United States Patent

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[54] **STEP-SWITCHING ARRANGEMENT**
1 Claim, 1 Drawing Fig.

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[50] **Field of Search** ..... 323/43.5; 200/11 TC; 307/17; 317/14, 15; 336/150

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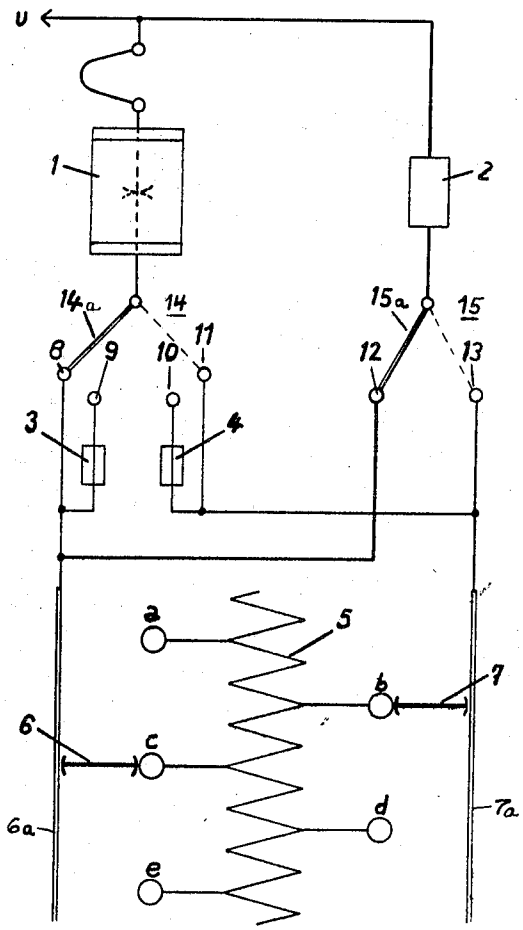
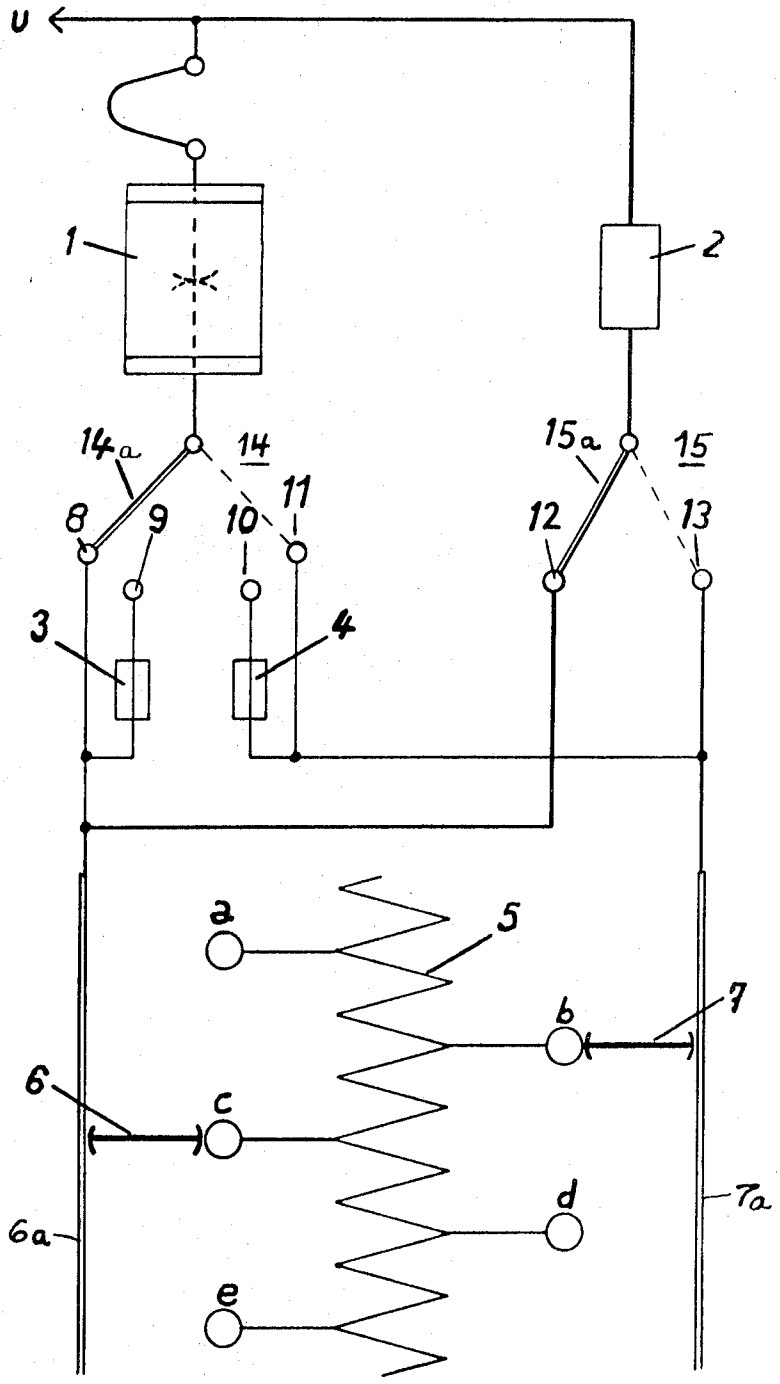
ABSTRACT: A step-switching arrangement for changing the taps on a transformer winding without interrupting the flow of current from the winding to a loadline includes a first switch and a resistance connected in series therewith extending from the transformer tap-changing contacts to the loadline which is paralleled by a changeover switch and vacuum switch connected in series therewith also extending from the transformer tap changing contacts to the loadline. A circulating current through the switches and resistance and part of the transformer winding occurs during a change in taps and this circulating current is normally interrupted by opening the contacts of the vacuum switch.

