

March 5, 1940.

R. HARDING, JR.

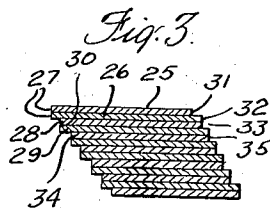
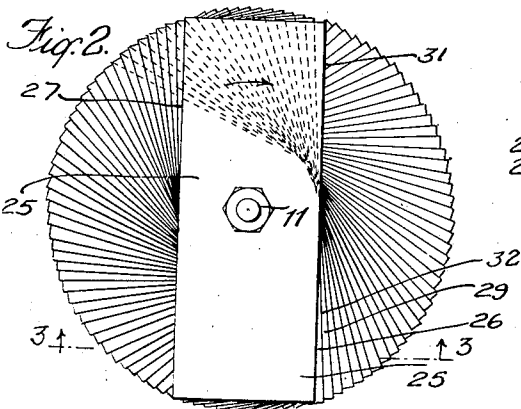
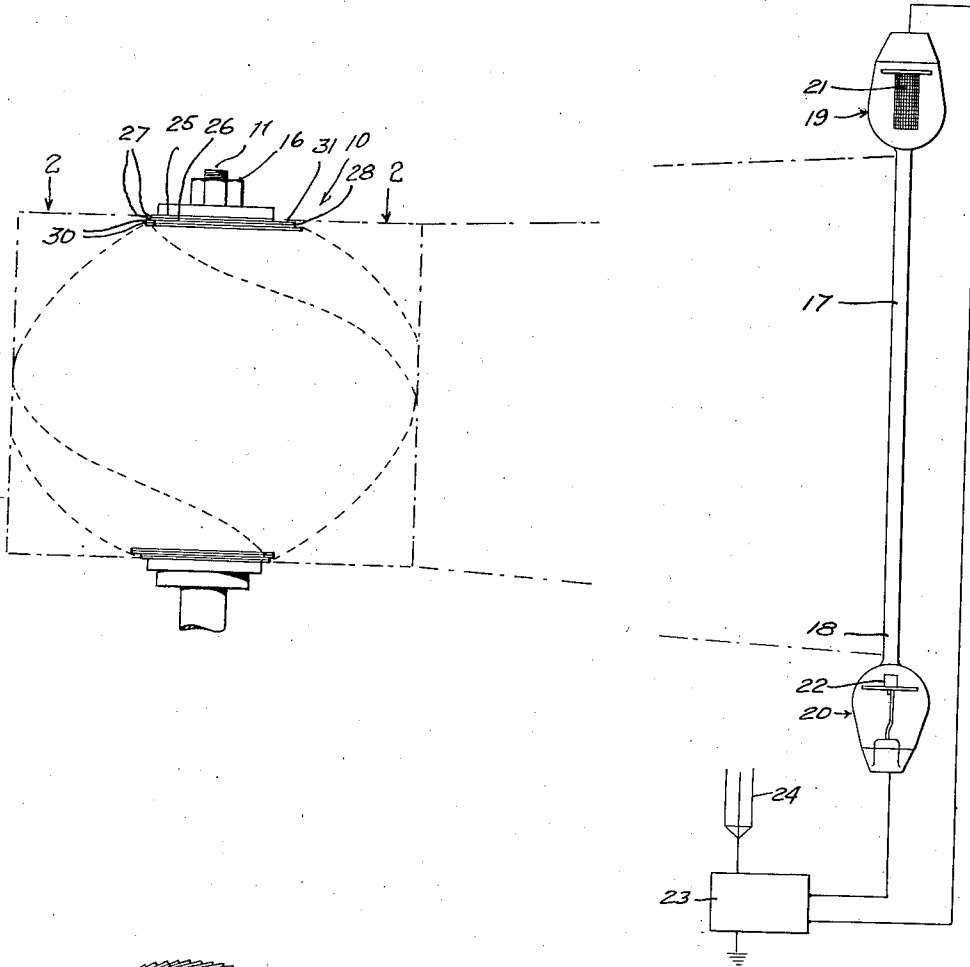
2,192,376

HIGH DEFINITION TELEVISION APPARATUS

Filed July 17, 1936

4 Sheets-Sheet 1

Fig. 1.



