Aug. 27, 1929. D. U. POWELL 1,726,041

OIL FIELD REJUVENATING MEANS

Filed Sept. 7, 1927 4 Sheets-Sheet 1

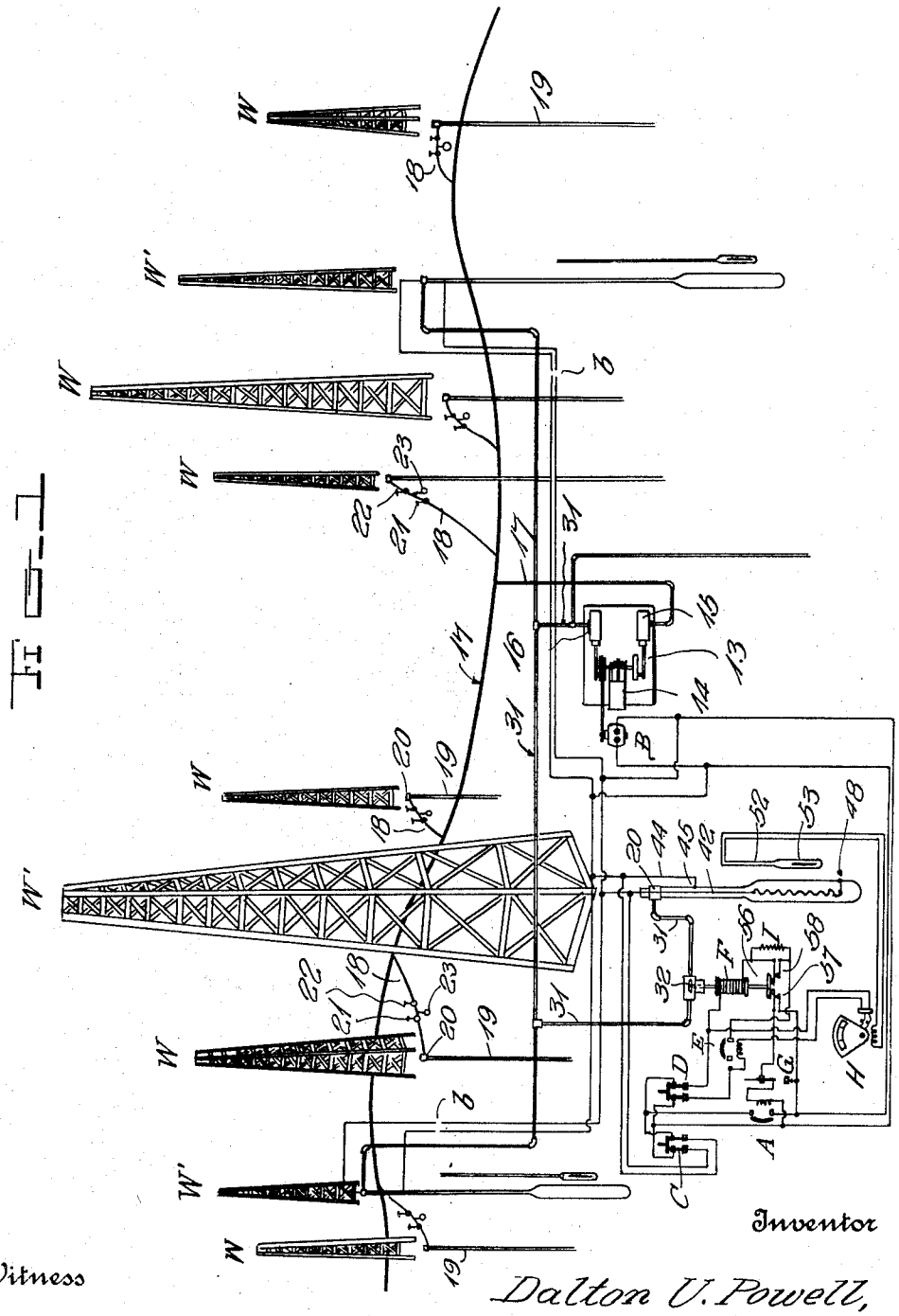

FIG. 1

Witness

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OIL FIELD REJUVENATING MEANS

