Feb. 13, 1940. R. A. MILLER ET AL 2,190,295

SWITCHING DEVICE

Filed Oct. 15, 1937

FIG. 1

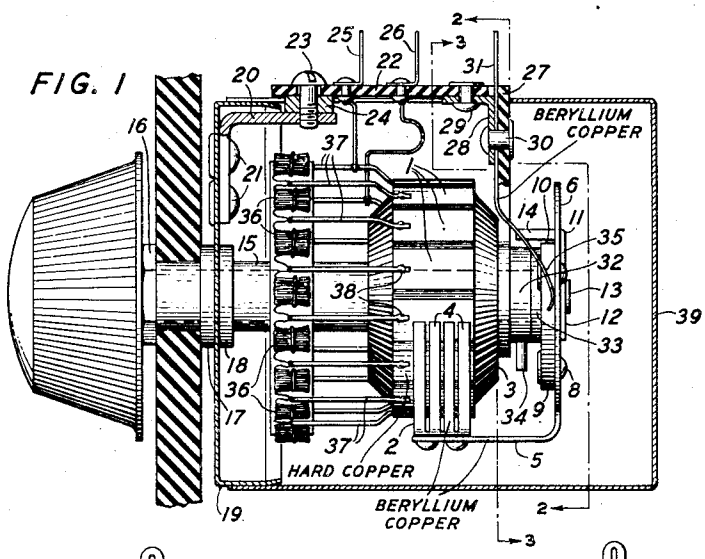


FIG. 2

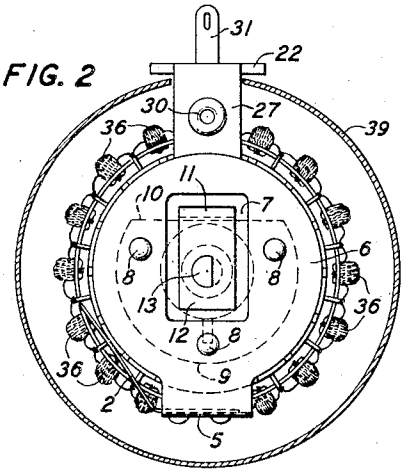


FIG. 3

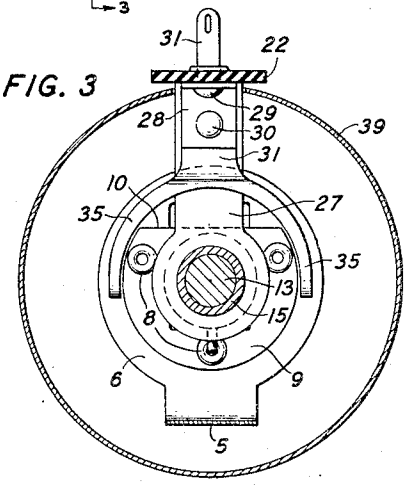


FIG. 5

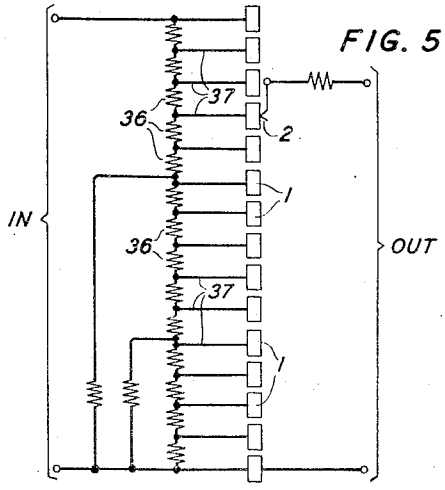
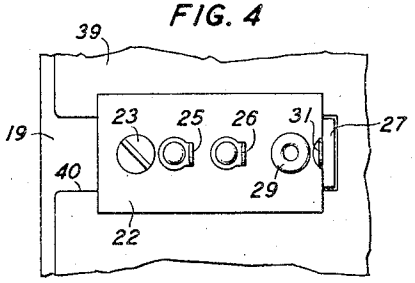


FIG. 4



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SWITCHING DEVICE

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3 Claims. (Cl. 200—8)

This invention relates to switching devices and more particularly to selective switching devices.

The object of this invention is to provide a switching device adaptable for use in electrical sound translating systems in which signals generated by operation of a switching device must be eliminated or reduced to a comparatively low level.

A feature of the invention resides in matched contact means in the relatively movable electrical conducting portions of the structure.

Another feature resides in the particular combination of elements by means of which a comparatively noiseless switching structure is obtained.

