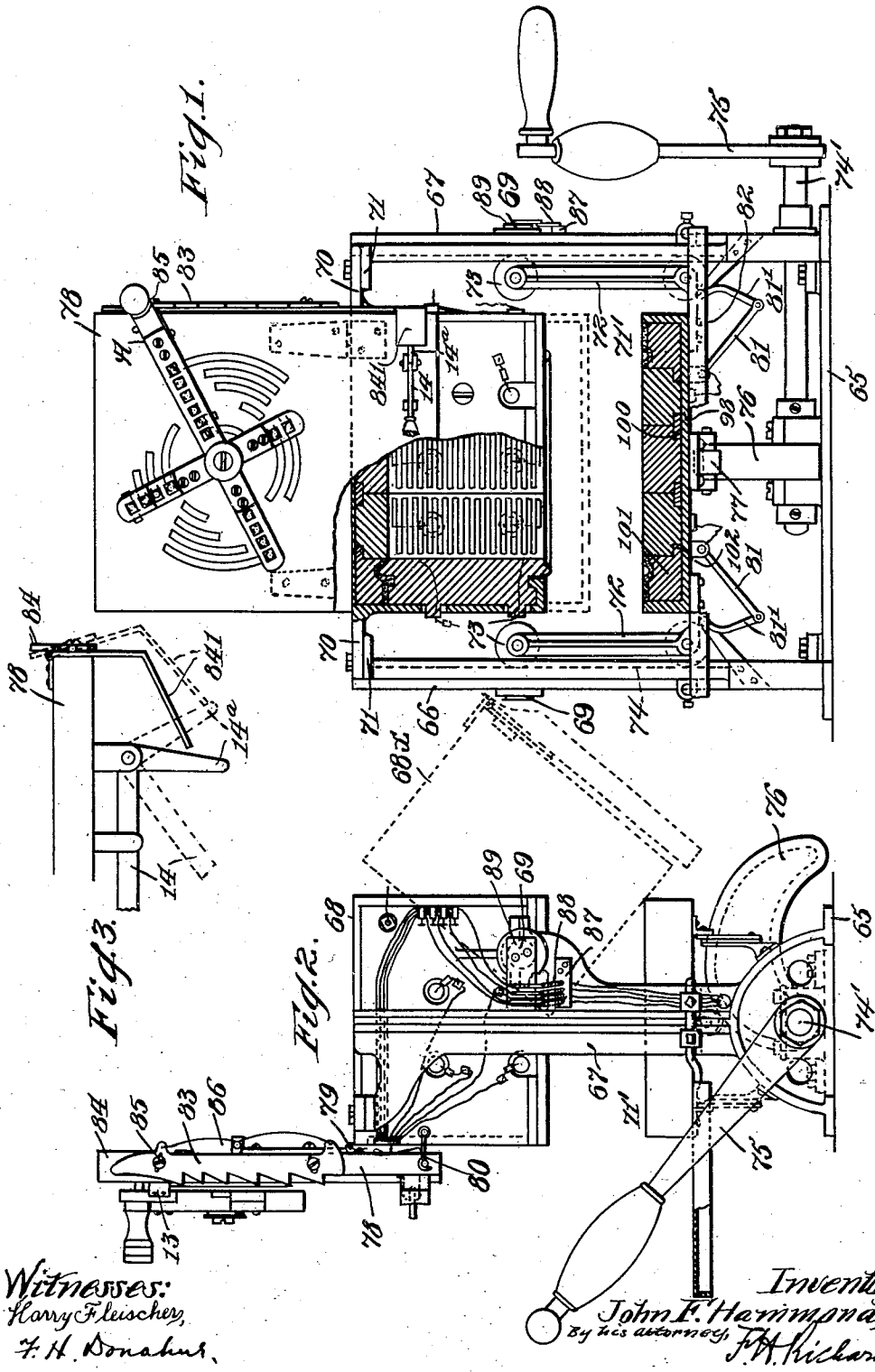
No. 825,386. PATENTED JULY 10, 1906.

J. F. HAMMOND.

ELECTRIC FURNACE.

APPLICATION FILED SEPT. 18, 1905.

4 SHEETS—SHEET 1.



Witnesses:
Harry Fleischer,
F. H. Donahue.

Inventor:
John F. Hammond,
By his attorneys,
F. H. Richards.

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4 SHEETS—SHEET 2.

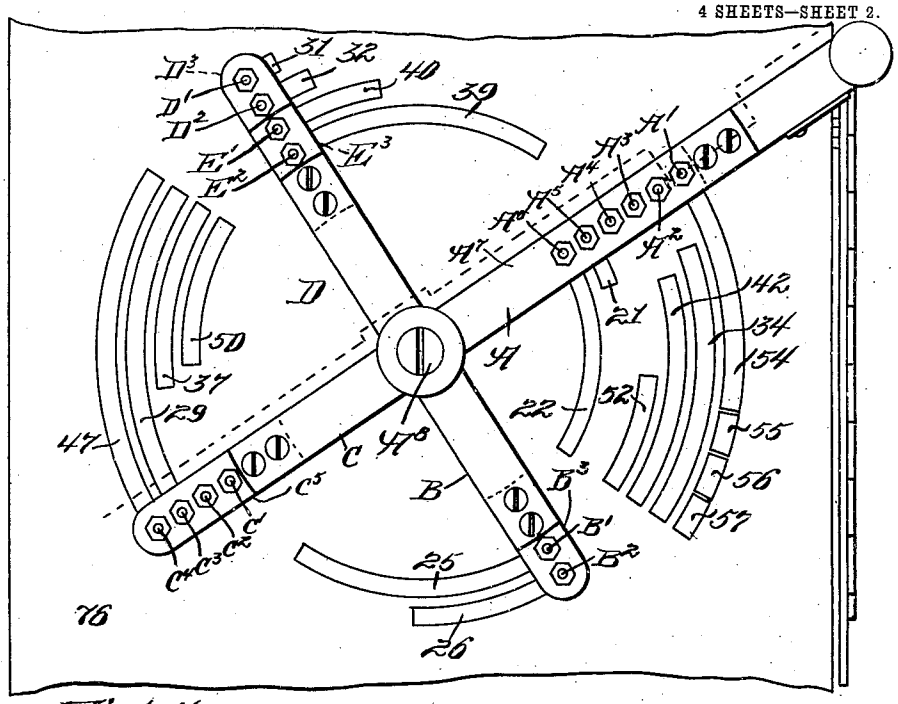


Fig. 4.