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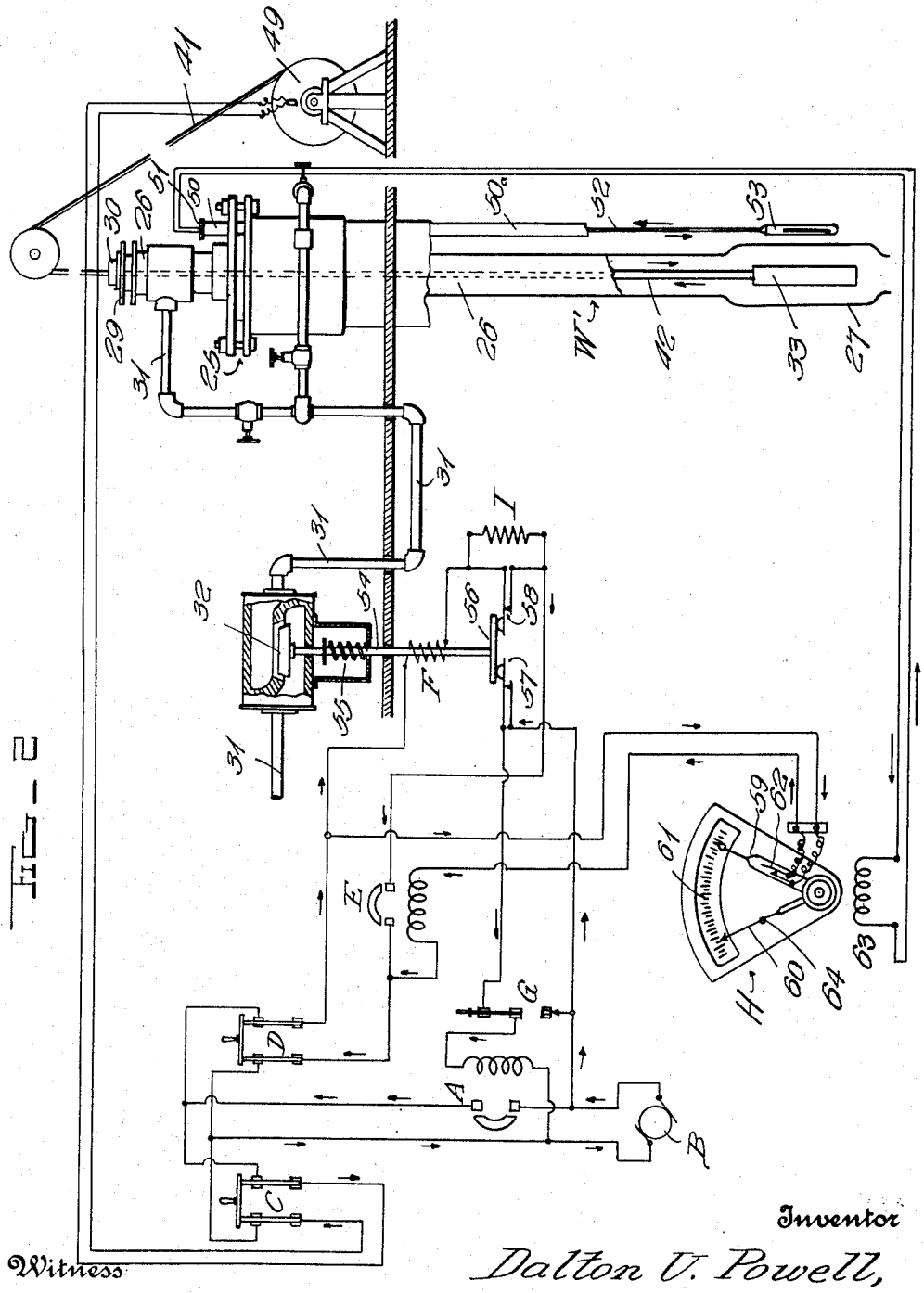

FIG - 2

Witness

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OIL FIELD REJUVENATING MEANS

