United States Patent

Marshall et al.

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[45] **Sept. 19, 1972**

[54] **ELECTROSTATIC RECORDER WITH RESILIENT CONDUCTIVE FABRIC BACKUP ELECTRODE**

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[52] **U.S. Cl.**.....**346/74 ES,** 101/DIG. 13, 346/74 E

[51] **Int. Cl.**.....**G03g 15/04**

[58] **Field of Search**....346/74 ES, 74 E; 101/DIG. 13

[56] **References Cited**

UNITED STATES PATENTS

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FOREIGN PATENTS OR APPLICATIONS

246,568	11/1969	U.S.S.R.	346/74 E

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[57] **ABSTRACT**

A matted nylon pile fuzz fabric is provided on a support plate for retaining the recording web in electrical engagement with the styli writing electrodes on a recording head. The fuzz fabric is conductive and functions as a backup electrode. The resilient nature of the fabric pile insures good mechanical and electrical contact with the recording web. The support plate and conductive fabric are located directly adjacent to the styli electrodes to minimize the portion of the recording web included in the charging path between each styli electrode and the backup electrode. The fuzz fabric is impregnated with silver and has a volume conductance of approximately one ohm centimeters. In another embodiment a silver impregnated nylon woven fabric was employed as the backup electrode. A soft sponge backing pad was placed behind the woven fabric to provide resilience. The sponge pad may also be employed with the fuzz fabric to provide increased resilience.

6 Claims, 5 Drawing Figures

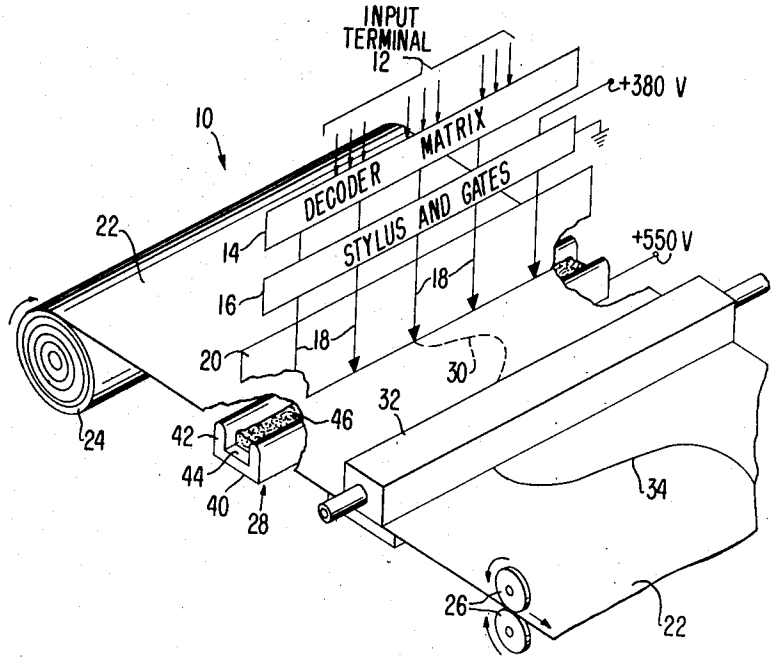
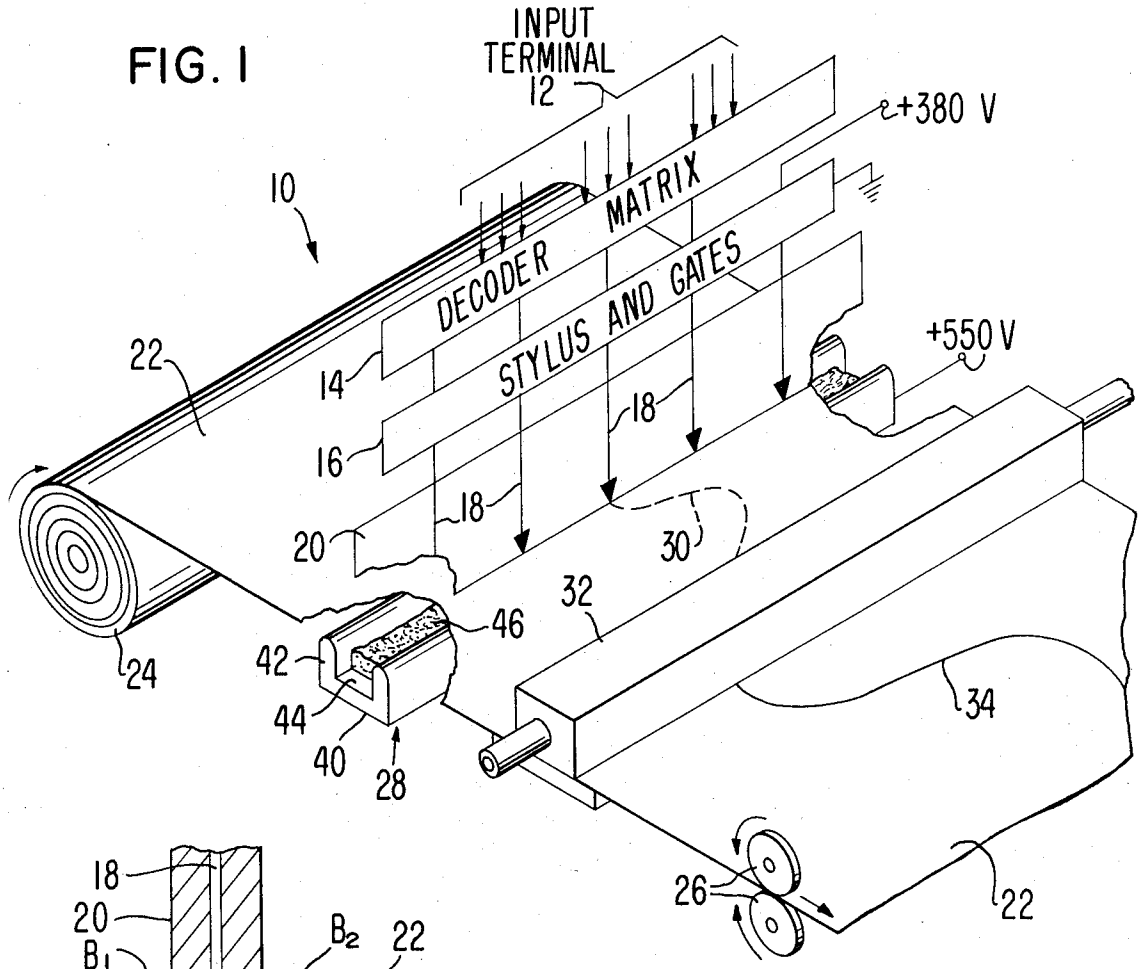


