

April 22, 1969

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3,439,431

MICROWAVE DRYER CONTROL CIRCUIT

Filed Dec. 15, 1967

Sheet 1 of 2

FIG. 1

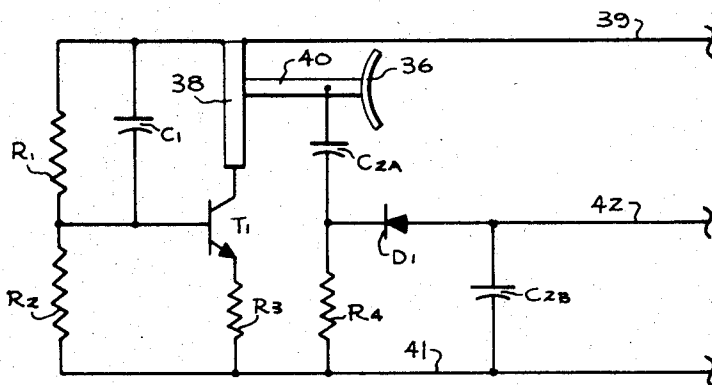
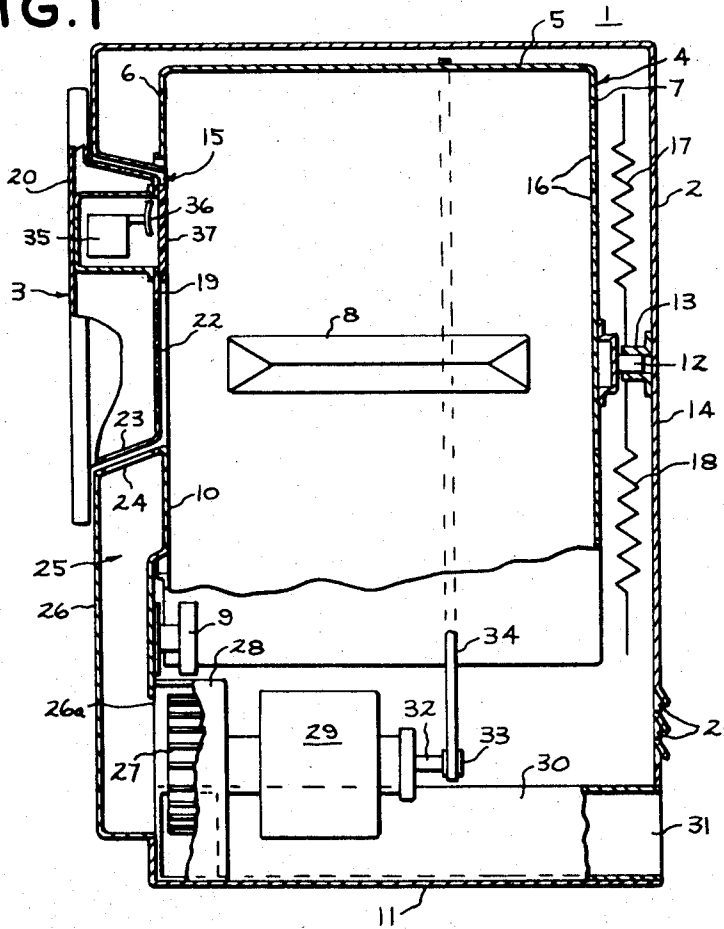


