Sept. 9, 1941. S. R. HARDWICK ET AL 2,255,166

MEANS FOR HEAT-TREATING METAL SHAPES

Filed July 15, 1940 3 Sheets-Sheet 1

Fig. 1.

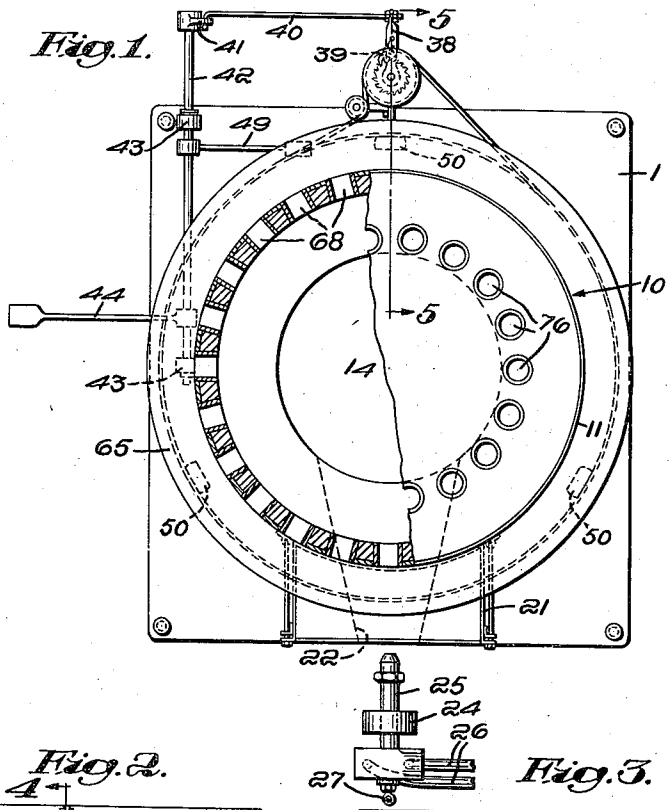






Fig. 2.

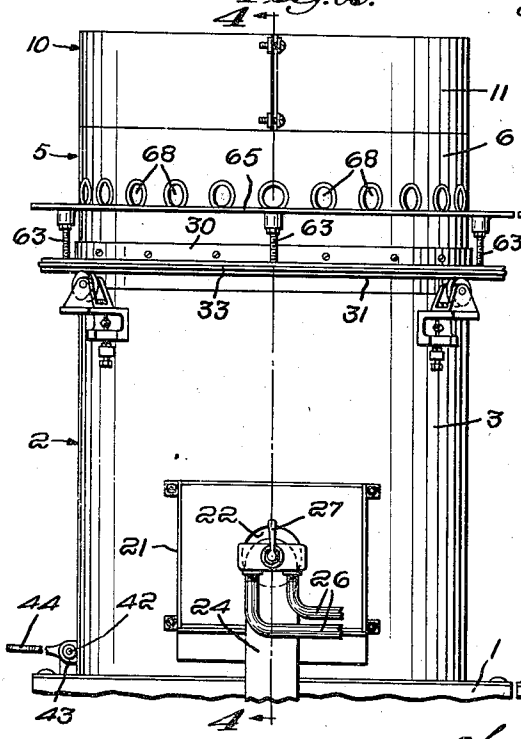
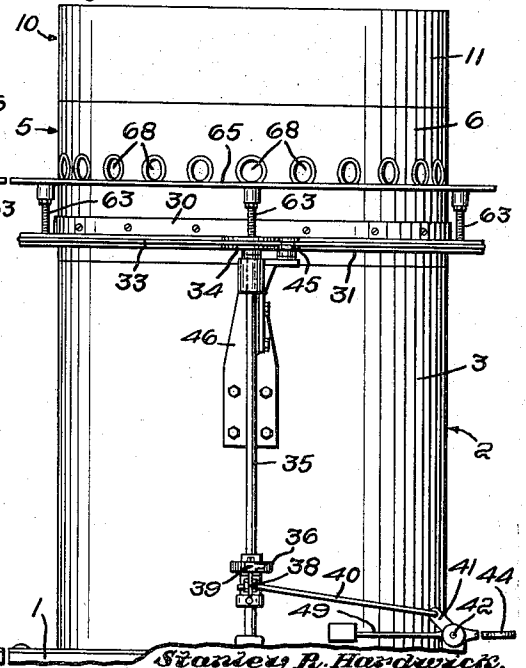



Fig. 3.




