Dec. 27, 1938. W. H. REICHARD 2,141,554

ADJUSTABLE MAGNETIC CORE STRUCTURE

Filed July 30, 1935

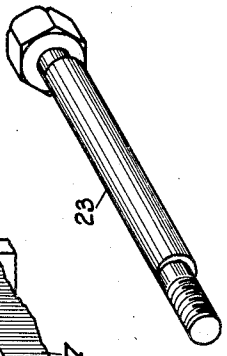


FIG. 4.

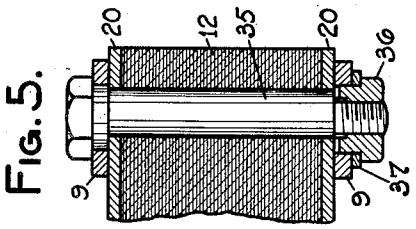


FIG. 5.

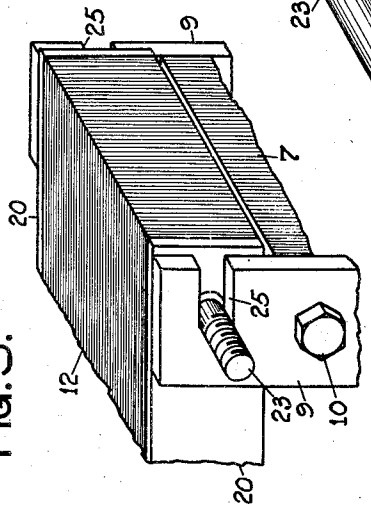


FIG. 3.

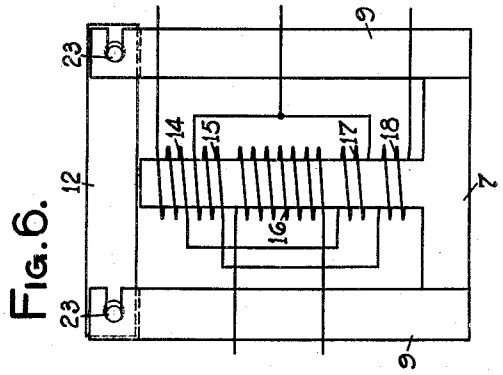


FIG. 6.

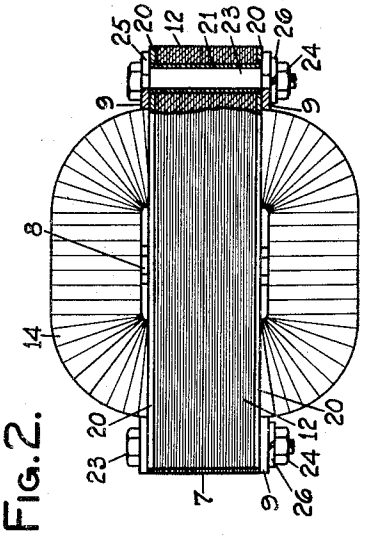


FIG. 2.

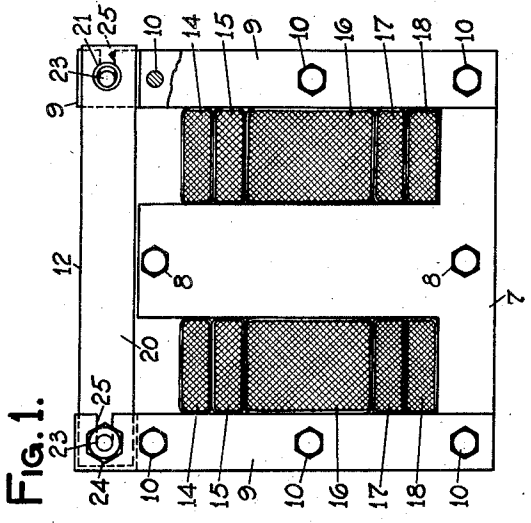


FIG. 1.

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Patented Dec. 27, 1938

2,141,554

UNITED STATES PATENT OFFICE

2,141,554

ADJUSTABLE MAGNETIC CORE STRUCTURE

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Application July 30, 1935, Serial No. 33,828

4 Claims. (Cl. 171—242)

This invention relates in general to electromagnetic devices, and more particularly to an adjustable magnetic core structure for transformers, reactors and the like.

In railway train control systems and the like, it is important to provide a definite magnetic coupling between the primary and secondary windings of certain transformers inasmuch as such transformers are a part of circuits tuned to a particular frequency. However, it is found in manufacturing such transformers that the magnetic core structures vary somewhat in their magnetic characteristics, and consequently it is difficult to provide transformers having uniform coupling between the primary and secondary windings. It is also found that when such transformers are used in circuits employing other non-adjustable factors such as capacitance and resistance, the variations encountered in these other factors may be conveniently compensated for by changing the characteristics of the magnetic structure.

