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HEATING APPARATUS

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FIG. 1

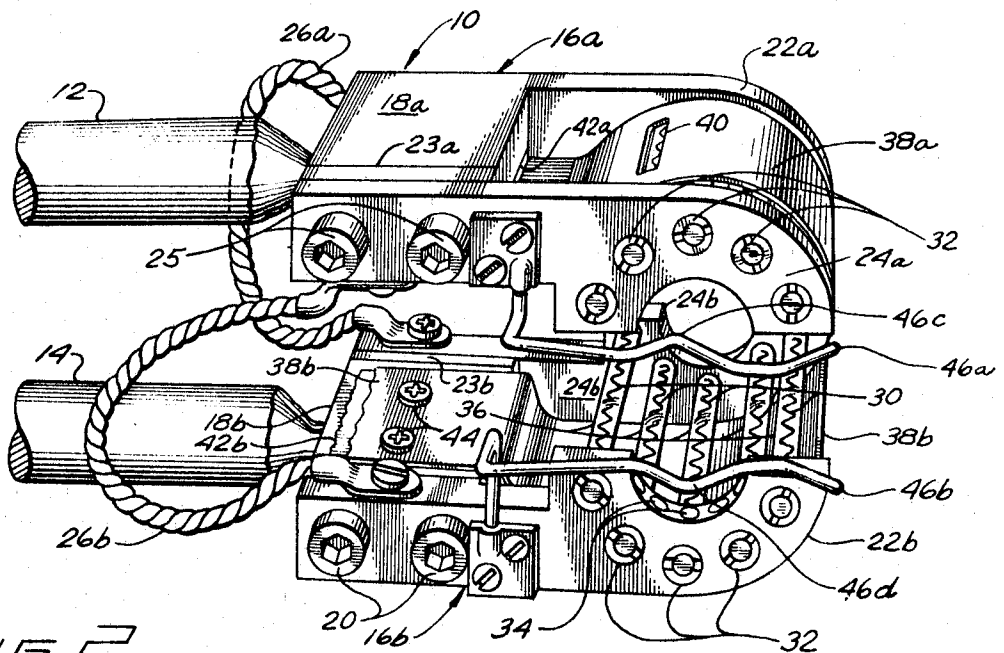
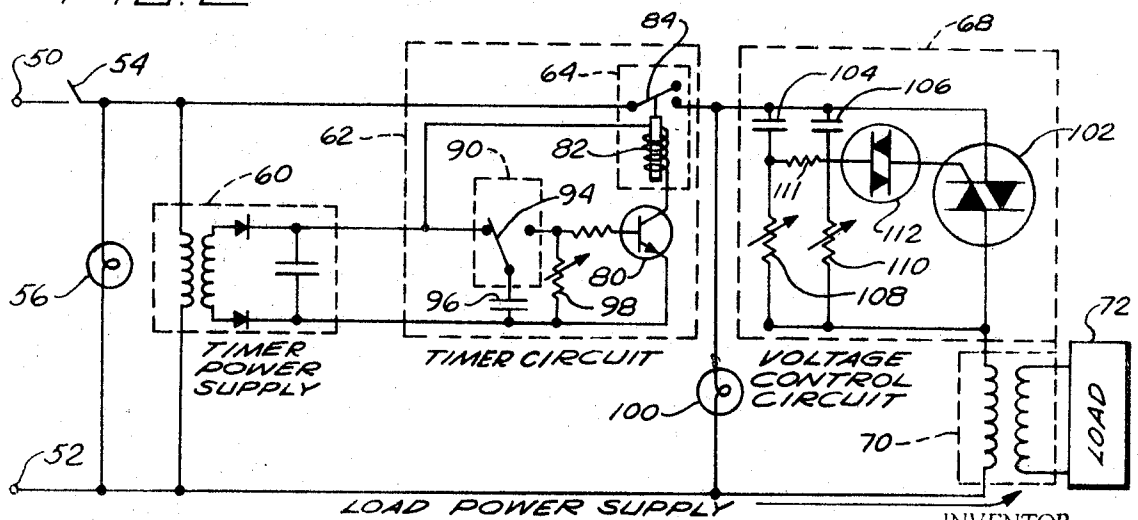


FIG. 2



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3,515,853

HEATING APPARATUS

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6 Claims

ABSTRACT OF THE DISCLOSURE

A heating tool has a pair of aligned, semicylindrical sub-heads, each supported at one end of a handle and each sub-head containing a plurality of elongated heating elements arranged parallel to the axis of the sub-heads. The handles are interconnected in a plier-type or sugar-tong type arrangement whereby the sub-heads can be moved from an open position to a closed position encircling a workpiece to be heated. The sub-heads may be provided with reflectors to reflect radiation toward the workpiece. The reflector may be apertured to permit viewing the workpiece while heating. A voltage-control circuit controls the amount of power applied to the filaments. A timing circuit controls the heating interval.

