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J. HENDRICH
NOISELESS SOUND RECORDING

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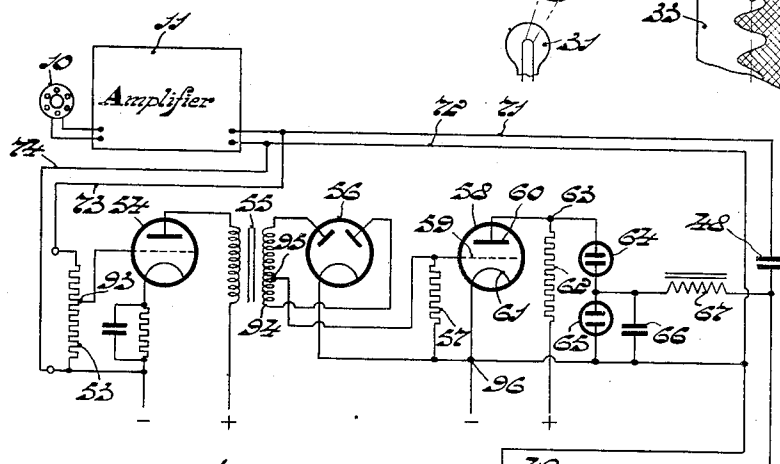
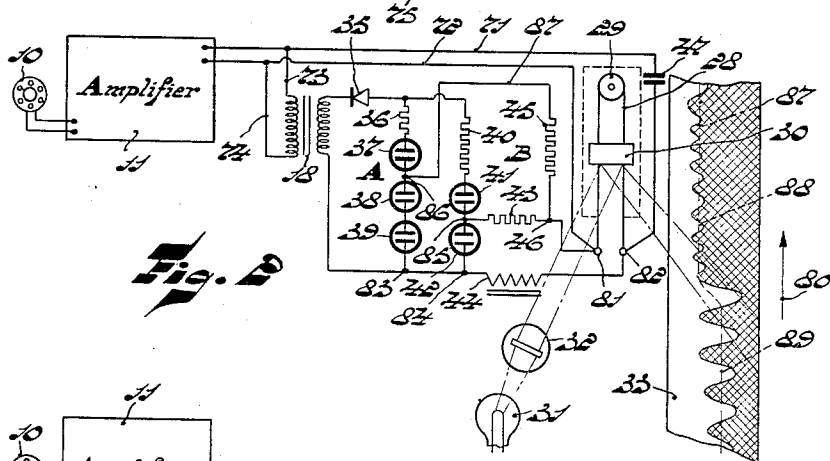
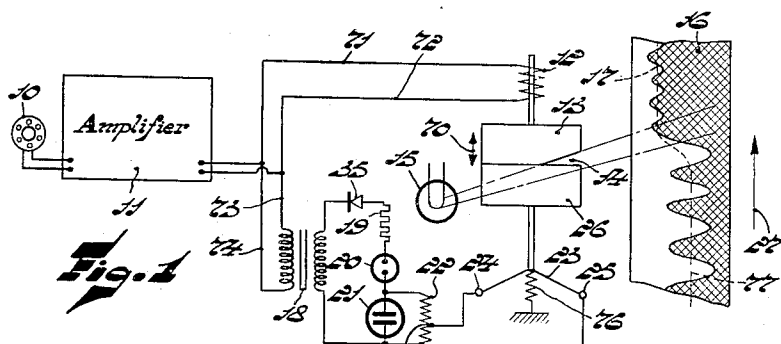


Fig. 3

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NOISELESS SOUND RECORDING

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6 Claims. (Cl. 179—100.3)

My invention relates to a system for recording noiseless sound records.

It is known to produce a noiseless sound record by controlling the mean transparency of the sound track in a stepwise manner with control currents whose values are fixed and are dependent upon the amplitudes of the sound to be recorded. For example, the U. S. Patent #2,093,215 describes a system in which a portion of the alternating sound currents is supplied to an electric light-control device whose beam of light influences, in accordance with the sound intensity, one or more light-sensitive members. These members, through a plurality of grid-controlled gas-discharge tubes, cause direct control current of different intensities to flow in the recording device. Although such a system has numerous advantages it is complicated and due to the light-control device, is particularly sensitive to mechanical vibrations.

The main object of my invention is to overcome the above difficulties and to provide a system which has a simple and inexpensive construction and is reliable in operation.

In accordance with the invention, I rectify a portion of the alternating sound voltages and supply the same to at least two discharge tubes which are ignited above a determined threshold value and of which at least one is a voltage stabilizer tube. I obtain the direct control voltage for the recording device from the voltage across the stabilizer tube or tubes.

As the step-wise control according to the invention acts completely electrically without any mechanical intermediate members, adjustment is very easy and wear and tear or disturbance of the correct adjustment due to mechanical shocks, etc., is impossible.

The term "voltage stabilizer tube" as used herein and in the claims is to be understood to mean a discharge tube which comprises two electrodes between which a discharge takes place when a voltage of a predetermined value is applied across the same and in which, after ignition, the voltage across the electrodes remains substantially constant independently of the intensity of the discharge current, i. e., varies not more than 10%. An example of such a tube is a gas-discharge tube filled with neon gas in which a glow-discharge takes place.

In order that the invention may be clearly understood and readily carried into effect I shall describe the same in more detail with reference to the accompanying drawing in which:

Figure 1 is a diagrammatic view of an optical-

recording system according to the invention.

Fig. 2 is a diagrammatic view of an optical-recording system according to another embodiment of the invention, and

Fig. 3 is a diagrammatic view of a mechanical-recording system according to the invention.

In the system illustrated in Figure 1 a sensitized film 16 is moved at a constant speed in the direction of arrow 27 and a beam of light emitted from a light source 15 toward the film 10 passes through a V-shaped slot 14 of varying width formed by two shutter members 13 and 14. In a manner to be described in more detail hereinafter, the member 13, which has an oblique lower edge, is vibrated in the direction of the arrow 10 and in accordance with the sound vibrations being recorded to thereby change the width of slot 14, and member 26 is shifted in steps to change the position of zero-line of the sound record.

The sound being recorded is picked up by a microphone 10 feeding into the input of an amplifier 11. The amplified alternating sound currents leave the output of the amplifier 11 and pass through two parallel circuits. More particularly, part of the current passes through a circuit including a conductor 71, a coil 12 which serves to move shutter 13, and a conductor 72. As a result the shutter 13 is vibrated in accordance with the sound vibrations. The remainder of the current passes through a circuit including a conductor 73, the primary winding of a step-down transformer 18, and a conductor 74.

Connected across the secondary winding of transformer 18 is a circuit comprising a rectifier 35, a resistance 19, a discharge tube 20 and a voltage stabilizer tube 21. When the amplitudes of the alternating sound currents exceed a certain value, i. e., a value at which the voltage across tubes 20 and 21 exceeds the sum of the ignition voltages of these tubes, a current will flow through these tubes. The resistance 19 serves to limit the intensity of this current.

Connected across the stabilizer tube 21 is a potentiometer 22 having a tap 75. The tube 20 acts as a blocking valve, i. e., serves to prevent passage of current through the potentiometer 22 when the voltage across tubes 20 and 21 is below the sum of the ignition voltages of these tubes.

Connected across tap 75 and one end of potentiometer 22 is a silver wire 23 arranged in a V with its ends fixed at points 24 and 25 and its apex connected to shutter member 26. A compression spring 76 forces member 26 upwards.

When wire 23 becomes heated due to the passage of current therethrough it lengthens and allows shutter member 26 to rise. Thus, when current passes through tubes 20 and 21, there is a constant voltage across tube 21 and potentiometer 22, and a constant current passes through wire 23. As a result wire 23 lengthens, member 26 is raised by spring 76, slit 14 is shortened, and zero-line 17 of the sound track is displaced to the right into the position indicated by reference numeral 77. In this position of the zero-line, which corresponds to the positions shown of member 26, the sound vibrations of larger amplitudes are being recorded. It should be noted that the thermal capacity, i. e., cooling time and heating time, of the wire 23 insures a regular passage of the zero-line from one stage to the other.

When the amplitudes of the alternating sound currents fall below that predetermined value at which the tubes 20 and 21 are extinguished, the current through wire 23 is interrupted, and the wire 33 cools, contracts, and draws the member 26 downwardly to displace the zero-line toward the left.

The device diagrammatically illustrated in Figure 2, which is adapted to shift the zero-line in two stages, is similar in some respects to that of Figure 1 and has the same parts indicated by the same reference numerals. The sound is recorded on a sensitized carrier 33 which moves at a constant speed in the direction of arrow 80 and for this purpose a narrow light beam produced by the light source 15 and an apertured diaphragm 32 is reflected upon the carrier by the mirror 30 of an oscillograph 29. The mirror is supported on a wire loop 28 which in the known manner is located in a magnetic field. As such oscillographs are well known in the art, further description or illustration of the same is believed unnecessary.

Part of the alternating sound currents leaving the output of amplifier 11 passes through conductor 71, a condenser 47, loop 28 and conductor 72 to cause mirror 30 and the light beam reflected thereby to oscillate in synchronism with the sound vibrations.

To produce the stepwise displacement of the zero-line of the sound track, part of the sound current leaving the output of amplifier 11 is passed through the primary winding of the transformer 18. Connected across the secondary winding of transformer 18 is the series connection of rectifier 35 and two parallel circuits A and B. Circuit A comprises the series connection of a current-limiting resistance 40 and two glow-discharge tubes 41 and 42.

The number and ignition voltages of tubes 37 to 42 are so chosen that when the amplitudes of the alternating sound currents exceed one given value, current flows only in circuit B, and when the amplitudes exceed a higher predetermined value current will flow in both circuits A and B.

The ends 83 and 84 of circuits A and B are connected together and through a choke 44 to one end 82 of the wire loop 28. The other end 81 of the wire loop is connected to a point 46 which is connected through a resistance 43 to a point 85 between tubes 41 and 42, and also through a resistance 45 to a point 86 between tubes 37 and 38.

When only circuit B is operative, current passes therethrough and, independently of the intensity of this current, a constant voltage will exist across the electrodes of tubes 41 and 42. As a result a direct current of constant value will flow

through the circuit comprising resistance 43, loop 28 and choke 44, which current causes a predetermined displacement of mirror 30 and of the zero-line of the sound track.

Choke 44 serves to prevent the alternating sound currents passing through conductors 71 and 72 from entering circuits A and B, and also serves to ensure that the portions of the zero line between the various stages are smooth. Condenser 47 serves solely to prevent the direct control currents from reaching the output circuit of amplifier 11.

When the amplitudes of the alternating sound voltages across the secondary winding of transformer 18 increase, the current through circuit B also increases. The voltage across resistance 40 also increases and at a predetermined threshold value of the alternating voltage amplitudes and—depending upon the ignition voltage of tubes 37, 38 and 39 and the values of resistances 40 and 36—also these discharge tubes ignite. The series connection of tubes 38 and 39 and the resistance 45 is connected across points 46 and 84 at which the control voltage is obtained, and as a result the control voltage is now considerably greater than when only circuit B was operating. Thus, a second control current flows in parallel to tubes 38 and 39 through conductor 87 and resistance 45, and then part of this current flows through loop 28 and choke 44 and part flows through resistance 43 and tube 42.

If the resistance 43 is given a value of the order of the magnitude of the internal resistance of tube 42 at its ignition point, the voltage between points 46 and 84 with both circuits A and B in operation will be about double the value obtained when only circuit B is operating. As a result the zero-line position of mirror 30 is displaced into a second position.

From the above it is seen that in accordance with the amplitudes of the sound being recorded mirror 28 will be placed in one zero-line position when neither circuit A or B is operating, in a second position when only circuit A is operating, and in a third position when both circuits A and B are operating. These three positions are indicated by the portions 87, 88 and 89 respectively of the zero line of the sound track on support 33.

In the recording system illustrated in Figure 3 the zero line is altered in a single stage and the recording is effected mechanically in the manner described in the U. S. Patent #1,919,116 to James A. Miller on a carrier 52 which moves at a constant speed in the direction of the arrow 90. The carrier 52 comprises a lower cutting layer of transparent material and a thin upper layer of opaque material. A recording device 50, which may be of the type described in the U. S. Patent #2,108,275 to Vermeulen et al., comprises two permanent magnets 91 which produce a magnetic field in which an armature 92 is located. Armature 92 is surrounded by a coil 49 and carries a cutting tool 51 having a V-shaped cutting edge. When current variations are passed through coil 49 the tool 51 vibrates to remove portions of the carrier 52 and form an optically-reproducible sound track having both width and depth variations.

Part of the alternating sound current leaving the output of amplifier 11 passes through a circuit including conductor 71, condenser 48, coil 49 and conductor 72. The passage of these currents through coil 49 causes the cutting tool to vibrate and produce the variations in the amplitudes of the sound tracks.

The remaining part of the amplified alternating sound currents are used to produce the stepwise displacement of the tool 51. For this purpose a potentiometer 53 having a tap 93 has its ends connected through conductors 73 and 74 to conductors 71 and 72 respectively. Tap 93 is connected to the grid of an amplifying tube 54 whose cathode is connected through the parallel connection of a condenser and resistance to one end of the potentiometer and to the negative terminal of a supply of plate current (not shown).

The plate circuit of tube 54 includes the primary winding of a push-pull transformer 55 having a secondary winding 94 provided with a tap 95. The ends of winding 94 are connected to the anodes of a full-wave rectifier 56 whose cathode is connected through a resistance 57 to the tap 95 to complete the circuit of the rectified currents.

The value of the rectified voltage across resistance 57 is exactly proportional to the mean value of the alternating current amplitudes. In contradiction to the systems shown in Figs. 1 and 2, this voltage is not directly applied to a series connection of stabilizing tubes. The reason for this is that many stabilizing tubes have the drawback that their ignition voltage is slightly higher than their extinguishing voltage with the result that when the zero line is displaced due to an increase in the amplitude at a determined value of the amplitude, the zero line will not be moved back when the amplitude decreases until the amplitude actually reaches a smaller value. This drawback is eliminated in the system of Fig. 3.

For the above purpose, a discharge tube 53 having a gaseous filling, for example helium, a grid 59, a cathode 61 and a plate 60 is used. The grid 59 is connected to one end of resistance 57 and the cathode 61 is connected to a point 63 which is connected to the other end of resistance 57 and to the negative terminal of a plate current supply (not shown). The plate 60 is connected to a point 63 which is connected through a resistance 62 to the positive terminal of the plate current supply and through the series connection of two stabilizing tubes 64 and 65, which are similar to tubes 21, 37, 38, 39, 41 and 42 of Figs. 1 and 2 and may have a neon filling, to point 96.

Tube 65 has one electrode connected to one end of coil 49 and its other electrode connected to a point 62 which is connected through a choke 67 to the other end of coil 49 and through a condenser 66 to the first electrode.

The direct control voltage first controls the current in tube 53, because when the voltage across resistance 57, which voltage forms a negative voltage on grid 59, exceeds a predetermined threshold value and depending upon the characteristics of the tube 53, the discharge between cathode 61 and plate 60 will be interrupted. The plate current passing through resistance 62 drops to zero, the voltage between points 63 and 96 increases and the neon stabilizer tubes 64 and 65 ignite. As a result a direct control current, which displaces armature 92 of the recording device 50 is passed through coil 49 and is superposed on the alternating sound currents passed therethrough. This direct control current displaces the mean position of the cutter 51 and thus the zero line of the sound track being produced in carrier 52.

When the alternating sound voltages decrease, the rectified voltage across resistance 57 also decreases, and the discharge through tube 53 takes place at the same grid bias voltage at which it

was extinguished. The voltage drop across resistance 62 increases and as a result tubes 64 and 65 are extinguished.

In a manner described in the German application No. 42,399 filed August 29, 1938, and in the corresponding copending U. S. application, Ser. No. 287,676, filed July 31, 1939, the condenser 66 and choke 67 form an oscillatory circuit in parallel with the direct control voltage and serve to ensure a uniform transition when the zero line is displaced. For this purpose condenser 66 may have a value of about 1.5 microfarads and choke 67 may have a value of about 50 henries. Choke 67 also serves to prevent the alternating sound currents from reaching the discharge tube 65.

The natural shape of the oscillation curve of the free natural oscillation in the circuit formed by condenser 66 and choke 67 is a sine curve. By giving the condenser and the choke suitable values, for example, those indicated above, the natural-frequency curve of this oscillatory system causes the zero line to be displaced from one position to another along a sine curve, i. e. one zero line passes according to a sine curve into the displaced zero line. This sinusoidal transition ensures a completely inaudible zero line displacement.

Although I have described my invention with reference to specific examples and certain details of construction, I do not desire to be limited thereto because obvious modifications will present themselves to one skilled in the art.

What I claim is:

1. A noiseless sound recording system comprising electrical recording means, means for supplying alternating sound currents to said recording means, and means for supplying to said recording means rectified control currents of predetermined value to stepwise change the zero line of the track in accordance with the amplitudes of the sound being recorded, said latter means comprising a plurality of discharge tubes which ignite at a voltage exceeding a predetermined value and including a voltage stabilizer tube.

2. A noiseless sound recording system comprising electrical recording means, means for supplying alternating sound current to said recording means, and means for supplying to said recording means rectified control currents of predetermined value to stepwise change the zero line of the track in accordance with the amplitudes of the sound being recorded, said latter means comprising a plurality of voltage stabilizer tubes and a resistance connected in series, said recording means being connected across one of said tubes.

3. A noiseless sound recording system comprising electrical recording means including a control member, means for supplying alternating sound currents to said recording means, a plurality of series-connected discharge tubes which ignite at a voltage exceeding a predetermined value and including a voltage stabilizer tube, said control member being connected across said stabilizer tube, and means to apply across the series connection of said tubes a rectified current whose value varies in accordance with the amplitude of the alternating sound currents.

4. A noiseless sound recording system comprising recording means including an electrically actuated control member, two parallel connections each including a plurality of series-connected voltage stabilizer tubes and a resistance, means to apply across both of said connections a rectified voltage which varies in accordance with

the amplitudes of the alternating sound currents, a circuit including said control member a resistance and one of the tubes of one of said connections, and a connection from a point between two
5 tubes of the second connection to one terminal of said control member.

5. A noiseless sound recording system comprising recording means including an electrically-actuated control member, means for supplying
10 alternating sound currents to said recording means, a gaseous tube having a grid, cathode and plate, means to apply between said grid and cathode an amplified rectified voltage which varies in accordance with the amplitudes of the
15 alternating sound currents, a plate circuit for

said tube including two series-connected voltage stabilizer tubes, and a circuit including said control member and one of said stabilizer tubes.

6. A system for producing a noiseless sound track comprising recording means including an
5 electrically-actuated member adapted to alter the mean light transparency of the sound track, means for supplying alternating sound currents to said recording means, and means to supply control current to said member, said latter means
10 including a plurality discharge tube including a neon tube, said member being controlled by the voltage produced across said neon tube.

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