Oct. 26, 1926. 1,604,292

C. L. LEE

FURNACE

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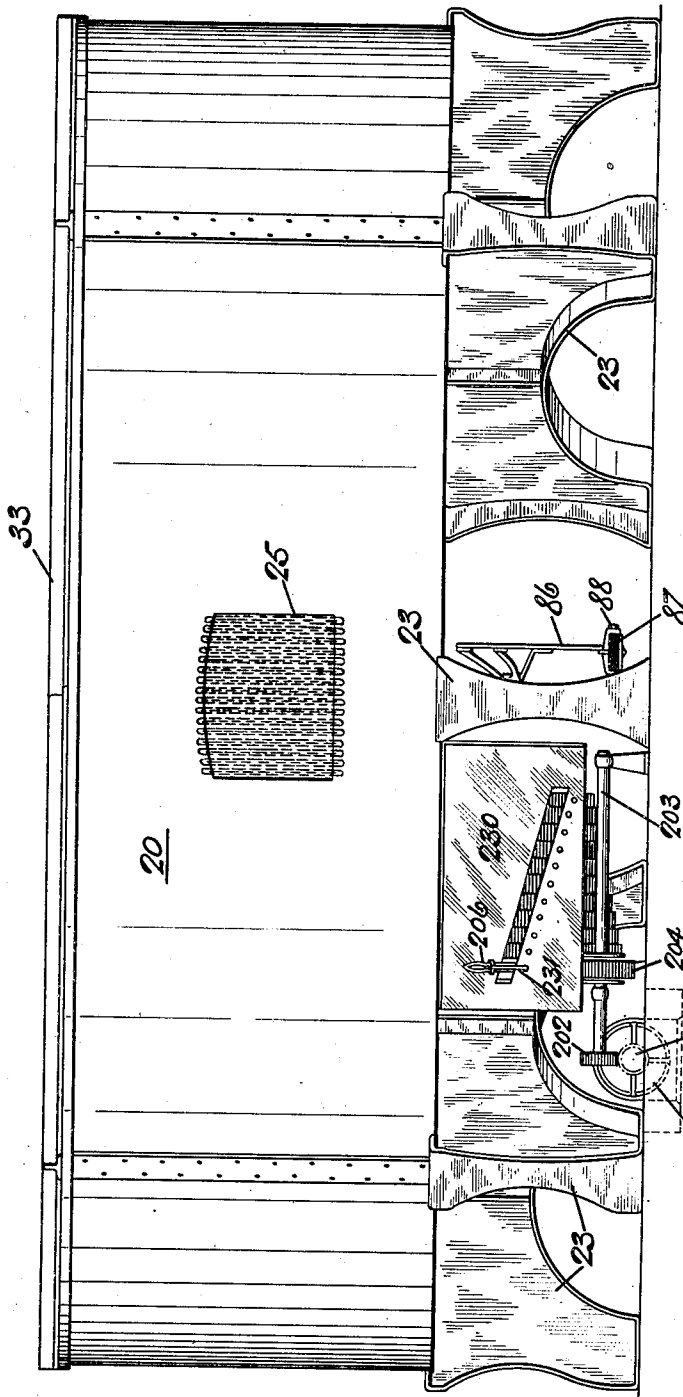


Fig. 1.

Witness.
Elmer E. Freud By
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FURNACE

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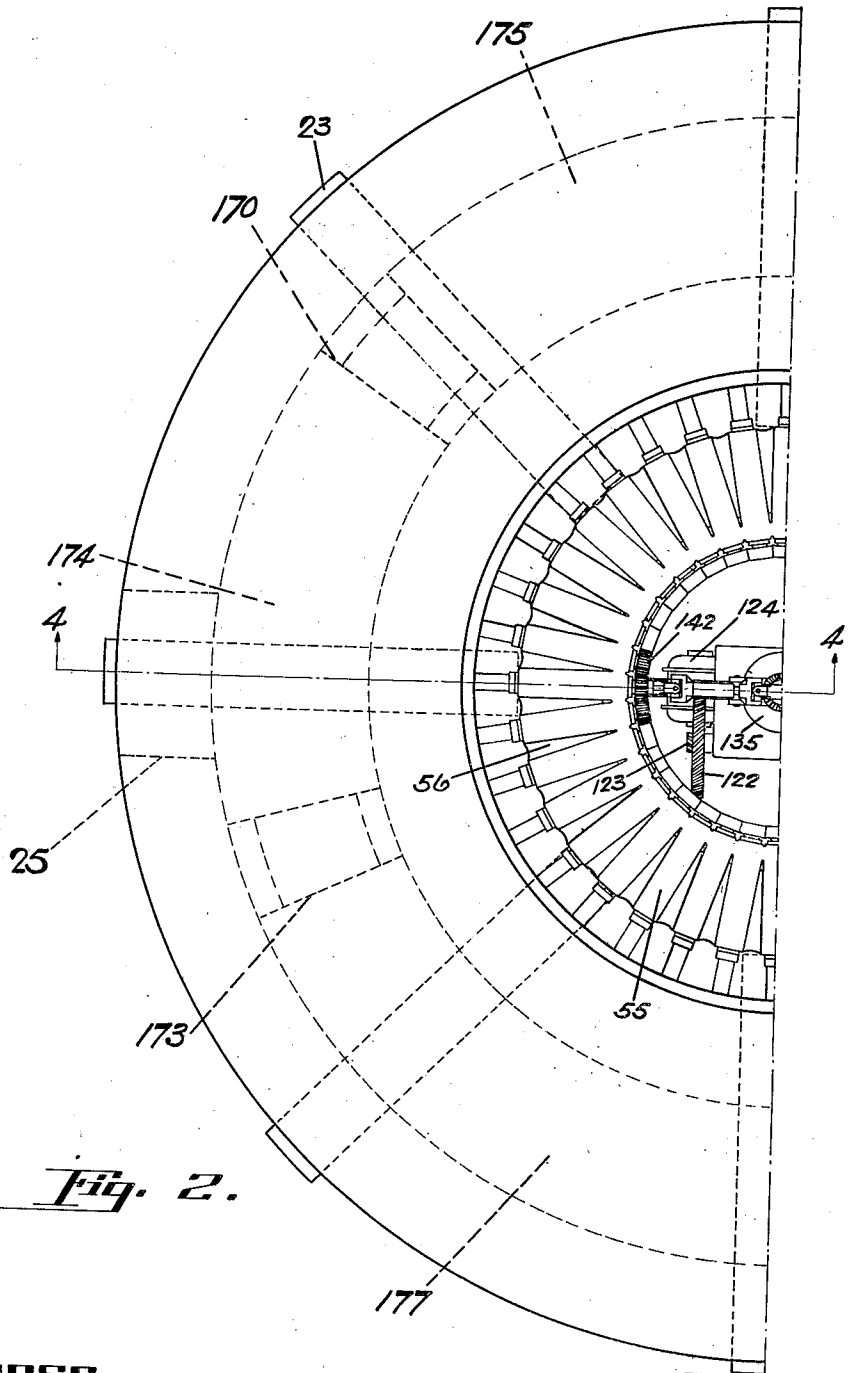


Fig. 2.