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Fig. 3

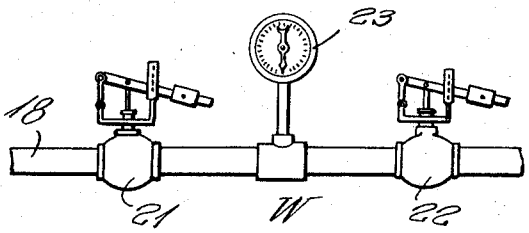


Fig. 4

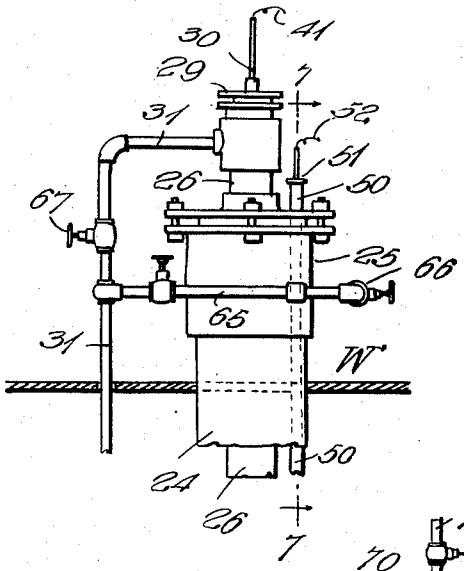


Fig. 5

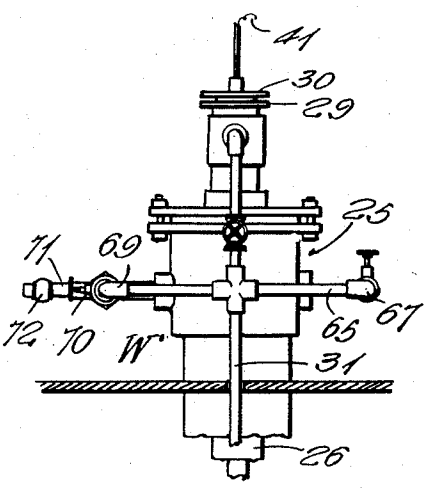


Fig. 6

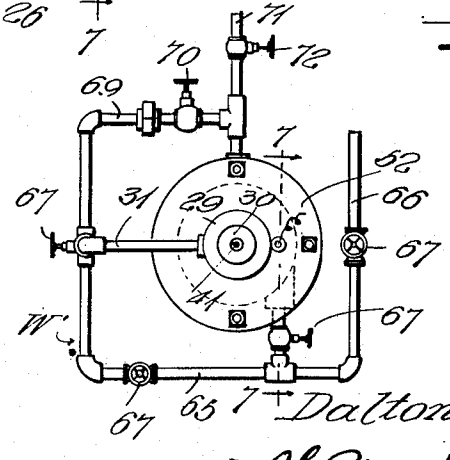
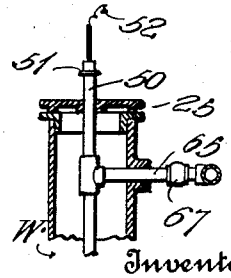


Fig. 7



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OIL FIELD REJUVENATING MEANS

