March 11, 1958 H. L. McFEATERS 2,826,405

CONVERTER VESSEL

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Fig. 2

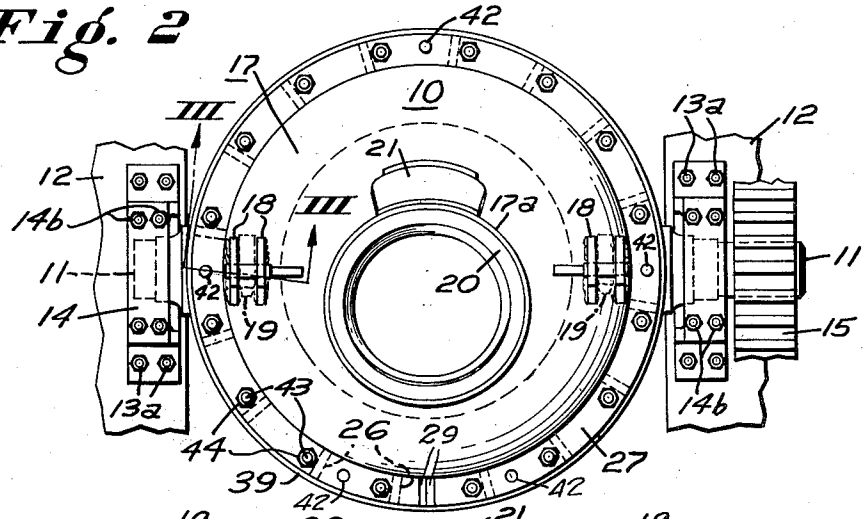
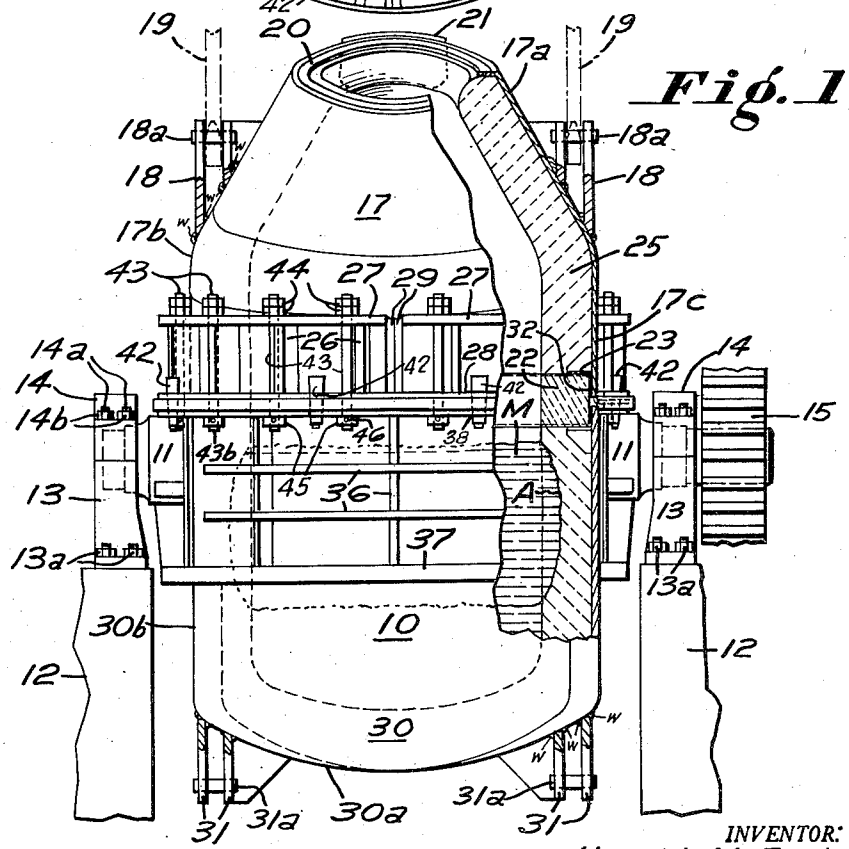



