

- [54] **MOBILE REFRACTORY GUNNING APPARATUS**
- [75] Inventor: **Joseph J. Marino**, Ridgefield, Conn.
- [73] Assignee: **Quigley Company, Inc.**, New York, N.Y.
- [22] Filed: **July 19, 1974**
- [21] Appl. No.: **490,009**

- [52] U.S. Cl. **239/132.3; 239/165; 239/176; 239/195; 239/295; 118/317; 118/323**
- [51] Int. Cl.²..... **B05B 3/12; B05B 9/06; B05C 5/00**
- [58] Field of Search **239/159-161, 239/178, 164-166, 187, 168, 172-176, 242, 239/195, 295, 132.3, 132.5; 118/306, 118/317, 323**

- [56] **References Cited**
- UNITED STATES PATENTS**
- | | | | |
|-----------|---------|--------------------------|-----------|
| 1,020,979 | 3/1912 | Hay et al. | 239/187 |
| 2,064,278 | 12/1936 | Tappe..... | 239/165 X |
| 2,388,517 | 11/1945 | Bailey et al. | 239/225 X |
| 2,868,163 | 1/1959 | Boyd..... | 118/317 |
| 3,276,695 | 10/1966 | Giardino et al. | 239/176 X |
| 3,351,289 | 11/1967 | Demaison 118/323 X | |
| 3,396,855 | 8/1968 | Demaison 118/317 X | |

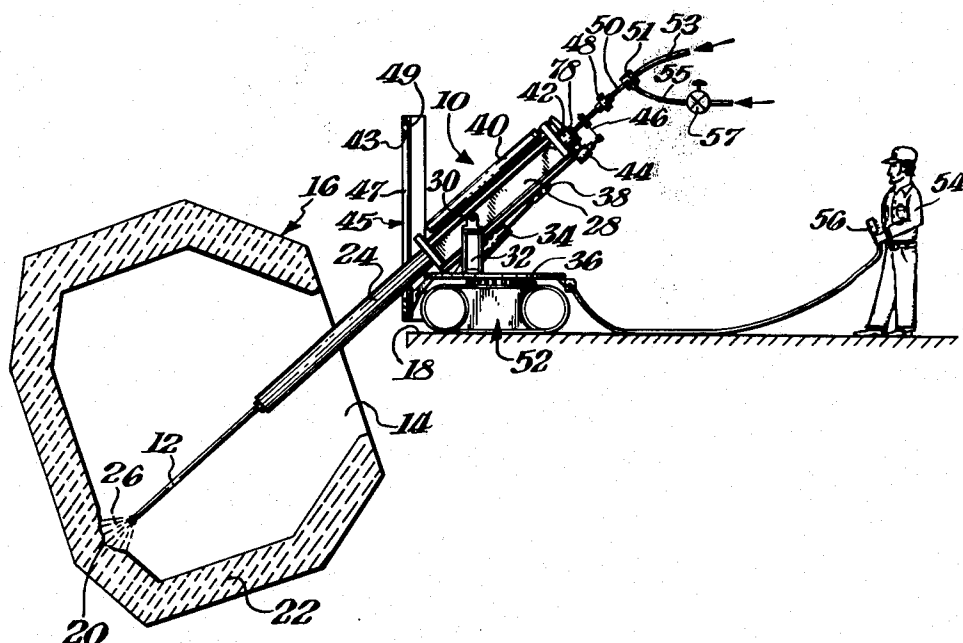
- | | | | |
|-----------|---------|-------------------|-----------|
| 3,473,737 | 10/1969 | Bowman..... | 239/187 |
| 3,477,178 | 11/1969 | Holbert..... | 118/306 X |
| 3,799,445 | 3/1974 | Marino | 118/317 X |
| 3,827,633 | 8/1974 | Kouno et al. | 118/306 X |