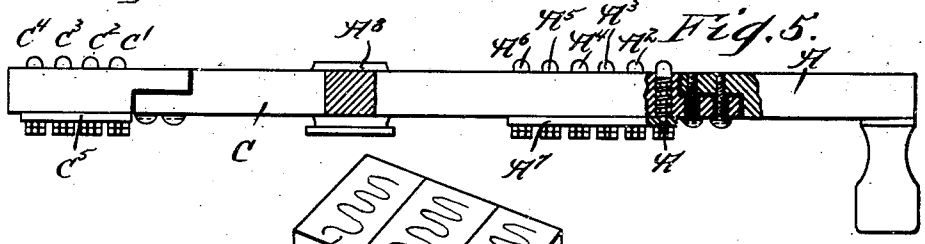


Fig. 5.

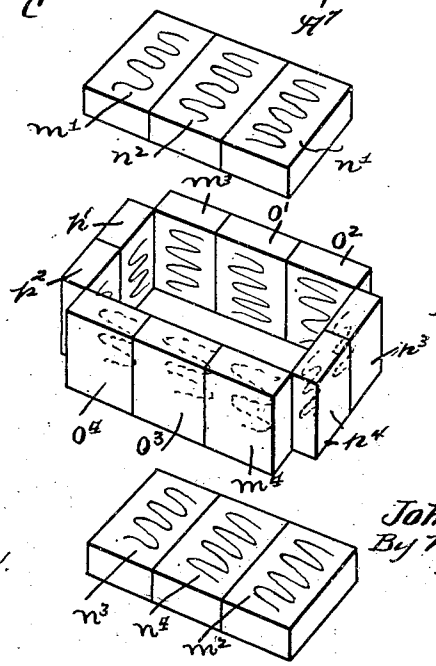


Fig. 8.

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Fig. 6.

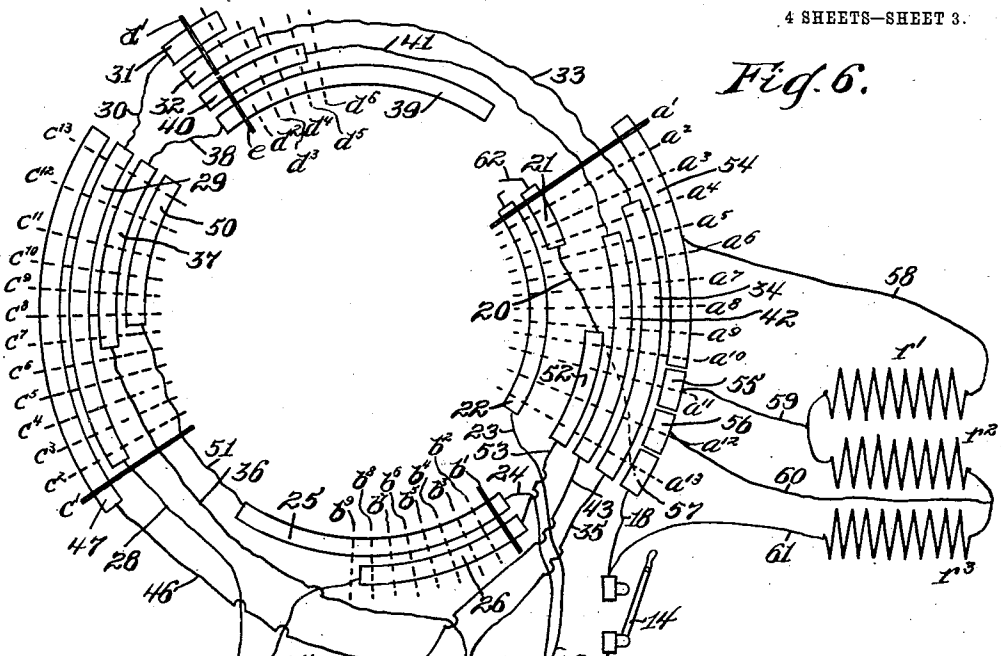
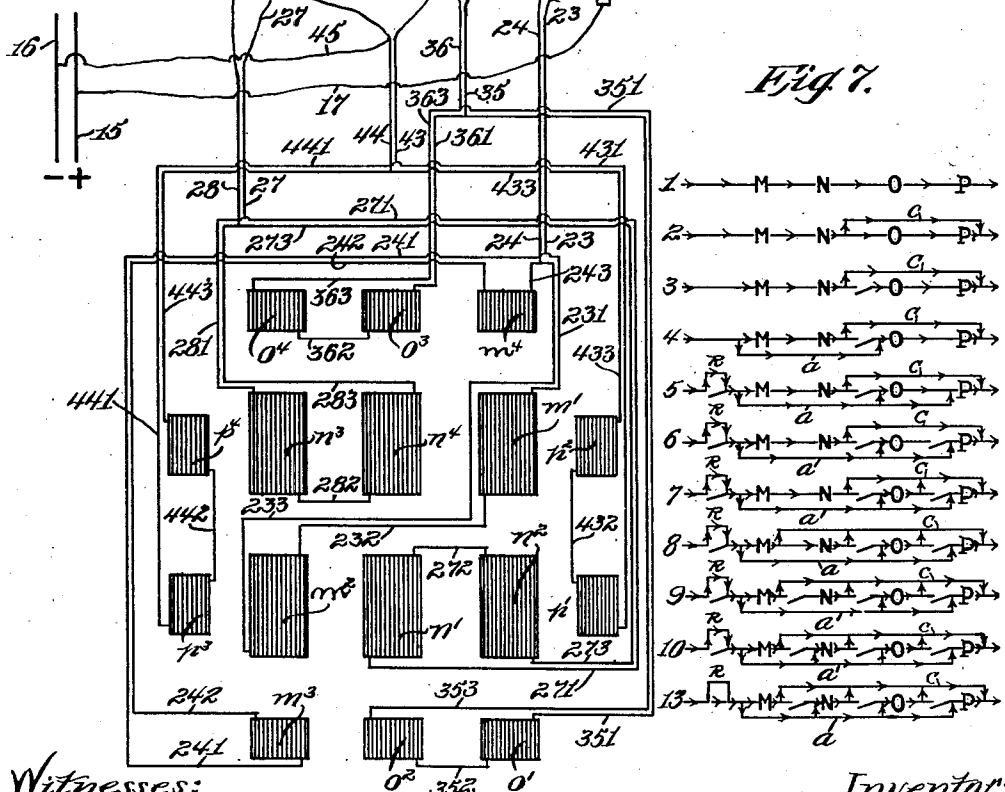


Fig 7.



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4 SHEETS—SHEET 4.

