April 18, 1944. W. N. ENGLER ET AL 2,346,670

METHODS OF AND MEANS FOR RECORDING SIGNALS ELECTRICALLY

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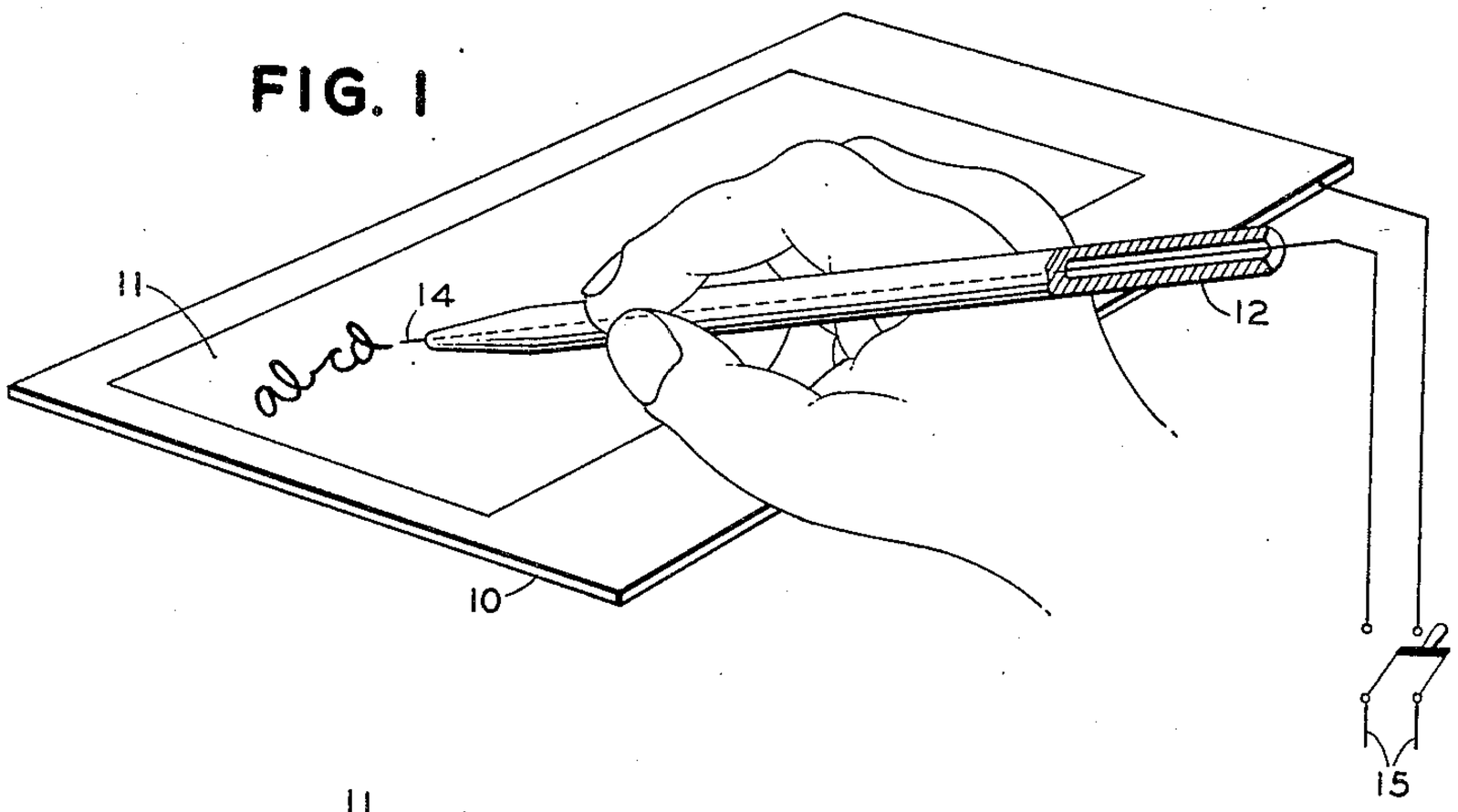
FIG. 1



