

Sept. 10, 1935.

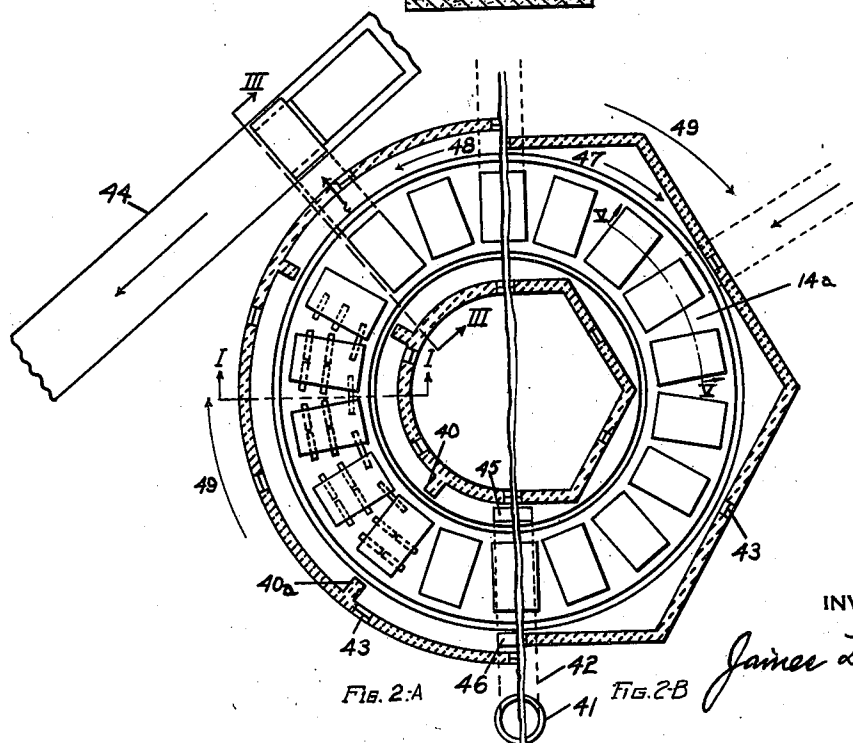
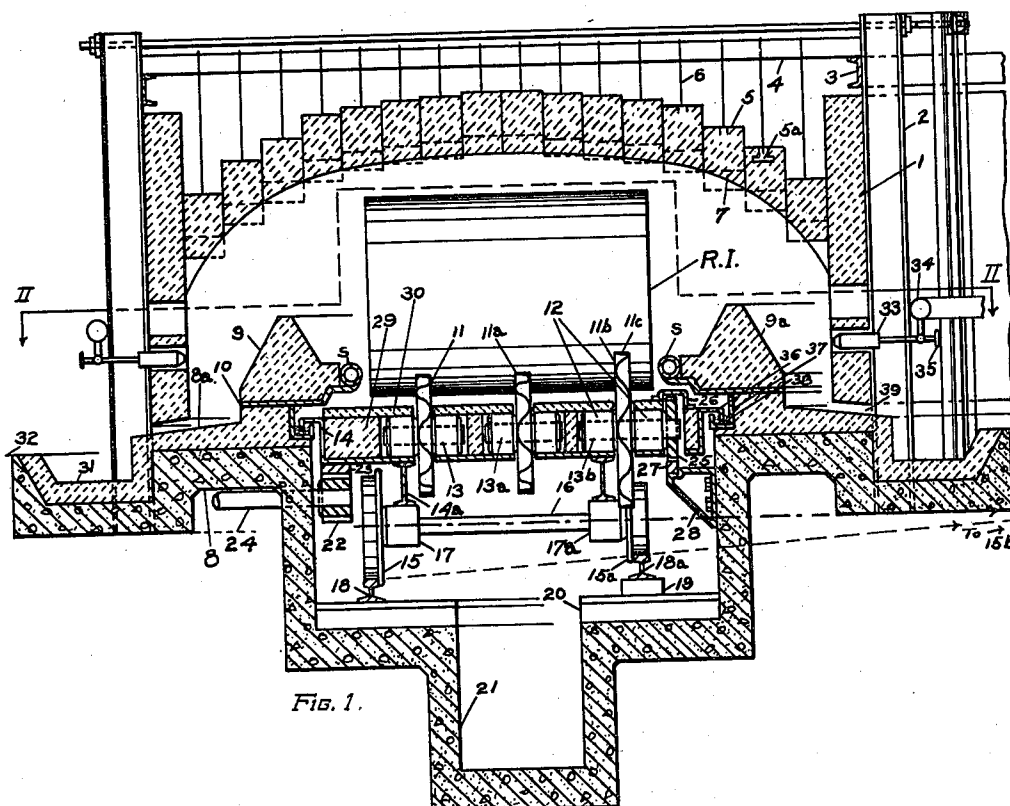
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2,013,905

CIRCULAR INGOT HEATING FURNACE

Filed Feb. 4, 1933

5 Sheets-Sheet 1



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CIRCULAR INGOT HEATING FURNACE

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5 Sheets-Sheet 2

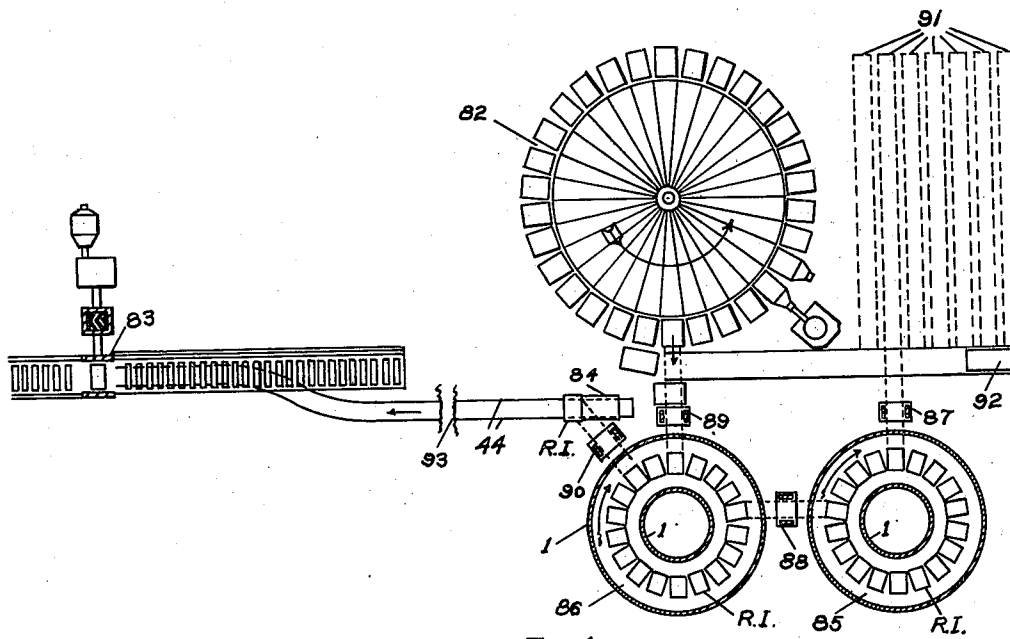


FIG. 4.

