

July 10, 1956

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2,754,104

METHOD AND APPARATUS FOR HEATING INGOTS

Filed Oct. 5, 1951

2 Sheets-Sheet 1

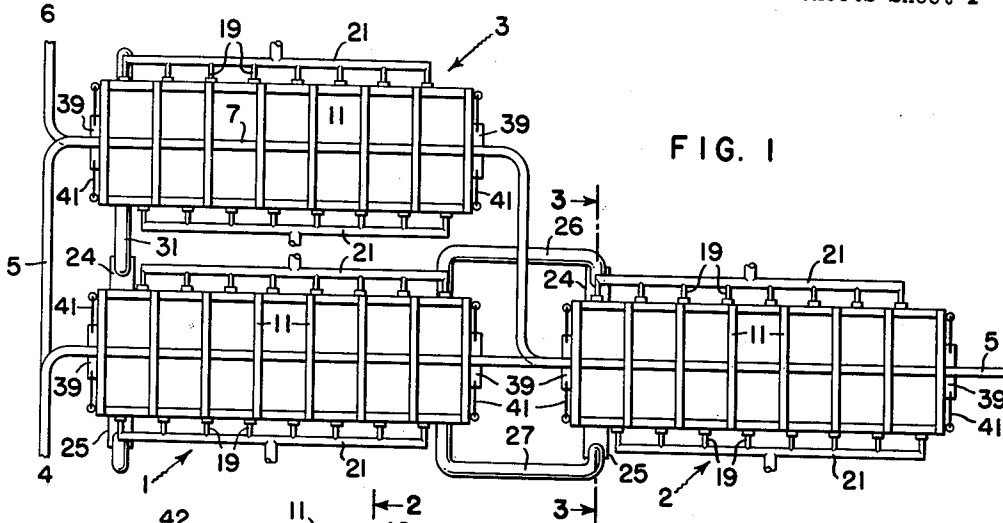


FIG. 1

FIG. 3

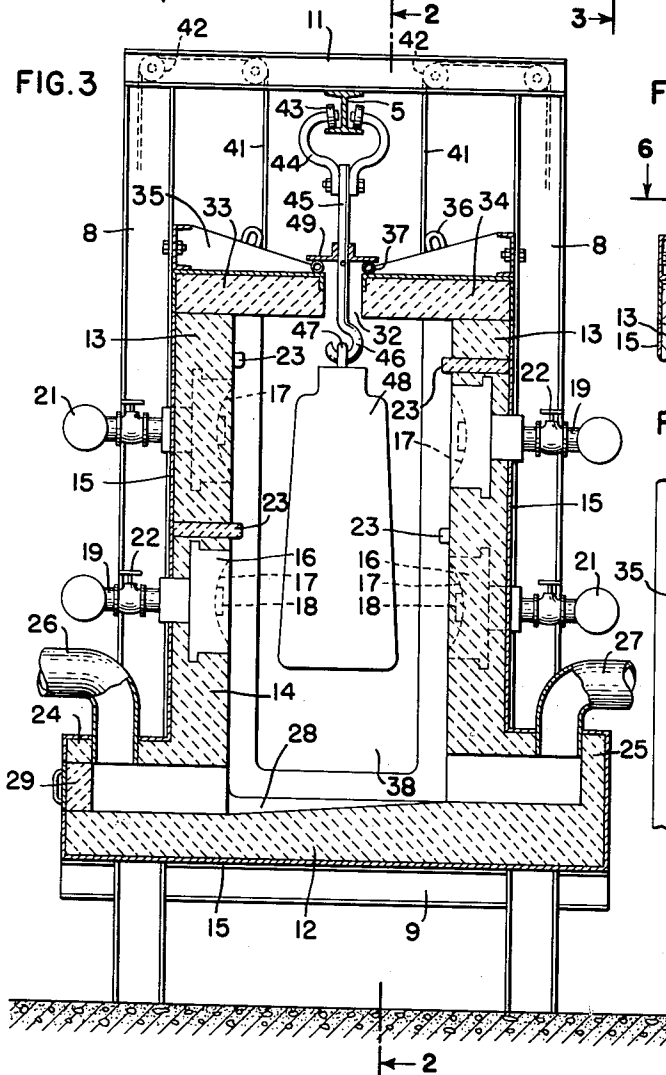


FIG. 5

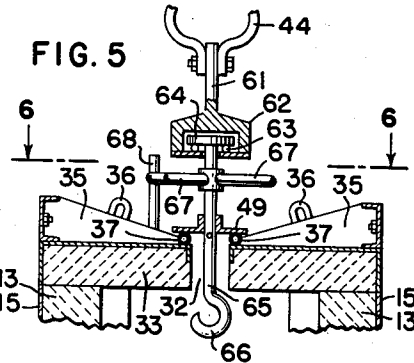
