Dec. 30, 1952 W. H. ANDERSON 2,623,982

DIELECTRIC HEATING APPARATUS

Filed Jan. 20, 1950 3 Sheets-Sheet 1

Fig. 1.

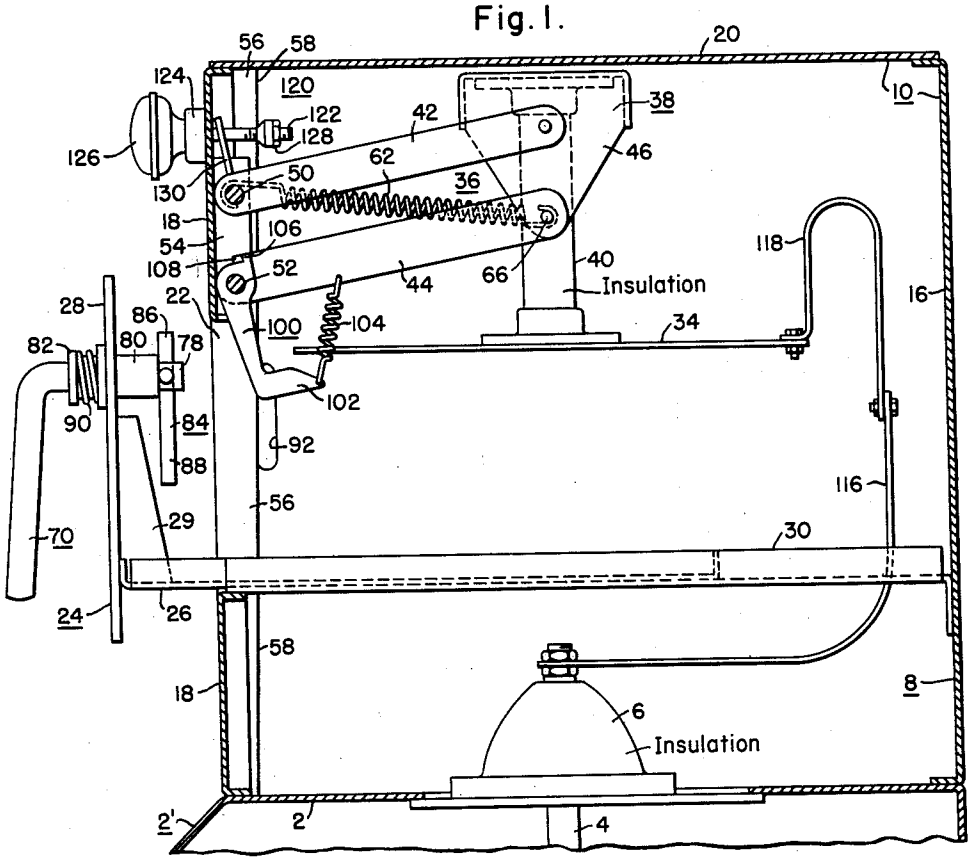
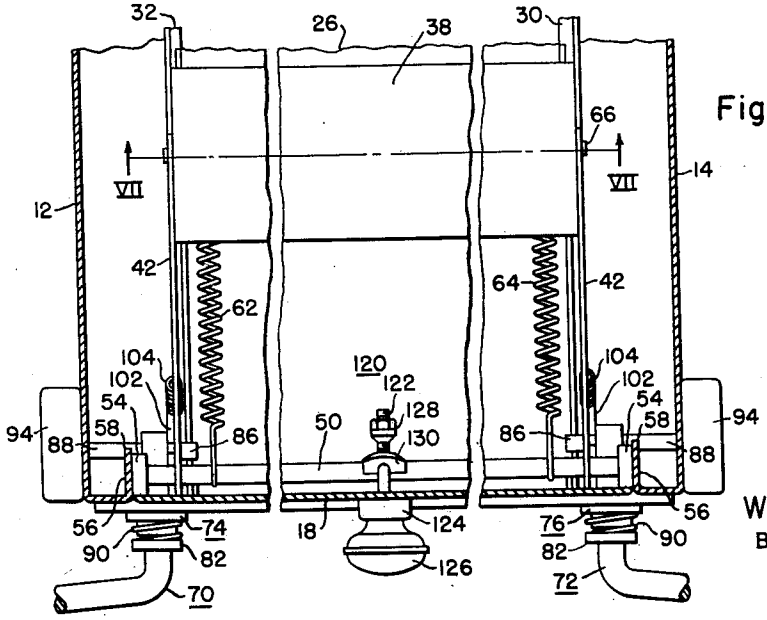


Fig. 3.



