# United States Patent [19]

**Pineno et al.**

[11] **3,786,639**

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[54] **METHOD AND APPARATUS FOR BACKFILLING AN UNDERGROUND CAVITY**


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[73] Assignee: **said Pineno and Tamburro**



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[52] **U.S. Cl.** ..... **61/35**

[51] **Int. Cl.** ..... **E21p 15/08**

[58] **Field of Search** ..... 61/35, 50; 141/67; 239/296, 239/298



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 3,707,848 | 1/1973 | Chelminski | 61/53.64 |
| 3,641,775 | 2/1972 | Godley et al. | 61/63 |
| 3,440,824 | 4/1969 | Doolin | 61/35 |



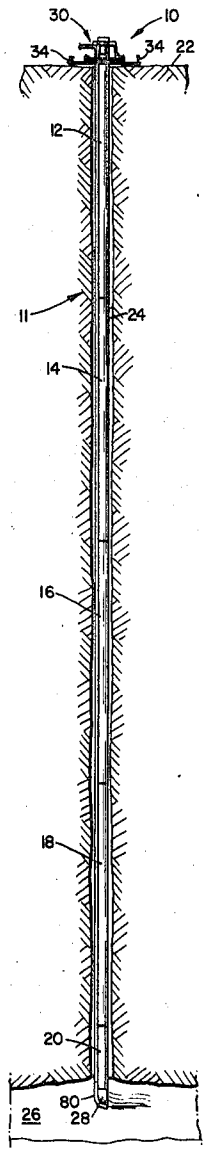
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[57] **ABSTRACT**

A system for backfilling an underground cavity, such as a coal mine or the like, wherein a slurry of fill material is uniformly displaced and propelled in all directions in the cavity through the aid of a high pressure air jet.


