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Krause et al.

[11] **3,892,394**

[45] **July 1, 1975**

[54] **METALLURGICAL VESSEL HAVING RESTRAINING MEANS**

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[73] Assignee: **Pennsylvania Engineering Corporation,** Pittsburgh, Pa.

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[52] **U.S. Cl.** ..... **266/36 P**

[51] **Int. Cl.** **C21c 5/46**

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

[56] **References Cited**

UNITED STATES PATENTS

855,603	6/1907	Adams	266/36 P
3,502,313	3/1970	Pastorius	266/36 P

FOREIGN PATENTS OR APPLICATIONS

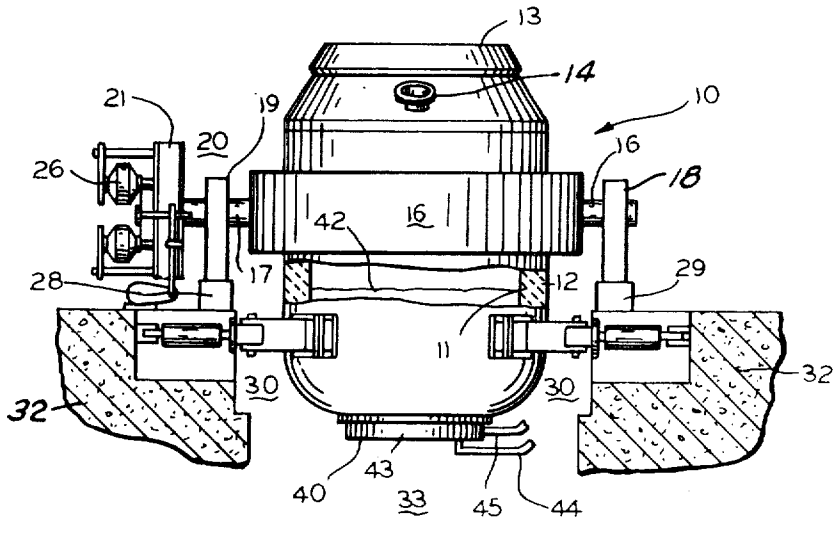
204,018	5/1966	Sweden	266/35

Primary Examiner—Gerald A. Dost
Attorney, Agent, or Firm—Fred Wiviott

[57] **ABSTRACT**

A refractory lined converter vessel for converting ferrous metals to steel is supported in a trunnion ring and constrained against the rocking movement which can result from the swirling and slopping of molten metal in the vessel during various stages of the metallurgical refining cycle. The constraint means of the invention includes a plurality of restraint arms operated by double acting air cylinders which press the arms against the lower section of the vessel during the oxygen blow period and retract them during other stages of the refining operation when the vessel needs to be tilted for charging, deslagging or molten metal pouring.

