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ELECTRIC POWER CABLE

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Fig. 1.

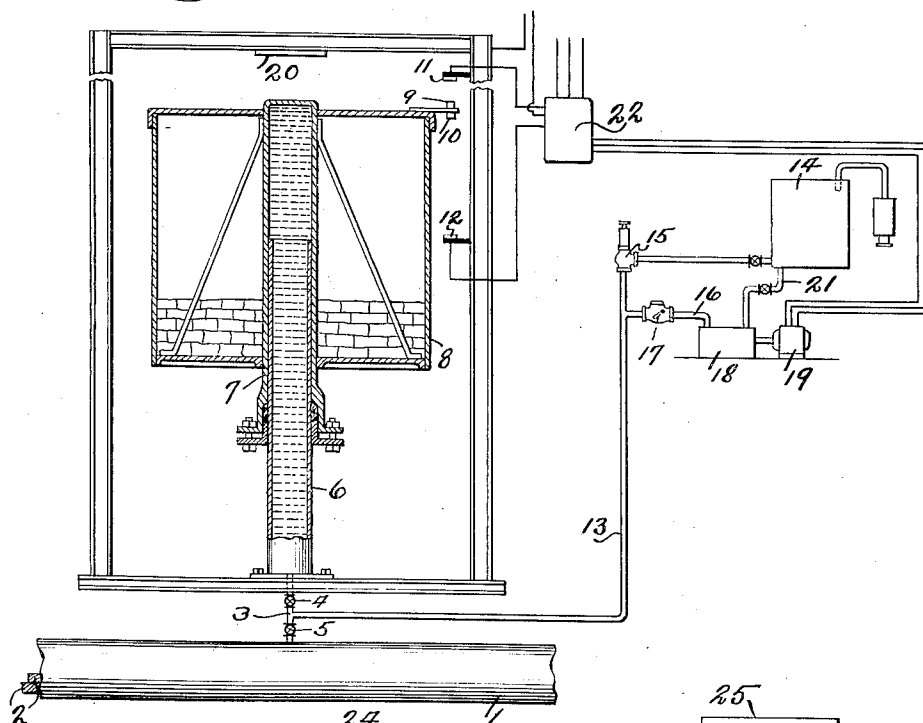
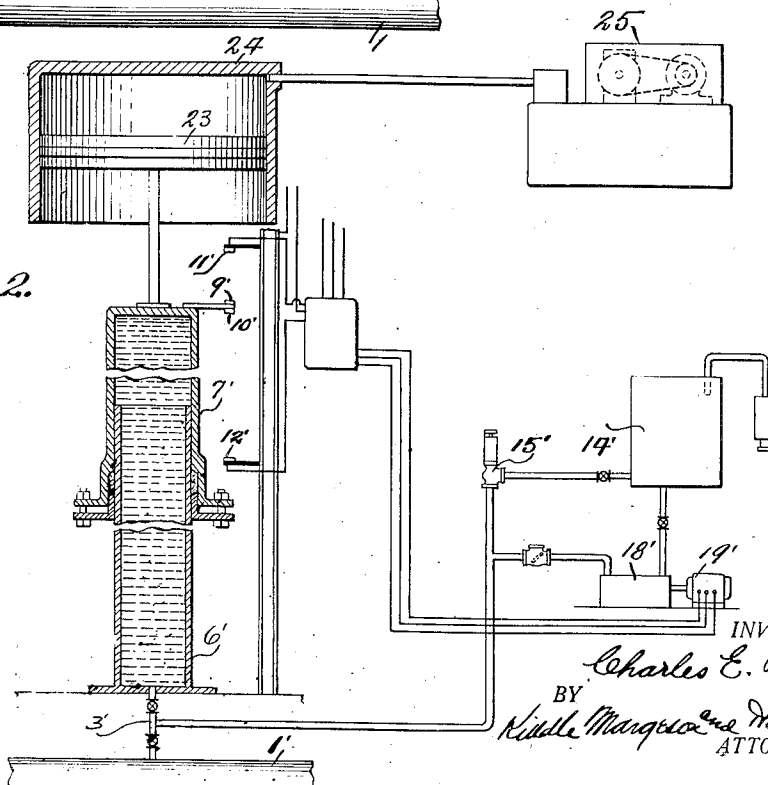


Fig. 2.



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ELECTRIC POWER CABLE

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9 Claims. (Cl. 247—3)

This invention is directed to an improved cable system for the transmission of high tension electrical energy. While the invention is adapted for use with oil filled cables in general it is particularly well adapted for a cable system in which the insulated unsheathed cable conductors are laid in a pipe line filled with oil under sufficiently high pressure to increase its dielectric strength, say for example a pressure of 200 pounds. The insulated but unsheathed conductors are submerged in this oil and the pipe line is of such a size as compared with the space occupied by the insulated unsheathed cable conductors that movement of the oil on the heating and cooling cycles involved in the operation of the cable is unrestricted, the pipe line also permitting of independent movement of the insulated conductors relatively to each other. The present invention provides for maintaining any desired steady pressure on the oil in the system at all times, which is of great advantage in insuring reliable and satisfactory operation. In the embodiment shown and described herein I have provided for maintaining a pressure sufficiently high to increase the dielectric strength of the oil and of the oil impregnated insulation of the cable conductors, and to reduce the volume of any gas that may be present or actually to cause this gas to be dissolved in the oil, and to force the oil back into the insulation during the cooling cycle without the possibility of formation of voids, whereby the formation of ionizable spaces under operating conditions is avoided.

In the accompanying drawing:

Fig. 1 is a part sectional and part elevational view of one embodiment of my invention; and

Fig. 2 is a similar view of a modification.

Referring to the drawing in detail and first of all to Fig. 1, my improved cable system as therein illustrated comprises a pipe line designated 1 in which are laid the unsheathed cable conductors 2, these conductors being insulated with impregnated insulation such as oil impregnated paper tape. The space in the pipe line 1 unoccupied by the conductors and their insulation is filled with oil maintained under a high pressure of the order indicated and in which the conductors and their insulation are submerged.

3 designates a stand pipe the lower end of which communicates with the interior of the pipe line 1, this pipe conveniently being provided with shut-off valves 4 and 5.

The upper end of the stand pipe 3 communicates with a fixed hollow piston 6 cooperating with a movable cylinder 7, which, as illustrated

in the drawing, is provided with a weight cage 8. The proportions of piston, cylinder and weight cage are predetermined, depending upon the pressure it is desired to carry on the oil in the system. The movable cylinder 7 carries contacts 9 and 10 adapted to cooperate with upper and lower limit contacts 11 and 12, respectively.

The purpose of this contact mechanism will be brought out shortly.

Connected to the standpipe 3, intermediate the shut-off valves 4 and 5 is an oil line 13 leading to a storage tank 14. This line 13 is equipped with pressure relief valve 15 set to lift at pressures slightly in excess of that intended to be carried on the oil in the pipe line. A line 16 equipped with a check valve 17 is connected at one end to the line 13 intermediate the relief valve 15 and pipe 3, the other end being connected to the discharge side of a pump 18, adapted to be driven by an electric motor 19.

Under normal conditions of operation of the cable system the heating and cooling of the oil in the system with consequent expansion and contraction of the oil causes the cylinder 7 to rise and fall, as will be understood, to maintain a predetermined steady pressure upon the oil in the pipe line, to prevent the formation of ionizable spaces in the system. Under abnormal operating conditions, however, where heating of the oil in the pipe line is excessive then the cylinder 7 will rise until the top thereof strikes the limit stop 20, further expansion of the oil building up pressure sufficient to cause the relief valve 15 to lift to permit the oil to be forced through pipe 13 to the storage tank 14. On the cooling cycle the cylinder 7 will simply move downwardly as the oil contracts to maintain the predetermined steady pressure on the oil and if the contraction of the oil in the pipe line is sufficient the cylinder will move down until the contact 10 engages the lower contact 12 to close a circuit to the motor 19 to start up the pump 18. The intake side of this pump is connected by pipe 21 to the storage tank 14 and hence oil will be taken from the tank and pumped back into the pipe line causing the cylinder 7 to move upwardly again until contact 9 engages contact 11 to open the motor circuit through a suitable switch shown diagrammatically at 22.

