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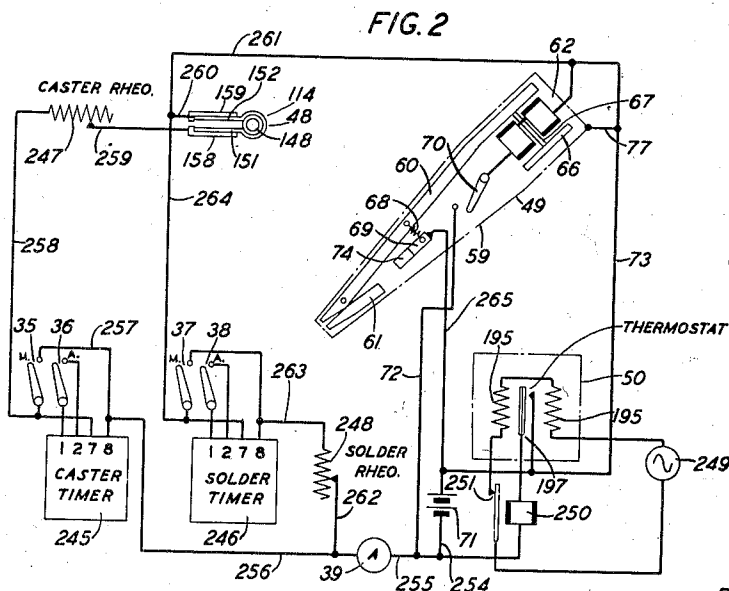
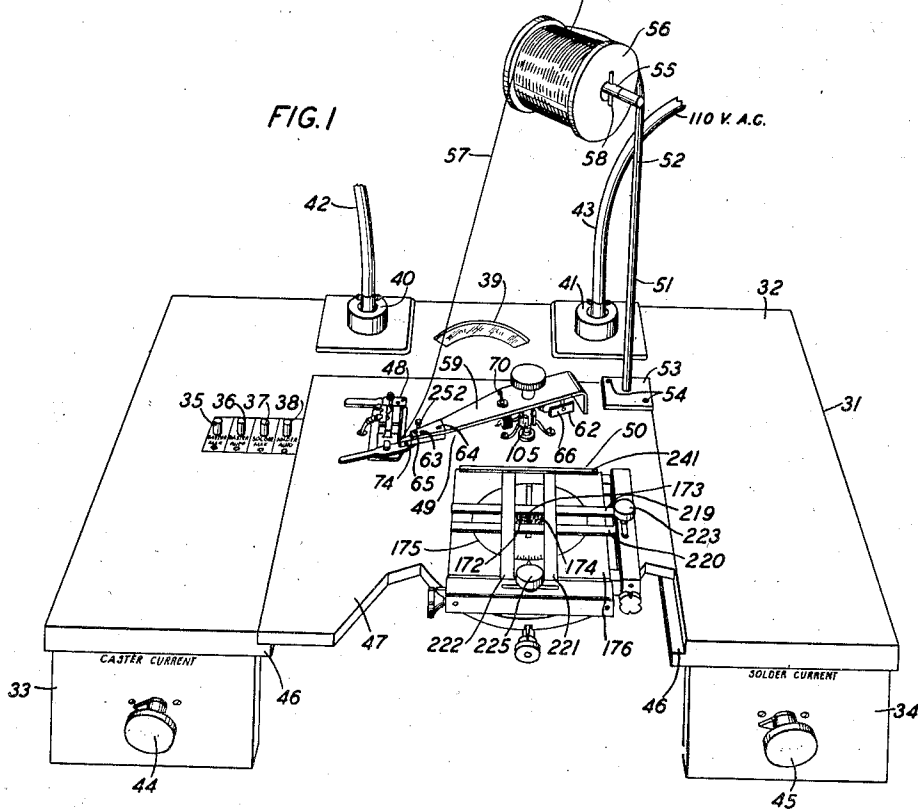
R. G. HUMPHREY