23 Claims, 4 Drawing Figures



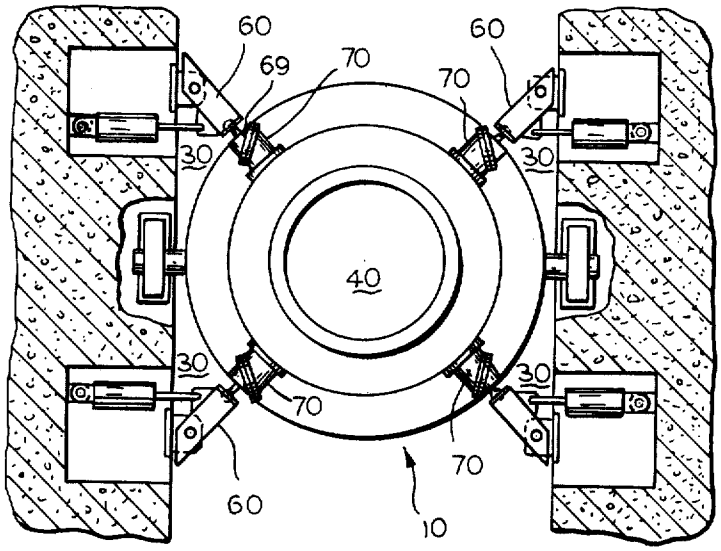


FIG.2

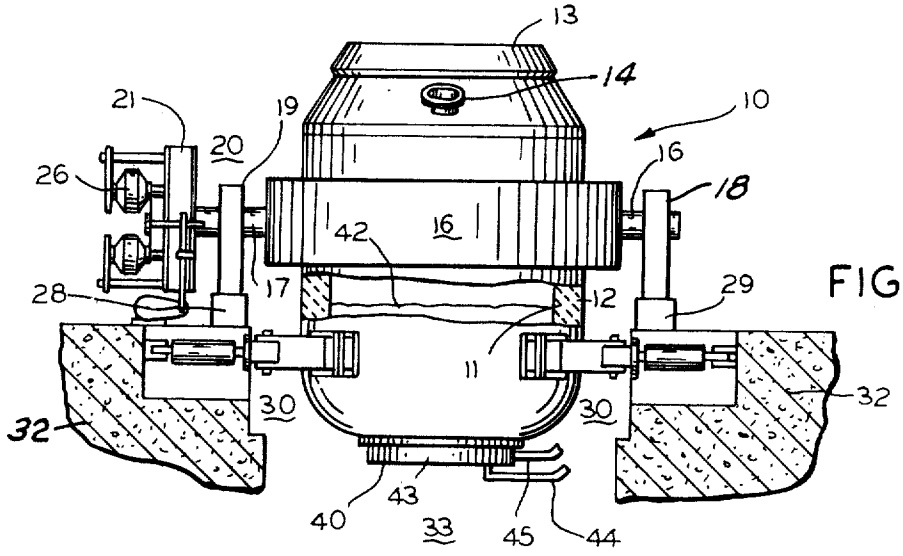


FIG.1

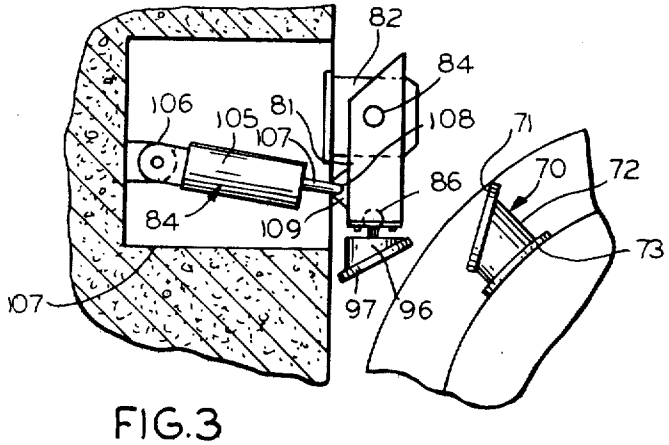


FIG.3

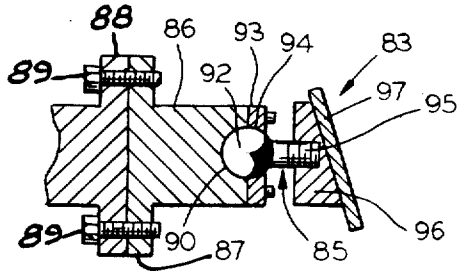


FIG.4

METALLURGICAL VESSEL HAVING RESTRAINING MEANS

BACKGROUND OF THE INVENTION

In the process of refining molten iron in pneumatic process vessels, process gases such as oxygen may be injected beneath the level of molten metal so as to create turbulence within the molten metal bath. Because the bath level is lower than the pivotal axis of the trunnion ring which supports the vessel, the metal agitation produces reaction forces tending to rock the vessel but this is normally restricted by the drive unit restraining means. The resulting torque forces are transmitted from the vessel shell to the supporting trunnion ring through the drive side trunnion pin into the vessel drive assembly and down through the torsion restraining devices and into the concrete or steel supporting foundation for the converter vessel. During oxygen blowing periods, deflection may result in the torsion restraint devices of the drive system which can become sympathetic with vessel movement and actually aggravate the problem. The torsion restraint devices are designed normally to protect drive gears and support bearing from torque shocks during the starting and stopping of vessel tilting while the rotational or rocking forces occur during the oxygen blow period when the vessel is normally at rest.

