No. 635,025. Patented Oct. 17, 1899.

W. E. SAUNDERS.

FURNACE FOR ANNEALING, BAKING, &c.

(Application filed Sept. 9, 1898.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1

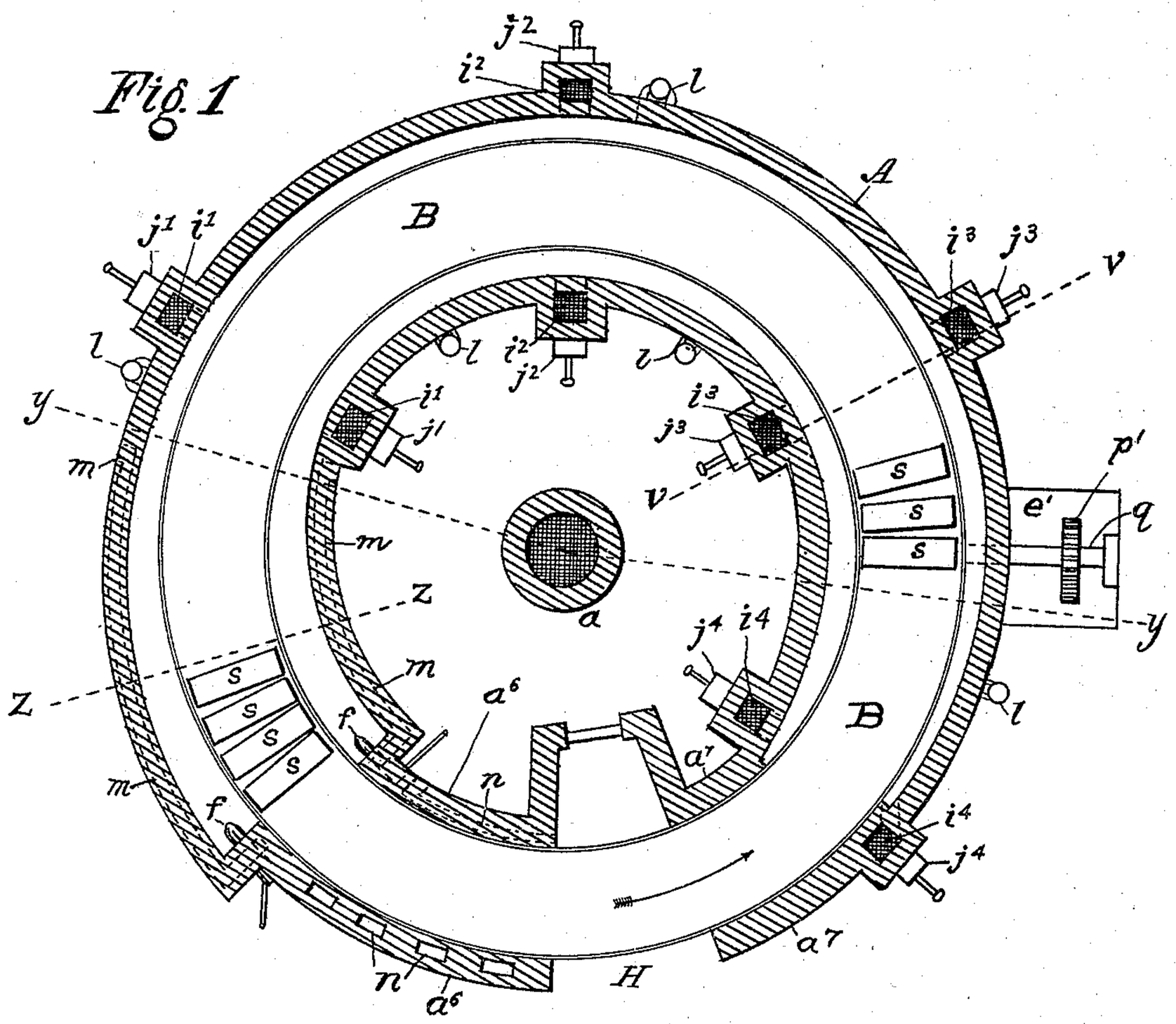
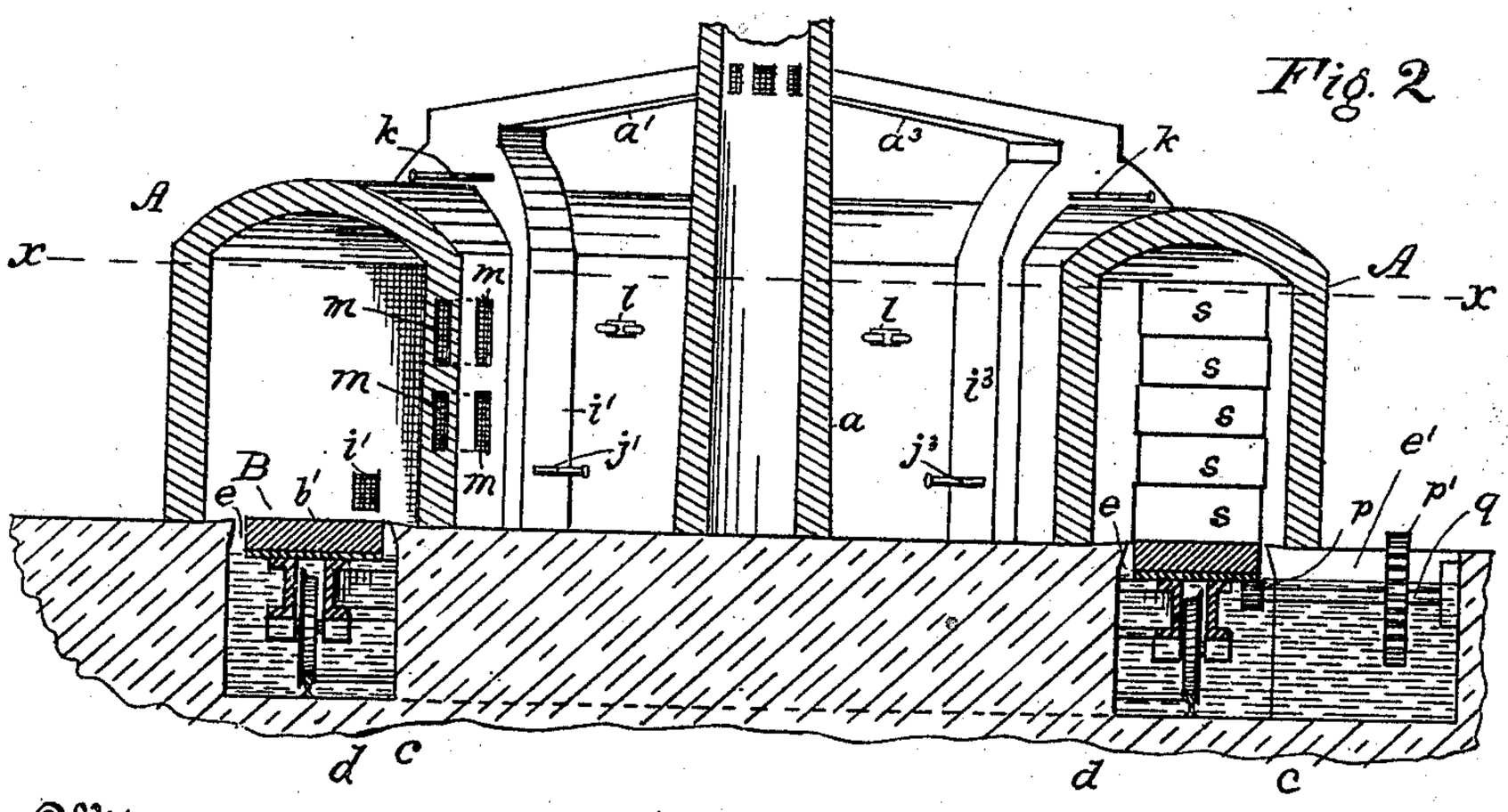


Fig. 2



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(No Model.) 4 Sheets—Sheet 2.