2,303,555

HOT PLATE DEVICE

Original Filed Dec. 31, 1940

3 Sheets-Sheet 1



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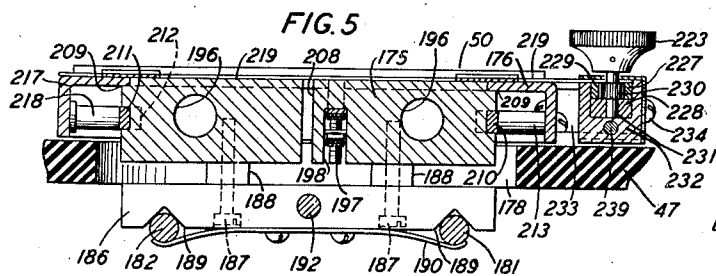
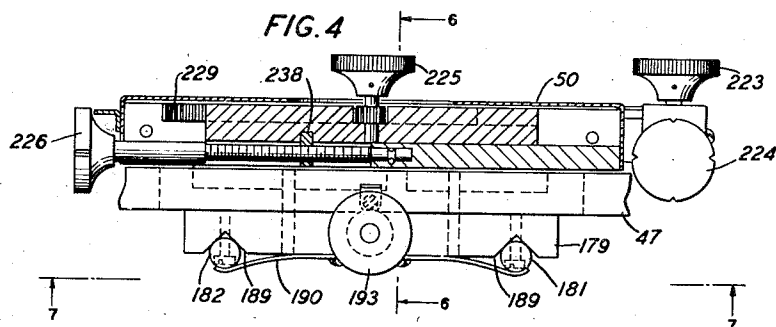
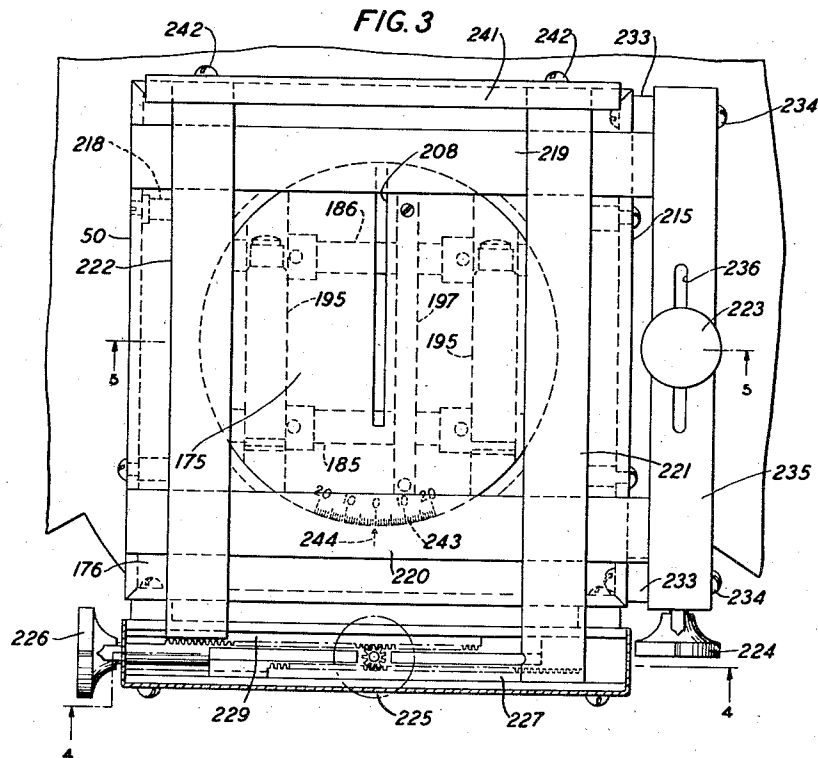
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3. Sheets-Sheet 2



