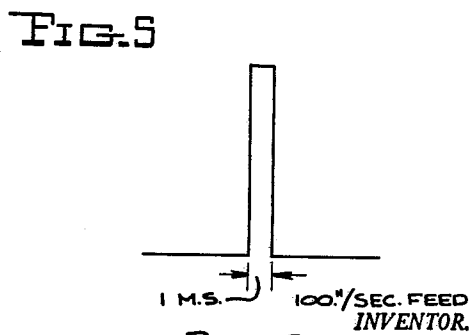
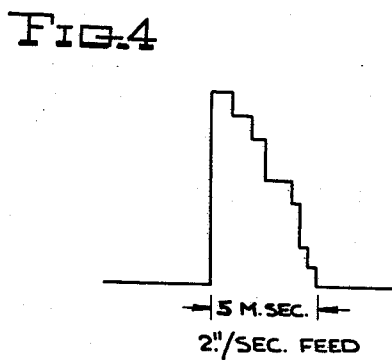
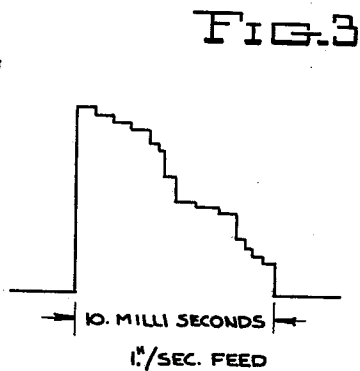
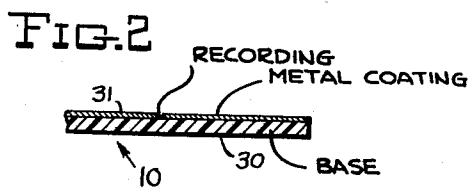
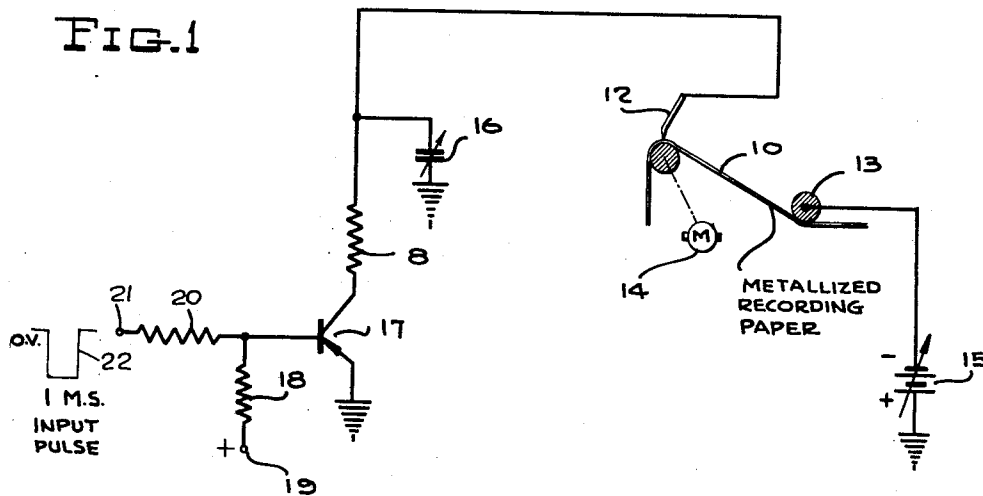


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P. CONERLY
SPARK BURNING RECORDER
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3,074,066



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3,074,066

SPARK BURNING RECORDER

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The present invention relates generally to recording systems, and more particularly to systems for recording on electrosensitive paper such that a mark of predetermined physical length is generated in response to a short writing pulse of predetermined duration, regardless of paper feed speed.

