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[54] **STABILIZED MOUNTING FOR BOF-LIKE VESSELS**

11 Claims, 14 Drawing Figs.

[52] **U.S. Cl.** **266/36**
[51] **Int. Cl.** **C21c 5/46**
[50] **Field of Search** 266/11, 34, 35, 36P, 38, 39; 75/60

[56] **References Cited**

UNITED STATES PATENTS

3,182,979	5/1965	Krause	266/35
3,191,921	6/1965	Johnson	266/36
3,337,205	8/1967	Puxkandl	266/36
3,358,984	12/1967	Grassin et al.	266/36
3,454,269	7/1969	Falk	266/36
3,502,314	3/1970	Puhringer	266/36

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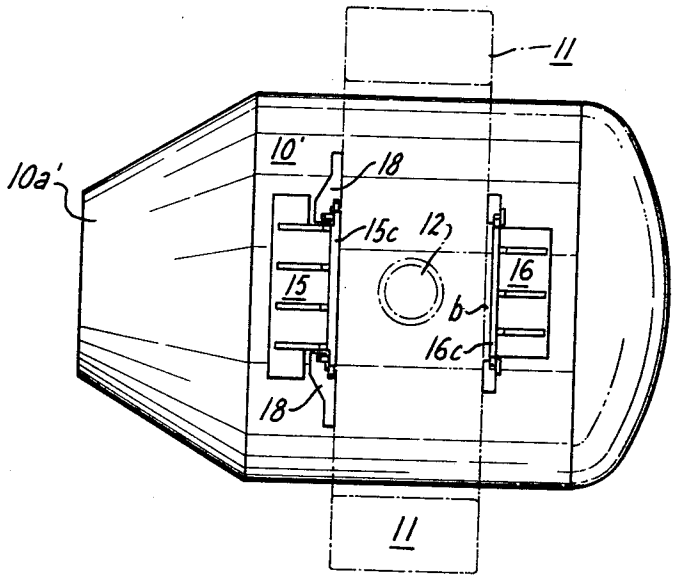
ABSTRACT: Expansion and contraction permitting bracket and keeper assemblies are provided between a trunnion ring and the metal outer shell wall of a molten material handling or processing vessel for mounting and supporting it in an upright position and during any tilting movement thereof in an improved stabilized manner. An upper group of pairs of diagonally-opposed mounting assemblies constitute the main mounting and supporting means for the vessel and an aligned lower group serve to supplement the support when the vessel is tilted from a vertical towards a horizontal position, all while permitting the vessel to expand and contract peripherally, vertically or longitudinally, laterally or transversely. Unique gib or keeper and wedge elements are employed for adjustably-connecting or adjustably-slidably-clamping the vessel on its trunnion ring.