FIG. 2

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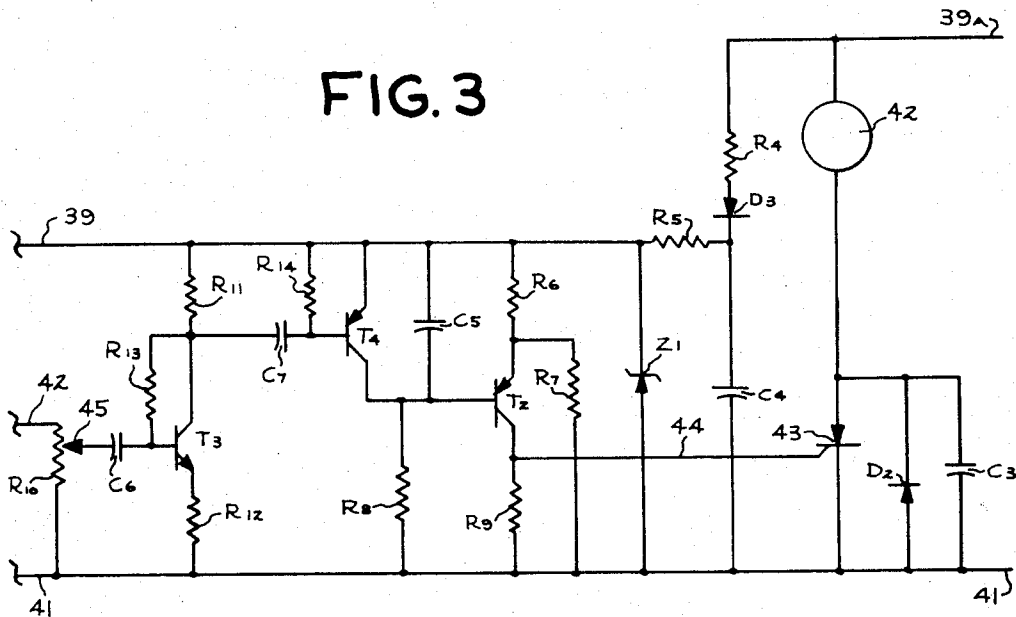
3,439,431

MICROWAVE DRYER CONTROL CIRCUIT

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FIG. 3



1

2

3,439,431
MICROWAVE DRYER CONTROL CIRCUIT
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Electric Company, a corporation of New York
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Int. Cl. F26b 3/34
U.S. Cl. 34—1 10 Claims

ABSTRACT OF THE DISCLOSURE

In a dryer of the type having means providing a signal responsive to the pattern of reflection of high frequency electromagnetic waves emitted into the drying chamber, a control including timing means to terminate operation of the dryer, an R-C charging circuit connected to the timing means to energize the timing means in response to a predetermined charge on the capacitor and a transistor, having its collector-emitter path connected across the capacitor and its base coupled to the signal means to dissipate the charge whenever the signal indicates wet items in the dryer.

Background of the invention

This invention relates to drying machines of the type having a "microwave" control, that is, a control which utilizes the pattern of reflection of high frequency electromagnetic waves emitted into the drying chamber to control the operation of the dryer. Two machines of this general type are described and claimed in U.S. Patents 3,192,642, Hughes; and 3,290,587, Chafee; both of which are assigned to General Electric Company, assignee of the present invention.

Summary of the invention

It is an object of this invention to provide an improved dryer control of the microwave type which more accurately responds to the true condition of the total load.

It is another object of the present invention to provide an improved dryer control of the microwave type which continues to be responsive to the reflected signal even after that signal first indicates the fabric load has reached the desired degree of moisture retention.

In accordance with one embodiment of this invention there is provided a control for a fabric drying machine having a chamber to receive fabrics to be dried, heating means arranged to heat fabrics in the chamber, and cyclically moving means for tumbling fabrics within the chamber. The control includes signal means for providing a signal responsive to the pattern of reflection of high frequency electromagnetic waves emitted into the chamber, the pattern of reflection being an indication of the moisture content of fabrics in the chamber. The control also includes shut-off control means effective, after energization, to terminate operation of the fabric drying machine and time delay means connected to the control means for normally causing energization of the control means after a predetermined time delay. Shunt means interconnects the signal means and the time delay means and shunts the time delay means in response to signals indicating at least a predetermined moisture content of the fabrics, whereby energization of the control means is prevented when the moisture content of the fabrics is at least as high as said predetermined value.

Brief description of the drawings

FIGURE 1 is a schematic side elevational view of a clothes dryer suitable for incorporation of my improved

dryer control, the view being partly broken away and partly sectionalized to illustrate details;

FIGURE 2 is a circuit diagram of an oscillator and detector which may be employed in the dryer control of the present invention;

FIGURE 3 is a circuit diagram of other portions of a control in accordance with one embodiment of this invention; and

FIGURE 4 is a circuit diagram of other portions of a control in accordance with another embodiment of this invention.