Should the vacuum switch fail to open and interrupt the circulating current, then as the changeover switch is actuated from one main contact to the other, the circulating current will be caused to flow from an auxiliary contact on this switch through an auxiliary circuit which includes a fuse. Blowing of the fuse interrupts the circulating current and thus takes over the function of the failing vacuum switch.





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STEP-SWITCHING ARRANGEMENT

This invention relates to a step-switching arrangement for changing the taps on a transformer winding wherein the individual voltage steps desired by shifting from one tap to another on the winding are preselected by a step selector in conjunction with a first switch connected via a switchover current-limiting resistance in series therewith to the transformer loadline, the series circuit connection of the first switch and current-limiting resistance being paralleled by another circuit consisting of a vacuum switch in series with a changeover switch.

A control device for step transformers is known where the tap can be preselected, without current, by a step selector and the uninterrupted load switching occurs by way of a switchover resistance and a vacuum switch, a mechanical changeover switch being assigned to each. The actuation of the two mechanical switches and of the vacuum switch can, in this case, be effected by means of a mechanical drive transmission, or pneumatically, as disclosed in Swiss Pat. No. 448,257. For economic reasons, the design of the load switch of a step-switching device as a vacuum switch, in itself advantageous, presupposes the use of commercial vacuum circuit elements manufactured in large quantities, which are provided without special additional devices for monitoring their operability. Thus, for example, for monitoring the vacuum in a vacuum circuit element arranged under oil, a pressure-sensitive chamber connected with the interior of the evacuated bulb is known which, upon a rise in pressure in the interior of the bulb, (leakage with penetration of liquid), blocks the actuating device of the element, in the case of closed contacts. Such an arrangement is disclosed in Swiss Pat. No. 460,121. However, there are causes other than loss of vacuum which may lead to premature failure of the vacuum switch.

The problem underlying the present invention is to make it possible to utilize structurally simple, and inexpensive commercially available vacuum circuit elements in a step-switching device without having to fear that failures of any kind of the vacuum circuit element, which lead to a reduction of the operational efficiency, in particular of the switching capacity, entail consequent damage to the step switch and transformer. According to the present invention, this problem is solved in that the changeover switch connected in series with the vacuum switch is provided not only with a pair of main switching contacts which lead to correspondingly assigned movable contacts along the taps on the transformer winding, but also a pair of auxiliary contacts each connected by way of an auxiliary circuit including a fuse to a corresponding one of the movable contacts along the taps of the transformer winding.

