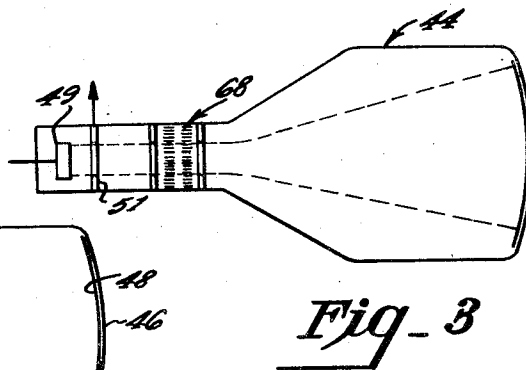
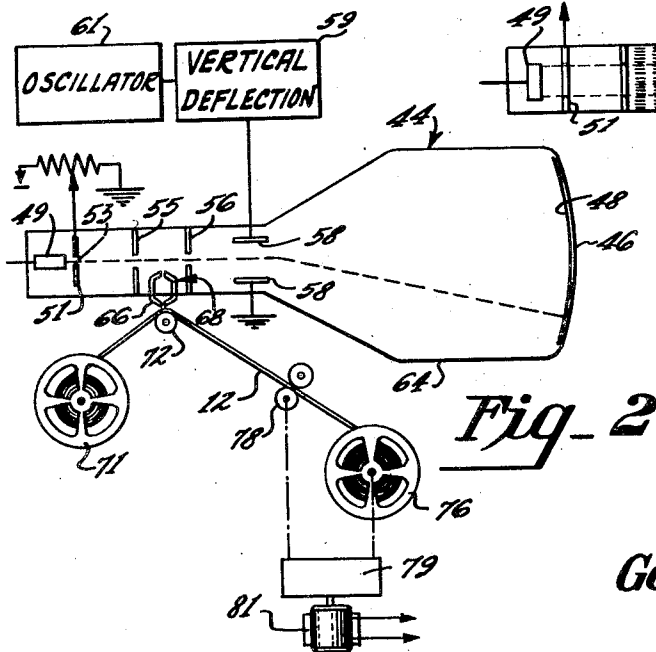
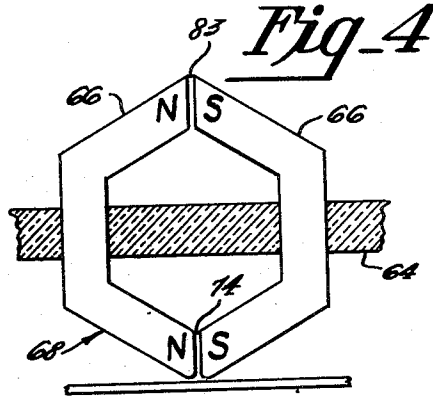
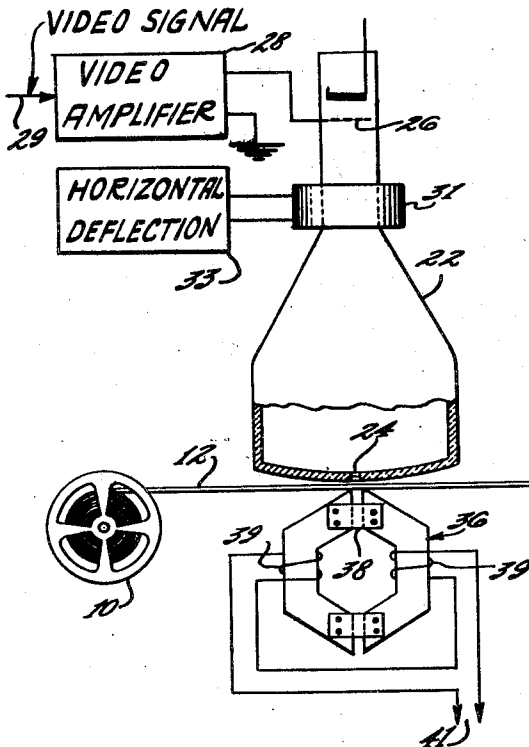


