Feb. 20, 1973 H. WITTICH ET AL 3,717,834

VOLTAGE TRANSFORMER WITH MEANS CONNECTED TO THE PRIMARY WINDING FOR EQUALIZING THE WINDING RATIO

Filed March 17, 1971 4 Sheets-Sheet 1

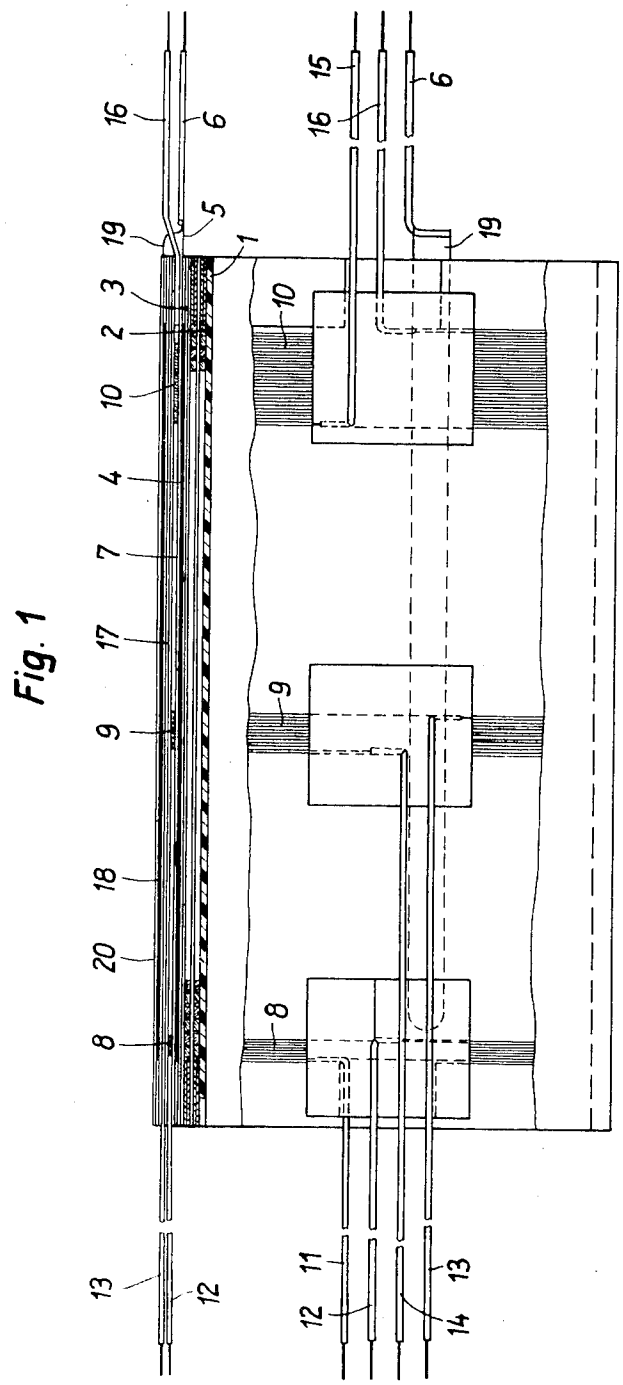


Fig. 1

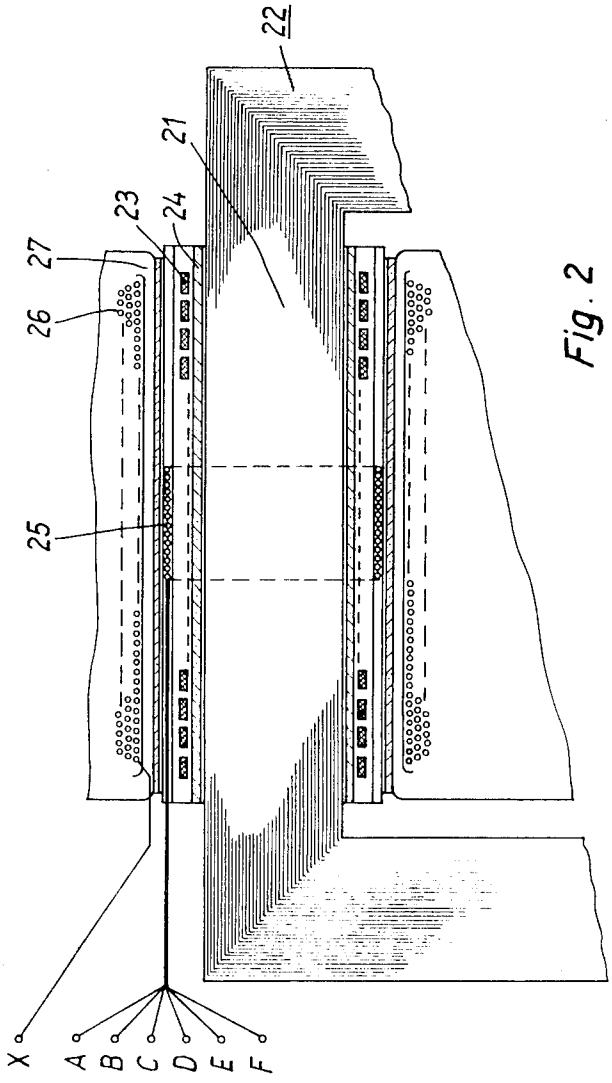


Fig. 2

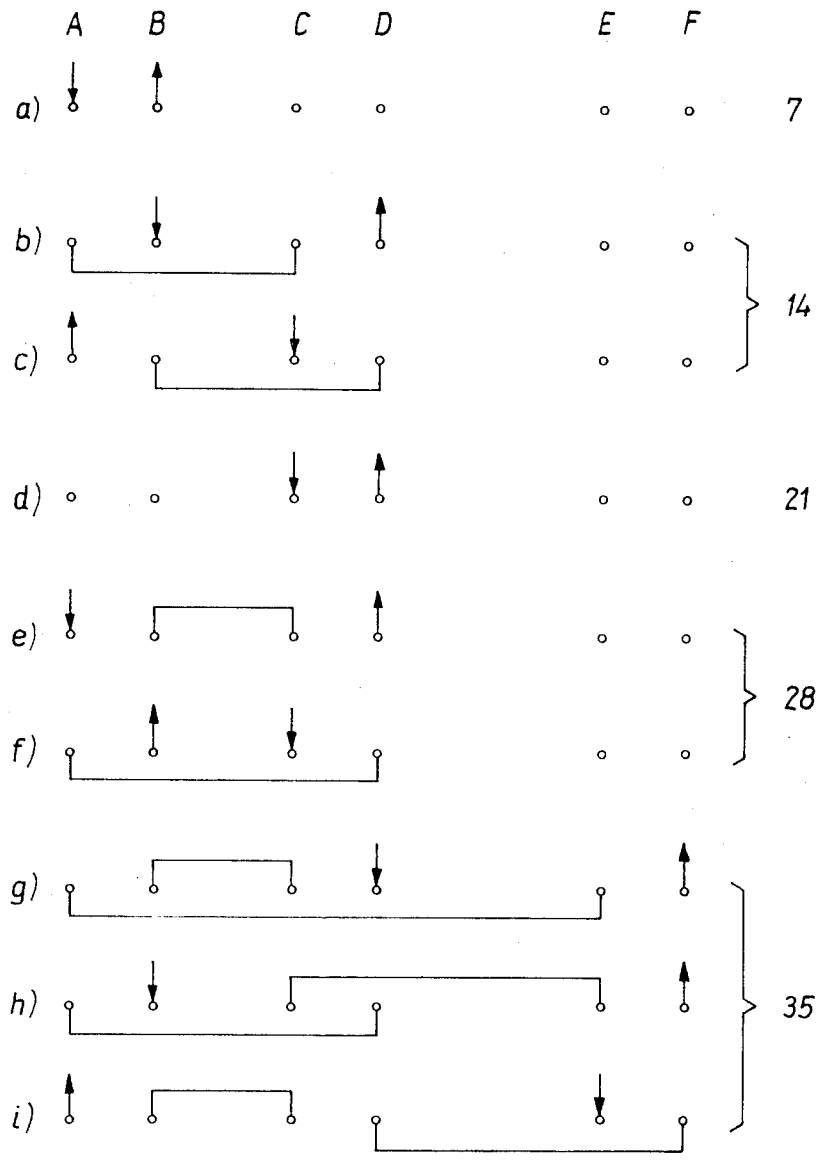


Fig. 3

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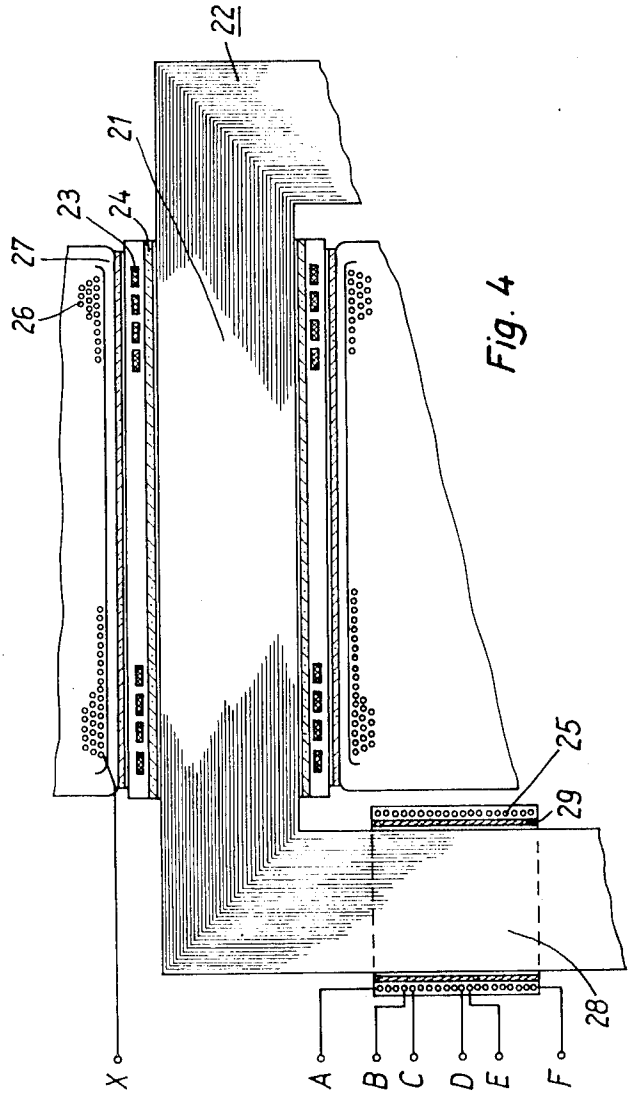


Fig. 4

United States Patent Office 3,717,834
Patented Feb. 20, 1973

3,717,834

VOLTAGE TRANSFORMER WITH MEANS CONNECTED TO THE PRIMARY WINDING FOR EQUALIZING THE WINDING RATIO

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Filed Mar. 17, 1971, Ser. No. 125,130
Claims priority, application Germany, Mar. 19, 1970, P 20 14 141.7
Int. Cl. H01f 15/04, 21/12
U.S. Cl. 336—70 5 Claims

ABSTRACT OF THE DISCLOSURE

A voltage transformer has an equalizing winding connected to the primary winding for equalizing the winding ratio. The equalizing winding is connected to the end of the primary winding at the low voltage side and at least one of its turns is structurally separated from the primary winding and is mounted on the iron core of the voltage transformer or on the secondary winding arrangement.