Fig. 3

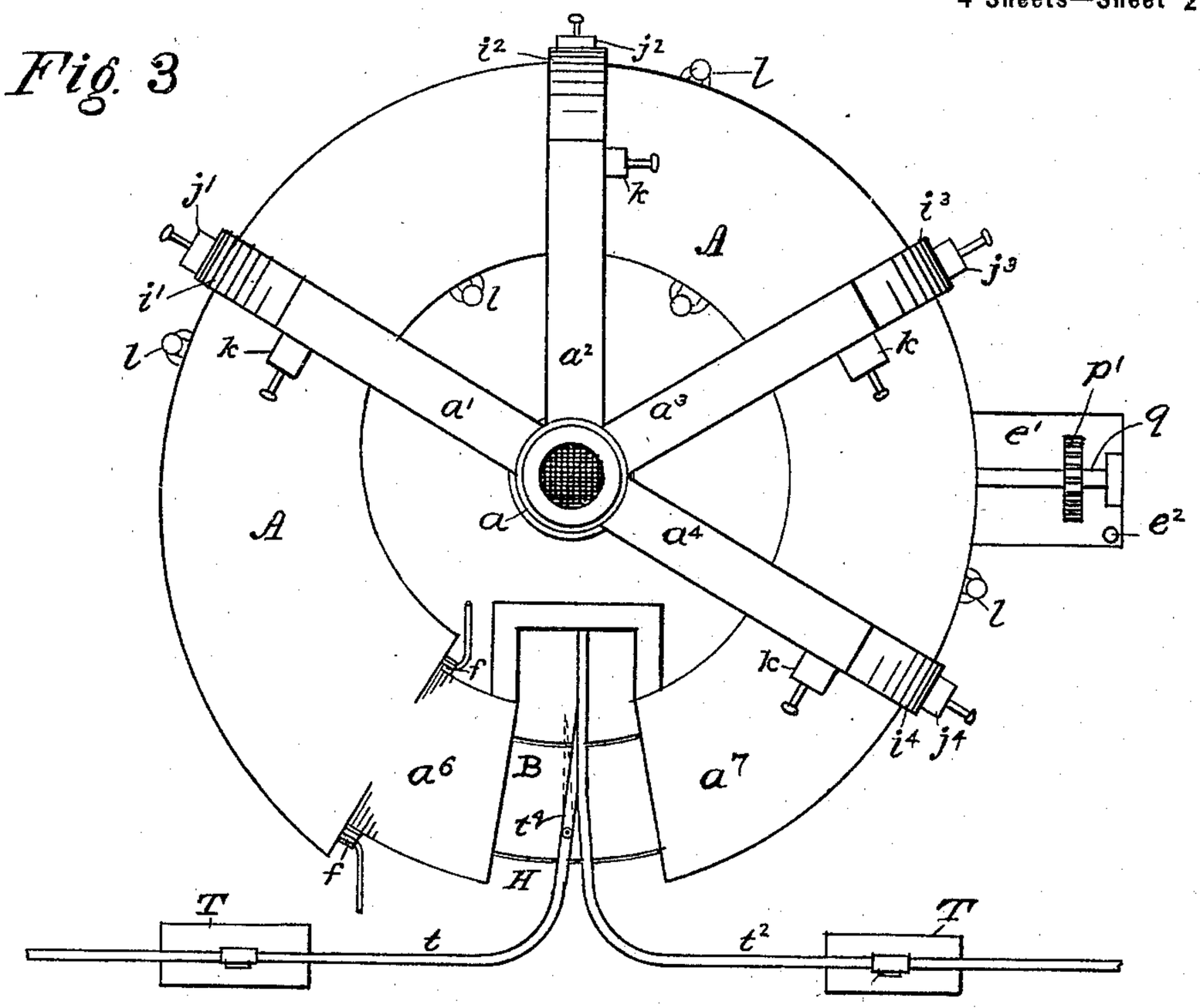


Fig. 4

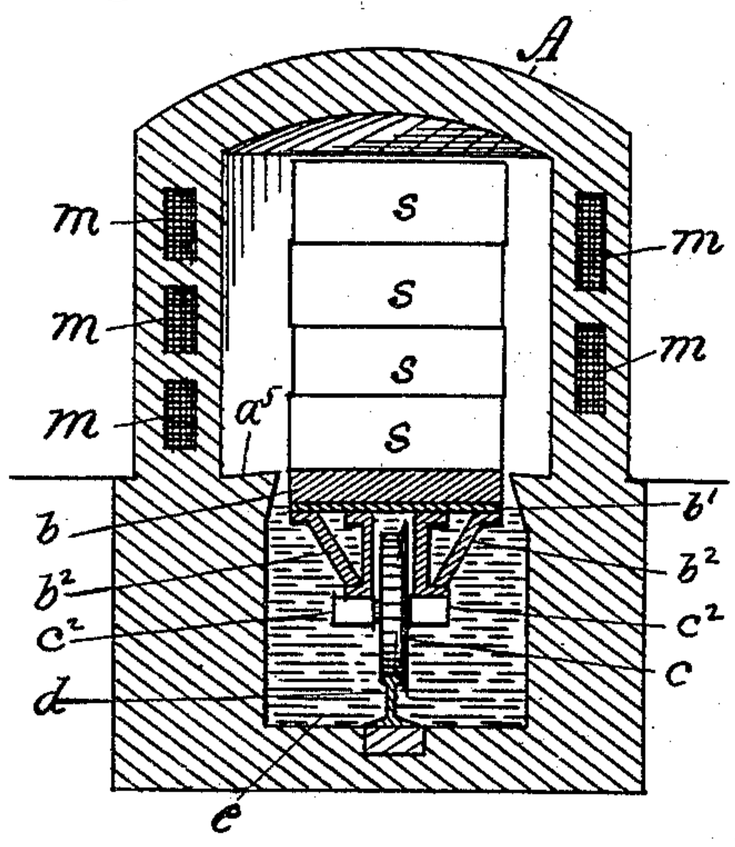
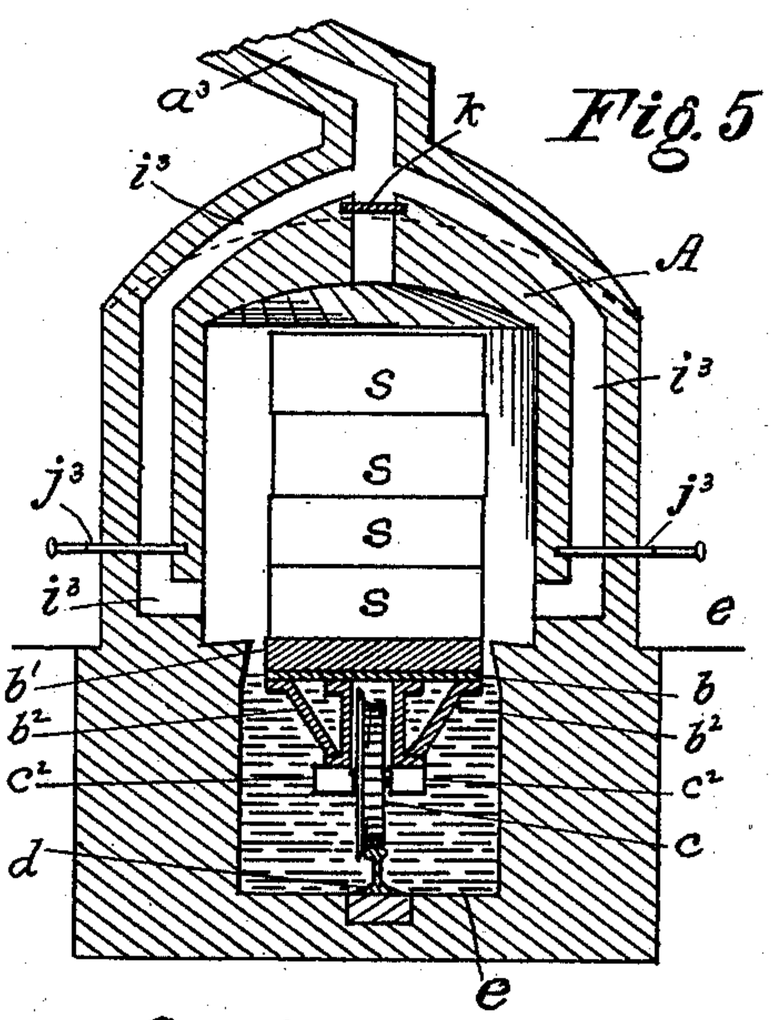


