

Aug. 6, 1968

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3,395,904

ROTARY FURNACE WITH ROTATABLE CHAMBER

Filed July 1, 1966

3 Sheets-Sheet 1

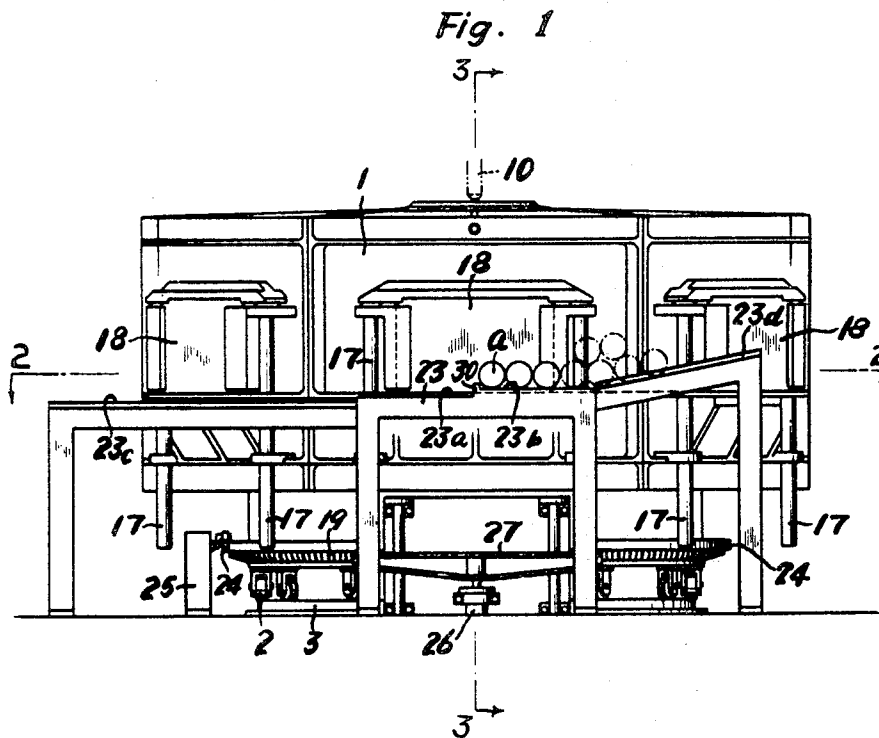


Fig. 6

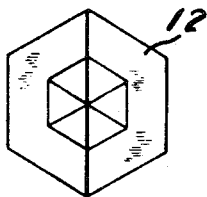
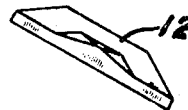


Fig. 7



Fig. 8



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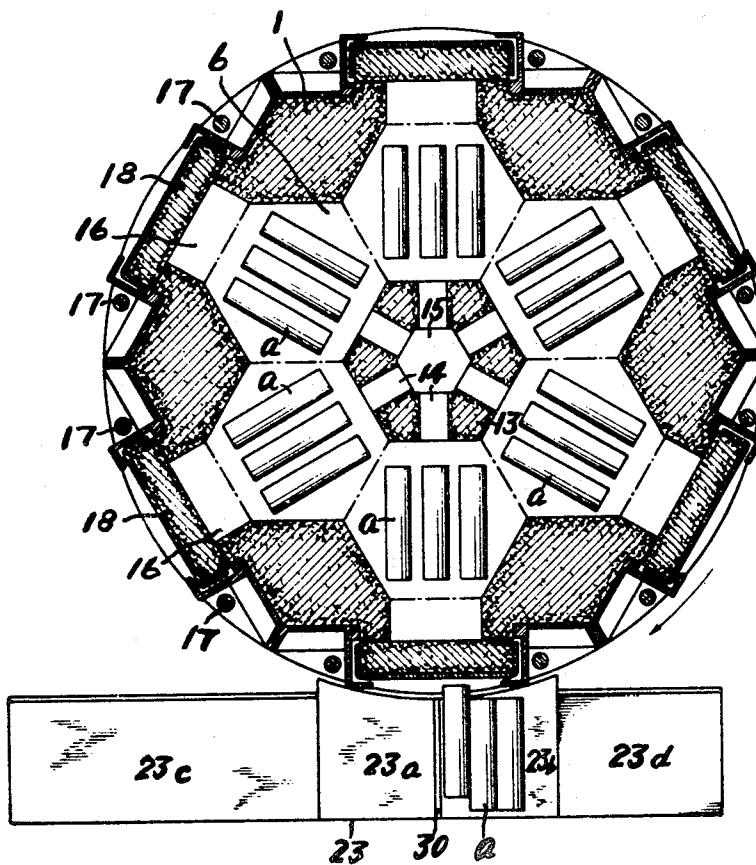
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Fig. 2