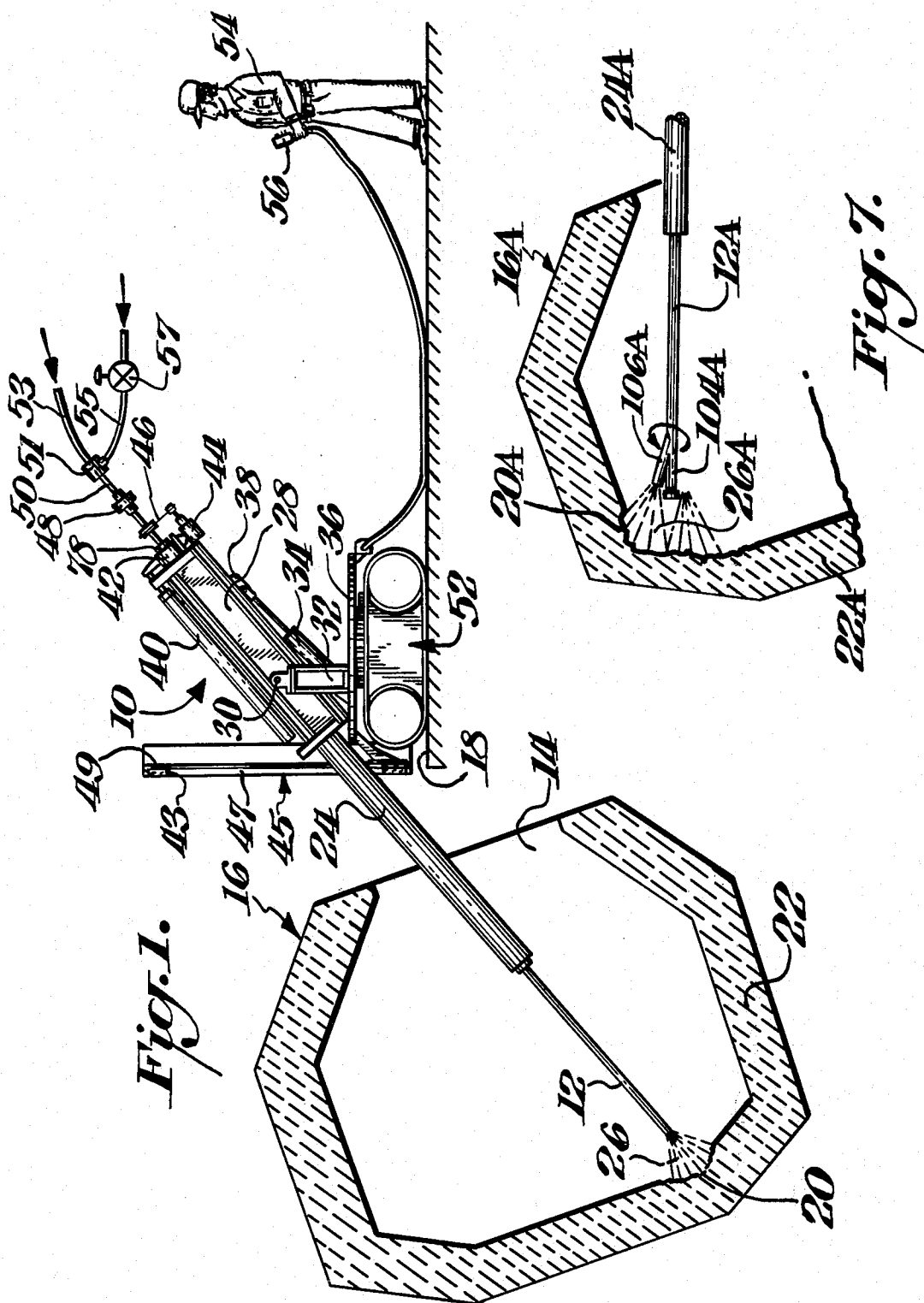
Primary Examiner—Robert S. Ward, Jr.
Attorney, Agent, or Firm—Connolly and Hutz

[57] ABSTRACT

A pipe for gunning a slurry of refractory material and water is rotatably received within a tubular boom. The composition of the slurry is maintained uniform by a water control valve before a mixing tee. The boom is encased in insulation and cooled by a flow of compressed air through an internal annular space around the rotating gunning pipe. The boom is received within roller supports in a barrel framework to permit the longitudinal extension of the boom to be varied. The barrel rocks up and down in a bracket on a turntable which swivels upon a motorized carriage. The longitudinal movement of the boom relative to the barrel and rocking of the barrel and contained boom are actuated by hydraulic piston and cylinder assemblies.

