Nov. 23, 1965 A. E. FEINBERG 3,219,957

CORE FOR ELECTROMAGNETIC DEVICE

Filed Dec. 3, 1957

Fig. 1.

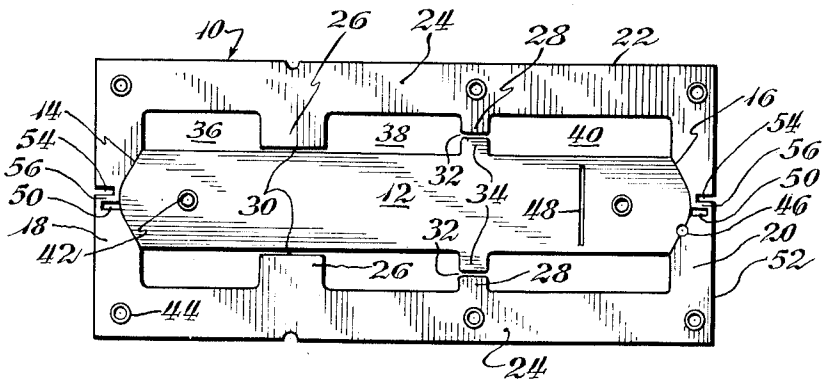


Fig. 2.

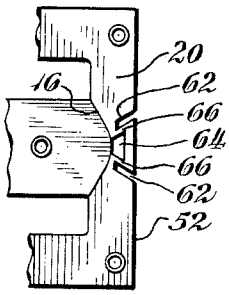


Fig. 3.

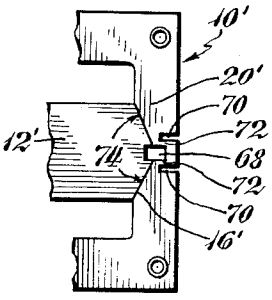


Fig. 4.

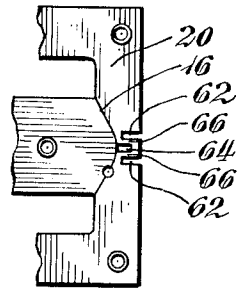
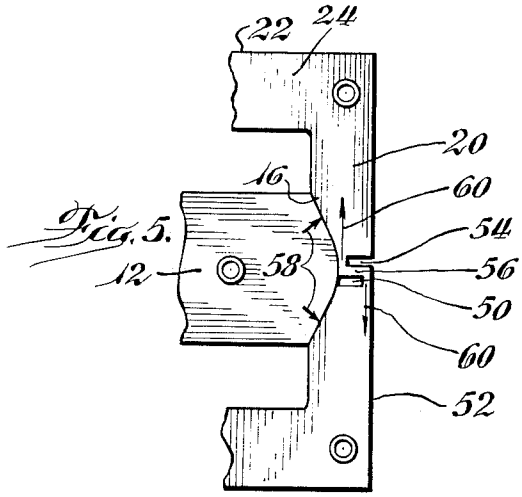


Fig. 5.



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CORE FOR ELECTROMAGNETIC DEVICE

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6 Claims. (Cl. 336—165)

This invention relates generally to a core construction for electromagnetic devices such as, for example, transformers, chokes and the like, and more specifically is concerned with the construction of a core of the so-called shell type having a central winding leg which is forced into the interior of the shell or outer frame member.

The shell type of core which has come into wide-spread use in recent years is formed of a plurality of stacked laminations which are rectangular in configuration, having elongate sides and yoke-like bridging ends. The laminations are integral, being stamped from the usual blank, and the center portion is stamped in such a manner as to form the central winding leg out of the same blank, leaving spaces to form windows for the pre-formed windings. Both the central winding leg and the outer shell or frame are stamped simultaneously so that the only scrap which is produced is that punched out to form the windows. Such stamping processes occur in high speed punch-presses with progressive, multi-stage dies.

When the frame laminations and winding leg laminations are formed they are separately stacked and riveted together. The air gaps, if any, are formed during the punching operations, usually by a cutting operation known as shaving. This operation establishes the dimensions of the air gaps, by means of which the eventual electrical characteristics of the electromagnetic device are controlled. The central winding leg stack has a plurality of pre-formed windings, or coils mounted on forms disposed thereon, the windings being usually provided upon rectangular coil forms whose dimensions are substantially the same as those of the cross-section of the winding leg. Obviously the coils or windings are positioned in alignment with the windows provided in the shell.

Thereafter the assembled winding leg and coils are forced into the center of the frame or shell. During the punching operation mating portions are provided on the winding leg lamination and upon the shell lamination to assure seating of the winding leg in the shell. Likewise, means may be provided identifying the position of the leg relative to the shell where the ends of the leg are substantially symmetrical.

As described in a co-pending application, Serial No. 475,043, filed Dec. 14, 1954, now Patent No. 3,002,263, issued Oct. 3, 1961, in which I am an applicant along with Paul J. Zerwes, and assigned to the same assignee as this application, since the central winding leg is formed of an aligned stack of laminations which have been punched from the same shell laminations which have been aligned and stacked together to form the outer frame portion, the winding leg should easily slip into the opening provided therefor in the shell. This does not occur, however, except perhaps with laminations punched from extremely close-fitting, sharp dies, and even not perfectly under those conditions. The manufacture of cores for ballasts for gaseous discharge devices, for example, is a process which must be carried on at high speed, with maximum efficiency. The punching of millions of laminations, even using carbide cutting edge dies, is wearing and not conducive to providing perfectly fitting mating laminations.

Through the necessary clearance of shearing dies, burrs or slight extensions are provided on the separated parts, whose dimensions are said to "grow" as the dies get duller. The assembled stacks of laminations are ordinarily 30 or

40 pieces thick, and obviously when forced into place in the shell, the central winding leg must spread the opening into which it is inserted. This is explained in some detail in the said co-pending application, and hence need not be discussed further here. Reference is had to said co-pending application and the illustrations thereof to expain the disadvantages inherent in the shell type of core with the forced central winding leg. Principally, the pushing out of the yokes tends to cause the shell to bow inwardly because of the integral nature of the shell, thus upsetting the dimensions of the gaps which are formed. This is difficult to compensate for because the amount of interference between the central winding leg and the shell varies from batch to batch, changes with the sharpness of the dies, etc. Another effect of the interference has been observed where the central winding leg bows so that, in addition to the gaps being changed in dimensions, they are changed in alignment and the windings are no longer symmetrically placed relative to the core.

The primary objects of this invention, as in the case of said co-pending application, comprise the elimination of the disadvantages caused by interference between the central winding leg and the shell core during insertion of the winding leg, but in this instance the manner in which this is done is considerably different than in said co-pending application.

An important object of the invention lies in providing a weakened portion in one or both of the yokes of the shell, each of the laminations having this weakened portion provided during the punching operation, so that the insertion of the central winding leg does not bow the elongate sides, but merely permits the weakened portion to twist slightly, allowing of a slight spreading of the halves of the affected yoke. The effect of this arrangement upon the dimensions of the air gaps has been found greatly improved over the cores which do not have this construction, and further, the flux path is in less measure decreased than with several of the examples described in said co-pending application which use slots parallel to the mating joint between winding leg and yoke.

Still another important object of this invention is to provide means which eliminates the distortion or bowing of the central winding leg or the misalignment of the gaps or windings.

A further object of the invention is to provide a novel core structure which is exemplified in two or more transverse slots in the yoke at one or both ends of the shell to provided a twistable weakened portion which prevents the yoke to be subjected to tensile stresses when the winding leg is inserted.

Other objects and advantages not specifically set forth will occur to those skilled in this art as the description of the invention proceeds, in connection with which I have described several preferred embodiments of the invention to show how the same is practiced. These embodiments are merely examples, and not intended as limitations upon the scope and coverage of the invention.

In connection with the description, I have illustrated the several embodiments, as required, the same or similar characters of reference being used throughout the several figures of the drawings to illustrate the same or similar parts.

In the said drawing:

FIG. 1 is a top plan view of an assembled core formed of outer shell or frame portions and center winding leg to show the manner in which the winding leg matingly engages in the shell, and illustrating one form of the invention.

FIGS. 2, 3, and 4 are fragmentary top plan views of the right hand end of several modified forms of the in-

vention as applied to a shell type core having a forced central winding leg.

FIG. 5 is a fragmentary top plan view of the right hand end of FIG. 1 but on an enlarged scale.

The invention herein prevents the distortion of the elongate sides of the shell or frame of the core which is normally caused by the interference between the mating edges of a central winding leg and shell as the winding leg is forced into position. This is done by providing a weakened section which is readily twistable to confine the spreading effect of the insertion of the winding leg to a small lateral spreading of the yoke end which has the weakened section. Cuts are provided which extend transverse of the leg, and co-operate with other cuts to provide such sections in a novel manner.

In FIG. 1 there is illustrated a core 10 of a type used to form a ballast for gaseous discharge devices. There is a central winding leg 12 which is disposed in mating engagement at 14 and 16 with the yoke ends 18 and 20 respectively of the shell or frame portion 22. The shell or frame portion 22 has elongate connecting sides 24 which have inwardly extending projections 26 and 28 which are spaced from the central winding leg to provide non-magnetic gaps 30 and 32 respectively. The central winding leg 12 may have outward extensions 34 which are aligned with the extensions 28 to assist in positioning of the windings on the central winding leg.

The windings are not shown in the figure in order to enable the illustration to be simple, but they will be disposed in the windows formed at 36, 38 and 40. The winding leg 12 is held in assembly by rivets such as shown at 42 while similar rivets 44 retain the outer shell portion 22 in assembly. The hole 46 punched partly in the yoke 20 and partly in the end of the winding leg 12 on the mating line 16 is for identification. Slot 48 in the winding leg prevents distortion in certain circuits and forms no part of the invention.

As will be noted in FIG. 1 and FIG. 5 I provide two cuts or slots transversely of the yokes 18 and 20, but each of the cuts not passing through the yoke and each stopping short of the end opposite that at which the cuts are started. Each cut of a yoke extends inward from opposite edges. Thus, yoke 20 has one slot 50 which starts at the mating line 16 and extends to the right, stopping short of the outer edge 52, and a second parallel slot 54 which commences on the edge 54 and extends inward toward the mating line 16 but stops short of the same. Between the two slots or cuts 50 and 54 there is thus formed a narrow weakened section 56 which is sufficient to connect the halves of the yoke 20 physically, but which nevertheless is readily twistable as will be explained.

The opposite yoke 18 has identical slots and an identical weakened section.

Examining FIG. 5 which is similar to the right hand end of the view of FIG. 1 (the identifying hole 46 has been omitted) it will be seen that arrows 58 have been illustrated to show the forces which I have found act upon the yoke 20 as the central winding leg 12 is forced home. The arcuate type of mating juncture 16 seems to produce such forces, there apparently being very little distorting force, if any, produced at the apex or crown of the arc, i.e., lying on the longitudinal center line of the winding leg 12. In the case that the mating junction is triangular as in FIG. 3, the principal force seems to occur at the apex, as will be mentioned in connection with the description of FIG. 3.

Returning to the description of FIG. 5, the forces applied by the central winding leg at arrows 58 could cause several effects. For one, it could cause bowing of the yoke to the right, as described in said co-pending application but since the silicon steel of which the laminations are formed does not readily strain in tension, the result would be the undesirable distortion. It could also cause spreading apart of the halves of the yoke 20, which if it occurred could not serve to seriously affect the gaps 30 and 32 whose dimensions will change substantially less than the amount that the halves spread.

According to my understanding of what occurs, the insertion of the central winding leg 12 causes forces to be applied to the yoke halves which are represented by the arrows 60, which provide a slight moment about the weakened section 56. Since this section readily twists, substantially all of the distorting force of arrows 58 results in a slight twisting strain upon the section 56 which results in the substantially innocuous spreading of the halves of the yoke 20. In such a structure, there has been found to be no distortion or bowing of either the shell or the winding leg, and the gaps maintain their dimensions quite satisfactorily.

Providing the slots at both ends divides the spreading between the yokes and decreases the total change in the gap dimensions when the central winding leg is inserted. Since the precise affect of the insertion of the central winding leg is confined to the spreading described, it is now possible to partially compensate for some of this spreading by making the gaps narrower than finally required.

In FIG. 2 I have illustrated a modified form in which there are two cuts or slots 62 commencing at the outer edge 52 and a central large triangular recess 64 which opens to the mating juncture 16 and has its opposite sides substantially parallel with the slots 62 to provide two weakened sections 66 which divide the total twisting strain between them so that the amount of twist may not unnecessarily strain either. This is a symmetrical structure also which provides longer weakened sections than the symmetrical structure of FIG. 4 which has slots 62 parallel and has the center slot 64 also parallel to the others to provide similar parallel weakened sections 66.

