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3,266,168

DOMESTIC DRYER APPARATUS

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3 Sheets-Sheet 1

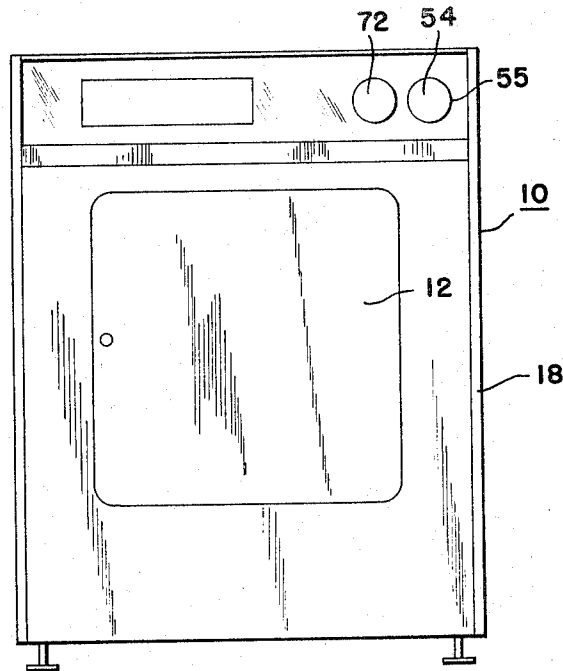


Fig. 1

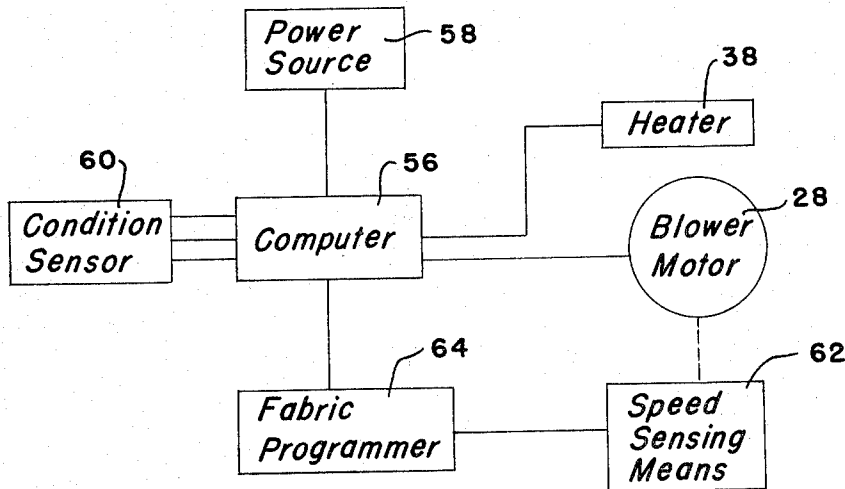


Fig. 2

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3 Sheets-Sheet 2

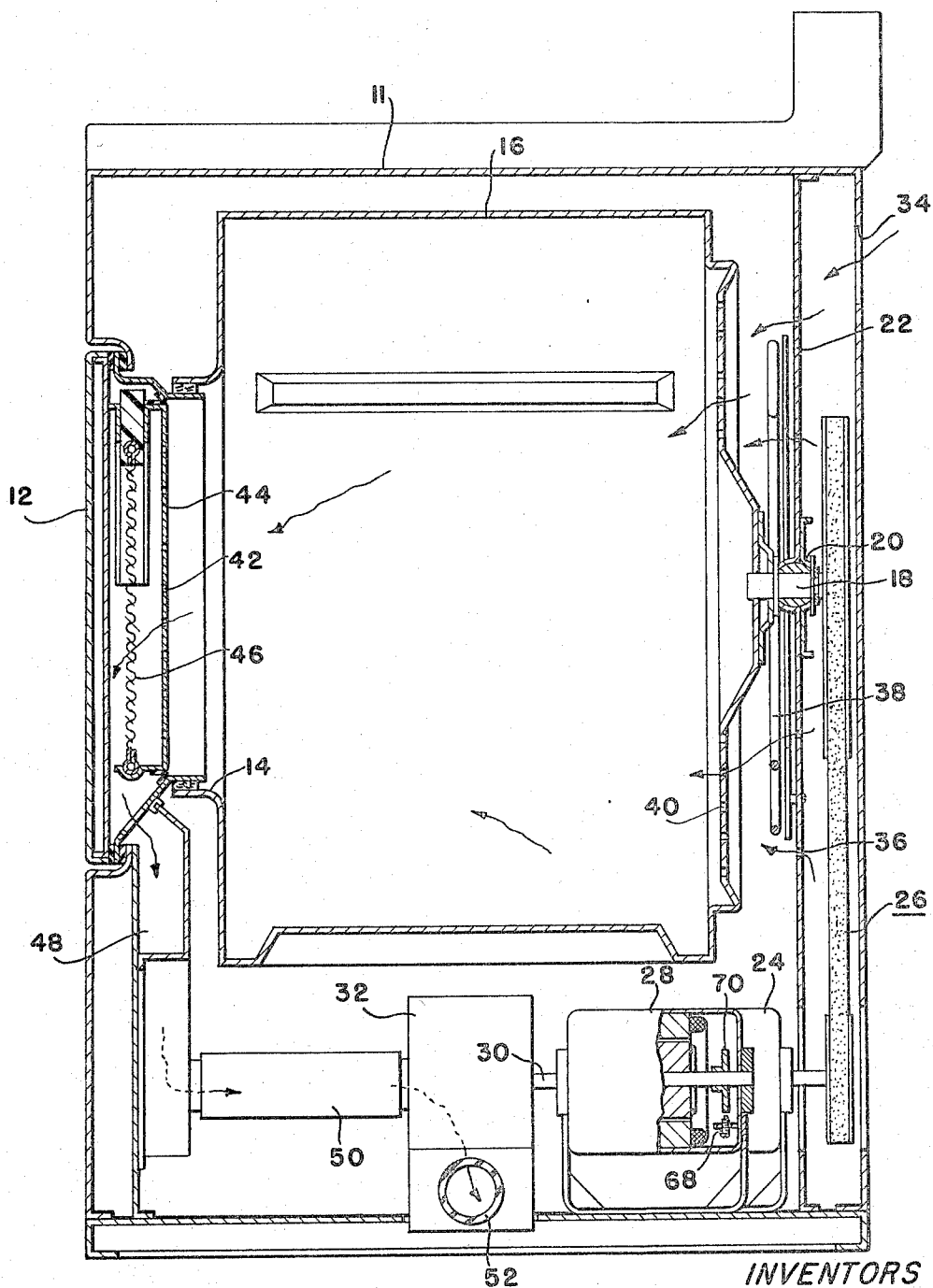


Fig. 3

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3 Sheets-Sheet 3

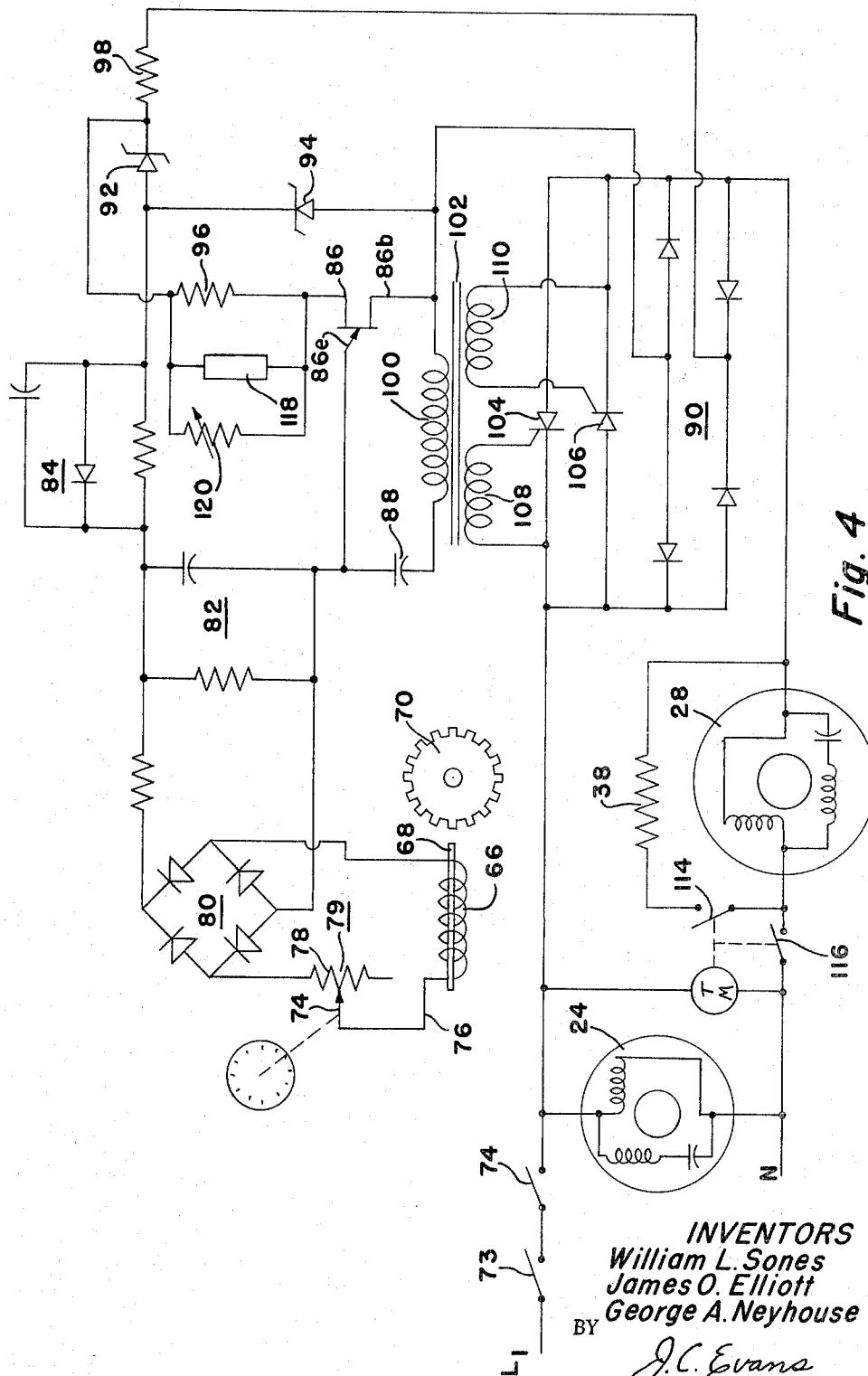


Fig. 4

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DOMESTIC DRYER APPARATUS

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9 Claims. (Cl. 34—45)

This invention relates to domestic dryer apparatus and more particularly to a control system combined with such apparatus for varying its blower capacity and heater output in accordance with articles being processed.

One problem in domestic dryer apparatus is to correlate the drying action thereof to various types of natural and synthetic fabrics in order to obtain an optimum drying action. In the past, a sequential timer control has been incorporated in the device for effecting varying cycles of machine operation suited for particular materials with the various cycles differing one from the other in length of drying time. In all cases, the operation of the blower, heat source and tumbling speed of the drum have been maintained at a substantially constant speed. By so operating dryer apparatus, it has been found that the drying operation during the cycles at times is not completely suited for a particular type of fabric. For example, present day wash and wear fabrics many times are subjected to a heat input rate of such a magnitude that the articles are dried to a bone dry state that can tend to adversely affect the fabric by setting wrinkles therein. Likewise, certain bulky, heavy articles can only suitably be processed by subjecting it to repeated manual cycles of operation. In the case where automatic drying controls are incorporated in the machine such bulky articles are often inadequately dried since the drying cycle tends to be terminated prematurely because the outer fibers dry and thereby trap moisture in the inner fibers of the article. The sensors in the automatic system sense a dry condition and shut down the dryer before all moisture has been removed.

