June 5, 1923. 1,457,479

E. R. WOLCOTT

METHOD OF INCREASING THE YIELD OF OIL WELLS

Filed Jan. 12, 1920

Fig. 2.

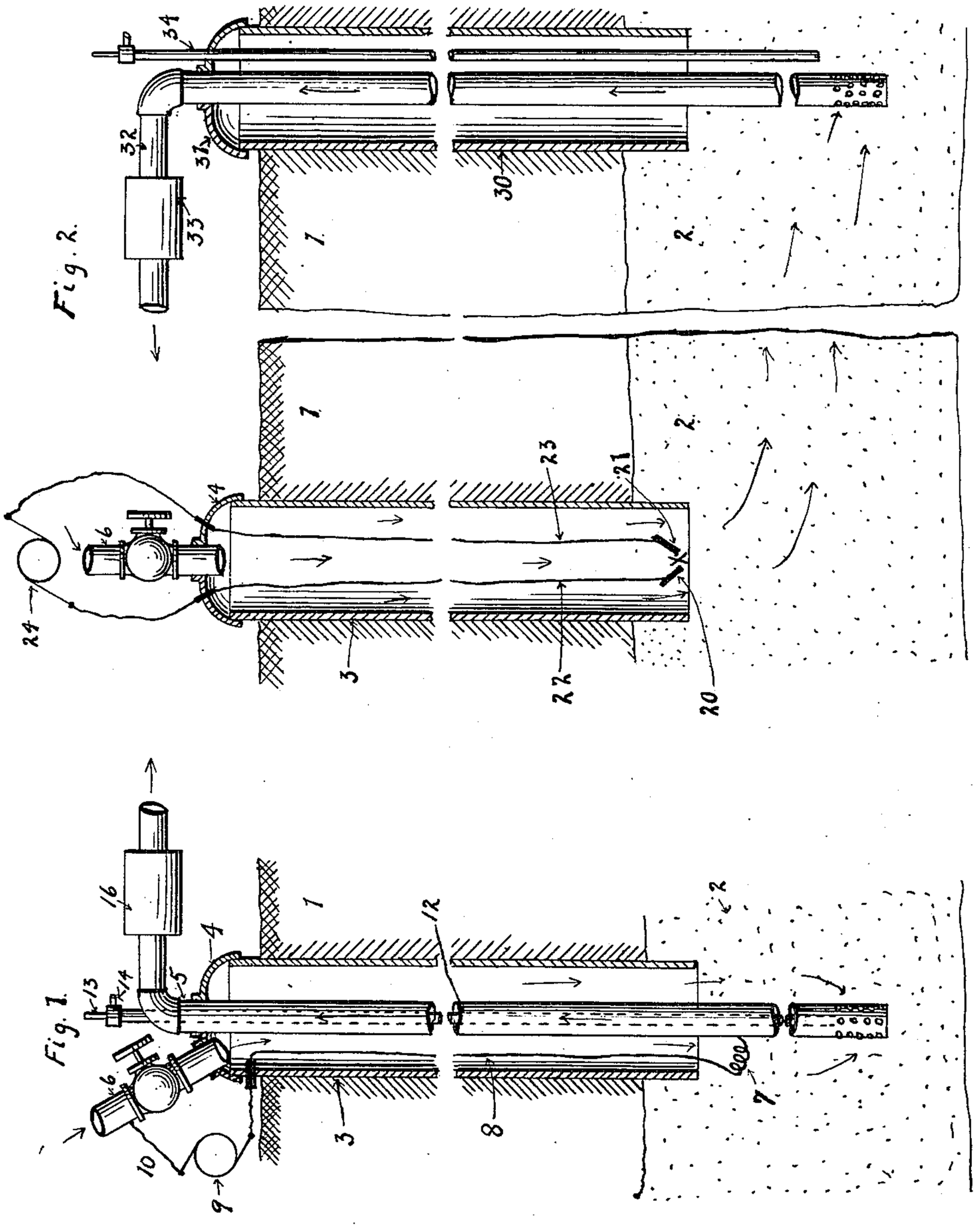
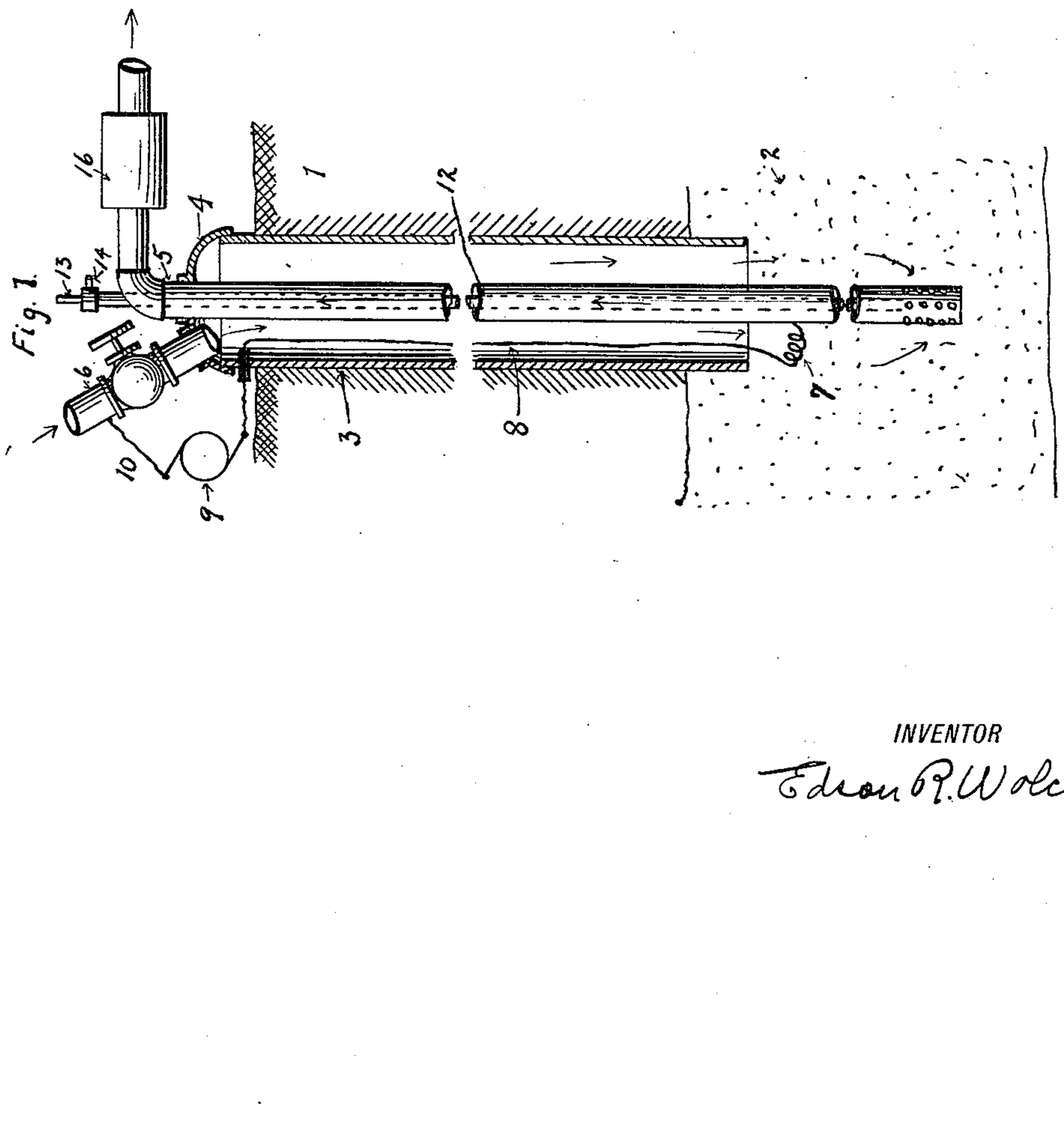


