United States Patent

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[54] **PORTABLE ELECTRIC AIR-HEATING GUN AND OVEN**
9 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **219/370,** 34/243, 219/364, 219/373, 219/374, 219/400
[51] **Int. Cl.** **F24h 3/04,** H05b 1/02, H05b 3/02
[50] **Field of Search** 219/363, 364, 365, 366–377, 379–381, 400; 34/43, 48, 237, 96–101, 243

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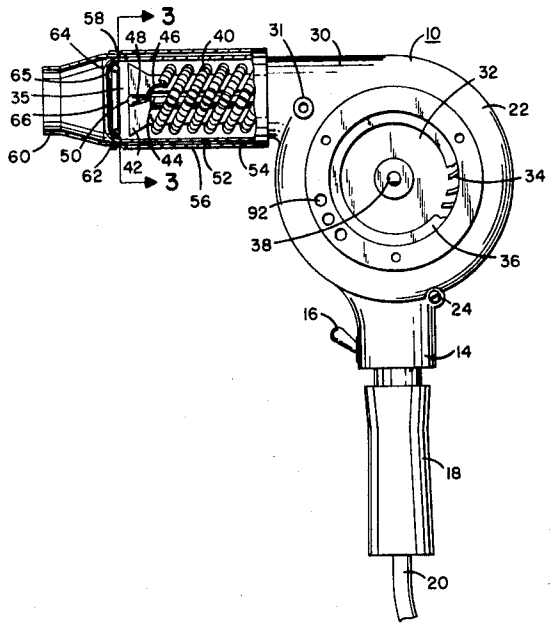
ABSTRACT: A portable hand-carried air gun having a fan that forces volumes of air through a casing. The casing has heating coils therein for heating the air passing therethrough. A plate in the discharge end of the casing blocks the direct flow of air out of the discharge end and forces the air to move through an annular space between the outer edge of the plate and the casing. The plate and casing thus forms a chamber between the plate and the heating coils for mixing the airflow after passing through the heating coils and prior to passing out through the annular spaced. A temperature-sensitive element responsive to the temperature of the air in the chamber adjusts the current to the heating coils to hold the air in the chamber to a set temperature. An oven container for receiving the discharge end of the portable air gun provides a quick and easily heated oven.