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Fig. 8

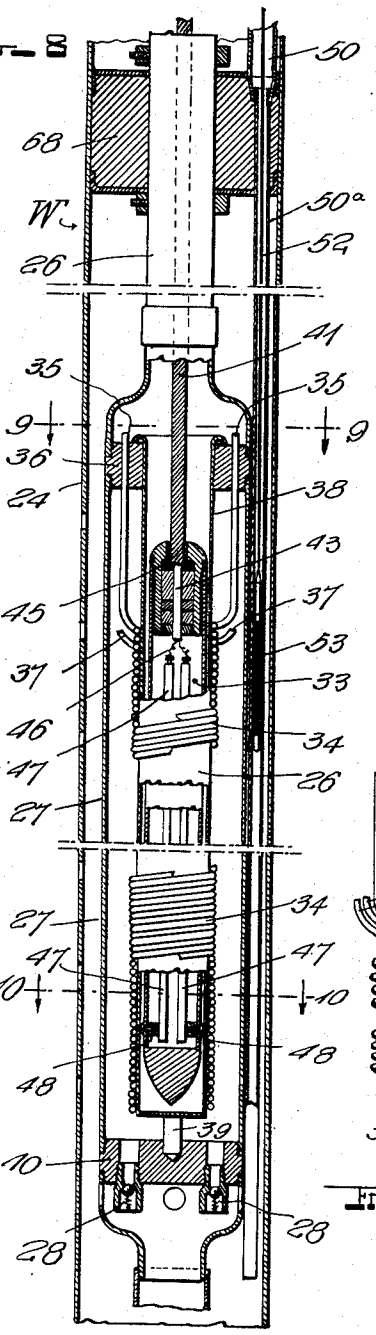


Fig. 9

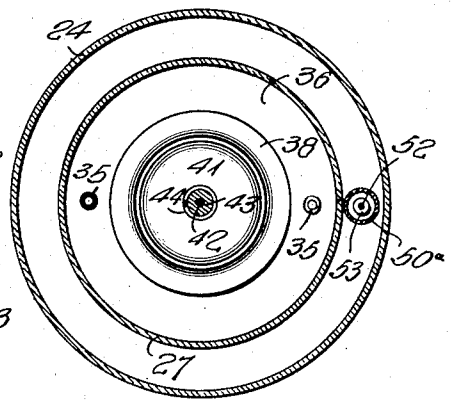


Fig. 12

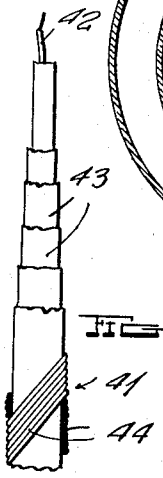


Fig. 10

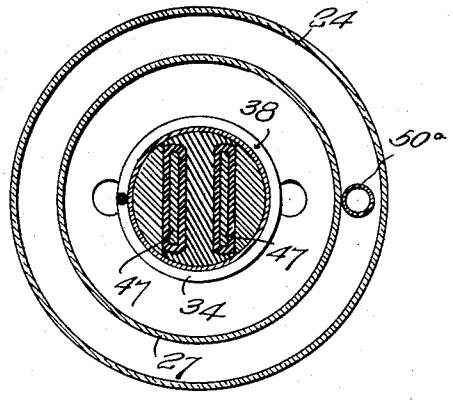
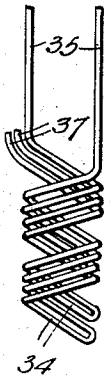


Fig. 11



Witness

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Patented Aug. 27, 1929. 1,726,041

UNITED STATES PATENT OFFICE.

DALTON U. POWELL, OF WOODSFIELD, OHIO, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO THE OIL RECOVERY CORPORATION, OF WHEELING, WEST VIRGINIA, A CORPORATION OF WEST VIRGINIA.

OIL-FIELD-REJUVENATING MEANS.

Application filed September 7, 1927. Serial No. 217,958.

The invention aims to provide a new and improved means for treating oil fields and bringing practically dead wells thereof back to a state of production. To attain this end, I connect the inlet of a compressor with a plurality of wells by a branched suction line to exhaust gas from and thus create suction in these wells. The compressor outlet is connected to compressed gas conducting means leading into another well or wells and discharging at the producing strata thereof, and an electric heater is provided in said other well or wells for highly heating the compressed gas immediately before discharge into the producing strata. This hot gas under pressure, permeates through and heats the producing strata, thereby melting paraffin and other deposits which have been clogging the pores thereof and holding gas and oil against flow to the wells. At the same time the strata is being heated, the gas and oil freed by such heating are driven by the compressed gas toward the wells in which suction is being created, the flow being assisted by such suction. Hence, the wells in which the suction is created will again receive gas and oil and may be operated in the usual way.

Some of the wells require more suction than others to restore or raise the pressure therein to the required extent for production, and it is another object of the invention to provide means whereby the suction on the different wells may be regulated so that the compressor cannot merely draw gas from the sources of least resistance, but must create suction on all of the wells with which the suction line communicates.

