

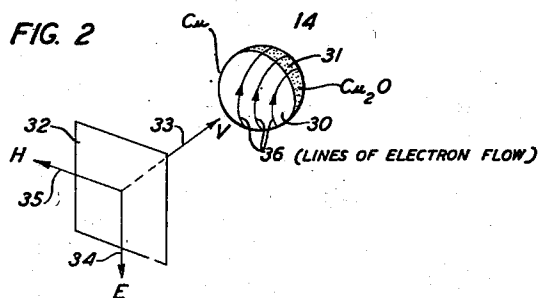
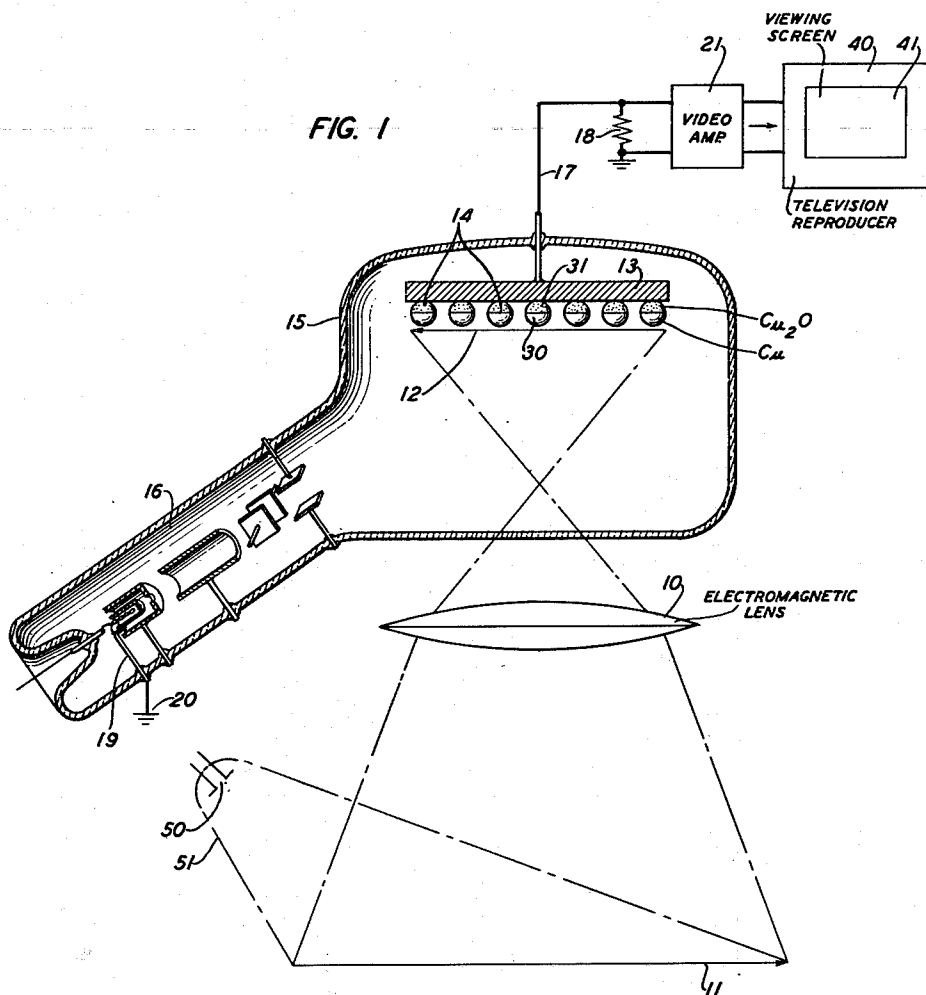
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J. W. GIBSON

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IMAGE TRANSLATING DEVICE

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INVENTOR
J. W. GIBSON
BY
Franklin Mohr
ATTORNEY

UNITED STATES PATENT OFFICE

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IMAGE TRANSLATING DEVICE

James W. Gibson, Avenel, N. J., assignor to
Western Electric Company, Incorporated, New
York, N. Y., a corporation of New York

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This invention relates to an image translating device and more particularly to means for translating an invisible image formed with short radio waves into a visible image or into a plurality of electric potential values from which a record or reproduction of an object or scene can be obtained.