The arrangement is such that when the vacuum switch is operating in its normal manner, the main switching contacts operate in series with the vacuum switch and the latter functions to interrupt a circulating current which flows through the switching devices and part of the transformer winding during a changeover from one tap to another. However, should the vacuum switch fail to perform its function of interrupting the circulating current, then as the changeover switch is actuated, the circulating current is shifted to one of the auxiliary contacts thus redirecting flow of the circulating current through one of the auxiliary fuse-containing circuits and the fuse then blows so as to break the flow of the circulating current.

One suitable embodiment of the invention will now be described and is illustrated in the accompanying drawing, the single FIG. of which is an electrical schematic.

With reference now to the drawing, the tapped transformer winding is indicated at **5**, and the taps along the winding are designated *a* through *e*. Obviously, more than these five taps are provided but the ones which have been illustrated are sufficient to explain the inventive concept. Taps *a*, *c* and *e* are associated with one tap selector movable contact member **6**, and tap *b* located intermediate taps *a* and *c*, and tap *d* located intermediate taps *c* and *e* are associated with another tap selector movable contact member **7**. The movable contact members **6** and **7** are associated respectively with and move along in contact with conductor rails **6***a* and **7***a*.

Conductor rail **6***a* is connected to contact **12** of a first switch **15** and conductor rail **7***a* is connected to contact **13** of this switch **15**. The switch arm **15***a* is movable back and forth between contacts **12** and **13**, and is connected through a current-limiting resistance element **2** to the loadline U.

Conductor rail **6***a* is also connected to one main switching contact **8** of a changeover switch **14**, and conductor rail **7***a* is connected to another main switching contact **11** of switch **14**. The switch arm **14***a* is movable back and forth between the main switching contacts **8** and **11** and is connected through a vacuum switch **1** to the loadline U.

In addition to the main switching contacts **8** and **11**, the changeover switch **14** includes two auxiliary contacts **9** and **10** located in the path of the switch arm **14***a* between contacts **8** and **11**. Connected in an auxiliary circuit with auxiliary contact **9** is a fuse **3** which connects with the circuit leading to the conductor rail **6***a*, and in a similar manner, a fuse **4** is connected in an auxiliary circuit leading from auxiliary contact **10** to conductor rail **7***a*.

The step selector mechanism which moves the contact members **6** and **7** along the taps of the transformer winding is of conventional construction and hence has not been detailed as to its specific mechanism.

In order to explain the mode of operation of the improved step-switching arrangement, the electrical schematic shows, for example, that tap selector contact **6** is located on tap *c* of the transformer winding **5** and tap selector **7** on tap *b*. Switch **15** is in the position indicated on the drawing wherein switch arm **15***a* in the solid line position is engaged with contact **12**. Switch **14** is in the position indicated wherein switch arm **14***a* in the solid line position is engaged with the main switching contact **8**.

The contacts of the vacuum switch **1** are closed and hence a circuit is completed from transformer winding tap *c* to the loadline U which can be traced from conductor rail **6***a* through switch contact **8**, switch arm **14***a* and switch **1**. Another circuit to loadline U is also completed from conductor rail **6***a* through switch contact **12**, switch arm **15***a* and resistance **2** but this circuit will carry very little current due to the presence of the resistance **2** and the fact that the circuit through switches **14** and **1** practically short circuits the circuit path through switch **15**.