For high speed multi-stylus recording, some conventional types of recording paper are found to have undesirable characteristics. The papers referred to are those which are continuously conductive, such as Teledeltos. For the latter recording paper dots of about .007" in diameter are minimum, for easy visibility. About 1 millijoule of energy is required to make a satisfactory mark of .01" D. In order to operate at high pulse repetition rates narrow pulse widths are required, i.e., of about 50 μ s. The writing circuit provides an open circuit voltage of about 400 v., and when loaded by the recording paper about 225 v. Stylus pulse current is about 50 ma. At high repetition rates power requirements for writing then become impractical, if many styli are required to write simultaneously. Stylus life is short because of the intense heating which occurs at high repetition rates and because of the collection of carbon which occurs at the styli. At 15 kc. repetition rate and at low paper speed, the styli glow red.

As paper speed is lowered and repetition rate increased, overlapping dots are produced. Impedance of Teledeltos paper when writing with non-overlapping dots is about 4.5K. When overlapping occurs impedance decreases to about 3K. This causes increased stylus current, which causes more burning and collection of carbon. No economical means of limiting these effects has been found.

In the practice of the present invention, recording paper is employed which is metallized, i.e., has a thin metallic coating. It is found that 20 v. D.C. at 1 ma. applied to this paper produces readily visible lines. In operation, styli are placed in contact with the metallic coating, and a heavy common roller electrode to the paper and from the paper to the styli, to effect writing. Current density at the styli is sufficiently great to effect removal of the metallic layer under the styli, but current density at the common electrode is low, and therefore generates no physical effects. The system accordingly writes by removing or fusing the metallic coating under the styli, and on such removal the paper becomes non-conductive where the coating has been removed. The low writing voltage required suggests the possibility of employing transistors in the system.

In accordance with the present invention, a source of D.C. voltage is connected in series with the common electrode and each stylus, and with a condenser. A circuit is provided for discharging the condenser at will. When the condenser is discharged, and such discharge may occur practically instantaneously in response to a short switching pulse, recharge of the condenser occurs via the recording paper. Each increment of charge removes a small bit of metallic coating, as the increment of charge proceeds to the condenser, and, accordingly, a predetermined amount of metal, and hence length of coating, is removed in response to each process of charging the condenser, regardless of the speed at which the paper is moving with respect to the stylus, within practical limits.

The total length of recorded mark per writing pulse can readily be controlled, either by varying the capacitance of the condenser, or the value of the D.C. source, or

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both. The discharge of the condenser may be effected by means of a transistor switch, in response to a very short control pulse, and each control pulse provides a mark of predetermined physical length for a wide range of recording paper feed speeds.

It is, accordingly, a broad object of the present invention to provide a system of electrical recording in which recorded marks of predetermined lengths are generated in response to each of a series of writing impulses, regardless of record paper feed speed.

It is another object of the invention to provide a system for electrically recording on metallized recording paper by means of a stylus, by removing metal from the paper in metered quantity in response to each of a series of writing pulses applied to the stylus, whereby the record made in response to each pulse is of approximately the same length regardless of the speed of the paper with respect to the stylus.

The above and still further objects, features and advantages of the present invention will become apparent upon consideration of the following detailed description of one specific embodiment thereof, especially when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a schematic circuit diagram of a system according to the invention, as applied to a single stylus of a multi-stylus system;

FIGURE 2 is a view in cross-section of recording paper utilized in the system of FIGURE 1; and

FIGURES 3, 4 and 5 are plots of stylus voltage as a function of paper speed, for the system of FIGURE 1.

Referring now more particularly to the accompanying drawings, the reference numeral 10 denotes a sheet of recording paper of the type having a metallic coating on a backing sheet of insulating material. The metal employed is of a type and the coating thickness is such that passage of electric current of sufficient density through a small area of the coating results in removal of the coating. One suitable type of recording paper is that sold commercially as Rohde and Schwarz Registrierpapier DP40071, made in Munich, Germany, which has been found to require 20 v. D.C. at 1 ma. to generate a readily visible line. However, the principles of the invention are applicable to a variety of metal coated recording papers or record receivers known to the art, and I do not therefore desire to be restricted to any specific paper. The paper 10 is driven by means of a stylus pressure roller 11, which is located under the paper 10, above the pressure roller 11. A contact roller 13 contacts the metal coated surface of the paper 10. The contact roller 13 is not driven, and is electrically conductive. The pressure roller 11 is driven by a variable speed drive, such as an electric motor 14, and is non-conductive. The drive 14 provides for a wide range of paper feed speeds, say over an exemplary range of 1" per second to 100" per second.

