



Office de la Propriété

Intellectuelle
du Canada

Un organisme
d'Industrie Canada

Canadian
Intellectual Property
Office

An agency of
Industry Canada

CA 2478503 C 2011/01/25

(11)(21) **2 478 503**

(12) **BREVET CANADIEN
CANADIAN PATENT**

(13) **C**

(86) Date de dépôt PCT/PCT Filing Date: 2003/04/09
(87) Date publication PCT/PCT Publication Date: 2003/10/16
(45) Date de délivrance/Issue Date: 2011/01/25
(85) Entrée phase nationale/National Entry: 2004/09/01
(86) N° demande PCT/PCT Application No.: EP 2003/003712
(87) N° publication PCT/PCT Publication No.: 2003/084841
(30) Priorité/Priority: 2002/04/09 (US10/118,033)

(51) Cl.Int./Int.Cl. *B65D 81/34* (2006.01),
A23L 1/01 (2006.01), *A23L 1/025* (2006.01),
A23L 1/16 (2006.01)

(72) Inventeurs/Inventors:

ZHANG, HUA, US;
HAYERT-BONNEVEAU, LAURENCE, FR;
YOUT, WILLIAM, FR;
HELSTERN, GARY, US;
LOIZEAU, GERARD, US

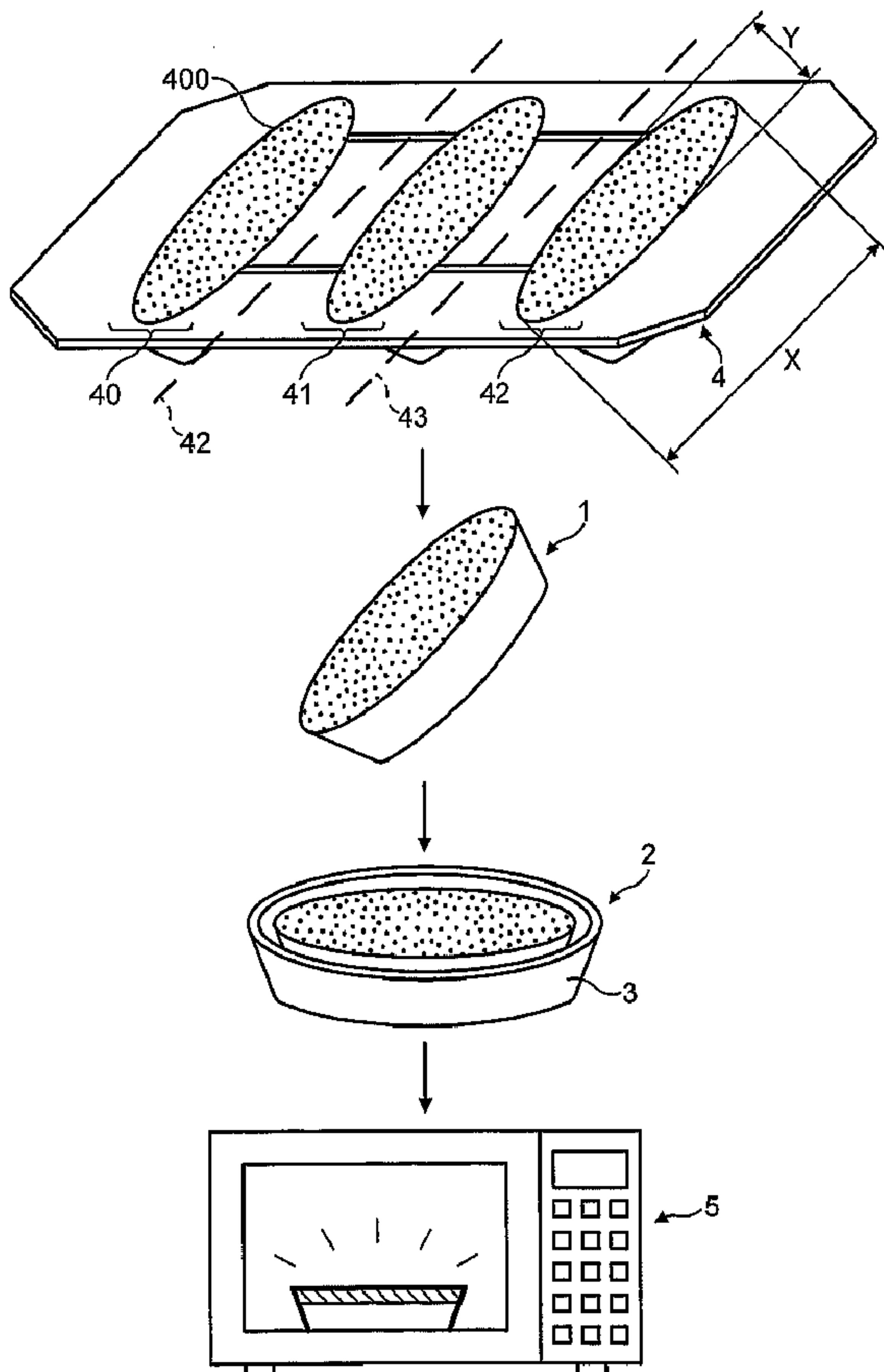
(73) Propriétaire/Owner:

SOCIETE DES PRODUITS NESTLE S.A., CH

(74) Agent: BORDEN LADNER GERVAIS LLP

(54) Titre : RECHAUFFEMENT UNIFORME D'ALIMENTS PAR MICRO-ONDES DANS UN CONTENANT

(54) Title: UNIFORM MICROWAVE HEATING OF FOOD IN A CONTAINER



(57) Abrégé/Abstract:

The invention relates to a device and method for ensuring more uniform heating of food by microwaves. The method includes providing food (1) in a portion having a predetermined size and shape; and providing a container (2) adapted for receiving and

(57) Abrégé(suite)/Abstract(continued):

reheating the portion of food in a microwave oven (5). The container forms a supporting cavity having peripheral sides (3) and a bottom side, with the portion of food placed within the supporting cavity. The peripheral sides of the container are circumferentially shielded by a microwave reflective material that forms a circumference having axial and transverse distances that are determined so as to change the wavelength of resonant modes inside the food thereby resulting in a more uniform heating food pattern.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau(43) International Publication Date
16 October 2003 (16.10.2003)

PCT

(10) International Publication Number
WO 03/084841 A1

(51) International Patent Classification⁷: B65D 81/34, A23L 1/025

(21) International Application Number: PCT/EP03/03712

(22) International Filing Date: 9 April 2003 (09.04.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data: 10/118,033 9 April 2002 (09.04.2002) US

(71) Applicant (for all designated States except US): SOCIÉTÉ DES PRODUITS NESTLE S.A. [CH/CH]; P.O. Box 353, CH-1800 Vevey (CH).

(72) Inventors; and

(75) Inventors/Applicants (for US only): ZHANG, Hua [CN/US]; 34 Morey Road, New Milford, CT 06776

(US). HAYERT-BONNEVEAU, Laurence [FR/FR]; 27 Rue Gustave Flaubert, F-76720 Auffay (FR). YOUT, William [FR/FR]; 25 Grande Rue, F-76630 Gouchaupre (FR). HELSTERN, Gary [US/US]; 50 Butterfield Road, Newtown, CT 06470 (US). LOIZEAU, Gérard [FR/US]; 22 Danvers Road, New Milford, CT 06776 (US).

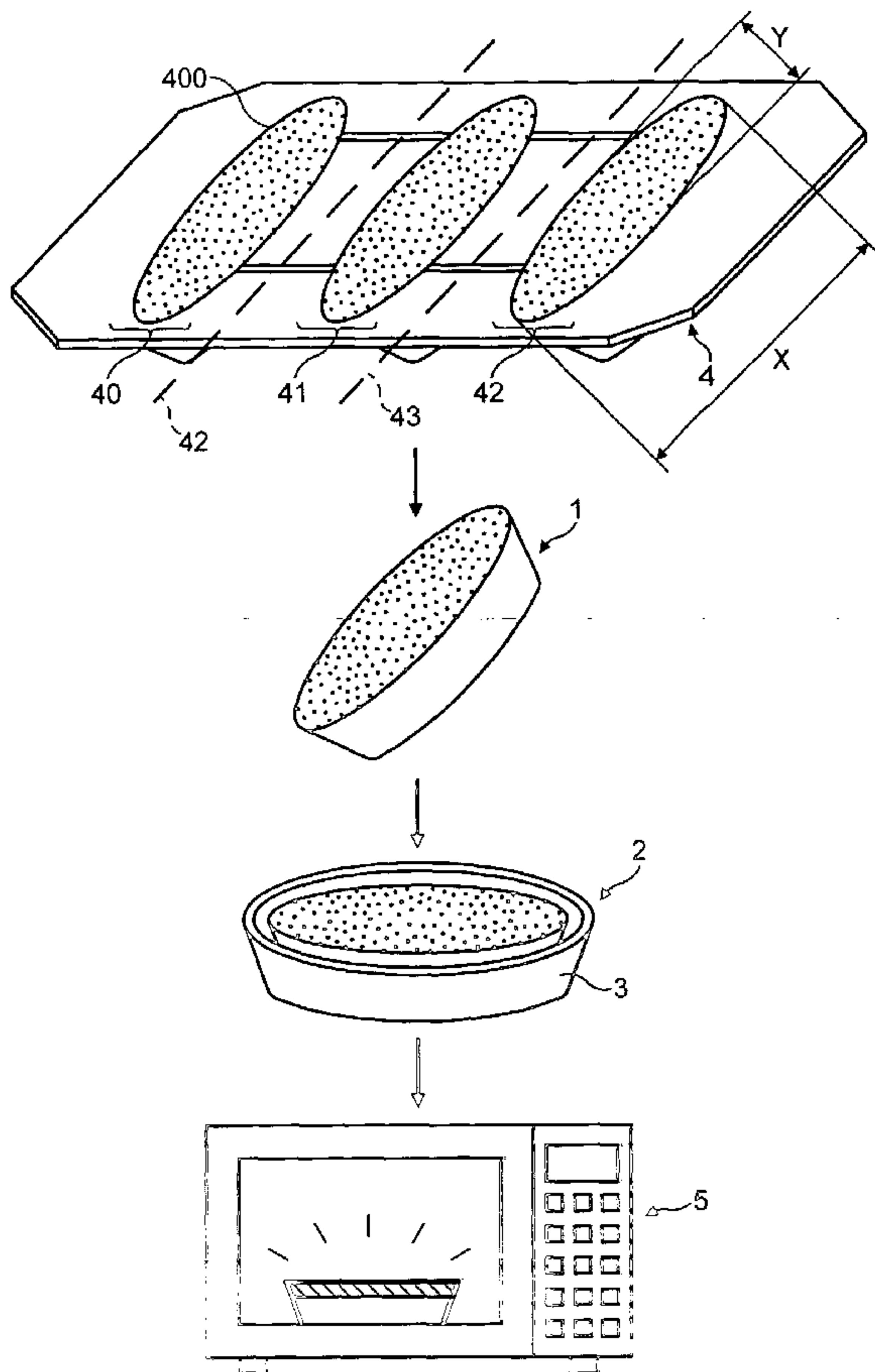
(74) Agent: BORNE, Patrice; Avenue Nestlé 55, CH-1800 Vevey (CH).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),

[Continued on next page]

(54) Title: UNIFORM MICROWAVE HEATING OF FOOD IN A CONTAINER



(57) Abstract: The invention relates to a device and method for ensuring more uniform heating of food by microwaves. The method includes providing food (1) in a portion having a predetermined size and shape; and providing a container (2) adapted for receiving and reheating the portion of food in a microwave oven (5). The container forms a supporting cavity having peripheral sides (3) and a bottom side, with the portion of food placed within the supporting cavity. The peripheral sides of the container are circumferentially shielded by a microwave reflective material that forms a circumference having axial and transverse distances that are determined so as to change the wavelength of resonant modes inside the food thereby resulting in a more uniform heating food pattern.

WO 03/084841 A1



Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS,*

JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

Published:

- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

UNIFORM MICROWAVE HEATING OF FOOD IN A CONTAINER

The present invention relates to a device and method for improving heating of food in a microwave oven. The invention addresses the problems of cold spot, uneven heating and splattering that traditionally occur when foods are heated in a microwave oven. In particular, the present invention proposes a method for handling and evenly heating frozen food that can be economically, conveniently and rapidly served in a foodservice location to the consumer. The invention also relates to a stand-like device adapted to receive a food container for improving the reheating of the food in a microwave oven.

10 Microwave reheating of frozen meals provides convenience for people seeking quick meal solutions because of the rapid thermal energy transfer into the food materials by the microwaves. However, microwave heating of frozen food is, in general, perceived as difficult and has many problems associated with it, such as overcooking of some portions of meals, cold spots, burnt edges and sauce splatter. In many instances, the meal 15 experiences serious burnt spots yet some places are still very cold, even often below 0°C. Furthermore, the concentration of the microwave energy on spots tends to create local boiling of the water contained in the food and/or sauce and therefore splattering off the dish.

20 Many attempts have been made in the past to solve this issue of re-heating frozen food in a more effective way.

It has previously been proposed in U.S. Patent No. 4,351,997 to provide a modified form of tray structure to attempt to provide a more even heating of foodstuff in the tray when exposed to microwave radiation. This prior art has a bottom wall of microwave-transparent material and an upwardly extending peripheral wall that is outwardly curved at 25 its upper end to define a horizontal peripheral rim. The rim is partly or completely coated with a material that is reflective and opaque to microwave radiation, such as aluminum foil. The peripheral wall also is partly or completely coated with the foil material. The effect of this aluminum foil coating on the wall is to provide reflection of microwave energy toward the center of the tray.

30 U.S. patent No. 4,626,641 describes an embodiment in which a similar structure is provided. In addition to the provision of aluminum foil in the side wall of a tray, the foil also extends into the base of the container but leaves a rectangular open area in the bottom wall.

WO 92/19511 relates to a tray useful for the microwave cooking of prepared foodstuff that comprises an outer layer formed of paperboard or molded plastic to which is laminated an inner polymeric film layer. A layer of microwave-reflective material, usually aluminum foil, is positioned between the outer and inner layers in the location of the 5 peripheral wall of the tray and in a pattern in a portion of the bottom wall.

JP 09-369450 relates to a container for a microwave oven that comprises a first microwave reflecting plate placed along a circumferential lateral parts and a second microwave reflecting plates in the base section of the container.

It is apparent from the prior art that attempts have essentially been made to provide energy 10 transmission structures with reflective material placed in locations that enable energy transfer from the edges and corners of the plate to a more central area of the plate. However, experimental trials have shown that these structures are, by themselves, insufficient to overcome the problems of uneven heating. In particular, cold areas are still 15 present in the food despite the presence of these structures. Thus, improvements in these devices are needed and are provided by the present invention.

The present invention aims at providing a satisfactory solution for evenly heating a frozen food in a plate by adopting a different approach where not only energy transfer is carried out but more importantly a modification of the overall heating pattern inside the 20 food block is achieved by changing the wavelength inside the food. Thus, the present invention aims at providing a convenient and easy way for improving microwave reheating of food while enabling the use of standard dishes such as ceramic and ceramic-like plates that may commonly be found in restaurants, cafeterias, hotels, or other foodservice 15 locations.

25 The present invention specifically relates to a method for ensuring a more uniform heating of frozen food by microwaves. This method is conducted by providing food in a portion having a predetermined size and shape; and providing a container adapted for receiving and reheating with microwaves the food portion. The container includes a supporting cavity having peripheral sides and a bottom side, with the peripheral sides of the 30 container being circumferentially shielded by a microwave reflective material such that the microwave reflective material on the peripheral sides forms a circumference which has axial and transverse distances that are determined so as to change the wavelength of resonant modes in the supporting cavity. The method includes placing the portion of food in the supporting cavity; and heating the food and container with microwaves so as to

expose the food to the changed wavelengths of resonant modes in the cavity thereby resulting in a more uniform heating food pattern and a more uniform heating of the food.

It has been surprisingly found that it is possible to render the heating of the food in the container relatively even by shortening the wavelength of the resonant modes inside the cavity of the food, especially for the transverse electric (TE) modes. Shortening of the wavelength and supporting of specific resonant modes can be obtained more specifically by determining the distances that separate the microwave reflective material when placed circumferentially along the side of the container in a manner to promote modes that show a more even electric field distribution.

10 In one embodiment, the microwave reflective material forms a resonating layer having a transverse dimension of less than 12.5 cm. Preferably, the transverse dimension of the resonating layer is of less than 12 cm, even preferably of from about 10 to 12 cm. Preferably, the axial dimension of the resonating layer is of 20 cm or less, even preferably of less than 18 cm. The preferred ratio axial dimension to transverse dimension is of from 15 1:1 to 2:1, even more preferably of from 1.5:1 to 1.8:1.

Therefore, the resonating layer can be regarded as a resonator or waveguide where shortened standing waves occur inside the food. As the transverse dimension of the resonating layer is shortened, transverse electric ("TE") modes that carry more power than transverse magnetic ("TM") modes are propagated in the cavity of the food. In particular, 20 the TE modes that are permitted for the selected geometry are those with a more concentrated heating in the center area of the cavity. More preferably, TE modes that are predominantly supported in the food cavity are $TE_{n,m,l}$ modes wherein n may be 0, 1, 2, 3 or 4 m may be 0 or 1 or 2 and l may be 0 or 1.

Preferably, the microwave reflective material forms a resonating layer having a 25 closed rounded contour. Even more preferably, the resonating layer has an oval contour with an axial dimension of less than 20 cm, preferably less than 18 cm, even most preferably comprised between 15 to 18 cm. In an alternative embodiment, the resonating layer has a circular contour. In a preferred embodiment, the bottom side is substantially free of shielding material.

30 In a second embodiment, the microwave reflective material forms a resonating layer having a transverse distance at the surface of the food within a range of from 15 to 20 cm and an axial distance at the surface of the food within a range of from 18 to 26 cm. Within this second range of specific transverse and axial dimensions of the resonating layer, resonant modes that promote a uniform heating are also selected successfully. The frozen

food block with such a shielding arrangement, which can be seen as a dielectric resonator with resonating boundaries, can effectively selects modes of more even field lines distribution which creates a micro-climate of well distributed energy inside and which is relatively not much dependent on the specific oven factors.

5 Remarkable results have been obtained by using such shapes and dimensions of a resonating layer. Comparative trials have shown that these are the preferred configurations for evenly heating food in the container.

10 The invention also relates to a method of using a container having the resonating layer as previously defined wherein, prior to placing the food portion in the container, the food portion is removed frozen from a package of defined shape and size which are predetermined to substantially match the shape and size of the cavity of the container. Therefore, the frozen food can be produced and packaged in the manufacturing facility according to specific standards of size and shape that are predetermined to provide optimal re-heating properties afterwards. Therefore, the food product may be packaged in a 15 package that is not the final heating tray with its resonating layer so as to reduce the packaging costs. Therefore, contrary to the package which may usually be disposable, the final heating tray may be a dish made of a non-disposable material for repeated uses in a foodservice location such as a restaurant, a fast food or a cafeteria.

20 The invention also relates to a stand-like device for improving the heating of food in a container. This device includes a support body of a shape and size adapted for receiving the container in a removable manner and a circumferential shielding surface of microwave reflective material adapted to be positioned adjacent to peripheral sides of the container.

25 In a preferred embodiment, the microwave reflective material of the circumferential shielding surface is defined by axial and transverse distances that are determined so as to change the wavelength of resonant modes inside the food thereby resulting in a more uniform heating food pattern. Still in a preferred embodiment, the support body has a wedge-shaped receiving surface to snuggly engage the complementary surface of the container and leverage means pivotally associated to the body to act on the bottom surface of the container to disengage the container from the wedge-shaped receiving surface.

