Sept. 24, 1968 G. L. HETRICK 3,402,478

DRYER CONTROL

Filed June 20, 1966 3 Sheets-Sheet 1

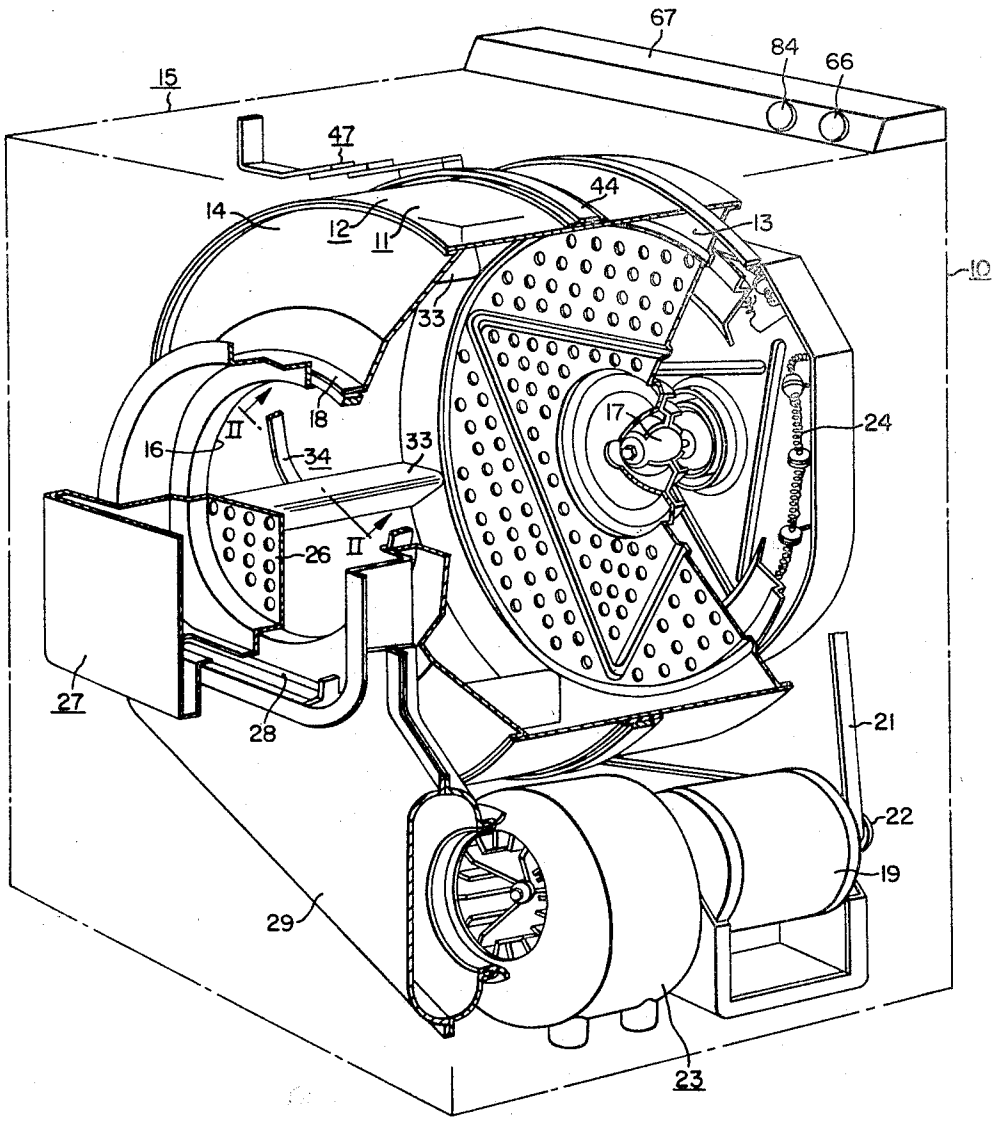


FIG.1.

