Jan. 17, 1939. L. W. KOLOZSY 2,144,379

TELEVISION SYSTEM

Filed April 26, 1935 2 Sheets-Sheet 1

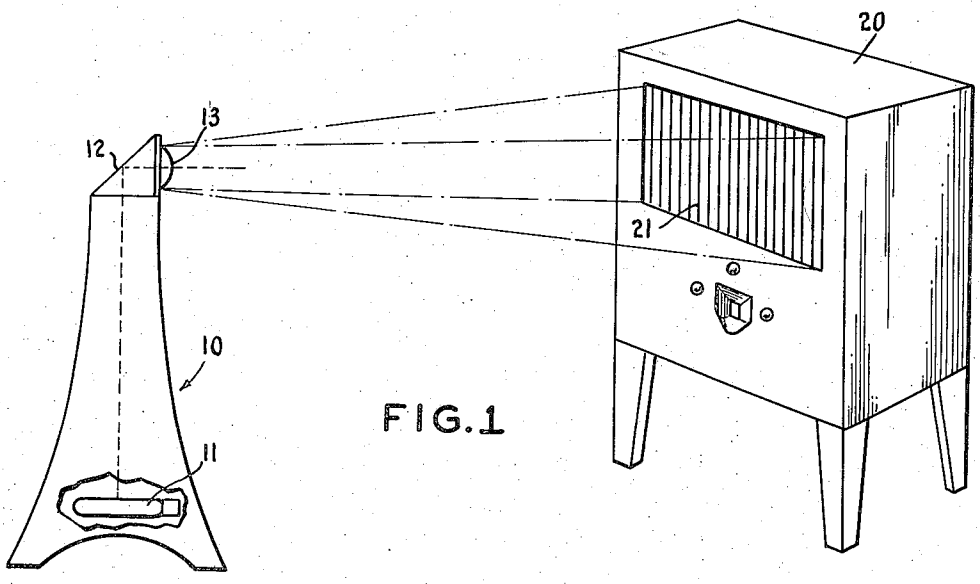


FIG. 1

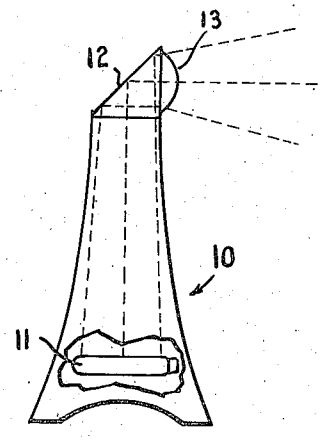


FIG. 3

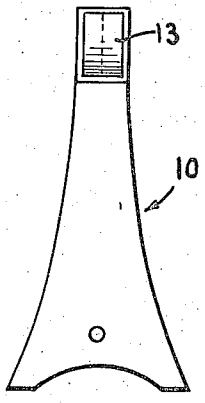


FIG. 2

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Jan. 17, 1939. L. W. KOLOZSY 2,144,379

TELEVISION SYSTEM

Filed April 26, 1935 2 Sheets-Sheet 2

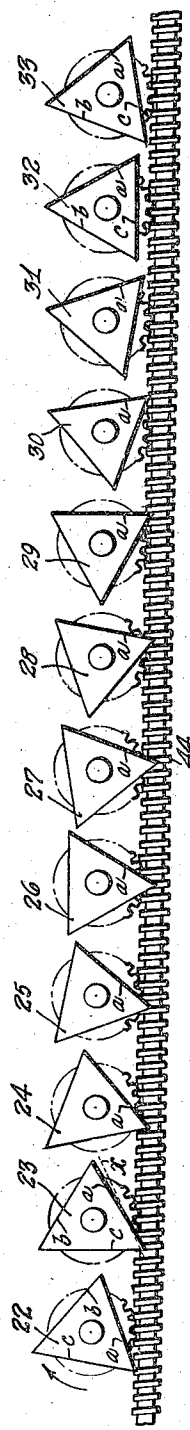


FIG. 4

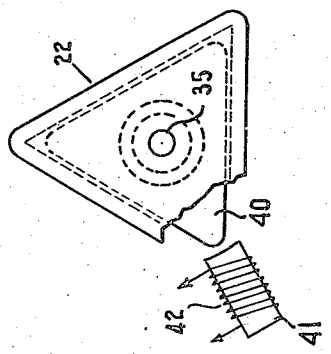


FIG. 6

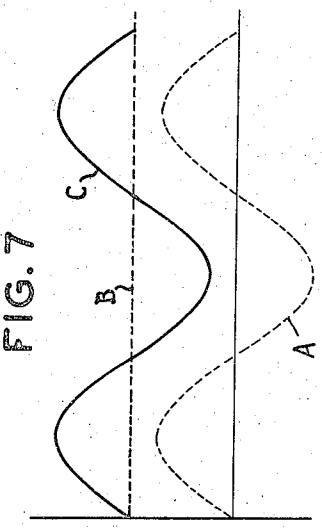


FIG. 7

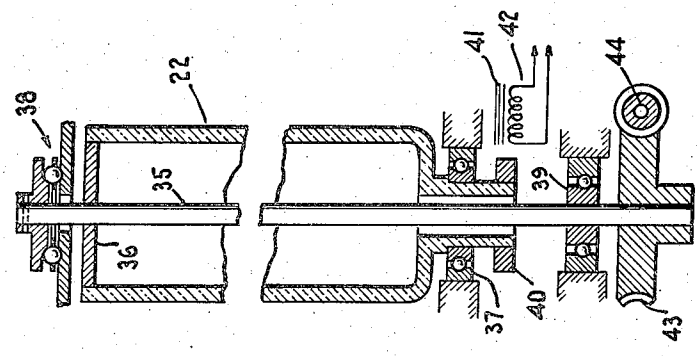


FIG. 5

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Patented Jan. 17, 1939 2,144,379

UNITED STATES PATENT OFFICE

2,144,379

TELEVISION SYSTEM

Louis W. Kolozsy, Astoria, N. Y., now by judicial change of name, Louis W. Parker

Application April 26, 1935, Serial No. 18,304

12 Claims. (Cl. 178—7.6)

This invention relates to the electrical transmission of pictures and images and more particularly to the electrical transmission of pictures or images at a relatively high rate of speed, commonly known as television. My invention is particularly concerned with apparatus for use at the receiving end of such systems, and for the purpose of this specification it will be assumed that there is available a signal transmitted according to any known system and representing the light intensities of successive elemental areas of the image to be reproduced, derived by scanning the subject in a series of straight lines in one direction, each successive line being slightly displaced at right angles to the direction of the line. I have assumed also that it is desired to produce twenty-four pictures per second of 240 lines each, but it will be understood that this is merely by way of example and for purposes of simplicity in explaining my invention, and that different numbers of pictures may be transmitted per second or a different number of lines per picture.

In general, television receiving systems such as heretofore proposed fall into two classes, the mechanical scanning system, and the cathode ray or electrical scanning system. Each of these two classes has certain advantages and disadvantages and neither of them as at present constituted is, in my opinion, completely satisfactory.

The cathode ray system is regarded by many as having advantages of simplicity and less mechanical complications, but it has other defects which have so far detracted from its usefulness. Among the difficulties of this type of system may be mentioned that of obtaining a picture large enough to be viewed by a fairly good sized audience. Even pictures as small as eight inches square are difficult to obtain with a cathode ray system, since the cost of the tubes, as now constructed, even for this relatively small size, is prohibitive.

It has been suggested to magnify an image produced by a cathode ray tube by means of a lens, but this has not proved to be practical because the angle through which the audience may view the picture is relatively small unless the lens is made extremely large. For a fairly good sized audience a field angle of 90° horizontally is desirable and at least 15° vertically.

In accordance with my invention I may utilize a cathode ray tube of new and improved construction and by control of the travel of the electron beam scan the screen in one direction and also vary the light intensity, but an ordinary cathode ray tube may be used, and modulated by any conventional means. I scan the screen in the other direction by means of a system of rotating mirrors providing a wide angle of view. The desired wide angle and magnification horizontally is afforded by the rotating mirrors. The vertical magnification in which the angle of the field of view is considerably smaller, may be provided by a lens and proper disposition of the screen of the tube.

In accordance with my invention I prefer to utilize a cathode ray to provide a vertical line of light traced by the moving luminous spot, the intensity of which is controlled as will be explained hereinafter, and I project this vertical line of light upon a series of closely spaced, vertically mounted, triangular mirror assemblies mounted side by side and arranged each for rotation about its own vertical axis.

The angle of the face vertical mirrors with respect to the plane of the screen and with respect to each other is so chosen together with the rate of speed of rotation of the mirrors, that upon rotation the vertical line of light appears at the extreme edge of the screen, say the left hand edge as the audience views it, and progressively travels across the first mirror to its right hand edge; thence on to the left hand edge of the second mirror; thence across the second mirror to its right hand edge; thence to the left hand edge of the third mirror, and so on progressively until it has completely crossed the screen, at which time the next line appears at the left hand edge of the screen and likewise travels across it, the whole process, of course, being sufficiently rapid so that the desired number of complete pictures per second are presented.

Among the objects of my invention are:

To provide an improved television receiving system capable of producing pictures of satisfactory detail and of considerably larger effective size than can be produced by known cathode ray systems and to avoid objectionable flickering of the pictures.

To provide new and improved forms of cathode ray tubes particularly adapted for use with my invention.

To provide new and improved rotary mirror systems particularly adapted for use with my invention.

To provide means for converting the uniform rotation of the prime mover of the mirror system into a cyclically varying speed of rotation.

To provide new and improved electrical cir-

cuits for controlling the intensity of the illumination.

To provide cathode ray tubes giving a greater effective illumination than has been heretofore possible.

To provide a new and improved cathode ray tube capable of producing in my system a larger picture than heretofore while reducing the cost and complexity and the manufacturing difficulties of producing the cathode ray tubes.

Still other objects and advantages of my invention will be apparent from the specification.

The features of novelty which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its fundamental principles and as to its particular embodiments will best be understood by reference to the specification and accompanying drawings, in which

Fig. 1 is a diagrammatic perspective view of a projector and receiving screen in accordance with my invention;

Figs. 2 and 3 are respectively front and side elevations, partly in section, of the projector according to my invention;

Fig. 4 is a diagrammatic plan view of the rotating mirror receiving screen in accordance with my invention;

Fig. 5 is a sectional elevation of a single mirror and its mounting as used in my receiving screen;

Fig. 6 is a diagrammatic view of a detail of the mirror speed control mechanism; and

Fig. 7 is a series of curves showing the relation between the speed of the prime mover and the speed of the mirror.

Referring now more particularly to Fig. 1, **10** designates generically the projector in which there is mounted the cathode ray tube **11**. The light from this cathode ray tube **11** is projected upwardly and falls upon the mirror or prism **12** which serves to direct it at right angles through the lens **13**, which is preferably a cylindrical lens arranged with its axis horizontal to give vertical magnification and to have substantially no effect horizontally. The light is projected upon the receiving screen **21**, mounted on the cabinet **20**, within which there may be provided the necessary receiving, amplifying and control apparatus; connections, not shown in Fig. 1, being provided between the receiver cabinet **20** and the projector **10**.

Assuming that the tube **11** produces in the projector head a vertical line of light as indicated in Fig. 2 (this being made up of a traveling spot traveling vertically but not horizontally), it will be seen that this line of light will be projected upon the screen.

The receiving screen is shown diagrammatically in Fig. 4, the view being a plan view. The screen is made up of a series of rotatable, triangularly arranged mirror assemblies, in this instance twelve being indicated by the numerals **22** to **33**, the vertical axes thereof being laterally aligned in the plane of the receiving screen. As will be seen, each of the mirror assemblies is, in horizontal section, in the form of an equilateral triangle, and each face thereof is approximately one inch in width. Vertically, the mirrors are whatever height of screen the system is designed for.

As will be noted from Fig. 4 the mirror assemblies are so mounted that the corresponding faces thereof are displaced 10° in a counter-clockwise direction, reading from left to right, when the mirror set is standing still. This will be seen by comparing the positions of the faces **22***a* to **33***a* inclusive.

All the mirror assemblies **22** to **33** are rotated simultaneously in the same direction, i. e., clockwise, and at the same rate of speed, by a common drive shaft **44** through worm gears **43**, as will be more fully hereinafter described.

In understanding the operation of this mirror system it will be appreciated that the full action takes place extremely rapidly when it is considered that 24 pictures, composed of a total of 5,760 lines, traverse the entire screen in each second. The action is, therefore, imperceptible to the naked eye in the detail in which it will be analyzed now.

The first step to understand is the movement of the picture lines of light across the screen to give the desired horizontal spreading or magnification. For this purpose the action will be described with reference to a single picture line of light. It is known that if a line is reflected in a mirror, and the mirror is rotated on its vertical axis, as in a clock-wise direction, that line of light will appear to move across the mirror toward the right, thus giving the effect of spreading the line of light if the action is fast enough to gain the effect through the persistence of vision.

Applying this phenomena to the present apparatus, and considering that the front of the screen is toward the bottom of Fig. 4, the line of light from the lens **13** will appear to an observer upon the face *a* of mirror **22**. As this mirror is rotated in a clock-wise direction, the line of light will appear to move across the face *a* of the mirror **22** toward the mirror **23**. By the time the mirror **22***a* reaches a position where its further movement will render it no longer effective to reflect the line of light to the observer, the line appears at the extreme right hand edge of mirror **22***a*, but by that time the mirror **23***a* has rotated so as to be in position (shown by dotted line A) to pick up the line of light, which it does as the rotation of the mirrors continues.

As mirror **23***a* rotates, the line of light again appears to move to the observer's right and, as mirror **23***a* is about to become ineffective to reflect the same to the observer, mirror **24***a* is then in position to pick up the line, which it does. Thus, the line of light forming the picture traverses the screen from the observer's left toward the right, and by reason of the rapidity of the action and the persistence of vision, the desired horizontal spreading is obtained.

It will be understood by those skilled in the art that the picture is made up of what appears to be 240 lines formed by the movement of the spot of light from the cathode ray tube in correspondence to the operation of the scanning apparatus. In this instance, the movement is vertically from the top of the screen to the bottom thereof so that the lines appear vertical.

Inasmuch as there are thirty-six mirrors, **22***a* to **33***c*, and the mirror assemblies **22** to **33** rotate eight times per second, each mirror surface reflects twenty picture lines during each interval that it is effective, or one-twelfth of the picture, and each line is of varying intensity in agreement with the particular portion of the picture being scanned. The rapidity with which the projected line of light moves across each mirror and from mirror to mirror is sufficiently fast

that the entire picture appears to the observer to fill the whole screen.

By the time the traversal is completed across mirror 33*a*, then mirror 22*b* is in position to reflect the first of the lines of the succeeding picture, and the action will pass from mirror 22*b* to mirror 23*b* to mirror 24*b*, and so on, across the screen as described above. When mirror 33*b* is no longer effective, mirror 22*c* is then in position to reflect the lines of the following picture, which traverses the screen in the same manner; and so the action continues so as to reproduce 24 pictures upon the complete screen in each second.

From the foregoing description it will be appreciated that using twelve mirrors for the screen, each mirror is displaced 10° with respect to the other because the two side edges of any mirror face are spaced circumferentially 120° apart and at all times, no matter from what direction the screen is being observed, there will be a continuity of reflecting surface or screen to the observer.

The second step to understand in the operation of the mirrors is that it has been found experimentally that a mirror of the width given in this specification is effective to reflect an image to an observer during a movement of approximately 1½°. However, from the foregoing description it will be seen that, if no compensating mechanism were provided, each of the 12 mirrors rotates a total of 10° during the time that its light reflecting surface is toward the observer, and a total of 120° in order to bring the following mirror face of its assembly into reflecting position. If the twelve mirrors were spaced apart circumferentially this small distance, then with twelve mirrors there would be a total movement of 18° with the result that until the mirror assemblies rotated the remaining 102° of the 120° movement required, there would be a time element during which no mirror would be in light reflecting position and hence the continuity of action would be interrupted and the apparatus would not be practical.

Accordingly, I provide means for retarding the rotation of the mirror during the time embracing its 1½° movement referred to above, and to accelerate the rotation of each mirror during the remainder of its operating movement. Again, it will be understood that this accelerated action occurs while the persistance of vision is maintaining the picture, and without passing the mirror through a light reflecting position, so that it is unnoticed by the naked eye.

Referring now more particularly to Fig. 5, 22 represents the mirror assembly which is made hollow and preferably in the shape of a bottle, as indicated, having a reduced rounded lower portion or neck. The mirror assembly is carried upon shaft 35 and its upper end only is secured to the shaft by means of a disk 36. The upper end of shaft 35 is preferably mounted in a suitable bearing diagrammatically indicated at 38 and its lower end may be mounted in bearing 39. The shaft 35 may carry a worm wheel 43 engaging worm 44 driven from the prime mover. The lower neck portion of the mirror assembly may be mounted in suitable bearing 37 and I preferably provide at the lower extremity of the mirror assembly a triangular piece of magnetic material such as iron 40 having its apexes rounded off and juxtapositioned to magnetic pole piece 41, that is provided with the magnetizing coil 42, as shown in detail in Fig. 6. The coil 42, being supplied with constant direct current, sets up a steady flux in pole piece 41 passing into the iron triangle 40.

As one of the apexes of armature 40 begins to approach the pole piece 41, as will be understood, there is developed a force tending to accelerate the rotation of the piece 40, and with it the mirror to which it is secured. After the apex passes across the face of the pole piece 41 and begins to move away from it, this force introduces a drag tending to slow down the rotation of the mirror. After the apex has passed off the pole piece 41 and substantially out of its zone of attraction, there will be no effect until the next succeeding apex has passed into the zone of attraction, when the same forces are again produced.

Thus it will be seen that three times during each complete revolution of the mirror assembly it receives an accelerating impulse and three times in each revolution a decelerating impulse, the magnitude of which may be controlled by the current through coil 42 or the position of the pole piece 41; and the time between the accelerating and decelerating impulses may be controlled by the width of the pole piece.

The phase of the impulses can of course be varied by changing the relative locations of the pole piece 41 and the armature 40.

The shaft 35 has torsional elasticity and the mirror 22 has relatively little, but has considerable mass, so that the system acts as a mechanical vibrator and can be set and is set into mechanical vibration at resonance which is the natural period of the shaft and its mirror assembly by the continued accelerating and decelerating impulses, the effect of which is shown by Fig. 7.

If the mirror were not rotated about its own axis but were set into vibration as by being given a twist, the mirror would continue to vibrate or oscillate torsionally, rotating clockwise, for example, through a small angle coming to rest, then rotating counter-clockwise through a similar angle, coming to rest and continuing to oscillate torsionally on the shaft as an axis, in the manner of a torsional pendulum. Its angular velocity might then be represented by curve A of Fig. 7, a sine wave whose axis is zero. Such an arrangement would not function satisfactorily in my system due to the re-reflection of the image as the mirror oscillated through its reflecting position. Hence I add the element of constant rotation.

Torsional vibration is not interfered with by the rotation of the shaft 35, supporting the mirror, at a constant rate of speed, which force is indicated by the dotted line B of Fig. 7, and the resultant angular velocity of the mirror in my system is given by the sun of the two motions, indicated in this instance by the full line curve C in which the angular velocity increases and decreases periodically also as a sine wave. By choosing the amount of torsional vibration and its velocity it will be seen that the mirror may be made to accelerate periodically over the constant velocity which it would otherwise have, and may be retarded to the degree desired.

The apparatus is so designed that the natural period of vibration or resonance of the shaft 35 and its mirror assembly is twenty-four per second. While it is only necessary to slow up the rotation of a mirror during 1/288 of a second in which time the mirror moves one and one-half degrees, the mechanism here provided slows up the rotation during approximately one-half of its rotative movement for one picture and acceler-

ates the rotation during the other half. In point of time, the deceleration and acceleration each lasts about one forty-eighth of a second.

With the parts proportioned and arranged as above described, the mirror assemblies rotate at the rate of eight revolutions per second, which is a slow speed for elements one inch or thereabout in width, whereby little noise or vibration is produced.

With this rotating mirror screen the aspect ratio of the picture would change, with a change in distance between the observer and screen, since an observer near it will see a narrower picture than an observer farther away, but this difficulty, however, may be overcome by proper proportioning of the lens in the projector, since magnifying lenses increase their magnification the greater the distance at which they are viewed. It is preferable to provide a lens with a focal length of 20'' in the example hereinbefore described, and the cathode ray screen is placed three-quarters of the focal length away from the lens, and the distance from the projector to the mirror screen is about six feet. If the observers are approximately the same distance from the screen as the projector, then the increase of magnification caused by the lens will equal the increase of the magnification caused by the vertical mirrors and within observing limits of four to eight feet from the screen the vertical dimension of the picture will increase equally with the horizontal dimension, and the aspect ratio of the picture will not noticeably change as the observer moves within the limit.

The same result might be obtained by the use of a cylindrical, concave lens placed in front of the screen, the effect of which would be to decrease the width of the picture with increasing observing distance and so to neutralize the above mentioned phenomena. This method of equalizing the aspect ratio is, however, not as desirable as the former.

While I have shown and described certain preferred embodiments of my invention by way of example, it will be understood that modifications and changes may be made within the spirit and scope of my invention, as will be understood by those skilled in the art.

For example, the mirrors may be wider and longer, with corresponding changes in projecting apparatus and effective degrees of movement of each mirror. Also, with changes in the number of lines comprising a picture the number of mirror assemblies may be varied with a corresponding proportioning of the speed of rotation of each, etc., for which purpose the foregoing example will serve as a guide.

I claim:

1. In a television receiver, in combination, a multiplicity of mirror assemblies, each mounted for rotation on its own vertical axis, with the vertical axes of the several mirror elements defining the plane of the screen, means for rotating the mirror assemblies, whereby the lines forming the picture may be spread horizontally, and means for projecting a vertically moving light spot upon said screen.

2. In a television receiver, in combination, a multiplicity of mirror assemblies, each mounted for rotation about its own axis, with the axes of the several mirror elements defining the plane of the screen, means for rotating the mirror assemblies, whereby the picture may be reproduced in one direction, and means for projecting upon said screen a spot of light moving in the direction of the said axes, whereby the picture may be reproduced in a second direction.

3. In a television receiver, in combination, a multiplicity of mirror assemblies, each mounted for rotation about its own axis, with the axes of the several mirror elements defining the plane of the screen, means for rotating the mirror assemblies, a cathode ray tube arranged to produce by movement of the electron beam a swinging spot of light, and means for projecting said swinging spot upon said screen in such a manner that movement of said spot traces a line of light on the mirror parallel to its axis.

4. A television receiver screen comprising, in combination, a multiplicity of mirror assemblies each mounted for rotation about its own axis with the axes of the several mirrors defining the plane of the screen, and each mirror assembly having at least three angularly disposed mirror faces, and means for rotating the mirror assemblies.

5. A television receiver screen comprising, in combination, a multiplicity of mirror assemblies each mounted for rotation about its own axis and with the several axes defining the plane of the screen, means for rotating all of said mirrors in synchronism, and means associated with each mirror assembly for cyclically increasing and decreasing the speed of rotation of each mirror independently.

6. A television receiver screen comprising, in combination, a multiplicity of mirror assemblies each mounted for rotation about its own axis and with the several axes defining the plane of the screen, means for rotating all of said mirrors in synchronism, each of said mirror assemblies being mounted for torsional oscillation upon its own axis of rotation, and means for maintaining each of said mirror assemblies in torsional oscillation while in rotation.

7. In a television system the method of maintaining the aspect ratio of a television image substantially constant within best viewing limits, which comprises projecting the picture upon a vertical mirror system such that the height of the picture remains substantially constant as the observer views it from different distances, rotating the mirror system to give breadth to the picture, and locating between the observer and the source of light a lens arranged to magnify in the height of the picture only in substantially the same ratio as the lateral magnification introduced by the vertical mirror system, whereby the aspect ratio of the picture remains substantially constant.

8. Television apparatus comprising, in combination, a projector, and a moving mirror screen, the latter magnifying the projected picture in a horizontal direction only with change in the observer's distance to the screen, and a lens interposed between the source of light and the observer affording vertical magnification only of substantially the same order as that of the screen, whereby the aspect ratio of the picture is maintained substantially constant as the observer moves.

9. A television screen comprising twelve triangular shaped, vertically mounted, rotative mirror assemblies, each disploced ten degrees in a counter-clockwise direction from the preceding mirror assembly, each face of the mirror assembly being the height of the screen and one-twelfth of the width of the screen, and means for rotating the mirror assemblies to successively bring a mirror face of each assembly into light reflecting position with respect to an observer.

10. A television screen comprising twelve triangular shaped, vertically mounted, rotative mirror assemblies, each displaced ten degrees in a counter-clockwise direction from the preceding mirror assembly, each face of the mirror assembly being the height of the screen and one-twelfth of the width of the screen, means for rotating the mirror assemblies to successively bring a mirror face of each assembly into light reflecting position with respect to an observer, and means for decelerating the speed of rotation of each mirror assembly during the period when it is in light reflecting position.

11. A television screen comprising twelve triangular shaped, vertically mounted, rotative mirror assemblies, each displaced ten degrees in a counter-clockwise direction from the preceding mirror assembly, each face of the mirror assembly being the height of the screen and one-twelfth of the width of the screen, means for rotating the mirror assemblies to successively bring a mirror face of each assembly into light reflecting position with respect to an observer, means for decelerating the speed of rotation of each mirror assembly during the period when it is in light reflecting position, and accelerating the rotation of each mirror assembly when it is not in light reflecting position, said means comprising a triangular shaped armature mounted upon the mirror assembly and a fixed electromagnet positioned to cooperate with the armature.

12. A television reproducing system comprising a standard containing a cathode ray tube suitably energized, a lens positioned to receive the light projected from said tube and having a substantial magnification in one direction with minor magnification in the cross direction, a screen located in front of the lens and spaced therefrom, said screen comprising a plurality of rotating mirrors brought into position successively so that each reflects only a position of the picture as the same is projected, but the operation is sufficiently fast that the action occurs within the limits of the persistence of vision whereby the whole picture is seen upon the screen simultaneously.

LOUIS W. KOLOZSY.

CERTIFICATE OF CORRECTION.

Patent No. 2,144,379. January 17, 1939.

LOUIS W. KOLOZSY.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, second column, lines 43 and 44, strike out the words "and to avoid objectionable flickering of the pictures" and insert the same after "presented" and before the period in line 37; page 3, second column, lines 32, 33 and 34, the words "which is the natural period of the shaft and its mirror assembly" should be enclosed in parentheses; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 4th day of April, A. D. 1939.

Henry Van Arsdale

(Seal)

Acting Commissioner of Patents.

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(Seal)

Acting Commissioner of Patents.