

[54] **SUPPORT ASSEMBLY FOR A
TILTABLE HOT METAL PROCESSING
VESSEL**

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[51] Int. Cl. C21c 5/50

[58] Field of Search 266/35, 36 P

[56] **References Cited**

UNITED STATES PATENTS

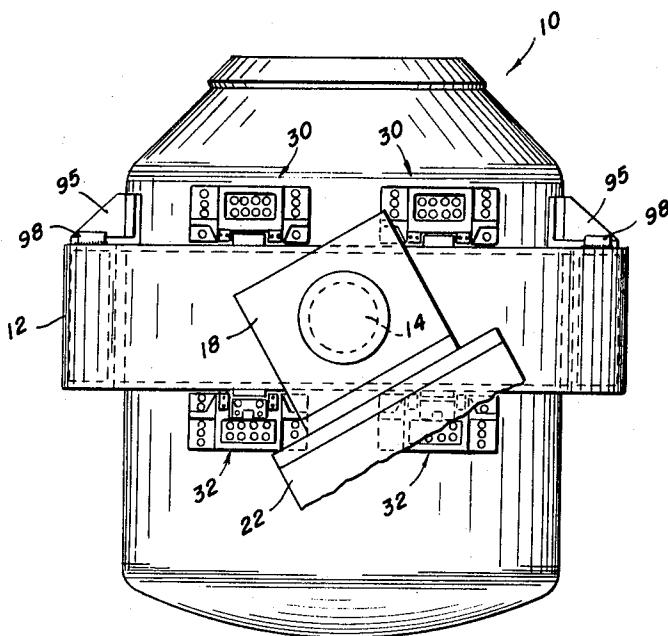
3,536,310 10/1970 Kalb et al. 266/36 P

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[57] **ABSTRACT**

A support assembly for a tiltable hot metal processing vessel, including a trunnion ring encircling the vessel, and upper and lower support brackets fixed to the vessel. The upper support brackets are arranged to engage bearing surfaces on the upper portion of the trunnion ring. The lower brackets are provided with inclined bearing surfaces sloped downwardly and outwardly from the upright vessel. The lower surface of the trunnion ring is provided with inclined support surfaces which confront the bearing surfaces of the lower brackets, and which slope downwardly and outwardly but diverge outwardly with respect to the bearing surfaces of the lower brackets. Wedge pieces are disposed between and engage the lower support surfaces of the trunnion ring and the bearing surfaces of the lower brackets.