Fig. 1.



INVENTOR

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METHOD OF INCREASING THE YIELD OF OIL WELLS.

Application filed January 12, 1920. Serial No. 350,935.

To all whom it may concern:

Be it known that I, EDSON R. WOLCOTT, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented a new and useful Method of Increasing the Yield of Oil Wells, of which the following is a specification.

This invention relates to means for increasing the yield of oil wells or producing an additional amount of oil from wells which have become substantially exhausted in producing oil therefrom by the usual pumping means. In the operation of the oil pumping process on oil deposits only a very partial recovery of the oil is generally obtained and, in fact, after the wells have become exhausted from such operation the major portion of the oil still remains in the ground being retained in the body of oil sand or shale partly by reason of its lack of fluidity and partly by reason of the lack of any expelling force capable of forcing it into the cavities from which the oil is pumped.

The present invention is directed to improved means for obtaining a considerable part of the oil thus remaining in the ground after substantial exhaustion as far as regards recovery by the usual pumping means. For this purpose I apply heat to the body of oil remaining in the ground in such manner as both to increase its fluidity and to produce a force tending to expel the oil from the ground and to bring it into position wherefrom it may be pumped, the necessary heat for this purpose being obtained mainly by combustion of a portion of the oil or hydrocarbon remaining in the ground.

The accompanying drawings illustrate different forms of the apparatus for carrying out my invention, and referring thereto:

Fig. 1 is a diagrammatic vertical section of a well provided with means for increasing the flow of oil therein;

Fig. 2 is a vertical section showing two wells provided with means whereby heat generated at or adjacent to one of the wells is utilized for increasing the flow of another well.

Referring to Fig. 1, the well therein shown is assumed to be bored through overlying strata, indicated at 1, into a bed or stratum of oil sand, indicated at 2. An upper casing 3 is provided in the bore of the well, this casing being, if desired, the usual well casing such as is usually present in oil wells, but being preferably sealed off, if necessary, so as to prevent escape of gas around the outside of the well casing and enable pressure to be maintained within the well. The upper end of this well casing is closed by a cap 4 and an inner pipe or tube 5 may extend downwardly through this cap to the lower end of the well and preferably into the bed of oil sand 2.

As shown in the drawing, the outer casing 3 is utilized as a means for conducting a stream or body of air from an air supply pipe 6 down into the bed of oil sand and the inner pipe 5 is shown as utilized for conducting or drawing away gas from the bed of oil sand, but, if desired, the inner pipe may be utilized for supplying the air and the outer pipe or casing may be used for conducting away the gas in case the later operation is considered necessary.

Suitable means are preferably provided for applying heat directly to the bed of oil sand, for example, an electrical heating element, indicated at 7, of any suitable construction, may be connected at one end to ground (for example, through pipe 5) and at the other end through a wire or conductor 8 to a source of electric current (such as a dynamo-electric machine) indicated at 9, which has a ground connection 10 to complete the circuit. The heating element 7 is preferably positioned in the lower part of the well and within or directly adjacent to the bed of oil sand or oil-bearing material from which it is desired to obtain the oil.

Suitable means are also provided for pumping or otherwise obtaining from the well the oil or hydrocarbon which is made available by the operation of the apparatus described above. For this purpose any suitable pumping means may be used, for example, a pipe or well tube 12, provided at its lower end with the usual working barrel or other pumping means operated by a sucker rod 13 and discharging the oil through an outlet 14 at the upper end of the well tube 12 or, if desired, an air lift pumping means may be used. The well tube 12 may be either within the inner pipe 5 or at any place within the outer casing 3, or, if desired, the inner pipe 5, which is used for drawing away the gaseous products, may also be used as a well tube for drawing away the liquid hydrocarbon or oil.

The inner tube 5 may be connected to any

suitable means for pumping or drawing away the gaseous products, for example, a pump indicated at 16.

The operation of my process in the above described apparatus is as follows:

The parts having been positioned as above described, the electric generator 9 is set in operation to generate an electric current which is conducted through wire 8 to the electric heating element 7, the circuit being completed through the ground connections shown, the resultant generation of heat at the electric heating means causes heat to be produced in the bed of oil in the oil-bearing stratum 2 in such manner as to warm the adjacent mass of oil or hydrocarbon and thereby increases the fluidity thereof, tending to aid in the flow of the oil under the action of gravity assisted, if desired, by maintaining a condition of suction in the inner pipe 5 so as to draw gas from the interior of the well casing and the adjacent portion of the oil-bearing stratum and thereby reducing the pressure of gas at such portion below atmospheric pressure so that the oil remaining in the oil sand or oil-bearing material will tend to flow to the intake of the well pump by reason of its increased fluidity. The heating of the oil in the manner above stated also has the effect of producing an increase in the vapor pressure of any volatile constituents that may be contained in the oil with the result that a condition of pressure is produced in the body or bed of oil or petroleum tending to expel the oil or force it to the region or zone of reduced pressure adjacent to the well casing.

