United States Patent [19]

Keenan, Jr.

[11] **3,882,945**

[45] **May 13, 1975**

[54] **COMBINATION LASER BEAM AND SONIC DRILL**

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[73] Assignee: **Sun Oil Company of Pennsylvania**, Philadelphia, Pa.

[22] Filed: **Nov. 2, 1973**

[21] Appl. No.: **412,212**

[52] **U.S. Cl.** **175/16;** 175/56; 175/107

[51] **Int. Cl.** **E21b 7/00**

[58] **Field of Search** 175/16, 69, 65, 104, 107; 166/302, 303

[56] **References Cited**

UNITED STATES PATENTS

3,036,645	5/1962	Rowley	175/104 X
3,251,424	5/1966	Brooks	175/56
3,461,964	8/1969	Venghiattis	175/16 X
3,493,060	2/1970	Van Dyk	175/16
3,545,552	12/1970	Angona	166/177 X
3,583,677	8/1969	Phillips	166/177 X
3,693,718	9/1972	Stout	175/16 X

Primary Examiner—Frank L. Abbott
Assistant Examiner—Richard E. Favreau
Attorney, Agent, or Firm—George L. Church; Donald R. Johnson; Anthony J. Dixon

[57] **ABSTRACT**

The method for drilling for subterranean fluids with a combination laser beam and sonic beam comprising positioning a laser beam generator and a sonic generator in a well hole each electrically connected to an in-hole voltage generator actuated by drilling mud or other liquid passing through a drilling housing connected to the drill string. A reflecting crystal for the laser beam is positioned within this housing to reflect the beam preferably in an elliptical pattern across the formation to be penetrated while the sonic beam is transmitted through the drilling mud into the formation to be penetrated.