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Fig. 3

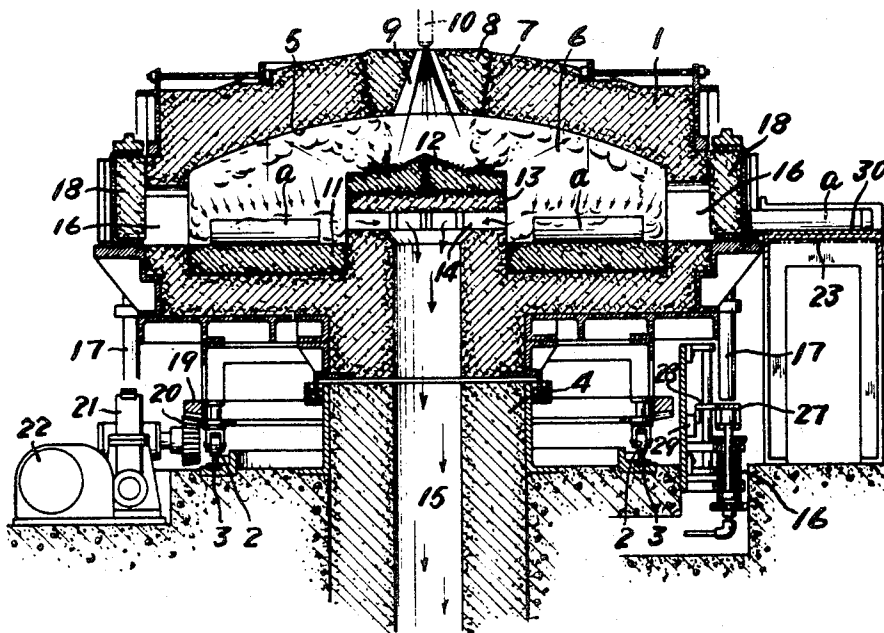


Fig. 4

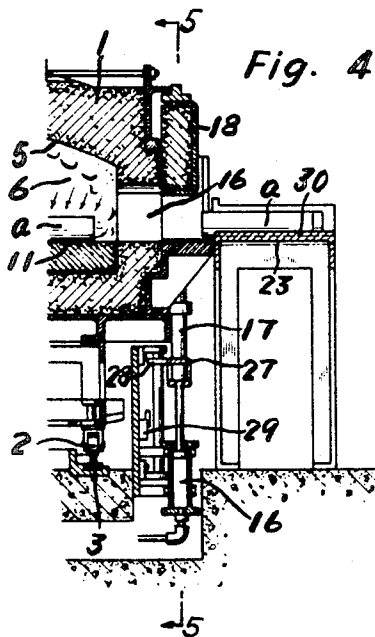
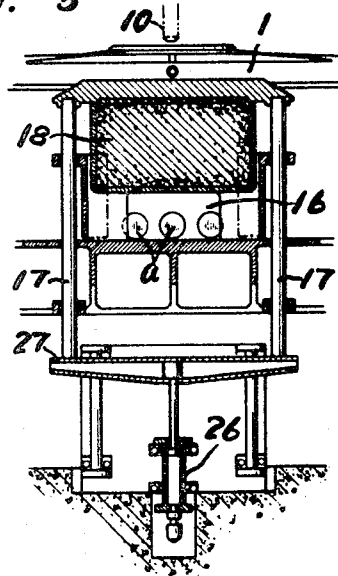


Fig. 5



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ROTARY FURNACE WITH ROTATABLE CHAMBER

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ABSTRACT OF THE DISCLOSURE

A rotary furnace with rotatable chamber rotatably supported by means of circular rail and wheels for predetermined periodic rotation in conjunction with the operation of charging and discharging the pieces treated, and the said chamber being defined by a domed ceiling and a hearth and the ceiling is provided at the center thereof with means for jetting the flame into the chamber, and the hearth has beneath the said flame jetting means a baffle plate for permitting turning the jetting flame from the ceiling along the shape of top surface of the baffle plate for diffusing the flame in predetermined directions for various predetermined heat-treatments.