The expense of furnishing the heat required for heating the deposit of petroleum, as above described, is, according to my invention reduced to a minimum by utilizing a portion of the petroleum within the well generating the required heat by combustion of the oil or hydrocarbon in the well cavity. For this purpose a supply of air under suitable pressure, which may be either low pressure or high pressure, as desired, is forced through the pipe 6 and casing 3 into the well cavity at the bottom of the well and current is passed through the electrical heating element 7 to cause ignition of the body of hydrocarbon, whether liquid or gaseous, or both liquid and gaseous constitutents thereof, which for the time being are present in the cavity. It is to be understood that under these conditions the outlet pipe 5 may be partially closed by suitable valve means so as to enable a condition of pressure to be developed in the well cavity, but, in general, it is desirable to maintain sufficient outlet through pipe 5 to allow a continual supply of fresh air to the well cavity so as to enable the combustion of the hydrocarbon to be maintained for a sufficient time to heat the adjacent body of petroleum in the oil sand. After operating under pressure in this manner for a given time the pipe 5 may be opened fully and, if desired, a condition of suction may be produced therein by the pumping means, indicated at 16, so as to enable the petroleum in the oil sand, which has been rendered more fluid by reason of the heat, to flow to the well cavity by the action of gravity assisted by the gas pressure developed in the petroleum by the action of the heat. When the process is carried out in this manner under considerable pressure during the heating operation, the effect of such pressure is to tend to cause the hot gases to be forced through the more or less porous oil sand so as to carry the heat to a larger portion or zone of the oil-bearing material, and on reduction of the pressure in the manner stated during the pumping operation the condition of pressure previously developed in the oil sand is of assistance in forcing the petroleum into the well cavity.

Another important application of my invention is connected with the recovery of the residual petroleum in an exhausted oil field in which a large number of abandoned wells exist in more or less close relation, Fig. 2 showing an apparatus suitable for applying the invention in such a connection. In said Fig. 2 the respective oil-bearing strata, the well casing and the air supply pipe are indicated by the same reference letters, as above, and the electric heating circuit may be the same as above described but, in this case, the heating means or element is shown as comprising electrodes 20 and 21 connected to the heating circuit 22 and 23, including a dynamo-electric machine 24, said electrodes being insulated and supported in such manner as to provide for the production of the electric arc between the same when current of suitable potential difference is passed through the circuit 23 and 24. The well casing 3 in this case is assumed to be in sufficient proximity to one or more well casings, such as indicated at 30, to enable the thermal and pressure conditions produced adjacent to the well casing 3 to influence the flow of petroleum in such adjacent wells. Each of the adjacent wells 30 may be provided with a cap 31 and with a suction pipe 32 feeding the pump 33 whereby gases may be drawn from the well or from the cavity at the bottom of the well, and also with a pumping means 34 of any suitable construction. In carrying out my invention with the equipment shown in Fig. 2 a condition of pressure and increased temperature is produced in the lower part of the well casing 3 by any of the means above mentioned, for example, by heat produced by the electric heating element 20, 21, or by combustion of a portion of the hydrocarbon in the adjacent bed of oil sand, whether such hydrocarbon be in the form of gases, or by

a combination of electric heating operation and combustion in such manner that the bed of oil sand adjacent to the well casing 3 is heated to a sufficiently high temperature to considerably increase the fluidity thereof.

It will be understood that in this form of the invention in order to maintain combustion for any considerable length of time, it will be necessary to continuously supply air with the air inlet pipe 6. In many cases the porosity of the oil sand after a portion of the oil has been extracted therefrom by the usual methods is such that fresh air can be continually forced into the well casing 3 and the products of combustion find vent through the pores or interstices of the oil sand in the oil-bearing stratum. In carrying out my invention in this manner, I prefer to shut off or cap all but one of the surrounding or adjacent wells, that is, those in the same oil-bearing strata, only one of the wells, for example, the one indicated at 30, being provided with an outlet pipe, indicated at 32, and under these conditions the gaseous products of combustion or gases under pressure emanating from the well casing 3 in which combustion is maintained, will eventually find their way mainly to this adjacent well casing 30 and will be drawn off through the outlet pipe 32. The described method of operation therefor in producing a considerable increase of temperature and pressure in and adjacent to the well casing 3 and in the adjacent body of oil sand accompanied if desired, by a reduction of pressure by operation of the pump 33 in the well 30 and the oil sand adjacent thereto will cause a large portion of the oil remaining in the body of oil sand between the well casings 3 and 30 to flow under the action of the difference of pressure in said well casings assisted by the action of gravity in the well cavity at the bottom of the well casing 30. In this case, however, as well as in the application of my invention above described, the heating of the residual oil or petroleum and the resultant increase of fluidity is an important factor in increasing the flow, as it enables the oil to be freed from the sand particles or rock in a manner which is not possible in the thick semi-solid petroleum which usually constitutes the residual hydrocarbon in such cases.