OBJECTS OF THE INVENTION

It is a primary object of this invention to provide a system for restraining the rocking motion of converter vessels resulting from the injection of oxygen into baths of molten metal.

It is another object of this invention to provide a converter restraint system which will not interfere with normal vessel tilting for charging, deslagging and pouring operations.

It is yet another object of the invention to provide a converter vessel restraint system which is readily adaptable to existing furnaces and which requires no modification in the vessel drive and support assembly.

A further object of the invention is to provide a restraining device for metallurgical vessels which reduce the thrust forces along the trunnion axis.

How these and other more specific objects of the invention are accomplished will appear from the following detailed description of a preferred embodiment of the invention taken in conjunction with the drawings. Generally, however, the invention comprises disposing restraint arms in the walls of a converter pit at approximately 90° angles around the lower portion of the converter vessel. Bumper plates attached to the furnace are similarly arranged so as to be in position for receiving the restraint arms when they are extended. The arms are bidirectionally activated by suitable power supply means such as air or hydraulic cylinders which press one end of each restraint arm firmly against its associated bumper plate and hold it there during the oxygen blow cycle. The contacting surface of each restraint arm is preferably ball and socket mounted to the remainder of the arm so as to insure proper contact between the restraint arm and the bumper plate. The restraint arms are designed so as to be retractable away from the vessel and out of the arc through which the bottom of the converter passes during normal tilting for charging, deslagging or molten metal pouring.

DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top plan view of a converter vessel having restraining means according to the invention;

FIG. **2** is a side elevational view of the converter shown in FIG. **1**;

FIG. **3** is a fragmentary view showing the restraining means of the invention in an alternate position; and

FIG. **4** is a fragmentary view of a portion of the restraining means according to a preferred embodiment of the invention.

DESCRIPTION OF A PREFERRED EMBODIMENT

FIG. **1** illustrates a metallurgical vessel **10** having a refractory lining **11** and metallic shell **12.** According to this invention, vessel **10** may also have an open upper end **13** for charging, deslagging and the evolution of hot gases during refining and pouring spout **14** may be provided adjacent the upper end for deslagging or pouring of the final melt. Surrounding vessel **10** is a generally annular trunnion ring **16** having trunnion shafts **16** and **17** extending from its opposite sides for being supported in bearings **18** and **19.**

As those skilled in the art will appreciate, one of the trunnion shafts is engaged by a drive assembly **20** for tilting vessel **10** as described above. The drive assembly **20** includes a bull gear (not shown) affixed to shaft **17** and disposed within a housing **21** and a plurality of motors **26,** may be mounted on housing **21.** As those skilled in the art will also appreciate, each motor **26** is suitably coupled to the bull gear for effective pivotal movement of vessel **10** and may be provided with brakes, speed reducers and the like. The trunnion bearings **18, 19,** drive system **20** and motors **26** have not been described in detail since they are ancillary to the invention and as such will not be described in detail. For a more specific description of a drive system **20,** reference is made to United States patent application Ser. No. **213,610** filed Dec. **29, 1971,** now U.S. Pat. No. **3,771,777** and assigned to the assignee of the present application.

Trunnion bearings **18** and **19** rest on support piers **28** and **29** respectively which in turn are supported by a concrete or steel foundation **32** which defines a pit **33** for containing the lower portion of converter **10.** The vessel **10** may include a gas injection system **40** which may be of any well known type for injecting process gases such as oxygen, argon, air, nitrogen and the like into the molten metal bath. For example, the gas distribution system may include a plurality of tuyeres, not shown, extending through the bottom or side of the vessel with their inner ends below the level of molten metal. In an exemplary gas injection system, the tuyeres may be of the type having a pair of concentric pipes wherein oxygen or an oxygen containing gas may be injected during the main blowing period and a shielding fluid, such as hydrocarbon containing gas or a light oil, is delivered through the outer pipe for the purpose of prolonging tuyere and refractory life. Also inert gases such as argon or nitrogen may be delivered through one or both pipes during various portions of the process cycle such as during vessel turn-up or turn-down or during desulfurization or recarburization. Particulate material such as lime, may be entrained in one or more of the gas streams and injected through the tuyeres if desired. The outer ends of the tuyeres may be coupled to a gas distribution system (not shown) but which is

well known in the art. A housing **43** may surround the gas system and a pair of gas pipes **44** and **45** are coupled through housing **43** to the individual gas distribution systems, not shown.

