(No Model.) 3 Sheets—Sheet 1.

W. S. HADAWAY, Jr.

AUTOMATICALLY CONTROLLED ELECTRIC OVEN.

No. 574,537. Patented Jan. 5, 1897.

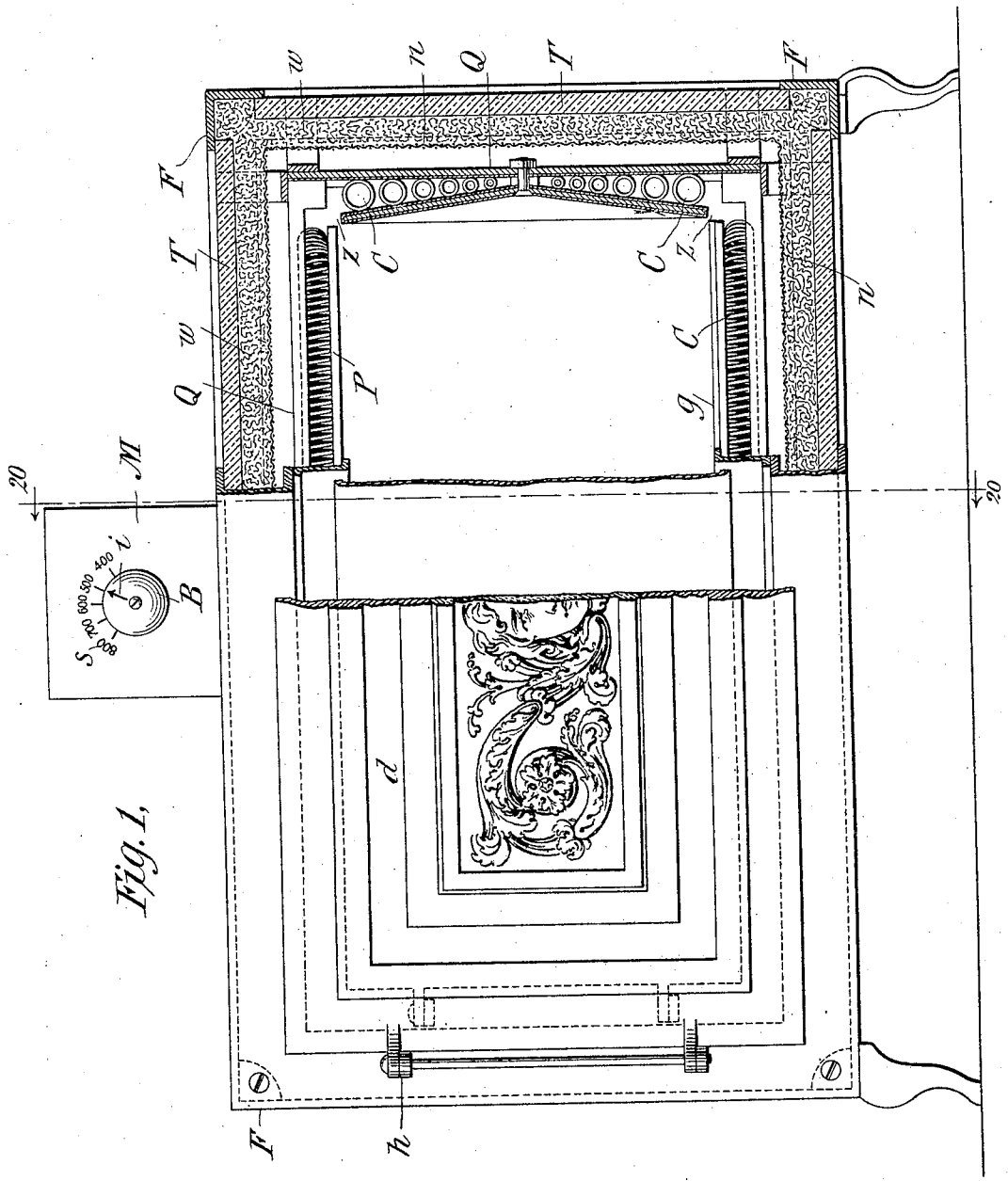

Fig. 1.

