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The present invention relates to telephone transmitters, serving for the conversion of sound into electrical current variations, in particular to those of the carbon granule type.

Transmitters or microphones which depend upon a variation in the resistance of their carbon granular charge for their operation are prone to "fry" when the voltage between granules and/or between the granules and their co-operating electrodes exceeds a certain value. There are three factors which can give rise to this phenomenon, namely the voltage impressed on the transmitter the resistance of the granular charge, and the expansion of the parts which form part of the transmitter due to heat generated by the passage of current through the transmitter.

The voltage impressed upon the transmitter is, in many instances, predetermined by the fact that the type of circuit in which it is to be used already exists, consequently no compensation can be made in this direction for a transmitter suitable for universal use except by varying the resistance of the transmitter to meet the requirements. The granular charge and the contacting electrodes being responsible for the transmitter resistance, a variation in resistance can only be obtained by changing the characteristics of these two items, and obviously, as the object is to lower the voltage across the transmitter, the resistance of the carbon granule must therefore be lowered. It is apparent, however, that the output of a transmitter, which determines its efficiency, depends upon the voltage change between the terminals of the transmitter consequent upon the stimulus of speech waves on the diaphragm and the ratio of this voltage to the voltage applied to the speech circuit or, as it can be stated, the ratio of the resistance change of the transmitter to the resistance of the telephone line of which the transmitter forms part. It is, therefore, not advisable for reasons stated to lower the transmitter resistance below a certain level.

Accordingly transmitters should be designed so that the voltage across them when put into use is below the voltage at which frying occurs.

If owing to expansion effects in use the pressure of the granules on the transmitter electrodes decreases, the resistance between the electrodes may increase and the voltage between them exceed the voltage at which frying occurs.

Tests we have made on known transmitters show that although frying may not occur when the transmitter is in use for a very short conversation yet the resistance continually increases as the conversation endures and frying may occur.

The liability to frying is greater when the line circuit in which the transmitter is used is short i.e. its resistance is low and the greater flow of current implies firstly a greater voltage across the transmitter and secondly, by reason thereof, a greater development of heat.

It is the object of the present invention to provide means whereby the heat developed in the transmitter is used to cause certain expansions which tend to prevent a reduction of granule-electrode pressure by the normal expansion of the electrode parts.

The means of the present invention consist in a part or parts in contact with the granule mass and/or in contact with the casing immediately surrounding or containing the granule mass which part or parts under the influence of heat advance one electrode towards the other or both towards each other to tend to compress the granules in bulk.

The part or parts concerned may be of a bi-metallic nature, that is, made up of two metals having different co-efficients of expansion whereby a distortion of the part takes place under the influence of heat and the compensating action results. Again the part itself may be made of ordinary metal and of a shape which under the action of heat, changes, for instance, its shape, and brings about the desired electrode movement.

It may be remarked that the cone shaped diaphragm shown in the transmitter described in Canadian Specification No. 299,779 does provide some compensating action in that under the action of heat it moves the moving electrode inwardly to some extent but such compensation may not be sufficient and the combination therewith of the further diaphragm of cone shape hereinafter described by reason of the proximity of the same to the granules and the case enhances the effect and is more suitable as far as long conversations are concerned.

In using parts of bi-metallic nature the use may be that of a support for an electrode the effect of heat being to bow the support whereby the electrode may be advanced towards the other. In another arrangement the bi-metallic part may be in the form of a cup which constitutes the granule chamber or a part thereof. The side of the cup would be slit in several places and the bending inwardly of the tongues so formed when heated would cause compression of the granules and a lowering of the resistance between the electrodes. In a further arrangement the electrodes themselves are bi-metallic.

Whilst the means of the present invention are primarily intended to keep the inter-electrode resistance more or less constant despite expansion effects, it is also within the scope of the invention that the means should over compensate or under compensate.

The accompanying drawings show by way of example ways in which the invention may be carried out.

Fig. 1 shows a transmitter of the type described in Canadian Specification No. 299,779 but in which the "fixed" electrode is mounted on a bi-metallic disc.

Fig. 2 shows a transmitter similar to that of Fig. 1 but with a compensation diaphragm.

Fig. 3 shows a form of transmitter referred to in Canadian Specification No. 310,898 in which the invention is embodied.

Figs. 4 and 5 show a transmitter in which a bi-metallic cup is used as an enclosure for the carbon granules. Figs. 6 and 7 show the cup.

Referring to Fig. 1 the transmitter or capsule as it is often termed comprises a body portion 1, a main diaphragm 2 to which is attached a cup part 3. The part 3 is coated outside with insulating enamel and supports a carbon electrode 4. The diaphragm 2 is clamped to the body portion by a ring 5 the under edge of which is pressed over onto the under edge of the mouth of the body portion. The auxiliary silk diaphragm 6 is clamped to the ring 5 by a pressed-on perforated cap 7.

The "fixed" electrode 8 of carbon is seated in a holder part 9 the tail of which is screw threaded. The tail part passes through a hole in a bi-metallic disc 10.. This disc is insulated from the metal body 1 by an insulating washer 11 and is clamped onto the body by a cap 12 of insulating material having a central hole. The nut 13 serves to secure the holder 9 to the bi-metallic disc.

The bi-metallic disc consisting of two superposed plates of metal firmly fixed together ofmetals having different co-efficients of expansion such as copper and nickel, brass and steel etc is inserted so that on being heated it tends to assume an inverted bowl shape moving the electrode holder 9 towards the interior of the transmitter thus increasing the compression of the granules 14 between the two electrodes fixed and moving. The commercial material has been found quite satisfactory.