Wilness.
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FURNACE

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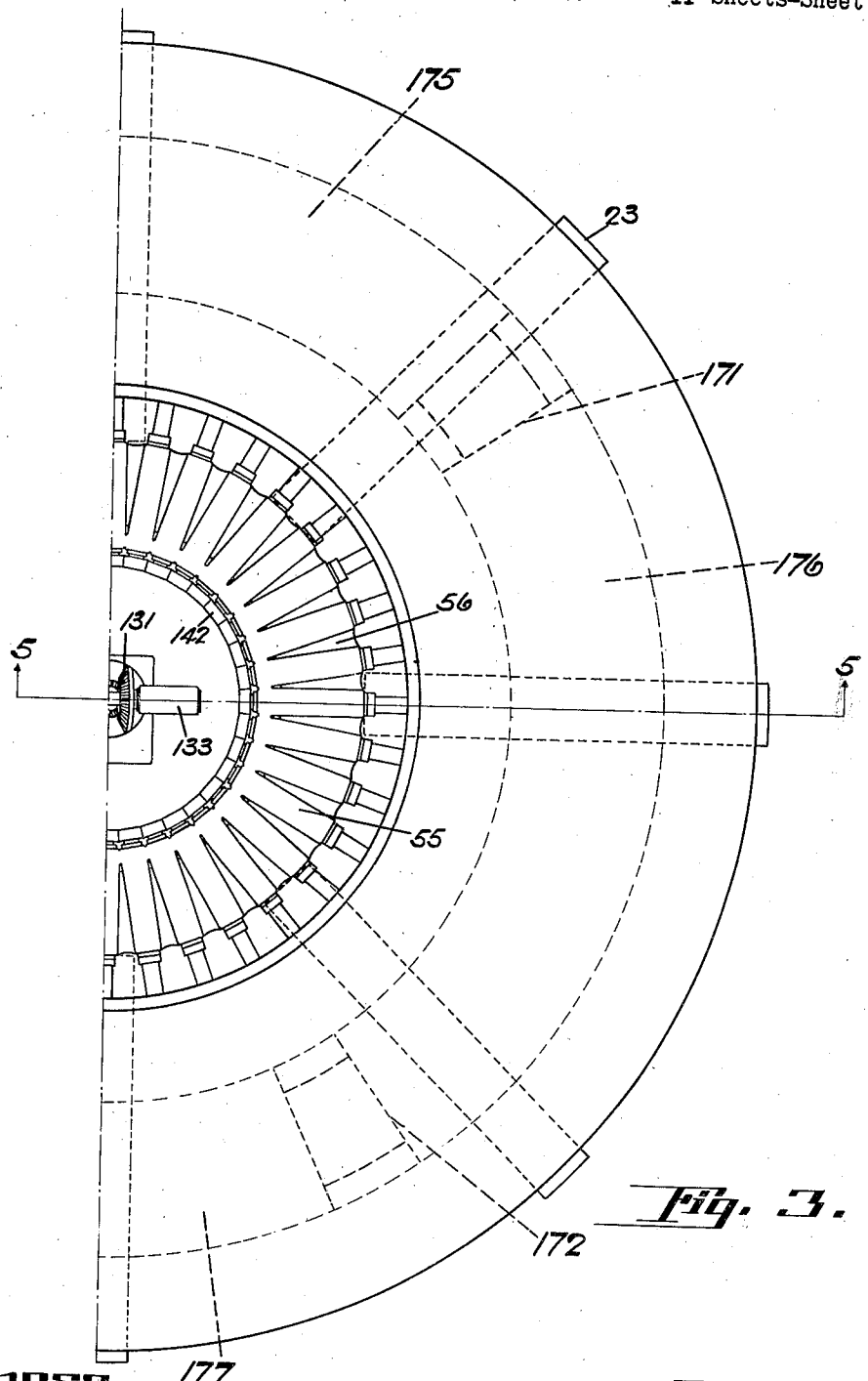


Fig. 3.

Witness.
Emyer E. Freed
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FURNACE

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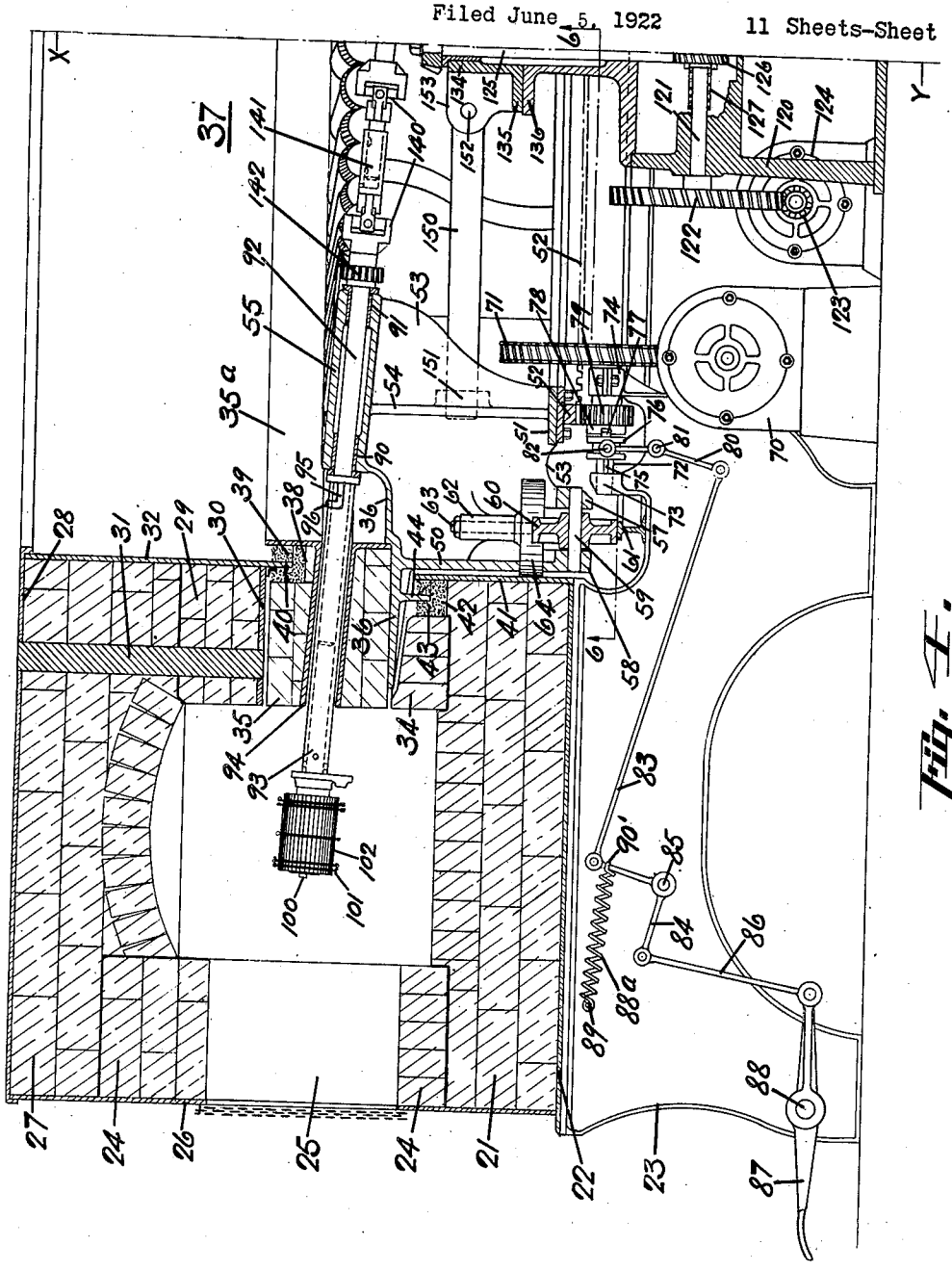


Fig. 4.

