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S. A. STAEGE

DRIER CONTROL SYSTEM

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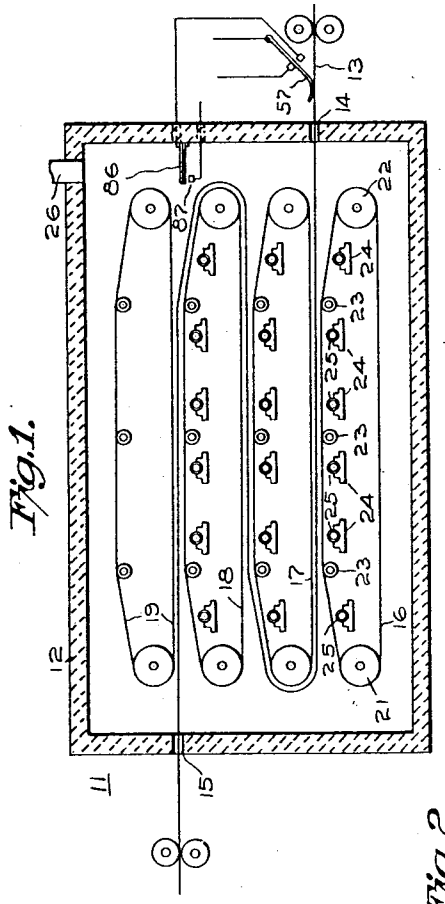


Fig. 1.

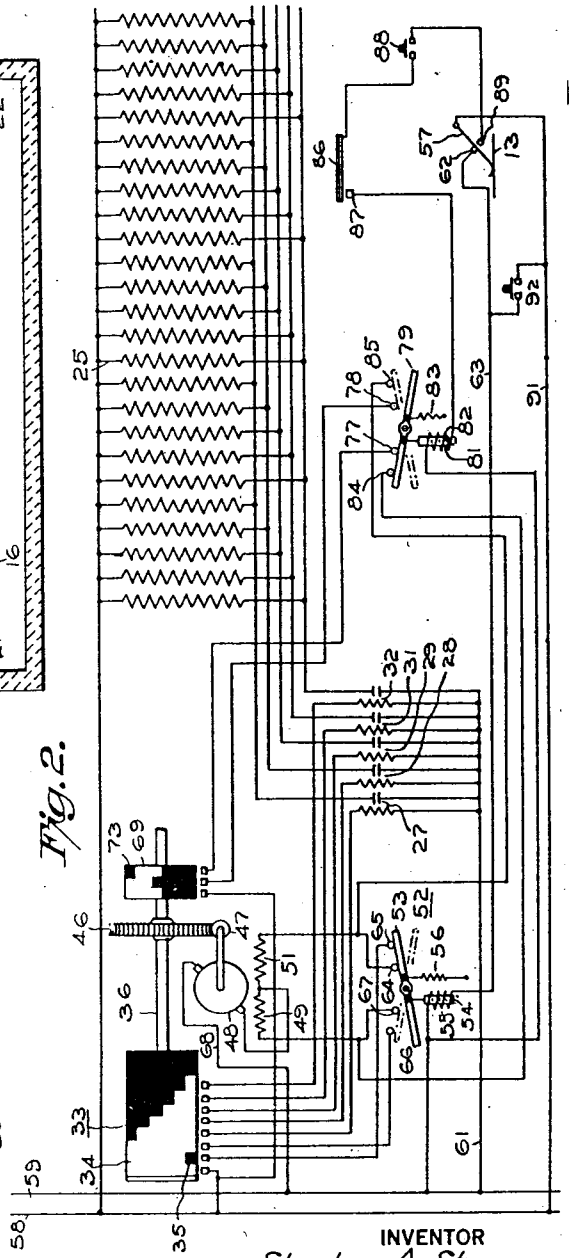


Fig. 2.

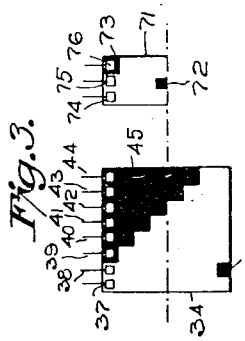


Fig. 3.