**18 Claims, 6 Drawing Figures**



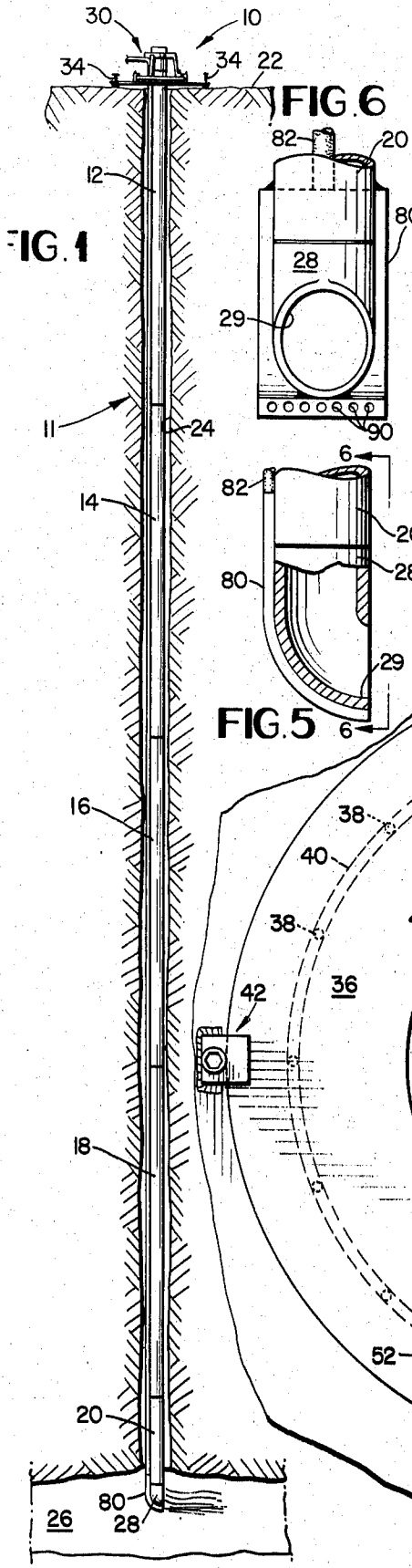



FIG. 1




FIG. 6




FIG. 5

