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Kuita et al.

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[54] **APPARATUS FOR AUTOMATICALLY LINING CONTAINERS**

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[52] **U.S. Cl.** **425/110;** 425/262; 425/426; 425/457; 425/460; 264/269

[51] **Int. Cl.** **B29c 27/16**

[58] **Field of Search** 425/60, 64, 110, 115, 90, 425/262, 347, 365, 402, 403, 457, 460, 426; 264/269, 71, 72

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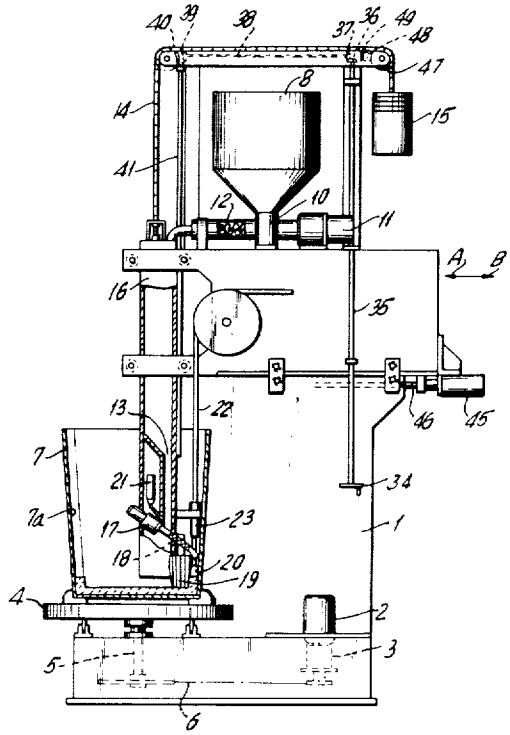
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Primary Examiner—Robert L. Spicer, Jr.
Attorney, Agent, or Firm—McGlew and Tuttle

[57] **ABSTRACT**

The apparatus comprises a segment former constituted by an endless travelling body providing a continuous surface in spaced parallel relation to the inner surface of a container to be lined. The travelling body is in the form of a pair of axially spaced endless chains trained about coaxial sprockets and carrying substantially rectangular plates which are vertically oriented and arranged to form the continuous surface. The endless chains travel about curvature defining guides facing the wall of the container to be lined. A non-shaped refractory is supplied to the space between the segment former and the inner surface of the container, and is rammed by a ramming device. The container is mounted on a rotary table which is rotated during the lining operation, and the travelling body, due to the engagement of the continuous surface with the rammed refractory, moves in the same direction as, and in synchronism with, the rotation of the rotary table, so that there is no relative angular movement between the continuous surface of the segment former and the inner surface of the container. The segment former prevents collapse of the compacted refractory while the latter is "setting."