Fig. 5



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FURNACE FOR ANNEALING, BAKING, &c.

(Application filed Sept. 9, 1898.)

(No Model.) 4 Sheets—Sheet 3.

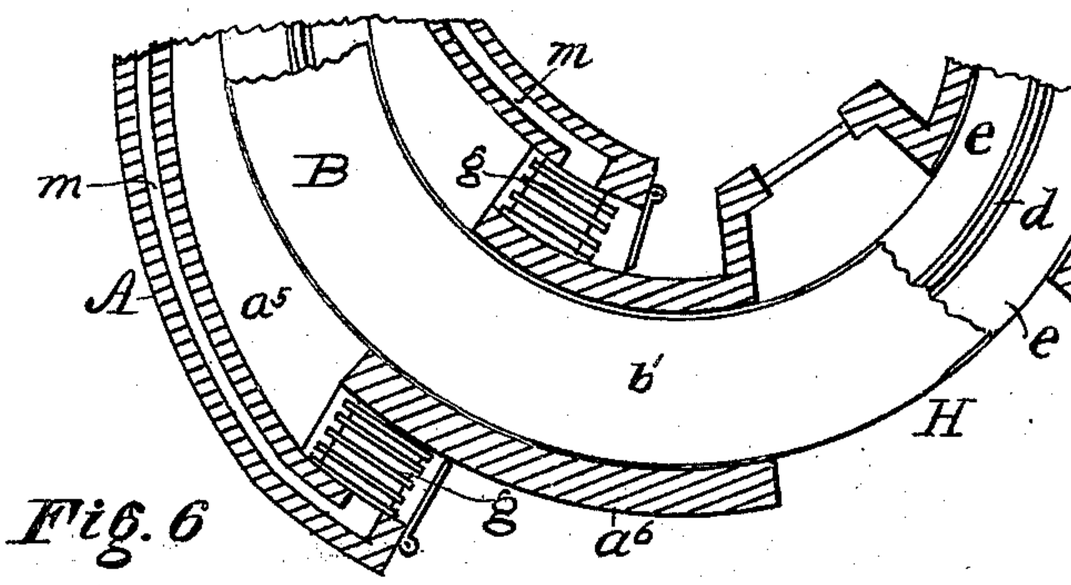

Fig. 6

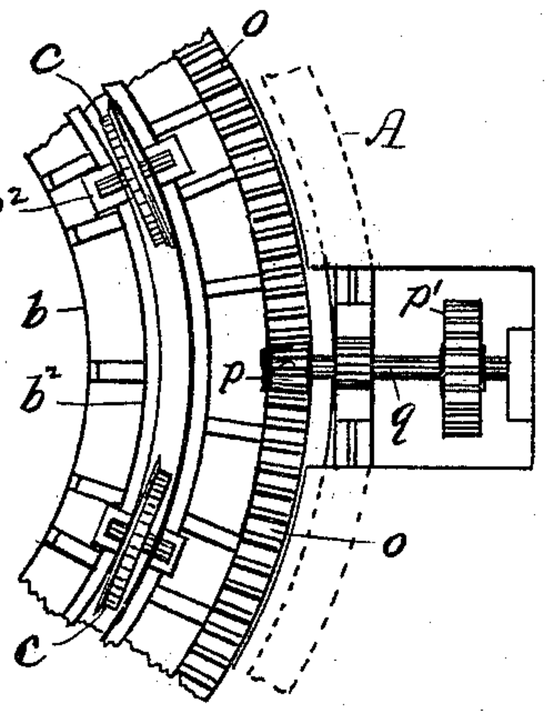

Fig. 8

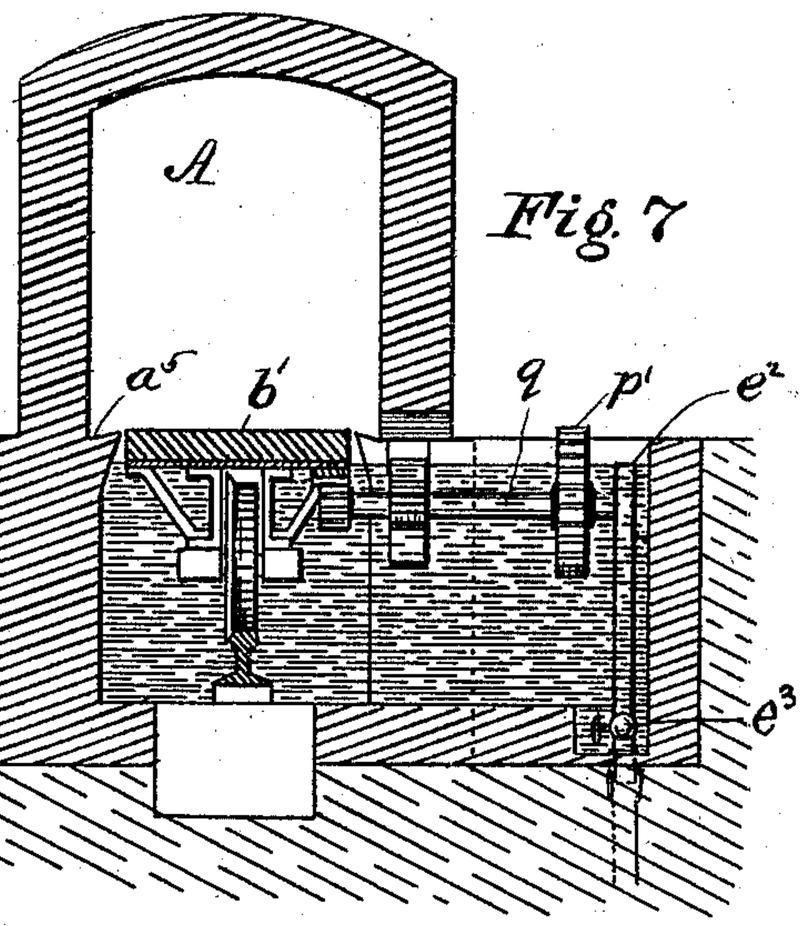

Fig. 7

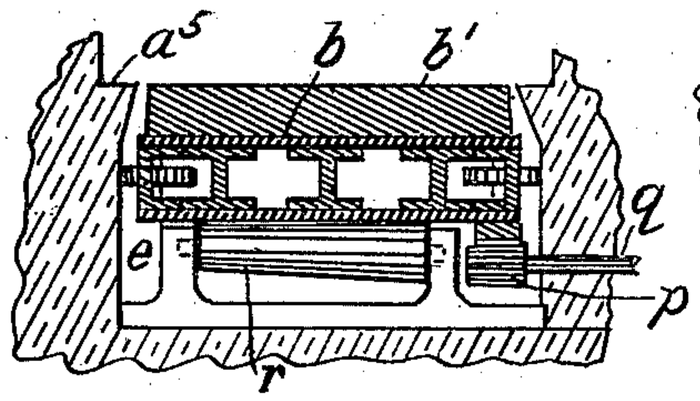

Fig. 9

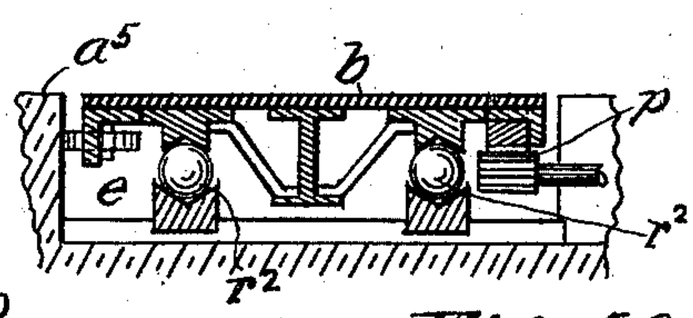

Fig. 10

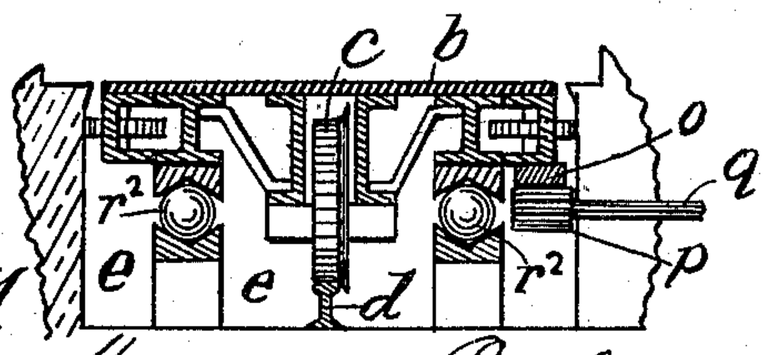

Fig. 11

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No. 635,025. Patented Oct. 17, 1899.

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FURNACE FOR ANNEALING, BAKING, &c.

(Application filed Sept. 9, 1898.)

(No Model.) 4 Sheets—Sheet 4.