It will be appreciated from all of the foregoing that my invention provides an oil filled cable system in which the oil is maintained under a steady predetermined high pressure by means of an apparatus capable of maintaining this steady high pressure on the oil during the heating and

cooling cycles of cable operation, the invention also providing, if desired, that this pressure be high enough to increase the dielectric strength of the oil and the impregnated insulation of the cable, and to force the oil into the insulation of the cable conductors on the cooling cycles whereby the formation of ionizable spaces in the system is prevented.

In the embodiment of my invention as illustrated in Fig. 2, the pipe line is designated 1', and a standpipe 3' is in communication with a hollow piston 6' carrying movable cylinder 7'. In this embodiment of the invention the weight cage 8 has been dispensed with, the cylinder 7' carrying a piston 23 disposed in an air cylinder 24, air being supplied to this cylinder by a compressor 25.

On ordinary heating and cooling of the oil in the pipe line 1', the cylinder 7' will rise and fall, the air piston 23, as will be understood, maintaining a positive steady high pressure at all times on the pipe line 1'. Under abnormal conditions, however, for example where the heating of the oil in the pipe line 1' is excessive then there will be an abnormal rise of the cylinder 7' and the pressure of the oil in the pipe line 1' will be sufficient to lift the relief valve 15' to permit excess oil to be returned to the storage tank 14', as explained in connection with Fig. 1. On the following cooling cycle the cylinder 7' will move downwardly and if it drops sufficiently to cause the contact 10' to strike the contact 12' then a circuit will be closed to the electric motor 19' which drives the pump 18' and this pump will take oil from the storage tank 14' and pump it back into the pipe line 1'. As explained in connection with Fig. 1 this will cause the cylinder 7' to move upwardly again, to bring the contact 9' into engagement with fixed contact 11' to open the circuit of the motor 18'.

This system possesses the same advantages as explained in connection with Fig. 1.

I wish to note that while I have shown an air cylinder 24 in this embodiment of my invention cooperating with the piston 23, this cylinder may be connected to a water main thereby eliminating the necessity for the air compressor 25. Rise of the cylinder 7' would simply, as will be appreciated, force the water out of the cylinder 24 back into the mains. If by reason of some local ordinance this is not permissible then a check valve could be provided in the line leading to the mains and a relief valve on the cylinder 24, the waste water discharging to the sewers.

What I claim is:—

1. A closed electric power cable system comprising in combination an oil filled cable a piston and cylinder, one of which is weighted, in communication with the oil in the cable for maintaining high pressure on the oil in the cable, said piston and cylinder varying in capacity with temperature changes in the oil of the cable system thereby to maintain a constant pressure on the oil of the system throughout said variations in temperature and resultant volumetric changes in the oil of the system.

2. A closed electric power cable system comprising in combination on oil filled cable in which the oil varies in volume by reason of temperature changes due to cable operation, two members arranged in telescopic relation, one of said members being hollow and communicating with the interior of the cable, the other being weighted for maintaining pressure on the oil in the cable, one of said members moving relatively to the

other to vary their capacity on volumetric changes in the oil of the cable due to temperature variations so that the oil is maintained under a predetermined constant pressure throughout said variations in temperature and resultant volumetric changes in the oil of the system.

3. A closed electric cable system for the transmission of high tension electrical energy and comprising in combination a pipe line loosely enclosing the insulated unsheathed cable conductors, the pipe line being filled with oil varying in volume due to cable operation in which the cable conductors are submerged, two members arranged in telescopic relation, one of said members communicating with said pipe line for maintaining said oil under pressure, one of said members being moved relatively to the other to vary the capacity of said members on volumetric changes in the oil in the pipe line thereby to maintain a predetermined constant high pressure on the oil throughout said variations in temperature and resultant volumetric changes in the oil of the system.

