

10

PATENT SPECIFICATION

(11) 1 485 348

1 485 348

- (21) Application No. 39584/75 (22) Filed 26 Sept. 1975
(44) Complete Specification published 8 Sept. 1977
(51) INT CL² H01F 29/00, 29/10, 29/12
(52) Index at acceptance
H1T 1F 7A10A 7A10B 7A11 7A4 7A5 7C3 7C4 7C5 8
(72) Inventor WILLIAM KENNETH BROUGHAM



(54) IMPROVED LEAKAGE REACTANCE TRANSFORMER

(71) We, WELDING INDUSTRIES OF AUSTRALIA PTY LTD, a Company incorporated under the laws of the State of Victoria, Australia, of 2—20, Austarc Avenue, Thomastown, Victoria 3074, Australia, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to leakage reactance transformers, particularly those suitable for use in supplying electric arc welding currents or in other situations where current control is required.

At the present time, there are basically two distinct types of leakage reactance welding transformers. These are commonly referred to as the moving coil type and the moving shunt type.

The moving coil transformer has a fixed secondary winding and a primary winding coil mounted for movement along the centre legs of the transformer core towards and away from the fixed secondary. By positioning the movable coil at maximum spacing from the secondary, the leakage reactance of the transformer is at a maximum and the volt/amp (V/A) output is at a minimum. When the coils are brought close together, the leakage reactance is minimised and the V/A output is at a maximum.

The rate of increase of leakage reactance with respect to distance between the windings is not linear but logarithmic and so in order to achieve a reasonable variation in the V/A output between the minimum and maximum values, the transformer core must be made with a long leg length. This results in high transformer costs.

The moving shunt transformer includes a steel shunt movably mounted on a frame located between the primary and secondary windings and capable of movement into and out of the space between the windings. The positioning of the shunt between the windings increases the leakage reactance and provides minimum V/A output determined by the size of the shunt and the

sum of the air gaps between the shunt and the core. Maximum V/A output is achieved by fully withdrawing the shunt but because the windings must be spaced for the shunt the maximum that can be achieved is limited.

When design requirements dictate a low V/A requirement or a large min/max ratio then the size of the shunt must be increased and the air gaps decreased thus increasing the magnetic forces on the shunt. This increases the need for precision slides to accurately guide the shunt frame between the windings. As the slides wear, jamming and other problems occur and complex arrangements are required to overcome this problem.

In one aspect therefore, the invention provides a leakage reactance transformer comprising a magnetic core formed from a stack of laminations and having an opening defining two spaced legs, primary and secondary windings on said core, one of said windings being movable relative to the other to vary the current output of the transformer, and a magnetic shunt means movable from a first position in which it contributes to the leakage reactance of the transformer to a second position in which it contributes substantially less leakage reactance, at least a portion of said core between the primary and secondary windings being arcuate and said movable winding being mounted for arcuate movement along said portion, said shunt means moving with said movable winding such that when said movable winding is most remote from the other winding said shunt means is in its first position and when said movable winding is close to the other winding said shunt means is in its second position, a keeper secured to the free ends of said legs to close the flux path, said magnetic shunt means being formed from that portion of the laminations removed to form the portion of the opening adjacent the arcuate portion of the core and substantially bridging the gap between said legs in said first position.

In its most preferred form the magnetic

55

60

65

70

75

80

85

90

95

100

core is formed with a substantially circular aperture substantially concentric with said arcuate portion, a further opening communicating with said aperture to create said legs on either side thereof, said shunt being located within said aperture and bridging the opening therein in said first position. Thus, the core may be regarded as having a 'key-hole' shaped window therein.

Preferably the shunt means is segment shaped.

In order that the invention may be more readily understood, two embodiments of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a front elevation of a transformer assembly embodying the invention;

Figure 2 is a side elevation of the assembly of Fig. 1;

Figure 3 is a perspective view of the transformer core of the embodiment shown in Figures 1 and 2;

Figure 4 is a front view of the transformer housing, of the embodiment shown in Figures 1 and 2;

Figure 5 is a front view of a modification including a double core transformer according to the invention; and

Figure 6 is a perspective view of the core used in the embodiment of Fig. 5.

