Aug. 17, 1965 H. KRAMER 3,201,108

STEEL CONVERTER WITH LOOSE SUPPORTING RING

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Fig. 1

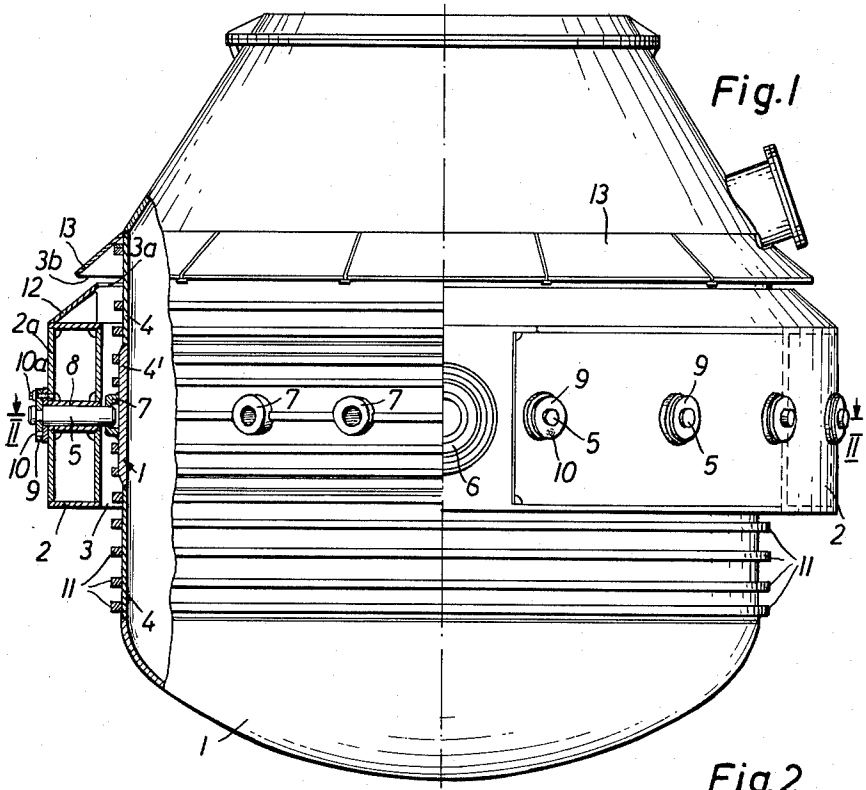
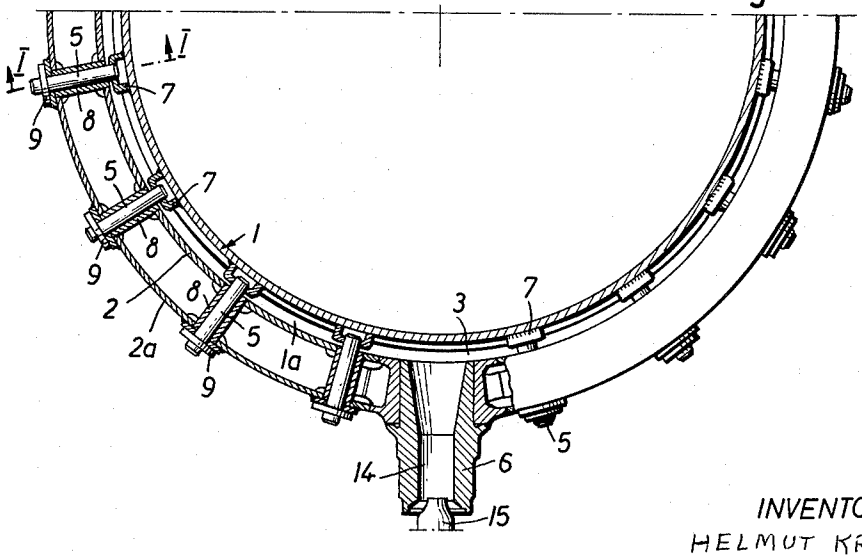