An object of the present invention, therefore, is to improve the operation of domestic dryer apparatus by the provision of improved control means in association therewith including a solid state computer control unit having semiconductor switch means for varying the average voltage input to its heater and blower motor and a fabric programmer unit for conditioning the operation of the computer unit to regulate the voltage output of the semiconductor switch means to correspond to particular types of articles being processed.

Yet another object of the present invention is to improve the operation of a domestic dryer unit by the provision of an improved control system operative to vary the speed of a blower A.C. induction motor and the output of a heater in response to a plurality of operative conditions in the dryer tumbling drum that are simultaneously processed by a computer control unit including semiconductor switch means responsive to the integrated control signals for maintaining an optimum drying operation irrespective of the type of fabric being provided.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the present invention are clearly shown.

In the drawings:

FIGURE 1 is a front elevational view of a domestic dryer including the present invention;

FIGURE 2 is a block diagram of the control system of the present invention;

FIGURE 3 is an enlarged view in vertical section taken substantially along the line 3—3 in FIGURE 1; and

FIGURE 4 is a diagrammatic electrical circuit showing details of the control system of FIGURE 2.

Referring now to the drawings in FIGURE 1, a domestic dryer 10 is representatively illustrated as including an outer cabinet 11 forming a front opening closed by a door 12 for closing an access opening 14 into a tumbling drum 16. A drum drive shaft 18 is supported by a spherical bearing assembly 20 supportingly received by a rear bulkhead 22 within the outer cabinet 11 as best seen in FIGURE 3. The tumbling drum 16 is driven by an electric motor 24 through a belt pulley drive system 26. Another electrical drive motor 28 has its shaft 30 operatively connected to a blower 32 for circulating air through the tumbling drum. The blower 32 draws air through an inlet opening 34 in the rear wall of outer cabinet 11 through openings 36 in the rear bulkhead 22 across an electrical resistance heating element 38, thence through openings 40 in the rear wall of the tumbling drum 16. The air is drawn through the tumbling drum through openings 42 formed in an inner wall 44 of the door 12, thence through a lint filter 46 to be returned through a forwardly located passageway 48 within the outer cabinet 11 to an inlet 50 to the blower 32. The blower connects at its outlet to a suitable vent conduit 52 for discharging the circulated air exteriorly of the dryer cabinet. For purposes of the present invention, the above structural details of the dryer will suffice. Further explanation of its structural features is set forth in United States Patent No. 3,099,542, issued July 30, 1963, to Van Scoyk. As pointed out above, the dryer apparatus 10 illustrated is merely representative of one dryer structure that is suited for practicing the present invention with it being understood that other kinds are equally suited to produce improved drying action.

The dryer apparatus 10 also includes a conventional sequential timer control 55 having a manually adjustable control member or knob 54 rotatable to one of a plurality of settings to preposition timer advanced cam operated switches for carrying out operating cycles such as normal drying cycle, a wash and wear drying cycle and the like.

In accordance with certain principles of the present invention, in addition to the sequential timer controller 55, the apparatus 10 includes a solid state control system basically shown in FIGURE 2 as including a computer control unit 56 for regulating the power supply to the blower motor 28 and heater 38 from a power source 58 in response to signals from condition sensor means 60. In the present invention, the motor 28 is a permanent capacitor start A.C. induction motor having a very low relative cost as compared to like horsepower universal and D.C. motors. Motor 28 also is characterized by extremely good torque characteristics throughout the varying speeds at which it is operated.

The computer unit 56 receives a signal of the blower motor speed from a speed sensing unit 62. The speed signal is modulated by a fabric programmer 64 that regulates the operation of the computer 56 to vary the average power input to the motor 28 and heater 38 to maintain a desired speed norm of motor operation and heating effect correlated to a particular fabric being processed by the apparatus 10.