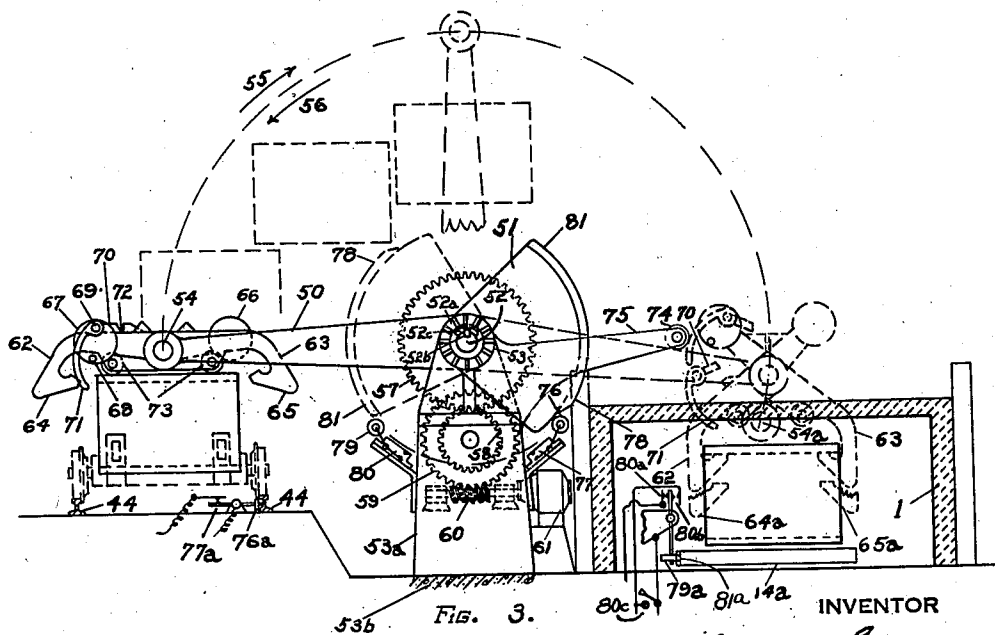


FIG. 3.

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5 Sheets-Sheet 3

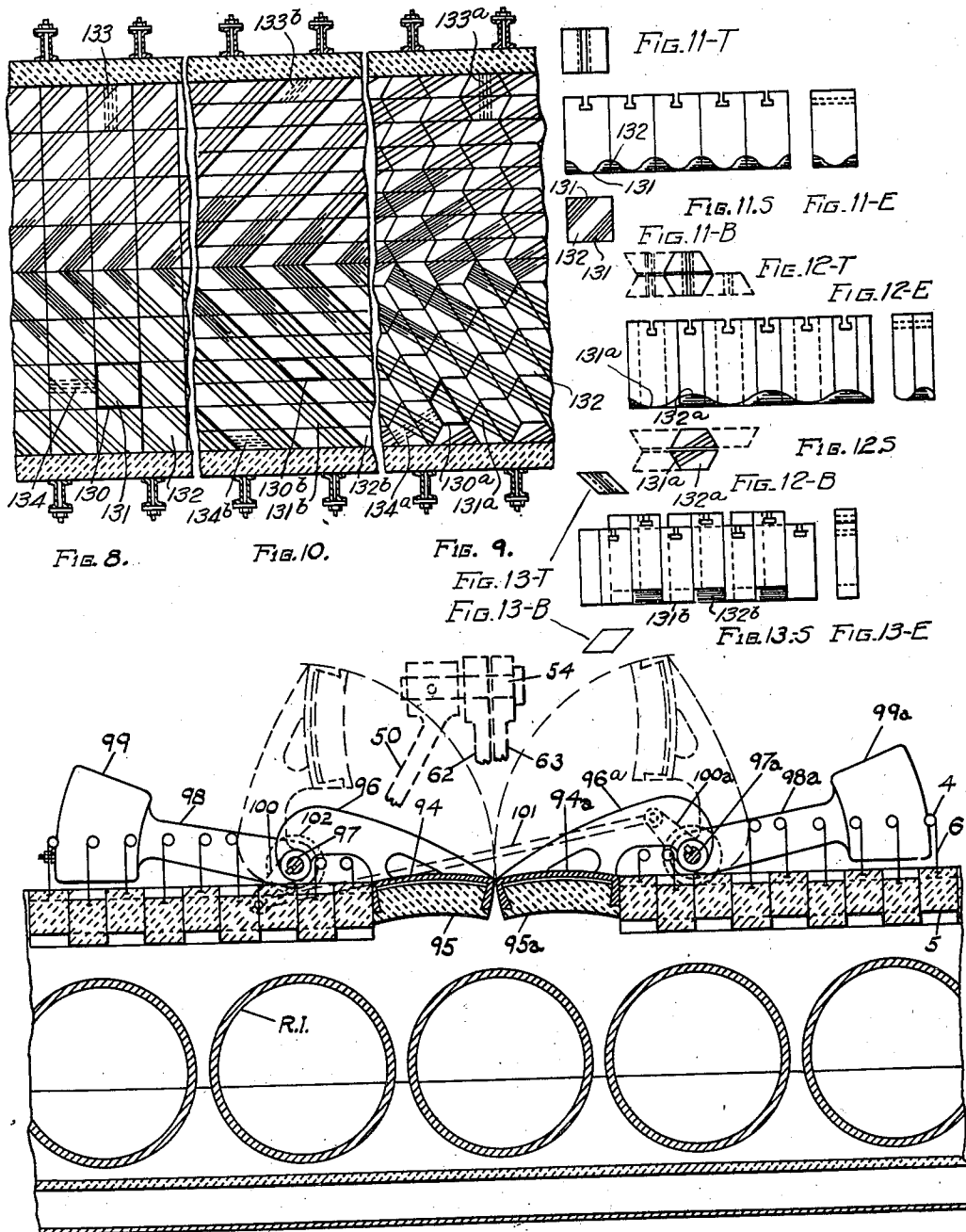


Fig. 5.

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CIRCULAR INGOT HEATING FURNACE

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5 Sheets-Sheet 4

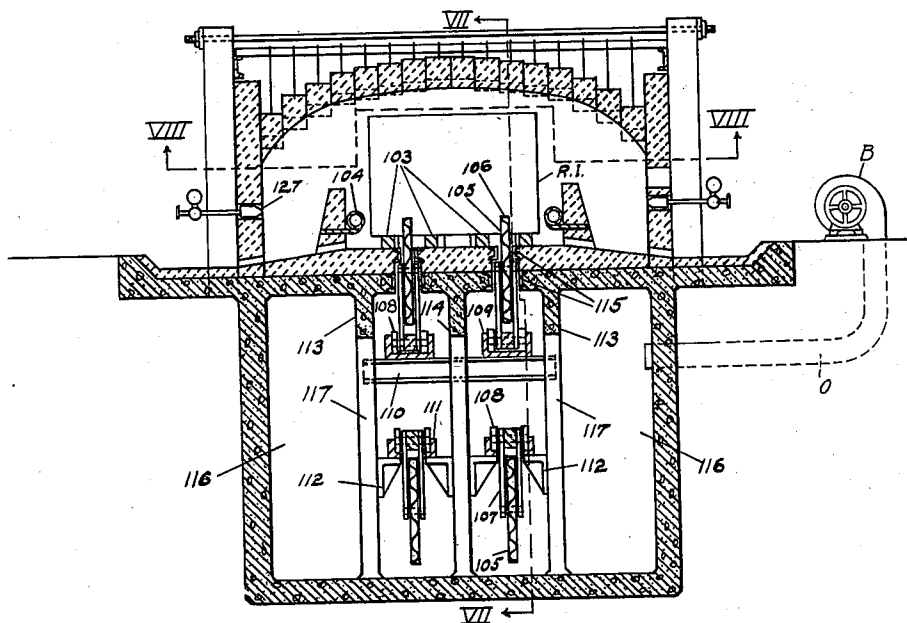


FIG. 6.

