

The present invention relates to a transformer with closed magnetic circuit made of ferrite including an air gap, more particularly a transformer of the above-mentioned type used in switching-mode power supplies.

5 In fact, switching-mode power supplies operating in storage or in "flyback" mode necessitate energy storage in the ferrite magnetic circuit of a transformer before transferring this energy to the electrical circuit connected downstream of the transformer. This energy
10 storage requires the use of a magnetic circuit with an air gap. Conventionally, a typical transformer for a switching-mode power supply consists of a magnetic circuit composed of two ferrite half-circuits having, in cross-section, an "E" shape and of a coil armature
15 supporting a coil including one or more electrically separated windings. The coil armature is provided with an axial hole into which the central legs of the "E" are inserted. The magnetic circuit and the coil armature are joined together by adhesive bonding. Preferably, one of
20 the ferrite half-circuits is adhesively bonded to the coil armature, then the two magnetic half-circuits are joined together by adhesively bonding the facing faces of the outer legs of the circuits. An air-filled air gap is thus obtained between the inner legs. Such joining
25 guarantees good mechanical integrity of the magnetic circuit and of the coil. In fact, the air-filled air gap easily absorbs the mechanical stresses caused especially by heat shocks, as per the stresses required by the standards in force. However, when the air gap is an air-
30 filled air gap, it generates magnetostrictive phenomena which are manifested by audible hum in the transformer, magnetostriction being a phenomenon of elastic deformation associated with the magnetization, that is to say the geometrical characteristics of the ferrite vary as a
35 function of the magnetic induction.

In order to overcome these shortcomings, it has been proposed, in French Patent Application No. 87/15202 filed on 3rd November 1987, in the name of the Applicant Company, to place a material of the silicone family in

the air gap of the central legs. Although this material has given satisfactory results for fixed frequencies, the same is not the case when the transformer has to work at variable frequencies. What is more, the silicones which
5 have to be used are neutral silicones which exhibit the drawback of being poorly adhesive.

The object of the present invention is therefore to overcome the above shortcomings by proposing a novel material.

10 Consequently, the subject of the present invention is a transformer of the type with closed magnetic circuit made of ferrite including an air gap, characterized in that the air gap is filled with a single-component mastic exhibiting a Shore hardness having a constant
15 behaviour as a function of the temperature. Preferably, the mastic has a Shore hardness of 30 at 25°C.

According to a preferential embodiment, the single-component mastic is chosen from polysulphide or polyurethane mastics. Preferably, the mastic used is a
20 polysulphide mastic.

Single-component mastics, such as polysulphide or polyurethane mastics, exhibit the advantage of being self-adhesive and of being sufficiently pliant in order to damp the vibrations and, moreover, to polymerize
25 without shrinkage over time.

Other characteristics and advantages of the present invention will appear upon reading the description made hereinbelow of a preferential embodiment taken as a non-limiting example and illustrated by the herein
30 appended drawing in which:

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

As shown in Figure 1, a transformer 1 for switching-mode power supply includes a magnetic circuit composed of two ferrite half-circuits 2, 3 having, in

cross-section, an "E" shape. The lower magnetic half-circuit 3 includes an inner leg or central leg 9 shorter than the two outer legs. The transformer 1 also includes a coil armature 4. This armature supports a coil 5 including one or more electrically separate windings. The magnetic circuit and the armature of the coil are joined together by adhesive bonding, as explained hereinbelow. The adhesive bonding of the magnetic circuit with respect to the armature 4 consists in depositing adhesive on the outer face of a side-plate 12 of the armature 4. This side-plate 12 is the one which is on the side of the lower magnetic half-circuit 3 and the base 13 for attaching the transformer and for electrically connecting its windings. The spots of adhesive 12a and 12b therefore enable the magnetic circuit 3 and the armature 4 to be fastened together. Next, spots of adhesive are deposited in the spaces 10, 11 between the facing faces of the outer legs of the magnetic circuits 2, 3 so as to fasten the two magnetic circuits together. In this case, the air gap 6 between the inner legs 8, 9 then consists of air. This type of air gap absorbs the mechanical stresses due to heat shock. As a result, there is no risk of the ferrites cracking. However, this air-filled air gap generates magnetostriction noise which is manifested by audible hum, hum which is particularly annoying.

In accordance with the present invention and in order to decrease this magnetostriction noise very considerably, the air gap defined by the legs 8 and 9 is filled with an absorbing material 15, as shown in Figure 2. This material 15 consists of a single-component mastic exhibiting a Shore hardness of approximately 30 Shore A at 25°C. This Shore hardness has, in addition, a constant behaviour as a function of the temperature. In fact, the single-component mastic is chosen from polysulphide or polyurethane mastics. Preferably, a polysulphide mastic is used which has the advantage of actually having greater flexibility than polyurethane mastics. The polysulphide mastic also has the advantage of being a good heat sink, thereby enabling the

heat generated within the air gap to be removed more efficiently than in the case of an air-filled air gap.

By way of example, the polysulphide mastic used was the mastic sold by CIBA-GEIGY under the name of ARA seal PRC. This mastic was deposited, in the form of a pasty blob of from 0.4 to 0.7 grams, in an air gap having a width of 0.8 mm. This type of mastic has the advantage of polymerizing without appreciable shrinkage over time. This paste was deposited before joining the two magnetic half-circuits 2 together by the spots of adhesive 10 and 11, as in the case of Figure 1.



Patent Claims

1. Transformer of the type with closed magnetic circuit (2, 3) made of ferrite including an air gap (6), characterized in that the air gap (6) is filled with a single-component mastic (15) exhibiting a Shore hardness having a constant behaviour as a function of the temperature.
2. Transformer according to Claim 1, characterized in that the Shore hardness is 30 Shore A at 25°C.
3. Transformer according to Claims 1 and 2, characterized in that the single-component mastic is chosen from polysulphide or polyurethane mastics.
4. Transformer according to any one of Claims 1 to 3, characterized in that the single-component mastic is deposited in the pasty state.