30 The benefit of such a supporting stand is that it allows to more evenly heat the food in a microwave oven while reusable standard dishes such as traditional dishes can be used. Therefore, reusable standard dishes can become more effective for microwave reheating of food as compared to the use of the same dishes without the supporting stand. The supporting stand may be of a convenient use in kitchens of restaurants, hotel chains,

transportation or other foodservice areas where paper or plastic dishes can not decently be used but only food in traditional ceramic or ceramic-like dishes can be served to the customer.

A possible alternative to a reusable stand-like shielding device is a non-reusable 5 shielding aid, made of material(s) configured to last for a limited number of uses, preferably a single use. The non-reusable shielding aid can be used in combination with a durable dish such as a ceramic, plastic or glass dish to provide the adequate shielding of its sides as aforementioned. The benefit is that it provides an economic, flexible and temporary solution that can be conveniently associated to a reusable container to improve the 10 microwave heating performance in the container. This solution is also more hygienic.

The shielding aid can preferably form a band of microwave reflective material of a shape configured for surrounding the peripheral sides of the container to provide a circumferential shielding surface of microwave reflective material. In particular, the band forms a microwave reflective circumference having axial and transverse distances that are 15 determined so as to change the wavelength of resonant modes in the supporting cavity.

The band is preferably made of a destroyable material. For instance, the band is a thin band of cardboard and/or plastic coated with a microwave reflective material. The band may have substantially the form of a crown.

The band can be destroyed by the effect of separating the band from the container 20 after a single use. For instance, the band comprises an adhesive layer at its inner surface to adhesively attach to the sides of the container and wherein the effect of separating the band from the container after heating, destroys the adhesive layer or creates a tearing of the band that damages the band so that no further use of the band to heat the food container is made possible.

25 Tearing of the band may be obtained by the relatively low mechanical strength of band coming from the intrinsic properties of the material, the humid environment and/or heat during heating in the microwave and/or additional weakening zones provided in the band itself.

In another possibility, the band comprises a polymeric material that shrinks upon 30 heating in the microwave. After shrinking of the material, the band becomes so tightly wrapped around the container that removal of the band from the container has for effect to tear off the band and damage it so that no second use can be envisaged. In another possibility, the band can be made of a material that separates or disperses upon washing of the container. For instance, the material can be a resin of soluble or dispersible material

containing an amount of reflective particles such as metallic particles. The resin material can be coated on the sides of the container in a liquid or paste form. The coating material could also be an edible material.

5 Fig. 1 is a perspective view of a plate adapted to form a resonator of shortened wavelength with a frozen food product ready for microwave heating;

Fig. 2 is a cross section along line O of Fig. 1;

Fig. 3 is a cross section along line O' of Fig. 1;

10 Fig. 4 is a schematic illustration of the preferred method for re-heating a frozen food;

Fig. 5 is a preferred embodiment of a plate assembly comprising a supporting stand of microwave resonating material in a configuration ready for microwave heating;

Fig. 6 is a view similar to Fig. 5 when the plate is removed from the stand after reheating;

15 Fig. 7 is a bottom view of the supporting stand of Fig. 5 without the container inside;

Figs. 8 to 20 are comparative thermograph diagrams of the heat distribution of the food after it has been submitted to microwave radiation in different plates and trays;

Fig. 21 is a computerized view of transverse modal field distribution for a circuit waveguide of circular contour in a TE11 mode;

20 Fig. 22 is a computerized view of a transverse modal field distribution for a circuit waveguide of circular contour in a TE21 mode;

Fig. 23 is a computerized view of transverse modal field distribution for a circuit waveguide of circular contour in TE31 mode.

Fig. 24 is a resonant mode chart for a resonating band of circular contour;

25 Fig. 25 shows a schematic view of a food container shielded with a disposable shielding aid according to an embodiment of the invention;

Fig. 26 shows the way the shielding aid of Fig. 25 is removed after heating of the food product in the container.

30 With reference to Figs. 1 to 3, the method of the invention aims at providing a solution for re-heating a frozen food product of predetermined size and shape in a plate that is specifically adapted for modifying the wave pattern during a microwave heating process in a manner that enables the transverse electric (TE) modes of higher power and more evenly distributed pattern to propagate inside the food product. The present invention aims at providing a method for quickly and evenly reheating food, in particular frozen food, with

microwaves, in particular those provided by a conventional microwave oven that is 2450 MHz.

The method comprises providing a food portion 1 that is frozen, placing the food portion in the supporting cavity 20 of a tray or plate 2 of specific shape and size and heating 5 the food portion in a microwave oven. The food may be any kind of food meal such as lasagna, pasta, rice, fish, meat, and vegetables with or without sauce and combinations thereof. The plate 2 includes a bottom portion 21 and upwardly oriented side portions 22 that together define a support member with the cavity for receiving the food portion 1. The plate should be formed, at least partly, from a material that is substantially transparent to 10 microwave so as to avoid microwave energy loss in the material but be sufficiently rigid to support the weight of the food without significant deformation and to maintain the side portions extending upwardly. Therefore, the material for the plate can be chosen among the list consisting of ceramic, porcelain, glass, cardboard, polymer and combinations thereof.

Importantly, a circumferential surface 3 made of a material that is reflective to the 15 microwave is provided that is placed adjacent the sidewall 22 of the plate. The circumferential surface may preferably be a band or layer of microwave reflective material that is placed adjacent the sidewall 22. The surface could also be part of the side portion itself or replace the whole sidewall 22. . The circumferential surface forms the boundaries around the food that makes the dielectric resonator while the rest of the plate is 20 substantially transparent to the microwaves.

According to the principle of the invention, the circumferential surface of reflective material has to respect dimensions and shapes that impart a modification of the wavelength in the dielectric food itself. As a result, in the event the plate and reflective surfaces are 25 distinct parts, the shape and size of the plate should preferably be such that the plate can insert itself inside the available volume determined by the circumferential surface of the band. Preferably, the plate 2 should have a shape and size that complementary match the shape and size of the band 3, even though this is not mandatory, provided the plate 2 can fit between the band 3. For instance, the plate could be smaller or of a different shape as the band 3 itself.

As illustrated in Fig. 1 to 3, the band has preferably a shape primarily extending in 30 an elongated manner along an axial line O. In such a configuration, it is possible to define an axial distance A that corresponds to a longer distance between the internal surfaces of the band along axial line O.

Similarly, the band 3 forms a second dimension T that is taken transversally along a transverse axis O' that is substantially oriented orthogonally to axis O and passes that through the centerline of axial distance A. The transverse distance T represents the distance at this centerline between the internal surfaces of the reflective band as measured 5 at a level of the upper surface of the food.

The distances A and T are preferably measured at the circumference of the band 3 at a level of the upper surface 5 of the food when the food is properly placed in the cavity for re-heating. However, in certain circumstances where the container is shallow and/or has sidewalls that form a low inclination relative to the bottom surface; e.g., the edges of a 10 dinner plate, the food may usually project upwardly beyond the height of the sidewalls. In that event, the circumference for considering distances A and T will be regarded at the upper edge of the resonating layer.

According to one essential aspect of the invention, the distances A and T of the band are determined to provide a shortening of the wavelength when the food plate, as 15 surrounded by the band 3, is heated in the microwave oven. Therefore, reflection or transfer of the microwave beam is not the primary effect that is sought. The primary effect that is sought is related to the modification of the propagation of the waves in the dielectric food material between two or more conductors that support a certain number of electromagnetic waves. These waves have a uniquely defined voltage, current and 20 impedance. Waveguides, often consisting of a single conductor, support transverse electric (TE) and/or transverse magnetic (TM) waves, characterized by the presence of longitudinal magnetic or electric, respectively, field components. Therefore, the principle of the invention is to look at determining the boundaries of the band that acts as a waveguide so that high power TE modes of even density are primarily induced. In order to promote 25 domination of the desired TE modes, it has been found that the transverse distance T of the resonating band should be of less than 12.5 cm, preferably lower than 12 cm, even preferably ranging of from 6 to 11 cm. Similarly, the axial distance A of the band should be of 20 cm or less, preferably lower than 18 cm, even preferably ranging of from 6 to 13 cm.

30 . More particularly, with respect to these particular dimensions, TE_{nm} modes of evenly distributed density such as TE_{01} , TE_{11} , TE_{21} are primarily supported while TE_{nm} or TM_{nm} modes of less evenly distributed density such as TE_{31} , TE_{41} , TE_{51} or TM_{31} are preferably discarded.

In a second embodiment, larger dimensions have also been found working to produce uniform heating. However, these larger dimensions must also be determined precisely to promote TE mode of even propagation while discarding the dimensions that promote TE modes of uneven propagation. For this, it has been found that the transverse 5 distance T of the resonating band should be comprised within a precise range of from 15 to 20 cm and the axial distance A of the resonating band should be comprised within a precise range of from 20 to 26 cm.

The number of modes increases as the size of the resonating band increases and new modes usually adds on existing modes while certain being more dominant than others. By 10 selecting the correct size of the resonating band, one promotes the dominant modes which have a field lines distribution which is more even over the surface food. In particular, for the larger sizes of the resonating band, as defined, modes that are promoted are, for instance: $TE_{01}, TE_{10}, TE_{22}, TE_{32}, TE_{42}$ and others.

As a result, remarkable and surprising results on the final temperature distribution 15 have been obtained if those distances are properly respected. This effectively changes the wavelength of the resonant modes inside the dielectric cavity of the plate (inside the food), especially for those TE modes. This shortening of the wavelength makes the heating happens in the center of the food, therefore promoting a more uniform heating pattern.

The band may comprise tapered surfaces as shown in Fig. 2 and 3 that form an 20 angle θ with respect to the bottom of the plate comprised between 10 to 120 degrees, preferably, 15 to 90 degrees, and even more preferably 20 to 85 degrees. In fact, slightly tapering down surfaces promote a better heating. However, a problem in energy transmission in the bottom of the food may occur if the bottom surface of the plate is reduced, e.g., becomes less than 5 cm. Therefore, regardless of the inclination of the 25 sidewall, the flat bottom of the plate should be maintained at a transverse dimension of at least 5 cm, and preferably at least 7 cm.

It has also been found that the microwave reflective material band should preferably be a continuous peripheral band of a height of at least 10 mm, preferably of from 10 to 60 mm, even preferably of from 25 to 55 mm. The food should preferably be placed so that its 30 upper surface 10 is placed below the upper line 30 of the band 3, preferably at 0 to 15 mm below, even preferably at 2 to 10 mm below. Similarly, the food lower surface 11 contacting the bottom of the plate should be at a level above the lower line 31 of the band of from 0 to 10 mm, preferably 0.5 to 5 mm, preferably 2 to 3 mm.

Although an oval contour is preferred for the band, since the best results have been found with such a configuration, it remains possible to have a band of circular contour. In that event, for the first preferred embodiment the transverse distance T and the axial distance A form a diameter that should be preferentially determined, as for the previous 5 example, to be a distance less than 12.5 cm, preferably equal to or less than 12 cm, even preferably of from 6 to 11 cm and, for the second embodiment, the transverse distance should be of from 15 to 20 cm and the axial distance A should be of from 20 to 24 cm.

The band or layer 3 may preferably comprise a metallic material that is placed adjacent the sidewall 22 of the plate. The band may be either attached or simply positioned 10 in close contact with the outer surface of the sidewall 22. In another embodiment, the band may be positioned adjacent to the inner surface of the sidewall 22 of the plate.

In a preferred embodiment, the band 3 may be a rigid metal foil that forms a ring or stand forming a large central aperture of a shape and size adapted for the plate to nest therein.

15 In an alternative, the band may be a coating material, for instance, a metal coating on the surface. In order to provide a sufficient microwave resonating effect, the coating has a thickness that preferably is at least 3.2 microns, and even more preferably of at least 10 microns. The coating may be carried out by any suitable means such as by vacuum metallizing or chemical etching. Those coating techniques are well known by the man skilled in the art of surface treatment and, therefore, do not need to be described further 20 herein.

In an alternative, the band may be a metallic tape that is adhered by an adhesive to the surface of the sidewalls of the plate.

The inside volume and shape demarcated by the circumferential band may be 25 determined to match the external volume and shape of the plate and, therefore, can take any possible cross sectional configuration such as parallel, trunconical or a stepped configuration.

Figure 4 shows a preferred method for preparing a warmed food in a plate from a frozen food product using the teaching of the present invention. The method preferably 30 includes the preliminary step of portioning the food to form food portions of given size and shape and individually packaging the food portions in a package for convenient and hygienic transport and storage. The portioning and packaging are preferably carried out in a food manufacturing facility utilizing all hygienic and quality standards required in the food manufacturing art. The food portions are preferably packaged in a pre-formed

package 4 that predetermines the final shape and size of each individual food portion that are subsequently re-heated. Preferably, the pre-formed package 4 comprises at least one and preferably a plurality of packaging cells 40, 41, and 42. The cells forms a plurality of individual cavities wherein each of them have a shape and a size adapted to precisely fit in 5 the cavity of the plate 2 for the microwave re-heating while considering the positioning constraints that have been determined earlier in the present description for obtaining the intended result on uniformity of heating. If the plate and the band has an oval contour, the cavity of the cell should also preferably have an oval contour 400 of predetermined length X and width Y. The dimensions X and Y are measured at the outer surface of the food. 10 The dimensions X and Y are determined to substantially correspond to the internal dimensions of the heating plate 2 it fits in so that no large gaps are left in the cavity between the product and the plate. It has been noticed that large gaps provide the edge of the food a higher than desired heating. Therefore, gaps, if any, between the product and the inner surface of the tray or dish should be of less than about 8 mm, preferably of less than 5 15 mm. Even more preferably, there should be no gap at all between the side surface of the dish and the side surface of the food. For example, the contour of the food may have dimensions of X of between about 15 to 19 cm and for Y between about 8 to 12 cm.

The pre-formed package 4 may be made of a thermoformed plastic foil or any 20 equivalent formable material that can retain a given shape after forming. The foil is thermoformed to form the cavities and edges that surround the cavity. The material should advantageously be sufficiently deformable to allow easy removal of the food block from the cell. The preformed package can be a foodgrade polypropylene or any other suitable plastic of from about 0.1 to 1 mm in thickness. A plurality of cells 40-42 can be formed in a single sheet of plastic as illustrated for cost manufacturing reasons and can be separated 25 along cutting lines 43, if necessary, or be kept grouped as a collective package 4, if there is a need for distributing or selling more than one food package at a time.

The cells are filled in by food to form the food portions. Depending on the food 30 recipes, freezing may be required before filling in the cells. Freezing may be carried out on discrete food components, for instance, pasta layers, vegetable pieces, meat balls, etc., or on the food block itself whereas other components such as sauce, cheese and the like, may be placed, poured or deposited in the cells at ambient or just at chilled temperature.

As a matter of safety, freezing of the filled cells should always be subsequently completed until the whole food portion has reached the frozen temperature range required. The food containing cells are usually rapidly cooled to the required freezing temperatures,

i.e., minus 18 to 40°C. Freezing may usually be carried out in a spiral freezer or in a freezing tunnel under liquid nitrogen jets or any other suitable freezing technology. Then, the cells may be closed by thin plastic wrap that is sealed onto the edges of the cells or, alternatively, the preformed package 4 may be simply stacked and packed in a cardboard 5 box with a partition film to separate them in the box.

In another embodiment (not shown), the cells may also be made of a flexible non-preformed material such as in thin plastic wrap with the shape and size of the cell's cavity to shape the food portion being defined by an external mould. In that event, the plastic wrap is covered onto the mould surface, the food components are deposited into the plastic 10 wrap and the final block is frozen and removed from the mould.

The advantage of the packaging cells resides in that packaged food blocks can be mass produced in an inexpensive manner that are properly sized to fit a shielded container of specific size as aforementioned. The container may, for instance, be such as a reusable ceramic dish used in restaurant or other foodservice catering areas. The food can, 15 therefore, be transferred from the cell to the ceramic dish to be reheated in a microwave oven and served directly to the consumer in its dish. After food consumption, the dish can thus be washed and re-used as a normal dish.

The dish is preferably shielded by a non-reusable shielding aid that is associated to the dish by the user when preparing the food before the microwave heating.

20 The shielding aid preferably forms a flat band comprising a reflective material that can be associated to the sides of the dish such as by folding the band to form a crown.

The aid can, for instance, be a laminate comprising a support substrate of reinforcing material such as one or more thin cardboard and/or plastic layers and an outer reflective layer such as a metallic coating. The band may be attached by its two ends and 25 positioned around the side of the dish.

In a preferred embodiment, the band is configured to be adhesively attached to the sides of the container by an adhesive layer. The laminate may thus comprises an additional external layer opposite the microwave reflective layer to adhere to the container. The adhesive layer can be configured such that it can be used only once. Any separation of the 30 shielding aid from the container after use leads the adhesive either to lose its adhesive properties and/or to tear off the band, for example, by damaging the support substrate. Weakening zones such as perforated lines may be added, such as several at intervals on the band, to ensure that removal of the band tears off along these lines and leaves the band in several non-reusable separate pieces.

In an alternative, the band can comprise a piece of shrinkable polymeric material that shrinks at the particular heating conditions in the microwave. The polymeric material would preferably be positioned to cover the food and so to be removed by the user to access the food.

5 In another alternative, the band comprises a single-use connection device configured to place the shielding aid around the sides of the container. The single-use connection system can be a tear line or zipper as it is illustrated in Figs. 25 and 26. In these figures, the shielding aid 110 may have the form of a lid with a shielding skirt which comprises a tear line 111 that extends, for instance, circumferentially along the sides of the 10 element thus permitting to separate the lid 110a from bottom part 110b after the heating.

Finally another possibility, the food could be heated in a disposable container with reflective sides such as a box or CPET tray in a box and then transferred to the dish for serving.

Figs.5 to 7 illustrate another embodiment in which a reusable supporting stand 7 comprising a reflective material is adapted to substantially nest the container 2 in a removable manner. The stand may be specifically adapted to receive reusable dish of specific size and shape. In particular, the stand 7 has a body 70 with a wedge-shaped receiving surface of microwave reflective material 71 arranged to snuggly engage the complementary shaped exterior surface 220 of the sidewalls 22 of the container. The 20 microwave reflective surface 71 extends circumferentially to encompass the sidewalls of the container. The body may be formed entirely of reflective material such as metal or be only partly coated of microwave reflective material on its inner receiving surface 71 while the rest is made of a different material such as plastic, ceramic, etc. The body may therefore form a central truncated surface of a shape that substantially complements the 25 external side portions 22 with a central bottom aperture 72 arranged to leave the bottom portion 21 of the container substantially uncovered by the shielding material. The stand 7 may further comprise leverage means 8 adapted for conveniently and safely disengaging the container from the metal body after the heating of the food container has been performed. For instance, the leverage means 8 may be formed of a pair of levers 80, 81 30 pivotally attached to the metal body, along rotational axis 73, to act on the bottom surface of the container to disengage the container from the stand by upward pushing on the bottom side 21 of the container. The levers may preferably have a hook type shape comprising a rounded support end 810 and a connecting portion 820. The rounded end 810 is large enough to form a well distributed fulcrum on the bottom of the container when the lever is

activated in rotation so to be able to properly lift the container without blocking. The levers are thus positioned in a retracted position where the support end 810 is maintained inset relative to the bottom support plane I_1 formed by the stand/container assembly when on rest onto the oven's surface (Fig. 5). Then, after sufficient heating has been carried out, the 5 heating assembly is taken out from the oven and the levers are manually actuated in pivot about their axis 73 to lift the container off the body of the stand (Fig. 6).

The stand should preferably respect the dimensions T and A, as previously defined, for promoting support of TE modes with more even electric field distribution. To provide an effective effect, the dimensions should be defined depending on the type of dish that is 10 intended to be received, e.g., whether it is a deep or shallow dish, so that the dimensions T and A will be taken, approximately at the surface of the food or, alternatively, at the uppermost edge of the reflective material surface. For instance, in Fig. 5 is more particularly illustrated a "plat à sabot" type dish that is inserted in the stand-like device of the invention. This type of dish is sufficiently deep to accommodate a food portion that 15 partially fills in the cavity of the dish until a certain stepped line which may be considered as the effective position for measuring dimensions T and A.