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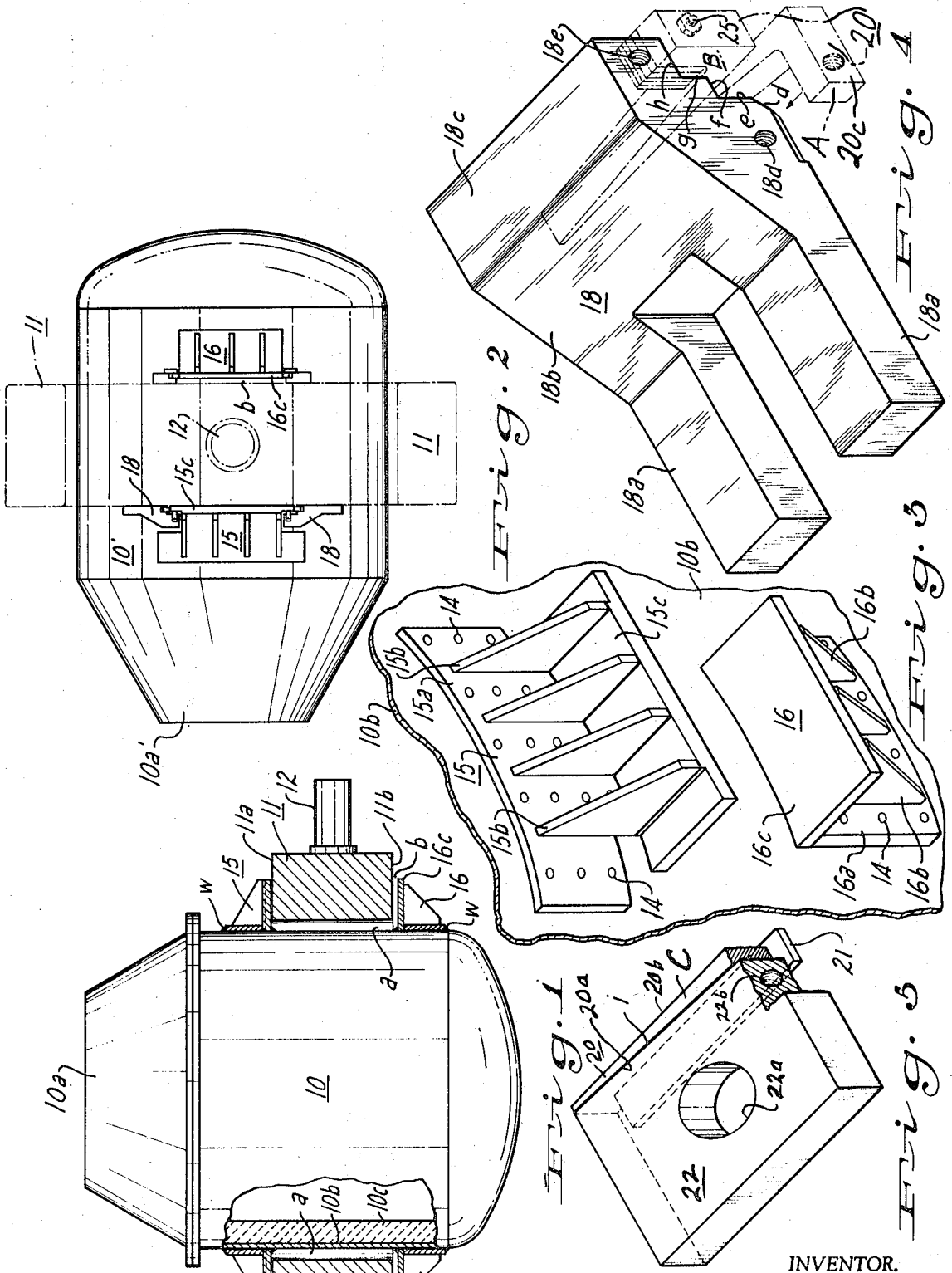

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

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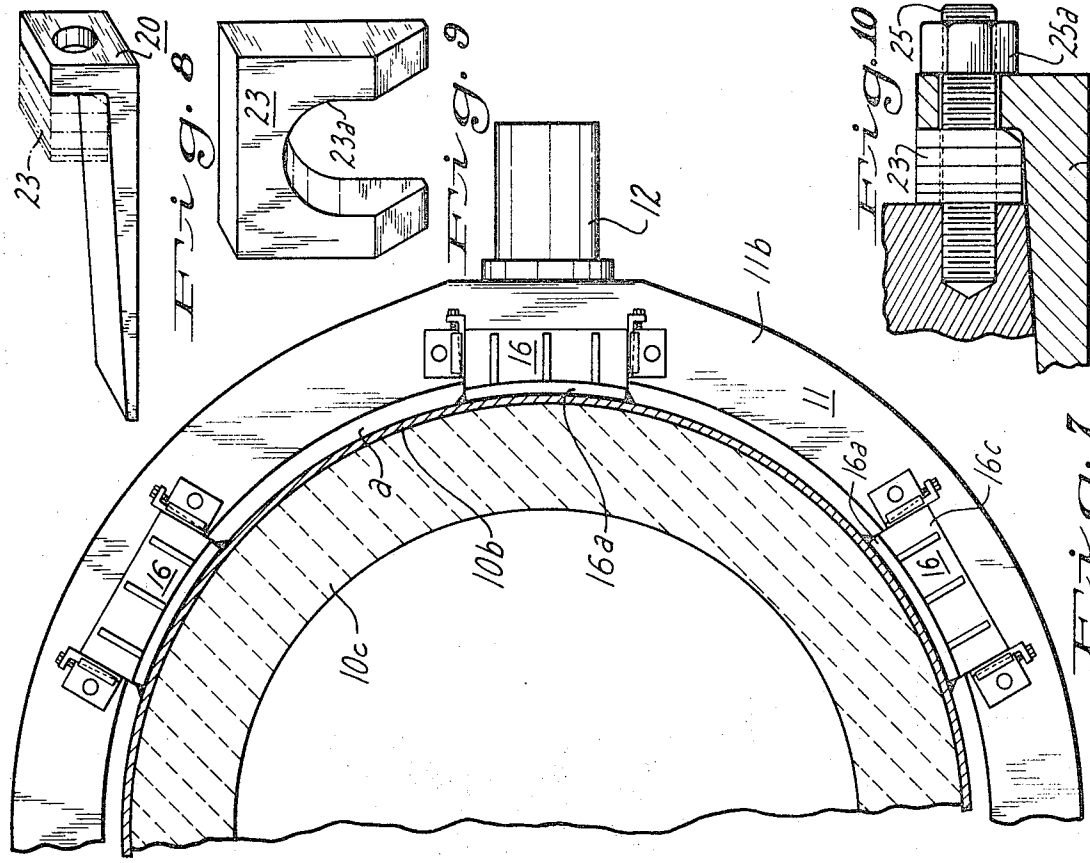