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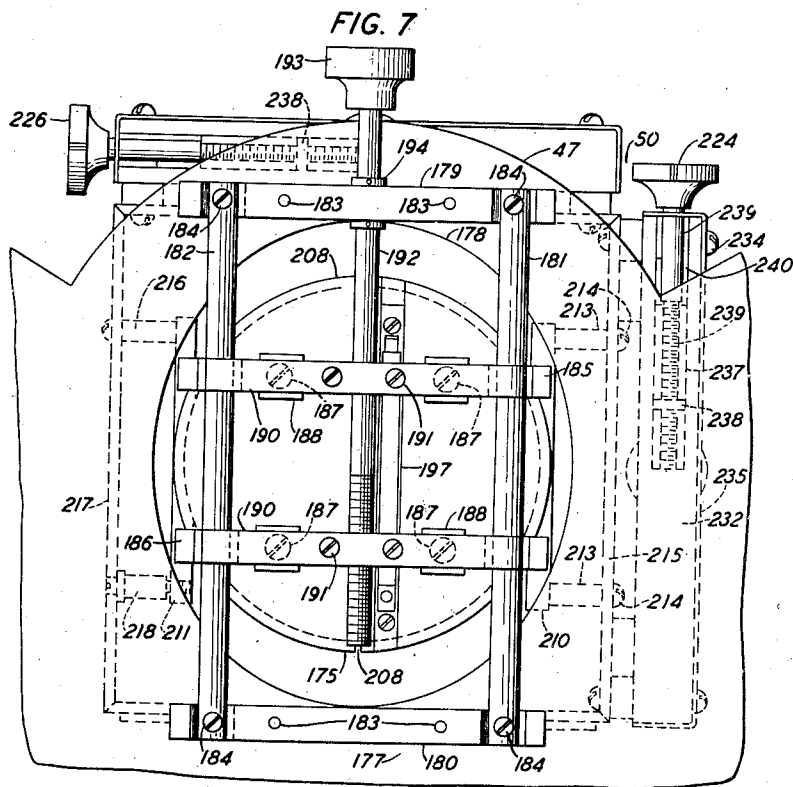
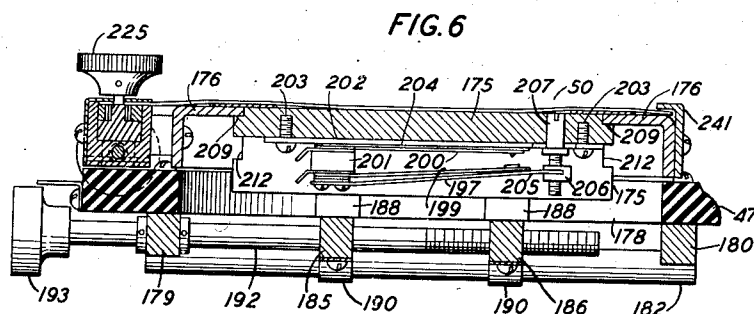
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HOT PLATE DEVICE

Original Filed Dec. 31, 1940 3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

2,303,555

HOT PLATE DEVICE

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Original application December 31, 1940, Serial No.
372,528. Divided and this application March
13, 1942, Serial No. 434,574

5 Claims. (Cl. 219—17)

This invention relates to electrowelding apparatus which may be employed in securing a wire of relatively fine gauge to a metal surface.

The invention, although not limited to such use, is applicable to the securing of wires of relatively fine gauge to metal surfaces formed on piezoelectric crystals in a manner described in my copending application R. G. Humphrey, Serial No. 372,528, filed December 31, 1940.

In accordance with the invention described in the copending application above identified, a pellet of solder of predetermined size and form is cast on an end of the wire. The pellet is then placed in contact with a suitably prepared metal surface on a crystal element and a solder connection is then made to electrically connect the wire to the metal surface. While the solder connection is being made the crystal element is supported on a hot plate device.

The present application covers the hot plate device and is a division of my copending application R. G. Humphrey Serial No. 372,528, filed December 31, 1940.

In the drawings:

Fig. 1 is a top and front view in perspective of a support with devices employed in making the solder connection and mounted on the support in required positions;

Fig. 2 is a schematic diagram of some of the apparatus involved;

Fig. 3 is a top plan view, partly in section, of the hot plate device equipped with means for adjusting and holding the crystal in required position;

Fig. 4 is a front view, partly in section, of Fig. 3, taken on the line 4—4;

Fig. 5 is a view in section taken on the line 5—5 in Fig. 3;

Fig. 6 is a side view in section of Fig. 4 taken on the line 6—6; and,

Fig. 7 is a view, partly in section, of the hot plate device and a portion of the support and taken from beneath the support.