Fig. 1




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Fig. 4

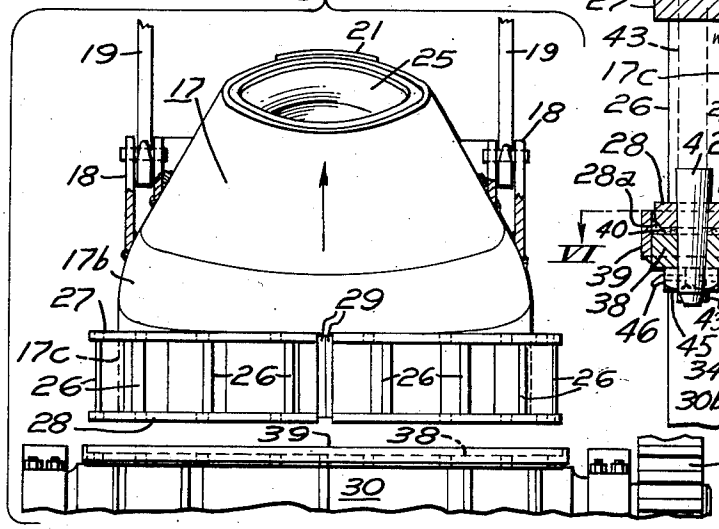



Fig. 3

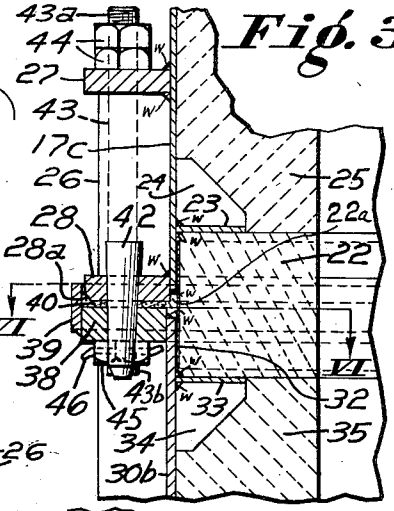



Fig. 5

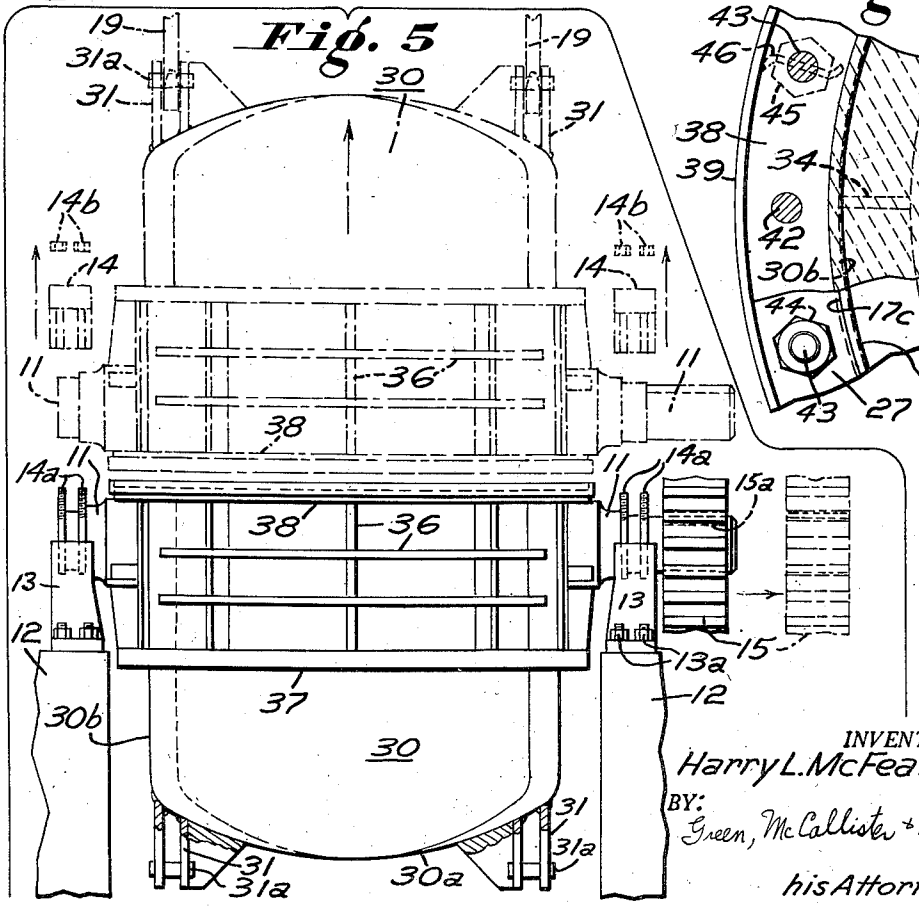



Fig. 6




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2,826,405

# CONVERTER VESSEL

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Application November 10, 1955, Serial No. 546,233

4 Claims. (Cl. 266—36)

This invention relates to an improved converter construction having separable parts or sectors and particularly, to an improved top blow construction for a metal refining converter or vessel of a type suitable for a so-called oxygen blow processing of metals, such as steel.