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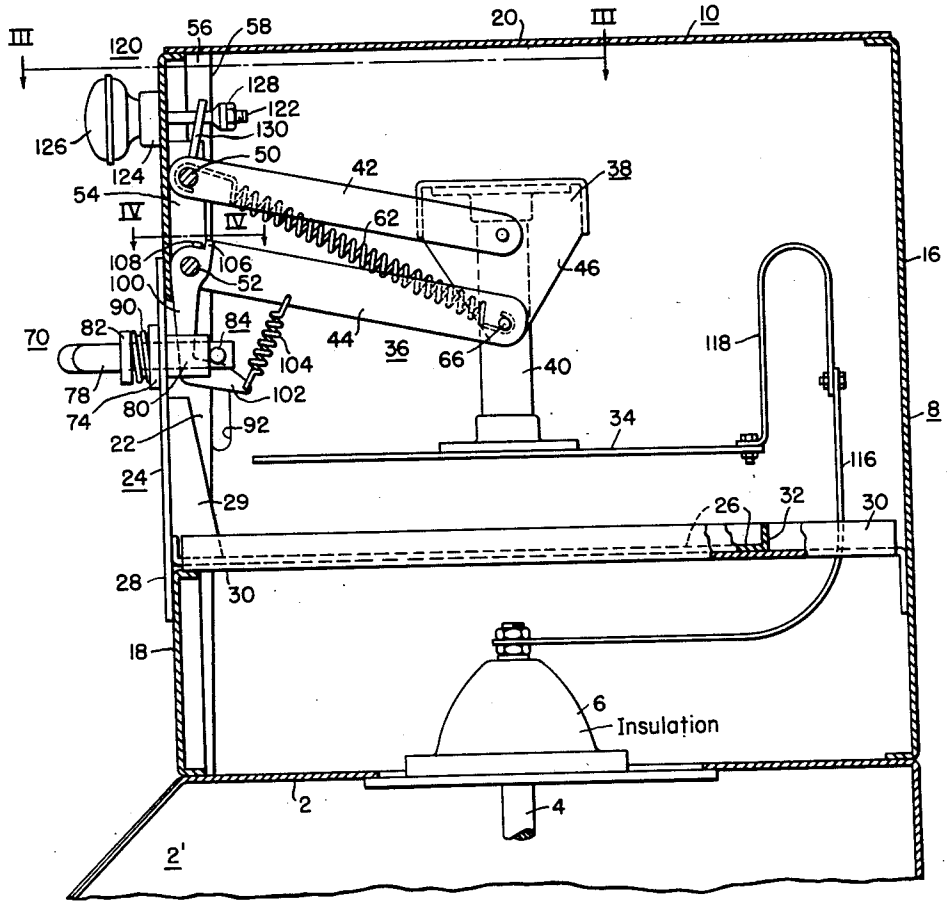
DIELECTRIC HEATING APPARATUS

Filed Jan. 20, 1950 3 Sheets-Sheet 2

Fig. 2.



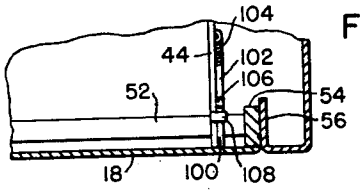


Fig. 4.

WITNESSES:

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DIELECTRIC HEATING APPARATUS

Filed Jan. 20, 1950 3 Sheets-Sheet 3

Fig. 5.

