

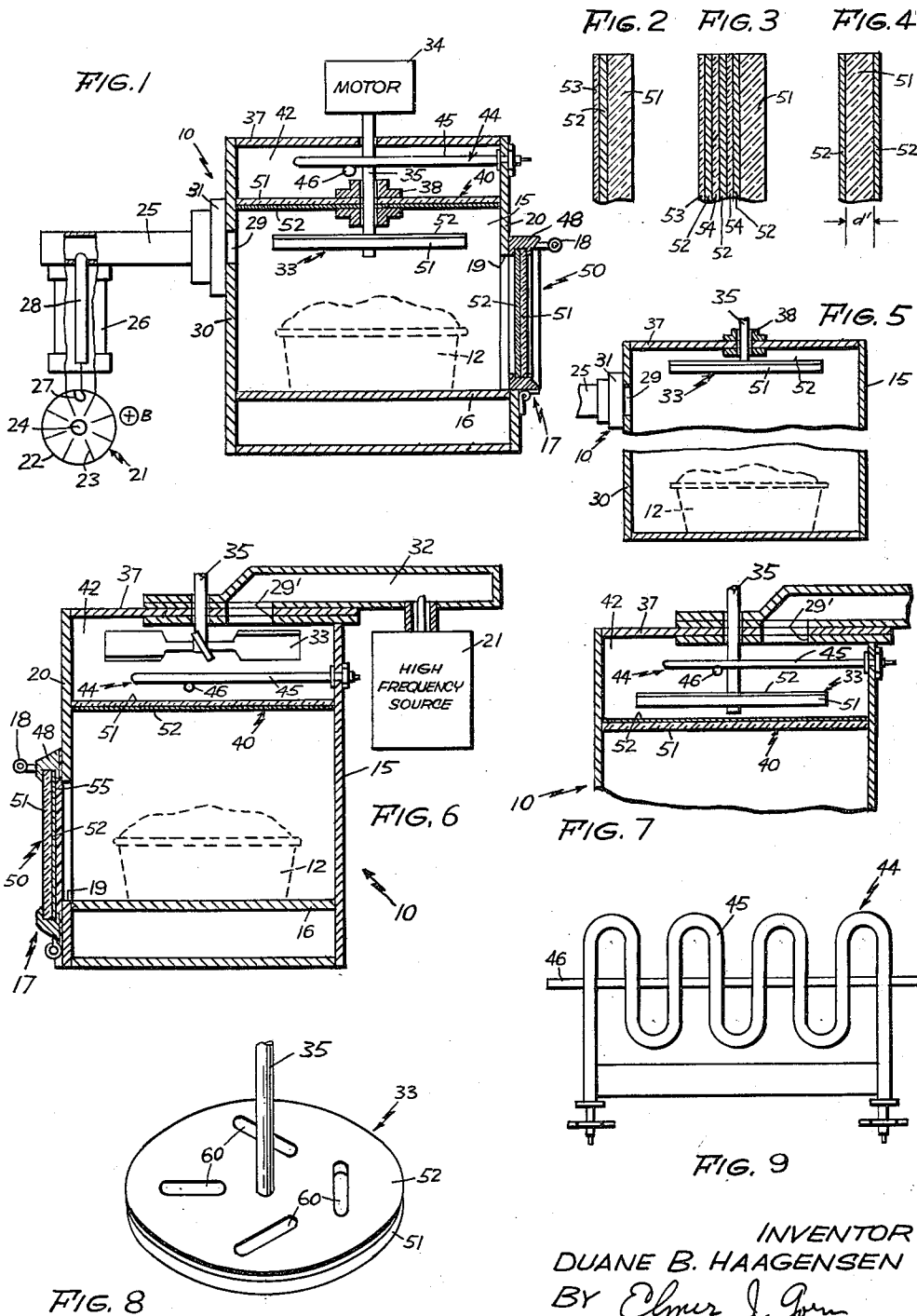
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MICROWAVE OVENS

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2,920,174

MICROWAVE OVENS

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19 Claims. (Cl. 219—10.55)

This invention relates to microwave electronic heating apparatus, and more particularly, to a microwave oven having at least a portion capable of transmitting optical or infrared radiation, or both, while at the same time being either partially or totally reflective of microwave energy.