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MEANS FOR HEAT-TREATING METAL SHAPES

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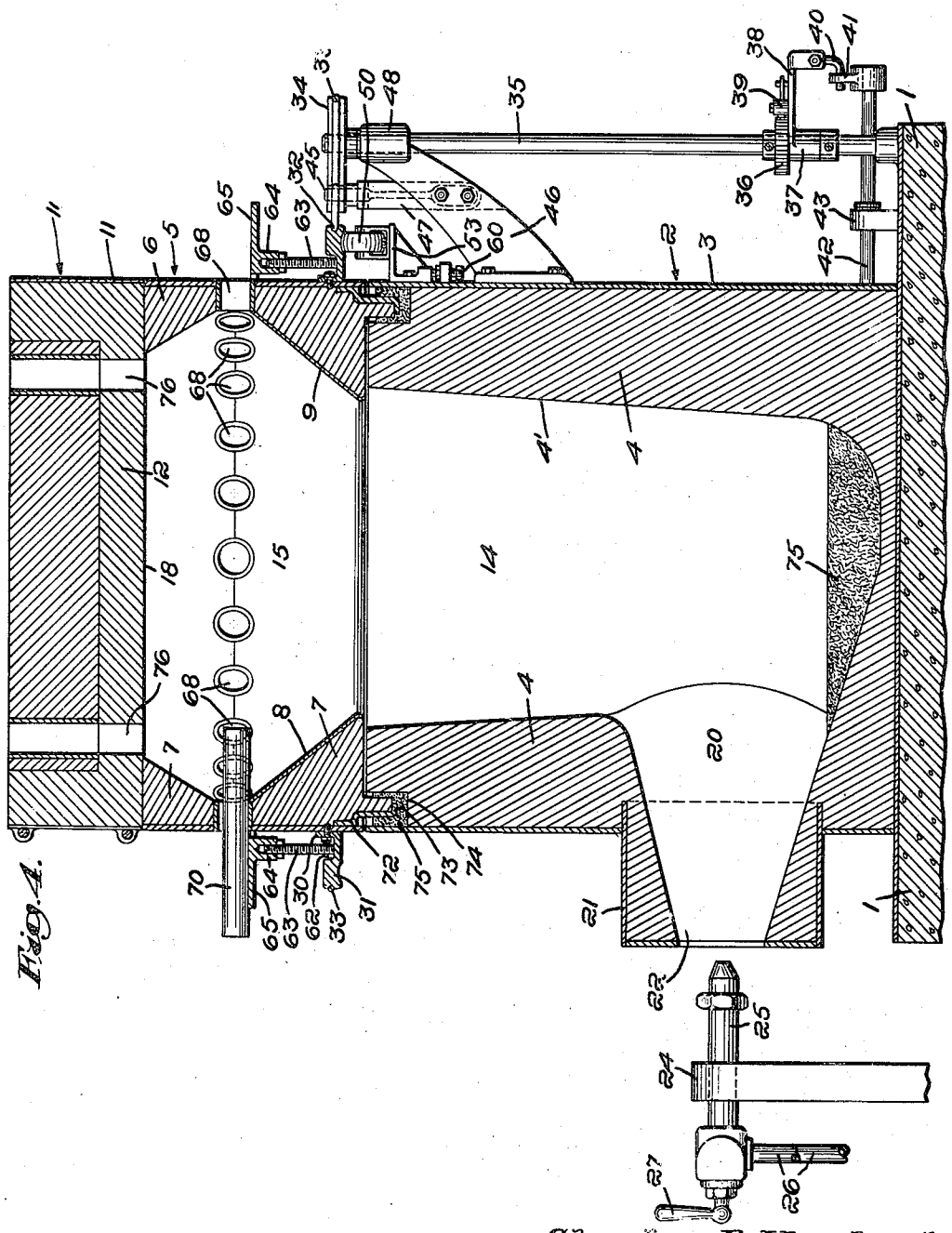


Fig. 4.