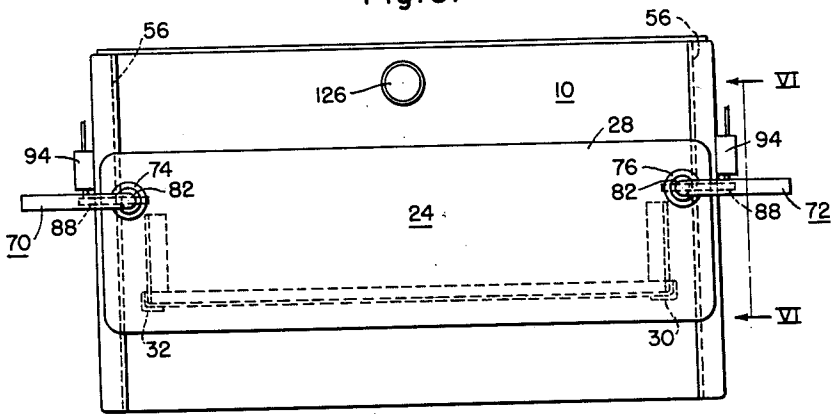


Fig. 6.

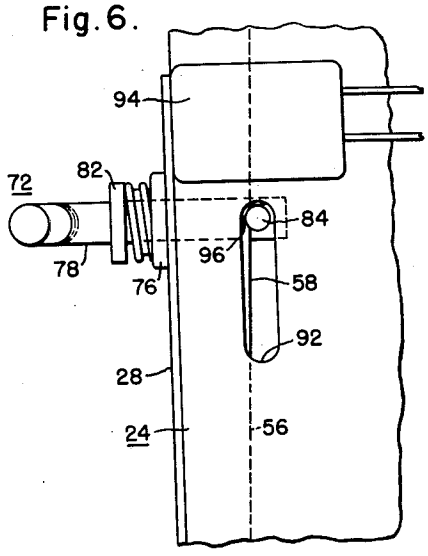
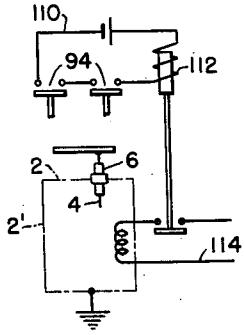


Fig. 8.



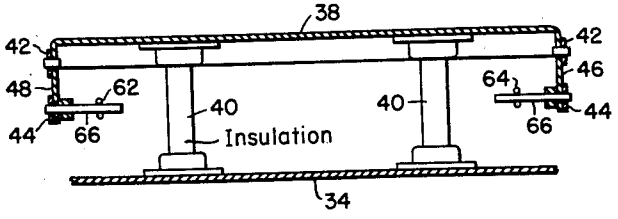


Fig. 7.

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UNITED STATES PATENT OFFICE

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DIELECTRIC HEATING APPARATUS

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Application January 20, 1950, Serial No. 139,547

13 Claims. (Cl. 219—47)

1

My invention relates to dielectric heating apparatus for dielectrically heating a plurality of workpieces.

More specifically, my invention is directed to dielectric heating apparatus which comprises a complete self-contained unit. Such a unit generally includes a pair of relatively insulated heating-electrodes between which the work is placed for heat-treatment. The heating-electrodes are energized from a high-frequency power supply that comes from a generating system carried in a casing of the unit; the generating system usually comprising electronic tubes and high-frequency circuits, as is known to the art.

In the smaller sized units, the associated heating-electrodes are usually two small parallel plates, or the equivalent, arranged one above the other so as to provide an upper and a lower heating-electrode. The upper heating-electrode is preferably carried on a pantographic linkage which assures that it will always be substantially horizontal. The pantographic linkage provides a flexibility which permits the unit to be used for heating batches of work of different heights and under different conditions, such as, for example, with different widths of air-gaps above different batches of work.

In order to prevent high-frequency radiation and to provide apparatus in which the work can be quickly and safely heat-treated, and for other reasons, the associated heating-electrodes are commonly enclosed or surrounded by a two-part metallic cage-structure which can be opened and closed. To this end the two parts of the cage comprise cage-members that are relatively movable with respect to each other, one of them usually being a part of or secured to the casing of the unit and also supporting the pantographic linkage. Apparatus of this kind, comprising a cage-structure consisting of two cage-members which are hinged together along a side, is shown in United States Patent No. 2,498,632 to W. H. Anderson and D. S. Shingler.

