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R. T. FOLEY ET AL
ELECTRIC SWITCH CONTACT

2,680,174

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Fig. 1.

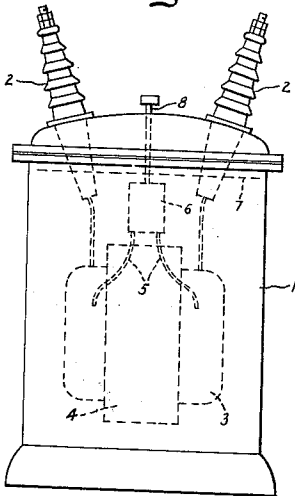


Fig. 2.

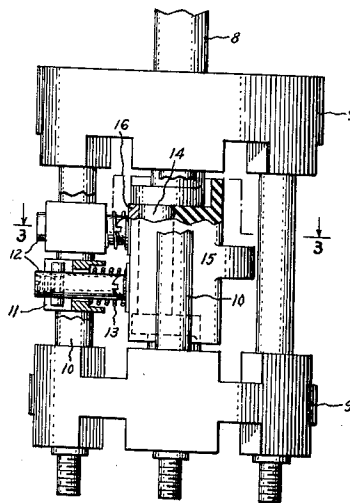


Fig. 4.

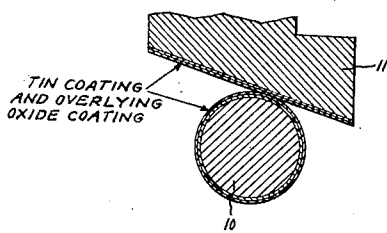


Fig. 3.

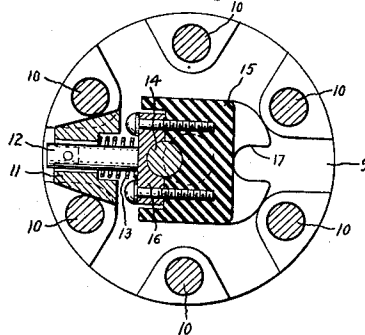
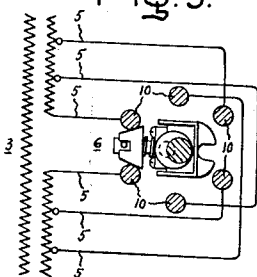


Fig. 5.



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ELECTRIC SWITCH CONTACT

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3 Claims. (Cl. 200-166)

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The present invention relates to electric switch contacts and more particularly to improved switch contacts in tap changing switches which are adapted to operate submerged in hot mineral oil. A typical tap changing switch of the non-arc duty tap changer type is described in Patent 2,255,501—Blume. Such a switch is used for changing the taps of a transformer and is usually mounted in the transformer tank below the surface of the insulating and cooling liquid with which the tank is substantially filled.

Due to the construction of this switch and the environment in which it is required to operate, the material from which the switch contacts are made must possess a combination of properties not obtainable in usual switch contact materials. While high quality refined mineral oil is ordinarily employed as the insulating and cooling liquid in the transformer tank, such oil contains minute quantities of sulfur which over a period of time will attack and sulfide any contact material which is not resistant to sulfidation. For example, silver which is a preferred contact material for many applications cannot be employed as it has been found that the traces of sulfur in the oil combine with the silver to form silver sulfide which flakes off and causes short circuits or arc overs in the switch by forming a conducting path between fixed contacts.

To avoid this difficulty with the sulfur present in the mineral oil, it has been proposed to employ cooperating switch contacts having a fused layer of tin on the surface thereof. Such contacts are described in Patent 2,469,873—Hannon et al. These tin contacts are not affected by the sulfur in the oil. The tin-to-tin contact also possesses a low contact resistance. However, the tin-to-tin contacts have not possessed good wearing properties over long periods of time under the repeated heavy pressures of from 10 to 75 pounds and the sliding or rubbing motion between the contact surfaces which are inherent in the type of switch described in the above-mentioned Blume patent. Furthermore, under the high pressures, there has been a tendency for a galling or seizing action between the contacting surfaces with resultant high friction losses within the switch. These high friction losses have shown up in the form of a high torque required for changing the switch taps or contacts.

It is therefore a primary object of the present invention to improve the wear resistance and decrease the friction losses of tap changing switches comprising tin coated contacts.

Another object of the invention is to improve

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the operation of tap changing switches in which the contact members are normally required slidably to engage one another at pressures of from 10 to 75 pounds.

The present invention is based on the discovery that the above objects and others which will become apparent from the following description of the invention can be attained by providing the tin coated switch contacts with a thin iridescent oxide coating.

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 side elevation view partly in phantom of a transformer provided with a ratio adjuster switch;

Fig. 2 is a side elevation view of the switch shown in Fig. 1;

Fig. 3 is a sectional view taken on line 3-3 of Fig. 2;

Fig. 4 is an enlarged view of a pair of abutting contacts of the switch taken in the plane of Fig. 3; and

Fig. 5 is a circuit diagram showing how the switch contacts are connected to a winding.

Referring now to the drawing and more particularly to Fig. 1, there is shown a conventional transformer tank 1 provided at its top with high voltage bushings 2 whose inner ends are connected to a transformer winding 3 on a magnetic core 4. Taps 5 brought out from the winding 3 are connected to a ratio adjuster switch 6. The tank 1 is substantially filled with mineral oil up to the level indicated by 7. This mineral oil during operation of the transformer is raised to a temperature substantially above that of the ambient temperature, the temperature rise being typically 50-70° C. The switch 6 is operated from outside the tank by an operating shaft 8. The details of the switch 6 are shown in Figs. 2 and 3. Referring now to these figures, the switch comprises a pair of end members 9 of insulation between which extend a plurality of parallel contact rods or bars 10. Adjacent pairs of these rods are interconnected selectively by a bridging contact member 11 in the shape of a wedge. Any desired number of wedges may be used, there actually being two of these wedge members, one above the other, as shown in Fig. 2.

The wedges 11 are carried on rods 12 and springs 13 which are provided for forcing the wedges between the adjacent pairs of fixed contact rods. The switch is operated by a crank arm

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or member 14 on the main shaft 8. The crank 14 is embraced by a pair of members 15 and 16 which are held together by screws. The member 15 is provided with a notch 17 for engaging the various contact rods 10 during the operation of the switch.

The operation of the switch is as follows: Assume that shaft 8 is rotated clockwise as viewed from above. This will cause the crank 14 to rotate clockwise as viewed in Fig. 3, thus causing the assembly which is carried by the crank to pivot about the point of contact of the wedge 11 with the rods 10 and thereby cause the right hand notched end of the member 15 to move upwardly as viewed in Fig. 3. When the shaft has made about one-fourth of a revolution, the notch 17 is about in line with the rod 10 which in Fig. 3 occupies approximately the position of the numeral 2 on the face of a clock. Further rotation of the shaft 8 causes the crank 14 to back the wedge out from between the contact rods 10 to move the notch 17 into embracing relation with the previously mentioned rod 10. Further rotation of the shaft will then cause the wedge assembly to pivot about the notch 17 and finally, when the shaft has made almost one complete revolution, the wedge will be driven between the next lowermost pair of adjacent contact rods. This completes one cycle of the operation and it will be seen that for a little less than one complete revolution of the operating shaft 8 in either direction, the wedge will be moved in the opposite direction from between one pair of adjacent contact rods to the next pair of adjacent contact rods.

Fig. 5 illustrates one way in which the contact rods 10 may be connected to taps 5 of the winding 3. This winding may be either the primary or secondary winding of the transformer.

In Fig. 3 the heavy shading of the contacts' surfaces indicates the tin coating and the overlying thin iridescent oxide coatings. Both contacts are provided with such coatings. The tin coating itself has a thickness less than 0.001" as applied by electroplating and is thereafter fused, or in other words partially melted, into the metal backing of the switch, after which the final or remaining tin coating has a thickness of at least .0001" but less than about .0004".

The tin coating is applied as described in the above-mentioned Hannon et al. patent. The wedges 11 and the contact rods or bars 10, which comprise the switch contacts, are preferably composed of copper or alloys of copper, such as an alloy of copper and silver. The tin coating is preferably electroplated onto the rods and wedges which comprise the metal backing for the actual switch contacting surfaces until a layer of electro-deposited tin of the desired thickness is obtained. A plating time of twenty minutes at a current density of about 15 amperes per square foot in an alkaline stannate plating bath results in a very satisfactory plate thickness.