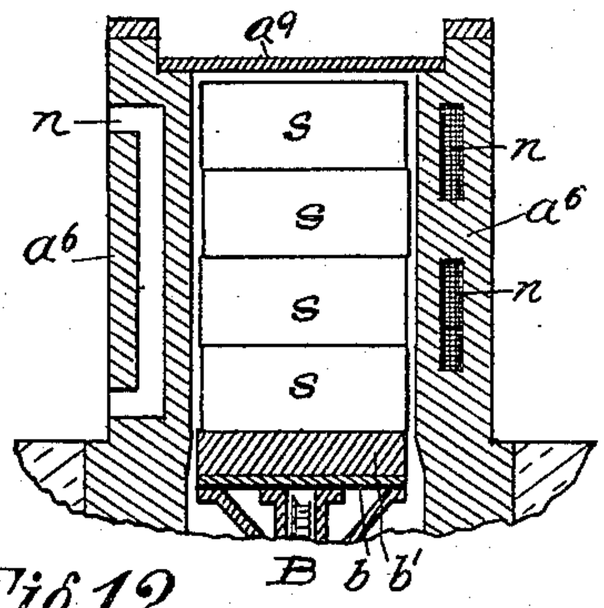

Fig. 12

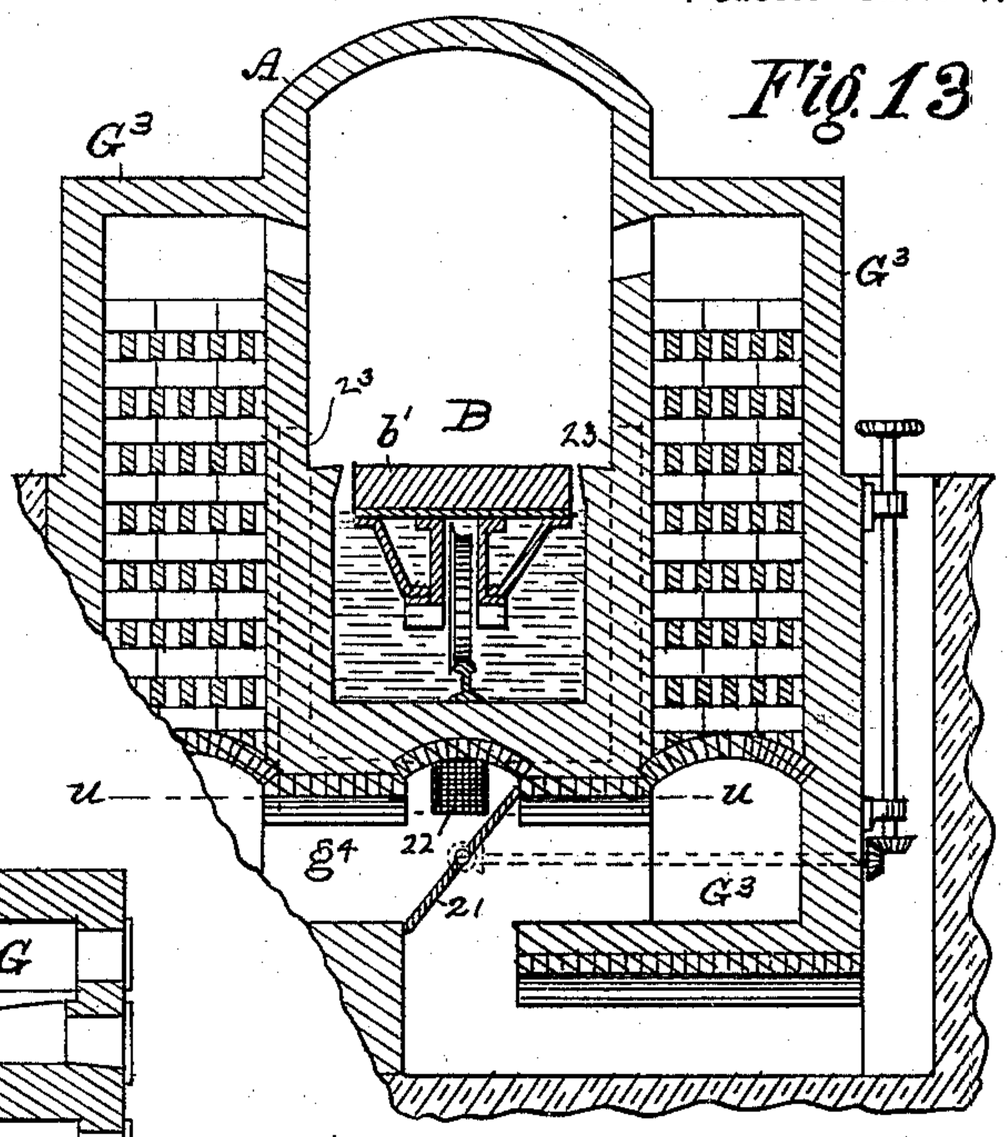

Fig. 13

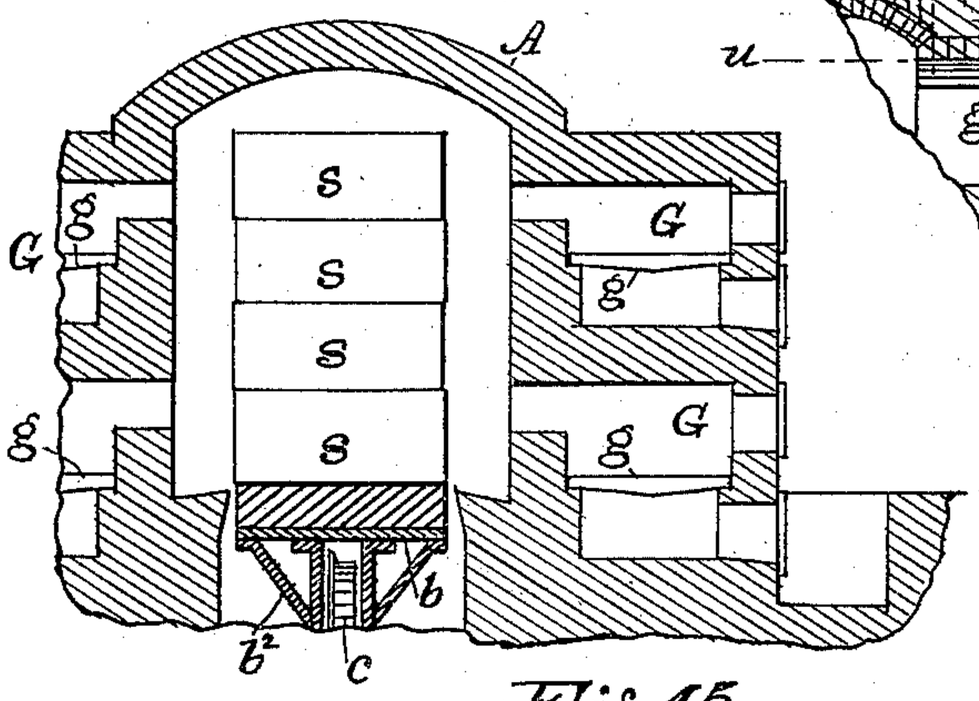

Fig. 15

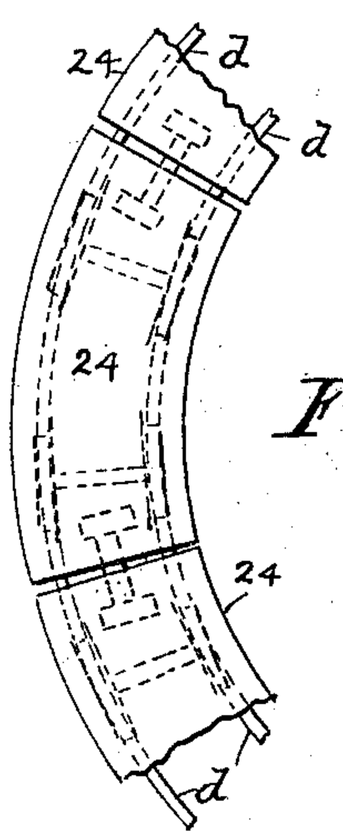

Fig. 16

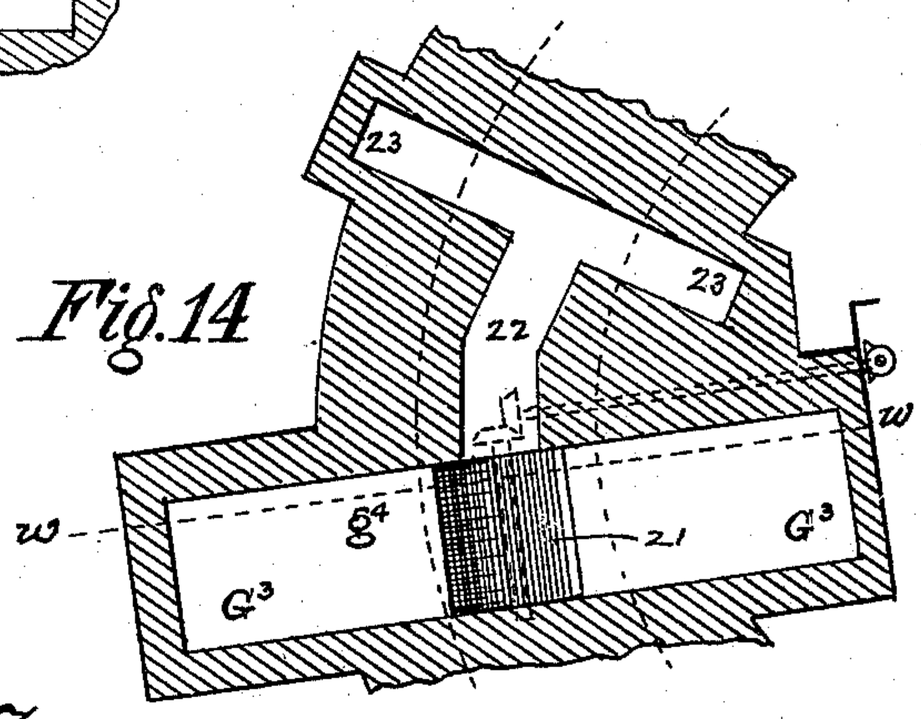

Fig. 14

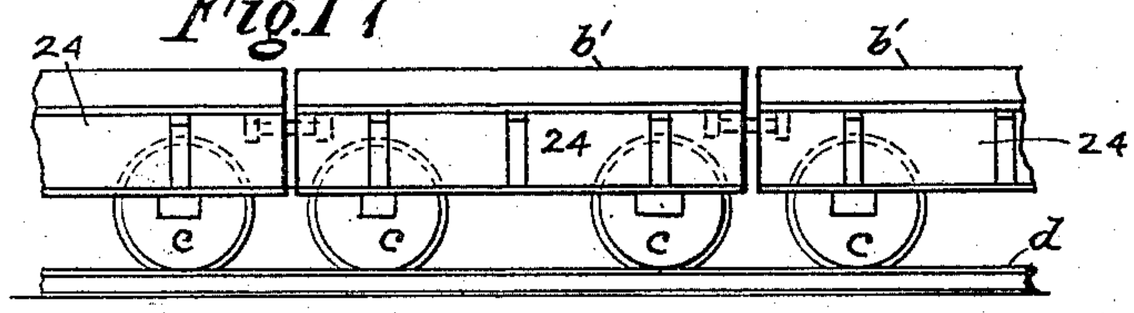

Fig. 17

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UNITED STATES PATENT OFFICE.

WILLIAM E. SAUNDERS, OF CLEVELAND, OHIO.

FURNACE FOR ANNEALING, BAKING, &c.

SPECIFICATION forming part of Letters Patent No. 635,025, dated October 17, 1899.

Application filed September 9, 1898. Serial No. 690,575. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM E. SAUNDERS, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Furnaces for Annealing, Baking, &c.; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to ovens or furnaces for baking, annealing, burning, drying, &c., in such manufacturing operations as the annealing of glass, metals, &c., the burning of pottery, bricks, &c., the baking of articles made from carbon, terra-cotta, &c., the drying of clay, roasting ores, and all analogous drying and heating operations.

The general features of the invention involve a rotary or revolving hearth, preferably of annular form, located in an annular tunnel-like furnace so constructed that the material can be subjected to a carefully-graduated temperature, which can be varied and controlled at will and so as to effect a gradual heating and gradual cooling of the material, whereby material may be continuously loaded on and discharged from the constantly-moving hearth without interrupting its operation, and thus the operation may be rendered continuous and a great saving of time, labor, and expense effected and a better result obtained, which is the object of my invention.

I am aware that a rotary hearth is not novel *per se;* but the construction, arrangement, and combination of parts embraced in the furnace hereinafter described and constituting the furnace as a whole I believe to be novel, and it is these features as set forth in the subjoined claims which substantially constitute my invention.