When the work consists of a plurality of small pieces or objects, considerable time may be required to load and unload the work from a dielectric heating unit if each piece is placed separately in the unit. According to my present invention, one of the cage-members is a drawer which removably slides into and out of the other cage-member. In accordance with my invention, the removable drawer has a work-supporting floor or bottom that may be fixed to or placed on the drawer, this floor or bottom constituting the lower heating-electrode. This makes it possible to use

2

a plurality of drawers so that one or more of them can be loaded with work outside of the unit during the time that another is in the unit with the work carried thereby being heated dielectrically.

The upper heating-electrode in my present preferred form of apparatus is carried by a linkage in such a manner that it can be moved so as not to interfere with movement of the drawer. However, the mechanism for moving the upper heating-electrode can be used to place it back in proper operating position after the drawer reaches closed position.

An object of my invention is to provide a unit having a drawer-type cage-structure of a type described.

A further object of my invention is to provide a drawer-type cage-structure of a type described having a stationary or fixed cage-member that is electrically grounded or connected to the casing of the unit.

A further object of the invention is to provide a drawer-type cage of a type described, which has an upper heating-electrode that is insulatedly carried by the fixed cage-member.

Still another feature of my invention is the provision of a drawer-type cage of a type described, having means which presses the two cage-members together, in closed position of the cage, so as to assure good electrical contact between the drawer and the fixed cage-member so that the drawer can constitute a grounded heating-electrode.

A further feature of my invention is the arrangement of an operable means which can be operated from outside a closed cage of the drawer type described, to lock the drawer in place and to unlock it. The operable means extends into the cage and cooperates with the mechanism which places the upper heating-electrode in its desired positions. The operable means is so arranged that the energy from the unit can be applied to the work between the heating-electrodes only when the drawer is so locked in place and the upper heating-electrode is in its lower, operative position.

Objects, features and innovations of my invention, in addition to the foregoing, will be discernible from the following description of a preferred embodiment thereof. This description is to be taken in conjunction with the accompanying drawings, on varying scales, in which:

Figure 1 is a vertical sectional view of an upper part of a self-contained dielectric heating unit embodying the principles of my invention, show-

ing the drawer cage-member partly withdrawn;

Fig. 2 is a similar view of the unit showing the drawer in closed, locked position;

Figs. 3 and 4 are horizontal sectional views substantially on the lines III—III and IV—IV, respectively, of Fig. 2;

Fig. 5 is a front view of the cage;

Fig. 6 is a partial side view looking in the direction of the line VI—VI of Fig. 5 of the cage;

Fig. 7 is a sectional view substantially on the line VII—VII of Fig. 3; and

Fig. 8 is a greatly simplified explanatory wiring diagram of a control circuit utilizable in the unit.

Referring more particularly to Figs. 1 and 8, a top wall 2 very sketchily represents the outer metallic casing 2' of a high-frequency generating unit that includes equipment, within the casing, for generating high-frequency power. A suitable circuit for delivering the high-frequency power includes an insulated conductor 4 which passes centrally through an insulating bushing 6 in the top wall 2.

The top wall 2 carries a two-part metal cage-structure which is referred to in its entirety by the reference numeral 8. The bushing 6 extends upwardly centrally into the lower part of the cage-structure. A first part of the cage-structure 8 comprises a cage-member 10 that is fixed to the top wall 2. The cage-member 10 comprises side walls 12 and 14, a back wall 16, a front wall 18 and a top wall 20. In a sense, the top wall 2 of the casing 2' forms the bottom of the stationary cage-member 10. The front wall 18 has a rectangular drawer-opening 22.

The second part of the cage-structure comprises a movable cage-member in the form of a drawer which is referred to in its entirety by the reference numeral 24. The drawer is metallic and comprises a flat work-supporting bottom wall or floor 26 and a front wall 28 held together in any suitable manner by means such as gusset plates 29. The front wall 28 is adapted to close the opening 22 when the cage is closed. The drawer 24 slides into and out of the other cage-member 10 on drawer-engaging means in the form of spaced horizontal angle-rails 30 and 32 fixed to the cage-member 10. The rails 30 and 32 are arranged symmetrically with respect to the bushing 6, so that the bottom 26 is over the bushing in closed position of the cage, but is spaced from the bushing for air-insulation. Work to be heat-treated is placed on this bottom or floor 26 which constitutes a lower heating-electrode 26 for the dielectric heating unit in its entirety.