Referring firstly to Figures 1 to 3, the transformer includes a steel core 1 formed from a stack of steel sheet laminations which are cut in the configuration shown in Fig. 3 by punching or any other suitable means. The stack of steel sheets is held together by clips 2 secured in slots S formed in the edges of the sheets. It will be noted that the basic core element is of square configuration with one corner C of the square rounded and having a centrally positioned 'key-hole' K cut therethrough. The magnetic circuit of the core 1 is completed by a laminated steel keeper A of rectangular configuration which is welded to the side of the core element through which the 'key-hole' K opens. The core 1 is suitably mounted on a base 3 on which the casing (Fig. 4) for the transformer is secured.

Prior to the securement of keeper A to the core 1, a secondary winding coil 5 is positioned around one leg of the core 1. The coil 5 is formed around brackets 6 by means of which the coil 5 is secured to the base 3. The coil 5 is formed from an aluminium strip insulated by paper sold under the Trade Mark "Nomex" or any other suitable combination. Leads 7 are provided for connection to output terminals 8 (Fig. 4).

Also prior to securement of the keeper A to the core 1, a primary winding 9 coil wound from glass covered aluminium wire

or other suitable material on three suitably insulated support brackets 10 is positioned on the core and secured to a supporting frame 11 by bolts 12 passing through the brackets 10 as shown. The frame 11 is in turn pivotally mounted on brackets 13 extending on either side of the core 1 and rigidly secured thereto by a cross bar 14. The frame 11 has extension lugs 15 extending downwardly and inwardly towards the core 1 and through which bolts 16 pass for securing a clamping bracket 17 adapted to hold a laminated steel shunt 18. The shunt 18 has a curved lower end matching the curvature of the central opening of the 'key-hole' K and is of such dimensions as to bridge the gap between the legs of the core 1 and form a flux path between the legs. The shunt 18 is of course electrically insulated from the frame 11 bolts 16 and bracket 17 by suitable insulating washers and brushes.

It will be evident from the above that the primary winding coil 9 and the steel shunt 18 are supported by a common frame 11 with the shunt 18 at about 180° to the coil 9, the common frame 11 being pivotally mounted on brackets 13. Thus, when the coil 9 is moved arcuately from the position shown in Fig. 1 to a position adjacent the secondary coil, the shunt 18 will be moved through the same angle to a position wherein it is remote from the gap between the legs of the core 1.

In this way, the transformer embodying the invention effectively combines the moving coil and moving shunt features of the prior art devices. In the position shown in Fig. 1, the coil 9 is remote from the coil 5 while the shunt is in the most effective position to maximise the additional leakage reactance introduced by the shunt and minimum V/A output is achieved. Maximum V/A output is achieved when the coil 9 is fully pivoted to a position adjacent secondary winding coil 5 and since the shunt is completely removed from the gap it contributes effectively no leakage reactance to the magnetic circuit.

Since the transformer embodying the invention incorporates substantial leakage reactance due to the spacing of the coils in the position shown in the drawing, the size of the shunt 18 is relatively much smaller and the air gaps greater than in the prior art moving shunt design. Thus the usually mandatory requirements of the moving shunt design are avoided and a greatly simplified design is permitted.

It will be apparent from the drawing that the amount of steel used in the embodiment described is substantially less than for the moving coil device and approximately the same as for the moving shunt design. Thus, in view of the simple nature of the design, a greater min/max V/A output ratio can be

achieved for a lower cost.

It will be appreciated that the roles played by the windings 5 and 9 may be reversed, i.e., winding 5 may operate as the primary while winding 9 is the secondary.

As shown in Fig. 4, the transformer described above is enclosed in a suitable casing having a front panel B formed with an arcuate slot C through which a threaded operating knob D passes for engagement with a boss 19 (Figs. 1 and 2) on the supporting frame 11. Thus, arcuate movement of the knob D moves the primary winding coil 9 and the shunt 18 as described to adjust the V/A output of the transformer. The knob D may be fixed in any desired position by screwing the knob into engagement with the front panel B. A nylon or like washer (not shown) is positioned between the panel B and the knob D for smooth operation.