In the annexed drawings, Figure 1 represents in horizontal section a furnace so constructed as to embrace my invention, the plane of section being indicated on Fig. 2 by the broken line $x\ x$. Fig. 2 is a vertical section of the furnace, taken on the line $y\ y$ of Fig. 1. Fig. 3 is a plan view of the furnace and tramways. Fig. 4 is a vertical section through one side of the furnace on line $z\ z$ of Fig. 1, showing more clearly some of the details of construction. Fig. 5 is a similar section taken through the flues $a^2\ i^3$, &c., on the line $v\ v$ of Fig. 1. Fig. 6 is a sectional detail showing the furnace constructed with fire-grates. Fig. 7 is a sectional detail showing the water-draining arrangement. Fig. 8 is a detail showing the under side of the rack, pinions, &c., for driving the hearth. Figs. 9, 10, and 11 are details showing modified forms of construction of the hearth B, involving the use of antifriction devices, &c. Fig. 12 is a sectional detail showing the roof-plates a^9 for facilitating the cooling of the discharge end of the furnace. Fig. 13 is a partial vertical section through the furnace when constructed to be heated by a regenerative furnace, the plane of section passing through a pair of regenerative checkerwork-chambers and being indicated on Fig. 14 by the broken line $w\ w$. Fig. 14 is a horizontal sectional detail on the plane indicated by the broken line $u\ u$ on Fig. 13, and shows the arrangement of certain of the flues, the dotted segments on Fig. 14 indicating not the underlying structure, but the relative position of the water-pit above. Fig. 15 is a sectional detail illustrating the arrangement of the heating-furnaces in tiers. Fig. 16 is a detail showing in plan view the construction of the hearth as a series of connected trucks. Fig. 17 is a detail showing the same style of construction in side elevation.

The construction of the hearths shown in Figs. 1, 2, 3, 4, 5, 6, 7, 8, 12, 13, and 15 is exactly alike and is fully lettered in Figs. 4 and 5, for which reason and to avoid confusion some parts of the hearth are not lettered in the other figures.

In the drawings, A represents the furnace, of substantially annular ground plan and having a preferably central stack a, with which the furnace connects by flues $a'\ a^2$, &c., as hereinafter more fully described; but it is obvious that the furnace might be built with a dome or roof covering the whole and with a stack located at one side, if preferred. The arrangement shown is, however, believed to possess advantages of convenience, accessibility, &c., which render it the most desirable form, although I do not intend to restrict my invention to the form shown.

B represents the rotary hearth, which is