7 Claims, 2 Drawing Figures

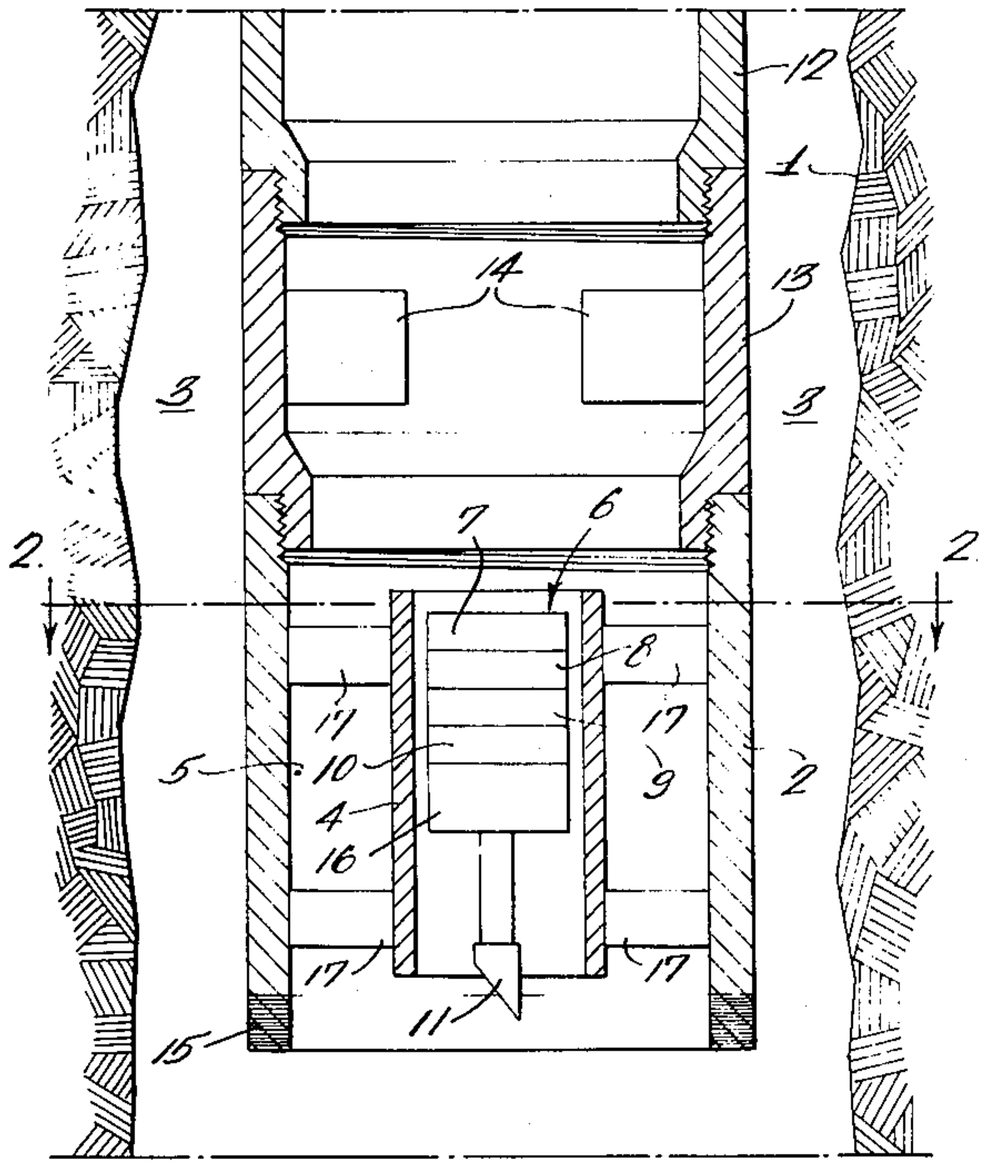

FIG. 1.

