

Oct. 1, 1935.

T. H. FORDE

2,015,926

ELECTRIC FURNACE

Filed Nov. 2, 1931

3 Sheets-Sheet 1

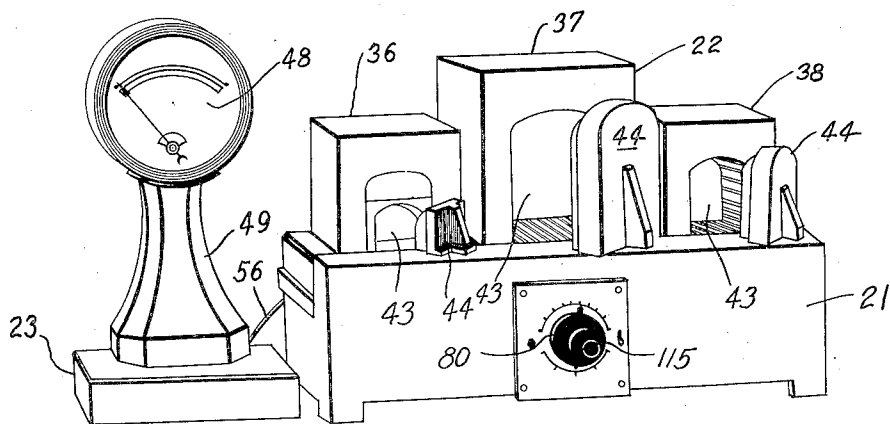


Fig. 1.

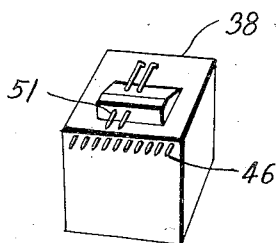


Fig. 2.

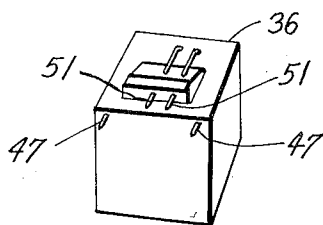


Fig. 3.

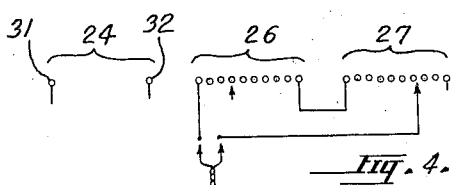


Fig. 4.

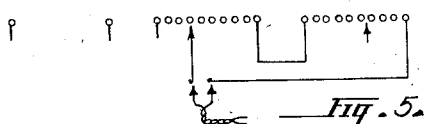


Fig. 5.

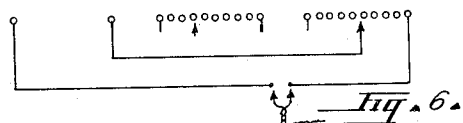


Fig. 6.

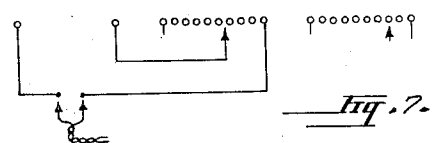


Fig. 7.

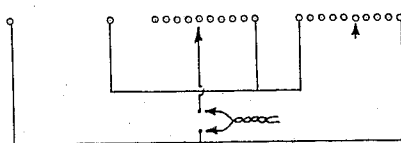


Fig. 8.

INVENTOR.

Thomas H. Forde

BY

Joseph B. Gardner
his ATTORNEY

Oct. 1, 1935.

T. H. FORDE

2,015,926

ELECTRIC FURNACE

Filed Nov. 2, 1931

3 Sheets-Sheet 2

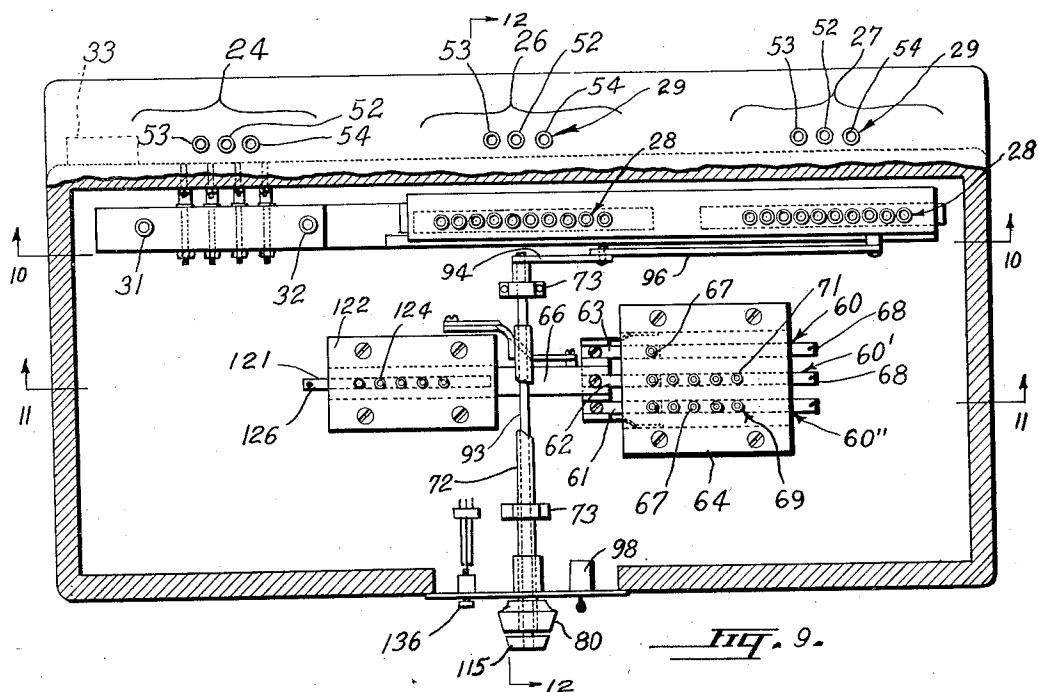


Fig. 9.

