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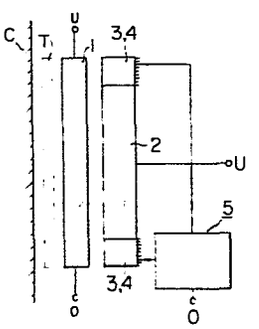
(54) Onload tap-changing transformer.

(57) An onload tap-changing transformer comprises a high voltage winding (2) a low voltage winding (1) wound on an iron core (C) a coarse tap winding (3) wound on the iron core and connected in series with the high voltage winding, and a fine tap winding (4) wound on the iron core and selectively connectable to the high voltage winding or the low voltage winding by a switch (S). The conductors making up the coarse tap winding and the conductors making up the fine tap winding are wound together, in juxtaposed relation with each other, into at least one integrated disc winding assembly and taps are led out of predetermined points of the fine tap winding, thereby inceasing the capacitance between the coarse tap winding and the fine tap winding so that the transfer voltage generated upon application of a lightning impulse and the potential difference between the windings are reduced, thus preventing any corona or dielectric breakdown.

FIG. 3



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ONLOAD TAP-CHANGING TRANSFORMER

The present invention relates to an onload tap-changing transformer and, more in particular, to an onload tap-changing transformer of the transfer switch type.

An onload tap-changing transformer of the transfer switch type generally comprises a low-voltage winding and a high-voltage winding wound on an iron core, and a tap winding connected to the high voltage winding. The tap winding is divided into a coarse tap winding and a fine tap winding.

In the onload tap-changing transformer of this type, the low-voltage winding is arranged innermost on the core and the high-voltage winding is disposed outside of the low-voltage winding. The coarse tap winding and the fine tap winding are adjacent to the high-voltage winding in that order.

The high-voltage winding is connected with the coarse tap winding and the fine tap winding in the manner shown in the wiring diagram of Fig. 1. Specifically, the low-voltage winding 1 provides a simple connection to terminals u and o. The high-voltage winding 2, on the other hand, has an end thereof connected to a line terminal U, and another end which is connected to the coarse tap winding 3, and also connected through a transfer switch S, was described later, to the fine

tap winding 4 having a plurality of tap terminals 13 to 21.

The transfer switch S includes a terminal 11 connected to the junction of the high-voltage winding 2 and one end of the coarse tap winding 3, a terminal 12 connected to another end of the coarse tap winding 3, a terminal 13 connected to the line side (higher potential side) end of the fine tap winding 4, and a contactor S_1 with an end connected to the terminal 13 for switching between the terminals 11 and 12.

An onload tap changer 5 connects selectively one of a plurality of tap terminals 13 to 21 led out of the fine tap winding 4 to another terminal such as a neutral terminal 0 by the switching operation thereof. The fine tap winding 4 is shown in detail in Fig. 2. A predetermine number of turns of the fine tap winding 4 are connected between each adjacent tap terminals. For the purpose, the onload tap changer 5 includes, as well known, tap selectors (not shown) each having a movable contact and stationary contacts which are connected to the tap terminals so that any one of the tap terminals can be connected to the movable contact and a change-over switch (not shown) for selectively connecting one of the movable contacts of the tap selectors to the neutral terminal 0.

When the contactor S_1 of the transfer switch S is switched to the terminal 11 as shown by the solid line in Fig. 1, the coarse tap winding 3 is disconnected

so that the high-voltage winding 2 is directly connected to the fine tap winding 4. Voltage regulation is effected by connecting the onload tap changer 5 to a selected one of the tap terminals 13 to 21. Upon switching the contactor S_1 to the terminal 12 as shown in dotted line, on the other hand, the coarse tap winding 3 is inserted in the circuit with the result that the voltage regulation is effected by switching the position of the onload tap changer 5 while using the coarse tap winding 3.

In this onload tap-changing transformer of transfer switching type, assume that a lightning inpulse is applied to the high-voltage line terminal U of the high voltage winding 2. A voltage is transferred to the coarse tap winding 3 and the fine tap winding 4 through the impedances (capacitance and inductance) existing between the high voltage winding 2 and the coarse tap winding 3 and between the coarse tap winding 3 and the fine tap winding 4. The value and waveform of the transfer voltage (deviations with time) in the windings are greatly dependent on the impedances. In the prior art construction of transformers, the coarse tap winding 3 and the fine tap winding 4 are wound separately, and therefore, the waveforms of the transfer voltages to the two windings are naturally different. As a result, a considerable potential difference occurs between the two windings, thereby leading to a disadvantage that a corona is generated or a dielectric

breakdown occurs in the onload tap changer 5 or the fine tap winding 4.

