Jan. 2, 1923. 1,440,546.

F. C. LANGENBERG ET AL.

FURNACE.

FILED APR. 14, 1921. 3 SHEETS—SHEET 1.

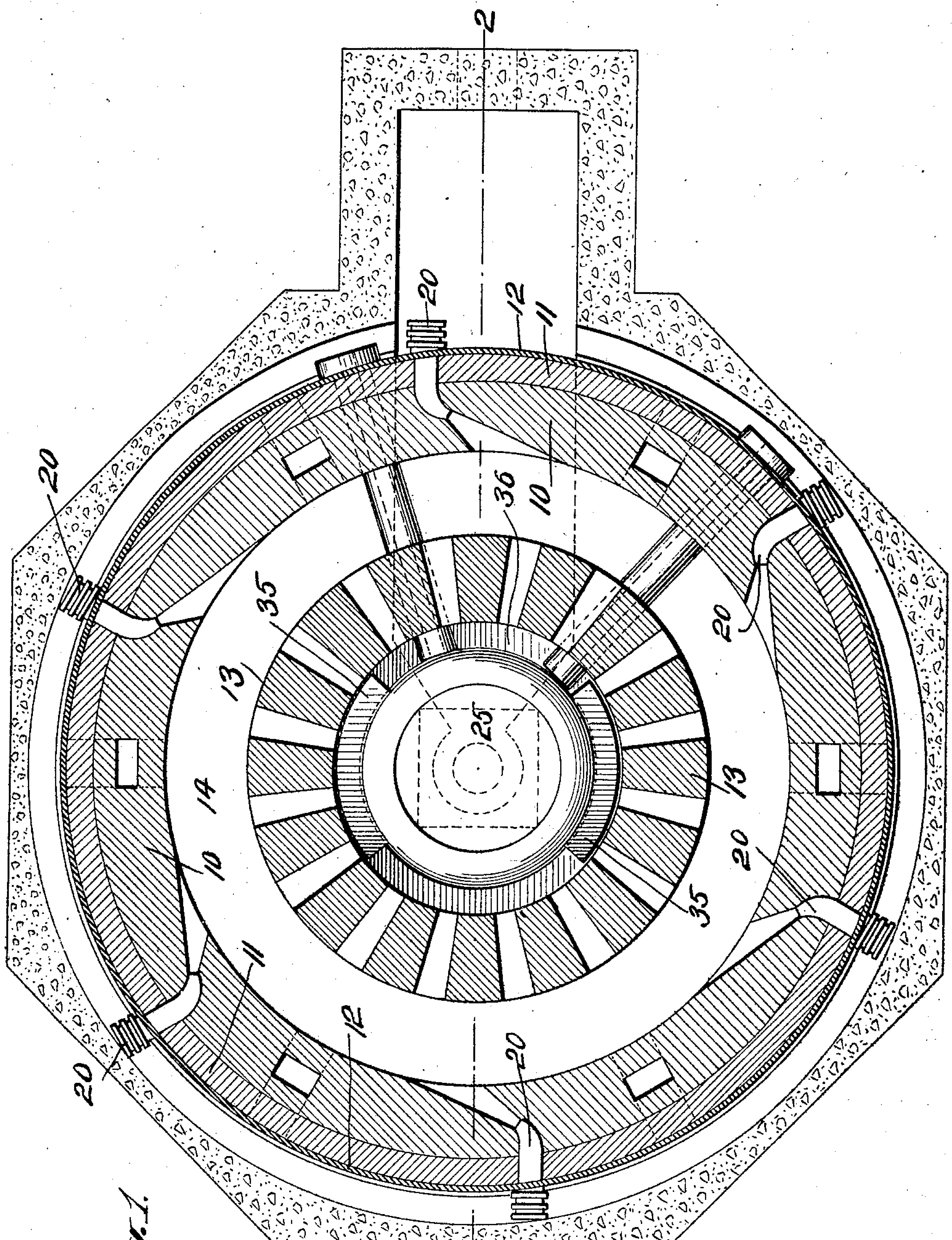

Fig. 1.

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by Arthur L. Kent
their Atty's

