Aug. 27, 1963 N. A. DE GIER 3,102,227

ARRANGEMENT FOR DERIVING AN ADJUSTABLE PARTIAL VOLTAGE FROM AN ELECTRIC SIGNAL VOLTAGE

Filed Feb. 28, 1958 2 Sheets-Sheet 1

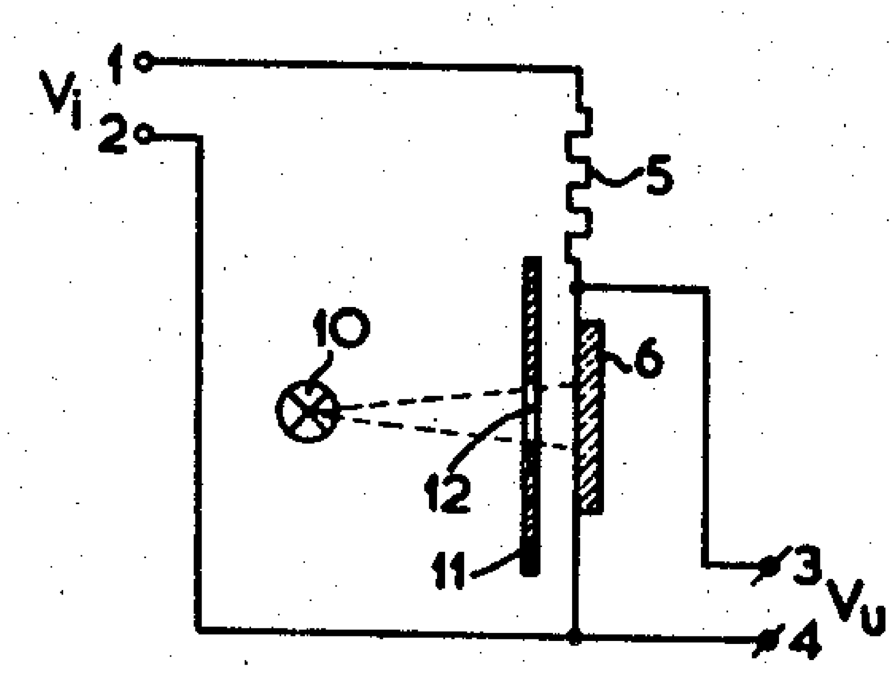

FIG.1

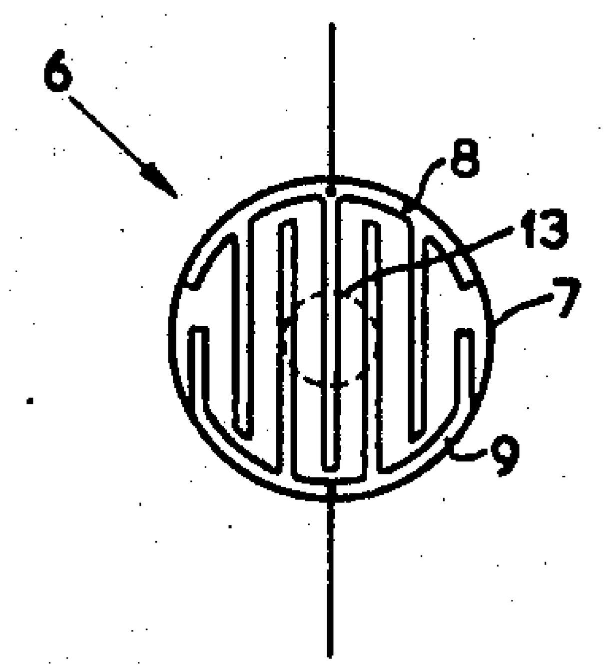

FIG.2

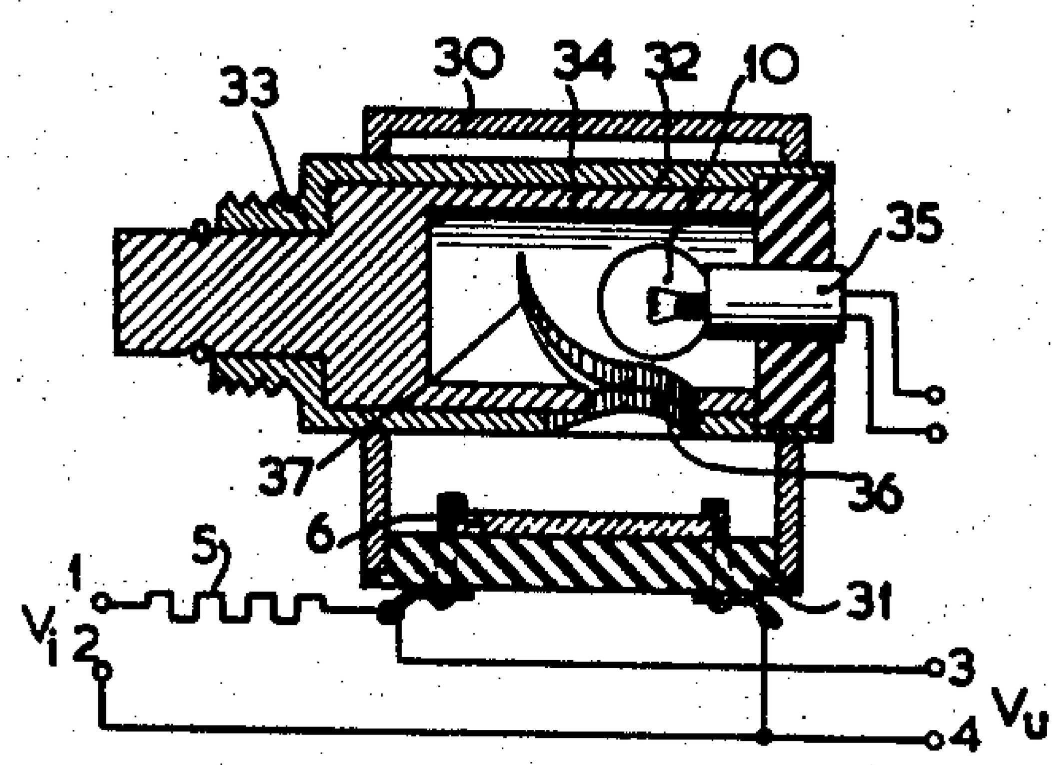

FIG.3

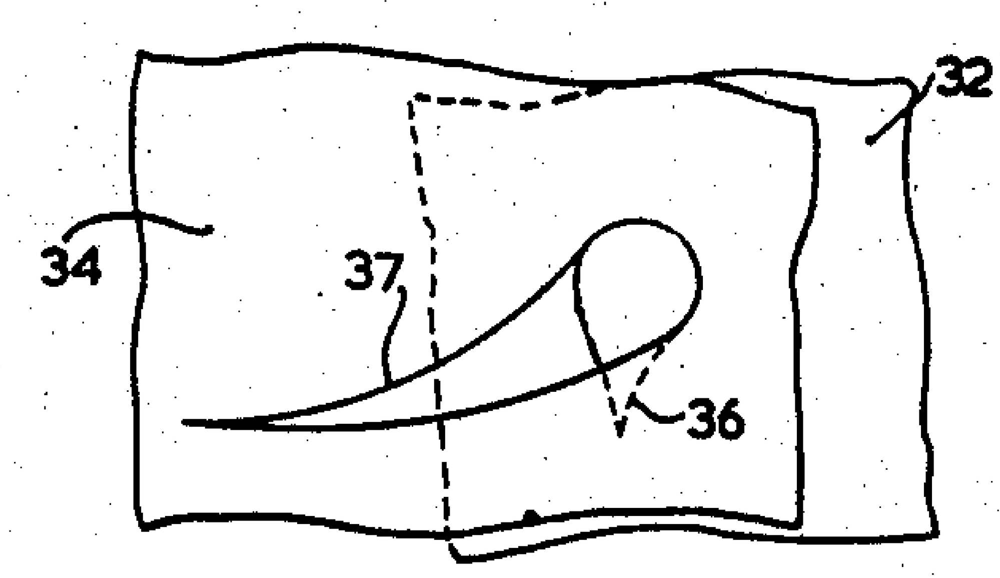

FIG.4