Description of the preferred embodiments

Referring now to FIGURE 1, the machine illustrated is a domestic clothes dryer generally indicated by the numeral 1. Dryer 1 is provided, in the usual way, with a cabinet 2 having a front door 3 to provide access to the interior of the cabinet. Within cabinet 2 there is provided a fabric tumbling chamber or drum 4, mounted for rotation on a substantially horizontal axis. The drum 4 is generally cylindrical in shape having an outer cylindrical wall 5, a front wall 6 and a back wall 7. The cylindrical wall 5 is imperforate so that the outer shell of the basket is imperforate. A plurality of clothes tumbling ribs, such as that illustrated at 8, are provided on the interior of the wall 5 to lift fabrics as the drum rotates, and then allow them to tumble back to the bottom of the drum.

The front of the drum is rotatably supported within the cabinet 2 by suitable idler wheels, one of which is shown at 9. These wheels are mounted on a member 10 which extends up from the base 11 of the cabinet. The wheels 9 are disposed beneath the drum and in contact with the cylindrical wall 5 so as to provide support on each side of the front portion of the drum. The rear end of the drum receives support by means of a stub shaft 12 which extends from the center of the wall 7 and is secured within a bearing 13 which, in turn, is rigidly secured to the back wall 14 of the cabinet.

In order to provide for the flow of a stream of drying air through the drum, the drum is provided with a central aperture 15 in its front wall 6 and an opening in the form of a plurality of perforations 16 in its rear wall 7. Electrical heating elements, such as those schematically illustrated at 17 and 18, are mounted between the rear wall 7 of the drum and the rear wall 14 of the cabinet. The front opening 15 of the drum is substantially closed by means of a stationary bulkhead structure made up of a number of adjacent members including the upper portion of member 10 and the inner member 19 of the door 3. A suitable clearance is provided between the edge of the drum providing opening 15 and the edges of the members constituting the bulkhead so that there will be no rubbing between the drum and the bulkhead during rotation of the drum.

The front opening 15 serves as a means whereby the clothes may be loaded into and unloaded from the drum. Door 3 includes an outer, flat, imperforate member 20 and the inner member 19, which is formed to be hollow and inwardly extending so as to extend into the opening 15 when the door is closed. The door is mounted on the cabinet 2 so that, when the door is open it exposes opening 15 so that clothes may be inserted into or removed from the drum through the opening 15 and when the door is moved to its closed position it closes opening 15.

The air inlet to the cabinet is provided by perforated openings 21 provided in the back wall 14 so that air may flow in through the openings 21 then upwardly over the heating elements 17 and 18 into the drum through the

openings 16. The air outlet from the drum is provided by perforated openings 22 formed in the inner member 19 of the door. The bottom wall section of the door and the adjacent wall of the cabinet are provided with aligned openings 23 and 24 so that the air may travel from the door to a duct 25, formed by the cooperation of member 10 with the front wall 26 of the cabinet. A lint trap may be positioned in the duct 25 at the opening 24 and supported by the wall around the opening. The duct 25 leads downwardly to an opening 26a formed in the member 10. The opening 26a constitutes the inlet to a blower member 27 contained in a housing 28 and directly driven by an electric motor 29. From the blower the air passes through an appropriate duct 30 and out of the machine through the opening 31 in the rear wall 14.

In addition to driving blower 27, motor 29 constitutes a cyclically moving means for rotating the drum to tumble fabrics within the drum. To this end, the motor 29 is provided with a shaft 32 having a small pulley 33 formed at the end thereof. A belt 34 extends around the pulley and completely around the cylindrical wall 5 of the drum. The relative circumferences of the pulley 33 and drum wall 5 cause the drum to be driven at a speed suitable to effect tumbling of the fabrics within the drum.

A dryness sensor for use with the present invention is positioned within the door 3. The dryness sensor comprises a circuit board 35 having a ground plane affixed to one surface thereof and upon which there is positioned an oscillator for generation of high frequency oscillations and a detector for the detection of waves reflected from the fabric chamber. An antenna 36 is affixed to the circuit board 35, the antenna 36 communicating with the chamber 4 through an electromagnetic wave transparent window 37, which forms a part of the inner member 19 of the door.

