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(54) IMPROVEMENT IN OR RELATING TO CHOKES OR REACTORS

(71) I, CHEW SENG KOH, a Singapore Citizen, of 108 Joo Chiat Terrace, Singapore 15, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to chokes or reactors.

One known type of choke or reactor comprises a core as shown in Figures 1a, 1b or 1c. The type of choke or reactor shown in Figure 1a has two stacks of E-shaped laminations with corresponding limbs of the laminations end to end. A winding is wound around the central core formed by the central limbs of the two stacks of E-shaped laminations. In the construction shown in Figure 1b, two stacks of U-shaped laminations are placed with their limbs end to end and a winding is fitted around one or both of the limbs of the thereby completed magnetic circuit. The constructions shown in Figures 1a and 1b have the disadvantage that they require different blanking tools and dies for cutting laminations for different shapes and sizes of cores. A certain proportion of material has to be wasted in cutting the laminations using the blanking process.

A choke or reactor is constructed using the stacks of laminations illustrated in Figure 1c using the following method. A coil is wound around a central limb which consists of a stack of flat laminations and then the arms of the two stacks of U-shaped cores are fitted around the coil so as to enclose it. The limbs of the U-shaped laminations are longer than the central core so that an air gap is left at each end of the central core. The U-shaped laminations are then inserted in a tightly fitting casing and force is applied to the bases of the U-shaped laminations to push them together so as to adjust the air gap. This construction has the disadvantage that the various components have to be made to considerable accuracy as they have to fit together tightly so as to avoid vibration. That is, in practice, difficult to achieve owing to toler-

ance in the materials, winding techniques of the coils and the forming of the core limbs. Secondly, force has to be applied to the bases of the stacks of the U-shaped laminations to adjust the air gaps in the core and this force sometimes results in the core laminations being forced out of position and this is not easily noticeable from outside. This may cause noise and vibration to be produced during testing and use and the only way to correct this is to dismantle the entire choke or reactor and re-assemble it. It will be appreciated that this is expensive and it slows production.

It is an object of this invention to provide a choke or reactor in which at least one of the stated disadvantages is alleviated.

According to this invention, there is provided a choke or reactor comprising a casing open at one end, laminations which define an E-shaped structure having a base, two outer limbs, and a central limb, and a winding which surrounds the central limb, the laminations of each outer limb being integral with the laminations of the base and being bent at the junction with the base, the laminations and the winding being disposed in the casing so that those ends of the central limb and outer limbs which are remote from the base are adjacent the open end of the casing.

Suitably some of the laminations define a U-shaped structure which provides the said outer limbs and the said base, others of the said laminations defining the central limb the inner end of which is adjacent the base. Preferably there is a non-magnetic gap between the inner end of the central limb and the base of the U-shaped structure the width of which gap is adjusted to set the value of the choke or reactor.

Alternatively the laminations define first and second U-shaped structures which are juxtaposed in line to provide the said E-shaped structure.

Preferably the central limb is divided into two parts with a non-magnetic gap between the two parts.

There may be no magnetic material providing a magnetic path between those ends

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of the outer limbs and the central limb which are remote from the base other than the limbs and the base.

5 However the free ends of the outer limbs and the central limb which are remote from the base may be connected by laminations disposed therebetween. These laminations may be normal to or parallel to the lamination of the limbs.

10 The E-shaped structure may comprise a plurality of U-shaped structures disposed side by side so that their limbs and bases are in line.

15 Embodiments of this invention will now be described, by way of example only, with reference to the drawings accompanying the Provisional Specification (Figures 1a to 1c, Figures 2a to 2c and Figures 3a to 3g) and to the accompanying drawing (Figure 3h) of which:—

20 Figures 1a, 1b and 1c illustrate known chokes or reactors and have been referred to;

25 Figures 2a, 2b and 2c illustrate a choke or reactor in accordance with this invention at various stages in its construction; and

Figures 3a, b, c, d, e, f, g and h illustrate various embodiments of this invention.

30 Referring to Figures 2a, 2b and 2c a casing 1 is filled with a quantity of resin 2 and a stack of U-shaped laminations 3 is placed over the mouth of the casing 1, an insulation pad 4 being disposed at the base of the stack of U-shaped laminations 3. As shown in Figure 2b, a central limb, comprising a stack of flat laminations 5 and having a coil 6 wound around it, is placed within the stack of U-shaped laminations 3 so as to rest against the insulation pad 4 and then short horizontal laminations 7 are inserted between the central stack of laminations 5 and the outer limbs of the stack of U-shaped laminations 3. This assembly is then pushed into the casing 1 until the stack of laminations 3 has entered the resin 2 at the base of the casing 1. If the outer limbs of the stack of laminations 3 do not fit firmly inside the casing 1 padding is inserted when the stack of laminations 3 is inserted into the casing 1. The choke or reactor is then connected to a reference circuit and the assembly of the stacks of laminations 3, 5 and 7 and the winding 6 is further forced into the casing 1 by a force applied to the central stack of laminations 5. During this process, the insulation pad 4 is compressed so as to vary the air gap through it until the value of the choke or reactor is that desired. It will be appreciated that while the entire assembly is forced inside the casing 1, the resin 2 flows up the side of the casing 1 and eventually covers the top of the assembly as illustrated in Figure 2c.

The construction shown in Figures 2a, 2b and 2c has the advantages that it is not necessary to use different tool sizes for different core shapes and sizes and only simple shearing and bending tools are necessary. Furthermore, there is little waste material and as shearing does not induce heavy stresses in the material annealing of the laminations to relieve the stress is not normally required. As has already been explained it is possible to use padding if the laminations 3 do not fit perfectly within the casing 1 and consequently as compared to the known construction shown in Figure 1c it is not necessary for every part of the reactor or choke to be precision made. It is, in fact, possible to use padding between the limbs of the laminations 3 and the central laminations 5 should the winding 6 not wholly fill this space. Furthermore, the resin 2 fills up all the remaining space and thereby limits the vibrations.

A further advantage is that the various steps of assembly of the choke or reactor including the adjustment of its air gap, testing of the choke or reactor and sealing are all carried out in one continuous operation. Consequently, less time is required in manufacture as compared to the manufacture of the chokes or reactors shown in Figures 1a to 1c and accurate adjustments are easier to achieve.

The laminations of each stack can be secured together by bending over the outer laminations but preferably by glueing, welding, bolting, clamping or any other convenient method.

Figures 3a and 3b show alternative methods of inserting laminations 7 to complete the core and the Figures 3c to 3g show the different constructions of the outer core which can be employed.

In the embodiment shown in Figure 3a, the laminations 7 are horizontal as in the embodiments of Figures 2a, 2b and 2c in contrast to the limbs of the stack of laminations 3 which have vertical laminations. In the embodiment shown in Figure 3b, the laminations 7 are short laminations in line with the outer limbs of the laminations 3 and, as shown, are vertical. The construction of the magnetic core shown in Figure 3c is as in the embodiments of Figures 2a, 2b, 2c.

In the embodiment shown in Figure 3d, two stacks of laminations 3a and 3b are juxtaposed so that the adjacent limbs of the stacks of laminations 3a and 3b provide the central core and the remote outer limbs of the stacks of laminations 3a and 3b provide the outer limbs.

In the embodiment shown in Figure 3e, the stacks of U-shaped laminations 3 are replaced by two stacks of L-shaped laminations 10 and 11, the shorter limb of the stack

10 being placed on the shorter limb of the stack 11 to provide the U-shaped core.

In the embodiment shown in Figure 3f, two crossed stacks of U-shaped laminations 12 and 13 are provided to entirely enclose the central stack of laminations 5.

In the embodiment shown in Figure 3g, the stack of U-shaped laminations 3 is replaced by several stacks of narrow laminations which are in line to provide effectively a wide U-shaped core in order to reduce eddy current loss if this be necessary.

In the embodiment shown in Figure 3h the central stack of laminations is divided into two stacks 5a and 5b with a gap 14 between them. The gap 14 serves to increase the gap leakage where this is required.

In a modification of the embodiments of Figures 3c to 3h, the laminations 7 are entirely omitted.

A choke or a reactor is the commonly used name of an inductor.

WHAT I CLAIM IS:—

1. A choke or reactor comprising a casing open at one end, laminations which define an E-shaped structure having a base, two outer limbs, and a central limb, and a winding which surrounds the central limb, the laminations of each outer limb being integral with the laminations of the base and being bent at the junction with the base, the laminations and the winding being disposed in the casing so that those ends of the central limb and outer limbs which are remote from the base are adjacent the open end of the casing.

2. A choke or reactor as claimed in claim 1 wherein some of the laminations define a U-shaped structure which provides the said outer limbs and the said base, others of the said laminations defining the central limb the inner end of which is adjacent the base.

3. A choke or reactor as claimed in claim 2 which comprises first and second U-shaped structures with the base of the first U-shaped structure resting against the base of the second U-shaped structure, the limbs of the U-shaped structures extending away from their respective bases with the limbs of the first U-shaped structure in planes normal to those of the second U-shaped structure, the inner end of the central limb being adjacent the base of the first U-shaped structure.

4. A choke or reactor as claimed in claim 2 wherein each outer limb of the U-shaped structure is the longer limb of a stack of laminations defining an L-shaped structure, the shorter limb of one L-shaped structure resting against the shorter limb of the other L-shaped structure to provide the generally U-shaped structure.

5. A choke or reactor as claimed in any of claims 2 to 4 wherein there is a non-magnetic gap between the inner end of the central limb and the base of the U-shaped structure the width of which gap is adjusted to set the value of the choke or reactor.

6. A choke or reactor as claimed in claim 5 wherein the gap between the inner end of the central limb and the base of the U-shaped structure is filled with compressible material.

7. A choke or reactor as claimed in claim 1 wherein the laminations define first and second U-shaped structures which are juxtaposed in line to provide the said E-shaped structure.

8. A choke or reactor as claimed in any preceding claim wherein the central limb is divided into two parts with a non-magnetic gap between the two parts.

9. A choke or reactor as claimed in any preceding claim wherein there is no magnetic material providing a magnetic path between those ends of the outer limbs and the central limb which are remote from the base other than the limbs and the base.

10. A choke or reactor as claimed in any of claims 1 to 8 wherein those ends of the outer limbs and the central limb which are remote from the base are connected by laminations disposed therebetween.

11. A choke or reactor as claimed in claim 10 wherein the laminations which connect those ends of the outer limbs and the central limb which are remote from the base are normal to the laminations of the limbs.

12. A choke or reactor as claimed in claim 10 wherein the laminations which connect those ends of the outer limbs and the central limb which are remote from the base are parallel to the laminations of the limbs.

13. A choke or reactor as claimed in claim 1 wherein the E-shaped structure comprises a plurality of said U-shaped structures disposed side by side so that their limbs and bases are in line.

14. A choke or reactor as claimed in any preceding claim which comprises resin which covers the laminations in the casing.

15. A choke or reactor as claimed in any preceding claim wherein padding is disposed between the outer limbs and the casing.

16. A choke or reactor substantially as hereinbefore described with reference to Figures 2a to 2c and 3a to 3h of the drawings accompanying the Provisional Specification and the accompanying drawings.

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10 being placed on the shorter limb of the stack 11 to provide the U-shaped core.

In the embodiment shown in Figure 3f, two crossed stacks of U-shaped laminations 12 and 13 are provided to entirely enclose the central stack of laminations 5.

In the embodiment shown in Figure 3g, the stack of U-shaped laminations 3 is replaced by several stacks of narrow laminations which are in line to provide effectively a wide U-shaped core in order to reduce eddy current loss if this be necessary.

In the embodiment shown in Figure 3h the central stack of laminations is divided into two stacks 5a and 5b with a gap 14 between them. The gap 14 serves to increase the gap leakage where this is required.

In a modification of the embodiments of Figures 3c to 3h, the laminations 7 are entirely omitted.

A choke or a reactor is the commonly used name of an inductor.

WHAT I CLAIM IS:—

1. A choke or reactor comprising a casing open at one end, laminations which define an E-shaped structure having a base, two outer limbs, and a central limb, and a winding which surrounds the central limb, the laminations of each outer limb being integral with the laminations of the base and being bent at the junction with the base, the laminations and the winding being disposed in the casing so that those ends of the central limb and outer limbs which are remote from the base are adjacent the open end of the casing.

2. A choke or reactor as claimed in claim 1 wherein some of the laminations define a U-shaped structure which provides the said outer limbs and the said base, others of the said laminations defining the central limb the inner end of which is adjacent the base.

3. A choke or reactor as claimed in claim 2 which comprises first and second U-shaped structures with the base of the first U-shaped structure resting against the base of the second U-shaped structure, the limbs of the U-shaped structures extending away from their respective bases with the limbs of the first U-shaped structure in planes normal to those of the second U-shaped structure, the inner end of the central limb being adjacent the base of the first U-shaped structure.

4. A choke or reactor as claimed in claim 2 wherein each outer limb of the U-shaped structure is the longer limb of a stack of laminations defining an L-shaped structure, the shorter limb of one L-shaped structure resting against the shorter limb of the other L-shaped structure to provide the generally U-shaped structure.

5. A choke or reactor as claimed in any of claims 2 to 4 wherein there is a non-magnetic gap between the inner end of the central limb and the base of the U-shaped structure the width of which gap is adjusted to set the value of the choke or reactor.

6. A choke or reactor as claimed in claim 5 wherein the gap between the inner end of the central limb and the base of the U-shaped structure is filled with compressible material.

7. A choke or reactor as claimed in claim 1 wherein the laminations define first and second U-shaped structures which are juxtaposed in line to provide the said E-shaped structure.

8. A choke or reactor as claimed in any preceding claim wherein the central limb is divided into two parts with a non-magnetic gap between the two parts.

9. A choke or reactor as claimed in any preceding claim wherein there is no magnetic material providing a magnetic path between those ends of the outer limbs and the central limb which are remote from the base other than the limbs and the base.

10. A choke or reactor as claimed in any of claims 1 to 8 wherein those ends of the outer limbs and the central limb which are remote from the base are connected by laminations disposed therebetween.

11. A choke or reactor as claimed in claim 10 wherein the laminations which connect those ends of the outer limbs and the central limb which are remote from the base are normal to the laminations of the limbs.

12. A choke or reactor as claimed in claim 10 wherein the laminations which connect those ends of the outer limbs and the central limb which are remote from the base are parallel to the laminations of the limbs.

13. A choke or reactor as claimed in claim 1 wherein the E-shaped structure comprises a plurality of said U-shaped structures disposed side by side so that their limbs and bases are in line.

14. A choke or reactor as claimed in any preceding claim which comprises resin which covers the laminations in the casing.

15. A choke or reactor as claimed in any preceding claim wherein padding is disposed between the outer limbs and the casing.

16. A choke or reactor substantially as hereinbefore described with reference to Figures 2a to 2c and 3a to 3h of the drawings accompanying the Provisional Specification and the accompanying drawings.

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