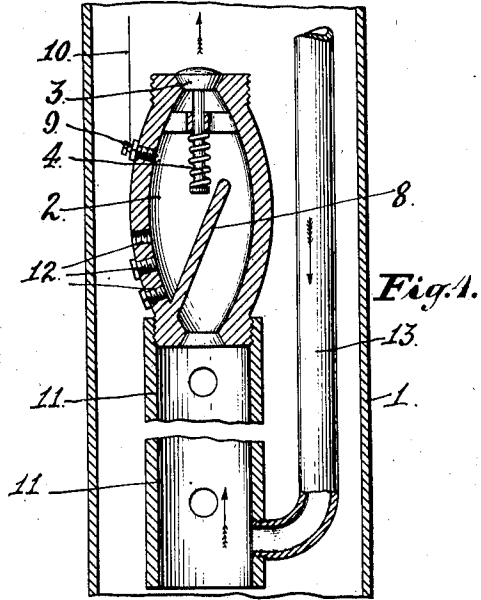
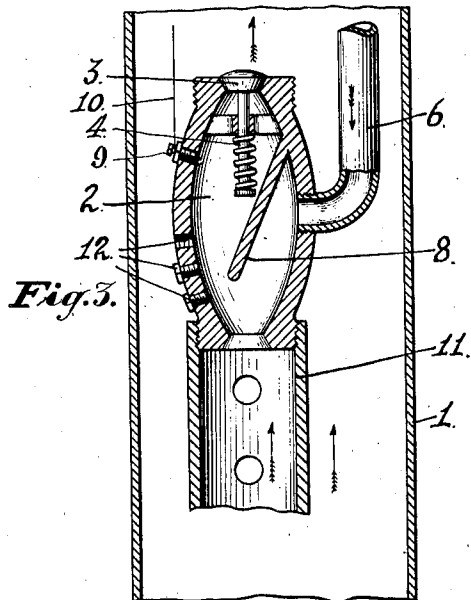
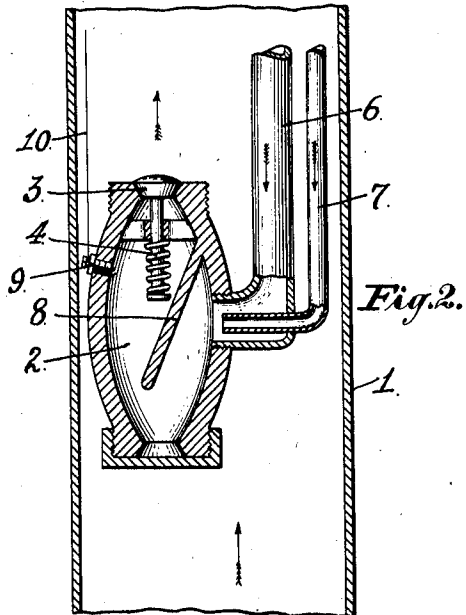
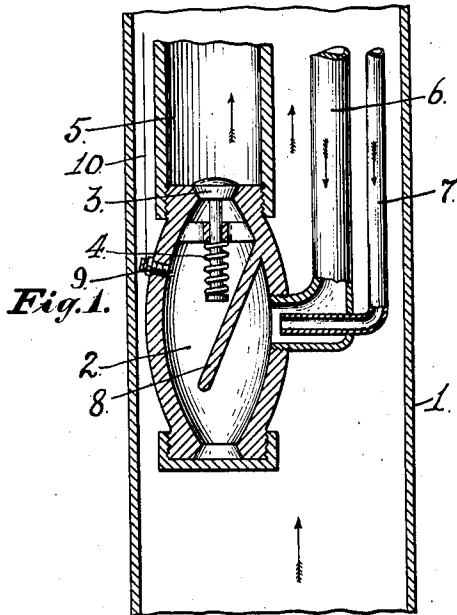


A. S. COOPER.
 REMOVING HEAVY LIQUIDS AND OTHER LIQUIDABLE MATTER FROM WELLS.
 APPLICATION FILED JULY 23, 1912.

1,057,121.

Patented Mar. 25, 1913.



WITNESSES

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UNITED STATES PATENT OFFICE.

AUGUSTUS STEIGER COOPER, OF SANTA BARBARA, CALIFORNIA.

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Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, AUGUSTUS STEIGER COOPER, a citizen of the United States, residing at Santa Barbara, in the county of Santa Barbara and State of California, have invented certain new and useful Improvements in Removing Heavy Liquids and other Liquidable Matter from Wells, of which the following is a specification.

My invention relates to the removal from wells of heavy liquids and other liquidable matter by the essential primary step of increasing their liquidity within the well, thus providing for their removal.

Before stating the nature of my invention, it will be best to briefly review the problem, and some of the efforts to solve it.

In California there are many wells that contain heavy petroleum oil of 12 to 14 degrees Baumé, or even heavier. To remove this oil previous attempts have met with little success. Ordinary pumping has proved impossible. Steam introduced results in the water of condensation sinking to the bottom of the well and closing it against the entrance of the oil. Hot water run into the well results in accentuating the bad effect of steaming. Compressed air used as an "air-lift", by its expansion congeals the oil, making the situation worse. Thin distillates emptied into the well, with the hope of dissolving the heavy oil, fails because of the difficulty of mixing. It will be seen that all these expedients have in view the necessary step of increasing the liquidity of the heavy oil, so that it can be removed, but, as I have shown, they have been unsuccessful.

My invention, in its essence, contemplates the increase of the liquidity of the heavy oil, by subjecting it within the well to the heat of explosive combustion; and it further contemplates the removal of said oil thus treated, by the "lift" assistance of the resultant gases of said explosive combustion.

In practice, the explosive mixture may be made in various ways. The following are examples:—It may be made by compressed air in conjunction with, first, the vapor made by atomizing the oil entering the well from the formation; or, second, by such air in conjunction with the gas which enters the well from said formation; or, third, by such air together with oil or gasoline piped down from the surface and atomized after entering the explosion chamber; or, fourth,

by such air together with gas piped down from the surface and mixed with the air after it enters the explosion chamber; or, fifth, by such air mixed with gas or vapor on the surface and piped down to and caused to enter the liquid below the explosion chamber, so that it will rise into and be exploded in said chamber.

The manner in which my invention may be utilized is fully illustrated in the accompanying drawings in which—

Figure 1 is a vertical sectional view, showing a portion of a string of pipe-casing, the exploding chamber and one means of supplying the explosive mixture and of applying the heat of the explosion. Fig. 2 is a similar view, showing another means of applying the heat of the explosion. Fig. 3 is a similar view, showing another means of supplying the explosive mixture. Fig. 4 is a similar view, showing still another means of supplying the explosive mixture.

In all these views similar numerals indicate similar parts.

In Fig. 1, a portion of a string of casing-pipe is indicated by 1. 2 is the explosion or combustion chamber which, it is to be understood, is submerged in the heavy oil within the casing 1. This chamber has an upwardly opening puppet valve 3 at its top, held normally closed by a spring 4. This valve controls the communication of the explosion chamber with a string of pipe 5 which is to lead to the surface. 6 is a pipe which leads compressed air from the surface into the explosion chamber. 7 is a pipe which conveys compressed gas from the surface and injects it into and mixes it with the compressed air, thereby forming the explosive mixture with which the chamber 2 is supplied. 8 is a baffle plate within the explosion chamber, to better distribute and deflect the explosive mixture. 9 is a spark-plug for a jump-spark ignition. 10 is the electric wire to the spark-plug.

The apparatus thus described is used as follows:—A certain amount of compressed air is forced down the pipe 6 and is mixed with the right proportion of compressed gas which is forced down the pipe 7, to make an explosive mixture, which mixture enters the explosion or combustion chamber 2. Suppose now that an explosion has just taken place, having been ignited by the spark-plug 9, driving the puppet valve 3

from its seat. As the gases produced by the explosion are under high pressure they instantly rush out or exhaust themselves through the opening made by the puppet valve being raised from its seat. At nearly the same time a fresh supply of air and gas under pressure enters through the pipes 6 and 7, and the explosion chamber 2 is again filled with the gaseous mixture in place of the burned gases which have just rushed out and which are ascending to the surface through the string of pipes 5. The incoming gaseous mixture is kept from mixing with the old gas that may have entirely left the combustion chamber 2, by the baffle plate 8. This cycle of operations is constantly repeated. The amount of the explosive used may be regulated by partly filling or emptying the combustion chamber 2 of pieces of iron, not here shown. Liquids ascending through the casing 1 come in contact with the heated combustion chamber 2 and the heated pipe 5. The liquids are thereby expanded and liquefied to such a degree that they can be pumped and otherwise handled the same as light oils.

Referring now to Fig. 2, it will be seen upon comparing it with Fig. 1, that the products of the explosive combustion, instead of passing up through a pipe 5, are delivered from the explosion chamber directly into the body or mass of the heavy liquid which is in the casing 1. The heated gases of explosive combustion thus come in contact with the liquid, which is thereby expanded and liquefied to such an extent that it can be pumped. Besides heating the liquid, the heated gases on account of having been discharged under a column of liquid will lift said column of liquid in a series of layers and intervening bubbles and bring the same to the surface. I am, of course, aware of the practice of pumping water by compressed air in the so called air-lift pump used in mine draining and in irrigation; but in my invention, instead of introducing the air directly into the liquid, the air is mixed with a vaporized or gaseous hydrocarbon and exploded, thus producing a large volume of heated gases from a much smaller volume of air and a hydrocarbon forced down the well. In this apparatus of Fig. 2, the amount of explosive mixture used is to be regulated, as before stated in connection with Fig. 1, by partly filling or emptying the combustion chamber with pieces of iron.

The device illustrated in Fig. 3 is operated the same as that of Fig. 2 with the exception that instead of the gas being forced down through a string of pipes, the natural gas derived from the formation and ascending with the liquid, is employed, by introducing it through a pipe 11 from below; and the amount of explosive mixture used

is regulated by opening and closing the holes in the explosion chamber indicated by 12.

The device shown in Fig. 4 is operated the same as those of Figs. 1 and 2 with the exception that the gas and air are mixed on the surface and forced down through the string of pipes 13 and discharged beneath the liquid into the pipe 11, in order to prevent firing the mixture in said string of pipes 13. The amount of explosive mixture used is regulated in this case also by opening and closing the holes 12.

When oil distillates or gasolene are employed the apparatus will have to be modified so as to evaporate the gasolene and mingle it with the air or to atomize the distillates.

In explanation of the operativeness of my invention I may state as follows:—The temperature of the burning mixture in the cylinder of a gas or oil engine at the moment of release is seldom lower than 1500 degrees F., and is frequently 2200 degrees F. The rate of expansion for all gases has been found to be about 1/490 of the volume which the gas possessed at 32 degrees for every degree of Fahrenheit thermometer. Consequently, a gas lift using the gases after combustion will have about four times a greater efficiency than if the air used to cause the explosion was used directly in an air lift. When heated gases are generated in a water well some steam will be formed which will assist in raising the water in a similar manner to an air lift, until it condenses. The effect of these heated gases on heavy petroleum oil in a well will have to be ascertained by experiment. Some practically incondensable gases will probably be formed which will assist in a similar manner as a gas or air lift in raising the oil. Heated vapors will also probably be formed. The average crude petroleum oil of 12 to 14 degrees Baumé reaches practically its maximum fluidity at 150 degrees F., losing very little in viscosity between 150 and 250 degrees Fahr. By comparison with the known table of viscosity of crude petroleum oil at 60 degrees and 185 degrees Fahr., water equaling 1, it will be found that oils ranging from 12 to 17 degrees Baumé, when heated to a temperature of 185 degrees Fahr., are more liquid than oils ranging from 19 to 23 degrees Baumé when at a temperature of 60 degrees Fahr.; consequently, heavy oils at a temperature of 185 degrees Fahr. can be handled as easily as light oils at a temperature of 60 degrees Fahr. The expansion of water with increase of temperature amounts to over four per cent. between 32 degrees and 212 degrees Fahr., that is, a given mass of water occupies a volume four per cent. greater at 212 degrees than at 32 degrees Fahr. If water is 180 degrees Fahr. hotter in the well than in the formation, 100

feet of water in the formation balances 104
feet of the ascending water in the well.
Therefore, the heating of the water by combustion will materially assist its upward
5 flow. The expansion of petroleum oil by heat is much greater than that of water.

The product of the combustion of a hydrocarbon and air is composed of carbonic acid gas and water. This gas being intimately mixed with the water raised will, to
10 some extent, go into solution with the same. Some lands when irrigated with this gaseous water will be benefited, producing larger crops. The water being warm helps the
15 growth of vegetation more than when cold.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:—

1. The process of removing heavy liquids
20 and other liquidable matter from wells, which consists in subjecting them to the heat of an explosive combustion taking place within their mass within the well.

2. The process of removing heavy liquids
25 and other liquidable matter from wells, which consists in exploding within their mass within the well, an explosive mixture,

and subjecting them to the heat of the products of said explosive combustion.

3. The process of removing heavy liquids 30
and other liquidable matter from wells, which consists in subjecting them to the heat of an explosive combustion taking place within their mass within the well, and directing the products of said explosive combustion into their mass to mingle therewith
35 and to assist in lifting said liquids.

4. The process of removing heavy liquids
and other liquidable matter from wells, which consists in exploding, within their
40 mass within the well, an explosive mixture, whereby they are subjected to the heat of the products of said explosive combustion to increase their liquidity, and directing said
45 products into their mass to mingle therewith to assist in lifting said liquids.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

AUGUSTUS STEIGER COOPER.

Witnesses:

C. C. HUNT,

C. A. THOMPSON.