WITNESSES

Theodore F. Wrobel

James F. Young

INVENTOR

George L. Hetrick

BY B B Blair, Jr.

AGENT

Sept. 24, 1968 G. L. HETRICK 3,402,478

DRYER CONTROL

Filed June 20, 1966 3 Sheets-Sheet 2

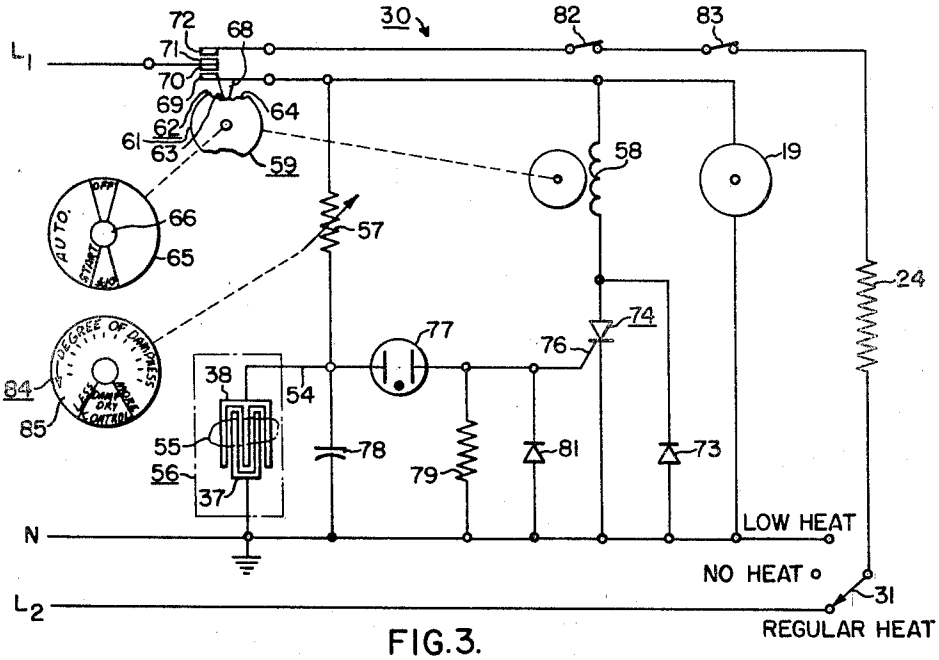


FIG.3.

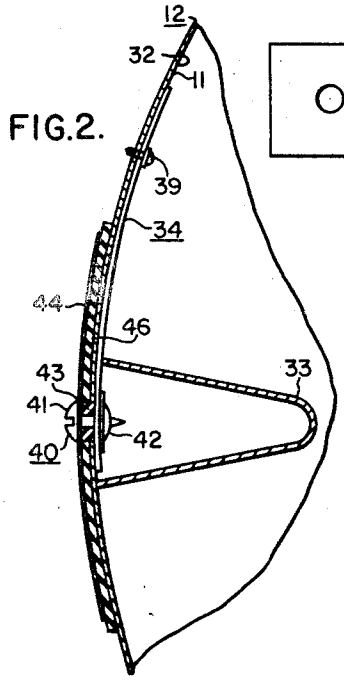


FIG.2.

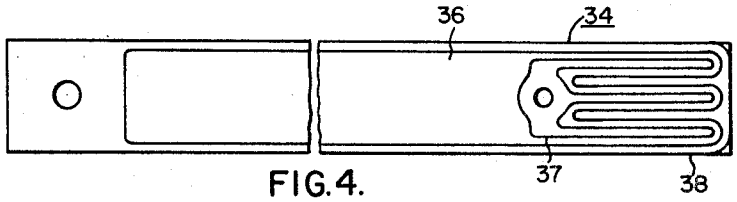


FIG.4.

