Feb. 22, 1966 N. B. ROYER ETAL 3,237,090

WELDING TRANSFORMER

Filed Oct. 11, 1961 2 Sheets-Sheet 1

FIG. 1

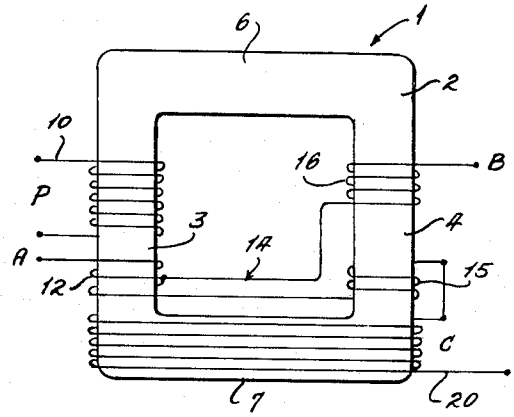


FIG. 2

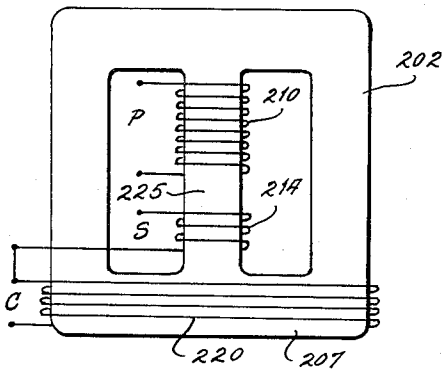


FIG 3

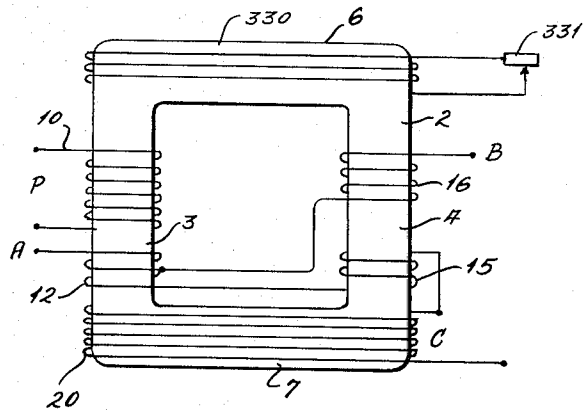
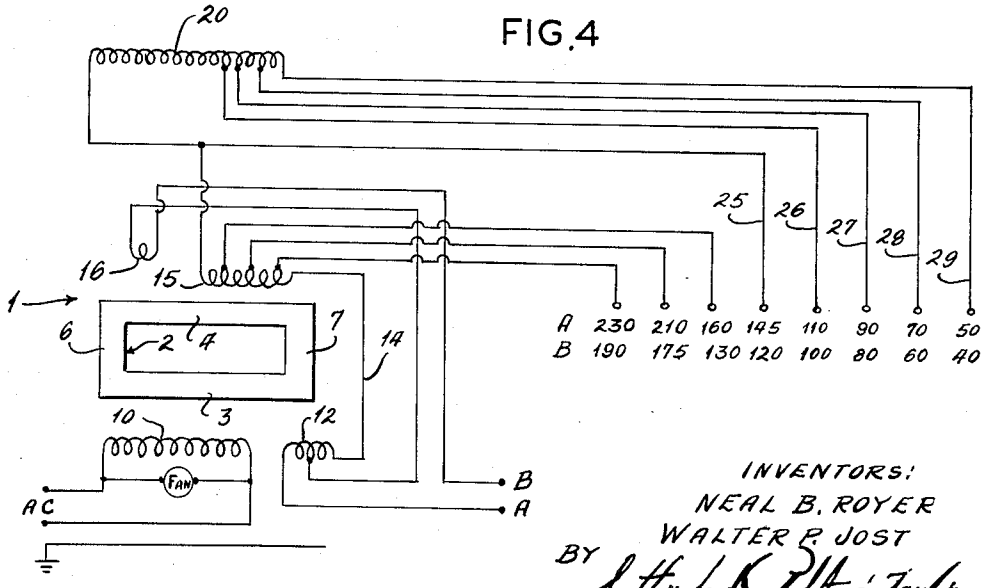