In metallurgical vessels where process gases are injected below the surface of the molten metal, the tuyeres are often arranged in an asymmetrical manner so as to produce a stirring action within the melt. As those skilled in the art will appreciate, for example, the tuyeres may be inclined, or a majority may be located on one side of the vessel's center line. As an alternative, the tuyeres may extend through the side wall of the vessel. Such tuyere arrangements are illustrated in U.S. Pat. No. **3,706,549,** issued Dec. **19, 1972** to H. Knupple et al. In any event, the asymmetrical insertion of process gases and other materials causes agitation and turbulence within the melt which may produce reaction forces within the support and drive assembly. Restraining means **30** according to the invention, are provided to protect the drive assembly bearings and supports from torque shock loading which occurs during the starting and stopping of the rotational forces which occur within the vessel during gas blowing periods.

As seen in FIG. **2** the illustrated embodiment employs four restraining devices **30** which are spaced apart at about **90°** intervals around the periphery of the vessel with each pair at about **45°** relative to the center line of the trunnion shafts **17** and **18.** It will be appreciated, however, that while four such devices or a lesser or greater number may be also employed.

Each of the restraint devices **30** includes a restraint arm assembly **60** pivotally mounted adjacent the vessel **10** and a coacting bumper assembly **70** affixed to the metallic shell **12** of vessel **10.**

As best illustrated in FIG. **3,** each of the bumper assemblies **70** includes a bumper plate **71** affixed to a tubular support **72** which in turn is suitably affixed to the metallic shell **12** of vessel **10** at a point below the trunnion ring **16.** The support **72** may have a radially extending flange **73** affixed to one end and having a curvature generally conforming to that of the vessel **10** whereby flange **73** may be suitably affixed as by welding to the vessel shell **12.** The opposite end of tubular member **72** may be formed at an oblique angle relative to its longitudinal axis for supporting bumper plate **71** in a plane which is generally tangential to the shell of vessel **10** and generally vertical when vessel **10** is in an untilted position. The bumper plate **71** may take any convenient shape and is shown to be circular in the preferred embodiment solely for purposes of illustration.

The restraint arm assembly **60** includes an arm **81** pivotally mounted on one end on bracket **82** which is suitably affixed to the walls of the pit **33** and an articulated bumper head **83** mounted on its other end. Suitable means, such as a fluid operated, double acting cylinder **84** may be provided for pivoting the arms **81** into and out of cooperative engagement with the bumper assembly **70.**

Each of the arms **81** may have any convenient cross-sectional configuration such as a rectangular member which is pivotally mounted between the legs of a generally U-shaped support bracket **82** by means of a pin **84** which extends through suitably aligned openings in bracket **82** and arm **81.** The end of arm **80** adjacent the wall of pit **33** may be configured so as to permit unimpeded pivotal motion.

The bumper heads **83** are preferably mounted on the free end of their respective arms **81** in any suitable manner which permits a slight degree of misalignment with the bumper plate **71.** For example, each bumper head **83** may be mounted on an arm **81** by means of a ball joint assembly **85** as shown in FIG. **4.** Each assembly **85** includes a socket member **86** having a radially extended flange **87** on one side for being secured to a mating flange **88** mounted on the end of arm **81** in any suitable manner such as by bolts **89.** Socket member **86** has a hemispheric concave surface **90** on the side opposite the flange **87** for receiving a ball **92** therein. A restraining plate **93** having a spherical opening **94** is affixed to the opposite side of socket member **86** and in surrounding relation to ball **92** to retain the latter in position. A stem **95** extends axially from one side of ball **92** and through the opening **94** in plate **93** and is threaded at its free end for being received within mating threads formed in the body portion **96** of bumper head **83.** Body **96** may take any convenient configuration such as a solid cylindrical member which is truncated at its end remote from the threads for having attached thereto a plate **97** which may have the same general configuration as bumper plate **71.**

