Dec. 30, 1952 W. H. ANDERSON ET AL 2,623,981

DIELECTRIC HEATING STRUCTURE WITH SHIELDING MEANS

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Fig.1.

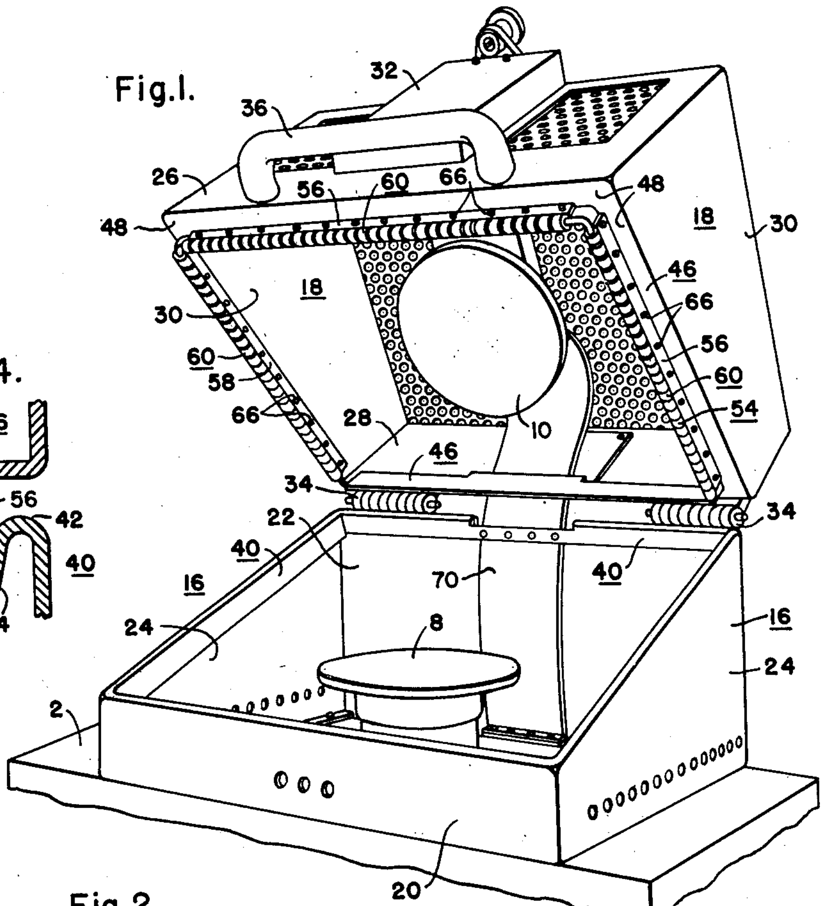


Fig.4.

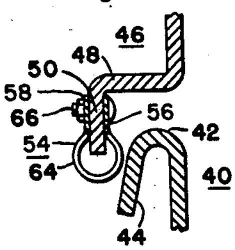


Fig.2.

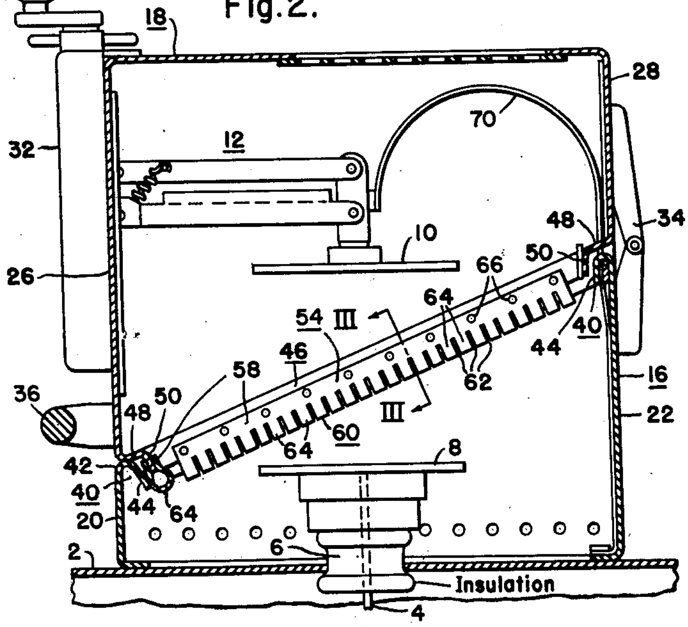
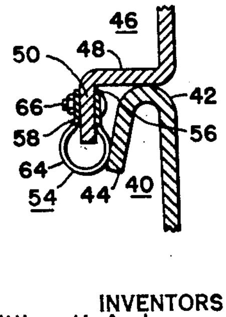