BACKGROUND

It is well known that electrical wires are covered with an insulating material—which may be rubber, plastic, or the like; and that when the insulation is nicked or cut, it should be repaired. One repair comprises a wrapping of insulative tape; but this tends to be bulky and unsightly. A preferred repair comprises sliding a length of tubing or sleeving of so-called “heat-shrinkable material” over the damaged area. When this sleeving is exposed to heat, it shrinks; and, in doing so, produces a tubular “glove” that is snugly adherent with the original wire—the glove acting as a repair for the damaged insulation.

In other situations, it has been found desirable or necessary to identify various wires by part number, an identifying code, or the like. There are times when this identification may be pre-printed on the wire's insulation; but frequently this cannot be done in advance. At such times it becomes convenient to slip a length of heat-shrinkable sleeving—having an identifying designation thereon—over the wire; and to apply heat—so that the identifying heat-shrinkable sleeving contracts onto, and adheres to the wire.

There are other situations when the wires enter a connector that has a ferrule or a similar connection that is not insulated; and, in these cases, it is convenient to use a piece of heat-shrinkable sleeving to insulate the ferrule and/or connector. This usage is discussed in U.S. Pat. No. 3,317,655.

Another use of heat-shrinkable tubing is as follows. When wires are to be spliced together, portions of the insulation are removed to expose the bare wires; and the bared wires are then twisted or wound together—producing a length of bare uninsulated wire that must now be covered with some type of insulating material. One convenient way of insulating the splice is to slide a length of insulating heat-shrinkable tubing over the bared splice; and, as discussed above, when the tubing is heated, it shrinks to provide an insulating glove.

There are times when it is convenient to splice wires by the use of a “solder-sleeve” of the type manufactured by Rayclad Tubes, Inc., of Redwood City, Calif. These solder-sleeves are heat-shrinkable sleeving of the type discussed previously, except that they have a solder “preform,” which takes the shape of a short cylinder of solder positioned on the inside of the sleeving, approximately at the

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center. These solder-sleeves may also contain so-called “sealing-rings” that are positioned near the ends of the sleeving. In use, the solder sleeve is slipped onto the wire, so that the solder-preform fits over the bared wires that are to be soldered together. When heat is applied, the solder melts; and the entire sleeve shrinks as described above; so that the end result is a soldered, spliced joint having a heat-shrinkable sleeving securely affixed to, and insulating the solder joint. U.S. Pat. 3,316,343 disclosed another type of heat-shrinkable connector with pre-placed solder therein.

Under still other conditions, one or a plurality of wires must be fed through an opening in a wall whose contained volume must be sealed, heated, cooled, evacuated, etc. One way of doing this is to use a length of shrinkable sleeving, and to seal the central outer portion thereof to the sides of the opening. The wire or wires are then fed through the sleeving; and the ends of the sleeving are then, as described above, shrunk to encompass the wires. This arrangement provides the desired sealed arrangement, and—with suitable sleeving—can withstand the specified conditions.

As may be understood from the above discussion, heat-shrinkable sleeveings are widely used. They generally comprise two circumjacent plastic tubings, the inner tubing generally comprising a material such as FEP (Fluorinated Ethylene Propylene) which melts at about 700° F.; and the outer pre-dilated tubing generally comprising a material such as TFE (Tetrafluor Ethylene), which conducts heat, but does not melt at this temperature. Sleeveings of these types are available from the Penntube Plastics Company, Division of Pennsylvania Fluorocarbon Company, Inc., Clifton Heights, Pa.

When the composite sleeving is suitably heated, the inner FEP tubing melts; while the outer TFE tubing shrinks—thus forming a snug glove around the wire. When the heat is removed, the melted FEP solidifies to adhere tightly to the original wire and the shrunken TFE coating. In this way, the combination produces a snug insulating and/or identifying sleeving that is firmly adhered to the wire.

