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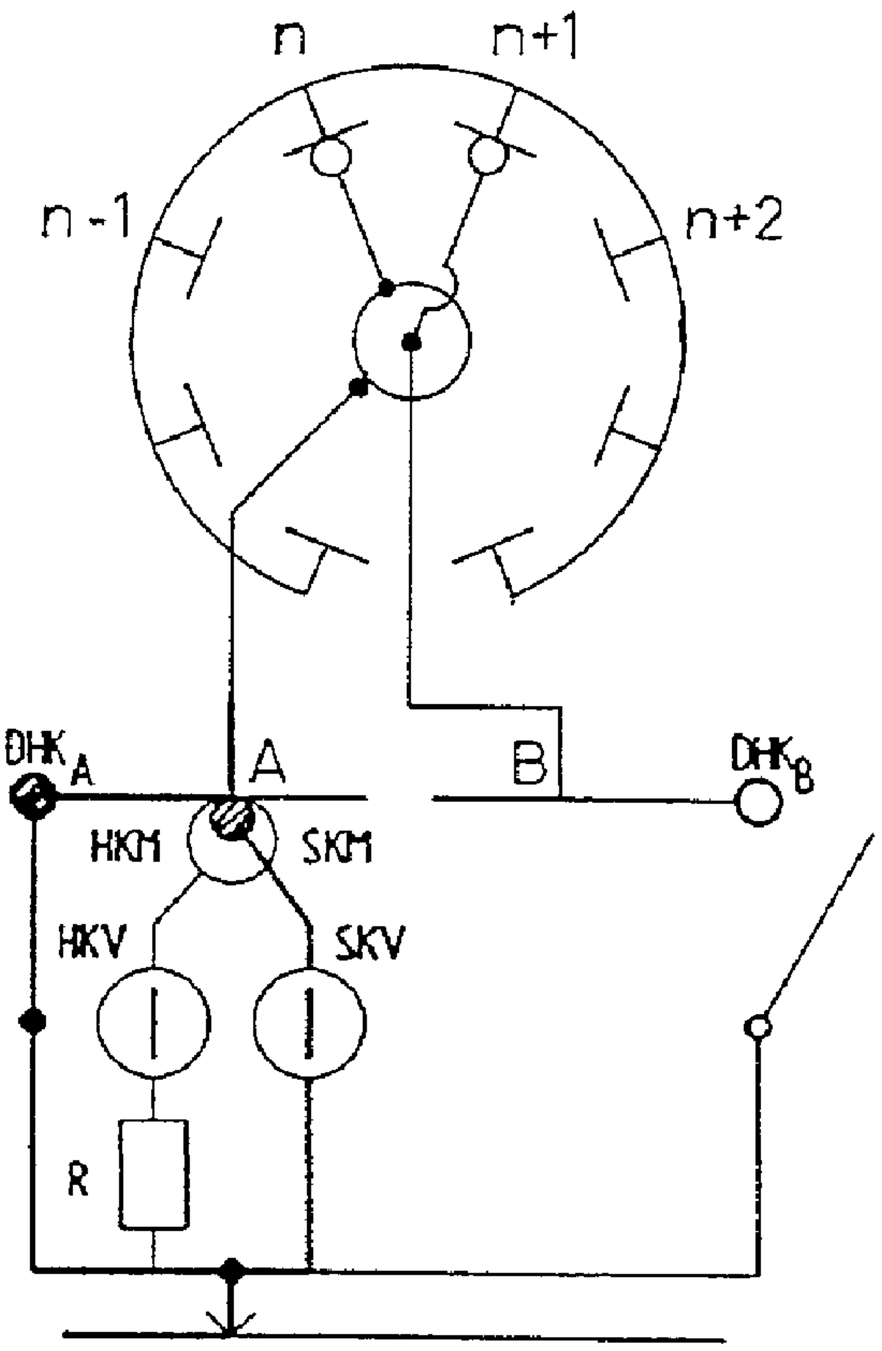
(54) Title: SWITCH-OVER ARRANGEMENT FOR LOAD SWITCHES OF TAP CHANGERS AND FOR LOAD SELECTORS



(57) Abrégé/Abstract:
The invention concerns a switching arrangement for load change-over switches of step switches and for selector switches, wherein two switching contacts movable in two directions are present. The first switching contact is in the form of a main switching contact and is connected to the load derivation by means of a first vacuum switchgear cell. The second switching contact is in the form of a

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(57) Abrégé(suite)/Abstract(continued):
resistance switching contact which is likewise connected to the load derivation by means of a series connection comprising a second vacuum switchgear cell and a transition resistor. Both the main and the resistance switching contacts can be moved independently of one another and without mutual coupling or influence. The main switching contact always reaches the new fixed contact abruptly and independently of the switching direction before the resistance switching contact leaves the previous fixed contact.

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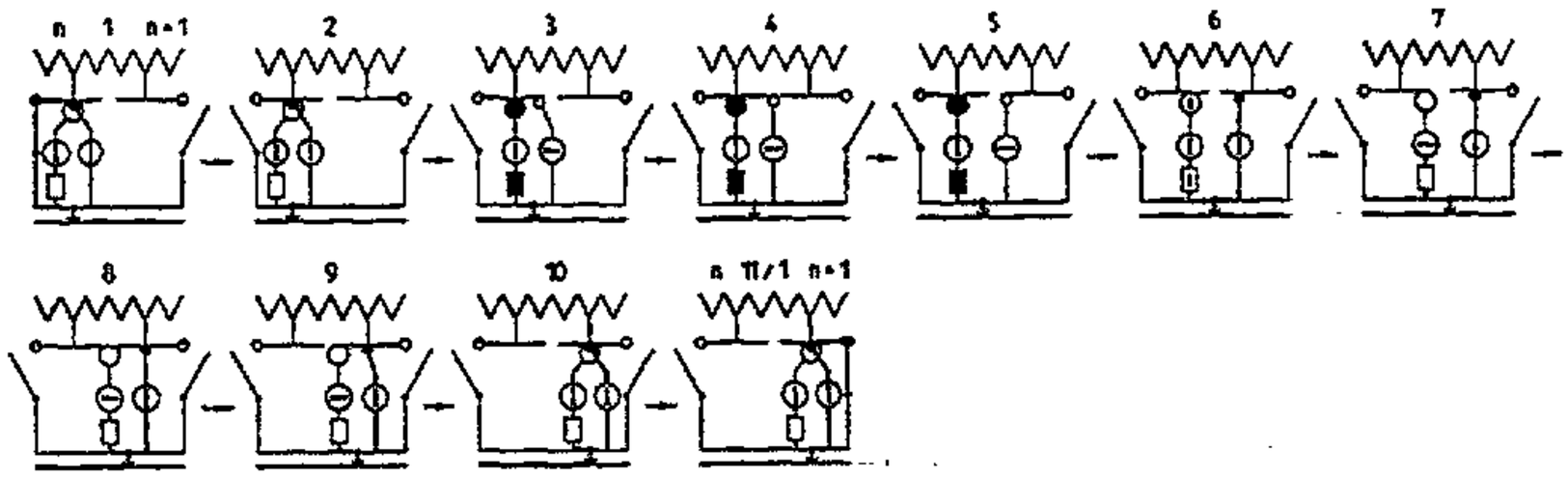
(54) **Title:** SWITCHING ARRANGEMENT FOR LOAD CHANGE-OVER SWITCHES OF STEP SWITCHES AND FOR SELECTOR SWITCHES