Fig. 8

Fig. 9

Fig. 10

Fig. 7

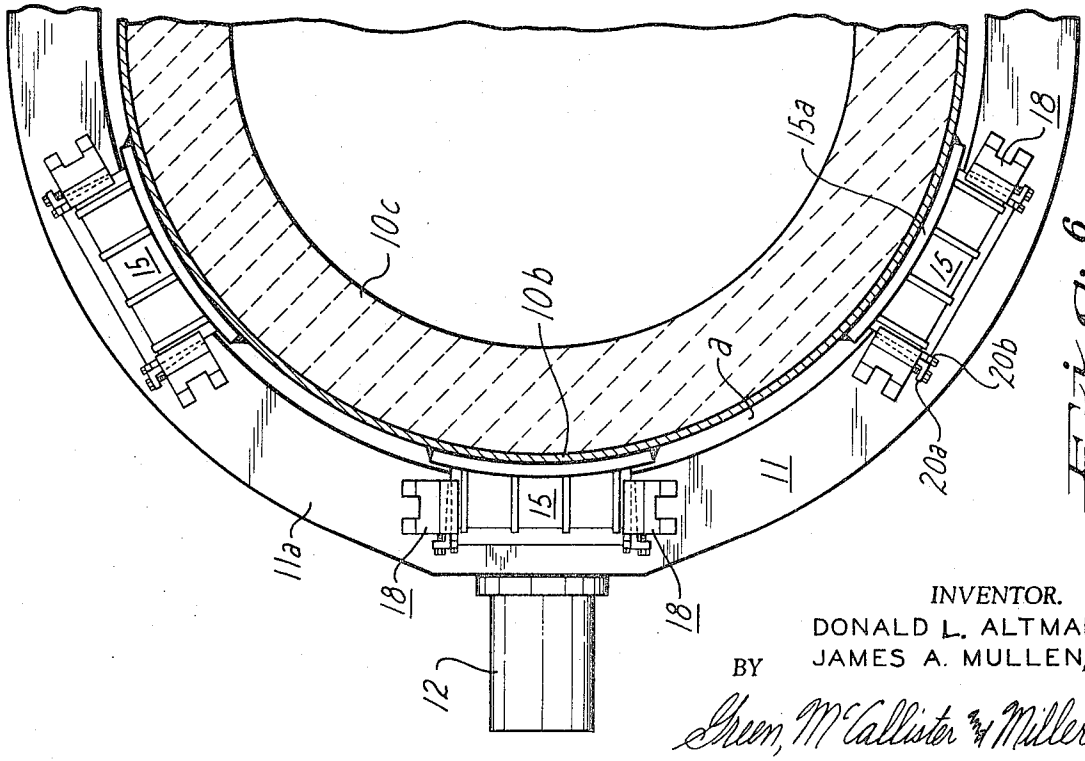

Fig. 6

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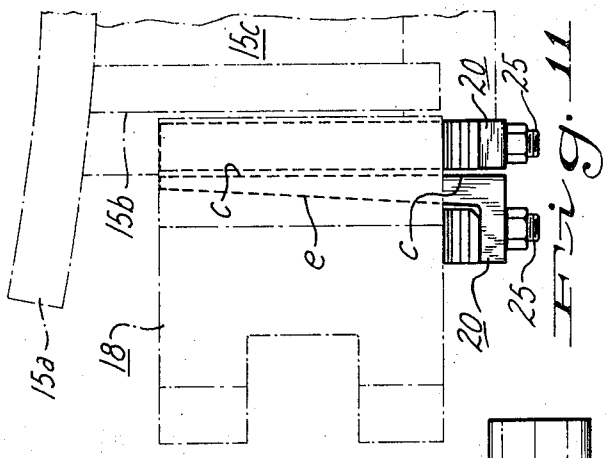

