April 26, 1949. H. J. NESS 2,468,456

FURNACE MUFFLE AND SUPPORTING MEANS THEREFOR

Filed April 15, 1944 3 Sheets-Sheet 1

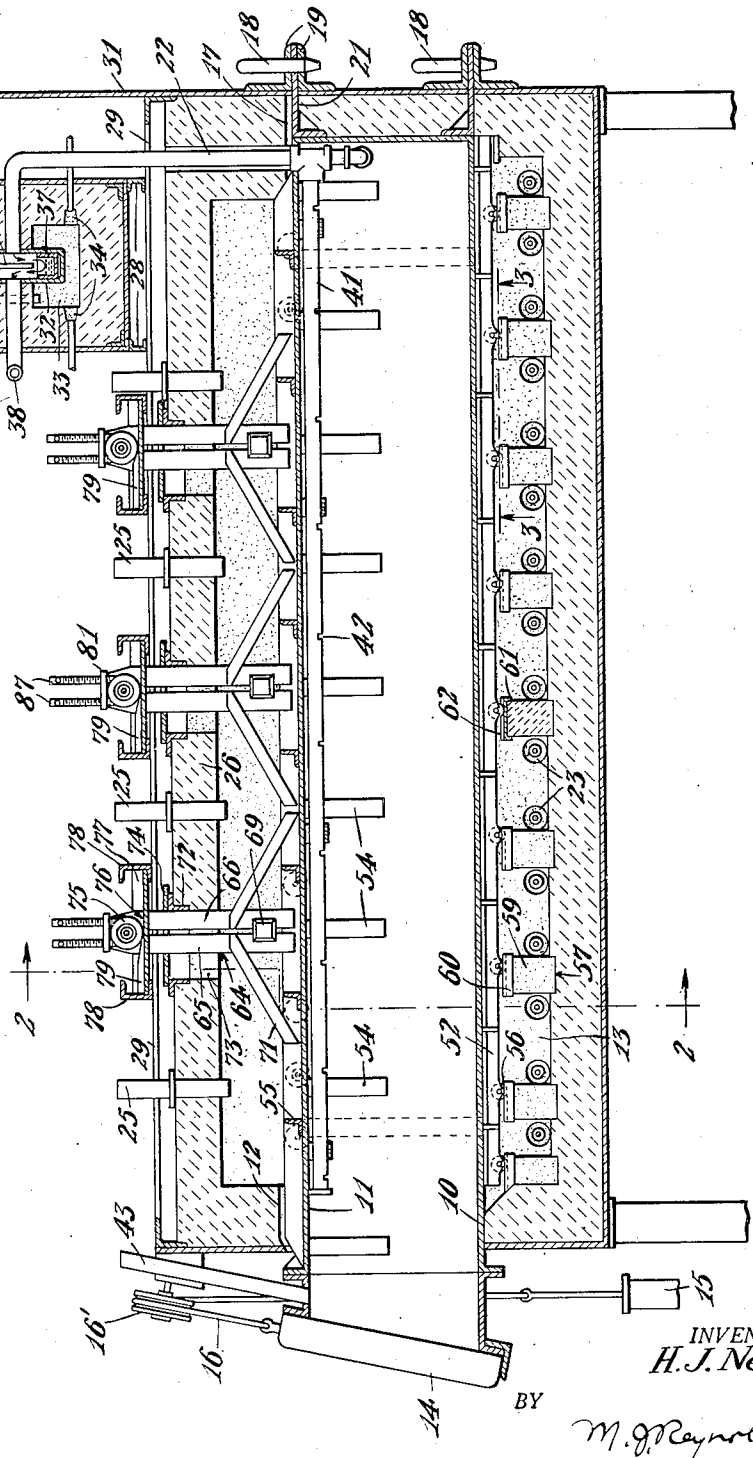


Fig. 1