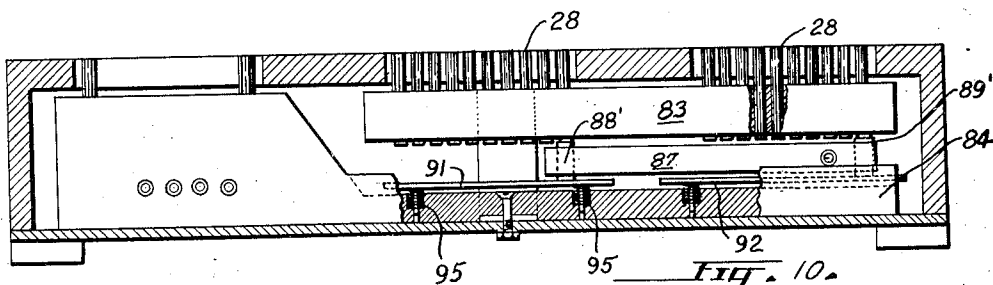
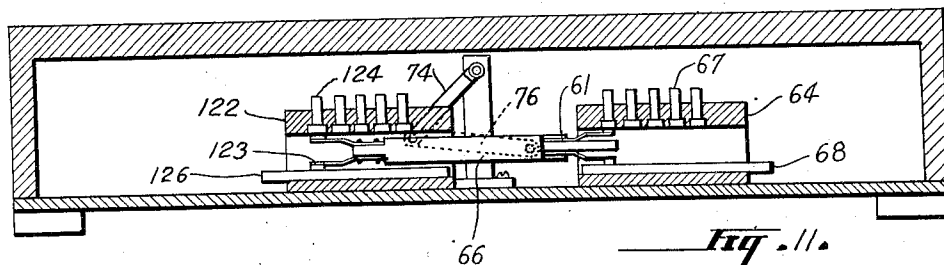


Fig. 10.



Oct. 1, 1935.

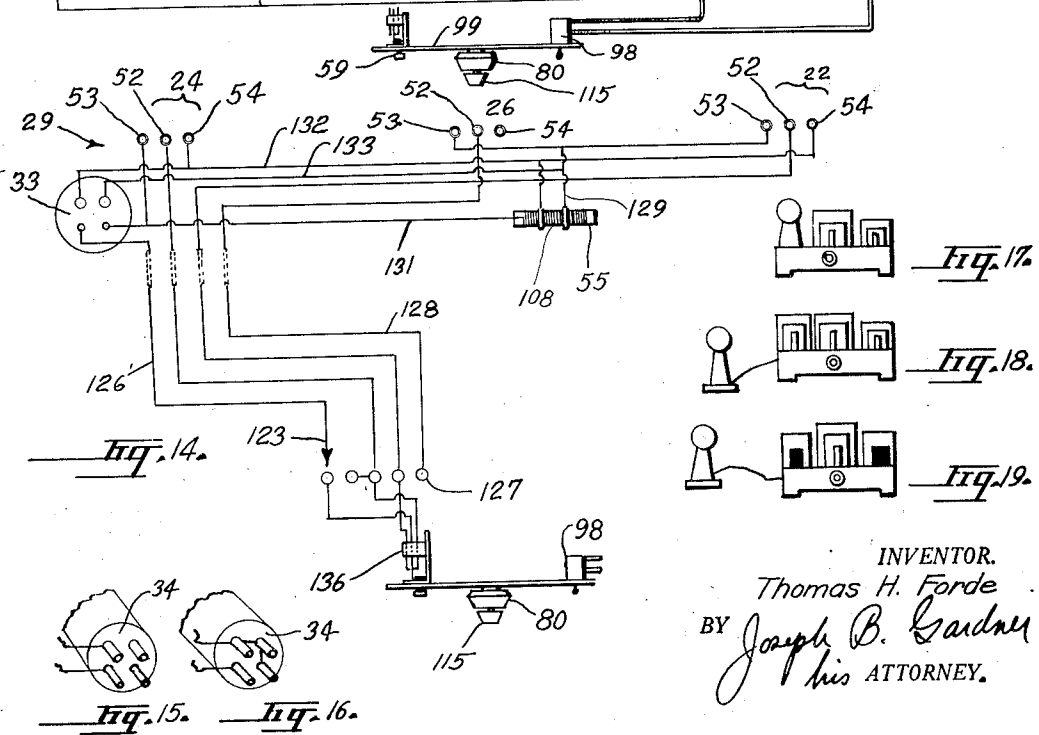
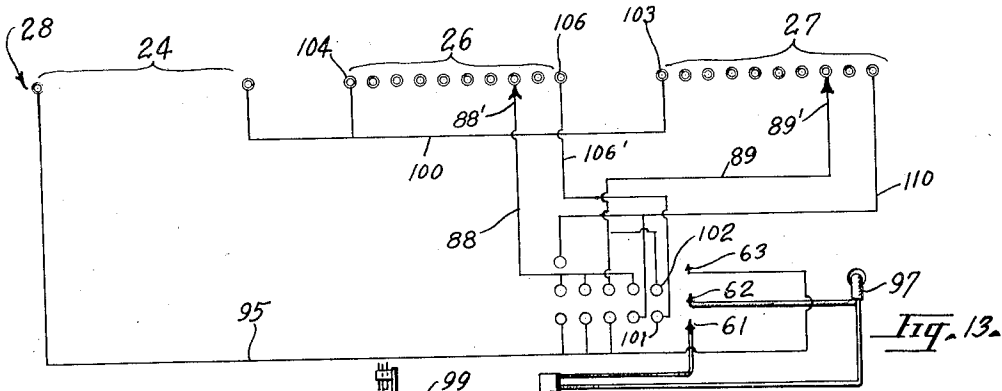
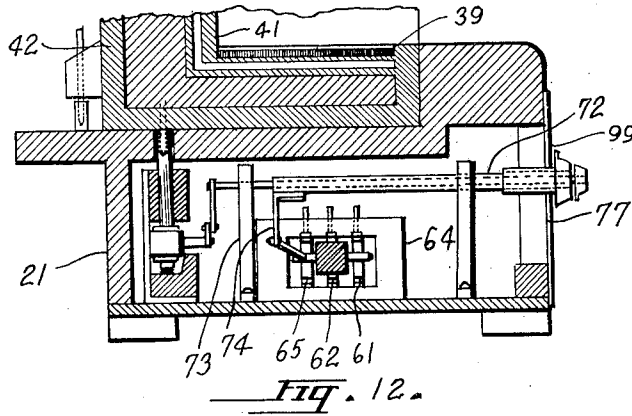
T. H. FORDE

