

[54] **METHOD FOR WELL BORE MINING IN AN UNCONSOLIDATED STRATUM**

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[52] U.S. Cl. .... **299/17; 175/67; 175/213; 299/18**

[51] Int. Cl. .... **E21c 45/00**

[58] Field of Search ..... **299/17, 18; 175/67, 213**

[56] **References Cited**

**UNITED STATES PATENTS**

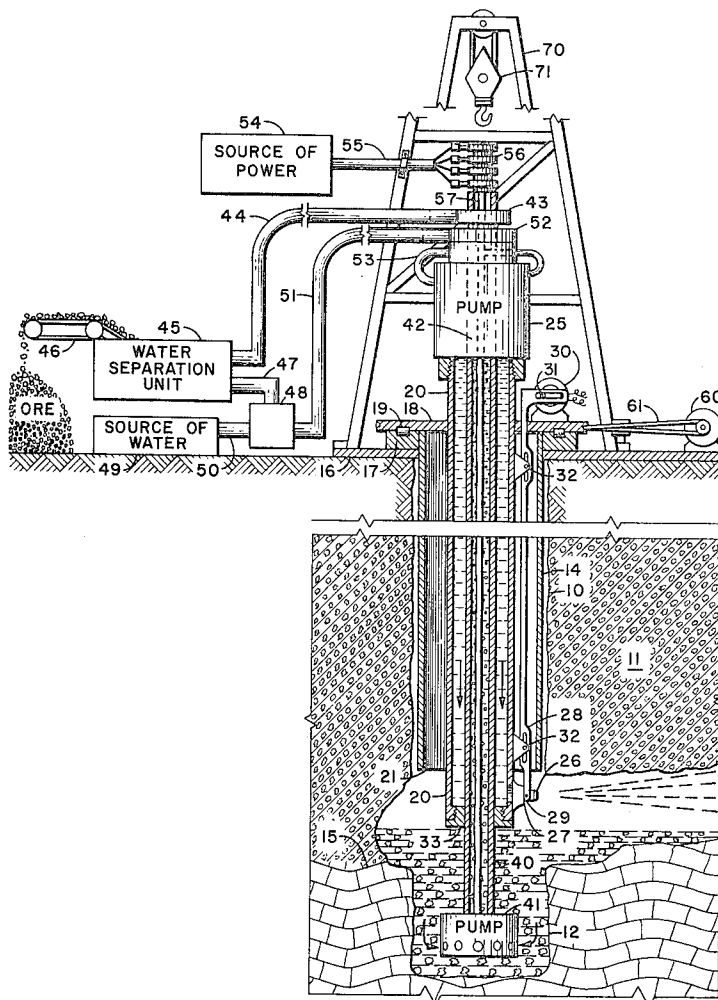
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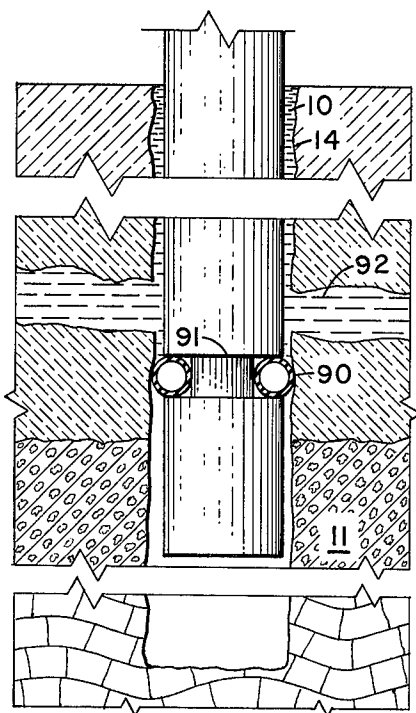
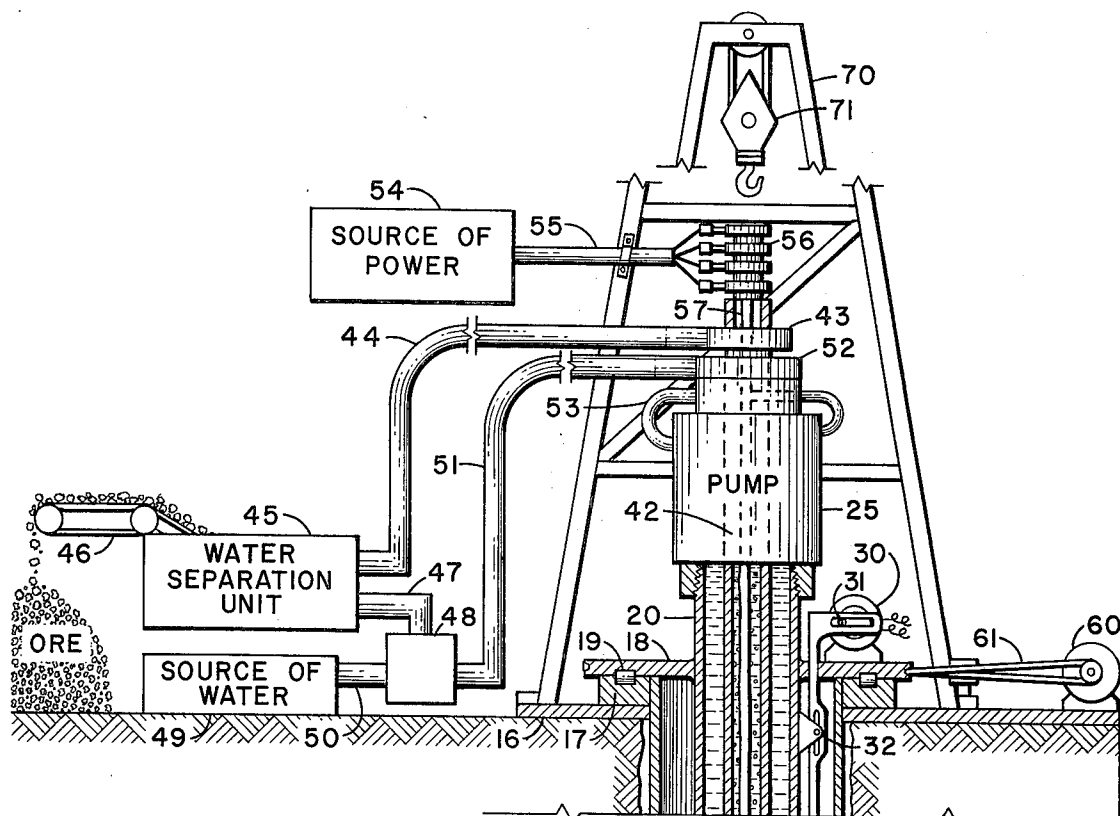
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[57] **ABSTRACT**