In the past, these heat-shrinkable sleeveings have been heated by blowing a stream of hot air at them; the stream of hot air generally being produced by a small blower that blows air through a flexible tube having a heater at its exit end. In this way, a jet of hot air is generated, and is directed at the heat-shrinkable sleeving. Unfortunately, however, this so-called hot-air gun is rather bulky; and its exit end—where the heater is located—tends to be quite hot. Thus, it is dangerous to the operator; and frequently burns the material upon which it is rested during its standby state. Another disadvantage of the hot-air gun is that frequently it cannot direct air to the back portion of the sleeving; so that sleeve shrinkage is not symmetrical, and therefore frequently unsatisfactory and unsightly. Still another disadvantage of this hot-air gun is that the hot air frequently melts adjacent soldered joints; so that even if the sleeving is properly affixed, previously-soldered wires may now become unsoldered, and loosened from their desired connections.

OBJECTS AND DRAWINGS

It is therefore an object of the invention to provide an improved tool for heating workpieces, such as heat-shrinkable sleeving.

The attainment of this object, and others, will be realized from the teachings of the following detailed description, taken in conjunction with the drawings of which:

FIG. 1 shows a novel heating-tool; and

FIG. 2 shows an electrical circuit for use in conjunction with such a heating tool.

Broadly speaking, the described embodiment is a heat-tool having a heating-head that is somewhat similar to a cylindrical tube that has been longitudinally slit into two. The heating-head thus comprises two aligned semi-cylindrical sub-heads, each containing a plurality of incandescent filaments positioned parallel to the axis of the sub-head; so that when the two sub-heads are closed, they form a cylindrical structure that encircles the sleeving that is to be heated. Resilient elements position the sleeving and its wire at the central longitudinal axis of the heating-head; so that the sleeving is substantially uniformly and symmetrically heated by the plurality of spaced incandescent filaments. A voltage-control circuit controls the amount of power applied to the filaments, and thus controls the temperature to which the sleeving is heated; and a timing-circuit controls the heating interval. In this way, the heat-shrinkable sleeving is exposed to a predetermined temperature for a predetermined interval of time; thus permitting the shrinking of heat-shrinkable sleeving of various sizes and materials.

A semi-cylindrical reflector is positioned adjacent the filaments to reflect the outwardly-directed radiation back to the interior portion of the sub-head. and, if desired, the reflector may have apertures that serve as windows to permit the operator to view the shrinking of the sleeving.

DETAILED DESCRIPTION

FIG. 1 shows a heating-head 10, which is supported by two handles 12 and 14; the handles being either of the plier-type or of the sugar-tong type—that is the handles are interconnected remote from the heating head, as by a pivot or resilient type connection (not shown) to permit the two opposed sub-heads to move from an open position (FIG. 1) to a closed position encircling a tubing to be heated.

Heating-head 10 comprises two sub-heads 16a and 16b, each of these comprising a block 18a and 18b of electrically-conductive material; these blocks having suitable recesses to accept the prong-like conductors of handles 12 and 14. In this way, the sub-heads 16a and 16b can slide onto or off their respective handles, being fastened in place by suitable fastening means such as socket-headed bolts 20.

It will be seen that blocks 18a and 18b are integral with, or may be affixed to, electrically-conductive end-pieces 22a and 22b respectively; these end-pieces being substantially planar, and having substantially semi-toroidal terminations. Other end-pieces 24a and 24b are mechanically attached to, but electrically insulated from, blocks 18a and 18b respectively; this being achieved by insulating sheets 23a and 23b, and by means such as insulating screws 25—or a combination of insulating sheets, insulating washers, insulating collars, and the like. For ease of explanation, end-pieces 22a and 22b (which are electrically connected to blocks 18a and 18b respectively) are designated "first" end-pieces; and end-pieces 24a and 24b (which are electrically insulated from blocks 18a and 18b respectively) are designated "second" end-pieces.

For reasons to be discussed later, it is desirable to electrically connect the first and second end-pieces on a given side of the tool; that is, to electrically connect end-pieces 22a and 24b; and to electrically connect end-pieces 22b and 24a. This may be accomplished by means of permanently-connected flexible wires 26a and 26b. Alternatively, the first and second end-pieces on the same side of the tool may be electrically connected by means of a switch that makes electrical contact when either the handles or the sub-heads approach to within a given distance of each other.

It will be seen that the electrically conductive portion of handle 12 is connected to block 18a, to first end-piece 22a—and by means of flexible wire 26a—to second end-piece 24b. In a similar manner, the electrically-conductive portion of handle 14 is connected to block 18b, to first

end-piece 22b—and by means of flexible wire 26b—to second end-piece 24a. Therefore, when electrical power is applied to the heating-tool, a voltage exists between each first end-pieces 22a and 22b, and their corresponding second end-pieces 24a and 24b.