(54) **Bezeichnung:** UMSCHALTANORDNUNG FÜR LASTUMSCHALTER VON STUFENSCHALTERN UND FÜR LASTWÄHLER



(57) Abstract

The invention concerns a switching arrangement for load change-over switches of step switches and for selector switches, wherein two switching contacts movable in two directions are present. The first switching contact is in the form of a main switching contact and is connected to the load derivation by means of a first vacuum switchgear cell. The second switching contact is in the form of a resistance switching contact which is likewise connected to the load derivation by means of a series connection comprising a second vacuum switchgear cell and a transition resistor. Both the main and the resistance switching contacts can be moved independently of one another and without mutual coupling or influence. The main switching contact always reaches the new fixed contact abruptly and independently of the switching direction before the resistance switching contact leaves the previous fixed contact.

SWITCH-OVER ARRANGEMENT FOR LOAD SWITCHES OF TAP CHANGERS AND FOR LOAD SELECTORS

The invention relates to a switch-over arrangement for load switches of tap changers and for load selectors.

Such a switch-over arrangement is known from WO 94/02955. This known switch-over arrangement has at least two fixed tap contacts and two bidirectionally movable switch contacts connected to a load output line and switching between the one fixed tap contact and the other fixed tap contact. Here one of the switch contacts is a main switch contact directly connectable with the load output line while the other switch contact is connectable also with the load output line as a resistance switch contact in series with a switch-over resistor. Both switching contacts are independent of each other and movable without direct mechanical interconnection or influence. With this solution the resistance contact is moved slowly and continuously by the drive shaft toward the new contact while loading a force-storage unit and the switch contact follows this movement in a spring-like manner after tripping of the force-storage unit. The arrangement described there is however only suitable for load selectors. In addition this known arrangement for load selectors is known for high switch loading which makes essential additional means in excess of the emergency switching shunt in order to provide sufficient safety in spite of the statistically undeniable possibility of failure of vacuum switch tubes. With the discussed switch loads with such arrangements it is also necessary to provide two vacuum

switch tubes in series in the load branch which are preferably simultaneously actuated. This on the one hand increases the switch cost and also necessitates additional mechanical means for simultaneously actuating both vacuum switch tubes.

A further switch-over arrangement is known from German published application 2,520,670. This known switch-over arrangement has two bidirectionally movable switch contacts serving to switch a load output line from one to another tap contact, one switch contact serving as main switch contact and the other as resistance switch contact, with both lying in stationary condition on the same tap contact. The movable switch contacts are thus fixedly coupled together and mounted on a common contact carrier and are also jointly actuated by movement of the common contact carrier. Dependent on the switching direction one contact always leads and the other follows.

Each of the movable switch contacts is in series with a mechanical series contact and the two series contacts are simultaneously and individually connectable with the load output line. This selectable connection is effected by a movable mechanical interrupting or switch-over contact. In addition with this known arrangement a force-storage drive is provided that when tripped actuates not only the two movable mechanically interconnected switch contacts as well as the interrupter contact.

These known switch-over arrangements have several disadvantages. First, they absolutely require a mechanical interrupter contact. Vacuum switching tubes, which are known for their fire-resistance and the resultant avoidance of fouling of the surrounding environment as well as for the large number of switch operations possible, cannot be used for the known switch-over apparatus. In addition the switch contacts reverse their mechanical functions depending on switching direction from leading to trailing; the switch cycle changes with the switching direction. Both switch contacts must therefore be actuated jointly by the force-storage unit and in addition the force-storage unit must as described actuate the movable interrupter contact which forms the current connection to the load output line so that the result is in general a complicated mechanism and

a correspondingly mechanically expensive force-storage unit.

It is an object of the invention to provide a switch-over arrangement of the above-described type that is usable for load switches and also for load selectors, which permits the use of vacuum switch tubes in the main and in the resistance branch, and with which the lowest possible switch loading can be achieved.

This object is achieved by the technical features detailed in the independent patent claims. The dependent claims contain particularly advantageous embodiments of the invention.

It is particularly advantageous with the switch-over arrangement according to the invention that with it the slightest possible switch loading is achieved. It is therefore possible to provide, for safety reasons against the possible and statistically unignorable failure of a vacuum switch tube, a mechanical series emergency switching branch which is provided anyhow in use of the switch-over arrangement according to the invention for a load selector and which can be monitored in a particularly simple manner by a known optoelectronic arc detector with load-switch quenching when needed. In addition as a result of the modest load switch loading of the switch-over arrangement according to the invention it can be built with smaller and correspondingly cheaper vacuum switch tubes. A particular advantage of the switch-over arrangement according to the invention is further that the separate actuation of the main switch contact on one side and of the resistance switch contact on the other side allows for provision of a long switching path which is significant with respect to the spacing of the contact elements and thus of the achievable voltage stability as also with respect to the restabilization voltage when the emergency switching shunt is used. It is significant for the switch-over arrangement according to the invention that, independent of the switching direction and thus of

the movement (rotation) direction of the drive, the main switch contact is always actuated first in a spring-like manner.

German patent 756,435 describes in principle that on direction change of the contact movement of the tap changer contacts the selector contact connected to the switch-over resistor "passes" the other, but in this known solution both tap changer contacts, i.e. the selector arms, are mechanically connected to each other and with the drive; the "passing" takes place either mechanically by a lost motion in the drive mechanism or electrically by two additional reversing switches which reverse the orientation, i.e. the switching of the tap changer contacts on rotation-direction reversal. In the switch-over arrangement according to the invention on the contrary both contact arms move fully independently of each other: The main switch contact is moved spring-like by the tripped force-storage unit to the new fixed contact and the resistance switch contact follows with a selectable speed.

The invention is described more closely by way of example with reference to drawings.

FIG. 1 shows a first switch-over arrangement according to the invention as part of a load switch;

FIG. 2 shows this first switch-over arrangement according to the invention as part of a load selector;

FIG. 3 shows in this first switch-over arrangement the steps necessary from one voltage tap to another;

FIG. 4 shows the switching diagram for this first switch-over arrangement for multiple tap changing;

FIG. 5 shows a second switch-over arrangement according to the invention as part of a load switch;

FIG. 6 shows in this second switch-over arrangement the necessary switching steps from one voltage tap to another;

FIG. 7 shows a third switch-over arrangement according to the invention as part of a load switch;

FIG. 8 shows in this third switch-over arrangement the necessary steps from one voltage tap to another and back again;

FIG. 9 shows the switching diagram for this third switch-over arrangement.

The switching cycles of the first switch-over arrangement according to the invention are essentially the same independent of whether this switch-over arrangement is part of a load switch or part of a load selector.

The sole difference is that with a load selector several switchings are possible in the same switching direction that is for example from n via n+1 to n+2 while with a load switch it is more likely that there are only two possible positions, that is the switch direction is changed.

