Feb. 3, 1953 R. H. RINES 2,627,600

METHOD OF AND APPARATUS FOR PRODUCING VISUAL LIKENESSES WITH THE AID OF RADIO WAVES

Filed Aug. 19, 1946 2 SHEETS—SHEET 1

Fig. 1.

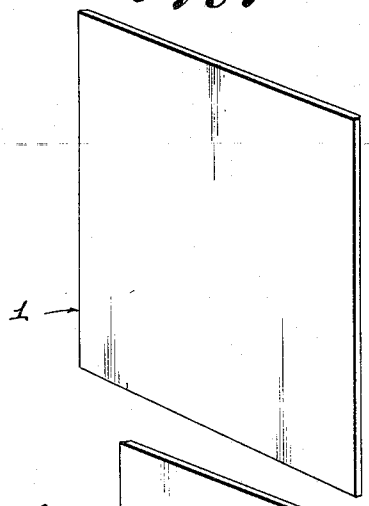


Fig. 2.

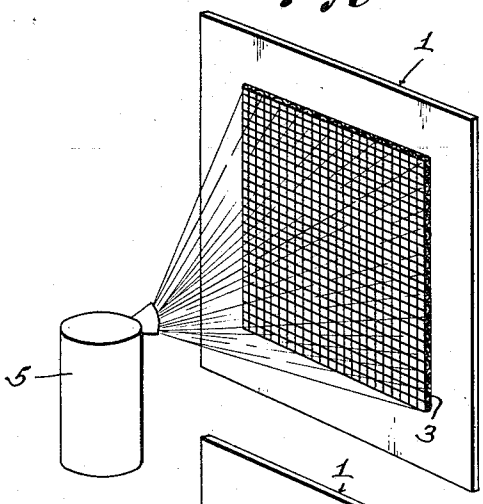


Fig. 3.

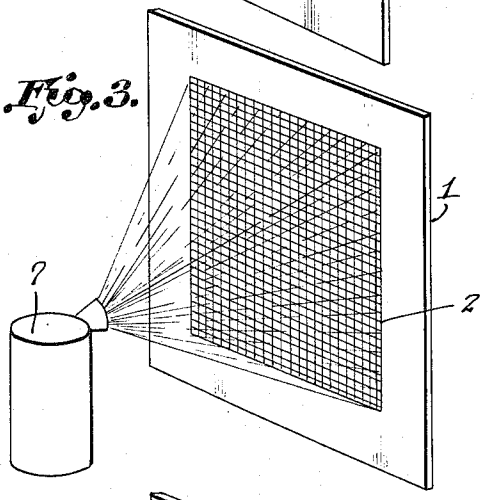


Fig. 5.

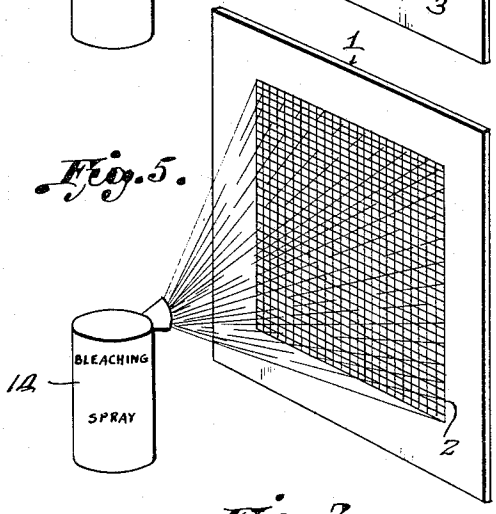


Fig. 4.

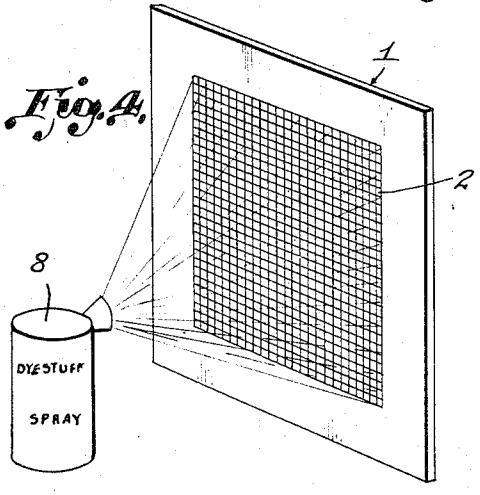
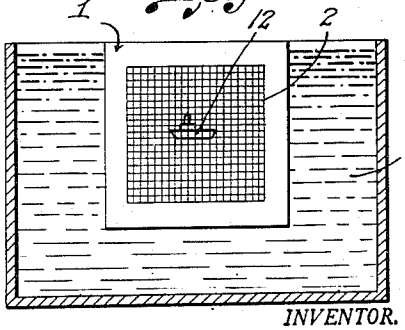


Fig. 7.



INVENTOR.
Robert H. Rines
BY David Rines
ATTORNEY.

Feb. 3, 1953 R. H. RINES 2,627,600
METHOD OF AND APPARATUS FOR PRODUCING VISUAL LIKENESSES WITH THE AID OF RADIO WAVES
Filed Aug. 19, 1946 2 SHEETS—SHEET 2

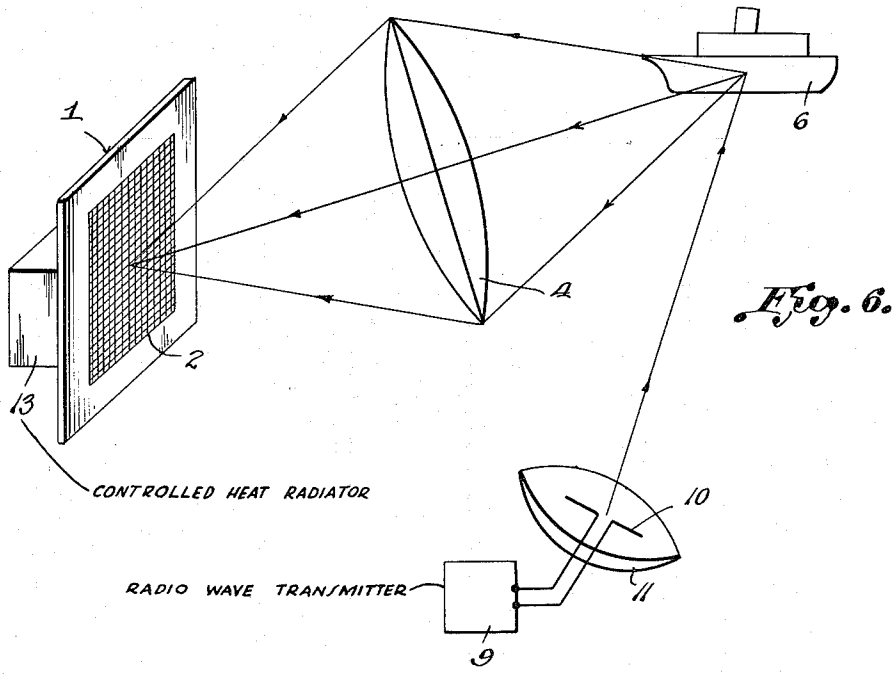
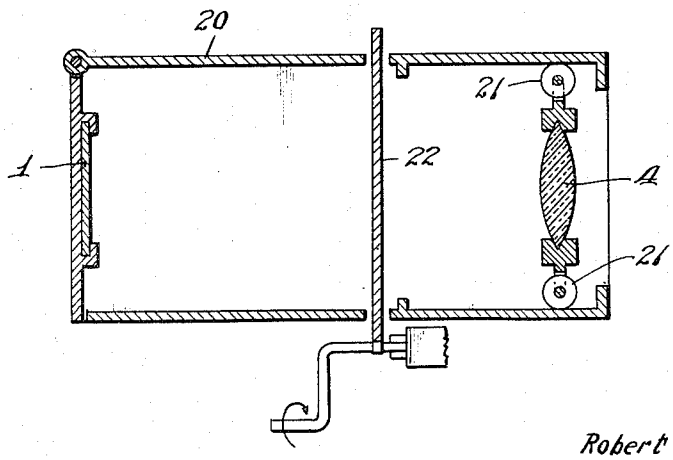


Fig. 6.

Fig. 8.



INVENTOR.
Robert H. Rines
BY
David Rines
ATTORNEY.

Patented Feb. 3, 1953 2,627,600

UNITED STATES PATENT OFFICE

2,627,600

METHOD OF AND APPARATUS FOR PRODUCING VISUAL LIKENESSES WITH THE AID OF RADIO WAVES

Robert H. Rines, Brookline, Mass.

Application August 19, 1946, Serial No. 691,638

27 Claims. (Cl. 343—17)

1

The present invention relates to methods of and apparatus for producing visual likenesses with the aid of radio waves.

It has heretofore been proposed to produce such likenesses with the aid of auxiliary apparatus, such as oscilloscope tubes, neon lamps, and the like.

An object of the present invention is to provide a new and improved method of and apparatus for visually recording radio waves that shall not require the employment of such auxiliary apparatus.

A further object is to provide a new and improved method of providing a new and improved mosaic for use in connection therewith.

Another object is to provide a new and improved radio-wave detector. Still an additional object is to provide a new and improved device for absorbing radio waves.

Other and further objects will be explained hereinafter, and will be particularly pointed out in the appended claims.

The invention will now be more fully explained in connection with the accompanying drawings, in which Fig. 1 is a view of a paper or other backing; Fig. 2 is a similar view illustrating the step of spraying the backing through a grating with a radio-reactive material; Fig. 3 is a similar view showing the step of further spraying the sprayed backing with a further material; Fig. 4 is a view similar to Fig. 3 of a modification; Fig. 5 is a view similar to Fig. 4 of a further modification; Fig. 6 is a perspective illustrating the use of the double-sprayed backing for receiving radio waves; Fig. 7 is a view illustrating the developing of the backing after it has been exposed to the radio waves; and Fig. 8 is a cross-sectional view of a preferred type of radio-receiving apparatus schematically shown in Fig. 6.

A film-backing element 1 of any suitable material, such as paper, is sprayed with metallic particles, such as an aluminum suspension, from a spray gun 5, through a grating or screen 3, to produce a correspondingly metallized reticulated mosaic 2.

Further to enhance the sensitivity of this film to radio waves, as hereinafter described, the metallic-spray solution in the gun 5 may preferably contain silicon, germanium, or any other suitable radio-wave absorbing or radio-wave rectifying particles.

A radio-wave detector is thus provided comprising a reticulated conducting layer having embedded in its outer surface a mosaic 2 composed of a plurality of integral though separated metallized sections corresponding to the areas between the bars or rods of the screen or grating 3. If desired, the backing 1 may be initially provided with a metallized coating. The silicon or other particle sections thus sprayed on the mosaic 2 are then further sprayed with a heat-sensitive layer from a spray gun 7. The grating or screen 3, if desired, may be removed during this further spraying. The layer may comprise, for example, a mixture of an acid salt that is readily decomposable on the application of heat, and a basic salt that heat can decompose only slowly; or a readily decomposable basic salt and a non-volatile acid salt. A suitable decomposable acid salt is barium acetate, and a suitable non-decomposable basic salt is secondary ammonium phosphate. The salts may, if desired, be applied by separate sprayings, being thus fixed in heat-transfer relation with the radio mosaic. Preferably, the salts are sprayed in equal concentrations, making a critically neutral salt mixture. The term "decompose" as used in the specification and the claims is intended to embrace the processes of chemical change effected in compounds by heat such as oxidation, reduction, volatilization, etc., hereinafter discussed.

2

A substantially continuous layer or film 1 thus produced may be exposed to the action of radio waves focused by a radio-wave-refracting lens 4, as of polystyrene, from an object 6 such as, say, a ship. The radio waves may be reflected from the object 6 after transmittal thereto from a dipole antenna 10, disposed at the focus of a directive parabolic reflector 11.

The antenna is shown excited from a radio-wave generator 9. It is today possible to produce continuous-wave-radio oscillations at 700 megacycles-per-second frequency with as much as 100 kilowatts-power output, as described, for example, at pp. 92 to 95, Electronics, McGraw-Hill, January 1946. Tremendous peak-pulse power can also be produced at higher frequencies in the thousands of megacycles. The object 6 may therefore be distant or near.

To prevent stray radiations from also impinging on the film 1, the lens 4 and the film 1 may be disposed in a shielded box 20. The lens 4, moreover, may be provided with a moving carrier 21 and a range scale (not shown), such as is used in light cameras, for adjusting the focus.

If the film 1 is disposed at the focus of the lens 4, there will be produced thereon a radio-energy image of the object 6, various parts of which will have radio-frequency-field strengths of varying magnitudes corresponding to the radio-frequency

energy reflected from corresponding different parts of the object 6. In accordance with a feature of the present invention, the radio waves directed upon the device 1 are absorbed thereby and not, therefore, appreciably reflected therefrom. The silicon crystals or other particle sections on which the radio waves from the object 6 are focused absorb and rectify the impinging radio energy. If the individual metallized sections of the film mosaic are one-quarter the wavelength of the radio energy, or are otherwise resonant to the radio frequency, moreover, they will become further heated by the radio waves impinging thereon. Since the crystals will absorb radiant energy, in accordance with the strength of the waves focused thereon, the degree of heating of the various sections or parts of the film coatings will depend upon the strength of the radio-frequency energy on the coatings. The crystals are so heat-responsive that continued exposure to even micro-joules of radio energy will produce heating effects. The heat-sensitivity of the mosaic sections, upon exposure to the received radio waves, will by heat transfer critically effect partial decomposition as by volatilization of the acid salt, and a consequent change of the acid concentration, or pH, of the acid-basic-salt mixture coating on the mosaic sections. The non-volatile basic salt, on the other hand, will be substantially unaffected by the heat. The pH variation on the mosaic will correspond to the radio-energy distribution focused on the mosaic and this, in turn, as before stated, will correspond to the radio-energy distribution on the object 6. In accordance with a further feature of the present invention, the effects of the radio waves absorbed by the mosaic are made visible as an indication of the radio-energy distribution impinged thereon, as later explained.

If desirable, as when the radio waves are reflected from more distant objects, the acid-basic-salt mixture on the mosaic may be conditioned for volatilization by the radio-frequency energy through additional heating, as by means of a controlled heat radiator 13 of any conventional type such as that described, for example, by P. D. Sale in volume 18 of the Bureau of Standards Technologic Paper No. 269, December 16, 1924.

The time of exposure of the film to the radio waves will have to be increased with increased ranges of the object, since the intensity of the returned or reflected radio waves will vary inversely as the square of the range, so that a longer period of radio-frequency heating will be necessary for large ranges, to produce the same given exposure effect. The exposure period may be adjusted by means of a metallic shutter 22 shown pivotally disposed in front of the film 1. The degree of exposure of the film 1 to the radio waves may be controlled by pivotally adjusting the shutter 22 in the direction of the arrow.

If desired, the radio-frequency transmitter 9 may be of the pulse variety, and the time of exposure of the film may be controlled by the pulse width; or the period of operation of the transmitter may determine the exposure.

After exposure, the film may be developed by dipping it for a short time in a litmus, phenophthalein or any other acid-base-indicator solution 15. Since neutralized-salt mixtures or solutions are extremely sensitive to very slight variations of pH or acid concentration, the pH variation will become manifest upon the film 1 in various intensities of, say, red, in the case of a litmus indicator, corresponding to the volatile-acid or volatile-base concentration resulting from the volatilization. Each separate, individual radio-receiving-and-absorbing section of the mosaic will thus produce a visual indication of the radio energy impinged thereon, and the totality of the sections will produce a visual likeness 12 of the object 6.

For a wave-length of ten millimeters, corresponding to a frequency of 30,000 megacycles, for example, the mosaic sections may be a fraction of a millimeter in width and, say, 2.5 millimeters long. This would provide a large number of sections on a one-meter-square-surface area of dimensions large compared with the wave-length, for providing good definition.

The image 12 of the object 6 may be made manifest on the film without developing by including litmus solution in the acid-base-salt spray from the spray gun 7. The color of the litmus particles on the mosaic will then change directly on the mosaic, in response to the volatilization resulting from the heating produced by the impinging radio frequency, in proportion to the resulting pH changes.

The object of using the grating or screen 3, in order to sectionalize the mosaic, is to prevent interaction between the adjacently disposed metallized sections of the mosaic. Marked independent effects are thus produced on exposure to the radio waves focused by the polystyrene or other lens 4. A continuous metallized coating could be used, formed without the grating 3. The visual likeness 12 of the object, however, would then be not sharp but, on the contrary, hazy.

The reticulated effect may, of course, be produced in other ways also, as by providing the film backing with suitably spaced metal strips or dielectric strips.

According to a further modification, the spray gun 7 may be replaced by a spray gun 8 for spraying a dyestuff instead of an acid-basic-salt mixture, through the screen or grating 3. The dyestuff should be such as to decompose on the application of heat; one such is fuchsin. A bleaching spray may thereafter be supplied from still a further spray gun 14.

If potassium chlorochromate is employed as the bleaching spray, it will critically decompose under heat, liberating chlorine for bleaching the dyestuff. The degree of bleacihng will depend upon the quantity of heat liberated. This, in turn, will depend on the intensity of the radio-wave energy distribution which, as before explained, will correspond to the object 6. The visual image 12 will thus result from the appearance of the differently bleached regions of the film coating, produced by the effects of the radio-frequency-energy heating.

Some dyestuffs, including fuchsin, themselves, change color, as a consequence of chemical change of decomposition in response to heat. Such dyestuffs could be employed as film coatings without the bleaching spray. The addition of the bleaching agent, of course, would render the result more effective.

Further modifications will occur to persons skilled in the art, and all such are considered to fall within the spirit and scope of the invention, as defined in the appended claims.

What is claimed is:

1. An article of the class described comprising a backing on which is provided radio-wave

absorbing means together with an acid salt and a basic salt one of which is readily decomposable and the other of which is not readily decomposable in response to heat produced by the absorbed radio waves.

2. A radio-wave indicator having, in combination, radio-wave receiving means for producing heat in response to the received radio-waves, a heat-responsive salt decomposable in response to heat, and means for heating the salt to a predetermined degree in order that the heat produced by the received radio waves may effect the heat-responsive decomposition, said salt being in heat-transfer relation with said radio-wave receiving means.

3. A radio-wave indicator having, in combination, a radio-wave receiving member for producing heat in response to radio waves received thereby provided with a heat-sensitive salt that changes color in response to the heating produced by the received radio waves, the heat-sensitive salt and the radio-wave receiving member being in heat-transfer relation.

4. A radio-wave indicator having, in combination, radio-wave receiving means for producing heat in response to the received radio waves comprising a heat-sensitive salt that changes color in response to the said heat and means for heating the heat-sensitive salt to a predetermined degree in order that the said heat produced by the received radio waves may produce color changes in the heat-sensitive salt.

5. A radio-wave indicator having, in combination, radio-wave receiving means and an acid salt and a basic salt one of which is readily decomposable and the other of which is not readily decomposable in response to the heating produced by the radio waves received by the radio-wave receiving means.

6. A radio-wave detector having, in combination, radio-wave receiving means comprising a mixture of an acid salt and a basic salt one of which is readily decomposable and the other of which is not readily decomposable in response to the heating produced by the received radio waves and an acid-base indicator for indicating the pH concentration of the mixture.

7. A method of the character described that comprises impinging radio waves upon a salt which is readily decomposable in response to heat, heating the salt to condition it for decomposition, and converting the energy of the radio waves impinged upon the salt into heat in order to decompose the salt.

8. A radio-wave system having, in combination, radio-wave receiving means, means for forming a radio-wave image of a source of radio waves upon the radio-wave receiving means, a heat-responsive salt decomposable in response to the heat produced by the received radio-wave image, and chemical indicator means for indicating the degree of decomposition of the heat-sensitive salt thereby to produce a visual image of the source.

9. A radio-wave system having, in combination, radio-wave receiving means for producing heat in response to the received radio waves, a heat-responsive salt decomposable in response to heat, said heat-responsive salt and said radio-wave receiving means being in heat-transfer relation, means for heating the heat-responsive salt to a predetermined degree, and means for forming a radio-wave image of a source of radio waves upon the radio-wave receiving means, in order that the heat produced by the received radio-wave image may correspondingly decompose the heat-responsive salt.

10. Apparatus of the character described comprising a conducting surface upon which radio-wave energy may be impinged and of dimensions large compared with the wavelength of the radio waves, said surface producing heat in response to the impingement thereon of radio waves, and a substantially continuous heat-absorptive layer of dielectric heat-decomposable material disposed upon the surface to face the radio waves for absorbing radio-wave energy impinged upon the conducting surface, said layer and said conducting surface being in heat-transfer relation.

11. A radio-wave detector having radio-wave absorbing material in combination with a heat-decomposable salt of the type that decomposes in response to the heat produced by the radio waves received by the radio-wave absorbing material.

12. A radio-wave detector having radio-wave absorbing material in combination with a heat-decomposable dyestuff of the type that decomposes in response to the heat produced by the radio waves received by the radio-wave absorbing material.

13. A radio-wave detector having radio-wave absorbing material in combination with a heat-decomposable salt of the type that decomposes in response to the heat produced by the radio waves received by the radio-wave absorbing material and selected from the group consisting of barium acetate, secondary ammonium phosphate, fuchsin and potassium chlorochromate.

14. A radio-wave detector having radio-wave absorbing-and-rectifying material in combination with a heat-decomposable salt of the type that decomposes in response to the heat produced by the radio waves received by the radio-wave detector and means for initially heating the said heat-decomposable salt to condition it for decomposition upon the receipt of radio waves by the radio-wave absorbing-and-rectifying material.

15. A radio-wave detector having, in combination, radio-wave receiving means for producing heat in response to the received radio waves provided with a heat-decomposable salt of the type that decomposes in response to the heat produced by the radio waves received by the radio-wave receiving means, said heat-decomposable salt and said radio-wave receiving means being in heat-transfer relation, and means for initially heating the said heat-decomposable salt to condition it for decomposition upon the receipt of radio waves by the radio-wave receiving means, and means for impinging radio waves upon the said radio-wave receiving means.

16. A radio-wave detector having, in combination, radio-wave receiving means provided with radio-wave absorbing material for producing heat in response to the absorption thereby of radio waves and a heat-decomposable salt in heat-transfer relation with said radio-wave absorbing material and of the type that decomposes in response to the heat produced by the radio waves received by the radio-wave receiving means and means for initially heating the said heat-decomposable salt to condition it for decomposition upon the receipt of radio waves by the radio-wave receiving means.

17. A radio-wave detector having, in combination, a plurality of radio-wave receiving means for producing heat in response to the reception

of radio waves thereby each provided with a heat-decomposable salt of the type that decomposes in response to the heat produced by the radio waves received by the radio-wave receiving means, the salt being in heat-transfer relation with the corresponding radio-wave receiving means, and means for initially heating the said heat-decomposable salt to condition it for decomposition upon the receipt of radio waves by the radio-wave receiving means.

18. A radio-wave detector as claimed in claim 11 and in which the heat-decomposable salt comprises a dyestuff.

19. A radio-wave detector as claimed in claim 11 and in which the heat-decomposable salt comprises fuchsin.

20. A radio-wave detector as claimed in claim 11 and in which the heat-decomposable salt comprises a bleaching agent.

21. A radio-wave detector as claimed in claim 11 and in which the heat-decomposable salt comprises a dyestuff in combination with a bleaching agent.

22. A radio-wave detector as claimed in claim 11 and in which the heat-decomposable salt is selected from the group consisting of an acid salt, a basic salt, a dyestuff and a salt bleaching agent.

23. A radio-wave detector as claimed in claim 19 and in which means is provided for heating the fuchsin to a predetermined degree.

24. A radio-wave system as claimed in claim 9 and in which the heat-responsive salt changes color upon decomposition.

25. A radio-wave detector as claimed in claim

22 and in which means is provided for initially heating the said heat-decomposable salt to condition it for decomposition upon the receipt of radio waves by the radio-wave receiving means.

26. A method as claimed in claim 7 and in which the further step of treating the salt with a pH indicator is effected.

27. A radio-wave apparatus as claimed in claim 10 and in which the said material comprises particles of radio-wave absorbing material.

ROBERT H. RINES.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,245,135	Thompson	Oct. 30, 1917
2,293,839	Linder	Aug. 25, 1942
2,400,544	Kline	May 21, 1946
2,423,476	Billings	July 7, 1946
2,429,933	Gibson	Oct. 28, 1947
2,438,110	Brattain	Mar. 23, 1948
2,492,358	Clark	Dec. 27, 1949

FOREIGN PATENTS

Number	Country	Date
237,064	Great Britain	July 23, 1925
372,637	Great Britain	May 12, 1932

OTHER REFERENCES

Physical Review: May 1922, volume 19, No. 5 (pages 447 to 455).