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ELECTROSTATIC RECORDING AND REPRODUCING

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FIG. 1

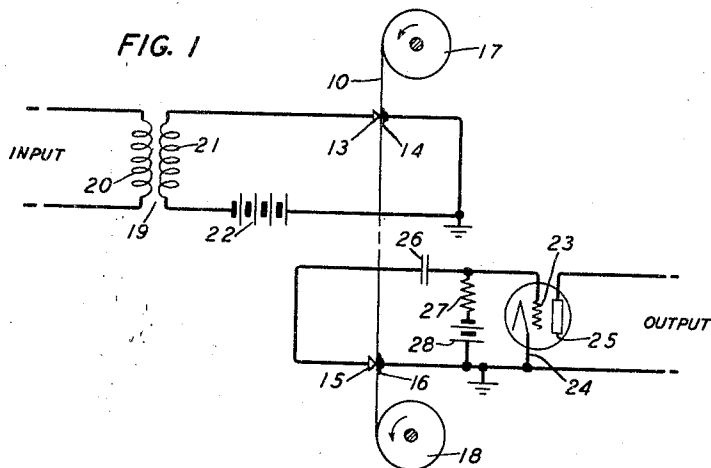


FIG. 3

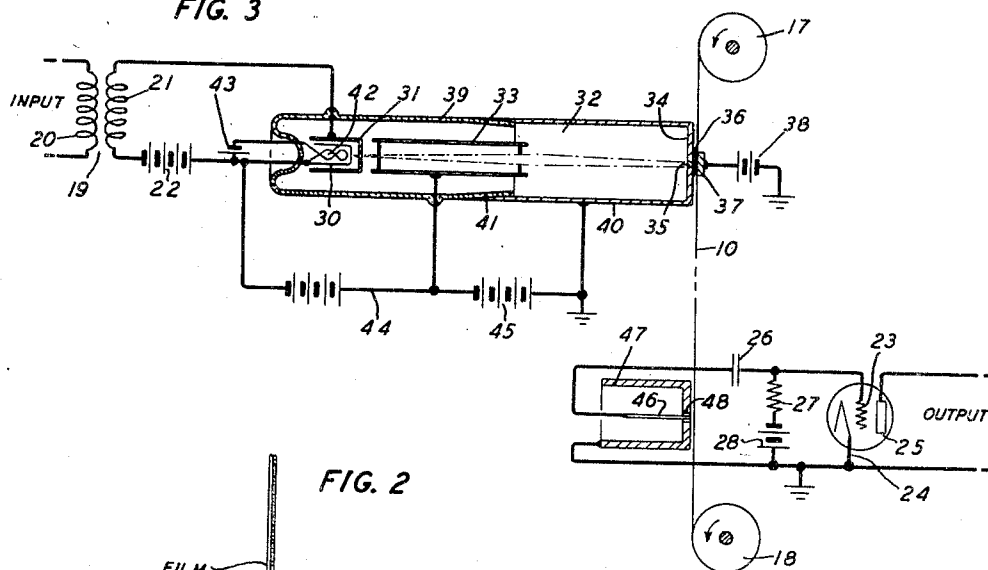
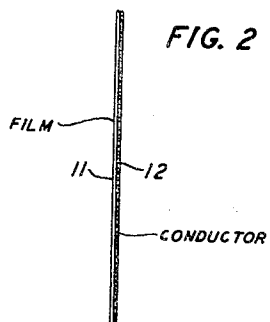


FIG. 2



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ELECTROSTATIC RECORDING AND REPRODUCING

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9 Claims. (Cl. 179-100.1)

This application relates to electric signaling and more specifically to the electrostatic recording of signals.

An object of this invention is to provide novel methods of and apparatus for the electrostatic recording of signals.

Several methods of recording signals electrostatically have been proposed before. None of these systems, however, possesses the flexibility, accuracy and speed of the well-known method of electromagnetic recording as performed by the telegraphone. In the present invention, an electrostatic method of recording is provided which is fully as flexible as the telegraphone and in addition possesses several advantages thereover. For example, because of the fact that there are no magnetic coils in either the recording or reproducing stages of this method, there is no consequent shift in phase between the input and output signals. This shift in phase in the case of a telegraphone offers very serious objections in a situation where it is desired to record and reproduce television signals. In the case of the telegraphone, the constant shift in phase angle will not be a constant shift in time for the various frequencies making up the composite television signal, a factor which will cause much distortion in the final television image. For example, a shift of 90 degrees is a shift in time of $\frac{1}{4000}$ th of a second for a 1500-cycle component but only $\frac{1}{60}$ th of a second for a 20-cycle component. This angular shift is also accompanied by a loss in amplitude at the lower frequencies, thus introducing more distortion. The present system offers further advantages in that it is simple to construct, easy to operate, and comparatively cheap.