More particularly, the computer control unit 56, which is a static solid state semiconductor network that avoids movable contact switching problems, integrates the signals from the condition sensor means 60 and the fabric programmer 64 to meter 60 cycle power from the power source 58 to the motor 28 and heater 38 for producing an optimum drying action best suited for the type of material being processed.

In the illustrated arrangement of the invention, the speed sensing unit 62 includes a permanent magnet pick-up means similar to the type used in dynamometers in-

cluding a number of turns of wire 66 wound on a small magnet 68 as shown in the circuit in FIGURE 4. The small magnet 68 in the structural view in FIGURE 3 is illustrated as being supported on a portion of the outer casing of the motor 28 so that it is located in radial alignment adjacent an outwardly toothed wheel 70 secured to the shaft 30 for rotation therewith. As the toothed wheel 70 rotates, the permanent magnet 68 is subjected to varying gaps and the effective reluctance change causes flux changes therein which induce a varying voltage in the coil 66 to be fed through the fabric programmer 64 to the computer 56.

The fabric programmer 64 more particularly is illustrated as including a manually adjustable control member or knob 72 located on the control panel of the apparatus 10 adjacent the control member 54. The knob includes suitable indicating means thereon related to particular types of fabrics, for example, cotton, wool, wash and wear materials and the like and is movable with respect to an indicator for presetting the programmer to obtain an infinitely variable motor and heater operation that is best correlated to the particular type of material being processed within the tumbling drum 16.

Referring now to the circuit of FIGURE 4, lines L₁-N of a residential A.C. power source are shown including a line switch 73 and a door safety switch 74 which are closed upon pushing in member 54 and closing door 12 respectively once a load has been placed within drum 16. Setting manual control knob 72 to a desired fabric setting moves a contact carrying arm 74 electrically connected by a conductor 76 to one of the terminals from the coil 66. Adjustment of the knob 72 will move the contact carrying arm 74 with respect to a resistance element 78 of a programmer potentiometer 79 for varying the speed signal to the computer 56. At any particular fabric setting, the speed signal to the computer 56 will vary both in frequency and amplitude depending upon the speed of rotation of the motor 28 and with the modification effected by the fabric control potentiometer 79, will act to condition the computer 56 to maintain a desired motor speed norm corresponding to the particular type of fabric being processed irrespective of changes in the driven load as for example produced by a removal of moisture from the fabric during a particular drying cycle and changes in line voltage and the like.

Referring now more particularly to the computer control unit 56, the speed signals modified by the fabric programmer 64 are rectified by a full wave rectifying bridge 80 and passed therefrom through capacitive filter units 82. The filtered signal is then directed through a solid state semiconductor unit including a unijunction transistor 86 connected emitter 86e to base 86b across a capacitor 88. The modified speed signal from the magnetic speed pick-up regulates firing of the transistor 86 in combination with a control or reference potential produced by a bridge circuit 90 that rectifies the A.C. power across SCRs 104, 106 to D.C. power. The output of the bridge 90 is then regulated by Zener diodes 92, 94 in conjunction with resistances 96, 98 and in part fed through capacitive network 84. Depending upon the imbalance between the control potential produced by the bridge 90 and the variable input signal from the bridge 80 and capacitive filters 82, 84, the unijunction transistor 86 fires to produce a switch control signal in a primary coil 100 of a pulse transformer 102. More particularly, firing of the transistor causes the capacitor 88 to discharge through a low impedance path from emitter 86e through base 86b and the primary coil 100 so as to produce a voltage spike therein. This voltage spike operates a static state power supply switch for varying the average voltage supply to the motor 28. In this embodiment of the invention, the power supply switch is representatively illustrated as including a pair of oppositely facing silicon controlled rectifiers 104, 106 which are actuated by voltage induced in the secondary coils 108, 110 of the transformer 102 to be

maintained conductive for a predetermined period of the full wave form of the A.C. power supply across lines L₁-N to produce a variable energization of the blower motor 28 and heater 38 that maintains the operative state thereof at a speed norm and heat output directly suited to the particular type of material being processed as preset by the control member 72 of the fabric programmer 64. By varying the position of the control member 72, the speed signal is modified to create a greater or lesser imbalance between the filtered signal from the bridge 80 and the reference potential from the bridge 90 for varying the firing rate of the unijunction transistor 86 and thereby varying the controlled conductivity of the silicon controlled rectifiers 104, 106 to correspond to the change in material setting.

