

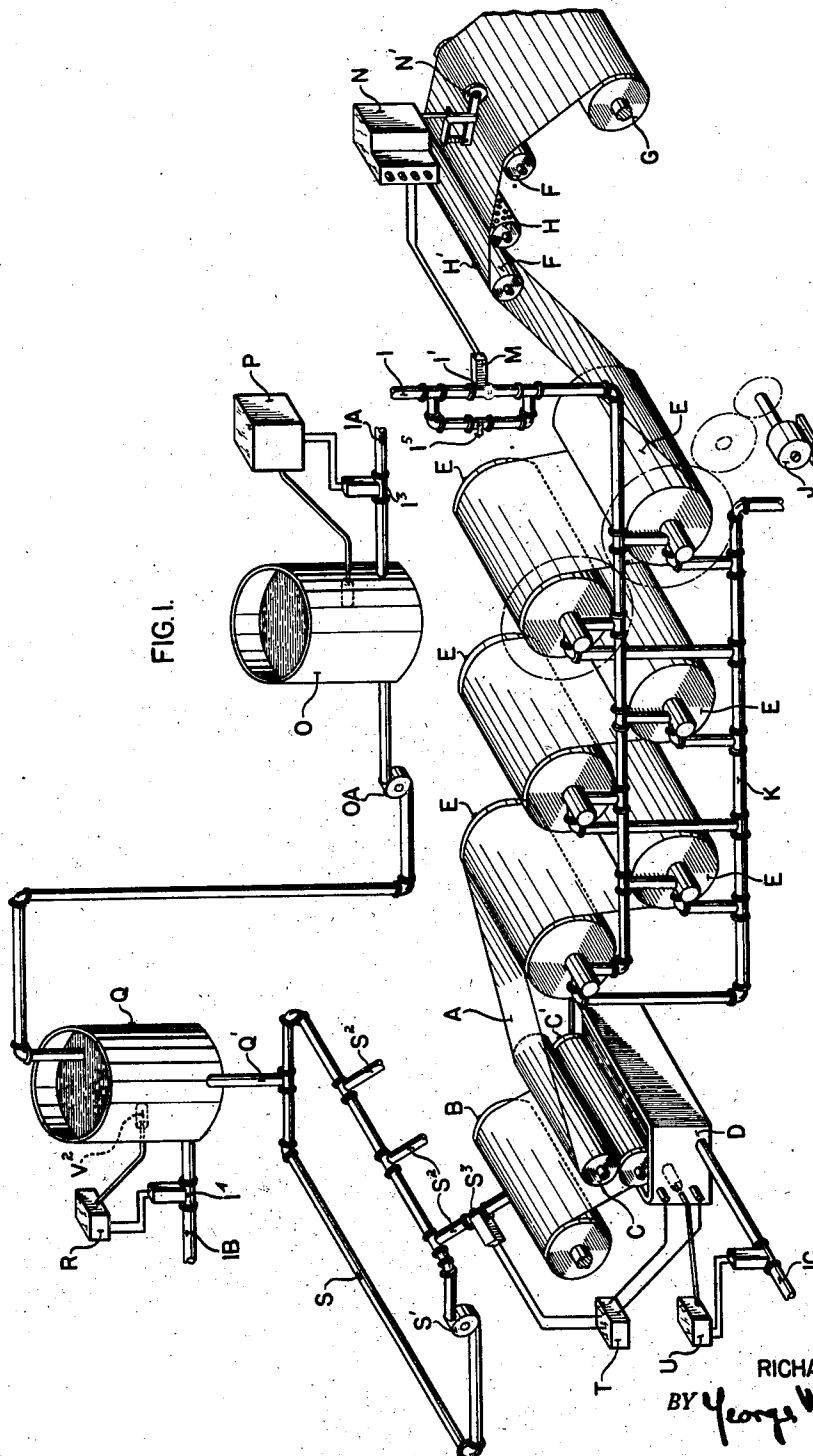
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R. P. HAWKINS
CONTROL APPARATUS

2,194,937

Filed Dec. 14, 1936

3 Sheets-Sheet 1



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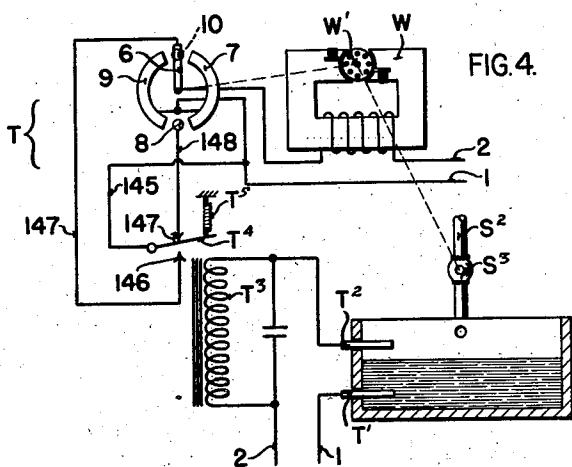
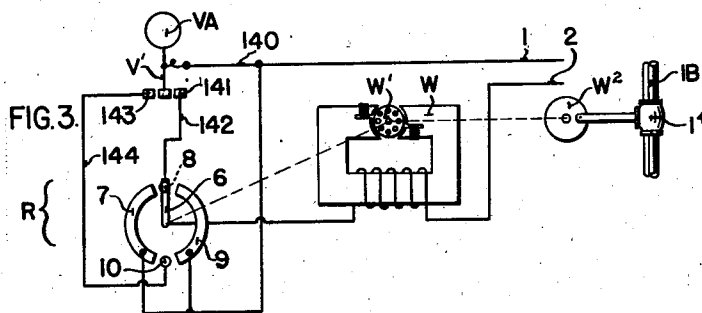
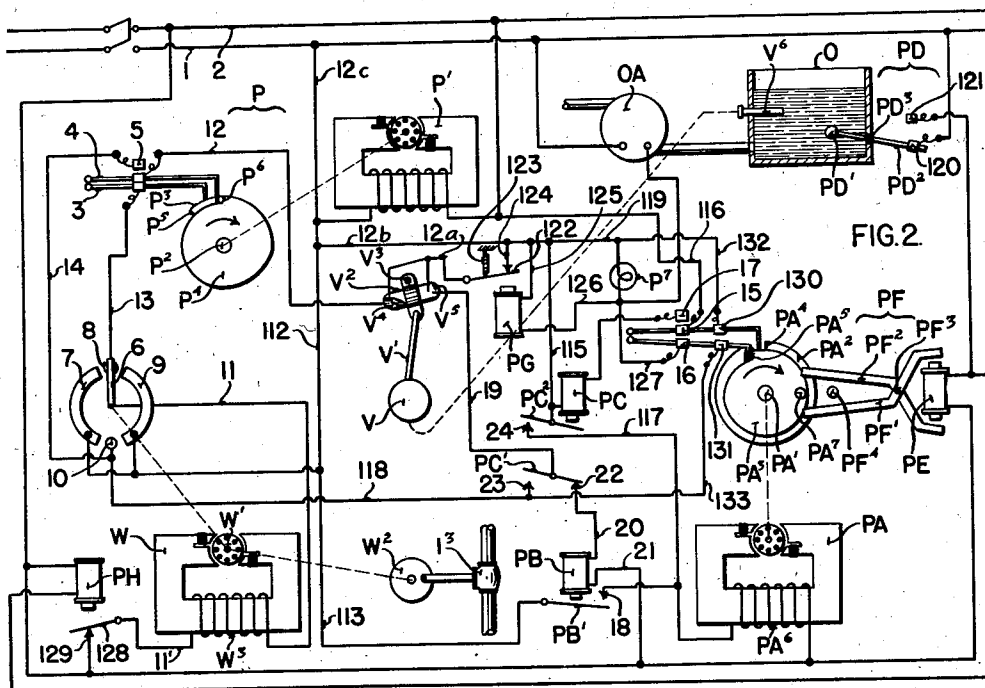
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CONTROL APPARATUS

