F. C. BROWN.

SELENIUM BRIDGE AND METHOD FOR MAKING SAME.

APPLICATION FILED JULY 28, 1916.

1,219,432. Patented Mar. 20, 1917.

Fig. 1.

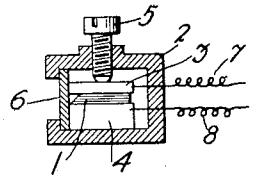


Fig. 2.

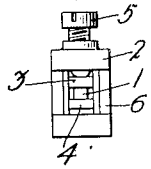
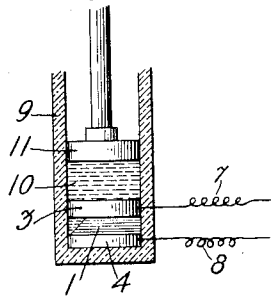


Fig. 3.



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UNITED STATES PATENT OFFICE.

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SELENIUM BRIDGE AND METHOD FOR MAKING SAME.

1,219,432. Specification of Letters Patent. Patented Mar. 20, 1917.

Application filed July 28, 1916. Serial No. 111,801.

To all whom it may concern:

Be it known that I, FAY C. BROWN, a citizen of the United States, residing at Berkeley, in the county of Alameda and State of California, have invented certain new and useful Improvements in Selenium Bridges and Methods for Making Same, of which the following is a full, clear, concise, and exact description.

This invention has reference to selenium bridges, and its object is to produce a light-sensitive selenium bridge of greatly increased sensitiveness.

It has long been known that selenium in some of its forms is less resistant to the passage of an electric current when under the influence of light than when in the dark, that is, protected from the action of light. Advantage has been taken of this property of selenium for various purposes, and the devices for utilizing the selenium in such manner have been customarily known as selenium cells, but such term is somewhat of a misnomer, wherefore the term selenium bridge is used throughout this specification, because the selenium is utilized to bridge a gap in the electric circuit, whereby the variable resistance represented by the selenium may be utilized.

Prior to the present invention crystallized selenium has been produced, but the crystals are microscopic, or even sub-microscopic in size. For this reason there can be no control of the arrangement of the crystals which because of their extremely small size are present in great multitudes in the ordinary selenium bridge. Such crystals have their axes pointing in all directions.

By the production of crystals of selenium of large size, that is, readily visible individually to the unaided eye and easy to handle, it is quite possible to produce a selenium bridge of suitable capacity from a single crystal, and the capacity may be increased by the employment of two or three or more crystals, for the crystals are of such large size as to be readily oriented. It has been found that a single hexagonal crystal shows a greater sensibility to light when the illumination impinges on the end of the crystal and travels in the direction of the principal axis of the crystal.

Moreover, it has been found that such crystals when subjected to pressure exhibit a many fold increase in sensitiveness to the action of light, so that a selenium crystal so arranged that the light strikes it in the direction of its principal axis and under compression to a considerable degree, is increased in light sensitiveness, say, a thousand times over the sensitiveness of selenium bridges as heretofore constructed.

The selenium bridge of the present invention, therefore, comprises one or more crystals of selenium with means for subjecting such crystal or crystals to pressure and at the same time having the crystals so presented that the light rays strike them in the direction of their principal axis.

The invention will be best understood from a consideration of the following detailed description, taken in connection with the accompanying drawings forming part of this specification, with the further understanding that while the drawings show a practical form of the invention, the latter is not confined to any strict conformity with the showing of the drawings, but may be changed and modified so long as such changes and modifications come within the scope of the appended claims.

In the drawings:—

Figure 1 is a longitudinal section of a more or less schematically illustrated selenium bridge embodying the present invention.

Fig. 2 is an elevation of the structure of Fig. 1 as seen from left hand side thereof.

Fig. 3 is a schematic representation of a selenium bridge embodying the present invention where the pressure upon the selenium crystal is brought about by an enveloping liquid or semi-liquid.

In the drawings no attempt is made to show other than schematically or diagrammatically a selenium bridge embodying the invention, for the construction in its details may vary considerably. In its essentials the selenium bridge comprises one or more large crystals of selenium indicated at 1, but without any attempt to show the structure of the crystal. In addition to such showing of the crystal, which showing is not proportional, especially as to cross-sectional area, the drawing shows in Figs. 1 and 2 one means which might be utilized for applying pressure to the crystal, and in Fig. 3 another means for the same purpose. In Figs. 1 and 2 there is shown a frame or holder 2 within which

are lodged electrodes 3, 4, respectively, containing the crystal or crystals 1 between them. Mounted in the frame 2 is a screw 5 shown as an ordinary machine screw, whereby the electrode 3 may be forced against the crystal 1 with the electrode 4 serving as a backing or bed for the crystal. A glass plate or window 6 is mounted in the frame 2 in front of the crystal 1 and the light which it is desired should affect the crystal is directed through such window. It will be understood, of course, that the window may be omitted, and also that the crystal may be suitably inclosed to prevent the action of light thereon except by those beams which it is desired should impinge upon the crystal in the direction of the length of its principal axis. The electrodes 3 and 4 are provided with connections to conductors 7, 8, respectively, for the inclusion of the bridge in the electric circuit to be controlled.

In Fig. 3 the crystal 1 and electrodes 3 and 4 are included in a vessel 9 which may contain a quantity of some suitable liquid or semi-liquid 10 immersing the crystal 1 and electrodes 3 and 4. Such liquid may consist of Canada balsam or celluloid, or some other suitable liquid or semi-liquid which will not materially interfere with the transmission of light. A piston 11 may represent any suitable means for applying pressure to the liquid 10, and through it to the crystal 1. The electrodes 3 and 4 are provided with conductor terminals 7 and 8 as in Fig. 1. Since the showing of the drawings is largely schematic it is deemed to be sufficient without further illustration to represent any suitable means for applying pressure to the crystals and also the drawings are deemed to be a sufficient representation for the purpose of this case of any suitable form of selenium bridge wherein large crystals are utilized with the crystals under pressure.

Selenium exists in the amorphous or non-conducting form, in the red crystalline form, also non-conducting, and in a crystalline metallic state with the crystals of monoclinic or hexagonal shape very sensitive to light and with properties peculiar to the various axes of the crystals and also due to the manner of operation of the crystals.

In the light sensitive crystalline form utilized in the present invention, isolated crystals ranging from 4 mm. to 9 mm. long, and even longer, have been produced by sublimation of the selenium vapor either in a high vacuum or at atmospheric pressure. When the selenium is sublimed in a high vacuum it is first freed from all occluded gases, wherefore the sealed receptacle contains nothing but selenium which becomes vaporized by the heat employed and from which vapor the crystals are deposited. The crystals are of the monoclinic form when the temperature is about 171° C. Hexagonal crystals of a maximum sensibility to light are obtained when the vapor is sublimed at a temperature of about 183° C.

A high sensitiveness has been obtained when occluded gases have been driven off from the selenium by repeated boiling and condensing in a high vacuum. For some purposes it is advantageous to have argon, neon, helium and other gases mixed with the vapor of selenium either separately or in combination, and again, it is advantageous to form the crystals in an atmosphere of selenium vapor only and afterward allow them to absorb any one gas or a mixture of the gases at temperatures below the temperature of formation.

While the temperatures named have been found to produce most excellent results, it is to be understood that the invention is not in any manner limited to any precise temperatures.

The production of selenium crystals which may be isolated and which may reach large sizes, is described with a minuteness of detail, not necessary to repeat here, in an article by me on the "Crystal forms of metallic selenium and some of their physical properties," published in the *Physical Review*, N. S., vol. 4, No. 2, August, 1914.

A single crystal of a substance is more likely to be pure and of the same crystalline structure throughout than is the case with a heterogeneous mass of material, wherefore such crystal has the advantage of a uniform molecular structure throughout, that is, a uniform and regular spacing of the molecules. Such uniformity of structure contributes to the stability of the crystal and of the selenium bridge in which the crystal is included.

Large crystals are advantageous in that because of the parallel plane faces of the crystal it is possible to apply pressure on the electrodes after the crystals are formed. The pressure on a single crystal or an assemblage of single crystals is more likely to produce a uniform stress in the crystal or crystals than is the case where pressure is applied to a mass-aggregate of sub-microscopic crystals.

Large crystals permit pressure to be applied with so simple a device as a screw, and also permit the control of the axis along which the crystal may be illuminated. Not only is the sensibility different, dependent upon the orientation of the axis to be illuminated, but this orientation determines which region of the spectrum will produce the maximum change of conductivity.

Experience has shown great stability of the new crystals of selenium over selenium as heretofore used in selenium bridges. A

selenium crystal as produced and employed in accordance with the present invention has been exposed to most intense light for twenty-four hours a day for thirty-five days without showing deterioration. Such a crystal mounted for a year has now the same sensibility as when first mounted.

The electrodes may be made of a material that does not attack the selenium chemically. For instance, platinum answers the purpose excellently, and in all probability tungsten or carbon in some one of its forms, or other substances may be employed.

The bridge may comprise a group of much smaller crystals than those of the particular sizes mentioned hereinbefore, and especially crystals which may be deposited from selenium vapor. It is not imperative that the light affecting the bridge shall reach the crystal or crystals in the direction of the principal axis thereof. For instance, the crystals may be illuminated through one of the electrodes which might be accomplished by employing an electrode consisting of a glass or quartz plate provided with a thin coating of platinum.

The selenium bridge of the present invention may be used wherever such an arrangement is adapted. One special use of the invention is in connection with and forming part of an optiphone such as is shown, described and claimed in my application Serial No. 26,357, filed by me on May 6, 1915, and in the present invention is briefly described.

What is claimed is:

1. A selenium bridge comprising a selenium crystal or crystals of microscopic dimensions.

2. A selenium bridge comprising a selenium crystal or crystals produced by sublimation and condensation.

3. A selenium bridge comprising one or more isolated or separate selenium crystals.

4. A selenium bridge comprising one or more selenium crystals, and a support therefor comprising electrodes engaging the crystals to permit the impinging of a beam or beams of light thereupon.

5. A selenium bridge comprising one or more crystals of selenium, a support for the crystal or crystals, and means for applying pressure to the crystal or crystals.

6. A selenium bridge comprising one or more monoclinic or hexagonal crystals of selenium, and a support therefor in which the crystal or crystals are mounted to be impinged by a beam or beams of light.

7. A selenium bridge comprising one or more elongated crystals of selenium, and electrodes engaging the crystal or crystals along the long sides thereof.

8. A selenium bridge comprising one or more elongated crystals of selenium, electrodes therefor engaging the crystal or crystals of selenium along long sides thereof, and means applying pressure to the crystal or crystals.

9. A selenium bridge comprising one or more elongated crystals of selenium, electrodes therefor engaging the crystal or crystals of selenium along long sides thereof, and means for applying pressure to the crystal or crystals, said means being arranged to apply the pressure through the electrodes.

In witness whereof, I hereunto subscribe my name this twentieth day of July A. D., 1916.

FAY C. BROWN.