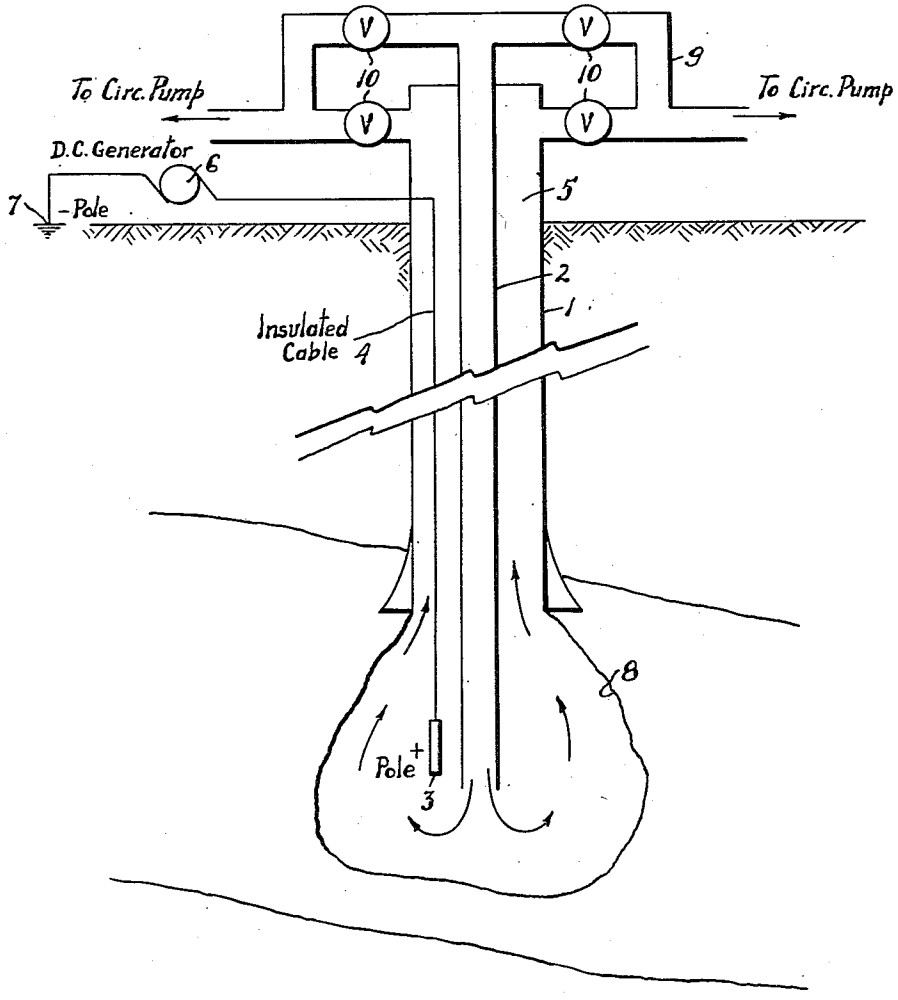
Sept. 17, 1957 K. C. HOWARD 2,806,818

ELECTROLYTIC METHOD FOR FORMING CAVITIES IN SHALE FOR STORAGE OF FLUIDS

Filed Aug. 15, 1955



Inventor:

Kenneth C. Howard

By Munson Thos

Atty.

United States Patent Office 2,806,818
Patented Sept. 17, 1957

2,806,818

ELECTROLYTIC METHOD FOR FORMING CAVITIES IN SHALE FOR STORAGE OF FLUIDS

Kenneth C. Howard, Fort Worth, Tex.

Application August 15, 1955, Serial No. 528,526

3 Claims. (Cl. 204—180)

This invention relates to underground storage of fluids and has reference to the storage of fluids in shale and shale like formations.

Heretofore, fluids have been stored in salt beneath the earth's surface by drilling and dissolving the salt to form storage cavities. Such storage has proven to be economically feasible, particularly for volatile liquids, such as liquefied petroleum gases and ammonia. Steel storage above the ground capable of holding volatile liquids under pressure is expensive, and in the petroleum industry large volumes of liquefied petroleum gases are produced the year around but used primarily during the winter months. Such storage in salt cavities is not only economical but is convenient in areas where salt formations are found. However, many geographical locations do not have salt formations, but subsurface shale formations are usually found in practically all areas. It would appear that cavities, similar to salt cavities may be readily formed in shale but it has been found that while hydratable shales dissolve in water, the rate of disintegration is comparatively slow and therefore expensive for the purposes contemplated.

An object of this invention is to increase the rate of dissolving cavities in shale and shale like formations for the purpose of forming storage spaces therein.

Another object of the invention is to provide means for controlling the distintegration of subsurface shale or shale like deposits so that storage cavities formed therein may be of substantially uniform diameter.