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3 Sheets-Sheet 2



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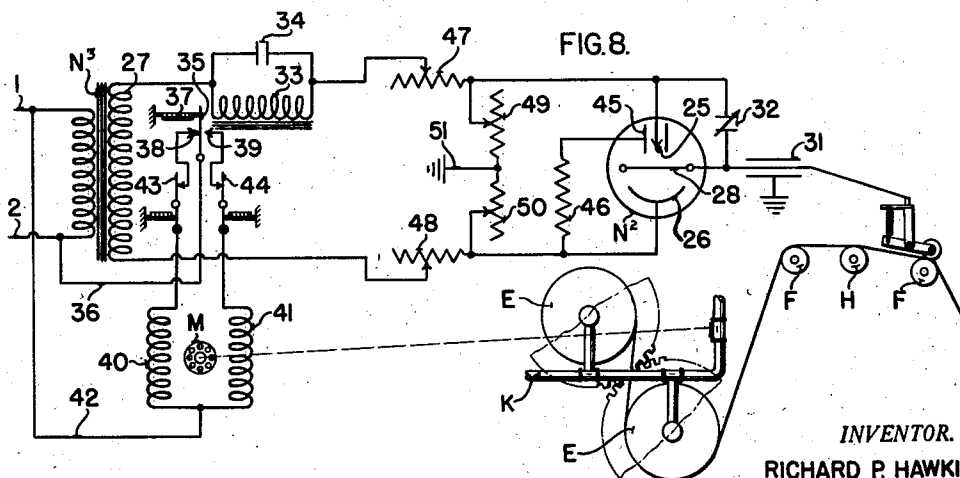
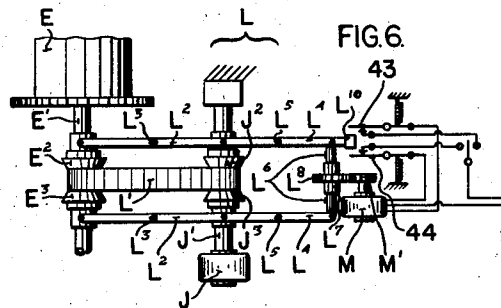
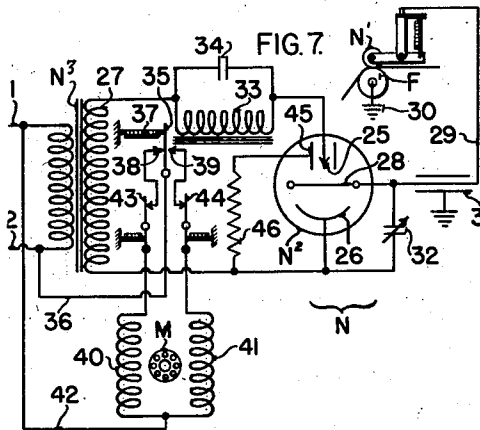
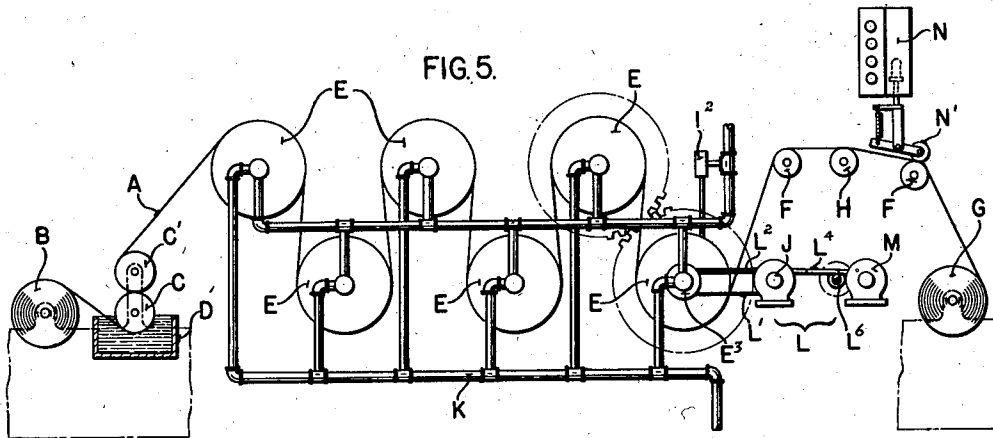
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2,194,937

CONTROL APPARATUS

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3 Sheets-Sheet 3



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2,194,937

CONTROL APPARATUS

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Application December 14, 1936, Serial No. 115,789

7 Claims. (Cl. 28—28)

The present invention comprises improve-
ments especially devised and adapted for use in
apparatus for sizing warp yarn, preparatory to
winding the yarn on a loom beam and the in-
5 insertion of the latter in a loom in which the warp
is incorporated or woven into a fabric web.

Sizing of the warp used in the manufacture
of woven textile webs by modern high speed
weaving methods, is necessary to increase the
10 strength of the warp threads or yarn, or at least
to increase their resistance to wear or deteriora-
tion resulting from friction and chafing to which
they are subjected by the loom harness and reeds,
and which, but for such sizing will wear and
15 weaken the threads and result in the production
of an inferior cloth. This is particularly true in
the case of rayon yarn warp material. While the
thread or yarn may be sized when in skein form,
or while running from spool to spool, it is ordi-
20 narily desirable to effect the sizing operation
after the warp has been wound on a warp beam,
and as it is being wound from the warp beam
onto a loom beam, as the final step in the prepa-
ration of the warp for insertion in the loom.

25 So-called slashing machines, or slashes, for siz-
ing the warp as it is being wound on a loom
beam are known. Such a machine consists, in
general, of supports for the warp and loom
beams, a pan or trough containing the sizing
30 material and so-called quetch or squeezing rolls,
through and over which the warp passes from
the warp beam, steam heated drying rolls or
drums over which the warp passes from the
squeeze rolls to the loom beam, and means for
35 rotating the various rolls and beams at the proper
speed and so as to maintain the proper warp
tension.

For the attainment of the proper sizing re-
sults, it is practically essential, or at least highly
40 desirable, that the proper amount of sizing ma-
terial be taken up by each short longitudinal
section of each warp yarn, and that the sizing
operation should be uniform, also, in respect to
the composition and condition, and particularly
45 the temperature and viscosity, of the sizing ma-
terial, and in respect to the moisture content
and temperature of the yarn as it is wound on
the loom beam. As will be apparent, the amount
of size carried by the yarn as it passes away from
50 the squeeze rolls is affected by the viscosity of
the size, the duration of the period during which
yarn section is in contact with the size in sizing
bath, and the extent to which size is squeezed
into and out of the yarn and separated from the
55 latter by the squeeze rolls.