9 Claims, 8 Drawing Figures



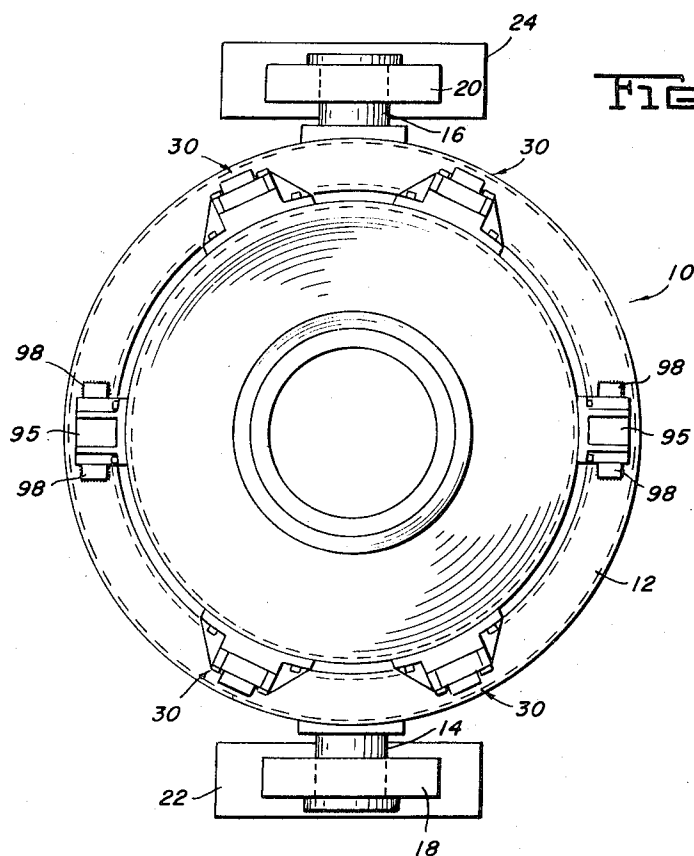


FIG. 1

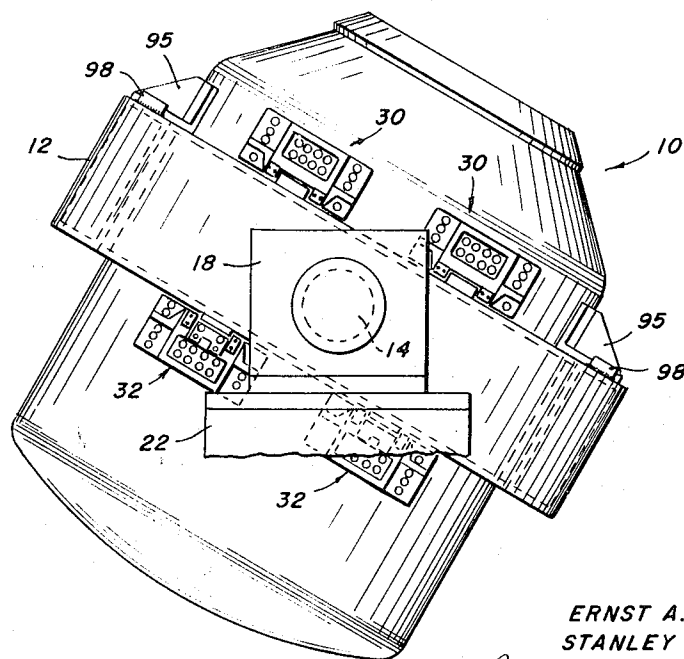


FIG. 2

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