In order to provide heat for shrinking the heat-shrinkable tubing, a plurality of heat-sources such as iodine-quartz lamps, filaments, etc. are connected electrically and mechanically between the first end-pieces and their corresponding second end-pieces; so that when the power is turned on, the heat sources radiate heat to the tubing. In the illustration, filaments 30 are attached as follows. The end of each filament fits onto the center aperture of a split-collar 32; and set-screws 34 compress and hold these collars in place. In this way, there is a mechanical and electrical connection between the end-piece and the ends of the filaments anchored in that end-piece.

As a safety precaution, to prevent the filaments from sagging and touching anything, they are enclosed in quartz tubes 36 that cover the exposed portion of the filament. The quartz tubes transmit the radiated heat from the incandescent filaments 30; and are able to withstand the achieved temperature, and to thus maintain their original tubular figuration.

To improve the efficiency of the heating-head 10, the radiation that would ordinarily be directed outwardly from the filaments is reflected to the interior portion of the heating-head by means of reflective semi-cylindrical surfaces 38a and 38b. These are preferably mechanically attached to, but electrically insulated from blocks 18, as by means of insulative sheets 42 and insulative screws 44—or a combination of insulative sheets, insulative collars, insulative washers, etc.

If desired, at least one of the reflectors may have a window 40 or apertures that permit the operator to see the progress of the shrinking operation.

It is preferable that the heat-shrinkable sleeving be positioned on the central axis of heating-head 10; and to achieve this result, resilient means—such as springs 46a and 46b having opposed rabbetted tubing-guide portions 46c, 46d—are attached to the heating-head in such a way that when the sub-heads 16a and 16b move toward each other, the sleeving and wire are trapped between the rabbetted portions of resilient springs 46a and 46b; and thus held on the central axis of the heating-head, in order to be uniformly and symmetrically heated.

As indicated previously, handles 12 and 14 may either be of the plier-type or of the ice-tong type; and an electrical connection may comprise axial conductive rods in the handles, or separate external wires—these being attached to a power-supply that will be described later. Alternatively, a pair of wires may be connected to respective end-pieces of a sub-head.

As may be understood, heat-shrinkable sleeving may be made in different diameters, thicknesses, and materials; and it is therefore desirable to control the amount of heat applied to the sleeving, and the length of time for which the heat is applied. Circuitry for controlling these factors is shown in FIG. 2. Here power from an external source is provided at terminals 50 and 52; the power being applied through a power switch 54, and a pilot-light 56 is connected in such a way as to indicate when the power is on. The power is applied to a timer power-supply 60 whose output is applied to a timer-circuit 62 that will be discussed later in greater detail. Timer 62 controls the duration of heating interval; the output from its relay 64 applying an output signal to a voltage-control circuit 68. This voltage-control circuit controls the amount of power provided; and thus controls the temperature of heating filaments. The output of the voltage-control circuit is applied to a load power-supply 70, whose output is in turn applied to the load 72 in the form of the heating-tool filaments previously described.

Various timers that may be employed in the described equipment are commercially available; the timer 62 of

FIG. 2 comprising a transistor 80 that, when conductive, permits electricity to flow from the timer power-supply 60 through the coil 82 of relay 64. Relay switch-arm 84 is normally in an open position; the flow of electricity through relay-coil 82 causing switch-arm 84 to move to its lower closed position, and to thus apply power to voltage-control circuit 68. Thus, when transistor 80 of timer circuit 62 is energized, power is applied to the voltage-control circuit 68; and thus to the heating tool.

Referring more specifically to the circuit of timer 62, it may be seen that actuating-switch 90 normally has its switch-arm 94 urged toward or arranged to be in the left-most position. In this position, closing power-switch 54 activates timer power-supply 60, so that power is applied through activating switch-arm 94 to a timing-capacitor 96, which therefore charges-up to the potential provided by the timer power-supply 60.

When actuating-switch 90 is closed by the operator, its switch-arm 94 moves to the right-most position. At this time it breaks the circuit between the timer power-supply 60 and timing-capacitor 96; and simultaneously connects the terminal of timing capacitor 96 to the base-electrode of transistor 80. Now, the potential at base-electrode 80 is the potential on charge-up timing-capacitor 96, which conductivates transistor 80; thus causing current flow through relay-coil 82, closing relay switch-arm 84, and activating the voltage-control circuit 68.