2,015,926

ELECTRIC FURNACE

Filed Nov. 2, 1931

3 Sheets-Sheet 3



INVENTOR.
Thomas H. Forde
BY *Joseph B. Gardner*
his ATTORNEY.

UNITED STATES PATENT OFFICE

2,015,926

ELECTRIC FURNACE

Thomas H. Forde, San Francisco, Calif., assignor
to Diascope Corporation Ltd., San Francisco,
Calif., a corporation of California

Application November 2, 1931, Serial No. 572,622

7 Claims. (Cl. 219—20)

The invention relates to electric furnaces and more particularly to means attendant thereto for obtaining various muffle and pyrometer combinations.

At the outset, attention is called to my co-pending application Serial No. 410,983 matured to Patent No. 1,907,290 drawn to cover a mode of operation and a selective switching mechanism similar to the device herein set forth. With the furnace described in the aforementioned application as a basis, it has been my object, and I have, through the invention of a novel switching arrangement, developed various sets of automatic muffle combinations heretofore entirely unavailable in previous furnaces.

An additional object has been to provide a pyrometer and a selective switching means therefor to automatically indicate the temperature of a preselected muffle.

A further object of my invention has been to provide a pyrometer compensating wiring circuit having the combination of a novel circuit and switching means which automatically allows for the use of either of two voltage indicating devices of different internal characteristics.

A still further object of my invention has been to provide a furnace with detachable and interchangeable muffles, wherein the operating contacts therefor are so arranged as to make the proper placement of the parts and the resulting correct operation of the furnace inevitable.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of the preferred form of the invention which is illustrated in the drawings accompanying and forming part of the specification. It is to be understood, however, that variations in the showing made by the said drawings and description may be adopted within the scope of the invention as set forth in the claims.

Referring to the drawings:

Figure 1 is a perspective view of the complete furnace in the preferred form of my invention.

Figures 2 and 3 are rear bottom perspective views of two of the muffles here embodied.

Figures 4 to 8 inclusive are schematic wiring diagrams of the five electric circuits employed herein.

Figure 9 is a plan view of the base with a portion of the top thereof removed.

Figure 10 is a cross sectional view taken on the line 10—10 of Figure 9.

Figure 11 is a cross sectional view taken on the line 11—11 of Figure 9.

Figure 12 is a cross sectional view taken on line 12—12 of Figure 9.

Figure 13 is a diagrammatic wiring lay-out of the muffle heating coil circuits.

Figure 14 is a diagrammatic wiring diagram of the pyrometer switching mechanism.

Figures 15 and 16 are diagrammatic views of two types of milli-voltmeter plugs used with my furnace.

Figures 17, 18, and 19 illustrate some of the possible muffle and pyrometer combinations.