The switch-over arrangement shown in FIG. 1 has two fixed tap contacts A, B which are connected in the known manner via a tap changer with taps n, n+1, n+2 ... of the tapped winding.

The actual switch-over arrangement moves between these contacts A and B. This consists of a main switch contact SKM which is connected via a first vacuum-switch cell SKV with a common output line as well as of a resistance switch contact HKM which is independent and mechanically decoupled therefrom and connected in series with a second vacuum-switch cell HKV and a switch-over resistor R to the common output line. In addition in this embodiment there are preferably continuous main switches DHK_A and DHK_B which in stationary use conduct the load current and thus bypass the switch-over arrangement.

These continuous main switches are not strictly necessary for the operation of the switch-over arrangement, the load current can, when the vacuum-switch cells are appropriately dimensioned, be conducted also by the main switch contact SKM and the first vacuum-switch

cell SKV, which is closed in stationary operation, in series therewith.

FIG. 2 shows this first switch-over arrangement as a part of a load selector, where the continuous main switches are also not strictly necessary; the differences between actuation of the switch-over arrangement as part of a load switch on the one hand and of a load selector on the other hand have already been given.

FIG. 3 shows in the first switch-over arrangement the necessary steps from one voltage tap to another. These steps are independent of whether the switching is from a lower to a higher voltage tap or vice versa. The individual steps are shown at 1 through 11.

Step 1: Starting position, DHK_A conducts the load current.

Step 2: DHK_A has opened, the main switch contact SKM and the first vacuum-switch tube SKV have taken over the load current.

Step 3: The first vacuum switch tube SKV has opened, the load current flows through the resistance switch contact HKM, the second vacuum switch tube HKV, and the switch-over resistor R.

Step 4: The main switch contact SKM leaves the fixed contact n or A after tripping of a force-storage unit.

Step 5: The main switch contact SKM reaches the new fixed tap contact n+1 or B.

Step 6: The first vacuum switch cell SKV closes and switches the load current to the fixed tap contact n+1 or B; the still closed second vacuum switch cell HKV and the switch-over resistor Ṙ conduct only the differential current.

Step 7: The second vacuum switch cell HKV opens and interrupts the flow of the differential current.

Step 8: The resistance switch contact HKM leaves the fixed tap contact n or A and follows the movement of the main switch contact SKM to the new fixed tap contact n+1 or B.

Step 9: The resistance contact HKM has reached the new fixed tap contact n+1 or B;

Step 10: The second vacuum switch cell HKV closes.

Step 11: The continuous main switch DHK_B closes and takes over the load current; The starting position has been reached and the switch-over arrangement is ready to be switched again.

It is clear that there is no addition of load and differential current, only a slight loading on switching.

Figure 4 shows the corresponding circuit diagram for this first switch over arrangement for a multiple step switching from n to n+1 and then n+2 and thereafter back to n+1 for a switch over arrangement according to Fig. 2. This circuit diagram is also applicable to the arrangement shown in Fig. 1 in which, as mentioned above, there is only mechanical switching between each of the two fixed tap contacts A and B.

It is thus clear that independently of whether one is moving to a higher or a lower voltage tap, the main switch contact SKM moves rapidly first and the resistance switch contact HMK follows rapidly.

It is thus necessary to actuate the main switch contact SKM rapidly by a tripped spring force or other energy-storage unit. The following resistance switch contact HKM can theoretically also follow slowly or continuously but this eliminates one of the advantages of

the invention, that is the simple monitoring of the vacuum switch tubes by a mechanical emergency switching shunt. This emergency circuit is only possible when the resistance switch contact HKM follows rapidly. This rapid movement of the following resistance switch contact HKM is possible by means of a two-part force-storage unit or two interconnected force-storage units so that after tripping of a first force-storage unit and movement of the main switch contact SKM with a time delay a second force-storage unit is tripped which causes the resistance switch contact HKM to follow.

FIG. 5 shows a second switch-over arrangement according to the invention which is specially set up for load switches where as described one only moves between two fixed contacts A and B. As a particularly advantageous feature of the invention the main switch contact SKM as well as the resistance switch contact HKM each consist of two interconnected and coupled individual breaker contacts SKM_A, SKM_B and HKM_A, HKM_B, each individual contact SKM_A and HKM_B being electrically connected with the first tap contact A and the other individual breaker contacts SKM_B and HKM_B being electrically connected to the other tap contact B.

In this embodiment of the invention there are thus two double interruptions; in this manner a simple load switching is possible during switch-over in which only simple interrupters, contact bridges or the like are necessary as mechanical switch elements.

FIG. 6 shows the appropriate switching cycle. It is clear that here permanent connections are merely closed or opened for transmitting the load through the respective individual breaker contacts.

FIG. 7 shows a third embodiment of a switch-over arrangement according to the invention. This embodiment is also set up specially for load switches where once again the switching only takes place between two fixed tap contacts A and B. The further above-described individual

breaker contacts SKM_A, SKM_B of the main switching circuit SKM as well as the individual breaker contacts HKM_A and HKM_B of the resistance switch contact HKM are here switched by two reversing switches S1 and S2.

The first reversing switch S1 selectively closes the individual breaker contact SKM_A or the individual breaker contact SKM_B. Here there is thus a double interruption by means of four individual breaker contacts which are in a special manner switched by only two reversing switches S1 and S2.

FIG. 8 shows the switching cycle from the fixed tap contact A to the fixed tap contact B and back again. One can see that even in this embodiment the main switch contact reaches the new fixed contact B, that is to connect same with the load output line L directly, before the resistance switch contact leaves the previous fixed tap contact, that is before the previous connection via the switch-over resistor R with the load line L is broken.

It is further clear that in all described embodiments of the invention the movement or the actuation of the main switch contact on the one hand and the resistance switch contact on the other hand takes place without a mechanical interconnection. Even in the last-described embodiments it is also possible to provide additional continuous main switches which in a stationary condition transmit the main current flow.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An under-load switch comprising:

two spaced-apart fixed contacts connected in an electrical circuit and selectively connectable under load;

a main switch contact and a resistance switch contact connected to a load mechanically decoupled from one another and movable independently from one another bidirectionally between said fixed contacts so that, independently of direction of movement, said main switch contact always engages a fixed contact to be selected before the resistance switch contact engages the fixed contact to be selected;

a switchover resistance in series with said resistance switch contact and between said resistance switch contact and said load;

a main vacuum switch cell connected in series with said main switch contact between said main switch contact and said load, and a resistance vacuum switch cell connected in series with said resistance switch contact between said resistance switch contact and said load, said vacuum switch cells being selectively rendered conductive and nonconductive independently of one another; and

a first force storing unit connected to said main switch contact and a second force storing unit connected with said resistance switching unit for:

tripping of said first force storing unit to jump said main switch contact into engagement with the fixed contact to be selected before said resistance switch contact leaves a prior fixed contact, and

thereafter tripping of said second force storing unit after a time delay to jump said resistance switch contact into engagement with said fixed contact.

2. The under-load switch defined in claim 1, wherein said main switch contact and said resistance switch contact are displaceable about a common axis and said fixed contacts extend in at least one of an axial direction and a radial direction so that said main switch contact and said resistance switch contact can be moved into engagement with said fixed contacts independently.