In the alternative form shown in Figs. 5 and 6, the magnetic core of the transformer is extended by joining two cores similar to 1 described above interleaved together as shown in Fig. 6 and held together by nylon rivets 20. Alternatively, the ends of laminations in each core may be welded together in some suitable manner either with or without interleaving as shown. A single winding 5 is positioned around one leg of the composite core and two windings 9 and steel shunts 18 are arranged as in the first embodiment on the respective core components 1. The arrangement works in the same manner as before only the two windings 9 are connected in parallel to constitute the secondary winding of the transformer and both are moved towards winding 5, which is the primary in this case, when additional V/A output is required. If desired, the two support frames for cores 9 and shunts 18 may be interconnected by a suitable linkage (not shown) so that they move in union. However, separate movement provides for a greater V/A range and allows individual outputs to be derived from each secondary so as to provide a dual operator welder.

By using basically the same core stamping for both embodiments a wide range of V/A outputs can be achieved at a lower cost.

It will be appreciated that the specific core configuration and other details described above are not essential to the invention. Similarly, the functions of the primary and secondary coils may be interchanged, that is, in an arrangement similar to that shown in Figures 1—3 coil 5 may be movable while coil 9 is fixed or both may be movable. With coil 5 movable and the shape of the window suitably changed, the shunt 18 may be fixed to a simple bracket on coil 5. In this arrangement the shunt would be

moved away from its bridging position by movement of the coil 5.

WHAT WE CLAIM IS:—

1. A leakage reactance transformer comprising a magnetic core formed from a stack of laminations and having an opening defining two spaced legs, primary and secondary windings on said core, one of said windings being movable relative to the other to vary the current output of the transformer, and a magnetic shunt means movable from a first position in which it contributes to the leakage reactance of the transformer to a second position in which it contributes substantially less leakage reactance, at least a portion of said core between the primary and secondary windings being arcuate and said movable winding being mounted for arcuate movement along said portion, said shunt means moving with said movable winding such that when said movable winding is most remote from the other winding said shunt means is in its first position and when said movable winding is close to the other winding said shunt means is in its second position, a keeper secured to the free ends of said legs to close the flux path, said magnetic shunt means being formed from that portion of the laminations removed to form the portion of the opening adjacent the arcuate portion of the core and substantially bridging the gap between said legs in said first position.

2. The transformer of claim 1, wherein the opening has a substantially circular part substantially concentric with said arcuate portion of the core, and a rectangular part communicating with the circular part to define said legs on either side thereof.

3. The transformer of claim 2, wherein said core has a key-hole shaped window therein.

4. The transformer of claim 1, 2, or 3 wherein said shunt means is segment shaped so as to fit within said circular part of the opening during its movement from its first position to its second position.

5. The transformer of any one of claims 1 to 4, wherein said movable winding and said shunt means are supported by a common frame pivotally mounted on brackets secured to said core, said shunt means being disposed at about 180° to the movable winding and maintaining this disposition relative to said movable winding during pivotal movement of said winding and shunt means between said first and second positions.

6. The transformer of any one of claims 1 to 5, wherein said core has a configuration substantially as described with reference to Figures 1 and 3 of the accompanying drawings.

achieved for a lower cost.

It will be appreciated that the roles played by the windings 5 and 9 may be reversed, i.e., winding 5 may operate as the primary while winding 9 is the secondary.

As shown in Fig. 4, the transformer described above is enclosed in a suitable casing having a front panel B formed with an arcuate slot C through which a threaded operating knob D passes for engagement with a boss 19 (Figs. 1 and 2) on the supporting frame 11. Thus, arcuate movement of the knob D moves the primary winding coil 9 and the shunt 18 as described to adjust the V/A output of the transformer. The knob D may be fixed in any desired position by screwing the knob into engagement with the front panel B. A nylon or like washer (not shown) is positioned between the panel B and the knob D for smooth operation.

In the alternative form shown in Figs. 5 and 6, the magnetic core of the transformer is extended by joining two cores similar to 1 described above interleaved together as shown in Fig. 6 and held together by nylon rivets 20. Alternatively, the ends of laminations in each core may be welded together in some suitable manner either with or without interleaving as shown. A single winding 5 is positioned around one leg of the composite core and two windings 9 and steel shunts 18 are arranged as in the first embodiment on the respective core components 1. The arrangement works in the same manner as before only the two windings 9 are connected in parallel to constitute the secondary winding of the transformer and both are moved towards winding 5, which is the primary in this case, when additional V/A output is required. If desired, the two support frames for cores 9 and shunts 18 may be interconnected by a suitable linkage (not shown) so that they move in unison. However, separate movement provides for a greater V/A range and allows individual outputs to be derived from each secondary so as to provide a dual operator welder.