FIG. 3

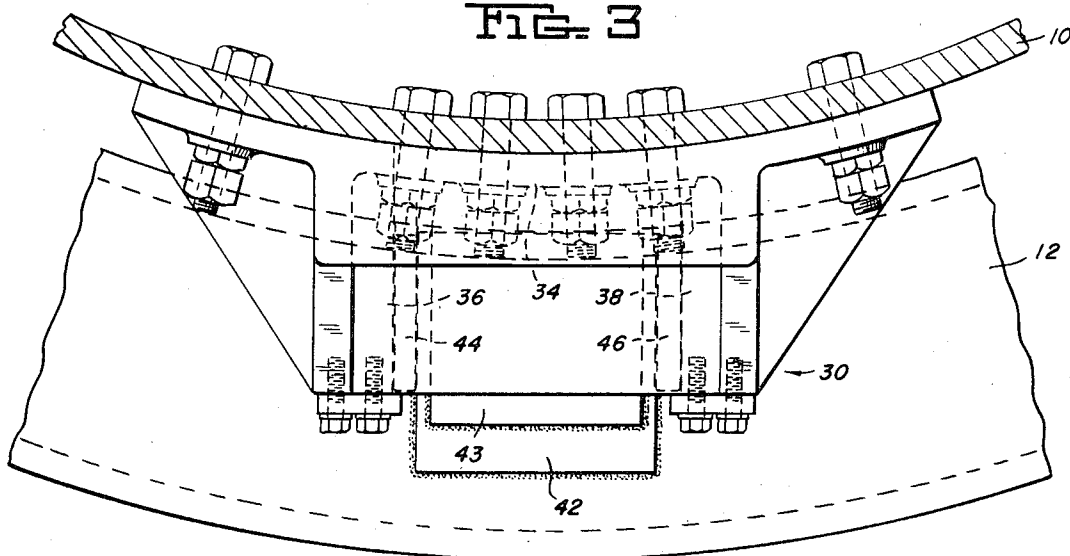


FIG. 4

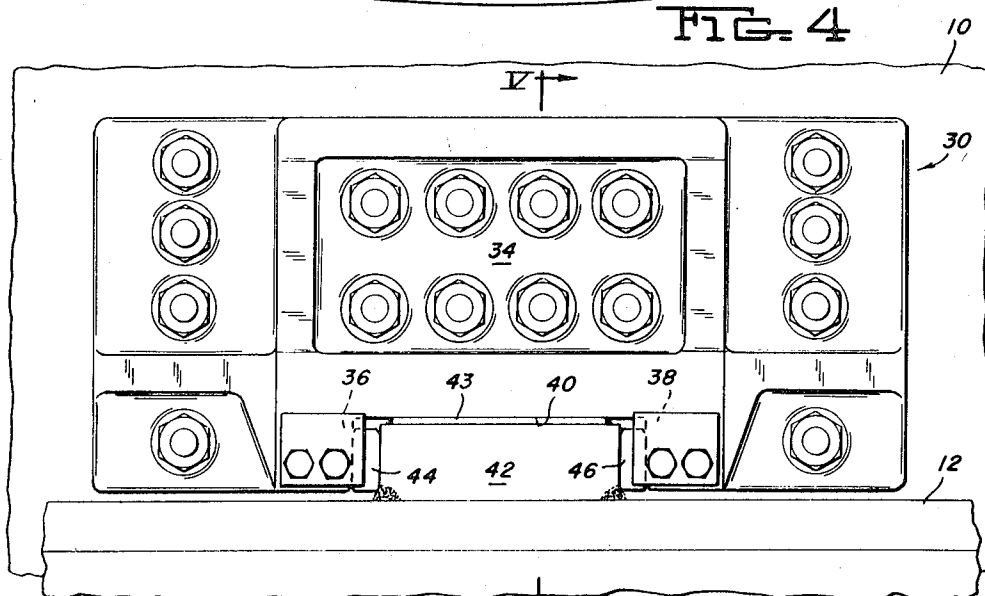
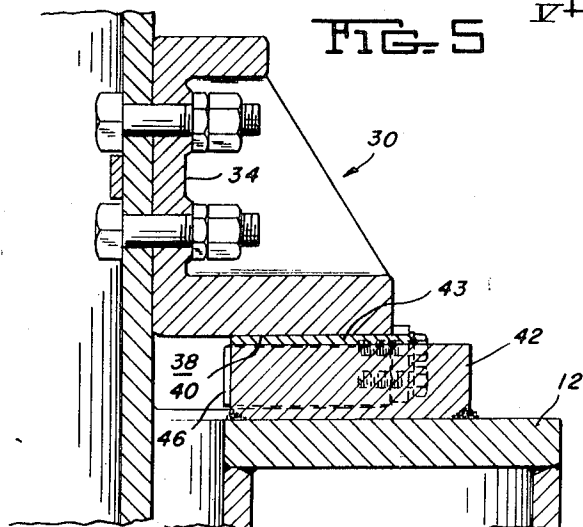


