supply duct **29** changes, the measuring device **30** senses such change and causes the amplifier **31** to send an impulse to the synchronizing device **28**. The adjustment is terminated when the sum of all impulses transmitted to the device **28** again equals zero. The time delay device **56** is adjusted in such a way that the temperature of the air current flowing into the chamber **1***a* of the drier **1** is changed at the time the chamber receives tobacco at the new rate. In other words, the delay caused by the device **56** corresponds to the interval necessary for a batch of weighed tobacco to advance from the belt conveyor **13***a* to the intake end of the drier **1**.

The manner in which the drying effect upon the tobacco stream T is changed in response to changes in the rate at which the tobacco particles are admitted into the channel **16** of the dielectric detector **25** can be observed by referring to the diagram of FIG. 3. That portion of the tobacco stream T which is already accommodated in the chamber **1***a* of the drier **1** is not affected (or is affected very little) by changes in the temperature of the air current. If the rate of tobacco flow is reduced, the temperature of the air current is also reduced (see the left-hand portion of the lowermost curve in FIG. 3). If the rate at which the tobacco is admitted increases, the temperature of the air current is raised accordingly (see the left-hand portions of the two upper curves in FIG. 3). The straight portions of the curves indicate the temperature in the interior of the chamber **1***a*.

The just described mode of changing the temperature of the air current is particularly desirable when the rate of tobacco flow is changed for a relatively short period of time and the tobacco thereupon begins to flow at the normal rate. However, if the moisture content of the tobacco stream is affected by factors other than those which are measured by the weighing device **54**, by the temperature measuring device **30** and by the dielectric detector **25**, adjustments are made in response to impulses from the dielectric detector **42**. Such adjustments will be made in response to longer-lasting disturbances whose duration is such that their effects are detected by the dielectric detector **42**. This detector will sense gradual changes in moisture content and the amplifier **43** sends corresponding impulses to the synchronizing device **52** which causes the servomotor **48** to adjust the valve **12** and to thereby change the steam pressure in the coils **10**. Thus, the valve **12** will insure that the actual moisture content of tobacco issuing from the drier **1** again equals the desired value.

When the synchronizing device **52** sends impulses to the servomotor **48**, such impulses pass through the amplifiers **46**, **47** and are communicated to the condenser of the time delay device **51** which is charged and, after a predetermined interval of time, discharges a current through the conductor **53**. Such current is proportional to the current flowing from the generator **43** to the receiving device **52** but is of opposite sign. Consequently, the adjustment of the valve **12** through the servomotor **48** is delayed for an interval of time which corresponds to the setting of the time delay device **51**. This setting is such that the delay corresponds to the interval of time which elapses from the moment when the steam pressure changes to the moment when the dielectric detector **42** actually detects changes in moisture content in response to such adjustment in steam pressure.

When the steam pressure is adjusted by changing the setting of the valve **12**, the pressure gauge **49** will cause the amplifier **50** to send an impulse which will produce a damping effect upon the servomotor **48**, i.e., changes in the setting of the valve **12** will be effected gradually.

If the moisture content of the tobacco stream T changes before the stream actually enters the drier **1**, such change is detected by the dielectric detector **25** and the resulting impulse is sent on the synchronizing device **28** which causes the servomotor **32** to adjust the position of the valve **9** in exactly the same way as was described in connection with the operation of the weighing device **54**. The devices **26**, **55** comprise adjusting elements (see FIG. 6) which may change their sensitivity, i.e., which will determine the exact range of changes in the rate of tobacco flow or in the moisture content of incoming tobacco to which the devices **26**, **55** respond by producing impulses which effect adjustments in the setting of the valve **9**.

The rated value setting device **44** is provided with a potentiometer or a similar selector which enables the operator to select the desired moisture content of tobacco which issues from the drier **1**.

If the valve **9** abuts against one of the limit switches **35**, **36** for a considerable interval of time, its setting cannot be changed in one direction. This will be readily understood since the valve **9** will engage the limit switch **35** or **36** at the time it is moved to one of its extreme positions. In such instance, the corresponding limit switch **35** or **36** initiates an impulse which causes the valve **9** to pivot stepwise and through small increments back toward its neutral position. The duration of adjustment to complete a step equals the time necessary to move a tobacco particle from the intake end to the discharge end of the drier **1**. During such stepwise movement of the valve **9** to neutral position, the servomotor **48** effects corresponding adjustments in the setting of the valve **12** to change the heating effect of the coils **10**.