FIG. 1



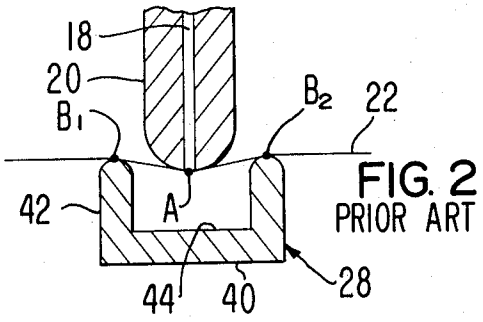


FIG. 2
PRIOR ART

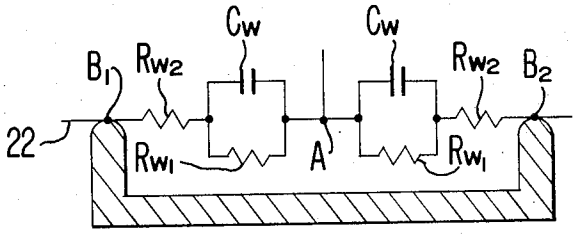
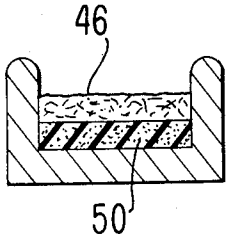


FIG. 3
PRIOR ART

FIG. 4



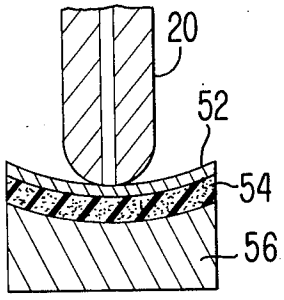


FIG. 5

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ELECTROSTATIC RECORDER WITH RESILIENT CONDUCTIVE FABRIC BACKUP ELECTRODE

FIELD OF THE INVENTION

This invention relates to electrostatic recorders and more particularly to an improved charging path between the styli electrodes and the backup electrode.