The stand may be particularly adapted for receiving a ceramic or ceramic-like dish into which is inserted the food portion coming from the packaging cells as described earlier. Therefore, one benefit of the supporting stand is that traditional dishes of 20 appropriate dimensions and shape such as "plat à sabot", "china plates" or other dishes, can be successfully used for reheating meals in a microwave oven such as dense frozen meals, whereas if they would be used alone, i.e., without the help of the stand, problems of cold spot, uneven heating and splattering would be clearly noticed.

25

EXAMPLES

EXAMPLE 1 (Comparative) - Heating of lasagna in oval plate without metallic side band:

A frozen lasagna product of 387 grams is placed in an oval plate ("plat à sabot") 30 having a long axis of 17.8 cm, a short axis of 10.4 cm, height of 3.1 cm, and no metallic shielding on the side wall. The food product is heated in Welbilt microwave oven (850Watts) for 6 minutes. The temperature measurement showed a cold spot below 18°C and edges boiled over.

Fig. 8 shows the corresponding thermograph at the end of the heating stage.

EXAMPLE 2 - Heating of lasagna in oval plate with half upper metallic side band:

The same food product is heated in a plate of identical dimension with a metallic shielding tape adhesively attached to the upper half of the upward sides of the plate. The lower half of the sides is left uncovered. The product weighed 389 grams and was heated in the same oven as Example 1 for 6 minutes. The product showed a cold spot below 39°C and edge slightly boiled over.

Fig. 9 shows the corresponding thermograph at the end of the heating stage.

EXAMPLE 3 - Heating of lasagna in oval plate with a full metallic side band:

The same food product is heated in a plate of identical dimension with a metallic shielding tape adhesively attached onto the full sides of the plate. The bottom of the plate is left uncovered. The product weighed 386 grams and was heated in same oven and for 6 minutes. It had no cold spot with a temperature of the surface higher than 65°C and no burnt edge and corner.

Fig. 10 shows the corresponding thermograph at the end of the heating stage.

EXAMPLE 4 – Heating of lasagna in a rectangular tray with no metallic side band:

The same food product is heated in a rectangular tray of 12.7 cm long, 15 cm large and 2.5 cm high, with no metallic shielding. The product weighed 360 grams and was heated in same oven and for 6 minutes. It showed good temperature but edge heating was excessive.

Fig. 11 shows the corresponding thermograph at the end of the heating stage.

EXAMPLE 5 - Heating of lasagna in a rectangular tray with full metallic side band:

The same food product is heated in a rectangular tray of 12.7 cm long, 15 cm large and 2.7 cm high, with a metallic shielding tape adhesively attached onto the full sides of the plate. The bottom of the plate is left uncovered. The product weighed 386 grams and was heated in same oven and for 6 minutes. It showed a cold spot (34°C) but edge was not boiled.

Fig. 12 shows the corresponding thermograph at the end of the heating stage.

EXAMPLE 6 - Heating of lasagna in a large oval plate with no metallic side band:

The same food product frozen lasagna product of 545 grams is placed in an oval plate ("plat à sabot") having a long (longitudinal) axis of 24 cm, a short (transverse) axis of 13.1 cm, height of 2.5 cm, and full metallic shielding on the side walls. The food product is heated in a LG1000W oven for 6.5 minutes. The center was still cold (2.5°C) but the edge 5 was boiled and dried.

Fig. 13 shows the corresponding thermograph at the end of the heating stage.

EXAMPLE 7 - Heating of lasagna in a large oval plate with full metallic side band:

The same food product frozen lasagna product of 545 grams is placed in an oval 10 plate ("plat à sabot") having a long (longitudinal) axis of 24 cm, a short (transverse) axis of 13.1 cm, height of 2.3 cm, and full metallic shielding on the side walls. The food product is heated in a LG1000W oven for 6.5 minutes. The center was still cold (3.5°C) but the edge was not boiled and dried.

Fig. 14 shows the corresponding thermograph at the end of the heating stage.

15

EXAMPLE 8 - Heating of lasagna in a rectangular tray with no metallic side band:

The same food product frozen lasagna product of 447 grams is placed in rectangular tray having a long (longitudinal) axis of 15.8 cm, a short (transverse) axis of 12.5 cm, height of 4 cm, and no metallic shielding on the side walls. The food product was heated in 20 a Delonghi oven for 5 minutes. The center was still cold (-2.5°C) and the edge was partially dried.

Fig. 15 shows the corresponding thermograph at the end of the heating stage.

EXAMPLE 9 - Heating of lasagna in a rectangular tray with metallic side band:

The same food product frozen lasagna product of 446 grams is placed in rectangular tray having a long (longitudinal) axis of 15.8 cm, a short (transverse) axis of 12.5 cm, height of 4 cm, and with metallic shielding on the side walls. The food product was heated in a Delonghi oven for 5 minutes. The center was still cold.

Fig. 16 shows the corresponding thermograph at the end of the heating stage.

30

EXAMPLE 10 - Heating of lasagna in a rectangular tray with no metallic side band:

The same food product frozen lasagna product of 636 grams is placed in rectangular tray having a long (longitudinal) axis of 19 cm, a short (transverse) axis of 14 cm, height of 4.2 cm, and no metallic shielding on the side walls. The food product was heated in a

Delonghi oven for 7 minutes. The center was warm (57 °C) and the edge was partially dried.

Fig. 17 shows the corresponding thermograph at the end of the heating stage.

5

EXAMPLE 11 - Heating of lasagna in a rectangular tray with metallic side band:

The same food product frozen lasagna product of 636 grams is placed in rectangular tray having a long (longitudinal) axis of 19 cm, a short (transverse) axis of 14 cm, height of 10 4.2 cm, and with metallic shielding on the side walls. The food product was heated in a Delonghi oven for 7 minutes. The center was warm (47 °C). For this dimension, the shielding does not help to make the product hotter in the center and more uniform across the surface.

Fig. 18 shows the corresponding thermograph at the end of the heating stage.

15

EXAMPLE 12 - Heating of lasagna in a rectangular tray with no metallic side band:

The same food product frozen lasagna product of 1220 grams is placed in rectangular tray having a long (longitudinal) axis of 20 cm, a short (transverse) axis of 15 cm, height of 5 cm, and no metallic shielding on the side walls. The food product was heated in a Delonghi oven for 14 minutes. The center was still very cold (-1 °C) and the edge was partially dried.

Fig. 19 shows the corresponding thermograph at the end of the heating stage.

25

EXAMPLE 13 - Heating of lasagna in a rectangular tray with metallic side band:

30 The same food product frozen lasagna product of 1220 grams is placed in rectangular tray having a long (longitudinal) axis of 20 cm, a short (transverse) axis of 15 cm, height of 5.2 cm, and with metallic shielding on the side walls. The food product was heated in a Delonghi oven for 14 minutes. The center was warm (40 °C).

Fig. 20 shows the corresponding thermograph at the end of the heating stage.

35

EXAMPLE 14 – Comparative heating of lasagna without and with a shielding side band in a 20 by 26cm tray:

Comparative tests were conducted on lasagna heated in a 20 by 26 cm tray heated in a Panasonic oven (1100W). Without shielding, the average temperature is lower (75 oC) but lost 8% of its weight; while the shielded one only has 4% weight loss yet with a higher temperature (82 oC) (see attached table). This illustrates that shielding has made a significant difference in heating. The results are provided in table 1.

Shape	T	A	Depth	Shield Y/N	Heating time (min.)	Weight (g)	Loss %	Average Temperature (°C)	Oven
Rec.	20	26	5.2	No	25	1658	8	75	Panasonic
Rec.	20	26	5.2	Yes	25	1654	4	82	Panasonic

10

Table 1

EXAMPLE 15 - Theoretical estimation of modes in heating of frozen meal in a circular shielded plate according to the invention:

Without being bound by theory, it is estimated that the invention is primarily based on a proper selection of the transverse modal fields that propagate within the food as determined by the rounded shape and the specific dimensions of the resonating layer associated to the support plate.

The resonating band and the cavity of the microwave oven make the meal in a rounded container a waveguide because standing waves occur inside the food. The modes inside the food can be estimated based on the theoretical analysis and the solutions of the electromagnetic fields of modes can be obtained by Maxwell's equations that are not given here for reasons of simplification but which can be found in "Foundation of Microwave Engineering" (R.E. Collin IEEE Press, 1991).

In the context of a circular resonating side layer, the following equation can be held:

$$(2af_{nm})^2 \epsilon_r = (cx_{nm}/\pi)^2 + (c.l/2)^2(2a/d)^2,$$

where a is the radius of the resonating layer; d is the height of the layer; n, m, l are related to the wavelength of the modes in three different directions respectively and are natural numbers starting counting from 0 to differentiate the modes; in particular, n and m are natural numbers related to the horizontal direction modes and l is a natural number related to the vertical direction modes; c is the speed of light;

f_{nml} is the frequency of microwaves, x_{nm} is p'_{nm} for TE modes and p_{nm} for TM modes; p'_{nm} are zeros for first Bessel function.

For frozen meals, the dielectric constants are usually ranging from 3 to 5, therefore, the resonating mode inside can be calculated based on the graphed equation of Fig. 24 for 5 various modes, as shown in the following table considering f_{nml} is 2450 MHz for usual microwave ovens and height d is 3.5 cm :

10

Radius a (cm)	$(2af_{nml})$	$2a/d$	TE $_{nml}$ modes supported
4	$15.4 \cdot 10^8$	2.3	TE ₁₁₁ , TE ₀₁₀ , TM ₁₁₀
5	$24 \cdot 10^8$	2.8	TE ₁₁₁ , TM ₀₁₀ , TM ₁₁₀
6	$34.5 \cdot 10^8$	3.4	TE ₁₁₁ , TE ₂₁₁ , TM ₀₁₀ , TM ₁₁₀ , TM ₀₁₁

According to the solutions of these modes, TE modes usually carry more electrical energy than TM modes, therefore the focus is on TE modes. Electromagnetic fields at cross sections are plotted in Figs. 21 and 22. When radius is small, the only TE_{nm} mode 15 that is supported is TE₁₁ that gives a fairly concentrated heating in the center area. When the radius increases, a new TE mode starts to become dominating, e.g., TE₂₁ mode (Fig. 22). For even larger containers, there will be supposedly more modes supported in the meal. Except TE₁₂ and TE₁₃ modes, most of them have a central cold spot. However, as the number of the "cold spot" TE modes usually increase, the influence of the non- "cold 20 spot" TE modes usually decreases accordingly.

It can be noted that the first two numbers n and m for the TE_{nml} propagation modes really matter with respect to the heating distribution in the food because it corresponds to the largest transverse distribution in the horizontal direction. The third number l describes the distribution in the vertical (or z -axis) direction. Since it distributes along a short 25 distance, i.e., the thickness of the meal, there is no much change in this direction except due to the dielectric loss factor.

EXAMPLE 16 - Theoretical estimation of modes in heating of frozen meal in container without shielding layer

When the meal is in a normal container heated in a microwave oven, the meal can be seen as a dielectric resonator. At a frequency of $f = 2450$ MHz, the resonating mode can be found through the following equations:

$$\tan(\beta d/2) = \alpha/\beta \text{ where } \alpha = \text{square root} [(p'_{nm}/a)^2 - k_0^2]$$

5 and $\beta = \text{square root} [\epsilon_r k_0^2 - (p'_{nm}/a)^2]$ and,

$$k_0 = 2\pi f/c$$

As an example, for a radius a of 5 cm and dielectric constant, ϵ_r , of 4, the resonating mode is TE_{31} which has a cold center as shown in Fig. 23. As it is shown, for containers without the resonating layer, the appearance of the modes with a cold center spot occurs at 10 a smaller size.

For simplification purpose, the calculations in the examples have been made on a circular resonating configuration. However, it has been found by experiments that an elongated rounded resonating mode would perform at least as well as the circular mode and would be supposedly based on a similar theoretical analysis. Relevant literature references 15 for more understanding of microwave theoretical analysis can be found in [1] R.E. Collin, Foundations of Microwave Engineering, IEEE Press, 1991, and [2] D.M. Pozar, Microwave Engineering, Addison-Wesley, 1993.

As used herein, the term "rounded" refers to a curved line configuration with no significant zone or portion of intersecting lines that would form angles equal to or less than 20 90 degrees. The term "oval" refers to any closed elongated convex curve having preferably two axis of symmetry. The term oval includes an elliptical curve but also a non-symmetrical or deformed curve or a curve having a few straight or concave portions but having a general elongated rounded shape. As an example, a bean-like shape is included. The "axial distance" refers to the longest distance that separates two points of the 25 circumferential microwave reflective surface at about the level of the food upper surface when the food surface remains below the upper edge of the plate or container. Alternatively, the "axial distance" refers to the longest distance that separates two points at the upper edge of the circumferential microwave reflective surface when the food surface is such that it projects above the upper edge of the container. The line that links the said two 30 points enables to define a primary axis. The food may project above the plate or container when the container is shallow and/or have relatively low inclined sides (for instance, a dinner plate).

Similarly, the "transverse" distance refers to the distance that separates two other points of the circumferential microwave reflective surface at about the level of the upper food surface, as taken along a secondary axis intersecting the primary axis at its centerline, when the food surface remains below the upper edge of the plate or container. The 5 "transverse" distance refers to the distance that separates two other points at the upper edge of the circumferential microwave reflective surface, as taken along a secondary axis intersecting the primary axis at its centerline, particularly when the food surface is such that it projects above the upper edge of the container.

The axial and transverse dimensions may be equal in the context of a regular shape 10 such as a circular shape or contour.

Where the term "substantially" is used, that term is generally defined to mean at least about 95% of the value referred to, to preferably at least about 100% of the value referred to.

CLAIMS:

1. A method for ensuring a more uniform heating of food by microwaves comprising:
 - providing food in a portion having a predetermined size and shape;
 - providing a container adapted for receiving and reheating the portion of food in a microwave oven; wherein the container includes a supporting cavity having peripheral sides and a bottom side, with the peripheral sides of the container being circumferentially shielded by a microwave reflective material such that the microwave reflective material on the peripheral sides forms a circumference having axial (A) and transverse (T) distances that are determined so as to change the wavelength of resonant modes in the supporting cavity; and
 - placing the portion of food in the supporting cavity; and heating the food and container with microwaves so as to expose the food to the changed wavelengths of resonant modes in the cavity thereby resulting in a more uniform heating food pattern and a more uniform heating of the food, wherein the change of wavelength of resonant modes is a shortening of said wavelength, so that the transverse electric modes (TE) predominantly supported in the cavity are $TE_{n,m,l}$ where n, m, 1 are such that $0 \leq n \leq 4$, $0 \leq m \leq 2$ and $0 \leq l \leq 1$.
2. The method of claim 1, wherein the microwave reflective material forms a resonating layer having a transverse distance at the surface of the food of about 12 cm or less.
3. The method of claim 1 or 2, wherein the resonating layer has a closed rounded contour.
4. The method of any one of claims 1 to 3, wherein the microwave reflective material forms a resonating layer having an oval contour with an axial distance (A) of about 20 cm or less.
5. The method of claim 1, wherein the microwave reflective material forms a resonating layer having a height of about 10 to about 60 mm.
6. The method of claim 1, wherein the microwave reflective material forms a resonating layer having a transverse distance (T) at the surface of the food within a range

of from 15 to 20 cm and an axial distance at the surface of the food within a range of from 20 to 26 cm.

7. The method of any one of claims 1 to 6, wherein the microwave reflective material forms a resonating layer having a height of 25 to 45 mm.

8. The method of any one of claims 1 to 7, wherein the bottom side of the container is substantially free of shielding material.

9. The method of any one of claims 1 to 8, wherein the reflective material forms at least a part of a supporting stand that substantially nests the container in a removable manner.

10. The method of claim 9, wherein the stand has a body portion with a wedge-shaped receiving microwave reflective surface to snuggly engage the complementary surface of the container and leverage means pivotally associated to the body portion to act on the bottom surface of the container to disengage the container from the wedge-shaped receiving surface.

11. The method of any one of claims 1 to 8, wherein the microwave reflective material has a thickness of at least 3.2 microns and is coated or attached to the sidewalls of the container.

12. The method of any one of claims 1 to 11, wherein the container is made of ceramic, glass, plastic, cardboard or combination thereof.

13. The method of any one of claims 1 to 8, wherein the reflective material is under the form of a shielding aid member that is configured to be placed substantially around the peripheral sides of the container and is disposable after a limited number of uses.

14. The method of claim 13, wherein the shielding aid member is a single use piece adapted to surround the peripheral sides of a non-disposable container.

15. The method of claim 14, wherein the shielding aid member comprises a layer of cardboard and/or plastic which is associated with a microwave reflective layer.

16. The method of any one of claims 1 to 15, which further comprises removing the food portion in a frozen state from a package of a defined shape and size prior to placing the food portion in the container, wherein the shape and size of the packaged food portion are predetermined to substantially match the shape and size of the cavity of the container.

17. The method of claim 16, wherein the package is disposable and removed for microwave heating of the food and wherein the food is placed in the cavity of the container in a manner to snuggly fit into the cavity of the container.

18. The method of claims 16 or 17, wherein the portion of food is filled in a thermoformed package cell that precisely determines the size and shape of the food portion.

19. A container assembly adapted for receiving and reheating of a food portion with microwaves; comprising a container forming a cavity having peripheral sides and a bottom side for the portioned food to be placed within the cavity, with the peripheral sides of the container being shielded by a microwave reflective material and the microwave reflective material of the peripheral sides defines a circumference having axial (A) and transverse (T) distances that are determined so as to promote propagation of certain resonant modes inside the cavity and in a food portion that is placed into the cavity, thus resulting in a more uniform heating food pattern and a more uniform heating of the food portion, wherein the resonating layer is arranged so that the TE modes predominantly supported in the cavity are $TE_{n,m,l}$ modes where n, m, l are such that $0 \leq n \leq 4$, $0 \leq m \leq 2$ and $0 \leq l \leq 1$.

20. The container assembly of claim 19, wherein the microwave material forms a resonating layer having a transverse distance (T) of about 13 cm or less, an axial distance (A) of about 20 cm or less, and a height of about 10 to 60 mm.

21. The container assembly of claim 19, wherein the microwave material forms a resonating layer having a transverse distance (T) of from 18 to 22 cm and an axial distance (A) of from 20 to 26 cm.

22. The container assembly of claims 19, 20 or 21, wherein the bottom side is substantially free of reflective material.

23. The container assembly of any one of claims 19 to 22, wherein the resonating layer has a circular or oval contour.

24. A stand-like device for improving the heating of food in a container, comprising a support body of a shape adapted for receiving a container in a removable manner and a circumferential shielding surface of microwave reflective material adapted to be positioned substantially adjacent to peripheral sidewalls of the container, wherein the microwave reflective material of the circumferential shielding surface is defined by axial (A) and transverse (T) distances that are determined so as to change the wavelength of resonant modes inside the cavity and inside of a food portion placed within the cavity thereby resulting in a more uniform heating food pattern and a more uniform heating of the food portion, wherein the change of wavelength is a shortening of said wavelengths of resonant mode, so that the transverse electric (TE) modes predominantly supported in the cavity are $TE_{n,m,l}$ where n, m, 1 are such that $0 \leq n \leq 4$, $0 \leq m \leq 2$ and $0 \leq l \leq 1$.

25. The stand-like device of claim 24, wherein the support body is made of a metal and includes a wedge-shaped receiving surface to snuggly engage the complementary surface of the container, and leverage means pivotally associated to the metal body to act on the bottom surface of the container to disengage the container from the wedge-shaped receiving surface.

26. A method for more evenly heating a meal served in a reusable dish by microwaves which comprises placing a food portion in the stand-like device of claim 24 or 25 and subjecting the device and food portion to microwaves to obtain a more uniform heating of the food portion.

