Jan. 25, 1966 MASAYASU OHTAKE 3,231,841

COMBINED TRANSFORMER AND CHOKE UNIT

Filed Dec. 6, 1961

Fig 1

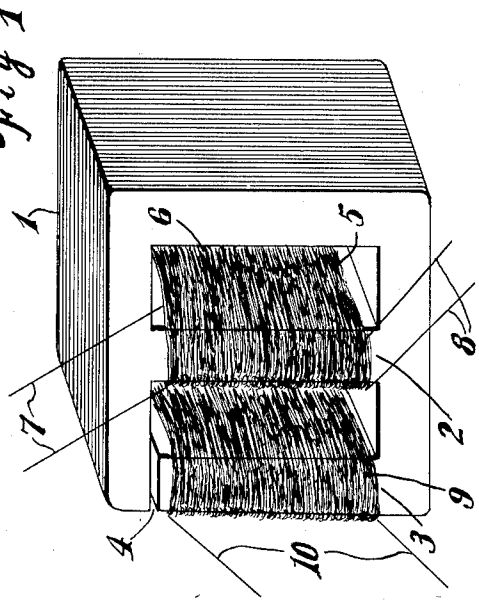


Fig 2

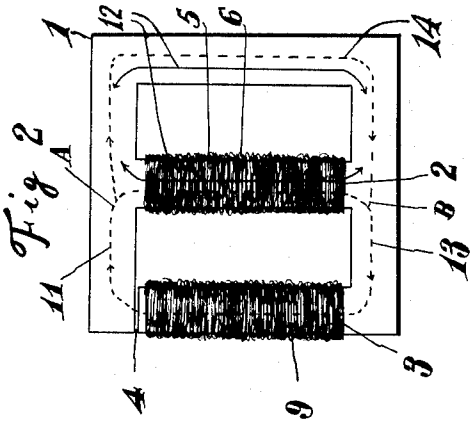


Fig 3

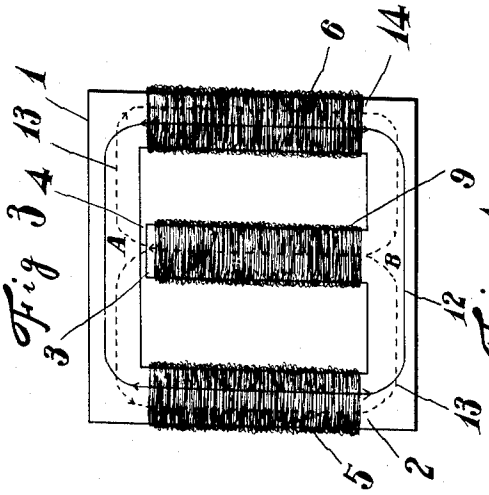
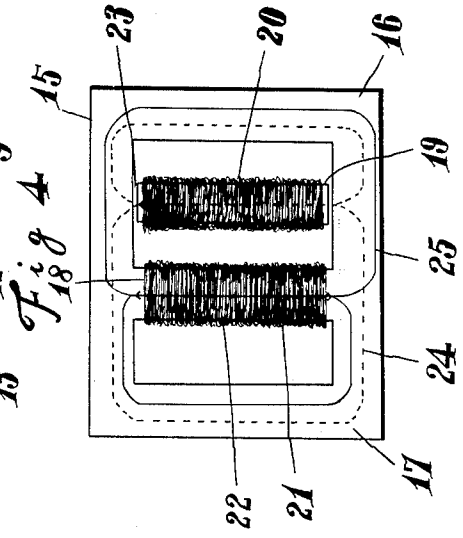


Fig 4



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COMBINED TRANSFORMER AND CHOKE UNIT

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4 Claims. (Cl. 336—165)

The present invention relates generally to a novel combined transformer and choke unit.

With recent remarkable developments in the art of communication appliances, electrical measuring instruments, electronic calculators, high fidelity amplifiers and the like, it has been expressly desired by those skilled in the art to provide light weight and compact transformers and choke coils to be embodied in the power source circuits used in the above mentioned various appliances.

Considerable efforts have been made in this connection, and, indeed, to improve the transformer and choke coil per se or separately.

