

YARN DRYING APPARATUS

Filed Feb. 27, 1941

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Fig. 1.

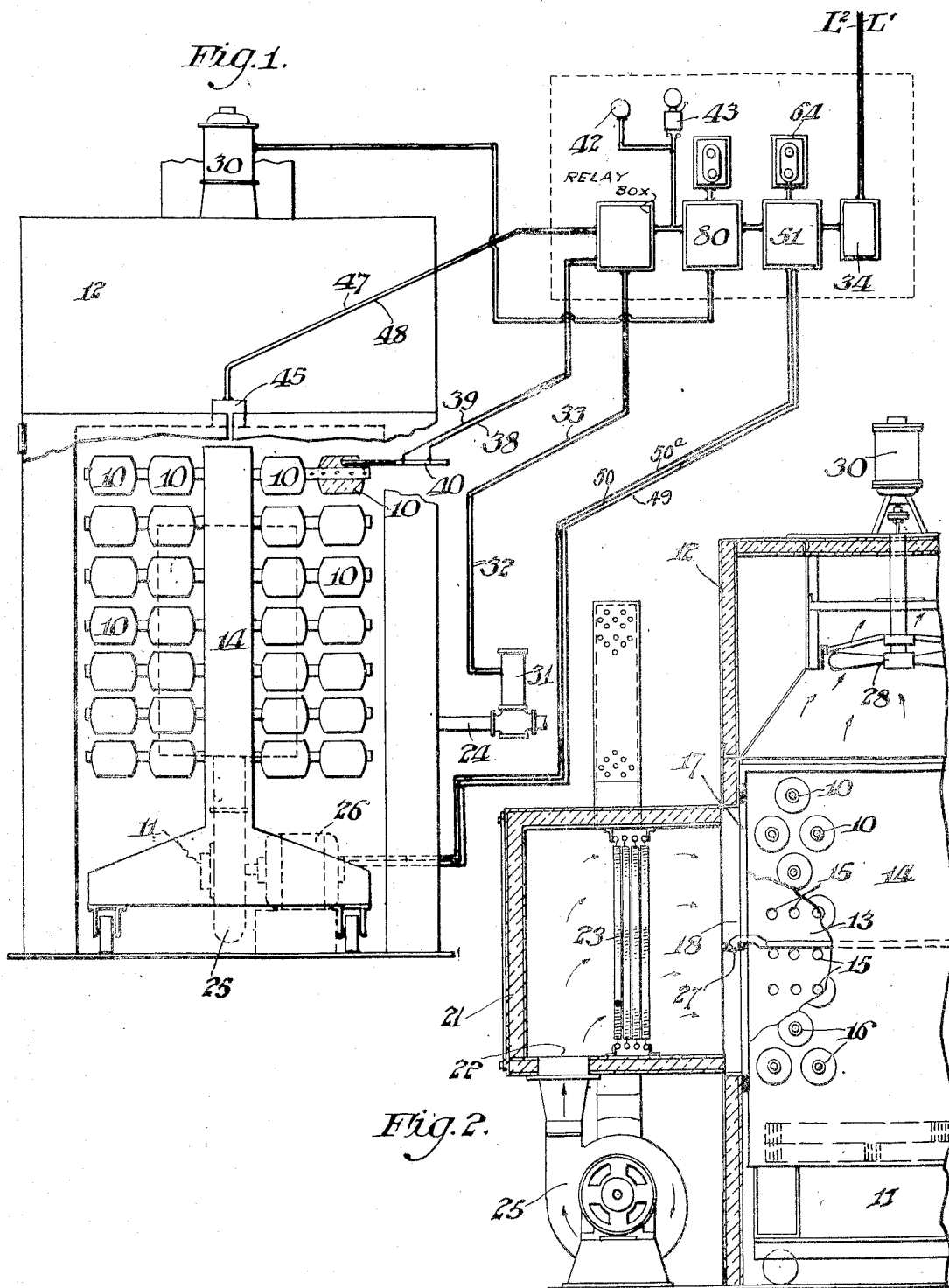
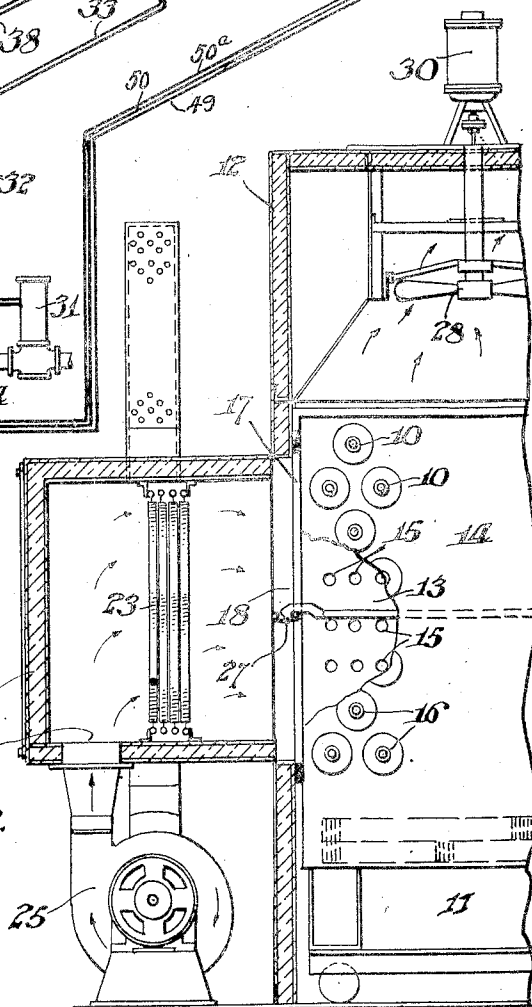