Referring now to FIGURE 2, there is shown a circuit diagram of a dryness sensor or signal means for providing signals responsive to the pattern of reflections of high frequency electromagnetic waves emitted into the chamber 4. The oscillator of the sensor comprises a transistor T_1 having a microstrip line 38 connected between its collector and a supply conductor 39. The microstrip line comprises a metal strip on the opposite side of the circuit board from the ground plane and is formed in accordance with well known printed circuit techniques. A second microstrip line 40 is connected between the intermediate point of the microstrip line 38 and the antenna 36 to couple the generated oscillations to the antenna. The base of the transistor T_1 is connected to the intermediate point of a voltage divider comprising resistances R_1 and R_2 connected between the supply conductor 39 and a neutral conductor 41 to establish a fixed bias voltage at the base of transistor T_1 . A current limiting resistance R_3 is connected between the emitter of transistor T_1 and the neutral conductor. An A.C. bypass capacitor C_1 is connected between the supply conductor 39 and the base of the transistor T_1 .

The detector portion of the sensor comprises a diode D_1 capacity coupled to an intermediate point of the microstrip 40 through a capacitance C_{2A} and connected to the neutral conductor 41 through a resistance R_4 . The detector serves to provide an A.C. signal between a signal conductor 42 and the neutral conductor 41 which is responsive to the pattern of reflection of the high frequency electromagnetic waves which are emitted into the chamber or drum formed by the antenna 36. A capacitor C_{2B} is connected between signal conductor 42 and neutral conductor 41. This capacitor filters out the high frequency signal but passes the low frequency signal associated with the pattern of reflection.

The operation of the oscillator in FIGURE 2 is such that the internal collector-to-emitter capacitance of the transistor T_1 causes positive feedback from the collector to the emitter, thereby developing oscillations. These

oscillations appear across the microstrip 38, which serves as a collector tuned circuit and which is resonant at the desired frequency. The resonant oscillations across the microstrip 38 are coupled to the antenna 36 through the microstrip 40.

The antenna 36 transmits electromagnetic waves into the fabric chamber or drum 4 and which are reflected from the container. The pattern of reflection is an indication of the moisture content of the fabrics in the chamber, which enables the reflected waves to be utilized to terminate the operation of the machine.

The detection may be achieved in several ways but can be expediently effected by measuring the standing wave ratio of the microstrip 40. The diode D_1 , in conjunction with the R-C network comprised of the resistance R_4 in capacitance C_{2A} , serves to detect the standing ratio and thus provide a signal responsive to the degree of dryness of the fabrics within the chamber. The detected signal, appearing between the conductors 42 and 41 is used to terminate operation of the machine. The dryness sensor or signal means described above is substantially similar to that shown in U.S. Patent No. 3,290,587, Chafee, assigned to General Electric Company, assignee of the present invention.

Referring now to FIGURES 3 and 4 there is shown therein, in circuit diagram form, other portions of the control, in accordance with two embodiments of the present invention. It will be noted from the use of the reference numerals 39, 41 and 42 for the supply conductor, neutral conductor and signal conductor in FIGURES 3 and 4 that the circuits illustrated in these figures are designed to be connected to the ends of the conductors 39, 41 and 42, as illustrated in FIGURE 2, so as to form a complete control circuit.

Conductor 41 and a conductor 39A are adapted to connect the control to a suitable source of electrical energy such as the usual 120 volt, A.C. domestic power supply with conductor 39A being the power conductor and conductor 41 the neutral conductor.

Referring now particularly to FIGURE 3, shutoff control means are connected between the conductors 39A and 41 and include timing means such as timer motor 42, which is effective after a predetermined amount of run time to terminate operation of the machine. Many ways in which timer motors may be used to terminate the operation in fabric dryers are well known and specific connections between the timer motor and other operative elements of the machine, such as heaters 17 and 18 and drive motor 29, do not form a part of this invention and have been omitted for the sake of simplicity.