Fig. 2



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Fig.3

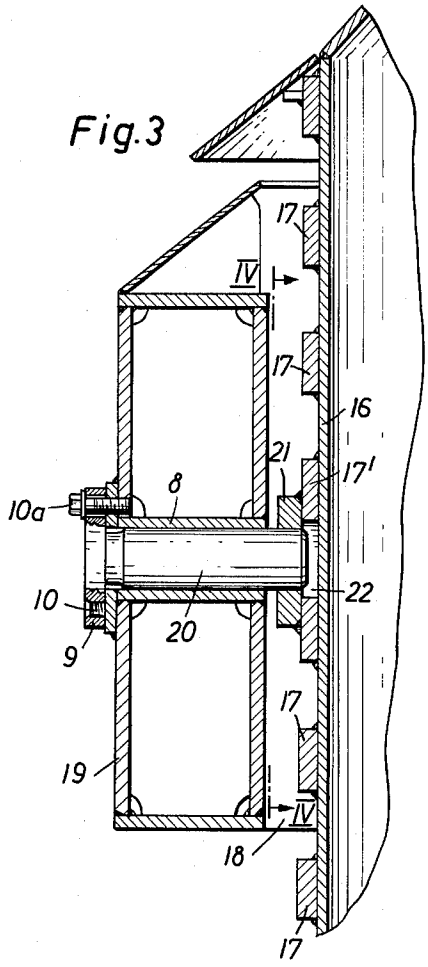
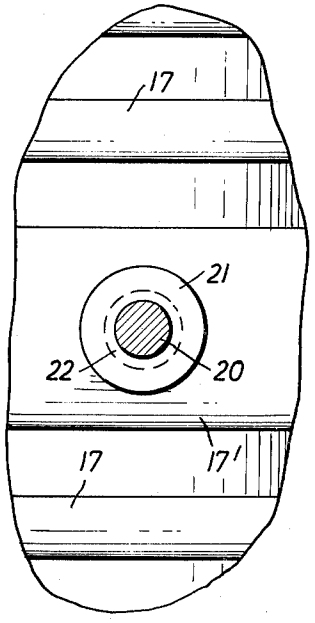


Fig.4



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United States Patent Office 3,201,108 Patented Aug. 17, 1965

3,201,108

STEEL CONVERTER WITH LOOSE SUPPORTING RING

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Filed Jan. 14, 1963, Ser. No. 251,315
Claims priority, application Germany, July 21, 1962, P 29,876
11 Claims. (Cl. 266—36)

This invention relates generally to metal smelting equipment and more particularly to converters for the production of steel having loose supporting rings, that is, rings which are arranged separate from the converter vessel around the latter.

The known converters with loose supporting rings purport to permit free heat expansion of the converter vessel and to permit replacement of the vessel on the supporting ring. However, after these prior art converters have been used for a certain time, these desired properties for the most part no longer exist. This is because the shell of the converter vessel is under considerable tensile stress due to thermal expansion pressure of the brickwork heated from the inside, which reduces the strength of the highly stressed plate shell, causing permanent deformation, growth of the vessel, bulges, and the like. Accordingly, after a period of use the converter vessels will bear firmly on the inner wall of the supporting ring and can even grow at the top and bottom over the supporting ring. The converter vessel is held by the supporting ring along the cylindrical center portion of the vessel and is held at its top and bottom by straps which are radially displaceable on the supporting rings between lugs. While the straps each cover a large part of the top and underside of the supporting ring, dust, slag, etc. can fall unhindered into the space between the vessel and the supporting ring, so that the entire annular gap between the converter vessel and the supporting ring becomes filled with foreign matter and is soon completely closed. Then the heat is localized in the filled up annular gap and the vessel temperature will have an uncontrolled rise. The heat can be dissipated in this region by the supporting ring only, so that much of the heat passes thereto considerably adding to the temperature of the supporting ring. The fastening of the riveted, or in rare cases screwed straps, requires bores to be made in the converter shell. These bores or openings, in most instances, cannot be closely spaced and are therefore frequently the origin of cracks, due to the unfavorable stress conditions along the peripheries of these bores. In order to replace the converter vessel, the straps must be disassembled, and such disassembly is cumbersome and time-consuming. Furthermore, due to the heat expansion of the converter vessel shell in the axial direction, the distance between the upper and lower straps increases slightly during the operation, so that the bottom straps no longer bear on the underside of the supporting ring. This results in an important disadvantage, because when the converter is tipped, the vessel will slide with a jerky motion, after overcoming the static friction, over a distance corresponding to the thermal expansion until the straps that were at the bottom now hold the vessel in the supporting ring. During this jerky motion, the great weight of the converter vessel causes shocks to occur which have an adverse effect, since these shocks cause additional stresses on the converter vessel and on the supporting ring. In addition, since the vessel is held only by the straps on one side of the supporting ring and is pushed and pulled during the tipping motion far outside the gravitational plane of the vessel, resulting additional internal torsional and bending moments result which cause additional unfavorable stresses on the converter vessel shell and on the supporting ring.

