Feb. 16, 1943. P. K. RANNEY 2,311,128

TRANSFORMER

Filed March 24, 1941 2 Sheets-Sheet 1

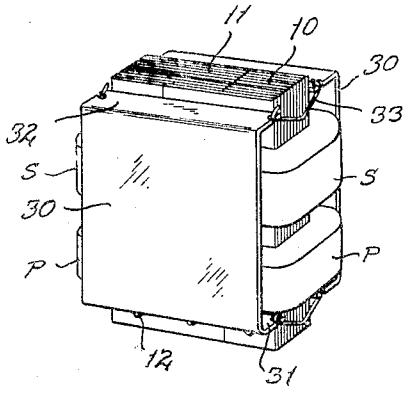



Fig. 3

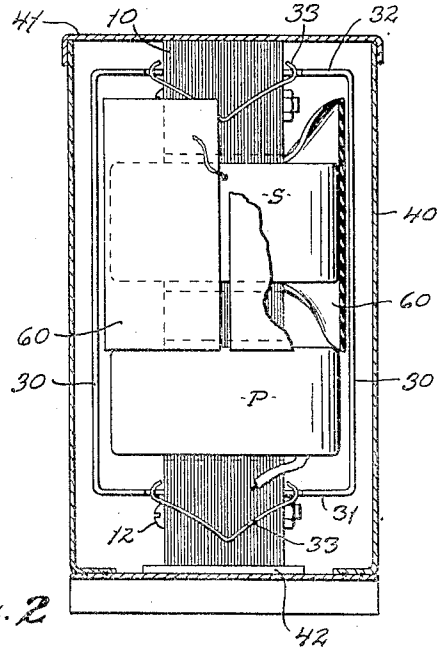



Fig. 2

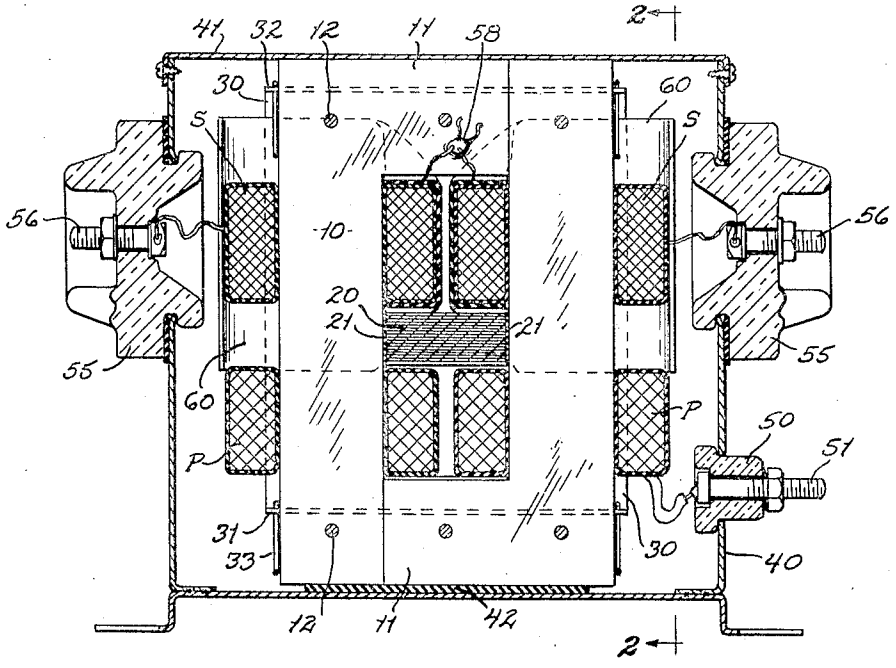



Fig. 1

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TRANSFORMER

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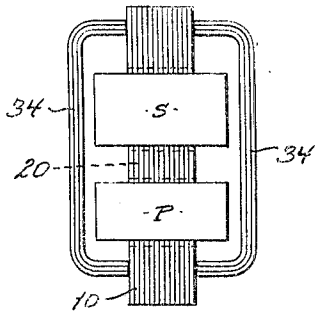