After pressure has been raised in any well to a required extent for operation of such well, it is essential to hold the pressure back and prevent escape thereof through the suction line, as otherwise this line would cease to be a suction line and would become a pressure line. It is a further object of my invention to make novel provision for holding said pressure back but for again permitting communication of the well with the suction line if such pressure diminishes to a predetermined extent.

The electric heater in any well into which compressed gas is being forced, would be in danger of burning out and possibly causing other trouble such as a short circuit, if the temperature in such well were permitted to rise above a predetermined amount. Moreover, better results are obtainable in different wells with different degrees of heat. It is hence another object of the invention to provide for automatically throwing the heater out of play when the desired temperature has been reached.

If compressed gas were permitted to flow into a well in which the heater had been cut off, it would chill such heater rapidly with danger of injury and would also decrease the temperature of the hot compressed gas trapped in the well. It is therefore a further object of my invention to provide for automatically stopping the flow of compressed gas to any well simultaneously with cutting off of its heater.

The automatic means for cutting off the heater and the flow of compressed gas, is controlled by a thermocouple or other thermally affected device suspended in the well on a current conducting cable. Preferably, a pipe is provided running down the well into which said device is initially lowered and from which it may be withdrawn at any time, and a further object is to provide means allowing the compressed gas from the above named conducting means to be conducted down the well through said pipe when the well-contained portion of said conducting means must be opened, for instance when the heater is to be removed for repairs or replacement. Yet another aim is to make provision for permitting discharge of oil from the well through this same pipe when desired.

With the foregoing in view, the invention resides in the novel subject matter hereinafter described and claimed, the description being supplemented by the accompanying drawings.

Fig. 1 is a diagram of an oil field equipped with the invention, parts however which are duplicates of certain parts shown in this view, being omitted at the breaks *b* in the wiring.

Fig. 2 is an enlarged diagrammatic side elevation partly in section showing more clearly the automatic control means which is employed for each electric heater and the cutoff valve for the piping which conducts compressed gas to said heater, the general arrangement of parts shown by this view,

being employed at each of the wells W′ of Fig. 1.

Fig. 3 is a side elevation of a branch of the main suction line showing the arrangement of parts at each of the wells W of Fig. 1.

Figs. 4 and 5 are side elevations looking in different directions showing certain parts which are associated with each of the wells W′.

Fig. 6 is a top plan view of the parts shown in Figs. 4 and 5.

Fig. 7 is a detail vertical section on line 7—7 of Figs. 4 and 6.

Fig. 8 is a vertical section partly in elevation of the electric heater and associated parts located in each of the wells W.

Figs. 9 and 10 are horizontal sectional views on the correspondingly numbered lines of Fig. 8.

Fig. 11 is a diagrammatic side elevation of the gas heating coils shown in Fig. 8.

Fig. 12 is a fragmentary side elevation partly broken away, showing the preferred form of cable for suspending the electric heater in the well.

The drawings above briefly described, illustrate a preferred construction and relation of parts and while such construction and relation will be herein specifically explained, it is to be understood at the outset that within the scope of the invention as claimed, variations may be made.

13 denotes a two-stage compressor driven by a gas engine 14 or otherwise, the inlet or low compression portion of said compressor being indicated at 15 while its outlet or high pressure side is denoted at 16. A suction line 17 leads to the compressor inlet and is provided with branches 18 leading from the casings 19 of all of the wells W, said casings having means such as casing heads 20, for closing their upper ends against escape of gas except through the branches 18 and the suction line 17, until the wells W have been brought back to a producing condition. Each branch 18 is provided with a suction regulator 21, with a pressure regulator 22, and preferably with a pressure gauge 23. By properly adjusting the suction regulators 21, the desired amount of suction may be created in any well W and if more suction is required in one well than in the others, or vice versa, the suction regulators may be adjusted to meet demands. When any well W has been brought back to such a condition that it contains sufficient pressure for production, it is essential that such pressure be held back and not permitted to escape into the suction line 17. Otherwise, this suction line would become a pressure line instead of a suction line and hence no suction would be created on the other wells. For the purpose of holding such pressure in check, the pressure regulators 22 are provided and it will be understood that they close under predetermined pressure but whenever the pressure dies down below the predetermined amount, they again open. Thus, when any well has been brought back to working condition, discharge of pressure therefrom into the suction line 17 is prevented, but should this pressure die down sufficiently, the pressure regulator will again open, placing it in communication with the suction line 17 so that more suction may be created in the well to restore the pressure.