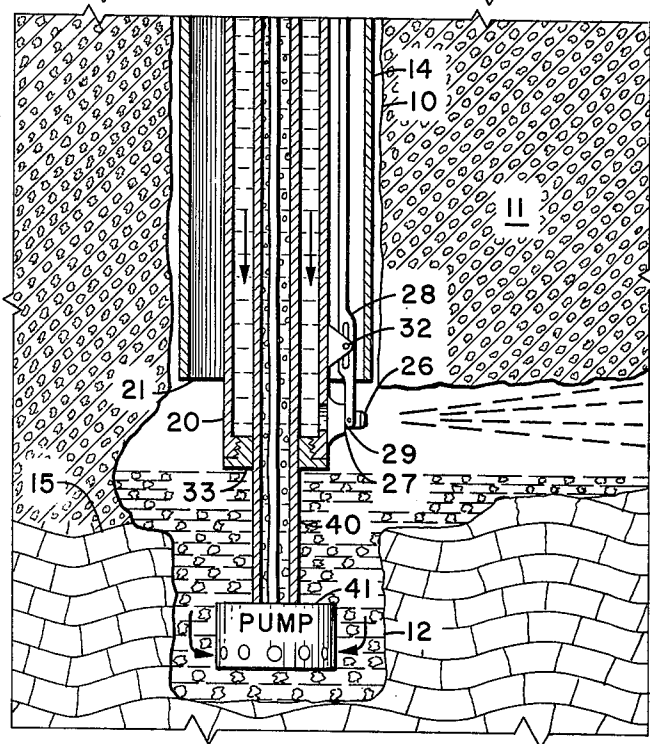
A method of mining in an unconsolidated structure is accomplished by forming a bore hole in the ground to at least the bottom of the structure to be mined, then casing the bore hole to a point at least five feet or less above the bottom of the bore hole. A sump is then formed between the bore hole and the bottom of the casing. A pump is positioned near the bottom of the sump, and a jet is positioned above the pump. Fluids are forced out of the jet against the formation while the jet is being moved vertically and axially in one direction about the axis of the bore hole to form an elongated slot in the formation. During the operation of the jet, the pump is removing dislodged formation material. After subsidence of the formation, the jet is continued in its rotation and vertical movement around the axis of the bore hole.

