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 [21] Appl. No. **883,703**
 [22] Filed **Dec. 10, 1969**
 [45] Patented **Sept. 7, 1971**
 [73] Assignee **The United States of America as**
represented by the United States Atomic
Energy Commission

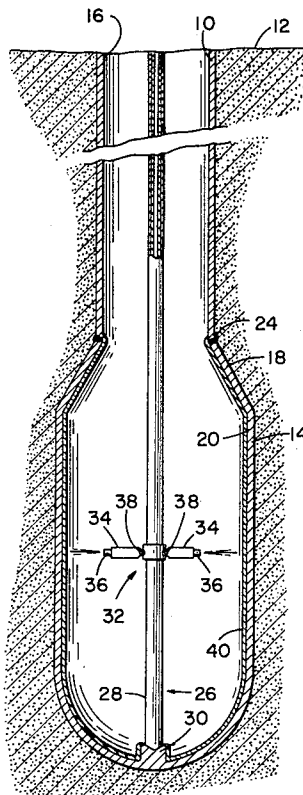
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UNITED STATES PATENTS
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 3,330,122 7/1967 Janner 61/46
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[54] **APPARATUS FOR INSTALLING A REINFORCED**
VESSEL IN AN UNDERGROUND CAVITY
 1 Claim, 2 Drawing Figs.

[52] U.S. Cl. **61/5,**
 61/46, 61/63, 117/96, 188/317
 [51] Int. Cl. **B65g 5/00,**
 B05b 13/06
 [50] Field of Search 61/5, 46,
 63; 118/317; 117/96

ABSTRACT: A distensible vessel, reduced in diameter by means of folds in its sidewall, is passed through a bore into a cavity and is expanded to size by internal pressure. The interior of the vessel is then reinforced by building up a suitably thick deposit of material applied to the walls in an adherent spray by means of an arc-spray gun arranged to traverse the interior of the vessel.



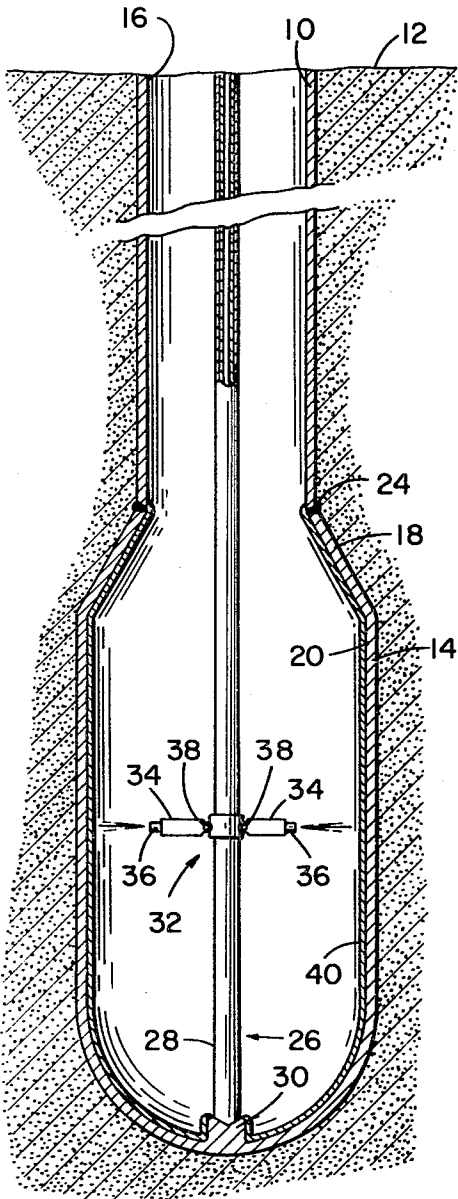


Fig. 1

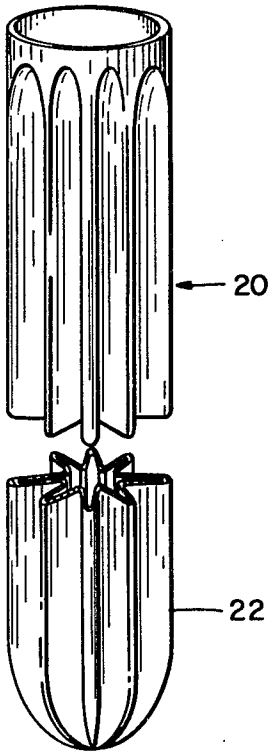


Fig. 2

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APPARATUS FOR INSTALLING A REINFORCED VESSEL IN AN UNDERGROUND CAVITY