Across lines L₁-N is connected a timer motor 112 of the timer control 55. It advances cams for operating switches 114 and 116 for cycling on and off the motor 28 and heater 38 respectively during the various types of drying cycles as is well known to those skilled in the art.

By virtue of the aforementioned system, the user of the apparatus 10 is thereby able to preselect a desired operational norm that constitutes an empirically selected optimum slower speed and heat input rate for a specific type of fabric. For example, when the programmer is set for a delicate wash and wear fabric, the computer unit 56 will receive the modified speed signal from the programmer 64 to regulate the power supply to the motor 28 and heater 38 in a manner to reduce the pulses of A.C. energization thereto whereby both the rate of circulated air and heat input will be reduced so as not to damage the material during the wash and wear cycle operation set by the sequential timer control 55. A like setting can be made for bulky articles automatically being processed. In this case, gradual drying prevents humidity sensors from prematurely sensing a dry condition in the air flow. The automatic cycle will thereby not be prematurely terminated but rather will continue until the articles are really dry.

Similarly, a programmer setting for regular types of fabric will modulate the speed signal to cause the computer 56 to direct a greater average voltage input to the motor 28 and heater 22 whereby more air will be circulated over a hotter heater resistance element to produce a heating effect more suited to processing this type of material.

In addition to the predetermined infinite range of fabric settings and corresponding motor speed norms established by the programmer 64, the improved control system may include means for further modifying the drying action in response to sensed conditions in the tumbling drum 16. Such supplemented control by the system is desirable to take into account variables that arise, as for example, by the fact that certain types of domestic washing machines leave greater or lesser amounts of moisture in all different types of fabrics following their spin dry cycle of operation. Thus in the illustrated embodiment of the invention, the condition sensor means 60 may include a high positive coefficient of resistance humidity sensor unit 118 for sensing the moisture level in the air circulated through the tumbling drum 16. The sensor 118 is connected in parallel with the resistance 96 of the computer control unit as shown in FIGURE 4 whereby during periods at which the moisture level is very high in the tumbling drum 16 the differential between the control voltage of the bridge 90 and the input signal from the bridge 80 is increased to allow more frequent firing of the unijunction transistor 86 and a consequent greater average output from the computer unit 56 to cause a greater rate of air circulation and greater heat input to effect a greater drying action for a predetermined period of time to thereby reduce the drying cycle time as compared to that which would be effected by controlling the system at the speed norm set for a particular fabric as set by the fabric programmer 64.

Additionally, a temperature sensor 120 might be included as part of the condition sensor means 60 for preventing overheating of articles being processed. A typical arrangement is illustrated as including the sensor 120 in parallel with resistance 96. For sensing temperature to prevent overshoot into an undesirable range the sensor 120, as arranged in the computer unit, would be a high negative coefficient of resistance element that would decrease the firing undesirable temperature levels within the drum 16.

The basic concept of a domestic appliance having an A.C. induction motor controlled by a static solid state or semiconductor computer control unit is set forth in our copending United States application, Serial No. 159,014, filed December 13, 1961, now U.S. Patent No. 3,152,462. The present invention incorporates the basic advantages of appliance control by such static control devices, namely greater control reliability and more exact control capability together with the further improvement comprising additional fabric programmer means for correlating the air circulation rate and heat input of the dryer apparatus to correlate the drying action thereof to particular fabric types being processed.