Fig.3.



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DIELECTRIC HEATING STRUCTURE WITH SHIELDING MEANS

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9 Claims. (Cl. 219—47)

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In the use of small dielectric heating units, one or more objects to be heat-treated are placed between a pair of relatively insulated heating-electrodes which is carried directly by the unit, the unit also containing the electronic tubes and high-frequency circuits which generate the high-frequency electrical energy supplied to the heating-electrodes. The heating-electrodes frequently are two small parallel plates, arranged one above the other. They are commonly enclosed or surrounded by a two-member metallic cage which carries one of the heating-electrodes. One of the members is hinged or otherwise raisable with respect to the other member so that the cage can be opened and closed for easy access to the heat-treating space between the heating-electrodes for quickly and easily replacing a treated object with another to be heat-treated. Consequently, the cage-members come together when they are closed, and form a joint. Unless the joint is carefully made, there is a likelihood of high-frequency radiation therethrough. Our invention is directed to improvements in apparatus of a type described for inexpensively providing a joint having shielding or sealing means for substantially entirely preventing radiation of high-frequency energy through the joint. Broadly, however, our invention may be applicable to radio-frequency shielding in other similar structures.

A purpose of our invention is to make a dielectric-heating cage of a type described, comprising two separable cage-members, having inexpensive but effective radiation shielding provisions that do not interfere with the repeated opening and closing of the cage-members. An ancillary object is to provide such a cage, having radiation shielding, in which the mating edges of the cage-members can be roughly, instead of carefully, formed.

A further object of our invention is to make a dielectric-heating cage of a type described, comprising radiation shielding means at the joint of its two cage-members that will allow the cage to be opened many, many times without affecting the sturdiness and effectiveness of the shielding.

Briefly stated, our invention comprises fixing a resilient slotted strip of metal to a flange of a cage-member, in solid electrical contact therewith. The second cage-member has a lip which the strip frictionally engages, with good electrical contact, when the cage is being closed. Thus the cage-members are electrically interconnected around the joint therebetween. Briefly, in accordance with our invention, an added force for

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the frictional engagement is obtained by so sloping the cooperating flange and lip that the strip is forceably pressed, with increasing pressure, against the lip as the first cage-member is being closed. Additionally, a space is provided between the flange and lip so that the strip will not be permanently deformed, and so that the cage-members can always be closed without binding.

Objects, features and innovations of our invention, in addition to the foregoing, will be discernible from the following description of a preferred embodiment, which is to be taken in conjunction with the accompanying somewhat schematic drawing on different scales, in which:

Figure 1 is a perspective view of an embodiment of our invention showing the dielectric-heating cage open;

Fig. 2 is a vertical sectional view through the closed cage;

Fig. 3 is a sectional view on the line III—III of Fig. 2, with the cage-members closed; and

Fig. 4 is a view similar to Fig. 3, but with the cage-members slightly apart.

Referring to the drawing, a top wall 2 very sketchily represents the outer metallic casing of a high-frequency generating unit that includes equipment, within the casing, for generating high-frequency power. A suitable circuit for delivering the power includes an insulated conductor 4 which passes centrally through an insulating bushing 6 in the top wall 2 and is connected to a lower first heating-electrode 8 carried by the bushing. The other side of the circuit is connected to an upper second heating-electrode 10 which is above the heating-electrode 8. This connection will be described subsequently. Accordingly, a pair of relatively insulated heating-electrodes is provided, having one heating-electrode above the other. Such heating-electrodes usually, but not necessarily, comprise flat metal plates having a square, circular, or other contour.