FIG. 5



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FIG. 6

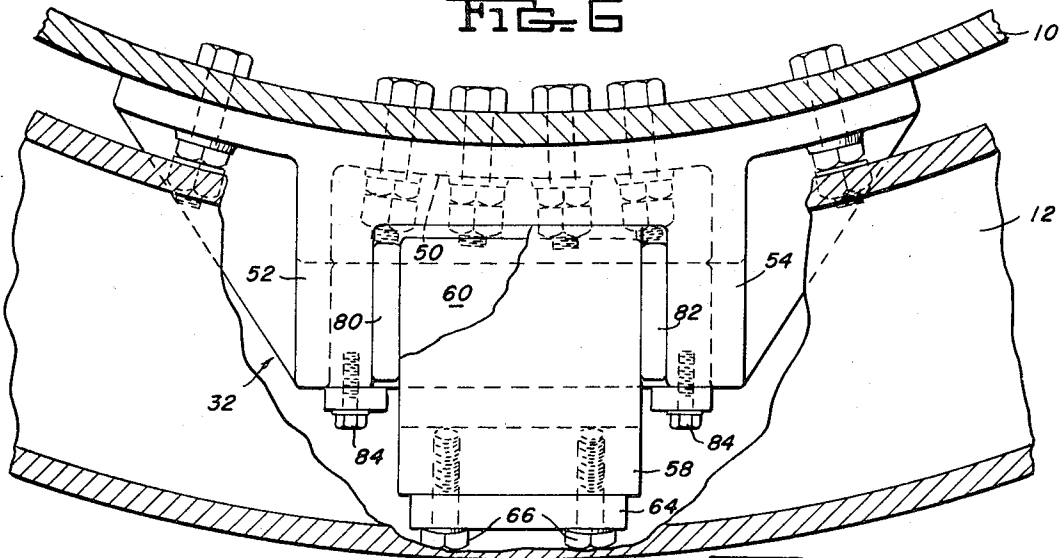


FIG. 7

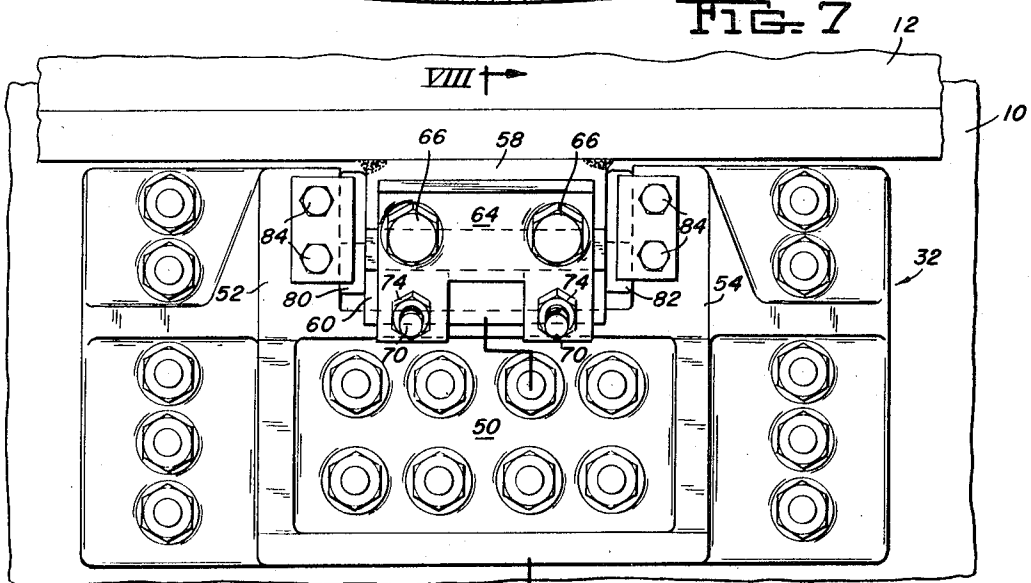
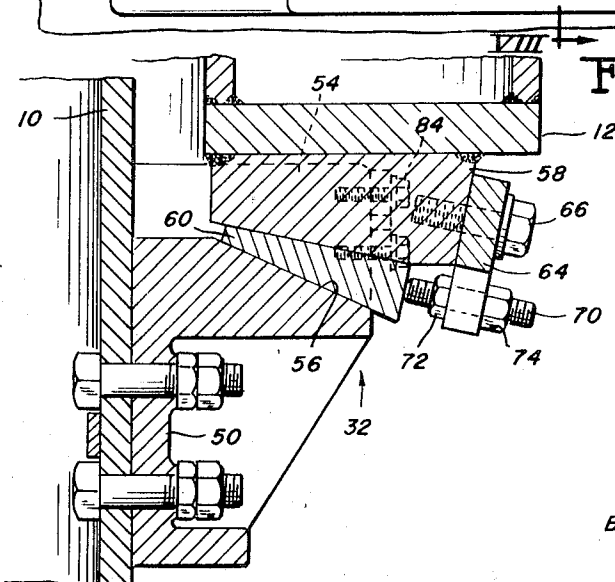


FIG. 8



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SUPPORT ASSEMBLY FOR A TILTABLE HOT METAL PROCESSING VESSEL

This invention relates to a support assembly for a tiltable hot metal processing vessel, and particularly to a support assembly for accommodating the radial and axial thermal expansion and contraction which the vessel undergoes as a result of the heat generated by the metal refining operation.

