Oct. 28, 1930. O. ACKERMANN 1,779,794

OSCILLOGRAPH

Filed June 22, 1929

Fig. 1.

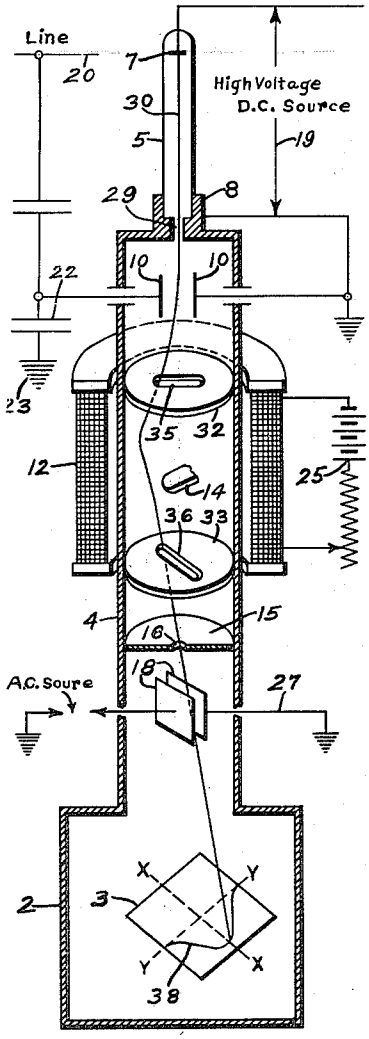


Fig. 2.

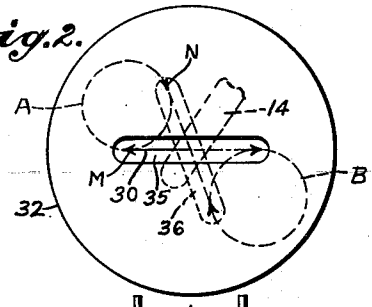


Fig. 3.

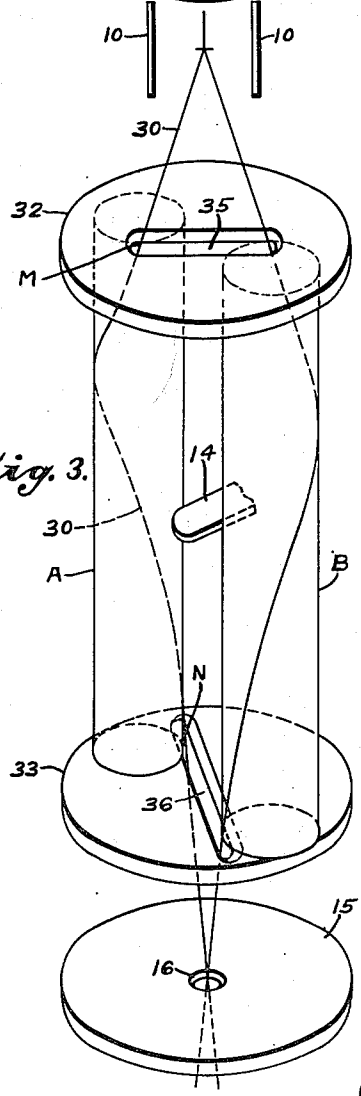
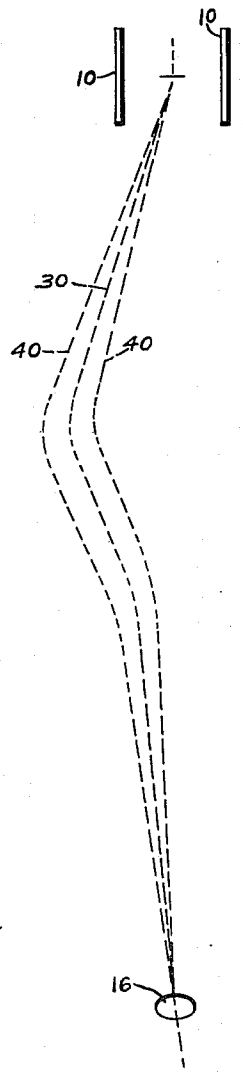


Fig. 4.



INVENTOR
Otto Ackermann

BY
Charles Lucas
ATTORNEY

Patented Oct. 28, 1930 1,779,794

UNITED STATES PATENT OFFICE

OTTO ACKERMANN, OF WILKINSBURG, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA

OSCILLOGRAPH

Application filed June 22, 1929. Serial No. 373,042.

My invention relates to electrical apparatus, such as oscillographs, and particularly to electrical-discharge or cathode-beam oscillographs.

One object of my invention is to provide a device of the above indicated character that shall comprise fewer parts than similar devices heretofore employed.

Another object of my invention is to provide a single or unitary device or means that shall perform the function of a plurality of elements heretofore employed.

Another object of my invention is to provide an oscillograph, of the cathode-beam type and embodying a target and an apertured shield, that shall provide greater deflection of the beam for a given space and that shall permit both the target and the opening in the shield to be smaller than in similar devices heretofore employed.

A further object of my invention is to provide an electrical apparatus that shall be simple and durable in construction, economical to manufacture and effective in its operation.

Heretofore, in cathode-beam oscillographs for deflecting the beam in accordance with a quantity to be measured on a sensitized record chart, it has been usual to protect the chart from diffusion of the beam, during periods that the beam is not being deflected from its neutral or zero position, to interpose a beam-absorbing target and a shield having an aperture in line with the beam in the neutral position thereof.

In order to direct the beam, aside from the target, through the shield opening, it has been usual to provide flux-producing means, such as condenser plates, for initially deflecting the beam, a second flux-producing means for re-directing the deflected beam and a third flux-producing means for concentrating the beam. A fourth flux-producing means is also usually provided to further deflect the beam in accordance with a time constant.

In practicing my invention, I provide a single or unitary device, means, or entity which both concentrates and re-directs the beam, after it has been initially deflected, thereby replacing a plurality of devices or means, such as the second and third means mentioned above, by a single entity and correspondingly simplifying, by reducing the number of parts and the size of the apparatus and rendering it more effective.

Fig. 1, of the accompanying drawing, is a diagrammatic view of an oscillograph embodying my invention, together with a diagram of appurtenant circuits and apparatus for rendering it operative.

Fig. 2, is a top plan view of a diagrammatic structure shown in Fig. 3.

Fig. 3 is an enlarged view of a portion of the device shown in Fig. 1, with certain spaces represented as geometric solids, and

Fig. 4 is a diagrammatic representation of a space discharge or beam, illustrating how it diffuses from a position near its origin and becomes concentrated before reaching its objective.

Referring to Fig. 1, the device comprises, in general, a fluid-tight vessel or container having a lower-end or base chamber portion 2 for the reception of a record-receiving element 3, an intermediate or beam-control chamber portion 4 and a top or electrode chamber 5, a cathode 7, an anode 8, initial beam or trace-deflecting means, such as condenser plates 10, a concentration coil 12, a target 14, a shield 15 having an aperture 16 therein, further beam-control means, such as condenser plates 18, a source 19 of electromotive force for energizing the electrodes 7 and 8, a transmission line or other circuit 20, a voltage of which is to be measured, a voltage-reducing device 22 for energizing the condenser plates 10 in proportion to the voltage between the line 20 and the ground 23, a source 25 of electromotive force for the concentration coil 12 and a circuit 27 for energizing the condenser plates 18.

The vessel, comprising the parts 2, 4, and 5, may be of any suitable construction that is sufficiently vacuum or gas tight; the parts 2 and 4 being preferably of metal and the part 5 preferably of glass.

The lower-end or base chamber portion 2 may be variously constructed, as by having a door, not shown, for the reception of the

record element 3, by having one of its walls of glass or other material whereby the element 3 may receive its record through such wall, or be otherwise constructed to receive a stationary record plate, as shown, or a movable plate or roll, as is well known in the art.

The anode 8 is provided with an opening 29 through which a beam 30, in the form of a permeable trace through space or an electrical discharge from the cathode 7, is normally projected along a line intercepting the target 14 and extending through the opening 16 in the shield 15.

The concentration coil 12, suitably spaced from and located beneath the condenser plates 10, is preferably located outside the intermediate chamber portion 4, as illustrated, although it may be disposed within the chamber by reducing the size of the coil or by enlarging the size of the chamber at this position.

Upper and lower magnetic disks 32 and 33, respectively, are disposed substantially in the planes of the ends of the coil 12 and are provided with slots 35 and 36, respectively, through which the beam 30 may pass. The coil 12 and the disks 32 and 33 are supported in the relations shown in any suitable manner, these elements, 12, 32, and 33 together constituting the single means, unitary device or entity for performing the double function of concentrating and deflecting or redirecting the beam 30, as will hereinafter more fully appear.

The target 14 is supported centrally, with respect to the length and diameter of the coil 12, in any suitable manner, not shown, and, while preferably grounded, may be insulated from ground or have a potential impressed thereon.

The shield 15, supported in the chamber portion 4, is preferably of metal.

The condenser plates 18 are disposed with respect to the beam 30 in such manner that, when the beam 30 tends to move therebetween, in a plane substantially parallel thereto, it is also deflected by a voltage from the circuit 27 at right angles to that plane and proportional to the second magnitude quantity measured, such as time, amperes or other quantity.

In operation, under normal conditions in the line 20, the beam 30 projects in a direct line from the cathode 7, through the anode opening 29, through a position between the condenser plates 10 and through the slot 35, to the target 14 by which it is absorbed. The target, being over the opening 16 in the shield 15, protects the sensitized element 3 against fogging by diffusion rays from the beam 30.

When a voltage surge occurs on the line 20, by an inductive lightning charge or other cause, the proportionately increased voltage between the condenser plates 10 causes a deflection of the beam by a space effect or electrostatic field action between the plates 10. Such deflection is illustrated, in Fig. 1, whereby the beam 30 extends, between a position adjacent to the center of the space between the plates 10 and through a position adjacent to the left end of the slot 35, to a left-side-center position in the coil 12.

During transit through the coil 12, the beam 30 is twisted, as is hereinafter more fully explained in connection with Figs. 2 and 3, so that it emerges from the lower slot 36, at an angle to its line of entry, to the upper slot 35. Irrespective of the degree or amplitude of deflection sufficient to cause the beam to bypass the target 14, the beam is always focused or directed through the opening 16 in the shield 15 and, if the condenser plates 18 are deenergized, oscillates back and forth between these plates in a plane substantially parallel thereto to record a line X—X on the record element or plate 3. The line X—X, under such conditions, is an indication of the maximum deflection of one or more deflections of the beam.

However, to obtain a time-voltage wave or curve record 38 on the element 3, the condenser plates 18, are energized and disposed to deflect the beam at right angles to its original deflection along the line X—X in the direction of a line Y—Y of the element, the resultant movement of the beam causing the curve 38.

In similar oscillographs heretofore employed, the condenser plates which are displaced by the coil 12 hereof, were necessarily of flat-plane shape and in parallel-plane relation, the size of such plates and the diameter of the intermediate chamber portion thus depending on each other. In other words, with the chamber portion 4 of the diameter shown herein, the condenser plates which might replace the coil 12, for deflecting purpose only, would limit the amplitude of beam deflection considerably, as compared with the amplitude permitted by my device. In this device, the amplitude of beam deflection is limited only by the diameter of the chamber 4 and not by condenser plates that could be placed therein.

By reason of this increased deflection, the blind spot caused on the curve 38 when the beam passes laterally over the target 14 becomes a smaller proportion of the curve. Further, by the construction shown, both the target 14 and the opening 16 may be smaller.

Referring to Figs. 2 and 3, in which corresponding parts are designated by corresponding reference characters, cylinders A and B are illustrated which, however, are not actually solids or structural elements in the device but are only outlines of cylindrical spaces about which the beam 30 is helically twisted by a space or magnetic-field effect thereon of the coil 12.

When the beam 30 is deflected to the left, as viewed in Fig. 3, by the effect of the plates 10,

it pivots about a center point between the plates 10 and along the straight-line slot 35 to a point M adjacent to the upper-end perimeter of the cylinder A.

The plates 32 and 33 are of magnetic material to cause a straight-line magnetic field therebetween that shall be parallel to the cylinders A and B.

The beam 30, entering this straight-line field at the point M at an angle to the field lines, is reacted upon by these lines to cause the beam to twist helically about the cylinder A and to approach the lower slot 36 from a point N.

As viewed in Fig. 2, the point N is about 200° about the cylinder A from the point M.

As shown more clearly in Fig. 2, the beam 30 is tangent to the cylinder A at both its approaching position M and at its departing position N relative thereto, thereby causing the beam, after deflection from its central origin or zero path between the plates 10, to return to a point on this path at the aperture 16 in the shield 15.

The point between the plates 10 and the point at the aperture 16 are equidistant from the center of the coil 12 at which the target 14 is disposed.

Thus, aside from the helical or twisting effect on the beam, the coil 12 acts as a lens to return the beam to its neutral or origin line.

As the beam 30 above the plate 32 swings back toward the central axis of the plate along the slot 35, the cylinder A progressively decreases in diameter until, at said axis, the cylinder disappears entirely or becomes merged as a straight line coincident with the then straight-line beam which hits the target 14. During this movement, and so long as the cylinder A retains its identity as such, the beam 30 is helically twisted about the cylinder but finally resolves itself into a straight line at the central axis or origin line of the beam.

Continued deflection of the beam to the right of center above the plate 32 begins the creation of the space cylinder B which gradually grows larger until it reaches the maximum diameter illustrated and about which the beam is similarly helically twisted and in the same direction to that in which it is twisted about the cylinder A.

Irrespective of the helical twisting of the beam in the space between the plates 32 and 33, it pivots about the central point between the plates 10 in the plane of the slot 35 and about a point in the aperture 16 in the plane of the slot 36. Below the shield 15, the beam is again deflected by the space effect provided by the plates 18.

Referring to Fig. 4, the beam 30 is shown in the position it occupies in Fig. 1 and in the position it occupies at the left in Fig. 3. Lines 40 diagrammatically outline diffusion rays from the beam 30.

While the beam gradually increases its diffusion from the anode opening 29, it is still appreciably concentrated at the point between the plates 10 and, as it passes through the concentration coil 12, it is again concentrated at the point 16 to a degree substantially equal to its concentration at the point between the plates 10.

This action serves to give a sharp record or line 38 on the sensitized element 3.

Devices heretofore employed have utilized condenser plates similar to the plates 10 and 18 but have also used another set of plates therebetween to cause the deflection caused by the coil 12 herein and have required a further element or coil for concentrating the beam.

By my invention, the functions of the intermediate set of plates and coil or coils, which have been used for concentration purposes alone, have been combined in one unit or entity, namely, the coil 12 and its appurtenant parts, with a resultant saving of space, reduction in the number of parts, economy of manufacture and other advantages.

While I have shown and described a particular form of my invention, changes may be made therein without departing from the spirit and scope thereof, as set forth in the appended claims.

I claim as my invention:

1. In combination, means for projecting a permeable trace through space for producing a remote effect, and means including a unitary device providing a space effect affecting the trace to concentrate the same and to direct the trace in accordance with predetermined conditions.

2. In combination, in electrical apparatus, means for effecting an electrical space discharge, and means including a unitary device providing electrical space effect affecting the discharge to concentrate the same and to direct the discharge in accordance with predetermined conditions.

3. In combination, in electrical apparatus, means for maintaining an electrical discharge beam, means for preventing access of the beam to a predetermined position, and means for rendering said preventing means inoperative to prevent access of the beam to said position including a unitary device for directing and concentrating the beam.

4. In combination, in electrical apparatus, means for maintaining an electrical discharge beam, means for preventing access of the beam to a predetermined position, and means for rendering said preventing means inoperative to prevent access of the beam to said position including means for deflecting the beam and a unitary device for re-directing and concentrating the beam.

5. In combination, in electrical apparatus, means for maintaining an electrical discharge beam, means including a unitary device for concentrating the beam and deflect-

ing it in accordance with predetermined conditions, and means for re-directing the beam.

6. In combination, in electrical apparatus, means for maintaining an electrical discharge beam, means for deflecting the beam, means including a unitary device for concentrating the deflected beam and re-directing it, and means for deflecting the re-directed beam.

7. In combination, in electrical apparatus, means for maintaining an electrical discharge beam, means for preventing access of the beam to a predetermined position, means for rendering said preventing means inoperative to prevent access of the beam to said position including a unitary device for directing and concentrating the beam, and means for directing the beam after it has been directed by said device.

8. In combination, in electrical apparatus, means for maintaining an electrical discharge beam, means for preventing access of the beam to a predetermined position, means for rendering said preventing means inoperative to prevent access of the beam to said position including means for deflecting the beam and a unitary device for re-directing and concentrating the beam, and means for further directing the re-directed beam.

9. In combination, in electrical apparatus, means for maintaining an electrical discharge beam, an element having an opening through which said beam may pass, and means including a unitary device for concentrating the beam and directing it toward said opening.

10. In combination, in electrical apparatus, means for maintaining an electrical discharge beam, an element having an opening through which said beam may pass toward predetermined position, means for preventing access of the beam to said position, means for rendering said preventing means inoperative to prevent access of the beam to said position including means for deflecting the beam and a unitary device for concentrating the beam and directing it toward said opening, and means for directing the beam after it has passed through said opening.

11. In combination, in an oscillograph, means including spaced electrodes energized by a source of constant voltage for maintaining an electrical discharge beam, means for preventing access of the beam to predetermined position including a shield having an opening and a target over said opening, and means for deflecting the beam around said target through said opening including means energized by a variable voltage for deflecting the beam and unitary means energized by a constant voltage for concentrating and redirecting the beam.

12. In combination, in an oscillograph, means including spaced electrodes energized by a source of constant voltage for maintaining an electrical discharge beam, means for preventing access of the beam to predetermined position including a shield having an opening and a target over said opening, means for deflecting the beam around said target through said opening including means energized by a variable voltage for deflecting the beam and unitary means energized by a constant voltage for concentrating and redirecting the beam, and means energized by another voltage for further deflecting the beam in accordance with a time constant.

13. In an oscillograph, means for positioning a sensitized record sheet, means including spaced electrodes energized by a source of constant voltage for maintaining an electrical discharge beam, a shield having an opening, a target on a line between said opening and the original zero line of the beam, means for deflecting the beam around said target in accordance with a quantity to be measured, a single coil for concentrating and redirecting the deflected beam through said opening onto said record sheet, and means for deflecting the beam after it has been passed through said opening.

14. In a cathode-beam oscillograph, a cathode, an apertured anode through which a cathode beam is projected, means for deflecting the beam as it comes from the anode, means including a single coil for concentrating and redirecting the deflected beam, a target in a space surrounded by said coil, an apertured shield toward the aperture of which the beam is directed by said coil, means for deflecting the beam after it passes through said shield, and means for recording movement of the beam.

15. In a cathode-beam oscillograph, a fluid-tight vessel including a base-end recording-chamber portion, an intermediate beam-control chamber portion and a top-end electrode chamber portion, a cathode in the electrode-chamber adjacent the top-end thereof, an anode disposed, and having an opening communicating, between the electrode-chamber and the intermediate chamber through which a cathode beam passes, condenser elements in the intermediate chamber beneath the anode for deflecting the beam, a single coil beneath the condenser elements for concentrating and redirecting the beam, a target in the intermediate chamber surrounded by the coil, a shield in the intermediate chamber below the coil having an aperture toward which the beam is directed, and condenser elements in the intermediate chamber below the coil for deflecting the beam at right angles to its deflection, caused by said first condenser elements and the coil, after it passes through the shield.

16. In a cathode-beam oscillograph, a fluid-tight vessel including a base-end recording-chamber portion, an intermediate beam-control chamber portion and a top-end electrode chamber portion, a cathode in the elec-

trode-chamber adjacent the top-end thereof, an anode disposed, and having an opening communicating, between the electrode chamber and the intermediate chamber through which a cathode beam passes, condenser elements in the intermediate chamber beneath the anode for deflecting the beams, a single coil surrounding the intermediate chamber portion beneath the condenser elements for concentrating and redirecting the beam, slotted plates in the intermediate chamber adjacent to the ends of the coil, a target in the intermediate chamber surrounded by the coil between said plates, a shield in the intermediate chamber below the coil having an aperture through which the beam is directed, and condenser elements in the intermediate chamber below the coil for deflecting the beam at right angles to its deflection, caused by said first condenser elements and the coil, after it passes through the shield.

17. In electrical apparatus, means for generating an electrical-discharge beam, means for preventing access of said beam to a predetermined position, and means for rendering said preventing means inoperative to prevent access of the beam to said position, including a pair of deflecting plates and a concentrating coil.

18. In electrical apparatus, means for generating an electrical-discharge beam, a target positioned below said means for preventing access of said beam to a predetermined position, and means for rendering said target inoperative to prevent access of the beam to said position, including a pair of deflecting plates located between said first-named means and said target, and a concentrating coil positioned below said deflecting plates.

In testimony whereof, I have hereunto subscribed my name this 17th day of June, 1929.

OTTO ACKERMANN.