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EDDY CURRENT HEATING DEVICE

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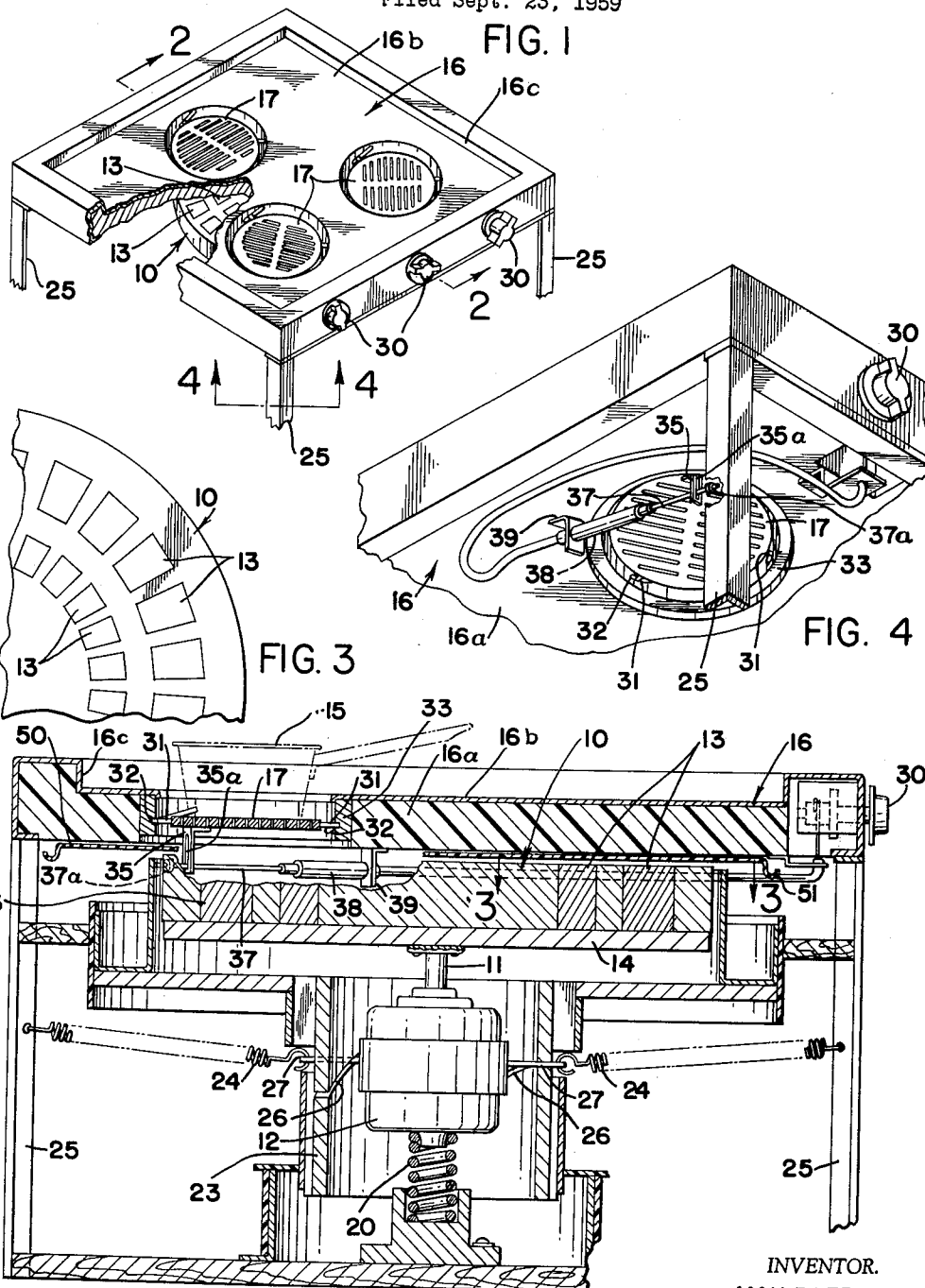


FIG. 2

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EDDY CURRENT HEATING DEVICE

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This invention pertains to the art of heating by eddy currents and more particularly to new and improved apparatus for generating such eddy currents.

Eddy currents are generated by subjecting electrically conductive materials, such as metals to varying or changing magnetic fields. These eddy currents, if of sufficient magnitude, can generate large amounts of heat within the material, in accordance with known electrical laws.