Various hot metal refining processes, such as steelmaking, require the use of a tiltable converting vessel. The vessel must be tiltable from a vertical blowing position to an upside down discharging position and back again into the upright position. The support assembly for the vessel includes a trunnion ring encircling an intermediate section of the vessel and engaging bearing surfaces of upper and lower brackets mounted on the vessel. Trunnions are fixed to the ring and means are provided to drive the trunnions and ring for tilting the vessel. During the refining operation when large amounts of heat are generated, the vessel will expand in the radial and axial directions as well as circumferentially. The radial and axial expansion will result in a gap between the lower bearing surfaces, and during tilting, the vessel will drop onto the trunnion ring lower bearing surfaces. This dropping of the vessel may result in damage to the vessel or to the trunnion ring.

Various support arrangements have been developed to accommodate the gap problem created by the thermally expanding vessel. Two such arrangements are described in U. S. Pat. Nos. 3,191,921 and 3,337,205. In both arrangements inclined bearing surfaces are provided between the trunnion ring and vessel mounted brackets where the inclination is designed to follow the direction of expansion of the vessel. Thus, when the vessel expands while in its upright position, the brackets, particularly the lower brackets, will move along the inclined bearing surface of trunnion ring. No gap will be created between the lower bearing surface, as would be the case were the bearing surfaces flat.

The combined radial and axial expansion of the vessel has a resultant direction of expansion. This direction is believed to be at an angle to the horizontal whose tangent is essentially the distance between the upper and lower brackets divided by the outer radius of the vessel. In U.S. Pat. No. 3,191,921 the angle of inclination of the lower bearing surfaces is the same as the theoretical expansion angle. U.S. Pat. No. 3,337,205 provides inclined upper and lower bearing surfaces, each being one half the theoretical expansion angle. In the U.S. Pat. No. 3,191,921 design a problem arises in that with the vessel in the inverted position the forces on the inclined lower bearing surfaces (now the upper bearing with the vessel inverted) are of such magnitude that the bearing surfaces on the trunnion ring could be urged out unless they have substantial structure to hold them in place. We overcome this problem while still providing for accommodation of the radial and axial expansion of the vessel, by placing wedge pieces between the bearing surfaces of the lower brackets and the lower bearing surfaces of the trunnion ring. More particularly we provide a supporting assembly for tiltable hot metal processing vessels preferably comprising a plurality of upper brackets for attachment to the vessel at spaced intervals thereabout, each having a laterally extending trunnion ring-engaging portion; a plurality of lower brackets for attachment to the vessel at spaced intervals thereabout at a level below the upper one, each lower bracket having a laterally projecting supporting portion, the supporting surface of which is inclined downwardly and outwardly with respect to a plane transverse to the axis of the vessel; a trunnion ring sized to encircle the vessel, the top surface of which is arranged to have sliding contact with the ring engaging portions of the upper brackets and the lower surface of which is spaced above the supporting portions of the lower brackets, the lower surface of the ring which is spaced from but which confronts the supporting portions of the lower brackets being also inclined downwardly and outwardly but diverging outwardly with respect to the supporting surfaces of the lower brackets; and a wedge on the supporting surface of each lower bracket in the space between the lower surface of the ring and the supporting surface of the

bracket with top and bottom surfaces sloped to match the slopes of the respective surfaces between which the wedge is entered, the wedge being confined to allow limited relative radial movement between it and the parts between which it is disposed.

Other details and advantages of this invention will become apparent as the following description of a present preferred embodiment thereof proceeds.

In the accompanying drawings we have shown a present preferred embodiment of this invention in which:

FIG. 1 is a plan view of a hot metal processing vessel with expansion accommodating support means constructed in accordance with the present invention;

FIG. 2 is a side elevation of the vessel of FIG. 1 shown tilted at an angle from the vertical;

FIG. 3 is an enlarged view in plan of one upper bracket forming part of the support means of this invention, and a fragmentary section of the wall of the vessel to which the bracket is mounted, and a fragmentary plan view of the trunnion ring upon which the bracket is disposed;

FIG. 4 is a side elevation view of the bracket arrangement of FIG. 3;

FIG. 5 is a view looking along the line V—V of FIG. 4;

FIG. 6 is an enlarged plan view of one lower bracket forming part of the support means of this invention, and support block with a part cut away to show the wedge piece below the block and a fragmentary section of the wall of the vessel to which the bracket is mounted, and a fragmentary section of the trunnion ring to which the block is fixed;

FIG. 7 is a side elevation view of the bracket, block, and wedge arrangement of FIG. 6; and

FIG. 8 is a view looking along the line VIII—VIII of FIG. 7.