Referring to Fig. 1, the support 31 comprises a U-shaped top 32 with downwardly extending walls 33 and 34. On the top 32 are mounted manually operated switches 35, 36, 37 and 38, an ammeter 39, and plug receptacles 40 and 41 to receive electrical supply lines 42 and 43. Manually operated control knobs 44 and 45 are mounted on shafts (not shown) but which extend through the respective wall members 33 and 34. Set within the space defined by the inner portion of the top 32 and resting on ledges 46 formed thereon is a slab 47 of suitable insulat-

ing material on which are mounted a solder pellet caster device 48, a chuck device 49, the hot plate device 50 and a reel support 51. The various devices by means of which the wire connections are made are so arranged and mounted on the support 31 and the slab 47, that the wire connections can be made in a rapid and accurate manner. The reel support 51 comprises a post 52 secured at its lower end in a flange 53 suitably mounted on the slab 47 by means of screws 54. The upper portion of the post 52 is bent to provide an axle 55 on which is rotatably supported the reel 56 containing a supply of wire 57, the reel 56 being retained against accidental dislodgement from the axle 55 by means of a cross-pin 58. The wire 57 is led downwardly from the reel 56 to the chuck device 49. The chuck device 49 is designed to receive and hold in a required position an end portion of the wire 57 preparatory to and while the end of the wire is being connected to the electrode surface on a crystal element.

The caster device 48 is used to cast a pellet of solder on the end of the wire 57 and comprises a crucible 114 shown in Fig. 2. The crucible 114 is electrically heated and comprises a ring 148 made of material suitable for transmitting heat to solder paste in the crucible and for holding the solder when the solder is in a molten condition.

Hot plate device

The hot plate device 50 is used to heat a crystal element to a required temperature and to hold the crystal in a required position, while a wire is being solder connected to a metallized surface on the crystal element, the crystal being heated to a temperature slightly below the melting point of the solder to reduce reaction of the crystal when a melting temperature for the solder is applied to the point at which the solder connection is being made.

As shown in Fig. 1, the hot plate device 50 is mounted on the slab 47 in such position that the chuck device 49 may be rotated thereover. In this figure a crystal element 172 is supported on the hot plate device 50 in a position to have an end of the wire 57 solder connected to a stripe 173 of silver on the crystal element. The crystal element 172 may be of any desired size and form and may be made of any required material. It will be assumed, however, and merely for the purpose of explaining the invention that the crystal comprises a rectangular slab of quartz coated on its upper and upper major plane sur-

faces with metal as shown at 174. The metal coatings 174 serve as electrodes for the quartz crystal and may be for instance coatings of silver or other suitable material applied to the crystal, for example, by sputtering, spraying, or by an evaporation process. The stripe 173 is shown as being located at a nodal point on the crystal but may be located at any other desired point, the point of location being determined by the particular character and form of the crystal and the use required. In piezoelectric crystals of the form shown, however, it is advantageous to have the wire connected at the nodal point since the mechanical load of the wire and the metal stripe on the crystal would then be at the lowest point of oscillation. For the purpose of illustration and not in the sense of limiting the invention, it will be assumed that the stripe 173 is a stripe of silver applied by any suitable means and manner across the flat plane surface of the crystal at the nodal point of the crystal.