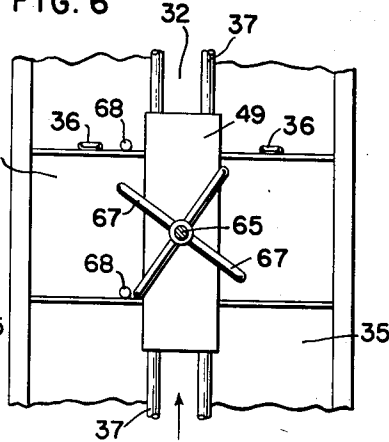


FIG. 6



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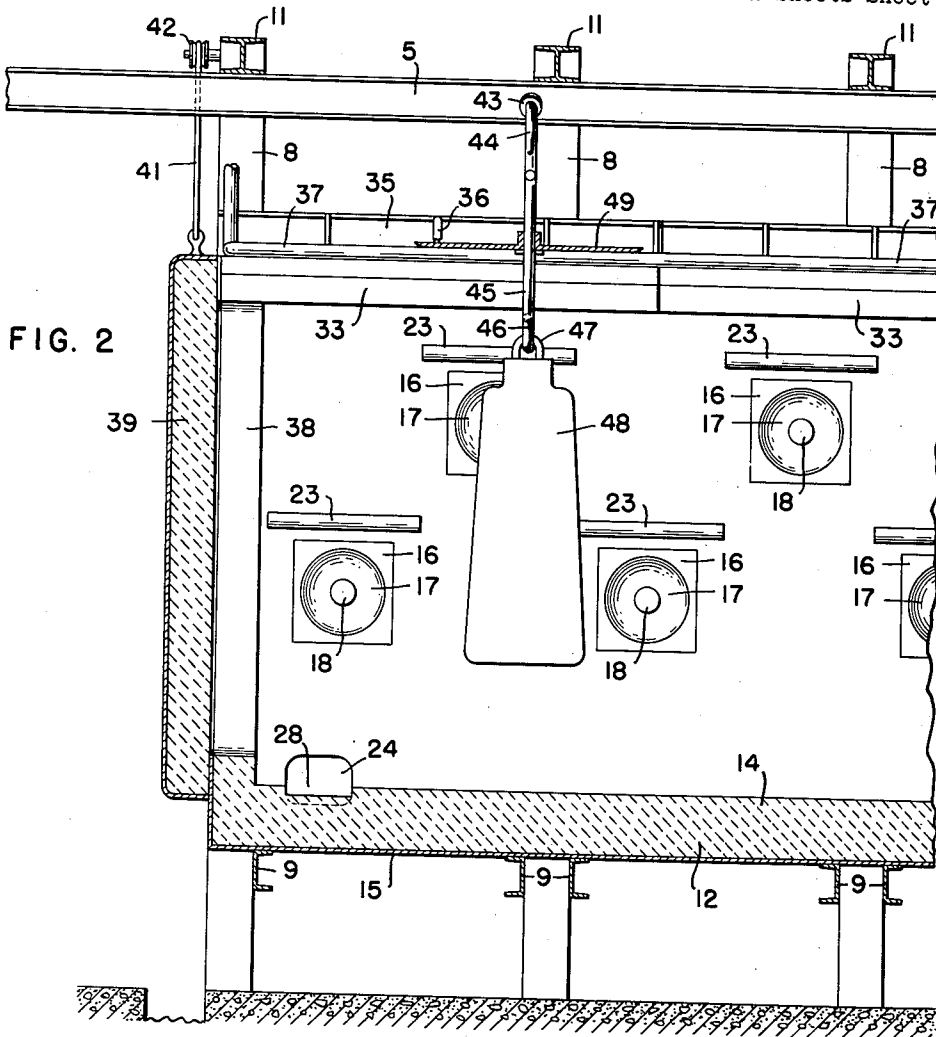
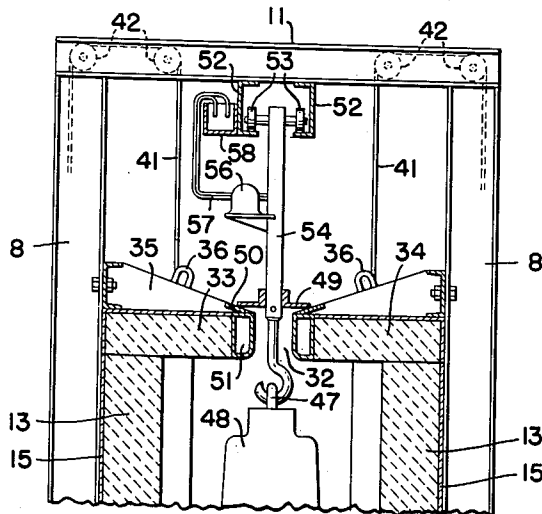
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METHOD AND APPARATUS FOR HEATING INGOTS

