April 15, 1947. H. A. IAMS 2,419,024

RADIO VIEWING SYSTEM

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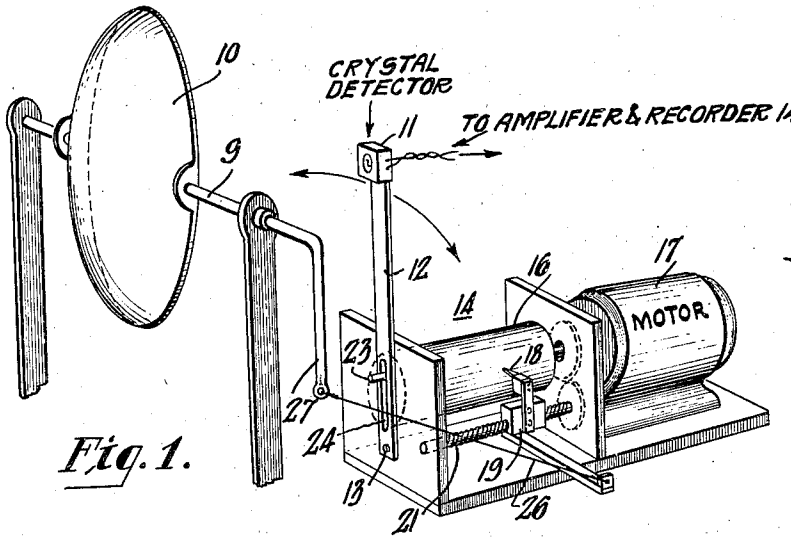

Fig. 1.

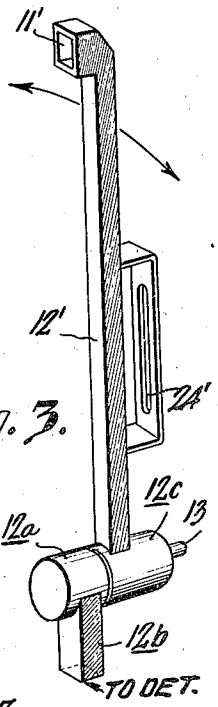

Fig. 3.

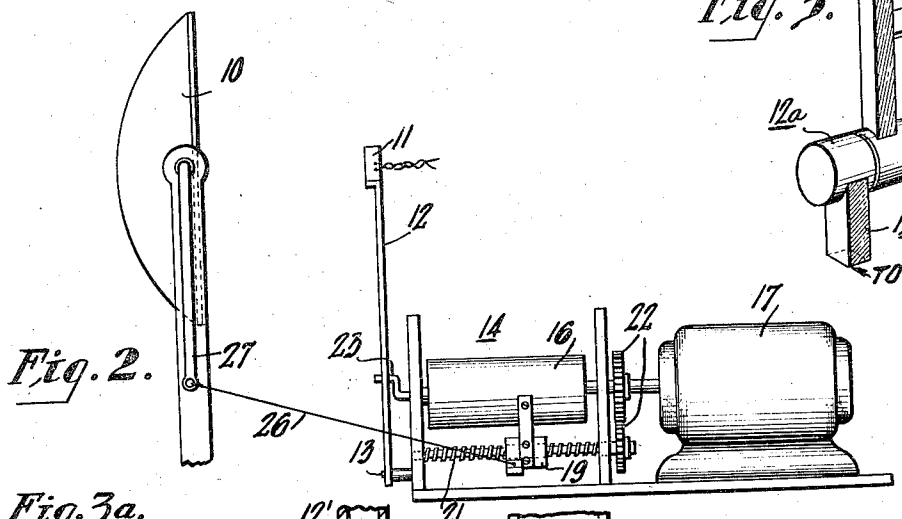

Fig. 2.

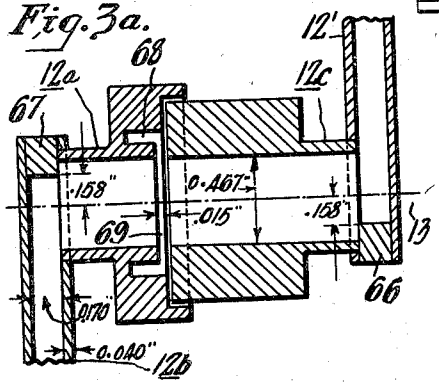

Fig. 3a.

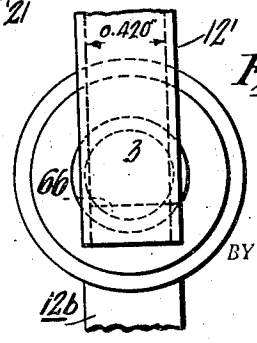

Fig. 3b.

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RADIO VIEWING SYSTEM

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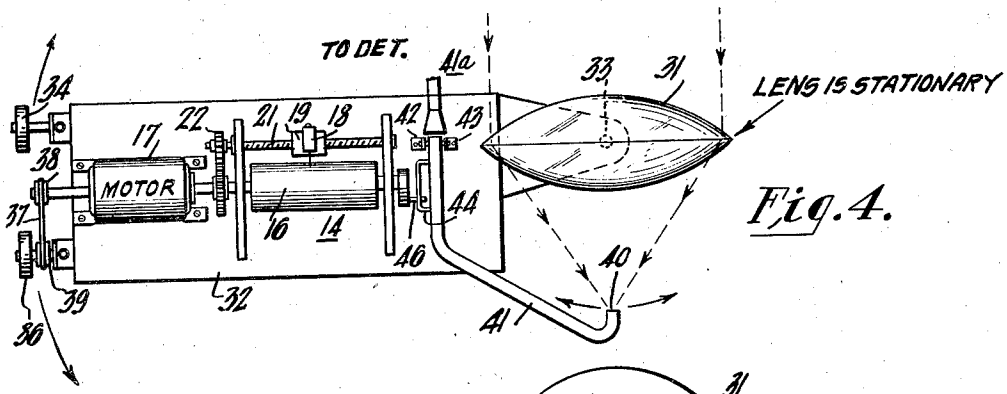

Fig. 4.

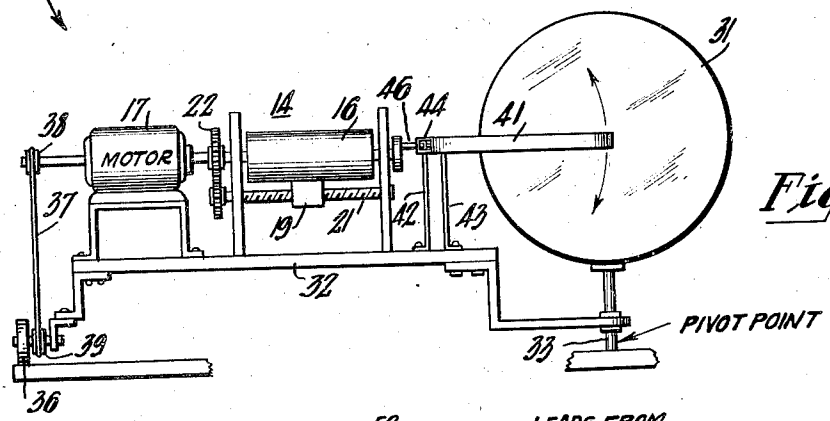

Fig. 5.

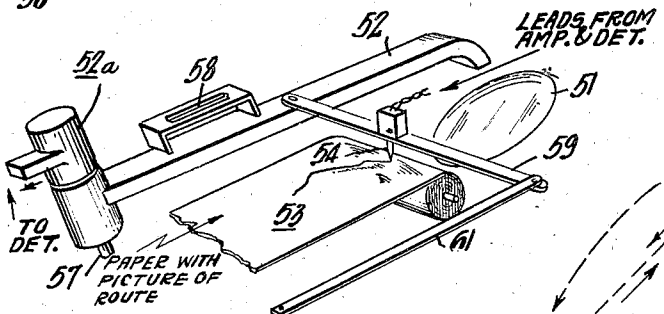

Fig. 6.

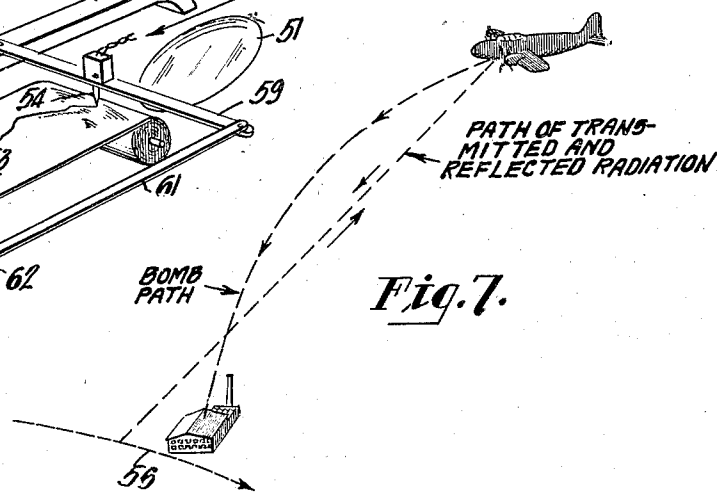

Fig. 7.

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2,419,024

RADIO VIEWING SYSTEM

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Application February 21, 1945, Serial No. 579,076

6 Claims. (Cl. 178—6.6)

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My invention relates to systems for viewing scenes in darkness or obscured by fog, smoke or the like, and in particular it relates to systems of this type wherein the scene is recorded.

An object of the invention invention is to provide an improved method of and means for obtaining a view of a scene by utilizing radio waves reflected therefrom.

A further object of the invention is to provide an improved method of and means for recording a scene that is obscured by darkness, fog or the like.

In practicing the invention, the radio waves from a scene are imaged by means of a mirror or a lens and this image is scanned by means of a pick-up device such as a detector or the end of a wave guide which is arranged to conduct the radiation to a detector. The signal from the pick-up device is amplified and supplied to a facsimile recorder or the like which is driven in synchronism with the scanning of the radio wave image whereby a record of the scene is obtained.

The invention will be better understood from the following description taken in connection with the accompanying drawing in which

Figure 1 is a view in perspective of one embodiment of the invention,

Figure 2 is a side view of the apparatus shown in Fig. 1,

Figure 3 is a view in perspective of a wave guide scanning arm that may be substituted for the scanning arm shown in Figs. 1 and 2,

Figures 3*a* and 3*b* are cross-sectional and end views, respectively, of a rotatable wave guide joint shown in Fig. 3,

Figure 4 is a plan view of a second embodiment of the invention,

Figure 5 is a side view of the apparatus shown in Fig. 4,

Figure 6 is a perspective view of a third embodiment of the invention, and

Figure 7 is a view that is referred to in discussing the operation of the invention illustrated in Fig. 6.

In the several figures, similar parts are indicated by similar reference characters.

Referring to Figs. 1 and 2, the radio waves from a scene to be viewed are imaged by a concave mirror 10 such as a spherical mirror supported by a shaft 9, the image being formed in the plane of a swinging pick-up device 11. The waves from the scene are obtained by "illuminating" or flooding the scene with radio waves of a wave length short enough to permit the formation of a sufficiently sharp image with an optical system of convenient size, but long enough to pass through clouds and fog. Wave lengths of about one centimeter, for example, or shorter, are suitable.

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The pick-up device 11 is mounted on a scanning arm 12 that is pivotally supported at 13 on the base of a facsimile recorder 14. The recorder 14, in the example shown, is of the well known type comprising a rotatable drum 16 that has a sheet of current-sensitive paper wrapped around it. The drum 16 is rotated through suitable gearing by a motor 17.

The recording stylus 18 is supported on a carriage block 19 that is supported in screw-threaded relation on a threaded rod 21 whereby the stylus 18 is moved longitudinally along the drum 16 when the rod 21 is rotated. The rod 21 is rotated through gears 22 by the motor 17 thus moving the stylus 18 along the drum 16 as the drum is rotated.

At the same time, the pick-up device 11 is swung in the plane of the image from left to right and return during each complete rotation of the drum 16 by means of a crank arm 23 that engages a slot 24 in the scanning arm 12. Also, as the stylus 18 moves along the drum 16, a link member 26 that connects the stylus carriage block 19 to an arm 27 of the mirror shaft 9 causes the mirror 10 to tilt, thereby moving the image in the vertical direction with respect to the pick-up device 11. It will be apparent that as a result the complete image is scanned by the device 11, the scanning being rapid in the left-right or horizontal direction and slow in the up-down or vertical direction.

The pick-up device 11 may be a crystal detector or the like as assumed in the example of Figs. 1 and 2, or it may be the end 11' of a wave guide 12' as illustrated in Fig. 3. The wave guide 12' is mounted on the facsimile recorder 14 in the same way the scanning arm 12 is mounted thereon with the pin of the crank arm 23 engaging a slot 24'. At the pivot point 13, the wave guide 12' is provided with a rotatable joint 12*a* whereby the energy picked up at 11' may be supplied through a wave guide section 12*b* to a suitable detector (or mixer) and amplifier not shown. As in the case of the embodiment of Figs. 1 and 2, the detected and amplified energy from the pick-up device is supplied to the stylus 18 where a mark is made on the recording paper due to the current flow from the stylus. As is well understood in the art, the mark is dark or light depending upon the amplitude or density of the current supplied to the stylus whereby a picture

corresponding to the image is obtained. With the scanning arrangement illustrated in Figs. 1 and 2, two pictures will be obtained on the paper surrounding the drum 16, one that is produced when the scanning arm 12 swings to the left and one that is produced when the scanning arm 12 returns to the right.

By employing the wave guide and concave mirror combination at the transmitter, the scene may be illuminated by flying spot scanning. This transmitter arrangement is the reverse of the receiver combination of spherical mirror 10 of Fig. 1 and wave guide of Fig. 3 in that the energy from the transmitter is radiated from the wave guide opening 11' toward the mirror 10. In the case of flying spot scanning the transmitter and receiver scanning must be synchronized as is well understood in the art.

If the transmitter is pulsed, well known radar technique may be employed for utilizing a common wave guide and mirror combination for both transmitting and receiving. In a pulsed system there should be at least one pulse transmitted for each desired picture element. Following radar practice, the receiver may be "gated" so that only echo pulses received during a certain time interval following trasmission of a pulse are applied to the facsimile recorder. Thus, a picture may be obtained showing only objects within a certain distance from the transmitter.

Figs. 4 and 5 show an embodiment of the invention wherein the radio waves reflected from a scene are imaged by a suitable lens 31 which may be made of a low-loss dielectric such as paraffin, for example, and which may be two or three feet in diameter.

The motor 17 and the recorder 14 are mounted on a platform 32 that has one end pivotally supported at 33 under the center of the lens 31. The other end of the platform 32 is supported on a pair of wheels 34 and 36. The wheel 36 is driven by the motor 17 through a belt 37 and pulleys 38 and 39 so that the platform 32 is swung about the pivot point 33 as the recorder is operated. The lens 31 remains stationary. Thus the pick-up end 40 of a wave guide 41 is moved horizontally at a slow rate across the image formed by the lens 31.

The end 40 of the wave guide 41 scans the image in the vertical direction at a comparatively rapid rate, the motion being from bottom to top and return for each rotation of the drum 16. This rapid vertical scanning is obtained by pivotally mounting one end of the wave guide 41 on a pair of supporting members 42 and 43, the said one end being opposite the horn of a wave guide 41a leading to a detector (not shown). Instead of the pivotal mounting illustrated, a rotatable wave guide joint may be employed. A member 44 attached to the wave guide 41 has a slot therein corresponding to the slot 24' shown in Fig. 3. The slot in member 44 is engaged by a crank-arm pin 46 that is driven by the shaft of the drum 16 whereby the wave guide 41 oscillates up and down as the drum rotates. With this arrangement the complete image is scanned without tilting the lens 31. It will be understood that the lens 31 may be replaced by a concave mirror if desired.

From the pivoted end of the wave guide 41 the energy picked up from the radio wave image is supplied through additional wave guide structure (not shown) to a suitable detector and amplifier (not shown). As in the system shown in Figs. 1 and 2, the amplified signal is then supplied to the recorder stylus 18.

Fig. 6 illustrates an embodiment of the invention where the motion of an airplane is used to provide the scanning motion in one direction, this scanning motion corresponding to the tilting of the mirror in Fig. 1.

As shown in Fig. 6, a lens 51 is mounted in the bottom of the plane to form an image of the terrain below. The image of an object on the ground sweeps across the path of a swinging wave guide 52 at a comparatively slow rate as the plane advances. The wave guide 52 is oscillated about a pivot point 57 of a rotatable wave guide joint 52a at a comparatively rapid rate by means of a crank arm pin (not shown) that engages a slot 58. A stylus 54 is supported on an arm 59 that, in turn, is pivotally attached at its ends to the wave guide 52 and to a supporting arm 61. The arm 61 is supported at a pivot point 62. Synchronized with the speed of the plane, a sheet of current-sensitive facsimile paper 53 is passed under the stylus 54 which is oscillated by the wave guide 52. The paper 53 is marked by the current flow from stylus to paper as in usual facsimile recorders, thus producing a strip map of the route which has been covered. This map can be used to follow a river or railroad to the target. By scanning a line 56 on the earth's surface that is a certain distance ahead of the airplane, as indicated in Fig. 7, time can be allowed for the release of the bomb after the target has been identified.

The rotatable wave guide joints referred to in connection with the preceding figures may be of the type shown in Figs. 3a and 3b, if desired. Several dimensions are given in inches in the two figures by way of example for the case where the wave length of the radio wave is substantially 1.25 centimeters. Figs. 3a and 3b are largely self-explanatory but it may be noted that the ends of the wave guides 12' and 12b contain plugs 66 and 67, respectively, which provide "steps" opposite the circular wave guide elements 12c and 12a, respectively, of the rotatable joint. These step portions cause the radio wave from a rectangular wave guide to travel into and through the circular wave guide portions 12a and 12c and then into the other rectangular wave guide with but little loss in energy. The circular slot 68 and the associated end spacing 69 act as a choke or filter to keep the radio waves from leaking out of the joint.

I claim as my invention:

1. In combination, means for imaging radio waves from a scene to be recorded, a radio wave pick-up device comprising a crystal detector, means for scanning the said radio wave image by said pick-up device and converting the energy thus picked up into an electrical signal, a facsimile recorder, means for operating said recorder in synchronism with said scanning, and means for supplying said signal to said recorder whereby a picture of said scene is recorded.

2. In combination, means for imaging radio waves from a scene to be recorded, a radio wave pick-up device comprising a wave guide, means for scanning the said radio wave image by said pick-up device and converting the energy thus picked up into an electrical signal, a facsimile recorder, means for operating said recorder in synchronism with said scanning, and means for supplying said signal to said recorder whereby a picture of said scene is recorded.

3. In combination, means for imaging radio

waves from a scene to be recorded, a radio wave pick-up device, means for scanning the said radio wave image by said pick-up device and converting the energy thus picked up into an electrical signal, said means for scanning said image comprising means for moving said pick-up device comparatively rapidly across said image in one direction, and means for tilting said image comparatively slowly substantially at right angles to said one direction, a facsimile recorder, means for operating said recorder in synchronism with said scanning, and means for supplying said signal to said recorder whereby a picture of said scene is recorded.

4. A scanning device comprising a mirror for focusing radio waves, means for tilting said miror about an axis to scan in one direction, a pick-up device for receiving said radio waves, and means for moving said pick-up device substantially parallel with the axis of tilt of said mirror.

5. In combination, means for imaging radio waves from a scene to be recorded, a radio wave pick-up device comprising a crystal detector, means for scanning the said radio wave image by said pick-up device and converting the energy thus picked up into an electrical signal, an image reproducing means, means for operating said image reproducing means in synchronism with said scanning, and means for supplying said signal to said reproducing means whereby a picture of said scene is obtained.

6. In combination, means for imaging radio waves from a scene to be recorded, a radio wave pick-up device comprising a wave guide having an open end positioned to receive energy from said image and having the other end mounted on and terminating in a rotatable wave guide joint, means for scanning the said radio wave image by said pick-up device and converting the energy thus picked up into an electrical signal, an image reproducing means, means for operating said image reproducing means in synchronism with said scanning, and means for supplying said signal to said reproducing means whereby a picture of said scene is obtained.

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Disclaimer

2,419,024.—*Harley A. Iams*, Princeton, N. J. RADIO VIEWING SYSTEM. Patent dated Apr. 15, 1947. Disclaimer filed June 30, 1950, by the assignee, *Radio Corporation of America.*

Hereby enters this disclaimer to claim 4 of said patent.

[*Official Gazette August 8, 1950.*]

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