

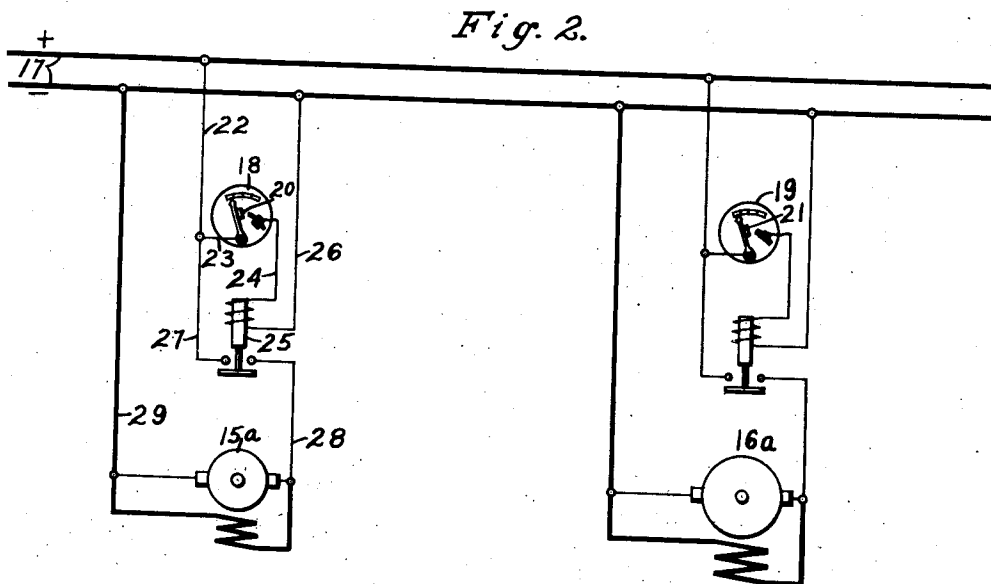
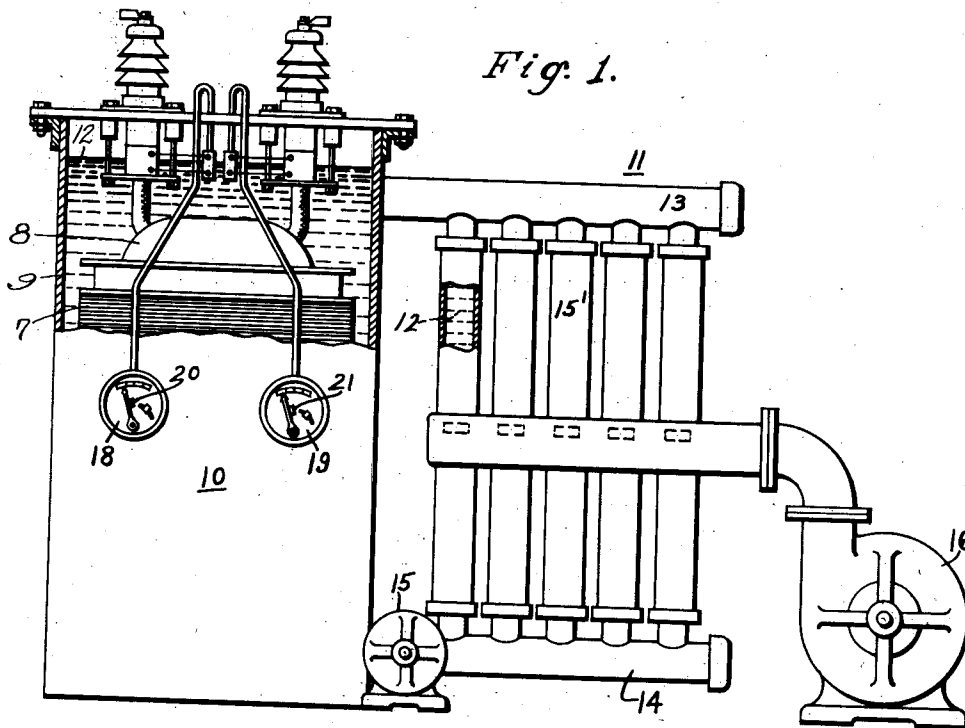
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TRANSFORMER COOLING SYSTEM

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TRANSFORMER COOLING SYSTEM

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My invention relates, generally, to cooling systems and particularly to the automatic control of forced-cooling systems for transformers or other apparatus.

5 The application of radiators to oil-filled transformers as a means of dissipating heat generated in the transformer is known, and, for the purpose of carrying out my invention, any suitable radiator construction may be utilized. It often occurs, in the operation of transformers, that the natural circulation of oil by gravity through the radiators is inadequate to dissipate enough heat to keep the transformer sufficiently cool for safe operation.

15 The heat dissipated by the coils of a transformer is a function of the load on the transformer. In an oil-cooled transformer of the radiator type this heat is conveyed, first to the oil and then through the walls of the transformer tank and radiator to the surrounding medium, which is usually air or water.

25 It has been found desirable to operate the coils of a transformer below a certain predetermined temperature. The greater the capacity of the cooling system for dissipating the heat generated by the transformer coils, the greater is the safe load that may be carried on a given transformer. The usual operating conditions of transformers are such that there is a considerable load variation during each twenty-four hours, so that the maximum capacity of the cooling system is only necessary during a part of this operating cycle.

35 My invention contemplates the use of circulating oil by gravity caused by changes in its temperature, and the additional use of a plurality of means that are responsive to the load on the transformer for increasing the capacity of the cooling system. In its broader aspect, my invention contemplates the use of a plurality of means for increasing the rate of circulation of the cooling oil or other fluid, or for bringing a cooling medium, such as air or water, into heat exchanging relation with the oil, or both. The use of my system permits the operation of a given transformer, or other electrical apparatus, at much higher

loads than would otherwise be permissible for that size of equipment, and, at the same time, avoids the necessity of continuously operating the entire cooling system, or of depending upon the uncertainties of manual control of the cooling system.

My invention provides for pumping oil through the radiators of the transformer at a higher rate than it would naturally flow by the action of gravity and, therefore, increases the heat-dissipating capacity of the radiators. Further cooling means are provided for forcing a cooling medium, such as a draft of air, about the outer surface of the radiators, thereby increasing the amount of heat transferred from the radiators to the surrounding air.

The object of my invention, generally stated, is to provide means for automatically varying the rate of cooling of electrical apparatus.

A more specific object of my invention is to provide a plurality of forced-cooling systems, each of which is controlled by thermally-responsive devices.

A further object of my invention is to provide a plurality of forced-cooling systems, each of which is actuated at different predetermined temperatures of the body to be cooled.

Another object of my invention is to provide a cooling system for a transformer in which the natural circulation of a heat-dissipating fluid is supplemented by a plurality of separate cooling systems during predetermined temperature ranges.

Other objects of my invention will become apparent to those skilled in the art when the following description is considered in conjunction with the accompanying drawings, in which:

Figure 1 is a view, in side elevation, of a transformer of conventional design which is equipped with cooling systems operated in accordance with my invention and having a section of its tank cut away to show the arrangement of elements; and

Fig. 2 is a diagrammatic view of a system for automatically controlling the operation of the pumping motors of a cooling system

organized in accordance with my invention.

A transformer 10 comprising the usual core 7, coils 8 and tank 9 is provided with cooling radiators 11, in accordance with common practice, one of which is shown in the drawings, and oil 12, contained in the transformer 10, may circulate from the tank 9 through the radiator 11 to be cooled by the air surrounding it.

The radiator 11 comprises an upper header 13 and a lower header 14 which are connected together by a plurality of radiator tubes 15. The upper header 13 is connected to the tank 9 of the transformer 10 near the top, and the lower header 14 is connected to the transformer tank near the bottom. When the oil is heated by the coils 8 of the transformer 10, it will ascend to the top of the transformer tank, since its specific gravity is decreased by expansion and will flow into the upper header 13. As the oil 12 in the upper header 13 of the radiator 11 is cooled, its specific gravity increases and it moves downwardly and continues to cool so that a continuous circulation of oil occurs in and about the transformer core and coils and through the radiator 11.

Such a natural circulation of oil is inadequate to keep the transformer winding below its desired maximum temperature when the load on the transformer, and the heat dissipated by the transformer coils exceeds a certain value. Consequently, I have provided an oil pump 15 which is connected between the lower header 14 of the radiator 11 and the tank of the transformer 10.

The pump 15 is provided for circulating the oil 12 through the radiator 11 at a higher rate than it would travel under its natural circulation by gravity. By this means, a greater rate of circulation of the oil is effected, which results in conveying a greater amount of heat from the transformer windings to the surrounding air.

An air blower 16 has been provided to assist in cooling the oil by producing a continuous draft of air about the tubes 15 of the radiator 11, thus increasing the rate of heat transfer from the oil to the air. It will be understood that the pump 16 may provide a circulation of fluids other than air about the radiator 11.

If the transformer 10 becomes so loaded that the operation of the oil pump 15 is insufficient to keep the temperature of the oil 12 below a predetermined value, a motor driving the air blower will be automatically started.

The oil pump 15 and the air pump 16 are operated by electric motors 15A and 16A, respectively, when they are connected to a supply line 17.

The transformer 10 is provided with a plurality of thermometers or other thermally-responsive devices 18 and 19 which indicate

the temperature of the oil within the transformer at or near its upper surface, or that is in approximately the hottest portion of the oil contained by the transformer 10.

The thermometers 18 and 19 are provided, respectively, with contact members 20 and 21 so that an electrical circuit is completed by these contact members when the pointers of the thermometers have reached a certain position, and will then indicate that an abnormal temperature condition exists within the transformer 10.

The contact members 20 of the thermometer 18, however, are disposed to become engaged at a temperature lower than that at which the contact members 21 of the thermometer 19 become engaged, so that as the temperature of the transformer continues to rise after the contact members 20 of the thermometer 18 have completed a circuit, the thermometer 19 will indicate such rise of temperature and, accordingly, the contact members 21 will engage each other when the indicator of the thermometer 19 has traveled to the predetermined position at which such contact members may complete another circuit.

The operations of the motors 15A and 16A are controlled, respectively, by the thermometers 18 and 19 so that, when the pointers of the respective thermometers have traveled to the right to predetermined points, the corresponding motors are set into operation.

When the temperature of the oil within the tank of the transformer 10 has reached the high temperature value at which the contact members 20 of the thermometers 18 engage, a circuit is completed which may be traced from the positively energized conductor of the supply line 17, through conductor 22, conductor 23, the contact members 20, conductor 24, the energizing coil of a magnetically operated relay 25 and conductor 26, to the negatively energized conductor of the supply line 17.

The operating coil of the relay 25 is thereby energized and its armature actuated to complete a circuit to the oil-pumping motor 15A. This circuit may be traced from the conductor 22, by conductor 27, the contact members of the relay 25, conductor 28, the motor 15A and by conductor 29, to the negatively energized conductor of the supply line 17. The oil-pumping motor 15A is thereby started when the thermometer 18 has been moved to the predetermined position at which its contact members 20 are engaged.

As hereinbefore set forth, the thermometer 19 has its contact members so disposed that they do not become engaged unless the thermometer 19 indicates a higher temperature than that at which the contact members 20 of the thermometer 18 were engaged. Thus, should the temperature of the transformer continue to rise after the oil pump 15 has

been set into operation, the thermometer 19 will indicate such a rise in temperature and its pointer will come to a position at which its contact members will become engaged and energize a control circuit to start the operation of the air-pump motor 16A, exactly as described above, for the starting of the oil-pumping motor 15A.

Although I have provided a system for forced-cooling a transformer under abnormal conditions of operation, it will be apparent to those skilled in the art that my forced-cooling apparatus will not be normally operated since the thermometers 18 and 19 will be so designed that an unusual temperature condition must occur within the transformer before either of the motors 15A and 16A will be connected to its source of supply or set into operation.

Thus, it is not necessary to continuously supply energy for the cooling of a transformer so equipped, but energy will be automatically supplied to the pumping devices upon the occurrence of an unusual or abnormal temperature condition within the transformer. It is further pointed out that, if the transformer 10 be operated under overload to produce the excessive heating within the oil 12 and set the pumps 15 and 16 in operation, the load on the transformer 10 may be decreased so that such heating is no longer existent, whereupon the thermometers 18 and 19 will recede and automatically interrupt the supply of energy to the pumping motors 15A and 16A, respectively, so that the transformer may continue to operate, being cooled by the natural circulation of oil by gravity without the attention of an operator or attendant.

Since it will be possible to modify the embodiment set forth and adapt it to various applications without departing from the spirit and scope of the invention, it is desired that the foregoing description shall be construed as merely illustrative and not in a limiting sense.

I claim as my invention:

1. In a cooling system, a plurality of motors and separate cooling means actuated thereby, means responsive to the temperature of the body to be cooled for controlling the motors, said means being disposed to set one motor into operation upon the attainment of a predetermined temperature and to set other motors into operation upon the attainment of a higher temperature.

2. In a heat-generating apparatus, a cooling system comprising circulating fluids, a plurality of pumps for forcing the circulation of the fluids during the existence of certain temperature conditions, means for operating one of said pumps when the apparatus reaches a predetermined temperature and means for operating other of said pumps upon a continued rise in temperature to a

higher predetermined value during the operation of said first pump.

3. In an electrical apparatus susceptible to heating, in combination, a plurality of separate forced-fluid cooling means, thermally-responsive means for controlling the cooling means when the apparatus reaches a predetermined temperature, said means being operated as the temperature of the apparatus continues to rise above said predetermined temperature.

4. In a transformer-cooling system comprising a transformer tank, a radiator, and a heat-conducting liquid normally circulated by gravity through the transformer tank and the radiator, a pump for forcing the circulation of the liquid, a pump for forcing the circulation of cooling gases about the radiator, and means for operating the pumps when the liquid in the transformer tank reaches a predetermined temperature.

5. In a transformer-cooling system comprising a transformer tank, a radiator, and a heat transferring liquid normally circulated by gravity through the transformer tank and the radiator, a pump for forcing the circulation of the liquid under certain temperature conditions, a pump for forcing the circulation of gases about the radiator, automatic means for controlling the operation of one pump when the liquid in the transformer reaches a predetermined temperature, and means for automatically controlling the operation of the other pump when the liquid in the transformer reaches a second predetermined temperature.

6. In an oil-filled transformer tank having radiators through which oil normally circulates by gravity, a pump for increasing the rate or circulation of oil through a radiator under certain conditions, means for impelling a draft of air about the radiator, and automatic means for operating the pump and said means when the oil in the transformer tank attains a predetermined temperature.

7. In a cooling system for electrical apparatus, a fluid-circulating system for conveying heat from the apparatus to a cooling medium, means for forcing the flow of fluid through said circulating system, means for forcing a cooling medium into heat-exchanging relation with said fluid-circulating system, and means for automatically controlling the operation of said last two named means in accordance with an operating condition of said apparatus.

8. In a cooling system for electrical apparatus, a fluid-circulating system for conveying heat from the apparatus to a cooling medium, means for forcing the flow of fluid through said circulating system, means for forcing a cooling medium into heat-exchanging relation with said fluid-circulating system, and means for automatically controlling the operation of said last two named means

over different predetermined load ranges of said electrical apparatus.

9. In a cooling system for electrical apparatus, a fluid-circulating system for conveying heat from the apparatus to a cooling medium, means for forcing the flow of fluid through said circulating system, means for forcing a cooling medium into heat-exchanging relation with said fluid-circulating system, automatic means for causing the operation of one of said means over a predetermined working range of said apparatus, and automatic means for causing the operation of the other of said means over a different predetermined working range of said apparatus.

In testimony whereof, I have hereunto subscribed my name this twenty-first day of August, 1928.

EARL B. CLARKE.