9 Claims, 3 Drawing Figures



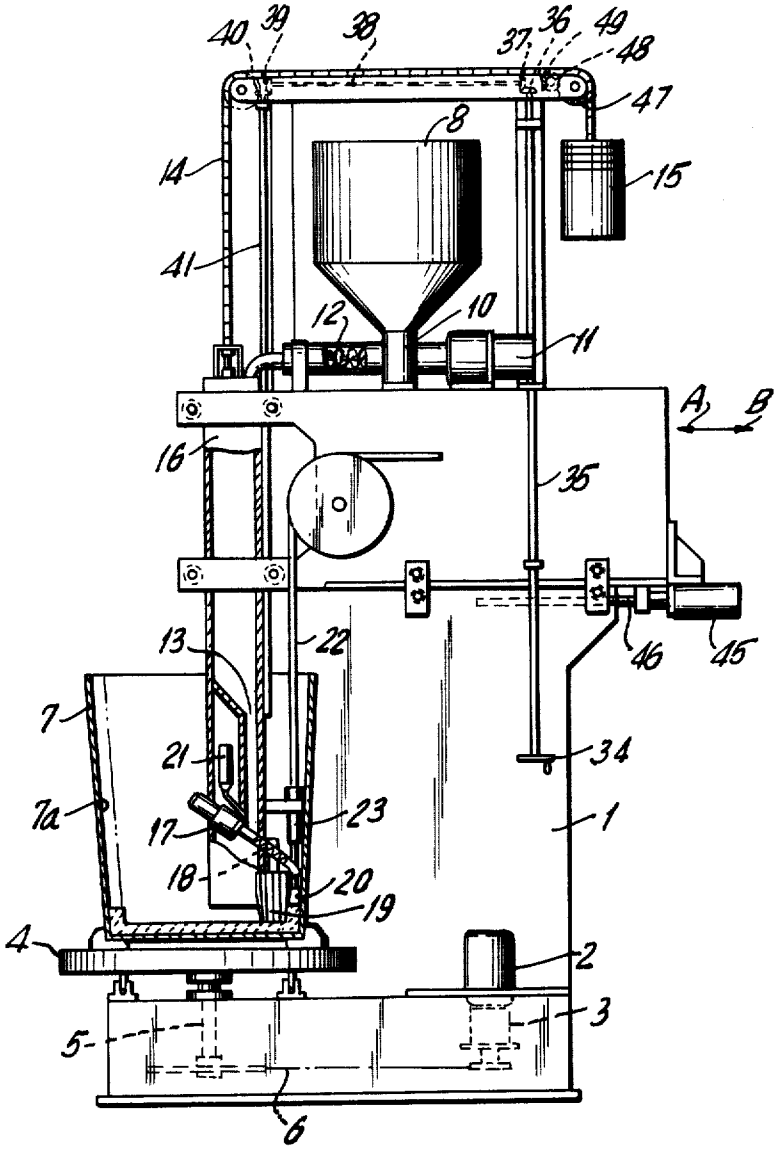

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FIG.1

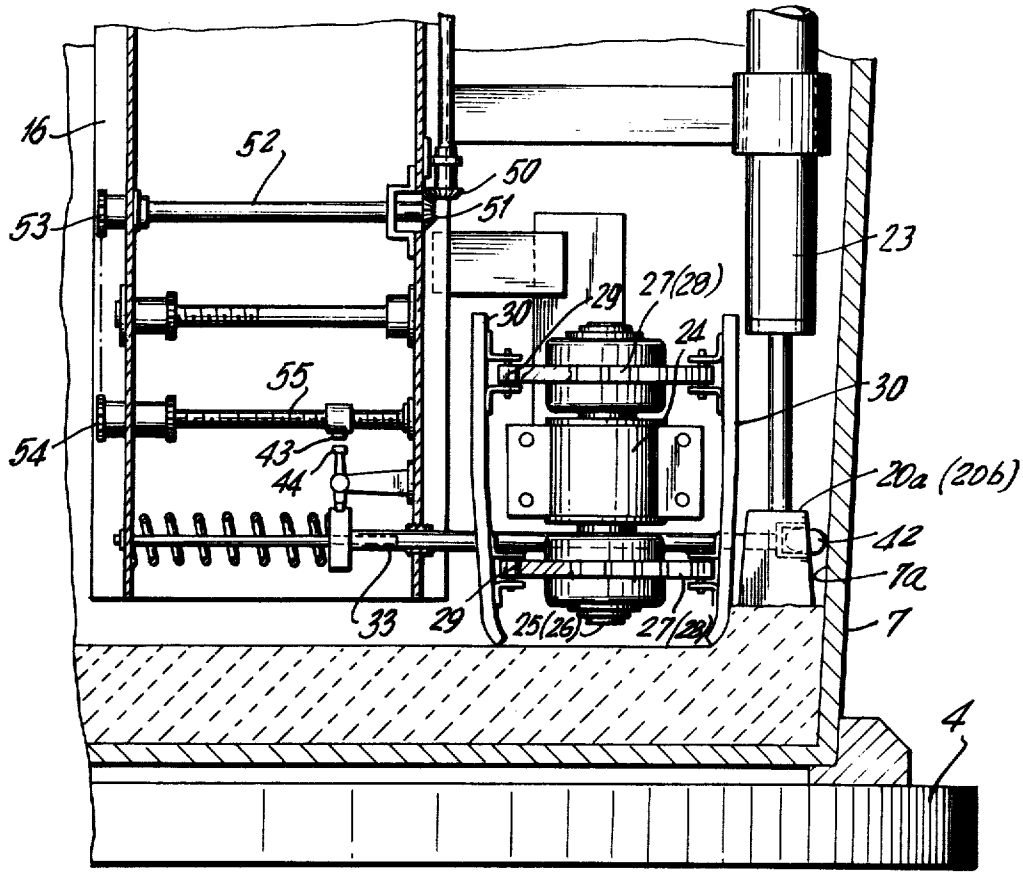

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27(28)
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20a (20b)
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7a
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FIG.2

