UNITED STATES PATENT OFFICE

ADJUSTABLE CURRENT TRANSFORMER

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11 Claims. (Cl. 171—777)

1 This invention relates to an adjustable current transformer applicable to various purposes including welding, battery charging and any use requiring a wide adjustability of current.

The principal object of the invention is to provide a less costly transformer having a wide range of current adjustability.

Another object of the invention is to provide a smaller and more compact transformer for a given capacity and range of current adjustment.

The spring adjustment of the invention is to reduce the size of the core required in an adjustable current transformer.

Another object is to more effectively prevent chatter and vibration in an adjustable current transformer.

Another object is to facilitate cooling of the windings and core of the transformer.

Another object is to provide a current regulator for a transformer wherein the scale of current adjustment for the increments of movement required for making adjustments is linear throughout substantially the entire range of adjustment, the current change being directly proportional to the distance of movement therefor.

Other objects and advantages are set forth in the description of transformers illustrated in the accompanying drawings.

In the drawing:

Figure 1 is a side elevation with parts broken away and showing a transformer in which a rotary motion effects the current regulation;

Fig. 2 is a top plan view of the transformer of Fig. 1;

Fig. 3 is a detail sectional view of a portion of the scale and showing the eccentric clamp for holding the lever arm;

Fig. 4 is a view similar to Fig. 1 showing the secondary winding and shunt core moved to the opposite extreme position of reduced current output;

Fig. 5 is a side elevation with parts broken away and showing a core type transformer showing a current regulator shunt applied thereto;

Fig. 6 is a top plan view of the transformer of Fig. 5;

Fig. 7 is a front elevation of the transformer; and

Fig. 8 is a view similar to Fig. 5 showing the secondary and shunt core in the opposite extreme position of adjustment.

The transformer illustrated in Figures 1 to 4, inclusive, is of the rotary type having a primary winding 1 and a secondary winding 2 normally disposed concentric to and encircling the primary winding.

A laminated core 3 has one leg 4 passing axially through the center of primary winding 1, and the remainder of the core provides a closed flux path encircling one side of the winding and also the corresponding side of the secondary winding 2.

The core 3 and the primary winding 1 thereon are supported by a frame comprising two end plates 5 and 6 spaced on opposite sides of the core and secured together by bolts 7 passing through corners of the core. Short tubes 8 encircle the bolts 7 and hold the core and end plates in spaced relation.

The center of the fixed core member 3 is cut through to provide a large circular opening 9 therein prescribed substantially with the outer adjacent surface of primary winding 1 substantially tangential thereto and with the entire side of the secondary winding 2 disposed within the opening.

A circular laminated shunt core member 10 substantially fills the opening 9 and has a recess 11 for receiving the side of the secondary winding 2 passing therethrough.

The core member 10 is mounted on a rotatable shaft 12 extending centrally therethrough and supported in end bearings 13 secured to the end plates 5 and 6.

The member 10 supports the secondary winding 2 and provides by its rotation for the movement of the winding from the position shown in Fig. 1 to that shown in Fig. 4.

When the secondary winding 2 is encircling the primary winding 1 as shown in Fig. 1 there is a maximum flux linkage in core 3 between the two windings, thereby producing maximum current output.

When the secondary winding 2 is spaced from the primary winding 1 and at right angles thereto as shown in Fig. 4 the shunt core 10 bridges the core 3 between the two windings and shunts the flux away from the secondary winding 2. This shunting of the flux tends to destroy the flux linkage between the two windings.

Maximum reduction in flux linkage would be obtained by rotating core 10 and winding 2 through 180° from the position in Fig. 1, but for most all practical purposes a movement to the 90° position as shown in Fig. 4 is sufficient.

Movement of core 10 and winding 2 to any position between the extremes shown in Figs. 1 and 4 results in an intermediate current output corresponding to the position of adjustment.
For the purpose of manually effecting the adjustment described and for more adequately supporting the secondary winding, an angle iron member 14 is secured to the side of core 10 and of winding 2 with its outer end extending radially outward to provide a handle 18.

An arcuate strip 16 is supported by brackets 17 on the opposite side of strip 18 from handle 15 in bearing brackets 19 carried by the handle, and an eccentric member 20 on the shaft effects clamping of the handle 18 to strip 16 at any adjusted position. A knob 21 is provided on the outer end of shaft 18 to facilitate turning of the shaft and clamping and unclamping of strip 16.

The bearings 13 are preferably of insulating material so as to prevent a closed current path through shaft 12, end plates 5 and 6 and bolts 7, linked by the flux from primary winding 1.

The transformer illustrated in Figs. 5 to 8 inclusive, comprises a rectangular laminated core 22 having a primary winding 23 encircling the upper leg and embedded in a recess 24 in the upper surface of the core so that the primary winding is flush with the upper core surface.

A secondary winding 25 encircles the primary winding 23 and is concentric thereto so that it also encircles the leg of core 22 and has a common flux linkage with the primary winding.

A shunt core member 26 is supported on top of core 22 and extends parallel and adjacent to the upper leg of the core 22.