**3 Claims, 2 Drawing Figures**





**FIG. 2**



**FIG. 1**

# METHOD FOR WELL BORE MINING IN AN UNCONSOLIDATED STRATUM

## PRIOR ART

All prior art relates to the slurry removal of material from a formation which is consolidated. Examples of mining using jets to dislodge the material are the U.S. Pats. to Brinton, No. 2,822,158; Schweitzer et al, No. 2,018,285; Cross, No. 2,251,916; Aston et al, No. 2,518,591; Gilmore, No. 2,745,627; and Bacon, No. 671,429. The patents to Bacon, Cross and Brinton all show jets which can be moved vertically; however, none of the patents disclose a method for operating a system in an unconsolidated formation.

## BRIEF DESCRIPTION OF THE INVENTION

Applicant's invention discloses casing the well with a movable and removable casing. The casing is located near the pump and the jet so that subsidence of the formation will not cause trapping of the pump or the cutting jet. The method of operating the jet, furthermore, is not disclosed in the art.

The jet is operated by forcing high pressure fluids into the formation and then moving the jet vertically to cut a notch in the formation. The jet is slowly rotated about the axis of the bore hole. As material is removed, the formation behind the jet will collapse, but the formation in the immediate vicinity of the jet will have sufficient strength to permit the jet to cut a substantial distance into the formation.

## BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 discloses apparatus useful in performing the method illustrating a cross-sectional view of the formation and the apparatus mounted in the bore hole; and

FIG. 2 illustrates a means for securing the casing in the bore hole and a means for sealing off surface waters from entering the bore hole.

Referring to all of the figures but in particular to FIG. 1, a bore hole 10 is formed vertically from the surface of the ground into a stratum 11 to be mined. The bore hole may have a portion 12 below the stratum if desired. The casing 14 is positioned in the bore hole such that its bottom or terminus is approximately five feet from the bottom 15 of stratum 11. Positioning the casing 14 much over 5 feet will cause the unconsolidated formation to subside onto the jet and pump trapping them. Casing 14 can be anchored into place by the use of packers (not shown) or a surface plate 16. Plate 16 will have a bearing surface 17 positioned over the bore hole, a turntable 18 mounted over bearing plate 17, and bearings 19 inserted therebetween. A jet fluid communication pipe 20 is attached to turntable 18 and positioned axially in casing 14 to a point below the terminus 21 of casing 14. One end of pipe 20 is attached to a pump 25. A jet 26 is attached at the other end of pipe 20 and normal to its axis. Jet 26 is hinged at a point 27 and has a rod 28 pivotally attached to jet 26 at a pivot 29. Rod 28 is attached to a motor drive system 30 through a cam and pin arrangement 31. Rod 28 may also be supported periodically along pipe 20 by sliding bearings 32, for example. A seal 33 is attached to pipe 20 and forms a seal between pipe 20 and a pump pipe 40 which is positioned axially in pipe 20 and is attached at its upper end to pump 25 and at its lower end to a down well pump 41. Pump 25 has a channel 42 through its drive shaft (not shown) to a rotating seal 43. Pipes

44 are connected to the inlet of a water separation unit 45. The mined material may be conveyed from the water separation unit to conveyer 46 while the water is returned through a pipe 47 to T coupling 48. A source of water 49 is connected through a pipe 50 to T coupling 48 and thence through a pipe 51 to rotating seal 52 to the inlet pipe 53 of pump 25. A source of power 54 for pump 25 is connected through wires 55, a slipping assembly 56, to wires 57, which are connected to pump 25, and the pump 41 through the center channel 42 of pump 25, and the center of pipe 40.