Each cylinder **84** includes a cylinder body **105** pivotally mounted at one end to a bracket **106** affixed to a recess **107** formed in the concrete wall **32** of pit **33.** A rod **107** extends axially from cylindrical body **105** and is pivotally connected by a pin **108** to a bracket **109** affixed to the side of arm **81.**

Those skilled in the art will appreciate that the vessel **10** will normally be pivoted by drive assembly **20** for the purpose of being charged by hot metal and/or scrap, for deslagging and for discharging the molten metal after the completion of a process cycle. During such periods, the double acting cylinder **84** will be pressurized to pivot each of the arm assemblies **60** from their positions shown in FIGS. **1** and **2** to the retracted position shown in FIG. **3.** This moves the bumper heads **83** out of an interfering position relative to bumper assemblies **70** whereby the vessel may then be freely pivoted about its trunnion shaft axis.

When it is desired to blow oxygen or other process gases into the molten metal bath within vessel **10,** the vessel will normally be in an upright position as shown in FIGS. **1** and **2.** Prior to the commencement of such blowing operations, each of the cylinder assemblies **84** will be actuated to pivot arm assemblies **60** away from the walls of pit **33** to move the plates **97** on bumper heads **83** into engagement with the bumper assemblies **70.**

The cylinder controls (not shown) for delivering pressurized fluid to cylinders **84** may be interlocked with the drive controls of the bull gear so as to prevent tilting of the furnace when the arms are in an extended position. Such interlocking apparatus is not shown but is well known in the art.

The contact between the arm assemblies **60** and the bumper assemblies **70** prevents the vessel **10** from rocking during the blowing of process gases. As a result, transfer of torque forces to the drive assembly **20,** bearings **18** and **19** and supports **28** and **29** are minimized.

An additional advantage of the system just described is that the dampening device on the lower portion of the vessel **10** can help to reduce the thrust forces which oscillate or hammer in a linear direction along the trun-

nion axis and tend to brinell the bearing races and rollers in the fixed side trunnion support bearing **19**. The thrust force is periodically reversed thereby tending to damage both sides of a typical double row bearing, the kind most commonly employed in support bearings such as **19**. The thrust forces, besides damaging the trunnion bearings, can be transmitted through the trunnion bearings and housing into the bearing foundation pier **29** and eventually cause damage in this structure. The restraining devices of the invention help to reduce the damaging effects of thrust forces as well as the rocking action caused by the swirling and spitting of molten metal in the vessel.

Although the invention has been described in connection with drawings illustrating a single preferred embodiment, such description should not be taken as limiting the invention to specific restraint configurations, numbers, or specific placements thereof. For example, the exact placement of the restraint arms **60** and the bumper assemblies **70** is a design choice which could be made by one skilled in the art, having knowledge of the particular vessel, tuyere placements and the particular metallurgical refining operations. Also the movable portion of the assemblies **30** could be mounted upon the vessel and the stationary portion mounted on the stationary support structure or the bumper plate **71** or bumper **70** could be flexibly mounted and the plate **97** or arm **81** could be fixed or both plates could be flexibly arranged.

Also, while one particular type of gas distribution is illustrated in the drawings, it will be appreciated that the invention has application to other types of pneumatic steel making vessels as well, For example, the vessel **10** could be one in which argon and oxygen, either as a mixture or delivered through separate tuyere pipes, could be injected through the vessel and beneath the level of molten metal as is done in one well known type of steel making process. The invention could also be employed in basic oxygen type vessels wherein reaction forces of the type described are induced during injection of oxygen through a top lance. It is not intended, therefore, to limit the invention to the foregoing preferred embodiment but only by the scope of the appended claims.