Fig. 2.



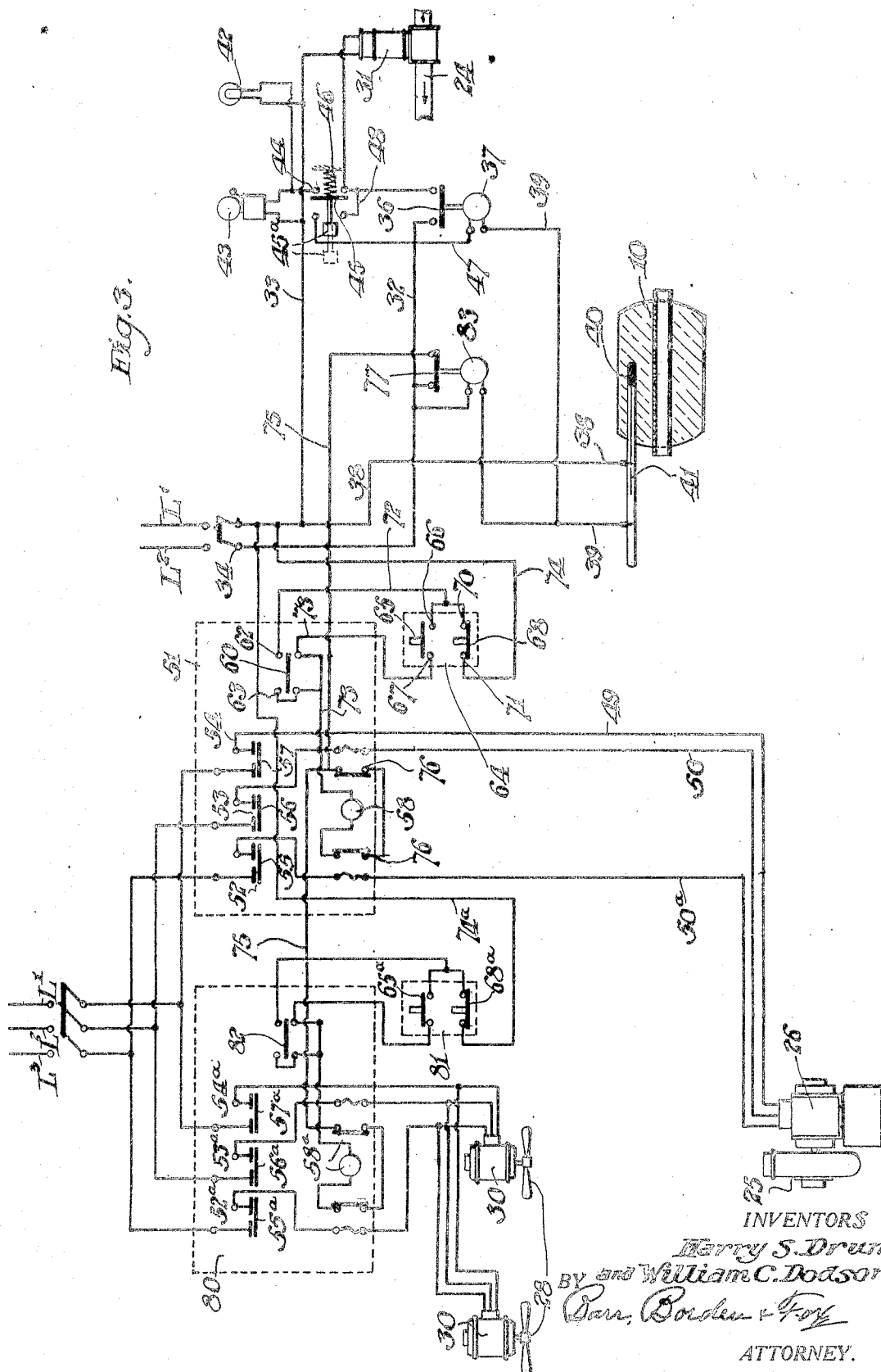
INVENTORS
Harry S. Drum
 and *William C. Dodson*
 BY *Bar, Corden & Fox*
 ATTORNEY

