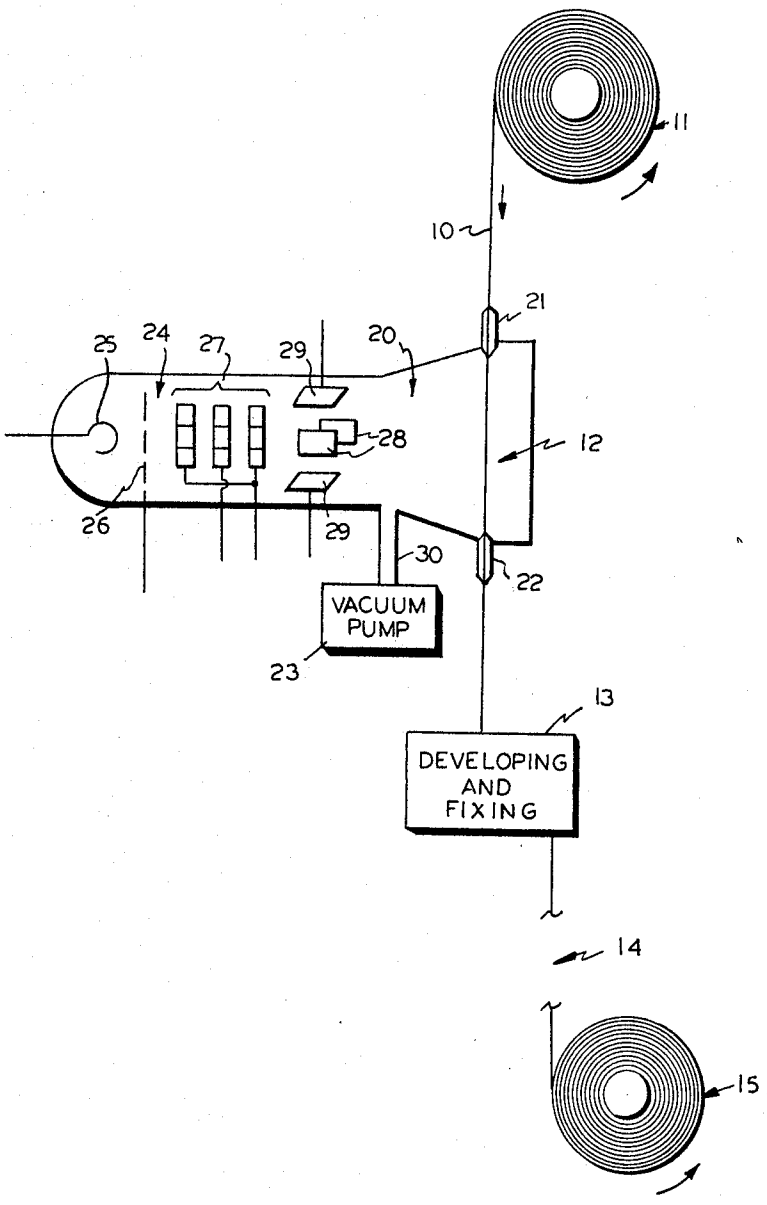
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ELECTRICAL RECORDING

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ELECTRICAL RECORDING

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The present invention relates to the field of electrical recording. In particular the present invention is concerned with recording on silver halide photographic materials by means of electrical energy.

It has heretofore been recognized that optically responsive silver halide photographic materials are also responsive to electrical enegry, and may be used to record information patterns presented electrically to the surface thereof. In particular, it is known in the prior art that conventional silver halide photographic emulsions are sensitive to high energy electrons. It has therefore been proposed to scan such silver halide emulsions with a cathode ray beam, and intensity modulate the beam in accordance with a desired pattern of intelligence to produce a latent image record of this intelligence on the emulsion. Upon conventional chemical photographic development of the latent image, a visible silver image record of the intelligence pattern is produced.