While suction is being created in the wells W, compressed gas from the compressor 13 is being forced down the wells W′ and discharged into the producing strata of the latter, such compressed gas being highly heated immediately before discharge. Thus, the actions of the heat and the pressure cause the compressed gas to permeate into the producing strata, not only melting paraffin or other accumulations which have been holding back gas and oil, but serving to force such gas and oil toward the wells W so as to restore the latter to such condition as to permit working thereof. It will be understood that both the suction in the wells W and the pressure and heat in the wells W′, are instrumental in causing flow of gas and oil to said wells W.

24 denotes a casing of one of the wells W′ and in this connection, it may be explained that in view of the fact that the features of construction associated with said wells W′, are practically identical, they will only be shown and described in connection with one of these wells W′. Casing 24 is provided with an appropriate casing head 25 through which a string of tubing 26 extends into the well, the lower end of said string of tubing terminating in an enlarged vertically elongated casing 27 which is disposed at the producing strata of the well W′ and is provided with check valves 28 for the discharge of hot compressed gas into said strata. The upper end of the tubing 26 is provided with a suitable head 29 having a stuffing box 30 for a purpose to appear. Leading to the interior of this tubing, is a compressed gas conducting line, various reaches of which are denoted at 31. This compressed gas conducting line leads from the outlet of the compressor 13 to conduct compressed gas from the latter to the tubing 26. This compressed gas passes down this tubing into the upper portion of the casing 27, is highly heated and is then discharged through the check valves 28 into the producing strata of the well W′. In order that the flow of compressed gas to the well W′ may be cut off when required, a cutoff valve 32 is provided for the compressed gas conducting line 31, said valve being controlled by means hereinafter described.

Within the casing 27, is an electric heater 33 which is surrounded by gas heating coils 34. These coils are provided with inlet ends 35 above a partition 36 in the casing 27, and with outlets 37 below said partition. Compressed gas from the tubing 26 is received in the coils 34 through their inlet ends 35, this gas passes downwardly through said coils around the heater 33, must then pass upwardly through said coils, is discharged from the outlets 37 into the portion of the casing 27 below the partition 36, and is finally discharged in its highly heated state through the check valves 28.

Preferably, a metallic tube 38 is secured to and projects downwardly from the partition 36 to removably receive the heater 33, the lower end of said tube being closed and provided with a support 39 resting on the lower head 40 of the casing 27. This heater 33 is supported by a current conducting cable 41 which embodies a current conducting wire 42, suitable insulation 43 around said wire, and a steeply pitched wire wrapping 44 around the insulation. This wrapping 44 and the wire 42 serve as the two current conducting wires for the heater 33. Preferably, the wrapping 44 is grounded at 45 to the heater casing, the wire 42 is branched at 46 and connected to the heater elements 47 and the latter are grounded at 48 to the heater casing.

The cable 41 passes through the stuffing box 30 and is wound on an appropriate drum 49 so that it may be pulled out of the well whenever necessary, for the purpose of removing the entire heater 33 for repairs or replacement. Any desired provision may be made for conducting current to the wires 42—44 of the cable 41, from electrical conducting means hereinafter described.

A pipe 50—50ª passes down the well W′, extends through the casing head 25 and is of course fluid-tightly connected with the latter. The upper end of this pipe is provided with a stuffing box 51 through which a current conducting cable 52 passes. This cable supports and is operatively connected with a thermocouple or other suitable thermally affected device 53 which is disposed in the well W′, in close proximity to the casing 27. This device 53 constitutes an automatic control for the heater 33 and the cutoff valve 32. In placing said heater and cutoff valve under the control of the thermally affected device 53, I make use of electrical means whose details of construction constitute no part of my invention. The principal features of this electrical means may be briefly described as follows:

A is an automatic reclosing circuit breaker and is the first piece of equipment on the line, said line being fed by a generator B driven from the engine or the like 14. This breaker is for the purpose of interrupting the current from the generator B and thus shutting down all electric equipment attached thereto.