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2 Sheets-Sheet 2



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METHOD AND APPARATUS FOR HEATING INGOTS

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Application October 5, 1951, Serial No. 249,831

10 Claims. (Cl. 263—2)

The present invention relates to the heating of ingots for rolling or other purposes, and more particularly to a method and apparatus for handling ingots between the time they are cast and the time they are supplied to a place where work is performed on them, and to the heating of the ingots while they are being handled.

It is customary to place a large number of steel ingots in a furnace known as a soaking pit to hold them between the time they are removed from the molds in which they were cast and the time they are supplied, at a high temperature, to a rolling mill or forge, for example. Such furnaces are fired to a high temperature and each ingot is kept in the furnace for a relatively long time. Consequently the ingots are covered with a heavy scale that represents a substantial loss. In addition to the above objections, ingots of all temperatures are placed in the furnace and removed therefrom from time to time through a large opening at the top. This results in substantial fluctuations in the temperature of the furnace as well as a great heat loss. Each time the furnace is opened air can come in contact with the ingots to increase their scaling. These objections to soaking pit operation have been known for many years, but they have always been accepted as part of the operation.

It is an object of the present invention to heat ingots, and particularly steel ingots, in steps in different furnace units and thereby reduce the time that each ingot is kept in an atmosphere of the highest temperature. It is a further major object of the invention to reduce the equipment required for handling ingots from the time they are cast until they are delivered at the desired temperature to a rolling mill, for example.

It is a further object of the invention to provide a series of furnaces in which ingots may be heated to the desired temperatures, and through which they are moved in a continuous stream while they are being heated. Another object of the invention is to suspend each ingot individually and move it through a path including the proper furnace units while it is being heated.

According to the present invention means is provided to suspend each ingot from an overhead conveyor, and to move the ingots along one of a plurality of paths. Located along the paths are a series of furnaces through which the ingots pass, while still suspended, to be brought up to the desired temperature. One of the furnaces is designed to heat the ingots from substantially ambient temperature to an intermediate temperature of from 1800° F. to 2000° F. while a second and alternately used furnace is designed to permit equalization of the temperature of a hot ingot and to stabilize it at the intermediate temperature. A third furnace is designed to heat ingots from either of the first mentioned furnaces to a final temperature in the neighborhood of 2400° F. This arrangement insures that the temperature and temperature gradient in each furnace will remain substantially the same thereby insuring fast heating of the ingots and economical operation. Because of the separate heating steps none of the ingots will be subjected to the high-

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est temperature for a long time, and there will be a consequent reduction of scale on their surfaces.