Witness.
Omer E. Freed
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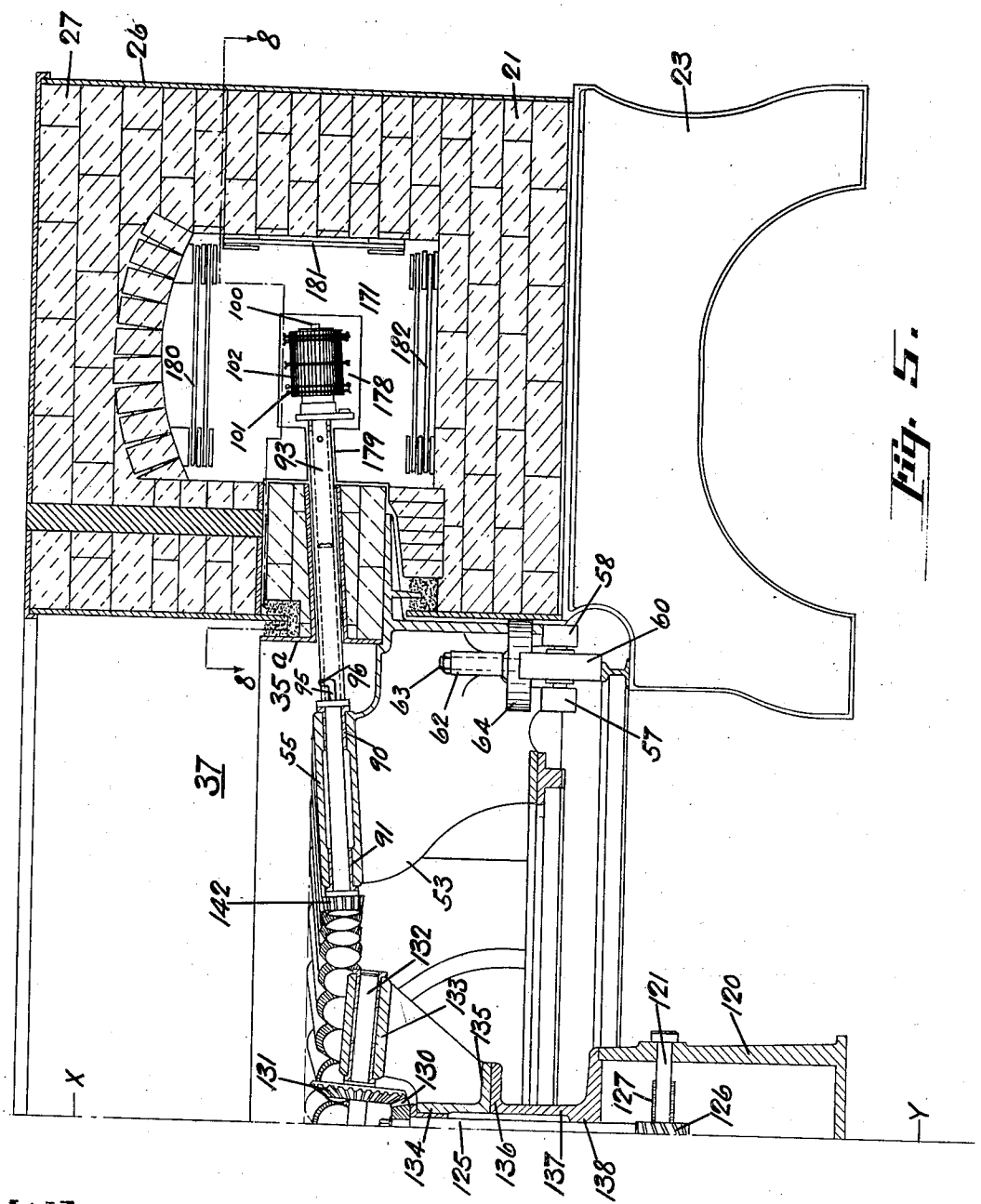


Fig. 5.

Witness.
Elmer E. Reed
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FURNACE

Filed June 5, 1922

11 Sheets-Sheet 6

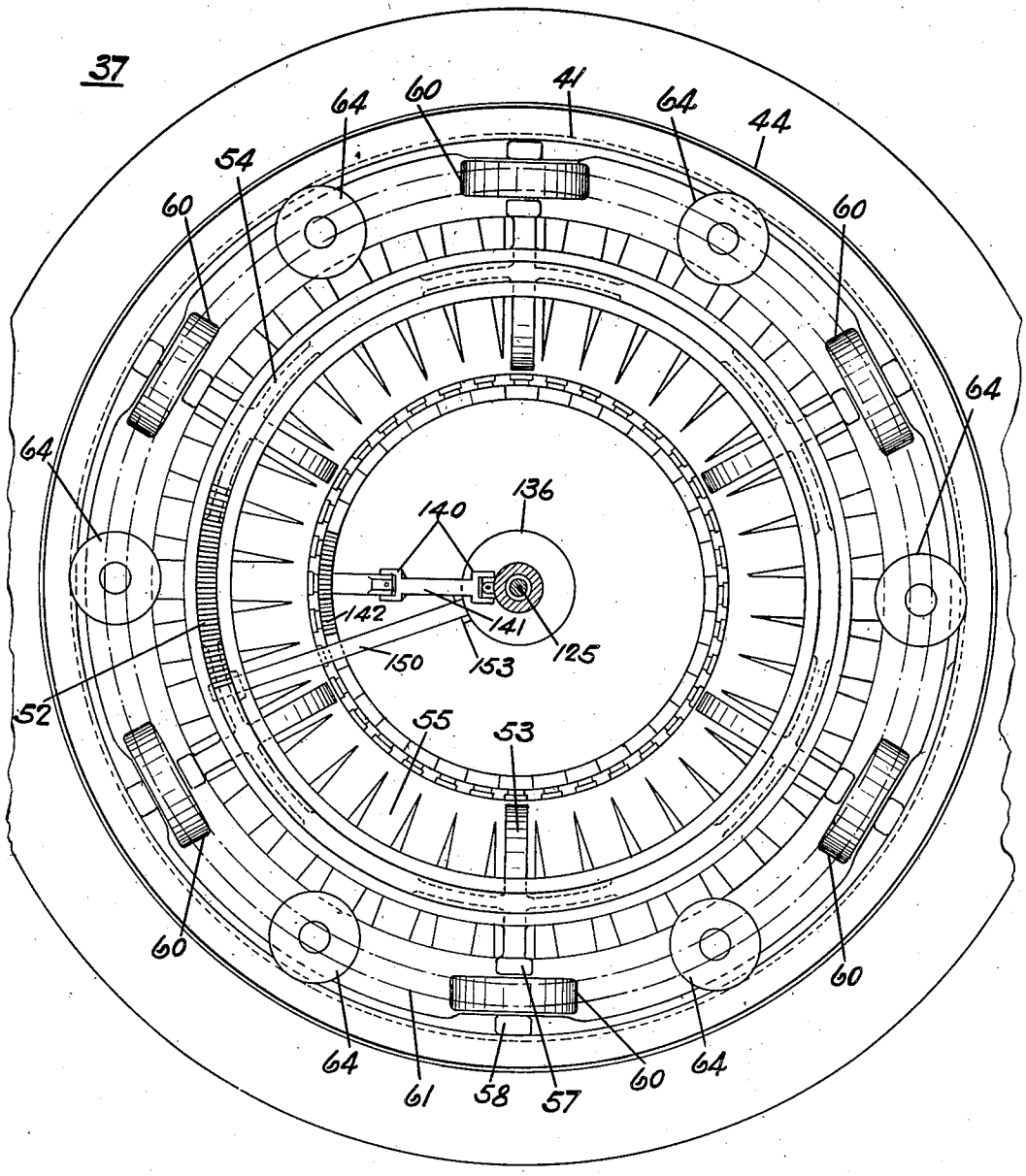


Fig. 6.

Witness.
Elmer E. Reed
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Filed June 5, 1922