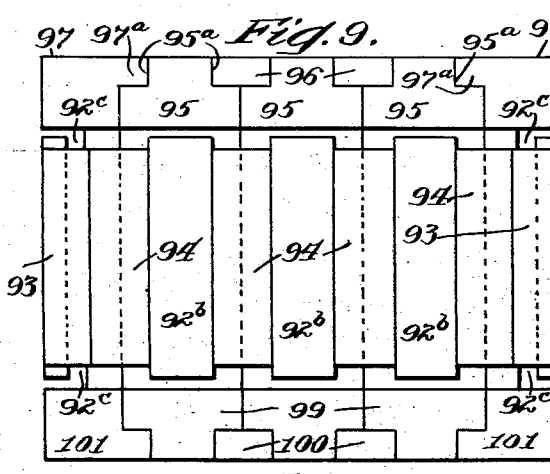


Fig. 9.

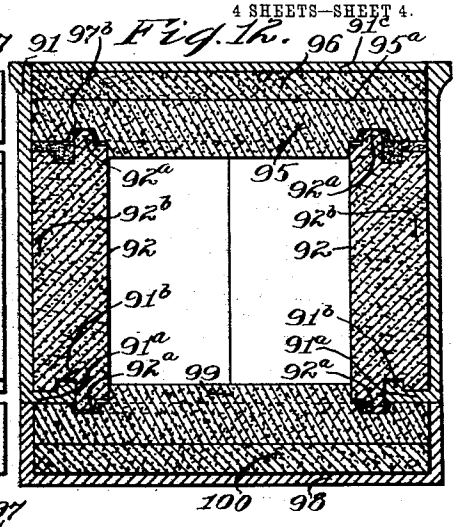


Fig. 12.

Fig. 14.

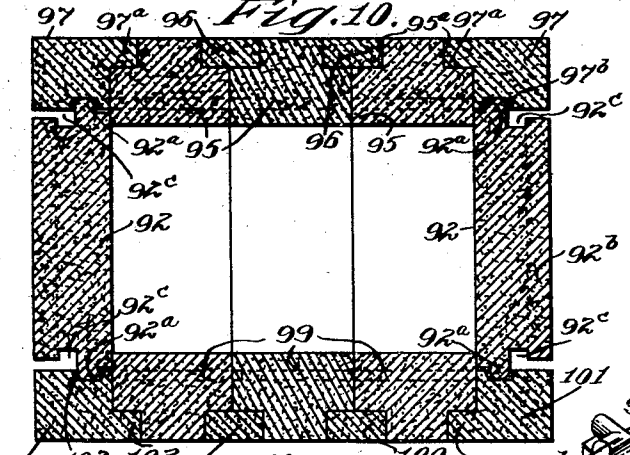


Fig. 10.

Fig. 11.

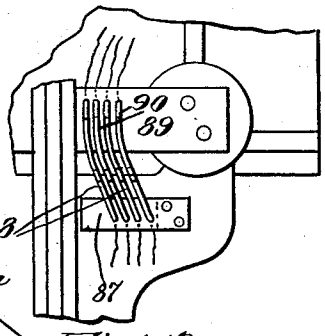


Fig. 13.

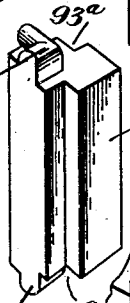
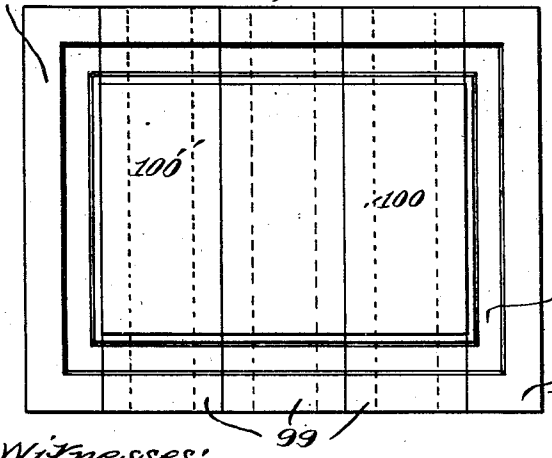
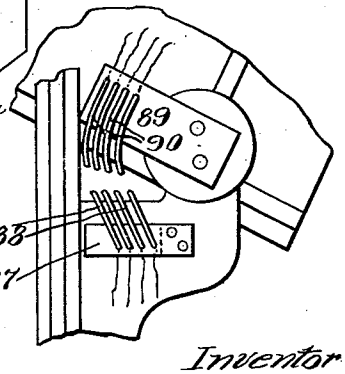


Fig. 15.





Witnesses:
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UNITED STATES PATENT OFFICE.

JOHN F. HAMMOND, OF BREWSTER, NEW YORK.

ELECTRIC FURNACE.

No. 825,386. Specification of Letters Patent. Patented July 10, 1906.

Application filed September 18, 1905. Serial No. 278,854.

To all whom it may concern:

Be it known that I, JOHN F. HAMMOND, a citizen of the United States, residing in Brewster, in the county of Putnam and State of New York, have invented certain new and useful Improvements in Electric Furnaces, of which the following is a specification.

This invention relates to electric furnaces, and has for its object to provide an improved form of means for applying heat to segregated portions of the furnace and for so controlling the current passing through such portions as to cause the increase of temperature of the furnace to be very gradual.

A further object of the invention is to provide means whereby results can be attained without disastrous sparking at the various terminals.

Another object of the invention is to provide an improved form of switch or commutating device for distributing the current through the segregated portions of the furnace, whereby the current may be caused to pass through such translating devices either in series or in multiple or in multiple series or in various combination of such arrangements.

In the drawings accompanying and forming part of this specification, Figure 1 represents a front elevation of the complete device, portions of the furnace being shown in vertical section. Fig. 2 is a side elevation of the same. Fig. 3 is a detail of the switch-controlling means. Fig. 4 is a plan view of a portion of the swinging top member, showing the pivoted switch-lever and its terminal-plates mounted thereon. Fig. 5 is a view of one of the arms of the switch-lever. Fig. 6 is a diagrammatic representation of the commutating device and the coils connected therewith. Fig. 7 represents diagrammatically the connections of the coils in their successive positions. Fig. 8 shows the relative location of the coils in the muffle. Figs. 9 to 13 show the muffle, and Figs. 14 and 15 show the muffle-switch.

The furnace comprises, essentially, a base, a frame supported on the base, a muffle adjustably supported in the frame, and a bottom member for the muffle having means for moving it to and from the muffle when in its normal position.

The invention further comprises heating-coils variously disposed in the interior walls of the muffle and a switch or commutating device whereby the electric current can be commutated to energize the heating-coils in various combinations.

