

[54] **MOBILE DEVICE FOR REPAIRING FURNACE WALLS AND THE LIKE**

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[51] Int. Cl..... **B05b 3/18**

[58] Field of Search 239/184, 186, 187, 164, 239/165, 132, 132.1, 132.3; 118/309, 306

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[57]

ABSTRACT

A mobile device for repairing furnace walls includes a mobile unit on which telescopically disposed conduit means are mounted. A nozzle is mounted on the conduit means such that refractory material fed through the conduit means is discharged from the nozzle for deposit on the furnace walls. Supporting means are provided for supporting the conduit means on the mobile unit and for controlling the location and position of the nozzle whereby the conduit means may be operated from a remote position to control the location and direction of discharge of refractory material from the nozzle and provide for depositing the refractory material on the furnace wall with a minimum of waste.

20 Claims, 29 Drawing Figures

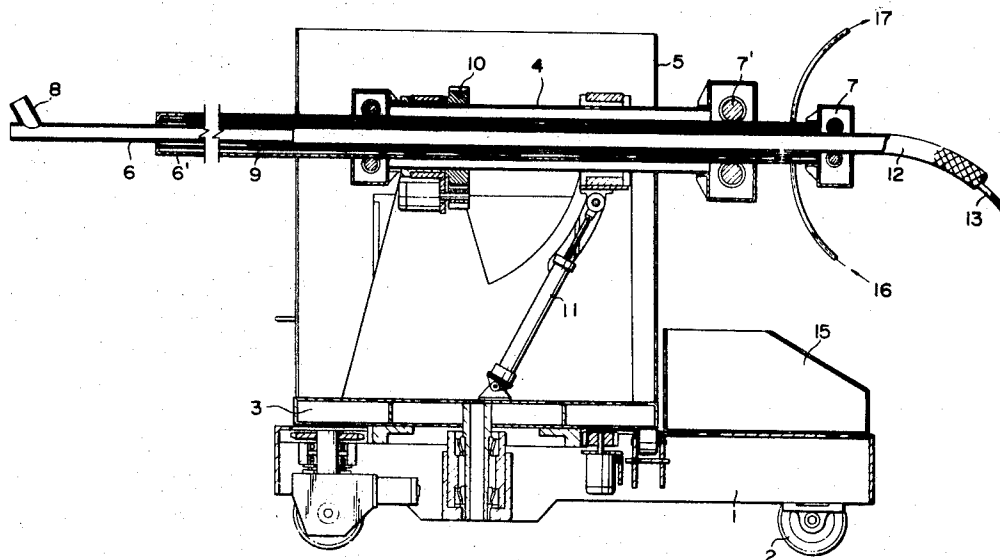


FIG. 1

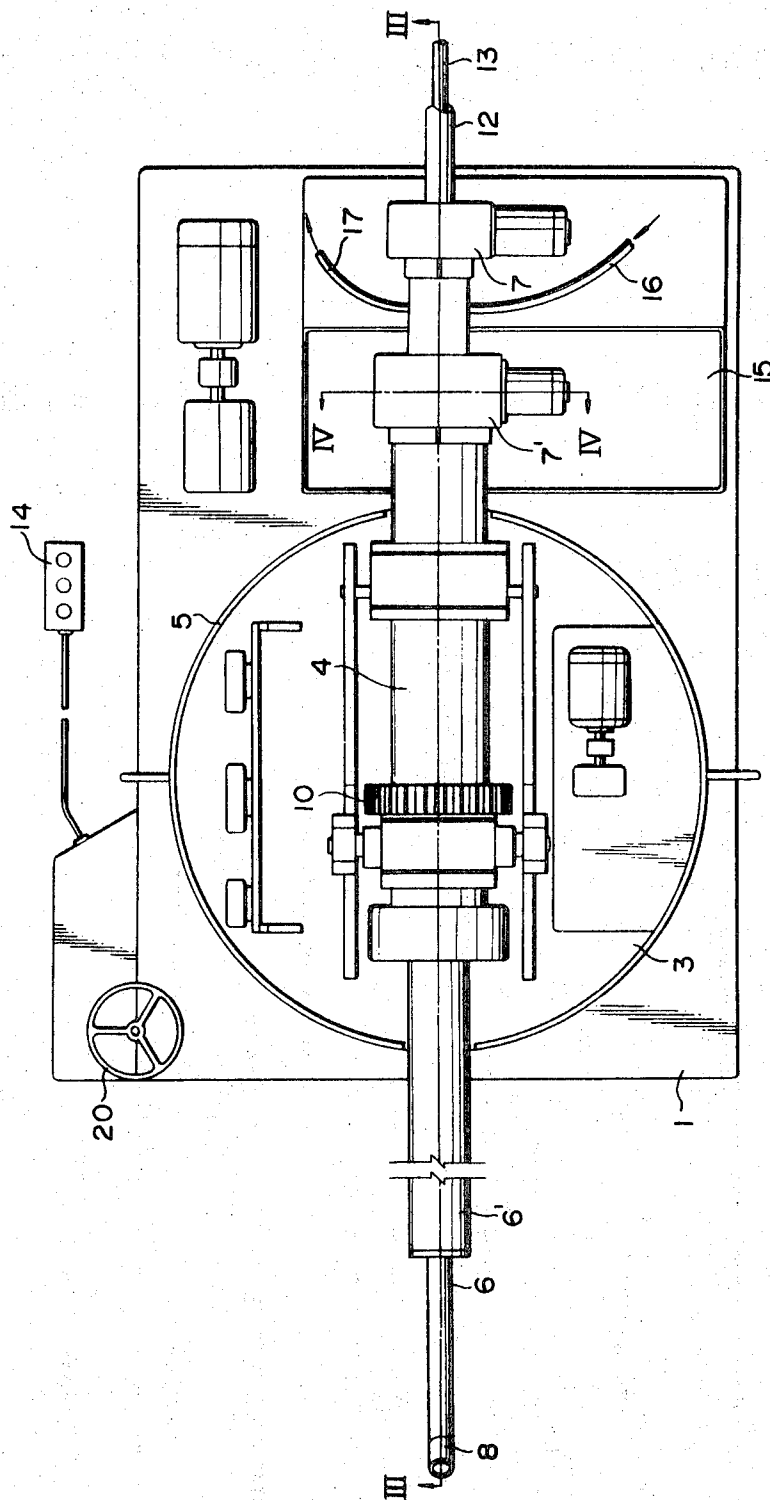


FIG. 2

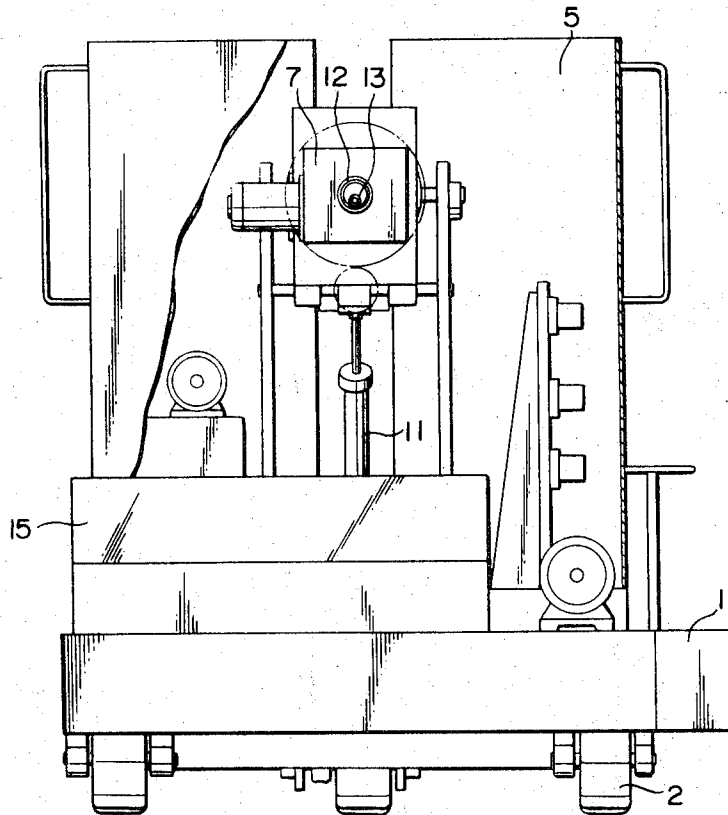


FIG. 4

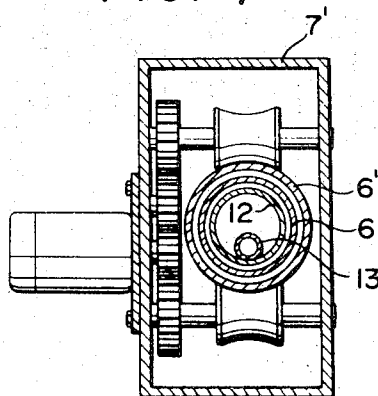


FIG. 3

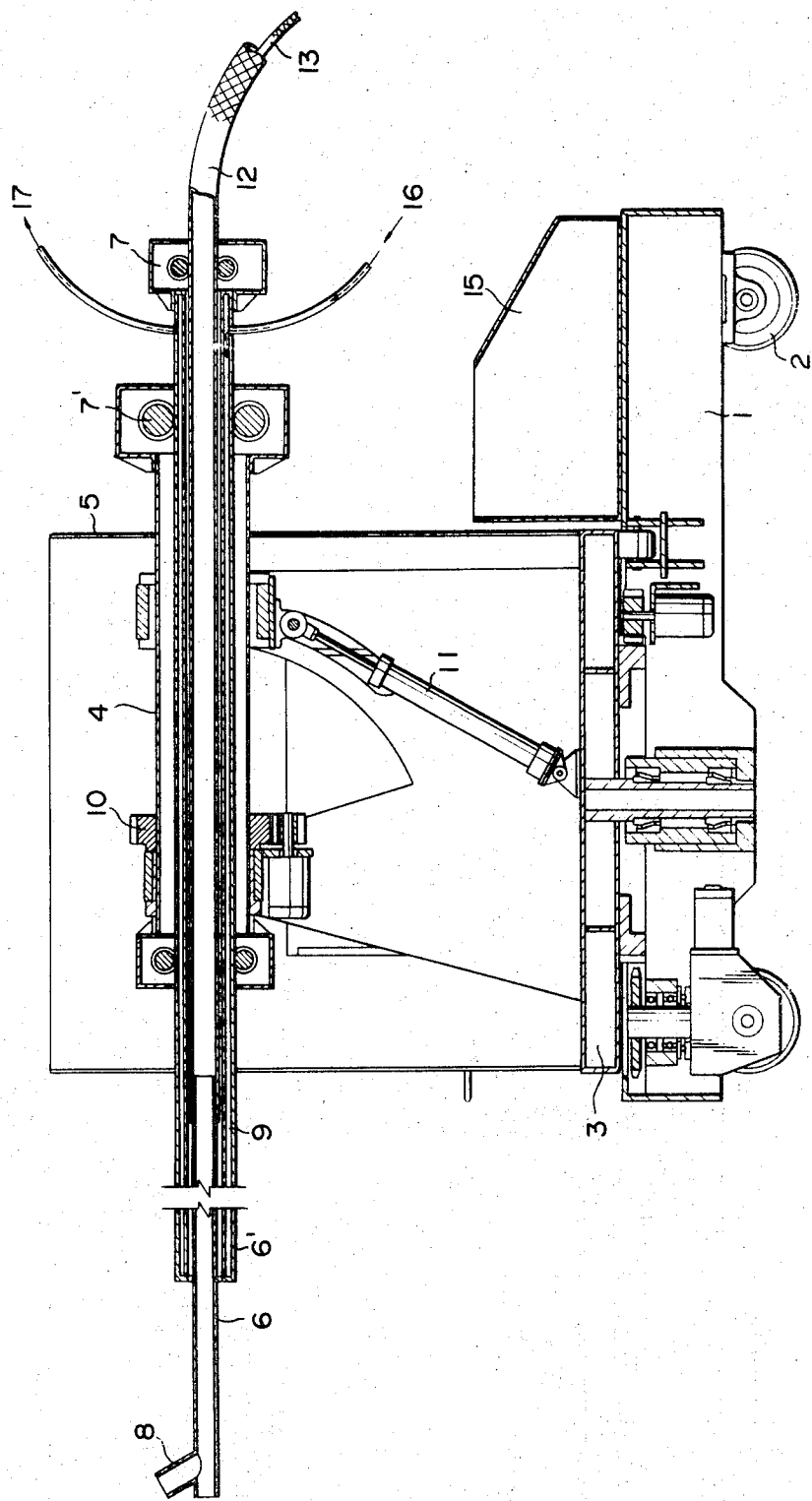


FIG. 5a

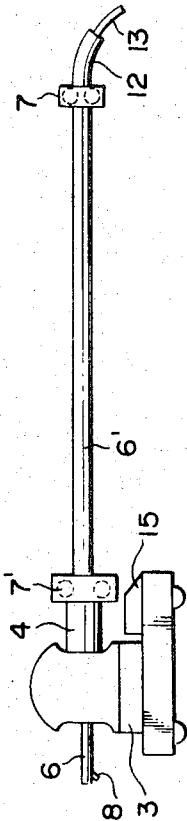


FIG. 5b

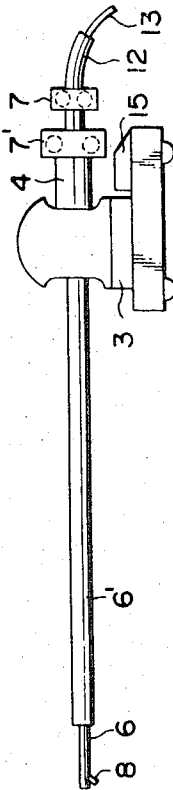
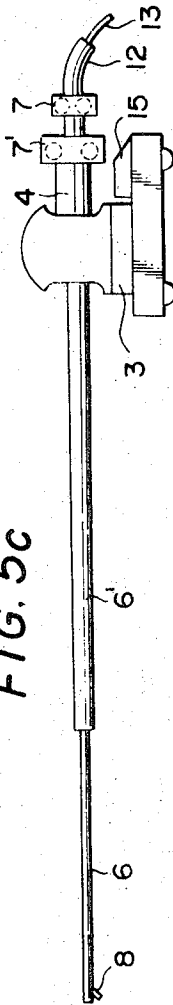