Such improvements have resulted in considerable loss of the operating efficiency and/or highly complicated design of these electrical components.

It would, therefore, be a considerable progress in the art if a compact and light weight assembly unit comprising a transformer and a choke coil could be realized without sacrificing the operative performance of either to any recognizable degree.

It is, therefore, the main object of the invention to provide a novel and compact, transformer and choke coil assembly unit, employing a common iron core.

It is another object of the invention to provide a novel assembly unit of the kind above referred to, wherein A.C. magnetic fluxes and D.C. fluxes developed therein, while the unit operates, have practically no interference upon each other, with the unit thus being capable of operating as if both these components would have been arranged with the use of separate respective cores.

It is a further object of the invention to provide a novel assembly unit of the kind above referred to, which is of light weight and simple design, without sacrificing its operating performance in my recognizable manner.

The above and further objects and novel features of the present invention will more fully appear from the following detail description when the same is read in connection with the accompanying drawing. It is to be expressly understood, however, that the drawing is for the purpose of illustration only and is not intended as a definition of the limits for the invention.

In the drawing, wherein like reference characters refer to like parts throughout the several views,

FIGURE 1 is a perspective view of an embodiment of the novel choke coil-transformer assembly;

FIGURE 2 is a top plan view of the assembly shown in FIGURE 1, wherein the A.C. magnetic circuit and the D.C. magnetic circuit are diagrammatically represented by a full line and a broken line, respectively;

FIGURE 3 is a view similar to FIGURE 2, showing a somewhat modified embodiment; and

FIGURE 4 is a similar view, illustrating a still further modified embodiment.

Now, referring to the accompanying drawing, especially FIGURES 1 and 2 thereof, reference numeral **1** denotes a laminated iron core, which is designed substantially in the shape of a rectangle having a pair of side legs, a pair of end members, and a leg intermediate and substantially parallel to said side legs as shown, and which has a constant path area for magnetic fluxes. In this core, however, a small air gap **4** is formed according to the invention along the junction line between the left

side leg **3** and the upper member. The position of this air gap may be altered as desired, as will be more fully described hereinafter.

As in the conventional technique, primary and secondary windings **5**–**6** are wound around the central leg **2** of the core, from which windings leads **7**—**7** and **8**—**8** extend for connection to a current source and a load circuit, respectively, although not shown. Around the left hand leg of the core, however, choke coil **9** is wound according to the invention, leads of which, shown by reference numeral **10**, are connected to a D.C. circuit, again although not shown.

In the operation of the above mentioned transformer-choke assembly, oscillating magnetic fluxes developed by energization of the primary winding **5** are subject to a high reluctance at the gap **4** if they should pass therethrough, so that they establish a magnetic path **12** (FIG. 2) in the core having practically no reluctance.

On the other hand, unidirectional magnetic fluxes developed by energization of choke coil **9** will establish in the core a magnetic path as represented by dotted lines **13**, thus including the gap **4**. They divide at a point A, pass through legs **2** and **14**, respectively, and meet together at a point B.

It will be thus clear that, since the D.C. fluxes flow through two shunt paths included in the A.C. magnetic circuit as shown, the passage area for the unidirectional fluxes will be at least twice as large as that for the oscillating fluxes. Thus, the density of the D.C. fluxes flowing through the A.C. magnetic circuit will be less than half that of the A.C. fluxes.

Since almost all the magnetic potential difference of the D.C. fluxes is distributed at the gap **4**, there will be substantially no magnetic influence of these fluxes upon those of the A.C. sides. Thus, both kinds of magnetic fluxes may flow through respective separate circuits without any mutual interference, and as if separate iron cores would have been employed for the transformer and the choke, respectively, as in the case of the conventional art. It will thus be clear that with use of the novel unit, the space and weight requirements may be reduced to less than half those in the conventional art for carrying out the same purpose.

In a modification shown in FIG. 3, the gap **4** is formed along the junction line between the upper member and the central leg **2** of the core, instead of the left side leg **3** in the foregoing embodiment. Similar reference numerals have been used herein to show the corresponding parts and magnetic circuits, so that any person skilled in the art can judge both the nature and operation of the present modification, without further explanation thereof.

