June 2, 1925. 1,539,837

S. Q. HAYES

TRANSFORMER COOLING SYSTEM

Filed Aug. 15, 1919

Fig. 1.

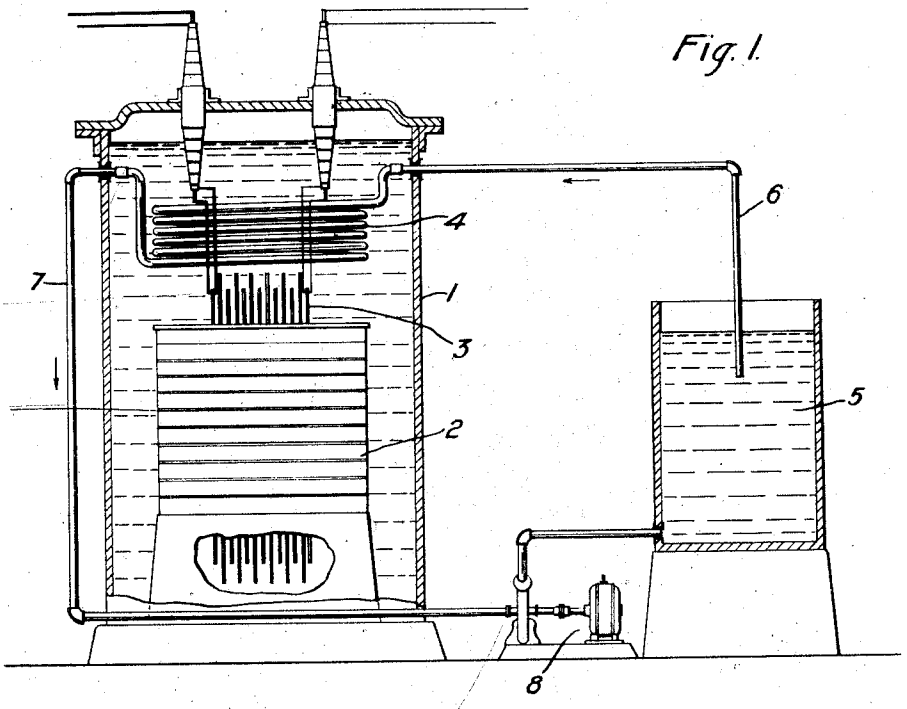


Fig. 2.

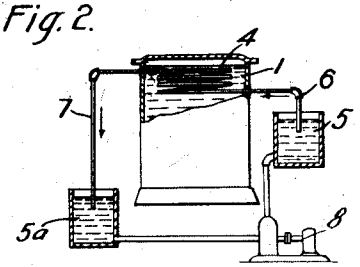
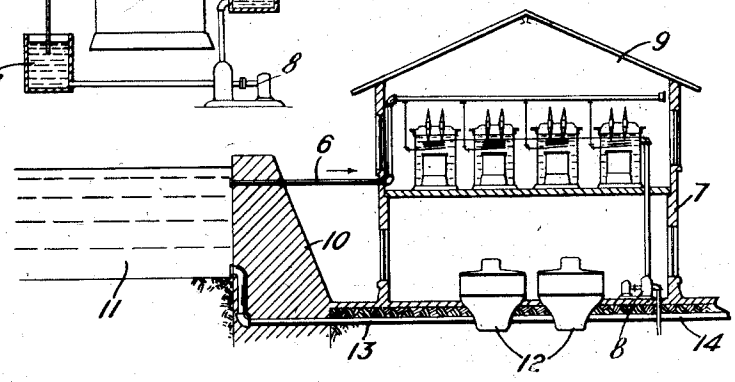


Fig. 3.



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TRANSFORMER COOLING SYSTEM.

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To all whom it may concern:

Be it known that I, STEPHEN Q. HAYES, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Transformer Cooling Systems, of which the following is a specification.

My invention relates to transformer cooling systems, particularly as applied to transformers of the oil-insulated, water-cooled type, and it has for its object to provide a system of the character described by which the insulating fluid may be effectively cooled by the immersion therein of a coil through which a cooling medium is passed, without the possibility of the fluid passing through the cooling coil leaking out into the insulating fluid upon the development of a leak in the coil, and thereby impairing the efficiency of the insulating qualities of the former mentioned fluid.

In the accompanying drawing, Figure 1 is an elevational sectional view of an oil-insulated, water-cooled transformer embodying my invention; Fig. 2 is an elevational view of transformer and cooling system, in which the circulation of the cooling fluid through the cooling coils thereof is purely siphonal; and Fig. 3 is an elevational sectional view illustrating the manner in which my invention may be installed in water power generating stations.

Some difficulty has been experienced heretofore in the operation of transformers as above described, on account of the tendency for whatever cooling medium is passed through the immersed coil to leak outwardly and into the insulating fluid upon the development of a fault in the coil wall. Any such admixture results in a decided impairment of the efficiency of the insulating fluid. In order to avoid this possibility, in some instances where it was imperative that the insulating fluid be maintained with a high factor of safety, it has been necessary to establish cooling systems in which the insulating fluid is drawn from the transformer tank and passed through a cooling means which is exterior to the tank itself. This method is, of course, quite expensive and results in comparative complication of the various piping arrangement necessary for its accomplishment.

In order to obviate the above difficulty, I propose to maintain the cooling medium passing through the immersed coil at a pressure lower than that of the insulating fluid with which the coil is in contact and thereby insure that, upon the development of a fault in the coil wall, the insulating fluid will pass into the inside of the coil and there mix with the cooling medium and be drawn off. Inasmuch as none of the cooling medium, which is usually water becomes mixed with the insulating fluid, which is usually oil, no harmful results will occur if some small fault develops whereby the wall of the coil is punctured. Having established the above method as one in which the difficulties heretofore attendant upon the use of cooling coils in oil-insulated, water-cooled transformers are obviated, I, furthermore, find that the use of a cooling system of the character described is especially beneficial in those power plants which are located adjacent to a dam or other stream obstruction and in which the power is furnished by the difference in head of two bodies of water.

As will hereinafter appear, I employ either a siphoning arrangement or a negative pressure pump to circulate the cooling medium through the coil, and find that an arrangement of this character maintains the required difference in pressure between the cooling medium and the insulating fluid with which the cooling coil is in contact. Another advantage of my proposed system results when the siphonal method is used inasmuch as after the siphonal circulation is once established, no pumping means are necessary to maintain the circulation, all of the work being done by the atmospheric pressure and by the difference in level of the outlet and inlet to the cooling coil. It should be mentioned, however, that in all cases, it is necessary that both the body of fluid from which the inlet is supplied as well as that to which the outlet is connected must be entirely below the level of the coil through which it is desired that the cooling medium circulate.

Referring now more particularly to the drawing, an oil-insulated, water-cooled transformer comprising a casing 1, and a core 2, embraced by coils 3, is shown. The casing 1 is substantially filled with an insulating fluid which surrounds the coil and

core and tends to maintain the temperature of the same within reasonable limits. As the insulating fluid becomes heated, it rises to the top, and in so doing, flows into contact with a cooling coil 4, through which is passed any suitable cooling medium which, for purposes of illustration only, I have designated, in this description, as water. A storage tank 5 is kept constantly filled with cooling fluid and is connected to the inlet of the coil 4 through a connecting pipe 6 and to the outlet of the coil 4 by a pipe 7, pumping means 8 being interposed between the outlet of the coil and the connection thereof to the storage tank 5, whereby the cooling fluid is sucked through the coil and negative pressure maintained therein as long as the pump functions in the normal manner.