DESCRIPTION OF THE PRIOR ART

Heretofore, the recording web was held in hard contact with the recording head by means of a flat backup plate. These plates were frequently spring-biased to urge the web-styli contact. Small distortions, warps, and longitudinal misalignments between the plate and the recording head produced areas of high pressure. At these pressure areas the dielectric coating of the web tended to rub off interfering with recording and deteriorating the quality of the copy. Also, friction heat created by these pressure points tended to wear down the plastic body of the recording head in which the writing styli are embedded. Spacing adjustments to prevent these high pressures were particularly difficult in view of the variation in paper thickness between paper stock and non uniformities appearing in a single roll of paper.

The above mechanical difficulties were in part solved by the development of a U-shaped backup electrode. The sidewalls of this backup electrode formed a channel partly encompassing the recording head for guiding the web over the curved surface of the head as shown in FIG. 2. The direct or hard web-head contact was eliminated and replaced by a soft engagement produced by web tension. This U-shaped guide channel configuration introduced electrical problems. The sidewalls which guide the web also electrically contact the web conductive substrate. These channel sidewalls were necessarily somewhat spaced from the point of styli-web contact in order to perform the web-guiding function. Therefore, the charging path between the recording head and the channel backup electrode included two small lengths of increments of recording web, one increment between the head and each of the channel sidewalls. The distributed resistance and capacitance of the web increment in the charging circuit limited the speed at which web charge could be laid down by the recorder.

SUMMARY OF THE INVENTION

It is therefore an object of this invention: to provide an electrostatic recorder having a more effective web charging path; to provide an electrostatic recorder having minimal web resistance and capacitance in the charging path; to provide a faster electrostatic recorder which can effectively handle shorter charging pulses; to provide an electrostatic recorder with an improved backup electrode which permits increased mechanical tolerance between the recording head and the backup electrode, and to provide an electrostatic recorder having an improved backup electrode which permits unobstructed passage of non uniformities in the surface of the web and small particles of foreign matter which has settled on the web.

BRIEF DESCRIPTION OF THE DRAWINGS

Further objects and advantages of the fabric backup electrode and the operation thereof will become apparent from the following detailed description taken in conjunction with the drawing in which:

FIG. 1 is a schematic isometric view of an electrostatic recorder partly in section showing the conductive fuzz fabric backup electrode mounted in a channel support plate;

FIG. 2 is an end view of the prior art guide channel and recording head without the present fuzz fabric showing the recording web and the points of electric contact thereof which include an increment of the web in the charging path;

FIG. 3 is a schematic diagram of the equivalent circuit of the prior art structure of FIG. 2 showing the distributed resistance and capacitance of the recording web increment included in the charging paths;

FIG. 4 is an end view of the U-shaped channel showing a fuzz fabric-sponge pad modification of the FIG. 1; and

FIG. 5 is an end view of a cradle embodiment of the guide channel with a woven fabric-sponge pad embodiment of the backup electrode.

THE RECORDER SYSTEM

FIG. 1 schematically illustrates a recorder **10** having input terminals **12** which apply analog or digital input signals to a decoder matrix **14**. The decoded signals are then processed by stylus AND gates **16** which activate selected ones of a plurality of styli electrodes **18** mounted or embedded in a plastic recording head **20**. Particular modes of addressing and activating which may be employed here are more fully disclosed in U. S. Pat. No. 3,394,383 and U. S. Pat. No. 3,465,360. A recording medium or web **22** is shown proximate recording head **20** with an air gap therebetween. Web **22** has a charge retentive surface or coating (dielectric film) over a conductive substrate (paper backing). Web **22** is stored on a supply roll **24** and is moved past head **20** by a pair of opposed friction drive wheels **26**. Web **22** is urged into engagement with head **20** by a backup electrode assembly **28** more fully disclosed hereinafter. Backup electrode **28** is normally held at about 550 volts and each styli **18** is normally held at about 380 volts. This voltage difference of 170 volts (priming voltage) is insufficient to cause writing (charge transfer onto web **22**). When a particular styli **18** is selected by AND gate **16**, that styli voltage drops to ground potential. The 550 volts then appearing between the selected styli and backup assembly **28** (the writing potential) is sufficient to cause charging or writing on web **22**. The writing potential activates the selected styli causing avalanche discharge in the normally non conductive fluid in the gap which is typically ordinarily air. Other suitable fluids may be employed. The writing or charging path is from ground, through the AND gate and the selected styli, across the avalanche discharge in the gap, through web **22** and backup assembly **28**, and returns to ground via a 550 volts source not shown. Charge accumulates on the charge retentive surface of web **22** proximate the selected styli. The selective activation of styli **18** in conjunction with the motion of web **22** creates a charge image **30** on web **22** which is developed by toning channel **32** to form a visible image **34**. The toning or developing process is more fully disclosed in U.S. Pat. No. 3,392,706. Other addressing, activating, driving and toning techniques may be employed. The above discussed techniques and apparatus are intended to be illustrative only.