17 Claims, 7 Drawing Figures





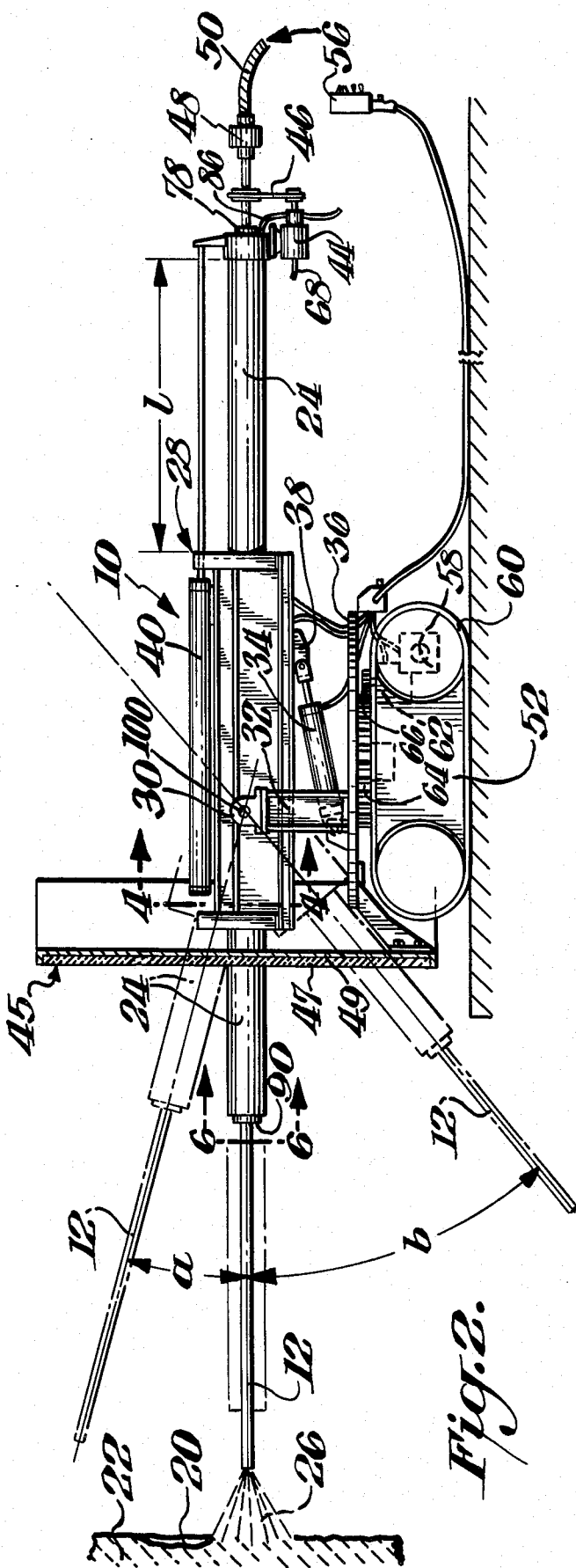
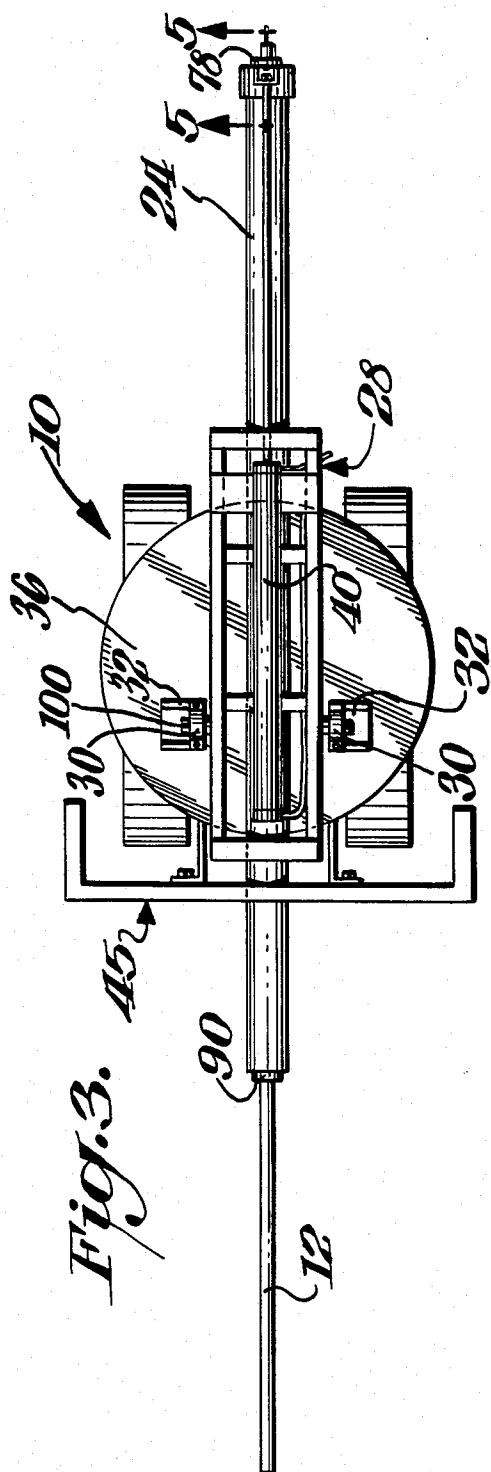