Shunt core 26 has a recess 27 in its lower surface for receiving the side of the secondary winding 25.

The central opening 28 in core 22 is considerably longer than the windings so that the secondary winding can be moved axially to a position substantially spaced from the primary winding to thereby provide for flux leakage between the two windings.

Movement of the secondary winding relative to the primary winding is effected by movement of shunt core 26 longitudinally along the upper leg of core 22.

When the core 26 and secondary 25 are in the position illustrated in Fig. 5, the secondary encircles the primary and there are two complete flux linkage paths common to the windings: i.e., one through the center of the windings and around the rectangular main core 22, and the other through the center of the windings, upper leg of core 22 and shunt core 26 back to the upper leg of core 22. The windings fit closely one within the other and there is substantially no flux leakage between the two, so that maximum current output is obtained.

When the core 26 and secondary 25 are in the position illustrated in Fig. 8, the secondary is axially spaced from the primary and shunt core 26 cooperates with the upper leg of core 22 to provide a complete leakage path for the flux between the two windings. In this position of the secondary the current output is at a minimum.

The regulation of current is obtained by adjusting the secondary 25 and core 26 to the required position for a given current output.

Regulation is facilitated by a suitable control device comprising a bracket 29 on the end of core 22 and a screw 30 supported for rotation thereby and threading into a lug 31 on the movable core 25. A hand wheel 32 on the outer end of screw 30 facilitates manual turning of the same.

Turning of screw 30 in one direction moves core 25 and winding 26 toward the maximum current output position shown in Fig. 5, while turning of the screw in the opposite direction moves the core and winding toward the minimum current output position shown in Fig. 8.

The invention provides a transformer in which the main core remains fixed and constitutes a closed flux circuit at all times. The shunt core is separate and instead of moving toward or away from the main core, it is adjacent the main core with a substantially constant air gap therebetween provided by the concentric mounting of core 10 in opening 9 in Fig. 1 and by the insulation plate 33 in Fig. 5, separating the cores 22 and 26. This construction reduces the effect of magnetic flux on the movement of the core and eliminates chatter and vibration.

By securing the shunt core to one of the windings to move therewith, there is an automatic control of the flux leakage as the windings separate and are brought together again. Only a single operating mechanism need be used and the regulation is more rapid and easier.

The reduction in size of the core substantially reduces the cost and weight of the transformer and increases its portability and usefulness.

The location of the windings in the construction of Figs. 1 to 4 with their axis vertical under maximum current output conditions provides ventilation by convection currents of air upwardly around each winding and separately for each winding. With this construction it is possible that the usual ventilating fan can be eliminated.

With the construction of Figs. 5 to 8 it is preferred to employ a ventilating fan, not shown.

The current control provided by the invention covers a wide range and needs no aid from auxiliary equipment such as external reactors and resistors. The increments of adjustment are infinite within the range of adjustment provided.

The voltage taps on the secondary may be the same as in other transformers. For welding purposes it is usual to provide at least two taps for the secondary as shown in the drawing. A third tap may also be provided in case it is desired to employ the transformer with a rectifier for charging batteries and the like.

Various embodiments of the invention may be employed within the scope of the accompanying claims.

I claim:

1. A transformer comprising a primary winding, a secondary winding, a main core providing a substantially closed permanent flux linkage path for said windings, said windings being disposed substantially concentrically with one another for maximum current output, and being adapted to be separated to a relative position providing substantial flux leakage therebetween for minimum current output, and a shunt core member movably relative to the main core as the windings move toward separation to increase the flux leakage between the windings, said shunt core being disposed to constitute part of a flux
linkage path for the windings when the latter are positioned for maximum current output.

2. A transformer of the class described, comprising a primary winding and a secondary winding disposed one within the other to provide for maximum current output of the secondary, a fixed core having a central opening and passing through the center of said windings and encircling one side thereof to provide a substantially closed flux linkage path for both windings, the inner winding having a side embedded in said core with its surface substantially tangential to said opening in said core, the corresponding side of the outer winding being disposed within said opening and embedded in a recess in a shunt core member substantially filling said opening, means supporting said shunt core and outer winding for rotation on an axis passing through said opening to provide regulation of the current output of the transformer by rotary movement of said outer winding relative to said inner winding and shunting of flux therebetween from said closed flux linkage path as said windings move toward separation.

3. A transformer of the class described, comprising a primary winding and a secondary winding disposed one within the other to provide for maximum current output of the secondary, a fixed core having a central opening and passing through the center of said windings and encircling one side thereof to provide a substantially closed flux linkage path for both windings, the inner winding having its side embedded in said core with its surface substantially tangential to said opening in said core, the corresponding side of the outer winding being disposed within said opening and embedded in a recess in a shunt core member substantially filling said opening, means supporting said shunt core and outer winding for rotation on an axis passing through said opening to provide regulation of the current output of the transformer by movement of said outer winding relative to said inner winding and shunting of the flux therebetween from said closed flux linkage path as said windings move toward separation, and a manual operating lever secured to said shunt core and outer winding to effect adjustments in the position of the same.