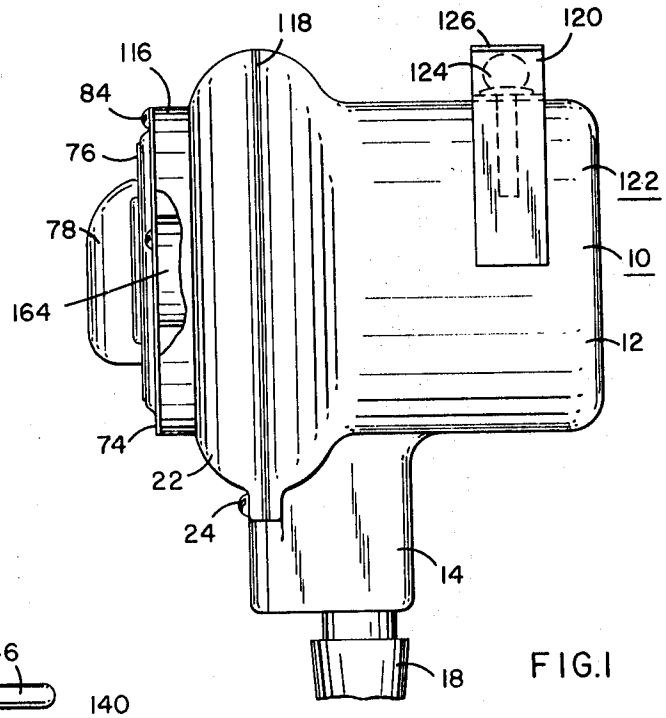


FIG.1

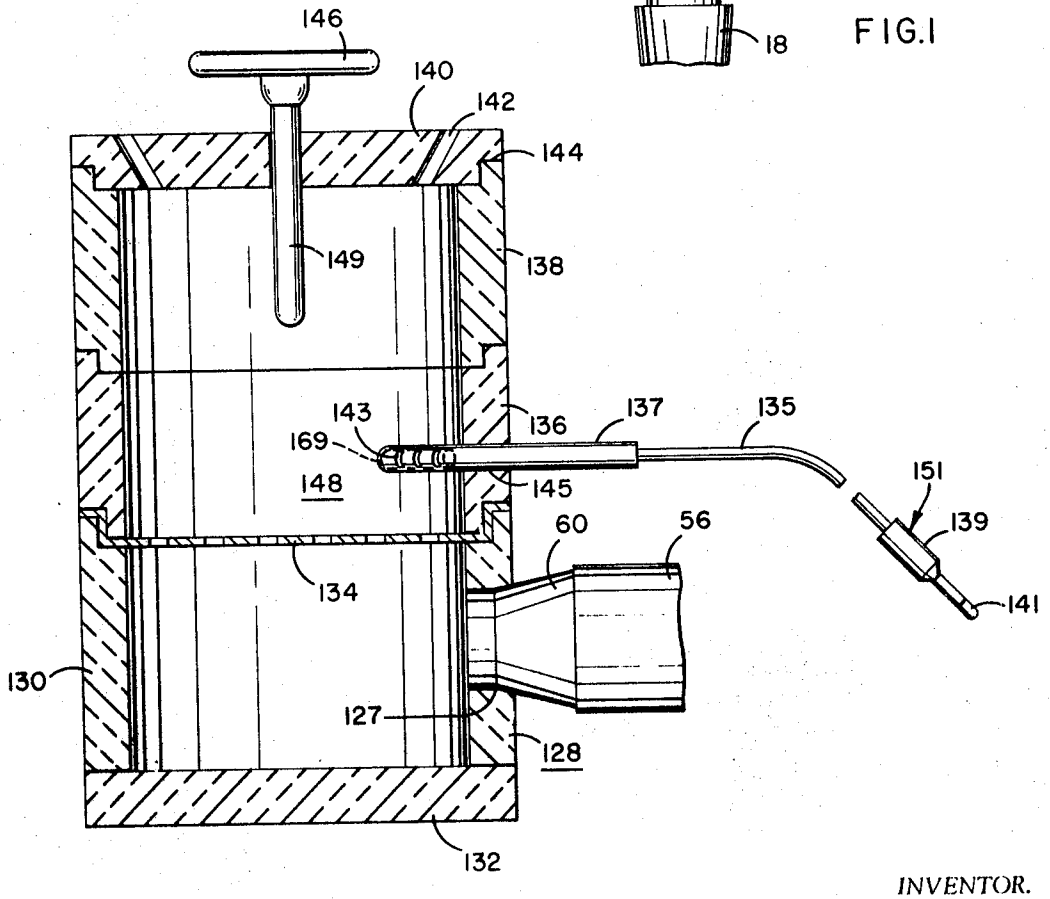


FIG.5

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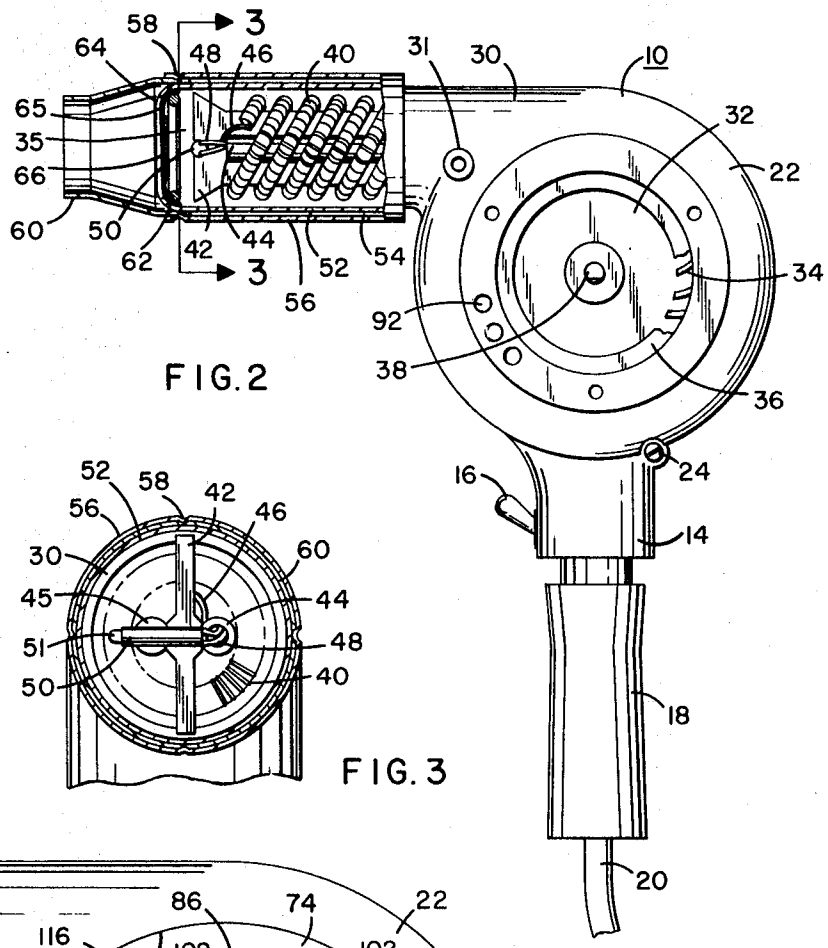