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Fig. 2

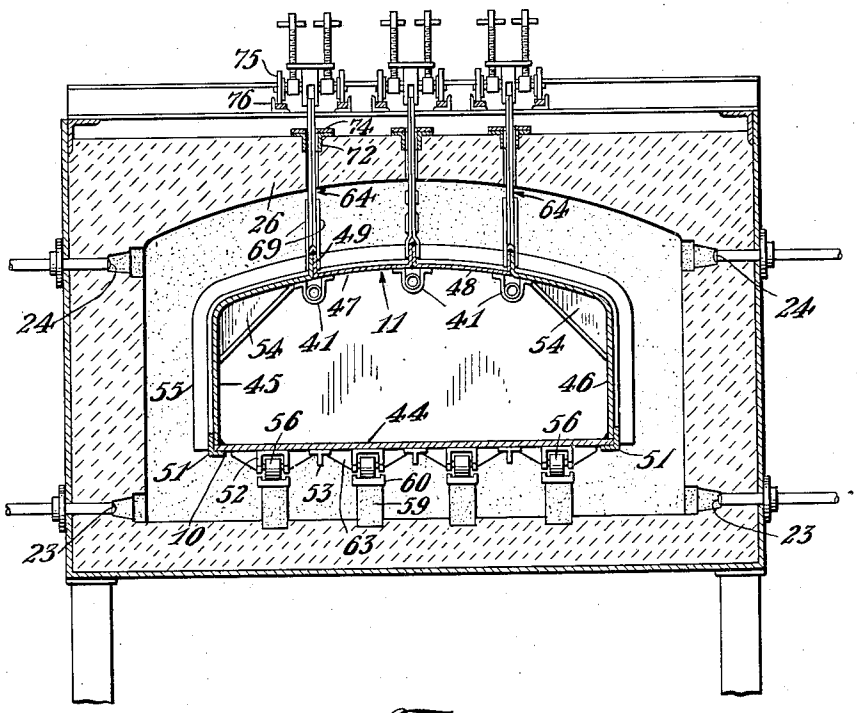


Fig. 3

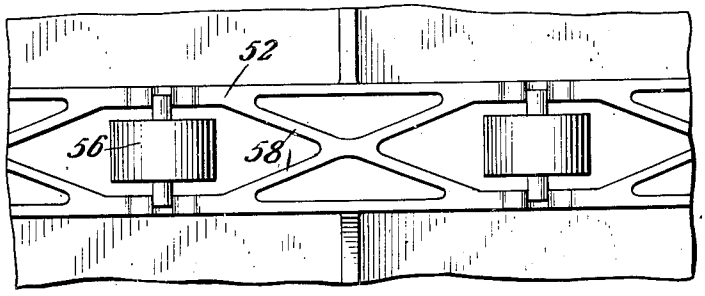
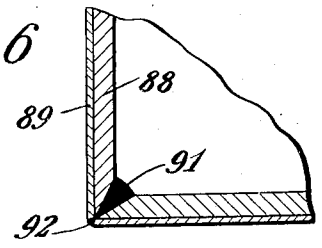