In a suitable base 65 are mounted two uprights 66 67, between which is pivotally supported the muffle, (designated generally by 68.) The muffle is carried by pivotal bearings 69, whereby it can swing from its normal position in which shown in drawings to an inverted position $68^{\times}$. (Indicated in broken lines in Fig. 2.) It is supported in the normal position by means of extensions 70 of the casing of the muffle-engaging lugs 71 on the uprights 66 67. The bottom of the muffle (indicated generally by 71′) carries on each side an upright bracket 72, provided with guide-wheels 73, that run in guideways 74 in the inner sides of the uprights 66 67. By this means the bottom is movable to and from the body of the muffle and in its upper position will close the chamber of the muffle, as will be evident from Fig. 1.

Suitable means are provided for raising and lowering the bottom of the muffle, which may comprise a shaft 74′, operated by crank or arm 75, and carrying a cam 76, that engages a friction-roller 77, pivoted to the bottom 71′ at a central portion. By rocking this shaft the cam will raise the bottom into engagement with the muffle and lock it in such position. When it is desired to use the muffle, the article to be baked or subjected to the heat of the muffle is placed on the bottom and thereupon the latter raised to engage with the body of the muffle. When it is desired to inspect the interior of the muffle, it is only necessary, the bottom being in its lowered position, to turn the muffle in its pivotal bearings to the position $68^{\times}$, which will partly invert the same and bring the open side uppermost.

The top, bottom, and four sides of the muffle have heating-coils embedded in the inner walls, and the current passing through such coils is controlled and directed by means of a switch or commutating device. The latter device is mounted upon a plate 78, that is hinged to the frame of the muffle at 79, whereby it may be placed in the vertical position, as shown, or rest on the top of the muffle. It is retained in the vertical position by suitable hooks 80.

The switch or commutating device is shown as cruciform, having four arms at right angles, and each arm carries a number of terminals. The arm A carries six suitably-mounted spring-pins A' A^2 A^3 A^4 A^5 A^6, all of which

pass through and remain in contact with a bar A^7. The next arm B of the switch carries two spring-pins B' B^2, that are electrically connected in their several positions by the plate B^3. The arm C of the switch in alinement with the arm A carries four spring-pins C', C^2, C^3, and C^4, which are electrically connected by a plate C^5. The fourth arm D carries two insulated pairs of spring-pins, one pair D' D^2 remaining in engagement with a plate D^3, while the other pair of spring-pins E' E^2 are electrically connected by engaging a plate E^3. Each of the said five plates connected with the various spring-pins are suitably insulated on the switch-lever, so that there is no connection between the pins, except by their respective plates, as just described. The switch-lever is pivoted at the intersection of its arms by a screw A^8, fast on the plate 78 of the furnace.

To engage and coöperate with the spring-pins on the four arms A, B, C, and D are four segregated sets of terminal blades or plates that may be stationarily arranged on the said top member. These plates are preferably arranged in arcs concentric with the paths of movement of the respective spring-pins with which they contact. The pins A', A^2, A^3, A^4, A^5, and A^6 will engage with the terminal plates 22, 21, 52, 42, 34, and 54, respectively, at various stages in the movement of the lever. The latter plate 54 has three other plates 55, 56, and 57 in circular alinement therewith, that are engaged by the spring-pin A', as will be hereinafter set forth. The two spring-pins on the arm B will engage the terminal plates 25 and 26, respectively. The four spring-pins C', C^2, C^3, and C^4 on the arm C will engage with the terminal plates 47, 29, 37, and 50, respectively, at the various stages in the movement of the switch. The two spring-pins D' and D^2 will engage with the terminal plates 31 and 32, respectively, while the spring-pins E' E^2 will engage with the plates 40 and 39, respectively. To simplify the tracing of the current, these five insulated sets of spring-pins will be treated as five separate insulated bars and designated as *a*, *b*, *c*, *d*, and *e*, respectively, as if the plates connecting the pins themselves engage the terminal blades of the switch.

The four sets of terminal-plates are connected with four sets or groups of heating-coils, which will be designated in a general way by M, N, O, and P. In Fig. 6 these groups are shown as each comprising two pairs of coils that are connected in multiple series. The current from a pair of mains 15 and 16 enters from the positive 15 to a lead 17 to a suitable switch 14. From thence the current passes through a conductor 18 to the blade 57, and the latter is connected by a conductor 20 with plate 21. The plate 22 connects by wire 23 with the series of coils generally designated by M and consisting of coils m', m^2, m^3, and m^4. After passing through these coils the current will pass through wire 24 to terminal-plate 25. Plate 26 connects by wire 27 with the group N, consisting of coils n', n^2, n^3, and n^4, and a return 28 connects with the plate 29. The plate 29 is connected with plate 31 by wire 30, and plate 32 is connected by wire 33 with a plate 34. This latter plate connects by wire 35 with the group O, comprising coils o', o^2, o^3, and o^4, and a return-wire 36 from the latter group leads to plate 37, the latter plate being connected with plate 39 by wire 38. A plate 40, disposed between the plates 32 and 39, connects by wire 41 with a plate 42. The latter plate is connected with the group P, consisting of coils p', p^2, p^3, and p^4, and a wire 44 leads from these coils to the negative lead 45. A wire 46 also connects the lead 45 with the plate 47. A terminal-plate 50 is disposed near the plate 37 and connects by wire 51 with the said plate 25. Another plate 52, disposed between plates 22 and 42, is connected by wire 53 with the said plate 26. A resistance R is shown as comprising three coils r', r^2, and r^3. A wire 58 connects the plate 54 with one end of coil r', and the other end of this coil is connected by wire 59 with the terminal-plate 55. This wire 59 is connected to one end of the coil r^2, whose other end is joined by wire 60 with the terminal-plate 56. The third coil r^3 has one end joined to the wire 60, while its other end is connected by wire 61 with the wire 18. The said four coils constituting each of the several groups M, N, O, and P are preferably arranged in multiple arc and are connected as follows: Wire 23 divides and a wire 231 leads to the coil m'. From thence wire 232 connects with coil m^2, while the return from the latter (233) is connected with the wire 24. The branch 241 of the wire 23 connects with the coil m^3, while from the other end of this coil wire 242 leads to the coil m^4, and the other end of this latter coil is connected by wire 243 with the wire 24. The wire 27 divides and a branch 271 connects with one end of coil n', whose other end is connected by wire 272 with coil n^2. The other end of coil n^2 connects by wire 273 with the wire 28. Another branch 281 of the wire 27 connects with coil n^3, whose other end is connected by wire 282 with coil n^4. The other end of coil n^4 is connected by wire 283 with the wire 28. The wire 36 divides and one branch 351 connects with one end of coil o', whose other end is connected by wire 352 with one end of coil o^2. The other end of coil o^2 is connected by wire 353 with the wire 36. The other branch 361 connects with one end of coil o^3, whose other end is connected by wire 362 with coil o^4, and the other end of coil o^4 connects by wire 363 with the wire 36. The wire 43 divides and one branch 431 connects with one end of coil p', whose other end is connected by wire 432

with one end of coil p^2. The other end of coil p^2 is connected by wire 433 with wire 44. The other branch 441 of wire 43 connects with one end of coil p^3, whose other end is connected by wire 442 with one end of coil p^4. The other end of coil p^4 is connected by wire 443 with the wire 44.