Fig. 4.

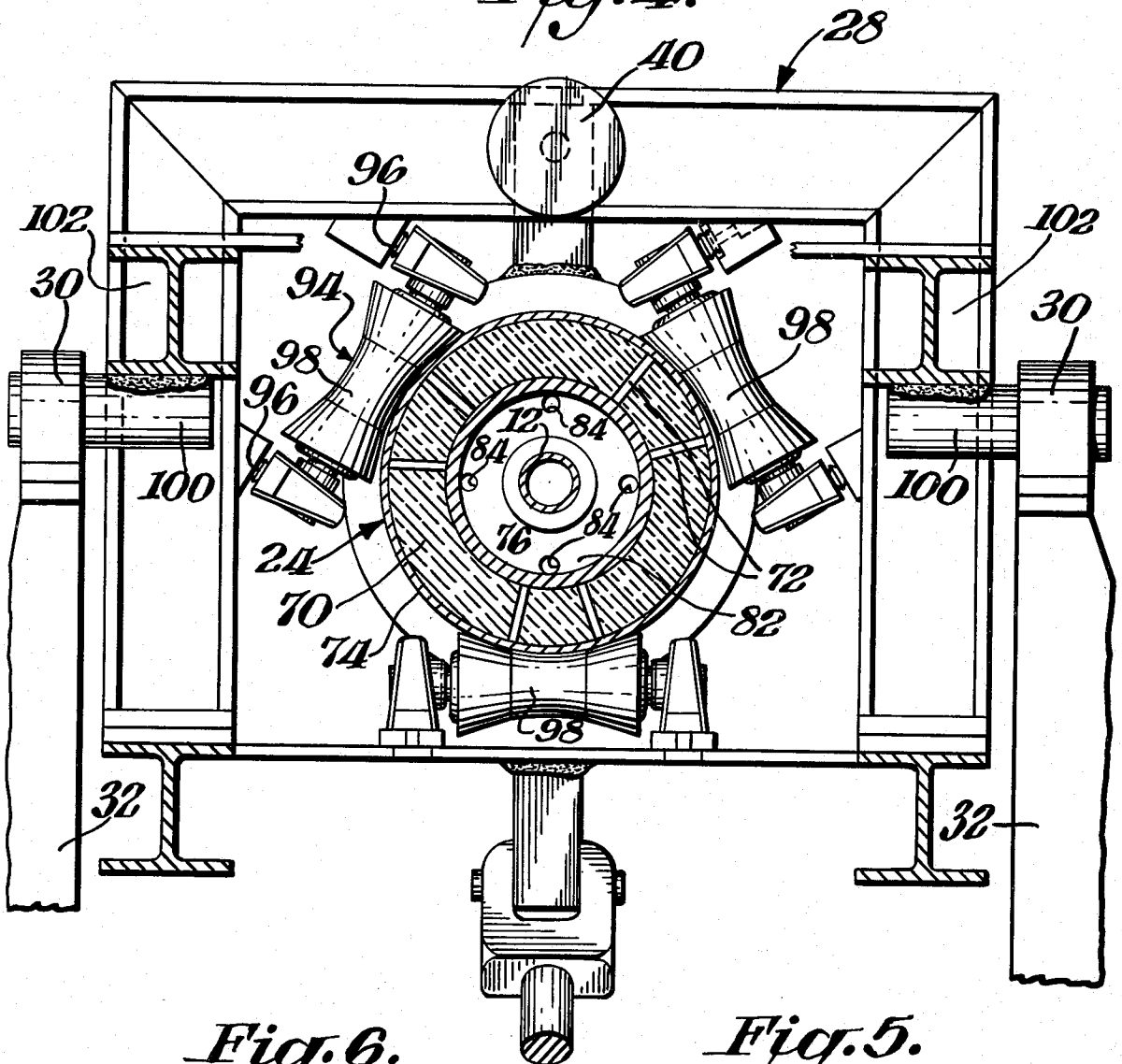


Fig. 6.

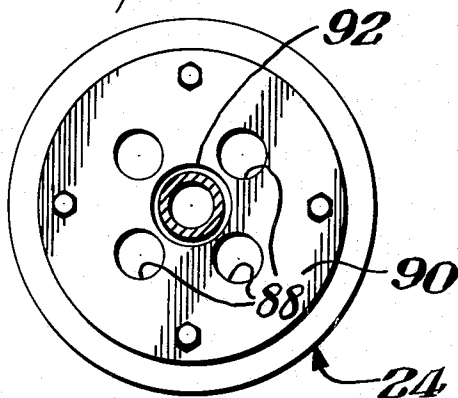
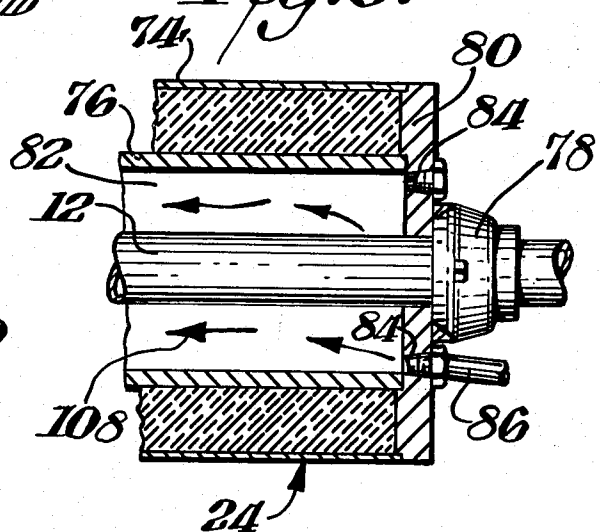


Fig. 5.



MOBILE REFRACTORY GUNNING APPARATUS

BACKGROUND OF THE INVENTION

There are various apparatus with boom-supported gunning pipes for applying fluid refractories within hot refractory-lined vessels such as those used in steel making, for example, as described in U.S. Pat. Nos. 3,351,289, 3,473,737 and 3,799,445. An apparatus for applying a coating within a vessel is also described in German Pat. No. 366,442 dated Jan. 5, 1923. The modern B.O.F. or B.O.P. steel-making process completes a heat of steel in as little as twenty or thirty minutes, thus allowing very little time between heats for refractory gunning, such as described in U.S. Pat. Nos. 3,351,460 and 3,460,933. An object of this invention is to provide a mobile refractory gunning apparatus, which makes it possible to efficiently approach and gun a steel-making refractory lined vessel in a minimum of time.