3. The under-load switch defined in claim 1, wherein said main switch contact and said resistance switch contact are displaceable independently from one another linearly and said fixed contacts are so arranged and constructed that they can be independently swept over by said main switch contact and said resistance switch contact.

4. An under-load switch comprising:

two spaced-apart fixed contacts connected in an electrical circuit and selectively connectable under load;

a main switch contact and a resistance switch contact connected to a load mechanically decoupled from one another and movable independently from one another bidirectionally between said fixed contacts so that, independently of direction of movement, said main switch contact always engages a fixed contact to be selected before the resistance switch contact engages the fixed contact to be selected;

a switch-over resistance in series with said resistance switch contact and between said resistance switch contact and said load;

a main vacuum switch cell connected in series with said main switch contact between said main switch contact and said load, and a resistance vacuum switch cell connected in series with said resistance switch contact between said resistance switch contact and said load, said vacuum switch cells being selectively rendered conductive and nonconductive independently of one another; and

a force storing unit connected to said main switch contact, the main switch contact and the resistance switch contact each being comprised of a pair of coupled and commonly actuated breaker contacts capable of sequentially making and breaking an electrical circuit for the respective switch contact and positioned so that one of said breaker contacts of the main switch contact opens a connection with a prior fixed contact before a second breaker contact of said main switch contact closes on a fixed contact to be selected and a first breaker contact of said resistance switch contact opens at said prior fixed contact before a second breaker contact of said resistance switch contact closes on said fixed contact to be selected.

5. The under-load switch defined in claim 4, wherein the breaker contacts of each pair are provided on respective rotary switches.

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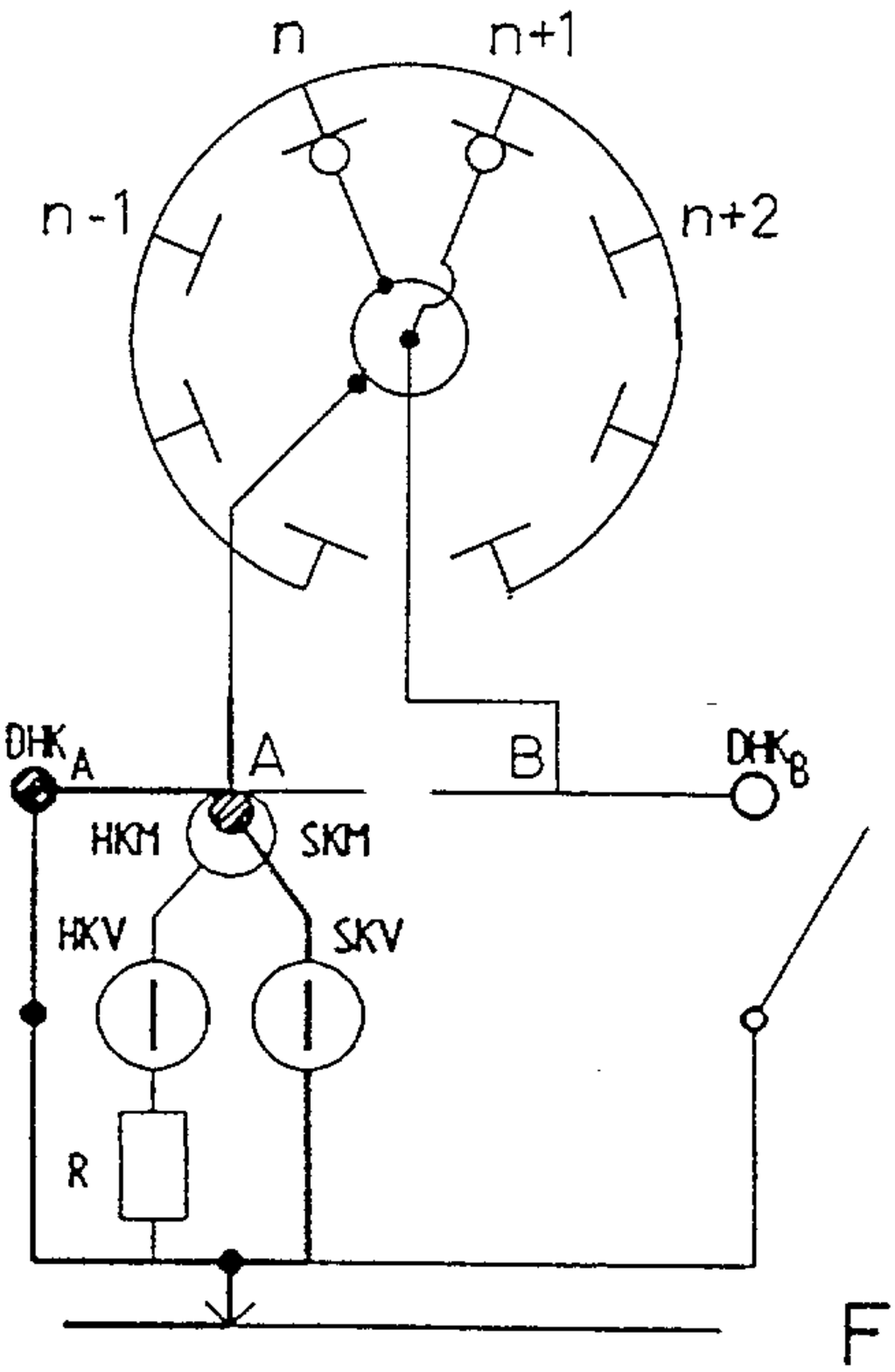


Fig.1

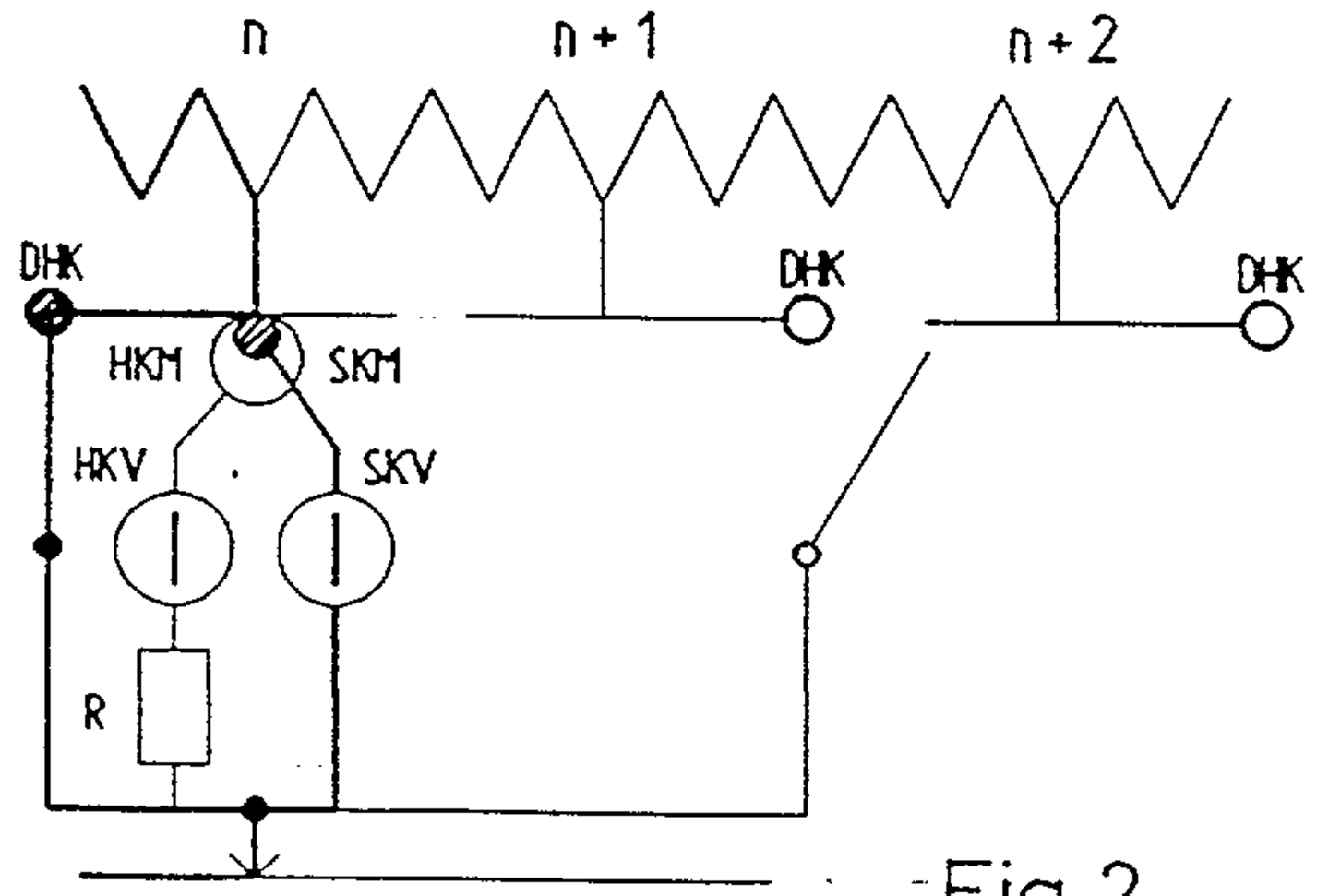


Fig.2

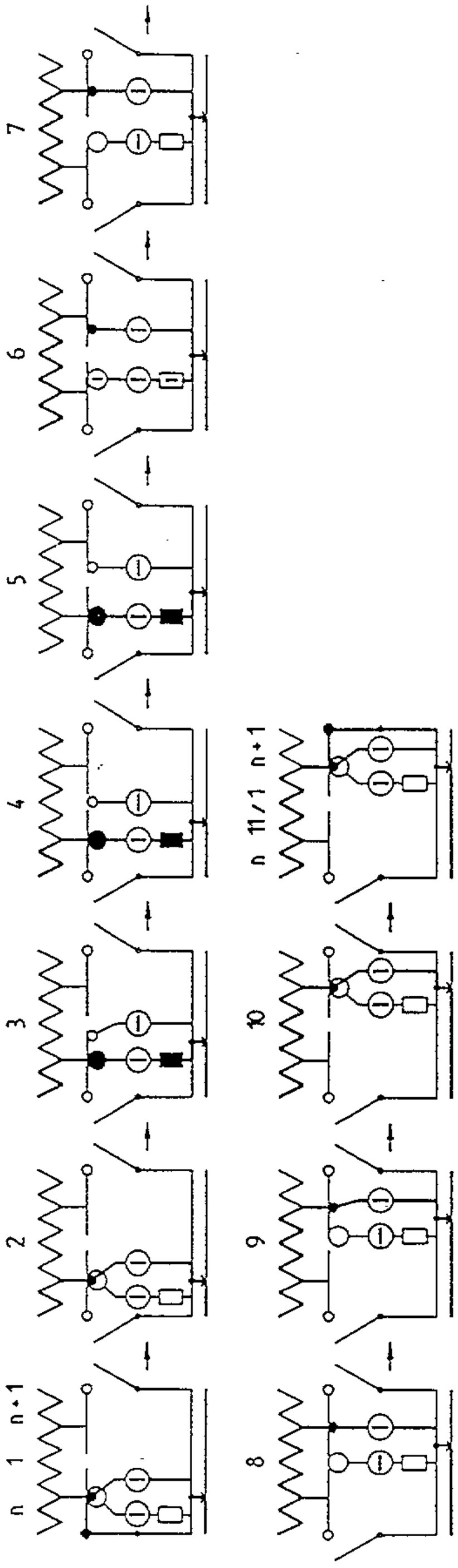


Fig. 3

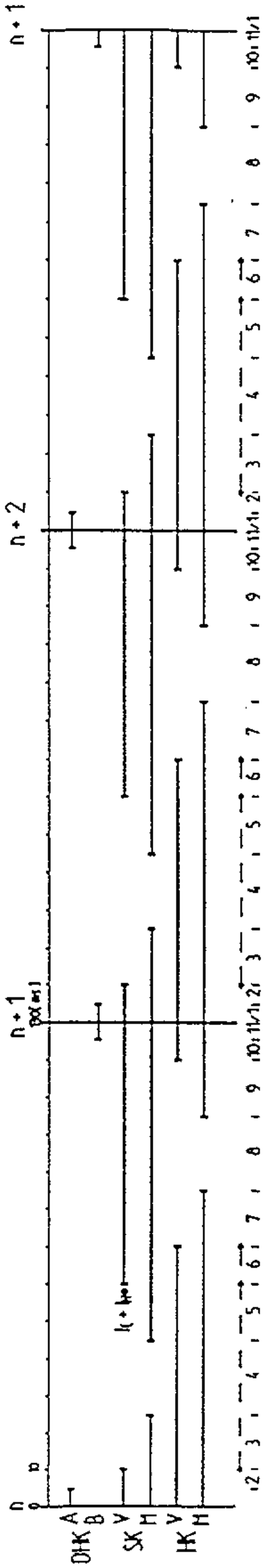


Fig. 4

