

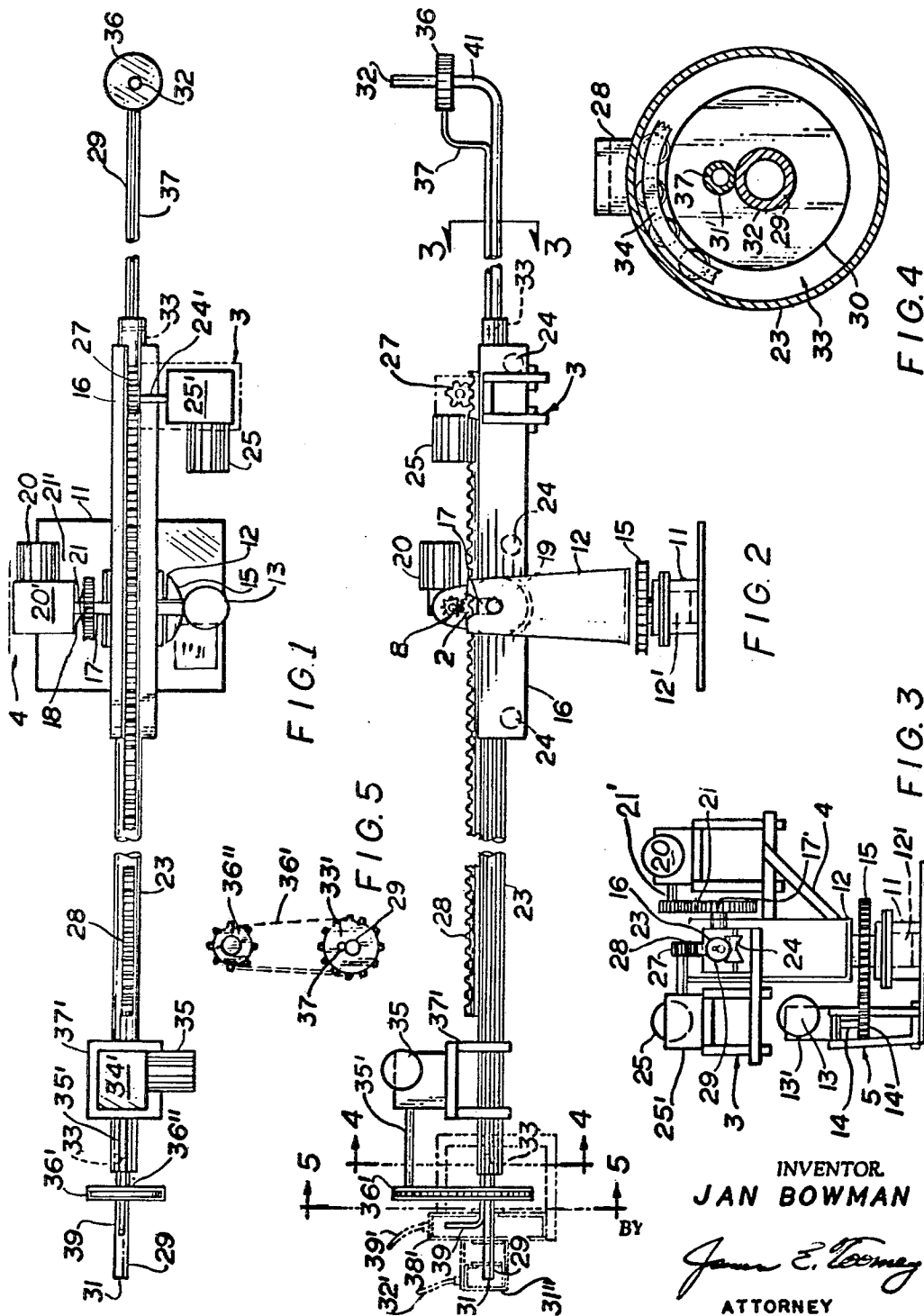
**Oct. 21, 1969**

**J. BOWMAN**

**3,473,737**

APPARATUS FOR GUNNING REFRACTORY MATERIAL HAVING  
ADJUSTABLE NOZZLE POSITIONING MEANS  
Filed March 9, 1966

Filed March 9, 1966



**INVENTOR**

**JAN BOWMAN**

*James E. Toomey*  
ATTORNEY

1

3,473,737

## APPARATUS FOR GUNNING REFRACTORY MATERIAL HAVING ADJUSTABLE NOZZLE POSITIONING MEANS

Jan Bowman, Los Gatos, Calif., assignor to Kaiser Aluminum & Chemical Corporation, Oakland, Calif., a corporation of Delaware