In one embodiment of the invention, there is provided an electrostatic recording and reproducing system comprising a film of insulating material, such as, for example, Cellophane, having on one side a coating of suitable conducting material, such as carbon, a pair of contacts between which the film passes to receive electrostatic charges proportional to signals applied between these contacts, and a set of reproducing contacts, through which the film is later caused to pass, which are connected in the input circuit of an amplifying device in the reproducing circuit. In a modification (which is a preferred embodiment of this invention), the electrostatic charges are applied to the dielectric tape by means of a modulated electron beam which is caused to pass through an aluminum window in a cathode ray device in which the beam is gener-

ated and modulated in accordance with incoming signals. In this embodiment the charged tape is adapted to run past but not to touch a metallic element, shielded from all but a narrow area of this tape by a suitable shield, in order to reproduce by electrostatic induction the signals successively positioned upon the tape. A feature of the preferred embodiment is that no contacts are provided which mechanically touch this tape either in the recording or reproducing stages although there may be provided a guide for the tape in the recording stage which may be placed at a suitable positive potential above ground.

The invention will be more readily understood by referring to the following description taken in connection with the accompanying drawing forming a part thereof in which:

Fig. 1 is a schematic diagram of an electrostatic recording and reproducing system;

Fig. 2 is a cross-section of a portion of the film used in the system of Fig. 1; and

Fig. 3 is a schematic diagram of a modified electrostatic recording and reproducing system.

Referring more particularly to the drawing, Fig. 1 shows schematically an electrostatic recording and reproducing system. The system comprises a dielectric tape 10 (see Fig. 2) of suitable insulating material 11, such as for example Cellophane, coated on one side with a thin layer or coating 12 of a suitable conducting material, such as carbon, which is caused to pass between contacts 13 and 14 in the recording stage and between contacts 15 and 16 in the reproducing stage. The film 10 is unwound from a roller 17 and wound again on a roller 18, the film being wound and unwound at any desired speed by any suitable means (not shown). The desired speed would, of course, be determined by the frequency of the incoming signals which are applied between the contacts 13 and 14 by means of a transformer 19 having a primary winding 20 and a secondary winding 21. Contact 14 is preferably connected to ground and a direct current bias is applied to contact 13 by means of a source of direct current potential 22.

As the moving dielectric tape passes between contacts 13 and 14, an electrostatic charge is imparted thereto. As the metallic coating 12 (see Fig. 2) is in contact with the contact member 14 a charge is laid on the front surface of the insulating film 11, which is proportional to changes in the signal in the primary winding 20 of the transformer 19, the film 11 acting as a dielectric for this purpose. Due to the high specific resistance of the material comprising the

film 11 there is little or no surface leakage to distort the signal.

A predetermined interval of time after a succession of charges have been imparted to successive elemental lengths of the tape or film 10 as described above, this interval being determined by the length of the film between the contacts 13 and 14 and the contacts 15 and 16 and the speed of the film between these two points, the tape is caused to pass between the contacts 15 and 16 for the removal of the charge. As the tape 10 passes between the contacts 15 and 16 a difference of potential is imparted to the input electrodes including the grid 23 and the cathode 24 of the vacuum tube amplifying device 25. The input circuit includes the customary coupling condenser 26, input resistor 27 and biasing battery 28. The amplifying device 25 may represent one or more stages of amplification and the output of this amplifying device may be conducted to any suitable translating device such as, for example, a telephone receiver, a loud-speaker or a television receiving device. Due to the fact that both recording and reproducing stages are electrostatic rather than electromagnetic, the phase relation of the current in the output circuit is substantially the same as that of the current in the input circuit, thus materially limiting the distortion in certain types of signals as, for example, television or picture transmission signals wherein a non-uniform shift in time between signal components of different frequencies (caused by a constant angular shift) may introduce serious distortion.