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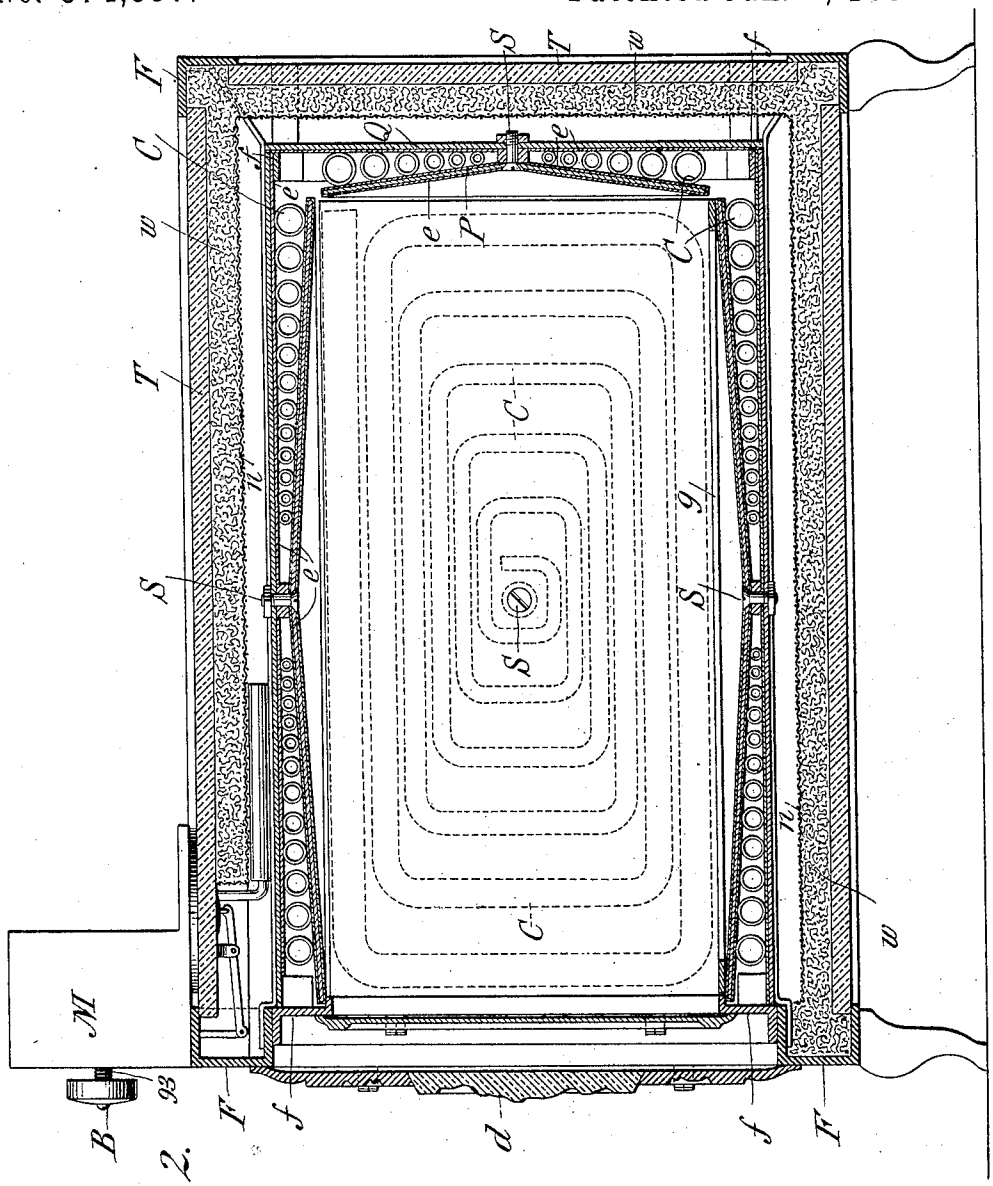

Fig. 2.

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(No Model.) 3 Sheets—Sheet 3.

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Fig. 5.