BACKGROUND OF THE INVENTION

This invention relates to subterranean cavities or galleries. More particularly, it relates to the emplacement of fluid pressure-tight vessels or liners within subterranean cavities formed in a bore, well, shaft or tunnel. In particular, it relates to a method and apparatus for the emplacement of a reinforced, pressure-tight vessel or liner within such a cavity.

For a variety of reasons in conjunction with underground operations such as mining, geophysical exploration, earth works, and for other purposes, it is often necessary to enlarge a portion of a subterranean bore to form a cavity or chamber within which can be placed geophysical instruments or other equipment. Frequently, the earth formation within which the cavity must be located is unstable or is in a region of subsurface water so that it is difficult to maintain a dry, fluid-tight cavity or chamber, impenetrable to ground water and capable of withstanding crushing pressure from the surrounding rock walls. It has been customary in the prior art to support the walls of the chamber and to seal them against the intrusion of ground water by means of struts, concreting and steel linings. Whatever the means employed, it has usually been necessary to make the bore sufficiently large to permit the installation of to skip or cage and to lower men into the cavity, to line or reinforce it or to assemble a vessel or liner. Where the earth formation is unstable or wet, the hazards to personnel are at once apparent.

Various methods have been proposed for lining such a cavity without the presence of personnel, one method being shown in U.S. Pat. No. 3,330,122 granted July 11, 1967 to Karl Janner for a "Method of forming Underground Nuclear Reactor Installation," whereby a collapsed metallic reactor vessel is lowered into a cavity at the bottom of a bore and expanded to the desired size, in situ. Where there is great likelihood of shifting of the surrounding rock formation, or if the cavity is located at great depth so that the hydrostatic pressure of ground water is very great, a distensible vessel of the type shown in the aforesaid patent to Janner, in order to withstand these conditions, would have to be made with its walls impractically thick and incapable of proper expansion.

SUMMARY OF THE INVENTION

The present invention provides a method and apparatus whereby an expandable subterranean vessel may be placed in a cavity, and after expansion may be lined completely with a high strength material such as steel, sprayed on in an electric arc molten spray process to any desired thickness, i.e., to a thickness of several inches if necessary, by remote control without the necessity of personnel being present.

This is accomplished by lowering into the expanded vessel an arc-spray gun, positioned within the vessel so that its spray or sprays are proximate the wall of the vessel, and causing the spray head to sweep about and along the wall until the desired thickness of coating is built up. In a practical application of the present technique it has been found that very high strength coatings can be readily built up, from an suitable material, the steels being particularly usable in the process.

Accordingly, it is an object of the invention to provide a novel technique for remotely forming a pressure vessel or liner in an underground cavity.

It is a further object of the invention to provide a novel method of reinforcing a pressure vessel emplaced in an underground cavity.

It is still another object of the invention to provide a novel method and apparatus enabling emplacement of a reinforced pressure vessel within an underground cavity, without the necessity of personnel being present within the cavity.

It is still further object of the invention to provide a novel method and apparatus for reinforcing the wall of an underground vessel emplaced within a cavity, by coating the in-

terior wall of the vessel with an adherent lining of any desired thickness, sprayed in place.

These and other objects of the invention will be apparent as the ensuing description proceeds, and from the appended drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a cross section of a subterranean bore having a cavity underreamed in it, and showing an emplaced vessel in the process of being reinforced according to the invention; and

FIG. 2 is an elevational view, partly in cross section, of a collapsed vessel ready for insertion through the bore and into the cavity, before distension and reinforcement.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG. 1, there is shown a bore 10 drilled from the surface of the earth 12 and extending downwardly, in the example shown, to a cavity 14, formed at the end of the bore by underreaming with an expansible bit, or in any other suitable manner. The bore 10 is lined with a casing 16 which terminates, in the exemplification shown, at the neck 18 of the cavity 14.