Fig. 6



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Fig. 4

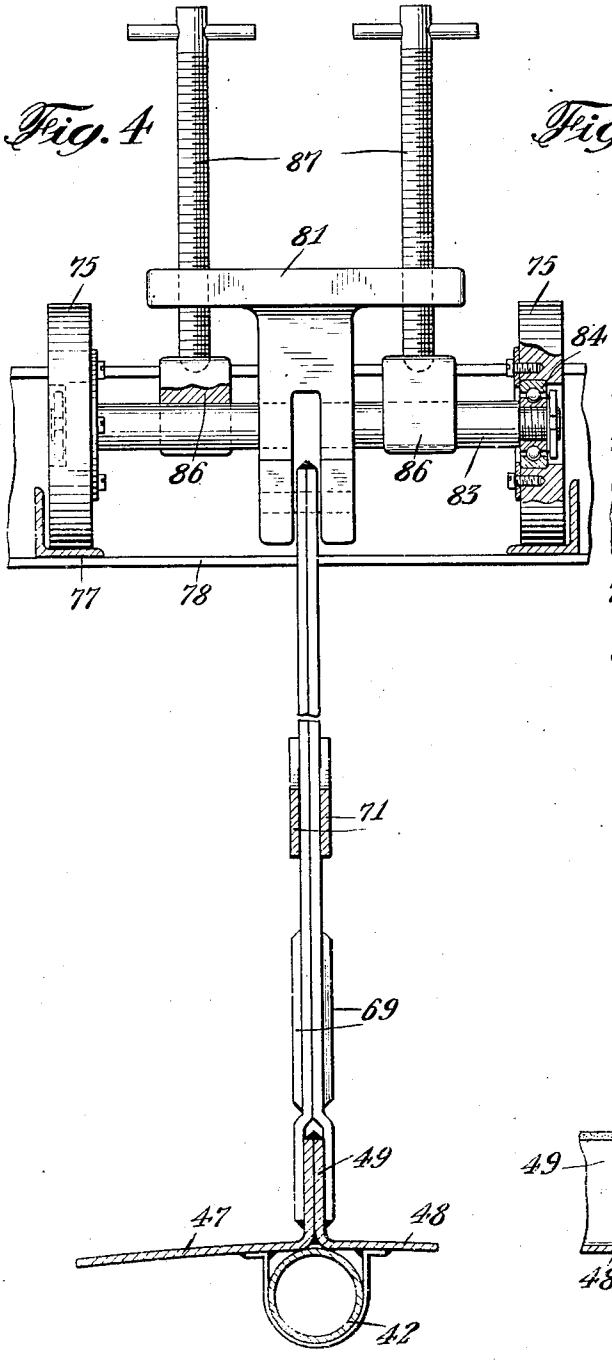
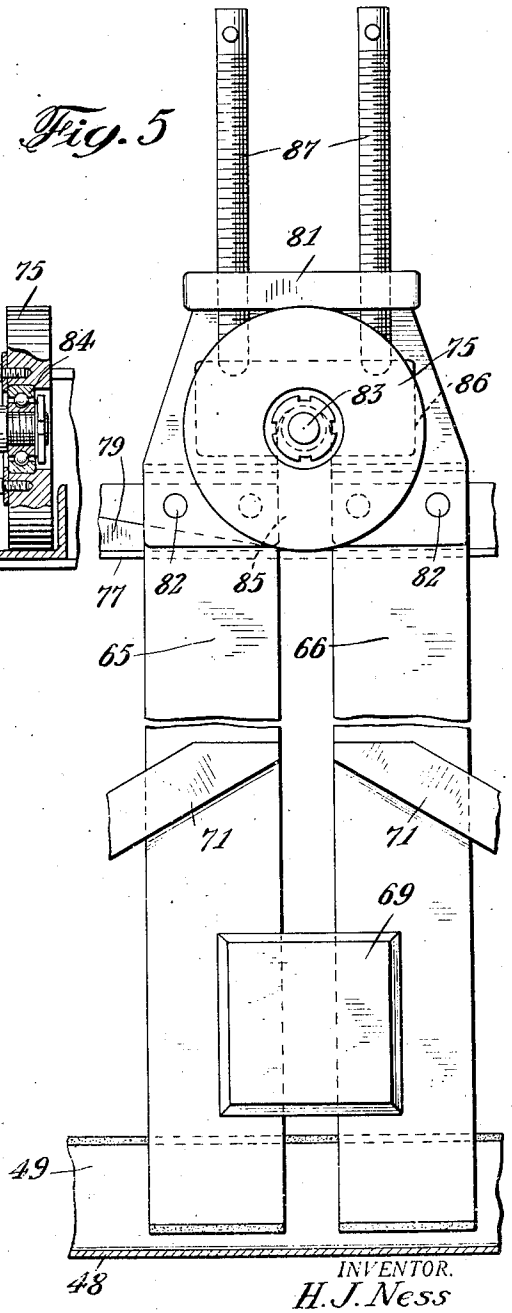


Fig. 5



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2,468,456

FURNACE MUFFLE AND SUPPORTING MEANS THEREFOR

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Application April 15, 1944, Serial No. 531,209

12 Claims. (Cl. 263—42)

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This invention relates to industrial furnaces and more particularly to muffles for such furnaces and to the manner of supporting the same within the combustion chamber.