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DRIER-CONTROL SYSTEM.

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My invention relates to heating devices and particularly to control means therefor.

An object of my invention is to provide a motor-driven and drag-link-controlled means for effecting the energization and de-energization of a plurality of heating units in step-by-step sequence.

Another object of my invention is to provide a system normally controlled by a drag link to control the energization of all of a plurality of heating units, and temperature-actuated means for controlling the step-by-step energization of a portion only of the heating units.

In practicing my invention, I provide a plurality of heating units, the energization of which is controlled by a motor-actuated contact drum, the motor being controlled by a drag link operatively associated with the material being dried.

A second contact drum is operatively associated with the first contact drum and is adapted to control the operation of the motor through a limited range of movement of the drum, the operation thereof being controlled by a thermostat means.

In the single sheet of drawing,

Figure 1 is a view, in longitudinal vertical section, of a drier unit with which is associated the system embodying my invention,

Fig. 2 is a diagrammatic view of circuits and apparatus embodying my invention, and

Fig. 3 is a fragmentary view illustrating the developed surfaces of contact drums comprising a part of my invention.

The system embodying my invention is particularly adapted for use in connection with an electrical heating unit for drying initially wet webs of material, such as paper, and I have elected to illustrate and describe the same in connection with such a drying unit indicated generally by the numeral 11 in Fig. 1 of the drawing.

The heating unit comprises a substantially enclosed casing designated by the numeral 12 that may be of any suitable or desired type of construction, and which will be of such contour and dimensions as to permit of moving therethrough an initially wet web of material 13. Two of the walls of the casing 12 are provided respectively with an entering slot 14 and a leaving slot 15 to permit of moving the web into and out of the casing 12.

Means for supporting the web of material within the casing 12 and for moving it therethrough in a circuitous path comprises a plurality of superposed endless woven wire belts 16, 17, 18 and 19. Each of the endless woven wire belts, that are of relatively small mesh, are supported by two spaced rollers or drums 21 and 22 that are supported in any suitable or desired manner usually employed in the art.

The drums or rollers 21 may be so mounted as to be movable in a horizontal plane relatively to the co-operating drum 22, in order that a uniform tension may be provided for the respective endless belts supported thereby. As the design and mounting of the rollers, and the means for maintaining an even tension on the endless belts are well known in the art and constitute no part of my invention, I have not thought it necessary to illustrate or describe them in detail.

The upper portion of each of the endless belts travels over a plurality of smaller auxiliary roller members 23, the positions of these rollers, being such that the upper portion of a lower endless belt and the adjacent lower portion of the superposed endless belt are in close operative engagement and will receive the web of paper or of material therebetween and cause it to be moved through the casing without wrinkling or cockling of the paper during the drying operation to which it is subjected during its movement through the casing.

Means for drying the initially wet web of material comprises a plurality of electric heating units, each comprising a suitable refractory suport 24 and a resistor member 25 mounted thereon, the heating units being located in spaced relation relatively to each other and to the individual passes of the web of material during its movement through the casing.

The heating units are preferably uniformly distributed, substantially as illustrated in Fig. 1 of the drawing, and are so energized that the temperature thereof will be relatively high, that is, of the order of 1200° F.

The relatively high temperature of the heating units effects a very rapid drying of the web of material by raising the temperature of a portion of the fluid contained in the web to 212° F., changing it into steam at 212° F. and then further increasing the temperature thereof to a value of approximately 500° F. This results in transforming fluid initially in the web of material, into a dry superheated vapor which, by reason of the substantially enclosed casing within which it is generated, will be under a slight pressure relatively to the outside of the casing.

The dry superheated vapor may be permitted to escape through a suitable exhaust conduit 26 or it may be conducted therethrough to other devices wherein the heat in the vapor may be profitably employed. The percentage of fluid that is transformed into dry superheated vapor and therefore, the dryness of the leaving web of material will, of course, be in accordance with the amount of energy translated to heat within the casing and in accordance with the amount of time which it takes to move the web through the casing as well as in accordance with the amount of fluid initially in the web.