composed of an iron annular table *b*, which is faced on its upper surface with a fireproof or refractory coating *b'*, of fire-brick or other suitable refractory material, when it is to be exposed to high temperatures, but may be used without the coating *b'* when only moderate temperatures are to be employed, such as would not injuriously affect the table *b*. The table *b* is shown mounted on wheels *c c*, which travel on a circular track *d*, rigidly secured on the bottom of the furnace-chamber. In the drawings I have shown the track placed at the bottom of a pit *e*, sunk in the bottom of the furnace below the level of the top of table or hearth B and just wide enough at the top to give clearance for the movement of the hearth, as best seen in Fig. 4. This construction is adopted to prevent the flame or heat of the furnace from reaching any part of the hearth B except its top, which is protected by a refractory coating, as stated; but it is evident that in cases in which the refractory coating *b'* is not needed the rail *d* and the entire hearth may be above the floor a^5 of the furnace-chamber, and I do not limit myself to a construction in which the hearth is located in the pit, as shown. As an additional safeguard against the injurious effects upon the metal-work of the hearth of a long-continued high temperature in the furnace, I construct the surface of the sides and bottom of the pit *e* of a waterproof material—such, for instance, as hydraulic cement—so as to make the pit water-tight, and I fill the pit with water high enough to make contact with the under side of the hearth, as seen in Figs. 2, 4, 7, &c. This water-cooling of the metal-work of the hearth effectually prevents the warping or buckling of the hearth and the injurious effects of repeated heating and cooling to which it would otherwise be subjected, and as the refractory coating *b'* is very little, if at all, affected and is very easily repaired or replaced if it is injured the hearth is preserved and maintained indefinitely true and rigid without requiring repair or substitution of parts aside from the natural effects of wear. The water also acts as a seal to prevent the too free access of air to the furnace, which might otherwise occur by the air entering the pit *e* at the recess B and rising into the furnace-chamber at other points, thereby diluting the hot combustion-gases and reducing their heating effect.