FIG. 2

FIG. 3

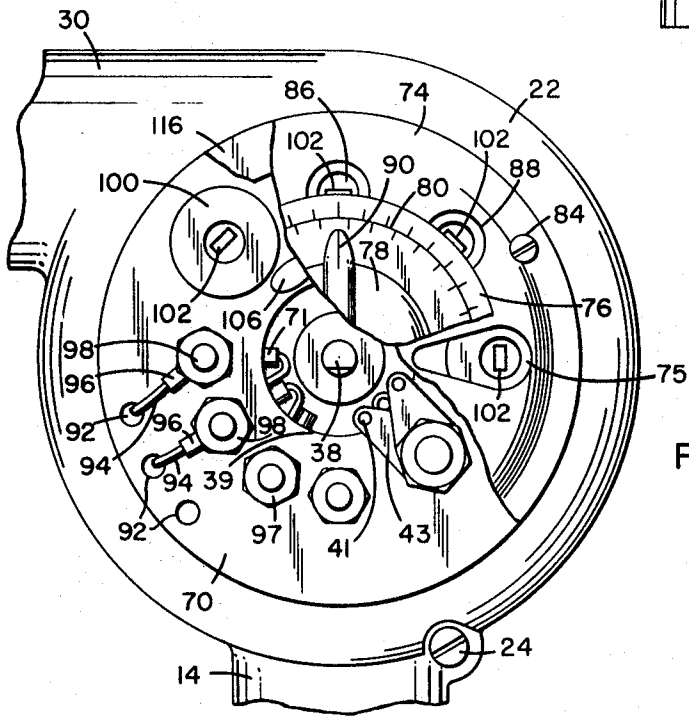

FIG. 4

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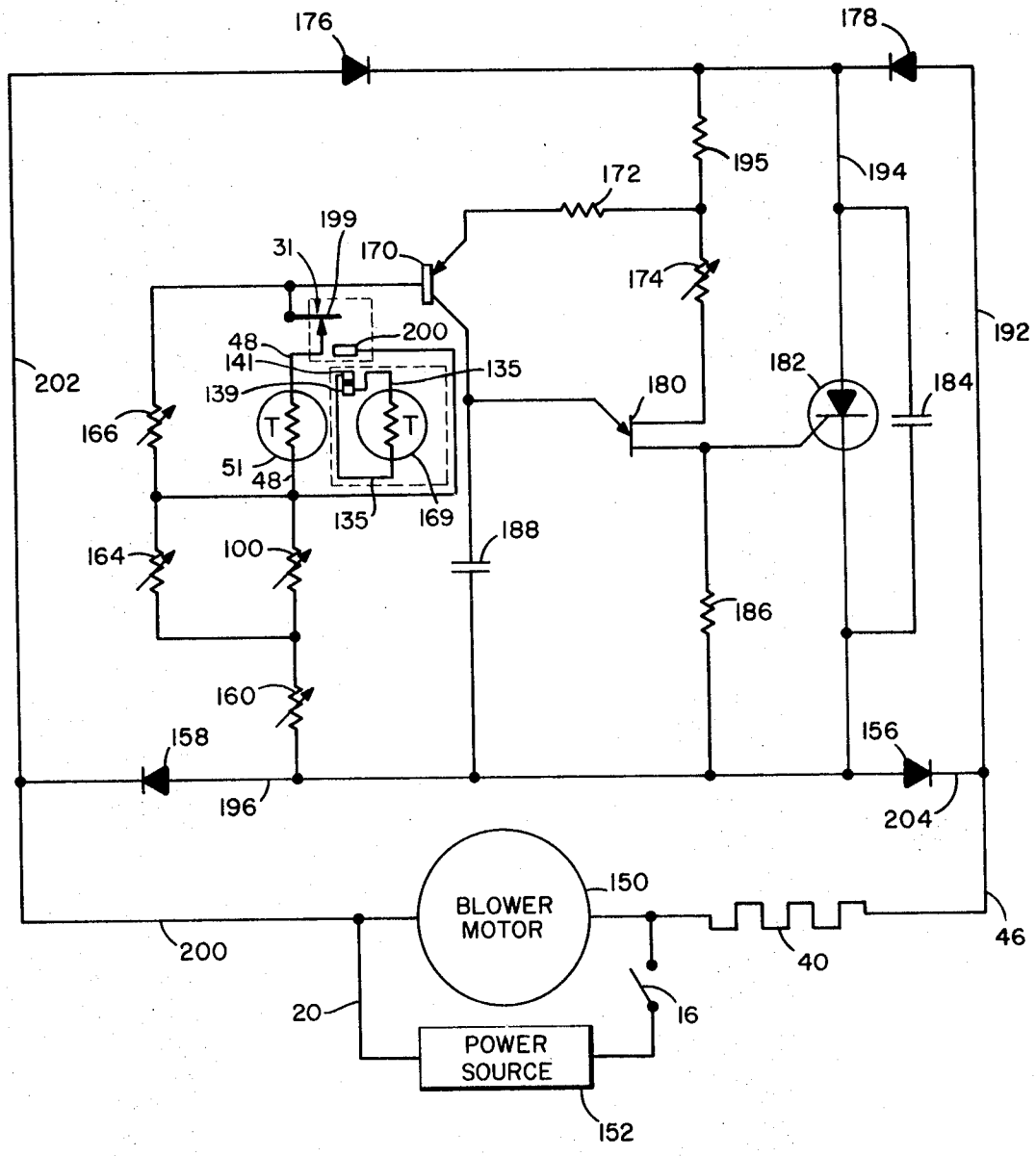