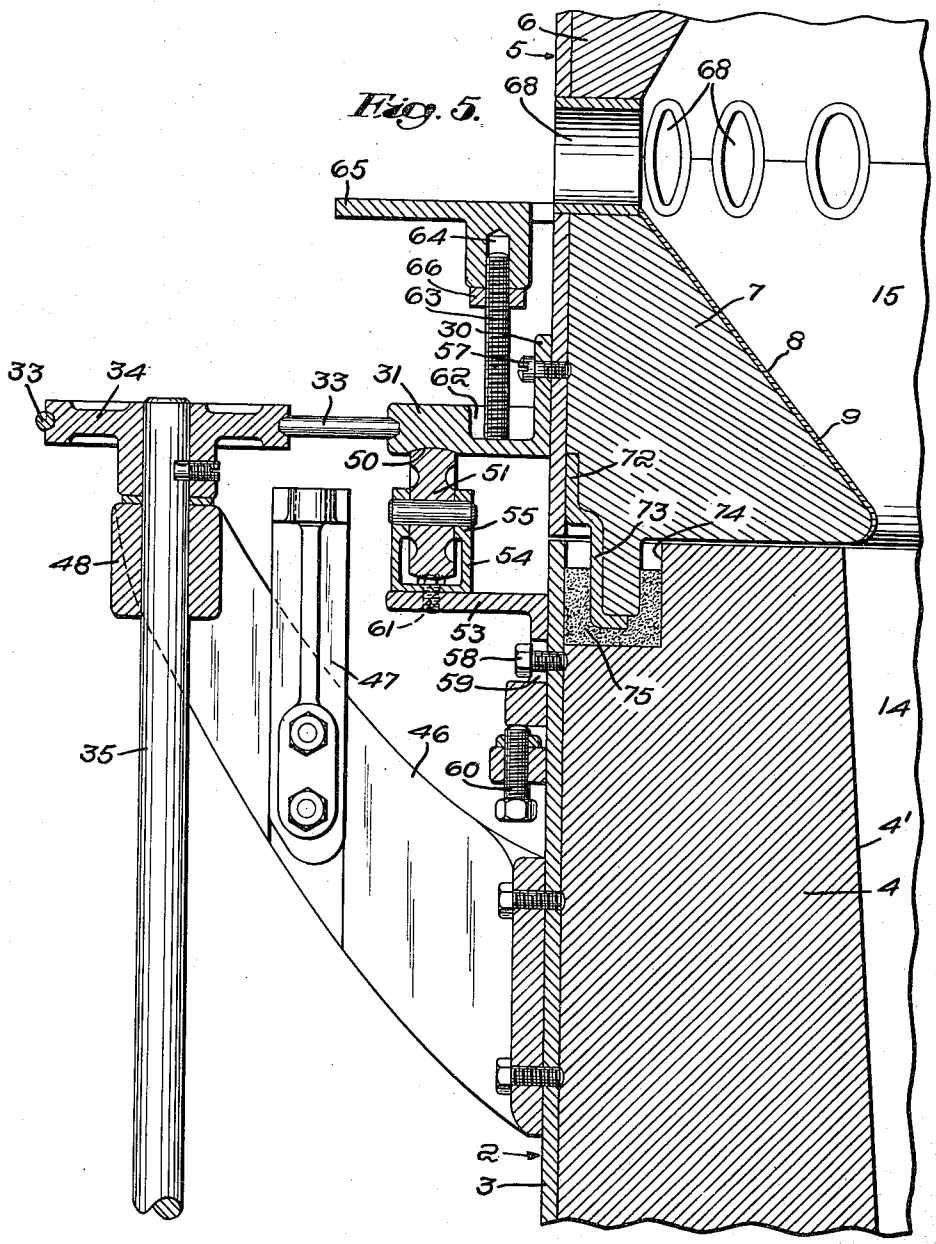
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MEANS FOR HEAT-TREATING METAL SHAPES

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Fig. 5.