Fig. 11

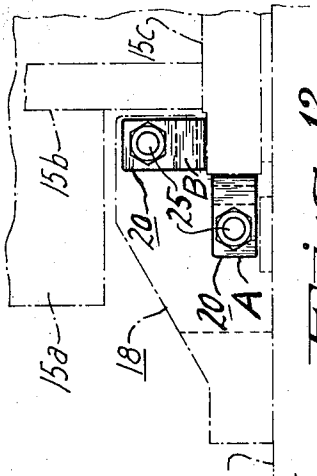

Fig. 12

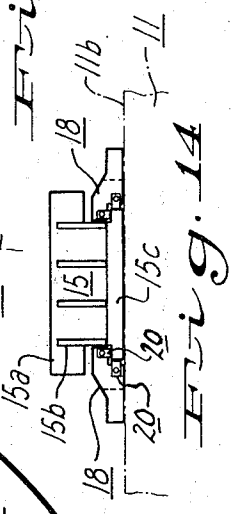

Fig. 14

Fig. 13

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STABILIZED MOUNTING FOR BOF-LIKE VESSELS

The invention pertains to an improved mounting and support for a molten material handling or processing vessel such as a furnace vessel, and particularly to a so-called stabilizing type of trunnion mounting which makes use of gibs or keepers having cooperating wedging elements, that are carried by the trunnion ring, and that cooperate with associated mounting brackets that are secured to project from the vessel.

Metal mounting and handling vessels such as oxygen blow or converter vessels used for melting and refining ferrous metal customarily employ a trunnion ring for supporting the vessel and for tilting it on a pair of trunnion shafts that are carried by the ring and that are adapted to be positioned on a pair of supports or bearings stands to facilitate refining, pouring and charging operation. Such vessels have been progressively increasing in size and now are available in capacities up to about **350** tons. The heavy mass or weight of the vessel and the weight of the molten metal which tends to shift in the vessel when it is tilted during its operation, and the high temperatures in the neighborhood of 3500° F. to which the vessel may be subjected all necessitate special means for supporting and connecting the vessel with respect to its trunnion ring or outer, centrally-positioned mounting structure.

There has been a need for an improved supporting construction in this particular field which will have a somewhat universal application to vessels, irrespective of whether they are of a conventional frustroconical shape or of some more exotic shape, such as an oval, a rectangle, etc. Such a vessel during its utilization and operating life, is subjected to various forces which cause it to expand and contract from the standpoint of its contour. Such physical shape adjustments in the vessel must be permitted to avoid damage thereto and to provide a maximum period of operating life. In this connection, it is highly desirable and important to make provision not only for vertical or longitudinal expansion and contraction, for lateral or transverse expansion and contraction, and for peripheral expansion and contraction, but also for angular expansion and contraction between its longitudinal and transverse axes.

The present invention deals with bracket and keeper or gib assembly which are constructed to provide an improved guide mounting for a vessel with respect to its trunnion ring, such as to provide an adjustable, stable type of physical change permitting support of its metal shell wall.

It has thus been an object of the invention to devise an new and improved form of supporting means for a hot material handling or processing vessel.

Another object has been to employ a combination of wedging means for providing an improved stabilized mounting of a vessel.

A further object of the invention has been to devise a supporting structure for a vessel that utilizes cooperating pairs of wedge elements for adjusting its mounted relation, both vertically and transversely with respect to its trunnion ring and with reference to its main support brackets.

A still further object has been to devise a mounting or supporting assembly utilizing the upper and lower brackets and keeper or gib assemblies, wherein the top or upper assemblies serve as main supporting assemblies for the vessel, and lower assemblies serve as a guide and tilt support for the vessel, and wherein both the upper and lower assemblies have tapered wedging elements for adjusting the engagement of their cooperating surfaces with respect to each other.

These and other objects of the invention will appear to those skilled in the art from the illustrated embodiment and the claims.

In the drawings:

FIG. **1** is a vertical view in elevation and partial section illustrating a vessel mounted and supported in accordance with the invention;

FIG. **2** is a view on the scale of FIG. **1** taken at right angles thereto and showing a modified form of vessel tilted 90° from a vertical position of FIG. **1** to a horizontal position. FIGS. **1** and **2** indicate that the invention may be applied to various types of vessels, in that the vessel of FIG. **1** has a so-called removable top cone and the vessel of FIG. **2** has a unitary metal shell construction;

FIG **3** is a enlarged vertical fragment in perspective illustrating the relative positioning of upper and lower longitudinally or vertically-aligned spaced-apart mounting brackets for the assemblies of the inventive construction;

FIG. **4** is a further enlarged horizontal perspective illustrating the construction of upper, trunnion ring mounted gibs of the inventive construction and how tapered wedge elements are utilized therewith;

