

April 25, 1939.

A. J. CAWLEY

2,155,471

FOG AND MIST PENETRATING DEVICE

Filed March 19, 1931

2 Sheets-Sheet 1

Fig. 1.

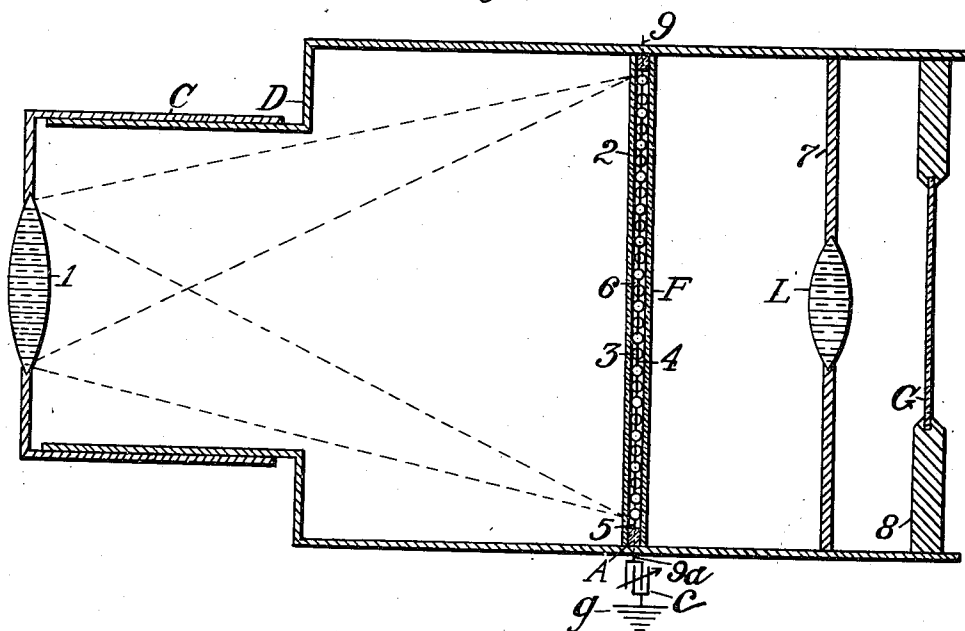


Fig. 2.

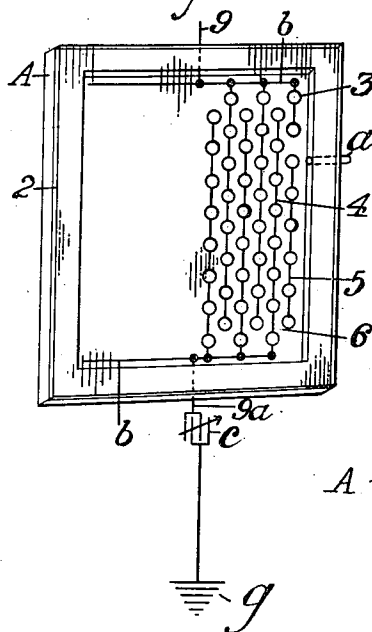


Fig. 3.

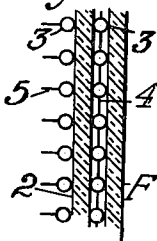


Fig. 4.

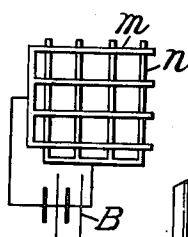


Fig. 2b

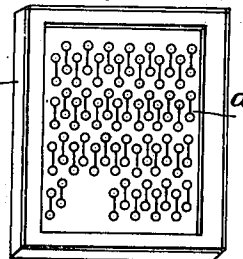
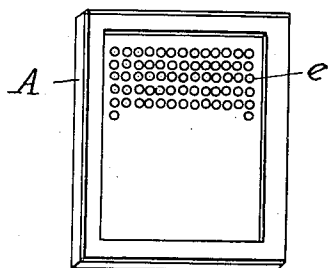


Fig. 2a



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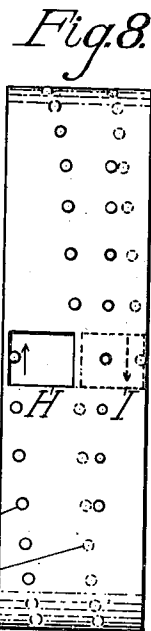
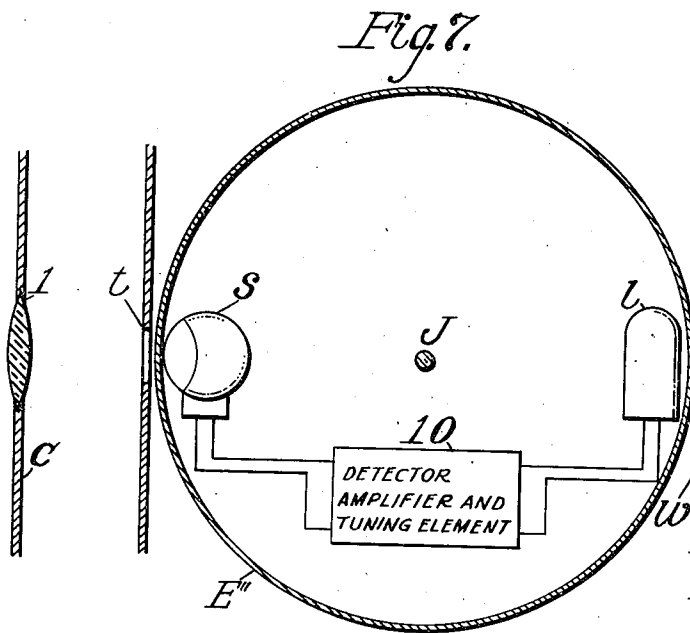
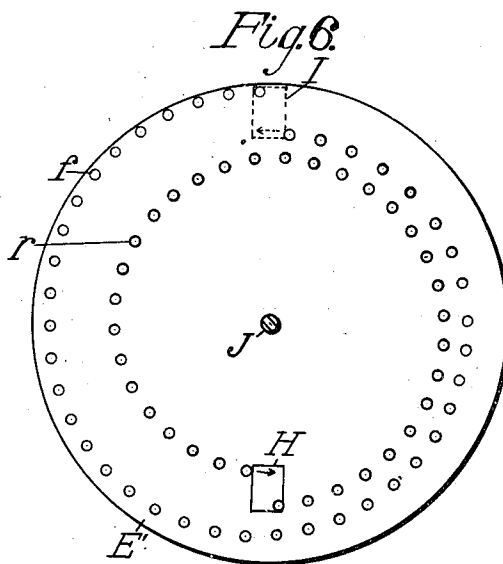
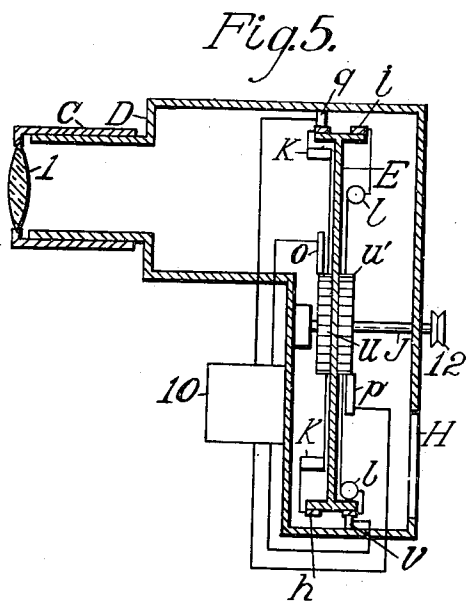
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FOG AND MIST PENETRATING DEVICE

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2 Sheets-Sheet 2



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## UNITED STATES PATENT OFFICE

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## FOG AND MIST PENETRATING DEVICE

Aloysius J. Cawley, Pittston, Pa.

Application March 19, 1931, Serial No. 523,791

13 Claims. (Cl. 250—1)

This application is a continuation-in-part application of my applications Serial No. 509,163, for Electric wave device, filed October 20, 1921, now abandoned, but during the pendency of which this application was filed, and Serial Number 424,748, for Divaision, filed January 30, 1930, and which is now U. S. Patent No. 2,083,292, issued June 8, 1937.

The invention has for its object in general, the perception of objects by means of electric waves which are longer than the visible light waves, but which are much shorter than those used in present day broadcasting. Since such electromagnetic waves are subject to all of the laws of reflection, refraction and polarization as are ordinary light waves, a beam of those waves is directed upon a body possessing the power or reflecting them. An invisible image is formed of those reflected waves, and this invisible image is converted into a visible image by means of the apparatus described in this application.

