Sept. 6, 1966 H. J. PHILIPS 3,271,659

TOP CHANGING AUTOTRANSFORMER

Filed May 7, 1963 2 Sheets-Sheet 1

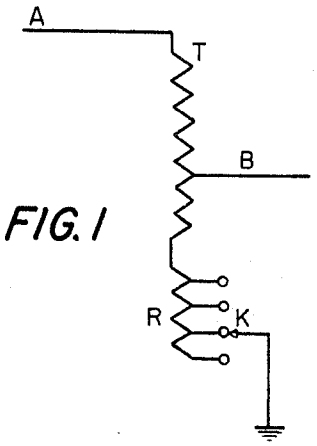


FIG. 1

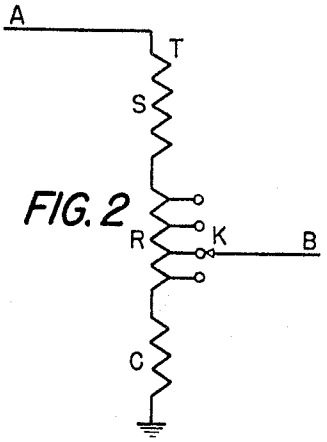


FIG. 2

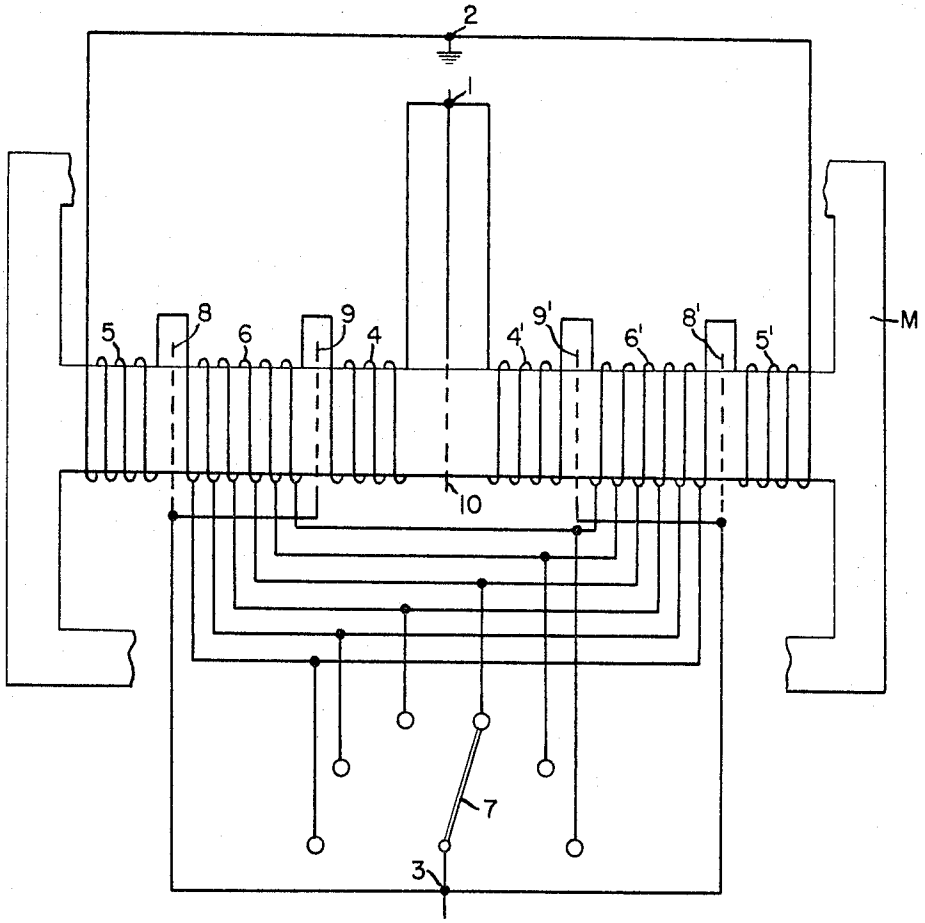


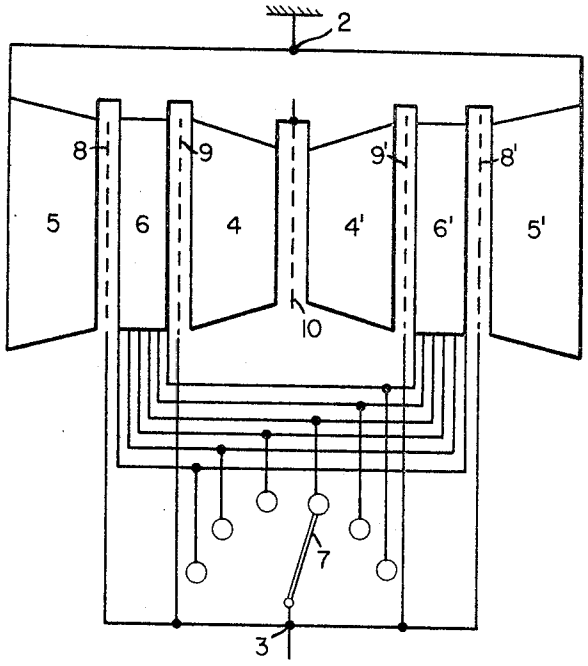
FIG. 3

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FIG. 4



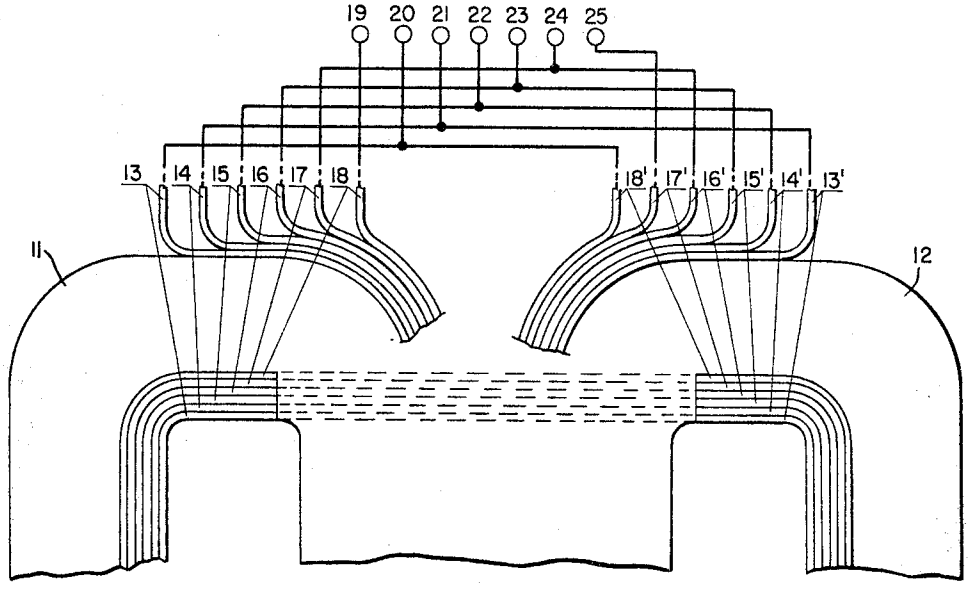


FIG. 5

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3,271,659

TAP CHANGING AUTOTRANSFORMER

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Claims priority, application France, Mar. 27, 1958, 761,650
4 Claims. (Cl. 323—47)

This invention is a continuation-in-part of my application Serial No. 802,384, filed March 27, 1959, now abandoned.

This invention relate to autotransformers which are employed to connect together two electrical circuits or transmission lines having different voltages.

When two transmission lines are connected together by means of an autotransformer it must often be equipped with switching or adjusting taps operably associated with suitably multipoint switching means which may be operated either on "no load" or on "full load."

In autotransformers the adjusting taps are sometimes located at the grounded end of the winding in order to make it easier to maintain the proper impulse insulation level. However, so locating the taps may lead to considerable variations of the magnetic induction in the core of the autotransformers so that it is often preferred to design the autotransformer with the adjusting taps at the medium voltage terminal even though the insulation of the tapped windings may cause difficulties.

The insulation difficulties arise from the stresses which occur in the autotransformer when a traveling steep front wave is applied to either one or the other of the two circuits or transmission lines connected by the autotransformer. It is known that when a steep front wave reaches a terminal of an autotransformer, the amplitude of the voltages which appear initially at the different sections or portions of the winding depend on the ratio between the series capacities and the ground capacities along the whole winding. The greater the series capacity and the lower the ground capacity the lower the stresses.

It is a principal object of this invention to provide an autotransformer with adjusting taps at the medium voltage terminal in which the electrical stresses caused by steep front waves in the adjusting portion of the winding are particularly low.