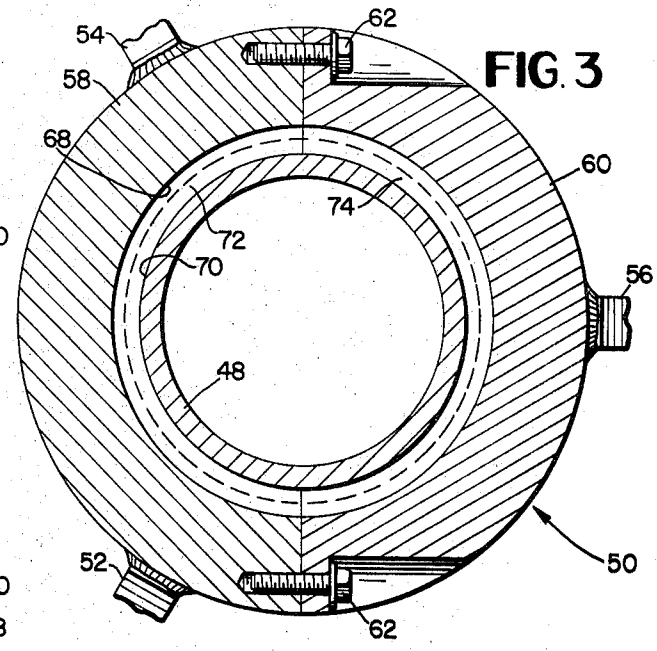



FIG. 3

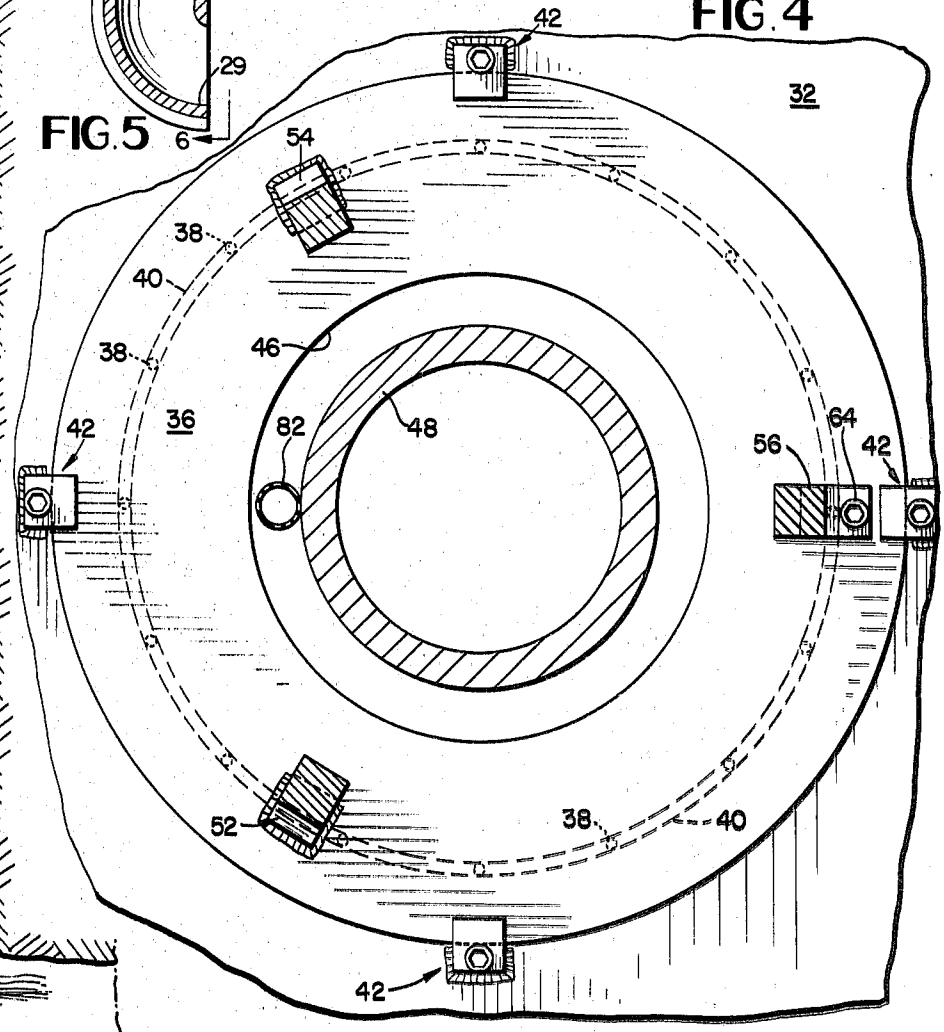
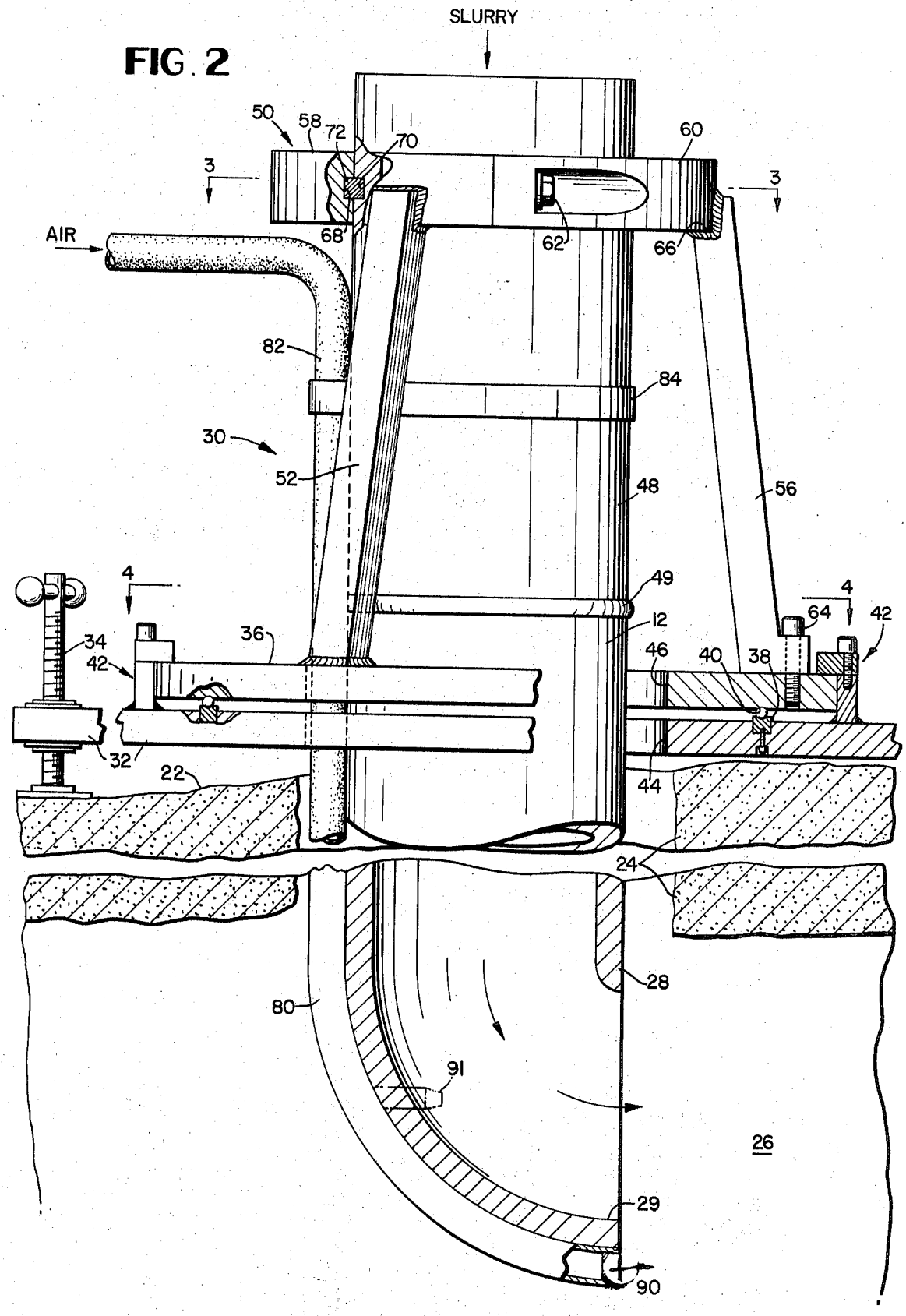