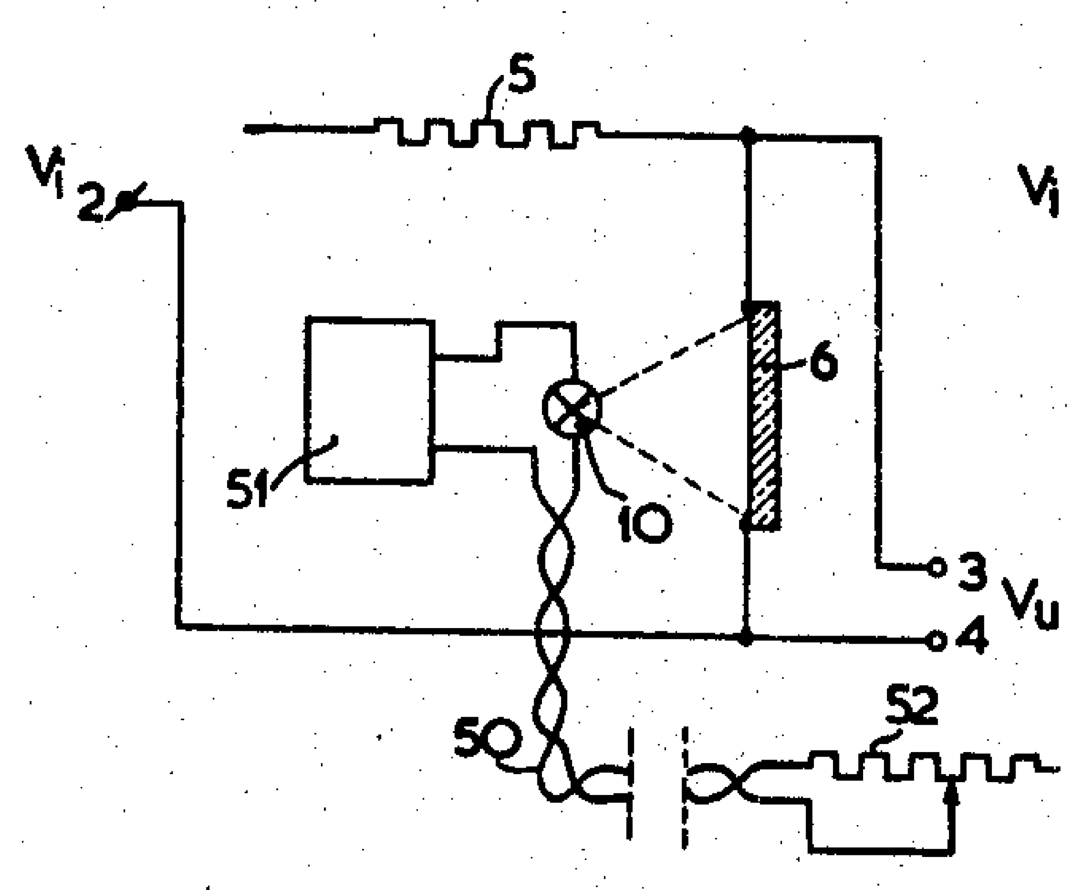

FIG.5

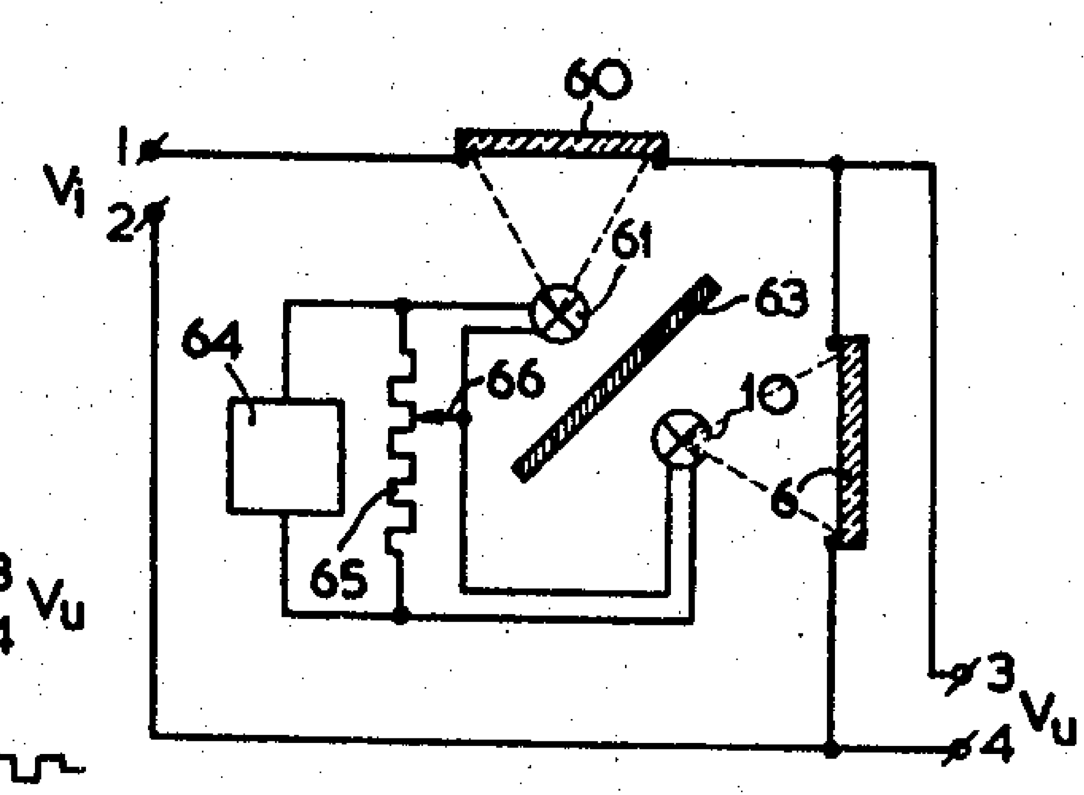

FIG.6

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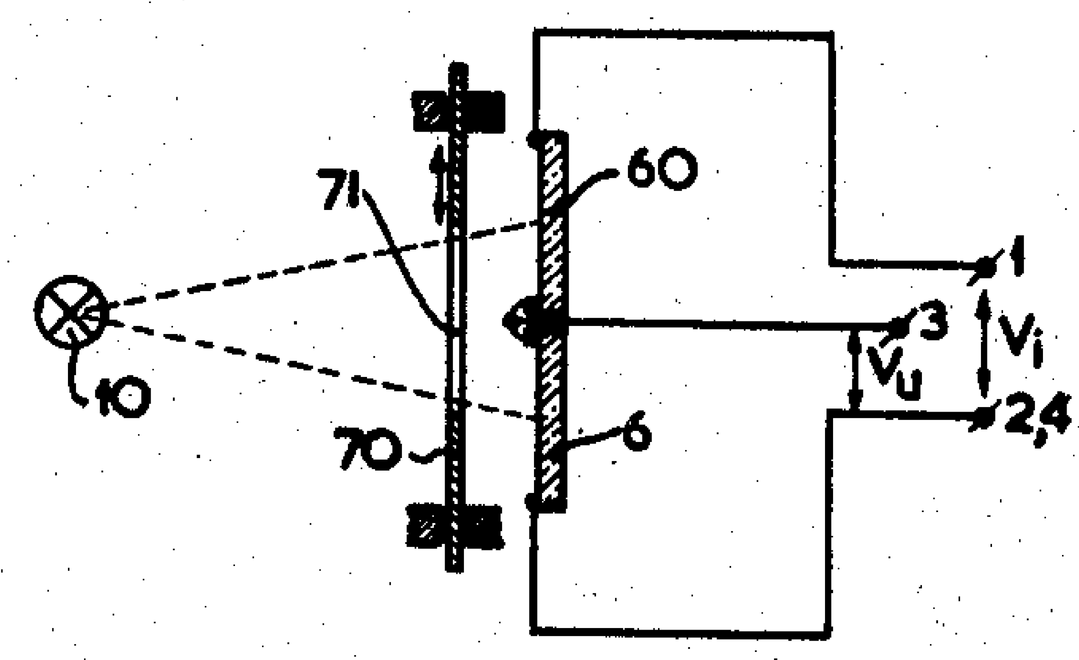