Primarily, the invention consists of a process for disintegrating subsurface shale in the presence of water by the application of an electrical current thereto. An underground storage cavity is formed as particles of shale thus disassociated from a shale deposit are removed therefrom and carried to the surface by hydraulic circulation.

In accordance with the invention as diagrammatically illustrated in the accompanying drawing, a well is drilled into the earth by conventional means through various overlying formations into a deposit of shale or shale like strata. The bore of the well is then lined between the ground surface and the top of the shale formation with a tubular casing 1. An inner string of pipe 2 is lowered within the casing into the well so that the base of the inner pipe is within or below the shale formation. The inner string of pipe is covered with electrical insulating material so that the metal thereof does not come in contact with fluids in the well. An anode 3 made of suitable electrical conducting material such as metal or carbon is connected to the lowest section of the inner pipe. In the absence of insulated pipe, an insulated cable 4 may be utilized to conduct electrical current from the well head to the submerged anode. In a preferred form of the invention the anode is pivotally attached to the inner pipe and is forced by spring tension toward the wall of the bore in the shale formation beneath the lower termination of the well casing. Water is pumped downwardly through the inner pipe which forces circulation of the water or drilling mud back to the well head through the annulus 5 between the inner pipe and the casing. The inner pipe is electrically connected

to the positive terminal of a direct current source of electricity 6; the negative terminal of the current source is grounded as at 7. In an additional form of the invention the anode is lowered through the tubing or the annulus on an insulated cable 4. The flow of electricity through the water or electrolyte from the shale accelerates the disintegration of the shale deposit and particles thereof are placed in suspension and subsequently carried upward through the annulus or tubing by the water in circulation. Water with a low content of dissolved salts has been found to be the most effective vehicle for the electrical disintegration of shale.

By changing the position of the anode at the shale formation the disintegration of various parts of the cavity 8 may be particularly promoted. When a cavity of the desired dimensions has been formed, fluids to be stored therein are pumped into the cavity through the inner pipe 2 and displaced through the annulus 5. Since most liquid hydrocarbons and all liquefied petroleum gases are lighter than water, the lighter fluid will seek its level above the heavier fluid; accordingly, a well head 9 is provided on the casing above the ground, and which well head supports the inner pipe and suitable control valves 10. It is to be understood that the fluid to be stored may be pumped into the cavity 8 through the annulus and thereby displace water in the cavity through the inner pipe 2.

Upon completion of the cavity the anode 3 may be removed or de-energized and further disintegration may be controlled by treating the walls of the cavity with drilling mud under elevated pressure or water with high salinity or high viscosity additives may be used to further inhibit disintegration of the walls of the cavity. Hydratable shales are generally hydrophilic and the presence of petroleum liquids tends to inhibit the disintegration of shale on the upper walls of the cavity.

Hydratable shale is essentially an indurated form of clay consisting of small disc particles in overlapping laminated arrangement. These particles are hydrophilic and exhibit pronounced cleavage and when mixed with water the particles are frequently reduced in size. The importance of the size of constituent particles of shale resides in the ability of extremely small particles to absorb enveloping liquid films and to this assume colloidal characteristics. In the electrical disintegration of shale it is presumed that many colloidal particles are held within a shale deposit by adsorbed water films of complex polarity. When these particles are subjected to external electrical forces they disassociate from one another and from their adsorbed films through a process of electrophoresis. The fact that the saline solutions tend to retard the electrical disintegration of shale gives support to this presumption, but an unexpected result which follows any increase in conducted electrical current indicates that electrophoresis alone cannot account for the process of disintegration. By experiment it has been found that disproportionate increases in the rate of shale distintegration accompany any increases in the flow of electrical current therethrough.

In the present specification the term "solution" is used in its broadest sense to include colloidal solutions.

The procedures herein described may be modified in various ways within the scope of the appended claims.

What is claimed is:

1. The method of forming an underground cavity for the storage of fluids therein, said method comprising the steps of drilling a hole into a shale formation, providing an electrolytic solution therein, and conducting a direct current through said solution, the negative terminal of said current being grounded with said shale formation and the positive terminal of said current being in electrical contact with said solution.

2. A method of forming an underground cavity for the storage of fluids therein which comprises drilling a hole in

a shale formation, introducing an electrolyte in said hole, applying a direct current with the negative terminal grounded to the shale formation and with the positive terminal in electrical contact with the electrolyte thereby disintegrating the wall of said hole to form the cavity, and removing the disintegrated shale from the cavity by means of circulation.

3. The use of an underground cavity produced in accordance with the method of claim 2 for the storage of fluids.

References Cited in the file of this patent

UNITED STATES PATENTS

2,211,696	Irons	Aug. 13, 1940
2,217,857	Byck	Oct. 15, 1940
2,518,591	Aston et al.	Aug. 15, 1950