In microwave electronic ovens the microwave energy is contained within the cooking compartment by means of metal walls or screens. Such construction renders it difficult for the operator to observe properly the manner in which the cooking process is proceeding. The use of wire or screen windows further presents a problem of contamination when vapor or foodstuffs collect on the irregular window openings. An optically transparent substance, such as glass, obviously is unsuitable since it presents such low losses to microwave energy that leakage of microwave energy from the cooking compartment becomes prohibitive. One of the objects of this invention is to provide a microwave oven with one or more optically transparent windows which also is substantially opaque to microwave energy. This object may be achieved by constructing the window of glass, plastic, ceramic, and the like, which is capable of passing readily the visible spectrum coated on one or both opposed surfaces thereof with an extremely thin layer or film of a low resistance metal or a coating comprising a combination of metals, each of which have different transmission response to portions of the visible spectrum. This thin metallic coating should be sufficiently thick to insure adequate reflection of microwave energy therefrom without cutting down unduly the transmission therethrough of light energy. An extension of the above technique is to make one or more of the oven walls, or even the entire microwave oven enclosure, of coated glass.

Another object of this invention is to provide the microwave oven with an optical transparent window which is coated so that microwave energy is prevented from leaving the cooking compartment, while at the same time the coating partially absorbs microwave energy. When the oven is energized without any load, or with a very small load, this object is achieved by proper choice of material and thickness of the metal layer. For example, a metal of relatively high volume resistivity, such as Nichrome, could be used for this purpose so that the power absorbed in the metal coating is correspondingly high. Since the surface resistivity of the metal layer increases inversely as its thickness, the amount of energy dissipated by the metallic coating may be increased as the coating is made thinner. The amount of energy absorbed by the metallic coating at low load or the degree of opacity to microwave energy, as the case may be, may be increased further by using more than a single layer of metal, each layer being separated from the adjacent metal layer by a layer of dielectric or low loss material, such as an oxide or a ceramic of the alumina type, since each layer will contribute to the total impedance to transmission of energy.

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In addition, when the thickness of the separating layers between adjacent metal layers is made any odd number of quarter wavelengths at the microwave frequency, the microwave energy at each of the various metal layers effectively tends to cancel and the composite layer acts like a single layer of decreased thickness. This arrangement may also be used simultaneously to provide proper optical filtering action for best light transmission. While the effective thickness of the composite layer may be decreased to effect a decrease in microwave transmittance, it is also possible to increase the microwave transmittance by making the thickness of the separating layers any odd number of half wavelengths, whereupon reinforcement of the energy at each of the metal layers tends to occur and the equivalent of a single layer of increased thickness may be obtained. The technique of combining more than a single metal layer with a space between layers of any odd number of quarter wavelengths is also useful to obtain a coating of practical thickness when a single layer having the desired transmission characteristic would be below the lower practical limit for coating techniques, namely, about one-hundredth of a mil. Similarly, there is an upper practical limit of thickness of coating for coating techniques, in which case, the technique of spacing the layers of metal by an odd number of half wavelengths becomes useful.

Another object of this invention is to provide means in a microwave oven which also supplies infrared energy to the load contained within the heating compartment whereby the radiant energy source may be placed outside the heating compartment. In this manner, interference with the microwave fields within the heating chamber and absorption of microwave energy by the infrared heating source may be eliminated. To achieve this result, the wall of the oven facing the radiant energy source comprises a coated object similar to that already described, except that the coating is capable of transmitting energy in the infrared portion of the electromagnetic spectrum while simultaneously presenting a substantial barrier to transmission of microwave energy. The coating material and thickness will determine the relative transmission of both microwave energy and infrared energy and will be chosen such that the best compromise is achieved between infrared transmission through the coated material and microwave reflection from the coated material. The technique of applying successive layers, previously referred to, may be resorted to in achieving this result.

Another object of the invention is to provide a microwave oven with a resonant slot mode stirrer consisting of a metallic layer having resonant slots therein, said metallic layer being coated on a homogeneous surface of a low loss material, such as plastic or glass. Energy from the microwave source may pass through the energy-radiating slots in the mode stirrer and the coating on the stirrer may be constructed of the proper material and thickness to permit transmission therethrough of infrared energy should an infrared source be employed.