Filed Mar. 9, 1966, Ser. No. 532,938

Int. Cl. B05b 3/18, 9/06; A62c 31/24

U.S. Cl. 239—187

5 Claims

### ABSTRACT OF THE DISCLOSURE

An apparatus for gunning refractory material onto the interior of a furnace, for example an oxygen converter, comprising means for supporting a gunning lance, moving it, and fixing it in position about one vertical axis and two horizontal axes at right angles to each other, as well as longitudinally along its axis.

This invention relates to an apparatus for lining the interior of an industrial furnace with refractory material. More particularly, it is concerned with an improved arrangement for controlling the operation and movements of an apparatus for lining the interior of an industrial furnace, such as an oxygen steel converter or furnace.

Although "gunnable" refractories have been used in the past in the initial construction and repair of industrial furnaces, including those employed in the basic oxygen steelmaking process, wherein molten steel is refined within a converter vessel by blowing a stream of oxygen onto the surface of the molten metal, the equipment used for applying these "gunnable" refractories has not been entirely satisfactory. In the past, only make-shift type devices have been employed due to the limited amount of space within which the equipment had to operate and a considerable amount of time has been involved in setting up and dismantling the equipment.

Ideally, a gun for projecting fluent refractory material onto a furnace wall should project the material at right angles to the furnace wall and at the optimum distance to minimize rebound and dusting and to place the maximum amount of material on the furnace wall with maximum density.

Accordingly, it is a primary purpose of the instant invention to provide an improved refractory gunning apparatus of simplified design which overcomes the deficiencies of prior gunning equipment, which is extremely flexible in its use, and, finally, one which permits proper admixing of fluent refractory material with water just prior to ejection of the gunning material from the apparatus. The instant apparatus also projects the refractory material onto the furnace lining at the optimum angle, no matter what part of the furnace is involved, and at the optimum distance from the furnace wall.

Other purposes and advantages of the instant invention will become apparent from a review of the following detailed description when taken in conjunction with the appended drawing which shows a preferred form of apparatus that can be used in carrying out the teachings of the instant invention wherein:

FIG. 1 is a broken plan view of an apparatus according to the invention with certain parts broken away and with other parts being shown in dotted lines;

FIG. 2 is a broken side elevational view of the apparatus of FIG. 1 with parts removed and with other parts shown in dotted lines;

FIG. 3 is a front sectional view taken generally along the line 3—3 of FIG. 2 with parts added and other parts removed for the sake of clarity;

2

FIG. 4 is an enlarged sectional view taken generally along line 4—4 of FIG. 2 and with parts removed; and FIG. 5 is a schematic view generally taken along the line 5—5 of FIG. 2 with parts removed.

The apparatus of the instant invention generally comprises a base 11 on which is mounted a rotatable pedestal 12 provided with a shaft 12' which fits in suitable bearing 5

The apparatus of the instant invention generally comprises a base 11 on which is mounted a rotatable pedestal 12 provided with a shaft 12' which fits in suitable bearings (not shown) in an opening in base 11. Base 11 is located in an appropriate position on the floor of a building housing the furnace to be serviced (said furnace not being shown) and in close proximity to the furnace. As indicated in FIG. 3, appropriate means for controllably rotating pedestal 12 is attached to base 11. This means can comprise a motor 13 attached to brackets 5 affixed to base 11. Motor 13 drives pedestal 12 through a reduction transmission 13', shaft 14, spur gear 14' and a main gear 15 attached to shaft 12' of pedestal 12.