The upper heating-electrode 10 is supported by an adjustable pantographic linkage indicated in its entirety by its reference numeral 12. This linkage is in turn carried from a supporting frame capable of completely enclosing or surrounding the heating-electrodes 8 and 10 and the space therebetween.

As is more apparent from Fig. 2, the supporting frame comprises a metal cage-structure of more or less conventional form. The cage-structure comprises the top wall 2, a lower member 16 fixed to the top wall 2, and an upper raisable member 18 which is movable with respect to the lower member 16. In a horizontal cross-section of the preferred embodiment shown in the drawing, the cage-members 16 and 18 would appear rectangular with slightly rounded corners.

The joint between the two cage-members 16 and 18 slopes downwardly to the front. The cage-members preferably are constructed and arranged so that their respective front walls, back walls, and side walls lie in common planes. One or more of the walls may be perforated for ventilation, but the holes should be small enough effectively to limit radiation of high-frequency energy out of the cage-structure, as is known to the art.

The lower cage-member 16 comprises a relatively low front wall 20, a higher rear wall 22 and side walls 24 having upper edges that slope downward toward the front. The upper cage-member 18 comprises a relatively high front wall 26, a shorter rear wall 28 and side walls 30 that slope downwardly toward the front. This front wall 26 is provided with a dished section 32 that contains an adjusting means for the pantographic electrode-support 12. A structure of this kind is described and claimed in our copending application, Serial No. 23,794, filed April 28, 1948, now Patent #2,498,632.

The cage-members 16 and 18 are hinged together by a hinge means 34 along the back side of the cage. Preferably the hinge means 34 is of a type that can automatically retain the cage-member 18 in a raised position without the help of an operator, but can be readily released and lowered by an operator. The upper cage-member 18 is raisable through a handle 36 secured to its front wall. A counterweight can be provided if desired for balancing the weight of the cage-member 18 about the hinge means 34.

As is apparent from the drawing, the lower cage-member 16 has an upper rectangular peripheral opening defined by a rim comprising the upper border-portions 40 of its upstanding walls, namely, the front wall 20, the rear wall 22 and the side walls 24. Each of the wall-borders 40 comprises a top bend 42 and a depending flange or lip 44. The lips 44 define the rectangular opening provided in the top of the cage-member 16.

The cage-member 18 has lower wall-borders 46 on each wall that are generally of inverted step-shape, as is more apparent from Figs. 3 and 4. Each step comprises a generally horizontal portion 48 and a depending lip or flange 50. The flanges 50 help define the rectangular opening provided in the bottom of the cage-member 18.

When the dielectric-heating cage is closed, the wall-borders 40 and 46 of the two cage-members overlap and the horizontal step-portions 48 may rest on the top-bends 42. In order to allow considerable tolerance in the closeness with which the two parts meet, while preventing radiation through the joint, the lips 44 of the cage-member 16 are spaced slightly outwardly from the depending flanges 50 of the cage-member 18, for receiving a shielding means therebetween. This means that the rectangle formed by the lips 44 is larger than and surrounds that formed by the flanges 50 so that the two rims of the cage-members are nested when the cage is closed. However, because of the shielding means, it is not necessary for all points of the top-bends 42 of the lower cage-member 16 to contact the step-portion 48 of the upper cage-member 18.

It is to be noted that the angle for the bend of the wall-border 40 of the rear wall 22 of the cage-member 16 is more than that for the bend of the side walls 24, which, in turn, is more than that for the bend of the front wall 20 of the same cage-member. In other words, the lip 44 of the rear wall 22 is substantially parallel to the main part of the rear wall; whereas the lip 44 of the side walls 24 and the front wall 20 diverge from the main part of the front wall, sloping downwardly and slightly inwardly, for reasons that will later be apparent.

