

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO	
RAD: 14-119143- -3	FECHA: 2015-07-28 14:35:55
DEP: 2020 DIRECCION DE NUEVAS CREACIONES	EVE: 378 FASE NACIONAL INCLUIDO CAPITULO I
TRA: 11 PCT-PATENTE DE INVENCION CAPITULOS I Y II	FOLIOS: 5
ACT: 430 REQUERSOLICITA	

DIRECCIÓN DE NUEVAS CREACIONES

2020
Bogotá, D.C.,

Abogado(a)/Señor(a)
LUZ CLEMENCIA DE PÁEZ

Asunto: Radicación: 14-119143- -3
 Trámite: 11
 Evento: 378
 Actuación: 430
 Oficio: 8967
 Folios: 5

Patente de Invención	X			Patente de Modelo de Utilidad	
Vía Nacional					
Vía PCT (Fase Nacional)	X	Capítulo I	X	Capítulo II	
No. Solicitud Internacional	PCT/EP2012/069859				
Fecha de Presentación Internacional	08/10/2012				

Como resultado del examen de fondo realizado, con fundamento en el Artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se comunica:

1. Documentos estudiados

Descripción:	Rad. N°14-119143-00000-0000	03/Junio/2014
Reivindicaciones:	Rad. N°14-119143-00000-0000	03/Junio/2014
Dibujos:	Rad. N°14-119143-00000-0000	03/Junio/2014
Prioridad:	EP 11190398.5	23/Noviembre/2011

2. Análisis de la Prioridad

Se acepta la reivindicación de prioridad porque ésta solicitud fue presentada dentro del plazo establecido (Art. 9 D 486) y su contenido técnico corresponde con el de la prioridad reivindicada.

3. Objeto de la invención

De acuerdo con lo establecido en el numeral 1.2.2.2 del Capítulo Primero del Título X de la Circular Única para efectos del examen de patentabilidad, se tendrá en cuenta la tasa pagada por el solicitante al momento de comenzar el examen para las reivindicaciones adicionales; esto es que cuando la solicitud contenga más de diez (10) reivindicaciones y no se haya pagado la tasa complementaria, sólo se estudiarán las cubiertas por la tasa pagada. Por lo tanto, se estudiarán las reivindicaciones 1 a 10.

Título de la solicitud: “Método para sellar latas de metal con tapas despegables y dispositivo para lo mismo” (Fl. 1).

El problema planteado en esta solicitud, consiste en lograr un método y un equipo con el cual se pueda hacer un calentamiento a una lata para poder adherir una tapa a la misma, que sea lo suficientemente versátil para que pueda hacerse el procedimiento con diferentes formas de lata, además de evitar daños en la misma.

Para resolver este problema técnico, la solicitud en estudio propone un método y un equipo para sellar una tapa despegable a un reborde de una lata, donde el método consiste en insertar una bobina de inducción en la lata, pasar corriente alterna a través de dicha bobina, remover la bobina de inducción y aplicar la tapa despegable al reborde de la lata.

El objeto de la presente solicitud se relaciona con la Clasificación Internacional de Patentes (CIP): B 65 B 51/22, 7/28; H 05 B 6/10; B 29 C 65/46.

4. De la solicitud de patente

Reivindicaciones (Art 30 D 486, Art 22 PCT)

El capítulo reivindicatorio no es claro porque:

- Las expresiones: “...por el cual el calor residual en el reborde sella o ayuda a sellar la tapa despegable al reborde” (reivindicación 1), “...de tal forma que el sellado de la tapa despegable al reborde separa el cuerpo de lata en compartimientos superior e inferior.” (reivindicación 7), “...para su inserción en un cuerpo de lata...”, “...para energizar la bobina mientras está dentro del cuerpo de lata.” (reivindicación 8), “...para ubicarla alrededor del exterior del cuerpo de lata...”, “...está configurado para energizar la bobina adicional cuando está alrededor del cuerpo de la lata.” (reivindicación 9), “...para proporcionar una sola unidad de operación.” (reivindicación 10); describen funciones, efectos, ventajas o resultados a alcanzar, los cuales no son aspectos susceptibles de patente. Para mayor claridad, el producto reclamado se debe definir técnicamente mediante sus características estructurales. Se sugiere al solicitante eliminar las expresiones citadas.
- El término: “sustancialmente” (reivindicación 1), es impreciso, por lo cual no permite distinguir la invención del estado de la técnica. Se sugiere eliminar el término citado.
- El “suministro de energía” (reivindicación 8 y 9) no es una característica constructiva de la invención. Es preciso mencionar, que la novedad o el nivel inventivo de una invención se determina con base en sus características constructivas.

5. Determinación del Estado de la Técnica

El estado de la técnica se determinó con base en la fecha de presentación de la solicitud de prioridad: noviembre 23 de 2011, y se encontraron los siguientes documentos que anticipan el objeto de esta solicitud:

Ítem	Documento	Título	Fecha de Publicación
D1	GB 1'207.306	'Container closing'	30/Septiembre/1970
D2	US 5'218.178	'Method of and apparatus for internal heating of solid bodies using electromagnetic induction'	08/Junio/1993

El documento D1¹ divulga un proceso para aplicar membranas de sellado a contenedores y el equipo para realizar dicho proceso (Pág. 1, líneas 9 a 11).

El documento D2² divulga un método y un aparato para calentar internamente cuerpos solidos usando inducción electromagnética (resumen).

6. Examen de Patentabilidad (Art 14 D486)

Novedad (Art 16 D486)

La reivindicación 8 consiste en: “*Un sistema de calentamiento para su uso en una línea de producción de latas y que comprende una bobina de inducción...*” (Ver página 24 del radicado N° 14-119143-00000-0000).

Comparación de las características técnicas esenciales, con las del estado de la técnica:

Características esenciales	D1	D2
Un sistema de calentamiento para su uso en una línea de producción de latas que comprende:	Un sistema para el calentamiento y sellado de membranas en latas que comprende:	Un aparato para internamente calentar cuerpos solidos caracterizado por:
Una bobina de inducción.	Una bobina de inducción (Pág. 3, líneas 25 a 29).	Una bobina de inducción (14) (Col. 2, líneas 35 y 36).