C is a two-pole single-throw knife switch for the purpose of interrupting the current to the electric heater 33 in the well W′. This switch is manually operated and is normally left closed.

D denotes a two-pole single-throw knife switch for the purpose of interrupting the control circuit. This switch is also manually operated and normally closed.

E is an electric relay or contactor for the purpose of closing the circuit between the generator B and the means hereinafter described for holding the cutoff valve 32 normally open. This relay normally remains closed. F denotes a solenoid type relay for normally holding the valve 32 open, and the armature of this relay may well consist of the stem 54 of the valve 32. When relay F is energized, it holds the valve 32 open against the action of a closing spring 55 but as soon as said relay is deenergized, spring 55 automatically closes said valve 32. On the lower end of the stem 54, is a disk 56, which when the valve is open, closes two sets of contact 57 and 58 which are permanently mounted below the disk in any desired way. With the valve closed, these contacts are open.

G denotes a single-pole double-throw knife switch for the purpose of giving either manual or automatic operation to the main line circuit breaker A. With the switch thrown up as shown, the holding-in coil of the breaker is energized through the contacts 57 associated with the gas valve relay F, and should the valve close, these contacts will open, thereby releasing the main line breaker A and shutting down the entire system. With the switch G thrown down, the main line breaker will remain in as long as the generator is running, thus feeding current to the system irrespective of the contacts associated with the relay F.

H represents a pyrometer for the purpose of recording and controlling the temperature in the well W′. This instrument is provided with two arms 59 and 60, both pivotally mounted and movable along a scale 61. Arm 59 carries a set of contacts 62 and may be moved by hand and set at the temperature at which it is desired to keep the well W′. The arm 60 is connected to the rotating element of a galvanometer 63 which receives its energy from the thermocouple 53 in the well W′. This thermocouple generates electricity, the amount of which depends upon the temperature, the greater the temperature, the greater the amount of electricity. The current from the thermocouple is carried to the coil of the galvanometer 63 by wires and instead of graduating the pyrometer H for the amount of electricity that the ther-

mocouple generates, it is graduated in degrees of heat that correspond to the amount of current in the coil which has been generated by the thermocouple. Thus, the arm 60 with its needle showing the temperature will ascend the scale 61 as the temperature in the well W′ increases. When arm 60 reaches the point at which the arm 59 has been manually set, a pin 64 on said arm 60, strikes one of the contacts 62, thus opening the latter. This breaks the circuit to the relay E, allowing the gas valve 32 to close under the action of the spring 55. When this valve closes, the contacts 57 break the circuit of the holding-in coil of the circuit breaker A, allowing this circuit breaker to open, thus opening the entire line and also discontinuing the supply of current to the electric heater 33. The wiring used is conventional and the flow of current is denoted by the arrows.

I denotes a non-inductive resistance which is shunted out by the closing of the contacts at the lower end of the gas valve 32. With the valve closed, this resistance is not in circuit so that when the relay shown at E closes, the operating relay F of the valve 32, is sure to operate. As this relay remains in operation for considerable time, there would be danger of burning it out and hence to protect it, the resistance is cut into the circuit by the action of the contacts on the gas valve relay. This cuts down the amount of current flowing through the relay but does not weaken it enough to open said relay.

The electrical means A, C, D, E, F, G, H and I and associated wiring, etc., are of course duplicated at each of the wells W′, and the breaks *b* in Fig. 1, denote their omission. The pyrometer H of any well W′ may be set at the maximum temperature to which it is desired to heat said well. Then, the heater 33 will operate until this maximum temperature has been attained. When said temperature is reached however, the heater 33 is automatically thrown out of play, and at the same time, the valve 32 is closed to stop discharge of compressed gas from the line 31 into the string of tubing 26. Were discharge of gas from line 31 into tubing 26 permitted after throwing the heater 33 out of play, this heater and other parts in the well W′ would be suddenly chilled, with danger of severe injury. Moreover, the comparatively cool gas going down the tubing 26, would decrease the temperature of the compressed gas trapped in the well W′ and hence would reduce its efficiency.