Radiation-shielding means comprising spring contacts 54 are secured to the flanges 50 of the front wall 26 and to the side walls 30 of the upper cage-member 18. As indicated in the drawing, each spring contact comprises a strip which is substantially coextensive with the associated flange, terminating just short of the corners where the flanges meet, the corners being exaggerated in the drawing. Each strip is generally of an inverted U-shape in cross-section having two, elongated, solid or continuous leg portions 56 and 58 joined by a transverse bowed portion 60 that is longitudinally coextensive with the leg portions. The bowed portion 60 has a plurality of transversely extending slots 62 spaced along its length that provide a plurality of loops 64.

The leg 56 of a spring contact 54 is secured to the outer face of the associated flange 50 and the other leg 58 is secured to the opposite inner face of the associated flange by any suitable means such as, for example, by bolt and nut means 66 which tightly clamp the spring contact to the flange for intimate electrical contact therebetween. Consequently, the open rim of the cage-member 18 is bounded in part by the spring contacts or strips 54.

As shown in Figs. 3 and 4, clearance is provided between the bottom of the strip-loops 60 and the bottom edge of the flanges 50, to permit the loops 60 to flex. The bow of the loops 60 is large enough to cause the loops to contact the lips 44 before the cage-members 16 and 18 are fully closed. Consequently, in closing movement of the cage, the loops 60 frictionally rub and press on the facing sides of the lips 44 so that good electrical contact between the spring contacts 54 and the lower cage member 16, and therefore between the two cage-members 16 and 18, is insured.

A greater pressure between the loops 60 and the lips 44 is obtained because of the inward slope of the lips 44. The path of movement of the loops 60 of the spring contacts which are on the side walls 30 of the upper cage-member 18 lie in vertical planes. The lips on the side walls slope inwardly from the planes toward the center of the cage so that the loops are forced inwardly with increasing force as the cage closes. Similarly, each point of the loop 60 of the strip 54 on the front wall 26 of the upper cage-member 18 moves in a path forming a cylindrical surface which is coaxial with the hinge means 34. The associated lip 44 on the front wall 20 of the cage-member 16 slopes into such a path.

In general it may be said that the lips 44 of the walls of the cage-member 16 have their upper points farther outward from the path of movement of the associated spring contacts than their lower points. In other words, with the cage-members closed the space between a lip 44 and a flange 50 tapers or decreases in the direction in which the upper cage member 18 moves to closed position. Consequently, closing of the cage-member 18 on the cage member 16 is accompanied by a pressure tending to press the slotted portions of the spring contacts 54 inwardly, the pressing force increasing as the cage-member comes closer to its final closed position. This added force further insures intimate electrical engagement between the spring contacts and the lower cage-member. However, the spacing between the flanges 50 and lips 44, in closed position of the cage, should be adequate to prevent the strip-material of the spring contacts from being caught between the two when in contact with both in a manner such as indicated in Fig. 3. Such spacing prevents the spring contacts from being permanently deformed so that they spring back to their original shape on the flanges, as indicated in Fig. 4, whenever the cage is opened. In one installation we satisfactorily used a springy strip of copper having a thickness of .010 for a spring contact.

It is important to have the wall-borders 40 of the lower cage-member 16 nest into or overlap the stepped wall-borders 46 of the upper cage-member 18. This overlap of the solid metal parts, coupled with the assurance of good electrical contact between the two cage-members through the spring contacts 54, provides virtually complete shielding against radiation of high-frequency energy thereat, for practical purposes.

The back part of the joint between the cage-members 16 and 18 is adequately sealed by the hinge means 34 and a copper strap 70 which passes through cuts in the turned over wall-border 40 of the rear wall 22 of the cage-member 16 and in the stepped wall-border 46 of the rear wall 28 of the cage-member 18. The strap 70 has the added function of providing the highly conductive connection between the upper heating-electrode 10 and the other conductor of the energizing circuit. In the embodiment disclosed, an end of the strap can be secured to the top of the heating electrode 10 and the other end attached to the top wall 2.

