Aug. 27, 1940. L. KÖRÖS ET AL 2,212,643

DISCHARGE TUBE FOR KEEPING VOLTAGES CONSTANT

Original Filed Aug. 22, 1936

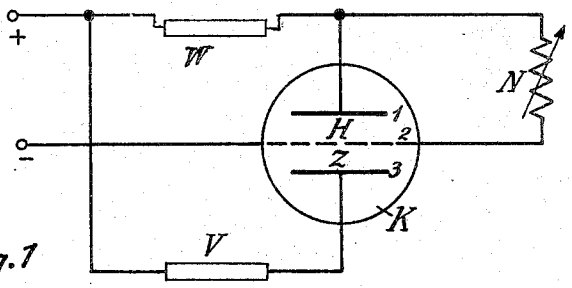


Fig.1

Fig.2

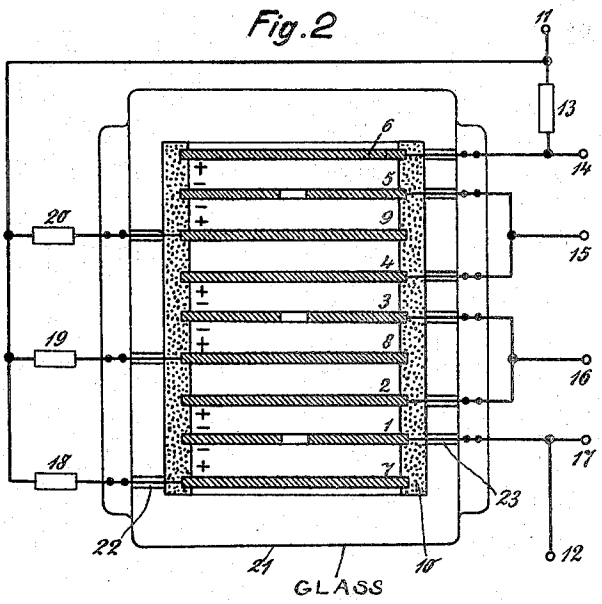


Fig.3

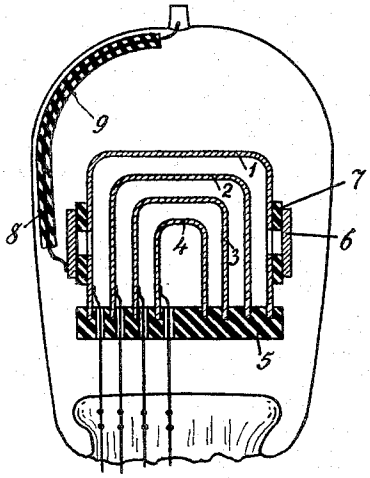


Fig.4

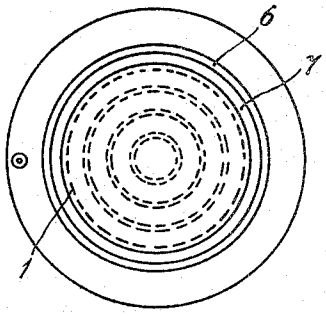
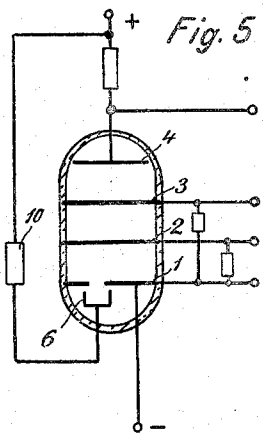


Fig.5



Inventors:
Ladislaus Körös
by Jan Friedrich Toennies
Otto Munk
their Attorney

Patented Aug. 27, 1940 2,212,643

UNITED STATES PATENT OFFICE

2,212,643

DISCHARGE TUBE FOR KEEPING VOLTAGES CONSTANT

Ladislaus Körös, Berlin-Tempelhof, Germany, and Jan Friedrich Toennies, New York, N. Y., assignors to Stabilovolt G. m. b. H., Berlin, Germany, a company

Application August 22, 1936, Serial No. 97,332. Renewed June 1, 1939. In Germany August 26, 1935