An object of the present invention is to provide an onload tap-changing transformer in which the transfer voltage and the potential difference between the coarse tap winding and the fine tap winding due to the transfer voltage are reduced.

Another object of the present invention is to provide an onload tap-changing transformer in which the adverse effect of the transfer voltage in the coarse tap winding and the fine tap winding is eliminated thereby to prevent a corona or a dielectric breakdown.

According to the present invention, there is provided an onload tap-changing transformer comprising an iron core, a low-voltage winding and a high-voltage winding wound on the iron core, a coarse tap winding wound on the iron core and connected in series with the high voltage winding, and a fine tap winding wound on the iron core and adapted to be selectively connected by a switch to the high voltage winding or the coarse tap winding, wherein the conductor making up the coarse tap winding and the conductor making up the fine tap winding are arranged in juxtaposition and wound in a disc form thereby to form a circular winding assembly, and taps are led out from selected points of the fine tap winding of the circular winding assembly, thereby integrating the coarse tap winding with the fine tap winding.

The above and other objects and features of the present invention will be clear from the following description in conjunction with the accompanying drawings in which:

Fig. 1 is a connection diagram showing onload tap-changing transformer in general use,

Fig. 2 is a connection diagram showing a fine tap winding used in the transformer of Fig. 1,

Figs. 3 to 6 are diagrams showing different winding arrangements of onload tap-changing transformers according to the present invention,

Fig. 7 is a connection diagram of a coarse tap winding and a fine tap winding according to an embodiment of the present invention,

Fig. 8 is a sectional view of the coarse tap winding and the fine tap winding shown in Fig. 7,

Fig. 9 is a connection diagram of a coarse tap winding and a fine tap winding according to another embodiment of the present invention, and

Fig. 10 is a sectional view of the coarse tap winding and the fine tap winding shown in Fig. 9.

The winding arrangement of an onload tap-changing transformer according to the present invention may be constructed in a manner as shown in any of Figs. 3 to 6. In Fig. 3, a low-voltage winding and a high-voltage winding 2 are wound in that order from inside on a core C, and a tertiary winding T may be wound as required on the innermost side. The high-voltage winding 2, as

well known, includes a stack of circular coils with a strand wound in disc. A center terminal connected to the central position of the stack is connected to the line-side terminal U and end terminals connected to upper and lower terminals thereof, respectively, are connected in together to the neutral point so that the upper and lower parts of the stack are electrically connected in parallel to each other. The upper and lower terminals of the high-voltage winding 2 are connected to respective integrated units each including a coarse tap winding 3 and a fine tap winding 4 so that the respective units are arranged in parallel to each other so as to provide the aforementioned connection through a transfer switch (not shown), and the terminals of the fine tap windings 4 are selectively connected through the tap changer 5 to the neutral terminal 0.

In the embodiments of Figs. 4 and 5, the tertiary winding T and the low-voltage winding 1 wound on the core C are arranged in the same manner as in the embodiment of Fig. 3, and the upper and lower halves of the high-voltage winding 2 are electrically connected in parallel to each other, whereas the integral units of coarse tap winding 3 and fine tap winding 4 are located in juxtaposition with and outside (Fig. 4) or inside (Fig. 5) of the upper and lower parts of the high-voltage winding 2, and connected so as to form a parallel connection of the upper and lower winding parts.

The embodiment of Fig. 6 includes an integral

unit of a coarse tap winding 3 and a fine tap winding 4 which is disposed at the lower side of the high-voltage winding 2 unlike the embodiments of Figs. 3 to 5. The upper end of the high voltage winding 2 is connected to the line-side terminal U and the lower end thereof is connected to the coarse tap winding 3 and the fine tap winding 4 in a similar manner to Fig. 1.

A connection of the coarse tap winding 3 and the fine tap winding 4 according to the present invention is shown in Fig. 7, in which terminals 11, 12 and tap terminals 13 to 21 are identical to those shown in Figs. 1 and 2. The coarse tap winding 3 is wound between the terminals 11 and 12, and the fine tap winding 4 is also wound together with the coarse tap winding 3 between the tap terminals 13 and 21 with tap terminals 14 to 20 being led out from intermediate points thereof.

The similar terminals in Fig. 8 which is a sectional view of the coarse tap winding and the fine tap winding are designated by the same reference numerals as those in Fig. 7.

Numerals 3_1 to 3_{48} designate a sectional view of conductors making up the coarse tap winding 3 between the terminal 11 and 12, in which conductors 3_1 to 3_3 wound in circular form in that order from outside make up a circular coil D_1, while conductors 3_4 to 3_6 make up the next circular coil D_2. The conductor 3_3 of the circular coil D_1 is connected with the conductor 3_4 of the circular coil D_2, whereby the conductors 3_1 to 3_6

are wound in series. In similar fashion, the circular coils D_3 to D_{16} are formed with leading and trailing ends of adjacent circular coils connected in series to make up the coarse tap winding wound.

Numerals 4_1 to 4_{48} designate a sectional view of conductors making up the fine tap winding 4, which conductors are wound in parallel with the conductors of the coarse tap winding 3 of the circular coils D_1 to D_{16}. The conductors in each pair of adjacent circular coils of the fine tap windings are connected to provide a series connection, of which the leading and trailing ends are connected to respective external terminals. The external terminal connected to the trailing end of the series connection of each pair provides one of the taps and also is connected to the external terminal connected to the leading terminal of the series connection of the next pair. This construction will be explained in more detail with reference to the drawings. First, the fine tap winding 4 is wound in the form of conductors 4_1 to 4_3 from outside to inside in the circular coil D_1 and conductors 4_4 to 4_6 from inside to outside in the circular coil D_2. The conductors 4_3 and 4_4 are connected to form a series connection of conductors 4_1 to 4_6 with a tap 14 led out of the conductor 4_6 at the trailing end of the series connection of conductors 4_1 to 4_6. In the two adjacent circular coils D_3 and D_4, the conductors 4_7 to 4_{12} are similarly wound with the next tap 15 led out of the conductor 4_{12} at the

trailing end thereof. In this case, the trailing end conductor 3_6 of the circular coil D_2 is connected with the leading end conductor 3_7 of the circular coil D_3. In similar fashion, taps 16 to 21 are led out. In this way, the coarse tap winding 3 and the fine tap winding 4 are formed integrally with each other unlike the conventional construction in which the coarse and fine tap windings were constructed and arranged as separate components.

The integral arrangement of the coarse tap winding 3 and the fine tap winding 4 described above is manufactured in such a manner that the conductors making up the coarse tap winding 3 and the fine tap winding 4 juxtaposed with each other are wound together to make up a circular coil. A selected number of such circular coils are accumulated in a stack extending axial direction and connected to provide electrical connection among predetermined conductors with taps led out appropriately.

As explained above, in the present embodiment, the conductors making up the coarse tap winding and the conductors making up the fine tap winding are wound together in juxtaposed relation with each other so as to form a circular winding in which the coarse tap winding and the fine tap winding are integrated with each other. As a result, the capacitance between the coarse tap winding and the fine tap winding is increased greatly as compared with the conventional arrangement in

which the windings are separated from each other. Thus, the transfer voltage and the potential difference due to the transfer voltage are reduced, thereby preventing the corona or dielectric breakdown. Further, since the insulation distance between the contacts of the onload tap changer can be reduced, it is allowed to reduce the size of the onload tap changer. Furthermore, the integrated arrangement of the windings is effective to reduce the number of working steps and the cost in production.

In Fig. 9 showing a connection of the coarse tap winding and the fine tap winding in another embodiment of the present invention, the coarse tap winding 3 is wound between terminals 11 and 12. The fine tap winding 4 is wound together with the coarse tap winding 3 only in the upper four circular coils and the lower four circular coils, and taps 13 to 21 are led out at predetermined points.

In Fig. 10 showing a sectional view of the coarse tap winding and the fine tap winding shown in the connection diagram of Fig. 9, the same terminals as those in Fig. 9 are denoted by the same reference numerals. As seen from the drawing, in this embodiment, the fine tap winding 4 is divided into upper and lower parts which are wound together with the respective parts of the coarse tap winding 3 wound in the upper four circular coils D_1 to D_4 and the lower four circular coils D_9 to D_{12}, respectively. Referring to adjacent

