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LEAK DETECTOR FOR HEAT EXCHANGERS IN GAS INSULATED ELECTRIC APPARATUS

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Fig. 1.

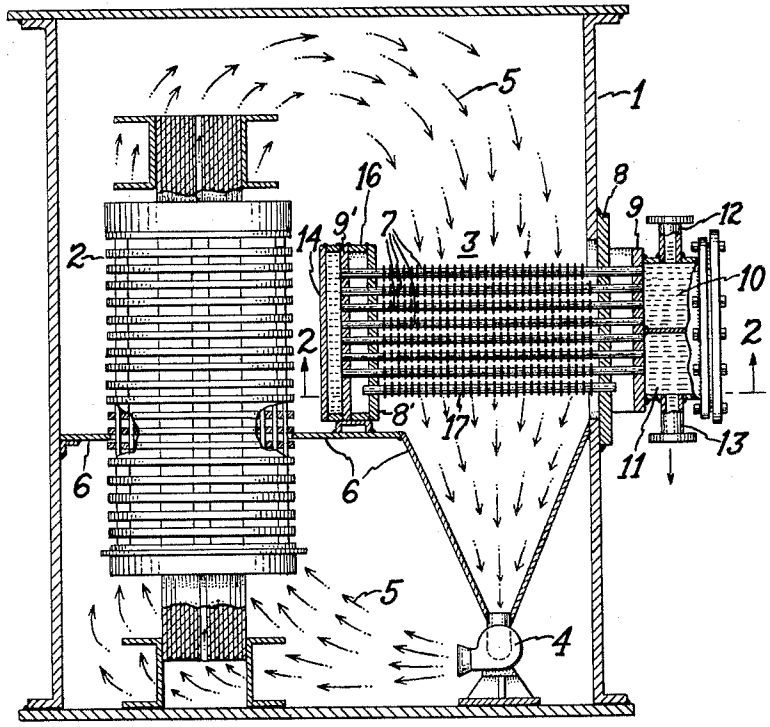
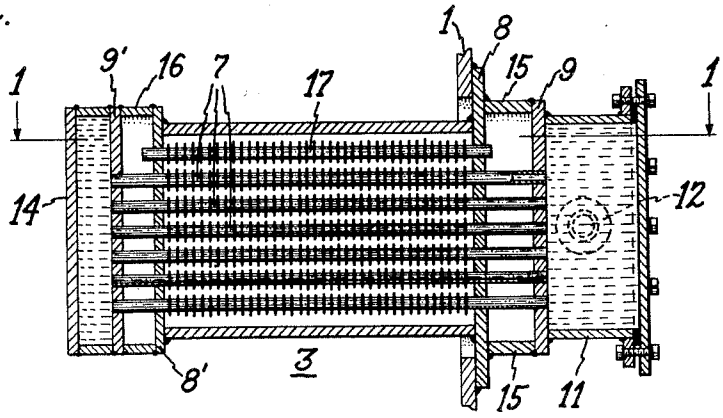


Fig. 2.



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LEAK DETECTOR FOR HEAT EXCHANGERS IN GAS INSULATED ELECTRIC APPARATUS

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This invention relates to gas insulated electric induction apparatus and more particularly to leak detectors for heat exchangers mounted directly inside such electrical apparatus.

Heat exchangers are often used to remove heat from electric induction apparatus, such as encased transformers. This usually involves the use of two different fluids which must be kept separated because of their different properties. In a gas filled apparatus one fluid is the insulating gas sealed within the apparatus casing. The other fluid, usually liquid, is primarily a cooling fluid. These fluids are brought into heat exchanging relation in the heat exchanger so that heat acquired from the apparatus by the insulating gas is transferred to the cooling fluid which then carries off the heat evolved by the apparatus so that the latter does not attain an excessively high operating temperature.

In order to increase the heat transfer capacity of the heat exchanger it is conventional to force one or the other or both fluids through the heat exchanger. This, however, requires power and thus decreases the overall efficiency of the apparatus. One way to decrease this power loss is to place the heat exchanger inside the apparatus casing so as to shorten the circulating path of the insulating fluid. This, however, greatly increases the danger to the apparatus from a leak in the heat exchanger.

Heat exchangers typically comprise a plurality of straight parallel spaced tubes or their equivalent with or without external fins for increasing their effective heat transferring surface. The tubes are usually joined at their respective ends to perforated so-called tube-sheets which form a part of header or fluid tight compartments. One fluid is circulated or passed through the inside of the tubes and the other fluid is circulated or passed over the outside of the tubes. When one is a liquid and the other a gas it is usually preferable to pass the liquid through the tubes and the gas over the tubes because the volume of the heat exchanger inside the tubes is usually less than the volume of the heat exchanger between the tubes and the liquid is usually denser than the gas.

By far the likeliest place for leaks to occur in a heat exchanger is at the joints between the tubes and the tube-sheets and these joints are most likely to leak when one or both liquids is forced through the heat exchanger because of the greater pressure and pressure differences which are created. One way to reduce the likelihood of intermixing the fluids as a result of such a leak in an external heat exchanger is to use a so-called double-tube-sheet construction. In this construction there are two spaced tube-sheets at each end of the tubes, the tubes passing through and extending beyond the inner tube-sheets and passing into but not materially beyond the outer tube-sheets, the outer surfaces of the tubes being sealed fluid tight to the edges of the holes in the tube-sheets in any suitable manner such as by roller expanding the tubes. In this way, the fluid passing over the outside of the tubes is confined by the inner tube-sheets and the fluid passing through the tubes is confined by the outer tube-sheets, and as there is a space between the inner and outer tube-sheets, any leak between the tubes and either tube-sheet at either end will merely result in fluid entering the space between those tube-sheets rather than in an intermixing of the fluids.

One way to mount such a double-tube-sheet heat exchanger inside the casing of the main apparatus would be to have it extend between walls of the casing with the inner tube-sheets sealingly closing openings in said walls. However, such casings are usually made of relatively rigid material and the elongated tubes of the heat exchanger usually have appreciable longitudinal thermal expansion and contraction so that this is not a feasible construction unless flexible seals capable of bearing the weight of the heat exchanger are employed between the inner tube-sheets and the adjacent walls of the casing and even though such seals could be provided they would be expensive and another potential zone of fluid leaks.

Accordingly, when such a double-tube-sheet heat exchanger is mounted inside the casing of the main apparatus it is preferable to have one end outside the casing and the other end only entirely within the casing and supported in such a manner that it can move enough to allow for thermal longitudinal expansion and contraction of the heat exchanger. This, however, accentuates the problem of preventing intermixing of the fluids in the event of leakage into the space between the inner and outer tube-sheets at the inner end of the heat exchanger.

In accordance with this invention, that space is closed off to form a sealed compartment which is provided with a drain conduit communicating with the outside of the main casing. In accordance with a further feature of the invention, this drain conduit can be a shortened dummy tube in the heat exchanger.

A principal object of the invention is to prevent intermixing of fluids resulting from a leak at the inner end of a double-tube-sheet type heat exchanger mounted directly within the sealed casing of an electric induction apparatus.

The invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing,

FIG. 1 is a partially sectionalized elevation view of apparatus embodying the invention with the heat exchanger sectionalized on line 1—1 of FIG. 2 when viewed in the direction of the arrows, and

FIG. 2 is an enlarged sectionalized view taken on line 2—2 of FIG. 1 when viewed in the direction of the arrows.

Referring now to the drawing, and more particularly to FIG. 1 there is shown therein a main casing 1 for enclosing the main apparatus 2 whose operation requires a heat exchanger indicated generally at 3. By way of example, the casing 1 may be a comparatively heavy gauge plate steel tank which can constitute a pressure vessel and the main apparatus 2 may be a core and coil assembly for a power transformer which evolves heat and the heat exchanger 3 may be a cooling radiator for the apparatus 2. The casing 1 is filled with an insulating gas which by means of any suitable pump 4 may be circulated as indicated by the arrows 5 through ducts in the apparatus 2 and through the heat exchanger 3. In order to maintain the necessary pressure differences between opposite sides or ends of the apparatus 2 and the heat exchanger 3 for causing circulation of the insulating fluid, the tank or casing 1 is divided into compartments by means of suitable baffle means indicated generally at 6, which may also slidingly support the inner end of the heat exchanger, so as to allow for its longitudinal expansion and contraction.