The relative arrangement of the several terminal-plates just referred to will be described in connection with the course of the current in the several stages of the switch-lever. If it is desired not to use the resistance R, the plate 21 is connected with the plate 22 by a switch 62. The several bars *a*, *b*, *c*, *d*, and *e* are represented in their normal or starting position. The bar *e* being carried by the same arm as the plate *d* will be always in radial alinement therewith. Upon the closing of the switch 14 the current will flow through wire 18, plate 57, wire 30, plate 21, and wire 62 to the plate 22. Since this latter plate 22 remains in contact with the switch-bar *a* throughout the length of its stroke, this plate can be considered as the starting-point for tracing the circuits in the several positions of the switch. Beginning with plate 22 the current will be seen to flow as follows: 22, 23, M, 24, 25, *b*, 26, 27, N, 28, 29, 30, 31, *d*, 32, 33, 34, 35, O, 36, 37, 38, 39, *e*, 40, 41, 42, 43, P, 44, 45. Upon the switch-lever being advanced the bars *a*, *b*, *d*, and *e* will remain in contact with the same respective plates, while the bar *c* will be brought into engagement with the plate 29 in position c^2. This will have the effect of establishing a shunt of low resistance around the group of coils O and P, which will practically cut them out. A further advance of the switch-lever will cause the bar *d* to leave the plate 31 in position d^3, breaking connection between it and the plate 32, which will leave the groups M and N in series across the mains, entirely cutting out of circuit the groups O and P. The reason of first establishing a shunt around the groups O and P is to prevent sparking when these groups are cut out of circuit by the bar *d*, which is effected by the bar *c* engaging the bar 29 before bar *d* leaves the plate 31. These three positions are represented diagrammatically in Fig. 7 in the successive diagrams 1, 2, and 3, respectively. In the first diagram it will be seen that M, N, O, and P are arranged in series, while in the second it will be observed that a shunt *c* is established around O and P. In diagram 3 the line is shown as broken between O and a point beyond where the shunt *c* leads off from the main line, thus putting M and N in series, while O and P are entirely cut out, and the successive positions at the bars *a*, *c*, and *d* corresponding to these three diagrams are indicated by the broken line a' a^2 a^3 and c' c^2 c^3 and d' d^2 d^3. The further advance of the switch-lever will bring the bar *a* into engagement with plate 34, thereby connecting the latter plate with 22, (shown at a^4.) This will have the effect of bringing the groups O and P in a parallel circuit with the groups M and N, with the result that the resistance of the translating devices is reduced one-half, and hence double the current will flow, giving twice as great efficiency as when the groups were in series. Upon the switch-lever being advanced still farther the bar *a* in position a^5 will contact with the strip 42, which will have the effect of establishing a shunt of low resistance around the group O in that branch of the circuit including the groups O and P, as indicated in diagram 5. Hence the group O will be practically cut out of operation. Advancing the switch-lever still farther the plate *e* that has been bridging the plates 39 and 40 will now leave the plate 40, thereby entirely cutting it out of service in position d^6. From diagram 6 it will be seen that the effect of this change is to entirely cut out the group O in its branch of the parallel circuit; but as the current flowing through this group was by the preceding operation of establishing a shunt around it reduced to almost nothing this breaking of the portion of the circuit including the group O will be effected with no destructive sparking. The further advance of the switch-lever will bring the bar *c* into engagement with the plate 37 in position c^7.

On referring to diagram 7 it will be seen that there is still a parallel circuit, one branch including the groups M and N in series and the current thence passing by means of the arm C to the return-wire. In the other branch of the circuit the current passes first through bar *a*, thence through group O to bar *c* and out, while a third branch of the circuit is established from bar *a* through the group P to the return-wire. This will give a parallel circuit of three branches, one passing through the groups M and N in series, the second including the group O, and the third passing through the group P. The next stage in the operation of the switch-lever will cause the bar *c* to engage the plate 50 in position c^8, which will have the effect of establishing a shunt of low resistance around the group N, thereby practically cutting out the current in this group, as shown in diagram 8, and the farther advance of the switch-lever will cause the bar b' to leave the plate 26 in position b^9, thereby breaking circuit between this plate and the plate 25. From diagram 9 it will be seen that this will have the effect of entirely cutting out the group N; but as the preceding movement of the switch-lever established a shunt of low resistance around this group N there will be practically no sparking when its circuit is opened. This will leave the three groups M, O, and P in parallel. The farther advancement of the switch-lever will bring the bar *a* into engagement with the plate 52 in position a^{10}, connecting the latter with the plate 22. The ef-

fect of this will be to add the group N in parallel to the other groups already in parallel, whereby the four groups will be arranged in parallel, with the result that four times the current will flow, with a constant potential circuit, as was flowing in the series arrangement in the first position. The path of the current in this position is as follows: Starting with the plate 22 one circuit is wire 23, group M, wire 24, plate 25, wire 51, plate 50, bar *c*, plate 47, wire 46, to the return 45. Another circuit is established through plate 22, bar *a*, plate 52, wire 53, plate 26, wire 27, group N, wire 28, plate 29, bar *c*, plate 47, and wire 46 to the return 45. Another circuit is from plate 22, through bar *a* to plate 34, wire 35, group O, wire 36, plate 37, bar *c*, plate 47, and wire 46 to return 45, and a fourth circuit is from bar *a* to plate 42, wire 43, group P, and wire 44 to the return-wire 45.

