May 22, 1951 R. H. DIERSTEIN 2,553,554

TRANSFORMER CORE

Filed Nov. 25, 1947

Fig. 1.

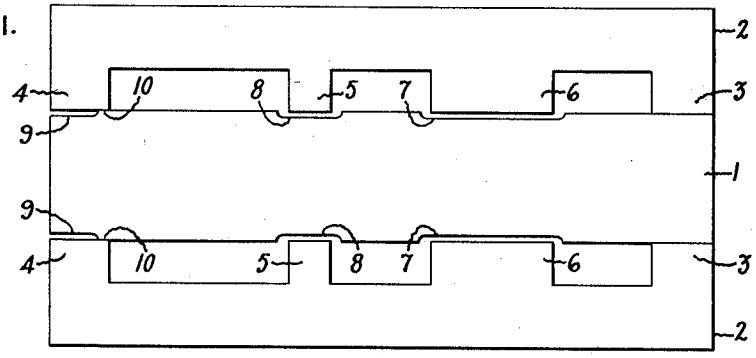


Fig. 2.

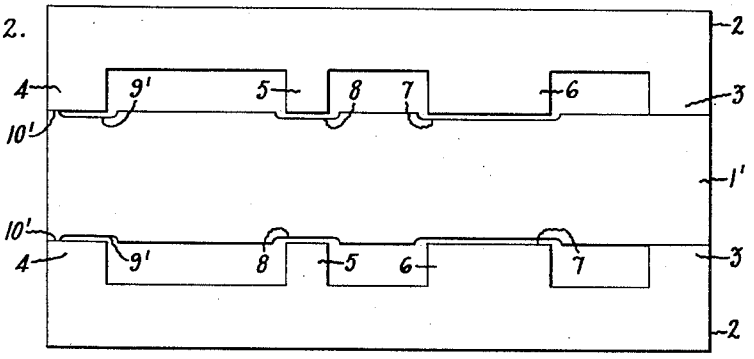


Fig. 3.

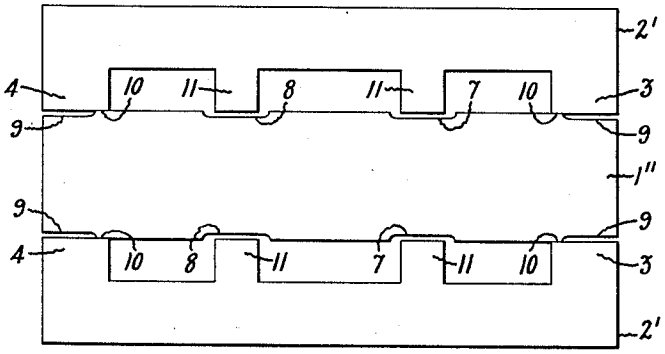
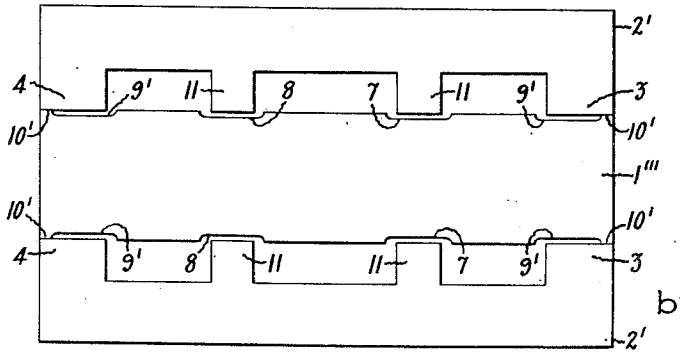


Fig. 4.



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Patented May 22, 1951

2,553,554

UNITED STATES PATENT OFFICE

2,553,554

TRANSFORMER CORE

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Application November 25, 1947, Serial No. 788,063

7 Claims. (Cl. 171—777)

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This invention relates to magnetic cores, and more particularly to improvements in cores for stationary induction apparatus.

In many types of magnetic cores, it is necessary to provide gaps in the magnetic circuit which are either complete breaks or gaps or else are so-called bridged gaps, in which in effect, there is a gap which is magnetically paralleled by a restricted section of the core which has a higher flux density than the rest of the core. Such gaps are used to control the exciting current of induction apparatus or the distribution of the flux in various parts of the core, and due to magnetic saturation in the bridging parts of bridged gaps, to control also the rate of change of flux in certain parts of the core relative to other parts thereof, so as to provide certain desirable voltage changes in the windings linking various parts of the core.

In accordance with this invention, there is provided a novel and simple core structure in which all of the gaps are formed in the same structural part of the core. Furthermore, in the preferred forms of the invention, this part is a relatively straight large cross section winding leg and the gaps are formed by providing notches or recesses in this part. In this way, relatively heavy and strong dies can be used for forming the notches at the same time that the relatively large lamination punchings which form this part are stamped out. This makes for much greater accuracy in the dimensioning of the gaps. Also, as the laminations of the core part which form the gaps can be made with a relatively rugged die, because there are no small pointed parts or parts of similar shape, the die wear is greatly reduced.

An object of the invention is to provide a new and improved magnetic core for stationary apparatus.