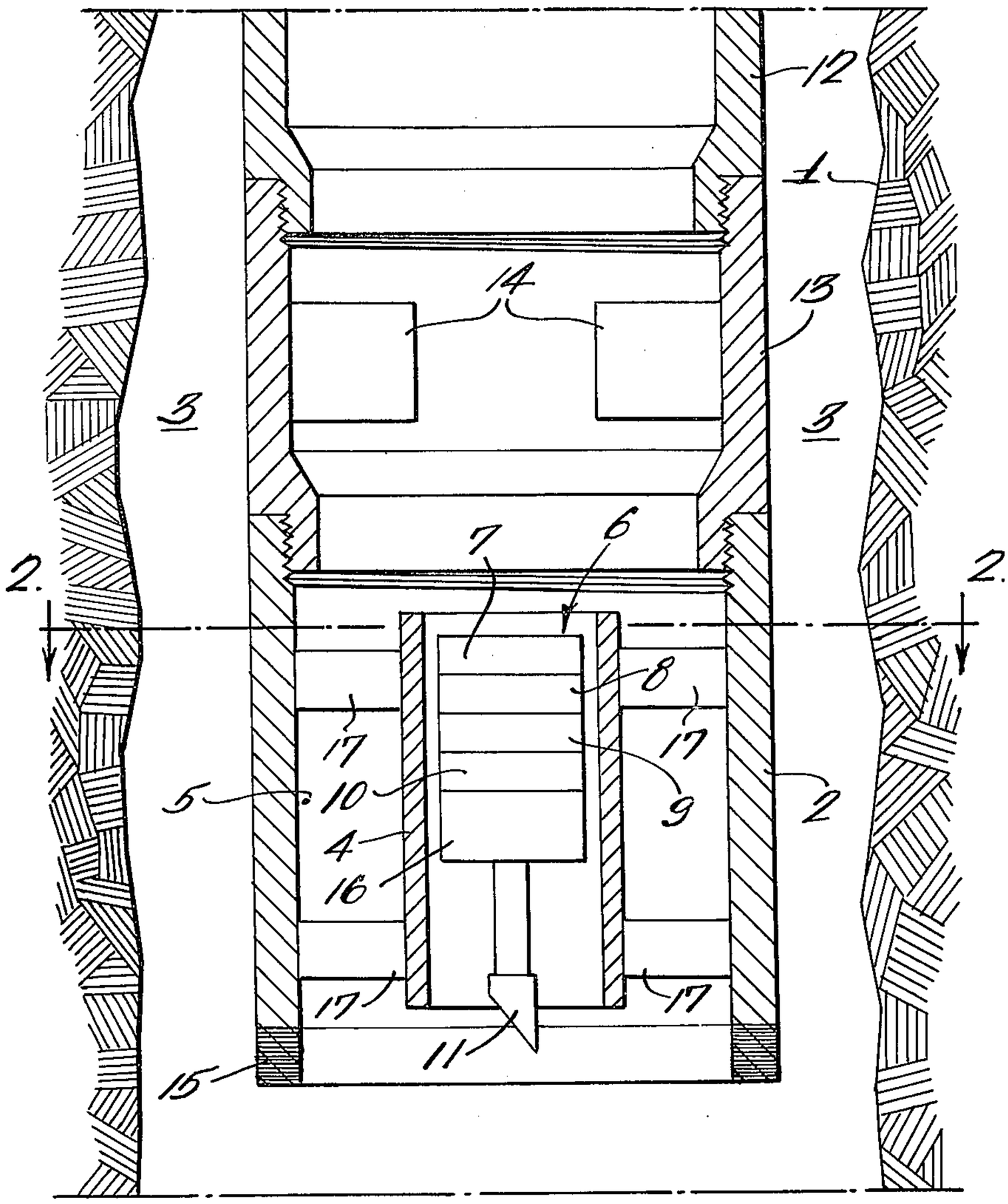
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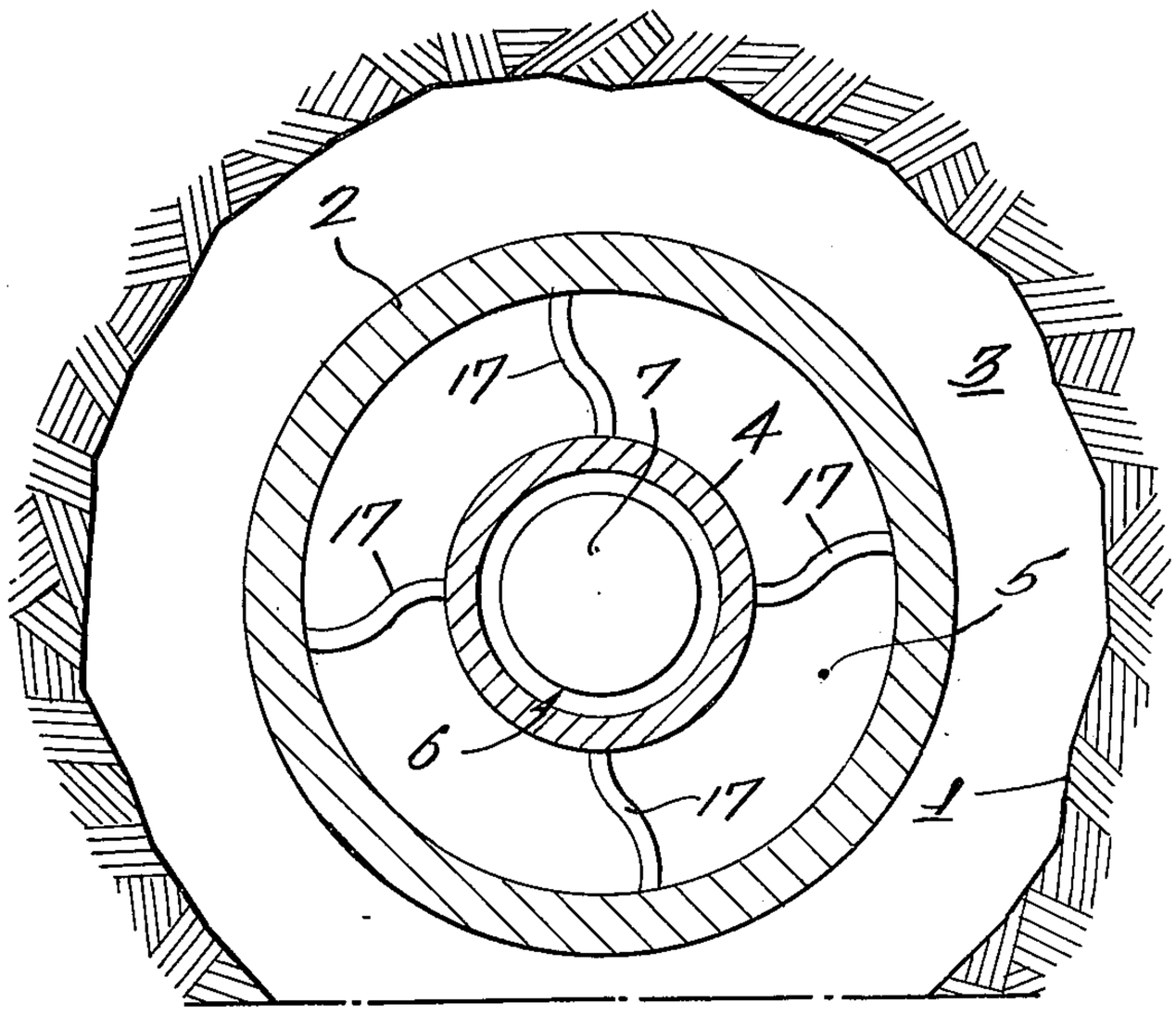
FIG. 2.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COMBINATION LASER BEAM AND SONIC DRILL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a method for recovering subterranean fluids from underground formations through a borehole. More particularly, this invention relates to the use of laser technology and sonic technology for boring into subterranean formations, and more particularly this invention relates to replacing the drilling heads normally used in drilling for underground fluids with a laser beam-sonic beam arrangement comprising a voltage generator actuated by the flow of drilling fluid through the drill pipe or collar and a laser beam generator and a sonic generator each drawing their respective power from a voltage generator also positioned in the in hole drilling housing and electrically connected to both the laser beam generator and the sonic generator.