Work on the drawer-floor or lower heating-electrode 26 is heated by a high-frequency electric field established between this lower heating-electrode 26 and an upper heating-electrode 34 in the form of a metal plate which is supported, in accordance with my invention, so as to be substantially parallel to the flat portion of the floor or lower heating-electrode 26. To this end, the upper heating-electrode 34 is floatingly carried by a support means carried by the fixed cage-member 10. The support-means comprises links of a pantographic linkage 36, a floating end member 38, and one or more insulating posts 40 which depend from the end member 38 to which the heating-electrode is secured.

The pantographic linkage 36 is constructed along the lines described in the aforesaid United States Patent No. 2,498,632 and comprises two pairs of vertically spaced, generally horizontal, tiltable links 42 and 44. One pair of vertically

spaced links 42 and 44 has its back ends pivotally connected to an end wall 46 of the end member 38, and the other pair of links has its back ends similarly pivotally connected to the opposite end wall 46 of the end member 38. The other, or front, ends of the links are secured to shafts 50 and 52 which are rotatably mounted in a pair of short vertical bars 54 that are secured to spaced vertical cam-plates 56. These shafts 50 and 52 and bars 54 form an end member for the pantographic linkage 36.

The cam-plates 56 are part of the fixed cage-member 10, being near the side walls 12 and 14 thereof. Each cam-plate 56 extends, preferably, for the height of the cage-member 10 and has a back edge 58 which slopes vertically, going frontward as it goes downward.

The pantographic linkage 36 has a biasing means in the form of a tension spring 62 near one set of links and a tension spring 64 near the other set, as shown in Figs. 1–3. These springs have their front ends anchored on the upper shaft 50. Their opposite ends are anchored on a lower pivot means 66 carried by the walls 46 and 48 of the end member 38, and to which the floating ends of the lower links 44 are pivotally secured. With this arrangement the biasing means comprising the springs 62 and 64 tends to turn the pantographic linkage so that its links turn counterclockwise with respect to the axes of the shafts 50 and 52. This means that the floating ends of the links, the end member 38, the insulating members 40 and the upper heating-electrode 34 also tend to move in an upward direction for raising the heating-electrode 34. Any suitable stop means can be provided for limiting such upward movement of the described assembly.

In accordance with my invention, an operating mechanism or means lowers the upper heating-electrode 34 to operative position above the drawer-floor or lower heating-electrode 26 after the drawer 24 is closed. This operating means comprises a pair of drawer-handles 70 and 72 that can be grasped for sliding the drawer or movable cage-member 24 into and out of the fixed cage-member 10. The drawer-handles are accessible from outside the cage and are near the sides of the front wall 28 of the drawer 24, being mounted in the front wall by journalling means 74 and 76, respectively.

Each handle and its journalling means is the same as the other, so that this description is limited to one of them. Each handle comprises an outer grasping portion and a horizontal shaft portion 78 extending at substantially a right angle therefrom. The shaft portion 78 passes through the front wall 28 and is rotatably held in a bearing 80 of the associated journalling means. The bearing is fixed to the rear of the front wall 28 of the drawer 24 so as to be near the edge 58 of a cam-plate 56 when the cage is closed.

The front or outer part of the shaft-portion 78 has fixed thereto a collar 82. The back end of the shaft-portion 78 has fixed thereto an operating member in the form of a rod 84 which extends perpendicularly from the shaft-portion 78 and in the same plane as the grasping portion. The operating rod 84 has a shorter end 86 extending outward from one side of the shaft-portion 78 and a longer end 88 extending outward from the other.

A compression spring 90, between the collar 82 and the front wall 28 of the drawer 24, tends to

push the handle forwardly, but the extent of such motion is limited by the operating rod 84 engaging the facing end of the bearing 80 when the drawer is unlocked, either with the cage open or closed.

For unlocking the drawer or movable cage-member 24 with respect to the fixed cage-member 10, when the cage is closed, the handles 70 and 72 are turned so that their grasping portions are vertical, thereby placing the operating rods 84 vertically. For locking the drawer, the handles are then turned so that the rods 84 move to horizontal positions. The direction of rotation of the handles is such that the longer ends 88 of the rods 84 move toward the side walls 12 and 14 of the fixed cage-member 10. The rods 84 are long enough so that their ends 88 pass through slots 92 in the side walls. In such horizontal position, the ends 88 engage and close interlock switches 94 secured to the outsides of the side walls 12 and 14. In any other position of the ends 88 the switches 94 are open.