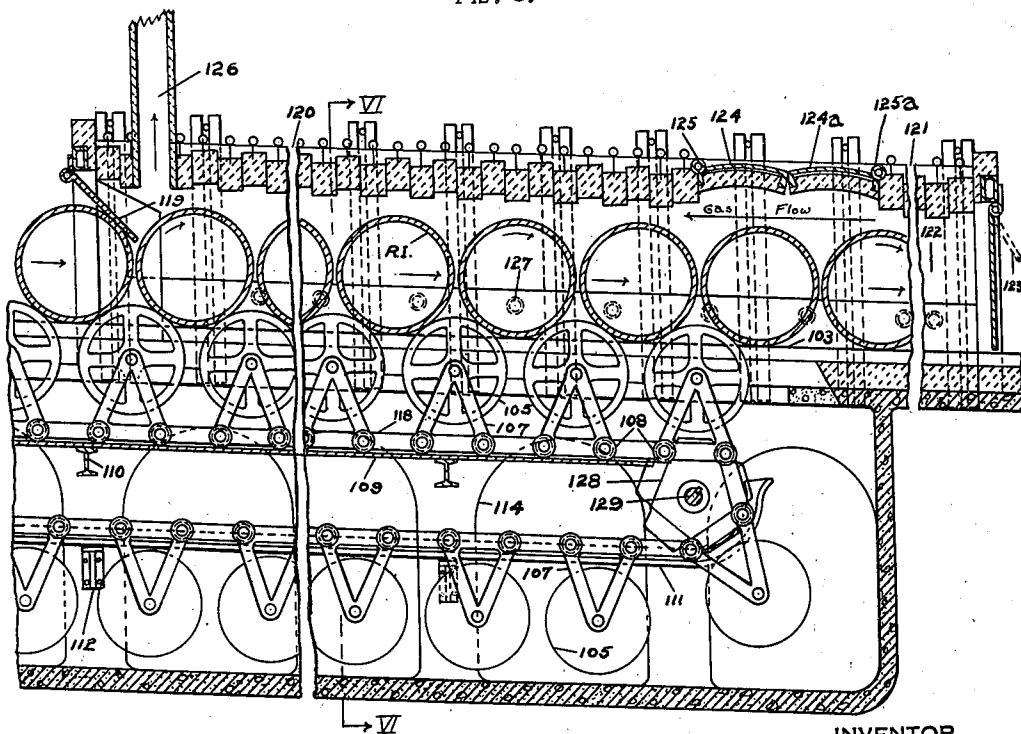


FIG. 7.

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CIRCULAR INGOT HEATING FURNACE

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5 Sheets-Sheet 5

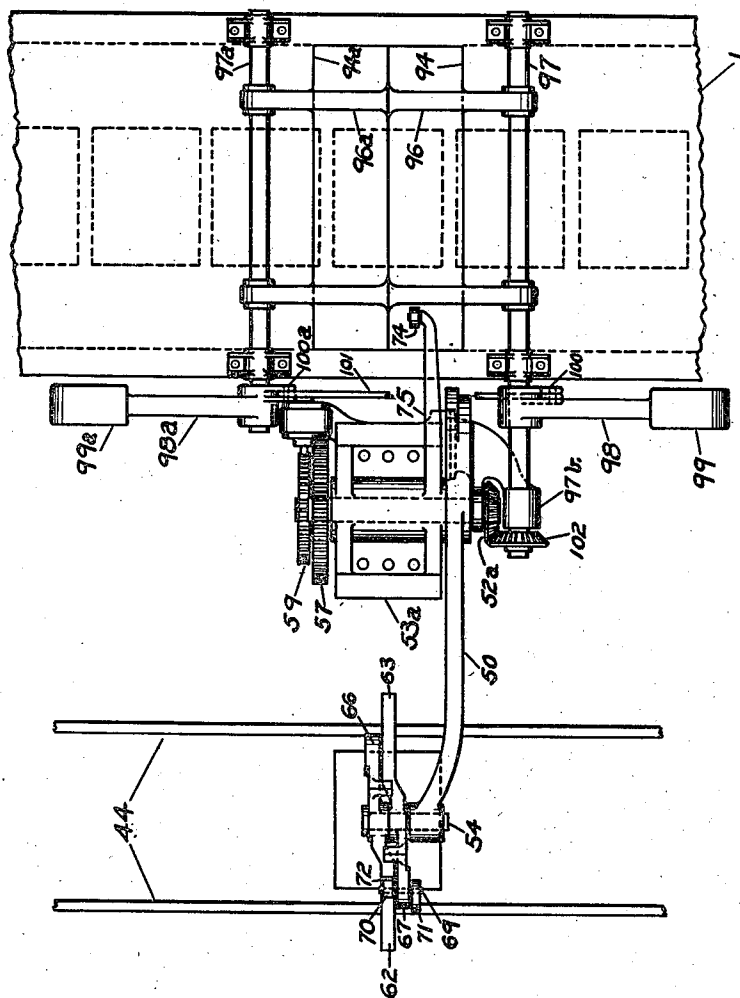


FIG. 14.

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UNITED STATES PATENT OFFICE

2,013,905

CIRCULAR INGOT HEATING FURNACE

James L. Adams, Jr., Youngstown, Ohio

Application February 4, 1933, Serial No. 655,185

15 Claims. (Cl. 263—7)

The present invention relates broadly to the art of heating metal ingots, and equalizing their temperature throughout, preparatory to rolling, and more particularly to the heating up to proper and uniform rolling temperature, of annular or ring ingots, such as may be used to advantage in a continuous belt-mill, such, for example, as that covered by my co-pending application, Serial No. 674,661, filed June 7, 1933.

One object of the present invention is to provide apparatus especially adapted to the very uniform heating of relatively thin and wide ring ingots in a minimum time.

Another object is to provide apparatus which will do the heating without producing cooler belts around the ingot corresponding with the usual lines of support thereof.

A valued object is to provide apparatus through which the ring or other ingot will be progressed while undergoing slow rotation around its generating axis, so as to bring all perimetral surface points therein into contact with substantially the same total amounts of heat.