SUMMARY

In accordance with this invention a refractory gunning pipe is rotatably contained within a boom which is mounted for relative longitudinal movement within a barrel. The barrel is supported to rock up and down on a bracket on a turntable. Longitudinally and vertically-acting extension means react between the barrel and the boom and the barrel and the turntable to vary the extension of the boom and its angle of inclination. A flow of cooling fluid within the boom and about the gunning pipe protects it from the heat in the vessel, and the boom is also encased in insulation to shield it from the heat. The barrel is effectively formed by a framework having a boom-receiving array of rollers at each of its ends which are resiliently biased against the boom. Piston and cylinder assemblies and hydraulic motors effectively perform the required movements.

BRIEF DESCRIPTION OF THE DRAWINGS

Novel features and advantages of the present invention will become apparent to one skilled in the art from a reading of the following description in conjunction with the accompanying drawings wherein similar reference characters refer to similar parts and in which:

FIG. 1 is a side view in elevation partially in cross-section of a mobile refractory gunning apparatus, which is one embodiment of this invention, being used to gun a refractory steel-making vessel;

FIG. 2 is an enlarged side view in elevation of the mobile refractory gunning apparatus shown in FIG. 1;

FIG. 3 is a top plan view of the apparatus shown in FIG. 2;

FIG. 4 is a cross-sectional view taken through FIG. 2 along the line 4—4;

FIG. 5 is a cross-sectional view taken through FIG. 3 along the line 5—5;

FIG. 6 is a cross-sectional view taken through FIG. 2 along the line 6—6; and

FIG. 7 is a view in elevation partially in cross-section of a nozzle portion of a modification of the gunning apparatus shown in FIG. 1 being used to gun the wall of a refractory steel-making vessel.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 is shown a mobile refractory apparatus 10 with its gunning pipe 12 inserted within the opening 14

of a basic oxygen process (B.O.P.) steel-making vessel 16, which has been tilted down toward operating floor 18 to facilitate repair of a worn portion 20 in its refractory lining 22. Boom 24 of apparatus 10 and gunning pipe 12 are inclined downwardly into refractory lined vessel 16 to direct gunning pipe 12 and the stream of pressurized refractory fluid 26 into and about worn area 20 in lining 22. As also shown in FIG. 1, tubular boom 24 is received within barrel framework 28, which is rocked upwardly about pivot bearings 30 at the tops of bracket posts 32 by the reaction of hydraulic piston and cylinder assembly 34 between turntable 36 and connecting link 38 on the bottom of barrel framework 28. Boom 24 is fully extended in front of barrel 28 by the fully engaged position of upper hydraulic piston and cylinder assembly 40 transmitted through collar assembly 42 joining it to the rear of boom 24. Boom 24 extends through window 43 in insulated shield 45 which comprises sheets 47 of mineral wool composition in a frame 49 of steel angles.

Motor 44 and pulley transmission 46 impart rotation to gunning pipe 12, which prevents it from sagging in the heat of vessel 16. Swivel coupling 48 isolates the rotation of gunning pipe 12 from supply conduit 50 through which a flow of refractory slurry is conducted to gunning pipe 12. The refractory slurry is formed at mixing tee 51 from a supply of dry refractory conducted through conduit 53 and water through conduit 55 which is regulated by control valve 57 to maintain substantially constant proportions of water and refractory. Turntable 36 is mounted upon mobile carriage 52. Turntable 36 and motor-driven carriage 52 are for example comprised of a rotatable base crawler portion of typical construction equipment such as a power shovel or mobile crane. The various movements of apparatus 10 are electrically controlled by an operator 54 operating a pushbutton control box 56 away from the heat of vessel 16.

Details of apparatus 10 are shown in FIGS. 2-6. FIG. 2 shows the extent of the various movements of apparatus 10 including upward and downward rocking of boom 24 and barrel 28 about bracket pivots 30 to an upwardly inclined angle a of approximately 15° and a downwardly inclined angle b of approximately 40° . Boom 24 and gunning pipe 12 are for example extendable and retractable relative to barrel framework 28 and carriage 52 by actuation of piston and cylinder assembly 40 a distance l which is for example approximately seven feet. Gunning pipe 12 extends for example in front of boom 24 from about zero to twenty feet and preferably extends in front of boom 24 about ten to twelve feet. Carriage 52 is for example driven by a hydraulic motor 58 which drives caterpillar tread assembly 60 and hydraulic motor 62 which rotates turntable bull gear 64 through pinion 66. Gunning pipe rotating motor 44 is also for example a hydraulic motor supplied through a conduit 68 leading to a suitable source of hydraulic pressure (not shown).

