Aug. 31, 1965 C. G. DUENKE 3,204,210

HIGH REACTANCE TRANSFORMER

Filed Dec. 28, 1962 2 Sheets-Sheet 1

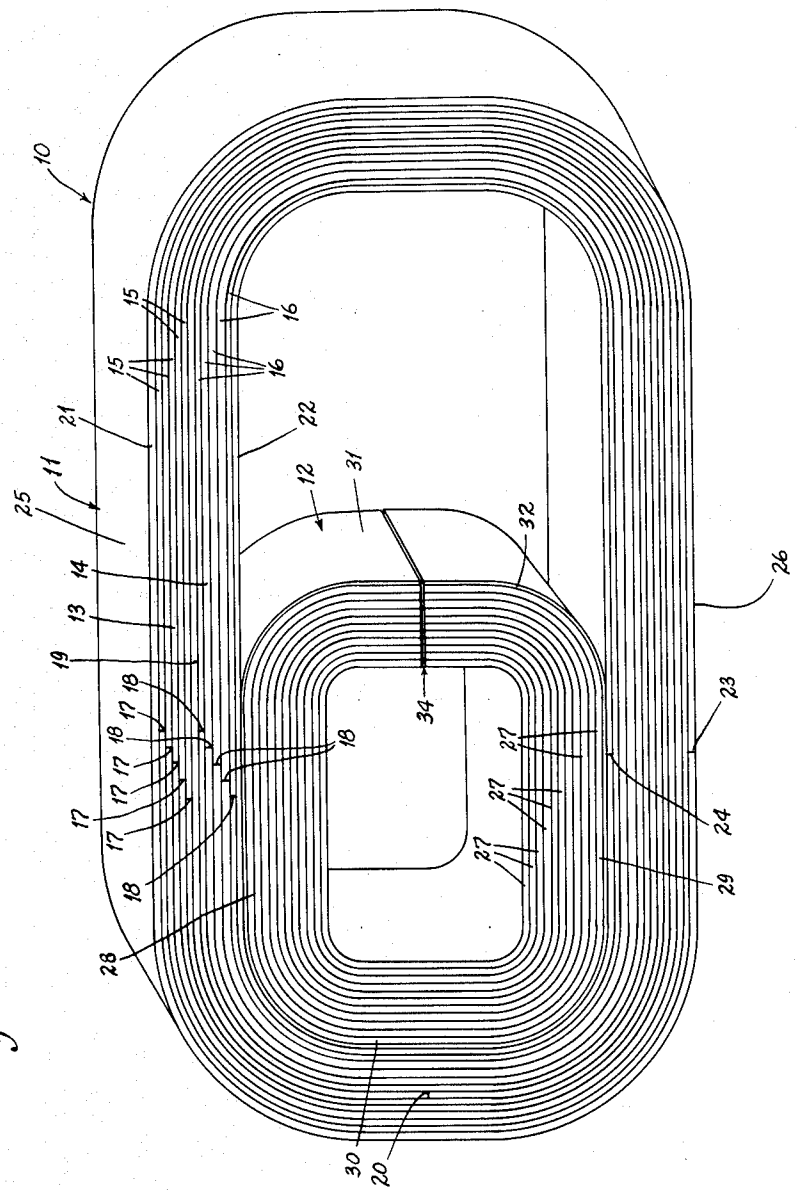


Fig. 1.