De acuerdo con la tabla anterior, las características esenciales del sistema de la reivindicación 1 habían sido divulgadas previamente en los documentos D1 y D2, por lo tanto, la materia reivindicada no es nueva.

Asimismo, los documentos D1 y D2 divulgan las características de las reivindicaciones dependientes así:

- Reivindicación 9: Una bobina grande y una bobina pequeña (D1: Pág. 3, líneas 71 a 75).
- Reivindicación 10: La bobina grande y la bobina pequeña están acopladas conjuntamente de manera mecánica en una sola unidad de operación (D1: Figs. 1 y

1 http://worldwide.espacenet.com/publicationDetails/biblio?CC=GB&NR=1207306&KC=&locale=en_EP&FT=E

2 https://www.google.ca/patents/US5218178?dq=5218178&hl=es&sa=X&ved=0CB0Q6AEwAGoVChMlosX8INDHxgIVaemACh2_nguS

2).

7. Conclusión

Los requisitos de Patentabilidad de la presente solicitud están afectados así:

Ítem	Documento	Reivindicaciones afectadas	Requisito que afecta
D1	GB 1'207.306	8 a 10	Novedad/Nivel Inventivo
D2	US 5'218.178	10	Novedad/Nivel Inventivo

En cumplimiento del artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le indica que debe dar respuesta dentro del término de sesenta (60) días contados a partir del día siguiente de la fecha de notificación de la presente comunicación. En caso de no dar respuesta al presente requerimiento, o si a pesar de la respuesta subsistieran los impedimentos para la concesión, se denegará la patente.

Se invita al solicitante se sirva indicar, si así lo considera, su renuncia al término faltante de sesenta (60) días para dar respuesta a este requerimiento y presentarla por escrito.

Finalmente, se le recuerda al solicitante que si como respuesta a este requerimiento llegara a modificar el capítulo reivindicatorio y éste contenga más de diez (10) reivindicaciones, no pagará la tasa de modificación voluntaria pero sí la correspondiente al pago por reivindicación adicional.

Notifíquese el presente oficio conforme a lo dispuesto en el numeral 5.2, literal e), del capítulo quinto del título primero de la Circular Única No. 10 de 2001.



JOSÉ LUIS SALAZAR LÓPEZ
Director de Nuevas Creaciones (c)

El anterior requerimiento fue notificado por fijación en lista, de fecha 2015-08-04

Elaboró: Monica Andrea Gutierrez Almonacid
Revisó: Sonia Andrea Diaz Pirazan

PATENT SPECIFICATION

(11) 1207306

1207306

DRAWINGS ATTACHED

- (21) Application No. 47845/66 (22) Filed 25 Oct. 1966
 (23) Complete Specification filed 20 Oct. 1967
 (45) Complete Specification published 30 Sept. 1970
 (51) International Classification B 67 b 5/02
 (52) Index at acceptance
 B8C 10D3B4 10D3D 10P1A 15A 15E1 1A1 25B 25D
 B8T 82E
 H5H 2G1 2G2X 3S
 (72) Inventor EDMOND PHILIP ADCOCK



(54) CONTAINER CLOSURING

(71) We, UNITED GLASS LIMITED, a Company organised under the laws of Great Britain, of Kingston Road, Staines, Middlesex, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The present invention relates to a process for applying sealing membranes to containers, and to a device for carrying out the process.

It is known that products such as dried milk powders and instant coffee powders, when placed in containers, require to be sealed by means of a membrane that prevents the ingress of both moisture and gases and that also has tamper-proof properties. The conventional method of effecting this seal is to fit the closure caps with waxed pulpboard pads or wads to which are lightly heat-sealed double glassine membranes. In the course of application of the closure caps, the sealing surfaces (i.e. the mouths) of the containers are first made adhesive by passing them under glue-coated rollers. The caps are then applied to the containers, and the adhesive dries in due course. When the caps are later unscrewed, the membranes part from the waxed pads and remain adhered to the mouths of the containers. In some cases metal foil membranes can be used instead of the double glassine membranes.

It is, of course, essential that the membranes are intact when the closure caps are removed from the containers, thus providing evidence that the contents of the containers have not been tampered with.

Membranes applied by means of adhesively coating the container mouth possess the disadvantage that the adhesive takes some time to dry and the resultant water vapour is absorbed by the contents of the container. It is also difficult for the efficiency of the operation to be inspected at the end of the packing line, since the adhesive would not by then have dried and the caps cannot safely be removed until much later.

While the above described method is still the one commonly used, various methods have been proposed involving the application of heat to soften or melt a thermoplastic material at the sealing interface. Such methods have either involved disadvantages or have not been felt applicable to sealing in the presence of a metal cap.

It is the object of the present invention to provide a process for the sealing of membranes to containers with metal caps already applied thereto over the membranes, which will give a hermetic gas-tight seal, which may be carried out in a single stage, and which may lend itself to the highest closing speeds attainable. Such membranes are to be readily removable without damaging or distorting the container. This object is achieved by actually utilising the metal cap as an essential integer in the sealing means.

Accordingly, the present invention provides a process for applying a sealing membrane to a container which comprises causing the membrane to be squeezed between a metal cap and the container mouth and heating the metal of the cap by means of an induced radio frequency current to a temperature sufficient to soften a thermoplastic material coated on or present in the material of the membrane, or coated on the material of the container finish, whereby the membrane is removably adhered to the container without distortion of the container.

It will be understood that the metal of the cap is heated by induction and that this heat is transmitted by conduction to the sealing interface, i.e. to the membrane and container mouth. This softens the thermoplastic material which must be present at this interface, and the pressure exerted between the metal cap and the container mouth effects a good seal without distortion of the container.