FIG. 5c



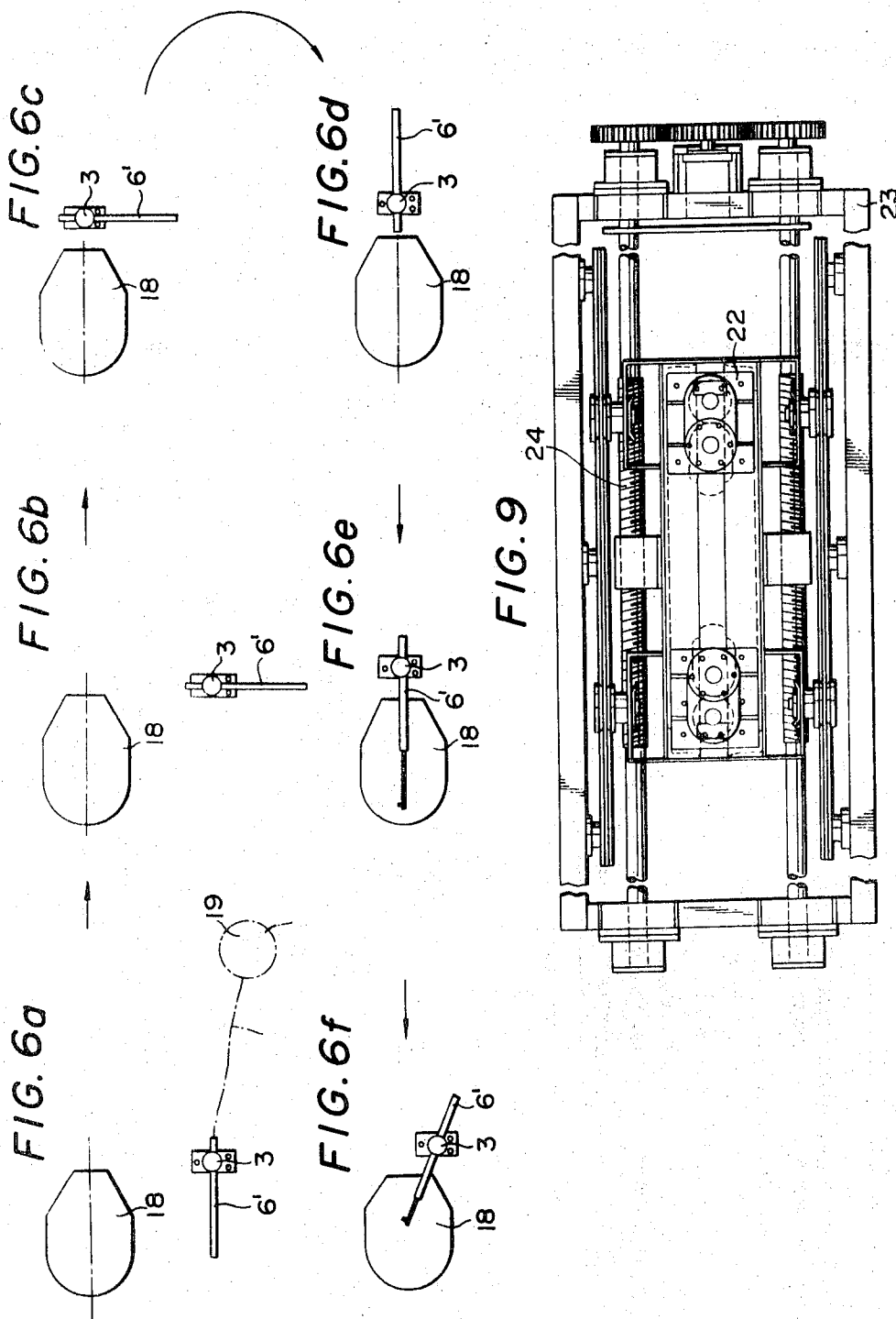


FIG. 7

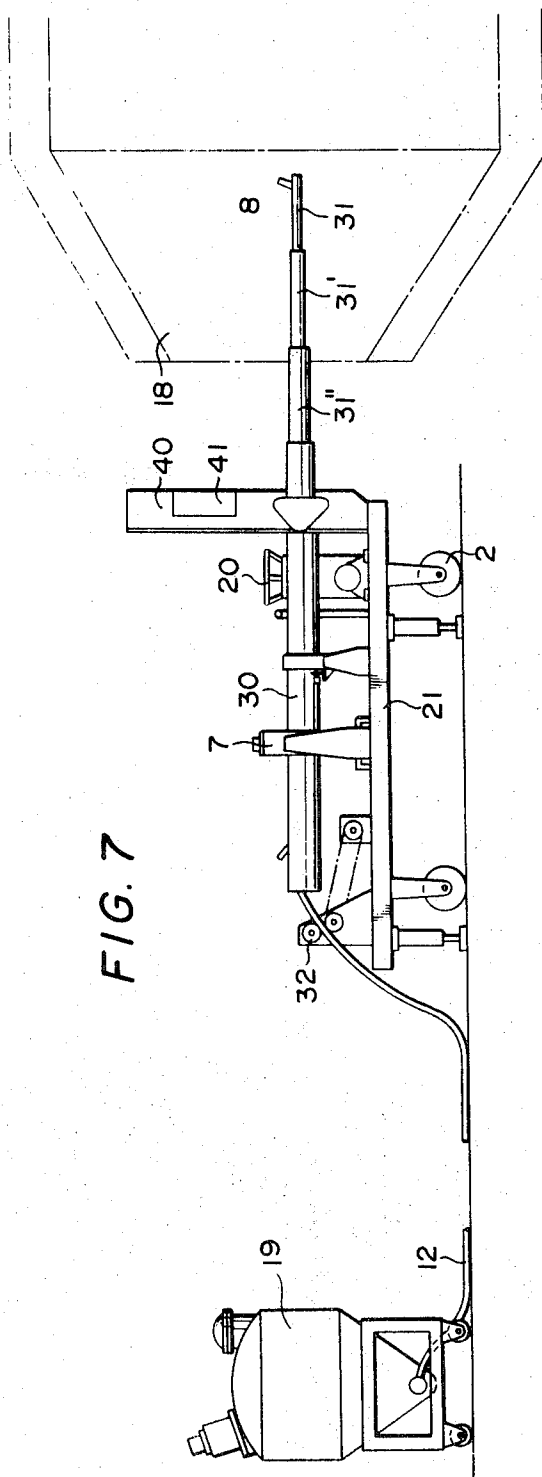


FIG. 14

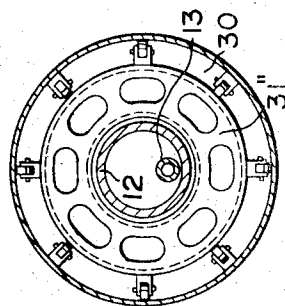
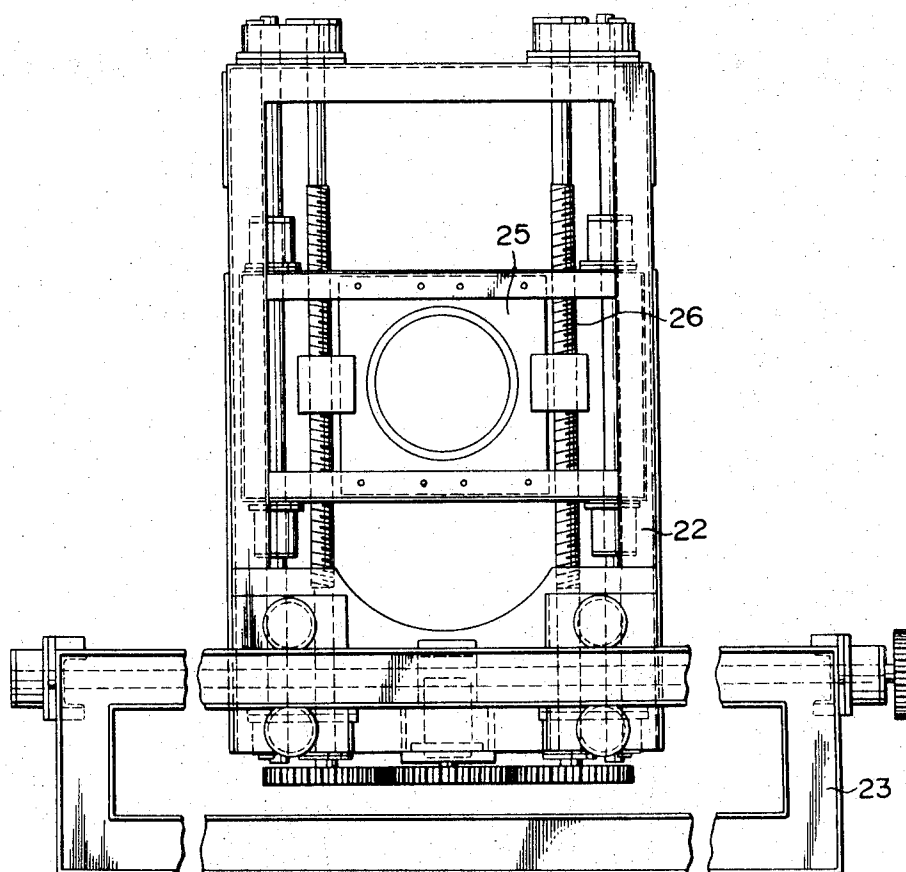