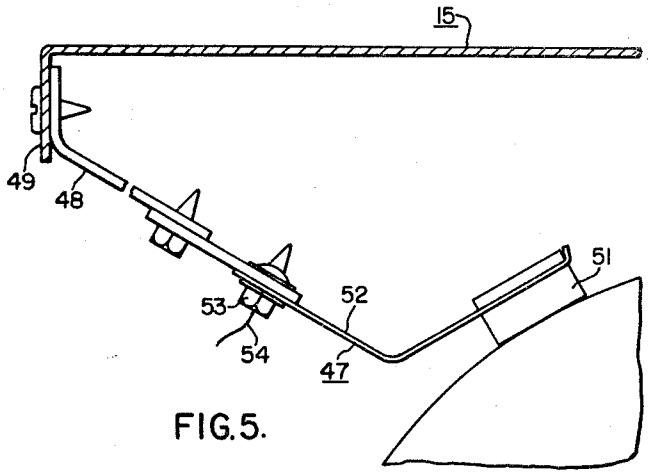


FIG.5.

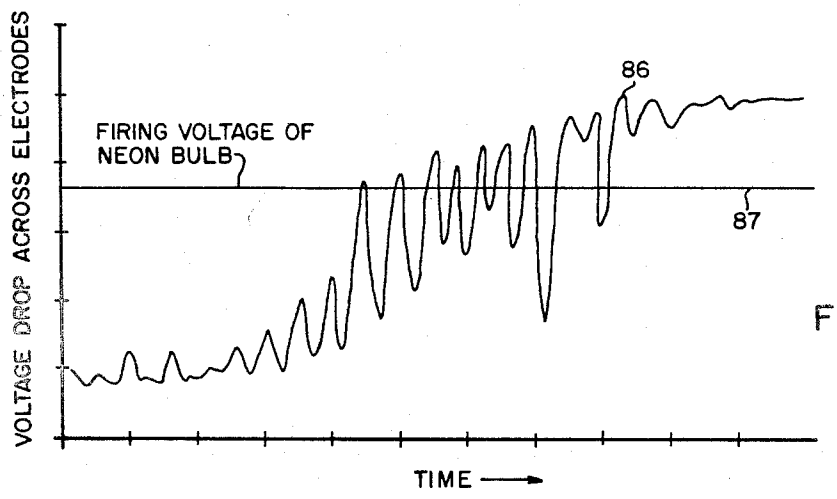


FIG.6.

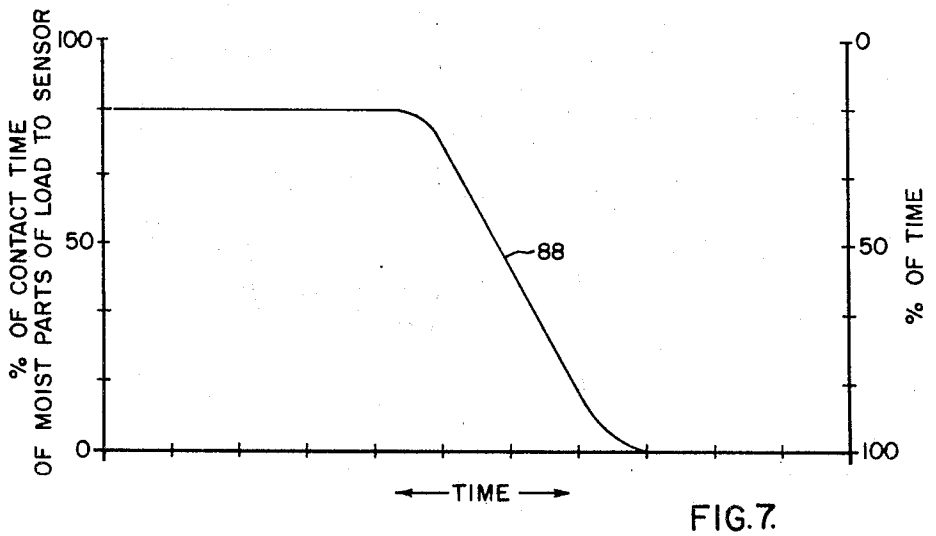


FIG.7.