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Fig. 3.



INVENTORS

Harry S. Drum

and William C. Dodson

BY *Bar. Borden & Foy*

ATTORNEY.

Dec. 15, 1942.

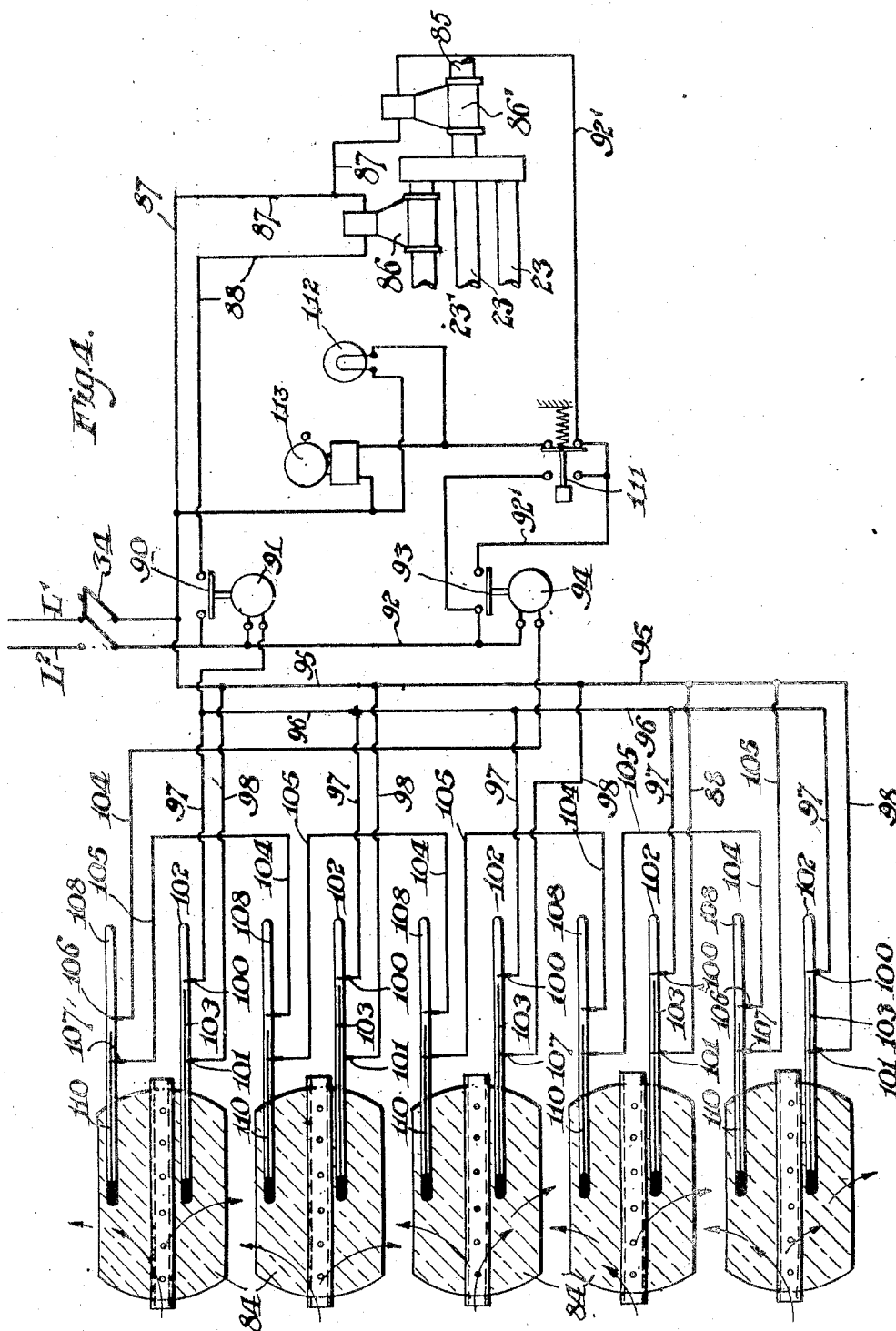
H. S. DRUM ET AL.