The synchronising devices **28**, **52** are simple branching points in which all wires belonging to the regulating respectively control circuits are meeting. The setting devices **39**, **44** are simple potentiometers with an applied continuous voltage by which a selected current as a nominal value is directed to the branching points.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can, by applying current knowledge, readily adapt it for various applications without omitting features which fairly constitute essential characteristics of the generic and specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. An apparatus for controlling the moisture content of tobacco, comprising a drier defining a conditioning chamber; means for advancing a stream of moist tobacco into and through said chamber; first and second adjustable supply means for respectively admitting into said drier a first and a second heated fluid so that the fluids exchange heat with and respectively expel some surplus moisture and the remainder of surplus moisture from tobacco passing through said chamber; detector means for measuring the moisture content of the tobacco stream ahead of said drier; first adjusting means for adjusting said first supply means when the moisture content measured by said detector means deviates from a predetermined value; a weighing device for measuring the weight of tobacco per unit length of said stream ahead of said drier; and second adjusting means for adjusting said first supply means when the actual weight measured by said weighing device deviates from a predetermined weight.

2. An apparatus as set forth in claim **1**, wherein each of said adjusting means comprises adjustable control amplifier means for initiating adjustments in the temperature of said first fluid independently of each other.

3. An apparatus as set forth in claim **1**, wherein said first fluid is air and wherein said first supply means comprises duct means for conveying a current of air into said drier so that the air is admitted concurrently with the tobacco stream, and means for heating said current.

4. An apparatus as set forth in claim **2**, wherein each of said adjusting means further comprises time delay

means for timing the adjustment of said first supply means in response to impulses produced by the respective amplifier means.

5. An apparatus for controlling the moisture content of tobacco, comprising a drier defining a conditioning chamber; means for advancing a stream of moist tobacco into and through said chamber; first and second adjustable supply means for respectively admitting into said drier a first and a second heated fluid so that the fluids exchange heat with and respectively expel some surplus moisture and the remainder of surplus moisture from tobacco passing through said chamber; detector means for measuring the moisture content of the tobacco stream ahead of said drier; first adjusting means for adjusting said first supply means when the moisture content measured by said detector means deviates from a predetermined value; a weighing device for measuring the weight of tobacco per unit length of said stream ahead of said drier; second adjusting means for adjusting said first supply means when the actual weight measured by said weighing device deviates from a predetermined weight; temperature measuring means provided in said first supply means for measuring the temperature of said first fluid; and third adjusting means for adjusting said first supply means in response to changes in temperature detected by said temperature measuring means.

6. An apparatus for controlling the moisture content of tobacco, comprising a drier defining a conditioning chamber; means for advancing a stream of moist tobacco into and through said chamber; first and second adjustable supply means for respectively admitting into said drier a first and a second heated fluid so that the fluids exchange heat with and respectively expel some surplus moisture and the remainder of surplus moisture from tobacco passing through said chamber; first and second detector means for respectively measuring the moisture content of the tobacco stream ahead of and past said drier; first and second adjusting means for adjusting the first and second supply means when the moisture content measured by said first and second detector means respectively deviates from a first and second predetermined value; a weighing device for measuring the weight of tobacco per unit length of said stream ahead of said drier; and third adjusting means for adjusting said first supply means when the actual weight measured by said weighing device deviates from a predetermined weight.

7. An apparatus as set forth in claim 6, wherein said drier is a rotary cylinder having an intake end and a discharge end and wherein said second detector means comprises a dielectric detector adjacent to the discharge end of said cylinder.

8. An apparatus as set forth in claim 6, further comprising first rated value selecting means operatively connected with said first and second adjusting means and second rated value selecting means operatively connected with said third adjusting means.

9. An apparatus for controlling the moisture content of tobacco, comprising a drier defining a conditioning chamber; means for advancing a stream of moist tobacco into and through said chamber; first and second adjustable supply means for respectively admitting into said drier a first and a second heated fluid so that the fluids exchange heat with and respectively expel some surplus moisture and the remainder of surplus moisture from tobacco passing through said chamber; detector means for measuring the moisture content of the tobacco stream ahead of said drier; first adjusting means for adjusting said first supply means when the moisture content measured by said detector means deviates from a predetermined value; a weighing device for measuring the weight of tobacco per unit length of said stream ahead of said drier; second adjusting means for adjusting said first supply means when the actual weight measured by said weighing device deviates from a predetermined weight; and further adjusting means for effecting stepwise adjustments of said first supply means.

10. An apparatus as set forth in claim 9, wherein said first supply means comprises duct means connected with the intake of said drier, blower means in said duct means for directing a current of air into said drier, heating means for heating the curent of air in said duct means, and adjustable valve means located upstream of said blower means for admitting into said duct means controlled quantities of cool air to regulate the temperature of said current, all of said adjusting means being operatively connected with said valve means.

References Cited

UNITED STATES PATENTS

2,768,629	10/1956	Maul	34—46 X
3,039,201	6/1962	Esenwein et al.	34—48

FREDERICK L. MATTESON, JR., *Primary Examiner.*

MELVIN D. REIN, *Examiner.*

A. D. HERRMANN, *Assistant Examiner.*