Referring now to the drawings, there is shown in FIGS. 1 and 2 a hot metal processing vessel 10 having a substantially circular cross-section, and being of any well known construction. The vessel 10 is supported for tilting from an upright vertical position to a completely inverted position and back again to the upright position. The support means for the vessel 10 includes a hollow trunnion ring 12 encircling an intermediate section of the vessel and radially spaced from the vessel. Diametrically opposed trunnion shafts 14 and 16 are fixed to the trunnion ring 12 and are supported for rotation in bearing housings 18 and 20, respectively, arranged on ground supported stanchions 22 and 24, respectively. One of the trunnion shafts is connected with a drive means, now shown, for providing the motive force to tilt the vessel 10.

Two pairs of diametrically opposed identically shaped, circumferentially spaced upper brackets 30 are mounted to the wall of the vessel 10. One pair of upper brackets 30 is arranged with one bracket adjacent to each side of the trunnion shaft and trunnion ring coupling. The other pair of upper brackets 30 is arranged similarly with respect to the opposite trunnion shaft. There are also provided two pairs of diametrically opposed identically shaped, circumferentially spaced lower brackets 32 mounted to the wall of the vessel 10, and in alignment with the upper brackets 30. FIGS. 3-5 illustrate one upper bracket 30 in its relationship to the wall of vessel 10 and a bearing surface on trunnion ring 12. All of the upper brackets 30 and associate parts are identically shaped and only one bracket arrangement will be described with the understanding that it also pertains to the other three brackets. Similarly, each lower bracket 32 and its associated parts are identically shaped and are illustrated in FIGS. 6-8, and only one description thereof will be made with the understanding that it also pertains to the other three lower brackets.

As shown in FIGS. 3-5, upper bracket 30 is bolted to the wall of the vessel 10 and includes a central portion 34 with an open lower section having side walls 36 and 38. The open lower section of central portion 34 defines a bearing surface 40 which seats on the upper surface of a flat bearing block 42 fixed on the upper surface of trunnion ring 12. Wear plates 44 and 46 are disposed between the sides of bearing block 42 and the side walls 36 and 38, respectively, of central portion 34.

The wear plates 44 and 46 are detachably fixed to the ends of side walls 36 and 38, respectively, for removal when replacement is necessary. A wear strip 43 forms the upper surface of bearing block 42 and may be replaced when necessary without need for replacing the entire block. When the wall of vessel 10 thermally expands circumferentially, the upper brackets 30 will also expand circumferentially. By embracing the bearing block 42, as just described, the bracket 30 will move away from the block 42 and, thus, no stresses will be created between the bracket and the block as the vessel expands circumferentially. As the vessel radially expands and contracts, the wear strips 44 and 46 will slide along the side surfaces of bearing block 42. Also, the bearing surface 40 of central portion 34 will slide along wear strips 43. This sliding between the surfaces will result in wear of the wear strips and a need for their eventual replacement.