FIG.7

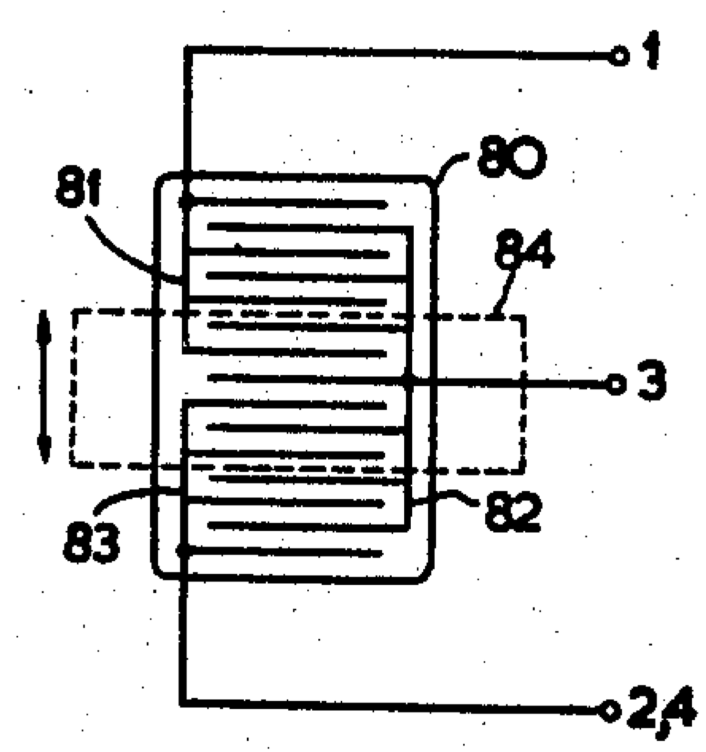

FIG.8

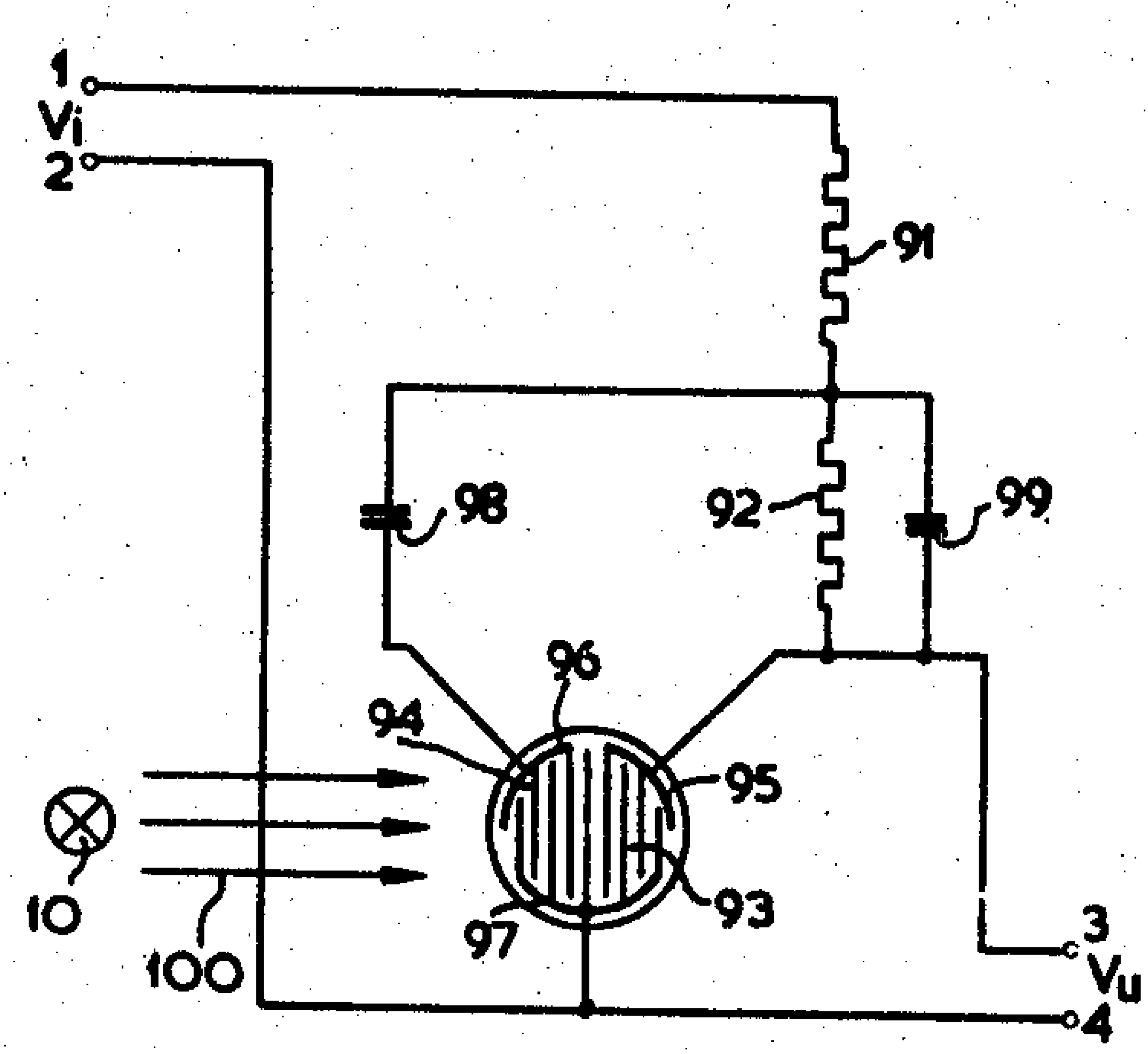

FIG.9

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3,102,227

Patented Aug. 27, 1963

3,102,227

ARRANGEMENT FOR DERIVING AN ADJUSTABLE PARTIAL VOLTAGE FROM AN ELECTRIC SIGNAL VOLTAGE

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Filed Feb. 28, 1958, Ser. No. 718,322
Claims priority, application Netherlands Mar. 9, 1957
15 Claims. (Cl. 323—64)

This invention relates to an arrangement for deriving an adjustable partial voltage from an electric signal voltage supplied to the arrangement, which signal voltage is supplied to a series combination of at least two impedances, the partial voltage being taken from a part of this series combination.

Such arrangements are frequently used in electrical and electronic apparatus, for example, radio receivers, amplifiers and measuring apparatus, in which an adjustable part of a given signal voltage must be transmitted. A well known use is the gain control in low-frequency amplifiers. To this end, use is generally made of a so-called resistance potentiometer comprising an electric resistance which is provided on an insulating support and may take the form of a carbon layer or of a resistance wire wound on the support, over which an electrical contact supported from a movable member can be adjustably displaced. Such potentiometers suffer from the disadvantage that they are liable to crackling, that is to say, the output signal taken from one end of the resistance path and the movable contact contains an electrical noise owing to contact phenomena.

It is an object of the present invention to provide an arrangement of the above-mentioned kind in which such contact noise is completely avoided.

An arrangement in accordance with the invention is characterized in that the series combination includes a photo-resistance which is associated with a light source, means being provided for adjustably varying the irradiation of the photo-resistance by the light. The adjustment of the required ratio between the partial voltage and the signal voltage supplied is obtained by optically varying the resistance of part of the series combination independently of the signal voltage. Consequently, all the junctions at which the applied signal voltage and/or the partial voltage is set up, are fixed and hence can be soldered.