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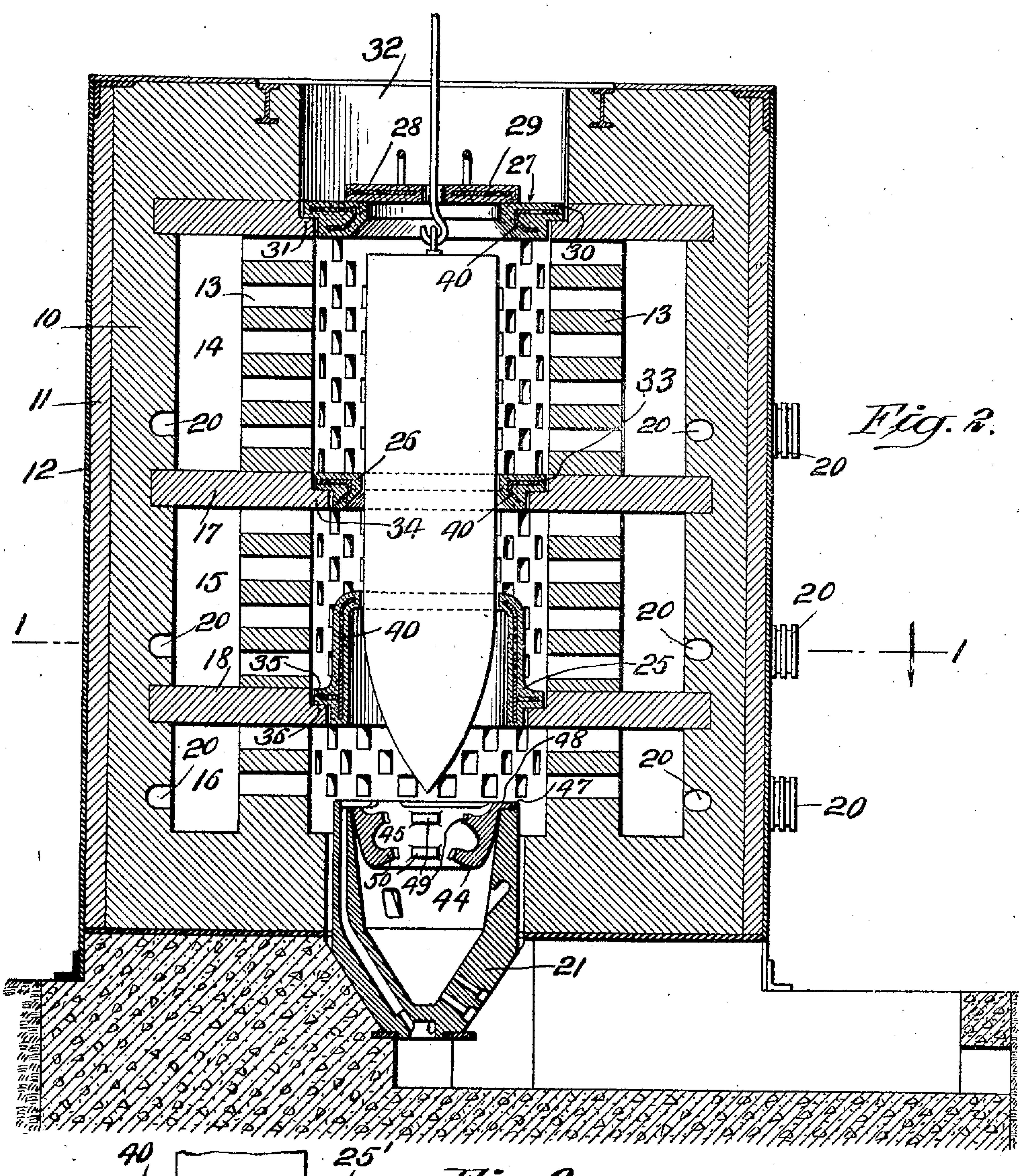

Fig. 2.