The invention is particularly applicable to the art of cooking appliances, such as kitchen stoves, and will be described with particular reference thereto although it will be appreciated that the invention has broader applications and may, in many instances, be applied wherever an electrically conductive material is to be heated by eddy currents.

The present application is a continuation-in-part of my co-pending application, Serial No. 637,491, filed January 31, 1957, now Patent No. 2,912,552. In that application a ring, comprised of a plurality of circumferentially-spaced, alternating-polarity, permanent magnets having preferably a magnetic privileged direction through the poles, is rotated below an electrically non-conductive, magnetically non-permeable, horizontally extending support on which an article to be heated, such as a cooking pan, of electrically conductive material rests. The present application, in some respects, is a clarification of the principles on which the earlier application functioned, and in some respects is an improvement on the apparatus there shown.

In the art of cooking, it is known to generate the cooking heat on the surface of the appliance, either by burning a gas or by flowing an electric current through an electric resistance heating element. In all cases, the heat is then transmitted to the pan by means of radiation, conduction, and/or convection, each inherently an inefficient arrangement for transferring heat. Furthermore, the heating elements are exposed so that they radiate heat into the room, as well as being open to receive spilled materials from the cooking pans. These spilled materials usually cake and char on the heating elements, making them difficult to clean.

It has heretofore been proposed to generate eddy currents in cooking utensils by placing them in an alternating magnetic field created by an electromagnet energized from an alternating current power source. With such an arrangement there is a tendency for the utensil to hum and otherwise create a noise unless the frequency of the alternating current power source is above the audible range. However, such power sources are expensive, bulky, and difficult to maintain.

It has heretofore been proposed, as is described in German Patent No. 328,229 and U.S. Patent No. 2,552,514 to generate eddy currents in electrically conductive materials, such as metals, but not cooking utensils, by providing a plurality of iron-cored electromagnets each energized from a source of direct current such that adjacent magnets have opposite magnetic polarity and rotating these electromagnets relative to the metal so that the pole tips of the magnets pass in proximity to the metal and the flux penetrates the metal and induces eddy currents.

Such last mentioned arrangement is not generally satisfactory for eddy current heating of the type to which this invention pertains. Thus the iron cores of the electromagnets have high magnetic permeability. Relatively

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close spacing between the pole tips and the metal to be heated is required in order to obtain any appreciable amounts of heating. Furthermore the high permeability core with the close spacing results in a very rapid change of flux in the metal creating large mechanical forces thereon and undue amounts of noise.

The present invention contemplates new and improved apparatus which overcomes all of the above-referred-to difficulties, and enables eddy current heating to be effected efficiently with a maximum spacing between the pole faces and of the metal to be heated and with a minimum of noise.

In accordance with the present invention, there is provided a plurality of magnets having generally parallel axes of magnetization and with adjacent magnets opposite magnetic polarity, all mounted for movement in a direction perpendicular to the axis of magnetization so that their pole tips move past the material to be heated. The magnets, and particularly the pole tips of the magnets, instead of being formed of a high permeability magnetic material as heretofore, are formed of a permanent magnetic material having a low magnetic permeability, particularly on the plane or axis perpendicular to the axis of magnetization.

The magnet materials coming within the scope of the present invention may be any of the known, low permeability, permanent magnetic materials, e.g., alni, alnico 5, or barium ferrite, either isotropic or anisotropic, as the case may be, although anisotropic is much preferred because it has a much higher permeability on the axis of magnetization than across or transverse to the axis of magnetization.

By permeability is meant the ratio of the number of flux lines of force produced by a given magneto-motive force in the material in question, relative to the number of flux lines produced by the same magneto-motive force in a vacuum. Air may be considered as having unity permeability, i.e. it has a magnetic permeability of 1.

The isotropic alnico magnetic materials have a maximum permeability in all directions of approximately 19, while the barium ferrite isotropic permeability is 4.5. The anisotropic alnico materials have a permeability in the preferred direction, that is, in the axis of magnetization, of 16.8 and; transverse to the preferred direction of 9.5. The barium ferrite anisotropic materials have a permeability in the preferred direction of 4.9 and transverse to the preferred direction of 1.7. These permeabilities may be distinguished from that of 110 for carbon steel of the permanent magnetic type which insofar as permanent magnetic materials is concerned is high, as well as being distinguished from the ferro magnetic materials which may have a permeability from a low of 5500 to 40,000. In particular, in accordance with the invention, the permeability of the magnetic material in a direction transverse to the axis of magnetization should be as low as possible and in any event less than 19, although it is possible to have a permeability on the axis of magnetization greater than this.