Fig. 4

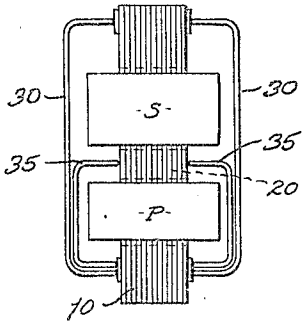



Fig. 5

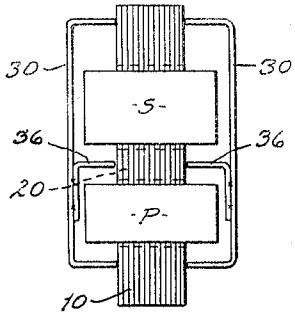



Fig. 6

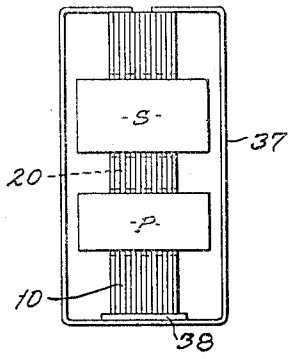



Fig. 7

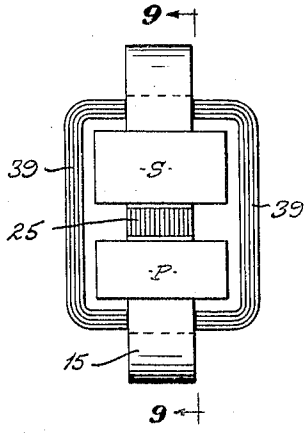



Fig. 8

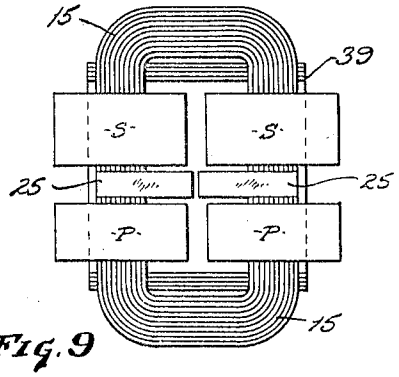



Fig. 9

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# UNITED STATES PATENT OFFICE

2,311,128

## TRANSFORMER

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Application March 24, 1941, Serial No. 384,836

3 Claims. (Cl. 171—119)

This invention relates to transformers which are adapted particularly for use with gaseous tubes, ignition systems and in any circuit where it is desirable to have a relatively high starting voltage and a lower operating voltage.

A transformer heretofore in use and having a relatively high starting voltage and a lower operating voltage has been one wherein primary and secondary windings have been positioned on a core, with shunts between the windings for regulating the secondary current. An object, therefore, of this invention is to so improve such transformer construction that the secondary current and heat may be sufficiently controlled, regardless of any combination of secondary short circuits, that the total heat generated will not result in failure of the transformer.

The aforesaid object is carried out in the preferred manner by means of a magnetic and heat dissipating shield which, when added to the high induction transformer aforesaid, accomplishes the desired features with a minimum of material, weight and space. The invention is hereinafter more fully described in the drawings which illustrate several embodiments thereof, while the essential novel features are summarized in the claims.

Fig. 1 is a vertical longitudinal section through the transformer; Fig. 2 is a transverse section on the plane indicated by the line 2—2 on Fig. 1; Fig. 3 is a perspective on smaller scale of the core, coils and shields of the transformer as ready for mounting in the case; Figs. 4 to 8 inclusive are views similar to Fig. 2 of five different modifications of the shield arrangement, and Fig. 9 is another view of the embodiment of Fig. 8, being a section on the line 9—9 on Fig. 8.

In my transformer I employ a closed or O-type of core with a primary coil and a secondary coil on each leg of the core and preferably with a magnetic shunt from one leg to the other located between the primary and secondary windings. Such is the construction illustrated in each of the views.