In the drawing, Fig. 1 is a side elevational view, partly in section, of the switching device;

Fig. 2 is a rear view of the device, partly in section, taken on the line 2—2 in Fig. 1;

Fig. 3 is a front view, partly in section, of a portion of the device and taken on the line 3—3 in Fig. 1;

Fig. 4 is a top view of a portion of the device shown in Fig. 1; and

Fig. 5 is a schematic view of a circuit arrangement in which the device shown in Fig. 1 may be used.

In sound translating electrical apparatus and systems it is often found that the switching devices and electrical apparatus units associated therewith produce electromotive forces resulting in sounds and that these sounds form part of the product of the sound translation equipment and interfere with the faithful reproduction of the sounds being translated. When a potentiometer, for instance, is used in connection with sound translating apparatus, sound currents may be generated in the relatively movable parts of the potentiometer or in a resistance element or elements associated with the electrical contacts in the potentiometer. The potentiometer switching structure and/or the element or elements associated therewith are therefore found to be, in effect, microphonic since sound currents are produced thereby. Such sound currents are objectionable since they interfere or combine with the desired sound currents produced by operation of the microphone per se.

We have found that in some cases thermocouple electromotive forces are developed in a potentiometer due to the existence in the structure of unlike materials in the contact making parts and that the thermocouple electromotive forces produced are at such levels that audible sounds are produced from the thermocouple electromotive forces, when the electrical currents are retranslated into sound waves through a receiver. A potentiometer very often becomes quite microphonic after a comparatively short period of service due to wearing away of the relatively fixed and movable contact making parts since the worn contact parts do not make sufficient contact with other contact parts to prevent sparking.

When a wiper contact for instance is moved with a wiping action over a series of fixed segmental contacts or when segmental contacts are moved with a wiping action into successive engagement with a wiper contact the heat generated at the point of contact results in the development of thermo-electromotive forces sufficient to introduce in a sound translating system variations in current which cause the translating apparatus to produce undesired sounds when the currents therein are retranslated. When the segmental contacts are made of a metal quite different to that of the wiper contact the thermo-electromotive forces produced are quite pronounced. We have found that a considerable reduction in the thermo-electromotive forces can be effected by making the respective fixed and movable contacts of the same kind of material. For instance, should the respective fixed and movable contacts be both made of silver the thermo-electromotive forces would be reduced to a very low level. This silver to silver contact structure however does not have good wearing qualities since the silver wears away too fast. A copper to copper contact structure provides good conducting means and has only very low thermo-electromotive force producing characteristics under increase of temperature produced by frictional engagement of the parts. To prevent wearing of the parts the contacting portions should be made substantially smooth. When a series of contacts are successively brought into engagement with a wiper contact the temperature of the wiper contact is raised relative to the temperature of the series of contacts since the wiper contact is continually being rubbed by the series of contacts while each contact in the series is only intermittently engaged by the wiper contact. This relative difference in temperature results in the production of some slight thermo-electromotive forces.

To provide a switching device in which the development of thermo-electromotive forces is

reduced to a very low degree we do four things, that is:

In the first place we make the contacting parts of materials of about the same order.

In the second place we make the contacting parts smooth at the point of engagement and so match these parts that there will be very little wearing away of the parts.

In the third place we provide sufficient spring pressure in one of the parts to keep the parts in sufficient engagement to prevent sparking.

In the fourth place we so form the wiper contact that there will be sufficient heat dissipation to prevent raising the temperature of this part appreciably above the temperature of the series of contacts.

The switching device when used as a potentiometer is further prevented from being in effect microphonic by providing a resistance structure which is substantially non-microphonic. To do this we provide a resistance structure comprising resistance elements having no loose particles of resistance material therein.

The invention provides a switching device which is almost entirely non-microphonic and has practically no thermocouple action and which will not change its characteristics over a comparatively long period of service. The switching device, therefore, is suitable for use in a sound translating system.

The switching device as shown particularly in Figs. 1, 2 and 3 in the drawing comprises a set of fixed segmental contacts 1 and a wiper contact 2. The segmental contacts 1 are mounted on the outer surface of an annular support 3 of insulating material, the segmental contacts being arranged in spaced relation in the form of a ring of separated segmental contacts.

The segmental contacts 1 are made of substantially dense metal so that there will be no appreciable pockets developed therein due to wearing away of the segmental contacts in service. Hard-drawn copper serves well as a material for the segmental contacts.

The wiper contact 2 is made of substantially hard metal, so that there will be no appreciable wearing away of the wiper contact 2 when the wiper contact 2 passes in a wiping action over the segmental contacts 1. The parts of the wiper contact 2 having engagement with the segmental contacts are made extremely smooth so that there will be no cutting of the segmental contacts by the wiper contact. The material in the wiper contact 2 must have an electrothermal characteristic about equal to that of the material of the segmental contacts 1. The material in the wiper contact 2 should also be such that sufficient spring pressure may be developed therein to continually urge a portion of the wiper contact 2 against the ring of segmental contacts 1. The wiper contact 2 has a plurality of spring finger portions 4 which are slightly bowed in the direction of the ring of segmental contacts 1, so that spring tension is developed in the finger portions 4 and so that the outer surface of the bowed portion is presented to and presses against the segmental contacts adjacent thereto. The spring finger formation in the wiper contact 2 provides for dissipating of heat and keeps the wiper contact 2 at about the same temperature as the segmental contacts 1.