The present invention embodies an improvement in this area of electrical recording on silver halide photographic materials, in effecting such recordings with electrons of a much lower energy level than has heretofore been considered possible, and in effecting when desired either directly visible print out images of the recording without development, or direct positive images of the recording upon subjecting the latent image recording to usual surface photographic development procedures. In accordance with the present invention, the recording is effected on a particular type of silver halide photographic material, namely one comprising a layer of silver halide microcrystals which are supported upon a substrate primarily by being bound directly to the substrate and directly to each other, as distinguished from being carried in an emulsion vehicle. Such photographic layers may be, and preferably are formed by vacuum evaporation of silver halide, such as silver bromide, with or without silver iodide and/or silver chloride, and condensation of the halide vapors on a suitable photographic quality substrate, such as baryta paper, a terephthalate film such as Cronar, or a suitable photographic quality acetate film. The silver halide crystals thus formed are supported on the substrate by being bound directly thereto and to each other. Although it is not essential, for purposes of the present invention, if desired, the silver halide layer may be sensitized with appropriate silver halide photographic sensitizers.

When utilizing conventional silver halide photographic emulsions, it has generally been the experience of prior efforts at electron beam recording thereon, that a threshold electron energy of at least about 5–10 kev. is necessary to affect the silver halide sufficiently to produce a developable latent image. We have found, however, that when employing non-emulsion silver halide materials of the type above suggested, developable latent images can be formed thereon with much lower energy electron beams, as for example, an electron energy of only about 0.3 kev.

It is accordingly one object of the present invention to provide for the electrical recording of intelligence by impinging an electron beam upon a photographic layer of silver halide microcrystals, wherein the silver halide microcrystals are supported on a substrate primarily by being bound directly to the substrate and directly to each other.

Another object of the present invention is to provide for such electrical recording of intelligence, wherein said silver halide layer is formed by vacuum evaporation of the silver halide onto the substrate.

Another object of the present invention is to provide for the electrical recording of a chemically developable latent intelligence image by impinging an electron beam upon a photographic layer of silver halide microcrystals, wherein the silver halide microcrystals are supported on a substrate primarily by being bound directly to the substrate and directly to each other.

Still another object of the present invention is to provide for the electrical recording of a print out intelligence image by impinging an electron beam upon a photographic layer of silver halide microcrystals, wherein the silver halide microcrystals are supported on a substrate primarily by being bound directly to the substrate and directly to each other.

A further object of the present invention is to provide for the electrical recording of a chemically developable direct positive latent intelligence image by impinging an electron beam upon a photographic layer of silver halide microcrystals, wherein the silver halide microcrystals are supported on a substrate primarily by being bound directly to the substrate and directly to each other.

And still another object of the present invention is to provide for the electrical recording of intelligence by impinging a beam of low energy electron upon a photographic layer of silver halide microcrystals, wherein the silver halide microcrystals are supported on a substrate primarily by being bound directly to the substrate and directly to each other.

Other objects and advantages of the present invention will become apparent to those skilled in the art from a consideration of the following description of one exemplary specific embodiment thereof had in conjunction with the accompanying drawing which is a schematic illustration of a cathode ray tube operating on a photographic web as the electron beam target.

As previously stated, the photographic material employed in the practice of the present invention comprises a layer of silver halide crystals carried by a substrate, wherein the crystals are primarily bound directly to the substrate and directly to each other. Preferably, this photographic material is fabricated by evaporating the silver halide under a vacuum and depositing the vapors thereof upon a suitable photographic substrate. Preferably the silver halide is silver bromide, with or without small amounts of other silver halides such as silver chloride and/or silver iodide. The substrate may be any suitable photographic quality base material, such as baryta paper, a terephthalate film, or an acetate film. However, for the purpose of illustration herein, the particular photographic material employed is silver bromide evaporated at a temperature of approximately 600–650° C., under a pressure of about 10^{-3} to 10^{-5} mm. of Hg, and deposited upon photographic quality baryta paper. This photographic paper may of course be prepared in webs of indefinite length by passing the paper web incrementally through the silver bromide evaporation zone, whereby a layer of silver bromide crystals is caused to be deposited uniformly over the extent of the web.

The resultant web of evaporated silver halide paper may be utilized in an electrical recording system such as is schematically illustrated in the drawing, wherein the photographic paper **10** is fed from a supply roll **11**, through the recording station **12** inside the envelope of cathode ray tube **20**, thence into conventional photographic chemical developing and fixing station **13**, whereupon the paper may be passed through a viewing station or area **14**, and/or collected on storage roll **15**. Tube **20**

is essentially a conventional cathode ray tube comprising the electron gun **24**, including a cathode **25**, control grid **26**, anodes **27**, horizontal deflection plates **28**, and vertical deflection plates **29**. Thus, the electron beam emerging from the gun **24** is deflected over a desired two-dimensional scanning raster and caused to impinge upon the portion of web **10** located in the recording area **12**, as a target. As the beam is thus caused to scan the target area of web **10**, the intensity of the beam is varied by control grid **26** in accordance with an intelligence electrical input to the system. At the same time, the feed of intelligence is time keyed to the scanning raster pattern, so that the pattern of electron impingement density over the target area of web **12** is denotative of the input intelligence. Since the foregoing operation of cathode ray beam scanning and intelligence input thereto is conventional and well known, the electrical operational system associated with the cathode ray tube **20** is not shown in the drawing.

The web **10** is fed in and out of the target area **12** of the cathode ray tube **20** through vacuum locks **21** and **22**, while the envelope of the tube is evacuated by means of a suitable vacuum pump **23** connected through nipple **30**.

Thus, in operation, a portion of photographic web **10** is located in the target area **12**, and is there scanned by the electron beam in accordance with the prescribed scanning raster employed for the system. As the web is thus scanned, the electron beam is modulated in intensity in accordance with a particular electrical pattern representative of the input intelligence. After a frame of intelligence has thus been impressed on the particular area of web of **10**, the grid **26** is biased to cut off the flow of electrons, and the web is advanced to locate a second portion in the recording area **12**, whereupon this next area is similarly exposed to the electron beam in accordance with said pattern of scan and intelligence modulation.

The foregoing system provides for a two-dimensional field of scan, and therefore requires that the advance of web **10** through the recording area **12** be intermittent with the web being advanced a complete frame area each time. It is apparent that if desired a one-dimensional or single line of scan could be employed. In such case the web **10** could be advanced continuously as the electron beam is rapidly and repetitively scanned across a single line target area while it is appropriately modulated with successive bits of intelligence. Also, if desired, for certain recording purposes the electron beam could be maintained stationary and intensity modulated as the web **10** is moved past the single exposure point to provide a single line trace on the web of density denoted intelligence.

When utilizing non-emulsion type of silver halide layer on web **10** as above described, depending upon the quantity of electron energy to which the silver halide is exposed and the sensitivity of the particular material employed, the image on web **10** as it emerges from the recording station **12** may be merely a latent negative image, it may be a print out visible image, or a latent direct positive image.

If the quantity of electron energy to which the silver halide target is exposed is sufficient only to establish a latent image on the web **10**, the web is subsequently passed through a conventional photographic developing and fixing station **13**, where the latent image is developed into a visible image. Thereafter, the recorded image may be viewed at **14** as the web emerges from the developing and fixing station, and/or the emerging web can be dried and then stored on roll **15**. If the latent image is a direct positive, then of course the development should be restricted to a surface developer as is usual for such purposes. If the image is a print out image and visible upon emergence from the recording station **12**, then obviously the developing step should be omitted.

In order to to illustrate further the present invention by way of specific example, an evaporated silver bromide paper was prepared wherein the silver bromide was evaporated onto a baryta paper base under a vacuum of about 4×10^{-4} to 4.6×10^{-4} mm. of Hg, and at a temperature of about 625–630° C. Samples of this photographic paper were tested and found to have an optical photographic speed of about 0.08 ASA. The grain size of the microcrystals was about 0.1–0.5 microns. This paper was exposed to an electron beam, and it was found that a threshold developable latent image is obtained with a charge density of 1.5×10^{-10} coulombs/sq. mm. at 0.3 kev. The energy of this threshold exposure is therefore about 4.5×10^{-8} joules/sq. mm. On the other hand, the literature on electron beam recording on emulsion silver halide photographic materials indicates that the electron energy threshold for recording is about 5–10 kev. In an article by Digby et al., entitled "The Photographic Effect of Medium Energy Electron" JPS, vol. 1, 1953, p. 194, an example of electron beam recording on Ilford Contact Lantern Plate is given. These emulsion silver halide plates are estimated to have an optical photographic speed of about 0.02 ASA, and are stated to have a grain size of about 0.1 to 0.5 micron. Optically, therefore this reference gelatin material is quite analogous to the above evaporated silver bromide sample. With the Ilford plates, a threshold developable latent image can be obtained with a charge density of 2×10^{-12} coulombs/sq. mm. at 25 kev. The energy of this threshold exposure is therefore about 5×10^{-8} joules/sq. mm. It will be observed that although for the two types of optically comparable materials the total exposure energy required for a threshold latent image is approximately the same, these essentially equivalent exposure results were obtained with electron energies of only 0.3 kev. for the evaporated silver bromide example, as against 25 kev. for the emulsion example, and as against a reported limiting or threshold electron energy of 5–10 kev. for that type of material.

The foregoing example of electron beam recording on evaporated silver bromide material utilized essentially pure silver bromide. The sensitivity of this material can be increased by the appropriate use of sensitizers, and we have observed that such materials are capable of direct print out images and reversal positive images when exposed to an appropriate quantity of electron beam energy.

Thus, from the foregoing specific embodiments and examples of the present invention it will be appreciated that there is provided a new process of electron beam recording employing as the recording medium a photographic layer of silver halide microcrystals on a substrate, wherein the silver halide microcrystals are supported on the substrate primarily by being bound directly to the substrate and directly to each other. The sensitivity of this medium to electron energy is many fold greater than conventional gelatin photographic silver halide materials of comparable optical speeds having a much lower electron energy threshold for developable response. However, it is not intended that the present invention shall be considered as limited to the described specific embodiments or examples, for various modifications and variations thereof will be apparent to those skilled in the art, and such variations and modifications as are embraced by the spirit and scope of the appended claims are contemplated as within the purview of the present invention.

What is claimed is:

1. A method of electrical recording comprising generating an electron beam, modulating said beam in accordance with an intelligence pattern, impinging said beam upon a target of photographic material comprised of a layer of silver halide microcrystals on a substrate wherein said microcrystals are supported upon said substrate primarily by being bound directly to the substrate and

to each other, and moving said beam and target relative to each other to effect a record on said target of said intelligence modulation.

2. A method of recording as set forth in claim 1, wherein said record is in the form of a latent image, and said method comprises the further step of chemically developing said latent image to produce a visible record of said intelligence modulation.

3. A metod of recording as set forth in claim 1, wherein said photographic material is formed by evaporating said silver halide under high vacuum conditions and depositing the resultant vapors upon said substrate.

4. A method of recording as set forth in claim 3, wherein said silver halide is silver bromide.

5. A method of recording as set forth in claim 4, wherein the energy of the electron in said beam is substantially less than about 5 kev.

6. A method of recording as set forth in claim 1, wherein said layer also includes a photographic sensitizer for the silver halide.

7. A method of recording as set forth in claim 1, wherein said relative movement is effected at least in part by causing said beam to scan an area of the target in accordance with a fundamental pattern of scan, and said beam modulation is an intensity modulation.

8. A method of electrical recording comprising impinging a beam of electrons upon a target of photographic material having a layer of silver halide microcrystals carried by a substrate wherein said microcrystals are supported upon said substrate primarily by being bound directly to the substrate and to each other, and moving said beam and target relative to each other.

9. A method of recording as set forth in claim 8, wherein the resultant record is in the form of an invisible latent image, and said method comprises the further step of chemically developing said latent image into a visible image.

10. A method of recording as set forth in claim 8, wherein said photographic material is formed by evaporating said silver halide under high vacuum conditions and depositing the resultant vapors upon said substrate.

11. A method of recording as set forth in claim 10, wherein said silver halide is silver bromide.

12. A method of recording as set forth in claim 11, wherein the energy of the electrons in said beam is substantially less than about 5 kev.

13. A method of recording as set forth in claim 8, wherein said layer also includes a photographic sensitizer for the silver halide.

14. A method of recording as set forth in claim 8, and further including the step of imposing a modulation on said beam.

15. A method of recording as set forth in claim 14, wherein said modulation is an intensity modulation.

16. A method of electrical recording comprising emitting electrons from a source, and causing said emitted electrons to impinge upon a target of photographic material having a layer of silver halide microcrystals carried by a substrate, wherein said microcrystals are supported upon said substrate primarily by being bound directly to the substrate and to each other.

17. A method of electrical recording comprising emitting electrons from a source, and causing said emitted electrons to impinge upon a target of photographic material having a layer of silver halide carried by a substrate, said layer of silver halide having been formed on said substrate by evaporation of said silver halide under high vacuum conditions and deposition of the resultant vapors upon said substrate.

18. A method as set forth in claim 17, wherein said silver halide is primarily silver bromide.

References Cited by the Examiner

UNITED STATES PATENTS

2,015,570 9/1935 Sabbah et al. ---------- 346—74

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