It is therefore an object of the invention to eliminate the disadvantages of the prior art converters having loose supporting rings.

To this end, in accordance with an illustrative embodiment of this invention there is provided a supporting ring which carries a plurality of retractable pins directed radially inwardly toward the converter vessel. The pins are arranged in one radial plane and engage retaining eyelets welded to the converter vessel shell; sufficient play for the radial thermal expansion of the converter vessel shell being provided between the front end of the pins and the vessel as well as between the retaining eyelets and the supporting ring. Due to this concentric mounting of the vessel, the undesirable effects of axial heat expansion of the converter vessel is completely eliminated, because there can be no change in the distance between the fastening elements due to axial expansion of the vessel, since all fastening elements are arranged in one radial plane. The radial heat expansion of the vessel, on the other hand, has merely the effect that the retaining eyelets carried by the converter shell are pushed further on the supporting pins. The retaining eyelets are heated slightly more during the heating of the converter vessel on which they are secured than the supporting pins arranged therein. They therefore expand slightly more than the pins. This results in a slight increase of the play with which the pins secured in the colder portion of the supporting ring engage the eyelets. The supporting pins are thereby protected against jamming in the respective eyelets, and in addition an equalization of play is also possible in the case of uneven heating of the vessel.

Another object of the invention is to provide a converter in which the radial heat expansion and reduction in strength remains less than in the pior art converters, because a cooling air current can be directed along the converter vessel shell, which is uninterrupted in the wide annular gap between the converter vessel and the supporting ring.

A further object of the invention resides in the provision of a converter in which the total dimensions of the converter, and particularly the bearing intervals of the trunnions on the supporting ring, remain at a minimum and are not increased by the wider air gap between the vessel and the supporting ring used in the present invention, as compared with the narrow gaps of known converters.

An additional object of the invention resides in an arrangement wherein the supporting ring can be made thinner and less bulky and space consuming, since on the one hand the supporting ring is less stressed mechanically by the mounting according to the invention than in the known converters, and on the other hand, is heated less, due to the better cooling and the smaller cross sections of the suspension for the thermal expansion.

In acordance with the concept of this invention, if the shell plate of the vessel, particularly in larger converters, cannot be selected so thick that it withstands to a sufficient degree the respective stresses; that is, if, despite natural cooling, the tensile stress caused by the pressure of the lining becomes too high in the converter shell plate, the converter vessel shell can be surrounded at least in the region of the supporting ring with fixed steel rings which reinforces the shell and makes the shell more resistant to the thermal expansion pressure of the lining. The reinforcing steel rings relieve the shell plate of tangential tensile stresses and at the same time serve as cooling fins, thus lowering the shell temperature and increasing the strength of the shell material.

It is another feature of the invention to provide, at

least the trunnion of the converter, with a continuous center bore which opens into the annular gap between the converter vessel and the supporting ring to permit additional cooling air to flow into the annular gap. If necessary, additional cooling air can be injected into the annular gap by means of a nozzle protruding into the trunnion bore, so that the resistivity of the plate shell against the pressure of the brickwork is further increased by improved cooling. The total amount of the inflowing cooling air can be considerably increased by injector-action, that is, the air injected from the vicinity of the trunnion inlet takes in larger amounts of air and delivers such air through the trunnion bore. To this end the nozzle has a substantially smaller diameter in the mouth region than the trunnion bore. This also has the additional advantage that no rigid connection or sealing of the nozzle with respect to the trunnion is required.