A second embodiment of this invention, which may be considered as the preferred embodiment, is disclosed in Fig. 3. In the system shown in this figure, the secondary winding 21 of the transformer 19 is connected in circuit with the cathode 30 and the modulating element 31 of a cathode ray device 32. The cathode ray device 32 has means, such as the cathode 30 and an accelerating anode 33, for forming an electron beam and for accelerating it toward the end wall 34 of the tube. The end wall 34 has an aperture 35 therein which is covered with a thin strip 36 of aluminum thus forming in the end wall 34 a narrow aluminum window. Aligned with this window is a guide member 37 which is preferably connected through a source 38 to ground. This source thus applies as positive potential to the guide member 37 with respect to ground.

The tube 32 is preferably made in two portions; a glass portion 39 enclosing the electron gun apparatus and a copper portion 40 which is sealed to the glass portion 39 so as to make a composite tube. In the preparation of the seal between the glass tube 39 and the metallic tube 40, the copper tube 40 is drawn out into a sharp edge indicated at 41, the reduction preferably being tapered so that the taper extends from $\frac{3}{16}$ of an inch to $\frac{1}{4}$ of an inch backward from the end of the tube. A section of the tapered tube 39 is fitted inside the copper tube adjacent the reduced portion 41 of the copper tube, the copper tube being held in a suitable fixture. The copper and glass tubes at the point of contact are then heated above the melting point of the glass to fuse the two together in a tight joint. For a complete description of the method of sealing glass and copper tubes briefly described above, reference may be made to Patent 1,294,466, issued February 18, 1919, to W. G. Houskeeper.

Cathode 30 is heated by heating means such as the filament 42 supplied with current from a

source of potential 43. The first accelerating anode 33 is placed at a positive potential with respect to the cathode 30 by means of a source of direct current potential, such as the battery 44. The copper tube 40 serves as a second accelerating and focussing member and is positively biased with respect to the accelerating anode 33 by means of a suitable source of direct current potential, such as the battery 45. The tube 40 is preferably connected to ground.

Instead of making direct contact between the tape 10 and a reading element, when reproducing the signals, an inductive method of reading may be used. In this modification, the charged tape 10 runs past but does not touch the metallic element 46 which is shielded from all but a narrow area of the tape 10 by a shield 47 having a small aperture 48 therein which is just sufficient to accommodate the metallic member 46 without touching it. Connections from the shield 47 and the metallic element 46 are made through a coupling condenser 26 to the input circuit of the amplifying device 25, this input circuit being otherwise as described above with reference to the reproducing circuit shown in Fig. 1.

The operation of the electrostatic recording and reproducing system shown in Fig. 3 will now be described. An electron beam is generated by the cathode 30 and accelerated and focussed by means of the accelerating anode 33 and the copper tube 40 so that a narrow beam of high velocity is directed towards the aluminum window 36 in the tube 40. Due to the high velocity of the electron beam, charged particles pass through the aluminum window and apply charges to the moving tape 10 which are proportional to changes in the intensity of the incoming signal used to modulate the electron beam by means of the modulating element 31. The means to move and guide the tape in its path may be as described above with reference to Fig. 1. As the electrons in the beam are negatively charged, the aluminum window is at ground potential and the guide member 37 at a high positive potential, a charge is imparted to each of the successive elemental areas of the moving film 10 which is held on that particular elemental area by means of the high specific resistance and the high dielectric constant of the insulating material 11 comprising the film 10. The device is operative if the contact and guide member 37 and the battery 38 are not used. A certain predetermined time after the charge corresponding to a specific signal has been applied to the tape 10 this specific elemental charged area passes opposite the metallic reproducing element 46 inducing an electrostatic charge thereon. The potential differences between element 46 and the grounded shield 47 may be amplified by means of an amplifying device 25 which may comprise one or more stages as in the similar amplifying device shown in Fig. 1.