Whenever the upper end of the tubing 26 must be opened, for instance when withdrawing the heater 33 from the well for repairs or replacement, it is desirable to force the compressed gas down the well through the piping 50—50ª. In order that this may be done, a branch 65 is provided from the pressure line 31 to the pipe 50, as shown in Figs. 4, 5, 6 and 7. It is also desirable at times to permit discharge of oil through the piping 50—50ª. Hence, pipe 50ª extends below the oil level of the well and an oil discharge branch 66 is provided, connected with the branch 65. Appropriate valves 67 are provided where needed in order to direct pressure from the line 31 into the tubing 26 or to cut such pressure off, to direct it through the branch 65 into the piping 50—50ª or to cut pressure off from this piping, or to open this piping to communication to the discharge pipe 66, or prevent such communication as desired.

A packer 68 is provided in the well W′, the tubing 26 and the piping 50—50ª extending through said packer as shown in Fig. 8. A portion of pipe 50 preferably rests directly on the packer to assist in seating the latter. However, to further assist in such seating, I provide a branch 69 from the pipe line 31 into the portion of the casing 24 above the packer, said branch having a control valve 70. When this valve is opened, pressure from the line 31 enters the casing 24, forcing downwardly upon the packer 68 and insuring that it shall be tightly seated. To relieve the pressure from the casing 24 when desired, a blow-off 71 having a valve 72 may be provided, said blow-off being preferably connected with the branch 69 as shown in Fig. 6.

By means of a system constructed as or substantially as herein shown and described, oil wells which have been virtually dead for a long period of time, may be so rejuvenated as to bring them back to efficient production, and the exact manner in which this is accomplished, will be understood from the foregoing without requiring more explanation.

Attention is further invited to the fact that the application of heat produced in the oil bearing strata, increases the gravity of the oil anywhere from two to six degrees or points. This is of special value to oil producers, as in numerous parts of the United States, the price of oil is based on the gravity thereof.

I claim:—

1. An oil field rejuvenating means comprising a gas compressor, a suction line leading to the inlet of said compressor from the casing of a well, said casing having means whereby it may be closed against escape of gas except through said suction line, compressed gas conducting means leading from the outlet of said compressor into another well and discharging substantially into the producing strata of the latter, an electric heater in said other well for heating the delivery portion of said compressed gas con-

ducting means, and means under a single control for simultaneously breaking the circuit of said heater and stopping flow of compressed gas from said conducting means to the well.

2. An oil field rejuvenating means comprising a gas compressor, a suction line leading to the inlet of said compressor from the casing of a well, said casing having means whereby it may be closed against escape of gas except through said suction line, compressed gas conducting means leading from the outlet of said compressor into another well and discharging substantially into the producing strata of the latter, an electric heater in said other well for heating the delivery portion of said compressed gas conducting means, thermally affected means in said other well, and means controlled by said thermally affected means for automatically breaking the circuit of said heater and simultaneously stopping flow of gas from said compressed gas conducting means to the well when the temperature in said other well rises to a predetermined extent.

3. An oil well rejuvenator comprising means for conducting a gas under pressure down a well and discharging it into the latter, an electric heater in the well for heating the delivery portion of said gas conducting means, and means under a single control for simultaneously breaking the circuit of said heater and stopping flow of compressed gas from said conducting means to the well.

4. An oil well rejuvenator comprising means for conducting a gas under pressure down a well and discharging it into the latter, an electric heater in the well for heating the delivery portion of said gas conducting means, thermally affected means in the well, and means controlled by said thermally affected means for automatically breaking the circuit of said heater and simultaneously stopping flow of gas from said gas conducting means to the well when the temperature in the well rises to a predetermined extent.

5. In an oil well rejuvenator, a string of tubing passing through a casing head for conducting gas down a well, a compressed gas line leading to said tubing, a pipe passing through the casing head and extending down the well, an electric heater for heating the gas discharged from said tubing, a thermally affected device in the well, and means controlled by said device and embodying a suspending cable in said pipe, for stopping flow of gas to said tubing from said compressed gas line and simultaneously breaking the circuit of said heater when the temperature in the well rises to a predetermined degree.

In testimony whereof I have hereunto affixed my signature.

DALTON U. POWELL.