4. A closed electric cable system for the transmission of high tension electrical energy and comprising in combination a pipe line filled with oil varying in volume due to cable operation, insulated unsheathed cable conductors loosely disposed in said pipe line and submerged in the oil therein the oil being freely movable in the pipe line, two members arranged in telescopic relation for maintaining the said oil under pressure, one of said members being stationary and communicating with the interior of the pipe line the other being movable under volumetric changes in the oil in the pipe due to temperature variations by reason of cable operation to prevent variations in the pressure of the oil in the pipe line.

5. A closed electric cable system for the transmission of high tension electrical energy and comprising in combination a pipe line filled with oil varying in volume due to cable operation, a plurality of insulated unsheathed cable conductors loosely disposed in said pipe line and submerged in said oil, the oil being freely movable in the pipe line, and means comprising a hollow piston communicating with the pipe line and a cooperating weighted cylinder for maintaining the oil in the pipe line at a high constant pressure throughout changes in the volume of the oil due to the heating and cooling cycles of cable operation, whereby the formation of ionizable spaces within the system under operating conditions is avoided.

6. A closed electric cable system for the transmission of high tension electrical energy and comprising in combination a pipe line filled with oil varying in volume due to cable operation, a plurality of insulated unsheathed cable conductors loosely disposed in said pipe line and submerged in said oil, the oil being freely movable in the pipe line, and means comprising a hollow piston and a cooperating hollow cylinder, one being stationary and communicating with said pipe line, the other being movable and weighted, for maintaining the oil in the pipe line under high pressure, said piston and cylinder varying in capacity during volumetric changes in the oil in the pipe line by reason of cable operation, thereby to maintain the oil pressure constant and prevent the formation of ionizable spaces within the system under operating conditions.

7. A closed electric cable system for the transmission of high tension electrical energy and comprising in combination a pipe line filled with

oil, a plurality of insulated unsheathed cable conductors loosely laid in said pipe line and submerged in the oil therein, the oil being freely movable in said pipe line, and means for maintaining the oil in the pipe line under high pressure and to maintain this pressure under changes in volume of the oil due to operating conditions substantially to prevent the formation of ionizable spaces within the system, said means comprising a fixed hollow piston communicating with the pipe line, and a weighted cylinder for said piston, said cylinder raising and lowering to vary its capacity automatically in accordance with the thermal conditions and resultant changes in oil volume existing in the system.

8. A closed electric cable system for the transmission of high tension electrical energy and comprising in combination a pipe line filled with oil, a plurality of insulated unsheathed cable conductors loosely laid in said pipe line and submerged in the oil therein, the oil being freely movable in said pipe line, and means for maintaining the oil in the pipe line under high pressure and to maintain this pressure constant, said means comprising a hollow piston in communication with the pipe line, a weighted cylinder receiving said piston and cooperating therewith, said cylinder rising and falling automatically to vary the capacity of the piston and cylinder with volumetric changes in the oil in the pipe line, a

storage tank, an oil line from said pipe line to the storage tank, a pressure relief valve in said oil line adapted to open upon expansion of the oil in the pipe line in excess of that capable of being compensated for by the piston and cylinder to permit excess oil to flow from the pipe line to the storage tank, and a pump controlled by said cylinder for returning the said excess oil to the pipe line upon cooling of the oil in the pipe line.

9. A closed electric cable system for the transmission of high tension electrical energy and comprising in combination a pipe line filled with oil, the oil being freely movable in the pipe line, a plurality of insulated unsheathed cable conductors loosely laid in said pipe line and submerged in the oil therein, and means for maintaining the oil in the pipe line at high pressure, said means comprising a hollow piston in communication with the pipe line, a cylinder receiving said piston and cooperating therewith, an air cylinder, and a piston therein connected to said cylinder, said hollow cylinder rising and falling with volumetric changes in the oil in the pipe line to vary the capacity of the piston and cylinder accordingly, said air actuated piston maintaining a steady pressure on said first-mentioned cylinder whereby a high steady pressure is maintained on the oil in the pipe line under cable operating conditions.

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