THE IMPROVED BACKUP ELECTRODE

Backup electrode assembly **28** is preferably formed by a conductive U-shaped channel **40** having sidewalls **42** and base **44**. A conductive fuzz fabric **46** is mounted inside channel **40** on base **44**. Channel **40** is mounted proximate to and partially surrounding head **20** so that sidewalls **42** may guide web **22** around the curve surface of head **20**, and permit fabric fuzz **46** to lightly urge web **22** into engagement against head **20**. The resilient characteristic of fabric fuzz **46** causes the gentle mechanical engagement of web **22** between fuzz **46** and recording heads **20**. This engagement establishes electrical contact between styli electrodes **18** and the dielectric surface of web **22** and also between fabric fuzz **46** and the conductive backing of web **22**.

The preferred fuzz fabric is silver impregnated nylon having myrids of soft loops or piles extending from a fabric-like base. The piles have good recovery characteristics and provide the resilience required for mechanical and electrical engagements. The matted nature of the pile prevents abrasion or scratching of the web conducting backing as would prevail from using conventional stiff brushes commonly used as commutators. Additionally, the present matted fabric permits changes in the direction of web movement, whereas the commutator brush would puncture or tear the web. The fabric base portion permits the fuzz fabric to be cut, prepunctured, or even sewn for easy shaping and mounting. It is preferred that the fuzz fabric be mounted with conductive epoxies; however, double-sided tape or adhesive on the conductive backing may be employed. The raised piles may be made of an artificial or synthetic resin or plastic material which gives the piles the desired matted configuration and retention characteristic. Nylon, which is a generic term for any long chain synthetic polymeric amide which has recurring amide groups as an integral part of the main polymer chain, and which is capable of being formed into filaments, is recommended. Of course, the fuzz fabric may be impregnated with other conductors. Silver and other noble metals are preferred because of their anti corrosive properties.

The width and thickness of the fuzz fabric is not critical. However, mounting of the fuzz fabric is expedited if its width dimension is the same as the width of support channel **40**. The width dimension permits limited longitudinal misalignment and warping between recording head **20** and support channel **40** along their elongated dimension. The resiliency and thickness of the fuzz fabric permits foreign matter, such as paper slitter debris particles which have settled on the web, to pass the recording head without accumulating thereon. The fuzz fabric shows no tendency to wear or lose its resilient characteristic or conductive property even after extended service. This longevity would seem to be due to the low coefficient of sliding friction of the fuzz fabric.

FIG. **2** illustrates the charging path between head **20** and channel support **40** without the present fuzz fabric. In this prior art structure, a longitudinal portion or increment of web **22** is included in the charging path. Head **20** contacts web **22** at point A, and sidewalls **42** of channel support **40** contacts web **22** at point B_1 and B_2. The increments of web **22** included between A and B_1 and between A and B_2 form parallel branches in the charging path between head **20** and support channel **40**. This included increment of web **22** has a distributive capacitance (C_w) and a distributive resistance (R_{w1} and R_{w2}) which are shown schematically in the FIG. **3** schematic circuit of the prior art charging path. C_w, R_{w1} and R_{w2} include the capacitance and resistance of both the dielectric surface coating and the conductive backing of web **22**. These parameters are small, but they inhibit the web-charging process and limit the speed of recorder **10**. At the present operating speeds, each selected styli **18** must be activated (avalanche discharge initiated) in about 3 microseconds and the proximate region of web **22** must be charged in approximately 40 microseconds. Increasing the writing potential overcomes to a certain extent this charging path impedance, but limits exist in the voltage handling capacity of AND gate **16** and head insulation between adjacent styli **18**. This small increment of web **22** is eliminated from the charging path by employing fuzz fabric backup electrode **46**. Fuzz fabric **46** electrically contacts web **22** at the web-stylus contact point directly beneath the styli. The length of web **22** which is included in the charging path is minimized, including only the thickness of web **22**. This reduction in charging path impedance increases the amount of charge that may be deposited upon the web in the time and voltage allowed. With the increments in the charging path as shown in FIG. **3**, 100 microseconds were required to deposit the same charge as the present invention deposits in only 40 microseconds.