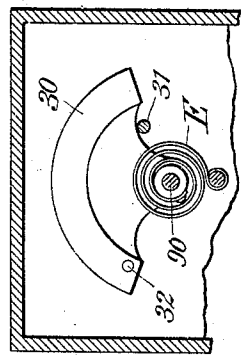
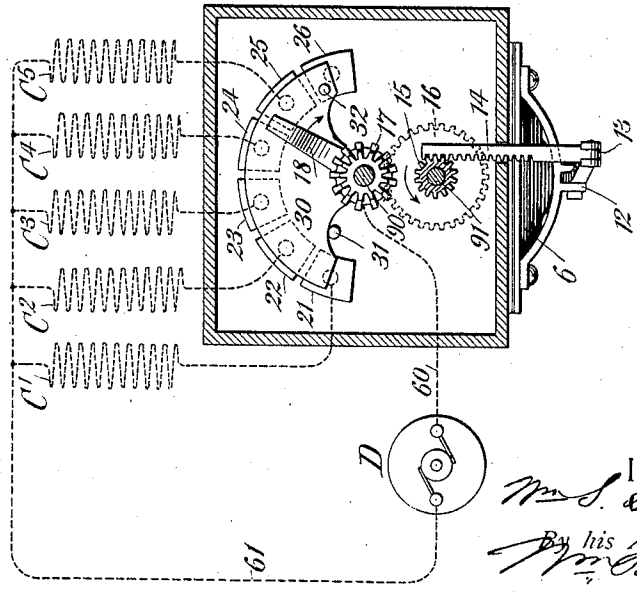


Fig. 3.

Fig. 4.



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UNITED STATES PATENT OFFICE.

WILLIAM S. HADAWAY, JR., OF NEW YORK, N. Y.

AUTOMATICALLY-CONTROLLED ELECTRIC OVEN.

SPECIFICATION forming part of Letters Patent No. 574,537, dated January 5, 1897.

Application filed May 4, 1896. Serial No. 590,134. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM S. HADAWAY, Jr., a citizen of the United States, and a resident of New York, in the county and State of New York, have made certain new and useful Improvements in Automatically-Controlled Electric Ovens, of which the following is a specification.

My invention is an improvement in the automatic control of electrically-heated apparatus, such as ovens, for baking food, &c.

An electric oven has heating capacity much in excess of the required normal cooking heat, and this heat is immediately available when the current of electricity is turned on. This high initial temperature is necessary to provide a quickly-heated oven and to provide for varying and unknown heat loss due to the variations in temperature of the air and the movement of the air, which is effective in causing heat loss at a varying and unknown rate. An efficient means for automatically regulating and controlling the temperature of the oven interior is therefore extremely desirable, and I provide an automatic switch, operated by variations of the temperature of the heated surface, to cut coil-sections of the heating-conductor in and out of circuit and so regulate the temperature in an economical manner.

My automatic controller is adjustable or variable, so that any predetermined temperature within the range or capacity of the apparatus may be maintained, and I am thus enabled to accurately establish the specified temperature best adapted to perform any baking or cooking operation for the time being desired to be accomplished.

I provide a switch or circuit-changer having a series of fixed insulated contacts arranged in the arc of a circle. Each of these contacts is permanently connected to a coil-section or to a point at the junction of two coil-sections of the heating-coil. There is a removable contact of the same arc shape and of sufficient extent to engage all the fixed contacts simultaneously, and a spring normally holds this movable contact in position to connect with all of said contacts simultaneously, so that all the coil-sections are normally in multiple arc. I provide a pivoted radial arm capable of independent movement for the purpose of changing the movable switch-contact from one point to another, and thus disconnect one coil-section after another to remove it from active operation as a heat-producing cause. The radial arm and movable contact are operated by variations in temperature inside the oven, and for this purpose a pivoted lever is connected to the radial arm through the medium of separable gear-wheels and a toothed bar engaging one of said wheels. The toothed bar is pivoted to the lever, and the lever is tilted in one direction or the other by a thermal-motor device consisting of a corrugated diaphragm and a reservoir in the form of a copper tube containing a hydrocarbon fluid which volatilizes at a temperature below the minimum working temperature of the oven.

The accompanying drawings illustrate my invention.