FIG. 4



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FIG.5

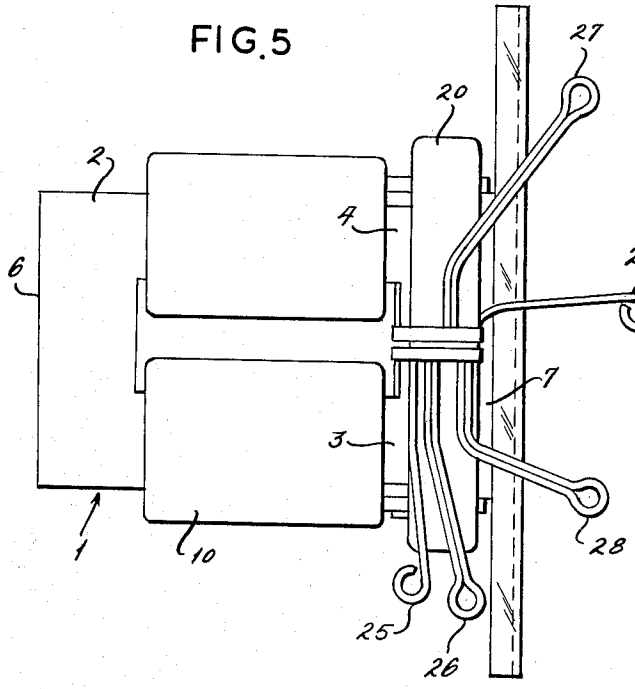


FIG.6

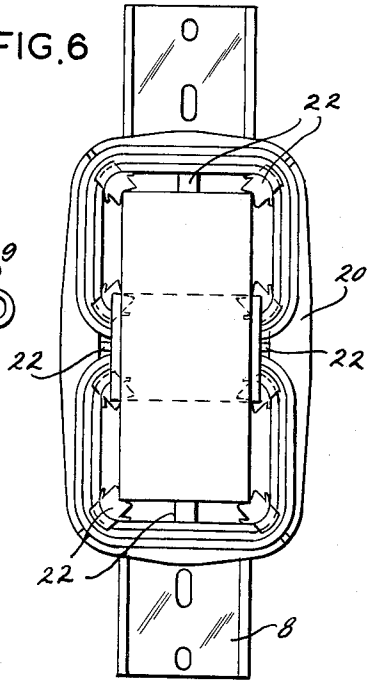


FIG.7

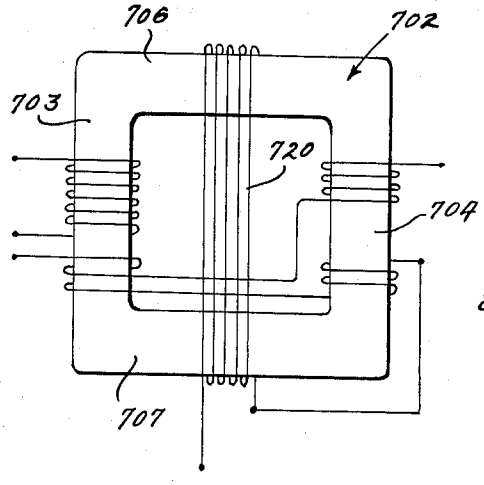
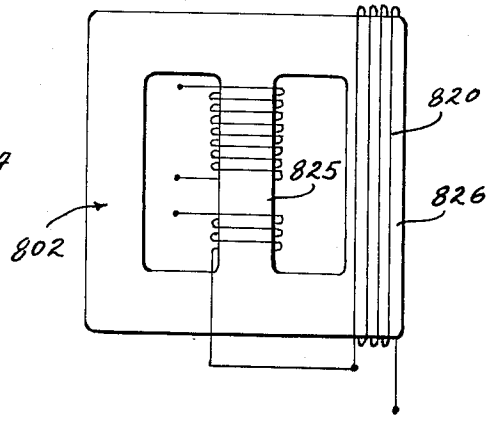


FIG.8



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3,237,090

WELDING TRANSFORMER

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Filed Oct. 11, 1961, Ser. No. 144,398
18 Claims. (Cl. 323—45)

This invention relates to welding transformers of the type in which a reactor or choke coil is used.