FIG. 8



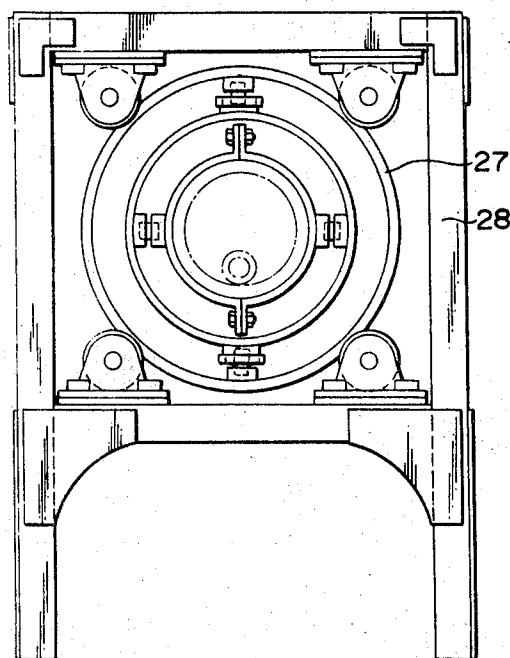


FIG. 11

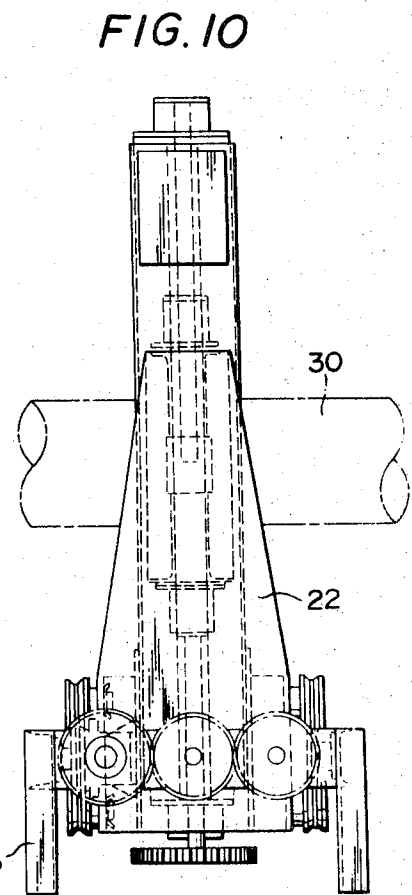


FIG. 10

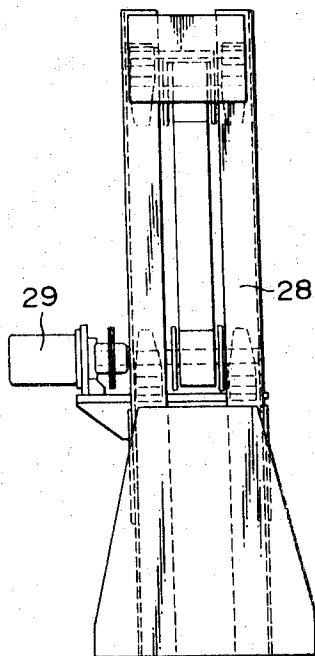


FIG. 12

FIG. 13

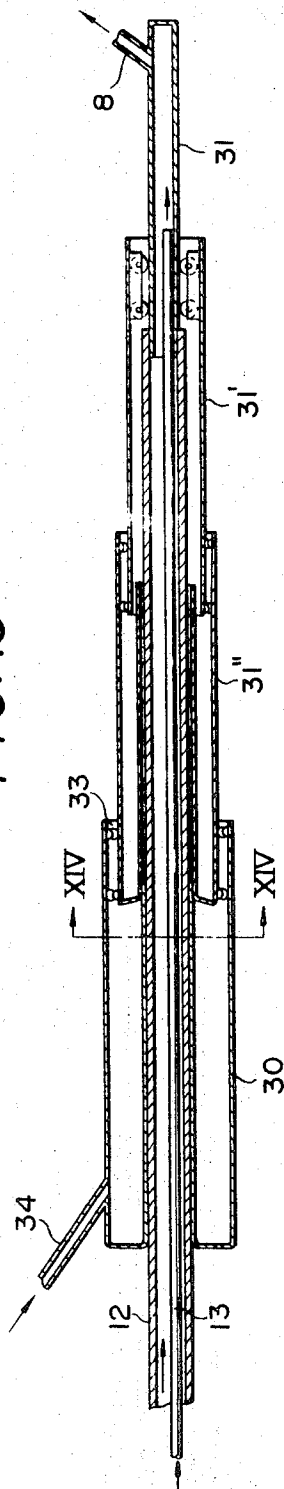
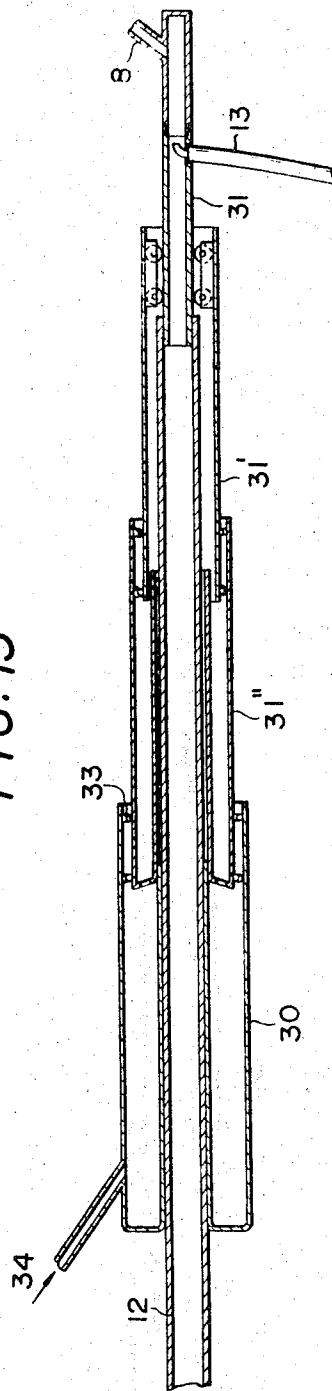


