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MEANS AND METHOD OF TREATING WELLS

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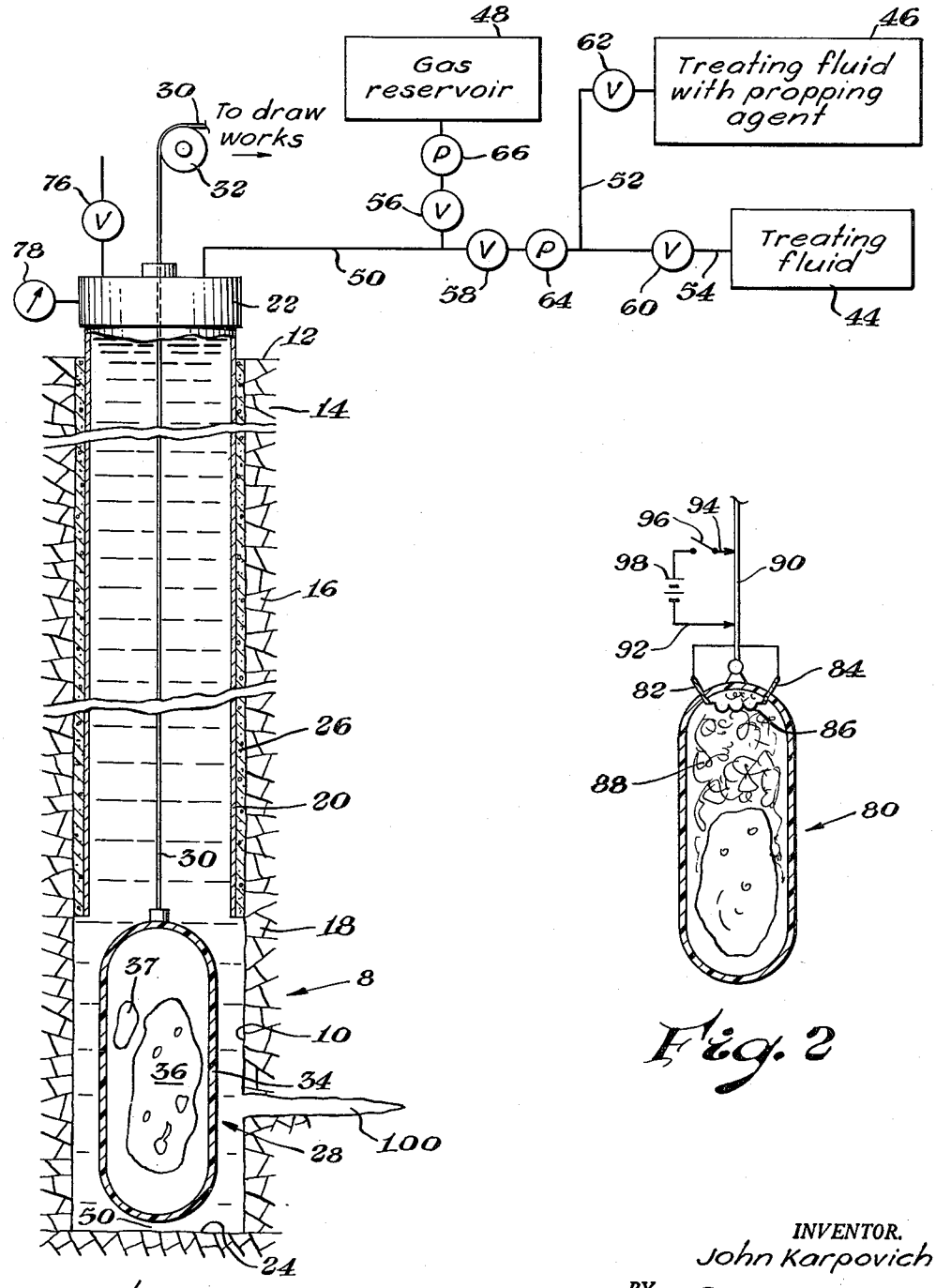


Fig. 1

Fig. 2

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MEANS AND METHOD OF TREATING WELLS

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This invention relates to earth well treatments and particularly to so called formation fracturing treatments.

It is known to use implodable frangible vessels or capsules in well stimulation treatments of the so-called "Rock Shock" type. In such treatments the vessel or capsule is disposed in a liquid column in a well bore adjacent to the formation to be stimulated and the hydraulic pressure is increased to the point where the capsule implodes. The forces resulting from the implosion often form fractures which were not practical to produce otherwise because of casing limitations as to the pressure it can withstand or because of limitations of surface pumping equipment.

While the implosion produces a violent reaction in the well bore, a second reaction to supplement the implosion is desirable to more effectively drive treating fluid into the adjacent earth formation.

Accordingly, a principal object of this invention is to provide an improved method of treatment of an earth well.

Another object of this invention is to provide an improved well stimulation apparatus.

A further object of this invention is to provide an improved method of fracturing earth formations which are adjacent to the bore of an earth well.

In accordance with this invention an implosion capsule having disposed therein materials which, when exposed to the well bore liquid or to shock, explodes. Thus, when the capsule is imploded, the violent reaction attendant to the implosion is supplemented by the explosion at the same point along the well bore, resulting in a more effective treatment of the adjacent earth formation. The invention, as well as additional objects and advantages thereof, will best be understood when the following detailed description is read in connection with the accompanying drawing, in which:

FIG. 1 is a diagrammatical view of apparatus which may be used in practicing this invention, and

FIG. 2 is a side elevational view, partly in section, of an alternative form of implosion device which may be used in accordance with this invention.

Referring to FIG. 1, there is shown an earth well **8** having a bore wall **10** which extends from the surface **12** of the earth through earth formations **14, 16, 18**, for example. Casing **20**, capped by a suitable casing head **22**, extends through the earth formations **14, 16** and into the formation **18** near the bottom **24** of the well. The casing **20** is bonded to the wall **10** by cement **26**.

A frangible capsule, indicated generally by the numeral **28**, is shown suspended from a cable **30** below the casing **20** in the well **8**. The cable **30** passes through the casing head **22**, over a sheave **32** and to a draw works (not shown). The capsule is held in a weighted carrier (not shown) as is conventionally done where implosion capsules are used in a well treatment. Such weighted carriers are listed in the publication "Dowell Technical Report" on "Rockshock," published in March 1960 by Dowell Div., The Dow Chemical Company, Tulsa, Oklahoma. Also, the March 1960 issue of "World Oil" magazine, in an article entitled "Implosion Technique Improves Fracturing Performance," by Donald D. Setser, notes that capsules may be suspended from the tubing in the well.

The capsule **28** comprises a frangible body part **34** which is a hollow fluid tight vessel. Material **36**, such as, for example, an alkali metal e.g. sodium or potassium in a form having large surface area per unit of weight such as wire, ribbon, wool etc. is disposed within the capsule. In the event the capsule **28** is to be imploded in a non-aqueous medium, a sealed container of an agent capable of oxidizing the alkali metal such as water or hydrogen peroxide is also disposed within the capsule **28**.

At the surface, a source **44** of treating fluid, a source **46** of treating fluid with propping agent, and a gas reservoir **48** are coupled to the well through the lines **50, 52, 54**, valves **56, 58, 60, 62** and pumps **64, 66**. Treating fluids and treating fluids with propping agent and their uses are disclosed in Farris Reissue Patent No. 23,733, issued Nov. 10, 1953.

A vent valve **76** and pressure gauge **78** are coupled to the casing head **22**.

In operation, with the casing head **22** opened, the capsule **28** is lowered into the well **8** on the cable **30** to the required depth adjacent to the earth formation to be stimulated. For the sake of simplicity, mechanical coupling means for holding the capsule **28** below the cable **30** have been shown only schematically.

The well bore may be, if desired, at least partially filled with liquid as the capsule **28** is lowered into position.

When the capsule is in position, the casing head is closed and, with valves **56, 62** closed, treating fluid from the reservoir **44** is pumped by means of pump **64** into the well **8**. The vent valve **76** is opened until the well bore is filled with treating fluid and is then closed while the pumping of treating fluid is continued. In some cases sufficient hydrostatic head on the capsule to collapse it may be reached without filling the well completely.

After the vent valve is closed, it is sometimes desirable to open valve **56** and, by means of pump **66**, inject gas from the reservoir **48** into the liquid being pumped into the well, in accordance with the teaching of U.S. Patent No. 3,004,594 to F. W. Crawford, especially lines 17 through 28 of column 2, for example.

The hydraulic pressure in the well bore is increased to cause the implosion of the capsule **28**, causing a violent reaction in the well bore, especially adjacent to the point along the bore where the implosion occurs. This violent reaction is in itself often sufficient to initiate fractures in the adjacent earth formations. However, in the instant invention the implosion of the capsule in turn results in an explosion in the well bore adjacent to the formation being treated. This explosion supplements the violent reaction of the implosion and causes more extensive fracturing of the formation than occurs when an implosion alone is used in the treatment.

Examples of materials which may be disposed within the vessel **28** to cause an explosion when the vessel implodes are metal hydrides, metallo-organic compounds, alkali metal, e.g. sodium in a form which presents a large surface area per unit weight, and shock sensitive explosives.

Metal hydrides which may be used include aluminum hydride. Metallo-organic compounds which may be used include metal alkyls such as trimethyl aluminum, triethyl aluminum, triethyl magnesium, and Grignard type compounds.

The addition of a capsule which may readily be ruptured and which may be made of polytrifluorochloroethane, for example, containing hydrogen peroxide will cause the explosive reaction to occur on implosion of the vessel **28** even when water is not present in the well bore adjacent to the capsule. **28**. The capsule **37** of hydrogen peroxide, of course, ruptures when the capsule **28** is imploded.

When shock sensitive explosives are provided in the capsule **28**, however, there is no need to provide peroxide or water as the force resulting from the implosion detonates the explosive regardless of the nature of the surrounding liquid medium in which the capsule **28** is disposed.

FIG. 2 shows a sealed vessel or capsule **80** which is similar to the vessel or capsule **28** except that it has a pair of electrical leads **82**, **84** extending from the exterior to the interior thereof, the leads having an electrically energizable filament **86** connected across them.

The capsule **80** has readily oxidizable material such as magnesium, aluminum or zirconium foil, wool, or ribbon **88** disposed therein in physical contact with the filament **86**. An oxygen atmosphere exists in the capsule **80**. The capsule **80** is suspended in any suitable manner from a cable **90** which has electrical conductors connected to the leads **82**, **84** and, as further shown schematically by the leads **92**, **94** and switch **96**, to a battery **98** or other source for energizing the filament **86**. The battery may be disposed at the surface **12** of the earth, for example.

In operation the filament **86** is energized by closing the battery circuit while the capsule is in place in the well bore adjacent to the earth formation to be treated and the liquid medium in the bore is under an appropriate pressure. Energizing the filament causes the foil, wool or ribbon **88** to fire, causing thermal stresses which, with the pressure of the liquid medium in the well bore, cause the capsule to collapse suddenly. The explosion of the material **35** then is initiated as described in connection with the capsule **28** in FIG. 1.

Following the implosion and explosion, it is usually desirable to close the valve **60** and open valve **62** in the line **52** leading to the reservoir **46** of treating fluid with propping agent. Thus, propping agent is pumped down the well bore and into the newly created or extended fractures **100** (see FIG. 1).

From the above description it is apparent that the instant invention provides a novel, safe means and method of fracturing or otherwise stimulating an earth well. For example, this invention is also applicable to acidizing and other treatments where the formation must be broken down before a well stimulation fluid or mixture of materials is pumped into an adjacent earth formation of either output or input wells.

What is claimed is:

1. A method of treating an earth well which comprises:
   (*a*) loading into a hollow frangible walled vessel explodable material from the class consisting of metal hydrides, metallo-organic compounds, alkali metals, and shock sensitive explosives,
   (*b*) sealing said vessel,
   (*c*) lowering said sealed vessel to a predetermined position in said earth well,
   (*d*) covering said sealed vessel with liquid,
   (*e*) subjecting said vessel to sufficient hydraulic pressure to compress fluid in said well bore and to implode and shatter said vessel, and
   (*f*) on shattering said vessel, exposing said explodable material to ambient well bore conditions which initiate detonation of said explodable material, thereby inducing the formation of fractures in the wall of said earth well adjacent by means of the shock wave of said implosion and the detonation of said explodable material.

2. A method in accordance with claim 1, wherein said earth well is filled with fluid before subjecting said vessel to sufficient hydraulic pressure to implode and shatter said vessel.

3. A method in accordance with claim 1, wherein said vessel, when sealed, has an internal pressure which is a minor fraction of the pressure at which it implodes.

4. A method in accordance with claim 1, wherein treating agent is pumped into said earth formation following said detonation.

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