FIG. 4 shows insulating casing 70 about boom 24 which helps protect it from the heat of vessel 16. Radial plates 72 space the outer shell 74 of boom 24 from inner shell 76. FIGS. 2, 3 and 5 also show rear bearing 78 within which gunning pipe 12 is rotatably connected to rear head 80 of boom 24. Compressed air is admitted into annular space 82 between boom inner shell 76 and gunning pipe 12 through one of holes 84 in rear boom head 80 to which compressed air hoses 86 are con-

nected. The compressed air flows through four holes 88 (shown in FIG. 6) in the front head 90 of boom 24. FIG. 6 also shows hole 92 in the front of boom 24 for rotatably receiving gunning pipe 12.

FIG. 4 shows how boom 24 is received within an array of resiliently biased centering rollers 94 mounted within barrel framework 28 and about the periphery of boom 24. Each of the three roller assemblies 94 is resiliently biased by springs 96 in resilient engagement with boom 24 for guiding its forward and backward movement within double tapered guiding and receiving rollers 98 in response to actuation by piston and cylinder assembly 40. FIG. 4 also shows the welding of stub shafts 100 to the bottom of I beams 102 on the sides of rectangular barrel framework 28 and the insertion of shafts 100 within bearings 30 at the top of bracket posts 32.

FIG. 7 shows a modified nozzle 104A attached to the front of gunning pipe 12A for directing a stream 26A of refractory material at a worn area 20A in the wall of refractory vessel 16A which could not be reached by straight gunning pipe 12. Outlet 106A of nozzle 104A is directed at an angle of approximately 20° to the longitudinal axis of gunning pipe 12A which discharges a cone of gunned material 26A as a result of the rotation of gunning pipe 12A. Nozzle 104A is similar in construction to that shown in U.S. Pat. No. 3,392,921 other than in the aforementioned angular inclination.

Apparatus 10 is capable of extremely rapid approach and efficient and rapid repair of worn portions of refractory lined vessels. It also enables an operator 54 to position himself for efficient control of the operation and protection from the heat of the vessel. Apparatus 10 is actuated by a hydraulic motor system, partially shown herein. The hydraulic system is energized by a diesel engine, hydraulic pump and accumulator of any effective type, which are not shown herein. The operator 54 can actuate all of the movement through switch-box 56, which for example includes pushbuttons for actuating each of the required movements including hydraulic piston and cylinder assemblies 34 and 40 and crawler motor 58, including the rotation of turntable 36. Motor 44 for rotation of gunning pipe 12 is for example reversible and effectively operates in either direction at a speed from about 1 to 5 r.p.m. This rotation prevents the gunning pipe from being deformed by the heat in the vessel, particularly, the very high radiant heat. The various movements of apparatus 10 permits a refractory spray to be effectively applied either to the bottom or sides of vessel 16 with the aid of an angularly offset nozzle 104A such as shown in FIG. 7.

Inner shell 76 of boom 24 is for example made of schedule eighty pipe to provide the strength required to dependably hold gunning pipe 12 in its required position. Inner stiffening plates 72 also stabilize the boom. Insulating sheath 70 and the flow of cooling air depicted by arrows 108 in annular space 82 (between inner boom shell 76 and gunning pipe 12 and out through exit holes 88 in front head 90 of boom head 24) help prevent boom 24 and gunning pipe 12 from becoming overheated in service.

Water control valve 57 is connected in conduit 55 to maintain a substantially constant quantity of water flowing into mixing tee 51, whereby substantially constant proportions of refractory material and water are supplied through conduit 50 and swivel coupling 48 to gunning pipe 12. The dry refractory is provided to mix-

ing tee 51 through conduit 53 connected to a source of dry refractory material (not shown) usually referred to as a refractory gun. Valve 57 is of any suitable type obtainable from various control valve manufacturers.