It is in general preferred that the thermoplastic material be provided on or in the membrane, suitably as a coating on a disc of metal or non-metal to provide strength for the mem-

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branc. In this connection, the term coating is used in the broad sense to include ordinary coatings where a liquid thermoplastic material is coated on the membrane and allowed to set, and also the alternative of providing such multi-layer product by laminating techniques, e.g. adhering pre-formed membrane discs to pre-formed discs of thermoplastic material, such adherence either being effected before sealing or during the sealing operation.

The sealing membrane may be metallic or non-metallic. It may be of any metallic foil, out we have found that aluminium foil is the most economical, and tin foil also makes a very good membrane. Another example is a tin-antimony foil. Before selecting the metal for the membrane consideration should, of course, be had to the contents of the container to be sealed. The metal of the membrane must be inert with respect to the contents of the container. The thickness of the foil membrane should be as thin as possible consistent with it being free from pin holes and readily handleable. Normally this will be between 0.025 and 0.05 millimetres. Non-metallic membranes include, inter alia, those made from paper, glassine, polythene, polypropylene, polystyrene, polyvinylchloride, styrene copolymers, cellulose acetate, polycarbonates, and phenoxy resins.

It is possible to use a membrane which consists merely of a layer of thermoplastic material, but this is not generally preferred since it being free from pin holes and readily handleposes in order to provide strength in the resultant membrane.

The thermoplastic coating can alternatively or additionally be applied to the container mouth, though this does not lend itself so well to mass-production sealing. The thermoplastic used should in any event have a melting point lower than the material of the container in order to avoid distortion of the container mouth during the sealing process.

The thermoplastic material is suitably the ethylene copolymer containing metal ions which is sold under the trade name Surlyn (Registered Trade Mark). Surlyn can be extrusion coated into the membrane or laminated thereto. Another thermoplastic material, applied by the roller coating technique, is the vinyl acetate copolymer supplied by Shawinigan Chemical Company under the trade name of MPS 270. Since roller coatings generally result in considerably thinner films than are obtained by the extrusion coating technique, it is advisable to coat the membrane first with a barrier film such as polyvinylidene chloride, to obtain maximum water vapour and gas impermeability.

The thermoplastic material may alternatively be a Vinylite (Registered Trade Mark) resin, a natural or synthetic wax, a micro-crystalline wax mixture, polyethylene or polypropylene or one of the many heat sealing coatings

which are commercially available and which consist substantially of mixtures of plastics materials and resins. Examples include those which are sold under the trade names Telstic, Delseal, Imseal, Thermostik, and Elvax (Registered Trade Mark).

The thermoplastic material may be coated on the whole of the underside of the membrane, or it may be coated in the form of an annular ring on the periphery thereof. The former is preferred when the membranes are stamped in large numbers from sheet material, since the sheet material may then suitably be coated beforehand. In the event that there is a coating of the thermoplastic material on the top side of the membrane, then care must be taken to avoid adherence of that top coating to the metal cap or any integers within the metal cap which are required to remain with the metal cap when the cap is removed. This can be done, for example, by providing a paper layer over the top side of the membrane.

The container may for example be of glass, metal or ceramics. It could be of plastic material, but such must of course be of high melting point, and the use of plastic material for the containers is not preferred.

It is often found necessary to provide a pad of resilient material between the cap and the membrane. This is so that resilient pressure can be applied to the membrane. The container mouth is seldom exactly smooth and planar, particularly if the container is made of glass. Under such circumstances, an effective seal can only be obtained if the membrane is brought into intimate contact with the container mouth by means of resilient pressure which will insure that the membrane is pressed into the valleys of the rough container mouth.

The resilient pad may be of any material which has resilient properties, for instance pulpboard, natural and synthetic rubbers, foamed and expanded rubbers, polyurethanes and other plastic materials, natural cork and composition cork.

The resilient pad will normally be of insulating material which would shield the thermoplastic material from heat in the top of the cap, but it has surprisingly been found that sufficient heat is conducted laterally to the thermoplastic material from the skirt of the metal cap.

In the event of the final membrane being a laminate, the separate layers of the laminate can be placed in position between the cap and the container and then joined together during the sealing process, when the thermoplastic material will soften and act as an adhesive. When it is stated in this specification that the membrane is squeezed between the metal cap and the container, the term membrane is used to include super-imposed layers, e.g. of paper and thermoplastic, not yet adhered together.