After the deposition of the tin coat, the members are removed from the bath and dried. Thereafter the tin coating is fused or melted onto the backing metal, preferably by immersion in hot oil. The fusing process provides an integral connection between the tin coating and the backing metal. The best resistance characteristics are obtained when the tin coating is between 0.0001 and 0.00026".

The resultant fused tin surfaces are then provided with a thin iridescent film of tin oxide by a short time anodic treatment in a suitable oxidizing bath.

Various oxidizing baths may be employed. For example, the tin contact surface may be made the anode in the solution of sodium carbonate containing 20 grams of the carbonate for each 100 milliliters of the aqueous solution. Within two hours at a current density of about 13 amperes per square foot at room temperature, there is obtained an iridescent surface coating on the tin which markedly increases the wear resistance and decreases the friction of the surface. Shorter treating times and higher current densities may also be employed. In fact it is desirable that the oxide film be as thin as possible and treating times as low as 30 seconds at a current density of 40 amperes per square foot have been found sufficient. The concentration of the sodium carbonate solution is not critical and satisfactory results have been obtained with solutions containing anywhere from 2.5 to 20 grams sodium carbonate per 100 milliliters solution. Regardless of the concentration of the solution, the treating times or the current densities, the oxidation process is continued until there is obtained on the surface a thin iridescent coating of oxide recognizable by the "rainbow" effect characteristic of thin films. It is, however, essential that the treatment be discontinued before the formation of the oxide film has progressed beyond the iridescent stage, as a thick opaque oxide film is undesirable both from the torque or friction standpoint and from the standpoint of high electrical resistance.

While the thin oxide coating increases the contact resistance somewhat, the increase is not sufficient to be objectionable from an electrical conductivity standpoint. For example, the average resistance of the oxidized contacts has been found to be in the neighborhood of from 20 to 60 microhms. However, if the oxide film is too thick and has progressed beyond the iridescent stage into a dark gray stage, the contact resistances may be as high as 400 to 440 microhms.

To determine the improved operating characteristics of the switches having the oxidized contacts, a number of tap changers of the type described in the Blume patent were assembled, some having ordinary tin coated contacts and others having the oxidized tin coated contacts. The torque required to rotate the shaft 8 through all of the positions directly after assembly and then after a high-potential test was measured. In these tests the recorded torque was the maximum torque and usually this maximum torque was exhibited in several of the tap changing positions. An average torque of about 5.2 pound-feet was recorded for those tap changers having the ordinary tin-to-tin contact surfaces. This average value was reduced to an average of 4.1 pounds-feet for oxidized contact surfaces having the thin iridescent oxide coating. Thus it is seen that the oxide coatings reduce the total torque by about 21 per cent which is a substantial reduction when it is taken into consideration that a large portion of the applied torque is required for the purpose of overcoming the resistance of the spring 13 which maintains the bridging wedge 11 between adjacent rods 10.

In a third group of tap changers in which the contacting surfaces had been over-oxidized beyond the iridescent stage, the average torque required to rotate shaft 8 was about 6.5 pounds-feet. Thus it is seen that a heavy oxidation layer increases the friction loss by about the same amount that a thin film lowers it.

While there has been shown and described a

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particular embodiment of the invention, it will be obvious to those skilled in the art that changes and modifications can be made without departing from the invention and, therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

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

1. An oil immersed switch comprising cooperating switch contacts adapted to slidably engage one another at pressures of 10 to 75 pounds, the surfaces of said contacts which are engaged by one another having thereon a fused coating of tin having a thickness of from .0001 to .0004" and a thin iridescent layer of tin oxide on the fused tin coating.

2. In an electric switch for operation submerged in hot mineral oil containing traces of

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sulfur, a plurality of insulated fixed contact members normally subjected to a potential difference, and a movable contact member for selectively and slidably engaging said fixed contact members at pressures of 10 to 75 pounds, the surfaces of said fixed contact members and the surfaces of said movable contact member which engage one another having thereon a fused tin coating and an overlying iridescent coating of tin oxide.

3. An electrical contact comprising a conducting base, a fused tin coating on said base and an oxidized tin layer on said fused tin coating.

References Cited in the file of this patent

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Number	Name	Date
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