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2,255,166

# UNITED STATES PATENT OFFICE

2,255,166

## MEANS FOR HEAT-TREATING METAL SHAPES

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Application July 15, 1940, Serial No. 345,486

4 Claims. (Cl. 266—5)

This invention relates to means for heat treating metal shapes in such a manner as to effect a substantially uniform heating of portions of the shapes in an expeditious manner and without changing the composition of the metal by the addition of elements which might affect its qualities.

Heretofore, in heat treating metal blanks, furnaces adapted for the use of charcoal or coke have been generally employed but furnaces using such fuels possess certain disadvantages such as a tendency toward heat variation, excessive care in operation, high cost of fuel and a tendency of the combustion products to deposit on the surface of the metal. In view of these facts the use of petroleum oil has been suggested for overcoming the difficulties above mentioned, and providing a readily controlled combustion and uniform temperature, as well as freedom from deleterious combustion products. The cost of fuel oil of the type employed is much less than that of coke or the like.

The use of heavy petroleum oil as a fuel possesses, however, certain disadvantages which have heretofore prevented its adoption for this purpose in connection with the types of furnaces previously employed. While heavy petroleum as a fuel provides a readily controllable heat, it is what may be termed a quick heat of high concentration, and if the furnace is so designed as to bring the flame into direct or substantially direct contact with the metal, the highly concentrated heat may prove injurious to the metal, the qualities of which are better preserved by providing a relatively large volume of heat at a temperature sufficiently low to heat the metal without injury. Many heavy petroleum oils now generally employed as fuels are also characterized by having a large sulphur content, in addition to the carbon, which is one of its principal constituents. If the oil flame is so positioned as to bring these elements into contact with the metal while in their nascent states, their avidity for elements with which they combine causes to a greater or less degree their absorption by the metal near its surface, thus changing to some extent the character of the latter.

One of the objects of the present invention is to provide a heat treating furnace adapted to overcome these disadvantages inherent in the use of petroleum as a fuel by providing a relatively large heating chamber wherein the metal shapes to be treated are spaced a sufficient distance from the flame to be out of direct contact therewith and subjected to the action of the heated combustion products only after the passage of these products through a distance sufficient to moderate to some degree their flame temperatures and permit such components as sulphur and carbon, existing in a free state, to form stable oxygen compounds before being brought into contact with the metal to be treated. For this purpose, I prefer to provide a heating chamber of substantial extent, so formed that the metal shapes to be heated are spaced a substantial distance from or located out of direct line with the flame, which consideration may lead even to shielding the metal shapes from direct action of the flame by interposing refractory material, such as that forming the walls of the chamber, into position to act as baffles.

Another object of the invention is to provide in a furnace of this character an adequate air space for supplying air to the burner, not only in a quantity sufficient for combustion requirement, but also in such excess as to provide a supply of heated oxygen to combine with free carbon and sulphur present in the flame before the heated gases come into direct contact with the metal shapes.

Another object of the invention is to provide in a furnace of this character a heating chamber lined with refractory material and so formed as to change the direction of travel of the heated gases out of the path of the flame itself and into deflected or indirect contact with the metal shape to provide a more uniform and gradual heating of the latter.

Another object of the invention is to provide in a furnace of this character a plurality of flues or gas exhaust passages so positioned with relation to the locations of the metal shapes as to bring the heated gases into intimate contact with the metal shapes after the temperatures and composition of the combustion gases have become stabilized by traversing a portion of the chamber.

A further object of the invention is to provide in a device of this character a slag deflecting incline for the rapid and uninterrupted passage of slag from the metal shapes into a portion of the furnace where it will not interfere with the operation of the furnace parts and from which it may be removed readily.

A further object of the invention is to provide in a device of this character a heating chamber of substantial extent adapted to maintain a high temperature throughout and shaped

to avoid the accumulation of slag at points within its working areas.

A further object of the invention is to provide in a rotating furnace of the character described a seal between the relatively movable parts which will not interfere substantially with the movement of the furnace parts, but will prevent the escape of heated gases as well as the inflow of unheated air between the rotating sections.