In the preferred operation of the invention,

- it is the cap closure which actually provides the pressure forcing the membrane down onto the container mouth, rather than some outside pressure means. The metal cap in this event will normally be of the screw-on type, though it is possible that some snap-on types of cap could exert sufficient pressure for sealing. The screw-on type may have a continuous thread for engagement with a corresponding thread on the container neck, or it may be provided with a series of lugs which engage a rim on the container neck or co-operate with a multi-start thread formed on the container neck. Thus a screw-on metal cap may be fitted with the pad of resilient material to which is lightly attached the membrane. The cap can then be screwed onto the container and thereafter the assembly is submitted to the induced radio frequency field. When the cap is subsequently removed, the light adherence between the membrane and the pad will be broken, the membrane will remain as a tight seal over the container mouth, while the pad will be removed with the cap.
- The most suitable procedure for mass-production is to arrange that the container assembly with the cap pressing the membrane against the container mouth is passed under the induction coil. There would normally be a conveyor to carry the series of container assemblies under the induction coil. Preferably the plane of the induction coil is wholly above, but not more than 3 inches above, the plane of the cap tops.
- Metal caps are normally coated with a lacquer, and this can give rise to difficulty in the present process since excessive heating of the metal cap will cause scorching of the lacquer. This can happen even if the lacquer is of the heat resistant type, as it normally would be with the present process. It is preferred that the lacquer should be a modified epoxy, such as an epi-phenolic lacquer.
- It is important that the induction coil should be so positioned and arranged that scorching of the said lacquer is minimised or avoided. The coil should be arranged so as to heat preferentially the skirt portion of the cap and minimise heating of the top portion of the cap since, as stated above, it has been found that it is this skirt portion which is able to conduct heat directly to the thermoplastic material, in the normal case of using a resilient pad between the membrane and cap.
- Despite these precautions, scorching of the lacquer can still take place in many cases, and it has been found preferable to use two induction coils, a relatively larger one and a relatively smaller one, the field of the smaller coil being substantially within the field of the larger coil. The principle of the operation is that a container coming along the conveyor is firstly brought under the upstream end of the larger coil which causes it to be moderately heated. The container then becomes under the extra heating influence of the smaller coil which gives a momentary boost of heat sufficient thoroughly to soften the thermoplastic material. Such boost of heat is not of sufficient duration, however, to scorch the lacquer. The container then moves along out of the influence of the small booster coil, but still under the influence of the downstream end of the larger coil which maintains the thermoplastic material soft for long enough to enable thorough sealing to take place. Thus, it is preferred that the effective field of the small coil is substantially in the upstream half of the field of the larger coil, since the initial influence of the larger coil alone does not require to be of long duration. The maximum protection for the lacquer is achieved if the arrangement is such that the heat induced in the metal cap by the larger coil alone is insufficient to cause effective sealing of the membrane.
- The larger coil is preferably of elongated shape, the long dimension being aligned with the direction of the containers. The smaller coil is preferably substantially circular. The transverse dimension of both coils is suitably equal approximately to the diameter of the cap.
- A suitable apparatus is illustrated in the accompanying drawings in which
- Figure 1 shows an assembly line for sealing containers, and
- Figure 2 is a perspective view from above of the induction coils shown in Figure 1.
- In the drawings, a conveyor belt 1 carries a series of containers 2. Metal caps 3 are tightly screwed over the mouths of the containers 2, and, under each cap 3 though not shown, is a membrane over the container mouth and a resilient pad between the membrane and the cap. The container assemblies are passed under two induction coils, a larger induction coil 4 and a smaller induction coil 5. Each induction coil is fed from the same source of electricity, not shown.
- In operation, the containers 2 are moved by the belt 1 from left to right and become sealed as described hereinabove.
- The following is a specific example of seals effected by the apparatus of the drawings.
- EXAMPLE**
- 8 oz. instant coffee jars of glass are to be sealed. A tin plate cap of 63 mm diameter has inserted therein firstly a 0.030 inches thick pulpboard pad and a membrane of 0.003 inches thick glassine paper coated with 0.001 inches thickness of Surllyn. The cap was then screwed firmly onto each jar, and the jars were placed on the conveyor belt 1. The latter was run at 25 feet/minute, which means that more than 100 containers per minute were passed under the induction coils. The larger induction coil 4 had dimensions of 20" × 4". The smaller coil 5 was of 3½ inches diameter. Both coils were made from ½ inches diameter copper tubing insulated with polytetrafluorethyl-

ene. The induction coils were set $\frac{3}{4}$ inch above the caps on the containers on the belt 1.

- 5 A Pye (Registered Trade Mark) 3 kw generator using 100% output was used to supply current to the induction coils and, on removing the caps after the containers had come to the end of the conveyor belt 1 and cooled, it was found that good seals were obtained between the membrane and the container mouths.
- 10 There was negligible scorching of the lacquer.

Pursuant to Section 9 subsection (1) of the Patents Act, 1949, reference is made to patent No. 1,135,943.

WHAT WE CLAIM IS:—

- 15 1. A process for applying a sealing membrane to a container which comprises causing the membrane to be squeezed between a metal cap and the container mouth and heating the metal of the cap by means of an induced radio frequency current to a temperature sufficient to soften a thermoplastic material coated on or present in the material of the membrane, or coated on the material of the container finish, whereby the membrane is removably
- 20 adhered to the container without distortion of the container.

2. A process as claimed in claim 1 wherein a pad of resilient material is provided between the cap and the membrane.

- 30 3. A process as claimed in claim 1 or 2 wherein the metal cap is screwed to the container to squeeze the membrane against the container mouth during the heating step.

- 35 4. A process as claimed in any of claims 1 to 3, wherein the container assembly, with the cap pressing the membrane against the container mouth, is passed under an induction coil.

- 40 5. A process as claimed in claim 4 wherein a series of container assemblies is passed on a conveyor under the induction coil.

- 45 6. A process as claimed in claim 4 or 5 wherein the plane of the induction coil is wholly above, but not more than 3 inches above, the plane of the cap tops.

- 50 7. A process as claimed in any of claims 4 to 6 wherein the container assembly passes under two induction coils, one larger than the other, the field of the smaller coil being substantially within the field of the larger coil.

8. A process as claimed in claim 7 wherein

the effective field of the relatively small coil is substantially in the upstream (in relation to the movement of the container assembly) half of the field of the relatively larger coil.

9. A process as claimed in claim 7 or 8 wherein the heat induced in the metal cap by the relatively large coil alone is insufficient to cause effective sealing of the membrane.

10. A process as claimed in any of claims 7 to 9 wherein the horizontal width of the two coils (i.e. the dimension at right angles to the direction of movement of the container assembly) is substantially equal to the diameter of the cap.

11. A process as claimed in any of the preceding claims wherein the membrane comprises a layer of non-metallic material coated with thermoplastic material.

12. A process as claimed in any of claims 1 to 10 wherein the membrane comprises metal foil coated with thermoplastic material.

13. A process as claimed in any of the preceding claims wherein a screw-on metal cap is fitted with a pad of resilient material to which is lightly attached the membrane, the cap is screwed onto the container, and thereafter the assembly is submitted to the induced radio frequency field.