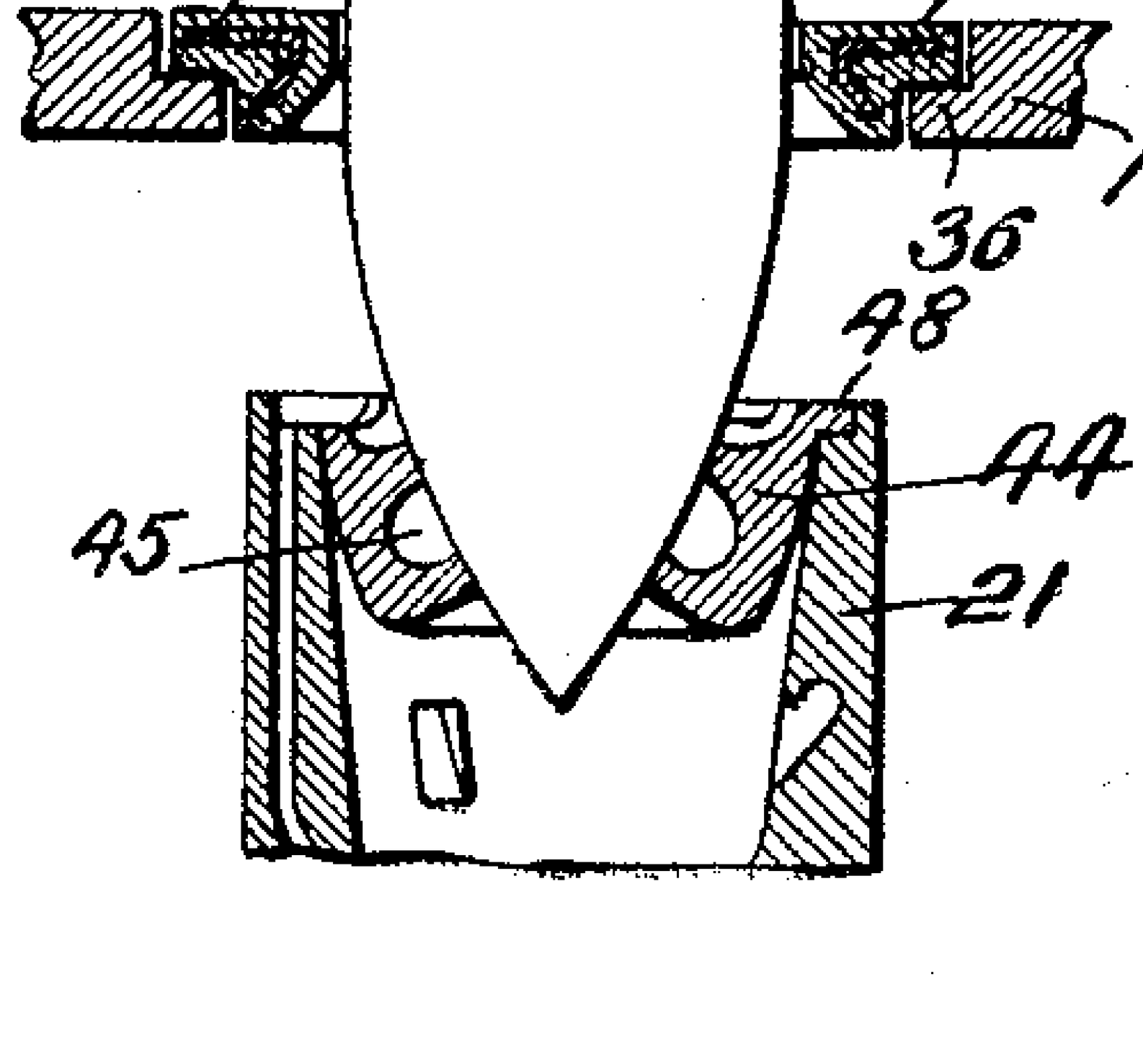

Fig. 3.

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FILED APR. 14, 1921. 3 SHEETS—SHEET 3.

Fig. 4.

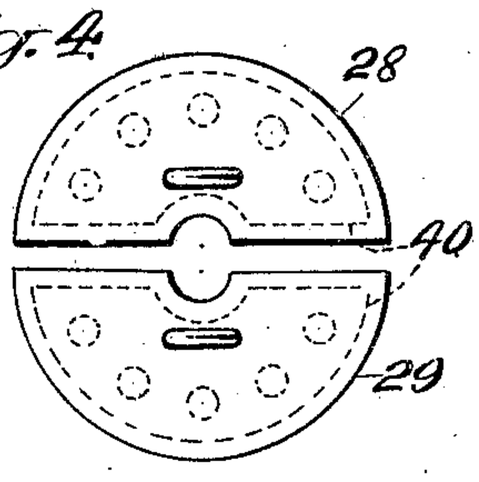


Fig. 5

Fig. 6.

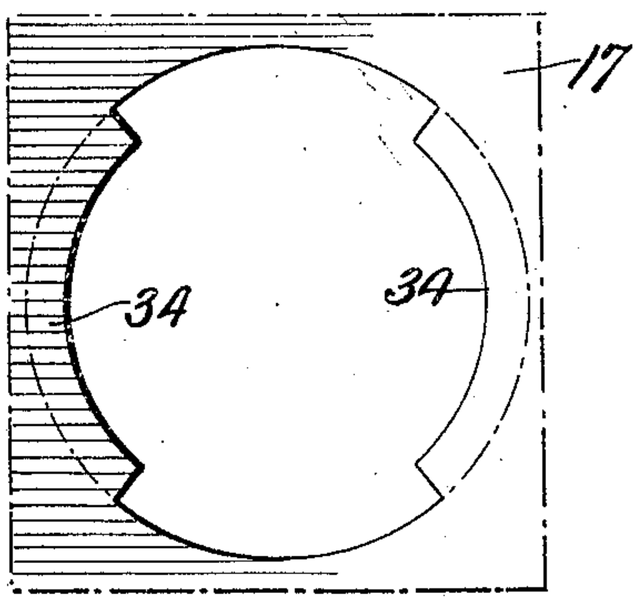
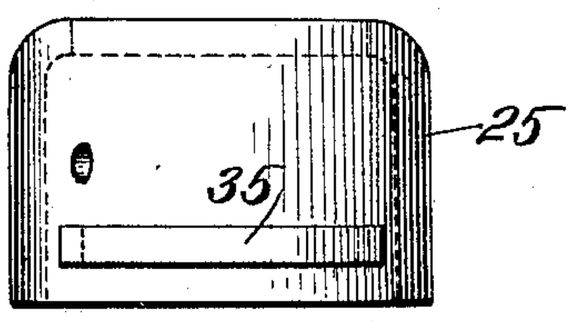


Fig. 7.