By using basically the same core stamping for both embodiments a wide range of V/A outputs can be achieved at a lower cost.

It will be appreciated that the specific core configuration and other details described above are not essential to the invention. Similarly, the functions of the primary and secondary coils may be interchanged, that is, in an arrangement similar to that shown in Figures 1—3 coil 5 may be movable while coil 9 is fixed or both may be movable. With coil 5 movable and the shape of the window suitably changed, the shunt 18 may be fixed to a simple bracket on coil 5. In this arrangement the shunt would be

moved away from its bridging position by movement of the coil 5.

WHAT WE CLAIM IS:—

1. A leakage reactance transformer comprising a magnetic core formed from a stack of laminations and having an opening defining two spaced legs, primary and secondary windings on said core, one of said windings being movable relative to the other to vary the current output of the transformer, and a magnetic shunt means movable from a first position in which it contributes to the leakage reactance of the transformer to a second position in which it contributes substantially less leakage reactance, at least a portion of said core between the primary and secondary windings being arcuate and said movable winding being mounted for arcuate movement along said portion, said shunt means moving with said movable winding such that when said movable winding is most remote from the other winding said shunt means is in its first position and when said movable winding is close to the other winding said shunt means is in its second position, a keeper secured to the free ends of said legs to close the flux path, said magnetic shunt means being formed from that portion of the laminations removed to form the portion of the opening adjacent the arcuate portion of the core and substantially bridging the gap between said legs in said first position.

2. The transformer of claim 1, wherein the opening has a substantially circular part substantially concentric with said arcuate portion of the core, and a rectangular part communicating with the circular part to define said legs on either side thereof.

3. The transformer of claim 2, wherein said core has a key-hole shaped window therein.

4. The transformer of claim 1, 2, or 3 wherein said shunt means is segment shaped so as to fit within said circular part of the opening during its movement from its first position to its second position.

5. The transformer of any one of claims 1 to 4, wherein said movable winding and said shunt means are supported by a common frame pivotally mounted on brackets secured to said core, said shunt means being disposed at about 180° to the movable winding and maintaining this disposition relative to said movable winding during pivotal movement of said winding and shunt means between said first and second positions.

6. The transformer of any one of claims 1 to 5, wherein said core has a configuration substantially as described with reference to Figures 1 and 3 of the accompanying drawings.



7. A transformer substantially as described with reference to Figures 1 to 4 of the accompanying drawings.

5 8. The transformer of any one of claims 1 to 5, comprising a further core similar to said core and connected to said core to complete the magnetic circuit, and a further movable winding and shunt means for said further core being arranged in a manner similar to said movable winding and said shunt means.

10 9. A transformer according to claim 8, wherein the core is substantially as described with reference to Figure 6 of the accompanying drawings.

15 10. A transformer substantially as described with reference to Figures 5 and 6 of the accompanying drawings.

20 11. A method of manufacturing a transformer comprising the steps of forming an opening in a stack of laminations to form a magnetic core, mounting primary and secondary windings on said core with one winding being movable towards and away from the other winding along an arcuate portion of said core, mounting magnetic shunt means within said opening to be movable with said one winding such that when said movable winding is most remote from the other winding said shunt means is in a first position in which it contributes to

the leakage reactance of the transformer and when said movable winding is close to the other winding said shunt means is in a second position in which it contributes substantially less leakage reactance, and in which said opening is formed to define said arcuate portion and two spaced legs, securing a keeper to the free ends of said legs to close the flux path of said core, said magnetic shunt means being formed from that portion of the laminations removed to form the arcuate portion of said opening and substantially bridging the gap between said legs in said first position.

45 12. The method of claim 11 wherein said core is formed with a substantially circular aperture substantially concentric with said arcuate portion, and a rectangular opening communicating with said aperture to create said legs on either side thereof.

50 13. The method of claim 12, wherein said core has a key-hole shaped window therein.

55 14. The method of any one of claims 11 to 13 wherein said core is formed in the configuration substantially as described with reference to Figures 1 and 3 or 5 and 6 of the accompanying drawings.

KILBURN & STRODE,
Chartered Patent Agents,
Agents for the Applicants.

