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VARIABLE ELECTRIC IMPEDANCE

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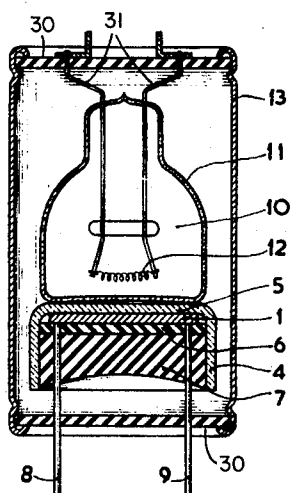


FIG. 1a

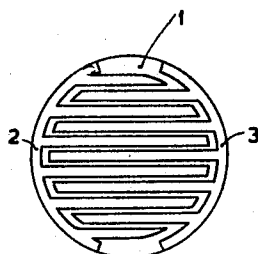


FIG. 2

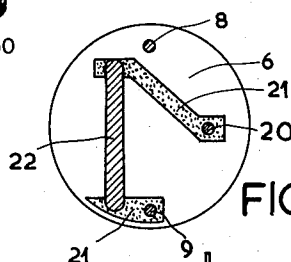


FIG. 1b

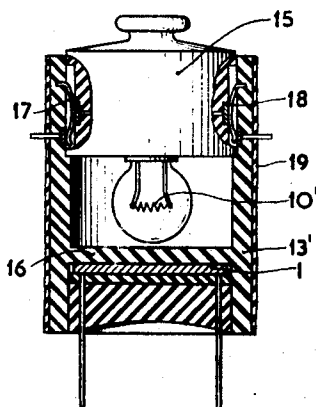


FIG. 3

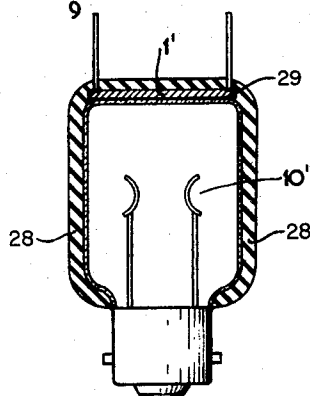


FIG. 4

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1

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VARIABLE ELECTRIC IMPEDANCE

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7 Claims. (Cl. 250—217)

This application is a continuation in part of application S.N. 718,322, filed Feb. 28, 1958.

This invention relates to variable electric impedances and more particularly variable resistances. Variable resistors are frequently used in electrical engineering and in their known type the resistance is regulated by mechanical means by sliding a contact along the resistor body. A known disadvantage of this design is inter alia that, due to contact phenomena on the sliding contact, more particularly in the end, so-called "crackling" or heavy noise occurs.

The invention has for its purpose inter alia to mitigate this disadvantage and it provides a particular type of such a device which is fundamentally different and the impedance of which may be regulated electrically in a simple manner.

A variable electric impedance according to the invention comprises a structural combination of a radiation-sensitive body on which at least two electrodes determining the impedance are provided and an adjustable source of radiation for regulating the impedance. The source of radiation and the radiation-sensitive body are preferably united by a common envelope to form a structural unit. If necessary, the common envelope may also serve as a protection against unwanted external radiation which influences the radiation-sensitive body in an interfering manner. In addition, the radiation-sensitive body and the source of radiation preferably each have a separate envelope and both these envelopes are united into a structural unit. The manufacture of such a device is thus considerably simplified and this embodiment also has the advantage that the two systems cannot influence each other chemically.

In one particular embodiment according to the invention, the envelope of the radiation-sensitive body also serves as a support for the envelope of the source of radiation. The two envelopes in this case consist, at least in part, of material permeable to radiation. The source of radiation comprises, for example, an ordinary small incandescent lamp (filament and glass bulb) or a small gaseous discharge tube, for example a neon lamp. By regulating the current and/or voltage through the source of radiation, the intensity of the radiation and hence the impedance between the two electrodes on the semiconductive body is varied. The radiation-sensitive body comprises, for example, a photo-resistance, preferably a thin sintered symmetrically-conductive cadmium-sulphide disc provided with an interdigital system of line electrodes. As an alternative, the radiation-sensitive body may be, for example, a photo-sensitive blocking-layer system, such as a photo-diode or a photo-transistor, or a photo-electric cell having an internal blocking layer (p-n transition).