This invention relates to a horizontal hearth type rotary furnace in which the entire heating chamber of the furnace is rotatable instead of just furnace hearth.

In the conventional rotating type furnace that heats a large quantity of metallic pieces on a rotating hearth, the rotating hearth is disposed in a fixed furnace body, and the pieces to be heated are charged onto and discharged from the rotating hearth through a charging opening provided in a portion of the fixed furnace body. Owing to the extreme thermal expansion of the rotating hearth because of the heating thereof during operation, it is the practice in order to overcome any difficulty in rotating the hearth due to sticking of the rotating hearth to the fixed furnace body, even when the rotating hearth expands because of heating thereof during operation of the furnace, to construct the rotating hearth with a relatively large clearance between the periphery of the rotating hearth and the opposed peripheral face of the fixed furnace body. However, oxides (scale or scraps) or portions of the pieces to be heated get caught in this clearance, and this is liable to damage the hearth or block rotation thereof. Such a furnace, because of this construction, is extremely poor in heating efficiency, and numerous defects occur during practical use thereof, such as in charging and discharging of pieces to be heated, inspection, repair and the like.

It is an object of the present invention to provide a rotary furnace in which the heating chamber is defined by a hearth and a domed ceiling in the furnace body, which body is supported so as to rotate freely on several wheels on a circular rail. Exhaust openings which communicate with the air outside the furnace are provided in the periphery of a reverberatory block which projects upwardly from the hearth opposite a stationary heavy oil burner that is directed into the heating chamber from the center of the domed ceiling. Charging openings for the heating chamber are provided at certain intervals around the periphery of the furnace body. A door is provided for each charging opening which closes the charging opening and the door opens only when the charging opening coincides with the handling stand provided at the side of the furnace body during the intermittent rotation of the furnace body.

It is a further object of the invention to provide a structure which makes the rotation of the furnace body smooth, as well as making possible the heating of a large

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quantity of pieces uniformly and with a high efficiency by means of a single heavy oil burner.

The invention will now be described in connection with the accompanying drawings, in which:

FIG. 1 is a front elevation view of the furnace according to the present invention;

FIG. 2 is a sectional plan view taken on line 2—2 of FIG. 1;

FIG. 3 is a vertical sectional view taken on line 3—3 of FIG. 1;

FIG. 4 is a view of a portion of the furnace as shown in FIG. 3 showing the charging and discharging door open;

FIG. 5 is a sectional view taken on line 5—5 of FIG. 4;

FIGS. 6 and 7 are plan and side elevational views, respectively, of the reverberatory block; and

FIG. 8 is a perspective view of half the reverberatory block of FIGS. 6 and 7.

The furnace to be described in connection with the drawings is used for heating pieces to be forced, such as pieces of round steel bar. The furnace comprises a rotatable furnace body 1 which has wheels 2 mounted thereon which run on a circular rail 3 beneath the furnace. The bottom of the furnace is in rotatable and airtight relationship with a main pedestal 4. A heating chamber 6 is defined by a domed ceiling 5 and a hearth 11. A tapered hole 7 is provided in the top of the domed ceiling 5, in which hole is fitted a burner tile 8. The tile 8 is fitted in the tapered hole 7 so that it can be easily positioned and removed therefrom. In a burner hole 9 in the tile 8 is an oil burner 10 for burning heavy oil, the burner 10 being stationary with respect to the furnace body 1 and mounted on an oil supply means (not shown) outside the furnace body 1. The burner 10 directs a flame downwardly into the interior of the chamber 6. At the center of the hearth 11 is a projection or pedestal 13 having a baffle plate 12 on the top thereof opposite the burner hole 9. Exhaust openings 14 extend radially out of the pedestal 13, opening out of the peripheral surface thereof, and at the inner ends thereof they are in communication with an exhaust bore 15 extending downwardly through the main pedestal 4 with which the furnace body 1 turns in substantially airtight relationship.

