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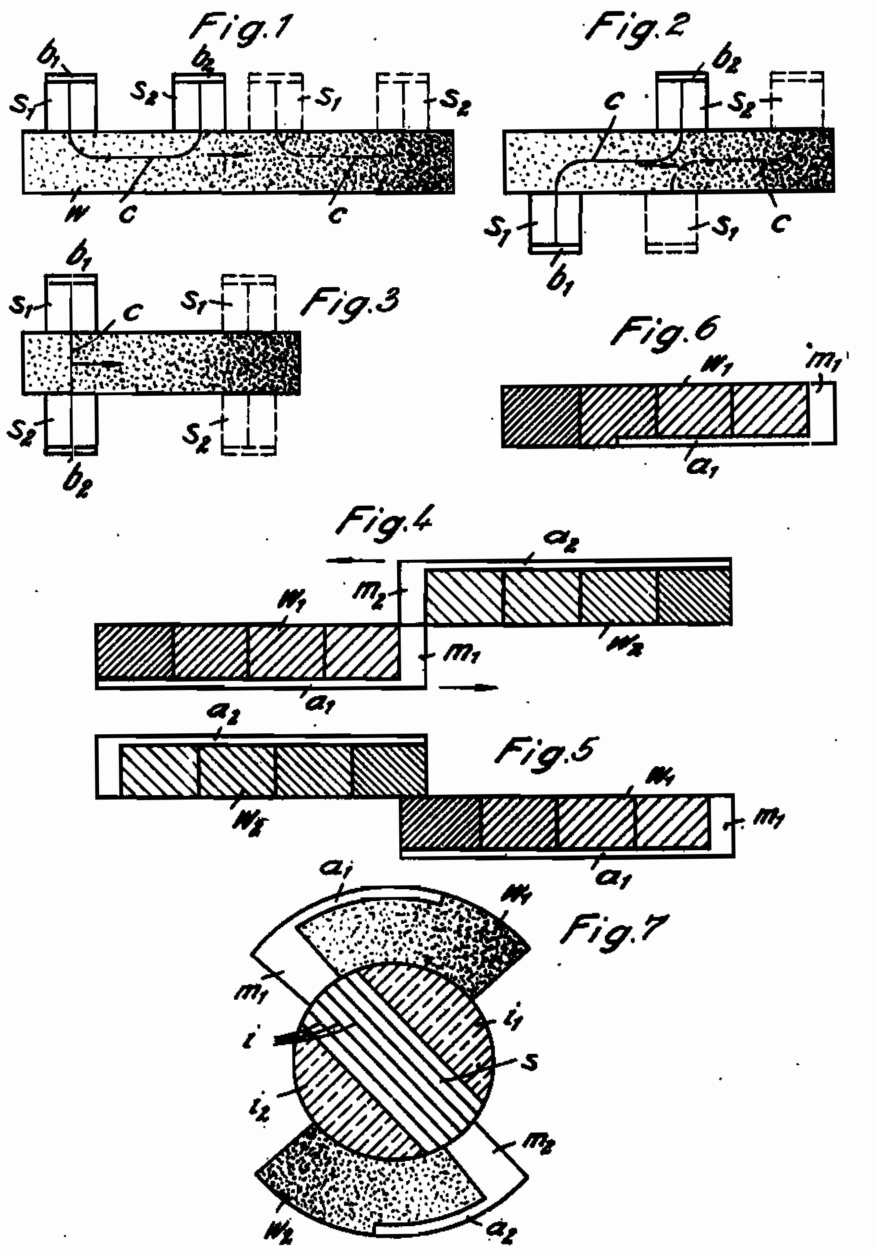

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VARIABLE RESISTORS

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This invention relates to variable resistors having a solid resistance body and adapted to carry very high loads, and more particularly to variable resistors for controlling power circuits. The parts of the resistance body of such variable resistors may be heavily loaded as regards the current density and are therefore liable of being deteriorated. When carrying out switching operations in power circuits such resistors must be capable of varying their resistance within a very short time and must therefore withstand also considerable mechanical stresses. Any undue thermal stress of the resistance body or of the contact cooperating therewith reduces at the same time the mechanical strength of the variable resistor and renders it unsuitable for the above purposes.

According to the invention the above-mentioned drawbacks are removed by the fact that the current carrying parts of the resistance body are so alternately stressed during the control that no part is subjected to a high current density. The tubes of current in which the max. current densities occur shall hereinafter be referred to as current core. According to the invention the volume elements of the resistance body carrying the current core must therefore change their position during the control.

The control is effected with the aid of such resistors for controlling power circuits within a fraction of a second. According to the invention the parts of the resistance body carrying the current core are only stressed temporarily by the latter during a portion of the short duration of control. In this way the resistance material is kept in good condition and the life of the variable resistor is considerably increased. Consequently, the volume elements of the resistance body carrying the current are therefore replaced in the shortest possible time by other elements so that the highly heated points wander through the resistance body. Owing to the rapid wandering of these points no undesirable accumulation of heat can occur in any part of the resistance body.