In one embodiment of the arrangement in accordance with the invention, the adjustment of the irradiation of the photo-resistance is obtained by means of a member which is arranged in the path of the luminous flux from the light source to the photo-resistance so as to be displaceable at right angles thereto and which, according to its position, intercepts this luminous flux in a greater or lesser degree. This member may be designed in various manners. It may, for example, be an apertured mask or a transparent member of continuously variable density, for example a photographic neutral wedge filter, while use may also be made of a colour filter which at different points passes light of a different colour.

In another embodiment of the arrangement according to the invention, the variable irradiation of the photo-resistance is produced by means of an electric light source, means being provided for controlling the electrical energy supplied to the light source.

In another design of the arrangement according to the invention, the arrangement contains a second photo-resistance connected in series with the first photo-resistance. This second photo-resistance may be completely screened from irradiation so that it acts as a resistance of fixed value in the series combination. In another embodiment of this design, a light source is associated

with this second photoresistance also, means being provided for adjustably varying the irradiation of this second photo-resistance by the associated light source. Preferably, the means for adjusting the irradiation of the two photo-resistances are coupled to one another so that the variation in the irradiation of one photo-resistance is always opposite to the variation in the irradiation of the other photo-resistance.

It should be noted that an arrangement is known which contains two series-connected photo-resistances, the electrical voltage being supplied through one of the photo-resistances to the grid of a discharge tube the anode circuit of which includes a relay switch. This arrangement is intended for use as a supervisory system, the photo-resistances being exposed to incident radiation by a light beam of predetermined intensity. On variation of the light falling on the photo-resistances, the relay switch actuates an alarm system.

In contradistinction to the arrangement in accordance with the invention, in which the electrical voltage impressed upon the series combination including a photo-resistance is a signal voltage and consequently contains certain information to be transmitted, in the known arrangement the electrical voltage impressed upon the series combination is set to a constant value which is matched to the protective light beam. In the known arrangement, the light incident on the photo-resistances contains the information to be utilized.

In order that the invention may readily be carried out, a number of embodiments thereof will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

FIG. 1 shows a first embodiment, and

FIG. 2 is a front elevation of a photo-resistance used in the arrangement shown in FIG. 1.

FIG. 3 is a cross-sectional view of a second embodiment, and

FIG. 4 is a developed view of two cooperating masks used in this second embodiment.

FIG. 5 shows an embodiment which is highly suited to remote control.

FIGURES 6 and 7 show an embodiment in which the impedance of the series combination is substantially independent of the adjustment of the arrangement.

FIG. 8 is a front elevation of a multiple photoresistance which may be used in the arrangement shown in FIG. 7.

FIG. 9 shows an embodiment to be used for physiological gain control in low-frequency amplifiers.

In the figures, the input terminals of the arrangements are designated 1 and 2, the output terminals being designated 3 and 4. An electrical signal voltage V_i is applied to the input terminals 1 and 2. This voltage at each instant contains certain information which is to be transmitted by the arrangement so that it appears in a voltage V_u which is set up across the output terminals 3 and 4 and has a certain relationship with the input voltage V_i, which relationship is determined by the adjustment of the arrangement.

In the arrangement shown in FIGURES 1 and 2, the input voltage V_i is supplied to a series combination of a resistance 5 and a photo-resistance 6. This photo-resistance comprises a pressed disc 7 of photo-sensitive material, that is to say, material the electrical resistivity of which depends upon the incident radiation. On this disc, which may consist of copper-activated cadmium sulphide, provision is made of two comb-shaped interlaced electrodes 8 and 9. One of these electrodes, which may consist of silver or conductive stannic oxide, is directly connected to the resistance 5, the other being directly connected to the input terminal 2 and the output terminal 4.

An electrical light source 10, which may be a bicycle headlight lamp, is associated with the photo-resistance 6. An iris diaphragm 11 is interposed between the light source 10 and the surface of the photo-resistance 6 upon which the electrodes 8 and 9 are provided. Adjustment of this diaphragm by enlarging or diminishing a central aperture 12 enables the surface area of the portion 13 (FIG. 2) of the photo-resistance 6 which is exposed to radiation from the lamp 10 to be adjusted at will. When the aperture 12 is large, so that the entire photo-resistance 6 or at least the greater part thereof is irradiated, the electric resistance of this photo-resistance is low, while with a very small aperture 12 the electric resistance of the photo-resistance 6 is high. If this photo-resistance is a cadmium sulphide disc having a diameter of 8.5 mms., the electrodes 8 and 9 being spaced from one another by 0.2 mm., the resistance value of the photo-resistance 6 can be adjusted by means of the diaphragm 11 from about 5 megohms to about 0.5 kilo-ohm.

This means that, with a value of the resistance 5 of, for example, 0.5 MΩ the value of the output voltage V_u across terminals 3 and 4 can be varied roughly from nine tenths to one thousandth of the input voltage V_i.

Since there are no movable electrical contacts in the input and output voltage circuits, the occurrence of contact noise in the output voltage V_u is prevented.

In the figures referring to the embodiments described hereinafter, the component parts corresponding to those of FIG. 1 are designated by like reference numerals.

The arrangement illustrated in FIGURES 3 and 4 is distinguished from that shown in FIGURES 1 and 2 only by the design of the means by which the luminous flux emitted by the lamp 10 and received by the photo-resistance 6 is controlled. In a housing 30, which is closed at the bottom by a support 31 upon which the photo-resistance 6 is provided, there is secured parallel to this base a cylindrical sleeve 32 having a nipple 33, which sleeve at one end is provided with a lampholder 35 in which a lamp 10 is centrally mounted. A second cylindrical sleeve 34 is mounted for rotation about its axis in the sleeve 32 so as to surround the lamp 10.

Between the lamp 10 and the photo-resistance 6, the sleeve 32 is provided with a substantially tear-shaped aperture 36, the sleeve 34 having a comet-shaped aperture 37 in which the longitudinal direction is at an angle to that of the aperture 36. FIG. 4 is a developed view of the outer surfaces of the apertured cylinders formed by the sleeves 32 and 34. By rotating the sleeve 34 from the position in which the apertures 36 and 37 overlap one another to a maximum extent, the overlapping part which shifts towards the aperture tails can be gradually reduced. Thus, the angular position of the rotatable sleeve 34 with respect to the stationary sleeve 32 determines the luminous flux received by the photo-resistance 6. Consequently, the angular positioning of the sleeve 34 determines the ratio between the output voltage V_u and the input voltage V_i similarly to the adjustment of the diaphragm 11 in the arrangement shown in FIGURES 1 and 2.