It is to be noted that it was known to utilise a radiation-sensitive body in conjunction with a source of radiation, for example in guard installations, the variation in impedance between the electrodes of the radiation-sensitive body which occurs when the radiation path between

2

the radiation-sensitive body and the source of radiation is interrupted being used as the alarm signal. However, in this case, the source of radiation and the radiation-sensitive body are used as elements structurally separated.

- 5 The particular possibilities concealed in such a combination as a variable electric impedance, more particularly as variable electric resistance, are accentuated by the step according to the invention and also a large-scale use is made possible in a simple and, in practice, serviceable and efficacious manner.

- 10 In order that the invention may be readily carried into effect, several embodiments will now be described in detail, by way of example, with reference to the accompanying drawings, in which:

- 15 Fig. 1a is a longitudinal section of one particular embodiment of the device according to the invention;

Fig. 1b is a bottom view of the hardpaper plate 6 of a modification of a device according to the invention;

- 20 Fig. 2 is a plan view of the radiation-sensitive body used in the device of Fig. 1;

Figures 3 and 4 are sectional views of further embodiments of devices according to the invention.

- 25 The embodiment of a variable electric impedance according to the invention shown in Fig. 1 is particularly suitable and simple in structure. At right angles to the plane of drawing, the assembly is substantially circular-symmetric. The radiation-sensitive body 1 comprises

- 30 a thin disc of sintered cadmium-sulphide powder activated with copper and gallium. On its upper side, the disc is provided with an interdigital system of line electrodes comprising two comb-like electrodes 2 and 3, as shown in detail in Fig. 2. Within the scope of the invention, it is naturally also possible to provide more than

- 35 two electrodes on the disc, for example by dividing one comb-like electrode into two or more separate parts. The cadmium-sulphide disc has a diameter of, for example, about 8 mms. and a thickness of about 0.5 mm. The line electrodes consist, for example, of aluminum provided by evaporation, the distance between the electrodes being, for example, several tenths of a millimetre.

- 40 The resistance between the electrodes, without illumination or with weak illumination only is, for example, 10 megohms, whereas the resistance may have decreased to less than 500 ohms with strong illumination, for example 15,000 luxes. It will be evident that much variation in said values is possible by suitable choice of the radiation-sensitive substance and the activation thereof.

- 45 The radiation-sensitive body 1 is housed in a separate box-like glass envelope 4, and this preferably directly under its flat upper side 5. In order to provide good protection of the radiation-sensitive layer 1 against moisture and the like and to ensure good mechanical rigidity of the assembly, the radiation-sensitive body 1 is glued on

- 50 a thin plate 6 of hardpaper, the lower side of the envelope being properly sealed by filling the remaining space 7 with cast resin. Supply leads 8 and 9 are connected to the comb-like electrodes 2 and 3, for example, with the aid of a silver paste. The variable source of radiation 10

- 55 comprises an ordinary small incandescent lamp (6.3 volts; 0.1 amp.), the glass bulb 11 of which is locally glued in position on the flat upper side of the envelope 4 for the radiation-sensitive body 1. At the area of the junction between the two envelopes, the bulb 11 has a substantially flat surface. This considerably simplifies the assembly and results in a considerable increase in radiation intensity because of the resultant smaller distance between the filament 12 and the radiation-sensitive body 1. Due to

- 60 their junction, the two envelopes are united into a structural assembly, the envelope for the radiation-sensitive body also serving as a support for the envelope of the source of radiation. The assembly is also housed in a small aluminum tube 13 impermeable to radiation, the

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3

upper and lower sides of which are closed 30 by means of a suitable insulating material, for example hardpaper. Protection against interfering radiation from without may alternatively be provided by covering the assembly with an opaque lacquer layer instead of using the common envelope. The supply leads 31 of the incandescent lamp are led to the exterior at the upper side and the supply leads 8 and 9 at the lower side. The intensity of radiation and hence also the resistance between the two electrodes 8 and 9 may be varied over a large range by regulating the current and/or voltage through the filament 12.