As shown in FIGS. 6-8, each lower bracket 32 is bolted to the wall of vessel 10 and is arranged below the lower surface of trunnion ring 12. Each lower bracket 32 has a central portion 50 with an open top end section formed by side walls 52 and 54 and an inner inclined section or bearing surface 56 sloping downwardly and outwardly with respect to a plane transverse to the axis of vessel 10. The bearing surface 56 is arranged directly below and spaced from a bearing block 58 fixed to the underside of trunnion ring 12. The bearing block 58 has an inclined bearing surface sloping downwardly and outwardly with respect to a plane transverse to the axis of vessel 10. The slope of the bearing surface of bearing block 58 is slightly less than that of bearing surface 56. Thus, the bearing surface of bearing block 58 diverges outwardly with respect to bearing surface 56. A wedge 60 is disposed between and engages the bearing surface of bearing block 58 and bearing surface 56. The upper face of wedge 60 is sloped to match the slope of bearing block 58, while the lower face of the wedge is sloped to match the slope of bearing surface 56. A plate 64 is detachably fixed, as by bolts 66, to the outer end of bearing block 58 and extends down to a point opposite the lower outer edge of wedge 60. Adjusting screws 70 are arranged through the lower end portion of plate 64, for engaging the outer end of wedge 60 for holding the wedge in place and also to move the wedge inwardly with respect to bearing surface 56 and bearing block 58. Nuts 72 and 74 are arranged in the screws 70 on opposite sides of plate 64 for turning the screws and locking them in place on the plate. Wear strips 80 and 82 are disposed between the end walls 52 and 54 and the sides of wedge 60 and bearing blocks 58. The wear strips 80 and 82 are detachably secured, as by bolts 84, to the outer ends of side walls 52 and 54. Wedge 60 is arranged between the bearing surface 56 and bearing block 58 so as to permit a limited relative radial movement between bearing surface 56 and the lower side of the wedge. In other words, wedge 60 is loosely fitted to permit the bearing surface 56 to slide on the lower side of the wedge.

As with respect to upper brackets 30, thermal expansion of vessel 10 circumferentially will not create stresses between the lower brackets 32 and the wedges 60 and bearing blocks 58 since the lower bracket will expand circumferentially with the wall of the vessel and away from the wedge and bearing blocks.

When vessel 10 undergoes radial and axial expansion, the bearing surfaces 56 will slide along the lower surfaces of wedges 60 and remain in engagement therewith. A gap is thus avoided between the bearing surfaces 56 and wedge 60 to thereby prevent the undesirable drop of vessel 10 which would otherwise occur when vessel 10 is inverted.

There is also provided a pair of identically shaped upper secondary brackets 95 fixed to the shell of the vessel 10 for limiting lateral movement of the vessel when it is in the upright and inverted positions. Each secondary bracket is located in a position approximately 90° from the centerline of trunnion shafts 14 and 16. Each bracket 95 is generally L-shaped with the back portion being contoured to the curvature of the vessel 10 while the bottom portion extends radially from the ves-

sel to engage a bearing surface on the top surface of trunnion ring 12. Identically shaped blocks 98 are fixed to the upper surface of trunnion ring 12 adjacent and spaced slightly (viz. 1/8 inch) from the opposite sides of the bottom portion of bracket 85. By the arrangement just described, brackets 95 and blocks 98 will cooperate to limit the lateral shifting of vessel 10 in its upright and inverted positions.

As noted previously, the expansion angle for the movement of the vessel 10 when it thermally expands is that angle having the tangent determined by the spacing of the upper and lower brackets divided by the outer radius of the vessel. In vessels in common use today, this expansion angle has been determined as being around 30°. By using a 30° slope for the lower bearing surface without an intermediate wedge, the vessel 10 would impart a large force on the wedge which could drive that wedge out from the trunnion ring if it were not adequately supported. We find that with our wedge 60 this problem is considerably reduced. We make our wedges 60 with an angle equal to about half the slope angle of our bearing surfaces 56, thus making the angle of inclination of the bearing blocks also equal to half the slope angle of the bearing surface 56. Also, we use about a 24° slope angle which is less than the theoretical angle of 30°, but we find, nevertheless, that it satisfactory in performing the intended function of accommodating the radial and axial expansion of vessel 10. It has also been found that by using a 30° slope for the lower bearing surfaces, bending between the sliding surfaces results during radial and axial thermal expansion of the vessel. Our 24° slope angle avoids bending of the sliding surfaces during radial and axial expansion of the vessel.

While we have shown and described a present preferred embodiment of this invention, it is to be distinctly understood that the invention is not limited thereto by may be otherwise variously embodied within the scope of the following claims.