FIG. 6

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PORTABLE ELECTRIC AIR-HEATING GUN AND OVEN

BACKGROUND OF THE INVENTION

Portable hand-held heat guns that supply heated air outputs have been used for many years. Such heat guns find many applications that extend from the use of elementary heat guns or blowers as hand held hair dryers to the more versatile portable heat guns that provide high-temperature air outputs. These high-temperature portable heat guns can be used for many purposes, such as shrinking tubing, plastic welding and forming, potting, rapid drying, and many other applications. However, it is advantageous in employing high-temperature heat guns, that the temperature of the heated air output be precisely controlled. Otherwise the temperature of the heated air output may vary so widely that predictable or repeated results from the use of the heated air are not possible; material and equipment heated are destroyed, considerable skill and judgment is required in using the heat gun, components are over cooked, and in many cases the erratic heat gun is dangerous to use.

The many uses for ovens is well known. However, most ovens are large and heavy structures, are difficult to move, require a considerable length of time to heat to temperature and then to cool and require a built-in heat source. Yet in many uses, it is desirable or necessary to have an inexpensive, light weight small in size, and portable oven for heating small components that may be quickly heated and cooled, and that has a reasonable control of the temperature of the air within the oven so that predictable results are possible and components are not ruined in the oven.

Thus in view of the foregoing, it is advantageous to have a portable air or heat gun that provides an air output having a relatively wide range of controlled temperatures, which discharge air temperatures are precisely held held at given temperature settings. It is also advantageous to have a small portable oven heated by the portable heat gun in which the oven temperature is precisely and quickly controlled and which oven is easily expandable in size.

SUMMARY OF THE INVENTION

In an embodiment of the portable air or heat gun and oven of this invention, a hollow elongated casing has an air inlet and an air outlet that is supported by a handle. A centrifugal fan unit draws air through an inlet in the side of the structure and discharges the air through the casing and out a discharge nozzle. An insulated plate is positioned in the elongated casing and has an insulated tube positioned at each side. Heating coils are spiraled around the insulated plate and tubings to form a substantially circular heating coil arrangement around the inner periphery of the casing for heating the airflow therethrough. A screen covers the circular outlet end of the casing and a circular plate is secured to the center of the screen. The plate has an area smaller than the area of the outlet , thus the heated air flows through the space between the outer edge of the blocking plate and the inner edge of the outlet opening.

An electrical circuit c controls the current through the heating coils and thus controls the heat imparted by the coils to the passing air and the temperature of the air flowing out the outlet end of the casing. A temperature sensitive probe is positioned in the casing adjacent the space between the blocking plate and the inner edge of the outlet and thus is in the channeled air flow therethrough. The temperature sensitive probe is electrically connected the electrical circuit means and control s the electrical power to the heating coils, thereby controlling the temperature of the air flowing out the outlet. Thus the circuit parameters a re set for a given temperature and the temperature setting probe holds the discharge air temperature at the set temperature.