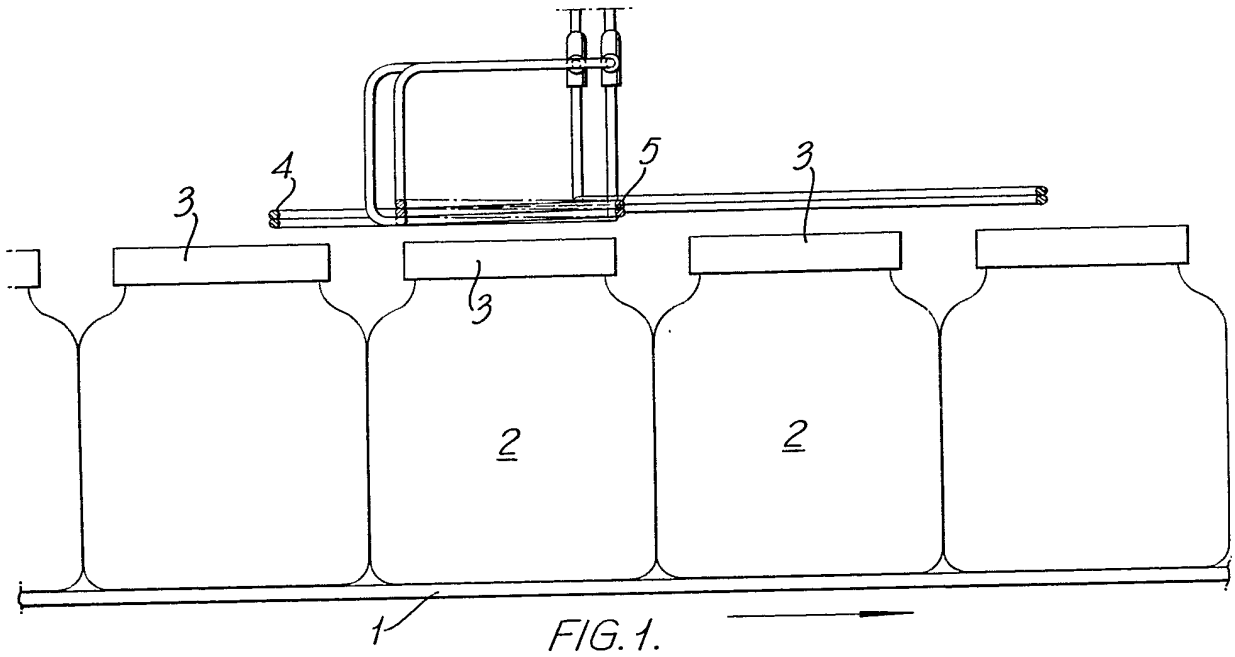
14. Apparatus for effecting the process of any of claims 7—10 comprising two induction coils of different size, the smaller coil being substantially within the larger induction coil, both said coils being substantially in the horizontal plane, and a conveyor for conveying containers under said coils, the larger coil being elongated in the direction of the conveyor and the smaller coil being positioned within the upstream (in relation to the direction of movement of the conveyor) half of the larger coil.

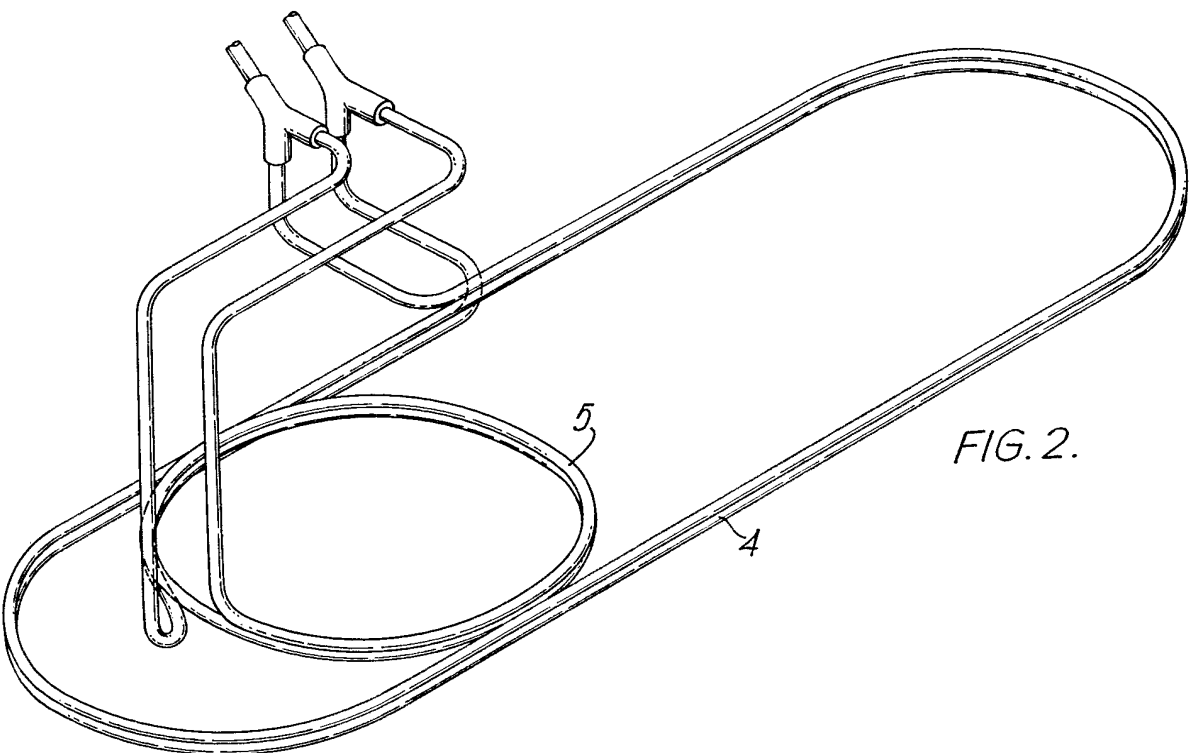
15. A process for sealing containers, as claimed in claim 11, substantially as specifically described herein.

16. Apparatus for sealing containers substantially as described herein and as shown in the accompanying drawings.

For the Applicants.

