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FIG. 3

FIG. 4

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ELECTRICAL CONNECTOR FOR FLUID COOLED TRANSFORMER WINDINGS

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1 Claim. (Cl. 174—15)

This invention relates to electrical connectors usable in connection with transformer coils and similar electrical equipment.

In many electrical conductors, especially those intended for carrying heavy currents, it is desirable that the conductor be cooled, and a common method of cooling is to make the conductor tubular and force a coolant through the conductor when carrying current so as to maintain the conductor temperature within the range of efficient operation. Where the conductor is applied to an electrical unit, such as a transformer coil as disclosed in my pending application Serial No. 496,719, filed July 30, 1943, now abandoned, of which this application is a division, there is usually a point of connection between the terminal of the unit and the external conductor which must take care not only of the break in the electrical circuit at this point, but also the break in the circuit of the coolant. Consequently, a connector must be provided which will insure a satisfactory electrical connection as well as a liquid-proof joint.

An object of the invention is to provide a connector which will insure a leak-proof connection between two hollow conductors as well as a low-resistance electrical junction.

Another object of the invention is to provide a connector which permits connection at right angles to the terminal of the apparatus conductor terminal.

Another object of the invention is to provide a type of connector which may be applied easily to a plurality of tubular conductor terminals so as to facilitate parallel junction in an electrical circuit.

Additional objects are to provide a connector which has particular applicability to the terminals of transformer coils. Referring to the drawings:

Figure 1 shows an elevation of a transformer to which my invention is applied;

Figure 2 is a section of the transformer taken along the lines 1—2 of Figure 1;

Figure 3 is a plan view of section of the transformer along lines 3—3 of Figure 2;

Figure 4 is a sectional detail of the junction with a connector as applied to the secondary coil of the transformer; and

Figure 5 is a perspective view of the connector as applied to a plurality of conductor terminals.

The transformer of the present invention is illustrated as of a stationary type and including a primary coil 10 enclosed by a secondary coil 11, as shown clearly in Figure 3 of the drawing.

As will appear from this figure and Figure 2, the primary coil is formed of two sections 12 and 13, each section consisting of a number of square turns of hollow conducting material, as copper, placed side by side to form a hollow enclosure of rectangular formation. The ends of the primary sections 12 and 13 adjacent each other are radially out-turned, forming terminals 15 and 16 which are side by side, as shown, to form a substantially unitary tap connection. The other ends of the sections, indicated by numerals 17 and 18, are outwardly turned from the end coil turns in parallel relation to the coil axis to form points of connection to the coolant and bus bars. For this purpose the terminal end sections 11 and 18 are formed with the ends cut at an inclined through the tubular section, the inclined terminating in an outer flattened extension 20.

Surrounding the primary unit 10, the secondary 11 is formed also of two sections 21 and 22, section 21 overlying the primary coil section 12 intermediately the tap unit 15—18 and a point outwardly displaced from the edge of the primary coil; and the lower section similarly extending from the tap unit 15—18 below the lower end primary coil. Each section of the secondary is formed of rectangular turns of tubular conducting material, all of the turns enclosing practically the whole peripheral area of the enclosed primary coil turns. These turns, however, are not continuous, but broken, the ends having fixed and fluid-proof connection with two manifolds 24 and 25, the manifold 24 forming the closure for one set of secondary terminals and the manifold 25 forming the closure for the adjacent overlying ends of the secondary. The mode of connection of these secondaries to the manifold is shown more particularly in Figures 3 to 6 of the drawings. From inspection of these figures it will appear that the manifold 24 consists of a block of material which should be electrically conducting, as metal, axially channeled on one edge to form the block face 27 and 28. Each secondary terminal is diagonally formed at its end with a flattened end piece 23, at the extreme end of which the edge of the block face 23 is brazed or otherwise attached. The edge of the block face 27 is similarly attached to the outer surface of the secondary and the terminal sides are likewise sealed so that the fluid channel 26 has direct communication with the interior of the tubular secondaries. Since each secondary terminal is similarly attached to the manifold 24 and since, moreover, the same construction is followed in the formation of the junction between the manifold 25 and the adjacent secondary terminals, it appears that by this construction there not only is secured an effective parallel electrical connection to the secondary turns of both sections of the

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secondary to the manifolds 24 and 25, but also a complete and satisfactory means of liquid communication is obtained, which is effective for all of the turns of the secondary coil.

