Oct. 25, 1949. W. H. TRIBBLE 2,485,678

FACSIMILE RECORDER

Filed Aug. 21, 1947 2 Sheets-Sheet 1

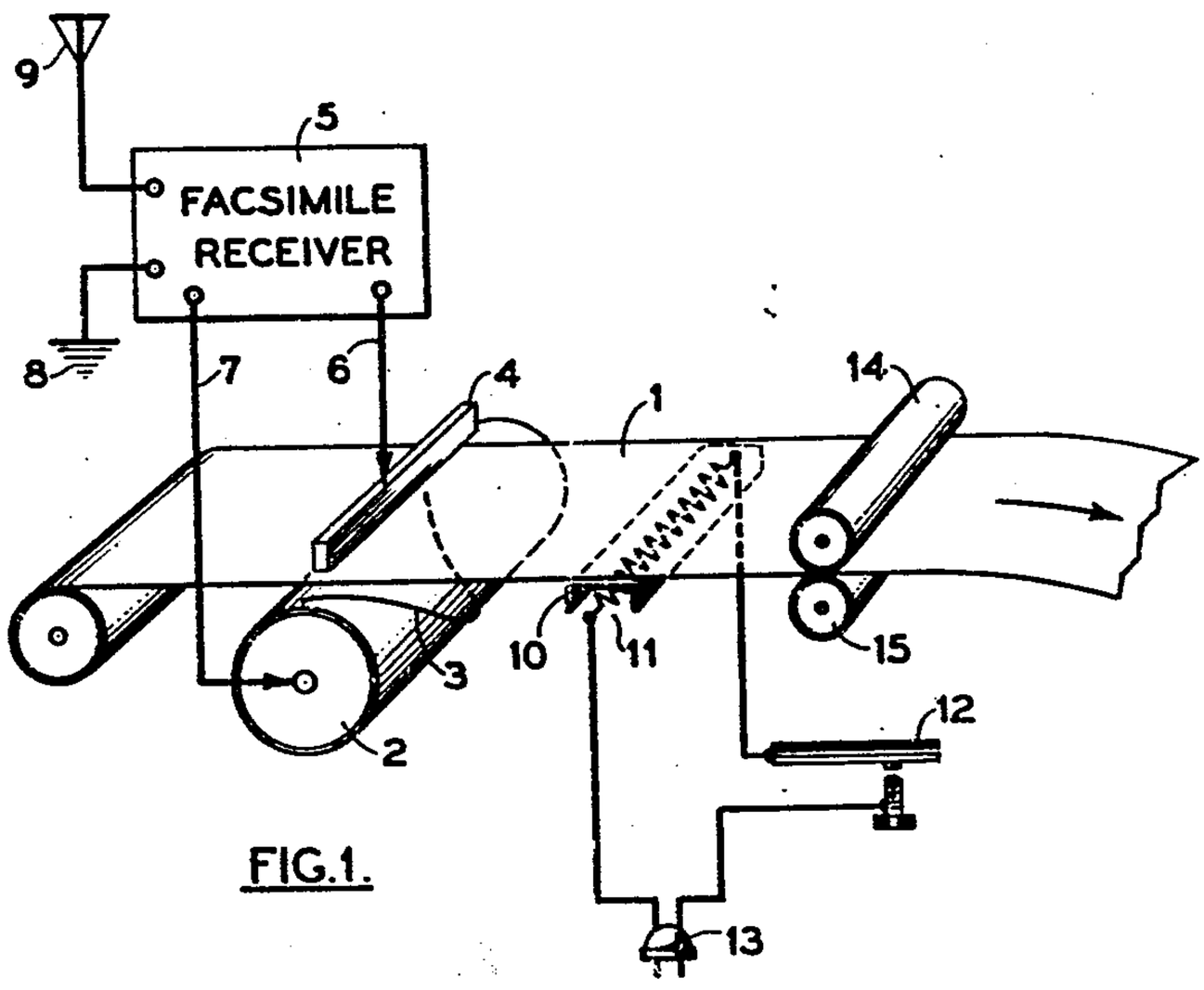

FIG.1.

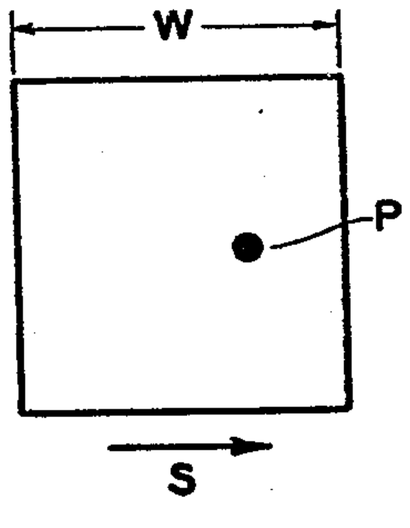

FIG.2.

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FACSIMILE RECORDER

Filed Aug. 21, 1947 2 Sheets-Sheet 2

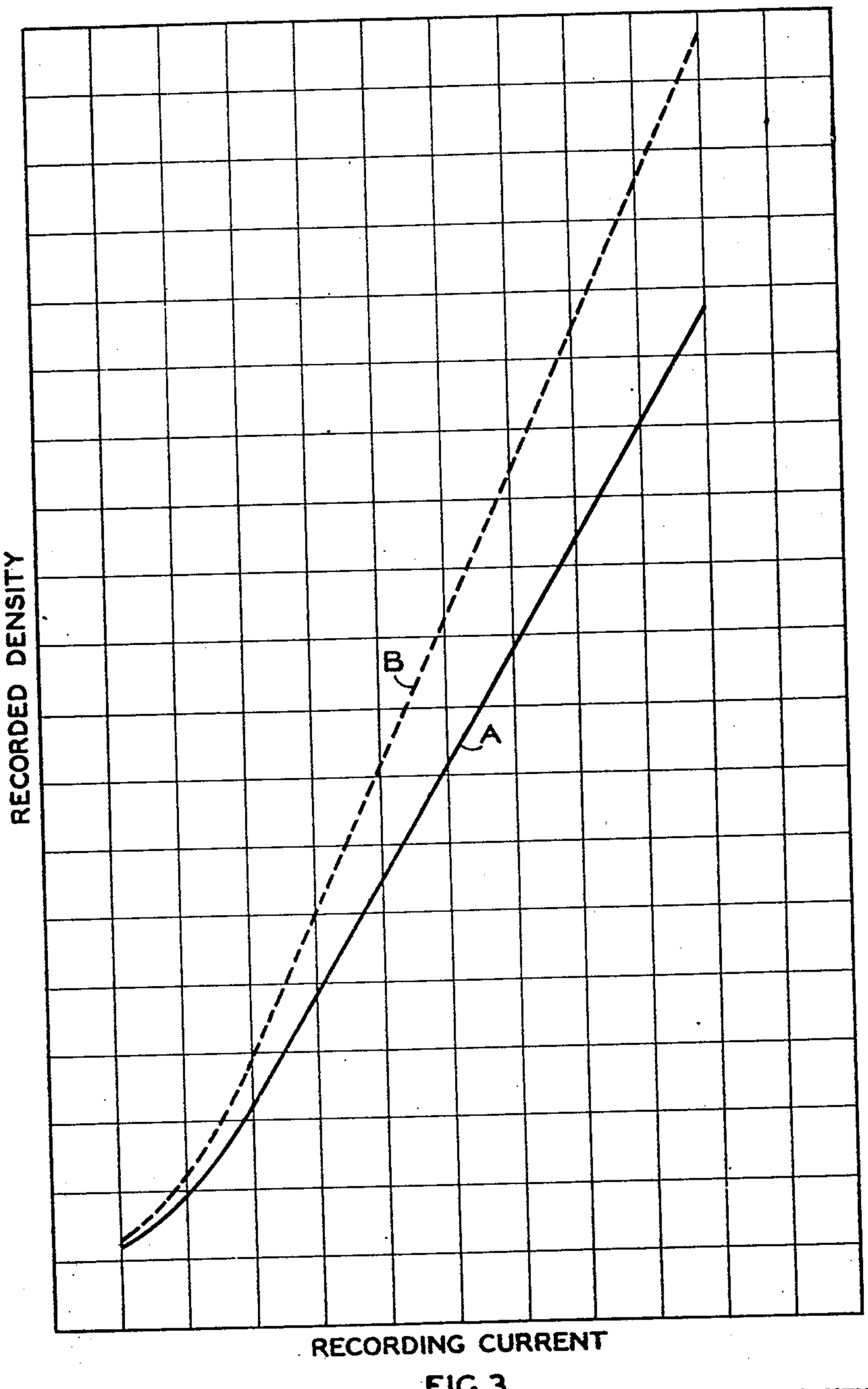

FIG.3.