The extent of yarn penetration by the size as
it passes through the sizing bath, depends upon
the bath temperature which directly affects the
viscosity of the size. Unless the warp yarn is
5 suitably cool when wound on the loom beam, and
then contains moisture for sufficient evaporative
cooling in the subsequent weaving operation, the
latter will result in an objectionable overheating
of the yarn, and fabric formed. Too much
10 moisture in the sized yarn is a disadvantage in
the weaving operation and in the woven web.
The desirable maximum range of variation in the
moisture content of the yarn at the end of the
sizing operation, while different with different
yarns, is always relatively small. An excessive
15 size content in the yarn as it leaves the squeeze
rolls is objectionable not only because it makes
the size content of the sized yarn objectionable,
but also because it increases the steam consump-
tion of the drying rolls required for a sufficient
20 yarn drying action.

Specific objects of the present invention are to
provide simple and effective apparatus for main-
taining uniform sizing conditions and particu-
larly uniformity in the temperature and viscosity
25 of the size in the sizing bath, and for continu-
ously measuring and controlling the moisture
content of the sized yarn as it is being rewound
on the loom beam.

Heretofore various methods have been devised
30 for determining the moisture content of warp
and for effecting corrective adjustments in the
operation of a slasher or warp size apparatus,
when the moisture content is not within suitable
limits, but such prior methods have been either
35 indirect and unduly slow, or otherwise impracti-
cal, and have involved an undesirable time lag
between the time at which a change in the mois-
ture content of the moving warp occurs and the
time when the necessary adjustment to correct
40 for the change is effected.

The above mentioned disadvantages of prior
methods are avoided, and other advantages are
obtained, with my improved warp sizing appa-
45 ratus as a result of the inclusion therein of means
which I employ to maintain suitably uniform
size conditions, and to measure the moisture con-
tent in the yarn as it passes from the drying
rolls to the loom beam, and, on a significant de-
50 parture of said moisture content from its desired
value or range, to immediately effect a suitable
corrective adjustment in the warp drying effect
of the drying rolls. That effect may be varied
either by varying the warp speed or rate of travel,
or by varying the amount of heat supplied to the
55

drying rolls, and preferably is controlled in the last mentioned manner, since control by varying the warp rate of feed through the slashing is open to the objection that a variation in the rate of feed, varies the duration of the periods in which each short section of the warp yarn is in the sizing bath and in contact with the squeeze rolls, and hence varies the amount of sizing material absorbed in the bath and squeezed out of the warp in its passage over the squeeze rolls.

My invention comprises improved means, including a grid glow tube, for measuring the warp moisture by measuring the electrical conductivity of the warp and for amplifying a minute electric current passed through the warp for resistance measuring purposes, to create an electrical control current of suitable amplitude for control purposes.

While a specific purpose of the present invention is to provide an improved warp sizing apparatus of the general character referred to above various novel inventive features and principles used in that apparatus are not restricted to such use, but are useful in sizing other materials than warp, such as, woven webs or paper webs, and are generally useful in measuring and controlling the moisture content of woven webs in the textile industry, of paper webs in the paper making art, and for other purposes in which the moisture content of material can be determined with advantage by measuring the electrical conductivity of the material, and are generally useful in controlling sizing baths or other liquid baths in respect to bath volume, temperature, and viscosity.

The various features of novelty which characterize my invention, are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention however, its advantages and specific objects attained with it, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated preferred embodiments of the invention.

Fig. 1 is a diagrammatic representation of a slasher, in which the moisture content of the warp is controlled by varying the amount of heat supplied to the drying rolls;

Fig. 2 is a diagrammatic representation of means employed in Fig. 1, in controlling the operation of the size cooker;

Fig. 3 is a diagrammatic representation of means employed in Fig. 1, in controlling the temperature in the hot size storage reservoir of Fig. 1;

Fig. 4 is a diagrammatic view of the means included in the slasher for controlling the volume of sizing liquid in the sizing bath;

Fig. 5 is a diagrammatic elevation of a slasher differing from the slasher shown in Fig. 1, in that it includes means for controlling the warp moisture by varying the warp rate of feed;

Fig. 6 is a somewhat diagrammatic plan view of the warp feed rate control means of Fig. 5;

Fig. 7 is a wiring diagram of one form of moisture measuring and control circuit including a grid glow tube; and

Fig. 8 includes a wiring diagram of a measuring and control circuit alternative to that shown in Fig. 5.

The improved apparatus for sizing, drying and controlling moisture in warp shown in Fig. 1, comprises a warp beam B, from which the warp A passes to lower and upper quetch or squeeze rolls C and C', the lower roll C' being partly

submerged in size bath held in a bath container or pan D. From the upper squeeze roll C, the warp passes into contact with a plurality of drying rolls or drums E, and thence over guide rolls F, to the loom beam G, on which the warp is wound up. As shown, the apparatus includes cooling means H, comprising a perforated cooling cylinder through which cool air under pressure is forced against the warp as it passes from the drying rolls E, to the beam G. The drying rolls are shown as rotated by a motor J, and are heated by steam supplied to their interiors through a steam supply pipe I, including a control valve I', and a manually adjustable valve I".

The apparatus shown in Fig. 1 necessarily includes means for controlling the warp tension, and means, including piping K as shown also in Fig. 5 for removing condensation from the drying drums, and other mechanical adjuncts which are customarily employed in such apparatus and hence need not be illustrated and described herein. The apparatus shown in Fig. 5 differs essentially from that shown in Fig. 1, only in that in Fig. 5, the rate of heat supply to the drying drums is maintained constant, as by means of a valve mechanism I" operating to supply steam at a constant pressure to the drying drums, E, and in that the moisture content of the warp is controlled by varying the speed of warp feed, by means of a variable speed drive L, hereinafter described, between the motor J and the drums E.

The regulation of the drying action by adjustment of the steam valve I' of Fig. 1, and by the adjustment of the variable speed drive gear L of Fig. 5, is effected, in each case, by an electric control motor M which is controlled by an electronic moisture responsive means N including a contact roller N' engaging the warp as it passes over the guide roll F adjacent the loom beam G. Prior to further reference to the moisture measuring and controlling means, the apparatus for maintaining the proper size conditions in the sizing bath will be described.

As shown in Fig. 1, the size is originally prepared in a size cooking kettle O, heated by steam supplied by a pipe IA at a rate controlled, as the size is brought up to temperature, by a time-temperature controller P, shown in Fig. 2. The cooked size in the kettle O is transferred from the cooking kettle O by an intermittently operating pump OA to an elevated hot size storage reservoir Q, heated by steam supplied by a pipe IB, subject to the control of a temperature controller R, shown in Fig. 3. From the storage reservoir Q, the size flows by gravity through an outlet pipe Q' into a size circulating system comprising a conduit S closed on itself, and a constantly running circulating pump S', and having a discharge branch S² through which size passes to the size pan or bath container D, at a rate regulated by a controller T, shown in Fig. 4, which operates to maintain a constant size level in the pan D. The supply of steam by a pipe IC to the pan D, is regulated as required to maintain the desired size bath temperature, by a controller U which may be like the above mentioned controller R. As shown, the recirculation pipe S is provided with other discharge branches S², adapted to supply sizes to additional slashers or other sizing apparatus, not shown in Fig. 1.