The furnace is heated by any usual means and in any preferred manner. For instance, by fuel, gas, or oil burned in burners *f f* and by the combustion of fuel on grates *g g* in furnaces G, (see Figs. 6 and 15,) or where very intense heat is required the common and well-known regenerative furnace may be employed, as shown in Fig. 13, the checkerwork or regenerative chambers G^3 being located at each side of the furnace A and communicating at bottom with a flue g^4, from which by a flue 22 beneath the pit *e* the combustion-gases are conducted to the stack in any manner preferred, as by discharging into vertical flues 23, (shown in dotted lines in Fig. 13), which open into the chamber of the furnace A, from which they pass by flues *i*, &c. The usual reversal-valve 21 serves to change the course of the combustion-gases at intervals in the usual method of operating regenerative furnaces. The grates or oil-burners are located at or a little above the level of the top of the hearth, and where a very intense heat is required may be in two tiers, one above the other, as shown in Fig. 15; but as the heat will naturally be greatest near the top of the furnace two tiers will seldom be required.

At a point near the grates or burners the furnace is so recessed on its outer side as to expose the hearth for a distance sufficient to afford convenient room for loading on and discharging material therefrom, as shown at B in Fig. 1. From the recess B to or nearly to the grates or burners the furnace-chamber is only enough wider than the hearth to afford clearance for the hearth and its load, as indicated at a^6 in Fig. 1, and the narrow space thus left admits a small amount of air between the load and the furnace-wall, which not only aids the combustion in the furnace-chamber, but also serves to slowly cool the articles or material on the hearth. The furnace-walls in the neighborhood of the grates or burners become in time intensely hot, and for some distance back of the grates the air which thus enters the part a^6 is being subjected to heat radiated from the furnace-walls, and is thus sufficiently warmed to prevent too-rapid cooling of the material on the hearth, but still exerts a slow cooling effect, which increases very materially as the distance from the grates or burners increases, so that by the time the slowly-moving hearth has brought the material around to the recess B it has been slowly and gradually cooled to the desired degree and is ready to be removed from the hearth and replaced by fresh material.

For a short part of its length at the entrance end the furnace is also narrowed so as just to give clearance for the hearth and its load, as indicated at a^7 in Fig. 1, and from thence widens more or less gradually to its full width. The last one of the flues i^3 i^4, &c., is located near the point where the widening of the furnace-chamber from the part a^7 begins, and the flames and hot combustion-gases traverse to a greater or less extent all of the furnace-chamber from the grates, gas-flues, or oil-burners around to the last one of the flues i^4, &c., thus heating to a high temperature all of the furnace-chamber except the contracted portions a^6 a^7, which are cool at their outer ends near the recess B and grow gradually warmer as they approach the hotter parts of the furnace. From the recess B, where the material enters the furnace, it is being slowly and gradually heated by radiation from the heated walls of the furnace, which effect is moderated by the slight inward current of air from

the recess B, so that when the material reaches the point where it first encounters the hot furnace-gases it has become partly heated, and as it passes on around toward the burners or grates, where the heat is most intense, is gradually heated up to the required degree, and then, entering the contracted part a^6, gradually cooled, as described.

From the grates or burners the furnace-chamber is widened enough to afford full play for the flames and hot combustion-gases upon, over, and among the material on the hearth or the saggars in which it may be placed, and this wider space is continued for a sufficient distance—say one-half, two-thirds, three-quarters, or even more of the remaining distance around to the recess B—so as to insure the exposure of the material on the hearth to the heat for a sufficient time.

To effect the proper distribution of the heat in a furnace of this class requires very careful management and in the furnaces ordinarily used is a matter of difficulty and frequently of imperfect attainment. With the object of securing a perfect distribution and regulation of the heat I provide at numerous points flues i' i^2 i^3, &c., which communicate with the furnace-chamber at different levels and connect with the flues a' a^2 a^3, &c., which extend to the stack. Dampers j' j^2, &c., are provided at suitable points in the flues i' i^2, &c., as shown in Fig. 5, by means of which dampers the hot gases may be drawn from any desired part of the furnace-chamber, and by the same means, in connection with dampers k in the flues a' a^2, &c., the gases may be drawn off at any desired part of the length of the furnace-chamber and in any proportion at different points or different levels, as preferred.

By means of the above-described system of flues and dampers the flames and heating gases can be made to traverse any desired portion of the length of the furnace, even to the flues a^4, and can be directed to either side or to the top or bottom of the chamber and distributed in just the proportion required in any part. With a view of aiding the judicious regulation of the heat I provide the furnace at suitable points with attachments for pyrometers l l, by which the temperature in the different parts of the furnace can be determined, and thus the operator, by means of the dampers, &c., is enabled to regulate the temperature and the time during which the material is subjected to it in accordance with the requirements of the particular material under treatment. The pyrometers may of course be made permanent fixtures of the furnace, if preferred.

With the double purpose of protecting the furnace-walls at the part where they are most severely taxed and of increasing the heating effect of the fires I form air-flues m m (shown in Fig. 4) in that portion of the furnace-walls forward of the grates or burners, which is of course the most highly heated portion, and these flues open into the fire-pit of the grates or into the air-chamber in which the oil-burner is set, so as to supply the highly-heated air from the flues m m to the combustion of the fuel, thereby very materially increasing the calorific effect, while the air in abstracting heat from the furnace-walls materially enhances their durability.

Where a somewhat rapid cooling of the material on the hearth is desired, air-flues n n may be formed in the furnace-walls, at the part a^6, opening to the outer air, and these flues by increasing the radiation of heat from the furnace-walls will cause them to more quickly absorb the heat from the material on the hearth, and for the same purpose the top of the furnace-chamber in a^6 may be made of iron plates a^9, (see Fig. 12,) whose greater heat conductivity will cause them to absorb and radiate heat more rapidly than would the brickwork of the walls.

The hearth B is rotated continuously or intermittently at the proper or desired speed by any suitable means—such, for instance, as a pinion p meshing with a rack o on the periphery of table b, and preferably on its under side, the pinion being actuated, as by gear p' on the shaft q, by any suitable power. While I have shown the hearth mounted on wheels whose axle-boxes c^2, Fig. 4, are attached to the framework b^2, which carries the table b, and I prefer this arrangement, it is within my invention to support the hearth on fixed rollers r, balls r^2, or wheels so arranged as to permit its rotation without lateral movement and to dispense with the track d or to employ the balls or rollers in conjunction with the track d and wheels c, as shown in Fig. 11; also, to use a series of connected trucks 24 instead of a solid hearth, as seen in Figs. 16 and 17.

In the drawings I have shown the furnace of a height sufficient to allow of the piling of saggars s upon the hearth, as would be done in burning pottery and other articles, and a similar height might be used in burning brick, which would be piled directly on the hearth; but in other operations—such as roasting ores, for instance—the furnace-chamber may be very low, and its proportions may be varied to suit the requirements of the particular operation to be conducted therein.

By the terms "forward" and "back" where I have used them in reference to the furnace I refer to the direction in which the combustion products travel in their passage from the grates, flues, or burners to the flues i' i^2, &c., on their way to the stack. As shown in the drawings, the hearth, as shown by the arrow, rotates in a direction contrary to that in which the heating gases pass; but it is to be fully understood that the hearth may be rotated in the same direction as the gases travel if the nature of the material treated or other circumstances should render it preferable.