The timer motor is connected on one side to the power conductor 39A and one the other to the neutral conductor 41 through a parallel path including the anode to cathode circuit of a controlled rectifier 43 and a diode D_2 . It will be seen that the controlled rectifier and diode D_2 are connected in the circuit in opposite polarity. Thus the diode D_2 will conduct when power conductor 39A is negative with respect to the neutral conductor 41 and the controlled rectifier will conduct when the power conductor 39A is positive with respect to the neutral conductor, assuming a suitable signal has been applied to its gate. The timer motor may be of the induction type and it will not run on the half wave power provided by the diode D_2 alone, so that operation of the motor 42 is possible only when the controlled rectifier 43 conducts for at least a portion of the half cycles when the power conductor 39A is positive. A capacitance C_3 is connected across the parallel connection of controlled rectifier 43 and diode D_2 primary for suppression of any transient signals received from the source.

Down circuit from the shut-off control means connections, the control circuit is provided with a regulated half wave D.C. power supply. The series connection of a dropping resistor R_4 and a diode D_3 is connected to the power conductor 39A. A capacitance C_4 is connected,

on one side, to the diode D_3 and, on the other side, to the neutral conductor 41. This provides a filtered, half-wave D.C. signal. A resistance R_5 is connected, on one side, to the junction of D_3 and C_4 and, on the other side, to supply conductor 39. A Zener diode Z_1 is connected between neutral conductor 41 and supply conductor 39 at the other side of R_5 . This provides a regulated D.C. power supply of a type well known in the art which establishes a stable D.C. potential between the conductors 39 and 41 with the voltage being established by the rating of the Zener diode.

Conduction of the controlled rectifier 43 is controlled through a time delay means including a voltage divider comprising a pair of serially connected resistances R_6 and R_7 , which are connected between the conductors 39 and 41. An R-C charging circuit, consisting of a serially connected capacitance C_5 and resistance R_8 is also connected between the conductors 39 and 41. A transistor T_2 is provided with its emitter connected to the junction of the resistances R_6 and R_7 , its base connected to the junction of the capacitance C_5 and resistance R_8 and its collector connected to the conductor 41 through a resistance R_9 . The gate of the controlled rectifier is connected by a conductor 44 to the junction between the collector of the transistor T_2 and the resistance R_9 . With this arrangement the transistor will conduct only when the voltage at its base, that is the voltage across the capacitance C_5 , has reached a level which is slightly greater than the voltage at the junction at the resistances R_6 and R_7 . When this occurs the transistor begins to conduct and the collector current gates the controlled rectifier 43. The resistance R_9 serves to prevent leakage current from gating the controlled rectifier.

With the circuit as thus far described the operation of the timer motor 42 would be delayed only for a few seconds after the dryer begins operation, that is until the voltage on the capacitance C_5 has built to a sufficient level. Thereafter the controlled rectifier would be gated so that the timer motor would run and cause termination of the operation of the machine. In order to prevent energization of the timer motor 42 until the pattern of reflection of the high frequency electromagnetic waves emitted in the chamber 4 indicates that the moisture content of the fabrics in the chamber have reached a predetermined desired level, generally corresponding to suitably dry fabrics, there is provided shunt means interconnecting the signal means and the time delay means. This shunts the time delay means in response to the pattern of reflection indicating a moisture content of the fabrics which is above the predetermined level.

To this end a resistance R_{10} is connected between the signal conductor 42 and the neutral conductor 41 and includes an adjustable center tap 45 so that the percentage of the signal responsive to the pattern of reflection appearing at the tap 45 may be varied to calibrate the control. A transistor T_3 has its collector connected to conductor 39 through a limiting resistance R_{11} , its emitter connected to neutral conductor 41 through a limiting resistance R_{12} and its base coupled to the center tap 45 through a capacitance C_6 . A bias resistance R_{13} is connected between the collector and base of transistor T_3 and provides a fixed current to the base to set the zero signal operating point of the transistor.

The signal at center tap 45 is a D.C. voltage with a low frequency A.C. voltage superimposed on it. The coupling provided by capacitance C_6 removes the D.C. portion of this signal so that only the A.C. component is fed into the base of the transistor T_3 . In the usual manner, the transistor T_3 operates as an amplifier and a larger but proportional collector-emitter current flows from conductor 39 through R_{11} , T_3 and R_{12} to conductor 41 in response to the A.C. base current.