Referring to the drawings, and to Figure 1 in particular, it will be noted that the dental furnace of my invention comprises in general a hollow base 21, a set of muffles 22 detachably secured thereto, and a pyrometer 23 electrically connected therewith. The base, as will be seen in Figures 9 to 12 inclusive, contains the switching mechanism for selecting various muffle combinations and for determining the muffle temperatures. Provided on the top of the base are, as here shown, three groups of female contacts 24, 26, and 27 arranged to receive cooperating male contacts on the muffle. As may be noted from Figure 9, each group comprises two rows of contacts. The forward row 28 of groups 26 and 27 is defined in the present embodiment by ten contacts, while situated directly therebehind is a second row 29 of three contacts. It will be noted that the forward row of contacts of group 24 consists of only two terminals 31 and 32 which are spaced apart a distance equal to the spacing of the outside terminals of rows 26 and 27, the portion of the top between said terminals 31 and 32 being left open and without the intermediate contacts therein. Aside from this single feature, the three groups of female contacts are practically the same. Due then to the similarity of the contact groups, the muffles to be hereinafter described are insertable into any one of the three contact groups.

The base also provides a "plug-in" arrangement for the pyrometer. As here shown this arrangement comprises a socket member 33 mounted on the casing, and a plug member 34 therefor connected directly through a flexible cable to the pyrometer 23. The pertinency of the foregoing will be hereinafter noted in setting forth the pyrometer compensating circuit in detail.

The muffles are designed to form an important part of the furnace in the present embodiment and are of three types to wit: a small high heat muffle 35, a larger low heat muffle 37 and a small low heat muffle 38. The three types are similarly

constructed with a wire wound resistance unit 39, a refractory 41 and an enclosure 42. Each is provided with an opening 43 through which the work may be placed into the refractory and a closure 44 for sealing the opening.

The muffle types differ mainly in the coil design. The two low heat muffles are provided with a tapped resistance unit, which in each instance includes two end terminals and eight intermediate taps. Electrical connection to these terminals and taps may, as here shown, be gained from the outer side of the muffle through a row of male contacts 46 extending from the bottom of the muffle. The high heat muffle preferably employs a platinum wound or other high heat producing resistance coil, but this coil, unlike the low heat coils, is not tapped, thereby leaving the muffle in contrast with the low heat muffle, with but two male contacts 47 electrically connected to the end terminals of the untapped coil. It should also be noted from Figure 3 that the spacing of the two contacts 47 is identical with that of the two outside male contacts of the row of contacts provided on the low heat muffles.

To determine the temperatures of the various muffles a pyrometer 23 is used, and in the present case the latter is of the type comprising a thermo-couple placed in the refractory of the muffle and a milli-voltmeter 48 which is mounted on a pedestal 49 and used for indicating the generated potential in the thermo-couple. Preferably, the milli-voltmeter is calibrated to read directly in degrees Fahrenheit.

The range of heat employed by the furnace is from room temperature, say 76 degrees Fahrenheit, to 3000 degrees Fahrenheit. Such a wide range of heat, as will be seen, introduces a thermo-couple problem. Base metal couples that normally react satisfactorily to temperatures below 2000 degrees Fahrenheit melt at temperatures substantially above this value. On the other hand, platinum thermo-couples suitable for high temperatures produce a very small potential when used at low temperatures, and accordingly demand the use of a sensitive, expensive milli-voltmeter. Now since the furnace of my invention may, if desired, be readily used with low heat muffles exclusively, wherein the maximum temperature usually reaches only about 1800 degrees Fahrenheit, it is readily seen that to equip such a furnace with platinum thermo-couples and an expensive milli-voltmeter would be very wasteful.

In effecting the solution of the foregoing, part thereof consists in the use of a relatively high-potential low-temperature base-metal thermo-couple with the low heat muffles, and a high-heat and comparatively low potential platinum couple for use with the high heat muffle. As aforesaid, the thermo-couple in each instance, as is conventional, is placed within the refractory chamber of the muffle. Wires connected to the terminals of the couple are led through the casing to two male contacts 51 extending downward from the rear of the casing directly behind the heating coil contacts.

As previously stated, the high and low heat muffles are interchangeable. It is to be noted, however, that the different types of thermo-couples employed in these muffles have different temperature-voltage characteristics. Accordingly, should the voltmeter be calibrated for the platinum thermo-couple which has a low voltage characteristic, and be used to indicate the temperature of a low heat thermo-couple which has

a high voltage characteristic, the indication received would be entirely too high. As it is desirable to use but a single voltage-indicating-device to record all of the temperatures directly, it is necessary, in order to permit such use, to provide a means whereby the voltage of the low heat couple may be reduced when the milli-voltmeter employed is calibrated in accordance with the low potential produced by the platinum couple.

Viewing the base from the top as in Figure 9, it will be seen, as before mentioned, that there is a rearward row of three female contacts 29 in each of the three contact groups. These contacts are arranged for the reception of the thermo-couple contacts provided on the muffles, two of such female contacts 52 and 53 being arranged for use with the platinum thermo-couple whereas the contacts 52 and 54 are adapted for use with the base-metal couple. In the circuit formed by the insertion of the platinum couple into contacts 52 and 53, direct connection is afforded the couple to the milli-voltmeter. On the other hand, as will be more fully hereinafter explained, in the circuit connecting the low heat couple contacts 52 and 54, a resistance unit 55 is provided, whereby connection to the milli-voltmeter can only be established through such resistance, the latter functioning to reduce the voltage impressed upon the meter to the same value as would be created by the platinum couple acting at the same temperature. Thus by use of such resistance a single voltmeter may be employed to indicate the temperatures of both types of muffles as previously described. Provision is therefore made that should the muffle be of the high heat type, its thermo-couple contacts will engage the two female contacts 52 and 53 comprising, as here shown, the center and left of the three contacts, and should the muffle be of the low heat type the thermo-couple contacts thereof will engage the two female contacts 52 and 54 comprising the center and right of the group. This is accomplished by positioning the couple contacts on the high heat muffle with respect to the heating coil contacts, in the same relation as the center and left contacts 52 and 53 are located with respect to the row of heating coil contacts on the base. Likewise the couple contacts of the low heat muffle are positioned in relation to the heating coil contacts thereon in the same relation as the center and right contacts 52 and 54 are located relative to the end contacts of the row of heating coil contacts on the base.