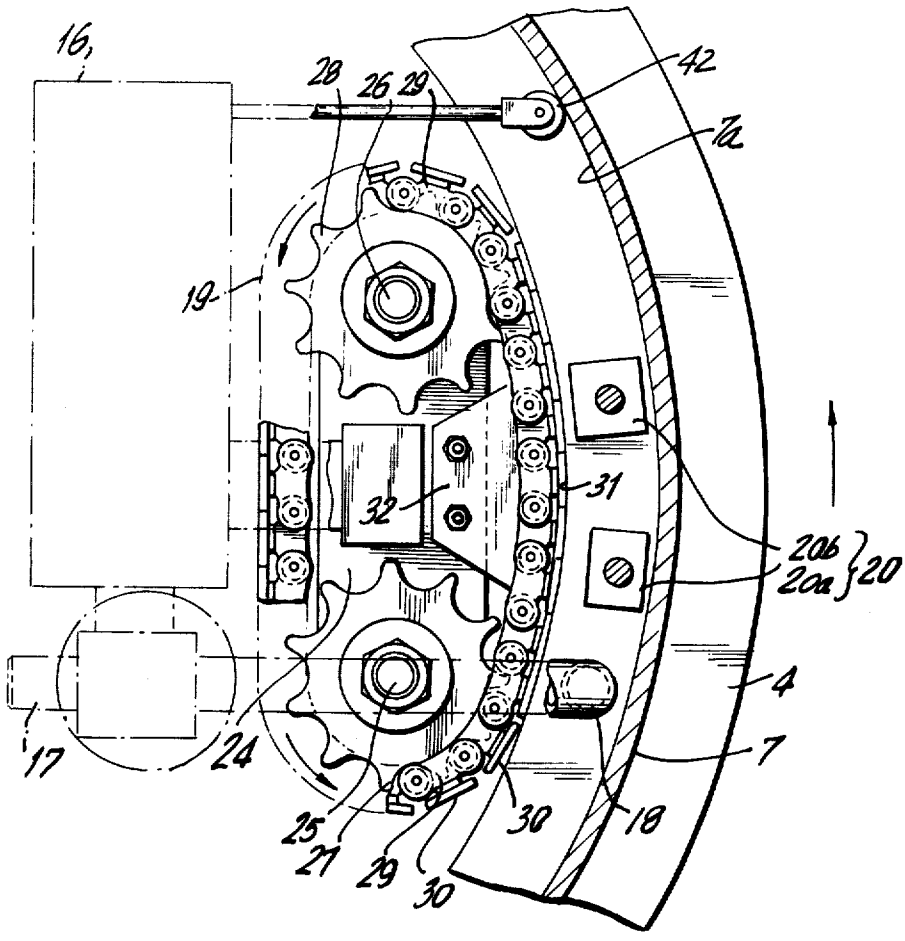


FIG.3

APPARATUS FOR AUTOMATICALLY LINING CONTAINERS

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for automatically lining a ladle for containing molten metal, or a like container (hereinafter referred to briefly as "container"), by ramming a non-shaped refractory (powdery refractory) onto the inner peripheral surface of the container.

Conventionally, a ladle or the like has been re-lined by laying refractory bricks in contact with the inner surface of the ladle, or by placing into the ladle a former having a shape similar to the internal surface of the ladle and ramming a non-shaped refractory which has been packed into the space between the former and the inner surface of the ladle.

The lining of a ladle by laying refractory bricks is a hazardous operation which must be performed within the narrow interior of the ladle. Additionally, the brick working or laying of the bricks has to be conducted in conformity with the desired lining, requiring skillful workers, and this produces brick powder which causes an occupational disease, such as silicosis. Furthermore, the bricks will become fused and damaged along the joints, markedly reducing the life of the lining.