Referring first to Figs. 1, 2, and 3, 10 indicates a laminated closed or O-type core. This may be readily made up of two sets or stacks of L-shaped stampings of thin sheet metal, the ends of the short legs 11 abutting the sides of the long legs of the other stack adjacent the free end thereof. To maintain all these laminations in position, I reverse the position of the outermost laminations so that the short legs of such outermost laminations may overlap the short legs of the other stack constituting the intermediate laminations—the outermost laminations thus making splice plates holding the intermediate laminations in place—and I secure all the parts together by bolts 12 extending through the laminations, as indicated in Figs. 1 and 2.

Around the long legs of such O-core (before the two stacks are secured together), I place the primary and secondary windings, as shown in Fig. 1; there are two primary coils designated P, and two secondary coils designated S.

Between the primary and secondary coils, in the space between the two legs of the core, I employ a metallic shunt 20. This is composed of magnetic laminae separated from the two legs of the core by interposed non-magnetic material 21, providing the desired air gap.

So much of the construction as is above described is of standard or conventional form, except that by reason of the electro-magnetic and heat shielding about to be described, I am able to make the transformer smaller and lighter than usual. The shields of my invention take various forms, as illustrated in different views hereof and will now be described.

In Figs. 1, 2, and 3, 30 indicates one pair of shields, being sheets of magnetic material bent inwardly at their ends 31 and 32 to make a structure channel-shaped in cross section. These shields abut the core outside of the primary and secondary windings, in a manner making a magnetic connection, and are retained in place by suitable means, as for instance, the connecting wire springs 33 hooking into openings in the two sheets and extending across the core. Thus the shield plates or shunts thread the magnetic circuit of the core.

The structure described is adapted for mounting in suitable case 40 of comparatively narrow rectangular form open at the top and covered by a downwardly flanged cover 41. The case is shown in Fig. 1 as carrying at one end an insulating block 50, in which both primary terminals 51 may be mounted (one being shown in Fig. 1), and carries at its opposite ends insulating bushings 55 carrying the two secondary terminals 56. Suitable insulating members 60 may extend about the outside of the secondary coils to insulate them from the shields and case.

The core, coils, insulation and magnetic shields as a unit are preferably imbedded in compound, which fills the space between the shields, core and windings and space outside of the shields and above and below them.

The connecting conductor between the two

secondaries may be bonded or grounded to the core (as indicated at **58** in Fig. 1), and the core may be bonded or grounded to the case about to be described, while the case in ordinary use may be grounded to the earth. Thus, there is a mid-point ground on the secondary keeping the voltage to ground of both terminals approximately one-half the total secondary voltage.

The magnetic shields **30** contacting with the core act as heat dissipators transferring some of the heat from the core by conduction into the idle space within the filling material in the case, or they may touch the case **40** and transfer heat directly. This enables the use of a smaller and lighter core without the same becoming unduly hot from the electro-magnetic action. This is a useful function of the shields, but in addition, they provide safety devices or shunts protecting the secondary coils from excessive current in case of a short-circuit. This will now be described.

The two secondary coils, as heretofore stated, are mid-point grounded. Now if one of the lead lines from a secondary terminal to a Neon sign, for instance, should happen to burn out, break or otherwise contact with the earth, that one of the coils from which such lead came would be short-circuited, while the other secondary coil would be open as there would be no circuit flowing through the Neon sign. Now in the aforesaid transformer not having my shields, such short-circuiting of one of the secondary coils would cause more than normal current in the short circuited secondary, hence, it would be likely to burn out. If the size of the wire of the secondary were heavy enough to stand such extra current there would be a waste of material in normal operation.

In normal operation, the shields are practically idle, but when one secondary is shorted, sufficient flux passes through the shields so that the secondary short circuited current is limited to safe values. Hence, the shorted secondary is not subjected to dangerous flow of current and is not burned out even though its wire is of the size needed for normal operation. It results that from the current limiting protection afforded by my shields, as well as from their heat dissipating function, that I can make the transformer lighter and smaller and more compact. The structure may therefore be said to be "mid-point shunted" because the shields act as shunts for the core between the mid-point of the primary windings and the mid-point of the secondary windings.