2. The Prior Art

Removal of petroleum fluids from subterranean formations is usually accomplished through rotary drilling techniques. In the actual drilling or boring of holes with this technique there are required a cutting tool or bit, a rotary motion of the tool, and means for maintaining pressure on the bit while the material is being cut, usually accomplished with a string of drill collars also a medium for removing the material displaced by the bit or cuttings needed. This material, sometimes referred to as drilling mud or circulating fluid, must be circulated in volume and velocity through the holes of the bit so that it not only cleans the bit, but it jets the bottom of the hole flushing it of cuttings and hard formations. The circulating fluid must have a downward velocity sufficient to clean the formation being drilled and an upward velocity sufficient to remove the cuttings from the hole. Also the fluid must be readily pumpable.

Use of lasers to penetrate underground formations has been discussed in U.S. Pat. No. 3,693,718, issued to Daniel W. Stoudt, Sept. 26, 1972. This patent along with prior apparatus and methods utilizing laser beam energy is limited in that laser beam generators are mounted by a frame assembly above the ground surface in alignment with the borehole communicating with the subterranean cavity from which recovery of oil and gas reserves is desired. Another disadvantage to these types of system is that they cannot be used easily with the present multiple bore single-head systems now being used to recover subterranean fluids especially in offshore applications. These types of systems often use radially extending boreholes from one main or mother borehole and a surface laser beam generator cannot follow the path of these boreholes without undue use of energy.

Use of sound technology to penetrate underground formations has been discussed in U.S. Pat. No. 3,315,755 issued to Warren B. Brooks, Apr. 25, 1967, which discloses alternating acoustic pressure pulses through drilling fluids being conducted downwardly through a borehole thereby subjecting the formation to alternating stresses due to particular pressure conditions set up in a drilling fluid at the bottom of the borehole. U.S. Pat. No. 3,251,424 issued to Warren B. Brooks, May 17, 1966, also relates to a method and apparatus for drilling boreholes using jet fluid streams and acoustic pulses. However, in both of these patents the power needed to generate these acoustic pulses is generated on the surface and is transmitted into the borehole by a conventional technique. There are disadvantages to having this transmission line running through the borehole, one of which is that it must be removed prior to adding another piece of drill pipe. Both of these patents are limited to discussions of pulses of acoustic energy.