Other objects and advantages of the invention relate to various improved details of construction and novel arrangements of the parts as will be more fully set forth in the detailed description to follow.

Referring to the drawings:

Figure 1 is a plan view of the furnace, partially in section, showing the arrangement of certain of the shape supporting openings and their arrangement in the wall of the rotating section, as well as the flue openings associated therewith, and a portion of the mechanism employed for rotating the rotatable section;

Figure 2 is a side elevational view of the furnace, and taken from that side upon which the burner is located, showing a portion of the shape carrying table and the adjustable supporting means therefor;

Figure 3 is a side elevational view of the furnace, taken from the side opposite to that shown in Figure 2, and showing a part of the mechanism employed for rotating the rotatable furnace section;

Figure 4 is a vertical sectional view through the furnace, taken substantially along the line 4—4 of Figure 2; and

Figure 5 is an enlarged vertical sectional view through one wall of the furnace, taken substantially along the line 5—5 of Figure 1, and showing certain of the operating elements in section.

While a furnace embodying our invention is suitable for use with many metal shapes, such as bolts, twist drills, reamers, rivets, double end hammer parts, nasal forgings, and the like, we herein show and describe as illustrative of our improvements a furnace particularly adapted for heating portions of metal shapes in the form of rods preliminary to striking up the ends thereof to form heads, as is the practice in the manufacture of bolts, and the improvements described are shown in their application to a rotating furnace of a type such as is commonly employed in bolt making.

The furnace may comprise a base 1 and a lower fixed furnace section 2 having an outer metal supporting shell 3 of any suitable character and formed in any desired manner, as in sections or in the form of an integral casting.

The metal shell 3 is provided with a suitable refractory lining 4 which may be formed from any appropriate heat resistant material. The interior surface of the lining 4 is preferably inclined slightly inwardly and downwardly from top to bottom. The upper section 5 of the furnace is mounted for rotation upon the lower fixed section 2 and comprises an outer metal shell or casing 6 supporting a refractory lining 7 formed from any suitable heat resistant material, such as kaolin or the like. The interior surface 8 of a portion of the refractory lining 7 is inclined inwardly and downwardly at a considerably greater angle of inclination than the interior surface of the lining 4, and projects inwardly somewhat beyond the upper portion of the lining 4. The inwardly and downwardly inclined area 8 of the lining 7 may be provided with a coating of silicon carbide or the like for a purpose which will be more fully described.

A cover section 10 is mounted on the upper section 5 of the furnace in such a manner as to rotate therewith and serve as a part thereof in the operation of the furnace, while being adapted for removal and replacement when desired. The cover section 10 is provided with an outer metal shell or casing 11 supporting a refractory lining 12 formed of any suitable fire resistant material and which may be in the form of bricks or sections suitably held in position within the metal shell 11.

The furnace as an operating unit may be considered as comprising the fixed base section 2 and the upper rotatable section 5, the latter section including the cover section 10 as an element, and being mounted to rotate upon the lower fixed section 2. The sections 2 and 5 of the furnace are thus shaped to provide an internal heating chamber 14 common to both sections, which chamber is preferably of an elongated form having the major axis thereof extending substantially vertically. The upper metal heating portion 15 of the chamber 14 is of materially greater transverse diameter than the lower and intermediate portions thereof to provide for the reception in the enlarged portion 15 of a considerable quantity of heated combustion gases which have become more or less stabilized as regards both temperature and composition during their passage through the lower and intermediate portions of the heating chamber. The intermediate chamber portion, of less diameter than the upper portion 15, serves to direct the flow of the combustion gases toward the top wall 18 of the heating chamber instead of into direct contact with the metal shapes to be heated, thereby assisting in the stabilization of the gases and shielding the metal shapes to some extent from direct contact therewith until the temperature of the gases has become equalized and the components of the gases changed into more or less stable compounds.