The hot plate device 50 as shown in Figs. 1, 3, 4, 5, 6 and 7 comprises a round table 175 and a rectangular frame plate 176 which is apertured to accommodate the table 175, the table 175 and the frame plate 176 being supported so that their upper surfaces are elevated relative to the slab 47. The table 175 and the frame plate 176 are adjustably mounted on a frame structure 177 supported on the under surface of the slab 47 and so that the table and frame plate may be moved as a whole backward and forward across a portion of the slab 47. As shown in Fig. 7, the slab 47 is provided with a relatively large oval aperture 178 to accommodate the table 175 which is relatively thick. The table 175 is made of suitable heat transmitting material such, for instance as aluminum or an aluminum composition and extends downwardly within the aperture 178. The frame structure 177 comprises the bars 179, 180 and the track rods 181 and 182, the bars 179 and 180 being secured to the under surface of the slab 47 by means of the screws 183 and the track rods 181 and 182 being secured at their ends to end portions of the bars 179, 180, by means of the screws 184. Crossbars 185, 186 are mounted on the under surface of the table 175 by means of the screws 187 extending through spacers 188 and rest on the track rods 181, 182, the crossbars 185, 186 being grooved at 189 to receive the track rods. Leaf springs 190 mounted on the under surface of the crossbars 185, 186 by means of the screws 191 extend into frictional engagement with the under portions of the track rods 181, 182 to hold the table 175 against undue lifting movements relative to the track rods. A rotatable shaft 192 equipped with a manually operable knob 193 is provided to move the table and the frame plate as a whole relative to the slab 47, the shaft 192 being journaled in the bearing 194 in the bar 179 and being journaled in the crossbar 185 and having screw-threaded engagement with a female threaded aperture in the crossbar 186. The round table 175 is equipped with cartridge type electrical heating elements 195 which are located in apertures 196 provided in the round table 175. A thermostat 197 is mounted in the slot 198 provided in the under surface of the table 175 to automatically control the operation of the heating elements 195. The thermostat 197 comprises a movable bimetallic contact finger 199 and a fixed contact strip 200 mounted at one end in a pile-up 201 which is mounted on a rectangular mounting strip 202 supported by means of the

screw 203 in the slot 198. An insulating strip 204 is interposed between the fixed contact strips 200 and the mounting strips 202. The bimetallic contact finger 199 normally rests against the adjustable back-stop 205 supported at one end in the pile-up 201 and having its other end supported in a nut 206, mounted on the screw 207 supported in the table 175. Turning of the screw 207 will cause adjustment of the bimetallic contact finger 199 relative to the fixed contact strip 200. An elongated aperture 208 is provided in the table 175 to accommodate wires after they have been attached to the crystal element and while other wires are being attached to the opposite face of the crystal element, the aperture 208 extending from an outer edge of the table 175 and more than half the distance across the table 175, and the width of the aperture 208 being much greater than the diameter of the wires.

The frame plate 176 is in the form of an inverted rectangular tray and rests on an annular shoulder 209 formed on the upper edge of the table 175. The frame plate 176 may be turned relative to the table 175 and is held against lifting movement relative to the table 175 by means of holding bars 210, 211 extending into an annular groove 212 provided in the outer edge of the table 175. The holding bar 210 is supported on posts 213 secured by means of screws 214 to a side wall 215 of the frame plate 176. The holding bar 211 is supported at one end on a post 216 extending inwardly from the opposite side wall 217 of the frame plate 176 and on its other end has screw threaded engagement with a shouldered-head adjusting screw 218, the shouldered-head portion of which bears against the wall 217 and having the reduced end portion of the head journaled in an aperture in the wall 217. The holding bars 210 and 211 are machined out to fit the curvature of the groove 212 in the outer portion of the table 175. When the screw 218 is tightened, the frame plate 176 will be held in a required rotated position relative to the table 175 since the bar 211 will be pressed against the base of the groove 212.

Two sets of positioning bands are provided to cooperatively form an adjustable frame for holding a crystal element in required position on the table 175. One set of bands comprises the bands 219, 220 and the other set the bands 221, 222. The bands 219, 220 extend across the upper surfaces of the frame plate 176 and the table 175 from right to left and are adjustably held in required parallel spaced relation. The bands 221 and 222 extend across the upper surfaces of the frame plate 176 and the table 175 from front to back and lie over the respective bands 219 and 220. Means are provided for separately adjusting each set of bands, the bands 219 and 220 being adjustable by means of the manually operated knobs 223, 224 and the bands 221 and 222 being adjustable by means of knobs 225 and 226. Since the bands and the means for adjusting them are identical in structure and arrangement, the description of one set will suffice for an understanding of both. The band 219 is secured at one end to a rack 227 which is slidably supported on a sliding block 228 on which is also slidably supported a rack 229 to which an end of the band 220 is attached. The racks 227 and 229 are engaged by a pinion 230 on a rotatable shaft 231 and since each rack is on an opposite side of the pinion 230, and the knob 223 is mounted on the shaft 231, turning of the knob 223 will cause simultaneous movement of the bands 219 and 220