In furnaces of the controlled atmosphere type in which the parts to be treated are surrounded by a protective atmosphere such as, for instance, that disclosed in my copending application Serial No. 455,720, now Patent No. 2,394,002, filed August 20, 1942, and entitled "Metallurgical furnace," of which the present application is a continuation in part, it is essential that the heating chamber be completely isolated from both the combustion gases employed to heat the work and the external atmosphere. For this purpose a work enclosing chamber or muffle, usually composed of a heat resisting alloy, is employed. The muffle may be of either the vertical or horizontal type, the present invention being concerned only with the latter type. Small horizontal muffles do not present any great difficulty but in larger sizes, adapted for heavy loads, two main problems are encountered, first, the supporting of the muffle and its load over a large span, at elevated temperatures at which the strength of the metal of which the muffle is composed is greatly reduced, and the accommodating of the supporting means to the longitudinal and vertical expansion of the muffle as its temperature is raised and lowered, and secondly, the supporting of the roof of the muffle, so as to prevent collapse thereof under similar conditions of high temperature and expansion.

The principal object of the present invention is to overcome the above enumerated difficulties.

Another object is to provide a muffle supporting means which will not impose frictional stresses on the muffle during the movement thereof in expanding and contracting.

Another object is to effect an economy of material in the muffle and its supporting structure.

Other objects and advantages will hereinafter appear.

In accordance with the present invention, I provide both longitudinal and transverse reinforcement for the muffle body whereby the latter may be composed of a relatively light stock and construct the body thereof of rolled sheet bent to shape and welded into a composite structure. I have found that such structures have increased strength, greater uniformity in thickness of wall, and greater density and freedom from porosity than cast material. The base of the muffle is supported on rollers at a number of longitudinally and transversely spaced points in such manner as to distribute the weight over a large area of

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the muffle base, and the arch or roof of the muffle is supported from above by mechanism which compensates both for the rise and longitudinal movement thereof. The roof support also includes a truss arrangement whereby great rigidity is imparted to the roof and its distributed load concentrated at a relatively few points of support outside of the heated area of the furnace.

The invention will be best understood by reference to the accompanying drawings in which:

Fig. 1 is a vertical sectional view of a furnace embodying the present invention;

Fig. 2 is a sectional view on the line 2—2 of Fig. 1;

Fig. 3 is a bottom view of a section of the reinforcement and roller supporting structure for the underside of the floor of the muffle, along the line 3—3 of Fig. 1;

Fig. 4 is a front elevation of one of the muffle roof supporting units;

Fig. 5 is a side elevation of the structure shown in Fig. 4; and

Fig. 6 is a fragmentary sectional view of a muffle fabricated from clad metal plate.

Referring first to Fig. 1, the furnace there shown comprises a horizontally disposed muffle 10 of substantially rectangular cross section and having an arched roof 11. It is composed preferably of a heat resisting metal, such as nickel or nickel-chromium alloy. However, since the interior of the muffle is continuously provided with a protective or non-oxidizing atmosphere, it may be provided with an iron or steel lining, preferably welded at one end to a nickel or nickel-chromium alloy jacket, or for low temperature usage, it may be composed entirely of copper plated iron or steel.

The muffle 10 extends, at its forward end, through a rectangular opening 12 in the refractory combustion chamber 13, terminating in a door 14, operated in any suitable manner, as by an air cylinder 15 connected thereto by a flexible cable 16 passing over a pulley 16'. The rear of the muffle is shown terminating within an opening 17 in the rear wall of the combustion chamber 13 and is rigidly anchored to the rear of the furnace by removable pins 18 passing through angle brackets 19 and rearwardly extending plates 21 secured to the rear wall of the muffle. Therefore, as the muffle is heated, it expands forwardly. This has two advantages. First, it retains the muffle stationary at the point of entrance of the atmosphere inlet pipe 22 and it enables the forward movement of the muffle at any point to be accurately calculated and com-

pensated for by the muffle supporting structure, as will hereinafter appear.