Figure 1 is a front or face view of the oven, partly in section. Fig. 2 is a section on the line 20, Fig. 1. Fig. 3 is a view of the automatic switch and thermal-motor device for operating it. Fig. 4 is a view of the thermal-motor device on the line 40, Fig. 3, the coils for heating and the electrical connections being indicated in dotted lines. Fig. 5 is a view on line 50, Fig. 3, showing the movable switch-contact and its retracting-spring.

As shown in Figs. 1 and 2, the form of oven to which my improvement is preferably applied consists of a framework of angle-iron F, to which the door *d* is hinged, as at *h*. The side walls of this skeleton frame are filled in with glazed tiles T. The tiling is backed with mineral wool *w*, and this is held in position by a network *n* of iron or other metal wire. The oven approximates a cube, but as shown the length and breadth somewhat exceed the height.

I prefer to employ for a heating-conductor a wire of nickel steel or tungsten steel in the form of a graduated helix C, the helix being disposed in convolutions around a central point. The object of this form of conductor is to uniformly heat the surface adjacent to the conductor. The oven proper is a shell, each wall consisting of two separated plates inclosing a space upon five sides, the door *d* completing the inclosure. The two plates of each wall are shown at P and Q, respectively.

The plate Q is a sheet of metal, as iron or steel, presenting a flat or plane surface. The inner side is coated with an enamel *e*, of a vitreous, electric-insulating, heat-conducting nature. The other plate, P, located inside the plate Q when in position in the oven, is in the form of a flattened cone or pyramid united to the flat plate by a bolt or screw S, passing through the apex of the conoidal plate and the center of the flat plate. The plate P is coated with a vitreous enamel *e* on both surfaces, but I sometimes use thin tiling upon the interior surface as a substitute for the enamel. The two plates P and Q, united at their centers, separated by a gradually-increasing space from the center outward, are intended to receive, and do receive and hold, the graduated helix C, the separating space at any radial distance being about equal to the diameter of a helical convolution of the conductor C when said helical conductor is disposed substantially as shown in the drawings, Figs. 1 and 2.

The several sides or walls of the oven are placed in a frame *f*, of angle-iron, fitting the interior space of the frame F. The oven proper and its frame *f* may be drawn out, a side wall removed, and the graduated coil removed and replaced in said wall by a winding movement, in which the two united plates are used like a reel. The plates P and Q have a certain degree of resilience, enabling them to hold the coiled conductor properly spaced, while the enamel forms an insulator at the points of contact between plate and conductor. A grate *g* is placed in the bottom of the oven to provide a level surface. There is a separate graduated helix between each pair of plates, and the degree of separation between the plates may be varied by employing washers on the central connecting-screw S. The coils have one terminal connected together and to one terminal of an electric circuit, and the second terminal of each coil is connected to a separate and insulated contact, so that they may all be connected in multiple arc, or one or more may be excluded from circuit in the manner now to be described.

Referring to Figs. 3, 4, and 5, an automatic switch or circuit-changer M is placed upon the exterior of the frame F and inclosed in a suitable case. A backboard or piece of insulating material J is fixed in an upright position, and upon it in the arc of a circle are placed a series of insulated contacts 21 to 26. Each of these contacts is electrically connected to one terminal of a coil C, located in one of the sides of the oven. In Fig. 4 these heating-coils are diagrammatically represented at C′ to C⁵. The second terminal of each coil is permanently connected to the conductor 61, extending to the dynamo D. There is a sector-shaped movable contact 30, journaled on arbor 90, where it moves independently. It is wide enough to make simultaneous contact with all the fixed contacts and is connected to the second terminal of dynamo D by conductor 60. There is a fixed stop 31 for the contact 30, and a coiled spring E, Fig. 5, normally holds 30 against stop 31. A radial arm 18 is journaled at 92, and a beveled gear-wheel 17 is fixed to the arm 18. A beveled gear-wheel 16 is journaled at 91 and is fixed to a toothed wheel 15. A rack-bar 14 meshes with the wheel 15. On the surface of movable contact 30 is a pin or stop in position to engage with radial arm 18 when said arm moves in the direction of the arrow, Fig. 4. The beveled gear-wheels 16 and 17 mesh, and the wheel 17 on the arbor 92 may be thrown out of mesh by pressing upon the button B, which moves the arbor 92 longitudinally against the force of the spring 93. There is a pointer *i* on the button B, Fig. 1, and on the outside of the case M there is a graduated scale. The radial arm 18 and the pointer *i* are in fixed relation, and the pointer and scale enable the operator to set the radial arm 18 at any point between the limit-stops 31 and 32, Fig. 4. By depressing the button B and turning it the radial arm 18 may be caused to engage the stop or pin 32, and the movable switch-contact may be moved by hand should occasion require.