FIG. 4

FIG. 2


SLURRY
50
58
72
70
60
3
3
AIR
68
62
66
82
84
30
52
48
56
4
49
4
64
42
12
34
36
42
46
40
38
32
22
44
24
28
80
91
26
29
90

# METHOD AND APPARATUS FOR BACKFILLING AN UNDERGROUND CAVITY

## BACKGROUND OF THE INVENTION

This invention relates generally to a system for backfilling or flushing an underground cavity, such as a coal mine or the like. More particularly, the invention is concerned with a novel method and apparatus by which a slurry of fill material is uniformly distributed in an underground cavity by high pressure air jets which are provided adjacent the discharge opening for the slurry.

In mining areas where coal or other minerals have been removed from underground locations or veins, surface subsidence or caving frequently occurs above the underground voids or cavities produced by the mining operations. These surface cave-ins not only create personal danger to human beings living in the mining areas, but also cause undesirable damage to surface property such as buildings, houses, roads, etc.

Upon completion of a mining operation, it is common practice to backfill or flush such an underground cavity in an attempt to stabilize the ground area above the cavity and thereby prevent the hazardous cave-ins. Various systems have been proposed to accomplish the flushing operation and several prior systems are illustrated in U.S. Pat. Nos. 3,440,824; 3,500,934; 2,710,232; and 508,523.

In conventional prior systems, a bore hole is drilled from the surface down to the underground cavity and fill material is then fed into the cavity either directly through the bore hole or through a conduit placed in the bore hole. It is often necessary to drill a number of such bore holes spaced a predetermined distance apart and to backfill through each of the holes to ensure that the underground cavity is filled as best is possible. The number of holes required is dependent upon the manner and degree to which the fill material is distributed in the cavity from the bore hole. For example, in many conventional systems, a slurry of fill material such as water and fine solids is merely deposited vertically into the cavity and is distributed in pyrimidal fashion. This has been unsatisfactory in at least two respects. First, the slurry is not distributed very far laterally, thus a large number of bore holes are required. Second, after settlement of the slurry material, some top areas of the underground cavity remain unfilled and cave-ins continue to occur above those areas.

In attempting to alleviate those problems, one prior commerical system pumps the slurry into the cavity through a closed hydraulic circuit at a high hydrostatic pressure. Although this produces somewhat better distribution of the slurry in the cavity, it creates additional problems of the slurry and hazards as a result of the high hydrostatic pressurre of the slurry which is trapped in the cavity. While U.S. Pat. No. 3,440,824 generally recognizes and proposes one solution to these prior art problems, the systme of the patent still basically relies on pumping and liquid flow to distribute and spread the slurry in the underground cavity.



## SUMMARY OF THE INVENTION

Accordingly, the primary object of this invention resides in the provision of novel method and apparatus for backfilling an underground cavity by distributing a slurry of fill material into the cavity with the aid of at least one high pressure air jet.

Another object of the invention resides in the provision of a novel method of backfilling an underground cavity comprising a slurry of fill material through a conduit extending through a vertical bore hole from surface level down to the cavity and displacing the slurry material laterally or horizontally within the cavity by at least one high pressure air jet directed into the slurry discharged from the bore into the cavity.

Still another object of the invention resides in the provision of novel apparatus for backfilling an underground cavity by which a slurry of fill material is fed down to the cavity by a vertical conduit having a bottom discharge port located within the cavity, the fill material then being displaced horizontally within the cavity by a high pressure air jet from air nozzle means positioned adjacent the slurry discharge port.