The present invention requires that the flux be projected outwardly from the pole tips of the magnets on the axis of magnetization. The invention also requires that the sides of the magnets be relatively close spaced, usually a distance equal to or less than the spacing of the metal to be heated from the pole tips in order that a maximum amount of magnetic material be in each ring. As the spacing between the sides of the magnets is made less and less, it will be appreciated that more and more of the flux will flow or exist in the space between the magnets and less and less will be projected outwardly from the pole tips. This effect becomes very pronounced with magnetic materials having a high permeability in the plane perpendicular to the axis of magnetization.

Thus flux generated interiorly of the magnet e.g. on the axis of the magnet will tend to flow through the high permeability material and transversely to the pole axis to the sides of the magnet and then across the space between the sides of the magnets. I have found that as the permeability decreases, this effect goes down. Thus it is essential that the permeability on the transverse axis be held as low as possible.

Electromagnets can be used for creating some or substantially all of the flux providing that the pole tips are formed of a material having a greater permeability on the magnetic axis than transverse thereto e.g., an anisotropic permanent magnetic material having a privileged direction on the axis of magnetization.

Further in accordance with the invention, the magnets are arranged in close spaced relationship on a circle, and each magnet has a transverse trapezoidal cross section with a maximum length to width ratio of not more than 3 to 1, and preferably not more than 2 to 1. With such an arrangement the length of the induced eddy current path in the metal to be heated is a minimum in relation to the area of the pole tip, and a maximum efficiency of heating results.

Furthermore in accordance with the invention, the magnets are arranged on a plurality of concentric circles or rings with adjacent magnets both radially and circumferentially having opposite magnetic polarity.

Further in accordance with the invention, at least the pole tip of each magnet is surrounded by a loop of high electrical conductivity material e.g., copper or aluminum which enables magnets with a lower coercive force to be employed without the danger of their being de-magnetized by the countermagneto motive forces generated by the currents in the metal being heated.

Still further in accordance with the invention, the magnets are mounted for movement towards and away from the metal to be heated and means responsive to the driving power for the magnets operate to move the magnets away from the metal as the power reaches predetermined levels.

Further in accordance with the invention, and in a cooking stove, a work-piece support of unity permeability and high electrical resistance is placed over the pole faces of the magnet, the total spacing from the upper surface of the work-piece support to the pole faces of the magnet being equal to or slightly greater than the maximum distance that effective amounts of flux are projected upwardly and outwardly from the magnets, the result being that if relatively light pieces of metal are dropped on to the support while the magnets are moving under the support, the metal will not have sideward forces thereon sufficient to move it on the support.

Furthermore in accordance with the invention, a work-piece support is provided surrounded by a vertical barrier for the purpose of preventing horizontal displacement of relatively light pieces of metal from off of the work-piece support under the influence of the moving magnetic fields.

Further in accordance with the invention, and in a cooking stove, the work-piece support is provided with a plurality of wells having a vertically movable bottom, in combination with spring means biasing the bottom upwardly in amounts such that when a utensil is placed on the bottom it will move downwardly against stops under the influence of the weight of such utensil.

Further in accordance with the invention, the spacing of the bottom is manually or automatically adjustable from the magnet pole tips so that the heating of a utensil may be readily controlled.

Further in accordance with the invention, a work-piece support is provided comprised of a metal having generally unity magnetic permeability, the metal being provided with a plurality of slits parallel to the direction of movement of the magnets whereby to minimize or eliminate the inducing of eddy currents in the metal support.

Accordingly, it is an object of the present invention to provide a novel and improved eddy current heating apparatus.

It is also an object of this invention to provide a novel eddy current heating apparatus which has improved heating efficiency.

Another object of this invention is to provide a novel eddy current heating apparatus which is capable of highly effective operation at a very low noise level.

Another object of this invention is to provide a novel eddy current heating apparatus which is highly advantageous and practical for incorporation in a cooking appliance, such as a range.

Another object of this invention is to provide a novel eddy current heating apparatus having a novel directional magnetic field characteristic which greatly improves the operation of the apparatus and enables it to be applied to uses for which eddy current heating devices previously were considered impractical, such as in cooking appliances.