We claim:

1. A metallurgical vessel,
support means for said vessel,
pivot means coupled to said vessel for pivoting the same about a generally horizontal axis,
means for delivering at least one process gas to said vessel, and
a plurality of restraint means including a first portion mounted on said vessel and a second portion relatively movable into and out of engagement with said first portion for stabilizing the vessel against rocking motion when said portions are in engagement and allowing said vessel to pivot when said portions are out of engagement, said second restraint portion including at least one arm means pivotally mounted adjacent said vessel for pivotal movement into and out of engagement with said first portion of said restraint means.

2. The invention as claimed in claim **1** wherein said first portion includes plate means mounted on said vessel and facing outwardly therefrom.

3. The invention set forth in claim **1** and including a plurality of said restraint means located in equi-spaced relation around the periphery of said vessel.

4. The invention set forth in claim **3** and wherein said support means includes shaft means mounted on said vessel and extending from the opposite sides thereof, bearing means for supporting said shaft means for pivoting said vessel on said bearing means, at least a pair of said restraint means being disposed on the opposite sides of said shaft means.

5. The invention set forth in claim **4** wherein said restraint means are displaced **45°** from the axis of said shaft means.

6. The invention as claimed in claim **4** wherein each of said plurality of restraint means is located below the axis of said shaft means.

7. A metallurgical vessel,
generally horizontal shaft means mounted on said vessel and extending from the opposite sides thereof, bearing means supporting said shaft means for pivotal movement,
pivot means coupled to said shaft means for pivoting said vessel about a generally horizontal axis,
means for delivering at least one process gas to said vessel, and
a plurality of restraint means disposed in equi-spaced relation about the periphery of said vessel and below said pivotal axis, at least a pair of said restraint means being disposed on the opposite sides of said shaft means, each of said restraint means including a first portion mounted on said vessel and a second portion relatively movable into and out of engagement with said first portion for stabilizing the vessels against rocking motion when said portions are in engagement and allowing said vessel to pivot when said portions are out of engagement, each of said second restraint portions including at least one arm means pivotally mounted adjacent said vessel for pivotal movement into and out of engagement with one of said first portions of said restraint means.

8. The invention as claimed in claim **7** and including fluid operated means for moving said second portion into and out of engagement with said first portion.

9. In combination,
a metallurgical vessel means for delivering process fluids to said vessel to cause agitation of molten metal disposed therein,
support means for said metallurgical vessel,
said support means including a trunnion support ring having trunnion shafts extending substantially horizontally from the opposite sides thereof,
support bearing means for said trunnion shafts,
vessel tilting drive means connected to one of said trunnion shafts, and
restraint means disposed below said trunnion ring and arranged for restraining motion of the vessel during the delivery of said process fluids for disengagement with said vessel to permit tilting of said vessel, said restraint means comprising:
a. four bumper plate means affixed to said vessel and disposed at **90°** angles with respect to the vertical axis of said vessel and at **45°** angles with respect to the axis of said trunnion shaft,
b. four restraint arms pivotally mounted adjacent said vessel for movement into and out of engagement with said bumper plate means,

c. means for pivoting said restraint arms.

10. The invention as claimed in claim **9** wherein said means for pivoting said restraint arms are fluid operated cylinder means.

11. The invention as claimed in claim **9** wherein at least one of said restraint arms or said bumper plate means are flexibly mounted so as to permit misalignment of the contacting portions of said restraint arms with said bumper plate means.

12. A metallurgical vessel,

support means for said vessel,

pivot means coupled to said vessel for pivoting the same about a generally horizontal axis,

means for delivering at least one process gas to said vessel, and

a plurality of restraint means disposed adjacent said vessel, said restraint means including a first portion mounted on said vessel and having a plate means facing outwardly therefrom and a second portion relatively movable into and out of engagement with said first portion for stabilizing the vessel against rocking motion when said portions are in engagement and allowing said vessel to pivot when said portions are out of engagement, and including plate means mounted on said second portion, one of said plate means being flexibly mounted to permit misalignment therebetween.