An elongated cradle 16 is supported by pedestal 12. In the embodiment illustrated, cradle 16 is supported by means of pins or trunnions 17 and 17' which rest in recesses 19 in the sidewalls of pedestal 12. Thus, cradle 16 is mounted on pedestal 12 so it is rotatable about a horizontal axis relative to pedestal 12. Pivotal movement of cradle 16 on pedestal 12 can be effected by a power means which includes a suitable motor 20. Motor 20 is appropriately attached to the bracket mounting 4 affixed to pedestal 12 and rotates cradle 16 through a reduction transmission 20', shaft 21', spur gear 18 and main gear 21 attached to the outer end of pin 17'.

A carrier 23, preferably in the form of a hollow, elongated pipe, is slidably mounted on cradle 16 by means of a series of grooved rollers 24. Mounted on one end of cradle 16, such as the front end, is an appropriate means for controllably moving or sliding carrier 23 longitudinally with respect to cradle 16. This means generally comprises a motor 25. Motor 25 is attached by bracket mounting 3 to cradle 16. Motor 25 operates through a reduction transmission 25', shaft 24', spur gear 27 and a rack 28 attached to carrier 23 to drive or move carrier 23 fore and aft.

A pipe 29, together with a water hose 37, is mounted within carrier 23 for conducting fluent refractory material. As indicated particularly in FIGS. 2 and 4, water hose 37 and pipe 29 are mounted in suitable keeper assemblies 33 located within the carrier 23. The keeper assembly comprises a holder disc 30 provided with openings 31' and 32 for receiving the hose 37 and pipe 29 respectively. Disc 30 is then disposed within a suitable ball race 34.

As indicated in FIG. 5, discs 30 along with pipe 29 and hose 37 are rotated within carrier 23 by means of a gear 33' within which the pipe 29 and hose 37 are mounted. Gear 33' is connected by a gear chain 36' to a gear 36'' driven by a shaft 35' connected to a motor 35 by means of a reduction transmission 34'. Motor 35 and transmission 34' are mounted on carrier 23 by a bracket mounting 37'.

During rotation of pipe 29 and hose 37, connection is maintained with the sources of supply of fluent refractory material and water (not shown) by means of appropriate manifold boxes, or headers, the entry end 31 of pipe 29 being sealably mounted in header 31'' connected to a supply of refractory material by a flexible conduit 32' and the entry end 39 of hose 37 being sealably mounted in header 38' connected to a source of water by a flexible conduit 39'. Headers 31'' and 38' are affixed by conventional brackets shown in dotted lines in FIG. 2 attached to carrier 23 and arranged on carrier 23 so as not to interfere with gear chain 36' or gear 33'.

In an advantageous embodiment of the invention, the fluent refractory material and water can be admixed prior to ejection from the gunning apparatus by a suitable water ring 36 after which the admixed material is ejected from nozzle 32 connected to ring 36. Other arrangements for conveying the water to mixer 36 can be used; for example, the water can be conveyed in a pipe concentrically disposed about the pipe carrying the dry fluent refractory, and thus provide water cooling of that pipe. The admixing means can take any appropriate form depending on the results desired. For example, it can be a water ring of the type shown in U.S. Patent 2,392,408, issued Jan. 8, 1946 to Radonich. It will be understood that water ring 36 is constructed so as to provide means, for example, internal ports, for admixing water entering through hose 37 with fluent refractory material entering through pipe 41.

Preferably the device for admixing water and fluent refractory material is placed in the right angle portion 41 of pipe 29 since admixture at this point minimizes clogging and permits the use of a refractory composition which will form a strong, dense, erosion resistant lining.

It will be understood that oxygen steel vessels, for use with which this apparatus is particularly adapted, are generally in the form of a pear-shaped barrel which is open at the top and closed at the bottom. They are mounted on trunnions on opposite sides so as to be tiltable about a horizontal axis and the vessel can be tilted sideways so that entrance may be had by a generally horizontal member. Thus, in the present instance, the pedestal 12 and base 11 would be located adjacent a vessel (not shown) in such a fashion whereby when the vessel was tilted the pipe 29 and hose 37 could be injected through the open mouth of the vessel and into the proper gunning position within the vessel.