It will now be clearly understood that either type of muffle may be operatively inserted in any of the contact groups provided on the base. To adapt the furnace to the particular requirements of any field of endeavor it is only necessary to select the most desirable combination of high and low heat muffles and set them in position in any desired relation to one another. As disclosed in my copending application aforesaid the furnace of my invention provides utilization as a source of heat for one muffle the heat given off by the rheostat resistance element used in the control of the current supplied to the heating element of another muffle, such mode of operation being afforded in general by arranging the resistance or heating elements of the set of muffles in series with one another. Means are therefore provided for automatically connecting the muffles together in such series relation, regardless of the combination of muffles selected. The foregoing means will now be described in connection with various of the possible muffle combinations

It will of course be clear that since the three interchangeable muffles are each adapted for insertion into any one of the three contact groups, the possible combinations available with such a structure are entirely too numerous to describe. All of these combinations, however, are here controlled by five simple electric circuits. With muffles operatively disposed in the contact groups, the first circuit, illustrated in Figure 4, places the heating elements of the muffles in the second and third contact groups in series, with the muffle in group three acting as the rheostat. The second circuit, shown in Figure 5, includes the second and third muffle elements in series, with the second muffle acting as the rheostat. Circuit number three places muffles of groups one and three in series, with the element of number three as the rheostat, and circuit number four similarly includes muffles of groups one and two in series, with the element of number two acting as the rheostat. Circuit number five provides for using muffle of group number two as the rheostat for both muffles of groups one and three. Circuits three, four and five are shown in Figures 6, 7, and 8 respectively.

The switching means here used for selecting the desired circuit is shown in Figures 9 to 12 inclusive, and comprises three cooperating switch units 60, 60', and 60''. These units consist of parallel contacts 61, 62, and 63 slidably mounted within a housing 64. Fastened to the contacts is an actuating bar 65 which is arranged to slide the contacts through the housing. Sets of fixed contact members 67 are provided in the housing directly over and engageable with the slidable contacts, and conducting metal-plates 68 are provided under the latter and engaged thereby, whereby an electric current may pass from the metal plates 68 through the sliding contacts into any of the fixed contacts 67 in the housing. In the arrangement of the contacts 67 as clearly shown in Figure 9, rows 69 and 71 of five contacts each are provided for engagement with the sliding contacts 61 and 62 and the adjacent contacts in the two rows are transversely aligned with respect to the longitudinal axis of the bar 65. On the other hand but a single fixed contact is provided for engagement with contact 63 and is in alignment with the extreme left contact of rows 69 and 71.

The sliding bar 65 is arranged to be actuated by the operator from the front of the furnace base. The actuating means comprises a hollow tubular member 72 rotatably supported by standards 73 and having fastened thereto a crank member 74 which is connected to the bar 65 by means of a link 76. For convenience of operation the fore end of the tube 72 is extended through the front wall 77 of the base and a knob 80 fixed thereto, the latter being preferably in the form of a dial so that the position of the switch may be readily determined. It will now be apparent that as the dial member is rotated, the contacts 61, 62, and 63 will slide within the housing 64 to progressively engage the contacts 67 therein.

Figure 13 illustrates the operation of the switching mechanism aforesaid. Electric power is supplied through the cable 97 brought directly to the base of the furnace, and a toggle switch 98 mounted on the front plate 99 of the base is inserted in series with one of the power leads, which is connected directly to the metal plates 68. As here shown arrows indicate the sliding contacts and are therefore numbered the same as the contact members they represent. With dial 80 rotated to the extreme left position wherein the bar

69 will be fully extended, the sliding contacts 61 and 62 will engage the right end contacts 101 and 102 of rows 69 and 71. The circuit thus made may be followed from contact 102 to the right muffle group 27 by way of conductor 89, thence through the muffle coil and out of the end terminal 103 thereof. From the muffle coil the current passes by lead 103 to the end terminal 104 of the muffle group, thence through the center muffle and out through end terminal 105 and back to power by way of conductor 106' and contact 101. The circuit thus made places the center and right muffle in series, with the right muffle acting as the rheostat for the center muffle. This circuit will be recognized as circuit number one hereinbefore described and illustrated in Figure 4. Rotating dial 80 in a clockwise direction from the first position, whereby bar 65 is retracted, the sliding contacts 61 and 62 engage the next two contacts of the rows 69 and 71 whereby circuit number two will be formed through the medium of conductors 88, coil of center muffle, conductor 100, the coil of right muffle, and lead 110. Likewise, on further rotating the dial to effect a further retraction of bar 65, contacts 61 and 62 are caused to successively engage the transversely aligned sets of contacts 61' whereby, through the medium of conductors, 88, 89, 95, 100, 106' and the coils of the different muffles, circuits three, four and five are made, it being noted in the last instance that the single contact 67 over slidable contact 63 is engaged therewith to afford connection with the coils of right muffle through the conductor 110.