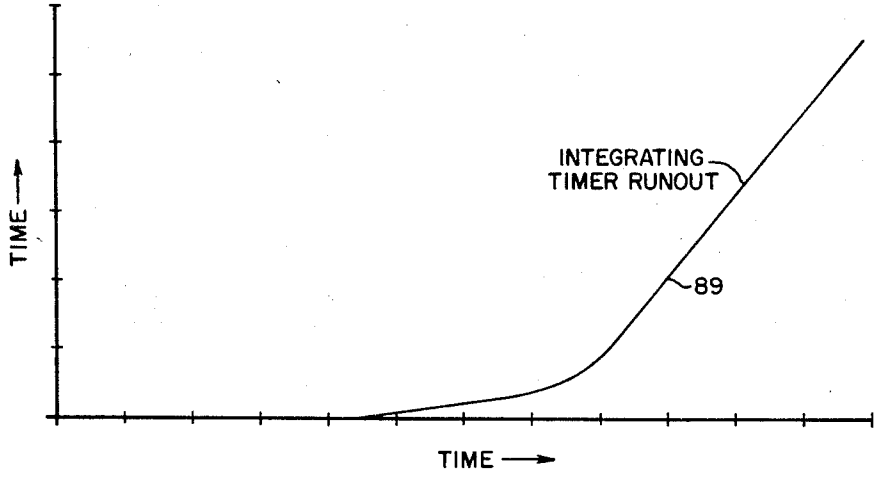


FIG.8.

United States Patent Office 3,402,478 Patented Sept. 24, 1968

3,402,478

DRYER CONTROL

George L. Hetrick, Washington Township, Mansfield, Ohio, assignor to Westinghouse Electric Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

Filed June 20, 1966, Ser. No. 558,951
8 Claims. (Cl. 34—53)

ABSTRACT OF THE DISCLOSURE

An automatic timer for a clothes dryer which includes a sensing portion which generates signals representative of moisture content in the clothes as a function of electrical conductivity therethrough. The timer is characterized in that the signals generated are manifested as a mechanical displacement of a conventional cam rotated by a conventional timer motor, accordingly, there is an electromechanical integration of the electrical signals generated.

This invention relates, in general, to clothes dryers and more particularly to an automatic or moisture sensing timer control for use therewith.

Clothes drying apparatus at an early date, utilized timers that could be manually set in order to establish the duration of the drying cycle so as to accommodate the drying of different size loads of clothes to different degrees of dryness, as desired by the user.

While such an arrangement is reasonably satisfactory, the end result is dependent upon the judgment of the operator with respect to his or her estimate as to the time required to dry the particular load of clothes to the desired degree of dryness. The use of many mechanical aids, for example, weighing scales, have been suggested and tried in order to better establish this estimate, the result being only to reduce the limits of error of the unaided estimate, however, not the total elimination of the error.

Many principles and related constructions have been tried to overcome the forging problem. All approaches appear to have paved the way for the latest principle which is based on the measurement of moisture content remaining in the clothes as a function of electrical conductivity or resistance. One of the first and probably the most typical controls of this type utilizes a moisture sensor in conjunction with an electromechanical timer motor which advances a cam between on and off positions. The moisture sensor provides an electrical signal which triggers means for starting the timer motor. With such an arrangement the run-out time of the timer motor and cam represents a fixed amount of quantity, therefore the timer motor must be calibrated such that the largest load will be completely dried. This, as will be obvious, presents a problem of overdrying where it is desired to dry a relatively small load of clothes utilizing such a control.

Accordingly, it is the general object of this invention to provide a new and improved automatic moisture sensing control for clothes or fabric dryers.

It is a more particular object of this invention to provide a new and improved automatic moisture sensing control for clothes dryers wherein varying electrical signals generated in the dryer basket are mechanically integrated by means of a conventional timer motor.