FIG. 15



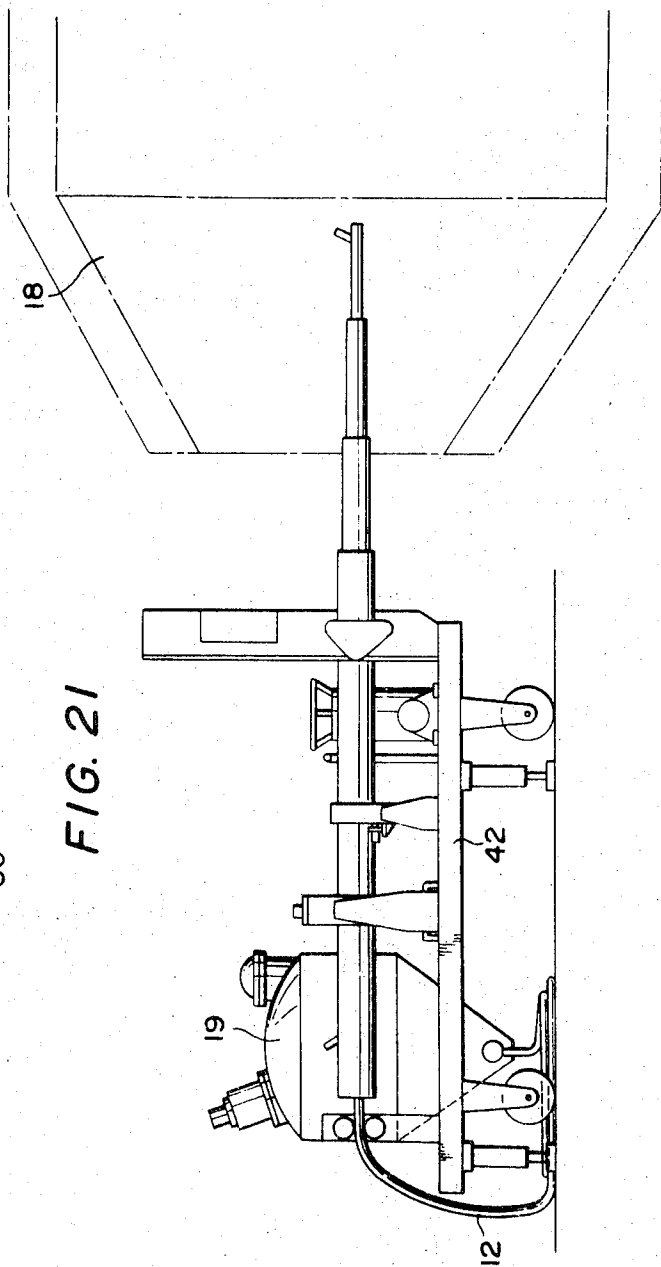
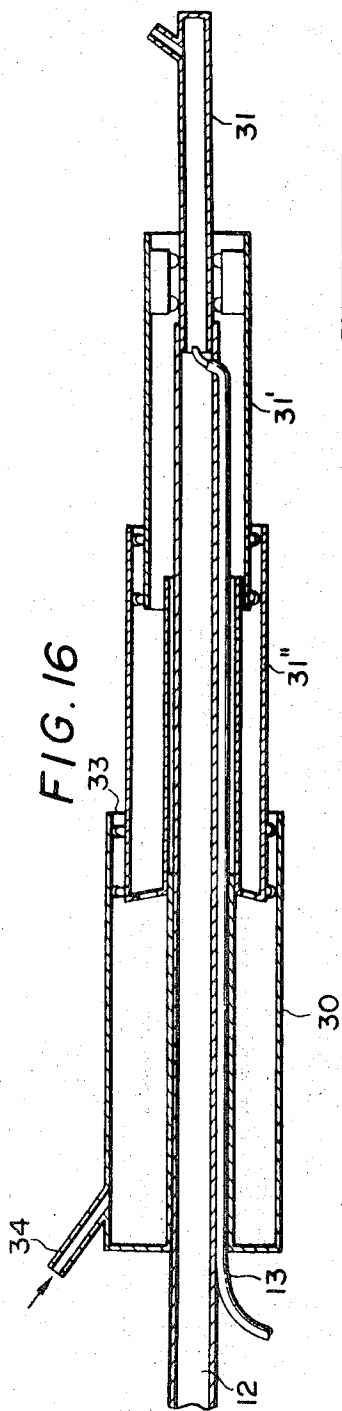