In view of the above and other considerations, it is proposed in accordance with the present invention to provide a magnetic core structure for transformers, reactors and the like wherein the characteristics of the magnetic circuit may be manually varied and locked in an adjusted condition providing the desired magnetic properties. More specifically, it is proposed to provide a magnetic structure having means for accurately adjusting the reluctance thereof and means for locking the adjusting means without disturbing the previously adjusted condition by such locking operation. It is also proposed to provide an improved arrangement of transformer windings on the above magnetic core structure providing a definite relation between the magnetic coupling of either of two portions of a primary winding with a secondary winding regardless of variations in the magnetic properties of the core structure.

Other objects, purposes and characteristic features of the present invention will become obvious as the description thereof progresses, during which references will be made to the accompanying drawing, in which:—

Fig. 1 is a sectional elevational view of one form of a transformer constructed in accordance with the present invention with parts thereof broken away to more clearly illustrate its construction.

Fig. 2 is a plan view of the transformer illustrated in Fig. 1 also having part thereof broken away.

Fig. 3 is an enlarged perspective view of a portion of the magnetic core structure of the transformer shown in Fig. 1.

Fig. 4 is an enlarged perspective view of a detail of the transformer shown in Fig. 1.

Fig. 5 is an enlarged sectional view of a portion of the present magnetic structure illustrating a modification which can be made in the magnetic structure illustrated in Fig. 1.

Fig. 6 is a diagrammatical view illustrating one method of distributing windings on the magnetic structure of the present invention.

In Fig. 1 of the accompanying drawing, a magnetic core structure for a transformer or reactor is illustrated as comprising a lower core portion 7 formed of E-shaped laminations clamped together by center through bolts 8 while the outer portions are clamped between vertical retaining strips 9 by through bolts 10. A top magnetic yoke 12 is formed of straight or I-shaped laminations and is arranged to magnetically couple the upper ends of the E-shaped lower core portion or to complete a magnetic circuit around coils 14, 15, 16, 17 and 18 all wound around the center leg of the E-shaped lower core portion.

The laminations of the top yoke 12 are clamped between two retaining strips 20 by tubular rivets 21 passing through the laminations and having their outer ends flared into countersunk holes in the retaining strips 20 as shown in the broken away section at the right hand end of the yoke 12 in Fig. 2, it being understood that the left hand end of yoke 12 is arranged in the same manner. Each of these two tubular rivets receives a closely fitting eccentric body portion of a bolt 23 which is shown in Fig. 4. The bolt 23 as may be seen in Fig. 4 has a smaller diameter concentric portion adjacent the head thereof and a threaded concentric end portion of the same diameter, while the round body portion is enlarged and eccentrically arranged in relation thereto.

The vertical retaining strips 9 extend upwardly beyond the top of the lower core portion 7, and the extending portion of these retaining strips 9 are provided with horizontal slots 25 all extending in the same direction as shown in Fig. 1. The slots 25 allow the top yoke 12 with the eccentric bolts 23 in place as described to be installed above the lower core portion 7 so that the slots 25 receive the concentric portions of the bolts 23 which are adjacent each end of the larger eccentric body portion as clearly illustrated in Fig. 3.

It will now be clear that as the smaller concentric portions of the bolts 23 are held rigidly

with respect to the lower core portion 7 by the retaining strips 9, a rotation of the heads of the bolts 23 will raise or lower the associated ends of the yoke 12 with respect to the core portion 7 due to the eccentric arrangement of the body portions of the bolts 23 which turn within the tubular rivets 21. In other words, the heads of the eccentric bolts 23 may be rotated in either direction to accordingly increase or decrease the air gap between the top yoke 12 and the top of the core portion 7, thereby providing a means for accurately adjusting the reluctance of the magnetic core structure.

In order to retain the adjusted position of the top yoke 12 relative to the core portion 7, the ends of the bolts 23 are provided with nuts 24 threaded thereon as shown in Fig. 2 and suitable lock washers 26 are provided between the nuts 24 and the vertical retaining strips 9. It will now be clear that each end of the top yoke 12 may be individually adjusted relative to the lower core portion 7 by turning the head of the associated eccentric bolt 23 with a suitable wrench, and while holding the bolt head, the nut 24 may be tightened thereon to lock the top yoke in its adjusted position. In this manner, the tightening of the nuts 24 does not change the relative position of the yoke and core 7, thereby providing a locking means which operates without disturbing the previous adjustment.

In the modified arrangement of the present invention shown in Fig. 5, an adjusting eccentric bolt 35 has been provided which permits the use of bearing holes in the upper ends of the retaining strips 9 in place of the slots 25. In other words, the eccentric adjusting bolt 23 in Fig. 4 has a center eccentric portion which is larger than the concentric adjacent portions held within the slots 25, and consequently the bolt 23 cannot be installed longitudinally through the strips 9 but must be installed transversely after being inserted in the top yoke 12. However, the bolt 35 in Fig. 5 has a concentric bearing portion between its head and its eccentric body portion which is larger than the eccentric and consequently a closely fitting bearing hole in the retaining strips 9 allows the longitudinal installation of this eccentric adjusting bolt 35.