A further object of the invention resides in the provision of a novel apparatus described in the above objects, wherein the slurry discharge port in thee conduit opens laterally into the cavity and the air nozzle means provides laterally directed pressurized air jets which propel and convey the slurry laterally within the cavity.

A still further object of the invention resides in the provision of the novel apparatus described in the above objects, wherein the conduit is mounted for rotation in the bore hole so that the slurry may be distributed in the cavity in any desired lateral direction.

Another object of the invention resides in the provision of the above described apparatus which includes a novel mounting assembly for rotatably supporting the flushing conduit during the flushing operation.

Other objects and advantages will become apparent from reading the following detailed description of the invention wherein reference is made to the accompanying drawings throughout which like numerals indicate like elements.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic elevation view of the novel apparatus of the invention mounted in place for a flushing operation;

FIG. 2 is an enlarged fragmentary section view of the apparatus of the invention;

FIG. 3 is a section view taken generally along line 3—3 of FIG. 2 showing a split collar support for the flushing conduit;

FIG. 4 is a schematic section view taken along line 4—4 of FIG. 2 illustrating the support assembly which enables the flushing conduit to be rotated;

FIG. 5 is a fragmentary elevation view illustrating the air nozzle unit located adjacent the discharge port for the slurry material; and

FIG. 6 is a fragmentary view taken generally along line 6—6 of FIG. 5;

## DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, the backfilling or flushing apparatus 10 of the invention includes a conduit 11 formed by a plurality of conventional pipe sections 12, 14, 16, 18, and 20 welded together and ex-

tending from ground surface 22 downwardly through a vertical bore hole 24 to an underground mine cavity 26. A 90° elbow 28 is welded on the bottom of pipe section 20 and provides a laterally or horizontally directed discharge port 20 for the fill material emitted from conduit 11.

A mounting assembly 30 shown in FIGS. 2, 3, and 4, supports conduit 11 in suspended fashion from surface 22 and enables the conduit to be rotated through 360° to distribute the material in any lateral direction within cavity 26. Assembly 30 includes a stationary support plate 32 which may be of square configuration and is provided at its corners with height adjusting and levelling screws 34 by which it is placed in position on surface 22. A circular plate 36 is rotatably mounted on plate 32 by way of a plurality of circumferentially spaced roller bearing units 38 fastened on plate 32 and riding in a circular groove 40 provided on the bottom of plate 36. Plates 36 and 32 are held in proper operating relationship by a plurality of retainer units 42 which prevent separation of the plates but still permit rotation of plate 36.

Plates 32 and 36 are provided with central aligned openings 44 and 46, respectively, which align with bore hole 24 to receive the upper end of the top pipe section 12. A short tubular support section 48 is welded at 49 to the top of pipe section 12 and supports the entire conduit 11 from plate 36 by way of a split collar 50 and a plurality of support legs 52, 54, and 56. As shown best in FIGS. 2 and 3, collar 50 is formed by two separable half sections 58 and 60 which are fastened together by screws 62. Collar section 58 is fixed on plate 36 since it is welded to the top of legs 52 and 54, the bottoms of which are welded on plate 36. However, collar section 60, selded to the top of leg 56, is removable from plate 36 since the bottom of leg 56 is merely screw fastened on plate 36 by screw 64. As shown in FIG. 2, the upper end of each of the legs 52, 54, and 56 has an L-shaped recess 66 in which the collar sections seat to afford a strong, stable connection between the collar and support leg.

Each of the collar sections is grooved on its inside face to provide a continuous circular groove 68 when the sections are fastened together. A continuous circular groove 70 is also formed in the outside surface of pipe section 48 and faces opposite the groove 68. A split support ring includes two half ring members 72 and 74 which fit snugly within grooves 68 and 70 to connect tubular section 48 to collar 50 and thereby support the entire conduit 11 from rotatable plate 36. Consequently, tubular section 48 and conduit 11 may be rotated to distribute the fill material discharged from port 29 in any desired lateral direction in cavity 26.