The amount of electrical energy transformed into heat within such casing is relatively large and is of the order of 75 kilowatts per ton of daily capacity of a paper machine accordingly, for a hundred ton paper machine the amount of energy translated to heat will be approximately 7500 kw. It is very undesirable to energize all of this capacity of heating units or to de-energize the same at one time because of the injurious effect upon not only the generator and its prime mover, but more particularly upon the voltage conditions in the network or line to which it is connected. In order to effect a step-by-step energization of the heating units in such drier system, it is suitable to subdivide the heating units in order that they may be symmetrically located within the casing and to permit of their energization in sequence through suitable circuit controlling means.

I have illustrated a plurality of resistor members 25 as divided into five groups of heating units directly controlled by five contactors 27, 28, 29, 31 and 32, respectively, that are illustrated symmetrically only as comprising an actuating coil and cooperating contact members.

The energization of the respective actuating coils of the contactors is controlled by a contact drum 33 that has mounted thereon an electric conducting contact plate 34, one edge portion of which is provided with a recess 35 and the other edge portion thereof is of serrated form, substantially as illustrated in Fig. 3 of the drawing, whereby one edge is relatively short as compared to the other edge portion thereof. The drum 33 is mounted on a suitable shaft 36 and is of such construction that a plurality of resilient contact members 37, 38, 39, 40, 41, 42, 43 and 44 may operatively engage either the electric-conducting surface 34 or the electric-insulating surface 45.

Means for effecting rotation of the drum 33 and of the shaft 36 in either a forward or a reverse direction comprise a worm gear 46 that is engaged by a worm 47 which is, in turn, mounted on the armature shaft of a motor 48 that has two field windings 49 and 51 that are wound in opposite directions or connected in such relation that their alternative energization will effect an operation of the motor in opposite directions.

Means for effecting energization of the motor and selective energizatin of the respective field windings 49 and 51 comprise a magnetic relay 52. The relay 52 comprises a double contact lever 53 pivotally mounted at its non-conducting intermediate portion and actuated by an electromagnet comprising a core member 54 and an energizing coil 55. A spring 56 biases the double contact lever to a predetermined position.

The energization of the coil 55 is controlled by a pivotally mounted drag link 57, the free end of which is normally in operative engagement with the moving web of material 13, as illustrated more particularly in the lower right-hand portion of Fig. 2 of the drawing.

The position of the drum 33 illustrated, is that in which all of the contactors 27 to 32, inclusive, are closed, the drum having been turned in such direction that the brushes, illustrated in Fig. 2 of the drawing, are in engagement with the wider portion of the contact plate 34, with the exception of the brush 38 that is located in the recess 35 of the contact plate. Energy is supplied from two supply circuit conductors 58 and 59 to all of the heating units and to the control device. A circuit may be traced from conductor 58 through brush 37, the contact plate 34, brushes 40, 41, 42, 43 and 44, corresponding conductors to the actuating coils of the contactors 27 to 32, and thence through a conductor 61 to supply circuit conductor 59.

In this position of the drum, all of the heating units are energized and the contactors are in their closed position, the drag link 57 is held in the position illustrated in which it is in operative engagement with the contact member 62 that is connected through a conductor 63 to one terminal of the actuating coil 55. As long as the web of material moves through the casing and the drag link is in substantially the position illustrated, it will be in operative engagement with the contact member 62 and the coil 55 will be energized to hold the lever 53 in the position

illustrated in which it connects two contact terminals 64 and 65, respectively connected to one terminal of the field magnet coil 51 and to the brush 38.

In case of breakage of the web of material, it is desirable to immediately de-energize the heating units in step-by-step sequence. A breakage of the web 13 permits the drag link 57 to be disengaged from the contact member 62, causing de-energization of the coil 55 and permitting a spring 56 to move the double arm lever 53 to the position illustrated by the broken lines in which the left hand conducting portion will be in operative engagement with two spaced contact members 66 and 67. The contact members 66 and 67 are respectively connected to brush 39 and to the outer terminal of field winding 49.

As soon as the web breaks and the drag link drops, causing de-energization of the coil 55 and consequent engagement of the lever 53 with the contact members 66 and 67, a circuit is completed which may be traced from supply circuit conductor 58 through brush 37, contact plate 34, brush 39, contact member 66, contact member 67, field winding 49, armature 48, and through a conductor 68 to the supply circuit conductor 59. The motor then rotates the drum in such direction that the brushes will, in effect, be moved to the positions shown in Fig. 3 of the drawing, that is, the surface of the drum will move downwardly in the plane of the paper as shown in Fig. 2 of the drawing.

The brush 44 will be the first to be disengaged from the electric conducting plate 34, thereby de-energizing the coil of the contactor 32 and, therefore, causing de-energization of the group of heating units controlled thereby. The brush 43 next engages the electric insulating surface 45 and the coil of contactor 31 is deenergized. The rotation of the drum 33 continues until the brush 39, connected to the contact member 66, is disengaged from the electric conducting surface 34, when the energizing circuit through the motor field 49 and the motor armature 48 will be interrupted and the motor will stop. In this position of the drum, all of the contactors are de-energized, this denergization having been effected in step-by-step sequence in order to gradually reduce the load on the generator or on the line.

It is highly desirable that the temperature within the casing 12 shall not fall below a predetermined value which temperature may be of the order of 500° F., that is, substantially the same as is normally maintained within the casing when the web of material is being moved therethrough to be dried. In order to maintain the temperature at substantially this value, I provide auxiliary temperature-controlled means for effecting the energization and the de-energization of a portion only of the heating units in accordance with the temperature conditions within the casing in case of breakage of the web of material.

An auxiliary drum 69 is mounted on the shaft 36 and is provided with an electric-conducting contact plate or surface 71 that is of relatively smaller arcuate extent than the surface 34. It is provided with a recess 72 in one side thereof and a corner recess 73 at the other side thereof substantially as illustrated in Fig. 3 of the drawing. Contact brushes 74, 75 and 76 are operatively associated therewith, the brush 74 being connected to the supply circuit conductor 58, as shown in Fig. 2 of the drawing.

The brushes 75 and 76 are electrically connected to two fixed contact members 77 and 78 that constitute a part of an electromagnetic relay that comprises a double arm contact lever 79 pivotally mounted at its central electric-insulating portion. The lever 79 is actuated by an electromagnet comprising a core member 81 pivotally connected thereto, and an energizing coil 82. A spring member 83 is connected to the other portion of the lever 79 and biases it to substantially the position illustrated in Fig. 2 of the drawing, where the conducting left-hand end portion engages contact members 77 and 84. The contact member 84 is connected to the outer terminal of the field winding 49. A fourth contact terminal 85 co-acts with the conducting right-hand end portion of the lever 79 and is connected to the outer terminal of the field winding 51.

The energization of the winding 82 is controlled by a thermostatic member 86 located within the casing 12 and having a contact member 87 that is connected to one terminal of the coil 81. The fixed end of the member 86 is connected to one terminal of a suitable push button switch 88, the other terminal of which is connected to a contact member 89 that is adapted to be engaged by the movable portion of the drag link 57 upon breakage of the web of material. The switch 88 is of such construction that it will remain in either its closed or its open position when moved thereto.

The thermostat 86 will open to be disengaged from the fixed contact member 87 as soon as the temperature to which it is subjected exceeds a value of about 400° F., that is, a value that is below the normal temperature existing within the casing 12 during operation thereof.

If it be assumed that the web of material has broken after several hours of normal operation, and if it be further assumed that the system, as controlled by the drag link 57, has caused the motor to actuate the drum 32 to the position in which the cooperating

brushes are in the positions illustrated in Fig. 3, that is, all of the heating units have been de-energized, and if the switch 88 is in the closed position, the thermostat 86 will remain in its open position for a predetermined length of time until the normal operating temperature of 500° F. has been reduced, by reason of heat radiation from the casing 12, to 400° or below.