To facilitate the following of the arms of the lever in their successive positions represented in the ten diagrams of Fig. 7, these positions of the bar *a* are indicated on Fig. 6 by a', a^2, a^3, a^4, a^5, a^6, a^7, a^8, a^9, and a^{10}. The corresponding successive positions of the bar *b* from its first position up to its ninth position are indicated by the dotted lines b' b^2 b^3 b^4 b^5 b^6 b^7 b^8 b^9. Since at this ninth position the bar *b* no longer bridges the plates 25 and 26, it forms no part of the circuit in the farther advancement of the switch-lever and its farther positions need not be taken into consideration. Similarly, the successive positions of the bar *c* are represented by the dotted lines c' c^2 c^3 c^4 c^5 c^6 c^7 c^8 c^9 c^{10}. The first three positions of the bar *d* are indicated by lines d', d^2, and d^3. In the latter position this bar no longer bridges the plates 31 and 32, and therefore in its farther positions it remains inactive and need not be considered. The bar *e*, carried by the same arm that actuates the bar *d* and arranged in alinement with the latter, has its positions indicated by e' e^2 e^3 e^4 e^5 e^6, whereupon it ceases to bridge the plates 39 and 40, and therefore is inactive during the farther advancement of the switch-lever, and its farther positions are of no consequence. In order to prevent an undue heating of the group P, the resistance-coils R are cut in at that stage of the operation where this group P is in parallel with the two coils M and N across the mains. This is effected by opening the lever 62, that heretofore has bridged the plates 21 and 22. Now as long as the bar *a* connected the plates 21 and 22 the circuits would be as heretofore described; but when moved from the fourth to the fifth position the bar *a* will leave the plate 21, thereby cutting off connection between the plate 22 and the controlling-switch 14 through the wire 20, plate 57, and wire 18. While the switch 62 was closed it established a shunt of low resistance around the resistance-coils R, practically cutting them out; but now that the switch is open and the plate 22 is disconnected from the plate 21 the only circuit left for the current is wire 61, resistance-coil r^3, coil r^2, coil r', wire 58, to the plate 54, from which the current will pass through the arm *a* to the plate 22. This will have the effect of throwing in the entire resistance R in series with the coils, in whatever grouping they may be connected, as long as the bar *a* engages the plate 54. The bar *a* will remain in engagement with the plate 54 up to and including the tenth position, as indicated in Figs. 6 and 7, in which latter position, as has been set forth, the four groups of coils are arranged in parallel series. A still farther advancement of the switch-lever will shift the bar *a* from the plate 54 to the plate 55, and by reference to Fig. 6 it will be seen that this will cut out the coil r' of the resistance, leaving the coils r^2 and r^3 still in series with the parallel arrangement of the four groups. The next advance of the lever will shift the bar *a* from the plate 55 to plate 56, cutting out the coil r^2, leaving only the coil r^3 in series with the said groups, and a still farther advancement of the switch-lever to the position a^{13} will bring the bar *a* into engagement with the plate 57, and the latter being connected with the switch 14 by the wire 18 the resistance-coils will be practically cut out by a shunt of low resistance; but it will be seen in these three last positions a^{11} a^{12} a^{13} the bar *a* remains in engagement with the same plates 22, 54, 42, and 34, with which it engaged in position 10, and therefore there is no change in the circuit to the four groups, and the same applies to the bar *c* in its corresponding positions c^{11}, c^{12}, and c^{13}, it remaining in engagement with the four strips 50, 37, 29, and 47. In these last four positions the bars *b*, *d*, and *e* are out of the circuit.

In Fig. 8 is shown the relative arrangement of the sixteen coils above described with reference to Fig. 6, but with the difference that the respective slabs in which such coils are suitably embedded are designated by the same reference character. In this figure the four side members of the muffle—that is, the front and back and two end portions—are shown as comprising ten slabs, there being two in each of the end portions and three, respectively, in the front and back portions. The top of the muffle is shown as composed of three slabs, and the bottom member also contains three slabs. By following the four pairs of leads running from the commutator to the slabs, as shown in Fig. 7, to the respective sets of coils with which they connect the circuit will be found to be as follows: The leads 23 24 include the coils m' m^2 m^3 m^4, which are located one in the top, one in the back, one in the front, and one in the bottom. The leads 35 36 connect with the four coils o' o^2 o^3 o^4, that are located two in the front and

two in the back of the muffle. The leads 43 44 connect with the coils p' p^2 p^3 p^4, located two in each end of the muffle, and the leads 27 28 connect with the four coils n' n^2 n^3 n^4, two or which are located in the top of the muffle and the other two in the bottom thereof. With this arrangement of the heating-coils in the muffle by inspection of Fig. 7, Diagram 1, it will be seen that the initial position current will traverse all of said sixteen coils. Considering next position 3, in which the groups represented by O and P are cut out and the groups M and N are in circuit in series, the portions of the muffle now energized will be one coil or slab each in the top, bottom, front, and back of the muffle, (represented by M,) which group will be in series with the four coils n, two located in the bottom and two in the top—that is, there are in circuit now the three coils in the bottom, the three coils in the top, and one each in the back and front.

In the position of Diagram 4, wherein M and N in series are connected in parallel with O and P in series, it is evident that all of the sixteen coils are again energized; but the four groups being now in multiple series instead of in series, as in position 1, double the current will flow through each coil and with the heating effect correspondingly augmented. In the position indicated in Diagram 6 the arrangement of the coils is similar to that of Diagram 4, except that the group O is now out of circuit, and hence two of the coils in the bottom and likewise two coils in the front are out of circuit. Since in this position the four coils represented by P—that is, the two ends—are connected in parallel with the other eight coils, and therefore will receive a greater strength of current, a suitable resistance R is introduced into the circuit to prevent overtaxing these end coils. In the position of Diagram 7 there will be a parallel circuit of three branches, one branch to include the top coils and the bottom coils and one coil each in the front and back, a second branch including two coils each in the front and back, and a third branch including the coils in the ends. In the position of Diagram 9 there will be a parallel circuit of three branches, one branch including one coil each in the top, bottom, front, and back, a second branch including two coils each in the top and the bottom, and a third branch including the coils in the ends. In the position of Diagram 10, having a parallel circuit of four branches, each of the said groups M, N, O, and P will be in parallel, and therefore all of the coils will be in circuit and four times the quantity of current will be passing through them as passed through in the position indicated in Diagram 1.

The bottom of the muffle being movable, it is connected with leads carried by the uprights and connected to four jointed links 81, connected between the bottom and a separating-plate 82, fast on the uprights. These latter serve to convey the current to the two circuits of the bottom, and n^3 and n^4 being in series and requiring but one pair of leads, the other pair connecting m^2. Suitable flexible leads connect with the other portions of the muffle and also with the several terminal plates on the switchboard.