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UNITED STATES PATENT OFFICE

2,485,678

FACSIMILE RECORDER

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Application August 21, 1947, Serial No. 769,808

3 Claims. (Cl. 346—1)

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This invention pertains to electrolytic facsimile devices and more particularly to a facsimile recording device which employs electrolytic paper.

This application is a continuation in part of application, Serial Number 694,014, now abandoned, filed August 30, 1946, by William H. Tribble, and entitled "Recorder heater." That application described the construction and method of use of a heater in facsimile recording systems for improving the quality of the recording.

In the application referred to above, it was stated that, during the process of high speed recording with color lake-forming materials, electrolytic recording action may not be completed during the short interval of the marking spot contact with the paper. It was further stated that the definition and resolution of the recorded copy as produced in a facsimile recorder could be improved by the use of a temperature controlled heating device. It was stated that, by such a device, it was possible to artificially and automatically complete the chemical marking reaction, in order to control the tone and obtain the maximum density of mark.

The art of facsimile recording includes the steps of utilizing a modulated signal to reproduce point by point and line by line the varying densities of an original picture, text, or other graphic material. One of the ways in which this may be accomplished is by drawing an electrically sensitive sheet or carrier across a rotating helical electrode and under an intersecting metallic linear electrode. The intersection of the electrodes forms a scanning area which moves across the paper from side to side while a steady forward motion of the paper completes the scanning operation. The required markings of variable density are produced by passing the facsimile signals of proper intensity between the linear and helical electrodes through the electrolytic recording sheet. The process of recording is electrolytic in action and the density and intensity of the marks produced, among other things, depend upon the chemical reactions that take place within the recording sheet during the passage of the recording current. In order to facilitate the electrolytic action in the recording sheet the sheet must be moist at the time of recording.

In the application referred to above the use of a recorder heater to complete this recording process was described. With the addition of the recorder heater the moist electrolytic recording sheet, carrying the recorded marks, travels from the marking electrodes to the recorder heater and

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is dried by the high temperature of the heater. In the above mentioned application the further use of the recorder heater as a means for artificially and automatically completing the electrolytic marking reaction was described. It is the purpose of the present continuation in part to set forth more fully the method by which this completion of the electrolytic marking reaction is brought about.

It is, therefore, one of the objects of the present invention to provide, in electrolytic facsimile recorder equipment, a method of and means for artificially and quickly completing the chemical marking reaction in order to obtain maximum tone density.

Another object of the present invention is to provide an artificial heating means so that even distribution of the heat may be applied to the recording sheet to complete the recording process, and to provide means for adjusting and automatically controlling the amount of heat applied.

A further object of the present invention is to provide a method of and means for heating which, when applied to the electrolytic recording sheet after recording, will automatically complete the recording process.

A still further object of the present invention is to provide an artificial heating means which, when applied to the electrolytic recording sheet after recording, will produce a chemical change in the markings on the recording sheet to increase their tone density.

A still further object of the present invention is to provide a heating means for artificially completing the marking reaction, which heating means will be thermostatically controlled in a manner to bring about maximum tone density.

It is a still further object of the present invention to provide a thermostatically controlled heating means for completing the marking reaction, which means will operate within certain temperature limits.

A particular object is to provide a method of and means for completing the chemical reaction to increase density and improve the tone scale in a recording made by means of color lake formation through electrolytic reaction.

Other and further objects will become apparent from a study of the present disclosure, and it is to be understood that the present description is by way of illustration only and not to be limited except by the scope of the sub-joined claims.

The use of the heater described above has special significance when used in conjunction with electrolytic recording papers of the types de-

scribed in U. S. Patent Number 2,358,839 entitled "Electrolytic recording" and issued on September 26, 1944 to Edgar R. Wagner, or with the recording paper described in U. S. Patent Number 2,339,267 also entitled "Electrolytic recording," and issued on January 18, 1944 to John V. L. Hogan, Hugh C. Ressler and William H. Tribble. In general, these recording papers employ a parchment or other high wet-strength type of paper as the carrier, an electrolyte, a lake-forming polyhydrophenolic compound such as catechol, and water. To these basic elements may be added small amounts of oxalic or maleic acid, or certain other acids, anti-oxidants and charge neutralizers to form the chemical composition of the respective sensitized papers. During the process of marking or recording upon such paper a minute quantity of the iron, or other lake-forming compound of the linear electrode, is dissolved by the electrolytic action of the recording current. This dissolved metal reacts with the lake-forming compound to form a color lake. The acids used would ordinarily dissolve the lake but, because of the neutralization at the point of marking, by the hydroxyl ions formed, the lake is allowed to form while unneutralized acid prevents it from spreading. It has been found that, during the marking or recording process, apparently the following reactions take place. The lake-forming metal forming the linear electrode, which is the anode, goes into solution. In certain cases, where the lake-forming metal is capable of existing in more than one valence state, it goes into solution in two or more valence states and generally as a combination of valence states, depending upon a number of factors. The most important of these factors are the current and voltage used for recording, the speed of recording, and the reducing or oxidizing action of the compounds in the solution. The voltage and current used are important because it is well known in practice that the greater the current the greater the oxidation. The speed of recording is important because it determines the time of flow of the current through any point on the recording sheet and at high speeds, therefore, tends to counteract or limit the oxidizing effect of the current used. The presence of oxidizing or reducing agents in the solution has a further effect on the valence of the ions present. Catechol, for example, is a strong reducing agent and reduces the metal from the higher to the lower valence under certain conditions. Thus, it is seen that a number of factors determine whether low valence or high valence metal will be produced, and no one factor is entirely controlling. It is sufficient to say that, usually, some proportion of low valence ions is produced and remains in the paper.

With some of the multi-valent metals usually regarded as lake-forming it is found that a lower valence form does not act as a lake-forming metal but that a higher valence form shows the usual lake-forming properties and forms a color lake with catechol or other lake-forming compounds. In the process described above, therefore, a state of equilibrium is reached in which some of the metal assumes the higher valence state, reacts with the catechol, and forms the marking, the remainder of the metal remaining in the lower valence state. Thus, it is seen that the normal efficiency for any operating speed of the recording system is lowered by the reducing action of the catechol or other lake-forming material and the inability of some of the metal to react to form a colored marking compound. Because of this

process the density of the marking is reduced and the amount of dissolved metal needed to obtain adequate marking increased. It has been found that the number of lower valence ions compared to higher valence ions present in the paper, immediately after recording, becomes greater as the speed of recording is increased. Therefore, the higher the speed of recording the less efficient is the recording process and the greater the power required to overcome the increasing inefficiency. However, the electrical power through the paper cannot be increased indefinitely without damaging the paper if the contact area is very small and the speed is high.

As has been stated above, the heater of the present invention is particularly useful in quickly completing the chemical reaction by counteracting the effect of the production of the lower valence ions during the process of recording and changing the lower valence ions to higher valence ions, allowing the latter to react with the catechol present to increase the density of the recorded marks. The same effect could conceivably occur in the atmosphere over a very long period of time but would not be useful because of the time element. It is necessary that the recording be quickly completed. In the recording system described, the recording paper travels between recording electrodes at high speeds, allowing the recording to be made at their point of intersection and then proceeds to travel over the heater bar. After leaving the electrodes, markings of an intermediate density appear on the wet recording sheet and remain in that condition until they pass over the recorder heater element. Upon reaching the recorder heater element the moisture is driven out of the recording sheet. During the initial process of drying the paper in this manner the temperature does not become sufficiently high to cause an appreciable oxidation of the lower valence ions to the higher valence state and, therefore, little change in marking density is noted. Upon the elimination of the moisture the temperature of the recorder heater causes the temperature of the dry portion of the sheet to rise to a temperature sufficient to cause appreciable oxidation of the lower valence ions to higher valence ions, which in turn immediately react with the catechol to increase the density of marking. The temperature at which this oxidation of the lower valence ions takes place is somewhat above the boiling point of water. If the speed of recording is high the short time during which this reaction must take place will raise the minimum temperature required. Excessive temperatures, however, may result in undesired chemical reactions between the chemicals within the paper or even charring of the paper. This upper temperature limit may vary with the lake-forming compound used. It has been found with recording papers containing the above mentioned ingredients that the temperatures of the order of 250 to 450 degrees Fahrenheit may be used to bring about the completion of the chemical reaction to produce maximum density of marking as described above.

While not intending to limit the scope of this disclosure it has been found that the lake-forming metals, iron, vanadium and cerium, when used in the linear electrode, operate particularly well according to the present description. These are multi-valent lake-forming metals, which in their lower valence state will form little or no color lake, but in their highest valences readily react with the lake-forming compound to form dark

colored color lakes. As an example, iron is deposited in the paper as ferrous iron and is oxidized to ferric iron, which is best adapted for marking the paper, by the use of temperatures higher than those required for drying the paper.