DESCRIPTION OF THE INVENTION

The invention relates to a voltage transformer having means connected to the primary winding for equalizing the winding ratio.

In a known precision voltage transformer having a multistep transforming ratio, the means for equalizing the winding ratio comprises an additional equalizing transformer having a variable transforming ratio. The additional equalizing transformer is connected to taps of the primary windings of the known voltage transformer and due to its controllable transformation ratio, permits an exact adjustment of the transformation ratio of the known voltage transformer.

The use of an additional equalizing transformer is disadvantageous, primarily because this necessitates a special iron circuit or structure which increases the production cost for the entire voltage transformer. This disadvantage does not occur in the known embodiment of a high voltage transformer whose primary winding is provided with several taps for obtaining a specific translating ratio. This embodiment is disadvantageous, since taps have to be led out of the bandaged or covered high voltage winding. Furthermore, voltages which occur at the unconnected taps of the known high voltage transformer during high frequency phenomena are excited, for example, by shock voltage discharges, may be detrimental to the turn and winding insulation.

An object of the invention is to avoid the disadvantages of known devices for equalizing the winding ratio by connecting the device for equalizing the winding ratio to the primary winding of the voltage transformer.

Another object of the invention is to expedite the production of a transformer having a device for equalizing the winding ratio and reduce the cost of manufacture thereof.

In accordance with the invention, the winding ratio equalizing device of a voltage transformer having one pole comprises an equalizing winding connected to the end of the primary winding at the low voltage side and its turns, which are structurally separated from the primary winding, are mounted on the iron core of the voltage transformer or on the secondary winding arrangement of the transformer.