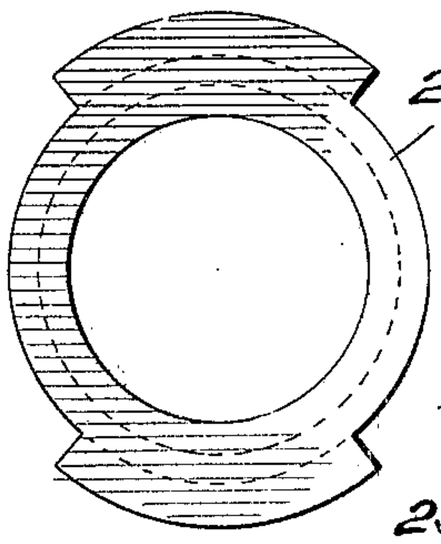


Fig. 8.

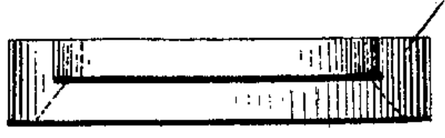


Fig. 9.

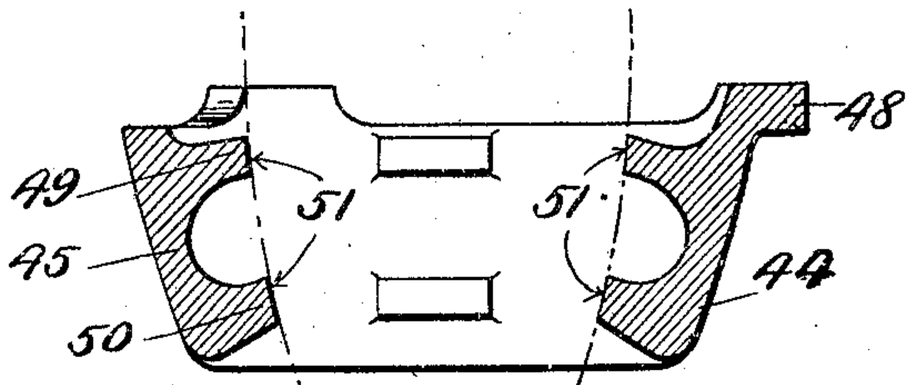


Fig. 10.

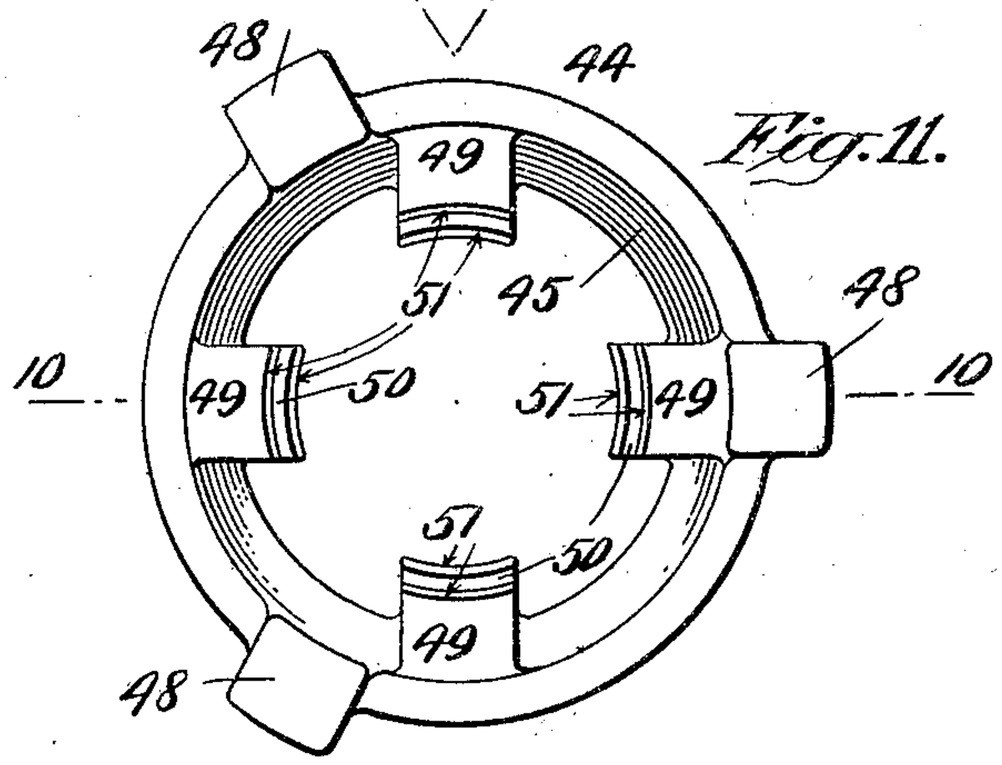


Fig. 11.