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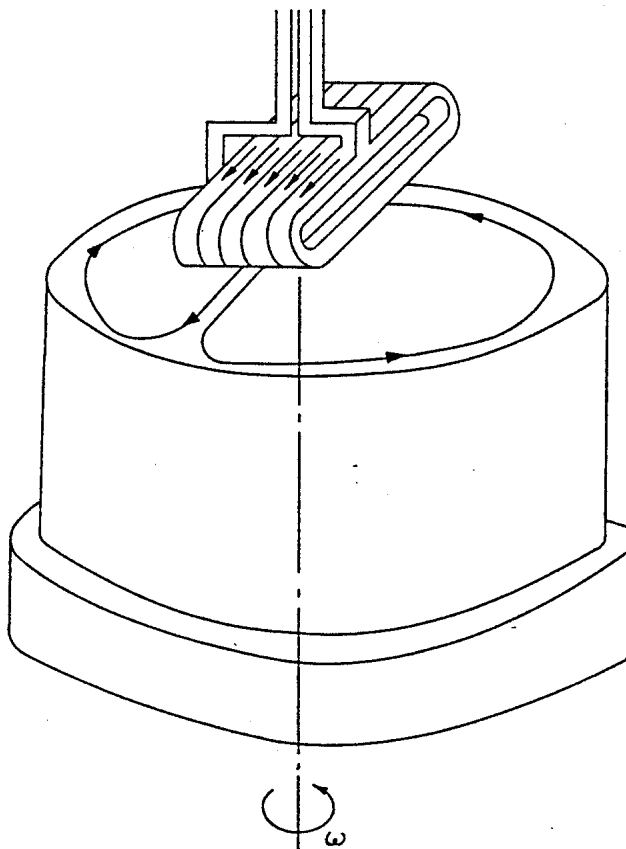
US005218178A

United States Patent [19]**Peysakhovich**[11] **Patent Number:** **5,218,178**[45] **Date of Patent:** **Jun. 8, 1993****[54] METHOD OF AND APPARATUS FOR
INTERNAL HEATING OF SOLID BODIES
USING ELECTROMAGNETIC INDUCTION****[75] Inventor:** Vitaly Peysakhovich, Moorestown,
N.J.**[73] Assignee:** Inductotherm Corp., Rancocas, N.J.**[21] Appl. No.:** 723,868**[22] Filed:** Jul. 1, 1991**[51] Int. Cl.⁵** H05B 6/40**[52] U.S. Cl.** 219/10.43; 219/10.491;
219/10.67; 148/574; 148/567; 266/129**[58] Field of Search** 219/10.43, 10.491, 10.67,
219/10.75, 7.5; 148/567, 572, 574, 575;
266/129, 124, 109**[56] References Cited****U.S. PATENT DOCUMENTS**

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Primary Examiner—Philip H. Leung*Attorney, Agent, or Firm*—Seidel, Gonda, Lavorgna &
Monaco**[57] ABSTRACT**

Method and apparatus for internally heating solid bodies using electromagnetic induction. The method comprises generating an electromagnetic induction field and causing it to induce the flow of an electric current in a preselected portion of a solid body to be heated. The electric current has a direction and magnitude sufficient to cause internal heating of the preselected portion of the body. The induction field and the body are rotated relative to one another for causing the direction of the induced current to rotate relative to the body about a preselected location to cause overheating at the preselected location. The body is cooled, except for the preselected portion to be heated. The apparatus comprises a coil for generating an electromagnetic induction field for inducing the flow of an electric current in a preselected portion of a solid body to be heated. The electric current has a direction and magnitude sufficient to cause internal heating of the preselected portion of the body. The apparatus includes a turntable for rotating the induction field and the body relative to one another to cause the direction of flow of the induced current to rotate relative to the body about a preselected location to cause overheating at the preselected location, and a cooling system for cooling the body except for the preselected portion to be heated.