If desired, means may be provided to protect the ingots from the atmosphere as they are moving from one furnace to the other. Means may also be provided to exhaust the hot products of combustion from the higher temperature furnaces to the cooler ones and thereby save some of the heat that would otherwise be lost.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

In the drawings:

Figure 1 is a plain view of the furnace arrangement of the invention;

Figure 2 is an elevation taken on line 2—2 of Figure 3;

Figure 3 is a section view taken on line 3—3 of Figure 1;

Figure 4 is a section similar to Figure 3 showing a different mechanism for supporting and conveying ingots through the furnace;

Figure 5 is a sectional view of another conveyor carriage on which the ingot is rotated; and

Figure 6 is a view on line 6—6 of Figure 5.

Referring to Figure 1 of the drawing, there are shown three furnaces 1, 2 and 3. The furnaces 1 and 2 are axially aligned with each other while the furnace 3 is parallel to the furnace 1. These furnaces are of substantially the same construction, the main difference between the furnaces being in the arrangement and number of the burners therein and the temperature to which the furnaces are fired. Ingots to be heated are brought in from location 4 which is adjacent to the point where the molds are stripped from the ingots, and are carried on a track 5 of a conveyor system through the furnaces 1 and 2 to a location where the ingots are worked upon such as rolling mill, for example. As will be explained more fully below, the furnace 3 is primarily intended to heat cold ingots or to store hot ones. Cold ingots can be brought in from a location 6 on a track 7 forming part of a conveyor that extends above the furnace 2. This track is connected with the track 5 by suitable switches and connecting rails.

The construction of the furnaces is best shown in Figures 2 and 3. Referring to those figures, it will be seen that each furnace has an elongated narrow chamber and is constructed on a steel frame work. This frame work includes vertical members 8 that are connected by lower horizontal members 9 upon which the furnace rests, and upper horizontal members 11. The furnace includes a floor 12 and side walls 13 that may be constructed in accordance with the ordinary furnace practice and may be either brick work or monolithic. As shown herein the walls and floor are constructed of refractory material 14 capable of withstanding the heat to which the furnace chamber is subjected and which may also have insulating properties or include a layer of insulation. The refractory work is backed up by sheet metal work 15.

Each wall is provided with a plurality of burners 16 that may be, and preferably are, of the type disclosed in Furczyk Patent No. 2,156,793 granted on July 24, 1951. Each of these burners comprises a refractory block that has formed in its face a cup shaped depression 17. Extending into the base of the cup is a distributor 18 through which a combustible mixture of fuel and air is supplied. This mixture is burned in the cup to heat the same and the walls of the furnace to incandescence and

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thereby heat work that is placed in the furnace chamber. Heat is also provided by the products of combustion which are swirling at a high velocity in the furnace chamber. The individual burners are connected by pipes 19 with manifolds 21. The pipes each have in them a valve 22 so that the fuel supply to the individual burners may be controlled as desired. As shown herein, the burners on opposite sides of the furnace chamber are staggered with relation to each other so that an even heat is provided in the furnace chamber from one end to the other, and from top to bottom. In order to protect the burners and the furnace walls if an ingot should fall from the conveyor and strike against the sides, the furnace walls may have inserted in them above each of the burners, silica carbide blocks 23. These blocks have strength enough at high temperatures to protect the burner and the walls of the furnace from damage by the ingots.