It was hereinbefore noted that the center and right contact groups 26 and 27 provided on the base were in the present embodiment adapted to receive the tapped ends of the coil windings of the low heat muffles. To successfully employ a low heat muffle positioned in either the center or right contact group as a rheostat, there has been provided a switching arrangement by means of which any of the various taps on the muffle coil may be selected for and connected into the electric circuits aforesaid. Referring to Figures 9 and 10 it will be noted that a sliding bar switch of the general character previously described is employed. In this instance the female contacts 28 for both the center and right groups are mounted directly in the top member 83 of a frame 94, and each presents an engaging surface on its lower extremity. Slidably carried within the housing is a bar 87 having in the ends thereof two independent contact members 88' and 89' which are insulated from each other and adapted to slidably engage the female contacts and metal plates 91 and 92 respectively, as shown in Figure 10. It will be understood that the contact 88' and plate 91 are arranged to form a circuit with the coil of the center muffle, whereas the contact 89' and plate 92 are designed to form a circuit for the right muffle coil. To insure proper electrical connection between the associated contact members, the plates are urged upwardly by means of springs 95. Referring to Figure 13, it will be noted that conductors 88 and 89 are connected to the respective contacts 88' and 89' and that therefore in any circuits closed through these conductors, the resistance in such circuits may be varied by placing the bar in position to effect connection between said contacts and any of the female contacts 28 desired. Actuation of bar 87 is accomplished from the front of the base by a rod 93 rotatably mounted within and extending through the tube 72 to which the dial 80 is secured. On the inner end of rod 93 is fastened a

crank arm 94 which is connected to bar 87 by means of a link 96. A dial knob 115 is preferably fixed on the exposed forward end of the rod so as to enable the operator to readily position the bar 87 to provide the desired amount of resistance in the circuits.

It should now be clear that by movement of dial 80 a particular electric circuit is selected and on rotating dial 115 the resistance of that circuit may be varied. Preferably suitable indicia are provided on the front panel of the base so as to denote the various connections made in the different positions of the dials. It is also pertinent to note that in the instances where either the center or right muffle is employed as a rheostat, the resistance of that muffle is always increased as the contacts 88' and 89' move to the left or as dial 115 is turned in a clockwise direction. Thus regardless of the circuit or combination employed, the turning of dial 115 in a clockwise direction increases the heat of the controlled muffle and likewise the turning back of this dial in a counter clockwise direction decreases the heat developed in such muffle. The operation of the muffle circuit selecting switch and the muffle resistance switch is thus positively fool-proof.

As hereinbefore stated, it is desirable that on selecting a muffle circuit combination, the pyrometer be automatically connected to indicate the temperature of the working muffle of the combination, such muffle being usually the one whereon the highest temperature is obtained. In order that such an arrangement may be accomplished, I have devised a pyrometer switching mechanism 121 to be actuated simultaneously with the muffle-combination circuit switching aforescribed. The pyrometer switch is preferably an exact duplicate of one section of said switch, and as shown in Figures 9 and 11, in addition to the sliding bar 66 comprises a housing 122 and a contact member 123 which is positioned on the bar to engage a row of contacts 124 in the top of the housing, a fixed contact-plate 126 being disposed under the sliding bar and connected by a conductor 126' to the pyrometer socket. Simultaneous operation of the switching mechanisms is obtained since the contact members 61, 62, 63, and 123 of these switches are rigidly fastened to the same bar 66 as clearly shown in Figure 11. Thus with dial 80 turned to the extreme left to form electric circuit number one, the sliding contact 123 of the pyrometer switching mechanism will be positioned to engage contact 127 on the extreme right of the group whereby the thermo-couple provided in the center muffle is connected directly to the pyrometer socket with a resistance 108 in series therewith, such connection as shown in Figure 14 being effected through conductors 126', 128, 129, and 131. Figures 15 and 16 show the milli-voltmeter plugs which are used together with the high and low temperature milli-voltmeters respectively. When the former is used the resistance 108 is left in the circuit but when the low range milli-voltmeter is used the resistance 108 is shorted out since the plug therefor has three of its terminals electrically connected so as to short conductors 131, 132, and 133 connected to the resistance. It will likewise be noted that with the sliding contact 123 on the second contact, the circuit is automatically connected to indicate the temperature of the right muffle in accordance with electric circuit number two.

In circuit number five the muffle in the central position acts as a dual rheostat for both the outside muffles. It is therefore desirable that the

temperatures of the left and right muffles be readily determinable. With contact 123 positioned to the extreme left corresponding to circuit number five, the pyrometer normally indicates the temperature of the muffle on the left. However, by means of a two-way switch 136 provided in the circuit, the pyrometer circuit to the left muffle may be broken and the circuit to the muffle on the right simultaneously completed.

It will be obvious, of course, that electrical circuits other than the five herein set forth may be employed by merely adding additional contacts to the muffle-circuit combination switch and the pyrometer switch. The five electric circuits here shown appear at the present time to be ample for adapting the furnace to the various requirements particular to dentistry. An explanation of some of the possible muffle combinations and their especial adaptability to the practice of dentistry and the needs of dental laboratories will now be appropriate.