In accordance with the primary aspect of this invention, distribution of the fill material in cavity 26 is enhanced by laterally or horizontally directed, pressurized air jets emitted from an air nozzle unit 80 fastened as by welding around the bottom of pipe section 20 and elbow 28. A high volume of pressurized air is delivered to nozzle unit 80 by a flexible hose 82 extending down through bore 24 along side conduit 11 and fastened to conduit 11 by one or more suitable removable straps 84. Hose 82 may normally be stored in rolled fashion on a reel. As shown best in FIGS. 2, 5, and 6, the outlet end of nozzlle unit 80 is located directly beneath port 29 and is provided with a plurality of air discharge openings 90 from which a plurality of high velocity air jets are emitted to propel and convey the fill material from port 29 a substantial distance laterally in cavity 26. If desired, one or more additional air jets or nozzles 91 (shown in broken line in FIG. 2) may extend directly into the back of elbow 28 to further assist in propelling the slurry material, although nozzles 91 will not usually be required.

A backfilling operation employing the novel apparatus discussed hereinabove will now be described. Initially, a bore hole 24 of suitable diameter is drilled down to cavity 26 by conventional drilling equipment. In many operations, the depth of the hole may be as much as 100 to 300 feet. Mounting assembly 30 may then be placed in position with openings 44 and 46 aligned with the top of bore hole 24. Initially collar section 60 and leg 56 will be removed from plate 36. Through the use of a suitable crane or similar equipment, pipe section 20, which has elbow 28 and nozzle unit 80 fixed on its lower end, is the first section to be lowered through openings 44 and 46 into bore hole 24. One end of flexible hose 82 of course is connected into nozzle unit 80 before it is placed in the hole. When only the upper end of section 20 projects above opening 46, the next pipe section 18 is brought into abutment with section 20 and welded thereto. Sections 18 and 20 are then lowered together down hole 24 until only the upper end of section 18 projects above opening 46, at which time section 16 is then welded to section 18. This continues until all the pipe sections have been installed and elbow 28 and nozzle 80 extend into the upper portion of cavity 26. During this installation process, hose 82 is unrolled from its storage reel and will extend down bore 24 alongside the connected pipe sections.

With ring member 72 in place in collar section 58, tubular support section 48 is next welded on pipe section 12. If necessary plate 32 is levelled and adjusted so that grooves 68 and 70 properly align so that ring member 72 fits within the grooves. Ring member 74 is then placed on section 48 and collar section 60 is fastened to collar section 58 by screws 62. Leg 56 is then secured in place on plate 36 by screw 64. Support assembly 30 is thus secured in operative position in which it supports the entire conduit 11 and the crane by which the conduit has been lowered may be removed. Hose 82 may be secured to pipe section 48 by strap 84 and the outer end of the hose is connected to a high volume pressurized air source suitable to provide for example, an air flow of about 100 cfm at 100 psi from each nozzle opening 90.

The flushing operation then proceeds by continually depositing a slurry of fill material consisting of water and fine rock solids into the upper open end of tubular support section 48. The slurry material falls rapidly by gravity down conduit 11 and exits from elbow port 29 horizontally into cavity 26. The high velocity air jets from nozzle openings 90 propel the slurry material a substantial distance horizontally so that the material is uniformly distributed over a wide area within cavity 26. Support assembly 30 enables conduit 11 to be periodically rotated so that the slurry material is displaced in all directions within cavity 26, and this again enhances more uniform distribution of the material.

Upon completion of a flushing operation, it is advantageous to a contractor if the various pipe sections forming conduit 11 may be withdrawn from bore hole 24 and reclaimed for future use, and this is permitted

by assembly **30**. After tubular section **48** or the upper end of pipe section **12** is grasped by suitable means such as a crane, collar section **60** and leg **56** are removed from plate **36**. After separating support section **48** from pipe section **12** by burning the weld joint between the sections, conduit **11** is then pulled upwardly and as each successive pipe section is totally withdrawn from hole **24**, it is separated by burning from the remainder of the conduit. During the withdrawal process, hose **82** may be rolled back onto its storage reel for future use.

