

## THE USE OF GROUND-SHIELDS IN TRANSFORMERS.

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In any transformer there is a possibility that the high-pressure winding may become metallically connected to the low-pressure winding through failure of the insulation between these windings, so that if the low-pressure winding is not connected to ground it may be raised to a high potential above the earth. Under these conditions a person coming in contact with the low-pressure circuit may receive a dangerous shock, while the apparatus connected to this circuit is subjected to undue strains. If, however, the low-pressure winding is connected to ground, the maximum difference of potential which can exist between any part of it and ground is that which is established between the grounded point and that portion of the winding farthest removed, electrically, from the ground.

The ground-shield is a metallic sheet so placed between the high- and low-pressure windings of a transformer that the high pressure cannot break through to the low pressure without first going to ground. The ground-shield should be made preferably of copper, of a thickness of approximately  $1/32$  in., though it may be of any conducting material, and of practically any thickness desired. A convenient arrangement is to connect the ground-shield to the core of the transformer, which is grounded directly, or through the case. It is obvious that since the ground-shield surrounds the magnetic circuit it must not form a complete turn, and for this reason it is cut through in one place and the joint insulated.

While upon first thought the use of a ground-shield would appear to eliminate entirely the possibility of an abnormal pressure existing between low-pressure winding and ground,

there are, nevertheless, ways in which it may fail in accomplishing its purpose, and there are numerous practical difficulties in its use, particularly in large high-pressure transformers.

Some of the objections to the ground-shield are:

1. It does not prevent the possibility of an abnormally high pressure existing between low-pressure winding and ground, due to a connection between high- and low-pressure leads inside the case, or in the wiring exterior to the transformer.

2. The ground-shield must be of thin material. With transformers of large size where enormous current may flow in case of a short circuit, it is possible that a portion of the shield may be burned away or that the connection between it and the ground connection may be burned off, thus leaving the high- and low-pressure windings connected, but insulated from ground.

3. The introduction of the ground-shield into a transformer increases its cost, or lowers its efficiency, or both; for the same amount of insulation must be placed between the high-pressure winding and the ground-shield as is ordinarily placed between high- and low-pressure windings; and in addition the ground-shield must be insulated from the low-pressure winding.

4. In transformers there is a leakage magnetic field between high- and low-pressure coils. In that portion of the coils outside the iron this leakage field cuts through the ground-shield, producing eddy currents which may greatly increase the transformer losses. This is particularly true on high-pressure transformers where it is necessary for insulation purposes to make a difference in the lengths of the coils. On such transformers it is necessary to use very thin sheet-metal for the shield, and to slit it at the ends into a number of narrow strips, which are insulated from each other, except at one point.

*Conclusions.*—Since the ground-shield does not afford absolute protection, and as it increases the cost or reduces the efficiency of the transformer, and on account of the mechanical and electrical difficulties involved in its use, it would seem that for large high-pressure transformers the ground-shield is a theoretical, rather than a practical, means of protection.

It is believed that the grounding of the low-pressure winding at the neutral point is a safer, more practical, and cheaper method of protection than is the use of the ground-shield.

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