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ELECTRONICALLY CONTROLLED MAGNETIC RECORDING
AND PRODUCING APPARATUS
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ELECTRONICALLY CONTROLLED MAGNETIC RECORDING AND PRODUCING APPARATUS

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8 Claims. (Cl. 178—6.6)

The present invention relates to apparatus for obtaining a magnetic record of a signal and for deriving a replica of the original signal from the record, and, more particularly, but not necessarily exclusively, to a novel arrangement in magnetic recording apparatus for obtaining distribution of elemental recording effects on a magnetic record receiving medium by impingement of electrons from a deflectable electron stream. In another and more specific aspect thereof, the invention relates to the recording and reproduction of images, reproduction of an image being accomplished by impingement of a magnetically modulated electron stream on a radiant energy or light producing surface such, for example, as a phosphor.

In accordance with the present invention, novel electron means are employed for apportioning signal recording effects over an extended area of a recording medium rather than along a single line. A deflectable stream of electrons is modulated by any signal to be recorded and this stream of electrons is deflected periodically to traverse one dimension of the record receiving medium. The other dimension of the recording receiving medium may be traversed conveniently by imparting movement to the record receiving medium by any well known mechanical method. A deflectable stream of electrons may be developed in a Lenard tube, similar in many respects to the well kinescope. The cathode ray tube is provided with a Lenard window through which the developed stream of electrons or the electron beam is projected. In the illustrative embodiment of the invention, later to be described, the Lenard window is diametrically located on the tube face and is preferably relatively narrow. The electron stream or focussed electron beam may be periodically deflected so as to traverse the Lenard window. Means are provided for supporting a magnetic record receiving medium substantially in contact with or but slightly spaced from the Lenard window. The magnetic record receiving medium is moved by any suitable means transversely of the Lenard window and longitudinally of itself and is subjected to a magnetic field in the neighborhood of and substantially along the line of the axis of the Lenard window. However, the direction of the applied magnetic field runs transversely to the axis of the Lenard window.

The invention also provides a novel arrangement for obtaining a replica of a signal originally recorded along spaced transverse lines on a magnetic record receiving medium. This is accomplished by providing a substantially uniform stream of electrons of sheet-like formation. Each element of width of the electron stream is subjected to an independently produced magnetic field. This magnetic field, applied locally to each element of width of the electron stream is varied or modulated by the presence of an elemental area of the magnetic record on the record receiving medium. The total effect on the stream is to impose the effect of a recorded line on the stream. The stream may then be deflected periodically and transversely of its width to provide a pattern, image or the like of successively recorded elements. As each recorded line is a magnetic record of an elemental line

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of a recorded image, then deflection of the electron stream will provide a reproduction of the image when it is swept over a phosphor.

This invention has for its principal aim to provide novel means for recording and reproducing signals by the direct agency of a stream or focussed beam of electrons.

Another aim or object of the invention is to provide novel means for recording signals on a magnetically sensitive recording medium by the impingement thereon of a beam or stream of electrons.

A further object of this invention is to provide novel means for reproducing signals from a magnetic record by employing a stream of electrons which is directly and simultaneously affected by a plurality of elemental areas of the record.

Other objects and advantages of the present invention will, of course, become apparent and immediately suggest themselves to those skilled in the art to which the invention is directed from a reading of the following specification in connection with the accompanying drawing in which:

Fig. 1 is a schematic illustration of a recorder embodying features of the present invention;

Fig. 2 is a diagrammatic showing of a reproducing system arranged for operation in accordance with one aspect of this invention;

Fig. 3 is a view in plan of the cathode ray tube which is shown in conjunction with the reproducing system of Fig. 2; and

Fig. 4 is a fragmentary sectional view drawn to an enlarged scale of one of the magnetic transfer elements shown schematically in Figs. 2 and 3.