An oven, that may have a cylindrical shape, has an opening in the bottom of the side through which the discharge end or nozzle of the portable heat gun of this invention is inserted for injecting temperature controlled heated air into the oven. The upper cover of the oven has openings therein for passing the continuously moving air through the oven. The temperature in the oven in the uniflow of air therethrough is dependent upon the temperature of the output air from the portable heat gun. Thus setting the output temperature of the air from the heat gun, sets the temperature in the oven. It may be understood that the temperature in the oven is immediately raised to the temperature of the air discharged from the air gun, since the air flow therethrough is continuous and uniform. The temperature in the fast heating oven may be controlled by the temperature-sensitive probe within the casing of the portable heat gun, or a second temperature-sensitive probe may be inserted into the oven itself and by appropriate switch means, switched into the electrical circuit means for controlling the electrical power to the heating coils. In this mode of operation the temperature of the air output of the heat gun into the oven is controlled by the temperature-sensitive probe positioned within the oven. The oven, being of relatively small size is easily set up, is portable, is inexpensive, and may be raised to a rather precise temperature quickly to permit instant temperature testing of thermally sensitive devices, matching resistors, and performing other heating processes.

It is therefore an object of this invention to provide a new and improved portable air gun.

It is another object of this invention to provide a new and improved portable air gun having probe control of the temperature of the air output.

It is another object of this invention to provide a new and improved portable heat gun in which the temperature of the air output is dial set and the air temperature output is held to the dial setting.

It is another object of this invention to provide a new and improved portable heat gun that may be effectively used in many processes to obtain repeatable heating results without damaging or overcooking the heated components.

It is another object of this invention to provide a new and improved portable heat gun with precise temperature control that is low in cost, low in maintenance and has a low power consumption.

It is another object of this invention to provide a portable air gun having unique temperature control of the discharge air that heats or cools, provides wide temperature ranges of air output, and permits testing and processing that is not feasible by other hand-operable air source means.

It is another object of this invention to provide a new and improved portable oven that is quickly heated or cooled to a given temperature and that employs the portable heat gun as the heat source.

Other objects and many attended advantages of this invention will be more apparent upon a reading of the following detailed description and an examination of the drawings, wherein like reference characters identify like parts throughout and in which:

FIG. 1 is a vertical plan view with parts broken away of an embodiment of the portable air or heat gun of this invention.

FIG. 2 is a side plane view, with parts in section and parts broken away, of an embodiment of the portable air or heat gun of this invention.

FIG. 3 is a cross sectional view taken along lines 3—3 of FIG. 2.

FIG. 4 is a side view of the centrifugal fan unit air intake with the electrical components positioned in that air intake and other control portions illustrated, and with parts being broken away for illustrative purposes.

FIG. 5 is a cross-sectional view of an oven in combination with the portable heat gun of this invention.

FIG. 6 is a schematic diagram of the electrical control circuit that controls the operation of the portable air or heat gun.

Referring now to FIGS. 1 and 2, a handle 18 supports the thermal air bath gun 10 having a housing 22 supported on a base portion 14. The housing 22 comprises two side members joined together at 118 by fastener means such as screw 24.

The housing 22 supports a centrifugal fan unit 36 having impeller blades 34 that are supported by a rotatable plate 32 that is secured to axle 28 that is turned by an electrical motor mounted in the housing 12. The electrical power to operate the electrical motor is supplied through power cord 20. Switch ! energizes the unit in a manner that will be explained in greater detail herein after . The barrel portion 30 of the gun housing 10 has a cylindrical metal casing 52 that is secured to the end of the barrel portion 30 by a slip fit. Casing 52 has an open end or outlet opening 54 that is covered with a screen of wire mesh 65 that is held in position by ring clip 62 . An air blocking or directing plate 66 is secured to the center of the screen and has a circular shape with a smaller area than the opening 64 a chamber exists between the forward end of the heating coil 40 and the blocking plates 66. Thus air flow out the outlet opening 64 passes through the screen material 65 between the outer edge of the plate 66 and the inner e edge of the opening in the cylindrical member 52. This circumferential discharge opening with space 35 and with the discharge nozzle 60, mixes the air into an airstream having a uniform temperature.