The special equalizing winding avoids or obviates all equalizing operations at the primary winding. With reference to production technique, this offers the great advantage that, after the primary winding has been wound to a predetermined datum number of turns, the bandaging or covering of the winding may be started at once and the winding banks or benches become immediately available for the production of new windings, following the termination of the winding process. The use of the equalizing winding of the invention no longer requires the equalization of the winding ratio at the end of the finished primary winding at the high voltage side, as was necessary heretofore. Heretofore, the equalization could be effected only prior to the bandaging or covering work, since a subsequent correction is not possible. It was therefore necessary that the equalizing operations which were found necessary during the interpolated pretesting process be carried out after the actual winding process, during a second working step, necessitating a renewed regulating process. Since pretesting was effected with an auxiliary core, the equalization was not quite reliable, which sometimes led to still another pretest, after the correction of the winding. The continuity of work during the winding process was considerably hampered by the necessary equalizing work, and the setting-up and transport operations cluttered up the workshop.

All these difficulties are eliminated in the voltage transformer according to the invention, due to the fact that the primary winding is wound in one work operation and its covering or bandaging is finished subsequently. These operations are considerably simpler than those conducted in known voltage transformers having taps, since the primary winding has no tap for correcting the transforming ratio. This is particularly advantageous with respect to modern construction methods in which high voltage windings are shielded, since each tap must be led out, insulated, through the shield.

It appears preferable in the voltage transformer of the invention that both ends o feach group of turns of the equalizing winding be led out and when taps are provided for a winding, that such taps also be led out, to permit a boost or buck connection relative to the primary winding. This offers the opportunity for subsequently correcting the transformation ratio in a positive and negative respect.

It proved particularly advantageous to select the number of turns for the individual groups of turns of the equalizing winding and the taps so as to effect the equalization in uniform stages. When three groups of turns or component equalizing windings are utilized, for example, the equalization opportunities so provided almost suffice with a relatively small number of terminal bushings.

It is especially advantageous to provide the inside and outside of the turns of the equalizing winding of the voltage transformer of the invention with an electrically effective shield and to ground both shields. This produces a relatively high capacity which does not permit the occurrence or development of voltages which damage or impair the turn and winding insulation during high frequency operations which are excited by changes in the surge voltage, as a result of the overvoltages caused by electrical storms or switching operations. The two shields are preferably galvanically connected and grounded together.

A suitable material for the shields is a semiconducting material, preferably carbon paper.

In order that the invention may be readily carried into effect, it will now be described with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic diagram, partly in top view and partly in section, of an embodiment of a voltage transformer having a secondary winding structure and an equalizing winding of the invention;

FIG. 2 is a sectional view of part of an embodiment of the voltage transformer of the invention having an equalizing winding with taps;

FIG. 3 is a diagram explaining the operation of the voltage transformer of FIG. 2; and

FIG. 4 is a sectional view of part of another embodiment of the voltage transformer of the invention in which the equalizing winding is mounted on the iron core.

As shown in FIG. 1, the secondary winding **2** is mounted in several turns on a hard paper tube **1**. The secondary winding **2** is preferably provided, in full winding width, with paper insulation **3**, which functions as an insulation for the test voltage between the secondary winding **2** and ground. A layer of carbon paper **4** is wound around the paper insulation **3** and is provided with a led-out, conductive foil **5**. The conductive foil **5** is connected, via a soldered-on stranded conductor **6** to the iron core (FIG. 2) and the housing, neither being shown in the drawing.

Another layer **7** is preferably mounted, in full winding width, on the layer of carbon paper **4**. The layer **7** functions as paper insulation relative to alternating voltages, surge voltages and switching voltages. Finally, the paper insulation is provided with individual groups of turns **8**, **9** and **10** of the equalizing winding. Each of the groups of turns **8**, **9** and **10** of the equalizing winding has its ends led out to the outside. That is, the group of turns **8** have led-out ends **11** and **12**, the group of turns **9** have led-out ends **13** and **14** and the group of turns **10** have led-out ends **15** and **16**. This permits the connection of the individual windings **8**, **9** and **10**, arbitrarily, in series, and their connection in boost or buck connection to the end of the primary winding of the voltage transformer at the low voltage side, according to the invention. The primary winding is not shown in FIG. 1.

The groups of turns **8**, **9** and **10** of the equalizing winding are provided with additional paper insulation **17**. Another layer **18** of carbon paper is placed on the paper insulation **17**. The layer **18** is galvanically connected to the stranded conductor **6** via a conductive foil **19**. Still another layer of protective insulation **20** is placed on the outer layer **18** of carbon paper.

