

COMPACT CORE FOR AN INDUCTIVE DEVICE

The present invention relates to a compact core for an inductive device such as a transformer or
5 transducer, suitable for use in various apparatuses such as flash discharge lamps, photographic cameras, lighting equipment and electric communication systems in general.

There has always been a demand for effectively reducing the outer dimensions of such devices. In
10 particular, there is a demand to reduce the outer dimensions of devices of tripod shell-type without loss of operational efficiency.

It is well known that the device (transformer or transducer) of this type often includes a core 1 having a
15 configuration in E-E or E-I shape as shown by Fig.1(a) or Fig.2(a), respectively, and a coil 2 wound thereon in such a manner as shown by Fig.1(b) and Fig.2(b). This means that the overall size of the device depends upon the length and the width of the core 1. Accordingly, there
20 might be an attempt to reduce the overall dimensions by reducing the dimensions of the core 1 itself. However, this would lead to problems with respect to mechanical strength and the electrically required amount of iron. Specifically, excessive reduction of the core legs in
25 their cross-section, and particularly in the cross-sections 1a,1b of the side legs, would lead to damage of said core 1 in the course of manufacturing said core itself or the device as a whole, since said core 1 is made of ferrite having a high magnetic permeability. It is for
30 this reason that the cross-section of commercially produced cores has been limited to a range between 8.82 mm^2 and 5.76 mm^2 .

The central leg 1c has conventionally had a cross-section twice as large as the cross-section of each of the
35 side legs 1a,1b and there must be spacings available

between the central leg lc and the side legs la, lb, respectively, at least sufficient for provision of the coil to generate a given output.

Furthermore, dimensional reduction of the core 1 is
5 subjected to a limitation also because any forcible attempt to achieve said dimensional reduction, for example, by reducing the cross-section of the central leg lc would result in an insufficient amount of iron to provide the desired output.

10 The present invention provides a core of tripod shell-type for an inductive device, comprising a central leg, and a side leg on each side thereof, the central leg having two side surfaces each facing an inner surface of
15 a respective side leg, the central leg also having a third surface extending between its two side surfaces, each side surface of the central leg having a first edge region adjoining the third surface and an opposing second edge region remote therefrom, the distance between the
20 first edge regions being greater than the distance between the second edge regions, the side legs being shaped such that their inner surfaces each extend substantially parallel to the corresponding side surface of the central leg.

Preferably, one of the side legs protrudes
25 beyond the level of the central leg, in a direction normal to the general plane of the three legs, into a space adjacent a space above or below the central leg, whereby a coil may be wound around the central leg and in said
latter space without the coil protruding in said direction
30 beyond said side leg.

Preferably both side legs are of the same form. In a preferred form, the central leg is trapezoidal in cross-section.

The present invention will now be described in more detail with reference to preferred embodiments shown in the accompanying drawings. In the drawings:

Fig.1(a) and Fig.2(a) are front views of respective prior art cores;

Fig.1(b) and Fig.2(b) are side views of these prior art cores;

Fig. 3 is a perspective view showing an inductive device utilising a core according to the present invention;

Fig. 4 is a side view in section showing the same;

5 Fig. 5 is a dismantled perspective view showing the same;

Fig. 6(a) is a plan view showing a core embodying the present invention;

Fig. 6(b) is an end view showing the same;

10 Fig. 7 is a schematic fragmentary view illustrating, on an enlarged scale, a principle of core construction embodying the present invention;

Fig. 8 is a side view showing another embodiment of a core constructed according to the present invention;
15 and

Fig. 9 is a perspective view similar to Fig. 3 but showing a device with an altered arrangement of terminal pins.

Referring to Figs.3 to 6 showing a preferred
20 embodiment of the present invention, reference numerals 11,12 designate identically configured core portions made of ferrite with a high magnetic permeability, reference numeral 13 designates a bobbin having an opening 13a which extends therethrough and adapted to receive said
25 core portions 11,12, and reference numeral 14 designates a coil consisting of a primary coil portion and a secondary coil portion both wound around said bobbin 13. A feedback or other coil may also be wound around said bobbin 13 if it is necessary. Reference numeral 15 designates terminal pins
30 vertically planted on said bobbin 13 at a thicker portion 13b. These terminal pins 15 have the opposite ends of the coil 14 fixed thereto, e.g. by soldering. Reference numeral 16 designates insulating material with which the outer periphery of said coil 14 is covered. This
35 insulating material 16 may for example take the form of insulator tape and is provided as the occasion demands.

Said core portions 11,12 are of a construction as shown by Figs.6(a) and (b). As seen from Figs.6(a) and (b), central legs 11c,12c associated with the core portions 11,12, respectively, each has a trapezoidal cross-section while side legs 11a,11b and 12a,12b associated with said core portions 11,12, respectively, each has a substantially right-angled triangular cross-section so that respective angularly inclined surfaces of the central legs 11c,12c extend substantially in parallel to the associated inner surfaces of the side legs 11a,11b and 12a,12b corresponding to the diagonal surfaces of the respective side legs.

As best seen from Figs.4 and 5, said core portions 11,12 are brought together into close abutment along the opposed end surfaces of the corresponding legs by inserting the respective central legs 11c,12c into the bobbin 13 from opposite sides. Then, said corresponding legs are fixed together e.g. with a suitable adhesive along the plane of said abutment between said end surfaces of the corresponding legs and thereby the core portions 11,12 are fixed to the bobbin 13.

In this manner, the transformer or transducer as a whole may be dimensionally reduced in accordance with a principle as will be described in reference with Fig.7. Referring to Fig.7, the area enclosed by a line connecting A,B,C,D,H,G,F and E corresponds to a portion of a conventional core 1 as shown by Figs.1 and 2, the area ABFE representing the central leg 1c and the area CDHG representing one of the side legs 1b. Letting ϕ represent the centre line with respect to the core thickness, and $\underline{f}$, $\underline{h}$ and $\underline{i}$ represent points at which the sides of the respective legs 1b,1c intersect said centre line ϕ , there are now established relationships $\underline{Bf} = \underline{fF}$, $\underline{Ch} = \underline{hG}$ and $\underline{Di} = \underline{iH}$. On the assumption of a straight line $\underline{ad}$ passing through the intersecting point $\underline{f}$ at an angle of θ ,

$A_{faB} = A_{fdF}$ and, therefore, it is possible to obtain a central leg lc with a trapezoidal cross-section which has a cross-sectional area equal to the total cross-sectional area of the side legs.

- 5 Now it is assumed that a straight line fg extends from said intersecting point f at the angle θ , $fg = fh$ and an imaginary straight line be passing the point g extends in parallel to the imaginary straight line ad . Further, on the assumption of a line ec normal to the straight line EH at the point e , a straight line bc extending in parallel to the straight line AD is selected so that Δbce has a cross-sectional area equal to that of $\Delta CDHG$. In this manner, the right leg lb can be replaced by a new leg having a cross-section corresponding to Δbce .
- 10 Because of the relationship $fg = fh$, the spacing required for winding the coil around the core remains unchanged even after such reformation. The width of the core can be reduced by an amount eH in respect of the right leg lb and, accordingly, overall the core width can be reduced by $2eH$.
- 15 The value of eH is given by

$$eH = FH - fh \cos \theta - (fh \sin \theta + fF) \tan \theta.$$

- As an example of core configuration, geometric relationships of $fF = x$, $fh = x$, $hi = x$ and $FH = 2x$ are set, and a value of θ is obtained when $eH = 0$, exclusive of the cases
- 25 $\theta = 90^\circ$ and $\theta = 0^\circ$, since the former case is meaningless and the latter case is unreal in the above-mentioned formula. Thus, $\theta = \cos^{-1} 0.8 = 36.87^\circ$ is obtained from a formula

$$eH = 2x - x \cos \theta - (x \sin \theta + x) \tan \theta = 0.$$

- 30 Accordingly, the core width can be reduced at an angle of 36.87° or less.