27. The method of claim 26, wherein the dish is a ceramic or ceramic-like dish or plastic.

28. The method of claim 26, wherein the dish is a "plat à sabot" or a "china plate".

29. A shielding aid for improving the microwave heating of food in a container forming a band of microwave reflective material of a shape configured for surrounding the peripheral sides of the container to provide a circumferential shielding surface of microwave reflective material,

wherein the band is made of a destroyable material adapted for a limited number of uses and,

wherein the band forms a microwave reflective circumference having axial and transverse distances that are determined so as to change the wavelength of resonant modes in the supporting cavity, wherein the change of wavelength is a shortening of said wavelength, so that the TE modes predominantly supported in the cavity are $TE_{n,m,l}$ where n, m, l are such that $0 \leq n \leq 4$, $0 \leq m \leq 2$ and $0 \leq l \leq 1$.

30. The shielding aid according to claim 29, wherein the band is a thin band of cardboard and/or plastic coated with a reflective material configured to connect to the sides of the container.

31. The shielding aid according to claims 29 or 30, wherein the band has substantially the form of a crown.

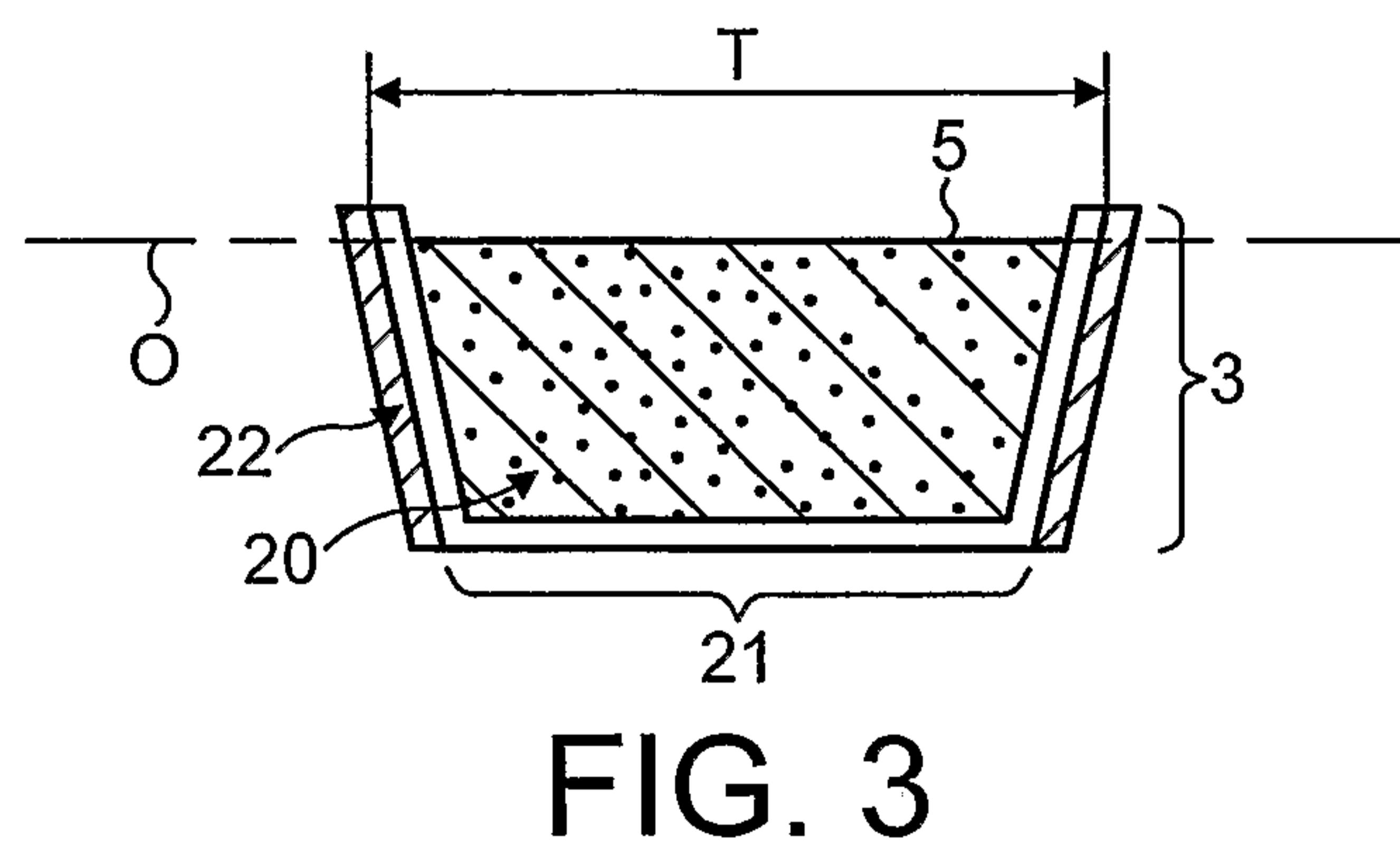
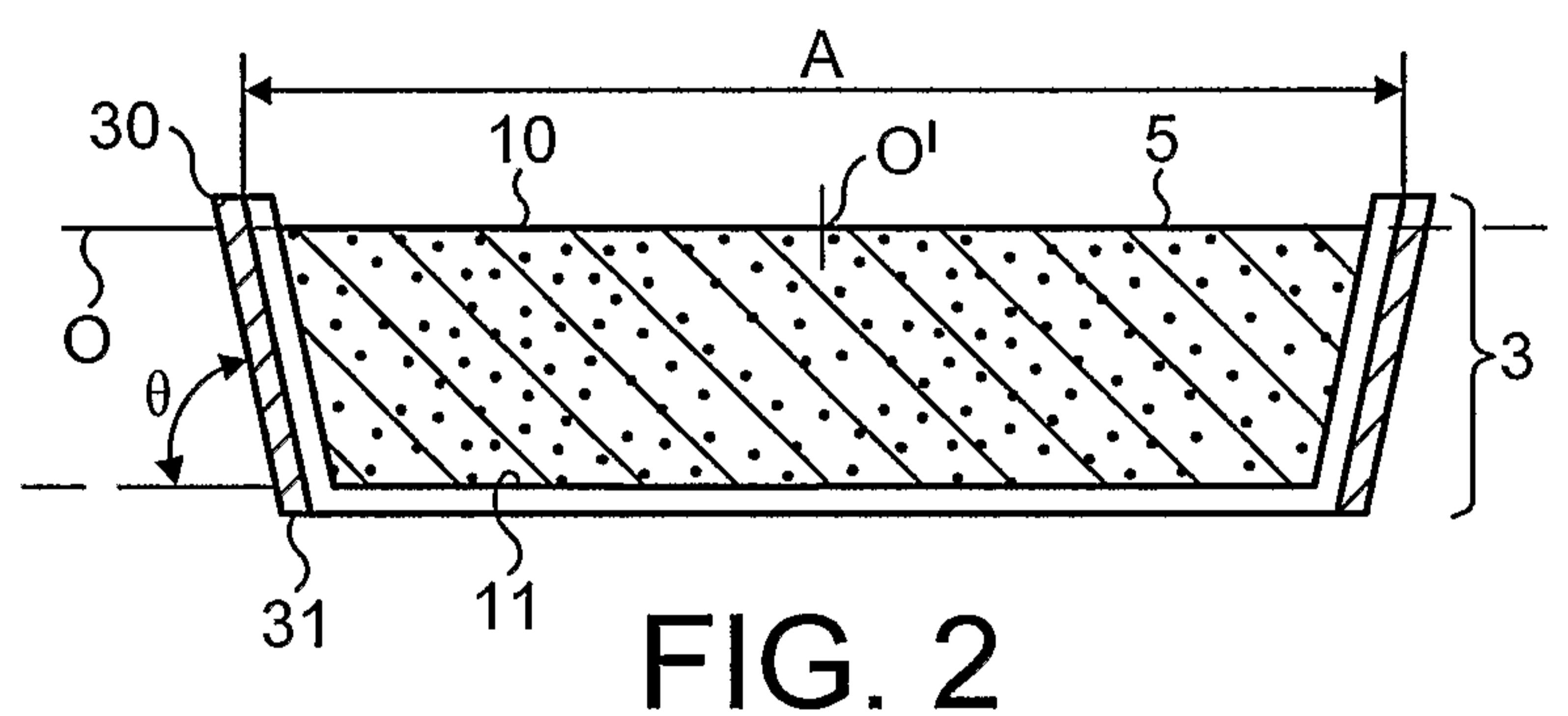
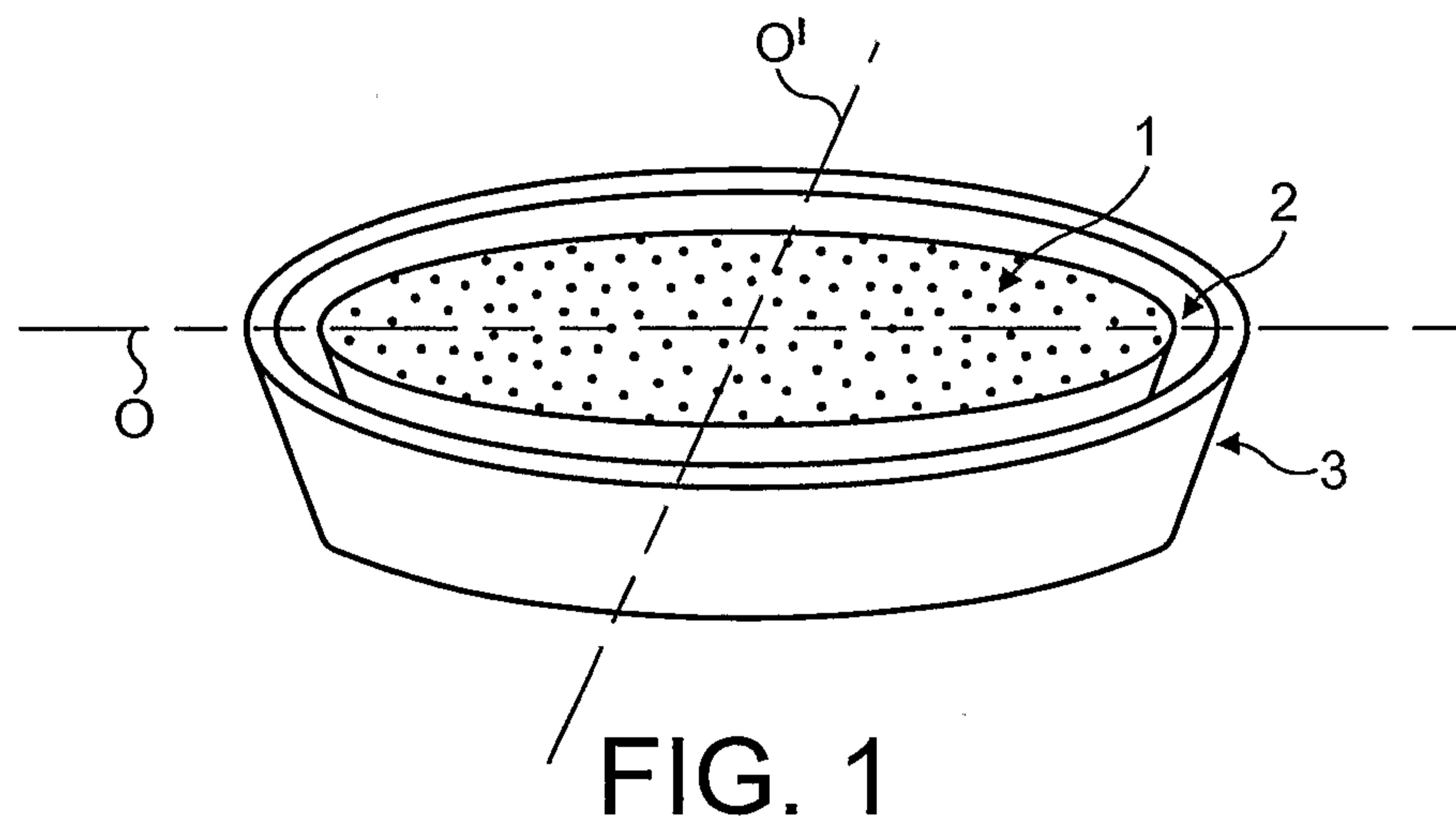
32. The shielding aid according to any of claims 29 to 31, wherein the band is destroyed by the effect of separating the band from the container after heating.

33. The shielding aid according to claim 32, wherein the band comprises an adhesive layer at its inner surface to adhesively attach to the sides of the container and wherein the effect of separating the band from the container after heating destroys the adhesive layer or creates a tearing of the band.

34. The shielding aid according to claim 31, wherein the band comprises a piece of shrinkable polymeric material that shrinks at the particular heating conditions in the microwave.

35. A method for more evenly heating a meal served in a dish by microwave heating which comprises placing the food in the dish and placing the shielding aid of any one of claims 29 to 34, about the sides of the dish and subjecting the so shielded dish to microwave heating to obtain a more uniform heating of the food in the dish.