If desired, I may augment the action of the shields by the case itself, by making the case of magnetic material and arranging its top and bottom to contact with the core or nearly so beyond the primary and secondary. This is illustrated in Figs. 2 and 3, when the core rests on a non-magnetic plate **42** which rests on the bottom of the case, while the cover of the case substantially contacts with the top of the core. The plate **42** provides the desired reluctance in the additional by-pass furnished by the case. If desired, the case alone might be used as the shield.

Fig. 4 shows a multiple shield **34** made up of several laminae which may carry more flux than a single sheet of metal. Figs. 5 and 6 show arrangements of shields which may be metallic, but non-magnetic material to coact with the core between the primary and secondary, this being either additional shield members **35** as shown in Fig. 5, or by means of two brackets **36**, as shown in Fig. 6. The purpose of this is to prevent radio frequencies which may develop in the secondary load from passing to the primary and, hence, to the electric light circuits, as such radio frequencies might interfere with radio reception.

In Fig. 7, I have illustrated a single U-shaped shield **37** taking the place of the two shields **30** of Figs. 1 and 3. This shield **37** may be separated from the bottom of the core by a non-magnetic spacing block **38**, providing a reluctance, while the free ends of the shield member engage the other end of the core, as illustrated.

In Figs. 8 and 9, I have shown the core **15** as made of nesting laminae **15** (which could be produced by spirally winding a continuous ribbon of metal and then cutting it into two U-shaped sections) and in that case I prefer to employ a set of nesting shields **39** of magnetic material having their inturned edges abutting the different core laminae, so that each lamina of the shield coacts or contacts with each lamina of the core. This construction has the advantage of providing a flux by-pass directly from each lamina of the core. The shunts **25** between the coils are arranged to extend between the two U-shaped core portions and project toward each other, the reluctance in the shunt path being provided by the central non-magnetic gap, as shown in Fig. 9.

It will be seen that in each of the embodiments shown, I have provided an O-type core with primary and secondary windings on the two legs with magnetic shunts between the legs of the core located between the primary and secondary and with my protecting shield plates on the outer sides of the core and windings, the shield plates having inturned portions coacting with the core beyond the primary and the secondary. The reluctance to the flux path provided by the shield may be controlled by its inherent magnetic inefficiency, or by its poor magnetic connection to the core, or both, so that the shield is substantially magnetically idle in ordinary operation. It further acts as a heat dissipator from the core.

In each embodiment, the shield is available, in case one of the secondaries should become short-circuited, to prevent burning out of such secondary by excessive current.

My shielding means, therefore, is always available as a heat dissipator, enabling the use of a lighter core, and is further available whenever necessary as a protection for one short-circuited secondary, thus making secondaries safe without requiring heavier winding. Shunt **20** is so adjusted that a short between the high voltage ends of both secondaries is not harmful, so that the secondary current is limited in normal operation.

I claim:

1. In a transformer, the combination of a closed circuit core, a pair of primary coils respectively on two legs of the core, a pair of secondary coils respectively on the same two legs of the core, a shunt between the legs located between the primary and secondary coils, one or more shunts disposed outside the coils and each comprising one or more channel shaped plates having an inturned portion at one end extending toward the core beyond the secondary and an inturned portion at the other end ex-

tending toward the core beyond the primary, and a case containing the transformer.

2. In a transformer, the combination of an O-type core, primary and secondary windings on said core, a shunt extending across the core between the primary and secondary windings, a case for the core and windings, and a shunt interposed between the core and the adjacent wall of the case, the last named shunt comprising a plate with inturned ends, the ends substantially abutting the core beyond the windings and means for holding the last named shunt in engagement with the core.

3. In a transformer, the combination of a closed circuit core, primary and secondary windings on said core, a shunt disposed between the primary and secondary windings, a case for the core and windings, a shunt positioned on each side of the core and interposed between the core and the adjacent wall of the case, each of said last named shunts comprising a plate with inturned ends, the ends substantially abutting the core beyond the primary and secondary windings, and means connecting the last named shunts and holding them in engagement with the core.

PERCIVAL K. RANNEY.