

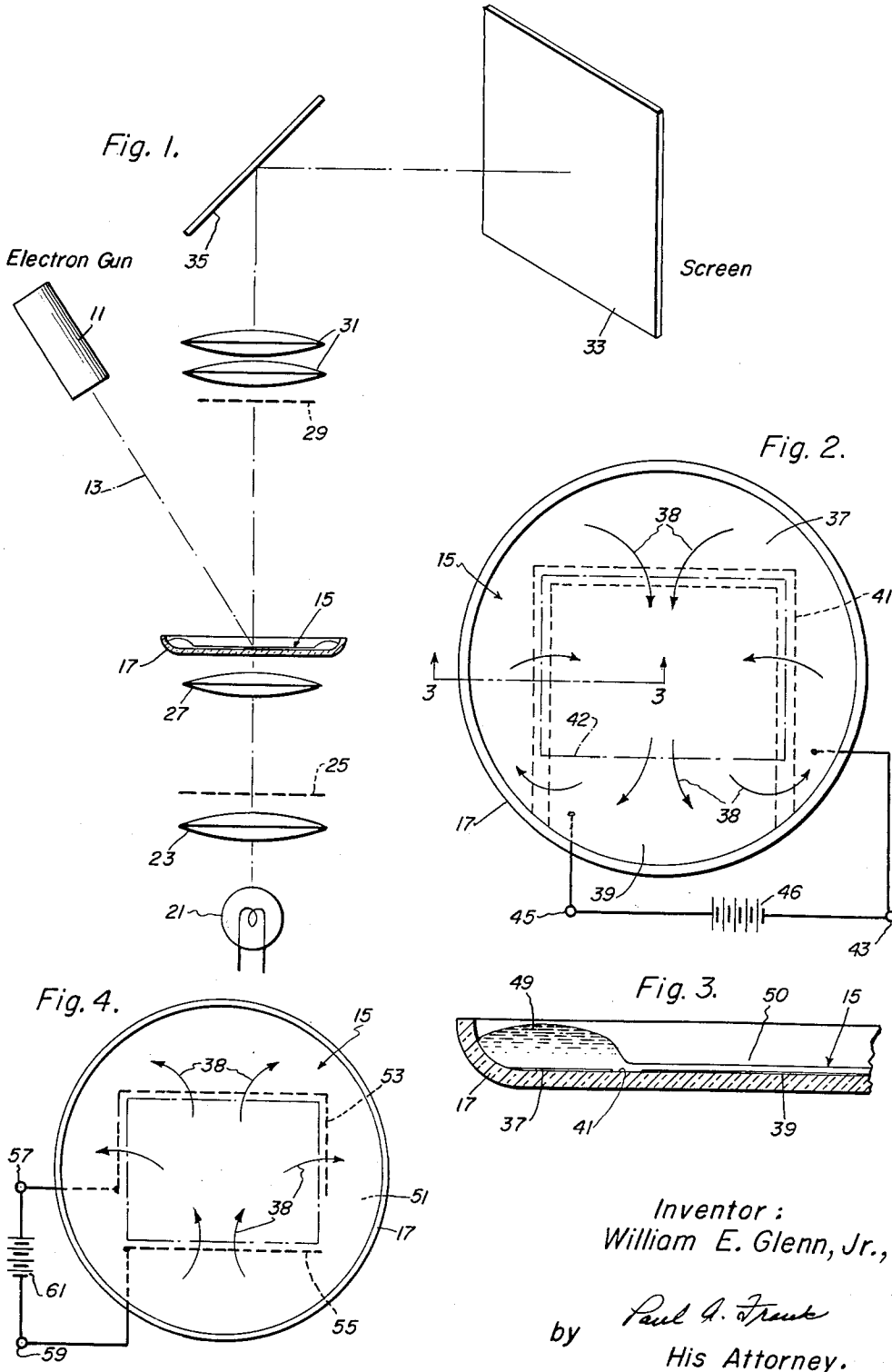
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PROJECTION TELEVISION SYSTEM

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The present invention relates to an improvement in a projection television system of the type in which an electron beam produces deformations in a liquid.

In some types of projection television systems, electrons are deposited on the surface of a deformable liquid by an electron beam that is modulated with an input television signal. The electrons, which are electrostatically attracted to the container for the liquid, produce deformations in the liquid surface that are utilized to diffract light in an optical system that produces a viewable image of the television signal as a function of the diffracted light. One such type of projection television system that is well known in the art is called the "Eidophor system."

Although for proper operation, the electron beam should only deform the liquid, after a short period of impingement it also produces an effect that is called "cross-linking," which is a decomposition of the liquid molecules by the electron beam and a subsequent combination of these molecules into different and longer molecules. These cross-linked molecules, which appear as lumps on the liquid surface, interfere with the signal deformations. Consequently, after a short period of use the liquid has to be replaced if the operation of the system is to be continued. Prior systems for replacing this liquid have been expensive, complex, and only partially satisfactory.

Accordingly, an object of the present invention is to provide an apparatus for diminishing the cross-linking effects of the deformable liquid in a projection television system.

Another object is to provide an inexpensive, simple apparatus for continuously circulating the liquid in a projection television system.

These and other objects are achieved in one embodiment of my invention in which I provide for the deformable liquid a container having two conducting portions separated by an insulated region and positioned such that at least a portion of the raster from an electron beam is over the insulated region. A direct voltage, applied across the two conducting portions, produces an electric field across the insulated region that causes the electrons on the portion of the raster over this region to move parallel to the liquid surface. In moving, the electrons transport the liquid in the raster region to the sides of the container where there is a large reservoir of liquid and thus also move liquid from this reservoir to the raster region.

The novel features that I believe are characteristic of my invention are set forth in the appended claims. My invention itself, however, together with further objects and advantages thereof, may best be understood by reference to the following description, taken in connection with the accompanying drawing in which:

Fig. 1 is a schematic representation of a transmission type projection television system,

Fig. 2 is a top plan view of a container embodying the present invention,

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Fig. 3 is a partial cross-sectional view taken along the line 3—3 of Fig. 2, and

Fig. 4 is a top plan view of another container embodying my invention.

In the several figures of the drawing, corresponding elements have been indicated by corresponding reference numerals to facilitate comparison, and those circuit elements which may in themselves be entirely conventional and whose details form no part of the present invention have been indicated in simplified block form with appropriate legends. Referring specifically to Fig. 1, I have illustrated an electron gun 11 that produces an electron beam 13, modulated by means (not shown) with an input electrical signal or signals and, deflected by suitable means (not shown) to form a rectangular raster over the surface of a deformable liquid 15 within a container 17. Liquid 15 must be transparent, have a high resistivity and be self-regulating or, in other words, have a finite thickness that is self-sustained and not diminished to zero by the electrons in the raster. Suitable materials for liquid 15 includes melted paraffin and melted white beeswax. Container 17 has a conducting coating on its interior surface to which the electrons on the surface of liquid 15 are electrostatically attracted. Due to this attraction they produce deformations in the surface of liquid 15 which correspond in amplitude with the modulation of beam 13. This coating, which is very thin, is not visible in the illustration of Fig. 1, but is shown in detail in other figures.

The light and optical system for converting the deformations of liquid 15 into a viewable image includes an extended light source 21 that is imaged by a lens 23 through a slit and bar system 25 on the surface of the liquid 15. Another lens 27 images, in the absence of deformations in the surface of liquid 15, the slits of bar and slit system 25 on the bars of another bar and slit system 29 so that in the absence of deformations no light passes through bar and slit system 29. However, any deformations which are present phase diffract the light so that some of it passes through the bar and slit system 29, the intensity of light so passing being a function of the amplitude of the deformation. A projection lens system 31 images the surface of liquid 15 on a screen 33 which receives the light from a mirror 35 that bends the light through a 90° angle. Of course the whole system illustrated in Fig. 1 must be enclosed in a vacuum envelope which has not been illustrated in order to simplify the drawing.

The electron beam 13 in striking liquid 15 eventually produces ionization of some of the liquid molecules, which, for example, if the liquid is a hydrocarbon, may result in the removal of hydrogen ions from a number of hydrocarbon molecules. Subsequently, several of these ionized molecules may unite to form a solid that produces lumps and thus noise deformations on the liquid surface that are readily visible in the viewable image.

In Fig. 2 I have illustrated a container 17 for the deformable liquid 15 that can be used to cause any cross-linked molecules to leave the raster area and to mix with a great quantity of non-cross-linked liquid outside of the raster area. The previously mentioned conducting coating on the bottom of container 17 is separated into two portions 37 and 39 that are insulated from each other by a U-shaped insulating region or strip 41 that has a width of the order of from 1/32 to 1/8 inch. Since container 17 is usually constructed from a non-conducting material such as glass, the insulating strip 41 may be formed by coating the bottom of container 17 with a transparent conducting coating and subsequently scratching a fairly wide U-shaped line in this coating. Suitable transparent conducting coatings, include, among others, tin oxide and copper iodide. Since portion 37 is outside the raster area, indicated by a dashed and dotted line 42, it may be

opaque. The raster preferably extends on three sides over the insulated strip 41 but not beyond it. A terminal 43 is provided for conducting portion 37 and another terminal 45 for portion 39 so that when a source of direct voltage 46, which should be of the order of 100 volts, is connected across these terminals an electric field is established across insulated strip 41.

Since some of the raster extends over strip 41 there are electrons on the surface of liquid 15 within the field established between the two conducting portions 37 and 39. With the indicated polarities at terminals 43 and 45, this field causes the electrons to move on the surface towards the center of container 17 and also down. In so moving, these electrons carry the liquid 15 with them in the directions indicated by the arrows 38. Consequently, any liquid in the raster area which has been at least partially cross-linked is circulated by the movement of the electrons to the non-raster areas where there is a large reservoir 49 of liquid. If the polarities on the portions 37, 39, are reverse, there is a similar liquid flow, although not as great, since with the polarities shown there is pressure inwardly on three sides of the raster area which causes the liquid in the raster area to thicken and thus permit increased flow.

The reservoir 49, which is better seen in the cross-sectional view of Fig. 3 extends completely around container 17 and exists wherever the raster is not present. This is because the electrons, which are present in large numbers only in the raster area, in being attracted to the coating 39 press in on the liquid 15 to diminish the thickness of the liquid under the raster area and leave a depressed region 50. The amount of liquid in region 50 is insignificant in comparison with the amount in the reservoir area 49. Consequently, when the cross-linked liquid in region 50 is removed to the reservoir 49, it does not materially affect the constitution of reservoir 49 until after many hours of operation after which the accumulation of cross-linked liquid may be considerable.

The container 17 of Fig. 2, although suitable for use in the transmission type projection television system of Fig. 1 may be used equally well with a reflection type projection television system. Then, at least the conducting coating 39 on the bottom of container 17 preferably comprises a reflecting material such as aluminum rather than a transparent material.

If high flow rates are used in the system of Fig. 2, the thickness of the liquid in the raster area becomes non-uniform due to non-uniform flow resulting from the electric field extending over only a portion of the raster area. This difficulty is eliminated by my container embodiment of Fig. 4 in which the field extends over the whole raster for more uniformity of flow. The bottom of the container 17 in Fig. 4 is coated with a transparent conducting film 51 that has a fairly high resistivity, for example of the order of 25,000 to 150,000 ohms per square, and which may be formed from tin oxide or copper iodide, as previously mentioned, with the thickness controlled to produce the desired resistivity. On this coating there is located a highly conducting strip 53; formed by a suitable material such as silver paste, separated from another highly conducting strip 55, the two strips having terminals 57 and 59, respectively. If a potential from a source 61 is applied between strips 57, 59, which are positioned outside the raster area, an electric field is established across the complete raster area. Because this field acts upon all of the electrons in the raster area rather than just a few, as in Fig. 2, greater uniformity of flow is obtained. The polarities of strips 53 and 55 may be reversed from those shown and adequate flow still obtained.

The container 17 of Fig. 4 can also be used with a reflection type television projection system in which case, of course, its interior would be covered with a reflecting coating. Unfortunately there is no known single coating that will produce reflection and also the desired resistivity.

However, a plurality of coatings may be used in which the coating next to the surface of container 17 is a multilayer insulated reflecting coating over which there is applied a transparent conducting coating such as tin oxide or copper iodide that provides the desired resistivity.

Although I have described my invention with respect to certain specific embodiments, it will be appreciated that many modifications and changes may be made by those skilled in the art without departing from the spirit of my invention. I intend, therefore, by the appended claims, to cover all such modifications and changes that fall within the true spirit and scope of my invention.

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

1. An apparatus comprising a container and a liquid in said container, means for subjecting said liquid to an electron beam, means for producing circulation of said liquid including a pair of spaced conductive members immersed in said liquid and being insulated from each other, means applying a unidirectional potential across said members to produce an electric field therebetween whereby the electrons received by said liquid from said beam are attracted by said electric field to the positivemost of said members to produce movement and circulation of said liquid propelled by electron motion between said members.

2. A container for containing and producing circulation of a liquid, the surface of which is subjected to an electron beam depositing electrons on said liquid, comprising a member shaped to contain the liquid, a first conducting coating on a first portion of the interior of said member, a second conducting coating on the second portion of the interior of said member, and a region of high resistivity separating said first and second conducting coatings, said region and portions of each of said coatings being directly beneath at least a portion of the liquid that is subjected to the electron beam whereby an electric field established between said coatings is effective to attract electrons on the liquid in said region to cause movement of said liquid across said region.

3. The container as defined in claim 2 wherein a direct potential is applied between said coatings to produce electric field.

4. A container for holding and producing flow of a liquid that is subjected to an electron beam that is deflected over the surface of the liquid to form a raster, comprising a member shaped to contain the liquid and having a substantially non-conducting interior, a first conducting coating applied to the interior of said member in a region that is completely exterior to the area beneath the raster produced by the electron beam, and a second conducting coating on the interior of said member and separated from said first conducting coating and having a large portion within the area under the raster produced by the electron beam whereby an electric field established between said coatings is effective to attract electrons on the liquid in said region to cause movement of said liquid across said region.

5. The container as defined in claim 4 wherein the edges of the conducting coating on the interior of said member are parallel with some edges of the raster and wherein some edges of the raster extend beyond the edges of said second conducting coating.

6. A container for containing and producing flow of a liquid that is subjected to an electron beam that is deflected over the surface of the liquid to form a raster, comprising a member shaped to contain the liquid and having a conducting interior surface that has a high resistivity, a first conducting coating applied to the interior of said member in a region that is exterior to the area beneath the raster, and a second conducting coating applied to the interior of said member in a region that is exterior to the area beneath the raster and on the side of said area remote from said first coating whereby a potential applied between said first and second conducting coatings

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establishes an electric field over substantially all of the raster area to produce circulation of said liquid by attraction of electrons deposited thereon between said coatings.

7. A container for containing and producing flow of a liquid that is subjected to an electron beam that is deflected over the surface of the liquid to form a raster, comprising a member shaped to contain the liquid, a high resistivity conducting coating on the interior of said member, a first conducting strip applied on said conducting coating in a region exterior to the area beneath the raster so that it extends substantially parallel to at least one edge of said raster, and a second conducting coating strip applied on said conducting coating in a region exterior to the area beneath the raster so that it extends substantially parallel to an edge opposite said one edge whereby an electric field established between said strips is effective to attract electrons on the liquid in said region to cause movement of said liquid across said region.

8. In a projection system in which a light modulating medium liquid is impinged by an electron beam to produce diffraction patterns, a container for the liquid comprising a member shaped to contain the liquid, two spaced conducting coatings positioned on said member, portions of said coatings and the space therebetween being covered by said liquid whereby application of a potential between said coatings establishes an electric field across said coatings substantially parallel to the surface of said liquid in

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a region including at least part of the surface of the liquid impinged by the electron beam.

9. A projection system comprising a liquid, a container for said liquid having two spaced conducting coatings, means for applying a direct potential across said coating and producing an electric field therebetween, means for impinging said liquid with an electron beam over at least part of the area separating said two coatings to produce an electron charge that forms diffraction patterns in said liquid, the electric field established between said coatings by said direct potential being effective to produce movement of electrons deposited on said liquid toward the positive-most of said coatings, a light source for projecting light on said liquid, a projection screen, means including slit and bar systems for masking said screen from light incident on said liquid except for at least some light diffracted by diffraction patterns in said liquid.

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