A transistor T_4 has its emitter connected to conductor 39 just down circuit of capacitance C_5 and its collector connected to the junction of the capacitance C_5 and re-

sistance R_8 of the charging circuit. The base of transistor T_4 is coupled to the collector of the transistor T_3 through a capacitance C_7 to remove the D.C. level of the amplified signal so that only the A.C. component of the amplified signal is applied to the base of transistor T_4 . A resistance R_{14} is connected between the conductor 39 and the junction of C_7 and the base of T_4 to provide a discharge path for C_7 when the base of T_4 is positive with respect to conductor 39 and to prevent leakage current from turning on T_4 .

With this arrangement of parts for the shunt means, the signal produced by the signal means in response to the pattern of reflection of high frequency electromagnetic waves emitted into the drying chamber 4 is amplified and fed to the base of the transistor T_4 so as to control the flow of current therethrough. When current flows through the transistor T_4 it will discharge the voltage which is tending to build on the capacitance C_5 . The elements are sized so that, as long as the pattern of reflection indicates that the degree of moisture in the fabrics being dried is above a predetermined level, the transistor T_4 conducts. This prevents capacitor C_5 from being charged to a level sufficient to cause the transistor T_2 to conduct and the timer motor 42 is prevented from running. Once the pattern of reflection indicates the degree of moisture in the fabrics has fallen to the predetermined level the signal from the dryness sensor or signal means will be insufficient to cause the transistor T_4 to conduct. Thereafter, within a few seconds, the capacitor C_5 will have charged to the firing voltage for transistor T_2 , which will conduct and gate the controlled rectifier 43. The timer motor then begins to run and, after a predetermined amount of run time, will cause the operation of the dryer to be terminated. The manner of control of the dryer by timer motors is well known in the art, such as for instance operating a number of cams which open and close switches controlling the various components. Therefore no particular cam and switch arrangement will be illustrated. The timer motor could, for instance, first cause the heating elements 17 and 18 to be de-energized while continuing operation of the motor 29 so as to provide a period of cooling of fabrics within the dryer and then interrupt the main power to the machine so as to de-energize both the main motor 29 and the control circuit itself.

It will be understood that the signal from the transistor T_2 could be used to operate other shut-off control means such as, for instance, a relay which would immediately de-energize the entire dryer upon conduction by the transistor T_2 .

It will be obvious to those skilled in the art that the transistors T_2 and T_4 are PNP types. Similar controls may be provided in accordance with the present invention wherein these transistors are of the NPN type and one such control is shown in FIGURE 4. Elements in FIGURE 4 which are the same as FIGURE 3 are identified with the same number. The timer motor control circuit is essentially the same as with FIGURE 3 and the power supply circuit is the same. The amplifier portion of the shunt means, that is those elements associated with the transistor T_3 is the same. The modification of the circuit essentially is in the time delay portion. The R-C charging circuit is reversed, that is the resistance R_8 is connected to the conductor 39 and the capacitance C_5 is connected to the neutral conductor 41. The transistor T_5 , which controls the gating of the controlled rectifier 43 has its collector connected to the conductor 39 through a resistance R_{15} , its emitter connected to the conductor 41 through a resistance R_{16} , and its base connected to the junction between resistance R_8 and capacitance C_5 . The shunt transistor T_6 has its collector connected to the junction between the resistance R_8 and the capacitance C_5 , its emitter connected to the conductor 41, and its

base coupled to the collector of the transistor T_3 through the capacitance C_7 . A resistor R_{17} is connected between the neutral conductor 41 and the base of transistor T_6 to provide a discharge path for C_7 when the base of T_6 is negative with respect to conductor 41 and to prevent leakage current from turning on T_6 .