For one specific paper, Rohde and Schwarz Registrierpapier OP40071, a recording voltage of 20 v. D.C. and a recording current of 1 ma. was found to provide a satisfactory recording. Minimum recording voltage was found to be about 12 v., and for excessive voltage, say above 30 v., spattered marks were produced, i.e., the marks did not conform to the cross-sectional shape of the stylus.

A source of D.C. voltage 15 is provided, which is illustrated as a battery, having its positive terminal grounded and its negative terminal connected to contact roller 13. The source 15 may be adjustable over a range 0-35 v.

The exemplary stylus 12 is connected to one side of a variable capacitor 16, of about 1 μ f. capacitance, the other side of which is grounded. A PNP transistor 17 is provided, the emitter of which is grounded and the collector of which is connected via current limiting resistance

18 to the one side of capacitor 16, and thus directly to stylus 12.

The base of transistor 17 is connected via a 10K resistance 8 to a +10 v. bias terminal 19, which exceeds cut-off bias for the transistor 17, and via a further relatively small current limiting resistance 20 to a signal input terminal 21. To the terminal 21 are applied writing control pulses in the form of negatively going square pulses, having a reference value of 0 volt.

It will be appreciated by those skilled in the art that various types of switching devices may be employed in place of the transistor 17, and that polarity of voltage source 15, and of the writing pulse 22 may be reversed, or otherwise modified, as required by the switching circuitry involved.

In operation, the pulses 22 may be about 1 millisecond in duration, and pulse repetition rates of up to 10 kc. may be employed. However, the principles of the invention do not require specific pulse rates, or durations. Essentially, the writing control pulses 22 are required to discharge the condenser 16 substantially instantaneously, and need be only sufficiently long to accomplish such discharge. The time between pulses need be only great enough to permit recording of a dot in response to a writing control pulse.

In accordance with the invention, the condenser 16 operates as a metering device, permitting a predetermined charge to flow through stylus 12 in response to each writing control pulse 22, regardless of the speed of feeding the paper speed, and experiment has demonstrated that dots of approximately 0.01" D. are generated at 1"/sec. paper speed, and lines of 0.1" long and 0.01" wide at 100"/sec. paper speed. Average current requirements are maximum at high repetition rates and high paper speeds, so that at 100"/sec. and 10 kc. a solid line can be written with an average current of about 55 ma., contrasting with a requirement for Teledeltos paper of 500 ma. At the same time the stylus runs cool, and carbon collection is nil.

Referring to FIGURE 2 of the drawings, there is illustrated, in cross-section, the paper 10, having a base of insulating material 30 and a coating 31 of metal. Suitable coatings are described in the art, and are known commercially, and have been more specifically identified hereinabove.

FIGURES 3-5 of the accompanying drawings disclose wave shapes occurring in the practice of the invention. In response to a 1.0 millisecond pulse of switching current 22 applied to the transistor 17, stylus voltage for paper speeds of 1"/sec., 2"/sec., and 100"/sec. are illustrated in plots 3, 4 and 5, respectively. It will then appear that for the slowest paper speed stylus voltage increases negatively in increments, or in ragged fashion, as the metallic coating 31 is removed. On initiation of current flow at the transistor, the voltage of the condenser, which is the same as stylus voltage, decreases rapidly to 0 volt. Thereafter, the condenser commences to charge via the recording paper, and acquires an approximately full charge in about 10 milliseconds. The record is then 0.1" long, or about 10 times as long as the writing or switching pulse. For a 2"/sec. speed the charge time is about 5 milliseconds, since it requires half as long a time for a given length of paper to pass under the stylus at the doubled paper speed, and therefore a given quantity of coating is removed in half the time at 2" speed, compared with 1" speed. At 100"/sec. paper feed speed the charge of the condenser is 1 millisecond, which is the length of the writing pulse applied to the transistor 17.