In order to change over from tap *c* to the next tap *b* on the transformer winding **5**, switch **15** is actuated to shift contact arm **15***a* to contact **13**. This completes temporarily a circuit from conductor rail **7***a* through switch **15**, resistance **2**, vacuum switch **1** and switch **14** to conductor rail **6***a* thus causing a circulating current, limited by the resistance **2**, to flow in that portion of the transformer winding **5** between taps *c* and *b*. Assuming that the vacuum switch **1** is not defective, the next step in the changeover sequence is for vacuum switch **1** to open thus interrupting the flow of circulatory current through part of the transformer winding, and also commutating the flow of the load current to the line U from contact member **6** to contact member **7** of the tap selector. Vacuum switch then recloses its contacts and the changeover switch **14** is actuated so that contact arm **14***a* now engages the main switching contact **11**, and a direct path from tap *b* to the line U is completed through the series connection of the two switches **14** and **1**.

This completes the changeover from tap *c* to tap *b*. The same sequence, in reverse, takes place when it is desired to change over from tap *b* to tap *a* for example.

Should, for some reason, the vacuum switch **1** fail and be unable to interrupt the circulating current which flows when switch contact arm **14***a* is on contact **8** and switch contact arm **15***a* is on contact **13**, then during the movement of switch arm **14***a* towards contact **11** as it passes by and engages the auxiliary contact **9** an auxiliary circuit will be completed through fuse **3** to the conductor rail **6***a*. The arc voltage of the changeover arc is sufficient so that the current reliably commutates

from contact 8 to contact 9. Thereupon, the circulation current flowing through fuse 3 is interrupted by blowing of this fuse and the load current is carried through switch 15 and resistance 2. Switch 14 then complete its switching movement, without current from contact 10 to contact 11 thus transferring the load current to the line U directly through switch 14 and the vacuum switch 1 whose contacts had failed to open. In a similar manner, contact arm 14*a* during the course of its shifting from contact 11 to contact 10 activates the auxiliary circuit through fuse 4 thus to interrupt the circulation current in the event that vacuum switch 1 failed to open its contacts during a tap-changing operation wherein switch 15 is shifted from the broken line position (contact 13) to the solid line position (contact 12) in going from a transformer tap controlled by movable contact 7 to one controlled by movable contact 6. Thus, if the vacuum switch 1 functions normally, and the circulation current is interrupted by it before movement of switch arm 14*a* begins, fuses 3 and 4 remain intact as switch arm 14*a* shifts from contact 8 to contact 11, or vice versa, since no current was caused to flow through them. However, if the interruption of circulation current by vacuum switch 1 does not succeed, one of the two fuses 3, or 4 melts and effects the desired current interruption. The fuse thus takes over the function of the failing vacuum switch 1 when it does not succeed in interrupting the circulation current.

In the illustrated schematic example, the two switches 14 and 15 are depicted as single interrupters. Alternatively, they may, in known manner be constituted as switches of the dual interrupter type which are actuated in the correct sequence, for example, by means of a corresponding cam plate mechanism. Also, actuation of the vacuum switch 1 may be controlled in such manner. It is also desirable, if one of the fuses 3 or 4 responds in the case of a disturbance (depending upon the direction of movement of changeover switch 14) to block any further actuation of the transformer winding tap selector mechanism by means of a device associated with the fuse, which provides a recognizable signal when the fuse blows to open the circuit through it, e.g. a strike pin common in fuses of the "HH" type.

I claim:

1. In a step-switching device for changing the taps on a transformer winding connected to a loadline, the combination comprising a tap selector mechanism including at least two contact members movable sequentially along different taps of the transformer winding, a first switch including two stationary contacts connected respectively with said movable contact members of said tap selector mechanism and a movable contact member selectively connectible with said stationary switch contacts, a resistance element connected in series with said first switch to a loadline a changeover switch including two stationary main switching contacts connected respectively with said movable contact members of said tap selector mechanism and a movable contact member selectably connectible with said main switching contacts, a vacuum switch connected in series with said changeover switch to said loadline, said changeover switch further including a pair of stationary auxiliary switching contacts located intermediate said main switching contacts in the path of travel of said movable contact member, and an auxiliary circuit extending between each of said auxiliary switching contacts and a respective one of said movable contact members of said tap selector mechanism, each said auxiliary circuit including a fuse element adapted to blow whenever said movable contact member of said changeover switch engages its corresponding auxiliary switching contact and current flows through the auxiliary circuit as a result of failure of said vacuum switch to open its contacts.

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