The cooking of the size in the kettle O, is essentially a batch treating operation, and in bringing the size up to the final cooking temperature it is desirable that the temperature increase should be effected in a definite and pre-

determined time period, and with suitable uniformity, to insure proper cooking, and the evaporation out of the batch of a definite amount of water, so that the consistency and water content of the cooked size, may be determined by the water content or percentage of the initial, unheated batch mixture. The heating steam supplied to the kettle O by the pipe 1A may be injected directly into the batch, but to avoid adding condensate to the size, the steam is preferably passed into a closed heating coil within the kettle. The amount of steam supplied is controlled by a valve I³ in the pipe 1A, which is opened and closed by the controller P. As shown, the latter alternately opens and closes the valve I³ at predetermined intervals, gradually increasing the batch temperature until a predetermined temperature is reached. The batch is then held at said predetermined temperature for a fixed period at the end of which it is pumped into the reservoir Q.

The means for gradually increasing the batch temperature includes a continuously running alternating current timing motor P¹ of any suitable type, energized by alternating current supply conductors 1 and 2. The motor P¹ rotates a cam shaft P² through suitable speed reducing gearing. The cam shaft P² carries two similar spiral edge cams P³ and P⁴. The latter are preferably mounted on the shaft P² for relative angular adjustment, to thereby vary the relative angular positions of the radial shoulders P⁵ and P⁶ respectively, of the cams P³ and P⁴. The shaft P² rotates in the direction of the arrow shown in Fig. 2, and the shoulder P⁵ trails, or lags behind, the shoulder P⁶, more or less, depending on the relative angular adjustment of the cams. Contact members 3 and 4 are pivoted, and gravitationally biased to bear against, or ride on, the cams P³ and P⁴, and are held out of engagement with one another, except during that portion of each revolution of the cam shaft P², in which the contact 4 rests on a low portion of the cam P⁴, while the contact 3 is still resting on a high portion of the cam P³, as shown in Fig. 2. On movement of the cam shaft, permitting contact 3 to drop down alongside cam shoulder P⁵, contact 3 separates from contact 4, and the contacts 3 and 4 do not re-engage until the rotation of the cam shaft again permits the contact 4 to drop down alongside the shoulder P⁶, onto the adjacent low portion of cam P⁴. At a predetermined but adjustable point in each rotation of the cam P⁴, during the batch heating up operation, the cam P⁴ moves the contact 4 into engagement with a relatively fixed contact 5, and maintains this engagement until the contact 4 again drops down alongside the cam shoulder P⁶.

The alternate engagement of contact 4 with contacts 3 and 5 results in energization of a valve operating motor W, which may be similar to the timing motor P¹, and which, when energized, imparts a movement of a half revolution to a shaft W¹. Shaft W¹, shown as the armature shaft of the motor W, may well be connected to and driven by said armature shaft through speed reducing gearing. As diagrammatically shown, the shaft W¹ carries a crank arm W² link connected to the operating member of the valve I³, so that the valve is closed by the half turn of the shaft W¹ resulting from the engagement of the contact 4 with the contact 5, and is opened by the half turn of the shaft W¹ resulting from the engagement of the contacts 3 and 4. To interrupt the energization of the mo-

tor at the end of each half turn of the shaft W¹, and to provide for the following energization of the motor, on the engagement of the contact 4 with the contact 3 or 5 which it next engages, a limit switch mechanism is provided.

The limit switch mechanism illustrated in Fig. 2, comprises a movable contact 6, in the form of an arm carried by the shaft W¹, and four stationary contacts 7, 8, 9, and 10 adapted to be engaged by arm 6. The contacts 7 and 9 are in the form of diametrically opposed arcs, each of a little less than 180°. The contacts 8 and 10 are diametrically opposed, and each is interposed between and spaced away from the corresponding ends of the contacts 7 and 9. Contacts 8 and 10 are electrically connected respectively to contacts 3 and 5, and contacts 7 and 9 are continuously energized by the direct connection of each to the supply conductor 1. The contact 6 is connected through a conductor 11, to one terminal of the winding W³, the other terminal of that winding being normally connected to the supply conductor 2. The contact 4 is connected to the supply conductor 1, through a conductor 12, a contact V⁴ of a mercury switch V², a conductor 12a, a switch blade 122, a conductor 12b, and a conductor 12c. The mercury switch V² is pivoted for rotation at V³ and is adapted to be actuated by the deflecting arm V¹ of a thermometer V, which may well be a recording thermometer, and, as shown is an expansible fluid thermometer, having a thermometer bulb V⁶ immersed in the size in the cooking kettle O. While the temperature of the size is still below its final temperature the mercury switch V² will be tilted as shown in Fig. 1, whereby the contact V⁴ will be closed and thereby the circuit from the supply conductor 1 to the contact 4 will be closed.

When the contact 4 engages the contact 3, the contact 8 is connected to the supply conductor 1, and the contact 8 is thereby operatively energized, through the conductor 13, connecting the contacts 3 and 8. When the contact 4 engages the contact 5, the contact 10 is connected to the supply conductor 1, and is thereby operatively energized, through a conductor 14 connecting the contacts 5 and 10. The operative energization of either contact 8 and 10 starts the motor W into operation.

The positions of the contacts 3, 4, and 6, shown in Fig. 2, are those required to initiate an energization of the motor W by which the valve I³ is moved into its open position. The energizing circuit for the motor W then closed, includes supply conductor 1, conductor 12c, conductor 12b, switch 122, conductor 12a, conductor 12, switch V², contact 4 and 3, conductor 13, contacts 8 and 6, conductor 11, motor energizing winding W³, and supply conductor 2. As the motor starts into operation, the contact 6 moves out of engagement with the contact 8 and into engagement with the contact 9. The energization of the motor thus initiated by the energization of contact 8, continues until the contact 6 passes out of engagement with the contact 9 and thereby interrupts current flow through the winding W³. Its movement out of engagement with the contact 9, carries the contact 6 into engagement with the then deenergized contact 10. When the contact 4 is subsequently moved into engagement with the contact 5, thereby operatively energizing contact 10, the motor W is energized by current flow through the circuit comprising supply conductor 1, conductor 12c, conductor 12b, conductor 12a, conductor 12,

contacts 4 and 5, conductor 14, contact 10, contact 6, conductor 11, winding W², and supply conductor 2. The energization of the motor then effected, and serving to close the valve I³, continues as the contact thus moved into engagement with and along the contact 7, until the contact 6 moves out of engagement with the contact 7. As it moves out of engagement with the contact 7, the contact 6 re-engages the contact 8, and restores the apparatus to the condition shown in Fig. 2, so that when the contact 4 is again moved into engagement with the contact 3, the controller P will start to repeat the above described operating cycle.

As will be apparent, the controller P is adapted to raise the temperature of the batch in the kettle O from its initial cold condition to a final temperature at which the mercury switch V² is tilted in a clockwise direction as seen in Fig. 2, by the deflecting arm V¹, and the circuit from contact 4 to the supply line 1 through the conductor is broken. The temperature of the batch is increased at a rate which cannot depart significantly in normal operation from a predetermined rate, the latter being varied by relative angular adjustments of the cams P³ and P⁴. The angular adjustment of the cam P³ relative to the cam P⁴ changes the predetermined rate of temperature increase since the effect of a clockwise or counterclockwise adjustment of the cam P³ relative to the cam P⁴ is to respectively shorten or elongate the period during which the valve I³ remains open following each valve opening operation of the motor W initiated by the engagement of contacts 3 and 4.