The muffle 10 is heated by two series of burners 23 extending into the combustion chamber 13 at opposite sides thereof below the muffle 10 and two oppositely disposed series of burners 24 above the muffle. The burners 23 and 24 are provided with a combustible mixture of air and gas in any desired manner, as shown for instance in my co-pending application Serial No. 495,113, filed July 17, 1943, and entitled "Work handling and quenching mechanism for furnaces." The combustion chamber 13 is vented by a plurality of pipes 25 extending through the arched roof 26 of the combustion chamber.

The atmosphere admitted into the muffle through the inlet conduit 22 is of the nature disclosed in my aforesaid application Serial No. 455,720, and briefly comprises the products of combustion of a gaseous fuel and air which have been partially dried by condensation and further dried and rendered innocuous to the work to be treated by the addition of the vapor of lithium or of a compound or compounds thereof. The lithium or lithium compound generating means 27 is shown, in Fig. 1, mounted on the roof of the furnace on channel beams 28 supported on angle reinforcing brackets 29 extending about the top inner wall of the furnace shell 31. This generator comprises a heat resisting alloy pot 32 suspended within a combustion chamber 33 formed in a mass of refractory insulation and provided with suitable burners 34 and a vent 35. The pot 32 is provided with a removable cover 36 through which a lithium compound containing cup 37 may be inserted in or removed from the pot. The pot 32 and its contained cup are heated to a sufficient temperature to produce a vapor pressure of lithium or a compound of lithium above the cup, and this vapor is entrained by a suitable carrier gas admitted into the pot 32 through a conduit 38 extending from suitable gas generating and drying apparatus not shown. This gas is deflected by a plate 39 appended to the cover 36 so as to pass over the cup 37 and thence into the conduit 22 by which it is conveyed into the muffle 10. It is distributed in the muffle through a group of three dispersion pipes 41 secured along the roof of the muffle and having a series of spaced slots 42 therein. The atmosphere is exhausted from the muffle through a vent 43 at the forward end thereof.

The muffle 10, as stated, is preferably composed of rolled stock suitably bent and welded into a composite structure. While the composite parts may be differently arranged, in the embodiment illustrated I have shown a muffle composed of a bottom sheet 44, two side sheets 45 and 46 of a somewhat lighter stock welded to the bottom sheet, and two top sheets 47 and 48 of still thinner stock having upwardly turned flanges 49 welded together and to an upturned flange of each of the side sheets. The side and top sections of the muffle, therefore, approximate a tapered arch, giving the required strength with maximum economy of metal. This economy of metal is not possible with cast muffles since it is necessary to employ relatively heavy walls in order to properly cast the metal. The thin walls of the composite welded muffle, moreover, permit faster heat transfer from the outer combustion gases to the inner atmosphere and to the work parts contained therein, thereby shortening the heat cycle and effecting increased production by the furnace. Cast metal structures, moreover, from the nature of their production have uneven wall thickness, which results in local hot spots during operation and this in turn sets up expansion strains which cause warpage and premature failures of the muffle. Blowholes, dross areas, and porosity, which are unavoidable in cast muffles, are entirely absent in muffles composed of welded plate, as also are casting strains which in cast muffles are often of sufficient magnitude to cause rupture of the mass if it is subjected to unequal or sudden temperature changes. The rolled plate is much more homogeneous, denser and of much greater strength per unit of thickness than cast muffles and, therefore, may be used in lighter sections without sacrificing strength. This is of considerable importance not only in economy of material but in the dead load it imposes on the muffle supports. Moreover, due to the smooth, flat surface of the rolled plate, it makes uniform contact with the various reinforcing members which must be welded thereto without the necessity of grinding or machining flat or even surfaces thereon, as is required of cast muffles. After the casting of a muffle, it is necessary to examine it carefully and methodically by X-ray to detect any cracks or other defects therein and to grind away the major defective areas and repair the same by welding. The magnitude of this operation is often greater than the entire operation of welding together the individual plates of a fabricated muffle. In practice, it has been found that cast muffles are not reliable, often failing unexpectedly after very short periods of service, whereas welded plate muffles are dependable for a long useful life under severe conditions of temperature variations in the furnace. They have the additional advantage that they may be quickly fabricated in any size or shape from stock plate. The flanges 49 form a rigid backbone structure for the arched roof 11 of the muffle which reinforces it against longitudinal sagging. Angle members 51 extend longitudinally of the muffle along each of the lower corners thereof and serve to strengthen the welds at these points. The base of the muffle is further reinforced by a series of channels 52 and interspersed T-sections 53 welded to the underside thereof.