FIG. **5** is a horizontal fragmental perspective, partially in section, illustrating the construction of lower keeper or gib and wedging element assemblies of the inventive structure;

FIG. **6** is a enlarged transverse or horizontal fragment taken along the upper half of a vessel, such as illustrated in FIGS. **1** and **2**, and above groups of diagonally-opposed pairs of upper supporting and mounting assemblies therefor; this view represents substantially one-half of a vessel, whose other half has the same number of mounting assemblies and the same general construction and arrangement of pairs of assemblies;

FIG. **7** is a horizontal section on the scale of FIG. **6** and looking upwardly from a lower part of a vessel, such as illustrated in FIGS. **1** and **2**, and showing the positioning and mounting of diagonally-opposed pairs of a lower group of mounting assemblies; this FIG. like FIG. **8**, shows substantially one-half of a vessel and thus the other half is the same as to its construction and as to its mounting assemblies. The lower mounting assemblies have a vertically or longitudinally aligned relation with the upper assemblies, one upper and one lower pair is in alignment with the axis of trunnion shafts and the assemblies of the two other pairs are shown arranged about the periphery of the construction in an equally 60° spaced relation with respect to each other and the first-mentioned pair of assemblies;

FIG. **8** is a perspective view of a tapered wedge part or equalizer element that is used in right-angularly positioned pairs for the upper support or mounting assemblies that is used singularly for lower assemblies;

FIG. **9** is a vertical perspective view of takeup, slip-on or spacer elements that are employed as shown in FIG. **10** in combination with the wedge elements of FIG. **8**;

FIG. **10** is an enlarged vertical sectional fragment illustrating how the wedge elements and their associated spacers are removably and adjustably secured to associated keepers or gibs;

FIGS. **11** and **12** are respectively top plan and vertical fragmental views illustrating the construction and employment of a bracket and cooperating pair of gibs of each upper or main supporting or mounting assembly for the vessel;

FIG. **13** is a top section taken transversely through a vessel and illustrating a further embodiment of the invention;

FIG. **14** is a side fragment taken along the line **14–14** of FIG. **13** and showing a mounting assembly.

The invention deals with an improved connecting structure between a vessel **10** or **10'** employed for carrying or processing molten material and a supporting trunnion structure or ring associated with its outer metal shell wall. For general usage, and of particular importance from the standpoint of larger size vessels or vessels having a ratio of longitudinal or vertical or horizontal or transverse dimension of greater than about two to one, the system involves the use of upper and lower groups of mounting or supporting assemblies. Each group employs or has diagonally-opposed pairs of bracket assemblies **15** and **16** disposed in an angular relation about the vessel and along upper and lower reaches of its trunnion ring **11**. The assemblies of the upper group are employed as the principal means of connecting and supporting the vessel **10** and are provided with means that has an adjustable wedge-operated clamping-engaging type of connection with the trunnion ring **11** for stabilizing relative movement therebetween, both transversely and longitudinally of the vessel. The lower group of assemblies is employed as a guide group and provides

an additional support in the direction of the extension of the trunnion ring against deflection when the vessel is tilted for example, for pouring molten slag or metal therefrom.

The optimum arrangement is illustrated in FIGS. **6** and **7** wherein three opposed pairs of bracket assemblies are employed in an equal, angularly spaced relation of, for example, 60° about the vessel **10** or **10'** and its trunnion ring **11**. In the embodiment of FIG. **13**, two 90° pairs are provided. The latter, construction is a simplified one particularly suited for lighter-weight vessels. However, in both instances, it will be noted that one pair of opposed bracket assemblies is always positioned in alignment with the axis of the trunnions, with the other pairs being in a substantially equally-spaced relation with respect to the trunnion-mounted pair.

With particular reference to FIGS. **1** and **2** of the drawings, the vessel **10** or **10'**, such as a converter or BOF vessel having an elongated shape and terminating at its upper end in an open mouth portion **10***a* or **10***a'*, is shown provided with an encircling trunnion ring **11** and a pair of conventional, oppositely-extending and opposed trunnions **12**. The latter, as customary, may be mounted on a pair of suitable journaling or supporting stands, such as illustrated, for example, in FIG. **2** of the Lakin et al. U.S. Pat No. 3,207,002. FIG. **3** particularly illustrates the spaced and aligned relation of upper and lower brackets **15** and **16** of the assemblies that may be secured to an outer metal shell wall **10***b* of the vessel **10**, as by means of weld metal *w* (see FIG. **1**) or by means of bolts (see FIGS. **3**, **13** and **14**).