The wiper contact 2 is attached at one end to an L-shaped arm 5 which is made of the same kind of material as the wiper contact 2. The arm 5 has a comparatively large flat disc portion 6 on one of its leg portions. The other leg portion supports the wiper contact 2. A comparatively large rectangular aperture 7 is provided in the central portion of the disc portion 6. Secured to one face of the disc portion 6 by means of rivets 8 is a ring 9 of insulating material. The ring 9 extends across the greater portion of the rectangular aperture 7 and has one straight edge portion 10 lying in spaced relation to one end of the rectangular aperture 7 in the disc portion 6. An L-shaped stop arm 11 apertured on one leg portion 12 to receive an end of an operating shaft 13 is secured to the operating shaft 13, an end of the operating shaft 13 extending through the aperture in the leg portion 12 and being upset or spun over against the leg portion 12. The leg portion 12 of the stop arm 11 is narrower than the width of the rectangular aperture 7 in the disc portion 6 of the arm 5, and rests against one face of the ring 9 of insulating material and does not touch at any point the disc portion 6 of the arm 5. A free leg portion 14 of the stop arm 11 extends over the straight edge portion 10 of the ring 9 and inwardly toward the annular support 3 of insulating material.

The operating shaft 13 is journaled in a comparatively long bearing 15 externally threaded on an outer end and having lock-nuts 16, 17 and 18 supported thereon. The bearing 15 projects through a central aperture in a shallow cup member 19, and is secured therein by means of the lock-nuts 17 and 18. The bearing 15 also extends through the annular support 3 of insulating material which supports the segmental contacts 1. An L-shaped bracket 20 is secured at one of its leg portions to an inner surface of the cup member 19 by suitable means such for instance as the rivets 21 and at a point offset radially from the central aperture in the cup member 19. The unsecured leg portion of the bracket extends parallel with the inner surface of the side wall of the cup member 19.

A rectangular apertured strip 22 of insulating material is supported above the unsecured arm of the bracket 20 by means of a machine screw 23 and a spacer 24, the machine screw 23 extending through an aperture in the strip 22 of insulating material and then through the spacer 24 and threading into an internally threaded aperture in the unsecured leg portion of the bracket 20. Spaced terminals 25 and 26 are secured to the strip 22 of insulating material and project upward from the upper surface of the strip 22. The strip 22 of insulating material is comparatively thick and is sufficiently stiff to serve as part of a supporting means for the inner end of the bearing 15. To provide the supporting means abovementioned, an apertured arm 27 of insulating material is supported at one end of the strip 22 of insulating material by means of a corner bracket 28, the arm 27 being comparatively thick and rigid and extending downward at an angle of 90 degrees from the plane of the strip 22. One leg portion of the corner bracket 28 is secured against the lower surface of the strip 22 of insulating material, by means of the rivet 29. The other leg portion of the corner bracket 28 supports a rivet 30 which extends through an aperture in the corner bracket 28 thence through an aperture in a terminal 31 and through an aperture in the arm 27, the rivet 30 serving to hold together the parts through which it extends. The lower end of the arm 27 is enlarged and apertured to permit extension therethrough of a portion of the bearing 15, the portion extending through the arm 27 being adjacent an annular flange 32 provided on the

inner end portion of the bearing 15. A washer 33 is supported on the shaft 13 between the flange 32 of the bearing 15 and the inner face of the ring 9 of insulating material.

The arm 5 which as above-mentioned is made of the same material as the wiper contact 2 has the disc portion 6 at one end, the disc portion 6 being secured to the ring 9 of insulating material. The ring 9 of insulating material has a central aperture adapted to receive the shaft 13 and fits thereover. When the ring 9 is placed on the shaft 13 and the shaft 13 is extended through the aperture in the stop arm 11 and the end of the shaft is upset or spun over against the stop arm 11, the parts are held together so that rotation of the shaft 13 will cause the wiper contact 2 to successively engage the segmental contacts 1. A stop pin 34 secured to the flange 32 and extending radially therefrom extends into the path of movement of the inwardly extending end 14 of the stop arm 11. Engagement of the end 14 of the stop arm 11 with the pin 34 limits the rotational movement of the wiper contact 2 over the segmental contacts 1.