Arrangements have been disclosed in the past whereby an invisible image may be formed by means of short radio waves collected from an object or scene by a lens, using technique similar to that used with light rays in a camera. Means have been shown for causing an invisible image of this sort to produce induced currents in small circuit elements distributed over the field of the image and arrangements have been shown whereby such induced currents might be used directly to produce flashes of light which combine to form a visible image corresponding to the object or scene from which the invisible image was formed. Apparatus has also been disclosed for translating an invisible image formed with infra red or ultra violet light rays into a visible image. In the field of television on the other hand, light-sensitive screens or mosaics have been developed for translating a visual image into a plurality of electric potential values or electric charges which in turn may be translated into picture impulses or video currents upon causing the mosaic to be scanned by a cathode ray. The video currents may be employed to reproduce the visual image in the same or another location according to well-known television technique by transmitting the video currents and using them to control the reproducing system.

An object of the present invention is to adapt the television technique, as employed with visible light rays so that the technique may be used in a system of television wherein short radio waves take the place of light rays between the object to be viewed and the image of that object which it is desired to reproduce.

A feature of the invention is an improved means for translating a primary, invisible image formed with short radio waves into a secondary, visible image.

Another feature is a rectifying element suitable for rectifying surface currents or eddy currents.

The invention is particularly applicable to a system for viewing a distant scene through darkness or fog, etc., by means of an image formed with electromagnetic waves, the image being translated into a plurality of electric charges by means of a mosaic of rectifying elements, said

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elements being discharged successively as by a scanning beam of electrons to form a video current which may be employed in known manner to form a secondary image which latter may be visual.

The invention is particularly adapted, but not limited, to use with electromagnetic waves of the order of 1 centimeter wavelength.

The scope of the invention is defined in the appended claims and the invention is more fully described hereinafter in connection with the accompanying drawing in which:

Fig. 1 shows an embodiment of the invention in a viewing system; and

Fig. 2 shows an enlarged perspective view of a rectifying element according to the invention, combined with a diagram useful in explaining the operation of the invention.

Referring to Fig. 1, 10 represents an electromagnetic lens arranged to gather radiation of short radio waves from an object represented by an arrow 11 and to form an invisible image represented by another arrow 12.

A conductive plate 13 having attached thereto a plurality of rectifying elements 14 forming a planar array or mosaic is placed in such a position that the image 12 is cast upon the elements 14. The plate 13 and elements 14 are enclosed in an evacuated envelope 15 having a neck portion 16 containing the usual elements of a cathode ray scanning device in operative position to scan the mosaic of elements 14. The rectifying elements 14 are each conductively attached to the plate 13 which in turn is conductively connected to ground through a lead 17 and an impedance element represented by a resistor 18. A cathode lead 19 for the scanning system is grounded as at 20. The resistor 18 is connected to a video amplifier 21, or the resistor may constitute an element included in the amplifier 21, which latter is in turn to be connected to a television reproducer 40 which may be of conventional design, having a viewing screen 41. To save space in the drawing, the television reproducer and viewing screen are shown schematically only and not to scale, these elements being of conventional design.

One of the rectifying elements 14 is illustrated on an enlarged scale in Fig. 2. The element 14 is preferably spherical and may be a copper ball. A portion 30 of the surface of the element 14, preferably a hemisphere, may be the untreated copper. The remainder of the surface, indicated at 31, has an exposed surface of cuprous oxide as in the conventional copper-oxide rectifier.

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The elements 14 are all to be oriented with the oxide portion attached to the plate 13, leaving the exposed copper portion facing the direction of approach of the electromagnetic waves from the lens 10.

The element 14 is not limited to a combination of copper and cuprous oxide, and other known combinations of rectifying elements may be substituted as desired. Both materials in the rectifying combination should be sufficiently good conductors to support surface currents, though there may be a considerable difference in their conductivities consistent with suitable rectifying properties at their junction.