The waves may be generated by any ordinary means, such as by vacuum tubes, Hertzian resonators, induction coils, Hertzian vibrators, by an antenna or plurality of antennae connected to suitable sources of high frequency alternating current. One of the main objects of the invention is the formation of invisible images by means of electromagnetic waves, which images are converted into visual images, thus making it possible to perceive objects through mists, buildings, dry earth, and in fact through nonconductors in general.

The accompanying drawings forming a part of this specification are to be referred to, in which like reference characters have similar meanings in all of the views, and in which,

Figure 1 is an elevational view showing an apparatus forming an invisible electromagnetic wave image which is rendered visible.

Figure 2 is an elevational view of the neon cell which is placed in the image plane and which forms a visible image from the invisible image.

Figure 2a is an elevational view of a modification of Figure 2.

Figure 2b is another modification in elevation of Figure 2.

Figure 3 is a cross section of a modification of the neon cell shown in Figure 2.

Figure 4 is a further modification of the neon cell shown in Figure 2.

Figure 5 is an elevational cross sectional view of an apparatus forming invisible electromagnetic wave images and rendering those images visible and employing a rotating element.

Figure 6 is a view of a disk, which may be used in conjunction with the apparatus illustrated in Figure 5 by substituting it for the rotating element illustrated therein.

Figure 7 is a view of an apparatus for forming visible images from electromagnetic wave invisible images after the method illustrated by Figure 6.

Figure 8 is a side view of Figure 7, showing the means carried on the surface of the cylinder for scanning the visible and invisible images.

In accordance with the principles outlined in connection with the above mentioned applications, the waves which have been directed upon the object are reflected and received by lens 1 in Figure 1, which forms an image of the invisible electromagnetic waves. This lens may be made of paraffin, bitumen, pitch, glass or any substance partially or wholly permeable to electromagnetic waves. In the focal plane of this image is placed a neon gas cell A containing a plurality of metallic elements, here shown as metal balls 3. This invisible image consists of electromagnetic waves of varying concentration or intensity in accordance with the image. Where the "high lights" of the image are located there is a great concentration of electromagnetic waves, at the "medium" lights of the image a lesser concentration, and so on. Therefore, the electromagnetic waves constituting the image will generate varying amounts of electromotive force in the different electrical conducting elements, such as balls 3. Now, as is well known, there will be a discharge between the neighboring balls, in the form of a high frequency alternating current, and this current, or rather those currents will cause an illumination of the neon gas, which is at a suitable degree of rarefaction to produce the greatest degree of illumination. As the varying intensity of electromotive force throughout the image area will produce varying intensities of electric current, there will be a resultant degree of illumination in the neon gas which will constitute a visible image of the objects from which the waves have been reflected.

Many modifications of the neon cell shown are covered by the invention. For instance a number of balls or cylindrical conductors may be distributed throughout the cell without any interconnections. Or they may be connected by means of wires 4 and 5 into alternately positive and negative rows. Wires 4 in one modification, may be connected to bus bars b at the top and all of wires 5 connected to the opposite bus bar. Lead-ins 9 and 9a, in certain modifications, may

be used to supply a biasing current by means of which the balls 3 are partly charged, so that the image varied electromagnetic waves may superpose their energy thereon to form the luminous image.

In one modification, the neon cell is not connected to any auxiliary source of power, the energy of the electromagnetic waves alone being relied upon to form the image.

In another modification, lead-in 9a is connected to the ground. The various balls 3, or the balls and wires 4 and 5 may be likened to a series of receiving antennae. The energy is received by the balls 3 and wires 4 and 5 and led to the ground *g* by connecting 9a thereto. Tuning means may be connected in circuit such as a variable reactance and a variable capacity such as *c*. Thus wires 5 may be compared to the receiving antennae having a plurality of spark gaps across which the electric currents generated in the antennae pass to the ground through wires 4, *b* and 9a. Those alternating electric currents in passing across the spark gaps render the neon luminous.

The neon cell is shown in this figure as being composed of a hollow glass body with two glass plates 2 and *F* cemented thereto. It is to be noted that the image produced by the cell will be reversed, i. e., wrong side up. If it is desired to correct this, a partition 7 may be placed in the camera-like apparatus *D*, containing glass lens *L*. Also, a ground glass *G* may be placed in a partition 8 which may be placed in position in the camera. Lens *L* will display this visible image right side up on ground glass screen *G*. In order to accomplish exact focusing a telescopic joint is shown between portions of the casing at *C* and *D*.

Figures 2, 2a and 2b illustrate the neon cell showing many modifications. Also many of the parts illustrated in these figures may be dispensed with without departing from the spirit of the invention.

The cell may consist of a plurality of metallic conductors, such as balls, or rods, or cylinders equidistantly spaced, as shown in a group at *e* of Figure 2a and Figure 2b. These may be used with or without an auxiliary current from bus bars *b*. It is to be particularly noted that the cell, in one modification, may simply consist of a glass "box" *A*, having a "lid" 2, which is tightly cemented to the rest of the cell, with nothing in the cell but a plurality of balls of metal and a special illuminable gas, such as neon. This is illustrated at *e* of Figure 2a.

Another modification consists of connecting the balls in pairs, as shown at *d* of Figure 2b. Here again, the ball may be left off, and we have a plurality of rods between which the luminous discharges occur.

In Figure 2, I show the balls as connected to wires 4 and 5 in such manner that alternate rows have the same charge or like charges. All wires 4 are connected to the lower bus bar *b*, and all wires 5 are connected to the upper bus bar *b*.

With any of the modifications described above, the leading in wires 9 and 9a may be connected either to a source of power, whether high frequency alternating, static machine, battery or other source of galvanic current, Oudin resonator, Tesla coil, etc. Another modification in regard to the manner of connection is that leading-in wires 9 may be connected to a source of power, and 9a to the ground. Or, another modification covers the leaving free of 9 and the con-

nection of 9a to the ground. Either between the cell and the ground, or between the cell and the auxiliary source of power, means may be suitably connected, such as variable condenser *c* and, if desired variable reactance (not shown). This tuning principle is very important, as it is highly desirable to have the conducting elements of the cell *A* in resonance with the source of electromagnetic waves from which the invisible image is formed, as then we have a greater degree of luminosity.

This principle of tuning is important from another standpoint, as the waves sent out may be tuned to some definite wave length, which would be known to only a certain few, and thus secrecy more or less maintained in case of war. That is there would be a light used to illuminate the enemy's position if a comparison of the invisible electromagnetic wave image to ordinary light waves may be made, which would only be discernible to a few. However, special attention is directed to exact tuning, thus securing resonance on the part of the receiving image device.

In the neon cell *A* a hole is bored and the glass tube *a* is inserted through which the air is exhausted and the neon gas admitted to the desired degree of rarefaction.

One other of the various modifications of the neon cell is shown in Figure 3 which shows the two plates of the glass cell at 2 and *F*. One set of balls 3 are shown inside the cell and the other set outside. Again, they may be unconnected in one modification. They may be connected with wires 4 and 5 parallelly arranged, or with one of the sets of wires 5 placed at right angles to 4.

Still another modification is shown in Figure 4. Here the conductors placed in the neon cell may consist of two "forks" placed at right angles to each other. Only four "prongs" are shown on each fork, but there may be hundreds. A battery is shown at *B* connected to the two elements *m* and *n*, or "forks". In all of the above described apparatus it is to be understood that the invisible electromagnetic wave image is converted into an image consisting of electric currents of varying intensity, and these are to be considered as an electrical image. But this electrical image is located in an illuminable gas, with the result that a luminous, visible image is produced.

The apparatus so far described consists of a large number of stationary elements. Figure 5 illustrates a device employing a smaller number of rotating elements to produce the images. The apparatus consists of a casing *D* made of metal or covered with metal foil, as described in connection with the previous figures for the purpose of eliminating stray electromagnetic waves from the camera-like structure. A part of the casing is telescopically arranged at *C*. Thus an adjustable means is provided for focussing the lens *L*. The electromagnetic waves reflected from the objects are received by lens *l* and focussed into an invisible image. In the plane of this image, there is a rotating disk *E* which turns upon shaft *J*, and connected to any suitable source of power by means of pulley 12. This disk *E* is provided with a cylindrical, peripheral portion which bears two collector rings *h* and *i*. On the left face of the disk there is a spirally arranged series of coils or antennae *K*, which traverse, or scan the invisible image, and have thus generated in them alternating currents of varying intensity. One terminal of each of the coils is connected to collector ring *h*, while the other

terminal of each coil is connected to a specific commutator segment of commutator *u*. Brush *O* plays on a commutator segment to which a coil which happens to be traversing or scanning the image field is connected. Brush *q* makes connection with collector ring *h*. The square 10 of Figures 5 and 7 represents a detecting and amplifying circuit which may be tuned to any wave length desired. It will be seen that, as a coil traverses the image area, it is connected to the detector, amplifier and of course tuning element 10 by the wires shown. Therefore, the current generated in the coil or antenna *K* is amplified by element 10 and transmitted by wires to brushes *p* and *v*. On the right hand side of the disk a series of spirally arranged glow lamps, such as neon lamps *l* is arranged. One terminal of each lamp *l* is connected to collector ring *i* and the other terminal of each lamp *l* is connected to a specific commutator segment. An important fact is that the two spirals, one of coils and one of lamps, although concentrically arranged, have their corresponding points displaced relative to each other by an angle of 180 degrees. The purpose of this is to produce a right side up luminous image opposite the window *H*, at the lower portion of the right side of the disk *E*. It will be seen that the current which has been amplified, will be delivered by means of the commutator *u* and brushes *pv* to that lamp which is traversing the visual image field opposite the window *H* through which it may be viewed. The manner of the reversal of the luminous image relative to the invisible image will be better understood by reference to Figure 6, which illustrates two spirals of different sizes, whereas the spirals of coils and lamps of Figure 5 are of equal size. Nevertheless, the spirals containing lenses *f* and *r* serve to demonstrate that the beginning of one spiral is in the upper portion of the disk *E'*, while the beginning of the other spiral is in the lower portion, or displaced by 180 degrees.

Figure 6 illustrates a disk *E'* which may be substituted for the rotating element in Figure 5. This disk is composed of metal and has two spirals of holes or lenses *f* and *r*. A photoelectric cell or coil or antennae is placed between the disk and observer at *I*, assuming that the disk has been substituted for disk *E* in Figure 5. The lenses *f* may be of paraffin, etc. The invisible image is produced at *I*, but the holes or lenses limit the area of it that is scanned at any instant. The photoelectric cell or antenna is connected to 10, where the current is amplified and then delivered by suitable wires to the glow lamp at *H*. This glow lamp has its intensity varied in synchronism with the variations produced in the antenna at *I*, and glass lens *r* scans the lamp face in reverse order to that of the scanning by the paraffin lenses *f* at *I*. Thus a luminous image is produced at *H*. The arrows indicate that the disk *E'* rotates counterclockwise, and that the upper image is scanned from right to left and from bottom to top, while the lower image is scanned from left to right and from top to bottom. Thus the inverted invisible image is converted into a right side up visible image, which is viewed at *H*.

Figure 7 is an illustration of a device similar to that of Figure 6, but differs in that a cylinder is used having two helices of scanning apertures or lenses on its cylindrical surface. Lens *f* forms an invisible image through the aperture *t* upon photoelectric cell *s*, or wire, or coil of wire, or antenna, as desired. *C* is the metallic casing

which excludes the extraneous electromagnetic waves. The cylinder rotates on shaft *J* similar to disk *E'* of Figure 6. The two juxtaposed helices on the cylindrical surface are relatively displaced by an angle of 180 degrees, as described above. The cylindrical surface of this cylinder at least should be made of metal. As the cylinder rotates, the invisible image is scanned as described in connection with the above figures. The result is that the photocell *s* has varying amounts of electric current generated in it; or the antennae has varying degrees of electric current generated in it. (A chopper may be included with the photocell in the well known manner.) The current is delivered to the amplifier 10, and the amplified current is delivered to neon or other glow lamp *l*. A separate helix scans the lamp area producing a visible image. This may be viewed through the aperture or frame in the partition *w*. Due to 180 degrees displacement in the two helices, a right side up image is produced at the neon lamp.

Figure 8 is a view of the cylindrical surface of the cylinder *E''*, and shows the two juxtaposed helices consisting of holes or lenses *r* and *f*. The dotted arrow at image area *I* shows that the helix scans from top to bottom and right to left. The full line arrow at *H* shows that the helix made up of holes *f* scans the image area at *H* from bottom up and left to right. However, as this cylinder is supposed to be placed in a horizontal position, the scanning in the latter aperture will be from top to bottom and left to right, or conventional scanning.

In one modification of the neon cell illustrated in Figure 2, the glass cell containing the neon alone, without the conducting bodies, is used. It is a well known fact that a plain tube of neon without any metal whatever, will glow in an electrical field. Every electromagnetic wave train has its accompanying electrical field. Therefore, the waves constituting the invisible image, since they are in varying intensity, will illuminate the body of neon to varying degrees in accordance with the invisible image. Therefore, the plain neon cell without any conductors may be used to render the invisible image visible.

In the rotating modifications illustrated in Figures 5 to 8, it is to be understood, of course, that the elements rotate with sufficient speed as to produce the effect of a continuous image by means of the persistence of vision of the eye.

Having described my invention, I claim as new and desire to secure by Letters Patent:

1. The process of forming images which consists in refracting electromagnetic waves to form an invisible image, converting said waves of said images into corresponding electric currents, constituting an electric image producing a corresponding visible image by converting said electric image into corresponding directly visible luminous discharges of varying degree of intensity.

2. The process of forming images which consists in forming an invisible image from electromagnetic waves, converting said waves constituting said image into corresponding electric currents, constituting an electric image, producing a corresponding visible image by converting said electric currents into corresponding directly visible luminous discharges of varying degree of intensity.

3. In combination: a source of electromagnetic waves, means for directing said waves upon objects, means for forming an invisible image of

said waves reflected from said objects, means for converting said waves into an electrical image and means for converting said electrical image into a directly visible image consisting of luminous discharges.

4. A device for rendering invisible electromagnetic wave images visible, which consists of means for forming invisible electromagnetic wave images, a transparent body having a chamber therein filled with an illuminable gas at low pressure, said chamber and gas coinciding with the focal plane of said invisible images and said gas producing luminosity constituting a visible image.

5. A device for converting an invisible electromagnetic wave image into a visible image, consisting of means for forming an invisible electromagnetic wave image, a transparent body containing a suitable gas at a suitable low pressure for the production of glow discharges placed in the plane of said invisible image, a plurality of metallic bodies arranged in said plane in said gas said electrodes being of a number corresponding in general to the number of elemental areas of said invisible image, alternate rows of said bodies being connected by suitable conductors into two distinct groups, said invisible image waves acting to generate electric currents in and between said conductors, whereby a plurality of simultaneous discharges resulting in a varying, diffused glow in said gas are produced thereby, constituting a visible image.

6. A device for rendering invisible electromagnetic wave images visible, consisting of an electromagnetic wave transparent hollow body containing a gas at low pressure, a plurality of electrodes in said gas and a corresponding plurality of electrodes outside of said hollow body said electrodes being arranged in a plane corresponding to the focal plane of said invisible image and of a number corresponding to the number of elemental areas of said invisible image, whereby a plurality of luminous discharges take place between the electrodes in said gas and said electrodes outside of said body, said discharge constituting a visible image.

7. In combination: means for forming an invisible image of electromagnetic waves and means including a body of illuminable gas for converting

said invisible image into a corresponding visible image consisting of luminous discharges of variable intensity.

8. In combination: means for forming an invisible image of electromagnetic waves, and means including a body of neon gas for converting said invisible image into a corresponding visible image consisting of luminous glow discharges of variable intensity.

9. In combination: means for forming an invisible image of electromagnetic waves and means including a glow discharge device for converting said invisible image into a corresponding visible image consisting of luminous glow discharges of variable intensity.

10. In combination: means for forming an invisible image of electromagnetic waves and means including a plurality of electrodes in a body of illuminable gas for converting said invisible image into a corresponding visible image consisting of luminous glow discharges of variable intensity.

11. In combination: means for forming an invisible image of electromagnetic waves and means including a body of ionized gas for converting said invisible image into a corresponding visible image consisting of luminous discharges of variable intensity.

12. The process of forming directly visible images by means of electromagnetic waves consisting of forming an invisible electromagnetic wave image, converting said invisible wave image into an electrical image consisting of an electrical field of varying intensity, and converting said electric field of varying intensity into corresponding glow discharges of varying intensity constituting a visible image.

13. An apparatus for producing visible images of objects by means of electromagnetic waves consisting of means for forming an invisible image of electromagnetic waves and means including a body of illuminable gas enclosed in a transparent body and a plurality of electrodes external to said transparent body for converting said invisible image into a corresponding visible image consisting of luminous discharges of variable intensity.

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