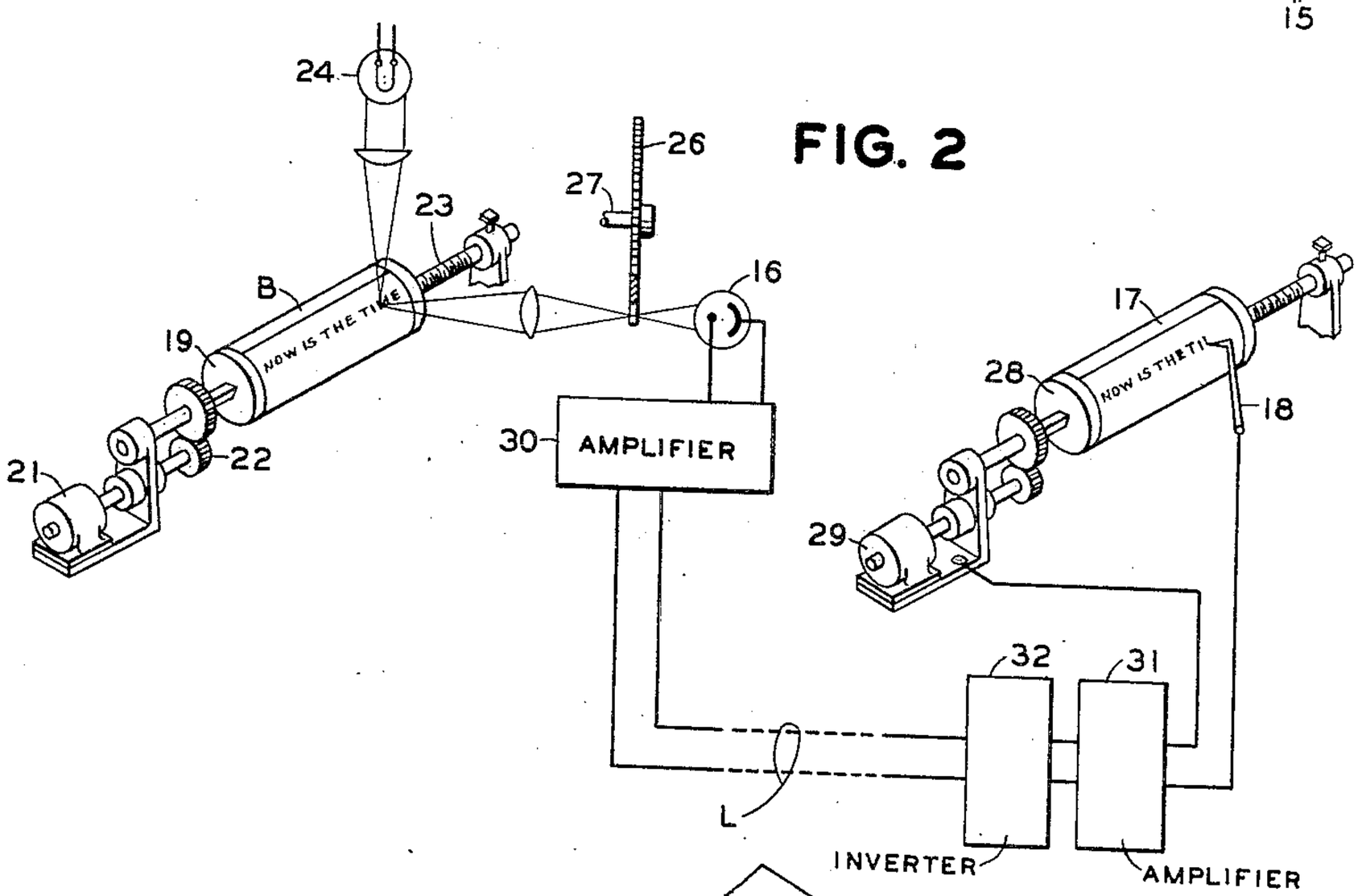


FIG. 2

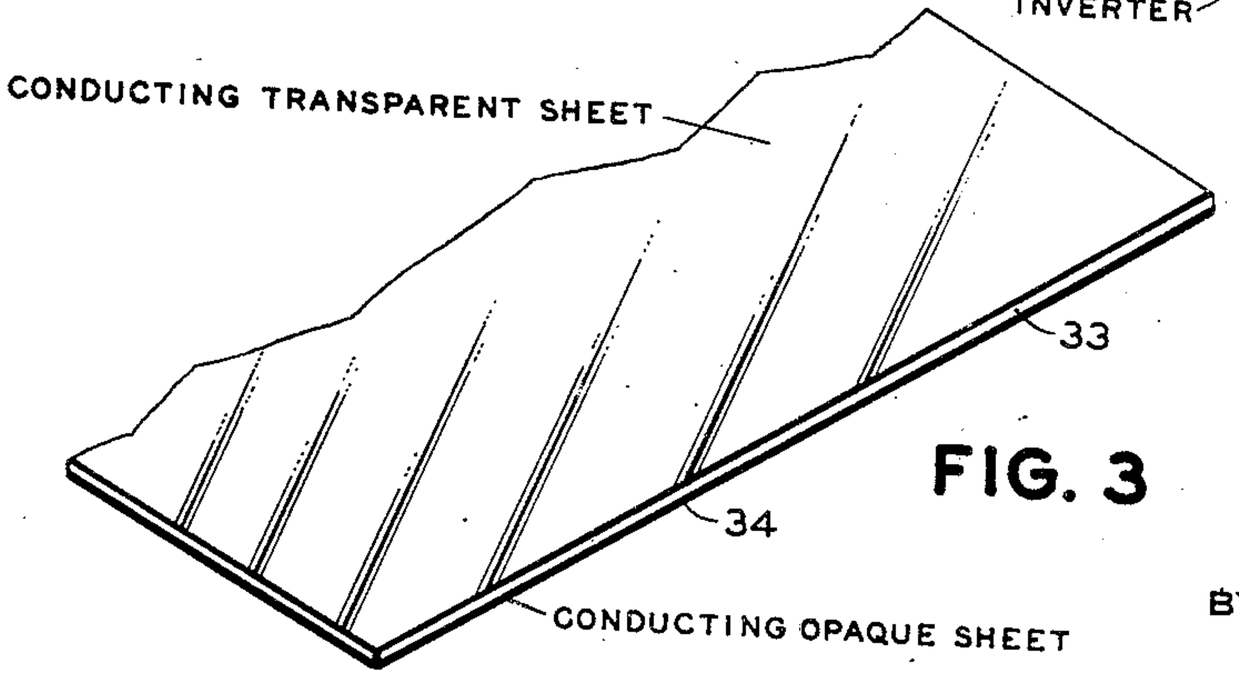


FIG. 3

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METHOD OF AND MEANS FOR RECORDING SIGNALS ELECTRICALLY

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6 Claims. (Cl. 204—2)

The present invention relates to electrical recording and more particularly to a novel method of and means for obtaining permanent visible marks or records on a record sheet.

In accordance with the present invention a sheet of transparent or translucent material, which is electrically conductive by reason of contained moisture or added conducting materials, is marked in a distinctive manner by an electrical current passing therethrough in minute localized areas. Thin sheets of plastic material, plasticised by relatively small quantities of a hygroscopic material, can be marked permanently by the electrical marking method of this invention. For certain purposes a record strongly contrasting with the background, may not be needed. Examples of such purposes are the production of advertising novelties, transparencies for the projection of silhouettes or pictures and records which may be reproduced on photo-sensitive material by passage of light through them. For producing these records of low contrast in accordance with the invention, it is only necessary to use a transparent or translucent material which contains moisture and if desired added material to enhance the conductivity. Plasticised highly calendered paper and sheets of plastic material containing a plasticizer will provide records of sharp definition but low contrast suitable for the purposes suggested.

Accordingly, an important object of the present invention is to produce permanent sharply defined records of a distinctive character by a novel method of electrical recording.

Another object of the invention is to produce permanent records of transparent and translucent sheets by altering the physical structure of a sheet without changing its composition.

A further object of the invention is to improve the conductivity of a transparent or translucent sheet of material and in the case of plasticised highly calendered papers, to increase the crispness of the texture thereof.

Still another object of the invention is to produce a novel blank for electrical recording in which high contrast is obtained between the marked and unmarked portions thereof.

A still further object of the invention is to provide, in a transparent or translucent record blank in which recording is effected by rendering the marked portions thereof opaque, an increased contrast between said marked and the unmarked portions of the blank.

Further and more specific objects will appear in the following complete disclosure of the invention in its several aspects. Referring to the drawing:

Fig. 1 is a perspective view of a simplified marking means illustrating one way of carrying out the method of this invention;

Fig. 2 illustrates diagrammatically a facsimile system embodying transmitting and recording means, the latter being of a simple type in which a blank may receive a permanent record in accordance with the present invention; and

Fig. 3 is a perspective view of a receiving blank capable of providing a high contrast record in accordance with the present invention.