The top of the baffle plate 12 is shaped so as to reverberate the flame from the oil burner 10 which jets downwardly through the burner hole 9, and to diffuse the flame widely and toward the ceiling 5 of the heating chamber 6, for example in the pattern shown in FIG. 3 of the drawings. The projection on the baffle plate should have the same general shape as the peripheral shape of the baffle plate 12. For example, when the plate is hexagonal, as shown in FIG. 2, in order to conform to the pattern of the heating areas in the furnace, the projection should have a hexagonal shaped pyramid on the top thereof, as shown more clearly in FIGS. 6—8, in order to diffuse the flame uniformly over the widest possible area of the chamber. When the plate 12 is circular, the projection can be conical. Moreover, in order to make the manufacture, mounting, and repair and replacement easy and economical, the plate 12 can be made in a plurality of segments, as shown in FIGS. 6—8.

An appropriate number of charging and discharging openings 16 are provided at spaced intervals along the chamber wall. In the embodiment shown, there are six such openings, one in each of the six sides of the hexagonal chamber. Each of the openings is provided with a door member 18 mounted on lifting rods 17 which in turn are mounted so as to be movable up and down on the outside of the furnace body 1. On the bottom periphery of the furnace body 1 is mounted a ring gear 19 in mesh

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with a driving pinion 20 driven in turn by a motor 22, such as an electric motor, on the base through a speed reduction gear 21.

In order to provide for intermittent rotation of the furnace body 1 around its central axis on the track 3, a limit switch 25 can be provided which is actuated by a cam head 24 which extends outwardly from the ring gear 19, there being one cam head 24 for each opening 16 and door 18. Thus, when the cam head 24 strikes the limit switch 25, the electric motor 22 is stopped for a certain period of time with the opening 16 corresponding to the particular cam head at a handling stand 23 at the side of the rotating body.

At a point coinciding with the position of the handling stand 23 is a means for lifting a door 18, which means comprises a support head 27 on which the lower ends of the rod 17 rest, and a motive means for moving said support head up and down, such as a fluid piston-cylinder lifting mechanism 26. The lifting mechanism 26 can be controlled either manually, or can be caused to operate by means of the limit switch which is actuated when the housing 1 reaches the appropriate position during its rotation. The length of time that the door 18 will remain raised can be controlled manually or by means of a timer switch (not shown) connected in the operating circuit for the lifting mechanism 26. Likewise, the motor 22 can be restarted manually when the door 18 has been lowered, or it can be started automatically by limit switch 29 which is engaged by a projection 28 on the movable member of the lifting mechanism 26. Thus, when the door 18 has been completely closed, after the heated pieces have been discharged and unheated pieces charged through the opening 16, the rotation of the furnace body 1 is resumed.

The handling stand 23, as shown in the drawings, has a receiving table 23a on a level slightly lower than bottom surface of the opening 18, and a delivery table 23b on a level slightly higher than the bottom surface of the opening 18. A separating flange 30 is provided between the receiving table 23a and the delivery table 23b in order to hold the unheated pieces in place while heated pieces are removed from the furnace and conveyed away on a level or slightly downwardly inclined forwarding table 23c adjacent the receiving table 23a. A feeding table 23d is attached to the delivery table 23b, and is inclined downwardly toward the delivery table 23b for feeding pieces to be heated either automatically or semi-automatically.

It is of course possible to provide additional handling stands if desired, and to provide door lifting means thereat, and to arrange to deliver unheated pieces to the furnace at one such stand and remove heated pieces at another such stand.

The hearth 11 in the heating chamber 6 is constructed of fire bricks or other fire resisting materials and is constructed so that the pieces thereof can be passed into and out of the chamber 6 through the openings 16 or the fitting hole 7, and as with the baffle plate 12, it is desirable to construct the hearth in pieces so that it can be readily replaced if it is damaged by a violent blow or from the heat. The six charging openings are provided so that access can be gained to all sides of the hexagonal baffle plate 12 and the pedestal 13, as the drawing shows. Hexagonal heating chambers are formed between the pedestal 13 and the charging openings 16, and the hexagonal hearths thereof are constructed so as to be separable into a plurality of pieces so that they can be passed in and out of openings 16 and hole 7 together with the pieces of the baffle plate.