13. The invention as claimed in claim **12** including fluid operated means for moving said plate means of said second portion into and out of engagement with said plate means of said first portion.

14. A metallurgical vessel,

support means, said vessel being mounted on said support means for pivotal movement about a generally horizontal axis,

means for delivering at least one process gas to said vessel,

a plurality of spaced apart restraint means, at least one of said restraint means being disposed on each of the opposite sides of a vertical plane containing said axis, each of said restraint means including a first portion mounted on said vessel and a second portion mounted on said support means, each of said second portions having a first and second position, said second means being out of the pivotal path of said vessel when in its first position thereby allowing said vessel to pivot about said axis, said second means being disposed in the pivotal path of said vessel and in engagement with said first portion when in its second position for stabilizing said vessel against rocking motion,

and means for moving each of said second portions between said first and second positions each of said second portions being pivotally mounted adjacent said vessel and about a fixed axis.

15. The invention as claimed in claim **14** wherein said first portion includes plate means mounted on said vessel and facing outwardly therefrom.

16. The invention as claimed in claim **15** and including plate means mounted on each of said second portions, at least one of said plate means being flexibly mounted to permit misalignment therebetween.

17. The invention as claimed in claim **16** wherein each of said plurality of restraint means is located below said pivotal axis.

18. The invention as claimed in claim **17** wherein each of said second restraint portions includes an arm means pivotally mounted adjacent said vessel for pivotal movement into and out of engagement with said first portion of said restraint means.

19. The invention set forth in claim **18** and including shaft means mounted on said vessel and extending from the opposite sides thereof, said support means including bearing means for supporting said shaft means for pivotal movement, at least a pair of said restraint means being disposed on the opposite sides of said shaft means.

20. The invention as claimed in claim **19** including fluid operated means for moving said plate means of said second portion into and out of engagement with said plate means of said first portion.

21. The invention set forth in claim **20** and including a plurality of said restraint means located in equispaced relation around the periphery of said vessel.

22. In combination,

a metallurgical vessel, means for delivering process fluids to said vessel to cause agitation of molten metal disposed therein,

support means for said metallurgical vessel,

said support means including a trunnion support ring having trunnion shafts extending substantially horizontally from the opposite sides thereof,

support bearing means for said trunnion shafts,

vessel tilting drive means connected to one of said trunnion shafts, and

restraint means disposed below said trunnion ring and arranged for restraining motion of the vessel during the delivery of said process fluids for disengagement with said vessel to permit tilting of said vessel, said restraint means comprising:

a. a plurality of bumper plate means affixed to said vessel and spaced apart therearound,

b. a plurality of restraint arms each pivotally mounted adjacent said vessel,

c. means for pivoting each of said restraint arms into and out of engagement with one of said bumper plate means.

23. The invention as claimed in claim **22** wherein at least one of said restraint arms or said bumper plate means are flexibly mounted so as to permit misalignment of the contacting portions of said restraint arms with said bumper plate means.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,892,394 Dated July 1, 1975

Inventor(s) Richard P. Krause and Harry T. Montgomery

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 4, Column 6, Line 10, after "of" insert --a plane containing the axis of--.

Claim 5, Column 6, Line 12, after "displaced" insert --through a horizontal angle of--; before "the" insert --a generally vertical plane containing--.

Claim 6, Column 6, Line 15, after "below" insert --a generally horizontal plane containing--.

Claim 7, Column 6, Line 28, after "below" insert --a generally horizontal plane containing--; Line 30, after "of" (first occurrence) insert --a vertical plane containing the axis of--.

Claim 9, Column 6, Line 64, after "respect to" insert --a generally vertical plane containing--.

Claim 14, Column 7, Line 44, after "and" insert --a--; Line 45, cancel "means" and substitute --portion--; Line 48, cancel "means" and substitute --portion--.

Claim 17, Column 8, Line 8, after "below" insert --a generally horizontal plane containing--.

Claim 19, Column 8, Line 19, after "sides of" insert --a generally vertical plane containing the axis of--.

Signed and Sealed this

tenth Day of February 1976

[SEAL]

Attest:

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Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks