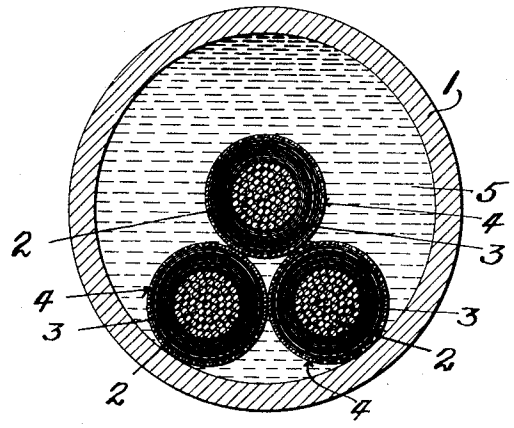
June 16, 1942. C. E. BENNETT 2,286,594

ELECTRIC CABLE SYSTEM

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Fig. 1



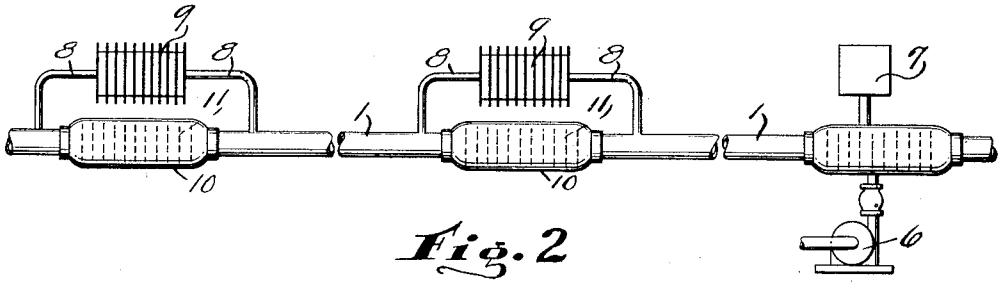


Fig. 2

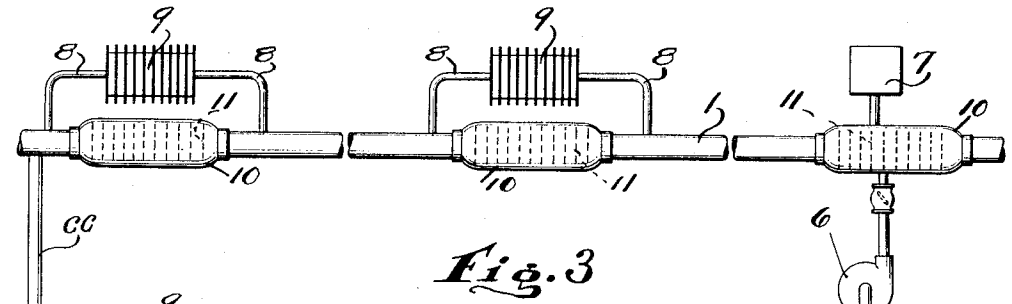
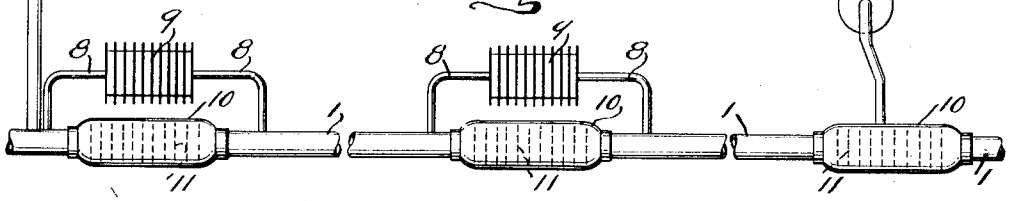


Fig. 3



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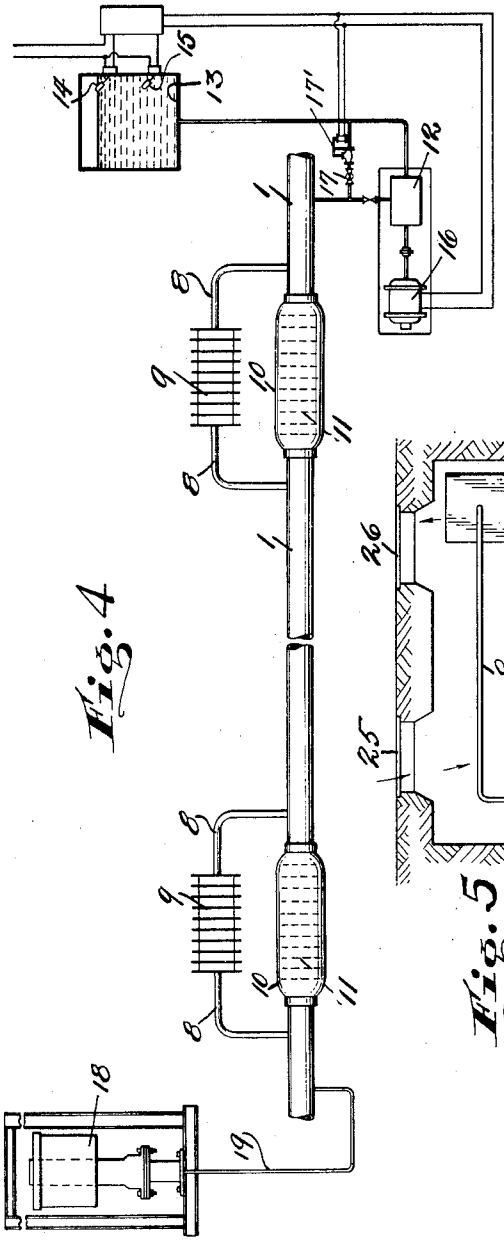


Fig. 4

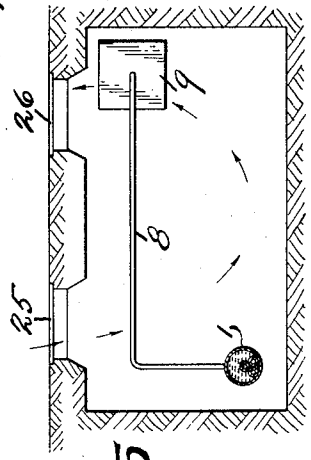


Fig. 5

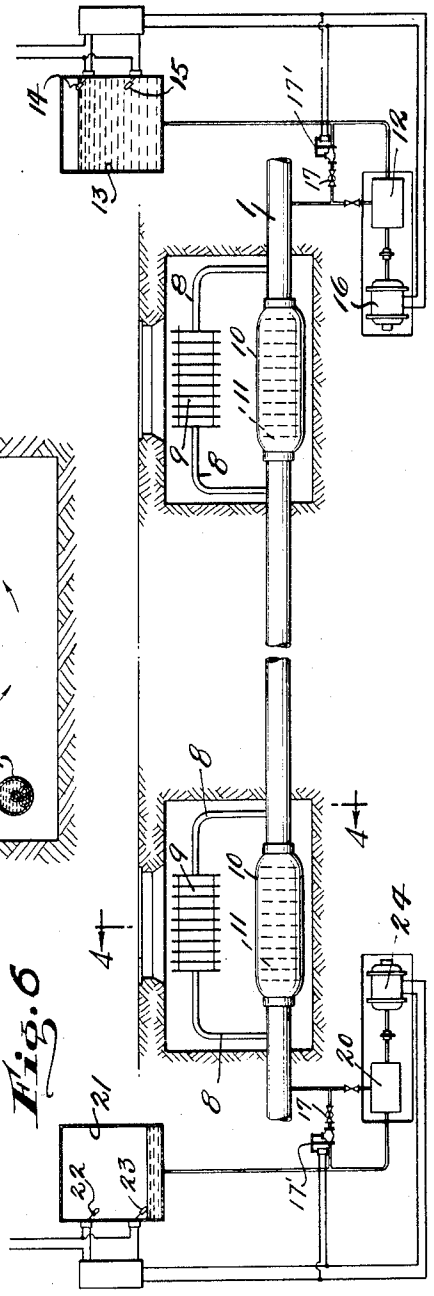


Fig. 6

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Patented June 16, 1942 2,286,594

UNITED STATES PATENT OFFICE

2,286,594

ELECTRIC CABLE SYSTEM

Charles E. Bennett, Hawthorne, N. J., assignor to The Okonite-Callender Cable Company, Incorporated, Paterson, N. J., a corporation of New Jersey

Application April 16, 1934, Serial No. 720,734

3 Claims. (Cl. 174—15)

This invention is directed to an improvement in underground high tension electric cables of the type disclosed in U. S. Patent No. 2,015,063, dated September 24, 1935.