The threaded end of each of the bolts 35 in Fig. 5 is concentric with the head and of a reduced diameter with a nut 36 threaded thereon for locking the bolt 35 in its adjusted position, which nut 36 is provided with a round inner end of the same diameter as the large concentric bearing portion on the bolt 35, which portion of the nut 36 enters the bearing hole in the retaining strip 9 to support the end of bolt 35 in a definite position relative to the lower core portion 7. A suitable washer 37 is provided between the shoulder of the nut 36 and the retaining strip 9, and it is clear that the modified arrangement in Fig. 5 is operable to adjust the air gap between the top yoke 12 and the lower core portion 7 and to lock the adjustment in the same general manner as the form shown in Fig. 4.

It is desirable in some applications of the present invention such as in decoding circuits of automatic train control systems to provide a transformer primary winding having a center or intermediate potential tap, and it is desirable to at all times maintain a definite magnetic coupling between the secondary winding and either one of the two portions of the primary winding formed by this center tap. However, it is found that when such a primary transformer winding is applied to an adjustable core transformer such as the type shown in Fig. 1, a change in the reluctance in the upper part of the magnetic circuit caused by an adjustment of the top yoke 12 changes the relative magnetic coupling of the two portions of the primary winding with respect to the secondary winding. In other words, when the two portions of the primary winding are distributed laterally on the center leg of core 7, the leakage flux between the upper part of the center leg and the outer legs causes a difference in the effective flux value produced in each of the two portions of the primary winding, the portion adjacent the gap between the core members having a lesser flux value and a change in the air gap between the core members 12 and 7 obviously changes the degree of this difference in relative values of flux in the parts of the primary to thereby change the relative effects of the two parts of the primary, upon the secondary voltage.

In order to maintain a definite relation of the secondary voltages regardless of adjustments of the top yoke 12, the primary and secondary coils have been arranged in accordance with the present invention as shown diagrammatically in Fig. 6. In this arrangement, a secondary winding or coil 16 is located centrally on the center leg of the core 7 with the primary winding consisting of four coils 14, 15, 17 and 18 located two on each side of the primary coil 16. An upper primary coil 14 is connected in series with a lower primary coil 17 to form one portion of the primary winding, while in a similar manner another upper coil 15 is connected in series with another lower coil 18 to form the other portion of the primary winding. In this manner the primary winding has been distributed on the magnetic structure so that each portion includes one coil above and one coil below the secondary winding, whereby to obtain a constant relation between the magnetic coupling of the two portions of the primary winding with the secondary winding regardless of changes in leakage flux caused by adjustment of the top yoke 12.

In describing the present invention, attention has been directed to the specific illustrated embodiments thereof, without attempting to point out all the various alternate or optional features of construction, or the different organizations of combinations that may be employed. For example, the magnetic core structure has been illustrated as employed in a transformer, but obviously such a magnetic core structure can be used in various other electrical devices such as a reactor, filtering choke and the like.

In other words, the particular embodiments of the present invention have been selected to facilitate in the disclosure thereof rather than to limit the number of forms which it may assume.

What I claim is:—

1. In a magnetic structure for electrical devices, a laminated open core structure, a laminated yoke for completing the open core structure, bolts transversely rotatable in the yoke, retaining members on the core structure rotatably holding the ends of the bolts, said ends of the bolts being eccentrically arranged with respect to portions thereof rotating in the yoke, and clamping nuts on the bolts engageable with the retaining members for preventing rotation of the bolts without disturbing the adjusted positions of the bolts.

2. In a magnetic device, two separable core members, windings on one of the core members,

bolts rotatably carried by one core member and passing through the other core member, eccentric means on the portions of the bolts passing through said other core member, and means for at times preventing rotation of the bolts.

3. An adjustable transformer comprising, two separable core members, eccentric means for adjusting the magnetic reluctance between the two core members, a secondary winding on one core member, and a plurality of primary windings on the same core member, each primary winding including a coil on each side of the secondary winding.

4. An adjustable transformer, including, a shell-shaped laminated member, a laminated leg extending up from the bottom of the shell, a laminated yoke for magnetically connecting the ends of the leg and the shell-shaped member, retaining members on the shell-shaped member embracing the sides of the yoke, bolts rotatably carried by the retaining members and having eccentric portions passing through the yoke, whereby to adjust the air-gap separating the yoke from the leg and the shell-shaped member by rotation of the bolts, a secondary winding on the leg, and two primary windings on the leg, each primary winding including a coil on each side of the secondary winding.

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