2 Claims. (Cl. 250—27.5)

It is known to keep consumers' voltages constant by means of non-ohmic conductors, which are preferably connected in parallel with the consumers' terminals. Potentiometer arrangements are also known which consist of a plurality of series-connected non-ohmic conductors. As non-ohmic conductors, that is, conductors, the potential drop of which is practically constant independently of the passage of current, it is preferable to use glow discharge tubes. As is well known in the art, a "glow discharge tube" is a tube filled with a rarefied inert gas, electrodes being disposed inside the tube in spaced relation to one another. The electrodes thus form gaps between which a special discharge called "glow discharge" takes place when the electrodes are connected to an electric current source of suitable voltage. A special feature of "glow discharge tubes" is the fact that electric current flowing through such a tube does not behave in accordance with Ohm's law. "Glow discharge tubes" are thus "non-ohmic" resistances and it is a characteristic feature that their potential output is practically constant, irrespective of fluctuations in the in-put current within certain limits. A description of a "glow discharge tube" is contained for example in U. S. Patent No. 1,973,082 of Sept. 11, 1934, to L. Koros, one of the present co-inventors. When dimensioning such circuits employing discharge tubes, the starting conditions must be taken into account, that is, insofar as a load is connected in parallel with the non-ohmic conductor, the voltage conditions must, as is well-known, be so chosen that, in this case too, satisfactory starting of the glow discharge in the tube takes place. If such a load is absent, the conditions are simpler, since the static voltage of the current source is then available for the starting operation. In practice, about 50 volts excess voltage in comparison with the operating voltage required to maintain the glow discharge in the tube is generally necessary for starting. This fact often leads to inconvenience in the practical design of the necessary circuit arrangements and the invention has for its object to provide an arrangement for which a lower excess starting voltage is sufficient.

The invention solves the existing problem by incorporating in the discharge tube an additional path which supplies electrons or ions to the space of the path of the glow discharge to be started. The constructional design of this arrangement is preferably realised by giving the intermediate electrode between the auxiliary path according to the invention and the main discharge path a perforated form.

Arrangements for carrying out the invention are shown by way of example in the accompanying drawing in which

Fig. 1 illustrates diagrammatically an arrangement in simple form,

Fig. 2 illustrates a more complex arrangement in which several main discharge paths are incorporated in a common envelope,

Fig. 3 represents a vertical section through one constructional form of a glow discharge tube potentiometer device according to the invention,

Fig. 4 represents a plan view of the tube of Fig. 3, and

Fig. 5 is a circuit diagram of a circuit arrangement embodying the tube of Fig. 3, by way of example.

Fig. 1 illustrates the principle of the invention in an arrangement which employs only one discharge path for keeping voltages constant. The invention, however, can equally be employed in arrangements where several discharge paths cooperate in a manner well-known per se for keeping voltages constant. Such arrangements are illustrated in Figs. 2 to 5.

In the arrangement according to Fig. 1, three electrodes 1, 2 and 3 are contained in a glass envelope K. The main discharge space H is formed by the electrodes 1 and 2. The useful load, which is connected in parallel with the main discharge space H, is denoted by N. It is only symbolically illustrated in the figure. The supply of the feeding voltage is effected in well-known manner through a resistance W. The circuit so far described corresponds to that which is well-known. The electrode 2 is perforated for the purposes of the present invention, as indicated diagrammatically in the figure. The envelope K contains a third electrode 3, by which a discharge path Z is produced between the electrodes 2 and 3. The electrode 3 is connected to the positive side of the supply voltage through a series resistance V. The starting path Z is not loaded by a consumer. If the supply voltage is connected to the arrangement, the static voltage exists at the electrode 3 and the starting operation is immediately initiated between the electrodes 2 and 3. The static voltage does not exist at the path H, as the useful resistance N is connected in parallel and a current immediately commences to flow through N on insertion, that is, the necessary voltage required for starting does not exist at the discharge path H. In the arrangement according to the invention

however, the discharge between the electrodes 2 and 3 is imparted to the main discharge space H through the perforations of the electrode 2 and effective starting is initiated.

In an experimental arrangement, in which the discharge path H was dimensioned for an operating voltage of about 70 volts and a current passage of 100 mA. and which normally requires an excess voltage, starting could be obtained by means of an auxiliary discharge path Z, the current passage through which amounted to 0.01 to 0.2 mA. at an excess voltage of about 0.2 volt, that is, only one hundredth of the previous amount. As will be seen from this numerical example, the current loss owing to the auxiliary path is insignificant, but the gain owing to the decreased expenditure is very considerable, since, in the hitherto known arrangements mentioned above, either the glow discharge path had to be given very ample dimensions or the useful load first had to be disconnected by means of a relay circuit and this useful load could only be inserted after starting, both constituting measures which involved additional material or apparatus, with consequent increased costs.

As has already been stated, the invention may be, and preferably is applied to glow discharge potentiometers with series-connected discharge paths, which are incorporated in a common envelope. In the arrangement illustrated in Fig. 2, a plurality of main discharge paths is provided in a common envelope, there being allotted to each main discharge path an auxiliary path, by which electrons or ions are supplied to the main discharge path. Of course, it is not necessary to allot an auxiliary path to each of the main discharge paths. The arrangement illustrated in Fig. 2 has the advantage that certain starting is obtained. The electrodes are constructed in disc form. However, the electrodes may also have cylindrical, hemispherical or other shape for the purpose of increasing the surface area.