A plate 42 of insulating material is secured in the end of the barrel portion 30 and projects into the casing 52. The insulating plate along with insulated conduits 44 and 45 support a spiral wound heating coil 40, as illustrated, with the end of the heating coil 46 passing through a slot in the end of the electrically insulative or insulating plate 42 and returning to the other side of the electrical circuit through the electrical insulative or insulated conduit 45. Conduits 44 and 45 are position d at the sides of plate 42 to give a circular position to the spiral coils 40 and further to carry electrical wires through the heating coil area. The heating coils as may be seen, heat the air passing through the internal volume of the casing 52 and do not touch the metal casing 52.

An outer metal tubing member 56 is mounted in concentric and spaced relation ship on the casing 52 and is held in position by four indentations 58 at each end that provides the space 54 of air therebetween. The airspace 54 provides thermal insulation against heat transfer from the casing 52 that allows member 56 to be grasped as necessary during operation of the thermal air bath gun. The discharge nozzle 60 is secured between the outer tube member 56 and the casing 52 by a known slip fit. A temperature control probe is positioned in the casing 52 to control the temperature of the output air. This control probe 51 is positioned in space 35 and is electrically responsive to changes in temperature and is supported by an insulated conduit 50 in the slot in the end of plate 42. The control probe 51 may be a thermister insulated wires 48 carried in the cylindrical insulator 44 connect the temperature sensitive probe 51 to circuitry positioned in the housing 22.

The centrifugal fan unit 32 draws air through the opening illustrated in FIG. 2 and ejects the air into the barrel portion 30. Positioned in the fan inlet is an insulated plate 70 that has an opening 39 through which inlet air passes. Electrical components 71, 100, 106, and other electrical components that comprise the electrical circuit, are secured to the plate 70 and project into the air inlet opening to be cooled by the passage of air . The electrical components supported on the insulative plate 70 are normally all those electrical components whose life can be shortened by excessive heat and are in general those electrical components illustrated in the schematic of FIG. 6, except for the thermistors 5! and 169, switches 197 and 31, male contactor 151, blower motor 150, switch 116, power sources 152, heater coil 40, and some of the connecting lines. The remaining components comprise a substantial number of the electrical components of the electrical circuit that are on plate 70. Electrical components, not shown, are secured to metal plates 43 that terminate in tubular extensions 41 through which inlet air passes. These metal plate structures 43 function as heat sinks for cooling the electrical components secured thereto. Electrical connections 96 and 98 connects the ends of probe wires 94 into the electrical circuit. The wires 94 pass through openings 92 in plate 70 that communicates with the barrel portion 30 to pass outside the rotating structure of the centrifugal fan unit 32. Other power connections, connected to for example, connector 97 , are from the power source input cord 20 that passes through the outer circumference of the housing 22 to avoid the rotating movement of the fan unit 32. An air control cover 74 has openings 75 therein that control the volume of air passing through to the inlet opening 39. These openings 75 also provide an opening through the air control plates 74 to insert a tool to turn the adjustment slots 102 of electrical components 75, 86 and 100. These adjustment slots, for example, set the electrical parameters of potentiometers 162, 164 , 166, and 174 of FIG. 6.

A cylindrical spaces 116 is positioned around the outer circumference of the component supporting plate 70 and is covered by the cover 74 that is secured thereto by alignment screws 84. Mounted against the outer surface of the cover 74 is a dial plate 76 having a temperature scale 80. The outer radial lines of the scale indicate fahrenheit temperatures and the inner lines of the scale indicate centigrade temperatures. A rheostat control 78 having an indicator 90 turns a potentiometer 114 secured to the cover 74. This accomplishes temperature setting of the air output in a manner that will be described in more detail hereinafter.

Referring to FIG. 6, an electrical circuit carries electrical power from a power source 152 , such as a normal AC voltage output, , through line 20 and switch 16 to supply electrical power to the blower motor 150 and the heating coil 40. Since the power source is AC in one half of the cycle the current flows from power source 152 through the heating coils 40 line 46 , line 192 through unidirectional device or diode 178, through the parallel circuits illustrated to output line 196, through unidirectional device 158 and line 200 to the power source 152. In the other half of the AX voltage cycle, the current flows through line 200, line 202, through unidirectional device 176 through the parallel circuits to line 196 , through unidirectional device 156, line 204, line 46, through the heating coils 40 and through switch contact 16 to the power source 152. A resistance bridge circuit comprising variable resistors 100, 164 and 166 and thermistor 51 is employed with variable resistor 160 to provide a base control to the PNP transistor 170. Thermistor 51 is connected in parallel with variable resistor 166 through line 48 and a switch 197 that is normally closed by its spring biased contact 199. The variable potentiometer 166 provides a linear adjustment of the response of the thermister 51 in the temperature environment . Potentiometer 164 functions as a range adjustment to place the entire resistance bridge into the temperature control range of the thermistor relative to the current passing through the heating coils 40 . Potentiometer 100 is the temperature setting potentiometer of the rotating hand control 78 illustrated in FIG. 1 and FIG. 4.