For lining a ladle by ramming non-shaped refractory between a former and the internal surface of the ladle, it is necessary to prepare beforehand various formers having a shape and size similar to those of the ladle, for varying thicknesses of the lining. This results in increased construction cost and difficulties in maintenance and storage. Moreover, from 50% to 90% of the total work time is required to place the former into position and to remove it after use. As a matter of fact, a lining operation of this type requires that it be conducted almost entirely manually, and thus requires a great deal of labor and is inefficient.

SUMMARY OF THE INVENTION

An object of this invention is to eliminate the described disadvantages and to provide a novel apparatus for forming linings with a non-shaped refractory rationally and automatically by a mechanical operation.

Briefly, the present invention is directed to a segment former to be placed into a container and constituted by an endless travelling body capable of providing a continuous surface where it faces or opposes the inner surface of the container and travelling in synchronism with the rotation of a rotary table, supporting the container, in the same direction so as to completely prevent a refractory lining from collapsing after it has been formed by ramming and to greatly reduce the driving force for associated devices including the rotary table mounting the container.

For an understanding of the principles of the invention, reference is made to the following description of a typical embodiment thereof as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the Drawings:

FIG. 1 is a side elevation view, partly in section, illustrating an embodiment of the invention apparatus in its entirety;

FIG. 2 is a vertical sectional view illustrating the principal parts of the apparatus; and

FIG. 3 is a horizontal sectional view showing the principal parts.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1, 2 and 3 which illustrate an embodiment of the apparatus of the invention, the apparatus includes a frame 1 on which there is a motor 2 which, through a reduction gearing 3, drives an endless chain 6 which, in turn, drives the supporting shaft 5 of a rotary table 4 to rotate a container 7, to be lined, supported on rotary table 4. A hopper 8, for storing a non-shaped refractory, is fixed to a support 9 positioned on the frame 1 to be slidable back and forth (i.e. in the direction of arrows A and B). The hopper 8 has an outlet 10 communicating with a screw feeder 12 driven by a motor 11. The refractory forced out from the outlet of screw feeder 12 is delivered into a subhopper 13 which is fixed to the lower portion of a guide bar 16. Guide bar 16 is connected by a chain 14 to a balance weight 15 and is thereby suspended from the support 9 for movement upwardly and downwardly. At the lower end of subhopper 13, there is a mixer 17 by which the non-shaped refractory, rendered uneven in its particle size distribution in the course of transport, is mixed again to a uniform state free of uneveness in particle size distribution. The refractory is supplied from mixer 17 to a screw feeder 18 connected to the mixer 17 and which supplies the refractory to a position immediately in advance of a rammer butt 20 within the space between a segment former 19 and the inner wall of container 7. A tank 21 containing a self-hardening agent communicates with subhopper 13 to add the self-hardening agent immediately before the refractory is rammed.

Rammer butt 20 comprises an outer rammer butt 20*a*, of a small width, and an inner rammer butt 20*b*, of a greater width, which are moved up and down by a predetermined force exerted by a rammer 23. Rammer 23 is operated by pressure air supplied from an air hose 22. Rammer butt 20 pounds the refractory when the refractory is brought to a position immediately therebelow by the rotation of the rotary table 4, namely by the rotation of the container 7.

Segment former 19, which is the most distinct feature of this invention, comprises upper and lower sprockets 27, 27 and 28, 28 keyed to respective shafts 25 and 26 spaced apart from each other by an adjustable distance, the shafts being rotatably supported by a frame member 24 secured to guide bar 16. Upper and lower endless roller chains 29 and 29 are reeved around the sprockets and a large number of vertically elongated rectangular pieces or plates 30 extend over and are fixed to chains 29 and arranged side by side. Respective curvature defining plates 32 for each chain 29 are fixed to frame member 24 to define a portion 31, of the path of travel of the rectangular pieces 30 and chains 29, opposing the inner surface of the container, having the same curvature as the curved inner surface of container 1. Thus, segment former 19 provides a continuous surface at the path portion 31 where it comes into opposing relation to the inner surface of the container. The rammed refractory lining between the rectangular pieces 30 and the inner surface 7*a* of the container, when driven along with container 7, imparts torque to segment former 19, which therefore travels without changing its relative relation to the lining. In other words, the segment former 19 is an endless body which

travels in synchronism with the rotation of rotary table 4 in the same direction as the rotary table.