In the operation of the system disclosed in the drawing, electromagnetic waves are reflected from the object or scene represented by the arrow 11, which object or scene may be irradiated by any suitable source of short radio waves either at the receiving station or elsewhere such as a dipole antenna 50 located at the focus of a parabolic reflector 51, the radiation from which may be directed toward the object or scene. Also, the object may, of course, be a generator and radiator of such waves. The waves from 11 are collected by the lens 10 and formed into an invisible image or pattern of electromagnetic waves at 12 in the plane of the rectifying elements 14. The square 32 in Fig. 2 represents a portion of a plane of a radio frequency wave front traveling in the direction of the arrow 33, the electric vector of the field being indicated by the arrow 34 and the magnetic vector by the arrow 35. As the plane 32 of the wave passes the rectifying element 14, electron flow is set up on the surface of the element 14 in the direction as indicated by arrows 36 in Fig. 2. The lines of electron flow may be generally described as circular. Since there is low resistance to electron flow from the copper to the oxide across the rectifying boundary and high resistance in the opposite direction, the result is an accumulation of electrons, that is, a negative charge on the back surface of the sphere at 31 and, hence a deficiency of electrons, that is, a positive charge on the front at the surface 30. The mosaic of elements 14, having the radio frequency image or pictures focussed upon it, by virtue of the accumulated charges transforms the image into an electrical picture, the front half of each element assuming a positive potential proportional to the radio frequency intensity at that point. The mosaic may be scanned by a cathode ray from the neck portion 16 of the vacuum container. When so scanned, each element 14 is discharged in turn, the resulting electron flow passing into plate 13 thence through the resistor 18 to ground and cathode lead 19. The potential drop across the resistor 18 due to the discharge current is impressed upon the input of the video amplifier 21. A succession of pulses is thus supplied to the video amplifier 21 during the scanning operation and these pulses convey the necessary information to the television reproducer 40 to form upon the viewing screen 41 reproduction of the invisible image 12. Between successive contacts with the scanning beam, each element 14 is recharged by the then existing field at the location of the element in question. The scanning should proceed at a uniform, steady rate to avoid flicker and distortion in the visual image.

The lens 10 may be of any conventional construction suitable for the refraction of radio waves of the wavelength employed. It is known that the refractive properties of an optical lens result from the fact that the velocity of light in the

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optical material such as glass is less than the velocity of light in air. By definition, $i=V/V'$, where i is the index of refraction of the medium, V is the velocity of light in air and V' is the velocity of light in the medium. Passing to electromagnetic waves in general, the velocity of the wave in any medium is given by the expression $V'=1/\sqrt{k\mu}$, where k is the dielectric constant of the medium and μ is the permeability of the medium. By combining these two equations and taking into account that the dielectric constant for air is unity and that the permeability for air and for all non-magnetic media is also substantially unity, it follows that $i=\sqrt{k}$. Using this relationship to design a double convex lens to be formed, for example, from porcelain (dry process) results in a lens having a radius of curvature of 13 feet and a focal length of 3.74 feet. A lens of this design is adapted to form an image 2 feet square from an object 5 miles square at a distance of 50,000 feet, as for example from an airplane at that altitude.

It is known from wave theory that two points of an image formed by any lens system in air, in order to appear separate and distinct, must be separated by at least $\lambda/2$, where λ is the wavelength of the radiation forming the image. This represents the theoretical maximum resolution which in practice can only be approached. A lens of the dimensions given above, when used with 1-centimeter radiation may be expected to give a degree of definition comparable to that in a 120 line television picture.

The element 14 may have a diameter approaching one-half wavelength as an upper limit imposed by the theoretical maximum resolution, but preferably the diameter of the element 14 should be considerably smaller and the individual elements 14 should be mounted as close together as possible to insure maximum definition in the final visible picture.

Using 1-centimeter radiation, the maximum diameter of the element 14 as determined by the theoretical maximum resolution is one-half centimeter, or approximately one-fifth of an inch. As stated above, the elements 14 should preferably be made considerably smaller in order that several of them may be set in the space of one-half centimeter.

In terms of an object which is 5 miles square, such as an area of terrain, the resolution in a system employing 1-centimeter waves has a theoretical value of 200 feet.