It has been common practice heretofore to control the output amperage of an A.C. arc welder "by placing in the arc circuit external to the transformer one or more separate iron-cored coils which function as "reactors"—i.e., coils whose sole function is to introduce reactance into the circuit." (Harnischfeger Corporation v. Miller Electric Manufacturing Company, 121 USPQ 304, 306.) These reactors or choke coils have been considered necessary to avoid design limitations on the tapping directly from the transformer, for low current requirements, since the open-circuit voltage necessarily rises as the number of turns on the secondary coil is increased. Choke coils known heretofore have been built on frames both with and without an air gap. Without an air gap, the choke coil tends to give a third harmonic condition which detracts from the stability of the arc. The use of an air gap tends to eliminate the dwell time at low current (cf. Oestreicher, No. 2,535,154) but results in a loss of impedance as compared with the use of a continuous frame.

In either event, the choke coil has normally been a separate unit with its own frame which, if connected to the transformer frame at all, has been connected physically as a matter of convenience. In those few commercial applications in which a choke coil has been associated directly with the transformer frame, it has been wound inboard of the frame.

One of the objects of this invention is to provide a welding transformer with a choke coil mounted on the frame of the transformer itself in such a way as to provide a compact unit with the improved wave form characteristic of air gap reactors, but wherein the frame upon which the choke coil is mounted is continuous.

Other objects will become apparent to those skilled in the art in the light of the following description and accompanying drawings.

In accordance with this invention, generally stated, a welding transformer is provided, in which primary and secondary coils are mounted conventionally, with at least a part of their reaches inboard of a frame defining a closed magnetic circuit. A choke coil is mounted on and outboard of the frame in such a way as to embrace the closed circuit.

The choke coil can be wound in such a way that the small resultant voltage induced by the flux in the magnetic circuit either augments the voltage of the secondary coils or diminishes the voltage in the secondary coils. In the preferred embodiment, the choke coil diminishes the secondary coil voltage, when the choke coil is in use.

In the usual rectangular transformer frame, of either the core or shell types, two of the choke coils of this invention can be mounted, one around each of the connecting end legs (the primary and secondary coils being wound on one or more side legs). One of the choke coils can be connected with a variable external impedance (resistor or reactor, i.e., inductor or capacitor) or connected to a source of alternating current, and utilized as a control coil. When both coils are untilized as choke coils, one can be wound to buck the voltage in the secondary, and the other to augment the voltage

In the drawing, FIGURE 1 is a diagrammatic view

of a welding transformer with a core type frame, provided with a choke coil in accordance with an illustrative embodiment of this invention;

FIGURE 2 is a diagrammatic view of a transformer with a shell type frame provided with a choke coil in accordance with one embodiment of this invention;

FIGURE 3 is a diagrammatic view of a transformer with a core type frame equipped with two choke coils in accordance with this invention, one of the choke coils being connected in series with a variable impedance, and serving as a control coil;

FIGURE 4 is a circuit diagram showing connections in a welding transformer of the general type indicated diagrammatically in FIGURE 1;

FIGURE 5 is a view in side elevation of a welding transformer constructed in accordance with the embodiment of this invention shown diagrammatically in FIGURES 1 and 4;

FIGURE 6 is a top plan view of the transformer shown in FIGURE 5;

FIGURE 7 is a diagrammatic view of a variation of the transformer with a core type frame shown in FIGURE 1; and

FIGURE 8 is a diagrammatic view of a variation of the transformer with a shell type frame shown in FIGURE 2.

Referring now to the drawings and particularly to FIGURES 1, 4, 5 and 6, reference numeral **1** indicates a welding transformer having a conventional core type frame **2** made up of a multiplicity of laminations. The frame **2** is continuous, and in this embodiment consists of a pair of side legs **3** and **4**, connected at their respective ends by connecting end legs **6** and **7**. A base **8** is welded or otherwise secured to the outside of the leg **7** of the wound frame **2**. A primary coil **10** is mounted on the side leg **3**. A closely coupled portion **12** of a secondary coil **14** is mounted on the same side leg **3**, and a loosely coupled portion **15** of the secondary coil **14**, and an auxiliary secondary coil **16**, are mounted on the side leg **4**.