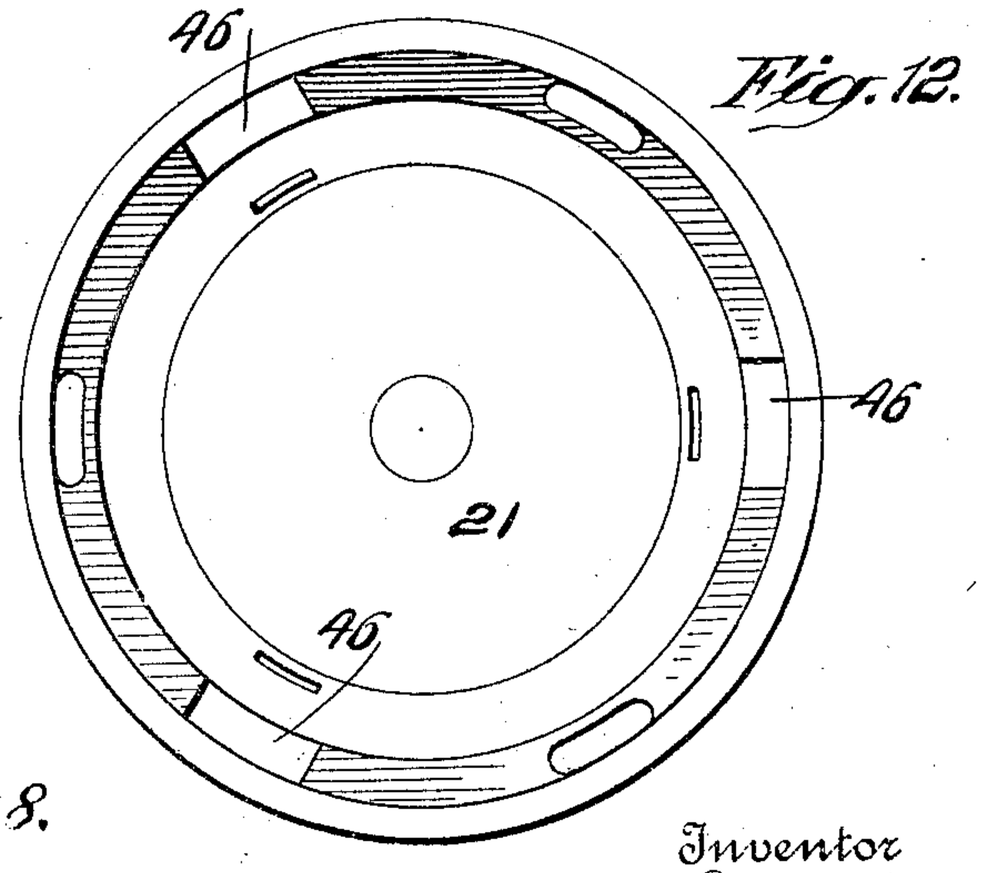


Fig. 12.

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Patented Jan. 2, 1923. 1,440,546

UNITED STATES PATENT OFFICE.

FREDERICK C. LANGENBERG, OF WATERTOWN, MASSACHUSETTS, AND JOHN F. FETTERLY, OF ALTOONA, PENNSYLVANIA, ASSIGNORS TO THE SURFACE COMBUSTION CO., INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

FURNACE.

Application filed April 14, 1921. Serial No. 461,401.

To all whom it may concern:

Be it known that we, FREDERICK C. LANGENBERG and JOHN F. FETTERLY, citizens of the United States, residing, respectively, at Watertown, county of Middlesex, and State of Massachusetts, and Altoona, county of Blair, and State of Pennsylvania, have invented certain new and useful Improvements in Furnaces, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to furnaces for differential heating and has for an object to provide for maintaining different parts of the object treated at different temperatures. The invention aims to improve furnaces heretofore used for this purpose by eliminating heat convection between the zones of different temperatures and so defining the zones more sharply than has heretofore been possible.

A further object of the invention is to provide means for changing the position and extent of the zones of differential treatment without altering the combustion chambers of the furnace.

A further object of the invention is to adapt a furnace to differential heating of objects of various sizes.

A still further object of the invention is to provide means for definitely fixing the position of the zones of treatment in relation to the object treated.

While the invention may be used in various types of furnaces, we will, for the sake of example, describe the application of it to a type of differential heating furnace which has been used in the heat treatment of armor piercing projectiles. In the accompanying drawings which illustrate this application of the invention:

Fig. 1 is a horizontal section of the furnace taken on the line 1—1 of Fig. 2;

Fig. 2 is a central vertical section of the furnace taken on the line 2—2 of Fig. 1 and showing in the furnace a shell in position for the hardening treatment;

Fig. 3 is a fragmentary central vertical section of the water receptacle and the lower partition and diaphragm showing a shell in position for the drawing treatment;

Fig. 4 is a top view and Fig. 5 is a side view of the cover plate;

Fig. 6 is a top view of the central portion of the upper partition;

Fig. 7 is a side view of the lower diaphragm used in the hardening operation looking in a direction parallel to the section plane of Fig. 2;

Fig. 8 is a top view and Fig. 9 a side view of the lower diaphragm used in the drawing operation;

Fig. 10 is a central vertical section and Fig. 11 a top view of the adapter; and

Fig. 12 is a top view of the water receptacle.