11 Sheets-Sheet 7

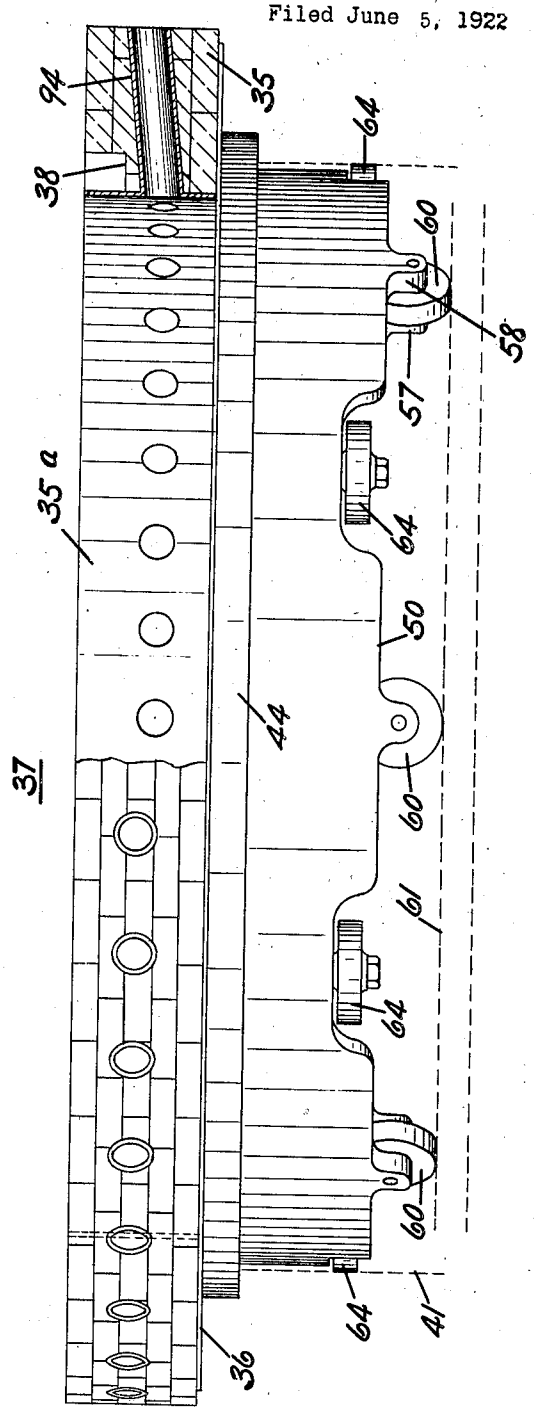


Fig. 7.

Witness.
Elmer E. Reed
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Filed June 5, 1922 11 Sheets-Sheet 8

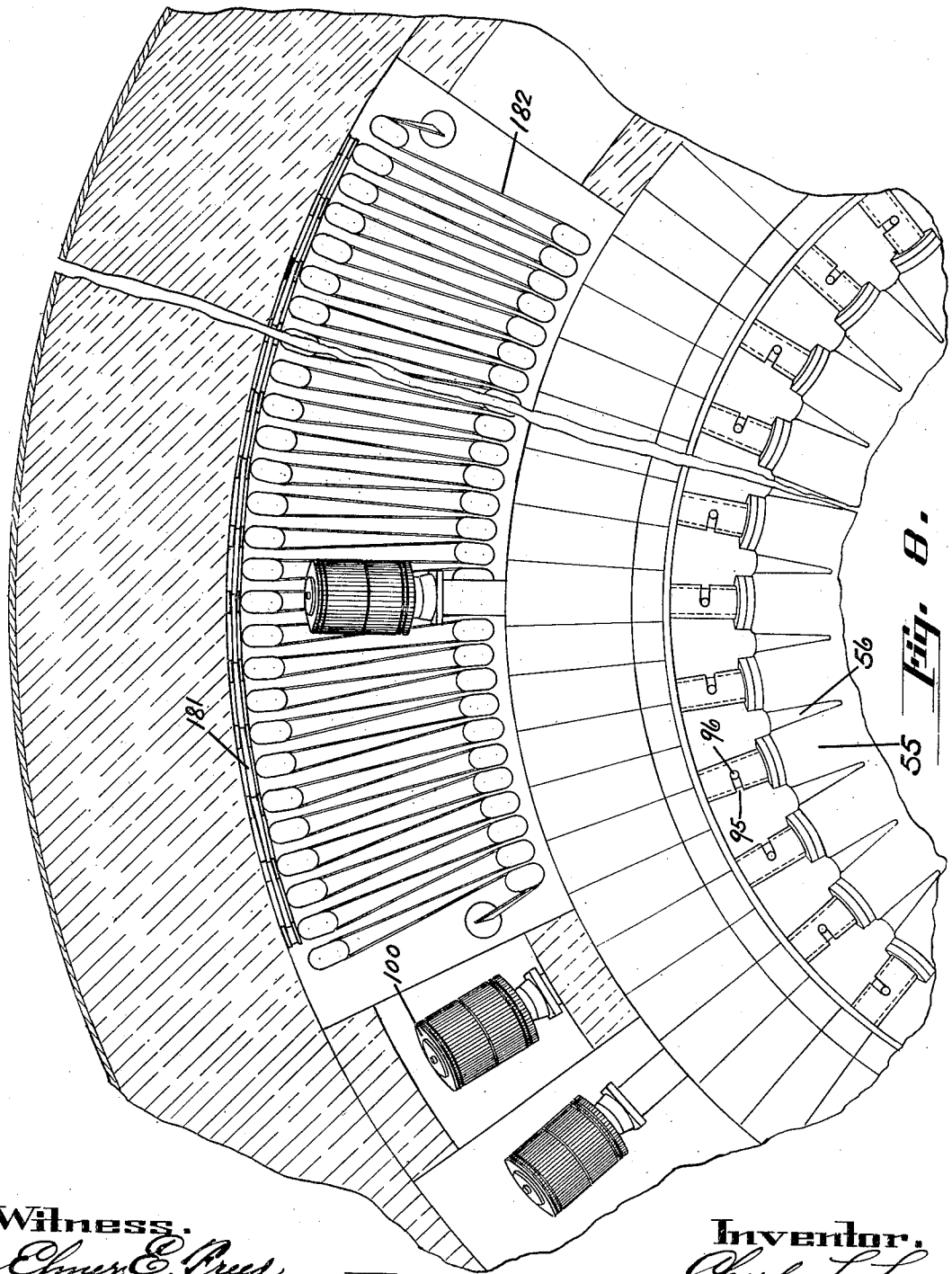


Fig. 8.

Witness.
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FURNACE

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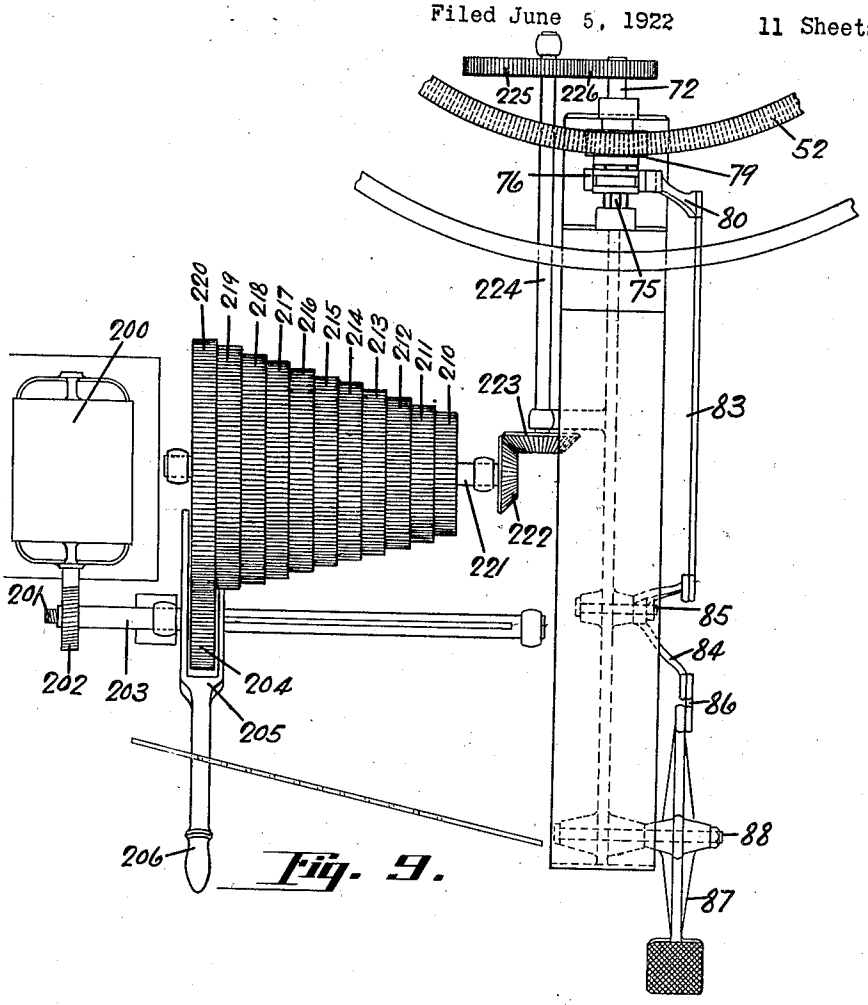


Fig. 9.