1 / 13



2 / 13

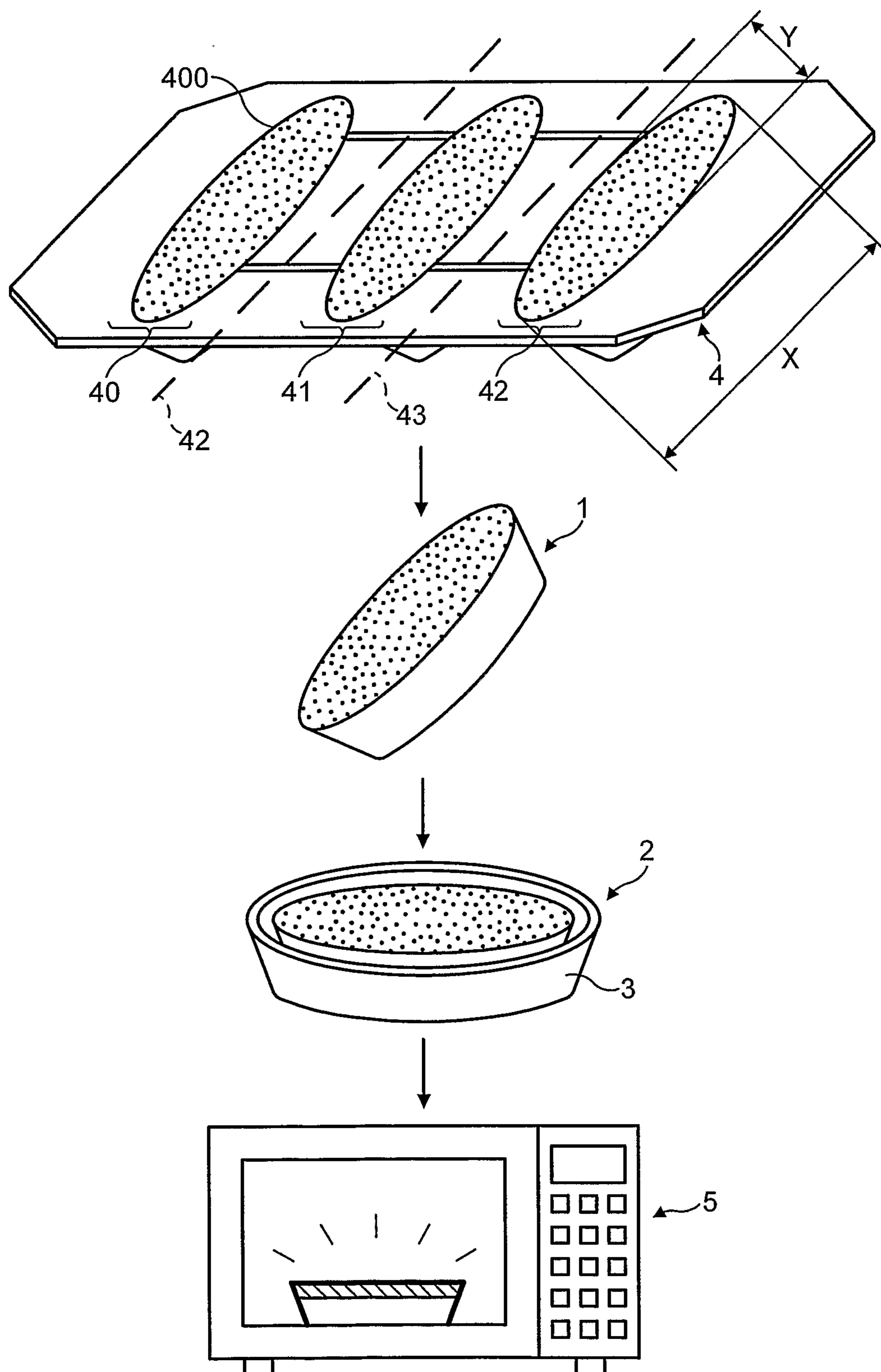


FIG. 4

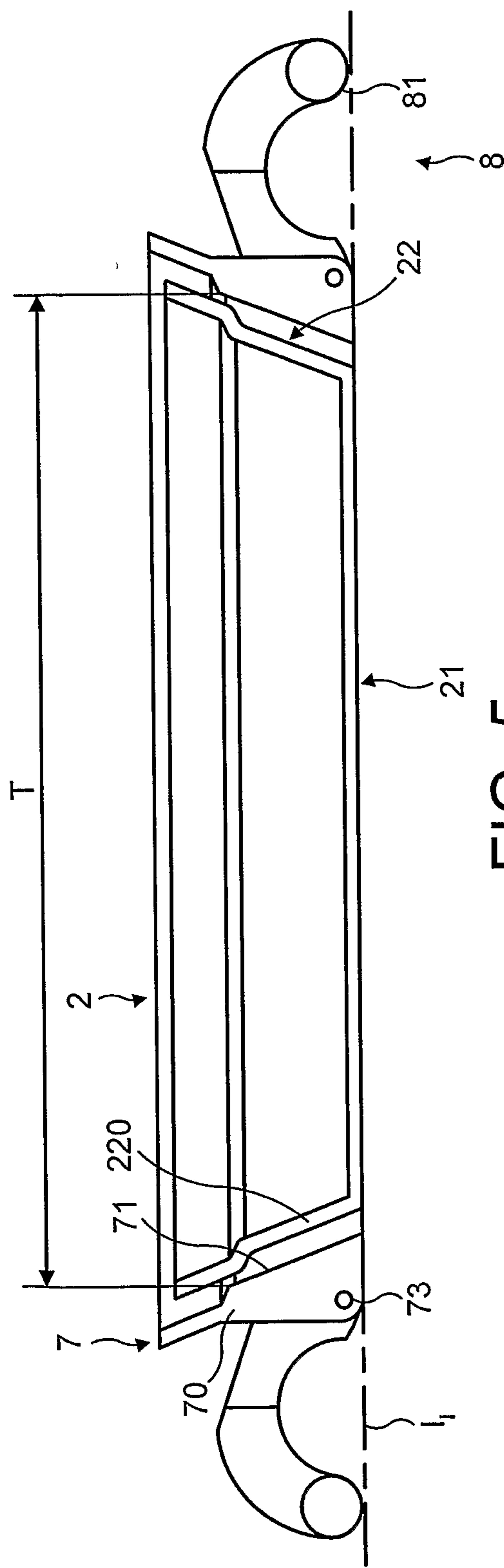


FIG. 5

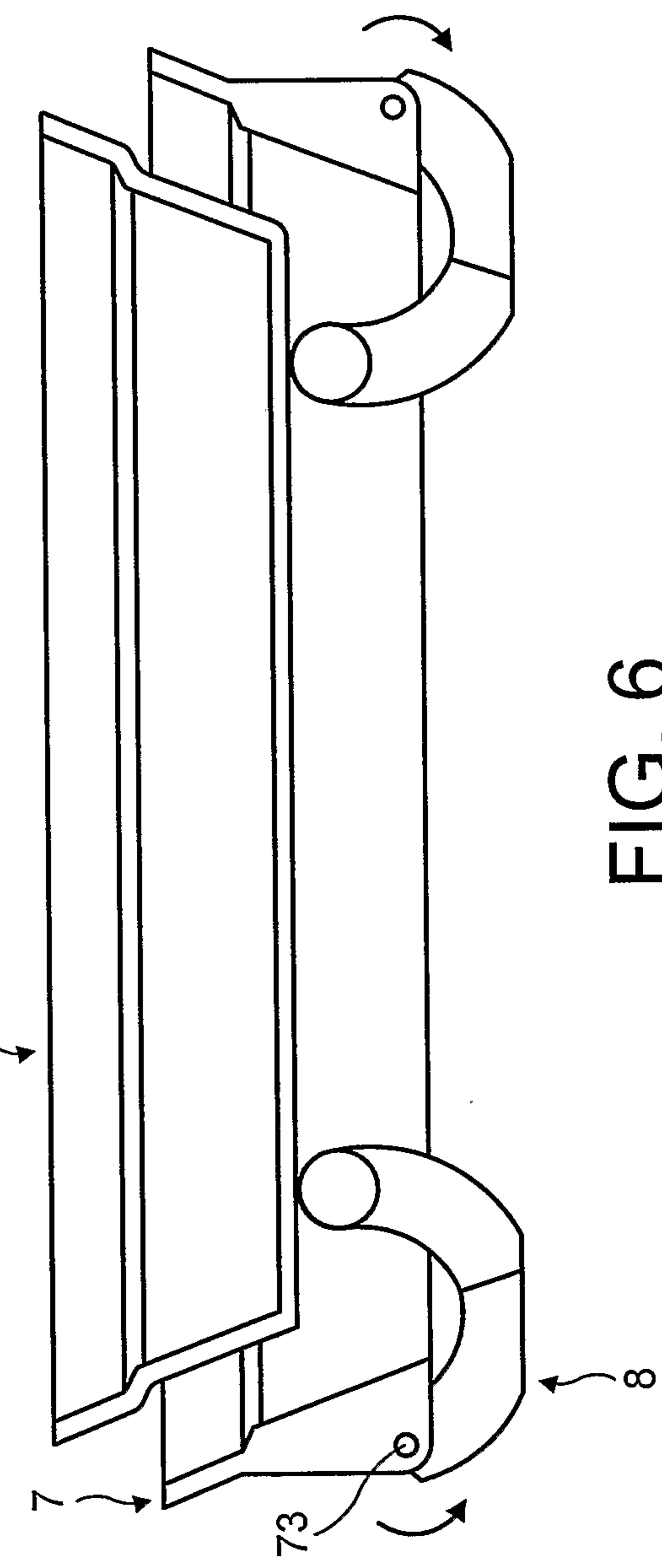


FIG. 6

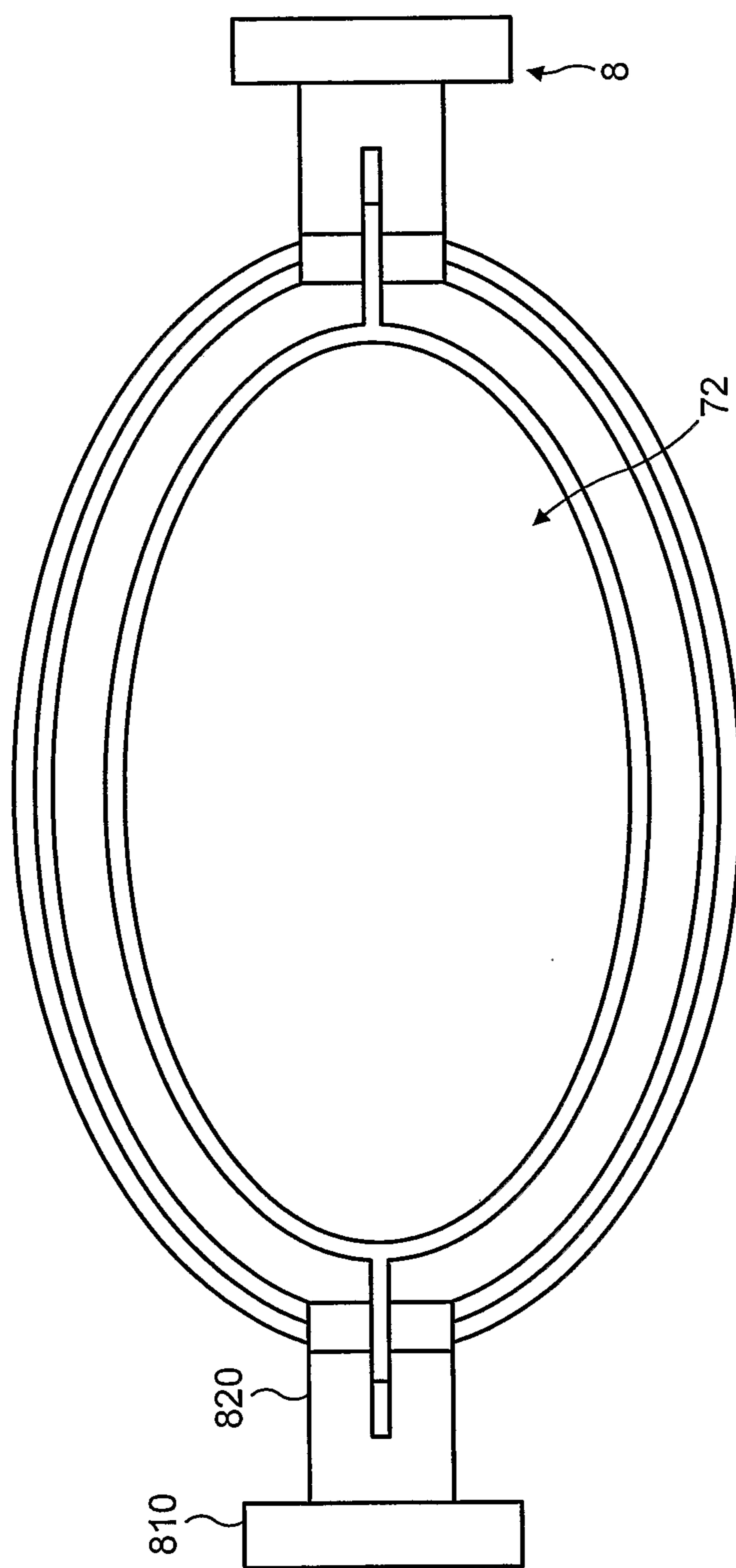
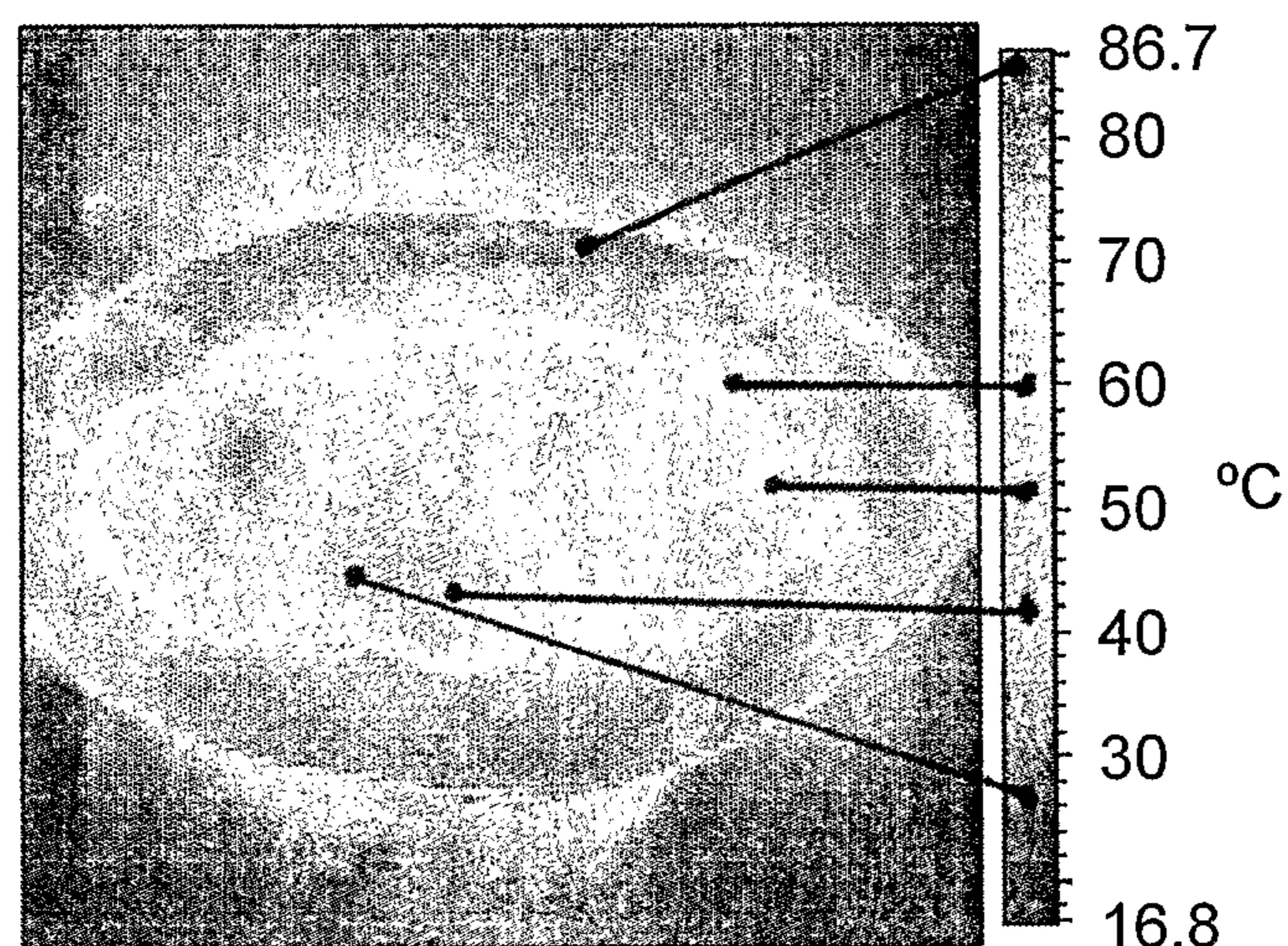
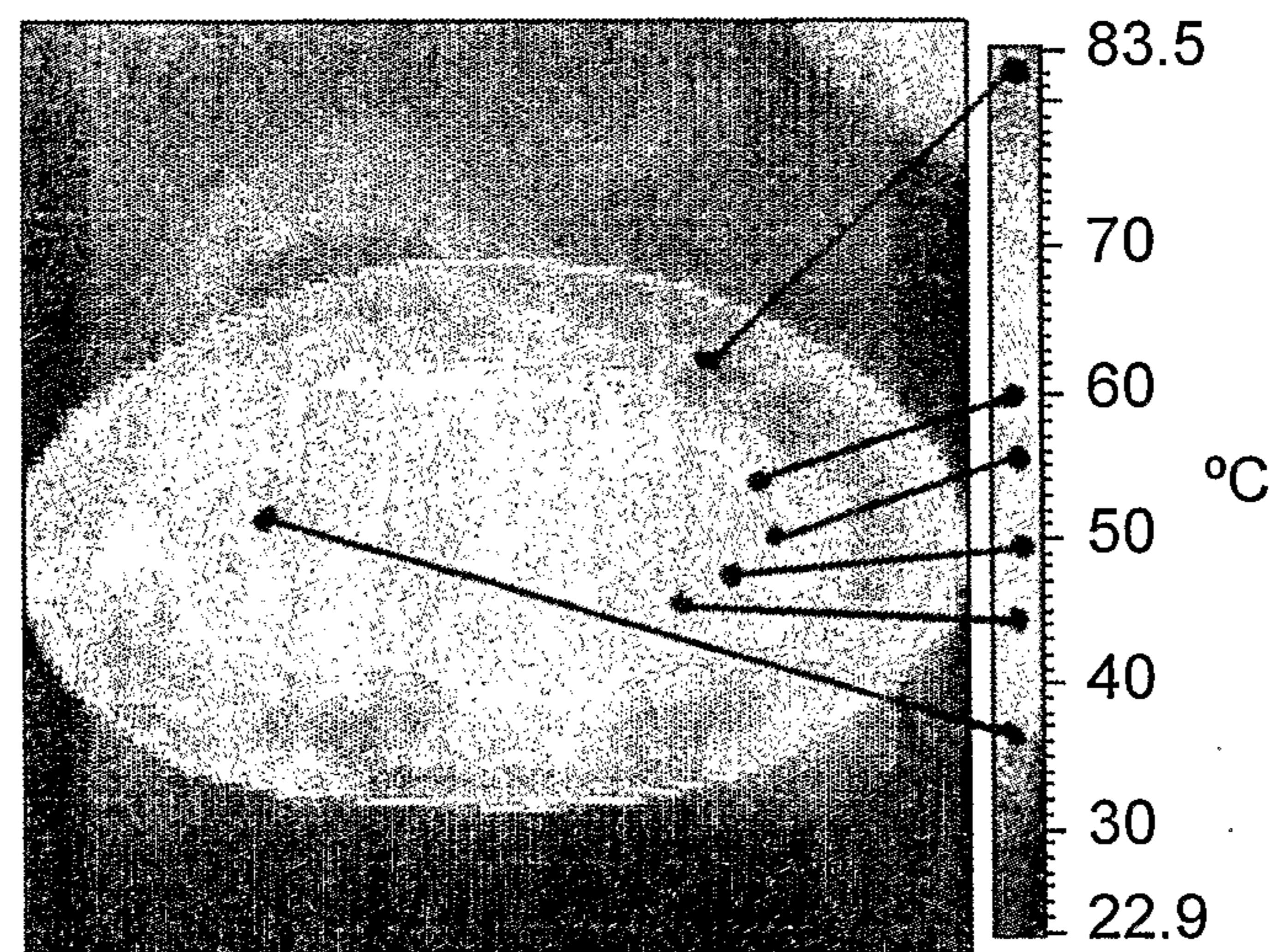