FIG. 19

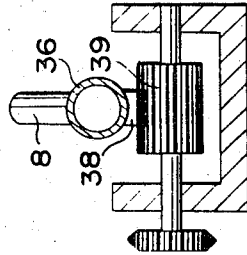


FIG. 17

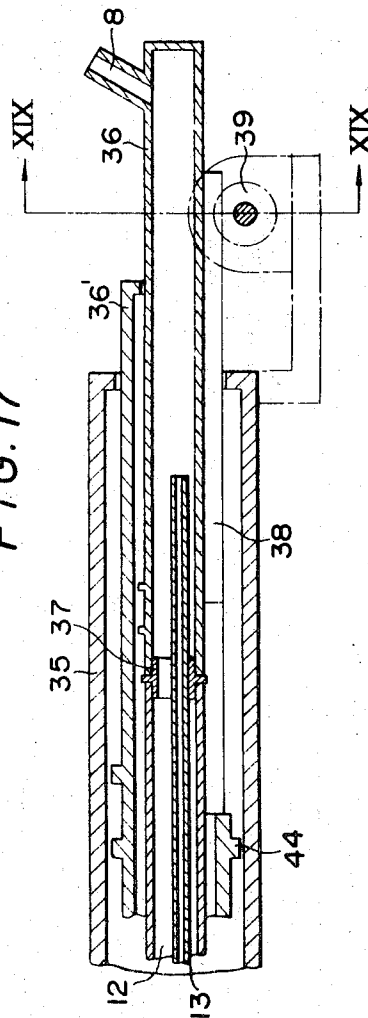


FIG. 18

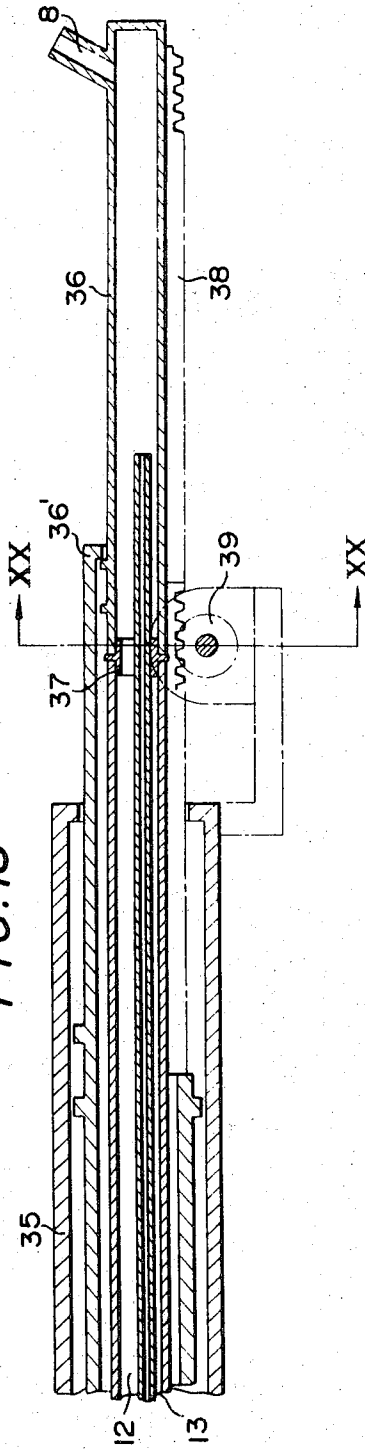


FIG. 20

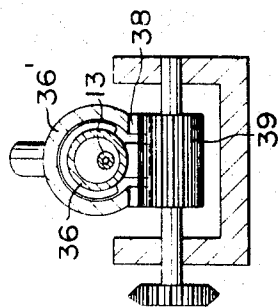
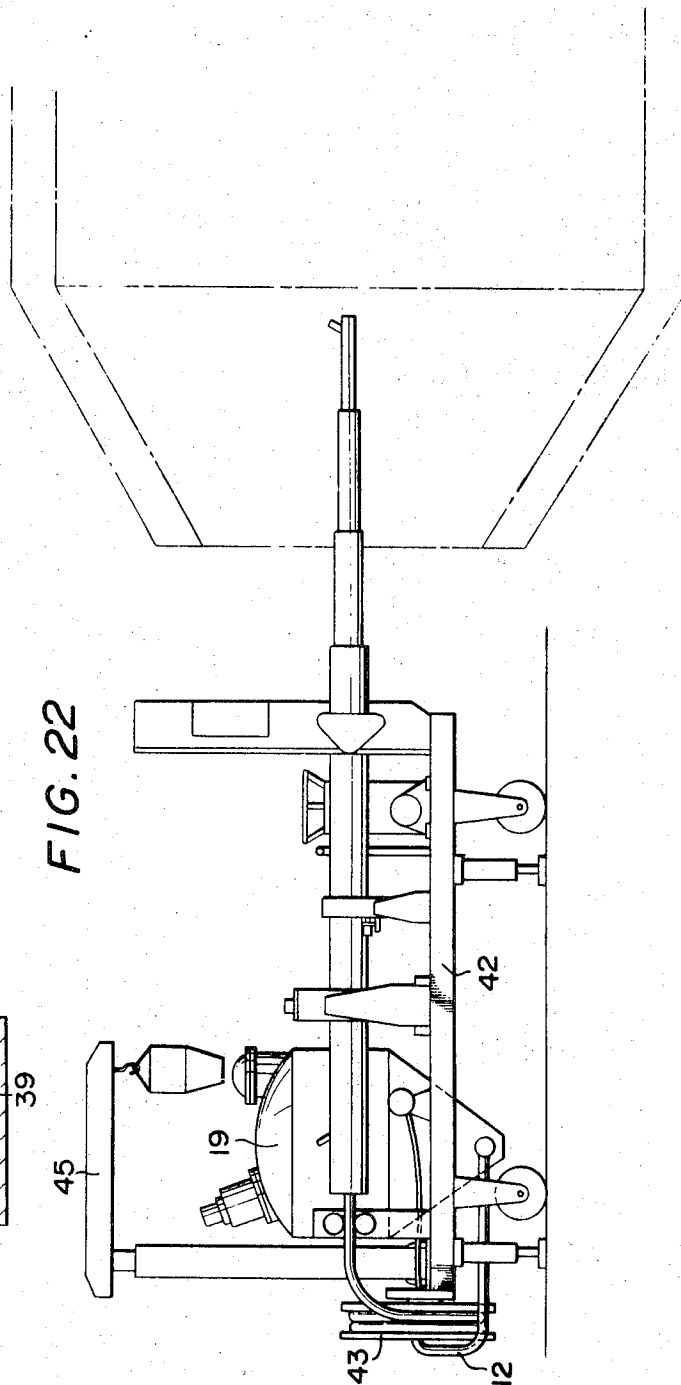


FIG. 22



MOBILE DEVICE FOR REPAIRING FURNACE WALLS AND THE LIKE

BACKGROUND OF THE INVENTION

This invention relates to a mobile device for repairing industrial furnaces and more particularly to a mobile spray gun which is operable to effect furnace repairs safely and efficiently.

Heretofore, repairmen have always entered into furnaces or at least moved to comparatively close proximity to furnaces when making repairs to the inner wall of the furnace. Accordingly, it was necessary to cool off the furnace before the repair work could be accomplished. After repairs were completed the cooled and repaired furnace had to be heated to be used again. The necessity of having to cool and then reheat the furnace has many disadvantages particularly from the viewpoint of the amount of time and expense expended during the cooling and reheating. At the same time, the down time or the duration of time over which the furnace could not be operated was increased.

In view of the above defects and disadvantages, there have been proposed and developed several types of apparatus or methods for repairing the inner walls of furnaces while at high temperature conditions without requiring unnecessary time, labor and expense for changing the temperature or cooling the furnace. However, these prior apparatus and methods still have many disadvantages. Accordingly, an object of the present invention is to overcome the defects, inefficiencies and disadvantages of prior apparatus and methods and to provide an improved and novel mobile device which can repair large-sized furnaces, such as a blast furnace, converter or the like, with a high degree of safety and exactitude even though high-temperatures exist in the furnace. According to the present invention there is provided a device having mobile structures and operating elements operable so that the inner wall of a furnace can be completely and equally repaired as desired even at reduced portions of the furnace and at locations removed far away from the outside of the furnace.

Another object of the present invention is to provide a device for repairing the furnace walls wherein the device is mobile and wherein there is provided an arrangement of telescopically disposed conduits which may be advanced or retracted in order that an operator can operate the spray gun remote and far away from the heated furnace.

Another object of the present invention is to provide a mobile device for repairing furnace walls which comprises various supporting means for a conduit and wherein the supporting means are operable to control the direction, position and angle of a nozzle mounted at the end of the conduit to repair the desirable walls in the furnace completely and equally as may be required.

A further object of the present invention is to provide a mobile device for repairing furnace walls in which cooling means are provided for supplying cooling water into conduit means through which refractory material is fed to prevent the portion thereof inserted into the heated furnace from being damaged due to the high temperatures within the furnace.

Still another object of the present invention is to provide a mobile device for repairing furnace walls which

is simple to operate and with which repair operations can be effected safely, exactly, and efficiently by a minimum number of workers even in the narrow space in front of a furnace.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

Although the invention is illustrated and described in relationship to specific embodiments, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit of the invention and within the scope and range of equivalents of the claims.

SUMMARY OF THE INVENTION

A mobile device for repairing furnace walls includes a mobile truck provided with support means for supporting a main pipe. A conduit means disposed in the main pipe includes at least two telescopically disposed conduits. The support means is operable to control the position of the main pipe and the conduit means. Forwarding means operably engage the conduit means for longitudinally extending and retracting the telescopically disposed conduits for spraying refractory material on the furnace wall and a hose is connected to the innermost conduit for conveying refractory material as the latter passes through the innermost conduit for discharge from the nozzle. Cooling means are also provided for introducing a cooling fluid to effect cooling of the conduit means.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a mobile device in accordance with a first embodiment of the present invention.

FIG. 2 is a rear view of the mobile device in FIG. 1 with a portion broken away.

FIG. 3 is a vertical section taken along the line III—III in FIG. 1.

FIG. 4 is a vertical section taken along the line IV—IV in FIG. 1.

FIGS. 5a, 5b, and 5c are schematic views of the mobile device showing different positions of the longitudinally extendable pipe.

FIGS. 6a to 6f inclusive are schematic views showing the relationship between the mobile truck, the spray gun, and the furnace at different positions.

FIG. 7 is an elevational view of a mobile device according to a second embodiment of the present invention and also showing a mixing vessel.

FIG. 8 is a front view showing the frames for controlling the horizontal and vertical movement of the main pipe in the embodiment of FIG. 7.

FIG. 9 is a plan view of FIG. 8.

FIG. 10 is a side view of FIG. 8.

FIG. 11 is a front view of a frame for controlling rotation of the main pipe in the embodiment of FIGS. 7 to 10.

FIG. 12 is a side view of FIG. 11.

FIG. 13 is a vertical sectional view of a pipe structure used in the embodiment of FIGS. 7 to 12.

FIG. 14 is a vertical sectional view taken along the line XIV—XIV of FIG. 13.

FIG. 15 is a vertical sectional view of an alternate pipe structure which differs from the embodiment of

FIG. 13 as regards the hose for conveying water or air.

FIG. 16 is a vertical sectional view of another variation of a pipe structure which may be used with the embodiment of FIGS. 7 to 10.

FIG. 17 is a vertical sectional view of yet a further alternate variation of a pipe structure.

FIG. 18 is a vertical sectional view of the pipe structure shown in FIG. 17, but showing the pipe structure in extended position.

FIGS. 19 and 20 are vertical sectional views taken respectively taken along the line XIX—XIX in FIG. 17 and the line XX in FIG. 18.

FIG. 21 is an elevational view of a mobile device of the type according to the embodiment of FIGS. 7 to 10 of the present invention but which is united with a mixing vessel on the truck.

FIG. 22 is an elevational view of a mobile device similar to the embodiment of FIG. 21 but showing an alternate variation as regards a reel on which a refractory hose is wound.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings, there is shown in FIGS. 1-6 a first embodiment of a mobile device comprising a truck 1 having a plurality of wheels 2 at the lower portion thereof. A turn table 3 is provided on the truck 1 and disposed over the turn table 3 is a main pipe 4 which passes through a portion of a guard fence 5 provided to protect the main part of the spray gun.