Another object of this invention is to provide a new and improved automatic moisture sensing control for clothes dryers comprising an electromechanical motor, the run-out time of which is a function of both moisture content in the clothes and the contact time of sensing electrodes by the moist portions of the clothes.

A further object of this invention is to provide a new

and improved clothes dryer control, the run-out time of which, for the purpose of damp drying, may be either a function of variable time or variable resistance.

Briefly, the present invention accomplishes the above-cited objects by providing mechanical integrating means in the form of a conventional clothes dryer timer motor and associated cam structure for integrating or storing electrical signals generated in a clothes dryer basket by means of electrodes bridged by wet clothes contained in the basket. The signals are indicative of moisture content, below a predetermined level, remaining in the clothes and are a function of the electrical conductivity through the clothes. Additionally, the signal is indicative of bridging or contact time of the clothes with the electrodes. As a result of those two characteristics the initial signals generated are not continuous but they are intermittent. Accordingly, switch means interposed between the signal generating means and the mechanical integrating timer is provided for advancing the timer motor in response to a signal generated and stopping advancement of the timer motor in the absence of a signal. (The cam associated with the motor is carried by the shaft of the motor or driven by a gear train such that it is advanced at the same rate as the motor.) Advancement of the cam is between a first position wherein the cam cooperating with a cam follower is effective to initiate operation of the dryer and a second position wherein the cam and its associated follower are effective to terminate operation of the dryer.

Other objects and advantages of the present invention will become more apparent when considered in view of the following detailed description in which:

FIGURE 1 is a perspective view, partly broken away, of a domestic clothes dryer incorporating the invention;

FIG. 2 is a cross-sectional view on the line II—II of FIG. 1;

FIG. 3 is a schematic wiring diagram incorporating the invention;

FIG. 4 is a top plan view of a sensor incorporated in the invention;

FIG. 5 is a side elevational view of a sensor pick-up incorporated in the invention; and

FIGS. 6–8 represent a set of curves illustrating functional characteristics of the invention.

Referring to the drawings, especially FIG. 1, reference character **10** designates generally a domestic clothes dryer comprising a metallic clothes receptacle or drum **11** having a generally cylindrical shape including an imperforate annular wall **12** and a perforate rear wall **13** opposite a front wall **14**. The front wall **14** has an opening **16** providing access to the interior of drum **11** for insertion or removal of clothes.

A bearing structure **17** journalled in the rear wall **13** and a peripheral flange **18** framing the opening **16** serve to support the drum **11** for rotation about a substantially horizontal axis within a cabinet **15**. The drum is rotated by means of a conventional motor **19** through a flat drive belt **21** encircling the annular wall **12** and a pulley **22** fixed to one end of the output shaft of the motor **19**.

An impeller means **23** including blades mounted on the other end of the motor output shaft serves to circulate moisture removing air through the clothes and out of the dryer. The circulating air may be heated by means of an electrical resistance heater **24** as the air is induced thereacross by the impeller means **23**. After being warmed by the heater **24** the air then flows through the perforate rear wall **13**, the clothes in the drum **11**, through a perforate rear panel **26** of the dryer door structure **27**, through lint trap **28**, front air duct **29**, through the air impeller means **23** and out of the dryer through an exhaust duct (not shown).

To provide the user with a choice of operation, therefore, with heat or without heat, a manually operable se-

lector switch **31**, connected in a control circuit **30** (illustrated schematically in FIG. 3), is adapted to connect a power supply line L_1 with a conductor L_2 to place 230 volts across the heater **24**. Alternately, the switch **31** is adapted to connect the supply line L_1 with a neutral conductor (N) to place 115 volts across the heater **24**. The dryer **10** may be operated without heat by placing the switch **31** in the "No Heat" position which as can be seen moves the heater from the circuit **31**.