So long as the transistor 17 is conductive the stylus 12 remains at essentially ground potential and stylus current flows. After the transistor 17 has become non-conductive stylus current serves to charge condenser 16, and can continue only until the voltage on the condenser attains near equality with the voltage battery 15. At this point stylus current ceases. Before this point is attained, how-

ever, stylus voltage is reduced sufficiently that recording ceases.

The recording paper itself acts as a renewable fuse in the condenser charging circuit, for so long as the voltage at the stylus remains sufficiently high to fuse the metallic coating of the recording paper, the fuse renewing itself by virtue of the feed of the paper. The capacitor 16 thus acts as a pulse lengthener or current metering device, to assure that a given amount of metallic coating will be removed in response to each writing pulse applied to transistor 17, regardless of the speed of paper feed, within practical limits of operation. In terms of duration of recording, in response to a single writing pulse applied to the system the minimum time of recording equals the time of a writing pulse, which occurs at high paper feed speeds. As paper feed speeds decrease, the durations of recordings increase in approximately inverse ratio.

While I have described and illustrated one specific embodiment of my invention, it will be clear that variations of the details of construction which are specifically illustrated and described may be resorted to without departing from the true spirit and scope of the invention as defined in the appended claims.

What I claim is:

1. A system for recording on electro-sensitive recording paper by means of a stylus in contact therewith, said paper having the characteristic of being normally conductive and becoming non-conductive at the area of contact by said stylus in response to current flow through said stylus, comprising a source of voltage, a condenser, means connecting said source of voltage to said condenser via said stylus, and means for at will discharging said condenser via a circuit in parallel with said source of voltage and said stylus.

2. The combination according to claim 1 wherein said recording paper is metal coated recording paper and wherein recording occurs by removal of the metal coating in response to current flow through said stylus.

3. The combination according to claim 2 wherein is provided means for feeding said recording paper with respect to said stylus at a wide range of velocities.

4. The combination according to claim 3 wherein said means for at will discharging said condenser is a transistor switch circuit connected in shunt to said condenser.

5. In a recorder having a stylus in contact with an electrically conducting recording medium, a capacity, a source of voltage, means connecting said capacity and said source of voltage in a series charging circuit including said stylus and said recording medium, and a normally open circuited discharge circuit for at will discharging said capacity, said discharge circuit being in parallel with said charging circuit across said capacity.

6. The combination according to claim 5 wherein said discharge circuit consists essentially of a switch.

7. In combination, a capacitive unit, having a first and a second terminal, a normally open switching circuit connected between said first and second terminals, a recording circuit connected between said first and second terminals in parallel with said switching circuit, said recording circuit including an electrically conductive recording medium and a source of voltage.

8. The combination according to claim 7, wherein said recording medium is of a type which becomes non-conductive in response to passage of current therethrough.

9. A system for recording on an electro-sensitive recording medium by means of a stylus in contact therewith, said medium being normally conductive and becoming non-conductive adjacent an elemental area contact with said stylus in response to current flow between said stylus and said medium, a capacitor, a charging circuit connected across said capacitor including a source of voltage connected between said stylus and said medium, whereby charging current to said capacitor flows between said stylus and said medium, and means for at will discharging said capacitor, said last means being a switching circuit

connected in parallel with said capacitor and said charging circuit.

10. The combination according to claim 9 wherein said stylus and recording medium possess relatively high resistance, said resistance being sufficient to prevent full charge of said capacitor through said elemental area of said recording medium. 5

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