June 20, 1961 H. J. TAYLOR 2,989,738

TRANSFORMER OVERLOAD INDICATING SYSTEM

Filed May 6, 1957

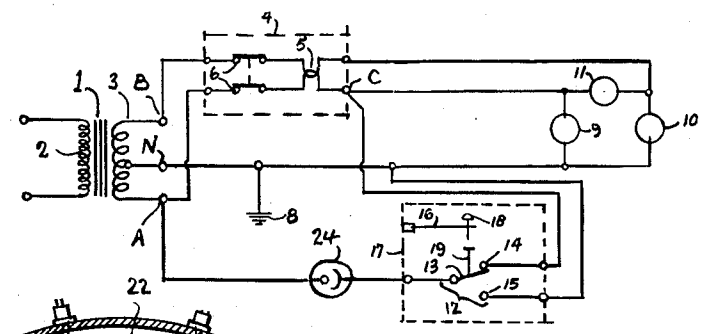


Fig. 1.

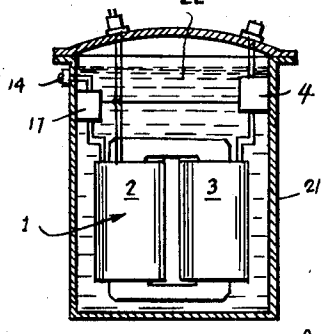


Fig. 2.

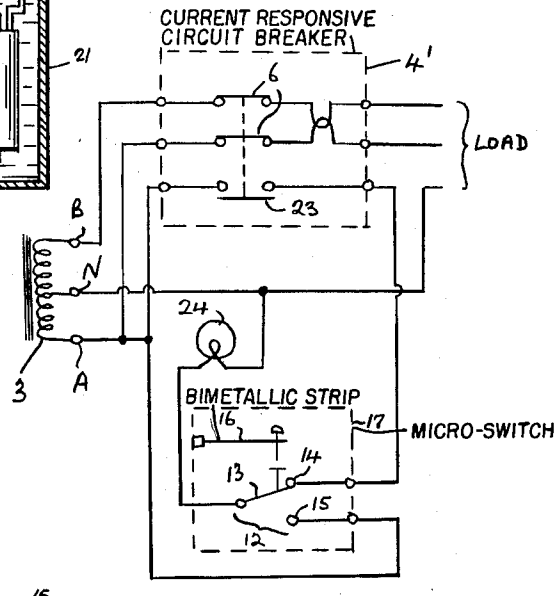


Fig 4

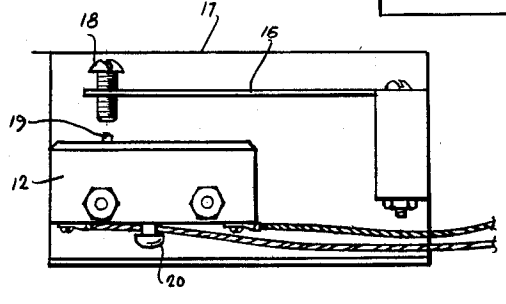


Fig. 3.

Inventor
Herbert J. Taylor
by Stevens, Davis, Miller & Mosher
his attorneys

United States Patent Office 2,989,738 Patented June 20, 1961

2,989,738
TRANSFORMER OVERLOAD INDICATING SYSTEM

Herbert John Taylor, Brandon, Manitoba, Canada, assignor to Pioneer Electric Brandon Limited, Brandon, Manitoba, Canada

Filed May 6, 1957, Ser. No. 657,138
Claims priority, application Canada July 11, 1956
7 Claims. (Cl. 340—248)

This invention relates to an overload indicating system for use with a transformer, and its purpose is to provide a warning of the occurrence of either of two different types of undesirable loading conditions that the transformer may experience. More specifically, the invention is concerned with a load indicating system for use with a transformer of the oil-immersed type, that is to say the type having a tank containing a liquid dielectric substantially filling the tank, and primary and secondary windings immersed in such dielectric.