The pit e is so constructed as to drain to one point, at which point an arm e' of the pit

extends beyond the furnace-wall and is provided with an outlet to a sewer or other convenient discharge. A stand-pipe e^2, connecting with the sewer, maintains the water in the pit e at a constant level and serves as an overflow-pipe in case a circulation of water through the pit is maintained, as may be desirable. By a suitable valve e^3, opening into pipe e^2 at the bottom or other means, the pit can be drained of its water and workmen can then enter the pit beneath the hearth for the purposes of inspection or repair. Preferably I locate the shaft e in this arm or extension e' of the pit e, and the shaft and pinion are thus brought below the water-level, as seen in Fig. 7, in which the outlet to a sewer is shown in dotted lines beneath pipe e^2.

For speed and convenience in handling I provide one or more elevated tracks $t\,t^2$, leading from the recess B to such points as the material may be taken from or to. By means of trolleys on these tracks carrying suspended slings, hooks, or platforms T the untreated material is brought to the furnace and the finished articles or materials conveyed to any desired point. By means of the common switch t^4 used in such tracks the trolleys bring the raw material on track t^2 and return on track t, loaded with finished material.

In the claims I have used the term "burners" in the broad sense of combustion apparatus of any kind, meaning to include in that term fire-grates, gas-burning flues, oil-burners, gas-burners, or any means of supplying heat to the furnace-chamber by combustion.

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

1. A furnace having an annular heating-chamber and a continuously-moving water-cooled hearth therein, substantially as described.

2. A furnace having an annular heating-chamber, an annular water-pit in the bottom of said chamber, an annular hearth in said pit and in contact with the water, and means for rotating said hearth, substantially as described.

3. A furnace having an annular heating-chamber contracted in the portion adjacent to the point of discharge, an annular hearth traversing in said chamber, a stack, and a plurality of flues connecting the stack with different parts of said heating-chamber, substantially as described.

4. A furnace having an annular heating-chamber recessed at the point of discharge and contracted in the portions adjoining said recessed part, an annular hearth traversing in said chamber and through said recess, a stack, and a plurality of flues connecting the stack with different parts of the heating-chamber, substantially as described.

5. A furnace having an annular heating-chamber contracted in the portion adjacent to the point of discharge, an annular hearth having a refractory coating and traversing in said chamber, said hearth with its load substantially filling the contracted portion of the chamber, a stack, and a plurality of flues connecting the stack with different parts of the heating-chamber, substantially as described.

6. A furnace having an annular heating-chamber, a continuously-moving water-cooled hearth traversing therein, a central stack, and a plurality of flues connecting different parts of the heating-chamber with the stack, substantially as described.

7. A furnace having an annular heating-chamber recessed at the point of discharge, a continuously-moving annular hearth traversing in said chamber and through said recess, a stack, and a plurality of flues connecting different parts of the heating-chamber with the stack, substantially as described.

8. A furnace having an annular heating-chamber contracted in the portion adjacent to the point of discharge, a water-pit in the bottom of said chamber, an annular hearth traversing in said chamber and in contact with the water in said pit, a stack, and a plurality of flues connecting the stack with different parts of the furnace-chamber, substantially as described.

9. A furnace having an annular heating-chamber recessed at the point of discharge and contracted in the portion adjacent to the recessed part, a water-pit in the bottom of said chamber, an annular hearth traversing in said chamber and in contact with the water in said pit, a stack, and a plurality of flues connecting the stack with different parts of the furnace-chamber, substantially as described.

10. A furnace having an annular heating-chamber with a water-pit therein, an annular hearth traversing in said chamber and in contact with the water in the pit, a central stack, and a plurality of flues connecting the stack with different parts of the heating-chamber, substantially as described.

11. A furnace having an annular heating-chamber contracted in the portion adjacent to the point of discharge, an annular hearth traversing in said chamber and with its load substantially filling said contracted portion, fire chambers or burners communicating with the wider part of the chamber, a stack, and a plurality of flues connecting the stack with different parts of said heating-chamber, substantially as described.

12. A furnace having an annular heating-chamber contracted in the portion adjacent to the point of discharge, an annular hearth traversing in said chamber and with its load substantially filling the contracted portion, burners or combustion-chambers communicating with the wider part of the furnace-chamber, a stack, a plurality of flues connecting the stack with different parts of the heating-chamber, and air-flues located in the walls of the contracted portion and commu-

nicating with the outer air for cooling the discharge end of the furnace, substantially as described.

13. A furnace having an annular heating-chamber contracted in the portion adjacent to the point of discharge and formed in part of metal in said contracted part, an annular hearth traversing in said chamber and with its load substantially filling said contracted portion, burners communicating with the wider part of the chamber, a stack, flues connecting said stack with the furnace-chamber, and air-flues in the walls of the contracted portion communicating with the outer air, whereby the cooling of the contents of said contracted portion of the furnace is accelerated, substantially as described.

14. A furnace having an annular heating-chamber recessed at the point of discharge and contracted in the portion adjacent to said recess, said contracted portion being formed in part of metal, an annular hearth traversing in said chamber and with its load substantially filling said contracted portion, burners communicating with the wider part of the chamber, a stack, flues connecting said stack with the furnace-chamber, and air-flues in the walls of the contracted portion communicating with the outer air, whereby the cooling of the contents of said contracted portion of the furnace is accelerated, substantially as described.

15. In a furnace the combination of an annular heating-chamber having a water-pit therein, an annular hearth traversing in said chamber and in contact with the water in said pit, a central stack, a plurality of flues connecting said stack with different parts of said chamber, burners in the walls of said chamber, air-heating flues in the furnace-walls opening to the outer air and connecting with said burners, and cold-air flues in the furnace-wall between the burners and the point of discharge, substantially as described.

16. In a furnace the combination of an annular heating-chamber recessed at the point of discharge and having a water-pit in its bottom, an annular hearth traversing in said chamber and through said recess in contact with the water in said pit, a central stack, a plurality of flues connecting said stack with different parts of said chamber, burners in the walls of said chambers, air-heating flues in the furnace-walls opening to the outer air and connecting with said burners, cold-air flues in the furnace-walls adjacent to the point of discharge, and tracks entering said recess for loading and discharging the hearth, substantially as described.

17. In a furnace the combination of an annular heating-chamber recessed at the point of discharge and contracted at the portions adjacent to said recess, a water-pit in the bottom of said furnace-chamber and recess, a track in the bottom of said pit, an annular hearth supported on said track and traversing in said chamber and through said recess in contact with the water in said pit, a central stack, a plurality of flues connecting said stack with different parts of said chamber, burners in the walls of said chambers, air-heating flues in the furnace-walls opening to the outer air and connecting with said burners, cold-air flues in the furnace-walls adjacent to the point of discharge, and tracks entering said recess for loading and discharging the hearth, substantially as described.

In testimony whereof I hereto affix my signature in presence of two witnesses.

WILLIAM E. SAUNDERS.

Witnesses:
CECIL L. SAUNDERS,
J. B. BARROW.