Mounted on an inner surface **32** of the annular wall **12** are a plurality of clothes tumbling vanes **33**, made from any suitable insulating material, for example, phenolic. There are preferably three such vanes and they are preferably equally spaced one from the other.

Secured to the inner surface **32** partially subadjacent each of the vanes **33** is a sensor structure **34** in the form of a printed circuit comprising an insulator board **36** and two sets of electrical conductors or electrodes **37** and **38**. Each sensor **34** is secured to the annular wall **12** by means of metal fasteners **39** and **40**. The head of the fastener **39** contacts the electrode **37** and the metallic drum **11** and is, therefore, effective in grounding the electrode **37** to the cabinet **15** of the dryer **10** through the drum **11** and the bearing structure **17**. The fastener **40** comprises a screw **41** and a speed nut **42**, the latter being in good contact with the electrode **38** and the former being suitably insulated from the drum **11** by means of an insulator bushing **43**.

The head of each of the screws **41**, of which there are three, projects outwardly from the annular wall **12** and contacts a continuous metal band **44** supported on the annular wall of the drum **11**. The band **44** is insulated from the drum by means of a felt pad **46** suitably bonded to the drum **11** and disposed intermediate the band and the drum.

A sensor pick-up structure **47** (see FIGS. 1 and 5) is mounted, by means of an insulating bracket **48**, to a flange **49** of the cabinet **15** such that a carbon brush **51** carried by a spring arm **52** engages the band **44**. The spring arm **52** is provided with an electrical terminal **53** for connecting the sensor pick-up **47** to the control circuit **30** by means of an electrical lead **54**.

It will be understood that the electrodes **37** and **38** of any one of the sensor structures **34** are so positioned as to be simultaneously bridged by clothes **55** tumbling in the drum **11** thereby providing a current flow path from the latter to the former, the latter being supplied with electrical energy from the power supply lead L_1 through a resistor **57** the resistance valve of which may be normally varied by the user for a purpose which will be discussed hereinafter, in conjunction with a damp dry cycle of operation. The clothes **55** together with the electrodes **37** and **38** constitute a variable resistor, or load sensing element, the resistance or conductivity of which is a function of the moisture content in the clothes. Therefore, when the moisture content is high the resistance is low and conversely when the moisture content is low the resistance is high.

A timer motor **58** indicated schematically in FIG. 3 carries a generally circular cam structure **59** on the output shaft thereof. The cam structure **59** is provided with a high portion **61** constituting the major part of the periphery thereof and an indented portion **62** having a pair of steps **63** and **64**. The cam **59** is adapted to be normally positioned by the operator by means of a program control knob **66** associated with an indicia bearing dial **65** carried by a back control panel **67**. When the control knob **66** is positioned by the operator a cam follower **68** rides on the high portion **61** and is cammed thereby to effect closure of a first pair of contacts **69** and **70** which completes a circuit from L_1 to N through the motor **19** and to ground through the variable resistor **57** and the clothes **55**. Simultaneously, the cam follower **68** effects closure of a second pair of contacts **71** and **72** thereby completing a circuit from L_1 to L_2 or N through the heater **24**, that is if the circulated air is to be heated, otherwise, no circuit will be established through the heater when the switch **31** is in the "No Heat" position.

The timer motor **58** is preferably an AC sixteen pole hysteresis type synchronous motor rated at 2.5 watts, 125 v. as marketed by International Register Company. In accordance with the present invention it is desired that operation of the motor **58** be delayed initially, immediately following closure of the contacts **69** and **70**, consequently, it is connected in series with a half wave rectifier or diode **73** and, therefore, will only operate upon firing of a thyristor or controlled rectifier **74** which bypasses the diode **73** in the oppostie polarity. An example of a suitable thyristor is type TSW23C (manufactured by the Transitron Co.) rated at 200 ma. with a gate sensitivity of 0.4 ma. The gate **76** of the rectifier **74** is connected to the electrode **38** through a voltage sensitive switch herein illustrated as a neon lamp or glow discharge tube **77**. Such a device is marketed by the Signalite Co. under type No. A–173–A. As is well known in the art such devices are nonconductive until a predetermined break down voltage is impressed thereacross. With such an arrangement the rectifier **74** is fired only when the voltage across the electrodes **37** and **38**, which with the clothes **55** constitute one leg **56** of a voltage divider consisting of the variable resistor **57** and the former, reaches the firing voltage of the neon lamp **77**. When the clothes are wet, the resistance and, therefore, voltage across the electrodes is low, consequently, a predetermined amount of moisture, for example, 80%, must be removed to raise the voltage across the electrodes **37** and **38** thereby changing the divider ratio the required amount for firing the neon bulb **77**.