A feature according to the invention is the fact that the transformer is of the shell-type with a "diabolo" winding. A so-called "diabolo" winding consists of two halves or portions connected in parallel and symmetrically disposed. Each half winding is constituted by a stack of flat coils in series, each of which is made of spirally wound conductors, the different coils having progressively increasing diameters as their potential decreases so that the lower their potential is the smaller is the distance of their external surface from the surrounding yoke of a magnetic core. The transmission line-end is connected to a common point with a static shield.

Another feature, according to the invention is that the adjusting portion of the winding is constituted by two tapped winding portions or sections in parallel, each of which is sandwiched between two electrostatic shields which are connected to the medium voltage terminal or output secondary terminal. The portions of the winding adjacent to these tapped adjusting sections are each constituted by two winding sections in parallel, symmetrically disposed, each of which is formed by stacked flat coils in series, made of spirally wound conductors, the diameters of the different coils increasing progressively as their potential decreases so that the lower the potential of a coil is, the smaller is the distance of its outer conductors from the yoke of a magnetic core.

Still another feature, according to the invention, is that the turns of the different coils constituting the adjusting steps overlap and are arranged imbricated with the turns of one coil overlapping respective turns of the other in each of the tapped winding sections so as to increase the series capacity of these sections.

Other features and advantages of the autotransformer in accordance with the present invention will be better understood as described in the following drawings in which:

FIG. 1 is a schematic diagram illustrative of a known autotransformer connection;

FIG. 2 is a schematic diagram illustrative of a known autotransformer connection to which the invention can be applied;

FIG. 3 is a schematic diagram illustrative of the electrical connections of an autotransformer according to the invention;

FIG. 4 is a diagram illustrating the construction and the arrangement of the windings and electrostatic shields in the autotransformers shown in FIG. 3; and

FIG. 5 is a diagram illustrating the construction of the tapped coils forming the adjusting sections of the winding of the autotransformer according to the invention.

Referring to FIG. 1 an autotransformer T connects together a high voltage line A and a medium voltage line B and comprises an adjusting section R at the grounded end of the winding (or at the end connected to a neutral point). The section R is tapped at various points and a suitable switching device is provided so that any one of several voltages may be selected at the tapped section.

As pointed out heretofore this type of construction causes considerable variations of the magnetic induction in the core of the autotransformer. Accordingly, the construction, shown in FIG. 2 is often preferred in which the adjusting or tapped section R is connected to the line B by means of the switch K. In this construction the tapped or adjusting section is inserted between the turns of a section S and the turns of a section C.

When a steep front wave reaches the autotransformer, a surge occurs at the terminals of the different sections or portions of the winding and, in particular, at the terminals of the tapped adjusting section. Since the insulation of the tapped section is more delicate than that of the other sections it can be damaged if the transient voltage distribution is unfavorable.

The autotransformer according to the invention, is of the shell-type, as shown in FIGS. 3 and 4, and possesses a very excellent transient voltage distribution. Its winding is disposed on a center leg of a magnetic core M shown fragmentarily in FIG. 3. The winding consists of two symmetrically disposed winding halves in parallel, respectively formed by the series winding sections **4**, **5**, **6** and **4'**, **5'**, **6'**.

The corresponding end sections **4**, **4'** of the winding halves are electrically connected to an input terminal **1** which is connectable to a high voltage line and the corresponding sections **5**, **5'** at the opposite end of the respective winding halves forming the opposite ends of the winding are electrically connected to a grounded terminal **2** which is alternatively connectable to a neutral point in a transmission system. The intermediate sectons **6**, **6'** disposed intermediate the respective pair of end sections **4**, **5** and **4'**, **5'** of a respective winding half are tapped at various points in a manner later herein described so that any of the several voltages may be selected at the tapped sections. A suitable switching device **7** is electrically connected to an output terminal **3** which is connectable to the medium voltage line. The switching device is selectively operable to different positions for electrically connecting individual ones of the taps to the terminal **3**.

Each tapped section 6, 6' is sandwiched between a pair of electrostatic shields or static plates 8, 9 and 8', 9' within its respective half of the winding and the plates are electrically connected to the secondary terminal 3. An electrostatic shield element 10 is provided between the sections 4 and 4' and is electrically connected to the primary terminal 1 which is connectable to the higher voltage transmission line in a transmission system.

The corresponding end sections 4, 4' and 5, 5' of the pair of sections forming the opposite ends of the winding halves comprise stacked flat coils in which the conductors are spirally wound with the different coils having progressively increasing diameters as their potential decreases so that the distance of their outer conductors from the yoke of the core M progressively decreases.