FIGS. **6** and **7** particularly illustrate the construction of a molten material processing or handling vessel **10** which may be of any suitable shape and whose outer metal platelike shell wall **10***b* is provided with an inner refractory lining **10***c*. The upper group of diagonally-opposed pairs of mounting assemblies, as particularly illustrated in FIGS. **1**, **2** and **6**, are shown provided with an upper angle-shaped bracket **15** whose vertical mounting plate **15***a* is contoured to abut or fit against the metal shell wall **10***b* and to be securely mounted or connected thereto, as by weld metal *w* or bolts or rivets **14**. The vertical plate **15***a* is integrally secured to and supports a substantially planar horizontal foot or base plate **15***c*, as reinforced by connecting, upstanding, spaced-apart reinforcing wings or ribs **15***b*. It will be noted from FIG. **3** that the end-positioned ribs have an inward spacing from end portions of the base or foot plate **15***c* to permit mounting cooperation with a pair of endwise-positioned opposed keepers or gibs **18**.

The construction of the keepers or gibs **18** is particularly illustrated in FIG. **4**. Each one has a substantially planar, forked or bifurcated mounting portion **18***a* that is secured as by weld metal to an upper face, side or surface **11***a* of the trunnion ring **11**. It also has a thickened, upwardly-tapered head portion **18***b* that terminates in a substantially planar top portion **18***c*. The portions **18***b* and **18***c* constitute an offset clamping part for each keeper **18** that are provided with a recess defined by an inner, vertical wall portion *e*. The portion *e* has a forwardly-diverging and backwardly-converging taper or slope; this clamping part also has an adjacent inner, horizontal wall portion *h* that also has a forwardly-diverging and backwardly-converging taper. A steplike ledge or shoulder portion consisting of a horizontal face *f* and a vertical face *g* space the tapered surfaces *e* and *h* and provide a clearance spacing and an offset mounting positioning for cooperating wedge, stay, adapter or equalizer elements **20** which are utilized therewith.

The elements **20** are particularly illustrated in FIG. **8** and as shown, are of angle-shape, having an inner tapered surface or face **20***a* along a leg thereof which forms a complementary engaging fit with an associated vertical surface *e* or horizontal surface *h* of FIG. **4**, to provide an adjustable clamping mounting on an associated keeper **18**. An opposed substantially planar, nontapered face or surface **20***b* of each leg is adapted to slidably clamp-engage either a vertical edge portion or the upper face of an end portion of the foot plate **15***c* of an associated bracket **15**. A group of relatively thin-metal slipon or spacer elements **23**, see FIGS. **8**, **9** and **10**, of suitable and preferably different thicknesses are employed to fit on a threaded stem or bolt element **25** between a front foot portion **20***c* of each element **20** and the outer side of a gib or keeper, such as shown in FIG. **4**, to provide a desired wedging engagement between the complementary tapered surfaces of the elements **20** and the keeper, gib or fastener **18** to thus adjust the slidable clamping engagement of each element **20** with respect to the foot plate **15***c*. As shown in FIG. **4**, a bevel *d* may be provided in the underside of the portion **18***b* to accommodate the inside of the angle shape of an associated element **20**, listed as A. The adjacent element **20** is listed as B and the elements **20** employed with bottom assemblies are listed as C. As particularly illustrated in FIGS. **4** and **10** to **12**, each element **20** (listed as A and B) is removably and adjustably secured to an associated keeper or gib **18** by first securing a threaded stem or bolt **25** within its threaded bores **18** *d* and **18***e* and then, after a suitable number of slips **23** have been inserted, applying and tightening down a nut **25***a*.

The group of bottom assemblies is illustrated particularly in FIGS. **1**, **2**, **3**, **5** and **7**. This group has pairs of diagonally-opposed assemblies that are aligned with the upper assemblies, but have a different mounting and construction. Lower brackets **16** are of somewhat similar construction to the upper brackets **15**, and each has a vertical mounting part **16***a* that is to be welded, bolted or riveted in a secure connecting relation on the metal shell wall **10***b*. A base or foot plate **16***c* is integrally-connected at right angles to the mounting portion **16***a* and is reinforced in its mounted connection thereto by diagonally-extending ribs or wings **16***b*. As in the case of the end ribs **15***b* of the bracket **15**, the end ribs **16***b* are inwardly spaced from the end portions of the foot or base plate **16***c*.