4 Claims, 2 Drawing Sheets

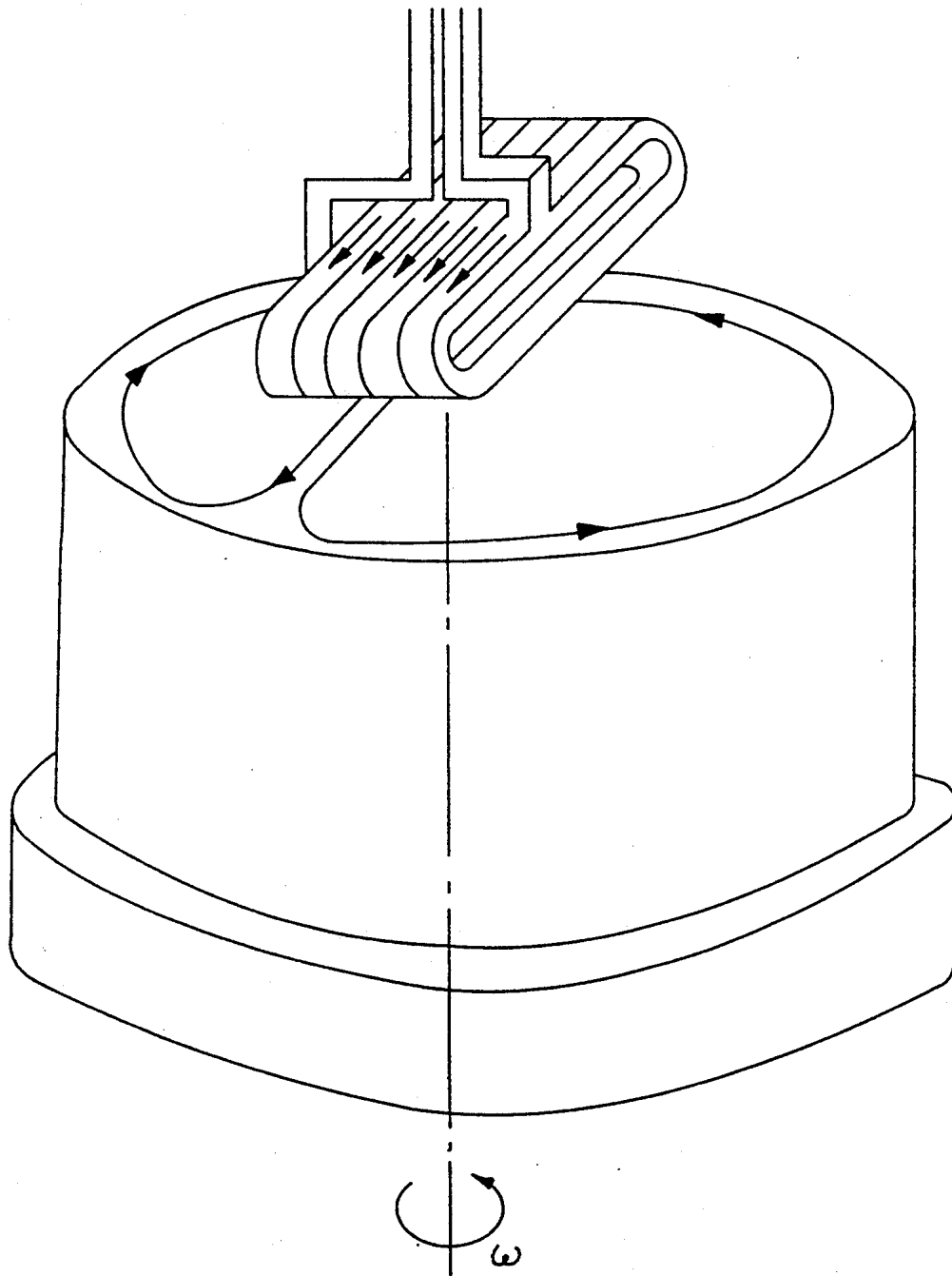


FIG. 1

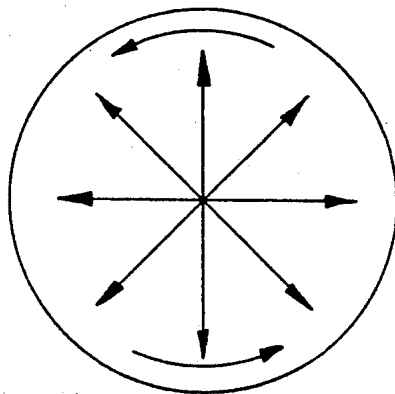


FIG. 2

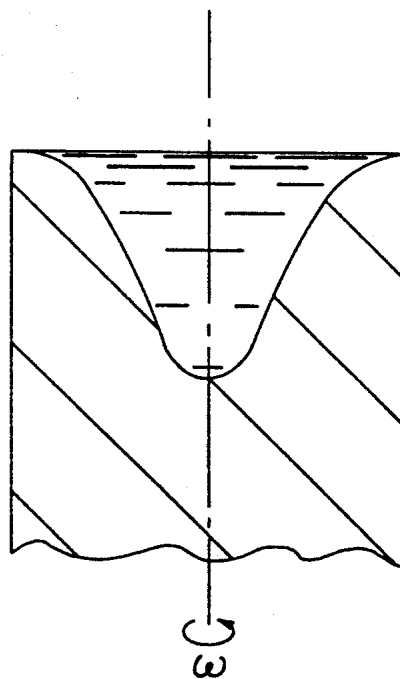


FIG. 3

METHOD OF AND APPARATUS FOR INTERNAL HEATING OF SOLID BODIES USING ELECTROMAGNETIC INDUCTION

FIELD OF THE INVENTION

The present invention relates to the field of induction heating and, in particular, to a method and apparatus for internally heating a solid body using electromagnetic induction.

BACKGROUND OF THE INVENTION

It is known in the art of induction heating that a solid body placed in an induction field, such as that generated by an induction coil excited by high-frequency ac current, begins to heat on its surface. The induction field induces electrical currents to flow on the surface of the body. Heating is the result of power dissipated by the currents as they flow against the electrical resistance of the body. The heat generated on the surface of the body can then propagate into the interior of the body. Hence, this known form of induction heating may be thought of as heating the body from the outside in. This property of induction heating is widely used for the heat treatment of metals, for example.

However, it is sometimes desirable to heat the body from the inside out. One application of "inside out" heating is in the melting and refining of metals in a vacuum. Presently, vacuum melting and refining typically requires the metal which is to be melted and refined to be contained in a crucible, usually of a ceramic material. The metal is thus susceptible to contamination from the crucible.

This source of contamination can be eliminated if the metal body itself acts as its own crucible. If the interior of the metal body is heated while the outside of the body is kept cool, i.e., the body is heated from the inside out, the metal will not be forced to contact a containing crucible and, therefore, could be refined in extremely clean conditions.

Typical induction heating apparatus heat from the outside in, and are not suitable for this type of melting and refining. There is thus a need for an induction heating apparatus and method that heats from the inside out. This invention fulfills that need.

SUMMARY OF THE INVENTION

The present invention comprises a method of and apparatus for internally heating solids bodies using electromagnetic induction. The method comprises the steps of generating an electromagnetic induction field, causing the electromagnetic field to induce the flow of an electric current in a preselected portion of a solid body to be heated, the electric current having a direction of flow associated therewith and having a magnitude sufficient to cause internal heating of the preselected portion of the body, rotating the induction field and the solid body relative to one another for causing the direction of flow of the induced current to rotate relative to the solid body about a preselected location within the preselected portion to cause overheating at the preselected location, and cooling the solid body except for the preselected portion to be heated such that substantially only the preselected portion is heated.

The apparatus comprises a coil for generating an electromagnetic induction field for inducing the flow of an electric current in a preselected portion of a solid body to be heated, the electric current having a direc-

tion of flow associated therewith and having a magnitude sufficient to cause internal heating of the preselected portion of the body, means for rotating the induction field and the solid body relative to one another to cause the direction of flow of the induced current to rotate relative to the solid body about a preselected location within the preselected portion to cause overheating at the preselected location, and means for cooling the solid body except for the preselected portion to be heated such that substantially only the preselected portion is heated.

DESCRIPTION OF THE DRAWINGS

For the purpose of illustrating the invention, there is shown in the drawings a form which is presently preferred; it being understood, however, that this invention is not limited to the precise arrangements and instrumentalities shown.

FIG. 1 is a simplified view of a form of apparatus according to the invention and for carrying out the method of the invention.

FIG. 2 illustrates the orientation of the induced currents in a solid body when heated by the apparatus and according to the method of the invention.

FIG. 3 is a transverse sectional view through a solid body heated by the apparatus and according to the method of the invention.