A simple combination of muffles of the furnace comprises, as shown in Figure 17, a large low heat muffle 37, a small low heat muffle 38, and a low scale pyrometer the electric circuit for which combination is illustrated in Figures 4 and 5. The muffles are both operatively mounted directly on the base as afore-described, the large muffle at the middle, and the small muffle on the right. The pyrometer is conveniently mounted and held on the base over the left group of contacts, the electrical connection thereto being afforded through a flexible conductor 56 associated with the plug and socket members 34 and 33. The large muffle, as here designed is capable of holding the largest sizes of dental flasks for plate work, and can accommodate large castings. The smaller muffle on the right is of sufficient size to hold several inlay rings of ordinary size. The maximum temperatures attained by the two muffles may be approximately 1700 degrees Fahrenheit for the large muffle, and 1800 degrees Fahrenheit for the small muffle. Now with dial 80 pointing to the extreme right the smaller muffle automatically becomes the rheostat for the larger one. With the pointer of dial 115 at the extreme left, the full length of the winding of the smaller muffle is in the circuit and as a result each muffle now idles at a mild, low heat. To increase the temperature of the center muffle it is only necessary to turn dial 115 to successively reduce the length of the right muffle coil in the circuit, and as this length is reduced, the heat of this muffle is also reduced notwithstanding the resultant increase of current. This phenomenon due to the series operation, positively acts to prevent extreme hot spots from forming in the refractory of the muffle acting as the rheostat.

To use the large muffle as the rheostat for the small, rapid-heating muffle, dial 80 is rotated to the left to place the indicator thereof to the second position. Again by turning dial 115 from left to right, portions of the large muffle coil are cut out of the circuit. By this procedure the large muffle remains warm, while the temperature of the small muffle may be raised as desired up to 1800 degrees Fahrenheit. This first combination is designed especially to meet the conditions prevailing in the average dental office. The large muffle will hold approximately twelve inlays, which can either be burned out in that muffle or transferred to the small muffle for rapid elimination as the operator requires. The furnace in its employment of the low heat muffles exclusively, makes possible the use of base metal

thermocouples of a high voltage-temperature characteristic and an inexpensive milli-voltmeter will thus suffice. Such a combination as hereinbefore noted materially reduces the pyrometer cost of the furnace. The connection of the voltmeter to the desired thermocouple is automatically made on the selection of the desired combination of muffles as aforesaid.

To the furnace as above described, a platinum wound muffle may be added. As shown in Figure 1, this muffle is preferably plugged in to the left group of female contacts provided on the base and from which the low range milli-voltmeter is removed. A high range milli-voltmeter replaces the lower range meter of the previous combination. The furnace here described is shown in Figure 1, and provides three muffles capable of simultaneously baking porcelain, drying out inlays and burning out inlays. The electrical circuit for such second muffle combination is made by rotating dial 39 to the extreme left whereby the large central muffle acts as a double rheostat for controlling both the platinum and the small low heat muffle. The voltmeter is automatically connected to read the temperature of the platinum muffle, but by operating the switch 135 the meter will indicate temperature of the small low heat muffle instead.

Muffle combinations one and two as above described are arranged for ordinary office practice. A further combination, as shown in Figure 18 and conveniently termed number three, is essentially a wax furnace, and designed particularly for laboratory usage. Using the same base, this furnace has two large low heat muffles in the center and left positions, with a small low heat muffle in the right position. The electrical circuit for this arrangement remains the same as described in combination two. Now with the central muffle acting as the rheostat for the other two it may be maintained at a low heat while the first and third muffles are at a high heat. Such an arrangement allows the cases to be dried out at a temperature suitable to prepare the case for the higher heat muffle and then transferred to the left large muffle for a quick elimination. By a simple transfer, then, two cases may be kept in continuous operation and at the same time the right muffle can be used for quick elimination of small cases.

A fourth combination, illustrated in Figure 19, is also designed for laboratory requirements. This furnace unit comprises a centrally disposed large low heat muffle and two small platinum muffles. In this case the electrical circuit remains the same as for muffle combination number three. The large wax muffle acts as a double rheostat for the two high heat muffles, and will maintain a temperature between 600 and 1000 degrees. With this arrangement the porcelain work may be dried out in the large muffle preparatory to its being placed into one of the platinum muffles for a fast mature baking or glazing.

An important feature of my invention is the inverse heat relation that may be established between any two or more muffles of my furnace and which may be varied through the use of a single heat control. With the heating elements of two muffles electrically connected in series and the resistance of one element variable so as to function as a rheostat for the second element, the heat produced in the rheostatic element varies as the resistance of that element, while it will be clear that the heat produced in