A further object of this invention is to provide a novel eddy current heating apparatus which has a novel overload release which prevents the apparatus from drawing excessive electrical power in its operation.

The invention may take physical form in certain parts and arrangements of parts, a preferred embodiment of which will be described in detail in the following specification, and illustrated in the accompanying drawing which forms a part hereof and wherein:

FIGURE 1 is a fragmentary, schematic, top perspective view partly broken away for the purposes of clarity of an eddy current heating device in the form of a cooking range and illustrating a preferred embodiment of the present invention;

FIGURE 2 is a vertical sectional view taken approximately on the line 2—2 of FIGURE 1;

FIGURE 3 is a fragmentary top plan view of the magnet rotor of the range taken approximately on the line 3—3 of FIGURE 2; and,

FIGURE 4 is a fragmentary view taken along the line 4—4 of FIGURE 1 and showing the underside of the cooking top at one of the pan supports.

Referring now to the drawings wherein the showings are for the purposes of illustrating a preferred embodiment of the invention only, and not for the purposes of limiting same, the figures show a cooking range including a horizontally extending support 16 having an article to be heated 15 supported thereon, a magnet rotor 10 disposed under the support 16 and a motor 12 for rotating the magnet rotor on an axis perpendicular to the support 16.

The article to be heated 15 may be any piece of electrically conductive material, but preferably is comprised of a ferromagnetic material having a bottom or lower surface of high conductivity material such as copper. In the embodiment of the invention shown, the article to be heated is illustrated as a cooking utensil.

The magnet rotor 10 is in the shape of a circular disc and is supported for rotation on a vertical axis that is in a plane parallel to and below the support 16 by the upper end of the output shaft 11 of the motor 12. The magnet rotor 10 is comprised of a circular disc of aluminum, or other high electrically conductive material, having imbedded therein one or a plurality (in the embodiment shown two) circular series of magnets 13. As best seen in FIGURE 2, the top surface of each magnet is flush with the flat top face of the aluminum and the bottom face of each magnet is flush with the flat bottom face of the aluminum. A suitable flat plate 14 of high magnetic permeability material, the higher the better, such as iron, extends across the bottom face of the aluminum and the magnets 13 to close the magnetic paths between all of the magnets.

The magnets are each magnetized on an axis perpendicular to the path of movement, which in the embodiment

shown is a vertical axis, and adjacent magnets both circumferentially and radially have opposite magnetic polarity.

In accordance with the invention, the magnets are each formed of a material which at least in the direction transverse to their axis of magnetization have a low magnetic permeability, as is characteristic of some of the known permanent magnetic materials such as alni, alnico, alnico 5, barium ferrite, or the like. Such materials may be distinguished from the steel-type permanent magnets which have relatively high magnetic permeabilities on the order of 35 to 110 or more. Also, preferably the materials are of the anisotropic type, having a privileged magnetic direction perpendicular to the path of movement, that is to say, in a vertical direction in the embodiment of the invention shown. Such magnets have a substantially greater magnetic permeability in the privileged direction than in the non-privileged direction, e.g., for alnico 5, 16.8 to 9.5, or for barium ferrite, 4.9 to 1.7. It will be appreciated that if desired, some of the magnetic force can be provided by electromagnets, but if such magnets are employed they must, in accordance with the invention, be provided with pole tips of the anisotropic permanent magnetic materials having a privileged direction perpendicular to the line of movement, that is to say, in a vertical direction in the embodiment of the invention shown.

It will be appreciated that each magnet as it passes under the workpiece, generates an eddy current which in effect is a circle or loop of electric current in the pan of a perimeter generally equal to the perimeter of the magnet. For the most efficient heating, the ratio of the length of this current path to the number of flux lines creating it must be held to a minimum. The shape of the magnet thus becomes important. A circular or round magnet would be the most efficient, but its space utilization factor on the disc is poor. Accordingly, it is preferred to use magnets which generally have the shape of a trapezoid having a maximum length to width ratio not greater than 2. If it is necessary to cover a greater radial width of the assembly with magnets, then a plurality of circumferential rows of magnets are employed. Adjacent magnets on a radial line have opposite magnetic polarity.