A further important object is to provide a furnace such as will permit individual time periods of heating for each individual ingot, without holding up the general progression of ingots therethrough by so doing; which will also allow any contained ingot to be spotted and withdrawn independently of all the rest, and which will allow any vacated position to be likewise filled up independently of its position in the general series along the furnace interior, and without disturbing other ingots therein.

As a further object I may sometimes provide an ingot heating system, which contains two furnace stages in tandem, so that red or yellow-hot ingots direct from the stripper of casting machine can be fed through the final stage only, while cold ingots taken from the storage tracks, can be put through the two stages in tandem, in any order or quantities respectively required, and all delivered fully heated to the mill, in proper sequence, and in any required proportion therebetween, with each ingot given its own selected time in the heat, as the pyrometer utilized may dictate.

An added object of importance is to provide a furnace with a herring-bone type of deeply fluted roof surface, designed to divert the actual gas flow toward those elements of ingot which normally tend to come through the usual furnace under-heated.

Another object of considerable value is to so shape the roof of furnace, or the interior cross-

contour thereof, as to lead to a concentration of the radiation therefrom upon those areas of the ingot underneath, which normally require the most heat to quickly bring to uniform rolling temperature, or upon those elements of the ingot which normally tend to be insufficiently heated, in the usual furnace.

One prime object is to get all bearings carrying rotating parts, well below the lower floor of furnace, where the temperatures encountered will be moderate.

Another object is to carefully stagger or offset the surfaces contacting directly with the ingot, or give them a wavy-outline on the bearing points against the ingot, so as to decrease the total time of contact of any one point on the ingot, with the relatively cool supporting elements below, and not produce a cold-streak around the ring, which would introduce difficulties during the rolling later on.

An added object is to provide a furnace system of such type that simple and sturdy selective-charging, transferring, and ingot-withdrawing means can be readily adapted thereto, and operated without material waste of hot-gases at such points.

One more object is to provide simple sand or other sealing, between the moving and stationary parts, to substantially avoid hot-gas wastes here.

A comprehensive object is to for the first time produce an apparatus which combines the advantageous elements of all the above objects in one machine.

Still further objects will be self-evident to anyone skilled in the art to which my invention appertains.

With all the above and other objects in view, I have provided suitable apparatus of a preferred form, for practicing my invention, and quickly bringing wide, thin-walled ring-ingots, such as those covered by my co-pending application Serial No. 649,181, filed December 28, 1932, to a suitably high and uniform rolling temperature, and delivering them successively into proper position convenient for transport to mill, by some such device as that covered by my co-pending application on Ingot transport apparatus, Serial No. 652,142, filed January 17, 1933.

In the accompanying drawings I have shown for purposes of illustration only, and not as determining the limits of my invention, or the scope of its application, one preferred form of apparatus constituting such invention, and two alternative forms.

In these drawings, Figure 1 is a vertical cross section of one side of my annular furnace, taken on the line I—I of Figure 2A, looking in the direction of the arrows.

- 5 Figures 2A and 2B are horizontal cross sections of the interior of two slightly different forms of my furnace one circular, and the other hexagonal in outline, either of which may be considered as taken on the line II—II of Figure 1, and also
10 looking with the arrows.

- Figure 3 is a view, taken partly in vertical-cross section and partly in elevation, on the line III—III of Figure 2A, in the direction of the arrows, and shows an ingot transfer mechanism.
15

This transfer arm can be readily adapted to "charging", or to "intra-furnace" operation, if so required, with only evident changes in structure.

- 20 Figure 4 is a general plan view of my preferred twin-furnace layout, and indicates the ingot-transfer locations; both intra-furnace and between the outside ingot-car tracks and the respective furnaces, the view also indicating some of the more directly associated items of mill equipment. The transfer positions shown
25 may be altered, however, and in many cases but a single furnace used.

- Figure 5 illustrates in vertical cross section on line V—V of Figure 2B, and looking in the direction of the arrows, a preferred type of entrance and exit door system for my furnaces, whereby charging, transfer, or discharge of ingots can be carried out rapidly, and substantially automatically, without serious loss of hot-gases during the transfer periods. But other doors, as per Figure 7, might be substituted.
30

- Figure 6 shows a vertical cross section, taken on the line VI—VI of Figure 7, in the direction of the arrows, of an alternative form of my heating furnace, likewise adapted to the handling of ring or other rotatable ingots, but in which the furnace itself is of the slightly inclined and straight-run pattern, on the sloping tracks of which the successive ingots may roll of their own accord, but slightly spaced by, and under the retarding speed control of, light guiding discs carried by a chain drive.
35

- Figure 7 is a vertical longitudinal cross section of such a straight furnace, taken on the line VII—VII of Figure 6, and again looking in the direction of the arrows, so that the caterpillar-chain system, with its associated guiding-discs, are shown in elevation, also the driving sprocket therefor.
40

- Figure 8 is an underneath view of a roof refractory assembly using square blocks, shown looking upward toward the furnace ceiling, from the line VIII—VIII of Figure 6, and indicating by the shading the general direction of the under surface fluting, one refractory unit being made to stand out by the use of heavier lines, to show the shape.
45

- Figure 9 is a view taken from the same point as Figure 8, but showing an alternative hexagonal refractory assembly, of the split-hexagon type, with one unit emphasized by heavier lines, as in the case of Figure 8. All units shown over-size for clearness.
50

- Figure 10 illustrates, from the same point of view as Figure 8, an alternative assembly of diamond-shaped refractories, with one unit emphasized as before.
55

- This alternative form may be flat-ended, the required ceiling corrugations being produced
60

by lowering alternate slanting rows of the refractories, thus giving a grooved effect.

Figures 11T, 11B, 11S, and 11E, show the top, bottom, side, and end views respectively, of one of the square type unit refractories, and bring
5 out the fluting underneath.

Figures 12T, 12B, 12S, and 12E are similar, but show a split-hexagon unit, which is much easier to build in to the approximate pattern indicated, should the furnace happen to be of
10 the hexagonal, or circular type, than is the square unit.

Figures 13T, 13B, 13S, and 13E show similarly the different aspects of a diamond-shaped refractory, just as was above outlined for the
15 others.

Figure 14 is a plan view looking down upon the top of the apparatus shown in Figure 3, and illustrating the interconnection between transfer-arm and the furnace doors.
20

In all these figures, corresponding elements are indicated by the same part numbers.

Referring now more particularly to Figure 1, my furnace is shown at 1 with side-walls suitably lined with high temperature fire-brick or
25 equivalent refractory, while on the outside there are positioned the heavy and appropriately spaced vertical buck-stays 2 of structural steel or cast-iron, and preferably supporting the longitudinal steel channels or other structural
30 shapes 3, which in turn carry at short intervals the cross pipes or beams 4, to which are attached the roof refractories 5 through the agency of the T slots 5a, or equivalent means, into which the small steel strips, rods, or equivalents 6, are
35 interlocked by well known means and their top ends attached to or clamped around the cross pipes 4, the several lengths of 6 being appropriately selected to give the required roof curvature for best concentration of the gas-flow and the
40 roof radiation upon desired elements of the successive ingots. These refractories 5 are preferably, but not necessarily, given a very deep and angularly directed bottom end fluting 7, with the angles so opposing on the two sides of the
45 longitudinal ceiling centre-line as to give a pronounced "herring-bone" effect, utilizable to gradually direct the hot-gas flow toward those axial positions along ingot which normally require most heat, as will be gone into in more
50 detail in a later figure, where it will be noted that I have so designed the several refractory blocks shown that one type of block only is required to give the two "herring-bone" angles, and also to enable fitting right up close to the
55 furnace wall on each side, the hexagonal blocks being therefore all made split to permit this. For a straight run furnace, any one of the blocks shown may be used; but for my preferred hexagonal or circular type of furnace, the hexagonal
60 blocks are generally found more adaptable to the work, as they allow successive 60° shifts.