Referring now to Fig. 2, I have shown somewhat diagrammatically a transformer casing and the cooling coil 4 immersed therein. In order to maintain a negative pressure within the coil 4 by the use of pure siphonal circulation, it is necessary that the coil itself be wholly above the level of both the supply fluid and the discharged body of fluid. I have indicated the tank of cooling fluid supply as 5 and the discharged body of fluid as 5^a. In this structure, the circulation of the cooling fluid through the coils is effected by siphonic action alone and the pump only functions to return the cooling fluid from the lower level to the higher level. By this construction, the cooling fluid is not only circulated at a constant pressure through the cooling coils but economy in the use of cooling fluid is effected.

It will be observed, therefore, that a cooling system constructed in accordance with my invention in which the pressure of the cooling fluid flowing through the cooling coil is less than the pressure of the insulating fluid, results in decidedly economical operation, since all that is necessary is an adjacent body of water above which the transformer tank may be placed.

Transformers embodying cooling systems of the character above described are particularly adapted for employment in water power generating stations, as may be understood from a consideration of Fig. 3 in which a power house 9 is represented, in elevational sectional view, as positioned adjacent to the down-stream wall of a dam 10, the latter restraining a body of fluid 11. Water-driven generating machines 12 are shown as supplied with power through a penstock 13, the waste water passing off in a tail-race 14. Transformers of the oil-insulated, water-cooled type, are shown as positioned on an upper floor of the generating station 9 in such manner that the cooling coils therein are substantially above the body of the fluid 11. It will be observed that the pipe 6 constitutes an inlet connection to the coil from the body of the fluid 11, while the outlet connection 7 is joined to the tail-race. By this particular location of, and connection of the transformers in, a water side generating station, I am able, after an initial establishment, to maintain a siphonal flow of cooling fluid through the transformers, and it will be evident, to those versed in cooling problems, after a consideration of my improved cooling system, that it is decidedly economical, inasmuch as no further power is required after the initial siphonal establishment and, moreover, since the required negative pressure is maintained within the cooling coil.

While I have shown but one embodiment of my invention, it is obvious that many modifications therein may occur to those skilled in the art, and I desire, therefore, that my invention be broadly interpreted and that it be limited only by the showing of the prior art or by the scope of the appended claims.

I claim as my invention:

1. In a transformer, a core and inductively related coils, an insulating fluid surrounding said coils, and a cooling coil in contact with said insulating fluid through which a cooling fluid may flow, pressure governing means comprising means for initiating a siphonal flow of said cooling fluid through said coil, and means for thereafter maintaining the flow without power consumption.

2. In a transformer, a core and inductively related coils, an insulating fluid surrounding said coils, and a cooling coil in contact with said insulating fluid through which a cooling fluid may flow, and pressure governing means comprising means for initiating a siphonal flow of said cooling fluid through said coil, and means for thereafter maintaining the flow without power consumption, and for further maintaining the cooling fluid at a lower pressure than the pressure of the insulating fluid whereby the former fluid is prevented from passing into the latter fluid upon the development of a fault in the cooling coil.

3. In a transformer, a core and inductively related coils, an insulating fluid surrounding said coils, and a cooling coil in contact with said insulating fluid through which a cooling fluid may flow, and connections from the inlet and outlet of the cooling coil to points of different pressure in a body of cooling fluid, both of said points being below the cooling coil, whereby a siphonal flow may be established through said coil.

4. In a transformer, a core and inductively related coils, an insulating fluid surrounding said coils, and a cooling coil in contact with said insulating fluid through which a cooling fluid may flow, and means

for initiating a siphonal flow of the cooling fluid, said flow being thereafter maintained wholly by the atmospheric pressure.

5. In a transformer cooling system, the combination with a transformer having a cooling coil immersed in insulating fluid, of means for connecting the inlet and outlet of said coil to points in a body of cooling fluid, said connecting points being below the level of said coil, and means for initially establishing a siphonal flow of the fluid in said body through said coil, the siphonal flow being thereafter maintained by atmospheric pressure.

In testimony whereof, I have hereunto subscribed my name this eleventh day of July 1919.

STEPHEN Q. HAYES.