The furnace is cylindrical and its side wall 10 may be composed of fire brick covered by insulating material 11 and a metal shell 12. Within the chamber formed by the side wall 10 is a checkered cylindrical wall 13 which extends from the bottom to the top of the furnace and divides it into an outer annular chamber and an inner cylindrical chamber. The outer annular chamber is divided into a plurality of heating chambers 14, 15 and 16 by horizontal separator walls or partitions 17, 18. Burners 20 are provided for heating the heating chambers. At the bottom of the inner cylindrical or treating chamber is a water receptacle 21.

The parts of the furnace thus far described were in use prior to the making of the invention herein claimed. In such furnaces a different degree of heat was produced in each of the heating chambers 14, 15 and 16. As each chamber was in free communication through the checkered wall with a portion of the treating chamber, different temperatures were produced in different parts of the treating chamber. As however, free convection of heat took place in the space between a shell suspended in the treating chamber and the checkered wall there were no clearly defined zones of different temperatures. In so far as zones of differing temperatures were produced, the location as well as the general extent of the zones were determined by the position of the partitions 17, 18 which formed a permanent part of the furnace.

The present invention aims to provide for more sharply defining the zones of different temperatures in the treating chamber and for varying the relative extent of such zones. For this purpose, one or more removable diaphragms or dividing members are pro-

vided for dividing the space between the wall of the treating chamber and the object being treated into the required number of zones, and these diaphragms are made removable so that by the use of different diaphragms suitably formed the relative extent of the several different zones may be varied without otherwise changing the furnace structure. The diaphragms are formed with a central opening of suitable size and shape so that the inner edge will extend closely about the object to be treated.

In the embodiment of the invention shown, the partitions 17, 18 are extended inwardly through the checkered or other foraminous wall 13 so that their inner portions form a part of this wall and their inner edges provide ledges extending into the treating chamber upon which are seated annular diaphragms 25, 26. The diameter of the central opening in these diaphragms is only slightly larger than that of the shell to be treated, so that while the diaphragms do not interfere with the placing of the shell in the furnace or the rotation of it during treatment, they substantially prevent convection of heat between the zones which they form in the treating chamber. Furthermore, the diaphragms may be, and in some cases are, so formed that the zones of different temperatures at the surface of the shell under treatment do not correspond with the position of the partitions 17, 18 which are fixed in the furnace. As shown in Fig. 2, the lower diaphragm 25 is formed to extend upwardly within the chamber so that its inner edge will surround the shell in a plane substantially above that of the partition 18, thereby increasing the extent of the lower heating zone and decreasing that of the next upper zone. When the diaphragm is so extended in the direction longitudinal of its axis, its longitudinally extending portion between its outer and inner edges should be of such diameter as to be spaced outward from the surface of the object to be treated and spaced inwardly from the chamber wall.

Seated upon a ledge 31 at the top of the treating chamber is a similar diaphragm 27 which has a central opening sufficiently large to permit the insertion of the shell in the treating chamber. Cover plates 28 and 29 are provided for closing this opening in the diaphragm 27 and thus substantially preventing the escape of heat from the top of the upper zone.

The diaphragms 25, 26, 27 are all removable. The top diaphragm 27 has a circumferential flange 30 which rests upon the ledge 31 at the top of the treating chamber. This ledge 31 extends outwardly from the surface of the wall of the treating chamber and the top opening 32 of the furnace is of greater diameter than the treating chamber proper so that the diaphragm 27 may be removed upwardly. The diaphragm 26 has a circumferential flange 33 which is seated upon two segmental ledges 34 formed on the inner edge of the partition 17 and extending into the treating chamber. As the outside diameter of the flange 33 is slightly less than that of the treating chamber, the diaphragm 26 may be removed upwardly. The diaphragm 25 is provided with two segmental peripheral flanges 35 which rest upon a circumferential ledge 36 formed on the inner edge of the partition 18 and extending into the treating chamber. The segmental flanges 35 are adapted to pass between the ends of the segmental ledges 34 of the partition 17 so that the diaphragm 26 may be lifted out of the chamber.

For use in place of the three diaphragms shown in Fig. 2, other diaphragms similar to these but having central openings of a different diameter may be provided to adapt the furnace to the treatment of shells of different diameter. In addition, other diaphragms may be provided which are so formed that their inner edges surround the shell at various different vertical distances from the partitions with which their outer peripheries are aligned. Thus, any desired arrangement of the position and extent of the zones of treatment of the shell may be secured without altering the extent of the combustion chambers. In Figs. 3, 8, 9 is shown a diaphragm 25′ which may be substituted for the diaphragm 25 shown in Fig. 2. The diaphragm 25′ has segmental flanges similar to the flanges 36 of the diaphragm 25, but its general shape is similar to that of the diaphragm 26 so that when it is used the upper limit of the lowest zone of treatment of the shell corresponds with the position of the partition 18 instead of being above this partition as is the case when the diaphragm 25 is used.

The diaphragms may be constructed in various ways and of various materials, it being essential, however, that they be capable of withstanding the furnace temperatures. It is desirable also that they be formed wholly or partly of insulating material to reduce heat conduction.