A profiling means 33 is provided for keeping the thickness of the lining constant along the inner surface of the container. An adjusting rod 41 is rotated by an adjusting handle 34 through a rod 35, bevel gears 36 and 37, a shaft 38 and bevel gears 39 and 40 to bring a profiling roller 42 into pressing contact with the inner surface of the container in advance of former 19, whereby an indentation or projection on the inner surface of the container, sensed by profiling roller 42, is transmitted to a signal generator 43 and a contact member 44 to drive a motor 45 fixedly mounted on support 9. Consequently, a rotatable screw 46 rotates to move support 9 forward or backward and thereby to maintain the lining at a predetermined thickness as rotary table 4 rotates.

Furthermore, the adjustment of the ramming position of rammer butt 20, during lining, is automatically effected by virtue of the relation between the repellent force of the rammer butt 20 and the total weight of guide bar 16 carrying subhopper 13, tank 21 and rammer 23. More specifically, the total weight of guide bar 16 and the components carried thereby is held in balance with weight 15 connected to the rear end of chain 14 suspending guide bar 16, so that, when the refractory is rammed to a specified hardness, the repellent force of rammer butt 20 acts on the rammer 23, permitting guide bar 16 to move progressively upward under the action of balance weight 15 to raise the ramming position of rammer butt 20. The consequent descent of the weight 15 moves the chain 14, which rotates shaft 38 through a sprocket 47 meshing with chain 14, a clutch (not shown) and gears 48 and 49, and shaft 38, in turn, rotates adjusting rod 41 through the bevel gears 39 and 40. Such rotation is then imparted through gears 50 and 51, a shaft 52, and sprockets 53 and 54, to a screw 55, which, in turn, move signal generator 43, in screw-thread engagement therewith, forward or backward. Generator 43 emits a signal, due to the change of phase relative to contact member 44, to drive motor 45, which consequently moves support 9 forward or backward so as to maintain constant distances between the inner surface of the container and rammer butt 20 and segment former 19 despite the elevation of the guide bar 16.

When the container 7 is placed on rotary table 4 to start a lining operation, the rammer and segment former, to be positioned within the container, must be lifted promptly. To this end, a winch and sprocket 47, which have been disconnected from each other by a clutch, are connected to wind up chain 14. At this time, sprocket 47 is disconnected from shaft 38 by the aforementioned clutch to permit support 9 to remain stationary.

To operate the automatic lining apparatus having the foregoing construction, a non-shaped refractory, uniform in the distribution of particle sizes and in humidity, is supplied continuously from screw feeder 18 into the space between segment former 19 and the inner wall 7*a* of container 7 while the container is being continuously rotated, and the refractory is rammed by rammer butt 20 to a specified hardness. Guide bar 16 is progressively lifted, utilizing the repellent force of the rammer butt when the specified hardness is achieved, to automatically line the container completely over the entire inner peripheral surface.

During the lining process described, the part of segment former 19 comprising chains 29 and rectangular pieces 30, which are in contact with the refractory, namely portion 31 opposing inner surface 7*a* of the container, moves with the refractory, with the result that no sliding contact takes place between the compacted refractory and rectangular pieces 30, which would collapse the refractory.

If a segment former constituted by a shield-like curved plate (i.e. an integrally formed curved plate corresponding to the portion 31 in FIG. 3) which is fixed to a guide bar and spaced by a definite distance from, and extending along, the inner surface of the container, the stationary shield-shaped segment former would be in sliding contact with a rotating refractory or lining, to act thereon as if it were a brake shoe, frequently having the objectionable result that the slightest irregularity in the curvature of the shield-like segment former collapses the lining when once formed. To eliminate such objection, the segment former must previously be formed to conform to the container to be lined in strict conformity therewith. The prior art segment former has another drawback in that it requires drive means of a greater capacity to operate the rotary table and rammer and to lift the associated devices, since the sliding contact between the segment former and the lining entails a power loss.