The support 16 extends across the top of the magnet rotor 10 in slightly spaced relationship thereto and constitutes the cooking top of the range. Preferably, and as shown in FIGURE 2, this support 16 is composed of a lower support 16a of suitable electrical non-conductive and unity permeability material and an overlying thin layer 16b of stainless steel of low or preferably unity magnetic permeability. This construction of the support 16 avoids the generation of eddy currents therein as the magnets 13 rotate beneath it. The support 16 has an upper surface spaced a predetermined distance from the upper surface of the magnets 13 and raised sides around its periphery, all for a purpose which will be explained hereinafter.

As best seen in FIGURE 2, the cooking top or support 16 carries individual pan supports for the respective cooking pan 15. Each of these pan supports is in the form of a thin, flat slotted plate 17 which is of low permeability material, such as non-magnetic austenitic stainless steel.

In order to prevent spillovers from the cooking pans from contacting the upwardly facing magnet pole tips or the rotor disc 10, there is provided a thin plate 50 (FIGURE 2) of suitable electrically non-conductive, magnetically non-permeable material positioned overlying the rotor and spaced below the cooking top. At its periphery this plate presents a trough 51 which may lead to a drain pipe (not shown) for passing the spillovers.

In the operation of this apparatus, the magnet rotor 10 is driven at a suitable rotational speed by the motor 12. The top face of the magnet rotor 10 rotates substantially parallel to the cooking top 16 in spaced relation below the latter. The neighboring, opposite polarity, upwardly facing poles of the magnets 13 produce magnetic fields

which extend up through the cooking top 16 and through the individual pan supports 17. These magnetic fields, of course, revolve with the rotor disc 10 and in succession they thread through the electrically conductive cooking pan supported on the cooking top. These successive, moving, alternating polarity magnetic fields induce eddy currents in the cooking pan of a sufficient value to heat it rapidly to an elevated temperature.

Because of the low permeability of the upwardly facing poles of the magnets 13 in the present invention, the magnetic flux tends to flow upwardly from these poles, rather than tending to fringe laterally over to the neighboring opposite polarity poles, as would be the case with high permeability magnet poles. Because of this tendency for the magnetic fields between the adjacent, opposite polarity magnet poles to extend upwardly directly away from the upwardly facing poles, enough of the magnetic flux projects sufficiently far from the poles that the necessary pan support and the spillover shield may be interposed between the magnets and the pans which are to be heated. Even though this spacing is rather substantial, considered from the standpoint of what was permissible practice in connection with the previously proposed eddy currents heating devices which employed magnets having high permeability poles, the magnetic flux from the magnets which passes into the electrically conductive pan is entirely adequate to generate eddy currents which effectively heated the pan. As pointed out hereinafter, such spacing between the rotating magnets and the electrically conductive workpieces is a practical necessity in a cooking device for use in the home. If the magnets had the usual high permeability poles, it would not be possible, as a practical matter, to generate effective eddy currents in cooking pans spaced as far from the magnet poles as is contemplated by the present invention.

One important aspect of the spacing between the upwardly facing magnet poles and the pan which is to be heated is the elimination of the strong power surge which would occur if the magnets rotated quite close to the pan. Such power surges would produce noise of such intensity as to make the device completely impractical for incorporation in a cooking appliance, such as a range, as well as for many other purposes. Because of the substantial spacing between the magnet poles and the cooking pans which is made possible by the use of low permeability magnet poles in the present invention, the problem of noise generation is reduced to the point where it is of no serious consequence from the practical standpoint. For this reason, it is possible to incorporate the present eddy current heating apparatus in a cooking appliance which is entirely effective for its intended purpose, but which is not subject to excessive noise.

Another important advantage which results from the use of low permeability magnet poles in the present invention is that it is possible to position the individual magnets closer together on the rotor without running the danger of excessive concentration of the magnetic flux at the adjacent lateral edges of the magnets. Thus, a given size rotor disc is able to accommodate a larger quantity of magnetic material than would be possible if the magnet poles were of high permeability material. Therefore, a greater number of magnets may be carried by the rotor, so that higher frequency eddy currents and a consequently improved heating action may be achieved for a given size and rotational speed of the rotor.

Furthermore, because of the rather substantial spacing between the top of the magnet rotor and the cooking top and the individual pan supports, the problem of dimensional manufacturing tolerances is minimized. This is significant because dimensional changes would tend to take place because of the heat generated in the operation of the apparatus.

