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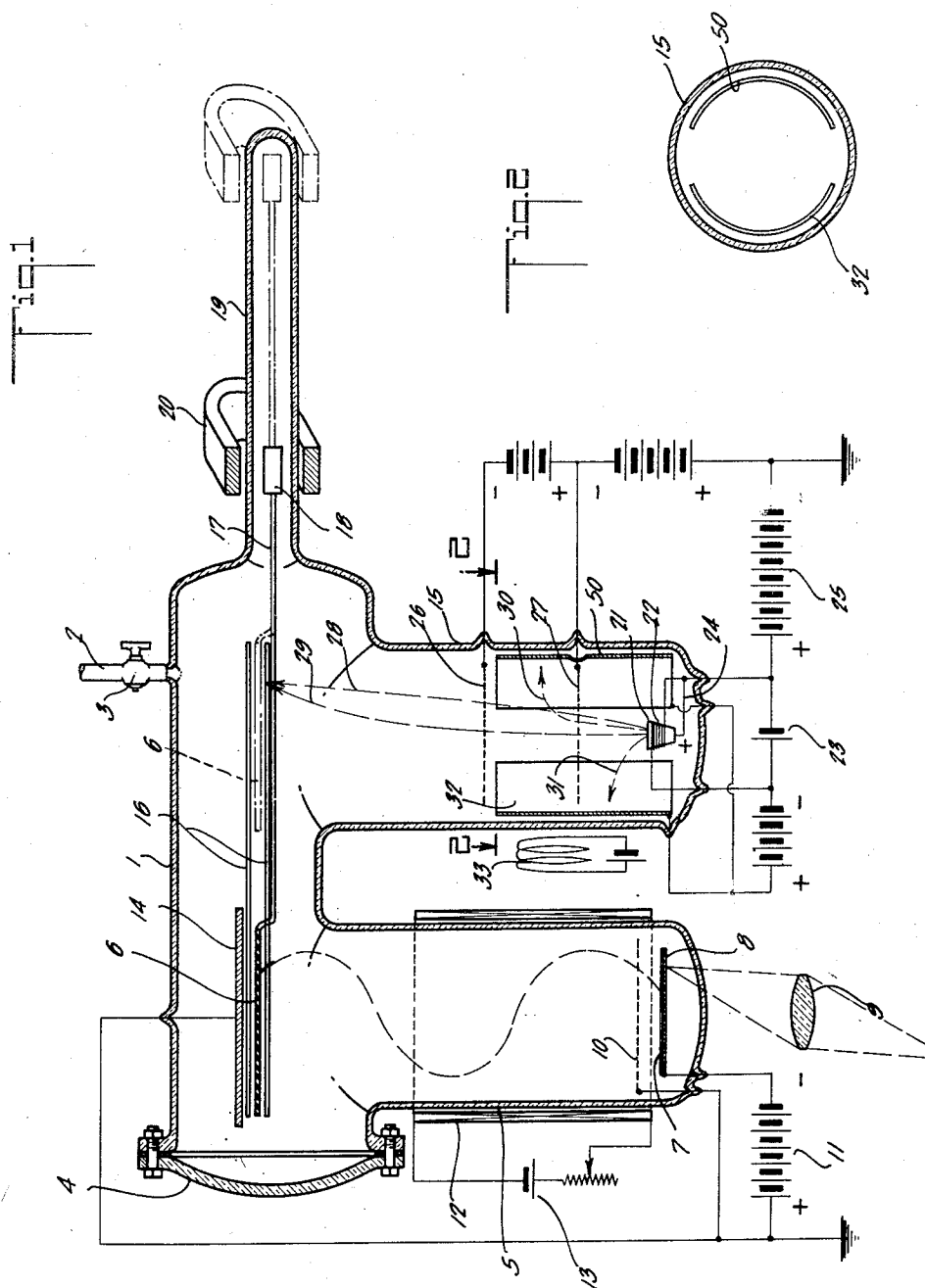
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ELECTRON CAMERA