In the drawings:

Fig. 1 shows a simplified diagram illustrating one mode of operation of a fascimile recorder according to the present invention.

Fig. 2 illustrates a recording area and point useful in explaining the operation of the invention.

Fig. 3 shows a typical curve of density vs. recording current compared with a curve in which heat has been applied to complete the chemical reaction.

In Fig. 1 a recording sheet 1 passes over a drum 2 carrying a recording helix 3 and under linear electrode 4. Drum 2 is rotated at a suitable speed by any well known means, not shown, causing a recording area, formed by the intersection of the linear electrode and the helical electrode, to travel successively across the recording sheet. The recording sheet is moved progressively in the direction of the arrow by suitable means such as rollers 14 and 15. As has been described above, the recording sheet is treated with electrically sensitive materials and linear electrode 4 contains a suitable lake-forming metal.

Recording currents are supplied from any suitable source such as facsimile receiver 5 connected to antenna 9 and ground 8. Recording currents are applied between helix 3 and linear electrode 4 by means of leads 6 and 7.

At the recording point the recording currents cause minute amounts of lake-forming metal to be dissolved from linear electrode 4 which dissolved metal eventually units with lake-forming material on the recording sheet to form a mark consisting of a color lake. While it might seem desirable to form the colored mark simultaneously with the passage of the recording current and at the marking point, as has been already stated, there are a number of factors which may prevent such formation. The most important factors are time and current. Sufficient current to complete the reaction may burn the recording sheet or be expensive to furnish. To allow sufficient reaction time would limit the recording speed. It has been found to be useful to dissolve the metal by means of the recording current and to subsequently complete the chemical reaction to form the colored mark by means of a suitable degree of heating. The recording sheet carrying the dissolved metal is, hence, passed over a suitable heater 10—11 located beyond the recording point. This heater may be supplied with electric current from plug 13 and may be regulated by a thermostat 12 as described in more detail in the patent application referred to above.

Fig. 2 shows an enlarged representation of a square recording area passing over a theoretical recording point P. The reaction time at point P will be

$$T=\frac{W}{S}$$

where W is the width of the recording area in its direction of travel and S is the speed of travel of the recording area across the recording sheet. It will be seen that increasing the speed of recording reduces the available reaction time under the recording electrodes as does decreasing width W in the case of recording at higher detail.

In Fig. 3, curve A shows a typical recording

curve of density vs. recording current utilizing a stainless steel linear electrode upon a recording sheet carrying an electrolyte containing catechol. Curve B shows the improvement in density and tone scale obtained by heating the record of curve A according to the above description. Curve B shows a greatly expanded tone scale and a considerably higher maximum density attained.

While but one form of the invention has been shown and described herein, it will be readily apparent to those skilled in the art that modifications may be made without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. The process of recording with a lake-forming metal electrode chosen from the group consisting of iron, vanadium and cerium upon a record support carrying an acidified electrolyte and a polyhydroxyphenolic lake-forming compound which includes the steps of passing modulated electric currents through said support and said electrode to provide a record at least partially consisting of a color-lake formed of metal from said electrode in combination with said polyhydroxyphenolic compound, then heating said support to dry it, and of further heating said support to a temperature in the range of 250 to 450 degrees Fahrenheit to deepen the color of said record.

2. The process of electrolytic recording on a sheet impregnated with catechol and an acidified electrolyte by means of an electrode containing a metal of the group consisting of iron, vanadium and cerium, comprising the steps of: passing a modulated current from the electrode through the sheet to form a substantially latent heat-sensitive image on the sheet;heating said sheet to dry it; and of further heating said sheet to a temperature in the range of from 250 to 450 degrees Fahrenheit to the sheet to bring out the image.

3. In an electrolytic recorder the combination of a recording electrode containing a metal of the group consisting of iron, vanadium and cerium and a second electrode for recording upon a recording surface carrying an electrolyte and a polyhydroxyphenolic compound, means for passing recording currents through said recording surface to provide a record consisting at least in part of a color-lake, a heater for drying said record, and a heating control for maintaining the temperature of said record in the range of 250 to 450 degrees Fahrenheit for a predetermined period to deepen the color of said record.

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