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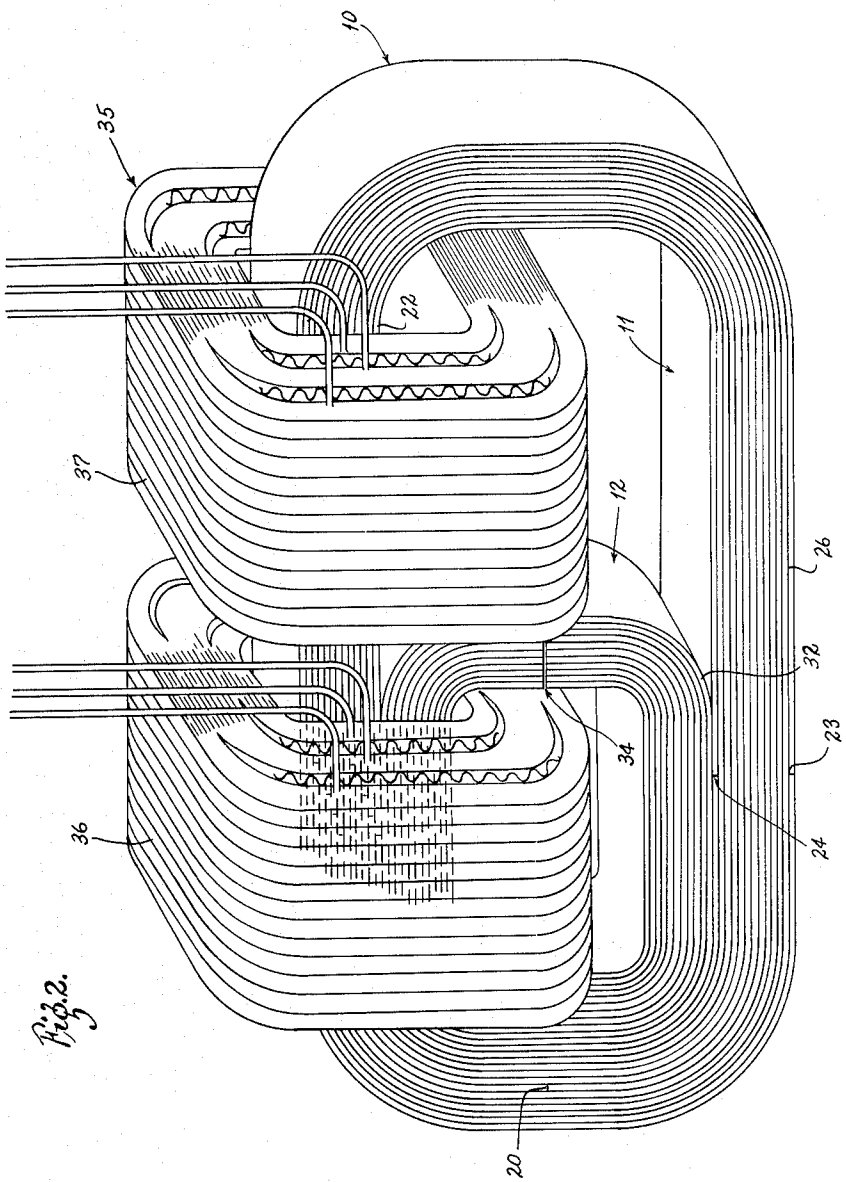


Fig. 2.

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HIGH REACTANCE TRANSFORMER

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3 Claims. (Cl. 336—165)

This invention relates to a high reactance inductive device and particularly to a high reactance transformer having the properties of an initial high voltage output followed by an output at a controlled current level. This kind of transformer is especially useful to start and then operate gas filled lamps such as mercury vapor lamps.

A characteristic of a gas filled lamp is that it requires a relatively high starting or igniting voltage, but immediately after it is started, continued and normal operation of the lamp requires a limited current flow. In general, these characteristics of gas filled lamps exist because the initial ionization of the gas requires a high voltage, but after ignition, as current flows through the lamp, the lamp impedance decreases. Therefore, unless the operating voltage across the lamp is reduced, the current flow through the lamp will increase substantially and ultimately destroy the lamp or its circuit.

The general object of this invention is to provide a transformer for starting and operating a gas filled lamp with a high leakage reactance for providing a high starting voltage followed by a controlled current flow through the output of the transformer and through the lamp.