In certain cases in which, instead of a gradual variation in resistance throughout the range, a more abrupt transition is desired, then according to a further aspect of the invention it is possible to use with much advantage a small gaseous discharge tube instead of an incandescent lamp in structurally the same manner, which gaseous discharge tube is not ignited until at a given threshold voltage, so that the resistance of the radiation-sensitive body is suddenly decreased drastically and may, if desired, be regulated back a little further above the threshold voltage. For this purpose, use may be made, for example, of neon tubes, which are commercially sold.

Fig. 3 shows a longitudinal section of another embodiment of the device according to the invention, in which the source of radiation may be replaced, if desired. For this purpose, the source of radiation 10' is secured in a fitting 15, which is detachably arranged in an envelope 13' common to the source of radiation 10' and the photo-conductive layer 1. The common envelope 13' consists of plastic material, which is transparent, and has a partition 16. The radiation-sensitive body 1 is housed in the space under the partition 16, without using a separate envelope, in the same manner as shown in Fig. 1. The fitting 15 may be slid out of the upper space of envelope 13' and is kept in position by means of two resilient strips 17, 18 which engage in two grooves of the fitting. The strips 17, 18 also serve as supply conductors for the source of radiation. The envelope 13' is externally provided with an opaque layer 19.

It has been found in practice that the possibility of replacement of the incandescent lamp is not absolutely necessary and that variable resistances as shown in Fig. 1 may be manufactured with a very long life by using a source of radiation having a long life per se, for example because of the comparatively low temperature of its filament, and also by subjecting the source of radiation to a load lower than normal.

Fig. 4 shows again another embodiment of a variable resistance according to the invention. In this case, the source of radiation comprises a small gaseous discharge tube, that is to say a neon tube 10''. An interdigital system 29 of line electrodes is first provided on the upper side of the bulb and on top of the electrode system there is sprayed a photo-sensitive layer 1', which consists of a mixture of organic binder and CdS-powder. The assembly is surrounded by an opaque lacquer layer 28.

It will be readily evident that for an expert it is possible to apply numerous structural modifications in this variable impedance within the scope of the invention. Thus, for example, it is possible for the incandescent lamp in the construction shown in Fig. 1 to be secured at a side wall of the bulb to the envelope of the radiation-sensitive body instead of at its top. The common envelope may internally be provided, for example, with a highly reflecting layer. The bulb of the source of radiation may be shaped so, and internally be provided in part with a reflecting layer so, that the radiation is concentrated to the radiation-sensitive layer.

The variable impedance according to the invention is suitable for use in all kinds of circuits. In this case it is an advantage that the regulating circuit including the source of radiation may be galvanically separated from the circuit to be regulated which includes the radiation-sensitive body. Another advantage of a variable

4

resistance according to the invention is that, due to the inertia of the source of radiation, it is free from noise or crackling, even though the regulating members in the regulating circuit are not. Another advantage is the simple possibility of remote control which considerably simplifies its incorporation in equipment. The variable impedance may be arranged in the equipment at an area which is optimum electronically, whereas the members for regulating the circuit of the source of radiation may be arranged in the equipment at the area which is simplest in mechanical respect, if desired at a distance of many metres from the variable impedance according to the invention.

