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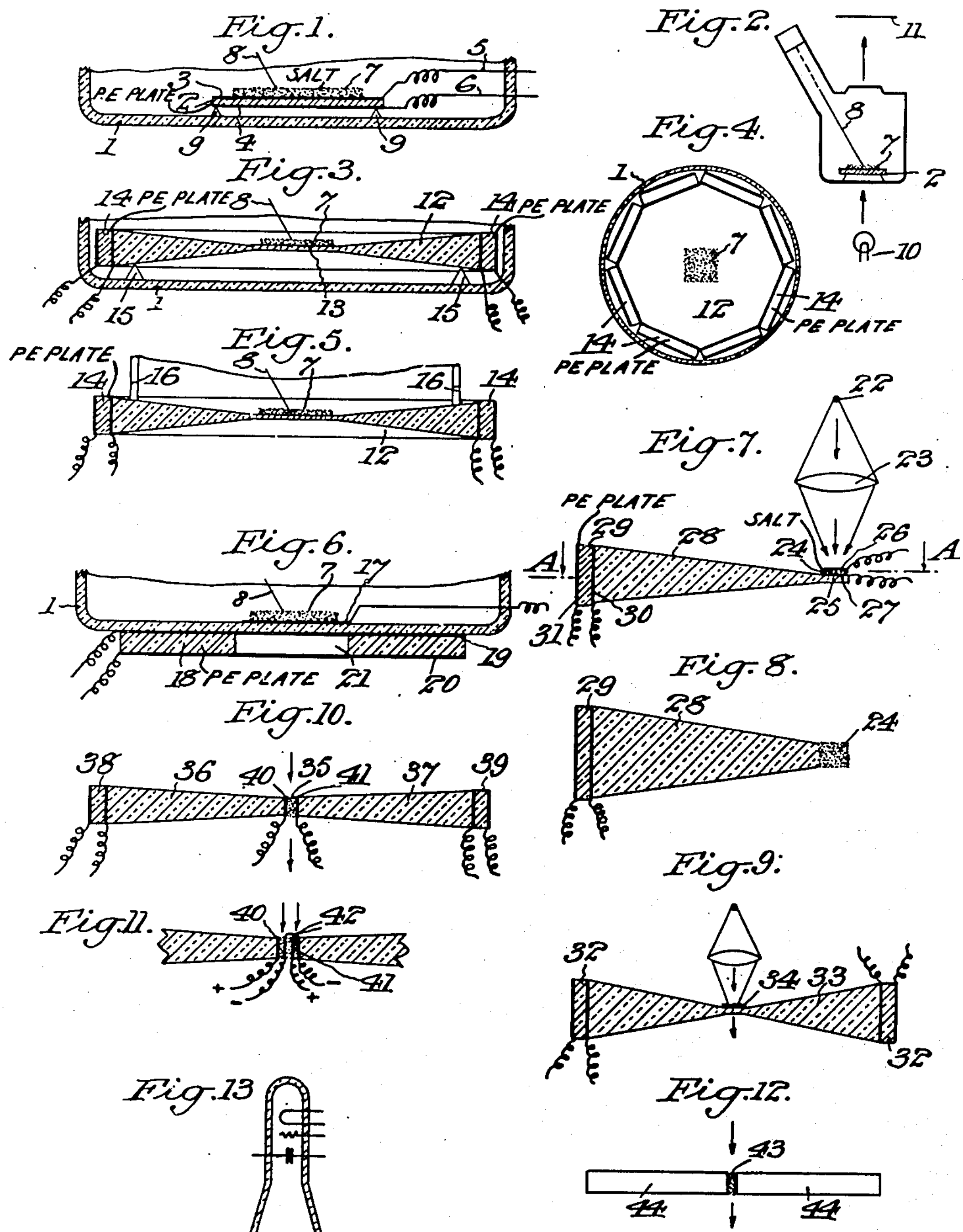
METHOD AND APPARATUS FOR IMPROVING THE RESPONSE OF RADIO-SENSITIVE SALTS

Filed June 15, 1945 — 2 Sheets-Sheet 1



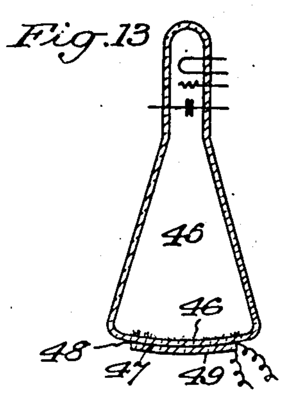


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Fig. 14.

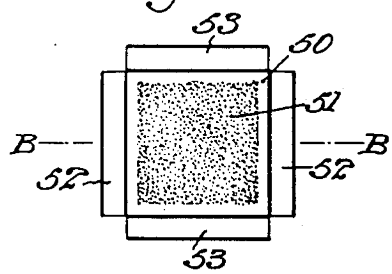


Fig. 16.

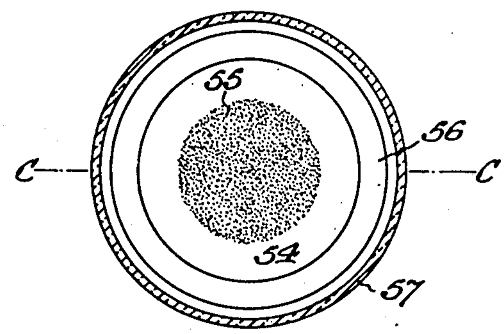


Fig. 15.

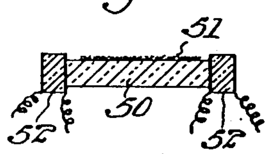


Fig. 17.

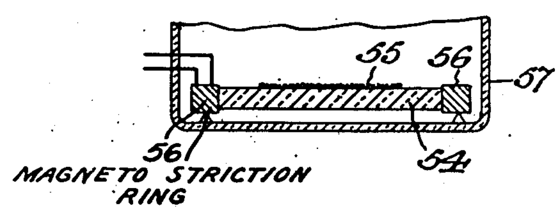


Fig. 19.

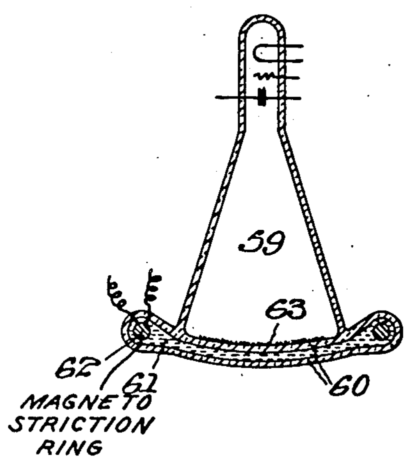
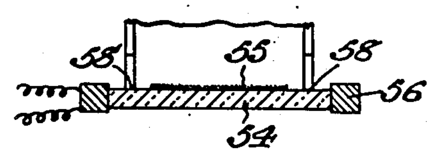


Fig. 18.



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METHOD AND APPARATUS FOR IMPROVING THE RESPONSE OF RADIO-SENSITIVE SALTS

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Application June 15, 1945, Serial No. 599,572

23 Claims. (Cl. 315—3)

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This invention relates to a method and apparatus for improving the response of radio-sensitive salts, and includes, the improvement of the functioning of crystals (particularly of halogen, salts, such as potassium chloride or bromide) which, when bombarded by cathode rays or by alpha and beta radium emanations, temporarily change their transparency and acquire coloration. It includes also improvement of the functioning of fluorescent screens covered with fluorescent powders (such as zinc sulfide and the like) which are used in cathode ray oscillographs.

Salts of the character described are used in television in which a beam of cathode rays is projected on a fine layer of a sensitive salt, the electrons causing formation of an opaque image which, in turn, may be projected on a large screen by suitable luminous and optical means.

It is also provided to use these layers of sensitive salts for controlling and modulating beams of light by applying variable potential at both sides of the layer, and obtaining coloration or blackening of the layer by exposing it to the action of alpha or beta rays of radium or other radioactive substances; or exposing the salts to the action of alpha or beta rays modulated in intensity, modulating also the light traversing the salt screen.

In the application of the sensitive salts as explained below, and in different other applications, generally two factors provide limitations: first, the rapidity with which the image (formed of opacities caused by the electrons traversing the salt) disappears under action of the difference of given potentials applied to the layer; and, second, sensitiveness of the salt, i. e., the degree of opacity produced by a particular number of electrons passing through the salt and momentarily present therein. Both may be considered matters of responsiveness of the salts.

According to the present invention, oscillations or mechanical vibrations of high frequency are maintained in the crystalline layer of sensitive salts when the layer functions as a screen of variable opacities (or this layer is exposed to such vibrations), thereby obtaining either more rapid disappearance of the opacity under action of a particular potential, or an increased intensity of the coloration of the opacity by the same number of electrons projected into the salt, or obtaining both effects at the same time.

Because of such increased rapidity of disappearance of the image, it is possible to obtain higher frequencies of reproduction of television images projected on a large screen, with the same or even smaller difference of potential applied to the layer of salt. It will also permit modulations of the light with frequencies considerably greater, e. g., acoustic or even supersonic.

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The increase of sensitiveness of the layer of sensitive salt exposed to cathode rays or alpha and beta rays and subjected at the same time to the action of high frequency vibrations may be explained as due to a certain dislocation of the crystalline network of the salt, caused by the high frequency vibrations. It is generally believed that free electrons, passing through the salt, are captured from time to time by the positive ions of alkalis, forming when captured, centers of the absorption of light. Such capture of the electrons takes place mainly at points where the molecular crystalline network is damaged, or at certain defective spots. High frequency mechanical vibrations of a sufficient intensity, traversing or saturating the crystalline layer, considerably increase the number of such defective points and, therefore, the frequency of the capture of the electrons, as well as the number of the colored centers formed thereby.

On the other hand, the increase of the rapidity of disappearance of the formed image by the action of supersonic vibrations can be partly explained by the same effect of dislocation of the crystalline network and by the increase of the average velocity of the electrons and the colored centers in certain similar cases of catalytic action by supersonic waves. In fact, in certain cases, the supersonic waves possess a catalytic action similar to the action produced by an increase in temperature (for instance, in cracking heavy oils, etc.). The rapidity of disappearance of the opaque image is considerably increased with the increase in temperature of the crystalline layer. However, in the majority of cases it is difficult or inconvenient to maintain this layer at a high temperature, for instance, of several hundred degrees C.; and the possibility of obtaining a similar result by the action of supersonic waves and without substantially raising the temperature, offers an important advantage.

Generally, the crystalline layer must be submitted to oscillations of sufficient intensity and of sufficiently high frequency to obtain the desired results clearly and without trouble. In many cases, there is a tendency to reach, at a certain intensity of supersonic waves, a point of saturation in the increase of sensitiveness and of the rapidity of disappearance of the image, and it is generally desirable to work near this limit of saturation in order to eliminate the influence of local intensity variations on the image.

The aforementioned catalytic phenomena can be obtained by using audible or supersonic frequencies. But it is preferred to use particularly high frequencies in order to obtain these effects without trouble. These high frequencies permit, on one hand, utilizing the phenomena of mechanical resonance of thin plates made of glass or of piezoelectric quartz, or even an artificial piezoelectric glass, these materials constituting generally a support for the crystalline layer and entraining this layer in vibrations; on the other hand, these high frequencies are useful in order to eliminate stationary waves and nodes of resonance which can be formed when the wave length is of the order of the linear dimensions of the screen support; and finally, the high frequencies make it possible to concentrate easily on the crystalline layer of salt a great amount of energy of the high frequency mechanical waves. It is preferable, for this reason—for instance, in television—to use wave lengths shorter than the linear dimensions of the image. For television, frequencies can reasonably vary, for instance, between several hundreds of thousands per second and several millions per second (assuming the supports to be of glass or quartz).

A combination of high frequency with an intensity near saturation can give particularly favorable results. However, oscillations of lower frequency (ultrasonic or even audible) which can be produced by magneto-striction devices may advantageously be used in some cases, due to the power and simplicity of such devices.

The invention also relates to fluorescent powders and to screens covered with fluorescent materials which are used in television tubes and in cathode ray oscillographs operated by a beam or pencil of cathode rays. In these cases it is desirable that the light emission of the fluorescent materials on the screen, excited by the cathode rays, should disappear sufficiently quickly after the cessation of the action of the rays, in order to give place to other following images.

According to the present invention these screens with fluorescent materials are submitted to the action of supersonics, or to the action of mechanical oscillations of very high frequency, in quite similar manner as used for the crystalline layer of sensitive salts. When these fluorescent screens are used for television the application to them of mechanical high frequency oscillations suppresses on them the phenomena of luminous after-glow, i. e., the delay in disappearance of light after suppression of cathodic bombardment. (Most fluorescent powders possess this characteristic.)

The reduction or suppression of the after-glow permits, in television, increasing the number (per second) of images available on the screen. In the cathode ray oscillograph the velocity of reproduction can be increased. The application of supersonics to such screens also frequently permits increasing the sensibility of these screens.

The invention will be better understood with the aid of the accompanying drawings given by way of an example, in which:

Fig. 1 represents a detail vertical section of the bottom of a cathode ray tube for television, provided with a sensitive salt screen on a piezoelectric plate;

Fig. 2 represents diagrammatically the whole of the tube, parts of which are shown in Fig. 1;

Fig. 3 represents a view similar to Fig. 1, showing a modification in which the salt screen is on a glass support having piezoelectric plates at its periphery;

Fig. 4 represents a top plan view, on a reduced scale, of the parts shown in Fig. 3;

Fig. 5 represents a modified form of the arrangement shown in Fig. 3;

Fig. 6 represents a view similar to Fig. 1, in which the piezoelectric material is on the outer surface of the tube;

Fig. 7 represents diagrammatically and in vertical section an application of the invention to the control of light passing through a layer of sensitive salt exposed to alpha and beta rays;

Fig. 8 represents a horizontal section on the line A—A of Fig. 7;

Fig. 9 represents a vertical section of an oscillation condenser, similar to that shown in Figs. 3 and 5, used for the control of light;

Fig. 10 represents a modified form of the arrangement shown in Fig. 9;

Fig. 11 represents a detail modification of the arrangement shown in Fig. 10;

Fig. 12 represents diagrammatically a modification applicable to the arrangements shown in Figs. 10 and 11;

Fig. 13 represents a vertical axial section of a cathode ray tube adapted for use as an oscillograph or for television;

Fig. 14 represents a plan view of a double-resonance oscillation generator;

Fig. 15 represents a vertical section on the line B—B of Fig. 14;

Fig. 16 represents a horizontal section of a tube containing a magneto-striction device (shown in plan view);

Fig. 17 represents a detail vertical section on the line C—C of Fig. 16;

Fig. 18 represents a detail vertical section of a modified form of magneto-striction device, and

Fig. 19 represents a vertical axial section of a cathode ray tube provided with a fluid-type magneto-striction device.

Referring to the drawings, and particularly Figs. 1 and 2 thereof, the cathode ray tube of a television receiver is shown at 1, this tube being intended for use in projection of an image on a large screen through a crystalline layer of a sensitive salt, scanned by a cathode ray. A thin plate of piezoelectric material 2 (such as quartz) having transparent metallic electrodes 3, 4 on its upper and lower surfaces is connected by the wires 5, 6 to a source of high electric frequency (not shown) outside of the tube. The plate 2 is adapted for mechanical oscillation in the direction of its thickness, and bears on its upper surface a layer of radio-sensitive salt 7; the electric frequency supplied to the plate being such as to maintain the plate 2 and layer 7 in high frequency mechanical oscillation. That is, the electric frequency corresponds to the resonant frequency of the plate as modified by the presence of the layer of salt deposited thereon. The layer 7 is scanned by the cathode beam or pencil 8, the electrode 3 being arranged to serve also as the anode of the layer. The plate 2 is shown as supported and secured to the wall of the tube 1 by suitable supports 9. A transparent metallic cathode may be applied to the top surface of the salt layer if necessary. The arrows in Fig. 2 indicate the passage of light from a source 10 for projecting the image formed in the layer 7 onto a larger screen 11.

In Figs. 3 and 4 the layer of sensitive salt 7 is shown as being deposited on a glass plate 12 which is relatively thick at its periphery and tapers to a relatively thin center portion 13 on which the salt layer is deposited. Piezoelectric quartz plates 14 are mounted at selected points or all around the periphery of the glass plate 12, as shown in Fig. 4, the quartz plates being provided with suitable electrodes and connections and being arranged to oscillate axially of the plate 12. The high frequency mechanical oscillations thus communicated to the plate 12 are concentrated in the thin center portion 13 where they can readily reach great intensity (compared to the oscillations of the individual quartz plates 14) and result, of course, in corresponding oscillation of the salt layer 7. The assembly of parts 7, 12, 13 and 14 is shown as mounted in the cathode ray tube 1 by means of supports 15 of any suitable character.

Fig. 5 shows the same assembly of parts mounted on a cathode ray tube in such a manner that the glass plate 12 constitutes the end of the tube, the side walls 16 of the tube being cemented or welded to the upper surface of the plate 12 near its periphery. This arrangement has the advantage that the quartz plates 14 are located outside the tube. The multiple oscillation generators (plates 14) may be replaced by a single circular generator, for instance, of artificial or synthetic piezoelectric material, in which case the periphery of the plate 12 would be circular. It is also possible to use oscillation generators of the piezoelectric sandwich type, or (for lower frequencies) suitably adjusted generators operating by magneto-striction.

A simplified arrangement is shown in Fig. 6 where the layer of sensitive salt crystals 7 is deposited directly on the wall of the cathode ray tube 1, with the interposition only of the transparent anode 17. Mechanical oscillations are communicated to the layer 7 from the bottom wall of the tube, on which is mounted a piezoelectric quartz plate 18 having electrodes 19 and 20. The plate 18 may be annular, as shown, leaving an opening 21 opposite the layer 7, or it may be a solid disc, in which case the electrodes must be transparent at least in the area opposite the said layer. The wall of the tube adjacent the plate 18 should be of uniform thickness so as to form, with the plate, a body capable of vibrating at a definite resonant frequency of mechanical oscillations.

Figs. 7 and 8 show the application of the invention to the control of light passing through a bed of sensitive salt crystals exposed to alpha and beta rays and blackened thereby, such control being effected by variation of the electric potential applied to the layer. In Fig. 7, light from the source 22 is concentrated by the lens 23 on the bed of crystals 24 carried by a glass support 25. A radioactive substance, such as radium, may be incorporated in the bed of crystals 24 or may be placed outside said bed. The electrodes 26, 27 apply to the bed 24 a field of electric potential which may be varied and which thus, by its modulation or by the modulation of intensity of the applied rays, determines and modulates the degree of opacity (optical blackness) of the bed of crystals. The support 25 constitutes the projecting end of a conical or prismatic glass body 28. The generator of high frequency mechanical oscillations, shown as a quartz plate 29 having electrodes 30, 31, is fixed on the large end of the body 28 and the oscillations generated thereby are concentrated to a high intensity as they are transmitted to the support 25.

The high frequency mechanical oscillations thus applied to the bed 24 assure a more rapid response (in variation of opacity) of said bed and permit higher frequencies of modulation of the light passed or stopped by the bed of crystals.

In Fig. 9 is shown an oscillation generator 32 and condenser 33 of the type shown in Figs. 3, 4 and 5, but adapted for use in the control of light as in Figs. 7 and 8. The bed of crystals 34, subjected to the action of alpha and beta rays and of a modulated electric field, and located at the center of the condenser 33, can receive a strong concentration of high frequency mechanical oscillations from the oscillation generators 32.

A modified light-control device is shown in Fig. 10 wherein a bed of crystals 35 is placed between the smaller ends of oscillation-condensing cones or prisms 36, 37 (each similar to the body 28, Figs. 7 and 8), the larger ends of which bear oscillation generators (quartz plates) 38, 39 having suitable electrodes. The electrodes 40, 41 between the bed 35 and the ends of the condensers 36, 37 apply the modulated field to said bed and need not, in this case, be transparent. The light passes through the bed 35 in a direction perpendicular to the direction of the field, as indicated by the arrows. The bed of salt crystals may, if desired, be subdivided into separate layers, as indicated in Fig. 11, where three such layers are shown separated by additional field electrodes 42 alternating in sign with the electrodes 40 and 41.

According to Fig. 12 the bed of crystals 43 may be clamped between the ends of bars 44, arranged to oscillate in resonance according to their length. These bars may be of quartz and maintained in oscillation by transverse or longitudinal electric fields from a suitable oscillating circuit, not shown; or they may be of nickel and maintained in resonant oscillation by magneto-striction in a known manner.

Fig. 13 shows a cathode ray tube 45 having a layer of fluorescent material 46 constituting a screen on the inner surface of its end wall, such a tube being adapted for use as an oscillograph or for television reproduction. A plate of piezoelectric quartz 47, having transparent electrodes 48, 49 is applied to the outer surface of the end wall of the tube (with the best possible mechanical continuity) and the screen 46 may then be maintained in mechanical oscillation by the connection of the electrodes 48, 49 in an oscillating circuit having a frequency corresponding to the resonance of the plate 47, end wall of the tube, and screen 46. If the end of the tube is curved as shown, the quartz plate may be cut with the same curvature, or the end wall itself may be made of artificial piezoelectric glass, in which case the electrode 48 would be inside the tube.

Figs. 14 and 15 show a square glass plate 50 supporting a layer of radio-sensitive salt 51 and having piezoelectric quartz plates 52, 53 arranged in opposite pairs on its four side edges; suitable electrodes being provided so that the quartz plates will oscillate mechanically in the direction of their thickness. The glass plate is so proportioned that it can have multiple resonance in the direction of its length and width and will also resonate in the direction of its thickness when oscillations of a suitable frequency, with overtones, are applied to the edges by the quartz plates 52, 53. The device shown in Figs. 14 and 15 can be placed in a cathode ray tube or the like as indicated, for instance, in Figs. 1 and 2.

Figs. 16 and 17 show a circular glass plate 54 supporting a layer of radio-sensitive salt 55 and having fitted to its periphery a magneto-striction ring 56 (for instance, of the Kallmeyer type as shown in German Patent No. 620,872 of 1934). The parts just described may be mounted within a cathode ray tube 57, of the types shown in Fig. 2 or Fig. 13; or the plate 54 may be arranged to constitute the end wall of such a tube, as shown in Fig. 18, the side walls of the tube being sealed to the upper surface of the plate at 58, 58 so that the ring 56 is outside of the tube. When the ring is connected in a suitable electric circuit to act as an oscillation generator its oscillations are communicated to the glass plate as waves converging toward the center, and the layer of salt on the surface of the plate is thereby strongly oscillated.

The cathode ray tube 59 shown in Fig. 19 has its bottom formed by a double-walled hollow body 60 containing a fluid 61 (preferably non-conducting). The periphery of the body 60 is enlarged somewhat to accommodate a magneto-striction ring 62 (similar to the ring 56 in Figs. 17 and 18) which is immersed in the fluid 61 and transmits oscillations to said fluid and thus to the layer of radio-sensitive salt 63 on the upper surface of the body 60.

Since the improved response of the salts described herein results from the multiplication of "defects" or fissures in their crystalline structure by rapid oscillation of the salts, it is also contemplated that the salt crystals may be subjected to the prolonged action of high frequency mechanical oscillations prior to their use or during the formation of the crystalline layer. Such pre-treated salts exhibit a more rapid and, particularly, more intense response to the several radiations to which they may be sensitive.

Description of parts of the devices shown as "glass" is not intended to be restrictive, but includes materials which may be functionally equivalent, such as certain plastics. The mounting of oscillation generators in or on cathode ray tubes should, of course, be effected with due regard for the possible interference of the oscillations with the cathode ray apparatus; thus the connections between the generator and the tube may need to be of a suitable vibration-insulating type.

It will be understood that the drawings herein are largely diagrammatic as to their dimensions since, for instance, the layer of salt and the quartz plate are generally or frequently of such thinness that it would be difficult to show them with strict accuracy in small-scale drawings. It will also be understood that various changes may be made in the form, construction and arrangement of the several parts, without departing from the spirit and scope of my invention, and hence I do not intend to be limited to the details herein shown and described, except as they may be included in the claims.

What I claim is:

1. The method of improving the response of radio-sensitive salts which includes, providing a compact solid body of radio-sensitive halogen salt, applying an electric field to said salt, exposing said salt to radiations adapted to modify the opacity of said salt, projecting a beam of light on a line passing through said salt, and subjecting said salt to the action of mechanical oscillations of at least audio-frequency simultaneously with the action of said electric field and said radiations.

2. The method of improving the response of radio-sensitive salts which includes, providing a compact solid body of radio-sensitive halogen salt,

applying an electric field to said salt, exposing said salt to radiations adapted to modify the opacity of said salt, projecting a beam of light on a line passing through said salt, and subjecting said salt to the action of mechanical oscillations of greater than audio-frequency simultaneously with the action of said electric field and said radiations.

3. The method according to claim 1 in which the salt is in the form of a thin layer and in which the electric field is applied in a direction normal to the surfaces of said layer.

4. The method according to claim 2 in which the salt is in the form of a thin layer and in which the electric field is applied in a direction normal to the surfaces of said layer.

5. Means for improving the response of radio-sensitive salts comprising, a compact solid body of radio-sensitive salt having the characteristic of exhibiting variable opacity when submitted to electronic bombardment, means for applying rays adapted to form opacity images in said salt, and a generator of mechanical oscillations in mechanical connection with said salt.

6. Means according to claim 5 in which the generator includes a piezoelectric plate.

7. Means according to claim 5 in which the generator includes a magneto-striction device.

8. Means according to claim 5 in which the salt is carried substantially directly by a piezoelectric plate, and in which the generator includes said plate.

9. Means according to claim 5 in which the salt is carried substantially directly by a glass element, and in which the generator includes a piezoelectric plate in mechanical connection with said element.

10. Means according to claim 5 in which the salt is carried substantially directly by a glass element, and in which the generator includes a magneto-striction device in mechanical connection with said element.

11. Means for improving the response of radio-sensitive salts comprising, a compact solid body of radio-sensitive salt, a solid support therefor, and a generator of mechanical oscillations in mechanical connection with said support, the mass of the support adjacent its connection with the generator being substantially greater than the mass adjacent the salt, whereby the oscillations communicated to the support by the generator are concentrated to a higher intensity in the area of the body of salt.

12. Means according to claim 11 in which the support is relatively thick at its periphery and relatively thin at its center, and in which the generator is connected to the periphery of the support and the salt is supported adjacent the center thereof.

13. Means according to claim 11 in which the support is relatively thick at one end and relatively thin at the other end, and in which the generator is connected to the thick end and the salt is supported adjacent the thin end.

14. Means for improving the response of radio-sensitive salts comprising, a thin layer of radio-sensitive salt, means for directing a beam of cathode rays on said layer, a piezoelectric quartz plate adapted for mechanical oscillation in the direction of its thickness, and transparent electrodes on the opposite surfaces of said plate, the layer of salt being supported on one of said surfaces.

15. Means for improving the response of radio-sensitive salts comprising, a thin layer of radio-

sensitive salt, means for directing a beam of cathode rays on said layer, a substantially circular glass support for said layer, the layer being disposed in the center of the support, a plurality of piezoelectric quartz plates secured to the periphery of the support, and electrodes on opposite faces of said plates.

16. Means according to claim 15 in which the quartz plates are adapted for mechanical oscillation in the direction of the plane of the support.

17. Means according to claim 15 in which the support is relatively thick at its periphery and tapers toward a relatively thin area at its center.

18. Means according to claim 15 in which the support forms one end of a cathode ray tube.

19. Means for improving the response of radiosensitive salts comprising, a thin layer of radiosensitive salt, means for directing a beam of cathode rays on said layer, a glass support for said layer, an annular piezoelectric plate secured to the surface of the support opposite to the surface which supports the layer, the center opening in said annular plate being disposed opposite the layer of salt, and annular electrodes on opposite faces of said plate.

20. Means for improving the response of radiosensitive salts comprising, a thin layer of radiosensitive salt, means for directing a beam of cathode rays on said layer, an oscillation-conductive support for said layer, and a magneto-striction oscillation generator connected to the periphery of said support.

21. Means according to claim 20 in which the support is a glass plate, and in which the generator includes a metallic ring surrounding said plate.

22. Means according to claim 20 in which the support is a hollow body filled with a fluid, and in which the generator includes a metallic ring in contact with said fluid.

23. Means according to claim 20 in which the support forms one end of a cathode ray tube.

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