The charge on timing-capacitor 96 now tends to leak off through timing-control resistor 98; and the potential applied to the base-electrode of transistor 80 begins to decrease. As the charge leaks off timing-capacitor 96, the potential at the base-electrode of transistor 80 progressively decreases; and, at a given instant the potential is so low that transistor 80 becomes non-conductive. At this time, the current flow through relay coil 82 is terminated; and relay 64 returns to its normal position—relay switch-arm 84 returning to its upper position, and breaking the circuit to the voltage-control circuit. Therefore, the power flow to the heating-tool is terminated. In this way, the action of timer-circuit 62 controls the duration of the heating interval.

Timing-circuit is normally in a charged-up standby state, awaiting only the closing of the actuating-switch 90 by the operator; and this switch may be foot-operated, manually-operated, or operated automatically by squeezing the handles of the heating-tool. Switch 90 is maintained closed, by the operator, for at least the time required to fully discharge the capacitor, and allow relay 64 to open. This is a fail-safe arrangement, because anytime that the operator releases the actuating-switch, switch-arm 94 immediately leaves its right-most position—this movement cutting off transistor 80, and acting to disable the operation of the heating-tool.

It will be noted that timing-control resistor 98 is manually variable, and thus controls the rate at which electricity leaks off timing-capacitor 96. If resistor 98 is set at a high value, the leakage rate is so small that transistor 80 is maintained conductive for a long period of time. If on the other time, timing-control resistor 98 is set at a low value, the leakage rate is quite high; and the conductive interval of transistor 80 is rather short. In this way, the setting of timing-control resistor 98 controls the interval during which the heating-tool is operative.

If desired, a timing-light 100 may be connected across the output of timer 62 in order to indicate when power is being supplied to the heating-tool.

In order to control the temperature to which the heat-shrinkable sleeving is exposed, a voltage-control circuit 68 controls an amount of power supplied to the heating-tool. This circuit, and the components thereof, are described in "Application Note 200.35-3/66" issued by the Semiconductor Products Department of General Electric; and operates as follows. Basically, the load current passes through a Triac 102, which is a device that permits electricity to flow through it in either direction. A gate-electrode con-

trols the point at which the Triac becomes conductive, after which it remain conductive until the voltage is removed.

Voltage-control circuit 68 contains a dual phase-shift network comprising capacitors 104 and 106, and resistors 108 and 110—resistor 110 being variable; and resistance 111 coupling the two networks. The output of the dual phase-shift network is applied to a Diac 112, which becomes conductive at an instant determined by the output of the dual phase-network—which is in turn controlled by the setting of variable resistor 110. Thus, the operation of voltage-control circuit 68 is controlled by the setting of resistor 110. Depending upon the setting of variable resistor 110, Diac 112 and Triac 102 become conductive at a given instant of the power cycle; thus controlling the "duty cycle" or on-off time-ratio. If resistor 110 were set to produce a one-hundred percent duty cycle, power would be applied continuously to load 72; whereas if resistor 110 were set to provide a one percent duty cycle, power would be applied to load 72 for only one percent of the time. In this way, voltage-control circuit 68 controls the power applied to heating-tool 72, and thus the temperature to which the filaments are heated.

In one model, the heating-tool had filaments designed for operation at ten volts; so that load power-supply 70 had a maximum output of ten volts, to insure that the filaments were never overheated.

It may be seen from the above description that the disclosed circuit provides power for the heating-tool, which in turn produces a shrinking effect on a heat-shrinkable sleeving. The voltage control circuitry assures that the temperature produced is high enough to melt the inner tubing, but not high enough to burn or blister the material of the sleeving; whereas the time-circuit 62 assures that the heat is applied for a long enough interval to securely shrink and seal the sleeving to its encompassed wire.

In use, a length of heat-shrinkable sleeving is slipped over the wire, and positioned at the desired location. The heating-head is opened, positioned with one sub-head on either side of the wire; and the heating-head is then closed. At this time, the wire is centered by the resilient springs; and the filaments are oriented along, and spaced circumferentially of, the wire. The timing and the voltage controls are set; power-switch 54 is closed and the actuating-switch 90 is closed and held closed. Thereupon, the filaments are heated for the pre-set interval to the preset temperature; the operator viewing the shrinking operation through the viewing window. During the shrinking operation, the normally translucent-white sleeving becomes transparent; and the operator is thus able to monitor whether the shrinking is satisfactory. He can then, if necessary, either repeat the operation, or reset the controls to achieve an improved result.