It has been my experience that a converter of the so-called top blow type and particularly, one of the oxygen blow type presents entirely different and exacting factors in its utilization and construction as compared to conventional converters of the so-called side or bottom blow types. The two-way flow of gas within a top blow converter, the intense heat of the reaction, e. g., in the neighborhood of 3500° F., the intensity and thus the limited time factor of the refining operation, and requirements for larger and larger capacities, in the neighborhood of 60 tons or more, have all contributed to the complexity of the probelm of providing a converter or vessel. The need is for a top blow vessel that can be provided at a reasonable cost, with further desired processing of the metal, and will have a relatively low maintenance cost, and particularly, one which will minimize and facilitate repair operations, for example, of the refractory lining.

My study and work in this particular field has indicated that the problem involved in producing a practical and improved top blow type of converter or vessel and essentially, one that will be practical for present-day so-called intense-heat oxygen-blow processing, arises out of the need for making the construction, assembly and disassembly of the converter in the form of sectors or segments. A practical solution to the problem centers about the need to provide a joint between the sectors such that they can be properly aligned, securely held together, held together without damage and, at the same time, easily formed and separated, and when in position will provide an efficient and effective closure seal between adjacent refractories. Since converters of this type, like the Bessemer converters, are adapted to be rotated to pour the refined metal, the refractory material about the joint has to withstand the molten pour, molten metal spatter from the bottom portion, and the scarifying, agitated flow of gases, fumes and flame during the blowing or refining operation.

It has thus been an object of my invention to provide a new and improved converter or refining vessel construction and one that is suitable for top-blow operations;

Another object has been to devise a converter of a construction mounting and utilization that will be practical for and that will better withstand the rough usage involved in a so-called oxygen blow process;

A further object has been to devise an improved joint construction between converter sections or sectors and particularly, from the standpoint of increasing the life of the refractories, of facilitating the repair of the construction, and of assuring an accurately-aligned strain-minimized re-assembly of the parts of the construction;

A still further object of my invention has been to minimize wear, stresses and strains as set up in a converter construction and to provide an over-all improved vessel;



These and many other objects of my invention will appear to those skilled in the art from the illustrated embodiment, as shown in the drawings and as described in the specification.

In the drawings,

Figure 1 is a side view in elevation, partially broken away, illustrating somewhat generally the construction of the coverter or vessel of my invention; this view somewhat diagrammatically shows a typical type of molten metal-induced erosion which may occur in the refractory lining of a bottom sector;

Figure 2 is a top plan view of the construction of Figure 1 and on the same scale as such figure;

Figure 3 is a greatly enlarged sectional detail of my joint assembly or construction as taken along line III—III of Figure 2 of the drawings;

Figure 4 is a somewhat diagrammatic view in elevation on the scale of Figures 1 and 2, illustrating how an upper part or sector may be removed after the sector has been raised off the lower sector and, of course, after securing bolts and aligning pins have been removed, but while trunnion bearing bolts are still in position as to the lower sector or half;

Figure 5 is a vertical side view in elevation on the same scale as Figure 4, showing the position of a bottom sector after it has been rotated about 180 degrees and illustrating how it may be lifted clear of the bearings for transportation to a repair station; the full lines show the bottom sector in its normal or lower position and the dot and dash lines show it in its upper 180 degree position. Such dot and dash lines also show how the bearing means and the gear for the trunnions may be removed;

And, Figure 6 is a fragmental section of the same scale as and taken on the line VI—VI of Figure 3.

A vessel or converter of the type of utilization here involved is periodically subjected to intense heat and to temperature variations. It is thus apparent that the parts and particularly, the refractory lining and shell and flange portions thereof will tend to expand and contract in accordance with the particular temperatures. I thus found that it is highly essential to minimize stresses and strains between the joint portions, members or parts of the construction and at the same time to protect the metal parts or portions at or adjacent the joint from the intense inner heat to which the vessel is subjected.