The lower portion of the heating chamber has an outwardly extending passage 20 formed in one face thereof and an auxiliary casing 21 is secured to the outer shell 3 of the fixed section 2 of the furnace outwardly of the passage 20, which casing is provided with an opening 22 located in substantial alignment with the passage 20 in the base section. A support 24 is provided for a fuel oil burner 25 located outwardly of the casing 21 and in position to direct a flame through the opening 22 and passage 20 into the lower portion of the heating chamber 14 in such a manner that the direction of the flame will be transversely of the major axis of the heating chamber and toward a portion of the wall thereof located opposite to the passage 20.

Supply pipes 26 are suitably connected to the oil burner 25 for supplying fuel and air thereto, and suitable valve means 27 is provided for controlling the air and fuel supply to the burner. By locating the oil burner outwardly of the lower section 2 of the furnace in such a manner as to direct the flame into the heating chamber through the opening 22, a sufficient quantity of air is carried along by the flame and made available in a heated condition to provide the necessary oxygen for combining with such carbon and sulphur as may be present in the combus-

tion gases during the passage of the gases upwardly in the heating chamber.

The metal casings 3 and 6 of the fixed and rotatable sections are substantially equal in external diameter and are located in substantial alignment to provide for the rotation of the upper section relative to the lower section about an axis of rotation which may coincide substantially with the major axis of the heating chamber.

Means for rotatably supporting the furnace section 5 relative to the section 2 may include an annular plate 30 extending around and firmly secured to the casing 6 adjacent to the lower edge thereof. The annular plate 30 is provided with an outwardly extending flange 31 which may have teeth formed at its edge to engage a pinion or a sprocket, or as herein shown may have a groove 32 formed in and extending throughout the outer circumferential edge thereof, which groove is adapted to receive an endless cable 33 having a portion located outwardly of the flange 31 and passing over a grooved pulley 34 mounted on a vertical shaft 35. The shaft 35 carries a ratchet wheel 36 fixedly secured thereto, and rotatably supports a sleeve 37 having a radial arm 38 carrying a detent member 39 in position to engage operatively with the ratchet face of the wheel 36. The radial arm 38 is connected by a link 40 with a lever arm 41 carried by a rock shaft 42 mounted in bearings 43 located adjacent to the base of the furnace. A pedal lever 44 is keyed or otherwise fixedly secured to the rock shaft 42 and extends outwardly therefrom into position to be manipulated by the operator for rotating the grooved pulley 34 and thereby imparting step-by-step rotation to the upper furnace section 5 through the operation of the mechanism above described. A grooved idler pulley 45, which may be supported from a brace 47 on a bracket 46 carried by the lower fixed portion of the furnace, engages the endless cable 33 to hold the same taut. The bracket 46 has a bearing 48 for rotatably supporting the vertical shaft 35 carrying the grooved pulley 34 and the ratchet wheel 36. A weighted lever arm 49 may be fixedly secured to the rock shaft 42 to return the radial arm 38 and detent member 39 carried thereby to their initial positions after being actuated by the operator to rotate the shaft 35.

The outwardly extending flange 31 of the annular plate 30 is provided upon its lower face with a continuous circular groove 50 adapted to serve as a track for a plurality of supporting rolls 51, each carried by the casing 3 of the lower fixed section of the furnace for supporting the upper section 5 so as to permit its rotation relative to the lower section 2. The casing 3 of the lower furnace section supports any suitable or desired number of brackets 53 spaced from each other circumferentially of the furnace section 2, and all located substantially equi-distant from the upper edge of the casing 3. Each of the brackets 53 carries a support 54 which may be mounted for adjustment radially of the axis of the furnace, and each support is provided with bearings 55 rotatably supporting one of the rolls 51 previously described. In this way, the upper section 5 of the furnace is supported in alignment with the lower portion 2 thereof and in such a manner as to be capable of being rotated by the operator for advancing the metal shapes progressively into position to be removed from the furnace.

The annular plate 30 carried by the casing 6 may be secured thereto in any suitable manner as by bolts or the like 57. The brackets 53 carried by the casing 3 of the lower furnace section may be secured to the casing by bolts 58 passed through slots 59 formed in the brackets, and adjusting bolts 60 may be provided for engaging the brackets 53 to adjust the same vertically. Each of the supports 54 carried by brackets may be adjustable in a direction radially of the axis of the furnace and secured in adjusted position relative to its bracket by means of a holding screw 61 or the ilke. In this way means is provided for leveling the annular plate 30 as well as the upper furnace section 5, and for adjusting the position of supporting rolls 51 to compensate for wear.