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YARN DRYING APPARATUS

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3 Sheets-Sheet 3



INVENTORS
Harry S. Drum
and William C. Dodson
 BY *Bar. Borden & Fry*
 ATTORNEY

UNITED STATES PATENT OFFICE

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YARN DRYING APPARATUS

Harry S. Drum and William C. Dodson, Abington, Pa., assignors to Smith, Drum and Company, Philadelphia, Pa., a corporation of Pennsylvania

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15 Claims. (Cl. 34-45)

The present invention relates to the drying of material following a treating, washing or other wet process during the transformation of that material into finished form, and relates more particularly to the drying of yarn in package form.

In the drying of wet material it has heretofore been proposed to control the drying apparatus by the varying humidity of the drying medium, such as air, which surrounds and circulates about the material. Another method has been to employ a mechanism which is responsive to the change in weight of the mass of material as it dries. Neither of these methods has been entirely satisfactory and have inherent disadvantages. By reason of the fact that material of substantial thickness does not dry uniformly it is essential that drying temperatures, such as follow the use of humidity or weight controls, must be kept below a safe temperature so as not to damage that portion of the material which has dried first. In thus maintaining a safe temperature the time for complete drying is far longer than would be required were it possible to use the required high temperatures. This loss of time translates itself into added cost of production.

Some of the objects of the present invention are to provide a drying apparatus in which the foregoing disadvantages are eliminated; to provide a drying apparatus arranged to ensure uniform drying of a yarn package or a relatively thick piece of material; to provide means for so controlling the drying of material that the efficiency due to high drying temperatures can be maintained without damage to the material; to provide a drying apparatus capable of compensating the drying time relative to the texture of the material, since heavy yarns, for example, require a different drying time than do fine yarns; to provide a control means whereby an average drying temperature can be secured for a plurality of yarn packages; and to provide other improvements as will hereinafter appear.

In the accompanying drawings Fig. 1 represents diagrammatically a sectional elevation of a package drying apparatus embodying one form of the present invention; Fig. 2 represents a fragmentary side elevation showing the heat exchange unit; Fig. 3 is a diagram of one system of circuits used for control purposes in the invention; Fig. 4 represents a diagram of a modified form of drying control.

Referring to the drawing, one form of the present invention is shown as arranged for use with yarn packages 10, mounted upon a carriage

type of carrier 11 which can be wheeled into and out of a door controlled cabinet 12. In this type of carrier, a chamber 13 is formed by a casing 14 and serves to distribute heated air to the interior of the packages 10 by way of holes 15 which communicate respectively with the ends of the channeled spindles 16. The tubular perforated tubes carrying the packages are mounted respectively upon these spindles 16, as is well known in the art and thus heated air enters the axis of each package and travels radially outward to dry the packages.

As shown by way of example the inner end wall of the casing 14 is provided with an inlet opening 17 so located as to register with the outlet 18 of a heat exchange unit when the carrier is in operative association with the cabinet 12. This unit consists of a box 21, having an air inlet 22, and steam coils 23 located between the inlet 22 and outlet 18. The heating medium, preferably steam, is supplied by a pipe 24 from a suitable source, while air is supplied to the box 21 from a blower 25 driven by an electric motor 26. An interlocking connection, such as a clamping latch 27, serves to anchor the carrier to the cabinet with a leak proof joint about the outlet from the transfer unit.