As will be apparent from the foregoing description, however, the segment former of this invention comprises an endless travelling body which is capable of providing a continuous surface where it comes into opposing relation to the inner wall of the container, and which is adapted to be driven in synchronism with the rotary table in the same direction. The segment former is therefore free of any sliding contact with the refractory or lining and the lining, once formed, will never be collapsed. Because there is no power loss due to sliding contact, the segment former of this invention involves smaller power requirements for the rotary table, rammer and associated devices. Furthermore, being in the form of an endless travelling body, the segment former can be readily adjusted with respect to its cirvature in corresponding relation to the shape of the inner surface of the container.

Although the endless travelling body constituting the segment former of the foregoing embodiment of this invention is adapted to have a torque imparted thereto by the lining, the invention is not necessarily limited to such construction. For instance, it is possible to positively drive sprockets 28 on shaft 26 in conformity with the speed of rotation of the rotary table.

While a specific embodiment has been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

We claim:

1. In apparatus for automatically lining a container with a non-shaped refractory, of the type including a rotary table mounting the container, drive means for rotating the table, a segment former positionable in the container in spaced relation to the inner surface of the container to define a space into which the non-shaped refractory is supplied, and means operable to ram the supplied refractory in such space to form a refractory lining on the inner surface of the container: the improvement comprising, in combination, a segment for-

mer constituted by an endless travelling body providing a continuous surface in spaced parallel relation to the inner surface of a container to be lined; and means mounting said travelling body for movement of said continuous surface in the same direction as, and in synchronism with, the rotation of said rotary table; whereby there is no relative angular movement between said continuous surface and the inner surface of the container, said travelling body comprises an endless series of vertically oriented, substantially contiguous, flat plates providing said continuous surface.

2. In apparatus for automatically lining a container, the improvement claimed in claim **1**, in which said mounting means comprises a pair of vertically spaced endless chains trained about respective pairs of longitudinally spaced sprockets.

3. In apparatus for automatically lining a container, the improvement claimed in claim **2**, including respective curvature forming guides engaging each endless chain in that run thereof facing the inner surface of the container, and constraining the associated chain to a curvature conforming to that of the inner surface of the container.

4. In apparatus for automatically lining a container, the improvement claimed in claim **3**, including a main frame; said rotary table being rotatably mounted on a lower portion of said main frame; a support on the upper portion of said main frame mounted for movement on said main frame toward and away from the axis of rotation of said rotary table; and a guide bar on said support extending downwardly therefrom toward said rotary table; said sprockets being rotatably supported on the lower end of said guide bar.

5. In apparatus for automatically lining a container, the improvement claimed in claim **4**, in which said guide bar is vertically displaceable on said support; an endless chain trained over pulleys on said support and having one end secured to said guide bar; and a counterbalancing weight secured to the other end of said endless chain.

6. In apparatus for automatically lining a container, the improvement claimed in claim **5**, including a rammer secured to said guide bar adjacent the lower end thereof; and a rammer butt operable by said rammer and extending into the space defined by said continuous surface and the inner surface of the container.

7. In apparatus for automatically lining a container, the improvement claimed in claim **6**, including a feeler mounted on the lower end of said guide bar to extend laterally therefrom into engagement with the inner surface of the wall of a container in advance of said segment former considered in the direction of rotation of said rotary table; means biasing said feeler to engage the inner surface of a container; sensing means responsive to movement of said feeler from a predetermined extension thereof; and means operable by said sensing means to displace said support toward and away from the axis of rotation of said rotary table to maintain constantly a fixed spacing between said continuous surface and the inner surface of the container.

8. In apparatus for automatically lining a container, the improvement claimed in claim **7**, including a hopper on said support arranged to contain a supply of a non-shaped refractory, a sub-hopper adjacent the lower end of said guide bar; means operable to deliver the refractory from said hopper through said guide bar to said subhopper; a mixer mounted adjacent the lower end of said guide bar and receiving the refractory from said subhopper to re-mix the refractory; and feeding means connected to said mixer and discharging the remixed refractory therefrom into the space between said continuous surface and the inner surface of the container for compacting by said rammer butt.

9. In apparatus for automatically lining a container, the improvement claimed in claim **8**, in which said weight counterbalances the weight of said guide bar and the components mounted on said guide bar; the reaction of said rammer butt on said rammer mounted on said guide bar resulting from an increase in the height of the refractory in the space between said continuous surface and the inner surface of the container moving said guide bar and the components supported thereby upwardly as the height of the lining increases.

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