A specific object of the invention is to provide a transformer core that may be used with a high leakage reactance transformer wherein the construction of the core is such that when properly wound it provides a flux path of high permeability linking the primary and secondary windings and a shunt having a high leakage reactance connected across the main core between the primary and secondary windings.

Another object of the invention is to provide a core structure for a high leakage reactance transformer that is extremely quiet in operation.

Another object of the invention is to provide a core for a high leakage reactance transformer that has a minimum copper loss.

Still another object of the invention is to provide a core for a high leakage reactance transformer that can be assembled quickly and easily.

Other objects and advantages will be apparent to those skilled in the art.

In the drawings:

FIGURE 1 is an isometric view of the core; and

FIGURE 2 is an isometric view of a transformer employing the core of FIGURE 1.

Referring to FIGURE 1, the core **10** comprises an outside loop **11** and an inside loop **12**. The outside loop **11** is intended to provide a path for magnetic flux linking primary and secondary windings whereas the inside loop **12** provides a shunt.

The outside core loop **11** comprises a plurality of groups of magnetically oriented metal strip laminations. In the core illustration there are two such lamination groups **13** and **14**, the group **13** comprising one plurality of laminations **15** and the group **14** another plurality of laminations **16**. Each of these laminations in the groups **13** and **14** makes a single turn about the loop **11**.

The laminations **15** of the group **13** have butt joints **17** that are staggered in substantially a straight line along a leg of the loop **11**, as clearly illustrated in FIGURE 1. The laminations of the group **14** also have staggered butt joints **18**. As shown in FIGURE 1, the joints **17** and **18** which are nearest one another are spaced apart a substantial distance. Also, there is a single lamination **19** between the groups **13** and **14** and having a butt joint **20** displaced a considerable distance from the joints **17** and **18**. This lamination **19** acts as a locking lamination and also as a path for any flux bypassing the adjacent joints **17** and **18**.

There are also locking laminations **21** and **22** on the outer and inner sides of the core loop **11**. These laminations **21** and **22** have single butt joints **23** and **24** positioned at points spaced a substantial distance from the joints **17** and **18**.

The outer loop **11** may comprise more than two lamination groups **13** and **14**, but it is preferable to include one or more locking laminations like the lamination **19** between each group. In any event, the joints of each group are staggered and the joints of the locking lamination are spaced from the staggered joints. The loop **11** thus formed has opposite legs **25** and **26**.

The inner core loop **12** comprises a plurality of concentric metal strip laminations **27** formed to a generally rectangular shape to provide opposing legs **28** and **29** and opposing yokes **30** and **31**. The inner loop may be surrounded by a strip of non-magnetic or para-magnetic material **32**, but is otherwise disposed with its legs **28** and **29** next to the legs **25** and **26** of the outer loop **11**. Thus, the strip **32** introduces a reluctance to the flow of flux from the core loop **11** to the loop **12**.

All of the laminations **27** have cuts **34** to provide a single air gap on the yoke **31**. Therefore, the inner core loop **12** has a high reluctance to the flow of flux. This is in contrast to the extremely low reluctance and high permeability of the outer loop **11**.

The core **10** may be used with a transformer **35** wound with a primary coil **36** and a secondary coil **37** as illustrated in FIGURE 2. The primary coil **36** is wound around the adjacent legs **25** and **28** of both core loops **11** and **12**. The secondary coil **37** is wound only about a leg **25** of the low reluctance outer core loop **11**. The relative number of turns of the primary and secondary coils may be chosen according to the desired input and output characteristics of the transformer.

In operation, the primary winding **36** is connected across an alternating current power supply such as a standard 110 volt 60 cycle supply. A gas filled lamp, such as a mercury vapor lamp is connected across the secondary coil **37**. Such a lamp requires a high starting voltage.