The heat exchanger 3 is of the multiple parallel tube type comprising a plurality of tubes 7, preferably provided with external fins as shown. The ends of the heat exchanger 3 are of the so-called double-tube-sheet construction in which there is an inner tube-sheet 8 and an outer tube-sheet 9 at the outer end of the heat exchanger, and

an inner tube-sheet 8' and an outer tube-sheet 9' at the inner end of the heat exchanger. The tubes 7 pass completely through holes in the inner tube-sheets 8 and 8' and beyond them into holes in the outer tube-sheets 9 and 9', but they do not need to extend beyond the outer tube-sheets 9 and 9'. The outer walls of the tubes 7 are sealed to the tube-sheets in any suitable manner such as by roller expanding the ends of the tubes so that they press tightly against the walls of the holes in the tube-sheets. The ends of the tubes 7 outside the outer tube-sheet 9 open into headers 10 and 11 provided respectively with an inlet port 12 for cooling fluid and an outlet port 13 for the same cooling fluid. Likewise the inner ends of the tubes 7 open into a closed box 14, one wall of which is the top sheet 9'. In this manner the cooling fluid makes two passes through the heat exchanger in going from the inlet 12 through a number of the tubes 7 into the closed box 14 and out of this box through another group of tubes to the header 11 and out the cooling fluid outlet 13. However, it will of course be understood that by the use of additional baffles in the box 14 and the headers 10 and 13 the cooling fluid can be made to have any desired even number of passes through the heat exchanger.

The insulating fluid may be any suitable insulating gas such, for example, as sulpherhexafluoride. Likewise the cooling fluid may be any suitable liquid and in the illustrated embodiment of the invention it will be considered to be water which is forced through the tubes 7 by pressure from a main or by a pump (not shown).

The space between the tube-sheets 8 and 9 is open although side brackets 15 as shown most clearly in FIG. 2 are provided between those sheets so that the weight of the inlet and outlet headers 10 and 11 will not be borne by the outer ends of the tubes 7. The tube-sheet sheet 8 is shown sealingly attached to a wall of the casing 1 around an opening therein through which the heat exchanger is inserted, this sealing being made in any suitable manner such as by welding. By means of this construction, any water leak between the tubes 7 and the tube-sheet 9 will merely result in water running out of the space between the tube-sheets 8 and 9 and not entering the casing 1 so as to become intermixed with the insulating fluid. However, if there were a similar leak between the inner end of a tube 7 and the tube-sheet 9' and the space between the tube-sheets 8' and 9' vented, water would get mixed with the insulating fluid. In order to prevent this and in order to detect such leaks, a peripheral wall 16 is fixed between the tube-sheets 8' and 9', as by welding, to form a closed compartment bounded by that wall and the tube-sheets 8' and 9'. It will be seen that this closed compartment and the water box 14 have a common wall comprising the tube-sheet 9'. For detecting either water trapped in the closed compartment by leakage between the tubes 7 and the tube-sheet 9' or gas leaking into the closed compartment between the tubes 7 and the tube-sheet 8', a drain conduit communicating between the interior of the closed compartment and the outside of the casing 1 is provided. While any suitable drain conduit can be used a novel and simple way of providing one is to make one of the lowermost heat exchanger tubes a shortened dummy

tube 17 whose inner end opens into the closed compartment near the bottom thereof and whose outer end opens into the open space between the inner and outer tube-sheets 8 and 9. Thus the dummy tube 17, which constitutes a preferred form of drainage conduit, does not extend to the outer tube-sheets 9 and 9'. By means of this construction any gas or water leakage at the inner end of the heat exchanger between the tubes 7 and the tube-sheets 8' and 9' respectively can be detected by observing gas or water, as the case may be, emerging from the end of the drainage conduit or dummy tube 17 between the tube-sheets 8' and 9'.

While there has been shown and described a particular embodiment of the invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention, and therefore it is intended by the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A gas insulated electric induction apparatus including a sealed enclosing casing containing a heat evolving device and a dielectric gas, means including a pump within said casing for circulating said gas through a predetermined path to cool said device, a liquid filled heat exchanger mounted upon a wall of said casing and extending into said casing in the path of circulation of said dielectric gas, said heat exchanger comprising a plurality of parallel tubes having at each end thereof a pair of juxtaposed inner and outer tube sheets in spaced relation and a liquid header, said headers each including the outer tube sheet at each end of said heat exchanger, means fixedly mounting one of said inner tube sheets to the wall of said casing in fluid tight relation thereby to support said heat exchanger with the space between the pair of tube sheets at the outer end of said heat exchanger being outside said casing and vented to atmosphere, said tubes extending into said casing with the inner ends of said tubes being free to move as said tubes expand and contract, means enclosing the space between the pair of tube sheets at the inner end of said tubes thereby to form a closed leakage compartment for dielectric gas and cooling fluid, and a drainage tube extending from said leakage compartment to the outside of said casing.

2. The combination as in claim 1 in which said drainage tube is a normally empty dummy tube in said exchanger which at its ends extends only through the associated inner tube sheets and into the spaces between said pairs of tube sheets.

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