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4 Sheets-Sheet 2

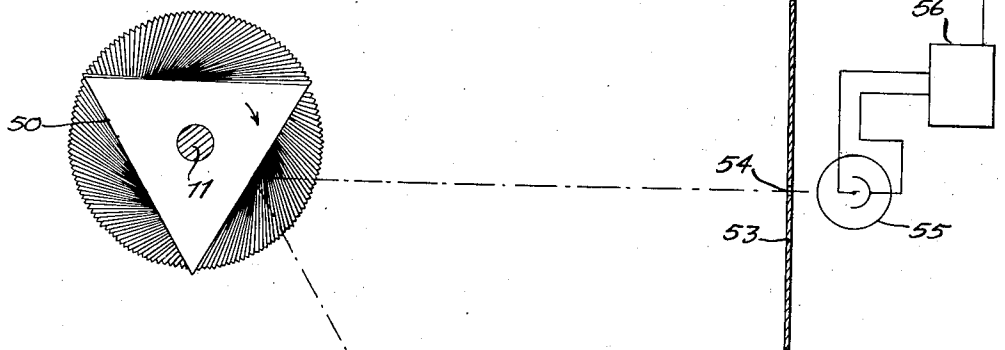
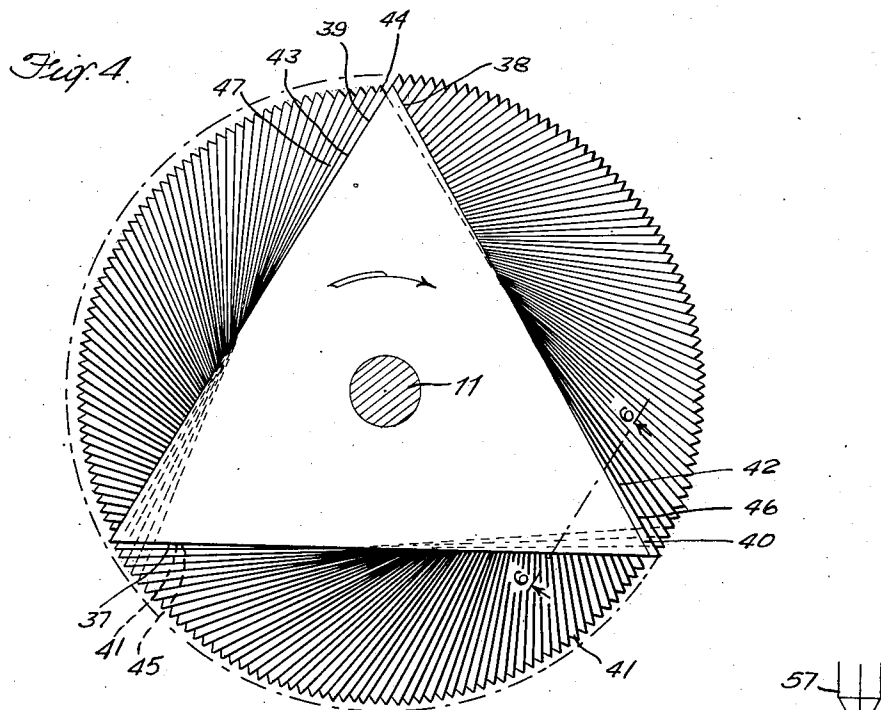
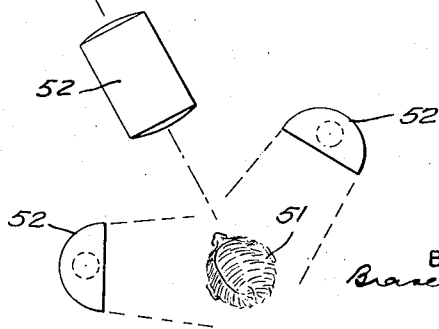


Fig. 10.



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4 Sheets-Sheet 3

Fig. 5.

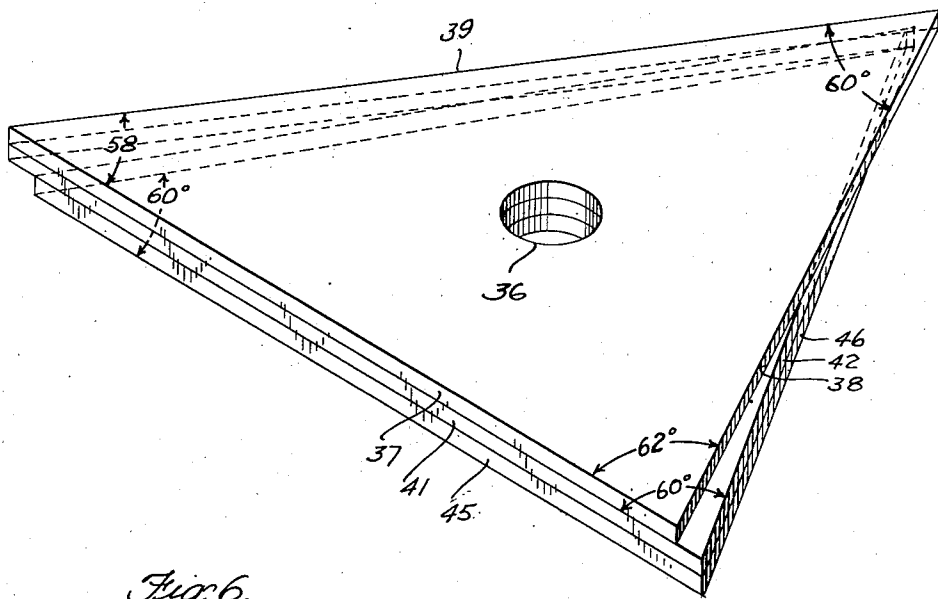
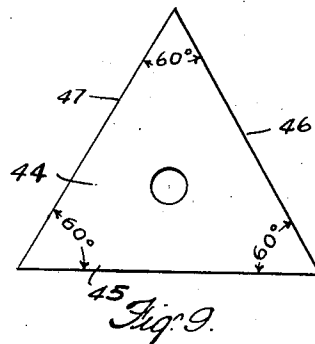
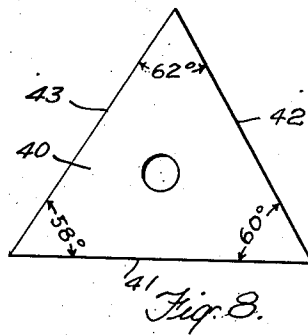
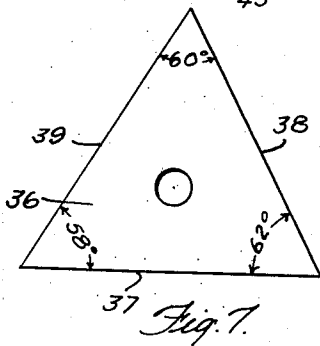
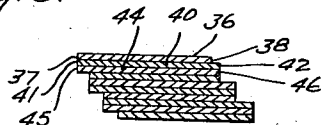


Fig. 6.



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4 Sheets-Sheet 4

Fig. 11.

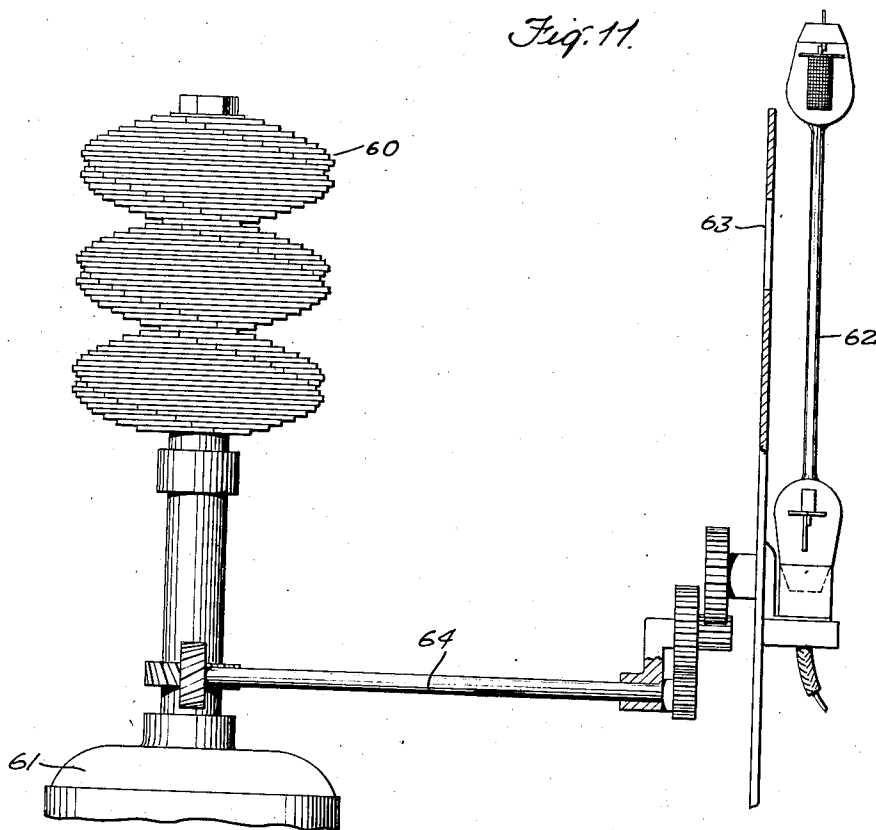
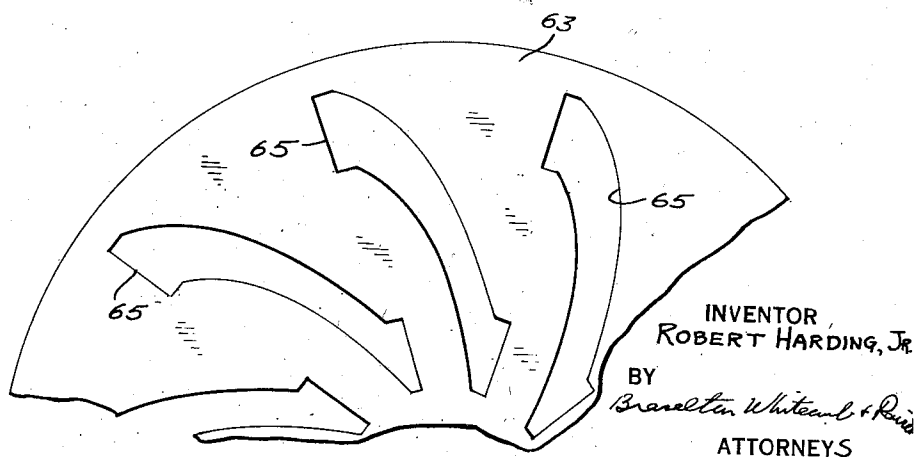


Fig. 12.



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UNITED STATES PATENT OFFICE

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HIGH DEFINITION TELEVISION APPARATUS

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Application July 17, 1936, Serial No. 91,083

9 Claims. (Cl. 178—7.6)

This invention relates to television apparatus and has for its principal object to provide an apparatus for improving the definition of the image transmitted and received.

Another object of the invention is to provide a television apparatus by means of which the dark lines usually formed between scanning lines of a picture are eliminated.

Another object of the invention is to provide a helical mirror drum which in itself will tend to improve the definition and decrease the formation of dark lines.

Another object of the invention is to provide a helical mirror drum with a plurality of separate groups of scanning elements displaced with respect to each other in a direction perpendicular to the direction of scanning.

Still another object of the invention is to provide an oscillating optical device to cooperate with a scanning apparatus to slightly shift successive images scanned thereby.

Other objects and objects relating to the method of constructing and assembling the various parts will be apparent as the description of the invention proceeds.

The invention is illustrated in the accompanying drawings, in which:

Fig. 1 is an elevational view of a helical mirror drum television receiving apparatus embodying the invention;

Fig. 2 is a sectional plan view of the drum shown in Fig. 1 and taken on the line 2—2 of that figure;

Fig. 3 is a sectional elevational view of a portion of the plates of Fig. 2;

Fig. 4 is a plan view of a modified form of the drum of Figs. 1, 2 and 3;

Fig. 5 is an isometric view of a group of the plates of Fig. 4;

Fig. 6 is a sectional elevational view of a portion of the plates of Fig. 4 taken on the line 6—6 of that figure;

Figs. 7, 8, and 9 are plan views of the three plates shown in Fig. 5;

Fig. 10 is a plan view of a television transmitter incorporating either of the drums of Figs. 1 to 9 inclusive;

Fig. 11 is an elevational view partly in section of a modified form of the receiving apparatus shown in the previous figures; and

Fig. 12 is a front elevational view of the shutter of Fig. 11.

In television apparatus where the picture is scanned in successive lines complete scanings of a picture are repeated usually at the rate of

20 per second or higher, each successive scanning of the picture reproducing the same number of picture lines in the same sequence, or, if not in the same sequence, at least with the lines coinciding, so that all of the lines of one picture fall exactly over the lines of a preceding picture.

Broadly the present invention provides for a slight shift of the position of the picture lines for successive pictures, this shift being preferably, but not necessarily, less than the width of one picture line. According to the invention, if picture line No. 1 falls at the top edge of the picture for one complete scanning, the same picture line for the second complete scanning will be positioned about one-half a picture line down, so that it will cover the dark line formed between the first two picture lines of the first scanning. The effect of such an arrangement is to increase the definition as well as to eliminate the dark lines between adjacent picture lines. Any small portion of the picture which falls between two picture lines of the first scanning, and therefore can not be clearly reproduced, will fall in one picture line of the second scanning in which it will be more accurately defined.

One way of carrying out this invention is illustrated in Fig. 1 in connection with a scanning device of the helical mirror drum type. A helical mirror drum 10 may be mounted upon the shaft 11 of a motor which may be of the synchronous type or may be driven at a constant predetermined speed by synchronizing apparatus, not shown. The mirror drum 10 may be somewhat similar in construction (except for the modification forming the invention) to that shown in the patent to Gardner No. 1,753,697. This drum comprises a plurality of plates mounted in stacked relation on the shaft 11 and held thereon by a disc at the lower end which may rest upon a shoulder formed in the shaft 11, and a disc at the top of the drum held in place by a suitable nut 16.

A modulatable light source 17 may be positioned at a predetermined distance from the drum 10 and may preferably take the form of a line of light which is arranged parallel to the axis of the drum. The lamp may comprise a tubular portion 18 of relatively small cross-section mounted between two bulbs 19 and 20 in which may be positioned respectively a cathode 21 and an anode 22. These electrodes may be made of some suitable metal, such as nickel, which may be easily degasified, and I prefer to make the cathode with an exceptionally large amount of active surface.

The two bulbs 19 and 20 and the tubular portion 18 form a single envelope which may be filled with an ionizable gas, such as neon, at a reduced pressure and in addition may contain a small amount of mercury. The lamp is adapted to be operated on the output of a radio set 23 provided with antenna connection 24 as shown.

One such lamp to give good results had a tubular portion 18 about 9 inches long with an outside diameter of about $\frac{1}{4}$ inch. The bulbs 19 and 20 measured about an inch and a half in diameter and the lamp was filled with neon at about 10 mm. of mercury pressure with the addition of a small drop of mercury. The cathode of this lamp was formed of nickel wire mesh, a strip about one inch wide and 10 inches long being rolled up into a cylinder and secured in the bulb 19 upon the press. The anode 22 was formed of a small cup-shaped piece of sheet nickel.

The drum 10 is intended to be viewed subjectively, the observer seeing the television image in the drum itself as the reflecting edge of each plate picks up a portion of the tubular light source 18 and causes it to sweep across the mirror surface in the opposite direction to the rotation of the mirror drum.

In accordance with the present invention I may use two reflecting surfaces on each plate, so that as the drum rotates there are two complete scan- nings of the picture in succession, and by a novel arrangement of the plates I position each reflecting surface of the second series in a plane corresponding to the plane of the line between two reflecting surfaces of the first series. In order to accomplish this result I use twice as many plates as in the Gardner patent referred to above, making the thickness of each plate one-half what it would normally be. Each reflecting surface then comprises the edges of two plates. But the plates are not identical, there being two sets. One set of plates has the two reflecting surfaces parallel to each other, while with the other set the surfaces are at a certain predetermined angle.

The first two upper plates 25 and 26 (Figs. 2 and 3), representing one plate of one set and one of the other set, have their left sides aligned to form the first reflecting surface 27. In like manner, the second two plates 28 and 29 (Fig. 3) have their two left reflecting edges aligned to form the reflecting surface 30 which corresponds to the second line of the picture, and so on for all of this group of the reflecting surfaces of the drum. The right reflecting edges of plates 25 and 26 however are not aligned but bear an angle to each other equal to the angular relation between the reflecting surfaces 27 and 30.

The top plate 25 has a reflecting surface 31 on the right side which may be parallel to the left hand surface 27, but the plate 26 has a reflecting surface 32 on the right side of the plate which forms an angle to the surface 31 equal to the angular spacing between the pairs of plates.

If the apparatus is designed to produce a 60 line picture, the left hand reflecting surfaces of the uppermost plates 25 and 26 form the edge 27, which makes the first line of the picture, and the left hand edges of the second two plates 28 and 29 coincide to form the reflecting surface 30 which may be rotated through an angle of 3° in a counterclockwise direction as viewed in Fig. 2. The edge 31 of the plate 25 is parallel to the edge 27 thereof but the edge 32 of the plate 26 is rotated 3° from the edge 31 of the plate 25 and coincides

with the right hand edge of the plate 28 which is parallel to the reflecting surface 30. This same 3° spacing arrangement is maintained for the remaining plates.

Arranged in this manner on the shaft 11 two complete helices of reflecting surfaces are formed. The left hand surface of plates 25 and 26 will then form the reflecting surface 27 which corresponds to the first line scanned by the helix beginning with that reflecting surface. The right hand edges of plates 25 and 28 however are aligned to form the reflecting surface 33 which forms the first line of the second helix, the right hand edges of plates 29 and 34 forming the reflecting surface 35 which corresponds to the second line of the second reflecting helix.

It will thus be seen that the first line represented by the surfaces 33 is even with the dividing line between the two reflecting surfaces 27 and 30, or the first two picture lines formed by the first helix. With this arrangement there will be two complete scanings of the picture with one rotation of the drum, and hence for a rate of 20 pictures per second, which may be assumed by way of example, the motor would be operated at 600 R. P. M. Means for obtaining a greater angle between reflecting surfaces with a higher speed of the motor, and with certain consequent advantages, will be hereinafter described.

It will be understood that the same shifting of successive picture lines should be carried out at the transmitter as has been described for the receiver. When the mechanism is correctly operated, the first scanning at the receiver, produced by the rotation of the drum, will produce an assembled television picture, while the second scanning produces lines slightly lower than the lines of the first. The picture, however, will not move downwardly as the second scanning at the transmitter has also taken place slightly lower with respect to the first scanning. The effect is to increase the definition as already described and to eliminate any tendency to form dark lines between adjacent picture lines.

With the arrangements of Figs. 1, 2, and 3 I have shown a drum with two sets of reflecting helices. I am not limited to two, however, as any number may be used, as desired.

In Fig. 4 I have shown a plan view of a 60 line drum using triangular plates with the three edges made reflecting. There will therefore be three separate helices of reflecting surfaces, and I may space the plates at such angles that each helix will completely scan the picture when the drum has rotated through 120° or one-third of a complete rotation. With this arrangement I use three plates for each reflecting surface and I design the plates so that the complete reflecting surfaces are displaced $\frac{1}{3}$ the width of a picture line for each helix, in a manner similar to that already described for the plates with two reflecting surfaces. In such an arrangement of triangular plates, if plate 36 represents the uppermost plate, then this plate will have a reflecting surface 37, a reflecting surface 38, making an angle of 62° with the surface 37, and a reflecting surface 39, making an angle of 60° with the surface 38 and 58° with the surface 37.

The second plate 40 has a surface 41 which is exactly aligned with the surface 37 of the plate 36, and a surface 42 which has an angle of 60° with the surface 41, or, in other words, a 2° rotation from the surface 38 of the plate 36. The third reflecting surface 43 lies flush with the surface 39 of the plate 36 and therefore has an

angle of 62° with the surface 42 and 58° with the surface 41.

The third plate 44 has a surface 45 also in alignment with the surfaces 37 and 41 of plates 36 and 40 respectively, and a surface 46 which is in alignment with the surface 42 of the plate 40 and therefore makes an angle of 60° with the surface 45. The third surface 47 is spaced at an angle of 2° from the aligned surfaces 39 and 43 respectively of plates 36 and 40 and therefore makes an angle of 60° with the edge 46 and 60° with the edge 45.

The plates are arranged in groups of three as shown in Figs. 4 to 9, and these groups are then spaced at 2° apart for the entire 60 groups. When so positioned it will be found that the reflecting surfaces forming the lines of the picture for the second helix will be spaced $\frac{1}{3}$ of a picture line down, while the picture lines formed by the third reflecting helix will be spaced $\frac{2}{3}$ of a picture line down. Thus the picture lines of the three successive pictures do not fall on the same horizontal position and the objects of the invention are attained. Of course, the transmitting apparatus must also be arranged to displace the picture lines for successive pictures through the same distance and in the same order.

In Fig. 10 a television transmitter is shown which makes use of either of the types of drums shown in Figs. 1 to 9 inclusive. Here the drum 50 is rotatably mounted on a vertical shaft, similarly to the arrangement of Fig. 1, and an image of the person 51 to be televised is projected by means of an optical system 52 towards the drum 50. A plate 53 provided with a slit 54 arranged parallel to the axis of the drum is positioned so as to receive light by reflection from the drum and the image of the person 51 is focused upon the plate 53. The person 51 may be illuminated by the electric lights 52', and each reflecting surface of the drum 50 will cause one line of the image to move across the plate 53 as the drum rotates. Inasmuch as only a small portion of the light from this picture line can pass through the slot 54 the photo-electric cell 55 will receive the picture elements of the line in succession. The photo-electric cell 55 may be connected to a radio transmitter 56 provided with a suitable antenna 57 for radiating the television signal.

In connection with the foregoing figures I have shown mirror drums which are adapted to make more than one complete scanning of the picture for one rotation of the drum, but it may be desired to increase the angle between the mirror surfaces so as to permit closer positioning of the light source and therefore obtain a brighter picture. This may be accomplished by permitting the helices to pass more than once around the surface of the drum, but provision must be made at the same time to prevent all but one mirror surface from reflecting light to the observer at a time. Where the helices of reflecting surfaces pass around the drum more than once there will always be more than one reflecting surface facing the observer which would produce several images in overlapping relation unless suitable arrangement is made for blocking out light from all but one surface.

In Figs. 11 and 12 I have shown one simple apparatus for operating a receiver in this manner. In this figure the drum 60 which may be any of the drums already shown and described except that the plates have greater angular spacings and the helices are arranged to pass more

than once around the axis of the drum, may be mounted on the driving motor 61 as indicated.

A light source 62 may be positioned at a suitable distance from the drum 60, and between the light source and the drum I provide a shutter 63 which may be rotated at a constant speed from the driving motor 61 by means of the driving mechanism 64. This shutter has a plurality of slots 65 provided therein which are arranged at such an angle and are so shaped that only a portion of the light from the source 62 is permitted to strike the drum. The speed of the shutter is arranged with respect to the speed of the drum so that the uncovered portion of the light source will be in line with that reflecting surface which it is desired to use at that time.

The arrangement of the shutter with greater spacing of the plates on the drum is shown and described in my copending application Serial No. 715,054 filed March 12, 1934 and is illustrated here for the purpose of showing the adaptability of the staggered picture lines for successive pictures with the greater angular spacing between plates.

With the mirror drums of Figs. 1 to 11 inclusive the displacement between the same picture lines of successively scanned pictures is preferably less than the width of one picture line, although greater displacement may be provided if desired.

Any of the scanning devices shown for the transmitter may also be used for the receiver and vice versa, as long as the amount of displacement for the lines is the same for both the transmitter and receiver. For the television receivers a particular type of television lamp has been illustrated and may be preferred, but other lamps may also be used, as long as the light thereof will freely follow the signal. Also the receiving apparatus may be designed to project a picture upon a screen while still maintaining the displacement of lines, as described.

Many other modifications may be made in the apparatus as shown and described and I do not therefore desire to limit myself to what has been shown and described except as such limitations are included in the appended claims.

What I claim is:

1. A television system comprising, in combination, a helical mirror drum having a plurality of mirror surfaces arranged in a plurality of helices around the axis of said drum, the reflecting surfaces of one helix being displaced one-third the width of one picture line slightly axially of said drum with respect to the mirror surfaces on another helix, means to scan an object field with said drum, means to translate the variations of light produced by said scanning means into electrical impulses, means to transmit said impulses to a remote point, means at said remote point to translate said electrical impulses into variations of light, means to repeatedly scan said variations of light, means to displace the picture lines of one complete scanning from the picture lines of the next successive complete scanning, said displacement being equal to the displacement of the reflecting surfaces of one helix on said mirror drum from those of another helix.

2. A television system comprising, in combination, means to repeatedly scan an object field to form a plurality of picture lines, the picture lines of one complete scanning being displaced a distance equal to one-third the width of one picture line, means to translate the variations of

light produced by said scanning means into electrical impulses, means to transmit said electrical impulses to a remote point, means at said remote point to translate said electrical impulses into variations of light, a helical mirror drum mounted adjacent said translating means, said drum comprising a plurality of reflecting surfaces arranged in a plurality of helices around the axis of said drum, each of said surfaces representing one line of the reproduced picture, the surfaces of one helix being displaced axially of the drum with respect to the surfaces of another helix by an amount equal to the displacement of said picture lines first mentioned.

3. A transmitting apparatus comprising, in combination, a mirror drum having a plurality of reflecting surfaces arranged in a plurality of helices around the axis of said drum, the reflecting surfaces of one helix being displaced less than the width of one reflecting surface from the reflecting surfaces of another helix.

4. A scanning apparatus comprising, in combination, a mirror drum having a plurality of reflecting surfaces arranged in a plurality of helices around the axis of said drum, the reflecting surfaces of one helix being displaced one-half the width of one reflecting surface from the reflecting surfaces of another helix.

5. A transmitting apparatus comprising, in combination, a mirror drum having a plurality of reflecting surfaces arranged in a plurality of helices around the axis of said drum, the reflecting surfaces of one helix being displaced one-third the width of one reflecting surface from the reflecting surfaces of another helix.

6. A scanning drum comprising a plurality of flat plates stacked one upon the other, each plate having a substantially straight reflecting edge, the plates being arranged in pairs, each pair being spaced at equal angular distance from the pairs adjacent to it, a second substantially straight reflecting edge on each plate, the angle of said second reflecting edge on one of the plates of each pair with said first reflecting edge being such that the second reflecting edges of each pair are spaced apart at the same angular distance that said pairs are spaced.

7. A scanning drum comprising a plurality of substantially flat plates, each of said plates having a straight reflecting edge, said plates being arranged in groups with the reflecting edges of each group in alignment and said groups being rotated to form equal angles between the reflecting surfaces of successive groups, a second reflecting edge on each plate, the second reflecting edge of at least one plate of each group bearing an angle to the first reflecting surface of that plate equal to the angular spacings between groups.

8. A scanning device comprising a drum, a group of reflecting surfaces arranged in equally spaced relation from end to end of said drum and in a helix at equal angles around said drum, a second group of the same number of reflecting surfaces arranged in equally spaced relation from end to end of said drum and in a helix at the same equal angles around said drum, the corresponding reflecting surfaces of the two groups being axially displaced a distance not greater than one-half the axial spacing of adjacent reflecting surfaces in the same group.

9. A scanning device comprising a drum, a group of long, narrow reflecting surfaces equally spaced from end to end of said drum and arranged at equal angles in a helix passing a predetermined angular distance around the axis of said drum, a second group of long, narrow reflecting surfaces spaced from end to end of said drum with the same equal spacing as said first group and arranged at equal angles in a helix passing through the same angular distance around the axis of said drum as said first reflecting surfaces, the first reflecting surface of each of said groups having substantially the same angular spacing from the last reflecting surface of the other group as the angular spacing between adjacent reflecting surfaces, corresponding reflecting surfaces of the two groups being axially displaced a distance substantially equal to one-half the axial displacement between adjacent reflecting surfaces in the same group.

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