From the description hereinabove, it is apparent that the method and apparatus of the invention afford a more uniform distribution of fill material over a wider area in an underground cavity, thereby enabling the cavity to be substantially filled to avoid undesirable cave-ins. Because the air jets distribute the slurry material over a wide area and because conduit **11** is rotatably mounted to eject the slurry in any desired direction, fewer bore holes are required to complete a flushing operation in a given mined area. This of course produces substantial savings in both time and money. Furthermore, since the slurry material descends only by gravity in conduit **11**, the slurry material trapped in cavity **26** is not under a dangerous hydrostatic pressure, and this is significant from a safety standpoint.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by Letters Patent is:

**1.** A method of backfilling an underground cavity comprising passing fill material downwardly through first conduit means to said cavity, passing pressurized air downwardly through second conduit means located externally of said first conduit means, and continuously directing the pressurized air into the fill material deposited in the cavity to displace the fill material laterally within the cavity.

**2.** The method defined in claim **1**, wherein the fill material is emitted from a laterally facing port in said first conduit means in a lateral direction into said cavity, and wherein said pressurized air includes at least one continuous laterally directed air jet which conveys said material laterally in the cavity.

**3.** The method defined in claim **2**, wherein the first conduit means is rotatable so that the fill material may be distributed in the cavity in any desired lateral direction.

**4.** The method defined in claim **3**, wherein the fill material descends by gravity through said first conduit means.

**5.** The method defined in claim **1**, wherein the pressurized air includes a plurality of continuous air jets flowing in the same direction.

**6.** The method defined in claim **2**, wherein said pressurized air includes a plurality of continuous air jets flowing in the same lateral direction.

**7.** Apparatus for backfilling an underground cavity comprising first vertical conduit means adapted to extend downwardly through a bore hole to said cavity and including a discharge port from which fill material is deposited into said cavity, air supply means including second conduit means located externally of said first conduit means and nozzle means connected to the lower end of said second conduit means and mounted adjacent said discharge port for directing a continuous flow of pressurized air into the fill material deposited in the cavity to thereby displace the material laterally within the cavity.

**8.** The apparatus defined in claim **7**, wherein said discharge port opens laterally into said cavity and said nozzle means emits at least one laterally directed air jet which conveys the fill material from said port in a lateral direction within the cavity.

**9.** The apparatus defined in claim **8**, wherein said nozzle means includes a plurality of nozzle openings which provide a plurality of air jets flowing in the same lateral direction to convey the fill material from said port in a lateral direction within the cavity.

**10.** The apparatus defined in claim **8**, comprising mounting means for supporting said first conduit means and permitting rotation thereof, whereby the fill material may be distributed into said cavity in any desired lateral direction.

**11.** The apparatus defined in claim **10**, said mounting means comprising a tubular support section fixed to the upper end of said first conduit means, a rotatable plate, and means connecting said tubular section to said plate.

**12.** The apparatus defined in claim **11**, said connecting means comprising support collar means mounted on said plate and including separable collar sections which when assembled on said tubular section support said first conduit means from said plate.

**13.** The apparatus as defined in claim **12**, said mounting means further comprising a stationary plate, bearing means mounting said rotatable plate on said stationary plate, and retainer means for holding said plates together.

**14.** The apparatus defined in claim **13**, said mounting means further including adjusting means connected to said stationary plate for adjusting the position of said stationary plate on ground surface.

**15.** The apparatus defined in claim **13**, wherein said second conduit means includes a flexible air hose adapted to extend down the bore hole and connected to said air nozzle means to deliver pressurized air thereto.

**16.** The apparatus defined in claim **7**, said second conduit means including a flexible air hose adapted to extend down the bore hole and connected to said air nozzle means.

**17.** The apparatus defined in claim **16**, said nozzle means including a plurality of nozzle openings which provide a plurality of air jets flowing in the same direction for displacing the material laterally within the cavity.

**18.** The apparatus defined in claim **7**, wherein said nozzle means includes a plurality of nozzle openings which provide a plurality of air jets flowing in the same direction to displace the material within the cavity.

* * * * *