The outwardly directed flange 31 of the annular plate 30 is provided upon the upper face thereof with a shallow circular groove 62 in which are seated a plurality of threaded standards 63 located in spaced relation with each other circumferentially of the upper furnace section 5. Each of the standards 63 is threaded within a socket 64 formed in the lower face of an annular supporting table 65 which surrounds the casing 6 of the upper furnace section. Each threaded standard 63 may be provided with an adjusting nut 66 serving as means for varying adjustably the vertical position of the supporting table 65 relative to the plate 30 and for obtaining horizontal adjustment thereof.

A plurality of radial openings 68 are formed in the wall of the upper furnace section 5 communicating with the interior of the heating chamber from points outwardly of the upper furnace section. These openings are located in a common horizontal plane and are spaced from each other throughout the circumferential extent of the upper frame section to receive the metal shapes 70 to be heated. The openings 68 may be located substantially flush with the upper face of the supporting table 65, whereby the outer end portion of each metal shape 70 rests upon and is supported by the table 65, while the inner end portion of each metal shape projects into the enlarged portion 15 of the heating chamber.

A gas seal is provided for the circumferential opening between the meeting edges of the metal shells 3 and 6 of the furnace sections 2 and 5 to prevent the escape of heated combustion gases or the inflow of air from outwardly of the furnace between the meeting edges of the sections. The sealing means may comprise an annular plate 72 secured to the inner face of the casing 6 of the upper furnace section in any suitable manner as by spotwelding or otherwise. The plate 72 is provided with a continuous downwardly extending flange 73 overlying the circular opening between the casings 3 and 6 and extending downwardly to fit within a circular groove 74 formed in the refractory lining 4 of the section 2. The circular groove 74 contains a suitable packing 75, which may be of fire resistant mineral wool or other suitable material against which the flange 73 engages closely to provide a continuous seal.

The downwardly and inwardly inclined surface 8 of the refractory lining 7 carried by the upper furnace section is provided with a surface coating 9 of silicon carbide, or the like, to prevent adherence of slag thereto as it falls from the inner ends of the metal shapes 70 while they are being heated. The shape and inclination

of the internal surface 8 of the refractory lining 7 carried by the upper furnace section is such as to provide an inclined path for the slag and to discharge the same generally inwardly of a portion of the refractory lining 4 of the lower furnace section 2 where it may fall to the base of the heating chamber, as indicated at 75.

The cover section 10 is provided with a plurality of flue openings 76, spaced from each other circumferentially of the upper enlarged portion 15 of the heating chamber for location adjacent to and in regularly spaced relation with the inner ends of the metal shapes 70 projecting within the heating chamber. It is regarded as desirable that the flue openings 76 be regularly arranged with respect to the metal shape receiving openings 68, that is, one arrangement which has proved satisfactory in practice is to provide one flue opening 76 for and located between each pair of adjacent metal shape receiving openings 68. The total areas of the flue openings should bear a definite relation to the total areas of the metal shape receiving openings 68, and it has been found that where the total area of the flue openings 76 amounts to 75 per cent of the total areas of the metal shape receiving openings 68 satisfactory conditions of operation are obtained.

The metal shape receiving openings 68 are located in that portion of the wall of the furnace section 5 adjacent to the maximum diameter of the enlarged portion 15 of the heating chamber, whereby the ends of the metal shapes projecting within the chamber are shielded from direct contact with the heated gases entering the enlarged portion 15 of the chamber until the gases become mingled by deflection from the top wall 18 of the heating chamber. The positioning of the flue openings 76 in regular proximity to the metal shape receiving openings 68 tends to effect a substantially uniform heat treatment of the several metal shapes through contact with the gases after a substantial stabilization of the temperature and composition of the gases has been accomplished.