The mode of operation with the NPN transistors T_5 and T_6 is slightly different than the mode of operation of the circuit shown in FIGURE 3. In the circuit of FIGURE 3, the transistor T_2 will not turn on until the capacitor C_5 has a charge which is slightly higher than the voltage at the junction between R_6 and R_7 . However, when this voltage is reached the transistor T_2 is essentially turned full on to provide a gate signal for the controlled rectifier 43. In the circuit of FIGURE 4, the transistor T_5 acts as an amplifier and, once the charge on the capacitor C_5 has built to some minimum value higher than the internal emitter to base voltage drop of the transistor, T_5 will begin to conduct, acting as an amplifier. This will provide a voltage across the resistance R_{16} which tries to gate the controlled rectifier 43. The transistor T_6 shunts the capacitor C_5 and thus controls the size of the signal at resistance R_{16} , however, T_5 will conduct to some extent before the fabrics are dry. In order to prevent the controlled rectifier from being gated until after the reflected wave pattern causes the transistor T_6 to be turned off, a voltage breakdown device such as Zener diode Z_2 is connected in the line 44. Thus the signal appearing across the resistance R_{16} must reach the breakdown voltage of the device Z_2 before the controlled rectifier is gated. The components are sized so that this will not occur until the charge on capacitance C_5 builds to a level that is impossible so long as transistor T_6 is conducting. A resistance R_{18} is connected between the neutral conductor 41 and the gate of the controlled rectifier to prevent leakage current from turning on the rectifier.

With a control built in accordance with the present invention the termination of the operation of the dryer is more truly responsive to the average moisture content of the load rather than any individual item. Normally the signal provided by a signal means such as that shown in FIGURE 2 will be responsive to the average degree of dryness of the fabrics in the dryer; however, if the volume of the items being dried is very small as compared to the volume of the container 4, there may be instances of time when none of the items are in the path of the high frequency waves emitted by the antenna 36. In this event the pattern of reflection will indicate the container is empty, which pattern is very similar to the one when the items are dry. Therefore, with very small loads, the signal may indicate that the load is dry even though the items in the container are still wet. The elements of the present control may be sized so that there is a delay of at least several seconds after the shunt transistor ceases to conduct before the controlled rectifier will be gated. This provides ample opportunity for items of a small load to move into the path of the high frequency waves and the shunt transistor to start conducting again and bleed the charge off the storage capacitor before the timer motor is energized.

Also, by using a timing means such as a timer motor to cause the operation of the dryer to continue for some predetermined period of timer run time after a dry signal is received, such as for a cool down operation; a circuit built in accordance with the present invention has the added advantage of continuing to monitor the moisture content of the load even after the pattern of reflection indicates dryness and the controlled rectifier is gated. Even after the timer motor begins to run it will continue to run until it causes termination of the operation of the dryer only so long as the shunt transistor, T_4 or T_6 does not conduct. Thus, if the timer motor starts and then the reflection pattern changes to show that the load is not dry, the shunt transistor will be turned on and the timer motor will turn off until the load is dry.

I have found that controls as illustrated in FIGURES 2, 3, and 4 for present day fabric dryers may be made with the below listed components:

R_1	-----ohms	8200
R_2	-----do	1500
R_3	-----do	390
R_4	-----do	330
R_5, H_6, R_7	-----kilohms	10
R_8	-----do	150
$R_9, \& R_{10}$	-----do	10
R_{11}	-----do	33
R_{12}	-----ohms	470
R_{13}	-----megohm	1
R_{14}	-----kilohms	47
R_{15}	-----ohms	2200
R_{16}	-----kilohms	10
R_{17}	-----do	47
R_{18}	-----do	1
C_1	-----microfarads	.0001
C_{2A}	-----picofarads	25
C_{2B}	-----do	100
C_3	-----microfarads	.05
C_4	-----do	10
C_5	-----do	15
C_6	-----do	10
C_7	-----do	10
T_1	-----Fairchild semiconductor	SE3005
T_2	-----	2N3638
T_3	-----	2N2926
T_4	-----	2N3638
T_5	-----	2N2926
T_6	-----	2N2926
D_1	-----	1N82A
D_2	-----	1N5059
D_3	-----	1N5059
Z_1	-----Fairchild semiconductor	FZ903
Z_2	-----Fairchild semiconductor	FZ902
Controlled rectifier 43	-----General Electric	C106B

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a fabric drying machine having a chamber to receive fabrics to be dried, heating means arranged to heat fabrics in the chamber, and cyclically moving means for tumbling fabrics within the chamber; a control including:

- a signal means for providing signals responsive to the pattern of reflection of high frequency electromagnetic waves emitted into the chamber, said pattern of reflection being an indication of the moisture content of fabrics in the chamber;
- shut-off control means effective, after energization, to terminate operation of the fabric drying machine;
- time delay means connected to said control means for normally causing energization of said control means after a predetermined time delay;
- shunt means interconnecting said signal means and said time delay means to shunt said time delay means in response to signals indicating at least a predetermined moisture content of the fabrics, whereby energization of said control means is prevented when the moisture content of the fabrics is at least as high as said predetermined value.