It can be seen that in each of the primary and secondary coils, a part of the reach of the coil is outboard of the frame, and another part is inboard of the frame. A choke coil **20**, in this embodiment, is wound around the end leg **7** outboard of both legs **3** and **4**, and of the closed magnetic circuit defined by the frame **2**.

In FIGURES 4 and 5, various taps **25**, **26**, **27**, **28** and **29**, from the choke coil **20** are shown. In FIGURE 4, taps from both the secondary and choke coil are labeled with illustrative amperages.

It can be seen that an account of the flux path in the frame **2**, the voltage induced at the end of the choke coil contiguous the side leg **3** will be substantially offset by the voltage, in the opposite direction, induced in the end of the choke coil contiguous the side leg **4**. Because of the presence of leakage flux in the transformer, there is likely, in the arrangement shown, in which, for example, the supply voltage is 230 volts, at 60 cycles, and the resulting voltage in the secondary is about 80, to be a resultant induced voltage in the choke coil of about 4 volts. Preferably the choke coil is wound so as to cause its voltage to be subtracted from that of the secondary, so that on the tap which provides the least amperage, the resulting voltage will be about 76 rather than 80. It can be seen that, depending upon the position of the taps, the voltage subtracted will vary with the number of effective turns involved.

In any event, the resultant voltage in the choke coil will be small.

As can be seen from FIGURE 5, the long reach of

the choke coil **20**, and its position at the end of the core, permit taps to be made from it by merely pulling one turn from the coil intermediate its ends.

The choke coil **20** is preferably such a size that, when it is slipped on the end of the core, it is spaced, for example, ¼", from the core, all the way around. Spacer-retainer blocks **22**, which may be in the form of plastic wedges, are used to hold the coil **20** in place, and to ensure its spacing from the core. This is to facilitate the cooling of the choke coil. In this connection, it can be seen that, for a given number of turns, the choke coil **20** requires a longer reach, hence a longer wire, than the conventional separate choke coil or reactor. However, because of the superior cooling, provided by the arrangement of the choke coil **20** on the transformer core, wherein the fan which is normally provided for the transformer can be utilized for cooling the choke coil as well, lighter gauge wire may be used for the choke coil than can be used for the conventional choke coil, so that the weight of conductor metal involved may be about the same.

In the embodiment shown in FIGURE 2, a shell type transformer frame **202** is shown diagrammatically as having a primary **210** and a simple secondary **214** wound on a central leg **225**. A choke coil **220** is mounted around a connecting leg **207**. Those skilled in the art will appreciate that in practice, the winding and tapping of the coils on a shell type frame will correspond, except for details, to the core type transformer circuit shown in FIGURE 4. As in the case of the core type frame, the voltages induced in the coil **220** by the magnetic flux passing between the center leg **225** and outside legs of the frame, will offset one another except for a small resultant voltage arising from the leakage flux of the transformer.

In the operation of the choke coil in both of the embodiments described above, the wave form produced by the choke coil is much like that shown in FIGURE 3 of the Oestreicher Patent No. 2,535,154, as contrasted with the form shown in FIGURE 2 of that patent, which is characteristic of the reactors in which no air gap is provided. While the theory of its operation forms no part of this invention, it is believed that this arises in part at least from the fact that a flux generated by the choke coil of this invention necessarily must have a path through air, since the coil is in effect wound around a straight core.

In the embodiment shown in FIGURE 3, the primary **10**, closely coupled secondary **12**, loosely coupled secondary **15** and auxiliary secondary **16**, and the choke coil **20** are all identical with their counterparts in the embodiment shown in FIGURE 1. However, a second "choke" coil **330** is mounted on the connecting end of leg **6**. While it is contemplated that the choke coil **330** can be of the same character as the choke coil **20** in some embodiments, in the present embodiment shown in FIGURE 3, the coil **330** is in reality a control coil. To this end, it is connected in series with a variable external impedance **331** which may be a variable resistor, inductor or capacitor. In this way, or by imposing an external alternating current, an almost continuous adjustment of amperage may be made within the extreme limits of amperage available from the welder.

Two variations in the winding of the transformer of this invention are illustrated in FIGURES 7 and 8. In FIGURE 7, a core type frame **702** has a choke coil **720** wound parallel with side legs **703** and **704**, outboard thereof, and around connecting legs **706** and **707**. In FIGURE 8, a shell type frame **802** has a choke coil **820**, wound parallel with a center leg **825**, longitudinally but outboard of an outside leg **826**. It can be seen that a similar coil can be mounted around the other outside leg.