The concrete floor or base 8, of generally annular or hexagonal plan, carries a heavy top lining 8a of fire-brick, in turn supporting the
65 annular baffles 9 and 9a, also of very high temperature-resistant fire-brick, which baffles are conveniently sub-divided into sections of say four or five feet length each, with perhaps an inch or so spacing therebetween, and made easily separable from 8a on the line of the $\frac{3}{8}$ " or $\frac{1}{2}$ " thick sectional base-plates 10, if occasion
should require.

Water-cooled ingot end-thrust guides, or stops S, are supported by these plates 10, the
75

water connections being omitted, as of usual construction, and well known, and although a pipe has here been utilized as a simple form of stop, substitutes will be self-evident, and may in some cases be preferred to that shown.

While my furnace has been especially designed to handle ring-ingots, it will be noted that any other shapes which can be rotationally progressed therethrough may be operated upon equally well.

A ring-ingot R. I. is rotatably carried upon the high-temperature resistant disc-wheels 11, 11a, and 11b, all of which present to the ingot wide edges 11c of decidedly wavy contour, so as to stagger the points of contact with ingot repeatedly and prevent undue heat abstraction around any one circular belt thereon.

These disc-wheels 11, 11a, and 11b are in turn mounted by means of the very-large-ball bearings 12, upon the horizontal shafts 13, 13a, and 13b, the bearings being carried by the plate-steel frame 14, of the annular carriage 14a, supported by the flanged wheels 15 and 15a, which it will be noted are of different respective diameters appropriate for rotation slowly around the general centre-line 15b of the annular furnace, and are carried on shaft 16, by the bearings 17 and 17a, the whole being supported upon the tracks 18 and 18a, the latter of which may be raised somewhat, if so preferred, upon block 19, carried by the steel tie 20, which is here made short so as to provide space for the headroom of maintenance-tunnel 21, under the furnace. Annular carriage 14a is driven by the heavy pinion 22, of coarse tooth type, appropriately meshing with the underneath toothed surface of rack 23 of carriage, and driven by suitable means through the extending shaft 24. The disc-wheels 11b and shaft 13b are slowly rotated as carriage 14a progresses, by the coarse-toothed spur-gear 25, suitably shielded on top by the apron 26, and meshing underneath with the stationary annular rack 27, mounted on supports 28, bolted to tunnel-wall.

The high-temperature brick fill of carriage 14a and plate lining 14, is indicated at 29, with its appropriate surface layer of still higher temperature fire-brick shown at 30, while 31 indicates the annular sump or slag well adjacent to wall of furnace, with 32 the general mill floor level. One of the numerous and appropriately distributed gas or oil burners is shown at 33, connected to main 34 through usual valve 35. The interlocking elements of a sand-seal are shown at 36 and 37 respectively, the sand content being pointed out at 38, while occasional slag drainage channels thru the furnace wall are illustrated at 39, all draining into sump 31.

Referring now to Figure 2A, about the only new parts disclosed beyond those just enumerated, are the occasional radially positioned baffle-walls 40, 40a, designed to prevent too much direct shunting of hot-gases by the furnace areas beyond each end of the moving ingot, but which conceivably might be dispensed with in some cases, as for a furnace of hexagonal outline such as that shown in Figure 2B; also the exhaust gas uptake or stack 41, with its connecting flue 42, the small open, or quartz-plate covered observation windows 43 which may be set outward from wall on a cone, if desired, and the out-going, or incoming and out-going ingot-carriage track 44. The connecting outlets for flue 42 are indicated at 45 and 46, the small arrows 47 and 48 show the divided course of the general furnace gases, while the long ar-

row 49 indicates the general course of travel of carriage 14a. The burners 33 of the preceding figure might be supplied with heated tar, or pulverized coal, as alternative fuels, and run "reducing" so as to prevent scale formation on ingot.

In some cases a single very large gas, or oil-spray mixer, and burner might be used.

In Figure 3, I have shown one preferred form of ingot-discharging mechanism, such as might be used between the furnace 1, and the outgoing tracks 44, but which, with relatively minor and obvious modifications, may be used between the two or more sections of a multi-stage type of furnace, such as will be outlined in a subsequent figure; or for furnace charging, as from tracks similar to those shown at 44.

Such transfer means, while claimed, and more fully disclosed, in my co-pending divisional application, Serial #680,967 filed July 18th, 1933, nevertheless is so intimately associated with my furnace, or furnaces, as to require illustration and description here, and in the figure is shown as a long transfer-arm 50, suitably counter-weighted at 51, mounted on the very short out-board end of heavy shaft 52, of considerable length, which carries on its other very short projecting end the bevel-gear 52a, keyed thereto by the narrow key 52b, operating in the relatively wide key-slot 52c, so as to give some lost motion to gear, and all in turn carried by the large bearing 53, also of very considerable length, at top of heavy pedestal 53a, suitably carried by concrete base 53b, while at outer end of said transfer-arm 50, there is provided the substantial stub shaft 54, oscillable between this point and its second limit position 54a, over the course indicated by the twin arrows 55, 56, above, by means of the large diameter gear 57, meshing with smaller pinion 58, in turn driven by the worm-wheel 59 keyed on same shaft therewith, the latter wheel being functioned by worm 60, and motor 61, of the reversible type, or some equivalent means.

Shaft 54 carries the tongs or grab-arms 62 and 63, mounted scissors-like so as to be freely revolvable on said shaft, and carrying the respective pawl-tips 64 and 65, while counterweights 66 and 67 at opposite ends of the grab-arms partially balance the latter. As best shown at left-hand end of swing of the arm 50, counter-weight 67 carries the stop 68, and a fairly heavy projecting pin 69, upon which is mounted freely the heavy pawl 70, integral with, but axially displaced from, the operating lever or cam 71, which in turn is limited in travel by the above stop 68, and in the other direction by the depth of the ratchet groove 72 on arm 62. Under each of the arms 62 and 63, a roller 73 is mounted integrally therewith, but freely rotatable.

As the right or 54a end of the travel of arm 50 is neared, cam 71 is thrown over to the right somewhat by contact with the projecting roll 74, mounted in proper position upon the substantial arm 75, either bolted to, or cast integrally with the pedestal 53a, before mentioned. It will be noted that the extreme 54a position of arm 50, is well below the position in which 62 and 63 are detailed at the right-hand end of swing, in order to make sure that the pawl-ends or tips 64 and 65 will fall well below the upper wall of the ring-ingot R. I., and hence be sure to pick up the latter when arm 50 again begins to rise, as shown in detail drawings here in dotted outline. This extreme position of the tips 64 and 65 is indicated at 64a and 65a.