As shown in FIG. 3, the main pipe 4 is provided in which there is disposed a conduit means which includes at least two pipes, that is a first pipe 6 and a second pipe 6' and so on. The first pipe 6 passes through the second pipe 6' and the two pipes 6, 6' maintain this relationship. The first and second pipes 6 and 6' are each separately advanced or retracted by forwarding means 7 and 7' mounted at the ends of the pipes 6, 6' respectively. The forwarding means 7, 7' may comprise spaced rollers. The first innermost pipe 6 to be advanced furthest away from the turn table 3 is provided with a nozzle 8 for spraying refractory material adjacent its end. The second pipe 6' into which the first pipe 6 is disposed is formed with a double-wall structure to define an inner space 9 defining a passage for cooling water.

It is preferable that the main pipe 4 be provided with rotational means for controlling its rotational movement, such as a ring means 10 located at a middle section of the main pipe 4 for controlling rotation of the main pipe 4 and conduit means 6, 6', and means 11 extending upwardly from the turn table 3 to support the main conduit means and control its inclination. The turn table 3, the rotational means 10 and the inclination means control movement of the main conduit means and operate the travelling spray gun of the present invention so that the combination of the three movements, that is, a turning movement, a rotational movement, and a change in inclination, created by them may give the nozzle 8 the desired best position, direction, or angle against the furnace wall.

Within the second or outer pipe 6', the first or innermost pipe 6 is joined to a hose 12 which conduits or conveys refractory material. In addition a fluid hose 13 passes through the hose 12 to supply water or air which

serves to spray the refractory material energetically from the hose 12.

A pendant switch 14, shown in FIG. 1, is attached to the spray gun to operate the various means, that is the forwarding means 7, 7', rotational means 10, inclination means 11, and turn table 3 for controlling various movements of the main pipe 4 and an electromagnetic valve (not shown) for permitting the refractory material in a mixing vessel to come out. Located at a corner on the truck 1 is a cooling water tank 15. As best shown in FIG. 3, the cooling water therein is introduced into the inner space 9 defined by the double wall of the second pipe 6' through an inlet hose 16, which opens at the outer wall of the pipe 6', by means of a pump (not shown). The water flows out of the inner space 9 through an outlet hose 17 which opens at another part of the outer wall of the outer pipe 6'.

Since the second pipe 6', together with the first pipe 6, enters a heated furnace to the extent of about half their length, it is necessary to cool the conduit means according to the above mentioned arrangement in order to prevent damage to the conduit means due to the heat resulting from the high temperature within the furnace.

In FIG. 6, reference numeral 18 indicates a furnace and numeral 19 indicates a vessel for mixing and agitating the refractory material to be sprayed. The numeral 20 indicates an operating handle for the truck 1.

In a mobile device and apparatus consisting of the above mentioned elements, movement of the apparatus will usually be carried out through a process as shown in FIG. 6. Prior to spraying, the spray gun truck 1 is stopped at the side of the furnace 18 as shown in FIG. 6a. The conduit means 4 is turned to the position shown in FIG. 6b by means of the turn table 3. The truck is then moved in front of the furnace as shown in FIG. 6c. The conduit means 4 is then turned to the position shown in FIG. 6d by means of the turn table 3 and subsequently, each pipe 6, 6' will be advanced by the forwarding means 7 and 7' as shown in FIG. 5. The second pipe 6' advances due to the rotation of the rollers which are part of the forwarding means 7', sliding longitudinally along the main pipe 4 and then, due to the other forwarding means 7, the first pipe 6 further extends from the second pipe 6'. Consequently, a portion of the second pipe 6' passes or extends into the furnace 18, for example to the extent of half its length as shown in FIG. 6e. The direction, angle, and position of the nozzle 8 can be determined at will by operating, in combination, the rotational means 10 for controlling rotation, the inclination means 11 for controlling inclination, and the turn table 3. In spraying refractory material against the inner wall of the furnace, it is important to operate with a particular and desirable distance and angle between the nozzle and the furnace wall, which will present the most favorable conditions for spraying. For example, it is known that refractory material is able to be sprayed almost without waste when the nozzle is directed perpendicular to the wall being sprayed while maintaining a suitable distance from the wall.

To provide and maintain these favorable conditions of the nozzle in the present invention, all the controlling means are freely operated by the pendant switch 14. In addition, when spraying to the reduced part of the furnace wall, the truck 1 may be moved to thereby

also take part in selecting and determining the position of the nozzle as shown in FIG. 6f.

Upon opening of the electromagnetic valve for controlling the flow of refractory material from the mixing vessel 19 by the pendant switch 14, after selecting the best position for the nozzle, refractory material is transferred from the hose 12 to the first pipe 6 by means of the air pressure in the mixing vessel utilizing the power source of water or air spraying out of the nozzle. In the wet method, the refractory material which is mixed with water and agitated by compressed air or a propeller in the mixing vessel, is conveyed to the refractory hose 12 by the air pressure and a slurry of this type of refractory material is spouted out of the nozzle with the jet of air conveyed through the fluid hose 13. In the dry method, granular refractory material is conveyed to the refractory hose 12 by air pressure and spouted or sprayed out of the nozzle with water discharged from the fluid hose 13.

In the second embodiment according to the present invention, provision is made for a different type of travelling spray gun. FIG. 7 shows a mobile device of the second embodiment connected with the mixing vessel 19 by means of the hose 12. In this device, some members or elements which are more or less different from those of the above described first embodiment are provided to control movement of the pipes and to determine the spraying direction of the nozzle. A means for controlling the vertical and horizontal movement of a main pipe 30 relative to a truck 21 consists of three structural elements as illustrated in FIGS. 8 to 10. Thus a longitudinal and vertically disposed frame 22 is set in a lateral frame 23 serving as a pedestal fixed on the truck 21, and in which the longitudinal frame 22 freely moves in both directions within the limits of its width. The frame 22 engages a lateral screw means 24 mounted in the pedestal or lateral frame 23 and the screw means 24 controls the movement of the frame 22 on the lateral frame 23. The longitudinal frame 22 also includes an elevating frame 25 that ascends and descends in the longitudinal frame 22 by means of a longitudinal screw means 26 in the longitudinal frame 22. The elevating frame 25 has an opening large enough to be adapted to receive a main pipe 30. Both screw means 24, 26 are driven by a motor (not shown). The main pipe 30 passes through the means for controlling vertical and horizontal movement and is received in a rotary ring 27 as shown in FIGS. 11 and 12. The ring 27 is provided in a supporting frame 28 placed on the truck and is rotated by a motor 29. In addition to the aforementioned means for controlling the main pipe 30 to determine the position of the nozzle 11, the desirable number of pipes are also disposed within the main pipe 30, but unlike the first embodiment, in this second embodiment, each pipe is forwarded or advanced with the assistance of both a forwarding means 32 in the form of rollers engaging or nipping the refractory hose 12 at the rear of the main pipe 30 and a plurality of rollers 33 which are disposed between the pipes as seen in FIGS. 13 and 14.

For the purpose of providing safe working conditions in the second embodiment, a shield 40 (FIG. 7) may be provided to shield and protect against heat at the top end of the truck 21. The shield may be provided with a window 41.

Turning to the movement of the pipes in greater detail as shown in FIG. 13, as the refractory hose 12,

which is connected with the first pipe 31, is pushed or advanced forward by rotation of the forwarding means 32 (FIG. 7), a second pipe 31' and a third pipe 31'' are respectively pulled or advanced outwardly from within while in contact with rollers 33 as shown in FIG. 13. The fluid hose 13 for water or air passes through the refractory hose 12 and opens near the nozzle 8. In order to protect the pipes against the heat, a cooling water pipe 34 is installed and leads to the main pipe 30. The cooling water is atomized by pressure and is sprayed to cool off the pipes and then discharged out of each end of the pipes.