4. A transformer of the class described, comprising a primary winding and a secondary winding disposed concentrically one within the other to provide for maximum current output of the secondary, a fixed core having a central circular opening, a leg of said core passing through the center of said windings and said core encircling one side thereof to provide a substantially closed flux linkage path for both windings, the inner winding having its side embedded in said core with its surface substantially tangential to said circular opening in said core, the corresponding side of the outer winding being disposed within said circular opening and embedded in a recess in a shunt core member substantially filling said opening, means supporting said shunt core and outer winding for rotation on an axis passing through the center of said circular opening to provide regulation of the current output of the transformer by movement of said outer winding relative to said inner winding and shunting of the flux therebetween from said closed flux linkage path as said windings move toward separation, a manual operating lever secured to said shunt core and outer winding to effect adjustments in the position of the same, and means for securing said lever in any adjusted position.

5. A transformer of the class described, comprising a primary winding and a secondary winding disposed substantially concentrically one within the other to provide for maximum current output of the secondary, a core passing through the center of said windings and providing a substantially closed flux linkage path for both windings, the inner winding having one side embedded in the surface of the core, and a shunt core member disposed adjacent and having a recess in which one side of the outer winding is embedded in the core surface, said cores being separated along a line passing between said windings along the flux surfaces referred to, and means to move one winding with its embracing core member relative to the other winding and its embracing core member longitudinally along the line of separation between said core members to effect a regulation of the current output of the transformer.

6. A transformer of the class described, comprising a primary winding and a secondary winding disposed one within the other to provide for maximum current output of the secondary, a fixed core passing through the center of said windings and encircling one side thereof to provide a substantially closed flux linkage path for both windings, the inner winding having its opposite side embedded in said core with its outer surface substantially flush with the outer surface of the core, and a shunt core member extending along said outer core surface and having a recess embracing the corresponding side of said outer winding with the plane of separation between said cores corresponding to the plane of separation of the flux surfaces of the embedded sides of said windings, said fixed core having a central opening of linear extent sufficient to provide for relative axial separation of said windings by movement of said outer winding relative to the fixed core and the inner winding, and said shunt core member being movable with said outer winding to provide additional flux linkage for the windings when the latter are closed together and to provide for shunting of the flux between the windings when the latter are separated.

7. A transformer of the class described, comprising a primary winding and a secondary winding disposed concentrically one within the other to provide for maximum current output of the secondary, a fixed core passing through the center of said windings and encircling one side thereof to provide a substantially closed flux linkage path for both windings, the inner winding having its opposite side embedded in said core with its outer surface substantially flush with the outer surface of the core, a shunt core member extending along said outer core surface and having a recess embracing the corresponding side of said outer winding with the plane of separation between said cores corresponding to the plane of separation of the flux surfaces of the embedded sides of said windings, said fixed core having a central opening of linear extent sufficient to provide for relative axial separation of said windings by movement of said outer winding relative to the fixed core and the inner winding, and said shunt core member being movable with said outer winding to provide additional flux linkage for the windings when the latter are closed together and to provide for shunting of the flux between the windings when the latter are separated, and a manual regulator for moving said shunt core and outer winding relative to said fixed core and inner winding.
8. An adjustable current transformer comprising a main core, a primary and a secondary winding disposed on said core and adapted to be moved relative to each other on said core to vary the transformer output, and a movable shunt core adjacent and parallel to said main core passing on the outside of one of said windings and carrying the other of said windings movable therewith.

9. An adjustable current transformer comprising a main core, a stationary winding disposed on and carried by said core, and another winding disposed on said core and movable thereon relative to the other winding, said windings being disposed substantially superimposed for maximum current output and relatively separated for reduced current output, and a shunt core parallel to and in close relation to said main core carrying said movable winding and disposed to provide a variable current output in substantially inverse relation to the linear distance between said windings.

10. An adjustable current transformer comprising a main core, a stationary winding disposed on and carried by said core, and another winding disposed on said core and movable thereon relative to the other winding, said windings being disposed substantially superimposed for maximum current output and relatively separated for reduced current output, and a shunt core carrying said movable winding and adapted to move therewith, said shunt core being disposed adjacent said main core to provide a common flux circuit path for said windings when the latter are superimposed for maximum current output and to provide separate substantially closed flux paths for the windings when the same are separated.

11. A transformer comprising a main core having at least one leg, a stationary winding encircling and carried on said leg, a second winding encircling and movable longitudinally on said leg, said windings being disposed substantially superimposed for maximum current output and relatively separated for reduced current output, and a shunt core parallel to and movable longitudinally of said main core leg, said shunt core being immediately disposed on three sides of said movable winding at all times and closely related to said main core leg to provide with said main core substantially closed and independent flux leakage paths for said windings when said windings are relatively separated for reduced current output and to provide an additional flux linkage path when said windings are disposed in superimposed relation for maximum current output.

REFERENCES CITED

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