The products of combustion are preferably withdrawn from the bottom of the furnace through a series of flues on opposite sides thereof. Two of these flues are shown best in Figure 3 at 24 and 25, and have extending from them pipes 26 and 27 that serve to conduct the exhaust gases to a suitable stack. As shown in Figure 1 it is preferred that the pipes 26 and 27 through which the hot products of combustion are withdrawing from furnace 2 are connected to deliver these gases to furnace 1. In this way, the heat in the exhaust gases is utilized to help bring furnace 1 up to temperature and to maintain this temperature. It is noted that the gases withdrawn from furnace 1 are conducted through similar ducts or pipes 31 to furnace 3. As shown herein, the bottom of the flue 24 is depressed below the surface of the floor of the furnace as shown at 28 and the outer end of the flues is provided with a removable cover 29. When the cover 29 is withdrawn, access may be obtained to the bottom of the furnace in order to remove dirt, scale, etc., from the floor of the furnace. While only two flues have been shown in the drawing, it will be understood that a series of flues is provided along each side of each of the furnaces. Any of these flues may be provided with a plug similar to plug 29 to give access to the furnace floor if so desired.

The roof of the furnace is provided with a slot 32 through which mechanism for supporting the ingots extends. The roof itself is made of sections 33, each of which consists of a refractory lining 34 that is backed up and supported by a metal structure indicated at 35. The metal backing members 35 of the roof sections are suitably fastened to the vertically extending supports 8 of the furnace framework. In view of the fact that ingots may from time to time fall into the furnace from the conveying mechanism, means must be provided for removing the roof sections so that the fallen ingots can be removed. It is for this reason the roof is made in sections which can be individually removed. Rings 36 are provided on each roof section to receive a hook of a suitable lifting mechanism to increase the ease with which they can be removed and replaced.

Each end of each furnace is provided with an opening 38 through which the ingots pass through as they travel from one end to the other end of the furnace. Each opening is normally closed by a door 39 that can consist of a metal casting which is lined with a suitable high temperature refractory material. The doors are guided for vertical movement in front of the ends of the furnace. In order to open the doors, they are moved downwardly below the openings 38 in suitable pits that are provided at each end of the furnace. The doors are supported by cables 41 passing over pulleys 42; the other ends of the cables having attached to them suitable counter weights to control their movement.

As best shown in Figure 3, the track 5 is an I beam which is fastened to the underside of the horizontally extending frame members 11. Carriages that carry the ingots comprise rollers 43 rolling along the lower flanges

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of the beam 5 and yoke members 44 mounted on the rollers. The lower ends of the yoke members 44 are joined by suitable fastening means such as bolts to a downwardly extending hanger member 45 that has a hook 46 on its lower end. This hook engages a ring 47 or other suitable attaching means that is cast into or fastened to the upper end of the ingot 48. Surrounding the hanger 45 and movable with the carriage assembly is a shield 49 that rides along the upper surface of the water cooled tubes 37. This shield is held in place on the hanger and serves to prevent the escaping of furnace gases through slot 32 in the roof of the furnace.

In the operation of this system, hot ingots are moved from a place beyond location 4 where they are stripped from the molds, along the track 5 and into the furnace 1. Ingot at this stage are frequently black on the exterior but have an interior temperature high enough so that in some cases they are substantially molten. Before the ingot can be sent to a rolling mill or other machine that works upon it, its temperature must be even throughout its entire area, and it must be heated to around 2400° F. The equalizing of the ingot temperature and its additional heating is accomplished in steps in the individual furnaces. The burners in furnace 1 are placed as indicated so that an even heat is produced throughout the furnace chamber which heat may vary slightly from one end to the other so that the ingot is heated and its temperature equalized as it travels through the furnace. The burners of the furnace 1 are fired at a rate which is sufficient to equalize the temperature throughout the ingot and to bring it up to a temperature of from 1800° to 2000° F. by the time it reaches the exit end of the chamber of that furnace. Upon leaving furnace 1, the ingots are moved directly to furnace 2 which is fired at a higher temperature in order to bring the ingots up to substantially 2400° F. by the time they leave that furnace. It is noted that the furnace 2 may be shorter than the furnace 1 although it is fired to a higher temperature.