Another object of the invention is to provide a new and improved core for high reactance transformers which have one or more magnetic gaps.

An additional object of the invention is to provide a new and improved shell-type transformer core having a plurality of magnetic gaps, all of which are formed in a single, generally straight central winding leg member.

The invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 is a plan view of a core for a high reactance transformer type two lamp lead lag fluorescent ballast, which embodies the

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invention, Fig. 2 is a modification of Fig. 1 in which the relative positions of the bridge and gap portions of the bridged-gaps have been reversed, Fig. 3 is a view similar to Fig. 1 of a core, suitable for use in high reactance transformer two lead lamp fluorescent ballasts, which embodies the invention, and Fig. 4 is a modification in which the bridging portions of the bridged gaps of Fig. 3 have been reversed.

Referring now to the drawing, and more particularly to Fig. 1, the core comprises a generally straight winding leg 1 and oppositely disposed multi-leg yoke members 2. It will, of course, be understood that the members 1 and 2 are laminated and the shapes of these members shown in the drawing may be taken to correspond with the actual shapes of the lamination pieces, the members then consisting of a plurality of pieces of the same shape stacked one above the other. The yoke members have end legs 3 and 4 and have intermediate leakage flux legs 5 and 6. In Fig. 1, the legs are all of the same length and their ends are square cut.

The center section of the winding leg 1, which is between the magnetic shunt legs 5 and 6, is adapted to receive a winding which may, for example, be the primary or exciting winding of a high reactance transformer. The section of the winding leg 1, which is between the yoke legs 4 and 5, is adapted to receive another transformer winding which may be a secondary winding, of either the insulated or extended autotransformer type, and likewise, the end section of the winding leg between the yoke legs 3 and 6 is adapted to receive another such secondary winding. Such windings may be conventional, and consequently, they are not shown. As is well known in two lamp ballasts for fluorescent lamps, one secondary winding is often operated with leading current which is produced by a series capacitor in the leading lamp circuit, and the other lamp and secondary winding is operated with lagging current which is produced by the transformer's leakage reactance. In this manner, the overall power factor of the device is relatively high.

It will be observed that the yoke leg 5 is substantially narrower than the yoke leg 6. This is because the leakage flux which traverses these two legs is substantially different in magnitude, due to the difference in the phase of the leading and lagging secondary fluxes with relation to the primary or exciting flux. Thus, if the secondary winding, which normally occupies the space between the legs 4 and 5 carries leading

current, then the flux in that part of the winding leg is more or less in phase with the exciting flux so that the vector difference between these two fluxes which is the only flux which flows in the yoke legs 5 will be relatively small. Likewise, if the portion of the winding leg which is between yoke legs 3 and 6 carries a lagging current secondary winding, then the flux produced by that winding is more or less in phase opposition to the exciting flux in the central part of the winding leg 1, and consequently, the vector difference between those two fluxes is relatively large and it is this vector resultant flux which flows in the yoke legs 6. Consequently, in order to have approximately equal flux density in the two leakage path yoke legs 5 and 6, the latter has a substantially greater area than the former.

In order to prevent the leakage flux paths from having too low a reluctance, it is usually necessary to provide them with a high reluctance section, such as an air gap and it has also been found that desirable results are obtained when the portion of the core which is traversed by the leading secondary flux is also provided with a high reluctance section, preferably a bridged gap. In Fig. 1, these various gaps are all obtained by properly shaping the winding leg punchings. Thus, it will be observed that there are depressions or notches 7 in the sides of the winding leg in the vicinity of the ends of the yoke legs 6, so as to form air gaps. Similarly, there are notches or depressions 8 in the winding leg 1 in the vicinity of the ends of the yoke legs 5 so as to form air gaps therebetween. It will further be observed that the notches 7 and 8 are in substantial alignment respectively with the center lines of the yoke legs 6 and 5 so that the gaps are full and complete gaps.

Notches 9 are also cut out of the left hand end of the winding leg 1, but these notches are not as wide as the end yoke legs 4 and they are offset toward the left as viewed in the drawing, from the center lines of the yoke legs 4 so that the gaps which are formed by this construction are bridged by shoulder portions 10 on the winding leg which makes butt contact with part of the ends of the yoke legs 4. In this manner, bridged gaps are formed. The inclusion of bridged gaps in the lead end of the magnetic core of a two lamp lead-lag high transformer ballast for discharge lamps such as fluorescent lamps is disclosed and broadly claimed in an application Serial No. 731,559, filed February 28, 1947 in the name of Harold W. Lord and assigned to the same assignee. The right-hand end of the winding leg does not have its sides notched, and consequently, those sides make low reluctance butt contact with the ends of the yoke legs 3.

By means of this construction, the dimensions of the gaps can be very accurately maintained, and as these dimensions are determined by the shape of a relatively rugged die which does not have to punch out small pointed projections on the laminations the life of the die is very materially increased and the control of the gap proportions is greatly improved.