FIG. 7

5 / 13



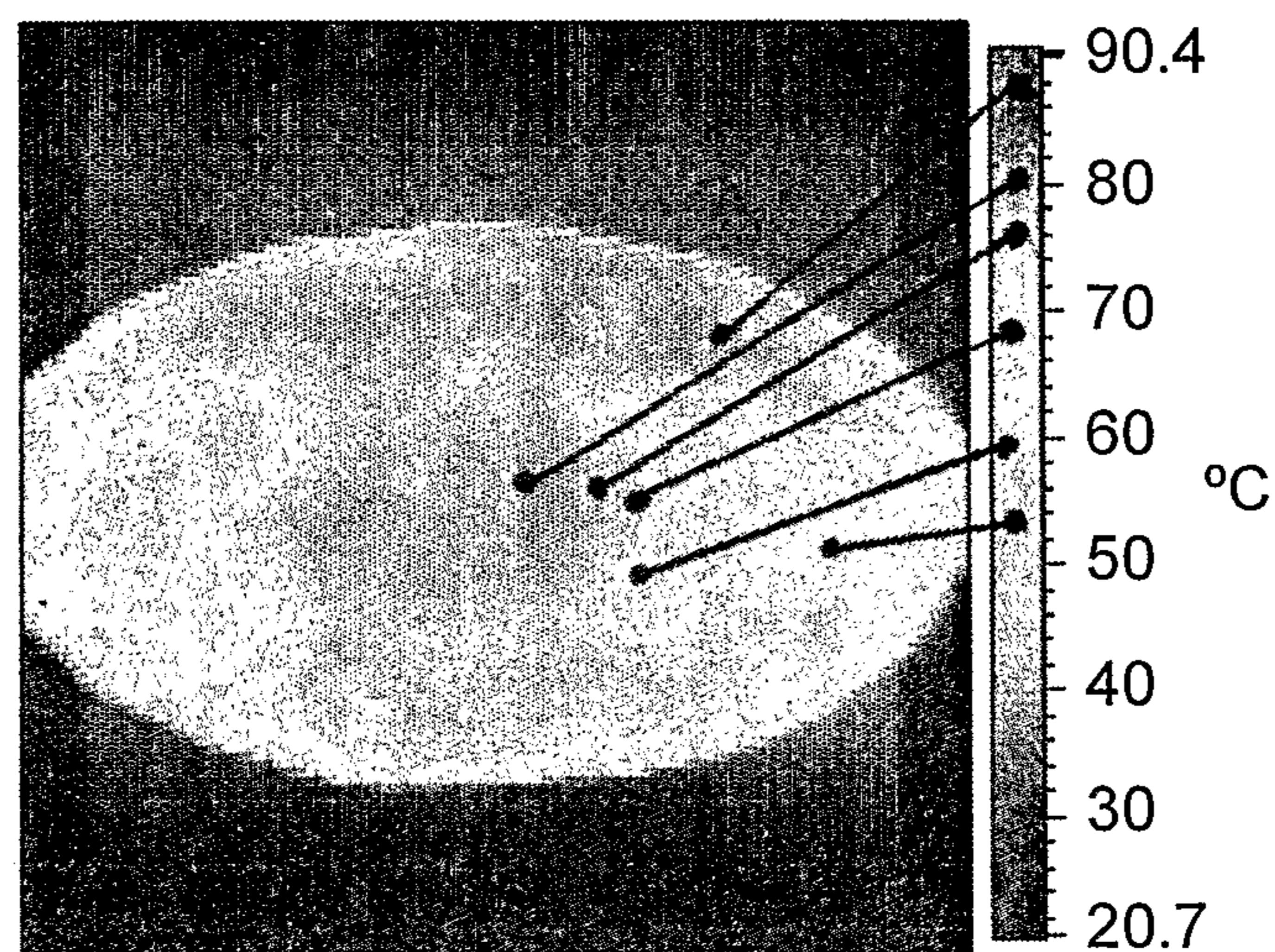
IR00135.ISI

FIG. 8

IR00133.ISI

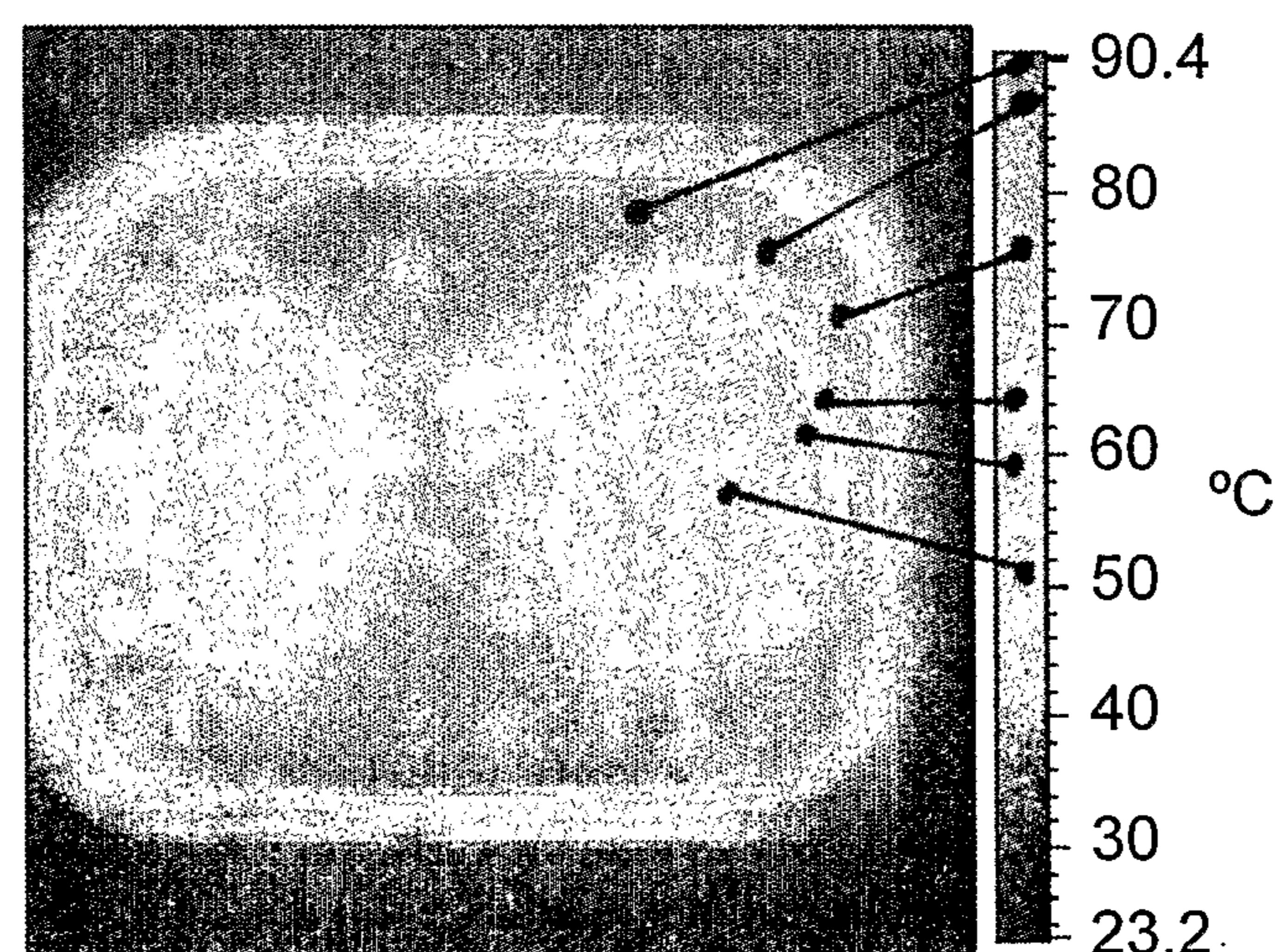
FIG. 9

6 / 13



IR00134.ISI

FIG. 10

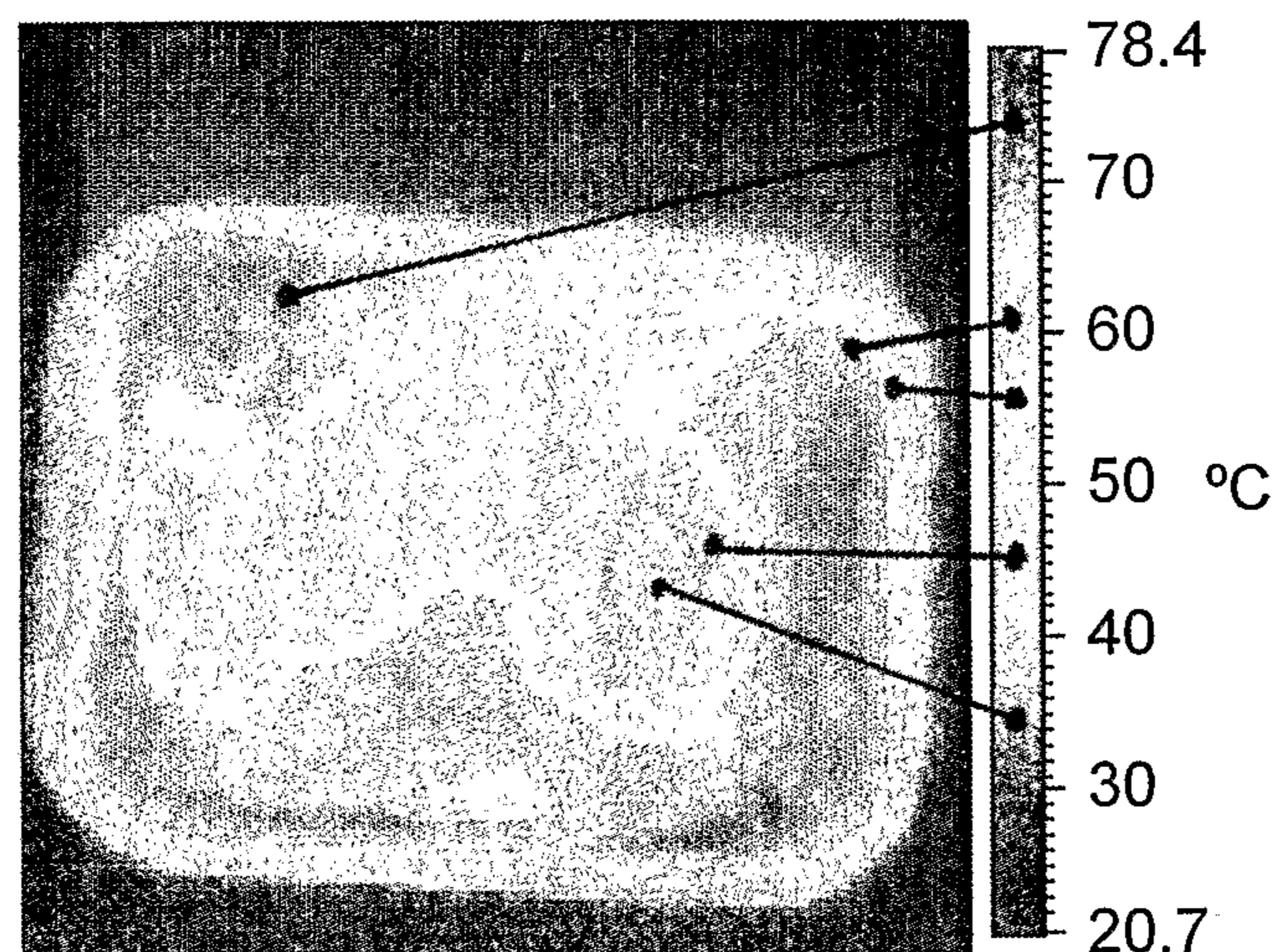


IR00140.ISI

FIG. 11

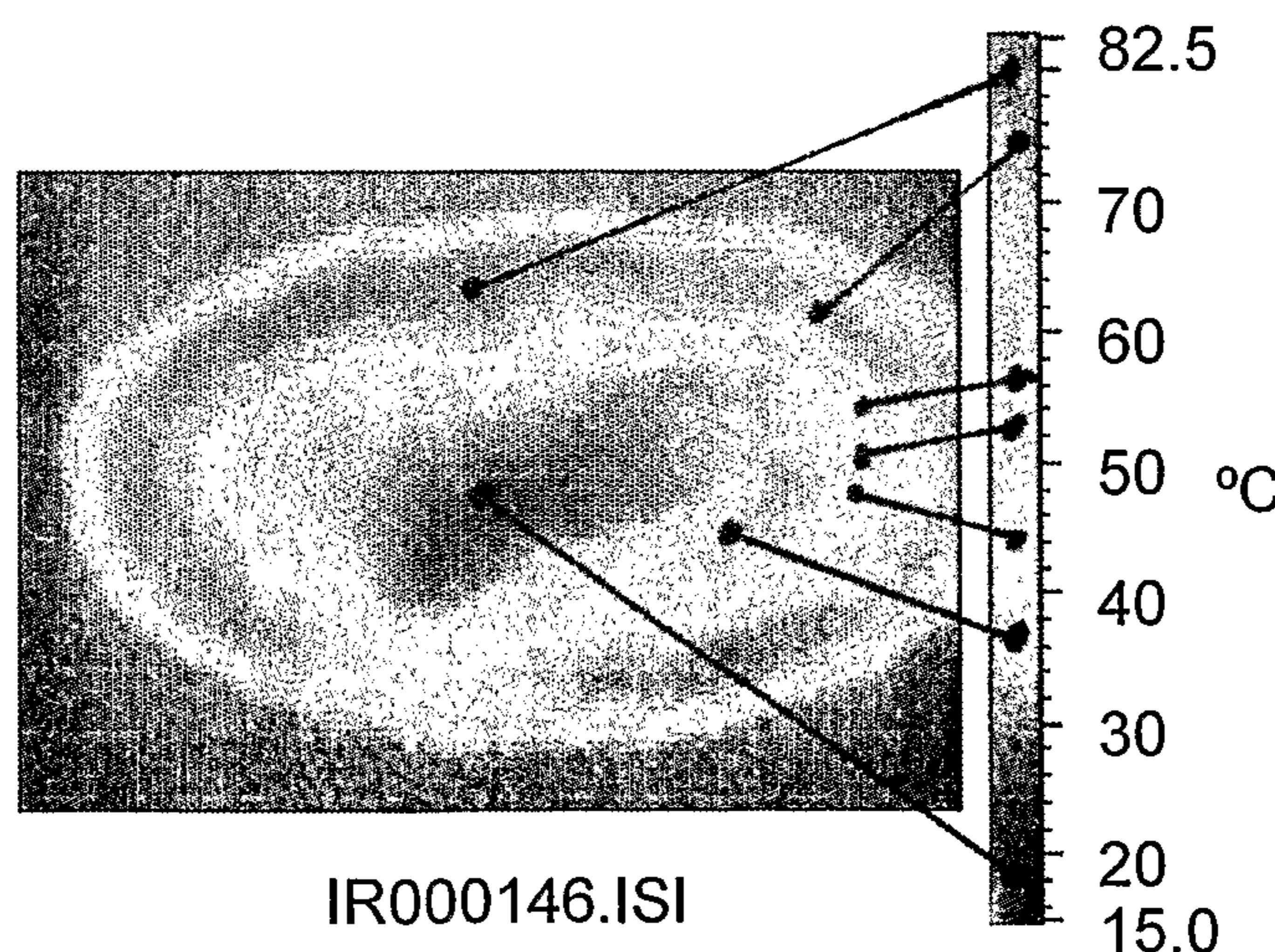
SUBSTITUTE SHEET (RULE 26)

7 / 13



IR00141.ISI

FIG. 12



IR000146.ISI

FIG. 13

SUBSTITUTE SHEET (RULE 26)

