

Jan. 5, 1926.

1,568,694

W. A. RUGGLES
PHOTO ELECTRIC DEVICE
Filed April 16, 1921

Fig. 1.

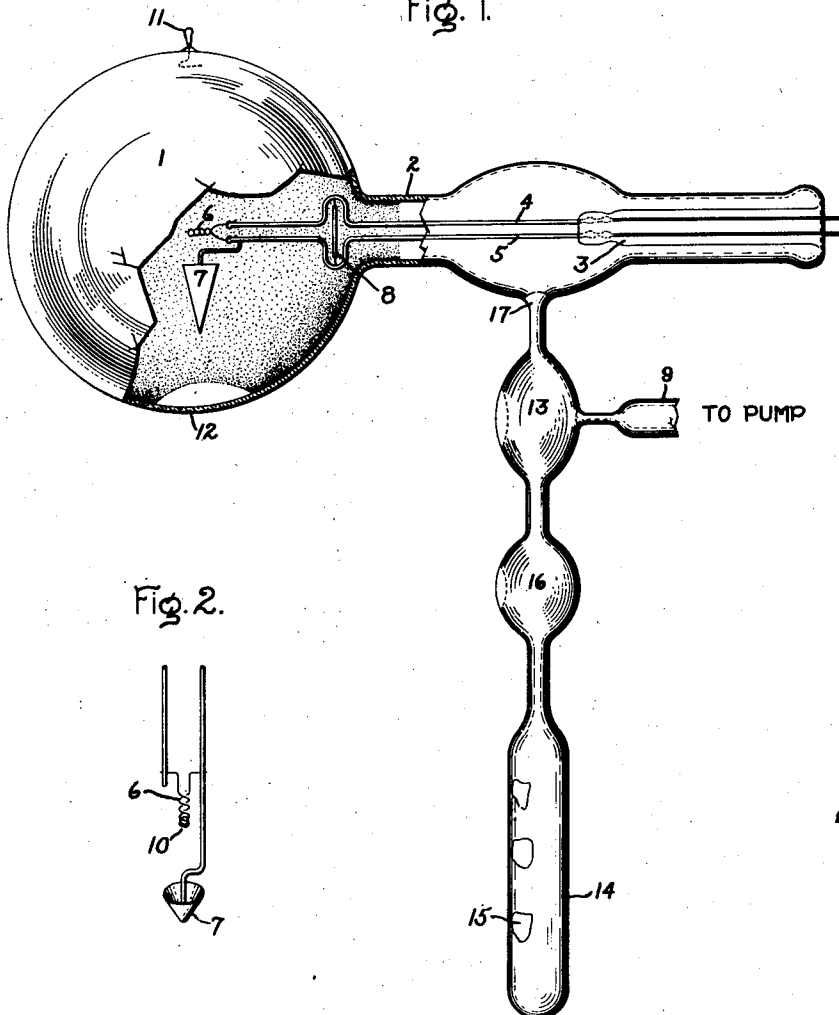


Fig. 2.

Inventor:
William A. Ruggles,
by *Robert G. Davis*
His Attorney.

Patented Jan. 5, 1926.

1,568,694

UNITED STATES PATENT OFFICE.

WILLIAM A. RUGGLES, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

PHOTO-ELECTRIC DEVICE.

Application filed April 16, 1921. Serial No. 462,052.

To all whom it may concern:

Be it known that I, WILLIAM A. RUGGLES, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Photo-Electric Devices, of which the following is a specification.

The present invention relates to the preparation of photo-electric devices and includes in particular a new method of forming the conductive support for an active electrode which commonly is constituted by a film of light-sensitive metal, as, for example, potassium.

Heretofore, a conductive backing for the active electrode material has been prepared by depositing a film of silver from an aqueous solution upon the inner surface of a glass bulb. Upon ordinary drying, potassium was admitted to the bulb in the presence of air and deposited upon the backing metal. The resulting electrode inevitably contained various impurities, notably oxidation products and occluded moisture, which were a source of variability in the photo-electric device.

In accordance with my invention, I have provided a photo-electric electrode of improved sensitivity by depositing a film of metal in a vacuum to serve as a conductive base for the light-sensitive metal which preferably is deposited likewise in a vacuum upon the conductive foundation surface. My invention includes also new methods of preparing metal films as set forth with greater particularity in the appended claims.

In the accompanying drawing, Fig. 1 illustrates in perspective a device to which my invention is applicable, the bulb wall being in part broken away, and Fig. 2 is an enlarged view of a slightly modified heater electrode with a bead of volatilizable metal attached.

The device shown in the drawing comprises a glass bulb 1 having a side arm 2 containing a glass stem 3 into which are sealed electric conductors 4, 5. Attached to these conductors is a vaporizer which is constituted by a coiled filament 6 consisting of a refractory metal, as, for example, tungsten, molybdenum or tantalum. The conductor 5 also acts as a support for a cone-shaped body 7 consisting of nickel, or other

suitable material, which acts as a shield to prevent deposition of metal upon part of the bulb. It is not necessary that the shield 7 should have the particular shape illustrated. A cone or pyramidal shape is preferable, as it reduces loss of light when the device is in use, rays of light striking the shield being reflected to the side walls upon the sensitive electrode. A shield 8 intercepts metal particles projected from the filament 6, as described below to prevent silvering of the inner surface of the side arm 2 which might cause electrical short-circuiting.

The bulb 1 is first carefully freed from moisture by baking at a temperature close to but below the softening temperature of glass, say, at 360° C. The bulb is then exhausted through the tubulation 9, a condensation pump preferably being used.

A bead of easily volatilizable metal, as, for example, silver, gold, or copper, is affixed to the filament 6 before sealing in the stem 3, as shown at 10 in Fig. 2. The filament 6 is heated by passage of current to the volatilizing temperature of the bead when the bulb has been well exhausted, say, to a vacuum of about 5 micron (0/0005 m.m. of mercury), the molten bead clinging to the turns of the coiled filament while the metal is volatilizing. The metal vapor is projected radially in the evacuated bulb interior and is condensed upon the inner surface of the bulb which is artificially cooled if necessary; for example, by immersing the bulb in water. The deposited metal film makes electrical contact with a sealed-in electrode 11 consisting of platinum or other suitable material. The shield 7 will shadow a portion of the bulb, as indicated at 12, which is left clear of deposit as the metal vapor in a high vacuum travels in straight lines. Thereupon the bulb is again heated and with the vacuum unbroken and the vacuum pump in constant operation, a light-sensitive material, for example, metallic potassium is introduced as a vapor into the bulb. Conveniently, the potassium, or other suitable light-sensitive material, may be contained in a small bulb 13 intercalated in the vacuum line 9, heat being applied in any convenient way to volatilize the same. In order to render the potassium free from impurities, I prefer to introduce the same in the unavoidably oxidized state into a side chamber 14, as indi-

cated at 15. After the silver or other metal has been deposited as above described, the chamber 14 is heated to distill the potassium into an adjoining chamber 16 where
 5 it distills as indicated by the dotted lines, the bulb 13 and the device 1 being gently heated. Thereupon the potassium is distilled in turn into the bulb 13 and then into the device 1. The potassium condensed
 10 upon the window 12 can be driven off by external heating.

The photo-electric device now may be subjected to a sensitizing treatment by admitting hydrogen at a pressure of say,
 15 100 microns of mercury, and passing a suitable current through the device, the hydrogen eventually being replaced by argon gas but these steps in the manufacture of the photo-electric device subsequent to the formation of the film electrode forms no part
 20 of my present invention. The completed device is finally sealed off by fusion at 17 in the usual manner.

During the operation of the device, light
 25 rays are admitted through the window 12 and impinge either directly or by reflection from the surface of the shield upon the surface of the film electrode which acts as a cathode, causing an electron current to be
 30 emitted. The filament 6 and the shield 7 functions as anode in the completed device, the filament being unheated. The photo-electric device produced as herein described is more sensitive and reproducible in its
 35 characteristic than devices formerly made by chemical methods.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. The method of preparing a light sensitive device which consists in depositing
 40 metal upon the inner surface of an evacuated container, and depositing a photo-sensitive material upon said surface while maintaining said vacuum.

2. A photo-electric device comprising a
 45 sealed bulb, a film of conductive material upon the inner surface of said bulb, said film being formed by the deposition of metal vapor in a vacuum, and having a clear area
 50 constituting a window formed by shielding a portion of said bulb surface from said vapor, a light-sensitive material superimposed upon said film and a cooperating electrode.

3. The method of preparing a cathode in
 55 a photo-electric device having an insulating container which consists in evacuating the container at an elevated temperature, depositing by vaporization a metal film upon
 60 the inner surface of said container except

for a region through which light is to be admitted while keeping said vacuum unbroken, and depositing a photo-electric material upon said film.

4. The method of preparing a photo-electric device comprising a glass container,
 65 which consists in removing gas from the walls and the space within said container, depositing a metallic film on the inner surface of said container and thereupon depositing a light-sensitive material, the
 70 vacuum remaining unbroken during the latter two operations.

5. The method of depositing a conductive film upon a non-conductive support adapted
 75 to receive the active material in a photo-electric device which comprises evacuating said device, vaporizing a metal in the evacuated space in said device, maintaining said foundation cool enough to condense vapor
 80 thereon and mechanically shielding portions of the support which is to be maintained clear from deposit.

6. The steps in the preparation of a photo-electric device which consists in evacuating
 85 said device at an elevated temperature, vaporizing a metal in said device while maintaining said vacuum intact, cooling the portion of the envelope of said device to deposit a film of metal thereon, shielding
 90 another portion of said envelope from a deposit of said metal and thereupon depositing a light sensitive material upon said film while keeping said vacuum unbroken.

7. The method of preparing a photo-sensitive electrode which consists in coating a
 95 gas-free interior surface of an evacuated envelope with a layer of metal in the absence of water, and thereupon depositing a layer of photo-sensitive material on said coating.
 100

8. A photo-electric device comprising a bulb, a shield within said bulb, the inner
 105 surface of said bulb being coated with metal layer formed by condensation from vapor in a vacuum and having a clear space whereon condensation has been prevented by said shield which constitutes a reflector in said device.

9. A photo-electric device comprising a bulb containing an attenuated gas, a
 110 conductive metallic film upon the inner surface of said bulb except for a clear area constituting a window, a leading-in conductor therefor, a photo-sensitive material upon said film, a cooperating electrode and a light
 115 reflector in said bulb opposite said window.

In witness whereof, I have hereunto set my hand this 15th day of April, 1920.

WILLIAM A. RUGGLES.