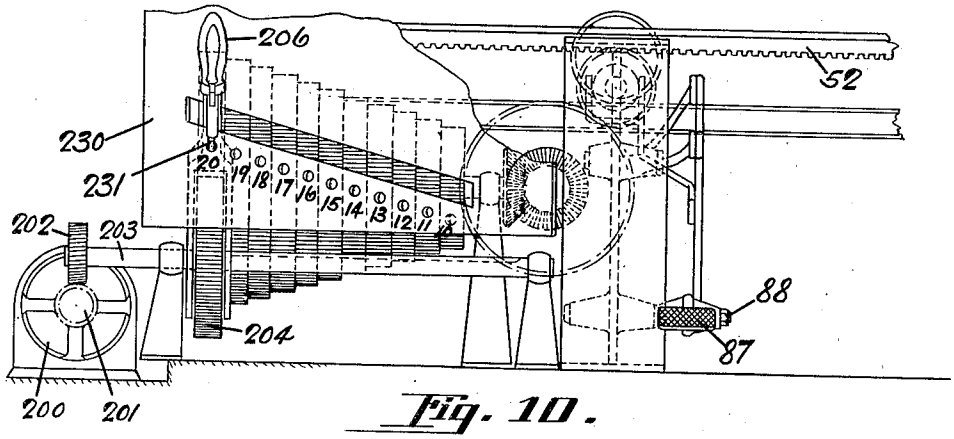


Fig. 10.

Witness,
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Oct. 26, 1926.

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FURNACE

Filed June 5, 1922

11 Sheets-Sheet 10

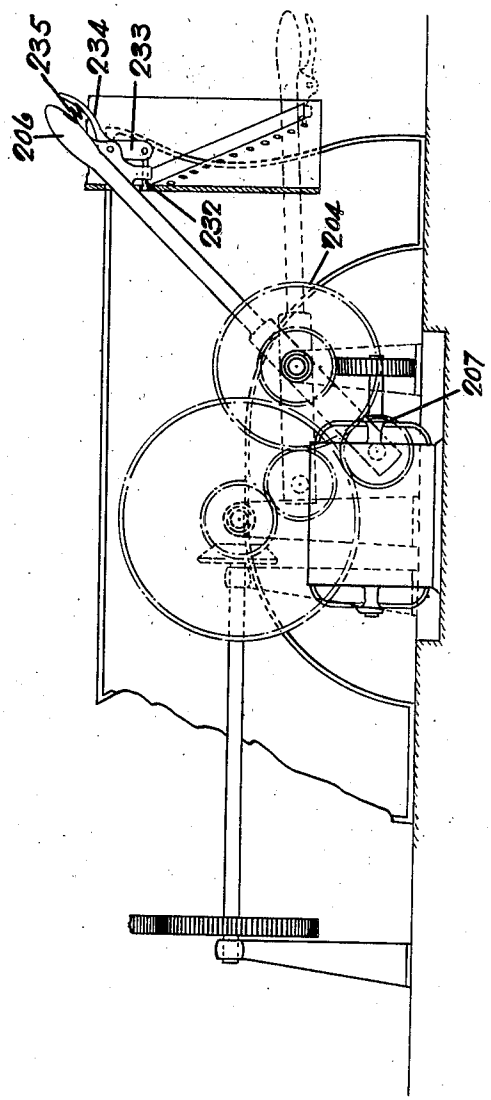


Fig. 11.

Witness.
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Oct. 26, 1926.

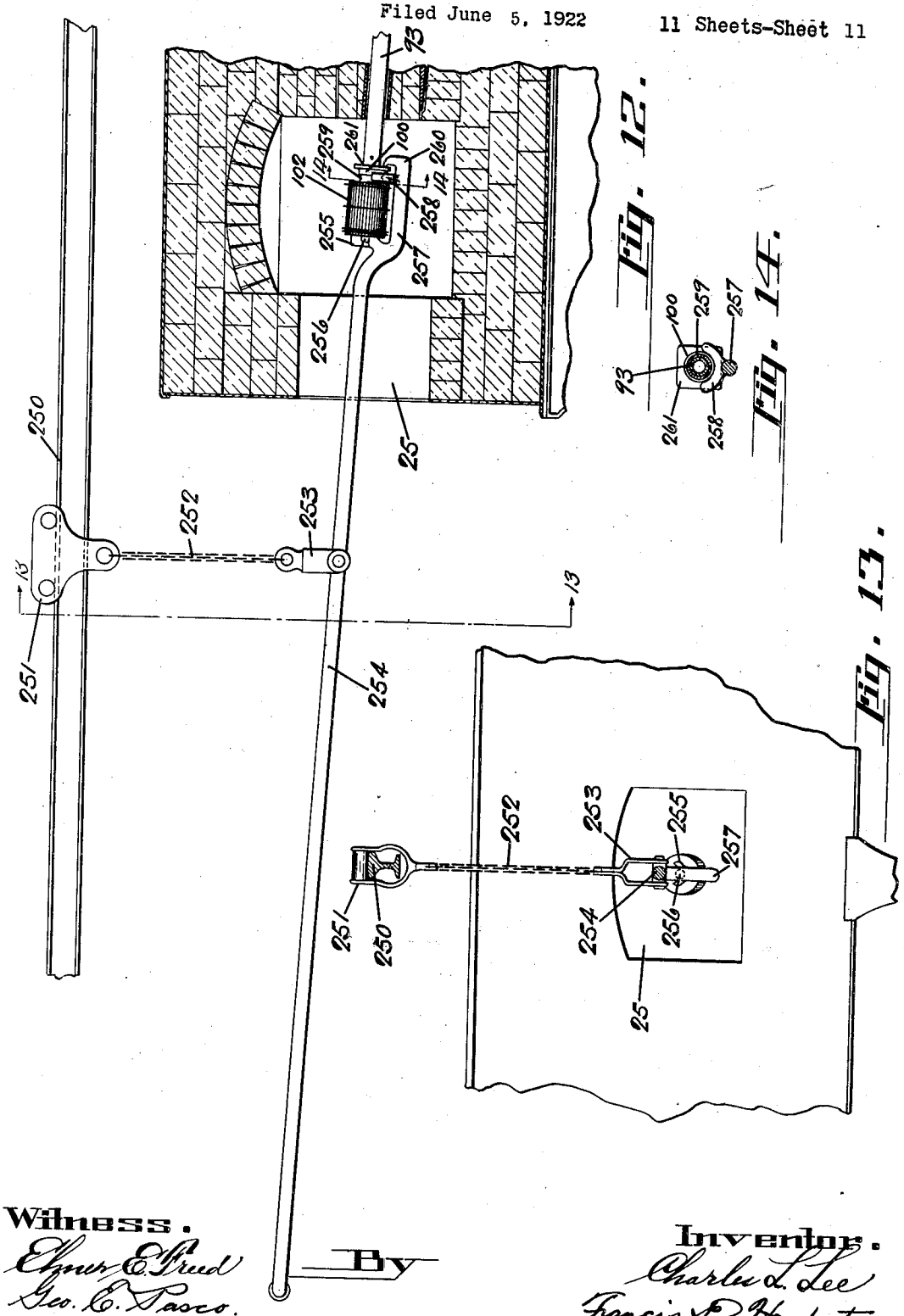
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FURNACE

Filed June 5, 1922

11 Sheets-Sheet 11



Witness.
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UNITED STATES PATENT OFFICE.

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FURNACE.

Application filed June 5, 1922. Serial No. 565,817.

This invention relates to heat treating furnaces and has among its objects the provision of a furnace wherein a body may be given continuous heat treatment at different temperatures as the body passes through the furnace. In carrying out this object there is provided a continuous furnace having zones which may be heated to different temperatures, and means are provided for conveying a plurality of bodies successively from a starting point through the zones of the furnace to a point of removal.