With no current flow through the lamp, the flux induced by the current flow through the primary coil **36** seeks the easiest path which is the low reactance path through the outer core loop **11**. Since this loop links the primary and secondary coils **36** and **37**, the magnetic flux links these coils and the maximum voltage occurs across the output conductors of the secondary coil **37**. As soon as the lamp ignites, it conducts and induces a counter E.M.F. in the secondary coil **37** producing a reluctance to the flow of flux in the outer core loop **11**. This increased reluctance causes the flux to bridge the air gap **34** in the shunt or yoke **31** of the inner core loop **12** thereby reducing the flux in the outer core loop **11**. Reduction of flux in the outer core loop of course reduces the voltage in the secondary coil **37**, and the current flowing through the coil, with a corresponding reduction in the counter E.M.F. Ultimately, the reluctance in the inner and outer core loops stabilizes and a stable current flow through the secondary coil **37** occurs. Under normal running conditions, the flux flow in the outer and inner core loops **11** and **12** is about equal. The extremely effective control produced by this transformer occurs because the outer core loop **11** has such a low reluctance whereas the inner core loop **12** has a high reluctance produced by the air gap **34**.

The assembly of this core is quick and easy. The lamination groups **13** and **14** can be assembled together, thereby eliminating the tedious assembly of one lamination at a time. The inner core loop **12** should be assembled first by stacking the concentric laminations **27**.

Assembly of the outer loop **11** begins with the inner locking lamination **22** which is positioned about an appropriately sized arbor. Then the laminations **16** comprising the group **14** are assembled together about the inner locking lamination **22**, the joints **18** falling in place in the step relationship illustrated. Next, the intermediate locking lamination **19** is fixed in place, followed by the group **13** of the laminations **15**. Finally the outer locking lamination **21** is fitted in place.

The two coils may be connected as either a two winding transformer or as an autotransformer. If the two coils are connected as an autotransformer, the gas filled lamp is connected across both the primary coil **36** and the secondary coil **37**. The primary coil **36** would become the common coil and the secondary coil **37** would become the series coil.

Various changes and modifications may be made within the purview of this invention as will be readily apparent to those skilled in the art. Such changes and modifications are within the scope and teaching of this invention as defined by the claims appended thereto.

What is claimed is:

1. A high reactance transformer comprising two core loops including an inner and an outer core loop each comprising a plurality of concentric metal strip laminations, the inner core loop being positioned within the outer core loop and having a yoke extending between opposite legs of the outer core loop with an air gap thereacross, the laminations of the outer core loop comprising a plurality of separate groups with the laminations of each group having staggered butt joints, a primary coil wound about adjacent legs of the inner and outer core loops, and a secondary coil wound about a leg of the outer core loop only, a locking lamination between each group of laminations on the outer core loop, and locking laminations on the inner and outer sides of the outer core loop, the locking laminations having butt joints located a substantial distance from the staggered joints of the lamination groups.

2. A core for a high reactance transformer comprising two core loops including an inner and an outer core loop each comprising a plurality of concentric metal strip laminations, the inner core loop being positioned within the outer core loop and having a yoke extending between opposite legs of the outer core loop with an air gap thereacross, the laminations of the outer core loop comprising a plurality of separate groups with the laminations of each group having staggered butt joints, a locking lamination between each group of laminations on the outer core loop, and locking laminations on the inner and outer sides of the outer core loop, the locking laminations having butt joints located a substantial distance from the staggered joints of the lamination groups.

3. A core for a high reactance transformer comprising two core loops including an inner and an outer core loop each comprising a plurality of concentric metal strip laminations, the inner core loop being positioned within the outer core loop and having a yoke extending between opposite legs of the outer core loop with an air gap thereacross, the laminations of the outer core loop comprising a plurality of separate groups with the laminations of each group having staggered butt joints, a locking lamination between each group of laminations on the outer core loop, and locking laminations on the inner and outer sides of the outer core loop, the outer core loop being generally rectangular with the staggered butt joints being located on one side of the rectangle, the locking laminations having butt joints located on different sides of the rectangle from the side on which the staggered butt joints are located.

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