The operation last described is usually performed automatically through the medium of a thermal-motor device. This device consists of a corrugated diaphragm of thin metal 6, fixed to the plate *p* by an air and liquid tight joint. A copper tube 9 is laid upon any desired part of the heated surface of the oven. The tube 9 is connected with the interior of the diaphragm 6 by a pipe-section 8, also of copper. The tube and diaphragm contain a quantity of some suitable hydrocarbon 7, which possesses the capacity of volatilizing at or below the normal or minimum working temperature of the oven. I prefer to employ the hydrocarbon identified by the chemical formula (C_2H_5) 2O, but others may be found equally satisfactory. With variations in temperature mechanical motion is produced at the center of the diaphragm 6, and this motion is communicated to the rack-bar 14 through the medium of the lever 10, having its fulcrum at 12. It is jointed to the center of the diaphragm at 11 and to the bar 14 at the point 13. As the temperature increases the diaphragm is expanded and the rack-bar 14 is moved upward, turning the gear-wheels in the direction indicated by the arrows in Fig. 4.

Let us assume that we wish to maintain the oven at a temperature indicated by the figure "500" on the scale *s*. We therefore set the arm 18 and pointer *i* as shown. Normally all the heating-coils are in circuit and the temperature rises rapidly. The rack-bar 14 moves upward, turning the wheels and moving the radial arm 18 to the right. The arm engages the stop 32 and carries the movable contact 30 with it, breaking connection with fixed contacts 21 22 23, &c., in succession, and throw-

ing coil-sections C′ C^2 C^3, &c., out of circuit, thus reducing the heating cause, and a point is soon found where the temperature due to the coils remaining in circuit corresponds with the temperature indicated by the designation "500" on the scale. Should the temperature now fall, the rack-bar 14 moves in the opposite direction and the coil-spring E draws the movable contact toward the left, making contact, successively, with the fixed contacts 23 22 21 until the desired temperature is again established. Should it be desired to establish any higher temperature than that above assumed, the radial arm 18 is turned back to a point where a greater degree or extent of movement will be necessary before said arm engages the stop 32. Such, for instance, would result from turning arm 18 back to the point "800" on the scale, when said arm would necessarily move entirely across the line of fixed contacts before engaging the point 32.

I provide spaces, as at *z*, Fig. 1, for conducting heated air to the interior, and thus increase the heat, which would otherwise be radiated alone.

What I claim, and desire to secure by Letters Patent, is—

1. In an electric heating device the combination of a surface to be heated, an electric conductor in sections located in proximity thereto, a series of fixed contacts respectively connected to different points in said sectional conductor, a contact movable across the surface of the fixed contacts, an engaging point on said movable contact, a radial arm in position to engage said point but capable of independent movement, a thermal-motor device and separable gearing connecting the motor device and radial arm whereby the arm may be set and the extent of free movement thereof may be varied, substantially as described.

2. In an electric heating device the combination of a surface to be heated, a sectional heating-conductor in proximity thereto, a series of fixed contacts respectively connected to different points in said sectional conductor, a movable contact traveling over said fixed contacts, a spring normally holding said contact at one limit, an engaging point on said contact, a radial pivoted arm capable of independent movement and of engaging said point to impart motion to said contact, a thermal-motor device for moving said arm and a variable mechanical connection between said motor and said arm whereby the extent of free movement of said arm may be varied, substantially as described.

WILLIAM S. HADAWAY, JR.

Witnesses:
THEODORE L. CUYLER, JR.,
WALTER S. PLACE.