The strap is resilient and has an upper loop which is sufficiently large to follow the movement of the heating-electrode 10 when the cage is being opened and closed, and when the heating-electrode is adjusted.

The width of the strap 70 and the length of the hinge means 34 in a corresponding direction is subject to wide choice, but should provide sufficient metal at the joint to seal its back end against radiation to the desired extent.

The heating-electrode 10 is kept at the same potential as the upper cage-member 18 by the metallic pantographic support 12. Consequently, the whole enclosing cage-structure can be at ground potential. When power is applied to the insulated conductor 4, a high-frequency field exists between the heating-electrodes 8 and 10 which heats dielectric material in the space between them without the danger of disturbing radiation coming out of the cage-structure. In fact, with the use of our shielding means, short resilient buffers can be secured to the step-portions 48 for absorbing shocks between the cage-members 16 and 18 as they are being closed. With such addition, the top-bends 42 of the cage-member 16 will be spaced slightly from the step-portions 48 of the cage-member 18 when the cage is closed. However, the contact strip 54 and the over-lapping flanges 50 and lips 44 adequately limit radiation through the joint between the cage-members 16 and 18.

While we have described our invention in preferred form, it is obvious that it is subject to considerable variations and can be applied to other apparatus of a similar nature.

We claim as our invention:

1. A shielded dielectric heating cage of metal adapted to enclose a pair of spaced relatively insulated heating-electrodes adapted to have a high-frequency electric field established therebetween, said dielectric heating cage comprising a pair of openable and closeable cage-members, said cage-members having rims defining nestable polygonal openings, a rim of a first cage-member comprising wall-borders having a flange means, spring contacts secured to said flange means substantially coextensive with sides of said flange means and in electrical contact therewith, each spring contact comprising a plurality of loops spaced along its length, the rim of the second cage-member comprising lip means, said flange means and lip means being transversely spaced in closed position of the cage, said loops resiliently and frictionally pressing on said lip means in electrical contact therewith when said cage is closed.

2. A shielded dielectric heating cage of metal adapted to enclose a pair of spaced relatively insulated heating-electrodes adapted to have a high-frequency electric field established therebetween, said dielectric heating cage comprising a pair of openable and closeable cage-members, said cage-members having rims defining nestable polygonal openings, a rim of a first cage-member comprising wall-borders having a flange means, spring contacts secured to said flange means substantially coextensive with sides of said flange means and in electrical contact therewith, each spring contact comprising a plurality of loops spaced along its length, the rim of the second cage-member comprising lip means, said flange means and lip means being transversely spaced in closed position of the cage, the spacing decreasing in the direction in which one of said members moves to closed position, said loops resiliently and frictionally pressing on said lip means in electrical contact therewith when said cage is closed.

3. An invention including that of claim 2 but further characterized by said cage-members forming a slanted joint which is hinged at one side, and a strap of electricity conducting flat metal secured to each cage-member in electrical contact therewith, the sheet extending transversely across the joint at said hinged side.

4. A shielded dielectric heating cage of metal adapted to enclose a pair of spaced relatively insulated heating-electrodes adapted to have a high-frequency electric field established therebetween, said dielectric heating cage comprising a pair of hinged cage-members, said cage-members having cooperating nestable wall-borders, the wall-borders of one of said cage-members being shaped to provide substantially coextensive steps, said steps and the other cage-member having overlapping mateable portions, one of said mateable portions having metallic spring-contact means, said spring-contact means having a longitudinally continuous portion secured to each side of the associated mateable portion in electrical contact therewith, said spring-contact means having loops extending transversely from said continuous portions and frictionally pressing on the other of said mateable portions in electrical contact therewith when said cage is closed.