The mode stirrer may be designed to absorb a portion of the microwave energy at no-load conditions by making the metal coating of the proper material and thickness, in line with remarks previously made in connection with the no-load protective feature.

Another object of the invention is to provide a microwave oven door having a capacity seal composed of a portion of the metal oven body, the metal layer coated on the optically transparent base member and a low loss film or strip interposed between the metal layer and the oven body. The capacitive reactance represented by this capacitor insures a proper closure, R.F.-wise, of the oven, even though there may be irregularities in the metal-to-metal contact between the edge of the oven door and

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the metallic oven wall. This capacity seal may supplement the usual metal-to-metal door seal or may be used even in the absence of such metal-to-metal contact.

The foregoing, and other objects of the invention will be best understood from the following description of some embodiments thereof, reference being had to the accompanying drawings, wherein:

Fig. 1 is a vertical section view through a microwave oven embodying the invention;

Figs. 2 to 4 are section views representing possible construction of either the shelf or the window in the oven of Fig. 1;

Fig. 5 is a vertical section view of a microwave oven which does not contain an infrared heating unit;

Fig. 6 is a vertical section view of an embodiment of the oven showing a slightly different door construction and energy feed means than shown in Fig. 1;

Fig. 7 is similar to Fig. 6 except that a different mode stirrer is shown and that the infrared heating unit is mounted above the mode stirrer, rather than below the mode stirrer, as in Fig. 6;

Fig. 8 is a view of a mode stirrer of the type shown in Figs. 1, 5, and 7; and

Fig. 9 is a top plan view of an infrared heating unit which is used in the ovens shown in Figs. 1, 6, and 7.

Referring to the drawings in which like elements are indicated by the same reference numerals, there is illustrated a microwave oven 10 constructed of a suitable metallic material, such as stainless sheet steel. A container 12 of food or other article to be heated may be placed inside the microwave heating compartment 15 of the oven 10; the container may rest on a tray 16, as indicated in Figs. 1 and 6, or may be located in any other suitable position therein, such as on the floor of the oven, in the manner shown in Fig. 5. Access to the interior of the microwave heating compartment 15 may be obtained by means of a hinged door 17 which, when opened by handle 18, exposes an aperture 19 formed in the front wall 20 of the oven.

Microwave energy having a frequency of the order of 2500 megacycles per second is derived from a suitable source, such as a magnetron 21, and includes, for example, an electrically-conductive evacuated envelope 22 provided with several radially-disposed anode vanes 23, a cathode 24, and means indicated by the reference character B and the cross within a circle, for establishing a magnetic field directed transverse to the electron path between cathode 24 and anode vanes 23. The energy from the magnetron 21 is delivered to a rectangular waveguide 25 through a coaxial transmission line 26 which is coupled inductively to the magnetron by a loop 27. The inner conductor 28 of transmission line 26 extends into the interior of waveguide 25 near one end thereof through an aperture in one wall, and serves as an exciting probe for the waveguide. The waveguide 25 is coupled to the interior of the microwave heating compartment 15 of oven 10 through an aperture 29 provided in the rear wall 30 of the oven, one end of the waveguide being secured to the rear wall 30 by fastening means 31. Alternately, the microwave energy from the high frequency source may be fed into the top of the oven through a slot 29', as explained later in connection with Figs. 6 and 7, and the output coupling means for the microwave energy source may be a waveguide 32, rather than a coaxial line, also as indicated in Figs. 6 and 7.

In order to provide more uniform heating, the field distribution of the microwave energy within the oven may be continuously varied by a so-called mode stirrer 33, which may be a fan-type stirrer, as indicated in Fig. 6, or a stirrer consisting of a coated, slotted disk, such as shown in Fig. 8 and described in more detail subsequently. The stirrer 33 is driven by a motor 34 either directly or through a speed reducer. The stirrer 33 is mounted on a motor shaft 35 which protrudes through an open-

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ing in the top wall 37 of the oven 10 and which extends through a bearing 38 fixed to the top surface or shelf 40 of the microwave heating compartment 15. The stirrer motor may be supported in any desired manner, such as from the wall 37 of the oven. The mode stirrer may be located within the microwave heating compartment, as shown in Figs. 1 and 5, or external thereto, as indicated in Figs. 6 and 7.