This may be accomplished according to the invention by causing the inlet point as well as the outlet point of the current core to wander along the resistance body. While in the known variable resistors a current junction is stationary on the resistance body and only the other current junction changes its position, both junctions or at least both end points of the current core change their position so that the effective current paths are shifted over their entire length relatively to the resistance body. This shifting must not be brought about by moving the current junction but may also be caused by moving the resistance body with respect to the stationary current junctions.

In Fig. 1 of the accompanying drawings is shown a rod or plate-shaped resistance body w on which slide two current contacts s_1 and s_2. For the control the two contacts are shifted in the direction as indicated by the arrows to the position shown in dash lines so that the middle current path c of the current core is shifted within the resistance body in its longitudinal direction. The same effect occurs also when shifting the resistance body with respect to both stationary contacts. In this case the change in resistance may be brought about either by the fact that the specific resistance of the resistance body differs in its longitudinal direction so that the two contacts for a constant distance are shifted to points having another specific resistance, or in the case of a homogeneous material the resistance between the contacts may be varied by moving both current contacts with different speeds. If in the end position the contacts are, for instance, spaced from one another more than in their initial position the effective resistance between the contacts is greater. According to the invention the two contacts must in this case also be moved to such an extent that the effective current path lies on another point of the resistance body.

It is particularly advantageous, if the movement of the current contacts, serving to control the resistance and their motion serving to displace the current core take place in different directions. For instance, one or both of the contacts s_1 and s_2 may be displaced during the control in the arrangement shown from one another in the plane of the drawing, while they are shifted at the same time over the surface of the resistance body w perpendicularly to the plane of the drawing. Also in this case the entire resistance body is traversed by current paths; however, the current paths effective for stressing the resistance body—the portion of the current paths referred to above as current core—are crowded within the space of the shortest possible connection between the two current contacts. This current core is therefore shifted according to the invention during the control to other points of the resistance body.

The two contacts s_1, s_2 may also lie as shown in Fig. 2 at different sides of the resistance body w, which has the advantage that the surfaces over which they slide are better cooled and that both current contacts may be moved in the direction of the line connecting the same without the surfaces overlapping each other over which the contacts slide. Also in the arrangement shown in Fig. 2 it is possible to shift the current core in the longitudinal direction of its middle portion as well as perpendicularly thereto with respect to the resistance body.

According to Fig. 3 the transverse displacement of the current core may be effected in the direction of the contact movement effecting the change in resistance, by arranging the two current contacts s_1 and s_2 on opposite sides of a resistance body whose specific resistance varies continuously or step by step. In this case the current path between the contacts run across the resistance body. If the current contacts are displaced to points having another specific resistance, the current core wanders at the same time perpendicularly to its longitudinal direction without substantially varying its own length.

Instead of the one movable current contact (for instance s_2) as shown in Fig. 3, also a stationary current junction may be employed which is arranged on the rod or plate-shaped resistance body at the side away from the contact surface and which extends over a considerable portion of this side.

According to Fig. 4 also two rod or plate-shaped resistance bodies w_1 and w_2 of the type shown in Fig. 3 slide over one another whose current junctions are arranged on the outer sides and take up the entire length of these sides. The current junctions a_1 and a_2 consist in this case of metal layers which are integral with the metal contacts m_1 and m_2 respectively lying at the end of the corresponding resistance body whose specific resistance is smallest. In particular cases also nonmetallic parts having a sufficiently small specific resistance may be employed instead of these metal parts. In the position shown in Fig. 4 the parts m_1 and m_2 are in engagement with each other. The connection is therefore practically without resistance. If the two bodies are shifted with respect to each other in the direction of the arrows, sections of higher specific resistance are inserter one after the other in the core of the current paths until, in the end position shown in Fig. 5, the sections of the max. specific resistance lie upon one another. During the control the current paths run substantially perpendicularly to the contact surface of the two resistance bodies and new volume elements come continuously into the zone of the max. current density.

In the control positions of the greatest resistance the current load of the resistance body is small and non-detrimental and in this phase of control the stressed volume elements need no longer change their position. Consequently, it suffices if the current junctions a_1 and a_2 extend as shown in Fig. 6 only over a considerable portion of length of the resistance bodies w_1 and w_2.

The same applies to the forms of the invention shown in Figs. 4 and 5.

The wandering of the current core in the resistance body may be facilitated by subdividing the current contact. The contacts consist of various metal layers separated by insulating layers or layers of greater specific resistance substantially perpendicular to the contact surface of the resistance body. In Fig. 7 is shown, for instance, a laminated contact s with insulating layers i. This form of the invention prevents a crowding of the current paths at the edge of the contact, particularly in one or both end positions of the current paths. The resistance bodies w_1 and w_2 are arcuate and come into engagement with the current contact s at the cylindrical surfaces opposite to each other. Their specific resistance increases from the end provided with the metal contacts m_1 and m_2 respectively towards the other end. The current contact s is associated with insulating pieces i_1 and i_2 to form a cylindrical body.

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