In my patent above referred to I have disclosed a cable system comprising an oil filled pipe line buried in the earth containing insulated but unsheathed cable conductors, the pipe line being of sufficiently large internal diameter to permit of drawing in of the unsheathed insulated conductors and for free relative movement of the conductors within the pipe line to permit the conductors to "snake." The pipe line is filled with oil maintained under sufficiently high pressure to increase its dielectric strength, pressures for example from five atmospheres upward.

While such a construction provides improved heat dissipating characteristics as compared with prior cable systems the invention constituting the subject matter of the present application provides additional cooling means and minimizes the chances of "hot spot" formation due to equalities of heat dissipation in the earth.

As set out in my prior application above referred to this additional cooling means may take the form of radiators disposed at suitable intervals along the pipe line and through which the oil or other liquid insulating material employed in the system is circulated.

On the other hand, this method of cooling may be varied if desired by pumping the oil or other insulating material longitudinally of the system from one end of the system to a reservoir at the other end or at some intermediate point. When the reservoir fills up the pump is stopped and the oil or other insulating liquid then returned to the pumping station by gravity or by some suitable pressure means, thereby producing a surge effect from pump to tank and back again. As the oil passes through the radiators it is cooled. Obviously the surges can be of long or short intervals according to the cooling required.

In the drawings accompanying this application:

Fig. 1 is a cross section of a cable system to which my invention is to be applied;

Fig. 2 is a longitudinal view of the system with my invention embodied therein;

Fig. 3 is a view of a system embodying my invention in which two lines run parallel to each other;

Fig. 4 is a more or less diagrammatic view showing another embodiment of my invention in which I provide for producing a surging movement of the insulating fluid;

Fig. 5 shows the installation as it appears at a manhole; and

Fig. 6 is a view similar to Fig. 4 showing another method for obtaining a surging movement of the insulating liquid.

Referring first of all to Figs. 1 and 2, 1 designates a pipe line, of steel, for instance, and adapted to be buried in the earth. 2 designates the conductors of a three phase electric cable system, each conductor being provided with its own insulation designated 3 in the form of oil impregnated paper, for example, and with shielding tape 4.

The pipe line 1, as will be obvious from an inspection of the drawings, is of sufficiently large internal diameter to permit of easy drawing in of the unsheathed insulated conductors and to permit of free relative movement or "snaking" of the cable conductors within the pipe line. The space in the pipe line 1 unoccupied by the cable is filled with oil 5, means being provided to maintain this oil under sufficiently high pressure to increase its dielectric strength. This pressure may be varied within a wide range but is preferably not substantially less than five atmospheres.

The shielding tape 4 which is applied about the insulation of each conductor may take the form, for example, of a perforated metal tape or other permeable material so that the oil 5 in which the unsheathed insulated conductors are submerged at all times will always have free access to the cable insulation. The pressure supply means may take the form of a pump or pumps 6 connected to a suitable source of oil supply, a regulator or regulators 7 being employed for maintaining the pressure constant.

Such a system provides greatly improved cooling characteristics as compared with existing structures owing to the relatively large body of oil 5 surrounding the cable conductors.

The pipe line 1 at intervals is provided with by-pass pipes 8, one end of each of these pipes communicating with the interior of the pipe line 1, the other end with a radiator 9.

It will be appreciated that these cooling devices may be inserted at desired intervals along the pipe line 1. For purposes of convenience of illustration I have shown the by-pass pipes 8 connected into the pipe line 1 at each side of the joints 10.

The joints 10 may be provided, if desired, with baffles 11 so that movement of the oil 5 through

the joints is retarded and movement through the radiators 9 increased.

It will be understood, of course, that in the operation of my cable system, with the cooling means 8 and 9 omitted, there is a certain amount of movement of the oil longitudinally of the pipe line by reason of the heating and cooling of the oil due to cable operation. While the pipe and large volume of oil employed provide for dissipating a great deal of the heat generated the radiators 9 which are directly connected to the pipe line provide for a very material increase in the heat dissipating characteristics of the system.

As explained above the radiators 9 may be disposed at such intervals as may be found desirable.

In the embodiment of my invention as illustrated in Fig. 3 I show a construction in which two pipe lines 1, each containing cables, as will be appreciated, extend parallel to each other, each being provided at intervals with by-pass pipes 8 one end of each of these pipes communicating with the interior of the pipe line, the other end with cooling devices or radiators 9. As explained in connection with Figs. 1 and 2 these cooling devices may be inserted at desired intervals along the pipe lines. For convenience I have shown the by-pass pipes 8 connected into the pipe lines at each side of the joints 10. The joints 10 may be provided, if desired, with baffles 11 as explained in connection with Figs. 1 and 2. The two lines 1 are connected to each other by cross connection CC. A pump 6 having its intake connected to one of the pipe lines and its discharge to the other pipe line provides a means for circulating the oil through the system, the oil in its passage passing through the cooling devices 9 where the heat in the oil is dissipated.

It will be appreciated, therefor, that so far as this embodiment of my invention is concerned I have provided in a system employing two cable pipe lines extending parallel to each other means for effecting a circulation of the oil through both lines, the oil as just explained above in its circulation passing through the cooling devices or radiators 9 for heat dissipation.

In the embodiment of my invention illustrated in Fig. 4 I provide means for causing a surge of the oil in the pipe line 1 first in one direction and then the other, the oil in its movement passing through the cooling means.

Referring to this embodiment of my invention, it will be seen that at one end of the pipe line I provide a pump 12 driven by an electric motor 16 for building up the desired pressure on the oil.

The intake side of the pump 12 is connected to a reservoir 13 conveniently equipped with suitable switches 14 and 15 so that the oil level in the reservoir 13 will automatically control the operation of the pump motor 16. A relief valve 17 in series with a solenoid valve 17' may be provided across the intake and discharge of the pump. At the other end of the line, or at least remote from the reservoir 13, I provide an accumulator shown diagrammatically at 18. This accumulator is connected to the pipe line 1 by pipe 19.

Intermediate the reservoir 13 and accumulator 18 the pipe line is equipped with radiators 9 and, if desired, baffles 11, as before.

With this system in operation it will be appreciated that oil will be pumped from reservoir 13, through pipe line 1 and radiators 9 to the accumulator 18. As oil is supplied to the accumulator 18 the latter expands so that when the oil in the reservoir 13 has reached a predetermined level, depending upon the setting of the float switch 15, the pump 12 automatically shuts off, the solenoid valve 17' opens and the accumulator 18 will then force the oil back through the radiators 9 through the relief valve 17 and solenoid valve 17' to the reservoir 13 until the level of the oil in the latter operates the float switch 14 to again close the circuit to the pump motor 16 to begin another cycle.

The solenoid valve 17' closes when the motor 16 is started and opens when the motor is stopped, thus allowing the oil to flow from the pump 12 to the accumulator 18 and back again to the reservoir 13 on the return. The relief valve 17 is set at a lower pressure than that given by the accumulator 18 in order that there will be an excess of pressure to force the oil back to the reservoir 13.

As above mentioned, when the motor 16 starts the solenoid valve 17' closes and the oil pushed into the accumulator, so that at this stage the accumulator governs the pressure. When the motor stops the solenoid valve opens and allows the relief valve 17 to function, so that the relief valve governs the minimum pressure and the rate of flow from the accumulator.

While the valve 17' has been referred to as a solenoid valve, it is to be understood other types of automatic valve may be employed if desired.

The capacity of the accumulator 18 is sufficient to take care of all the oil contained in a length of pipe line 1 between adjacent joints 10 so that I am assured of maximum cooling in that the entire mass of oil in the pipe line is necessarily moved through the radiators 9. If desired the accumulator 18 may be substituted by a gas reservoir capable of building up a pressure as oil is forced thereinto by the motor driven oil pump.

From the foregoing it will be apparent that I have provided for surging back and forth of all the oil in the pipe line, the oil in its movements passing through the radiators 9.

It is to be understood that I have shown a pump at one end of the system and an accumulator at the other end merely for purposes of illustration and description inasmuch as obviously pumps and accumulators may be distributed along the system intermediate the ends if found desirable.

The apparatus shown in Figs. 5 and 6 is similar to the construction shown in Fig. 3 except that in this case instead of employing a reservoir and pump at one point in the system cooperating with an accumulator at another point I employ reservoirs and pumps only.

Referring to this embodiment of the invention it will be seen that the pump shown at 12 pumps oil out of a reservoir 13 into the pipe line 1. Remote from the reservoir 13 is a pump 20 and reservoir 21.

In operation oil is drawn from the reservoir 13 and pumped through the pipe line 1 as described in connection with Fig. 4, the oil thus displaced flowing into the reservoir 21. This reservoir is equipped with float switches 22 and 23 similar to the switches 14 and 15, and controlling the circuit of the motor 24 for the pump 20, this motor starting up when the oil level in the reservoir 21 closes the switch 22 at which time owing to the lowering of the oil level in the reservoir 13 the pump 12 has stopped. If desired the circuits for the pumps and valves may be interlocked in order to overcome any difficulty in obtaining a balance in the two systems.

It will be evident that this construction provides for surging of the oil in the pipe line

through the cooling system provided by the radiators **9**.

The cable system described is buried in the earth and in Figs. 5 and 6 I have shown the construction of the system at the manholes where the joints occur. As will be seen from Fig. 5, for instance, the radiator **9** in the manhole is so disposed relatively to the openings **25** and **26** in the manhole covers that there will be a natural draft of air passing over the radiator to promote its efficiency as a cooling medium.

It will be appreciated from all of the foregoing that my invention provides for a very substantial increase in the cooling characteristics of the system thereby materially increasing its current carrying capacity. This is a very valuable contribution to the art of transmitting high tension electrical energy not only under normal operating conditions but when it is necessary to transmit large blocks of power over a circuit for a short interval of time.

What I claim is:

1. A multi-conductor high tension electric cable system comprising in combination a plurality of unsheathed cable conductors of the solid stranded type, each conductor being independently insulated with permeable impregnated insulating material, a pipe line loosely enclosing said conductors, oil filling the space in the pipe line unoccupied by the said conductors and their insulation, said conductors and their insulation being submerged in said oil and in direct contact therewith, means for maintaining said oil under high pressure, a pressure regulator, said pressure regulator and the relatively large internal diameter of the pipe line permitting the oil in the pipe line to move bodily longitudinally thereof on volumetric changes in the oil due to temperature variations, the total cross section of the oil at any instant moving in one direction, and cooling means through which the oil in its described movement is caused to flow.

2. A multi-conductor high tension electric cable system comprising in combination a plurality of unsheathed cable conductors of the solid stranded type, each conductor being independently insulated with permeable impregnated insulating material, a pipe line loosely enclosing said conductors, oil filling the space in the pipe line unoccupied by the said conductors and their insulation, said conductors and their insulation being submerged in said oil and in direct contact therewith, means for maintaining said oil under high pressure, a pressure regulator, said pressure regulator and the relatively large internal diameter of the pipe line permitting the oil in the pipe line to move bodily longitudinally thereof on volumetric changes in the oil due to temperature variations, the total cross section of the oil at any instant moving in one direction, and radiators at intervals along the pipe line through which the oil in its described movement is caused to flow.

3. A multi-conductor high tension electric cable system comprising in combination a plurality of unsheathed cable conductors of the solid stranded type, each conductor being independently insulated with permeable impregnated insulating material, a pipe line loosely enclosing said conductors, oil filling the space in the pipe line unoccupied by the said conductors and their insulation, said conductors and their insulation being submerged in said oil and in direct contact therewith, means for maintaining said oil under high pressure, a pressure regulator, said pressure regulator and the relatively large internal diameter of the pipe line permitting the oil in the pipe line to move bodily longitudinally thereof on volumetric changes in the oil due to temperature variations, the total cross section of the oil at any instant moving in one direction, joints in the pipe line, and radiators connected to the pipe line at each side of said joints through which the oil in its described movement is caused to flow.

CHARLES E. BENNETT.

CERTIFICATE OF CORRECTION.

Patent No. 2,286,594. June 16, 1942.

CHARLES E. BENNETT.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, first column, line 23, for the word "equalities" read --inequalities--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 21st day of July, A. D. 1942.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)

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