circular coils D_1 and D_2, as in the preceding embodiment the fine tap winding 4 are wound with the conductors 4_1, 4_2 and 4_3 from outside to inside in the circular coil D_1, and with the conductors 4_4, 4_5, 4_6 from inside to outside in the circular coil D_2, and the conductors 4_3 and 4_4 are connected to each other with the tap 14 led out of the conductor 4_6 at the trailing end. In the present embodiment, the conductors for the next tap are also wound with the circular coils D_1 and D_2. Specifically, the conductors 4_7 to 4_9 for the next tap are wound, in juxtaposed relation with the conductors 4_1 to 4_3, from outside to inside in the circular coil D_1, and the conductors 4_{10} to 4_{12}, in juxtaposed relation with the conductors 4_4 to 4_6, from inside to outside in the circular coil D_2. In this arrangement, the conductors 4_9 and 4_{10} are connected with each other and the tap 15 is led out of the trailing-end conductor 4_{12}. Further, the trailing-end conductor 4_5 of the first-mentioned conductor group is connected with the leading end conductor 4_7 of this conductor group. In this way, two groups of conductors for two taps are wound in juxtaposed relation in the circular coils D_1 and D_2, with a tap led out at the trailing end of each group respectively. Similarly in the circular coils D_3 and D_4, the conductors 4_{13} to 4_{18} are wound in juxtaposed relation with conductors 4_{19} to 4_{24}, respectively, and taps 16 and 17 are led out of the trailing ends thereof, respectively, while the conductors 4_{18} and 4_{19} are connected

with each other. This is also the case with the circular coils D_9 to D_{12}. In this way, the coarse tap winding 3 and the fine tap winding 4 are formed integrally.

The integral arrangement of the coarse tap winding 3 and the fine tap winding 4 is made in such a manner that a strand including the conductors making up the coarse tap winding 3 and two strand including the conductors for the two taps of the fine tap winding 4 are wound together in juxtaposed relation with each other, into a circular coil of first type, and a circular coil of second type is formed of a strand including the conductors making up the coarse tap winding 3 alone. Then as shown in Fig. 10, such coils are laid one over the other in axial direction so that selected number of the circular coils of the first type are laid above and under a stack of the circular coils of the second type, and the predetermined conductors are connected with taps led out.

As described above, in the present embodiment, the conductors making up the coarse tap winding are arranged in juxtaposition with the conductors for two taps of conductors making up the fine tap windings to form the circular coil of the first type. The circular coils of the first type are arranged to dispose above and below a stack of the circular coils of the second type including the conductors making up the coarse tap windings alone. Thus, the coarse and fine tap windings

are integrated into a disc-type winding assembly which has the same advantage as the embodiment mentioned above. At the same time, the conductors covering a pair of taps are wound in juxtaposed relation with each other, so that the necessary number of the circular coils is reduced thereby to reduce the height of the winding assembly. This feature is effectively used in the case where the height of the device is limited for reasons of design or manufacture.

In the aforementioned embodiments, the conductors for one tap of the fine tap winding are wound in two circular coils. However, the present invention is not limited to such a construction and the conductors for one tap of the fine tap winding may be wound in any even number more than 2 of the circular coils. Further, in the embodiment in which the circular coils each made up of the conductors of the coarse tap winding alone are combined with circular coils each made up of the conductors of the coarse tap winding and the conductors of the fine tap winding in juxtaposed relation with each other, the arrangement of the circular coils is not limited to the one shown in the above-mentioned embodiment but may be determined appropriately.

It will be understood from the foregoing description that according to the present invention, the conductors making up the coarse tap windings are arranged in juxtaposed relation with the conductors making up the fine tap windings and wound into a circular

form thereby to make up an integrated disc winding assembly and taps are led out from predetermined points of the fine tap winding, so that the capacitance between the coarse tap winding and the fine tap winding is increased thereby reducing the transfer voltage and the potential difference between the windings due to the transfer voltage and also preventing the corona or dielectric breakdown. Further since the insulation distance between the contacts of the onload tap changer is shortened, a compact onload tap changer is realized. Furthermore, since the coarse and fine tap windings are integrated it is possible to reduce the manufacturing processes and the production cost.

CLAIMS:

1. An onload tap-changing transformer comprising an iron core (C), a low-voltage winding (1) and a high-voltage winding (2) wound on said iron core, a coarse tap winding (3) wound on said iron core and connected in series with said high voltage winding, a fine tap winding (4) selectively connectable to any one of said high voltage winding and said coarse tap winding by a switch (S), wherein at least a part of conductors making up said coarse tap winding and conductors making up said fine tap winding are wound together, in juxtaposed relation with each other, into a disc winding assembly including at least one circular coil, thereby integrating said coarse tap winding and said fine tap winding and taps are led out of predetermined points of said fine tap winding of said disc winding assembly.

2. An onload tap-changing transformer according to Claim 1, wherein each tap is led out of said fine tap winding at the trailing end of the conductors thereof wound in each pair of two adjacent circular coils of said disc winding assembly.

3. An onload tap-changing transformer according to Claim 1, wherein two groups of conductors of said fine tap winding covering two adjacent taps thereof, respectively, are wound together, in juxtaposed relation with each other, into a pair of adjacent circular coils of said disc winding assembly, and a tap is led out from the trailing end of each group of the conductors.

4. An onload tap-changing transformer according to Claim 1, wherein said high voltage winding is made of a stack of circular coils piled along an axial direction of said core, and a terminal is led out of the center portion of said stack to be connected to a power-line terminal, and wherein said disc winding assembly is divided into two parts, which are disposed at upper and lower sides of said stack, respectively.

5. An onload tap-changing transformer according to claim 1, wherein said high voltage winding is made of a stack of circular coils piled along an axial direction of said core, and a terminal is led out of the center portion of said stack to be connected to a power-line terminal, and wherein said disc winding assembly is divided into two parts which are disposed in juxtaposed relation with upper and lower portions of said stack, respectively.

6. An onload tap switching transformer according to Claim 1, wherein one end of said high voltage winding is provided with a terminal connected to a line side terminal, the other end thereof is provided with another terminal and said integral assembly of the coarse tap winding and the fine tap winding is disposed at the other end of said high voltage winding.

7. An onload tap-changing transformer comprising an iron core (C), a low-voltage winding (1) and high-voltage winding (2) wound on said iron core, a coarse tap winding (3) wound on said iron core and connected

in series with said high voltage winding, and a fine tap winding (4) wound on said iron core and selectively connectable to any one of said high voltage winding and said coarse tap winding by a switch (5), wherein the center portion of said high voltage winding extends to a terminal to be connected to a line side terminal (U), the upper and lower ends thereof are connected to another terminal, and the conductors making up the coarse tap winding and the conductors making up the fine tap winding are wound together, in juxtaposed relation with each other, into two integrated disc winding assemblies, which are disposed at the upper and lower ends of said high voltage winding, respectively.

8. An onload tap-changing transformer comprising an iron core (C), a low-voltage winding (1) and a high-voltage winding (2) wound on said iron core, a coarse tap winding (3) wound on said iron core and connected in series with said high voltage winding, and a fine tap winding (4) wound on said iron core and connectable selectively to any one of the high voltage winding and the coarse tap winding by a switch (S), wherein the central portion of said high-voltage winding extends to a terminal to be connected to a line side terminal (U), the upper and lower ends of the high-voltage winding being connected to another terminal, the conductors making up the coarse tap winding and the conductors making up the fine tap winding are wound together, in juxtaposed relation with each other into two integrated disc winding

assemblies, taps being led out from predetermined points of said fine tap winding and, said two integrated disc winding assemblies being disposed in juxtaposed the relation with the upper and lower end portions of said high voltage winding, respectively.