From this construction it will be seen that the packages are dehumidified and dried by heated air passing through them from the inside to the outside, or vice versa. Circulation of the air within the cabinet 12 is maintained by one or more overhead fans 28 driven respectively from the exterior of the cabinet by an electric motor or motors 30. It should be kept in mind, however, that this described apparatus is but one example of an apparatus suitable for use with the invention, so that the particular manner in which the packages are heated is of minor importance as compared to the direct control of yarn package drying.

For the purpose of shutting off the supply of steam to the heating coils 23 a thermal type of valve 31 is located in the steam supply pipe 24 and is arranged to cut off the steam when the electric circuit of conductors 32 and 33 is closed. It is believed unnecessary to describe this valve structure in detail because it is a well known valve having an enclosed bulb containing a heat responsive medium to develop sufficient pressure under the radiated heat of a coil to close the valve. The conductors 32 and 33 are in a circuit including a main switch 34, a source of current supply L^1L^2 and a relay switch 36, this last being

normally open so that the control thermal valve 31 is open.

In order to close the relay switch 36 when the temperature within a package 10 reaches a predetermined maximum, the magnet coil 37, for the switch 36, is in an electric circuit including conductors 38 and 39, the main switch 34, and a control element in the form of a circuit closing thermometer 40 of a size and shape to be readily inserted endwise of a yarn package. The terminals of the conductors 38 and 39 are led through the glass wall of the thermometer body in such spaced relation that at the selected maximum temperature the expanding mercury column 41 will bridge such terminals and close the circuit of relay coil 37 to thereby close the switch 36 and energize the steam valve 31 as required to cut off the steam supply.

For notifying the operator that the switch 36 has closed the control circuit, a visual signal, in the form of a lamp 42, and an audible signal in the form of an electric bell 43 are arranged in parallel in the control circuit so that both are energized as the steam is cut off. This indicates to the operator that the package temperature has reached the desired maximum, and the package is ready to be removed.

Since it is advisable to have the steam shut off when access is to be had to the cabinet, a double pole two way switch 44 is shown in shunt relation across the switch 36 and has its contactor 45 under the pressure of a spring 46 to move it in the direction to close the thermal valve circuit by way of conductors 47 and 48. A plunger 45a is connected to the contactor 45 and is arranged to be pressed inwardly by the closing of the door or other closure of the cabinet to overcome the action of the spring 46 so that the valve circuit is open and the parallel circuit for the signals set to respond to the closing of the switch 36.

For controlling the blower motor 26, a three phase current is supplied by conductors 49, 50 and 50a under control of a magnetic contactor unit 51 of well known commercial form. Briefly, three switches 52, 53 and 54 are located in the respective conductors 49, 50 and 50a and have contactors 55, 56 and 57 arranged to be simultaneously opened or closed by the action of the armature of magnet or solenoid coil 58. A maintaining switch contactor 60 is also operated by the solenoid coil 58.

A source of current $L^1L^2L^3$ supplies the three phase current to the conductors 49, 50 and 50a when the magnetic contactor switches are closed. The maintaining switch contactor 60 electrically connects contacts 62 and 63 when the solenoid coil 58 is energized to keep the solenoid circuit closed as will later appear.

As a means to start and stop the blower motor 26, a well known type of switch unit 64 is provided having a starting push button contactor 65, which is normally spring-held to break a circuit between contacts 66 and 67, and a stop push button contactor 68 normally spring-held to electrically connect contacts 70 and 71. The contacts 66 and 70 are connected by a conductor 72 to the contact 62, while contact 67 is connected by a conductor 73 to both the contact 63 and the coil 58. Contact 71 is connected by a conductor 74 to the current supply line L^1 . The return conductor 75 of the coil 58 leads through a pair of overload switches 76 to the line L^2 by way of a normally closed relay switch 77.

In order to control the operation of the fan

motors 30, a magnetic contactor unit 80, similar to the contactor unit 51, is connected in parallel with that unit to the source of current $L^1L^2L^3$ and is under the control of a starting and stopping unit 81, like the unit 64 plus a maintaining switch 82 like switch 60. The two contactor units 51 and 80 have the respective solenoid circuits supplied from the source L^1L^2 and include common return conductor 75 which is normally closed by the switch 77. It is believed unnecessary to describe the units 80 and 81 in detail, as each should be understood from the description of the units 51 and 64.