In moving to the horizontal position described, each end 88 also rides upwardly on the edge 58 of the adjacent cam-plate 56, thereby locking the drawer closed. Since the width of the cam-plate increases in the upward direction, the associated drawer-handle is forced backward, compressing the spring 90 and forcing the front wall 28 of the drawer 24 rightly against the front wall 18 of the cage-member 10. In this way the electrical contact between the floor or lower heating-electrode 26 of the drawer 24 and the fixed cage-member 10 is made better, and augments the electrical contact between the bottom or lower heating-electrode 26 and the metal rails 30 and 32 on which it rests. The edges 58 of the cam-plates 56 have shallow positioning notches 96 at the horizontal positions of the rods 84, as shown in Fig. 6.

After the drawer is closed, the upper heating-electrode 34 is lowered to an operative position by means extending outside the closed cage. In accordance with the preferred form of my invention, this is done simultaneously with locking of the drawer and by the same operating means comprising, more specifically, a handle or handles 70 and 72. To this end, the shorter end 86 of the operating rod 84 of each handle is effective.

Each shorter end 86 of a rod 84 rides on a pull-down arm 100 which is loosely rotatably carried on the lower shaft 52 of the pantographic linkage 36. Each arm 100 is generally in the shape of a right angle and has a lower arm member 102 adapted to be engaged by the associated end 86 as the end turns from vertical to horizontal position when the associated handle is turned to lock the drawer 24. As an end 86 of the rod 84 engages the arm portion 102, it causes the pull-down arm to move forwardly, that is, clockwise on the shaft 52 with respect to Fig. 2.

Each arm 100 has a tension spring 104 that has an end secured to the lower link 44 at a point intermediate the pivot points 52 and 66, and another end attached to the end of the arm member 102.

Normally, with the drawer 24 unlocked, the bias of the springs 104 on the pantographic linkage 36 is less than that of the springs 62 and 64 so that the upper heating-electrode 34 is in raised position. When a handle is turned, it forces the end 86 of the associated rod 84 downwardly, turning the arm 100 and extending a spring 104. The increased force overcomes the springs 62 and 64 so that the upper heating-electrode 34 drops. Lugs 106 and 108 on the pull-down arms and links 44, respectively, keep the arms and links in proper position.

The interlock switches 94 control the application of high-frequency energy to the heating-electrodes 26 and 34. Suitable electrical connections for the unit are shown in simplified form in Fig. 8. When engaged by the end-portions 88 of the operating rods 84, the switches 94, in series, close a circuit 110 to a relay 112 that operates to close the power-supply circuit 114 that supplies power to the generating equipment inside the casing 2. Consequently the conductor 4 is energized. Obviously, the switches 94 cannot be closed by the end-portions 84 unless the drawer 24 is in closed position with its bottom wall or lower heating-electrode beneath the upper heating-electrode 34.

It is to be noted that the upper heating-electrode 34 is carried by the stationary cage-member 10, but is insulated therefrom by the insulating posts 40. To convey high-frequency power to the upper heating-electrode, a connector 116 is provided having an end attached to the conductor 4. This connector is shaped to pass around the innermost end of the drawer in closed position, as indicated in Fig. 2, and terminates in a bowed resilient strap 118 that is tightly fastened to the upper heating-electrode 34. As the upper heating-electrode 34 moves between its upper and lower positions, the strap bends into different shapes.

The high-frequency path or circuit is completed through any suitable grounding means that includes the metal of the cage-structure 8, and of the casing 2'. Since this path must necessarily include a portion that passes from the bottom or lower heating-electrode 26 to the stationary cage-member 10, the provision for intimate electrical contact between the drawer 24 and the cage-member 10, resulting from the end-portions 88 of the rods 84 engaging the cam-plates 56, assures a satisfactory path for the high-frequency current.