Each bottom or lower assembly which includes the bracket **16** has a pair of opposed, endwise-positioned stabilizer blocks, keepers or gibs **22** that are rigidly-securing, as by weld metal, on the under face, side or surface **11***b* of the trunnion ring **11**, as shown in FIG. **7**. Each bottom keeper **22** may have an open center portion **22***a* to facilitate welding it securely on the trunnion ring **11**. As shown particularly in FIG. **5**, each keeper **20** has a vertical edge *i* that is tapered along its extent to converge backwardly and diverge forwardly to complementarily-receive the tapered inner face **20***a* of a key element **20** (listed as C) that is of the same construction as used for the upper keepers **18**. Opposed planar outer face or side **20***b* of the bottom-employed key elements **20** (C) are adapted to engage an adjacent vertical edge of the foot plate **16***c*. A guide piece or plate **21** is secured to extend crosswise of each lower keeper **22** on its under side and along its tapered edge *i* to serve as a slide-guide retainer for an associated wedge element **20**. Each lower keeper **22** also has a threaded bore **22***b* (see FIG. **5**) for receiving a bolt **25** and mounting an associated key element **20** (C) in a manner shown in FIG. **10**.

It is important (illustrated in FIGS. **4**, **11** and **12**) to provide clearance spacing between the vertical and horizontally-mounted and employed adjustable wedge elements **20** (A and B) of the upper assemblies, to provide clearance spacing *a* (see FIG. **1**) between the outer periphery of the wall of the vessel **10** and the inner side of the trunnion ring **11**, and to provide an under clearance spacing *b* between the under face or side **11***b* of the trunnion ring **11** and the foot or base plates **16***c* of the lower brackets **16**. As a result of the latter-mentioned spacing, the bottom mounting assemblies function primarily when the vessel is tilted, for example represented in FIG. **2**, such that the weight thereof is concentrated transversely or laterally. Adjustment of the mounting of the elements **20** on the keepers **18** and **22** of the upper and lower mounting assemblies provides a desired tightness of clamping-gripping adjustment between the trunnion ring **11** and the vessel **10** such that a controlled or stabilized type of expansion and contraction, creep or distortion of the vessel may be readily accommodated, and without undue stress and strain on the vessel and in such a manner as to increase its operating life.

FIG. **13** of the drawings illustrates the simplest embodiment of the invention wherein two pairs of diagonally-opposed mounting assemblies are utilized. In this embodiment, as

shown in FIG. 14, the foot or base plate 15c is thickened to provide it with greater strength.

Summarized, the trunnion ring 11 or the like is connected to the vessel 10 through the agency of brackets, such as 15 or 16 that are secured to project in an angular relation from the vessel and in a vertically or longitudinally spaced and aligned relation with each other, and that are adapted to cooperate with pairs of spaced-apart keepers or gibs 18 and 22 that are carried by and that are secured on upper and lower faces 11a and 11b of the trunnion ring 11. Each upper mounting assembly consists of a bracket 15 and a pair of keepers 18, and each keeper has a pair of wedge elements 20 (A and B) that operate longitudinally and transversely in their adjustment and that have a straight line engagement with the foot plate 15c of an associated upper bracket 15. Each keeper 22 of each lower mounting assembly has a lateral-adjusting wedge element 20 (C) but not vertical or longitudinal element. The aligned upper 15 and lower brackets 16 have a spaced relation with respect thereto that is greater than the thickness of width of the trunnion ring 10. The upper brackets 15 thus support the vessel for movement with respect thereto under vertical changes to which it may be subject due to the application or removal of heat, vertical impact, creep of materials, etc., and which will function when the vessel is in an upright position, in an angularly tilted, or in a substantially fully tilted, reverse, upside-down position. The lower assemblies serve as guide and lateral supporting assemblies when the vessel 10 is in a tilted relation and primarily, as a protection against excessive sag or deflection of the vessel under the weight of, for example, molten metal being poured.

It will be apparent that various modifications, additions and subtractions may be made as to the illustrated embodiment of the invention without departing from its spirit and scope.

We claim:

1. In a furnace vessel for processing molten metal having an outer metal shell wall and an inner refractory lining and adapted to be positioned on a pair of supports, an improved combination defined when the vessel is in a vertical upright position as follows: a trunnion ring extending in a spaced position about a substantially central area of the outer periphery of the metal shell wall, a pair of trunnions projecting from diagonally-opposite positions on a common horizontal axis from said ring for mounting the vessel on the pair of supports, a group of diagonally-opposed upper pairs of mounting assemblies in a spaced-angular relation with respect to each other about said ring, said group being connected to the shell wall on a common transverse horizontal plane adjacent an upper side of the trunnion ring, each said upper mounting assembly having an angle-shaped bracket and a pair of spaced-apart cooperating keepers, each said bracket having a vertical mounting plate secured on the shell wall and having a substantially planar horizontal foot plate secured in an angular relation to said mounting plate to form a unitary construction, each keeper of said cooperating pair having a mounting portion rigidly-secured on an upper side of the trunnion ring to extend therealong and having an upwardly-offset clamping portion adapted to extend over one end portion of said foot plate of an associated bracket, a pair of angle-shaped wedge elements for each of said keepers, each of said wedge elements having an inner tapered face therealong and an opposed outer substantially planar face therealong, said offset clamping portion of each of said keepers having an inner vertical wall portion defining a complementary taper with the inner tapered face of one of said wedge elements and having an adjacent inner horizontal wall portion defining a complementary taper with inner tapered face of the other wedge element of the same pair, means adjustably-securing the one wedge element on an associated keeper with its inner tapered face in complementary wedging engagement with said inner vertical wall portion and with its outer planar face in cooperating slidable engagement with an end of said horizontal foot plate of the associated bracket, and means adjustably-securing the other wedge element of the same pair with its inner tapered face in complementary wedging engagement with said adjacent inner horizontal wall portion of the associated keeper and with its outer planar face in cooperating slidable clamping engagement with a top face of said foot plate of the associated bracket.

2. In a combination as defined in Claim 1, one pair of said diagonally-opposed upper mounting assemblies being substantially axially-aligned with the trunnions.

3. In a combination as defined in claim 2, said upper assemblies each having a spaced-apart angular relation with respect to each other of about 60° about said trunnion ring.

4. In a combination as defined in claim 2, said upper assemblies each having a spaced-apart angular relation of about 90° with respect to each other.

5. In a combination as defined in claim 1, a group of diagonally-opposed lower pairs of mounting assemblies in a vertically-aligned position with respect to said upper pairs, each lower mounting assembly having an angle-shaped lower bracket and a pair of spaced-apart cooperating lower keepers, each bracket of said lower assembly having a vertical mounting plate secured on the shell wall and having a substantially planar horizontal foot plate secured in an angular relation to said mounting plate to form a unitary construction and having a downward clearance-defining space relation with respect to a lower side of said trunnion ring, and each pair of said lower keepers being secured in a spaced relation to the lower side of said trunnion ring in a cooperative slidable engagement with opposite end portions of the foot plate of an associated lower bracket.

6. In a combination as defined in claim 5, said wedge elements also providing a lower element for each of said lower keepers, each of said lower keepers having a tapered vertical wall portion, and means adjustably-securing each of said lower wedge elements on an associated lower keeper with its tapered face in complementary wedging engagement with the tapered vertical wall portion thereof and with its planar face in cooperating slidable engagement with an end of said foot plate of the associated lower bracket.

7. In a combination as defined in claim 1, a group of diagonally-opposed lower pairs of assemblies, each of which has a lower angle-shaped mounting bracket and a pair of lower spaced-apart keepers, each of said lower mounting brackets having a vertical mounting plate secured to the shell wall of the vessel and having a substantially planar horizontal foot plate secured in an angular relation to said mounting plate to form an integral construction, said foot plate of each of said lower brackets having a clearance-defining under-positioned relation with an underside of said trunnion ring, each said lower pair of keepers being secured on the underside of said ring adjacent opposite ends of the foot plate of an associated lower bracket, each of said lower keepers having a tapered leading edge and an under-positioned support ledge-portion extending along said tapered leading edge, a lower wedge element of the previously defined construction for each of said lower keepers; and means adjustably-securing each lower wedge element on an associated keeper with its tapered inner face in cooperating wedging engagement with said tapered leading edge, with its bottom edge in guided engagement with said ledge portion and with its planar outer side in slidable-clamping engagement with an adjacent end portion of said horizontal foot plate of the associated lower bracket.

8. In combination as defined in claim 7, one upper and lower pair of each of said diagonally-opposed pairs of mounting assemblies being substantially axially-aligned with the trunnions, and each of said assemblies having a spaced angular relation about said trunnion ring.

9. In a combination as defined in claim 8, said mounting and foot plates of each of said upper and lower brackets being reinforced by connecting spaced-apart wings therebetween.

10. In a combination as defined in claim 1, each keeper of said upper pairs having a connecting under-ledge portion between said vertical and horizontal tapered inner surface portions thereof that positions an associated pair of said

wedge elements in a clearance-defining relationship with respect to each other.

11. In a combination as defined in claim 1, said mounting plate of each of said upper brackets being connected by a group of spaced-apart wings to said foot plate, and end-positioned wings of each of said brackets having an inwardly-spaced relation with respect to end portions of said foot plate.