For the purpose of breaking the circuits of the contactor units 51 and 80 to stop the blower 25 and fans 30 when the selected package temperature has been attained the normally closed switch 77 is provided under the control of a relay magnet 83 in the circuit of conductors 38 and 39. Thus when the thermometer contacts close the circuit to energize the relay magnet 37, the relay magnet 83 is also energized. The former therefore closes the circuit to cut off the steam, while the latter opens the circuit for the blower and fans.

In the operation of the apparatus the control element 40 is set to close the circuit 38 and 39 at a predetermined temperature at which the dryer is to be automatically shut down and, with the control element inserted into the package as shown, the apparatus is then ready to function. The doors of the cabinet are closed and this action moves the door switch 45 to break the circuit 47 and 48 including the valve 31 and at the same time partially closes the circuit for the bell and lamp signals. Since the valve 31 is now de-energized it opens and allows steam to be delivered to the heat exchange coils and, therefore, the blower and fans are ready to be started. Since the two separate magnetic contactors and starting buttons operate exactly alike but on different motors, the starting circuits will be confined to but one of these as the other will be merely a repetition. The starting push button 65 closes the circuit between the contacts 66 and 67 thereby permitting current to flow by way of conductor 73 to the magnet coil 58 and return by conductor 75 and conductor 77 to the other side of the supply line. The energizing of the magnet coil 58 shifts the solenoid contactor to not only close the contactors 55, 56 and 57 of the several line switches but also throws the contactor 60 across the contact 62 and 63 whereby the circuit is maintained closed and the starting push button short circuited. The blower motor is thus in operation and upon a like push button closing of the unit 81 a similar circuit closing takes place and the fan motors 30 are in operation.

Heated air is now circulating from the inside of the packages to the outside and when the temperature of the package used as a control reaches that predetermined one, the mercury column 41 closes the circuit 38 and 39 which results in relay 83 being energized to open switch at contactor 77 and to energize relay 37 to close contactor 36. The opening of the switch formed by contactor 77 breaks the circuit to the two magnetic contactor coils and thus brings both the blower motor and fan motors to rest. The closing of the switch formed by contactor 36 closes the circuit to the thermal valve 31 which is thus heated and brought to a closed position cutting off steam to the heating coils. Also closing the contactor 36 results in energizing the bell and lamp circuits

and hence the visual and audible signals give warning to the operator that the proper temperature has been reached. The signals will operate until the door of the cabinet is opened when the spring 46 throws the door switch to its other position to open the signal circuits but close the circuit which includes the thermal valve 31 so that this last element is held closed as long as the door is open.

The blower motor 26 is controlled by the de-energizing of the magnet coil 53 which opens the three circuits at the contactors 55, 56 and 57. Simultaneously the maintaining switch 60 is opened so that restarting can only take place by operating the starting button 65.

The fan motors 30 are controlled by a separate magnetic contactor unit 80 of like construction to the unit 51, in that it includes three switches 52a, 53a, and 54a, for controlling the respective conductors to the fan motors 30, and which switches have contactors 55a, 56a and 57a arranged to be closed by the energization of a magnet coil 58a by a circuit in parallel with the circuit of magnet coil 58. This coil 58a also serves to close the circuit maintaining switch 82 after the starting push button 65a is operated. Since the stopping push buttons 68 and 68a for the respective units 51 and 80 are normally in circuit closing position, either circuit can be opened by pushing its starting button to open circuit position.

In the form of the invention shown in Fig. 4, provision is made for obtaining uniform drying of a plurality of yarn packages which are being simultaneously subjected to a heating medium. It is to be understood that the yarn packages 84, shown diagrammatically, are contained within a drying cabinet, such as heretofore described, and circulation of heated air is from the inside to the outside of the packages. Steam from a supply pipe 85 supplies the heating medium to the several banks of heating pipes 23 and 23', which are the pipes heretofore described as associated with the heat exchange box 21, except in this instance the pipe bank 23' is separately controlled by an automatic thermal valve 86, while all of the pipe banks are controlled by an automatic thermal valve 86' in the steam supply main 85.