5. An openable and closeable metallic cage structure of a type described adapted to enclose

an element energized with high-frequency electrical energy, said cage structure comprising a pair of hinged cage-members, said cage-members having cooperating nestable wall-borders, the wall-borders of one of said cage-members being shaped to provide substantially coextensive steps, and the wall-borders of the other of said cage-members being shaped to provide bent-over portions, the steps providing flanges and the bent-over portions providing lips, metallic spring-contact means secured to said flanges, said spring-contact means comprising a longitudinally continuous portion secured to a side of a flange and in electrical contact therewith, said spring contact means having loops extending transversely outwardly from said continuous portion, with the loops passing around an edge of the associated flange with clear space therebetween, said loops being adapted to frictionally press against said lips for intimate electrical contact as said cage-members are closed.

6. A shielded dielectric heating cage of metal adapted to enclose a pair of spaced relatively insulated heating-electrodes adapted to have a high-frequency electric field established therebetween, said dielectric heating cage comprising a pair of hinged cage-members, said cage-members having cooperating wall-borders, the wall-borders of one of said cage-members overlapping the wall-borders of the other, but with a space between the overlapped wall-borders, the wall-borders of a first cage-member having spring-contact means secured thereto in intimate electric contact therewith, said spring-contact means providing a plurality of curved sections spaced along the length of the associated wall-borders for substantially the full length thereof, said curved sections having ends secured to a wall-border of a first cage-member, and having bowed portions transversely extending outwardly from the associated wall-borders, said bowed portions comprising a substantial part of the total length of said spring-contact means, said bowed portions facing the wall-borders of the second cage-member and frictionally pressing thereon for good electrical contact when said cage is closed.

7. An openable and closeable metallic cage structure of a type described adapted to enclose an element energized with high-frequency electrical energy, said cage structure comprising a pair of hinged cage-members, said cage-members having cooperating wall-borders, the wall-borders of one of said cage-members overlapping the wall-borders of the other, but with a space between the overlapped wall-borders, the space decreasing in the direction in which one of the cage-members moves relative to the other for closing the cage structure, the wall-borders of a first cage-member having spring-contact means secured thereto in intimate electric contact therewith, said spring-contact means providing a plurality of loops closely spaced along the length of the associated wall-borders, said loops having ends secured to a wall-border of a first cage-member and having bowed portions clearing such wall-border and facing the wall-borders of the second cage-member, said bowed portions resiliently and frictionally pressing thereon for good electrical contact when said cage structure is closed.

8. An openable and closeable metallic cage structure of a type described adapted to enclose an element energized with high-frequency energy, said cage structure comprising a pair of cage-members, said cage-members having cooperating nestable wall-borders, means for supporting said cage-members so that the wall-borders of one of said cage-members overlap those of the other cage-member, and a first of said cage-members is movable along a predetermined path with respect to the second cage-member, the wall-borders of said second cage-member having a bent-over portion providing a lip sloped so as to have a first portion which is farther outward from said path than a second portion of said lip, and metallic shielding means secured to and along the wall-borders of one of said cage-members, said shielding means comprising a plurality of relatively closely spaced loops extending transversely of said lip for resiliently and frictionally engaging the wall-borders of the second cage-member, and making electrical contact therewith.

9. An openable and closeable metallic cage structure of a type described adapted to enclose an element energized with high-frequency electrical energy, said cage structure comprising a pair of hinged cage-members, said cage-members having cooperating nesting wall-borders providing a flange wall-portion and a lip wall-portion, a plurality of relatively closely spaced metallic shielding loops, each loop having at least one of its ends secured to a first of said wall-portions and extending transversely therefrom, said loops being spaced substantially along the full length of the last said wall-portion, each loop extending transversely clear of the edge of the last said wall-portion, said transversely extending loop being clear of said edge for the major portion of the length of said loop, and having a bowed portion adapted to engage the second wall-portion and flex when the two wall-portions are nested.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,737,824	Brower	Dec. 3, 1929
2,065,651	Burton	Dec. 29, 1936
2,130,243	Mitchell	Sept. 13, 1938
2,379,047	Thomas	June 26, 1945
2,442,451	Albin	June 1, 1948
2,528,492	Bradley et al.	Nov. 7, 1950

FOREIGN PATENTS

Number	Country	Date
383,524	Great Britain	Nov. 17, 1932