The embedding of the individual magnets 13 in the aluminum disc 10 is advantageous in that the disc pro-

vides a short circuit winding of large cross section surrounding the exposed, upwardly facing pole of each magnet. It will be recognized that the change of flux involved in the operation of the present invention would tend to induce currents in the magnets themselves. In certain magnetic materials such induced currents can cause demagnetizing. In the present case, however, the aluminum disc provides a short circuit winding around the exposed pole of each magnet which effectively prevents the formation of such currents in the magnets themselves.

Another important aspect of the present invention is directed to a novel overload release which prevents the motor 12 which drives the magnet rotor from being loaded beyond a safe maximum rated value. This overload release effectively limits the amount of electrical power which the range can draw.

In accordance with the invention, the magnet rotor assembly is vertically movable in proportion to the load on the motor. While this may be accomplished in a number of different ways, in the embodiment of the invention the entire motor along with the magnet rotor assembly, is mounted for vertical movement. In the embodiment of the invention shown, and referring to FIGURE 2, the motor 12 includes a rotor to which the output shaft 11 is connected, and a stator which carries the field windings and also includes bearings rotatably supporting the shaft 11. The stator includes a pair of horizontal arms 27 slidable at their outer ends in spiral slots 26 formed in a fixed support member 23. Thus by rotating the stator and moving the arms 27 in the spiral slots 26, the magnetic rotor assembly may be adjusted vertically. One or a plurality of springs 24 extending between the frame 25 of the apparatus and the arms 27 bias the arms in a direction such that they are normally in the uppermost portion of the spiral slots 26. The direction of rotation of the motor is such that as a braking force is imposed on the magnetic rotor assembly, the resultant torque is against the bias of the springs such that the arms will move in the slots 26 and permit the motor and magnet rotor assembly to be lowered. In the embodiment of the invention shown, a coil spring 20 engages the underside of the motor and supports the weight thereof so that the arms may freely move in the spiral slots 26 in direct proportion to the braking forces on the magnet rotor assembly.

The purpose of this assembly is to provide an automatic arrangement whereby the spacing between the upper surface of the magnet rotor assembly and the pans on the support 16 may be increased as the torque on the motor approaches or exceeds its rated output torque, it being appreciated that as the rotational speed of the motor is generally constant, that the torque on the motor is directly proportional to the power which the motor is delivering.

A further advantage of this arrangement is that when the motor is initially started from a stopped position, the torque will be such as to move the motor and the magnet rotor assembly downwardly to reduce the starting load in the event a pan or other work piece should be on the stove when the motor is started.

The motor 12 is preferably one having a high rotational speed. This is advantageous for a number of reasons, one of which is that for a given number of permanent magnets, the higher the rotational speed, the higher will be the frequency of the induced eddy currents in the metal being heated. Additionally, the higher the rotational speed for a given horse power motor, the lower will be the force tending to move the metal being heated, such as the cooking utensils, in the direction of movement of the magnet.

Thus, when an electrically conductive material is placed on the support 16, it will have with the support 16, a predetermined or known coefficient of friction with the surface and the force required to move the material

sidewardly on the support is equal to the product of this coefficient of friction times the weight of the material. Preferably the speed of the motor will be such that the desired amount of heat can be accomplished without creating horizontal forces on the material in excess of this frictional force.

The present cooking range also has provision for selectively adjusting the level of each pan support 17 individually to thereby control the amount of heat generated in the corresponding cook-pan. The spacing of the cooking pan above the magnet rotor determines the magnetic coupling between them, and thus the heating effect due to the eddy currents induced in the pan.

To this end, referring to FIGURES 2 and 4, each pan support 17 is arranged to be operated by a corresponding control knob 30 at the front of the cooking top. Each pan support plate 17 has a plurality of laterally extending horizontal arms 31 around its periphery which are received in upwardly spiralled grooves 32 formed on the inside of a corresponding ring member 33 carried by the cooking top. By turning the pan support 17 about its own vertical axis, it will ride upward or downward along these spiral grooves, depending upon the direction in which it is turned. For selectively controlling the vertical position of each pan support 17 there is provided a conventional flexible control cable 37 connected between each pan support and a corresponding control knob 30, as shown in FIGURES 2 and 4. The control cable is suitably coupled at one end to the control knob 30 such that by turning the knob in one direction, the cable may be pulled to operate the corresponding pan support 17. The opposite end of the control cable 37 is slidably received in a vertical slot 35a formed in an inverted L-shaped bracket 35 attached to the underside of the pan support 17. The control cable at this end has an enlarged head 37a which, when the cable is pulled, engages the bracket 35 and causes the pan support 17 to turn in the corresponding direction. A bearing 38 carried by an inverted L-shaped bracket 39, which is attached to the bottom of the cooking top, constitutes a support and guide for this end of the control cable.