A motor 60 may be connected through a belt 61 to turntable 18 for rotational purposes. It is obvious, of course, that turntable 18 can be turned by hand. A derrick 70 is attached to surface plate 16 and includes a winch 71 useful for working on the down well equipment and for removing the casing 14.

## Operation

In many instances a formation 11 will be unconsolidated. If such is the case slurry mining has proven extremely difficult or impossible, since the formation tends to collapse trapping the down hole equipment. Furthermore, the method of mining previously disclosed has not been successful in mining unconsolidated materials.

To provide protection for the equipment, a casing 14 having a smooth outer surface is inserted into bore hole 10 either as the bore hole is being formed or, if the formation has some consolidation, after the bore hole has been formed. Once the bore hole is formed pipe 20 and pipe 40 are inserted into the bore hole with pump 41 at the terminus of pipe 40. Jet 26 is positioned near the bottom 15 of the formation 11.

A source of water 49 supplies water through pipes 50 and 51 through rotating joint 52 to the inlet 53 of pump 25. Pump 25 then forces water down pipe 20 and out jet 26. Motor 30, as it revolves, moves cam and pin arrangement 31 so that rod 28 is moved up and down in the direction of the arrow. This will cause jet 26 to be moved vertically, cutting a vertical slot into formation 11. Pipe 20 is then rotated, causing the jet to move the vertical slot horizontally about the axis of rotation. As the slot is gradually moved, the unconsolidated material will tend to collapse behind the jet. As the jet rotates through 360°, it will be cutting into a new portion of the formation, since the old formation has subsided. Once all material has been removed that will subside, any unsubsided, minable material remaining can be dislodged by raising the casing and jet, dislodging the material so that it will subside to the pump area where it can be removed.

Referring to FIG. 2 an alternate embodiment of the casing is illustrated which includes a packer element 90 mounted in a recess 91 in casing 14. Packers suitable for the above are manufactured commercially. Formation water 92 oftentimes will travel down well bore 10 and into the formation 11 being mined. Under these conditions the jet will operate inefficiently. To prevent the formation water 92 from entering well bore 10, the recess 91 is made in casing 14 and a packer 90 placed therein. When casing 14 is set, packer 90 is inflated, shutting off the downward movement of formation water. Since the pipe is being mounted in unconsolidated material, bore hole 10 can easily collapse against casing 14; therefore, packer 90 should be mounted in a recess 91 so that, when packer 90 is deflated, it will have sub-

stantially the same diameter as casing **14** or else the casing could not be removed from the bore hole. In place of the mechanically, vertically moved jet, the jet can be rigidly oriented horizontally and the pipe moved up and down; or the jet can be pivoted as disclosed but the mechanical movement can be accomplished by hydraulic means.

It is obvious that other modifications and changes can be made in the method as specifically set out and still be within the scope of the specification and claims appended hereto.

I claim:

**1.** A method of mining in an unconsolidated structure comprising:

- a. forming a bore hole in the ground to at least the bottom of the structure to be mined;
- b. casing said bore hole to a point at not more than five feet about the bottom of said bore hole;
- c. forming a sump between the bottom of said bore hole and the bottom of said casing in consolidated

material;

d. positioning a pump near the bottom of said formed sump;

e. positioning a jet above said pump;

f. forcing fluids out of said jet against said formation while moving said jet vertically and axially in one direction about the axis of said bore hole to form an elongated slot in said formation;

g. pumping out dislodged formation material after subsidence of said formation continuing to rotate said jetted fluid into said subsided formation; and

h. pumping out said additionally dislodged formation material.

**2.** A method as described in claim **1** wherein said bore hole is formed in said ground to a depth below the formation to be mined about five feet.

**3.** A method as described in claim **1** where the step of casing said bore hole comprises releasably anchoring a casing pipe to said bore hole.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

PATENT NO. : 3,880,470

DATED : April 29, 1975

INVENTOR(S) : J Gilbert Davis, II

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 18, "about" should be --above--.

Signed and Sealed this

second Day of September 1975

[SEAL]

*Attest:*

RUTH C. MASON  
*Attesting Officer*

C. MARSHALL DANN  
*Commissioner of Patents and Trademarks*