FIG. 1
PRIOR ART

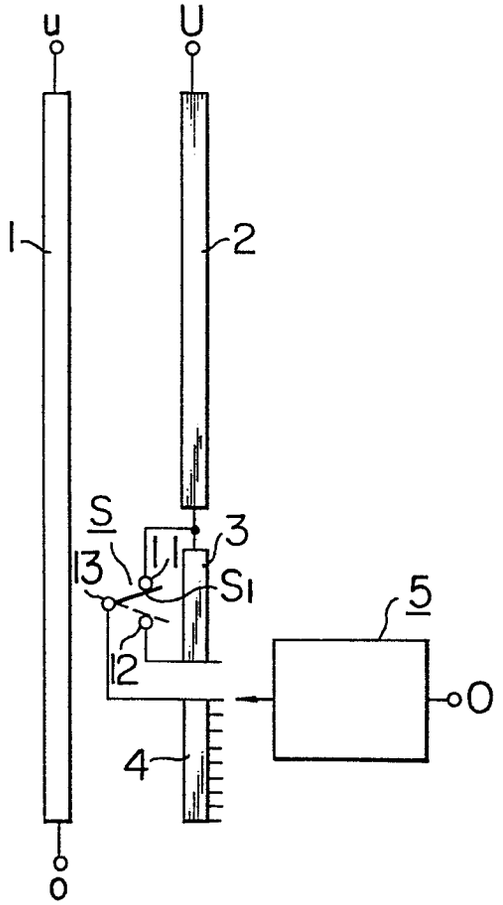

FIG. 2
PRIOR ART

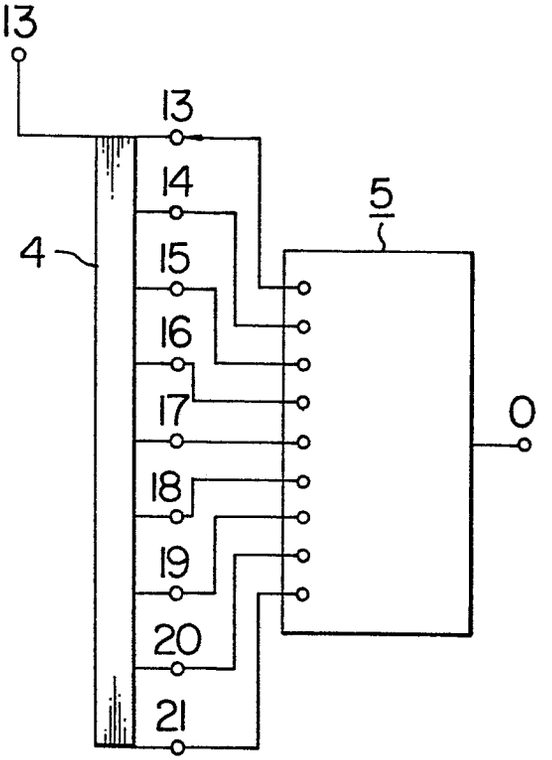

FIG. 3

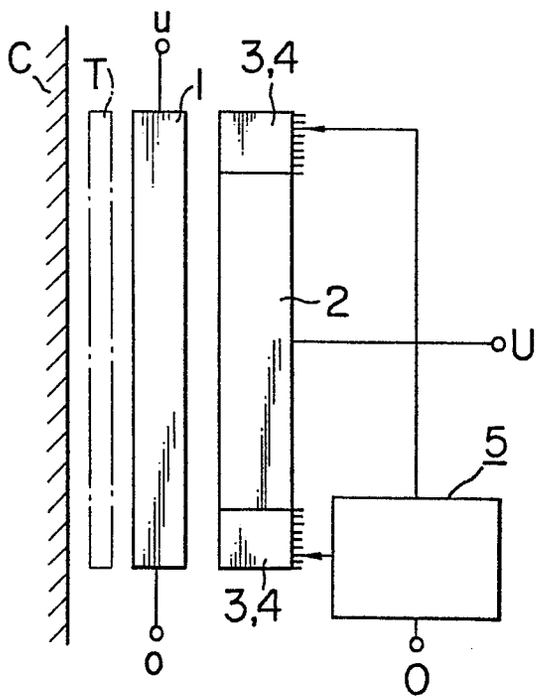

FIG. 4

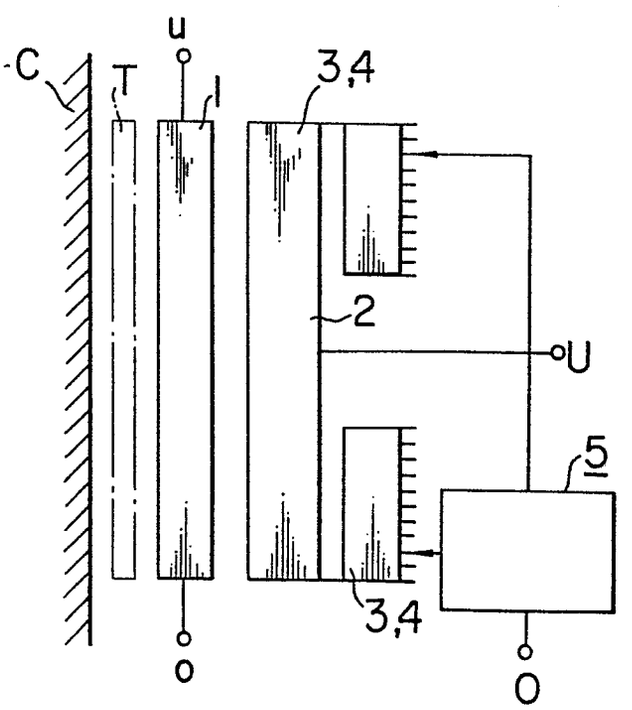