In making use of the apparatus of this invention to line an oxygen vessel with refractory material, the nozzle or exit end 32 of pipe 29 is manipulated so as to be injected into the oxygen vessel by controlled use of the various motor means aforementioned and appropriately positioned so that it will project refractory material from the desired distance and at the proper angle against the lining of the vessel which is to be repaired or installed. Thereupon, controls (not shown) are operated to cause the fluent refractory material and water to flow through the apparatus and the gunning operation commenced.

From the above, it will be noted that the nozzle 32 can be simultaneously rotated while being moved in one or more planes whereby for all practical purposes the nozzle can be advantageously directed against any given wall area within the vessel. Thus, the gunning device can be said to have a movement in substantially all directions relative to a furnace lining whereby the innermost reaches of the vessel can be lined or repaired.

It is an advantage of the apparatus of this invention that with it, it is possible to place gunned refractory material within a furnace so that it is projected at the optimum angle and from the optimum distance and at almost any advantageous angle. This results in better adherence, better density, and better strength and erosion resistance in the placed refractory, all of which is effected in a simple yet controlled fashion and, due to the aforementioned motor controls, the nozzle has almost universal movement relative to the interior of the vessel being worked on and while located within the vessel. Also, it is an advantage of this apparatus that it enables the mixing of the water with the refractory material at a time just prior to projection of the refractory material onto the wall, so that a refractory composition of optimum formulation for gunning can be used. Thus, use of this apparatus obviates the necessity of premixing the refractory with an excessive amount of water in order to

form a slurry which can be conveyed through pipes and hoses. However, it will be understood that the apparatus of this invention can be used with a premixed slurry if desired.

What is claimed is:

1. An apparatus for lining the interior of an industrial furnace with refractory material, said apparatus comprising in combination:

- (a) a pedestal rotatable about a vertical axis;
- (b) common means for controllably rotating said pedestal and for maintaining it in a fixed rotational position;
- (c) a cradle mounted on said pedestal so as to be rotatable with respect to the pedestal about a horizontal axis;
- (d) common means for rotating said cradle with respect to said pedestal and for maintaining said cradle in a fixed rotated position;
- (e) a carrier slidably mounted on said cradle;
- (f) common means for sliding said carrier to preselected positions on said cradle and for maintaining said carrier in a preselected position;
- (g) a first conduit having an entry end and being connected to a gunning nozzle at the opposite end, said first conduit being mounted on said carrier so as to be rotatable about its longitudinal axis;
- (h) common means for rotating said first conduit and gunning nozzle and for maintaining said first conduit and gunning nozzle in a fixed position; and
- (i) first header means sealably surrounding the entry end of said first conduit whereby said entry end is connected to a source of refractory material at all times irrespective of the gunning position to which said first conduit and gunning nozzle may have been moved.

2. An apparatus according to claim 1 wherein the nozzle is adapted to project fluent material at an angle to the axis of the conduit.

3. An apparatus according to claim 1 wherein said apparatus includes a second conduit having an entry and an opposite end connected to a water and fluent refractory mixing element for mixing water and fluent refractory material prior to ejection of the mixture from said apparatus.

4. An apparatus according to claim 3 wherein said first conduit terminates in a section disposed at right angles to its axis and said mixing element is located in said right angle section.

apparatus includes second header means sealably surrounding the entry end of said second conduit whereby said second conduit is connected to a source of water irrespective of the particular gunning position to which said gunning nozzle may have been moved, and wherein said first header means connecting said first conduit to a source of refractory material and said second header means connecting said second conduit to a source of water both permit unlimited rotation of said gunning nozzle.

#### References Cited

##### UNITED STATES PATENTS

|           |         |                  |            |
|-----------|---------|------------------|------------|
| 2,176,891 | 10/1939 | Crom             | 118—305 X  |
| 3,061,201 | 10/1962 | Rienecker        | 239—281    |
| 3,153,510 | 10/1964 | Brannfors et al. | 239—286    |
| 3,276,695 | 10/1966 | Giardino et al.  | 239—186 XR |
| 3,351,289 | 11/1967 | Demaison         | 239—187 XR |

M. HENSON WOOD, JR., Primary Examiner

HOWARD NATTER, Assistant Examiner

U.S. Cl. X.R.

118—323; 239—280