After the batch temperature has been increased to the final temperature at which the thermometer controller tilts the mercury switch V² to deenergize the contact 4, the controller P will operate to maintain the batch at approximately said final temperature for a predetermined period and then set a pump OA into operation for transferring the batch from the kettle O to the storage kettle Q.

The means by which the controller P operates to maintain the batch at the final temperature for a predetermined period includes a cam operating motor PA which is set into operation when the batch has reached said final temperature. Two energizing circuits are provided for the motor PA, one of which is completed through the mercury switch V² when the batch has reached its final temperature, and the other of which is completed as a result of subsequent rotation of the cam shaft PA¹. The latter mentioned energizing circuit is thereafter maintained in a closed condition, until the end of the cycle, by means to be described hereinafter.

When the batch has reached its final temperature the mercury switch V² will be tilted in a clockwise direction about its pivot V³, opening the energizing circuit to contact 4 and closing an energizing circuit to a relay PB. The relay PB includes a pivoted armature switch member PB¹, biased gravitationally or by spring means, as desired, into a lower position, but drawn into an upper position into engagement with a contact 18 when the relay PB is energized. The energizing circuit for the relay PB includes supply conductor 1, conductor 12c, conductor 12b, conductor 12a, a mercury switch contact V⁵, conductor 19, contact 22 of a relay PC, conductor 20, relay PB, conductor 21 and supply conductor 2. As seen in Fig. 2 when the relay PB is energized, the resulting engagement of the armature

PB¹ with the contact 18 closes the aforementioned energizing circuit to the motor PA which includes supply conductor 1, conductor 12c, conductor 112, conductor 113, armature PB¹, contact 18, motor winding PA⁵, and supply conductor 2.

The motor PA rotates, through suitable reduction gearing, a cam shaft PA¹ carrying two cams PA² and PA³ which are preferably so mounted on the shaft PA¹ as to permit relative angular adjustment of a pair of radial shoulders PA⁴ and PA⁵, respectively. The shaft PA¹ rotates in the direction of the arrow shown in Fig. 2 and the cams are so relatively adjusted that the shoulder PA⁵ trails, or lags behind the shoulder PA⁴. Contact members 15 and 16 are pivoted, and 15 gravitationally biased to bear against, or ride on, the cams PA² and PA³, and are held out of engagement with each other except at the end of the cooking cycle when the contact 15 drops down alongside the shoulder PA⁴ and comes to rest on a low portion of the cam PA² while the contact 16 is still resting on a high portion of the cam PA³ as seen in Fig. 2. On further movement of the shaft PA¹ to a position as shown in Fig. 2 permitting contact 16 to drop down alongside the shoulder PA⁵, contacts 15 and 16 separate and do not reengage until the rotation of the cam shaft again permits the contact 15 to drop down alongside the shoulder PA⁴ onto the adjacent low portion of cam PA².

As the motor PA starts into operation, the contact member 15 rides onto a high portion of the cam PA² into engagement with a relatively fixed contact 17, resulting in energization of a relay PC over a circuit including supply conductor 1, conductor 12c, conductor 12b, conductor 115, relay PC, contact 17, contact 15, conductor 116 and supply conductor 2. The contour of the cam PA² is such that once this circuit is closed it is thereafter maintained closed until the end of the cycle when the contact member 15 slides down alongside the shoulder PA⁴ out of engagement with the contact 17. The relay PC includes two pivoted armatures switch members PC¹ and PC², insulated from each other. The armatures PC¹ and PC² are pivoted intermediate their ends for rotation and are biased gravitationally or by spring means for rotation in a clockwise direction, but are rotated counterclockwise when the relay PC is energized. The armature PC¹ is normally held into engagement with the contact 22, but when the relay is energized, is rotated out of engagement therewith and into engagement with a contact 23. The armature PC² is adapted to cooperate with a contact 24 engaging the latter when the relay is energized. Rotation of the armature PC¹ out of engagement with the contact 22 results in deenergization of the relay PB and thereby opening of the energizing circuit to the motor PA, but simultaneous with the operation of the armature PC¹, the armature PC² rotates into engagement with the contact 24 to close the second energizing circuit for the motor PA mentioned hereinbefore. This energizing circuit for the motor PA includes the supply conductor 1, conductor 12c, conductor 12b, conductor 115, armature PC², contact 24, conductor 117, motor energizing winding PA⁵, and supply conductor 2. The motor PA then continues to rotate the cams PA² and PA³ until the end of the cycle when the contact members 15 and 17 are separated deenergizing the relay PC.

Engagement of armature PC¹ with the contact 23 establishes a connection between contact V⁵

of mercury switch V² and the limit switch contact 10 over conductors 19 and 118. If the temperature of the batch then rises above the desired value tilting switch V² clockwise, the motor W will be energized through an energizing circuit from supply conductor 1, conductor 12c, conductor 12b, relay contact 122, conductor 12a, mercury switch contact V⁵, conductor 19, armature PC¹, contact 23, conductor 118, contact 10, contact arm 6, conductor 11, motor energizing winding W³ and supply conductor 2 to operate the motor W to close the valve I³. The energization of the motor W is only initiated through the contact 10, the energizing circuit being maintained, in the manner previously described, through the contact 7 until the arm 6 leaves the contact 7 and engages the contact 8 to thereby deenergize the motor. When closure of valve I³ is effected by clockwise tilting of switch V², the circuit to contact 4 will be interrupted by opening of contact V⁴ so that no subsequent opening of the valve can be effected by the timing means including contacts 3 and 4 until switch V² is tilted counterclockwise on a fall in temperature. If the temperature of the batch subsequently drops due to the valve I³ being closed, the resulting closure of the contact V⁴ energizes the contact 4, and at a point in the cycle of rotation of the cam shaft P², as shown in Fig. 2, the contact will engage the contact 3 to initiate the energization of the motor W for opening the valve I³. The valve I³ will thus be intermittently turned on and off so long as the temperature is below the desired value and the rate of heat input under such conditions will correspond to the rate of heat input during the heating up period so as to produce a gradual temperature rise. Such gradual temperature rise is desirable in that it minimizes over heating and consequent cycling or hunting although as will be clear the opening of valve I³ during a greater portion of the time that the temperature is low, may be effected by adding another armature to the relay PC which will connect contact V⁴ of switch V² with conductor 13 when relay PC is energized and if continuous opening of valve I³ is desired while the temperature is low, such armature may also simultaneously disengage contact V⁴ from conductor 12.

The controller P continues to operate in this manner to open and close the valve I³ and thereby maintain the temperature of the batch constant until the cam shaft PA¹ has rotated through almost 360°. The contact member 15 then drops down alongside the shoulder PA⁴ out of engagement with the contact 17, resulting in deenergization of the relay PC and consequent deenergization of the motor PA. Conveniently, the controller includes a signal element for signalling the end of the cooking cycle. This element may be in the form of an electric lamp P⁷ connected to the supply conductors 1 and 2 when the cooking cycle is complete. At the end of the cooking cycle, as seen in Fig. 2, the contact 16 will be on a high portion of the cam PA³ adjacent the shoulder PA⁵ when the contact member 15 drops down alongside the shoulder PA⁴ so that engagement of the contacts 15 and 16 results in closure of an energizing circuit to the lamp P⁷. This energizing circuit includes supply conductor 1, conductor 12c, conductor 12b, conductor 119, lamp P⁷, contact 16, contact 15, conductor 116 and supply conductor 2.