On now transferring this ingot R. I. to the 54

shaft position as shown on the figure, or to left-hand end of travel of arm 50, via course 56, then if, and only if, a receiving ingot-car be there-under in proper position, the downward travel of the ingot will be arrested thereby, but arm 50 proceeds onward a little further, rolls 73 contact with ingot and spread the tongs 62, 63, until pawl 70 finally latches into groove or notch 72 of the other grab-arm 62, and thereby retains the tongs in fully-opened position, just after which step the limit-stop roll 76 must be set to function definitely, opening the normally-closed contacts 77, which being connected in series with the shunt operating coil for "forward" throw of contactor supplying motor 61, the latter is immediately stopped as said contactor (not shown) opens up.

The moving cam-surface 78, which functions roll 76, mounted on the end of a pivoted switch arm carrying one of the 77 contacts, is itself conveniently mounted near one axial end of counterweight 51, reserving space for another cam-surface axially displaced from 78, to be mentioned later.

If no ingot-car be under arm 50 as ingot swings down at left, the arms 62 and 63 will not release said ingot, so no harm will be done, but by placing a normally-open type of limit-stop close to track 44, so that its roll 76a will be depressed by the front wheel flange of car, and connecting its contacts 77a likewise in series with the "forward" throw shunt coil of contactor above mentioned, motor 61 will be prevented from functioning arm 50 in the left-hand direction, unless said car be in proper position under the arm just mentioned.

The right-hand travel of arm 50, as indicated by arrow 55, is terminated by limit-stop roll 79, with its associated normally-closed contacts 80, functioned by the second and axially displaced cam-surface 81, also mounted on counter-weight 51.

These contacts 80 serve to open up the "reverse" running shunt-coil circuit of the double-throw contactor provided for motor 61, thus stopping the latter, as the terminus of cam 81 is reached by roll 79.

The housings for contacts 77 and 80 are conveniently mounted upon pedestal 53a.

To make sure that moving ingots within the furnace will always have been stopped, and in proper exact position to register with arm 50, before the latter can be made to enter the furnace doors, a limit-stop roll 79a, mounted upon a contact arm carrying normally-open contacts 80a as well as normally-closed contacts 80b, is suitably supported near edge of carriage 14a of my hexagon or circular furnace, for example, so as to enter periodically into the indexing notches 81a, thus momentarily closing 80a and opening 80b. But all this indexing, roller, and contact mechanism may, of course, be placed in pit, under the furnace proper, in order to get away from the heat. Now the last mentioned contacts are connected in series with shunt operating-coil of contactor controlling the ingot propelling motor connected to shaft 24 of furnace, thus stopping said motor as soon as these contacts open up, while at the same instant contacts 80a, in series with the "reverse" contactor shunt coil for motor 61, close, and thus permit latter motor to function in furnace direction.

I prefer to parallel the 80b contacts with a hand-operated single-pole, single-throw switch 80c, as indicated, however, so that the moving

elements within furnace can be made to run past all index-stop positions without stopping, whenever this may be desirable, as when none of a new batch of ingots is yet ready for rolling, or when mill may be temporarily held up for re-adjustments, or re-placements, for a few minutes or more.

This switch 80c also serves to make the furnace "selective", as to which ingot is to be next withdrawn from the entire group undergoing heating, and may be conveniently under the direct control of the optical-pyrometer observer, thus enabling him to determine the sequence of ingots directly, for transfer to the mill.

The functions of parts 52a, 52b, and 52c will be indicated in connection with a later figure, showing the operation of self-opening furnace doors.

Turning now to Figure 4, new parts not previously cited appear as follows: a high-speed, high-output centrifugal casting unit, producing "jarred" steel, as per my co-pending application Serial No. 680,570, filed July 15th, 1933, is illustrated at 82; a high-speed belt mill at 83, with its proper live-roll table systems, and heavy motor drive; while 84 indicates an ingot-car, the details of all of which may be ascertained by reference to the appropriate applications, already cited.

My twin heating-furnaces are indicated at 85 and 86, although usually one only will be in use at a time, while transfer-arms, very closely associated operatively with my present invention, are shown in plan-view at 87, 88, 89, and 90, although under a modified disposition, this number might conceivably be cut to one.

As here shown, however, furnace 85 would be assigned to the preliminary heating to about red-heat or a little more, of all initially cold ingots, such as those taken from storage, which are charged via transfer-arm 87, and then later transferred to the second-stage furnace 86 by the arm 88, for final heating to full temperature and "soaking", after which they would be transferred to the ingot-car 84.

As the more usual case, however, initially hot ingots taken direct from the casting unit 82, would enter furnace 86, via transfer-arm 89, and leave it for the ingot car via arm 90; or arm 89, with readily made modifications, might conceivably be utilized both for charge and discharge here, if so preferred.

Storage tracks for extra ingots from casting unit 82, are indicated at 91, these tracks being amplified in extent as required, and used to provide an emergency store of ingots, or to absorb temporarily the production of casting unit, in case a furnace happens to be out of commission for an hour or two, or even longer.

A suitable cross-transfer for these hot or cold ingots is shown at 92, usually in the form of a wheeled car, properly motor driven, or otherwise.

This general plan had to be fore-shortened somewhat as indicated at 93.

Referring now to Figure 5, new parts not previously listed include the two cast or plate metal over-head doors 94 and 94a, the interior fire-brick linings 95 and 95a therefor, the carrying arms 96 and 96a, heavy shafts 97 and 97a, the counter-weight arms 98 and 98a, and counter-weights 99 and 99a, both of the last two sets of parts being mounted back off to one side of the furnace proper, likewise the crank-arms 100 and 100a, keyed to the respective shafts 97 and 97a, and the inter-connecting rod 101, it being noted that the single long shaft 97, which may or may

not be quite horizontal, will have mounted thereon at its extreme back end, where it will be appropriately supported by a convenient bracket 97b, carried by base 53a close to the left-hand side of shaft 52 of Figure 3, a bevel gear 102 of appropriate size, meshing directly with the left-hand side of the matching bevel gear 52a, mounted upon and keyed to shaft 52 just mentioned, this key 52b being somewhat narrower than the key-slot 52c, if so preferred, so as to delay the initial start of the door-opening process until the arm 50 is well on its road toward the furnace, and close the doors promptly as it recedes, the doors 94 and 94a being made a little heavier than the respective counterweights 99 and 99a, in order to permit this mode of operation, and all the travel speeds being relatively slow so that a lost-motion type of key will function satisfactorily without undue shock or wear.