The variable impedance according to the invention is very suitable, for example, for use in so-called potentiometer circuits. For this purpose, a fixed resistor is included in the circuit in series with the radiation sensitive body, the total voltage being applied to this series-combination, while the partial voltage to be controlled is derived between the two electrodes of the radiation-sensitive body and the electric control signals are supplied to the source of radiation. For applications in which a fixed resistor is used in combination with the radiation-sensitive body, according to a further aspect of the invention, the resistor may be included in a simple manner in the structural unit comprising the source of radiation and the radiation-sensitive body, for example as indicated in Figure 1b. Such a device may be quite similar to the one shown in Figure 1a except the details shown in Figure 1b. In order to include the fixed resistor in the structure, the hard paper plate 6 has been provided at the bottomside, shown in plan view in Figure 1b, with a thin resistance layer 22 by a known technique with the aid of a carbon suspension, a third electrode 20 similar to electrodes 8 and 9 has been added, which is connected with the carbon layer 22 in the way indicated by means of a silver paste layer 21, while the other end of the carbon layer 22 has been connected with the electrode 9 also by means of a thin silver paste layer 21.

In conclusion, a particular effect is mentioned which may be obtained with a variable impedance according to the invention, the source of radiation of which comprises a small incandescent lamp and the radiation-sensitive body of which comprises a photo-resistance of cadmium sulphide, more particularly sintered cadmium sulphide, activated with Cu and Ga, each about 10^{-4} gram-atom per gram-molecule of CdS. For this purpose, the device is included in a circuit, a linearly-variable resistance being included in series with the filament of the incandescent lamp. It has been found that the impedance of the photo-resistance as a function of the angle of rotation of the linearly-variable resistance connected in series with the lamp shows a logarithmic course. Such a combination according to the invention thus permits of obtaining a logarithmic-variable resistance in a simple manner.

What is claimed is:

1. A variable-impedance electrical device comprising an electrical lamp including an envelope and a filament whose voltage determines its output light intensity, a hollow, optically-transparent body secured to the lamp envelope, a support member, a photo-conductive member mounted on the support, a thin fixed-resistance member mounted on the support and connected to the photo-conductive member, said support being mounted within the hollow body with the photo-conductive member oriented to receive directly the light radiated by said lamp, an opaque element surrounding the lamp envelope and hollow member, and a pair of electrodes coupled to spaced points of the photo-conductive member.

2. As a new variable-impedance circuit component, the combination comprising an electrical lamp including an envelope and a filament whose voltage determines its output light intensity, a hollow, optically-transparent body secured to the lamp envelope, a symmetrically-conductive, photo-conductive member mounted within

5

the hollow body to receive directly the light radiated by said lamp, an opaque element surrounding the lamp envelope and hollow member, an interdigital system of line electrodes coupled to spaced points of the photo-conductive member, and external terminals on the component connected to the lamp filament and the line electrodes.

3. A component as set forth in claim 2 wherein the photo-conductive member comprises a sintered layer of cadmium sulphide.

4. A component as set forth in claim 2 wherein the hollow member supports the lamp envelope.

5. As a new variable-impedance circuit component, the combination comprising an opaque housing, a hollow glass body within the housing, a layer of photo-conductive material on the inside surface of a wall portion of the hollow glass body, an electrical lamp within the housing and comprising a glass envelope secured to the outside surface of said wall portion of the hollow glass body and opposed to the photo-conductive layer and electrode means within the lamp envelope for generating radiation in response to an exciting voltage applied to the electrode means, a pair of electrodes coupled to spaced points of the photo-conductive layer, and separate external terminals on the component internally connected to the lamp electrodes and the electrodes coupled to the photo-conductive layer.

6

6. A circuit component as claimed in claim 5 wherein the said wall portion of the hollow glass body is flat, and the lamp envelope has a flattened portion joined thereto.

7. As a new variable-impedance circuit component, the combination comprising an electrical lamp including an envelope and a filament whose voltage determines its output light intensity, a hollow, optically-transparent body secured to the lamp envelope, a symmetrically-conductive, photo-conductive member mounted within the hollow body to receive directly the light radiated by said lamp, an opaque element surrounding the lamp envelope and hollow member, a pair of electrodes coupled to spaced points of the photo-conductive member, and external terminals on the component connected to the lamp filament and the pair of electrodes.

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