SUMMARY OF THE INVENTION

An improved method for drilling for subterranean fluids has now been found utilizing a self-contained unit containing therein a voltage generator actuated by the flow of drilling fluid, a laser beam generator electrically connected to said voltage generator, a sonic generator electrically connected to said voltage generator, and a beam deflecting crystal for reflection of the laser beam generated by said laser beam generator across the face of the formation within the borehole which is being drilled. Simultaneously, the sound waves being generated by the sonic generator are being transmitted through the drilling mud and carried thereby into the formation, wherein fracturing of the formation takes place. The cuttings from both processes are then carried to the surface by the drilling mud. The entire self-contained unit hereinafter called the drill assembly is positioned in a drill housing in turn connected to the drill string, where would previously have been connected to a rotary bit, to replace this rotary bit now used in most subterranean drilling techniques and also to utilize the flow of drilling mud already present to pass over the self-contained unit and drive the generator obtained therein so that in-situ power generation, laser beam generation and sound generation is accomplished. The advantages of this system are that laser beam coring techniques and sound generation techniques can be used in radially-directed wells and can also be used in wellbores which veer from a straight line pattern.

Other advantages to be gained from such a system are that equipment costs can be greatly decreased since the size of the laser beam generator and sonic generator need not be as powerful when they are positioned inbore as they need be when they are positioned on the surface. This also results in less energy costs.

Further, the laser beam-sonic system can be attached to a present drill collar or drill string by making the connection on the uppermost section of the drill housing to match the connection on the end of the existing drill string. It is also envisioned that drill collar can be replaced with drill pipe during the drilling operation since maintaining of pressure on a bit is no longer necessary.

Although two voltage generators, one for providing power to the laser beam generator and one for the power needed for the sonic generator are preferred, one large generator is also envisioned.

Another advantage to be realized in making use of such an arrangement combining laser beam technology and sound technology is that the larger particles cut loose from the formation by the laser beam will be broken up by the additional use of the sonic wave thus enabling the drill to penetrate at a faster pace.

These and other advantages will be more readily determinable upon review of the description of the drawing in the preferred embodiment which follows.

DESCRIPTION OF THE DRAWING AND THE PREFERRED EMBODIMENT

FIG. 1 is a vertical cross section of a wellhole penetrated by a drill string containing a lower most section wherein is positioned the apparatus used in the present invention.

FIG. 2 is a horizontal cross sectional diagram along lines 2—2 of FIG. 1.

Shown in FIG. 1 is an existing wellhole, 1, penetrated by a drill pipe connected at its lower most end to a laser beam and sonic housing assembly, 2, connected in turn to a vane sub, 13, containing radially based vanes, 14, for mud flow directional control which is in turn connected to drill housing, 2, with an annular space, 3, defined between the wall of said wellhole and the wall of said laser beam and sonic housing. Within the laser beam and sonic housing, 2, is contained a laser beam and sonic drill positioner, 4, with an annulus, 5, being finned, 17, between the laser beam and sonic housing, 2, and the outer circumference of the laser beam and sonic drill positioner, 4, all within said wellhole, 1. Wherein the prior art is positioned a rotary bit is now positioned a self-contained laser beam and sonic assembly, 6, containing therein a first voltage generator, 7, a laser beam generator, 8, a second voltage generator, 9, and a sonic generator 10. The first voltage generator is electrically connected to the laser beam generator and the second voltage generator is electrically connected to the sonic generator. Also contained in the laser beam and sonic housing is a gear box, 16, rotatably connected to a deflecting crystal, 11. The gear box is arranged in such a way so as to provide an elliptical motion of the beam generated by the laser beam generator and reflected by the reflecting crystal over and across the face of the formation being drilled. Further, the gearbox, 16, the second voltage generator, 9, and the sonic generator, 10, are arranged to allow a path for the laser beam from generator, 8, to deflecting crystal, 11. The drilling mud travelling downward through the drill pipe is directed in a rotational flow pattern via the vanes in the previously described vane sub section and this rotary motion of the mud drives the turbine blades of the voltage generator. In actual operation drilling mud flows down the annulus between the laser beam and sonic housing and the laser beam and sonic positioner and passes over the generator thereby turning the generators and producing power. This drilling mud then flows past the sonic generator wherein sonic vibrations are transmitted through the mud to the bottom of the wellbore. It is also envisioned that the gear box, 16, which drives the reflecting crystal can be driven either by mud flow, mechanically, by the generator turbine, mechanically, or by power generated by the generator, electrically. This drilling mud then flows to the bottom of the wellbore where it not only transmits sonic vibrations to the formation, but it picks up cuttings which would previously have been made from a rotary drill which are now the result of laser and sonic cuttings, and carries these cuttings along its path in the annulus between the drill pipe or drill collar and the wall of the wellhole with sufficient upward velocity to carry the mud and cuttings of said drilling to the surface wherein conventional separation means are used to remove the cuttings from said mud and return the mud down the drill pipe or collar as previously discussed. The lower circumference of the laser beam and sonic housing, 2, is hardened at location, 15, so as to more readily withstand erosion which is caused by the flow of the mud and entrained cuttings which flow around it. Another liquid (water) can be substituted for drilling mud when the laser sonic generator system is used to replace a rotary bit. The sound vibrations from the sonic generator will also be breaking up the sections being cut from the formation by the laser generator into smaller pieces which can more easily be carried to the surface by the drilling mud. The laser, sonic generator and voltage generator section or the laser beam and sonic housing is positioned where conventional bit would have been previously positioned and the power for the generators is derived from the energy contained in the flow of drilling mud past the generators. The entire system is self-contained and removable which allows removal without pulling the entire drill string out of the wellhole. This results in the saving of time and money. The self-contained drill assembly can snap into the drill housing by conventional spherical bearings around the outer circumference of the self-contained unit and semi-spherical indentations around the inner circumference of the laser beam and sonic positioner corresponding in radial position to said bearings meet the indentations a snapping and locking in of the self-contained unit is achieved. For the sake of simplicity and due to the conventionality of such a system, it is not pictured in the drawing.