The arch of the muffle is braced transversely by a series of T-section gusset plates 54 disposed at the base of the arch and spaced at suitable intervals along the length of the muffle. A series of angles 55 bent to the contour of the sides and top of the muffle are also welded thereto at suitable intervals to stiffen the arch transversely.

The flanges of the channel members 52 are provided at intervals therealong with open slots or bearings for a series of supporting rollers 56 by which the muffle is supported for forward expansion, upon a series of pedestals 57 projecting from the floor of the combustion chamber 13. Between each pair of rollers 56 the flanges of the channels 52 are cross-braced by cast webs 58. The pedestals 57 consist of a hard burned refractory block 59, preferably composed of mullite, embedded in the refractory floor of the combustion chamber and having heat resisting alloy bearing caps 60 resting on top thereof. The caps 60 have depending side flanges 61 fitting over the blocks 59 and upwardly extending side roller guides 62. The pedestals are so disposed along the floor of the combustion chamber that they will be centrally aligned with the rollers 56 when the muffle is at operating temperature. Since the forward movement of the muffle under expansion is accumulative, it is necessary to progressively

increase the spacing of the pedestals from back to front. In Fig. 1 the muffle is shown in its cold position and it will be noted that the rollers **56** are spaced progressively greater distances from the centers of the pedestals from the front towards the rear of the furnace.

Mullite is employed for the pedestals **57** because of its extremely high crushing strength and its negligible coefficient of expansion. By virtue of this latter quality, the level of the pedestals remains substantially unchanged as the furnace is brought up to heat, and the level of the floor of the muffle remains substantially unchanged. The weight of the muffle is distributed over a substantial area of the channel members **52** through the side flanges thereof, and any tendency for the channels to distort is counteracted by the cross-bracing between each pair of rollers. Further transverse bracing may be effected by gusset plates **63** disposed at spaced intervals between the channel members **52** and the T-ribs **53**.

The roof or arch of the muffle imposes a considerable load on the side walls of the muffle tending to cause buckling thereof at elevated temperature. To relieve this load and to prevent collapse of the arch, I prefer to support the same independently of the underneath supports, as by hangers **64** secured to the muffle arch and suspended from above the furnace arch **26**. As shown, each hanger comprises two spaced pairs **65** and **66** of plates, each pair of plates having their lower ends spaced to straddle the upturned flanges **49** of the muffle arch, to which they are secured as by welding or bolting. The pairs of plates are united by cross-plates **69** welded thereto at opposite sides thereof. A truss structure, comprised of struts **71** secured to the hangers **64** and to the flanges **49**, distribute the support to sections of the arch intermediate the hangers and add to the longitudinal strength and rigidity of the roof.

The hangers **64** pass upwardly through collars **72** contained in slots **73** in the roof **26** of the combustion chamber. A plate **74** loosely surrounds each of the hangers **64** and rests on the collar **72** so as to move forward and backward with the hangers and thereby to close the opening in the collar to prevent leakage of the combustion gases upwardly therearound. Above the furnace roof the hangers are provided with rollers **75** by which the weight of the muffle arch is transferred to track supports **76**.

The track supports **76** comprise angle members **77** supported on the inturned lower flanges of pairs of channel beams **78** extending transversely across the furnace, and resting in turn on the peripheral angles **29**. The track angles **77** each have a wedge member **79** thereon with which the rollers **75** engage in the upward and forward expansion of the muffle. It will be appreciated that the vertical expansion of the muffle and the heated portion of its supporting hanger **64** will be the same for all zones of the furnace and hence the rise of all of the wedges **79** is the same. However, the forward expansion is cumulative so that the slope of the forward wedges decreases relative to the more rearwardly ones.