8 / 13

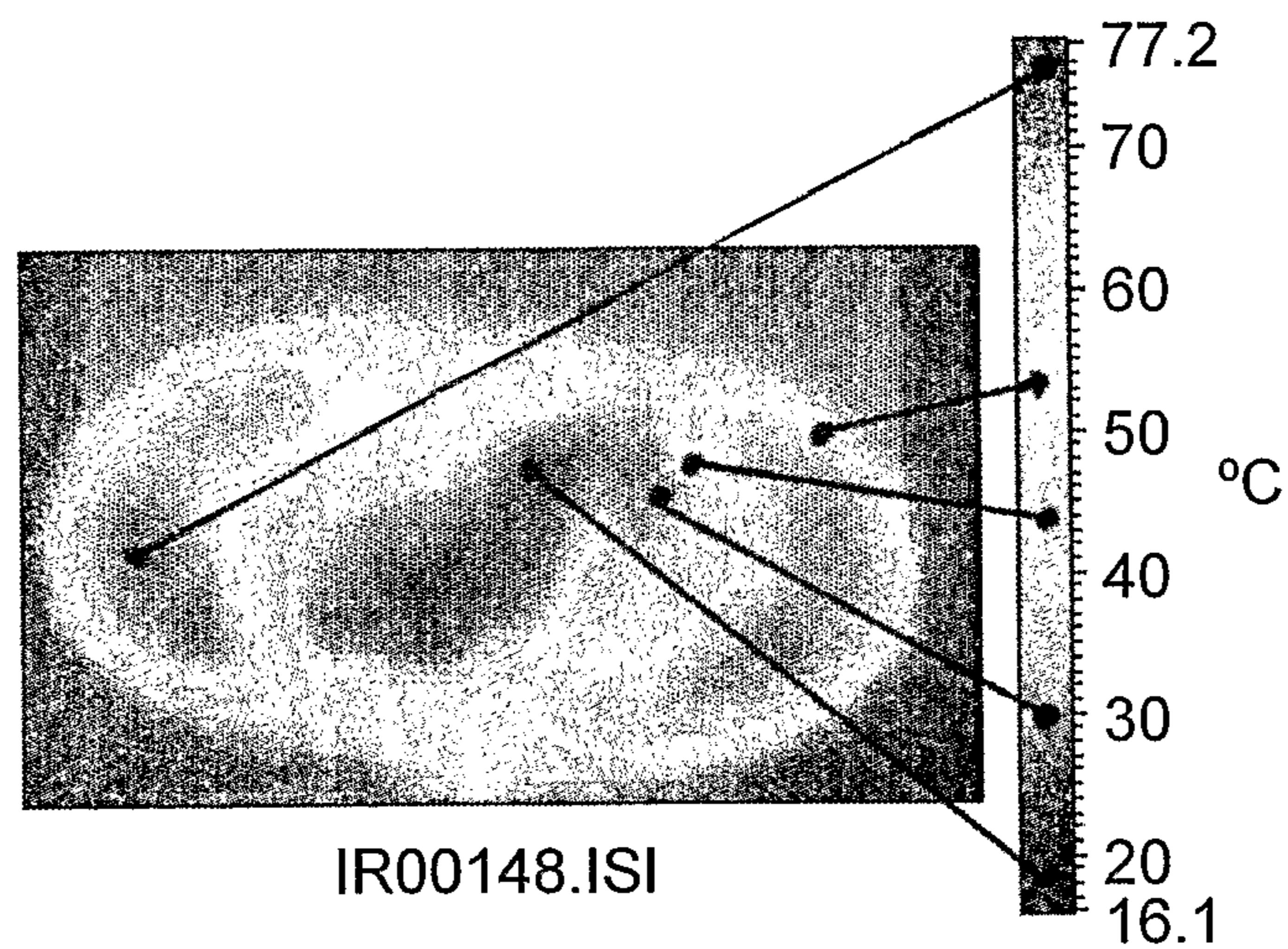


FIG. 14

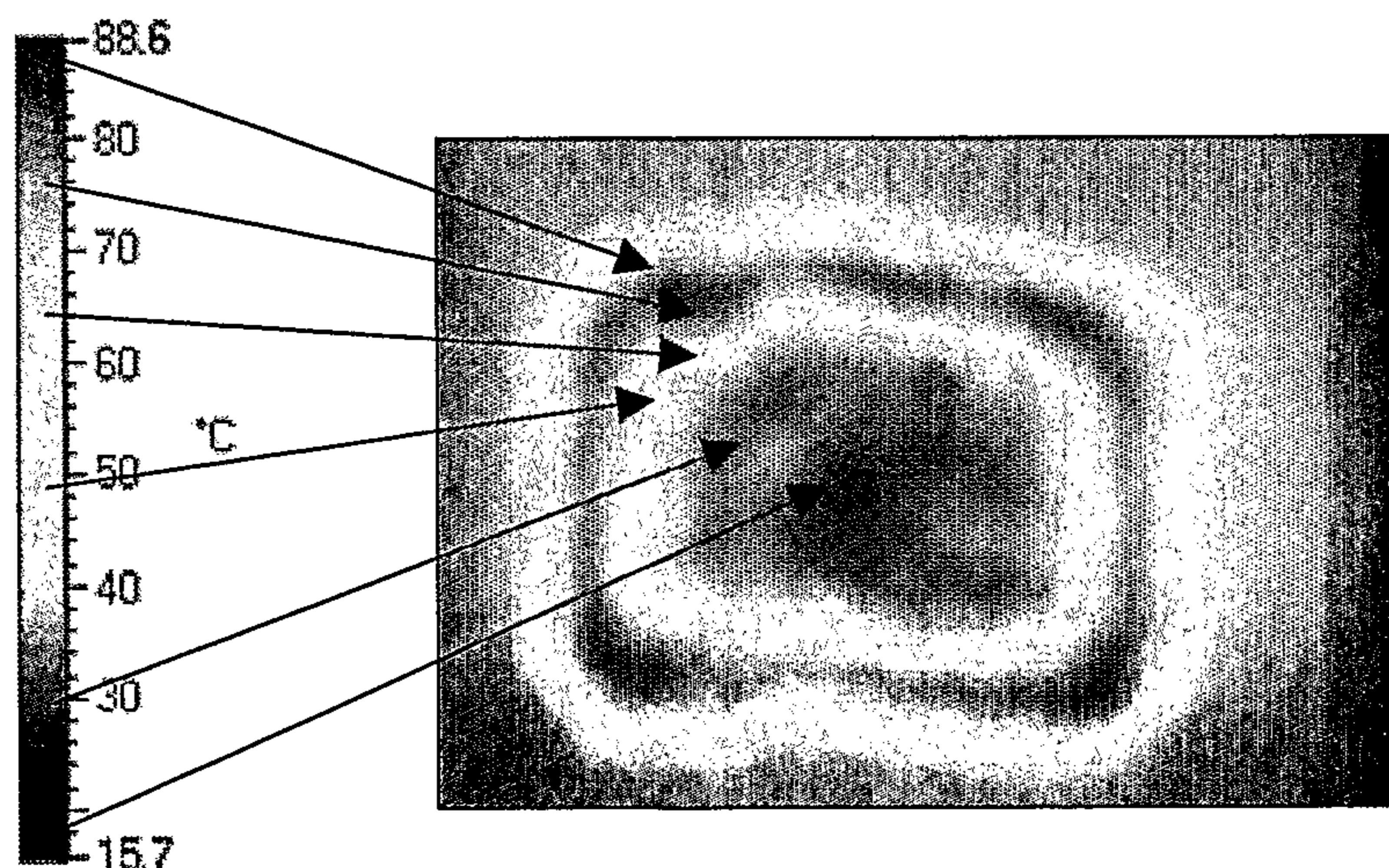


FIG. 15

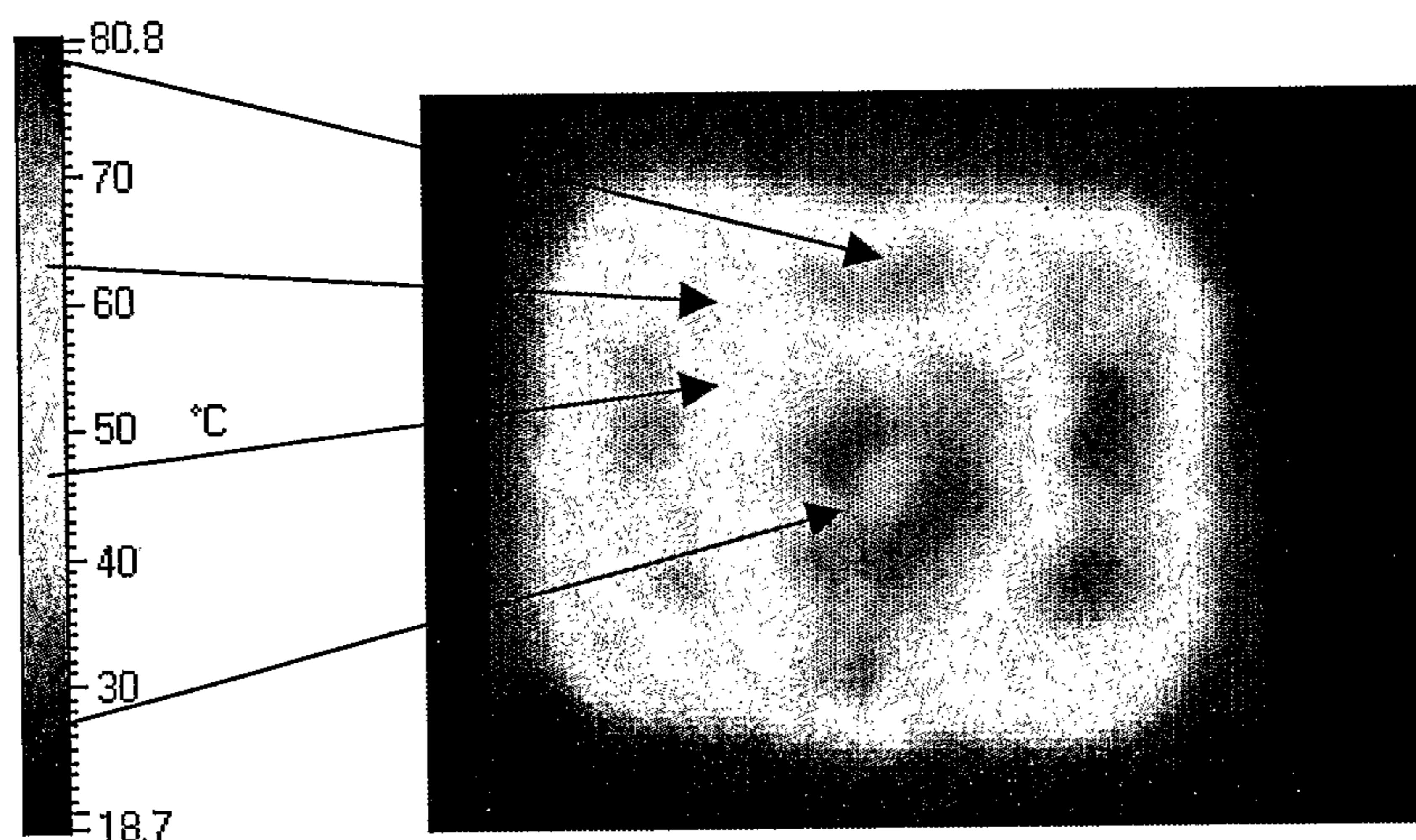


FIG. 16

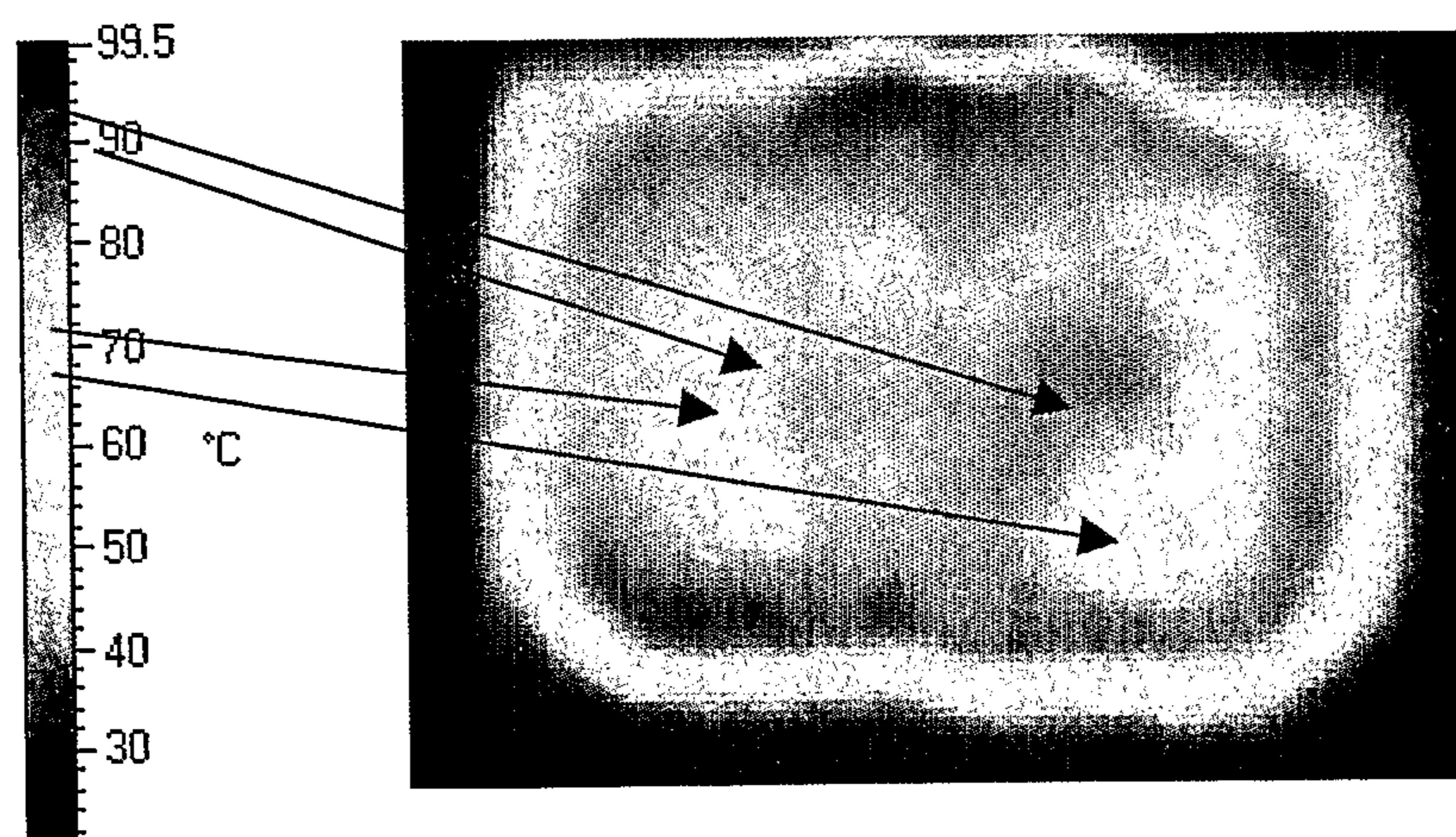


FIG. 17

10 / 13

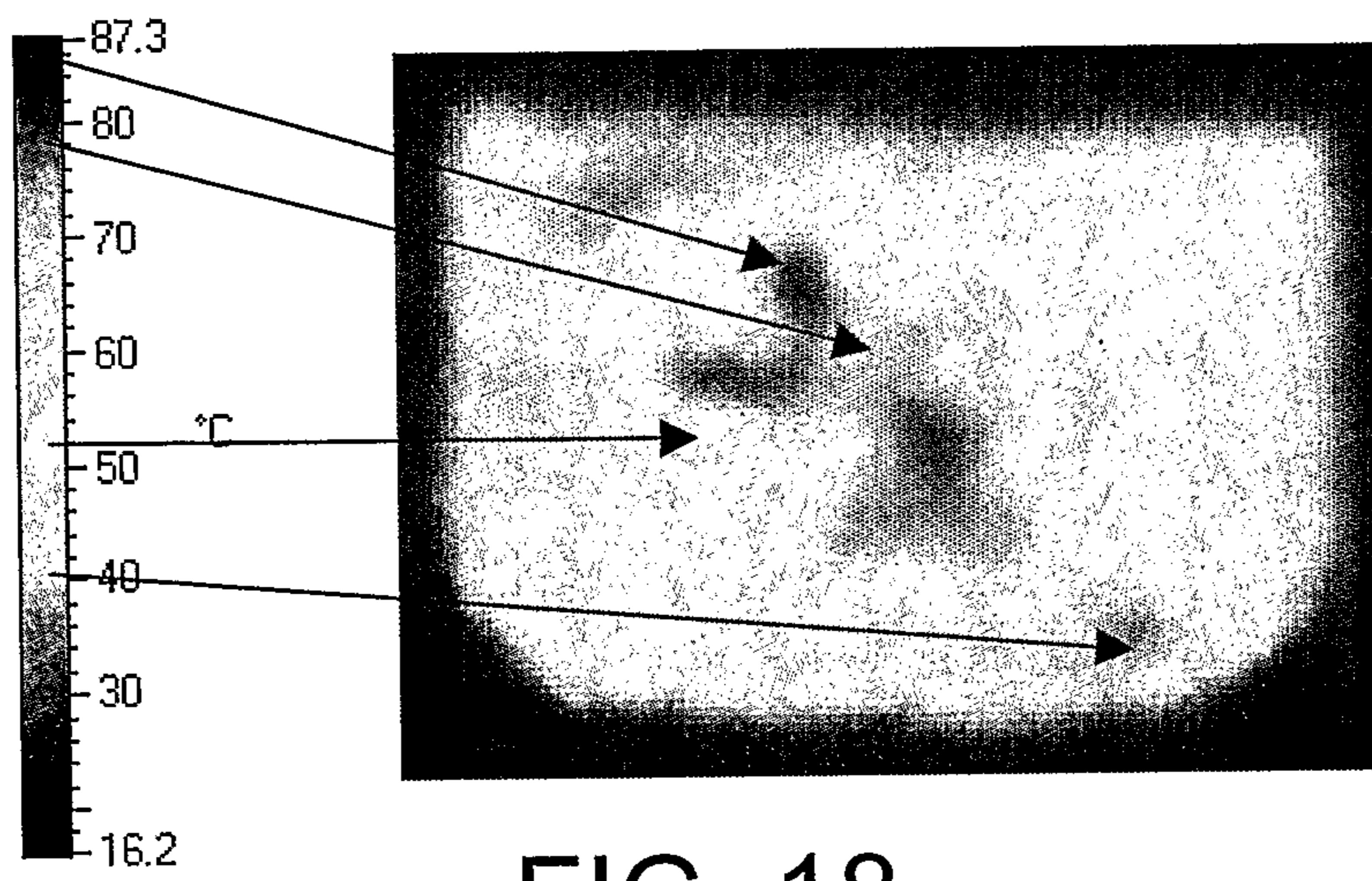


FIG. 18

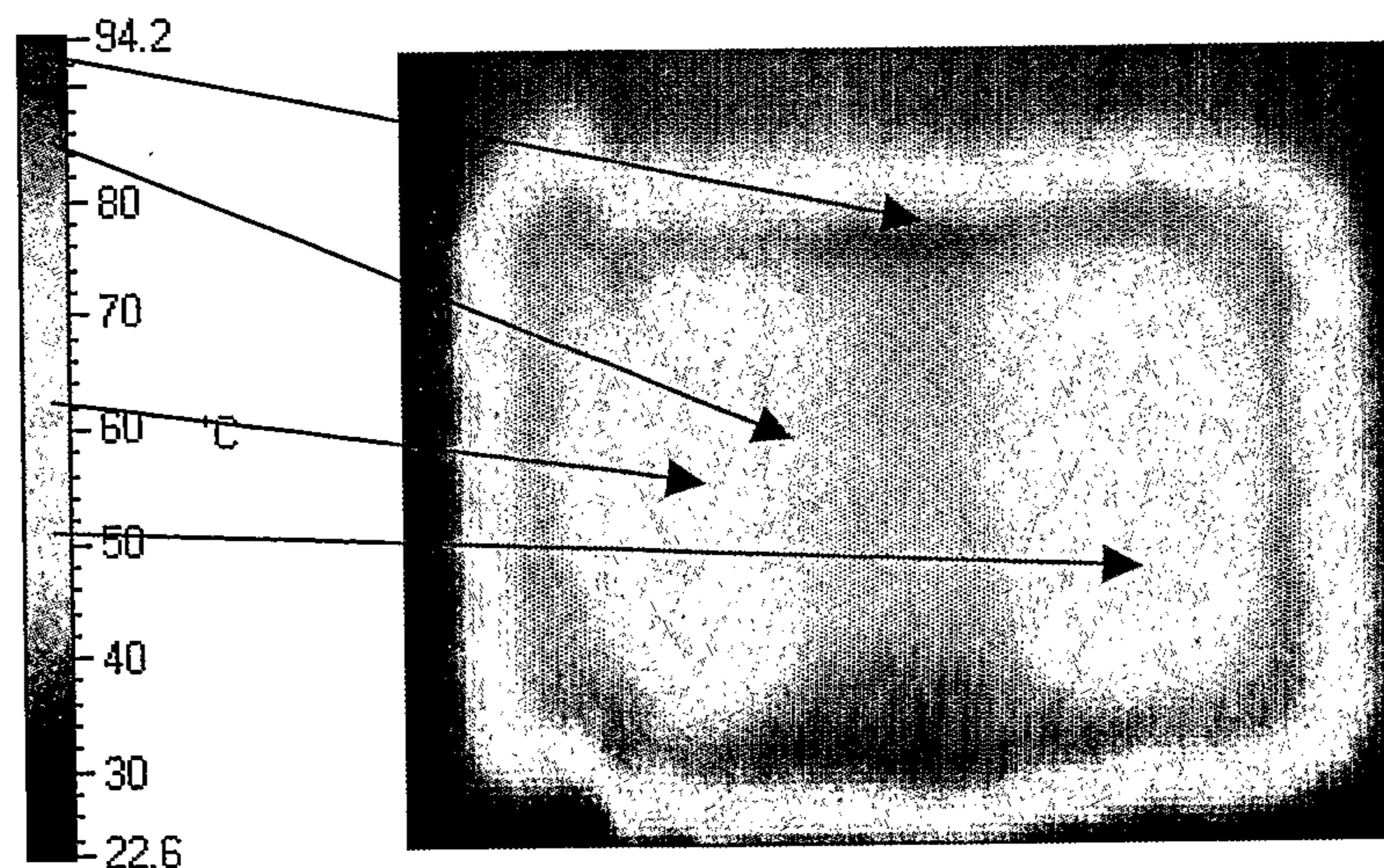


FIG. 19

11 / 13