As shown in the drawings, the diaphragms, and the cover plates, each consists of a perforated metal frame 40 covered on both sides with layers of refractory insulating material, such as high temperature cement and fire clay, or other suitable material. The insulating material extends through the perforations in the frame 40 as well as around the edges of the frame, so that the layers of it upon opposite sides of the frame are securely bonded together.

In shell treating furnaces heretofore used it has been customary to support the shell

by suspending it. It has been found difficult to adjust the vertical position of a suspended shell so as to immerse its ogival portion in a cooling liquid to just the desired extent during the drawing operation. A part of our present invention has been to eliminate this difficulty by providing means for engaging the shell and thus accurately determining its vertical position in the furnace. In the embodiment shown in the drawings, the means for determining the vertical position of the shell comprises an adapter 44 which is located in the upper portion of the water receptacle 21.

The water receptacle 21 contains passages providing for a continuous circulation of the water contained in it, and is in general similar to the receptacles which have heretofore been used in furnaces of this kind. In the form shown in the drawings it differs from such receptacles in that three recesses 46 are formed in the portion of its upper edge which is within a flange 47. The adapter 44 has a frusto-conical body 45. It is provided at its top with three outwardly extending projections 48 which are adapted to be seated in the recesses 46 of the receptacle 21 so as to suspend the adapter in the upper portion of the receptacle as shown in Figs. 2 and 3. The inner surface of the adapter is provided with a plurality of inwardly extending upper projections 49 and a plurality of inwardly extending lower projections 50. The inner edges 51 of the projections 49 and 50 are so formed that they all engage at the same time the ogival portion of a shell lowered into the receptacle 21. The adapter thus serves to engage and support the shell during the drawing treatment with exactly the desired portion of its nose immersed in the water of the receptacle. The arrangement of the adapter is such that it does not interfere with the circulation of the water in the receptacle about the nose of the shell.

Separate adapters may be provided for each size of shell to be treated in the furnace. These adapters are all similar to the adapter 44 except for variations in the lengths of the projections 49 and 50 and the shape of the inner surfaces 51 of these projections which are made to enable them to fit the shells of different sizes.

The operation and use of the furnaces containing our improvements will be apparent to those skilled in the art from the above detailed description. It is apparent that the cover plates 28 and 29 must be removed and replaced each time a shell is removed from the furnace and a new shell introduced. The diaphragms 25, 26 and 27 may remain in place during the heating of a number of shells for hardening, each shell being lowered to the position indicated in Fig. 2 for such heating. It is desirable to remove the water receptacle 21 from the furnace during such heating.

For the drawing or tempering treatment of the shell, it is desirable to substitute a diaphragm such as the diaphragm 25′ of Figs. 3, 8 and 9 for the diaphragm 25. In order to remove the diaphragm 25, the diaphragms 26 and 27 must be first removed, and they are replaced after the diaphragm 25′ has been set in position on the ledge 36. For the drawing treatment, the shells are lowered until they are supported by the projections 49 and 50 of the adapter 44, (Fig. 3).

When a shell of a different diameter is to be treated in the furnace, the diaphragms 25 or 25′, 26 and 27 and the adapter 44 are replaced by similar parts proportioned to fit the diameter of the new shell.

The use of the furnace described is by no means limited to hardening and drawing treatment, as various other sorts of heat treatment of various articles may be carried out by means of it. Furthermore, we wish it clearly understood that our invention is by no means limited to its application to the particular type of furnace in connection with which it has been described for the invention may be incorporated in differential treatment furnaces of other types.

What is claimed is:

1. In a differential heating furnace, the combination of a treating chamber, a diaphragm extending inwardly from the wall of said chamber and having an inner edge adapted to extend close to the surface of the object to be treated, and means for supplying heat to the zones formed in said chamber by said diaphragm, whereby a desired temperature may be maintained in each zone.

2. In a differential heating furnace, the combination with a cylindrical heating chamber of an annular diaphragm extending inwardly from the wall of said chamber and having its inner edge adapted to extend closely around the object to be treated, and means for supplying heat to the zones formed in said chamber by said diaphragm, whereby a desired temperature may be maintained in each zone.

3. In a differential heating furnace, the combination of a treating chamber and a removable diaphragm having an outer edge adapted to engage the wall of said chamber, and an inner edge adapted to extend close to the object to be heated, and means for supplying heat to the zones formed in the chamber by said diaphragm, whereby a desired temperature may be maintained in each zone.

4. In a differential heating furnace, a treating chamber, a removable diaphragm in said treating chamber having an outer edge adapted to engage the wall of said treating

chamber, and an inner edge spaced longitudinally from said outer edge and adapted to extend close to the surface of the object to be treated.

5. In a differential heating furnace having a plurality of combustion chambers separated by partitions and a treating chamber having a foraminous wall separating it from said combustion chambers, the combination of a plurality of diaphragms extending inwardly from said foraminous wall opposite said partitions and each having an inner edge adapted to extend close to the surface of the object to be treated.