According to another feature of the invention the annular gap between the converter vessel and the supporting ring can be covered by inclined upper and lower shielding plates in the manner of a roof, which are so secured that a lateral outlet cross section remains open in communication with the annular gap for the cooling air current. Fouling of the annular gap is thereby avoided by the use of the shielding plates, and the region is thus protected against foreign matter causing functional troubles of the mounting arrangement, and against localized heat.

Still further objects and features of this invention reside in the provision of a converter having a loose supporting ring which is efficient in operation, which facilitates replacement of the converter vessel, which is strong and durable, and which will greatly reduce the number of accidents occurring due to faulty operation of prior art converter mounting arrangements.

These, together with the various ancillary objects and features of the invention which will become apparent as the following description proceeds, are attained by the coneverter having a loose supporting ring, preferred embodiments being shown in the accompanying drawings, by way of example only, wherein:

FIG. 1 is a side elevational view of a converter having a loose supporting ring, and further illustrating the converter in a partial sectional view taken along the plane of line I—I in FIG. 2;

FIG. 2 is a horizontal sectional view through one half of the converter taken along the plane of line II—II in FIG. 1, and illustrating other parts of the converter in top plan view;

FIG. 3 is an enlarged sectional detail view of a part of the converter shell and the supporting ring of another embodiment of the invention; and

FIG. 4 is a partial sectional detail view of the converter shell taken along the plane of line IV—IV in FIG. 3.

With continuing reference to the accompanying drawings wherein like reference numerals designate similar parts throughout the various views, in FIG. 1 the converter vessel 1 is disposed with and radially spaced from a supporting ring 2 so there is an annular gap 3 between the vessel 1 and the supporting ring 2. The atmospheric air, which becomes hotter during passage over the internally heated converter shell 4 and which air therefore rises, can pass freely through this annular gap 3, so that a uniform cooling air current can flow about the converter.

The converter vessel 1 is held in the supporting ring 2 by a plurality of spaced cylindrical supporting pins extending through the supporting ring. The supporting pins 5 are circular in transverse cross section and are distributed in the center plane of the supporting ring on which the trunnions 6 of the supporting ring 2 are also mounted. The radial inner ends of the supporting pins 5 engage retaining rings 7 which are welded on a reinforced central part 4' of the converter shell 4. The retaining rings 7 are arranged slightly above the gravitational plane of the lined converter vessel 1. The horizontal plane containing the centers of the retaining rings 7 is above the center of gravity of the converter vessel 1. Due to this type of fastening where the retaining elements 5, 7 lie in the same plane as the trunnions 6, the load of the supporting ring is reduced as far as is practically possible. The mounting and tipping plane is arranged slightly above the gravitational plane of the vessel, so that the converter does not become top-heavy during tipping action, even with a bath running forward. Since the weight of the bath generally amounts hardly to more than 20% of the total weight to be tipped, only a slight displacement of the mounting and tipping plane compared to the gravitational plane of the lined converter vessel 1 is necessary to achieve this stabilization.

The bearing surfaces of the pins 5 in the retaining rings 7 are relatively small, as it can be seen from FIGS. 1 and 2. The fit is thus particularly good and the necessary overall length can be as short as possible. The cylindrical form of the pins 5 as well as of the retaining rings 7 with the relatively small diameter, made possible by the relatively great number of retaining elements, has advantages both in manufacture and in operation. In manufacture, the individual retaining rings 7 can be welded successively on the reinforced portion 4' of the converter shell 4; or the rings 7 are first produced with undersized bores, welded on the shell, and then bored to size through the bores in the supporting ring which later receive the retaining pins. The thermal expansion, and thus the thermal stress in the welded seam with which the retaining rings are secured on the converter shell, is kept at the attainable minimum value, because these stresses can be kept lower and more uniform in a circular welded seam than in any other form of seam.

The fastening of the supporting pins 5 in the supporting ring 2 is likewise very simple. The pins 5 penetrate through the entire width of the supporting ring 2. They are guided in sleeves 8, which are welded into the hollow supporting ring 2. The radial outer ends of the pins 5 carry flanges 9 which are bolted to the outer wall of the supporting ring. The flanges 9 are attached on the ends of pins 5, for example, in two parts, then welded together and subsequently machined. This way it is possible to use lower grade material for the flanges 9 than for the pins 5. The flanges 9 are provided with threaded bores 10 which facilitate the removal of the flanges 9 from the outer wall 2*a* of the supporting ring 2, after the fastening screws 10*a* have been removed, so that the pins 5 can be pulled out easier from their retaining rings 7 when the converter vessel 1 is replaced. It may also be of advantage to provide a hydraulic device, not shown, for advancing and retracting the pins respectively. The simplified replacement of the vessel 1 achieved by the invention, permits a regular replacement of the vessel 1 for relining, that is, to use alternately two or more vessels for one converter, so that prolonged stoppages during relining are avoided.