DESCRIPTION OF THE INVENTION

Referring now to the drawings, wherein like numerals indicate like elements, there is shown in FIG. 1 an apparatus 10 according to and for carrying out the method of the present invention. The apparatus comprises a rotatable support, or base, 12 and an induction coil generally indicated by reference numeral 14. The induction coil 14 has a magnetic core 15.

Base 12 is preferably in the form of a right cylindrical turntable and is rotatable about its axis 16, indicated by the chain line in FIG. 1. Base 12 may be rotated by any suitable means, such as a direct-drive electric motor, a belt and pulley arrangement, a gear arrangement, or the like. The exact manner in which base 12 is rotated is not crucial to the invention, and any suitable means for rotating base 12 can be employed without departing from the invention. Base 12 is rotated at an angular velocity ω . The precise magnitude of angular velocity ω is not critical to the invention, as long as it is not so great as to cause splashing or scattering of molten metal by centrifugal forces.

Base 12 is preferably cooled to maintain base 12 at a temperature substantially below the melting temperature of the body to be heated and refined. For this purpose, base 12 may be equipped with cooling lines 18 and 20 for admitting and exhausting coolant to and from base 12, respectively. A preferred coolant is water, but other cooling fluids such as air or other liquids can be used. In some cases, where the body to be heated and refined is small, cooling may not be necessary.

Induction coil 14 is generally elongated in a direction perpendicular to axis 16 and comprises at least one turn 22. Coil 14 is excited, in known manner, by a high-frequency ac current. Magnetic core 15 intensifies the magnetic flux generated by coil 14. The current direction in the coil turns for one half-cycle is in the direction illustrated by arrows 24. The current direction for the other half-cycle is, as those skilled in the art will understand, in the opposite direction. The length of coil 14 in

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the long direction is preferably no greater than the longest dimension of the solid body to be heated. The width of the coil in the transverse direction is determined by the diameter of the preselected portion of the body to be heated. The diameter depends on the ratio between the diameter and height of the metal body and the chosen technology of metal melting. Coil 14 is located coaxially with base 14, so that the centerline of coil 14 lies along axis 16.

A body 26 to be heated and refined is placed on base 12 below induction coil 14. Conveniently, although not necessarily, body 26 is in the form of a right cylinder. The dimensions of body 26, and its exact shape are not critical to the invention. Body 26 may be a rectangular solid, or may have a hexagonal or polygonal cross-section without departing from the scope of the invention. If necessary or desired, base 12 or coil 14, or both, may be movable up and down along axis 16 as required to accommodate body 26.

Coil 14 induces a current 28, represented by arrows, to flow on the top surface, or buttress, 30 of body 26. As those skilled in the art will understand, current 28 will flow in the direction indicated when the current in coil 14 is in the direction shown by arrows 24. Current 28 will change direction and flow in the opposite direction when the current in coil 14 is in the direction opposite to that indicated by arrows 24.

Since body 26 is being rotated by base 12, the azimuthal orientation of the surface current 28 is constantly changing, as shown in FIG. 2. FIG. 2 depicts a top plan view of buttress 30 of body 26. In FIG. 2, the surface current flowing in buttress 30 is represented as double-headed arrows 32, and the portion of the surface current that flows along the circumference of buttress 30 is omitted from the figure for the sake of clarity. As body 26 is rotated in the direction of arrows 34, the azimuthal direction of the surface currents 32 will likewise rotate relative to buttress 30. However, since the centerline of coil 14 lies along axis 16, all of the current lines 32 will intersect at axis 16. This will result in a very high current density adjacent axis 16, and the current density will decrease radially outwardly from axis 16. Consequently, the center of buttress 30 will overheat and, as long as sufficient power is supplied by the coil 14, will melt. The heat produced at the center of buttress will propagate downward into body 26 and radially outward along the top 30 of body 26, heating and melting a portion of body 26 from the inside out. By cooling base 12, the remaining portions of body 26 are kept below its melting temperature, so that the center of body 26 can melt while being contained by the cool outside surface of body 26.

A typical melting pattern for a cylindrical body is illustrated in FIG. 3. A pool of molten metal 36 is formed in the upper portion of body 26, and the remaining portions of body 26, which are cooled and thus do not melt, contain the molten metal. Thus, the solid portions of body 26 act as a crucible for molten metal 36. However, since molten metal 36 contacts only like

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metal in the solid portions of body 26, instead of a ceramic crucible, molten metal 36 is not contaminated as it would be by the crucible. Molten metal 36 can therefore be melted and refined to a high degree of purity.

Means for drawing or pouring off molten metal 36 may be provided as desired. For example, base 12 may be tilted to pour off molten metal 36, or body 26 may be lifted and poured separately.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicating the scope of the invention.

I claim:

1. Method of internally heating a solid body using electromagnetic induction, comprising the steps of

- (a) generating an electromagnetic induction field,
- (b) causing the electromagnetic field to induce the flow of an electric current in a preselected portion of a solid body to be heated, the electric current having a direction of flow associated therewith and having a magnitude sufficient to cause internal heating of the preselected portion of the body,
- (c) rotating the induction field and the solid body relative to one another for causing the direction of flow of the induced current to rotate relative to the solid body about a preselected location within the preselected portion to cause overheating at the preselected location, and
- (d) cooling the solid body except for the preselected portion to be heated such that substantially only the preselected portion is heated.

2. Apparatus for internally heating a solid body using electromagnetic induction, comprising

- (a) means for generating an electromagnetic induction field for inducing the flow of an electric current in a preselected portion of a solid body to be heated, the electric current having a direction of flow associated therewith and having a magnitude sufficient to cause internal heating of the preselected portion of the body,
- (b) means for rotating the induction field and the solid body relative to one another to cause the direction of flow of the induced current to rotate relative to the solid body about a preselected location within the preselected portion to cause overheating at the preselected location, and
- (c) means for cooling the solid body except for the preselected portion to be heated such that substantially only the preselected portion is heated.

3. Apparatus according to claim 2, wherein the means for generating an electromagnetic induction field comprises an induction coil having at least one turn.

4. Apparatus according to claim 2, wherein the means for rotating and the means for cooling comprise a cooled rotatable turntable.

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