 Provision for inflow and outflow of liquid into the manifold is made of the ducts 30 and 31 in the manifolds 24 and 25, respectively, which ducts are screw-threaded to receive connecting nipples for transmission of an appropriate cooling liquid. Two of these ducts are formed in the manifold, either one of which may serve as the inlet or the outlet opening. Duck 30 is located as shown, and such as these two separate secondary coil assemblies, they must be electrically connected in parallel. To do this and support the manifolds 24 and 25 in relation to the transformer as a whole, use is made of the supporting and electrically conducting attaching bars 32 and 33, the bar 32 being fixed against the manifold 24, and the bar 33 against the manifold 25 and bolted thereto by means of bolts 34, as indicated in dotted outline in Figure 4 and shown in Figure 1. Additional rigidity is given to this manifold structure by use of a transverse bolt 35, as shown in Figure 4, bolted structure including the screw-threaded plate 36, insulation strip 37, manifold 24, intermanifold strip insulation 38, manifold 25, insulation strip 39, metal plate 40, bolt enclosing insulation strip 80, and bolt head 41. Reference is made to Figure 5 as clarifying the mode of connection of the secondary terminals (indicated in dotted outline) to the manifold 24 or 25, this view bringing out the lesser depth of the face 27 which overlies the tubing, as contrasted to the face 28 of the manifold which overlies the flattened end piece 29 of the tubing.

 Insulation between the various turns of the coils of the primary is indicated by the numeral 42 in Figure 2. Also, insulation is provided between the metal of the transformer structure and the primary coil by the insulation strip 44 and between the primary and secondary coil by the insulation strips 45. It is pointed out that the turns of both primary and secondary are substantially rectangular in section so as to facilitate assembly.

 The coils of the transformer are placed in proper magnetic relationship to the core 47, whereupon the pressure upon the transformer sides, serving as a central branch 48 enclosed by the coils and connected external branches 49 forming a closed magnetic path from end to end of the coils.

 To provide an adjustable support for the transformer as a whole, use is made of angle plates 58 having a vertical section secured by bolts 59 to the vertical angle plates 54, as shown in Figure 2, and a horizontal section receiving the bolt 58 screw-threaded therein, the bolt being adjustable vertically by threads in angle plate 56 and locked by keys of the nut 61. Since there are four of these supporting bolts 58, it is apparent that any desired adjustment of the transformer relative to the vertical may be made.

 The inner core section 48 supports the coil units of the transformer, the core lying within the coil assembly and the whole unit positioned as shown in Figure 1 and Figure 3. The secondary outlet connections including the manifolds 24 and 25 are on one side of the transformer and the primary connections on the other side. The secondary connections are supported on the frame of the transformer enclosure by attaching means including the screw-threaded wing plates 60 on either side of the supporting blocks for the manifold elements.

 The adjacent middle terminals 15-16 of the primary coils are enclosed in an electrically conducting conduit 89 leading to a pipe filter 70 to which, by means of the pipe connection 71, cooling fluid is supplied the primary circuit through a rubber hose. This fluid flows through the primary sections from the central inlet point 69 and is removed through the tubular connectors 61 and 81.

 It is worthy of note that the arrangement of manifold connection to the secondary turns is such as not to increase appreciably the resistance or reactance of the secondary circuit and that this arrangement also facilitates cooling as desired and permits easy adjustment of the load circuit connections. In general, the efficient cooling means in the construction as described makes possible an increased output by reducing the average temperature of the windings without reducing the effective area of coil turns. By reducing the average temperature of coils, the rate of aging of the insulation of the winding is also reduced to such an extent that the life of the transformer is proportionally increased. In addition, the construction facilitates modification of output since, for example, only one section of the primary may be used.

 Modifications of the construction to meet minor requirements of installation and equipment may, of course, be made, the invention being comprehended within the claim hereunto appended.

 What is claimed is:

 Apparatus of the type described comprising in combination a terminal block generally U-shaped in cross section, the legs of the U defining a channel extending generally the entire length of the terminal block, one of said legs being shorter than the other by a predetermined amount; and a plurality of hollow conductors generally rectangular in cross section each having a pair of opposed first side walls and a pair of opposed second side walls, one of said second side walls and said pair of first side walls terminating short of the end of the other of said second side walls, said conductors being arranged with their first side walls in side-by-side relationship with the ends of each extending across the opening of said terminal block and shortened second side wall engaging and terminating adjacent said shorter leg, said other second side wall engaging and terminating adjacent the longer of said legs whereby said conductors may close the opening of said terminal block with the hollow of the conductors in communication with the channel.

 HAROLD A. STRICKLAND, Jr.

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