Reference will now be had to Fig. 1 of the drawing to aid in explaining the method of obtaining records in accordance with the invention. Fig. 1 illustrates a simple arrangement for passing electrical current through progressive localized areas of a recording blank to produce line records and comprises an electrically conducting block 10 on which is placed a sheet of transparent or translucent conductive material 11 in intimate electrical contact therewith. A pencil 12 having an electrode or stylus 14 of conductive material, preferably metal, that may be placed at any point on the sheet 11 or moved thereover, is connected to one terminal of a source of electrical energy 15, the other terminal of which is connected to the platen 10. The energy source 15 may be a battery, rectifier or other means for supplying direct current, or it may be an A. C. service connection. The sheet 11, as explained above, is preferably composed of a material which is transparent or translucent, or is made so by calendering, and which contains a hygroscopic plasticizer. Materials and plasticizers will be described more in detail hereinafter. Because the preferred plasticizing materials are hygroscopic, the sheet 11 will contain some moisture making it sufficiently conductive to permit current to pass through the sheet between the base 10 and the conducting point 14 of the stylus. When this occurs the sheet 11 is rendered opaque in a minute area substantially coextensive with the area of the stylus 14. If the stylus is moved while current is passing through the sheet 11, a line will be drawn substantially equal in width to the diameter of the stylus. The opaque mark produced by passage of current through the sheet 11 is white in appearance and may be caused by destruction of the homogeneity of the body of the sheet between the stylus 14 and the base 10 by including voids therein concurrent with a sharply confined local swelling of the sheet. The sheet is not scorched

or burned to produce the mark in accordance with the invention and there is no color change in any of the components composing the body of the sheet. This is evident upon inspection of sheets having various kinds of recorded subject matter thereon obtained by the present invention.

In the facsimile system illustrated in Fig. 2, which may be of a conventional type, the photoelectric cell 16 scans the surface of the sheet B bearing the subject matter to be recorded on the record sheet 17 by the electrode or stylus 18. The sheet B is mounted on a drum 19 rotated at a suitable speed by a driving motor 21 which is connected to the drum by a coupling device 22. Axial movement of the drum 19 is produced by a suitable means 23 so that the entire field of the sheet B is scanned. A concentrated spot of light from a source 24 is projected onto the sheet B and as the cylinder 19 rotates and moves axially, the beam of light reflected to the photo cell 16 will describe a helical path over the surface of the transmitting sheet B. The light which is reflected from the surface of the sheet B into the photo cell 16 is interrupted in the usual way to provide an alternating current output from the photo cell, by a shutter or light chopper 26 mounted on a power driven shaft 27.

The receiving device shown at the right hand side of Fig. 2 is provided with cylinder 28 rotated in synchronism with the cylinder 19 by the motor 29. The record sheet 17 is carried by the cylinder 28 so as to be exposed to the action of the stylus 18 which in effect traverses the blank with a helical movement, covering all parts of the blank by a series of parallel lines. Suitable amplifiers 30 and 31, employed in the transmitter and receiver, are interconnected by a communication channel L. Numeral 32 indicates a signal inverter which may be of the type disclosed and claimed in the copending application of F. L. O'Brien, Ser. No. 293,165, filed Sept. 2, 1939, now Patent No. 2,266,988 issued December 23, 1941. Because of the presence of the inverter 32, the stylus 18 will record a positive copy on the blank 17.

To record pictures or messages in accordance with the invention, the recording blank 17 on the cylinder 28 of the recorder of Fig. 2 is similar to the blank 11 mentioned above and as previously stated is a sheet of transparent or translucent electrically conductive material. The transparent or translucent material may be composed of paper pulp of any kind, reconstituted cellulose, plain or colored with a dye, or a sheet of a water swelling colloid such as gelatin, or any other well known colloids such as gums or starch. Plasticizers which may be used in a sheet composed of any of the materials named above are glycerine, the glycols or certain other high boiling esters, sugars and specialty soaps. The conductivity of the sheet may be enhanced by adding an electrolyte such as ammonium nitrate, salts which exhibit solubility in ethyl alcohol such, for example, as salts of sodium, potassium and ammonium, preferably their iodides, sulpho-cyanides, bromides, chlorides, nitrates and sulphates. Certain organic compounds also may be employed such as nitrobenzene sulphonic acid. The most suitable salts for use as electrolytes are those which are soluble in the plasticizer used. If a translucent rather than transparent sheet is desired, fillers or pigments may be added such as clays, chalk, barium sulphate, white paint pigments with or without dyes to produce colors, or colored pigments of the type used in paints. The degree of transparency of the sheet may in general be regulated not only by the addition of such materials but also by the pressure under which the sheet is calendered and this is especially true of sheets fabricated from paper pulp or reconstructed cellulose. For a sheet of high transparency the calendering is carried out under heavy pressure, whereas for the less transparent or translucent sheets a lower degree of calendering is used.