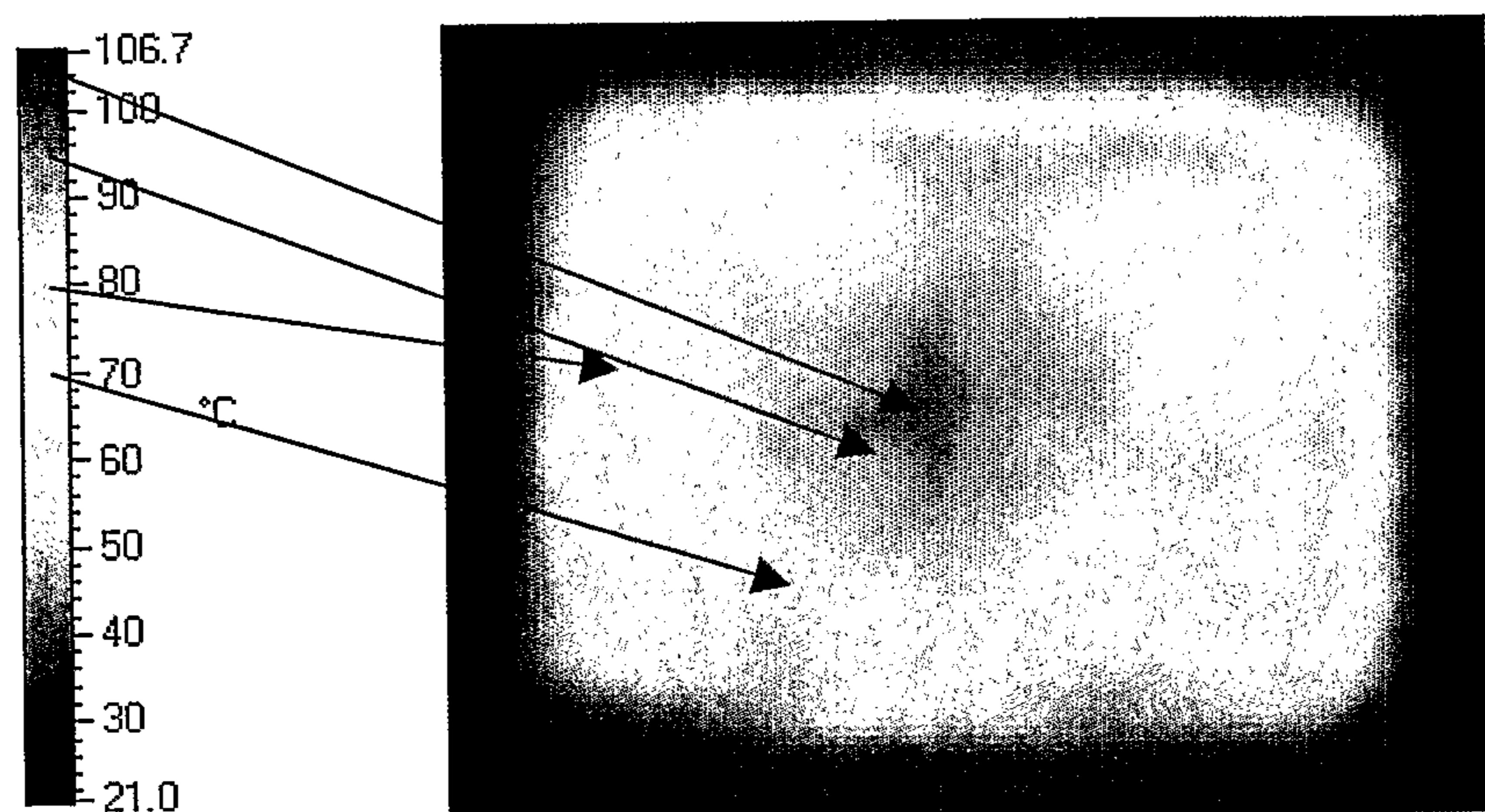


FIG. 20

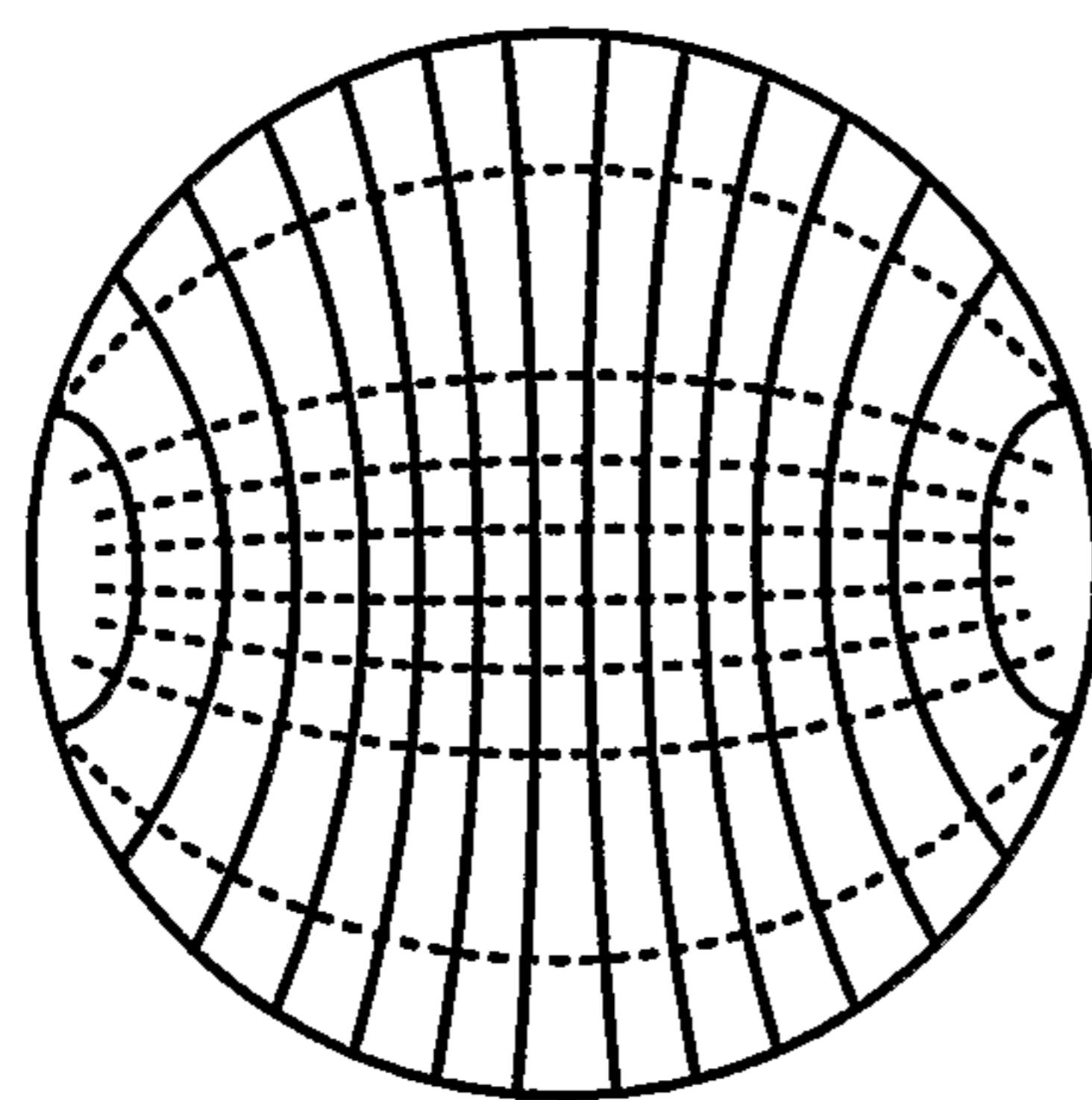


FIG. 21

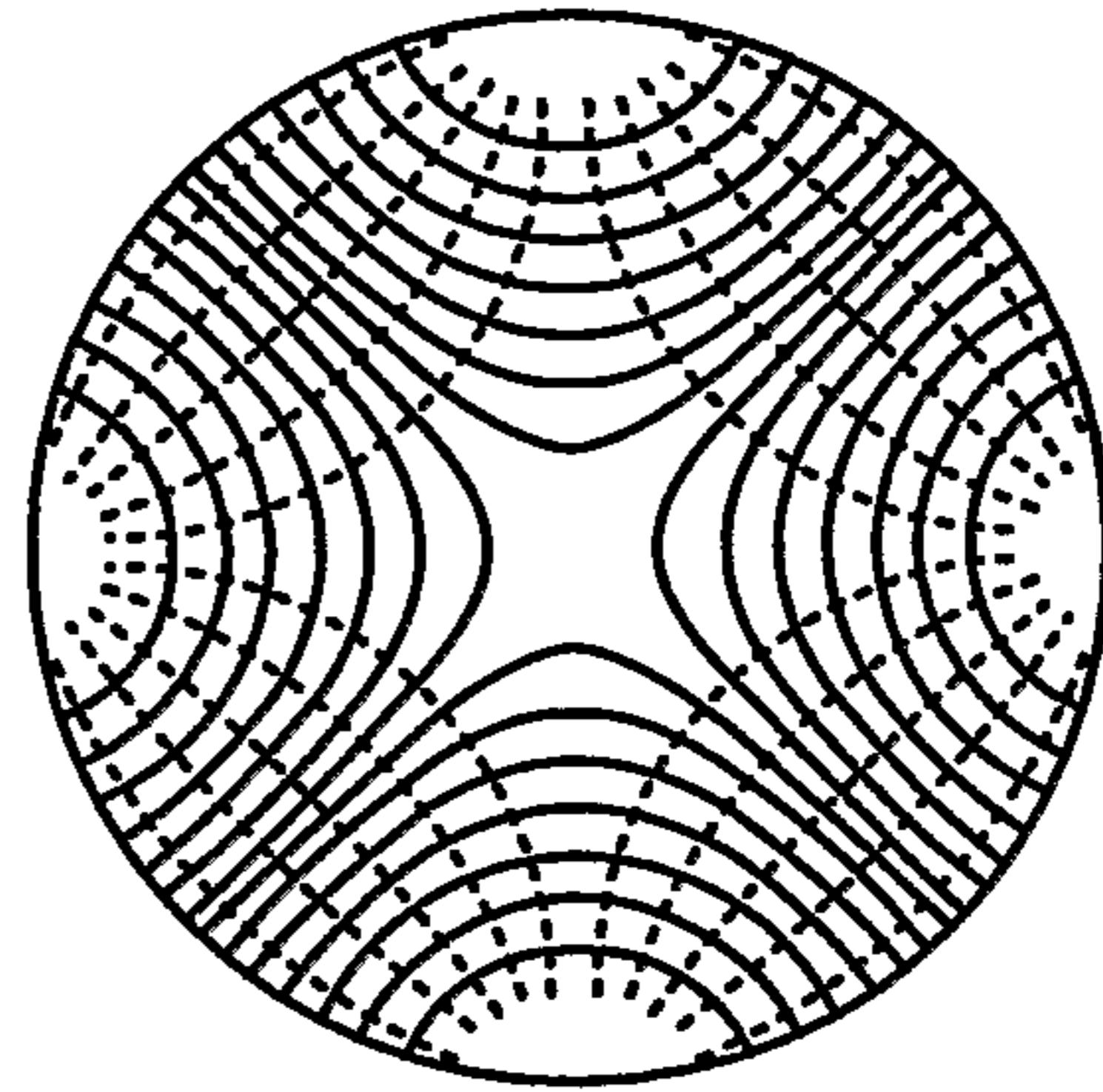


FIG. 22

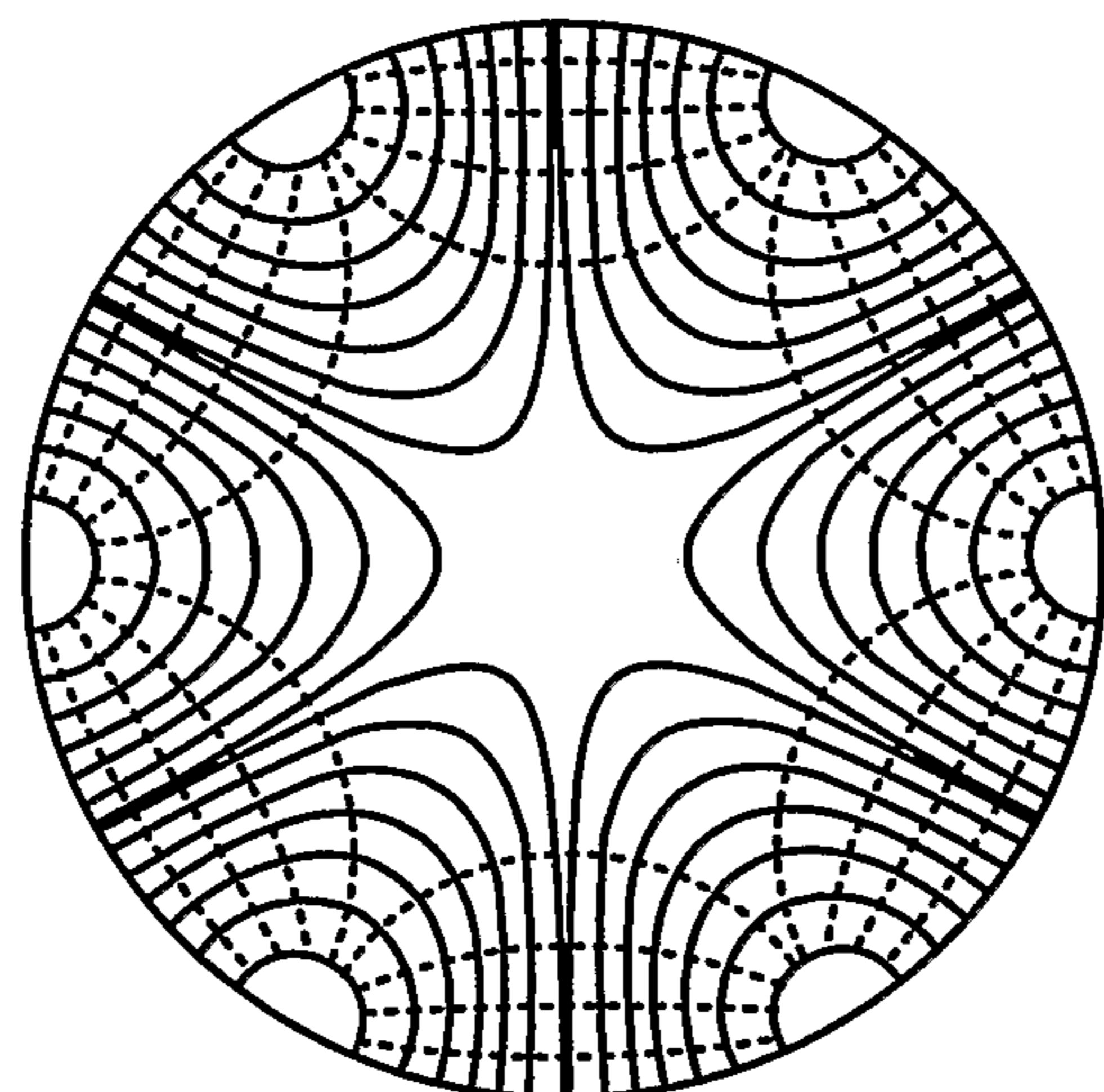


FIG. 23

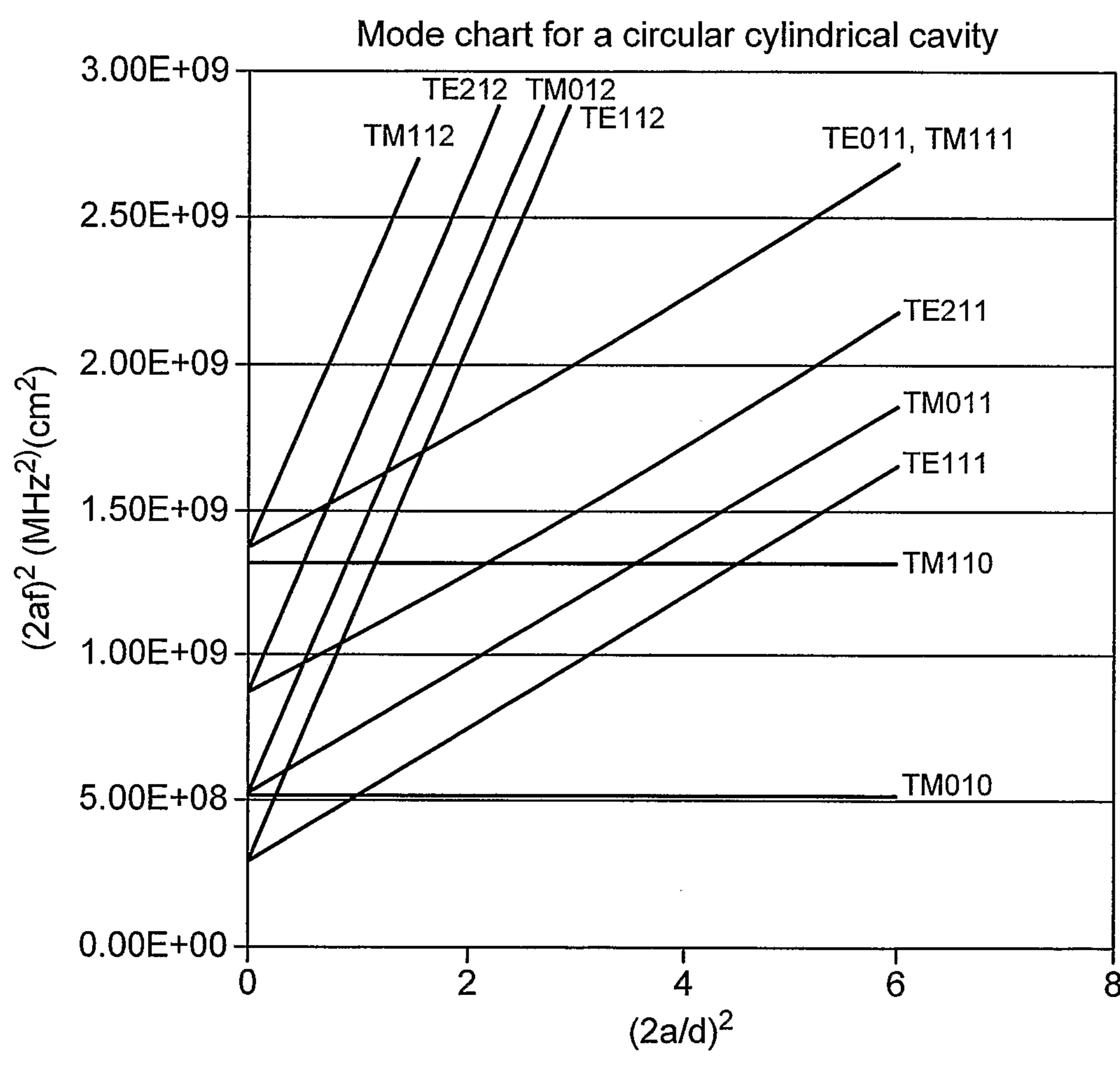
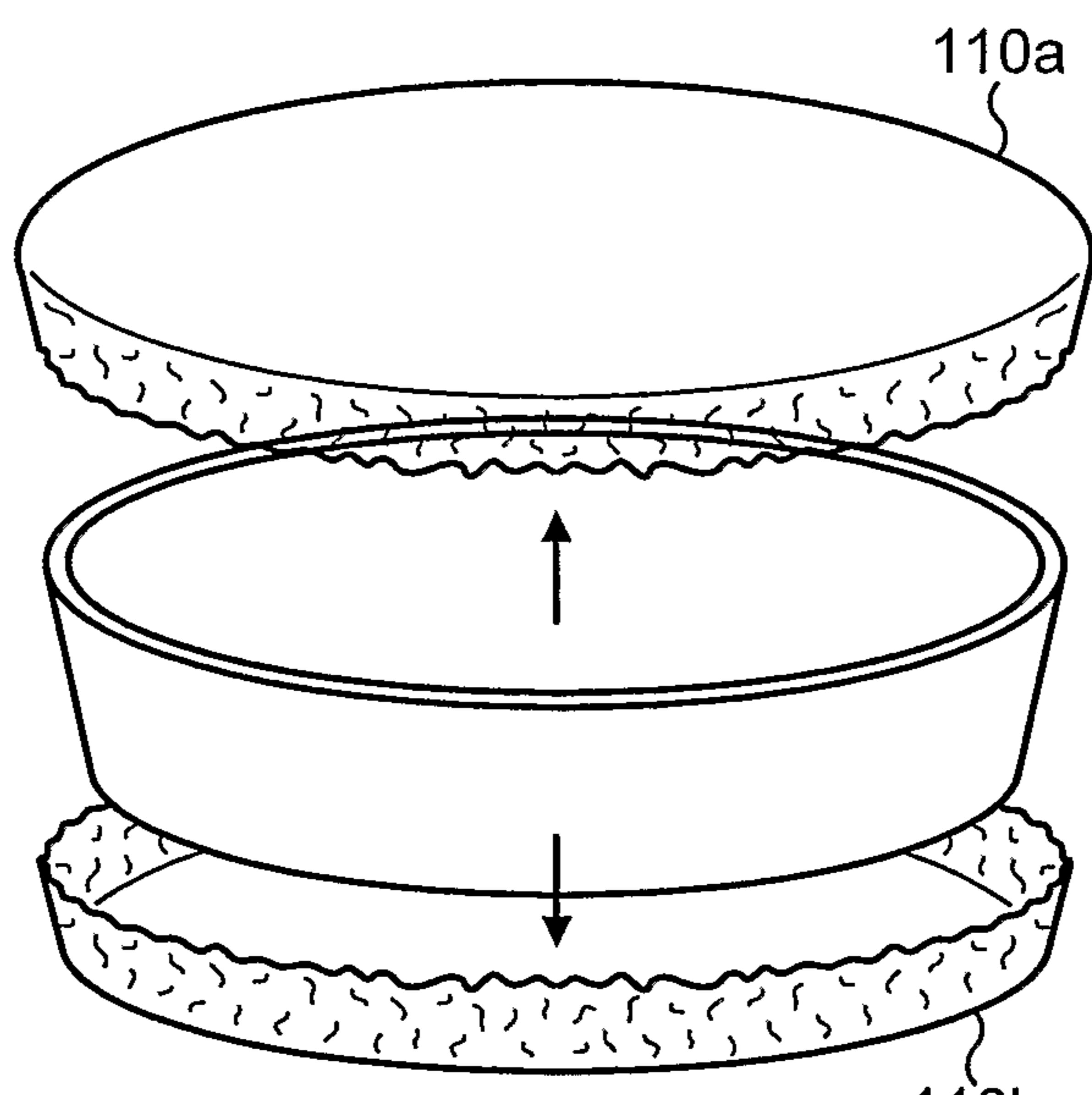
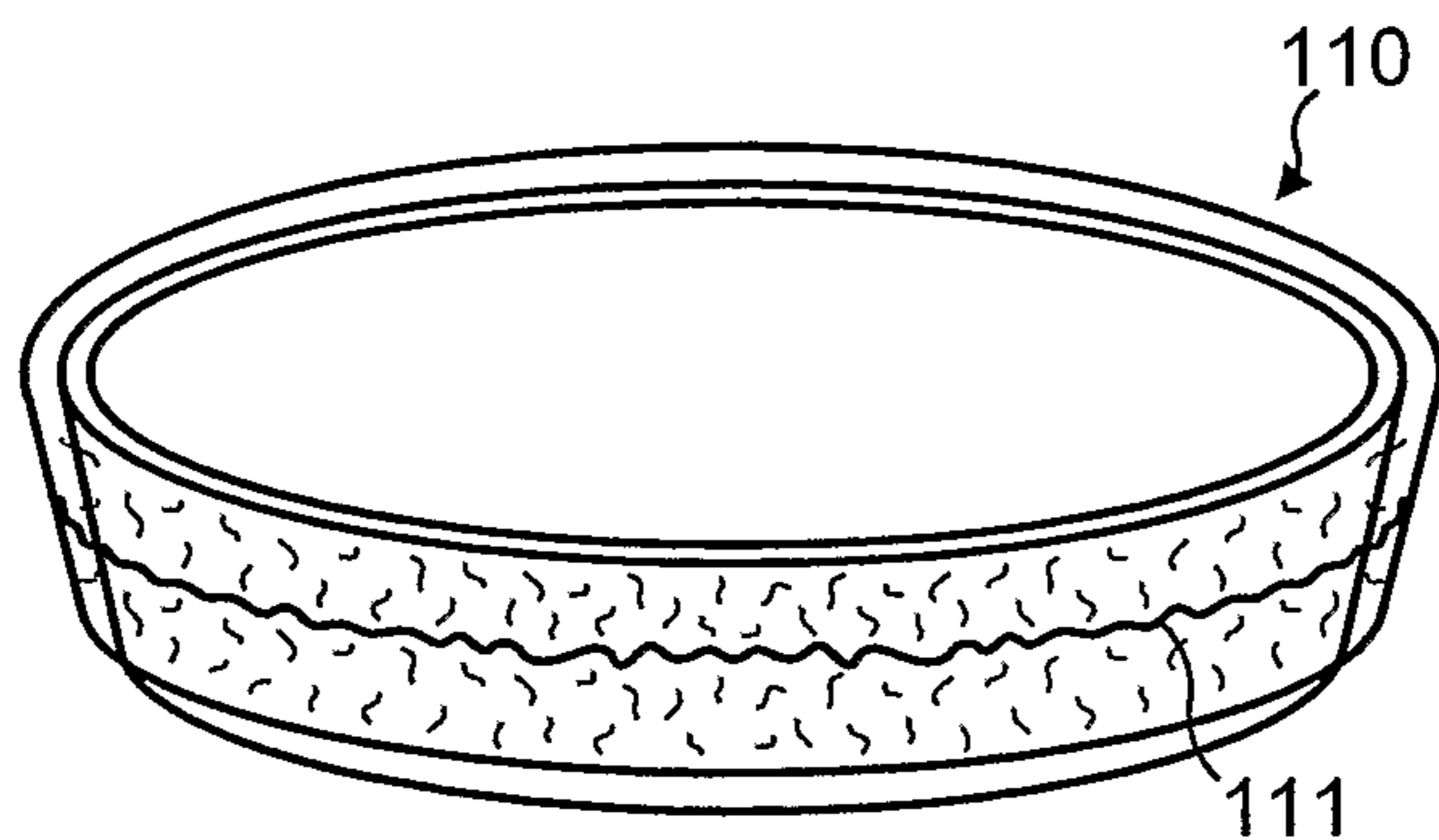


FIG. 24

13 / 13



SUBSTITUTE SHEET (RULE 26)

