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H. STRÜBIG ET AL

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METHOD OF PROJECTING ELECTRICAL RECORDINGS

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Fig. 1.

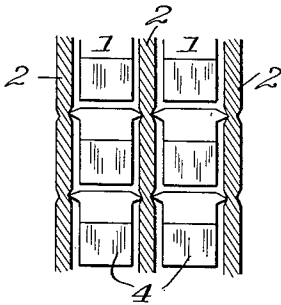


Fig. 2.

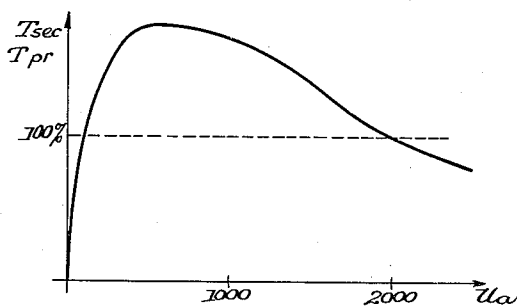
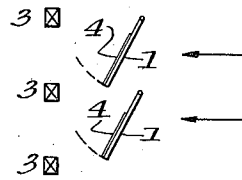


Fig. 3.

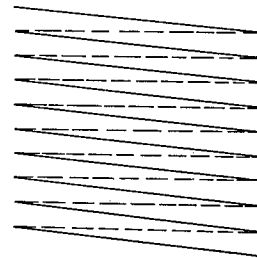


Fig. 4.

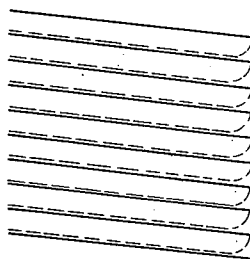


Fig. 5.

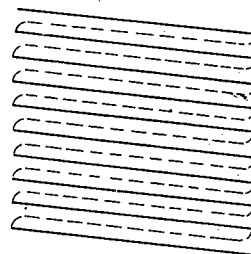


Fig. 6.

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METHOD OF PROJECTING ELECTRICAL RECORDINGS

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7 Claims. (Cl. 178-7.5)

This invention relates to a method of projecting recordings which are produced on a screen in rapid succession by means of a cathode ray beam. It is the object of the invention to provide a projection device with especially high efficiency.

It is known to place a screen within a cathode ray tube in which the electron beam is modulated with picture impulses of a television transmission, wherein the screen contains a plurality of movable elements, or so-called flippers, of elementary area. These flippers are more or less charged by the cathode ray so that they allow a certain amount of light from a constant light source to pass, this amount corresponding to the charge. A large, brilliant television image may be obtained by projecting the flipper screen upon a projection area.

In the known arrangement the flippers are discharged within one frame period by virtue of their connection with the solid framework by a material of suitable conductivity. The flippers discharge according to exponential function so that each individual light valve has practically returned to its initial position at the end of the frame period. Thus, the degree of useful modulation is not so large as it would be if the light valves had a constant opening over the entire period.

Furthermore, the light valves are completely open in the initial conditions and are controlled from light to dark by the ray. Therefore, the obtained images are considerably less rich in contrast than they would be when obtained from a device in which the light valves would be normally closed and opened only under the influence of the cathode ray. A further disadvantage lies in the fact that the flippers are to be moved away from their carrier by repulsion. The requirement for a so-called repulsion, however, is that a counterelectrode which attracts the flippers be provided in their proximity and held at a definite potential. The known device, however, lacks this counterelectrode.

These disadvantages are eliminated by this invention inasmuch as the recording remains unchanged between two recordings and is wiped out before each new recording by means of a second cathode ray beam or the same beam. If light valves constitute the elemental areas of the image, the amount of opening once conveyed to them remains practically the same during the entire time which elapses between two recordings. In this manner full use is made of the light source and flicker is eliminated.

The light valves remain, nearly without interruption, more or less widely open, and only a few of them will be closed for a short time. Thus, it is no longer necessary to operate at a certain minimum number of images per second for maximum brilliancy of the image. The number of images needs only to be such that there is sufficient smoothness of movements. This fact carries in itself the possibility of transmitting television signals on a considerably narrower frequency band than is usual at present.

If a suitable material is chosen for the impacted surface of the flippers, or if the velocity of the cathode ray beam is chosen suitably, it is possible to use the same cathode ray beam for the recording, that is, to convey various charges to the flippers as well as to wipe out this recording, that is, to neutralize all charges previously conveyed to the flippers.

The possibility of wiping out the recording by the same cathode ray beam is due to the fact that many materials assume an equilibrium potential when bombarded with electrons independently of the charge previously conveyed to them. This equilibrium potential is determined by liberation of secondary electrons. In the range in which the ratio of secondary electrons to primaries is greater than unity, the equilibrium potential is practically identical to the velocity expressed in volts with which the electrons impact.

For recording, use is also made of a cathode ray beam which would produce an equilibrium potential if it were allowed to remain at the same spot for a longer period of time. This ray, however, impacts each point only for a length of time corresponding to an individual elemental area and this time is also shorter in recording than would be required for acquiring the equilibrium potential. Consequently, the potential of each flipper is increased towards the value of the equilibrium potential corresponding to the recording cathode ray only by such an amount as may correspond to the instantaneous value of the beam current. If the cathode ray beam is modulated with picture impulses of a television transmission, a charged image is produced upon the screen which corresponds to the received transmission.

Referring to the drawing, Figs. 1 and 2 show an arrangement of several light valves in a picture screen. Fig. 3 illustrates the secondary emission as a function of the electron velocity. Figs. 4 to 6 illustrate methods of recording.

In Figs. 1 and 2 the picture elements have the shape of movable flippers 1. They are held by

the isolating rods 2, which may be for instance of glass, and their points of contact may be, for instance, point-shaped. Fig. 2 shows a side view of the arrangements. The electrons impact from the right. On the side of the screen remote from the electron gun is a foraminated counter electrode 3 of conducting wires, or similar material, which may serve as an attractor electrode for the entire set of flippers and is held at a certain potential. Attracting electrostatic forces appear in operation between the flippers and the electrode 3 which forces open the light valves more or less. The valves are closed in the unexcited state.

Fig. 3 shows the secondary emission of a material, such as, for instance, nickel, as a function of the electron velocity. As may be seen from the curve, the secondary emission is at first low at low electron velocities. At approximately 100 volts unity ratio of secondary emission is reached. Further increase of the electron velocity leads to a maximum of the secondary emission ratio, whereupon this ratio decreases and unity ratio is again reached at 2,000 volts, whereupon the ratio decreases further.

It may be seen that the potential difference between a flipper element and the cathode which will be obtained in the equilibrium when bombarding the flippers with electrons will depend upon the beam velocity. Thus, in the first range of the curve of Fig. 3, for secondary emission ratio less than unity, the potential difference will be zero; in the second range of secondary emission greater than unity the potential difference will correspond to the beam velocity; and in the third range of secondary emission less than unity the potential difference will be equal to the potential for the second unity ratio point, that is, in this case, about 2,000 volts. For other materials, for instance, soot, the curve has a different shape; namely, it stays below unity ratio over the entire range. Independently of the electron velocity, a soot surface bombarded by electrons will always seek to reach zero potential in the equilibrium.

From these facts, definite possibilities follow for recording and subsequent extinguishing by means of one or several cathode ray beams. The use of a second cathode ray beam for extinction has the advantage that the same deflecting fields may be used and that both rays traverse the same deflecting and lens fields. The extinction ray, in this case, consists of a constant high current. Both rays have a velocity of, for instance, 1500 volts. The arrangement can be made in such a manner that the recording ray impacts soot surfaces in one scanning line whereas the extinction ray scans nickel surfaces of the following line. In the first case the potentials of the flippers decrease towards zero by an amount corresponding to the instantaneous intensity of the cathode ray beam, whereas in the latter case all elements reach the equilibrium potential of 1500 volts. Flippers to be operated in this manner are shown in Figs. 1 and 2. Each element has, for instance, in its upper part a nickel surface, while the rest of the surface is covered with soot, as indicated by 4. It may be to advantage that the extinction ray leads the recording ray by not only one but several scanning lines.

Recording and extinguishing may also be accomplished by means of only one ray, whereby this ray records one line and simultaneously extinguishes the following line during each useful period of saw-tooth scanning. The beam may

have a velocity of, for instance, 1500 volts and simultaneously impact the soot surfaces of one line as well as the nickel surfaces of the following line. The flipper elements may be constructed exactly as described above and the identical physical effects occur. Below will be considered the difficulty that the amplitude modulated beam is modulated to complete cut-off in present-day methods and is, therefore, unsuitable for extinction of the following line during this period.

Another method which makes use of exactly the same light valves consists in having the cathode ray beam extinguish the following line during the retrace time between two useful scanning periods and, thereby, prepare this following line for a new recording. During the useful part of scanning, the ray will be focused solely upon the soot surfaces of the flippers of one line, whereas it will be solely focussed upon the nickel surfaces of the flippers of the following line during the retrace period. During the retrace period, which is only approximately 10% of the useful scanning period, the beam is given a constant intensity as high as possible in order to bring all flipper elements to the predetermined potential in spite of the shorter time.

The described methods may also be reversed so that the recording ray impacts the nickel surfaces and the extinction ray the soot surfaces. In place of a nickel and a soot surface, two metals, for instance, nickel, copper, silver, aluminum, may be combined as long as their equilibrium potentials are different. If both metals have a secondary emission ratio greater than unity in certain ranges of impacting velocity, the impacting velocity is suitably chosen in such a manner that it is in the range of greatest secondary emission ratio for one metal but for the other metal in a range where the secondary emission ratio has again dropped below unity. Instead of focusing the recording and extinction beam with the same velocity upon different materials, the system may be operated with identical materials if the velocities of the recording and the extinction beams differ. The extinction may then naturally occur only during the retrace period. The ray is given a velocity during the retrace period of, for instance, 1,000 volts at a high intensity, whereas its velocity during the useful period of scanning is, for instance, 2,000 volts. The homogeneous flipper elements are all brought to the equilibrium potential of 1,000 volts during the retrace period, whereas during the useful part of the scanning period their potentials increase towards the equilibrium potential of 2,000 volts corresponding to the velocity of the recording ray, by an amount corresponding to the instantaneous intensity of the beam. It is, however, required that a secondary emission ratio greater than unity occurs at least during one of the operations, that is, either recording or extinguishing.

Usually the extinction during the retrace period will require a special development of the line deflecting fields because the stage slope of the sawtooth wave obtained in Kipp circuits is by no means strictly linear. This is of no disadvantage as long as no use is made of the retrace period and only the more gradual slope is used for useful scanning. In this case, however, it will be to advantage to develop scanning generators which deliver a sawtooth output where not only the gradual slope but also the steep slope is strictly linearly proportional to the time. Furthermore, it will be necessary to modify the

low-frequency deflecting fields so that the retrace after each scanning line falls substantially exactly parallel between the recorded and the following line, or exactly upon the following line. So far the retrace was a more or less irregular curve, and in the past case a diagonal between two lines. Figs. 4 to 6 show a schematic comparison between the present-day method (Fig. 4) and the above-mentioned methods whereby the useful part of the scansion is shown by solid lines and the retrace by dotted lines.

In order to shift the retrace upon the following line (Fig. 5) the low frequency scanning waves are superimposed by an impulse of high frequency scanning frequency, whereby the amplitude of the impulse corresponds to the distance between lines and the duration of the impulse corresponds to the flyback time. The impulses usually have a steep front and then a linear, less steep slope. If the retrace is to be placed parallel between the records and the following line, impulses must be used which are, for instance, similar to an oscillation with an amplitude corresponding to half the distance between lines. In both cases it will be preferable to produce the impulses in separate circuits and apply them to a second deflecting system aiding the frame deflecting system.

If a cathode ray beam is focused upon two different surfaces which are conductively connected, a secondary emission ratio is obtained which is partly determined by one surface and partly by the other. This case occurs if the ray trespasses the edge of the impacted surface and partly falls upon the neighboring surface because of insufficient focusing. This may occur, for instance, at high beam current during the extinction. As long as the impacted portion of the neighboring surface is not sufficiently great to cause the total secondary emission ratio to become greater than or equal to unity, or smaller than or equal to unity, respectively, this effect will cause no disturbance. Furthermore, the possibility results of producing electrodes with arbitrary or variable secondary emission ratio. By deflecting the beam over the separating line between the two surfaces any secondary emission ratio may be obtained between the limits predetermined by the two pure surfaces.

It is a known fact that in an instrument which contains a stationary and a movable part between which electrostatic forces appear, the motion is approximately a square-law function of the applied voltage. Similar conditions prevail between the movable flipper elements and the electrode 3, of Fig. 2. This could introduce a distortion in the relation of signal intensity to projected light intensity in picture reproduction. Therefore, it is preferable to convey a certain predeflection to the flipper elements. In suitably constructed light valves of this type complete blocking of the light in the unexcited state of the flippers exists in spite of predeflection of the flippers. The deflection shown in Fig. 2 may correspond to the unexcited normal state as is produced by means of the extinction ray only. It may be seen that in spite of the flipper deflection, no light which falls perpendicular to the screened surfaces may pass through the valves. The predeflection may be accomplished by placing the screen at an angle to the vertical or by applying to the electrode 3 a potential which is greater than the potential to which the flipper elements can be charged by the ray. In this case the extinction ray may, for instance, be directed

upon a nickel surface and a potential of 2,500 volts is applied to the electrode 3. The ray then arrives with a velocity which corresponds to the upper range of the curve of Fig. 3, in which the secondary emission ratio has again fallen below unity. As already mentioned, the equilibrium potential of the impacted elements in this range will be about 2,000 volts independent of the beam velocity. Thus, a voltage of 500 volts between the elements and the counter electrode exists to begin with.

On the other hand, the fact that the motion is a square-law function of the voltage is favorable if it is desired that the recording and extinction shall be accomplished during the useful part of the scansion by means of only one ray. If a ray is used which is not modulated to cut-off but which possesses a certain minimum intensity, this minimum intensity will cause practically no motion of the flipper elements but will be sufficient for extinction of the following line.

In order to avoid resonant oscillations of the flippers, their natural frequency must be small in comparison with the picture frequency. Normally, the flippers will possess a slight amount of inertia. This is favorable because the valves will not completely close during the extinction but will immediately acquire a new position corresponding to the following recording.

This invention is naturally not limited to a screen in which a change of permeability to light is obtained by mechanical movement of flipper elements. This invention may also be applied to all other screens in which recording is extinguished by means of a cathode ray beam, for instance, such screens in which the percentage of reflection factor is varied.

We claim:

1. In a system for television reception having a screen whose light transmitting ability varies in response to electron bombardment, the method of operating such system comprising scanning said screen with a modulated cathode ray to build up a screen controlling charge image on said screen with primary electrons, binding the charge image elements of said charge image for substantially a complete scansion of said screen, and subsequently erasing said controlling image with secondary electrons.

2. In a system for television reception having a light valve screen whose light transmitting ability varies in response to electron bombardment, the method of operating such system comprising directing light of a constant intensity upon said screen, scanning said screen with a modulated cathode ray to build up a valve screen controlling charge image on said valve screen with primary electrons to thereby control the distribution of such light through said screen, maintaining the charge image elements of said image for a predetermined time period, and erasing said controlling image with secondary electrons.

3. In a system for television reception having a screen whose light transmitting ability varies in response to electron bombardment, the method of operating such system comprising creating a screen controlling image on said screen with primary electrons and subsequently scanning said screen with a beam of electrons to liberate secondary electrons therefrom, thereby to erase said controlling image with said secondary electrons.

4. In a system for television reception having a screen whose light transmitting ability varies

in response to electron bombardment, the method of operating such system comprising creating a screen controlling image on said screen with primary electrons and scanning said screen with a beam of electrons to liberate secondary electrons therefrom, thereby to erase said controlling image with said secondary electrons.

5. The method of controlling the light transmitting characteristics of a valve screen to produce a succession of light images comprising charging the elemental areas of said valve screen in varying amounts in accordance with the corresponding areas of the image to be produced, simultaneously illuminating one side of said screen with illumination of substantially constant intensity whereby said elemental area charges will determine passage of an illumination image through said screen, and subsequently bombarding elemental areas of said screen uniformly with electrons to alter said charges to a substantially uniform value in preparation for the production of another image.

6. The method of controlling the light transmitting characteristics of a valve screen to produce a succession of light images comprising charging the elemental areas of said screen in varying amounts in accordance with the corresponding areas of the image to be produced,

maintaining the elemental areas of said screen in their charged condition for a predetermined period of time, and subsequently bombarding said screen uniformly with electrons to reduce said charges to a substantially uniform minimum value in preparation for the production of another image.

7. In a television receiving system, a device of the cathode ray type having a valve screen whose light transmitting ability is responsive to electron charges placed thereon, a source of illumination of substantially constant intensity for directing a beam of illumination of substantially constant intensity upon one face of said screen, means for scanning said screen with a modulated beam of electrons to build up a charge image on said screen for enabling transmission of a corresponding illumination image therethrough, means for holding the elemental areas of said charge image substantially throughout a complete image building up period, and means for scanning said screen with an unmodulated beam of electrons subsequently to erase said charge image in preparation for a succeeding charge image.

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