In FIG. 1, a vessel 20 of steel plate or other suitable material is shown lining the cavity 14. Referring to FIG. 2, the vessel 20, of a length appropriate to the length of the cavity 14, is formed with its sidewall in one or more pleats or folds 22, so that the cross-sectional shape as shown in figure, is petalous or stellate. In the example shown in FIG. 2, the vessel 20 has its sidewall pleated about its entire circumference; however, any appropriate number of pleats may be used, as indicated for the material and stresses involved. The vessel 20 is welded at 24 to the end of the casing 10 and in its collapsed or pleated form as seen in FIG. 2, is of a diameter that can be passed through the bore 10 into the cavity 14.

To emplace the vessel 20 in the cavity 14, it is first welded at 24 to the adjoining section of casing 16, which in turn is joined to the next section of casing, and so on. The casing, with the vessel welded to it, is lowered into the bore, subsequent sections of casing being added to the string until the vessel has passed into the cavity 14 and is in proper position for expansion. Internal pressure is then applied to the vessel hydraulically, explosively, or in any other well-known manner until it is distended or "inflated" to its desired size.

After the vessel 20 is expanded to its desired size within the cavity 14, it is ready to be reinforced. A spraying apparatus 26, is lowered into the vessel until its end rests on a seat 30 disposed at the bottom of the vessel. A spray head generally indicated at 32 is disposed on a supporting column 28, the column 28 and the spray head 32 being arranged so that the spray head is controllable and manipulatable remotely from the surface 12 and can be made to transverse back and forth along the axis of the vessel and can be rotated as desired, about the interior of the vessel. The details of the spray head and the traversing and rotating mechanism form no part of this invention, but spraying, traversing and rotating can be readily accomplished by means well known and available commercially.

The spray head 32 is provided with one or more radially disposed arms 34, having spray nozzles 36 located at their out-board ends so that the nozzles are positioned at the proper working distance from the wall of the vessel 20. Pivotal mounting 38 of the arms 34 enables them to be retracted so that the spraying apparatus 26 and the supporting column 38 can be passed through the casing 16.

As previously indicated, the particular type of metal spraying apparatus to be employed forms no part of this invention. One particular type that has been used and is suitable is known as an arc spray, in which two wires, made of the material to be sprayed, are fed continuously to the nozzle and an electric arc maintained between them. A gas jet, usually air, blows the molten metal onto the surface to be coated. The melting rate

for commercial arc-spraying equipment is comparatively great and thick coatings can be readily built up with additional thicknesses for reinforcing ribs or hoops, if desired. After the coating 40 is deposited, by repeated traverses of the interior surface of the vessel as may be necessary, the spraying apparatus 26 is withdrawn from the vessel through the casing 16.

In the preceding discussion, a preferred embodiment of the invention has been described and illustrated. It will be apparent, however, to those skilled in the art, that modifications may be made in the method and apparatus according to the invention, without exceeding the ambit of its spirit and scope.

What I claim is:

1. In means for lining an underground chamber, said chamber constituting an enlargement in a bore, the combination of:

a vessel emplaced within said underground chamber, the walls of said vessel being disposed in proximity to the walls of said chamber and having an opening therethrough directed toward said bore;

locating means affixed to the interior of said vessel at a location opposite said opening;

a supporting column extending into said vessel from said bore through said opening, one end of said column being positioned by said locating means;

a spray head disposed within said vessel for depositing a reinforcing coating upon the interior thereof, said spray head being supported by said column and being movable rotationally and translationally about and along the interior of said vessel;

arm means mounted upon said spray head and disposed generally radially of said column;

spray nozzle means carried by said arm means and directed toward the wall of said vessel, and

pivot means mounting said arm means to permit retraction thereof so that said spray head and column can be inserted into and withdrawn from said vessel through said opening and said bore.

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