In accordance with my present invention, I provide a sectored vessel or converter, as shown in the drawings, of two parts or sections which may be readily removed with respect to each other to not only speed up the cooling for repair purposes, but to also facilitate repair and, if desired, to provide for immediate replacement by spare sectors or halves, so that production of time lost due to maintenance and repair will be minimized. The construction is such that the bottom or top sector may be removed from the other or, in other words, lifted out of position with respect to the other and by employing the same type of handling equipment or hoist mechanism.

Importantly, in carrying out my present invention, and as illustrated particularly in Figures 3 and 4 of the drawings, I have devised a shell construction whose parts are provided both with aligning and with securing means. The securing means has one positioning point or flange located in a spaced or slightly remote relationship with respect to the joint, so as to not only aid in pulling up and securing the joint, in the aligned relationship set by the aligning means, but to also reinforce and strengthen the structure or the structural halves or parts adjacent to and along the joint therebetween.

The inner or refractory wall lining of the vessel may comprise refractory brick tile which, as to the top sector half, extends vertically from an open mouth portion

downwardly to a position and adjacent the joint. As to the bottom sector or half of the vessel, a second and segregated refractory wall lining projects from a position adjacent the joint, downwardly into a cooperating relationship with a bottom refractory lining. The wall linings of the two halves at their joint end portions are held and supported in a widely spaced-apart position by shelf flanges and reinforcing ribs therefor and essentially, in such a manner that they terminate in a vertically spaced relationship with each other circumferentially of the vessel and above and below the actual parting line or plane between the adjacent joint edges of the shell portions of the upper and lower halves or sectors.

A central refractory girdle, annular band or cylindrical sealing refractory part is positioned between opposed reaches of the adjacent end portions of the wall refractories of the upper and lower halves of the vessel to tightly abut or cooperate with them to provide the inner portions of the joint. This refractory girdle or band has an effective vertical extent and projects circumferentially about and in a substantially centrally-aligned relationship with the joint (between the outer metal shell portions of the upper and lower sectors or halves) to, in effect, close-off or isolate the latter from the standpoint of the inner portion of the vessel.

Thus, the refractory girdle or band presents a solid face to the immediate joint of the metal shell portions and defines two, tightly-fitting, and spaced-apart joints between the end portions of the upper and lower wall halves of the refractory wall lining. Such band may be rammed in position and thus, will operate as an intermediate strain and stress-resisting refractory which bears stress or strain set up by the expansion and contraction of the halves or members of the vessel during its operation. It further fully protects the metal members and particularly, the outer securing and aligning flanges of their joint from the hot gases and intense heat of the interior of the vessel.

In the drawings, I have illustrated a converter or refining vessel **10** constructed in accordance with my invention. This vessel carries trunnions **11** that project from its opposite sides and are rotatably mounted within bearing halves **13** and **14**. The latter are secured by bolt and nut assemblies **13***a* to upright stands **12**. As shown particularly in Figure 5, the bearing assembly comprises a lower portion **13** of semicircular shape which carries projecting bolts **14***a* and is adapted to receive and cooperate with an upper bearing half **14**, also of semicircular shape. The bolts **14***a* project through the upper half **14** and are removably secured in position thereon by nuts **14***b*.

As shown in Figures 1 and 5, a bull gear wheel **15** is feathered on one trunnion at **15***a*. The gear **15** is adapted to mesh in the ordinary manner with a drive pinion, so as to turn or rotate the vessel or converter **10** on the stands **12** from, for example, an upright vertical blow position of Figure 1 to tilted, molten-metal-pouring, and charge-receiving, somewhat horizontal positions, and to an inverted or 180° position to lift a bottom part or sector **30** off the stands, compare Figures 1 and 5 of the drawings.

Referring particularly to Figure 1 of the drawings, I have shown a vessel **10** of two halves, sectors or parts comprising an upper part **17** and a lower part **30**. The upper part or sector half **17** has, as shown, an integral, upper metal shell consisting of an upper cone-shaped nose portion **17***a*, an intermediate transition portion **17***b*, and a lower cylindrical body or wall portion **17***c*. A radially-inwardly projecting annular top flange, refractory support rim, metal nose or mouth ledge **20** is secured about an upper end of the upper metal shell and about the charging opening. Also, as shown particularly in Figures 1, 2 and 4, a pouring lip or bib **21** projects downwardly along the pouring side of the converter from the rim **20**. Lift trunnions **18** for the upper structure or half **17** are secured to metal shell portions **17***a* and **17***b* thereof to receive bales **19** of a crane or hoist.