The terminal 31 has two rather widely separated leg portions 35 offset from the plane of the upper portion of the terminal and extending into frictional engagement with the disc portion 6 of the arm 5, the free ends of the leg portions 35 being curved to present a rounded surface against the disc portion 6.

As above-mentioned the wiper contact 2 and the arm 5 are made of the same kind of material and this material has about the same electrothermal characteristic as the material of the segmental contacts 1. The terminal 31 is also made of the same kind of material as the wiper contact 2 and the arm 5. Since the wiper contact 2, the arm 5 and the terminal 31 have curved and bent portions and cannot well be formed from hard-drawn copper and since the parts make frictional contact with other parts some material having like electrothermal characteristics to that of hard-drawn copper but being more readily workable is desirable. We have found that beryllium copper has about the same electrothermal characteristics as hard-drawn copper, and that it may be annealed and worked to required shape and given a smooth surface and then hardened to provide a substantially hard smooth surfaced contact. The parts such as the wiper contact 2, the arm 5 and the terminal 31 requiring bending to form them into the required shapes may therefore be readily made of beryllium copper. These parts may then be hardened as required. When the segmental contacts 1 are made of hard-drawn copper and the wiper contact 2, the arm 5 and the terminal 31 are made of beryllium copper and the beryllium copper parts are hardened, there is comparatively little wearing of the parts in service. The contact making parts throughout also possess about the same electrothermal characteristics as each other, the generation of thermo-electromotive forces between the parts, therefore, is reduced to such a low point as to be negligible. The switching device, therefore, is in effect comparatively non-microphonic and is suitable for use in connection with sound translating apparatus and will give long service.

Connected to the segmental contacts 1 are resistance devices 36. The resistance devices 36 comprise suitable lengths of resistance wire or other like non-microphonic resistance material. The resistance devices 36 are connected by means of comparatively stiff conductor wires 37 to predetermined segmental contacts 1 which are slotted at 38 to receive the wires 37. With this arrangement the resistance devices 36 are supported by means of the conductor wires 37 in their required positions relative to the segmental contacts 1 and require no other means of support. The resistance devices 36 may be connected in series and arranged as shown in Fig. 5 or in any other desired manner, and connected to the segmental contacts 1 by means of the conductor wires 37.

A cup-shaped cover 39 is applied over the switching parts and resistance devices above described. The open end of the cover 39 fits over the side walls of the cup-shaped member 19 and frictionally engages the outer surface of the side wall. An open ended slot 40 is provided in the open end portion of the cover 39 to accommodate the upper end portion of the arm 27 when the cover 39 is being applied or removed. When the cover 39 is applied the side edge portions defining the slot 40 pass under the rectangular strip 22 of insulating material and are overlapped thereby since the slot 40 is narrower than the strip 22 and the strip 22 is elevated by means of the spacer 24 a sufficient distance to permit passage of the wall of the cover under the strip 22.

What is claimed is:

1. In a switching device, in combination, a ring of spaced segmental contacts, a support for said contacts, an arm movable relative to said ring of contacts, a support for said arm, a fingered wiper contact supported on said arm and slightly bowed into tangential engaging position relative to said segmental contacts and having only a central portion presented into engaging position relative to said segmental contacts and said segmental contacts, said arm and said wiper contact being made of metal of the same general kind to minimize the development of electro-thermocouple effects in the parts.

2. In a switching device, in combination, a ring of spaced segmental contacts of hard-drawn copper, a support for said contacts, an arm of beryllium copper movable relative to said ring of contacts, a support for said arm, a fingered wiper contact of beryllium copper supported on said arm and having finger portions slightly bowed into tangential frictional spring pressed engagement with said ring of contacts and so that only the central portion of the wiper contact is in engaging position relative to said segmental contacts, a terminal of beryllium copper and curved leg portions on said terminal bowed in long radius curved formation into spring pressed frictional engagement with said arm and having the long radius curved portion in engagement with said arm.

3. In an electrical switching device, in combination, a cup member, a tubular bearing extending through the diametrical center of said cup member and supported in said cup member, a ring of insulating material supported on said bearing, spaced segmental contacts supported in ring formation on said ring, a rotatable shaft journaled in said bearing and having a portion projecting beyond said bearing, an V-shaped arm supported on said shaft and extending in spaced relation over said segmental contacts, a wiper contact supported on said arm and extending tangentially of and into engaging position relative to said segmental contacts, an insulating support supported on said cup member and ex-

tending in spaced parallel relation with said bearing and then downwardly to meet said bearing, the portion meeting said bearing being apertured to receive said bearing and serving as a support for one end of said bearing, a bifurcated terminal supported on said insulating support and relatively long radius curved leg portions on said terminal in frictional engagement with said arm and said segmental contacts, said wiper contact, said arm and said terminal being all made of metal of the same general kind.

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