in opposite directions. A clockwise rotation of the knob 223 will bring the bands 219 and 220 toward the center of the table 175. The sliding block 228 and the racks 227 and 229 are located in a channel bar 232, the opposite side walls of which extend upward in frictional engagement with the block 228 and the racks 227 and 229. The channel bar 232 is supported on posts 233 by means of screws 234 and extends in parallel spaced relation with the side wall 215 of the frame plate 176. A cover 235 is provided for the upper and outer side portions of the channel bar 232, the cover 235 being supported in place by the screws 234 and having an elongated aperture 236 provided therein for accommodation of the shaft 231. The base portion of the channel bar 232, as shown in Fig. 7, is cut away at 237 to accommodate a tapped lug 238 which extends downward from the sliding block 228. The lug 238 is in screw-threaded engagement with the male-threaded shaft 239 which is journaled in a bearing 240 supported in one end of the channel bar 232, the inner end of the shaft 239 being rotatably supported and retained against longitudinal movement in a portion of the base of the channel bar 232. When the knob 224 is turned, the sliding block 228 is moved longitudinally within the channel bar 232 and this same motion is transmitted by means of the shaft 231, the pinion 230 and the racks 227 and 229 to the bands 219 and 220. It will be seen therefore that the bands 219 and 220 may be simultaneously moved toward or away from the center of the table 175 by operation of the knob 223, but when the knob 224 is turned, the bands 219 and 220 are simultaneously moved either backward or forward over the upper surface of the frame plate 176 and over the table 175. The bands 221 and 222 are provided with the same kind of operating means as the bands 219 and 220 and may be simultaneously moved toward or away from the center of the table 175 by turning the knob 225 and may be simultaneously moved both in the same direction over the frame plate 176 and the table 175 by turning the knob 226, the bands 219, 220, 221 and 222 may therefore be moved to operatively embrace, as shown in Fig. 1, the crystal 172 and will hold the crystal 172 in a required position on the table 175 while an end of the wire 57 is being solder-connected to the stripe 173 on the crystal. It will be seen that the bands 221 and 222 overlap the bands 219 and 220 and that the free ends of the bands 221 and 222 are overlapped by an angle bar 241 which is secured to the rear portion of the frame plate 176 by means of the screws 242 shown in Fig. 3. The bands 219, 220, 221 and 222 are therefore prevented from jumping over the crystal. If in order to get the solder connection at some predetermined point off-center from the central portion of the stripe 173, it is found necessary to slightly rotate the crystal from the position shown in Fig. 1, this may be accomplished by loosening the screw 218 shown in Fig. 7 to release the pressure of the holding bar 211 against the table 175. The frame plate 176 may then be rotated relative to the table 175. This action will skew the crystal from the position shown in Fig. 1. The screw 218 may then be tightened to hold the frame plate 176 and the crystal 172 in the new position. The aperture 208 in the table 175 is made wide enough to permit movement of the crystal to the new position without breaking or bending a wire secured to the under surface of the crystal 172. The table 175 as shown in Fig. 3 is calibrated at 243 and a mark is provided at 244 on the frame plate 176 to

indicate the extent of rotation of the frame plate 176.

As shown in Fig. 2, a caster timer 245 is provided to control with time the application of heating current to the caster device 48. A solder timer 246 is provided to control with time the application of heating current to the point at which the wire is being solder-connected to the stripe 173 on the crystal 172. These timer devices may be of any conventional character and form suitable for controlling with time the application of heating current. The thermostat 197 controls the application of heating current to the heating elements 195 in the table 175. Suitable rheostats 247 and 248 are provided to control the strength of the current applied to the caster device 48 and the point at which the solder connection is being made on the crystal, the rheostats being labeled "Caster rheo" and "Solder rheo." The switches 35 and 36 are provided for respective manual and automatic control of the duration of the current applied to the caster device 48. Switches 37 and 38 provide for respective manual and automatic control of the duration of the current applied to the point of solder connection on the crystal.