There are two principal types of overload to which such a transformer may be subjected. Firstly there is the effect of a gradual increase of secondary current sufficient over a period of time to raise the temperature of the windings and the dielectric to a deleterious extent; and secondly there is the sudden type of overloading resulting from the flow of a fault current. In this latter case the temperature of the windings rises rapidly but there is insufficient time for any significant rise in the dielectric temperature before some protective device interrupts the circuit.

A practical distribution transformer will commonly have mounted on it or in association with it a circuit breaker which is sensitive to overcurrent, this circuit breaker normally completing a circuit from the secondary winding to a group of low-voltage loads, but being adapted to interrupt such circuit on the occurrence of an overload the value of which will be predetermined in accordance with the setting of the circuit breaker. Such a circuit breaker thus provides immediate protection for the transformer against the second type of overloading, namely sudden fault currents. In the case of the other type of overloading, however, it is desirable that there should be some means for obtaining an indication that an overload condition is being approached, before such condition actually exists.

It is the primary object of the present invention to provide a load indicating system for use with a transformer of the type described, in which an indication will be given when either of these two conditions occur, i.e. opening of the circuit breaker as a result of currents sufficient to trip it, or the approach of an undesirably high temperature in the transformer when insufficient current is flowing actually to trip the circuit breaker.

To this end the present invention provides a load indicating system comprising an indicating device (which may be a lamp, buzzer or other warning instrument), auxiliary switching means connected to said indicating device and having two positions, and means sensitive, preferably solely, to the temperature of the dielectric for changing said auxiliary switching means over from its first to its second position on attainment of a predetermined dielectric temperature, said first position being such as to connect said indicating device in series with winding of the transformer (preferably a low-voltage secondary winding) when the main protective device (e.g. circuit breaker) is open, and the second position being such as to establish a circuit from a terminal of a transformer winding (also preferably a secondary winding) through said indicating device to an electrically different terminal of such winding.

The means sensitive to the temperature of the dielectric will be set to switch the auxiliary switching means over into its second position at a temperature that can be achieved without an overcurrent sufficient to trip the circuit breaker being drawn. When the auxiliary switching means is so switched over it will complete a circuit from the secondary winding of the transformer to the indicating device thus providing the warning required. On the other hand, if the circuit breaker trips on fault current before the dielectric temperature has risen sufficiently to switch over the auxiliary switching means, such means will remain in its first position in which the indicating device is connected across a transformer winding when the circuit breaker opens.

In the specific examples that follow two types of connection are disclosed whereby the auxiliary switching means achieves its object in its first position. The first type of connection involves placing the indicating device in parallel with a pair of main contacts of the circuit breaker, while at the same time arranging that the load circuit that these main contacts complete is always otherwise partially completed. Although there will be no voltage across these main contacts when they are closed, so that the indicating device will not be energized under normal operating conditions, when they are open, there will be a circuit established from one terminal of the secondary winding, through the indicating device and through the loads, back to a different terminal of the secondary winding. Thus an indication will also be given under these conditions even though the temperature sensitive means will not have operated.

In order to establish this return circuit through the loads it is essential that there be one connection to the loads which is not interrupted by the main circuit breaker. In the specific example which follows, the invention has been shown as applicable to the single-phase three-wire Edison type of distribution system in which the two active leads are taken through the circuit breaker and the neutral lead is permanently connected to the loads. The present invention is equally applicable to a single-phase two-wire system, provided the circuit breaker only interrupts one of the leads and the other remains to provide a return connection for the indicating device. Similarly the invention is applicable to a polyphase system, provided, as before, that one connection to the loads remains uninterrupted whatever the position of the circuit breaker. In referring to the provision of an uninterrupted connection between the secondary of the transformer and the loads, it is not intended to exclude the possibility of this connection being established through ground without any actual wired connection.

The second method of connecting the auxiliary switching means is to provide a pair of normally closed auxiliary contacts on the circuit breaker, that is to say contacts that are normally closed when the circuit breaker is open and which are thus normally open when the main contacts of the circuit breaker are closed and the system is on load. These auxiliary contacts are then connected in series with the indicating device across a winding of the transformer so that opening of the circuit breaker completes the indicating circuit.

Examples of the invention are illustrated in the accompanying drawings, in which:

FIGURE 1 shows a diagrammatic circuit of a load indicating system;

FIGURE 2 is a simplified representation of the structure of a transformer to which the invention may be applied and showing the method of mounting the parts of the apparatus thereon;

FIGURE 3 is a more structurally detailed illustration of a portion of the apparatus employed in the circuit of FIGURE 1; and

FIGURE 4 is a fragment of an alternative circuit.

Referring firstly to FIGURES 1 and 2, there is provided a transformer **1** mounted in a tank **21** and consisting electrically of a primary winding **2** and a centre-tapped secondary winding **3**. The transformer is of a conventional distribution type in which the windings are submerged in a liquid dielectric **22** substantially filling the tank **21**. This general layout is shown in FIGURE 2, conventional parts such as lead-in conductors and insulators, etc. having been shown only diagrammatically for clarity of illustration.

As will appear from FIGURE 1, the transformer **1** is connected on its secondary side into a three-wire single phase Edison type of distribution system, the two active leads A and B being connected through a circuit breaker **4** to a series of loads. In this type of distribution system the majority of the loads will be of the lower voltage type so that they will be connected between one or other of the active leads A and B and the neutral lead N. Such loads are represented at **9** and **10**. In addition, loads such as load **11** requiring the higher voltage may be connected directly across the active leads. The neutral lead N may be grounded, as shown at **8**, and in some systems it may be practical to dispense with the actual neutral connection and rely solely upon a further grounding of the neutral sides of the loads **9** and **10**.

The circuit breaker **4** is double pole and may conveniently be of the totalizing type in which tripping of the circuit breaker is determined in accordance with the sum of the currents flowing in the two active leads and the degree of unbalance. Canadian Patent No. 551,908 issued January 21, 1958 discloses a basic form of such a device. In FIGURE 1 the intersecting loops **5** are symbolic of the totalizing function, the main contacts being shown at **6**. No further detailed description of the circuit breaker **4** is deemed necessary in this specification, but it should be mentioned that the circuit breaker **4** will preferably be mounted on the inside of the tank **21** immersed in the dielectric (as shown in FIGURE 2) so as to be operated as a function of the combination of the dielectric temperature and the currents flowing through the secondary windings.

The signalling system comprises a double throw micro-switch **12**, the movable arm **13** of which is connected through an indicating lamp **14**, or other suitable signalling or warning device, to the active lead A at the secondary winding **3** of the transformer. It is desirable that this warning device be of a high resistance type and therefore a neon lamp is preferably used. Normally the movable arm **13** of the micro-switch **12** makes contact with a stationary contact **14** which is in electrical connection with the active lead A on the load side of the circuit breaker **4**, i.e. at terminal C. The other stationary contact **15** of the micro-switch **12** is connected to the neutral lead N.

The micro-switch **12** is controlled by a temperature responsive device comprising a deflectible bi-metallic strip **16** which carries at its end an adjustable screw **18** arranged for mechanical cooperation with the operating rod **19** of the micro-switch **12** (also see the structural illustration of FIGURE 3 which shows the top of the casing **17** removed). This temperature responsive device is mounted together with the micro-switch in a casing **17** which is secured to the inside of the tank **21** at a point beneath the surface of the liquid dielectric **22**.

With the system operating normally, that is to say with the circuit breaker contacts **6** closed, there will be no significant potential across the lamp **14**. As the load on the transformer gradually increases and the dielectric heats, the bimetallic strip **16** will flex downwardly at its free end, until ultimately the screw **18** forces the operating rod **19** sufficiently far into the casing of the micro-switch **12** to snap such micro-switch over into its opposite position in which the movable arm **13** comes into contact with the stationary contact **15**. In this position the voltage across the leads A and N of the secondary winding **3** will be applied to the lamp **14** so that this lamp will glow brightly and thus provide an indication that a certain predetermined condition of load has been exceeded. This condition will normally be chosen to be rather less than the sustained overload condition that will be sufficient to trip the circuit breaker **4** so that the warning lamp will provide an indication of the approach of a dangerous overload rather than the presence of such an overload. The micro-switch **12** will preferably be of the resetting type, so that the switch will require manual resetting before the lamp can be extinguished, thus ensuring that the warning will not pass unnoticed. A resetting knob **20** (FIGURE 3) is provided for this purpose.

The foregoing description of the operation assumes that the load on the transformer will increase gradually. In the event of a sudden heavy overload the circuit breaker **4** which is sensitive to the currents through the windings will trip long before the dielectric temperature will have risen sufficiently to deflect the bimetallic strip **16** to switch over the micro-switch **12**, and thus the movable arm **13** will remain in its original position in contact with the stationary contact **14** even though an overload condition had existed and the circuit breaker **4** had opened. However, an indication of the overload condition will still be provided, because a circuit will now exist extending from the lead A at the secondary winding **3**, through the lamp **14** and the micro-switch **12** to terminal C, and thence through the load **9** (and also loads **10** and **11** in series, if there is a load **11**) back to the neutral lead N of the winding **3**. The fact that the neon lamp **14** will only pass a small current avoids the possibility of danger to a linesman working on the otherwise disconnected load circuit.

If it is essential to avoid any connection between the load circuit and the tranformer when the circuit breaker is open, the alternative circuit illustrated in FIGURE 4 may be adopted. This circuit employs a modified circuit breaker **4'** similar to the circuit breaker **4** but also having a pair of normally closed auxiliary contacts **23**. These contacts are referred to as "normally closed" because this is their condition in the open position of the circuit breaker. FIGURE 4 shows the circuit breaker in its closed position with the auxiliary contacts **23** open. The main contacts **6** of the circuit breaker **4'** are connected as before in the active leads A and B leading from the secondary winding **3** of the transformer to the load elements.

A micro-switch **12** and associated parts, including a bimetallic strip **16**, are provided as before. The movable arm **13** of the micro-switch **12** is now connected through a warning lamp **24** to the neutral lead N. The stationary contact **14** with which the movable arm **13** is normally in contact is connected through the auxiliary contacts **23** to the active lead A. The other stationary contact **15** of the micro-switch **12** is connected directly to such active lead A, these two latter connections to the active lead both being made on the transformer side of the circuit breaker **4'**.

The operation of this alternative circuit is basically the same as that described in FIGURE 1 in that if the micro-switch **12** is operated by the bimetallic strip **16**, it will connect the movable arm **13** to the stationary contact **15** and thus place the warning lamp **24** across the active lead A and the neutral lead N of the secondary winding **3**. Thus on slow overloads, the warning is given as sole function of oil temperature and completely independently of the currents in the winding **3**. The difference between the circuits of FIGURES 1 and 4 lies in the method of operation under sudden overloads. In this case the auxiliary contacts **23** are closed long before the bimetallic strip **16** can switch over the micro-switch **12**. A circuit is thus established by the auxiliary contacts **23** when they close through the movable arm **13** and stationary contact **14** of the micro-switch **12** to connect the lamp **24** across the leads A and N. This circuit does not include any of the load elements which except for their connection to the neutral lead N are fully isolated from the transformer. Of course, the circuit breaker could have a third pair of

main contacts to interrupt the neutral lead if complete isolation is required without any effect on the operation of the warning lamp.

I claim:

1. In combination with a transformer comprising a tank, liquid dielectric in said tank, primary and secondary windings immersed in said dielectric and a protective device to open circuits, which includes said secondary winding, due to an overcurrent condition; a load indicating system comprising an indicating device, auxiliary switching means connected to said indicating device and having two positions, and means sensitive to the temperature of said dielectric for changing said auxiliary switching means over from its first to its second position on attainment of a predetermined dielectric temperature, said first position being such as to connect said indicating device in series with one of said windings when the protective device is open, and said second position being such as to establish a circuit from one terminal of one of said windings through said indicating device to an electrically different terminal of such winding.