In operation, the major portion of the flame from the oil burner 10 for the heavy oil which is directed downwardly from the burner hole 9 in the center of the burner tile 8 in the central portion of the ceiling of the furnace body, strikes the baffle plate 12 and heats it red hot. In addition, the flame reverberates and is diffused, by virtue of the polygonal pyramidal or conical projection on the top face of the baffle plate 12, uniformly over a wide area

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toward the ceiling and heats the ceiling red hot as well. After heating the entire heating chamber to a high temperature, it is exhausted through the exhaust openings 14 and the exhaust passage 15.

The pieces to be heated are laid on the hearth 11 of the heating chamber 6 after having been charged through the charging opening 16, and are heated uniformly by being exposed to the high temperature in the heating chamber. When the pieces to be heated have been charged into the heating chamber through the charging opening 16 and the door 18 is closed, either by a timer switch or a manually actuated switch, the projection 28 strikes the limit switch 29 and the electric motor 22 is operated. The furnace body 1 rotates while the action of the fixed burner 10 continues as described above. The furnace body 1 stops when a cam head 24 corresponding to the next charging and discharging opening 16 and provided on the side of the furnace body strikes and actuates the limit switch 25 and stops the operation of the electric motor 22. Since the stopping position of the furnace body 1 is determined so that the next opening 16 coincides with the handling stand 23, the lifting rods 17 that control the door 18 for the charging opening stop right above the supporter head 27 on the fluid hoist 26. At the same time as the furnace body stops due to the actuation of the limit switch 25, the fluid that actuates the fluid lifting mechanism 26 is caused to flow. Alternatively, a pushbutton electric switch can be provided to be manually actuated to accomplish the same result. The fluid lifting mechanism is lifted, the lifting rods 17 positioned on the supporter head 27 are lifted, and the door 18 connected to the rods is lifted. It will be seen that it is possible to open only the charging opening 16 that is positioned at the handling stand 23. There is no means to lift the rods 17 controlling the doors 18 of the other openings.

Thus, the pieces *a* to be heated in the heating chamber 6 that are charged into the chamber through the charging opening are exposed to a high temperature and are heated uniformly for the period of time it takes the furnace body to rotate intermittently through the angle to where the pieces are discharged. In the construction shown in the drawing, the rotation is through 360°. The heating temperature and the intermittent rotating speed of the furnace body and the number of handling stands can be selected so as to keep the pieces constantly at the optimum temperature for the purposes of the treatments to follow the heating, such as forging and hardening, and also depending on the shape, composition, volume, etc. of the pieces.

The heated pieces *a* that are in the heating chamber which is open at the handling stand 23 must be transferred rapidly away from the charging opening, and in the structure of the invention as shown in the drawings this is accomplished by the provision of the receiving table 23a being on a level slightly below the bottom edge of the charging opening. After the pieces which have been heated are removed from the furnace, they are transferred to their next destination by the forwarding table 23c, or a conveyor or the like adjacent the receiving table 23a. Since the unheated pieces *a* are charged into the heating chamber through the same charging opening through which the heated pieces have been removed from the delivery table 23b which is on a level slightly higher than the bottom edge of the charging opening and the pieces *a* are supplied automatically from the inclined feeding table 23d, the operation of removing heated pieces and charging unheated pieces through the charging opening is very rapid and relatively easy.

After the heated pieces *a* have been removed from the furnace and the unheated pieces *a* charged in their place, the fluid supply to the fluid lifting mechanism 26 is again caused to flow, either by a pre-set timer means or manually, so that the door 18 is lowered to close the charging opening and simultaneously the limit switch 29 is actuated by the projection 28 to operate the electric motor 22 so as to rotate the furnace. When the next charging

opening 16 reaches the position in front of the handling stand 23, the motor 22 is again stopped and the above described operation is repeated.

Because none of the rods 17 other than the rods which are at the handling stand 23 will be above the supporting head 27 on the fluid lifting mechanism 26, none of the other doors will be opened at the same time the door at the handling stand 23 is opened, and it is therefore possible to prevent the temperature of the heating chamber from dropping unduly and to make the heating of the pieces even because there can be no accidental opening of any of the other doors. The thermal efficiency of the furnace will likewise be increased.