Fig. 1 of the drawing shows the general arrangement of a recording system capable of operation in accordance with the present invention. There is conventionally shown a reel 10 or the like upon which is wound a quantity of magnetically sensitive recording web 12. This web may suitably be made of paper or other pliable material coated or impregnated with any known magnetically sensitive material. It will also be understood that the web 12 may be made of metal having suitable magnetic properties. There is conventionally shown a take-up reel 14 upon which the tape 12 is wound as recording progresses. The tape 12 is shown schematically and conventionally as being propelled through the recording zone by a driving roller 16 and an idler roller 18. The take-up reel 14 and the driving roller 16 are suitably connected mechanically to a motor 17. The mechanical connection is indicated schematically as a gear drive mechanism or the like 19 which serves not only to couple the motor to the tape propelling mechanism but also to adjust the speed of the take-up reel 14 with respect to the speed of the driving roller 16 so that the tape may be driven at a reasonably constant velocity. If there is a predictable variation in velocity or if the same or a similar mechanism is used for reproducing the recorded signals, such, for example, as a television program, then variation in tape velocity is of minor importance. The motor 17 is of the type operating at constant speed and is preferably a synchronous motor. The motor speed is selected in accordance with the desired system characteristics and the character of the signal to be recorded. Recording medium sensitivity and the magnetic properties of the magnetic circuits employed are factors to be used in determining effective motor speeds.

In accordance with present day television practice a television image is produced by a moving scanning spot which traverses a viewing field to create or produce a visual image. In accordance with present day television methods, a viewing field is scanned a plurality of times, twice for example, to produce interlaced frames. Com-

plete television images are produced under current standards at a frame frequency at 30 per second and where multiple scanning is employed, for example, duplicate interlaced scanning, the scanning of each field occurs at twice this frequency. In the interlaced scanning system of television image transmission and reproduction, each complete excursion of the scanning means in either the video signal generator or the image producing device is ordinarily referred to as a "field" and two of these fields make up an image "frame." By way of example, and in accordance with present practice, the period of the initiating pulses for each field is $\frac{1}{60}$ of a second, nominally, which is the time required to scan one field. The complete cycle for a frame, including the blanking period at the end of each of two fields, is constituted by 525 horizontal lines. This means that the image of the original subject matter is analyzed into picture elements that form a horizontal line 15,750 times in a second. Thus, each picture element in one vertical line corresponds to a maximum frequency of less than 15,750 cycles. If two successive lines were dark and light, the frequency would be only one-half of the 15,750 cycles, but if the sequence is irregular some sideband spread may be created. A frequency of 15,750 cycles can be recorded and reproduced from a magnetically sensitive web, such for example as a magnetic paper tape, at a speed of 90 ft. per minute. This relatively low speed made possible in a novel manner by the present invention without the need for signal commutation is identical with the 35 mm. motion picture film speed. Thus, considering a parallel recording of 40 lines per inch, for example, a 10 inch wide tape running at a velocity of 90 ft. per minute is capable of completely recording a 525 line double interlaced 30 frame per second image with 400 line horizontal resolution. The apparatus so far described is shown in United States Patent No. 2,517,808 granted to George C. Sziklai on August 8, 1950.

The distribution of image intelligence laterally of the web or tape 12 in accordance with the invention, so that the tape speed may be reasonably low as pointed out above, is accomplished in the illustrative embodiment by operation of impinging electrons upon the recording medium. The electron impingement preferably occurs in the presence of a directed magnetic field of suitable strength. Referring again to Fig. 1 of the drawing, there is shown a cathode ray tube 22 having an electron gun of any known or desired type for producing a focussed beam of electrons. The tube 22, rather than being provided with a phosphor or other electron receiving target, is provided with an elongated Lenard window 24. Membranes serving as Lenard windows are by now well known and the window 24 need not be further described.

The following publications describe the Lenard window: Handbuch der Experimental Physik, 1927, vol. 14. Kathodenstrahlen by P. Lenard and A. Becker, page 178. Also: Chamber's Technical Dictionary, 1942, Macmillan Co., page 494.

The control electrode of the electron gun, for example the grid, indicated diagrammatically at 26, is suitably coupled to the output stage of a video amplifier 28. A signal to be recorded, such as a video signal, is applied as indicated diagrammatically at 29 to the input terminal of the video amplifier 28. Since the Lenard window 24 is elongated and since one component of scanning may be obtained by moving the tape 12, the cathode ray beam produced by the electron gun is deflected to and fro in one direction by a single deflection means such as the horizontal yoke 31. It will be understood by those skilled in the art that electrostatic deflection may be employed. The yoke 31 is supplied with a sawtooth of current at the horizontal frequency by any known deflection current source indicated schematically at 33.

The magnetic field preferably applied to the tape in the region of the Lenard window 24 is provided by a magnetic structure or head 36 having an air gap 38 and

exciting coils 39. The exciting coils are connected to a suitable exciting source (not shown) as indicated schematically at 41.

The cathode ray beam passing through the Lenard window 24 impinges on the magnetic tape 12. When the electrons from the beam impinge, the magnetic dipoles will be able to move in their suspension and they will re-orient themselves according to the external field created by the magnetic head 36. The external field provided by the head 36 may also act as an erasure of previous signals. As pointed out previously, the magnetic head 36 is preferably at least as long as the width of the tape and therefore only one magnetic head need be used.

Without necessary subscription to any particular theory of operation it is believed that three effects changing the magnetization and the order of the importance they are assumed to have in connection with the present invention are as follows:

The temperature effect.—The intensity of magnetization I is related to the field intensity H , according to the relation

$$I=KH$$

where K is the susceptibility. Curie's law states however that the susceptibility is inversely proportional to the temperature measured from the Curie point. Thus as the electrons deliver their energy to the tape or other magnetic recording media it brings it closer to the Curie point according to its total energy (beam intensity modulated by the intelligence) and changes the susceptibility and the intensity of magnetization.

The inductive effect.—As the electrons pass the magnetic material it provides an induction intensity B , which is related to the field intensity as,

$$H=\frac{B}{\mu}$$

where μ is the permeability of the material.

Saturation effects.—The permeability of the material changes as a function of the magnetic field, temperature and its own magnitude, thus providing a saturation due to both effects mentioned above and enhancing the change in magnetization due to either effect.

It will be understood that the web 12, or its equivalent, may be moved and that the electron beam may be signal modulated and undeflected. In this way signals, such, for example, as sound signals may be recorded along a tape or wire.

Figs. 2 and 3 of the drawing show a reproducing arrangement in accordance with the invention. A tube 44 is shown which is similar in many respects to the tube arrangement illustrated in United States Patent No. 2,449,339, granted September 14, 1948, to George C. Sziklai. This tube employs a special electron gun which provides a deflectable sheet of electrons capable of being deflected to sweep over the target face 46 of the tube. The interior of the target face 46 of the tube is coated with any suitable phosphor 48. As shown schematically, the cathode 49 of the tube is elongated so as to provide emission over a relatively great length. The tube electrode 51, which may serve as a grid, is provided with an elongated aperture 53 through which the electron stream in the form of a sheet of electrons emerges. A pair of spaced electrodes 55 and 56 also provided with elongated apertures serve to focus and direct the electron sheet. A pair of electrostatic deflection plates serves to deflect the sheet of electrons over the phosphor 48. The plates 58 are excited from a vertical deflection wave generator 59. The latter is controlled from any oscillator 61 of suitable frequency. In the illustrative example deflection occurs at the rate of 60 cycles per second which corresponds to the vertical field rate in accordance with present day television standards, as pointed out in the foregoing. The envelope 64 of the tube carries a plurality of pairs of laterally arranged magnetic members

66. These pairs of magnetic members, each pair constituting a magnetic head 68, are shown schematically in Figs. 2 and 3 and more in detail in Fig. 4.

A supply reel 71 is provided with the tape 12 bearing a record as obtained by the apparatus of Fig. 1 or similar record obtained in the manner shown in Patent No. 2,517,808 referred to above. The tape 12, as shown in Fig. 2, passes over a roller 72 which positions the surface of the tape close to or in contact with the portions of the heads 68 presenting the air gaps 74. Take-up reel 76 and a tape drive roller 78 are driven through a suitable gear drive mechanism 79 by a motor 81. The arrangement just described including the motor 81, the gear drive mechanism 79, the drive roller 78 and the take-up reel 76 are or may be identical with the arrangement shown in Fig. 1.

In operation of the signal generating system of Fig. 2 the tape record borne by the tape 12 which is carried by the reel 71 passes over the roller 72 at the same rate as this tape passes through the recording device for a recording operation. It will be understood that if the identical motor and reeling system are used then the rate of signal production will be correct. Provided that the motor 81 is a synchronous motor or other constant speed motor whose speed matches the speed of the recording motor then signal production will occur at the proper rate. As the transverse line of signal increments or signal points passes beneath the row of recording heads 68 the flux in the gap 83 of each head will be varied which in turn will modulate a narrow portion of the electron sheet. A scanning line will thus be produced across the target face 46 of the tube on the phosphor 48. Operation of the deflection generator will space these scanning lines so as to present a luminous image to the viewer observing the target face 46 of the tube 44.

What is claimed is:

1. A signal recording system comprising means for supporting and moving a magnetic recording medium in a predetermined direction, means for producing an electron beam, means whereby electrons from said beam impinge upon the recording medium, and means to magnetically excite said recording medium in the region of electron impingement on the recording medium.

2. A signal recording system comprising means for supporting and moving a magnetic recording medium in a predetermined direction, means for producing an electron beam modulated in accordance with the signal to be recorded, means whereby electrons from said beam impinge upon the recording medium, and means magnetically to excite said recording medium in the region of electron impingement on the recording medium.

3. A signal recording system comprising means for supporting a recording medium, a source of electrical signals, means for producing an electron beam modulated in accordance with the electrical signals from said source, means for deflecting said beam to traverse said recording medium, means whereby electrons from said beam impinge upon the recording medium, and means to magnetically excite said recording medium substantially along the line of electron impingement.

4. A signal recording system comprising means for moving a recording medium in the form of a strip of material having magnetizable characteristics in a predetermined direction, an image signal source, means responsive to the image signal from said source for producing an electron beam, means for deflecting said beam to progressively traverse said recording medium, means whereby electrons from said beam impinge upon the recording medium, and means to magnetically excite said recording medium substantially along the line of electron impingement.

5. A signal recording system comprising means for moving a recording medium of substantial width in a predetermined direction, means providing an image signal, means for producing a signal modulated electron beam,

means responsive to said image signal for deflecting said beam to progressively traverse said recording medium, means whereby electrons from said beam impinge upon the recording medium, and means to magnetically excite said recording medium along the line of electron impingement on the recording medium.

6. A signal reproducing system comprising means for moving a magnetic record of substantial width having television signals recorded transversely thereof along successive lines oriented in a predetermined direction, a cathode beam tube having an envelope, means in said tube for producing a sheet of electrons, means for deflecting said electron sheet, a fluorescent target at the end of said tube for receiving said electron sheet to produce a pattern thereon of said transversely recorded television signals, said deflection means providing for the movement of said electron sheet over said target in a direction transverse to the length of said pattern, a plurality of magnetic heads extending through said envelope from the exterior thereof and being positioned to influence successive transversely disposed portions of said electron sheet, said magnetic record moving to transfer magnetic effects therefrom to said magnetic heads whereby said pattern provides for the visual reproduction of successive lines of said transversely recorded signals.

7. A signal reproducing system comprising means for moving a magnetic record having a dimension in width and having signals recorded transversely thereof in a predetermined direction across the width thereof, means for producing an electron stream, a fluorescent screen for receiving said stream, means for making said stream incident upon said screen to provide a line of illumination in one direction across said screen, means for deflecting said stream over said screen in a direction transverse to said one direction to provide a raster of successive ones of said lines on said screen, and means for impressing magnetic effects from said magnetic record on said stream such that the components of said stream incident on said screen along said one direction exhibit modulation corresponding to components of said signals recorded on said record in said predetermined direction.

8. A signal reproducing system comprising means for moving a magnetic record having a dimension in width and having signals recorded transversely thereof in successive lines spaced from each other along the length of said record in a predetermined direction across the width thereof, a cathode beam tube having a fluorescent screen at one end thereof, and means for producing an electron stream incident upon said screen along the width thereof to provide an illuminated line across said screen, deflection means in said tube for moving said stream across said screen in a direction transverse to the direction of said line to provide a raster on said screen, and means for impressing magnetic effects from said record on said screen to produce an image on said screen on successive ones of said lines corresponding to signals recorded on successive lines of said record.

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