As shown in Figs. 1, 6 and 7, the space 42 between the top oven wall 37 and the shelf, viz., the top surface 40 of the heating compartment 15, also may contain an infrared heater unit 44 suitably attached to the portion of the back wall 20 of the oven lying above the top surface 40 of heating compartment 15. The heater element 44 preferably takes the form of a serpentine coil 45 whose loops may be supported further by a support rod 46 placed under the coil loops 45 and having the ends thereof attached to opposite side walls of the oven. It should be understood that the top wall of the oven may be provided by the shelf 40 and that the portion of oven 10 lying above this shelf may be omitted, in which case the heater unit 44 could be mounted in several ways, including by means of a bracket attached to one of the walls of the microwave heating compartment. The purpose of the heater unit 44 is to provide means for browning the surface of the food mass in container 12 and acts in conjunction with microwave heating to improve the appearance of the food mass. The heater unit 44, of course, may be eliminated, as shown in Fig. 5, in cases where absence of external crusting or browning is not considered objectionable.

The oven door 17 includes a generally rectangular frame 48, in which is fitted a composite viewing window 50 comprising an optically transparent base member 51, such as glass, Lucite or the like, at least one surface of which is coated with a very thin metallic layer or film 52. The thickness of film 52 has been greatly exaggerated in Fig. 1, as well as in other figures of the drawing, for the sake of clarity. A typical cross section of the window 50 is shown in Fig. 2. As shown in Fig. 2, the metal film 52 may be covered with a protecting layer 53, which preferably is a low loss dielectric, such as an oxide or a ceramic of the alumina type. For the sake of clarity, this protective film 53 has been eliminated elsewhere in the drawings, since it is not essential to the invention. The object of the window 50 is to permit visual inspection of the contents of the oven, while at the same time preventing substantial loss of microwave energy from the heating compartment 15 by way of transmission of microwave energy through the window. The thin metallic film 52 of window 50 acts to reflect microwave energy impinging upon it in the same manner as from the metal walls of the heating compartment 15. The film 52, however, is sufficiently thin to allow a substantial portion of the optical spectrum to be transmitted. A compromise between optical transmissivity and microwave reflectivity of the metal film must be made in proper design of the film thickness and film material.

It has been found that a more uniform transmission over the optical frequency range may be obtained by using more than one layer of metal, each of the layers preferably being spaced apart as by a thin dielectric layer 54, each metal layer 52 being of a different material. In this manner, a resultant of the individual frequency transmission characteristic of the various metals may be obtained so that the appearance of the contents of container 12 is natural and not distorted by virtue of the predominance of transmission through the window of any one color or colors. The arrangement for achieving this effect may be as shown in Fig. 3, where the several layers 52 of metal are deposited on the glass base member 51. The metal layers may be separated by spacer layers 54 of a dielectric material which may be of the same material as used for the protective coat-

ing 53. One example of a composite layer structure is a combination of successive metal layers of chromium, copper and chromium.

An alternative door arrangement is shown in Fig. 6 wherein a capacitive door seal is employed. The door 17 of Fig. 6 is provided with an optically transparent member 51, such as glass, coated with a thin metallic film 52, like the window of Fig. 1. A layer 55 of a low-loss dielectric material, such as an alumina layer, may be disposed in contact with metal film 52 in such a manner that a portion of the dielectric material contacts the front oven wall 20 when the door is closed. The dielectric material 55 may take the form of a thin sheet which is secured to the window by appropriate fastening means, or it may be a thin film of plastic which is sprayed in liquid form over the metal film 52 and allowed to harden. The successive layers 52 and 55, together with the portion of oven wall 52 contacting layer 55, constitute a capacitor which has extremely low impedance at microwave frequencies, thereby insuring an effective closure of the oven access aperture 19 when the door 17 is in the closed position, even in spite of possible irregularities in the metal-to-metal contact between the edge of the door frame and the outer surface of wall 20 of the oven.