Preferably, suitable spring means (not shown) is provided for biasing each pan support 17 in one direction, and the cable when pulled acts against this spring bias to position the pan support at a height determined by the angular setting of the corresponding control knob 30. In the preferred embodiment such spring means may bias the pan support 17 to its uppermost position.

In the operation of this cooking range, each pan of food to be cooked is placed on a selected individual pan support 17 and the corresponding control knob 30 is turned to adjust the heat intensity for that pan.

As shown in FIGURE 2, the bottom of the pan extends down into a well whose sides are formed by the ring 33 which carries the pan support 17. Also, the entire cooking top or support 16 because of its raised marginal sides 16c, constitutes a trough-like or sink-like structure. This is a safety precaution to guard against the pan's being thrown sideways off the cooking top because of the magnetic forces acting on it. While this is most unlikely to occur, even in the case of a light-weight pan which is empty, there is a possibility that a child might insert a piece of aluminum foil onto the cooking top, and the magnetic forces acting on such a light-weight electrically conductive member might be sufficient to displace it sideways, with the possibility of injuring a person nearby. This is positively prevented by the raised sides on the present cooking top.

As already stated, as the magnet rotor 10 is driven by the motor 12, the magnets 13 produce upwardly directed moving magnetic fields which act in succession on the cooking pan to induce eddy currents in the pan and heat the food therein. Because of the slots in the pan supports 17 and the nature of the material of which the pan

supports are composed, little or no eddy currents are induced in the pan supports themselves.

From the foregoing, it will be apparent that the schematically illustrated embodiment of the present invention is capable of improved operation which adapts its particularly well for incorporation in a cooking appliance, such as a range.

While the described arrangement of the permanent magnets on the rotor is considered preferably from a practical standpoint, it is to be understood that electromagnets having low permeability upwardly facing poles may be substituted in place of the permanent magnets if desired. Also, while the embedding of the magnets of the high conductivity disc 10 is considered advantageous for the reasons stated above, other rotor supports for the magnets could be employed. Moreover, the cooking top arrangement may be changed by eliminating the individual pan supports and providing holding magnets for holding the cooking pans in place, if desired. Also, the cooking pans may have incorporated therein material of high magnetic permeability so that the heating effect will be enhanced by hysteresis losses produced therein by the magnet rotor.

Using the present invention, tests have indicated that a quart of water can be raised from 60° F. to 212° F. in 3.03 minutes as against 5.30 minutes for a known highly efficient electrical resistance radiant type heating unit.

Therefore, it is to be understood that, while there has been described herein and illustrated in the accompanying drawing a presently-preferred embodiment of this invention, various modifications, omissions and refinements which depart from the disclosed embodiment may be adopted without departing from the spirit and scope of this invention.

Having thus described my invention, I claim:

1. A cooking range comprising a support defining a cooking top of low electrical conductivity and low magnetic permeability, and a multi-pole magnet rotor rotatable below said cooking top substantially parallel thereto to induce eddy currents in an electrically conductive workpiece supported at said cooking top, said magnet rotor including a rotor disc of high electrical conductivity material, and plurality of spaced magnets embedded in said disc and presenting upwardly facing poles of low permeability material which are arranged in a sequence of alternate polarity at the top of the rotor disc.

2. The cooking range of claim 1 wherein each of said magnets is a low permeability permanent magnet having a magnetically privileged direction toward the overlying cooking top.

3. The cooking range of claim 2 wherein each of said magnets in cross-section has a length-to-width ratio not appreciably greater than 2 to 1.

4. The cooking range of claim 1 wherein each of said upwardly facing magnet poles has a magnetic permeability not substantially greater than 25.

5. The cooking range of claim 1 wherein there is provided a shield of substantially electrically non-conductive and magnetically non-permeable material positioned below said cooking top and completely overlying said magnet rotor in spaced relationship thereto.

6. The cooking range of claim 1 wherein there are provided a plurality of pan supports at said cooking top which are vertically adjustable individually.