The granules are introduced into the granule chamber from the back of the capsule i.e. the underside in Fig. 1. Layers of silk rings 15 form a closure at the front of the granule chamber and are kept in position by a washer and spring ring.

Fig. 2 shows a transmitter capsule which as regards its rear portion is similar to that shown in Fig. 1 and like parts are designated by the same reference numbers.

However in the capsule of Fig. 2 a metal diaphragm 16 which is similar in shape to the main diaphragm 2 but inserted in a reverse direction is provided.

The diaphragm 16 is secured in a recess in the body 1 by a screwed ring 17. The holder or cup 3 for the electrode 4 is conically shaped.

The effect of heat developed in the granules appears to have the following effect. Owing to the close proximity of the diaphragm 16 to the granules and the contact of the apex of diaphragm 2 therewith expansion occur first in the central parts of the diaphragms and these being coned in opposite directions the effect of their respective expansions on the moving electrode practically neutralises each other.

The body 1 of the capsule heats up more slowly owing to its greater mass and its expansion would give rise to a decrease in the pressure between the granules.

Although the heating of the diaphragm 16 alone would cause its apex to rise and decrease the pressure on the granules, the expansion of that part of the body 1 adjacent to the granules to which the edge of diaphragm 16 is attached causes a change of shape of the diaphragm by which the apex of the diaphragm is lowered and the pressure tends to be restored. The part of the body 1 where diaphragm 2 is clamped heats up by conduction but to a lesser extent than that part adjacent to the granules. The central part is also heated as before explained. On the whole the predominant effect as heating continues is the outward movement of the rim of diaphragm 16 and the consequent inward movement of the electrode 4, whereby pressure on the granules is changed in a sense opposite to the reduction of pressure due to expansion of body 1.

The electrode 8 is also moved inwardly towards the other electrode due to the distortion of the bi-metal disc 10.

Fig. 3 shows a transmitter of the type described in Canadian Specification No. 310898 in which the electrode termed the fixed electrode is bi-metal annulus.

In the transmitter depicted the "diaphragm" consists of two disc parts 18 of thin light material positioned in a central boss 19 and clamped at their outer edges to a flexible ring 20, which ring itself is clamped to the holder 21 by a ring 22 which presses a stiffened edge of ring 20 against the holder 21.

A protective cap is indicated at 23.

The holder 21 itself is screwed into a fitting 24 more or less of inverted cup shape there being apertures 25 in the side of the cup.

In the tubular stalk of holder 21 is a casing 26 which is fixed in position by set screw 27. This casing is closed at the lower end by a mica disc 28 which is clamped to casing 26 by ring 29. The disc 28 carries the moving electrode 30. The electrode rests on a felt washer 31 The disc 28 and the moving electrode 30 together with the felt washer 31 are secured to the rod 46 by nuts 32 and nut 45. In turn the rod 46 being threaded at both ends is secured to the insulating boss 19 by nuts. The boss 19 secures the two disc parts 18 together.

The fixed electrode 44 of bi-metallic material takes the shape of an annulus. The electrode 44 is so assembled that on heat being applied to it it tends to assume a bowl shape so that the inner circle of the annulus moves towards the moving electrode 30. It is suitably gold covered by electrolytic deposition or sputtering. The electrode 44 is secured in the casing 26 by the threaded nut 47 on top of which is a mica washer 33 a felt washer 48 and a threaded nut 39 which effects the closure of the granule chamber.

The compensation for expansion of parts due to heat being generated by the passage of current through the carbon granule is obtained by predetermining the movement of the fixed electrode 44 so that it expands towards the moving electrode 30 and tends to increase the compression of the carbon granule. When further compensation is required the disc 28 is made from bi-metallic sheet of a thickness suitable for voice frequencies response. 1.5 mil sheet has been found satisfactory for this purpose. The ring 29 is then made from insulating material and a mica washer is interposed between the bi-metallic diaphragm or disc 28 and the casing 26 for insulating purposes.

With this arrangement further compensation is obtained by assembling the bi-metallic disc 28 so that on heating it assumes an inverted bowl shape, that is it bows towards the fixed electrode 44 and causes a greater compression of the carbon granule between them.

Referring now to Fig. 4 the transmitter depicted here is very like in construction to that shown in Fig. 1 and differences only will be pointed out.

The case 1 contains a bi-metal cup 34 which is slit in a manner which will be apparent from Figs 6 and 7.

The movable electrode 35 and the fixed electrode 36 are both bi-metal discs being placed in the holders so that when warmed up their middle portions tend to approach each other. The face of each electrode in contact with the granules is suitably gold covered.

The cup 34 is insulated by an insulating enamel and under the action of heat the tongues formed in the cup tend to turn inwardly whereby the granules are compressed.

An insulating washer 37 is placed at the bottom of the cup more effectively to insulate the holder of electrode 36 from the cup. The part indicated at 38 is an insulating collet whereby the stub 39 which holds the holder of electrode 36 in position is insulated from the body portion 1.

As the transmitter warms up in use the relief of pressure on the granules due to expansion of the case is counter-balanced by the approach of the middle portions of the electrodes and the bending inwards of the tongues in cup 34.

Fig. 5 shows a similar arrangement to that depicted in Fig. 4 the difference being that the cup 34 is lined with a flexible cup 40 of silk, the material known under the British registered trade mark "Cellophane", or other suitable insulating material in which case the cup need not be coated with insulating material.

It is possible to replace the bi-metal disc shown in several figures by ordinary metal disc or even mica discs which are initially bowed outwardly and as the granule chamber casing expands they would tend to flatten. They will not however be so effective as the bi-metal disc.

It is further open to use the arrangements before described to obtain under or over compensation of the resistance increase which would occur without employing the invention to suit the conditions under which the transmitter is employed.