In the bridge circuit, the known thermistor 51 passes potential to the base of transistor 170 dependent upon its temperature environment. Thus with a temperature decrease in the temperature environment, transistor 170 energizes the unijunction device 180 that in turn energizes the SCR 182. The sum of the load current through the SCR is set by the aforesaid circuit parameters which total power over a period of time is dependent upon the on time and off time of the SCR 182 as determined by the thermistor 51 . Parallel connected capacitor through the SCR during the times that the SCR is tuned on and off 184 serves to level out or regulate the current flow. Potentiometer 174 functions as an ambient compensating resistor and resistors 186 and 195 are current limiting resistors with resistor 172 functioning as a voltage comparator resistor circuit. Thus it may be understood that environmental temperature variations around the thermistor 51 vary its electrical parameters and thus controls the current magnitude that flows through the heating coil 40 and the heat imparted to the air passing through the casing 52. The thermistor 51 is sensitive to air temperatures that, for example, may range from 100 to 600° fahrenheit. Accordingly at a temperature of 100° fahrenheit, the air passing through the thermal air bath gun 10

will have a cooling effect upon components or devices having higher temperatures. However, air discharge at temperatures of 600° fahrenheit will constitute a heat gun mode of operation for heating components in the manner previously described.

Referring to FIG. 5, oven 128 has a base member 132 and stacked cylindrical sections 130, 136 and 138 with an upper cap portion 140 having air passages 142 therethrough and a temperature probe 149 with a scale 146. An opening 127 is shaped to receive the discharge end 60 of the thermal air bath gun 10 illustrated in FIG. 2. Thus the temperature controlled air output from nozzle 60 passes through opening 127 into the volume 148 of the oven 128, which air passes through opening 142 to the atmosphere. With the small controlled volume 148 and the volume of heated air passing therethrough, the temperature in volume 148 rapidly assumed the same temperature as the air discharged from nozzle 60. Thus by setting the output temperature from gun 10 in the manner previously described through use of the thermistor or temperature control probe 51, the temperature in volume 148 is automatically set and held. This set temperature is rapidly achieved in volume 148 and is maintained by the continuous uniflow of heated air through volume 149. The thermometer 148 provides a check of the actual temperature in the volume 148. A ventilated baffle 134 serves as a chamber floor for supporting test specimens in the oven 128. The sides of the oven 128 may be made of insulating material or double-walls sheet metal using airgap insulation.

Where a more critical control of the temperature in the volume 148 of oven 128 is desired then a second electrical control probe having a covered thermistor 169 illustrated in dotted lines, is positioned in a housing 137 having openings 143 in the end that project through opening 145 in the side of the oven 128. Electrical line 135 carries the temperature signal information to a normal male connector 151 having insulated electrical contacts 129 and 141 that fits into a female receptacle 31 in housing 22, see FIG. 2. In a manner well known in the art, the male connector 151 when inserted into receptacle 31, moves contact 141 into contact with movable contact 199 of switch 197 to open the switch This opens the circuit through line 48 to thermistor 51 and closes the circuit to one side of thermistor 169, through 141 and 197. Simultaneously contact 139 makes electrical contact with conductor 250 closing the other side of the circuit to thermistor 169. This places the circuit of probe housing 137 and thermistor 169 into the temperature responsive electrical control means of the electrical circuit . Thus thermistor 169 functions to control the temperature of the air passing from discharge nozzle 60 into the volume 148 and thus directly controls the temperature of the air in the oven. An inexpensive, expandable and portable oven chamber is thereby provided that is capable of being modified as to size, shape or access for use in combination with the thermal air bath gun 10.

Referring to FIG. 1, a pair of plates 126 are supported on support 120 that in turn is secured by a fastener to housing 12. These oppositely directed flat supports allow the thermal air bath gun 10 to be rested in a supported horizontal and inverted position.