Taking up Figure 6, referring to a straight type of furnace, new parts appearing for the first time are as follows: high-temperature resistant rails 103, mounted on fire-brick floor of furnace, but set at a very slight angle longitudinally of the said furnace and in the plane of the floor thereof, like herring-bone gear teeth to some extent, so that the rolling ingots will not contact continuously around one limited belt on their periphery, with said rails, but will shift the line of contact continuously, instead. Water-cooled ingot side-guides or stops are shown at 104. At 105 I have shown discs for controlling the forward movement of the ring-ingots, and keeping the latter squared with the desired straight line of travel through the furnace. These discs have wavy edges 106, for the purpose before cited, and are carried in suitable graphite bushed bronze or heavy-ball bearings at apex of the triangular chain-links 107, mounted upon pins carrying the rollers 108, riding within the heavy channels 109, suitably mounted upon the cross I-beams 110. The rolls 108 of the return portion of this chain, as shown below, ride upon the angles 111, mounted upon the brackets 112, carried by outer wall 113 of chain-tunnel, or the central wall 114 thereof. The chain 107 and discs 105 move forward through a channel 115 in the floor of furnace, this being kept narrow. 116 shows a maintenance-tunnel, with arches 117 into chain-tunnel. A motor-driven blower is indicated at B, connected by outlet tube O with the tunnel 116.

In Figure 7, the intermediate connecting plain chain-links 118 are shown, while 119 indicates an automatically swinging entrance door; 120 and 121 show the necessary fore-shortening of the figure to bring it within the limits of sheet, 122 indicates an extending end of furnace where extra heat can be applied to occasional ingots requiring this, and 123 shows one form of swinging exit door.

An alternative form of automatic opening roof exit door is shown at 124, 124a, mounted upon the heavy shafts 125, 125a, to which suitable counterweights and driving mechanism will usually be coupled, about as already explained in connection with similar parts 94 to 101 inclusive, in Figure 5, so that the description need not be repeated here. In some cases there might be two or more of such double doors, successively placed along the furnace.

In connection with the discs 105 used for determining the speed of self-propulsion of the ingots in their down-hill course, and spacing said ingots concomitantly, it will be noted that these discs do not here have to carry the weight of the ingots, the latter being fully supported by the fur-

nace rails 103, set in the floor at a very slight angle with the side walls of furnace, as before mentioned.

Furthermore, a large fraction of each disc 105 will be observed to lie below the general floor level of the furnace, while the projecting portion occupies the coolest available portion of the furnace interior, and if found necessary, in order to better enable these discs to withstand the high temperatures encountered, the entire lower maintenance and chain-tunnel system can very readily be kept under an ounce or so of excess pressure of cooled burnt gases, or of air, as by a small blower, for example, so that a gentle upward flow of relatively cooler gases can be maintained thru the slot 115, thus holding down the temperature of these discs.

The uptake flue 126 will usually be located near the ingot entering end of the furnace, while if a multiplicity of burners 127 be utilized, these will usually, but not necessarily, be distributed more or less along the sides of furnace, so as to give a hot-gas flow normally counter to that of the ingots.

In some cases, these burners will be grouped more closely together at points where the major part of the heating is to be done quickly.

The chain driving sprocket is shown at 128, its power-driven shaft at 129.

Referring now to Figure 8, one unit refractory is indicated at 130, its square shape being emphasized by a slightly heavier line, while depressed elements of the heavy surface fluting are indicated by the shaded area at 131, and the projecting elements by the clear areas 132. The position of T slot on opposite end is indicated above at 133, and in the lower half of the figure at 134, or at right angles to that above. This is in order that the same block may be used throughout, and still get the required fluting directions.

In Figure 9, a hexagonal block system is shown, one half of a two-part unit being emphasized as before, and the hexagons being split so that special blocks need not be added for the side-wall fit. Part numbers are the same as for Figure 8, except with an "a" added, for the successive elements. This block is best when a hexagonal furnace is to be used, as successive 60° shifts are easily made in fluting direction.

In Figure 10, I have shown an alternative "diamond-shaped" refractory system, using the same part numbers as in Figure 8, but with a "b" added, and emphasizing the shape of one unit by heavier line outline, as before.

This refractory has the great advantage of simplicity, as no fluting need be provided on its furnace or interior face, alternate entire rows of blocks being displaced up or down as indicated, to produce a fluting effect, which means that in regular continued service the older blocks can be used for the short elements as they wear off from the tremendous heat, the longer alternate rows being made up of the new replacements, as required from time to time. The diamond shape is, however, not quite as good for setting up a circular or hexagonal type of furnace, as the hexagonal brick is, as will be self-evident. All blocks are shown enlarged.

In Figures 11T, 11B, 11S, and 11E, "top", "bottom", "side", and "end" views, respectively, are shown for the square blocks, while Figures 12T, 12B, 12S, and 12E show the hexagonal, and 13T, 13B, 13S, and 13E show similar detailed views of diamond-shaped blocks, which require no further explanation here.

In utilizing a circular or hexagonal furnace in

which the general gas-flow is split two-ways from one side toward the final outlet, the general fluting slopes may be reversed on the second half of furnace, if desired, still utilizing the same refractory blocks throughout, without alterations of shape.

In Figure 14, the only new element, not previously described, is the bracket 97b, provided to support the transfer-arm end of shaft 97, extending back from the furnace door 94, and which bracket is in turn mounted upon the heavy cast-iron base 53a, indicated on this figure and on Figure 3. The meshing of gear 102 of Figure 5, with the gear 52a of Figure 3, is here plainly shown, whereby a properly timed interconnection is made between transfer-arm 50 and the entrance doors 94 and 94a into furnace 1.

It is believed that with the descriptions already given in connection with the several figures, the general mode of operation of my furnaces will be self-evident without further elaboration herein, the course of travel of the ingots into and through the one or two stages of furnaces, being obvious from Figure 4.

Certain very definite advantages accrue from heating up ingots while they are under slow rotation, preferably around a generating axis, when the said ingot is more or less closely circular in its exterior outline, as this motion brings all parts of the ingot in succession, into contact with substantially the same type of hot-gas flow, and the same temperature sequences, whereas an ingot lying stationary in a furnace may have widely different flame heats presented to its different faces, or projecting corners, or both, due to the normal burner differences, while one side of the ingot is usually more or less imbedded in the coke-breeze of floor, in customary types of "soaking pit", and hence out of contact with the flame.

The thin-walled ring ingot, which I prefer to use, is vastly better adapted to quick and uniform heating anyway, than the customary straight types of ingot, and in my furnace this heating is further speeded up, so that very definite advantages accrue from the vastly higher tonnage output, and ultra uniformity of the heating which the furnace of my invention makes possible.

Other advantages accrue from the simple ingot handling means provided.

Since temporary interruptions may occasionally occur in the centrifugal casting unit, or its immediate accessories, whereas it will be advantageous from the cost standpoint to keep the rolling mill in continuous operation, my provision of twin-furnaces capable of taking cold-ingots from the storage tracks, or red-hot ingots just out of the stripper, in any succession or proportions required, without interrupting the normal regular sequence of delivery to the mill, results in still further advantages accruing from the use of my furnace system.

Additional advantages result from my provision of means for rolling the ingots over and over as they progress through the furnace, over angularly laid rails, or over rotating-rolls which have a staggered tread, whereby "cold-streaks" or spots over the ingot are largely avoided.