While the embodiments of the present invention as herein disclosed constitute a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In a domestic dryer apparatus, the combination of means for tumbling articles to be dried, means for circulating heated air through said tumbling means, A.C. induction motor means for driving said air circulating means, semiconductor switch means in power supply relationship with said A.C. induction motor means, means for deriving a control voltage responsive to the speed of said motor means, computer means for processing said control voltage for controlling conductivity of said semiconductor switch means to maintain said A.C. induction motor means at a predetermined speed norm, and fabric programmer means for infinitely varying said control voltage within predetermined limits to operate said motor means at variable speeds for producing a circulation of heated air corresponding to particular types of fabrics being processed during the operative cycles of the dryer apparatus.

2. In the combination of claim 1, said fabric programmer means including a manually adjustable control member for selecting a type of motor operation corresponding to a particular type of material being processed, and variable resistance means positioned by said control member for modifying the signal of said speed sensing means to correspond to the type of materials being processed.

3. In a dryer apparatus, the combination of means for tumbling material to be processed, means for circulating heated air through said tumbling means, means for driving said air circulating means including an A.C. induction motor, means for sensing at least two conditions within said tumbling means and adapted to produce at least two signals corresponding to each of said sensed conditions, computer control means including semiconductor switch means in power supply relationship to said A.C. induction motor, said computer control means including means for simultaneously processing said signals together to control the voltage characteristic of power supply through said semiconductor switch means to said A.C. induction motor to vary the speed of operation thereof in accordance with said sensed conditions.

4. In the combination of claim 3, said sensing means including circuit means having a high coefficient of re-

sistance humidity sensor for sensing the moisture level in the air being circulated through said tumbling means.

5. In the combination of claim 3, said sensing means including circuit means having a high coefficient of resistance humidity sensor and a high coefficient of resistance temperature sensor for conjointly sensing moisture and temperature, respectively, in said tumbling means.

6. In the combination of claim 3, means for deriving a control voltage responsive to the speed of said A.C. induction motor to be directed to said computer control means for modifying the power supply controlling action thereof, and fabric programmer means for infinitely varying said control voltage within predetermined limits to operate said A.C. induction motor means at variable speeds for producing a basic drying effect related to a particular type of article being processed during the operative cycles of the dryer apparatus.

7. In a domestic dryer apparatus, the combination of means for tumbling articles to be dried, means for circulating heated air through said tumbling means, motor means for driving said air circulating means, semiconductor switch means in power supply relationship with said motor means for deriving a control voltage responsive to the speed of said motor means, computer means for processing said control voltage for controlling conductivity of said semiconductor switch means to maintain said motor means at a predetermined speed norm, and fabric programmer means for infinitely varying said control voltage within predetermined limits to operate said motor means at variable speeds for producing a circulating heated air corresponding to particular types of fabrics being processed during the operative cycles of operation of the dryer apparatus.

8. In a domestic dryer apparatus, the combination of means for tumbling articles to be dried, means for circulating air through said tumbling means, an electrical resistance element for heating the circulated air, an A.C. induction motor for driving said air circulating means, semiconductor switch means in power supply relationship with said A.C. induction motor and said resistance element, means for deriving a control voltage responsive to the speed of said A.C. induction motor computer means for processing said control voltage for controlling conductivity of said semiconductor switch means to maintain said motor means at a predetermined speed norm and said resistance element at a heat output norm, and fabric programmer means for infinitely varying said control voltage within predetermined limits to operate said motor means at variable speeds and said resistance element at varying temperature levels for producing a heating effect corresponding to particular types of fabrics being processed during the operative cycles of operation of the dryer apparatus.

9. In the combination of claim 6, said fabric programmer means including a manually adjustable control member for programming a type of motor and heater operation corresponding to a particular type of material being processed, and variable resistance means positioned by said control member for modifying the signal of said speed sensing means to correspond to the type of material being processed.

References Cited by the Examiner

UNITED STATES PATENTS

3,152,462 10/1964 Elliott et al. 68—12
3,191,313 6/1965 Moorhouse et al. 34—52

JOHN J. CAMBY, *Acting Primary Examiner.*