Moreover, with the rotary furnace of the invention, because the furnace body 1 is freely rotatable on the wheels 2 on the circular rail 3, and because during the intermittent rotation of the furnace, the main pedestal 4 and the furnace body 1 are maintained in substantially airtight relationship so that air can enter the furnace chamber 6 only through top and peripheral openings thereof and can be withdrawn only through the exhaust openings 14 and the exhaust passage 15, the interior of the chamber 6 is heated throughout to a substantially uniform high temperature by the flame directed through the opening 9 at the top of the furnace chamber from the single burner 10. It is easy to rotate the furnace smoothly and intermittently and at the desired speed and still maintain this heating. Consequently, a large quantity of pieces can be heated to a certain temperature continuously, uniformly, and equally and with a large degree of precision within a relatively small working space. The efficiency of the operation is thereby increased and in addition the subsequent treatments of the metal pieces, such as forging, hardening, and the like, can be performed so as to produce uniform quality products with consistency. The ability consistently to heat the pieces evenly to a certain temperature for a certain time without damage to the pieces makes it possible to prevent adverse effects due to faulty heating on the pieces during subsequent treatments. This is particularly true since the intermittent rotation of the furnace body and the opening and closing actions of the door which is at the handling stand can be interconnected so as to be performed automatically or semi-automatically so that the heating is to the optimum temperature for the particular shapes, nature of the material and the size of the pieces and the uses to which they are to be put. Moreover, the apparatus can be used for long periods of time without it being necessary to shut it down, and when repairs are necessary, the various segments of the different parts can be readily replaced.

What is claimed is:

1. In a rotary furnace of the type in which the entire heating chamber of the furnace is rotated, the combination comprising a heating chamber having a hearth and a domed ceiling, a circular rail beneath said heating chamber, a plurality of wheels on said heating chamber and running on said circular rail, drive means coupled with said heating chamber for driving it in rotational movement along said circular rail and comprising a ring gear on said furnace, a motor having a pinion gear engaged with said ring gear, a plurality of cam heads on said chamber corresponding in number to the number of charging openings, a limit switch adjacent the rotational path of said cam heads and connected to said motor, said cam heads being positioned to engage and actuate

said limit switch when the corresponding charging opening is at said handling stand, said domed ceiling having an aperture at the top thereof, a burner directed into said chamber through said aperture, fixed burner mounting means above said chamber and unconnected therewith on which said burner is mounted, a baffle plate projecting upwardly from the hearth of said furnace beneath said aperture, said furnace having exhaust openings beneath said baffle plate and an exhaust flue extending downwardly beneath said baffle plate into which said exhaust openings open, a fixed exhaust flue beneath said chamber with which said downwardly extending exhaust flue is in rotational sealing engagement, said chamber having a plurality of charging openings around the periphery thereof, doors over each charging opening, and at least one handling stand adjacent the periphery of said chamber with which the charging openings are successively aligned when the furnace chamber is rotated.

2. The combination as claimed in claim 1 in which said baffle plate has a polygonal periphery with sides corresponding in number to the number of charging openings through which the treating pieces are charged and discharged for the efficient reverberation of the flame for good heat-treatment.

3. The combination as claimed in claim 2 in which said baffle plate has at least three sides and the inner peripheral wall of the chamber extends radially inwardly into the space between adjacent treating piece charging openings for improving the flame reverberation effect.

4. The combination as claimed in claim 2 in which said baffle plate has a pyramidal projection on the top surface thereof having a number of sides corresponding to the number of sides in the periphery thereof so that the reverberation of the flame to the treating pieces can be efficiently performed.

5. The combination as claimed in claim 2 in which the exhaust openings correspond in number to the number of sides in the periphery of the baffle plate.

6. The combination as claimed in claim 1 in which said doors move vertically, and further comprising lifting means for said doors, said lifting means comprising at least one lifting rod on each door, and hydraulic hoist means at said handling stand engageable with the lifting rod on the door at said stand for lifting the door so as to open the changing opening.

7. The combination as claimed in claim 1 in which said handling stand comprises a receiving table extending across at least parts of the charging opening and being at a level slightly below the level of the bottom of the charging opening, and a delivery table extending across the remainder of the charging opening and being at a level slightly higher than the bottom of the charging opening, and a separating flange between said delivery table and said receiving table and projecting upwardly from the level of said delivery table to prevent pieces to be charged from moving from the delivery table to the receiving table.

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