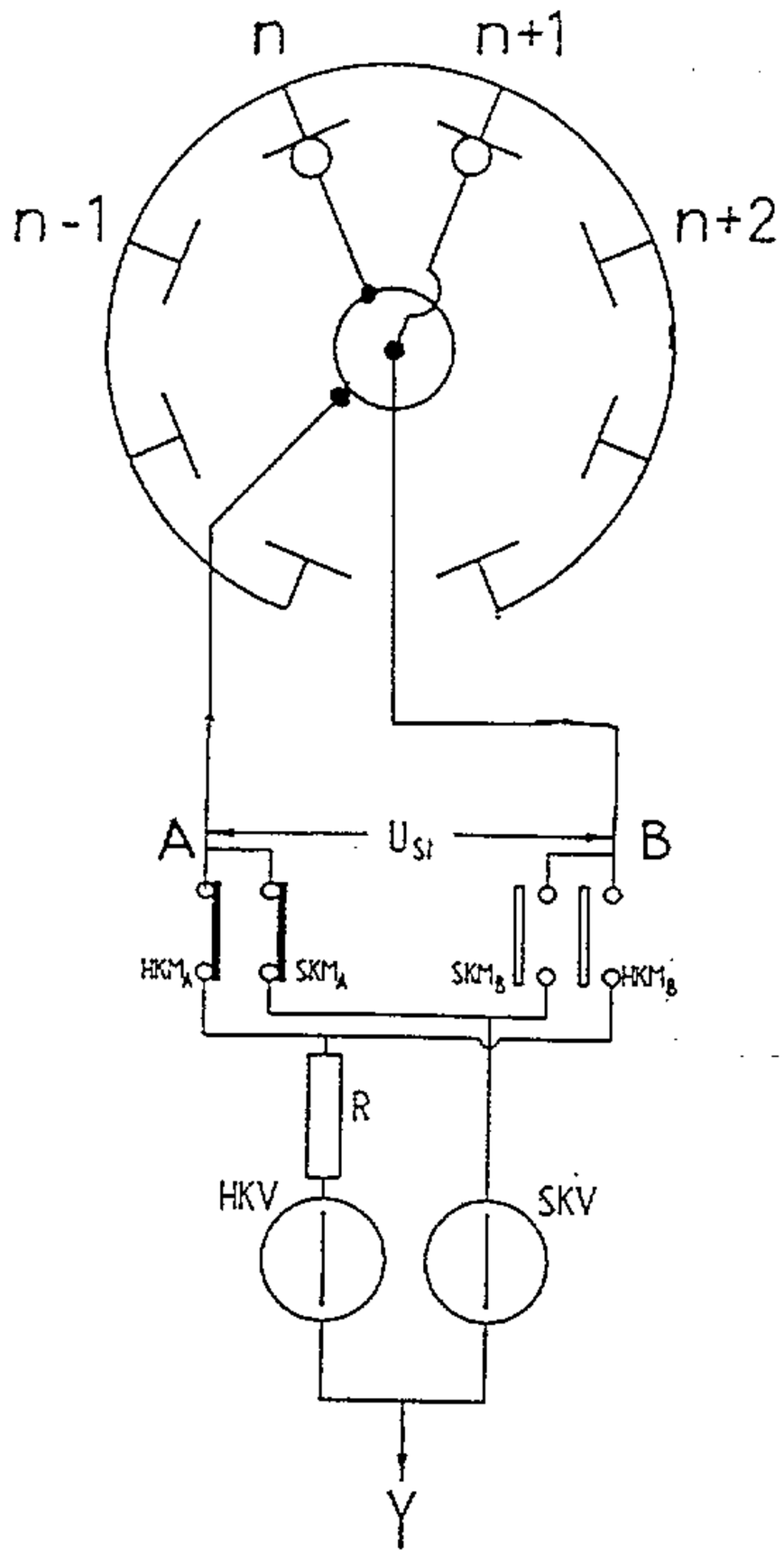


Fig. 5

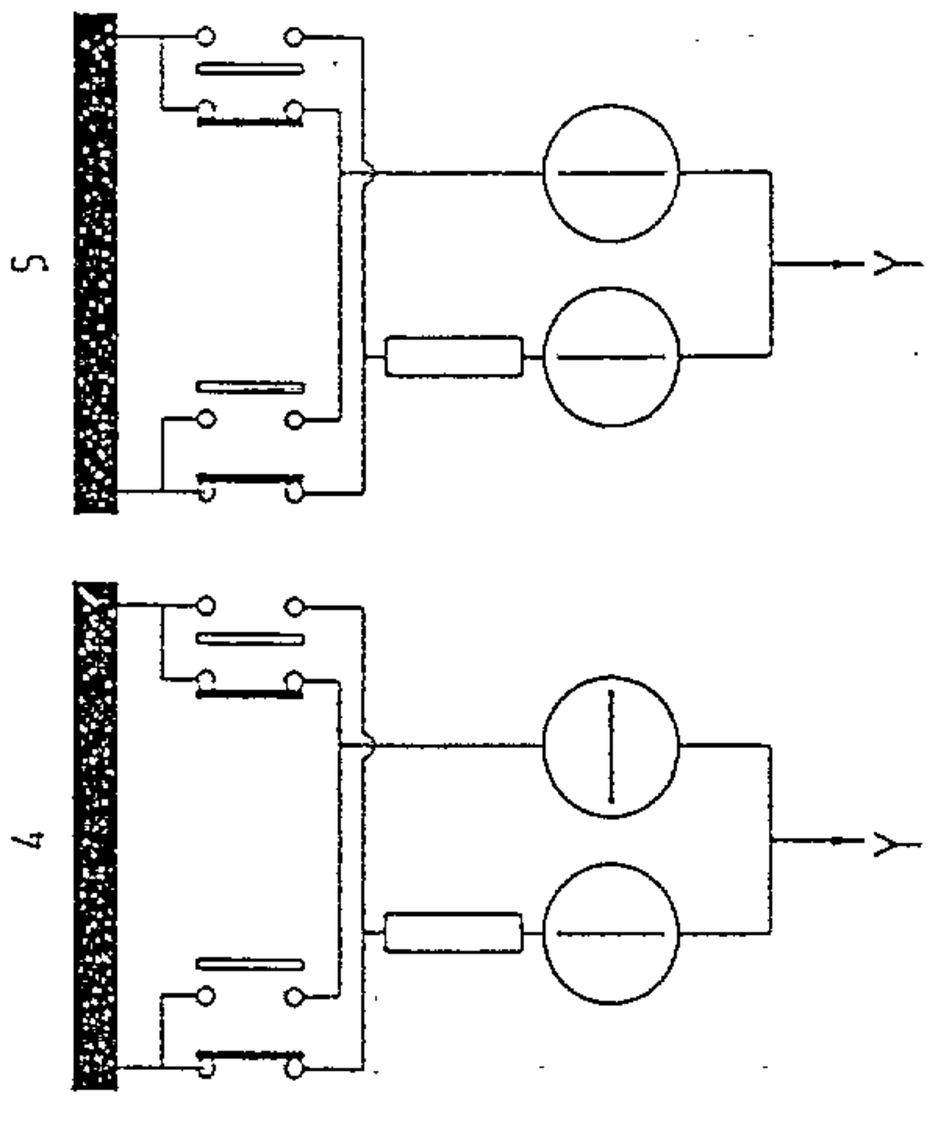


Fig.6

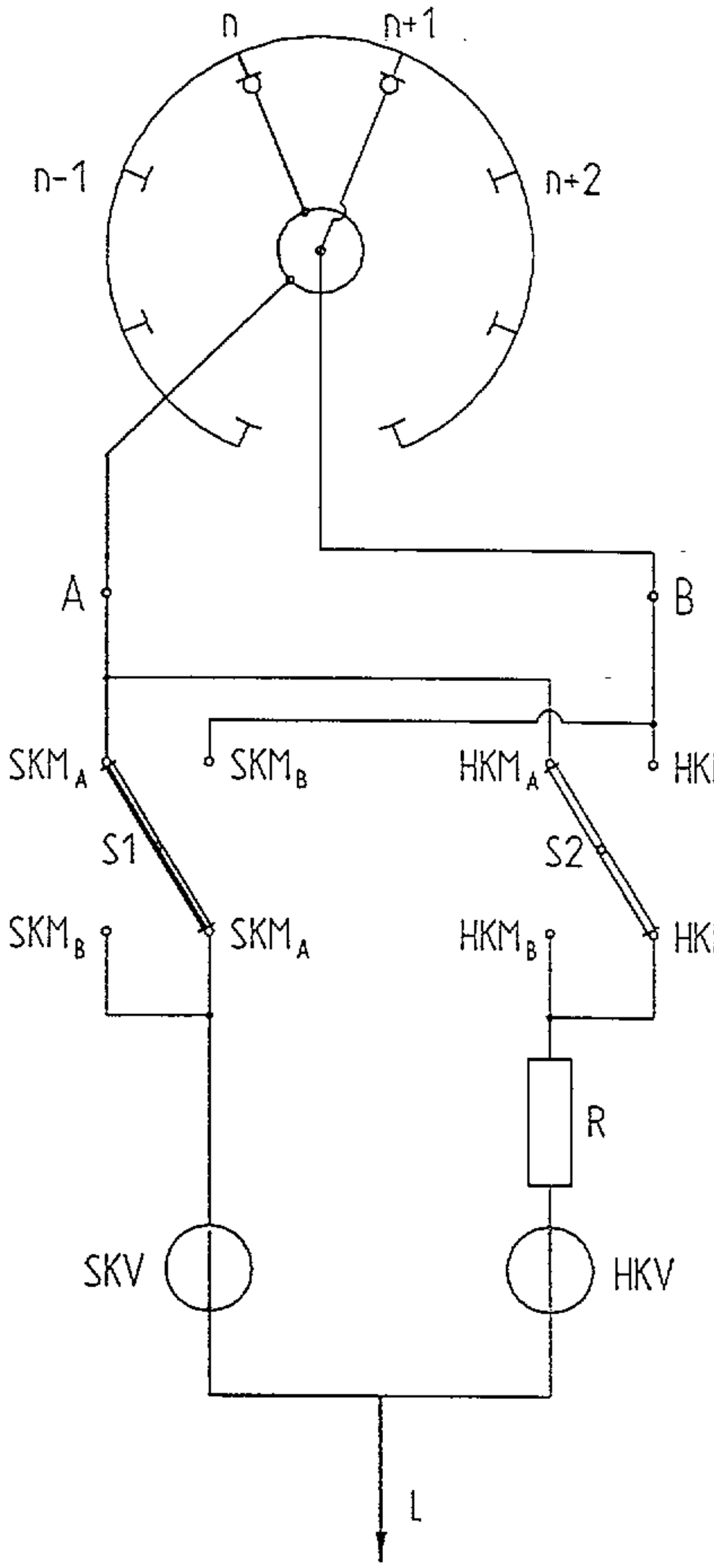

n
n+1
n-1
n+2
A
B
SKM A
SKM B
HKM A
HKM B
S1
S2
SKM B