It should be noted that the slope of each wedge corresponds to the direction of movement of the base or point of contact of the roller **75** therewith so that the lifting of the roller up the wedge is effected entirely by the upward expansion of the heated parts rather than by forward movement of the roller in contact with the wedge. The purpose of the wedge is therefore not to apply any upward tension to the arch but to prevent the slow sagging or creeping thereof under long periods of operation at elevated temperatures. In order to avoid any wedging action on the rollers **75** during the forward movement thereof, they are made adjustable relative to the track **77**, as more clearly shown in Figs. 4 and 5. Referring to these figures, it will be seen that the hanger plates **64** terminate in a T-shaped head **81** secured thereto as by bolts **82**. The shafts **83**, on which the rollers **75** are mounted through antifriction bearings **84**, pass loosely through a vertical slot **85** in the stem of the member **81**. Pressure pads **86** engaging the shaft **83** are adjustable up and down by adjusting screws **87** so as to regulate the pressure of the rollers **75** on the tracks **77**.

In Fig. 6 I have shown a composite muffle composed of an inner layer **88** of steel and an outer layer **89** of a heat resisting metal or alloy, such as nickel, nickel-chromium alloy, or a stainless steel, such as nickel-chromium steel. Nickel and nickel-chromium alloy unite with steel by rolling at temperatures of about 2200° F. forming a permanent bond which is not affected during operation of the composite metal in the furnace. The modulus of elasticity of nickel and nickel-chromium alloys, particularly an alloy of from 78–80% nickel, from 12–14% chromium, and 6–8% iron is essentially the same as steel and its hot working range is the same. Consequently there is an equal distribution of stresses across the section of the muffle with no sudden change at the interface of the two metals. The coefficient of expansion of both nickel and nickel-chromium alloys is so close to that of steel that they may be considered identical, and the melting points of these metals are also relatively close together. Such a composite metal thereof is, therefore, suitable for use in a furnace such as that described herein, since the heat resisting outer layer provides adequate protection from the corrosive effects of the combustion gases in the outer combustion chamber **13** and the inner layer of iron is protected from corrosion by the protective lithiated atmosphere within the muffle. For economy and strength I prefer to employ a relatively thick inner steel layer and an outer layer of from 5 to 10% of the thickness of the steel portion.

The composite muffle is fabricated in the same manner as the muffle of Figs. 1 and 2, namely, by welding suitably shaped plates of the clad metal into a gas tight tubular body. In this operation the steel inner weld **91** is first made using a covered steel welding rod. The outer face of the joint is then grooved as at **92** and welded with a covered nickel or nickel-chromium alloy rod.

It will be understood that many variations may be made in the exact construction of the muffle and its supporting structure, and therefore I do not desire to be limited to the specific embodiment shown but contemplate all changes and modifications thereof coming within the terms of the appended claims.

Whart is claimed is:

1. A muffle adapted to be disposed in a horizontal position for the heating of metal at elevated temperatures by externally applied heat comprising an elongated tubular body portion composed of a plurality of sheets of heat resisting metal or alloy having a relatively thin wall, said sheets having predetermined abutting edges and said abutting edges being upturned and

welded together to form a plurality of stiffening web members disposed substantially normal to said wall and extending longitudinally of said muffle.

2. A muffle adapted to be disposed in a horizontal position for the heating of metal at elevated temperatures by externally applied heat comprising an elongated tubular body portion, composed of welded sections of heat resisting metal or alloy plates having bottom, side and top walls of progressively reduced thickness in the order named, and a plurality of longitudinally extending stiffening flanges bent up from adjacent edges of said sections substantially normal thereto, and welded along their abutting surfaces.

3. A muffle adapted to be disposed in a horizontal position for the heating of metal at elevated temperatures by externally applied heat comprising an elongated tubular body portion composed of a heat resisting metal or alloy having bottom, side and arched roof walls, said side and roof walls being of reduced thickness relative to said bottom wall and a plurality of longitudinally extending stiffening ribs, each having a width several times its thickness, integral with said bottom and roof walls and disposed normal thereto.