The voltage selection or adjusting tapped sections 6, 6' are each formed by a pair of stacked flat coils 11, 12 as shown in FIG. 5. The coils are shown in the drawing side by side for the sake of clarity. The coil 11 is wound from a plurality of spirally wound conductors 13–18. The coil 12 is similarly wound spirally but in an opposite direction.

The individual conductors of coil 11 are connected in series to a respective corresponding conductor of coil 12 as shown by the broken lines in FIG. 5 so that the corresponding turns of the coils are in series and are arranged overlapping each other with the turns of one coil interleaved in the other coil.

Taps 19–25 are provided and at least some which are connected to the two coils 11, 12 in a sequence in which the successive turns of one coil, starting with the innermost turn thereof, are connected in series with respective turns of the other coil starting in a connecting sequence with an inner turn of the other coil. Thus taps 21, 22, 23 and 24 are connected to series connections between the conductors or turns 13', 14' and 15' and 16' and conductors 15, 16, 17 and 18 respectively. The innermost turn or conductor 13 of one coil 11 is connected by a series tap connection with the outermost turn 18' of the other coil 12 to which is connected tap 20. Two taps 19 and 25 are connected directly to respective conductors or turns 18 and 17' respectively. In this manner the number of voltages selection steps are equal in number to the number of turns in each of the two coils forming the tapped section of the autotransformer.

While a preferred embodiment of the invention has been shown and described, it will be understood that many modifications and changes can be made within the scope of the invention.

What I claim and desire to secure by Letters Patent is:

1. In an autotransformer having a high voltage terminal, a grounded terminal alternatively connected to a neutral point and a medium voltage terminal, two alike symmetrically disposed winding halves electrically connected in parallel between said high voltage terminal and said grounded terminal forming the winding of the autotransformer, said winding having two like symmetrically disposed tapped winding sections each in a respective winding half, each having respective taps so any one of several voltages may be selected therefrom and the taps of the two said tapped winding sections being connected in parallel, for each winding half two winding sections disposed on each side of the tapped section and connected in series therewith, two corresponding sections of the halves being connected to the high voltage terminal and the two other corresponding sections being connected to the grounded terminal, for each winding half a pair of electrostatic shields electrically connected to the medium voltage terminal and sandwiching the tapped winding section in their respective winding half, an electrostatic shield electrically connected to the high voltage terminal and disposed between the two corresponding winding sections connected to said high voltage terminal, each of said tapped winding sections comprising a pair of flat coils in series, said winding sections disposed in each half on each side of the tapped section comprising flat coils in series made of spirally wound conductors, the diameters of the different coils increasing progressively as their potential decreases, and switching means electrically connected to said medium voltage terminal and selectively operable to different positions for electrically connecting individual ones of the taps to the medium voltage terminal.

2. In an autotransformer having a high voltage terminal, a grounded terminal alternatively connected to a neutral point and a medium voltage terminal, two alike symmetrically disposed winding halves electrically connected in parallel between said high voltage terminal and said grounded terminal forming the winding of the autotransformer, said winding having two like symmetrically disposed tapped winding sections each in a respective winding half, each having respective taps so any one of several voltages may be selected therefrom and the taps of the two said tapped winding sections being connected in parallel, for each winding half two winding sections disposed on each side of the tapped section and connected in series therewith, two corresponding sections of the halves being connected to the output terminal and the other corresponding sections being connected to the grounded terminal, for each winding half a pair of electrostatic shields electrically connected to the medium voltage terminal and sandwiching the tapped winding section in their respective winding half, electrostatic shield electrically connected to the high voltage terminal and disposed between the two corresponding winding sections connected to said high voltage terminal, each of said tapped winding sections comprising a pair of stacked flat coils spirally wound in opposite directions and with the corresponding turns of the two coils in series, said winding sections disposed in each half on each side of the tapped section comprising flat coils in series made of spirally wound conductors, the diameters of the different coils increasing progressively as their potential decreases, and switching means electrically connected to said medium voltage terminal and selectively operable to different positions for electrically connecting individual ones of the taps to the medium voltage terminal.

3. In an autotransformer according to claim 2, in which the coils of the tapped sections comprise said spirally wound conductors each forming a turn on the two coils and connected so that the corresponding turns overlap and are in series, and in which said taps comprise at least some of which are connected progressively in a sequence in which the successive turns of one coil are connected starting from the innermost turn of respective successive turns starting with the outermost turns of the other coil.

4. In an autotransformer according to claim 3, in which the taps are connected to form voltage selection steps corresponding in number to the number of turns in one of said flat coils.

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