It will be noted that, to promote legibility in Fig. 1, the amount of separation between the elements 14 is exaggerated beyond what is necessary to avoid danger of contact. Also, only a few elements 14 are pictured, whereas many such elements and rows of elements will be required depending upon the dimensions of the image 12.

It will be understood that in the operation of the system, the television reproducer will show a reproduction in visible form of the image formed upon the elements 14 by the invisible radiation from the object or scene at 11.

It will be evident that the arrangement of Fig. 1 is sensitive to radiation of suitable wavelength arriving from the direction perpendicular to the plate 13 and that the device may be turned in any direction to discover the presence of either a source of waves or a reflecting object and that when waves therefrom are intercepted, the television reproducer will respond and the direction

in which the device is pointed will show the direction to the source or reflecting object.

It will be further evident that the element 14 is useful apart from the system described, in any application calling for a rectifier for electric currents such as eddy currents induced in the surface of an element.

Modifications of the system disclosed, within the scope of the appended claims will occur to one skilled in the art and additional uses will appear which may be made without exceeding the limits of the claims.

What is claimed is:

1. A translating system comprising a conductive plate, a plurality of spaced spherical elements each having a hemispherical surface portion of copper and having the remaining surface portion of cuprous oxide, each of said spherical elements having the cuprous oxide surface portion thereof conductively attached to said plate, means projecting upon said spherical elements a pattern of electromagnetic waves of wavelength of the order of magnitude of the diameter of one of said spherical elements to accumulate electric charges on the respective hemispherical surface portions of said spherical elements, means neutralizing the charge on the unoxidized copper surface portion of the spherical elements in succession, and a return circuit from said conductive plate to said neutralizing means for indicating variations in the accumulated charges from one spherical element to the next.

2. A translating system comprising a conductive plate, a plurality of spaced spherical elements each having a hemispherical surface portion of copper and having the remaining surface portion of cuprous oxide, each of said spherical elements having the cuprous oxide surface portion thereof conductively attached to said plate, cathode ray scanning means in position to scan said spherical elements successively, and a return circuit from said conductive plate to the cathode of said scanning means, said return circuit including video current responsive means.

3. A system for transforming a primary image formed by electromagnetic waves into a secondary image formed by other electromagnetic waves, said system comprising a plurality of spaced rectifying elements each having a conductive surface divided into two portions separated by a rectifying boundary region, means supporting said rectifying elements in the form of a mosaic lying substantially in the plane of the primary image, each said rectifying element being arranged to have its direction of best conduction substantially perpendicular to the plane

of the primary image and said elements being poled with the conductive direction of each element the same as any other with respect to the said plane, whereby the electric field variations at any given point in the primary image give rise to surface alternating currents on a particular one of said rectifying elements thereby accumulating an electric charge on one side of said rectifying boundary in proportion to the electric field intensity at the given point, means periodically discharging said rectifying elements in succession thereby producing a fluctuating current varying in accordance with the magnitude of the accumulated charge from element to element, and means producing a secondary image from the information carried by the fluctuations in said current.

4. A rectifier for surface currents induced by electromagnetic waves, said rectifier comprising a spherical element the diameter of which is of the same order of magnitude as the wavelength of the waves and the surface of which is divided into two hemispheres one of which is cuprous oxide and the other unoxidized copper.

5. A combined antenna and detector for electromagnetic waves, comprising a spherical element of diameter of the order of magnitude of the wavelength of the wave to be detected, the surface of which spherical element is composed of two substances of unequal conductivity segregated in different portions of the surface of said element and having rectifying properties at their junction.

6. A device for extracting energy from a passing electromagnetic wave and storing said energy in the form of an electric charge, said device comprising a spherical element the diameter of which is of the same order of magnitude as the wavelength of the wave and the surface of which is divided into two portions of unequal conductivity separated by a rectifying boundary.

JAMES W. GIBSON.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
50 2,049,472	Rosett	Aug. 4, 1936
2,140,994	Gorlich	Dec. 20, 1938
2,149,977	Morton	Mar. 7, 1939
2,065,570	Essig	Dec. 29, 1936
2,171,213	Janes	Aug. 29, 1939
55 2,246,328	Smith	June 17, 1941
1,905,724	Liebel	Apr. 25, 1933