PRESSURE PAD MODIFICATION

Referring to FIG. **4**, channel **40** is shown having a sponge pressure pad **50** under the fuzz fabric **46**. The softness or lower resilience of pad **50** permits a greater displacement of the fuzz fabric and increases the misalignment tolerance between recording head **20** and channel **40**. Further, the presence of sponge pad **50** contributes to the total thickness of resilient material in channel **40** which enhances the ability of channel **40** which enhances the ability of channel **40** to pass foreign particles on the web. Pad **50** may be any suitably flexible resilient substance such as dacron felt or any low durometer elastomer. Polyurethane foam is preferred.

CLOTH FABRIC EMBODIMENT

FIG. **5** shows a nylon cloth **52** impregnated with a suitable conductive material such as silver, employed in place of fuzz fabric **40** of FIG. **1**. Preferably, a suitable pressure pad **54** is provided in a support cradle **56** underneath the cloth fabric **52** to increase the resiliency of the fabric backup electrode. The cloth fabric has a conductivity of about 1 ohms centimeter. Sponge pad **54** may be suitable resilient substance such as the material employed in the FIG. **4** fabric fuzz sponge embodiment. Other conductive low friction resilient substances may be employed as the backup electrode. The mounted fuzz fabric or woven cloth fabric are preferred because they permit easy reversal of recording web motion. A bristle type substance which is suitable in other respects may resist change in the recording web direction by puncturing or scratching the conductive substrate of web **22**.

CONCLUSION

It will be apparent to those skilled in the art that the objects of this invention have been accomplished by providing an improved backup electrode employing a

conductive resilient low friction fabric. The charging path impedance has been minimized by contacting the web immediately adjacent the recording head. The improved charging path traverses the web in a substantially perpendicular fashion so as to minimize the portions of the web included in the charging path. The selected styli may now deposit a greater charge on the recording web with the same writing potential in the brief time permitted. The resiliency of the electrode fabric reduces the alignment requirement between the recording head and the support channel. These members are no longer required to be strictly parallel along their longitudinal dimensions. This resiliency also permits increased passage of foreign particles in non uniform areas of the recording web through the constriction between the recording head and the electrode fabric.

Clearly, changes may be made in the structure and in the embodiments shown herein without departing from the concept of the present invention. For example, the cradle configuration of FIG. 5 may replace the U-shaped channel of FIGS. 1 and 4. Further features and advantages of each modification may be employed with other modifications.

WHAT IS CLAIMED IS:

1. In an electrostatic recorder responsive to input signals for forming a surface charge image on a recording medium having a charge retentive coating and a conductive base, the combination comprising:

recording head means having a plurality of styli electrodes;

a conductive resilient fabric base backup electrode with extending looped piles mounted directly adjacent to the plurality of styli electrodes, the looped piles having a relatively low coefficient of friction and good recovery characteristics to permit easy passage of the recording medium while the recording medium is engaged between the recording head means and the looped piles of the backup electrode;

rigid means for mounting the backup electrode;

means for urging the rigid means and the recording head means together with the recording medium engaged therebetween with the backup electrode conductive looped piles in electrical contact with the conductive base to establish a charging path from the plurality of styli electrodes through the recording medium to the backup electrode, the charging path traversing the recording medium substantially perpendicularly for including a minimum of the recording medium in the charging path;

means for moving the recording medium past the recording head while the recording medium is electrically engaged between the plurality of styli electrodes and the backup electrode;

means for receiving and processing the input signals for addressing and activating selected styli to cause charging current to flow through the charging path which in conjunction with the moving recording medium creates a surface charge image on the charge retentive coating of the recording medium.

2. The electrostatic recorder of claim 1 wherein the styli electrodes are arranged in an elongated array, and the fabric backup electrode is sufficiently wide and thick to permit limited misalignments along the longitudinal axis.

3. The electrostatic recorder of claim 1 wherein a resilient pressure pad is provided between the fabric base and the rigid mounting means to increase the effective resilience of the backup electrode means.

4. The electrostatic recorder of claim 1, wherein the rigid mounting means is a U-shaped channel with the backup electrode mounted in the trough portion thereof.

5. The electrostatic recorder of claim 1 wherein the backup electrode fabric base is formed by a woven fabric material impregnated with a conductive substance.

6. The electrostatic recorder of claim 5 wherein the woven fabric base is organic.

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