6. In a differential heating furnace having a treating chamber separated by a foraminous wall from combustion chambers, the combination of a plurality of partitions separating the combustion chambers and extending through the foraminous wall, and a plurality of diaphragms in said treating chamber each extending inwardly from the edge of one of said partitions and having an inner edge adapted to extend close to the surface of the object to be treated.

7. In a differential heating furnace having a central treating chamber, a cylindrical foraminous wall separating said treating chamber from an outer annular chamber, partitions dividing said annular chamber into a plurality of combustion chambers and extending through said foraminous wall, ledges on the inner edges of said partitions extending into the treating chamber, and a plurality of annular diaphragms each having at its periphery a flange adapted to be seated upon one of said ledges and its inner edge being adapted to extend closely around the object to be treated.

8. In a differential heating furnace the combination with a treating chamber and a plurality of combustion chambers, a foraminous wall separating said treating chamber from said combustion chambers, and a partition separating said combustion chambers, of a diaphragm in the treating chamber extending inward from the foraminous wall opposite said partition and having its inner edge adapted to extend close to the surface of the object to be treated at a distance from said partition so that the zones of treatment of the object differ in position and extent from the combustion chambers.

9. In a differential heating furnace the combination with a central treating chamber and an outer annular chamber, a foraminous wall separating said treating chamber from said outer chamber, a partition dividing said outer chamber into a plurality of combustion chambers, of a removable annular diaphragm in the treating chamber formed to engage the foraminous wall thereof opposite said partition and to surround the object to be treated at a distance from said partition.

10. In a differential heating furnace, the combination with a treating chamber and a plurality of combustion chambers, a foraminous wall separating said treating chamber from said combustion chambers, and a partition separating said combustion chambers, of a removable diaphragm in the treating chamber having an outer edge adapted to engage the foraminous wall opposite said partition and an inner edge adapted to extend close to the surface of the object to be treated at a distance from said partition so that the zones of treatment of the object differ in position and extent from the combustion chambers.

11. In a differential heating furnace, the combination with a central treating chamber and an outer annular chamber, a foraminous wall separating said treating chamber from said outer chamber, and a partition dividing said outer chamber into a plurality of combustion chambers, of a removable annular diaphragm in the treating chamber having a substantially cylindrical portion spaced inwardly from the wall of the treating chamber and spaced outwardly from the surface of the object to be treated, an external engaging edge at one end of said wall adapted to engage the wall of the treating chamber opposite said partition, and an internal edge at the other end of said cylindrical portion adapted to surround the object to be treated.

12. In a differential heating furnace having a plurality of combustion chambers separated by partitions and a treating chamber having a foraminous wall separating it from said combustion chambers, the combination of a plurality of removable diaphragms each having an outer edge adapted to engage said foraminous wall and an inner edge adapted to extend close to the surface of the object to be treated, and means for positioning said diaphragms in the treating chambers with their outer edges in alignment with said partitions.

13. In a differential heating furnace, a treating chamber of uniform cross-section, spaced ledges in said chamber, one of said ledges being interrupted, a zoning diaphragm having an interrupted external flange adapted to pass through said interrupted ledge and to engage the other ledge, and another zoning diaphragm having an external flange adapted to engage said interrupted ledge, so that both said diaphragms may be removed from the chamber.

14. A zoning diaphragm for use in a differential heating furnace, comprising an annular body of heat resisting material having its inner periphery formed closely to surround the object to be treated in the furnace, having its outer periphery of a form corresponding to the cross-sectional form of the treating chamber of the furnace, and

provided at its periphery with means for supporting it in the treating chamber of the furnace.

15. A zoning diaphragm for use in a differential heating furnace, comprising a perforated metal frame and refractory insulating material forming a coating on each side of said frame and extending around the edges thereof and through the perforations thereof.

16. In a differential heating furnace having a treating chamber, the combination of a plurality of annular diaphragms arranged in spaced positions in said chamber and each adapted closely to surround the object to be treated, and engaging means in the chamber adapted to engage a surface of the object and to determine its position with respect to said diaphragms.

17. In a differential heat treating furnace having a treating chamber and a liquid receptacle at the bottom thereof, an adapter removably seated in said receptacle having spaced projections located below the level of the liquid in said receptacle adapted to engage the object to be treated and to determine the extent to which said object is inserted in the receptacle while permitting a free circulation of the liquid in said receptacle about the portion of the object submerged in the liquid.

18. In a differential heat treating furnace having a treating chamber and a liquid receptacle at the bottom thereof, an adapter in said receptacle having spaced internal projections formed to engage the ogival portion of a shell inserted in the treating chamber and to determine the extent to which said shell is inserted in said receptacle while permitting a free circulation of the liquid in said receptacle about the nose of the shell.

19. In a furnace having a treating chamber, the combination of an annular diaphragm at the top of said chamber containing a central opening to permit the insertion of a shell in the chamber, and a divided cover plate seated upon said diaphragm and covering the opening therein to prevent substantially the escape of heat from the treating chamber.

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

FREDERICK C. LANGENBERG.
JOHN F. FETTERLY.

Witnesses:
JOHN C. SOLBERG,
R. H. WEBBER.