The control of the pump OA by which the cooked size, is transferred from the kettle O

to the storage kettle or reservoir Q may be effected manually or may be effected automatically as shown in Fig. 2. Thus, as shown in Fig. 2, the closure of contacts 15 and 16 for energizing the lamp P⁷ may also complete a circuit to energize the motor pump OA. The operation of the pump OA thus started continues until a float controlled switch PD, cooperating with the size in kettle O, operates to open the energizing circuit to the pump. The float controlled switch PD includes a float PD¹ mounted on one end of a switch member PD² carrying a contact 120 at the other end and pivoted intermediate its ends for rotation at PD³. The contact 120 is adapted to cooperate with a contact 121, disposed above the contact 120. The buoyant effect of the size in the kettle O on the float UD¹ operates to maintain the contact 120 in the position shown in Fig. 2. When all the cooked size has been transferred from the kettle O to the kettle Q, however, the switch PD¹ will rotate counterclockwise to move the contact 120 into engagement with the contact 121, resulting in energization of a relay PE. The relay PE cooperates with a scissors arrangement PF and when so energized actuates the latter to impart a slight clockwise rotational impulse to the cams PA² and PA³ for deenergizing the pump OA and the signal lamp P⁷ and for adjusting said cams to initiate the next size batch heating up operation.

The scissors arrangement PF comprises a pair of crossed arms PF¹ and PF², pivoted intermediate their ends at PF³, and one corresponding end of each of the arms being disposed on opposite sides of the magnetic core of the relay PE and in inductive relation therewith. The other ends of the arms are adapted to cooperate with a pin PA⁷ for clamping the latter to thereby move the pin PA⁷ into alignment with the pivot PF³ and a fixed stop PF⁴. The position of the pin PA⁷ at the end of the cooking cycle, as the contact member 15 drops down alongside shoulder PA⁴, is slightly above the point of alignment with the stop PF⁴ and pivot PF³, as seen in Fig. 2, so that energization of the relay PE and resulting actuation of the scissors arrangement PF results in a slight downward movement of the pin PA⁷. The incident movement of the cams PA² and PA³ results in the contact member 16 dropping down alongside the shoulder PA⁵ and thereby separation of the contacts 15 and 16 to deenergize the pump OA and the signal lamp P⁷, and to adjust the cams PA² and PA³ for the start of a new batch heating up operation.

As shown in Fig. 2, the energization of the motor pump OA is initiated after the cooking cycle has been completed, and the controller P is then rendered inoperative to supply heat to the kettle O by means of a relay PG which may conveniently be energized upon engagement of the contacts 15 and 16. The relay PG includes a pivoted armature 122 biased by spring means 123 into engagement with a contact 124 and drawn out of engagement therewith when the relay is energized. The armature 122 and contact 124 are disposed in the conductor 12a which connects contacts V⁴ and V⁵ of the mercury switch V² to the supply line 1 so that energization of the relay PG results in deenergization of the mercury switch V², and the controller P is thereby rendered inoperative to open the steam supply valve I³. The energizing circuit for the relay PG includes the supply conductor 1 conductor 12c, conductor 12b, conductor 125, relay PG, con-

ductor 126, conductor 127, contact 16, contact 15, conductor 116 and supply conductor 2. After the size has been transferred from the kettle O to the kettle Q, the float controlled switch PD will be operated to close contacts 120 and 121 resulting in actuation of the scissors arrangement PF as previously described, and consequent rotational movement of the cams PA² and PA³ to separate the contacts 15 and 16, resulting in deenergization of the relay PG and closure of the armature 122 and contact 124 so that the controller P is again operative.

In the event that the valve I³ should be open at the end of the cooking cycle after the mercury switch V² has been deenergized, means have been provided, as illustrated in Fig. 2, for energizing the contact 10 of the limit switch mechanism and thereby initiating the operation of the motor W for closing the valve I³. In order to accomplish this end, additional contacts 130 and 131 have been disposed on the contact members 15 and 16 respectively, so that engagement of the latter at the end of the cooking cycle will result also in closure of the contacts 130 and 131, which are insulated from the contacts 15 and 16, to thereby energize the contact 10. The energizing circuit for the motor W then includes supply conductor 1, conductor 12c, conductor 12b, conductor 119, conductor 132, contact 130, contact 131, conductor 133, conductor 118, contact 10, contact arm 6, conductor 11, motor energizing winding W³ and supply conductor 2.

In order to prevent the controller P from operating to open the valve I³ when the cooked size has been transferred from the kettle O to the kettle Q, and before the kettle O has been filled with a new batch of size, means have been provided, for rendering the motor W inoperative, in the form of a relay PH which conveniently is energized upon engagement of the contacts 121 and 120, the latter carried by the float arm PD². The relay PH includes a pivoted armature 128 biased gravitationally or by spring means as desired into engagement with a contact 129 and drawn out of engagement therewith when the relay is energized. The armature 128 and contact 129 are disposed in the conductor 11¹ connecting the motor energizing winding W³ to the supply conductor 2 so that energization of the relay renders the motor inoperative. When the kettle O is filled with another batch of size, the contacts 120 and 121 disengage and the relay PH is deenergized so that the armature 128 engages the contact 129 and the motor W will again be responsive to the controller P.

The controller R which operates to supply steam through the pipe IB to a heating coil in the kettle or reservoir Q, as required to maintain a constant size temperature in that kettle, may include a motor W exactly like the motor W of Fig. 2, in form, and in respect to its operating connections to the controlled steam valve I⁴ and in respect to its limit switch mechanism. In the controller R, however, the alternative energization of the limit switch contacts 8 and 10 is directly controlled by the deflecting element V¹ of a thermometer VA, which may be exactly like the thermometer V of controller P, and has its bulb V² immersed in the size in the reservoir Q. The deflecting element V¹ of the thermometer VA serves as a contact arm which is connected by a conductor 140 to the supply conductor 1. On a drop in the temperature in the reservoir Q, the contact arm V¹ deflects counterclockwise into engagement with a stationary contact 141 con-

nected by a conductor 142 to the contact 8 of Fig. 3, whereupon the motor W of Fig. 3 operates to open the valve I⁴ as the motor W of Fig. 2 is operated to open the valve I³ by the energization of the contact 8, resulting from the engagement of the contacts 3 and 4. Conversely, when following the opening of the valve I⁴, the temperature of the size of the kettle Q is suitably increased, the clockwise deflection of the contact arm V¹ of thermometer VA brings that arm into engagement with the contact 143 and thereby energizes the limit switch contact 10 which is connected to the contact 143 by a conductor 144, and the motor W of controller R then operates to close the valve I⁴.

The controller T, shown in Fig. 4, includes a motor W and associated limit switch provisions like those included in the controllers P and R, and giving opening and closing adjustments to a valve S³ in the branch discharge pipe S² of the size circulating system leading to the pan D. The valve S³ may be similar in character, and in its operating connections with its controller motor, to the previously mentioned steam valves I³ and I⁴. The energization of the limit switch contacts 8 and 10 of the controller T are controlled, however, by the height of liquid level in the pan D. The liquid level responsive means of the controller T comprise an electrode T¹ in the pan D, near the bottom of the latter, and an electrode T² in the pan at the liquid level normally maintained therein. The electrodes T¹ and T² are insulated from one another, but are electrically connected by the size in the pan D when the size level is at its normal height, so that current then flows between the supply conductors 1 and 2 through the electrode T¹, the size liquid, electrode T² and a relay winding T³ through which the electrode T² is connected to supply conductor 2.