Assuming that the drawer is to be unlocked, the handles 70 and 72 are turned to place their outer grasping portions vertically. The longer end-portions 88 of the operating rods 84 attached to the handles, first release the interlock switches 94, thereby opening the circuit 110 which in turn opens the power-supply circuit 114 for the high-frequency equipment in the casing 2'. Hence, the heating-electrodes 26 and 34 are deenergized. The longer end-portions 88 then pass through the slots 92 and into the cage-structure 8. Simultaneously the shorter end-portions 86 of the operating rods 84 move away from the pull-down arms 100 so that the biasing means, comprising the springs 62 and 64, can move the upper heating-electrode upwardly. Accordingly, the drawer 24 and work thereon can be freely removed and another similar drawer with work thereon inserted.

A feature of my invention is the provision of means that permits the lowermost operating position of the upper heating-electrode 34 to be predetermined, without interfering with the mechanisms and operations described. This means comprises the springs 104 that are associated with the pull-down arms 100, and comprises an adjusting means near the top and front of the cage-structure 8 and indicated in its entirety by the reference numeral 120.

The adjusting means 120 comprises a screw

rod 122 having a threaded portion rotatably carried in a threaded bearing 124 in the front wall 18 of the fixed cage-member 10, and an adjusting knob 126 outside of the cage. The inner end of the threaded portion carries a manually adjustable stop nut 128. The rod 122 passes through an enlarged hole in a small plate 130 that is centrally fixed to the upper shaft 50 of the pantographic linkage 36. By adjusting the position of the nut 128 backward or forward, the plate moves clockwise or counter-clockwise with respect to the shaft 50, carrying the pantographic linkage with it.

Ordinarily, the biasing means comprising the springs 62 and 64 raises the upper heating-electrode 34 so that the plate 130 is away from the nut 128, as shown in Fig. 1. However, when one or both of the handles 70 and 72 are turned, for locking the drawer 24 closed, their operating rods 84 turn the pull-down arms 100 which act through the springs 104 to pull the linkage 36 downward and move the plate 130 toward the positioning nut 128. Assuming that the lowermost position which the upper heating-electrode is to reach is above the work on the drawer bottom 26, the plate 130 reaches and engages the nut 128, as shown in Fig. 2; and the pantographic linkage 36 and upper heating-electrode stop in a position which depends on the adjustment of the nut 128. Continued movement of the handles 70 and 72 merely stretches the springs 104. Usually, the metal of the cage-structure is perforated and the adjustments obtained by tuning the knob 126 can be seen through the perforations.

While I have described my invention in a form preferred, it is obviously subject to wide variations, and its principles are applicable in other embodiments.

I claim as my invention:

1. A dielectric heating apparatus of a type described comprising a pair of relatively insulated heating-electrodes, a metallic cage about said heating-electrodes, said cage comprising a pair of cage-members, one of said members being relatively movable with respect to the other to open and close the cage, whereby the cage may be loaded with work to be heated and the heated work unloaded, said movable cage-member carrying a first of said heating-electrodes, and pressure-applying means comprising a cooperative part carried by a first of said cage-members, a cooperating part carried by a second of said cage-members and a cooperative part carried by one of said heating-electrodes, said pressure-applying means being operable for pressing said cage-members firmly together with said heating-electrodes properly positioned and spaced to provide a work-heating space therebetween.

2. Apparatus as defined in claim 1 but further characterized by said one of said parts comprising a sloped surface and another of said parts comprising a member ridable thereon, said sloped surface being positioned respecting said ridable member such that the pressure is effected thereby.

3. Dielectric heating apparatus comprising, in combination, a pair of relatively insulated heating-electrodes, a first of said heating-electrodes being above a second of said heating-electrodes, a cage, means supporting said first heating-electrode inside said cage, said means comprising a pantographic linkage including a pair of vertically spaced, generally horizontally extending links, a floating end member to which ends of said links are pivoted, said end member carrying said first heating-electrode, support means carried by said cage pivotally carrying the other ends of said links, and a pair of biasing force-exerting means associated with said pantographic linkage, said pair of biasing means acting to turn said pantographic linkage in opposite directions, a first of said biasing means being stronger than the second.

4. A dielectric heating apparatus as defined in claim 3 but further characterized by each of said biasing means comprising a spring attached to said pantographic linkage at a point removed from said support means.