Numerous other variations in the details of construction of the welding transformer of this invention, within the scope of the appended claims, will occur to those skilled in the art in the light of the foregoing disclosure.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. In a welding transformer wherein primary and secondary coils are mounted at least partly inboard of a frame defining a closed magnetic circuit the improvement comprising a choke coil mounted on and outboard of said frame to embrace said closed circuit and a plurality of welding taps connected to and along said choke coil.

2. The improvement of claim **1** wherein the choke coil is so wound with respect to the primary and secondary coils that voltage induced in the choke coil subtracts from the voltage in the secondary coil.

3. The improvement of claim **1** wherein the choke coil is so wound with respect to the primary and secondary coils that voltage induced in the choke coil adds to the voltage in the secondary coil.

4. In a welding transformer wherein primary and secondary coils are mounted at least partly inboard of a frame defining a closed magnetic circuit the improvement comprising two choke coils, one mounted on and outboard of said frame at each end of said frame to embrace said closed circuit, a variable external impedance connected in series to one of said choke coils whereby said choke coil is utilized as a control coil and a plurality of welding taps connected to and along the other of said choke coils.

5. In a welding transformer wherein primary and secondary coils are mounted at least partly inboard of a frame defining a closed magnetic circuit, the improvement comprising a choke coil mounted on and outboard of said frame to embrace said closed circuit, and a variable external impedance connected in series to said choke coil whereby said choke coil is utilized as a control coil.

6. In a welding transformer wherein primary and secondary coils are mounted at least partly inboard of a frame defining a closed magnetic circuit the improvement comprising two choke coils mounted on said frame to embrace said closed circuit, said coils being so wound with respect to the primary and secondary coils that voltage induced in one choke coil adds to the voltage in the secondary coil, and the other substracts from the voltage in the secondary coil, and a plurality of welding taps connected to and along at least one of said coils.

7. In a welding transformer wherein primary and secondary coils are mounted at least partly inboard of a frame defining a closed magnetic circuit, the improvement comprising two choke coils mounted on and outboard of said frame to embrace said closed circuit, and a plurality of welding taps connected to and along at least one of said choke coils.

8. In a welding transformer wherein primary and secondary coils are mounted at least partly inboard of a frame defining a closed magnetic circuit the improvement comprising two choke coils mounted on and outboard of said frame to embrace said closed circuit, and a variable external impedance connected in series to at least one of said choke coils.

9. The improvement of claim **1** wherein the primary and secondary coils are mounted on side legs of a core type frame.

10. The improvement of claim **1** wherein primary and secondary coils are mounted on a leg of a shell type frame.

11. The improvement of claim **1** wherein primary and secondary coils are mounted on side legs of a core type frame and the choke coil embraces longitudinally a connecting end leg of said frame outboard of said side legs.

12. The improvement of claim **1** wherein primary and secondary coils are mounted on a center leg of a shell type frame and the choke coil is mounted longitudinally of, on and around an outside leg of said frame.

13. The improvement of claim **1** wherein the frame is a core type frame, with side legs and connecting end legs, primary and secondary coils are mounted on said side legs and the choke coil is mounted on and outboard of a part of the frame defined by a span of said connecting end legs of said frame spacing the said side legs.

14. The improvement of claim 5 wherein the primary and secondary coils are mounted on side legs of a core type frame.

15. The improvement of claim 5 wherein the primary and secondary coils are mounted on a leg of a shell type frame and the choke coil is mounted around the outside of said frame.

16. The improvement of claim 5 wherein the primary and secondary coils are mounted on side legs of a core type frame and the choke coil is mounted longitudinally to embrace a connecting end leg of the frame, outboard of said side legs.

17. The improvement of claim 5 wherein the primary and secondary coils are mounted on a center leg of a shell type frame and the choke coil is mounted longitudinally of, on and around an outside leg of said frame.

18. The improvement of claim 5 wherein the frame is a core type frame, with side legs and connecting end legs, the primary and secondary coils are mounted on said side legs and the choke coil is mounted on and outboard of a part of the frame defined by a span of said connecting end legs of said frame spacing the said side legs.

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