If cold ingots are used, they are normally brought from a storage place beyond the location indicated at 6 to be heated to the desired working temperature. In this case, the ingots are brought into furnace 3 on track 7. This furnace can also be used to receive ingots from the stripping point if for some reason there has been a mill stoppage so that the ingots are backing up in furnace 1. Furnace 3 is fired at a rate that is sufficient to bring cold ingots up to a temperature of between 1800° and 2000° F. so that these ingots can be moved directly from furnace 3 into furnace 1 for the final heating.

By providing separate furnaces that are connected by a conveyor system each furnace can be fired at the proper rate for the heating which is to be accomplished by it. Such an arrangement means that each furnace can be fired at a more even temperature and that the load of the furnace will be more constant than would otherwise be the case. This means that the furnaces can be fired more efficiently than would be possible if ingots in all stages of heating were in them. In addition to the above advantages, the ingots are kept at the highest temperature for only the relatively short period of time required for them to travel through furnace 2, thereby reducing appreciably the amount of scale that is formed on each ingot during the heating process. The relatively cool and cold ingots that are heated in furnaces 1 and 3 respectively can be brought up to their median temperature in an ordinary furnace atmosphere without any appreciable damage to the surface of the ingot or scale loss. The final heating furnace 2 can be maintained with some desired atmosphere that will be beneficial to the ingot as it is being brought up to its final temperature.

In the contemplated operation of this system, there will be a continual line of ingots from one end to the other of each of the furnaces 1 and 2. As an ingot is removed from furnace 2 to be forwarded to the rolling mill, for example, another ingot will be brought from furnace 1

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to the entrance end of the furnace 2. At the same time, a new ingot will be brought from the stripping point to the entrance of furnace 1. Thus, each of the furnaces is continuously loaded with ingots in the same temperature range with the result that the load in each furnace is substantially constant. This increases the operating efficiency of furnaces of this type. It is noted that the shields 49 carried by the conveyor are of such length that, when the furnaces are full, the shields completely cover the slot 32 formed in the roof of each furnace so that the furnace chambers are closed at all times except when the doors are opened to move ingots into and out of them. It is also noted that the efficiency of this system is increased by supplying the hot exhaust gases from the high temperature furnace 2 to the furnace 1 and from this furnace to the furnace 3. Since the ingots that are supplied to the furnace 3 are normally cool, the heating period in this furnace will be longer than the heating period required in furnace 1. The ingots can be supplied from this furnace to the furnace 2 if for some reason the supply of ingots from the stripping point has been slowed down so that their supply is not continuous.

In the operation of a system of the type described, it must be assumed that occasionally an ingot will fall from its carriage. For this reason, the furnace chamber has been made higher than the ingots are long. When an ingot drops, it will either fall on its side or be moved into that position by the following ingots. The other ingots that are being heated then pass over the one that is lying on its side in the bottom of the furnace. Thus, the continuous operation of the system is not interrupted because an occasional ingot may fall from its carriage. The roof sections can be removed, when convenient, to lift the fallen ingot from the furnace, or in some cases, the fallen ingot can be dragged along the floor and through one of the end openings.

It may be desirable to use a protective casing of some type between the various furnaces to protect the ingots from the effects of the atmosphere as they are being moved from one furnace to the other. Such a casing may comprise a refractory housing extending between the furnaces, or other suitable means.

The embodiment disclosed in Figure 4 is the same as that previously described except that in this figure the furnace roof sections and the conveyor are different from those that have been described. As shown herein, the inner edge of each roof section 33 adjacent to the slot 32 is provided with a water cooled casing indicated at 51. These casings serve to cool the edges of the roof and protect them from the hot gases in the furnace chamber, and suitable sealing strips 50 are provided along the upper edges.

