Aug. 9, 1949. G. L. BEERS 2,478,681

CATHODE-RAY TYPE SOUND RECORDING SYSTEM

Filed July 18, 1945

Fig. 1.

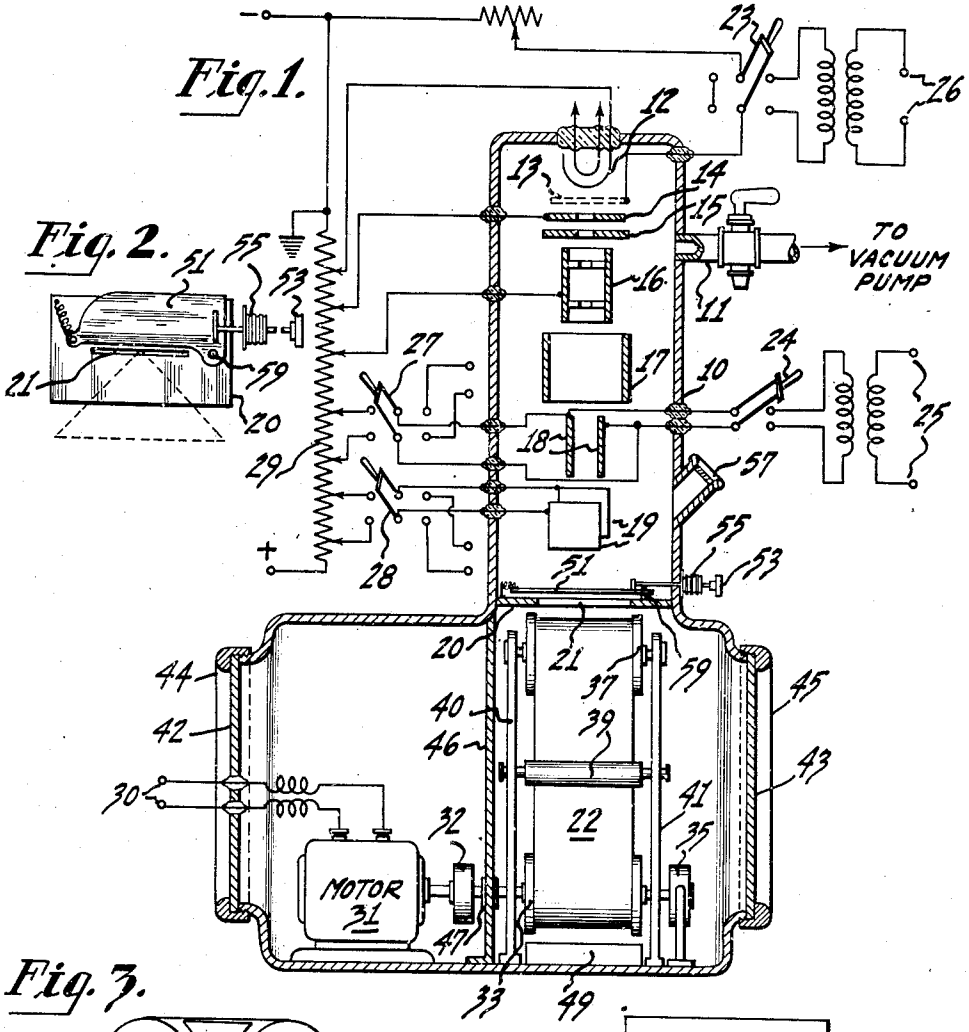


Fig. 2.

Fig. 3.

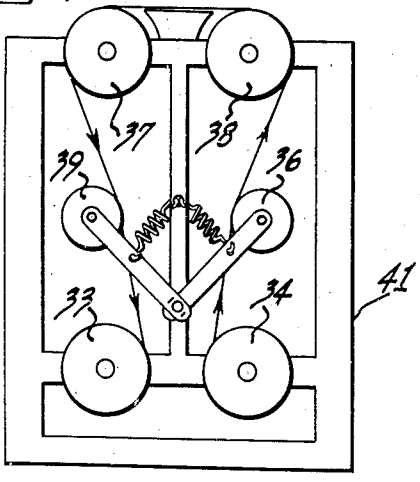
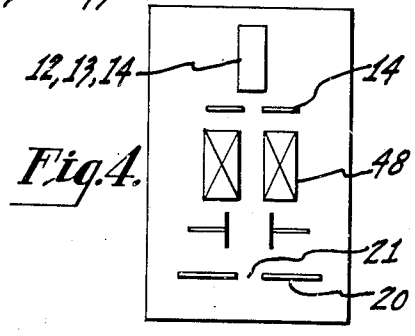


Fig. 4.



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CATHODE-RAY TYPE SOUND RECORDING SYSTEM

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1 Claim. (Cl. 179—100.3)

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This invention relates to the recording of sound on a photographic medium, or the like, and has for its principal object the provision of an improved apparatus and method of operation whereby sound records of the variable area or variable density types are readily produced either on a stationary recording medium or on a medium which is moved at a substantially uniform speed.

It has been proposed to record sound by means of a cathode ray tube provided with a Lenard window through which a cathode ray, or electron beam, modulated in accordance with the audio frequency signals is applied to a moving photographic strip. Proposals of this character are found in U. S. Patents 1,864,363 and 1,870,975, for example. Such sound recording devices are not altogether satisfactory for the reason that the electron beam tends to disperse due to collision with the gas molecules of the air and the fidelity of the recorded sound is impaired.

It has also been proposed to record transient electrical phenomena by means of a cathode ray device within which is supported a photographic recording medium which is maintained stationary while the phenomena are being recorded. A device of this character is disclosed by U. S. Patent 2,086,546 in accordance with which a timing pulse is applied to one pair of ray deflectors while a potential representative of the phenomena to be recorded is applied to another ray of deflectors.

The sound recording apparatus of the present invention is similar in some respects to the apparatus of the aforesaid Patent 2,086,546, but differs therefrom in other important respects. For example, the present invention provides a cathode ray type of sound recorder which operates (1) to record a variable area record on a moving record medium when the signals to be recorded are applied to one pair of its deflectors, (2) to record a variable density record on a moving record medium when the signals to be recorded are applied to its control grid, or (3) to record a record in the form of a spiral on a stationary record medium when the signals to be recorded are applied to its control grid and the separate pairs of its deflectors are subjected to potentials which are in quadrature, have the same frequency and have their amplitudes varied from a relatively high value to a relatively low value, or vice versa, as disclosed by U. S. Patent 1,470,696, for example.

One suitable means of effecting these various results is a type of cathode ray device commonly known as an electron microscope. As is well

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known, the electron microscope includes an evacuated container within which may be mounted means for supporting a specimen to be examined, means for producing an electron beam, means for focusing this beam on the specimen, and means for focusing an image of the specimen on a photographic recording medium or on a viewing screen. In this type of apparatus, focusing of the electron beam at the desired points in its path is effected by means of electron lenses which may be of the electrostatic type, the electromagnetic type, or a combination of these two types. For scanning the specimen, the electron microscope may be provided with deflectors to which suitable potentials are applied for moving the beam from one point of the specimen to another.

Like the electron microscope, the sound recorder of the present invention includes means for forming, focusing and controlling the position of an electron beam. It differs from the conventional electron microscope in that it includes (1) means for forming a light slit, (2) means for moving a photographic film or strip transversely of this slit at a substantially uniform speed, (3) means for varying the position or the intensity of the beam at the slit in accordance with impulses to be recorded, (4) means for conforming the beam to a desired shape or form such that its movement with respect to the slit exposes the record medium in accordance with the applied impulses, and (5), where a spiral record is to be produced on a stationary record medium, means for applying quadrature potentials of the same frequency and varying amplitudes to the separate pairs of deflectors of the recorder. As hereinafter explained, the light slit member may be removed from the path of the beam during the production of a record of spiral form. The means by which the beam is conformed to a predetermined shape also may be removed if not essential to the particular type of record produced at any given time.

Important objects of the invention are the provision of an improved sound recorder wherein the use of moving optical parts is avoided; the provision of a recorder which obviates halation in the photographic record medium and realizes the full resolution capabilities of such medium; the provision of a sound recorder which is readily adapted to produce different types of records; and the provision of a recorder which affords an improvement in the signal to noise ratio due to the better recording densities made possible, and makes possible an extension of the frequency range of the recorded impulses.

The invention will be better understood from the following description considered in connection with the accompanying drawings, and its scope is indicated by the appended claim.

Referring to the drawings:

Fig. 1 is a diagrammatic view, partly in section, of a preferred form of the invention,

Fig. 2 illustrates one form the electron beam may assume and its relation to the light slit,

Fig. 3 illustrates certain details of the record moving mechanism of Fig. 1 and

Fig. 4 illustrates a modified form of the invention which employs an electronic lens of the electromagnetic type.

The sound recorder of Fig. 1 includes an evacuated receptacle 10 of metal or the like which is illustrated as having an outlet 11 through which it may be connected to a continuously operating vacuum pump.

Within the receptacle 10 are mounted a cathode 12, a control grid 13, a first accelerating anode 14, a member 15 provided with an aperture for shaping the electron beam, a focusing anode 16, a second accelerating anode 17, pairs of deflectors 18 and 19 which function to move the beam in directions at right angles to one another, and a member 20 having a very narrow light slit 21. It is, of course, apparent that the illustrated arrangement of these different parts may be modified in various ways without changing the functions performed by the recorder as a whole. For example, the electronic lens formed by the electrodes 16 and 17 may be replaced by an electromagnetic lens such as those disclosed by U. S. Patent 2,301,303 and an objective electronic lens of any suitable type may be interposed in the path of the beam between the light slit and the recording medium.

In any case, the overall function of the electronic optical system formed by the various electrodes, the apertured member 15 and the light slit member 20 is to produce at the surface of a photographic recording medium 22 an electron beam which varies in cross-sectional area or in intensity in accordance with the audio frequency signals to be recorded on the medium 22. Thus, if a switch 23 is closed to the left to connect the grid 13 to a fixed source of a potential, and a switch 24 is closed to the right to connect the deflectors 18 to the audio frequency signal terminals 25, the position of the electron beam with respect to the slit 21 is varied in accordance with the applied audio frequency signal and a variable area record is produced.

As indicated by Fig. 2, the aperture in the member 15 may be triangular shape so that a beam having the form indicated by the broken lines is vibrated transversely of the light slit 21.

If the switch 23 is closed to the right to connect the grid 13 to the signal supply terminals 26 and the deflectors 18 and 19 are subjected to fixed potentials by which the beam is adjusted to the required position on the light slit, the recording medium 22 is exposed to an electron beam which is of constant area and varies in intensity in accordance with the audio frequency signals supplied to the terminals 26. In order that the operator may properly focus and predetermine the operating limits of the electronic beam, the slit is covered by a mask 51 which is coated with fluorescent material. The mask 51 may be positioned by a lever 53. The lever may be arranged to work through a vacuum seal or bellows 55 in the casing near the window 57 for viewing the fluorescent mask. The window should be covered with a light tight cap when not in use, thereby to avoid exposing the film. The mask 51 is pivoted at a suitable point 59.

If a sound record in the form of a spiral is to be produced, the members 15 and 20 may be moved out of the path of the beam which, in this case, is focused to a relatively small cross-sectional area at the surface of the recording medium 22. With the switches 27 and 28 closed to the right to apply to the deflectors 18 and 19 quadrature potentials which are of the same frequency and are gradually changed in amplitude, and the switch 23 closed to the right to apply audio frequency signals to the grid 13, there is applied to the surface of the record 22 an electron beam which is of constant cross-sectional area, traces a spiral path, and varies in intensity or is controlled in accordance with the applied signals.

Power for operating the electronic part of the recorder is supplied from any suitable direct current source through a voltage divider resistor 29 which is provided with adjustable contacts arranged to be connected to the various electrodes either directly or as previously explained.

Power for operating the record moving mechanism (shown at the lower part of Fig. 1) is supplied through terminals 30 to a drive motor 31 by which the record moving mechanism is coupled through a coupling 32. The coupling 32 may be of such type as smooths irregularities in the torque applied through it, and is shown as connected to a take-up reel 33, although it may be connected to any other suitable part of the drive mechanism.

The film moving mechanism illustrated is intended to be illustrative of any suitable mechanism of the prior art which may be substituted for it if desired. It includes a feed reel 34, which may be provided with a brake or other retarding device 35 mounted on the end of its shaft.

From the feed reel 34, the record strip passes over a spring pressed roller 36, over the rollers 37 and 38, over the spring pressed roller 39, and thence to the take-up reel 33. These various rollers are shown as mounted between upright members 40 and 41 which are so fastened to the base of the receptacle 10 as to afford firm bearings for the various rollers and to be readily removed for disassembling the mechanism through openings provided with air-tight covers 42 and 43 held in place by collars 44 and 45 which are threaded on opposite sides of the lower part of the receptacle 10.

The lower part of the casing 10 is divided into two compartments by a partition 46. Where the shaft of the motor 31 passes through this partition, there is provided an air tight seal 47. Under these conditions, the vacuum pump is not required to remove the gas otherwise given off by the motor 31 and the coupling 32. A vessel 49 containing hygroscopic material may be placed in the receptacle 10 for taking up moisture given off by the record strip 22. Instead of using a mechanical coupling which requires a seal, the connection between the motor 31 and film take-up reel 33 may be a magnetic coupling which can act through a thin non-magnetic plate, thus eliminating the need for a vacuum tight bearing.

Fig. 4 illustrates a modified electron optical system wherein electromagnetic focusing is employed. In this form of the invention, the coil 48 focuses the beam so that the triangular shape given the beam by the aperture of the member

14 is maintained at the slit 21 of the member 20. In this figure, the cathode 12, grid 13 and first anode 14 are shown in the form of a block. The electromagnetic lens 48 may be of any satisfactory type such as those disclosed by U. S. Patents 2,301,987 or 2,301,303, for example.

Another method of operating the forms of the invention described above is to permanently remove the aperture and slit members 15 and 20 and to focus the beam in a fine spot directly on the film. Under these conditions, a radio frequency deflecting voltage (say 200 kc.) is applied to one pair of the deflectors. This voltage is modulated by the audio frequency signals to be recorded for producing a variable area record. For producing a variable density record, the radio frequency potential applied to the pair of deflector plates is kept at a constant amplitude and the audio signals are applied to the grid as previously indicated in connection with the spiral type of record which is recorded on a stationary record medium.

The present invention thus makes available a sound recorder which is adapted to produce various types of sound records. These records are of high quality due to the fact that they are produced by an electron beam without the use of moving optical parts, thus better utilizing the capabilities of the photographic record medium.

What is claimed is:

In a sound recorder adapted to produce a record which is alternatively of the linear variable width type, the linear variable density type or the spiral variable density type, the combination of an evacuated receptacle having opaque walls, means for forming an electron beam of triangular cross section, means for focusing said beam at a predetermined point, means for moving a sound record medium within said receptacle along a path which includes said point, means

forming a narrow slit movable into the path of said beam for restricting the area of said medium exposed to said beam, a grid for controlling the intensity of said beam, deflectors for controlling the position of said beam along paths which are perpendicular to one another, means for applying a unidirectional voltage, means for applying alternating voltages which are in quadrature, means for applying an audio frequency voltage, means for connecting said deflectors alternatively to said unidirectional voltage applying means or to said quadrature applying means, and means for connecting said audio frequency voltage applying means alternatively to said grid or to a predetermined pair of said deflectors.

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