The upper half or sector **17** has an inner refractory lining **25** which may, as particularly shown in Figure 3, comprise tile brick. The refractory lining **25** is, at its upper end, confined and supported by the mouth flange, rim or ledge **20** and, at its lower end, is confined and supported by a continuous or annular, radially-inwardly projecting bottom flange or metal ledge **23** that is secured to the shell portion **17***c*. As shown particularly in Figure 3, a series of circumferentially-spaced-apart upright angle pieces **24** serve as reinforcing ribs for the ledge **23** and project into the refractory wall **25**. Also, as shown in Figure 3, the ledge **23** has an upwardly-spaced relationship with respect to the bottom edge of the metal shell portion **17***c* which is to define the joint.

The outer reaches or circumference of the upper shell is reinforced by and carries an outer cage or frame structure, see Figure 1. This frame or cage is made up of vertically-spaced-apart radially-outwardly extending upper and lower banding rings or flanges **27** and **28**. The upper ring **27** is secured to the outer side of the shell portion **17***c* above the ledge **23** and in a substantially remote, upwardly-spaced relationship with respect to the lower joint-forming edge of such shell portion. The lower ring **28** is secured to the shell portion **17***c* below the ledge **23** and centrally to the immediate edge of **17***c* which forms the joint. Vertical cross-tie pieces **26** are secured, as by welding, between the upper and lower rings **27** and **28**. As shown in Figure 1, the upper and lower rings **27** and **28** are split to provide expansion joints in a circumferential direction. A pair of bar key pieces **29** are shown wedged in position between the split ends of the rings and secured thereto, as by weld metal.

The other or lower half **30** of the converter **10** has an integral metal shell made up of a bottom portion **30***a* and an upper cylindrical body or wall portion **30***b*. A refractory wall lining **35** is shown as of the same type of construction and of the same diameter as the upper refractory wall **25** and, at its lower end, provides and is supported by a concave refractory bottom **35***a*, see Figure 6. The lining **35** is limited and supported at its upper end by a continuous or annular, radially-inwardly projecting top flange or metal ledge **33** which is secured to the shell portion **30***b* in a downwardly-spaced relationship from its joint edge, and in substantially the same spaced relationship as the ledge **23** has with respect to the joint edge of its shell portion **17***c*. Reinforcing ribs or webs **34** of similar construction and spaced mounting as the webs **24** are secured to the ledge **33** to project into the lower refractory wall lining **35**.

As shown particularly in Figures 1 and 3, the inner extent of the joint formed between the upper and lower halves **17** and **30** is defined by a central girdle or annular refractory sealing band **22** which may be, in effect, rammed or tightly fitted in an abutting relationship between the opposed end portions of the upper and lower refractory walls **25** and **35**. It is thus apparent that the refractory band **22** has a vertically-centralized relationship with the joint between the edges of the shell portions **17***c* and **30***b* to thus seal them off. The sealing band **22** provides or defines two parting lines, one of which is above the metal joint and one of which is below it, but both of which are out of or off-set with respect to the plane of the joint. As shown in Figure 3 to further seal off the joint, a light gauge plate member **32** of ferrous or non-ferrous metal may be inset within the outer face of the refractory band **22** in substantial central-vertical alignment both with it and the joint defined by the members **17***c* and **30***b*.

As will be noted from Figures 1 and 3, the lower metal shell construction consisting of portions **30***a* and **30***b* may be of heavier metal thickness or plate than the upper part consisting of portions **17***a*, **17***b* and **17***c*. Like the

upper part, the lower part also has a reinforcing frame or cage construction **36**.

The cage **36** projects between and is secured to upper and lower, radially-outwardly-projecting, banding flanges or rings **37** and **38**. It will be noted that the ring **38** is secured to the outer side of the shell portion **30***b* above the ledge **33** and somewhat centrally of the immediate edge which forms the joint. The ring **38** is in a relatively close and opposed relationship with and cooperates with the ring **28** which is similarly secured to the shell portion **17***c*. As disclosed particularly in Figure 3, the rings **28** and **38** are of sufficient thickness or vertical extent to project above and below or beyond the relatively wide joint or seam between the opposed edges of the shell portions **17***c* and **30***b*.