When the temperature drops to 400° F. or below, the thermostat 86 engages the contact member 87 to complete an energizing circuit extending from supply circuit conductor 58 through conductor 91, drag link 57, contact 89, switch 88, thermostat 86, contact member 87 and actuating coil 82 to the other supply circuit conductor 59. The core 81 is energized and moves the lever 79 to the position indicated by the broken lines in Fig. 2 of the drawing, thereby closing an energizing circuit from supply circuit conductor 58 through brush 74, contact plate 71, brush 75, contact member 78, lever 79, contact 85, field winding 51, armature 48 and conductor 68 to the other supply circuit conductor 59. The motor then rotates the two drums clockwise, as viewed from the right, whereby the brushes or contact members 40 and 41 will be caused to engage the electric-conducting surface, energize the cooperating actuating coils of the contactors and thereby effect energization of a portion only of the heating units. The rotation of the drums continues until contact member or brush 75 reaches the recess 72 at which time the energizing circuit through the motor is interrupted, and the motor will stop. The arcuate extent of the electric conducting plate 71 is so selected that, as nearly as possible, the amount of electric energy translated into heat in the heating units thus energized will be just sufficient to maintain approximately the normal operating temperature within the casing 12. This temperature may be made or maintained at substantially 400° F. as it is evident that if a temperature of 400° is exceeded, the thermostatic member 86 will be disengaged from the contact member 87, the coil 82 will be deenergized and the switch lever 79 will be permitted to return to the position shown by the full lines to cause energization of the motor through the other field winding 49, thereby effecting a return movement of the drum to the initial position in which all of the contactors and, therefore, all of the heating units are deenergized.

As soon as the web of paper is again moved through the casing, the drag link will be disengaged from the contact member 89 and be in engagement with the contact member 62, whereby an energizing circuit is closed through coil 55, moving the switch lever 53 to the position illustrated by the full lines in Fig. 2, and causing energization of the field winding 51 of the motor 48 to effect rotation of the drums to the positions shown in Fig. 2 of the drawing. In this position, all of the brushes associated with the actuating coils of the contactors are in engagement with the electric-conducting surfaces 34, the contactors are closed and all of the heating units are energized.

A push button control switch 92 has been provided in order that the circuit normally controlled by the drag link 57, may be closed to effect energization of all of the heating units a short time in advance of the time when the web of paper is again moving through the casing and the drag link is controlled thereby.

The system embodying my invention thus provides a drag-link controlled and motor-operated contact drum for effecting a step-by-step energization and de-energization of a plurality of heating units, with limit switches associated therewith for effecting de-energization of the motor at the desired limit of travel of the contact drum. An auxiliary contact drum is provided that is thermally controlled in case of breakage of the web and through the hereinbefore described drag link, to effect a step-by-step energization and deenergization of a portion only of the heating elements to maintain a substantially uniform temperature in the system as long as the web of paper is not moving through the drier unit.

As hereinbefore stated, I have illustrated and described a system embodying my invention as applied to an electrically heated paper drier unit, but its use is not restricted thereto.

Various modifications may be made in the system embodying my invention without departing from the spirit and scope thereof and all such modifications are intended to be covered by the appended claims which are to be limited only by the prior art.

I claim as my invention:

1. In a heating system for drying a web of material, the combination with a plurality of heating units, of means for effecting the energization of said heating units in step-by-step sequence, a relay for controlling the energization of said means, and a drag link, normally operatively engaging said web of material and effective upon breaking of said web to actuate said relay to energize said operating means to effect deenergization of the heating units in step-by-step sequence.

2. In a heating system for drying a moving web of material, the combination with a plurality of heating units, of a drag-link-controlled means for effecting deenergization of all of said heating units in step-by-step sequence in case of breakage of said web, and a thermal element, energized only in case of breakage of said web, for energizing said means to effect re-energization

of a predetermined number only of said heating units.

3. In a heating system for drying a web of material, the combination with a plurality of heating units, of means for effecting deenergization of said heating units in step-by-step sequence in case of breakage of said web, and thermal means for causing re-energization of a portion only of said heating units upon the occurrence of a predetermined temperature in said system.

4. In a heating system for drying a web of material, the combination with a plurality of heating units, of a reversible contact drum effective to cause energization and deenergization of all of said heating units in step-by-step sequence, a motor for actuating said drum, a drag link normally operatively engaging said web for controlling said motor, and a thermal element, energized by said drag link in its inoperative position for causing said motor to energize and deenergize a part of said heating elements only in accordance with the temperature of said thermal elements.

In testimony whereof, I have hereunto subscribed my name this 8th day of July 1925.

STEPHEN A. STAEGE.