The track for the conveyor in this case includes a pair of channel members 52 that are attached to the cross pieces 11 of the frame above the slot in the furnace roof. Rollers 53 ride on the lower flanges of these channels and carry a downwardly extending carrier 54 that has a hook on its lower end to receive the ring or other support on the upper end of the ingot. Due to the fact that the hanger may be overheated as a result of the hot gases as well as the fact that a portion of it extends into the furnace chamber, the hanger shown in this figure is water cooled. To this end, the carrier 54 has mounted on it a pump 56 that is connected by suitable tubes 57 with a source of supply of cooling water which flows in a trough 58 that is attached to one of the members 52. In operation, the pumps 56 will continually circulate water from the trough 58 through the hanger 54 and back to the trough. Although they are not shown herein, suitable electrical connections for driving the pumps may be carried along the bottom of the trough 58.

At times, it may be desirable to rotate the ingots as they are being moved through the various furnaces. A work supporting carriage with which this may be accomplished is shown in Figures 5 and 6. In those figures, the

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yoke members 44 of the conveying mechanism have attached to them a downwardly extending member 61 that has a socket 62 on its lower end. This socket is provided with bearings 63 which support a head 64 on the upper end of a rod 65 that has a hook 66 for carrying the ingot on its lower end. Attached to the rod 65 at a point between the head 64 and the head 49 is a spider that is shown as having four arms 67 extending horizontally from it. The arms 67 of the spider engage pins 68 that extend upwardly from portions of the metal work 35 supporting the roof sections as the carriages move along the track.

When an ingot supporting carriage of the type shown in Figures 5 and 6 is used, and with the conveyor moving in the direction of the arrow in Figure 6, it will be seen that the arms 67 of the spider periodically engage the pins 68. Each time one of the arms engages one of the pins, the rod 65 and the ingot carried thereby will be rotated through approximately 90° so that the various faces of the ingot will be moved to a position in which they are directly in front of the burners that are located in the walls of the furnace chamber. It will, therefore, be seen that with a conveyor using ingot carriages of this type, the ingots will be rotated as they are moved through the furnace chamber to help heat them more evenly and rapidly than would be the case if they were not rotated.

From the above description, it will be seen that I have provided a novel and efficient means for equalizing the temperature of ingots and heating them to a working temperature. The arrangement of this invention does away entirely with the defects of the conventional soaking pit, and supplies in a novel manner a continual stream of ingots that are heated to the proper temperature to be worked upon.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit and scope of the invention, as set forth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

What is claimed is:

1. In apparatus for treating ingots, the combination of means to suspend an ingot vertically from one end, means to guide said suspending means through a path, a first furnace in said path through which the ingot passes while carried by said suspended means, means in said first furnace to supply heat to said ingot in sufficient quantities to raise the temperature thereof to a first temperature below working temperature, a second furnace located in said path beyond said first furnace and through which the ingot passes while carried by said suspending means, means in said second furnace to raise the temperature of said ingot from said first temperature to working temperature, said path extending from said second furnace to a point at which work is performed on the billet, a third furnace, and means to direct said suspending means through a second path which by-passes said first furnace and passes through said third furnace, whereby ingots can pass through said first or third furnaces and through said second furnace, and means in said third furnace to heat said ingots.

2. In apparatus for heating ingots, the combination of a first furnace and a second furnace, each of said furnaces being provided with an elongated chamber and a slot extending through the top of said chamber from end to end thereof, a track above said furnaces and aligned with the slots therein and extending from a point beyond the entrance of the first furnace to a point beyond the exit of the second furnace, a carriage mounted for travel along said track, a hanger depending from said carriage and of a length to extend through said slots into the furnace chambers, said hanger including means to support an ingot

to be heated from its upper end as it moves through the furnace chambers, means located in the side walls thereof to heat said first furnace chamber to one temperature, and means located in the side walls thereof to heat said second furnace chamber to a higher temperature whereby ingots will be heated in steps as they are moved successively through said furnace chambers.