the second or controlled element varies inversely with the resistance of the rheostatic element. Thus on increasing the resistance of the first element, the heat of this element is increased and the heat of the second element is simultaneously decreased. Likewise on decreasing the resistance of the rheostatic element the heat of this element is decreased while the heat of the controlled element is increased. It will of course be clear that a greater number than two muffles may be arranged in different series parallel combinations to obtain such an inverse heat relation between the heating elements. An example of such a combination is illustrated in Figure 1 of the drawings. This feature becomes of importance in the production of certain materials wherein it is not only necessary to increase the heat slowly by steps in the heat process of the article but also to slowly step down the heat of the article on the cooling portion of its heat process cycle. An example of such a requirement occurs in the annealing of certain enamels. In this latter case an article is covered with the enamel and placed in an oven whose heat is slowly increased up to the annealing temperature of the enamel. While in some instances it is not considered harmful to increase the heat above this value, extreme care must be exercised to prevent the article from cooling too quickly. In using my furnace, the freshly enameled article may be placed in the rheostatic muffle with the heating element thereof at a minimum resistance whereby the muffle is substantially unheated and residing at approximately room temperature. By increasing the resistance of this element the temperature of the rheostatic muffle may be increased at will. When the rheostatic muffle reaches its maximum temperature it will be clear that the controlled muffle would be at a minimum temperature, and is eligible for receiving a freshly coated piece of work. The resistance of the rheostatic element may then be reduced in steps to insure the proper cooling of the product therein and at the same time the heat of the controlled muffle is slowly increased to insure proper heating of freshly covered products therein. It will thus be evident that with but a single control I may increase the heat of one muffle while simultaneously decreasing the heat of a second muffle to effectively carry out a continuous process as above noted.

I claim:

1. In an electric furnace, a plurality of muffles each provided with an electric heating element, a plurality of electric contact members on said muffles connected to said elements, a support for said muffles, a plurality of electric contact members on said support detachably receiving said muffle contact members and arranged in different groups corresponding in number to the number of muffles and adapted to interchangeably receive the latter, electric power input terminals, and a switch mechanism operative to connect certain contact members in two of the groups in parallel and to connect certain contact members in a third group in series with said first named contact members and with said power terminals.

2. In an electric furnace, a plurality of muffles each provided with an electric heating element, a plurality of electric contact members on said muffles connected to said elements, a support for said muffles, a plurality of electric contact members on said support detachably receiving said muffle contact members and arranged in differ-

ent groups, said groups corresponding in number to the number of muffles and adapted to interchangeably receive same, electric power input terminals, and a switch mechanism operative to connect certain contact members in two of the groups in parallel and to connect certain contact members in a third group in series with said first named contact members and with said power terminals, or to connect certain contact members in the third group in series with certain contact members in either of said first and second groups and to said power terminals.

3. In an electric furnace, a plurality of muffles each provided with an electric heating element, a plurality of electric contact members on said muffles connected to said elements, a support for said muffles, a plurality of electric contact members on said support detachably receiving said muffle contact members and arranged in different groups, said groups corresponding in number to the number of muffles and adapted to interchangeably receive same, electric power input terminals, and a switch mechanism operative to connect certain contact members in two of the groups in parallel and to connect certain contact members in a third group in series with said first named contact members and with said power terminals, or to connect certain contact members in the first two groups of contact members in series with each other and with said power terminals.

4. In an electric furnace, a plurality of muffles each provided with an electric heating element, a plurality of electric contact members on said muffles connected to said elements, a support for said muffles, a plurality of electric contact members on said support detachably receiving said muffle contact members and arranged into different groups, said groups corresponding in number to the number of muffles and adapted to interchangeably receive same, electric power terminals, and a switch mechanism operative to selectively connect certain contact members in one group of contact members in series with certain contact members in a second and third group connected in parallel and with said power terminals, or to connect certain contact members in the first and second groups of contact members in series with each other and to said power terminals, or to connect certain contact members in the second and third groups of contact members in series with each other and to said power terminals, or to connect certain contact members in the first group of contact members in series with certain contact members in the third group and with said power terminals.

5. An electric furnace comprising a high heat muffle and a low heat muffle, electric heating

elements in said muffles, engageable contacts provided on the base of said muffles and electrically connected to said elements, a support, sets of contacts on said support arranged to detachably receive said muffle contacts and provide for the interchanging of said muffles from one set to the other, a thermocouple in one of said muffles, a thermocouple in the other of said muffles having a different temperature-voltage characteristic than said first thermocouple, a pair of contacts on each of said muffles adjacent said first muffle contacts and connected to said thermocouples, and a group of three contacts on said support adjacent each of said sets of contacts and arranged to receive said pair of muffle thermocouple contacts, said pair of thermocouple contacts on one of said muffles being positioned to engage with two of said groups of three contacts and said thermocouple contacts on the other muffle being positioned to engage another two of said group of three contacts, and means for connecting said sets of contacts to a source of electric power and said groups of contacts to a pyrometer.

6. An electric furnace comprising, a base, a plurality of vertically set electric contact members carried by said base, a muffle supported on said base and provided with a tapped electric heating element and contact members connected thereto and engaging the upper ends of said first contact members, and means for connecting said muffle element to a source of electric power including a switch member arranged to slidably engage the lower ends of said first contact members for selectively energizing different lengths of said element.

7. An electric furnace comprising, a plurality of muffles including tapped heating elements, a base support for said muffles, contact members carried by said base and connected to intermediate portions of said elements, a plurality of banks of contacts carried by said base, conductors connected to said elements and banks of contacts and providing a plurality of electric circuits including said elements in various series and parallel combinations, a plurality of sliding contacts simultaneously and selectively engaging said banks of contacts for selecting the circuit desired, another sliding contact selectively engaging said first contact members for incorporating in the circuit selected a variable portion of one of said heating elements, and means manually controlled at the front of said base for moving said first named plurality of sliding contacts simultaneously and for moving said second named sliding contact independently of said plurality of sliding contacts.

THOMAS H. FORDE.