FIG. 2 shows a voltage transformer constructed in accordance with the invention. In order to provide better clarity of illustration, the details of the insulation between the primary and secondary windings are not shown. As shown in FIG. 2, a leg **21** of an iron core **22** is provided with a secondary winding **23**, which is supported by a winding body **24**. An equalizing winding **25** is mounted on the secondary winding **23**. The equalizing winding **25** has winding ends A and F and taps B, C, D and E, all of which are led to the outside.

A primary winding **26** is supported by a winding body **27** and is mounted on the secondary winding **23** and the equalizing winding **25**. The end of the primary winding **26** at the low voltage side is led out to a terminal X which is connected, during the equalizing of the winding, to one of the terminals A to F of the equalizing winding **25**.

FIG. 3 is a schematic illustration of the possibilities or opportunities for boost or buck connections of individual turns sections of the equalizing winding provided, for example, with taps B, C, D and E. It may be assumed, for example, that 7 turns are provided between the winding end A and the tap B, 21 turns are provided between the tap C and the tap D, and 63 turns are provided between the tap E and the other winding end F. The equalizing winding, as indicated in FIG. 3, may then be connected to provide among other things, an effective number of 7 turns, as shown in circuit *a* of FIG. 3, 14 turns, as shown in circuits *b* and *c* of FIG. 3, 21 turns, as shown in circuit *d* of FIG. 3, 28 turns, as shown in circuits *e* and *f* of FIG. 3, and 35 turns, due to the connections shown in circuits *g*, *h* and *i* of FIG. 3. The arrow which points downward indicates the terminal which is connected to the end X of the primary winding.

FIG. 4 shows another embodiment of the voltage transformer of the invention, wherein the details of the winding insulation are not shown in order to provide better clarity of illustration. The components of FIG. 4 which correspond with those of FIG. 2 are provided with the same reference numerals. As shown by a comparison of FIGS. 2 and 4, the only difference between the embodiments illustrated in these figures is that the equalizing winding **25** of FIG. 4 is no longer mounted between the primary winding **26** and the secondary winding **23** of the voltage transformer, as in FIG. 2, but lies outside said primary and secondary windings on another leg **28** of the iron core **22**.

In FIG. 4, the equalizing winding **25** is mounted on a winding body **29**, constructed as a tube, which is positioned directly on the leg **28** of the iron core **22**. As in the embodiment of FIG. 2, the equalizing winding **25** has a plurality of taps B to E which may be interconnected, in a manner shown in FIG. 3, to provide variable numbers of turns for equalizing the winding ratio. According to the possibilities for the connection of the equalizing coil, which are indicated in FIG. 3, one end A of the equalizing winding **25** or one of the taps B, C, D and E may be connected to the terminal X which is connected to the end of the primary winding **26** at the low voltage side.

The invention provides a voltage transformer with an equalizing winding for equalizing the winding ratio which is connected to the primary winding. The equalizing winding is connected to the end of the primary winding at the low voltage side.

Due to the mounting of the equalizing winding on the core or on the secondary winding arrangement, the equalizing winding permits a subsequent equalization of the winding ratio, without interfering with the primary winding, thus considerably simplifying the manufacture of voltage transformers. This in turn reduces the costs of manufacture of the voltage transformers.

While the invention has been described by means of specific examples and specific embodiments, we do not wish to be limited thereto, for obvious modifications will occur to those skilled in the art without departing from the spirit and scope of the invention.

We claim:

1. A single phase voltage transformer having an iron core, a primary winding having an end at the low voltage side and a secondary winding, said voltage transformer comprising an equalizing winding connected to the low voltage end of the primary winding for equalizing the winding ratio of the voltage transformer, said equalizing winding having a plurality of groups of turns and taps, each of the groups of turns having two ends leading out of the transformer to provide boost and buck con-

nections for the groups of turns relative to the primary winding, at least one of the groups of turns being mounted, structurally isolated from the primary winding, on one of the iron core and the secondary winding of the voltage transformer; an electrically effective shield on the inside of the equalizing winding; and an electrically effective shield on the outside of the equalizing winding, both shields being connected to a point at ground potential.

2. A voltage transformer as claimed in claim 1, wherein the number of turns in each of the groups of turns and the taps of the equalizing winding are selected to effect equalization in uniform stages.

3. A voltage transformer as claimed in claim 1, wherein both shields are galvanically interconnected and are grounded together.

4. A voltage transformer as claimed in claim 1, wherein the shields comprise semiconducting material.

5. A voltage transformer as claimed in claim 4, wherein the semiconductor material comprises carbon paper.

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