FIG. 4 shows a still further modified embodiment of the invention, again in a diagrammatic representation. In thise case, an off-center leg **18** of a laminated iron core **15** having substantially a rectangular shape with a central or intermediate leg, carries thereon primary and secondary winding **21** and **22**. A separate laminated core **19** carrying thereon a choke coil winding **20** is placed in position within the broader core space opposite gap **23** being maintained between the small core **19** and the upper and lower members of the larger core **15**, as shown. If necessary, however, the gaps may be reduced to one at the upper or lower position only. The oscillatory magnetic fluxes are divided as shown by full lines **25** into two component circuits flowing through both side legs of the larger core, while the unidirectional fluxes flow through two shunt circuits again including the said opposite side legs, as denoted by dotted lines **24**.

It will be clear from the foregoing that by the provision of one or more air gaps in the magnetic path of

the iron core, a transformer core and a choke coil core are incorporated into a single assembly, without any substantial interference between A.C. fluxes and D.C. fluxes. Thus, by the present novel technique, the space and weight requirements for the transformer and the choke coil can be reduced to less than those in the case of the conventional technique, and the invention finds its broad use in the fields of communication, electric measurement, electronic calculation, high fidelity amplification and the like, which require rectifying elements. In these technical fields, the invention thus provides considerable progress in the art, in connection with least requirement of the material, simplicity in design and manufacture, and low costs in the production of rectifying appliances.

Although the invention has been described in considerable detail in the foregoing for the purpose of illustration, it is to be understood that such detail is solely for this purpose and that variations can be made therein by those skilled in the art without departing from the spirit and scope of the invention except as set forth in the appended claims.

I claim:

1. A combined transformer and choke unit comprising in combination a substantially rectangular laminated magnetic core of substantially uniform cross sectional area, including a pair of side legs, a pair of end members and at least one leg intermediate and substantially parallel to said side legs, a choke coil wound on one of said legs; terminal means for applying a D.C. potential to said choke coil; and a transformer including a primary winding and a secondary winding, each connected to a respective pair of terminals, and each wound on a leg of said core solidly connected with said end members and other than that leg on which said choke coil is wound; said one leg being spaced at at least one end from the adjacent one of said end members to form at least one air gap to provide a high reluctance to the flow of A.C. magnetic flux through said one leg; whereby substantially only D.C. magnetic flux will flow through a circuit including said one leg and said air gap; said core having three legs; and said primary winding and said secondary winding being wound on the same leg.

2. A combined transformer and choke unit, as claimed in claim **1**, in which said one leg having said air gap is a side leg; said primary winding and said secondary winding being wound on the central leg of said core.

3. A combined transformer and choke unit comprising in combination a substantially rectangular laminated magnetic core of substantially uniform cross sectional area, including a pair of side legs, a pair of end members and at least one leg intermediate and substantially parallel to said side legs, a choke coil wound on one of said legs; terminal means for applying a D.C. potential to said choke coil; and a transformer including a primary winding and a secondary winding, each connected to a respective pair of terminals, and each wound on a leg of said core solidly connected with said end members and other than that leg on which said choke coil is wound; said one leg being spaced at at least one end from the adjacent one of said end members to form at least one air gap to provide a high reluctance to the flow of A.C. magnetic flux through said one leg; whereby substantially only D.C. magnetic flux will flow through a circuit including said one leg and said air gap; said core including an intermediate leg solidly connected to said end members and disposed substantially closer to one side leg than to the other side leg to provide a relatively larger area opening between said intermediate leg and said other side leg; and a second leg intermediate and substantially parallel to said side legs and extending substantially centrally of said relatively larger open area parallel to said side legs; said second intermediate leg constituting said one leg having said choke coil wound thereon, and being separated from both of said end members by air gaps at each end of said second intermediate leg.

4. A combined transformer and choke unit, as claimed in claim **3**, in which said primary winding and said secondary winding are wound on said first-mentioned intermediate leg solidly connected to said end members.

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JOHN F. BURNS, *Primary Examiner.*