The relay of which the winding T³ forms a part, includes a pivoted armature switch member T⁴ biased for movement into an upper position by a spring T⁵, but drawn down into a lower position when the winding T³ is energized. The armature T⁴ is connected to supply conductor 1 by a conductor 145, and when in its lower position, the armature T⁴ engages a contact 146 connected by a conductor 147 to the limit switch contact 10. In consequence, the movement of the armature T⁴ into engagement with the contact 146, occurring when the liquid level in pan D reaches the desired maximum, energizes the contact 10 and starts the motor W of the controller T into operation to close the valve S³. On a decrease in the height of liquid level in pan D, breaking the circuit between the electrodes T¹ and T² and deenergizing the winding T³, the armature T⁴ moves up under the action of its bias spring T⁵ into engagement with a contact 147 which is connected by conductor 148 to the limit switch contact 8. The motor W of the controller T then operates to open the valve S³.

The controller U shown in Fig. 1 and employed to control the supply of steam by the pipe IC to a heating coil in the pan D, may be exactly like the controller R of Fig. 3, and operates to open and close a valve I⁵ in the steam supply pipe IC, as the size temperature in pan D falls below, and rises to the predetermined temperature. The valve I⁵ may be similar to the valve I⁴ adjusted by the controller R.

In the form shown in Fig. 7 the electronic moisture responsive means N for controlling the motor M which regulates the drying action of the sizing apparatus, includes a grid glow tube N².

The latter has its anode 25 connected to one terminal, and its cathode 26 connected to the other terminal of the secondary 27 of a transformer N³, which has its primary winding connected between alternating supply conductors 1 and 2, and constitutes the power source for the moisture responsive means. The grid element 28 of the tube N² is connected by a conductor 29 to the roller N¹, which forms a part of the device N, and is spring held against the portion of the warp above one of the guide rolls F, the latter having a ground connection 30. To avoid the effect of stray currents, the conductor 29 is heavily shielded, as by shielding means 31. A variable condenser 32 is connected between the cathode 26 and the grid 28.

The connection between the anode 25 and the corresponding terminal of the transformer secondary 27 includes a relay winding 33 shunted by a condenser 34. When the winding 33 is energized by a suitable current flow therethrough, it attracts a pivoted armature 35 and moves the latter out of engagement with a switch contact 38, against the action of a bias spring 37, and into engagement with a switch contact 39. The armature 35 serves as a switch element and is connected by a conductor 36 to the supply conductor 2. The contacts 38 and 39 are connected by windings 40 and 41, respectively, to one end of a conductor 42 which is connected at its opposite end to supply conductor 1. The windings 40 and 41 are the energizing windings of the motor M. The latter may be of any available reversible alternating current motor type adapted to operate in one direction when current flows through the winding 40, and in the opposite direction when current flows through the winding 41. In particular the motor 40 may be of the type described in the Shivers U. S. Patent No. 1,877,605 and comprising two rotor elements, one in inductive relation with the winding 40, and the other in inductive relation with the winding 41. As shown, the windings 40 and 41 are connected to the contacts 38 and 39 respectively, through limit switches 43 and 44, respectively, whereby the maximum movement of the motor in each direction is limited. As shown, the tube N² includes an auxiliary cathode 45 in close proximity to the anode 25 and connected to the main cathode 26 by a resistance 46, which serves to prevent the collection of electro-static charges on the glass shield (not shown) of the anode, when current is conducted by the tube.

In the operation of the apparatus shown diagrammatically in Fig. 7, there will be no anode current flow operatively energizing relay winding 33, when the resistance between the grid 28 and the ground connection 30 is high enough to permit the grid to be sufficiently negative to prevent the ionization or breakdown of the neon or other gas in the tube N². With the apparatus properly adjusted, when the moisture content in the warp passing between the roller N¹ and adjacent grounded guide roll F is lower than is desirable, the conductivity of the warp will be correspondingly low and the potential of the grid 28 relative to the cathode 26 will be sufficiently negative to prevent an energizing current flow through the winding 33. In consequence the armature switch member 35 will then be held by its bias spring 37 in engagement with the contact 38, the winding 40 will be energized and the motor M will operate in the direction to decrease the steam supply to the drying rolls in the arrangement shown in Fig. 1, or to increase the speed of the

warp feed in the arrangement of Fig. 5, to reduce the size drying effect in each case, and to correctively increase the moisture content of the warp engaged by the roller N¹.

When the moisture content of the warp engaged by the roller N¹ rises above the desired value, the resultant increase in conductivity of the warp, will reduce the resistance in the connection between the grid and the ground connection 30, and permit the current flow through that connection to increase to the critical value at which the reduced negative potential of the grid relative to the cathode potential, will permit the tube gas to be ionized, or break down. The winding 33 will then be energized by the anode current flow, and the armature switch member 35 will be moved into engagement with the contact 39. This will energize the winding 41 and the motor M will then operate to increase the drying effect and suitably reduce the moisture content of the warp engaged by the roller N¹.

The critical control current flow from the grid 28 through roller N, the warp and the ground connection 30, required to initiate the power current flow between the cathode and anode of the tube N², need be only a small fraction of a milliamper, and very much smaller than the last mentioned current flow. The grid glow tube used as described, thus forms a powerful amplifier, highly effective for the control of the motor M by the minute control current flowing from the grid through the ground connection 30. While the anode current flow through the tube N² created by an increase in the grid control current to its critical value, destroys the control effect of the last mentioned current with alternating current energization, the anode current will flow through the tube only during the portion of each alternation period in which the anode potential is positive. In consequence, the control effect of the current flow through the grid to ground connection, is restored during each alternation period, as soon as the anode potential reduces to zero, so that for practical purposes, the operation of the motor M is at all times subject to the control of the controlling grid current, as the latter rises to and falls below its critical tube ionizing magnitude.

The actual critical magnitude of the control current, and thereby the warp moisture content which the apparatus tends to maintain, may be varied by adjustment of the variable condenser 32. While the anode current is pulsating, the condenser 34 in shunt with the winding 33, discharges current through the winding 33 when the anode current reduces to zero, and thus permits the coil 33 to maintain a steady magnetic pull, and avoids chattering of the armature switch member 35. To insure a proper grid current flow to the ground connection 30, the anode 25 may be connected to ground, or a ground connection like the ground connection 51 of Fig. 8, may be made to any suitable point in the external circuit of the tube N². However with the arrangement shown in Fig. 5, the capacity effect of the winding 33 and of the transformer N³, makes it unnecessary to provide a second ground connection, and the omission of the latter avoids risk of accidental overloading of the tube N², such as might occur as the result of a short circuit between the roller N¹ and the adjacent grounded guide roll F.

I consider the circuit arrangement of Fig. 8 preferable to that of Fig. 7, when use is made of a second ground connection. Aside from that

ground connection, the circuit of Fig. 8 differs from that of Fig. 7 by the inclusion of variable resistances 47, 48, 49, and 50, and in the connection of the variable condenser 32 between the grid 28 and the anode 25 instead of having the condenser between the grid and the cathode as it is in Fig. 7. As will be apparent with the arrangement shown in Fig. 8, an increase in the capacitance of the condenser 32 will increase the warp moisture content which the apparatus will tend to maintain. The resistances 47 and 48 in the connections between the transformer secondary 27 terminals and the anode and the cathode of the tube N², delays the relay circuit action to an extent which may be increased and decreased by increasing and decreasing the amounts of said resistance in circuit, and thus permits of a variation in the sensitivity of the control action.