Filed May 17, 1940

2 Sheets-Sheet 1



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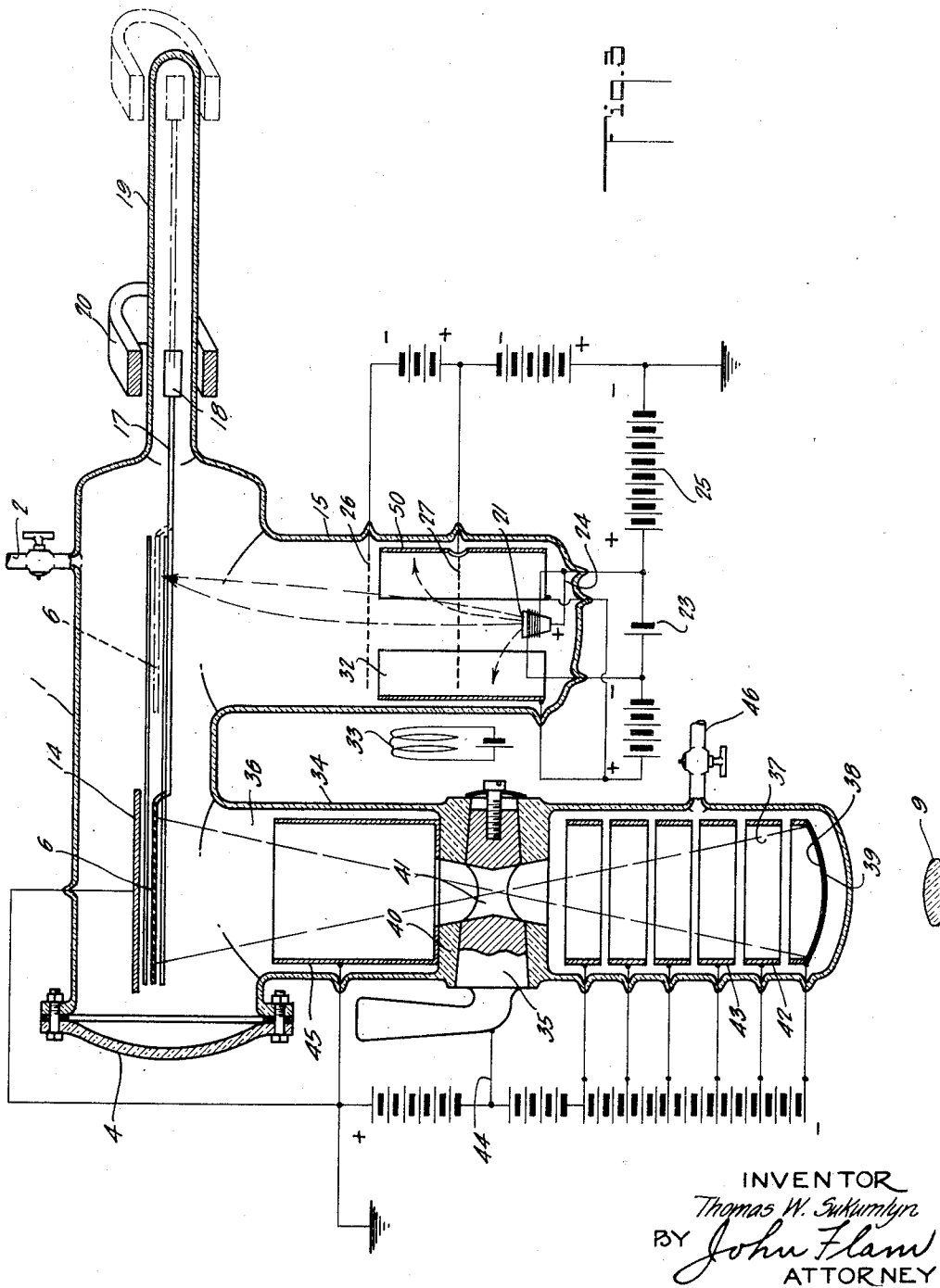
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UNITED STATES PATENT OFFICE

2,281,638

ELECTRON CAMERA

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11 Claims. (Cl. 250—41.5)

This invention relates to an optical system for making a permanent record of an image by the aid of electrons.

In an ordinary light camera, it is essential to provide a photosensitive surface, usually formed by a silver salt emulsion. It is possible to affect this surface by ordinary light or even by radiation outside of the visible spectrum. Such emulsions however have definite limitations. Thus it is difficult to obtain any image record for low intensities of radiation in any reasonably short period of exposure. For example, when distant stars are photographed it has been necessary to expose the photographic plate for such long intervals that definition is seriously affected, due to camera unsteadiness and changing atmospheric conditions.

It is one of the objects of this invention to produce an image record without the aid of a photo sensitive solution, and in such manner that the periods of exposure can be very greatly reduced.

Photosensitive emulsions necessarily have a grain structure, imposing a limit upon the resolving power. By the aid of the present invention, this disadvantage is overcome.

In order to accomplish these results, an electron image is formed, and this image is later caused to be made permanent.

It is accordingly another object of this invention to provide a photographic apparatus which utilizes electrons to produce a permanent image without the aid of a photosensitive emulsion.

This invention possesses many other advantages, and has other objects which may be made more easily apparent from a consideration of several embodiments of the invention. For this purpose there are shown a few forms in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a diagrammatic view of an apparatus incorporating the invention;

Fig. 2 is a detail section as seen on line 2—2 of Fig. 1; and

Fig. 3 is a view similar to Fig. 1 showing a modified form of the invention.

The electron camera includes in general, a vessel 1 adapted to be evacuated as by the aid of a connection 2 to a vacuum pump. This con-

nection 2 may be controlled by a stop cock 3. Furthermore, in order to permit access to the interior of the vessel 1, whenever it may be desired to remove or replace the member adapted to carry the image, a removable cap 4 is provided which may be appropriately sealed to one end of the vessel 1.

The vessel 1 carries a tubular extension 5 through which photoelectrons are intended to pass to an insulation plate or member 6. This insulation plate may conveniently be made of glass or other translucent material whereby when the electron image on the member 6 is rendered permanent, this member may be utilized as a printing plate.

The photoelectrons may be caused to be emitted from a photoelectric layer 7, placed upon a transparent supporting medium 8, such as glass, which may be supported in any appropriate manner. This supporting medium 8 permits the passage of light therethrough to affect the thin partly transparent photoelectric layer 7. The vessel 1 is preferably made of transparent material, whereby an image may be focused upon the lower side of the supporting medium 8, as by the aid of a lens system diagrammatically illustrated at 9. However, it is to be understood that no light is permitted to enter the vessel 1 other than the light which passes through the lens system 9.

The image cast upon the supporting medium 8 causes emission of photoelectrons from the layer 7 in conformity with the light pattern produced upon the medium 8. This stream of photoelectrons may be accelerated as by the aid of a grid structure 10 maintained positive with respect to the photoelectric cathode 7, as by the aid of a source of direct current energy 11. Furthermore, the stream of photoelectrons is focused upon the surface of the insulation member 6 as by the aid of a coil 12 disposed around the extension 5 and shown as supplied with electrical energy from a battery 13. Adjacent the upper surface of the member 6, a conducting plate or anode 14 is provided maintained at a potential positive with respect to the cathode layer 7.

By appropriate choice of constants, it is possible to cause the photoelectrons to be retained upon the surface of member 6 in a pattern corresponding to the light pattern produced by the lens system 9 on the cathode structure 7—8. Since the plate or anode 14 is placed quite close to the member 6, a very considerable charge is built up on the member 6 corresponding to the electrons. The electric field caused by the collection of the electrons on the member 6 is con-

fined to the space between the charge and the plate 14.

This pattern thus formed by the photoelectrons may be caused to be converted into permanent form, as by deposition of particles in conformity with the position of the electrons on the member 6. For this purpose the member 6 is arranged to be moved to its dotted line position, opposite an extension 15 of the vessel 1. This movement can be so accomplished as not to disturb the electron pattern on the member 6, the lens being obscured before this movement is made. In the new position, the plate 6 is in the path of moving particles of metal or other suitable material, produced in a manner to be hereinafter described. In order to facilitate movement of the member 6 from its left hand position to the right hand position, this member 6 is shown as slidable between the parallel guides 16. It is attached to an elongated rod 17 carrying at its extremity a magnetic armature 18. This armature is shown as placed within the narrow tubular extension 19 of the vessel 1. In order to control the position of the member 6 without disturbing the seal of the vessel 1, use may be made of a magnetic member 20 such as a permanent horseshoe magnet. This magnetic member influences the armature 18, since the armature is placed directly between the pole pieces of magnet 20. By manually moving the magnet 20, the armature 18 is caused to move with the magnet 20.

Near the bottom of the extension 15 is located a source of suitable vaporizable material, which may be metallic or other materials, located in a crucible 21. This crucible is shown as adapted to be heated by heating element 22 energized from a source of electrical energy 23. The heat of the element 22 causes ionization of the vaporizable material in crucible 21. Further, the vaporized particles from crucible 21 can be charged positively as by the aid of the connection 24, leading to the positive terminal of the source of electrical energy 25.

In order to avoid imparting too high a speed to metal particles or ions passing into the space near the plate 6, with consequent loss of control, the decelerating electrodes 26 and 27 of grid form may be utilized. These electrodes are maintained at potentials negative with respect to the charge of the material in crucible 21. Those charged particles which are sufficiently energized to arrive in the field of control of the electric charge image on plate 6 will have paths indicated by the lines 28 and 29. Those which are not sufficiently energized are shown as deflected along paths such as the lines 30 and 31.

Electrons may also be emitted from the material in crucible 21. These, however, are arranged to be captured upon positively charged electrodes 32 and 33 which as shown in Fig. 2, are of arcuate cross-section with their respective concave surfaces facing each other. A transverse magnetic field produced by the coil 33 may also serve to deflect the electrons on to the plate 32.

The positively charged particles are captured by the negative charge on member 6 in accordance with the electron pattern and are thus caused to reproduce in permanent form the image formed by the electrons. The seal may then be broken between the cap 4 and the vessel 1 and cap 4 removed to permit removal of the member 6. To produce another pattern, a new member 6 may be utilized. The cap 4 is sealed as by the use of wax, rubber or highly polished surface.

Then evacuation may be effected by the aid of the connection 2 and the process repeated.

Movement of member 6 away from beneath plate 14 causes the potential of the charge on member 6 to be increased, since work is thus performed in opposition to the attraction between the charges on member 6 and plate 14. Accordingly there is an enhanced effect between the vaporized particles and the electrons on member 6.

In the form just described, air is permitted to enter into the extension 5, whenever the plate 6 is removed. This may to some extent injure the photoelectric layer 7. In order to obviate this difficulty, a form of the invention may be utilized such as that illustrated in Fig. 3. The extension 15 in this figure carries apparatus entirely similar to that described in connection with Fig. 1. The extension 34, replacing extension 5, is arranged somewhat differently so as to incorporate a stop cock plug 35 in the extension 34, dividing the space in extension 34 into an upper space 36 and a lower space 37.

In the lower space 37 is located the photoelectric layer 38 deposited on the translucent support 39. The extension 34 is provided with a transverse integral wall 40 forming a seat for the plug 35 which is preferably made of metal. In the position shown in Fig. 3 the plug 35 is opened, permitting the stream of electrons to pass through the restricted passageway 41 to affect the member 6.

Below the plug 35 in the space 37 may be located a number of focusing cylindrical anodes 42, 43, etc. maintained at progressively higher potentials as the plug 35 is approached. The plug 35 itself may serve as a directing anode by appropriate connection 44.

In the compartment 36 may be located a supplemental focusing electrode 45, maintained at a still higher potential than the plug 35.

In this form of the invention, upon completion of the deposition of the vaporized particles from crucible 21, the plug 35 may be turned to the closed position, maintaining the compartment 37 sealed. Then the cap 4 may be removed and the plate 6 taken out of the vessel 1. The operation may then be repeated, by placing a new member 6 within the vessel, sealing the cap 4 and evacuating the vessel 1 through the connection 2.

If desired, an evacuating connection 46 may be provided for connection to a suction pump into the compartment 37, for ensuring proper vacuum conditions therein.

What is claimed is:

1. In an electron camera, an evacuated vessel, means in said vessel, forming a photo-electric surface, means for focusing an image on said surface to cause emission of photoelectrons therefrom, a member in said vessel, made from insulation material, and capable of receiving said electrons, whereby a negative charge is formed on said member, electric focusing means for causing said electrons to be distributed in a pattern upon said member in conformity with said image, and means forming a source of positively charged particles disposed within the vessel, spaced from said member and so located with respect thereto that the charge on said member is effective to attract particles from said source to the member, whereby said pattern is converted into permanent form.

2. In an electron camera, an evacuated vessel, means in said vessel, forming a photo-electric surface, means for focusing an image on said sur-

face to cause emission of photoelectrons therefrom, a member in said vessel, made from insulation material, and capable of receiving said electrons, whereby a negative charge is formed on said member, electric focusing means for causing said electrons to be distributed in a pattern upon said member in conformity with said image, means forming a source of positively charged particles disposed within the vessel, and means for moving said member out of the influence of the emitted photoelectrons, while retaining said pattern on the member, and into a position such that the charge on said member is effective to attract particles from said source to the member, whereby said pattern is converted into permanent form.

3. In an electron camera, an evacuated vessel, means in said vessel, forming a photoelectric surface, means for focusing an image on said surface to cause emission of photoelectrons therefrom, a member in said vessel, made from insulation material, and capable of receiving said electrons, whereby a negative charge is formed on said member, electric focusing means for causing said electrons to be distributed in a pattern upon said member in conformity with said image, and means whereby said pattern is converted into permanent form, comprising a source of positively charged particles, so disposed within the vessel that the particles are attracted to said member, and means for collecting electrons from the path of said particles, comprising a positively charged plate adjacent said path.

4. In an electron camera, an evacuated vessel, means in said vessel, forming a photo-electric surface, means for focusing an image on said surface to cause emission of photoelectrons therefrom, a member in said vessel, made from insulation material, and capable of receiving said electrons, whereby a negative charge is formed on said member, electric focusing means for causing said electrons to be distributed in a pattern upon said member in conformity with said image, and means whereby said pattern is converted into permanent form, comprising means for moving said member out of the influence of the emitted photoelectrons, while retaining said pattern on the member, means for evaporating positively charged material onto said member, and means for collecting electrons from the path of said charged material, comprising a positively charged plate adjacent said path.

5. In an electron camera, an evacuated vessel, means in said vessel, forming a photoelectric surface, means for focusing an image on said surface to cause emission of photoelectrons therefrom, a member in said vessel, made from insulation material, and capable of receiving said electrons, whereby a negative charge is formed on said member, an electromagnetic coil for producing a magnetic field along the path of the photoelectrons, to cause the said photoelectrons to be distributed in a pattern upon said member in conformity with said image, and means forming a source of positively charged particles disposed within the vessel, spaced from said member and so located with respect thereto that the charge on said member is effective to attract particles from said source to the member, whereby said pattern is converted into permanent form.

6. In an electron camera, an evacuated vessel, means in said vessel, forming a photoelectric surface, means for focusing an image on said surface to cause emission of photoelectrons

therefrom, a member in said vessel, made from insulation material, and capable of receiving said electrons, an electromagnetic coil for producing a magnetic field along the path of the photoelectrons, to cause the said photoelectrons to be distributed in a pattern upon said member in conformity with said image, and means whereby said pattern is converted into permanent form, comprising means for moving said member out of the influence of said emitted photoelectrons, while retaining said pattern on the member, and means for evaporating positively charged particles onto said member while out of the influence of said emitted electrons.

7. In an electron camera, an evacuated vessel, means in said vessel, forming a photoelectric surface, means for focusing an image on said surface to cause emission of photoelectrons therefrom, a member in said vessel, made from insulation material, and capable of receiving said electrons, whereby a negative charge is formed on said member, electrodes in said vessel adapted to cause the said photoelectrons to be distributed in a pattern upon said member in conformity with said image, and means forming a source of positively charged particles disposed within the vessel, spaced from said member and so located with respect thereto that the charge on said member is effective to attract particles from said source to the member, whereby said pattern is converted into permanent form.

8. In an electron camera, an evacuated vessel, means in said vessel, forming a photoelectric surface, means for focusing an image on said surface to cause emission of photoelectrons therefrom, a member in said vessel, made from insulation material, and capable of receiving said electrons, electrodes in said vessel adapted to cause the said photoelectrons to be distributed in a pattern upon said member in conformity with said image, and means whereby said pattern is converted into permanent form, comprising means for moving said member out of the influence of the emitted photoelectrons, while retaining said pattern on the member, and means for evaporating positively charged material onto said member while out of the influence of said emitted electrons.

9. In an electron camera, means forming a photoelectric surface, means for causing emission of the photoelectrons in a pattern from the surface, means forming a positively charged surface spaced from the photoelectric surface, an insulation member interposed in the space between the photoelectric surface and the positively charged surface, and adapted to receive and retain said photoelectrons, whereby a negative charge is formed on said member, means for moving said member away from the positively charged surface to increase the potential of the photoelectrons on said insulation member, and a source of positively charged particles arranged to be attracted to the member in its moved position, and to be attached thereto in conformity with the pattern.

10. In an electron camera, a vessel, a rotary stop cock for dividing the space in the vessel into two compartments, said vessel providing a seat for the stop cock, means forming a photoelectric surface in one of the compartments, and means comprising a positively charged plate, causing emitted photoelectrons to pass through the cock when it is in open position, and located in the other compartment.

11. In an electron camera, a vessel, a rotary

stop cock for dividing the space in the vessel into two compartments, said vessel providing a seat for the stop cock, means forming a photoelectric surface in one of the compartments, means causing emitted photoelectrons to pass through the cock when it is in open position, and located in the other compartment, means in the vessel for focusing the stream of photoelectrons, an insulation member capable of receiving and retaining the photoelectrons in a definite focused pattern, 10

said photoelectrons forming a negative charge on said member, and means forming a source of positively charged particles disposed within the vessel, spaced from said member and so located with respect thereto that the charge on said member is effective to attract particles from said source to the member, whereby said pattern is converted into permanent form. 5

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