FIG. 5

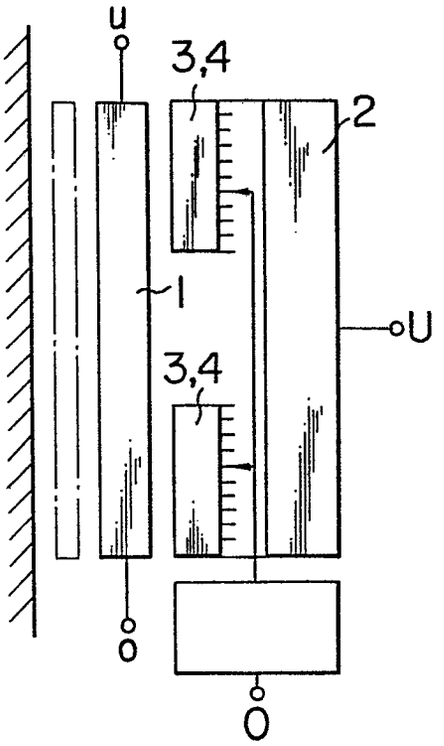

FIG. 6

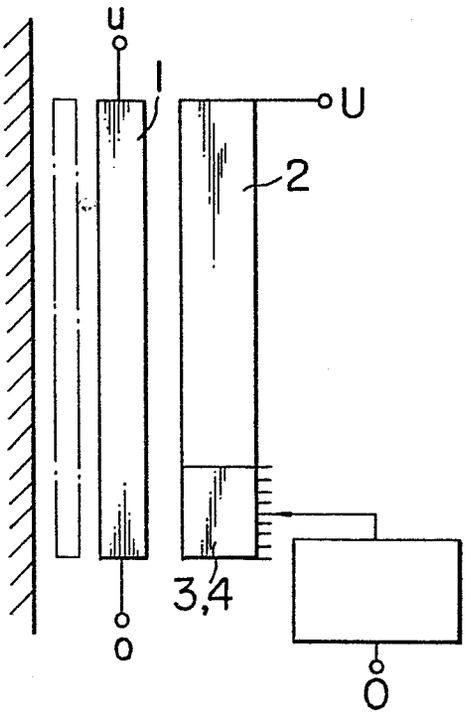

FIG. 9

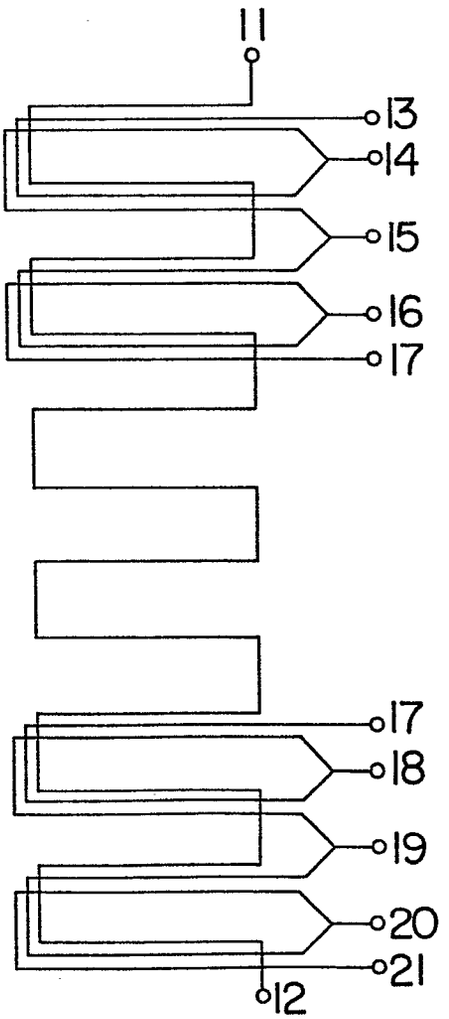

FIG. 10

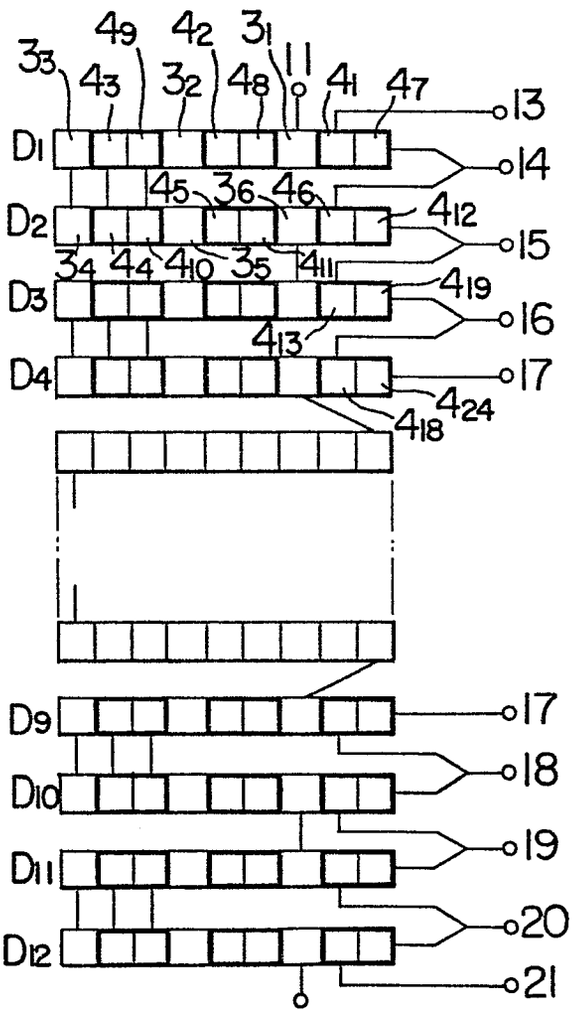

