

June 1, 1943.

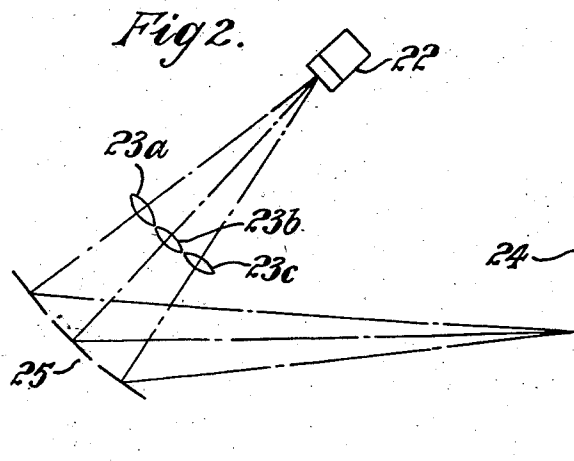
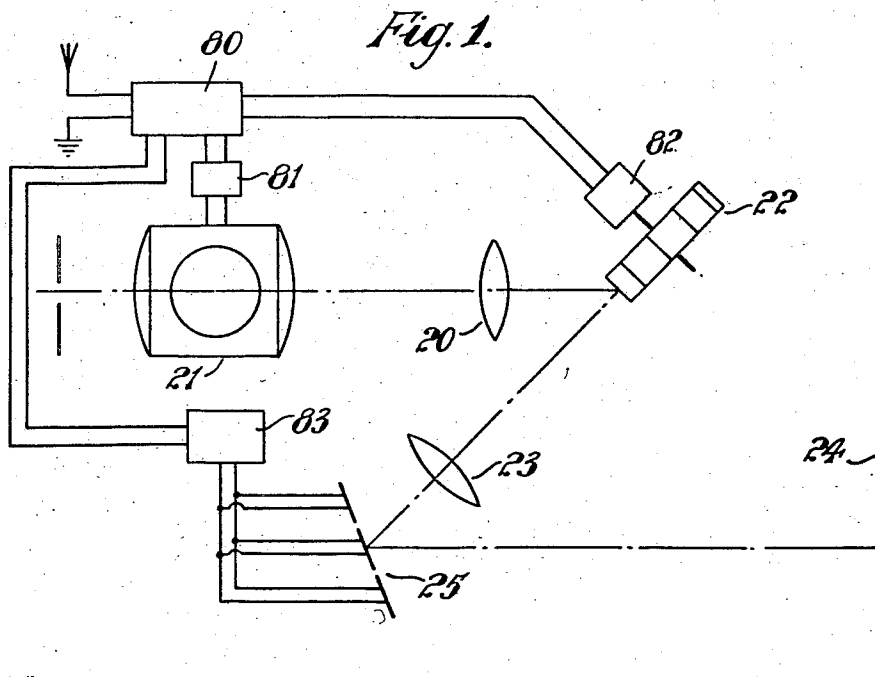
F. OKOLICSANYI ET AL

2,320,380

TELEVISION SYSTEM AND SCANNER THEREFOR

Filed July 10, 1940

4 Sheets-Sheet 1



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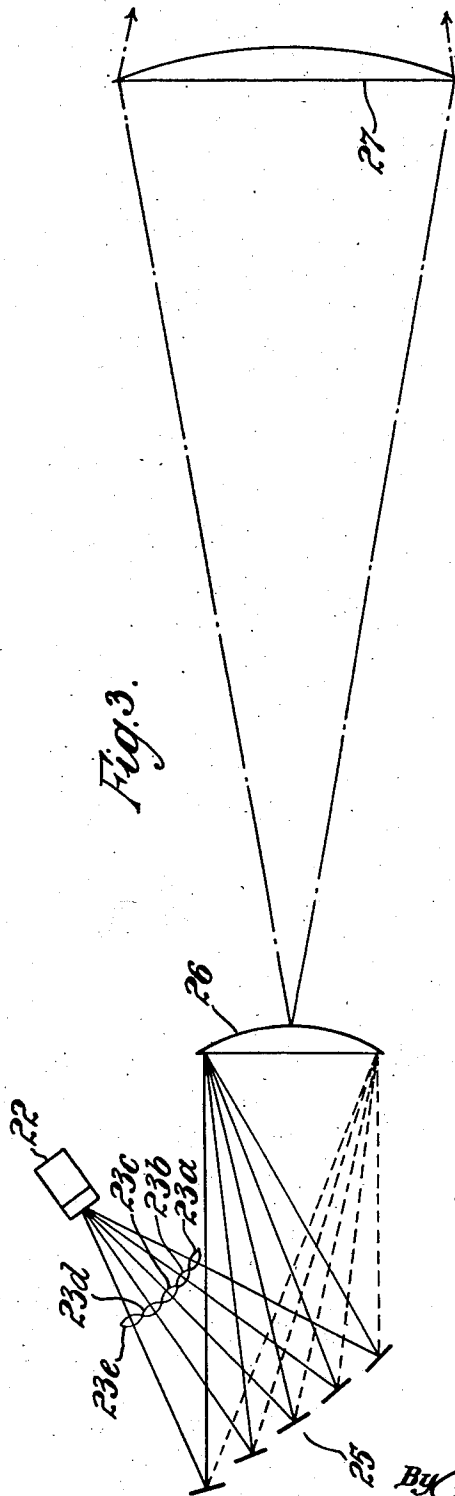
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Filed July 10, 1940