2. The invention as set forth in claim 1 wherein said time delay means includes an R-C charging circuit effective to cause energization of said control means in response to a predetermined charge on said capacitor and wherein said shunt means is effective to dissipate the charge on said capacitor when the signal indicates at least a predetermined moisture content of the fabrics.

3. The invention as set forth in claim 1 wherein said control means includes timing means effective to terminate operation of the dryer after a predetermined amount of timing means operation.

4. The invention as set forth in claim 3 wherein said

time delay means includes an R-C charging circuit and is effective to cause energization of said timing means in response to a predetermined charge on said capacitor and wherein said shunt means is effective to dissipate the charge on said capacitor when the signal indicates the moisture content of the fabrics is at least said predetermined value; whereby said timing means is energized only when the signal indicates the moisture content of the fabrics is below said predetermined value.

5. In a fabric drying machine having a chamber to receive fabrics to be dried, heating means arranged to heat fabrics in the chamber, and cyclically moving means for tumbling fabrics within the chamber; a control including:

- (a) signal means for providing signals responsive to the pattern of reflection of high frequency electromagnetic waves emitted into the chamber, said pattern of reflection being an indication of the moisture content of fabrics in the chamber;
- (b) an energizing circuit for connection to a source of electrical energy;
- (c) shut-off control means effective, after energization, to terminate operation of the fabric drying machine;
- (d) a first transistor, including a collector, an emitter and a base, said control means being connected in said energizing circuit through the collector-emitter circuit of said first transistor;
- (e) time delay means connecting said base in said energizing circuit and effective for normally causing conduction of said first transistor to energize said control means after a predetermined time delay;
- (f) shunt means interconnecting said signal means and said time delay means to shunt said time delay means in response to signals indicating at least a predetermined moisture content of the fabrics, whereby energization of said control means is prevented when the moisture content of the fabrics is at least as high as said predetermined value.

6. The invention as set forth in claim 5 wherein said time delay means includes an R-C charging circuit effective to cause conduction of said first transistor to energize said control means in response to a predetermined charge on said capacitor and wherein said shunt means includes a second transistor having its collector-emitter

circuit connected across said capacitor and its base coupled to said signal means to dissipate the charge on said capacitor when the signal indicates the moisture content of the fabrics is at least said predetermined value, whereby said control means is energized only when the signal indicates the moisture content of the fabrics is below said predetermined value for a predetermined time delay.

7. The invention as set forth in claim 6 wherein a third transistor is connected in said energizing circuit with its collector-emitter circuit coupled to said base of said second transistor and its base coupled to said signal means thereby to amplify said signal.

8. The invention as set forth in claim 5 wherein said control means includes timing means effective to terminate operation of the dryer after a predetermined amount of timing means operation.

9. The invention as set forth in claim 8 wherein said time delay means includes an R-C charging circuit effective to cause conduction of said first transistor to energize said timing means in response to a predetermined charge on said capacitor and wherein said shunt means includes a second transistor having its collector-emitter circuit connected across said capacitor and its base coupled to said signal means to dissipate the charge on said capacitor when the signal indicates the moisture content of the fabrics is at least said predetermined value; whereby said timing means is energized only when the signal indicates the moisture content of the fabrics is below said predetermined value for a predetermined time delay.

10. The invention as set forth in claim 9 wherein a third transistor is connected in said energizing circuit with its collector-emitter circuit coupled to said base of said second transistor and its base coupled to said signal means thereby to amplify said signal.

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KENNETH W. SPRAGUE, *Primary Examiner.*

U.S. Cl. X.R.

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