FIG. 15 is a view showing a pipe structure similar to the pipe-structure shown in FIG. 13. In the FIG. 15 embodiment, however, the fluid hose 13 for water or air extends into the first pipe 31 from the outside near the nozzle. Furthermore, in another similar pipe-structure shown in FIG. 16, the fluid hose 13 extends along the refractory hose 12 and joins the refractory hose 12 within the second pipe 31'. The location of the fluid hose 13 has to be selected depending on whether the wet method or dry method is used. Since the fluid hose 13 transfers water in the dry method and has cooling capability itself, it may be located outside the cooled pipes as in FIG. 15. However, in the wet method the fluid hose should be necessarily placed in the pipes cooled by water since it transfers air.

According to the present invention, exclusive of the heretofore mentioned pipe structures, another further alternate embodiment of the pipe-structure may be arranged as shown in FIGS. 17-20. In FIG. 17, the refractory hose 12 is connected to a first pipe 36 by means of a joint connector 37 through which the fluid hose 13 for water or air passes. A rack 38 is mounted or attached to the lower part of the first pipe 36 which is joined to the refractory hose 12. In providing for advancement of the pipe, the rack 38 engages a pinion 39 mounted on a main pipe 35 and suitably driven by a motor. The first pipe 36 and a second pipe 36' are formed with a plurality of brake projections 44 suitable positioned on the pipes and adapted to prevent each pipe 36, 36' from sliding out or being advanced too far and consequently falling out upon rotation of the pinion 39.

In the first and the second embodiments as heretofore described, the mobile device is separate from the mixing vessel in order to realize simplifying or miniaturizing the apparatus and providing it with a sufficient mobility. However, it is possible to provide a device which is united with a mixing vessel on a truck to form a united apparatus. It will be observed that workers can obtain desired objectives and results with a unitized apparatus which are equal to those obtained with a separated mixing tank. Accordingly, in a third embodiment shown in FIG. 21, the mixing vessel is placed on an extended truck 42 to the rear of a travelling spray gun similar to the type shown in FIG. 7. As a further construction the spray gun unit may be arranged into a structure as shown in FIG. 22 wherein a reel 43 for refractory hose is provided at the end portion of the truck 42. This latter arrangement prevents the refractory hose 12, which extends from the main pipe 30 to the mixing vessel 19, from dangling and obstructing the travel of the spray gun. The refractory pipe 12 starting from the mixing vessel 19 is wound on the reel 43 several times and is inserted into the main pipe 30. In addition it will be useful for working that a crane 45 be pro-

vided on the truck to supply refractory material into the mixing vessel as shown in FIG. 22.

The trucks mentioned in the various embodiments are all designed to travel by means of the wheels 2 and are operated by the operating handle 20. Depending upon working situation, it is also possible for the truck to be hung or suspended from an overhead travelling crane or the like.

As described herein before, the mobile device according to the present invention is characterized by means for freely advancing and retracting the pipe means and by various controlling means attached to the apparatus to change the direction, position, and angle of the discharge nozzle for the refractory material. The nozzle can be positioned as desired to face the desired furnace wall in spite of the unit operating remote or far away from the furnace such that there is no wasted quantities or refractory material. In addition there is an additional advantage in that the travelling of the spray gun is effected smoothly with high efficiency since each pipe can be held compactly inwardly.

While the invention has been described by means of specific examples and in specific embodiments, it is not intended to be limited thereto, for obvious modifications will occur to those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. A mobile apparatus for repairing furnace walls comprising, a mobile truck, a main pipe means, support means supporting said main pipe means on said truck and operable to control the position of said main pipe, conduit means disposed in said main pipe means, said conduit means comprising at least two telescopically disposed conduits, forwarding means operably engaging said conduit means for longitudinally extending and retracting said telescopically disposed conduits, said conduit means including cooling means introducing a cooling fluid to effect cooling of said conduit means, a nozzle mounted on an innermost conduit of said telescopically disposed conduits for spraying refractory material on said furnace wall, a hose means connected to said innermost conduit for conveying refractory material thereto, and a fluid hose means to facilitate spraying of said refractory material as the latter passes through said innermost conduit for discharge from said nozzle.

2. A mobile apparatus according to claim 1 wherein said support means comprises a turn table rotatable about a generally vertical axis and providing for rotation of said main pipe and conduit means about said vertical axis, said support means also comprising rotating means for effecting rotation of said main pipe about its longitudinal axis, said support means further comprising inclination means for pivoting said main pipe and conduit means about a generally horizontal axis to provide for disposing said main pipe and conduit means at an inclined angle relative to horizontal.

3. A mobile apparatus according to claim 1 wherein said cooling means includes a double wall structure on one of said telescopically disposed conduits, said double wall structure defining an inner passage, means for introducing a cooling fluid to said inner passage, and means for conducting cooling fluid from said inner passage.

4. A mobile apparatus according to claim 1 wherein said support means comprises a first means for effecting vertical displacement of said main pipe and second

means for effecting horizontal displacement of said main pipe, said first means including a screw-operated elevating frame, said second means including a screw-operated lateral frame, one of said first and second means including a rotary ring through which said main pipe passes, and means for effecting rotation of said rotary ring and said main pipe.

5. A mobile apparatus according to claim 1 wherein said fluid hose means comprises a fluid hose extending within and opening into said innermost conduit of said telescopically disposed conduits.

6. A mobile apparatus according to claim 1 wherein said fluid hose means comprises a fluid hose extending outside of said conduit means, said fluid hose having an end portion connected to and in communicating with the innermost of said telescopically disposed conduits.

7. A mobile apparatus according to claim 1 wherein said fluid hose means comprises a fluid hose extending outside of said innermost conduit but within the outermost of said telescopically disposed conduits, said fluid hose having an end portion connected to and in communicating with the innermost of said telescopically disposed conduits.

8. A mobile apparatus according to claim 1 wherein said fluid hose means includes a fluid hose for introducing water into said innermost conduit to thereby provide a dry method for spraying said refractory material.

9. A mobile apparatus according to claim 1 wherein said fluid hose means includes a fluid hose for introducing air into said innermost conduit to thereby provide a wet method for spraying said refractory material.

10. A mobile apparatus according to claim 1 wherein said conduit means includes rollers between said telescopically disposed conduits to facilitate relative longitudinal extension and retraction.

11. A mobile apparatus according to claim 1 including a refractory hose for said refractory material, means connecting said refractory hose to said innermost conduit, said forwarding means including rollers engaging said refractory hose to effect longitudinal movement of the latter, and rollers between said telescopically disposed conduits to provide a rolling action therebetween during extension and retraction of said conduit means.

12. A mobile apparatus according to claim 1 wherein said conduit means includes three telescopically disposed conduits each longitudinally extendable and retractable relative to each other.

13. A mobile apparatus according to claim 12 wherein said cooling means introduces said cooling fluid to the outermost of said three conduits.

14. A mobile apparatus according to claim 1 wherein said forwarding means includes a rack formed on said innermost of said telescopically disposed conduits, and a pinion mounted on said support means and engaging said rack for longitudinally extending and retracting said conduit means.

15. A mobile apparatus according to claim 14 including brake projections on said conduit means to limit the maximum extension of said conduit means.

16. A mobile apparatus according to claim 1 wherein said forwarding means includes spaced rollers located about respective telescopically disposed conduits, and means for driving said rollers to effect longitudinal displacement of said telescopically disposed conduits.

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17. A mobile apparatus according to claim 1 including a mixing vessel for said refractory material, and a refractory hose extending between said mixing vessel and said innermost conduit of said telescopically disposed conduits.

18. A mobile apparatus according to claim 17 wherein said mixing vessel is mounted on said mobile truck.

19. A mobile apparatus according to claim 1 includ-

ing operating means for controlling the operation of the travelling spray gun said operating means including a pendant switch.

20. A mobile apparatus according to claim 1 including a shield mounted on said mobile truck for shielding said spray gun apparatus against heat from said furnace walls.

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