Although pumping means have been shown for removing the petroleum from the oil wells, my invention is by no means limited to this method, since by increasing the gaseous pressure acting upon the petroleum in the oil sands, more especially by the electrical means when the air inlet valve is closed, a condition of pressure may be attained sufficient to produce a flowing well.

Whenever it is desired to preheat the air or oxygen delivered to the petroleum in the oil sands to promote more efficient combustion or to bring it to a sufficiently high temperature to ignite the petroleum, any suitable preheating means may be employed, for example, the electrical heating unit 7 may be extended to any desired length within the casing 3 so that the incoming air may pass around it and assume the desired temperature.

What I claim is:

1. The process of obtaining petroleum from oil sand, etc., which consists in supplying oxygen to the deposit of petroleum, causing combustion of a portion of the petroleum in the deposit by means of such oxygen so as to generate heat within the deposit of petroleum substantially without the supply of fuel from an external source, and thereby heating the deposit of petroleum in the oil sand in such manner as to increase the fluidity of same and generating pressure within the body of petroleum, and then subjecting the body of petroleum to pumping action.

2. A process as set forth in claim 1, wherein the body of petroleum is subjected at a certain portion thereof to suctional effect to decrease the barometric pressure in such portion to assist in the flow of petroleum to such portion of reduced pressure, and the petroleum is then pumped from such portion at reduced pressure.

3. The method for increasing the flow of petroleum from deposits thereof, which consists in increasing the fluidity of the petroleum and the pressure within the deposit, by supplying oxygen to the deposit, causing combustion of a portion of the petroleum in the deposit by means of such oxygen, and thereby generating heat within the deposit substantially without the supply of external fuel thereto.

4. The method which consists in supplying oxygen-bearing gas to a deposit of petroleum, applying sufficient heat to said deposit adjacent to the point of such gas supply to cause heating of the petroleum and ignition of a portion of the petroleum and continuing to supply oxygen-bearing gas to said deposit to cause combustion of a portion of the petroleum in said deposit in such manner as to heat the deposit of petroleum substantially without the supply of external fuel thereto and to thereby increase the fluidity of the petroleum and the pressure existing thereon and withdrawing petroleum from the deposit under the increased flow produced by such heating action.

5. The method which consists in producing heat within a petroleum deposit by the action of an electrical current, supplying oxygen-bearing gas to said deposit to effect combustion of a portion of the petroleum in said deposit which is ignited by the heating action of such current thereby generating heat within the deposit in addition to that

furnished by the electrical current, substantially without the use of fuel from an external source, and causing increase of fluidity of the petroleum and of the pressure thereon and withdrawing the petroleum from the deposit under the resulting conditions of increased fluidity and pressure.

6. The method of increasing the flow of petroleum from an oil well which consists in heating a portion of the oil-bearing material by causing combustion of a portion of the hydrocarbon in such material by means of oxygen supplied thereto and withdrawing the products of combustion under such control as to maintain a condition of pressure within the deposit.

7. The method for increasing the flow of petroleum from deposits thereof, which consists in generating hot gases under pressure by burning a portion of the hydrocarbon contained in the deposit by means of oxygen-bearing gas forced into the deposit, confining the gases so generated within the deposit to maintain the condition of pressure, and removing the petroleum from the deposit under the condition of increased fluidity and pressure due to the presence of such hot gases under pressure.

8. The method of operating oil wells consisting of closing the top of a central well, pumping air into said well, producing combustion therein, and pumping the surrounding wells.

In testimony whereof I have hereunto subscribed my name this 7th day of January, 1920.

EDSON R. WOLCOTT.