3. Apparatus for heating ingots and the like comprising a plurality of furnaces, each furnace having an elongated chamber having bottom and opposed side walls, burners in said side walls, a roof comprising roof sections removably mounted above said side walls, said sections being of a size to provide a slot extending lengthwise of said chamber from end to end thereof, an elongated track, means to mount said track above said furnaces in alignment with the slot formed in the roof thereof and between and beyond said furnaces, carriages on said track adapted to travel therealong, ingot supporting means depending from said carriages through said slots into said chambers, whereby ingots on said supporting means can be moved progressively through said furnace chambers, and means to supply fuel at different rates to burners in the different chambers to heat said ingots to one temperature in the first chamber and through which they travel and to another and higher temperature in a chamber through which they next travel.

4. The combination of claim 3 including means forming a rotary joint in said ingot supporting means whereby an ingot on said supporting means can be rotated with respect to said carriage, and cooperating means on said supporting means and said furnaces operative to rotate said supporting means as said carriages move along said track.

5. The method of heating ingots which comprises suspending the ingots freely from an overhead conveyor and moving them single file through a path on the conveyor while they are still suspended from the point where they are stripped from the molds to a point where work is done on them, treating the ingots at a first location in the path with heat applied equally from opposite sides to equalize the temperature of the ingot throughout and bring its temperature to within a predetermined range, and treating the ingot at a second location in the path with heat applied equally from opposite sides to raise its temperature from said predetermined range to a desired working temperature.

6. The method of treating ingots which comprises carrying the ingots single file through an elongated path in a freely suspended position so that heat may be applied equally to all sides thereof, carrying the ingots at one point in said path through a first location while so suspended, treating the ingots in said location with heat applied equally to opposite sides to equalize the heat distribution throughout their volume and raising their temperature to within a predetermined temperature range that is below final working temperature, moving the ingots while suspended to a separate location in said path, and treating the ingots in the same manner in said second location to raise their temperature to a final working temperature.

7. The method of heating ingots and the like which comprises suspending the ingots freely from one end and moving them single file one after the other while they are so suspended through a path that includes a plurality of heating stations, treating the ingots with heat equally from opposite sides in the first heating station in said path to equalize the temperature thereof throughout its entire area and bring the temperature thereof up to some

intermediate value, treating the ingots with heat equally from opposite sides in subsequent heating stations along said path to raise the temperature of the ingots to a desired value, and moving the ingots along said path in such a manner that as a heated ingot is moved from the last heating station an ingot will be moved into said station from previous heating stations, and a new ingot will be moved into the first heating station to thereby keep all of the heating stations full of ingots.

8. A method of heating ingots and the like comprising suspending ingots freely from one end so that heat can be applied evenly to all sides thereof, moving the ingots single file through a path having a plurality of independent heating stations therein, supplying heat to the ingots equally from opposite sides while they are suspended at the first heating station in a manner to equalize the temperature therein and bring the temperature to a value within a predetermined range below the final temperature, supplying heat equally from opposite sides to the ingots at a subsequently reached heating station while they are still suspended to bring the ingots up to the final desired temperature, and moving the ingots through said path in such a manner that the heating stations are at all times full of ingots.

9. The method of heating metal bodies which comprises suspending the bodies freely at one end from an overhead conveyor and moving them single file through a path from a point where a supply of the bodies is maintained to a point where work is performed upon them, treating the bodies with heat from a plurality of incandescent heat sources on opposite sides thereof at a first location in the path to equalize the temperature of each body and bring its temperature to within a predetermined range, and treating each body while still suspended with heat from a plurality of incandescent heat sources on opposite sides thereof at a second location in the path to raise its temperature from said predetermined range to a desired working temperature.

10. A method of heating metal bodies which comprises suspending the bodies freely from one end only so that heat can be applied evenly to all sides thereof, moving the bodies single file while so suspended through a path having a plurality of heating stations therein, supplying radiant heat to the bodies from incandescent surfaces on opposite sides thereof at a first point along said path in a manner to equalize the temperature therein and to bring the temperature to a range below the final temperature, supplying radiant heat from incandescent surfaces to opposite sides of the bodies while they are still suspended at a subsequently reached point along said path to bring the bodies up to the final desired temperature, and moving the suspended bodies one after the other through said path.

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