Method of making solder connection

The crystal 172 with the solder stripe 173 thereon is placed on the table 175 which is heated by means of the heating elements 195, 195 supplied with current from a suitable source 249 over an obvious circuit. The heating current from the source 249 is automatically controlled by means of the thermostat 197 and a relay 250 which will be energized to open its contacts 251 and thus open the current supply circuit when the contacts of the thermostat 197 close at a predetermined temperature.

The wire 57 is placed between the jaws of the chuck device 49 and is extended through the aperture in the button 112, the structure and arrangement of which are described in my original application above identified. The chuck device 49 is lifted and rotated to bring the projecting end of the wire 57 over the table 175. The bands 219, 220, 221 and 222 are moved by operation of the knobs 223 and 225 and the knobs 224 and 226 to engage the crystal 172 and bring the desired portion of the stripe 173 directly under the end of the wire 57. A suitable flux is applied to the end of the wire 57 and the fluxed end of the wire 57 is brought into engagement with the stripe 173 so that some of the flux on the wire will be deposited on the stripe 173.

The chuck device 49 with the wire 57 therein is then lifted and rotated over to the caster device 48 and is lowered to bring the end of the wire 57 into the crucible 114. The chuck device is operated to hold the wire 57 so that a predetermined length of the wire will project below the button 112, the jaws of the chuck device being operated to a closed position by means of the electromagnet 62 which is energized from the source of current supply 71 when the switch 70 is closed. The chuck device 49 is lifted and swung to the position shown in Fig. 1 so that the end of the wire 57 is removed from the crucible 114.

The caster device 48 is operated to fill the crucible 114 with solder paste. The chuck device 49 is lifted again and swung to a position over the crucible 114 and so that the end of the wire 57 is thrust into the crucible, the depth of thrust being limited by the screw 252 which is arranged

to bear against the under surface of the chuck device 49. The crucible 114 is electrically heated by current supplied from the source 71. For manual control of the duration of the heating current for the caster device 48, the switch 35 is operated. This closes the following circuit from the source of current supply 71, conductor 254, conductor 255, ammeter 39, conductor 256, conductor 257, contacts of switch 35, conductor 258, caster rheostat 247, conductor 259, electrode 158, leg 151, leg 152, electrode 159, conductor 260, conductor 261, conductor 73 to source of current supply 71. The crucible 114 is heated to a sufficiently high temperature to melt the solder paste in the crucible 114. The reduced end portion 113 of the button 112 is pressed downwardly within the crucible 114 by the weight of the chuck device 49 while the solder paste is being brought to a molten condition. It will be seen therefore that a pellet of solder of predetermined size and form is cast on the end of the wire 57. Automatic timing of the duration of the heating current may be obtained by closing the switch 36 instead of the switch 35.

The chuck device 49 is lifted and rotated to bring the wire 57 with the solder pellet cast thereon directly over the stripe 173 on the crystal 172 and the chuck device is then lowered to bring the pellet of solder into engagement with the stripe 173. In this position the contact finger 74 on the chuck device 49 touches the metal coating 174 or the stripe 173 on the crystal to close the electrosoldering circuit as follows: source of current supply 71, conductor 254, conductor 255, ammeter 39, conductor 262, solder rheostat 248, conductor 263, contacts of switch 37, conductor 264, conductor 261, conductor 77, and 59 and jaws 60 and 61, wire 57, the solder pellet on the end of the wire, stripe 173, finger contact 74, conductor 265, to source of current supply 71. Since the hot plate device 50 comprising the table 175 is maintained at a temperature only slightly below the melting point of the solder pellet on the end of the wire 57, the current applied to the point of engagement of the solder pellet and the stripe 173 is sufficient to raise the temperature in this point of contact to a melting temperature for the solder. The material in the solder pellet on the end of the wire 57 and in the stripe 173 is therefore sufficiently heated to make the parts fuse together. The current applied may be regulated by operation of the rheostat 248. If it is desired to automatically regulate the duration of the current supplied, this may be accomplished by closing the switch 38 instead of the switch 37, the solder timer 246 then functioning to control the duration of the current supply.