In applications using infrared heating for browning purposes, it is desirable to mount the infrared heating unit 44 external to the microwave heating compartment 15 to insure against interference of the heating unit with microwave field inside the heating compartment and against absorption of the microwave energy by the heating unit. Although this problem has been alleviated by coating the heating unit, obviously it is simpler to make use of a conventional uncoated heating element. This can be done by separating the heating element from the microwave heating compartment by means of the shelf 40 shown in Figs. 1, 6, and 7. This shelf may form the top wall of the open instead of wall 37, as previously pointed out. This shelf 40, like the oven door 17 previously described, may consist of a base member 51, such as glass or any low-loss dielectric which is capable of transmitting infrared radiation. This base member 51 is coated with a thin film 52 of a metal capable of transmitting a substantial portion of infrared energy while simultaneously acting as a barrier to the passage of microwave energies. The shelf 40 then serves as an effective top wall of the microwave heating compartment to prevent appreciable egress of microwave energy from within the microwave heating compartment, while being transparent to infrared radiation from the externally-positioned heating unit 44.

The mode stirrer 33 of Fig. 8 comprises a resonant slot structure which may be made up somewhat in the same manner as the window 17, and shelf 40 described above; that is, it may include a base member 51, such as glass, plastic or ceramic, upon one surface of which a thin metallic coating 52 is deposited. Portions of the base member are left uncoated to form resonant slots 60 through which microwave energy may be directed. When no infrared heating unit is employed, as in the case of Fig. 5, the metal film 52 may be of thickness such that the surface resistivity is large enough to allow for dissipation of a portion of the microwave energy under no-load conditions, whereby damage to the magnetron may be prevented. Microwave energy absorption in the mode stirrer may be enhanced if the metal used to coat the stirrer inherently has a high volume resistivity. When an infrared heating unit 44 is used, as in Figs. 1 and 7, it is also essential that the thickness of the stirrer coating 52 of Fig. 8 be of such surface resistivity as to permit appreciable transmission of infrared energy through the coating. The mode stirrer 33 may be mounted either above or below the infrared heating unit—when positioned outside the microwave heating

compartment in a top-fed oven, as indicated in Figs. 6 and 7, respectively.

The metallized coating 52 on the top shelf 40 of compartment 15 of Figs. 6 and 7 may be of such thickness as to permit both infrared energy from heating unit 44 and microwave energy from high frequency source 21 to pass therethrough, but at the same time partially absorbing microwave energy at no-load or low-load conditions. The metallic coating 52 may be on either side of the glass member 51, as shown by a comparison of Figs. 6 and 7.

The use of several spaced metallic layers, as shown in Fig. 3, for obtaining proper transmission throughout the optical frequency band already has been mentioned. As these metallic layers are spaced apart by an odd number of quarter wavelengths at the midband frequency of the infrared region, in the case of the shelf 40 and the stirrer 33, or at the midband frequency of the optical region, in the case of the window 17, it is possible to achieve substantial cancellation of energy from the various layers and the transmissivity achieved, in comparison with that obtained from a single metal layer or a plurality of layers randomly spaced, can be reduced. Moreover, by maintaining the spacing between metal layers at an odd number of half wavelengths, substantial reinforcement of energy from the various layers may be obtained, whereupon the transmissivity is correspondingly increased. Since the optical or infrared region of the electromagnetic spectrum, as the case may be, is quite far removed from the microwave frequency region, no appreciable reinforcement or cancellation effects are likely to occur as regards the transmission of microwave energy through the compound path represented by Fig. 3. Since the transmissivity of a thin metallic film for microwave energy tends to increase with increasing thickness (decreasing surface resistivity) while the ability of the film to transmit optical or infrared energy tends to decrease as film thickness increases, a compromise must be reached in designing multiple-layer films to maintain adequate transmission of optical or infrared radiation as well as a sufficient deterrent to transmission of microwave radiation.

The effective thickness of a single metal film 52, such as shown in Fig. 2, may be increased by metallizing opposed surfaces of base member 51, as shown in Fig. 4, because of the additional path length through which transmission must occur. If the thickness of member 51 is so designed that the spacing between the layers 52 of Fig. 4 is made equal to an odd number of half wavelengths, however, the effect is the same as a single layer of increased thickness, while the effective thickness may be decreased provided the spacing between layers 52 of Fig. 4 is made an odd number of quarter wavelengths.