The resistances 49 and 50 which respectively connect the anode 25 and cathode 26 to the common ground connection 51, provide for rough adjustments of the moisture content control range. The resistance 49 may be of the order of 70,000 ohms, while the resistance 50 may be varied from zero to 60,000, according to installation characteristics as required to make mid scale adjustment of the variable condenser 32 appropriate for the normal or average operating condition in any particular installation.

The variable speed driving connection L between the drying rolls E and their driving motor J, may be of any usual or suitable type, adapted for adjustment by the reversible control motor M. As shown in Fig. 6, the said connection includes a belt L', connecting two axially adjustable cone pulleys E² and E³ splined on the shaft E' of the directly driven drum E, and two similar axially adjustable cone pulleys splined on the shaft J' of the motor J. The pulleys E² and J² at one side of the belt L' are connected by a lever L² pivoted at L³ midway between the shafts E' and J'. The other two pulleys, E³ and J³ are similarly connected by a corresponding lever L² pivoted at L³ midway between the two shafts. The pulleys J² and J³ are given relative movements of approach and separation by means of two levers L⁴, each pivoted between its ends on a fulcrum pivot L⁵, and each connected at one end to the corresponding pulley E³ or J³ and each pivotally connected at its opposite end to a corresponding threaded rod L⁶. The two threaded rods L⁶ are screwed into a turn buckle L⁷ which comprises a spur gear L⁸ in mesh with a gear M' carried by the shaft of the control motor M.

As the latter rotates in one direction as a result of a decrease in the moisture content of the warp in contact with the roller N' of the controlling device N, the turn buckle L⁷ is rotated in the direction to move the pulleys J² and J³, each toward the other, and, through the levers L⁴, to correspondingly move the pulleys E² and E³, each away from the other whereby the speed of the web is increased to reduce the drying action on, and increase the moisture content of, the warp. Conversely, when the moisture content of the warp engaged by the roller N' becomes too large, the motor M rotates in the direction to spread the pulleys J² and J³ apart and to move the pulleys E² and E³ closer together, and thereby decrease the web speed and increase the drying effect so as to reduce the moisture content in the warp.

In Fig. 6, one of the levers L⁴ has an end portion L¹⁰ arranged to actuate the previously men-

tioned limit switches 43 and 44, and thus prevent operation of the motor M in either direction, in excess of that required for the maximum desired corresponding adjustment of the variable speed drive connection L.

As will be apparent to those skilled in the art, the various control means which have been described are relatively simple and desirably effective for their intended purposes. The means provided by which the size bath in the pan D is maintained uniform in respect to volume, temperature, and physical condition including viscosity, not only contributes to the proper sizing of the warp, but also facilitates the practical sensitivity and effectiveness of the means provided for directly controlling the moisture content of the warp, as it passes from the sizing apparatus proper to the loom beam G.

As will be apparent also, each of the controllers P, R, T and U contribute to the ultimate effect of maintaining the proper size temperature and other desirable size physical conditions in the sizing bath. The effective and sensitive control of the bath level effected by the controller T is directly advantageous from the standpoint of the physical condition of the size, because it permits of the proper supply of size, adequately agitated or stirred up in the circulating system, without subjecting the size to excessive circulation which tends to break down and thin the size. The character of the cooked size is improved, and the risk of its deterioration in its subsequent handling is diminished, by the proper cooking insured by the operation of the controller P. The delivery of the cooked size to the storage kettle Q at the proper temperature increases the effectiveness of the controller R in controlling the size temperature in the kettle Q, and the delivery of the size at the proper temperature to the circulating system also increases the effectiveness of the controller U in controlling the size temperature in the pan D. The different controllers thus coact to minimize variations in size temperature, which if relatively large, not only interfere with the effectiveness of the temperature control, but involve risk of overheating the size as a result of the considerable amounts of steam required to quickly raise the size to the proper temperature, following any considerable reduction in that temperature below its desired value.

While in accordance with the provisions of the statutes I have illustrated and described preferred embodiments of the present invention, those skilled in the art will understand that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims, and that some features of the present invention may sometimes be used with advantage, without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In apparatus for continuously sizing material comprising a size bath receptacle containing sizing solution the height of which affects the sizing and subsequent drying of said material and drying rolls over which the material is continuously moved, means for regulating the drying action to which the material is subjected by the drying rolls, and means responsive to the level of the size in said receptacle for supplying size to said receptacle as required to maintain said level approximately constant.

2. In apparatus for continuously sizing ma-

terial comprising a size receptacle containing sizing solution the temperature of which affects the sizing and subsequent drying of said material and drying rolls over which the material is continuously moved, means for varying the drying action to which the material is subjected by the drying rolls, and means responsive to the temperature of the size in said receptacle to supply heat to the size in said receptacle as required to maintain said temperature approximately constant.

3. In apparatus for continuously sizing material comprising a size receptacle containing sizing solution the height and temperature of which affects the sizing and subsequent drying of said material and drying rolls over which the material is continuously moved, means for regulating the drying action to which the material is subjected by the drying rolls, means responsive to the level of the size in said receptacle for supplying size to said receptacle as required to maintain said level approximately constant, and means responsive to the temperature of the size in said receptacle to supply heat to the size in said receptacle as required to maintain said temperature approximately constant.

4. In apparatus for continuously sizing material comprising a size receptacle containing sizing solution the height of which affects the sizing and subsequent drying of said material and drying rolls over which the material is continuously moved, means for varying the drying action to which the material is subjected by the drying rolls, and means responsive to the level of the size in said receptacle for supplying size to said receptacle as required to maintain said level approximately constant, said means comprising electrodes extending into said tank electrically connected and disconnected by the size in said receptacle accordingly as the size extends to or is below said level, means for maintaining a potential difference between said electrodes, and means responsive to current flow between the electrodes through the size.

5. An apparatus for continuously sizing ma-

terial, comprising a size bath receptacle containing sizing solution the temperature of which affects the sizing and subsequent drying of said material and drying rolls over which the material is continuously moved, means for maintaining an approximately constant amount of hot size in said receptacle at an approximately constant temperature, and means responsive to the moisture content in the material passing away from the drying rolls for automatically regulating the drying action thereof as required to maintain said moisture content approximately constant.

6. An apparatus for continuously sizing material, comprising a size bath receptacle containing sizing solution the temperature of which affects the sizing and subsequent drying of said material and drying rolls over which the material is continuously moved, means for maintaining said size bath at an approximately constant temperature, means rotating said rolls at an approximately constant speed, and means responsive to the moisture content in the material passing away from the drying rolls for automatically regulating the heating of said rolls as required to maintain said moisture content approximately constant.

7. An apparatus for continuously sizing material, comprising a size bath receptacle containing sizing solution the amount and temperature of which affects the sizing and subsequent drying of said material and drying rolls over which the material is continuously moved, means for maintaining an approximately constant amount of hot size in said receptacle at an approximately constant temperature, means for heating said rolls to an approximately constant temperature, and means responsive to the moisture content in the material passing away from the drying rolls for automatically regulating the rate of material movement through said bath and over said rolls as required to maintain said moisture content approximately constant.

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