We claim:

1. In combination with a tiltable steel-making converter vessel, a support for the vessel designed to provide for radial and axial thermal expansion and contraction of the vessel comprising:

a trunnion ring designed to encircle an intermediate section of the vessel and having an upper bracket-contacting surface and a lower supporting surface;

a plurality of circumferentially spaced upper brackets mounted on the vessel, said upper brackets each having a bearing surface engaging correspondingly the bracket-contacting upper surfaces of said trunnion ring;

a plurality of circumferentially spaced lower brackets mounted on the vessel, said lower brackets having inclined bearing surfaces sloping downwardly and outwardly from a plane transverse to the centerline of the vessel;

said trunnion ring having its lower supporting surface spaced above and confronting the bearing surfaces of the lower brackets and sloping downwardly and outwardly from a plane transverse to the centerline of the vessel, but diverging outwardly from the confronting sloping surfaces of the lower brackets; and

separate wedge pieces disposed between and engaging the bearing surfaces of said lower brackets and the lower supporting surfaces of said trunnion ring.

2. Supporting means for a tiltable hot metal processing vessel subject to thermal expansion and contraction in radial and axial directions, comprising:

a plurality of upper brackets for attachment to the vessel at spaced intervals thereabout, each having a laterally extending trunnion ring-engaging portion;

a plurality of lower brackets for attachment to the vessel at spaced intervals thereabout at a level below the upper ones, each lower bracket having a laterally projecting supporting portion, the supporting surface of which is inclined downwardly and outwardly with respect to a plane transverse to the axis of the vessel on which it is mounted;

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a trunnion ring adapted to encircle the vessel, the top surface of which is arranged to have sliding contact with the ring-engaging portions of the upper brackets when they are operatively positioned on the vessel and the lower surface of which is spaced above the supporting portions of the lower brackets when the lower brackets are in operative position on the vessel, the lower surface of the ring which is spaced from but which confronts the supporting portions of the lower brackets being also inclined downwardly and outwardly from a plane transverse to the axis of the vessel but diverging outwardly with respect to the supporting surfaces of the lower brackets; and
a wedge on the supporting surface of each lower bracket in the space between the lower surface of the ring and the supporting surface of the bracket with top and bottom surfaces sloped to match the slopes of the respective surfaces between which the wedge is entered, the wedge being confined to allow limited relative radial movement between it and the parts between which it is disposed.
3. The support means as set forth in claim 2 wherein the surfaces of the trunnion ring which confront the supporting surfaces of the lower brackets are provided by metal blocks of outwardly increasing thickness fixed to the bottom of the ring.
4. The support means as set forth in claim 3 wherein the lower brackets have a side wall at each end of the outwardly and downwardly inclined supporting surface between which said blocks have a working fit to substantially limit the vessel against axial movement relative to the ring.
5. The support means as set forth in claim 2 wherein the upper brackets have a slide wall at each end of the ring-engaging portion thereof between which the portions of the top sur-

face of the trunnion ring which contact the ring-engaging portions have a working fit to substantially limit the vessel against axial movement relative to the ring.
6. The support means as set forth in claim 3 wherein each wedge piece is adjustably not fixed to a block for relative adjustment radially of the vessel.
7. In the combination of a tiltable hot metal processing vessel, a trunnion ring encircling the vessel, and upper and lower support means between the vessel and trunnion ring; the improvement therewith in the lower support means, comprising:
a plurality of circumferentially spaced brackets mounted on the vessel and having inclined bearing surfaces thereon sloping downwardly and outwardly from a plane transverse to the centerline of the vessel;
the trunnion ring having inclined lower supporting surface spaced above and confronting the bearing surfaces of the brackets and sloping downwardly and outwardly from a plane transverse to the centerline of the vessel, but diverging outwardly from the confronting sloping surfaces of the brackets; and
separate wedge pieces disposed between and engaging the bearing surfaces of said brackets and the lower supporting surfaces of the trunnion ring.
8. The improvements as set forth in claim 7 wherein the lower supporting surface of the trunnion ring which confronts the bearing surfaces of the brackets are metal blocks of outwardly increasing thickness fixed to the bottom of the ring.
9. The improvement as set forth in claim 8 wherein each wedge piece is adjustably not fixed to a block for relative adjustment radially of the vessel.

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