After the wire 57 is solder-connected to the stripe 173 on the crystal 172, the wire 57 is severed at a required point to leave a relatively small length of the wire extending from the crystal. This small length of wire may be used as a lead-in wire for the crystal and also as a supporting wire for the crystal. A similar wire may be electrosoldered to the stripe 173 on the opposite face of the crystal by the process above described. In this case the wire already soldered to the surface of the crystal extends into the aperture 208 in the table 175 while the crystal 172 is being adjusted to required position and during the second soldering operation.

An explanation in detail of the structures of the caster device 48 and the chuck device 49 is given in my original application, Serial No. 75

372,528, filed December 31, 1940, and to which reference may be had for an explanation of parts shown and numbered in the drawings in the present application not described in this application.

What is claimed is:

1. A hot plate crystal supporting device comprising a support, an apertured table adjustably mounted on said support and adapted to serve as a support for said crystal, means for heating said table, an apertured frame plate rotatably mounted on said table and encompassing said table, sets of movable straps extending across said frame plate and said table, said straps being operable to cooperatively embrace said crystal and means for adjustably moving said straps into engagement with said crystal.

2. A hot plate device comprising, in combination, a support with an opening formed therein, spaced tracks located beneath said support, supporting means for said tracks, a table movably supported on said tracks and operating in the opening in said support, means for heating said table, a frame rotatably supported on said table, a set of movable bands extending over said frame and across said table, adjusting means for moving said table and said frame as a whole along said tracks, means adjustably supporting said bands and operable to move said bands in the same direction, and means for moving said bands in opposite directions.

3. A hot plate device comprising, in combination, a support, spaced tracks, supporting means on said support and supporting said tracks, a table movably supported on said tracks, means to move said table along said tracks, means for heating said table, a frame plate apertured to accommodate said table and rotatably supported on said table, a set of bands extending in parallel relation across said table and said frame plate, means for simultaneously moving said bands in the same direction on said table, means for simultaneously moving said bands in opposite directions on said table, a second set of bands extending across said table and said frame plate, and extending angularly over the first set of bands, means for simultaneously moving said second set of bands in the same direction, means for simultaneously moving said second set of bands in opposite directions, and said bands cooperating to embrace an article placed on said table and hold said article in required position on said table.

4. A hot plate device comprising, in combination, an apertured support, a round table extending into the aperture in said support, heating elements in said table, a frame plate encompassing said table and rotatably supported on said table, track means supported on said support and supporting said table, means for moving said table and said frame plate as a whole along said track means, a pair of bands extending in parallel relation cross said table and said frame plate, a channel bar supported along one end of said frame plate, a slide bar supported in said channel bar, a pair of racks slidably supported on said slide bar and individually connected to said bands, a pinion engaging said racks and supported on said slide bar, means to operate said pinion to simultaneously move said racks in opposite directions along said slide bar, said racks imparting a corresponding movement to said bands and means supported in said channel bar and operating to move said slide bar to simultaneously move said racks in the same direction

and cause simultaneous movement of said bands in the same direction over said table.

5. A hot plate device comprising, in combination, a support, a round table supported on said support, heating elements in said table, a frame plate encompassing said table and rotatably supported on said table, track means supported on said support and supporting said table, means for moving said table and said frame plate as a whole along said track means, a pair of bands extending in parallel relation across said table and said frame plate, a channel bar supported along one end of said frame plate, a slide bar supported in said channel bar, a pair of racks slidably supported on said slide bar and individually connected to said bands, a pinion supported on said slide bar and between said racks

and engaging said racks, means to operate said pinion to simultaneously move said racks in opposite directions along said slide bar, said racks operating to move said bands in opposite directions, means supported in said channel bar and operating to move said slide bar to simultaneously move said racks in the same direction, a second pair of bands extending across said table and crossing over said pair of bands at an angle, means supported along another edge of said frame plate for moving said second pair of bands in like movement to the first pair of bands and said pairs of bands cooperating to form a holding frame for holding an article in required position on said table.

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