- The principle has been described above on the basis of the formulae for calculation. However, a more remarkable effect can be expected than as expected from such description of the principle, when the core portions
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11,12 constructed in accordance with the embodiment of the present invention above are practically assembled into a transformer or transducer. Specifically, with the core portions 11,12 as in the embodiment, the side legs 11a,11b and 12a,12b include portions protruding upward (as seen in Figs.6 and 7), respectively, which corresponding to a space defined immediately above the side legs 1a,1b shown by Figs.1(b) and 2(b). Furthermore, the coil 14 wound around the core portions 11,12 would protrude, as seen from Fig.6(b), into a space defined immediately below the side legs 1a,1b of the conventional core 1. Both the spaces defined above and below the side legs 1a,1b of the conventional core 1 are left empty after incorporation of the transformer or transducer and are not used for construction of such transformer or transducer itself. In contrast with this, these spaces are effectively utilized for construction of the transformer or transducer in accordance with the above embodiment of the present invention.

When the central legs 11c,12c of the core are configured so as to be exactly trapezoidal in the respective cross-sections, each central leg would have its outer peripheral surface defined by four planes and, as a result, the coil 14 wound therearound would swell outward. A depressive force exerted thereon tending to bring the coil into close contact with the leg surface might adversely influence the coil. To avoid this, it is preferred to curve the surface of each central leg 11c,12c convexly and simultaneously to curve the inner surface of each side leg 11a,11b,12a,12b concavely so that the convexity and the concavity may complement each other, as shown by Fig.8.

The central leg may have a triangular cross-section to provide the same effect as obtained from the above-mentioned construction. An embodiment is also

possible according to the present invention, wherein said terminal pins 15 laterally project from the device as shown by Fig.9, instead of projecting downward.

It will be obviously understood from the foregoing
5 description that the core constructed as described can more effectively be substantially reduced dimensionally than a conventional core having the same amount of iron therein, without any loss of the operating efficiency since the amount of iron as well as the number of coil
10 windings remain the same.

It should be noted here that the present invention may be executed also with a core of E-I form by combining one of said core portions 11,12 (provided with relatively long legs) with an I-shaped core.

CLAIMS:

1. A core of tripod shell-type for an inductive device, comprising a central leg, and a side leg on each side thereof, the central leg having two side
5 surfaces each facing an inner surface of a respective side leg, the central leg also having a third surface extending between its two side surfaces, each side surface of the central leg having a first edge region adjoining the third surface and an opposing second edge
10 region remote therefrom, the distance between the first edge regions being greater than the distance between the second edge regions, the side legs being shaped such that their inner surfaces each extend substantially parallel to the corresponding side surface of the
15 central leg.
2. A core according to claim 1, in which one of the side legs protrudes beyond the level of the central leg, in a direction normal to the general plane of the three
20 legs, into a space adjacent a space above or below the central leg, whereby a coil may be wound around the central leg and in said latter space without the coil protruding in said direction beyond said side leg.
- 25 3. A core according to claim 1 or claim 2 wherein the two side legs are of the same form as each other.
4. A core according to any one of the preceding claims in which said side legs are substantially
30 triangular in cross-section.
5. A core according to any one of the preceding claims in which the central leg is substantially trapezoidal in cross-section.
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6. A core according to any one of claims 1 to 4 in which the central leg is substantially triangular in cross-section.



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7. A core according to any one of the preceding claims in which the side surfaces of the central leg are convexly curved, and the inner surfaces of the side legs have a concave curve.

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8. A core for an inductive device substantially as any described herein with reference to Figs. 3 to 9 of the accompanying drawings.

10 9. A transformer or transducer having a core according to any one of the preceding claims.

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