2. In combination with a transformer comprising a tank, a liquid dielectric in said tank, primary and secondary windings immersed in said dielectric and a circuit breaker adapted to be tripped by an overcurrent condition and having main contacts for completing a circuit from the secondary winding to a load element and a pair of auxiliary contacts open when the main contacts are closed and vice versa; a load indicating system comprising an indicating device, auxiliary switching means connected to said indicating device and having two positions, and means sensitive to the temperature of said dielectric for changing said auxiliary switching means over from its first to its second position on attainment of a predetermined dielectric temperature, said first position being such as to connect said indicating device in series with said auxiliary contacts between one terminal of one of said windings and an electrically different terminal of such winding, and said second position being such as to establish a circuit from one terminal of one of said windings through said indicating device to an electrically different terminal of such latter winding.

3. In combination with a transformer comprising a tank, liquid dielectric in said tank, primary and secondary windings immersed in said dielectric and a circuit breaker adapted to be tripped by an overcurrent condition and having a pair of main contacts for completing a circuit from the secondary winding to a load element; a load indicating system comprising an indicating device, auxiliary switching means connected to said indicating device and having two positions, and means sensitive to the temperature of said dielectric for changing said auxiliary switching means over from its first to its second position on attainment of a predetermined dielectric temperature, said first position being such as to connect said indicating device in parallel with said pair of contacts of the circuit breaker, and said second position being such as to establish a circuit from one terminal of one of said windings through said indicating device to an electrically different terminal of such winding.

4. The combination claimed in claim 1, wherein said means sensitive to the temperature of said dielectric is sensitive solely thereto.

5. The combination claimed in claim 1, wherein said auxiliary switching means is such as to remain in said second position until reset by an externally applied force.

6. The combination with a transformer comprising a tank, a liquid dielectric in said tank, and primary and secondary windings immersed in said dielectric, of a load element, an uninterrupted connection from a terminal of said secondary winding to one side of said load element, a circuit breaker sensitive to overcurrent and having a pair of main contacts for completing a circuit from a terminal of said secondary winding to the other side of said load element, an indicating device, auxiliary switching means connected to said indicating device and having two positions, and means sensitive to the temperature of said dielectric for changing said auxiliary switching means over from its first to its second position on attainment of a predetermined dielectric temperature, said first position being such as to connect said indicating device in parallel with said pair of contacts of said circuit breaker, and said second position being such as to establish a circuit from a terminal of said secondary winding through said indicating device to an electrically different terminal of said secondary winding.

7. The combination with a transformer comprising a tank, a liquid dielectric in said tank, a primary winding immersed in said dielectric, and a secondary single-phase centre-tapped winding immersed in said dielectric, of a load element, an uninterrupted connection from the centre-tap terminal of said secondary winding to one side of said load element, a circuit breaker sensitive to overcurrent and having a pair of main contacts for completing a circuit from an end terminal of said secondary winding to the other side of said load element, an indicating device, auxiliary switching means connected to said indicating device and having two positions, and means sensitive to the temperature of said dielectric for changing said auxiliary switching means over from its first to its second position on attainment of a predetermined dielectric temperature, said first position being such as to connect said indicating device in parallel with said pair of main contacts of said circuit breaker, and said second position being such as to establish a circuit from said end terminal of said secondary winding through said indicating device to said centre-tap terminal of said secondary winding.

References Cited in the file of this patent

UNITED STATES PATENTS

1,920,037	Tauber	July 25, 1933
2,175,893	Hill	Oct. 10, 1939
2,704,841	Van Ryan	Mar. 22, 1955
2,795,779	Book	June 11, 1957
2,886,805	Joublanc	May 12, 1959