In the modification shown in Fig. 2, the winding leg 1' differs from the winding leg 1 in Fig. 1, in that the relative positions of the end notches and shoulders which form the bridged gaps at the left-hand of the core, have been reversed. Thus, there is a notch 9' in the winding leg 1' which is offset inwardly or toward the center of the core from the center line of the

yoke legs 4, so as to form what may be considered as shoulders 10' on the winding leg 1' which make butt contact with the outer parts of the ends of the yoke legs 4 so as to form the bridges of the bridged gaps. An advantage of this latter construction is that the magnetic bridge of the gaps being on the outside, they tend to retain the flux in the core and prevent it from leaking out into adjoining areas and metal surfaces such as a metal case for the device. Thus, in Fig. 1 the flux which goes through the air gap between the notch 9 and the yoke leg 4, after the shoulder 10 is saturated, tends to fringe outwardly and stray into adjoining metal parts and thus cause undesirable heating of those parts. In Fig. 2 any flux which tends to stray or fringe out from the air gap between the notch 9' and the end legs 4 will fringe inwardly toward the center of the core.

Fig. 3 is a modified core construction which is suitable for use in high reactance transformer ballasts, which supply two leading current discharge lamp circuits. This construction is symmetrical because the two end parts of the core carry similar magnitude fluxes having similar leading phase relationship with respect to the exciting flux which traverses the center part of the core. The duplicate yokes 2' are similar to the yokes 2 in Figs. 1 and 2, except that the two intermediate leakage flux yoke legs are of equal width. These are shown at 11 in Fig. 3. The winding leg 1'' differs from the winding leg 1 in Fig. 1 in that there is a bridged gap 9—10 on opposite sides of each of its two ends.

Fig. 4 bears the same relation to Fig. 3 that Fig. 2 does to Fig. 1 and it differs from Fig. 3 in that the relative positions of the notches 9' and the bridges 10' are reversed so that the bridges are on the outside of the core and tend to act as shields for retaining the flux in the core and preventing it from fringing out and entering adjoining metal parts.

While there have been shown and described particular embodiments of the invention, it will be obvious to those skilled in the art that changes and modifications can be made without departing from the invention and, therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A magnetic core for stationary induction apparatus, comprising, in combination, a yoke member having a plurality of sidewise extending legs including end legs and at least one intermediate leg, and a winding leg contiguous to the ends of said yoke legs, said winding leg having a notch in the vicinity of the end of one of said yoke end legs for providing a magnetic gap in said core, said notch being offset from the end of the winding leg and from the center line of said yoke end leg so that said gap is a bridged gap with the bridge part thereof toward the outside of said core with respect to the gap part thereof.

2. A core for a high reactance transformer type two lamp fluorescent ballast, comprising, in combination, a pair of four-legged yoke members whose inner two legs are of substantially different width, said yoke members being disposed with their legs extending toward each other, a generally straight winding leg between said yoke members and lying across the ends of their legs, notches on opposite sides of the end of the wind-

ing leg which is adjacent the end yoke legs which are nearest the narrower of the two intermediate yoke legs, said notches being offset from the center lines of the adjacent end yoke legs so as to form bridged magnetic gaps.

3. A core for a high reactance transformer type two lamp fluorescent ballast comprising, in combination, a pair of four-legged yoke members whose inner two legs are of substantially different width, said yoke members being disposed with their legs extending toward each other, a generally straight winding leg between said yoke members and lying across the ends of their legs, notches on opposite sides of the end of the winding leg which is adjacent the end yoke legs which are nearest the narrower of the two intermediate yoke legs, said notches being offset from the center lines of the adjacent end yoke legs so as to form bridged magnetic gaps, said notches being offset toward the middle of said winding leg whereby the bridge portions of said bridge gaps are toward the outside of said core.

4. A core of a high reactance transformer ballast for two electric discharge lamps comprising in combination, a pair of similar four legged yoke members all of whose legs are of equal length with square ends, said yoke members being disposed opposite each other with their legs extending toward each other, a straight central winding leg member disposed between said yoke members and lying across the ends of their legs, said members all being of equal length and being permanently aligned crosswise with respect to each other, notches in opposite sides of said straight winding leg member opposite to and coextensive with the width of the two intermediate legs of each yoke member so as to provide full magnetic gaps between said intermediate yoke legs and said winding leg member, the ends of the outer legs of each

yoke member being in contact with the sides of said straight winding leg member near the ends thereof in order to make the length of said gaps equal to the depth of said notches, and additional notches in opposite sides of said straight winding leg member near at least one end thereof, said additional notches being partially offset with respect to the ends of at least one pair of said outer yoke legs so as to form bridged magnetic gaps of fixed dimensions whose bridge parts determine the length of the gaps associated with said intermediate legs.

5. A core as defined in claim 4 in which the offset of said additional notches is toward the outer end of said winding leg member so that the bridge part of the bridged gaps is inside of the core with respect to the gap portion thereof.

6. A core as defined in claim 4 in which said additional notches are on opposite sides of both ends of said winding leg member.

7. A core as defined in claim 4 in which said additional notches are on opposite sides of both ends of said winding leg member and the offset of said additional notches is toward the center of said winding leg member so that the bridge part of the bridged gaps is toward the outside of said core with respect to the gap portion thereof.

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