I claim:

1. A mobile refractory gunning apparatus comprising a motorized carriage capable of movement over a substantially horizontal surface, a turntable, rotatable bearing means having a substantially vertical axis of rotation mounting the turntable on the carriage, an inclinable support barrel, a bracket on the turntable mounting the barrel to rock up and down on the turntable, the barrel having spaced longitudinal motion-permitting bearings, a tubular boom being mounted in the spaced longitudinal motion-permitting bearings in the barrel, longitudinal extension means reacting between the barrel and the boom whereby the longitudinal extension of the boom in front of the carriage is varied, a vertically-acting extension means reacting between the turntable and the barrel whereby the angle of inclination of the boom is varied, an elongated gunning pipe for carrying and directing a flow of fluid refractory material, pipe receiving bearings in the boom, the pipe being inserted in the pipe-receiving bearings and through the boom, an insulating casing incorporated within the outer periphery of the boom, whereby the pipe is shielded from refractory heat, a rotating drive reacting between the boom and the gunning pipe for rotating the gunning pipe about its longitudinal axis within the boom, and supply means for pressurized cooling fluid being connected to the boom for conducting a flow of cooling fluid through it and about the gunning pipe.

2. An apparatus as set forth in claim 1 wherein the carriage and turntable comprise a construction type crawler having a rotatable turntable.

3. An apparatus as set forth in claim 2 wherein the bracket comprises a pair of support posts having pivotal bearings at their upper ends.

4. An apparatus as set forth in claim 1 wherein the inclinable support barrel comprises a boom-surrounding framework having a boom-receiving array of rollers at each of its ends to comprise the longitudinal motion-permitting bearings which receive the boom.

5. An apparatus set forth in claim 4 wherein spring means is connected to each array of rollers for resiliently biasing them against the boom.

6. An apparatus as set forth in claim 1 wherein the longitudinal extension means and the vertically-acting extension means each comprise a piston and cylinder assembly.

7. An apparatus as set forth in claim 6 wherein the longitudinal extension piston and cylinder assembly includes a rearwardly extending rod and a rear collar which attaches the rod to the boom.

8. An apparatus as set forth in claim 6 wherein the vertically-acting piston and cylinder means reacts between the top of the turntable and the bottom of the barrel.

9. An apparatus as set forth in claim 1 wherein a swivel coupling is connected to the rear of the gunning pipe for connecting a source of pressurized fluid refractory thereto.

10. An apparatus as set forth in claim 1 wherein the turntable bracket and barrel are constructed and arranged to rock the barrel and retained boom upwardly

5

approximately 15° and downwardly approximately 40°.

11. An apparatus as set forth in claim 1 wherein the source of pressurized cooling fluid comprises hose connections for coupling to a compressed air supply.

12. An apparatus as set forth in claim 1 wherein an angularly inclined nozzle is connected to the front of the gunning pipe for directing the spray of pressurized fluid refractory material at an angle to the gunning pipe.

13. An apparatus as set forth in claim 1 wherein electrical control means is connected to the carriage, the longitudinal and vertically-acting extension means and to the rotating drive whereby the operation of the apparatus is electrically controlled.

14. An apparatus as set forth in claim 7 wherein the boom is tubular, the barrel comprises a boom-

6

surrounding framework, a boom-receiving array of rollers at each end of the framework, and spring means connected to each array of rollers for resiliently biasing them against the tubular boom.

15. An apparatus as set forth in claim 1 wherein a rotating drive is reversible for rotating the gunning pipe in either direction.

16. An apparatus as set forth in claim 9 wherein the source of pressurized fluid refractory comprises a mixing tee, the mixing tee having a connection for dry refractory and a connection for water.

17. An apparatus as set forth in claim 16 wherein a water control valve is connected to the water connection of the mixing tee for maintaining substantially constant proportions of refractory and water.

* * * * *

20

25

30

35

40

45

50

55

60

65

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,917,170
DATED : November 4, 1975
INVENTOR(S) : Joseph J. Marino

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

Column 3, line 48, change "permits" to -- permit --
Column 4, line 23, change "pipe receiving" to -- pipe-receiving

Signed and Sealed this
eighteenth Day of May 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks