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METHOD OF TREATING WELLS

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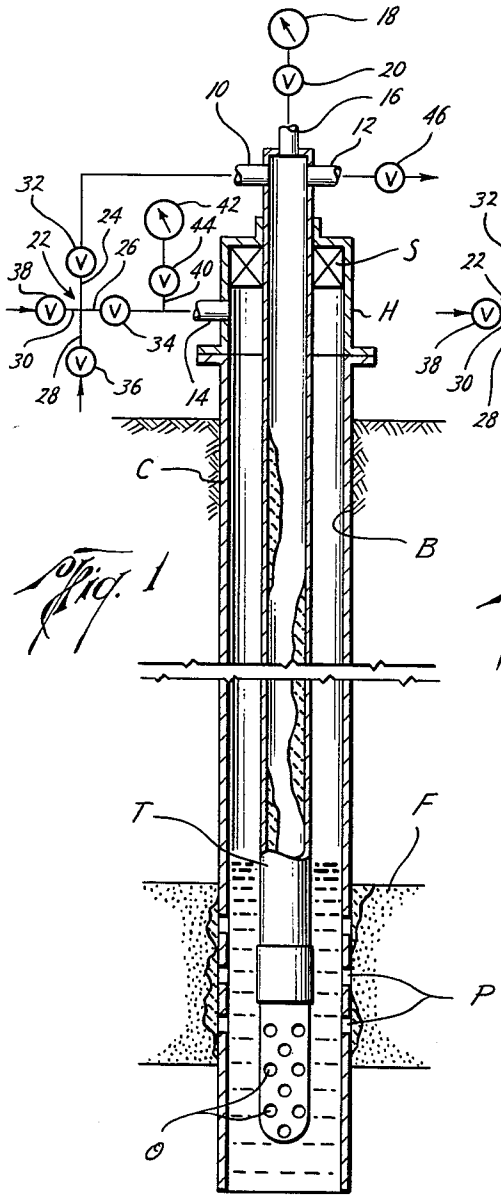

Fig. 1

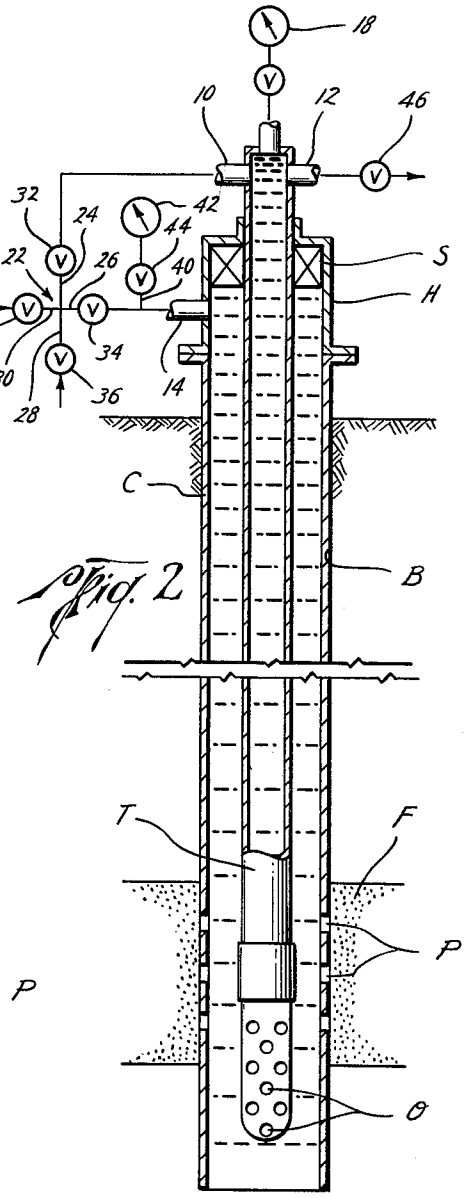

Fig. 2

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METHOD OF TREATING WELLS

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This invention relates to a method of treating wells and more particularly to a method of cleaning wells and of removing paraffin from wells and earth formations.

In the operation of oil and gas wells paraffin, or the like, often accumulates in the well bore and the equipment therein, as well as in the surrounding earth formation which is in communication with the well, to an extent to make further production unprofitable. Under such conditions it becomes necessary to carry out expensive and time consuming well cleaning operations, often involving the removal and replacement of the well tubing and the swabbing or other treatment of the well. Moreover, the removal of the accumulated paraffin and the cleaning of the well is not effective to prevent further accumulation during subsequent production, so that it becomes necessary to carry out the cleaning operations at frequent intervals to maintain the production at an efficient rate.

Various methods have been proposed heretofore for the cleaning of wells and the removal of the accumulated paraffin therefrom and from the adjacent surrounding formation by the use of mechanical scraping mechanism, solvents and other means, but such means have not proven generally satisfactory. The use of mechanical scraping devices is limited to the well bore and the equipment therein and is not effective to keep the surrounding earth formation open, while the use of solvents such as petroleum distillates, butane and propane as now employed as displacement fluids is attended by considerable danger of fire, so that the use of solvents is generally unsuitable for reasons of safety.

The present invention has for an important object the provision of a method of treating wells whereby accumulated paraffin may be effectively removed from the well bore and equipment therein as well as from the surrounding earth formation.

Another object of the invention is to provide a well treating method embodying the use of a solvent for paraffin and the like, which is introduced into the well under pressure to penetrate the surrounding earth formation to dissolve and entrain the accumulated paraffin which may then be removed with the solvent.

A further object of the invention is the provision of a well cleaning method which makes use of a relatively volatile solvent such as butane, propane and the like, which is maintained in a liquid condition in the well and in the surrounding earth formation to dissolve and entrain accumulated paraffin therein, and which is then removed from the well under the force of its own vapor pressure carrying with it the dissolved and entrained paraffin.

Another object of the invention is to provide an improved well cleaning method in which relatively volatile and inflammable solvents which are gaseous at atmospheric pressure, such as butane or propane, may be safely employed and in which the danger of fire or explosion is greatly reduced.

A further object of the invention is the provision of a method of treating wells to remove accumulated paraffin or other similar material therefrom and from the surrounding earth formation which method is easily and quickly carried out and may be frequently repeated at little expense.

The above and other important objects and advantages of the invention may best be understood from the following detailed description, constituting a specification of the same, when considered in conjunction with the annexed drawings, wherein—

FIGURE 1 is a side elevational view, partly in cross-section, of a well, and well equipment therein, illustrating the condition of the well prior to the treatment of the well by the method of the invention; and

FIGURE 2 is a view similar to that of FIGURE 1 illustrating the treatment thereof by the method of the invention.

Referring now to the drawings in greater detail, the invention is disclosed herein in connection with its use in the treatment of an oil well having a bore B which penetrates an oil bearing formation F and which is provided with the usual well casing C having perforations P through which fluid from the formation F may enter the casing. Within the casing the well is provided with the usual well tubing T having perforation O at its lower end through which fluid in the casing may enter the tubing and flow upwardly therein to remove the fluid from the well. The casing C and tubing T extend upwardly to the ground level and are provided with the customary casing head equipment, such as the packing S surrounding the tubing within the casing head H on the casing and forming a fluid tight seal between the casing and the tubing. The tubing T extends upwardly somewhat beyond the casing head H and is connected in communication with inlet and outlet pipes **10** and **12**, for a purpose to be more fully described hereinafter, and the casing head H is also connected in communication with a pipe or conduit **14** through which fluid may be introduced into or withdrawn from the casing in a manner to be hereinafter more fully described.

The well tubing may also have a pipe **16** connected in communication therewith at its upper end which leads to a pressure gauge **18** of usual type and which is under the control of a valve **20**, whereby the pressure within the tubing may be determined.

The pipe **14** leads to a T connection **22** of usual construction having an arm **24** which is connected to the pipe **10**, an arm **26** connected to pipe **14**, an arm **28** which leads to a source of air under pressure and an arm **30** which is connected in communication with a source of propane, butane or other similar material under pressure and which is suitable for the purposes of the invention. The arms **24**, **26**, **28** and **30** of the T connector member **22** are provided with valves **32**, **34**, **36** and **38**, respectively, whereby the flow of fluid through the arms may be controlled. The pipe **14** may also be provided with a branch pipe **40** to which a pressure gauge **42** is connected and this branch pipe may have a valve **44** by which the pressure to the gauge **42** may be turned on or off.

A valve **46** is provided in the pipe **12** for controlling the flow of fluid therethrough.

In the treatment of a wall by the method of this invention, the well may, for example, be in the condition illustrated in FIGURE 1, with the formation F clogged with paraffin, emulsions, or the like, in the vicinity of the well, and the flow of fluid through the tubing T obstructed by substantial deposits of paraffin or the like therein. There may also be a substantial column of liquid in the casing C.

The method of the invention is preferably carried out by first introducing air under pressure into the casing C through the arm **28** of the T **22** and the pipe **14** to force the column of liquid therein through the perforations O of the well tubing T to cause an upward flow of liquid in the tubing until the liquid has been removed and the casing and tubing are filled with air, the formation surrounding the casing in the vicinity of the openings P being clogged to such an extent as to prevent substantial penetration of the formation by the air and

liquid in the casing. During this step of the method the liquid is removed from the tubing through the pipe **12**, the valves **32**, **26** and **38** being closed and the valves **34**, **36** and **46** being open.

After the casing and tubing have been thus cleared of liquid, valves **38**, and **32** are then opened, to allow the propane, butane, or other suitable easily liquifiable gaseous solvent under pressure to flow into the casing C and tubing T. The introduction of the solvent under pressure into the casing and tubing is continued until the casing and tubing have been substantially filled with the liquified solvent as shown in FIGURE 2. Propane has been found to be an effective solvent for carrying out the method of the invention, because of its relatively great solvent and penetrating properties and also because it becomes liquid under a pressure of about 225 pounds per square inch, so that it is easily liquified in the well and caused to penetrate into the surrounding formation to dissolve the paraffin and similar material therein. It will be understood, however, that the method of the invention is not intended to the use of propane only but is capable of being carried out by the use of other volatile, easily liquified solvent materials such as butane, which is liquifiable at a pressure of about 24 pounds per square inch. The use of propane is to be preferred, however, because of the higher pressure at which it liquifies.

Under normal operating conditions the solvent will be introduced into the casing and tubing in a liquid condition under pressure. Upon first introduction of the solvent the pressure in the casing may be lower than that at which the solvent will remain liquid, so that the solvent will be transformed into a gas in the casing. As the pressure is built up in the casing, however, the solvent will become liquified therein and further introduction of the solvent will be in a liquid state. Because of the fact that the pressure at the bottom of the well, or at the level of the producing formation is usually higher than at the well head, the solvent will be in a liquid state when it enters the formation.

When the casing and tubing have thus been substantially filled with liquid solvent under pressure, the valve **38** is closed and valve **36** again opened to introduce air into the casing and tubing above the liquid solvent therein at a pressure substantially above the pressure at which the solvent is liquified. The air thus introduced into the casing and tubing through pipes **10** and **14** is maintained at a pressure substantially above that at which the solvent is liquified so that the solvent will remain in a liquid condition in which the air and solvent do not become mixed in proportions likely to cause explosion, and the solvent in a liquid state will be displaced from the casing and caused to penetrate into the formation to clear the formation of deposited paraffin.

The column of liquid in the casing and tubing is maintained under the pressure of the air above for any desired length of time depending upon the quantity of deposited paraffin present and the amount of penetration of the formation which is required. The time during which such pressurization of the solvent is required will vary substantially under varying conditions and may be from a few hours to a number of days or longer.

Since the volume of liquid required to fill the well casing may be easily determined, the amount of liquid which is introduced into the surrounding formation may be readily controlled, so that the amount of penetration of the formation may be regulated as desired.

After the solvent has been held under pressure in the well for the desired length of time the valve **36** may be closed and valve **46** opened, whereupon the air under pressure above the liquified solvent will escape through the pipes **14**, **10** and **12**, and the solvent will quickly evaporate in the well and flow out through the pipes **14**, **10** and **12**. It will be noted that as soon as the pressure on the well is released, the liquid solvent will be rapidly transformed to the gaseous state, so that the solvent with the dissolved and entrained paraffin and other material will flow automatically from the well without any necessity for the introduction of external pressure or the use of pumping apparatus. Moreover, since there is no heavy column of liquid above the solvent in the well, such as might be present in the use of oil or other displacement agent for the treatment of the well, the pressure of the solvent as it becomes transformed from the liquid to the gaseous state is effective to cause a rapid flow of the solvent together with the dissolved and entrained paraffin from the formation.

The solvent as it flows from the well may be conducted to a safe distance from the well and released or disposed of in a manner to prevent danger of explosion or fire.

When the well has thus been cleared of paraffin, oil from the formation may enter the casing to be recovered through the tubing.

It will be apparent that due to the maintenance of air under pressure at the source of air supply at a pressure substantially above the pressure at which the solvent will be liquified, and applying the air to the well above the liquified solvent therein at such elevated pressure, the air will not become mixed with the solvent, so that the method of the invention possesses the advantage that it may be employed with relative safety and with little or no danger of explosion.

In the event that there should be further accumulations of paraffin in the well or in the surrounding formation to an extent to substantially interfere with the production of oil from the well, the method of the invention may be repeated as often as necessary, to keep the well in a clean and flowing condition.

It will also be apparent that the method of the invention may be substantially varied when expedient or desirable, to suit different operating conditions which may be encountered. Thus, the solvent may be introduced into the casing and tubing simultaneously or may be introduced first into one of these and then into the other, or the air under pressure may be similarly introduced.

The invention thus provides an improved method of treating wells to remove paraffin or the like therefrom, which is simple and economical in operation and which may be employed with relative safety.

The invention is disclosed herein in connection with certain specific apparatus and steps in the operation of the method, but it will be understood that these are intended by way of example only and that various changes can be made in the equipment as well as in the steps of the method employed, without departing from the spirit of the invention or the scope of the appended claims.

Having thus clearly disclosed the invention, what is claimed as new and desired to secure by Letters Patent is:

1. A method of treating a well having a well bore extending into an oil bearing formation containing paraffin in amounts to substantially impede the flow of oil from the formation, a casing in the bore whose interior is in communication with said formation surrounding the well and a well tubing extending into the casing and which is in communication at its lower end with the interior of the casing, which comprises introducing air under pressure into the casing, to cause an upward flow of liquid in the tubing to empty the casing and tubing of liquid, introducing into the tubing and casing a paraffin solvent which is gaseous at atmospheric pressure, continuing the introduction of the solvent to increase the pressure of the solvent to cause the solvent to liquify and to substantially fill the casing and tubing with liquid solvent, introducing air under pressure into the tubing and casing above the solvent at a pressure above the pressure at which the solvent will liquify to maintain the solvent in a liquid condition and to cause the solvent to penetrate the formation and thereafter releasing the pressure on the solvent in the casing and tubing.

2. A method of treating a well having a well bore extending into an oil bearing formation containing paraf-

fin in amounts to substantially impede the flow of oil from the formation, a casing in the bore whose interior is in communication with said formation surrounding the well, and a well tubing extending into the casing and which is in communication at its lower end with the interior of the casing, which comprises introducing into the casing and tubing a solvent which is gaseous at atmospheric pressure and which in a liquid state is a solvent for paraffin, continuing the introduction of the solvent to increase the pressure of the solvent to cause the solvent to liquify and penetrate the formation and substantially fill the casing and tubing with liquid solvent, introducing air under pressure into the casing and tubing above the solvent at a pressure above the pressure at which the solvent will liquify to maintain the solvent in a liquid condition, and thereafter releasing the pressure on the solvent in the tubing, to reduce the pressure in the tubing to permit the solvent in the casing to return to the gaseous state to cause an outflow of the solvent through the tubing.

3. A method of treating an earth formation containing paraffin surrounding a well penetrating the formation and having a casing whose interior is in communication with the formation and a tubing extending into the casing and which is in communication with the interior of the casing, which comprises introducing into the tubing and casing a solvent for paraffin which is gaseous at atmospheric pressure, continuing the introduction of the solvent to increase the pressure of the solvent to cause the solvent to liquify in the tubing and casing to substantially fill the tubing and casing with liquid and to penetrate the formation, introducing air under pressure into the tubing and casing above the solvent at a pressure above the pressure at which the solvent will liquify to maintain the solvent in a liquid condition and thereafter releasing the pressure in the tubing to allow the solvent to flow out through the tubing under its own pressure.

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