For controlling the electrically operated thermal valve 86, it is included in an electrical circuit of conductor 87, current source L¹ and L², and conductor 88, the last having a normally open switch 90 therein controlled by a relay magnet 91. This relay 91 is arranged to be energized by the closing of a circuit including the conductors 95 and 96, current source L¹ and L², and any one of a number of circuit branches 97 and 98, each of which latter is open at contacts 100 and 101 within a thermometer 102, the mercury column of which serves as a contactor 103 to close the contacts 100 and 101. The circuit branches 97 and 98 are all in parallel with the circuit of relay 91, so that when any one of the thermometer 102 closes its circuit the relay 91 will be energized to operate the thermal valve 86 to cut off the steam from the pipe coils 23'. As shown these thermometers are inserted in the respective packages 84 in close proximity to the core of the package, and all are so set as to close their contacts at the same predetermined temperature.

For controlling the electrically controlled thermal valve 86', it is included in an electrical circuit of current source L¹L², conductor 92, normally open switch 93, conductor 92', and common return conductor 88. The switch 93 is arranged to be closed by the energizing of a relay 94. This relay

94 is arranged to be energized by the closing of a circuit including the conductors 92 and 96, current source L¹ and L², and an interconnected series circuit of conductor branches 104 and 105, each of which latter is open at contacts 106 and 107 within a thermometer 102, the mercury column of which serves as a contactor 103 to close the contacts 106 and 107. Since the circuit branches 104 and 105 are all in series with the circuit of relay 94, all such circuits must be closed before the control valve 86' is energized to cut off all steam to the coils 23. As shown these control or contact thermometers 102 are inserted in the respective packages 84 in close proximity to the outside surface of the package, and all are so set as to close their contacts at the same predetermined temperature.

In the foregoing modification it is also proposed to employ a door switch 111, lamp 112 and bell 113 signals, which are operated and controlled as explained in connection with the description of circuits in Fig. 3.

In this form of the invention the thermometers 102 are set to close any control circuit in which the temperature near the core of any yarn package approaches the danger line where damage may be done to the yarn. Thus a maximum temperature is selected which will cause the responsive device of any package to close a circuit through the thermal steam valve to cause that valve to partially close and thus reduce the amount of steam being supplied to the heating medium, which in this case is the heat exchange unit. When this happens heated air continues to travel through the packages and finally the temperature in the packages adjacent the outer layers thereof reaches the selected maximum and the series circuit is closed when all of the thermometers 102 have functioned as circuit closers. If yarn conditions are substantially the same and there has been uniform drying of each, all of the thermometers 102 may act simultaneously to close the circuit to the thermal steam valve and so shut off the steam. On the other hand the density of some packages may be greater than others and hence the series circuit for all packages will be delayed in closing until all the thermometers have functioned. Even though this last condition may be an appreciable lag after one or more packages have reached the selected temperature, yet no damage will be done to these packages while waiting for the others to dry, because the set of thermometers 102 guard against any temperature high enough to damage the yarn being reached.

From the foregoing it will be seen that a control for yarn drying has been devised which, not only permits the use of a high starting temperature whereby the time of drying is materially reduced, but safeguards the yarn against damage. The starting high temperature will not harm the yarn as long as the yarn is damp, and hence a control instrument near the axis of the yarn package operates as a safety means to reduce the temperature automatically to a harmless one and yet one which continues the drying to the outside of the yarn package. The control instrument near this outer surface of the yarn package serves to either cut off the supply of the heating medium or to stop the circulating fans, or to do both.

In the drying of yarn packages there are many factors which affect the drying, such as variations in the degree of extraction of the packages before placing them in the dryer; different methods of processing in which some batches

may be finished cold while others may be finished hot; different kinds of dyes; different diameters of packages; and the density of the wind. Because of these variations all packages do not dry with the same speed. Heretofore it has been customary to manually remove a number of packages from the drier and weigh them in order to obtain an average from which it is determined whether or not all the packages are dry. Obviously this is not only a crude method but an unpleasant and uncertain one because the operator facing a hot chamber naturally grabs out those packages most conveniently located and hence does not obtain a true average condition.

By the present invention these disadvantages and uncertainties are eliminated because the instruments are precisely located at widely separated points and hence a real average condition is indicated automatically and no sample packages have to be removed.

Having thus described our invention, we claim:

1. In a drying apparatus, the combination of means to introduce air into a yarn package to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, means for circulating said air over said unit, and means responsive to the internal temperature of said package for regulating the supply of heat to said unit.