If a record is desired in two tones or shades of a given color a dark colored dye may be added to the material from which the transparent sheet is formed. This dye will show up intensely in electrified areas without, however, having been changed in any way by passage of current to produce a mark.

An ordinary sheet of reconstituted cellulose, calendered to be transparent or translucent, and plasticized with glycerine, is sufficiently hygroscopic to be electrically conductive. Such sheets are approximately .001 to .002 inch in thickness. Excellent records were obtained with a potential of from 250 to 400 volts between the stylus 18 and the cylinder 28, the resultant marking current being approximately 2 to 20 milliamperes. Voltage, current, atmospheric humidity and speed of recording are factors which may vary within wide limits in practicing the invention. Successful recording may be accomplished at speeds in the neighborhood of 18 linear inches per second.

When paper pulp is used, the resulting transparent or translucent product, commonly called glassine paper, is manufactured by supercalendering the paper fibers plasticized with any of the plasticizing materials previously named. The conductivity of plasticized glassine paper, which exists by reason of contained moisture, is enhanced by the addition thereto of one or more of the electrolytes named above in solution in the plasticizer. The conductivity of glassine paper treated with an electrolyte is, however, inherently higher than that of ordinary paper similarly treated since supercalendering eliminates voids thus permitting the paper to pass electrical impulses uniformly and in a straight path through it. Sufficient conductivity of glassine paper can be obtained by impregnation thereof with from 5% to 20% of the weight of the paper of a solution of an electrolyte in the plasticizer as contrasted with 100% impregnation for ordinary paper. Excellent conductivity has been obtained with a glassine paper impregnated in the percentage limits by weight specified, with a 50% solution of ammonium nitrate in glycerine. A glycol, such as triethylene glycol, instead of glycerine also gives good results.

The stiffness or crispness of a highly calendered paper sheet may be increased, without substantially changing its conductivity, by the addition of solid aliphatic and aromatic alcohols, both monohydric or polyhydric, or solid aldehyde or ketone materials to the glycerine or glycol solution of any of the above mentioned electrolytes. In glassine paper, a stiffening agent is particularly desirable for ease of handling and mannitol, which has good solvent properties for electrolytes, serves this purpose even when used in small amounts. Mannitol, also known as mannite, is a hexahydric alcohol obtainable in white powder form. For example, if paper is impregnated with

a mixture of 40% glycerine, 40% mannitol and 20% ammonium nitrate, the stiffness of the sheet is materially improved over that of a sheet impregnated similarly with glycerine and ammonium nitrate alone.

The conductive highly calendered paper, including a solid stiffening material, just described may be used as the conducting base of a recording blank of the kind disclosed in the copending application of R. J. Wise, Ser. No. 253,153, filed January 27, 1939, now Patent No. 2,294,146, issued August 25, 1942. Briefly, that application discloses a conducting sheet coated with a material which is removed upon passage of current through the blank to expose the conducting base or which is otherwise marked upon passage of current therethrough. By incorporating particles of an opaque material in the conductive highly calendered sheet described above as part of the present invention and coating said sheet as disclosed in the Wise application above referred to, markings may be obtained by particle transfer in combination with the other effects set out in the Wise application.

The conductive highly calendered sheet of this invention may also be used as the conducting base of a blank of the kind disclosed in the copending application of B. L. Kline, Ser. No. 30,555, filed July 9, 1935, now Patent No. 2,229,091, issued January 21, 1941, or the blank disclosed in the copending application of R. J. Wise et al., Ser. No. 23,928, filed May 28, 1935, now Patent No. 2,294,147, issued August 25, 1942.

The marks produced on a sheet of moisture containing transparent or translucent material are more readily seen if the recorded sheet is backed with a dark colored material. The white marks stand out sharply and clearly against the dark background of the colored material on which the recorded sheet is superimposed.

Recordings may be obtained by placing a sheet of conducting paper of contrasting color, such as is disclosed in the copending application of Kline et al., Ser. No. 286,804, filed July 27, 1939, or the black carbon bearing conducting paper disclosed in the copending application of R. J. Wise, referred to above, Ser. No. 253,153, Patent No. 2,294,146, between the platen 10 of Fig. 1 or the cylinder 28 of Fig. 2 and the record sheet. The backing sheet is preferably secured to the record sheet, for example, by a narrow bond of adhesive material adjacent one or more edges of the superimposed sheets.