SKM A
HKM B
HKM A
R
SKV
HKV
L

Fig. 7

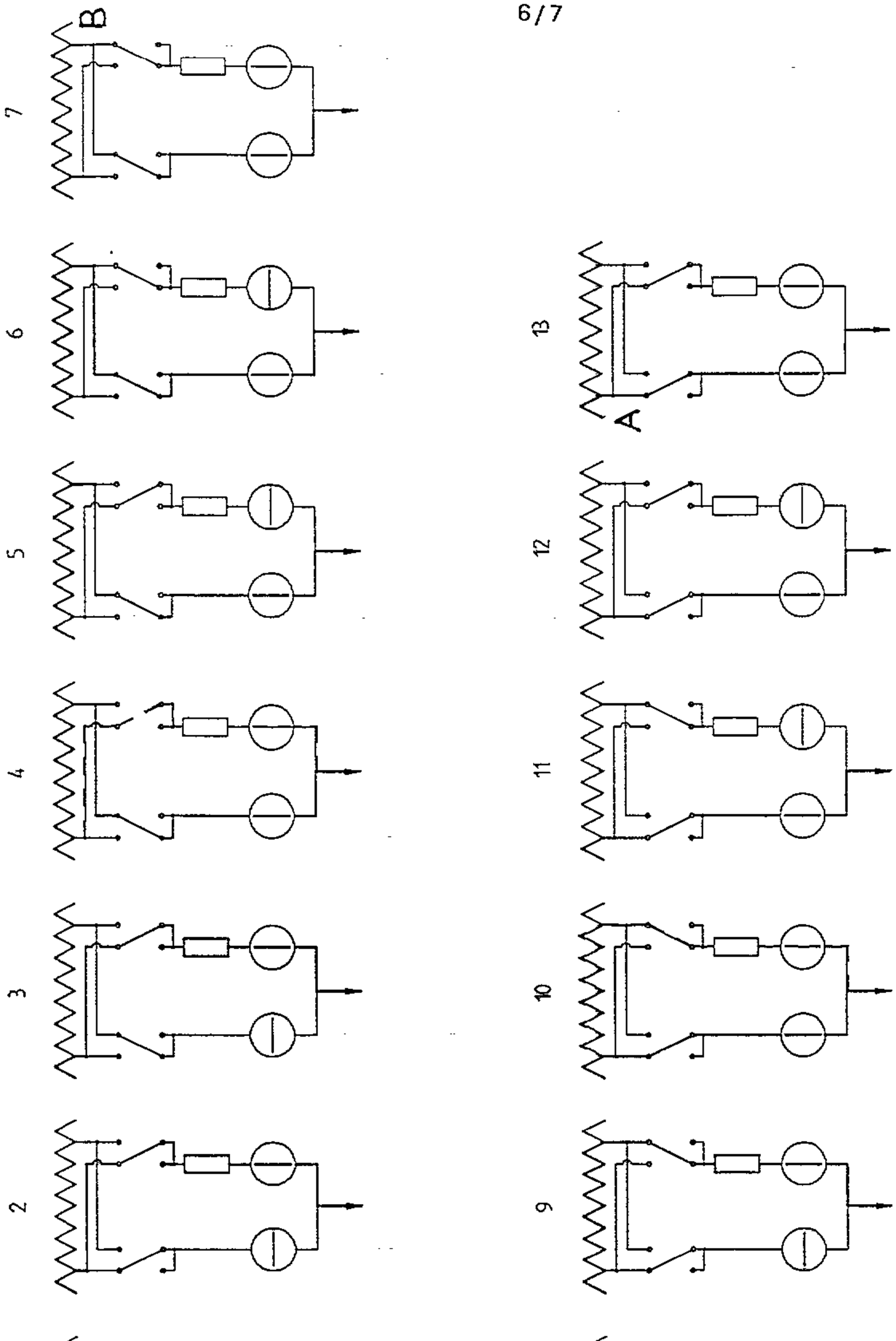


Fig. 8

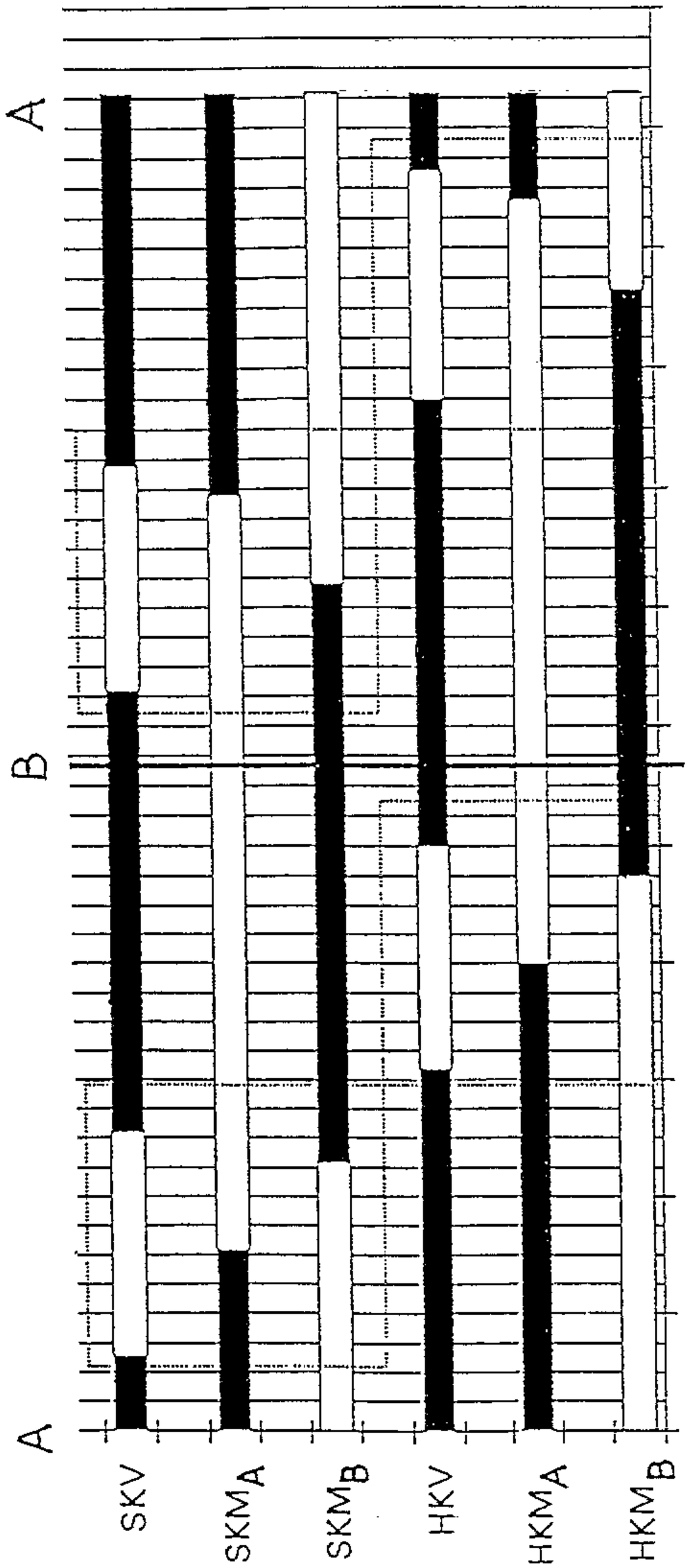
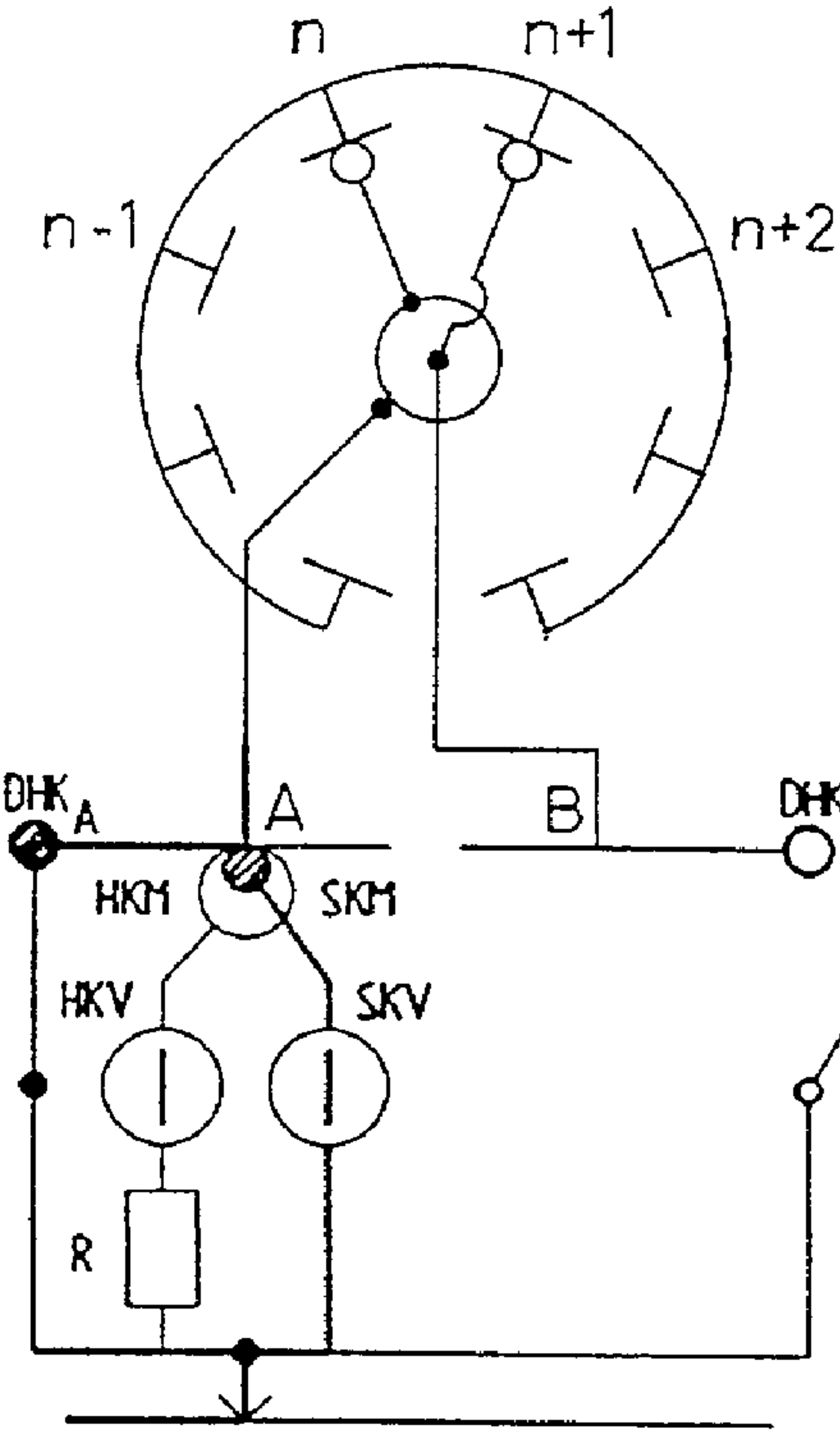


Fig. 9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n+2
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B
DHK B
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