It is a further object to provide for movement of the body through the zones of the furnace in such a manner that the various heat treatments will be uniformly applied to the body.

A further object is to provide means for increasing or reducing the speed of the conveyor as desired. For example, if relatively large bodies are treated, then the speed of the conveyor may be reduced so that the large bodies may be brought up to the desired temperature.

A preferred embodiment of this invention comprises a continuous heat treatment furnace of the circular type wherein bodies to be treated are introduced into the furnace at an opening in the furnace wall and mechanism is provided for conveying the objects to be treated continuously through the various treatment zones of the furnace and finally bringing these bodies back to the opening where they are removed from the conveying mechanism and replaced by untreated bodies. There is provided means for moving the bodies in such a manner as to secure uniform treatment while the bodies are being conveyed through the furnace and are returned finally to the opening for removal.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein preferred forms of embodiments of the present invention are clearly shown.

In the drawings:

Fig. 1 is a front elevation of the furnace embodying the present invention.

Figs. 2 and 3 taken together constitute a plan view of the furnace shown in Fig. 1.

Figs. 4 and 5 taken together constitute a sectional view taken on the line 4—4, 5—5 of Figs. 2 and 3 respectively.

Fig. 6 is a bottom plan view of the center member and a portion of the furnace mechanism.

Fig. 7 is a side view partly in section of the part shown in Fig. 6.

Fig. 8 is a fragmentary sectional view taken on he line 8—8 of Fig. 5.

Fig. 9 is a plan view of variable speed mechanism for operating the furnace conveyor.

Fig. 10 is a front elevation thereof.

Fig. 11 is a side elevation thereof.

Fig. 12 is a side elevation of mechanism for placing cylinder assemblies within a furnace and for removing from the furnace.

Figs. 13 and 14 are sectional views taken, respectively, on the lines 13—13 and 14—14 of Fig. 12.

Referring to the drawings, the furnace, which is designated as a whole by the numeral 20, in Fig. 1, includes an annular chamber which is bounded by bottom wall 21 resting upon an annular metal table 22 supported by a plurality of legs 23, by a cylindrical outer wall 24 provided with an opening 25 and faced on the outside by a cylindrical metal sheathing 26, and by a top wall 27 which is supported by the outer wall 24 and is provided with a metal sheathing 28 which is attached to the front sheathing 26. The interior wall portion 29 is suspended from the upper wall 27, portion 29 resting upon a shelf 30 which is tied by means of a plurality of bars 31 to the upper wall covering 28, this covering 28 assisting in transmitting the load carried by the shelf over to the front wall 24 and the metal sheathing 26. A metal sheathing 32 covers the outside of the interior wall 29, and top wall 27. This sheathing 32 is supported at its upper end by the top cover 28 and supports adjacent its lower end the shelf 30. Bracing members 33 shown in Fig. 1 are used to assist in transmitting the load of the top wall 27 and interior wall por-

tion 29 over to the outer wall 24. These bracing members 33 are ordinary I-beams placed radially from a common connecting means located over the center of the furnace annulus and are secured to the uprights extending from legs 23. The legs 23, uprights, and members 33 form a supporting framework. The bottom wall 21 supports an annular interior wall portion 34. The annular gap between the interior wall portions 29 and 34 is substantially occupied by an annular wall portion 35 which is supported for rotation upon the annular shelf portion 36 of a rotatable center member 37. This rotatable wall 35 is sheathed by an annular sheet metal member 35ª from which the upper portion of wall 35 is spaced to form an annular trough 38 which is filled with sand or other loose material 39 into which the lower end 40 of the wall 32 may extend. The bottom wall 21 is covered by a sheathing of sheet metal 41 which is spaced from the wall portion 34 to provide an annular pocket 42 which is filled with sand 43 into which projects an annular flange 44 depending from the shelf 36. The sand pockets or grooves 38 and 43 cooperate with the portions 40 and 44, which portions provide seals between the stationary and movable wall members thereby assisting to retain the heat within the furnace while the movable wall of the furnace is rotated.

The center member 37 includes an annular flange 50 which supports the shelf 36, this flange being located substantially concentric to the wall sheathing 41. Member 37 includes an annular pad 51 to which is bolted an annular rack or crown gear 52. The pad 51, the flange 50 and the shelf 36 are connected by a plurality of webs 53 which are braced by ribs 54, and the shelf 36 merges into another annular portion of the center member 37 which includes a plurality of bearing frames 55 connected by webs 56. These bearing frames 55 are all radially disposed with respect to the axis of rotation of the center member 37, this axis being represented by the line XY in Figs. 4 and 5. The webs 53 will tie the bearings frames 55 down to the annular crown gear pad 51. The webs 53 and the flange 50 are provided with lugs 57 and 58 respectively which support trunnion shaft 59 upon which a roller 60 is rotatably mounted. There are preferably six of these rollers 60 which rest upon a circular track 61 supported by the legs 23, the weight of the center member 37 being transmitted through the roller 60 to the track 61 into the legs 23. The webs 53 are provided with a plurality of bearing portions 62, each supporting a shaft 63 carrying a guide wheel 64 adapted to bear against the sheathing 41. In this manner the center member 37 is maintained concentric with respect to the sheathing wall 41 during the rotation of the center member.

An electric motor 70 is connected by means of suitable gearing not shown with a worm gear 71 connected with a shaft 72 journalled upon bearings 73 and 74 provided on one of the legs 23 as shown in Fig. 4. The shaft 72 is splined at 75 to receive a grooved collar 76 having sliding driving connection with said shaft 72 and provided with a clutch member 77 adapted to engage with complementary clutch member 78 carried by a gear 79 which meshes with the crown gear 52. A bell crank lever 80 which is pivoted at 81 upon the leg 23 is provided with a fork 82 for engaging the groove collar 76, and lever 80 is connected by link 83 with a bell crank lever 84 pivoted at 85 upon leg 23, lever 84 being connected by link 86 with foot lever 87 pivoted at 88. These clutch members 77 and 78 are maintained in engagement by virtue of a spring 88ª fixed at one end 89 upon the leg 23 and connected at the other end 90' with the lever 84. The speed of the motor is preferably controlled by means of a suitable rheostat or controller box and hence the speed of the rotation of center member 37 may be controlled as desired. In case it becomes necessary to stop the center member 37 without waiting for the motor to come to rest after being deenergized, the foot treadle 87 is pressed down causing the collar 76 to be moved to the left as viewed in Fig. 4, thereby disconnecting the gear 79 from the shaft 72 allowing the motor to run free while the center member 37 is stationary. If an electric switch alone were relied upon to stop rotation of the center member 37 this member would not stop immediately after the switch were open because the motor would continue to rotate through its own inertia. As will be explained later, the speed of rotation of the center member 37 is relatively slow and friction of its rollers and gearing is relatively great so that the center member 37 will stop relatively soon after the treadle 87 is pressed to disconnect the center member drive as explained.

Each of the bearing frames 55 carry bearings 90 and 91 within which is journalled a shaft 92 which supports for rotation a rod or tube 93 which extends through a tube 94 into the furnace 20. The tube 94 extends through the movable wall 35 as shown in Figs. 4 and 5. The tube 93 is detachably secured to the shaft 92 by means of a bayonet slot and pin connection shown at 95, 96 in Fig. 4. The inner end of rod 93 carries the body 100 to be treated. This body may be anything which is capable of being treated within a furnace of this type, but by way of example the body 100 is an engine cylinder having copper cooling fins

to be attached to the iron or steel walls of the cylinder by means of a process explained and described in the copending application of Charles F. Kettering, Serial No. 514,014, filed November 9, 1921.