It is also envisioned that two voltage generators can be used instead of one voltage generator each serving respectively the sonic generator and the laser beam generator.

It is also envisioned that the lower-most opening of the well pipe can have a series of jets which would direct the drilling mud in a jetting action into the formation. Advantages of such a configuration are that not only would sound generation and laser generation be used to cut into the formation, but the jetting action of the drilling mud can also be used for the same purpose.

As shown in FIG. 2 the connections, 17, between the laser beam and sonic housing and the laser beam and sonic positioner which spans the annular space, 5, are shaped in such a way so as not to impede the flow of mud down through the drill pipe into the cavity being drilled.

It will be understood that various changes may be made in the form and arrangement of the elements used in the method illustrated herein without departing from the spirit of the present invention or from the scope of the annexed claims. For example, the path of the laser beam across the formation can be other than elliptical and the advantages of the system can still be achieved; or modifications in the flow of liquid to drive the generator can be made without departing from the scope of the combination of the claims.

The invention claimed is:

1. A method for recovering liquid reserves from a subterranean formation through a wellbore containing a drill string comprising

a. attaching a laser beam and sonic housing to the lower most section of the drill string,

b. positioning a self-contained laser beam and sonic assembly within the laser beam and sonic housing containing a voltage generator, a laser beam generator electrically connected to and deriving its power from the voltage generator and a sonic gen-

erator electrically connected to and deriving power from the voltage generator,

c. actuating the voltage generator by drilling fluid passing through the drill string,

d. generating a sonic beam and transmitting it through the drilling fluid into the formation,

e. separating the drilling fluid entering the formation cavity into a plurality of jet streams, and

f. generating a laser beam and projecting it into the formation.

2. The method of claim **1** wherein the voltage generator further comprises two voltage generators, one being electrically connected to the sonic generator and the other being electrically connected to the laser beam generator.

3. The method of claim **1** wherein a rotating reflecting crystal is positioned within the laser beam and sonic beam assembly whereby said laser beam is reflected across the face of the formation being drilled.

4. The method of claim **3** wherein the reflecting crystal rotation provides an elliptical pattern for the laser beam across the face of the formation being drilled.

5. The method of claim **3** further comprising positioning a gear box in the self-contained drill assembly whereby the rotating action of the generator is translated to an elliptical motion of the reflecting crystal.

6. The method of claim **5** wherein the mud flow drives a turbine which drives the gear box.

7. The method of claim **5** wherein electrical power derived from the voltage generator actuates an electrical drive motor which drives the gear box.

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