In FIG. 3 the invention is applied to a type of shell core 10' which has the central winding leg 12' provided with a triangular end 16' matingly engaged with the yoke 20'. I have found that the principal interfering force in this type of structure occurs right at the apex of the triangular formation and hence in applying the teachings of my invention, I punch a relatively large slot 68 at the apex which is carried substantially into the yoke 20'. Then I provide the parallel symmetrically positioned slots 70 on opposite sides, giving rise to the weakened sections 72. In this case, the same effect occurs because the slot 68, besides providing the weakened sections while cooperating with the slots 70, also shifts the principal distorting force from the apex to the straight juncture lines on both sides of the apex, as indicated by arrows 74.

It is believed that the invention lends itself to application in many different forms and with variations of the details thereof. The disadvantages of the shell type core are not only manifest in the changes of dimension and alignment of the air gaps, but in other ways such as the bowing and misalignment of coils described. It is desired to point out therefore, that the invention is applicable to cores which have no integral shunts and air gaps, but utilize the benefits of the invention to achieve more readily controllable electrical characteristics through a minimum of bowing or distortion of the parts of the core.

Further description may be dispensed with, bearing in mind that the only limitations which require to be made upon the scope and coverage of the invention are those set forth in the appended claims and necessarily dictated by pertinent prior art suitably construed in view of the degree of advance I have made in the arts and sciences by this invention. I consider the claims will encompass by their language equivalents and variations to which I am entitled under the law.

I claim:

1. A core construction for electromagnetic devices, which comprises a generally rectangular integral shell member having yokes connecting elongate sides thereof, a central winding leg adapted to be forcedly engaged in the center of the shell member with its ends matingly engaged in the yokes, and at least one weakened section in

at least one of said yokes between the ends thereof dividing said yoke into two parts and said section being transversely distortable relative to said shell and operable to enable the said parts to be slightly spread apart when said winding leg is forced into said matingly engaged position through twisting of said weakened section.

2. A transformer construction comprising a shell having end yokes, an *elongate* central winding leg adapted to carry a transformer winding and whose ends are adapted to engage respective end yokes of said shell when inserted therebetween under pressure, the sides of said shell and said winding leg arranged to define a shunt air gap therebetween on insertion of said central winding leg, said end yokes each being arranged cross-wise of said central winding leg to define generally an axis perpendicular to said central winding leg and each comprising two portions having a bar therebetween extending transversely of said axis of the portions of said end yokes, each bar integrally joined at opposite ends to a respective portion of the respective yoke whereby the force exerted by said elongate winding leg on insertion between said end yokes causes said bar to pivot in a direction to align said bar with the axis of said end yokes to permit the respective parts of said end yokes to move apart in order to maintain the alignment of said shunt air gap.

3. A magnetic core structure comprising a frame member having an opening, another member pressed into the opening to form at least two junctions with the frame member, and a compliant portion integral with the frame member and adjacent to one of the junctions including a first section wherein the member has a reduced width, a second section wherein the member has a reduced width, and an intermediate section of reduced width between the first and second sections and laterally displaced from the junction of one of the first and second sections with the remainder of the member, whereby the compliant portion is transversely deformable relative to said frame member to enlarge the opening and permit the other member to be pressed in easily.

4. A core construction for electromagnetic devices, which comprises a generally rectangular integral shell member having yokes connecting elongate sides thereof, a central winding leg adapted to be forcedly engaged in the center of the shell member with its ends matingly engaged in the yokes, and at least one weakened twistable section in at least one of said yokes between the ends thereof dividing said yoke into two parts, and operable

to enable the said parts to be slightly spread apart when said winding leg is forced into said matingly engaged position through twisting of said weakened section, said one yoke having at least a pair of slots therein closely disposed alongside one another and extending generally transverse of the yoke, the slots extending from respective opposite side edges of said yoke and extending only partially through said yoke, thereby forming said weakened section between said slots.

5. A core construction for an electromagnetic device which comprises a rectangular outer member having end yokes and elongate sides integrally connected, a central winding leg matingly engaged between the inner edges of said yokes on a juncture with at least one yoke which is generally convex relative the center of said winding leg, a slot in said yoke commencing substantially at the center of said juncture on the inside edge of said yoke and extending toward said opposite edge of said yoke but stopping short of same, and a pair of additional slots in said yoke, one on each side of the center slot and relatively close thereto, said additional slots commencing from the outer edge of the said yoke and extending toward said junction but stopping short of the same and converging at their inner ends, whereby to provide two weakened twistable sections between the said slots dividing the moment produced during the forcing of the center leg into said rectangular outer member.

6. A core construction as claimed in claim 5 in which said pair of slots converge at their inner ends, and the center slot is generally triangular in configuration with two sides parallel to the respective pair of slots and an apex of said triangle at the said juncture.

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