5. Dielectric heating apparatus comprising, in combination, a pair of relatively insulated heating-electrodes, a first of said heating-electrodes being above a second of said heating-electrodes, a cage, means supporting said first heating-electrode inside said cage, said means comprising a pantographic linkage including a pair of vertically spaced, generally horizontally extending links, a floating end member to which ends of said links are pivoted, said end member carrying said first heating-electrode, support means carried by said cage pivotally carrying the other ends of said links, a pair of biasing force-exerting means associated with said pantographic linkage, said pair of biasing means acting to turn said pantographic linkage in opposite directions, a first of said biasing means being stronger than the second, and force-augmenting means operable to increase the force of said second biasing means so as to overcome the power of said first biasing means.

6. A dielectric heating apparatus of a type described comprising, in combination, a pair of relatively insulated heating-electrodes, a first of said heating-electrodes being placeable in operating position above a second of said heating-electrodes, a cage about said heating-electrodes, said cage having a first member and a second member which are relatively movable so that work to be heat-treated can be placed between said heating-electrodes, a linkage in said cage comprising a first member carrying said first heating-electrode, and a second member carried by a first of said cage-members, biasing means associated with said linkage and tending to move said first heating-electrode in a predetermined direction, and electrode-positioning means comprising a first part carried by said first cage-member and a second part carried by said second cage-member and operable against said biasing means to move said heating-electrode in a direction opposite to said predetermined direction.

7. Apparatus as defined in claim 6 but further characterized by said first part comprising a pull-down arm and a spring connecting said arm to said linkage, and said second part comprising a member engaging said arm to move it against the action of said spring.

8. Apparatus as defined in claim 7 but further characterized by said linkage being a pantographic linkage, and by said biasing means tending to move said linkage and said first heating-electrode in a direction away from said second heating-electrode.

9. A cage-structure for dielectric heating apparatus of a type described, comprising wall means including an outer metallic front wall, said wall means providing a drawer-opening having an entrance-portion in said front wall, a drawer slidable in said opening and having a work-receiving bottom adapted to provide a lower heating-electrode, said drawer having a front wall adapted to close said entrance-portion and a drawer-operating handle movably carried by said

drawer-wall, an upper heating-electrode inside said cage-structure, biasing force-exerting means tending to hold said upper heating-electrode in raised position above its operating position with respect to said bottom, and a mechanism operated by said handle and associated with said biasing force-exerting means for lowering said upper heating-electrode, said upper heating-electrode being supported inside said cage-structure by a pantographic linkage, and said mechanism having an operating member operated by said handle and a cooperating pull-down member associated with said pantographic linkage, the last of said member being engageable by said operating member, in closed position of said drawer, for lowering said upper heating-electrode.

10. A cage-structure for dielectric heating apparatus of a type described, comprising wall means including an outer metallic front wall, said wall means providing a drawer-opening having an entrance-portion in said front wall, a drawer slidable in said opening and having a work-receiving bottom adapted to provide a lower heating-electrode, said drawer having a front wall adapted to close said entrance-portion and a drawer-operating handle movably carried by said drawer-wall, a floating end member inside said cage structure, an upper heating-electrode, said end member comprising a depending support carrying said upper heating-electrode over and relatively insulated from said bottom, vertically spaced, horizontal links having ends pivotally secured to said end member and other ends pivotally held by said wall means at a point above said drawer-opening, biasing force-exerting means tending to keep said links and upper heating-electrode in raised position, a pull-down arm loosely connected to said linkage on the side toward said outer front wall, and mechanism comprising an operating rod attached to said drawer-handle and operable by movement of said drawer-handle to tend to force said pull-down arm downwardly so as to lower said links and upper heating-electrode to an operative position above said bottom.

11. A cage-structure as defined in claim 10 but further characterized by a spring connected to said pull-down arm and said links, said pull-down arm having a sloped surface on which said operating rod rides and forces said drawer downwardly.

12. A cage-structure as defined in claim 10 but further characterized by adjustable stop means determining the lowermost point of said operative position of said upper heating-electrode.

13. A cage-structure as defined in claim 12 but further characterized by said adjustable stop means comprising a plate, and a rod means engaging said plate and passing through a wall of said cage-structure.

WILLIAM H. ANDERSON.

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