The rings **28** and **38** have a circumferentially spaced-apart series of aligned holes therethrough (about five spaced as shown) to receive assembly guide and alignment wedge pins **42** (see Figures 1, 2, 3 and 6). Although the rings **28** and **38** are adapted to be held in a rather closely spaced and opposed relationship with each other, an upwardly-projecting face flange or plate ring or rim **39** is secured to the outer edge face of the ring **38** to project above or across the joint between opposed faces of the rings **28** and **38** and along the front edge or face of the upper ring **28** in a slightly spaced relationship with respect thereto. The ring **28** may be slightly beveled at **28***a* (see Figure 3) to form an overflow pocket for sealing mud or ganister **40**, as employed to seal off the joint between the metal rings **28** and **38**.

To secure the joint between the upper and lower halves of the converter in their aligned relationships under compression, the rings **27** and **38** are provided with a series of vertically-aligned holes for receiving and mounting take-up or tension bolts **43** that extend therebetween. The bolts **43** also extend through aligned holes in the ring **28**, so that they have a three-point support along their extent and project between upper and lower reaches of the upper cage, the upper reaches of the lower cage **36**, along the upper shell portion **17***c* and considerably beyond the joint. Locking nut pairs **44** are adapted to be secured on upper threaded ends **43***a* of the bolts to cooperate with nuts **45** on lower threaded end portions **43***b*. The nuts **45** are shown secured in position by cotter pins **46** and although they are not normally removed during a disassembly, may be removed if there is any tendency for the nut and bolt assembly to stick or jam.

It may be noted that the lower half or sector **30** is also provided with a pair of lift trunnions **31** that are secured to bottom shell portion **30***a*, so that, as illustrated for example in Figures 4 and 5, the bottom half **30** may also be lifted off the stands **20** by rotating the converter after the upper half **17** has been removed.

In Figure 1, I have somewhat diagrammatically indicated how molten metal M in a converter will, in time, tend to eat-out or sluff-off the refractory lining, as at A. This emphasizes the need for a reinforced and stronger bottom half of the vessel, as well as the importance of facilitating the removal of the lower half **30** from the upper half **17**. The latter, being for the most part subjected to the hot gases and only during the pouring operation to molten metal, has a longer life. However, the intense heat involved in a refining or blowing operation and the temperature variations involved in the processing steps, all tend to cause distortions due to expansion and contraction. Thus, it is highly important that the vessel or converter **10** be capable of withstanding such forces and particularly so from the standpoint of a joint between its upper and lower halves or sectors.

In accordance with my present invention, temperature variations at the immediate area of the joint are minimized by a compression fit of the refractory material **22** and a new type of positioning of such material, as well as a new type of construction of the joint. The construction is such as to avoid an over-centralization or concentration of stresses and strains of the metal parts in the immediate joint area and a more or less uniform distribution of them throughout the extent of the vessel or converter. The construction is also such as to minimize stresses and strains in the refractory walls of the upper and lower halves (as isolated by their angle shelves **23** and **33**) and to concentrate those present in an easily-replaceable, banding or central refractory wall part **22**.



From the standpoint of minimizing stresses and strains, I have found that it is highly essential to provide means for aligning the two parts of the vessel and for maintaining them in alignment without entire reliance upon the securing assemblies. The construction is such that the aligning means aids in the securing operation and enables the securing to be effected at points of wider spacing with respect to each other for better force distribution and also, in such a manner as to further distribute the stresses and strains and prevent their localization at the immediate cross plane of the joint.

However, as to the inner or refractory wall linings, the construction protects the lining of the upper and lower halves, so that their maximum operative life will be attained. The tightening-down of the upper and lower halves **17** and **30** and the maintenance of them in a sealed relationship from the standpoint of the interior of the vessel is accomplished on a rather wide width of sealing refractory band or girdle **22** that lies intermediate the refractories of the upper and lower halves and bears the brunt of wear and tear of periodic joint disassembly and assembly.

For the purpose of illustration, I have shown a vessel or converter of about 60 net tons capacity that can be operated under an oxygen blow of about 300 cubic feet per minute and about 400 pounds of melt per cubic feet, by employing an oxygen lance that is adapted to be moved vertically downwardly through its mouth to a point adjacent the surface of its melt M. This indicates that my invention provides a vessel and particularly, a joint construction that may be used in larger tonnage installations and for maximum capacities that may be required.