Theoretically, the design of the electrodes and sensor pick-up may be such that there would be enough stray capacity to fire the thyristor **74**, however, a capacitor **78** connected across the electrodes **37** and **38** serves to store sufficient energy to fire the rectifier **74**. A 220 pf. capacitor was satisfactorily used in practicing the present invention.

A diode **81** protects the gate **76** against reverse polarity. A resistor **79** is provided to turn off (thyristor) in the absence of a firing signal. Other protective devices, shown schematically in FIG. 3, comprise an exhaust air thermostat **82** serving to control the general air temperature in the dryer, and a safety thermostat **83** adapted to monitor the inlet and temperature in the vicinity of the heater **24** and to prevent overheating of the apparatus.

It will be appreciated that during a cycle of operation, of the dryer **10**, the moisture level at which firing of the neon lamp **77** takes place can be either raised or lowered by adjusting the variable resistor **57** by means of a dampness control knob **84** having indicia **85** indicative of degree of dampness. This changes the divider resistance ratio such that the voltage to the neon lamp **77** is either higher or lower for any given moisture. The higher the moisture at which the firing voltage of the lamp bulb **77** is reached the more moisture will be left in the clothes according to the degree of dampness and as indicated on the scale **85**.

It will be readily understood by those skilled in the art that in lieu of using variable resistance for controlling dampness variable time in the form of differential increments of distance on the surface of a cam associated with the timer motor **58** may be employed.

To illustrate the operation of the present invention, reference may be had to FIG. 6 wherein a graph **86** depicts the relationship of the voltage drop across the electrodes **37** and **38** as an electrical signal generated thereby and occurring during a cycle of operation of the dryer **10**. A straight line curve **87** represents the firing voltage of the neon bulb **77**. As will be apparent from the graph **86**, during the early part of the drying cycle when the clothes are very wet, the voltage across the

electrodes **37** and **38** is low and fairly smooth, but as the clothes begin to dry, the moisture becomes more uneven and the clothes load lightens thereby producing a noisy signal with ever increasing periods of high voltage (i.e., voltage which exceed the firing voltage of the neon bulb **77** as represented by the straight line **87**) until the voltage drop across the electrodes **37** and **38** finally levels off above the firing voltage of the neon bulb **77**.

Since the controlled rectifier **74** is fired, thereby advancing the timer motor, only during the periods when the voltage drop across the electrodes **37** and **38** exceeds the firing voltage of the neon lamp, the run-out or percent "on time" of the timer motor **58** is inversely proportional to the contact time of the moist portions of the clothes **55** with the electrodes. This characteristic of the invention is illustrated in FIG. 7 by a curve **88** representing percent contact time of the moist portions of a relatively large load of cothes with the electrodes versus percent "on time" of the timer motor with respect to time. As indicated by the flat or horizontal portion of the curve **88**, the clothes **55** are initially very wet, consequently, the wet clothes contact the electrodes **37** and **38** 100% of the time. Once some of the moisture has been removed the contacting of the electrodes by the wet clothes becomes less and less as indicated by the sloped portion of the sensor **88**. It should be apparent that with relatively smaller loads of clothes, the contact time will be somewhat less than 100% of the time. Consequently the present invention compensates the load size.