FIG. 7

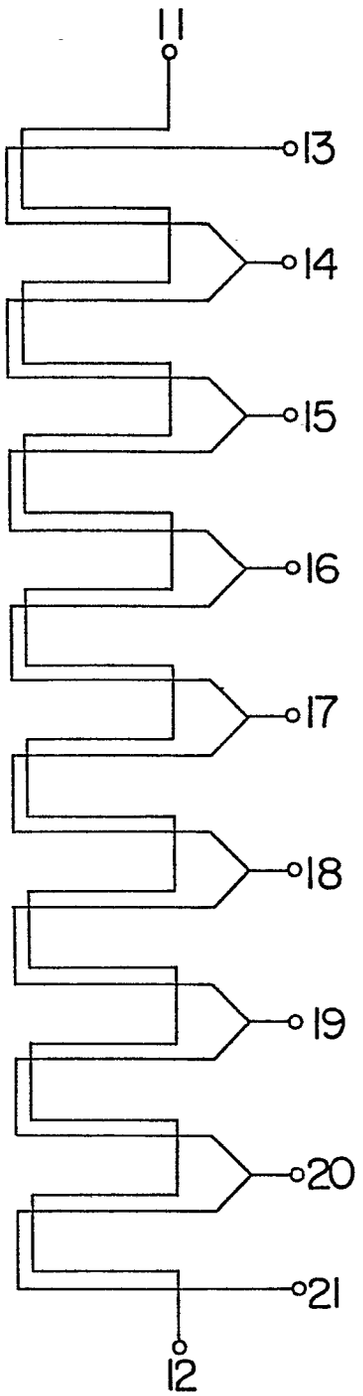
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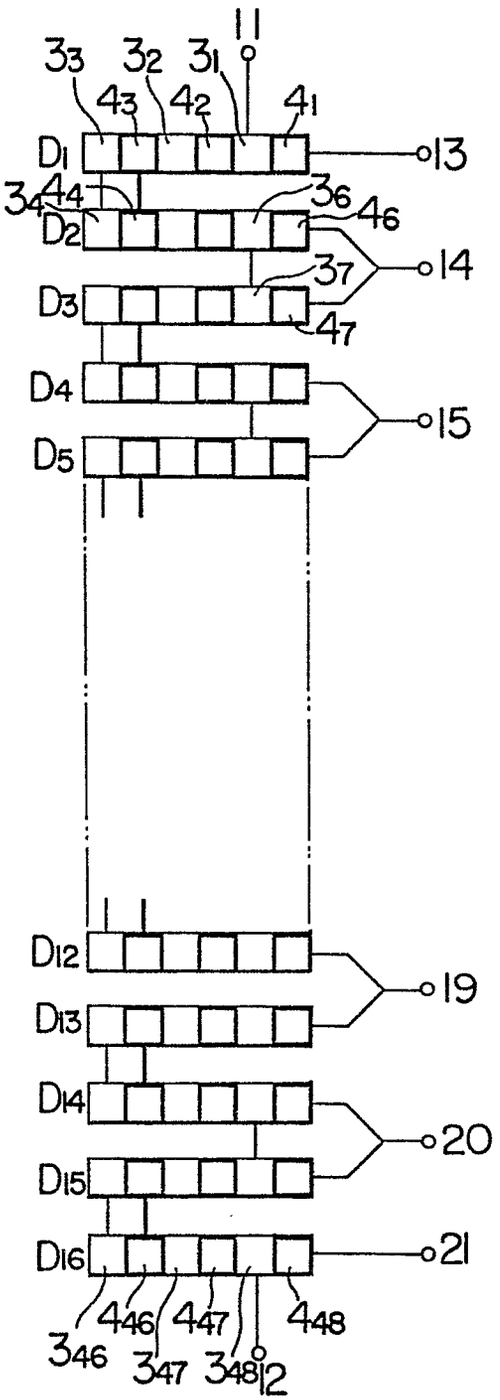
FIG. 8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