The upper and lower halves of the vessel are independent in the sense of their inner refractory linings and the secure mounting of such linings within and along their respective shell halves. The metal shell of each sector or half, at its joint end portion, projects beyond the end portion of its supporting refractory wall or lining in such a manner as to define an annular joint area or spacing between opposed end portions of the refractory walls of each sector or half and adjacent to the end portions of the metal shells that provide the joint. The refractory band is securely and in a flush relationship mounted in position in such spacing area to seal off the furnace interior and in such a tight fitting sealing relationship with respect to end portions of the refractory walls as to eliminate the necessity for sealing material therebetween. This band provides an offset type of joint construction with respect to adjacent ends of the metal shells. The band, at its upper and lower faces, is out of alignment with the joint spacing or opening between adjacent end portions of the metal shells to avoid a through-type of joint. The spacing at the joint outwardly in front of the plate **32** and between the opposed edges of the members **17***c* and **30***b* may, as shown, be filled with an outer refractory band **22***a* (see Figure 3). However, if desired, the sealing mud or ganister **40** may be employed to fill such spacing.

Normally in a Bessemer converter, a bottom portion being subjected to the most severe wear may average only about 25 to 35 blows. Deterioration may be at a relatively fast rate or as much as an inch per minute after a so-called initial boring or cavitation has been effected. I have discovered that initial deterioration is greatly hastened if the refractory portion is, at the time, being subjected to stress and strain and particularly, to

a localized type and that this follows through as to subsequent deterioration. By way of example, a slight failure or cracking of a portion of a refractory starts the initial boring or cavitation and if such portion is still under stress and strain of a more localized nature, it furthers a spread of such cavitation and a more rapid over-all deterioration of the lining.

In accordance with the invention of my construction, the main lining portions of the vessel are independently supported with respect to each other, but dependently supported as to their respective outer metal shells. Any localized joint stress and strain is concentrated in a separate and intermediately positioned refractory lining means or band part which, by reason of its location, size and construction, can be easily and inexpensively replaced. Its location above the melt line is important.

What I claim is:

1. In an improved top-blow converter construction suitable for high-temperature oxygen-blow operations and having upper and lower body halves; each half having an outer metal shell and an inner refractory wall, each metal shell having a metal joint portion that projects towards a similar joint portion of the other shell and in a vertically-spaced relationship beyond a joint-defining end portion of its respective inner refractory wall to define a metal outer joint and an inner relatively wide joint spacing area between opposed joint-defining end portions of the inner refractory walls, a metal shelf flange projecting radially-inwardly from each metal shell in a supporting relationship along the joint-defining end portion of its respective refractory wall to independently support each refractory wall in position with respect to its respective metal shell, a refractory band securely positioned within said inner joint spacing area and in abutment against said opposed joint-defining end portions of the inner refractory walls to close-off the interior of the converter, said shelf flanges being inset within said refractory walls to smoothly abut said refractory band, a pair of opposed and cooperating joint rings secured to project radially-outwardly from said metal joint portions to further define the metal outer joint, means cooperating between said pair of joint rings to position them in an aligned relationship with each other, said refractory band being positioned above the melt level of the converter and substantially midway across the metal outer joint to define a pair of refractory joints with the opposed end portions of said refractory walls that are vertically-offset with respect to each other and with respect to the metal outer joint, a third metal ring secured about one of said metal shells to project radially-outwardly therefrom in a vertically-spaced relationship with the metal outer joint, and take-up assemblies between said third ring and said pair of joint rings to securely hold the body halves in an aligned and tensioned relationship with each other and to hold said refractory band under substantially uniform compression between the opposed joint-defining end portions of said refractory walls.



2. A converter construction as defined in claim 1 wherein a series of vertical reinforcing webs are secured between said metal shells and their respective shelf flanges to project into their respective refractory walls.

3. A converter construction as defined in claim 1 wherein, a support cage projects downwardly from a lower one of said joint rings, and trunnions are carried by said cage beneath said metal outer joint to rotatably position the converter.

4. A converter construction as defined in claim 1 wherein, sealing mud is positioned between opposed joint defining faces of said pair of joint rings to extend from said refractory band, and a vertical metal end rim is secured to project from one of said joint rings along the other joint ring and across the joint therebetween to retain the sealing mud in position.

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