4. A muffle adapted to be disposed in a horizontal position for the heating of metal at elevated temperatures by externally applied heat comprising an elongated tubular body portion composed of a heat resisting metal or alloy having bottom, side and arched roof walls composed respectively of separate plates of rolled stock having the adjoining edges thereof secured together by gas-tight welds, certain of the abutting longitudinal edges of said plates being upturned substantially normally of said plates to form a longitudinally extending stiffening rib.

5. A muffle adapted to be disposed in a horizontal position for the heating of metal at elevated temperatures by externally applied heat comprising an elongated tubular body portion composed of a heat resisting metal or alloy having bottom, side and arched roof walls composed respectively of separate plates of rolled stock having the adjoining edges thereof secured together by gas-tight welds, the adjoining edges of said roof and side plates being bent substantially normal to the body of the plates to provide stiffening flanges extending longitudinally of said muffle.

6. A muffle adapted to be disposed in a horizontal position for the heating of metal at elevated temperatures by externally applied heat comprising an elongated tubular body portion composed of a heat resisting metal or alloy having a relatively thin wall, reinforcing structural members secured to the underside of said tubular body and having depending flanges, and a plurality of muffle supporting rollers carried by said flanges.

7. In a furnace structure, the combination of a supporting framework, refractory walls therein defining a heating chamber, a muffle horizontally disposed in said chamber and having one end thereof anchored to said framework, whereby the opposite end of said muffle expands longitudinally away from said anchored end, a plurality of supporting pedestals within said chamber beneath said muffle, trackways carried by said pedestals and rollers disposed between said muffle and said trackways.

8. In a furnace structure, the combination of a supporting framework, refractory walls therein defining a heating chamber, a muffle horizontally disposed in said chamber and having one end thereof anchored to said framework, whereby the opposite end of said muffle expands longitudinally away from said anchored end, reinforcing structural members disposed beneath said muffle and having depending flanges, a plurality of muffle supporting rollers carried by said flanges and pedestal means within said combustion chamber engaged by said rollers for supporting said muffle at a plurality of points between said ends.

9. In a furnace structure, the combination of a supporting framework, refractory side, top and bottom walls therein defining a combustion chamber, a horizontally disposed muffle in said chamber having bottom, side and arched roof walls, means for anchoring one end of said muffle to said framework whereby the opposite end thereof expands away from said anchored end, a support disposed above said refractory top wall and means carried thereby and extending through said latter wall into said combustion chamber for supporting said arched roof wall, said means maintaining substantially equal support for said arched roof irrespective of the extent of expansion of said muffle.

10. In a furnace structure, the combination of a supporting framework, refractory side, top and bottom walls therein defining a combustion chamber, a horizontally disposed muffle in said chamber having bottom, side and arched roof walls, means for anchoring one end of said muffle to said framework whereby the opposite end thereof expands away from said anchored end, a support disposed above said refractory top wall and means carried thereby and extending through said latter wall into said combustion chamber for supporting said arched roof wall, said means being movable with said muffle during expansion and contraction thereof and anti-friction rollers between said support and said means.

11. In a furnace structure, the combination of a supporting framework, refractory side, top and bottom walls therein defining a combustion chamber, a horizontally disposed muffle in said chamber having bottom, side and arched roof walls, means for anchoring one end of said muffle to said framework whereby the opposite end thereof expands away from said anchored end, a support disposed above said refractory top wall and means carried thereby and extending through said latter wall into said combustion chamber for supporting said arched roof wall, said means being movable both upwardly and longitudinally during expansion and contraction of said muffle, and said support being maintained in supporting engagement with said means during said movement.

12. In a furnace structure, the combination of a supporting framework, refractory side, top and bottom walls therein defining a combustion chamber, a horizontally disposed muffle in said chamber having bottom, side and arched roof walls, means for anchoring one end of said muffle to said framework whereby the opposite end thereof expands away from said anchored end, a support disposed above said refractory top wall and means carried thereby and extending through said latter wall into said combustion chamber for supporting said arched roof wall, said means being movable both upwardly and longitudinally during expansion and contraction of said muffle, said support having an inclined track and

said means having one or more anti-friction rollers engaging said track whereby said support and means are maintained in supporting engagement during said movement.

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