7. The cooking range of claim 1 wherein said cooking top has raised sides at its periphery.

8. A cooking range comprising a cooking top, a multi-pole magnet rotor assembly rotatable below said cooking top to induce eddy currents in an electrically conductive member supported at said cooking top, an electric motor positioned below said magnet rotor assembly and having a stator and a rotor, an output shaft connected to the rotor of the motor to be driven thereby and coupled to said magnet rotor assembly to support and rotate the latter, and means supporting the stator of the motor to turn about its axis and to move downward away from

the cooking top to retract the magnet rotor assembly down away from the cooking top when the opposing magnetic torque on the magnet rotor assembly by the eddy currents induced in the electrically conductive member supported at the cooking top causes the motor to approach a predetermined power consumption value.

9. The cooking range of claim 8 wherein there is provided means resiliently biasing the motor upward toward the cooking top.

10. A cooking range comprising a support defining a cooking top of low electrical conductivity and low magnetic permeability, and a multi-pole magnet rotor mounted for rotation below said cooking top to induce eddy current in an electrically conductive workpiece supported at said cooking top, said magnet rotor including a plurality of magnets which present upwardly facing poles of low permeability material with upwardly facing poles of successive magnets on the rotor being of alternate polarity, said magnet poles having magnetically privileged direction toward the over-lying cooking top.

11. The range of claim 10 wherein said rotor presents material of high electrical conductivity surrounding each of said upwardly facing magnet poles at the upper face of the rotor and constituting a short-circuit winding for each magnet.

12. A cooking range comprising a support defining a cooking top of low electrical conductivity and low magnetic permeability and a multi-pole magnet rotor mounted for rotation below said cooking top to induce eddy currents in an electrically conductive workpiece supported at said cooking top, said magnet rotor including a plurality of magnets which present upwardly facing poles of low permeability material, with the upwardly facing poles of successive magnets on the rotor being of alternate polarity, said magnet rotor having a plurality of radially spaced, circularly arranged rows of said magnets disposed concentrically about the axis of rotation of said rotor.

13. An eddy current cooking range comprising a support defining a cooking top of low electrical conductivity and low magnetic permeability, and a multi-pole magnetic rotor mounted for rotation below said cooking top to induce eddy current in an electrically conductive workpiece, and a low permeability plate means for supporting said workpiece at said cooking top, said plate means having a plurality of closely spaced substantially parallel slots.

14. An eddy current cooking range comprising a support defining a cooking top of low electrical conductivity and low magnetic permeability, a multi-pole magnet rotor mounted for rotation below said cooking top to induce eddy currents in an electrically conductive workpiece supported at said cooking top, said magnet rotor comprising a plurality of substantially concentric rings of magnets with the poles of successive magnets in each ring on said rotor being of alternate polarity.

15. An eddy current cooking range comprising a support defining a cooking top of low electrical conductivity and low magnetic permeability, and a multi-pole magnet rotor mounted for rotation below said cooking top to induce eddy currents in an electrically conductive workpiece, and a substantially flat, electrically non-conductive, magnetically non-permeable means between said cooking top and said magnet rotor for preventing accumulation of deleterious material on said magnet rotor.

16. An eddy current cooking range comprising a support defining a cooking top of low electrical conductivity and low magnetic permeability, and a multi-pole magnet rotor mounted for rotation below said cooking top to induce eddy currents in an electrically conductive workpiece, and a means for supporting said workpiece on said cooking top, said means comprising an opening in said cooking top for receiving said workpiece and for laterally restraining said workpiece.

17. In an eddy current cooking device, a low electrical conductivity cooking top and a magnet rotor rotatably mounted below said top and comprising a composite disk

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of low permeability high electrical conductivity material, a plurality of magnets embedded in said material and presenting outwardly facing poles of low permeability material, said outwardly facing poles of successive magnets on the disk being of alternate magnetic polarity.

18. In an eddy current cooking device as defined in claim 17, said disk presenting a flat upper face and said outwardly facing poles of said magnets are positioned at said upper face of said disk.

19. In an eddy current cooking device as defined in claim 18, each of said magnets being a permanent magnet having a magnetical privileged direction substantially perpendicular to said upper face of said disk.

20. An induction heating device comprising a support for an electrical conductive article to be heated, a multipole magnet rotor assembly, an electric motor coupled to and supporting said magnet rotor assembly for rotation in proximity to said support, cam means for supporting said motor, said motor and rotor assembly being moved away from said support on rotation of said motor in a

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predetermined direction with respect to said cam means, and torque responsive means for rotating said motor in said predetermined direction when the power to drive said motor approximates a predetermined value.

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