2. In a drying apparatus, the combination of means to introduce air into a yarn package to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, means for circulating said air over said unit, and means responsive to a predetermined temperature within said package for lowering the temperature of said unit.

3. In a drying apparatus, the combination of means to introduce air into a yarn package to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, means for circulating said air over said unit, and means including a thermal responsive instrument inserted in said package for lowering the temperature of said unit when a predetermined temperature is reached within said package.

4. In a drying apparatus, the combination of means to introduce air into a yarn package to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, means for circulating said air over said unit, a pipe from said source to said unit, a valve in said pipe, and means responsive to a predetermined temperature within said package for operating said valve.

5. In a drying apparatus, the combination of means to introduce air into a yarn package to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, means for circulating said air over said unit, means including a normally open electric circuit for controlling the temperature of the heat supply to said unit, and a thermal responsive instrument in said package arranged to close said circuit at a predetermined temperature to lower the temperature of the heat supply to said unit.

6. In a drying apparatus, the combination of means to introduce air into a yarn package to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, means for circulating said air over said unit means including an electric circuit for controlling the temperature of the heat supply to said

unit, and a thermometer in said package arranged to control said circuit at a predetermined temperature to lower the temperature of the heat supply to said unit.

7. In a drying apparatus, the combination of means to introduce air into a yarn package to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, a pipe from said source to said unit, a valve in said pipe, a blower for circulating said air over said heating unit, electrical means for operating said blower, and means responsive to a predetermined temperature within said package for closing said valve and also rendering said blower operating means ineffective.

8. In a drying apparatus, the combination of means to introduce air into a yarn package to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, a blower for circulating said air over said heating unit, electrical means for operating said blower, and means responsive to a predetermined temperature within said package for rendering said blower operating means ineffective.

9. In a drying apparatus, the combination of means to introduce air into a yarn package to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, means for circulating said air over said unit, a motor driven fan for circulating air about the outside of said package, and means responsive to a predetermined temperature within said package for stopping said fan.

10. In a drying apparatus, the combination of means to introduce air into a yarn package to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, means for circulating said air over said unit, and means located respectively at different places in a yarn package and responsive to the temperature at said places for independently lowering the temperature of the heat supply to said heating unit.

11. In a drying apparatus, the combination of means to introduce air into a yarn package to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, means for circulating said air over said unit, means including a thermometer located within and adjacent the core of said package for reducing the temperature of the heat supply to said heating unit at a predetermined yarn temperature, and means including a thermometer located within and adjacent the outer layer of said package for also reducing the temperature of the heat supply to said heating unit at a predetermined yarn temperature.

12. In a drying apparatus, the combination of means to introduce air into a yarn package to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, means for circulating said air over said unit, means responsive to a predetermined temperature within and adjacent the outer layer of said yarn package for reducing the temperature of the heat supply to said heating unit, and means operating on said heating unit to prevent the temperature adjacent the core of said package from rising above a predetermined temperature.

13. In a drying apparatus, the combination of means to introduce air simultaneously into a plurality of yarn packages to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, means

for circulating said air over said unit, and means, including temperature responsive devices respectively in a plurality of said packages, for reducing the temperature of the heat supply to said heating unit when the temperature in any one of said yarn packages rises to a predetermined maximum.

14. In a drying apparatus, the combination of means to introduce air simultaneously into a plurality of yarn packages to travel there-
through for drying purposes, a heating unit for said air supplied from a source of heat, means for circulating said air over said unit, and means, including temperature responsive devices in a plurality of said packages for reducing the temperature of the heat supply to said heating unit when the temperature of all of said yarn packages rises to a predetermined maximum.

15. In a drying apparatus, the combination of

means to introduce air simultaneously into a plurality of yarn packages to travel therethrough for drying purposes, a heating unit for said air supplied from a source of heat, means for circulating said air over said unit, means including temperature responsive devices located respectively in said packages adjacent the cores thereof for reducing the temperature of the heat supply to said heating unit when the temperature adjacent the core of any one of said packages rises to a predetermined maximum, and means, including temperature responsive devices operative to further reduce the temperature of the heat supply to said heating unit when the temperature adjacent the outer layer of all of said packages rises to a predetermined maximum.

HARRY S. DRUM.
WILLIAM C. DODSON.