It is regarded as desirable that the burner 25 be so positioned as to direct the combustion products into the heating chamber in a direction angularly related to the major axis of the heating chamber to engage directly one wall of the chamber and thus be deflected backwardly as they are drawn upwardly into the chamber in changing directions so that an intermingling of the combustion gases may take place and the temperataure and composition thereof may become stabilized to some degree before reaching the upper enlarged portion 15 of the chamber.

In the operation of the structure above described, after starting the burner 25 and bringing the internal temperature of the heating chamber to a point adequate for the purpose of heat treating the metal shapes, metal shapes 70 are inserted in the openings 68 in such a manner that they will rest upon the annular supporting table 65 and have portions projecting through the openings 68 and into the heating chamber.

The machine operator may adjust the valve means 27 for controlling the air and fuel supply to the burner 25 as conditions may require, and operate the pedal lever 44 for advancing the line of metal shapes into position for removal through the actuation of the grooved pulley 34 and endless cable 33 operated by the pedal member 44. As each metal shape is removed by the operator for manipulation, as in the present case forming a head thereon, he replaces the removed metal shape with an unheated metal shape and continues this operation while rotating the upper section of the furnace with a step-by-step movement. In this way, and after the initial loading of the furnace, each metal shape is subjected to the influence of the heated combustion gases in the portion 15 of the heating chamber during one complete revolution of the rotating furnace section 5. The operating mechanism actuated by the pedal member 44 results in a step-by-step rotation of the upper furnace section 5, each movement being adapted to bring a metal shape into position for removal and replacement by the operator.

What we claim is:

1. In a means for heat treating metal shapes, a furnace comprising fixed and rotatable sections having top and side walls enclosing a common elongated heating chamber the major axis of which is substantially vertical, that portion of the heating chamber located adjacent to the top wall thereof having a cross-sectional area materially greater than that of a portion of the chamber located immediately below the upper enlarged portion, a series of openings in the side wall of the rotating section at the level of the greatest internal cross-sectional area thereof, means adjacent said side openings for supporting a plurality of metal shapes within the chamber portion of enlarged cross-sectional area adjacent to the side wall thereof and outwardly of the inner face of the side wall of the lower restricted chamber portion, said top wall being provided with a series of spaced-apart flue openings located adjacent to said metal shape supporting means, and means for directing heated combustion gases into the heating chamber below the restricted portion thereof and in a direction transversely of the major axis of the chamber.

2. In a means for heat treating metal shapes, a furnace comprising fixed and rotatable sections having top and side walls enclosing a common elongated heating chamber the major axis of which is substantially vertical, that portion of the heating chamber located adjacent to the top wall thereof having a cross-sectional area materially greater than that of a portion of the heating chamber located below the upper enlarged portion, the side and top walls of the enlarged portion of the heating chamber being provided respectively with metal shape receiving openings and a series of flue openings located in substantially uniformly spaced relation with each other circumferentially of the chamber to provide for a substantially uniform association of heated combustion products passed upwardly through the chamber with each metal shape.

3. In a means for heat treating metal shapes, a furnace comprising fixed and rotatable sections having top and side walls enclosing a common elongated heating chamber the major axis of which is substantially vertical, that portion of the heating chamber located adjacent to the top wall thereof having a cross-section area materially greater than that of a portion of the heating chamber located below the upper enlarged portion, the side and top walls of the enlarged portion of the heating chamber being provided respectively with circumferentially spaced metal shape receiving openings and a series of flue openings located in substantially uniformly spaced relation with each other and in which the total area of the flue openings approxi-

mates seventy-five per cent of the total area of the shape receiving openings to provide for a substantially uniform association of heated combustion gases passed upwardly through the chamber with each metal shape.

4. In a means for heat treating metal shapes, a furnace comprising fixed and rotatable sections having top and side walls enclosing a common elongated heating chamber the major axis of which is substantially vertical, that portion of the heating chamber located adjacent to the top wall thereof having a cross-sectional area materially greater than that of a portion of the heating chamber located below the upper enlarged portion, the inner face of the chamber wall located adjacent to the base of the upper enlarged chamber portion being inclined inwardly and downwardly to merge into the inner face of the more restricted portion of the chamber wall and having a slag deflecting surface on the inwardly and downwardly inclined face thereof.

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