If the switch-lever or commutator were reversed—that is, moved backward from any of its positions—it would produce disastrous results unless the circuit were first opened at the switch 14 or some other suitable place. To prevent such effect, there is provided a locking-rack 83, movably carried by a strip 84, hinged along one of its longitudinal edges to the edge of the base-plate 78, which is in the handle portion of the switch-lever. The strip 84 has two screws 85 passing through suitable slots in the rack, permitting the latter to slide into and out of position of engagement with the switch-arm. It is yieldably retained in such position by a spring 86. The switch-lever or cut-out 14 has an arm 14^a arranged to engage the bent end 841 of the strip 84 when the switch is opened, as indicated in broken lines in Fig. 3. Such movement of the switch will rock the strip on its hinged connection with the switch-plate 78 and swing the rack 83 out of position of engagement with the switch-lever, permitting the latter to return to its initial position; but it is evident that the rack will not be moved to such position except when the switch 14 is opened, cutting out of circuit to the terminals of the commutator.

For convenience in referring specifically to four translating members of any type or form whatsoever, in the claims a, b, c, and d will be used to designate such translating devices or groups of translating devices, it being understood that such designating characters do not refer specifically to the four groups of heating-coils hereinbefore referred to, but to any form of a translating device or group of translating devices.

In order to electrically connect the movable body of the muffle with the wires on the stand, a four-blade switch is provided on each side. (Shown separately in Figs. 14 and 15.) An insulating-block 87 is fast on the frame at each side, and each block carries four separate blades 88, connected, respectively, with the resistance R and the leads. An insulating-block 89 is secured on each side of the hinge portion that is secured to the muffle-body, and on each of these blocks is arranged four separate blades 90, arranged to engage the respective blades 88 when the muffle-body is in its normal position, as shown in Figs. 2 and 13; but upon the muffle-body being swung to the open position these blades will disengage, as indicated in Fig. 15.

In Figs. 9 to 13 is shown the arrangement

of the slabs or blocks constituting the main portion of the muffle. Fig. 9 is a side elevation of the blocks with the outer frame removed. Fig. 10 is a vertical section through the same. Fig. 11 is a plan view of the bottom member of the muffle; and Fig. 12 is a transverse vertical section, the latter figure showing the frame supporting the muffle-slabs. The body portion of the muffle comprises a metal framework 91, comprising a top and four sides that may be integral or separate and secured together in any preferred manner. The vertical side slabs 92 have at each end a projecting rib 92^a extending along the end. At the outer face of each block there is a strip 92^b extending along its intermediate portion and projecting at each end beyond the end portion of the block, forming at such portion a channel 92^c. At each of the four corners are located blocks 93, having the outer edges adjoining the blocks 92 channeled at 93^a and have ribs 93^b at the top and bottom. Strips 94 are inserted between the projecting portions of the side blocks and also that of the end pieces 93, thereby serving to break joints with the adjoining edges of the slabs. The frame 91 has inwardly-projecting portions 91^a, that project under the lower ends of the blocks 92 and 93, with the ribbed portions 91^b extending upward in the channel 92^c of the blocks, thereby supporting the side members and retaining them in position. The top members of the muffle are formed of three slabs 95, that have their outer edges channeled at 95^a for the insertion of strips 96, serving to break joints at the edges of the slabs. At each end of the top portion is a slab 97, having a projecting portion 97^a extending over the adjacent slab to break joint therewith. The top ribs 92^a and 93^b of the vertical slabs extend into suitable channels 97^b, and a packing, such as asbestor fiber, is arranged between the rib and the channeled portion to effectually close such joints and prevent escape of heat. The bottom portion of the muffle comprises a pan-shaped frame 98, in which are supported the bottom slabs. The latter comprise three transverse slabs 99, having their lower adjacent edges channeled for the insertion of strips 100, serving to close the joints of the slabs. At each end of the bottom is a slab 101, having a portion 102 projecting underneath the adjacent slab to break joint therewith. The top face of the slabs 101 is lower than that of the three intermediate slabs, and a channeled portion is provided at the ends of the intermediate slabs, forming a rectangular channel extending around the top of the bottom slabs. An additional channel 103 is also formed in this rectangular channeled portion for the reception of the projecting ribs along the bottom portions of the side members that extend into this channel 103 when the bottom is raised into engagement with the body portion of the muffle. A suitable packing, such as asbestos fiber, is placed in this channel to insure a tight joint.

Having thus described my invention, what I claim is—

1. In an electric furnace, the combination of a muffle having a top and a bottom and side members, each of said portions of the muffle being provided with heating-coils, said coils being connected by leads into a plurality of groups, and a commutator arranged to connect with the terminals of said groups of coils; said terminals and commutator being arranged whereby said groups will first be connected in series, at an advanced position of the commutator said groups will be connected in parallel, and in all positions of the commutator between said positions circuit will be established through one or more of said groups.

2. In an electric furnace, the combination of a muffle having a top and a bottom and side members, each of said portions of the muffle being provided with heating-coils, said coils being connected by leads into a plurality of groups; and a commutator arranged to connect with the terminals of said groups of coils; said terminals and commutator being arranged whereby said groups will first be connected in series; at a further stage in the advancement of the commutator two sets of such groups, each containing a plurality of groups arranged in series, will be disposed in parallel; at a still further advanced position of the commutator all of said groups will be disposed in parallel; and in all positions of the commutator between said series position and said parallel position circuit will be established through one or more of such groups.

3. In an electric furnace, the combination of a muffle provided with side members and a top and a bottom, electric coils arranged in each of said portions of the muffle; an electric switch comprising a commutator, and a set of terminals connected with said coils of the muffle; said coils being divided into four groups, one group of coils *a* being disposed in the top, bottom, front and back of the muffle; a second group of coils *b* comprising coils disposed in the bottom and top of the muffle; a third group of coils *c* comprising coils disposed in the front and back of the muffle, and a fourth group comprising coils disposed in the two other sides of the muffle; said terminals being arranged relative to the commutator whereby circuit will first be established through all of the groups in series; at a further stage in the advancement of the commutator the groups will be connected in multiple series, at a still further advanced position of the commutator all of said groups will be connected in parallel, and in all positions of the commutator between said series positions

and said parallel position circuit will be established through one or more of such groups.

4. In an electric furnace, the combination of a muffle provided with side members and a top and a bottom, electric coils arranged in each of said portions of the muffle, an electric switch comprising a commutator, and a set of terminals connected with said coils of the muffle; said coils being divided into four groups, one group of coils *a* being disposed in the top, bottom, front and back of the muffle; a second group of coils *b* comprising coils disposed in the bottom and top of the muffle; and a third group of coils *c* comprising coils disposed in the front and back of the muffle; and a fourth group comprising coils disposed in the two other sides of the muffle; and a commutating device arranged to connect with the terminals of the translating members, said terminals and commutator being arranged whereby said groups will first be connected in series, at an advanced position of the commutator said members will be connected in parallel, and in all positions of the commutator between said positions circuit will be established through one or more of said translating members.