In FIG. 1 the cylindrical portion of the converter shell 4 is reinforced by welded-on strong steel reinforcing rings 11. The rings 11 are of a rectangular cross section, and are substantially square in cross section. Due to the relatively small radial thickness of the rings, the temperature differences appearing therein and the resulting thermal stresses are very low, so that the rings 11 can still withstand considerable stresses caused by the pressure of the brickwork. Further, the rings 11 have a cooling-fin effect which considerably reduces the temperature of the converter vessel 1 so that the vessel temperature remains considerably lower than in vessels whose shell is not surrounded by such steel rings.

In order to protect the annular gap 3 between the converter vessel 1 and the supporting ring 2 against fouling, and to ensure thus a satisfactory flow of cooling air about the entire converter shell, roof-shaped lower and upper shielding plates 12, 13 are arranged above the supporting ring 2. The lower shielding plates 12 form a

conical plate ring which bears with its bottom edge on the outer rim of the supporting ring 2 and extends from the bearing point obliquely inwardly and upwardly, so that it covers the supporting ring 2 in a roof like manner. Between the converter vessel 1 and the upper edge of the shielding plate 12 there is left a free space 3*a* corresponding in size to the width of the annular gap 3 to permit the unhindered flow of the cooling air. This free annular gap is covered with the upper roof-shaped conical shielding plates 13 formed of detachable segments. The upper plates 13 are bolted to the converter vessel shell 4 close to its upper edge on the uppermost of the steel rings 11 which are secured on the converter shell 4. Between the two shielding plates 12 and 13 there is left sufficient space forming an outlet 3*b* for the lateral issue of the cooling air.

FIG. 2 illustrates the manner in which the cooling air current may be augmented by application of air under pressure according to the invention. The trunnion 6 has a center bore 14, and into this bore 14, extending up to the annular gap 3 between the converter vessel and the supporting ring, is blown additional cooling air from an auxiliary air nozzle 15 arranged in front of bore 14. It may be sufficient if this additional air is only injected through the trunnion not used for starting tipping action. But additional air can also be injected without any difficulties through the opposite trunnion, because no fixed cooling air connections are required which could hinder the tipping drive or necessitate a complicated design of the latter.

Reference will now be made to the modification shown in FIGS. 3 and 4, illustrating an embodiment which reduces the necessary radial dimensions of the total converter mounting arrangement to a minimum with a given vessel diameter. Flat steel straps 17 are welded on to reinforce the vessel shell 16. The radial extension of straps 17 is very small. These flat belt straps 17 reduce only slightly the free cross section of the annular gap 18 between the vessel shell 16 and the supporting ring 19 so that a narrow design of the annular gap 18 is possible. The retaining eyelet which is engaged by the retaining bolt 20 projecting from the supporting ring 19, can in this embodiment have a particularly simple form. A plate ring 21, which has the thickness of the pin support, is welded on a wide belt strap 17′ which extends in the mounting plate of the converter vessel. The play between the front end of the pin and the converter shell, which is necessary in view of thermal expansion, is ensured by bores 22 in the belt strap 17′, into which the pin end can move correspondingly.

Thus, it can be seen that there has been defined a converter for the production of steel comprising a supporting ring 2, a converter vessel 1, and means mounting said converter vessel 1 within said supporting ring 2 in spaced relationship thereto. The mounting means include a plurality of annularly spaced retaining eyelets 7 on the converter vessel, and a plurality of pins 5 secured to said supporting ring 2 slidably engaged in said eyelets 7.

In operation, cooling air passes from nozzle 15 through the trunnion 14 into the gap 3, passing over cooling-fins 11 and thence through space 3*a* out of outlet 3*b*. The plates 12 and 13 prevent foreign matter from entering the gap 3 protecting the converter vessel 1 from hot spots due to clogged foreign matter.