Having described may invention, I now claim:

1. A portable air gun comprising,
a hollow elongated casing and air inlet and an air outlet,
air source means for supplying volumes of air under pressure to said inlet for flow through said casing and out said outlet,
electrical heating coils positioned around the inner periphery of said casing for heating the air flow therethrough,
electrical circuit means for supplying electrical power for said electrical heating coils,
a plate positioned in the center of said outlet and having an area smaller than the area of the outlet for directing airflow through the space between the outer edge of said plate and the inner surface of said casing at said outlet,
said electrical circuit means includes power control means for controlling the electrical power to said heating coils, thereby controlling the temperature of the air flowing out , which power control means has temperature-sensitive means positioned in said casing adjacent said space and electrically connected to said electrical circuit means and electrically responsive to the temperature of said airflow,
an electrically insulative plate positioned longitudinally in said casing,
and electrically insulative tube positioned longitudinally on each side of said plate,
said heating coils being spiralled around said electrically insulative plate and said tubes,
said temperature-sensitive means comprising a thermistor
circuit wires for electrically connecting said thermistor in said electrical circuit means which wires pass through said electrically insulative tube,
said air source means comprises a centrifugal fan unit having an air intake and an air discharge that is connected to said air inlet,
said electrical circuit means includes a plurality of electrical components, some of which electrical components have electrical parameters that are mechanically adjustable,
plate means for supporting a substantial number of said electrical components in said air intake, whereby said components are cooled by the passage of the intake air,
a plurality of said components in said electrical circuit means being connected to metallic plates projecting into said air inlet t for dissipation of heat from said components to the airflow through said metallic plates,
a cover positioned over said plates means and said electrical circuit means having air passage openings for passing airflow through said inlet,
and a plurality of said components of said electrical circuit being reachable for selective adjustment through said air passage openings.

2. A portable air gun comprising,
a hollow elongated casing having an air inlet and an air outlet,
air source means for supplying volumes of air under pressure to said inlet that will flow through said casing and out said outlet,
electrical heating coil positioned around the inner periphery of said casing for heating the airflow therethrough,
electrical circuit means for supplying electrical power to said electrical heating coil,
a flat plate positioned in the center of aid outlet and having an area smaller than the area of the outlet for directing airflow through the space between the outer edge of said plate and the inner surface of said casing at said outlet,
said plate being spaced forwardly of said heating coils and forming a chamber therebetween and having a blocking surface on the side adjacent said coils for blocking airflow and causing mixing of the airflow in said chamber after passage of said airflow through said coil and prior to passage through said space,
a temperature-sensitive element having electrical parameters that change with temperature being positioned in said chamber adjacent said space,
and said electrical circuit means including power control means electrically connected to said temperature sensitive element and being responsive to changes in said electrical parameters for controlling the electrical power to said heating coils, thereby controlling the temperature of the air flowing out said outlet.

3. A portable air gun as claimed in claim 2 in which,
said air air source means comprising a centrifugal fan unit having an air intake and an air discharge that is connected to said air inlet,
said electrical circuit means includes a plurality of electrical components that are subject to deterioration from heat,
and plate means for supporting said plurality of electrical components in said air intake whereby said components

are cooled by intake air and are separated from said heating coil by said plate means.

4. A portable air gun as claimed in claim 3 including,
a cover for being positioned over said plate means and said components of said electrical circuit means,
selective ones of said electrical components have adjustable means for mechanically adjusting the electrical parameters of said selective ones of said electrical components,
and said cover having openings therethrough for engaging said adjustment means.

5. A portable air gun as claimed in claim 3 in which,
said components in said electrical circuit means being connected to metallic plates projecting into said inlet for dissipation of heat from said components through said metallic plates projecting into said inlet for dissipation of heat from gun components through said metallic plates to the air flow.

6. A portable air gun as claimed in claim 2 including,
an oven compartment having an opening in the side near the bottom for receiving the outlet end of said casing and having an opening in the top for passing heated air from said outlet end through said oven compartment,
a second temperature-sensitive element having electrical parameters that change with temperature which element is placed in said oven volume,
and switch means for switching said second temperature-sensitive element means into said electrical circuit means in place of the temperature-sensitive element.

7. A portable air gun as claimed in claim 2 in which,
said plate is supported in said openings by a screen,
and a tube being concentrically mounted on the outer surface of said casting and spaced therefrom providing an air space therebetween.

8. A portable air gun as claimed in claim 2 including,
an electrically insulative plate positioned in said casing,
and electrically insulative tube positioned longitudinally on each side of this plate,
said heating coil being spiralled around said electrically insulative plate and tubes,
said temperature sensitive element comprising an electrical temperature sensitive probe,
and circuit wires between said probe and said electrical circuit means for passing through said electrically insulative tube.

9. A portable air gun as claimed in claim 8 in which,
said temperature sensitive probe comprises a thermistor,
and said power control means including means responsive to the temperature condition of said thermistor for controlling the magnitude of current flow through said heating coils.