Thus the disclosed heating-tool may be used for repair, identification, and splicing of electrical wire. While the foregoing explanation has been given in terms of heating a heat-shrinkable tubing, it may also—by use of a suitable load power-supply and high-temperature components and insulating materials—be used for heating, brazing, etc. portions of metallic tubing. Alternatively, the sub-heads may be planar—rather than cylindrical—for heating other types of workpieces.

Although the invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only, and is not to be taken by way of limitation; the spirit and scope of this invention being limited only by the terms of the appended claims.

What is claimed is:

1. A heating-tool, comprising:

a heating-head longitudinally split to form two aligned sub-heads, each of said sub-heads comprising a first electrically-conductive end-piece and a second electrically-conductive end-piece, said end-pieces being

electrically insulated from each other, at least one of said sub-heads being adapted to electrically-connect said end-pieces to respective terminals of a power-supply;

a plurality of electrical radiant-heat producing elements positioned in each sub-head;
means for electrically and mechanically connecting respective ends of said electrical heat-producing elements to respective end-pieces of said sub-heads; and
means for closing said sub-heads to form a heating-head that may be juxtaposed to opposite sides of a workpiece for uniformly heating said workpiece with heat from said radiant-heat producing elements.

2. The combination of claim 1 wherein said electrical radiant-heat producing elements comprise a wire heatable to an incandescent state, and said connecting means comprises screw-means for constricting and holding said wire in said end-pieces of said sub-head.

3. The combination of claim 1 wherein said radiant-heat producing elements each comprises a wire heatable to an incandescent state, and said connecting means comprises a split-collar encircling an end of said wire, and screw-means for constricting and holding said split-collar and said wire-end in one of said end-pieces of said sub-heads.

4. The combination comprising:

(I) a pair of squeeze-type handles for bringing adjacent ends thereof into proximity;

(II) a sub-head removably mounted on respective said adjacent ends of said handles, each sub-head comprising:

(A) a first electrically conductive endpiece having a substantially planar semitoroidal termination;

(B) a second electrically conductive endpiece having a substantially planar semitoroidal termination;

(C) means for positioning said end-pieces in a spaced-apart electrically-isolated relation;

(D) a plurality of split-collar receptacles spaced along said semi-toroidal terminations;

(E) a plurality of incandescent-type filaments have respective ends positioned in corresponding split-collars located in respective end-pieces, said filaments being supported at their ends by said split-collars, and extending between said sub-heads;

(F) individual quartz tubes enclosing the portions of individual filaments exposed between said end-pieces, said exposed portion being prevented from touching anything except said quartz tubes;

(III) electrical conducting means for interconnecting the first end-pieces of sub-heads;

(IV) electrical conducting means for interconnecting the second end-pieces of said sub-heads;

(V) reflector means, comprising semi-cylindrical metal sheets mounted circumjacent the outer peripheries of said quartz tubes, for reflecting outwardly-directed radiation from said filaments to the interior portion

of said sub-heads, at least one of said sheets having window means for viewing said interior portions;

(VI) holding means, comprising resilient material associated with said sub-heads, for positioning a longitudinal structure to be heated at the longitudinal axis of said sub-heads;

(VII) means for electrically connecting electrical power to said first end-pieces; and

(VIII) means for electrically connecting electrical power to said second end-pieces—whereby said filaments may be made incandescent by said electric power.

5. The combination of claim 4 wherein limitation I further comprises:

(G) a pair of electrical conductors;

(H) means for connecting one end of each conductor to a respective terminal of a power supply;

(J) means for electrically connecting the other end of one conductor to said first end-pieces; and

(K) means for electrically connecting the other end of the other conductor to said second end-pieces—whereby said filaments may be made incandescent by electricity from said power-supply.

6. The combination comprising:

an adjustable timer;

an adjustable voltage-control circuit;

means for causing the output of said timer to control the operation-interval of said voltage-control circuit;

a load power-supply;

means for causing the output of said voltage-control circuit to control the output of said load power-supply;

a load connected to the load power-supply, said load comprising

a heating-head longitudinally split to form two aligned sub-heads;

a plurality of radiant-heat producing elements positioned in each sub-head; and

means for closing said sub-heads to form a heating-head that may be juxtaposed to opposite sides of a workpiece for uniformly heating said workpiece with heat from said radiant-heat producing elements.

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ANTHONY BARTIS, Primary Examiner

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