As an exact nature of the process for attaching copper fins to engine cylinders is not of itself a part of the present invention, it is deemed unnecessary to describe the process in detail. In order that the operation of the furnace may be more clearly understood the process for preparing a cast iron engine cylinder for heat treatment is preferably as follows: After the outer surface of the cylinder has been cleaned and machined to present a clean surface which may be copper plated to protect it from rust, this surface is treated with flux known as thin flux which may be a combination of borax and boracic acid. A thin strip of brazing material is wrapped about the cylinder and then the fin material which is formed in a continuous strip of connected loops is wrapped about the brazing material and the whole assembly is secured by means of wires 101, the finning material being indicated by numeral 102. Before wrapping the finning material about the brazing material parts of the finning material which contact with the brazing material are coated with the thin flux. After the assembly of brazing material, fin material and iron cylinder has been completed it is dipped into a thick flux to protect the finning material from disintegration during the heat treating process. As this process requires that the cylinders be rotated while translated bodily through the furnace, the mechanism for rotating the spindles 92 will now be described.

Centrally disposed within the furnace 20 is a frame 120 which supports a shaft 121 carrying a gear 122 which meshes with a gear 123 carried upon the shaft of an electric motor 124. Motion of the motor 124 is transmitted to a shaft 125, through this gearing and through a gear 126 driven by shaft 121 and meshing with gear 127 carried by shaft 125. The axis of shaft 125 is coincident with the furnace axis XY, and the upper end of shaft 125 is connected with a beveled gear 130 which meshes with a beveled gear 131 carried by a shaft 132 which is supported by a frame 133 which provides at 134 a bearing for the upper end of shaft 125. Frame 133 includes an annular flange 135 which rests upon an annular pad 136 supported by frame 137 which is in turn supported by the frame 120. Frame 137 provides a bearing at 138 for the shaft 125.

The shaft 132 is connected by universal joint members 140 and 141 and intermediate shaft 142 with one of the shafts 92. Each of the shafts 92 is provided with a beveled gear 142, each beveled gear 142 meshing with the corresponding gears adjacent to them. Therefore, since one of the shafts 92 is driven by the motor 124 through the gearing and shafts described, all of the shafts 92 will be rotated. Adjacent shafts are rotated in opposite directions, however. The direction of rotation of the body to be treated is immaterial.

As the center member 37 rotates it is desired that the mechanism connecting one of the shafts 92 with the beveled gear 130 shall rotate in unison therewith. In order that the shaft 132 may be kept as near as possible in alignment with shaft 92 to which it is directly connected, a bar 150 is employed for transmitting motion from the center member 37 to the flange 133. This member engages at 151 one of the webs 53, and at 152 to a lug 153 included in the frame 133. It is understood that the speed of the motor 124 may be likewise controlled so as to give the body 100 the desired rate of rotation about its own axis. The operation of the furnace mechanism will be readily understood. The motors 70 and 124 are actuated at the desired rate to give the desired motion to the center member 37 and to the shafts 92. As each of the tubes 93 carried by the spindles 92 come opposite to the opening 25 an operator will place a cylinder 100 to be treated upon the tube. As the cylinders progress through the furnace chamber other cylinders are consecutively introduced into the furnace and placed on similar tubes 93. All of the tubes will be filled by the time the first cylinder to be placed in the furnace for treatment will have received the full course of heat treatment and will have returned again to the opening 25 for removal.

Referring to Figs. 2 and 3 the annular furnace chamber is divided by four partitions 170, 171, 172 and 173 into chambers 174, 175, 176 and 177. As shown in Fig. 5 each partition is provided with an opening 178 to provide for the workpiece passing therethrough and is divided at one side of the opening by means of a narrow opening 179 provided for the passage of the tubes 93. These openings 178 and 179 conform substantially to the outline of the bodies 100 which pass through them to as great a degree as is practical so that since these bodies are relatively close together these openings will be closed at all times more or less as these parts pass through them. In other words, as the center member 37 rotates and the cylinders 100 are carried through the opening 178 these cylinders are located so close together and the partitions are of such a thickness that the partition is substantially occupied by cylinders which act as doors partially closing the opening 178. Therefore although the partitions are provided with apertures permitting bodies 100 to pass

through them, these bodies will in turn act as doors for assisting in dividing off the different furnace chambers or zones so that where it is desired to retain a certain quantity of heat within a certain furnace chamber, this heat will not be transmitted readily to the other chambers. In the particular furnace described it is desired that the chamber 174 shall be employed merely for the introduction of cylinders into the furnace, and, to serve as a cooling chamber for the heated bodies as these come out of the heated parts of the furnace. The chambers 175, 176 and 177 are heated preferably to different degrees of temperature by means of any suitable heating apparatus. One form of heating apparatus, shown in Figs. 5 and 8, embodies a series of electrical heating elements 180, 181 and 182. As the exact nature, construction and location of these heating elements do not constitute a part of the invention no further description is necessary except to state that these elements are adapted to translate electrical energy into heat energy with relatively slow deterioration. For certain kinds of treatment electrical heating means may be preferable on account of lending itself easily to exact control and regulation of temperature. It is easily understood that the temperature of the furnace may be regulated by means of pyrometers of the resistance type which are so connected up with suitable rheostats in the circuits leading to the heating elements as to regulate the quantity of current passing through these elements in accordance with temperature changes so that the desired furnace temperature may be maintained constant.

In order to give one example of how the furnace of this type may be employed, its use in connection with heat treating a cylinder in accordance with the process described in the copending application of Charles F. Kettering referred to, will be described. Referring to Figs. 2 and 3, the direction of rotation of the conveyor is counterclockwise. The cylinder assemblies 100 are introduced into the furnace one at a time through the door 25 and are placed on the tubes 93 as shown in Fig. 4 as these tubes are conveyed to a position opposite the door. The assemblies pass through the partition 173 and into the chamber or zone 177 wherein a temperature of for example 1650° Fahr. is maintained, then into chamber 176 wherein the temperature is for example 1700° Fahr., and then into the chamber 175 of maximum temperature wherein the temperature is maintained at approximately 1750° Fahr., this temperature having been found to be the most satisfactory for effecting the union between the copper fins and cylinder shell as explained in the copending application referred to. At the temperature of 1750° the brazing material melts, effects an alloying or intermingling with the copper fins and the iron of the cylinder shell, while the copper and iron portions are still in a solid condition. The assemblies return to the chamber 174 which is at a much lower temperature, and in this chamber the brazing material solidifies and the bonding operation is completed. During the progress of the cylinder assemblies through the furnace, they are rotated about their own axes at such a rate that the heating of the assemblies will be uniform and so that the brazing material, when molten, will be uniformly distributed. The rate of rotation which has been found satisfactory is about 20 R. P. M.

The rate of travel of the furnace conveyor depends on the size of the bodies to be treated and the temperature to which the bodies should attain before the treatment is completed. Where the maximum temperature is 1750° Fahr. and 36 cylinder assemblies are treated at the same time, the conveyor should make one revolution in about 16 minutes, where the cylinder bore is 2 13/16 inches and adapted for a piston stroke of 4⅛ inches. Smaller cylinder assemblies will of course require less time, and larger assemblies more time on account of the mass of cylinder metal to be brought up to bonding temperature.

In the bonding process described, the assemblies first enter a heating chamber at relatively high temperature so that the masses of cylinder shell material as well as the fins will be brought up to nearly the bonding temperature as quickly as possible, and in the second heating chamber the temperature is slightly increased. The reason for not subjecting the assemblies to bonding temperature immediately is to keep the flux coating protecting the fins away from the high bonding temperature as long as possible to prevent excessive decomposition of the fin material by the flux.

The partitions 170 to 173 prevent free circulation of air through the furnace and help to limit the amount of heat which can be carried from the hotter chambers to the cooler ones.

When the size of the cylinder assemblies is large enough to permit it, the partition 172 can be omitted and the chambers 177 and 176 can be combined in one and heated at or nearly to the temperature of the hottest chamber 175. This may be necessary in order to bring the relative large mass of material up to bonding temperature within a time consistent with economical use of the furnace heating means. The amount of decomposition of the fin material by the flux may be increased, but it may not be excessive in cases where the original thickness of the fin material is sufficient to permit of such heat treatment.

It is preferable to provide the bottom and top walls of the heated chambers with resistance ribbons 180 and 182 of sufficient size to provide for the heating of the cylinder size walls in the desired time. In cases when the cylinder end wall or head is thicker than the side wall, it is desirable to use the ribbons 181 in order more nearly to equalize the heating of the cylinder shell. The ribbons 181 should carry less current then the ribbons 180 and 182.