The shape of the apertures 36 and 37 is chosen so that the resistance value of the photo-resistance 6 as a function of the angular position of the sleeve 34 has a substantially logarithmic variation. By a suitable choice of the shapes of the apertures 36 and 37, substantially any required form of the resistance curve of the photo-resistance can be achieved.

While in the arrangements described hereinbefore the resistance value of the photo-resistance connected in the series combination is determined by an aperture in a mask, which aperture determines the light beam incident on the photo-resistance, in the arrangement according to FIG. 5 it is not the size of the light beam, but the amount of light per unit of surface of the photo-resistance which is varied. Such can be obtained by the interposition between the lamp 10 and the photo-resistance 6 of a displaceable mask having a continuously variable density or constituting a variable colour filter. However, in the arrangement shown in FIG. 5 the luminous flux is controlled in a different manner, which is particularly suitable for remote control.

The arrangement shown in FIG. 5 is distinguished from those shown in FIGURES 1 to 4 by the absence of a separate movable member between the lamp 10 and the photo-resistance 6 and by the inclusion of a variable resistance 52 in a supply lead 50 through which the lamp 10 is supplied from a source 51.

The supply source 51 may be a supply transformer in a radio receiver or the like. The adjustment of the variable resistance 52, which may be a cheap wire resistance or carbon resistance, determines the luminous flux which strikes the photo-resistance 6 and hence the resistance value of this photo-resistance. This arrangement is particularly suited for remote gain control in sound reproducing and/or recording apparatus. The control resistance 52 can be connected to the apparatus incorporating the remainder of the arrangement by means of a two-conductor cord of substantially arbitrary length. The arrangement shown in FIG. 5 is of advantage also when the control resistance 52 is located in the apparatus itself. In a radio receiver, for example, the series combination of the resistance 5 and the photo-resistance 6 can be disposed in the immediate vicinity of the detector and the following first low-frequency amplifying stage, the control resistance 52 being mounted at a readily accessible point. This provides the advantage that the length of the conductors through which the low-frequency signal is transmitted can be kept to a minimum without detracting from the operability.

In the arrangement shown in FIG. 6, the resistance value of the photo-resistance 6 is also adjusted by controlling the electrical energy absorbed by the lamp 10. However, this arrangement is distinguished from the preceding by the fact that the fixed resistance 5 is replaced by a photo-resistance 60 with which is associated a second lamp 61 of the same kind as the lamp 10. A screen 63 prevents light from the lamp 10 from falling on the photo-resistance 60 and light from a lamp 61 from falling on the photo-resistance 6. The lamps 10 and 61 are series-connected to a transformer 64. In parallel with the two lamps 10 and 61 there is connected a potentiometer 65 of the usual kind, a movable contact 66 of which is electrically connected to the midpoint of the series combination of the two lamps. In the highest position (FIG. 6) of the contact 66, the lamp 61 is short-circuited while the lamp 10 has the full voltage of the transformer 64 applied to it. In the lowest position of the contact 66, this condition is reversed. When the adjustment of the contact 66 is changed, the resistance values of the photo-resistances 6 and 60 are changed in opposite senses. Thus, the output voltage V_u across the terminals 3 and 4 can be varied through a range extending from a very slight fraction of the input voltage V_i to substantially the entire input voltage.

A further advantage of the arrangement shown in FIG. 6 consists in that the impedance measured at the input terminals 1 and 2 is less dependent upon the adjustment than in the embodiments described hereinbefore. Similarly to the arrangement described with reference to FIG. 6 the arrangement shown in FIG. 7 includes two series-connected photo-resistances 6 and 60 the resistance values of which can be controlled in opposite senses. This control is effected by displacing a mask 70, which is provided with a rectangular aperture 71, parallel to the photo-resistances which are situated in the same plane behind the mask. The two photo-resistances 6 and 60 both co-operate with a lamp 10 which through the aperture 71 irradiates a portion of each of these photo-resistances which is determined by the position of the mask 70. The ratio of the surface areas of the exposed portion is determined by the position of the mask 70.

The two photo-resistances **6** and **60** of the arrangement shown in FIG. 7 may form an integral structure. FIG. 8 is a front elevation of such a structure. A photosensitive layer **80**, which is coated on a support which is not shown in the drawing, is provided with a number of parallel extending electrode lines which are interconnected so as to form three groups **81**, **82** and **83**. The lines of the group **81** and those of the group **83** are interlaced by lines of the group **82**. The lines of the group **81** are connected to the input terminal **1**, the lines of the group **82** are connected to the output terminal **3**, while the lines of the group **83** are connected to the input terminal **2** which is also the output terminal **4**. The part of the resistance structure which in the position of the mask **70** shown in FIG. 7 is exposed to light from the lamp **10**, is shown in FIG. 8 by a rectangle **84** shown in broken lines.

A multiple photo-resistance as shown in FIG. 8 can be used to replace the resistance **5** together with the photo-resistance **6** of the embodiments shown in FIGURES 1, 3 and 5. In this event, part of the photo-resistance, for example the part containing the electrode lines **81**, must be permanently screened from light from the lamp **10**, for example, by coating it with black lacquer.

In all the embodiments described hereinbefore, the output voltage V_u is taken from the photo-resistance **6** one end of which is directly connected to the input terminal **2**. It will be appreciated that a voltage produced across other points of the circuit arrangement may alternatively be used as the output voltage. Thus, the voltage across the terminals **1** and **3** can be taken as the output voltage.

The resistance **5** can be replaced by a reactance, for example a capacitor, or by a series combination of at least two impedances. In this latter case, the output voltage can be taken from one of these impedances.

FIG. 9 shows an arrangement in accordance with the invention which is intended for physiological gain control of audio-frequency electric signals.

The audio-frequency input voltage is supplied, through terminals **1** and **2**, to the series combination of a resistance **91**, a second resistance **92** and a photo-resistance **93** which forms an integral structure with a second photo-resistance **94**. The two photo-resistances have comb-shaped electrodes **95**, **96** and **97**, the latter being common to both photo-resistances. These electrodes are provided on a disc pressed from a photo-sensitive substance, for example copper-activated cadmium sulphide. Through a capacitor **98**, the electrode **96** of the photo-resistance **94** is connected to the junction of the resistances **91** and **92**. Furthermore, a capacitor **99** is connected in parallel with the resistance **92**. The ouput terminals **3** and **4** are directly connected to the electrodes of the photo-resistance **93**.

By means of a lamp **10**, which may be connected to a transformer in a radio receiver, an amplifier or other sound apparatus in which the arrangement is included, the two photo-resistances **93** and **94** are equally irradiated. The luminous flux **100** striking these photo-resistances can be controlled by means which are not shown in the drawing. These means may consist of a displaceable mask interposed between the lamp **10** and the two photo-resistances or of a filter of locally varying density or colour. Alternatively, use may be made of means for controlling the supply of energy to the lamp **10**. Embodiments of these means have already been described with reference to the preceding examples.

Suitable values of the various impedances in the arrangement shown in FIG. 9 are:

Resistance **91**	MΩ	0.5
Resistance **92**	MΩ	1.5
Photo-resistance **93** (dark resistance)	MΩ	30
Photo-resistance **94** (dark resistance)	MΩ	30
Capacitor **98**	μμF	3300
Capacitor **99**	μμF	27

When the irradiation on the photo-resistances **93** and **94** is comparatively intense, so that their resistance values are low, the low and high frequencies are more pronounced in the resulting low output voltage than if they are exposed to light of lesser intensity, in which event the output voltage is higher.

Throughout this specification, use is made of the terms light source, luminous flux and irradiation. Where we are concerned with radiation for modifying the electrical resistance of a photo-resistance, the term "light" should not be understood to be limited to visible radiation. For the end in view, use can also be made of radiation outside the visible part of the spectrum, for example ultraviolet and infrared radiations, provided that the photo-resistance or -resistances are sensitive to such radiation.

Obviously, in an arrangement in accordance with the invention, precautions must, if required, be taken to exclude any undesirable radiation which may affect the photo-resistance of the photo-resistances, for example by mounting the photo-resistance or photo-resistances and the source of radiation in a separate housing, similarly to what has been described with reference to FIG. 2.

What is claimed is:

1. A circuit arrangement comprising a source of time varying intelligence signal voltage, first and second impedance elements connected in series circuit arrangement, at least one of said impedance elements comprising a photosensitive impedance, means for impinging radiations upon said photosensitive impedance, means for varying the intensity of radiations impinging on said photosensitive impedance independently of said source of intelligence signal thereby varying the impedance value of the said photosensitive impedance, means for aplying said time varying intelligence signal voltage across said series circuit arrangement, and means for deriving an output voltage from one of said impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance value of said photosensitive impedance.

2. A circuit arrangement comprising a source of time varying intelligence signal voltage, first and second impedance elements connected in series circuit arrangement at least one of said impedance elements comprising a photosensitive impedance, means for impinging light upon said photosensitive impedance, means for varying the intensity of light impinging on said photosensitive impedance independently of said source of intelligence signal thereby varying the impedance value of the said photosensitive impedance, means for applying said time varying intelligence signal voltage across said series circuit arrangement, and means for deriving an output voltage from one of said impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance value of said photosensitive impedance.

3. A circuit arrangement comprising a source of time varying intelligence signal voltage, first and second impedance elements connected in series circuit arrangement at least one of said impedance elements comprising a photosensitive impedance, means for impinging light upon said photosensitive impedance, means for varying the intensity of light impinging on said photosensitive impedance independently of said source of intelligence signal thereby varying the impedance value of the said photosensitive impedance, said last-mentioned means comprising movable masking means positioned between said light impinging means and said photosensitive impedance, means for applying said time varying intelligence signal voltage across said series circuit arrangement, and means for deriving an output voltage from one of said impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance value of said photosensitive impedance.

4. A circuit arrangement comprising a source of time

varying intelligence signal voltage, first and second impedance elements connected in series circuit arrangement at least one of said impedance elements comprising a photosensitive impedance, means for impinging light upon said photosensitive impedance, means for varying the intensity of light impinging on said photosensitive impedance independently of said source of intelligence signal thereby varying the impedance value of the said photosensitive impedance, said last-mentioned means comprising means controlling the input energy of said light impinging means, means for applying said time varying intelligence signal voltage across said series circuit arrangement, and means for deriving an output voltage from one of said impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance value of said photosensitive impedance.

5. A circuit arrangement comprising a pair of photosensitive impedances connected in series circuit arrangement with each other, means for impinging light upon said photosensitive impedances, means for varying the intensity of light impinging on said photosensitive impedances thereby varying the impedance values of the said photosensitive impedances, means for applying a signal voltage across said series circuit arrangement, and means for deriving an output voltage from one of said photosensitive impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance values of said photosensitive impedances.

6. A circuit arrangement comprising a pair of photosensitive impedances connected in series circuit arrangement with each other, said photosensitive impedances forming an integral structure comprising a photosensitive material and linear electrodes spaced in at least three groups positioned on the surface of said photosensitive material, said electrodes being interlaced with each other, means for impinging light upon said photosensitive impedances, means for varying the intensity of light impinging on said photosensitive impedances thereby varying the impedance values of the said photosensitive impedances, means for applying a signal voltage across said series circuit arrangement, and means for deriving an output voltage from one of said photosensitive impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance values of said photosensitive impedances.

7. A circuit arrangement comprising first and second photosensitive impedances connected in series circuit arrangement with each other, a first light source for impinging light upon said first photosensitive impedance, a second light source for impinging light upon said second photosensitive impedance, means for varying the intensity of light impinging on said first photosensitive impedance thereby varying the impedance value of the said first photosensitive impedance, means for varying the intensity of light impinging on said second photosensitive impedance thereby varying the impedance value of the said second photosensitive impedance, means for applying a signal voltage across said series circuit arrangement, and means for deriving an output voltage from one of said photosensitive impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance values of said photosensitive impedances.

8. A circuit arrangement comprising first and second photosensitive impedances connected in series circuit arrangement with each other, said first and second photosensitive impedances forming an integral structure comprising a photosensitive material and linear electrodes spaced in at least three groups positioned on the surface of said photosensitive material, said electrodes being interlaced with each other, a first light source for impinging light upon said first photosensitive impedance, a second light source for impinging light upon said second photosensitive impedance, means for varying the intensity of light impinging on said first photosensitive impedance thereby varying the impedance value of the said first photosensitive impedance, means for varying the intensity of light impinging on said second photosensitive impedance thereby varying the impedance value of the said second photosensitive impedance, means for applying a signal voltage across said series circuit arrangement, and means for deriving an output voltage from one of said photosensitive impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance values of said photosensitive impedances.

9. A circuit arrangement comprising a pair of photosensitive impedances connected in series circuit arrangement with each other, a single light source for impinging light upon said photosensitive impedances, means for varying the intensity of light impinging on said photosensitive impedances thereby varying the impedance values of the said photosensitive impedances, means for applying a signal voltage across said series circuit arrangement, and means for deriving an output voltage from one of said photosensitive impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance values of said photosensitive impedances.

10. A circuit arrangement comprising a pair of photosensitive impedances connected in series circuit arrangement with each other, said photosensitive impedances forming an integral structure comprising a photosensitive material and linear electrodes spaced in at least three groups positioned on the surface of said photosensitive material, said electrodes being interlaced with each other, a single light source for impinging light upon said photosensitive impedances, means for varying the intensity of light impinging on said photosensitive impedances thereby varying the impedance values of the said photosensitive impedances, means for applying a signal voltage across said series circuit arrangement, and means for deriving an output voltage from one of said photosensitive impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance values of said photosensitive impedances.

11. A circuit arrangement comprising a pair of photosensitive impedances connected in series circuit arrangement with each other, means for impinging light upon said photosensitive impedances, means for varying the intensity of light impinging on said photosensitive impedances thereby varying the impedance values of the said photosensitive impedances, said last-mentioned means comprising means for increasing the intensity of light impinging on one of said photosensitive impedances and simultaneously decreasing the intensity of light impinging on the other of the said photosensitive impedances, means for applying a signal voltage across said series circuit arrangement, and means for deriving an output voltage from one of said photosensitive impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance values of said photosensitive impedances.

12. A circuit arrangement comprising first and second photosensitive impedances connected in series circuit arrangement with each other, a first light source for impinging light upon said first photosensitive impedance, a second light source for impinging light upon said second photosensitive impedance, potentiometer means controlling the input energy of said first and second light sources in a manner whereby the intensity of light impinging on one of said first and second photosensitive impedances is increased and the intensity of light impinging on the other of the said first and second photosensitive impedances is simultaneously decreased, means for applying a signal

voltage across said series circuit arrangement, and means for deriving an output voltage from one of said photosensitive impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance values of said photosensitive impedances.

13. A circuit arrangement comprising a pair of photosensitive impedances connected in series circuit arrangement with each other, a single light source for impinging light upon said photosensitive impedances, means for varying the intensity of light impinging on said photosensitive impedances thereby varying the impedance values of the said photosensitive impedances, said last-mentioned means comprising movable masking means positioned between said light source and said photosensitive impedances in a manner whereby the intensity of light impinging on one of said photosensitive impedances is increased and the intensity of light impinging on the other of said photosensitive impedances is simultaneously decreased, means for applying a signal voltage across said series circuit arrangement, and means for deriving an output voltage from one of said photosensitive impedances, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance values of said photosensitive impedances.

14. A circuit arrangement comprising a source of time varying signal intelligence voltage, a first photosensitive impedance, an impedance connected in series circuit arrangement with said first photosensitive impedance, a second photosensitive impedance, a capacitor connected in series circuit arrangement with said second photosensitive impedance, said last-mentioned series circuit arrangement being connected in parallel with said first-mentioned series circuit arrangement, a single light source for impinging light upon said first and second photosensitive impedances, means for varying the intensity of light impinging on said first and second photosensitive impedances independently of said sources of intelligence signal thereby varying the impedance values of the said first and second photosensitive impedances, said last-mentioned means comprising means for varying the intensity of light impinging on one of said first and second photosensitive impedances in one of an increasing and decreasing direction and simultaneously varying the intensity of light impinging on the other of the said first and second photosensitive impedances in the same sense, means for applying said time varying intelligence signal

voltage across said first and second series circuit arrangements, and means for deriving an output voltage from said first photosensitive impedance, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance values of said photosensitive impedances.

15. A circuit arrangement comprising a source of time varying signal intelligence voltage, a first photosensitive impedance, an impedance connected in series circuit arrangement with said first photosensitive impedance, a second photosensitive impedance, said first and second photosensitive impedances forming an integral structure comprising a photosensitive material and linear electrodes spaced in at least three groups positioned on the surface of said photosensitive material, said electrodes being interlaced with each other, a capacitor connected in series circuit arrangement with said second photosensitive impedance, said last-mentioned series circuit arrangement being connected in parallel with said first-mentioned series circuit arrangement, a single light source for impinging light upon said first and second photosensitive impedances, means for varying the intensity of light impinging on said first and second photosensitive impedances independently of said source of intelligence signal thereby varying the impedance values of the said first and second photosensitive impedances, said last-mentioned means comprising means for varying the intensity of light impinging on one of said first and second photosensitive impedances in one of an increasing and decreasing direction and simultaneously varying the intensity of light impinging on the other of the said first and second photosensitive impedances in the same sense, means for applying said time varying intelligence signal voltage across said first and second series circuit arrangements, and means for deriving an output voltage from said first photosensitive impedance, said output voltage having a magnitude relatively less than that of said signal voltage and varying in a predetermined relationship with the impedance values of said photosensitive impedances.

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