A latitude of modification, change and substitution is intended in the foregoing disclosure, and in some instances some features of the invention will be employed without a corresponding use of other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the spirit and scope of the invention herein.

I claim:

1. A converter for the production of steel comprising a supporting ring, a converter vessel, means mounting converter vessel within said supporting ring in spaced relationship thereto and defining an annular gap between the vessel and the ring to permit radial heat expansion of said converter vessel, said means comprising a plurality of annularly spaced retaining eyelets secured to said converter vessel and defining openings whose axes are perpendicular to the vessel wall, and a plurality of pins radially mounted on said supporting ring and slidably engaged in said eyelet openings.

2. A converter according to claim 1, wherein said converter vessel is provided with a shell having a refractory lining and defining in refractory-lined and empty condition a predetermined center of gravity, said eyelets being secured to said shell slightly above the horizontal plane containing said center of gravity.

3. A conveter according to claim 2, including hollow trunnions on said supporting ring, said trunnions defining a duct therein communicating with said annular gap.

4. A converter according to claim 2, including a plurality of spaced rings of rectangular cross-section secured to said shell, each of said spaced rings extending around the periphery of said shell and being spaced from an adjacent ring in the direction of the converter axis, the axial widths of said spaced rings being at least as great as their respective radial thicknesses.

5. A converter for the production of steel comprising a supporting ring, a converter vessel, means mounting said converter vessel within said supporting ring, said converter vessel being spaced from said supporting ring and defining an annular gap therebetween, said means comprising a plurality of annularly spaced retaining eyelets mounted on said converter vessel and defining openings whose axes are perpendicular to the vessel wall, a plurality of pins radially mounted on said supporting ring and slidably engaged in said eyelet openings, and hollow trunnions attached to said supporting ring for tiltably mounting said converter for pouring.

6. A converter according to claim 5, including a plurality of spaced rings of rectangular cross-section secured to said converter vessel, each of said spaced rings extending around the periphery of said converter vessel and being spaced from an adjacent ring in the direction of the converter axis, the axial widths of said spaced rings being at least as great as their respective radial thicknesses.

7. A converter for the production of steel comprising a supporting ring, a converter vessel, means mounting said converter vessel within said supporting ring and in spaced relationship to said ring, said means comprising a plurality of retaining eyelets mounted on said converter vessel spaced around the periphery thereof and having openings with axes perpendicularly oriented relative to the vessel wall, a plurality of pins mounted on said ring and slidably engaged in said eyelet openings, said pins extending radially through said supporting ring, flanges on the ends of said pins outwardly of said supporting ring, and fastening means detachably securing said flanges to said supporting ring.

8. A converter for the production of steel comprising a supporting ring, a converter vessel, means mounting said converter vessel within said supporting ring in spaced relationship thereto, said means comprising a plurality of annularly spaced retaining eyelets mounted on said conveter vessel and defining openings whose axes are perpendicular to the vessel wall, and a plurality of cylindrically shaped pins extending radially inwardly from and detachably secured to said supporting ring and slidably engaged in said eyelet openings.

9. A converter according to claim 8, including a plurality of spaced steel rings of rectangular cross-section secured to said converter vessel, each of said spaced rings extending around the periphery of said shell and being spaced from and adjacent ring in the direction of the converter axis, the axial widths of said spaced rings being at least as great as their respective radial thicknesses.

10. A converter for the production of steel comprising a supporting ring, a converter vessel, means mounting said converter vessel within said supporting ring in spaced relationship thereto and defining an annular gap therebetween, said means comprising a plurality of annularly spaced retaining eyelets secured to said converter vessel and defining openings whose axes are perpendicular to the vessel wall, and a plurality of pins extending radially inward from and secured to said supporting ring and slidably engaged in said eyelet openings, upper shielding plates secured to said conveter vessel, and lower shielding plates secured to said supporting ring and spaced from said upper shielding plate to define an outlet communicating with said annular gap, said upper and lower shielding plates overlying said annular gap.

11. A converter according to claim 10, wherein said upper shielding plates extending downwardly and outwardly, and said lower shielding plates extend inwardly and upwardly.

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