Records obtained by practicing this invention may be reproduced photographically on a photosensitive surface by optically printing through the transparent record sheet. If positive pictures are desired, the exposure may be first made on a photographic film or plate and a positive print of the resulting negative made in the usual manner.

Fig. 3 of the drawing discloses a composite sheet providing a record of good contrast which comprises a sheet 33 similar in all respects to sheet 11 of Fig. 1, but which has an adherent coating 34 thereon. This coating is opaque and is substantially unaffected by the passage of current through it and through the sheet 11 during recording to produce the mark characteristic of a record obtained in practicing this invention. Any material in general which is opaque and is electrically conductive is suitable for use in coating the sheet 33. One conducting material which gives excellent results in practice is an ink containing colloidal graphite. The coating may also be formed of colloidal carbon or graphite carried in a suitable vehicle such as a colloid. Gelatin or glue may be used as well as other known colloids. The coating after application is preferably toughened with formaldehyde. The coating serves the purpose of the separate sheet of conducting material mentioned above by making the record clearly visible by contrast.

From the foregoing disclosure of the invention in several aspects thereof, it will be seen that a method of recording is provided which produces results distinctive from the results obtained by prior art methods of recording. The nature of the invention will be determined from the foregoing and the scope thereof is defined in the appended claims.

We claim:

1. The method of recording marks which combine to represent a picture or other subject matter upon the surface of a homogeneous electrically conducting recording blank, comprising passing an electric signaling current of such magnitude through said blank in successive minute areas composing the total recorded area as to induce voids in said minute areas concomitantly with a sharply defined local swelling of the blank and thereby alter the homogeneity of the body of the blank in said minute areas to produce substantially opaque marks therein while maintaining its chemical composition substantially unchanged in said areas.

2. The method of recording marks which combine to represent a picture or other subject matter upon the surface of a sheet of reconstituted cellulose plasticized by a hydroscopic plasticizer, comprising passing an electric signaling current of such magnitude through said sheet in successive minute areas composing the total recorded area as to induce voids in said minute areas concomitantly with a sharply defined local swelling of the sheet and thereby alter the homogeneity of the body of said sheet in said minute areas to produce substantially opaque marks therein while maintaining its chemical composition substantially unchanged in said areas.

3. The method of preparing a recording sheet and recording marks thereon by passage of electric current through the sheet, comprising first, introducing a hygroscopic component into the material from which the sheet is to be formed and rendering it light transmitting by calendering under heavy pressure, and, after said sheet is so formed, passing an electric signaling current of such magnitude through said sheet in successive minute areas composing the total recorded area as to induce voids in said minute areas concomitantly with a sharply defined local swelling of the sheet and thereby alter the homogeneity and hence the light transmitting properties of the sheet to produce substantially opaque marks within the recorded area while maintaining its chemical composition substantially unchanged in said minute areas.

4. The method of forming an electrical recording blank and recording marks thereon comprising the steps of adding a plasticizer and an electrolyte soluble in said plasticizer to the material from which said blank is to be formed, forming a sheet from said material, calendering said sheet to eliminate voids, thereby giving it a compact homogeneous structure having the property of transmitting light, and thereafter passing an electric current of such magnitude through said sheet in successive minute areas

composing the total recorded area as to induce voids in said minute areas concomitantly with a sharply defined local swelling of the sheet and thereby alter the homogeneity and hence the light transmitting properties of said sheet within the recorded area while maintaining its chemical composition substantially unchanged in said minute areas.

5. An electrical recording blank comprising a light transmitting sheet formed of a material having a hygroscopic component, and a coating of electrically conducting material on one side thereof, said coating having the property of transmitting less light than said sheet, said sheet and said coating being electrically conductive, said sheet having the characteristic that the homogeneity of the composition of said sheet is altered by the formation of minute voids therein concomitantly with a sharply defined swelling of the sheet upon passage of an electric signaling current of such magnitude therethrough as to produce a mark visible by contrast against the background provided by said coating.

6. An electrosensitive recording blank comprising an electrically conducting light transmitting sheet composed of highly calendered fibrous material containing a solution of ammonium nitrate in glycerine, and in addition thereto, containing a quantity of a solid polyhydric alcohol to impart crispness to said sheet.

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