What is claimed is:

1. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, and means for supplying microwave energy, all portions of said element being capable enclosure having a portion thereof constructed of a composite element which is substantially impervious to microwave energy, all portions of said element being capable of transmitting a substantial amount of radiant energy lying outside the microwave region higher in the electromagnetic frequency spectrum.
2. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, and means for supplying microwave energy to the interior of said compartment, said enclosure having a portion thereof constructed of a composite element which is substantially impervious to microwave energy, all portions of said element being capable of transmitting a substantial amount of radiant energy lying at least as high in frequency as the infrared portion of the electromagnetic frequency spectrum.
3. A high frequency heating apparatus comprising a

metallic enclosure forming a compartment for reception of a body to be heated, and means for supplying microwave energy to the interior of said compartment, said enclosure having a portion thereof constructed of a composite element which is substantially impervious to microwave energy, all portions of said element being capable of transmitting a substantial amount of radiant energy lying within the infrared spectrum and the visible spectrum.

4. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, and means for supplying microwave energy to the interior of said compartment, a heating unit positioned outside said metallic enclosure for radiating infrared energy, said metallic enclosure having a portion thereof constructed of a composite element which is substantially impervious to microwave energy, all portions of said element being capable of permitting transfer of infrared energy from said heating unit into the interior of said heating compartment.

5. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, means for supplying microwave energy to the interior of said compartment, and a heating unit positioned outside said metallic enclosure for radiating infrared energy, said metallic enclosure having a portion thereof constructed of a composite element, said element including a base member transparent to infrared radiation having at least one of its major surfaces coated with at least one thin metallic film which is substantially impervious to microwave energy, all portions of said element being capable of permitting transfer of infrared energy from said heating unit into the interior of said heating compartment.

6. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, means for supplying microwave energy to the interior of said compartment, and a heating unit positioned outside said metallic enclosure for radiating infrared energy, said metallic enclosure having a portion thereof constructed of a composite element, said element including a base member transparent to infrared radiation having at least one of its major surfaces coated with at least one thin metallic film capable of absorbing a portion of said microwave energy and of transmitting infrared energy from said heating unit into the interior of said heating compartment.

7. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, means for supplying microwave energy to the interior of said compartment, and a heating unit positioned outside said metallic enclosure for radiating infrared energy, said metallic enclosure having a portion thereof constructed of a composite element, said element including a base member transparent to infrared radiation having a surface thereof coated with a plurality of metallic films, said metallic films being transparent to infrared radiation and substantially impervious to microwave energy.

8. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, means for supplying microwave energy to the interior of said compartment, and a heating unit positioned outside said metallic enclosure for radiating infrared energy, said metallic enclosure having a portion thereof constructed of a composite element, said element including a base member transparent to infrared radiation having a surface thereof coated with a plurality of metallic films spaced apart by dielectric spacing layers, said metallic films being transparent to infrared radiation and substantially impervious to microwave energy.

9. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception

of a body to be heated, means for supplying microwave energy to the interior of said compartment, and a heating unit positioned outside said metallic enclosure for radiating infrared energy, said metallic enclosure having a portion thereof constructed of a composite element, said element including a base member transparent to infrared radiation having a surface thereof coated with a plurality of metallic films spaced apart by dielectric spacing layers, said metallic films being transparent to infrared radiation and substantially impervious to microwave energy, said metallic films being spaced by an odd number of quarter wavelengths at a frequency lying within the infrared region of the electromagnetic spectrum.

10. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, means for supplying microwave energy to the interior of said compartment, and a heating unit positioned outside said metallic enclosure for radiating infrared energy, said metallic enclosure having a portion thereof constructed of a composite element, said element including a base member transparent to infrared radiation having a surface thereof coated with a plurality of metallic films spaced apart by dielectric spacing layers, said metallic films being transparent to infrared radiation and substantially impervious to microwave energy, said metallic films being spaced by an odd number of half wavelengths at a frequency lying within the infrared region of the electromagnetic spectrum.

11. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, and means for supplying microwave energy to the interior of said compartment, said enclosure having a portion thereof constructed of a composite element which is substantially impervious to microwave energy, all portions of said element being capable of transmitting energy lying within the visible portion of the electromagnetic spectrum.

12. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, and means for supplying microwave energy to the interior of said compartment, said enclosure having a portion thereof constructed of a composite element, said element including a base member transparent to visible radiation having at least one of its major surfaces coated with at least one thin metallic film which is substantially impervious to microwave energy and capable of transmission of visible radiation whereby the interior of said heating compartment may be inspected visually.

13. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, and means for supplying microwave energy to the interior of said compartment, said metallic enclosure having a portion thereof constructed of a composite element, said element including a base member transparent to visual radiation having a surface thereof coated with a plurality of metallic films, said metallic films being transparent to visual radiation and substantially impervious to microwave energy.

14. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, and means for supplying microwave energy to the interior of said compartment, said metallic enclosure having a portion thereof constructed of a composite element, said element including a base member transparent to visual radiation having a surface thereof coated with a plurality of metallic films spaced apart by dielectric spacing layers, said metallic films being transparent to visual radiation and substantially impervious to microwave energy, said metallic films being spaced by an odd number of quarter wavelengths at a frequency lying within the visual region of the electromagnetic spectrum.

15. A high frequency heating apparatus comprising a

metallic enclosure forming a compartment for reception of a body to be heated, and means for supplying microwave energy to the interior of said compartment, said metallic enclosure having a portion thereof constructed of a composite element, said element including a base member transparent to visual radiation having a surface thereof coated with a plurality of metallic films spaced apart by dielectric spacing layers, said metallic films being transparent to visual radiation and substantially impervious to microwave energy, said metallic films being spaced by an odd number of half wavelengths at a frequency lying within the visual region of the electromagnetic spectrum.

16. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, means for supplying microwave energy to the interior of said compartment, a heating unit positioned outside said metallic enclosure for radiating infrared energy, and a movable structure adjacent said means for supplying for effecting a variation in the electric field distribution pattern within said compartment, said structure including a base member transparent to infrared radiation and a thin metallic film coated on at least one of the major surfaces thereof for dissipating microwave energy, said base member containing uncoated portions to provide resonant slots through which microwave energy can be directed.

17. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, means for supplying microwave energy to the interior of said compartment, a heating unit positioned outside said metallic enclosure for radiating infrared energy, and a movable structure positioned adjacent said means for supplying for effecting a variation in the electric field distribution pattern within said compartment, said structure including a base member transparent to infrared radiation and a thin metallic film coated on at least one of the major surfaces of said base member which is capable of transmitting infrared radiation, said base member containing uncoated portions to provide resonant slots through which microwave energy may be directed.

18. A high frequency heating apparatus comprising a

metallic enclosure forming a compartment for reception of a body to be heated, means for supplying microwave energy to the interior of said compartment, a heating unit positioned outside said metallic enclosure for radiating infrared energy, and a movable structure positioned outside said heating compartment for effecting a variation in the electric field distribution pattern within said compartment, said structure including a base member transparent to infrared radiation and a thin metallic film coated on at least one of the major surfaces of said base member which is capable of transmitting infrared radiation, said base member containing uncoated portions to provide resonant slots through which microwave energy may be directed.

19. A high frequency heating apparatus comprising a metallic enclosure forming a compartment for reception of a body to be heated, and means for supplying microwave energy to the interior of said compartment, said enclosure having access means forming a portion thereof, said access means including a composite element which in conjunction with said metallic enclosure constitutes a capacitor, said composite element having a base member transparent to visible radiation and a surface of said base member coated with at least one thin metallic film which is substantially impervious to microwave energy and capable of transmitting visible radiation, said composite element further including a dielectric layer superimposed upon said metallic film and adapted to contact a portion of the metallic enclosure when said access means is in the closed position.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,920,174

January 5, 1960

Duane B. Haagensen

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 27, for "iti s" read -- it is --; line 38, for "open" read -- oven --; column 6, line 58, for " , all portions of said element being capable" read -- to the interior of said compartment, said --; line 61, for "porttions" read -- portions --.

Signed and sealed this 14th day of June 1960.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

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