4 Sheets-Sheet 2



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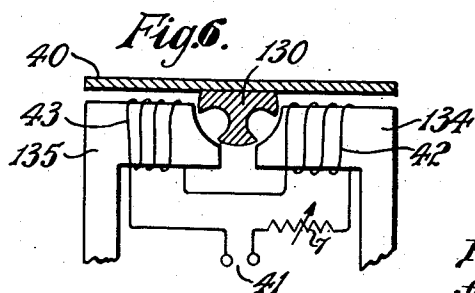
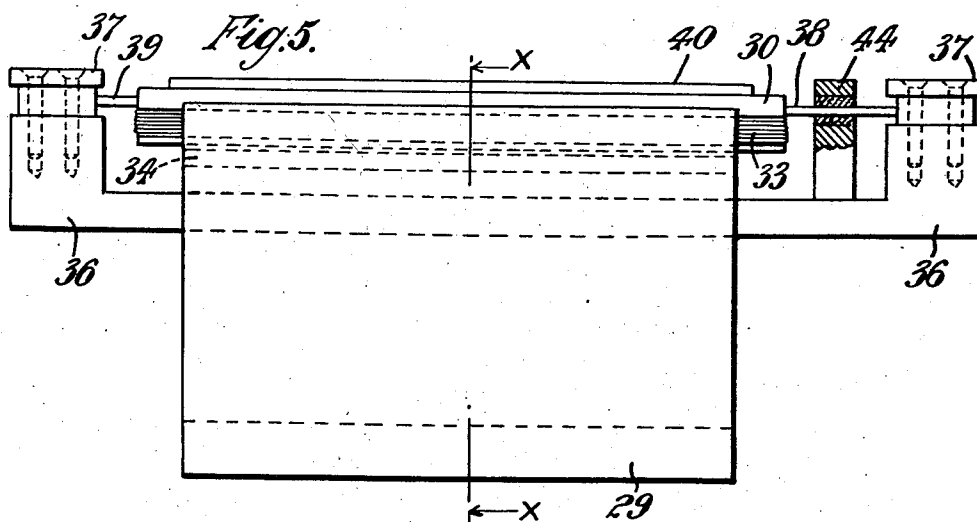
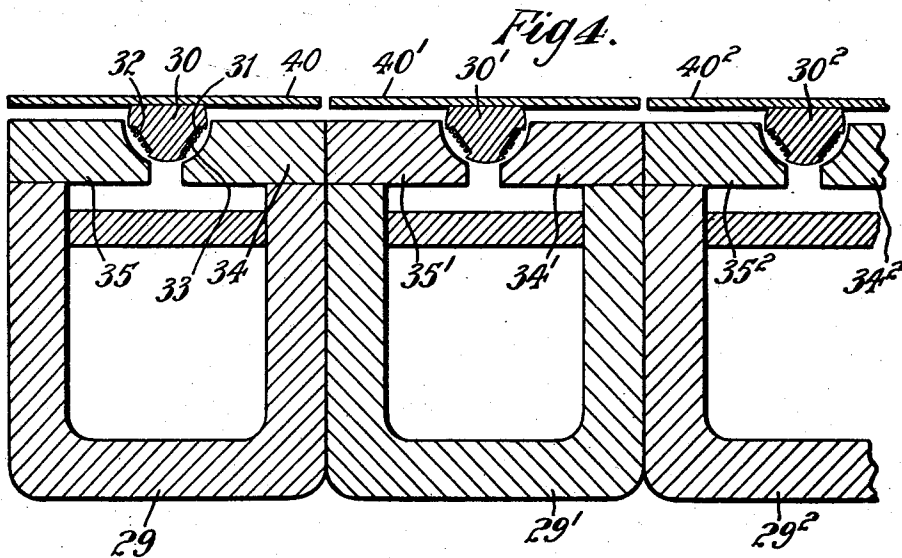
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TELEVISION SYSTEM AND SCANNER THEREFOR