The recording and reproducing system shown and described in this application is particularly well suited for producing a signal time delay of short duration in, for example, systems of television, telephotography or telephony. By properly proportioning the amount of tape between the recording and reproducing element and the speed of the tape, the delay time may be controlled. The successive charges representative of the successive incoming signals, unless removed by a reproducing contact as in Fig. 1, remain on the tape for a relatively long period of time until they are removed either by wiping a metallic element, which may be grounded, across the

front surface, i. e., the insulated surface of the film 10, or by winding on the roll 18 in such manner that the charged surface comes in contact with the metallic coating of the adjacent layer in the roll, thus dissipating the charges. The invention however is obviously not limited to the uses just mentioned. The scope of the invention in its various aspects is indicated by the appended claims, the specific embodiments described above being merely illustrative of possible means for carrying out the invention as defined by the broader claims.

While there have been described two methods of electrostatic recording and reproducing, it is obvious that this invention is not limited to these specific means as other methods of electrostatic recording and reproducing are possible within the scope of this invention. For a description of different apparatus for electrostatic recording and reproducing, reference may be made to a copending application of R. R. Riesz and H. S. Wertz, Serial No. 145,442, filed May 29, 1937.

What is claimed is:

1. A recorder and reproducer of signals comprising a film of insulating material, a conducting backing for said film, means for generating electron beam, means for modulating said beam, means causing relative movement between said electron beam and said film for imparting a varying charge to successive portions of the surface of said film remote from said conducting backing, means for applying a polarizing voltage to said conducting backing, and means for utilizing said varying charge at a later time to control the production of signals.

2. Apparatus for reproducing signals from a recording member comprising a film of insulating material having a conducting backing therefor comprising a conducting member adjacent but not in contact with said film, a shielding member for said metallic member, means for causing relative movement between said film and said metallic and shielding members, an amplifying device comprising input and output circuits, means for connecting said shielding member and said metallic member to the input circuit of said amplifying device, and means for connecting the output circuit to a translating device.

3. In combination, a moving film of insulating material having a conducting backing therefor and having varying charges applied to successive portions of the surface of said film remote from said conducting backing, a metallic member, means producing relative movement between said metallic member and said film for inducing charges in said metallic member corresponding respectively to the charges on successive portions of said film, and means for shielding said metallic member from said film except for a small portion thereof adjacent said metallic member.

4. The combination with an electrical conductor, of a conducting shield member, means for supporting said conductor out of electric contact with said shield and with one end thereof extending through an aperture in said shield, a non-conducting element adapted to receive and retain electric charges, means for moving said element so that said charges pass consecutively adjacent to said end of said conductor, and an

electric circuit terminating in said conductor and said shield respectively which utilizes said charges to control the production of signals.

5. The combination with a strip of dielectric material, of means for spraying free electrons on different portions of a continuous surface of said strip in succession, said means including a cathode ray tube having a cathode and an accelerating anode member, a conducting element in fixed relation to said electron spraying means and so positioned that said strip is between said means and said element, and means for maintaining said element positively charged with respect to said anode member.

6. In combination, an element of insulating material, a conducting backing for said element, means under control of a variable electromotive force for imparting electric charges in succession to different portions of the surface of said element remote from said backing, said charges being of such character that they can be wiped off with a metal contact, means for applying a polarizing potential to said conducting backing, and means for utilizing these charges at a later time to control the production of signals.

7. In combination, an element of insulating material, a pair of metallic elements, means for causing said insulating element to pass between said pair of elements, means for positively biasing one of said metallic elements with respect to the other, means for applying a variable voltage between said pair of elements to impart electric charges in succession to different portions of said insulating element, said charges being of such character that they can be wiped off with a metal contact, and means for utilizing these charges at a later time to control the production of signals.

8. In combination, an element of insulating material, a pair of metallic elements, means for positively biasing one of said metallic elements with respect to the other, means for applying a varying source of potential between said metallic elements, means for causing said element of insulating material to pass between said metallic elements to have surface charges applied to said insulating material in accordance with signals applied between said metallic elements, a second pair of metallic elements, an external electric circuit connected between said second pair of elements, and means for passing said charged insulating element between said second pair of elements to energize said external circuit.

9. In combination, an element of insulating material, a cathode ray device for generating a beam of electrons and for accelerating and directing said beam upon successive portions of said insulating element, a guide member for said insulating element located on the opposite side of said element with respect to said cathode ray device, means for placing said guide member at a positive potential with respect to that of the accelerating means of said cathode ray device, means for modulating said beam so that electric charges varying in accordance with signals are imparted to successive portions of said insulating element in succession, and means for utilizing these charges at a later time to control the production of signals.