5. In an electric furnace, the combination of a muffle provided with four sides and a top and a bottom, electric coils arranged in each of said six portions of the muffle, an electric switch comprising a commutator, and a set of terminals connected with said coils of the muffle, said coils being divided into four groups, one group of coils *a* being disposed in the top, bottom, front and back of the muffle; a second group of coils *b* comprising coils disposed in the bottom and top of the muffle; a third group of coils *c* comprising coils disposed in the front and back of the muffle and a fourth group comprising coils disposed in the two other sides of the muffle; said terminals being arranged whereby the said groups will first be connected in series, and in the successive positions of advancement of the commutator the latter will so connect the terminals of the groups whereby in the second position a shunt of low resistance will be established around two of such groups as *c* and *d;* in the third position of the commutator said groups *c* and *d* will be out leaving groups *a* and *b* in circuit; in the fourth position of the commutator groups *a* and *b* in series will be connected in parallel with groups *c* and *d* in series; in the fifth position of the commutator a shunt of low resistance will be established around group *c* in the said latter multiple-series arrangement; in the sixth position the groups *a* and *b* in series will be connected in paralel with the group *d;* in the seventh position the groups *a* and *b* connected in series will be connected in parallel with group *c* and also with group *d;* in the eighth position a shunt of low resistance will be established around the group *b* in the said seventh position; in the ninth position the groups *a*, *c* and *d* will be connected in parallel; and in the tenth position the four groups *a*, *b*, *c* and *d* will be connected in parallel.

6. In an electric furnace, the combination of a muffle having a top and a bottom and four sides, each of such six portions being provided with heating-coils, a switch device comprising terminals connected with said coils and a commutator; said terminals being arranged and connected with coils whereby in the first position of the switch said coils will be divided into four groups and such groups will be connected in series, at an advanced position of the commutator one group of coils including the top, bottom, front and back of the muffle, will be connected in series with another group including coils in the top and bottom of the muffle; at a still further advanced position of the commutator two groups of coils as *a* and *b* in series will be connected in parallel with two other groups of coils as *c* and *d* also connected in series, the first group *a* including coils disposed in the top, bottom, front and back of the muffle, the second group *b* including coils disposed in the top and bottom of the muffle, the third group *c* comprising coils disposed in the front and back of the muffle, and the fourth group *d* comprising coils disposed in the two end portions of the muffle; at a still further advanced position two groups of coils will be connected in series of which one group includes coils disposed in the top, bottom, front and back of the muffle, and the other group includes coils disposed in the top and bottom of the muffle, in the said latter position, a third group of coils also being connected in parallel with said two groups of coils, said third group including coils disposed in the end portions of the muffle; at a still further advanced position of the commutator three groups of coils will be connected in parallel, one group including coils disposed in the end portions of the muffle, the second group including coils disposed in the front and the back of the muffle, and the third of said parallel groups comprising two sets of coils in series, of which latter one set includes coils disposed in the top, bottom, front and back of the muffle, and the other set including coils disposed in the top and bottom of the muffle; at a still further advanced position of the commutator three groups of coils will be connected in series, one group comprising coils arranged in the top, bottom, front and back of the muffle, another said group comprising coils disposed in the bottom and top of the muffle, and the third of said latter groups including coils disposed in the end portions of the muffle; and at a still further advanced position of the commutator four groups of coils will be connected in series, one group comprising coils disposed in the top, bottom, front and back of the muffle,

another group comprising coils disposed in the bottom and top of the muffle, another group comprising coils disposed in the front and back of the muffle and the fourth group comprising coils disposed in the end portions of the muffle.

7. In an electric furnace, the combination of a muffle having its four sides and top permanently closed, a frame on which the muffle is mounted, a pivoted joint between the muffle and the frame whereby the muffle can be inverted from its normal position, a bottom member for the muffle, and means carried by the frame for raising and lowering the bottom member to close the muffle, the latter including means for locking the bottom when engaging the muffle.

8. The combination with the frame supporting the muffle-bottom, and the muffle-body pivoted thereon, of switch-blades secured to the frame, and switch-blades secured to the muffle-body and arranged to engage with said blades respectively when the muffle-body is swung on the frame.

9. The combination with the muffle-body supported on a frame, of a bottom member vertically movable in said frame to engage the body member and close its bottom, rollers connected with the bottom member and guided in said frame, a cam member arranged to reciprocate the bottom member, and a handle-lever arranged to control said cam.

10. In a muffle, the combination of a supporting-frame having a top and side portions, inwardly-projecting parts at the lower parts of the side portions, vertical slabs engaging the side portions and supported by said inwardly-extending parts, strips breaking joints with the side slabs, slabs extending across the top and resting on the side slabs, strips breaking joints with said slabs at their upper portions, the side slabs having ribs projecting upwardly at their top portions, the top having channeled portions into which said ribs project, packing located between said ribs and the channeled portions, and a bottom member comprising a frame and slabs arranged to engage the body member.

11. In a muffle, the combination of a supporting-frame having a top and side portions, inwardly-projecting parts at the lower parts of the side portions, vertical slabs engaging the side portions and supported by said inwardly-extending parts, strips breaking joints with the side slabs, slabs extending across the top and resting on the side slabs, strips breaking joints with said slabs at their upper portions, the side slabs having ribs projecting upwardly at their top portions, the top having channeled portions into which said ribs project, packing located between said ribs and the channeled portions, and a bottom member comprising a pan-shaped frame having slabs extending across the frame, strips at the bottom portions of the slabs breaking joints therewith, said slabs having a rectangular channel adjacent the edges, ribs projecting downwardly from the said side slabs arranged to enter said channel when the bottom and body members are brought together, and suitable packing arranged between said ribs and the channel portion.

12. In a muffle, the combination of a frame comprising a frame and side portions, the side portions having inwardly-projecting plates at the lower part, the vertical side slabs 92 provided with the projecting strip portions 92^b, the channels 92^c, and the ribbed portions 92^a, the corner-blocks 93 provided with the channeled portions 93^a, and the ribbed portions 93^b, the top slabs 95 and 97 having the strips 96 breaking joints therewith, and having a rectangular channel portion engaging the said ribs of the side members, the bottom portion of the muffle comprising a pan-shaped frame having the slabs 99 and 101 located therein, the strips 102 breaking joint with the bottom slabs, the bottom slabs having the channel portion 102 coöperating with the said ribs on the side members, and suitable packing located in said channeled portions.

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Witnesses:
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