

**TRANSFORMER WITH FERRITE MAGNETIC CIRCUIT
RESISTANT TO THERMAL SHOCKS**

The subject of the present invention is a transformer with ferrite magnetic circuit resistant to thermal shocks.

Chopped supplies operating in "flyback" accumulation mode require energy storage in the ferrite double "E" magnetic circuit of the transformer before transferring this energy to the electrical circuit plugged in downstream of the transformer. This energy storage entails the use of a magnetic circuit with gap. Conventionally, assembly of the magnetic circuit and coil is carried out by gluing the outer limbs of the magnetic circuit as well as the gap.

Such a method of producing transformers makes it possible to guarantee good mechanical holding of the magnetic circuit and of the coil but does not meet the requirements of resistance to the thermal stresses prescribed by the standards in force (for example, ten thermal shock cycles with retention at -25°C for 30 min, abrupt change in a few seconds, to $+85^{\circ}\text{C}$ and retention for 30 min at this latter temperature, etc.). Indeed, the different coefficients of thermal expansion of the magnetic circuit and of the glue spot in the region of the gap then generate faults in the ferrite of the magnetic circuit.

In order to avoid the formation of such faults in the ferrite, an air gap could be provided, while gluing the coil to the coil to the magnetic circuit [sic]. The air gap would take up the mechanical stresses induced by the thermal tests, but would generate magnetostrictive phenomena evidenced by audible humming in the transformers, the magnetostriction being a phenomenon of elastic deformation linked to magnetisation.

A transformer is known from the document DE-U 8 609 584, for which it is sought to reduce the magnetostriction noise and the risks of fracturing the magnetic circuit, the solution proposed being to glue the

outer limbs and the gap with the aid of an epoxy glue, however it is specified therein that the coefficient of thermal expansion of this glue is "almost" equal to that of the ferrite of the magnetic circuit, which means that
5 this solution is unsuitable for strong thermal variations.

A transformer with cylindrical pot core magnetic circuit, whose gap is air, and which therefore has the abovementioned disadvantages, is known from the document
10 FR-A-1 380 363.

A transformer into which a deformable material is introduced in at least one gap is known from the document GB-A-2 039 156, but its magnetic circuit is "U"-shaped.

The subject of the present invention is a trans-
15 former of the type with ferrite magnetic circuit with double "E" cross-section, whose magnetic circuit may resist the thermal stresses of the aforesaid type, and which is not the site of magnetostriction noise.

The transformer according to the invention
20 includes, apart from a gluing of the outer limbs of the magnetic circuit, a gluing between coil former and magnetic circuit in the region of the base of the coil and includes, in the gap between the central limbs, a material from the silicone family. This material can be
25 deposited in the pasty state or in the form of a pellet having a thickness greater by a few tens of millimetres than the nominal thickness of the gap.

The present invention will be better understood on reading the detailed description of two embodiments given as non-limiting examples and illustrated by the
30 attached drawing in which:

- Figure 1 is a sectional view of a transformer with double "E" magnetic circuit, produced according to the prior art;
- 35 - Figure 2 is a sectional view of a transformer of the type of that of Figure 1, produced according to a first embodiment of the invention, and
- Figure 3 is a sectional view of a transformer of the type of that of Figure 1, produced according to a

preferred embodiment of the invention.

The transformer 1 of Figure 1 includes a magnetic circuit composed of two ferrite half-circuits 2, 3 having, in section, an "E" shape. The former 4 for coiling the transformer 1 carries a coil 5 including one or more electrically separated windings. Assembly of the magnetic circuit and the coil former is carried out by gluing. This gluing consists in injecting glue into the gap 6, into the space 7 between the walls of the axial hole of the former 4 and the inner limbs 8, 9 of the magnetic half-circuits 2, 3 and into the spaces 10, 11 between the opposing faces of the outer limbs of the circuits 2, 3.

Such assembly makes it possible to guarantee good mechanical holding of the magnetic circuit and of the coil, but only if the thermal variations to which the transformer 1 is subjected are not too wide and fast. Indeed, if the transformer were made to undergo "thermal shocks" of the type cited in the preamble, they induce [sic] faults in the ferrites owing to substantially different coefficients of thermal expansion of the ferrite and of the glue.

In order to solve this problem of resistance to thermal shocks, the present invention proposes, according to the embodiment of Figure 2, to carry out assembly of the magnetic circuit 2, 3 and of the former 4 of the transformer 1A differently. The gluing of the magnetic circuit with respect to the former 4 is undertaken only at the aforesaid spots 10 and 11 and on the outer face of a web 12 of the former 4 (glue spots 12A, 12B). This web 12 is the one which is on the side of the lower magnetic half-circuit 3 and of the base 13 for fixing the transformer and for electrical connection of its windings. The glue is that customarily used.

The gap 14 between the limbs 8, 9 is then empty, that is to say, it is an air gap. It takes up the mechanical stresses due to thermal shocks, which means that there are no longer any risks of fracturing the ferrites.

However, the air gap generates magnetostriction

noise which is evidenced by audible humming.

The embodiment of Figure 3 makes it possible very substantially to reduce this magnetostriction noise. The transformer 1B of Figure 3 is produced in the same way as the transformer 1A of Figure 2, but its gap determined by the limbs 8, 9 is filled with an absorber material 15 from the silicone family. According to this embodiment of Figure 3, the material 15 is deposited in the pasty state on the limb 9 of the lower magnetic half-circuit 3, in a thickness slightly greater than the nominal thickness which the gap should have. Before the hardening of this paste, the transformer is assembled as in the case of Figure 2, that is to say in particular with the glue spots 10, 11, 12A, 12B.

According to a variant, the material 15 is an already-hardened pellet which is deposited between the limbs 8, 9. The thickness of this pellet should be greater by about a few tens of millimetres than the nominal thickness of the gap. The surface area of its faces in contact with the limbs 8, 9 should be greater than about a quarter of the surface area of the opposing faces of the limbs and at most equal to the surface area of these faces.

The use of this silicone-coated material has, furthermore, the advantage of making it possible to reduce the operating temperature of the ends of the limbs 8, 9 by virtue of the good thermal conductivity of silicone. The magnetic circuit can therefore then allow a higher maximum operating temperature.



CLAIMS

1. Transformer with ferrite magnetic circuit resistant to thermal shocks, including a magnetic circuit of the type with double "E" cross-section, characterised in
5 that it includes a gluing (10, 11) of the outer limbs of the magnetic circuit and a gluing (12A, 12B) between coil former (4) and magnetic circuit (3) in the region of the base (13) of the coil, and in that a material from the
10 silicone family is arranged in the gap between the central limbs (8, 9).
2. Transformer according to Claim 1, characterised in that the thickness of the material is greater by a few
tens of millimetres than the nominal thickness of the gap.
- 15 3. Transformer according to one of Claims 1 or 2, characterised in that the material is deposited in the pasty state.
4. Transformer according to one of Claims 1 or 2, characterised in that the material is deposited in the
20 form of a pellet.
5. Transformer according to Claim 4, characterised in that the surface area of the faces of the pellet in contact with the central limbs (8, 9) is greater than
about a quarter of the surface area of the opposing faces
25 of these limbs, and at most equal to the surface area of these faces.