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4 Sheets-Sheet 3



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TELEVISION SYSTEM AND SCANNER THEREFOR

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4 Sheets-Sheet 4

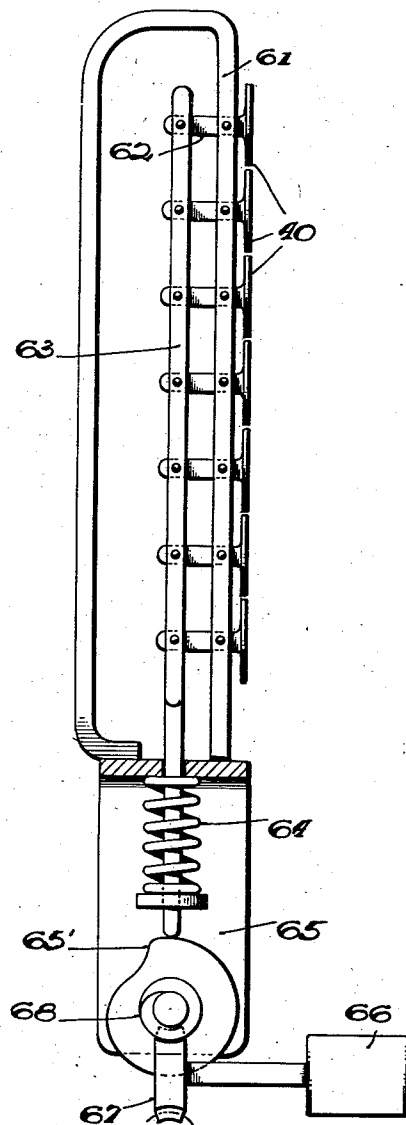


FIG. 7.

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UNITED STATES PATENT OFFICE

2,320,380

TELEVISION SYSTEM AND SCANNER
THEREFOR

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Application July 10, 1940, Serial No. 344,786
In Great Britain July 24, 1939

20 Claims. (Cl. 178—7.6)

The present invention relates to television and like systems and to scanning members therefor.

Rotating scanners such as mirror drums, suffer from the disadvantage that the maximum safe size for a given speed of revolution limits the size of the mirrors or other scanning elements, particularly their size measured in the direction of the scanning motion. Also, the angle of scan is fixed for a given scanner.

Scanners in the form of oscillating mirrors are an improvement in these respects, but they even must be of comparatively small size in the scanning direction, since their inertia increases as the square of their size measured in this direction. Furthermore, since usually they must oscillate in a saw-toothed fashion, they must be light enough to be able to execute the quick fly-back movement, and hence the inertia must be kept very low.

It is an object of the present invention to provide an oscillatory slow-speed scanner for television and like receivers or transmitters in which the size in the scanning direction can be substantially increased.

According to the present invention such a scanning member comprises a plurality of closely adjacent mirrors adapted to oscillate about parallel axes, the mirrors being placed side by side in the scanning direction. In operation it is arranged that the mirrors operate with equal frequency and equal, or nearly equal, amplitude.

The inertia of such systems of mirrors will be only $1/n$ th of the inertia of a single mirror having a reflecting surface the dimension of which in the scanning direction is equal to the total length of the system measured in the scanning direction, where n is the number of mirrors in the system.

Preferably, the mirrors are so arranged that, when in the rest position, their surfaces are coplanar. When associated with a suitable optical system, however, they can be arranged so that when in the rest position, they reflect light in slightly different directions, and when oscillating, they vibrate with different amplitudes.

Such scanning members can be used in television receivers or transmitters and can be adapted to serve either as the high speed or low speed scanner. Although their use is especially advantageous in television systems employing unidirectional scanning, in which case the waveform of the driving currents for the mirrors has a saw-toothed shape, they can also be used with advantage in systems employing oscillatory scan-

ning, in which case the driving currents have a sinusoidal wave form.

Many methods of driving the mirrors are possible. For example, they can be driven by bimorph piezo-electric crystal elements, by electro-magnetic means, either of the moving coil or moving iron type, or by electrostatic means.

In order to render clearer the nature of the invention preferred forms of scanning members according to the invention will be described by way of example, with reference to the accompanying drawings in which

Figs. 1, 2 and 3 show optical systems employing a device according to the invention, Figs. 2 and 3 being alternative arrangements to a part of Fig. 1,

Figs. 4 and 5 show in section and side view respectively alternative construction according to the invention, Fig. 4 being a section along the line X—X of Fig. 5,

Fig. 6 shows an alternative sectional construction of Fig. 4, and

Fig. 7 shows a further embodiment of the invention employing purely mechanical means for driving the mirrors.

The receiver shown in Fig. 1 consists of a super-sonic wave light modulating device, a high speed scanner in the form of a mirror drum and a low speed scanner comprising a plurality of adjacent mirrors adapted to oscillate about parallel axes. Details of the construction of such a scanner are described later in this specification. The usual system of optical stops is associated with the light modulating device for separating the diffracted from the non-diffracted light, and a lens situated between the light modulating device and the mirror drum focusses, in the line scanning direction, an image of the moving waves in the light modulating device on a receiving screen, this image being swept over the screen by the mirror drum so that the wave images are immobilized with respect to the screen. In the frame scanning direction which is illustrated in Fig. 1, a cylindrical lens 20 focusses an image of the light modulating device 21 on to the mirror drum 22, and a second cylindrical lens 23 situated between the two scanners focusses an image of the illuminated faces of the mirror drum 22 on the receiving screen 24. For given cylindrical lenses, the line width, and hence the definition clearly will depend upon the size of these illuminated faces in the frame scanning direction, so that, for high definition the axial length of the mirror drum must be small. This, in turn, involves larger angular apertures of

the light cone emerging from the mirror drum, and consequently, in order to grasp the whole of this light, the size of the low speed scanner must be large in the frame scanning direction. It will be clearly seen from the figure that if the lens 20 is to focus a small area of light on to the mirror drum 22, it must be close to it, and it will therefore produce a cone of light having a large apex angle. This beam of light will diverge after reflection from the mirror drum. Now the lens 23 must be as far from the mirror drum 22 as possible, for it has to produce as small an image of the mirror drum surface on the screen 24. On the other hand, the widely diverging cone of light from the drum will require a large lens to grasp it if the lens has to be far away. As, from other considerations, the low speed scanner 25 must be near this lens, it must also be large in the frame scanning direction. This is achieved according to the present invention by building it from a number of mirrors as previously described, the number being sufficient to grasp the whole of the light emerging from the second cylindrical lens.

For the sake of fullness of disclosure, in Fig. 1 there is shown a receiver of television signals 80, which also separates the frame and line synchronising signals and picture signals from each other. The picture signals are fed to the supersonic wave light modulating device through a modulator 81 providing the necessary high frequency oscillation for driving the piezo-crystal. The line synchronising signals are used to synchronise the motor 82 of the mirror drum 22, and the frame synchronising signals, after suitable amplification and transformation at 83 to drive the mirrors of the scanner 25.

In an alternative arrangement shown in Fig. 2, the second cylindrical lens 23 of Fig. 1 is replaced by a plurality of small cylindrical lenses 23a, 23b, 23c, placed one above the other in one plane and each co-operating with one of the mirrors of the low speed scanner 25. With this arrangement the individual mirrors are not coplanar when in the rest position but are so relatively tilted about their axes that the images formed by the separate cylindrical lenses are brought to coincidence on the receiving screen 24. In order to compensate for the different distances of the individual mirrors from the screen 24, they preferably oscillate with different amplitudes; their amplitudes may be adjusted by means of the resistance 7 shown in Figure 4, described later.

In my co-pending application entitled Television Receiver, on which a patent was applied for in Great Britain on July 3, 1939, and numbered 19,335/39, and on the subject matter of which I have signed documents for a patent application in the United States of America (Ser. No. 342,183, filed June 24, 1940), there is described a television receiving system employing a supersonic wave light modulating device, a high speed scanner and a low speed scanner, both scanners being in the form of mirror drums. In the arrangement described in the specification it is proposed to form in one plane an intermediate immobilised image of the waves in the supersonic modulating device (i. e. an intermediate line image) and in the other plane to form an intermediate image of the light source; the intermediate line image is formed between the two scanners, and the intermediate image of the light source is formed after the low speed scanner and is an intermediate frame image. An astigmatic optical pro-

jection system is employed to form final images of these intermediate images on the projection screen. Such a system is particularly advantageous where it is desired to project a television image on to a screen which is situated a long distance away from the scanning and light modulating system.

The present invention is particularly advantageous when applied to the low speed scanning system for forming the intermediate frame image. Referring to Fig. 3, light from a high speed mirror drum 22 is projected on to the mirrors of a scanner 25 formed as previously described by a number of lenses 23a, b, c, d and e. The mirrors of the scanner 25 are so tilted with respect to one another, and the focussing power of the lenses 23 is such that each mirror forms an intermediate image of the face of the drum 22 in the plane of a field lens 26, the tilt of the mirrors ensuring that all images are coincident. Thus at one end of the frame scan the light from all the mirrors follows the full lines in the drawing, and at the other end it follows the dotted line. Here again the amplitude of swing is preferably different for each mirror. A projection lens 27 focusses an image of this field lens on the projection screen (not shown). Between the lens 23a-e, and the mirror drum 22 there may be provided for forming in a plane at right angles to the plane of Fig. 3 an intermediate immobilised image of the waves in the supersonic wave light modulating device. Such optical system is omitted from Fig. 3 for the sake of clearness and is fully described in my co-pending application above referred to. Its omission from the present case in no way affects the principles of the optical design of an operative structure.

Systems for driving the mirrors of a low speed scanner of this type can have forms other than that described. For example, in an alternative moving coil arrangement, shown in Figs. 4 and 5 the shaft 30 of each mirror is provided with two grooves 31 and 32 along the whole of its length, and the coil 33 is wound lengthwise in these grooves so that its axis is at right angles to the axis of the shaft 30. The pole pieces 34 and 35 connected by the magnet 29 extend along the whole length of the coil 33, and the shaft itself serves as the core. The shaft is clamped at each end by clamping pieces 36 and 37 at each end, and near to each clamping point its diameter is greatly reduced as shown at 38 and 39. These portions of reduced diameter serve as torsional springs for supplying the necessary restoring force. The mirror 40 is mounted on the shaft, a part of which projects from the pole pieces, and is flattened. The width of the mirror (Fig. 4) extends over the pole pieces, and the structure for the neighbouring mirror is placed adjacent, as shown at 29', 35', 40'. The magnet 29' may be a permanent magnet as shown or may be energised electrically. Damping means, indicated at 44, Fig. 5, and comprising for example a pad of oiled cotton wool in a suitable holder may be provided for the purpose indicated previously.

A moving iron drive for the mirrors may be employed as shown in Fig. 6. The shaft 130 is formed as shown in the figure, and the poles 134, 135 are provided with windings 42 and 43 connected in parallel, the driving current being fed to the terminals 41. In side view the arrangement will appear the same as in Fig. 5 with the exception that the coil 33 will not be present. The amplitude of oscillation of the mirrors in

this embodiment and in the embodiment of Figures 4 and 5 may be regulated by varying the amplitude of the driving current for each mirror; for example, by means of a variable resistance 7 inserted in the circuit supplying the said current.

A mechanical form of drive for the mirrors is shown in Fig. 7. In this figure the mirrors 40 are mounted to vibrate about shafts secured in a frame work 61, and each mirror has a rear projecting arm 62. All the arms are mechanically connected to a rod 63 which at one end is connected to a cam follower 64 running against a cam 65 driven by a motor 66 through spiral gears 67, 68. A spring 64 keeps the cam follower 64 against the cam 65, and is sufficiently strong to ensure that all the mirrors are brought back with a rapid motion at that part of the cam 65 where the radius becomes suddenly smaller. The cam may therefore be so designed that the mirrors execute a saw-tooth scanning motion. The motor 66 is a synchronous motor held in synchronism with synchronising signals in any known or suitable manner. To obtain different rest positions and amplitudes of swing, the distances between the points of connection of arms 62 to the rod 63 and the lengths of the arms 62 themselves may be adjusted.

We claim:

1. A television receiving system comprising a light source, a light modulating device, a high speed scanner and a slow speed scanner, and optical means for forming a modulated scanning spot in a receiving plane, said slow-speed scanner comprising a plurality of adjacent mirrors adapted to oscillate about parallel axes with equal amplitude under the influence of received synchronising signals.

2. A television receiver comprising a light source, a supersonic wave light modulating device, optical separating means, a high speed scanner, and a slow speed scanner comprising a plurality of adjacent mirrors adapted to oscillate about parallel axes under the influence of received synchronising signals, optical means having optical power in the frame scanning direction for forming an image of said light source on said high speed scanner and for forming an image of said high speed scanner surface in a receiving plane.

3. A television receiving system comprising a light source, a light modulating device, a high speed scanner and a slow speed scanner, comprising a plurality of adjacent mirrors adapted to oscillate about parallel axes and a lens situated close to each mirror, and adapted to focus the light falling thereon into an image of the light source on a receiving plane, the rest position of each mirror being so adjusted that the light therefrom falls on the same part of said image plane as the light from the remaining mirrors.

4. A television receiver comprising a light source, a light modulating device, a high speed scanner and a slow speed scanner, comprising a plurality of adjacent mirrors adapted to oscillate about parallel axes and a lens situated close to each mirror and adapted to focus the light falling thereon into an image of the light source on an intermediate frame image plane, the rest position of each mirror being so adjusted that the light therefrom falls on the same part of said image plane as the light from the remaining mirrors and an optical projection system for forming an image of said intermediate frame image plane on a receiving plane.

5. A television receiving system according to claim 12 wherein said slow speed scanner comprises a plurality of parallel shafts a winding running lengthwise of each shaft, torsion means for imparting to each shaft a natural frequency of oscillation, means for producing a magnetic field across each shaft, and a mirror mounted on each shaft, the edge of one mirror being closely adjacent the edge of the next mirror.

6. A television receiving system according to claim 12 wherein said slow speed scanner comprises a plurality of parallel shafts, torsion means for imparting to each shaft a natural frequency of oscillation, means for producing a magnetic field across each shaft, and a mirror mounted on each shaft, the edge of one mirror being closely adjacent the edge of the next mirror, each shaft being so shaped as to act as a moving iron element in said magnetic field when said field is varied in accordance with received synchronising signals.

7. A television system comprising a light source, a light modulating device, a high speed scanner and a slow speed scanner, and optical means having power in the frame scanning direction for forming an image of said light source on said high speed scanner and for forming a modulated scanning spot in a receiving plane, said slow speed scanner comprising a plurality of adjacent mirrors capable of oscillation about parallel axes, a rotating driving member and a mechanical connection between said driving member and each of said mirrors, said connection being such that the rotation of said driving member produces an oscillatory scanning movement of said mirrors and during scanning all the mirrors reflect light on to substantially the same part of the receiving plane.

8. A television system according to claim 7 wherein said mechanical connection includes a rotating cam, and a cam follower mechanically connected to said mirrors.

9. A television receiving system comprising a light source, a supersonic wave light modulating device, optical separating means, a high speed scanner, optical means having power in the frame scanning direction for forming an image of the light source on said high speed scanner and a slow speed scanner comprising a plurality of adjacent mirrors adapted to oscillate about parallel axes under the influence of received synchronizing signals, a rotating driving member, and a mechanical connection between said driving member and each of said mirrors including a rotatable cam and a cam follower mechanically connected to said mirrors, optical means having optical power in the frame scanning direction for forming an image of said light source on said high speed scanner and for forming an image of said high speed scanner surface in a receiving plane, said mechanical connections being such that during scanning all the mirrors reflect light onto substantially the same part of the receiving plane.

10. A television system comprising a light source, a light modulating device, a high speed scanner, and a slow speed scanner comprising a plurality of mirrors adapted to oscillate about parallel axes under the influence of received synchronizing signals, an astigmatic optical system for forming an image of said light modulating device on said high speed scanner having definition only in the non-scanning direction thereof, a receiving screen, and an optical focussing system adjacent said slow speed scanner for

forming an image of the faces of said high speed scanner on said receiving screen.

11. A system according to claim 10 wherein said optical focussing system comprises a plurality of lenses one close to each mirror of said slow speed scanner, and wherein the mirrors of said scanner are given such initial positions and are adapted to be driven in such a manner that the light from each mirror falls on substantially the same point on said receiving screen.

12. A television receiving system comprising a light source, a light modulating device, high speed scanning means, and a slow speed scanner comprising a plurality of adjacent mirrors adapted to oscillate about substantially parallel axes, means having optical power associated with each mirror for focussing the light falling thereon into an image of the light source in a receiving plane, the rest position of each mirror being so adjusted that, in operation of said system, the light from each mirror falls on the same part of said receiving plane as the light from the remaining mirrors.

13. A television receiving system comprising a light source, a light modulating device, high speed scanning means, and a slow speed scanner comprising a plurality of adjacent mirrors adapted to oscillate about substantially parallel axes, means having optical power associated with each mirror for focussing the light falling thereon into an image of the light source in a receiving plane, the rest position of each mirror and its amplitude of oscillation being so adjusted that, in operation, the light from each mirror falls on the same part of said receiving plane as the light from the remaining mirrors.

14. A television receiving system comprising means for modulating a light beam in accordance with received television signals, high speed scanning means, slow speed scanning means comprising a plurality of mirrors mounted to oscillate about substantially parallel axes under the control of received synchronizing signals, and means having optical power in the frame scanning direction and associated with each mirror for focussing the light beam on to a receiving plane, the relative angular positions of said mirrors being so adjusted that in operation the light from each mirror falls on the same part of said receiving plane as the light from the remaining mirrors.

15. A television receiving system comprising means for modulating a light beam in accordance with received television signals, high speed scanning means, slow speed scanning means comprising a plurality of mirrors mounted to oscillate about substantially parallel axes under the control of received synchronizing signals, and an optical member associated with each mirror having power at least in the frame scanning direction for focussing the part of the light beam falling thereon on to a receiving plane, the relative angular positions and amplitude of oscillation of said mirrors being such in operation that the light from each mirror falls on the same part of said receiving plane as the light from the remaining mirrors.

16. A television receiving system comprising a light source, a light modulating device, high speed scanning means, and a slow speed scanner comprising a plurality of adjacent mirrors adapted to oscillate about substantially parallel axes, means having optical power associated with each mirror for focussing the light falling thereon into an image of the light source in a receiving plane, and oscillatory driving means adapted to be controlled by received synchronizing signals, a mechanical connection between each of said mirrors and said driving means, said connections being so adjusted that during operation, the light from each mirror falls on the same part of said receiving plane as the light from the remaining mirrors.

17. A television receiving system comprising a light source, a light modulating device, a high speed scanner, and a slow speed scanner comprising a plurality of adjacent mirrors adapted to oscillate about parallel axes and a lens situated close to each mirror and adapted to focus the light falling thereon into an image of the light source on a receiving plane, the rest position of each mirror and its amplitude of motion being so adjusted that in operation the light therefrom falls on the same part of said image plane as the light from the remaining mirrors.

18. A television receiving system comprising a light source, a light modulating device, high speed scanning means, a slow speed scanner and optical means for forming a modulated scanning spot in a receiving plane, said slow speed scanner comprising a plurality of adjacent mirrors adapted to oscillate about substantially parallel axes under the influence of received synchronizing signals with such relative motions that the light from each mirror falls on substantially the same part of the receiving plane as the light from the remaining mirrors.

19. A television receiver comprising a light source, a supersonic wave light modulating device, a high speed scanner, optical means having optical power in the frame scanning direction for forming an image of said light source on said high speed scanner and for forming an image of said high speed scanner surface in a receiving plane, and a slow speed scanner comprising a plurality of adjacent mirrors adapted to oscillate about parallel axes under the influence of received synchronizing signals with such relative motions that the light from each mirror falls on substantially the same part of the receiving plane as the light from the remaining mirrors.

20. A television receiving system comprising a light source, a light modulating device, means for producing a high speed scanning, a slow speed scanner comprising a plurality of adjacent mirrors adapted to oscillate about parallel axes, and an optical system for forming the light reflected from said mirrors into a single modulated scanning spot in a receiving plane.

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