The rolling progression further obviates the deep "scoring" or "galling" often produced in the ingot, when the latter is advanced by forcible skidding along the usual floor rails, or skids, while its surfaces are soft from the heat.

The speed of movement of my ingot-progress-

ing means is such as to carry the ingot several times around my annular type of furnace during the course of its normal heating up, so that every ingot is presented many times to the discharge position before its final removal.

This leads at once to the further great advantage that my furnace is 100% selective, since any ingot can be brought up to the discharge position, and a new one put in the furnace to replace it, irrespective of its position on the annular-carriage, and without in the least disturbing any other ingot on the platform. Any ingot which happens to be a little slow in heating up to the required pyrometer temperature, can be allowed to simply remain for another circuit or two around the furnace, until it is up to the required heat, yet without disturbing the normal ingress, or egress, of any other ingot in the series.

In Figure 3, I have shown a "discharging" type of transfer-arm only, but with self-evident modifications it may be readily converted to a "charging" arm, or into an "intra-furnace" type of transfer-arm, as required. Of course, all its motions may be under simple manual control, without any automatic interlock features, but I have illustrated what I consider to represent a preferred form.

Other advantages of my furnace system will be evident to anyone skilled in the art.

While I have herein illustrated and described one preferred embodiment of the apparatus constituting my invention, together with two alternative forms of the furnace proper, it will be understood that still further moderate changes in the construction, or arrangement of the parts, may be made without departing either from the spirit of my invention or the scope of my broader claims.

I claim:

1. An apparatus for heating ring-ingots, comprising a substantially annular furnace enclosure, a substantially circular moving-side-walk mounted horizontally in the floor of said furnace enclosure, a plurality of power-driven ingot-carrying means each combined with an ingot rotating means and an ingot spacing device all in one and all mounted operatively on said moving-side-walk and geared so as to function as the latter progresses, and a power-drive applied to progress said moving-side-walk around said furnace enclosure, said ingot spacing device being operative to hold successive hot ingots out of contact with each other during rotation, to obviate surface galling thereof.

2. An apparatus for heating cylindrical ingots, comprising a substantially circular furnace, a substantially circular moving-platform device mounted for circular advancement around said furnace in the floor thereof, an ingot-rotating mechanism mounted operatively above said device, a power-drive for said ingot-rotating mechanism, an intermittently operable power-drive applied to said device, a stop element and an indexing element attached to said device to operate said stop element and connected with the last mentioned power-drive to determine the position of stopping of said device.

3. An apparatus for heating cylindrical ingots, comprising a substantially annular furnace enclosure, an annular moving side-walk type of ingot-transport means mounted substantially horizontally in the floor of said enclosure, a plurality of combined rotating, supporting, and spacing means for said ingots and all mounted in succession upon said ingot-transport means,

power means applied to progress the latter means around said enclosure and to concomitantly rotate the said combined means, and an ingot-centering means mounted adjacent said ingot-transport means to align said ingots during transport.

4. An apparatus for heating cylindrical ingots, comprising a substantially annular furnace enclosure, a moving-side-walk device operatively mounted therein, a power drive applied to said device, a plurality of ingot supporting means mounted in succession around said device and operative also to rotate and to space said ingots apart, and a gearing mechanism connecting with said means to rotate the same as said device is advanced by said power drive.

5. A furnace for heating ingots, comprising a substantially circular enclosure, a moving platform device mounted for advance horizontally around said enclosure, a power drive applied to said device, an indexing mechanism providing for definite successive stop positions of said device in its advance around said enclosure, through connections with said power drive, and a power means applicable to lift one of said ingots at a stop position of said device and transfer said one ingot to a point outside said furnace, or into said furnace, as desired.

6. A furnace for heating ingots, comprising a substantially circular enclosure, a moving platform device mounted for horizontal advance around said enclosure, a power drive applied to said device, an indexing mechanism connectible to said power drive to determine the positions of successive stops of said device, and a manually operable selector means connected with said indexing mechanism to provide for running-past successive stops as desired, whenever no ingot transfers are to be made to or from said furnace.

7. A furnace for heating ingots, comprising an enclosure lined with refractory blocks, those on the ceiling forming projecting herringbone teeth with intermediate channels, all converging at an angle toward centre-line of said enclosure, for hot-gas directing purposes, and a moving-side-walk device mounted for ingot carrying purposes in the floor of said enclosure.

8. A furnace for heating ingots, comprising a substantially annular enclosure, a substantially annular refractory ceiling in said enclosure, said ceiling being formed of a herringbone grouping of toothed projecting members and alternate channel elements substantially centering in said annular enclosure, and provided for gas directing purposes, power driven means effective to advance said ingots around said enclosure while substantially centred under said herringbone elements and members, and a device determining the stoppage of said means at indexed positions around said enclosure.

9. In an ingot heating system, parts comprising a substantially annular furnace enclosure, a moving side-walk type of ingot transport means mounted operatively in the floor of said enclosure and arranged for substantially horizontal advance within the same, a power-drive for said means, an index means connected to said power-

drive to determine stop positions of said transport means, an ingot transfer-arm mounted adjacent to said enclosure and arranged to lift said ingot therefrom at a stop position of said transport means, and a second ingot transport means operable outside said enclosure and positionable to receive an ingot from said transfer-arm at outer end of the swing thereof.

10. A claim as in 6 but in which the said furnace enclosure is characterized as having ingot doors in the ceiling thereof, operable for ingress or egress of an ingot at any stop position of said moving platform device.

11. An apparatus for heating circular ingots, comprising a substantially circular furnace enclosure, a moving side-walk device mounted about horizontally in the floor of said enclosure, a power-drive arranged to advance said device around said enclosure, a limit switch connectible to terminate the operation of said power-drive when required, an indexing element mounted to contact with portions of said device so as to function said limit-switch at definite successive positions in the travel of said device, and a manually operable switch connected to maintain said power-drive in continuous operation independent of the action of said limit-switch, when desired, as when no ingots are being withdrawn.

12. An apparatus for heating substantially cylindrical ingots, comprising a substantially circular furnace enclosure, a plurality of rotatable ingot supports, a moving-side-walk device mounted for advance around said enclosure and providing a mounting for said supports which are spaced uniformly therearound, power means to advance said device, gearing providing concomitant rotation of said ingot supports during said advance, and an ingot positioning device operable to substantially centre said ingot on said supports during the advance thereof.

13. A claim as in 12 in which said furnace enclosure is characterized by the provision of a maintenance tunnel under said moving-side-walk device.

14. A claim as in 12 in which said furnace enclosure is characterized by the addition of a maintenance tunnel under said moving-side-walk device, said tunnel providing a channel for the supply of cool air to the operative mechanism of said device.

15. The method of heating substantially cylindrical ingots, which comprises the steps of continuous slow rotation of said ingots to give uniformity of heating, the directing repeatedly of considerable portions of the heating gases toward the normally under-heated central sections of said ingots for the same reason, the continued separation of said ingots both from each other and from the floor in order to obviate the usual galling up of the outside surfaces as where such contacting is allowed, and the prevention of circular cold streaks around said ingots by the utilization of non-regular lines of contact with the hot metal thereof by the supporting and rotating means.

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