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IMPROVEMENT TO TRANSFORMERS OF THE TYPE WITH CLOSED MAGNETIC CIRCUIT MADE OF FERRITE

The present invention relates to an improvement
5 to transformers with closed magnetic circuit made of
ferrite including an air gap.

Transformers with closed magnetic circuit made
of ferrite including an air gap are used in particular
in switching-mode power supplies. In fact, switching-
10 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
15 storage requires the use of a magnetic circuit with an
air gap. Conventionally, a 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
20 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.
25 Preferably, one of 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
30 between the inner legs. Such joining guarantees good
mechanical integrity of the magnetic circuit and of the
coil. This is because the air-filled air gap easily
absorbs the mechanical stresses caused especially by
the heat shocks as per the standards in force. However,
35 when the air gap is an air-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 charac-

teristics of the ferrite vary as a function of the magnetic induction.

In order to overcome this drawback, it has been proposed to fill the air gap with various types of pliant materials so as to damp the magnetostriction vibrations created by the two facing faces of the air gap of the magnetic circuit. Thus, in French Patent No. 87 15207 filed on 3 November 1987, in the name of the company Oréga Electronique et Mécanique, it has been proposed to place a material of the silicone family in the air gap. Moreover, in order to obtain this damping effect when the transformer works at variable frequencies, it has been proposed in European Patent Application No. A 390,643, filed in the name of the company Oréga Electronique et Mécanique, to fill the air gap with a single-component mastic exhibiting a Shore hardness having a constant behaviour as a function of temperature, such as polysulphide or polyurethane mastic.

Although these materials have given good results when the air gap is narrow, that is to say when it has a thickness of less than 1 mm, this is not so when the air gap is larger. In fact, the filling material must be quite soft in order to fulfil the role of vibration damper, but also quite hard in order to limit the amplitude of these said vibrations. Now, the currently used materials do not allow this hardness/softness compromise when the air gap is large.

Consequently, the object of the present invention is mainly to overcome this drawback by proposing a novel type of filling for the air gap.

Thus, the subject of the present invention is a transformer of the type with closed magnetic circuit made of ferrite including an air gap partly filled with a material which is sufficiently pliant to damp the vibrations, characterized in that, in addition, a rigid component is inserted into the air gap.

In this case, the rigid component may fill either the entire air gap or only part of the air gap.

Preferably, the rigid component fills the air gap to within 0.1 mm, the rest being filled with the pliant material.

According to another characteristic of the present invention, the rigid component consists of a non-magnetic material which does not deform at the temperatures of operation of the transformer, namely for temperatures of up to 110°C. Preferably, the non-magnetic material is the material known by the name bakelite.

According to yet another characteristic of the present invention, the air gap has a thickness greater than 1 mm.

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

- Figure 1 is a sectional view of a transformer with a magnetic circuit in the form of a double "E" according to an embodiment to which the present invention may apply, and

- Figure 2 is an enlarged sectional view of the air gap of the transformer in Figure 1, provided with a sufficiently pliant material and with a rigid component in accordance with the present 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 4 shorter than the two outer legs, while the upper magnetic half-circuit 2 includes an inner leg or central leg 5 having the same length as the two outer legs. Thus, when the two half-circuits 2 and 3 are brought together, an air gap 6 having a thickness e is produced between the two inner legs 4,5.

Moreover, the transformer 1 also includes a coil armature 7. This armature supports a coil 8

including one or more electrically separate windings. The magnetic circuit and the armature of the coil are joined together, in a known manner, by adhesive bonding. Likewise, the two magnetic half-circuits 2 and 3 are joined together by adhesively bonding the facing faces of the outer legs so as to fasten the magnetic circuits together. In addition, the lower magnetic half-circuit 3 is fixed in a known manner to a base 9 for attaching the transformer and for electrically connecting its windings by pins 10.

In accordance with the present invention and as shown in a more detailed manner in Figure 2, the air gap 6 between the inner legs 5 and 4 of the two magnetic half-circuits is filled with a material making it possible to reduce the magnetostriction noise very considerably. In accordance with the present invention, this absorbing material consists of a first material 11 which is sufficiently pliant to damp the vibrations. This material 11 may consist either of a single-component mastic or of a material of the silicone family. The single-component mastic is a mastic exhibiting a Shore hardness of approximately 30 Shore A at 25C° [sic], displaying a constant behaviour as a function of 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 currently having greater flexibility than polyurethane mastics. A material of the silicone family, namely neutral silicones, can also be used.

Under this pliant material, which is provided under the upper leg 5, a rigid component forming an insert is deposited. This rigid component consists of a non-magnetic material chosen from synthetic resins such as bakelite. The resin must be able to withstand temperatures of 110°C without deforming. This rigid material may be placed within substantially the entire air gap or only in part of the air gap, so as to act as a mechanical damper. This type of filling for the air

gap appears to be particularly advantageous for air gaps having a thickness a of greater than 1 mm. In this case, the magnetostriction noise is markedly decreased, while at the same time producing a good damper. In order to achieve maximum efficiency, the insert fills most of the air gap, a thickness of approximately 0.1 mm being filled with the mastic.

The process of putting the assembly, consisting of the pliant material and the rigid component into the air gap 6 will now be described in more detail. Thus, a spot of adhesive is deposited on the inner leg, for example 4, of one of the ferrite half-circuits. This spot of adhesive enables the bakelite insert to be mechanically held in place. Next, this half-circuit 3 equipped with the insert 12 is positioned in the armature. A metered amount of mastic 11 is then deposited, using a known system, on the insert 12 before the magnetic circuit is closed by the ferrite half-circuit 2.



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REPLACED

1. Transformer of the type with closed magnetic circuit made of ferrite including an air gap (6) partly filled with a material (11) which is sufficiently
5 pliant to damp the vibrations, characterized in that, in addition, a rigid component (12) is inserted into the air gap.
2. Transformer according to Claim 1, characterized in that the rigid component substantially fills the
10 entire air gap.
3. Transformer according to Claim 1, characterized in that the rigid component fills part of the air gap.
4. Transformer according to any one of Claims 1 to 3, characterized in that the rigid component consists
15 of a non-magnetic material.
5. Transformer according to Claim 4, characterized in that the non-magnetic material consists of bakelite.
6. Transformer according to any one of Claims 1 to 5, characterized in that the material sufficiently
20 pliant to damp the vibrations is chosen from single-component mastics or a material of the silicone family.
7. Transformer according to any one of Claims 1 to 6, characterized in that it has an air gap ≥ 1 mm.

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