Another way of illustrating the run-out characteristic of the timer motor **58** is by a curve **89** which is a plot of timer run-out or "on time" versus time. As can be seen on the first portion of the curve (no slope), the clothes being very wet and the contact time very high, the timer motor does not run. When this foregoing condition exists no signal is generated. As the clothes become dryer and the contact time as represented by the second portion of the curve **89** (very shallow slope) the voltage exhibited across the electrodes **37** and **38** intermittently exceeds the firing voltage of the neon bulb **77** but does not remain above that level. Once this voltage or signal exceeds the firing voltage and remains at that level as represented by the third portion of the curve **89** (i.e., very steep slope) the timer motor **58** remains energized and functions as a straight time run-out type of motor.

It will be understood that each time the timer motor **58** is advanced as a result of a signal generated by the sensors **34**, the cam **59** is advanced between contact closing and contact opening positions. In other words the cam advances between a point on the high portion **61** of the cam contacted by the cam follower **68** and the step **64** wherein both sets of contacts **69**, **70** and **71** and **72** are opened to terminate operation of the dryer. It should therefore, be appreciated that the cam structure **59** is storing or mechanically integrating the electrical signals generated by the sensor structure **34**.

Since numerous changes may be made in the above described apparatus and different embodiments of the invention may be made without departing from the spirit thereof, it is intended that all matter contained in the foregoing description or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. In fabric drying apparatus including a fabric supporting drum and means for rotating said drum to tumble said fabrics, control structure comprising:

means for generating signals indicative of the condition of said fabrics,

signal integrating means operable between a first condition for initiating operation of said drum rotating means and a second condition for terminating operation of said drum rotating means,

and means responsive to said signal generating means for progressing said signal integrating means from said first condition to said second condition,

said generating means generating electrical signals and said integrating means being electromechanical,

said electromechanical integrating means comprising an alternating current motor and cam means supported for rotation thereby,

rectifier means in series with said motor, said means responsive to said signal generating means comprising a bistable element connected to said motor such that it bypasses said rectifier means in the opposite polarity.

2. Structure as specified in claim **1**, wherein said signal generating means comprises sensing means supported in said drum and voltage sensitive switch means.

3. Structure as specified in claim **2**, wherein said sensing means comprises a plurality of electrodes adapted to be bridged by the fabrics in said drum and said bistable element comprises a thyristor having its gate connected to said voltage sensitive switch means.

4. In a fabric dryer including a fabric containing drum and means for rotating the drum during a complete cycle of operation, means for controlling at least a part of said cycle of operation, said control means comprising:

signal generating means,

integrating means,

and means responsive to said signal generating means for rendering operable said integrating means,

said generating means generating electrical signals and said integrating means manifesting the integrated signals as a mechanical displacement,

said integrating means comprising an alternating current device and said means for rendering said integrating means operable comprising a half wave rectifier connected in series with said alternating current device and a bistable device connected to said alternating current device such that it bypasses said half wave rectifier in the opposite polarity.

5. Structure as specified in claim **4**, wherein said signal generating means comprises sensing means and voltage sensitive switch means the triggering voltage of which serves to create a signal each time said triggering voltage is sensed.

6. Structure as specified in claim **5**, wherein said sensing means comprises at least one set of electrodes supported in the drum and adapted to be bridged by the fabrics in said drum and said bistable device comprises a thyristor controlled rectifier having its gate connected to said voltage sensitive switch.

7. Structure as specified in claim **6**, wherein said voltage sensitive switch means comprise a glow discharge tube.

8. Structure as specified in claim **7**, for manually varying the duration of noncontrolled part of the cycle of operation.

References Cited

UNITED STATES PATENTS

3,248,799	5/1966	Worst	34—53 XR
3,248,800	5/1966	Pierce	34—53 XR
3,324,568	6/1967	Nelson et al.	34—45

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

A. D. HERRMANN, *Assistant Examiner.*