The electrodes by which the main discharge paths are formed are denoted by the reference numbers 1–6 in Fig. 2. The electrodes 7–9 are auxiliary electrodes for producing the auxiliary discharge. The electrodes are supported by an insulator system 10, which comprises, for instance, individual rings connected together. In the figure, the supply leads connected to the main electrodes are led out to the right and the supply leads connected to the auxiliary electrodes to the left. The supply voltage is connected at the terminals 11 and 12. As can be seen from the figure, the electrodes 5, 4 and 2, 3 respectively are electrically connected together, so that a potentiometer comprising three series-connected glow discharge paths is formed. The potentiometer thus formed from the main discharge paths is connected through the series resistance 13 to the supply voltages. The three consumers' voltages are derived at the terminals 14–17. The starting electrodes are connected, for instance, through series resistances 18–20, to the positive terminal 11 of the supply voltage. The whole potentiometer is surrounded by an envelope 21 (glass, metal or the like). The supply leads are protected within the envelope by insulating sleeves 22.

As can be seen from Fig. 2, the electrodes 1, 3 and 5 belonging to the main discharge paths have apertures at the centre. However, a plurality of perforations may also be provided. Only the immediate surroundings of the perforation are decisive for the development of the discharge. Therefore, it is possible to fill the space between the auxiliary electrodes and the respective perforated electrodes largely with insulating material and to allow the discharge to arise only in the immediate surroundings of the apertures.

It is sometimes important to take care in manufacture that the discharge does not arise between the electrodes of the auxiliary ionisation chamber and the adjacent main electrodes (e. g., auxiliary electrode 9 and main electrode 4). This can be prevented by making the distance, e. g., between the auxiliary electrode 9 and the main electrode 4, greater than the distance between the electrodes forming a main discharge path, or by covering the auxiliary electrodes or main electrodes, or even both, on the particular sides which come into question with insulating material or, alternatively, in the case of activated tubes, by not activating the opposite surfaces at which starting is not to take place. Although any discharge at such surfaces does not in itself prevent the operation of the tube, the starting of the discharge in the ionisation paths themselves is to be prevented as much as possible from being endangered on the occurrence of such a discharge.

In the arrangement illustrated in Figs. 3 to 5, a potentiometer tube is shown in which electrons or ions are supplied to only one of the main discharge paths. It is particularly advantageous to employ such a potentiometer tube in circuits which serve for feeding amplifying arrangements. In such arrangements, for example, one discharge path is used for deriving the grid biases and the remaining paths are used for deriving the anode voltages. It is then particularly important to ensure satisfactory starting of the discharge path from which the grid voltages are derived.

The electrodes are denoted by the reference numbers 1 to 4, and are constructed in cap form, that is, the electrodes each consist substantially of a cylinder closed at one end. The open ends of the electrodes are closed by a plate 5 of insulating material. In the insulating material grooves are provided, in which the caps are seated. The discharge paths are formed in well-known manner between the electrodes 1, 2; 2, 3 and 3, 4 respectively. In a frequently employed potentiometer circuit, the electrode 4 is connected to the positive pole of a supply voltage through a suitable series resistance, while the electrode 1 is connected to the negative pole of the supply voltage source, as can also be seen from Fig. 5. The cylindrical surface of the cap 1 is circumferentially interrupted and is surrounded at this zone by an electrode 6, which, in turn, is insulated from the electrode 1 by interposed insulating material 7 but is supported by the electrode 1. It is not necessary to effect a circumferential interruption, but it is sufficient to provide the cap 1 at different points with apertures. The ring 6 may be connecter to a supply through the supply lead 8 which (as illustrated) is led out of the top of the potentiometer tube, but may be led out at any other suitable point. The lead 8 is preferably insulated by an insulating sleeve 9.

The circuit connections of the potentiometer tube illustrated in Figs. 3 and 4 will be seen from Fig. 5. By means of the electrode 1, 6, the auxiliary discharge path is formed, which supplies electrons or ions to the main discharge path 1, 2. The voltage necessary for producing the auxiliary discharge is derived in the same manner as in Fig. 1, from the positive pole of the supply volt-

age through a series resistance 10. The mode of operation is the same as described above with reference to Fig. 1. In the present case, the projection of ions and electrons from the auxiliary electrode into the space between the main electrodes, greatly facilitates the electric discharge between the main electrodes.

What we claim is:

1. A glow discharge potential divider, comprising a container, a plurality of electrodes disposed in said container parallel to one another and one behind the other, said electrodes forming a plurality of series interconnected glow discharge gaps, a current inlet terminal and a current outlet terminal connected to the first and last of said electrodes, the said last electrode being perforated, an auxiliary electrode for emitting electrons to the space of the path of the glow discharge and being spaced from said perforated electrode and disposed in said container for cooperation with the latter, whereby the starting of the glow discharge in said series interconnected discharge gaps is facilitated.

2. The device claimed in claim 1, in which the breakdown resistances between the said electrodes forming a plurality of glow discharge gaps and the said auxiliary electrode are of predetermined values in relation to the operating currents, whereby glow discharge is limited to the said glow discharge gaps aforementioned, while glow discharge is prevented between the said auxiliary electrode and any other electrode, and in which the said electrodes are cup-shaped structures nested within each other, the said perforated electrode being formed by the outer-most cup, and an insulating member surrounding each perforation of said perforated electrode being interposed between the latter and the said auxiliary electrode.

LADISLAUS KÖRÖS.
JAN FRIEDRICH TOENNIES.