The speed of the furnace conveyor may be varied by varying the speed of the motor 70, in any suitable manner known to the art. If it is desired to use a constant speed motor, for example an A. C. induction motor, a form of change speed gearing such as shown in Figs. 9, 10 and 11 may be used to connect the motor with the pinion 79. Motor 200 drives gear 201 meshing with gear 202 on shaft 203 to which is splined a slidable gear 204 moved by a yoke 205 having a handle 206. Yoke 205 carries swinging gear 207 meshing with gear 204, and gear 207 is adapted to mesh with each of a plurality of gears 210 to 220 inclusive carried on shaft 221. Gears 222 and 223 connect shaft 221 with shaft 224 and gears 225 and 226 connect shaft 224 with shaft 72. The gearing may be so related that when gear 220 is connected as shown, the furnace conveyor will rotate once in 20 minutes, and when gear 210 is connected the rotation will be once in 10 minutes. Within this range there are 9 different speeds so that by selecting the proper gear, the speed may be varied from 10 to 20 minutes in one minute increments. An index plate 230 is provided with a series of holes 231 numbered 10 to 20 inclusive to indicate the position in which the handle 206 should be locked. Handle 206 carries a slidable plunger 232 adapted to enter any of the holes 231, said plunger being pivoted on lever 233 having a grip handle 234 yieldingly urged by spring 235 away from handle 206.

The great advantage of the present invention is the economical heat treatment of bodies in large quantities. After the furnace has once been brought up to temperature, it is only necessary to supply the exterior radiation losses, and the quantity of heat absorbed by the bodies treated. The inserting and removal of the bodies does not require the furnace to be opened up and furnace parts to be cooled off. Very little time is required to remove treated bodies and substitute untreated ones, and this operation takes place while the conveyor is in motion, hence the conveyor need not be stopped and started each time the change of cylinders is made. When thirty six cylinders are treated at a time and the conveyor rotates one in 18 minutes, two cylinders will be completed each minute. This example gives one an idea of the great value of the present invention to the quantity production of treated bodies, such as bonded cylinder assemblies.

In Figs. 12, 13 and 14 mechanism is shown for placing a cylinder assembly within the furnace for treatment and for removing the cylinder from the furnace when completed. An overhead rail 250 supports for movement thereon a hanger 251 connected by a chain 252 with a yoke 253 pivotally suspending a lever 254 having a fork 255 for supporting a projection 256 extending from the head of cylinder 100. This fork 255 is connected by portion 257, extending below the cylinder fins 102 and spaced therefrom, with a fork 258 which supports the shell of cylinder 100, and with a finger 260 which may engage the base 261 of the cylinder 100.

These parts of the lever 254 provide a cradle for the cylinder. The fork 255 is used to push against the head of the cylinder when placing the latter on the tube 93, and the finger 260 is used to push against the base 261 when removing the cylinder from the tube 93. By the use of such travelling tongs the operator is protected from the heat of the furnace and the hot cylinders.

While, electrical heating means are disclosed, it is to be understood that other heating devices, such as gas or liquid fuel burners, may be substituted if desired.

Further, while the forms of mechanisms herein shown and described, constitute preferred forms of embodiments of the present invention, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What I claim is as follows:

1. In a continuous furnace, the combination with a heating up chamber and a cooling off chamber arranged to form at least a part of an annulus; of means for conveying a plurality of bodies successively and continuously through the heating chamber and through the cooling chamber.

2. A continuous furnace comprising in combination, a heating chamber and a cooling-off chamber; translating means including arms extending into the furnace for supporting bodies to be treated and conveying said bodies through the heating and cooling-off chambers; and means for rotating the said arms so as to rotate axially the bodies while they are being conveyed through the heating and cooling-off chambers.

3. In a continuous furnace, the combination with a plurality of heating chambers arranged to form at least a part of an annulus; of means for conveying a plurality of bodies successively and continuously through the heating chambers; and means for moving the bodies relatively to the conveying means in order that the bodies may be uniformly treated

4. In a continuous furnace, the combination with a plurality of heating chambers arranged to form at least a part of an annulus; of means for conveying a plurality of bodies successively and continuously through the heating chambers; and means for moving the bodies relatively to the conveying means in order that the bodies may be uniformly treated.

5. In a circular continuous furnace, the combination with a stationary annular chamber having a heating zone; of means for conveying a plurality of bodies successively and continuously through said chamber; and means for moving the bodies relatively to the conveying means in order that the bodies may be uniformly heated.

6. In a circular continuous furnace, the combination with a stationary annular chamber having a heating zone and a cooling zone; of means for conveying a plurality of bodies successively and continuously through said chamber; and means for moving the bodies relatively to the conveying means in order that the bodies may be uniformly heated.

7. In a circular continuous furnace, the combination with an annular chamber having a cylindrical movable wall; of a plurality of body supporting members extending through said movable wall; and means for moving said movable wall and supporting members concentrically to said annular chamber.

8. In a circular continuous furnace, the combination with an annular chamber having a movable cylindrical wall; of a plurality of body supporting members extending through said movable wall; means for moving said movable wall and supporting members concentrically to said annular chamber; and means for rotating each supporting member relatively to the movable wall.

9. In a circular continuous furnace, the combination with an annular chamber mounted with its axis vertical and having a movable cylindrical inner wall; of a plurality of body supporting members extending through said movable wall; a center member mounted for rotation about the axis of said chamber and supporting said movable wall and said supporting members; and means for rotating said center member.

10. In a circular continuous furnace, the combination with an annular chamber mounted with its axis vertical and having a movable cylindrical inner wall; of a plurality of body supporting members extending through said movable wall; a center member mounted for rotation about the axis of said chamber and supporting said movable wall and said suppporting members; and means for rotating each supporting member relatively to the movable wall.

11. In a circular continuous furnace, the combination with an annular chamber mounted with its axis vertical and having a movable cylindrical inner wall; of a plurality of body supporting members extending through said movable wall; a center member mounted for rotation about the axis of said chamber and supporting said movable wall and said supporting members; a circular track upon which the center member is mounted for movement; means for moving said center member about said track; and means for guiding said center member in order to maintain said center member concentric to said annular chamber.

12. In a circular continuous furnace, the combination with an annular chamber having a heating zone; of means within the annulus for conveying a plurality of bodies successively and continuously through said chamber; and a plurality of body supporting members detachably mounted upon said conveying means.

13. In a circular continuous furnace, the combination with an annular chamber having a heating zone; of means for conveying a plurality of bodies successively and continuously through said chamber; a plurality of shafts rotatably mounted upon said conveying means; a body supporting member mounted upon each shaft and detachable therefrom; and means for rotating said shafts about their own axes while the conveying means is in motion.

14. In a circular continuous furnace, the combination with an annular chamber mounted with its axis vertical and having a movable cylindrical inner wall, a center member mounted for rotation about the axis of said chamber and supporting said movable wall; a plurality of shafts rotatably mounted upon said center member; a body supporting tube mounted upon each shaft and detachable therefrom; means for rotating said center member; and means for rotating said shafts.

15. In a circular furnace, the combination with a furnace chamber divided by partitions into a plurality of heat treatment zones, and a cooling-off zone, each heat-treatment zone having a heating device, said partitions being provided with openings shaped to permit the passage through the partitions of bodies to be treated; and radial means extending into the furnace chamber for conveying a plurality of bodies successively and continuously through said furnace chamber, the thickness of said partitions and the spacing of the bodies when mounted upon the conveying means being such that the partition openings are at least partially closed by a body whereby to decrease circulation from one zone to another.

16. In a continuous furnace for treating

bodies having relatively thin sidewalls and a relatively thick endwall, the combination with a furnace chamber having heating elements disposed on opposite sides of the body; and heating elements disposed adjacent the endwall of the body; means for conveying the bodies through the furnace chamber; and means for moving said bodies relative to said conveying means in order that the bodies may be uniformly heated.

In testimony whereof I hereto affix my signature.

CHARLES L. LEE.